CITY OF DALLAS

INTERIOR LEVEE DRAINAGE STUDY

WEST LEVEE – PHASE II

VOLUME 1 of 2 – REPORT

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1. PROJECT BACKGROUND

Historically, mankind has settled near a source of fresh water – often alongside rivers. Floods would inevitably occur, and citizens would be forced to seek a means to prevent future flood damages to existing development and to allow future development to take place. Levees were often constructed to protect the community from riverine flooding. However, the levees block runoff from the interior (protected) side of the levee from reaching the river. Unless measures are taken to deal with the problem of interior drainage, the flooding on the protected side of the levee due to interior drainage may be as bad as or worse than the original riverine flooding.

Interior drainage is usually handled by allowing the stormwater runoff to pond in low areas (sumps) on the interior side of the levee. Then the water is pumped over the levee into the river, or allowed to gravity flow into the river through sluice gates in the levee. This strategy has been utilized by the City of Dallas to manage interior drainage along the Trinity River for approximately 75 years.

1.1 HISTORY OF DALLAS INTERIOR DRAINAGE

The City of Dallas was founded in the 1840's on the Trinity River, just downstream of the confluence of the West Fork and Elm Fork of the Trinity River. The Trinity River was vital to the early development of the City. However, numerous large floods, including the catastrophic flood of 1908, led the citizens of Dallas to seek protection from Trinity River floodwaters. A plan was developed to build levees along a 13-mile corridor through the City. The confluence of the Elm Fork and West Fork was relocated, and the Trinity River was channelized, creating the Dallas Floodway. Interior drainage was accommodated by a system of sumps and a number of gravity sluices, four pumping plants (two on each bank of the Floodway) and three pressure sewers. Generally, the sumps consisted of the old channels of the Elm Fork, West Fork, and Main Stem of the Trinity River, as well as borrow ditches created during levee construction. The pressure sewers are large gravity conduits that discharge directly into the Floodway. The inlets of the pressure sewers are located far enough upstream in the watershed to develop sufficient head to discharge against flood stages in the Floodway. The construction of the Dallas Floodway levees and associated interior drainage features was completed in 1932.

The condition of the levees had begun to deteriorate by the late 1940's, with numerous slides, cracks, and seepage failures occurring. During the period 1953-1960, the US Army Corps of Engineers (USACE) Fort Worth District reconstructed and improved the Dallas Floodway levees and pilot channel. Interior drainage was improved during the project by building three new pressure sewers, adding an additional pump station at one of the existing pumping plants, and adding two new pumping plants (one on each side of the Dallas Floodway). Interior drainage has been further enhanced since the levees were reconstructed by the construction of new pump stations at two of the pumping plants, a new pressure sewer along the alignment of Woodall Rodgers Freeway, and continuous operational improvements throughout the system.

1.2 DALLAS FLOODWAY WEST LEVEE INTERIOR DRAINAGE SYSTEM

The objective of this project was to identify and recommend upgrades to the Dallas Floodway West Levee interior drainage system so that the maximum predicted elevations in the sumps for the 100-year, 24-hour storm event do not exceed the established City of Dallas design elevations. The West Levee protects parts of West

Dallas and Oak Cliff from riverine flooding. This section presents a brief history and description of the West Levee interior drainage system.

1.2.1 West Levee Interior Drainage Development

The original West Levee interior drainage features were installed in the early 1930's during the construction of the Dallas Floodway and consisted of two pumping plants and one pressure sewer. Pumping Plant C (later known as Charlie) was built at the West Levee at the Jefferson Street Viaduct and included two 30,000 gpm pumps. Pumping Plant D (later known as Delta) was built just downstream of the Hampton Road crossing of the Dallas Floodway and included two 30,000 gpm pumps. Sump storage for the pump stations consisted of the old West Fork and Main Stem of the Trinity River channels. The original Coombs Creek Pressure Sewer (later known as Old Coombs Creek pressure Sewer) was constructed upstream of the Houston Street Bridge, and conveyed drainage from the Coombs Creek watershed into the Floodway. In the 1950's a second pressure sewer (later known as Coombs Creek Pressure Sewer) was constructed parallel to Old Coombs Creek Pressure Sewer to provide additional drainage capacity for the Coombs Creek watershed.

When the Dallas Floodway levees were reconstructed in the 1950's, several new interior drainage features were added to the West Levee system. A new pumping plant, Pavaho, was constructed on the West Levee along Canada Drive between the Hampton Road and Sylvan Avenue bridges and consisted of two 30,000 gpm pumps. The Lake Cliff Pressure Sewer was constructed with an outfall just upstream (north) of the Charlie Pump Station to provide drainage for the Lake Cliff watershed. Two 6'x8' gravity sluices are also located at the Lake Cliff Pressure Sewer outfall to provide gravity drainage for the Charlie Sump.

In 1963, the City of Dallas upgraded two pumps (40,000 gpm each) at the Charlie Pump Station and two pumps (42,000 gpm each) at the Delta Pump Station.

In 1979, the City added new sump pumps (6,000 gpm capacity) to all three of the West levee pump stations. These small sump pumps were added to handle the frequent small drawdowns in the sump to limit the use of the large pumps to reduce operation and maintenance costs.

In 2003, the City replaced one of the original 30,000 gpm pumps at Pavaho Pump Station with a 46,000 gpm submersible pump.

In addition to increasing the discharge capacity of the pumping plants, the City of Dallas has made a number of significant improvements to the West Levee interior drainage system over the years. The Dallas Floodway pilot channel was dredged from the downstream end of the Floodway to the Houston Street Viaduct. A SCADA system incorporating closed-circuit TV cameras has been installed to control and monitor the operation of the pumping plants. Data collection has been enhanced through the installation of the ALERT system, allowing real-time measurement of precipitation and stream and sump levels throughout the watershed.

One of the primary operational problems associated with the interior levee pumping plants is dealing with the debris load in the runoff. The pump station trash racks can quickly become clogged during pumping operations, diminishing the capacity of the pump station. Over the years, the City has dealt with this problem in a number of ways, from manually scraping the bar screens with long-handled rakes to the installation of specially-designed cranes to scrape the bar screens. More recently, the City has installed automated trash racks that periodically scrape the bar screens and lift the debris to a staging area at the top of the screen, where it can be scooped away with loading equipment. These automated trash racks are installed at all three of the West Levee pump stations.

1.2.2 Description of West Levee Interior Drainage Features

This section identifies and briefly describes the major features of the West Levee interior drainage system and provides the framework for further discussion of the system in subsequent sections of the report. An overview of the major West Levee drainage features is shown in Exhibit 1.

1.2.2.1 Charlie Pumping Plant and Sump

Charlie Pumping Plant is located at the West Levee at the Jefferson Street Viaduct and is known as Charlie (CX). Charlie consists of a main pump station and a low flow pumping facility. Photo 1.1 shows the existing Charlie Pumping Plant and surrounding features.

Photo 1.1 - Charlie Pumping Plant

The pumping capacities and operational procedures of Charlie Pumping Plant pump are summarized in Table 1.1.

Table 1.1 - Charlie Pumping Plant Properties

Charlie Pump Station (CX) Pump floor elevation = 403.0 ft NAVD88			
Pump No.	**Capacity (gpm)**	**Turn-On Elevation (ft NAVD88)**	**Shut-Off Elevation (ft NAVD88)**
1	**40,000**	**388.0**	**385.0**
2	**40,000**	**388.5**	**387.5**
Sump Pump	**6,000**	**387.0**	**382.0**

Photos 1.2 and 1.3 show the interior of the Main Charlie Pump Station and Low Flow Charlie Pump Station, respectively.

Photo 1.2 – Main Charlie Pump Station Interior

Photo 1.3 – Low Flow Charlie Pump Station Interior

The Charlie Sump area is generally located along the West Levee from the Jefferson Street Viaduct to the IH-30 Bridge. Two gravity sluice structures are located in the northern part of the sump, the Old Coombs Creek Pressure Sewer and the Lake Cliff Pressure Sewer gravity sluice. These structures are described in more detail in subsequent sections of this report.

The Corinth Street Sump also drains into the Charlie Sump. The Corinth Street Sump is located along the West Levee, just upstream of the Corinth Street bridge. The Corinth Street Sump is connected to the Charlie Sump by an underground RCP pipeline, running approximately parallel to the West Levee, and varying in diameter from 54-inch to 72-inch. A detailed view of Charlie and Corinth Street Sumps is shown in Exhibit 2.

URS/Forrest and Cotton, Inc. Consulting Engineers completed an interior drainage study of the various West Levee interior drainage areas in September 1973. The primary recommendation from the study was the addition of a 6,000 gpm sump pump to reduce the number of start-up operations for the larger pumps for low flows. This pump was added to Charlie Pump Station in 1979.

The existing City of Dallas 100-year design sump elevation for Charlie Sump is 404.1 ft, from a memo entitled "100 YR. W.S. Elevations for Sump Areas Used by City of Dallas" provided by the City of Dallas Public Works and Transportation Department. A summary table of existing and proposed design elevations for all West Levee sumps is found in Chapter 4.

1.2.2.2 Pavaho Pumping Plant and Sump

Pavaho Pumping Plant is located on the West Levee along Canada Drive between the Hampton Road and Sylvan Avenue Bridges and is known as Pavaho (PX). Pavaho consists of a main pump station and a low flow pumping facility. Photos 1.4 and 1.5 show the existing Pavaho Pumping Plant and surrounding features.

Photo 1.4 - Pavaho Pumping Plant

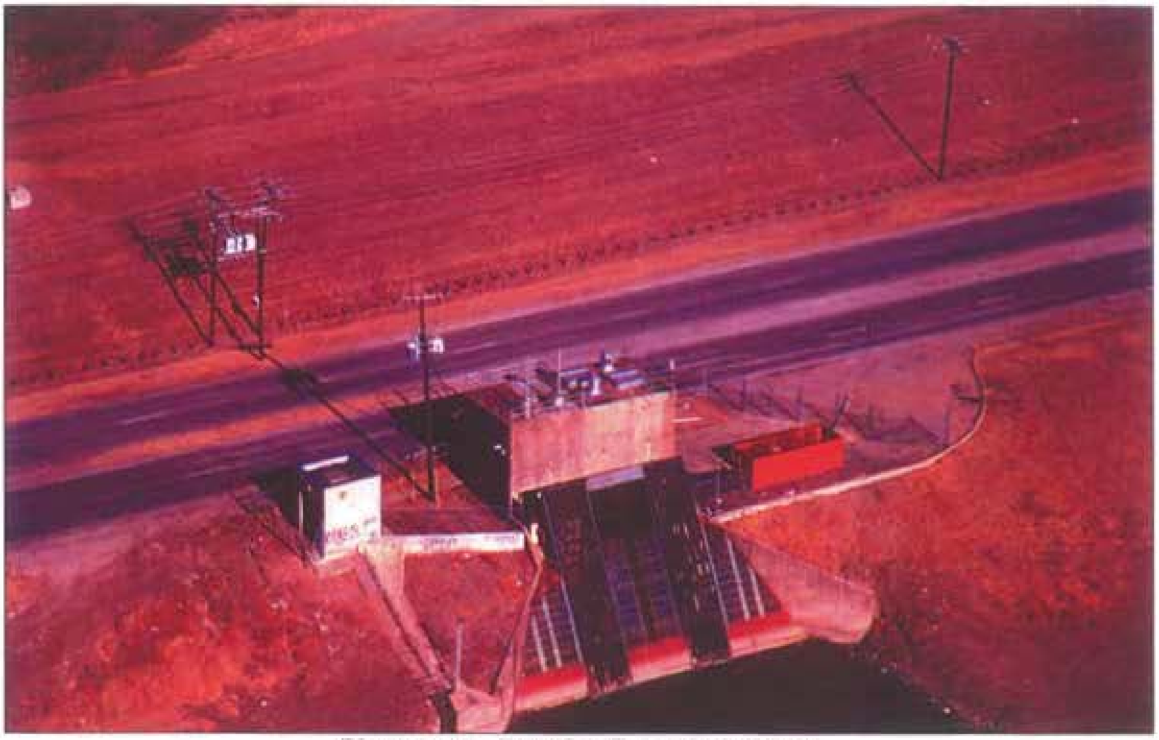


Photo 1.5 - Pavaho Pumping Plant

The pumping capacities and operational procedures of the Pavaho Pumping Plant pumps are summarized in Table 1.2.

Table 1.2 – Pavaho Pumping Plant Properties

Pavaho Pump Station (PX) Pump floor elevation = 411.5 ft NAVD88			
Pump No.	**Capacity (gpm)**	**Turn-On Elevation (ft NAVD88)**	**Shut-Off Elevation (ft NAVD88)**
1	**30,000**	**388.5**	**387.5**
2	**46,000**	**393.0**	**392.0**
Sump Pump	**6,000**	**387.5**	**384.0**

Photos 1.6 and 1.7 show the interior of the Main Pavaho Pump Station and Pavaho Low Flow Pump Station, respectively.

Photo 1.6 – Main Pavaho Pump Station Interior

Photo 1.7 – Low Flow Pavaho Pump Station Interior

The Pavaho Sump area consists of 3 interconnected storage areas located generally parallel to the West Levee from the Hampton Road Bridge to east of the Sylvan Street Bridge, Flow in the Pavaho Sump is predominantly west to east towards the Pavaho Pump Station. Pond A is the westernmost pond and is connected to Pond B by a 10'x8' reinforced concrete box culvert at Canada Drive. Pond B is connected to Pond C by a 72" diameter reinforced concrete pipe underneath the Sylvan Avenue bridge. The Pavaho Pump station is located in Pond C.

It should be noted that the Pavaho Sump is connected to Westmoreland-Hampton Sump by a 10'x8' reinforced concrete box culvert located at the Hampton Street bridge. A detailed view of Pavaho Sump is shown in Exhibit 3.

URS/Forrest and Cotton, Inc. Consulting Engineers completed an interior drainage study of the Various Pumping Plant areas in September 1973. One of the recommendations of the study was the addition of a 6,000 gpm sump pump to reduce the number of start-up operations for the larger pumps for low flows. This pump was added to Pavaho Pump Station in 1979. Other recommendations of the 1973 study for the Pavaho area including replacing the box culvert in the sump channel at Canada Drive with a bridge, and enlarging the waterway opening under Hampton Road at the Westmoreland-Hampton Sump / Pavaho Sump connection. These improvements were not constructed.

The existing City of Dallas 100-year design sump elevation for Pavaho Sump is 408.7 ft, from a memo entitled "100 YR. W.S. Elevations for Sump Areas Used by City of Dallas" provided by the City of Dallas Public Works and Transportation Department. A summary table of existing and proposed design elevations for all West Levee sumps is found in Chapter 4.

1.2.2.3 Delta Pumping Plant and Sumps

Delta Pumping Plant is located on the West Levee just upstream of the Hampton Bridge and is known as Delta (DX). Delta Pumping Plant consists of a main pump station and a low flow pumping facility. Photos 1.8 and 1.9 show the existing Delta Pumping Plant and surrounding features.

Photo 1.8 – Delta Pumping Plant

Photo 1.9 - Delta Pumping Plant

The pumping capacities and operational procedures of Delta Pumping Plant pumps are summarized in Table 1.3.

Table 1.3 - Delta Pumping Plant Properties

Delta Pump Station (DX) Pump floor elevation = 412.11 ft NAVD88			
Pump No.	Capacity (gpm)	Turn-On Elevation (ft NAVD88)	Shut-Off Elevation (ft NAVD88)
1	42,000	395.0	394.0
2	42,000	396.0	395.0
Sump Pump	6,000	392.0	387.0

Photos 1.10 and 1.11 show the interior of the Main Delta Pump Station and Low Flow Delta Pump Station, respectively.

Photo 1.10 – Main Delta Pump Station Interior

Photo 1.11 - Low Flow Delta Pump Station Interior

The sump area for Delta Pumping Plant consists of a series of three interconnected storage areas, generally parallel to the West Levee, and predominantly flowing west to east towards the Delta Pump Station. The Trinity-Portland Sump is the westernmost sump area and flows into the central Frances Street Sump. The Frances Street Sump flows directly into the Westmoreland-Hampton Sump. The Delta Pump station is located in the Westmoreland-Hampton Sump. A detailed view of the sump areas drained by Delta Pumping Plant is shown in Exhibit 4.

URS/Forrest and Cotton, Inc. Consulting Engineers completed an interior drainage study of the Various Pumping Plant areas in September 1973. A recommendation from the study was the addition of a 6,000 gpm sump pump to reduce the number of start-up operations for the larger pumps for low flows. This pump was added to the Delta Pump Station in 1979. Other recommendations of the 1973 report included the enlargement of

Trinity-Portland sump, which was done, and the addition of 10'x10' gravity sluices, which were not constructed.

The existing City of Dallas 100-year design sump elevations for the Delta Sump area are summarized in Table 4 below.

Table 1.4 – Existing 100-Year Delta Sump Area Design Elevations

Sump Designation	Elevation
Trinity Portland	413.0
Frances Street	410.1
Westmoreland-Hampton	406.9

The source of the above existing design sump elevations is a memo entitled "100 YR. W.S. Elevations for Sump Areas Used by City of Dallas" provided by the City of Dallas Public Works and Transportation Department. A summary table of existing and proposed design elevations for all West Levee sumps is found in Chapter 4.

1.2.2.4 Lake Cliff Pressure Sewer

The Lake Cliff Pressure Sewer was constructed in the 1950's to provide drainage for the Lake Cliff watershed. The Lake Cliff Pressure Sewer is a 7-foot diameter pipe which runs from Lake Cliff with an outfall just upstream of the Charlie Pump Station. Two 6'x8' gravity sluices were also constructed adjacent to and on each side of the Lake Cliff Pressure Sewer outfall to provide additional gravity drainage for the Charlie Sump. The Lake Cliff Pressure Sewer Inlet is shown in Photo 12. The Lake Cliff Pressure Sewer Outfall and Gravity Sluices are shown in photos 13 and 14, respectively.

The Lake Cliff Pressure Sewer section transitions to a 6'x8' concrete box culvert prior to passing through the levee. The box culvert creates a barrier across Charlie Sump. To prevent the box from obstructing flow in the sump, a 3'x6' concrete box culvert was provided to convey flow under the pressure sewer.

Photo 1.12 - Lake Cliff Pressure Sewer Inlet

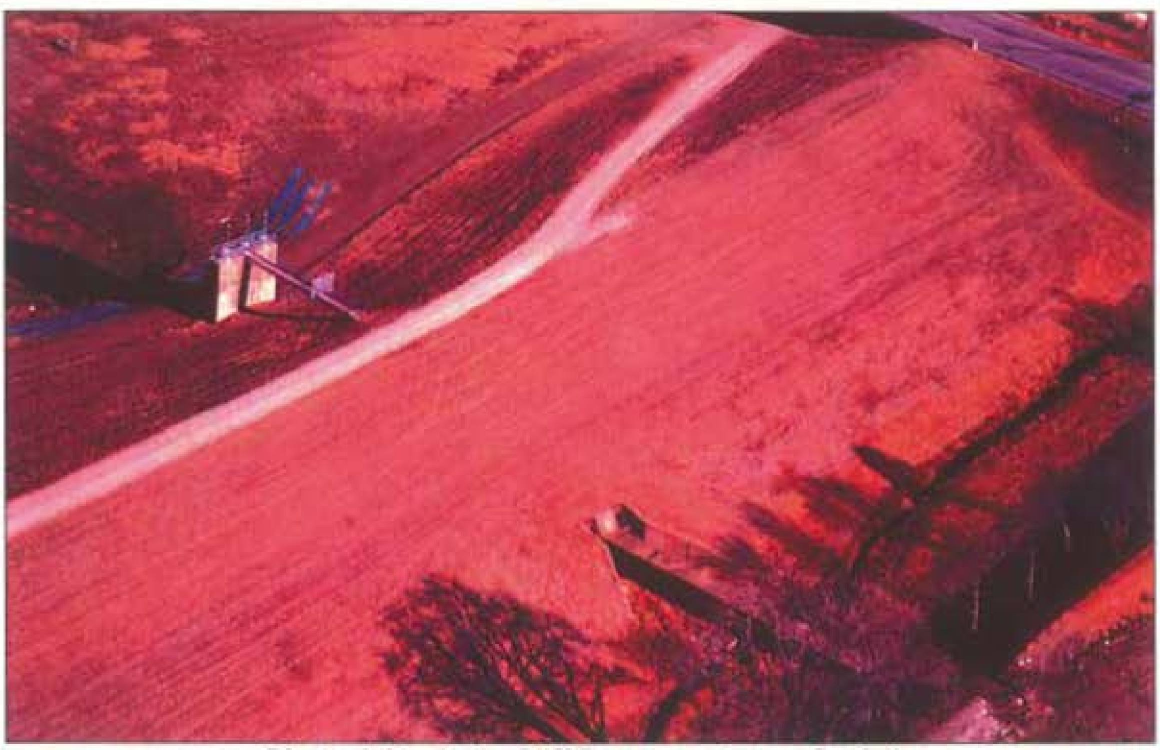


Photo 1.13 - Lake Cliff Pressure Sewer Outfall

Photo 1.14 – Gravity Sluices at Lake Cliff Pressure Sewer Outfall

1.2.2.5 Old Coombs Creek and Coombs Creek Pressure Sewer

The original Coombs Creek Pressure Sewer (later known as Old Coombs Creek Pressure Sewer) was constructed upstream of the Houston Street Bridge, and conveyed drainage from the Coombs Creek watershed into the Floodway. In the 1950's a second pressure sewer (later known as Coombs Creek Pressure Sewer) was constructed parallel to Old Coombs Creek Pressure Sewer. The lower Coombs Creek area was substantially re-worked when the Dallas-Fort Worth Turnpike (IH-30) was constructed. Prior to the construction of the DFW Turnpike, Coombs Creek flowed into a large detention reservoir, which was drained by the Old Coombs Creek Pressure Sewer. Currently, Coombs Creek flows directly into the inlet of the Coombs Creek Pressure Sewer. The Coombs Creek Pressure Sewer inlet and side-channel weir overflow structure are located just south of IH-30 and west of Beckley Avenue. The Coombs Creek Pressure Sewer is an 18.5-ft semi-elliptical conduit that discharges directly into the Dallas Floodway. Any Coombs Creek flows in excess of the pressure sewer capacity are stored upstream of the pressure sewer inlet until the crest of a side-channel weir is overtopped at elevation 427 ft. Flows over the weir spill into a small storage area at the upstream inlet of the Old Coombs Creek Pressure Sewer.

The Old Coombs Creek Pressure Sewer is a 6-ft diameter conduit that has two open inlets at a junction box in the borrow ditch near the base of the West Levee. The pressure sewer conduit creates a barrier across the sump. The junction box is open on either side to equalize the water levels across the pressure sewer conduit. Because the Old Coombs Pressure Sewer conduit is open to the atmosphere at the junction box, the conduit no longer functions as a true pressure sewer. Flow can also exit the junction box and discharge into Charlie Sump from upstream in the watershed. The Old Coombs Creek Pressure Sewer upstream inlet is on the north side of the Coombs Creek side channel weir structure. In case of flow over the side channel weir, the Old Coombs

Creek Pressure Sewer can convey overflow from Coombs Creek into Charlie Sump, where it can be gravity discharged or pumped. The Old Coombs Creek Pressure Sewer upstream inlet also accepts local runoff from IH-30 and conveys it to Charlie Sump.

The Old Coombs Creek Pressure Sewer junction box and outfall are shown in photos 15 and 16, respectively. The Coombs Creek Pressure Sewer inlet and outfall are shown in photos 17 and 18, respectively.

Photo 1.15 – Old Coombs Creek Pressure Junction Box

Photo 1.16 – Old Coombs Creek Pressure Sewer Outfall

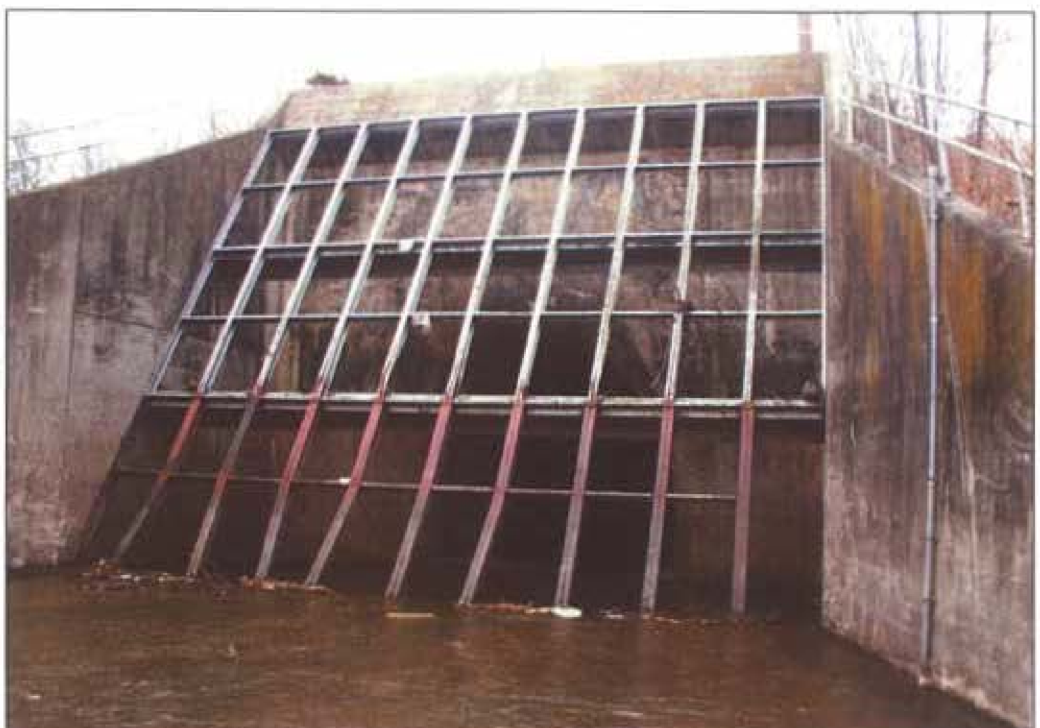


Photo 1.17 – Coombs Creek Pressure Sewer Inlet

Photo 1.18 – Coombs Creek Pressure Sewer Outfall

1.2.2.6 Eagle Ford Gravity Sluices

The Eagle Ford Sump is the westernmost sump area in the West Levee Drainage System. The Eagle Ford Sump is located generally in an area bounded on the west and north by the West Levee, on the South by I-30 and on the east by US Highway 12. Eagle Ford Sump consists of a series of storage areas connected by various culverts. A detailed view of the Eagle Ford Sump area is shown in Exhibit 5.

Eagle Ford Sump has an emergency overflow into Trinity-Portland Sump. The drop inlet emergency overflow structure is set very high, at elevation 417.5 ft. This elevation was set above the maximum predicted 100-year sump stage by recommendation of the 1973 West Levee Interior Drainage Study. There is a 24" gated opening at the base of the drop inlet. The gate is left open at all times, but the opening is blocked by silt and debris. Therefore, there is little or no exchange of flow between Eagle Ford Sump and Trinity-Portland sump.

The Eagle Ford Sump drains to the West Fork of the Trinity River through two 4'-6"x4'-6" gravity sluices located at the West Levee just upstream of Loop 12. The Eagle Ford Gravity Sluices inlet and outfall are shown in Photos 19 and 20, respectively.

Photo 1.19 – Eagle Ford Gravity Sluices Inlet

Photo 1.20 – Eagle Ford Gravity Sluices Outfall

2. PROJECT METHODOLOGY

This chapter describes the techniques used to model and analyze the West Levee interior drainage system.

2.1 CONCEPTUAL MODELING PLAN

It was necessary to develop a comprehensive hydrologic modeling strategy capable of simulating both the surface-water rainfall/runoff process and the dynamic sump water level fluctuations associated with stormwater inflow to the sumps and outflow from the pump stations, pressure sewers, and gravity sluices. The basic modeling concept was to compute stormwater runoff and sump water levels for selected storm events. For calibration simulations, measured rainfall data were used; for hypothetical storm event simulations, rainfall totals and distributions associated with specific storm probabilities were used. Existing conditions simulations were run to establish a baseline for comparison with proposed improvement scenarios. Then pump station and gravity sluice capacities, sump volumes, and other parameters were varied to evaluate the effects of proposed improvements. The computer models developed for this study provide the framework for analyzing existing conditions and recommending proposed improvements. It was essential to select modeling software flexible enough to accomplish these purposes.

2.1.1 Computer modeling software selection

In selecting computer hydrologic modeling software for this project, some of the selection criteria included:

- Capability to simulate rainfall/runoff and reservoir routing
- Ease of use
- Size of user base and acceptance by the engineering community
- Cost of the software and restrictiveness of the license agreement.

Some of the software packages considered were HEC-1 and HEC-HMS, both developed by the US Army Corps of Engineers Hydrologic Engineering Center (HEC), EPA-SWMM, developed by the US Environmental Protection Agency, and XP-SWMM, a retail software package published by XP Software. One of the primary constraints of the West Levee modeling effort is the requirement to perform dynamic interconnected reservoir routing. This capability is necessary to model the interconnected storage areas that make up most of the West Levee sumps. EPA-SWMM and XP-SWMM both have dynamic interconnected reservoir modeling capability, but neither HEC-1 nor HEC-HMS has this ability. For this reason, reservoir modeling in HEC-1 or HEC-HMS was eliminated from consideration. However, both HEC-1 and HEC-HMS have desirable hydrologic modeling features that are not included in EPA-SWMM or XP-SWMM. It was apparent that some combination of software would be optimum. Rainfall-runoff simulations would be done in HEC-1 or HEC-HMS, while reservoir routing would be done with EPA-SWMM or XP-SWMM.

HEC-HMS is part of the "next-generation" software suite developed by HEC, and is considered a functional replacement for the older HEC-1 software. Early releases of HEC-HMS had numerous software bugs, primarily related to the graphical user interface (GUI). For this reason, consideration was given to using HEC-1 for this project. For version 3 of HEC-HMS, which was released just prior to the start of this project, HEC developed a new Java-based GUI for HEC-HMS that improved the usability of the software. It was decided to choose HEC-HMS over HEC-1 to take advantage of the graphical interface of HEC-HMS and more importantly, to provide the capability for the models to be updated as future versions of HEC-HMS are released. No further software development will be done on HEC-1, so any models developed in HEC-1 will remain stagnant unless they are imported into HEC-HMS. Like all HEC software, HEC-HMS is in the public domain, so there is no cost to obtain the software.

Both EPA-SWMM version 5 and XP-SWMM have all the necessary modeling features to handle the interconnected reservoir routing simulations. Unlike XP-SWMM, EPA-SWMM is in the public domain. While XP-SWMM adds proprietary enhancements to the SWMM engine, these features were not necessary for this analysis. Therefore, EPA-SWMM version 5 was used for the reservoir routing for this project. Because XP-SWMM and other software packages can import standard EPA-SWMM input files, the selection of EPA-SWMM does not prevent the migration of the model to other software packages in the future.

Based on these criteria, the software packages selected for this project were HEC-HMS version 3.1.0 for rainfall-runoff modeling and EPA-SWMM version 5 for reservoir routing.

2.1.2 Model development

The first step in the hydrologic model development was to delineate the watershed draining to the West Levee sumps and to subdivide the watershed into subbasins of appropriate detail based on topography and the storm sewer network. Once the subbasin topology was established, a detailed analysis was developed to determine hydrologic parameters for the subbasins. Topographic data were used to establish elevation-volume and elevation-area curves for the sumps. Sump connecting culverts were surveyed to determine their size, length, and flowline elevations. Pump stage turn-on/shut-off elevations supplied by the City of Dallas Flood Control District were used to develop sump elevation-pump station capacity curves for the main stormwater pump stations. These were the building blocks of the hydrologic and reservoir routing models.

The most important results of the modeling process were the predicted stage hydrographs for the sumps. The maximum predicted water surface elevations in the sumps were used to prepare flood inundation maps and were compared against design sump levels and finished floor elevations to evaluate the effectiveness of proposed alternatives in reducing flooding compared to baseline conditions.

Careful consideration was given to the hydrologic computation methods to be used to model the rainfall-runoff process for this study. The primary components of a rainfall-runoff model are the loss method and the transform method. The loss method is used to compute excess precipitation and either directly or indirectly accounts for precipitation losses due to infiltration, interception, and evaporation. Alternatives considered for the loss method were the SCS (Soil Conservation Service, now known as the Natural Resources Conservation Service, or NRCS) curve number method and the initial+uniform loss rate method. The SCS curve number method was chosen because of its quantitative approach to assigning loss parameters based on land use and soil type. The primary parameter in the SCS method is the runoff curve number – the higher the curve number, the greater the runoff potential. Each subbasin is assigned a curve number based on its hydrologic characteristics. The assignment of curve numbers for the subbasins is covered in detail in Section 2.3.2.1.

Once the excess precipitation hyetograph is computed in the model, a transform method is used to compute direct runoff from the watershed. Usually, this transform method is an empirical unit hydrograph function; however, sometimes nonlinear physically-based techniques such as the kinematic wave method are used. For this project, several methods were considered for the transform function including the SCS dimensionless unit hydrograph, the kinematic wave method, and Snyder's synthetic unit hydrograph. Snyder's synthetic unit hydrograph was chosen due to the extensive research by the USACE Fort Worth District in the estimation of Snyder unit hydrograph parameters for the Dallas-Fort Worth area. This research was based on measured streamflow data in the region collected by the USGS and others during the 1960's-1970's. Many of the gaged basins were heavily developed and fully urbanized, making this method particularly applicable to the West Levee area. This research led to the development of the NUDALLAS program by the Fort Worth District in the 1980's. Consequently, Snyder's synthetic unit hydrograph is probably one of the most commonly applied hydrologic modeling transform methods in the Dallas-Fort Worth area over the last 30 years. Further discussion of the NUDALLAS implementation of Snyder's synthetic unit hydrograph is found in Section 2.3.2.2.

2.1.3 Basic assumptions

A number of basic assumptions were inherent in the development of the hydrologic and reservoir routing models. These assumptions are consistent with previous studies of the East and West Levee interior drainage basins.

1. All hydrologic parameters were derived based on existing land uses within the watershed, and proposed alternatives were evaluated based on existing conditions hydrology. This is a reasonable assumption for the near future given the high level of development and urbanization within the West Levee watershed.

2. It was assumed that the individual storage areas that make up the sumps behaved like true reservoirs; i.e., level-pool routing is applicable for the storage areas. Many of the West Levee sumps, either collectively or sometimes within individual sump areas, consist of multiple storage areas connected by culverts and weirs. Where appropriate, these individual storage areas were modeled as reservoirs connected to the upstream and/or downstream reservoirs by connecting culverts and weirs.

3. No hydraulic routing was performed for individual storm sewer outfalls or open channels conveying stormwater into the sumps. The effect of this assumption is that stormwater runoff peak attenuation and lag in the model may be less than in reality. Because much of the storm sewer network in the West Levee area predates modern design criteria and was designed for smaller storm events than those considered in this analysis (e.g., the 25-year event rather than the 100-year event), it is possible that some surface storage in the watershed created by localized ponding as a result of surcharged storm sewer systems was unaccounted for in the hydrologic model. This effect was considered in the selection of Snyder unit hydrograph parameters, as discussed in Section 2.3.2.2. A detailed hydraulic analysis of the entire storm sewer network contributing to the sumps was beyond the scope of this project and would be inappropriate for a project of this scale. It is believed that the lack of hydraulic routing results in a more conservative prediction of sump levels due to the absence of some lag and

attenuation in the hydrologic modeling. However, hydrologic channel routing was included in the rainfall-runoff model developed in HEC-HMS to route computed hydrographs through downstream subbasins to the collection point. Muskingum-Cunge hydrologic routing with 8-point channel cross sections was used.

4. Pressure sewers were accounted for in the model by computing the runoff hydrographs for the pressure sewer drainage basins in HEC-HMS and then simulating the pressure sewer hydraulics in XP-SWMM. XP-SWMM was selected for this application because it has more robust channel and conduit hydraulic simulation capabilities than EPA-SWMM. The pressure sewer hydraulic calculations showed that neither Coombs Creek nor Lake Cliff pressure sewer had any spillage or overflow to the sumps for the 100-year event. This was assumed to be the case for all calibration event simulations, since they were less than 100-year events.

5. The nominal rated capacities for the existing pumps at the main stormwater pumping plants were assumed to be accurate. No pump curves were available for most of the existing pumps; therefore, the most consistent approach was to model the pumps at their nominal rated capacities. Calibration simulations compared against measured data revealed that the use of the pumps at their nominal rated capacities yielded acceptable results. Therefore, the nominal rated capacities of the pumps were used in all hypothetical event simulations.

6. Steady-state tailwater conditions at interior drainage structure outfalls were assumed for the Main Stem and West Fork of the Trinity River. Further detailed discussion of design tailwater conditions is found in Section 2.3.4.

2.1.4 Calibration

Once the hydrologic model was assembled, the next step was to perform calibration simulations to test the validity of the modeling assumptions and to verify the model parameters. Observed precipitation, sump level, and pumping data were used in the calibration simulations. Since no observed flow data were available in the lower part of the drainage basin (near the sumps), it was necessary to calibrate against measured sump elevations. The only calibration parameters adjusted in this process were the runoff curve numbers. Further discussion of the calibration process is found in Section 3.1.

2.1.5 Hypothetical Scenario Simulations

The design criterion for most stormwater facilities in the City of Dallas is the 100-year (1% annual chance) event. Therefore, the 100-year event was the primary focus of the modeling effort for this project. Both 12-hour and 24-hour duration storms were modeled. The 24-hour storm duration resulted in higher peaks and thus was considered the design condition for this study.

The precipitation data used for the hypothetical storm scenarios came from tabulated data in the North Central Texas Council of Government (NCTCOG) iSWM (Integrated Storm Water Management) manual, September 2004 Review Draft (the latest version of the manual available at the start of this study). Precipitation data are published in the iSWM manual on a per-county basis for all the NCTCOG participating counties. The data for durations greater than 15 minutes were derived from a recent study of precipitation depth-duration frequency in Texas by the USGS. Five- and 10-minute rainfall totals were taken from the National Weather Service Hydro-35 publication. The Dallas County NCTCOG rainfall data were checked against hypothetical rainfall data from the US Weather Bureau TP-40 report and were found to agree closely. The NCTCOG precipitation data were used for this analysis because these data are more recent, are specific to the project area, and were presumably derived from a longer period of record than TP-40 (TP-40 was published in 1961). The 100-year and 500-year precipitation data used in this analysis is shown in Table 2.1.

Table 2.1 – Hypothetical Storm Precipitation Data

Duration	100-year Precipitation (in)	500-year Precipitation (in)
5 min	0.93	---
15 min	2.00	3.00
1 hr	3.86	4.86
2 hr	4.90	6.12
3 hr	5.55	6.99
6 hr	6.72	8.76
12 hr	8.04	11.04
24 hr	9.60	13.68

2.2 DATA SOURCES

For a project of this size and complexity, many different data sources were required. The goal of the data collection effort was to identify and acquire the best and most recent data available. This section lists the major data types used for this project and their sources.

2.2.1 City of Dallas Public Works and Transportation Department

Almost all of the data manipulation and mapping for the Interior Drainage Study was performed in GIS. The project sponsor, the City of Dallas Public Works and Transportation Department, was a major source of GIS data used in the project.

2.2.1.1 Topographic Data

Consistent topographic mapping was needed for the entire West Levee watershed. The City provided topographic data in the form of seamless digital contours. The contours were developed using an airborne Light Detection and Ranging (LiDAR) system flown in winter 2000-2001. The data collection was facilitated by NCTCOG. This was the most recent area-wide digital topographic data available at the start of this project. Table 2.2 summarizes the specifications of the contour data.

Table 2.2 – 2001 LiDAR Contour Data Specifications

Sensor Type	Airborne LiDAR
Altitude of Capture	8,000 ft above mean terrain
Capture Period	November 2000-January 2001
Control Sources	Ground survey, airborne GPS and inertial measurement
DEM Point Spacing	3-5 m (9.8-16.4 ft)
DEM Point Accuracy	15-20 cm (5.9-7.8 in) vertical on clearly defined ground features
Contour Interval	2 ft
Coordinate System	Texas State Plane, North Central Zone
Horizontal Datum	NAD 83
Vertical Datum	NGVD 88
Units	US Survey Feet
DEM Format	ASCII
Contour Format	ArcInfo

The City supplied the contour data in the form of tiled ArcInfo shapefiles. Each tile was 3,000 ft x 2,000 ft. To make the data easier to use, the individual tile shapefiles were merged into one seamless shapefile. This master contour shapefile was used for all subsequent topographic analysis and mapping.

2.2.1.2 Aerial Photography

The City provided high-resolution aerial photography of the West Levee watershed. The aerial photography was an invaluable tool for a variety of project tasks, including watershed and subbasin delineation and inundation mapping. Table 2.3 summarizes the specifications of the aerial photography.

Table 2.3 – 2001 Aerial Photography Data Specifications

Sensor Type	Aerial film camera with 6-in focal length
Altitude of Capture	4,500 ft above mean terrain
Focal Length	120 mm
Capture Period	January-March 2005
Control Sources	Ground and airborne GPS
Ground Resolution	6-inch pixel
Coordinate System	Texas State Plane, North Central Zone
Horizontal Datum	NAD 83
Units	US Survey Feet
Format	jpeg, TIFF or MrSID

The City provided the aerial photography in the form of tiled jpeg files. Each tile was 3,020 ft x 2,020 ft. To make the aerial photography data more convenient to use, the tiled files were merged into composite images of various resolutions. For example, the entire West Levee area was merged into a single image and downsampled to 3-ft pixel resolution for mapping of larger areas. The full resolution 6-inch pixel images were used to zoom into particular areas of interest.

2.2.1.3 Streets

The City provided an ArcGIS shapefile of City of Dallas street centerlines for the West Levee watershed. The shapefile was updated in September 2005. The horizontal accuracy of the street shapefile was undefined, but the street centerlines matched extremely well with the aerial photography.

2.2.1.4 Land Use

The City provided an ArcGIS shapefile and database of land uses in the West Levee watershed. The source of the data was the Dallas Central Appraisal District (DCAD) 2006 parcel layer. This polygon shapefile contains assigned property classes (land uses) for tax parcels in the City of Dallas. The property class designations were relatively detailed, so the classes were consolidated into more general categories suitable for hydrologic land use classification.

2.2.1.5 Storm Sewers

The City provided an ArcGIS shapefile of storm sewer lines in the City of Dallas. This shapefile is a representation of the system of pipes and concrete channels which make up the storm sewer network. The shapefile was developed from the storm sewer locator maps and estimation based on the locations of inlets, manholes, and outfalls. The database contains the material type and size of the pipes, as well as data such as the condition of the pipe at the time of the last inspection. The shapefile was updated in January 2006. While the dataset is not necessarily complete, it was useful for general visualization of the storm sewer system.

2.2.2 GIS Data From Other Sources

To supplement GIS data supplied by the City of Dallas Public Works and Transportation Department, a number of additional GIS data sources were used.

2.2.2.1 North Central Texas Council of Governments

NCTCOG maintains a regional clearinghouse of GIS data for the Dallas-Fort Worth area. As mentioned previously, the origin of some of the GIS data provided by the City was NCTCOG. Some additional datasets used for this project were obtained directly from NCTCOG.

2.2.2.1.1 1991 Topography and Planimetrics

The 1991 Topography and Planimetrics dataset consists of 2-ft contours and planimetrics derived from conventional aerial photography. The original source of this dataset was the USACE Fort Worth District, but it is available for purchase from NCTCOG. The dataset does not cover the entire West Levee watershed, but does include the lower part of the watershed and provides complete coverage of the sump areas.

The file format for the 1991 data is tiled Microstation drawing files. Although the plan information shows the correct coordinates, the drawing features are not georeferenced. Therefore, the drawing features were converted to AutoCAD format and a coordinate offset was applied to georeference them to the coordinate system used for the GIS analysis (State Plane feet, North Central Texas, NAD83). Because a simple coordinate transform rather than a proper map projection was used to relocate the drawing features, it is possible that some minor horizontal displacement error was introduced in this process. However, the size of the project area is small enough that errors were probably minimal, and a visual comparison of the relocated drawing features to aerial photography and the 2001 topographic data revealed excellent agreement. The converted and relocated AutoCAD files were then imported into ArcGIS.

Because the 1991 dataset did not cover the entire West Levee watershed, it was not suitable for watershed and subbasin delineation. However, careful consideration was given to deciding which of the two available topographic datasets to use for the sump elevation-volume curves. Visual comparison of the 2001 and 1991 topographic data showed that the two sets of contours were quite similar, despite the fact that the two datasets are referenced to different vertical datums. The 1991 dataset is referenced to NGVD29 whereas the 2001 dataset is referenced to NAVD88. Spot checks of the elevation differences for these two vertical datums at coordinates spread over the West Levee watershed area were made using the Corpscon program, and it was found that the maximum elevation difference in the area that could be attributed to the difference in vertical datums was less than 0.1 ft.

Because the 1991 dataset contains planimetric data, the contours are not seamless. This would have complicated the use of automated volumetric calculations to develop the sump elevation-volume curves, and would have required a significant amount of hand editing of the contours and drawing cleanup. Because the datum differences and visually observed differences between the two datasets were small enough to be insignificant, it was decided to use the 2001 topographic data exclusively for this project.

2.2.2.1.2 Other GIS Data

Other NCTCOG GIS datasets used for this project included road centerlines, railroads, city limits, and streams. All of these datasets were in the form of ArcInfo shapefiles, and were used only for mapping.

2.2.2.2 Natural Resources Conservation Service

The NRCS Soil Survey Geographic (SSURGO) database was the source of all soils data used for this project. The SSURGO database used was TX113, Dallas County, Version 2, dated December 29, 2004. The dataset consists of an ArcGIS shapefile (the soil survey map) and a database file that contains a large number of soil property tables. The soil survey map and the soil property tables were used to develop hydrologic parameters for the West Levee subbasins, as described in Section 2.3.2.

2.2.2.3 US Army Corps of Engineers, Fort Worth District

The Fort Worth District provided an HEC-FDA economic flood damage model of the Dallas Floodway. Accompanying this model was a GIS dataset that consisted of building footprints for structures in the lower part of the West Levee watershed (Trinity River corridor) along with a database containing pertinent economic and physical data for each structure. For example, the database contains data such as the structure's street address, market value, ground stage, and foundation height. The database classified structures into the following four categories based on their use, structural characteristics, and market value: residential structures, non-residential structures, unique structures, and tunnel (underground) structures. Unique structures are high market value non-residential structures.

For this project, the most important data in the database were the ground stage and foundation height for above-ground structures. According to the GIS metadata, the ground stages were determined by assigning elevations to the building footprint centroids using a TIN created from 2-ft contours. The contour dataset was unspecified, but the metadata indicated the source was the Fort Worth District. The foundation heights were estimated based on visual estimation of average slab heights in the field – residential structures were assigned a foundation height of 1.0 ft, and all other above-ground structures were assigned a foundation height of 1.6 ft.

The ground stage and foundation height were summed to compute an estimated finished floor elevation for each structure, except in the case of some unique structures, which had surveyed finished floor elevations in the database. The estimated finished floor elevations were then used to screen structures for finished floor elevation surveys.

2.2.3 City of Dallas Flood Control District

The City of Dallas Flood Control District provided scans of available plans for West Levee pump stations and miscellaneous structures such as pressure sewers and gravity sluices.

The Flood Control District also supplied calibration data for use in this project. Flood Control personnel provided time series rainfall data for precipitation gages in the City's ALERT system, time series sump elevations, and pump operation records (number of pumps operating at each station) for these events. The same calibration events used in Phase I of the Interior Levee Drainage Study (East Levee) were used for the West Levee study. Further discussion of calibration data and the calibration process is found in Section 3.1.

2.2.4 US Army Corps of Engineers, Fort Worth District

The Fort Worth District provided the latest (March 2007) Corridor Development Certificate (CDC) HEC-RAS model of the Upper Trinity River, including the Main Stem and Clear, West, and Elm Forks. This model was used to establish design tailwater conditions for West Levee interior drainage features.

For Phase I of the Interior Levee Drainage Study (East Levee), the Fort Worth District had previously provided an HEC-RAS model of the Main Stem of the Trinity River that included a preliminary version of the Trinity Parkway and Trinity Park features. However, the planned Trinity Parkway and the Trinity Park features have changed significantly since that model was developed, so it was unsuitable for this project. Jacobs Carter Burgess coordinated with the consulting firms working on the updated hydraulic model of the Trinity Parkway and Trinity Park features, but that model was not completed in time for use in this project. Further discussion of the hydraulic models and tailwater elevations is found in Section 2.3.4.

2.2.5 City of Dallas Public Works and Transportation Vault

Storm sewer system locator maps and plans for West Levee pressure sewers were obtained from the City of Dallas Public Works and Transportation Vault. The storm sewer locator maps and pressure sewer plans were used to refine the watershed and subbasin delineations, as described in Section 2.3.1. The pressure sewer plans were used to develop hydraulic analyses of the pressure sewers.

2.2.6 Field Surveys

Field surveys were performed to obtain sump cross sections and structure finished floor elevations. The sump cross sections are discussed in Section 2.3.3.

The GIS shapefiles and database from the USACE Fort Worth District economic model of the Dallas Floodway described in Section 2.2.2.3 were used in numerous GIS analyses to select structures located in inundation areas and having estimated finished floor elevations less than the sump elevation used to create the inundation map. From these analyses, proposed 100-year design sump elevations were selected for the West Levee sumps. GIS maps and databases were created of the structures potentially affected by flooding at the proposed design sump elevations. For this analysis, "potentially affected" means that the structure is touched by the inundation area, regardless of its estimated or surveyed finished floor elevation. From this analysis, approximately 160 structures were selected for finished floor elevation surveys. These structures were surveyed in the spring of 2008.

2.3 HYDROLOGIC ANALYSIS

2.3.1 Watershed/subbasin delineation

The entire watershed draining to the West Levee sumps was delineated by hand using the 2001 LiDAR 2-ft contour data and aerial photography provided by the City. The watershed delineation was refined based on the GIS shapefile of the storm sewer network, the storm sewer locator maps and pressure sewer plans, and field investigations.

Once the total watershed area had been established, the watershed was first subdivided into the areas draining to the individual sumps and to the pressure sewers. Useful resources for the subbasin delineation were the September 1973 report on the Interior Drainage Study West Levee Dallas Floodway Project by URS/Forrest and Cotton, and the June 1991 Master Drainage Study of West Dallas by Brockette-Davis-Drake.

Finally, the individual sump watersheds were subdivided into the final subbasin network based on topography and the layout of the storm sewer system. Logical starting points for the subbasin delineation included the subbasins drained by major creeks or storm sewer trunk lines. In many cases, these areas were then further subdivided as appropriate. At this level of detail, heavy emphasis was placed on the storm sewer layout for subbasin delineation guidance.

Exhibit 6 shows the subbasins developed for the West Levee watershed. Cross-hatched subbasins in Exhibit 6 are drained by pressure sewers. Table 2.4 summarizes the drainage areas for the West Levee sumps and pressure sewers.

Table 2.4 – West Levee Interior Drainage Feature Watersheds

Sump / Pressure Sewer	Drainage Area (square miles)
Eagle Ford Sump	3.16
Trinity-Portland Sump	4.81
Frances Street Sump	1.03
Westmoreland-Hampton Sump	1.63
Pavaho Sump	2.97
Charlie / Corinth Street Sumps	1.26
Coombs Creek Pressure Sewer	4.78
Lake Cliff Pressure Sewer	0.89
Kidd Springs	1.24
Total	21.77

After the subbasins were delineated, the longest flow path from the upstream divide to the subbasin outlet was determined. In most cases, the drainage flow path generally followed natural drainage patterns. In some other cases, the subbasins were heavily urbanized with only remnants or no trace at all of the natural drainage remaining. For these subbasins, the storm sewer locator maps were used to help define the flow paths.

2.3.2 Hydrologic Parameter Development

GIS data analysis was used to calculate the hydrologic parameters for the subbasins. The use of GIS allowed the calculation of some parameters to be automated to some extent. All parameter values calculated in GIS were checked for reasonableness before use in the model.

2.3.2.1 SCS Curve Numbers

The SCS runoff curve number for a watershed is primarily dependent upon land use, soil type, and antecedent moisture conditions. For this analysis, antecedent moisture condition (AMC) II (normal soil moisture conditions) was used. GIS spatial analysis was used to calculate the composite SCS curve numbers for the subbasins. The section provides a brief description of the process.

The land use GIS data provided by the City were used to establish the primary land uses in the West Levee watershed. The land uses considered in this analysis are listed in Table 2.5 and shown graphically on Exhibit 7.

The other major variable that affects the runoff curve number is the hydrologic soil type. The NRCS classifies soils into one of four groups depending on their runoff potential as follows:

- Group A: deep sand, deep loess, aggregated silts – lowest runoff potential
- Group B: shallow loess, sandy loam
- Group C: clay loams, shallow sandy loam, soils low in organic content, and soils usually high in clay
- Group D: soils that swell significantly when wet, heavy plastic clays, and certain saline soils – highest runoff potential

A matrix of reference SCS curve numbers relating each land use and each soil type was created using data from NRCS publication TR-55, *Urban Hydrology for Small Watersheds*. The reference curve number matrix is tabulated in Table 2.5.

Table 2.5 - Reference Curve Number Matrix

Land Use	SCS CN by Hydrologic Soil Type				Comment
	A	B	C	D	
Commercial	89	92	94	95	Commercial/business/industrial land use; average 85% impervious
Infrastructure	83	89	92	94	Railroads, utility easements, electrical substations, etc.; average 75% impervious
Institution	77	85	90	92	Includes schools, hospitals, churches, etc.; average 65% impervious
Multi-family Residential	83	89	92	94	Average 75% impervious
Protected Open Space	44	65	77	82	Open space, average of fair and good condition CNs
Park/ Recreation	39	61	74	80	Open space, good condition (grass cover > 75%)
Streets/Roads	95	96	97	98	Paved roads with curbs and storm drains - area includes ROW, average 95% impervious
Single-family Residential	61	75	83	87	1/4 acre lots, average 38% impervious
Vacant	68	79	86	89	Open space, poor condition (grass cover <50%)

The NRCS Soil Survey Geographic (SSURGO) dataset for Dallas County was the source of all soils data used in this analysis. The spatial component of the SSURGO dataset defines the geographic extent of soil map units. A map unit is defined as "a collection of areas defined and named in terms of their soil components or miscellaneous areas or both." Map units are typically depicted on NRCS soil survey maps by polygons, and each map unit is assigned a unique number or map symbol to differentiate it from surrounding map units.

The tabular database component of SSURGO contains many different soil properties both for the soil map units and the individual soil components which form the map units. In general, each soil component has an associated hydrologic soil type in the tabular database. Some soil components do not have a listed hydrologic soil type; for these components, the worst case for runoff potential was assumed and hydrologic soil type D was assigned.

Some soil map units are composed of more than one soil component, with each component potentially having a different hydrologic soil group. The SSURGO database lists the percent composition of each component in the map unit. In these cases, the predominant hydrologic soil type based on the percentages of the individual components was assigned to the entire map unit. These rules were used to assign a hydrologic soil type to each map unit. The SSURGO spatial dataset was modified to include these hydrologic soil types as part of its feature attribute table. The SSURGO spatial dataset is shown on Exhibit 8.

In ArcGIS, the subbasin shapefile, the land use shapefile with associated reference SCS curve numbers, and the soil map unit shapefile with associated hydrologic soil types were overlaid and merged. GIS spatial analysis was used to compute a composite curve number for each subbasin based on the area-weighted percentages of both individual land uses and individual soil map units within each subbasin. The computed curve numbers are listed in Table 2.6.

In HEC-HMS, the implementation of the SCS method requires the following parameters to be specified for each subbasin: the curve number, the initial abstraction, and the percent of impervious cover in the subbasin. No excess precipitation (runoff) occurs until the initial abstraction has been satisfied. The initial abstraction is a function of the curve number, and is computed by the following equation:

$$I_a = 0.2\left(\frac{1000}{CN} - 10\right)$$ **Equation 1**

where: I_a = initial abstraction in inches
CN = SCS curve number

In HEC-HMS, the percent impervious value is used only if the definition of the curve number for the subbasin does not account for impervious area. Since the curve number calculations for this analysis included impervious area, the percent impervious field in the HEC-HMS input was zero for all subbasins.

2.3.2.2 Snyder's synthetic unit hydrograph parameters

The two parameters required for the implementation of Snyder's synthetic unit hydrograph in HEC-HMS are the Snyder standard lag (t_p), or the difference in time between the centroid of the unit excess rainfall hyetograph and the unit hydrograph peak, and the Snyder peaking coefficient (C_p), a coefficient which is a regional watershed characteristic.

The Fort Worth District has collected a large volume of research on Snyder hydrograph parameters in the North Central Texas region. The basic formulation of Snyder's synthetic unit hydrograph as implemented in the Fort Worth District's NUDALLAS program was used for this analysis.

2.3.2.2.1 Snyder Lag time, t_p

The method used to determine t_p for a subbasin involves the use of urbanization curves developed for clay and sandy soils in the Dallas-Fort Worth area. The urbanization curves relate t_p to the function $\frac{L \times L_{ca}}{\sqrt{S_{st}}}$, where L is the distance in miles along the flow path from the upstream divide to the watershed outlet, L_{ca} is the distance in miles along the flow path from the centroid of the watershed to the watershed outlet, and S_{st} is the weighted slope of the flow path in feet per mile. Curves are developed for estimates of urbanization ranging from zero to 100 percent. For a given soil type, the curves plotted on a log-log scale take the form of a series of parallel lines for each urbanization level. For the Dallas-Fort Worth area, the two sets of urbanization curves used are the Blackland Prairie (clay soil) curves and the East-West Cross Timbers (sandy soil) curves.

The equation described by the urbanization curves is

$$t_p = I_p \left(\frac{L \times L_{ca}}{\sqrt{S_{st}}} \right)^{0.3833} \times 10^{-BW\left(\frac{\%URB}{100}\right)}$$ **Equation 2**

where: t_p = the lag time in hours from the centroid of unit excess rainfall to the peak of the unit hydrograph

L = the distance in miles along the flow path from the upstream divide to the watershed outlet

L_{ca} = the distance in miles along the flow path from the centroid of the watershed to the watershed outlet

S_{st} = the weighted slope of the flow path in ft/mi

$\%URB$ = percent value of the degree of urbanization of the watershed

BW = the bandwidth, or the log of the width between each 20% urbanization line on the plot

I_p = the calibration point, defined as t_p where $\frac{L \times L_{ca}}{\sqrt{S_{st}}} = 1$ and $\%URB=0$

For the Dallas-Fort Worth urbanization curves, BW is 0.266 and I_p is 0.94 for clay and 1.76 for sand. The percent urbanization for all subbasins in the West Levee watershed was taken to be 100%.

The equation for the weighted flow path slope is

$$S_{st} = \left(\frac{el_{85\%} - el_{10\%}}{0.75L} \right)$$ **Equation 3**

where: S_{st} = weighted slope of the flow path in ft/mi

$el_{85\%}$ = the elevation in feet at the point 85% of the flow path length (L) upstream from the outlet

$el_{10\%}$ = the elevation in feet at the point 10% of the flow path length (L) upstream from the outlet

L = the distance in miles along the flow path from the upstream divide to the watershed outlet

The weighted stream slopes were computed for each subbasin in the West Levee watershed using this equation. The 2001 LiDAR 2-ft contour data were used to establish the flow path elevation at the 10% and 85% points. For fully urbanized subbasins where most or all of the flow path consists of storm sewer conduits, the ground elevations at the 10% and 85% points were used – the presumption being that the average storm sewer pipe slope would be similar to the average ground slope along the flow path.

The equation for t_p yields values for soils that are purely sand or purely clay, depending on what value of I_p is used in the equation. However, most soils fall between these extremes. The approach for these cases is to compute a weighted average of the sand and clay values based on the relative percentages of the two soil types as follows:

$$t_{p,weighted} = t_{p,sand}(\%sand) + t_{p,clay}(\%clay)$$ **Equation 4**

The SSURGO database for Dallas County lists representative percentages of sand, silt, and clay for most soil components. In order to consolidate these percentages from three categories (sand-silt-clay) to two categories (sand-clay), the silt category was distributed between sand and clay by assuming that "silt" is 67% clay and 33% sand.

Some soil components in the SSURGO database do not have representative percentages of sand, silt, and clay listed. For these cases, the soil component was assumed to be 100% clay to be conservative.

Because some soil map units consist of more than one soil component, a weighted average sand-clay percentage was computed for the map unit based on the individual soil components that make up the map unit. Once the sand and clay percentages were calculated for every soil map unit, GIS spatial analysis was used to compute a weighted sand-clay percentage for each subbasin based on the map units that make up the subbasin. Then the weighted Snyder lag time (t_p) was computed for each subbasin using the above equations. The computed weighted Snyder lag times are listed in Table 2.6.

2.3.2.2.2 Snyder Peaking Coefficient, C_p

The Snyder peaking coefficient is usually taken to be a regional value. The general interpretation of this parameter is that it is related to the storage capacity of the watershed. In these terms, the higher the value of the peaking coefficient, the less storage in the watershed. The relationship between q_p, the peak discharge per unit of drainage area, t_p, and C_p is given by the following equation:

$$q_p = \frac{640C_p}{t_p}$$ **Equation 5**

where: q_p = peak discharge per unit of drainage area in cfs/mi^2
C_p = Snyder peaking coefficient
t_p = Snyder lag time in hours

Because $640C_p$ appears in the above equation, many hydrologists and engineers think in terms of the value of $640C_p$ rather than the value of C_p itself.

The generally accepted value for $640C_p$ in the Dallas-Fort Worth area has been 460, yielding a C_p value of 0.719. This value is a result of the research conducted by the Fort Worth District using stream gage data in the Dallas-Fort Worth area. Most of the watersheds used to develop this value were larger than 10 square miles. However, a research study by Steven Veal ("Unit Hydrograph Relationships for Small Urban Texas Watersheds") on smaller urban basins in the region (less than 10 square miles) indicated that a $640C_p$ value of 370 would be more appropriate for these smaller basins, resulting in a C_p value of 0.578. Veal theorized that the lower value of C_p for heavily urbanized areas might indicate that unintended storage was occurring in the watershed due to clogged or undersized bridges, culverts, or storm drainage systems. Because all of the subbasins developed for this analysis are significantly smaller than 10 square miles, a C_p value of 0.578 was used for this project.

Table 2.6 - West Levee Subbasin Hydrologic Parameters

Basin	Subbasin	Area (mi^2)	SCS CN	L (mi)	L_{ca} (mi)	S_{st} (ft/mi)	% sand	% clay	t_p (hr)	C_p
Eagle Ford Sump										
	EF1	1.242	89.32	2.04	0.93	35.18	19.66	80.34	0.39	0.578
	EF2	0.847	92.06	1.72	0.74	85.79	25.56	74.44	0.29	0.578
	EF3	1.068	86.72	1.82	0.88	87.55	33.01	66.99	0.33	0.578
Trinity-Portland Sump										
	TP1	2.019	84.71	2.18	1.22	19.50	13.55	86.45	0.47	0.578
	TP2	0.215	87.86	0.99	0.54	46.87	18.45	81.55	0.22	0.578
	TP3	0.354	88.51	1.01	0.44	39.82	15.94	84.06	0.21	0.578
	TP4	0.767	85.90	1.49	0.71	123.52	32.67	67.33	0.27	0.578
	TP5	1.459	85.89	1.78	1.06	99.49	25.92	74.08	0.33	0.578
Frances Street Sump										
	FS	1.032	86.16	2.14	0.97	69.93	18.54	81.46	0.35	0.578
West Moreland-Hampton Sump										
	WH	1.627	85.89	2.77	1.00	29.01	8.57	91.43	0.42	0.578
Pavaho Sump										
	P1-A	0.131	77.27	1.26	0.65	16.94	13.91	86.09	0.31	0.578
	P1-B	0.840	75.65	2.05	1.03	11.87	22.65	77.35	0.51	0.578
	P1-C	0.725	76.42	1.89	0.72	7.38	38.95	61.05	0.52	0.578
	P2	1.277	79.00	3.01	1.48	50.03	19.60	80.40	0.50	0.578
Charlie Sump and Corinth Strreet Sumps										
	CH	1.258	90.52	1.65	0.54	20.90	30.39	69.61	0.35	0.578
Coombs Creek										
	CC1	1.577	87.80	3.17	1.76	60.35	20.34	79.66	0.53	0.578
	CC2	1.533	88.65	2.04	0.76	83.60	18.57	81.43	0.30	0.578
	CC3	1.666	88.00	1.87	0.82	79.60	18.35	81.65	0.30	0.578
	KS	1.244	88.22	2.68	1.29	57.92	17.36	82.64	0.43	0.578
Lake Cliff										
	LC	0.891	90.64	2.06	0.81	60.90	16.43	83.57	0.32	0.578

2.3.3 Sump Elevation-Volume Curves

Because the most important model results for a given modeling scenario are the sump water surface elevation hydrographs, accurate sump elevation-volume and/or elevation-area curves were a critical component of the model. Therefore, the final elevation-volume curves were compared with the curves used for previous studies. Sump cross sections cut from the topographic data were compared with field surveyed cross sections as shown in Figures 2.1 – 2.7. The cross sections were spaced throughout the sumps to provide a complete overview of the differences in the data over the entire project area.

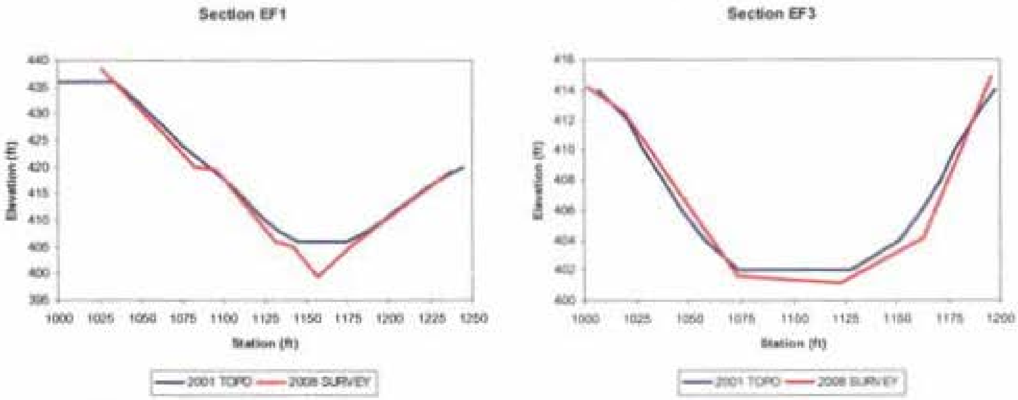


Figure 2.1 - Representative Eagle Ford Sump Cross Sections

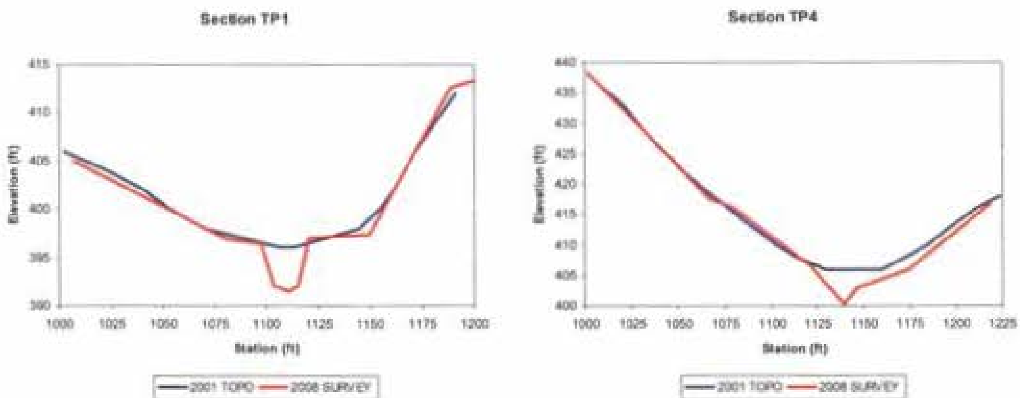


Figure 2.2 - Representative Trinity-Portland Sump Cross-Sections

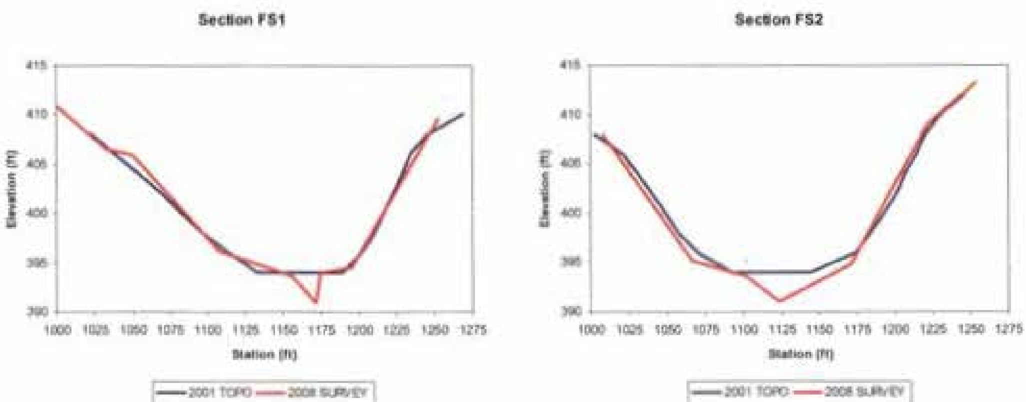


Figure 2.3 - Representative Frances Street Sump Cross Sections

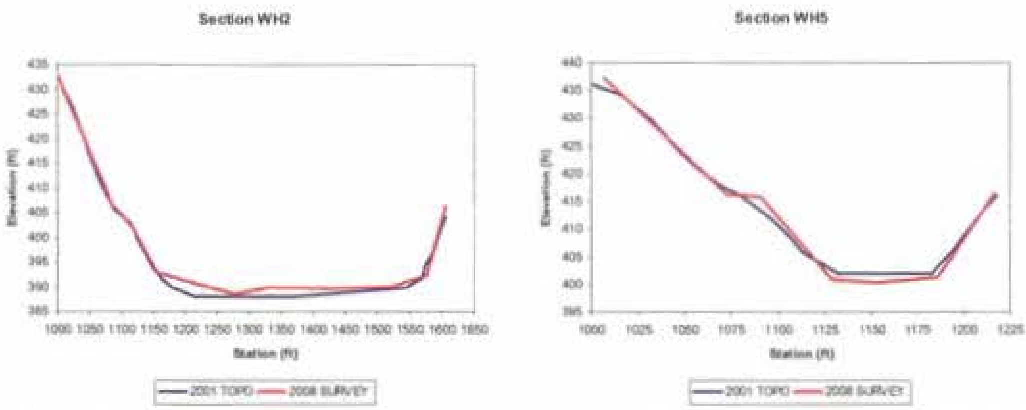


Figure 2.4 - Representative Westmoreland-Hampton Sump Cross-Sections

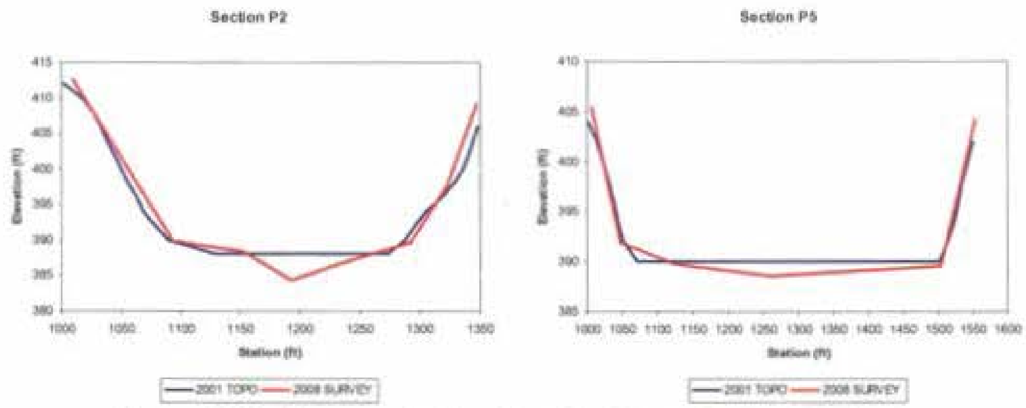


Figure 2.5 - Representative Pavaho Sump Cross-Sections

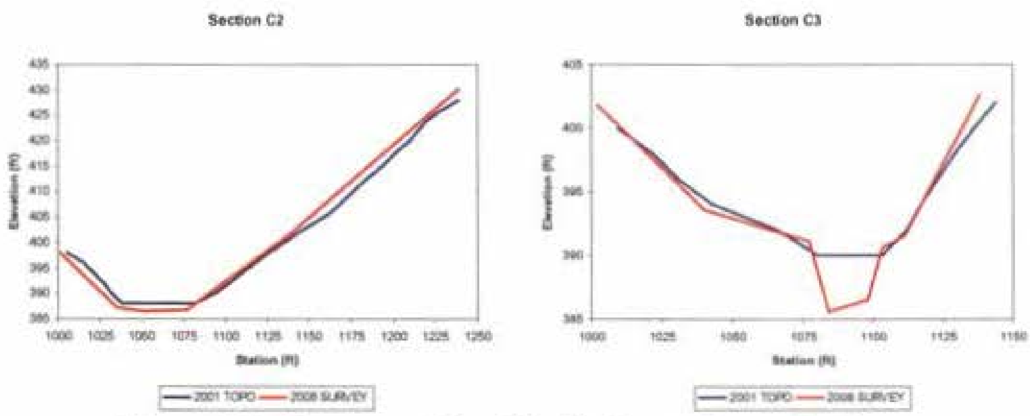


Figure 2.6 - Representative Charlie Sump Cross-Sections

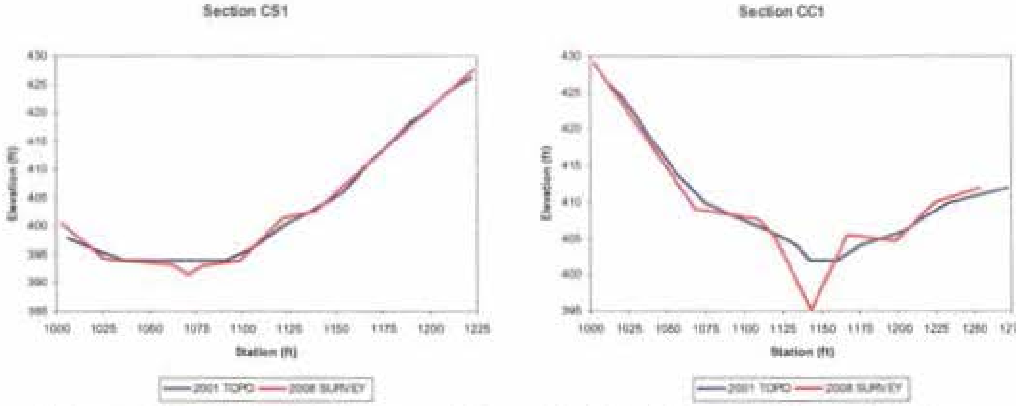


Figure 2.7 - Corinth Street and Coombs Creek Sump Cross-Sections

Figures 2.1-2.7 show that, in general, the 2001 topographic data fails to capture the lowest elevations in the sumps. This is probably due to the presence of water in the sumps during the time of the aerial surveys that were used to develop the topographic data. Neither conventional aerial photography nor LiDAR is capable of penetrating water. This is not a problem for the elevation-volume and elevation-area curves developed for the sump areas, because there is very little storage at these lowest elevations in the sumps, and there tends to be a small amount of water in the sumps during much of the year.

Sump elevation-volume curves were developed by isolating the sump areas in AutoCAD Land Development Desktop (LDD). For this process, minor contour edits were done to ensure that disconnected low areas outside the sumps were filled so as to prevent their storage from being added to the sump storage. Then, a TIN surface of the edited contours was created. LDD was used to compute cut/fill volumes at each contour elevation starting at the minimum elevation in each sump. The computed fill volume for each elevation was the sump storage volume at that elevation.

SWMM uses elevation-area curves for reservoirs rather than elevation-volume curves. The elevation-area curves were developed using the edited contours as described above, to prevent disconnected low areas outside the sumps from being counted as sump storage. The elevation-area curves were developed in AutoCAD.

Figures 2.8 – 2.14 compare the sump elevation-volume curves developed from the 2001 LiDAR 2-ft contours with elevation-volume curves from previous interior drainage reports. This comparison reveals generally good agreement between the new and old elevation-volume curves. The plots show sump elevation-volume curves from the 1973 URS/Forrest and Cotton report and the 1991 Brockette-Davis-Drake report. The 1991 report did not include the Pump Station "C" area, which includes Charlie and Corinth Street sump areas. The 1973 and 1991 data generally agree well with each other, with the notable exception of Trinity-Portland Sump.

The 1973 URS/Forrest and Cotton report shows elevation-volume curves for Eagle Ford and Trinity-Portland sumps both with and without overbank storage included. As shown in Figures 2.8 and 2.9, the new elevation-volume curves developed for this analysis agree closely with the 1973 curves with overbank storage included. For the new elevation-volume curves for all the West Levee sumps, the approach was to include overbank storage that is directly connected to the main sump channel; i.e., the area that would be inundated as the sump water surface elevation increases from its minimum value and overflows the sump banks. Disconnected low areas outside the sump bank were not counted as sump storage. For example, consider a hypothetical scenario in which the sump top of bank elevation is approximately 400 ft, and there is a low area outside the sump banks that extends down to elevation 396 ft. The low area does not become connected to the sump until the sump bank overtops at elevation 400 ft. The volume in the low area below 400 ft is not be counted as sump storage, but as the sump elevation increases above 400 ft, all the connected storage volume above 400 ft would be counted. In this scenario, the volume in the low area between elevation 396 ft and 400 ft is not counted as sump storage volume.

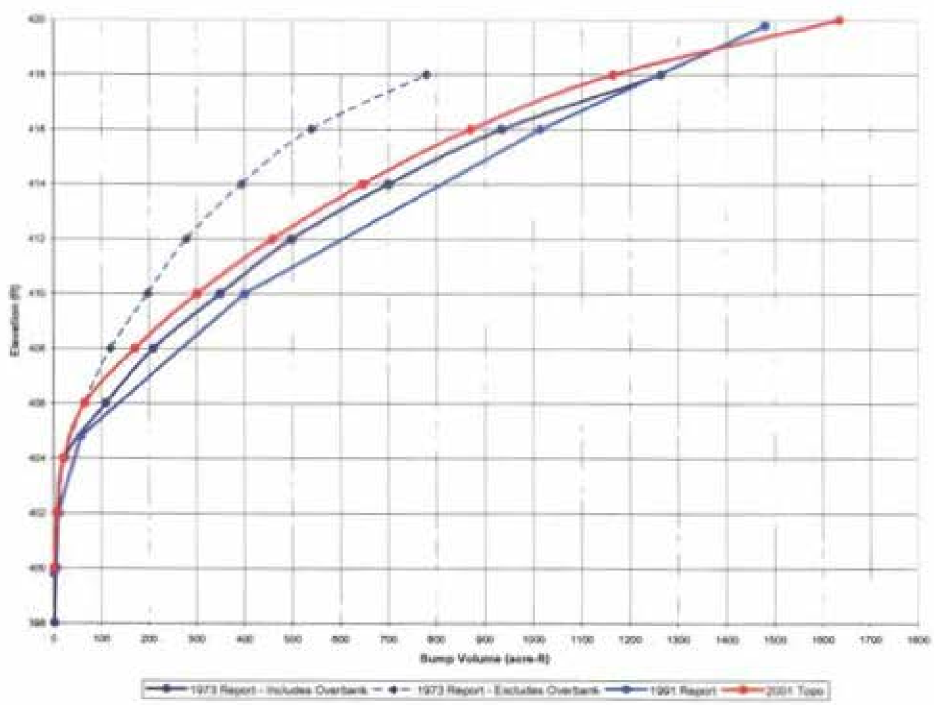


Figure 2.8 – Eagle Ford Elevation-Volume Curves

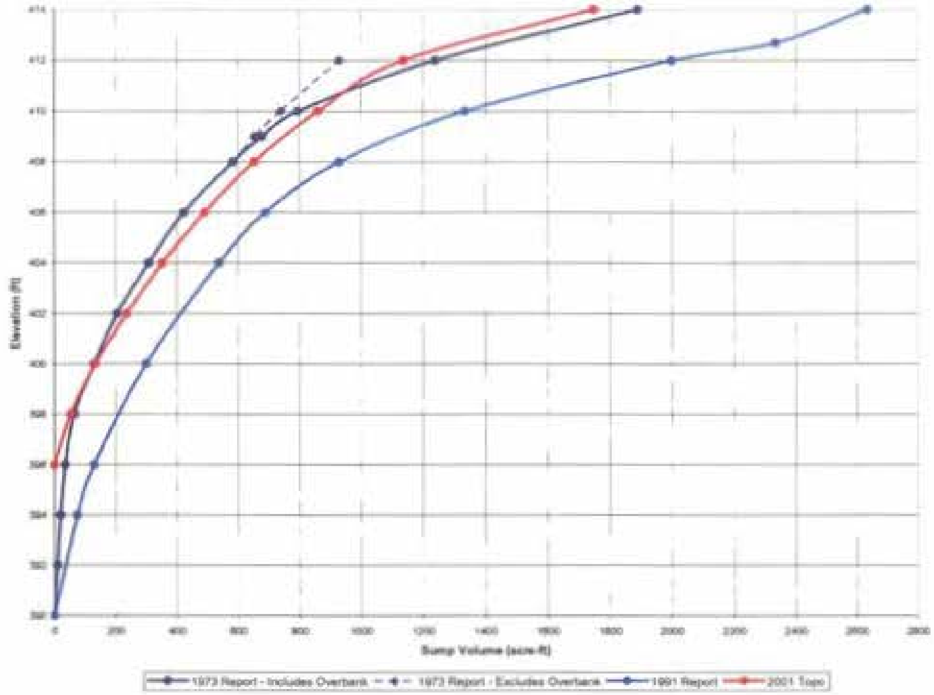


Figure 2.9 – Trinity-Portland Sump Elevation-Volume Curves

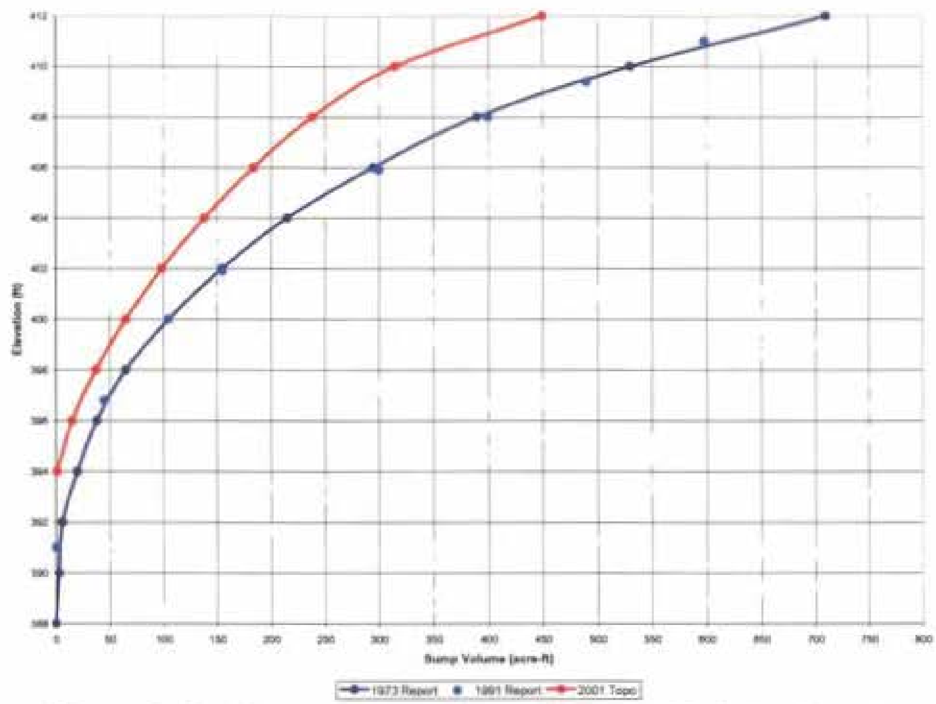


Figure 2.10 – Frances Street Sump Elevation-Volume Curves

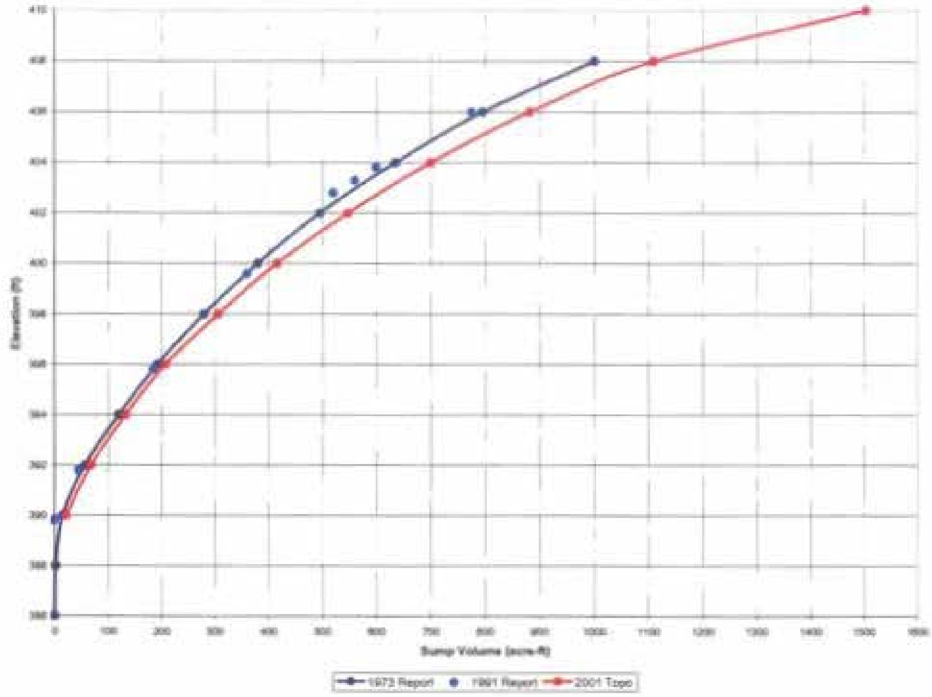


Figure 2.11 – Westmoreland-Hampton Sump Elevation-Volume Curves

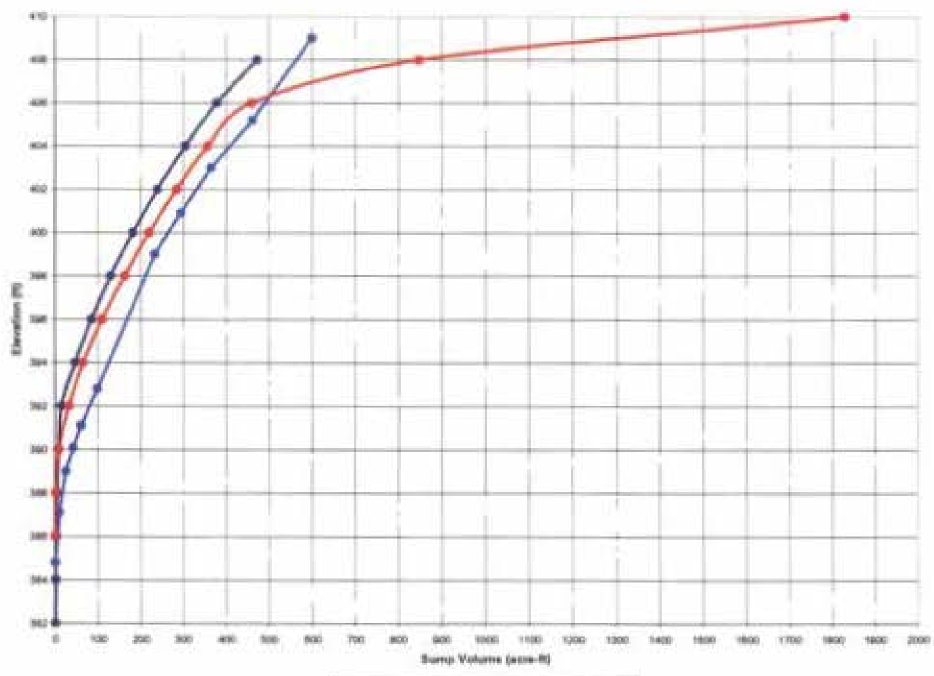


Figure 2.12 – Pavaho Sump Elevation-Volume Curves

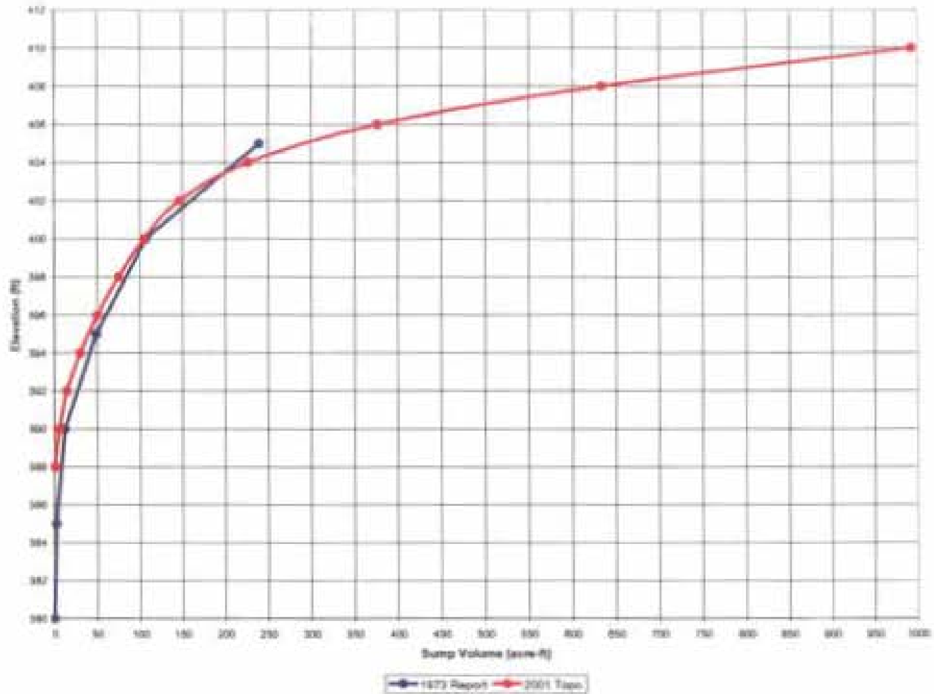


Figure 2.13 - Charlie Sump Elevation-Volume Curves

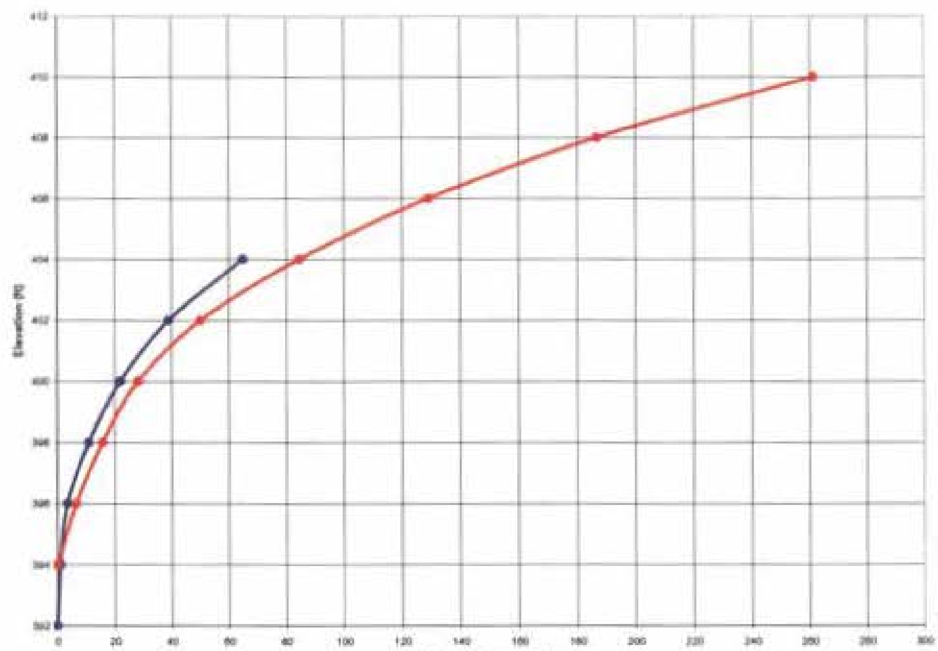


Figure 2.14 – Corinth Street Sump Elevation-Volume Curves

2.3.4 Dallas Floodway Tailwater Elevations

The West Levee pump stations, pressure sewers, and gravity sluices discharge into the Dallas Floodway. Thus, the Dallas Floodway water surface elevations at the interior drainage outfalls can have a significant effect on the capacities of the drainage structures. Of course, the water surface elevations in the Floodway are primarily determined by the flow rate in the river. Therefore, the design flow rate in the Dallas Floodway was an important consideration in this study.

This topic was discussed at length with the USACE Fort Worth District. The same issue confronted the Fort Worth District as part of the design of the Dallas Floodway Extension levees and interior drainage features for the Cadillac Heights Levee and Lamar Levee areas. For these designs, the District used a steady uniform flow in the Trinity Floodway of 20,000 cfs, slightly less than a 2-year event on the Dallas Floodway at the East Levee area.

In the Dallas Floodway Extension General Reevaluation Report, Appendix A, the USACE Fort Worth District describes the coincident peak analysis developed for the Dallas Floodway Extension study. The District prepared a statistical correlation between Trinity River flows and localized precipitation at Dallas for the period of May 1957 to September 1994. This period was used since most of the major flood control reservoirs that impact Trinity River flows at Dallas were in place by May 1957. A generally weak correlation was found between localized storms at Dallas and high mean flows on the Trinity River at Dallas. The explanation given for the lack of correlation is that substantial rainfall in the central and upper portions of the Clear, West and Elm Forks of the Trinity is required to produce high sustained flows at Dallas. The report notes that "runoff from the small localized interior basins watersheds at Dallas is often fully evacuated prior to the arrival [of] significant flows on the river itself."

Based on these findings, the Fort Worth District elected to use the prevailing steady-state release rate used in evacuating water from USACE reservoir flood control pools (15,000 cfs) plus an assumed 5,000 cfs from uncontrolled Trinity River inflows to yield a total design tailwater flow rate of 20,000 cfs for the Dallas Floodway Extension project. This discharge was used as the Dallas Floodway design tailwater discharge for the West Levee interior drainage study.

This approach defined the tailwater flow rate for interior drainage features which discharge into the Main Stem of the Trinity River, but one West Levee interior drainage structure (Eagle Ford gravity sluice) discharges into the West Fork of the Trinity River upstream of the confluence with the Elm Fork. Discussions were held with the Fort Worth District to determine the West Fork flow rate corresponding to the design 20,000 cfs flow rate in the Main Stem. At the heart of the issue is the distribution of the 20,000 cfs flow rate between the West Fork and Elm Fork. The Fort Worth District indicated that no specific consideration of the distribution of flow was done for the Dallas Floodway Extension study.

An indication of the flow distribution between the Elm Fork and West Fork can be inferred from the latest version (March 2007) of the Fort Worth District's Corridor Development Certificate (CDC) HEC-RAS model of the Upper Trinity River. In that model, the 1-year future conditions flow rate in the Main Stem of the Trinity at Dallas is 20,700 cfs. The corresponding 1-year future conditions flow rate in the West Fork at the confluence with the Elm Fork is 14,400 cfs. Previous drainage analyses produced by the Fort Worth District for flood insurance studies used 12,000 cfs as the West Fork design discharge, although no documentation for this discharge could be found. Because the CDC model 1-year future conditions flow rate in the Main Stem is so close to the desired 20,000 cfs design flow rate, it was decided to use the corresponding 14,400 cfs flow rate as the design discharge in the West Fork. There was more evidence to support this flow rate than any other, and it results in a more conservative design, although the differences in computed water surface elevation between 12,000 cfs and 14,400 cfs are less than 1.0 feet.

With the design tailwater flow rates established, the next question to be resolved was which hydraulic model to use to compute the tailwater elevations at interior drainage structures. This question arises due to the ongoing design of the Trinity Parkway and proposed park features in the Dallas Floodway. At the time of the beginning of the East Levee interior drainage study (summer 2005), the Fort Worth District supplied a conceptual model of the Dallas Floodway (modified version of the CDC HEC-RAS model) that included a bench for the Trinity Parkway and conceptual excavation for the proposed lake features. This model was later invalidated by major revisions to the Trinity Parkway and park feature concepts. Jacobs Carter Burgess coordinated with the design consultants working on the updated Trinity River model, but no updated hydraulic model that reflected the current concepts of the Parkway and park features was available in time for the West Levee interior drainage study. Therefore, the latest version of the CDC HEC-RAS model was used to compute tailwater elevations for this study. The 1-year future conditions flow rate in the Dallas Floodway (20,700 cfs) was used. The CDC HEC-RAS model was executed and outfall elevations at all West Levee interior drainage outfalls were computed, as shown in Table 2.7.

Table 2.7 - West Levee Interior Drainage Feature Tailwater Elevations

Feature	CDC Model Reach	Approx River Station	Flow (cfs)	Outfall WSEL (ft)
Charlie Pumping Plant	Main Stem	1159+04	20,700	401.72
Lake Cliff Pressure Sewer	Main Stem	1165+12	20,700	401.87
Coombs Creek Pressure Sewer	Main Stem	1173+34	20,700	401.92
Coombs Creek Relief	Main Stem	1177+44	20,700	402.07
Pavaho Pumping Plant	Main Stem	1262+31	20,700	404.56
Delta Pumping Plant	Main Stem	1363+60	20,700	408.20
Trinity-Portland Pumping Plant (proposed)	West Fork Reach 1	38+31	14,400	412.74
Eagle Ford Gravity Sluice	West Fork Reach 1	101+38	14,400	414.12

The USACE enforces a no-rise policy for the 100-year water surface profile on the Dallas Floodway. It is not expected that the proposed Trinity Parkway and park features will cause a rise for the 100-year event. It is possible that rises may be allowed for more frequent events, such as the design event used for the interior drainage studies. When the final models are available for the Trinity Parkway and park features, the design conditions tailwater elevations at interior drainage features should be revised. New stormwater pump stations at Baker and Pavaho are being designed to operate at full capacity independent of the tailwater elevation. Considering the uncertainty involved in establishing the tailwater elevations, it is recommended that all new stormwater pump stations currently proceeding to 35% plans also be designed to operate independently of the tailwater elevation.

3. EXISTING CONDITIONS ANALYSIS

After the hydrologic parameters were computed, an HEC-HMS model of the West Levee watershed was developed. HEC-HMS version 3.1.0 was used. All rainfall/runoff modeling and hydrologic channel routing was performed in HEC-HMS, but no sump routing was attempted in HEC-HMS. Due to the interconnected nature of the West Levee sumps, the steady-state tailwater reservoir routing assumption inherent in HEC-HMS was deemed too much of a limitation to accurately simulate the West Levee sumps. Therefore, all sump routing was performed in EPA-SWMM version 5. EPA-SWMM was chosen for this analysis instead of XP-SWMM which had been used for the Able Sump routing in the Interior Levee Drainage Study Phase I (East Levee) because EPA-SWMM has all the reservoir and conduit routing features necessary for the West Levee sumps, but is in the public domain and requires no software licensing. This is a significant advantage of EPA-SWMM - in the future, the City of Dallas can use the EPA-SWMM model of the West Levee sumps as a tool to model various scenarios without the necessity of investing in an expensive software license. The combined use of the models was simple, but required some manual data manipulation. HEC-HMS runoff hydrographs were copied into a spreadsheet from the HEC-DSS files for the various modeling scenarios. Minor formatting of the runoff hydrographs was necessary, then the hydrographs were copied into EPA-SWMM as inflow to the particular sump for which the hydrograph was computed. This mix of two separate software programs combined the strengths of both programs to provide a comprehensive modeling solution for the West Levee drainage basin and sumps.

3.1 CALIBRATION

The City of Dallas Flood Control District provided calibration data for the following four storm events: May 13, 1995; October 16-26, 2002; July 26-August 5, 2004, and March 17-25, 2006. These are the same calibration events used for the Interior Levee Drainage Study, Phase I (East Levee). The data consisted of measured incremental precipitation data for ALERT sensors throughout the City, measured water levels in the sumps at the West Levee storm water pumping plants, and pump records indicating how many pumps were on at each station during a given time period (15-minute increments). Measured water levels were available at Charlie Pumping Plant (Charlie Sump), Pavaho Pumping Plant (Pavaho Sump Pond C), and Delta Pumping Plant (Westmoreland-Hampton Sump). The City also provided measured water level data for Eagle Ford Sump at the Eagle Ford Gravity Sluice for the 2002 and 2004 storm events. The gage had not been installed at the time of the 1995 event, and was apparently out of service during the 2006 event. A few other water level measurements within the West Levee drainage basin were provided, but they were generally too far upstream in the watershed for use in sump level calibration.

The basic philosophy of the calibration process was to attempt to match the timing and magnitudes of the peak sump stages as closely as possible. More emphasis was put on matching the peaks, since those are the elevations used for flood inundation mapping. Other parts of the hydrograph, particularly the falling limb, were not as much of a concern. It is desirable but usually not practical to match all parts of the hydrograph equally well, since at lower flows and sump levels, the multitude of system processes unaccounted for in the model have a relatively more significant effect than they do at higher flows and sump levels. Thus, the criteria for judging the success of calibration were first and foremost matching the peak sump stage in magnitude and timing, and secondly matching the overall shape of the hydrograph.

Both experimentation and engineering judgment are required for any calibration process. For example, it may be possible to develop an acceptable fit to measured data using a numerical model, but the model parameters should always be assessed to ensure that their values conform to reasonable and expected ranges. All calibration parameters were evaluated against this criterion, and any calibration parameters outside of their normal ranges were rejected.

Of the four events available for calibration, March 2006 had the largest rainfall and the highest peak sump elevations. Because it was also the most recent calibration event, the conditions in effect during the March 2006 event are most similar to current conditions. Therefore, it was decided to focus more attention on attempting to match the peak sump elevation of the March 2006 event than the other calibration events, so that the model parameters were optimized for the March 2006 event.

3.1.1 Calibration Methodology

The HEC-HMS model had to be set up to use measured rainfall data for the calibration events. The ability of the HEC-HMS software to compute a spatial precipitation distribution automatically is one of its major advantages over HEC-1. For this analysis, the HEC-HMS inverse-distance gage weighting option was used. This approach requires the coordinates of the precipitation gages to be entered in the model, as well as the coordinates of one or more precipitation nodes for each subbasin. One precipitation node was established for each subbasin, located at the centroid. The HEC-HMS model creates a coordinate system at each precipitation node and determines the closest precipitation gage in each quadrant. Then a weighted average precipitation is computed for the precipitation node based on the inverse squared distance between the node and the closest gage in each quadrant.

First, precipitation gages were created in HEC-HMS for the closest ALERT precipitation gages to the West Levee watershed. All of the rain gage data were plotted in a spreadsheet to check for reasonableness and consistency. A few gages had missing or incomplete data for some time periods. If a gage did not have complete data for the entire duration of a calibration event, none of its data were used for that event. For each calibration event, the measured precipitation data provided by the City were copied to the precipitation gage data editor in HEC-HMS. The HEC-HMS precipitation gages included the latitude-longitude coordinates of the gage. Then, for each subbasin, the coordinates of the subbasin centroid were used to create a precipitation node. The resulting spatial distribution of precipitation is influenced by the number of subbasins and the locations of their centroids, as well as the number of precipitation gages and their locations. For the West Levee watershed, at least twelve precipitation gages were input for each calibration event. The distribution of precipitation gages was more than adequate to cover the entire watershed.

The HEC-HMS model was executed to compute the composite inflow hydrographs for the West Levee sumps. The resulting runoff hydrographs were copied into a spreadsheet and formatted for use with EPA-SWMM. The hydrographs were then copied into EPA-SWMM as inflow hydrographs for the appropriate sumps. The inflow hydrographs were plotted in EPA-SWMM prior to model execution and were checked against the HEC-HMS output to ensure that the hydrographs were the same.

The EPA-SWMM model was then executed. The data plotting and reporting tools of EPA-SWMM were used to ensure that the simulation results were reasonable and free from major numerical oscillations or other anomalies. The resulting computed sump stage hydrographs were copied into a spreadsheet for comparison with measured sump stage hydrographs. The success of the calibration was assessed by comparing the plots of measured versus predicted sump stage hydrographs.

The emphasis of this calibration process was entirely on hydrology (HEC-HMS) and not hydraulics (EPA-SWMM). In general, the EPA-SWMM model parameters that could have a significant influence on the final results are less susceptible to judgment than the hydrologic parameters. For example, the sump elevation-area curves in EPA-SWMM could have a significant impact on the computed sump stage hydrographs. Because these elevation-area curves were developed from topographic information that was adequately detailed and had been checked against surveyed cross sections in the sump areas, the computed elevation-area curves were not subject to adjustment in the calibration process. Similarly, pump station capacities could have a large impact on the computed model results, but because pump curves were not available for the pumps, their pumping capacities were taken as firmly established. Other EPA-SWMM parameters, such as culvert diameters, materials, and lengths, were easily established by survey data. Parameters such as Manning's n values and entrance and exit coefficients are both more readily established and have less impact on the results. Therefore, no parameter adjustment of any kind was attempted for the EPA-SWMM model in the calibration process.

3.1.2 Calibration Results

For the initial model results from all the calibration events, the EPA-SWMM computed sump stage hydrographs using the original computed hydrologic subbasin parameters matched the shapes of the measured sump stage hydrographs very well. These results confirmed the modeling approach was valid. However, there were differences in the magnitudes of the computed and measured sump stage hydrographs. In general, the computed sump stage hydrographs were higher than the measured sump stage hydrographs. The focus of the calibration effort was placed on adjusting the magnitudes of the computed hydrographs. The primary calibration parameter that can affect the magnitude of the computed hydrographs without impacting the timing is the NRCS runoff curve number. It was decided to vary the subbasin curve numbers to determine if acceptable calibration results could be obtained. Only subbasins that had an impact on computed sump stage hydrographs were adjusted. If no calibration data were available for an area (e.g., Lake Cliff or Kidd Springs), its parameters were left at their original computed values.

The initial computed results for Charlie Sump were higher than observed for some calibration events and lower than observed for the others. However, the Charlie Sump computed stage hydrograph for the major peak of the March 2006 storm was a remarkable fit to the measured data. Although some perturbation of the curve number was done in an iterative fashion, no curve number was found that significantly improved the overall fit for all the calibration event. Because the decision had been made to calibrate primarily to the March 2006 storm, the final curve number used for the Charlie/Corinth Street sump contributing drainage area was the initial value computed from watershed conditions. Table 3.1 shows a comparison of the original computed curve numbers versus the final calibrated curve numbers for the West Levee subbasins.

The initial computed results for Pavaho Sump were higher than observed for all of the events. Therefore, the curve numbers contributing to Pavaho Sump were lowered relative to their initial computed values based on land use and soil type. After iterating through several different sets of curve numbers, it was found that reducing all of the Pavaho subbasins curve numbers by 15% produced an exceptionally good fit for the March 2006 event, and at least an acceptable fit for all the other calibration events. A 15% reduction in curve number is towards the upper end of the acceptable range of adjustment, and may imply that there is additional storage in the Pavaho subbasins due to undersized drainage infrastructure, isolated low areas, etc. that is not otherwise accounted for in the modeling. The calibrated Pavaho subbbasin curve numbers are lower than the remainder of the West Levee subbasin curve numbers, as shown in Table 3.1.

The initial computed results for the Westmoreland-Hampton Sump (Delta Pumping Plant) were higher than observed for all of the events. The curve numbers for all of the subbasins contributing to sumps drained by Delta Pumping Plant were reduced. These include all the subbasins for Trinity-Portland, Frances Street, and Westmoreland-Hampton sumps. It was found that reducing all of these curve numbers by 7% produced and excellent fit for the March 2006 event, and an acceptable fit for the other calibration events.

Calibration for Eagle Ford sump was problematic since the sump is drained by gravity flow only and the gravity flow is highly dependent on the tailwater elevation in the West Fork of the Trinity River. Calibration was attempted for Eagle Ford Sump for the two available events by estimating a time series of tailwater elevations at the gravity sluice from the nearest Trinity River gage (Sylvan Avenue), but it is difficult to ascertain how the tailwater elevation at the Eagle Ford Gravity Sluice is related to the Sylvan Avenue gage data since the Eagle Ford Gravity Sluice outfall is located on the West Fork of the Trinity River upstream of the confluence with the Elm Fork. The Upper Trinity River CDC hydraulic model was consulted to compare predicted Trinity River water surface elevations at Sylvan Avenue with predicted West Fork water surface elevations at the Eagle Ford gravity sluice for the steady-state events included in that model, but no stable correlation was evident for multiple storm events, which is to be expected. Despite this, for these two storm events, the Eagle Ford sump elevation data exhibited a remarkably strong correlation with the Sylvan Avenue Trinity River gage in both magnitude and timing. Since the Eagle Ford Gravity Sluice is approximately 4 miles upstream of Sylvan Avenue, it seems unlikely that the tailwater elevation at the sluice (and hence the Eagle Ford Sump water level) would be less than or equal to the Sylvan Avenue Trinity River stages. Based on the CDC model results, the West Fork at the Eagle Ford Gravity Sluice should be several feet higher than the Trinity River at Sylvan Avenue. It is possible there could be a gage datum issue affecting the comparison with the sump stage gage and the Sylvan Avenue gage. Further investigation is necessary to determine the cause of these issues and to interpret the data. For this analysis, the initial model simulations with the hydrologic parameters computed from land use and soils data produced unacceptable results for the October 2002 calibration event, but the July 2004 calibration event results were acceptable for the main peak of the hydrograph.

Table 3.1 – Comparison of Original Computed Curve Numbers with Final Calibrated Curve Numbers for West Levee Watershed

Subbasin	Original Computed CN	Calibrated CN
CC1	87.8	87.8
CC2	88.7	88.7
CC3	88.0	88.0
CH	90.5	90.5
EF1	89.3	89.3
EF2	92.1	92.1
EF3	86.7	86.7
FS	92.6	86.2
KS	88.2	88.2
LC	90.6	90.6
P1_A	90.9	77.3
P1_B	89.0	75.7
P1_C	89.9	76.4
P2	92.9	79.0
TP1	91.1	84.7
TP2	94.5	87.9
TP3	95.2	88.5
TP4	92.6	86.1
TP5	92.6	85.9
WH	92.4	85.9

The calibration results for all the sumps and all the storm events are presented graphically in Figures 3.1 – 3.12.

