Appendix **B**

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Galveston District

Preliminary Engineering Report

for

Luce Bayou Interbasin Transfer Project

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Abbreviations and Acronyms

Ac-ft/yr	Acre feet per year
ADF	Average daily flow
AEP	Annual Exceedance Probability
ANSI	American National Standards Institute
CFS	Cubic feet per second
CHCRWA	Central Harris County Regional Water Authority
COH	City of Houston
CR	County Road
CWA	Coastal Water Authority
DEM	Digital Elevation Model
EWPP	East Water Purification Plant
FM	Farm-to-Market
GPM	Gallons per minute
HGSD	Harris Galveston Subsidence District
HI	Hydraulic Institute
HP	Horsepower
LBITP	Luce Bayou Interbasin Transfer Project
LiDAR	Light detection and ranging
MGD	Million gallons per day
MSL	Mean sea level
MUD	Municipal Utility District
NEWPP	Northeast Water Purification Plant
NFBWA	North Fort Bend Water Authority
NHC	North Harris County
NHCRWA	North Harris County Regional Water Authority
NPSHR	Net positive suction head required
PER	Preliminary engineering report
ROW	Right-Of-Way
RWA	Regional water authority
RWP	Regional water plan
SCADA	Supervisory Control and Detection Acquisition
SEWPP	Southeast Water Purification Plant
SH	State Highway
SJRA	San Jacinto River Authority
TCEQ	Texas Commission on Environmental Quality
TDH	Total dynamic head
TRA	Trinity River Authority
TRNWR	Trinity River National Wildlife Refuge

UC	Usage Coefficient
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
WAM	Water Availability Model
WHCRWA	West Harris County Regional Water Authority
WRAP	Water Rights Analysis Package
WSE	Water surface elevation

Executive Summary

Project Introduction and Overview

This Preliminary Engineering Report (PER) establishes all of the basic design aspects of the major components of the Luce Bayou Interbasin Transfer Project (LBITP). This PER is written in support of and provides information for the Clean Water Act Section 404 Permit Application needed for construction.

The purpose of the LBITP is to provide additional surface water supplies to end users that utilize water from Lake Houston. Additional surface water supplies will be transferred to Lake Houston from the Trinity River via the LBITP due to the increased surface water demand in the Harris-Galveston Subsidence District Area 3. Increased demand in the area is being driven by the conversion from groundwater supplies to surface water supplies.

The recommended concept for this interbasin transfer project includes a raw water intake structure and pump station, nearly 3 miles of pipeline, a sedimentation basin, and approximately 23.6 miles of canal. The pump station will be located on the Trinity River at Capers Ridge. The pipeline will extend west-southwest approximately 3 miles along a geological ridge (Capers Ridge) to the watershed divide between the Trinity River and the Lake Houston Watersheds. The pipeline will then outfall into the sedimentation basin at the start of the canal. The canal will outfall into the lower reaches of Luce Bayou, which flows into the northeastern corner of Lake Houston.

Trinity River Conditions

Several studies were conducted to comprehend the characteristics of the Trinity River at Capers Ridge prior to beginning the preliminary engineering. A hydraulic and sediment transport model was developed to assess water surface elevation and sediment transport in the Trinity River. Water surface elevations were determined and are expected to range in elevation between 16.9 feet and 44.7 feet in the Trinity River near Capers Ridge. A bathymetric survey of the Trinity River at Capers Ridge was performed for the purposes of the hydraulic model and preliminary engineering of the pump station intake. The results of the bathymetric model can be found in *Appendix C*.

The sediment transport analysis predicted great variation in suspended sediment concentrations in relation to flow rate within the Trinity River. Significant vertical and horizontal stratification in sediment concentration is also predicted to occur during high flow events. Peak concentrations of up to 10,000 mg/l are found in the bed load near the center of the river channel. Suspended sediment concentrations entering the pump station are anticipated to range from 20 mg/l to 1,800 mg/l. To determine the size distribution of particles suspended for different flows in the Trinity River, an analysis of suspended sediment size distributions was prepared and provided in the report.

Under low flow conditions, Lake Livingston Dam operators monitor raw water withdrawals and release only as much water from the dam as needed to meet all downstream water rights. When the Capers Ridge Pump Station comes online, the Trinity River Authority may have to release additional water during otherwise low natural flows in order to meet the increased raw water demand associated with the LBITP.

Project Capacity and Preliminary Operations Plan

AECOM received untreated water delivery requirements from the City of Houston (COH), which are based on Water Supply Contracts between the COH and the other co-participants (collectively known as the Water Authorities), as well as existing raw water supplies and estimates of future COH demands from Lake Houston. The Water Supply Contracts specify estimated raw water demand allocations for the Water Authorities for the years 2025, 2030, 2035, and 2040. The City is authorized to divert a maximum of 775 cubic feet per second (500 million gallons per day [MGD]) from the Capers Ridge diversion point.

The LBITP capacity is planned to be phased. Construction of the initial supply is mandated to be completed no later than June 30, 2019 by the project's contract between the Coastal Water Authority (CWA) and the COH, and the pump station may be expanded to full capacity in subsequent years as dictated by future demand. Accordingly, untreated water delivery requirements to Lake Houston received from the COH are identified for two phases, 2020 and 2040. Losses along the canal system, estimated to be 15 percent of the total pumped volume, were added to the untreated water delivery requirements. Based on untreated water delivery requirements and estimated canal losses, the required LBITP capacity is projected to be 230 MGD in 2020 and 425 MGD in 2040.

Several portions of the project will be constructed to convey the maximum allowable water right, including the intake structure, electrical service, pipeline, settling basin, and canal structure. Typical operations at the Capers Ridge Pump Station will follow certain guidelines in order to achieve various goals. For example, at least one pump will operate at the Capers Ridge Pump Station during non-flood conditions to preserve flow in the canal, maintain a relatively stable water surface elevation, and reduce sloughing in the channel. Pumping will not occur during extreme flood events. It is anticipated that LBITP will normally be taken out of operation during times when Lake Houston is overflowing the spillway due to a rate of inflow that exceeds demand.

Pump Station Facilities

The major raw water pump station facilities will include a side-channel river intake, trash rack, trash rack cleaning mechanism, sediment settling basin, pump bay, vertical pumps, and a discharge header outfitted with various check, isolation, and air release valves.

Three duty pumps and no redundant pumps were selected as the preferred configuration to provide the required LBITP Phase 1 capacity and to satisfy raw water demand up to the year 2025. In Phase 1, under typical Trinity River conditions, each pump will pump between 53,200 gpm and 56,500 gpm, depending on the number of pumps in operation and final pumps selected. Up to five additional pumps can be added as necessary to meet future demands. An additional three duty pumps can be added to provide a total pumping capacity capable of meeting the projected 2040 LBITP capacity requirement of 425 MGD. Two further pumps can then be added to equal a total of eight installed pumps. A firm pumping capacity of 500 MGD and a total pumping capacity of 557 MGD can be achieved with eight pumps if the impellers of all eight pumps are changed to larger diameter.

The *American National Standards Institute (ANSI) / HI American National Standard for Pump Intake Design, Version 9.8, Copyright 1998* (HI Version 9.8), was used to establish the preliminary layout and design of the proposed Capers Ridge Pump Station. These dimensions are shown in *Exhibits B- 9* and

B-10 of the PER Volume II. Calculations, a summary table, and additional information are provided in *Appendix A-Section III*.

The intake structure will be designed to meet velocity constraints through the trash rack and intake, exclude as much sediment as is practical, and withdraw the required flow under anticipated minimum water surface elevations. The intake will have a total width of 118.5 feet, an interior of 112.5 feet, and an intake elevation of 12 feet, which is 4.9 feet below the minimum anticipated water surface elevation.

The trash rack will be designed to prevent debris from entering the pump station, potentially damaging the pumps and mechanical equipment. AECOM recommends a trash rack bar spacing of 2 inches. The trash rack cleaning mechanism will remove trash and debris from the trash rack on a routine basis to maintain the pump station's capacity. Hydraulically operated articulating boom mechanisms were identified by the AECOM design team as the most effective solution available.

To minimize damage to the impeller, bearings, and wear rings, selective extraction of course sediment ahead of the pumps is recommended. A 40' pre-pump settling basin will be provided to remove all coarse sands and to minimize concentrations of medium to fine sands to the maximum extent practical. Multiple options for removing, handling, and storing settled sediment are provided and will be further developed in a later phase of the design and based on owner preferences.

Conveyance System

The Conveyance System for the LBITP project consists of three major sections: a pipeline section, a sedimentation basin section, and a canal section. The capacity of the conveyance system will be 500 MGD. The pipeline section consists of approximately 3 miles of dual 108" pipelines that begin within the Capers Ridge Pump Station. The conveyed water within the pipelines will then empty into the sedimentation basin where sediment and other buildup settle out of the flow along the bottom of the basin. After the conveyed water passes through the sedimentation basin, it enters the canal section. The canal is approximately 23.6 miles long and empties into an outfall structure located in Lake Houston.

Section 1 – Project Introduction and Overview

1.1 Introduction

This document represents the Preliminary Engineering Report (PER) for the Luce Bayou Interbasin Transfer Project (LBITP). This PER establishes all basic design aspects of the LBITP, anticipated to be required for the Section 404 Permit. Key components of the project include the raw water pump station, transfer pipeline, settling basin, canal, and outfall. General facility layouts, sections, and equipment selections have been developed for the pump station facilities and settling basin, and general plan and profile sections have been developed for the pipeline and canal. Additional information required for the Section 404 Permit is also provided herein, in support of that permitting effort.

1.2 Overall Purpose of Project

The purpose of the LBITP is to transfer water from the Trinity River to Lake Houston, which is the San Jacinto River Basin. Additional surface water supplies are needed due to the increased surface water demand in the Harris-Galveston and Fort Bend Subsidence Districts that is being driven by the conversion from groundwater supplies to surface water supplies. The additional surface water supplies will be transferred to Lake Houston from the Trinity River via the LBITP.

1.3 Background Information

Harris-Galveston Subsidence District (HGSD) Area Three is being progressively converted from groundwater to surface water. Eighty percent of their total water usage must be from surface water by January 1, 2030. Existing infrastructure allows for the transfer of Trinity River water to the City of Houston (COH) East Water Purification Plant (EWPP) and the Southeast Water Purification Plant (SEWPP). However, there is currently no way of providing raw Trinity River water to the Northeast Water Purification Plant (NEWPP), which treats water from Lake Houston. Due to its location, the NEWPP is vital in providing treated surface water to HGSD Area Three. Previous studies have shown that Lake Houston and NEWPP cannot meet future demands with their current capacity. Sufficient raw water in Lake Houston and treatment capacity in the NEWPP is not currently available to allow for the mandatory conversion from groundwater to surface water. The LBITP will provide the additional raw water resources necessary to satisfy these demands. The LBITP is a regional water supply project to transfer raw water from the Trinity River Basin (including raw water originating from Lake Livingston) to customers that receive water from Lake Houston.

The COH holds permits to divert raw water at a maximum rate of 775 cubic feet per second (CFS) (approximately 500 million gallons per day [MGD]) from the Capers Ridge site to Lake Houston. The Certificates of Adjudication are numbered 08-4261 and 08-4261B.

The LBITP planning, permitting, and preliminary engineering are being financed by a $28 million Texas Water Development Board Water Infrastructure Fund (WIF) Loan.

1.4 Project Participants

The LBITP is being implemented by the Coastal Water Authority (CWA) as authorized by the COH. CWA is a Conservation and Reclamation District created by the Special Act of the Texas Legislature in 1967. CWA has been given authority to transport and deliver water inside and outside of the three-

county area of Chambers, Liberty, and Harris Counties. Participating third parties in the LBITP include COH, North Harris County Regional Water Authority (NHCRWA), West Harris County Regional Water Authority (WHCRWA), Central Harris County Regional Water Authority (CHCRWA), and North Fort Bend Water Authority (NFBWA), herein referred to as the Co-Participants. Other entities may benefit from the LBITP in the future.

1.5 Project Description

The recommended concept for this interbasin transfer project includes a raw water pump station (the Capers Ridge Pump Station), approximately 3 miles of pipeline, a sedimentation basin, and approximately 24 miles of open canal, as shown in *Exhibit A-1* and *Exhibit A-2* of PER Volume II. The pump station will be located on the Trinity River, in an area primarily above the 100-year floodplain, known as Capers Ridge, which is approximately 18 miles south of Romayor and was previously owned by the COH. CWA purchased the property from COH in 2010. The pipeline extends west-southwest approximately 3 miles along the geological ridge (Capers Ridge) between the Trinity River and the Lake Houston Watersheds where it outfalls into the sediment basin at the start of the canal. The canal then continues west-southwest through Liberty County and into the northeast portion of Harris County east of Lake Houston. To the maximum extent possible, the route was selected to minimize environmental impacts and ROW acquisition costs while providing sufficient conditions for operation of the canal. The canal will outfall into the lower reaches of Luce Bayou, which flows into the northeastern corner of Lake Houston.

The LBITP capacity will be based on untreated water delivery requirements provided by the City of Houston (COH) and estimated canal losses. Untreated water delivery requirements provide by the COH are based on Water Supply Contracts between the COH and the other co-participants (collectively known as the Water Authorities), existing water supplies, and estimates of future COH demands from Lake Houston. The Water Supply Contracts specify estimated raw water demand allocations for the Water Authorities for the years 2025, 2030, 2035, and 2040. The pump station will be constructed in two or more phases. The Phase 1 pumping capacity will be approximately 230 MGD. This pumping capacity will be sufficient to supplement the Lake Houston water supplies so that raw water demands will be satisfied up to the year 2025. Subsequent phases may include the expansion of the pumping station to the ultimate firm capacity permitted, 500 MGD. Certain aspects of the project will be designed in Phase 1 to accommodate the ultimate capacity permitted. These project aspects include the raw water intake, pump station structure, electrical power supply, pipeline, sedimentation basin, and canal.

Prior to the initial delivery of LBITP water, the NEWPP will require expansion to treat additional raw water.

1.6 Previous Work Completed

AECOM received notice to proceed on the definition, preliminary engineering, and permitting of the LBITP on April 19, 2006. In January 2007, AECOM completed the *Purpose and Need Assessment* and the *Alternative Analysis*. These reports establish the preliminary need for the project and the most cost effective and environmentally acceptable project alternative. In 2008, AECOM began preparation of permit applications for the various agencies with jurisdiction over this project. As part of the permit preparation, significant field work was conducted in approximately 70 separate parcels of land. This field work included environmental evaluation, archeological study, wetland mitigation, and survey of endangered species. Also in 2008, AECOM initiated detailed topographical and boundary survey, geotechnical assessment, hydraulic modeling, construction feasibility evaluation and aspects of the preliminary engineering report necessary to support the permitting process. In March 2010, AECOM completed and submitted the Clean Water Act Section 404 Permit Application

for the Luce Bayou Interbasin Transfer Project. A substantially complete PER was required for submittal of the permit application.