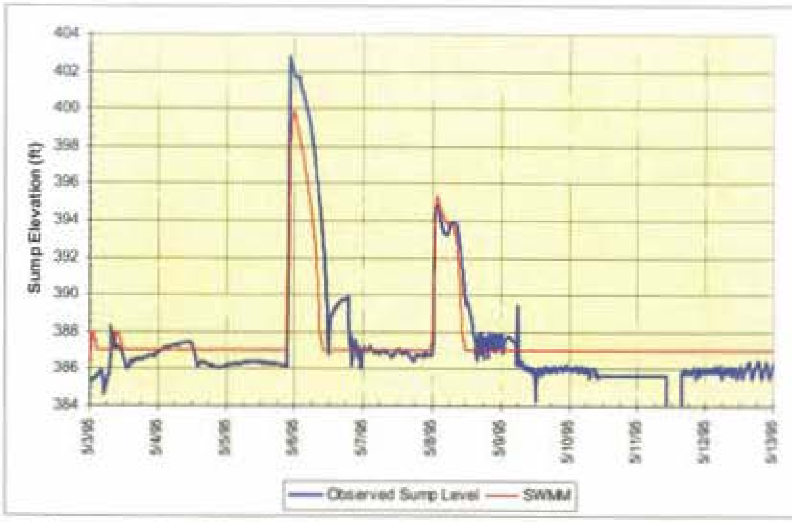


Figure 3.1 - Charlie Sump Calibration, May 1995 Event

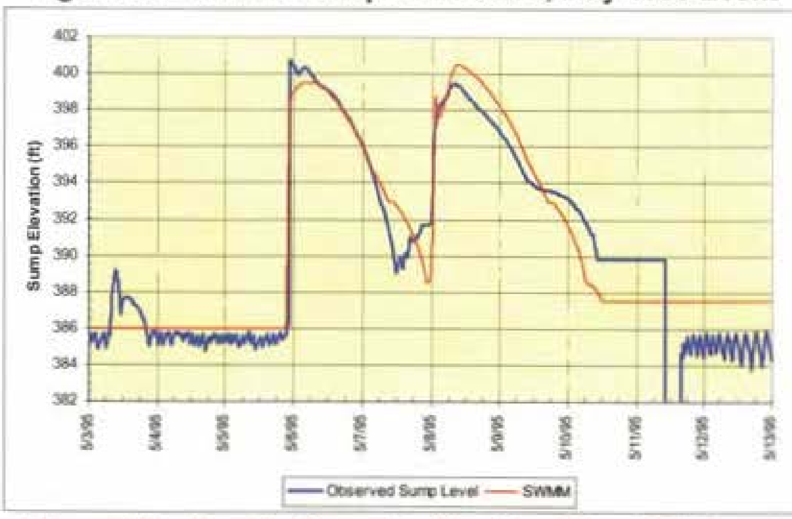


Figure 3.2 - Pavaho Sump Calibration, May 1995 Event

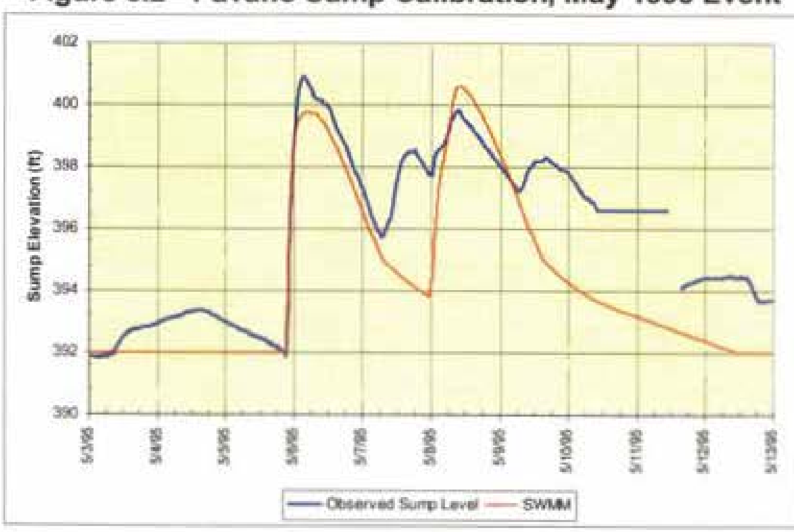


Figure 3.3 – Westmoreland-Hampton Sump Calibration, May 1995 Event

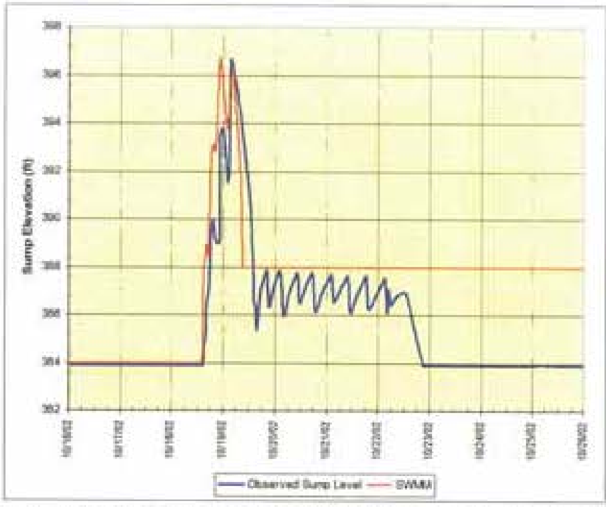


Figure 3.4 - Charlie Sump Calibration, October 2002 Event

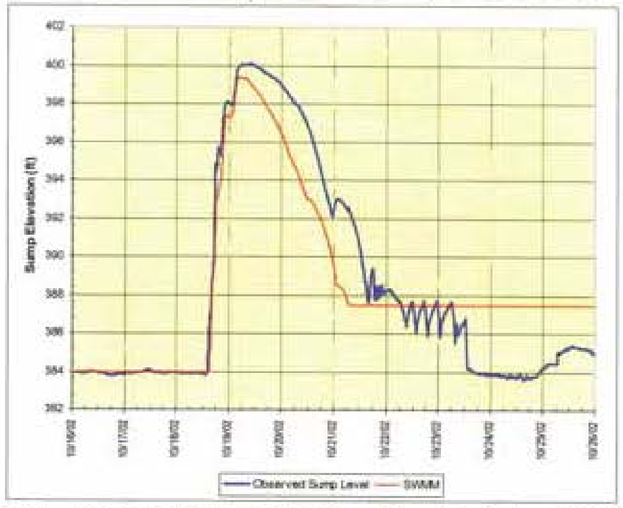


Figure 3.5 - Pavaho Sump Calibration, October 2002 Event

Figure 3.6 – Westmoreland-Hampton Sump Calibration, October 2002 Event

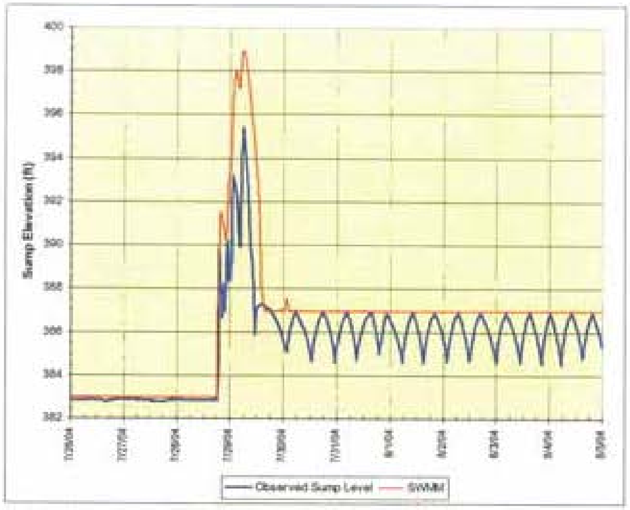


Figure 3.7 - Charlie Sump Calibration, July 2004 Event

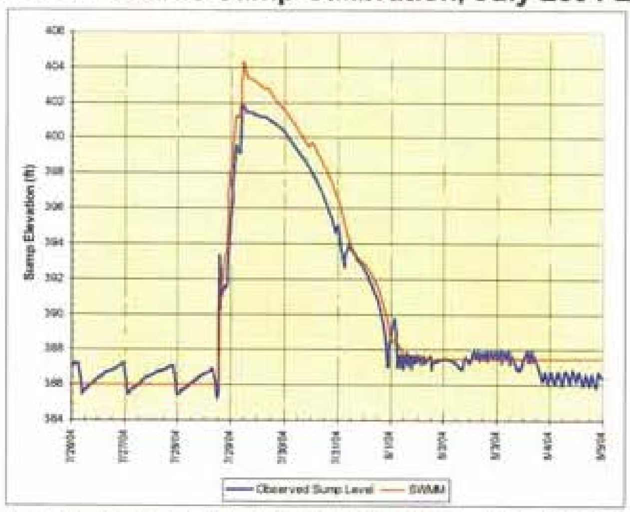


Figure 3.8 - Pavaho Sump Calibration, July 2004 Event

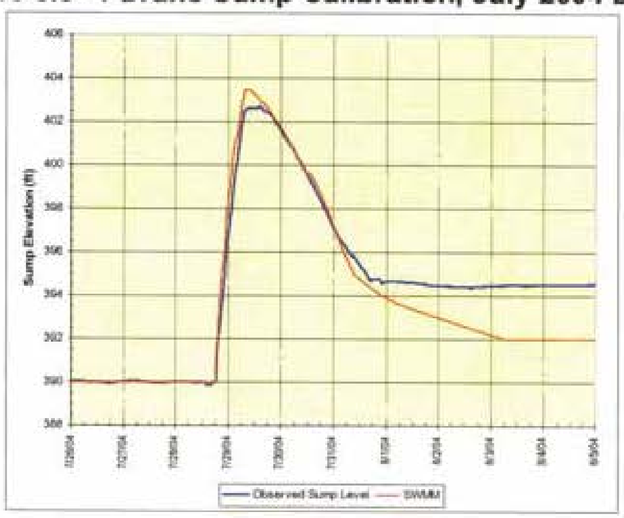


Figure 3.9 – Westmoreland-Hampton Sump Calibration, July 2004 Event

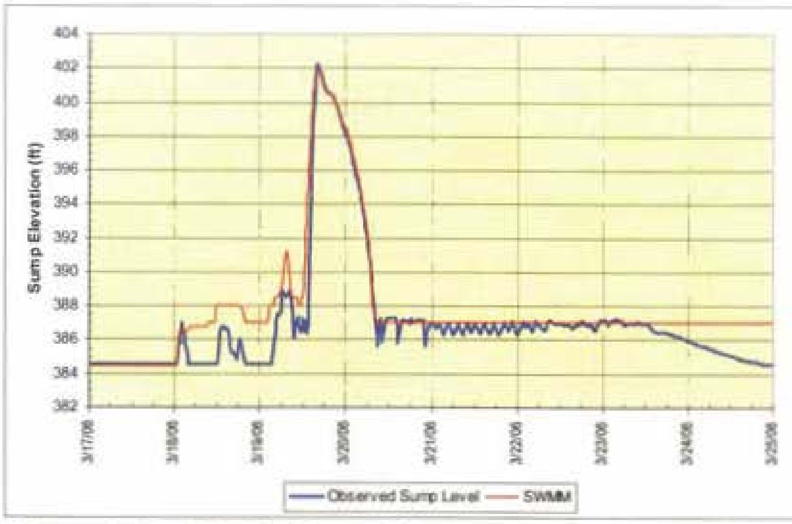


Figure 3.10 - Charlie Sump Calibration, March 2006 Event

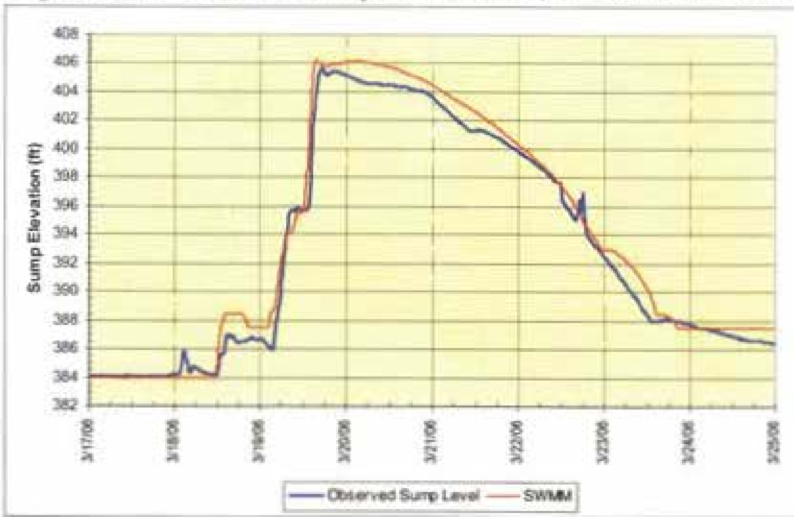


Figure 3.11 - Pavaho Sump Calibration, March 2006 Event

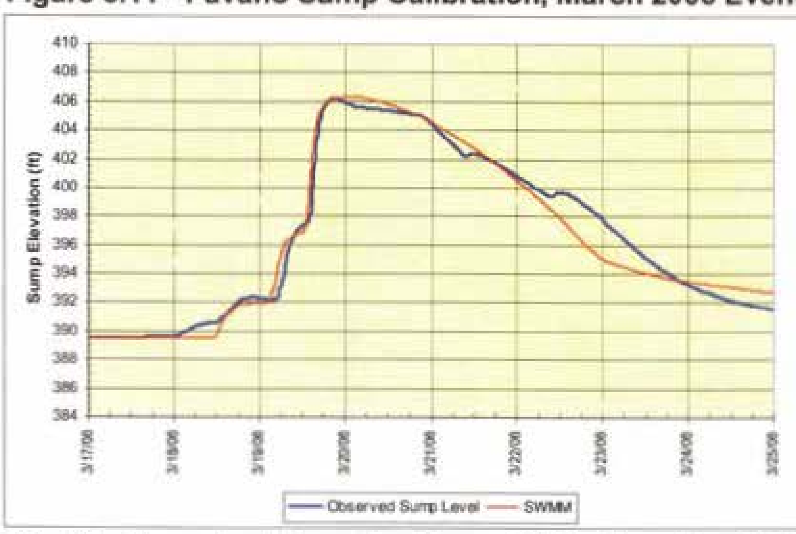


Figure 3.12 – Westmoreland-Hampton Sump Calibration, March 2006 Event

The calibration results validated the modeling approach and methodology developed for this analysis. Although the modeling approach involves many assumptions and simplifications, the shapes of the computed hydrographs for all the calibration events match the measured hydrographs quite well. The March 2006 calibration results are excellent.

3.2 ANALYSIS OF WEST LEVEE FLOODING, MARCH 18-19, 2006

Because the flood event of March 18-19, 2006 occurred during the duration of this project, documentation of the nature and flooding effects of the event was captured as part of the study. This section presents an analysis of this event in the West Levee area.

In the West Levee area, widespread street and some minor residential flooding occurred in the Eagle Ford, Trinity-Portland, Frances Street, Westmoreland-Hampton, and Pavaho Sump areas. No significant flooding is believed to have occurred in the Charlie Sump area, probably because the band of most severe rainfall was generally to the north of the Charlie Sump drainage area and because the Charlie Sump area has more topographic relief than the rest of the West Levee sumps.

In the Pavaho Sump area, Canada Drive was flooded, and Winnetka Avenue, Topeka Avenue, and other streets near the sump were flooded. Photo 3.1 shows the large "equalizer pond" area of Pavaho sump on the morning of Monday, March 20. Although Canada Drive was not flooded at the time this photo was taken, debris line evidence indicated that Pavaho Sump had previously inundated Canada Drive.

Photo 3.2 shows street flooding on Winnetka Avenue near Pavaho Sump on the morning of March 20.

Photo 3.1 - Pavaho Sump at Canada Drive near Canada Place - March 20, 2006

Photo 3.2 - Winnetka Avenue Street Flooding, Pavaho Sump Area - March 20, 2006

Of the sumps drained by Delta Pumping Plant (Trinity-Portland, Frances Street, and Westmoreland-Hampton), the most significant flooding seemed to be in the Trinity-Portland sump area. On a reconnaissance trip to the West Levee area on March 20, street and structure flooding were observed along Schofield Drive north of Bernal Drive and Mican Drive south of Bernal Drive.

Photo 3.3 shows the Trinity-Portland Sump channel between Bernal Drive and South Ottawa Road on the morning of Monday, March 20. In the photo, it is apparent that some structure flooding occurred at this location; although the surveyed finished floor elevations of the residences are higher than the estimated maximum sump elevation. The garage/storage building in the picture is clearly flooded and the residences are surrounded by water and most likely have water intrusion into the pier-and-beam foundations.

Photo 3.4 shows street flooding south of Bernal Drive at the intersection of Bernal Drive and Mican Drive near the Eladio Martinez Education Center. Photo 3.4 was taken looking south towards Mican Drive.

Photo 3.5 shows debris from flooding on Schofield Drive north of Bernal Drive. Photo 3.6 shows the high water mark on the residence at 3936 Schofield Drive, which backs up to Trinity-Portland Sump. It is difficult to see in the photo, but this structure had a high water mark 12 to 18 inches above the foundation.

Photo 3.3 - Trinity–Portland Sump North of Bernal Drive - March 20, 2006

Photo 3.4 - Bernal Drive at Mican Drive Near Eladio Martinez Educational Center, Trinity-Portland Sump Area - March 20, 2006

Photo 3.5 - Schofield Drive, Trinity-Portland Sump Area - March 20, 2006

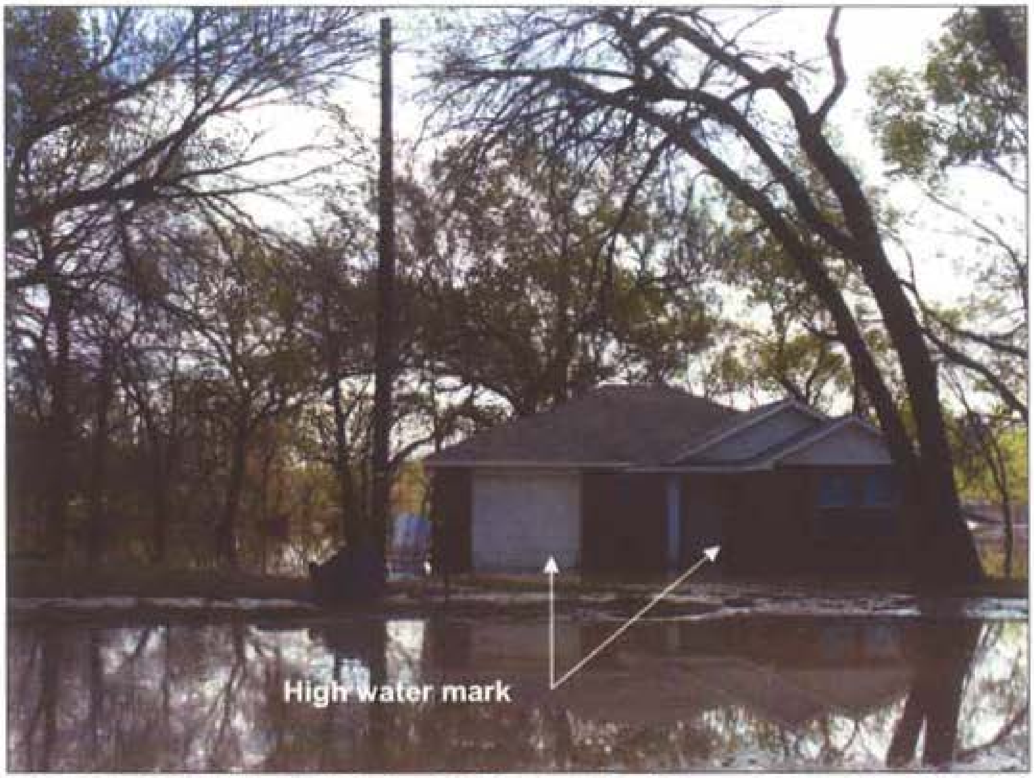


Photo 3.6 - 3936 Schofield Drive, Trinity-Portland Sump Area - March 20, 2006

Photo 3.7 shows the Ledbetter Dike control structure, just south of Bernal Drive at the intersection with Kilgore Street. Ledbetter Dike is a gated conduit structure that separates Trinity-Portland Sump from France Street Sump. In the photo, the water surface elevation difference between the two sump areas separated by Ledbetter Dike is apparent. This observation led to a discussion of the operation of the Ledbetter Dike structure during the flood event with Dallas Flood Control District Manager Ron Shindoll. Mr. Shindoll indicated that once all three sumps drained by Delta Pumping Plant had been pumped down sufficiently to dewater the flooded structures, the Ledbetter Dike structure was closed to enable the sumps on the pumping plant side of the structure (Frances Street and Westmoreland-Hampton sumps) to be pumped down more rapidly. Once Frances Street and Westmoreland-Hampton Sumps had been pumped down sufficiently, Ledbetter Dike was opened. Because the existing Delta Pumping Plant does not have enough capacity to quickly pump down all three sumps simultaneously, Ledbetter Dike was operated to partition the sumps to allow the most rapid drawdown possible of Frances Street and Westmoreland-Hampton sumps.

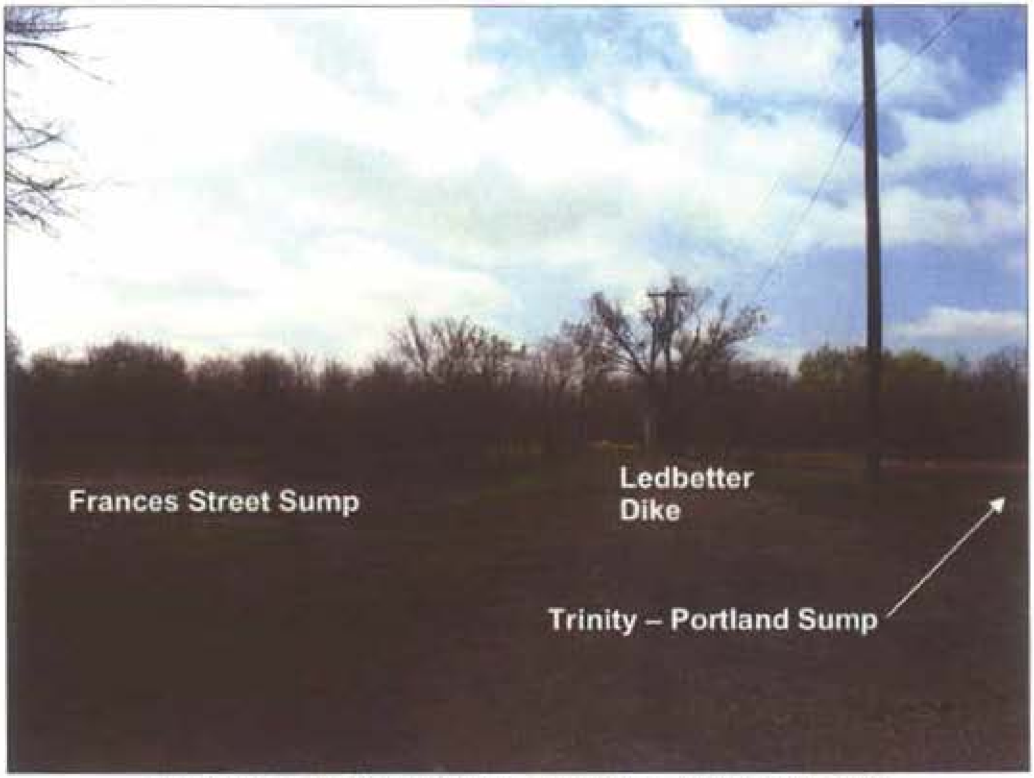


Photo 3.7 - Ledbetter Dike Structure - March 20, 2006

In the Eagle Ford Sump area, street flooding occurred along Singleton Boulevard near Loop 12 and on side streets north of Singleton Boulevard such as Cartwright Street and Toronto Street.

3.2.1 Precipitation Statistical Analysis and Mapping

The precipitation event of March 18-19, 2006 was significant not only in its magnitude and impact to the City of Dallas; it was also an important opportunity to observe how the City's interior drainage facilities functioned during a large flood event. To enhance the understanding of the event, Carter & Burgess, Inc. developed statistical analyses and mapping of the precipitation event based on measured data from the City's network of ALERT precipitation gages. Hourly incremental precipitation for the gages is available in real time from the City of Dallas Flood Control District website. These data were downloaded for all of the available gages across the City. For this event, 58 gages were active and had usable data.

The two primary goals of the precipitation analyses were as follows:

- to develop a graphical depictions of the magnitude and spatial variation of the precipitation event
- to determine the frequencies or exceedence probabilities associated with the event for various storm durations

To accomplish these goals, the hourly precipitation data for all 58 gages for the 7hour period beginning at midnight on March 17, 2006 were downloaded, reformatted, and imported into a spreadsheet. The maximum precipitation totals for the 1-, 2-, 3-, 6-, 12-, 24-, 36-, 48-, and 72-hour durations were then computed for each gage. For a given duration, this was accomplished by calculating a rolling sum of the total rainfall in all contiguous periods equal to the duration, then selecting the maximum value. For example, the maximum precipitation total at a gage for the hour duration is not the sum of the three maximum hourly incremental values, but rather the maximum total of any contiguous hour period during the event. With this methodology, the contiguous period associated with a duration is not necessarily the same from gage to gage.

The next step in the analysis was to determine the frequency associated with the total precipitation for each duration at each gage. This was done by comparing the precipitation totals with the NCTCOG iSWM intensity-duration-frequency (IDF) curves for Dallas County. The iSWM IDF curves were chosen for this analysis because they incorporate recent Texas precipitation depth-duration-frequency research developed by the USGS in cooperation with TxDOT, and because they are tabulated on a county-by-county basis. The iSWM IDF curves are similar to the IDF curves obtained from the traditional TP-40/Hydro-35 sources. The iSWM data are limited to durations of 24 hours or less; therefore, precipitation data for the 36-, 48-, and 72-hour durations were extrapolated. The precipitation totals at each gage for each duration were then interpolated against the iSWM tabular IDF curves to determine the frequency associated with the duration. Thus, two discrete calculated data points were associated with each gage for each duration – a total rainfall depth and a frequency.

Tables 3.2 and 3.3 summarize the maximum precipitation and computed frequency for the ALERT sensors for the period March 17-20, 2006. The ALERT sensors in Tables 3.2 and 3.3 are grouped according to the drainage basins associated with the interior drainage system. A qualitative analysis of the data in Table 3.3 indicates that the 1hour and 24-hour duration storm frequencies for most of the West Levee drainage basin was between 20 and 30 years (3%-5% annual chance). Some areas of the West Levee drainage basin experienced a 40 to 50 year event (2%-2.5% annual chance) for the 1hour and 24-hour storm durations.

Table 3.2 - Maximum Depth-Duration Table, March 17-20, 2006

GAGE	1-hr MAX PRECIP (in)	2-hr MAX PRECIP (in)	3-hr MAX PRECIP (in)	6-hr MAX PRECIP (in)	12-hr MAX PRECIP (in)	24-hr MAX PRECIP (in)	36-hr MAX PRECIP (in)	48-hr MAX PRECIP (in)	72-hr TOTAL PRECIP (in)
EAST LEVEE SUMP DRAINAGE AREA									
155	1.73	3.11	3.46	3.86	5.88	6.84	7.52	7.88	7.92
195	1.46	2.80	3.19	3.67	5.87	6.87	7.51	7.75	7.83
6135	1.26	2.36	3.23	3.79	5.29	6.49	7.09	7.45	7.61
6715	1.93	3.35	3.86	4.38	6.67	7.67	8.27	8.51	8.59
6775	1.93	3.47	4.06	4.61	6.90	7.94	8.74	9.18	9.26
6835	1.93	2.80	3.15	3.66	5.87	6.71	7.47	7.91	7.95
6855	2.32	3.70	4.13	4.57	5.98	6.78	7.42	7.82	7.82
6895	2.05	3.51	3.86	4.34	6.83	7.75	8.43	8.79	8.83
7725	1.22	1.73	1.97	2.49	4.26	5.33	6.01	6.25	6.29
7735	1.72	2.48	2.88	3.36	5.16	6.32	7.00	7.24	7.32
WEST LEVEE SUMP DRAINAGE AREA									
5045	1.14	2.12	3.26	3.78	5.21	6.53	7.17	7.65	7.77
5055	0.94	1.85	2.72	3.24	4.47	5.43	5.91	6.27	6.39
5235	1.10	1.81	2.52	2.68	3.39	3.75	4.35	4.67	4.67
5295	1.34	2.64	3.74	4.37	5.88	6.96	7.52	7.92	8.04
5515	2.44	3.70	4.96	5.47	7.01	7.89	8.53	8.93	9.05
6235	1.34	2.36	3.30	3.94	5.52	6.68	7.32	7.72	7.92
6355	1.61	3.15	3.98	4.46	5.72	6.72	7.20	7.48	7.56
6475	2.52	3.78	4.37	4.88	6.46	7.10	7.58	7.86	7.94
MILL CREEK DRAINAGE AREA									
1535	1.61	2.52	2.83	3.26	4.76	5.56	5.88	6.12	6.20
1655	2.32	4.25	5.08	5.75	7.75	8.82	9.58	9.90	10.02
1855	1.89	3.43	4.18	4.81	6.42	7.53	8.13	8.49	8.57
1955	2.09	3.78	4.25	4.65	6.46	7.34	8.18	8.38	8.50
2255	2.09	3.78	4.65	5.32	7.21	8.36	9.08	9.44	9.52
WHITE ROCK LAKE VICINITY									
915	2.80	4.97	5.32	6.15	8.71	9.82	10.46	10.74	10.86
935	2.01	3.19	3.54	4.21	6.73	7.73	8.41	8.65	8.73
1155	2.83	4.64	5.11	5.78	8.26	9.45	10.05	10.41	10.53
1235	2.56	4.73	5.12	5.95	8.39	9.23	9.87	10.15	10.27
1295	1.46	2.40	2.56	2.99	4.37	5.48	5.96	6.04	6.08
1515	1.50	2.64	3.07	3.59	5.48	6.51	7.03	7.19	7.27
OTHER AREAS									
345	0.55	0.79	0.99	1.74	2.18	3.41	4.21	4.25	4.33
1055	0.79	1.22	1.42	2.25	2.89	4.20	4.92	5.00	5.04
1075	0.51	0.79	0.99	1.86	2.34	3.81	4.65	4.77	4.85
1095	0.55	0.67	0.91	1.65	2.01	3.56	4.44	4.52	4.60
1715	1.57	3.11	3.66	4.49	6.43	7.81	8.49	8.81	8.89
1755	1.65	2.95	3.58	4.21	6.61	8.00	8.64	8.96	9.00
2055	0.87	1.70	2.05	2.65	4.02	5.33	5.93	6.33	6.41
2535	0.64	0.72	0.84	1.52	3.00	4.28	4.84	5.28	5.36
2555	0.28	0.44	0.52	0.88	1.48	2.12	2.76	3.12	3.16
2775	0.79	0.95	1.26	2.05	3.39	5.01	5.65	6.01	6.09
3055	0.87	1.50	1.97	2.41	3.51	4.79	5.47	5.87	5.95
3075	0.67	1.26	1.73	2.17	3.16	4.16	4.68	5.12	5.16
3775	0.71	0.94	1.30	2.01	2.95	4.77	5.53	5.93	5.97
3975	0.51	0.98	1.14	1.85	2.95	4.34	5.02	5.46	5.54
4135	1.10	1.65	2.04	2.44	3.27	4.11	4.71	5.19	5.31
4155	0.51	0.90	1.21	1.77	2.91	4.19	4.95	5.59	5.75
4515	1.06	1.61	2.04	2.44	3.28	4.32	4.84	5.44	5.56
4535	0.52	1.00	1.36	1.96	3.08	4.44	5.04	5.56	5.68
4555	0.79	1.54	2.21	2.61	3.29	3.73	4.33	4.65	4.73
4855	0.88	1.48	2.28	2.64	3.76	4.84	5.32	5.80	5.84
5535	0.91	1.54	2.41	2.97	3.99	4.87	5.43	5.95	6.15
7035	0.59	0.87	1.03	1.51	2.37	3.40	3.96	4.04	4.08
7355	0.87	1.34	1.77	2.43	3.66	4.76	5.40	5.40	5.48
7455	0.98	1.41	1.69	2.47	3.74	5.39	6.31	6.43	6.47
7535	0.63	0.94	1.14	1.62	2.72	3.64	4.12	4.24	4.32
7555	0.59	0.87	1.03	1.59	2.33	3.44	4.16	4.24	4.28
7755	1.30	1.77	2.01	2.53	3.95	5.06	5.66	5.78	5.86
7775	0.98	1.49	1.77	2.44	3.35	4.69	5.41	5.53	5.57
7955	0.43	0.67	0.91	1.58	2.02	3.37	4.32	4.36	4.40

Table 3.3 - Duration-Frequency Table, March 17-20, 2006

GAGE	1-hr FREQ (year)	2-hr FREQ (year)	3-hr FREQ (year)	6-hr FREQ (year)	12-hr FREQ (year)	24-hr FREQ (year)	36-hr FREQ (year)	48-hr FREQ (year)	72-hr FREQ (year)
EAST LEVEE SUMP DRAINAGE AREA									
155	2	9	9	7	22	21	21	19	15
195	1	5	6	4	22	22	21	18	14
6135	< 1 yr	3	7	6	15	18	16	16	13
6715	3	13	15	12	[illegible]	[illegible]	[illegible]	24	20
6775	3	16	20	16	[illegible]	[illegible]	[illegible]	[illegible]	24
6835	3	5	6	5	22	20	20	19	15
6855	6	22	21	15	23	21	20	19	14
6895	4	17	15	11	[illegible]	[illegible]	[illegible]	[illegible]	21
7725	< 1 yr	1	1	2	5	8	6	6	6
7735	2	4	4	4	13	16	15	14	11
WEST LEVEE SUMP DRAINAGE AREA									
5045	< 1 yr	2	7	6	14	18	17	17	14
5055	< 1 yr	1	4	4	7	8	7	8	7
5235	< 1 yr	1	3	2	3	2	3	3	2
5295	< 1 yr	4	13	12	22	22	21	19	16
5515	8	22	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	23
6235	< 1 yr	3	7	8	17	20	19	18	15
6355	2	9	18	13	20	20	17	16	12
6475	9	24	[illegible]	20	[illegible]	24	21	19	15
MILL CREEK DRAINAGE AREA									
1535	2	4	4	4	9	9	7	7	6
1655	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1855	3	15	22	19	[illegible]	[illegible]	[illegible]	24	20
1955	4	24	24	16	[illegible]	[illegible]	[illegible]	23	19
2255	4	24	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
WHITE ROCK LAKE VICINITY									
915	16	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
935	4	10	9	10	[illegible]	[illegible]	[illegible]	[illegible]	21
1155	17	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1235	9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
1295	1	3	3	3	6	9	8	6	5
1515	1	4	5	5	17	18	16	14	10
OTHER AREAS									
345	< 1 yr	< 1 yr	< 1 yr	< 1 yr	< 1 yr	2	3	2	2
1055	< 1 yr	< 1 yr	< 1 yr	1	2	3	4	4	3
1075	< 1 yr	< 1 yr	< 1 yr	< 1 yr	< 1 yr	3	3	3	3
1095	< 1 yr	< 1 yr	< 1 yr	< 1 yr	< 1 yr	2	3	3	2
1715	2	9	11	14	[illegible]	[illegible]	[illegible]	[illegible]	22
1755	2	7	10	10	[illegible]	[illegible]	[illegible]	[illegible]	22
2055	< 1 yr	1	1	2	4	8	7	8	7
2535	< 1 yr	< 1 yr	< 1 yr	< 1 yr	2	4	4	4	4
2555	< 1 yr	< 1 yr	< 1 yr	< 1 yr	< 1 yr	< 1 yr	< 1 yr	1	< 1 yr
2775	< 1 yr	< 1 yr	< 1 yr	< 1 yr	3	6	6	6	5
3055	< 1 yr	< 1 yr	1	2	3	5	5	6	5
3075	< 1 yr	< 1 yr	< 1 yr	1	2	3	3	4	3
3775	< 1 yr	< 1 yr	< 1 yr	< 1 yr	2	5	6	6	5
3975	< 1 yr	< 1 yr	< 1 yr	< 1 yr	2	4	4	4	4
4135	< 1 yr	< 1 yr	1	2	2	3	4	4	4
4155	< 1 yr	< 1 yr	< 1 yr	< 1 yr	2	3	4	5	5
4515	< 1 yr	< 1 yr	1	2	2	4	4	4	4
4535	< 1 yr	< 1 yr	< 1 yr	< 1 yr	2	4	4	5	4
4555	< 1 yr	< 1 yr	2	2	2	2	3	3	2
4855	< 1 yr	< 1 yr	2	2	4	5	5	5	5
5535	< 1 yr	< 1 yr	2	3	4	5	5	6	6
7035	< 1 yr	< 1 yr	< 1 yr	< 1 yr	< 1 yr	2	2	2	2
7355	< 1 yr	< 1 yr	< 1 yr	2	3	5	5	4	4
7455	< 1 yr	< 1 yr	< 1 yr	2	4	8	9	8	7
7535	< 1 yr	< 1 yr	< 1 yr	< 1 yr	1	2	2	2	2
7555	< 1 yr	< 1 yr	< 1 yr	< 1 yr	< 1 yr	2	2	2	2
7755	< 1 yr	1	1	2	4	6	6	5	5
7775	< 1 yr	< 1 yr	< 1 yr	2	3	5	5	5	4
7955	< 1 yr	< 1 yr	< 1 yr	< 1 yr	< 1 yr	2	3	2	2

LEGEND:

10-year or less | 10-year to 25-year | Over 25-year

GIS mapping was used to depict the spatial variation of rainfall across the city based on the rain gage data. Because the map coordinates of the rain gages are known, terrain modeling techniques were used to develop contour maps of rainfall depth and frequency for selected durations. This was done by using the rainfall depth or calculated frequency as the z-coordinate or "elevation" associated with the rain gage points. Then the contour maps were color-shaded between contour lines, such that a single color represents a range of rainfall depths between contour lines. The maps of 12- and 24-hour duration depth and frequency were deemed most significant, and these maps and associated data summary tables were provided to City of Dallas Public Works staff to assist in decision-making and assessing the impacts of the precipitation event.

3.2.2 Aerial Reconnaissance

On the afternoon of Tuesday March 21, 2006, Carter & Burgess, Inc. used a helicopter to perform aerial reconnaissance to document the remaining extent of sump and Dallas Floodway flooding. By this time, water surface elevations in the Dallas Floodway had receded substantially compared to the day before. At the time, no flooding was observed on the East Levee side, and the East Levee sumps were apparently at normal levels. However, elevated sump stages were still apparent on the West Levee side at this time, implying that the West Levee sumps were not able to be pumped down as rapidly as the East Levee sumps. Selected aerial reconnaissance photos are shown in Photos 3.8 – 3.11.

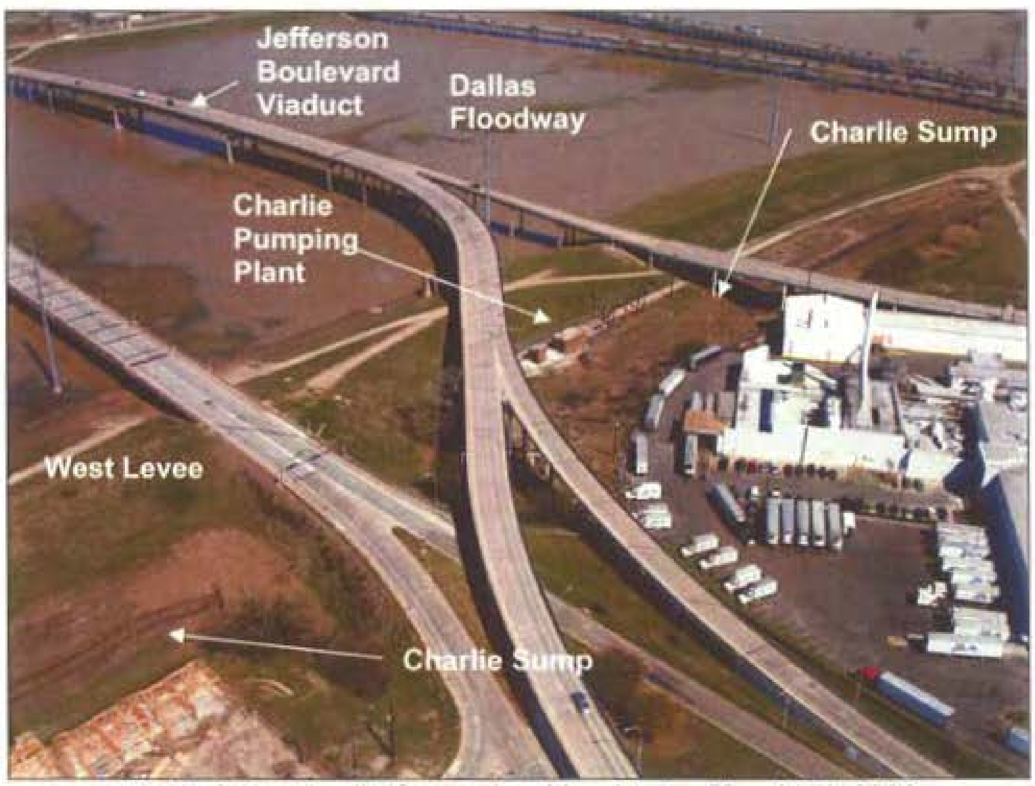


Photo 3.8 – Charlie Sump, Looking East – March 21, 2006

Photo 3.9 – Pavaho Sump, Looking West – March 21, 2006

Photo 3.10 – Westmoreland-Hampton Sump, Looking Southwest – March 21, 2006

Photo 3.11 – Trinity-Portland Sump – March 21, 2006

3.2.3 Sump hydrographs and inundation mapping

Figures 3.13 – 3.15 show measured sump stage and pump outfall hydrographs for Charlie, Pavaho, and Westmoreland-Hampton Sumps for the period March 18-24, 2006. These figures show that none of the West Levee sumps exceeded their City of Dallas 100-year design elevations at the pumping plants. Observation of Figures 3.13 – 3.15 reveals a noticeable difference in the behavior of the sumps – Charlie Sump has a very rapid drawdown, in contrast with the other two sumps. Within approximately 18 hours of the peak of the rainfall event on the afternoon of March 19, Charlie Sump was at an approximate steady-state at the pre-storm water level. Photo 3.8 shows that Charlie Sump was essentially empty on March 21, 2006.

Despite the apparently good performance of Charlie Sump and Charlie Pumping Plant, there was an issue during the event which should be noted. The maximum measured sump elevation at Charlie Pumping Plant was 402.27 ft, and the pump floor elevation of the pumping plant is at 403.00 ft. City of Dallas Flood Control District personnel were concerned that Charlie Pumping Plant would flood during the event. The City of Dallas 100-year design elevation for Charlie Sump is 404.1 ft, which would flood the pumping plant.

The Pavaho Sump and Westmoreland-Hampton Sump plots are significantly different than Charlie Sump. The durations of elevated sump levels in these sumps are much longer, with slow drawdowns despite maximum pumping at the pumping plants. Both sumps were just beginning to approach pre-storm levels approximately 4.5 days after the peak of the rainfall event, after 3.5 – 4 days of nearly continuous maximum pumping. Photos 3.9 – 3.11 show elevated water levels in those sumps on March 21,

2006. Despite the slow drawdowns, neither sump exceeded its 100-year design elevation, so from that standpoint the pumping plants were effective. Part of the reason for the slow drawdowns of Pavaho and Westmoreland-Hampton sumps is that these sump areas are considerably larger in terms of volume than Charlie Sump.

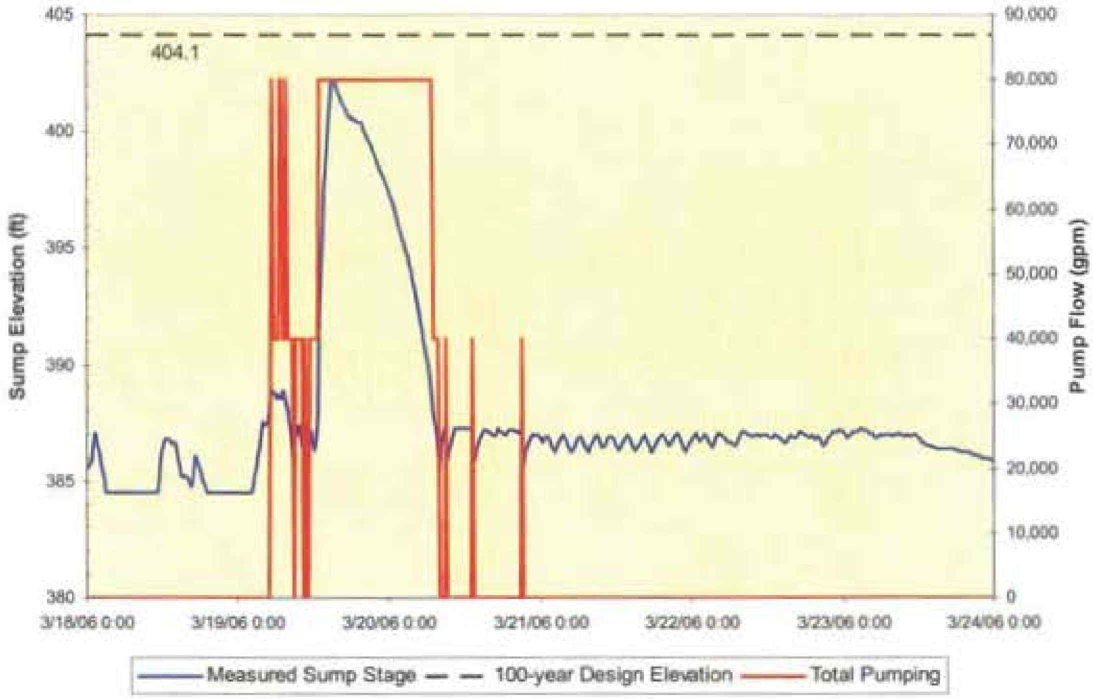


Figure 3.13 - Charlie Sump Stage and Pump Outflow Hydrographs, March 18-24, 2006

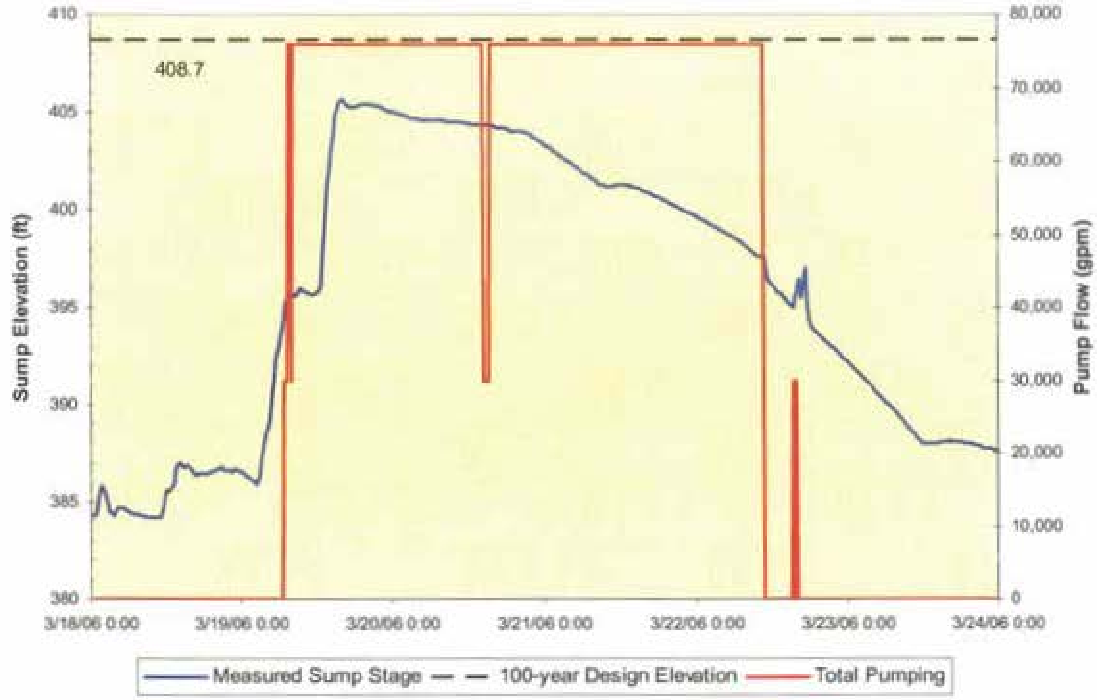


Figure 3.14 - Pavaho Sump Stage and Pump Outflow Hydrographs, March 18-24, 2006

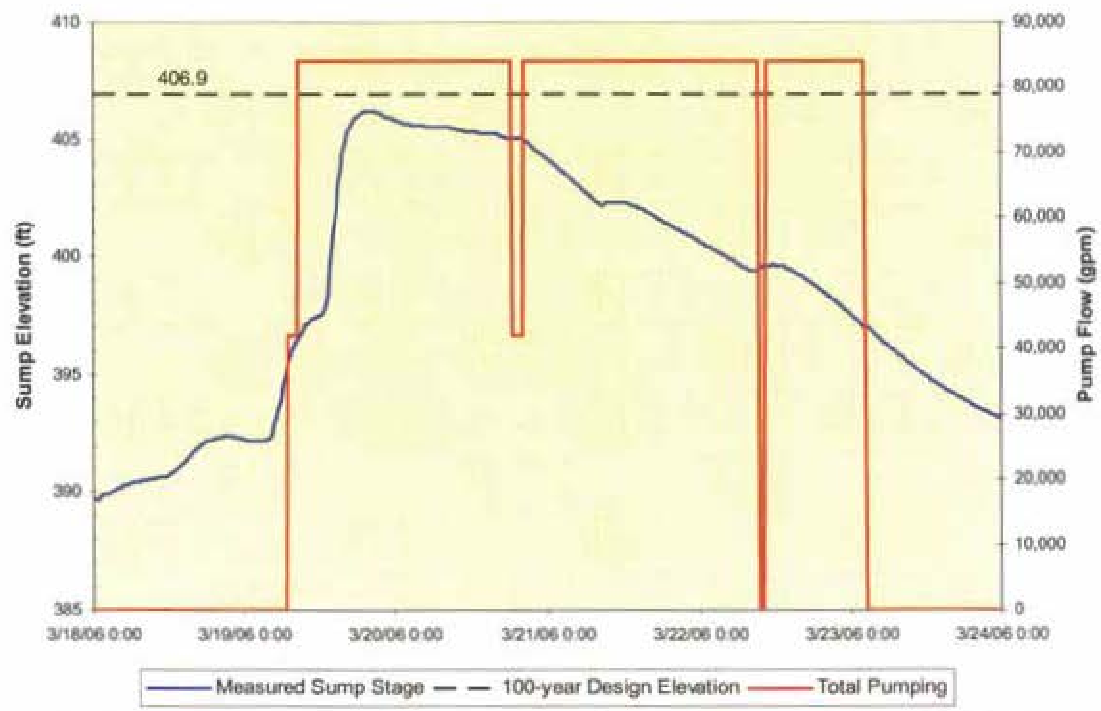


Figure 3.15 - Westmoreland-Hampton Sump Stage and Pump Outflow Hydrographs, March 18-24,2006

The maximum sump elevations for Charlie, Pavaho, and Westmoreland-Hampton were taken from measured sump elevations at the pumping plants. For Frances Street, Trinity-Portland, and Eagle Ford sumps, the maximum sump elevations were estimated from surveyed high water marks. Table 3.4 summarizes the maximum sump elevations.

Table 3.4 – West Levee Maximum Sump Elevations, March 19, 2006

Sump	Maximum Sump Elevation (ft)
Charlie	402.27
Pavaho	405.63
Westmoreland-Hampton	406.17
Frances Street	408.0*
Trinity-Portland	411.9*
Eagle Ford	416.2*
* estimated from surveyed high water marks	

3.2.4 High Water Marks and Finished Floor Elevation Surveys

On Wednesday March 22, Carter & Burgess, Inc. mobilized a survey crew to survey the elevation of high water marks (debris lines) near the East and West Levee sumps. Using GPS, the crew was able to survey high water marks near the sumps while the debris lines were still intact. When the surveyed debris line elevations were compared with the maximum sump elevations from the level sensors at the pumping plants, some differences were observed. For example, the measured debris line elevations in Able Sump are consistently several feet lower than the maximum measured sump elevation at the Able Pumping Plant level sensor. In all cases, the measured maximum sump elevations from the level sensors at the pumping plants were assumed to be more reliable indicators of the maximum sump levels than the surveyed debris lines. At one location, two surveyed high water marks near one another differed by as much as 6 inches. These examples illustrate the unreliability associated with debris lines and high water marks as indicators of maximum water surface elevations.

The City of Dallas contracted with Carter & Burgess, Inc. to survey high water marks associated with the March 18-19 storm event and finished floor elevations of structures which may have been impacted by sump flooding in the East and West Levee sump areas. In the days following the storm event, City of Dallas departments such as Housing and Code Compliance as well as relief agencies such as the Red Cross performed preliminary inspections of flood-affected areas and developed databases of possible flood-damaged structures. Using these databases, the City of Dallas Housing Department compiled a master database of addresses of possible flood-affected structures. The Housing Department provided the database to Carter & Burgess, Inc. for use in the Interior Levee Drainage Study. The database was condensed to those addresses which might potentially have been affected by high sump elevations. The finished floor elevations of the structures at these addresses were surveyed along with any visible high water mark. The survey crew interviewed residents of the structures whenever possible to assess the extent of structure flooding. Because the surveys were performed in the weeks following the flood event, it is probable that some high water marks were obliterated by the time of the survey. Nevertheless, the surveyed finished floor elevations provided an important comparison to the estimated finished floor elevations from the Fort Worth District economic model database. Over 100 finished floor elevations were surveyed near the West Levee sumps.

Based on an analysis of all of the West Levee area surveyed finished floor elevations, only the three properties listed in Table 3.5 were flooded by high sump elevations. In this case, "flooded" means that the surveyed finished floor elevation of the structure is less than the maximum sump elevation of the adjacent sump. Due to the limitations of the data used to develop the list, this list is not intended to be a comprehensive list of flood-affected structures for the West Levee sump areas. There are potentially numerous structures that may have been affected by water intrusion into foundations. Also, detached non-residential structures such as garages and storage sheds are not included in the list. There may also have been structures affected by localized flooding due to inadequate or malfunctioning storm drainage infrastructure.

Table 3.5 – Flooded West Levee Structures Based on Surveyed Finished Floor Elevations

Address	Surveyed Finished Floor Elevation (ft)	Adjacent Sump	Maximum Sump Elevation (ft)
3301 Topeka Ave	405.5	Pavaho	405.63
4422 S Ottawa Dr	411.7	Trinity-Portland	411.9
3936 Schofield Dr	411.4	Trinity-Portland	411.9

Because of the surprisingly small number of flooded structures based on surveyed finished floor elevations, a separate analysis was performed based on estimated finished floor elevations from the Fort Worth District economic model database. From this analysis, only 19 addresses were identified as potentially affected based on estimated finished floor elevations. These addresses are listed in Table 3.6. The addresses in Table 3.6 did not necessarily sustain any damage during the storm event; but the potential for flooding at these addresses was identified based on available data.

Table 3.6 – Potentially Affected West Levee Structures Based on Estimated Finished Floor Elevations

Address	Estimated Finished Floor Elevation (ft)	Adjacent Sump	Maximum Sump Elevation (ft)
3235 Topeka Ave	405.3	Pavaho	405.63
3231 Topeka Ave	405.4	Pavaho	405.63
3242 Topeka Ave	405.2	Pavaho	405.63
3226 Topeka Ave	405.5	Pavaho	405.63
3302 Topeka Ave	405.0	Pavaho	405.63
3307 Topeka Ave	405.5	Pavaho	405.63
3301 Topeka Ave	404.7	Pavaho	405.63
3332 Topeka Ave	405.2	Pavaho	405.63
3328 Topeka Ave	404.5	Pavaho	405.63
3324 Topeka Ave	405.0	Pavaho	405.63
3318 Topeka Ave	405.0	Pavaho	405.63
3909 Mican Dr	411.6	Trinity-Portland	411.9
3932 Schofield Dr	411.9	Trinity-Portland	411.9
3936 Schofield Dr	411.4	Trinity-Portland	411.9
4411 N Ottawa Dr	411.0	Trinity-Portland	411.9
4402 S Ottawa Dr	411.5	Trinity-Portland	411.9
4404 S Ottawa Dr	410.4	Trinity-Portland	411.9
4422 S Ottawa Dr	410.2	Trinity-Portland	411.9
3938 Tumalo Trl	411.3	Trinity-Portland	411.9

3.2.5 Summary

Despite widespread street flooding and an extended period of elevated sump levels, the West Levee sump areas did not appear to sustain significant structural damages from sump flooding. The most significant conclusions from this analysis are:

- The pump floor elevation for Charlie Pumping Plant is low relative to the maximum sump elevation for this event and is below the 100-year design sump elevation for Charlie Sump. Recommendations to address this deficiency will be addressed in the West Levee Interior Drainage Study.

- Pavaho and Delta Pumping Plants did not have sufficient capacity to dewater Pavaho, Trinity-Portland, Frances Street, and Westmoreland-Hampton sumps in a timely manner.

- Based on the data used to perform this analysis and recognizing its limitations, a conservative estimate of only 19 structures sustained flood elevations above the finished floor elevation. An unknown number of structures sustained water intrusion to the foundation, and an unknown number of detached structures such as garages and storage sheds were flooded.

3.3 HYPOTHETICAL STORM EVENT SIMULATIONS FOR EXISTING CONDITIONS

Hypothetical storm event scenarios were run for existing conditions to identify problems with the system and to establish a baseline against which proposed alternatives would be evaluated. The 100-year (1% annual chance of occurrence) 24-hour duration storm event was simulated using the combined West Levee watershed HEC-HMS and EPA-SWMM models. These simulations used the NCTCOG iSWM 100-year, 24-hour duration precipitation data described in Chapter 2.

Table 3.7 summarizes the existing conditions computed peak water surface elevations for the West Levee sumps.

Table 3.7 – Existing Conditions 100-year Peak Sump Elevations for West Levee Sumps

Sump	Maximum 100-year Sump Elevation Existing Conditions (ft)
Corinth Street	402.1
Charlie	403.5
Pavaho	Pond A – 407.9 Pond B – 407.9 Pond C – 408.0
Westmoreland-Hampton	408.4
Frances Street	410.2
Trinity-Portland	411.9
Eagle Ford	417.3

Exhibit 9 shows the inundation areas associated with these peak 100-year water surface elevations. The US Army Corps of Engineers Fort Worth District economic model database was used to determine "potentially affected" structures and "flooded" structures associated with these inundation areas and peak 100-year water surface elevations. "Potentially affected" means that any part of the structure is touched by the inundation area. "Flooded" means that any part of the structure is touched by the inundation area, and the estimated finished floor elevation is below the water surface elevation. Table 3.8 lists the numbers of potentially affected and flooded structures for the 100-year, 24-hour duration hypothetical storm event under existing conditions. The data in Table 3.8 are depicted graphically on Exhibits 10-13.

Options to reduce the 100-year maximum sump elevations and reduce the number of potentially affected and flooded structures are discussed in detail in Section 4.

Table 3.8 – Potentially Affected and Flooded Structures for Existing Conditions 100-year Peak Sump Elevations

Sump	Number of Potentially Affected Structures	Number of Flooded Structures
Corinth Street	12	2
Charlie	34	3
Pavaho	1047	205
Westmoreland-Hampton	71	3
Frances Street	11	3
Trinity-Portland	59	8
Eagle Ford	34	0

4. ALTERNATIVES

A number of alternatives were evaluated to determine a set of recommended improvements to the City's West Levee interior drainage system. The computer models described in Chapter 3 were used to evaluate the alternatives. The initial goal of the alternatives was to reduce computed peak sump elevations for the 100-year, 24-hour event to the City's design elevations for all of the West Levee sumps. After review of the number of structures that would remain affected by floodwaters at the design elevations, further study was initiated to determine new recommended design elevations and to evaluate alternatives to lower the flood levels below the design elevation. An analysis comparing inundation elevation versus potentially affected and flooded structures was conducted.

Using GIS, a series of inundation maps depicting the inundation area for each sump at a number of 6-inch intervals around the existing design elevation was produced. The inundation elevations were compared with estimated finished floor elevations for structures in the inundation areas to determine the number of potentially affected and potentially flooded structures. In this analysis, potentially affected structures are those structures touched by the inundation area. Potentially flooded structures are a subset of potentially affected structures, defined as those structures touched by the inundation area that have estimated finished floor elevations below the water surface elevation.

The potentially affected and potentially flooded structures were tabulated for each inundation elevation. The number and spatial distribution of potentially affected and potentially flooded structures at each inundation elevation were noted. Based on this analysis, recommended design elevations were selected for each sump. It was not practical to select recommended design elevations for each sump that were low enough to preclude all potentially affected and potentially flooded structures.

Once the recommended design elevations were selected, the potentially affected structures were surveyed to determine their finished floor elevations. If the surveyed finished floor elevation of a structure was less than the design elevation, the structure was classified as a flooded structure at the recommended design elevation. Exhibit 14 is a map of all the proposed design elevations for the West Levee sumps. Exhibit 15-18 show the proposed design elevation inundation areas isolated for various sumps. The bar charts on Exhibit 15-18 illustrate the estimated and surveyed finished floor elevations for potentially affected structures in that sump area. The red line on the bar charts is the recommended sump design elevation. If the surveyed finished floor elevation (depicted by the orange bars on the chart) for a structure falls below the recommended sump design elevation, that structure is classified as a flooded structure and is labeled on the chart. Some potentially affected structures do not have associated surveyed finished floor elevations. This is because the structure no longer exists, or was a non-qualifying structure such as a storage shed. In rare cases, the structure was not surveyed because it could not be accessed.

Table 4.0.1 shows how the West Levee design elevations have changed over the years. Table 4.0.1 also shows the recommended design elevations developed for this project. Alternatives identified for this project met the objective of the recommended design elevations for all the West Levee sumps.

Table 4.0.1 – West Levee Sump Design Elevations

Sump	1950's COE Report	1973 URS/F&C Report (4)	1980's to present City of Dallas (5)	2008 Recommended
Corinth Street	399.6 (1)	400.4	404.3	402.5
Charlie	403.4 (1)	402.7	404.1	402.5
Pavaho	404.2 (2)*	406.0	408.7	405.5
Westmoreland-Hampton	404.2 (2)*	406.0	406.9	406.9
Frances Street	410.0 (2)	409.4	410.1	410.1
Trinity-Portland	413.8 (2)	412.7	413.0	411.5
Eagle Ford	417.5 (3)	415.7	416.0	416.0

* No distinction is made in the COE report between Westmoreland-Hampton and Pavaho Sumps - the combined area is referred to as "Below Westmoreland Road Area"

(1) Fort Worth District COE. "Definite Project Report on Dallas Floodway - Volume V - Interior Drainage Facilities Pumping Plant C Area," October 1954. "Pertinent Data" Table, Page B

(2) Fort Worth District COE. "Definite Project Report on Dallas Floodway - Volume III - Interior Drainage Facilities Pumping Plant D Area Including Pavaho Street Pumping Plant," October 1952. "Pertinent Data" Table, Page A

(3) Fort Worth District COE. "Definite Project Report on Dallas Floodway - Volume III - Interior Drainage Facilities Pumping Plant D Area Including Pavaho Street Pumping Plant," October 1952. Attachment to report: Memo to the Division Engineer, Southwestern Division Corps of Engineers, 5 December 1952.

(4) URS/Forrest and Cotton, Inc. "Report on Interior Drainage Study - West Levee - Dallas Floodway Project," September 1973

(5) City of Dallas Memorandum "100 YR. W.S. Elevations for Sump Areas Used by City of Dallas" - undated, but no earlier than 7-30-85

The flooded structures at the recommended design elevations are tabulated in Table 4.0.2. Table 4.0.2 is not an exhaustive list – it was not possible to survey every structure. Furthermore, it is likely that many more structures will flood due to localized drainage issues not directly related to the sump elevations.

Table 4.0.2 – Flooded Structures at Recommended Sump Design Elevations

Sump	Flooded Structure Address
Corinth Street	426 Pecan Drive
Pavaho	3301 Topeka Avenue
Pavaho	3302 Topeka Avenue
Pavaho	3318 Topeka Avenue
Pavaho	3328 Topeka Avenue
Trinity-Portland	3413 Bernal Drive

In addition to improvements necessary to reduce the peak sump stages, consideration was given to modernizing and extending the service life of any remaining existing pump stations at least another 50 years. Recommendations for rehabilitating existing pump stations were developed to accomplish these goals.

For planning purposes, the preliminary opinions of probable costs have been escalated at six percent per year to an assumed mid point of construction of three years. Present-day preliminary probable costs are based on 2008 conditions, and the cost escalation factor for future probable costs is 1.191. The detailed preliminary opinions of probable costs for the recommended alternatives include both present-day probable costs and future probable costs. For simplicity, comparisons of alternates in this chapter are made on the basis of present-day probable costs. The selection of alternates based on present-day probable costs is also valid if future costs are considered, since the future probable costs are a multiple of the present-day probable costs.

When constructing new interior drainage facilities and rehabilitating existing facilities, all outfall structures in the Dallas Floodway must be compatible with the Balanced Vision Plan for the Trinity River Corridor. On the East Levee side of the Floodway, some of the existing and proposed outfall structures will have to pass under the proposed man-made lakes to discharge into the realigned pilot channel in the Dallas Floodway. On the West Levee side of the Floodway, none of the existing and proposed outfall structures will be affected by the Balanced Vision Plan (as of this writing). Therefore, the recommendations from this study did not need to address extension of outfall structures to tie into the proposed lakes or realigned pilot channel for the Balanced Vision Plan. These estimates and associated probable costs may need to be revised if the Balanced Vision Plan features are revised.

Fundamentally, reduction of peak stages in a sump may be accomplished by decreasing the magnitude or altering the timing of the inflow hydrograph to the sump, increasing the discharge from the sump, or increasing the storage capacity of the sump. It is not considered feasible to decrease the magnitude or alter the timing of the existing sump inflow hydrographs significantly due to the large amount of detention storage which would be required. Certainly, future land development in the interior drainage basins should include drainage features including detention in accordance with City of Dallas development guidelines. Increasing sump storage capacity and/or discharge capacity are the only viable alternatives to reducing peak stages in the sumps.

If land is available or can be acquired at a favorable price, it could be more cost-effective to increase sump storage capacity rather than increasing discharge capacity; however, the highly developed nature and possibly high property values in the area surrounding the existing West Levee sumps limit their potential expansion except in a few areas. In discussions with the City of Dallas, a potential area of sump expansion was identified south of Trinity-Portland sump (commonly known as the "railroad property"). A number of alternatives involving increased sump storage in this area were identified and evaluated. Preliminary opinions of probable costs were developed for these alternatives, and were found not to be cost-competitive with additional pumping capacity. Furthermore, this property is slated for development and could not be fully devoted to additional sump storage. It is imperative that any development in this area or in any area adjacent to a sump does not reduce the available sump storage in any way.

The following sections describe the significant alternatives that were evaluated in each sump to lower the existing conditions 100-year flood level to the elevation described in the alternative. Not all alternatives evaluated in this study are described. As was indicated above, the evaluation of alternatives in each sump started with lowering the existing conditions water level down to the design elevation. As was the case in most sumps, inundation to the design elevation left numerous structures affected by the proposed water level. From there an analysis was undertaken to add drainage capacity to the sump area to further lower the flood levels. These analyses included combinations of the following alternatives:

1. Constructing additional culverts under selected roadways to improve the conveyance of floodwaters between sump storage areas,
2. Constructing new or additional gravity sluices through the West Levee to allow more flood water to pass through the levee and into the Floodway under gravity conditions, and
3. Constructing additional pumping capacity to pump floodwaters into the Floodway under non-gravity flow conditions.

The alternatives were evaluated qualitatively by comparing the number of flooded or affected structures that remained. As this evaluation progressed, it became clear that protecting all structures within the sump area by constructing additional flood conveyance capacity in the interior system might not be feasible. As these alternatives are considered by the City of Dallas and the U. S. Army Corps of Engineers, it will be left to those agencies to determine if further reductions in flood water levels would be needed to protect all structures.

Table 4.0.3

DALLAS INTERIOR DRAINAGE STUDY - WEST LEVEE

Charlie & Corinth Street Sumps

Option Number	Description	Construction Work Effort (w/o escalation)	**Construction Work Effort (w/ escalation)	**City Contract Administration, Construction Materials Testing, Construction Management, and Engineering and Surveying Services	**Total Costs
Charlie Rehab		$2,690,400	$3,600,293	$1,134,092	$4,734,386
C1	2-10'x10' Gravity Sluices	$3,157,116	$4,224,853	$1,330,829	$5,555,681
C2A	**225,000 gpm Charlie Pump Station (discharge through existing gravity sluices)**	**$22,896,863**	**$30,640,582**	**$9,651,783**	**$40,292,365**
C2B	145,000 gpm Charlie Pump Station (existing gravity sluices remain)	$20,752,752	$27,771,333	$8,747,970	$36,519,303
Charlie & Corinth Street Sumps Recommended Options Subtotal		$22,896,863	$30,640,582	$9,651,783	$40,292,365

Eagle Ford, Trinity-Portland, Frances Street, Westmoreland-Hampton, & Pavaho Sumps

Option Number	Description	Construction Work Effort (w/o escalation)	**Construction Work Effort (w/ escalation)	**City Contract Administration, Construction Materials Testing, Construction Management, and Engineering and Surveying Services	**Total Costs
P1	500,000 gpm Pavaho Pump Station	$28,619,277	$34,085,559	$10,736,951	$44,822,510
***P2**	**375,000 gpm Pavaho Pump Station**	**$23,871,153**	**$28,430,543**	**$8,955,621**	**$37,386,164**
P2	**2-10x6' RCB at Sylvan Avenue**	**$1,018,800**	**$1,363,358**	**$429,458**	**$1,792,816**
P2	**1-10'x8' RCB at Canada Drive**	**$558,264**	**$747,069**	**$235,327**	**$982,396**
	P2 Total	$25,448,217	$30,540,970	$9,620,405	$40,161,375
D1A	250,000 gpm Delta Pump Station - Levee Penetration	$25,992,945	$34,783,759	$10,956,884	$45,740,643
D1A	2-10'x6' RCB at Westmoreland Road	$1,533,900	$2,052,665	$646,589	$2,699,254
D1A	1- 6'x4' gated RCB at Ledbetter Dike	$1,032,924	$1,382,259	$435,412	$1,817,670
	D1A Total	$28,559,769	$38,218,683	$12,038,885	$50,257,568
D1B	166,000 gpm Delta Pump Station	$20,394,182	$27,291,495	$8,596,821	$35,888,316
D1B	2-10'x6' RCB at Westmoreland Road	$1,533,900	$2,052,665	$646,589	$2,699,254
D1B	1- 6'x4' gated RCB at Ledbetter Dike	$1,032,924	$1,382,259	$435,412	$1,817,670
D1B	Delta Rehab	$2,540,400	$3,399,563	$1,070,862	$4,470,426
	D1B Total	$25,501,406	$30,726,419	$9,678,822	$40,405,241
D2	150,000 gpm Trinity Portland Pump Station - Levee Penetration	$24,070,800	$32,211,545	$10,146,637	$42,358,182
D2	Delta Rehab	$2,540,400	$3,399,563	$1,070,862	$4,470,426
	D2 Total	$26,611,200	$35,611,108	$11,217,499	$46,828,607
D3	1- 6'x6' gated conduit structure between Eagle Ford and Trinity-Portland sumps	$1,224,600	$1,638,760	$516,209	$2,154,969
D3	2-6'x4' gated RCB at Ledbetter Dike	$1,390,140	$1,860,285	$585,990	$2,446,275
D3	3-10'x6' RCB at Westmoreland Road	$1,124,988	$1,505,459	$474,220	$1,979,679
D3	400,000 gpm Delta Pump Station (no station at Eagle Ford or Trinity-Portland)	$26,271,926	$35,157,091	$8,955,621	$46,231,575
	D3 Total	$30,011,654	$40,161,595	$10,532,040	$52,812,498
D4	**1- 6'x6' gated conduit structure between Eagle Ford and Trinity-Portland sumps**	**$1,224,600**	**$1,638,760**	**$516,209**	**$2,154,969**
D4	**250,000 gpm Trinity-Portland Pump Station - Levee Penetration**	**$25,810,605**	**$34,539,751**	**$10,880,022**	**$45,419,773**
D4	**Delta Rehab**	**$2,540,400**	**$3,399,563**	**$1,070,862**	**$4,470,426**
	D4 Total	$29,575,605	$39,578,074	$12,467,093	$52,045,168
EF1	7-4.5'x4.5' Gravity Sluices	$2,782,296	$3,723,269	$1,172,830	$4,896,098
EF2	2-10'x10' Gravity Sluices	$2,152,488	$2,880,459	$907,345	$3,787,804
EF3	1-10'x12' Gravity Sluice	$1,830,168	$2,449,131	$771,476	$3,220,607
EF4	100,000 gpm Eagle Ford Pump Station	$19,299,318	$25,826,347	$8,135,299	$33,961,647
EF5	150,000 gpm Eagle Ford Pump Station	$20,760,048	$27,781,097	$8,751,045	$36,532,142
Eagle Ford, Trinity-Portland, Frances Street, Westmoreland-Hampton, & Pavaho Sumps Subtotal		**$55,023,821**	**$70,119,044**	**$22,087,499**	**$92,206,543**
All Recommended Options Total		**$77,920,684**	**$100,759,626**	**$31,739,282**	**$132,498,908**

*Estimates for the Pavaho Pump Station options carry a 10% contingency due to being further along in estimating process. All other options carry a 20% contingency due to the initial stages of the estimating process.

**costs are escalated at 6% for 5 years for all except Pavaho. Pavaho's escalated at 6% for 3 years.

4.1 CHARLIE AND CORINTH STREET SUMPS

Several alternatives were evaluated in the Charlie and Corinth Street Sumps to lower the existing conditions flood level. These alternatives are described in the following sub sections.

4.1.1 Option C1 – Rehab Existing Pump Station, 2 New 10'x10' Gravity Sluices

This option includes the following items:

1. Rehabilitation of the existing Charlie Pump Station, and
2. Construction of two new 10'x10' gravity sluices adjacent to the existing station.

No new pump station is proposed for this option. The preliminary opinion of probable cost for rehabilitation Charlie Pump Station is shown in Table 4.1.1.

The proposed new gravity sluices are shown in Figure 4.1.1 and the preliminary opinion of probable cost is shown in Table 4.1.2.

TABLE 4.1.1
Engineer's Preliminary Opinion of Probable Costs
DALLAS INTERIOR DRAINAGE STUDY
Rehabilitation Work @ Charlie Pump Station

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Mobilization	1	LS	$0.00	$0	$50,000.00	$50,000	$50,000
Subtotal for Division 1				$0		$50,000	$50,000
[illegible]							
Repair Vehicular Gates	1	LS	$500.00	$500	$200.00	$200	$700
Repair Outfall Channel	1,000	CY	$10.00	$10,000	$5.00	$5,000	$15,000
Repair South Staircase	1	LS	$5,000.00	$5,000	$500.00	$500	$5,500
New Fence	1	LS	$10,000.00	$10,000	$2,000.00	$2,000	$12,000
New Concrete Drive	20	CY	$200.00	$4,000	$100.00	$2,000	$6,000
Outlet Rip Rap	50	Tons	$100	$5,000	$10.00	$500	$5,500
Subtotal for Division 2				$34,500		$10,200	$44,700
[illegible]							
Subtotal Division 3				$0		$0	$0
[illegible]							
Re-brick closed openings to provide weather tight enclosure	1	LS	$800.00	$800	$200.00	$200	$1,000
Regrout/Repair Existing Brickwork	1	LS	$2,500.00	$2,500	$2,500.00	$2,500	$5,000
Subtotal for Division 4				$3,300		$2,700	$6,000
[illegible]							
New Handrails	1	LS	$2,500.00	$2,500	$500.00	$500	$3,000
Subtotal for Division 5				$2,500		$500	$3,000
[illegible]							
Subtotal for Division 6				$0		$0	$0
[illegible]							
Replace and Repair Tile Coping and Roof	1	LS	$17,000	$17,000	$2,550.00	$2,550	$19,550
Replace Roof Hatch Hardware	1	LS	$2,000	$2,000	$500.00	$500	$2,500
Subtotal for Division 7				$19,000		$3,050	$22,050
[illegible]							
Replace Steel Sliding Door and Hardware	1	LS	$3,000	$3,000	$500.00	$500	$3,500
Replace Wall Louvers: Fixed and Operable	1	LS	$1,200	$1,200	$600.00	$500	$1,700
Subtotal for Division 8				$4,200		$1,000	$5,200
[illegible]							
Paint Interior (walls,floors, & ceiling)	1	LS	$1,500.00	$1,500	$500.00	$2,500	$4,000
Glaze and Paint Steel Casement Windows	1	LS	$300.00	$300	$150.00	$150	$450
Subtotal for Division 9				$1,800		$2,650	$4,450
[illegible]							
Subtotal for Division 10				$0		$0	$0
[illegible]							
New Pumps	2	Each	$800,000.00	$1,600,000	$50,000.00	$100,000	$1,700,000
Piping/Valves	1	LS	$100,000.00	$100,000	$25,000.00	$25,000	$125,000
Subtotal for Division 11				$1,700,000		$125,000	$1,825,000
[illegible]							
Subtotal for Division 12				$0		$0	$0
[illegible]							
Subtotal for Division 13				$0		$0	$0
[illegible]							
New Screenings Conveyor	1	LS	$75,000.00	$75,000	$5,000.00	$5,000	$80,000
Subtotal for Division 14				$75,000		$5,000	$80,000
[illegible]							
HVAC	1	LS	$55,000	$55,000	$5,000.00	$5,000	$60,000
Subtotal for Division 15				$55,000		$5,000	$60,000
[illegible]							
Replace Transformers and Panelboards	1	LS	$20,000	$20,000	$3,000.00	$3,000	$23,000
New 480V Motor Control Center	1	LS	$57,500	$57,500	$8,625.00	$8,625	$66,125
New Conduit & Wire	1	LS	$16,500.00	$16,500	$2,475.00	$2,475	$18,975
New Lighting	1	LS	$2,500	$2,500	$1,000.00	$1,000	$3,500
Subtotal for Division 16				$96,500		$15,100	$111,600
Division 17 - I&C							
Controls and Scada System Improvements	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Subtotal for Division 17				$25,000		$5,000	$30,000
Division Subtotal [illegible]				[illegible]		[illegible]	[illegible]
Contingency (20%)							$448,400
[illegible]							[illegible]
[illegible]							[illegible]
[illegible]							[illegible]
Engineering and Surveying Services (12%)							$432,035
Construction Management (8%)							$288,023
Construction Materials Testing (1.5%)							$54,004
City Contract Administration (10%)							$360,029
Services Subtotal [illegible]							[illegible]
Total Estimated Project Cost							$4,734,386

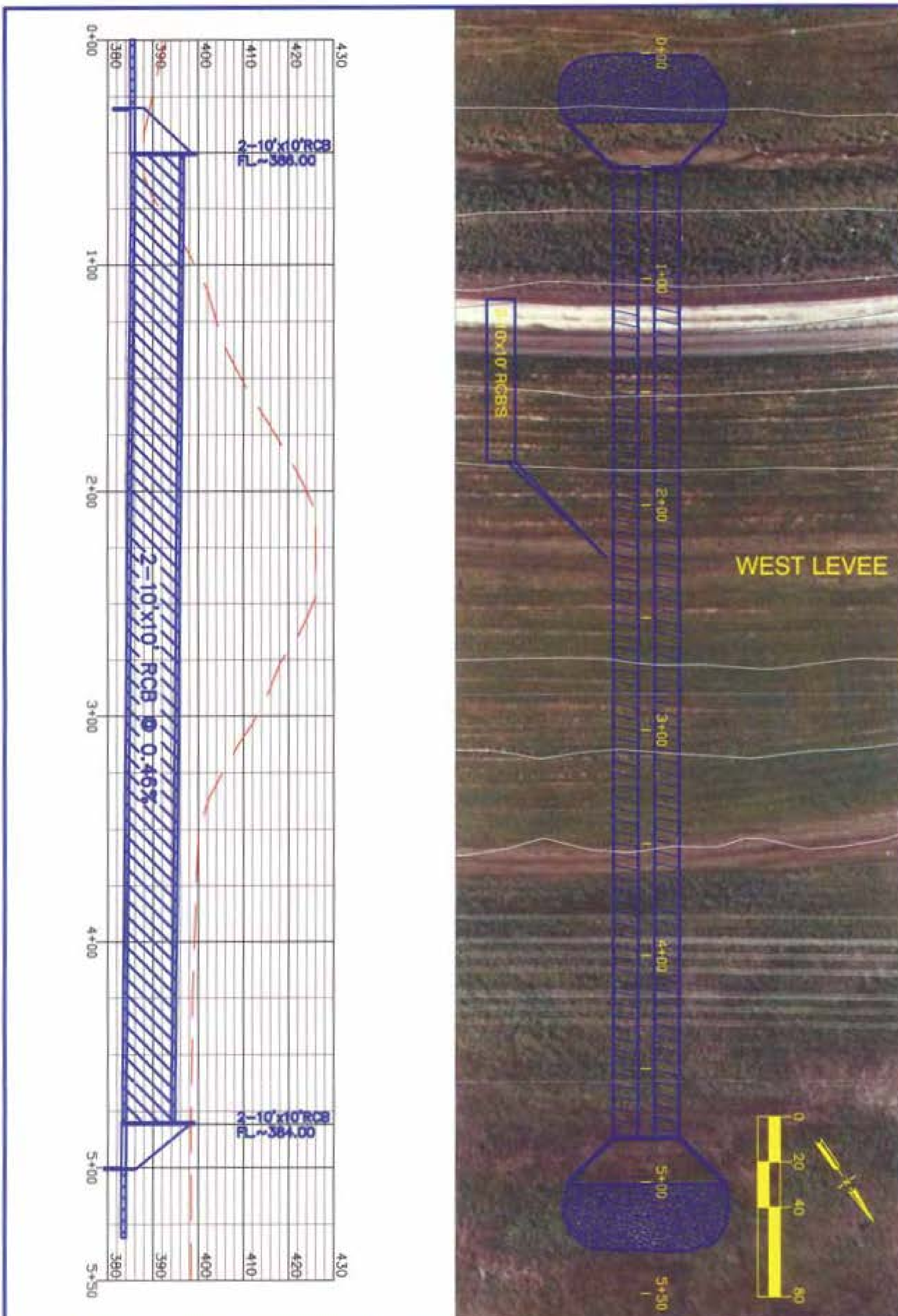


FIGURE 4.1.1	OPTION C1 PROPOSED CHARLIE SUMP 2-10'x10' RCB'S	CITY OF DALLAS DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION	JE JACOBS Carter Burgess

Table 4.1.2
Engineer's Preliminary Opinion of Probable Costs

Option C1 Culvert Improvements
Charlie Sump

Item No.	Description	Unit	Quantity	Unit Cost	Estimated Cost
1	10' x 10' RCB	LF	417	$3,500	$1,459,500
2	Trench Safety and Support	LF	170	$4	$680
3	CIP Headwall	EA	2	$25,000	$50,000
4	6" Concrete Apron Pavement	SY	70	$40	$2,800
5	PVC Coated Gabions	CY	75	$250	$18,750
6	Sodding	SY	600	$7	$4,200
7	Erosion Control	LS	1	$25,000	$25,000
8	Dewatering	LS	1	$50,000	$50,000
9	10'x10' Sluice Gate	EA	2	$160,000	$320,000
9	Operators	EA	2	$30,000	$60,000
10	Flap Gates	EA	2	$45,000	$90,000
11	Cofferdam	CY	10000	$20	$200,000
12	Sluice Structure	LS	1	$250,000	$250,000
13	Mobilization	LS	1	$100,000	$100,000
Subtotal					$2,630,930
20% Contingency					$526,186
Total					**$3,157,116**
Escalation to Midpoint @ 6%/year& 5 yrs					$1,067,737
Subtotal					**$4,224,853**
Engineering and Surveying Services (12%)					$506,982
Construction Management (8%)					$337,988
Construction Materials Testing (1.5%)					$63,373
City Contract Administration (10%)					$422,485
Service Subtotal					**$1,330,829**
Total Estimated Project Cost					**$5,555,681**

4.1.2 Option C2 – New Pump Station

Numerous options were evaluated in the Charlie and Corinth Street Sump area to reduce flood levels. Two of those options will be described below. The options are Option C2A and C2B.

4.1.2.1 Option C2A – Demo Existing Pump Station, New 225,000 GPM Pump Station

This option includes constructing a new pump station at the existing Charlie Pump Station site and demolishing the existing Charlie Station.

The Charlie Storm Water Pump Station evaluated for Option C2A has a total pumping capacity of 225,000 gpm. The pumping is accomplished with the use of three 75,000 gpm vertical axial flow pumps, each rated at 55 feet total dynamic head (TDH). Each of these pumps is driven by a 1500 horsepower electric motor operating at 295 rpm, eliminating the need for a gear reducer between the motor and pump. Additionally, a 6,000 gpm vertical axial flow pump is provided for dewatering the sump during periods of low flow.

Pump station discharge piping will be configured to use the two existing 4'x4' gravity sluices at Charlie Pump Station as outfall to the river. Each individual pump will be equipped with a dedicated discharge header with a goose-neck high point elevation above the top of levee and an air release valve to prevent back-siphoning into the station. Station piping will be lined with high density polyurethane and coated with suitable epoxy-based systems.

The pump station will be configured in accordance with the guidance contained in the following documents:

- "Hydrologic Analysis of Interior Areas" EM 1110-2-1413, dated 15 January 1987
- "Hydrologic Frequency Analysis" EM 1120-2-1415, dated 05 March 1993
- "Flood Run-off Analysis" EM 1110-2-1417, dated 31 August 1994
- "Risk-Based Analysis for Flood Damage Reduction Studies" EM 1120-2-1619, dated 01 August 1996
- *EM1110-2-2100 Stability Analysis of Concrete Structures*
- *EM1110-2-2102 Waterstops and Other Preformed Joint Materials for CW Structures*
- *EM1110-2-2502 Retaining Walls*
- *EM1110-2-3104 Structural and Architectural Design of Pumping Stations*
- *EM1110-2-3105 Mechanical and Electrical Design of Pumping Stations*
- *EM1110-2-1804 Geotechnical Investigations*

The pump station substructure is cast-in-place concrete designed in accordance with ACI 310R and other appropriate standards. The foundation is a mat consisting of a five foot thick concrete slab to which the walls are attached. The walls utilize a stepped design in which the walls are reduced in thickness as the height of the structure increases and the soil load decreases. The sump area is deep and a removable hatch has been incorporated into the floor deck to provide access for removing debris that will accumulate in the sump area. The hatch is large enough to accommodate a small Bobcat.

The superstructure of the pump station is cast-in-place concrete and beams are incorporated into the structure to accommodate the installation of a bridge crane for maintenance. The pump station roof is designed to be double tees, which increases the stiffness of the structure and simplifies construction and maintenance. The roof will consist of the double tees, a two-inch layer of light-weight grout, and a membrane. The superstructure has been designed so that a drive through corridor is incorporated into the station, permitting truck access directly adjacent to the pumps for maintenance.

The exterior wall sections have been assumed to be concrete masonry units with brick veneer, although a different system may be incorporated in the final design.

The pump station interior in the pump room is unfinished; however, the interiors of the switchgear room, office, and restroom have conventional dry wall construction and are painted. Flooring throughout the station is concrete with a troweled finish. The main pump room is provided with ventilation, while the switchgear room, office, and restroom are conditioned.

The primary electrical supply to the station is three-phase, 4160 v.a.c. and is provided by TXU. The supply is from two independent substations providing needed redundancy. Therefore, the standby generator set is for use by limited equipment including the control system, lighting, HVAC components, and the bridge crane. The switchgear is located in the switchgear room and includes soft starts for each of the main pumping units. The switchgear is configured as a main-tie-main to provide additional redundancy and reliability in station operation.

This pump station is located on the West Levee, adjacent to the existing Charlie Pump Station, between Houston and Jefferson Streets. Access to the station is provided via a concrete paved access road. Roll-up doors on the station provide the drive-through access. Since the site is located next to the sump a retaining wall is provided to level the site for routine operations. Water and sewer are available in adjacent public streets, and a two-inch water service and a 4-inch sanitary sewer has been provided for the station.

The interior lighting level will be maintained at 85 foot candles. All handrails will be four-rung aluminum. Grating will be hot-dipped galvanized.

The instrumentation and control system will incorporate monitoring and alarming for motor and pump bearing temperature, motor winding temperature, reverse rotation, flow for each pump, sump elevation, and precipitation. The controls system will be integrated into the SCADA system operated by the City of Dallas. Individual pump control can be initiated at the pump, in the operator office/control room, or remotely by the SCADA system.

Figure 4.1.2 is a site plan for this alternative.

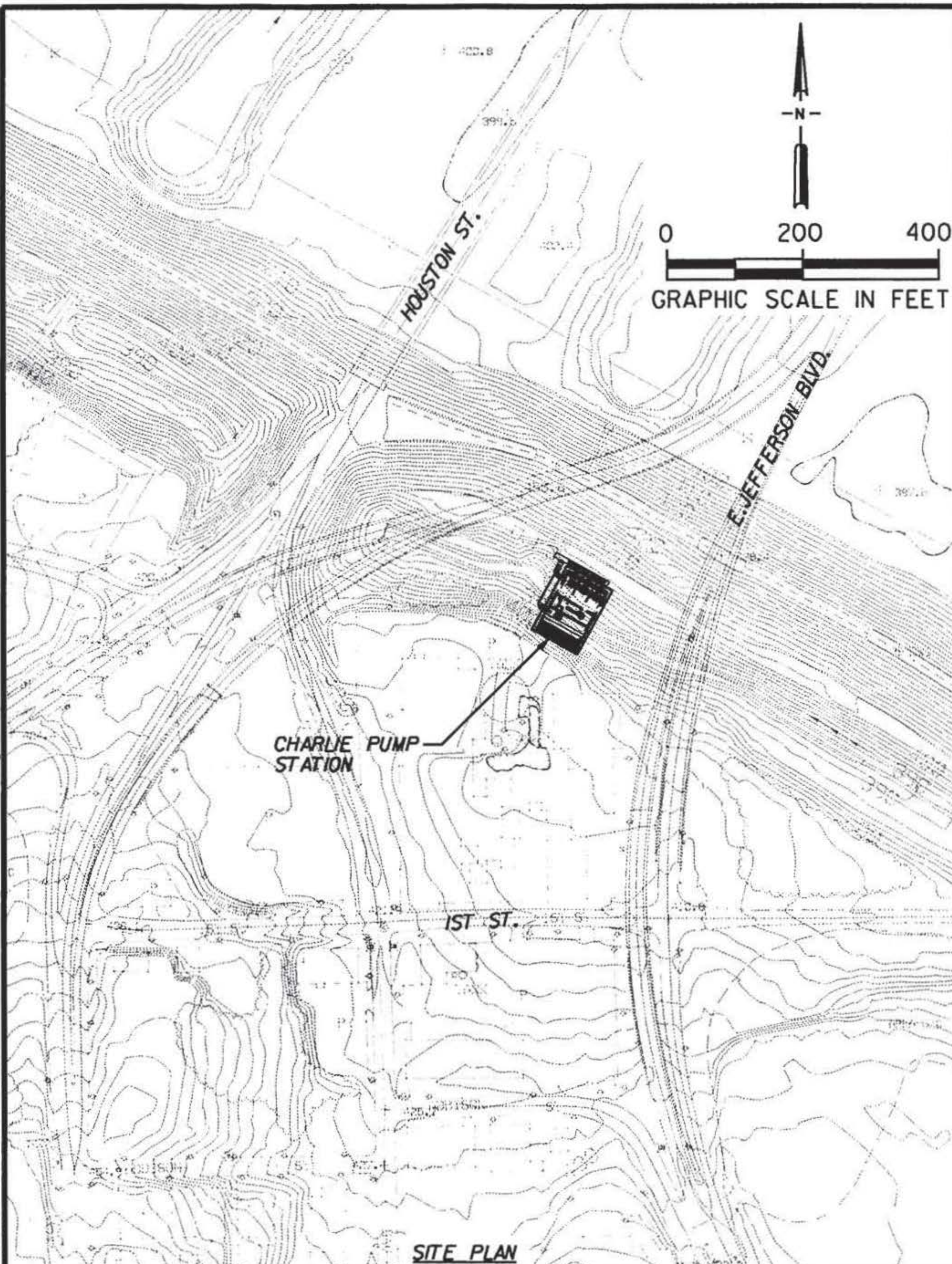
Figure 4.1.3 is a plan view of the 225,000 gpm pump station. The trash rack in the front of the station will be equipped with mechanically-cleaned screens manufactured by Du Perion, since these screens have demonstrated ability to function very effectively in this harsh environment. The switchgear room is adjacent to the pump room.

Figure 4.1.4 is Section A and the relationship of the pumping units, intake sump, and discharge piping are clearly indicated. The bridge crane has 27-foot clearance above the drive through for removal and/or installation of the pumping equipment.

Figures 4.1.5A and 4.1.15B are the electrical one-line diagrams for the station. The double-ended switchgear is indicated. Each of the main pumps is operated by a soft start that has a by-pass that permits the motor to be started even if the soft start is out of service. In addition to the protection provided by the soft start, each of the motors will be equipped with a Multilin 469 to provide motor protective relay systems.

Figure 4.1.6 is a preliminary process and instrumentation diagram for the pump station. The vibration monitoring equipment is shown, as are the RTDs for monitoring motor winding temperatures, and the pump and motor bearing temperatures. Each of the pumps will be equipped with an ultrasonic flow meter to monitor pump discharge.

The Engineer's Preliminary Opinion of Probable Cost for the storm water pump station for Option C2A is summarized in Table 4.1.3.



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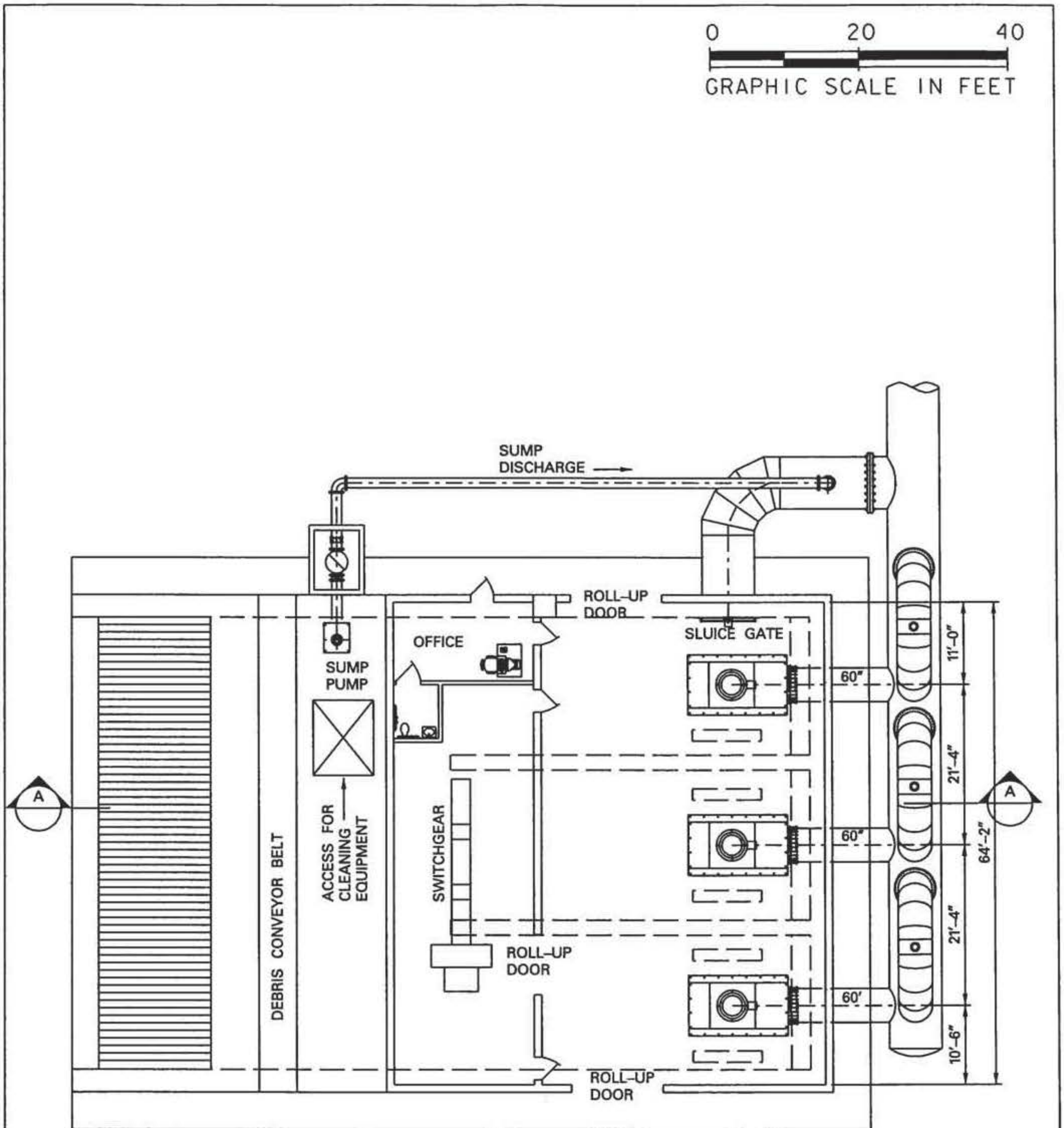

PLAN VIEW
SCALE: 1" = 20'

STATION CAPACITY = 225,000 GPM
75,000 GPM PER PUMP

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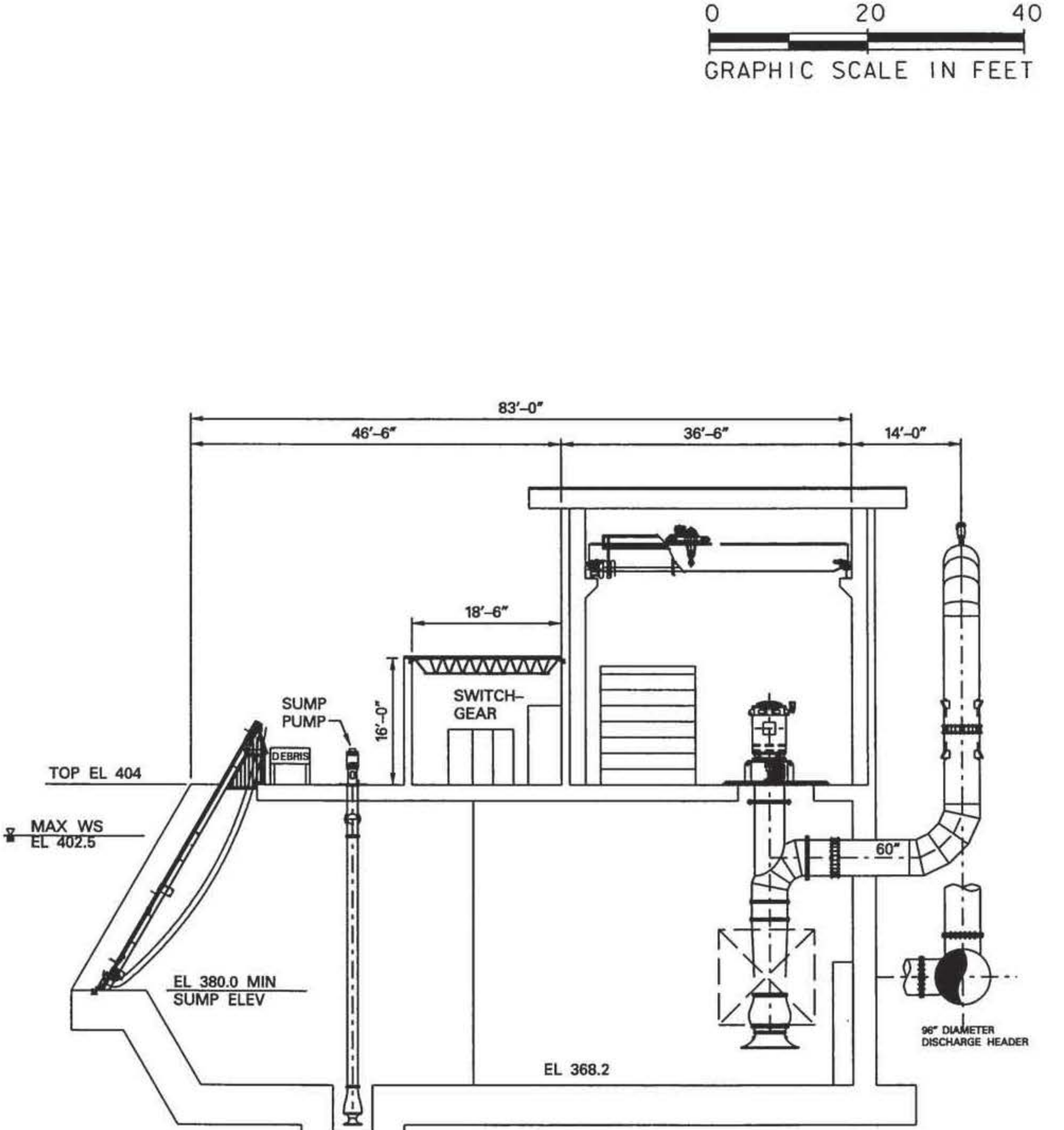

SECTION A – VERTICAL PUMPS

SCALE: 1" = 20'

STATION CAPACITY = 225,000 GPM
75,000 GPM PER PUMP

JACOBS Carter Burgess	CITY OF DALLAS DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION	PROPOSED CHARLIE PUMP STATION VERTICAL PUMPS 225,000 GPM CAPACITY	FIGURE 4.1.4

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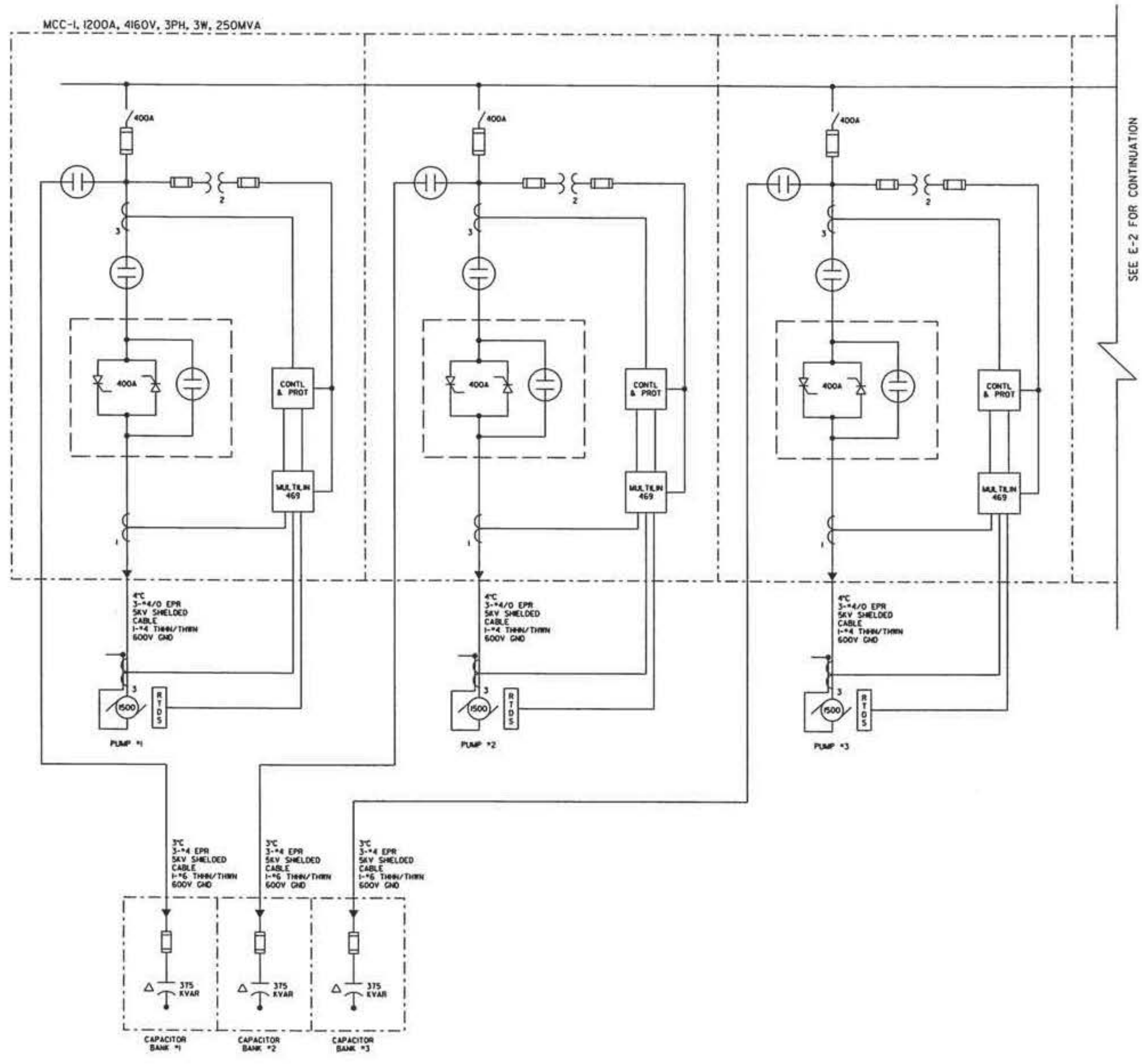

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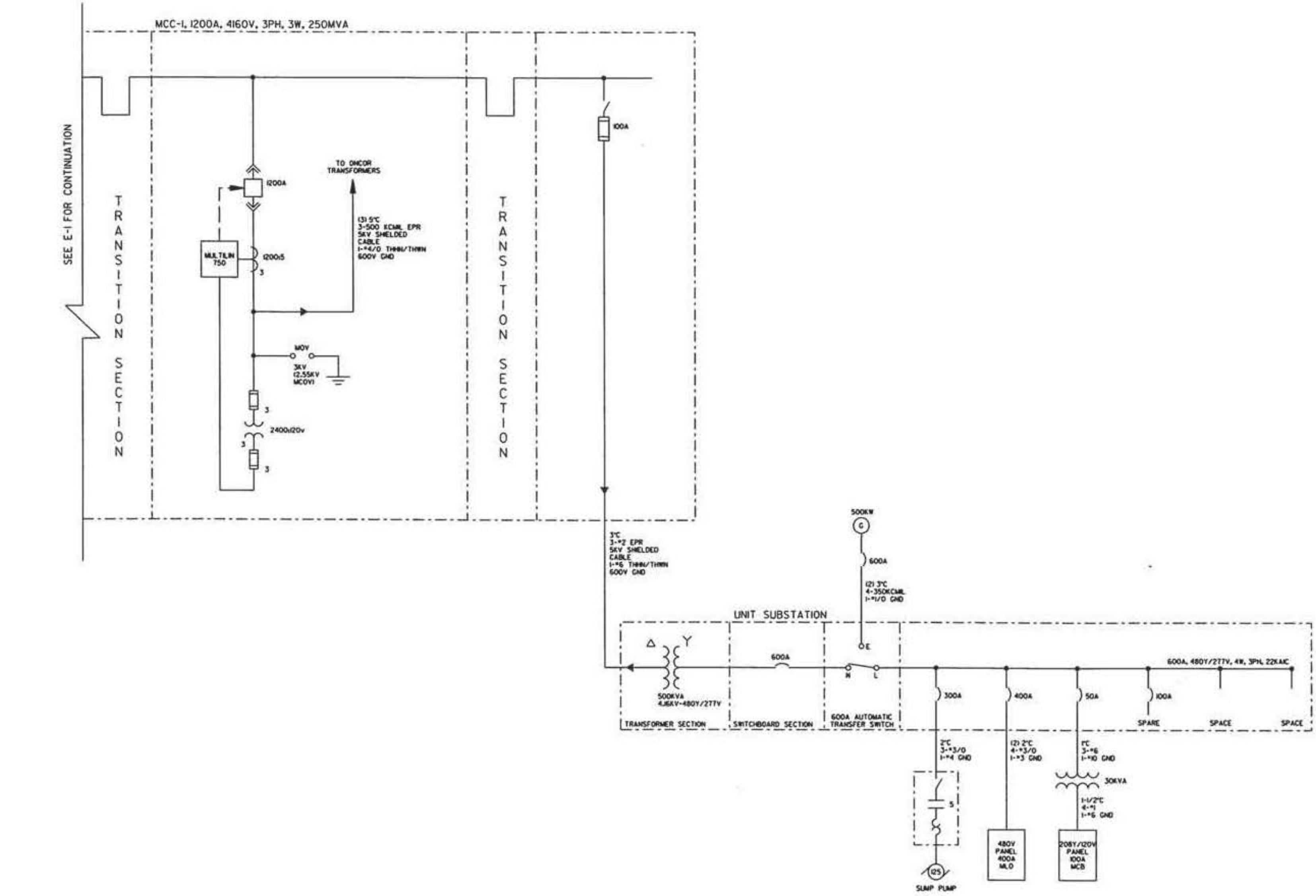
PROPOSED CHARLIE PUMP STATION
VERTICAL PUMPS
225,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

FIGURE
4.1.5A



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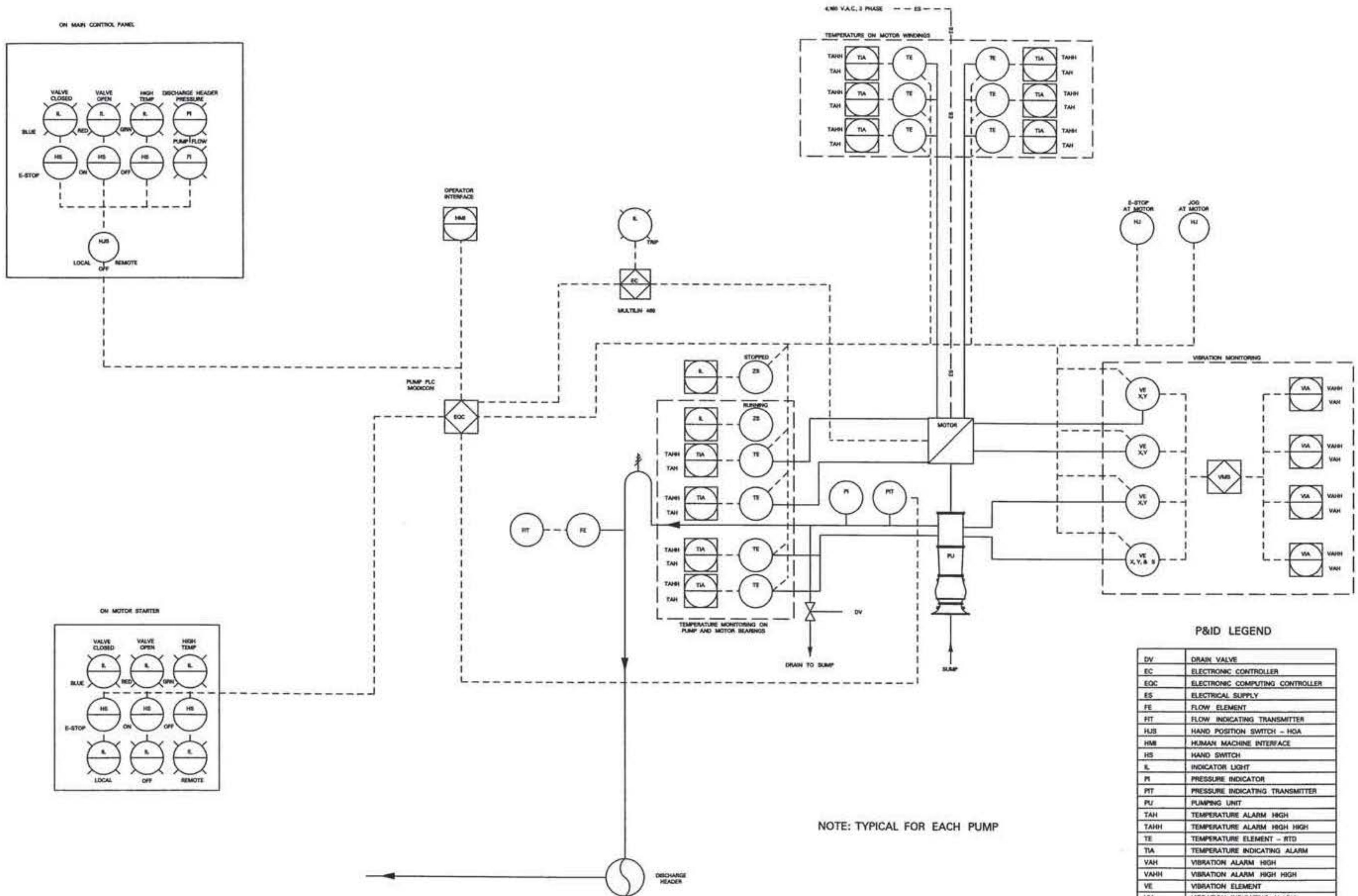
PROPOSED CHARLIE PUMP STATION
VERTICAL PUMPS
225,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

FIGURE
4.1.5B



P&ID LEGEND

DV	DRAIN VALVE
EC	ELECTRONIC CONTROLLER
EQC	ELECTRONIC COMPUTING CONTROLLER
ES	ELECTRICAL SUPPLY
FE	FLOW ELEMENT
FIT	FLOW INDICATING TRANSMITTER
HJS	HAND POSITION SWITCH – HOA
HMI	HUMAN MACHINE INTERFACE
HS	HAND SWITCH
IL	INDICATOR LIGHT
PI	PRESSURE INDICATOR
PIT	PRESSURE INDICATING TRANSMITTER
PU	PUMPING UNIT
TAH	TEMPERATURE ALARM HIGH
TAHH	TEMPERATURE ALARM HIGH HIGH
TE	TEMPERATURE ELEMENT – RTD
TIA	TEMPERATURE INDICATING ALARM
VAH	VIBRATION ALARM HIGH
VAHH	VIBRATION ALARM HIGH HIGH
VE	VIBRATION ELEMENT
VIA	VIBRATION INDICATING ALARM
VMS	VIBRATION MONITORING SYSTEM
ZS	POSITION SWITCH

NOTE: TYPICAL FOR EACH PUMP

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DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

PROPOSED CHARLIE PUMP STATION
225,000 GPM CAPACITY
PROCESS AND INSTRUMENTATION DIAGRAM

FIGURE
4.1.6

Table 4.1.3

Summary for Charlie 3 Pump 225,000 gpm

Division	Cost
Division 1 - General Conditions	$2,504,000
Divison 2 - Site Work	$2,238,200
Division 3- Concrete	$2,395,100
Division 4 - Masonry	$87,072
Division 5- Metals	$118,515
Division 6 - Carpentry	$4,000
Division 7 - Thermal & Moisture Protection	$784,835
Division 8 - Doors & Windows	$12,700
Division 9 - Finishes	$85,075
Division 10 - Specialties	$9,700
Division 11 - Equipment	$4,939,750
Division 12 - Furnishings	$4,110
Division 13- Special Construction	$0
Division 14 - Conveying Systems	$350,000
Division 15 - Mechanical	$235,018
Division 16 - Electrical	$2,341,500
Division 17 - Instrumentation & Control	$1,293,500
Division Subtotal	**$17,403,075**
Contractor's Profit of Materials - 10%	$1,212,250
Prime Profit on SubConstractors - 10%	$465,394
Subtotal	**$19,080,719**
Construction Contingencies - 20%	$3,816,144
Construction Work Effort subtotal	**$22,896,863**
Escalation to Midpoint @ 6%/Yr & 3 yrs	$7,743,719
Subtotal	**$30,640,582**
Engineering and Surveying Services (12%)	$3,676,870
Construction Management (8%)	$2,451,247
Construction Materials Testing (1.5%)	$459,609
City Contract Administration (10%)	$3,064,058
Services Subtotal	**$9,651,783**
Total Estimated Project Cost	**$40,292,365**

Table 4.1.3

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Charlie Site with 3 Pumps

225,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 1 - General Conditions							
Mobilization	1	LS	$0	$0		$0	$600,000
Construction Surveying	1	LS	$0	$0	$45,000.00	$45,000	$45,000
Telephone	30	Mo	$150	$4,500	$0.00	$0	$4,500
SWWWP	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Trench Excavation Safety & Support/Structural Plan	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Traffic Control Plan	1	LS	$15,000	$15,000	$0.00	$0	$15,000
PM	30	Mo	$0	$0	$15,000.00	$450,000	$450,000
Superintendent	30	Mo	$0	$0	$12,000.00	$360,000	$360,000
Admin	30	Mo	$0	$0	$7,000.00	$210,000	$210,000
Sanitary Services	30	Mo	$0	$0	$500.00	$15,000	$15,000
Security Services	30	Mo	$0	$0	$2,000.00	$60,000	$60,000
Pick Up Trucks - 3 each	30	Mo	$0	$0	$1,800.00	$54,000	$54,000
Office Equipment	30	Mo	$0	$0	$350.00	$10,500	$10,500
150 Ton Crane - 24 Months	24	Mo	$0	$0	$20,000.00	$480,000	$480,000
Loader - 30 Months	30	Mo	$0	$0	$2,000.00	$60,000	$60,000
Office Trailors - 2 each	30	Mo	$0	$0	$1,500.00	$45,000	$45,000
Tool Trailors - 2 each	30	Mo	$0	$0	$500.00	$15,000	$15,000
Subtotal for Division 1							**$2,504,000**
Division 2 - Site Work							
Structural Excavation	12,000	CY	$0.00	$0	$8.00	$96,000	$96,000
Structural Backfill	10,000	CY	$6.00	$60,000	$3.00	$30,000	$90,000
Paving	1,300	SY	$12.00	$15,600	$12.00	$15,600	$31,200
Pavement Striping	2,450	SF	$6.00	$14,700	$2.00	$4,900	$19,600
Access Road	1,800	SY	$7.00	$12,600	$13.00	$23,400	$36,000
Traffic Control	1	LS	$5,000.00	$5,000	$20,000.00	$20,000	$25,000
Curb Stops	10	EA	$200.00	$2,000	$50.00	$500	$2,500
8-inch Bollards	10	EA	$1,000.00	$10,000	$150.00	$1,500	$11,500
Grading	3,000	SY	$1.00	$3,000	$2.00	$6,000	$9,000
Fencing - 10 Ft. Man Proof	1,000	LF	$50.00	$50,000	$10.00	$10,000	$60,000
16-foot slide gate (Electric Motor)	1	EA	$6,000.00	$6,000	$1,000.00	$1,000	$7,000

Table 4.1.3

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Charlie Site with 3 Pumps

225,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
3-foot ped. Gate	1	EA	$400.00	$400	$100.00	$100	$500
Landscaping	1	LS	$50,000.00	$50,000	$5,000.00	$5,000	$55,000
Channel Liner	2,000	SY	$10.00	$20,000	$5.00	$10,000	$30,000
60-inch steel discharge pipe - 3@130' each	390	LF	$800	$312,000	$100.00	$39,000	$351,000
60-inch nut, bolt and gasket sets	6	EA	$2,000	$12,000	$1,500.00	$9,000	$21,000
96-inch steel dischage pipe	200	LF	$1,300	$260,000	$100.00	$20,000	$280,000
Retrofit discharge tower	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Water - 2-inch	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Sewer	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Telephone	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Misc Utilities	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Shoring	5,000	SF	$35	$175,000	$5.00	$25,000	$200,000
Dewatering	1	LS	$250,000	$250,000	$25,000.00	$25,000	$275,000
Coffer Dam - 26' high 2:1ss	10,000	CY	$15	$150,000	$5.00	$50,000	$200,000
3-inch mud slab	140	CY	$100	$14,000	$25.00	$3,500	$17,500
Demolition of existing Charlie Station	1	LS	$200,000.00	$200,000	$35,000.00	$50,000	$250,000
Subtotal for Division 2							**$2,238,200**
Division 3 - Concrete							
Substructure Concrete (Foundation)							
Concrete	1300	CY	$100	$130,000	$15.00	$19,500	$149,500
Rebar (310 lb/CY)	202	TON	$1,020	$205,530	$300.00	$60,450	$265,980
Forming	7622	SF	$10	$76,220	$5.00	$38,110	$114,330
Curing	80	CSF	$5	$400	$5.00	$400	$800
Waterstops	320	LF	$10	$3,200	$5.00	$1,600	$4,800
Substructure Concrete (Pump Room Floor)							
Concrete	200	CY	$100	$20,000	$15.00	$3,000	$23,000
Rebar (310 lb/CY)	31	TON	$1,020	$31,620	$300.00	$9,300	$40,920
Forming	4237	SF	$10	$42,370	$5.00	$5	$42,375
Curing	63	CSF	$5	$315	$5.00	$315	$630
Waterstops	315	LF	$10	$3,150	$5.00	$1,575	$4,725
Substructure Concrete (Perimeter walls) - ext. 4' thick avg.							