1.7 Project Schedule

The ultimate project schedule is dictated by the January 1, 2020 HGSD conversion deadline of 70 percent surface water in HGSD Area 3 and as specified in the contract between CWA and COH. To meet this date, the project must be constructed and operational no later than June 30, 2019. A Preliminary Project Schedule is provided in *Appendix D-1*.

Section 2 – Trinity River Conditions

It is necessary to understand the characteristics of the Trinity River at Capers Ridge prior to beginning the preliminary engineering. In order to determine the depth, width, and extent of the intake, an understanding of the hydraulic nature and extreme conditions that may occur within the river is necessary. Similarly, in order to properly prepare to manage and control the volume of debris and sediment that may enter and impact the pump station, the concentration and characteristics of these factors within the river must be known. This section presents an analysis of the following existing Trinity River conditions that will affect the project design and operation:

- Historical Trinity River flows
- Anticipated water surface elevations (WSEs) at the proposed Capers Ridge Pump Station for various flow rates
- Suspended sediment concentrations for various flow rates

2.1 Statistical Minimum Flow Analysis

A United States Geological Survey gaging station is located on the Trinity River near the town of Romayor, approximately 18 miles north of the Capers Ridge Pump Station Site. AECOM performed a statistical analysis of historical flow data obtained from this gage for the Trinity River at Romayor, Texas. The purpose of the statistical analysis is to understand the low flow characteristics of the Trinity River as they hydraulically relate to the proposed intake of the pump station. Certain low percentile flows were identified from the historical record for various periods and provided in Table 2-1.

Table 2-1 Statistical Low Flow Analysis

Time Period	Comments	Trinity River Flow at Romayor		
		1% (cfs[1])	**5%** (cfs[1])	**10%** (cfs[1])
1925-2009	Full Record*	220	405	625
1925-1968	Pre-Dam	182	312	448
1970-2009	Post-Dam	366	731	933
1989-2009	Last 20 years	757	918	1,040
1999-2009	Last 10 years	777	935	1,030

*Full record is based on all complete years on record. Data began to be recorded in May of 1924. This year was excluded from the analysis due to it being incomplete.
[1] CFS= cubic feet per second

This analysis revealed significant increases in low flow over the period of record. This increase can be attributed to the construction of the Livingston dam, dam releases during low flow conditions (discussed in *Section 2.3*), and a general increase in rainfall in the region which occurred over the past 20 years.

2.2 WSE Modeling

W.F. Baird & Associates (Baird) completed a hydraulic and sediment transport study of the Trinity River near Capers Ridge to assess WSE and sediment transport in the Trinity River. This effort was conducted to assess potential effects of the project on flow rate, WSE, and sediment erosion and deposition within the river and better understand river characteristics as they pertain to the design of the intake. The hydraulic models were calibrated versus a detailed set of recorded WESs obtained during a low flow period in May 2009. *Table 2-2* lists WSEs determined by the hydraulic model for the proposed Capers Ridge Pump Station site for a variety of flow events. A report detailing the hydraulic and sediment transport modeling efforts is provided in a separate report developed by Baird titled *Luce Bayou Interbasin Transfer Project Hydrodynamic and Sedimentation Modeling, January 2010, Report No. 11208.101*. A bathymetric survey of the Trinity River at Capers Ridge was conducted for the purpose of the hydraulic model and preliminary engineering of the pump station intake. The results of the bathymetric model are presented in *Appendix C*.

Table 2-2 Hydraulic Model Results at Proposed Pump Station Intake

Flow (cfs)	**Description**	**WSE** (ft)
1,000	Low Flow Scenario 1	16.9
1,500	Low Flow Scenario 2	17.8
3,000	Approximate Median Flow	19.8
6,000	Flow Scenario 3	22.3
48,600	2-year Design Flow	35.6
73,100	5-year Design Flow	41.5
88,300	10-year Design Flow	42.1
130,000	100-year Design Flow	44.0
159,500	500-year Design Flow	44.7

2.3 Effects of Lake Livingston Dam Operation

During median flow conditions in the Trinity River, sufficient flow is present to meet all downstream water rights. Under low flow conditions, Lake Livingston Dam operators carefully track raw water withdrawals and release only as much water from the dam as needed to meet all downstream water rights. Over the past 20 years, flows have generally been maintained above 757 CFS (the 1 percentile flow as calculated in *Table 2-1*) through releases from the Lake Livingston Dam. When the Capers Ridge Pump Station comes online, the Trinity River Authority will continue to release additional water during natural low flows in order to meet the raw water demand associated with the LBITP. Total Trinity River withdrawals by the COH will not exceed existing permitted values.

2.4 Future Anticipated Minimum Water Surface Elevations

Future minimum flow rates were determined by AECOM through a Water Rights Analysis Package (WRAP) modeling exercise. The WRAP model uses naturalized flow and precipitation data in conjunction with information about man-made infrastructure and surface water rights to calculate streamflows for a flow network. For each condition modeled, WRAP executes a 57-year simulation at a monthly timestep.

As part of the exercise, future natural flow conditions were predicted and based on the available historic flow record, dating from 1925 through the present. The future natural flow conditions were then compared to the projected future raw water demand in the Trinity River. The future minimum flow rate was determined to be the greater of the two values, since Lake Livingston will artificially increase flow rate in the river on days when natural flow would otherwise have been less than the raw water demand from the Trinity River. *Table 2-3* presents two low flow scenarios at various pump station withdrawal rates. Two low flow scenarios are presented since, at low flow, the Trinity River flow rate is dependent on the amount of water being withdrawn from it on a given day, as discussed in *Section 2.1.*

Table 2-3 Low Flow Scenarios and WSEs at Capers Ridge Pump Station

Flow Scenario	Flow Rate (cfs)	Approximate WSE (feet)
Minimum Anticipated Flow Rate When Pumping 56,500 gpm (81.4 MGD), 1 Pump	958	16.9
Minimum Anticipated Flow Rate When Pumping 500 MGD	1,490	17.8

2.5 Sediment Transport Analysis

The Trinity River is a dynamic, low-gradient coastal plain river, which actively transports large quantities of sand and sediment during flood events. The river is characterized by significant bank erosion, point bar creation, and channel migration. Understanding sediment transport in this sand-bed river is critical for the design of the proposed Capers Ridge Pump Station as high levels of sediment can significantly increase wear on pump components and thus increase maintenance costs. Baird was subcontracted to develop a hydraulic and sediment transport model of the Trinity River to predict sediment transport, sediment size, and expected sediment concentrations for a wide variety of flows.

A detailed description of the sediment transport modeling performed is included in separate report developed by Baird, and only a summary of key findings is included in this report. The sediment transport model for the Trinity River was calibrated using a combination of new field samples of suspended sediment, bed sediment, and bank sediment near Capers Ridge and historic samples of suspended sediment concentration and sediment distribution at the USGS gaging station near Romayor, TX.