Table 4.1.3

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Charlie Site with 3 Pumps

225,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Concrete	1100	CY	$100	$110,000	$15.00	$16,500	$126,500
Rebar (310 lb/CY)	171	TON	$1,020	$173,910	$300.00	$51,150	$225,060
Forming	8532	SF	$10	$85,320	$5.00	$42,660	$127,980
Curing	180	CSF	$5	$900	$5.00	$900	$1,800
Waterstops	275	LF	$10	$2,750	$5.00	$1,375	$4,125
Substructure Concrete (Divider walls-int. 2' thick avg)							
Concrete	280	CY	$100	$28,000	$15.00	$4,200	$32,200
Rebar (310 lb/CY)	43	TON	$1,020	$44,268	$300.00	$13,020	$57,288
Forming	4602	SF	$10	$46,020	$5.00	$23,010	$69,030
Curing	190	CSF	$5	$950	$5.00	$950	$1,900
Waterstops	500	LF	$10	$5,000	$5.00	$2,500	$7,500
Substructure Columns and Beams							
Concrete	40	CY	$100	$4,000	$15.00	$600	$4,600
Rebar (310 lb/CY)	6	TON	$1,020	$6,324	$300.00	$1,860	$8,184
Forming	1200	SF	$10	$12,000	$5.00	$6,000	$18,000
Curing	40	CSF	$5	$200	$5.00	$200	$400
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Electrical Room Bottom Slab							
Concrete	120	CY	$100	$12,000	$15.00	$1,800	$13,800
Rebar (310 lb/CY)	19	TON	$1,020	$18,972	$300.00	$5,580	$24,552
Forming	1248	SF	$10	$12,480	$5.00	$6,240	$18,720
Curing	60	CSF	$5	$300	$5.00	$300	$600
Waterstops	150	LF	$10	$1,500	$5.00	$750	$2,250
Superstructure Columns							
Concrete	56	CY	$100	$5,600	$15.00	$840	$6,440
Rebar (310 lb/CY)	9	TON	$1,020	$8,854	$300.00	$2,604	$11,458
Forming	3100	SF	$10	$31,000	$5.00	$15,500	$46,500
Curing	200	CSF	$5	$1,000	$5.00	$1,000	$2,000
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Superstructure Beams							
Concrete	56	CY	$100	$5,600	$15.00	$840	$6,440
Rebar (310 lb/CY)	9	TON	$1,020	$8,854	$300.00	$2,604	$11,458

Table 4.1.3

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Charlie Site with 3 Pumps

225,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Forming	2164	SF	$10	$21,640	$5.00	$10,820	$32,460
Curing	250	CSF	$5	$1,250	$5.00	$1,250	$2,500
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Superstructure double-Tees	4752	SF	$18	$85,536	$5.00	$23,760	$109,296
Retaining Walls - MSE wall >20'	15500	SF	$40	$620,000	$10.00	$155,000	$775,000
Subtotal Division 3							**$2,395,100**
Division 4 - Masonary							
CMU Partitions	12,000	SF	$3.00	$36,000	$4.00	$48,000	$84,000
Glazed CMU Restroom Walls	256	SF	$8.00	$2,048	$4.00	$1,024	$3,072
Subtotal for Division 4				**$0**		**$0**	**$87,072**
Division 5 - Metals							
Grating	800	SF	$20	$16,000	$5.00	$4,000	$20,000
Mtl deck	7,505	SF	$2	$15,010	$1.00	$7,505	$22,515
Bar Joists	1	LS	$60,000	$60,000	$5,000.00	$5,000	$65,000
Handrail	200	LF	$40	$8,000	$15.00	$3,000	$11,000
Subtotal for Division 5							**$118,515**
Division 6 - Carpentry							
Misc.	1	ls	$1,000	$1,000	$3,000.00	$3,000	$4,000
Subtotal for Division 6							**$4,000**
Division 7 - Thermal and Moisture Protection							
Exterior walls	11,000	SF	$45	$495,000	$20.00	$220,000	$715,000
Roofing	4,752	SF	$4	$19,008	$2.00	$49,827	$68,835
Roof Hatch-Pumps	0	EA	$15,000	$0	$500.00	$0	$0
Roof Hatch-Access	1	EA	$800	$800	$200.00	$200	$1,000
Subtotal for Division 7							**$784,835**
Division 8 - Doors and Windows							

Table 4.1.3
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Charlie Site with 3 Pumps
225,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Doors, 3-0 x 7-0 steel	5	Ea	$200	$1,000	$100.00	$500	$1,500
Doors, roll-up 12' x 14' steel	2	Ea	$5,000	$10,000	$600.00	$1,200	$11,200
Subtotal for Division 8				**$0**		**$0**	**$12,700**
Division 9- Finishes							
Process Piping (pump rm risers & hdrs)	4,100	SF	$0.50	$2,050	$1.25	$5,125	$7,175
Misc. Structural Steel Surf. Prep.	8,900	LS	$1.00	$8,900	$2.00	$17,800	$26,700
Paint Structural Steel	8,900	sf	$1.00	$8,900	$4.00	$35,600	$44,500
Paint Building Interior Walls	10,000	SF	$0.10	$1,000	$0.57	$5,700	$6,700
Subtotal for Division 9							**$85,075**
Division 10 - Specialities							
Signage	1	LS	$5,000	$5,000	$1,000.00	$1,000	$6,000
Woven Wire Partition - 15'x15'x10'Tall	1	LS	$2,500	$2,500	$500.00	$500	$3,000
Toilet Accessories	1	LS	$500	$500	$200.00	$200	$700
Subtotal for Division 10				**$0**		**$0**	**$9,700**
Division 11 - Equipment							
Veritical sump pump, 7000 gpm	1	Ea	$80,000	$80,000	$5,000.00	$5,000	$85,000
Trash Rack (25' x 65')	1,625	SF	$400	$650,000	$10.00	$16,250	$666,250
Restrained Couplings	9	Ea	$15,000	$135,000	$1,500.00	$13,500	$148,500
Vertical Pumps and Motors - 75,000 gpm	3	Ea	$1,200,000	$3,600,000	$30,000.00	$90,000	$3,690,000
Stop Logs	1	LS	$200,000	$200,000	$15,000.00	$15,000	$215,000
6.5' - Flap Gate	1	Ea	$25,000	$25,000	$5,000.00	$5,000	$30,000
Sluice Gate - 9'x9'	1	Ea	$100,000	$100,000	$5,000.00	$5,000	$105,000
Subtotal for Division 11							**$4,939,750**
Division 12 - Furnishings							
Desk	1	Ea	$1,000	$1,000	$100.00	$100	$1,100
Chair	1	Ea	$600	$600	$10.00	$10	$610
Storage Shelves	4	Ea	$500	$2,000	$100.00	$400	$2,400

Table 4.1.3
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Charlie Site with 3 Pumps
225,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Subtotal for Division 12							**$4,110**
Division 13 - Special Construction							
Subtotal for Division 13							**$0**
Division 14 - Conveying Systems							
30 Ton Bridge Crane	1	Ea	$200,000	$200,000	$25,000.00	$25,000	$225,000
Automated Conveyor System	1	LS	$100,000.00	$100,000	$25,000.00	$25,000	$125,000
Subtotal for Division 14							**$350,000**
Division 15 - Mechanical							
Ventilation Fan(S)	3	EA	$2,000	$6,000	$500.00	$1,500	$7,500
Roof Curb(S)	3	EA	$1,000	$3,000	$250.00	$750	$3,750
Controls	1	LS	$25,000	$25,000	$10,000.00	$10,000	$35,000
Floor Drain(S)	6	EA	$300	$1,800	$150.00	$900	$2,700
Toilet(S)	1	EA	$200	$200	$200.00	$200	$400
Sink(S)	2	EA	$400	$800	$100.00	$200	$1,000
Urinal(S)	1	EA	$200	$200	$75.00	$75	$275
Faucet(S)	2	EA	$350	$700	$100.00	$200	$900
Trap Primer(S)	2	EA	$350	$700	$150.00	$300	$1,000
Drain/Waste/Vent Plumbing	1000	LF	$15	$15,000	$7.00	$7,000	$22,000
Cold Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Hot Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Dx Hvac Air Handler(S)	2	EA	$17,500	$35,000	$5,000.00	$10,000	$45,000
Dx Hvac Condensing Unit(S)	2	EA	$15,000	$30,000	$1,500.00	$3,000	$33,000
Controls	1	LS	$7,500	$7,500	$5,000.00	$5,000	$12,500
Condensing Unit Pad(S)	1	EA	$500	$500	$100.00	$100	$600
Ductwork	1000	LBS	$50	$50,000	$5.00	$5,000	$55,000
Diffuser(S)/Register(S)/Grille(S)	9	EA	$17	$153	$10.00	$90	$243
Louvre(S)	9	EA	$150	$1,350	$100.00	$900	$2,250
Fire Hose Rack	2	EA	$350	$700	$100.00	$200	$900
Subtotal for Division 15							**$235,018**

Table 4.1.3

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Charlie Site with 3 Pumps
225,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 16 - Electrical							
Mobilization	1	LS	$0	$0	$0.00	$0	$50,000
Temporary Power	1	LS	$50,000	$50,000	$2,000.00	$2,000	$52,000
Duct Banks	200	CY	$400	$80,000	$20.00	$4,000	$84,000
Manholes	3	EA	$6,000	$18,000	$500.00	$1,500	$19,500
1/0 15 Kv Cable	1,000	LF	$7	$7,000	$3.00	$3,000	$10,000
250 Mcm 15 Kv Cable	1,000	LF	$8	$8,000	$3.00	$3,000	$11,000
100 Mcm 15 Kv Cable	1,000	LF	$15	$15,000	$3.00	$3,000	$18,000
5 Kv Terminations	50	EA	$175	$8,750	$25.00	$1,250	$10,000
Conduit	1	LS	$175,000	$175,000	$20,000.00	$20,000	$195,000
Wire	1	LS	$125,000	$125,000	$10,000.00	$10,000	$135,000
Lighting							
Exterior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Interior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Mv Switchgear	1	LS	$100,000	$100,000	$25,000.00	$25,000	$125,000
Soft Starts - 1200 HP	3	EA	$52,000	$156,000	$15,000.00	$45,000	$201,000
1500 Kva Transformers	3	EA	$50,000	$150,000	$10,000.00	$30,000	$180,000
480 Volt Mcc	1	EA	$85,000	$85,000	$50,000.00	$50,000	$135,000
Misc. Switchgear	1	LS	$50,000	$50,000	$6,000.00	$6,000	$56,000
Lightning Protection	1	LS	$35,000	$35,000	$5,000.00	$5,000	$40,000
Telephone System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Fire Alarm System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Security And Entrance Equipment	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Embedded Conduit	1	LS	$25,000	$25,000	$8,000.00	$8,000	$33,000
Grounding	1	LS	$50,000	$50,000	$10,000.00	$10,000	$60,000
Cable Tray	1	LS	$25,000	$25,000	$15,000.00	$15,000	$40,000
500 Kva Gen Set With ATS	1	Ea	$98,000	$98,000	$5,000.00	$5,000	$103,000
TXU Firm Backup Capabiltiy	1	LS	$600,000	$600,000	$30,000.00	$30,000	$630,000
Testing	1	LS	$15,000	$15,000	$5,000.00	$5,000	$20,000

Table 4.1.3

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Charlie Site with 3 Pumps

225,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Subtotal for Division 16							**$2,341,500**
Division 17 - I&C							
Engineering & Submittals	1	LS	$75,000	$75,000	$5,000.00	$5,000	$80,000
Computers And Printers	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
F O Cable And Comm. Equip.	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Control Panels	1	LS	$250,000	$250,000	$10,000.00	$10,000	$260,000
Start Up-Check Out	1	LS	$35,000	$35,000	$10,000.00	$10,000	$45,000
Ultra Sonic Flow Meters	4	Ea	$5,000	$20,000	$2,500.00	$10,000	$30,000
HMI Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
PLC Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
O&M Manuals	1	LS	$5,000	$5,000	$2,000.00	$2,000	$7,000
Training	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Software	1	LS	$85,000	$85,000	$15,000.00	$15,000	$100,000
Factory Test	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Bonds	1	LS	$0	$0	$0.00	$0	$80,000
Level transmitters	3	Ea	$2,000	$6,000	$500.00	$1,500	$7,500
PLC - Primary + hot back-up	1	Ea	$17,500	$17,500	$7,500.00	$7,500	$25,000
PC and Monitor	1	Ea	$8,000	$8,000	$1,000.00	$1,000	$9,000
MMI Software + Programming	1	Ea	$7,000	$7,000	$15,000.00	$15,000	$22,000
Instrumentation wiring	1	LS	$75,000	$75,000	$28,000.00	$28,000	$103,000
SCADA Transmitter	1	Ea	$100,000	$100,000	$10,000.00	$10,000	$110,000
Security Cameras	1	LS	$75,000	$75,000	$10,000.00	$10,000	$85,000
Subtotal for Division 17							**$1,293,500**
Division subtotal				**$12,122,501**		**$3,872,074**	**$17,403,075**
Contractor's Profit on Material (10%)							$1,212,250
Prime Profit on Subcontractors - 10% on Div 5, 6, 7, 8, 9, 10, 12, 16, 17							$465,394
Subtotal							**$19,080,719**
Contingency (20%)							$3,816,144
Construction Work Effort subtotal							**$22,896,863**
Escalation to Midpoint @ 6%/year& 5 yrs							**$7,743,719**

Table 4.1.3

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Charlie Site with 3 Pumps
225,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Subtotal							**$30,640,582**
Engineering and Surveying Services (12%)							$3,676,870
Construction Management (8%)							$2,451,247
Construction Materials Testing (1.5%)							$459,609
City Contract Administration (10%)							$3,064,058
Services Subtotal							**$9,651,783**
Total Estimated Project Cost							**$40,292,365**

4.1.2.2 Option C2B – Rehab Existing Pump Station, New 145,000 GPM Pump Station

This option includes rehabilitation of the existing Charlie Pump Station and construction of a new 145,000 gpm station adjacent to the current station.

The Charlie Storm Water Pump Station evaluated for Option C2B has a total pumping capacity of 145,000 gpm. The pumping is accomplished with the use of three 50,000 gpm vertical axial flow pumps, each rated at 55 feet total dynamic head (TDH). Each of these pumps is driven by a 900 horsepower electric motor operating at 295 rpm, eliminating the need for a gear reducer between the motor and pump. Additionally, a 6,000 gpm vertical axial flow pump is provided for dewatering the sump during periods of low flow.

Pump station discharge piping will be configured to route up and over the levee to discharge to the river. Each individual pump will be equipped with a dedicated discharge header with a goose-neck high point elevation above the top of levee and an air release valve to prevent back-siphoning into the station. Station piping will be lined with high density polyurethane and coated with suitable epoxy-based systems.

The pump station will be configured in accordance with the guidance contained in the following documents:

- "Hydrologic Analysis of Interior Areas" EM 1110-2-1413, dated 15 January 1987
- "Hydrologic Frequency Analysis" EM 1120-2-1415, dated 05 March 1993
- "Flood Run-off Analysis" EM 1110-2-1417, dated 31 August 1994
- "Risk-Based Analysis for Flood Damage Reduction Studies" EM 1120-2-1619, dated 01 August 1996
- *EM1110-2-2100 Stability Analysis of Concrete Structures*
- *EM1110-2-2102 Waterstops and Other Preformed Joint Materials for CW Structures*
- *EM1110-2-2502 Retaining Walls*
- *EM1110-2-3104 Structural and Architectural Design of Pumping Stations*
- *EM1110-2-3105 Mechanical and Electrical Design of Pumping Stations*
- *EM1110-2-1804 Geotechnical Investigations*

The pump station substructure is cast-in-place concrete designed in accordance with ACI 310R and other appropriate standards. The foundation is a mat consisting of a five foot thick concrete slab to which the walls are attached. The walls utilize a stepped design in which the walls are reduced in thickness as the height of the structure increases and the soil load decreases. The sump area is deep and a removable hatch has been incorporated into the floor deck to provide access for removing debris that will accumulate in the sump area. The hatch is large enough to accommodate a small Bobcat.

The superstructure of the pump station is cast-in-place concrete and beams are incorporated into the structure to accommodate the installation of a bridge crane for maintenance. The pump station roof is designed to be double tees, which increases the stiffness of the structure and simplifies construction and maintenance. The roof will consist of the double tees, a two-inch layer of light-weight grout, and a membrane. The superstructure has been designed so that a drive through corridor is incorporated into the station, permitting truck access directly adjacent to the pumps for maintenance.

The exterior wall sections have been assumed to be concrete masonry units with brick veneer, although a different system may be incorporated in the final design.

The pump station interior in the pump room is unfinished; however, the interiors of the switchgear room, office, and restroom have conventional dry wall construction and are painted. Flooring throughout the station is concrete with a troweled finish. The main pump room is provided with ventilation, while the switchgear room, office, and restroom are conditioned.

The primary electrical supply to the station is three-phase, 4160 v.a.c. and is provided by TXU. The supply is from two independent substations providing needed redundancy. Therefore, the standby generator set is for use by limited equipment including the control system, lighting, HVAC components, and the bridge crane. The switchgear is located in the switchgear room and includes soft starts for each of the main pumping units. The switchgear is configured as a main-tie-main to provide additional redundancy and reliability in station operation.

This pump station is located on the West Levee, adjacent to the existing Charlie Pump Station, between Houston and Jefferson Streets. Access to the station is provided via a concrete paved access road. Roll-up doors on the station provide the drive-through access. Since the site is located next to the sump a retaining wall is provided to level the site for routine operations. Water and sewer are available in adjacent public streets, and a two-inch water service and a 4-inch sanitary sewer has been provided for the station.

The interior lighting level will be maintained at 85 foot candles. All handrails will be four-rung aluminum. Grating will be hot-dipped galvanized.

The instrumentation and control system will incorporate monitoring and alarming for motor and pump bearing temperature, motor winding temperature, reverse rotation, flow for each pump, sump elevation, and precipitation. The controls system will be integrated into the SCADA system operated by the City of Dallas. Individual pump control can be initiated at the pump, in the operator office/control room, or remotely by the SCADA system.

Figure 4.1.7 is a site plan for this alternative.

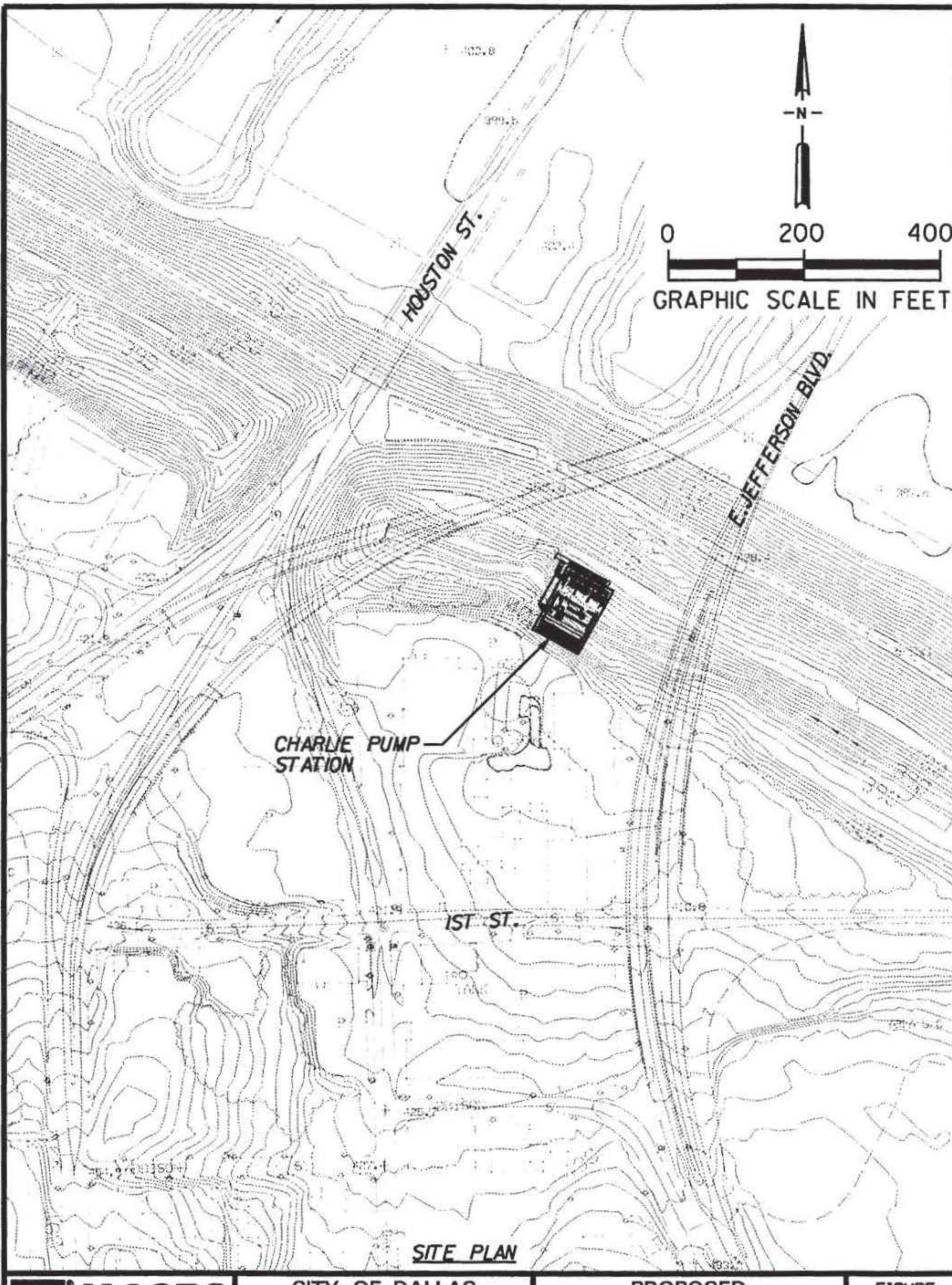
Figure 4.1.8 is a plan view of the 150,000 gpm pump station. The trash rack in the front of the station will be equipped with mechanically-cleaned screens manufactured by Du Perion, since these screens have demonstrated ability to function very effectively in this harsh environment. The switchgear room is adjacent to the pump room.

Figure 4.1.9 is Section A and the relationship of the pumping units, intake sump, and discharge piping are clearly indicated. The bridge crane has 27-foot clearance above the drive through for removal and/or installation of the pumping equipment.

Figures 4.1.10A and 4.1.10B are the electrical one-line diagrams for the station. The double-ended switchgear is indicated. Each of the main pumps is operated by a soft start that has a by-pass that permits the motor to be started even if the soft start is out of service. In addition to the protection provided by the soft start, each of the motors will be equipped with a Multilin 469 to provide motor protective relay systems.

Figure 4.1.11 is a preliminary process and instrumentation diagram for the pump station. The vibration monitoring equipment is shown, as are the RTDs for monitoring motor winding temperatures, and the pump and motor bearing temperatures. Each of the pumps will be equipped with an ultrasonic flow meter to monitor pump discharge.

The Engineer's Preliminary Opinion of Probable Cost for the storm water pump station for Option C2B is summarized in Table 4.1.4.



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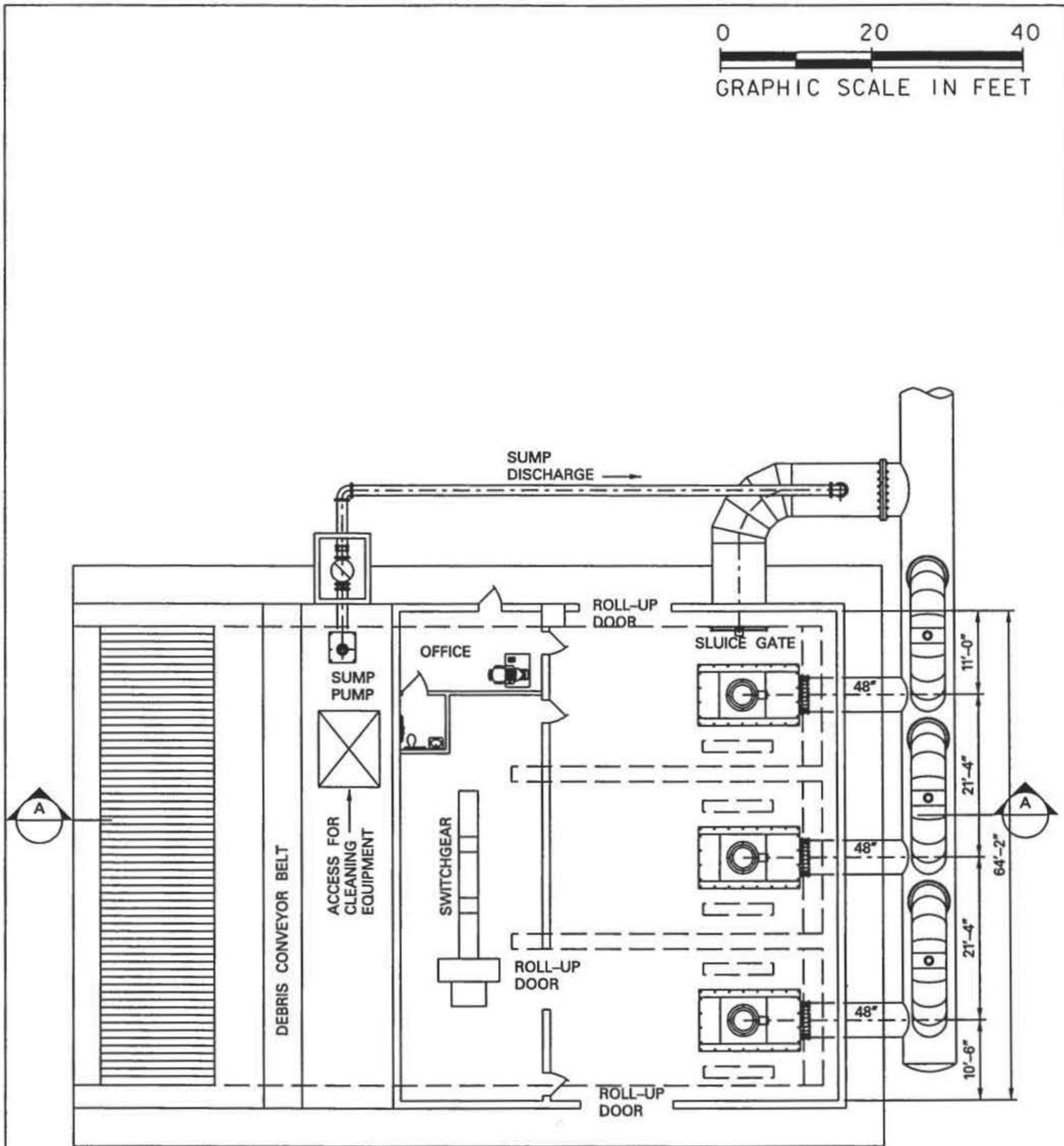

PLAN VIEW
SCALE: 1" = 20'

STATION CAPACITY = 145,000 GPM
50,000 GPM PER PUMP

JACOBS Carter Burgess	CITY OF DALLAS DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION	PROPOSED CHARLIE PUMP STATION VERTICAL PUMPS 145,000 GPM CAPACITY	FIGURE 4.1.8

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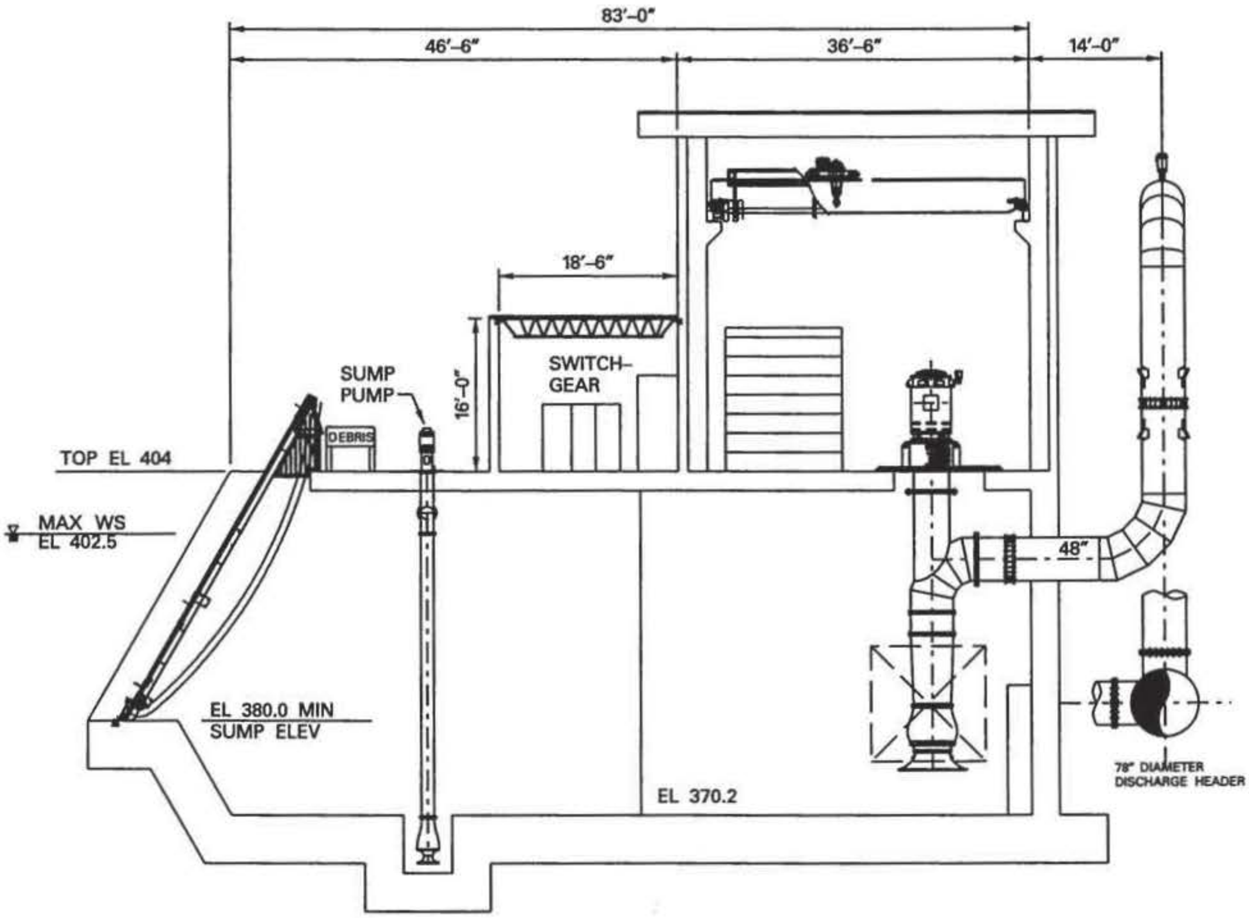
GRAPHIC SCALE IN FEET



SECTION A – VERTICAL PUMPS

SCALE: 1" = 20'

STATION CAPACITY = 145,000 GPM
50,000 GPM PER PUMP

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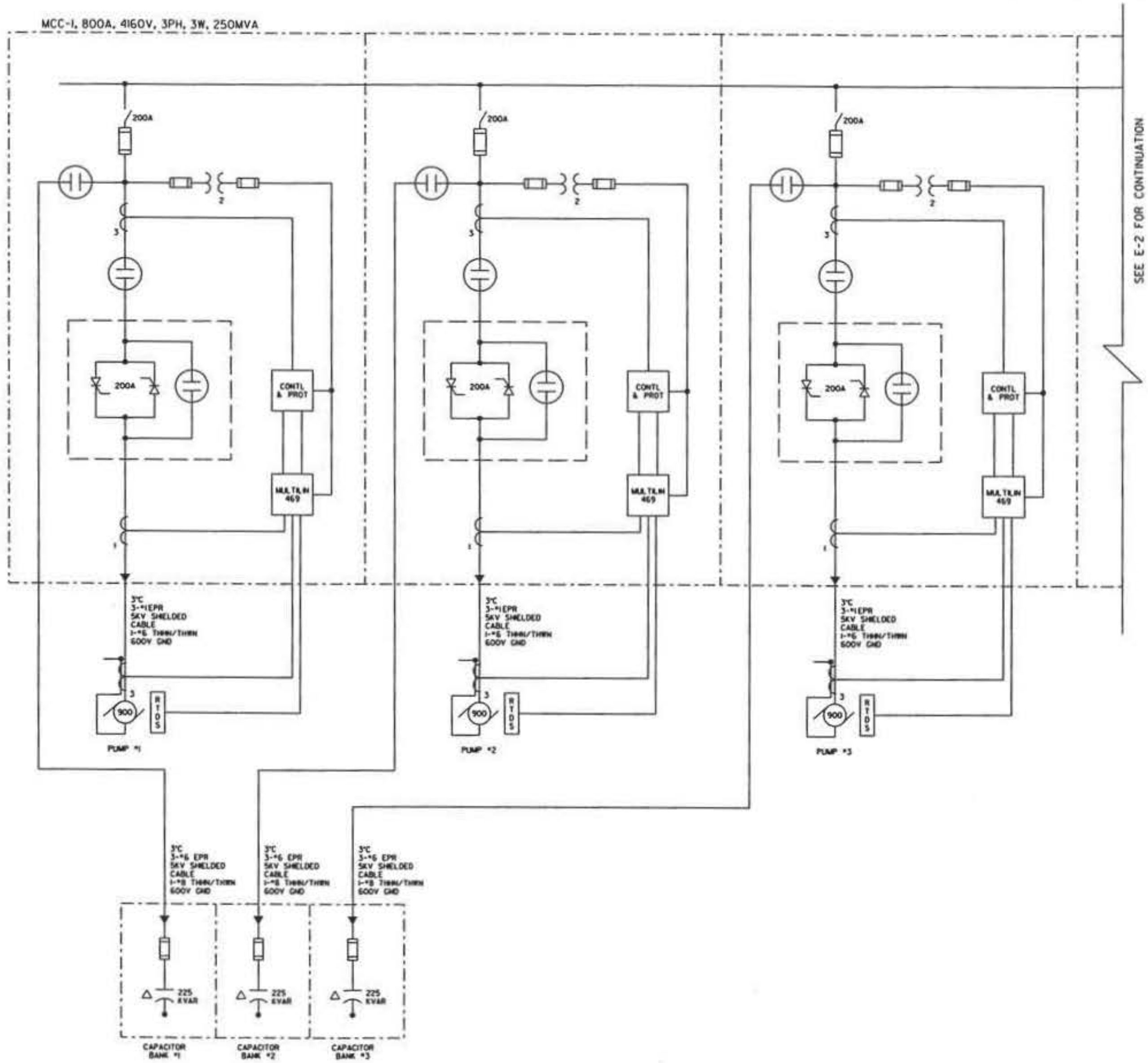

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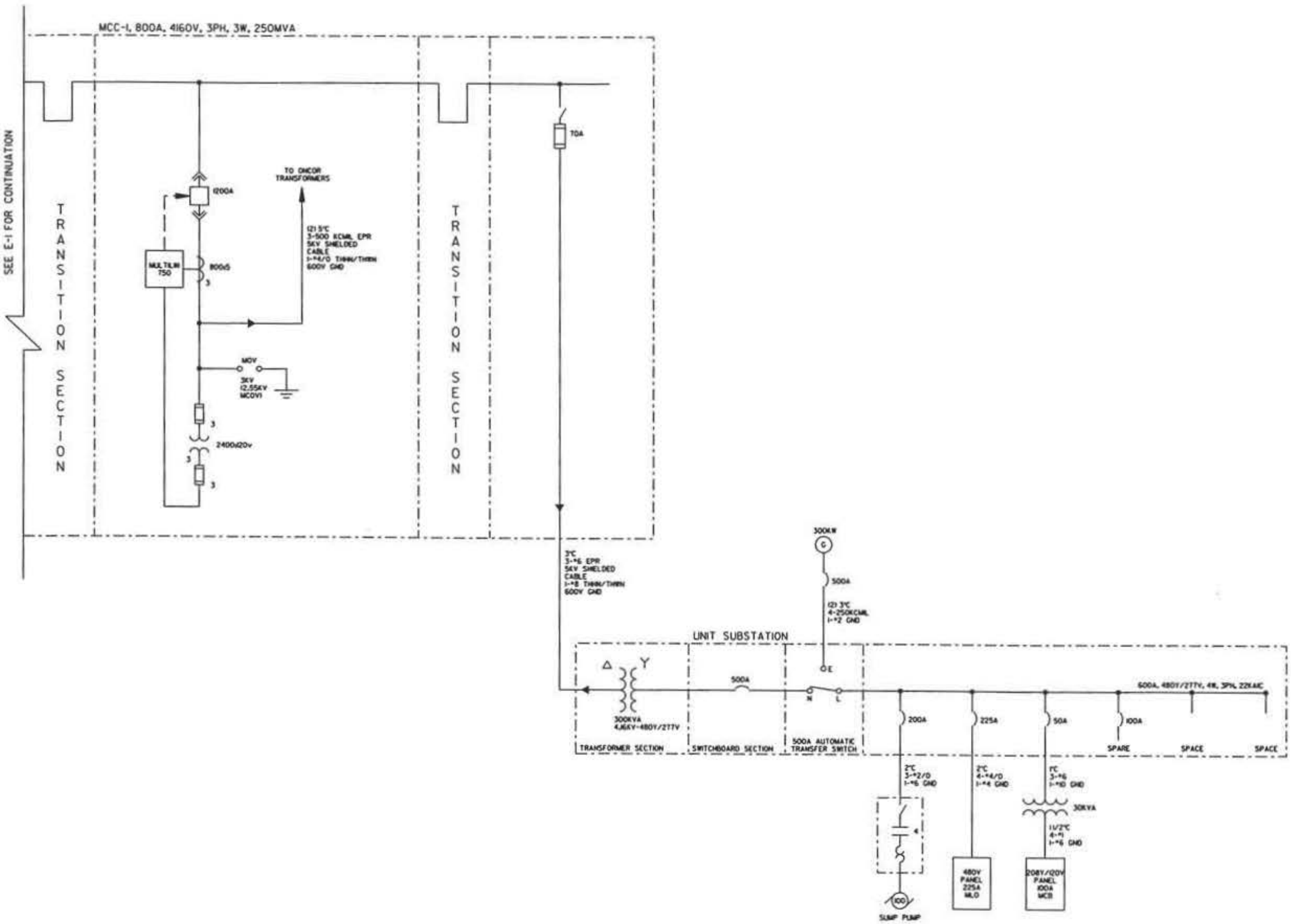
CITY OF DALLAS
DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

PROPOSED CHARLIE PUMP STATION
VERTICAL PUMPS
145,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

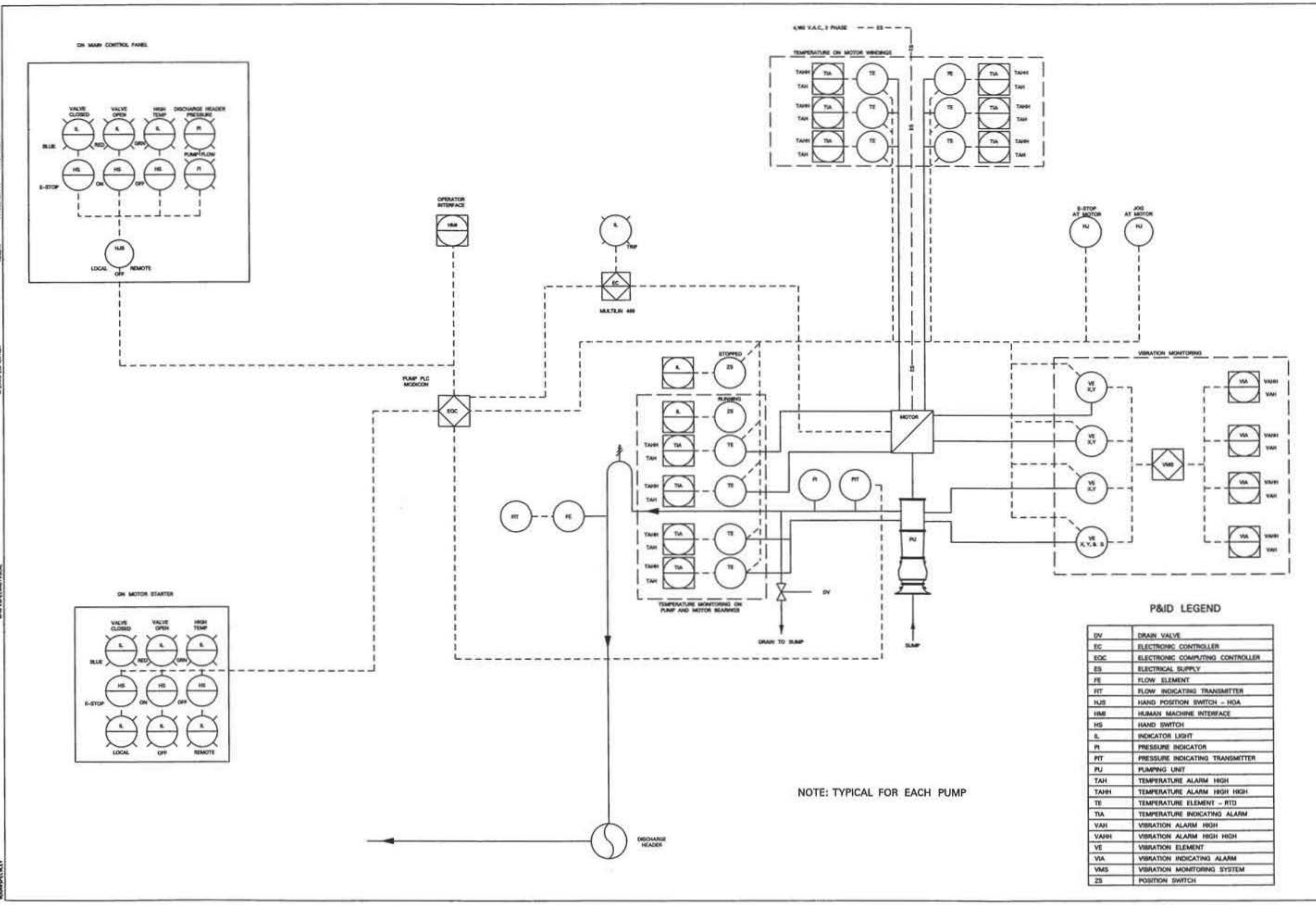
FIGURE
4.1.10A



CITY OF DALLAS
DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

PROPOSED CHARLIE PUMP STATION
VERTICAL PUMPS
145,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

FIGURE
4.1.10B



NOTE: TYPICAL FOR EACH PUMP

P&ID LEGEND

DV	DRAIN VALVE
EC	ELECTRONIC CONTROLLER
ECC	ELECTRONIC COMPUTING CONTROLLER
ES	ELECTRICAL SUPPLY
FE	FLOW ELEMENT
FIT	FLOW INDICATING TRANSMITTER
HJS	HAND POSITION SWITCH – HOA
HMI	HUMAN MACHINE INTERFACE
HS	HAND SWITCH
IL	INDICATOR LIGHT
PI	PRESSURE INDICATOR
PIT	PRESSURE INDICATING TRANSMITTER
PU	PUMPING UNIT
TAH	TEMPERATURE ALARM HIGH
TAHH	TEMPERATURE ALARM HIGH HIGH
TE	TEMPERATURE ELEMENT – RTD
TIA	TEMPERATURE INDICATING ALARM
VAH	VIBRATION ALARM HIGH
VAHH	VIBRATION ALARM HIGH HIGH
VE	VIBRATION ELEMENT
VIA	VIBRATION INDICATING ALARM
VMS	VIBRATION MONITORING SYSTEM
ZS	POSITION SWITCH

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CITY OF DALLAS
DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

PROPOSED CHARLIE PUMP STATION
145,000 GPM CAPACITY

PROCESS AND INSTRUMENTATION DIAGRAM

FIGURE 4.1.11

Table 4.1.4

Summary for Charlie 3 Pump 145,000 gpm

Division	Cost
Division 1 - General Conditions	$2,127,200
Divison 2 - Site Work	$1,833,300
Division 3- Concrete	$2,242,243
Division 4 - Masonry	$87,072
Division 5- Metals	$118,515
Division 6 - Carpentry	$4,000
Division 7 - Thermal & Moisture Protection	$784,835
Division 8 - Doors & Windows	$12,700
Division 9 - Finishes	$85,075
Division 10 - Specialties	$9,700
Division 11 - Equipment	$4,355,000
Division 12 - Furnishings	$4,110
Division 13- Special Construction	$0
Division 14 - Conveying Systems	$350,000
Division 15 - Mechanical	$235,018
Division 16 - Electrical	$2,206,500
Division 17 - Instrumentation & Control	$1,293,500
Division Subtotal	**$15,748,768**
Contractor's Profit of Materials - 10%	$1,093,299
Prime Profit on SubConstractors - 10%	$451,894
Subtotal	**$17,293,960**
Construction Contingencies - 20%	$3,458,792
Construction Work Effort subtotal	**$20,752,752**
Escalation to Midpoint @ 6%/Yr & 3 yrs	$7,018,581
Subtotal	**$27,771,333**
Engineering and Surveying Services (12%)	$3,332,560
Construction Management (8%)	$2,221,707
Construction Materials Testing (1.5%)	$416,570
City Contract Administration (10%)	$2,777,133
Services Subtotal	**$8,747,970**
Total Estimated Project Cost	**$36,519,303**

Table 4.1.4
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Charlie Site with 3 Pumps
145,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 1 - General Conditions							
Mobilization	1	LS	$0	$0		$0	$600,000
Construction Surveying	1	LS	$0	$0	$45,000.00	$45,000	$45,000
Telephone	24	Mo	$150	$3,600	$0.00	$0	$3,600
SWWWP	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Trench Excavation Safety & Support/Structural Plan	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Traffic Control Plan	1	LS	$15,000	$15,000	$0.00	$0	$15,000
PM	24	Mo	$0	$0	$15,000.00	$360,000	$360,000
Superintendent	24	Mo	$0	$0	$12,000.00	$288,000	$288,000
Admin	24	Mo	$0	$0	$7,000.00	$168,000	$168,000
Sanitary Services	24	Mo	$0	$0	$500.00	$12,000	$12,000
Security Services	24	Mo	$0	$0	$2,000.00	$48,000	$48,000
Pick Up Trucks - 3 each	24	Mo	$0	$0	$1,800.00	$43,200	$43,200
Office Equipment	24	Mo	$0	$0	$350.00	$8,400	$8,400
150 Ton Crane - 18 Months	18	Mo	$0	$0	$20,000.00	$360,000	$360,000
Loader - 24 Months	24	Mo	$0	$0	$2,000.00	$48,000	$48,000
Office Trailors - 2 each	24	Mo	$0	$0	$1,500.00	$36,000	$36,000
Tool Trailors - 2 each	24	Mo	$0	$0	$500.00	$12,000	$12,000
Subtotal for Division 1							**$2,127,200**
Division 2 - Site Work							
Structural Excavation	12,000	CY	$0.00	$0	$8.00	$96,000	$96,000
Structural Backfill	10,000	CY	$6.00	$60,000	$3.00	$30,000	$90,000
Paving	1,300	SY	$12.00	$15,600	$12.00	$15,600	$31,200
Pavement Striping	2,450	SF	$6.00	$14,700	$2.00	$4,900	$19,600
Access Road	1,800	SY	$7.00	$12,600	$13.00	$23,400	$36,000
Traffic Control	1	LS	$5,000.00	$5,000	$20,000.00	$20,000	$25,000
Curb Stops	10	EA	$200.00	$2,000	$50.00	$500	$2,500
8-inch Bollards	10	EA	$1,000.00	$10,000	$150.00	$1,500	$11,500
Grading	3,000	SY	$1.00	$3,000	$2.00	$6,000	$9,000
Fencing - 10 Ft. Man Proof	1,000	LF	$50.00	$50,000	$10.00	$10,000	$60,000
16-foot slide gate (Electric Motor)	1	EA	$6,000.00	$6,000	$1,000.00	$1,000	$7,000

Table 4.1.4

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Charlie Site with 3 Pumps

145,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
3-foot ped. Gate	1	EA	$400.00	$400	$100.00	$100	$500
Landscaping	1	LS	$50,000.00	$50,000	$5,000.00	$5,000	$55,000
Channel Liner	2,000	SY	$10.00	$20,000	$5.00	$10,000	$30,000
48-inch steel discharge pipe - 3@130' each	390	LF	$600	$234,000	$100.00	$39,000	$273,000
48-inch nut, bolt and gasket sets	6	EA	$1,500	$9,000	$850.00	$5,100	$14,100
72-inch steel dischage pipe	200	LF	$950	$190,000	$100.00	$20,000	$210,000
Retrofit discharge tower	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Water - 2-inch	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Sewer	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Telephone	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Misc Utilities	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Shoring	5,000	SF	$35	$175,000	$5.00	$25,000	$200,000
Dewatering	1	LS	$250,000	$250,000	$25,000.00	$25,000	$275,000
Coffer Dam - 26' high 2:1ss	10,000	CY	$15	$150,000	$5.00	$50,000	$200,000
3-inch mud slab	140	CY	$100	$14,000	$25.00	$3,500	$17,500
Subtotal for Division 2							**$1,833,300**
Division 3 - Concrete							
Substructure Concrete (Foundation)							
Concrete	1105	CY	$100	$110,520	$15.00	$16,578	$127,098
Rebar (310 lb/CY)	171	TON	$1,020	$174,732	$300.00	$51,392	$226,124
Forming	6630	SF	$10	$66,300	$5.00	$33,150	$99,450
Curing	80	CSF	$5	$400	$5.00	$400	$800
Waterstops	320	LF	$10	$3,200	$5.00	$1,600	$4,800
Substructure Concrete (Pump Room Floor)							
Concrete	183	CY	$100	$18,270	$15.00	$2,741	$21,011
Rebar (310 lb/CY)	28	TON	$1,020	$28,885	$300.00	$8,496	$37,380
Forming	3641	SF	$10	$36,410	$5.00	$5	$36,415
Curing	63	CSF	$5	$315	$5.00	$315	$630
Waterstops	315	LF	$10	$3,150	$5.00	$1,575	$4,725
Substructure Concrete (Perimeter walls) - ext. 4' thick avg.							
Concrete	1040	CY	$100	$103,950	$15.00	$15,593	$119,543

Table 4.1.4
Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Charlie Site with 3 Pumps
145,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Rebar (310 lb/CY)	161	TON	$1,020	$164,345	$300.00	$48,337	$212,682
Forming	7795	SF	$10	$77,950	$5.00	$38,975	$116,925
Curing	180	CSF	$5	$900	$5.00	$900	$1,800
Waterstops	275	LF	$10	$2,750	$5.00	$1,375	$4,125
Substructure Concrete (Divider walls-int. 2' thick avg)							
Concrete	246	CY	$100	$24,570	$15.00	$3,686	$28,256
Rebar (310 lb/CY)	38	TON	$1,020	$38,845	$300.00	$11,425	$50,270
Forming	3678	SF	$10	$36,780	$5.00	$18,390	$55,170
Curing	190	CSF	$5	$950	$5.00	$950	$1,900
Waterstops	500	LF	$10	$5,000	$5.00	$2,500	$7,500
Substructure Columns and Beams							
Concrete	36	CY	$100	$3,600	$15.00	$540	$4,140
Rebar (310 lb/CY)	6	TON	$1,020	$5,692	$300.00	$1,674	$7,366
Forming	1200	SF	$10	$12,000	$5.00	$6,000	$18,000
Curing	40	CSF	$5	$200	$5.00	$200	$400
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Electrical Room Bottom Slab							
Concrete	108	CY	$100	$10,800	$15.00	$1,620	$12,420
Rebar (310 lb/CY)	17	TON	$1,020	$17,075	$300.00	$5,022	$22,097
Forming	1073	SF	$10	$10,730	$5.00	$5,365	$16,095
Curing	60	CSF	$5	$300	$5.00	$300	$600
Waterstops	150	LF	$10	$1,500	$5.00	$750	$2,250
Superstructure Columns							
Concrete	54	CY	$100	$5,400	$15.00	$810	$6,210
Rebar (310 lb/CY)	8	TON	$1,020	$8,537	$300.00	$2,511	$11,048
Forming	3100	SF	$10	$31,000	$5.00	$15,500	$46,500
Curing	200	CSF	$5	$1,000	$5.00	$1,000	$2,000
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Superstructure Beams							
Concrete	54	CY	$100	$5,400	$15.00	$810	$6,210
Rebar (310 lb/CY)	8	TON	$1,020	$8,537	$300.00	$2,511	$11,048
Forming	2164	SF	$10	$21,640	$5.00	$10,820	$32,460

Table 4.1.4
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Charlie Site with 3 Pumps
145,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Curing	250	CSF	$5	$1,250	$5.00	$1,250	$2,500
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Superstructure double-Tees	4752	SF	$18	$85,536	$5.00	$23,760	$109,296
Retaining Walls - MSE wall >20'	15500	SF	$40	$620,000	$10.00	$155,000	$775,000
Subtotal Division 3							**$2,242,243**
Division 4 - Masonary							
CMU Partitions	12,000	SF	$3.00	$36,000	$4.00	$48,000	$84,000
Glazed CMU Restroom Walls	256	SF	$8.00	$2,048	$4.00	$1,024	$3,072
Subtotal for Division 4				**$0**		**$0**	**$87,072**
Division 5 - Metals							
Grating	800	SF	$20	$16,000	$5.00	$4,000	$20,000
Mtl deck	7,505	SF	$2	$15,010	$1.00	$7,505	$22,515
Bar Joists	1	LS	$60,000	$60,000	$5,000.00	$5,000	$65,000
Handrail	200	LF	$40	$8,000	$15.00	$3,000	$11,000
Subtotal for Division 5							**$118,515**
Division 6 - Carpentry							
Misc.	1	ls	$1,000	$1,000	$3,000.00	$3,000	$4,000
Subtotal for Division 6							**$4,000**
Division 7 - Thermal and Moisture Protection							
Exterior walls	11,000	SF	$45	$495,000	$20.00	$220,000	$715,000
Roofing	4,752	SF	$4	$19,008	$2.00	$49,827	$68,835
Roof Hatch-Pumps	0	EA	$15,000	$0	$500.00	$0	$0
Roof Hatch-Access	1	EA	$800	$800	$200.00	$200	$1,000
Subtotal for Division 7							**$784,835**
Division 8 - Doors and Windows							
Doors, 3-0 x 7-0 steel	5	Ea	$200	$1,000	$100.00	$500	$1,500

Table 4.1.4
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Charlie Site with 3 Pumps
145,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Doors, roll-up 12' x 14' steel	2	Ea	$5,000	$10,000	$600.00	$1,200	$11,200
Subtotal for Division 8				**$0**		**$0**	**$12,700**
Division 9- Finishes							
Process Piping (pump rm risers & hdrs)	4,100	SF	$0.50	$2,050	$1.25	$5,125	$7,175
Misc. Structural Steel Surf. Prep.	8,900	LS	$1.00	$8,900	$2.00	$17,800	$26,700
Paint Structural Steel	8,900	sf	$1.00	$8,900	$4.00	$35,600	$44,500
Paint Building Interior Walls	10,000	SF	$0.10	$1,000	$0.57	$5,700	$6,700
Subtotal for Division 9							**$85,075**
Division 10 - Specialities							
Signage	1	LS	$5,000	$5,000	$1,000.00	$1,000	$6,000
Woven Wire Partition - 15'x15'x10'Tall	1	LS	$2,500	$2,500	$500.00	$500	$3,000
Toilet Accessories	1	LS	$500	$500	$200.00	$200	$700
Subtotal for Division 10				**$0**		**$0**	**$9,700**
Division 11 - Equipment							
Veritical sump pump, 7000 gpm	1	Ea	$80,000	$80,000	$5,000.00	$5,000	$85,000
Trash Rack (30' x 55')	1,650	SF	$400	$660,000	$10.00	$16,500	$676,500
Restrained Couplings	9	Ea	$15,000	$135,000	$1,500.00	$13,500	$148,500
Vertical Pumps and Motors - 50,000 gpm	3	Ea	$1,000,000	$3,000,000	$30,000.00	$90,000	$3,090,000
Stop Logs	1	LS	$200,000	$200,000	$15,000.00	$15,000	$215,000
72" - Flap Gate	1	Ea	$30,000	$30,000	$5,000.00	$5,000	$35,000
Sluice Gate - 9'x9'	1	Ea	$100,000	$100,000	$5,000.00	$5,000	$105,000
Subtotal for Division 11							**$4,355,000**
Division 12 - Furnishings							
Desk	1	Ea	$1,000	$1,000	$100.00	$100	$1,100
Chair	1	Ea	$600	$600	$10.00	$10	$610
Storage Shelves	4	Ea	$500	$2,000	$100.00	$400	$2,400
Subtotal for Division 12							**$4,110**

Table 4.1.4
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Charlie Site with 3 Pumps
145,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 13 - Special Construction							
Subtotal for Division 13							**$0**
Division 14 - Conveying Systems							
30 Ton Bridge Crane	1	Ea	$200,000	$200,000	$25,000.00	$25,000	$225,000
Automated Conveyor System	1	LS	$100,000.00	$100,000	$25,000.00	$25,000	$125,000
Subtotal for Division 14							**$350,000**
Division 15 - Mechanical							
Ventilation Fan(S)	3	EA	$2,000	$6,000	$500.00	$1,500	$7,500
Roof Curb(S)	3	EA	$1,000	$3,000	$250.00	$750	$3,750
Controls	1	LS	$25,000	$25,000	$10,000.00	$10,000	$35,000
Floor Drain(S)	6	EA	$300	$1,800	$150.00	$900	$2,700
Toilet(S)	1	EA	$200	$200	$200.00	$200	$400
Sink(S)	2	EA	$400	$800	$100.00	$200	$1,000
Urinal(S)	1	EA	$200	$200	$75.00	$75	$275
Faucet(S)	2	EA	$350	$700	$100.00	$200	$900
Trap Primer(S)	2	EA	$350	$700	$150.00	$300	$1,000
Drain/Waste/Vent Plumbing	1000	LF	$15	$15,000	$7.00	$7,000	$22,000
Cold Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Hot Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Dx Hvac Air Handler(S)	2	EA	$17,500	$35,000	$5,000.00	$10,000	$45,000
Dx Hvac Condensing Unit(S)	2	EA	$15,000	$30,000	$1,500.00	$3,000	$33,000
Controls	1	LS	$7,500	$7,500	$5,000.00	$5,000	$12,500
Condensing Unit Pad(S)	1	EA	$500	$500	$100.00	$100	$600
Ductwork	1000	LBS	$50	$50,000	$5.00	$5,000	$55,000
Diffuser(S)/Register(S)/Grille(S)	9	EA	$17	$153	$10.00	$90	$243
Louvre(S)	9	EA	$150	$1,350	$100.00	$900	$2,250
Fire Hose Rack	2	EA	$350	$700	$100.00	$200	$900
Subtotal for Division 15							**$235,018**
Division 16 - Electrical							

Table 4.1.4
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Charlie Site with 3 Pumps
145,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Mobilization	1	LS	$0	$0	$0.00	$0	$50,000
Temporary Power	1	LS	$50,000	$50,000	$2,000.00	$2,000	$52,000
Duct Banks	200	CY	$400	$80,000	$20.00	$4,000	$84,000
Manholes	3	EA	$6,000	$18,000	$500.00	$1,500	$19,500
1/0 5 Kv Cable	1,000	LF	$7	$7,000	$3.00	$3,000	$10,000
250 Mcm 5 Kv Cable	1,000	LF	$8	$8,000	$3.00	$3,000	$11,000
500 Mcm 5 Kv Cable	1,000	LF	$6	$6,000	$2.00	$2,000	$8,000
5 Kv Terminations	50	EA	$175	$8,750	$25.00	$1,250	$10,000
Conduit	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Wire	1	LS	$75,000	$75,000	$10,000.00	$10,000	$85,000
Lighting							
Exterior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Interior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Mv Switchgear	1	LS	$100,000	$100,000	$25,000.00	$25,000	$125,000
Soft Starts - 800 HP	3	EA	$52,000	$156,000	$15,000.00	$45,000	$201,000
1500 Kva Transformers	3	EA	$50,000	$150,000	$10,000.00	$30,000	$180,000
480 Volt Mcc	1	EA	$85,000	$85,000	$50,000.00	$50,000	$135,000
Misc. Switchgear	1	LS	$50,000	$50,000	$6,000.00	$6,000	$56,000
Lightning Protection	1	LS	$35,000	$35,000	$5,000.00	$5,000	$40,000
Telephone System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Fire Alarm System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Security And Entrance Equipment	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Embedded Conduit	1	LS	$25,000	$25,000	$8,000.00	$8,000	$33,000
Grounding	1	LS	$50,000	$50,000	$10,000.00	$10,000	$60,000
Cable Tray	1	LS	$25,000	$25,000	$15,000.00	$15,000	$40,000
500 Kva Gen Set With ATS	1	Ea	$98,000	$98,000	$5,000.00	$5,000	$103,000
TXU Firm Backup Capabiltiy	1	LS	$600,000	$600,000	$30,000.00	$30,000	$630,000
Testing	1	LS	$15,000	$15,000	$5,000.00	$5,000	$20,000
Subtotal for Division 16							**$2,206,500**

Table 4.1.4

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Charlie Site with 3 Pumps

145,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 17 - I&C							
Engineering & Submittals	1	LS	$75,000	$75,000	$5,000.00	$5,000	$80,000
Computers And Printers	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
F O Cable And Comm. Equip.	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Control Panels	1	LS	$250,000	$250,000	$10,000.00	$10,000	$260,000
Start Up-Check Out	1	LS	$35,000	$35,000	$10,000.00	$10,000	$45,000
Ultra Sonic Flow Meters	4	Ea	$5,000	$20,000	$2,500.00	$10,000	$30,000
HMI Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
PLC Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
O&M Manuals	1	LS	$5,000	$5,000	$2,000.00	$2,000	$7,000
Training	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Software	1	LS	$85,000	$85,000	$15,000.00	$15,000	$100,000
Factory Test	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Bonds	1	LS	$0	$0	$0.00	$0	$80,000
Level transmitters	3	Ea	$2,000	$6,000	$500.00	$1,500	$7,500
PLC - Primary + hot back-up	1	Ea	$17,500	$17,500	$7,500.00	$7,500	$25,000
PC and Monitor	1	Ea	$8,000	$8,000	$1,000.00	$1,000	$9,000
MMI Software + Programming	1	Ea	$7,000	$7,000	$15,000.00	$15,000	$22,000
Instrumentation wiring	1	LS	$75,000	$75,000	$28,000.00	$28,000	$103,000
SCADA Transmitter	1	Ea	$100,000	$100,000	$10,000.00	$10,000	$110,000
Security Cameras	1	LS	$75,000	$75,000	$10,000.00	$10,000	$85,000
Subtotal for Division 17							**$1,293,500**
Division subtotal				**$10,932,988**		**$3,407,280**	**$15,748,768**
Contractor's Profit on Material (10%)							$1,093,299
Prime Profit on Subcontractors - 10% on Div 5, 6, 7, 8, 9, 10, 12, 16, 17							$451,894
Subtotal							**$17,293,960**
Contingency (20%)							$3,458,792
Construction Work Effort subtotal							**$20,752,752**
Escalation to Midpoint @ 6%/year& 5 yrs							**$7,018,581**
Subtotal							**$27,771,333**

Table 4.1.4
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Charlie Site with 3 Pumps
145,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Engineering and Surveying Services (12%)							$3,332,560
Construction Management (8%)							$2,221,707
Construction Materials Testing (1.5%)							$416,570
City Contract Administration (10%)							$2,777,133
Services Subtotal							**$8,747,970**
Total Estimated Project Cost							**$36,519,303**

4.2 DELTA AND PAVAHO SUMPS

4.2.1 Option P1 – Demo Existing Pump Station, New 500,000 GPM Pump Station At Pavaho

In identifying potential solutions to lower the predicted maximum 100-year sump elevation in Pavaho Sump to the desired elevation, the initial concept was that a series of options would be identified for Pavaho Sump independent of the options for the Delta sumps (Trinity-Portland, Frances Street, and Westmoreland-Hampton). This initial effort led to the identification of Option P1, which includes constructing a new 500,000 gpm pump station at the existing Pavaho Pumping Plant site and demolishing the existing Pavaho pump station. This option would be effective in lowering the maximum 100-year flood elevation in Pavaho sump to 405.5 feet. However, in examining the model results for this scenario, it was apparent that additional improvements to sump pond connectivity in Pavaho Sump could lower this pumping requirement, while simultaneously lowering maximum flood elevations in the Delta sumps. It was recognized that the Delta and Pavaho sumps should be treated as a combined system, and the proposed solutions should be developed accordingly. Although Option P1 could be considered a standalone solution for Pavaho Sump only, the combined system of improvements that would accompany Option P1 as a solution for the combined Delta/Pavaho sump system would result in unnecessarily high costs. Therefore, no additional Delta/Pavaho system improvements were developed with Option P1 as a basis. Option P1 is included here only as a worst-case (most expensive and maximum pumping capacity) alternative for Pavaho Sump. Option P1 does not help the Delta sumps, and Delta sump options to accompany Option P1 have not been identified.

The Pavaho Storm Water Pump Station evaluated for Option P1 has a total pumping capacity of 500,000 gpm. The pumping is accomplished with the use of three 166,700 gpm concrete volute pumps, each rated at 55 feet total dynamic head (TDH). Each of these pumps is driven by a 3000 horsepower electric motor operating at 295 rpm, eliminating the need for a gear reducer between the motor and pump. Additionally, a 6,000 gpm vertical axial flow pump is provided for dewatering the sump during periods of low flow.

Pump station discharge piping will be configured to use the two existing 6'x8' gravity sluices at Pavaho Pump Station as outfall to the river. Each individual pump will be equipped with a dedicated discharge header with a goose-neck high point elevation above the top of levee and an air release valve to prevent back-siphoning into the station. Station piping will be lined with high density polyurethane and coated with suitable epoxy-based systems.

The pump station will be configured in accordance with the guidance contained in the following documents:

- "Hydrologic Analysis of Interior Areas" EM 1110-2-1413, dated 15 January 1987
- "Hydrologic Frequency Analysis" EM 1120-2-1415, dated 05 March 1993
- "Flood Run-off Analysis" EM 1110-2-1417, dated 31 August 1994
- "Risk-Based Analysis for Flood Damage Reduction Studies" EM 1120-2-1619, dated 01 August 1996

- *EM1110-2-2100 Stability Analysis of Concrete Structures*
- *EM1110-2-2102 Waterstops and Other Preformed Joint Materials for CW Structures*
- *EM1110-2-2502 Retaining Walls*
- *EM1110-2-3104 Structural and Architectural Design of Pumping Stations*
- *EM1110-2-3105 Mechanical and Electrical Design of Pumping Stations*
- *EM1110-2-1804 Geotechnical Investigations*

The pump station substructure is cast-in-place concrete designed in accordance with ACI 310R and other appropriate standards. The foundation is a mat consisting of a five foot thick concrete slab to which the walls are attached. The walls utilize a stepped design in which the walls are reduced in thickness as the height of the structure increases and the soil load decreases. The sump area is deep and a removable hatch has been incorporated into the floor deck to provide access for removing debris that will accumulate in the sump area. The hatch is large enough to accommodate a small Bobcat.

The superstructure of the pump station is cast-in-place concrete and beams are incorporated into the structure to accommodate the installation of a bridge crane for maintenance. The pump station roof is designed to be double tees, which increases the stiffness of the structure and simplifies construction and maintenance. The roof will consist of the double tees, a two-inch layer of light-weight grout, and a membrane. The superstructure has been designed so that a drive through corridor is incorporated into the station, permitting truck access directly adjacent to the pumps for maintenance.

The exterior wall sections have been assumed to be concrete masonry units with brick veneer, although a different system may be incorporated in the final design.

The pump station interior in the pump room is unfinished; however, the interiors of the switchgear room, office, and restroom have conventional dry wall construction and are painted. Flooring throughout the station is concrete with a troweled finish. The main pump room is provided with ventilation, while the switchgear room, office, and restroom are conditioned.

The primary electrical supply to the station is three-phase, 4160 v.a.c. and is provided by TXU. The supply is from two independent substations providing needed redundancy. Therefore, the standby generator set is for use by limited equipment including the control system, lighting, HVAC components, and the bridge crane. The switchgear is located in the switchgear room and includes soft starts for each of the main pumping units. The switchgear is configured as a main-tie-main to provide additional redundancy and reliability in station operation.

This pump station is located on the West Levee, in the vicinity of the existing Pavaho Pump Station, directly adjacent to Canada Drive. Access to the station is provided via a concrete paved access road. Roll-up doors on the station provide the drive-through access. Since the site is located next to the sump a retaining wall is provided to level the site for routine operations. Water and sewer are available in adjacent public streets, and a two-inch water service and a 4-inch sanitary sewer has been provided for the station.

The interior lighting level will be maintained at 85 foot candles. All handrails will be four-rung aluminum. Grating will be hot-dipped galvanized.

The instrumentation and control system will incorporate monitoring and alarming for motor and pump bearing temperature, motor winding temperature, reverse rotation, flow for each pump, sump elevation, and precipitation. The controls system will be integrated into the SCADA system operated by the City of Dallas. Individual pump control can be initiated at the pump, in the operator office/control room, or remotely by the SCADA system.

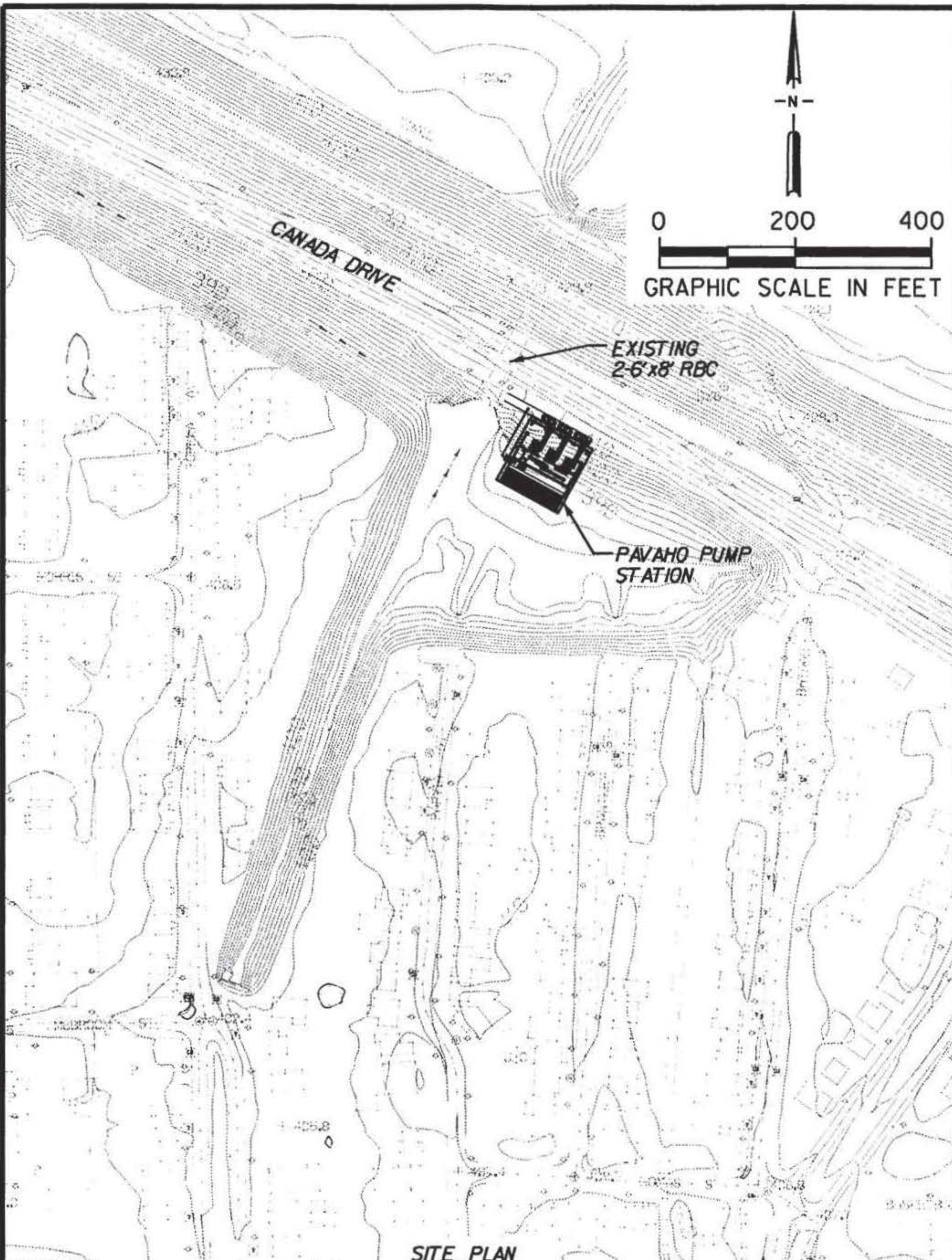
Figure 4.2.1 is a site plan for this alternative.
Figure 4.2.2 is a plan view of the 500,000 gpm pump station. The trash rack in the front of the station will be equipped with mechanically-cleaned screens manufactured by Du Perion, since these screens have demonstrated ability to function very effectively in this harsh environment. The switchgear room is adjacent to the pump room.

Figure 4.2.3 is Section A and the relationship of the pumping units, intake sump, and discharge piping are clearly indicated. The bridge crane has 27-foot clearance above the drive through for removal and/or installation of the pumping equipment.

Figures 4.2.4A and 4.2.4B are the electrical one-line diagrams for the station. The double-ended switchgear is indicated. Each of the main pumps is operated by a soft start that has a by-pass that permits the motor to be started even if the soft start is out of service. In addition to the protection provided by the soft start, each of the motors will be equipped with a Multilin 469 to provide motor protective relay systems.

Figure 4.2.5 is a preliminary process and instrumentation diagram for the pump station. The vibration monitoring equipment is shown, as are the RTDs for monitoring motor winding temperatures, and the pump and motor bearing temperatures. Each of the pumps will be equipped with an ultrasonic flow meter to monitor pump discharge.

The Engineer's Preliminary Opinion of Probable Cost for the storm water pump station for Option P1 is summarized in Table 4.2.1.



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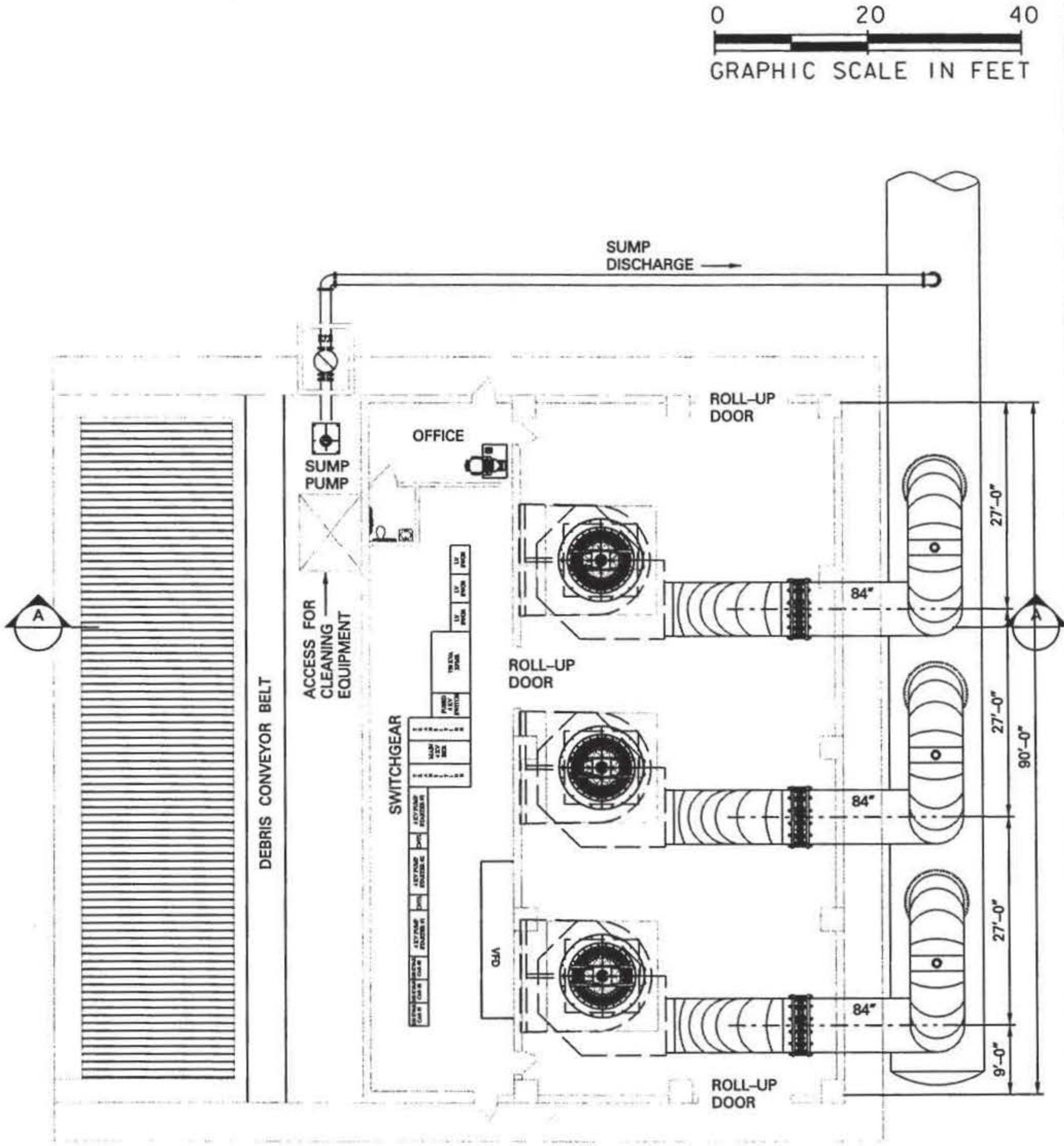

PLAN VIEW

SCALE: 1" = 20'

STATION CAPACITY = 500,000 GPM
170,000 GPM PER PUMP

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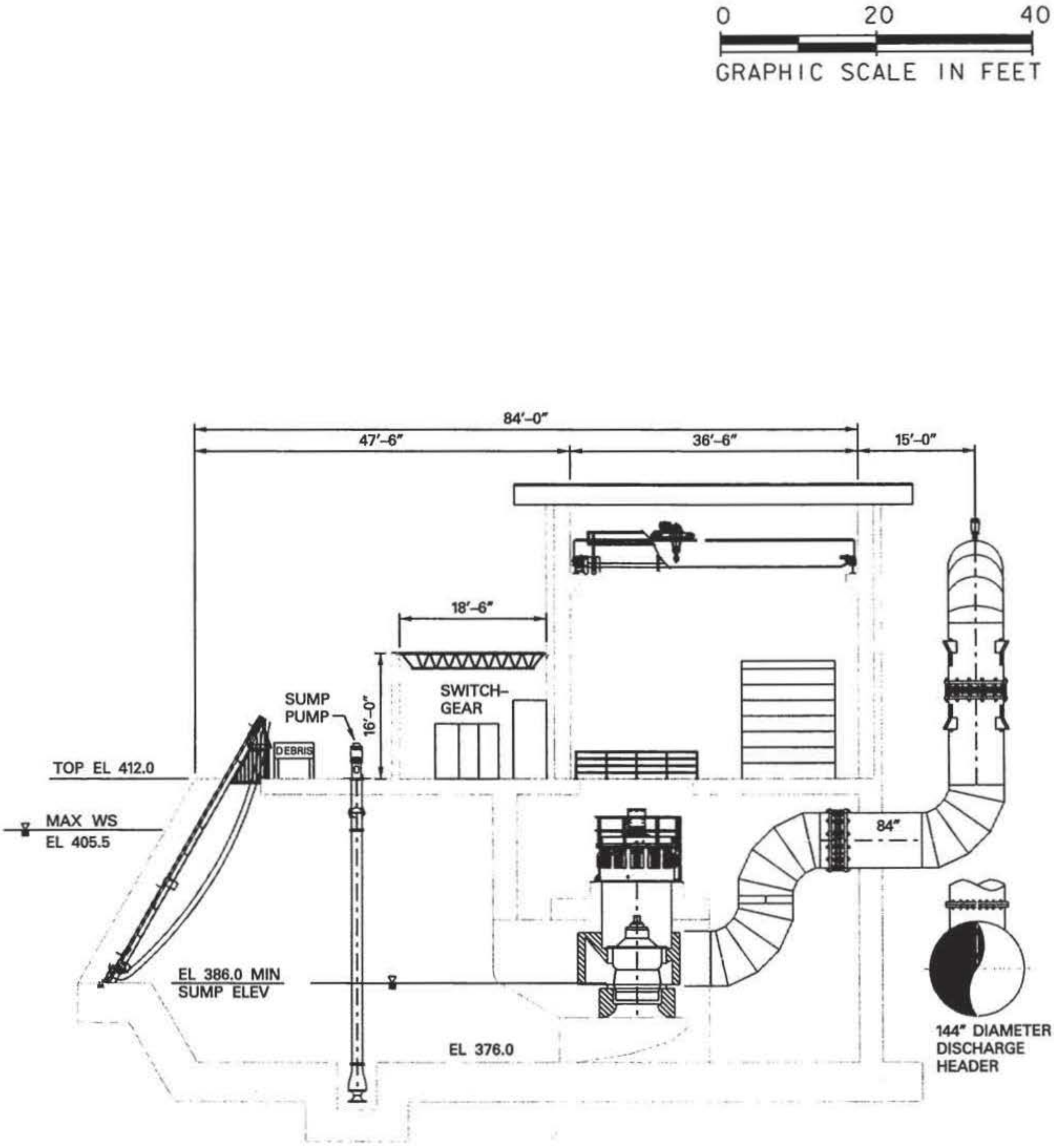

SECTION A – CONCRETE VOLUTE PUMPS
SCALE: 1" = 20'

STATION CAPACITY = 500,000 GPM
170,000 GPM PER PUMP

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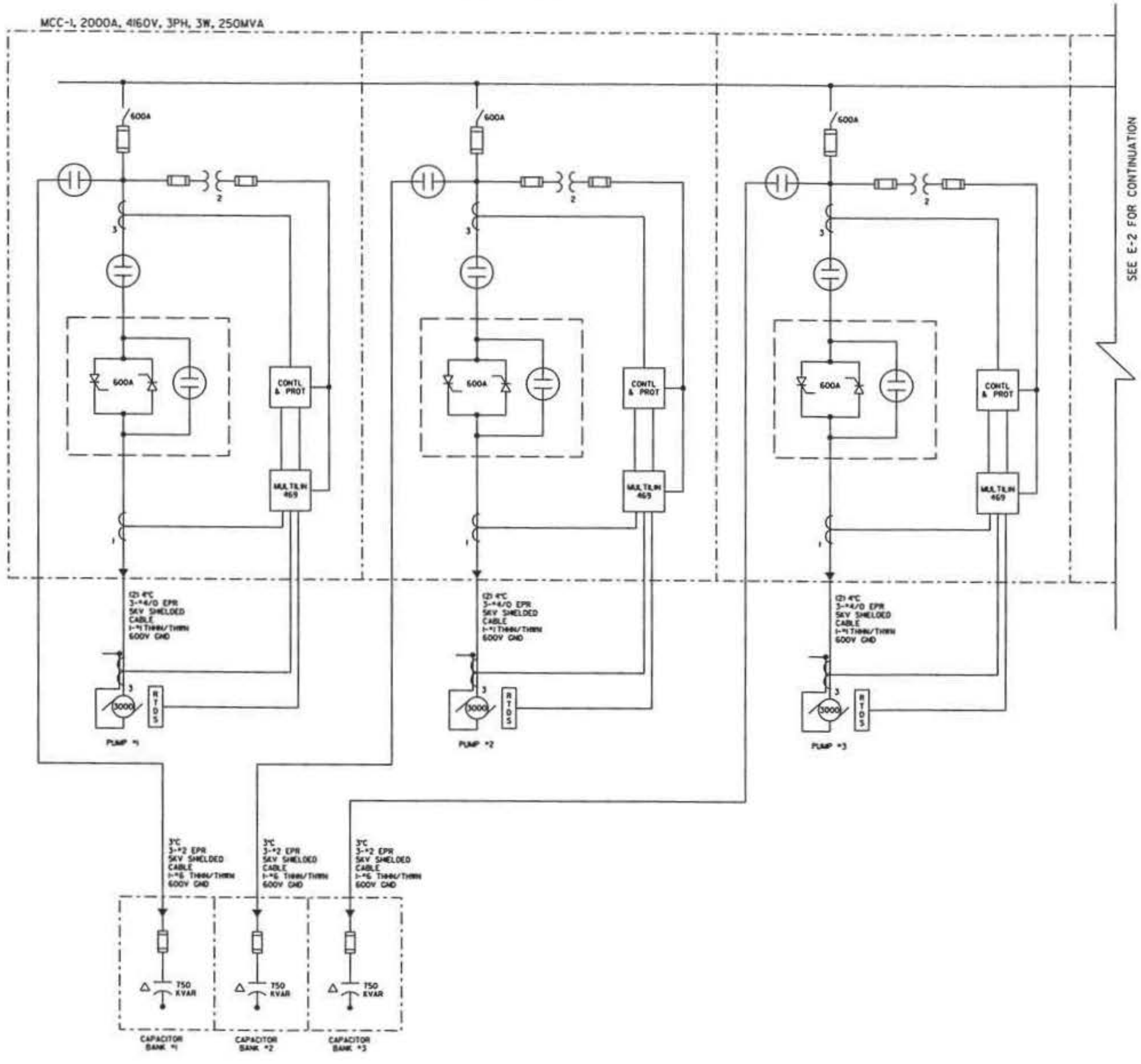

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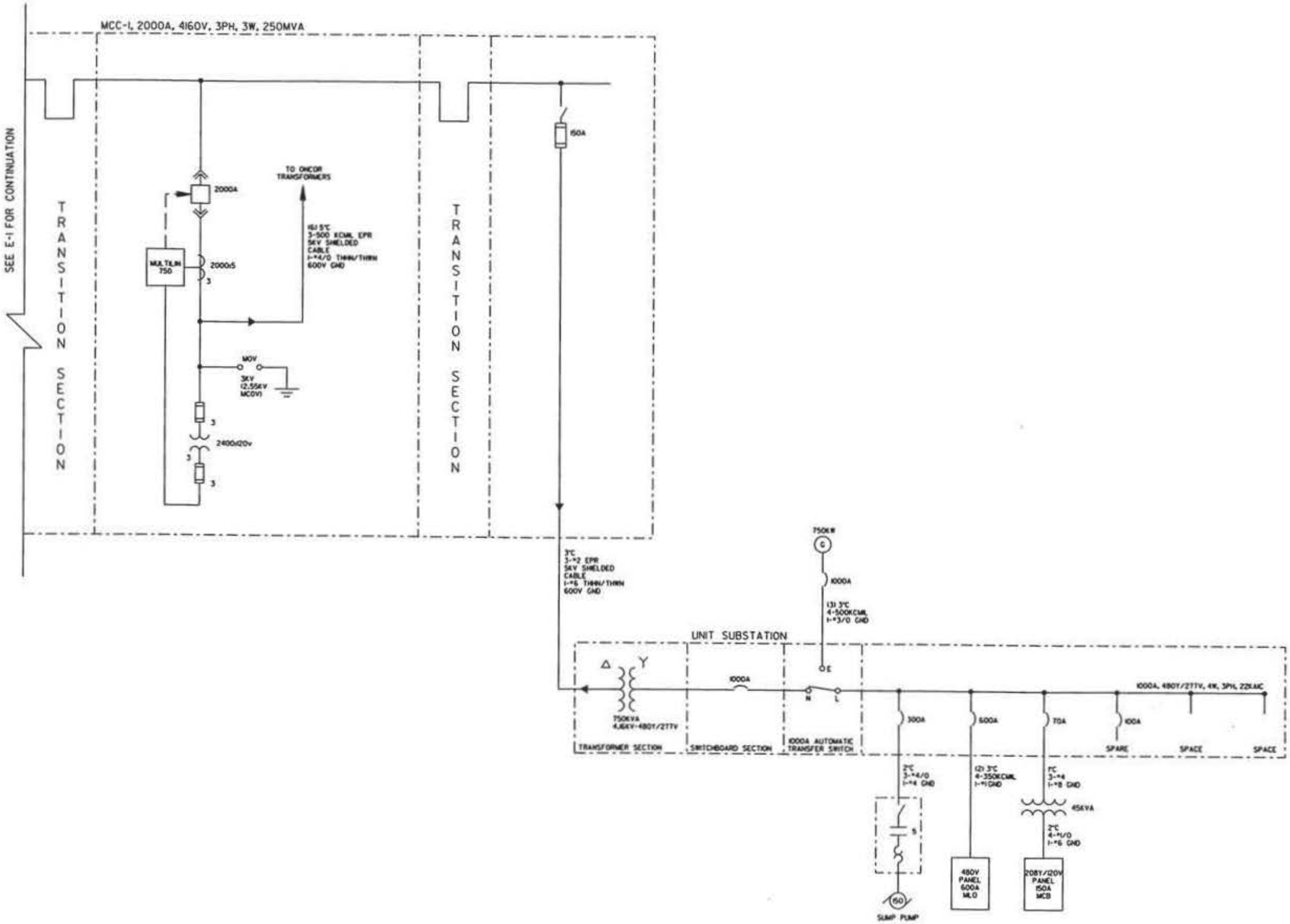
PROPOSED PAVAHO PUMP STATION
CONCRETE VOLUTE PUMPS
500,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

FIGURE 4.2.4A



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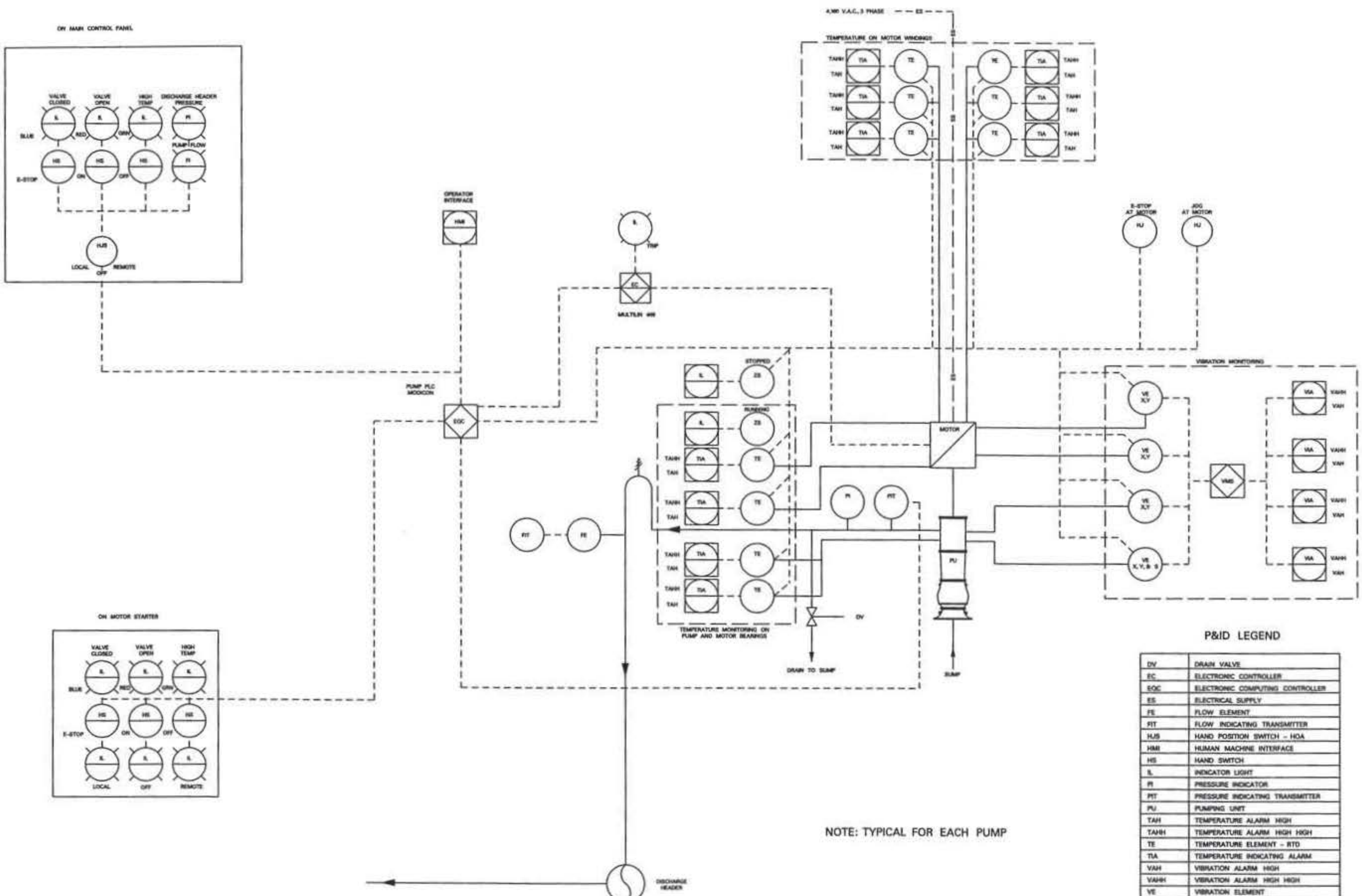
PROPOSED PAVAHO PUMP STATION
CONCRETE VOLUTE PUMPS
500,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

FIGURE
4.2.4B



NOTE: TYPICAL FOR EACH PUMP

P&ID LEGEND

DV	DRAIN VALVE
EC	ELECTRONIC CONTROLLER
EQC	ELECTRONIC COMPUTING CONTROLLER
ES	ELECTRICAL SUPPLY
FE	FLOW ELEMENT
FIT	FLOW INDICATING TRANSMITTER
HJS	HAND POSITION SWITCH – HOA
HMI	HUMAN MACHINE INTERFACE
HS	HAND SWITCH
IL	INDICATOR LIGHT
PI	PRESSURE INDICATOR
PIT	PRESSURE INDICATING TRANSMITTER
PU	PUMPING UNIT
TAH	TEMPERATURE ALARM HIGH
TAHH	TEMPERATURE ALARM HIGH HIGH
TE	TEMPERATURE ELEMENT – RTD
TIA	TEMPERATURE INDICATING ALARM
VAH	VIBRATION ALARM HIGH
VAHH	VIBRATION ALARM HIGH HIGH
VE	VIBRATION ELEMENT
VIA	VIBRATION INDICATING ALARM
VMS	VIBRATION MONITORING SYSTEM
ZS	POSITION SWITCH

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PROPOSED PAVAHO PUMP STATION
500,000 GPM CAPACITY
PROCESS AND INSTRUMENTATION DIAGRAM

FIGURE
4.2.5

Table 4.2.1

Summary for Pavaho 3 Pump 500,000 gpm

Division	Cost
Division 1 - General Conditions	$2,889,200
Divison 2 - Site Work	$2,352,200
Division 3- Concrete	$3,058,573
Division 4 - Masonry	$87,072
Division 5- Metals	$118,515
Division 6 - Carpentry	$4,000
Division 7 - Thermal & Moisture Protection	$791,827
Division 8 - Doors & Windows	$12,700
Division 9 - Finishes	$85,075
Division 10 - Specialties	$9,700
Division 11 - Equipment	$8,232,000
Division 12 - Furnishings	$4,110
Division 13- Special Construction	$0
Division 14 - Conveying Systems	$245,600
Division 15 - Mechanical	$235,018
Division 16 - Electrical	$2,365,500
Division 17 - Instrumentation & Control	$1,293,500
Division Subtotal	**$21,784,590**
Contractor's Profit of Materials - 10%	$1,596,315
Prime Profit on SubConstractors - 10%	$468,493
Subtotal	**$23,849,397**
Construction Contingencies - 10%	$4,769,879
Construction Work Effort subtotal	**$28,619,277**
Escalation to Midpoint @ 6%/Yr & 3 yrs	$5,466,282
Subtotal	**$34,085,559**
Engineering and Surveying Services (12%)	$4,090,267
Construction Management (8%)	$2,726,845
Construction Materials Testing (1.5%)	$511,283
City Contract Administration (10%)	$3,408,556
Services Subtotal	**$10,736,951**
Total Estimated Project Cost	**$44,822,510**

Table 4.2.1
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Pavaho Site with 3 Pumps
500,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 1 - General Conditions							
Mobilization	1	LS	$0	$0		$0	$600,000
Construction Surveying	1	LS	$0	$0	$45,000.00	$45,000	$45,000
Telephone	39	Mo	$150	$5,850	$0.00	$0	$5,850
SWWWP	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Trench Excavation Safety & Support/Structural Plan	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Traffic Control Plan	1	LS	$15,000	$15,000	$0.00	$0	$15,000
PM	39	Mo	$0	$0	$15,000.00	$585,000	$585,000
Superintendent	39	Mo	$0	$0	$12,000.00	$468,000	$468,000
Admin	39	Mo	$0	$0	$7,000.00	$273,000	$273,000
Sanitary Services	39	Mo	$0	$0	$500.00	$19,500	$19,500
Security Services	39	Mo	$0	$0	$2,000.00	$78,000	$78,000
Pick Up Trucks - 3 each	39	Mo	$0	$0	$1,800.00	$70,200	$70,200
Office Equipment	39	Mo	$0	$0	$350.00	$13,650	$13,650
150 Ton Crane - 24 Months	24	Mo	$0	$0	$20,000.00	$480,000	$480,000
Loader - 39 Months	39	Mo	$0	$0	$2,000.00	$78,000	$78,000
Office Trailors - 2 each	39	Mo	$0	$0	$1,500.00	$58,500	$58,500
Tool Trailors - 2 each	39	Mo	$0	$0	$500.00	$19,500	$19,500
Subtotal for Division 1							**$2,889,200**
Division 2 - Site Work							
Structural Excavation	12,000	CY	$0.00	$0	$8.00	$96,000	$96,000
Structural Backfill	10,000	CY	$6.00	$60,000	$3.00	$30,000	$90,000
Paving	1,300	SY	$12.00	$15,600	$12.00	$15,600	$31,200
Pavement Striping	2,450	SF	$6.00	$14,700	$2.00	$4,900	$19,600
Access Road	1,600	SY	$7.00	$11,200	$13.00	$20,800	$32,000
Traffic Control	1	LS	$5,000.00	$5,000	$20,000.00	$20,000	$25,000
Curb Stops	10	EA	$200.00	$2,000	$50.00	$500	$2,500
8-inch Bollards	10	EA	$1,000.00	$10,000	$150.00	$1,500	$11,500
Grading	3,000	SY	$1.00	$3,000	$2.00	$6,000	$9,000
Fencing - 10 Ft. Man Proof	1,000	LF	$50.00	$50,000	$10.00	$10,000	$60,000
16-foot slide gate (Electric Motor)	1	EA	$6,000.00	$6,000	$1,000.00	$1,000	$7,000

Table 4.2.1
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Pavaho Site with 3 Pumps
500,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
3-foot ped. Gate	1	EA	$400.00	$400	$100.00	$100	$500
Landscaping	1	LS	$50,000.00	$50,000	$5,000.00	$5,000	$55,000
Channel Liner	2,000	SY	$10.00	$20,000	$5.00	$10,000	$30,000
84-inch steel discharge pipe - 3@130' each	390	LF	$1,000	$390,000	$100.00	$39,000	$429,000
84-inch nut, bolt and gasket sets	6	EA	$2,000	$12,000	$1,500.00	$9,000	$21,000
144-inch steel dischage pipe	200	LF	$1,800	$360,000	$100.00	$20,000	$380,000
Raise existing Pavaho pump discharge structure an addtiaonal 5 feet	1	LS	$50,000	$50,000	$10,000.00	$10,000	$60,000
Water - 2-inch	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Sewer	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Telephone	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Misc Utilities	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Shoring	5,000	SF	$35	$175,000	$5.00	$25,000	$200,000
Dewatering	1	LS	$250,000	$250,000	$25,000.00	$25,000	$275,000
Coffer Dam - 26' high 2:1ss	10,000	CY	$15	$150,000	$5.00	$50,000	$200,000
3-inch mud slab	140	CY	$100	$14,000	$25.00	$3,500	$17,500
Demolition of existing Pavaho station	1	LS	$200,000.00	$200,000	$35,000.00	$50,000	$250,000
Subtotal for Division 2							**$2,352,200**
Division 3 - Concrete							
Substructure Concrete (Foundation)							
Concrete	1901	CY	$100	$190,100	$15.00	$28,515	$218,615
Rebar (310 lb/CY)	295	TON	$1,020	$300,548	$300.00	$88,397	$388,945
Forming	10265	SF	$10	$102,650	$5.00	$51,325	$153,975
Curing	80	CSF	$5	$400	$5.00	$400	$800
Waterstops	320	LF	$10	$3,200	$5.00	$1,600	$4,800
Substructure Concrete (Pump Room Floor)							
Concrete	331	CY	$100	$33,100	$15.00	$4,965	$38,065
Rebar (310 lb/CY)	51	TON	$1,020	$52,331	$300.00	$15,392	$67,723
Forming	5964	SF	$10	$59,640	$5.00	$5	$59,645
Curing	63	CSF	$5	$315	$5.00	$315	$630
Waterstops	315	LF	$10	$3,150	$5.00	$1,575	$4,725
Substructure Concrete (Perimeter walls) - ext. 4' thick avg.							

Table 4.2.1

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Pavaho Site with 3 Pumps

500,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Concrete	1768	CY	$100	$176,800	$15.00	$26,520	$203,320
Rebar (310 lb/CY)	274	TON	$1,020	$279,521	$300.00	$82,212	$361,733
Forming	11928	SF	$10	$119,280	$5.00	$59,640	$178,920
Curing	180	CSF	$5	$900	$5.00	$900	$1,800
Waterstops	275	LF	$10	$2,750	$5.00	$1,375	$4,125
Substructure Concrete (Divider walls-int. 2' thick avg)							
Concrete	476	CY	$100	$47,600	$15.00	$7,140	$54,740
Rebar (310 lb/CY)	74	TON	$1,020	$75,256	$300.00	$22,134	$97,390
Forming	6420	SF	$10	$64,200	$5.00	$32,100	$96,300
Curing	190	CSF	$5	$950	$5.00	$950	$1,900
Waterstops	500	LF	$10	$5,000	$5.00	$2,500	$7,500
Substructure Columns and Beams							
Concrete	40	CY	$100	$4,000	$15.00	$600	$4,600
Rebar (310 lb/CY)	6	TON	$1,020	$6,324	$300.00	$1,860	$8,184
Forming	1200	SF	$10	$12,000	$5.00	$6,000	$18,000
Curing	40	CSF	$5	$200	$5.00	$200	$400
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Electrical Room Bottom Slab							
Concrete	160	CY	$100	$16,000	$15.00	$2,400	$18,400
Rebar (310 lb/CY)	25	TON	$1,020	$25,296	$300.00	$7,440	$32,736
Forming	1443	SF	$10	$14,430	$5.00	$7,215	$21,645
Curing	60	CSF	$5	$300	$5.00	$300	$600
Waterstops	150	LF	$10	$1,500	$5.00	$750	$2,250
Superstructure Columns							
Concrete	60	CY	$100	$6,000	$15.00	$900	$6,900
Rebar (310 lb/CY)	9	TON	$1,020	$9,486	$300.00	$2,790	$12,276
Forming	3100	SF	$10	$31,000	$5.00	$15,500	$46,500
Curing	200	CSF	$5	$1,000	$5.00	$1,000	$2,000
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Superstructure Beams							
Concrete	60	CY	$100	$6,000	$15.00	$900	$6,900
Rebar (310 lb/CY)	9	TON	$1,020	$9,486	$300.00	$2,790	$12,276

Table 4.2.1

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Pavaho Site with 3 Pumps

500,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Forming	2164	SF	$10	$21,640	$5.00	$10,820	$32,460
Curing	250	CSF	$5	$1,250	$5.00	$1,250	$2,500
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Superstructure double-Tees	4752	SF	$18	$85,536	$5.00	$23,760	$109,296
Retaining Walls - MSE wall >20'	15500	SF	$40	$620,000	$10.00	$155,000	$775,000
Subtotal Division 3							**$3,058,573**
Division 4 - Masonary							
CMU Partitions	12,000	SF	$3.00	$36,000	$4.00	$48,000	$84,000
Glazed CMU Restroom Walls	256	SF	$8.00	$2,048	$4.00	$1,024	$3,072
Subtotal for Division 4				**$0**		**$0**	**$87,072**
Division 5 - Metals							
Grating	800	SF	$20	$16,000	$5.00	$4,000	$20,000
Mtl deck	7,505	SF	$2	$15,010	$1.00	$7,505	$22,515
Bar Joists	1	LS	$60,000	$60,000	$5,000.00	$5,000	$65,000
Handrail	200	LF	$40	$8,000	$15.00	$3,000	$11,000
Subtotal for Division 5							**$118,515**
Division 6 - Carpentry							
Misc.	1	ls	$1,000	$1,000	$3,000.00	$3,000	$4,000
Subtotal for Division 6							**$4,000**
Division 7 - Thermal and Moisture Protection							
Exterior walls	11,000	SF	$45	$495,000	$20.00	$220,000	$715,000
Roofing	6,500	SF	$4	$26,000	$2.00	$49,827	$75,827
Roof Hatch-Pumps	0	EA	$15,000	$0	$500.00	$0	$0
Roof Hatch-Access	1	EA	$800	$800	$200.00	$200	$1,000
Subtotal for Division 7							**$791,827**
Division 8 - Doors and Windows							

Table 4.2.1
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Pavaho Site with 3 Pumps
500,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Doors, 3-0 x 7-0 steel	5	Ea	$200	$1,000	$100.00	$500	$1,500
Doors, roll-up 12' x 14' steel	2	Ea	$5,000	$10,000	$600.00	$1,200	$11,200
Subtotal for Division 8				**$0**		**$0**	**$12,700**
Division 9- Finishes							
Process Piping (pump rm risers & hdrs)	4,100	SF	$0.50	$2,050	$1.25	$5,125	$7,175
Misc. Structural Steel Surf. Prep.	8,900	SF	$1.00	$8,900	$2.00	$17,800	$26,700
Paint Structural Steel	8,900	SF	$1.00	$8,900	$4.00	$35,600	$44,500
Paint Building Interior Walls	10,000	SF	$0.10	$1,000	$0.57	$5,700	$6,700
Subtotal for Division 9							**$85,075**
Division 10 - Specialities							
Signage	1	LS	$5,000	$5,000	$1,000.00	$1,000	$6,000
Woven Wire Partition - 15'x15'x10'Tall	1	LS	$2,500	$2,500	$500.00	$500	$3,000
Toilet Accessories	1	LS	$500	$500	$200.00	$200	$700
Subtotal for Division 10				**$0**		**$0**	**$9,700**
Division 11 - Equipment							
Veritical sump pump, 7000 gpm	1	Ea	$80,000	$80,000	$5,000.00	$5,000	$85,000
Trash Rack (35' x 70')	2,450	SF	$400	$980,000	$10.00	$24,500	$1,004,500
Restrained Couplings	9	Ea	$15,000	$135,000	$1,500.00	$13,500	$148,500
CV Pumps and Motors - 170,000 gpm	3	Ea	$2,100,000	$6,300,000	$30,000.00	$90,000	$6,390,000
Stop Logs	1	LS	$200,000	$200,000	$15,000.00	$15,000	$215,000
12' - Flap Gate	1	Ea	$65,000	$65,000	$5,000.00	$5,000	$70,000
Sluice Gate - 9'x9'	1	Ea	$100,000	$100,000	$5,000.00	$5,000	$105,000
Vibration Monitoring Equipment	1	LS	$194,000	$194,000	$20,000.00	$20,000	$214,000
Subtotal for Division 11							**$8,232,000**
Division 12 - Furnishings							
Desk	1	Ea	$1,000	$1,000	$100.00	$100	$1,100
Chair	1	Ea	$600	$600	$10.00	$10	$610
Storage Shelves	4	Ea	$500	$2,000	$100.00	$400	$2,400

Table 4.2.1
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Pavaho Site with 3 Pumps
500,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Subtotal for Division 12							**$4,110**
Division 13 - Special Construction							
Subtotal for Division 13							**$0**
Division 14 - Conveying Systems							
20 Ton Bridge Crane	1	Ea	$95,600	$95,600	$25,000.00	$25,000	$120,600
Automated Conveyor System	1	LS	$100,000.00	$100,000	$25,000.00	$25,000	$125,000
Subtotal for Division 14							**$245,600**
Division 15 - Mechanical							
Ventilation Fan(S)	3	EA	$2,000	$6,000	$500.00	$1,500	$7,500
Roof Curb(S)	3	EA	$1,000	$3,000	$250.00	$750	$3,750
Controls	1	LS	$25,000	$25,000	$10,000.00	$10,000	$35,000
Floor Drain(S)	6	EA	$300	$1,800	$150.00	$900	$2,700
Toilet(S)	1	EA	$200	$200	$200.00	$200	$400
Sink(S)	2	EA	$400	$800	$100.00	$200	$1,000
Urinal(S)	1	EA	$200	$200	$75.00	$75	$275
Faucet(S)	2	EA	$350	$700	$100.00	$200	$900
Trap Primer(S)	2	EA	$350	$700	$150.00	$300	$1,000
Drain/Waste/Vent Plumbing	1000	LF	$15	$15,000	$7.00	$7,000	$22,000
Cold Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Hot Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Dx Hvac Air Handler(S)	2	EA	$17,500	$35,000	$5,000.00	$10,000	$45,000
Dx Hvac Condensing Unit(S)	2	EA	$15,000	$30,000	$1,500.00	$3,000	$33,000
Controls	1	LS	$7,500	$7,500	$5,000.00	$5,000	$12,500
Condensing Unit Pad(S)	1	EA	$500	$500	$100.00	$100	$600
Ductwork	1000	LBS	$50	$50,000	$5.00	$5,000	$55,000
Diffuser(S)/Register(S)/Grille(S)	9	EA	$17	$153	$10.00	$90	$243
Louvre(S)	9	EA	$150	$1,350	$100.00	$900	$2,250
Fire Hose Rack	2	EA	$350	$700	$100.00	$200	$900

Table 4.2.1
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Pavaho Site with 3 Pumps
500,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Subtotal for Division 15							**$235,018**
Division 16 - Electrical							
Mobilization	1	LS	$0	$0	$0.00	$0	$50,000
Temporary Power	1	LS	$50,000	$50,000	$2,000.00	$2,000	$52,000
Duct Banks	200	CY	$400	$80,000	$20.00	$4,000	$84,000
Manholes	3	EA	$6,000	$18,000	$500.00	$1,500	$19,500
1/0 5 Kv Cable	1,000	LF	$7	$7,000	$3.00	$3,000	$10,000
250 Mcm 5 Kv Cable	1,000	LF	$8	$8,000	$3.00	$3,000	$11,000
500 Mcm 5 Kv Cable	1,000	LF	$15	$15,000	$3.00	$3,000	$18,000
5 Kv Terminations	50	EA	$175	$8,750	$25.00	$1,250	$10,000
Conduit	1	LS	$175,000	$175,000	$20,000.00	$20,000	$195,000
Wire	1	LS	$125,000	$125,000	$10,000.00	$10,000	$135,000
Lighting							
Exterior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Interior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Mv Switchgear	1	LS	$100,000	$100,000	$25,000.00	$25,000	$125,000
Soft Starts - 3000 HP	3	EA	$60,000	$180,000	$15,000.00	$45,000	$225,000
1500 Kva Transformers	3	EA	$50,000	$150,000	$10,000.00	$30,000	$180,000
480 Volt Mcc	1	EA	$85,000	$85,000	$50,000.00	$50,000	$135,000
Misc. Switchgear	1	LS	$50,000	$50,000	$6,000.00	$6,000	$56,000
Lightning Protection	1	LS	$35,000	$35,000	$5,000.00	$5,000	$40,000
Telephone System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Fire Alarm System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Security And Entrance Equipment	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Embedded Conduit	1	LS	$25,000	$25,000	$8,000.00	$8,000	$33,000
Grounding	1	LS	$50,000	$50,000	$10,000.00	$10,000	$60,000
Cable Tray	1	LS	$25,000	$25,000	$15,000.00	$15,000	$40,000
500 Kva Gen Set With ATS	1	Ea	$98,000	$98,000	$5,000.00	$5,000	$103,000
TXU Firm Backup Capabiltiy	1	LS	$600,000	$600,000	$30,000.00	$30,000	$630,000
Testing	1	LS	$15,000	$15,000	$5,000.00	$5,000	$20,000

Table 4.2.1
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Pavaho Site with 3 Pumps
500,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Subtotal for Division 16							**$2,365,500**
Division 17 - I&C							
Engineering & Submittals	1	LS	$75,000	$75,000	$5,000.00	$5,000	$80,000
Computers And Printers	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
F O Cable And Comm. Equip.	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Control Panels	1	LS	$250,000	$250,000	$10,000.00	$10,000	$260,000
Start Up-Check Out	1	LS	$35,000	$35,000	$10,000.00	$10,000	$45,000
Ultra Sonic Flow Meters	4	Ea	$5,000	$20,000	$2,500.00	$10,000	$30,000
HMI Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
PLC Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
O&M Manuals	1	LS	$5,000	$5,000	$2,000.00	$2,000	$7,000
Training	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Software	1	LS	$85,000	$85,000	$15,000.00	$15,000	$100,000
Factory Test	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Bonds	1	LS	$0	$0	$0.00	$0	$80,000
Level transmitters	3	Ea	$2,000	$6,000	$500.00	$1,500	$7,500
PLC - Primary + hot back-up	1	Ea	$17,500	$17,500	$7,500.00	$7,500	$25,000
PC and Monitor	1	Ea	$8,000	$8,000	$1,000.00	$1,000	$9,000
MMI Software + Programming	1	Ea	$7,000	$7,000	$15,000.00	$15,000	$22,000
Instrumentation wiring	1	LS	$75,000	$75,000	$28,000.00	$28,000	$103,000
SCADA Transmitter	1	Ea	$100,000	$100,000	$10,000.00	$10,000	$110,000
Security Cameras	1	LS	$75,000	$75,000	$10,000.00	$10,000	$85,000
Subtotal for Division 17							**$1,293,500**
Division subtotal				**$15,963,150**		**$4,412,940**	**$21,784,590**
Contractor's Profit on Material (10%)							$1,596,315
Prime Profit on Subcontractors - 10% on Div 5, 6, 7, 8, 9, 10, 12, 16, 17							$468,493
Subtotal							**$23,849,397**
Contingency (20%)							$4,769,879
Construction Work Effort subtotal							**$28,619,277**

Table 4.2.1
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Pavaho Site with 3 Pumps
500,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Escalation to Midpoint @ 6%/year& 3 yrs							**$5,466,282**
Subtotal							**$34,085,559**
Engineering and Surveying Services (12%)							$4,090,267
Construction Management (8%)							$2,726,845
Construction Materials Testing (1.5%)							$511,283
City Contract Administration (10%)							$3,408,556
Services Subtotal							**$10,736,951**
Total Estimated Project Cost							**$44,822,510**

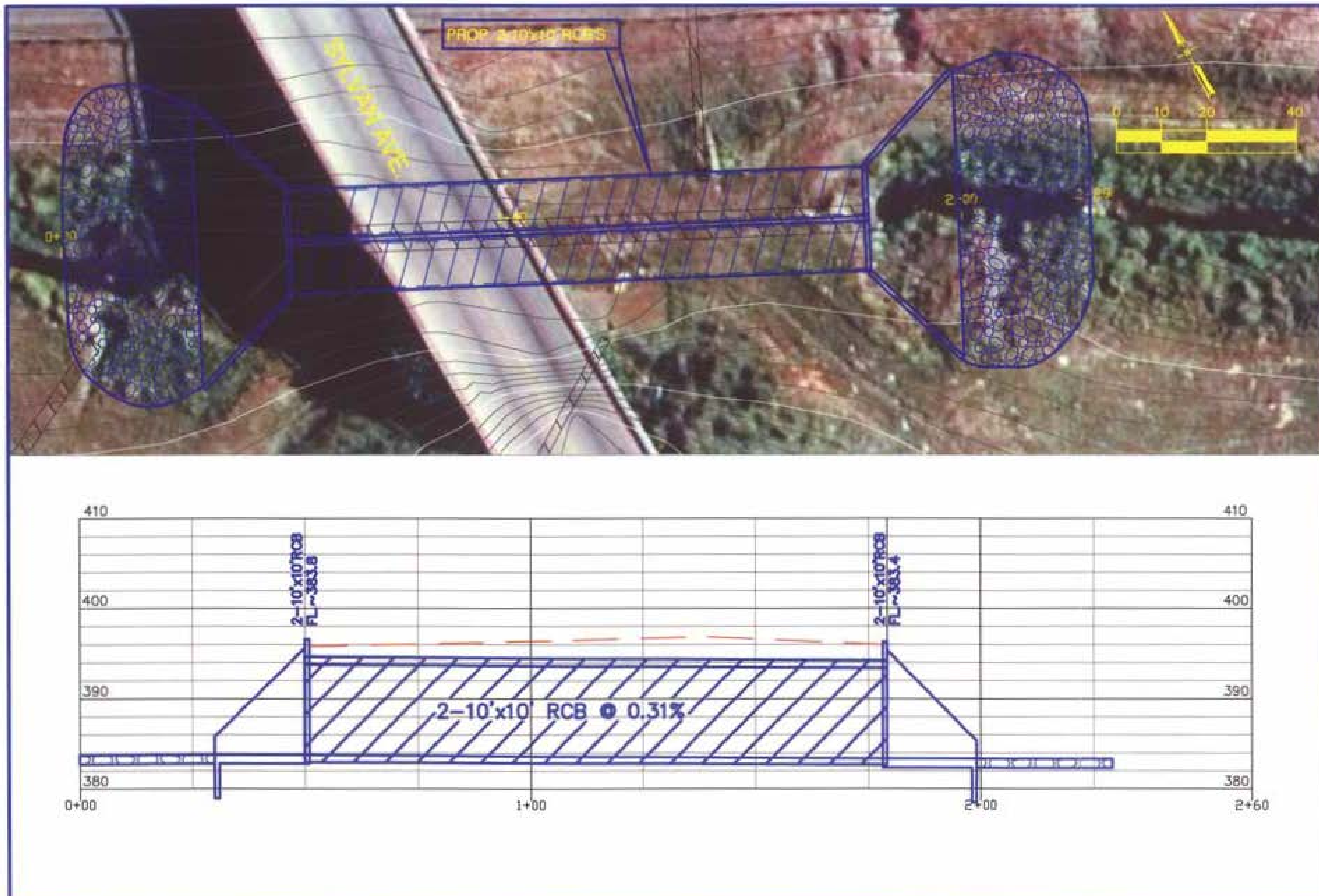
4.2.2 Option P2 – Demo Existing Station, New 375,000 GPM Pump Station

This option consists of several separate items. The items contained in this option are listed below:

1. Demolition of the existing Pavaho Station,
2. Construction of a new 375,000 gpm pump station at the current Pavaho station site,
3. Construction of two new 10'x6' reinforced concrete box culverts under Sylvan Avenue, and
4. Construction of one new 10'x8' reinforced concrete box culvert at Canada Drive.

Option P2 must be combined with Option D1A, D1B, or D2 to provide a complete solution for the combined Delta/Pavaho sump area.

The proposed Sylvan Avenue culverts serve to more efficiently convey flood water under the Sylvan Avenue crossing of the Pavaho sump and West Levee. The estimate of probable cost for the new Sylvan Avenue culverts is shown in Table 4.2.2. A schematic drawing of the proposed culverts is shown on Figure 4.2.6.



JACOBS Carter Burgess

CITY OF DALLAS
DEPARTMENT OF PUBLIC WORKS
AND TRANSPORTATION

OPTION P2
PROPOSED PAVAHO SUMP
2-10'x6' RCB @ SYLVAN AVE.

FIGURE 4.2.6

Table 4.2.2
Engineer's Preliminary Opinion of Probable Costs
Option P2 Culvert Improvements
Pavaho Sump at Sylvan Avenue

Item No.	Description	Unit	Quantity	Unit Cost	Estimated Cost
1	Traffic Control and Barricading	LS	1	$20,000	$20,000
2	Removal of Headwall and Wingwalls	EA	2	$10,000	$20,000
3	Removal of Existing 72" Culvert Pipe	LS	1	$15,000	$15,000
3	10' x 6' RCB By Open Cut	LF	150	$700	$105,000
4	10' x 6' RCB By Jacking	LF	120	$3,500	$420,000
5	Trench Safety and Support	LF	150	$4	$600
6	CIP Headwall	EA	2	$30,000	$60,000
7	6" Concrete Apron Pavement	SY	60	$70	$4,200
8	PVC Coated Gabions	CY	100	$250	$25,000
9	Sodding	SY	600	$7	$4,200
10	Erosion Control	LS	1	$25,000	$25,000
11	Dewatering	LS	1	$50,000	$50,000
12	Mobilization	LS	1	$100,000	$100,000
Subtotal					$849,000
20% Contingency					$169,800
Total					**$1,018,800**
Escalation to Midpoint @ 6%/year& 5 yrs					$344,558
Subtotal					**$1,363,358**
Engineering and Surveying Services (12%)					$163,603
Construction Management (8%)					$109,069
Construction Materials Testing (1.5%)					$20,450
City Contract Administration (10%)					$136,336
Service Subtotal					**$429,458**
Total Estimated Project Cost					**$1,792,816**

The Pavaho Storm Water Pump Station evaluated for Option P2 has a total pumping capacity of 375,000 gpm. The pumping is accomplished with the use of three 125,000 gpm concrete volute pumps, each rated at 55 feet total dynamic head (TDH). Each of these pumps is driven by a 2250 horsepower electric motor operating at 295 rpm, eliminating the need for a gear reducer between the motor and pump. Additionally, a 6,000 gpm vertical axial flow pump is provided for dewatering the sump during periods of low flow.

Pump station discharge piping will be configured to use the two existing 6'x8' gravity sluices at Pavaho Pump Station as outfall to the river. Each individual pump will be equipped with a dedicated discharge header with a goose-neck high point elevation above the top of levee and an air release valve to prevent back-siphoning into the station. Station piping will be lined with high density polyurethane and coated with suitable epoxy-based systems.

The pump station has (will be) been configured in accordance with the guidance contained in the following documents:

- "Hydrologic Analysis of Interior Areas" EM 1110-2-1413, dated 15 January 1987
- "Hydrologic Frequency Analysis" EM 1120-2-1415, dated 05 March 1993
- "Flood Run-off Analysis" EM 1110-2-1417, dated 31 August 1994
- "Risk-Based Analysis for Flood Damage Reduction Studies" EM 1120-2-1619, dated 01 August 1996
- *EM1110-2-2100 Stability Analysis of Concrete Structures*
- *EM1110-2-2102 Waterstops and Other Preformed Joint Materials for CW Structures*
- *EM1110-2-2502 Retaining Walls*
- *EM1110-2-3104 Structural and Architectural Design of Pumping Stations*
- *EM1110-2-3105 Mechanical and Electrical Design of Pumping Stations*
- *EM1110-2-1804 Geotechnical Investigations*

The pump station substructure is cast-in-place concrete designed in accordance with ACI 310R and other appropriate standards. The foundation is a mat consisting of a five foot thick concrete slab to which the walls are attached. The walls utilize a stepped design in which the walls are reduced in thickness as the height of the structure increases and the soil load decreases. The sump area is deep and a removable hatch has been incorporated into the floor deck to provide access for removing debris that will accumulate in the sump area. The hatch is large enough to accommodate a small Bobcat.

The superstructure of the pump station is cast-in-place concrete and beams are incorporated into the structure to accommodate the installation of a bridge crane for maintenance. The pump station roof is designed to be double tees, which increases the stiffness of the structure and simplifies construction and maintenance. The roof will consist of the double tees, a two-inch layer of light-weight grout, and a membrane. The superstructure has been designed so that a drive through corridor is incorporated into the station, permitting truck access directly adjacent to the pumps for maintenance.

The exterior wall sections have been assumed to be concrete masonry units with brick veneer, although a different system may be incorporated in the final design.

The pump station interior in the pump room is unfinished; however, the interiors of the switchgear room, office, and restroom have conventional dry wall construction and are painted. Flooring throughout the station is concrete with a troweled finish. The main pump room is provided with ventilation, while the switchgear room, office, and restroom are conditioned.

The primary electrical supply to the station is three-phase, 4160 v.a.c. and is provided by TXU. The supply is from two independent substations providing needed redundancy. Therefore, the standby generator set is for use by limited equipment including the control system, lighting, HVAC components, and the bridge crane. The switchgear is located in the switchgear room and includes soft starts for each of the main pumping units. The switchgear is configured as a main-tie-main to provide additional redundancy and reliability in station operation.

This pump station is located on the West Levee, in the vicinity of the existing Pavaho Pump Station, directly adjacent to Canada Drive. Access to the station is provided via a concrete paved access road. Roll-up doors on the station provide the drive-through access. Since the site is located next to the sump a retaining wall is provided to level the site for routine operations. Water and sewer are available in adjacent public streets, and a two-inch water service and a 4-inch sanitary sewer has been provided for the station.

The interior lighting level will be maintained at 85 foot candles. All handrails will be four-rung aluminum. Grating will be hot-dipped galvanized.

The instrumentation and control system will incorporate monitoring and alarming for motor and pump bearing temperature, motor winding temperature, reverse rotation, flow for each pump, sump elevation, and precipitation. The controls system will be integrated into the SCADA system operated by the City of Dallas. Individual pump control can be initiated at the pump, in the operator office/control room, or remotely by the SCADA system.

Figure 4.2.7 is a site plan for this alternative.

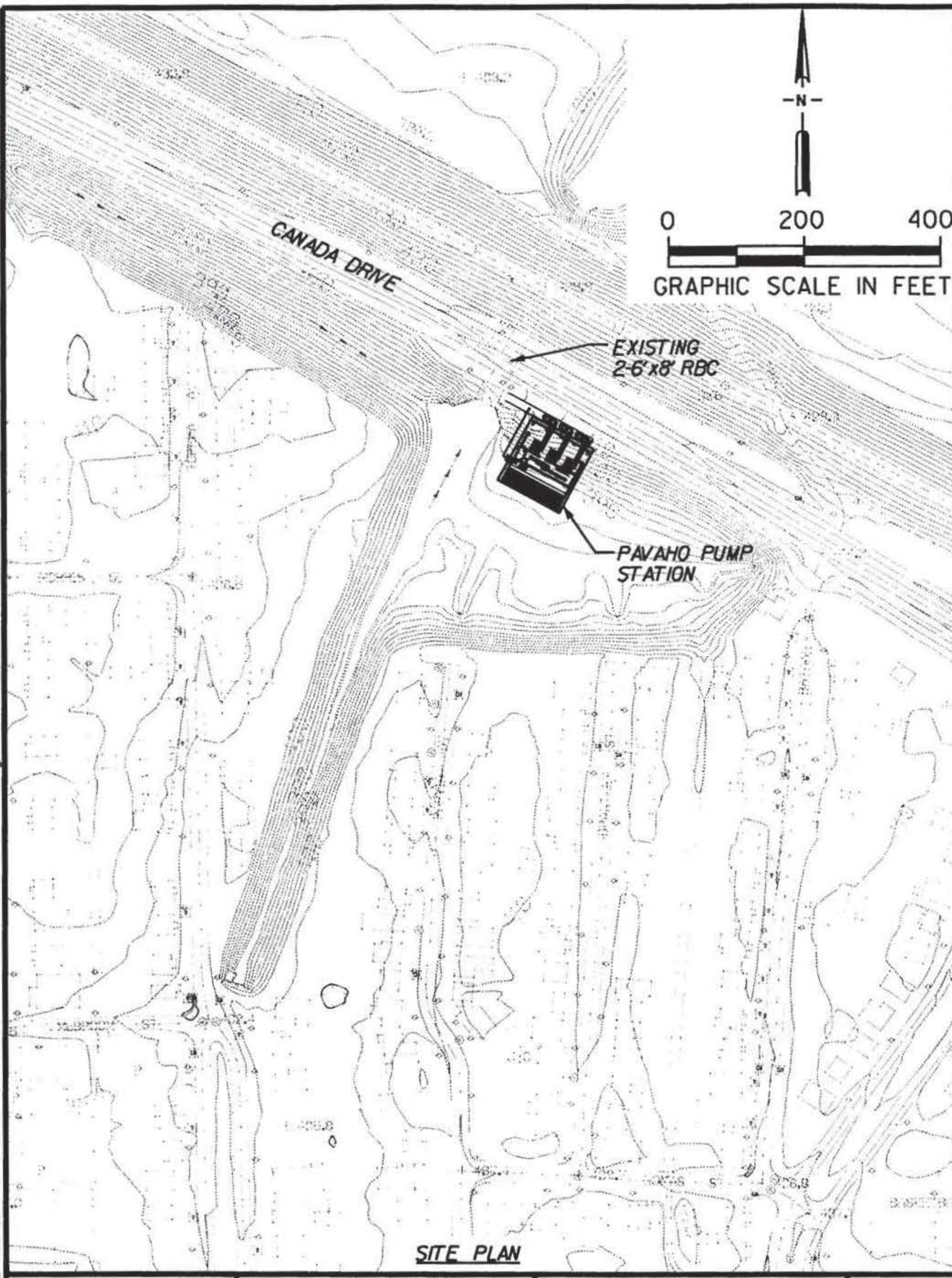
Figure 4.2.8 is a plan view of the 375,000 gpm pump station. The trash rack in the front of the station will be equipped with mechanically-cleaned screens manufactured by Du Perion, since these screens have demonstrated ability to function very effectively in this harsh environment. The switchgear room is adjacent to the pump room.

Figure 4.2.9 is Section A and the relationship of the pumping units, intake sump, and discharge piping are clearly indicated. The bridge crane has 27-foot clearance above the drive through for removal and/or installation of the pumping equipment.

Figures 4.2.10A and 4.2.10B are the electrical one-line diagrams for the station. The double-ended switchgear is indicated. Each of the main pumps is operated by a soft start that has a by-pass that permits the motor to be started even if the soft start is out of service. In addition to the protection provided by the soft start, each of the motors will be equipped with a Multilin 469 to provide motor protective relay systems.

Figure 4.2.11 is a preliminary process and instrumentation diagram for the pump station. The vibration monitoring equipment is shown, as are the RTDs for monitoring motor winding temperatures, and the pump and motor bearing temperatures. Each of the pumps will be equipped with an ultrasonic flow meter to monitor pump discharge.

The Engineer's Preliminary Opinion of Probable Cost for the storm water pump station for Option P2 is summarized in Table 4.2.3.



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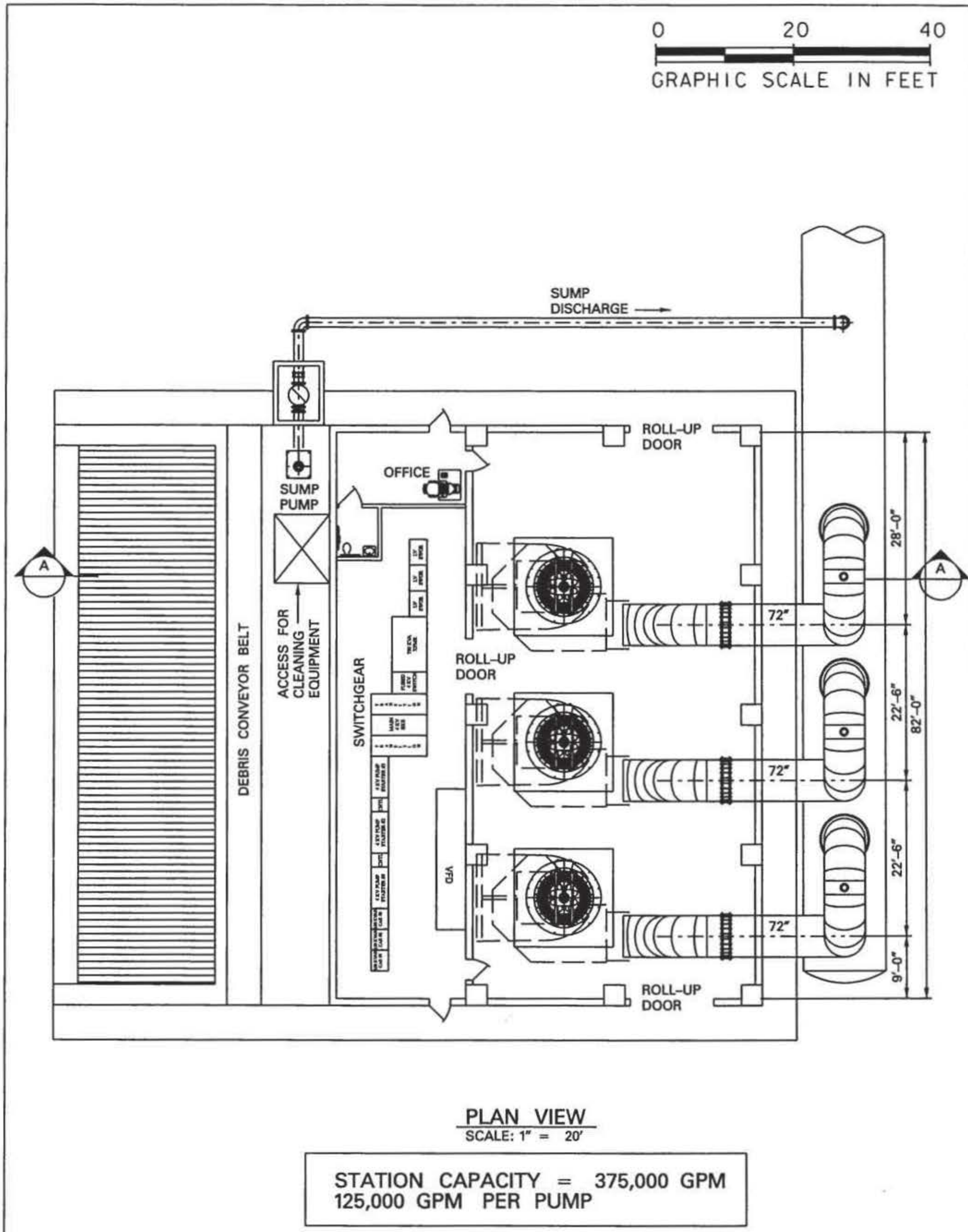
JACOBS Carter Burgess THESE DRAWINGS/DOCUMENTS ARE BEING SUBMITTED BY CARTER & BURGESS INC. CARTER & BURGESS, INC. IS A WHOLLY OWNED SUBSIDIARY OF JACOBS ENGINEERING GROUP INC AND HEREINAFTER REFERRED TO AS JACOBS CARTER BURGESS.	CITY OF DALLAS DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION	PROPOSED PAVAHO PUMP STATION CONCRETE VOLUTE PUMPS 375,000 GPM CAPACITY	FIGURE 4.2.7



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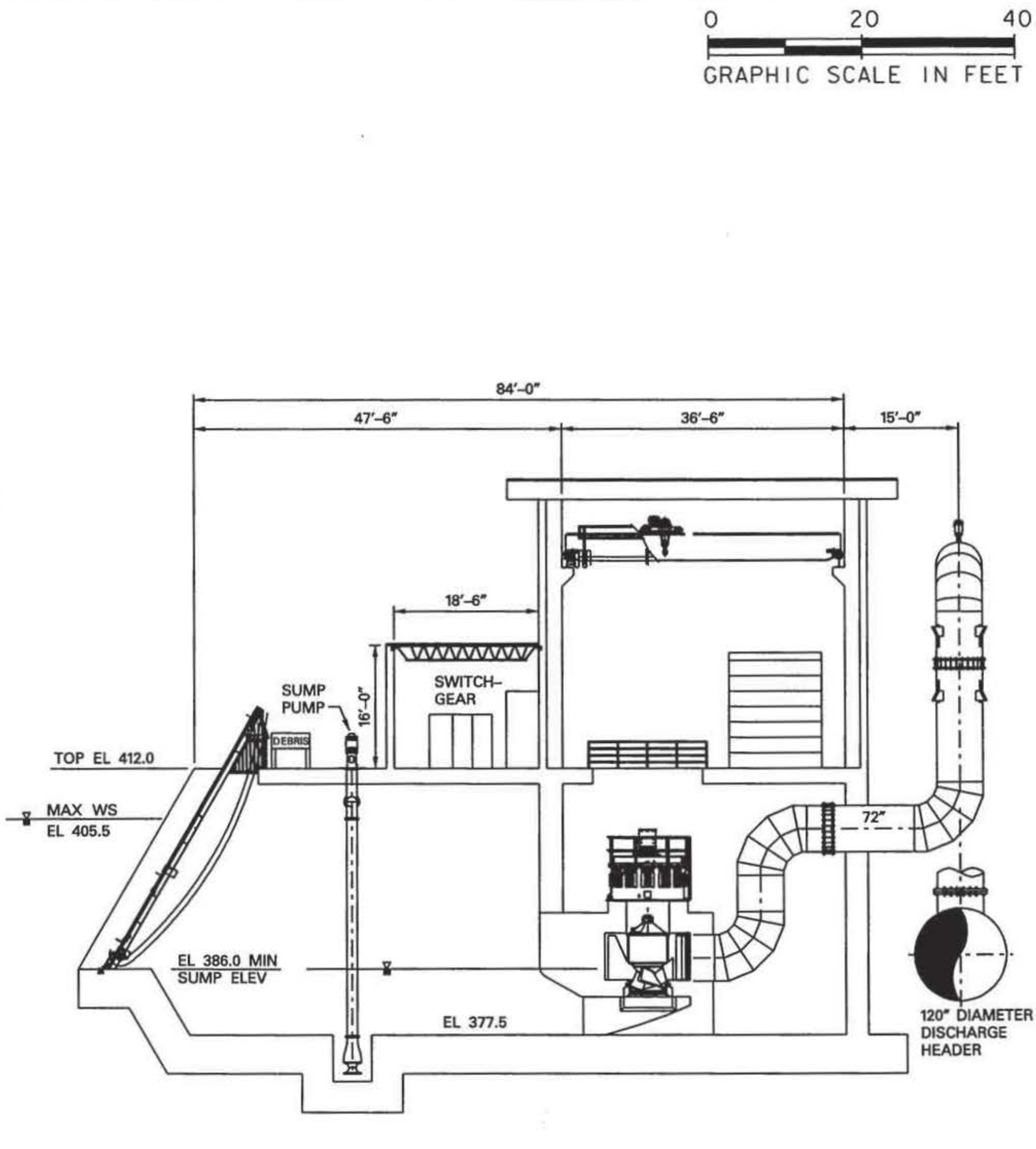

SECTION A - CONCRETE VOLUTE PUMPS

SCALE: 1" = 20'

STATION CAPACITY = 375,000 GPM
125,000 GPM PER PUMP

JE JACOBS Carter Burgess THESE DRAWINGS/DOCUMENTS ARE BEING SUBMITTED BY CARTER & BURGESS INC. CARTER & BURGESS, INC. IS A WHOLLY OWNED SUBSIDIARY OF JACOBS ENGINEERING GROUP INC AND HEREINAFTER REFERRED TO AS JACOBS CARTER BURGESS.	CITY OF DALLAS DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION	PROPOSED PAVAHO PUMP STATION CONCRETE VOLUTE PUMPS 375,000 GPM CAPACITY	FIGURE 4.2.9

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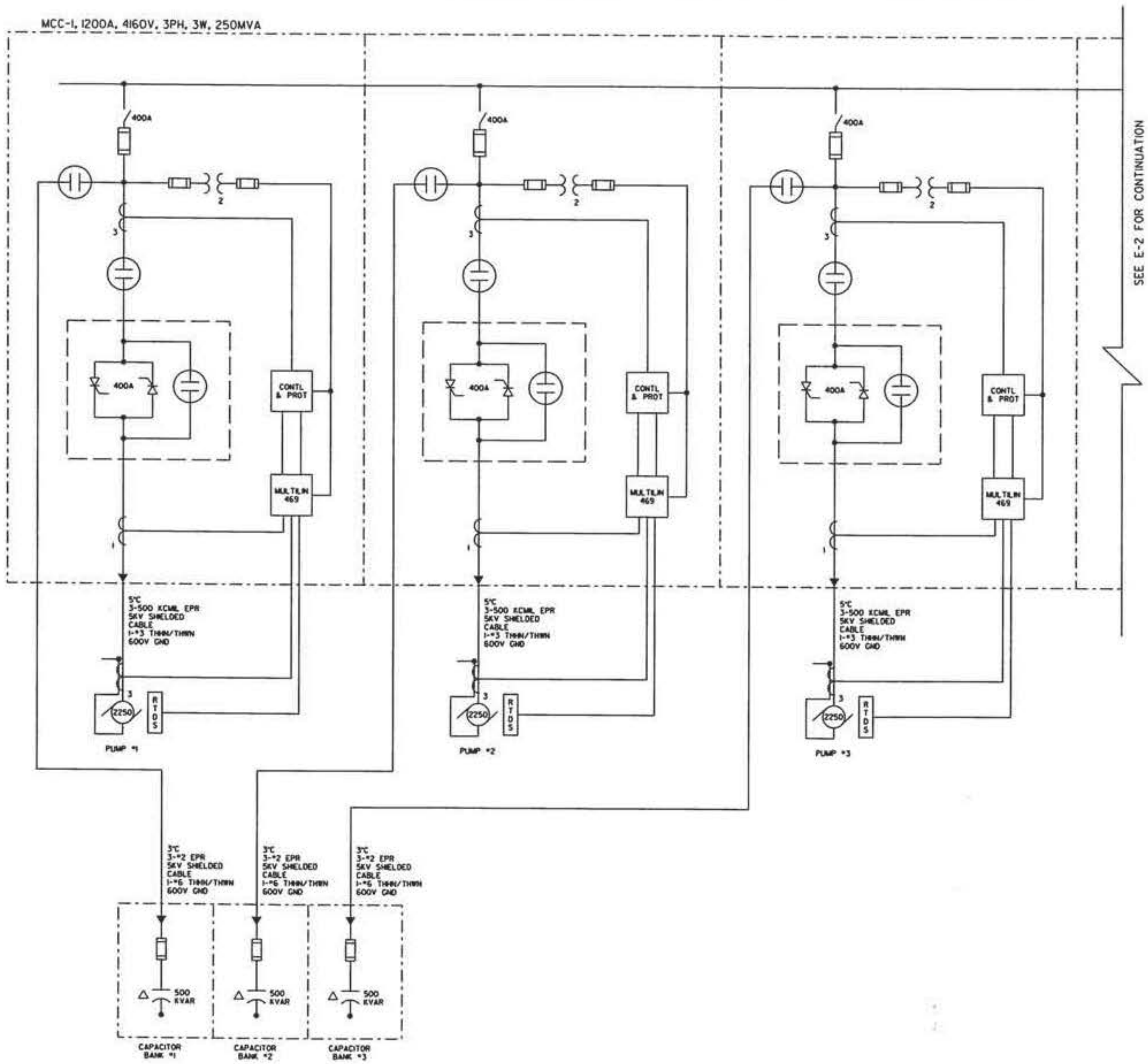
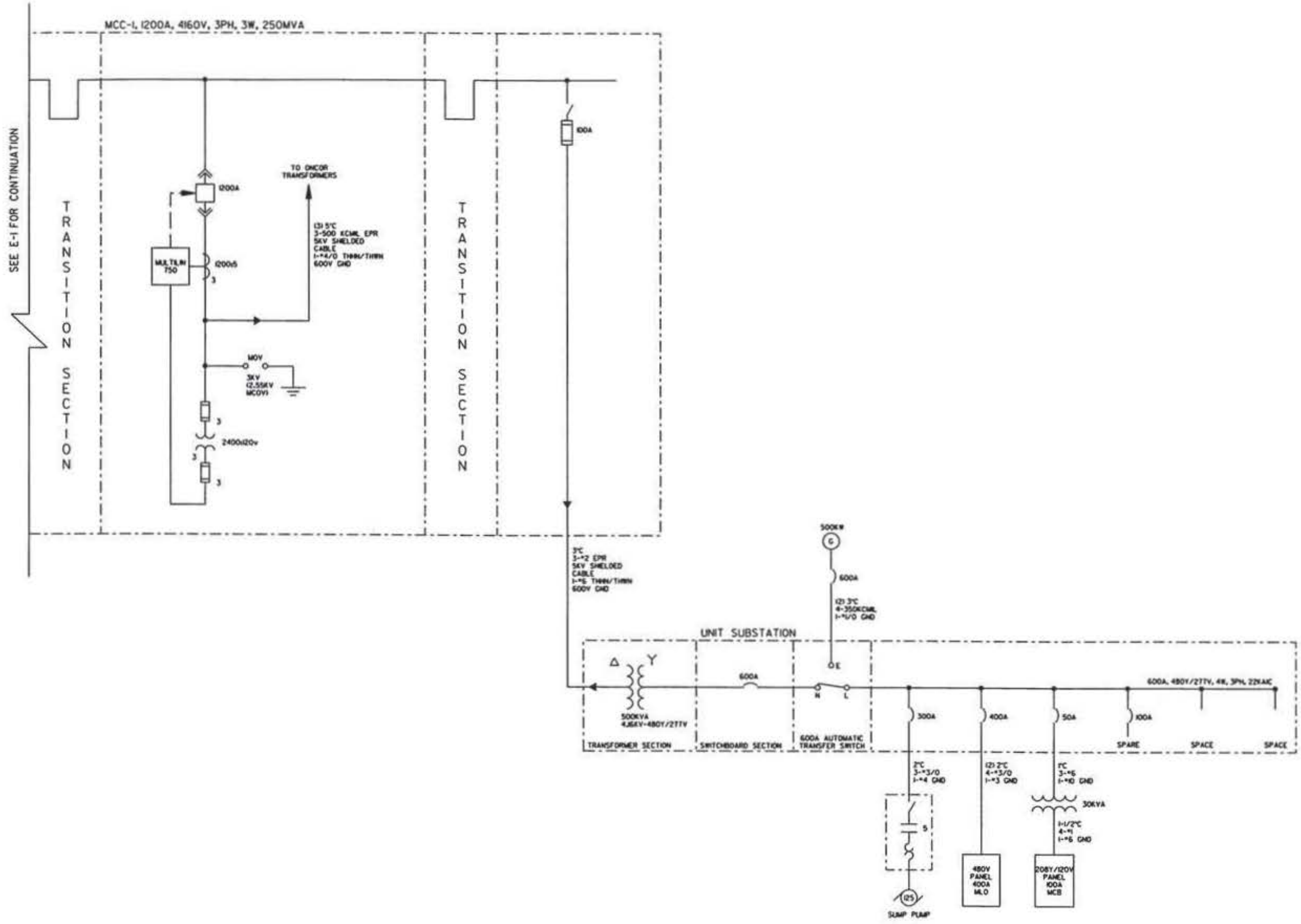


JACOBS Carter Burgess

CITY OF DALLAS
DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

PROPOSED PAVAHO PUMP STATION
CONCRETE VOLUTE PUMPS
375,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

FIGURE
4.2.10A



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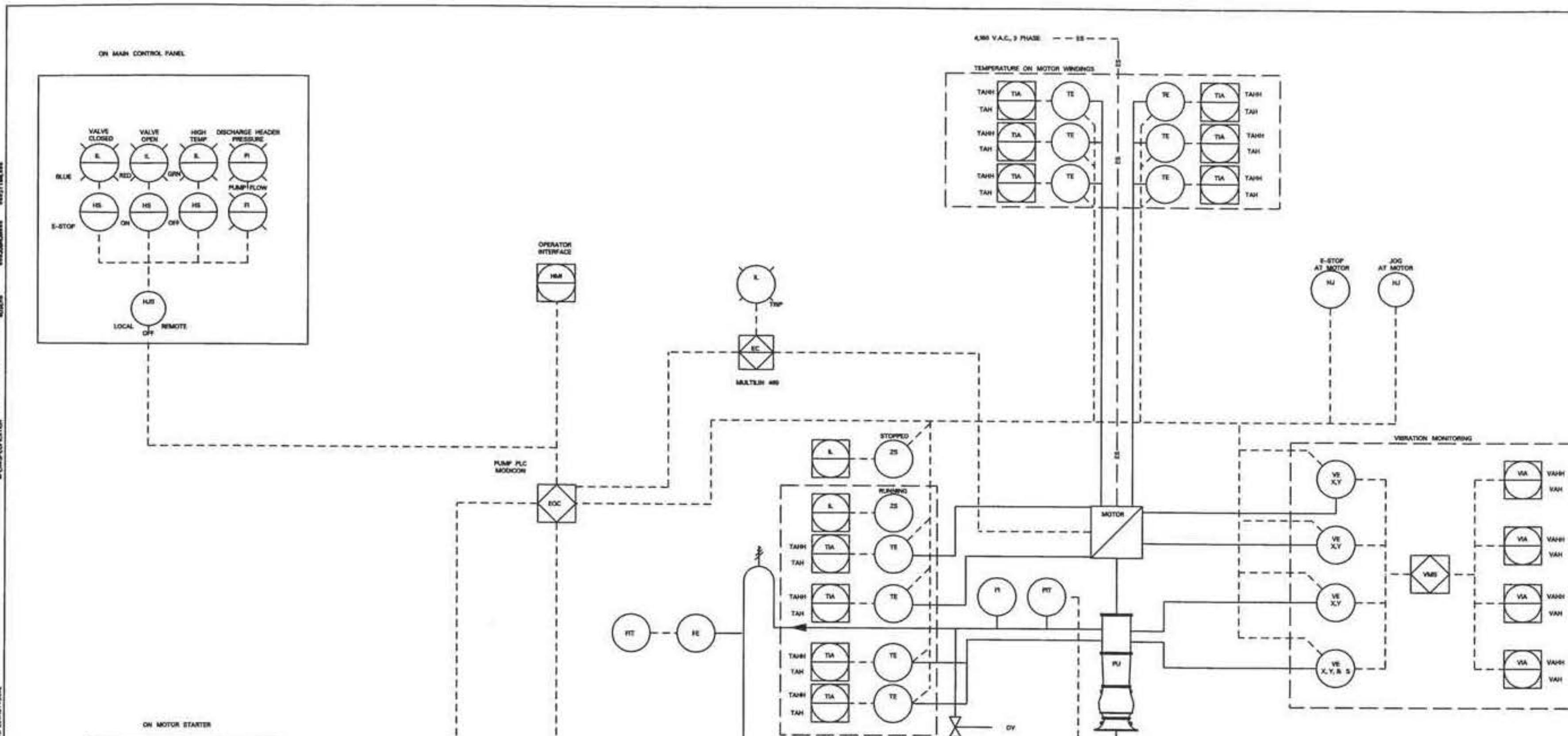
CITY OF DALLAS
DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

PROPOSED PAVAHO PUMP STATION
CONCRETE VOLUTE PUMPS
375,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

FIGURE
4.2.10B



NOTE: TYPICAL FOR EACH PUMP

P&ID LEGEND

DV	DRAIN VALVE
EC	ELECTRONIC CONTROLLER
EOC	ELECTRONIC COMPUTING CONTROLLER
ES	ELECTRICAL SUPPLY
FE	FLOW ELEMENT
FIT	FLOW INDICATING TRANSMITTER
HJS	HAND POSITION SWITCH – HOA
HMI	HUMAN MACHINE INTERFACE
HS	HAND SWITCH
IL	INDICATOR LIGHT
PI	PRESSURE INDICATOR
PIT	PRESSURE INDICATING TRANSMITTER
PU	PUMPING UNIT
TAH	TEMPERATURE ALARM HIGH
TAHH	TEMPERATURE ALARM HIGH HIGH
TE	TEMPERATURE ELEMENT – RTD
TIA	TEMPERATURE INDICATING ALARM
VAH	VIBRATION ALARM HIGH
VAHH	VIBRATION ALARM HIGH HIGH
VE	VIBRATION ELEMENT
VIA	VIBRATION INDICATING ALARM
VMS	VIBRATION MONITORING SYSTEM
ZS	POSITION SWITCH

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CITY OF DALLAS
DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

PROPOSED PAVAHO PUMP STATION
375,000 GPM CAPACITY
PROCESS AND INSTRUMENTATION DIAGRAM

FIGURE 4.2.11

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Table 4.2.3

Summary for Pavaho 3 Pump 375,000 gpm

Division	Cost
Division 1 - General Conditions	$2,889,200
Divison 2 - Site Work	$2,292,700
Division 3- Concrete	$2,190,121
Division 4 - Masonry	$101,072
Division 5- Metals	$118,515
Division 6 - Carpentry	$4,000
Division 7 - Thermal & Moisture Protection	$634,507
Division 8 - Doors & Windows	$12,700
Division 9 - Finishes	$82,165
Division 10 - Specialties	$9,700
Division 11 - Equipment	$7,363,040
Division 12 - Furnishings	$4,110
Division 13- Special Construction	$0
Division 14 - Conveying Systems	$245,600
Division 15 - Mechanical	$235,018
Division 16 - Electrical	$2,350,500
Division 17 - Instrumentation & Control	$1,293,500
Division Subtotal	**$19,826,448**
Contractor's Profit of Materials - 10%	$1,423,631
Prime Profit on SubConstractors - 10%	$450,970
Subtotal	**$21,701,048**
Construction Contingencies - 10%	$2,170,105
Construction Work Effort subtotal	**$23,871,153**
Escalation to Midpoint @ 6%/Yr & 3 yrs	$4,559,390
Subtotal	**$28,430,543**
Engineering and Surveying Services (12%)	$3,411,665
Construction Management (8%)	$2,274,443
Construction Materials Testing (1.5%)	$426,458
City Contract Administration (10%)	$2,843,054
Services Subtotal	**$8,955,621**
Total Estimated Project Cost	**$37,386,164**

Table 4.2.3
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Pavaho Site with 3 Pumps
375,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 1 - General Conditions							
Mobilization	1	LS	$0	$0		$0	$600,000
Construction Surveying	1	LS	$0	$0	$45,000.00	$45,000	$45,000
Telephone	39	Mo	$150	$5,850	$0.00	$0	$5,850
SWWWP	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Trench Excavation Safety & Support/Structural Plan	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Traffic Control Plan	1	LS	$15,000	$15,000	$0.00	$0	$15,000
PM	39	Mo	$0	$0	$15,000.00	$585,000	$585,000
Superintendent	39	Mo	$0	$0	$12,000.00	$468,000	$468,000
Admin	39	Mo	$0	$0	$7,000.00	$273,000	$273,000
Sanitary Services	39	Mo	$0	$0	$500.00	$19,500	$19,500
Security Services	39	Mo	$0	$0	$2,000.00	$78,000	$78,000
Pick Up Trucks - 3 each	39	Mo	$0	$0	$1,800.00	$70,200	$70,200
Office Equipment	39	Mo	$0	$0	$350.00	$13,650	$13,650
150 Ton Crane - 24 Months	24	Mo	$0	$0	$20,000.00	$480,000	$480,000
Loader - 39 Months	39	Mo	$0	$0	$2,000.00	$78,000	$78,000
Office Trailors - 2 each	39	Mo	$0	$0	$1,500.00	$58,500	$58,500
Tool Trailors - 2 each	39	Mo	$0	$0	$500.00	$19,500	$19,500
Subtotal for Division 1							**$2,889,200**
Division 2 - Site Work							
Structural Excavation	12,000	CY	$0.00	$0	$8.00	$96,000	$96,000
Structural Backfill	10,000	CY	$6.00	$60,000	$3.00	$30,000	$90,000
Paving	1,300	SY	$12.00	$15,600	$12.00	$15,600	$31,200
Pavement Striping	2,450	SF	$6.00	$14,700	$2.00	$4,900	$19,600
Access Road	1,600	SY	$7.00	$11,200	$13.00	$20,800	$32,000
Traffic Control	1	LS	$5,000.00	$5,000	$20,000.00	$20,000	$25,000
Curb Stops	10	EA	$200.00	$2,000	$50.00	$500	$2,500
8-inch Bollards	10	EA	$1,000.00	$10,000	$150.00	$1,500	$11,500
Grading	3,000	SY	$1.00	$3,000	$2.00	$6,000	$9,000
Fencing - 10 Ft. Man Proof	1,000	LF	$50.00	$50,000	$10.00	$10,000	$60,000
16-foot slide gate (Electric Motor)	1	EA	$6,000.00	$6,000	$1,000.00	$1,000	$7,000

Table 4.2.3
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Pavaho Site with 3 Pumps
375,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
3-foot ped. Gate	1	EA	$400.00	$400	$100.00	$100	$500
Landscaping	1	LS	$50,000.00	$50,000	$5,000.00	$5,000	$55,000
Channel Liner	2,000	SY	$10.00	$20,000	$5.00	$10,000	$30,000
72-inch steel discharge pipe - 3@130' each	390	LF	$950	$370,500	$100.00	$39,000	$409,500
72-inch nut, bolt and gasket sets	6	EA	$2,000	$12,000	$1,500.00	$9,000	$21,000
120-inch steel dischage pipe	200	LF	$1,600	$320,000	$100.00	$20,000	$340,000
Raise existing Pavaho pump discharge structure an addtiaonal 5 feet	1	LS	$50,000	$50,000	$10,000.00	$10,000	$60,000
Water - 2-inch	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Sewer	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Telephone	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Misc Utilities	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Shoring	5,000	SF	$35	$175,000	$5.00	$25,000	$200,000
Dewatering	1	LS	$250,000	$250,000	$25,000.00	$25,000	$275,000
Coffer Dam - 26' high 2:1ss	10,000	CY	$15	$150,000	$5.00	$50,000	$200,000
3-inch mud slab	140	CY	$100	$14,000	$25.00	$3,500	$17,500
Demolition of existing Pavaho stations	1	LS	$200,000.00	$200,000	$35,000.00	$50,000	$250,000
Subtotal for Division 2							**$2,292,700**
Division 3 - Concrete							
Substructure Concrete (Foundation)							
Concrete	1412	CY	$100	$141,200	$15.00	$21,180	$162,380
Rebar (310 lb/CY)	219	TON	$1,020	$223,237	$300.00	$65,658	$288,895
Forming	7622	SF	$10	$76,220	$5.00	$38,110	$114,330
Curing	80	CSF	$5	$400	$5.00	$400	$800
Waterstops	320	LF	$10	$3,200	$5.00	$1,600	$4,800
Substructure Concrete (Pump Room Floor)							
Concrete	235	CY	$100	$23,500	$15.00	$3,525	$27,025
Rebar (310 lb/CY)	36	TON	$1,020	$37,154	$300.00	$10,928	$48,081
Forming	4237	SF	$10	$42,370	$5.00	$5	$42,375
Curing	63	CSF	$5	$315	$5.00	$315	$630
Waterstops	315	LF	$10	$3,150	$5.00	$1,575	$4,725
Substructure Concrete (Perimeter walls) - ext. 4' thick avg.							

Table 4.2.3
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Pavaho Site with 3 Pumps
375,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Concrete	1264	CY	$100	$126,400	$15.00	$18,960	$145,360
Rebar (310 lb/CY)	196	TON	$1,020	$199,838	$300.00	$58,776	$258,614
Forming	8532	SF	$10	$85,320	$5.00	$42,660	$127,980
Curing	180	CSF	$5	$900	$5.00	$900	$1,800
Waterstops	275	LF	$10	$2,750	$5.00	$1,375	$4,125
Substructure Concrete (Divider walls-int. 2' thick avg)							
Concrete	340	CY	$100	$34,000	$15.00	$5,100	$39,100
Rebar (310 lb/CY)	53	TON	$1,020	$53,754	$300.00	$15,810	$69,564
Forming	4602	SF	$10	$46,020	$5.00	$23,010	$69,030
Curing	190	CSF	$5	$950	$5.00	$950	$1,900
Waterstops	500	LF	$10	$5,000	$5.00	$2,500	$7,500
Substructure Columns and Beams							
Concrete	40	CY	$100	$4,000	$15.00	$600	$4,600
Rebar (310 lb/CY)	6	TON	$1,020	$6,324	$300.00	$1,860	$8,184
Forming	1200	SF	$10	$12,000	$5.00	$6,000	$18,000
Curing	40	CSF	$5	$200	$5.00	$200	$400
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Electrical Room Bottom Slab							
Concrete	140	CY	$100	$14,000	$15.00	$2,100	$16,100
Rebar (310 lb/CY)	22	TON	$1,020	$22,134	$300.00	$6,510	$28,644
Forming	1248	SF	$10	$12,480	$5.00	$6,240	$18,720
Curing	60	CSF	$5	$300	$5.00	$300	$600
Waterstops	150	LF	$10	$1,500	$5.00	$750	$2,250
Superstructure Columns							
Concrete	60	CY	$100	$6,000	$15.00	$900	$6,900
Rebar (310 lb/CY)	9	TON	$1,020	$9,486	$300.00	$2,790	$12,276
Forming	3100	SF	$10	$31,000	$5.00	$15,500	$46,500
Curing	200	CSF	$5	$1,000	$5.00	$1,000	$2,000
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Superstructure Beams							
Concrete	60	CY	$100	$6,000	$15.00	$900	$6,900
Rebar (310 lb/CY)	9	TON	$1,020	$9,486	$300.00	$2,790	$12,276

Table 4.2.3

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Pavaho Site with 3 Pumps

375,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Forming	2164	SF	$10	$21,640	$5.00	$10,820	$32,460
Curing	250	CSF	$5	$1,250	$5.00	$1,250	$2,500
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Superstructure double-Tees	4752	SF	$18	$85,536	$5.00	$23,760	$109,296
Retaining Walls - MSE wall >20'	8850	SF	$40	$354,000	$10.00	$88,500	$442,500
Subtotal Division 3							**$2,190,121**
Division 4 - Masonary							
CMU Partitions	14,000	SF	$3.00	$42,000	$4.00	$56,000	$98,000
Glazed CMU Restroom Walls	256	SF	$8.00	$2,048	$4.00	$1,024	$3,072
Subtotal for Division 4				**$0**		**$0**	**$101,072**
Division 5 - Metals							
Grating	800	SF	$20	$16,000	$5.00	$4,000	$20,000
Mtl deck	7,505	SF	$2	$15,010	$1.00	$7,505	$22,515
Bar Joists	1	LS	$60,000	$60,000	$5,000.00	$5,000	$65,000
Handrail	200	LF	$40	$8,000	$15.00	$3,000	$11,000
Subtotal for Division 5							**$118,515**
Division 6 - Carpentry							
Misc.	1	ls	$1,000	$1,000	$3,000.00	$3,000	$4,000
Subtotal for Division 6							**$4,000**
Division 7 - Thermal and Moisture Protection							
Exterior walls	8,640	SF	$45	$388,800	$20.00	$172,800	$561,600
Roofing	5,520	SF	$4	$22,080	$2.00	$49,827	$71,907
Roof Hatch-Pumps	0	EA	$15,000	$0	$500.00	$0	$0
Roof Hatch-Access	1	EA	$800	$800	$200.00	$200	$1,000
Subtotal for Division 7							**$634,507**
Division 8 - Doors and Windows							

Table 4.2.3
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Pavaho Site with 3 Pumps
375,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Doors, 3-0 x 7-0 steel	5	Ea	$200	$1,000	$100.00	$500	$1,500
Doors, roll-up 12' x 14' steel	2	Ea	$5,000	$10,000	$600.00	$1,200	$11,200
Subtotal for Division 8				**$0**		**$0**	**$12,700**
Division 9- Finishes							
Process Piping (pump rm risers & hdrs)	4,000	SF	$0.50	$2,000	$1.25	$5,000	$7,000
Misc. Structural Steel Surf. Prep.	8,600	SF	$1.00	$8,600	$2.00	$17,200	$25,800
Paint Structural Steel	8,600	SF	$1.00	$8,600	$4.00	$34,400	$43,000
Paint Building Interior Walls	9,500	SF	$0.10	$950	$0.57	$5,415	$6,365
Subtotal for Division 9							**$82,165**
Division 10 - Specialities							
Signage	1	LS	$5,000	$5,000	$1,000.00	$1,000	$6,000
Woven Wire Partition - 15'x15'x10'Tall	1	LS	$2,500	$2,500	$500.00	$500	$3,000
Toilet Accessories	1	LS	$500	$500	$200.00	$200	$700
Subtotal for Division 10				**$0**		**$0**	**$9,700**
Division 11 - Equipment							
Veritical sump pump, 7000 gpm	1	Ea	$80,000	$80,000	$5,000.00	$5,000	$85,000
Trash Rack (26' x 69')	1,794	SF	$400	$717,600	$10.00	$17,940	$735,540
Restrained Couplings	9	Ea	$15,000	$135,000	$1,500.00	$13,500	$148,500
CV Pumps and Motors - 125,000 gpm	3	Ea	$1,900,000	$5,700,000	$30,000.00	$90,000	$5,790,000
Stop Logs	1	LS	$200,000	$200,000	$15,000.00	$15,000	$215,000
12' - Flap Gate	1	Ea	$65,000	$65,000	$5,000.00	$5,000	$70,000
Sluice Gate - 9'x9'	1	Ea	$100,000	$100,000	$5,000.00	$5,000	$105,000
Vibration Monitoring Equipment	1	LS	$194,000	$194,000	$20,000.00	$20,000	$214,000
Subtotal for Division 11							**$7,363,040**
Division 12 - Furnishings							
Desk	1	Ea	$1,000	$1,000	$100.00	$100	$1,100
Chair	1	Ea	$600	$600	$10.00	$10	$610
Storage Shelves	4	Ea	$500	$2,000	$100.00	$400	$2,400

Table 4.2.3

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Pavaho Site with 3 Pumps

375,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Subtotal for Division 12							**$4,110**
Division 13 - Special Construction							
Subtotal for Division 13							**$0**
Division 14 - Conveying Systems							
20 Ton Bridge Crane	1	Ea	$95,600	$95,600	$25,000.00	$25,000	$120,600
Automated Conveyor System	1	LS	$100,000.00	$100,000	$25,000.00	$25,000	$125,000
Subtotal for Division 14							**$245,600**
Division 15 - Mechanical							
Ventilation Fan(S)	3	EA	$2,000	$6,000	$500.00	$1,500	$7,500
Roof Curb(S)	3	EA	$1,000	$3,000	$250.00	$750	$3,750
Controls	1	LS	$25,000	$25,000	$10,000.00	$10,000	$35,000
Floor Drain(S)	6	EA	$300	$1,800	$150.00	$900	$2,700
Toilet(S)	1	EA	$200	$200	$200.00	$200	$400
Sink(S)	2	EA	$400	$800	$100.00	$200	$1,000
Urinal(S)	1	EA	$200	$200	$75.00	$75	$275
Faucet(S)	2	EA	$350	$700	$100.00	$200	$900
Trap Primer(S)	2	EA	$350	$700	$150.00	$300	$1,000
Drain/Waste/Vent Plumbing	1000	LF	$15	$15,000	$7.00	$7,000	$22,000
Cold Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Hot Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Dx Hvac Air Handler(S)	2	EA	$17,500	$35,000	$5,000.00	$10,000	$45,000
Dx Hvac Condensing Unit(S)	2	EA	$15,000	$30,000	$1,500.00	$3,000	$33,000
Controls	1	LS	$7,500	$7,500	$5,000.00	$5,000	$12,500
Condensing Unit Pad(S)	1	EA	$500	$500	$100.00	$100	$600
Ductwork	1000	LBS	$50	$50,000	$5.00	$5,000	$55,000
Diffuser(S)/Register(S)/Grille(S)	9	EA	$17	$153	$10.00	$90	$243
Louvre(S)	9	EA	$150	$1,350	$100.00	$900	$2,250
Fire Hose Rack	2	EA	$350	$700	$100.00	$200	$900

Table 4.2.3
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Pavaho Site with 3 Pumps
375,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Subtotal for Division 15							**$235,018**
Division 16 - Electrical							
Mobilization	1	LS	$0	$0	$0.00	$0	$50,000
Temporary Power	1	LS	$50,000	$50,000	$2,000.00	$2,000	$52,000
Duct Banks	200	CY	$400	$80,000	$20.00	$4,000	$84,000
Manholes	3	EA	$6,000	$18,000	$500.00	$1,500	$19,500
1/0 15 Kv Cable	1,000	LF	$7	$7,000	$3.00	$3,000	$10,000
250 Mcm 15 Kv Cable	1,000	LF	$8	$8,000	$3.00	$3,000	$11,000
500 Mcm 15 Kv Cable	1,000	LF	$15	$15,000	$3.00	$3,000	$18,000
5 Kv Terminations	50	EA	$175	$8,750	$25.00	$1,250	$10,000
Conduit	1	LS	$175,000	$175,000	$20,000.00	$20,000	$195,000
Wire	1	LS	$125,000	$125,000	$10,000.00	$10,000	$135,000
Lighting							
Exterior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Interior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Mv Switchgear	1	LS	$100,000	$100,000	$25,000.00	$25,000	$125,000
Soft Starts - 2200 HP	3	EA	$55,000	$165,000	$15,000.00	$45,000	$210,000
1500 Kva Transformers	3	EA	$50,000	$150,000	$10,000.00	$30,000	$180,000
480 Volt Mcc	1	EA	$85,000	$85,000	$50,000.00	$50,000	$135,000
Misc. Switchgear	1	LS	$50,000	$50,000	$6,000.00	$6,000	$56,000
Lightning Protection	1	LS	$35,000	$35,000	$5,000.00	$5,000	$40,000
Telephone System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Fire Alarm System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Security And Entrance Equlipment	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Embedded Conduit	1	LS	$25,000	$25,000	$8,000.00	$8,000	$33,000
Grounding	1	LS	$50,000	$50,000	$10,000.00	$10,000	$60,000
Cable Tray	1	LS	$25,000	$25,000	$15,000.00	$15,000	$40,000
500 Kva Gen Set With ATS	1	Ea	$98,000	$98,000	$5,000.00	$5,000	$103,000
TXU Firm Backup Capabiltiy	1	LS	$600,000	$600,000	$30,000.00	$30,000	$630,000
Testing	1	LS	$15,000	$15,000	$5,000.00	$5,000	$20,000

Table 4.2.3

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Pavaho Site with 3 Pumps

375,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Subtotal for Division 16							**$2,350,500**
Division 17 - I&C							
Engineering & Submittals	1	LS	$75,000	$75,000	$5,000.00	$5,000	$80,000
Computers And Printers	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
F O Cable And Comm. Equip.	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Control Panels	1	LS	$250,000	$250,000	$10,000.00	$10,000	$260,000
Start Up-Check Out	1	LS	$35,000	$35,000	$10,000.00	$10,000	$45,000
Ultra Sonic Flow Meters	4	Ea	$5,000	$20,000	$2,500.00	$10,000	$30,000
HMI Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
PLC Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
O&M Manuals	1	LS	$5,000	$5,000	$2,000.00	$2,000	$7,000
Training	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Software	1	LS	$85,000	$85,000	$15,000.00	$15,000	$100,000
Factory Test	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Bonds	1	LS	$0	$0	$0.00	$0	$80,000
Level transmitters	3	Ea	$2,000	$6,000	$500.00	$1,500	$7,500
PLC - Primary + hot back-up	1	Ea	$17,500	$17,500	$7,500.00	$7,500	$25,000
PC and Monitor	1	Ea	$8,000	$8,000	$1,000.00	$1,000	$9,000
MMI Software + Programming	1	Ea	$7,000	$7,000	$15,000.00	$15,000	$22,000
Instrumentation wiring	1	LS	$75,000	$75,000	$28,000.00	$28,000	$103,000
SCADA Transmitter	1	Ea	$100,000	$100,000	$10,000.00	$10,000	$110,000
Security Cameras	1	LS	$75,000	$75,000	$10,000.00	$10,000	$85,000
Subtotal for Division 17							**$1,293,500**
Division subtotal				**$14,236,305**		**$4,181,643**	**$19,826,448**
Contractor's Profit on Material (10%)							$1,423,631
Prime Profit on Subcontractors - 10% on Div 5, 6, 7, 8, 9, 10, 12, 16, 17							$450,970
Subtotal							**$21,701,048**
Contingency (10%)							$2,170,105
Construction Work Effort subtotal							**$23,871,153**

Table 4.2.3

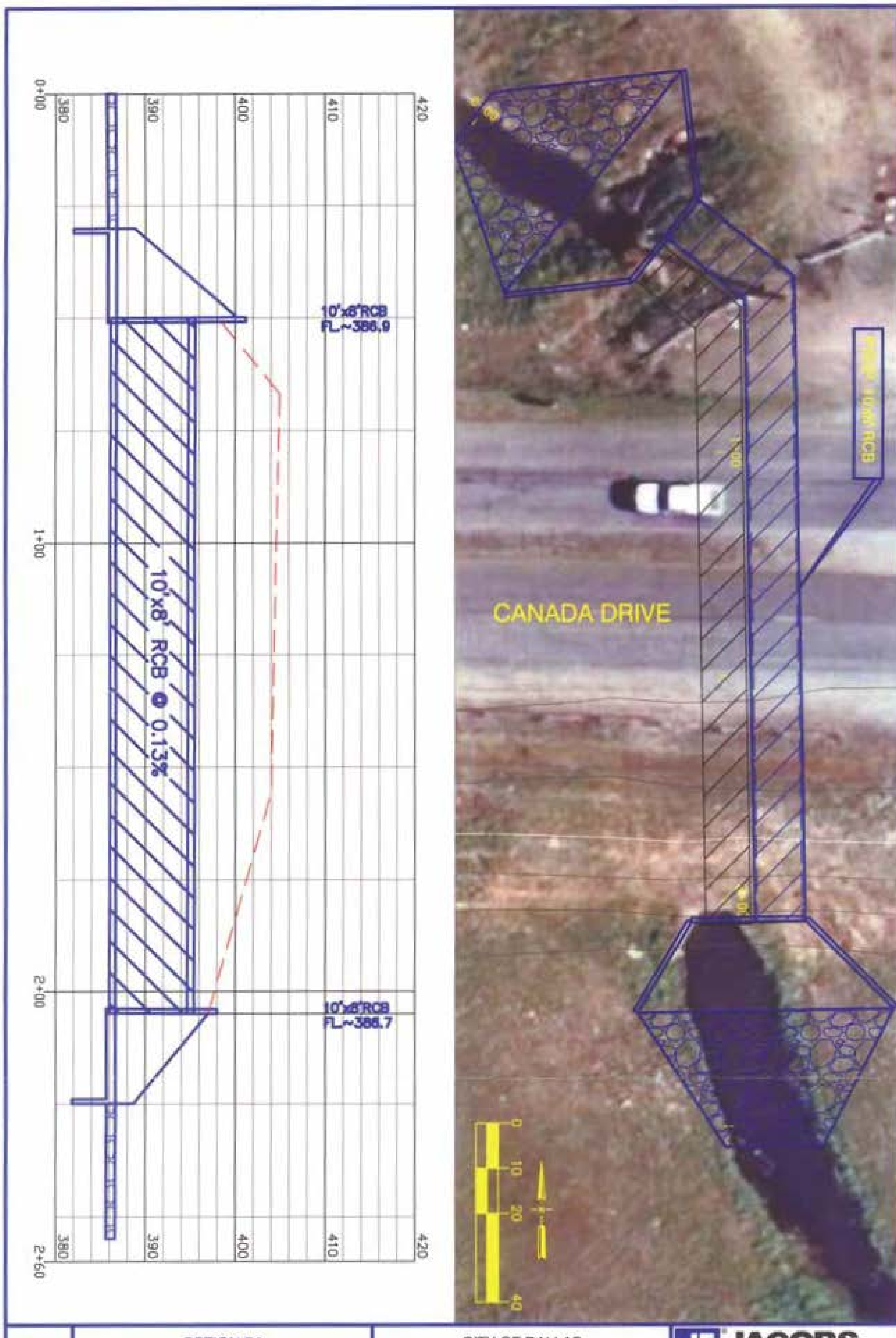
Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Pavaho Site with 3 Pumps

375,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Escalation to Midpoint @ 6%/year& 3 yrs							**$4,559,390**
Subtotal							**$28,430,543**
Engineering and Surveying Services (12%)							$3,411,665
Construction Management (8%)							$2,274,443
Construction Materials Testing (1.5%)							$426,458
City Contract Administration (10%)							$2,843,054
Services Subtotal							**$8,955,621**
Total Estimated Project Cost							**$37,386,164**

The proposed Canada Drive culverts serve to more efficiently convey flood water between the two Pavaho sump segments that are separated by Canada Drive along the West Levee. The estimate of probable cost for the new Canada Drive culverts is shown in Table 4.2.4. A schematic drawing of the proposed culverts is shown on Figure 4.2.12.



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OPTION P2
PROPOSED PAVAHO SUMP
1-10'x8' RCB @ CANADA DR.

FIGURE
4.2.12

Table 4.2.4
Engineer's Preliminary Opinion of Probable Costs
Option P2 Culvert Improvements
Pavaho Sump at Canada Drive

Item No.	Description	Unit	Quantity	Unit Cost	Estimated Cost
1	Traffic Control and Barricading	LS	1	$20,000	$20,000
2	Removal of Headwall and Wingwalls	EA	2	$10,000	$20,000
3	Removal of Existing 72" Culvert Pipe	LS	1	$15,000	$15,000
3	10' x 8' RCB By Open Cut	LF	155	$800	$124,000
4	Trench Safety and Support	LF	155	$4	$620
4	Remove and Replace Concrete Pavement	SY	110	$150	$16,500
5	CIP Headwall	EA	2	$30,000	$60,000
5	6" Concrete Apron Pavement	SY	70	$70	$4,900
6	PVC Coated Gabions	CY	100	$250	$25,000
6	Sodding	SY	600	$7	$4,200
7	Erosion Control	LS	1	$25,000	$25,000
7	Dewatering	LS	1	$50,000	$50,000
8	Mobilization	LS	1	$100,000	$100,000
Subtotal					$465,220
20% Contingency					$93,044
Total					**$558,264**
Escalation to Midpoint @ 6%/year& 5 yrs					$188,805
Subtotal					**$747,069**
Engineering and Surveying Services (12%)					$89,648
Construction Management (8%)					$59,766
Construction Materials Testing (1.5%)					$11,206
City Contract Administration (10%)					$74,707
Service Subtotal					**$235,327**
Total Estimated Project Cost					**$982,396**

4.2.3 OPTION D1A – DEMO EXISTING PUMP STATION, NEW 250,000 GPM PUMP STATION

This option consists of several separate items. The items contained in this option are listed below:

1. Demolition of the existing Delta pump station,
2. Construction of a new 250,000 gpm pump station at the current Delta station site,
3. Construction of two new 10'x6' reinforced concrete box culverts under Westmoreland Avenue, and
4. Addition of one new 6'x4' gated culvert at the Ledbetter Dike control structure.

Option D1A must be combined with Option P2 to provide a complete solution for the combined Delta/Pavaho sump areas. Option D1A does not provide a solution for Eagle Ford Sump and must be combined with an improvement option for Eagle Ford Sump.

The Delta Storm Water Pump Station evaluated for Option D1A has a total pumping capacity of 250,000 gpm. The pumping is accomplished with the use of three 83,333 gpm vertical axial flow pumps, each rated at 55 feet total dynamic head (TDH). Each of these pumps is driven by a 1500 horsepower electric motor operating at 295 rpm, eliminating the need for a gear reducer between the motor and pump. Additionally, a 6,000 gpm vertical axial flow pump is provided for dewatering the sump during periods of low flow.

Pump station discharge piping will be configured to use the two existing 4'x4' gravity sluices at Delta Pump Station as outfall to the river. Each individual pump will be equipped with a dedicated discharge header with a goose-neck high point elevation above the top of levee and an air release valve to prevent back-siphoning into the station. Station piping will be lined with high density polyurethane and coated with suitable epoxy-based systems.

The pump station will be configured in accordance with the guidance contained in the following documents:

- "Hydrologic Analysis of Interior Areas" EM 1110-2-1413, dated 15 January 1987
- "Hydrologic Frequency Analysis" EM 1120-2-1415, dated 05 March 1993
- "Flood Run-off Analysis" EM 1110-2-1417, dated 31 August 1994
- "Risk-Based Analysis for Flood Damage Reduction Studies" EM 1120-2-1619, dated 01 August 1996
- *EM1110-2-2100 Stability Analysis of Concrete Structures*
- *EM1110-2-2102 Waterstops and Other Preformed Joint Materials for CW Structures*
- *EM1110-2-2502 Retaining Walls*
- *EM1110-2-3104 Structural and Architectural Design of Pumping Stations*
- *EM1110-2-3105 Mechanical and Electrical Design of Pumping Stations*
- *EM1110-2-1804 Geotechnical Investigations*

The pump station substructure is cast-in-place concrete designed in accordance with ACI 310R and other appropriate standards. The foundation is a mat consisting of a five foot thick concrete slab to which the walls are attached. The walls utilize a stepped design in which the walls are reduced in thickness as the height of the structure increases and the soil load decreases. The sump area is deep and a removable hatch has been incorporated into the floor deck to provide access for removing debris that will accumulate in the sump area. The hatch is large enough to accommodate a small Bobcat.

The superstructure of the pump station is cast-in-place concrete and beams are incorporated into the structure to accommodate the installation of a bridge crane for maintenance. The pump station roof is designed to be double tees, which increases the stiffness of the structure and simplifies construction and maintenance. The roof will consist of the double tees, a two-inch layer of light-weight grout, and a membrane. The superstructure has been designed so that a drive through corridor is incorporated into the station, permitting truck access directly adjacent to the pumps for maintenance.

The exterior wall sections have been assumed to be concrete masonry units with brick veneer, although a different system may be incorporated in the final design.

The pump station interior in the pump room is unfinished; however, the interiors of the switchgear room, office, and restroom have conventional dry wall construction and are painted. Flooring throughout the station is concrete with a troweled finish. The main pump room is provided with ventilation, while the switchgear room, office, and restroom are conditioned.

The primary electrical supply to the station is three-phase, 4160 v.a.c. and is provided by TXU. The supply is from two independent substations providing needed redundancy. Therefore, the standby generator set is for use by limited equipment including the control system, lighting, HVAC components, and the bridge crane. The switchgear is located in the switchgear room and includes soft starts for each of the main pumping units. The switchgear is configured as a main-tie-main to provide additional redundancy and reliability in station operation.

This pump station is located on the West Levee, adjacent to the existing Delta pump Station, along Canada Drive. Access to the station is provided via a concrete paved access road. Roll-up doors on the station provide the drive-through access. Since the site is located next to the sump a retaining wall is provided to level the site for routine operations. Water and sewer are available in Canada Drive, and a two-inch water service and a 4-inch sanitary sewer has been provided for the station.

The interior lighting level will be maintained at 85 foot candles. All handrails will be four-rung aluminum. Grating will be hot-dipped galvanized.

The instrumentation and control system will incorporate monitoring and alarming for motor and pump bearing temperature, motor winding temperature, reverse rotation, flow for each pump, sump elevation, and precipitation. The controls system will be integrated into the SCADA system operated by the City of Dallas. Individual pump control can be initiated at the pump, in the operator office/control room, or remotely by the SCADA system.

Figure 4.2.13 is a site plan for this alternative.

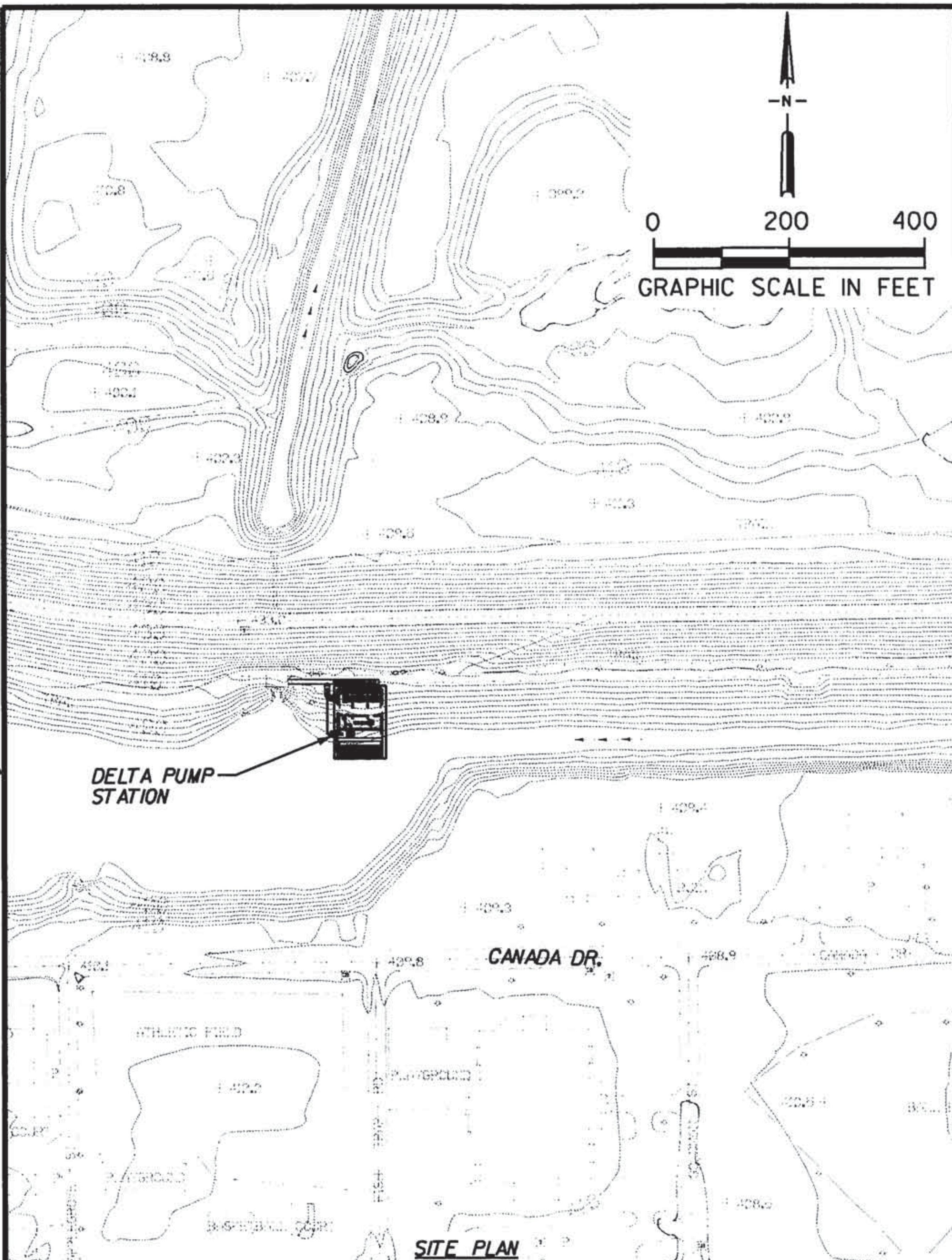
Figure 4.2.14 is a plan view of the 250,000 gpm pump station. The trash rack in the front of the station will be equipped with mechanically-cleaned screens manufactured by Du Perion, since these screens have demonstrated ability to function very effectively in this harsh environment. The switchgear room is adjacent to the pump room.

Figure 4.2.15 is Section A and the relationship of the pumping units, intake sump, and discharge piping are clearly indicated. The bridge crane has 27-foot clearance above the drive through for removal and/or installation of the pumping equipment.

Figures 4.2.16A and 4.2.16B are the electrical one-line diagrams for the station. The double-ended switchgear is indicated. Each of the main pumps is operated by a soft start that has a by-pass that permits the motor to be started even if the soft start is out of service. In addition to the protection provided by the soft start, each of the motors will be equipped with a Multilin 469 to provide

Figure 4.2.17 is a preliminary process and instrumentation diagram for the pump station. The vibration monitoring equipment is shown, as are the RTDs for monitoring motor winding temperatures, and the pump and motor bearing temperatures. Each of the pumps will be equipped with an ultrasonic flow meter to monitor pump discharge.

The Engineer's Preliminary Opinion of Probable Cost for the storm water pump station for Option D1A is summarized in Table 4.2.5.



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JACOBS Carter Burgess	CITY OF DALLAS DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION	PROPOSED DELTA PUMP STATION VERTICAL PUMPS 250,000 GPM CAPACITY	FIGURE 4.2.13

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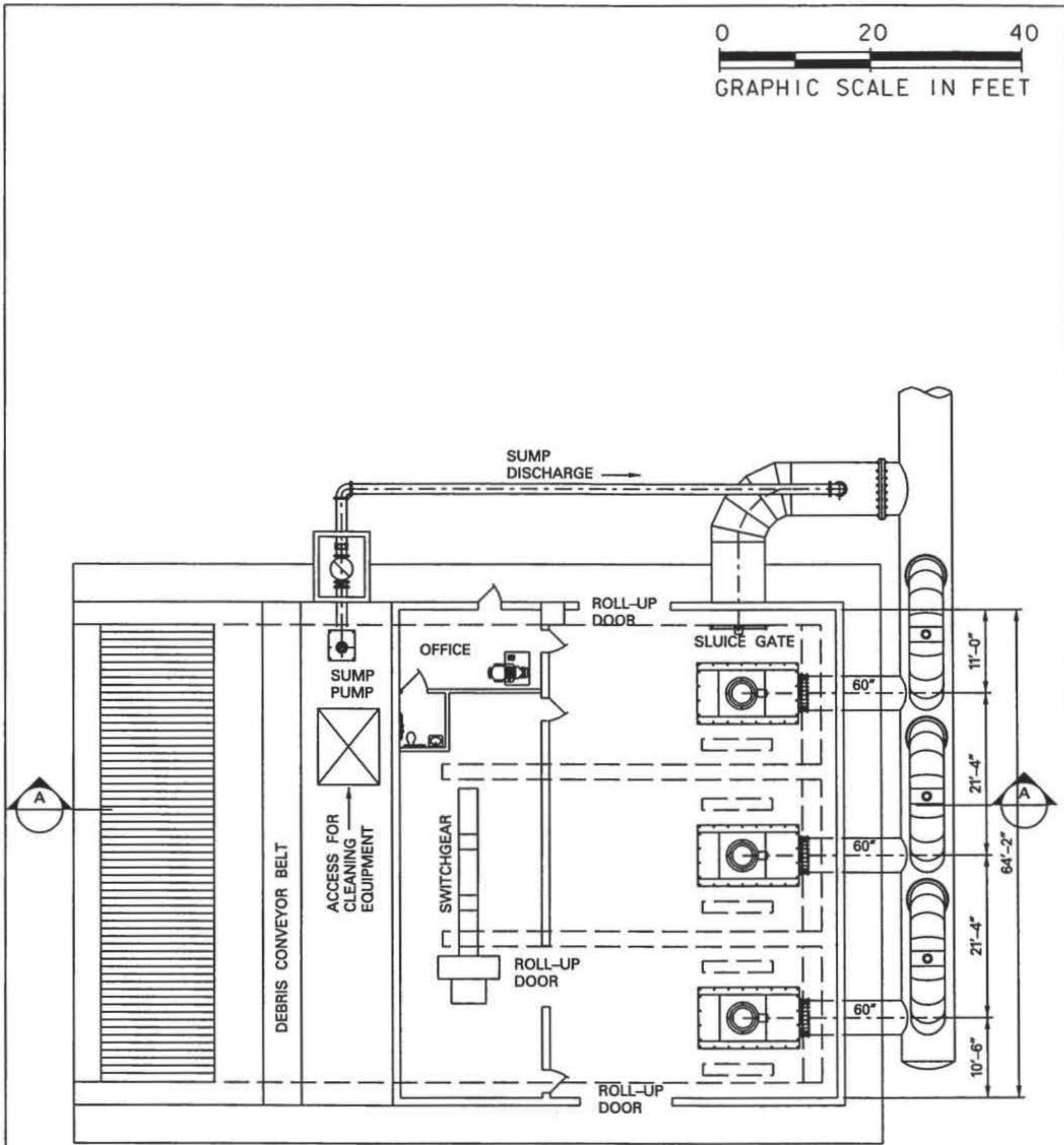

PLAN VIEW
SCALE: 1" = 20'

STATION CAPACITY = 250,000 GPM
84,000 GPM PER PUMP

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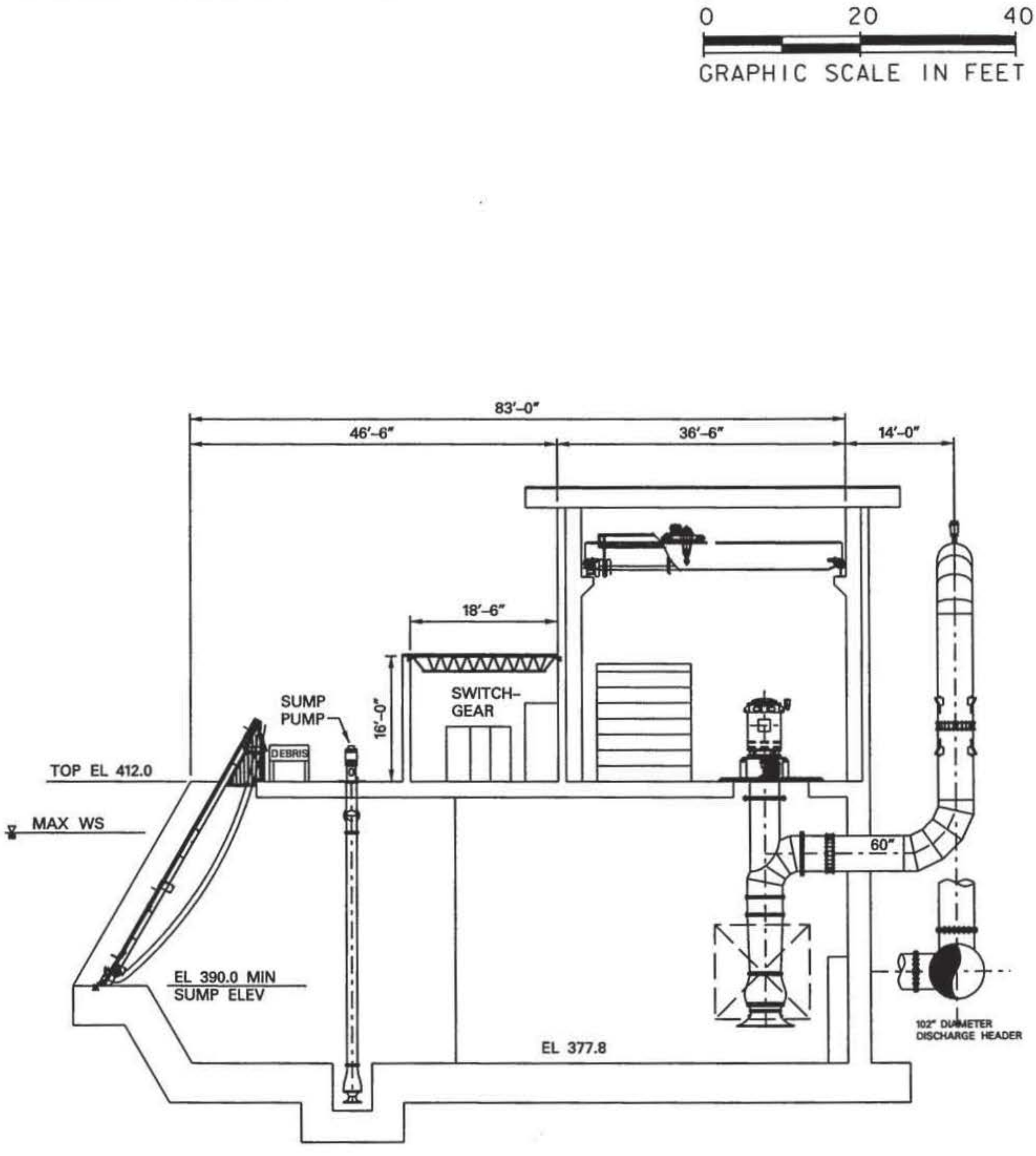

SECTION A – VERTICAL PUMPS
SCALE: 1" = 20'

STATION CAPACITY = 250,000 GPM
84,000 GPM PER PUMP

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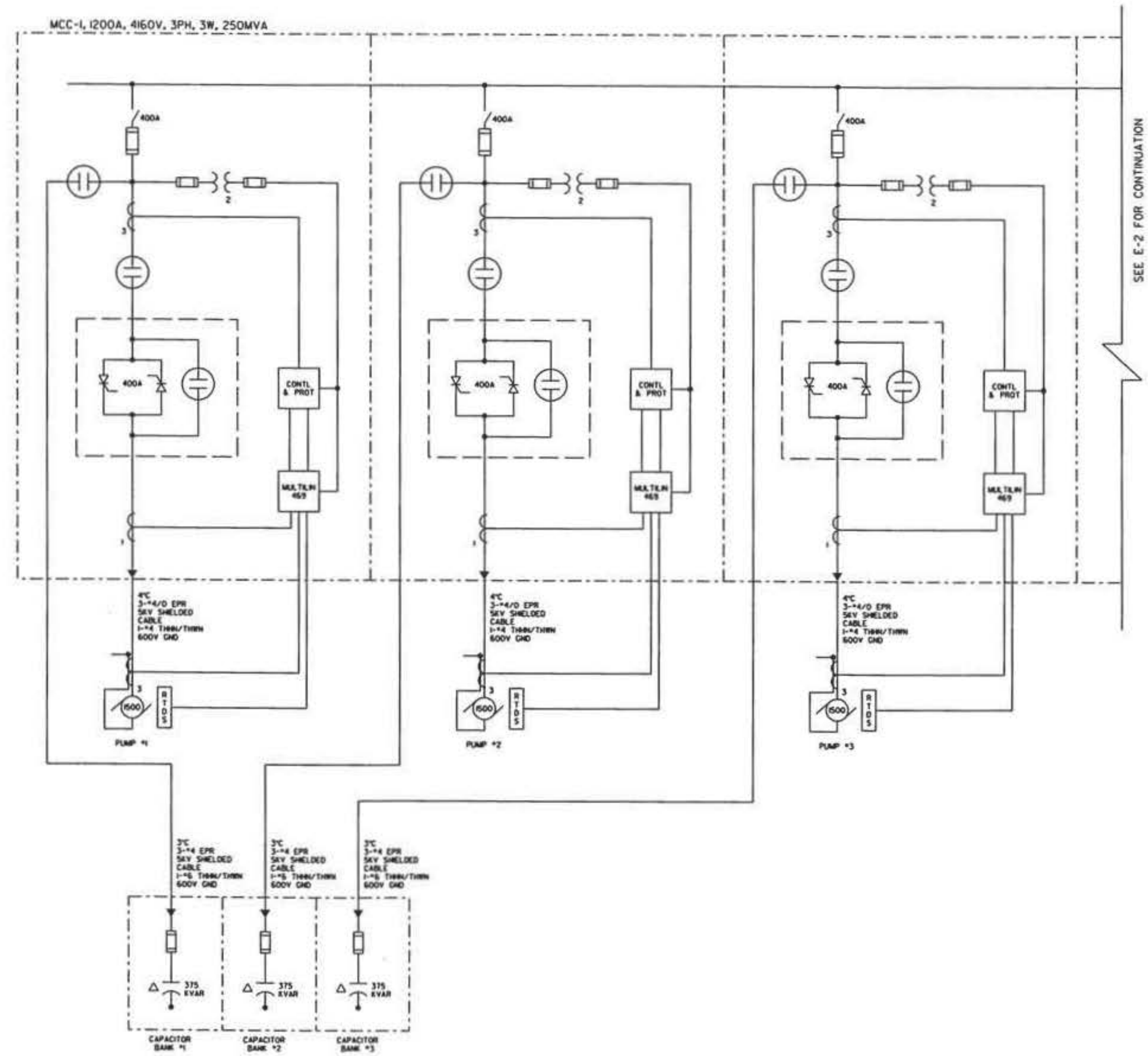

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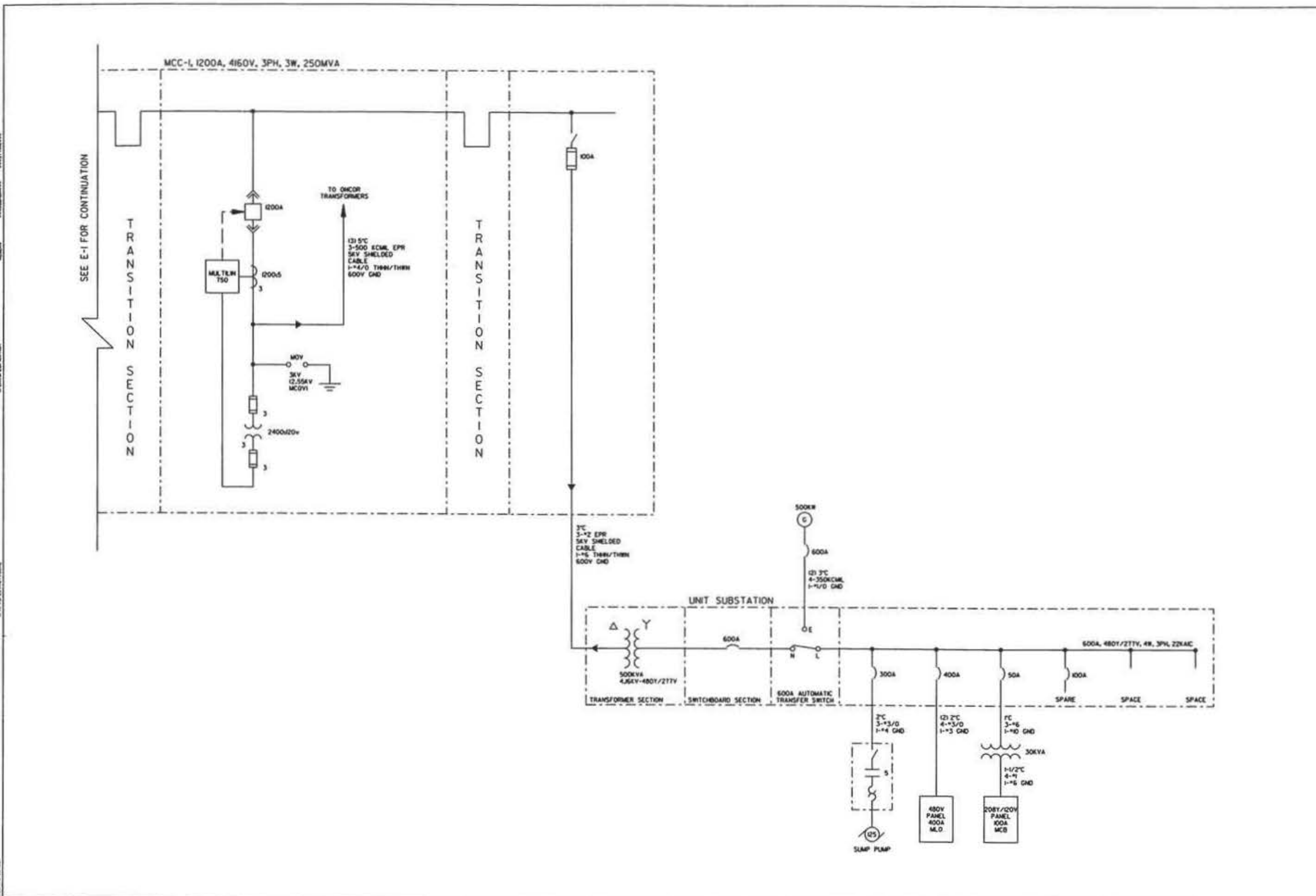
PROPOSED DELTA PUMP STATION
VERTICAL PUMPS
250,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

FIGURE 4.2.16A



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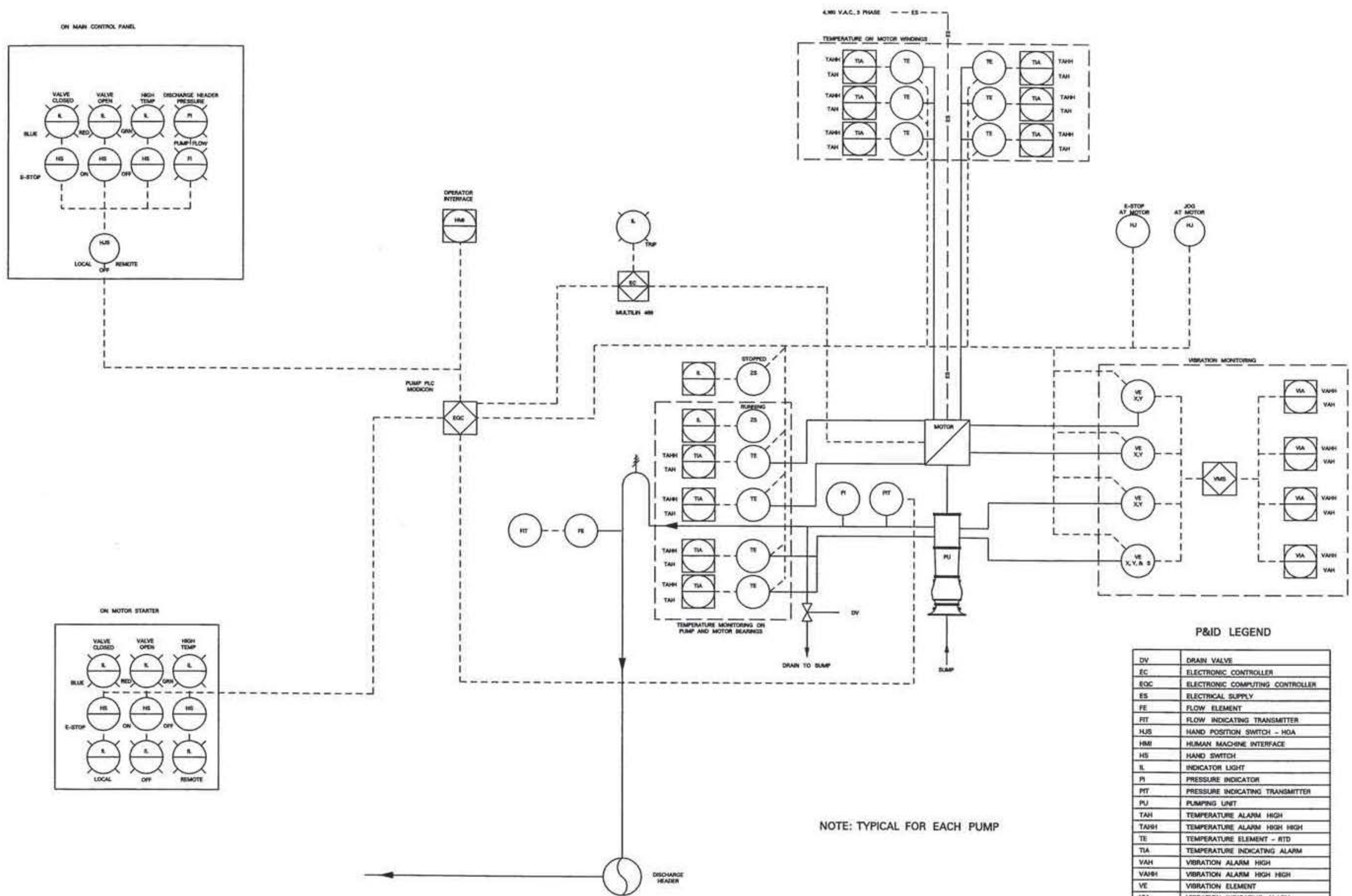
PROPOSED DELTA PUMP STATION
VERTICAL PUMPS
250,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

FIGURE
4.2.16B



NOTE: TYPICAL FOR EACH PUMP

P&ID LEGEND

DV	DRAIN VALVE
EC	ELECTRONIC CONTROLLER
EQC	ELECTRONIC COMPUTING CONTROLLER
ES	ELECTRICAL SUPPLY
FE	FLOW ELEMENT
FIT	FLOW INDICATING TRANSMITTER
HJS	HAND POSITION SWITCH – HOA
HMI	HUMAN MACHINE INTERFACE
HS	HAND SWITCH
IL	INDICATOR LIGHT
PI	PRESSURE INDICATOR
PIT	PRESSURE INDICATING TRANSMITTER
PU	PUMPING UNIT
TAH	TEMPERATURE ALARM HIGH
TAHH	TEMPERATURE ALARM HIGH HIGH
TE	TEMPERATURE ELEMENT – RTD
TIA	TEMPERATURE INDICATING ALARM
VAH	VIBRATION ALARM HIGH
VAHH	VIBRATION ALARM HIGH HIGH
VE	VIBRATION ELEMENT
VIA	VIBRATION INDICATING ALARM
VMS	VIBRATION MONITORING SYSTEM
ZS	POSITION SWITCH

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PROPOSED DELTA PUMP STATION
250,000 GPM CAPACITY
PROCESS AND INSTRUMENTATION DIAGRAM

FIGURE 4.2.17

Table 4.2.5

Summary for Delta 3 Pump 250,000 gpm

Division	Cost
Division 1 - General Conditions	$2,504,000
Divison 2 - Site Work	$4,158,200
Division 3- Concrete	$2,522,621
Division 4 - Masonry	$87,072
Division 5- Metals	$118,515
Division 6 - Carpentry	$4,000
Division 7 - Thermal & Moisture Protection	$784,835
Division 8 - Doors & Windows	$12,700
Division 9 - Finishes	$85,075
Division 10 - Specialties	$9,700
Division 11 - Equipment	$5,344,500
Division 12 - Furnishings	$4,110
Division 13- Special Construction	$0
Division 14 - Conveying Systems	$250,000
Division 15 - Mechanical	$235,018
Division 16 - Electrical	$2,341,500
Division 17 - Instrumentation & Control	$1,293,500
Division Subtotal	**$19,755,346**
Contractor's Profit of Materials - 10%	$1,440,048
Prime Profit on SubConstractors - 10%	$465,394
Subtotal	**$21,660,787**
Construction Contingencies - 20%	$4,332,157
Construction Work Effort subtotal	**$25,992,945**
Escalation to Midpoint @ 6%/Yr & 3 yrs	$8,790,814
Subtotal	**$34,783,759**
Engineering and Surveying Services (12%)	$4,174,051
Construction Management (8%)	$2,782,701
Construction Materials Testing (1.5%)	$521,756
City Contract Administration (10%)	$3,478,376
Services Subtotal	**$10,956,884**
Total Estimated Project Cost	**$45,740,643**

Table 4.2.5
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Delta Site with 3 Pumps
250,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 1 - General Conditions							
Mobilization	1	LS	$0	$0		$0	$600,000
Construction Surveying	1	LS	$0	$0	$45,000.00	$45,000	$45,000
Telephone	30	Mo	$150	$4,500	$0.00	$0	$4,500
SWWWP	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Trench Excavation Safety & Support/Structural Plan	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Traffic Control Plan	1	LS	$15,000	$15,000	$0.00	$0	$15,000
PM	30	Mo	$0	$0	$15,000.00	$450,000	$450,000
Superintendent	30	Mo	$0	$0	$12,000.00	$360,000	$360,000
Admin	30	Mo	$0	$0	$7,000.00	$210,000	$210,000
Sanitary Services	30	Mo	$0	$0	$500.00	$15,000	$15,000
Security Services	30	Mo	$0	$0	$2,000.00	$60,000	$60,000
Pick Up Trucks - 3 each	30	Mo	$0	$0	$1,800.00	$54,000	$54,000
Office Equipment	30	Mo	$0	$0	$350.00	$10,500	$10,500
150 Ton Crane - 24 Months	24	Mo	$0	$0	$20,000.00	$480,000	$480,000
Loader - 30 Months	30	Mo	$0	$0	$2,000.00	$60,000	$60,000
Office Trailors - 2 each	30	Mo	$0	$0	$1,500.00	$45,000	$45,000
Tool Trailors - 2 each	30	Mo	$0	$0	$500.00	$15,000	$15,000
Subtotal for Division 1							**$2,504,000**
Division 2 - Site Work							
Structural Excavation	12,000	CY	$0.00	$0	$8.00	$96,000	$96,000
Structural Backfill	10,000	CY	$6.00	$60,000	$3.00	$30,000	$90,000
Paving	1,300	SY	$12.00	$15,600	$12.00	$15,600	$31,200
Pavement Striping	2,450	SF	$6.00	$14,700	$2.00	$4,900	$19,600
Access Road	1,800	SY	$7.00	$12,600	$13.00	$23,400	$36,000
Traffic Control	1	LS	$5,000.00	$5,000	$20,000.00	$20,000	$25,000
Curb Stops	10	EA	$200.00	$2,000	$50.00	$500	$2,500
8-inch Bollards	10	EA	$1,000.00	$10,000	$150.00	$1,500	$11,500
Grading	3,000	SY	$1.00	$3,000	$2.00	$6,000	$9,000
Fencing - 10 Ft. Man Proof	1,000	LF	$50.00	$50,000	$10.00	$10,000	$60,000
16-foot slide gate (Electric Motor)	1	EA	$6,000.00	$6,000	$1,000.00	$1,000	$7,000

Table 4.2.5
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Delta Site with 3 Pumps
250,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
3-foot ped. Gate	1	EA	$400.00	$400	$100.00	$100	$500
Landscaping	1	LS	$50,000.00	$50,000	$5,000.00	$5,000	$55,000
Channel Liner	2,000	SY	$10.00	$20,000	$5.00	$10,000	$30,000
60-inch steel discharge pipe - 3@130' each	390	LF	$800	$312,000	$100.00	$39,000	$351,000
60-inch nut, bolt and gasket sets	6	EA	$2,000	$12,000	$1,500.00	$9,000	$21,000
102-inch steel dischage pipe (open cut)	200	LF	$1,400	$280,000	$100.00	$20,000	$300,000
102-inch steel dischage pipe (by other than open cut)	400	LF	$4,500	$1,800,000	$100.00	$40,000	$1,840,000
New Headwall	1	LS	$50,000	$50,000	$10,000.00	$10,000	$60,000
Retrofit discharge tower	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Water - 2-inch	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Sewer	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Telephone	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Misc Utilities	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Shoring	5,000	SF	$35	$175,000	$5.00	$25,000	$200,000
Dewatering	1	LS	$250,000	$250,000	$25,000.00	$25,000	$275,000
Coffer Dam - 26' high 2:1ss	10,000	CY	$15	$150,000	$5.00	$50,000	$200,000
3-inch mud slab	140	CY	$100	$14,000	$25.00	$3,500	$17,500
Decommissioning of existing Delta station	1	LS	$200,000.00	$200,000	$35,000.00	$50,000	$250,000
Subtotal for Division 2							**$4,158,200**
Division 3 - Concrete							
Substructure Concrete (Foundation)							
Concrete	1412	CY	$100	$141,200	$15.00	$21,180	$162,380
Rebar (310 lb/CY)	219	TON	$1,020	$223,237	$300.00	$65,658	$288,895
Forming	7622	SF	$10	$76,220	$5.00	$38,110	$114,330
Curing	80	CSF	$5	$400	$5.00	$400	$800
Waterstops	320	LF	$10	$3,200	$5.00	$1,600	$4,800
Substructure Concrete (Pump Room Floor)							
Concrete	235	CY	$100	$23,500	$15.00	$3,525	$27,025
Rebar (310 lb/CY)	36	TON	$1,020	$37,154	$300.00	$10,928	$48,081
Forming	4237	SF	$10	$42,370	$5.00	$5	$42,375
Curing	63	CSF	$5	$315	$5.00	$315	$630

Table 4.2.5
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Delta Site with 3 Pumps
250,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Waterstops	315	LF	$10	$3,150	$5.00	$1,575	$4,725
Substructure Concrete (Perimeter walls) - ext. 4' thick avg.							
Concrete	1264	CY	$100	$126,400	$15.00	$18,960	$145,360
Rebar (310 lb/CY)	196	TON	$1,020	$199,838	$300.00	$58,776	$258,614
Forming	8532	SF	$10	$85,320	$5.00	$42,660	$127,980
Curing	180	CSF	$5	$900	$5.00	$900	$1,800
Waterstops	275	LF	$10	$2,750	$5.00	$1,375	$4,125
Substructure Concrete (Divider walls-int. 2' thick avg)							
Concrete	340	CY	$100	$34,000	$15.00	$5,100	$39,100
Rebar (310 lb/CY)	53	TON	$1,020	$53,754	$300.00	$15,810	$69,564
Forming	4602	SF	$10	$46,020	$5.00	$23,010	$69,030
Curing	190	CSF	$5	$950	$5.00	$950	$1,900
Waterstops	500	LF	$10	$5,000	$5.00	$2,500	$7,500
Substructure Columns and Beams							
Concrete	40	CY	$100	$4,000	$15.00	$600	$4,600
Rebar (310 lb/CY)	6	TON	$1,020	$6,324	$300.00	$1,860	$8,184
Forming	1200	SF	$10	$12,000	$5.00	$6,000	$18,000
Curing	40	CSF	$5	$200	$5.00	$200	$400
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Electrical Room Bottom Slab							
Concrete	140	CY	$100	$14,000	$15.00	$2,100	$16,100
Rebar (310 lb/CY)	22	TON	$1,020	$22,134	$300.00	$6,510	$28,644
Forming	1248	SF	$10	$12,480	$5.00	$6,240	$18,720
Curing	60	CSF	$5	$300	$5.00	$300	$600
Waterstops	150	LF	$10	$1,500	$5.00	$750	$2,250
Superstructure Columns							
Concrete	60	CY	$100	$6,000	$15.00	$900	$6,900
Rebar (310 lb/CY)	9	TON	$1,020	$9,486	$300.00	$2,790	$12,276
Forming	3100	SF	$10	$31,000	$5.00	$15,500	$46,500
Curing	200	CSF	$5	$1,000	$5.00	$1,000	$2,000
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Superstructure Beams							

Table 4.2.5
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Delta Site with 3 Pumps
250,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Concrete	60	CY	$100	$6,000	$15.00	$900	$6,900
Rebar (310 lb/CY)	9	TON	$1,020	$9,486	$300.00	$2,790	$12,276
Forming	2164	SF	$10	$21,640	$5.00	$10,820	$32,460
Curing	250	CSF	$5	$1,250	$5.00	$1,250	$2,500
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Superstructure double-Tees	4752	SF	$18	$85,536	$5.00	$23,760	$109,296
Retaining Walls - MSE wall >20'	15500	SF	$40	$620,000	$10.00	$155,000	$775,000
Subtotal Division 3							**$2,522,621**
Division 4 - Masonary							
CMU Partitions	12,000	SF	$3.00	$36,000	$4.00	$48,000	$84,000
Glazed CMU Restroom Walls	256	SF	$8.00	$2,048	$4.00	$1,024	$3,072
Subtotal for Division 4				**$0**		**$0**	**$87,072**
Division 5 - Metals							
Grating	800	SF	$20	$16,000	$5.00	$4,000	$20,000
Mtl deck	7,505	SF	$2	$15,010	$1.00	$7,505	$22,515
Bar Joists	1	LS	$60,000	$60,000	$5,000.00	$5,000	$65,000
Handrail	200	LF	$40	$8,000	$15.00	$3,000	$11,000
Subtotal for Division 5							**$118,515**
Division 6 - Carpentry							
Misc.	1	ls	$1,000	$1,000	$3,000.00	$3,000	$4,000
Subtotal for Division 6							**$4,000**
Division 7 - Thermal and Moisture Protection							
Exterior walls	11,000	SF	$45	$495,000	$20.00	$220,000	$715,000
Roofing	4,752	SF	$4	$19,008	$2.00	$49,827	$68,835
Roof Hatch-Pumps	0	EA	$15,000	$0	$500.00	$0	$0
Roof Hatch-Access	1	EA	$800	$800	$200.00	$200	$1,000

Table 4.2.5
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Delta Site with 3 Pumps
250,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Subtotal for Division 7							**$784,835**
Division 8 - Doors and Windows							
Doors, 3-0 x 7-0 steel	5	Ea	$200	$1,000	$100.00	$500	$1,500
Doors, roll-up 12' x 14' steel	2	Ea	$5,000	$10,000	$600.00	$1,200	$11,200
Subtotal for Division 8				**$0**		**$0**	**$12,700**
Division 9- Finishes							
Process Piping (pump rm risers & hdrs)	4,100	SF	$0.50	$2,050	$1.25	$5,125	$7,175
Misc. Structural Steel Surf. Prep.	8,900	SF	$1.00	$8,900	$2.00	$17,800	$26,700
Paint Structural Steel	8,900	SF	$1.00	$8,900	$4.00	$35,600	$44,500
Paint Building Interior Walls	10,000	SF	$0.10	$1,000	$0.57	$5,700	$6,700
Subtotal for Division 9							**$85,075**
Division 10 - Specialities							
Signage	1	LS	$5,000	$5,000	$1,000.00	$1,000	$6,000
Woven Wire Partition - 15'x15'x10'Tall	1	LS	$2,500	$2,500	$500.00	$500	$3,000
Toilet Accessories	1	LS	$500	$500	$200.00	$200	$700
Subtotal for Division 10				**$0**		**$0**	**$9,700**
Division 11 - Equipment							
Veritical sump pump, 7000 gpm	1	Ea	$80,000	$80,000	$5,000.00	$5,000	$85,000
Trash Rack (30' x 70')	2,100	SF	$400	$840,000	$10.00	$21,000	$861,000
Restrained Couplings	9	Ea	$15,000	$135,000	$1,500.00	$13,500	$148,500
Vertical Pumps and Motors - 84,000 gpm	3	Ea	$1,300,000	$3,900,000	$30,000.00	$90,000	$3,990,000
Stop Logs	1	LS	$200,000	$200,000	$15,000.00	$15,000	$215,000
8.5' - Flap Gate	1	Ea	$40,000	$40,000	$5,000.00	$5,000	$45,000
Subtotal for Division 11							**$5,344,500**
Division 12 - Furnishings							
Desk	1	Ea	$1,000	$1,000	$100.00	$100	$1,100
Chair	1	Ea	$600	$600	$10.00	$10	$610
Storage Shelves	4	Ea	$500	$2,000	$100.00	$400	$2,400

Table 4.2.5
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Delta Site with 3 Pumps
250,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Subtotal for Division 12							**$4,110**
Division 13 - Special Construction							
Subtotal for Division 13							**$0**
Division 14 - Conveying Systems							
30 Ton Bridge Crane	1	Ea	$100,000	$100,000	$25,000.00	$25,000	$125,000
Automated Conveyor System	1	LS	$100,000.00	$100,000	$25,000.00	$25,000	$125,000
Subtotal for Division 14							**$250,000**
Division 15 - Mechanical							
Ventilation Fan(S)	3	EA	$2,000	$6,000	$500.00	$1,500	$7,500
Roof Curb(S)	3	EA	$1,000	$3,000	$250.00	$750	$3,750
Controls	1	LS	$25,000	$25,000	$10,000.00	$10,000	$35,000
Floor Drain(S)	6	EA	$300	$1,800	$150.00	$900	$2,700
Toilet(S)	1	EA	$200	$200	$200.00	$200	$400
Sink(S)	2	EA	$400	$800	$100.00	$200	$1,000
Urinal(S)	1	EA	$200	$200	$75.00	$75	$275
Faucet(S)	2	EA	$350	$700	$100.00	$200	$900
Trap Primer(S)	2	EA	$350	$700	$150.00	$300	$1,000
Drain/Waste/Vent Plumbing	1000	LF	$15	$15,000	$7.00	$7,000	$22,000
Cold Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Hot Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Dx Hvac Air Handler(S)	2	EA	$17,500	$35,000	$5,000.00	$10,000	$45,000
Dx Hvac Condensing Unit(S)	2	EA	$15,000	$30,000	$1,500.00	$3,000	$33,000
Controls	1	LS	$7,500	$7,500	$5,000.00	$5,000	$12,500
Condensing Unit Pad(S)	1	EA	$500	$500	$100.00	$100	$600
Ductwork	1000	LBS	$50	$50,000	$5.00	$5,000	$55,000
Diffuser(S)/Register(S)/Grille(S)	9	EA	$17	$153	$10.00	$90	$243
Louvre(S)	9	EA	$150	$1,350	$100.00	$900	$2,250
Fire Hose Rack	2	EA	$350	$700	$100.00	$200	$900

Table 4.2.5

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Delta Site with 3 Pumps

250,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Subtotal for Division 15							**$235,018**
Division 16 - Electrical							
Mobilization	1	LS	$0	$0	$0.00	$0	$50,000
Temporary Power	1	LS	$50,000	$50,000	$2,000.00	$2,000	$52,000
Duct Banks	200	CY	$400	$80,000	$20.00	$4,000	$84,000
Manholes	3	EA	$6,000	$18,000	$500.00	$1,500	$19,500
1/0 5 Kv Cable	1,000	LF	$7	$7,000	$3.00	$3,000	$10,000
250 Mcm 5 Kv Cable	1,000	LF	$8	$8,000	$3.00	$3,000	$11,000
100 Mcm 5 Kv Cable	1,000	LF	$15	$15,000	$3.00	$3,000	$18,000
5 Kv Terminations	50	EA	$175	$8,750	$25.00	$1,250	$10,000
Conduit	1	LS	$175,000	$175,000	$20,000.00	$20,000	$195,000
Wire	1	LS	$125,000	$125,000	$10,000.00	$10,000	$135,000
Lighting							
Exterior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Interior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Mv Switchgear	1	LS	$100,000	$100,000	$25,000.00	$25,000	$125,000
Soft Starts - 1200 HP	3	EA	$52,000	$156,000	$15,000.00	$45,000	$201,000
1500 Kva Transformers	3	EA	$50,000	$150,000	$10,000.00	$30,000	$180,000
480 Volt Mcc	1	EA	$85,000	$85,000	$50,000.00	$50,000	$135,000
Misc. Switchgear	1	LS	$50,000	$50,000	$6,000.00	$6,000	$56,000
Lightning Protection	1	LS	$35,000	$35,000	$5,000.00	$5,000	$40,000
Telephone System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Fire Alarm System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Security And Entrance Equipment	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Embedded Conduit	1	LS	$25,000	$25,000	$8,000.00	$8,000	$33,000
Grounding	1	LS	$50,000	$50,000	$10,000.00	$10,000	$60,000
Cable Tray	1	LS	$25,000	$25,000	$15,000.00	$15,000	$40,000
500 Kva Gen Set With ATS	1	Ea	$98,000	$98,000	$5,000.00	$5,000	$103,000
TXU Firm Backup Capabiltiy	1	LS	$600,000	$600,000	$30,000.00	$30,000	$630,000
Testing	1	LS	$15,000	$15,000	$5,000.00	$5,000	$20,000

Table 4.2.5
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Delta Site with 3 Pumps
250,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Subtotal for Division 16							**$2,341,500**
Division 17 - I&C							
Engineering & Submittals	1	LS	$75,000	$75,000	$5,000.00	$5,000	$80,000
Computers And Printers	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
F O Cable And Comm. Equip.	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Control Panels	1	LS	$250,000	$250,000	$10,000.00	$10,000	$260,000
Start Up-Check Out	1	LS	$35,000	$35,000	$10,000.00	$10,000	$45,000
Ultra Sonic Flow Meters	4	Ea	$5,000	$20,000	$2,500.00	$10,000	$30,000
HMI Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
PLC Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
O&M Manuals	1	LS	$5,000	$5,000	$2,000.00	$2,000	$7,000
Training	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Software	1	LS	$85,000	$85,000	$15,000.00	$15,000	$100,000
Factory Test	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Bonds	1	LS	$0	$0	$0.00	$0	$80,000
Level transmitters	3	Ea	$2,000	$6,000	$500.00	$1,500	$7,500
PLC - Primary + hot back-up	1	Ea	$17,500	$17,500	$7,500.00	$7,500	$25,000
PC and Monitor	1	Ea	$8,000	$8,000	$1,000.00	$1,000	$9,000
MMI Software + Programming	1	Ea	$7,000	$7,000	$15,000.00	$15,000	$22,000
Instrumentation wiring	1	LS	$75,000	$75,000	$28,000.00	$28,000	$103,000
SCADA Transmitter	1	Ea	$100,000	$100,000	$10,000.00	$10,000	$110,000
Security Cameras	1	LS	$75,000	$75,000	$10,000.00	$10,000	$85,000
Subtotal for Division 17							**$1,293,500**
Division subtotal				**$14,400,483**		**$3,946,363**	**$19,755,346**
Contractor's Profit on Material (10%)							$1,440,048
Prime Profit on Subcontractors - 10% on Div 5, 6, 7, 8, 9, 10, 12, 16, 17							$465,394
Subtotal							**$21,660,787**
Contingency (20%)							$4,332,157
Construction Work Effort subtotal							**$25,992,945**

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Table 4.2.5

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Delta Site with 3 Pumps

250,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Escalation to Midpoint @ 6%/year& 5 yrs							**$8,790,814**
Subtotal							**$34,783,759**
Engineering and Surveying Services (12%)							$4,174,051
Construction Management (8%)							$2,782,701
Construction Materials Testing (1.5%)							$521,756
City Contract Administration (10%)							$3,478,376
Services Subtotal							**$10,956,884**
Total Estimated Project Cost							**$45,740,643**

The proposed Westmoreland Avenue culverts serve to more efficiently convey flood water between Frances Street Sump and Westmoreland-Hampton Sump separated by Westmoreland Avenue. This item includes the replacement of all three existing culverts at this location with a new double-barrel 10'x6' RCBC. The estimate of probable cost for the new Westmoreland Avenue culverts is shown in Table 4.2.7. A schematic drawing of the proposed culverts is shown on Figure 4.2.23.