It was found that only a minimal amount of sediment from the river bed (bed load) is suspended during flows less than 48,600 CFS, the 2-year Design Flow in the Trinity River. At low flow, minimal sand is entrained and only clays and silts are suspended in the water column. This suspended concentration of clays and silts is referred to as wash load because it is typically washed in from the surrounding water shed. For these circumstances, Baird recommended that historical suspended sediment concentrations obtained from prior field samples be used to predict suspended sediment concentrations. Figure 2-1 shows the correlation of suspended sediment concentration for low flow conditions with discharge. Based on a statistical analysis of historical suspended sediment concentration data, Baird developed a best fit curve for uniformly distributed suspended sediment carried in low flows, which is shown in Figure 2-1. The concentrations provided in Table 2-4 were determined using the best fit line provided in Figure 2-1. For this exercise, low flows are considered

to be those less that 48,600 cfs and high flows are considered to be equal to or greater than 48,600 CFS.

Figure 2-1 Correlation of Suspended Sediment Concentration with Discharge at Romayor

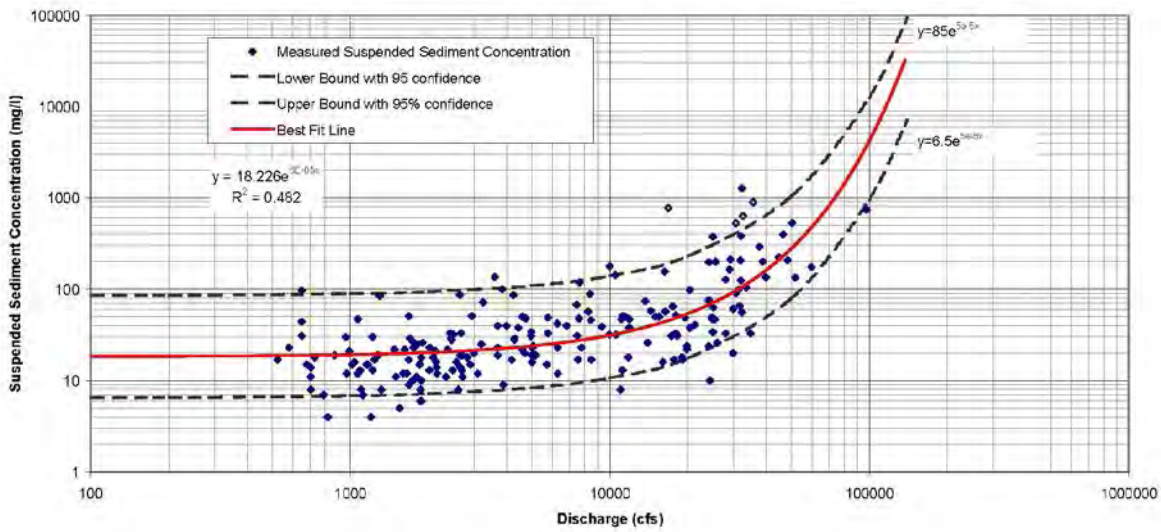


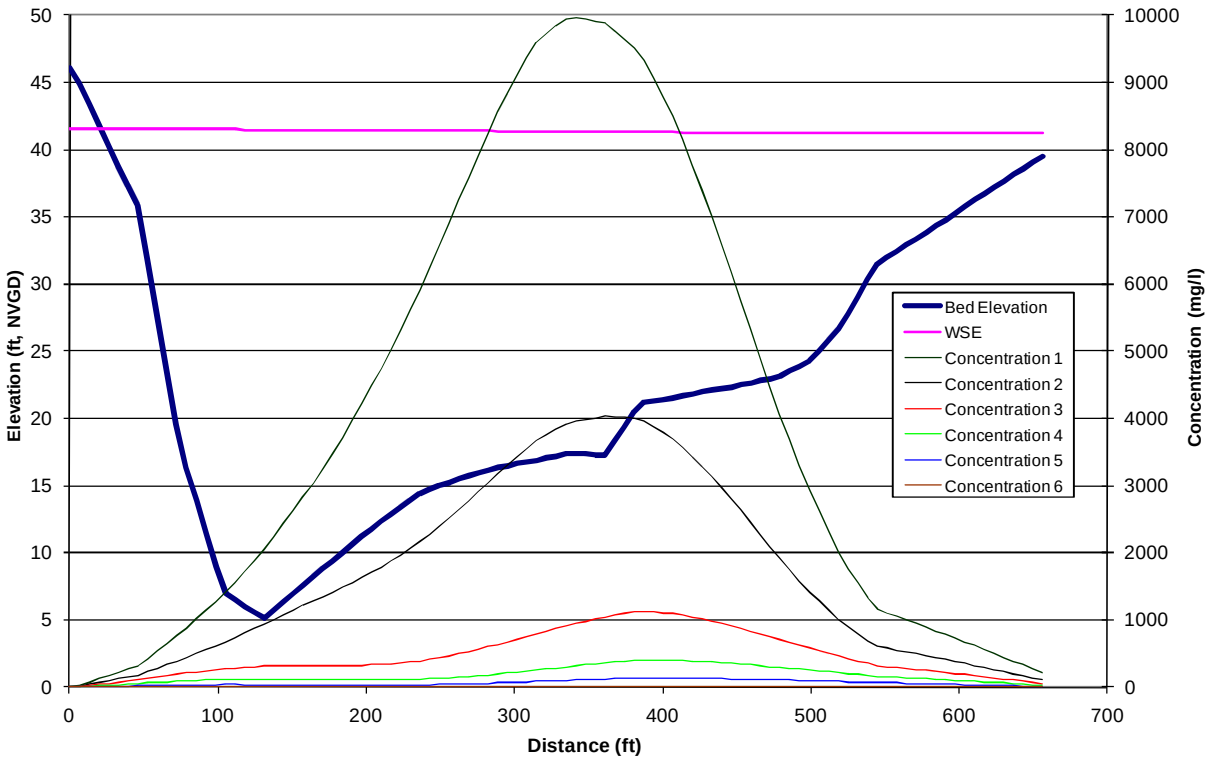
Table 2-4 Low Flow Suspended Sediment Concentration

Flow (cfs)	**Description**	**Concentration** (mg/l)
1,000	Low Flow Scenario 1	19
1,500	Low Flow Scenario 2	20
3,000	Approximate Median Flow	21
6,000	Flow Scenario 3	25
8,600	Mid-level Flow Scenario 1	28
20,000	Mid-level Flow Scenario 2	50

For high flows, a single suspended sediment concentration cannot be provided due to the significant vertical and horizontal stratification in sediment concentration that occurs near Capers Ridge. Peak concentrations of up to 10,000 mg/l are found in the bed load near the center of the river channel, over the existing point bar. Concentrations at the bank, where the proposed Capers Ridge Pump Station is located, are approximately 10 percent of the concentrations found in the channel center for the 2-, 5-, and 10-year design floods. Significant vertical stratification is also found. Concentrations near the surface are approximately 20 percent of the bed load concentration for the 2-year design flood and approximately 5 percent of the bed load or less for the lower-frequency flood events. Significant drops in concentration, between 30 percent and 75 percent, are found when comparing bed load concentration to the concentration at an elevation 5 to 7 feet above the channel invert. This will become an important factor when determining the raw water intake elevation. An example of the significant vertical and horizontal stratification for a high flow event (5-year flood) is shown in Figure

2-2. Additional figures for other flow scenarios are provided in Appendix I-7 of the separate report developed by Baird. In these figures, WSE and river bed elevation are provided and measured on the left y-axis. Suspended sediment concentration is shown for six different WSEs within the cross-section and measured on the right y-axis. Concentration 1 correlates to the concentration at the river bed. Concentration 2 correlates to the suspended sediment concentration at a depth within the cross-section that equals to 20 percent of the total water depth. For example, if the total water depth is 10 feet, Concentration 2 would provide the suspended sediment concentration at a depth 2 feet above the bed elevation. Concentration 3 through Concentration 6 correlate to the suspended sediment concentration at a depth equal to 40 percent, 60 percent, 80 percent, and 100 percent of the water column, as measured from the riverbed, moving upward.