The proposed improvements to Ledbetter Dike include an additional 6'x4' reinforced concrete gated culvert with remote operated motor controller. This item would result in a total of three gates at the Ledbetter Dike structure. The third gate would provide more efficient conveyance of water between Trinity-Portland and Westmoreland-Hampton sumps during times of peak flow. The estimate of probable cost for this item is shown in Table 4.2.8. A schematic drawing of the proposed culverts is shown on Figure 4.2.24.

4.2.4 OPTION D1B – REHAB EXISTING PUMP STATION, NEW 166,000 GPM PUMP STATION

This option consists of several separate items. The items contained in this option are listed below:

1. Rehabilitation of the existing Delta pump station,
2. Construction of a new 166,000 gpm pump station at the current Delta station site,
3. Construction of two new 10'x6' reinforced concrete box culverts under Westmoreland Avenue, and
4. Addition of one new 6'x4' gated culvert at the Ledbetter Dike control structure.

Option D1B must be combined with Option P2 to provide a complete solution for the combined Delta/Pavaho sump areas.

The Delta Storm Water Pump Station evaluated for Option D1B has a total pumping capacity of 166,000 gpm. The pumping is accomplished with the use of three 55,333 gpm vertical axial flow pumps, each rated at 55 feet total dynamic head (TDH). Each of these pumps is driven by a 900 horsepower electric motor operating at 295 rpm, eliminating the need for a gear reducer between the motor and pump. Additionally, a 6,000 gpm vertical axial flow pump is provided for dewatering the sump during periods of low flow.

Pump station discharge piping will be configured to route up and over the levee as outfall to the river. Each individual pump will be equipped with a dedicated discharge header with a high point elevation above the top of levee and an air release valve to prevent back-siphoning into the station. Station piping will be lined with high density polyurethane and coated with suitable epoxy-based systems.

The pump station will be configured in accordance with the guidance contained in the following documents:

- "Hydrologic Analysis of Interior Areas" EM 1110-2-1413, dated 15 January 1987
- "Hydrologic Frequency Analysis" EM 1120-2-1415, dated 05 March 1993
- "Flood Run-off Analysis" EM 1110-2-1417, dated 31 August 1994
- "Risk-Based Analysis for Flood Damage Reduction Studies" EM 1120-2-1619, dated 01 August 1996
- *EM1110-2-2100 Stability Analysis of Concrete Structures*
- *EM1110-2-2102 Waterstops and Other Preformed Joint Materials for CW Structures*
- *EM1110-2-2502 Retaining Walls*
- *EM1110-2-3104 Structural and Architectural Design of Pumping Stations*
- *EM1110-2-3105 Mechanical and Electrical Design of Pumping Stations*
- *EM1110-2-1804 Geotechnical Investigations*

The pump station substructure is cast-in-place concrete designed in accordance with ACI 310R and other appropriate standards. The foundation is a mat consisting of a five foot thick concrete slab to which the walls are attached. The walls utilize a stepped design in which the walls are reduced in thickness as the height of the structure increases and the soil load decreases. The sump area is deep and a removable hatch has been incorporated into the floor deck to provide access for removing debris that will accumulate in the sump area. The hatch is large enough to accommodate a small Bobcat.

The superstructure of the pump station is cast-in-place concrete and beams are incorporated into the structure to accommodate the installation of a bridge crane for maintenance. The pump station roof is designed to be double tees, which increases the stiffness of the structure and simplifies construction and maintenance. The roof will consist of the double tees, a two-inch layer of light-weight grout, and a membrane. The superstructure has been designed so that a drive through corridor is incorporated into the station, permitting truck access directly adjacent to the pumps for maintenance.

The exterior wall sections have been assumed to be concrete masonry units with brick veneer, although a different system may be incorporated in the final design.

The pump station interior in the pump room is unfinished; however, the interiors of the switchgear room, office, and restroom have conventional dry wall construction and are painted. Flooring throughout the station is concrete with a troweled finish. The main pump room is provided with ventilation, while the switchgear room, office, and restroom are conditioned.

The primary electrical supply to the station is three-phase, 4160 v.a.c. and is provided by TXU. The supply is from two independent substations providing needed redundancy. Therefore, the standby generator set is for use by limited equipment including the control system, lighting, HVAC components, and the bridge crane. The switchgear is located in the switchgear room and includes soft starts for each of the main pumping units. The switchgear is configured as a main-tie-main to provide additional redundancy and reliability in station operation.

This pump station is located on the West Levee, adjacent to the existing Delta pump Station, along Canada Drive. Access to the station is provided via a concrete paved access road. Roll-up doors on the station provide the drive-through access. Since the site is located next to the sump a retaining wall is provided to level the site for routine operations. Water and sewer are available in Canada Drive, and a two-inch water service and a 4-inch sanitary sewer has been provided for the station.

The interior lighting level will be maintained at 85 foot candles. All handrails will be four-rung aluminum. Grating will be hot-dipped galvanized.

The instrumentation and control system will incorporate monitoring and alarming for motor and pump bearing temperature, motor winding temperature, reverse rotation, flow for each pump, sump elevation, and precipitation. The controls system will be integrated into the SCADA system operated by the City of Dallas. Individual pump control can be initiated at the pump, in the operator office/control room, or remotely by the SCADA system.

Figure 4.2.18 is a site plan for this alternative.

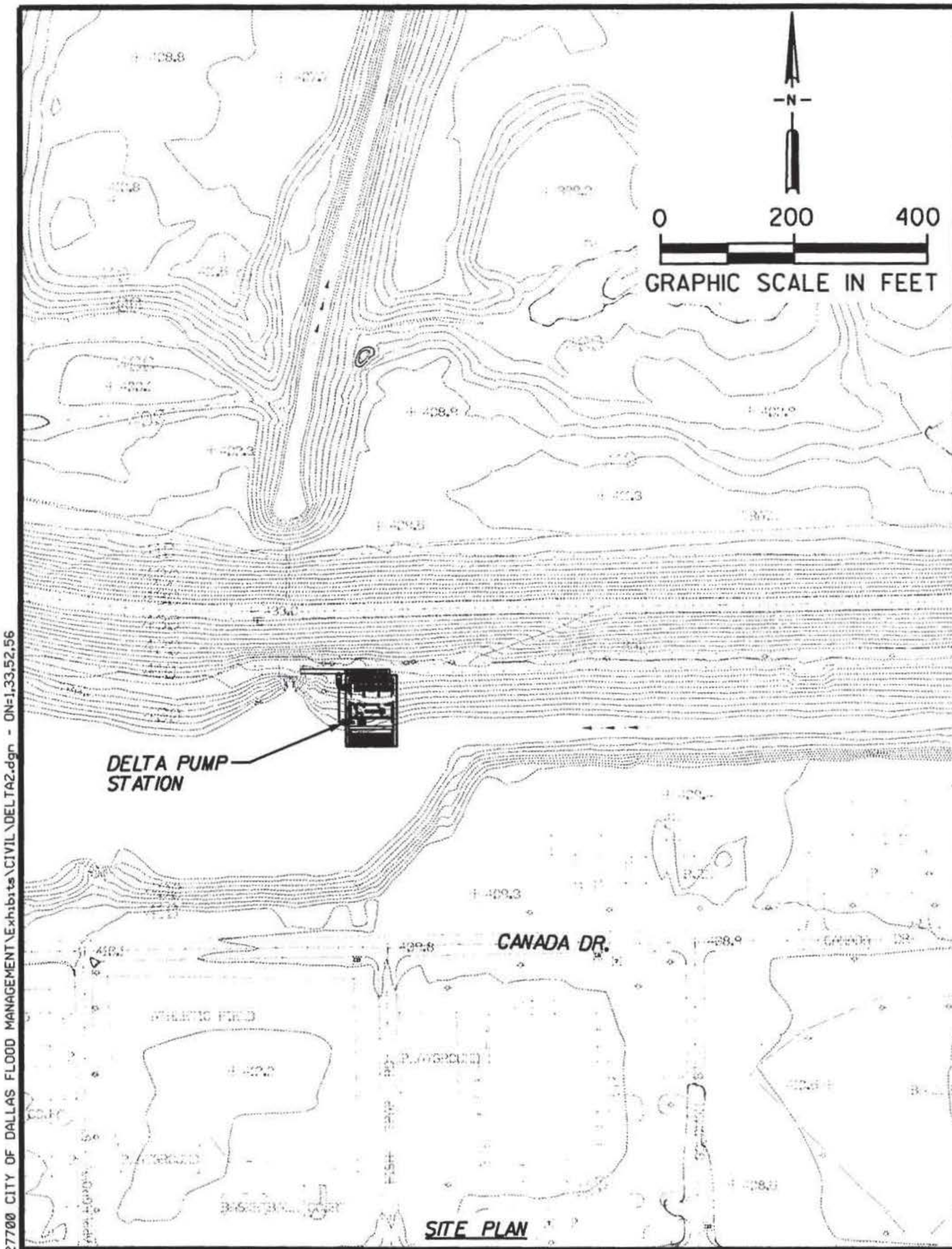
Figure 4.2.19 is a plan view of the 166,000 gpm pump station. The trash rack in the front of the station will be equipped with mechanically-cleaned screens manufactured by Du Perion, since these screens have demonstrated ability to function very effectively in this harsh environment. The switchgear room is adjacent to the pump room.

Figure 4.2.20 is Section A and the relationship of the pumping units, intake sump, and discharge piping are clearly indicated. The bridge crane has 27-foot clearance above the drive through for removal and/or installation of the pumping equipment.

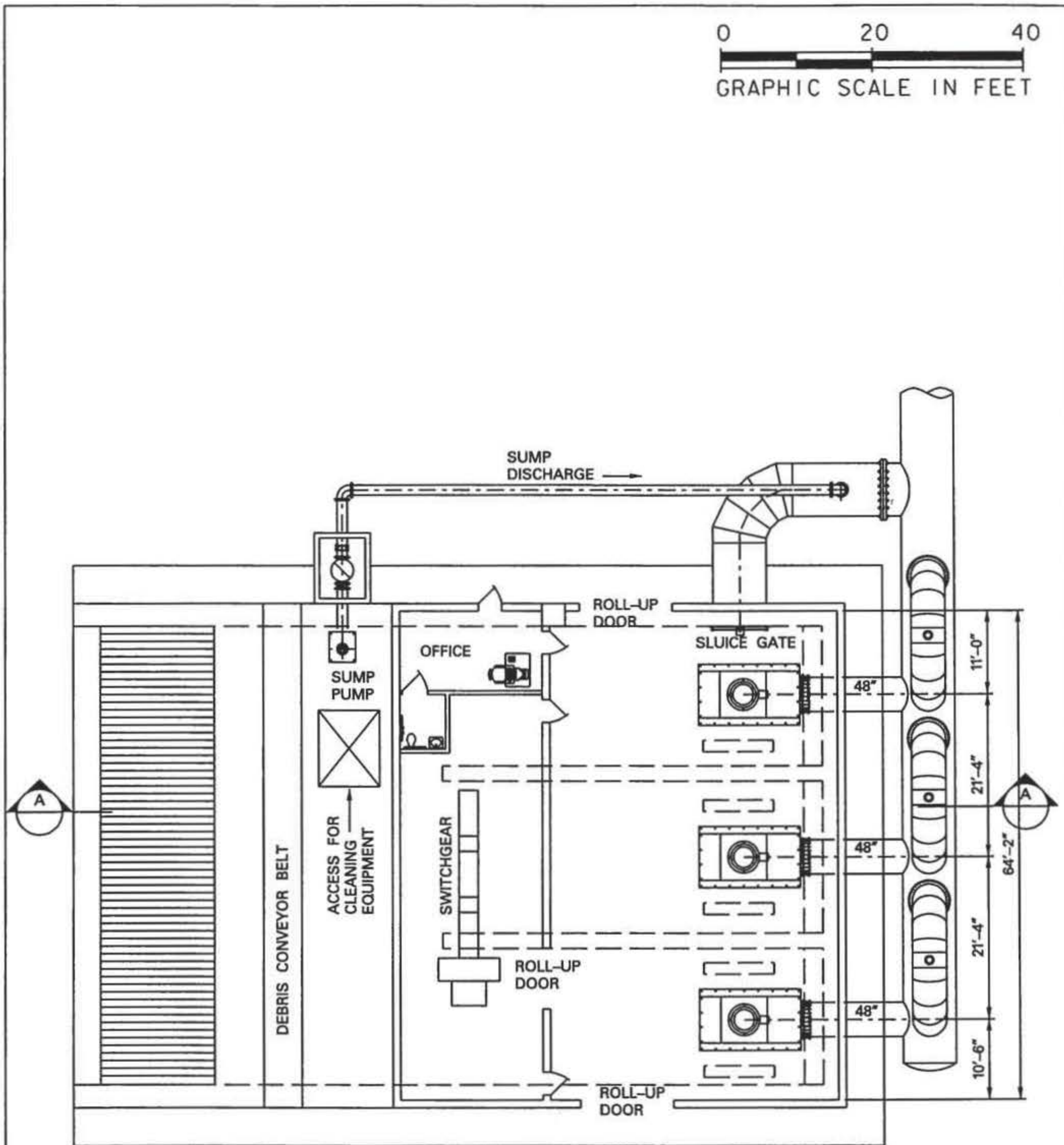
Figures 4.2.21A and 4.2.21B are the electrical one-line diagrams for the station. The double-ended switchgear is indicated. Each of the main pumps is operated by a soft start that has a by-pass that permits the motor to be started even if the soft start is out of service. In addition to the protection provided by the soft start, each of the motors will be equipped with a Multilin 469 to provide motor protective relay systems.

Figure 4.2.22 is a preliminary process and instrumentation diagram for the pump station. The vibration monitoring equipment is shown, as are the RTDs for monitoring motor winding temperatures, and the pump and motor bearing temperatures. Each of the pumps will be equipped with an ultrasonic flow meter to monitor pump discharge.

The Engineer's Preliminary Opinion of Probable Cost for the storm water pump station for Option D1B is summarized in Table 4.2.6.



JE JACOBS Carter Burgess	CITY OF DALLAS DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION	PROPOSED DELTA PUMP STATION VERTICAL PUMPS 166,000 GPM CAPACITY	FIGURE 4.2.18



PLAN VIEW
SCALE: 1" = 20'

STATION CAPACITY = 166,000 GPM
56,000 GPM PER PUMP

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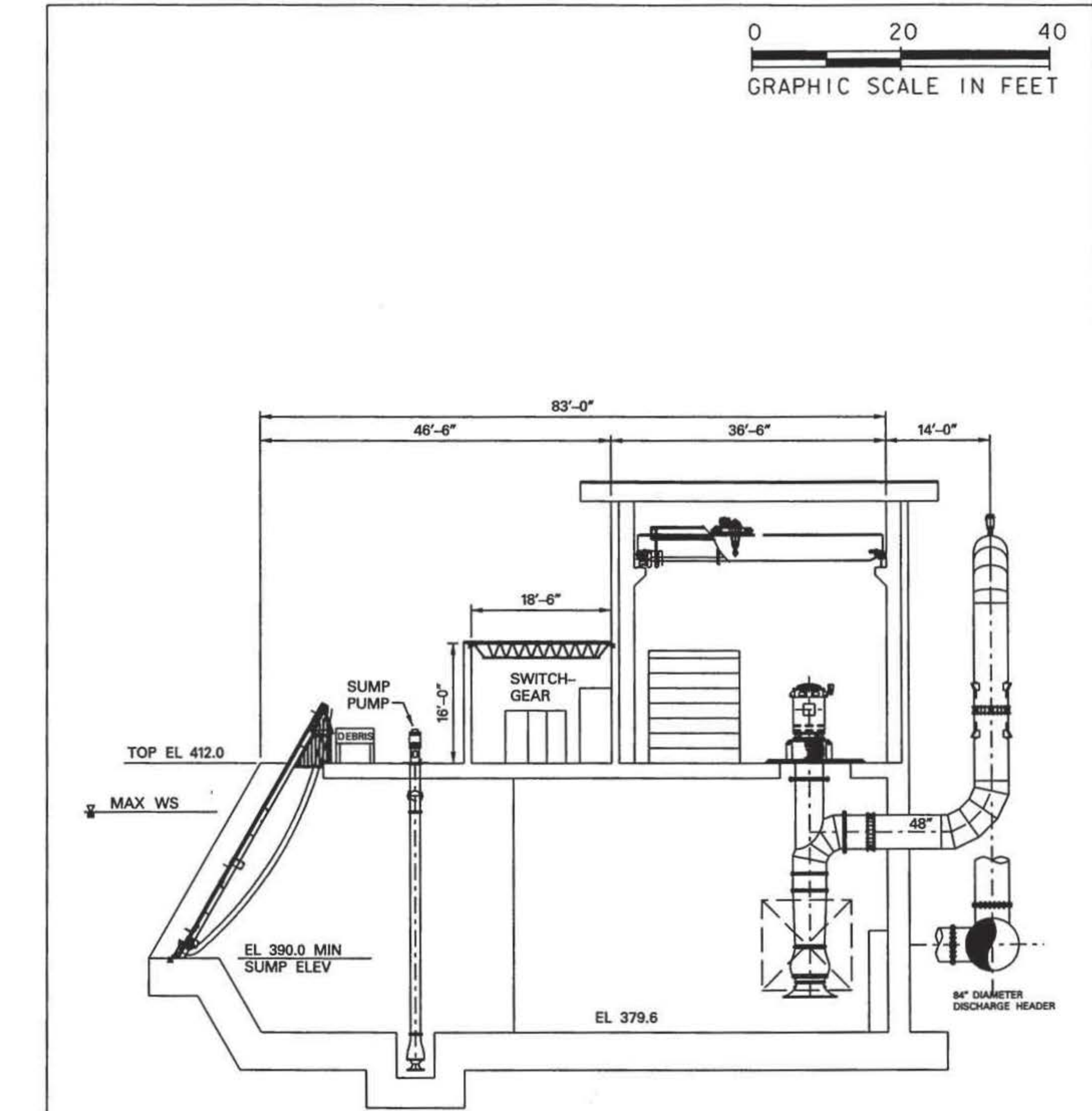
DGNSPEC$LEV



SECTION A – VERTICAL PUMPS
SCALE: 1" = 20'

STATION CAPACITY = 166,000 GPM
56,000 GPM PER PUMP

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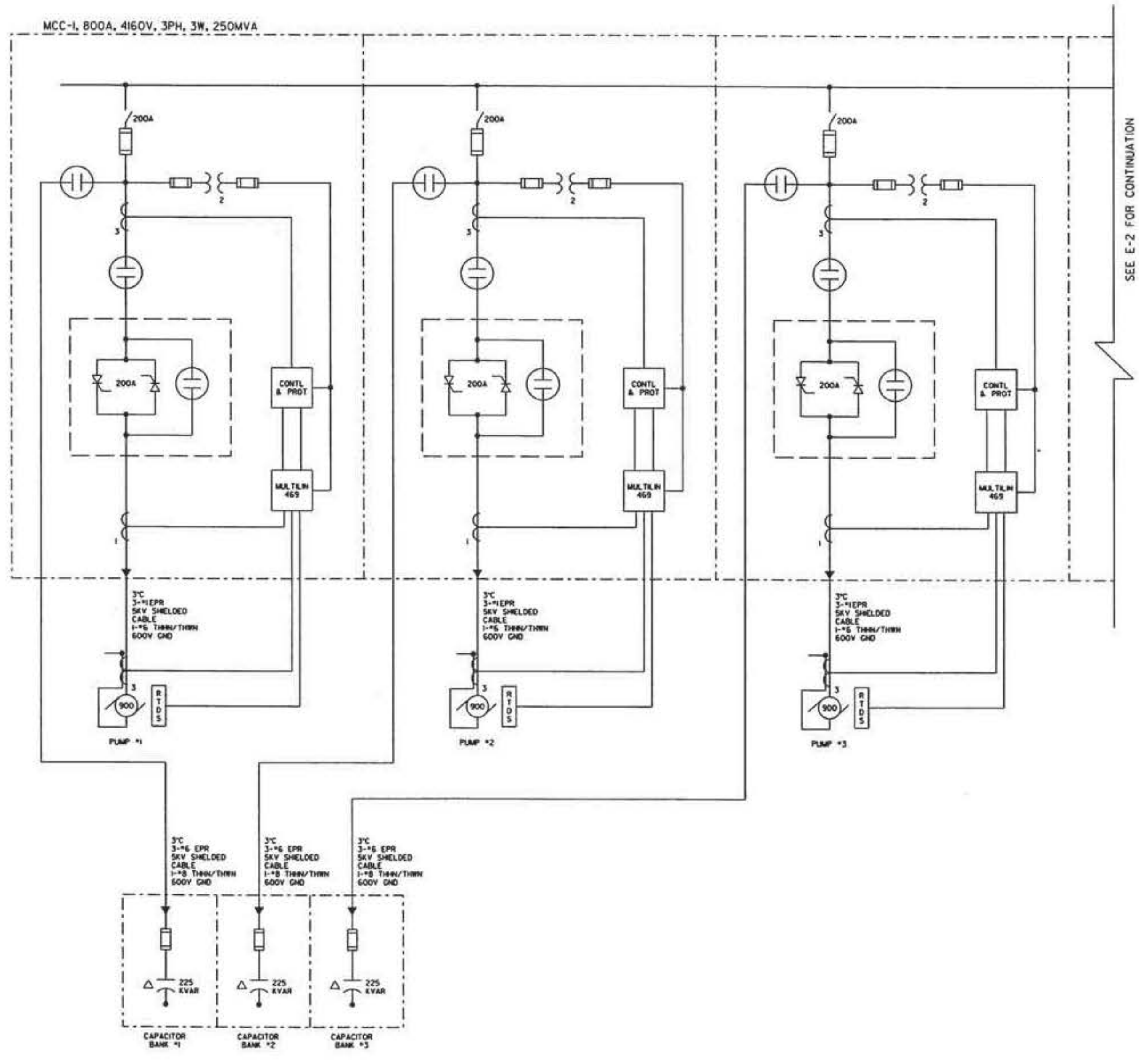
DGNSPEC$LEV



SEE E-2 FOR CONTINUATION

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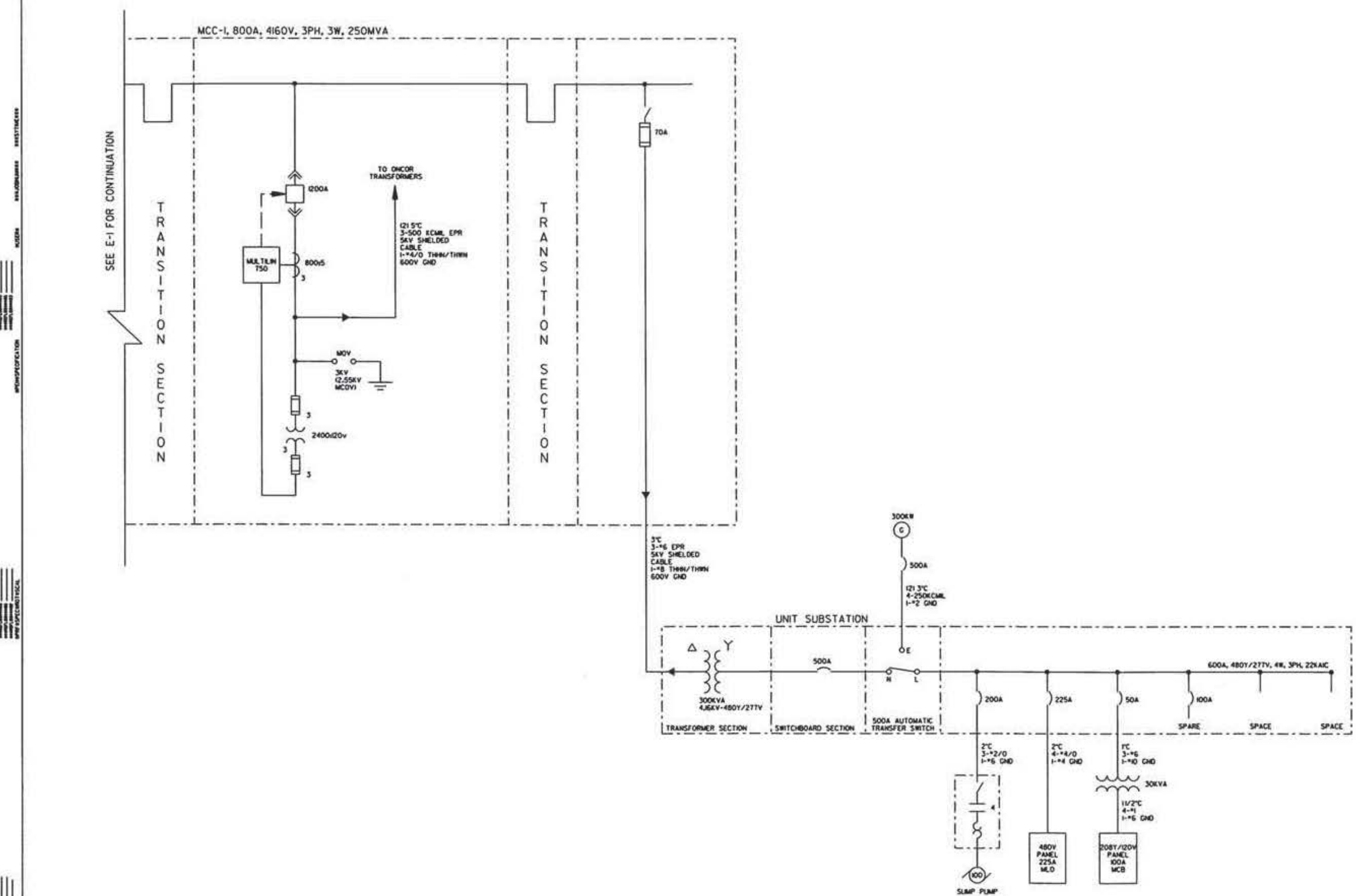
PROPOSED DELTA PUMP STATION
VERTICAL PUMPS
166,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

FIGURE
4.2.21A



PROPOSED DELTA PUMP STATION
VERTICAL PUMPS
166,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

CITY OF DALLAS
DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

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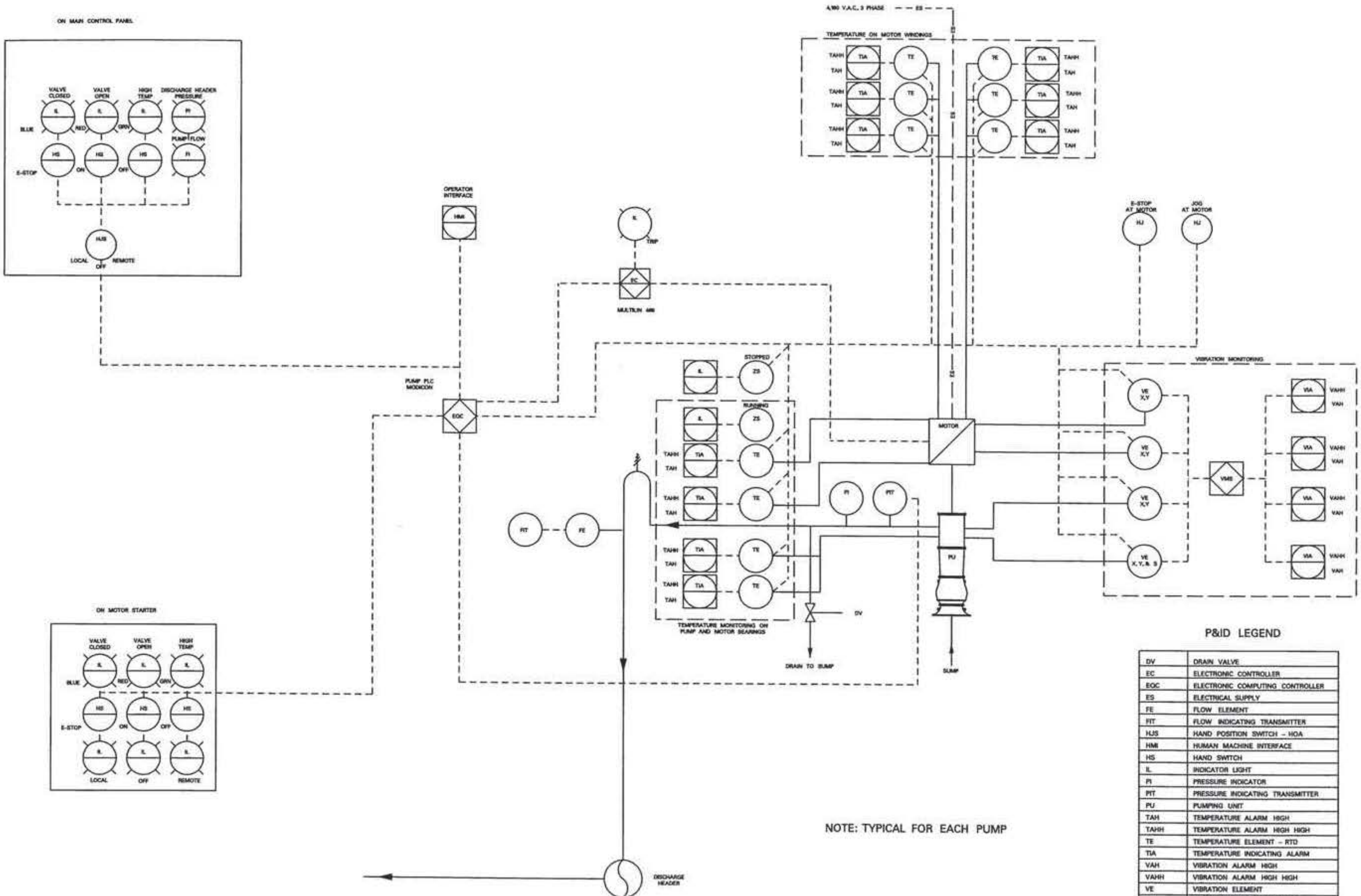
FIGURE
4.2.21B



P&ID LEGEND

DV	DRAIN VALVE
EC	ELECTRONIC CONTROLLER
EQC	ELECTRONIC COMPUTING CONTROLLER
ES	ELECTRICAL SUPPLY
FE	FLOW ELEMENT
FIT	FLOW INDICATING TRANSMITTER
HJS	HAND POSITION SWITCH – HOA
HMI	HUMAN MACHINE INTERFACE
HS	HAND SWITCH
IL	INDICATOR LIGHT
PI	PRESSURE INDICATOR
PIT	PRESSURE INDICATING TRANSMITTER
PU	PUMPING UNIT
TAH	TEMPERATURE ALARM HIGH
TAHH	TEMPERATURE ALARM HIGH HIGH
TE	TEMPERATURE ELEMENT – RTD
TIA	TEMPERATURE INDICATING ALARM
VAH	VIBRATION ALARM HIGH
VAHH	VIBRATION ALARM HIGH HIGH
VE	VIBRATION ELEMENT
VIA	VIBRATION INDICATING ALARM
VMS	VIBRATION MONITORING SYSTEM
ZS	POSITION SWITCH

NOTE: TYPICAL FOR EACH PUMP

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CITY OF DALLAS
DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

PROPOSED DELTA PUMP STATION
166,000 GPM CAPACITY
PROCESS AND INSTRUMENTATION DIAGRAM

FIGURE
4.2.22

Table 4.2.6

Summary for Delta 3 Pump 166,000 gpm

Division	Cost
Division 1 - General Conditions	$2,127,200
Divison 2 - Site Work	$1,843,300
Division 3- Concrete	$2,285,357
Division 4 - Masonry	$87,072
Division 5- Metals	$118,515
Division 6 - Carpentry	$4,000
Division 7 - Thermal & Moisture Protection	$586,827
Division 8 - Doors & Windows	$12,700
Division 9 - Finishes	$77,030
Division 10 - Specialties	$9,700
Division 11 - Equipment	$4,349,750
Division 12 - Furnishings	$4,110
Division 13- Special Construction	$0
Division 14 - Conveying Systems	$250,000
Division 15 - Mechanical	$235,018
Division 16 - Electrical	$2,206,500
Division 17 - Instrumentation & Control	$1,293,500
Division Subtotal	**$15,490,579**
Contractor's Profit of Materials - 10%	$1,073,285
Prime Profit on SubConstractors - 10%	$431,288
Subtotal	**$16,995,152**
Construction Contingencies - 20%	$3,399,030
Construction Work Effort subtotal	**$20,394,182**
Escalation to Midpoint @ 6%/Yr & 3 yrs	$6,897,312
Subtotal	**$27,291,495**
Engineering and Surveying Services (12%)	$3,274,979
Construction Management (8%)	$2,183,320
Construction Materials Testing (1.5%)	$409,372
City Contract Administration (10%)	$2,729,149
Services Subtotal	**$8,596,821**
Total Estimated Project Cost	**$35,888,316**

Table 4.2.6
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Delta Site with 3 Pumps
166,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 1 - General Conditions							
Mobilization	1	LS	$0	$0		$0	$600,000
Construction Surveying	1	LS	$0	$0	$45,000.00	$45,000	$45,000
Telephone	24	Mo	$150	$3,600	$0.00	$0	$3,600
SWWWP	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Trench Excavation Safety & Support/Structural Plan	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Traffic Control Plan	1	LS	$15,000	$15,000	$0.00	$0	$15,000
PM	24	Mo	$0	$0	$15,000.00	$360,000	$360,000
Superintendent	24	Mo	$0	$0	$12,000.00	$288,000	$288,000
Admin	24	Mo	$0	$0	$7,000.00	$168,000	$168,000
Sanitary Services	24	Mo	$0	$0	$500.00	$12,000	$12,000
Security Services	24	Mo	$0	$0	$2,000.00	$48,000	$48,000
Pick Up Trucks - 3 each	24	Mo	$0	$0	$1,800.00	$43,200	$43,200
Office Equipment	24	Mo	$0	$0	$350.00	$8,400	$8,400
150 Ton Crane - 18 Months	18	Mo	$0	$0	$20,000.00	$360,000	$360,000
Loader - 24 Months	24	Mo	$0	$0	$2,000.00	$48,000	$48,000
Office Trailors - 2 each	24	Mo	$0	$0	$1,500.00	$36,000	$36,000
Tool Trailors - 2 each	24	Mo	$0	$0	$500.00	$12,000	$12,000
Subtotal for Division 1							**$2,127,200**
Division 2 - Site Work							
Structural Excavation	12,000	CY	$0.00	$0	$8.00	$96,000	$96,000
Structural Backfill	10,000	CY	$6.00	$60,000	$3.00	$30,000	$90,000
Paving	1,300	SY	$12.00	$15,600	$12.00	$15,600	$31,200
Pavement Striping	2,450	SF	$6.00	$14,700	$2.00	$4,900	$19,600
Access Road	1,800	SY	$7.00	$12,600	$13.00	$23,400	$36,000
Traffic Control	1	LS	$5,000.00	$5,000	$20,000.00	$20,000	$25,000
Curb Stops	10	EA	$200.00	$2,000	$50.00	$500	$2,500
8-inch Bollards	10	EA	$1,000.00	$10,000	$150.00	$1,500	$11,500
Grading	3,000	SY	$1.00	$3,000	$2.00	$6,000	$9,000
Fencing - 10 Ft. Man Proof	1,000	LF	$50.00	$50,000	$10.00	$10,000	$60,000
16-foot slide gate (Electric Motor)	1	EA	$6,000.00	$6,000	$1,000.00	$1,000	$7,000

Table 4.2.6
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Delta Site with 3 Pumps
166,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
3-foot ped. Gate	1	EA	$400.00	$400	$100.00	$100	$500
Landscaping	1	LS	$50,000.00	$50,000	$5,000.00	$5,000	$55,000
Channel Liner	2,000	SY	$10.00	$20,000	$5.00	$10,000	$30,000
48-inch steel discharge pipe - 3@130' each	390	LF	$600	$234,000	$100.00	$39,000	$273,000
48-inch nut, bolt and gasket sets	6	EA	$1,500	$9,000	$850.00	$5,100	$14,100
84-inch steel dischage pipe	200	LF	$1,000	$200,000	$100.00	$20,000	$220,000
Retrofit discharge tower	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Water - 2-inch	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Sewer	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Telephone	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Misc Utilities	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Shoring	5,000	SF	$35	$175,000	$5.00	$25,000	$200,000
Dewatering	1	LS	$250,000	$250,000	$25,000.00	$25,000	$275,000
Coffer Dam - 26' high 2:1ss	10,000	CY	$15	$150,000	$5.00	$50,000	$200,000
3-inch mud slab	140	CY	$100	$14,000	$25.00	$3,500	$17,500
Subtotal for Division 2							**$1,843,300**
Division 3 - Concrete							
Substructure Concrete (Foundation)							
Concrete	1200	CY	$100	$120,000	$15.00	$18,000	$138,000
Rebar (310 lb/CY)	186	TON	$1,020	$189,720	$300.00	$55,800	$245,520
Forming	6630	SF	$10	$66,300	$5.00	$33,150	$99,450
Curing	80	CSF	$5	$400	$5.00	$400	$800
Waterstops	320	LF	$10	$3,200	$5.00	$1,600	$4,800
Substructure Concrete (Pump Room Floor)							
Concrete	190	CY	$100	$19,000	$15.00	$2,850	$21,850
Rebar (310 lb/CY)	29	TON	$1,020	$30,039	$300.00	$8,835	$38,874
Forming	3641	SF	$10	$36,410	$5.00	$5	$36,415
Curing	63	CSF	$5	$315	$5.00	$315	$630
Waterstops	315	LF	$10	$3,150	$5.00	$1,575	$4,725
Substructure Concrete (Perimeter walls) - ext. 4' thick avg.							
Concrete	1050	CY	$100	$105,000	$15.00	$15,750	$120,750

Table 4.2.6

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Delta Site with 3 Pumps

166,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Rebar (310 lb/CY)	163	TON	$1,020	$166,005	$300.00	$48,825	$214,830
Forming	7795	SF	$10	$77,950	$5.00	$38,975	$116,925
Curing	180	CSF	$5	$900	$5.00	$900	$1,800
Waterstops	275	LF	$10	$2,750	$5.00	$1,375	$4,125
Substructure Concrete (Divider walls-int. 2' thick avg)							
Concrete	260	CY	$100	$26,000	$15.00	$3,900	$29,900
Rebar (310 lb/CY)	40	TON	$1,020	$41,106	$300.00	$12,090	$53,196
Forming	3678	SF	$10	$36,780	$5.00	$18,390	$55,170
Curing	190	CSF	$5	$950	$5.00	$950	$1,900
Waterstops	500	LF	$10	$5,000	$5.00	$2,500	$7,500
Substructure Columns and Beams							
Concrete	40	CY	$100	$4,000	$15.00	$600	$4,600
Rebar (310 lb/CY)	6	TON	$1,020	$6,324	$300.00	$1,860	$8,184
Forming	1200	SF	$10	$12,000	$5.00	$6,000	$18,000
Curing	40	CSF	$5	$200	$5.00	$200	$400
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Electrical Room Bottom Slab							
Concrete	110	CY	$100	$11,000	$15.00	$1,650	$12,650
Rebar (310 lb/CY)	17	TON	$1,020	$17,391	$300.00	$5,115	$22,506
Forming	1073	SF	$10	$10,730	$5.00	$5,365	$16,095
Curing	60	CSF	$5	$300	$5.00	$300	$600
Waterstops	150	LF	$10	$1,500	$5.00	$750	$2,250
Superstructure Columns							
Concrete	55	CY	$100	$5,500	$15.00	$825	$6,325
Rebar (310 lb/CY)	9	TON	$1,020	$8,696	$300.00	$2,558	$11,253
Forming	3100	SF	$10	$31,000	$5.00	$15,500	$46,500
Curing	200	CSF	$5	$1,000	$5.00	$1,000	$2,000
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Superstructure Beams							
Concrete	55	CY	$100	$5,500	$15.00	$825	$6,325
Rebar (310 lb/CY)	9	TON	$1,020	$8,696	$300.00	$2,558	$11,253
Forming	2164	SF	$10	$21,640	$5.00	$10,820	$32,460

Table 4.2.6
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Delta Site with 3 Pumps
166,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Curing	250	CSF	$5	$1,250	$5.00	$1,250	$2,500
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Superstructure double-Tees	4752	SF	$18	$85,536	$5.00	$23,760	$109,296
Retaining Walls - MSE wall >20'	15500	SF	$40	$620,000	$10.00	$155,000	$775,000
Subtotal Division 3							**$2,285,357**
Division 4 - Masonary							
CMU Partitions	12,000	SF	$3.00	$36,000	$4.00	$48,000	$84,000
Glazed CMU Restroom Walls	256	SF	$8.00	$2,048	$4.00	$1,024	$3,072
Subtotal for Division 4				**$0**		**$0**	**$87,072**
Division 5 - Metals							
Grating	800	SF	$20	$16,000	$5.00	$4,000	$20,000
Mtl deck	7,505	SF	$2	$15,010	$1.00	$7,505	$22,515
Bar Joists	1	LS	$60,000	$60,000	$5,000.00	$5,000	$65,000
Handrail	200	LF	$40	$8,000	$15.00	$3,000	$11,000
Subtotal for Division 5							**$118,515**
Division 6 - Carpentry							
Misc.	1	ls	$1,000	$1,000	$3,000.00	$3,000	$4,000
Subtotal for Division 6							**$4,000**
Division 7 - Thermal and Moisture Protection							
Exterior walls	8,000	SF	$45	$360,000	$20.00	$160,000	$520,000
Roofing	4,000	SF	$4	$16,000	$2.00	$49,827	$65,827
Roof Hatch-Pumps	0	EA	$15,000	$0	$500.00	$0	$0
Roof Hatch-Access	1	EA	$800	$800	$200.00	$200	$1,000
Subtotal for Division 7							**$586,827**
Division 8 - Doors and Windows							
Doors, 3-0 x 7-0 steel	5	Ea	$200	$1,000	$100.00	$500	$1,500

Table 4.2.6
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Delta Site with 3 Pumps
166,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Doors, roll-up 12' x 14' steel	2	Ea	$5,000	$10,000	$600.00	$1,200	$11,200
Subtotal for Division 8				**$0**		**$0**	**$12,700**
Division 9- Finishes							
Process Piping (pump rm risers & hdrs)	4,000	SF	$0.50	$2,000	$1.25	$5,000	$7,000
Misc. Structural Steel Surf. Prep.	8,000	SF	$1.00	$8,000	$2.00	$16,000	$24,000
Paint Structural Steel	8,000	SF	$1.00	$8,000	$4.00	$32,000	$40,000
Paint Building Interior Walls	9,000	SF	$0.10	$900	$0.57	$5,130	$6,030
Subtotal for Division 9							**$77,030**
Division 10 - Specialities							
Signage	1	LS	$5,000	$5,000	$1,000.00	$1,000	$6,000
Woven Wire Partition - 15'x15'x10'Tall	1	LS	$2,500	$2,500	$500.00	$500	$3,000
Toilet Accessories	1	LS	$500	$500	$200.00	$200	$700
Subtotal for Division 10				**$0**		**$0**	**$9,700**
Division 11 - Equipment							
Veritical sump pump, 7000 gpm	1	Ea	$80,000	$80,000	$5,000.00	$5,000	$85,000
Trash Rack (25' x 65')	1,625	SF	$400	$650,000	$10.00	$16,250	$666,250
Restrained Couplings	9	Ea	$15,000	$135,000	$1,500.00	$13,500	$148,500
Vertical Pumps and Motors - 56,000 gpm	3	Ea	$1,000,000	$3,000,000	$30,000.00	$90,000	$3,090,000
Stop Logs	1	LS	$200,000	$200,000	$15,000.00	$15,000	$215,000
84" - Flap Gate	1	Ea	$35,000	$35,000	$5,000.00	$5,000	$40,000
Sluice Gate - 9'x9'	1	Ea	$100,000	$100,000	$5,000.00	$5,000	$105,000
Subtotal for Division 11							**$4,349,750**
Division 12 - Furnishings							
Desk	1	Ea	$1,000	$1,000	$100.00	$100	$1,100
Chair	1	Ea	$600	$600	$10.00	$10	$610
Storage Shelves	4	Ea	$500	$2,000	$100.00	$400	$2,400
Subtotal for Division 12							**$4,110**

Table 4.2.6
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Delta Site with 3 Pumps
166,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 13 - Special Construction							
Subtotal for Division 13							**$0**
Division 14 - Conveying Systems							
30 Ton Bridge Crane	1	Ea	$100,000	$100,000	$25,000.00	$25,000	$125,000
Automated Conveyor System	1	LS	$100,000.00	$100,000	$25,000.00	$25,000	$125,000
Subtotal for Division 14							**$250,000**
Division 15 - Mechanical							
Ventilation Fan(S)	3	EA	$2,000	$6,000	$500.00	$1,500	$7,500
Roof Curb(S)	3	EA	$1,000	$3,000	$250.00	$750	$3,750
Controls	1	LS	$25,000	$25,000	$10,000.00	$10,000	$35,000
Floor Drain(S)	6	EA	$300	$1,800	$150.00	$900	$2,700
Toilet(S)	1	EA	$200	$200	$200.00	$200	$400
Sink(S)	2	EA	$400	$800	$100.00	$200	$1,000
Urinal(S)	1	EA	$200	$200	$75.00	$75	$275
Faucet(S)	2	EA	$350	$700	$100.00	$200	$900
Trap Primer(S)	2	EA	$350	$700	$150.00	$300	$1,000
Drain/Waste/Vent Plumbing	1000	LF	$15	$15,000	$7.00	$7,000	$22,000
Cold Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Hot Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Dx Hvac Air Handler(S)	2	EA	$17,500	$35,000	$5,000.00	$10,000	$45,000
Dx Hvac Condensing Unit(S)	2	EA	$15,000	$30,000	$1,500.00	$3,000	$33,000
Controls	1	LS	$7,500	$7,500	$5,000.00	$5,000	$12,500
Condensing Unit Pad(S)	1	EA	$500	$500	$100.00	$100	$600
Ductwork	1000	LBS	$50	$50,000	$5.00	$5,000	$55,000
Diffuser(S)/Register(S)/Grille(S)	9	EA	$17	$153	$10.00	$90	$243
Louvre(S)	9	EA	$150	$1,350	$100.00	$900	$2,250
Fire Hose Rack	2	EA	$350	$700	$100.00	$200	$900
Subtotal for Division 15							**$235,018**
Division 16 - Electrical							

Table 4.2.6
Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Delta Site with 3 Pumps
166,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Mobilization	1	LS	$0	$0	$0.00	$0	$50,000
Temporary Power	1	LS	$50,000	$50,000	$2,000.00	$2,000	$52,000
Duct Banks	200	CY	$400	$80,000	$20.00	$4,000	$84,000
Manholes	3	EA	$6,000	$18,000	$500.00	$1,500	$19,500
1/0 5 Kv Cable	1,000	LF	$7	$7,000	$3.00	$3,000	$10,000
250 Mcm 5 Kv Cable	1,000	LF	$8	$8,000	$3.00	$3,000	$11,000
100 Mcm 5 Kv Cable	1,000	LF	$6	$6,000	$2.00	$2,000	$8,000
5 Kv Terminations	50	EA	$175	$8,750	$25.00	$1,250	$10,000
Conduit	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Wire	1	LS	$75,000	$75,000	$10,000.00	$10,000	$85,000
Lighting							
Exterior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Interior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Mv Switchgear	1	LS	$100,000	$100,000	$25,000.00	$25,000	$125,000
Soft Starts - 800 HP	3	EA	$52,000	$156,000	$15,000.00	$45,000	$201,000
1500 Kva Transformers	3	EA	$50,000	$150,000	$10,000.00	$30,000	$180,000
480 Volt Mcc	1	EA	$85,000	$85,000	$50,000.00	$50,000	$135,000
Misc. Switchgear	1	LS	$50,000	$50,000	$6,000.00	$6,000	$56,000
Lightning Protection	1	LS	$35,000	$35,000	$5,000.00	$5,000	$40,000
Telephone System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Fire Alarm System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Security And Entrance Equipment	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Embedded Conduit	1	LS	$25,000	$25,000	$8,000.00	$8,000	$33,000
Grounding	1	LS	$50,000	$50,000	$10,000.00	$10,000	$60,000
Cable Tray	1	LS	$25,000	$25,000	$15,000.00	$15,000	$40,000
500 Kva Gen Set With ATS	1	Ea	$98,000	$98,000	$5,000.00	$5,000	$103,000
TXU Firm Backup Capabiltiy	1	LS	$600,000	$600,000	$30,000.00	$30,000	$630,000
Testing	1	LS	$15,000	$15,000	$5,000.00	$5,000	$20,000
Subtotal for Division 16							**$2,206,500**

Table 4.2.6
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Delta Site with 3 Pumps
166,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 17 - I&C							
Engineering & Submittals	1	LS	$75,000	$75,000	$5,000.00	$5,000	$80,000
Computers And Printers	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
F O Cable And Comm. Equip.	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Control Panels	1	LS	$250,000	$250,000	$10,000.00	$10,000	$260,000
Start Up-Check Out	1	LS	$35,000	$35,000	$10,000.00	$10,000	$45,000
Ultra Sonic Flow Meters	4	Ea	$5,000	$20,000	$2,500.00	$10,000	$30,000
HMI Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
PLC Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
O&M Manuals	1	LS	$5,000	$5,000	$2,000.00	$2,000	$7,000
Training	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Software	1	LS	$85,000	$85,000	$15,000.00	$15,000	$100,000
Factory Test	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Bonds	1	LS	$0	$0	$0.00	$0	$80,000
Level transmitters	3	Ea	$2,000	$6,000	$500.00	$1,500	$7,500
PLC - Primary + hot back-up	1	Ea	$17,500	$17,500	$7,500.00	$7,500	$25,000
PC and Monitor	1	Ea	$8,000	$8,000	$1,000.00	$1,000	$9,000
MMI Software + Programming	1	Ea	$7,000	$7,000	$15,000.00	$15,000	$22,000
Instrumentation wiring	1	LS	$75,000	$75,000	$28,000.00	$28,000	$103,000
SCADA Transmitter	1	Ea	$100,000	$100,000	$10,000.00	$10,000	$110,000
Security Cameras	1	LS	$75,000	$75,000	$10,000.00	$10,000	$85,000
Subtotal for Division 17							**$1,293,500**
Division subtotal				**$10,732,848**		**$3,349,231**	**$15,490,579**
Contractor's Profit on Material (10%)							$1,073,285
Prime Profit on Subcontractors - 10% on Div 5, 6, 7, 8, 9, 10, 12, 16, 17							$431,288
Subtotal							**$16,995,152**
Contingency (20%)							$3,399,030
Construction Work Effort subtotal							**$20,394,182**
Escalation to Midpoint @ 6%/year& 5 yrs							**$6,897,312**
Subtotal							**$27,291,495**

Table 4.2.6
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Delta Site with 3 Pumps
166,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Engineering and Surveying Services (12%)							$3,274,979
Construction Management (8%)							$2,183,320
Construction Materials Testing (1.5%)							$409,372
City Contract Administration (10%)							$2,729,149
Services Subtotal							**$8,596,821**
Total Estimated Project Cost							**$35,888,316**

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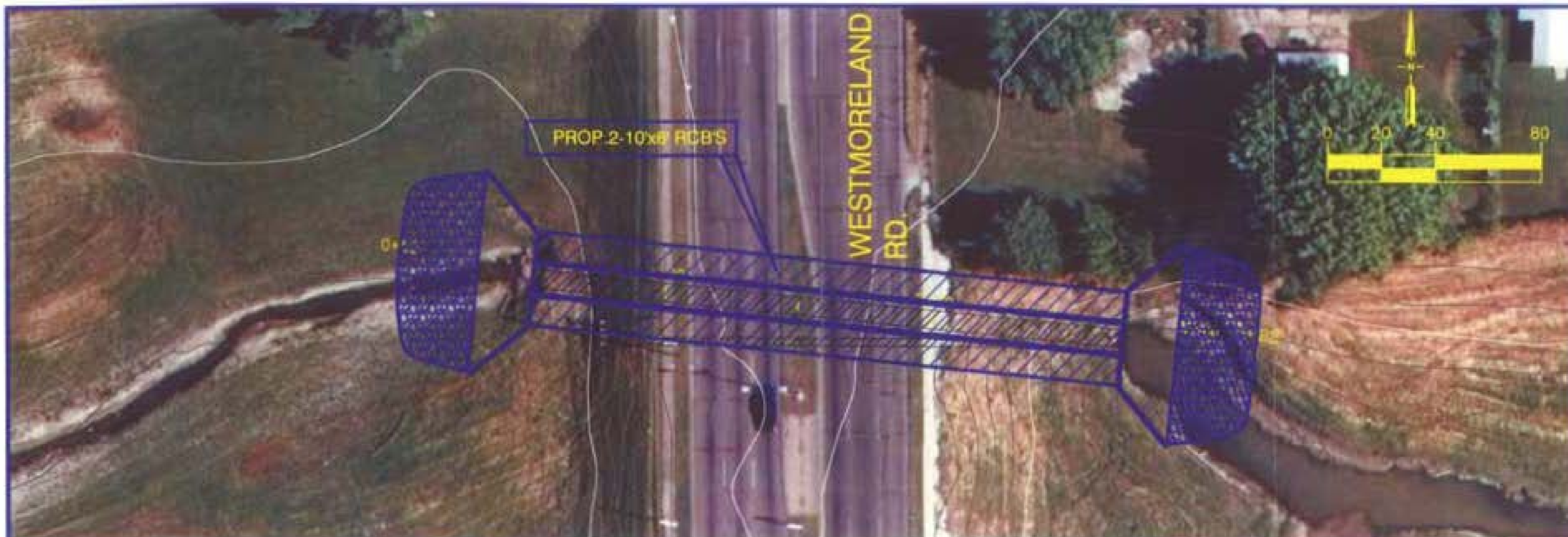

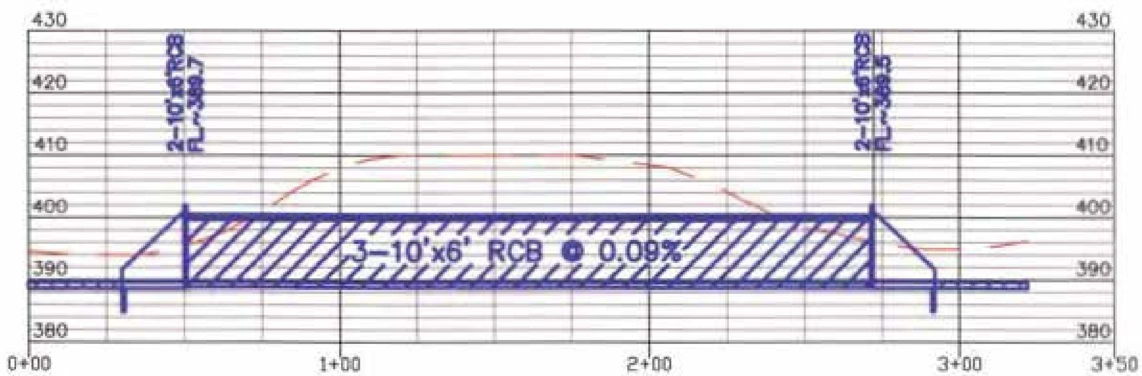

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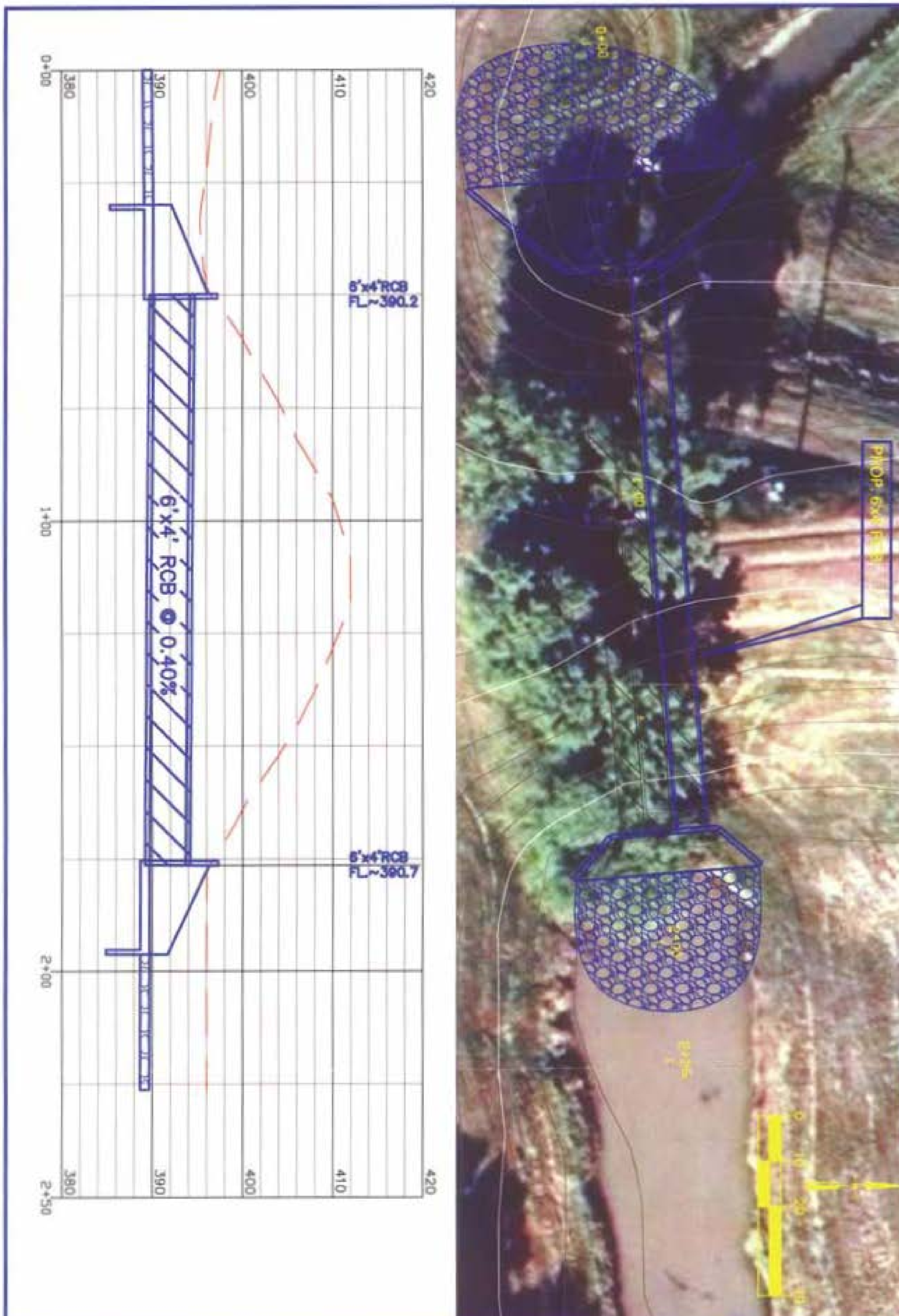
OPTION D1A & D1B
PROPOSED DELTA SUMP
2-10'x6' RCB @ WESTMORELAND RD.

FIGURE
4.2.23

Table 4.2.7
Engineer's Preliminary Opinion of Probable Costs
Options D1A and D1B Culvert Improvements
Delta Sump at Westmoreland Road

Item No.	Description	Unit	Quantity	Unit Cost	Estimated Cost
1	Traffic Control and Barricading	LS	1	$ 20,000	$ 20,000
2	Removal of Headwall and Wingwalls	EA	2	$ 10,000	$ 20,000
3	Removal of Existing 72" Culvert Pipe	LS	1	$ 10,000	$ 10,000
4	10' x 6' RCB By Open Cut	LF	200	$ 600	$ 120,000
5	10' x 6' RCB By Jacking	LF	250	$ 3,500	$ 875,000
6	Trench Safety and Support	LF	100	$ 4	$ 400
7	CIP Headwall	EA	2	$ 15,000	$ 30,000
8	6" Concrete Apron Pavement	SY	70	$ 70	$ 4,900
9	PVC Coated Gabions	CY	75	$ 250	$ 18,750
10	Sodding	SY	600	$ 7	$ 4,200
11	Erosion Control	LS	1	$ 25,000	$ 25,000
12	Dewatering	LS	1	$ 50,000	$ 50,000
13	Mobilization	LS	1	$ 100,000	$ 100,000
Subtotal					$ 1,278,250
20% Contingency					$ 255,650
Total					**$1,533,900**
Escalation to Midpoint @ 6%/year& 5 yrs					$518,765
Subtotal					**$2,052,665**
Engineering and Surveying Services (12%)					$246,320
Construction Management (8%)					$164,213
Construction Materials Testing (1.5%)					$30,790
City Contract Administration (10%)					$205,266
Service Subtotal					**$646,589**
Total Estimated Project Cost					**$2,699,254**



OPTION D1A AND D1B
PROPOSED DELTA SUMP
1-6'x4' RCB @ LEDBETTER DIKE

FIGURE 4.2.24

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Table 4.2.8

Engineer's Preliminary Opinion of Probable Costs

Options D1A and D1B Culvert Improvements

Delta Sump at Ledbetter Dike

Item No.	Description	Unit	Quantity	Unit Cost	Estimated Cost
1	6' x 4' RCB By Open Cut	LF	130	$600	$78,000
2	Trench Safety and Support	LF	130	$4	$520
3	CIP Headwall	EA	2	$15,000	$30,000
4	6" Concrete Apron Pavement	SY	20	$70	$1,400
5	PVC Coated Gabions	CY	75	$250	$18,750
6	Sodding	SY	300	$7	$2,100
7	Erosion Control	LS	1	$25,000	$25,000
8	Dewatering	LS	1	$50,000	$50,000
9	6'x4' Sluice Gate	EA	1	$75,000	$75,000
10	Operators	EA	1	$15,000	$15,000
11	Flap Gates	EA	1	$15,000	$15,000
12	Cofferdam	CY	10000	$20	$200,000
13	Sluice Structure	LS	1	$250,000	$250,000
9	Mobilization	LS	1	$100,000	$100,000
Subtotal					$860,770
20% Contingency					$172,154
Total					**$1,032,924**
Escalation to Midpoint @ 6%/year& 5 yrs					$349,335
Subtotal					**$1,382,259**
Engineering and Surveying Services (12%)					$165,871
Construction Management (8%)					$110,581
Construction Materials Testing (1.5%)					$20,734
City Contract Administration (10%)					$138,226
Service Subtotal					**$435,412**
Total Estimated Project Cost					**$1,817,670**

4.2.5 OPTION D2 – CONSTRUCT NEW 150,000 GPM PUMP STATION IN TRINITY-PORTLAND SUMP

This option consists of the construction of a new 15,000 gpm pump station in Trinity-Portland Sump. No culvert improvements are included with this option. Option D2 must be combined with Option P2 to provide a complete solution for the combined Delta/Pavaho sump areas.

The Trinity Portland Storm Water Pump Station evaluated for Option D2 has a total pumping capacity of 150,000 gpm. The pumping is accomplished with the use of three 50,000 gpm vertical axial flow pumps, each rated at 55 feet total dynamic head (TDH). Each of these pumps is driven by a 900 horsepower electric motor operating at 295 rpm, eliminating the need for a gear reducer between the motor and pump. Additionally, a 6,000 gpm vertical axial flow pump is provided for dewatering the sump during periods of low flow.

Pump station discharge piping will be configured to pump flow up and over the existing West Levee to outfall to the river. Each individual pump will be equipped with a dedicated discharge header with a high point elevation above the top of levee and an air release valve to prevent back-siphoning into the station. Station piping will be lined with high density polyurethane and coated with suitable epoxy-based systems.

The pump station will be configured in accordance with the guidance contained in the following documents:

- "Hydrologic Analysis of Interior Areas" EM 1110-2-1413, dated 15 January 1987
- "Hydrologic Frequency Analysis" EM 1120-2-1415, dated 05 March 1993
- "Flood Run-off Analysis" EM 1110-2-1417, dated 31 August 1994
- "Risk-Based Analysis for Flood Damage Reduction Studies" EM 1120-2-1619, dated 01 August 1996
- *EM1110-2-2100 Stability Analysis of Concrete Structures*
- *EM1110-2-2102 Waterstops and Other Preformed Joint Materials for CW Structures*
- *EM1110-2-2502 Retaining Walls*
- *EM1110-2-3104 Structural and Architectural Design of Pumping Stations*
- *EM1110-2-3105 Mechanical and Electrical Design of Pumping Stations*
- *EM1110-2-1804 Geotechnical Investigations*

The pump station substructure is cast-in-place concrete designed in accordance with ACI 310R and other appropriate standards. The foundation is a mat consisting of a five foot thick concrete slab to which the walls are attached. The walls utilize a stepped design in which the walls are reduced in thickness as the height of the structure increases and the soil load decreases. The sump area is deep and a removable hatch has been incorporated into the floor deck to provide access for removing debris that will accumulate in the sump area. The hatch is large enough to accommodate a small Bobcat.

The superstructure of the pump station is cast-in-place concrete and beams are incorporated into the structure to accommodate the installation of a bridge crane for maintenance. The pump station roof is designed to be double tees, which increases the stiffness of the structure and simplifies construction and maintenance. The roof will consist of the double tees, a two-inch layer of light-weight grout, and a membrane. The superstructure has been designed so that a drive through corridor is incorporated into the station, permitting truck access directly adjacent to the pumps for maintenance.

The exterior wall sections have been assumed to be concrete masonry units with brick veneer, although a different system may be incorporated in the final design.

The pump station interior in the pump room is unfinished; however, the interiors of the switchgear room, office, and restroom have conventional dry wall construction and are painted. Flooring throughout the station is concrete with a troweled finish. The main pump room is provided with ventilation, while the switchgear room, office, and restroom are conditioned.

The primary electrical supply to the station is three-phase, 4160 v.a.c. and is provided by TXU. The supply is from two independent substations providing needed redundancy. Therefore, the standby generator set is for use by limited equipment including the control system, lighting, HVAC components, and the bridge crane. The switchgear is located in the switchgear room and includes soft starts for each of the main pumping units. The switchgear is configured as a main-tie-main to provide additional redundancy and reliability in station operation.

This pump station is located on the West Levee between Mexicana Road and Canada Drive. Access to the station is provided via a concrete paved access road. Roll-up doors on the station provide the drive-through access. Since the site is located next to the sump a retaining wall is provided to level the site for routine operations. Water and sewer are available in adjacent public streets, and a two-inch water service and a 4-inch sanitary sewer has been provided for the station.

The interior lighting level will be maintained at 85 foot candles. All handrails will be four-rung aluminum. Grating will be hot-dipped galvanized.

The instrumentation and control system will incorporate monitoring and alarming for motor and pump bearing temperature, motor winding temperature, reverse rotation, flow for each pump, sump elevation, and precipitation. The controls system will be integrated into the SCADA system operated by the City of Dallas. Individual pump control can be initiated at the pump, in the operator office/control room, or remotely by the SCADA system.

Figure 4.2.25 is a site plan for this alternative.

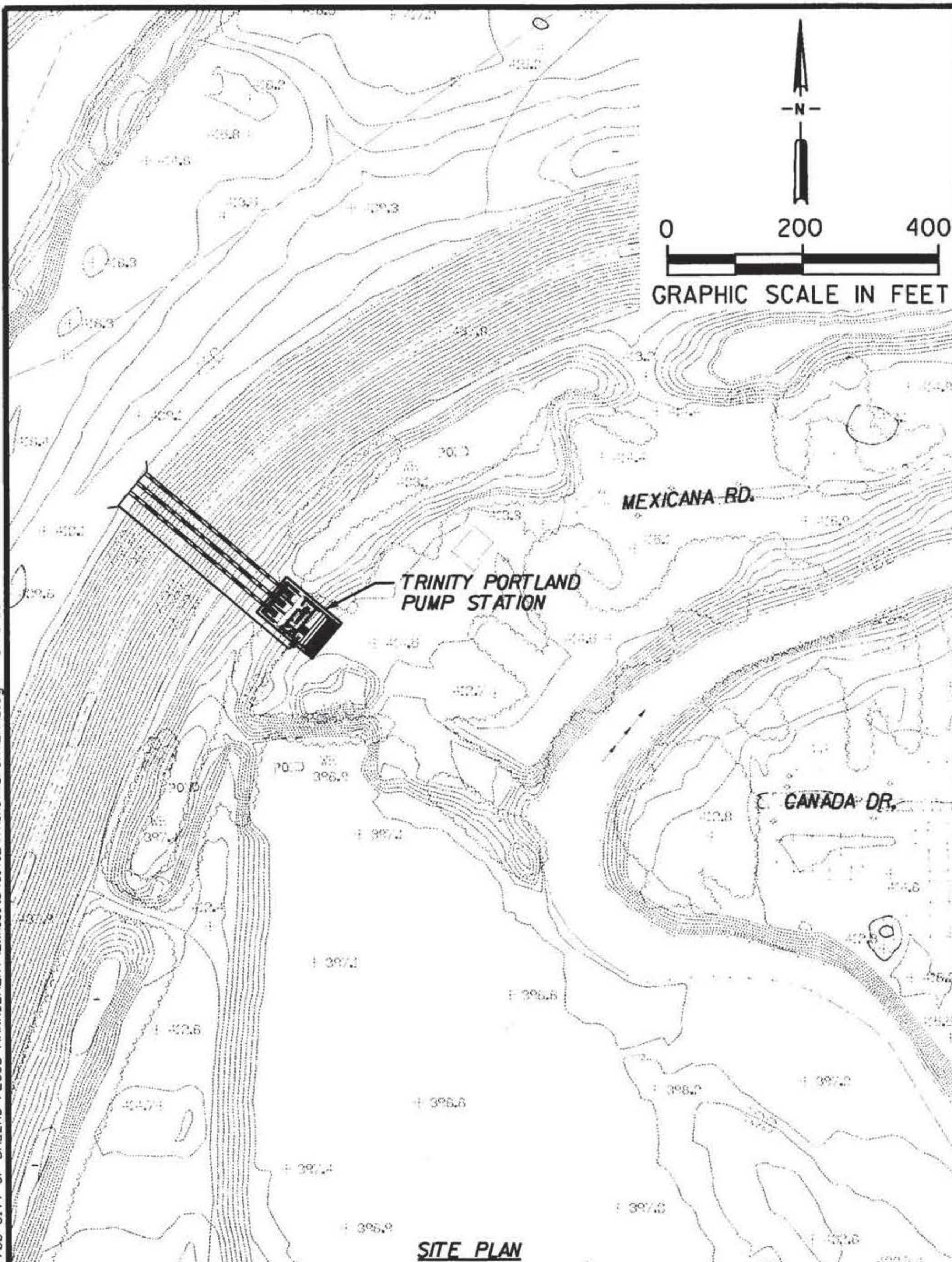
Figure 4.2.26 is a plan view of the 150,000 gpm pump station. The trash rack in the front of the station will be equipped with mechanically-cleaned screens manufactured by Du Perion, since these screens have demonstrated ability to function very effectively in this harsh environment. The switchgear room is adjacent to the pump room.

Figure 4.2.27 is Section A and the relationship of the pumping units, intake sump, and discharge piping are clearly indicated. The bridge crane has 27-foot clearance above the drive through for removal and/or installation of the pumping equipment.

Figures 4.2.28A and 4.2.28B are the electrical one-line diagrams for the station. The double-ended switchgear is indicated. Each of the main pumps is operated by a soft start that has a by-pass that permits the motor to be started even if the soft start is out of service. In addition to the protection provided by the soft start, each of the motors will be equipped with a Multilin 469 to provide motor protective relay systems.

Figure 4.2.29 is a preliminary process and instrumentation diagram for the pump station. The vibration monitoring equipment is shown, as are the RTDs for monitoring motor winding temperatures, and the pump and motor bearing temperatures. Each of the pumps will be equipped with an ultrasonic flow meter to monitor pump discharge.

The Engineer's Preliminary Opinion of Probable Cost for the storm water pump station for Option D2 is summarized in Table 4.2.9.



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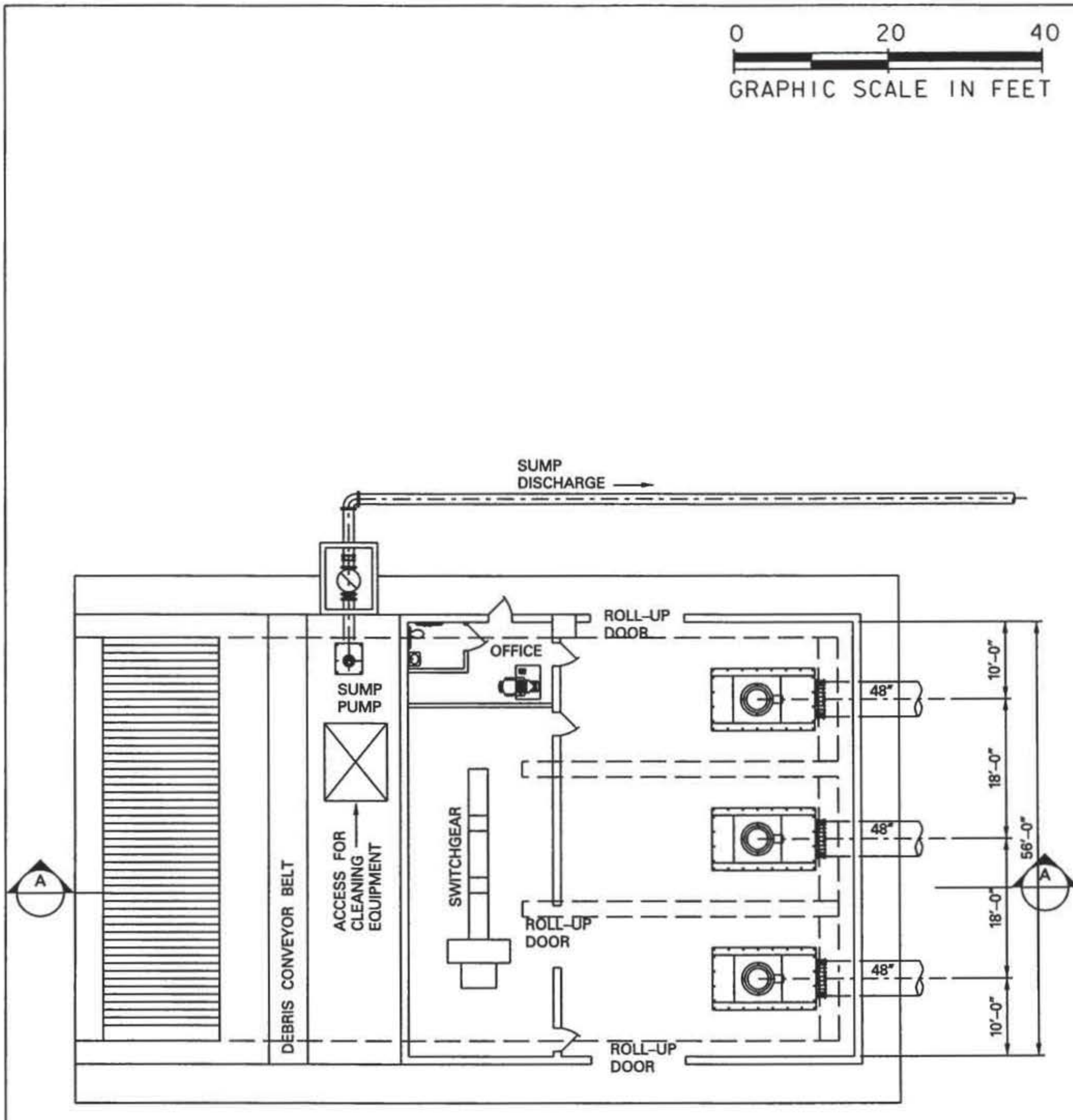

PLAN VIEW
SCALE: 1" = 20'

STATION CAPACITY = 150,000 GPM
50,000 GPM PER PUMP

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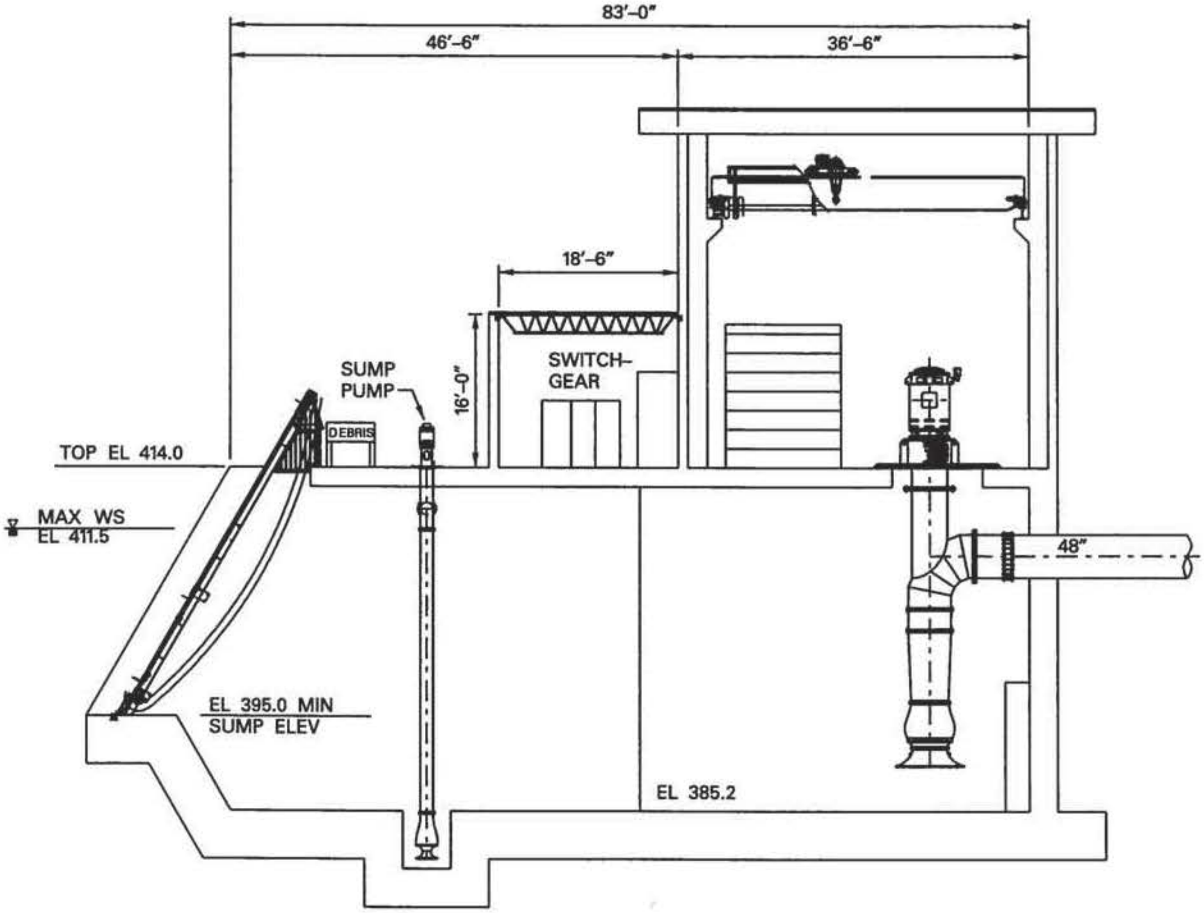
DGNSPEC$LEV

0 20 40
GRAPHIC SCALE IN FEET



SECTION A – VERTICAL PUMPS

SCALE: 1" = 20'

STATION CAPACITY = 150,000 GPM
50,000 GPM PER PUMP

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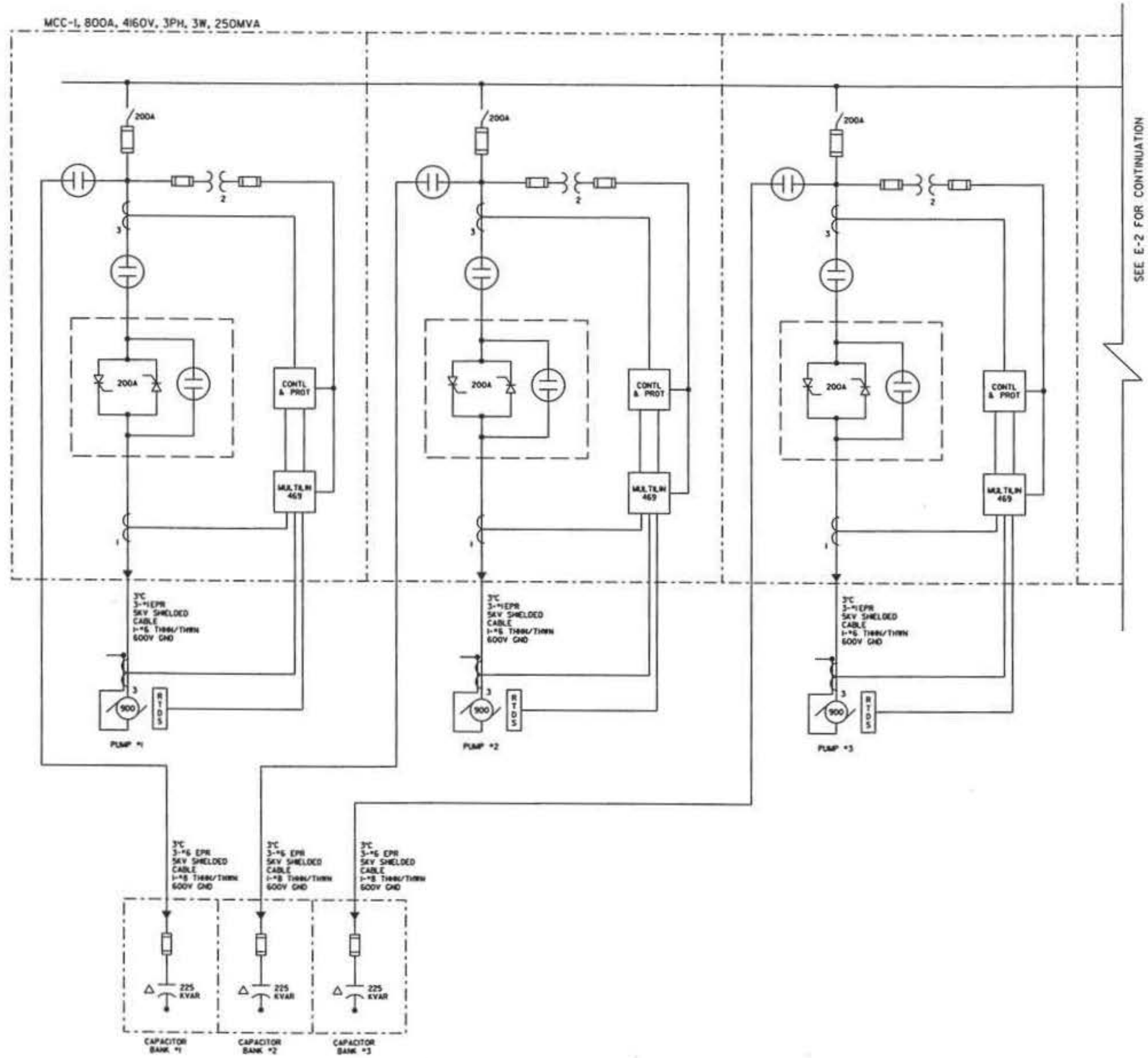

SEE E-2 FOR CONTINUATION

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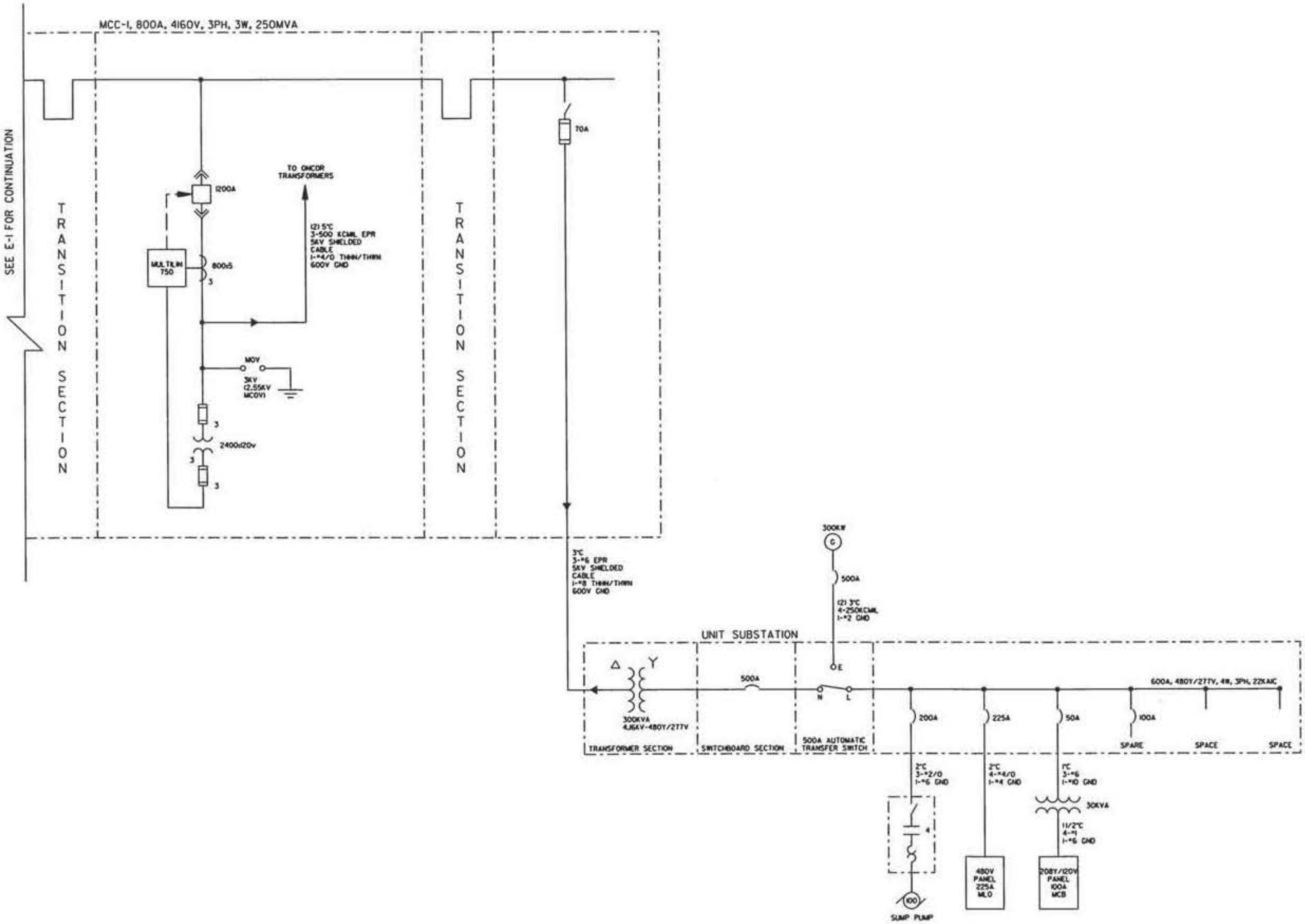
PROPOSED TRINITY PORTLAND PUMP STATION - VERTICAL PUMPS 150,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

FIGURE 4.2.28A



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PROPOSED TRINITY PORTLAND
PUMP STATION – VERTICAL PUMPS
150,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

FIGURE
4.2.28B

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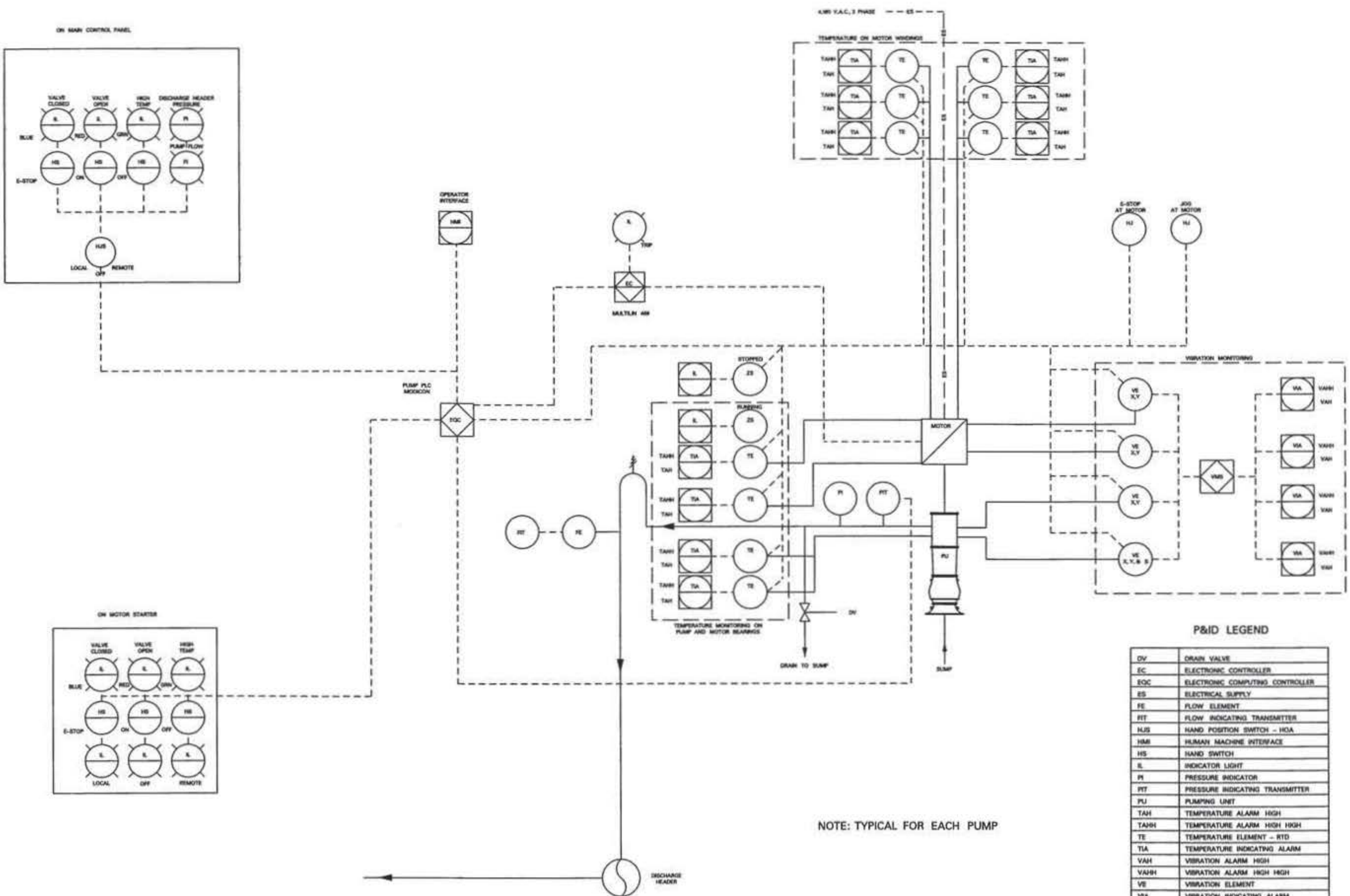

P&ID LEGEND

DV	DRAIN VALVE
EC	ELECTRONIC CONTROLLER
EQC	ELECTRONIC COMPUTING CONTROLLER
ES	ELECTRICAL SUPPLY
FE	FLOW ELEMENT
FIT	FLOW INDICATING TRANSMITTER
HJS	HAND POSITION SWITCH – HOA
HMI	HUMAN MACHINE INTERFACE
HS	HAND SWITCH
IL	INDICATOR LIGHT
PI	PRESSURE INDICATOR
PIT	PRESSURE INDICATING TRANSMITTER
PU	PUMPING UNIT
TAH	TEMPERATURE ALARM HIGH
TAHH	TEMPERATURE ALARM HIGH HIGH
TE	TEMPERATURE ELEMENT – RTD
TIA	TEMPERATURE INDICATING ALARM
VAH	VIBRATION ALARM HIGH
VAHH	VIBRATION ALARM HIGH HIGH
VE	VIBRATION ELEMENT
VIA	VIBRATION INDICATING ALARM
VMS	VIBRATION MONITORING SYSTEM
ZS	POSITION SWITCH

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PROPOSED TRINITY PORTLAND PUMP STATION
150,000 GPM CAPACITY

PROCESS AND INSTRUMENTATION DIAGRAM

FIGURE
4.2.29

Table 4.2.9

Summary for Trinity Portland 3 Pump 150,000 gpm

Division	Cost
Division 1 - General Conditions	$2,127,200
Divison 2 - Site Work	$4,015,300
Division 3- Concrete	$2,512,243
Division 4 - Masonry	$87,072
Division 5- Metals	$118,515
Division 6 - Carpentry	$4,000
Division 7 - Thermal & Moisture Protection	$784,835
Division 8 - Doors & Windows	$12,700
Division 9 - Finishes	$85,075
Division 10 - Specialties	$9,700
Division 11 - Equipment	$4,425,000
Division 12 - Furnishings	$4,110
Division 13- Special Construction	$0
Division 14 - Conveying Systems	$350,000
Division 15 - Mechanical	$235,018
Division 16 - Electrical	$2,206,500
Division 17 - Instrumentation & Control	$1,293,500
Division Subtotal	**$18,270,768**
Contractor's Profit of Materials - 10%	$1,336,339
Prime Profit on SubConstractors - 10%	$451,894
Subtotal	**$20,059,000**
Construction Contingencies - 20%	$4,011,800
Construction Work Effort subtotal	**$24,070,800**
Escalation to Midpoint @ 6%/Yr & 3 yrs	$8,140,745
Subtotal	**$32,211,545**
Engineering and Surveying Services (12%)	$3,865,385
Construction Management (8%)	$2,576,924
Construction Materials Testing (1.5%)	$483,173
City Contract Administration (10%)	$3,221,155
Services Subtotal	**$10,146,637**
Total Estimated Project Cost	**$42,358,182**

Table 4.2.9
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Trinity Portland Site with 3 Pumps
150,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 1 - General Conditions							
Mobilization	1	LS	$0	$0		$0	$600,000
Construction Surveying	1	LS	$0	$0	$45,000.00	$45,000	$45,000
Telephone	24	Mo	$150	$3,600	$0.00	$0	$3,600
SWWWP	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Trench Excavation Safety & Support/Structural Plan	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Traffic Control Plan	1	LS	$15,000	$15,000	$0.00	$0	$15,000
PM	24	Mo	$0	$0	$15,000.00	$360,000	$360,000
Superintendent	24	Mo	$0	$0	$12,000.00	$288,000	$288,000
Admin	24	Mo	$0	$0	$7,000.00	$168,000	$168,000
Sanitary Services	24	Mo	$0	$0	$500.00	$12,000	$12,000
Security Services	24	Mo	$0	$0	$2,000.00	$48,000	$48,000
Pick Up Trucks - 3 each	24	Mo	$0	$0	$1,800.00	$43,200	$43,200
Office Equipment	24	Mo	$0	$0	$350.00	$8,400	$8,400
150 Ton Crane - 18 Months	18	Mo	$0	$0	$20,000.00	$360,000	$360,000
Loader - 24 Months	24	Mo	$0	$0	$2,000.00	$48,000	$48,000
Office Trailors - 2 each	24	Mo	$0	$0	$1,500.00	$36,000	$36,000
Tool Trailors - 2 each	24	Mo	$0	$0	$500.00	$12,000	$12,000
Subtotal for Division 1							**$2,127,200**
Division 2 - Site Work							
Structural Excavation	12,000	CY	$0.00	$0	$8.00	$96,000	$96,000
Structural Backfill	10,000	CY	$6.00	$60,000	$3.00	$30,000	$90,000
Paving	1,300	SY	$12.00	$15,600	$12.00	$15,600	$31,200
Pavement Striping	2,450	SF	$6.00	$14,700	$2.00	$4,900	$19,600
Traffic Control	1	LS	$5,000.00	$5,000	$20,000.00	$20,000	$25,000
Curb Stops	10	EA	$200.00	$2,000	$50.00	$500	$2,500
8-inch Bollards	10	EA	$1,000.00	$10,000	$150.00	$1,500	$11,500
Grading	10,000	SY	$3.00	$30,000	$2.00	$20,000	$50,000
Fencing - 10 Ft. Man Proof	1,000	LF	$50.00	$50,000	$10.00	$10,000	$60,000
16-foot slide gate (Electric Motor)	1	EA	$6,000.00	$6,000	$1,000.00	$1,000	$7,000
3-foot ped. Gate	1	EA	$400.00	$400	$100.00	$100	$500

Table 4.2.9

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Trinity Portland Site with 3 Pumps

150,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Landscaping	1	LS	$50,000.00	$50,000	$5,000.00	$5,000	$55,000
Channel Liner	2,000	SY	$10.00	$20,000	$5.00	$10,000	$30,000
48-inch steel discharge pipe - 3@300' each	900	LF	$700	$630,000	$100.00	$90,000	$720,000
84-inch steel discharge pipe - 1 @ 400'	400	LF	$4,500	$1,800,000	$100.00	$40,000	$1,840,000
48-inch nut, bolt and gasket sets	6	EA	$1,500	$9,000	$850.00	$5,100	$14,100
Headwalls	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Water - 2-inch	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Sewer	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Telephone	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Misc Utilities	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Shoring	5,000	SF	$35	$175,000	$5.00	$25,000	$200,000
Dewatering	1	LS	$350,000	$350,000	$25,000.00	$25,000	$375,000
Coffer Dam - 26' high 2:1ss	10,000	CY	$15	$150,000	$5.00	$50,000	$200,000
3-inch mud slab	140	CY	$100	$14,000	$25.00	$3,500	$17,500
Subtotal for Division 2							**$4,015,300**
Division 3 - Concrete							
Substructure Concrete (Foundation)							
Concrete	1105	CY	$100	$110,520	$15.00	$16,578	$127,098
Rebar (310 lb/CY)	171	TON	$1,020	$174,732	$300.00	$51,392	$226,124
Forming	6630	SF	$10	$66,300	$5.00	$33,150	$99,450
Curing	80	CSF	$5	$400	$5.00	$400	$800
Waterstops	320	LF	$10	$3,200	$5.00	$1,600	$4,800
Substructure Concrete (Pump Room Floor)							
Concrete	183	CY	$100	$18,270	$15.00	$2,741	$21,011
Rebar (310 lb/CY)	28	TON	$1,020	$28,885	$300.00	$8,496	$37,380
Forming	3641	SF	$10	$36,410	$5.00	$5	$36,415
Curing	63	CSF	$5	$315	$5.00	$315	$630
Waterstops	315	LF	$10	$3,150	$5.00	$1,575	$4,725
Substructure Concrete (Perimeter walls) - ext. 4' thick avg.							
Concrete	1040	CY	$100	$103,950	$15.00	$15,593	$119,543
Rebar (310 lb/CY)	161	TON	$1,020	$164,345	$300.00	$48,337	$212,682

Table 4.2.9

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Trinity Portland Site with 3 Pumps

150,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Forming	7795	SF	$10	$77,950	$5.00	$38,975	$116,925
Curing	180	CSF	$5	$900	$5.00	$900	$1,800
Waterstops	275	LF	$10	$2,750	$5.00	$1,375	$4,125
Substructure Concrete (Divider walls-int. 2' thick avg)							
Concrete	246	CY	$100	$24,570	$15.00	$3,686	$28,256
Rebar (310 lb/CY)	38	TON	$1,020	$38,845	$300.00	$11,425	$50,270
Forming	3678	SF	$10	$36,780	$5.00	$18,390	$55,170
Curing	190	CSF	$5	$950	$5.00	$950	$1,900
Waterstops	500	LF	$10	$5,000	$5.00	$2,500	$7,500
Substructure Columns and Beams							
Concrete	36	CY	$100	$3,600	$15.00	$540	$4,140
Rebar (310 lb/CY)	6	TON	$1,020	$5,692	$300.00	$1,674	$7,366
Forming	1200	SF	$10	$12,000	$5.00	$6,000	$18,000
Curing	40	CSF	$5	$200	$5.00	$200	$400
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Electrical Room Bottom Slab							
Concrete	108	CY	$100	$10,800	$15.00	$1,620	$12,420
Rebar (310 lb/CY)	17	TON	$1,020	$17,075	$300.00	$5,022	$22,097
Forming	1073	SF	$10	$10,730	$5.00	$5,365	$16,095
Curing	60	CSF	$5	$300	$5.00	$300	$600
Waterstops	150	LF	$10	$1,500	$5.00	$750	$2,250
Superstructure Columns							
Concrete	54	CY	$100	$5,400	$15.00	$810	$6,210
Rebar (310 lb/CY)	8	TON	$1,020	$8,537	$300.00	$2,511	$11,048
Forming	3100	SF	$10	$31,000	$5.00	$15,500	$46,500
Curing	200	CSF	$5	$1,000	$5.00	$1,000	$2,000
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Superstructure Beams							
Concrete	54	CY	$100	$5,400	$15.00	$810	$6,210
Rebar (310 lb/CY)	8	TON	$1,020	$8,537	$300.00	$2,511	$11,048
Forming	2164	SF	$10	$21,640	$5.00	$10,820	$32,460
Curing	250	CSF	$5	$1,250	$5.00	$1,250	$2,500

Table 4.2.9

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Trinity Portland Site with 3 Pumps
150,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Headwall	1	LS	$250,000	$250,000	$20,000.00	$20,000	$270,000
Superstructure double-Tees	4752	SF	$18	$85,536	$5.00	$23,760	$109,296
Retaining Walls - MSE wall >20'	15500	SF	$40	$620,000	$10.00	$155,000	$775,000
Subtotal Division 3							**$2,512,243**
Division 4 - Masonary							
CMU Partitions	12,000	SF	$3.00	$36,000	$4.00	$48,000	$84,000
Glazed CMU Restroom Walls	256	SF	$8.00	$2,048	$4.00	$1,024	$3,072
Subtotal for Division 4				**$0**		**$0**	**$87,072**
Division 5 - Metals							
Grating	800	SF	$20	$16,000	$5.00	$4,000	$20,000
Mtl deck	7,505	SF	$2	$15,010	$1.00	$7,505	$22,515
Bar Joists	1	LS	$60,000	$60,000	$5,000.00	$5,000	$65,000
Handrail	200	LF	$40	$8,000	$15.00	$3,000	$11,000
Subtotal for Division 5							**$118,515**
Division 6 - Carpentry							
Misc.	1	ls	$1,000	$1,000	$3,000.00	$3,000	$4,000
Subtotal for Division 6							**$4,000**
Division 7 - Thermal and Moisture Protection							
Exterior walls	11,000	SF	$45	$495,000	$20.00	$220,000	$715,000
Roofing	4,752	SF	$4	$19,008	$2.00	$49,827	$68,835
Roof Hatch-Pumps	0	EA	$15,000	$0	$500.00	$0	$0
Roof Hatch-Access	1	EA	$800	$800	$200.00	$200	$1,000
Subtotal for Division 7							**$784,835**
Division 8 - Doors and Windows							
Doors, 3-0 x 7-0 steel	5	Ea	$200	$1,000	$100.00	$500	$1,500

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Table 4.2.9
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Trinity Portland Site with 3 Pumps
150,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Doors, roll-up 12' x 14' steel	2	Ea	$5,000	$10,000	$600.00	$1,200	$11,200
Subtotal for Division 8				**$0**		**$0**	**$12,700**
Division 9- Finishes							
Process Piping (pump rm risers & hdrs)	4,100	SF	$0.50	$2,050	$1.25	$5,125	$7,175
Misc. Structural Steel Surf. Prep.	8,900	LS	$1.00	$8,900	$2.00	$17,800	$26,700
Paint Structural Steel	8,900	sf	$1.00	$8,900	$4.00	$35,600	$44,500
Paint Building Interior Walls	10,000	SF	$0.10	$1,000	$0.57	$5,700	$6,700
Subtotal for Division 9							**$85,075**
Division 10 - Specialities							
Signage	1	LS	$5,000	$5,000	$1,000.00	$1,000	$6,000
Woven Wire Partition - 15'x15'x10'Tall	1	LS	$2,500	$2,500	$500.00	$500	$3,000
Toilet Accessories	1	LS	$500	$500	$200.00	$200	$700
Subtotal for Division 10				**$0**		**$0**	**$9,700**
Division 11 - Equipment							
Veritical sump pump, 7000 gpm	1	Ea	$80,000	$80,000	$5,000.00	$5,000	$85,000
Trash Rack (30' x 55')	1,650	SF	$400	$660,000	$10.00	$16,500	$676,500
Restrained Couplings	9	Ea	$15,000	$135,000	$1,500.00	$13,500	$148,500
Vertical Pumps and Motors - 50,000 gpm	3	Ea	$1,000,000	$3,000,000	$30,000.00	$90,000	$3,090,000
Stop Logs	1	LS	$200,000	$200,000	$15,000.00	$15,000	$215,000
48" - Flap Gate	3	Ea	$30,000	$90,000	$5,000.00	$15,000	$105,000
Sluice Gate - 9'x9'	1	Ea	$100,000	$100,000	$5,000.00	$5,000	$105,000
Subtotal for Division 11							**$4,425,000**
Division 12 - Furnishings							
Desk	1	Ea	$1,000	$1,000	$100.00	$100	$1,100
Chair	1	Ea	$600	$600	$10.00	$10	$610
Storage Shelves	4	Ea	$500	$2,000	$100.00	$400	$2,400
Subtotal for Division 12							**$4,110**

Table 4.2.9
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Trinity Portland Site with 3 Pumps
150,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 13 - Special Construction							
Subtotal for Division 13							**$0**
Division 14 - Conveying Systems							
30 Ton Bridge Crane	1	Ea	$200,000	$200,000	$25,000.00	$25,000	$225,000
Automated Conveyor System	1	LS	$100,000.00	$100,000	$25,000.00	$25,000	$125,000
Subtotal for Division 14							**$350,000**
Division 15 - Mechanical							
Ventilation Fan(S)	3	EA	$2,000	$6,000	$500.00	$1,500	$7,500
Roof Curb(S)	3	EA	$1,000	$3,000	$250.00	$750	$3,750
Controls	1	LS	$25,000	$25,000	$10,000.00	$10,000	$35,000
Floor Drain(S)	6	EA	$300	$1,800	$150.00	$900	$2,700
Toilet(S)	1	EA	$200	$200	$200.00	$200	$400
Sink(S)	2	EA	$400	$800	$100.00	$200	$1,000
Urinal(S)	1	EA	$200	$200	$75.00	$75	$275
Faucet(S)	2	EA	$350	$700	$100.00	$200	$900
Trap Primer(S)	2	EA	$350	$700	$150.00	$300	$1,000
Drain/Waste/Vent Plumbing	1000	LF	$15	$15,000	$7.00	$7,000	$22,000
Cold Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Hot Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Dx Hvac Air Handler(S)	2	EA	$17,500	$35,000	$5,000.00	$10,000	$45,000
Dx Hvac Condensing Unit(S)	2	EA	$15,000	$30,000	$1,500.00	$3,000	$33,000
Controls	1	LS	$7,500	$7,500	$5,000.00	$5,000	$12,500
Condensing Unit Pad(S)	1	EA	$500	$500	$100.00	$100	$600
Ductwork	1000	LBS	$50	$50,000	$5.00	$5,000	$55,000
Diffuser(S)/Register(S)/Grille(S)	9	EA	$17	$153	$10.00	$90	$243
Louvre(S)	9	EA	$150	$1,350	$100.00	$900	$2,250
Fire Hose Rack	2	EA	$350	$700	$100.00	$200	$900
Subtotal for Division 15							**$235,018**
Division 16 - Electrical							

Table 4.2.9
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Trinity Portland Site with 3 Pumps
150,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Mobilization	1	LS	$0	$0	$0.00	$0	$50,000
Temporary Power	1	LS	$50,000	$50,000	$2,000.00	$2,000	$52,000
Duct Banks	200	CY	$400	$80,000	$20.00	$4,000	$84,000
Manholes	3	EA	$6,000	$18,000	$500.00	$1,500	$19,500
1/0 5 Kv Cable	1,000	LF	$7	$7,000	$3.00	$3,000	$10,000
250 Mcm 5 Kv Cable	1,000	LF	$8	$8,000	$3.00	$3,000	$11,000
100 Mcm 5 Kv Cable	1,000	LF	$6	$6,000	$2.00	$2,000	$8,000
5 Kv Terminations	50	EA	$175	$8,750	$25.00	$1,250	$10,000
Conduit	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Wire	1	LS	$75,000	$75,000	$10,000.00	$10,000	$85,000
Lighting							
Exterior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Interior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Mv Switchgear	1	LS	$100,000	$100,000	$25,000.00	$25,000	$125,000
Soft Starts - 800 HP	3	EA	$52,000	$156,000	$15,000.00	$45,000	$201,000
1500 Kva Transformers	3	EA	$50,000	$150,000	$10,000.00	$30,000	$180,000
480 Volt Mcc	1	EA	$85,000	$85,000	$50,000.00	$50,000	$135,000
Misc. Switchgear	1	LS	$50,000	$50,000	$6,000.00	$6,000	$56,000
Lightning Protection	1	LS	$35,000	$35,000	$5,000.00	$5,000	$40,000
Telephone System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Fire Alarm System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Security And Entrance Equipment	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Embedded Conduit	1	LS	$25,000	$25,000	$8,000.00	$8,000	$33,000
Grounding	1	LS	$50,000	$50,000	$10,000.00	$10,000	$60,000
Cable Tray	1	LS	$25,000	$25,000	$15,000.00	$15,000	$40,000
500 Kva Gen Set With ATS	1	Ea	$98,000	$98,000	$5,000.00	$5,000	$103,000
TXU Firm Backup Capabiltiy	1	LS	$600,000	$600,000	$30,000.00	$30,000	$630,000
Testing	1	LS	$15,000	$15,000	$5,000.00	$5,000	$20,000
Subtotal for Division 16							**$2,206,500**

Table 4.2.9

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Trinity Portland Site with 3 Pumps

150,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 17 - I&C							
Engineering & Submittals	1	LS	$75,000	$75,000	$5,000.00	$5,000	$80,000
Computers And Printers	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
F O Cable And Comm. Equip.	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Control Panels	1	LS	$250,000	$250,000	$10,000.00	$10,000	$260,000
Start Up-Check Out	1	LS	$35,000	$35,000	$10,000.00	$10,000	$45,000
Ultra Sonic Flow Meters	4	Ea	$5,000	$20,000	$2,500.00	$10,000	$30,000
HMI Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
PLC Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
O&M Manuals	1	LS	$5,000	$5,000	$2,000.00	$2,000	$7,000
Training	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Software	1	LS	$85,000	$85,000	$15,000.00	$15,000	$100,000
Factory Test	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Bonds	1	LS	$0	$0	$0.00	$0	$80,000
Level transmitters	3	Ea	$2,000	$6,000	$500.00	$1,500	$7,500
PLC - Primary + hot back-up	1	Ea	$17,500	$17,500	$7,500.00	$7,500	$25,000
PC and Monitor	1	Ea	$8,000	$8,000	$1,000.00	$1,000	$9,000
MMI Software + Programming	1	Ea	$7,000	$7,000	$15,000.00	$15,000	$22,000
Instrumentation wiring	1	LS	$75,000	$75,000	$28,000.00	$28,000	$103,000
SCADA Transmitter	1	Ea	$100,000	$100,000	$10,000.00	$10,000	$110,000
Security Cameras	1	LS	$75,000	$75,000	$10,000.00	$10,000	$85,000
Subtotal for Division 17							**$1,293,500**
Division subtotal				**$13,363,388**		**$3,498,880**	**$18,270,768**
Contractor's Profit on Material (10%)							$1,336,339
Prime Profit on Subcontractors - 10% on Div 5, 6, 7, 8, 9, 10, 12, 16, 17							$451,894
Subtotal							**$20,059,000**
Contingency (20%)							$4,011,800
Construction Work Effort subtotal							**$24,070,800**
Escalation to Midpoint @ 6%/year& 5 yrs							**$8,140,745**
Subtotal							**$32,211,545**

Table 4.2.9
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Trinity Portland Site with 3 Pumps
150,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Engineering and Surveying Services (12%)							$3,865,385
Construction Management (8%)							$2,576,924
Construction Materials Testing (1.5%)							$483,173
City Contract Administration (10%)							$3,221,155
Services Subtotal							**$10,146,637**
Total Estimated Project Cost							**$42,358,182**

TABLE 4.2.10
Engineer's Preliminary Opinion of Probable Costs
DALLAS INTERIOR DRAINAGE STUDY
Rehabilitation Work @ Delta Pump Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 1 - General Conditions							
Mobilization	1	LS	$0.00	$0	$10,000.00	$10,000	$10,000
Subtotal for Division 1				**$0**		**$10,000**	**$10,000**
Division 2 - Site Work							
Repair Vehicular Gates	1	LS	$500.00	$500	$200.00	$200	$700
Repair Outfall Channel	1,000	CY	$10.00	$10,000	$5.00	$5,000	$15,000
New Fence	1	LS	$10,000.00	$10,000	$2,000.00	$2,000	$12,000
Repair Outfall Structure	1	LS	$10,000.00	$10,000	$2,000.00	$2,000	$12,000
Subtotal for Division 2				**$30,500**		**$9,200**	**$39,700**
Division 3 - Concrete							
Subtotal Division 3				**$0**		**$0**	**$0**
Division 4 - Masonery							
Re-brick closed openings to provide weather tight enclosure	1	LS	$800.00	$800	$200.00	$200	$1,000
Regrout/Repair Existing Brickwork	1	LS	$2,500.00	$2,500	$2,500.00	$2,500	$5,000
Subtotal for Division 4				**$3,300**		**$2,700**	**$6,000**
Division 5 - Metals							
New Handrails	1	LS	$2,500.00	$2,500	$500.00	$500	$3,000
Subtotal for Division 5				**$2,500**		**$500**	**$3,000**
Division 6 - Carpentry							
Subtotal for Division 6				**$0**		**$0**	**$0**
Division 7 - Thermal and Moisture Protection							
Replace and Repair Tile Coping and Roof	1	LS	$17,000	$17,000	$2,550.00	$2,550	$19,550
Replace Roof Hatch Hardware	1	LS	$2,000	$2,000	$500.00	$500	$2,500
Subtotal for Division 7				**$19,000**		**$3,050**	**$22,050**
Division 8 - Doors and Windows							
Replace Steel Sliding Door and Hardware	1	LS	$3,000	$3,000	$500.00	$500	$3,500
Replace Wall Louvers: Fixed and Operable	1	LS	$1,200	$1,200	$600.00	$500	$1,700
Subtotal for Division 8				**$4,200**		**$1,000**	**$5,200**
Division 9- Finishes							
Paint Interior (walls,floors, & ceiling)	1	LS	$1,500.00	$1,500	$500.00	$2,500	$4,000
Glaze and Paint Steel Casement Windows	1	LS	$300.00	$300	$150.00	$150	$450
Subtotal for Division 9				**$1,800**		**$2,650**	**$4,450**
Division 10 - Specialities							
Subtotal for Division 10				**$0**		**$0**	**$0**
Division 11 - Equipment							
New Pumps	2	Each	$800,000.00	$1,600,000	$50,000.00	$100,000	$1,700,000
Piping/Valves	1	LS	$100,000.00	$100,000	$25,000.00	$25,000	$125,000
Subtotal for Division 11				**$1,700,000**		**$125,000**	**$1,825,000**
Division 12 - Furnishings							
Subtotal for Division 12				**$0**		**$0**	**$0**
Division 13 - Special Construction							
Subtotal for Division 13				**$0**		**$0**	**$0**
Division 14 - Conveying Systems							
Subtotal for Division 14				**$0**		**$0**	**$0**
Division 15 - Mechanical							
HVAC	1	LS	$55,000	$55,000	$5,000.00	$5,000	$60,000
Subtotal for Division 15				**$55,000**		**$5,000**	**$60,000**
Division 16 - Electrical							
Replace Transformers and Panelboards	1	LS	$20,000	$20,000	$3,000.00	$3,000	$23,000
New 480V Motor Control Center	1	LS	$57,500	$57,500	$8,625.00	$8,625	$66,125
New Conduit & Wire	1	LS	$16,500.00	$16,500	$2,475.00	$2,475	$18,975
New Lighting	1	LS	$2,500	$2,500	$1,000.00	$1,000	$3,500
Subtotal for Division 16				**$96,500**		**$15,100**	**$111,600**
Division 17 - I&C							
Controls and Scada System Improvements	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Subtotal for Division 17				**$25,000**		**$5,000**	**$30,000**
Division Subtotal				**$1,937,800**		**$179,200**	**$2,117,000**
Contingency (20%)							$423,400
Construction Work Effort subtotal							**$2,540,400**
Escalation to Midpoint @ 6%/year& 5 yrs							**$858,163**
Subtotal							**$3,398,563**
Engineering and Surveying Services (12%)							$407,948
Construction Management (8%)							$271,965
Construction Materials Testing (1.5%)							$50,993
City Contract Administration (10%)							$339,956
Services Subtotal							**$1,070,862**
Total Estimated Project Cost							**$4,470,426**

4.2.6 OPTION D3 – DEMO EXISTING PUMP STATION, NEW 400,000 GPM PUMP STATION

This option consists of several separate items. The items contained in this option are listed below:

1. Demolition of the existing Delta pump station,
2. Construction of a new 400,000 gpm pump station at the current Delta station site,
3. Construction of a new 6'x6' gated conduit structure between Trinity-Portland and Eagle Ford sumps,
4. Construction of three new 10'x6' reinforced concrete box culverts under Westmoreland Avenue, and
5. Addition of two new 6'x4' gated culvert at the Ledbetter Dike control structure.

Option D3 must be combined with Option P2 to provide a complete solution for the combined Delta/Pavaho sump areas. Option D3 also provides a solution for the Eagle Ford sump area, so no additional improvement would be required for the Eagle Ford sump.

The Delta Storm Water Pump Station evaluated for Option D3 has a total pumping capacity of 400,000 gpm. The pumping is accomplished with the use of three 133,333 gpm vertical axial flow pumps, each rated at 55 feet total dynamic head (TDH). Each of these pumps is driven by a 1500 horsepower electric motor operating at 295 rpm, eliminating the need for a gear reducer between the motor and pump. Additionally, a 6,000 gpm vertical axial flow pump is provided for dewatering the sump during periods of low flow.

Pump station discharge piping will be configured to use the two existing 4'x4' gravity sluices at Delta Pump Station as outfall to the river. Each individual pump will be equipped with a dedicated discharge header with a goose-neck high point elevation above the top of levee and an air release valve to prevent back-siphoning into the station. Station piping will be lined with high density polyurethane and coated with suitable epoxy-based systems.

The pump station will be configured in accordance with the guidance contained in the following documents:

- "Hydrologic Analysis of Interior Areas" EM 1110-2-1413, dated 15 January 1987
- "Hydrologic Frequency Analysis" EM 1120-2-1415, dated 05 March 1993
- "Flood Run-off Analysis" EM 1110-2-1417, dated 31 August 1994
- "Risk-Based Analysis for Flood Damage Reduction Studies" EM 1120-2-1619, dated 01 August 1996
- *EM1110-2-2100 Stability Analysis of Concrete Structures*
- *EM1110-2-2102 Waterstops and Other Preformed Joint Materials for CW Structures*
- *EM1110-2-2502 Retaining Walls*
- *EM1110-2-3104 Structural and Architectural Design of Pumping Stations*

- *EM1110-2-3105 Mechanical and Electrical Design of Pumping Stations*
- *EM1110-2-1804 Geotechnical Investigations*

The pump station substructure is cast-in-place concrete designed in accordance with ACI 310R and other appropriate standards. The foundation is a mat consisting of a five foot thick concrete slab to which the walls are attached. The walls utilize a stepped design in which the walls are reduced in thickness as the height of the structure increases and the soil load decreases. The sump area is deep and a removable hatch has been incorporated into the floor deck to provide access for removing debris that will accumulate in the sump area. The hatch is large enough to accommodate a small Bobcat.

The superstructure of the pump station is cast-in-place concrete and beams are incorporated into the structure to accommodate the installation of a bridge crane for maintenance. The pump station roof is designed to be double tees, which increases the stiffness of the structure and simplifies construction and maintenance. The roof will consist of the double tees, a two-inch layer of light-weight grout, and a membrane. The superstructure has been designed so that a drive through corridor is incorporated into the station, permitting truck access directly adjacent to the pumps for maintenance.

The exterior wall sections have been assumed to be concrete masonry units with brick veneer, although a different system may be incorporated in the final design.

The pump station interior in the pump room is unfinished; however, the interiors of the switchgear room, office, and restroom have conventional dry wall construction and are painted. Flooring throughout the station is concrete with a troweled finish. The main pump room is provided with ventilation, while the switchgear room, office, and restroom are conditioned.

The primary electrical supply to the station is three-phase, 4160 v.a.c. and is provided by TXU. The supply is from two independent substations providing needed redundancy. Therefore, the standby generator set is for use by limited equipment including the control system, lighting, HVAC components, and the bridge crane. The switchgear is located in the switchgear room and includes soft starts for each of the main pumping units. The switchgear is configured as a main-tie-main to provide additional redundancy and reliability in station operation.

This pump station is located on the West Levee, adjacent to the existing Delta pump Station, along Canada Drive. Access to the station is provided via a concrete paved access road. Roll-up doors on the station provide the drive-through access. Since the site is located next to the sump a retaining wall is provided to level the site for routine operations. Water and sewer are available in Canada Drive, and a two-inch water service and a 4-inch sanitary sewer has been provided for the station.

The interior lighting level will be maintained at 85 foot candles. All handrails will be four-rung aluminum. Grating will be hot-dipped galvanized.

The instrumentation and control system will incorporate monitoring and alarming for motor and pump bearing temperature, motor winding temperature, reverse rotation, flow for each pump, sump elevation, and precipitation. The controls system will be integrated into the SCADA system operated by the City of Dallas. Individual pump control can be initiated at the pump, in the operator office/control room, or remotely by the SCADA system.

Figure 4.2.30 is a site plan for this alternative.

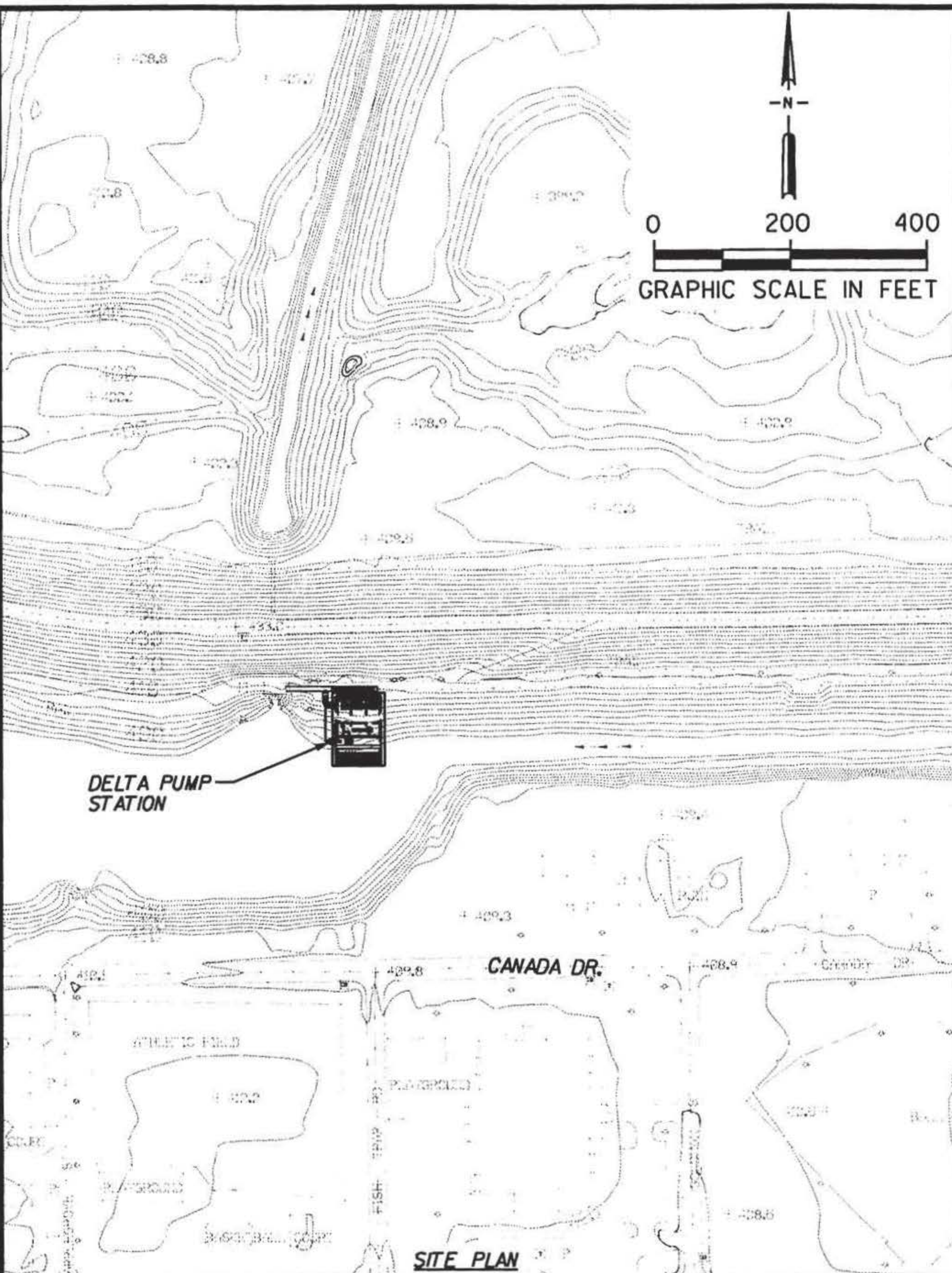
Figure 4.2.31 is a plan view of the 400,000 gpm pump station. The trash rack in the front of the station will be equipped with mechanically-cleaned screens manufactured by Du Perion, since these screens have demonstrated ability to function very effectively in this harsh environment. The switchgear room is adjacent to the pump room.

Figure 4.2.32 is Section A and the relationship of the pumping units, intake sump, and discharge piping are clearly indicated. The bridge crane has 27-foot clearance above the drive through for removal and/or installation of the pumping equipment.

Figures 4.2.33A and 4.2.33B are the electrical one-line diagrams for the station. The double-ended switchgear is indicated. Each of the main pumps is operated by a soft start that has a by-pass that permits the motor to be started even if the soft start is out of service. In addition to the protection provided by the soft start, each of the motors will be equipped with a Multilin 469 to provide

Figure 4.2.34 is a preliminary process and instrumentation diagram for the pump station. The vibration monitoring equipment is shown, as are the RTDs for monitoring motor winding temperatures, and the pump and motor bearing temperatures. Each of the pumps will be equipped with an ultrasonic flow meter to monitor pump discharge.

The Engineer's Preliminary Opinion of Probable Cost for the storm water pump station for Option D1A is summarized in Table 4.2.11.



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JACOBS Carter Burgess	CITY OF DALLAS DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION	PROPOSED DELTA PUMP STATION VERTICAL PUMPS 400,000 GPM CAPACITY	FIGURE 4.2.30

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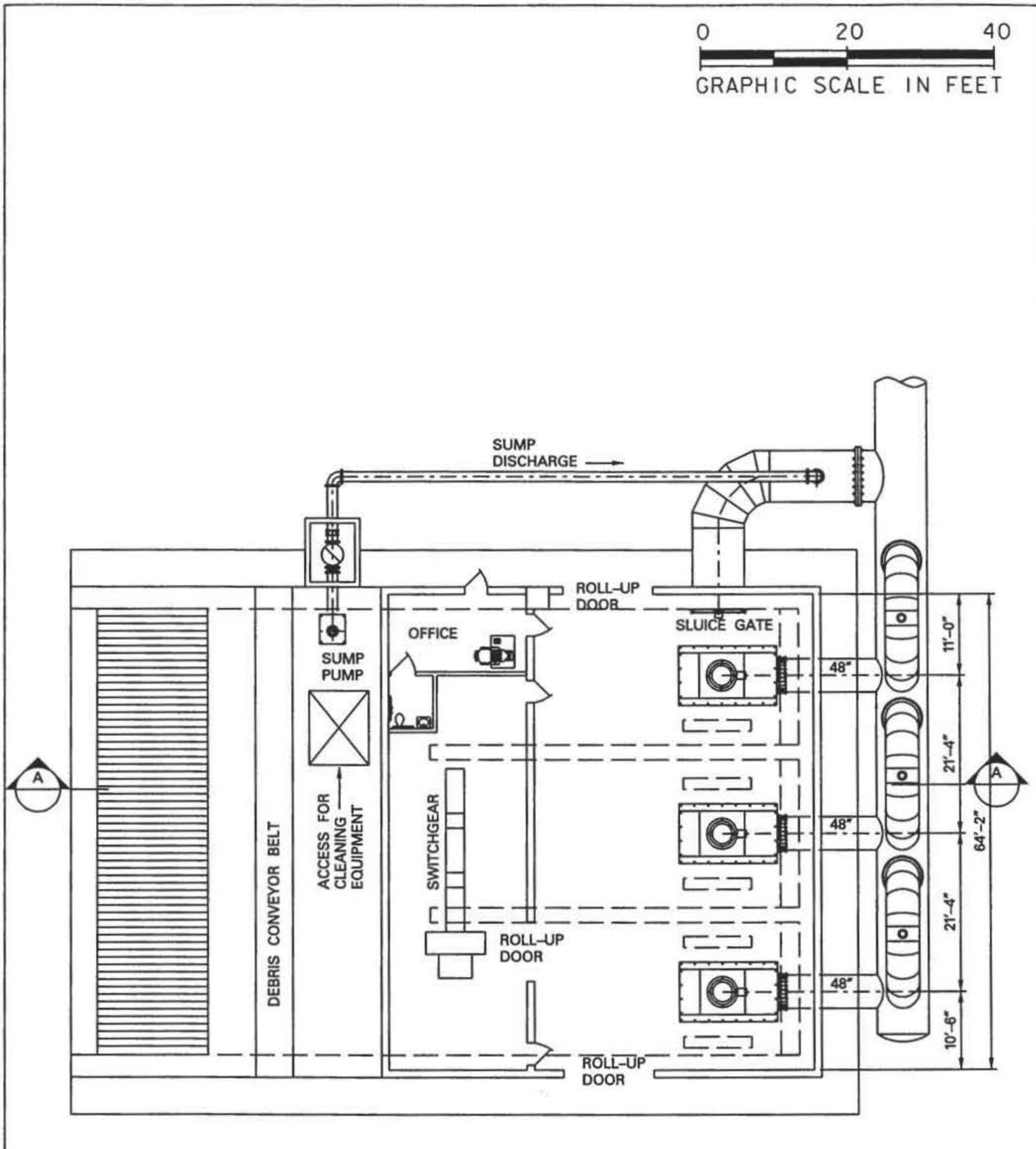

PLAN VIEW
SCALE: 1" = 20'

STATION CAPACITY = 400,000 GPM
133,333 GPM PER PUMP

JE JACOBS Carter Burgess THESE DRAWINGS/DOCUMENTS ARE BEING SUBMITTED BY CARTER & BURGESS INC. CARTER & BURGESS, INC. IS A WHOLLY OWNED SUBSIDIARY OF JACOBS ENGINEERING GROUP INC AND HEREINAFTER REFERRED TO AS JACOBS CARTER BURGESS.	CITY OF DALLAS DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION	PROPOSED DELTA PUMP STATION VERTICAL PUMPS 400,000 GPM CAPACITY	FIGURE 4.2.31

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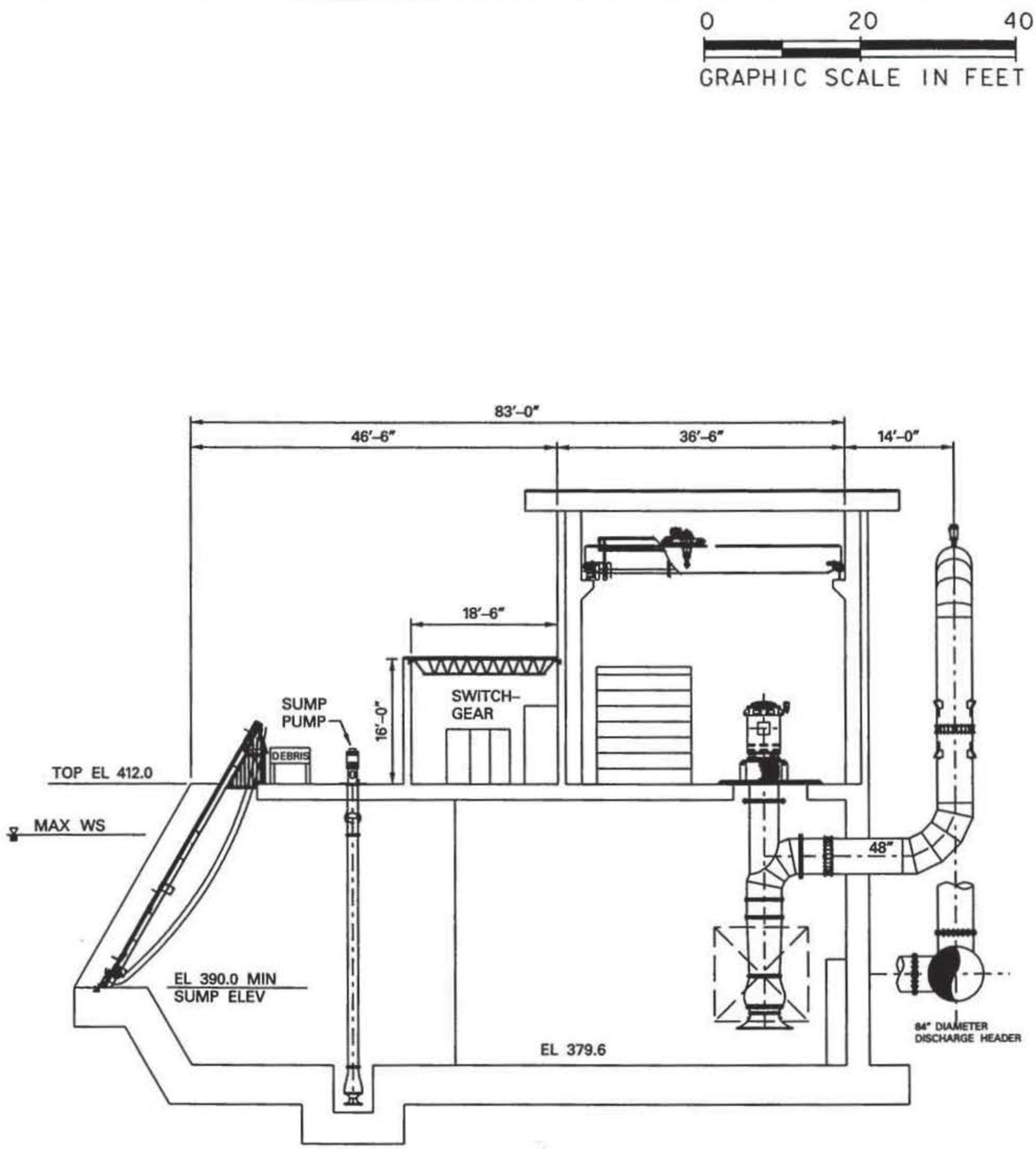

SECTION A – VERTICAL PUMPS

SCALE: 1" = 20'

STATION CAPACITY = 400,000 GPM
133,333 GPM PER PUMP

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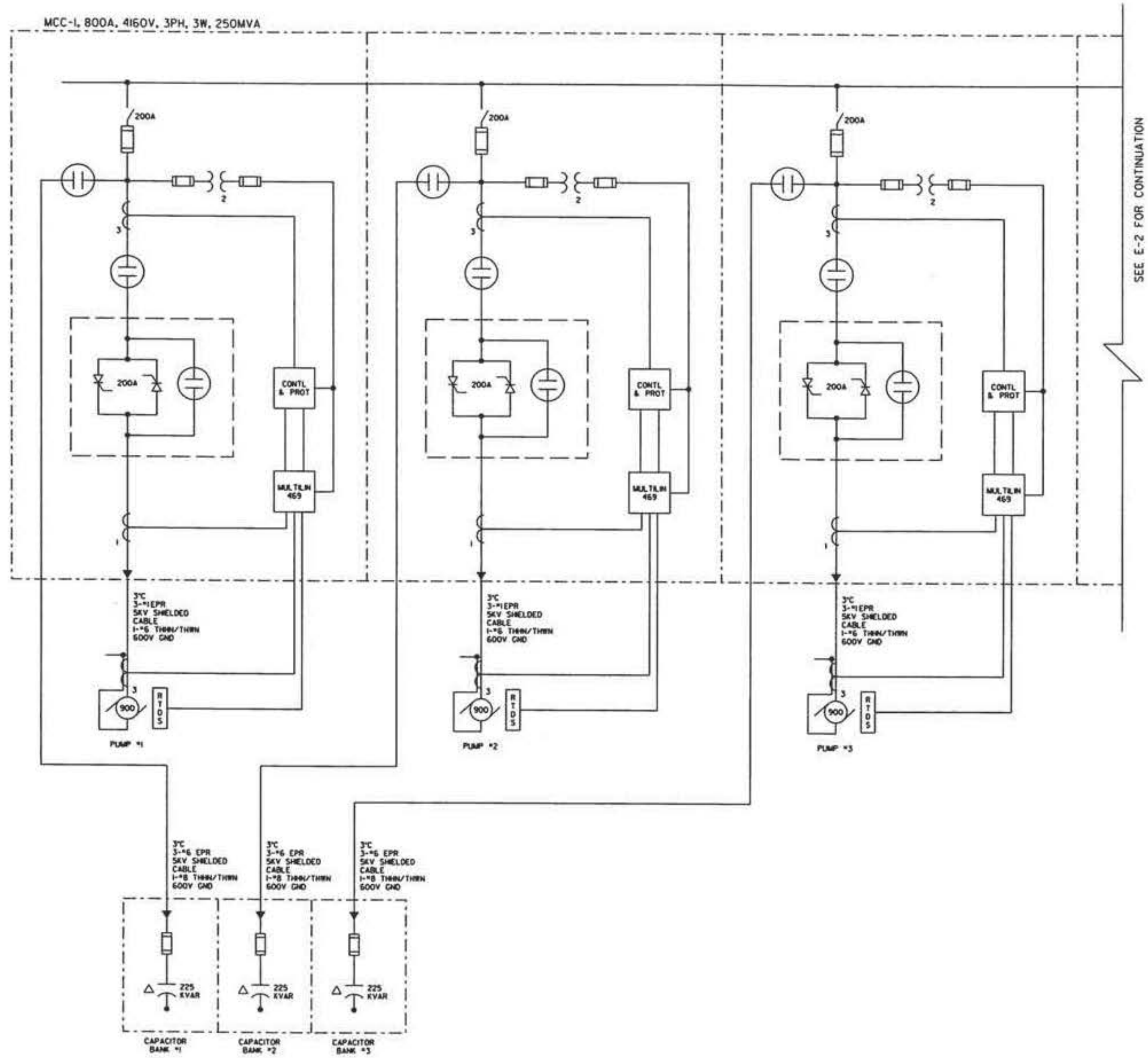

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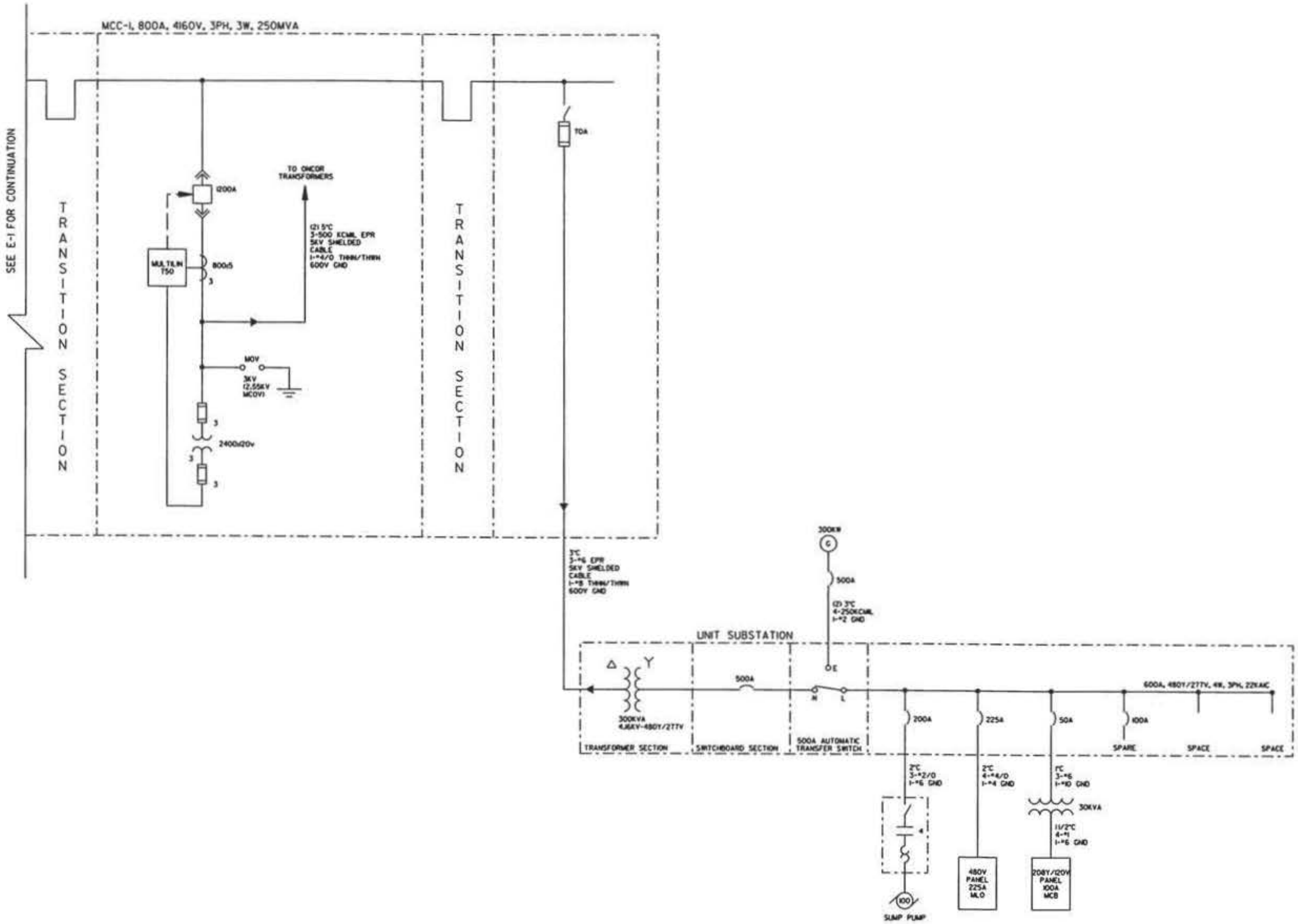
CITY OF DALLAS
DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

PROPOSED DELTA PUMP STATION
VERTICAL PUMPS
400,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

FIGURE
4.2.33A



PROPOSED DELTA PUMP STATION
VERTICAL PUMPS
400,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

CITY OF DALLAS
DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

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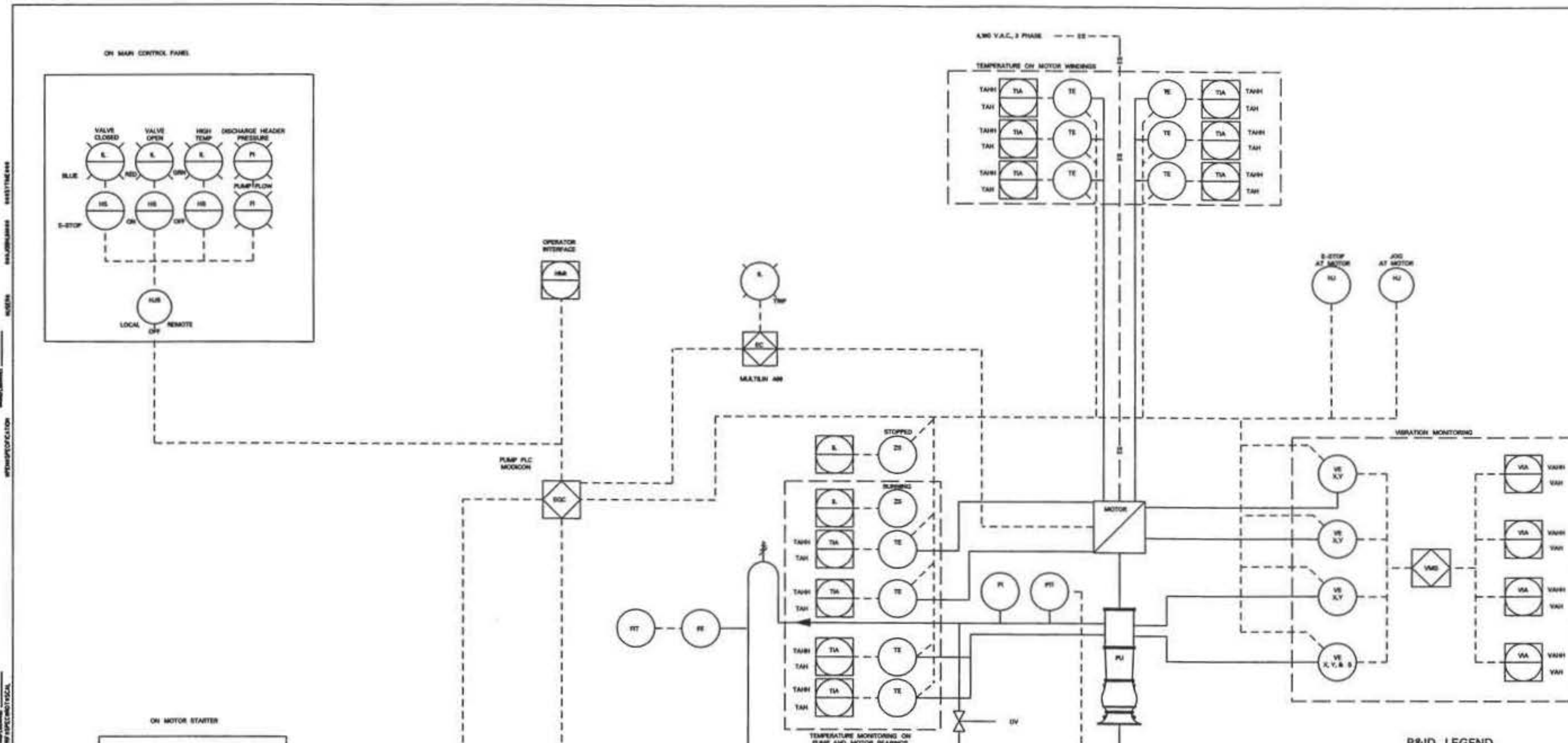
FIGURE
4.2.33B



P&ID LEGEND

DV	DRAIN VALVE
EC	ELECTRONIC CONTROLLER
ECC	ELECTRONIC COMPUTING CONTROLLER
ES	ELECTRICAL SUPPLY
FE	FLOW ELEMENT
FIT	FLOW INDICATING TRANSMITTER
HJS	HAND POSITION SWITCH – HOA
HMI	HUMAN MACHINE INTERFACE
HS	HAND SWITCH
IL	INDICATOR LIGHT
PI	PRESSURE INDICATOR
PIT	PRESSURE INDICATING TRANSMITTER
PU	PUMPING UNIT
TAH	TEMPERATURE ALARM HIGH
TAHH	TEMPERATURE ALARM HIGH HIGH
TE	TEMPERATURE ELEMENT – RTD
TIA	TEMPERATURE INDICATING ALARM
VAH	VIBRATION ALARM HIGH
VAHH	VIBRATION ALARM HIGH HIGH
VE	VIBRATION ELEMENT
VIA	VIBRATION INDICATING ALARM
VMS	VIBRATION MONITORING SYSTEM
ZS	POSITION SWITCH

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DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

PROPOSED DELTA PUMP STATION
400,000 GPM CAPACITY
PROCESS AND INSTRUMENTATION DIAGRAM

FIGURE
4.2.34

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Table 4.2.11

Summary for Delta 3 Pump 400,000 gpm

Division	Cost
Division 1 - General Conditions	$2,760,800
Divison 2 - Site Work	$3,472,200
Division 3- Concrete	$2,288,877
Division 4 - Masonry	$101,072
Division 5- Metals	$118,515
Division 6 - Carpentry	$4,000
Division 7 - Thermal & Moisture Protection	$784,835
Division 8 - Doors & Windows	$12,700
Division 9 - Finishes	$85,075
Division 10 - Specialties	$9,700
Division 11 - Equipment	$7,913,500
Division 12 - Furnishings	$4,110
Division 13- Special Construction	$0
Division 14 - Conveying Systems	$350,000
Division 15 - Mechanical	$235,018
Division 16 - Electrical	$2,350,500
Division 17 - Instrumentation & Control	$1,293,500
Division Subtotal	**$21,784,402**
Contractor's Profit of Materials - 10%	$1,632,874
Prime Profit on SubConstractors - 10%	$466,294
Subtotal	**$23,883,569**
Construction Contingencies - 10%	$2,388,357
Construction Work Effort subtotal	**$26,271,926**
Escalation to Midpoint @ 6%/Yr & 3 yrs	$8,885,165
Subtotal	**$35,157,091**
Engineering and Surveying Services (12%)	$4,218,851
Construction Management (8%)	$2,812,567
Construction Materials Testing (1.5%)	$527,356
City Contract Administration (10%)	$3,515,709
Services Subtotal	**$11,074,484**
Total Estimated Project Cost	**$46,231,575**

Table 4.2.11
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Delta Site with 3 Pumps
400,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 1 - General Conditions							
Mobilization	1	LS	$0	$0		$0	$600,000
Construction Surveying	1	LS	$0	$0	$45,000.00	$45,000	$45,000
Telephone	36	Mo	$150	$5,400	$0.00	$0	$5,400
SWWWP	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Trench Excavation Safety & Support/Structural Plan	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Traffic Control Plan	1	LS	$15,000	$15,000	$0.00	$0	$15,000
PM	36	Mo	$0	$0	$15,000.00	$540,000	$540,000
Superintendent	36	Mo	$0	$0	$12,000.00	$432,000	$432,000
Admin	36	Mo	$0	$0	$7,000.00	$252,000	$252,000
Sanitary Services	36	Mo	$0	$0	$500.00	$18,000	$18,000
Security Services	36	Mo	$0	$0	$2,000.00	$72,000	$72,000
Pick Up Trucks - 3 each	36	Mo	$0	$0	$1,800.00	$64,800	$64,800
Office Equipment	36	Mo	$0	$0	$350.00	$12,600	$12,600
150 Ton Crane - 24 Months	24	Mo	$0	$0	$20,000.00	$480,000	$480,000
Loader - 36 Months	36	Mo	$0	$0	$2,000.00	$72,000	$72,000
Office Trailors - 2 each	36	Mo	$0	$0	$1,500.00	$54,000	$54,000
Tool Trailors - 2 each	36	Mo	$0	$0	$500.00	$18,000	$18,000
Subtotal for Division 1							**$2,760,800**
Division 2 - Site Work							
Structural Excavation	12,000	CY	$0.00	$0	$8.00	$96,000	$96,000
Structural Backfill	10,000	CY	$6.00	$60,000	$3.00	$30,000	$90,000
Paving	1,300	SY	$12.00	$15,600	$12.00	$15,600	$31,200
Pavement Striping	2,450	SF	$6.00	$14,700	$2.00	$4,900	$19,600
Access Road	1,600	SY	$7.00	$11,200	$13.00	$20,800	$32,000
Traffic Control	1	LS	$5,000.00	$5,000	$20,000.00	$20,000	$25,000
Curb Stops	10	EA	$200.00	$2,000	$50.00	$500	$2,500
8-inch Bollards	10	EA	$1,000.00	$10,000	$150.00	$1,500	$11,500
Grading	3,000	SY	$1.00	$3,000	$2.00	$6,000	$9,000
Fencing - 10 Ft. Man Proof	1,000	LF	$50.00	$50,000	$10.00	$10,000	$60,000
16-foot slide gate (Electric Motor)	1	EA	$6,000.00	$6,000	$1,000.00	$1,000	$7,000

Table 4.2.11
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Delta Site with 3 Pumps
400,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
3-foot ped. Gate	1	EA	$400.00	$400	$100.00	$100	$500
Landscaping	1	LS	$50,000.00	$50,000	$5,000.00	$5,000	$55,000
Install Discharge conduit through Levee - 10'x10' (by other than open cut)	400	LF	$4,500	$1,800,000	$100.00	$40,000	$1,840,000
Transition piece	1	LS	$100,000	$100,000	$10,000.00	$10,000	$110,000
120-inch steel dischage pipe	200	LF	$1,600	$320,000	$100.00	$20,000	$340,000
Water - 2-inch	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Sewer	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Telephone	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Misc Utilities	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Shoring	5,000	SF	$35	$175,000	$5.00	$25,000	$200,000
Dewatering	1	LS	$250,000	$250,000	$25,000.00	$25,000	$275,000
Coffer Dam - 26' high 2:1ss	10,000	CY	$15	$150,000	$5.00	$50,000	$200,000
3-inch mud slab	140	CY	$100	$14,000	$25.00	$3,500	$17,500
Subtotal for Division 2							**$3,472,200**
Division 3 - Concrete							
Substructure Concrete (Foundation)							
Concrete	1500	CY	$100	$150,000	$15.00	$22,500	$172,500
Rebar (310 lb/CY)	233	TON	$1,020	$237,150	$300.00	$69,750	$306,900
Forming	7622	SF	$10	$76,220	$5.00	$38,110	$114,330
Curing	80	CSF	$5	$400	$5.00	$400	$800
Waterstops	320	LF	$10	$3,200	$5.00	$1,600	$4,800
Substructure Concrete (Pump Room Floor)							
Concrete	300	CY	$100	$30,000	$15.00	$4,500	$34,500
Rebar (310 lb/CY)	47	TON	$1,020	$47,430	$300.00	$13,950	$61,380
Forming	4237	SF	$10	$42,370	$5.00	$5	$42,375
Curing	63	CSF	$5	$315	$5.00	$315	$630
Waterstops	315	LF	$10	$3,150	$5.00	$1,575	$4,725
Substructure Concrete (Perimeter walls) - ext. 4' thick avg.							
Concrete	1350	CY	$100	$135,000	$15.00	$20,250	$155,250
Rebar (310 lb/CY)	209	TON	$1,020	$213,435	$300.00	$62,775	$276,210
Forming	8532	SF	$10	$85,320	$5.00	$42,660	$127,980

Table 4.2.11
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Delta Site with 3 Pumps
400,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Curing	180	CSF	$5	$900	$5.00	$900	$1,800
Waterstops	275	LF	$10	$2,750	$5.00	$1,375	$4,125
Substructure Concrete (Divider walls-int. 2' thick avg)							
Concrete	400	CY	$100	$40,000	$15.00	$6,000	$46,000
Rebar (310 lb/CY)	62	TON	$1,020	$63,240	$300.00	$18,600	$81,840
Forming	4602	SF	$10	$46,020	$5.00	$23,010	$69,030
Curing	190	CSF	$5	$950	$5.00	$950	$1,900
Waterstops	500	LF	$10	$5,000	$5.00	$2,500	$7,500
Substructure Columns and Beams							
Concrete	40	CY	$100	$4,000	$15.00	$600	$4,600
Rebar (310 lb/CY)	6	TON	$1,020	$6,324	$300.00	$1,860	$8,184
Forming	1200	SF	$10	$12,000	$5.00	$6,000	$18,000
Curing	40	CSF	$5	$200	$5.00	$200	$400
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Electrical Room Bottom Slab							
Concrete	150	CY	$100	$15,000	$15.00	$2,250	$17,250
Rebar (310 lb/CY)	23	TON	$1,020	$23,715	$300.00	$6,975	$30,690
Forming	1248	SF	$10	$12,480	$5.00	$6,240	$18,720
Curing	60	CSF	$5	$300	$5.00	$300	$600
Waterstops	150	LF	$10	$1,500	$5.00	$750	$2,250
Superstructure Columns							
Concrete	60	CY	$100	$6,000	$15.00	$900	$6,900
Rebar (310 lb/CY)	9	TON	$1,020	$9,486	$300.00	$2,790	$12,276
Forming	3100	SF	$10	$31,000	$5.00	$15,500	$46,500
Curing	200	CSF	$5	$1,000	$5.00	$1,000	$2,000
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Superstructure Beams							
Concrete	60	CY	$100	$6,000	$15.00	$900	$6,900
Rebar (310 lb/CY)	9	TON	$1,020	$9,486	$300.00	$2,790	$12,276
Forming	2164	SF	$10	$21,640	$5.00	$10,820	$32,460
Curing	250	CSF	$5	$1,250	$5.00	$1,250	$2,500
Waterstops	0	LF	$10	$0	$5.00	$0	$0

Table 4.2.11
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Delta Site with 3 Pumps
400,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Superstructure double-Tees	4752	SF	$18	$85,536	$5.00	$23,760	$109,296
Retaining Walls - MSE wall >20'	8850	SF	$40	$354,000	$10.00	$88,500	$442,500
Subtotal Division 3							**$2,288,877**
Division 4 - Masonary							
CMU Partitions	14,000	SF	$3.00	$42,000	$4.00	$56,000	$98,000
Glazed CMU Restroom Walls	256	SF	$8.00	$2,048	$4.00	$1,024	$3,072
Subtotal for Division 4				**$0**		**$0**	**$101,072**
Division 5 - Metals							
Grating	800	SF	$20	$16,000	$5.00	$4,000	$20,000
Mtl deck	7,505	SF	$2	$15,010	$1.00	$7,505	$22,515
Bar Joists	1	LS	$60,000	$60,000	$5,000.00	$5,000	$65,000
Handrail	200	LF	$40	$8,000	$15.00	$3,000	$11,000
Subtotal for Division 5							**$118,515**
Division 6 - Carpentry							
Misc.	1	ls	$1,000	$1,000	$3,000.00	$3,000	$4,000
Subtotal for Division 6							**$4,000**
Division 7 - Thermal and Moisture Protection							
Exterior walls	11,000	SF	$45	$495,000	$20.00	$220,000	$715,000
Roofing	4,752	SF	$4	$19,008	$2.00	$49,827	$68,835
Roof Hatch-Pumps	0	EA	$15,000	$0	$500.00	$0	$0
Roof Hatch-Access	1	EA	$800	$800	$200.00	$200	$1,000
Subtotal for Division 7							**$784,835**
Division 8 - Doors and Windows							
Doors, 3-0 x 7-0 steel	5	Ea	$200	$1,000	$100.00	$500	$1,500
Doors, roll-up 12' x 14' steel	2	Ea	$5,000	$10,000	$600.00	$1,200	$11,200

Table 4.2.11
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Delta Site with 3 Pumps
400,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Subtotal for Division 8				$0		$0	$12,700
Division 9- Finishes							
Process Piping (pump rm risers & hdrs)	4,100	SF	$0.50	$2,050	$1.25	$5,125	$7,175
Misc. Structural Steel Surf. Prep.	8,900	LS	$1.00	$8,900	$2.00	$17,800	$26,700
Paint Structural Steel	8,900	sf	$1.00	$8,900	$4.00	$35,600	$44,500
Paint Building Interior Walls	10,000	SF	$0.10	$1,000	$0.57	$5,700	$6,700
Subtotal for Division 9							$85,075
Division 10 - Specialities							
Signage	1	LS	$5,000	$5,000	$1,000.00	$1,000	$6,000
Woven Wire Partition - 15'x15'x10'Tall	1	LS	$2,500	$2,500	$500.00	$500	$3,000
Toilet Accessories	1	LS	$500	$500	$200.00	$200	$700
Subtotal for Division 10				$0		$0	$9,700
Division 11 - Equipment							
Veritical sump pump, 7000 gpm	1	Ea	$80,000	$80,000	$5,000.00	$5,000	$85,000
Trash Rack (35' x 60')	2,100	SF	$400	$840,000	$10.00	$21,000	$861,000
Restrained Couplings	9	Ea	$15,000	$135,000	$1,500.00	$13,500	$148,500
CV Pumps and Motors - 133,000 gpm	3	Ea	$2,100,000	$6,300,000	$30,000.00	$90,000	$6,390,000
Stop Logs	1	LS	$200,000	$200,000	$15,000.00	$15,000	$215,000
Vibration Monitoring Equipment	1	LS	$194,000	$194,000	$20,000.00	$20,000	$214,000
Subtotal for Division 11							$7,913,500
Division 12 - Furnishings							
Desk	1	Ea	$1,000	$1,000	$100.00	$100	$1,100
Chair	1	Ea	$600	$600	$10.00	$10	$610
Storage Shelves	4	Ea	$500	$2,000	$100.00	$400	$2,400
Subtotal for Division 12							$4,110
Division 13 - Special Construction							
Subtotal for Division 13							$0

Table 4.2.11

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Delta Site with 3 Pumps

400,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 14 - Conveying Systems							
30 Ton Bridge Crane	1	Ea	$200,000	$200,000	$25,000.00	$25,000	$225,000
Automated Conveyor System	1	LS	$100,000.00	$100,000	$25,000.00	$25,000	$125,000
Subtotal for Division 14							**$350,000**
Division 15 - Mechanical							
Ventilation Fan(S)	3	EA	$2,000	$6,000	$500.00	$1,500	$7,500
Roof Curb(S)	3	EA	$1,000	$3,000	$250.00	$750	$3,750
Controls	1	LS	$25,000	$25,000	$10,000.00	$10,000	$35,000
Floor Drain(S)	6	EA	$300	$1,800	$150.00	$900	$2,700
Toilet(S)	1	EA	$200	$200	$200.00	$200	$400
Sink(S)	2	EA	$400	$800	$100.00	$200	$1,000
Urinal(S)	1	EA	$200	$200	$75.00	$75	$275
Faucet(S)	2	EA	$350	$700	$100.00	$200	$900
Trap Primer(S)	2	EA	$350	$700	$150.00	$300	$1,000
Drain/Waste/Vent Plumbing	1000	LF	$15	$15,000	$7.00	$7,000	$22,000
Cold Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Hot Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Dx Hvac Air Handler(S)	2	EA	$17,500	$35,000	$5,000.00	$10,000	$45,000
Dx Hvac Condensing Unit(S)	2	EA	$15,000	$30,000	$1,500.00	$3,000	$33,000
Controls	1	LS	$7,500	$7,500	$5,000.00	$5,000	$12,500
Condensing Unit Pad(S)	1	EA	$500	$500	$100.00	$100	$600
Ductwork	1000	LBS	$50	$50,000	$5.00	$5,000	$55,000
Diffuser(S)/Register(S)/Grille(S)	9	EA	$17	$153	$10.00	$90	$243
Louvre(S)	9	EA	$150	$1,350	$100.00	$900	$2,250
Fire Hose Rack	2	EA	$350	$700	$100.00	$200	$900
Subtotal for Division 15							**$235,018**
Division 16 - Electrical							
Mobilization	1	LS	$0	$0	$0.00	$0	$50,000
Temporary Power	1	LS	$50,000	$50,000	$2,000.00	$2,000	$52,000
Duct Banks	200	CY	$400	$80,000	$20.00	$4,000	$84,000

Table 4.2.11

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Delta Site with 3 Pumps
400,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Manholes	3	EA	$6,000	$18,000	$500.00	$1,500	$19,500
1/0 15 Kv Cable	1,000	LF	$7	$7,000	$3.00	$3,000	$10,000
250 Mcm 15 Kv Cable	1,000	LF	$8	$8,000	$3.00	$3,000	$11,000
500 Mcm 15 Kv Cable	1,000	LF	$15	$15,000	$3.00	$3,000	$18,000
5 Kv Terminations	50	EA	$175	$8,750	$25.00	$1,250	$10,000
Conduit	1	LS	$175,000	$175,000	$20,000.00	$20,000	$195,000
Wire	1	LS	$125,000	$125,000	$10,000.00	$10,000	$135,000
Lighting							
Exterior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Interior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Mv Switchgear	1	LS	$100,000	$100,000	$25,000.00	$25,000	$125,000
Soft Starts - 2200 HP	3	EA	$55,000	$165,000	$15,000.00	$45,000	$210,000
1500 Kva Transformers	3	EA	$50,000	$150,000	$10,000.00	$30,000	$180,000
480 Volt Mcc	1	EA	$85,000	$85,000	$50,000.00	$50,000	$135,000
Misc. Switchgear	1	LS	$50,000	$50,000	$6,000.00	$6,000	$56,000
Lightning Protection	1	LS	$35,000	$35,000	$5,000.00	$5,000	$40,000
Telephone System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Fire Alarm System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Security And Entrance Equipment	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Embedded Conduit	1	LS	$25,000	$25,000	$8,000.00	$8,000	$33,000
Grounding	1	LS	$50,000	$50,000	$10,000.00	$10,000	$60,000
Cable Tray	1	LS	$25,000	$25,000	$15,000.00	$15,000	$40,000
500 Kva Gen Set With ATS	1	Ea	$98,000	$98,000	$5,000.00	$5,000	$103,000
TXU Firm Backup Capabiltiy	1	LS	$600,000	$600,000	$30,000.00	$30,000	$630,000
Testing	1	LS	$15,000	$15,000	$5,000.00	$5,000	$20,000
Subtotal for Division 16							**$2,350,500**
Division 17 - I&C							
Engineering & Submittals	1	LS	$75,000	$75,000	$5,000.00	$5,000	$80,000
Computers And Printers	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000

Table 4.2.11
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Delta Site with 3 Pumps
400,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
F O Cable And Comm. Equip.	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Control Panels	1	LS	$250,000	$250,000	$10,000.00	$10,000	$260,000
Start Up-Check Out	1	LS	$35,000	$35,000	$10,000.00	$10,000	$45,000
Ultra Sonic Flow Meters	4	Ea	$5,000	$20,000	$2,500.00	$10,000	$30,000
HMI Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
PLC Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
O&M Manuals	1	LS	$5,000	$5,000	$2,000.00	$2,000	$7,000
Training	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Software	1	LS	$85,000	$85,000	$15,000.00	$15,000	$100,000
Factory Test	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Bonds	1	LS	$0	$0	$0.00	$0	$80,000
Level transmitters	3	Ea	$2,000	$6,000	$500.00	$1,500	$7,500
PLC - Primary + hot back-up	1	Ea	$17,500	$17,500	$7,500.00	$7,500	$25,000
PC and Monitor	1	Ea	$8,000	$8,000	$1,000.00	$1,000	$9,000
MMI Software + Programming	1	Ea	$7,000	$7,000	$15,000.00	$15,000	$22,000
Instrumentation wiring	1	LS	$75,000	$75,000	$28,000.00	$28,000	$103,000
SCADA Transmitter	1	Ea	$100,000	$100,000	$10,000.00	$10,000	$110,000
Security Cameras	1	LS	$75,000	$75,000	$10,000.00	$10,000	$85,000
Subtotal for Division 17							**$1,293,500**
Division subtotal				**$16,328,736**		**$4,047,166**	**$21,784,402**
Contractor's Profit on Material (10%)							$1,632,874
Prime Profit on Subcontractors - 10% on Div 5, 6, 7, 8, 9, 10, 12, 16, 17							$466,294
Subtotal							**$23,883,569**
Contingency (10%)							$2,388,357
Construction Work Effort subtotal							**$26,271,926**
Escalation to Midpoint @ 6%/year& 5 yrs							**$8,885,165**
Subtotal							**$35,157,091**
Engineering and Surveying Services (12%)							$4,218,851
Construction Management (8%)							$2,812,567
Construction Materials Testing (1.5%)							$527,356

Table 4.2.11

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Delta Site with 3 Pumps

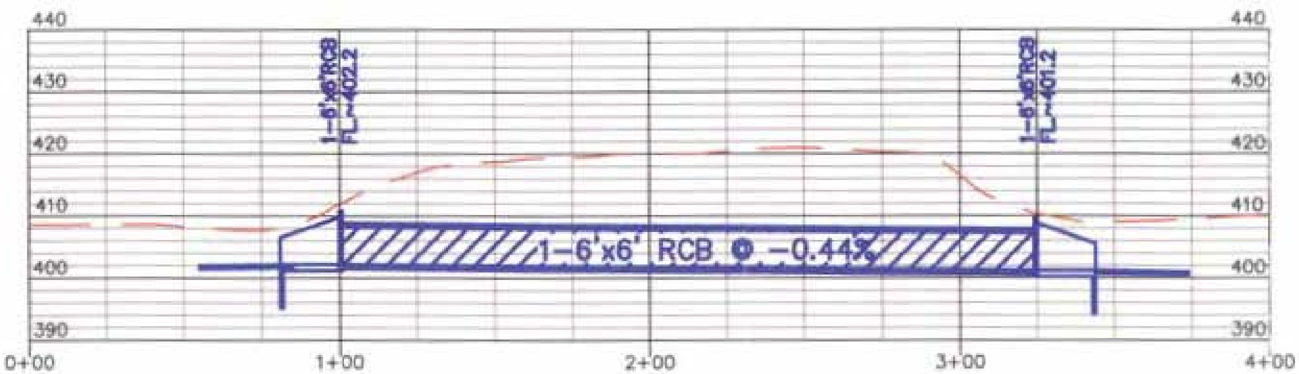
400,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
City Contract Administration (10%)							$3,515,709
Services Subtotal							**$11,074,484**
Total Estimated Project Cost							**$46,231,575**

The proposed gated conduit structure between Trinity-Portland and Eagle Ford sumps allows selective exchange of flow between these two sump areas. This item includes the construction of a new 6'x6' gated culvert with remote operated motor controller at the berm which currently divides Eagle Ford and Trinity-Portland sumps. The estimate of probable cost for the new gated conduit structure is shown in Table 4.2.12. A schematic drawing of the proposed gated conduit structure is shown on Figure 4.2.35.

The proposed improvements to Ledbetter Dike include two additional 6'x4' reinforced concrete gated culverts with remote operated motor controller. This item would result in a total of four gates at the Ledbetter Dike structure. The two additional gates would provide more efficient conveyance of water between Trinity-Portland and Westmoreland-Hampton sumps during times of peak flow. The estimate of probable cost for this item is shown in Table 4.2.13. A schematic drawing of the proposed culverts is shown on Figure 4.2.36.

The proposed Westmoreland Avenue culverts serve to more efficiently convey flood water between Frances Street Sump and Westmoreland-Hampton Sump separated by Westmoreland Avenue. This item includes the replacement of all three existing culverts at this location with a new triple-barrel 10'x6' RCBC. The estimate of probable cost for the new Westmoreland Avenue culverts is shown in Table 4.2.14. A schematic drawing of the proposed culverts is shown on Figure 4.2.37.



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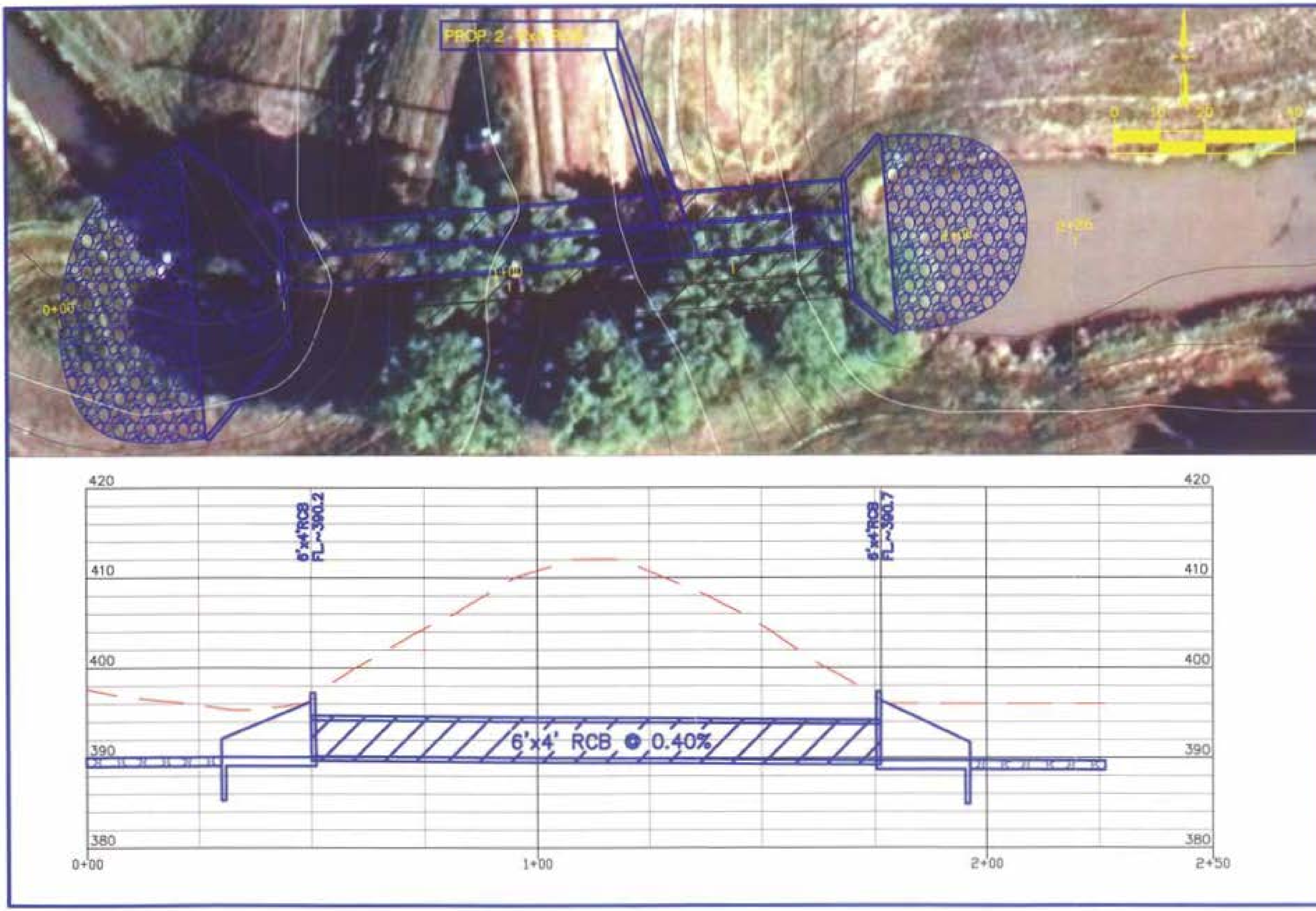
PROPOSED TRINITY-PORTLAND SUMP
1-6'x6' GATED RCB

FIGURE
4.2.35

Table 4.2.12
Engineer's Preliminary Opinion of Probable Costs
Gated Culvert between Trinity-Portland and Eagle Ford

Item No.	Description	Unit	Quantity	Unit Cost	Estimated Cost
1	1- 6' x 6' RCB By Open Cut	LF	225	$750	$168,750
2	Trench Safety and Support	LF	225	$20	$4,500
3	CIP Headwall	EA	2	$15,000	$30,000
4	6" Concrete Apron Pavement	SY	20	$70	$1,400
5	PVC Coated Gabions	CY	75	$250	$18,750
6	Sodding	SY	300	$7	$2,100
7	Erosion Control	LS	1	$25,000	$25,000
8	Dewatering	LS	1	$50,000	$50,000
9	6'x6' Sluice Gate	EA	1	$85,000	$85,000
10	Operators	EA	1	$15,000	$15,000
11	Cofferdam	CY	10000	$20	$200,000
12	Sluice Structure	LS	1	$250,000	$250,000
13	SCADA	LS	1	$50,000	$50,000
14	Decommission existing drop inlet	LS	1	$20,000	$20,000
15	Mobilization	LS	1	$100,000	$100,000
Subtotal					$1,020,500
20% Contingency					$204,100
Total					**$1,224,600**
Escalation to Midpoint @ 6%/year& 5 yrs					$414,160
Subtotal					**$1,638,760**
Engineering and Surveying Services (12%)					$196,651
Construction Management (8%)					$131,101
Construction Materials Testing (1.5%)					$24,581
City Contract Administration (10%)					$163,876
Service Subtotal					**$516,209**
Total Estimated Project Cost					**$2,154,969**



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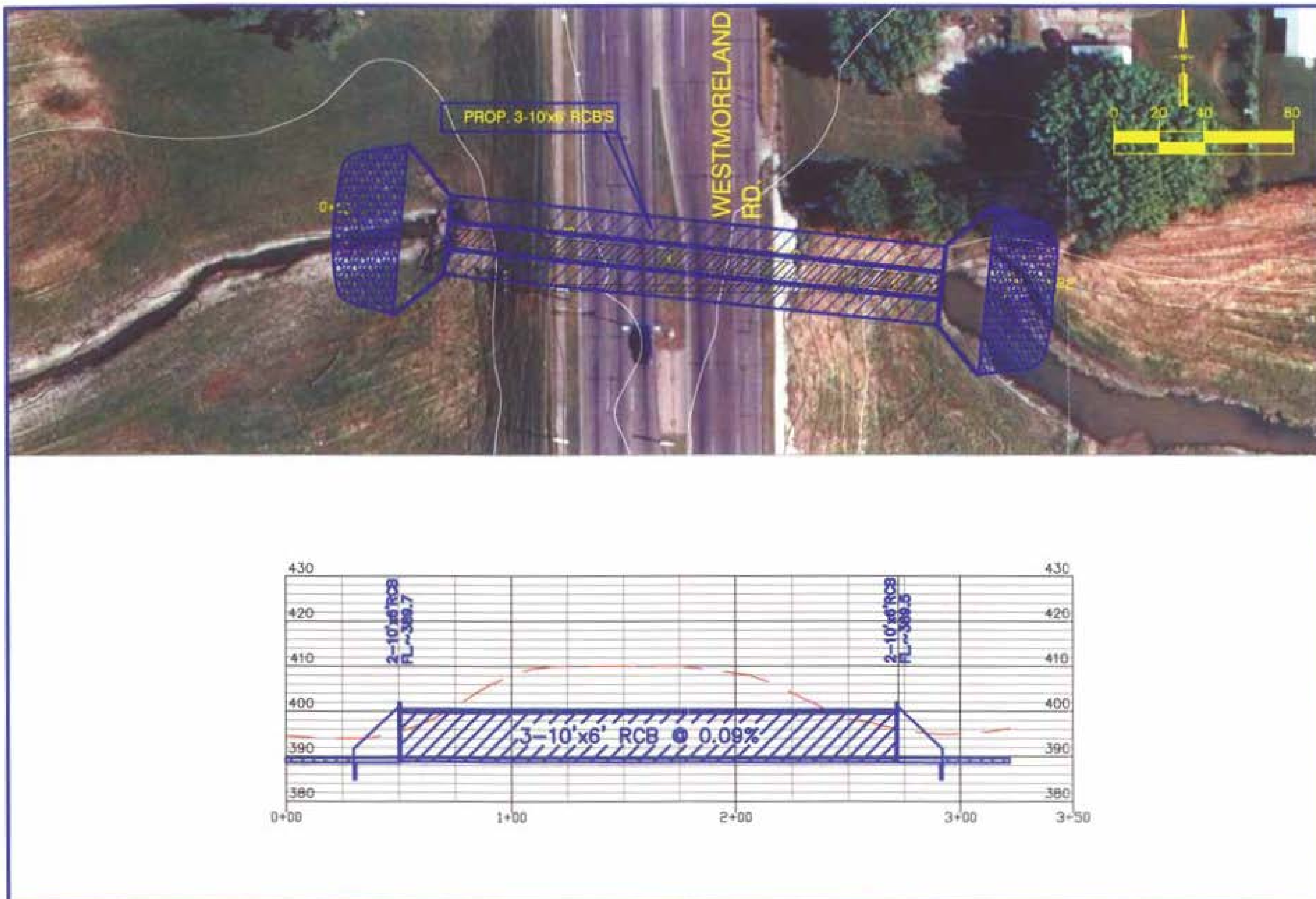
OPTION D3
PROPOSED DELTA SUMP
2-6'x4' RCB @ LEDBETTER DIKE

FIGURE
4.2.36

Table 4.2.13
Engineer's Preliminary Opinion of Probable Costs
Ledbetter Dike - 2 Additional 6'x4' RCB

Item No.	Description	Unit	Quantity	Unit Cost	Estimated Cost
1	2- 6' x 4' RCB By Open Cut	LF	260	$600	$156,000
2	Trench Safety and Support	LF	260	$20	$5,200
3	CIP Headwall	EA	2	$15,000	$30,000
4	6" Concrete Apron Pavement	SY	20	$70	$1,400
5	PVC Coated Gabions	CY	75	$250	$18,750
6	Sodding	SY	300	$7	$2,100
7	Erosion Control	LS	1	$25,000	$25,000
8	Dewatering	LS	1	$50,000	$50,000
9	6'x4' Sluice Gate	EA	3	$75,000	$225,000
10	Operators	EA	3	$15,000	$45,000
11	Cofferdam	CY	10000	$20	$200,000
12	Sluice Structure	LS	1	$250,000	$250,000
13	SCADA	LS	1	$50,000	$50,000
14	Mobilization	LS	1	$100,000	$100,000
Subtotal					$1,158,450
20% Contingency					$231,690
Total					**$1,390,140**
Escalation to Midpoint @ 6%/year& 5 yrs					$470,145
Subtotal					**$1,860,285**
Engineering and Surveying Services (12%)					$223,234
Construction Management (8%)					$148,823
Construction Materials Testing (1.5%)					$27,904
City Contract Administration (10%)					$186,029
Service Subtotal					**$585,990**
Total Estimated Project Cost					**$2,446,275**



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OPTION D3
PROPOSED DELTA SUMP
3-10'x6' RCB @ WESTMORELAND RD.

FIGURE 4.2.37

Table 4.2.14
Engineer's Preliminary Opinion of Probable Costs
Westmoreland Road Culverts 3 - 10'x6' RCB

Item No.	Description	Unit	Quantity	Unit Cost	Estimated Cost
1	3-10' x 6' RCB By Open Cut	LF	667	$700	$466,900
2	Trench Safety and Support	LF	667	$20	$13,340
2	Demolish existing culverts	LS	1	$20,000	$20,000
3	CIP Headwall	EA	2	$20,000	$40,000
4	6" Concrete Apron Pavement	SY	20	$70	$1,400
5	PVC Coated Gabions	CY	75	$250	$18,750
6	Sodding	SY	300	$7	$2,100
7	Erosion Control	LS	1	$25,000	$25,000
8	Dewatering	LS	1	$50,000	$50,000
9	Cofferdam	CY	10000	$20	$200,000
10	Mobilization	LS	1	$100,000	$100,000
Subtotal					$937,490
20% Contingency					$187,498
Total					**$1,124,988**
Escalation to Midpoint @ 6%/year& 5 yrs					$380,471
Subtotal					**$1,505,459**
Engineering and Surveying Services (12%)					$180,655
Construction Management (8%)					$120,437
Construction Materials Testing (1.5%)					$22,582
City Contract Administration (10%)					$150,546
Service Subtotal					**$474,220**
Total Estimated Project Cost					**$1,979,679**

4.2.7 OPTION D4 – CONSTRUCT NEW 250,000 GPM PUMP STATION IN TRINITY-PORTLAND SUMP

This option consists of the construction of a new 250,000 gpm pump station in Trinity-Portland Sump. No culvert improvements are included with this option. Option D4 must be combined with Option P2 to provide a complete solution for the combined Delta/Pavaho sump areas. Option D4 provides a solution for Eagle Ford sump, so no Eagle Ford improvements are needed in conjunction with this option.

The Trinity Portland Storm Water Pump Station evaluated for Option D4 has a total pumping capacity of 250,000 gpm. The pumping is accomplished with the use of three 83,333 gpm vertical axial flow pumps, each rated at 55 feet total dynamic head (TDH). Each of these pumps is driven by a 900 horsepower electric motor operating at 295 rpm, eliminating the need for a gear reducer between the motor and pump. Additionally, a 6,000 gpm vertical axial flow pump is provided for dewatering the sump during periods of low flow.

Pump station discharge piping will be configured to pump flow up and over the existing West Levee to outfall to the river. Each individual pump will be equipped with a dedicated discharge header with a high point elevation above the top of levee and an air release valve to prevent back-siphoning into the station. Station piping will be lined with high density polyurethane and coated with suitable epoxy-based systems.

The pump station will be configured in accordance with the guidance contained in the following documents:

- "Hydrologic Analysis of Interior Areas" EM 1110-2-1413, dated 15 January 1987
- "Hydrologic Frequency Analysis" EM 1120-2-1415, dated 05 March 1993
- "Flood Run-off Analysis" EM 1110-2-1417, dated 31 August 1994
- "Risk-Based Analysis for Flood Damage Reduction Studies" EM 1120-2-1619, dated 01 August 1996
- *EM1110-2-2100 Stability Analysis of Concrete Structures*
- *EM1110-2-2102 Waterstops and Other Preformed Joint Materials for CW Structures*
- *EM1110-2-2502 Retaining Walls*
- *EM1110-2-3104 Structural and Architectural Design of Pumping Stations*
- *EM1110-2-3105 Mechanical and Electrical Design of Pumping Stations*
- *EM1110-2-1804 Geotechnical Investigations*

The pump station substructure is cast-in-place concrete designed in accordance with ACI 310R and other appropriate standards. The foundation is a mat consisting of a five foot thick concrete slab to which the walls are attached. The walls utilize a stepped design in which the walls are reduced in thickness as the height of the structure increases and the soil load decreases. The sump area is deep and a removable hatch has been incorporated into the floor deck to provide access for removing debris that will accumulate in the sump area. The hatch is large enough to accommodate a small Bobcat.

The superstructure of the pump station is cast-in-place concrete and beams are incorporated into the structure to accommodate the installation of a bridge crane for maintenance. The pump station roof is designed to be double tees, which increases the stiffness of the structure and simplifies construction and maintenance. The roof will consist of the double tees, a two-inch layer of light-weight grout, and a membrane. The superstructure has been designed so that a drive through corridor is incorporated into the station, permitting truck access directly adjacent to the pumps for maintenance.

The exterior wall sections have been assumed to be concrete masonry units with brick veneer, although a different system may be incorporated in the final design.

The pump station interior in the pump room is unfinished; however, the interiors of the switchgear room, office, and restroom have conventional dry wall construction and are painted. Flooring throughout the station is concrete with a troweled finish. The main pump room is provided with ventilation, while the switchgear room, office, and restroom are conditioned.

The primary electrical supply to the station is three-phase, 4160 v.a.c. and is provided by TXU. The supply is from two independent substations providing needed redundancy. Therefore, the standby generator set is for use by limited equipment including the control system, lighting, HVAC components, and the bridge crane. The switchgear is located in the switchgear room and includes soft starts for each of the main pumping units. The switchgear is configured as a main-tie-main to provide additional redundancy and reliability in station operation.

This pump station is located on the West Levee between Mexicana Road and Canada Drive. Access to the station is provided via a concrete paved access road. Roll-up doors on the station provide the drive-through access. Since the site is located next to the sump a retaining wall is provided to level the site for routine operations. Water and sewer are available in adjacent public streets, and a two-inch water service and a 4-inch sanitary sewer has been provided for the station.

The interior lighting level will be maintained at 85 foot candles. All handrails will be four-rung aluminum. Grating will be hot-dipped galvanized.

The instrumentation and control system will incorporate monitoring and alarming for motor and pump bearing temperature, motor winding temperature, reverse rotation, flow for each pump, sump elevation, and precipitation. The controls system will be integrated into the SCADA system operated by the City of Dallas. Individual pump control can be initiated at the pump, in the operator office/control room, or remotely by the SCADA system.

Figure 4.2.38 is a site plan for this alternative.

Figure 4.2.39 is a plan view of the 250,000 gpm pump station. The trash rack in the front of the station will be equipped with mechanically-cleaned screens manufactured by Du Perion, since these screens have demonstrated ability to function very effectively in this harsh environment. The switchgear room is adjacent to the pump room.

Figure 4.2.40 is Section A and the relationship of the pumping units, intake sump, and discharge piping are clearly indicated. The bridge crane has 27-foot clearance above the drive through for removal and/or installation of the pumping equipment.

Figures 4.2.41A and 4.2.41B are the electrical one-line diagrams for the station. The double-ended switchgear is indicated. Each of the main pumps is operated by a soft start that has a by-pass that permits the motor to be started even if the soft start is out of service. In addition to the protection provided by the soft start, each of the motors will be equipped with a Multilin 469 to provide motor protective relay systems.

Figure 4.2.42 is a preliminary process and instrumentation diagram for the pump station. The vibration monitoring equipment is shown, as are the RTDs for monitoring motor winding temperatures, and the pump and motor bearing temperatures. Each of the pumps will be equipped with an ultrasonic flow meter to monitor pump discharge.

The Engineer's Preliminary Opinion of Probable Cost for the storm water pump station for Option D2 is summarized in Table 4.2.15.

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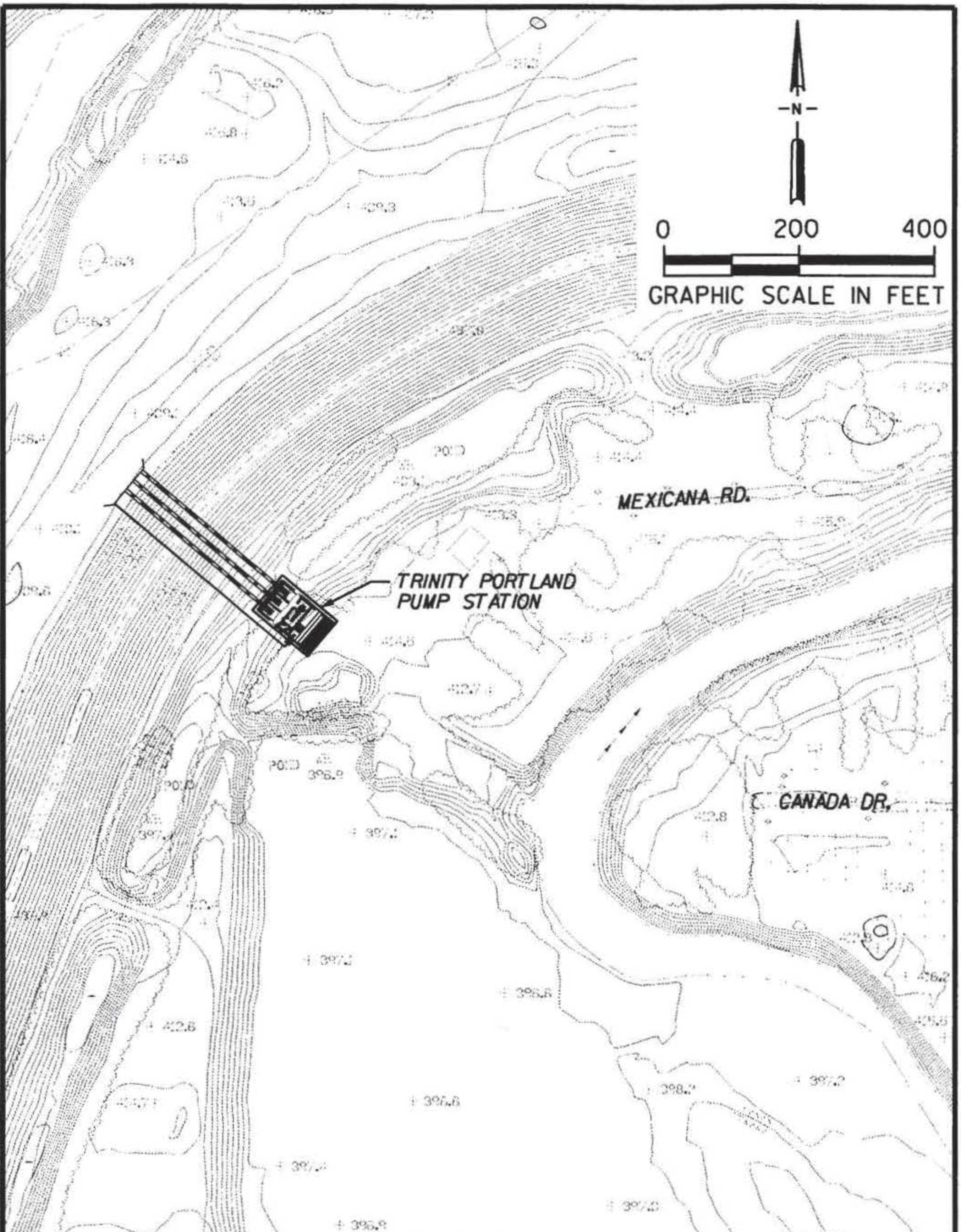
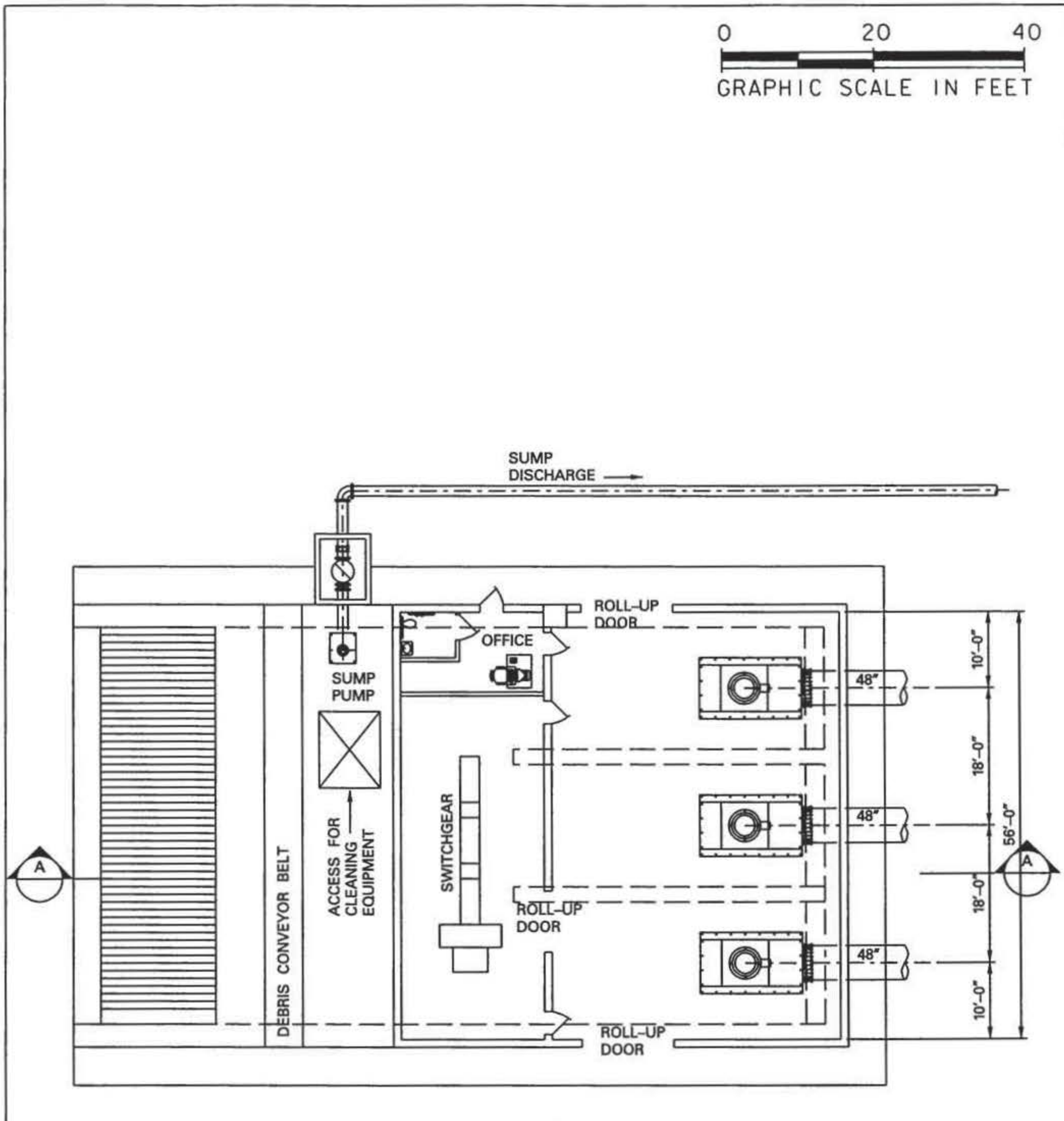


SITE PLAN

JACOBS Carter Burgess THESE DRAWINGS/DOCUMENTS ARE BEING SUBMITTED BY CARTER BURGESS INC. CARTER & BURGESS, INC. IS A WHOLLY OWNED SUBSIDIARY OF JACOBS ENGINEERING GROUP INC AND HEREINAFTER REFERRED TO AS JACOBS CARTER BURGESS.	CITY OF DALLAS DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION	PROPOSED TRINITY PORTLAND PUMP STA. VERTICAL PUMPS 250,000 GPM CAPACITY	FIGURE 4.2.38



PLAN VIEW
SCALE: 1" = 20'

STATION CAPACITY = 250,000 GPM
83,333 GPM PER PUMP

JACOBS Carter Burgess	CITY OF DALLAS DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION	PROPOSED TRINITY PORTLAND PUMP STA. VERTICAL PUMPS 250,000 GPM CAPACITY	FIGURE 4.2.39

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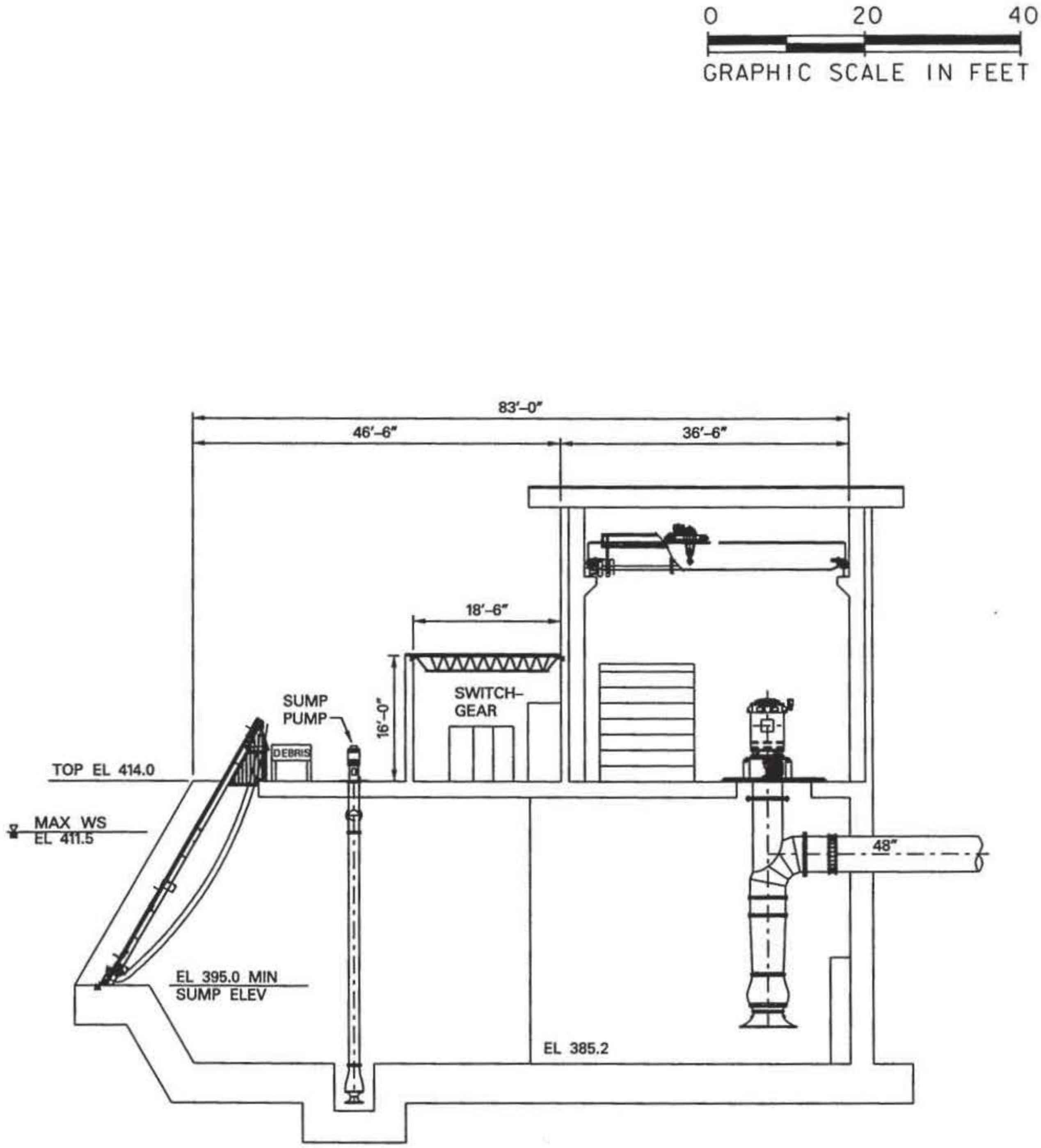

SECTION A – VERTICAL PUMPS

SCALE: 1" = 20'

STATION CAPACITY = 250,000 GPM
83,333 GPM PER PUMP

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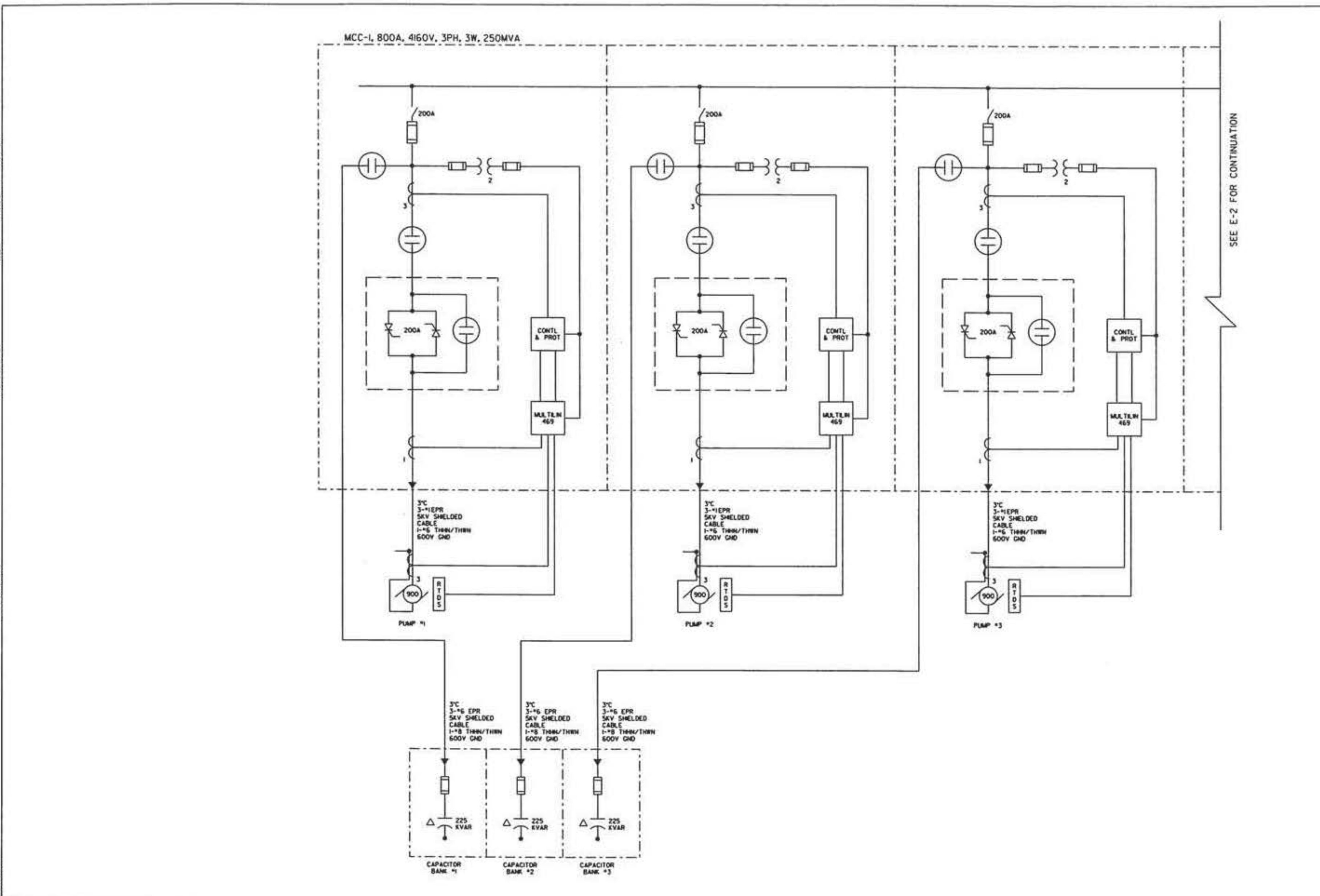

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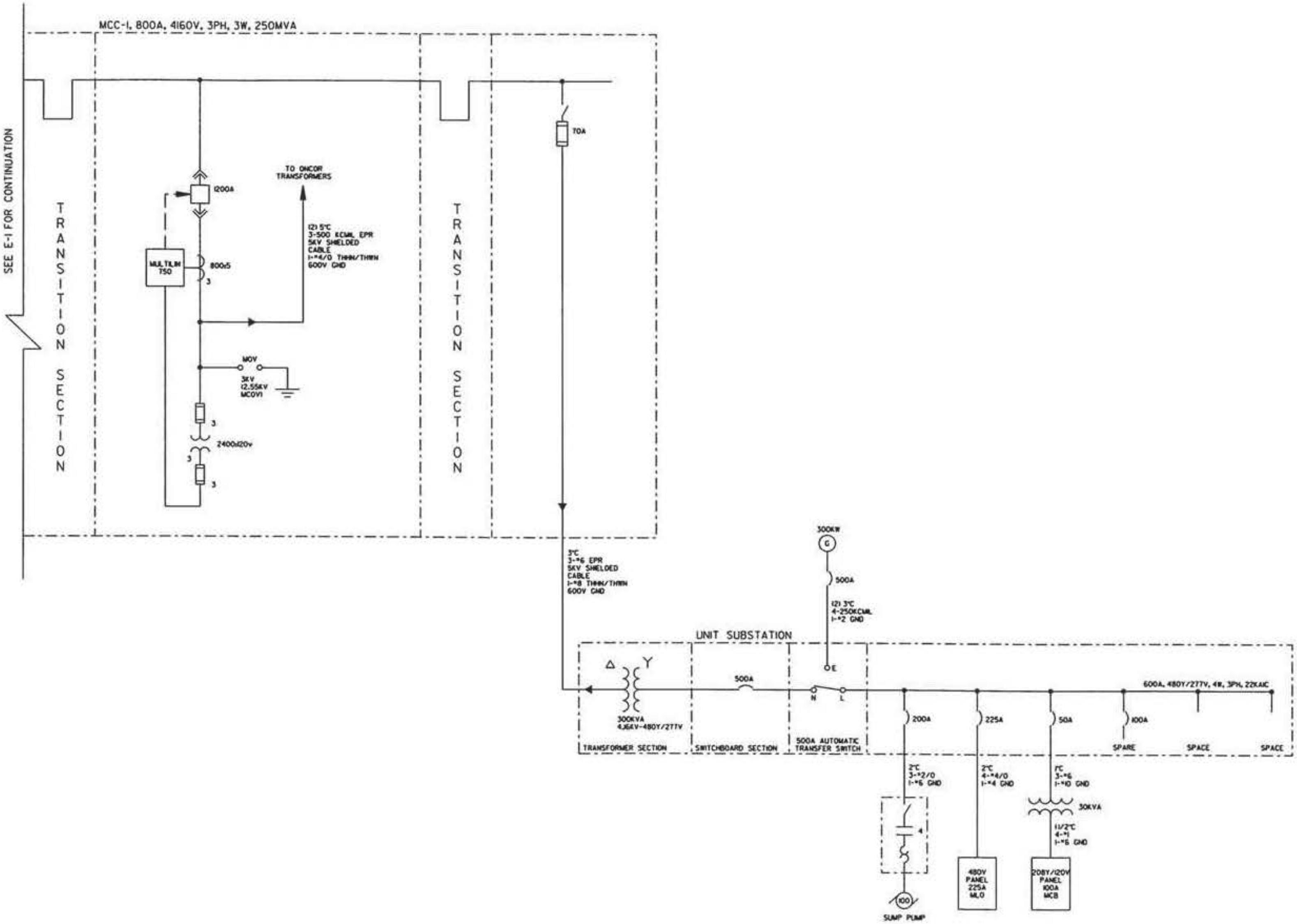
DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

PROPOSED TRINITY PORTLAND
PUMP STATION – VERTICAL PUMPS
250,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

FIGURE
4.2.41A



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PROPOSED TRINITY PORTLAND
PUMP STATION – VERTICAL PUMPS
250,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

FIGURE
4.2.41B

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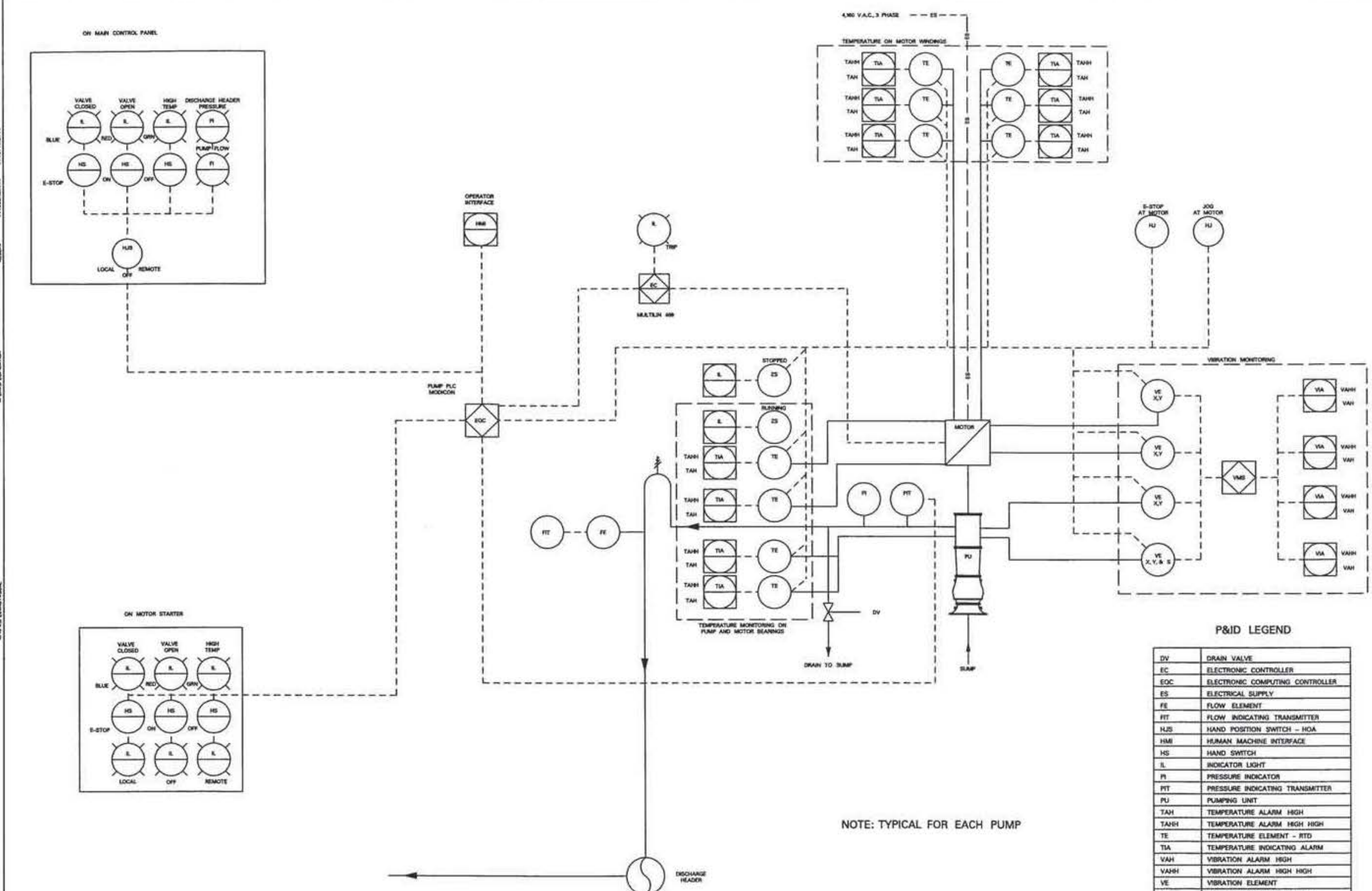

NOTE: TYPICAL FOR EACH PUMP

P&ID LEGEND

DV	DRAIN VALVE
EC	ELECTRONIC CONTROLLER
EOC	ELECTRONIC COMPUTING CONTROLLER
ES	ELECTRICAL SUPPLY
FE	FLOW ELEMENT
FIT	FLOW INDICATING TRANSMITTER
HJS	HAND POSITION SWITCH – HOA
HMI	HUMAN MACHINE INTERFACE
HS	HAND SWITCH
IL	INDICATOR LIGHT
PI	PRESSURE INDICATOR
PIT	PRESSURE INDICATING TRANSMITTER
PU	PUMPING UNIT
TAH	TEMPERATURE ALARM HIGH
TAHH	TEMPERATURE ALARM HIGH HIGH
TE	TEMPERATURE ELEMENT - RTD
TIA	TEMPERATURE INDICATING ALARM
VAH	VIBRATION ALARM HIGH
VAHH	VIBRATION ALARM HIGH HIGH
VE	VIBRATION ELEMENT
VIA	VIBRATION INDICATING ALARM
VMS	VIBRATION MONITORING SYSTEM
ZS	POSITION SWITCH

JACOBS Carter Burgess

CITY OF DALLAS
DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

PROPOSED TRINITY PORTLAND PUMP STATION
250,000 GPM CAPACITY

PROCESS AND INSTRUMENTATION DIAGRAM

FIGURE
4.2.42

Table 4.2.15

Summary for Trinity Portland 3 Pump 250,000 gpm

Division	Cost
Division 1 - General Conditions	$2,504,000
Divison 2 - Site Work	$4,007,200
Division 3- Concrete	$2,522,621
Division 4 - Masonry	$87,072
Division 5- Metals	$118,515
Division 6 - Carpentry	$4,000
Division 7 - Thermal & Moisture Protection	$784,835
Division 8 - Doors & Windows	$12,700
Division 9 - Finishes	$85,075
Division 10 - Specialties	$9,700
Division 11 - Equipment	$5,254,750
Division 12 - Furnishings	$4,110
Division 13- Special Construction	$0
Division 14 - Conveying Systems	$350,000
Division 15 - Mechanical	$235,018
Division 16 - Electrical	$2,341,500
Division 17 - Instrumentation & Control	$1,293,500
Division Subtotal	**$19,614,596**
Contractor's Profit of Materials - 10%	$1,428,848
Prime Profit on SubConstractors - 10%	$465,394
Subtotal	**$21,508,837**
Construction Contingencies - 20%	$4,301,767
Construction Work Effort subtotal	**$25,810,605**
Escalation to Midpoint @ 6%/Yr & 3 yrs	$8,729,147
Subtotal	**$34,539,751**
Engineering and Surveying Services (12%)	$4,144,770
Construction Management (8%)	$2,763,180
Construction Materials Testing (1.5%)	$518,096
City Contract Administration (10%)	$3,453,975
Services Subtotal	**$10,880,022**
Total Estimated Project Cost	**$45,419,773**

Table 4.2.15
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Trinity Portland Site with 3 Pumps
250,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 1 - General Conditions							
Mobilization	1	LS	$0	$0		$0	$600,000
Construction Surveying	1	LS	$0	$0	$45,000.00	$45,000	$45,000
Telephone	30	Mo	$150	$4,500	$0.00	$0	$4,500
SWWWP	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Trench Excavation Safety & Support/Structural Plan	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Traffic Control Plan	1	LS	$15,000	$15,000	$0.00	$0	$15,000
PM	30	Mo	$0	$0	$15,000.00	$450,000	$450,000
Superintendent	30	Mo	$0	$0	$12,000.00	$360,000	$360,000
Admin	30	Mo	$0	$0	$7,000.00	$210,000	$210,000
Sanitary Services	30	Mo	$0	$0	$500.00	$15,000	$15,000
Security Services	30	Mo	$0	$0	$2,000.00	$60,000	$60,000
Pick Up Trucks - 3 each	30	Mo	$0	$0	$1,800.00	$54,000	$54,000
Office Equipment	30	Mo	$0	$0	$350.00	$10,500	$10,500
150 Ton Crane - 24 Months	24	Mo	$0	$0	$20,000.00	$480,000	$480,000
Loader - 30 Months	30	Mo	$0	$0	$2,000.00	$60,000	$60,000
Office Trailors - 2 each	30	Mo	$0	$0	$1,500.00	$45,000	$45,000
Tool Trailors - 2 each	30	Mo	$0	$0	$500.00	$15,000	$15,000
Subtotal for Division 1							**$2,504,000**
Division 2 - Site Work							
Structural Excavation	12,000	CY	$0.00	$0	$8.00	$96,000	$96,000
Structural Backfill	10,000	CY	$6.00	$60,000	$3.00	$30,000	$90,000
Paving	1,300	SY	$12.00	$15,600	$12.00	$15,600	$31,200
Pavement Striping	2,450	SF	$6.00	$14,700	$2.00	$4,900	$19,600
Access Road	1,800	SY	$7.00	$12,600	$13.00	$23,400	$36,000
Traffic Control	1	LS	$5,000.00	$5,000	$20,000.00	$20,000	$25,000
Curb Stops	10	EA	$200.00	$2,000	$50.00	$500	$2,500
8-inch Bollards	10	EA	$1,000.00	$10,000	$150.00	$1,500	$11,500
Grading	3,000	SY	$1.00	$3,000	$2.00	$6,000	$9,000
Fencing - 10 Ft. Man Proof	1,000	LF	$50.00	$50,000	$10.00	$10,000	$60,000
16-foot slide gate (Electric Motor)	1	EA	$6,000.00	$6,000	$1,000.00	$1,000	$7,000

Table 4.2.15
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Trinity Portland Site with 3 Pumps
250,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
3-foot ped. Gate	1	EA	$400.00	$400	$100.00	$100	$500
Landscaping	1	LS	$50,000.00	$50,000	$5,000.00	$5,000	$55,000
Channel Liner	2,000	SY	$10.00	$20,000	$5.00	$10,000	$30,000
60-inch steel discharge pipe - 3@300' each	900	LF	$800	$720,000	$100.00	$90,000	$810,000
60-inch nut, bolt and gasket sets	6	EA	$2,000	$12,000	$1,500.00	$9,000	$21,000
102-inch steel dischage pipe	400	LF	$4,500	$1,800,000	$100.00	$40,000	$1,840,000
Headwalls	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Water - 2-inch	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Sewer	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Telephone	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Misc Utilities	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Shoring	5,000	SF	$35	$175,000	$5.00	$25,000	$200,000
Dewatering	1	LS	$250,000	$250,000	$25,000.00	$25,000	$275,000
Coffer Dam - 26' high 2:1ss	10,000	CY	$15	$150,000	$5.00	$50,000	$200,000
3-inch mud slab	140	CY	$100	$14,000	$25.00	$3,500	$17,500
Subtotal for Division 2							**$4,007,200**
Division 3 - Concrete							
Substructure Concrete (Foundation)							
Concrete	1412	CY	$100	$141,200	$15.00	$21,180	$162,380
Rebar (310 lb/CY)	219	TON	$1,020	$223,237	$300.00	$65,658	$288,895
Forming	7622	SF	$10	$76,220	$5.00	$38,110	$114,330
Curing	80	CSF	$5	$400	$5.00	$400	$800
Waterstops	320	LF	$10	$3,200	$5.00	$1,600	$4,800
Substructure Concrete (Pump Room Floor)							
Concrete	235	CY	$100	$23,500	$15.00	$3,525	$27,025
Rebar (310 lb/CY)	36	TON	$1,020	$37,154	$300.00	$10,928	$48,081
Forming	4237	SF	$10	$42,370	$5.00	$5	$42,375
Curing	63	CSF	$5	$315	$5.00	$315	$630
Waterstops	315	LF	$10	$3,150	$5.00	$1,575	$4,725
Substructure Concrete (Perimeter walls) - ext. 4' thick avg.							
Concrete	1264	CY	$100	$126,400	$15.00	$18,960	$145,360

Table 4.2.15

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Trinity Portland Site with 3 Pumps

250,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Rebar (310 lb/CY)	196	TON	$1,020	$199,838	$300.00	$58,776	$258,614
Forming	8532	SF	$10	$85,320	$5.00	$42,660	$127,980
Curing	180	CSF	$5	$900	$5.00	$900	$1,800
Waterstops	275	LF	$10	$2,750	$5.00	$1,375	$4,125
Substructure Concrete (Divider walls-int. 2' thick avg)							
Concrete	340	CY	$100	$34,000	$15.00	$5,100	$39,100
Rebar (310 lb/CY)	53	TON	$1,020	$53,754	$300.00	$15,810	$69,564
Forming	4602	SF	$10	$46,020	$5.00	$23,010	$69,030
Curing	190	CSF	$5	$950	$5.00	$950	$1,900
Waterstops	500	LF	$10	$5,000	$5.00	$2,500	$7,500
Substructure Columns and Beams							
Concrete	40	CY	$100	$4,000	$15.00	$600	$4,600
Rebar (310 lb/CY)	6	TON	$1,020	$6,324	$300.00	$1,860	$8,184
Forming	1200	SF	$10	$12,000	$5.00	$6,000	$18,000
Curing	40	CSF	$5	$200	$5.00	$200	$400
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Electrical Room Bottom Slab							
Concrete	140	CY	$100	$14,000	$15.00	$2,100	$16,100
Rebar (310 lb/CY)	22	TON	$1,020	$22,134	$300.00	$6,510	$28,644
Forming	1248	SF	$10	$12,480	$5.00	$6,240	$18,720
Curing	60	CSF	$5	$300	$5.00	$300	$600
Waterstops	150	LF	$10	$1,500	$5.00	$750	$2,250
Superstructure Columns							
Concrete	60	CY	$100	$6,000	$15.00	$900	$6,900
Rebar (310 lb/CY)	9	TON	$1,020	$9,486	$300.00	$2,790	$12,276
Forming	3100	SF	$10	$31,000	$5.00	$15,500	$46,500
Curing	200	CSF	$5	$1,000	$5.00	$1,000	$2,000
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Superstructure Beams							
Concrete	60	CY	$100	$6,000	$15.00	$900	$6,900
Rebar (310 lb/CY)	9	TON	$1,020	$9,486	$300.00	$2,790	$12,276
Forming	2164	SF	$10	$21,640	$5.00	$10,820	$32,460

Table 4.2.15

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Trinity Portland Site with 3 Pumps

250,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Curing	250	CSF	$5	$1,250	$5.00	$1,250	$2,500
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Superstructure double-Tees	4752	SF	$18	$85,536	$5.00	$23,760	$109,296
Retaining Walls - MSE wall >20'	15500	SF	$40	$620,000	$10.00	$155,000	$775,000
Subtotal Division 3							**$2,522,621**
Division 4 - Masonary							
CMU Partitions	12,000	SF	$3.00	$36,000	$4.00	$48,000	$84,000
Glazed CMU Restroom Walls	256	SF	$8.00	$2,048	$4.00	$1,024	$3,072
Subtotal for Division 4				**$0**		**$0**	**$87,072**
Division 5 - Metals							
Grating	800	SF	$20	$16,000	$5.00	$4,000	$20,000
Mtl deck	7,505	SF	$2	$15,010	$1.00	$7,505	$22,515
Bar Joists	1	LS	$60,000	$60,000	$5,000.00	$5,000	$65,000
Handrail	200	LF	$40	$8,000	$15.00	$3,000	$11,000
Subtotal for Division 5							**$118,515**
Division 6 - Carpentry							
Misc.	1	ls	$1,000	$1,000	$3,000.00	$3,000	$4,000
Subtotal for Division 6							**$4,000**
Division 7 - Thermal and Moisture Protection							
Exterior walls	11,000	SF	$45	$495,000	$20.00	$220,000	$715,000
Roofing	4,752	SF	$4	$19,008	$2.00	$49,827	$68,835
Roof Hatch-Pumps	0	EA	$15,000	$0	$500.00	$0	$0
Roof Hatch-Access	1	EA	$800	$800	$200.00	$200	$1,000
Subtotal for Division 7							**$784,835**
Division 8 - Doors and Windows							
Doors, 3-0 x 7-0 steel	5	Ea	$200	$1,000	$100.00	$500	$1,500

Table 4.2.15
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Trinity Portland Site with 3 Pumps
250,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Doors, roll-up 12' x 14' steel	2	Ea	$5,000	$10,000	$600.00	$1,200	$11,200
Subtotal for Division 8				**$0**		**$0**	**$12,700**
Division 9- Finishes							
Process Piping (pump rm risers & hdrs)	4,100	SF	$0.50	$2,050	$1.25	$5,125	$7,175
Misc. Structural Steel Surf. Prep.	8,900	LS	$1.00	$8,900	$2.00	$17,800	$26,700
Paint Structural Steel	8,900	sf	$1.00	$8,900	$4.00	$35,600	$44,500
Paint Building Interior Walls	10,000	SF	$0.10	$1,000	$0.57	$5,700	$6,700
Subtotal for Division 9							**$85,075**
Division 10 - Specialities							
Signage	1	LS	$5,000	$5,000	$1,000.00	$1,000	$6,000
Woven Wire Partition - 15'x15'x10'Tall	1	LS	$2,500	$2,500	$500.00	$500	$3,000
Toilet Accessories	1	LS	$500	$500	$200.00	$200	$700
Subtotal for Division 10				**$0**		**$0**	**$9,700**
Division 11 - Equipment							
Veritical sump pump, 7000 gpm	1	Ea	$80,000	$80,000	$5,000.00	$5,000	$85,000
Trash Rack (25' x 65')	1,625	SF	$400	$650,000	$10.00	$16,250	$666,250
Restrained Couplings	9	Ea	$15,000	$135,000	$1,500.00	$13,500	$148,500
Vertical Pumps and Motors - 84,000 gpm	3	Ea	$1,300,000	$3,900,000	$30,000.00	$90,000	$3,990,000
Stop Logs	1	LS	$200,000	$200,000	$15,000.00	$15,000	$215,000
8.5' - Flap Gate	1	Ea	$40,000	$40,000	$5,000.00	$5,000	$45,000
Sluice Gate - 9'x9'	1	Ea	$100,000	$100,000	$5,000.00	$5,000	$105,000
Subtotal for Division 11							**$5,254,750**
Division 12 - Furnishings							
Desk	1	Ea	$1,000	$1,000	$100.00	$100	$1,100
Chair	1	Ea	$600	$600	$10.00	$10	$610
Storage Shelves	4	Ea	$500	$2,000	$100.00	$400	$2,400
Subtotal for Division 12							**$4,110**

Table 4.2.15
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Trinity Portland Site with 3 Pumps
250,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 13 - Special Construction							
Subtotal for Division 13							$0
Division 14 - Conveying Systems							
30 Ton Bridge Crane	1	Ea	$200,000	$200,000	$25,000.00	$25,000	$225,000
Automated Conveyor System	1	LS	$100,000.00	$100,000	$25,000.00	$25,000	$125,000
Subtotal for Division 14							$350,000
Division 15 - Mechanical							
Ventilation Fan(S)	3	EA	$2,000	$6,000	$500.00	$1,500	$7,500
Roof Curb(S)	3	EA	$1,000	$3,000	$250.00	$750	$3,750
Controls	1	LS	$25,000	$25,000	$10,000.00	$10,000	$35,000
Floor Drain(S)	6	EA	$300	$1,800	$150.00	$900	$2,700
Toilet(S)	1	EA	$200	$200	$200.00	$200	$400
Sink(S)	2	EA	$400	$800	$100.00	$200	$1,000
Urinal(S)	1	EA	$200	$200	$75.00	$75	$275
Faucet(S)	2	EA	$350	$700	$100.00	$200	$900
Trap Primer(S)	2	EA	$350	$700	$150.00	$300	$1,000
Drain/Waste/Vent Plumbing	1000	LF	$15	$15,000	$7.00	$7,000	$22,000
Cold Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Hot Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Dx Hvac Air Handler(S)	2	EA	$17,500	$35,000	$5,000.00	$10,000	$45,000
Dx Hvac Condensing Unit(S)	2	EA	$15,000	$30,000	$1,500.00	$3,000	$33,000
Controls	1	LS	$7,500	$7,500	$5,000.00	$5,000	$12,500
Condensing Unit Pad(S)	1	EA	$500	$500	$100.00	$100	$600
Ductwork	1000	LBS	$50	$50,000	$5.00	$5,000	$55,000
Diffuser(S)/Register(S)/Grille(S)	9	EA	$17	$153	$10.00	$90	$243
Louvre(S)	9	EA	$150	$1,350	$100.00	$900	$2,250
Fire Hose Rack	2	EA	$350	$700	$100.00	$200	$900
Subtotal for Division 15							$235,018
Division 16 - Electrical							

Table 4.2.15
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Trinity Portland Site with 3 Pumps
250,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Mobilization	1	LS	$0	$0	$0.00	$0	$50,000
Temporary Power	1	LS	$50,000	$50,000	$2,000.00	$2,000	$52,000
Duct Banks	200	CY	$400	$80,000	$20.00	$4,000	$84,000
Manholes	3	EA	$6,000	$18,000	$500.00	$1,500	$19,500
1/0 5 Kv Cable	1,000	LF	$7	$7,000	$3.00	$3,000	$10,000
250 Mcm 5 Kv Cable	1,000	LF	$8	$8,000	$3.00	$3,000	$11,000
100 Mcm 5 Kv Cable	1,000	LF	$15	$15,000	$3.00	$3,000	$18,000
5 Kv Terminations	50	EA	$175	$8,750	$25.00	$1,250	$10,000
Conduit	1	LS	$175,000	$175,000	$20,000.00	$20,000	$195,000
Wire	1	LS	$125,000	$125,000	$10,000.00	$10,000	$135,000
Lighting							
Exterior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Interior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Mv Switchgear	1	LS	$100,000	$100,000	$25,000.00	$25,000	$125,000
Soft Starts - 1200 HP	3	EA	$52,000	$156,000	$15,000.00	$45,000	$201,000
1500 Kva Transformers	3	EA	$50,000	$150,000	$10,000.00	$30,000	$180,000
480 Volt Mcc	1	EA	$85,000	$85,000	$50,000.00	$50,000	$135,000
Misc. Switchgear	1	LS	$50,000	$50,000	$6,000.00	$6,000	$56,000
Lightning Protection	1	LS	$35,000	$35,000	$5,000.00	$5,000	$40,000
Telephone System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Fire Alarm System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Security And Entrance Equipment	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Embedded Conduit	1	LS	$25,000	$25,000	$8,000.00	$8,000	$33,000
Grounding	1	LS	$50,000	$50,000	$10,000.00	$10,000	$60,000
Cable Tray	1	LS	$25,000	$25,000	$15,000.00	$15,000	$40,000
500 Kva Gen Set With ATS	1	Ea	$98,000	$98,000	$5,000.00	$5,000	$103,000
TXU Firm Backup Capabiltiy	1	LS	$600,000	$600,000	$30,000.00	$30,000	$630,000
Testing	1	LS	$15,000	$15,000	$5,000.00	$5,000	$20,000
Subtotal for Division 16							**$2,341,500**

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Table 4.2.15
Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Trinity Portland Site with 3 Pumps
250,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 17 - I&C							
Engineering & Submittals	1	LS	$75,000	$75,000	$5,000.00	$5,000	$80,000
Computers And Printers	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
F O Cable And Comm. Equip.	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Control Panels	1	LS	$250,000	$250,000	$10,000.00	$10,000	$260,000
Start Up-Check Out	1	LS	$35,000	$35,000	$10,000.00	$10,000	$45,000
Ultra Sonic Flow Meters	4	Ea	$5,000	$20,000	$2,500.00	$10,000	$30,000
HMI Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
PLC Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
O&M Manuals	1	LS	$5,000	$5,000	$2,000.00	$2,000	$7,000
Training	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Software	1	LS	$85,000	$85,000	$15,000.00	$15,000	$100,000
Factory Test	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Bonds	1	LS	$0	$0	$0.00	$0	$80,000
Level transmitters	3	Ea	$2,000	$6,000	$500.00	$1,500	$7,500
PLC - Primary + hot back-up	1	Ea	$17,500	$17,500	$7,500.00	$7,500	$25,000
PC and Monitor	1	Ea	$8,000	$8,000	$1,000.00	$1,000	$9,000
MMI Software + Programming	1	Ea	$7,000	$7,000	$15,000.00	$15,000	$22,000
Instrumentation wiring	1	LS	$75,000	$75,000	$28,000.00	$28,000	$103,000
SCADA Transmitter	1	Ea	$100,000	$100,000	$10,000.00	$10,000	$110,000
Security Cameras	1	LS	$75,000	$75,000	$10,000.00	$10,000	$85,000
Subtotal for Division 17							**$1,293,500**
Division subtotal				**$14,288,483**		**$3,917,613**	**$19,614,596**
Contractor's Profit on Material (10%)							$1,428,848
Prime Profit on Subcontractors - 10% on Div 5, 6, 7, 8, 9, 10, 12, 16, 17							$465,394
Subtotal							**$21,508,837**
Contingency (20%)							$4,301,767
Construction Work Effort subtotal							**$25,810,605**
Escalation to Midpoint @ 6%/year& 5 yrs							**$8,729,147**
Subtotal							**$34,539,751**

Table 4.2.15

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Trinity Portland Site with 3 Pumps

250,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Engineering and Surveying Services (12%)							$4,144,770
Construction Management (8%)							$2,763,180
Construction Materials Testing (1.5%)							$518,096
City Contract Administration (10%)							$3,453,975
Services Subtotal							**$10,880,022**
Total Estimated Project Cost							**$45,419,773**

The proposed gated conduit structure between Trinity-Portland and Eagle Ford sumps allows selective exchange of flow between these two sump areas. This item includes the construction of a new 6'x6' gated culvert with remote operated motor controller at the berm which currently divides Eagle Ford and Trinity-Portland sumps. The estimate of probable cost for the new gated conduit structure is shown in Table 4.2.12. A schematic drawing of the proposed gated conduit structure is shown on Figure 4.2.35.