Figure 2-2 Cross-Section Profile of Trinity River Bed Elevation and Sediment Concentration for 5-Year Design Flow at the Capers Ridge Pump Station (Looking Upstream)

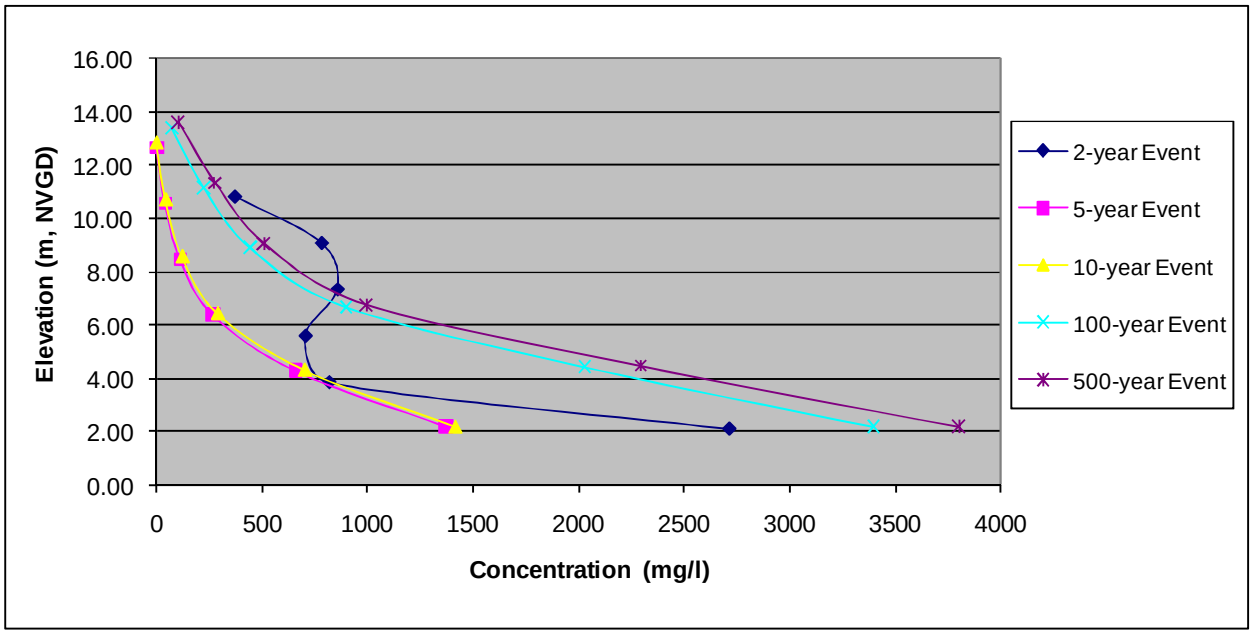


For high flows, suspended sediment concentrations entering the pump station were predicted from the sediment transport models developed by Baird. Concentrations determined by the model at an elevation of 17 feet (mid-point of sluice gate controlling flow into the intake) and a distance of approximately 80 feet from the western top of bank were used to predict the quality of water entering the pump station. This data is shown in Table 2-5 and was taken from Figure 2-3. Figure 2-2 shows concentrations for multiple storm events at a point horizontally even with the start of the intake approximately 80 feet from the western top of bank. A full report summarizing concentrations throughout the entire river cross section is included the separate report developed by Baird.

Table 2-5 High Flow Suspended Sediment Concentration

Flow (CFS)	**Description**	**Concentration** (mg/l)
48,600	2-year Design Flow	700
73,100	5-year Design Flow	450
88,300	10-year Design Flow	500
130,000	100-year Design Flow	1,500
159,500	500-year Design Flow	1,800

Figure 2-3 Suspended Sediment Concentration Profiles for Different Flood Events



Concentrations in the 2-year event are higher than those in the 5- and 10-year events because the 2-year event is contained inside the regular channel banks. For larger storms, the wide floodplain fills with floodwater and reduces velocity and suspended sediment carrying capacity.

To determine the size distribution of particles suspended for different flows in the Trinity River, Baird prepared an analysis of suspended sediment size distributions for a series of samples taken over a range of flows). The sediment distribution for several key flow rates are shown in *Table 2-6.*

Table 2-6 Suspended Sediment Size Distribution

Flow (cfs)	**% Clay and Silt (33 microns)**	**% Very Fine Sand (94 microns)**	**% Fine Sand (188 microns)**	**% Medium Sand (375 microns)**	**% Coarse Sand (750 microns)**
1,000	100	0	0	0	0
5,000	82	18	0	0	0
20,000	55	13	27	5	0
40,000	42	15	32	7	4
60,000	34	15	35	8	8
80,000	27	15	39	9	10
100,000	20	18	41	9	12
150,000	15	15	45	10	15

Section 3 – Project Capacity

3.1 Introduction and Overview

This section will present assumptions used for developing the projected Phase 1 and Ultimate Luce Bayou Interbasin Transfer Project (LBITP) capacity requirements. Co-participants within Harris County are subject to surface water conversion requirements of Harris Galveston Subsidence District (HGSD) Area Three, which mandates that groundwater pumpage be reduced by 30 percent, 70 percent, and 80 percent in the years 2010, 2020, and 2030, respectively. The North Fort Bend Water Authority (NFBWA) is subject to groundwater reductions of 30 percent by 2013 and 60 percent in 2025 as mandated by the Fort Bend Subsidence District.

AECOM received untreated water delivery requirements from the City of Houston (COH), which are based on Water Supply Contracts between the COH and other co-participants (collectively known as the Water Authorities), existing water supplies, and estimates of future COH demands from Lake Houston. The Water Supply Contracts specify estimated raw water demand allocations for the Water Authorities for the years 2025, 2030, 2035, and 2040. The COH is authorized to divert water from multiple points on the Trinity River at a combined maximum rate of 2,197 MGD as designated by the Certificate of Adjudication No. 08-4261 and as amended by Certificate No. 08-4261B. The City is authorized to divert a maximum of 775 CFS (500 MGD) of this combined rate specifically at the Capers Ridge diversion point.

3.2 Demand Summary

Water Supply Contracts between the COH and the Water Authorities will be accommodated through COH infrastructure, which includes the Northeast Water Purification Plant (NEWPP) and the East Water Purification Plant (EWPP). The NEWPP will satisfy the entire surface water demand for the NHCRWA and CHCRWA. The West Harris County Regional Water Authority (WHCRWA) and NFBWA will receive surface water from both the NEWPP and the EWPP. In addition to surface water demands for the Water Authorities, the COH will require surface water supply for other COH customers at the NEWPP and EWPP. The EWPP receives surface water from Lake Houston via the West Canal in addition to CWA's Main Canal, which conveys surface water from the Trinity River.

The LBITP capacity is planned to be phased. Construction of LBITP Phase 1 is contractually mandated to be completed no later than June 30, 2019. The Capers Ridge Pump Station may be expanded to full capacity in subsequent years as dictated by future demand. Accordingly, untreated water delivery requirements received from the COH are identified for two phases, 2020 and 2040. Losses along the canal system, estimated to be 15 percent of the total pumped volume, were added to the untreated water delivery requirements. Based on untreated water delivery requirements and estimated canal losses, the required LBITP capacity is projected to be 230 MGD in 2020 and 425 MGD in 2040. Untreated water delivery requirements are based on Water Supply Contracts between the COH and the Water Authorities, existing water supplies, and estimates of future COH demands from Lake Houston. *Table 3-1* shows Lake Houston supply requirements. *Table 3-2* shows the estimated LBITP capacity in 2020 and 2040. *Figure 3-1* graphically displays the project capacity requirements. The 2020 project capacity is anticipated to satisfy demands through the year 2025 based on the Water Supply Contracts between the COH and the Water Authorities.

Table 3-1 Lake Houston Supply Requirements (MGD)

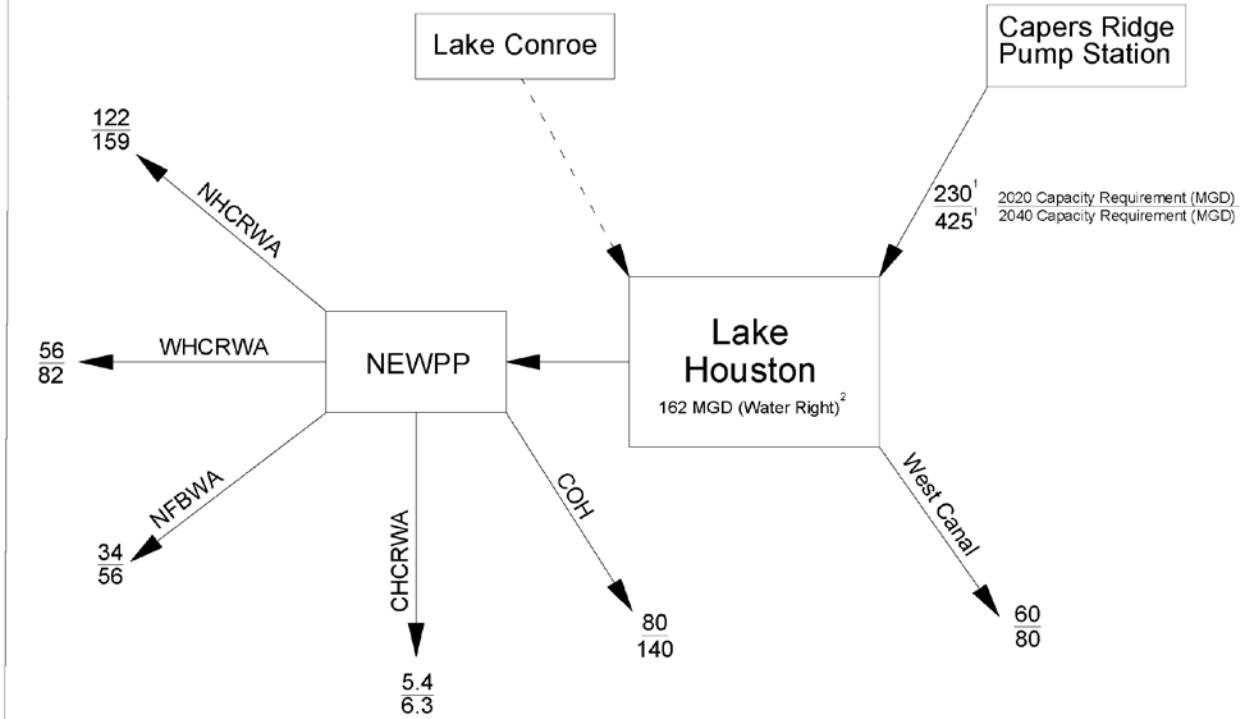
Authority	A	B	C	D		
	Original Contracted Reservation[1]	Revised Contracted Reservation[2]	2025 Contract Demand Estimate[3]	EWPP Supply	2020 Lake Houston Supply Requirements (A + C - D)	2040 Lake Houston Supply Requirements (B - D)
NHCRWA	31	159	90.9	0	121.9	159
WHCRWA	28.25	110.3	55.9	28.25	55.9	82.05
CHCRWA	2.12	6.3	3.26	0	5.38	6.3
NFBWA	19.5	75.3	34.1	19.5	34.1	55.8
COH - NEWPP	N/A	N/A	N/A	N/A	80	140
COH - EWPP	N/A	N/A	N/A	N/A	60	80
Total					357	523

Table 3-2 Projected LBITP Capacity (MGD) Requirements

Year	2020	2040
Total Lake Houston Supply Requirements	357	523
Existing Lake Houston Water Right	-162	-162
Subtotal - Additional Untreated Water Supply Needed	195	361
15% Canal Loss	35	64
Total LBITP Capacity	**230**	**425**

1. From initial water supply contracts between Water Authorities and City of Houston
   - Water Supply Contract Between the City of Houston, Texas And The North Harris County Regional Water Authority, 2003
   - Water Supply Contract Between the City of Houston, Texas And The West Harris County Regional Water Authority, 2003
   - Water Supply Contract Between the City of Houston, Texas And The Central Harris County Regional Water Authority, 2003
   - Water Supply Contract Between the City of Houston, Texas And The North Fort Bend Water Authority, 2008
2. Total Untreated Demand Reservation which also equals 2040 untreated demand estimate; taken from:
   - First Supplement to Water Supply Contract Between the City of Houston, Texas And The North Harris County Regional Water Authority, 2009
   - First Supplement to Water Supply Contract Between the City of Houston, Texas And The West Harris County Regional Water Authority, 2008
   - First Supplement to Water Supply Contract Between the City of Houston, Texas And The Central Harris County Regional Water Authority, 2008
   - First Supplement to Water Supply Contract Between the City of Houston, Texas And The North Fort Bend Water Authority, 2008
3. Values from First Supplements to Water Supply Contracts referenced in Note 2

Figure 3-1 Water Demand Distribution



PROJECT CAPACITY TABLE (MGD)

	2020	2040
COH NEWPP	80	140
NHCRWA	122	159
WHCRWA	56	82
CHCRWA	5.4	6.3
NFBWA	34	56
COH RAW	60	80
TOTAL	**357**	**523**
Exist Lk Hou Water Right	-162	-162
Delivery Requirement	195	361
Canal Loss	35	64
LBITP Capacity Requirement	230	425

LEGEND

NEWPP	North East Water Purification Plant
EWPP	East Water Purification Plant
NHCRWA	North Harris County Regional Water Authority
WHCRWA	West Harris County Regional Water Authority
CHCRWA	Central Harris County Regional Water Authority
NFBWA	North Fort Bend Water Authority
COH	City of Houston

Note:
1 - Luce Bayou Transfer Loss 15% included
2 - 181,500 Ac-ft/yr = 162 MGD

Section 4 – Pump Station Facilities

4.1 Introduction

This section discusses the pump station facilities that are planned for the LBITP. Included herein is a description of the regulations, design factors, calculations, assumptions, and preferences that were used to develop the preliminary pump station design. A summary of the project capacity is included in *Section 3*. Calculations that support the design decisions are provided in *Appendix A*. Exhibits pertaining to the pump station are provided as *Exhibits B-1* through *B-17* in PER Volume II.

4.2 General Pump Station Facilities Description

The major raw water pump station facilities will include a side-channel river intake, trash rack, trash rack cleaning mechanism, sediment settling basin, pump bay, vertical pumps, and a discharge header outfitted with various control, isolation, and air release valves. Additional facilities will be provided onsite to facilitate the operation and maintenance of the pump station. These facilities include the electrical service with substation, electrical switchgear building, control building, maintenance building, sediment handling facilities, and raw water meters. A potable and process water system will also be provided, as well as sanitary facilities. General site improvements will also be constructed, including site paving, site drainage, and river bank stabilization.