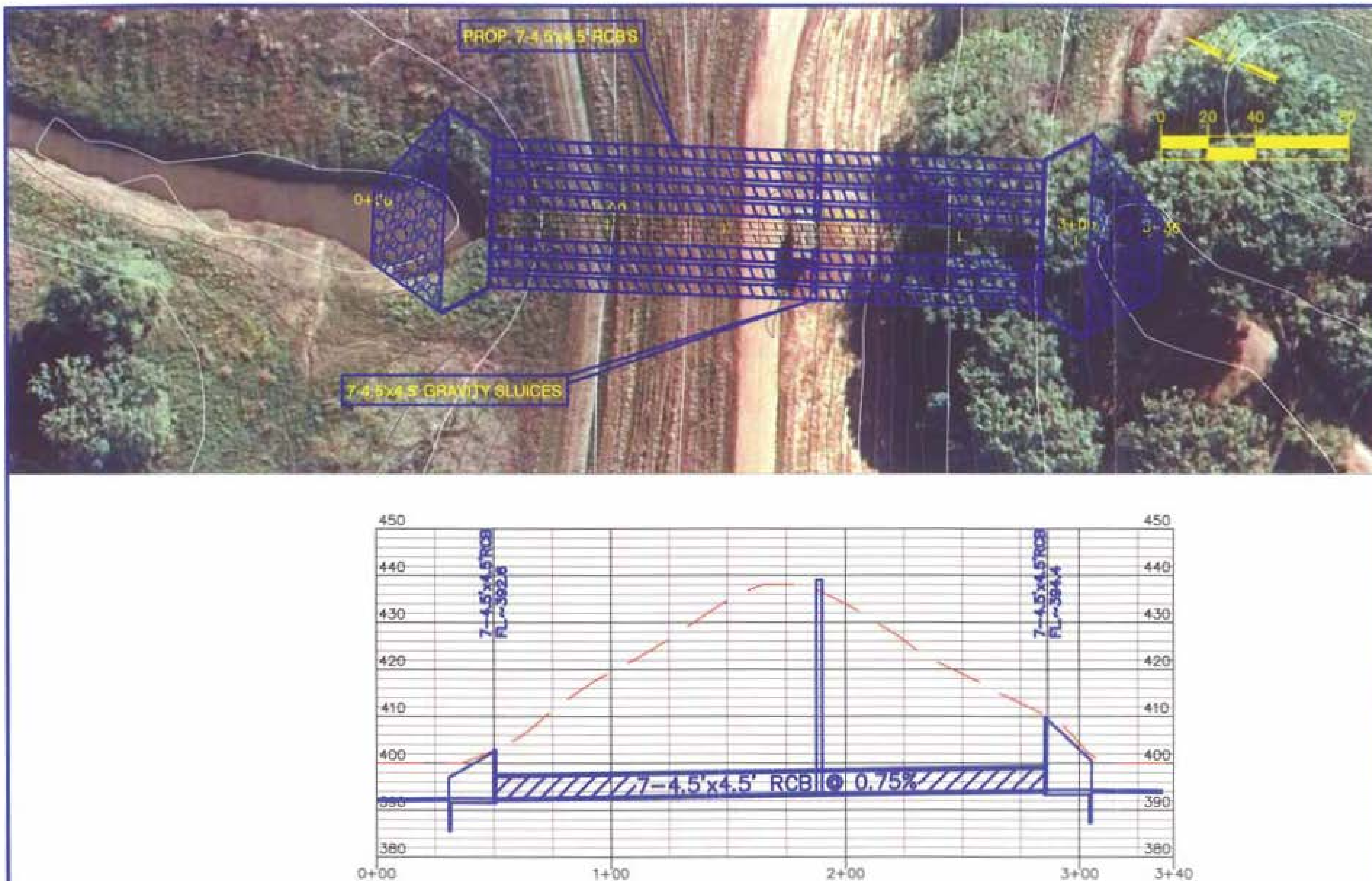
4.3 EAGLE FORD SUMP

Several alternatives were evaluated in the Eagle Ford Sump to lower the existing conditions flood level. These alternatives are described in the following sub sections.

4.3.1 Option EF1 – Retain Existing Gravity Sluices, 7 New 4.5'x4.5' Gravity Sluices

This option involves adding seven new 4.5'x4.5' gravity sluices to the existing gravity sluices in the Eagle Ford Sump. Included in the construction will be the addition of motor operated sluice gates and a gate tower to house the gates. No new pump stations were needed for this option.

The proposed new gravity sluices are shown in Figure 4.3.1 and the preliminary opinion of probable cost is shown in Table 4.3.1.



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OPTION EF1
PROPOSED EAGLE FORD SUMP
7-4.5'x4.5' RCB'S

FIGURE
4.3.1

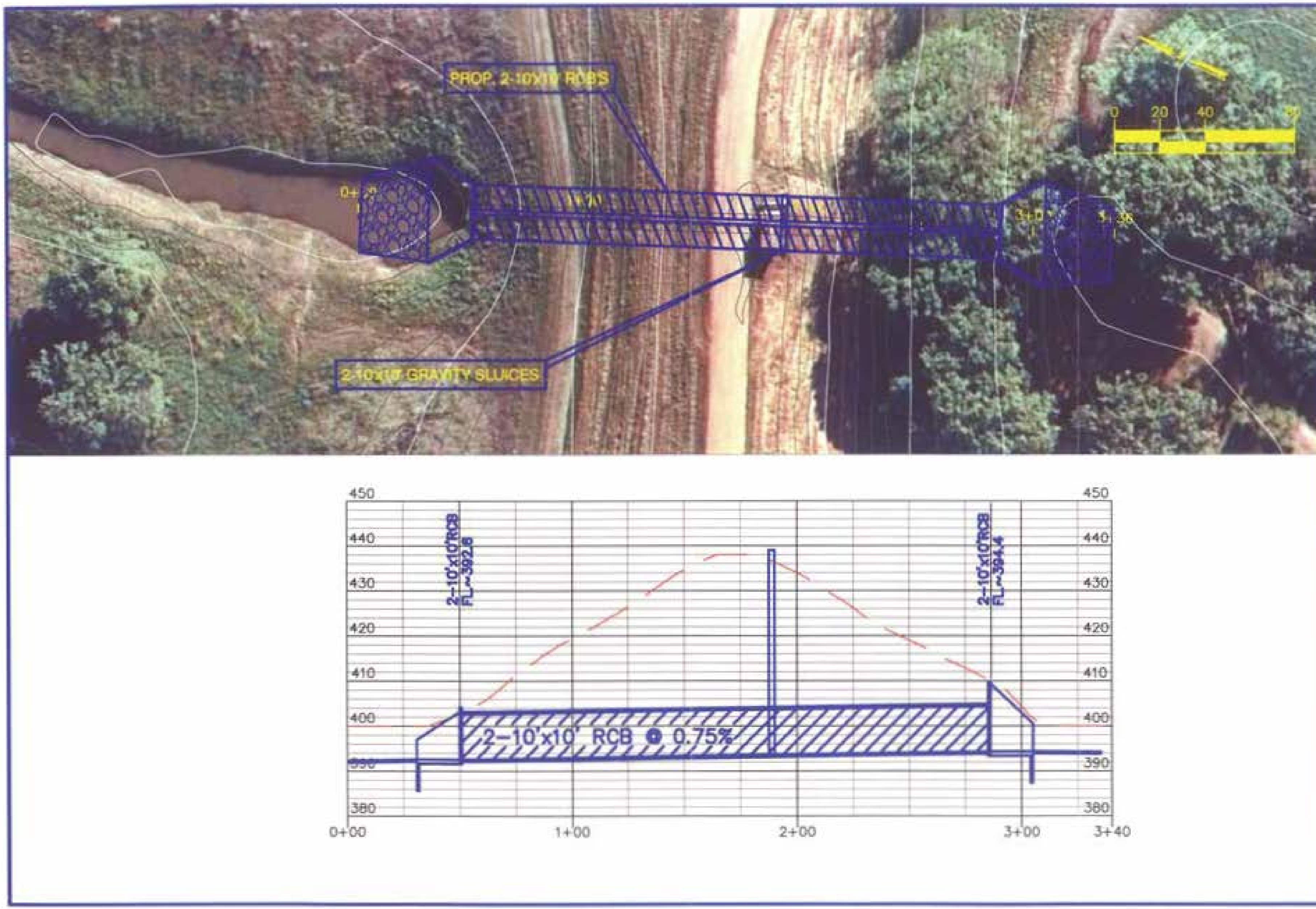
Table 4.3.1
Engineer's Preliminary Opinion of Probable Costs
Option EF1 Culvert Improvements at Eagle Ford Sump

Item No.	Description	Unit	Quantity	Unit Cost	Estimated Cost
1	4.5' X 4.5' RCB By Open Cut	LF	1645	$380	$625,100
2	Trench Safety and Support	LF	470	$4	$1,880
3	CIP Headwall	EA	4	$30,000	$120,000
4	6" Concrete Apron Pavement	SY	30	$70	$2,100
5	PVC Coated Gabions	CY	150	$250	$37,500
6	Sodding	SY	500	$4	$2,000
7	Erosion Control	LS	1	$25,000	$25,000
8	Dewatering	LS	1	$50,000	$50,000
9	4.5'x4.5' Sluice Gate	EA	7	$65,000	$455,000
10	Operators	EA	7	$15,000	$105,000
11	Flap Gates	EA	7	$35,000	$245,000
12	Cofferdam	CY	10000	$20	$200,000
13	Sluice Structure	LS	1	$350,000	$350,000
14	Mobilization	LS	1	$100,000	$100,000
Subtotal					$2,318,580
20% Contingency					$463,716
Total					**$2,782,296**
Escalation to Midpoint @ 6%/year& 5 yrs					$940,973
Subtotal					**$3,723,269**
Engineering and Surveying Services (12%)					$446,792
Construction Management (8%)					$297,861
Construction Materials Testing (1.5%)					$55,849
City Contract Administration (10%)					$372,327
Service Subtotal					**$1,172,830**
Total Estimated Project Cost					**$4,896,098**

4.3.2 Option EF2 – Demo Existing Gravity Sluices, 2 New 10'x10' Gravity Sluices

This option involves demolishing the existing Eagle Ford gravity sluices and constructing two new 10'x10' gravity sluices at the current location in the Eagle Ford Sump. Included in the construction will be the addition of motor operated sluice gates and a gate tower to house the gates. No new pump stations were needed for this option.

The proposed new gravity sluices are shown in Figure 4.3.2 and the preliminary opinion of probable cost is shown in Table 4.3.2.



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OPTION EF2
PROPOSED EAGLE FORD SUMP
2-10'x10' RCB'S

FIGURE
4.3.2

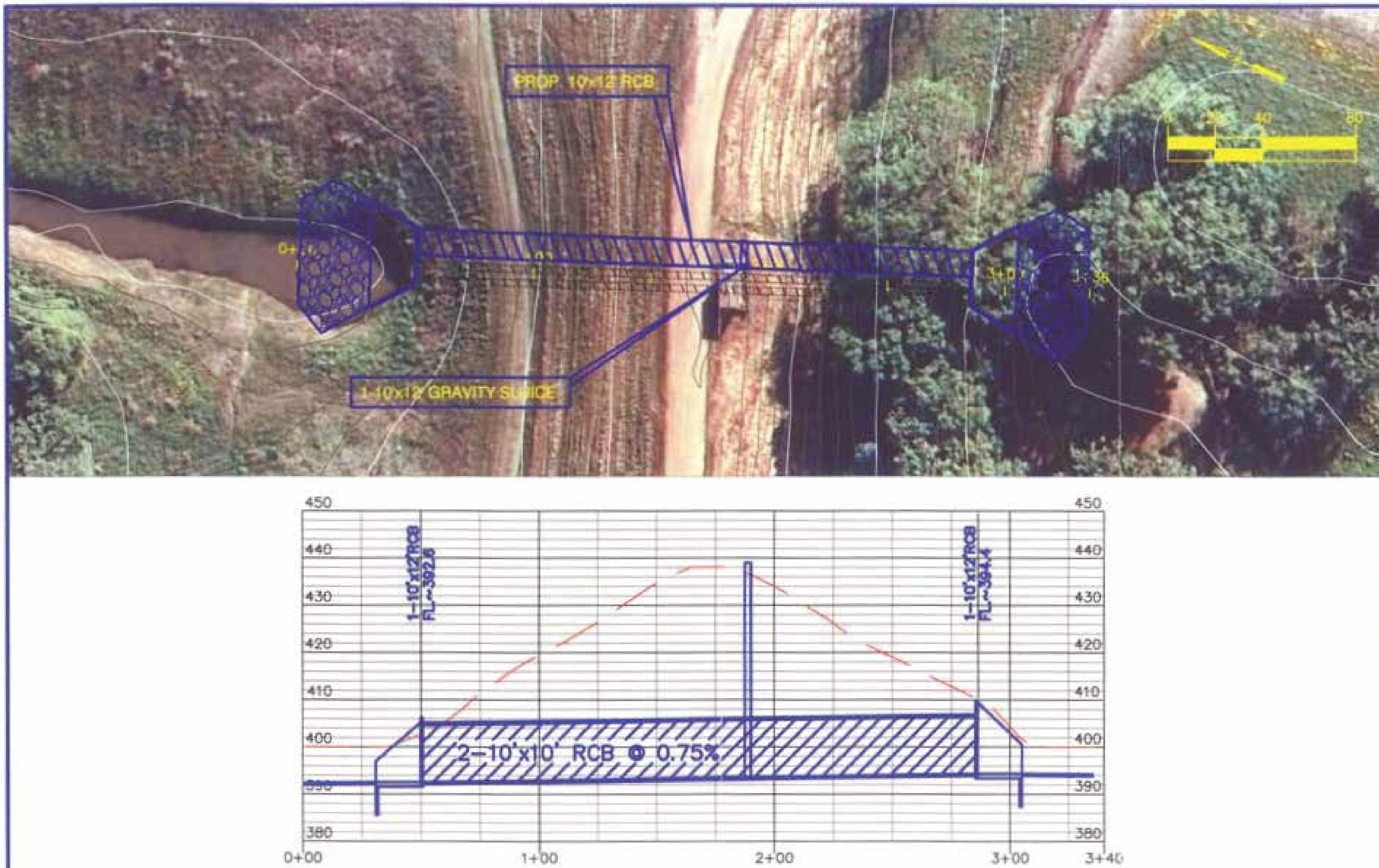
Table 4.3.2
Engineer's Preliminary Opinion of Probable Costs
Option EF2 Culvert Improvements at Eagle Ford Sump

Item No.	Description	Unit	Quantity	Unit Cost	Estimated Cost
1	Removal of Headwall and Wingwalls	EA	2	$15,000	$30,000
2	10' x 10' RCB	LF	470	$1,000	$470,000
3	Trench Safety and Support	LF	235	$4	$940
4	CIP Headwall	EA	2	$15,000	$30,000
5	6" Concrete Apron Pavement	SY	20	$70	$1,400
6	PVC Coated Gabions	CY	100	$250	$25,000
7	Sodding	SY	200	$7	$1,400
8	Erosion Control	LS	1	$25,000	$25,000
9	Dewatering	LS	1	$50,000	$50,000
10	10'x10' Sluice Gate	EA	2	$160,000	$320,000
11	Operators	EA	2	$30,000	$60,000
12	Flap Gates	EA	2	$40,000	$80,000
13	Cofferdam	CY	10000	$20	$200,000
14	Sluice Structure	LS	1	$250,000	$250,000
15	Demolish existing Gravity Sluices	LS	1	$150,000	$150,000
16	Mobilization	LS	1	$100,000	$100,000
Subtotal					$1,793,740
20% Contingency					$358,748
Total					**$2,152,488**
Escalation to Midpoint @ 6%/year& 5 yrs					$727,971
Subtotal					**$2,880,459**
Engineering and Surveying Services (12%)					$345,655
Construction Management (8%)					$230,437
Construction Materials Testing (1.5%)					$43,207
City Contract Administration (10%)					$288,046
Service Subtotal					**$907,345**
Total Estimated Project Cost					**$3,787,804**

4.3.3 Option EF3 – Retain Existing Gravity Sluices, 1 New 10'x12' Gravity Sluices

This option involves adding one new 10'x12' gravity sluice to the existing gravity sluices in the Eagle Ford Sump. Included in the construction will be the addition of motor operated sluice gates and a gate tower to house the gates. No new pump stations were needed for this option.

The proposed new gravity sluices are shown in Figure 4.3.3 and the preliminary opinion of probable cost is shown in Table 4.3.3.



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OPTION EF3
PROPOSED EAGLE FORD SUMP
1-10'x12' RCB

FIGURE
4.3.3

Table 4.3.3

Engineer's Preliminary Opinion of Probable Costs

Option EF3 Culvert Improvements at Eagle Ford Sump

Item No.	Description	Unit	Quantity	Unit Cost	Estimated Cost
1	10' x 12' RCB	LF	235	$1,200	$282,000
2	Trench Safety and Support	LF	235	$4	$940
3	CIP Headwall	EA	2	$20,000	$40,000
4	6" Concrete Apron Pavement	SY	20	$70	$1,400
5	PVC Coated Gabions	CY	100	$250	$25,000
6	Sodding	SY	200	$4	$800
7	Erosion Control	LS	1	$25,000	$25,000
8	Dewatering	LS	1	$50,000	$50,000
9	10'x12' Sluice Gate	EA	2	$200,000	$400,000
10	Operators	EA	2	$30,000	$60,000
11	Flap Gates	EA	2	$45,000	$90,000
12	Cofferdam	CY	10000	$20	$200,000
13	Sluice Structure	LS	1	$250,000	$250,000
14	Mobilization	LS	1	$100,000	$100,000
Subtotal					$1,525,140
20% Contingency					$305,028
Total					**$1,830,168**
Escalation to Midpoint @ 6%/year& 5 yrs					$618,963
Subtotal					**$2,449,131**
Engineering and Surveying Services (12%)					$293,896
Construction Management (8%)					$195,930
Construction Materials Testing (1.5%)					$36,737
City Contract Administration (10%)					$244,913
Service Subtotal					**$771,476**
Total Estimated Project Cost					**$3,220,607**

4.3.4 Option EF4 – Retain Existing Gravity Sluices, New 100,000 GPM Pump Station

This option includes retaining the existing Eagle Ford gravity sluices and constructing a new 100,000 gpm pump station at the site.

The Eagle Ford Storm Water Pump Station evaluated for Option EF4 has a total pumping capacity of 100,000 gpm. The pumping is accomplished with the use of three 33,333 gpm vertical axial flow pumps, each rated at 55 feet total dynamic head (TDH). Each of these pumps is driven by a 600 horsepower electric motor operating at 295 rpm, eliminating the need for a gear reducer between the motor and pump. Additionally, a 6,000 gpm vertical axial flow pump is provided for dewatering the sump during periods of low flow.

Pump station discharge piping will be configured to route up and over the levee and outfall to the river. Each individual pump will be equipped with a dedicated discharge header with a goose-neck high point elevation above the top of levee and an air release valve to prevent back-siphoning into the station. Station piping will be lined with high density polyurethane and coated with suitable epoxy-based systems.

The pump station will be configured in accordance with the guidance contained in the following documents:

- "Hydrologic Analysis of Interior Areas" EM 1110-2-1413, dated 15 January 1987
- "Hydrologic Frequency Analysis" EM 1120-2-1415, dated 05 March 1993
- "Flood Run-off Analysis" EM 1110-2-1417, dated 31 August 1994
- "Risk-Based Analysis for Flood Damage Reduction Studies" EM 1120-2-1619, dated 01 August 1996
- *EM1110-2-2100 Stability Analysis of Concrete Structures*
- *EM1110-2-2102 Waterstops and Other Preformed Joint Materials for CW Structures*
- *EM1110-2-2502 Retaining Walls*
- *EM1110-2-3104 Structural and Architectural Design of Pumping Stations*
- *EM1110-2-3105 Mechanical and Electrical Design of Pumping Stations*
- *EM1110-2-1804 Geotechnical Investigations*

The pump station substructure is cast-in-place concrete designed in accordance with ACI 310R and other appropriate standards. The foundation is a mat consisting of a five foot thick concrete slab to which the walls are attached. The walls utilize a stepped design in which the walls are reduced in thickness as the height of the structure increases and the soil load decreases. The sump area is deep and a removable hatch has been incorporated into the floor deck to provide access for removing debris that will accumulate in the sump area. The hatch is large enough to accommodate a small Bobcat.

The superstructure of the pump station is cast-in-place concrete and beams are incorporated into the structure to accommodate the installation of a bridge crane for maintenance. The pump station roof is designed to be double tees, which increases the stiffness of the structure and simplifies construction and maintenance. The roof will consist of the double tees, a two-inch layer of light-weight grout, and a membrane. The superstructure has been designed so that a drive through corridor is incorporated into the station, permitting truck access directly adjacent to the pumps for maintenance.

The exterior wall sections have been assumed to be concrete masonry units with brick veneer, although a different system may be incorporated in the final design.

The pump station interior in the pump room is unfinished; however, the interiors of the switchgear room, office, and restroom have conventional dry wall construction and are painted. Flooring throughout the station is concrete with a troweled finish. The main pump room is provided with ventilation, while the switchgear room, office, and restroom are conditioned.

The primary electrical supply to the station is three-phase, 4160 v.a.c. and is provided by TXU. The supply is from two independent substations providing needed redundancy. Therefore, the standby generator set is for use by limited equipment including the control system, lighting, HVAC components, and the bridge crane. The switchgear is located in the switchgear room and includes soft starts for each of the main pumping units. The switchgear is configured as a main-tie-main to provide additional redundancy and reliability in station operation.

This pump station is located on the West Levee, in the vicinity of the existing Eagle Ford Gravity Sluices, directly adjacent to US Highway 12. Access to the station is provided via a concrete paved access road. Roll-up doors on the station provide the drive-through access. Since the site is located next to the sump a retaining wall is provided to level the site for routine operations. Water and sewer are available in adjacent public streets, and a two-inch water service and a 4-inch sanitary sewer has been provided for the station.

The interior lighting level will be maintained at 85 foot candles. All handrails will be four-rung aluminum. Grating will be hot-dipped galvanized.

The instrumentation and control system will incorporate monitoring and alarming for motor and pump bearing temperature, motor winding temperature, reverse rotation, flow for each pump, sump elevation, and precipitation. The controls system will be integrated into the SCADA system operated by the City of Dallas. Individual pump control can be initiated at the pump, in the operator office/control room, or remotely by the SCADA system.

Figure 4.3.4 is a site plan for this alternative.

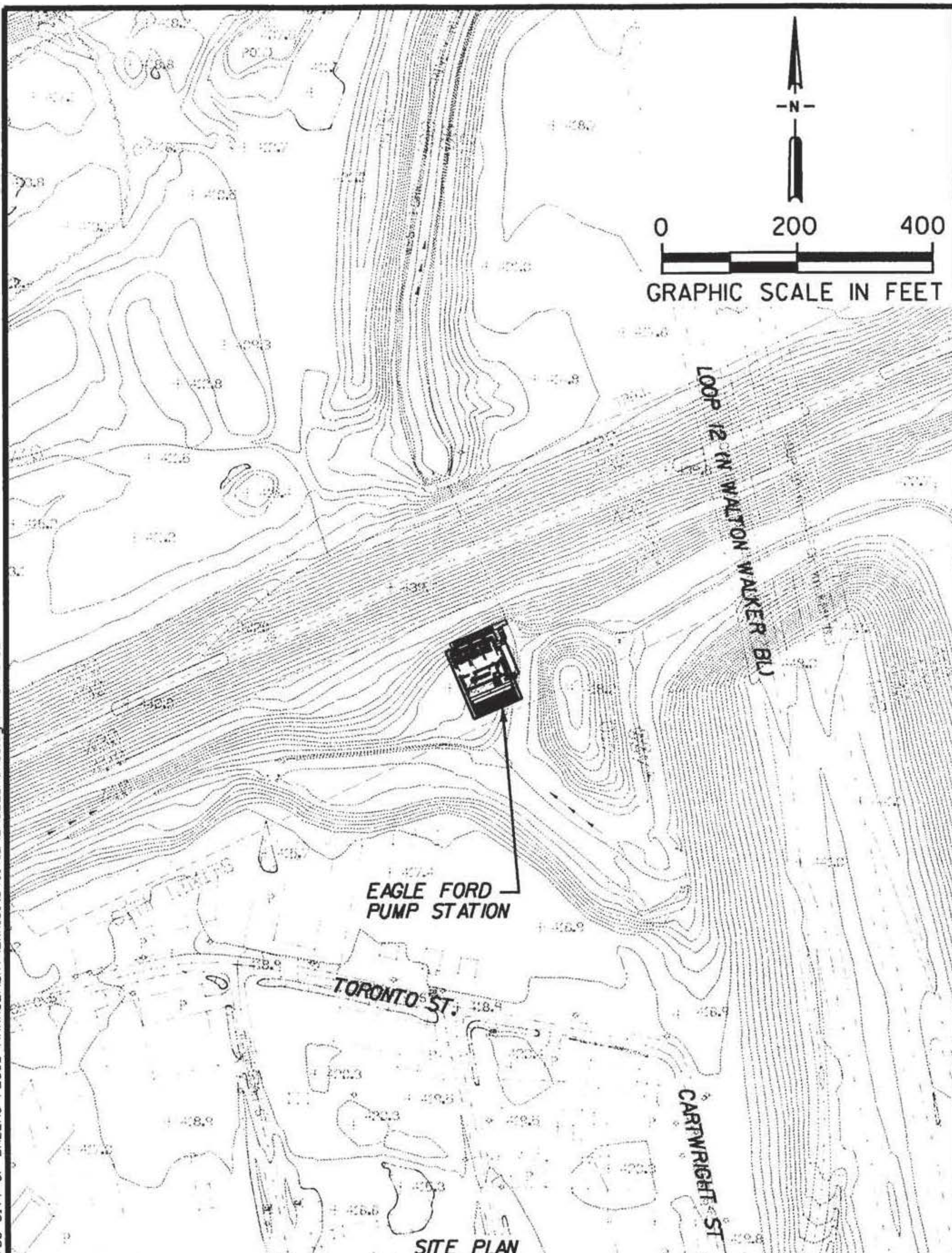
Figure 4.3.5 is a plan view of the 100,000 gpm pump station. The trash rack in the front of the station will be equipped with mechanically-cleaned screens manufactured by Du Perion, since these screens have demonstrated ability to function very effectively in this harsh environment. The switchgear room is adjacent to the pump room.

Figure 4.3.6 is Section A and the relationship of the pumping units, intake sump, and discharge piping are clearly indicated. The bridge crane has 27-foot clearance above the drive through for removal and/or installation of the pumping equipment.

Figures 4.3.7A and 4.3.7B are the electrical one-line diagrams for the station. The double-ended switchgear is indicated. Each of the main pumps is operated by a soft start that has a by-pass that permits the motor to be started even if the soft start is out of service. In addition to the protection provided by the soft start, each of the motors will be equipped with a Multilin 469 to provide motor protective relay systems.

Figure 4.3.8 is a preliminary process and instrumentation diagram for the pump station. The vibration monitoring equipment is shown, as are the RTDs for monitoring motor winding temperatures, and the pump and motor bearing temperatures. Each of the pumps will be equipped with an ultrasonic flow meter to monitor pump discharge.

The Engineer's Preliminary Opinion of Probable Cost for the storm water pump station for Option D2 is summarized in Table 4.3.4.



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JACOBS Carter Burgess	CITY OF DALLAS DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION	PROPOSED EAGLE FORD PUMP STATION VERTICAL PUMPS 100,000 GPM CAPACITY	FIGURE 4.3.4

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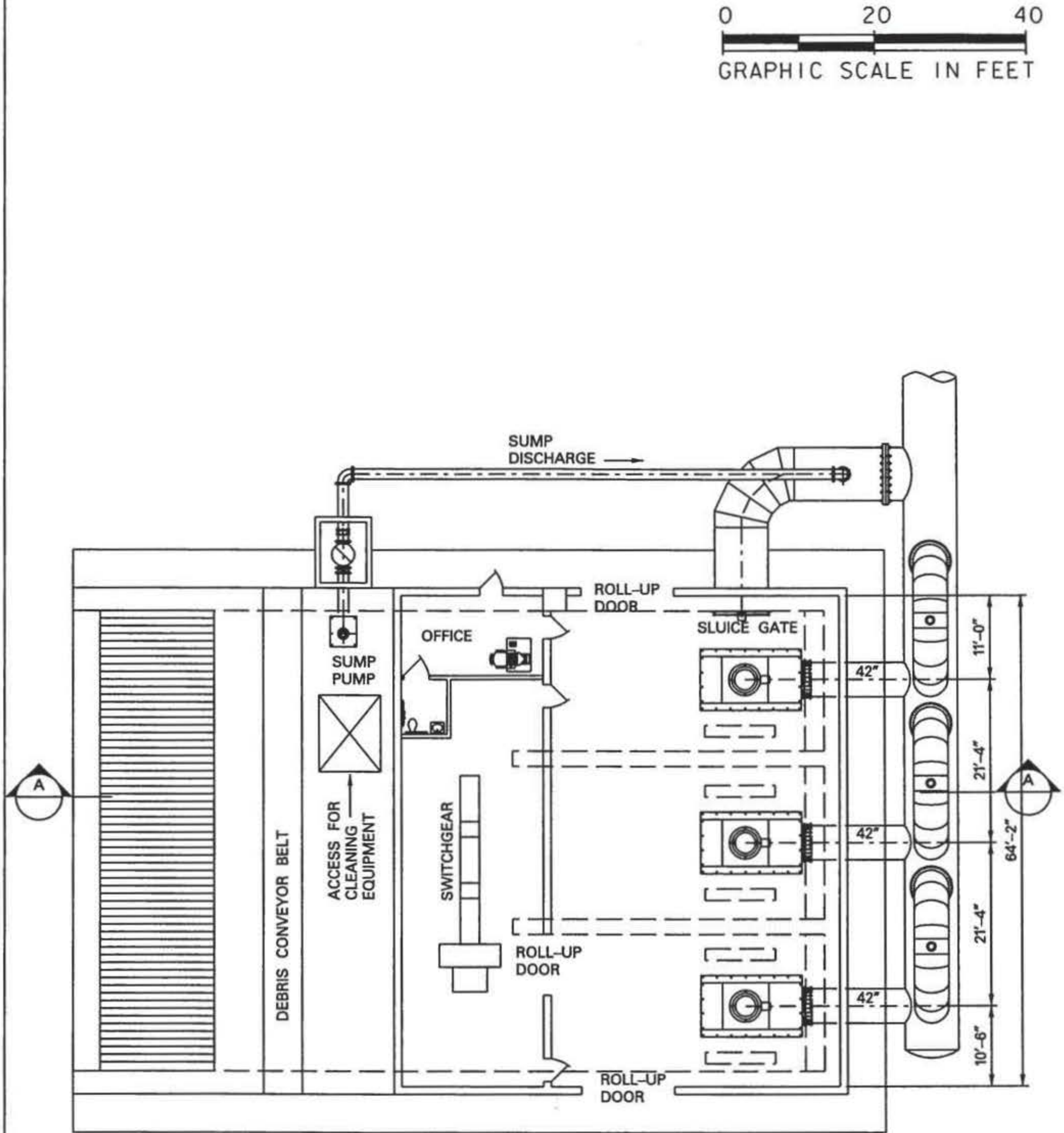
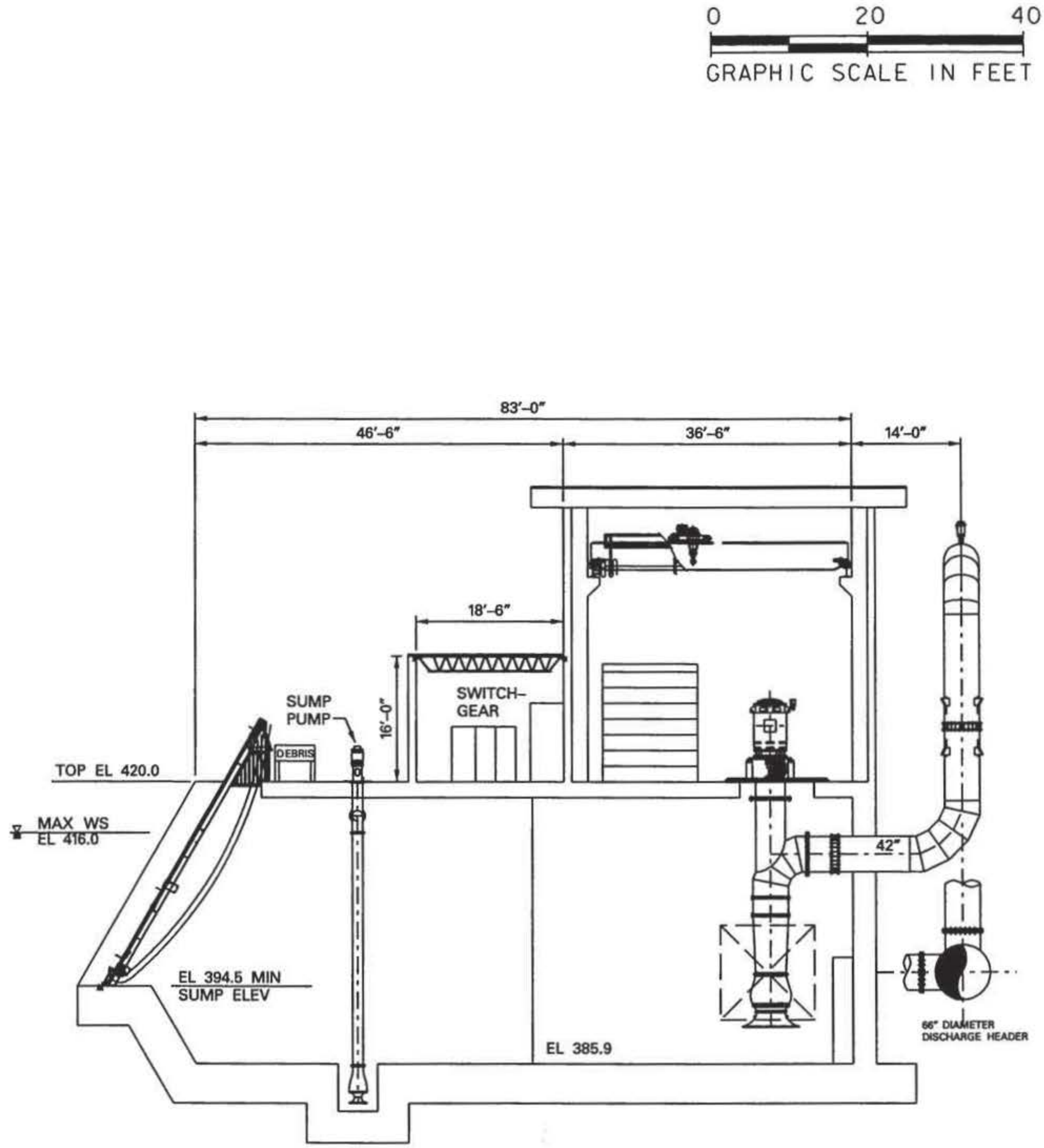


PLAN VIEW
SCALE: 1" = 20'

STATION CAPACITY = 100,000 GPM
35,000 GPM PER PUMP

DGNSPEC$LEV

JACOBS Carter Burgess	CITY OF DALLAS DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION	PROPOSED EAGLE FORD PUMP STATION VERTICAL PUMPS 100,000 GPM CAPACITY	FIGURE 4.3.5



SECTION A – VERTICAL PUMPS
SCALE: 1" = 20'

STATION CAPACITY = 100,000 GPM
35,000 GPM PER PUMP

JE JACOBS Carter Burgess THESE DRAWINGS/DOCUMENTS ARE BEING SUBMITTED BY CARTER & BURGESS INC. CARTER & BURGESS, INC. IS A WHOLLY OWNED SUBSIDIARY OF JACOBS ENGINEERING GROUP INC AND HEREINAFTER REFERRED TO AS JACOBS CARTER BURGESS.	CITY OF DALLAS DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION	PROPOSED EAGLE FORD PUMP STATION VERTICAL PUMPS 100,000 GPM CAPACITY	FIGURE 4.3.6

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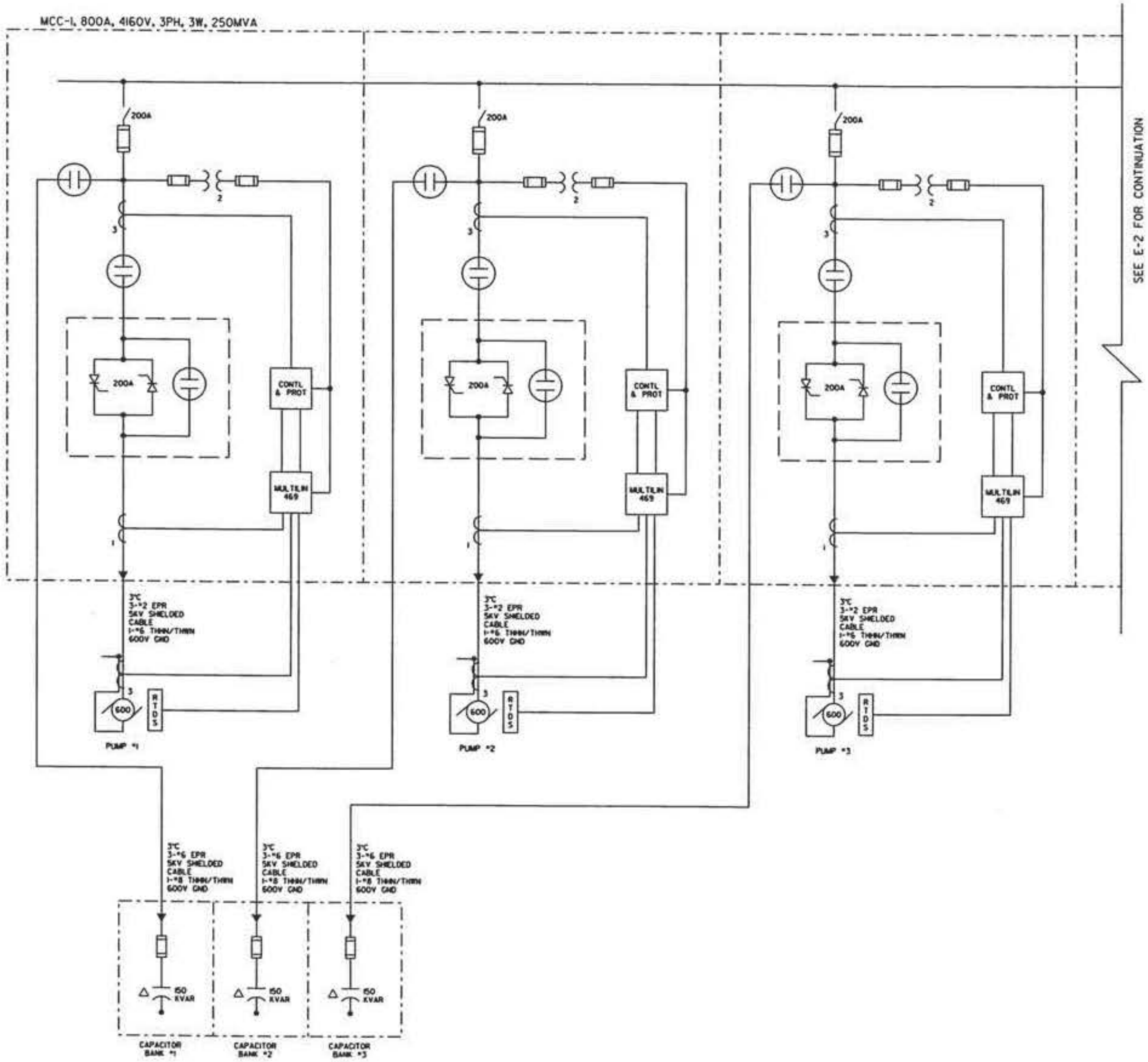

SEE E-2 FOR CONTINUATION

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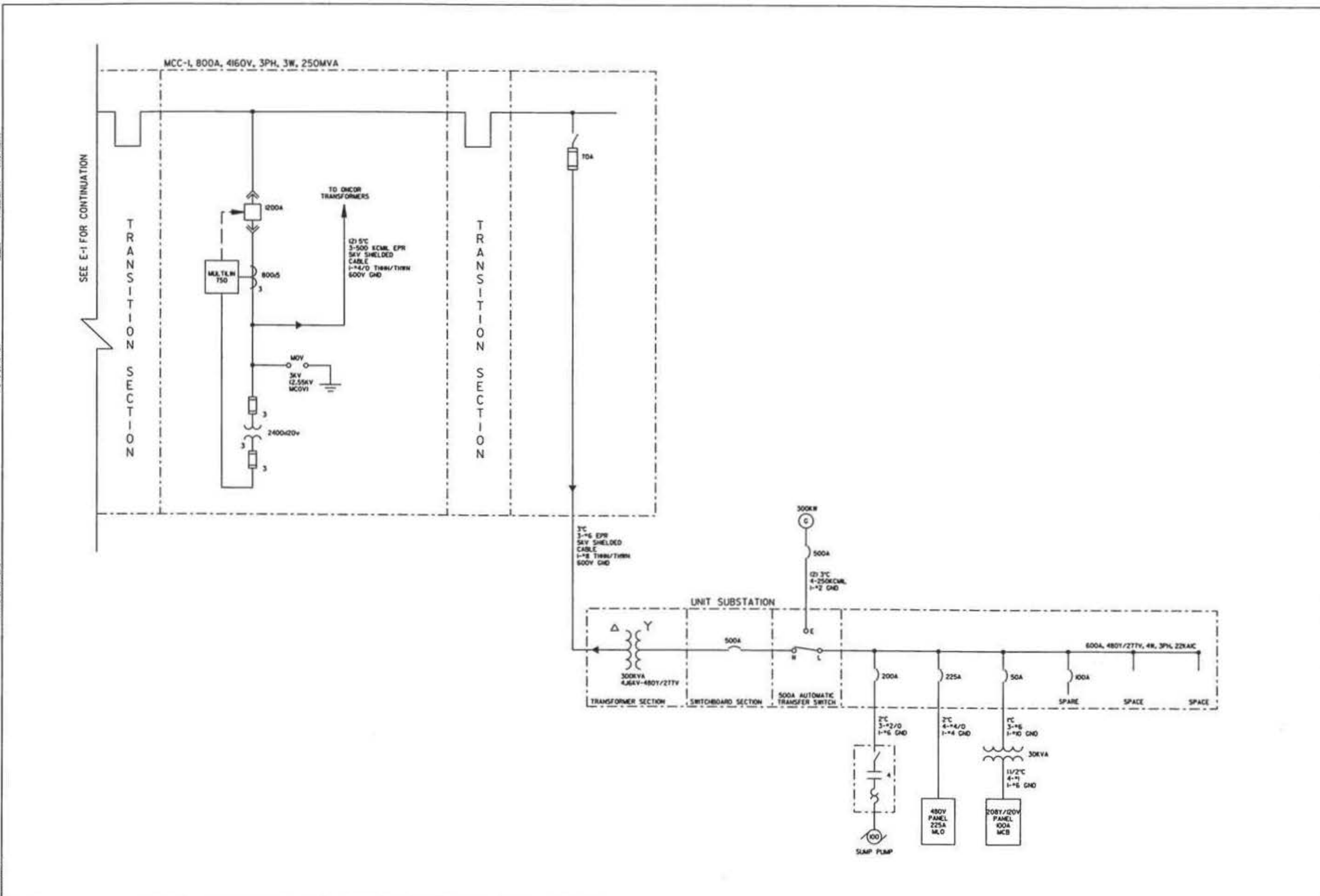
CITY OF DALLAS
DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

PROPOSED EAGLE FORD PUMP STATION
VERTICAL PUMPS
100,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

FIGURE
4.3.7A



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PROPOSED EAGLE FORD PUMP STATION
VERTICAL PUMPS
100,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

FIGURE
4.3.7B

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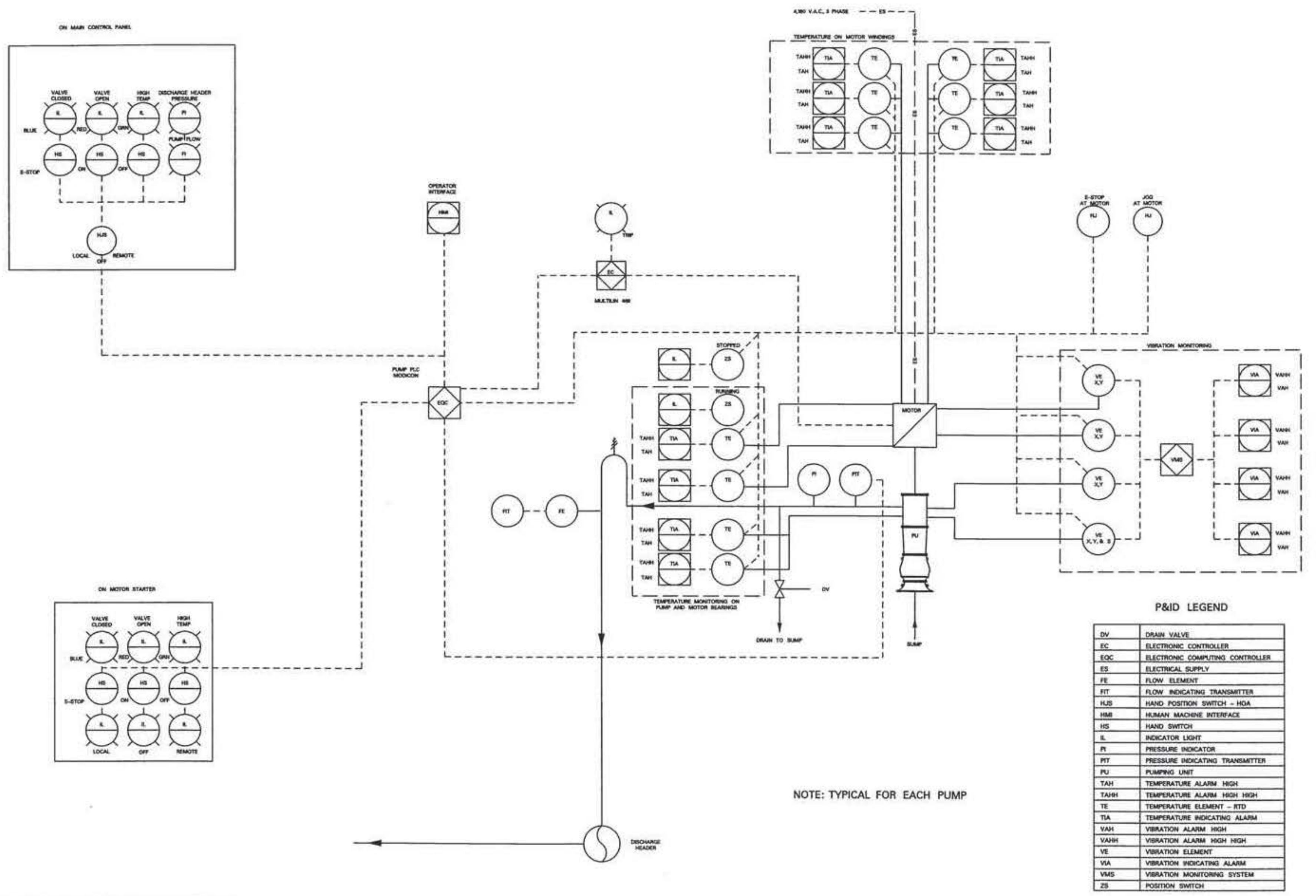

P&ID LEGEND

DV	DRAIN VALVE
EC	ELECTRONIC CONTROLLER
EQC	ELECTRONIC COMPUTING CONTROLLER
ES	ELECTRICAL SUPPLY
FE	FLOW ELEMENT
FIT	FLOW INDICATING TRANSMITTER
HJS	HAND POSITION SWITCH – HOA
HMI	HUMAN MACHINE INTERFACE
HS	HAND SWITCH
IL	INDICATOR LIGHT
PI	PRESSURE INDICATOR
PIT	PRESSURE INDICATING TRANSMITTER
PU	PUMPING UNIT
TAH	TEMPERATURE ALARM HIGH
TAHH	TEMPERATURE ALARM HIGH HIGH
TE	TEMPERATURE ELEMENT – RTD
TIA	TEMPERATURE INDICATING ALARM
VAH	VIBRATION ALARM HIGH
VAHH	VIBRATION ALARM HIGH HIGH
VE	VIBRATION ELEMENT
VIA	VIBRATION INDICATING ALARM
VMS	VIBRATION MONITORING SYSTEM
ZS	POSITION SWITCH

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CITY OF DALLAS
DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

PROPOSED EAGLE FORD PUMP STATION
100,000 GPM CAPACITY

PROCESS AND INSTRUMENTATION DIAGRAM

FIGURE
4.3.8

Table 4.3.4

Summary for Eagle Ford 3 Pump 100,000 gpm

Division	Cost
Division 1 - General Conditions	$2,127,200
Divison 2 - Site Work	$1,667,300
Division 3- Concrete	$2,183,085
Division 4 - Masonry	$87,072
Division 5- Metals	$118,515
Division 6 - Carpentry	$4,000
Division 7 - Thermal & Moisture Protection	$784,835
Division 8 - Doors & Windows	$12,700
Division 9 - Finishes	$85,075
Division 10 - Specialties	$9,700
Division 11 - Equipment	$3,473,500
Division 12 - Furnishings	$4,110
Division 13- Special Construction	$0
Division 14 - Conveying Systems	$350,000
Division 15 - Mechanical	$235,018
Division 16 - Electrical	$2,206,500
Division 17 - Instrumentation & Control	$1,293,500
Division Subtotal	**$14,642,110**
Contractor's Profit of Materials - 10%	$988,761
Prime Profit on SubConstractors - 10%	$451,894
Subtotal	**$16,082,765**
Construction Contingencies - 20%	$3,216,553
Construction Work Effort subtotal	**$19,299,318**
Escalation to Midpoint @ 6%/Yr & 3 yrs	$6,527,029
Subtotal	**$25,826,347**
Engineering and Surveying Services (12%)	$3,099,162
Construction Management (8%)	$2,066,108
Construction Materials Testing (1.5%)	$387,395
City Contract Administration (10%)	$2,582,635
Services Subtotal	**$8,135,299**
Total Estimated Project Cost	**$33,961,647**

Table 4.3.4
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Eagle Ford Site with 3 Pumps
100,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 1 - General Conditions							
Mobilization	1	LS	$0	$0		$0	$600,000
Construction Surveying	1	LS	$0	$0	$45,000.00	$45,000	$45,000
Telephone	24	Mo	$150	$3,600	$0.00	$0	$3,600
SWWWP	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Trench Excavation Safety & Support/Structural Plan	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Traffic Control Plan	1	LS	$15,000	$15,000	$0.00	$0	$15,000
PM	24	Mo	$0	$0	$15,000.00	$360,000	$360,000
Superintendent	24	Mo	$0	$0	$12,000.00	$288,000	$288,000
Admin	24	Mo	$0	$0	$7,000.00	$168,000	$168,000
Sanitary Services	24	Mo	$0	$0	$500.00	$12,000	$12,000
Security Services	24	Mo	$0	$0	$2,000.00	$48,000	$48,000
Pick Up Trucks - 3 each	24	Mo	$0	$0	$1,800.00	$43,200	$43,200
Office Equipment	24	Mo	$0	$0	$350.00	$8,400	$8,400
150 Ton Crane - 18 Months	18	Mo	$0	$0	$20,000.00	$360,000	$360,000
Loader - 24 Months	24	Mo	$0	$0	$2,000.00	$48,000	$48,000
Office Trailors - 2 each	24	Mo	$0	$0	$1,500.00	$36,000	$36,000
Tool Trailors - 2 each	24	Mo	$0	$0	$500.00	$12,000	$12,000
Subtotal for Division 1							**$2,127,200**
Division 2 - Site Work							
Structural Excavation	12,000	CY	$0.00	$0	$8.00	$96,000	$96,000
Structural Backfill	10,000	CY	$6.00	$60,000	$3.00	$30,000	$90,000
Paving	1,300	SY	$12.00	$15,600	$12.00	$15,600	$31,200
Pavement Striping	2,450	SF	$6.00	$14,700	$2.00	$4,900	$19,600
Traffic Control	1	LS	$5,000.00	$5,000	$20,000.00	$20,000	$25,000
Curb Stops	10	EA	$200.00	$2,000	$50.00	$500	$2,500
8-inch Bollards	10	EA	$1,000.00	$10,000	$150.00	$1,500	$11,500
Grading	3,000	SY	$1.00	$3,000	$2.00	$6,000	$9,000
Fencing - 10 Ft. Man Proof	1,000	LF	$50.00	$50,000	$10.00	$10,000	$60,000
16-foot slide gate (Electric Motor)	1	EA	$6,000.00	$6,000	$1,000.00	$1,000	$7,000
3-foot ped. Gate	1	EA	$400.00	$400	$100.00	$100	$500

Table 4.3.4

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Eagle Ford Site with 3 Pumps

100,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Landscaping	1	LS	$50,000.00	$50,000	$5,000.00	$5,000	$55,000
Channel Liner	2,000	SY	$10.00	$20,000	$5.00	$10,000	$30,000
42-inch steel discharge pipe - 3@130' each	390	LF	$600	$234,000	$100.00	$39,000	$273,000
42-inch nut, bolt and gasket sets	6	EA	$1,500	$9,000	$850.00	$5,100	$14,100
66-inch steel dischage pipe	200	LF	$900	$180,000	$100.00	$20,000	$200,000
Water - 2-inch	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Sewer	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Telephone	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Misc Utilities	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Shoring	5,000	SF	$35	$175,000	$5.00	$25,000	$200,000
Dewatering	1	LS	$250,000	$250,000	$25,000.00	$25,000	$275,000
Coffer Dam - 26' high 2:1ss	10,000	CY	$15	$150,000	$5.00	$50,000	$200,000
3-inch mud slab	140	CY	$100	$14,000	$25.00	$3,500	$17,500
Subtotal for Division 2							**$1,667,300**
Division 3 - Concrete							
Substructure Concrete (Foundation)							
Concrete	1000	CY	$100	$100,000	$15.00	$15,000	$115,000
Rebar (310 lb/CY)	155	TON	$1,020	$158,100	$300.00	$46,500	$204,600
Forming	6630	SF	$10	$66,300	$5.00	$33,150	$99,450
Curing	80	CSF	$5	$400	$5.00	$400	$800
Waterstops	320	LF	$10	$3,200	$5.00	$1,600	$4,800
Substructure Concrete (Pump Room Floor)							
Concrete	175	CY	$100	$17,500	$15.00	$2,625	$20,125
Rebar (310 lb/CY)	27	TON	$1,020	$27,668	$300.00	$8,138	$35,805
Forming	3641	SF	$10	$36,410	$5.00	$5	$36,415
Curing	63	CSF	$5	$315	$5.00	$315	$630
Waterstops	315	LF	$10	$3,150	$5.00	$1,575	$4,725
Substructure Concrete (Perimeter walls) - ext. 4' thick avg.							
Concrete	1000	CY	$100	$100,000	$15.00	$15,000	$115,000
Rebar (310 lb/CY)	155	TON	$1,020	$158,100	$300.00	$46,500	$204,600
Forming	7795	SF	$10	$77,950	$5.00	$38,975	$116,925

Table 4.3.4
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Eagle Ford Site with 3 Pumps
100,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Curing	180	CSF	$5	$900	$5.00	$900	$1,800
Waterstops	275	LF	$10	$2,750	$5.00	$1,375	$4,125
Substructure Concrete (Divider walls-int. 2' thick avg)							
Concrete	230	CY	$100	$23,000	$15.00	$3,450	$26,450
Rebar (310 lb/CY)	36	TON	$1,020	$36,363	$300.00	$10,695	$47,058
Forming	3678	SF	$10	$36,780	$5.00	$18,390	$55,170
Curing	190	CSF	$5	$950	$5.00	$950	$1,900
Waterstops	500	LF	$10	$5,000	$5.00	$2,500	$7,500
Substructure Columns and Beams							
Concrete	35	CY	$100	$3,500	$15.00	$525	$4,025
Rebar (310 lb/CY)	5	TON	$1,020	$5,534	$300.00	$1,628	$7,161
Forming	1200	SF	$10	$12,000	$5.00	$6,000	$18,000
Curing	40	CSF	$5	$200	$5.00	$200	$400
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Electrical Room Bottom Slab							
Concrete	100	CY	$100	$10,000	$15.00	$1,500	$11,500
Rebar (310 lb/CY)	16	TON	$1,020	$15,810	$300.00	$4,650	$20,460
Forming	1073	SF	$10	$10,730	$5.00	$5,365	$16,095
Curing	60	CSF	$5	$300	$5.00	$300	$600
Waterstops	150	LF	$10	$1,500	$5.00	$750	$2,250
Superstructure Columns							
Concrete	50	CY	$100	$5,000	$15.00	$750	$5,750
Rebar (310 lb/CY)	8	TON	$1,020	$7,905	$300.00	$2,325	$10,230
Forming	3100	SF	$10	$31,000	$5.00	$15,500	$46,500
Curing	200	CSF	$5	$1,000	$5.00	$1,000	$2,000
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Superstructure Beams							
Concrete	50	CY	$100	$5,000	$15.00	$750	$5,750
Rebar (310 lb/CY)	8	TON	$1,020	$7,905	$300.00	$2,325	$10,230
Forming	2164	SF	$10	$21,640	$5.00	$10,820	$32,460
Curing	250	CSF	$5	$1,250	$5.00	$1,250	$2,500
Waterstops	0	LF	$10	$0	$5.00	$0	$0

Table 4.3.4

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Eagle Ford Site with 3 Pumps

100,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Superstructure double-Tees	4752	SF	$18	$85,536	$5.00	$23,760	$109,296
Retaining Walls - MSE wall >20'	15500	SF	$40	$620,000	$10.00	$155,000	$775,000
Subtotal Division 3							**$2,183,085**
Division 4 - Masonary							
CMU Partitions	12,000	SF	$3.00	$36,000	$4.00	$48,000	$84,000
Glazed CMU Restroom Walls	256	SF	$8.00	$2,048	$4.00	$1,024	$3,072
Subtotal for Division 4				**$0**		**$0**	**$87,072**
Division 5 - Metals							
Grating	800	SF	$20	$16,000	$5.00	$4,000	$20,000
Mtl deck	7,505	SF	$2	$15,010	$1.00	$7,505	$22,515
Bar Joists	1	LS	$60,000	$60,000	$5,000.00	$5,000	$65,000
Handrail	200	LF	$40	$8,000	$15.00	$3,000	$11,000
Subtotal for Division 5							**$118,515**
Division 6 - Carpentry							
Misc.	1	ls	$1,000	$1,000	$3,000.00	$3,000	$4,000
Subtotal for Division 6							**$4,000**
Division 7 - Thermal and Moisture Protection							
Exterior walls	11,000	SF	$45	$495,000	$20.00	$220,000	$715,000
Roofing	4,752	SF	$4	$19,008	$2.00	$49,827	$68,835
Roof Hatch-Pumps	0	EA	$15,000	$0	$500.00	$0	$0
Roof Hatch-Access	1	EA	$800	$800	$200.00	$200	$1,000
Subtotal for Division 7							**$784,835**
Division 8 - Doors and Windows							
Doors, 3-0 x 7-0 steel	5	Ea	$200	$1,000	$100.00	$500	$1,500
Doors, roll-up 12' x 14' steel	2	Ea	$5,000	$10,000	$600.00	$1,200	$11,200

Table 4.3.4

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Eagle Ford Site with 3 Pumps

100,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Subtotal for Division 8				**$0**		**$0**	**$12,700**
Division 9- Finishes							
Process Piping (pump rm risers & hdrs)	4,100	SF	$0.50	$2,050	$1.25	$5,125	$7,175
Misc. Structural Steel Surf. Prep.	8,900	LS	$1.00	$8,900	$2.00	$17,800	$26,700
Paint Structural Steel	8,900	sf	$1.00	$8,900	$4.00	$35,600	$44,500
Paint Building Interior Walls	10,000	SF	$0.10	$1,000	$0.57	$5,700	$6,700
Subtotal for Division 9							**$85,075**
Division 10 - Specialities							
Signage	1	LS	$5,000	$5,000	$1,000.00	$1,000	$6,000
Woven Wire Partition - 15'x15'x10'Tall	1	LS	$2,500	$2,500	$500.00	$500	$3,000
Toilet Accessories	1	LS	$500	$500	$200.00	$200	$700
Subtotal for Division 10				**$0**		**$0**	**$9,700**
Division 11 - Equipment							
Veritical sump pump, 7000 gpm	1	Ea	$80,000	$80,000	$5,000.00	$5,000	$85,000
Trash Rack (25' x 40')	1,000	SF	$400	$400,000	$10.00	$10,000	$410,000
Restrained Couplings	9	Ea	$15,000	$135,000	$1,500.00	$13,500	$148,500
Vertical Pumps and Motors - 35,000 gpm	3	Ea	$800,000	$2,400,000	$30,000.00	$90,000	$2,490,000
Stop Logs	1	LS	$200,000	$200,000	$15,000.00	$15,000	$215,000
66" - Flap Gate	1	Ea	$15,000	$15,000	$5,000.00	$5,000	$20,000
Sluice Gate - 9'x9'	1	Ea	$100,000	$100,000	$5,000.00	$5,000	$105,000
Subtotal for Division 11							**$3,473,500**
Division 12 - Furnishings							
Desk	1	Ea	$1,000	$1,000	$100.00	$100	$1,100
Chair	1	Ea	$600	$600	$10.00	$10	$610
Storage Shelves	4	Ea	$500	$2,000	$100.00	$400	$2,400
Subtotal for Division 12							**$4,110**
Division 13 - Special Construction							

Table 4.3.4
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Eagle Ford Site with 3 Pumps
100,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Subtotal for Division 13							$0
Division 14 - Conveying Systems							
30 Ton Bridge Crane	1	Ea	$200,000	$200,000	$25,000.00	$25,000	$225,000
Automated Conveyor System	1	LS	$100,000.00	$100,000	$25,000.00	$25,000	$125,000
Subtotal for Division 14							**$350,000**
Division 15 - Mechanical							
Ventilation Fan(S)	3	EA	$2,000	$6,000	$500.00	$1,500	$7,500
Roof Curb(S)	3	EA	$1,000	$3,000	$250.00	$750	$3,750
Controls	1	LS	$25,000	$25,000	$10,000.00	$10,000	$35,000
Floor Drain(S)	6	EA	$300	$1,800	$150.00	$900	$2,700
Toilet(S)	1	EA	$200	$200	$200.00	$200	$400
Sink(S)	2	EA	$400	$800	$100.00	$200	$1,000
Urinal(S)	1	EA	$200	$200	$75.00	$75	$275
Faucet(S)	2	EA	$350	$700	$100.00	$200	$900
Trap Primer(S)	2	EA	$350	$700	$150.00	$300	$1,000
Drain/Waste/Vent Plumbing	1000	LF	$15	$15,000	$7.00	$7,000	$22,000
Cold Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Hot Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Dx Hvac Air Handler(S)	2	EA	$17,500	$35,000	$5,000.00	$10,000	$45,000
Dx Hvac Condensing Unit(S)	2	EA	$15,000	$30,000	$1,500.00	$3,000	$33,000
Controls	1	LS	$7,500	$7,500	$5,000.00	$5,000	$12,500
Condensing Unit Pad(S)	1	EA	$500	$500	$100.00	$100	$600
Ductwork	1000	LBS	$50	$50,000	$5.00	$5,000	$55,000
Diffuser(S)/Register(S)/Grille(S)	9	EA	$17	$153	$10.00	$90	$243
Louvre(S)	9	EA	$150	$1,350	$100.00	$900	$2,250
Fire Hose Rack	2	EA	$350	$700	$100.00	$200	$900
Subtotal for Division 15							**$235,018**
Division 16 - Electrical							
Mobilization	1	LS	$0	$0	$0.00	$0	$50,000
Temporary Power	1	LS	$50,000	$50,000	$2,000.00	$2,000	$52,000

Table 4.3.4
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Eagle Ford Site with 3 Pumps
100,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Duct Banks	200	CY	$400	$80,000	$20.00	$4,000	$84,000
Manholes	3	EA	$6,000	$18,000	$500.00	$1,500	$19,500
1/0 15 Kv Cable	1,000	LF	$7	$7,000	$3.00	$3,000	$10,000
250 Mcm 15 Kv Cable	1,000	LF	$8	$8,000	$3.00	$3,000	$11,000
100 Mcm 15 Kv Cable	1,000	LF	$6	$6,000	$2.00	$2,000	$8,000
5 Kv Terminations	50	EA	$175	$8,750	$25.00	$1,250	$10,000
Conduit	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Wire	1	LS	$75,000	$75,000	$10,000.00	$10,000	$85,000
Lighting							
Exterior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Interior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Mv Switchgear	1	LS	$100,000	$100,000	$25,000.00	$25,000	$125,000
Soft Starts - 800 HP	3	EA	$52,000	$156,000	$15,000.00	$45,000	$201,000
1500 Kva Transformers	3	EA	$50,000	$150,000	$10,000.00	$30,000	$180,000
480 Volt Mcc	1	EA	$85,000	$85,000	$50,000.00	$50,000	$135,000
Misc. Switchgear	1	LS	$50,000	$50,000	$6,000.00	$6,000	$56,000
Lightning Protection	1	LS	$35,000	$35,000	$5,000.00	$5,000	$40,000
Telephone System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Fire Alarm System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Security And Entrance Equipment	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Embedded Conduit	1	LS	$25,000	$25,000	$8,000.00	$8,000	$33,000
Grounding	1	LS	$50,000	$50,000	$10,000.00	$10,000	$60,000
Cable Tray	1	LS	$25,000	$25,000	$15,000.00	$15,000	$40,000
500 Kva Gen Set With ATS	1	Ea	$98,000	$98,000	$5,000.00	$5,000	$103,000
TXU Firm Backup Capabiltiy	1	LS	$600,000	$600,000	$30,000.00	$30,000	$630,000
Testing	1	LS	$15,000	$15,000	$5,000.00	$5,000	$20,000
Subtotal for Division 16							**$2,206,500**
Division 17 - I&C							
Engineering & Submittals	1	LS	$75,000	$75,000	$5,000.00	$5,000	$80,000

Table 4.3.4
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Eagle Ford Site with 3 Pumps
100,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Computers And Printers	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
F O Cable And Comm. Equip.	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Control Panels	1	LS	$250,000	$250,000	$10,000.00	$10,000	$260,000
Start Up-Check Out	1	LS	$35,000	$35,000	$10,000.00	$10,000	$45,000
Ultra Sonic Flow Meters	4	Ea	$5,000	$20,000	$2,500.00	$10,000	$30,000
HMI Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
PLC Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
O&M Manuals	1	LS	$5,000	$5,000	$2,000.00	$2,000	$7,000
Training	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Software	1	LS	$85,000	$85,000	$15,000.00	$15,000	$100,000
Factory Test	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Bonds	1	LS	$0	$0	$0.00	$0	$80,000
Level transmitters	3	Ea	$2,000	$6,000	$500.00	$1,500	$7,500
PLC - Primary + hot back-up	1	Ea	$17,500	$17,500	$7,500.00	$7,500	$25,000
PC and Monitor	1	Ea	$8,000	$8,000	$1,000.00	$1,000	$9,000
MMI Software + Programming	1	Ea	$7,000	$7,000	$15,000.00	$15,000	$22,000
Instrumentation wiring	1	LS	$75,000	$75,000	$28,000.00	$28,000	$103,000
SCADA Transmitter	1	Ea	$100,000	$100,000	$10,000.00	$10,000	$110,000
Security Cameras	1	LS	$75,000	$75,000	$10,000.00	$10,000	$85,000
Subtotal for Division 17							**$1,293,500**
Division subtotal				**$9,887,614**		**$3,345,996**	**$14,642,110**
Contractor's Profit on Material (10%)							$988,761
Prime Profit on Subcontractors - 10% on Div 5, 6, 7, 8, 9, 10, 12, 16, 17							$451,894
Subtotal							**$16,082,765**
Contingency (20%)							$3,216,553
Construction Work Effort subtotal							**$19,299,318**
Escalation to Midpoint @ 6%/year& 5 yrs							**$6,527,029**
Subtotal							**$25,826,347**
Engineering and Surveying Services (12%)							$3,099,162
Construction Management (8%)							$2,066,108

Table 4.3.4
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Eagle Ford Site with 3 Pumps
100,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Construction Materials Testing (1.5%)							$387,395
City Contract Administration (10%)							$2,582,635
Services Subtotal							**$8,135,299**
Total Estimated Project Cost							**$33,961,647**

4.3.5 Option EF5 – Demo Existing Gravity Sluices, New 150,000 GPM Pump Station

This option includes demolishing the existing Eagle Ford gravity sluices and constructing a new 150,000 gpm pump station at the site. This option will lower the flood level in the sump to 416.1 feet.

The Eagle Ford Storm Water Pump Station evaluated for Option EF5 has a total pumping capacity of 150,000 gpm. The pumping is accomplished with the use of three 50,000 gpm vertical axial flow pumps, each rated at 55 feet total dynamic head (TDH). Each of these pumps is driven by a 900 horsepower electric motor operating at 295 rpm, eliminating the need for a gear reducer between the motor and pump. Additionally, a 6,000 gpm vertical axial flow pump is provided for dewatering the sump during periods of low flow.

Pump station discharge piping will be configured to use the two existing 4.5'x4.5' gravity sluices as outfall to the river. Each individual pump will be equipped with a dedicated discharge header with a goose-neck high point elevation above the top of levee and an air release valve to prevent back-siphoning into the station. Station piping will be lined with high density polyurethane and coated with suitable epoxy-based systems.

The pump station will be configured in accordance with the guidance contained in the following documents:

- "Hydrologic Analysis of Interior Areas" EM 1110-2-1413, dated 15 January 1987
- "Hydrologic Frequency Analysis" EM 1120-2-1415, dated 05 March 1993
- "Flood Run-off Analysis" EM 1110-2-1417, dated 31 August 1994
- "Risk-Based Analysis for Flood Damage Reduction Studies" EM 1120-2-1619, dated 01 August 1996
- *EM1110-2-2100 Stability Analysis of Concrete Structures*
- *EM1110-2-2102 Waterstops and Other Preformed Joint Materials for CW Structures*
- *EM1110-2-2502 Retaining Walls*
- *EM1110-2-3104 Structural and Architectural Design of Pumping Stations*
- *EM1110-2-3105 Mechanical and Electrical Design of Pumping Stations*
- *EM1110-2-1804 Geotechnical Investigations*

The pump station substructure is cast-in-place concrete designed in accordance with ACI 310R and other appropriate standards. The foundation is a mat consisting of a five foot thick concrete slab to which the walls are attached. The walls utilize a stepped design in which the walls are reduced in thickness as the height of the structure increases and the soil load decreases. The sump area is deep and a removable hatch has been incorporated into the floor deck to provide access for removing debris that will accumulate in the sump area. The hatch is large enough to accommodate a small Bobcat.

The superstructure of the pump station is cast-in-place concrete and beams are incorporated into the structure to accommodate the installation of a bridge crane for maintenance. The pump station roof is designed to be double tees, which increases the stiffness of the structure and simplifies construction and maintenance. The roof will consist of the double tees, a two-inch layer of light-weight grout, and a membrane. The superstructure has been designed so that a drive through corridor is incorporated into the station, permitting truck access directly adjacent to the pumps for maintenance.

The exterior wall sections have been assumed to be concrete masonry units with brick veneer, although a different system may be incorporated in the final design.

The pump station interior in the pump room is unfinished; however, the interiors of the switchgear room, office, and restroom have conventional dry wall construction and are painted. Flooring throughout the station is concrete with a troweled finish. The main pump room is provided with ventilation, while the switchgear room, office, and restroom are conditioned.

The primary electrical supply to the station is three-phase, 4160 v.a.c. and is provided by TXU. The supply is from two independent substations providing needed redundancy. Therefore, the standby generator set is for use by limited equipment including the control system, lighting, HVAC components, and the bridge crane. The switchgear is located in the switchgear room and includes soft starts for each of the main pumping units. The switchgear is configured as a main-tie-main to provide additional redundancy and reliability in station operation.

This pump station is located on the West Levee, in the vicinity of the existing Eagle Ford Gravity Sluices, directly adjacent to US Highway 12. Access to the station is provided via a concrete paved access road. Roll-up doors on the station provide the drive-through access. Since the site is located next to the sump a retaining wall is provided to level the site for routine operations. Water and sewer are available in adjacent public streets, and a two-inch water service and a 4-inch sanitary sewer has been provided for the station.

The interior lighting level will be maintained at 85 foot candles. All handrails will be four-rung aluminum. Grating will be hot-dipped galvanized.

The instrumentation and control system will incorporate monitoring and alarming for motor and pump bearing temperature, motor winding temperature, reverse rotation, flow for each pump, sump elevation, and precipitation. The controls system will be integrated into the SCADA system operated by the City of Dallas. Individual pump control can be initiated at the pump, in the operator office/control room, or remotely by the SCADA system.

Figure 4.3.9 is a site plan for this alternative.

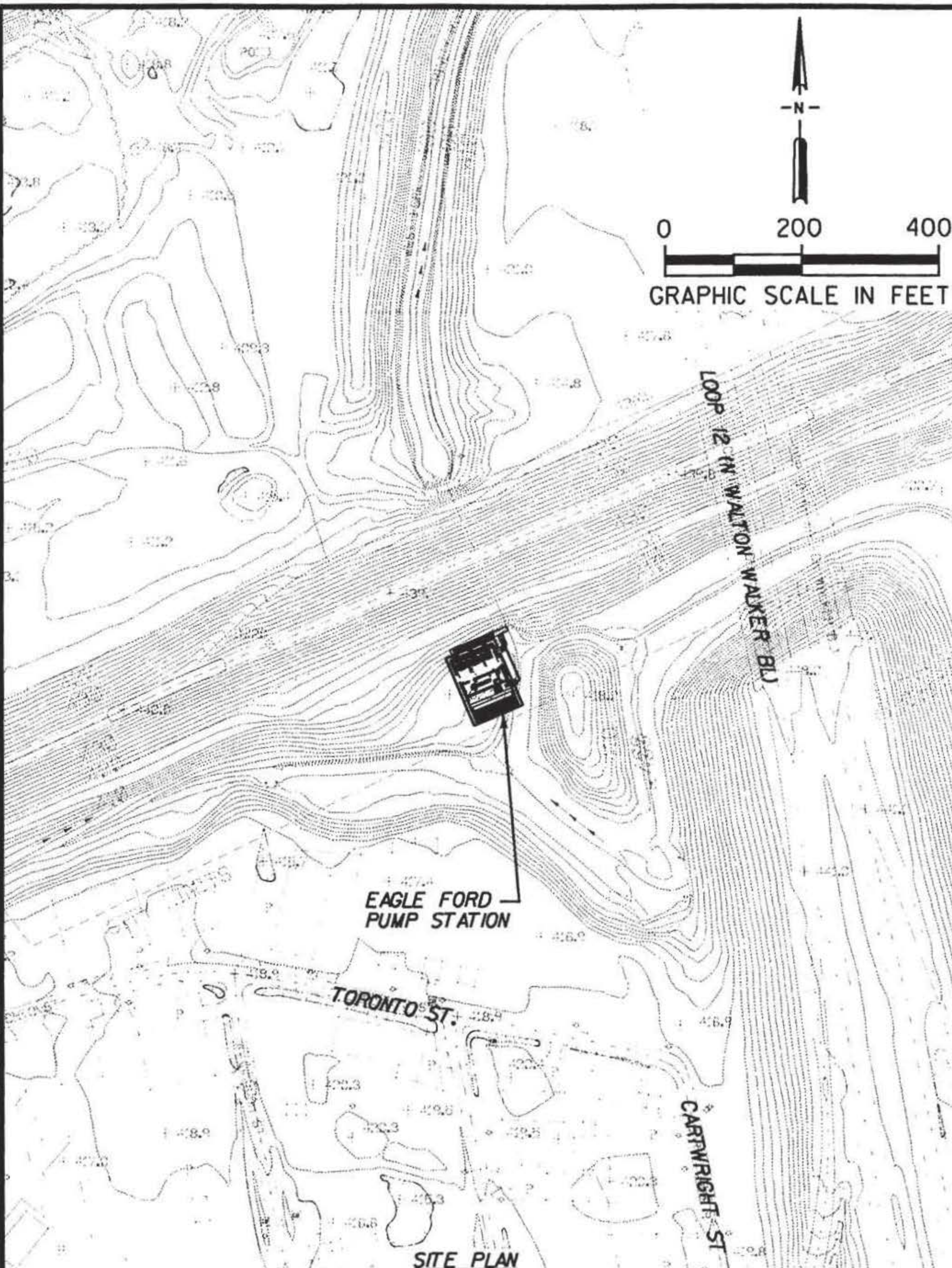
Figure 4.3.10 is a plan view of the 150,000 gpm pump station. The trash rack in the front of the station will be equipped with mechanically-cleaned screens manufactured by Du Perion, since these screens have demonstrated ability to function very effectively in this harsh environment. The switchgear room is adjacent to the pump room.

Figure 4.3.11 is Section A and the relationship of the pumping units, intake sump, and discharge piping are clearly indicated. The bridge crane has 27-foot clearance above the drive through for removal and/or installation of the pumping equipment.

Figures 4.3.12A and 4.3.12B are the electrical one-line diagrams for the station. The double-ended switchgear is indicated. Each of the main pumps is operated by a soft start that has a by-pass that permits the motor to be started even if the soft start is out of service. In addition to the protection provided by the soft start, each of the motors will be equipped with a Multilin 469 to provide motor protective relay systems.

Figure 4.3.13 is a preliminary process and instrumentation diagram for the pump station. The vibration monitoring equipment is shown, as are the RTDs for monitoring motor winding temperatures, and the pump and motor bearing temperatures. Each of the pumps will be equipped with an ultrasonic flow meter to monitor pump discharge.

The Engineer's Preliminary Opinion of Probable Cost for the storm water pump station for Option EF5 is summarized in Table 4.3.5.



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JACOBS Carter Burgess	CITY OF DALLAS DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION	PROPOSED EAGLE FORD PUMP STATION VERTICAL PUMPS 150,000 GPM CAPACITY	FIGURE 4.3.9

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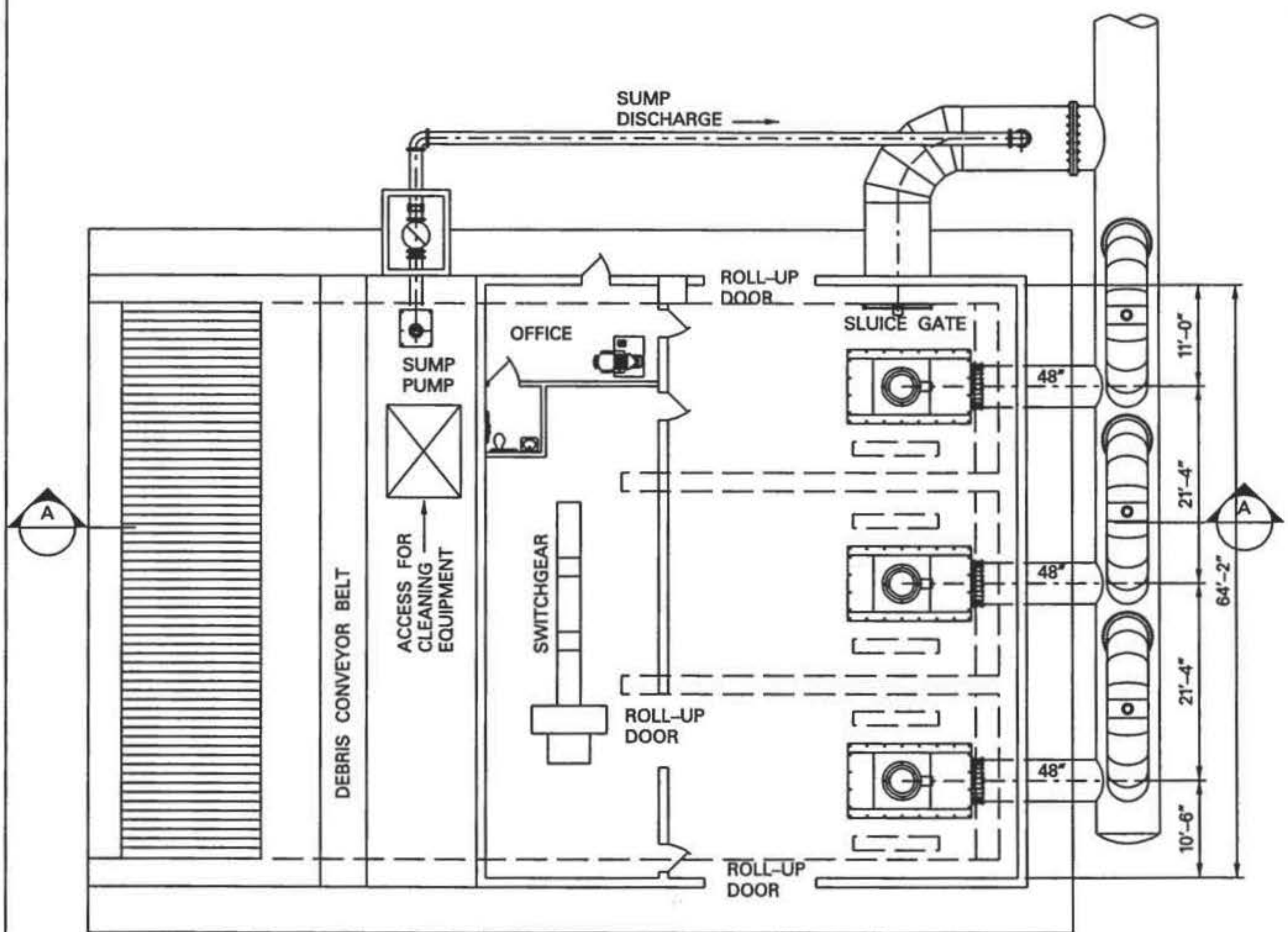

PLAN VIEW
SCALE: 1" = 20'

STATION CAPACITY = 150,000 GPM
50,000 GPM PER PUMP

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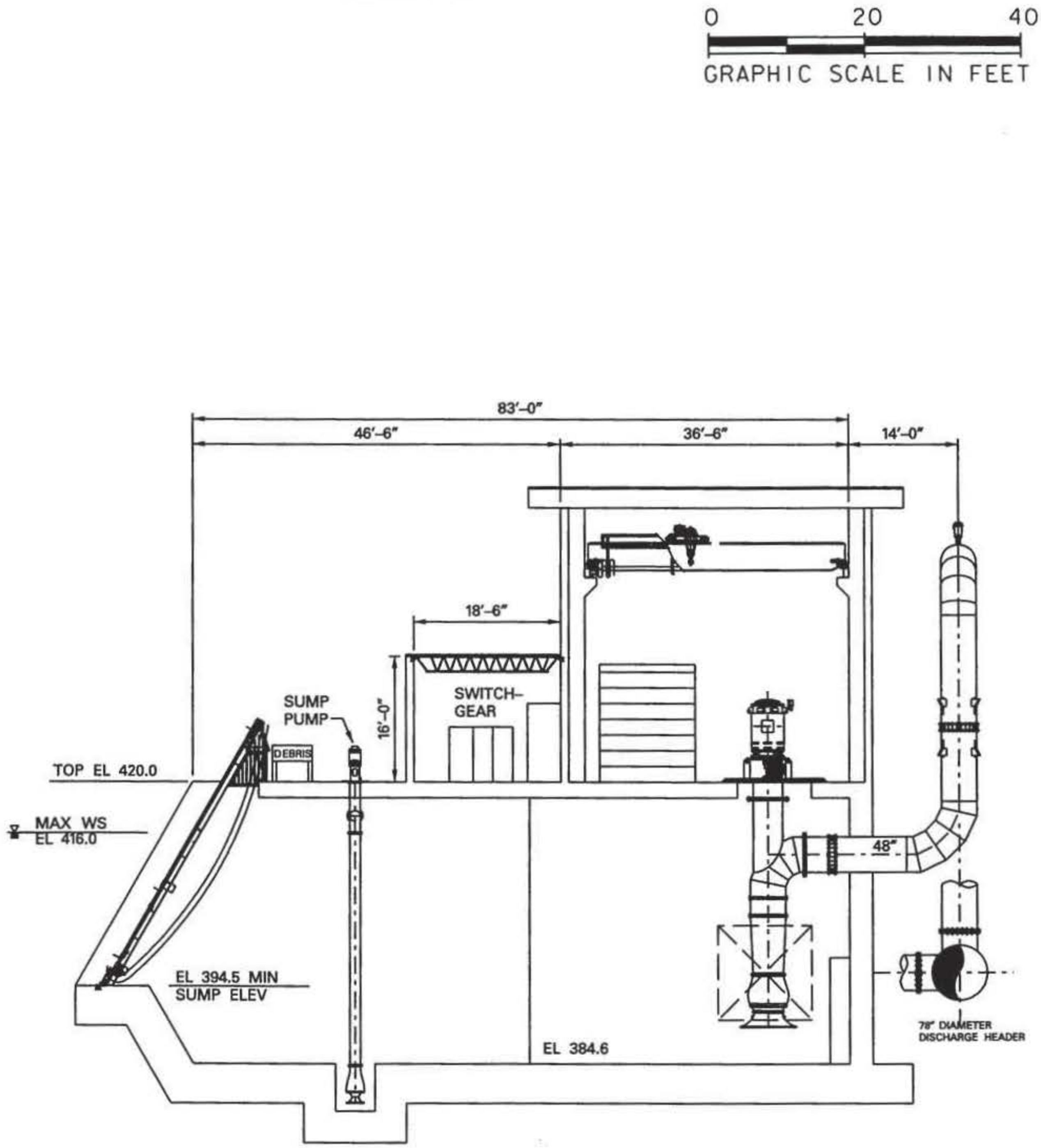

SECTION A – VERTICAL PUMPS
SCALE: 1" = 20'

STATION CAPACITY = 150,000 GPM
50,000 GPM PER PUMP

JE JACOBS Carter Burgess THESE DRAWINGS/DOCUMENTS ARE BEING SUBMITTED BY CARTER & BURGESS INC. CARTER & BURGESS, INC. IS A WHOLLY OWNED SUBSIDIARY OF JACOBS ENGINEERING GROUP INC AND HEREINAFTER REFERRED TO AS JACOBS CARTER BURGESS.	CITY OF DALLAS DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION	PROPOSED EAGLE FORD PUMP STATION VERTICAL PUMPS 150,000 GPM CAPACITY	FIGURE 4.3.11

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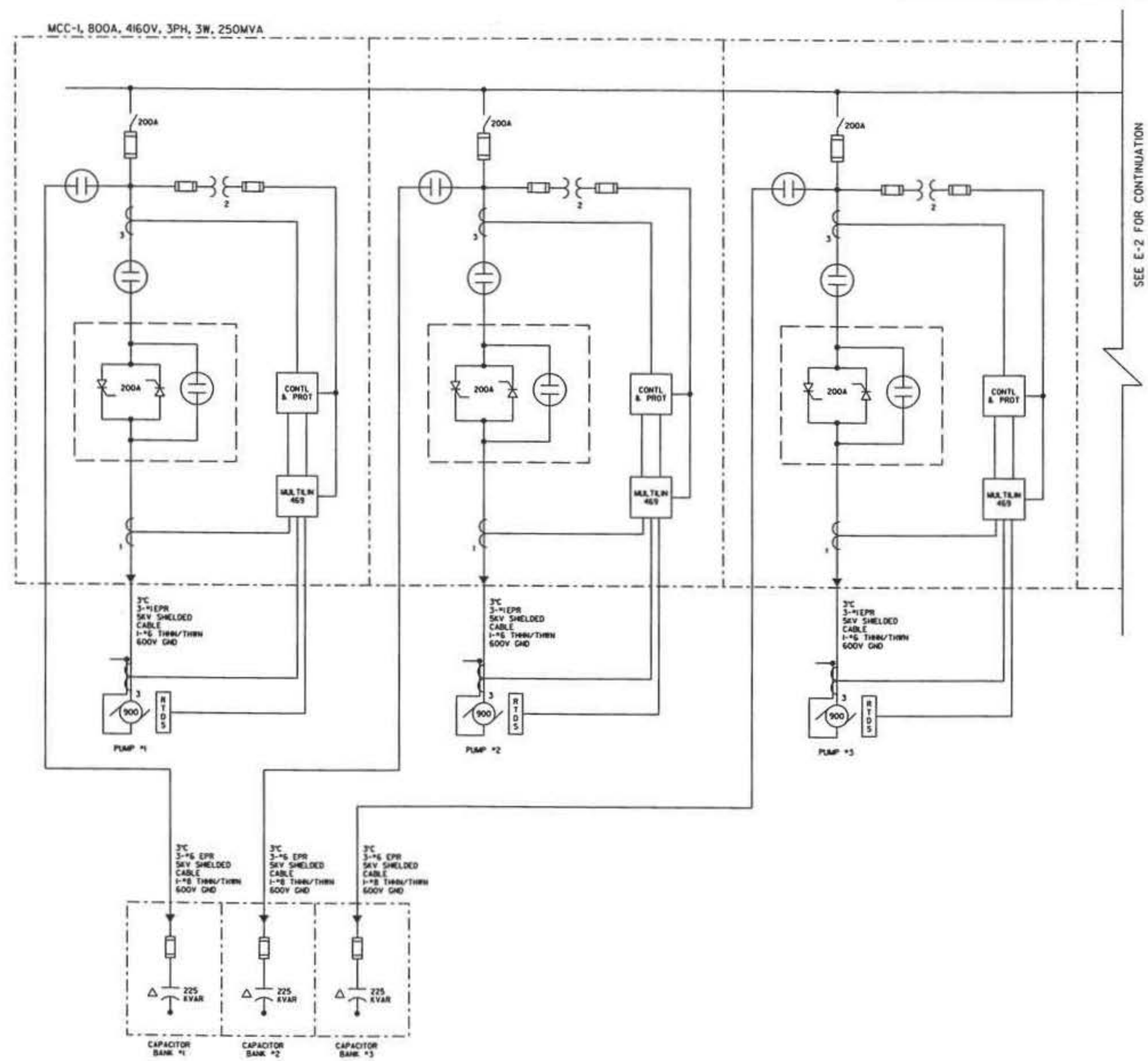

CITY OF DALLAS
DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

PROPOSED EAGLE FORD PUMP STATION
VERTICAL PUMPS
150,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

FIGURE
4.3.12A

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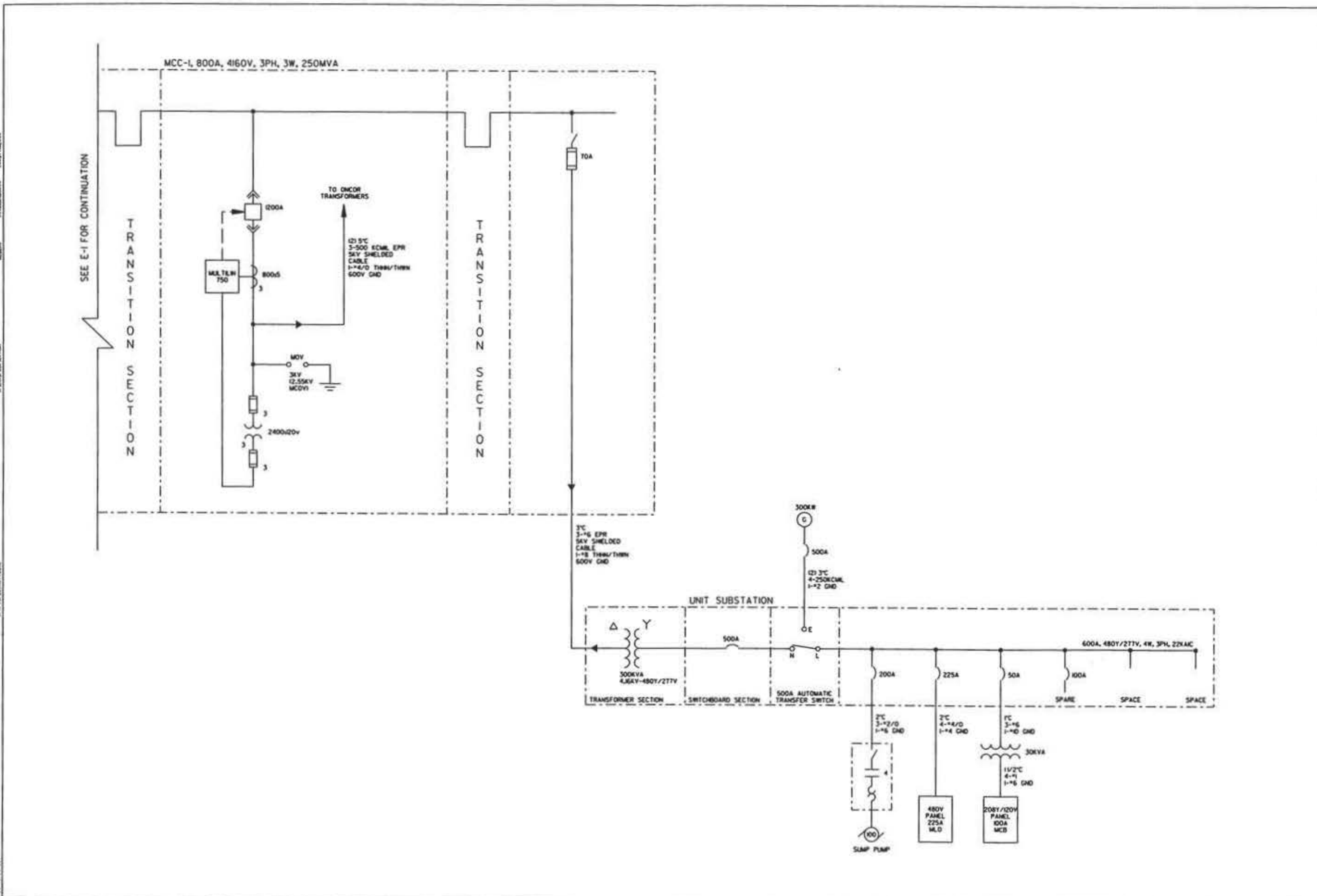

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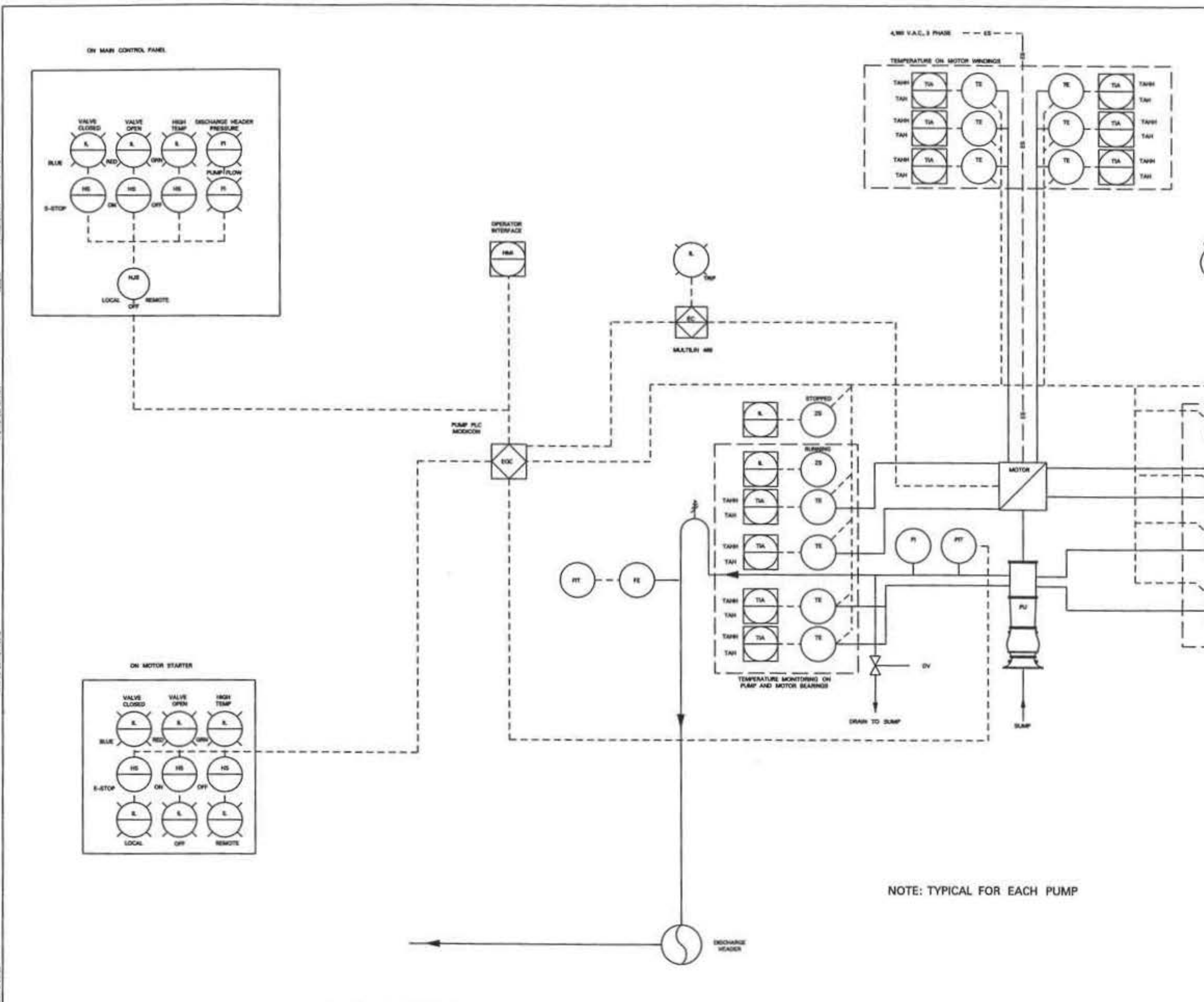
CITY OF DALLAS
DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

PROPOSED EAGLE FORD PUMP STATION
VERTICAL PUMPS
150,000 GPM CAPACITY
ELECTRICAL ONE-LINE DIAGRAM

FIGURE
4.3.12B



P&ID LEGEND

DV	DRAIN VALVE
EC	ELECTRONIC CONTROLLER
EOC	ELECTRONIC COMPUTING CONTROLLER
ES	ELECTRICAL SUPPLY
FE	FLOW ELEMENT
FIT	FLOW INDICATING TRANSMITTER
HJS	HAND POSITION SWITCH - HOA
HMI	HUMAN MACHINE INTERFACE
HS	HAND SWITCH
IL	INDICATOR LIGHT
PI	PRESSURE INDICATOR
PIT	PRESSURE INDICATING TRANSMITTER
PU	PUMPING UNIT
TAH	TEMPERATURE ALARM HIGH
TAHH	TEMPERATURE ALARM HIGH HIGH
TE	TEMPERATURE ELEMENT - RTD
TIA	TEMPERATURE INDICATING ALARM
VAH	VIBRATION ALARM HIGH
VAHH	VIBRATION ALARM HIGH HIGH
VE	VIBRATION ELEMENT
VIA	VIBRATION INDICATING ALARM
VMS	VIBRATION MONITORING SYSTEM
ZS	POSITION SWITCH

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CITY OF DALLAS
DEPARTMENT OF PUBLIC WORKS AND TRANSPORTATION

PROPOSED EAGLE FORD PUMP STATION
150,000 GPM CAPACITY
PROCESS AND INSTRUMENTATION DIAGRAM

FIGURE 4.3.13

Table 4.3.5

Summary for Eagle Ford 3 Pump 150,000 gpm

Division	Cost
Division 1 - General Conditions	$2,127,200
Divison 2 - Site Work	$1,863,300
Division 3- Concrete	$2,242,243
Division 4 - Masonry	$87,072
Division 5- Metals	$118,515
Division 6 - Carpentry	$4,000
Division 7 - Thermal & Moisture Protection	$784,835
Division 8 - Doors & Windows	$12,700
Division 9 - Finishes	$85,075
Division 10 - Specialties	$9,700
Division 11 - Equipment	$4,345,000
Division 12 - Furnishings	$4,110
Division 13- Special Construction	$0
Division 14 - Conveying Systems	$350,000
Division 15 - Mechanical	$234,568
Division 16 - Electrical	$2,200,800
Division 17 - Instrumentation & Control	$1,286,000
Division Subtotal	**$15,755,118**
Contractor's Profit of Materials - 10%	$1,094,349
Prime Profit on SubConstractors - 10%	$450,574
Subtotal	**$17,300,040**
Construction Contingencies - 20%	$3,460,008
Construction Work Effort subtotal	**$20,760,048**
Escalation to Midpoint @ 6%/Yr & 3 yrs	$7,021,048
Subtotal	**$27,781,097**
Engineering and Surveying Services (12%)	$3,333,732
Construction Management (8%)	$2,222,488
Construction Materials Testing (1.5%)	$416,716
City Contract Administration (10%)	$2,778,110
Services Subtotal	**$8,751,045**
Total Estimated Project Cost	**$36,532,142**

Table 4.3.5
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Eagle Ford Site with 3 Pumps
150,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 1 - General Conditions							
Mobilization	1	LS	$0	$0		$0	$600,000
Construction Surveying	1	LS	$0	$0	$45,000.00	$45,000	$45,000
Telephone	24	Mo	$150	$3,600	$0.00	$0	$3,600
SWWWP	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Trench Excavation Safety & Support/Structural Plan	1	LS	$40,000	$40,000	$0.00	$0	$40,000
Traffic Control Plan	1	LS	$15,000	$15,000	$0.00	$0	$15,000
PM	24	Mo	$0	$0	$15,000.00	$360,000	$360,000
Superintendent	24	Mo	$0	$0	$12,000.00	$288,000	$288,000
Admin	24	Mo	$0	$0	$7,000.00	$168,000	$168,000
Sanitary Services	24	Mo	$0	$0	$500.00	$12,000	$12,000
Security Services	24	Mo	$0	$0	$2,000.00	$48,000	$48,000
Pick Up Trucks - 3 each	24	Mo	$0	$0	$1,800.00	$43,200	$43,200
Office Equipment	24	Mo	$0	$0	$350.00	$8,400	$8,400
150 Ton Crane - 18 Months	18	Mo	$0	$0	$20,000.00	$360,000	$360,000
Loader - 24 Months	24	Mo	$0	$0	$2,000.00	$48,000	$48,000
Office Trailors - 2 each	24	Mo	$0	$0	$1,500.00	$36,000	$36,000
Tool Trailors - 2 each	24	Mo	$0	$0	$500.00	$12,000	$12,000
Subtotal for Division 1							**$2,127,200**
Division 2 - Site Work							
Structural Excavation	12,000	CY	$0.00	$0	$8.00	$96,000	$96,000
Structural Backfill	10,000	CY	$6.00	$60,000	$3.00	$30,000	$90,000
Paving	1,300	SY	$12.00	$15,600	$12.00	$15,600	$31,200
Pavement Striping	2,450	SF	$6.00	$14,700	$2.00	$4,900	$19,600
Access Road	1,800	SY	$7.00	$12,600	$13.00	$23,400	$36,000
Traffic Control	1	LS	$5,000.00	$5,000	$20,000.00	$20,000	$25,000
Curb Stops	10	EA	$200.00	$2,000	$50.00	$500	$2,500
8-inch Bollards	10	EA	$1,000.00	$10,000	$150.00	$1,500	$11,500
Grading	3,000	SY	$1.00	$3,000	$2.00	$6,000	$9,000
Fencing - 10 Ft. Man Proof	1,000	LF	$50.00	$50,000	$10.00	$10,000	$60,000
16-foot slide gate (Electric Motor)	1	EA	$6,000.00	$6,000	$1,000.00	$1,000	$7,000

Table 4.3.5
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Eagle Ford Site with 3 Pumps
150,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
3-foot ped. Gate	1	EA	$400.00	$400	$100.00	$100	$500
Landscaping	1	LS	$50,000.00	$50,000	$5,000.00	$5,000	$55,000
Channel Liner	2,000	SY	$10.00	$20,000	$5.00	$10,000	$30,000
48-inch steel discharge pipe - 3@130' each	390	LF	$600	$234,000	$100.00	$39,000	$273,000
48-inch nut, bolt and gasket sets	6	EA	$1,500	$9,000	$850.00	$5,100	$14,100
72-inch steel dischage pipe	200	LF	$950	$190,000	$100.00	$20,000	$210,000
Water - 2-inch	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Sewer	400	LF	$50	$20,000	$10.00	$4,000	$24,000
Telephone	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Misc Utilities	1	LS	$1,000	$1,000	$200.00	$200	$1,200
Shoring	5,000	SF	$35	$175,000	$5.00	$25,000	$200,000
Dewatering	1	LS	$250,000	$250,000	$25,000.00	$25,000	$275,000
Coffer Dam - 26' high 2:1ss	10,000	CY	$15	$150,000	$5.00	$50,000	$200,000
Demolish existing Gravity Sluices	1	LS	$130,000	$130,000	$20,000.00	$20,000	$150,000
3-inch mud slab	140	CY	$100	$14,000	$25.00	$3,500	$17,500
Subtotal for Division 2							**$1,863,300**
Division 3 - Concrete							
Substructure Concrete (Foundation)							
Concrete	1105	CY	$100	$110,520	$15.00	$16,578	$127,098
Rebar (310 lb/CY)	171	TON	$1,020	$174,732	$300.00	$51,392	$226,124
Forming	6630	SF	$10	$66,300	$5.00	$33,150	$99,450
Curing	80	CSF	$5	$400	$5.00	$400	$800
Waterstops	320	LF	$10	$3,200	$5.00	$1,600	$4,800
Substructure Concrete (Pump Room Floor)							
Concrete	183	CY	$100	$18,270	$15.00	$2,741	$21,011
Rebar (310 lb/CY)	28	TON	$1,020	$28,885	$300.00	$8,496	$37,380
Forming	3641	SF	$10	$36,410	$5.00	$5	$36,415
Curing	63	CSF	$5	$315	$5.00	$315	$630
Waterstops	315	LF	$10	$3,150	$5.00	$1,575	$4,725
Substructure Concrete (Perimeter walls) - ext. 4' thick avg.							
Concrete	1040	CY	$100	$103,950	$15.00	$15,593	$119,543

Table 4.3.5
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Eagle Ford Site with 3 Pumps
150,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Rebar (310 lb/CY)	161	TON	$1,020	$164,345	$300.00	$48,337	$212,682
Forming	7795	SF	$10	$77,950	$5.00	$38,975	$116,925
Curing	180	CSF	$5	$900	$5.00	$900	$1,800
Waterstops	275	LF	$10	$2,750	$5.00	$1,375	$4,125
Substructure Concrete (Divider walls-int. 2' thick avg)							
Concrete	246	CY	$100	$24,570	$15.00	$3,686	$28,256
Rebar (310 lb/CY)	38	TON	$1,020	$38,845	$300.00	$11,425	$50,270
Forming	3678	SF	$10	$36,780	$5.00	$18,390	$55,170
Curing	190	CSF	$5	$950	$5.00	$950	$1,900
Waterstops	500	LF	$10	$5,000	$5.00	$2,500	$7,500
Substructure Columns and Beams							
Concrete	36	CY	$100	$3,600	$15.00	$540	$4,140
Rebar (310 lb/CY)	6	TON	$1,020	$5,692	$300.00	$1,674	$7,366
Forming	1200	SF	$10	$12,000	$5.00	$6,000	$18,000
Curing	40	CSF	$5	$200	$5.00	$200	$400
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Electrical Room Bottom Slab							
Concrete	108	CY	$100	$10,800	$15.00	$1,620	$12,420
Rebar (310 lb/CY)	17	TON	$1,020	$17,075	$300.00	$5,022	$22,097
Forming	1073	SF	$10	$10,730	$5.00	$5,365	$16,095
Curing	60	CSF	$5	$300	$5.00	$300	$600
Waterstops	150	LF	$10	$1,500	$5.00	$750	$2,250
Superstructure Columns							
Concrete	54	CY	$100	$5,400	$15.00	$810	$6,210
Rebar (310 lb/CY)	8	TON	$1,020	$8,537	$300.00	$2,511	$11,048
Forming	3100	SF	$10	$31,000	$5.00	$15,500	$46,500
Curing	200	CSF	$5	$1,000	$5.00	$1,000	$2,000
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Superstructure Beams							
Concrete	54	CY	$100	$5,400	$15.00	$810	$6,210
Rebar (310 lb/CY)	8	TON	$1,020	$8,537	$300.00	$2,511	$11,048
Forming	2164	SF	$10	$21,640	$5.00	$10,820	$32,460

Table 4.3.5
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Eagle Ford Site with 3 Pumps
150,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Curing	250	CSF	$5	$1,250	$5.00	$1,250	$2,500
Waterstops	0	LF	$10	$0	$5.00	$0	$0
Superstructure double-Tees	4752	SF	$18	$85,536	$5.00	$23,760	$109,296
Retaining Walls - MSE wall >20'	15500	SF	$40	$620,000	$10.00	$155,000	$775,000
Subtotal Division 3							**$2,242,243**
Division 4 - Masonary							
CMU Partitions	12,000	SF	$3.00	$36,000	$4.00	$48,000	$84,000
Glazed CMU Restroom Walls	256	SF	$8.00	$2,048	$4.00	$1,024	$3,072
Subtotal for Division 4				**$0**		**$0**	**$87,072**
Division 5 - Metals							
Grating	800	SF	$20	$16,000	$5.00	$4,000	$20,000
Mtl deck	7,505	SF	$2	$15,010	$1.00	$7,505	$22,515
Bar Joists	1	LS	$60,000	$60,000	$5,000.00	$5,000	$65,000
Handrail	200	LF	$40	$8,000	$15.00	$3,000	$11,000
Subtotal for Division 5							**$118,515**
Division 6 - Carpentry							
Misc.	1	ls	$1,000	$1,000	$3,000.00	$3,000	$4,000
Subtotal for Division 6							**$4,000**
Division 7 - Thermal and Moisture Protection							
Exterior walls	11,000	SF	$45	$495,000	$20.00	$220,000	$715,000
Roofing	4,752	SF	$4	$19,008	$2.00	$49,827	$68,835
Roof Hatch-Pumps	0	EA	$15,000	$0	$500.00	$0	$0
Roof Hatch-Access	1	EA	$800	$800	$200.00	$200	$1,000
Subtotal for Division 7							**$784,835**
Division 8 - Doors and Windows							
Doors, 3-0 x 7-0 steel	5	Ea	$200	$1,000	$100.00	$500	$1,500

Table 4.3.5
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Eagle Ford Site with 3 Pumps
150,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Doors, roll-up 12' x 14' steel	2	Ea	$5,000	$10,000	$600.00	$1,200	$11,200
Subtotal for Division 8				**$0**		**$0**	**$12,700**
Division 9- Finishes							
Process Piping (pump rm risers & hdrs)	4,100	SF	$0.50	$2,050	$1.25	$5,125	$7,175
Misc. Structural Steel Surf. Prep.	8,900	LS	$1.00	$8,900	$2.00	$17,800	$26,700
Paint Structural Steel	8,900	sf	$1.00	$8,900	$4.00	$35,600	$44,500
Paint Building Interior Walls	10,000	SF	$0.10	$1,000	$0.57	$5,700	$6,700
Subtotal for Division 9							**$85,075**
Division 10 - Specialities							
Signage	1	LS	$5,000	$5,000	$1,000.00	$1,000	$6,000
Woven Wire Partition - 15'x15'x10'Tall	1	LS	$2,500	$2,500	$500.00	$500	$3,000
Toilet Accessories	1	LS	$500	$500	$200.00	$200	$700
Subtotal for Division 10				**$0**		**$0**	**$9,700**
Division 11 - Equipment							
Veritical sump pump, 7000 gpm	1	Ea	$80,000	$80,000	$5,000.00	$5,000	$85,000
Trash Rack (30' x 55')	1,650	SF	$400	$660,000	$10.00	$16,500	$676,500
Restrained Couplings	9	Ea	$15,000	$135,000	$1,500.00	$13,500	$148,500
Vertical Pumps and Motors - 50,000 gpm	3	Ea	$1,000,000	$3,000,000	$30,000.00	$90,000	$3,090,000
Stop Logs	1	LS	$200,000	$200,000	$15,000.00	$15,000	$215,000
72" - Flap Gate	1	Ea	$20,000	$20,000	$5,000.00	$5,000	$25,000
Sluice Gate - 9'x9'	1	Ea	$100,000	$100,000	$5,000.00	$5,000	$105,000
Subtotal for Division 11							**$4,345,000**
Division 12 - Furnishings							
Desk	1	Ea	$1,000	$1,000	$100.00	$100	$1,100
Chair	1	Ea	$600	$600	$10.00	$10	$610
Storage Shelves	4	Ea	$500	$2,000	$100.00	$400	$2,400
Subtotal for Division 12							**$4,110**

Table 4.3.5
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Eagle Ford Site with 3 Pumps
150,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 13 - Special Construction							
Subtotal for Division 13							$0
Division 14 - Conveying Systems							
30 Ton Bridge Crane	1	Ea	$200,000	$200,000	$25,000.00	$25,000	$225,000
Automated Conveyor System	1	LS	$100,000.00	$100,000	$25,000.00	$25,000	$125,000
Subtotal for Division 14							$350,000
Division 15 - Mechanical							
Ventilation Fan(S)	3	EA	$2,000	$6,000	$500.00	$1,500	$7,500
Roof Curb(S)	3	EA	$1,000	$3,000	$250.00	$750	$3,750
Controls	1	LS	$25,000	$25,000	$10,000.00	$10,000	$35,000
Floor Drain(S)	5	EA	$300	$1,500	$150.00	$750	$2,250
Toilet(S)	1	EA	$200	$200	$200.00	$200	$400
Sink(S)	2	EA	$400	$800	$100.00	$200	$1,000
Urinal(S)	1	EA	$200	$200	$75.00	$75	$275
Faucet(S)	2	EA	$350	$700	$100.00	$200	$900
Trap Primer(S)	2	EA	$350	$700	$150.00	$300	$1,000
Drain/Waste/Vent Plumbing	1000	LF	$15	$15,000	$7.00	$7,000	$22,000
Cold Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Hot Water Plumbing	250	LF	$12	$3,000	$10.00	$2,500	$5,500
Dx Hvac Air Handler(S)	2	EA	$17,500	$35,000	$5,000.00	$10,000	$45,000
Dx Hvac Condensing Unit(S)	2	EA	$15,000	$30,000	$1,500.00	$3,000	$33,000
Controls	1	LS	$7,500	$7,500	$5,000.00	$5,000	$12,500
Condensing Unit Pad(S)	1	EA	$500	$500	$100.00	$100	$600
Ductwork	1000	LBS	$50	$50,000	$5.00	$5,000	$55,000
Diffuser(S)/Register(S)/Grille(S)	9	EA	$17	$153	$10.00	$90	$243
Louvre(S)	9	EA	$150	$1,350	$100.00	$900	$2,250
Fire Hose Rack	2	EA	$350	$700	$100.00	$200	$900
Subtotal for Division 15							$234,568
Division 16 - Electrical							

Table 4.3.5
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Eagle Ford Site with 3 Pumps
150,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Mobilization	1	LS	$0	$0	$0.00	$0	$50,000
Temporary Power	1	LS	$50,000	$50,000	$2,000.00	$2,000	$52,000
Duct Banks	200	CY	$400	$80,000	$20.00	$4,000	$84,000
Manholes	3	EA	$6,000	$18,000	$500.00	$1,500	$19,500
1/0 5 Kv Cable	1,000	LF	$7	$7,000	$3.00	$3,000	$10,000
250 Mcm 5 Kv Cable	700	LF	$8	$5,600	$3.00	$2,100	$7,700
100 Mcm 5 Kv Cable	700	LF	$6	$4,200	$2.00	$1,400	$5,600
5 Kv Terminations	50	EA	$175	$8,750	$25.00	$1,250	$10,000
Conduit	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Wire	1	LS	$75,000	$75,000	$10,000.00	$10,000	$85,000
Lighting							
Exterior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Interior							
Fixtures	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Mv Switchgear	1	LS	$100,000	$100,000	$25,000.00	$25,000	$125,000
Soft Starts - 800 HP	3	EA	$52,000	$156,000	$15,000.00	$45,000	$201,000
1500 Kva Transformers	3	EA	$50,000	$150,000	$10,000.00	$30,000	$180,000
480 Volt Mcc	1	EA	$85,000	$85,000	$50,000.00	$50,000	$135,000
Misc. Switchgear	1	LS	$50,000	$50,000	$6,000.00	$6,000	$56,000
Lightning Protection	1	LS	$35,000	$35,000	$5,000.00	$5,000	$40,000
Telephone System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Fire Alarm System	1	LS	$20,000	$20,000	$2,000.00	$2,000	$22,000
Security And Entrance Equipment	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Embedded Conduit	1	LS	$25,000	$25,000	$8,000.00	$8,000	$33,000
Grounding	1	LS	$50,000	$50,000	$10,000.00	$10,000	$60,000
Cable Tray	1	LS	$25,000	$25,000	$15,000.00	$15,000	$40,000
500 Kva Gen Set With ATS	1	Ea	$98,000	$98,000	$5,000.00	$5,000	$103,000
TXU Firm Backup Capabiltiy	1	LS	$600,000	$600,000	$30,000.00	$30,000	$630,000
Testing	1	LS	$15,000	$15,000	$5,000.00	$5,000	$20,000
Subtotal for Division 16							**$2,200,800**

Table 4.3.5
Engineer's Preliminary Opinion of Probable Costs
New Storm Water Pump Station @ Eagle Ford Site with 3 Pumps
150,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Division 17 - I&C							
Engineering & Submittals	1	LS	$75,000	$75,000	$5,000.00	$5,000	$80,000
Computers And Printers	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
F O Cable And Comm. Equip.	1	LS	$25,000	$25,000	$5,000.00	$5,000	$30,000
Control Panels	1	LS	$250,000	$250,000	$10,000.00	$10,000	$260,000
Start Up-Check Out	1	LS	$35,000	$35,000	$10,000.00	$10,000	$45,000
Ultra Sonic Flow Meters	3	Ea	$5,000	$15,000	$2,500.00	$7,500	$22,500
HMI Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
PLC Programming	1	LS	$10,000	$10,000	$50,000.00	$50,000	$60,000
O&M Manuals	1	LS	$5,000	$5,000	$2,000.00	$2,000	$7,000
Training	1	LS	$100,000	$100,000	$20,000.00	$20,000	$120,000
Software	1	LS	$85,000	$85,000	$15,000.00	$15,000	$100,000
Factory Test	1	LS	$20,000	$20,000	$10,000.00	$10,000	$30,000
Bonds	1	LS	$0	$0	$0.00	$0	$80,000
Level transmitters	3	Ea	$2,000	$6,000	$500.00	$1,500	$7,500
PLC - Primary + hot back-up	1	Ea	$17,500	$17,500	$7,500.00	$7,500	$25,000
PC and Monitor	1	Ea	$8,000	$8,000	$1,000.00	$1,000	$9,000
MMI Software + Programming	1	Ea	$7,000	$7,000	$15,000.00	$15,000	$22,000
Instrumentation wiring	1	LS	$75,000	$75,000	$28,000.00	$28,000	$103,000
SCADA Transmitter	1	Ea	$100,000	$100,000	$10,000.00	$10,000	$110,000
Security Cameras	1	LS	$75,000	$75,000	$10,000.00	$10,000	$85,000
Subtotal for Division 17							**$1,286,000**
Division subtotal				**$10,943,488**		**$3,403,130**	**$15,755,118**
Contractor's Profit on Material (10%)							$1,094,349
Prime Profit on Subcontractors - 10% on Div 5, 6, 7, 8, 9, 10, 12, 16, 17							$450,574
Subtotal							**$17,300,040**
Contingency (20%)							$3,460,008
Construction Work Effort subtotal							**$20,760,048**
Escalation to Midpoint @ 6%/year& 5 yrs							**$7,021,048**
Subtotal							**$27,781,097**

Table 4.3.5

Engineer's Preliminary Opinion of Probable Costs

New Storm Water Pump Station @ Eagle Ford Site with 3 Pumps
150,000 gpm Station

	QTY	UNIT	UNIT MAT'L	TOTAL MAT'L	UNIT LABOR	TOTAL LABOR	TOTAL COST
Engineering and Surveying Services (12%)							$3,333,732
Construction Management (8%)							$2,222,488
Construction Materials Testing (1.5%)							$416,716
City Contract Administration (10%)							$2,778,110
Services Subtotal							**$8,751,045**
Total Estimated Project Cost							**$36,532,142**

5. CONCLUSIONS AND RECOMMENDATIONS

This section lists the recommended improvements to lower the maximum predicted 100-year West Levee sump elevations to their recommended design elevations.