4.3 Pump Station Location

The pump station will be located on the western bank of the Trinity River at a location known as Capers Ridge in Liberty County, approximately 18 miles south of Romayor. This site was selected as the pump station location in a previous scope of work documented in a report titled *Luce Bayou Interbasin Transfer Project, Alternative Analysis*, completed in January 2007 for the Coastal Water Authority by AECOM. Nine alternative delivery methods were evaluated and compared as part of the 2007 Alternatives Analysis. The selected alternative that included the use of the Capers Ridge serves as the basis of this preliminary engineering report and was selected through the use of a multi-variable environmental constraints matrix. The location of the pump station site is shown on *Exhibit A-1*.

4.4 Raw Water Pumps

The purpose of this section is to discuss the preliminary pump design and pumping strategy for the proposed Capers Ridge Pump Station. This section will discuss the methodology for selecting the pump type, size, and operational parameters for the initial phase of pump station operation with consideration of the ultimate permit capacity. Pump bay dimensions were also determined and are presented in *Appendix A – Section III*. A more detailed description of the project demand and operation is provided in *Section 3*.

4.4.1 Pump Capacity

As discussed in detail in Section 3, the capacity and pumping strategy of the proposed Capers Ridge Pump Station is based on untreated water delivery requirements provided by the City of Houston (COH) and anticipated canal losses. Untreated water delivery requirements are based on Water Supply Contracts between the COH and the Water Authorities, existing water supplies, and estimates of future COH demands from Lake Houston. Project capacity requirements for the years 2020 and

2040 are shown in the Table 4-1 and further discussed in *Section 3*. A pump station capacity of approximately 230 MGD is expected to meet projected water demands up to the year 2025 based on the Water Supply Contracts between the COH and the Water Authorities. However, accelerated growth in demand may require expansion of pumping capacity before 2025.

Table 4-1 Project Capacity Requirements

Year	Capacity (MGD)
2020	230
2040	425

Pump Station construction is anticipated to be completed in two or more phases. In Phase 1, portions of the pump station will be constructed to meet the ultimate potential project capacity. These portions include the pump station structure, intake, and electrical service, and will be constructed to convey up to 500 MGD, as is allowed by the COH's water rights. Mechanical equipment provided in Phase 1, including pumps, will be constructed to meet project capacity requirements for the year 2020, which is 230 MGD. Future expansions of the pump station will be completed as necessary to provide a firm capacity of up to 500 MGD. Up to five additional pumps can be added to the Phase I pump station to allow future expansion of its capacity. An additional three duty pumps can be added to provide a total pumping capacity capable of meeting the projected 2040 project capacity requirement of 425 MGD. Two additional pumps can then be added for a total of eight installed pumps. A firm pumping capacity of 500 MGD and a total pumping capacity of 557 MGD can be achieved with eight pumps if the impellers of all eight pumps are exchanged for larger diameters.

4.4.2 Pump Selection Criteria

A total of eight pump bays will be provided at the Capers Ridge Pump Station. As is described in the preceding section, the pumps will be phased in over time to meet increasing demand. It is planned that similar sized, constant speeds pumps will be utilized, each having a pump capacity that varies between 69,500 gpm and 49,200, depending on pumping conditions. The number and size of pumps were determined based on a review of available pumps and pump curves. Emphasis was placed on meeting selected design points described in Section 4.4.4 while maintaining high pumping efficiencies. In addition, cost optimization, maintenance requirements, and operational constraints were also considered in the preliminary pump selection.

Cost optimization is based on consideration of both capital cost and operational cost. Special consideration is given to operational costs, especially in terms of the relationship between pumping rates, velocities, and pumping costs. Maintenance costs are based on the number of pumps, types, and motors to be serviced. Operational constraints include pumping strategies, minimum required flow rates, and pump redundancy requirements. The following is a more detailed description of the design aspects that were considered when determining recommended pump strategies.

4.4.2.1 Pump Efficiency Optimization

Pump curves for a wide variety of pumps were analyzed to determine which pump strategies resulted in the highest pumping efficiencies. A goal was to select pumps with high efficiencies (greater than 86 percent) during typical Phase 1 pumping conditions and ideally under all pumping scenarios.

Considerations were also given to how the pumping capacity would be expanded in the future. Ideally, pumps would not have to be replaced and high pumping efficiencies would be maintained as the project capacity is expanded in the future; however pump impellers and bearings will have to be replaced in the future due to wear.

4.4.2.2 Cost Optimization

Decreasing the size of pumps and increasing the quantity would improve the ability of the pump station to better match the pumping rate with demand. Doing so will reduce velocities through the system and lower pumping costs. Inversely, increasing the size of pumps and decreasing the number of pumps will limit the ability of the operators to match the pumping rate with demand and will result in elevated velocities through the system, which will increase pumping costs**.**

AECOM conducted an evaluation in which pumping costs were determined for various pumping strategies. A more detailed description and a table summarizing the results of this evaluation are provided in *Appendix A- Section II*.

4.4.2.3 Maintenance Requirements

Maintenance cost is roughly proportional to the number of pumps that need to be serviced regularly. Increasing the number of pumps would increase the maintenance burden, while decreasing the number of pumps should reduce the maintenance burden and cost.

Use of similarly sized pumps was selected in lieu of the use of pumps of varying size. Doing so will allow the operator to standardize spare parts, reduce the number of spare parts maintained onsite, distribute pump operating time more evenly, and generally make maintenance easier.

4.4.2.4 Operational constraints

Coastal Water Authority (CWA) has specified that it is ideal to have at least one pump in operation at all times (under typical, non-flood conditions) to ensure constant flow through the canal. Doing so will reduce the amount of sloughing in the canal and the associated maintenance burden. To prevent unnecessary water from being pumped during initial low demand periods, it will be ideal to size the single pump flow rate to be less than the minimum expected demand. Having constant flow above 2 ft/s will reduce the deposition of sediment within the pipeline. Providing a single pump capacity that maintains a velocity of approximately 2 ft/s within the 108” diameter pipeline will help combat sedimentation and likely be lower than the minimum project water demand capacity in the year 2020 (thereby allowing the single pump to operate continuously). At times, pump station operators will operate the pumping system at velocities greater than 5 ft/s to flush sediment out of the pipes. This will be done as needed, but not under typical situations.

Due to the storage volume present in Lake Houston, it is not necessary to match the instantaneous pumping rate with demand in Lake Houston. Volume of pumped water and Lake Houston demands will need to match on a weekly or monthly basis, but are not required to match on an hourly or daily basis. This flexibility allows for the use of constant speed pumps and negates the need for more expensive and less efficient variable frequency drives. Although they are not mandatory for pump station operation, one or more variable frequency drives will be considered during final design, and may be included if requested by the Operator.

4.4.2.5 Pump Redundancy

No redundant pumps will be provided in the initial phase of the project at the request of the Co-participants. It is anticipated that the storage capacity of Lake Houston will be sufficient to meet water

demands in emergency situations such as power outages or equipment failures, when project water demands cannot be met by the LBITP. Furthermore, in the event that outages occur as the result of catastrophic storm events, it is likely that Lake Houston will be at full capacity as a result of the storm. Pump bays will be provided and pumps selected to allow for the ultimate expansion to a firm capacity of 500 MGD, meaning the pump station would be capable of providing a flow rate of 500 MGD with one redundant pump out of service.