The costs for the recommended improvements are shown in Table 5.1. This table shows the construction cost for the project in 2008 dollars. This "Construction Work Effort" column does not include services such as construction administration, materials testing or engineering. The next column shows the escalated construction cost. The construction cost in that column has been escalated at six percent per year to the proposed midpoint of construction in five years. The next column lists professional services costs associated with the escalated construction cost. These services include City contract administration, construction materials testing, construction management and engineering and surveying services. The total costs are then shown in the last column on the right of the table.

The locations and total costs of the recommended improvements are shown on Figure 5.1.

5.1 CHARLIE AND CORINTH STREET SUMPS

The recommended improvement for the Charlie and Corinth Street sump areas is Option C2A, which consists of a new 225,000 GPM pump station in Charlie Sump at a total preliminary probable cost of $22,897,000 in 2008 construction dollars. As explained above, this cost does not include professional services or escalation.

Option C1, the gravity flow alternative, was rejected for several reasons. First, there is uncertainty of having sufficient head differential between the sump and the Dallas Floodway for the system to operate reliably during the 100-year event. Gravity-flow solutions potentially involve greater risk due to the difficulty of reliably predicting the tailwater elevations against which the gravity sluices must operate. In this case, the head differential between the 100-year design sump elevation and the design conditions steady-state Dallas Floodway tailwater elevation is less than 0.8 feet. This differential, although sufficient for gravity flow to be efficient at evacuating water from the sump, is relatively small. Assuming steady-state conditions in the Dallas Floodway, this also means that the sump would have to get within 0.8 feet of its 100-year design elevation before gravity flow could begin at all. It is impossible to predict discharges and water surface elevations in the Dallas Floodway with that degree of certainty, especially with the proposed Trinity Park features such as off-channel lakes and pilot channel relocation currently under design. While these features will surely be designed to have no negative impact on Dallas Floodway water surface elevations for large events such as the 100-year event on the Trinity River system, their effect on much smaller events such as the design conditions is currently unknown. Furthermore, Dallas Floodway flows of the magnitude of the design condition might be experienced for a long duration during flood control releases from upstream reservoirs, increasing the likelihood that gravity flow might be ineffective during a 100-year event on the interior drainage watershed. A pumping plant can be designed to meet or exceed its design capacity against a wide range of head differentials. Gravity-flow solutions have advantages over pumping due to their lower operating and life-cycle costs. However, a pumping plant is a much more reliable alternative when the head differential between the sump and the tailwater conditions is small enough to be unpredictable.

Second, gravity sluices would be difficult to construct. Construction of gravity sluices would require either breaching the existing levee (requiring a cofferdam during construction), or tunneling under the existing levee. Both options are very expensive and risky due to the potential for damaging the existing levee. Because of the emphasis that has been placed on levee integrity since Hurricane Katrina in 2005, it is believed that the best options for improving Dallas Interior Drainage will preclude breaching the levee or tunneling under the levee. For these reasons, the recommended option for Charlie and Corinth Street sumps involves pumping.

Option C2B has the same total pumping capacity as Option C2A, but involves the rehabilitation of the existing Charlie Pumping Plant and the construction of a new 145,000 GPM pump station adjacent to the existing station. This option was not selected due to site limitations and because of the age and condition of the existing Charlie Pumping Plant. As one of the original interior levee drainage system storm water pumping plants, Charlie pumping plant is approximately 75 years old. Significant rehabilitation is required to bring the facility up to modern standards. The pumps were replaced in 1963, but these pumps are now over 45 years old. The pump floor elevation at the existing Charlie Pumping Plant is only 403.0 ft, making the existing pump station susceptible to flooding during a major flood event. For these reasons, it is recommended that the existing Charlie Pumping Plant be abandoned. With proper planning and design, it should be possible to design the new pump station to discharge through the existing gravity sluices at Charlie Pumping Plant, thus reducing costs and preventing the need to either breach the levee to construct a pump station outfall or running pump station discharge piping over the top of the levee.

5.2 PAVAHO, DELTA, AND EAGLE FORD SUMPS

As previously discussed, Trinity-Portland, Frances Street, Westmoreland-Hampton, and Pavaho Sumps form a combined system. The recommended improvements for this system were not based solely on the minimum preliminary probable costs, but also on the most hydraulically effective solutions. The recommended improvement for this system is a combination of Option P2 and D4, at a total preliminary probable construction cost of $55,024,000 in 2008 construction dollars. Option P2, with a preliminary probable construction cost of $25,448,000 in 2008 construction dollars, includes replacement of the existing Pavaho Pumping Plant with a new pumping plant with a capacity of 375,000 GPM plus a 6,000 GPM low-flow pump, as well as culvert improvements in the Pavaho Sump channel beneath the Sylvan Avenue bridge and at Canada Drive. Replacement of the existing Pavaho Pumping Plant was included in the November 2006 City of Dallas bond program, and design of the new Pavaho Pumping Plant is currently underway.

Option D4, with a preliminary probable construction cost of $27,289,000 in 2008 construction dollars, calls for the addition of a new pumping plant with a capacity of 250,000 GPM plus a 6,000 GPM low-flow pump in Trinity-Portland Sump, as well as the addition of a new 6'x6' gated culvert connecting Eagle Ford and Trinity-Portland sumps. Option D4 also includes the rehabilitation and upgrade of the existing Delta Pumping Plant at a preliminary probable construction cost of $2,540,000 in 2008 construction dollars. While Delta Pumping Plant is as old as Charlie Pumping Plant discussed in the previous section, the pump floor elevation at Delta is 412.1 ft, which is comfortably above the maximum predicted existing conditions 100-year sump elevation for Westmoreland-Hampton Sump. Therefore, it will be more cost-effective to rehabilitate Delta Pumping Plant than it would be for Charlie.

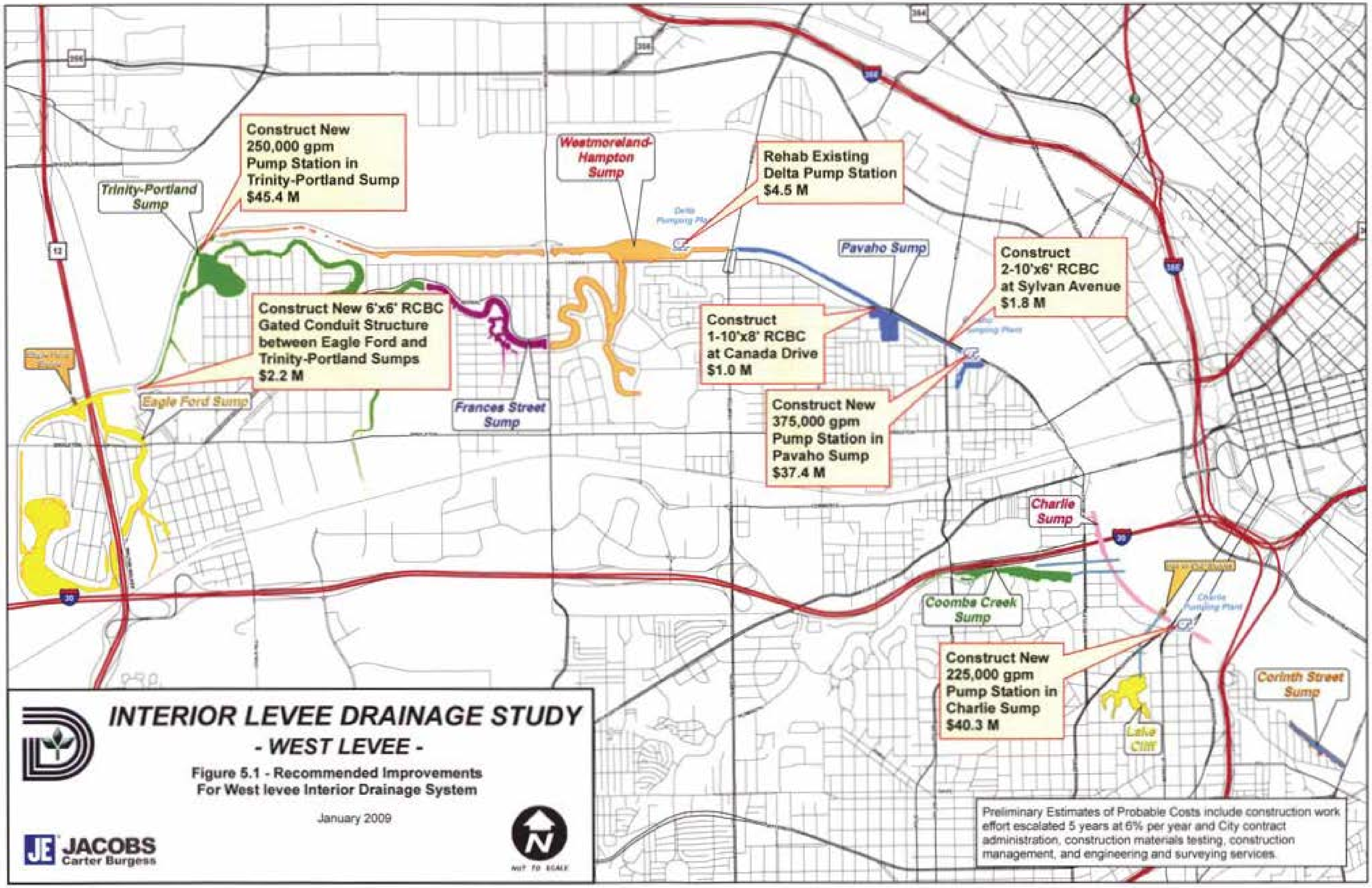
The new Trinity-Portland Pumping Plant will allow discharge directly from Trinity-Portland Sump to the Dallas Floodway, a concept that has been recommended at least since the 1973 West Levee Interior Drainage Study performed by URS/Forrest and Cotton, Inc. That report, as well as the 1991 Brockette-Davis-Drake, Inc. Master Drainage Study of West Dallas, recommended the construction of gravity sluices to discharge from Trinity-Portland Sump. The current Upper Trinity CDC hydraulic model shows that for the 1-year future conditions discharge on the West Fork of the Trinity River, gravity discharge would not be possible from Trinity-Portland Sump due to high tailwater elevation.

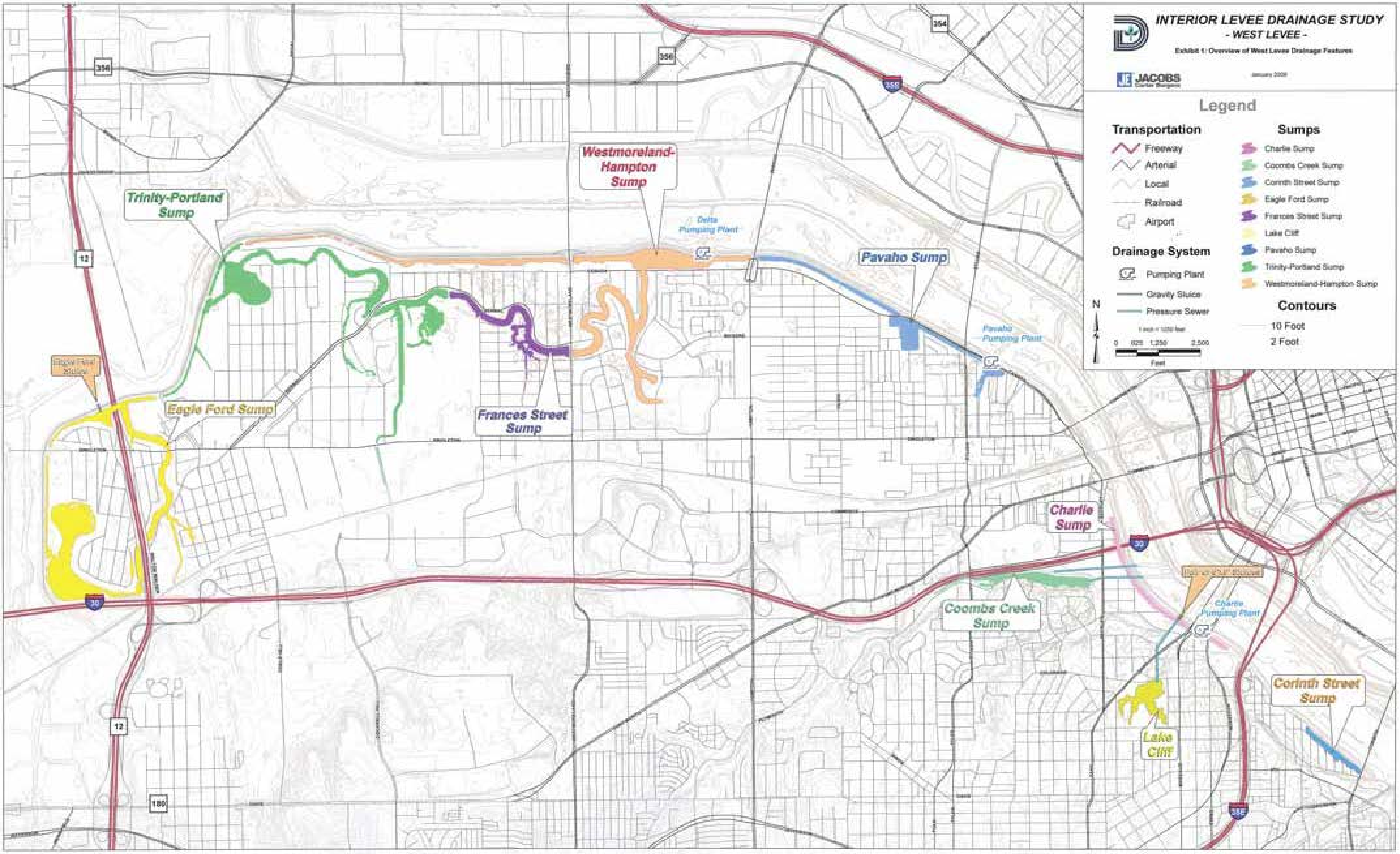
Option D4, with its new recommended gated culvert connection between Eagle Ford and Trinity-Portland sumps, will allow the new Trinity-Portland pump station to drain Eagle Ford Sump. Therefore, no new drainage improvements in Eagle Ford sump are required. Maintenance to the Eagle Ford gravity sluice is recommended to ensure it remains in good working order. Pumping from Eagle Ford is desirable due to the relatively small difference between the recommended sump design elevation and the design conditions tailwater elevations. For the design conditions, less than 2 feet of head differential exists between the 100-year design sump elevation and the tailwater elevation. While this is a slightly more comfortable head differential than exists at Charlie Sump, it means that for the design condition, Eagle Ford Sump would have to rise to within 2 feet of its 100-year design elevation before any discharge could begin from the sump. The pumping capacity provided by Option D4 eliminates this dependence on gravity flow alone.

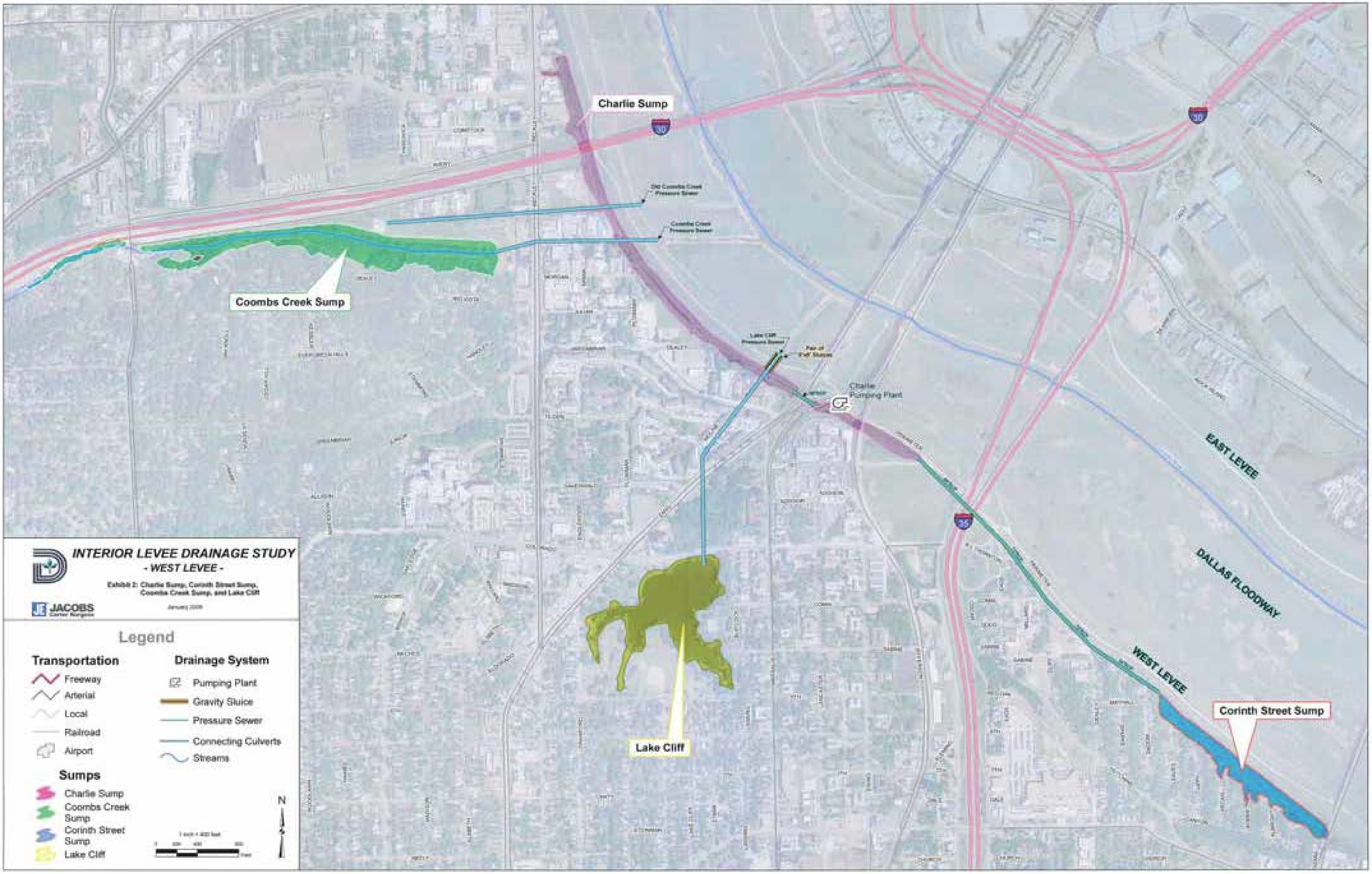
Table 5.1
DALLAS INTERIOR DRAINAGE STUDY - WEST LEVEE

Recommended Options					
Charlie & Corinth Street Sumps					
Option Number	Description	Construction Work Effort (w/o escalation)	**Construction Work Effort (w/ escalation)	**City Contract Administration, Construction Materials Testing, Construction Management, and Engineering and Surveying Services	**Total Costs
C2A	225,000 gpm Charlie Pump Station	$22,896,863	$30,640,582	$9,651,783	$40,292,365
Charlie & Corinth Street Sumps Subtotal		**$22,896,863**	**$30,640,582**	**$9,651,783**	**$40,292,365**
Eagle Ford, Trinity-Portland, Frances Street, Westmoreland-Hampton, & Pavaho Sumps					
Option Number	Description	Construction Work Effort (w/o escalation)	**Construction Work Effort (w/ escalation)	**City Contract Administration, Construction Materials Testing, Construction Management, and Engineering and Surveying Services	**Total Costs
*P2	375,000 gpm Pavaho Pump Station	$23,871,153	$28,430,543	$8,955,621	$37,386,164
P2	2-10x6' RCB at Sylvan Avenue	$1,018,800	$1,363,358	$429,458	$1,792,816
P2	1-10'x8' RCB at Canada Drive	$558,264	$747,069	$235,327	$982,396
D4	1-6'x6' gated conduit structure between Eagle Ford and Trinity-Portland sumps	$1,224,600	$1,638,760	$516,209	$2,154,969
D4	250,000 gpm Trinity-Portland Pump Station	$25,810,605	$34,539,751	$10,880,022	$45,419,773
D4	Delta Rehab	$2,540,400	$3,399,563	$1,070,862	$4,470,426
Eagle Ford, Trinity-Portland, Frances Street, Westmoreland-Hampton, & Pavaho Sumps Subtotal		**$55,023,821**	**$70,119,044**	**$22,087,499**	**$92,206,543**
Recommended Options Total		**$77,920,684**	**$100,759,626**	**$31,739,282**	**$132,498,908**

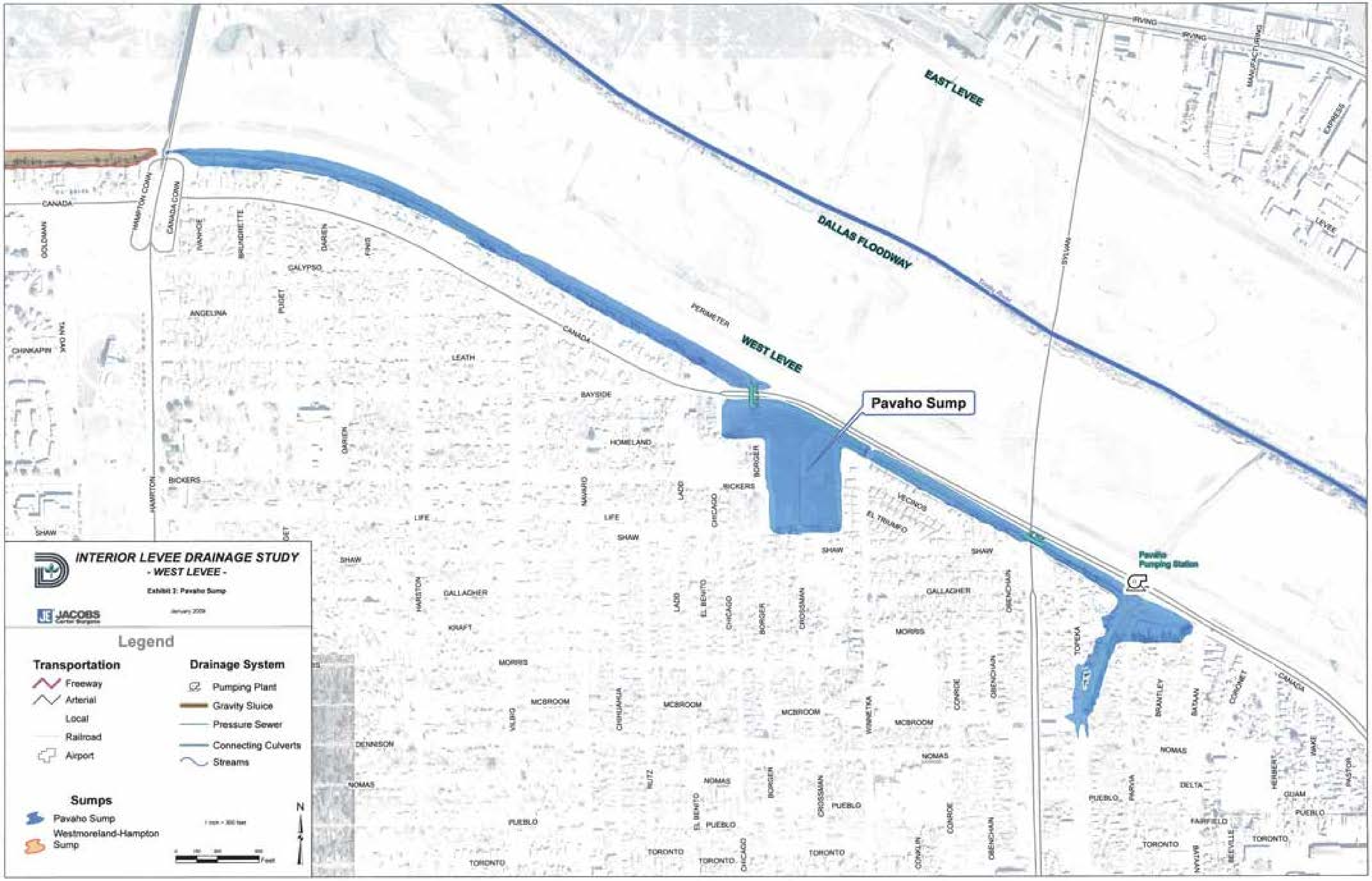
*Estimates for the Pavaho Station options carry a 10% contingency due to the being further along in estimating process. All other options carry a 20% contingency due to the initial stages of the estimating process.
**costs are escalated at 6% for 5 years for all except Pavaho. Pavaho's escalated at 6% for 3 years.


Construct New 250,000 gpm Pump Station in Trinity-Portland Sump $45.4 M
Trinity-Portland Sump
Westmoreland-Hampton Sump
Rehab Existing Delta Pump Station $4.5 M
Pavaho Sump
Construct 2-10'x6' RCBC at Sylvan Avenue $1.8 M
Construct New 6'x6' RCBC Gated Conduit Structure between Eagle Ford and Trinity-Portland Sumps $2.2 M
Construct 1-10'x8' RCBC at Canada Drive $1.0 M
Eagle Ford Sump
Frances Street Sump
Construct New 375,000 gpm Pump Station in Pavaho Sump $37.4 M
Charlie Sump
Coombs Creek Sump
Construct New 225,000 gpm Pump Station in Charlie Sump $40.3 M
Corinth Street Sump
Lake Cliff
INTERIOR LEVEE DRAINAGE STUDY
- WEST LEVEE -
Figure 5.1 - Recommended Improvements
For West levee Interior Drainage System
January 2009
JACOBS
Carter Burgess
NOT TO SCALE
Preliminary Estimates of Probable Costs include construction work effort escalated 5 years at 6% per year and City contract administration, construction materials testing, construction management, and engineering and surveying services.

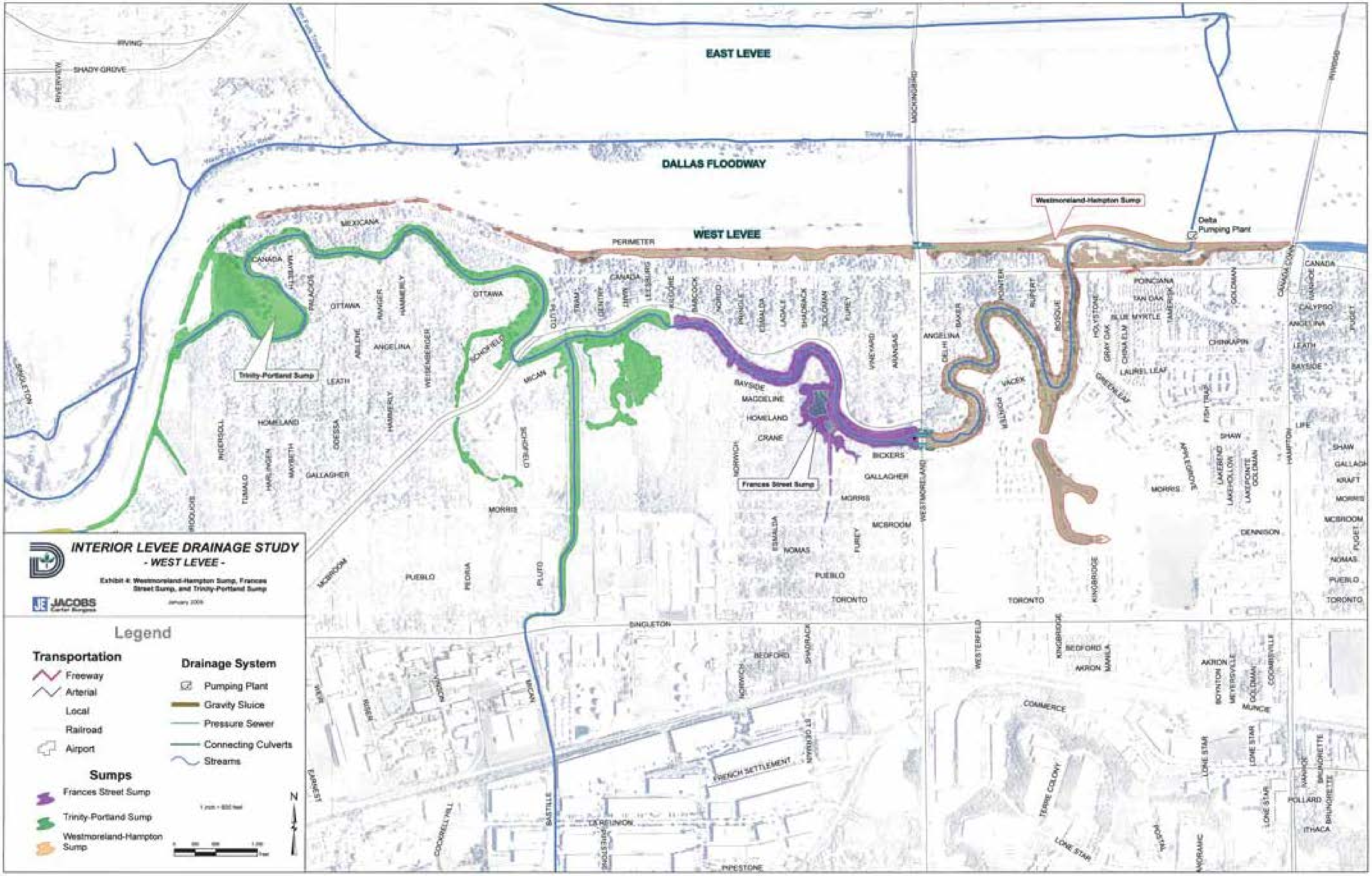

INTERIOR LEVEE DRAINAGE STUDY
- WEST LEVEE -
Exhibit 1: Overview of West Levee Drainage Features
JACOBS
Carter Burgess
January 2009
Legend
Transportation
Freeway
Arterial
Local
Railroad
Airport
Drainage System
Pumping Plant
Gravity Sluice
Pressure Sewer
Sumps
Charlie Sump
Coombs Creek Sump
Corinth Street Sump
Eagle Ford Sump
Frances Street Sump
Lake Cliff
Pavaho Sump
Trinity-Portland Sump
Westmoreland-Hampton Sump
Contours
10 Foot
2 Foot
N
0 625 1,250 2,500
Feet
Westmoreland-Hampton Sump
Trinity-Portland Sump
Delta Pumping Plant
Pavaho Sump
Pavaho Pumping Plant
Eagle Ford Sump
Frances Street Sump
Charlie Sump
Coombs Creek Sump
Charlie Pumping Plant
Corinth Street Sump
Lake Cliff
356
354
12
30
35E
180

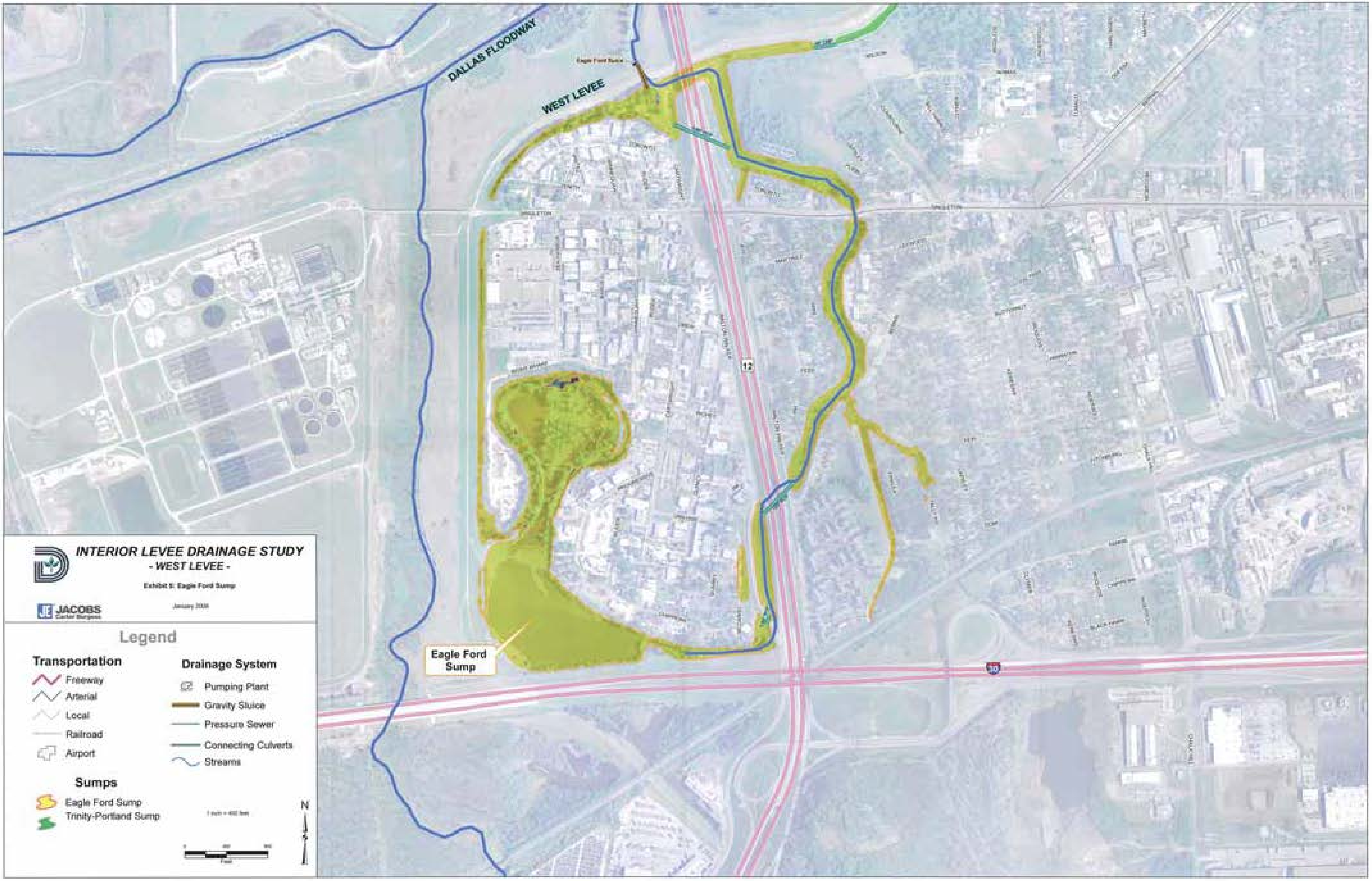


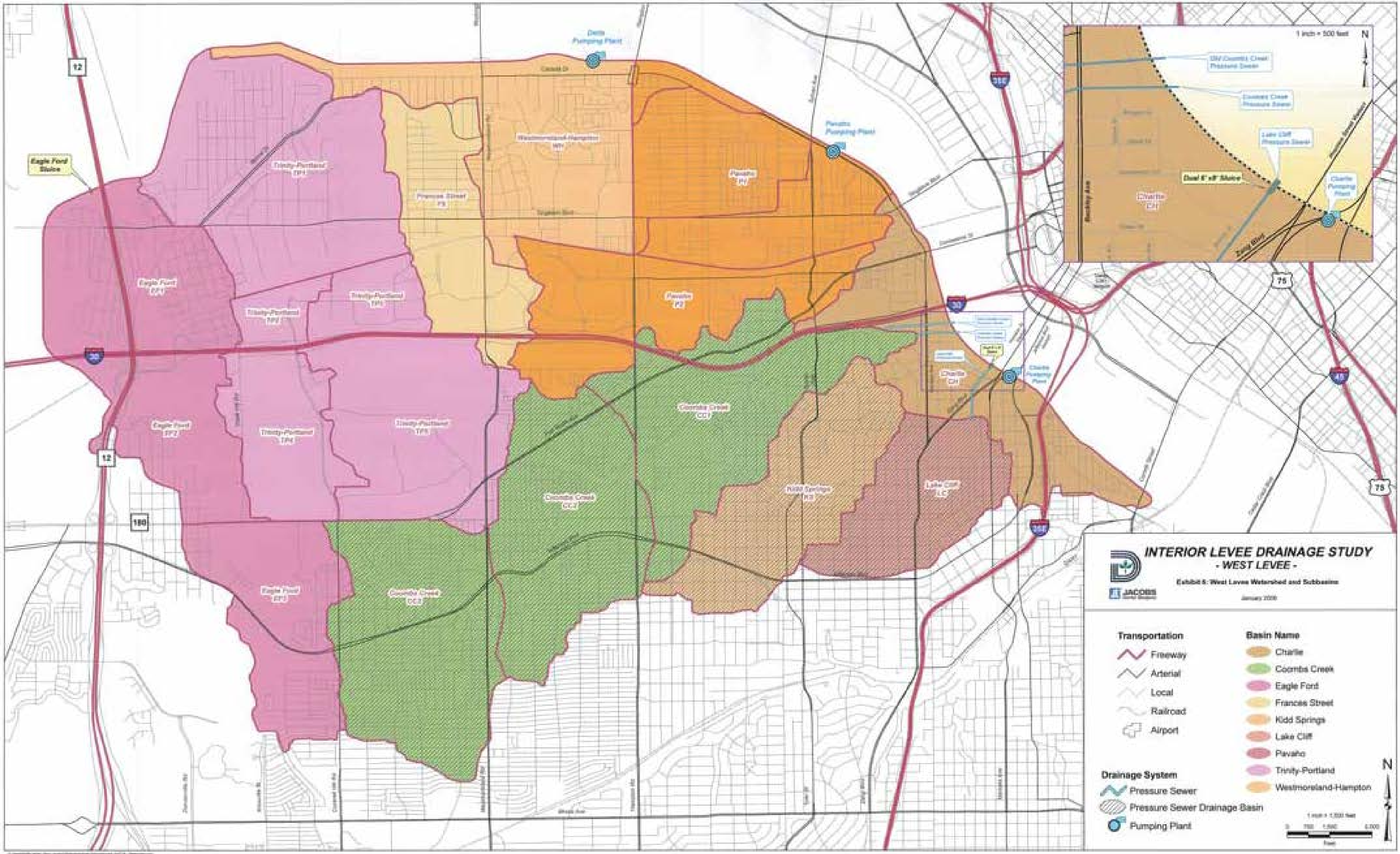
Charlie Sump
Coombs Creek Sump
Lake Cliff
Corinth Street Sump
Old Coombs Creek Pressure Sewer
Coombs Creek Pressure Sewer
Lake Cliff Pressure Sewer
Pair of 8'x8' Sluices
Charlie Pumping Plant
EAST LEVEE
DALLAS FLOODWAY
WEST LEVEE
INTERIOR LEVEE DRAINAGE STUDY
- WEST LEVEE -
Exhibit 2: Charlie Sump, Corinth Street Sump, Coombs Creek Sump, and Lake Cliff
JACOBS
Carter Burgess
January 2009
Legend
Transportation
Freeway
Arterial
Local
Railroad
Airport
Drainage System
Pumping Plant
Gravity Sluice
Pressure Sewer
Connecting Culverts
Streams
Sumps
Charlie Sump
Coombs Creek Sump
Corinth Street Sump
Lake Cliff
N
1 inch = 400 feet

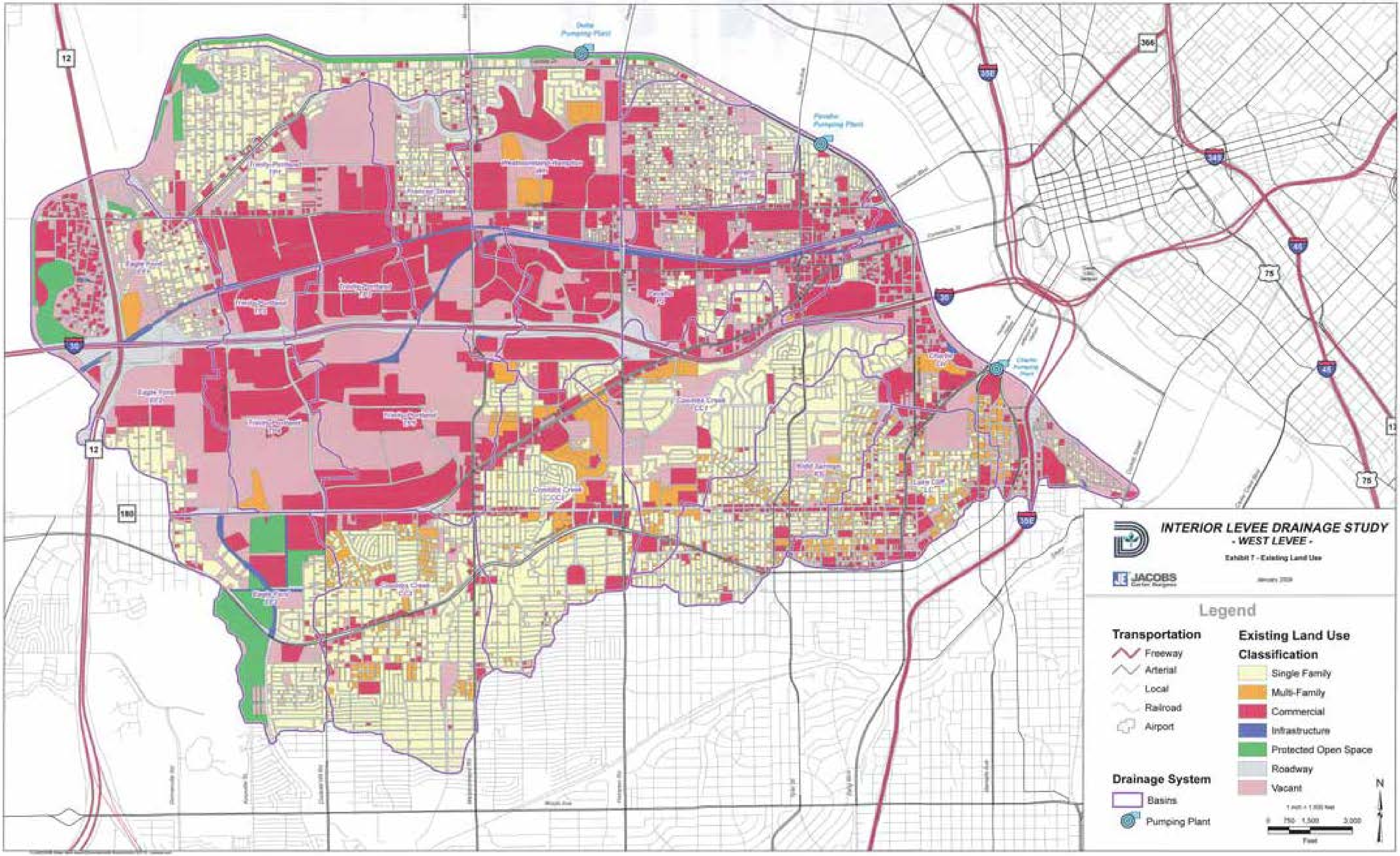


INTERIOR LEVEE DRAINAGE STUDY
- WEST LEVEE -
Exhibit 3: Pavaho Sump
January 2009
JACOBS
Legend
Transportation
Freeway
Arterial
Local
Railroad
Airport
Drainage System
Pumping Plant
Gravity Sluice
Pressure Sewer
Connecting Culverts
Streams
Sumps
Pavaho Sump
Westmoreland-Hampton Sump
N
Feet
Pavaho Sump
Pavaho Pumping Station
EAST LEVEE
DALLAS FLOODWAY
WEST LEVEE
PERIMETER
CANADA
HAMPTON CONN
CANADA CONN
IRVING
MANUFACTURING
EXPRESS
LEVEE
SYLVAN
HAMPTON
GOLDMAN
TAN OAK
CHINKAPIN
IVANHOE
BRUNDRETTE
DARIEN
FINIS
CALYPSO
ANGELINA
PUGET
LEATH
BAYSIDE
HOMELAND
BORGER
BICKERS
LADD
CHICAGO
NAVARO
LIFE
SHAW
VECINOS
EL TRIUMFO
GALLAGHER
HARSTON
KRAFT
MORRIS
EL BENITO
CROSSMAN
OBENCHAIN
TOPEKA
MCBROOM
CHIHUAHUA
WINNETKA
CONROE
BRANTLEY
BATAAN
CORONET
DENNISON
NOMAS
RUTZ
PUEBLO
PARVIA
DELTA
FAIRFIELD
TORONTO
CONKLIN
BEEVILLE
HERBERT
GUAM
WAKE
PASTOR

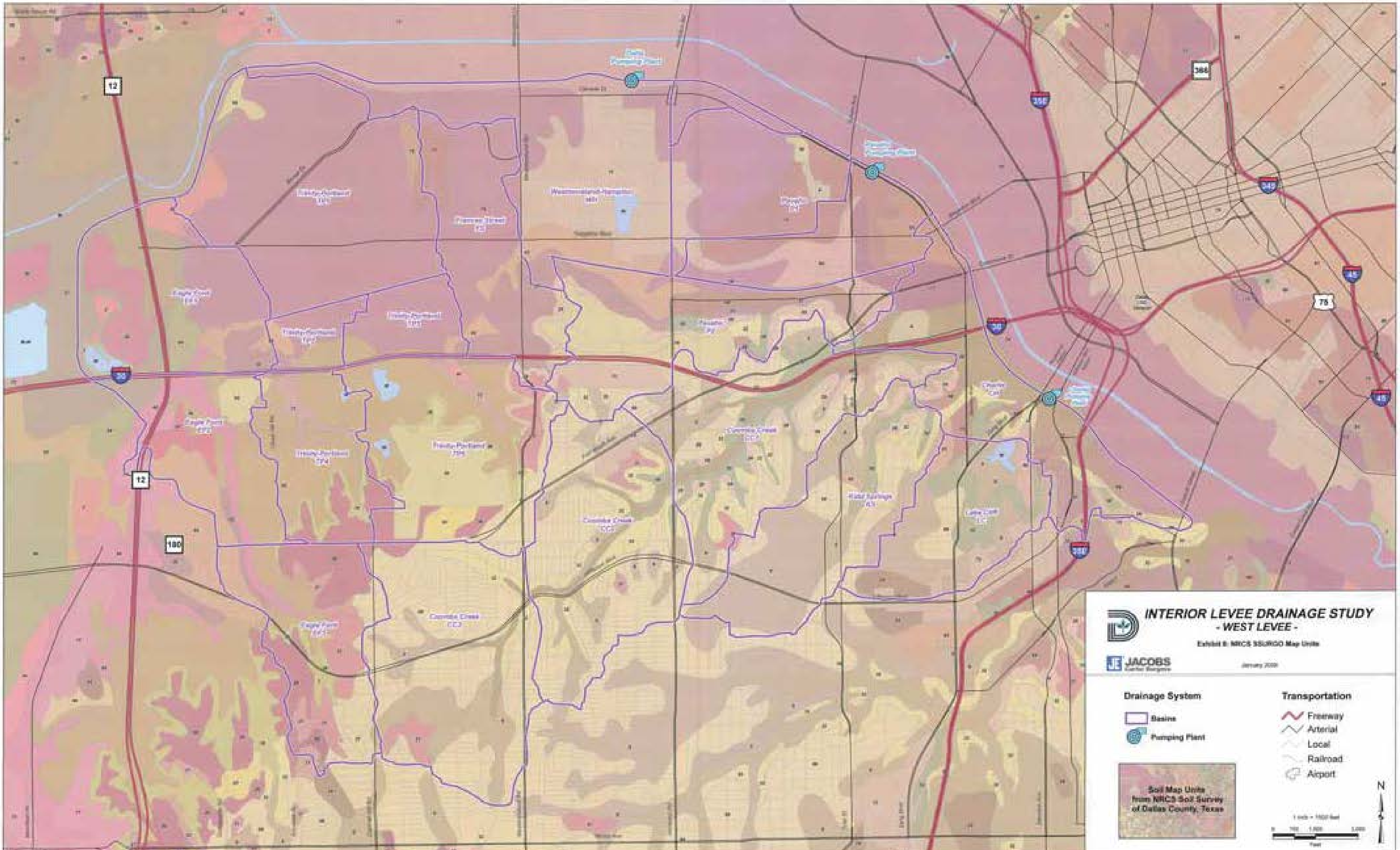

INTERIOR LEVEE DRAINAGE STUDY
- WEST LEVEE -
Exhibit 4: Westmoreland-Hampton Sump, Frances Street Sump, and Trinity-Portland Sump
JACOBS
Carter Burgess
Legend
Transportation
Freeway
Arterial
Local
Railroad
Airport
Drainage System
Pumping Plant
Gravity Sluice
Pressure Sewer
Connecting Culverts
Streams
Sumps
Frances Street Sump
Trinity-Portland Sump
Westmoreland-Hampton Sump
N
EAST LEVEE
DALLAS FLOODWAY
WEST LEVEE
Westmoreland-Hampton Sump
Delta Pumping Plant
Trinity-Portland Sump
Frances Street Sump
PERIMETER
MEXICANA
SINGLETON
WESTMORELAND
HAMPTON
MOCKINGBIRD
IRVING
SHADY GROVE
RIVERVIEW
CANADA
OTTAWA
ANGELINA
LEATH
HOMELAND
GALLAGHER
MORRIS
MCBROOM
PUEBLO
TORONTO
BICKERS
BAYSIDE
MADDELINE
CRANE
NOMAS
PLUTO
MICAN
SCHOFIELD
COMMERCE
FRENCH SETTLEMENT
BASTILLE
PIPESTONE
LONE STAR
TERRE COLONY
KINGBRIDGE
WESTERFELD
BEDFORD
AKRON
DENNISON

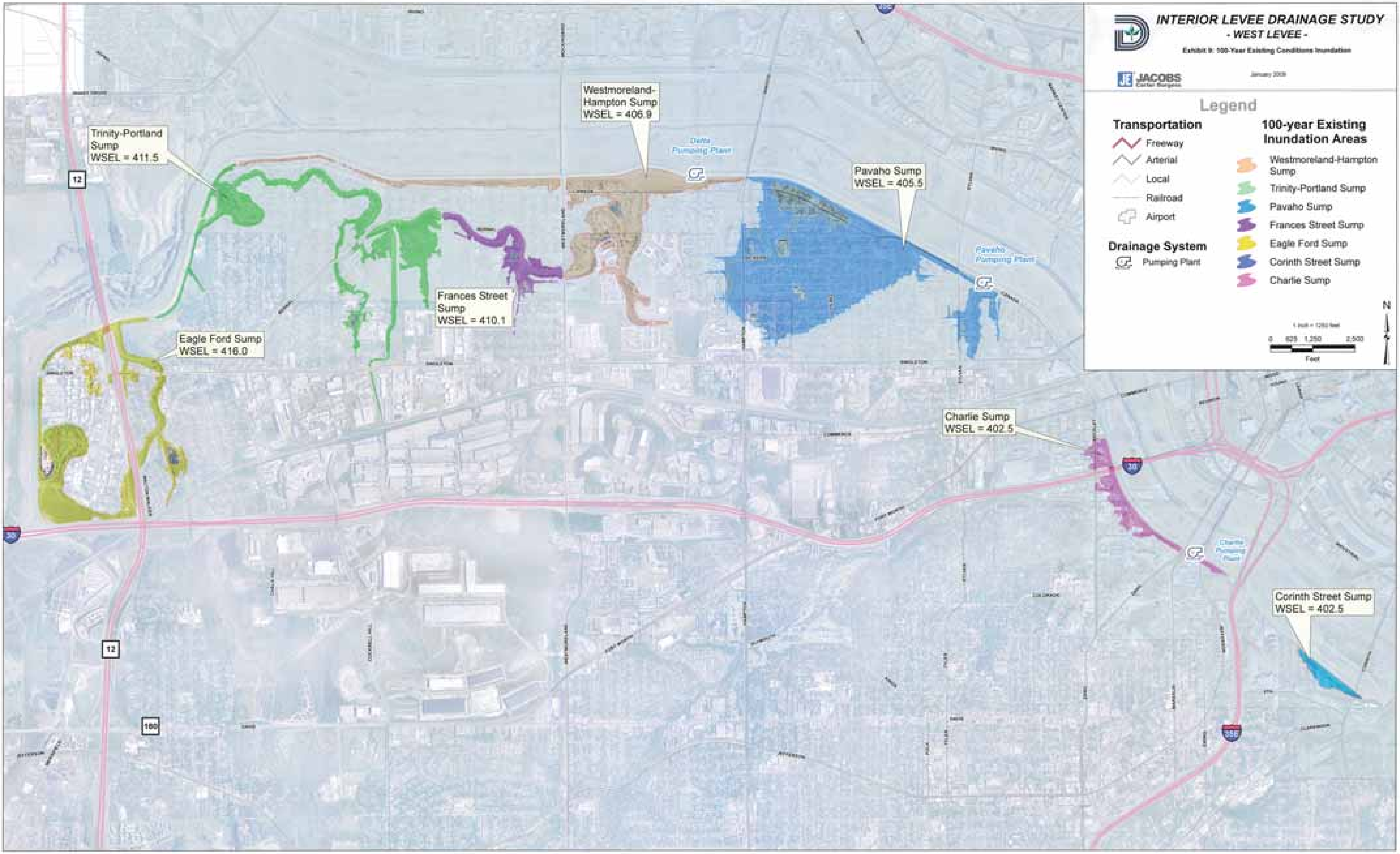

DALLAS FLOODWAY
WEST LEVEE
SINGLETON
12
Eagle Ford Sump
INTERIOR LEVEE DRAINAGE STUDY
- WEST LEVEE -
Exhibit 5: Eagle Ford Sump
JACOBS
Legend
Transportation
Freeway
Arterial
Local
Railroad
Airport
Drainage System
Pumping Plant
Gravity Sluice
Pressure Sewer
Connecting Culverts
Streams
Sumps
Eagle Ford Sump
Trinity-Portland Sump
N
Feet

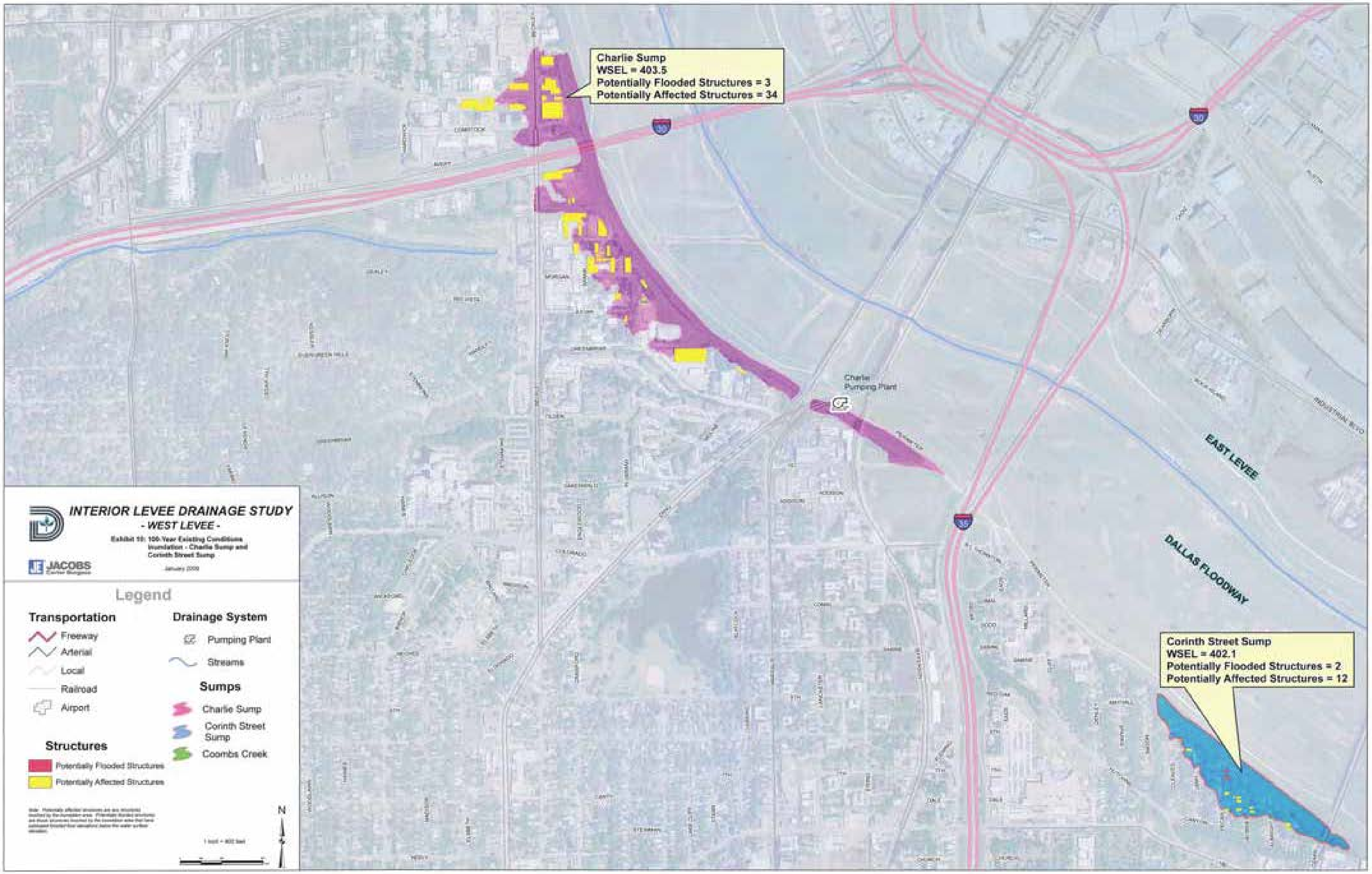

INTERIOR LEVEE DRAINAGE STUDY
- WEST LEVEE -
Exhibit 6: West Levee Watershed and Subbasins
JACOBS
Transportation
Freeway
Arterial
Local
Railroad
Airport
Basin Name
Charlie
Coombs Creek
Eagle Ford
Frances Street
Kidd Springs
Lake Cliff
Pavaho
Trinity-Portland
Westmoreland-Hampton
Drainage System
Pressure Sewer
Pressure Sewer Drainage Basin
Pumping Plant
N
Eagle Ford Sluice
Delta Pumping Plant
Pavaho Pumping Plant
Charlie Pumping Plant
Dual 6' x8' Sluice
Trinity-Portland TP1
Eagle Ford EF1
Frances Street FS
Westmoreland-Hampton WH
Pavaho P1
Pavaho P2
Eagle Ford EF2
Trinity-Portland TP4
Trinity-Portland TP5
Coombs Creek CC1
Coombs Creek CC2
Coombs Creek CC3
Kidd Springs KS
Lake Cliff LC
Charlie CH
Eagle Ford EF3
12
180
30
35E
75
45
1 inch = 500 feet

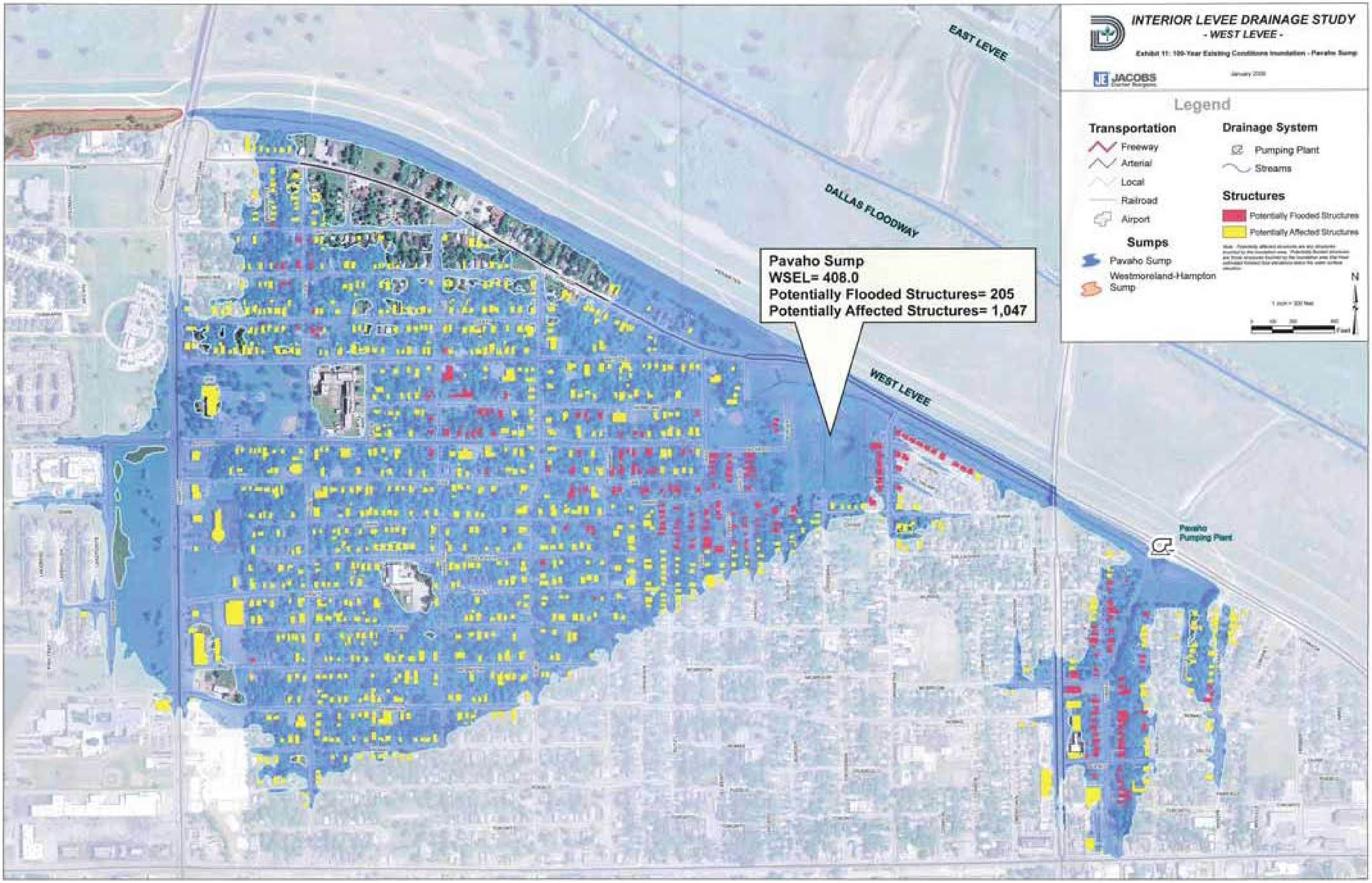


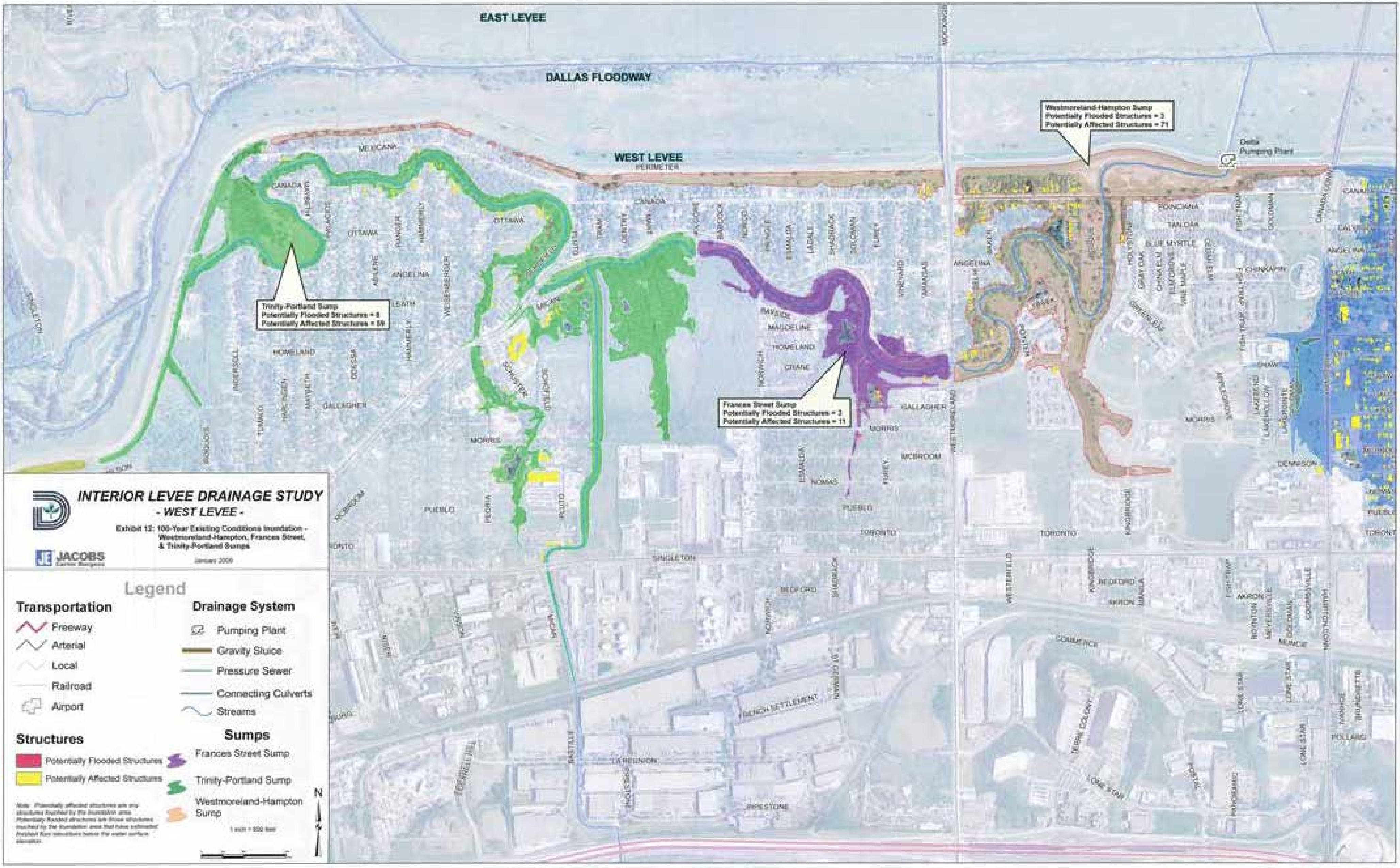
INTERIOR LEVEE DRAINAGE STUDY
- WEST LEVEE -
Exhibit 7 - Existing Land Use
JACOBS
Legend
Transportation
Freeway
Arterial
Local
Railroad
Airport
Existing Land Use Classification
Single Family
Multi-Family
Commercial
Infrastructure
Protected Open Space
Roadway
Vacant
Drainage System
Basins
Pumping Plant
0
750
1,500
3,000
Feet
N
12
180
30
35E
366
345
45
75

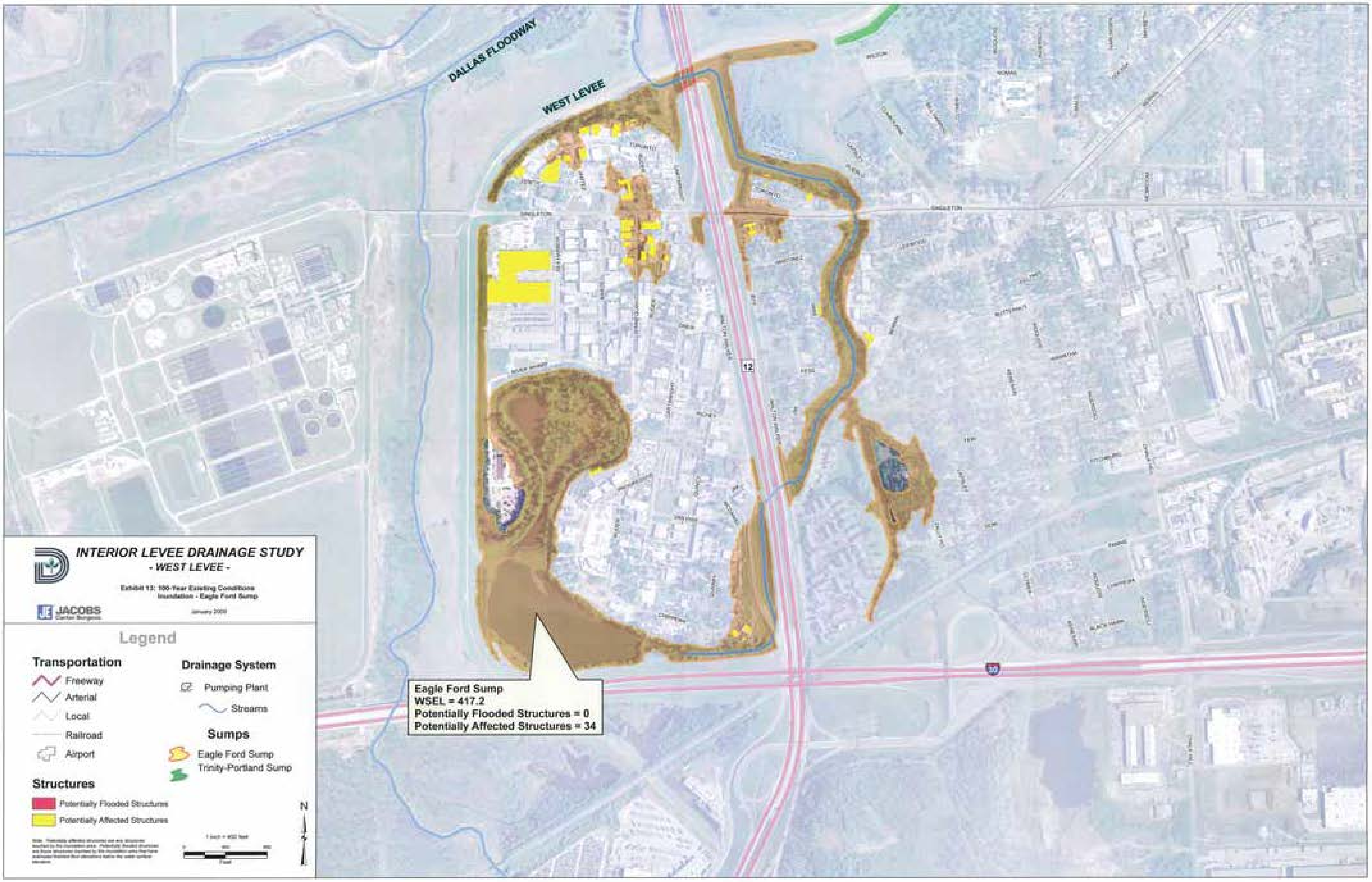

INTERIOR LEVEE DRAINAGE STUDY
- WEST LEVEE -
Exhibit 8: NRCS SSURGO Map Units
JACOBS
Drainage System
Basins
Pumping Plant
Transportation
Freeway
Arterial
Local
Railroad
Airport
Soil Map Units from NRCS Soil Survey of Dallas County, Texas
N
12
180
20
30
35E
366
345
45
75


INTERIOR LEVEE DRAINAGE STUDY
- WEST LEVEE -
Exhibit 9: 100-Year Existing Conditions Inundation
JACOBS
Carter Burgess
January 2009
Legend
Transportation
Freeway
Arterial
Local
Railroad
Airport
Drainage System
Pumping Plant
100-year Existing Inundation Areas
Westmoreland-Hampton Sump
Trinity-Portland Sump
Pavaho Sump
Frances Street Sump
Eagle Ford Sump
Corinth Street Sump
Charlie Sump
N
Feet
Westmoreland-Hampton Sump WSEL = 406.9
Trinity-Portland Sump WSEL = 411.5
Delta Pumping Plant
Pavaho Sump WSEL = 405.5
Pavaho Pumping Plant
Frances Street Sump WSEL = 410.1
Eagle Ford Sump WSEL = 416.0
Charlie Sump WSEL = 402.5
Charlie Pumping Plant
Corinth Street Sump WSEL = 402.5
12
30
180
35E

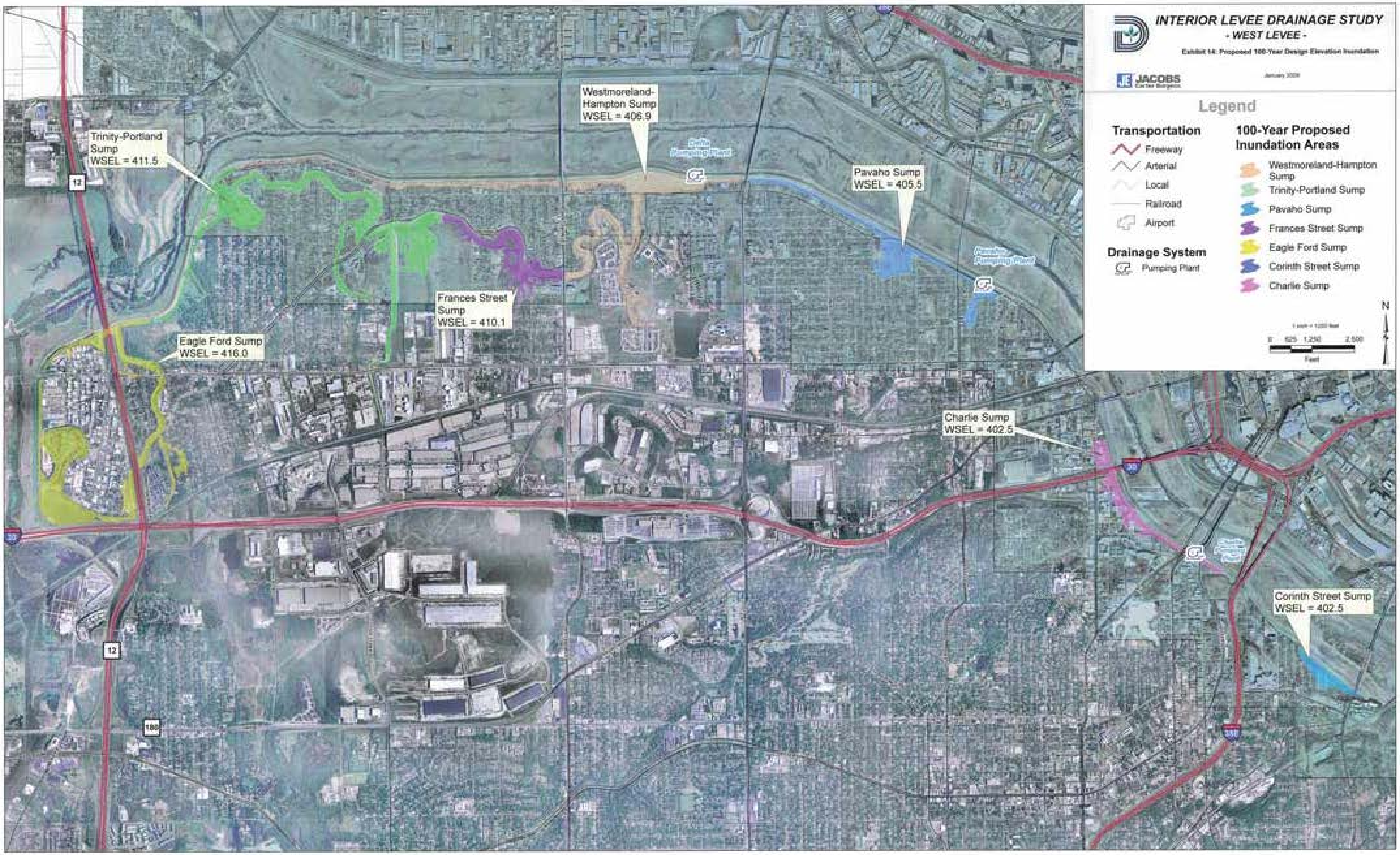

Charlie Sump
WSEL = 403.5
Potentially Flooded Structures = 3
Potentially Affected Structures = 34
Charlie Pumping Plant
EAST LEVEE
DALLAS FLOODWAY
Corinth Street Sump
WSEL = 402.1
Potentially Flooded Structures = 2
Potentially Affected Structures = 12
INTERIOR LEVEE DRAINAGE STUDY
- WEST LEVEE -
Exhibit 10: 100-Year Existing Conditions Inundation - Charlie Sump and Corinth Street Sump
JACOBS
Legend
Transportation
Freeway
Arterial
Local
Railroad
Airport
Drainage System
Pumping Plant
Streams
Sumps
Charlie Sump
Corinth Street Sump
Coombs Creek
Structures
Potentially Flooded Structures
Potentially Affected Structures
N

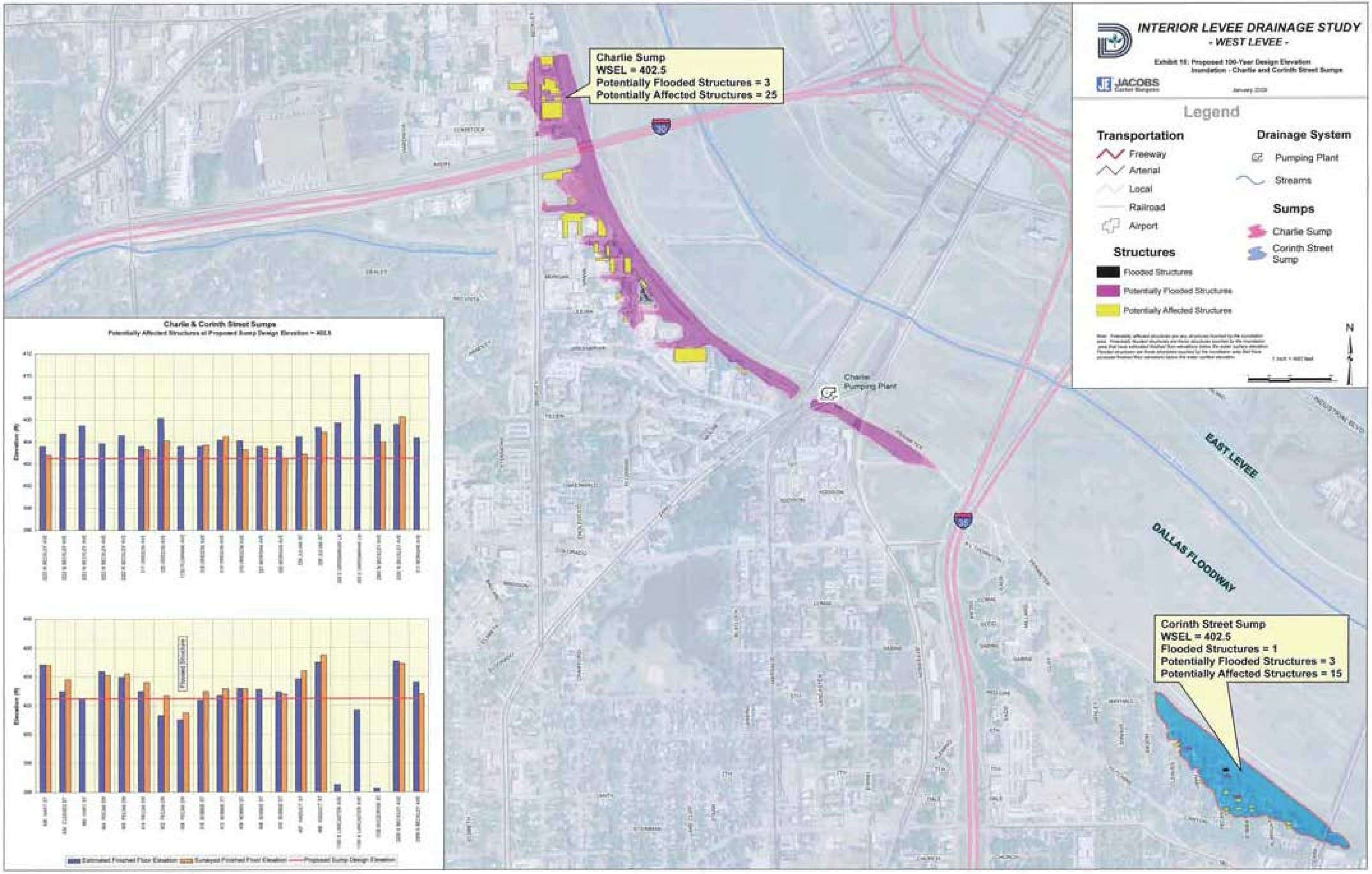

INTERIOR LEVEE DRAINAGE STUDY
- WEST LEVEE -
Exhibit 11: 100-Year Existing Conditions Inundation - Pavaho Sump
JACOBS
Legend
Transportation
Freeway
Arterial
Local
Railroad
Airport
Sumps
Pavaho Sump
Westmoreland-Hampton Sump
Drainage System
Pumping Plant
Streams
Structures
Potentially Flooded Structures
Potentially Affected Structures
N
Feet
EAST LEVEE
DALLAS FLOODWAY
WEST LEVEE
Pavaho Sump
WSEL= 408.0
Potentially Flooded Structures= 205
Potentially Affected Structures= 1,047
Pavaho Pumping Plant

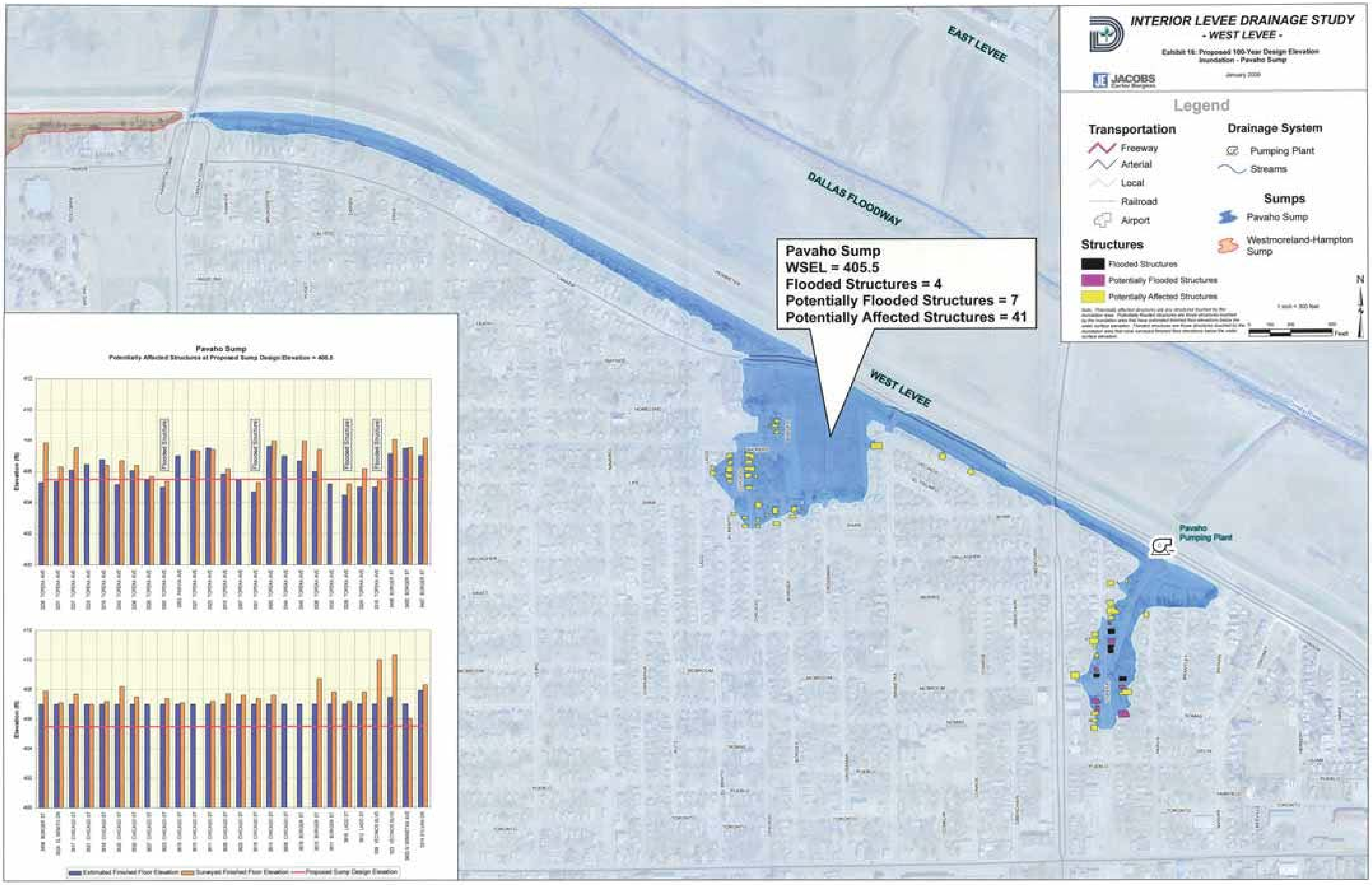

INTERIOR LEVEE DRAINAGE STUDY
- WEST LEVEE -
Exhibit 12: 100-Year Existing Conditions Inundation - Westmoreland-Hampton, Frances Street, & Trinity-Portland Sumps
JACOBS
January 2009
Legend
Transportation
Freeway
Arterial
Local
Railroad
Airport
Drainage System
Pumping Plant
Gravity Sluice
Pressure Sewer
Connecting Culverts
Streams
Structures
Potentially Flooded Structures
Potentially Affected Structures
Sumps
Frances Street Sump
Trinity-Portland Sump
Westmoreland-Hampton Sump
N
EAST LEVEE
DALLAS FLOODWAY
WEST LEVEE
PERIMETER
Westmoreland-Hampton Sump
Potentially Flooded Structures = 3
Potentially Affected Structures = 71
Delta Pumping Plant
Trinity-Portland Sump
Potentially Flooded Structures = 8
Potentially Affected Structures = 59
Frances Street Sump
Potentially Flooded Structures = 3
Potentially Affected Structures = 11
MEXICANA
CANADA
OTTAWA
ANGELINA
LEATH
HOMELAND
GALLAGHER
MORRIS
PUEBLO
TORONTO
SINGLETON
BEDFORD
AKRON
COMMERCE
FRENCH SETTLEMENT
LA REUNION
FIRESTONE
LONE STAR
BAYSIDE
MAGDELINE
CRANE
MCBROOM
NOMAS
POINCIANA
TAN OAK
BLUE MYRTLE
CHINKAPIN
SHAW
DENNISON
POLLARD
WESTMORELAND
WESTERFIELD
KINGBRIDGE

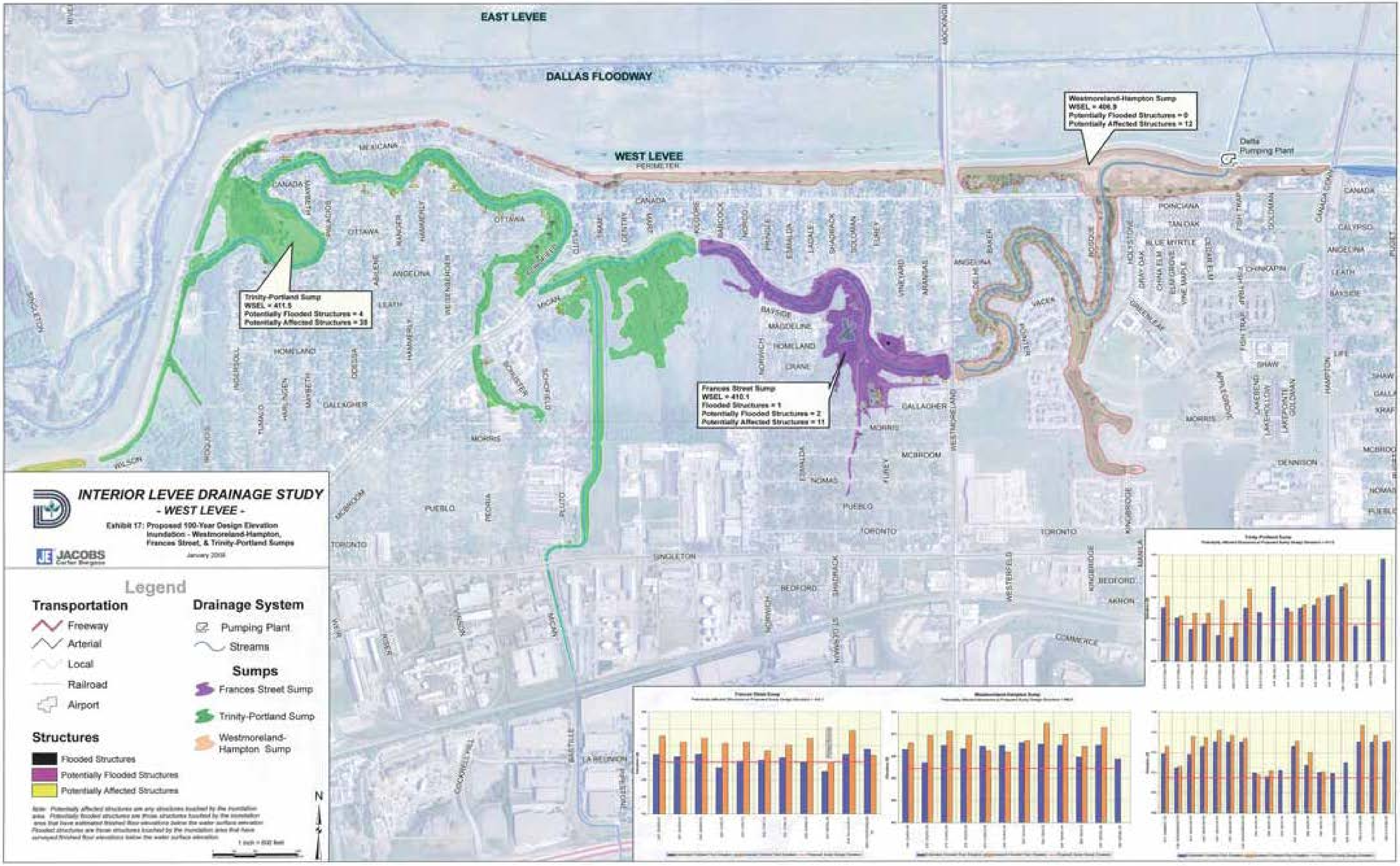


DALLAS FLOODWAY
WEST LEVEE
SINGLETON
12
30
Eagle Ford Sump
WSEL = 417.2
Potentially Flooded Structures = 0
Potentially Affected Structures = 34
INTERIOR LEVEE DRAINAGE STUDY
- WEST LEVEE -
Exhibit 13: 100-Year Existing Conditions
Inundation - Eagle Ford Sump
JACOBS
Carter Burgess
January 2009
Legend
Transportation
Freeway
Arterial
Local
Railroad
Airport
Drainage System
Pumping Plant
Streams
Sumps
Eagle Ford Sump
Trinity-Portland Sump
Structures
Potentially Flooded Structures
Potentially Affected Structures
N

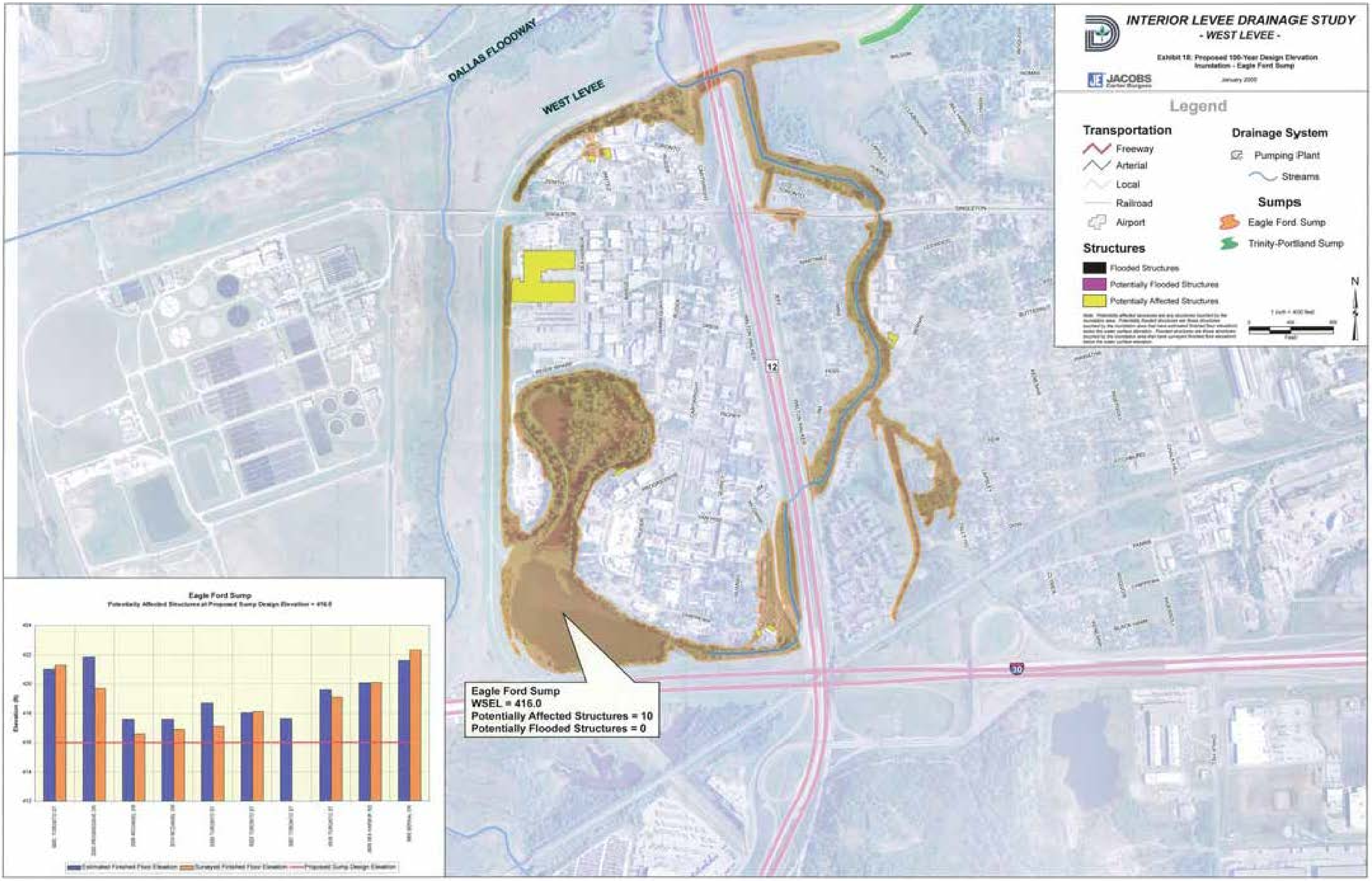

INTERIOR LEVEE DRAINAGE STUDY
- WEST LEVEE -
Exhibit 14: Proposed 100-Year Design Elevation Inundation
JACOBS
Carter Burgess
Legend
Transportation
Freeway
Arterial
Local
Railroad
Airport
Drainage System
Pumping Plant
100-Year Proposed Inundation Areas
Westmoreland-Hampton Sump
Trinity-Portland Sump
Pavaho Sump
Frances Street Sump
Eagle Ford Sump
Corinth Street Sump
Charlie Sump
N
0 625 1,250 2,500
Feet
Trinity-Portland Sump WSEL = 411.5
Westmoreland-Hampton Sump WSEL = 406.9
Delta Pumping Plant
Pavaho Sump WSEL = 405.5
Pavaho Pumping Plant
Frances Street Sump WSEL = 410.1
Eagle Ford Sump WSEL = 416.0
Charlie Sump WSEL = 402.5
Corinth Street Sump WSEL = 402.5
12
180


INTERIOR LEVEE DRAINAGE STUDY
- WEST LEVEE -
Exhibit 15: Proposed 100-Year Design Elevation Inundation - Charlie and Corinth Street Sumps
JACOBS
Carter Burgess
January 2009
Legend
Transportation
Freeway
Arterial
Local
Railroad
Airport
Structures
Flooded Structures
Potentially Flooded Structures
Potentially Affected Structures
Drainage System
Pumping Plant
Streams
Sumps
Charlie Sump
Corinth Street Sump
N
Charlie Sump
WSEL = 402.5
Potentially Flooded Structures = 3
Potentially Affected Structures = 25
Charlie Pumping Plant
EAST LEVEE
DALLAS FLOODWAY
Corinth Street Sump
WSEL = 402.5
Flooded Structures = 1
Potentially Flooded Structures = 3
Potentially Affected Structures = 15
Charlie & Corinth Street Sumps
Potentially Affected Structures at Proposed Sump Design Elevation = 402.5
Elevation (ft)
Flooded Structure
Estimated Finished Floor Elevation
Surveyed Finished Floor Elevation
Proposed Sump Design Elevation


INTERIOR LEVEE DRAINAGE STUDY
- WEST LEVEE -
JACOBS
Legend
Transportation
Freeway
Arterial
Local
Railroad
Airport
Drainage System
Pumping Plant
Streams
Sumps
Pavaho Sump
Westmoreland-Hampton Sump
Structures
Flooded Structures
Potentially Flooded Structures
Potentially Affected Structures
N
Feet
EAST LEVEE
DALLAS FLOODWAY
WEST LEVEE
Pavaho Sump
WSEL = 405.5
Flooded Structures = 4
Potentially Flooded Structures = 7
Potentially Affected Structures = 41
Pavaho Pumping Plant
Pavaho Sump
Flooded Structure
Estimated Finished Floor Elevation
Surveyed Finished Floor Elevation
Proposed Sump Design Elevation



INTERIOR LEVEE DRAINAGE STUDY
- WEST LEVEE -
Exhibit 17: Proposed 100-Year Design Elevation Inundation - Westmoreland-Hampton, Frances Street, & Trinity-Portland Sumps
January 2009
JACOBS
EAST LEVEE
DALLAS FLOODWAY
WEST LEVEE
Westmoreland-Hampton Sump
WSEL = 406.9
Potentially Flooded Structures = 0
Potentially Affected Structures = 12
Delta Pumping Plant
Trinity-Portland Sump
WSEL = 411.5
Potentially Flooded Structures = 4
Potentially Affected Structures = 28
Frances Street Sump
WSEL = 410.1
Flooded Structures = 1
Potentially Flooded Structures = 2
Potentially Affected Structures = 11
Legend
Transportation
Freeway
Arterial
Local
Railroad
Airport
Drainage System
Pumping Plant
Streams
Sumps
Frances Street Sump
Trinity-Portland Sump
Westmoreland-Hampton Sump
Structures
Flooded Structures
Potentially Flooded Structures
Potentially Affected Structures
N



INTERIOR LEVEE DRAINAGE STUDY
- WEST LEVEE -
Exhibit 18: Proposed 100-Year Design Elevation Inundation - Eagle Ford Sump
JACOBS
Legend
Transportation
Freeway
Arterial
Local
Railroad
Airport
Drainage System
Pumping Plant
Streams
Sumps
Eagle Ford Sump
Trinity-Portland Sump
Structures
Flooded Structures
Potentially Flooded Structures
Potentially Affected Structures
N
DALLAS FLOODWAY
WEST LEVEE
12
30
Eagle Ford Sump
WSEL = 416.0
Potentially Affected Structures = 10
Potentially Flooded Structures = 0
Eagle Ford Sump
Estimated Finished Floor Elevation
Surveyed Finished Floor Elevation
Proposed Sump Design Elevation