4.4.3 Pump Strategy Conclusion

Based on the considerations listed above in Section 4.4.2, the pump station will be constructed to include eight pump bays. Three pumps were selected as the preferred configuration to meet Phase 1 project capacity requirements. Expansion to 425 MGD can be achieved through the installation of three additional similar pumps. Expansion in a later phase to a firm capacity of 500 MGD can be achieved through the installation of two additional, similar pumps and the replacement of the impellers on the six existing pumps. In Phase 1, under typical Trinity River conditions, each pump will pump approximately 53,200 gpm when all three duty pumps are in operation at once for a total capacity of 230 MGD. If one pump is operating by itself during typical river conditions, that pump will pump at a slightly higher rate of 56,500 gpm based on the sample pump curves evaluated by AECOM. During isolated flood events on the Trinity River (and when Lake Houston is below flood stage), the pumps may deliver as much as 69,500 gpm each, depending upon the pump selected.

The selected pump strategy will allow for a wide variety of pumping rates, but will not excessively burden maintenance staff and require an unsustainable quantity of repair and rehabilitation. Based on the pumps evaluated during preliminary engineering, high efficiencies will be obtained over all pumping conditions, both in Phase 1 and future phases without the Phase 1 pumps being replaced. This configuration also results in reasonable velocities for the range of flows expected (2 ft/sec minimum velocity assuming one pump operating at 56,500 gpm and one 108” pipeline is in operation; 6ft/s under a maximum flow of 500 MGD and two 108” pipelines are in operation).

4.4.4 Detailed Pump Criteria

The following preliminary pump selection criteria are based on the pumping strategy and phasing plan discussed above and the available pump options reviewed by the design team in cooperation with pump manufacturers. The criteria were developed according to the capacity demands projected for Phase 1 and checked against the ultimate capacity criteria for eight pumps to ensure acceptable pump efficiencies under all conditions. A more detailed determination of the design point, sample pump curves, system curves, and additional information can be found in *Appendix A-Section I*.

Design Point 1* –	53,200 gpm (76.7 MGD) at 97' TDH (3 duty pumps producing 230 MGD)
Design Point 2* –	≥ 49,200 gpm (70.8 MGD) at 108.5' TDH (6 duty pumps producing greater than 425 MGD)
Future Condition –	≥ 49,600 gpm (71.4 MGD) at 114' TDH (7 duty pumps producing 500 MGD. Pumps must be capable of meeting Future Condition with only an impeller change.)
Minimum Shutoff –	130' TDH
Maximum Run-out –	50' TDH
Speed –	Max speed of 700 rpm. Preferred range of 300 to 500 rpm

Pump Efficiency – Minimum of 86 percent between Design Points 1 and 2. Design Point 1 must be on the right-hand side of the best efficiency point on the pump's efficiency curve.

Horse Power – Maximum HP on entire curve is 1,900 hp

NPSHR – Maximum of 40' at Design Point 2

Solids Passage – Minimum allowable solid size of 2.25"

*Note: The individual pump capacity will be greater than the design point flow rate specified when only a single pump is in service.

4.4.5 Pump Bay Layout

Standards for pump bay design in the United States are set forth by the Hydraulic Institute (HI) in the *American National Standard for Pump Intake Design*. While not mandatory, these guidelines are the industry-accepted standard utilized in the design of intakes and pump stations. The design standards have been developed to minimize submerged vertices, free-surface vortices, excessive pre-swirl of flow entering the pump, non-uniform spatial distribution of velocity at the impeller eye, excessive variations in velocity and swirl with time, and the entrainment of air or gas bubbles. The negative impacts of these adverse hydraulic conditions include reduced flow rate, increased head, increased power consumption, and increased vibration, noise, and wear.

The *American National Standards Institute (ANSI) / HI American National Standard for Pump Intake Design, Version 9.8, Copyright 1998* (HI Version 9.8), was used to establish the preliminary layout and design of the proposed Capers Ridge Pump Station. Based on the guidelines for rectangular wet pit intake structures, the preliminary pump bay layout is shown in *Exhibits B-9* and *B-10* of PER Volume II. Additional pump bay features were designed according to recommendations presented in the *Pump Station Design*, *Garr M. Jones, 3rd Edition, 2008*. These pump bay features primarily consist of guide vanes and corner fillets used to stabilize and guide flow into the pumps.

A pump inlet design diameter was determined according to recommended inlet velocities presented in HI Version 9.8. The remaining pump bay dimensions were based on proportions of the pump inlet design diameter. Minimum submergence requirements were determined according to HI Version 9.8 criteria. These dimensions are shown in *Exhibits B- 9* and *B-10*. Calculations, a summary table, and additional information are provided in *Appendix A-Section III*.

AECOM recommends the development of a physical model during final design to further establish that a sufficient hydraulic design is being provided. HI Version 9.8 also recommends development of a physical model for all pump stations greater than 100,000 gpm in size. It would be most appropriate to conduct the physical model analysis at a professional laboratory during the early portion of the final design phase.

4.5 Raw Water Intake

4.5.1 Intake Capacity

The proposed raw water intake will be designed to operate at flows up to 500 MGD or 775 CFS. This capacity is based on the maximum instantaneous raw water removal rate allowed by the COH's water right.

4.5.2 Intake Design Factors

A longitudinal side channel intake was selected to extract flow from the Trinity River due to the diversion rate required for the LBITP, suspended sediment concerns, low flow river characteristics, and potential impacts to river traffic. Several key constraints were analyzed to determine the optimal bottom elevation of the side channel intake structure. The intake structure will be designed to meet velocity constraints through the trash rack and intake, exclude as much sediment as is practical, and successfully withdraw the required flow under anticipated minimum WSEs. These constraints are discussed in more detail below.

4.5.2.1 Trash Rack Constraints

There are no mandatory design guidelines in Texas for velocities through raw water intake structures or trash racks. A commonly recommended approach velocity for trash racks is 0.5 ft per second. This recommended approach velocity was utilized in determining the depth of the intake and is further discussed in *Section 4.6.2*.

4.5.2.2 Sediment Exclusion

To minimize wear on the pumps, it is essential to minimize the intake of high concentrations of solids, especially large solids such as coarse sand and gravel. The highest concentration of large solids is carried in the bed load slurry that roll along the bottom of the river channel. The bed load slurry most often resides in a zone within several feet of the channel invert. Selection of an intake elevation above the channel invert can exclude the bed load and minimize the intake of coarse solids. For example, and as shown in *Figure 2-3*, during a 5-year storm event the bed load concentration on the western bank of the river is expected to be 1,400 mg/l; however, the concentration at an elevation of 12 feet is expected to be 800 mg/l. On the other hand, raising the intake to higher elevations has a diminishing benefit. For example, at an elevation of 16 feet, the suspended sediment concentration is expected to be roughly 400 mg/l during a 5-year storm event. The relationship of height and suspended sediment concentration is illustrated further in the results of the W. F. Baird and Associates (Baird) modeling effort, which is provided in the separate report developed by Baird.

4.5.2.3 Minimum Water Surface Elevations

A primary goal of the intake design is to locate it such that the maximum pumping rate can be withdrawn from the river under all circumstances. As described in *Section 2.4*, exercises were conducted to determine the future anticipated minimum WSE. The intake elevation will be located sufficiently below the minimum anticipated WSE (16.9 feet) to guarantee that the maximum flow rate can be withdrawn in low flow conditions.

4.5.3 Intake Design Resolution

The intake will have a total width of 118.5 feet and an interior width of 112.5 feet. An intake elevation of 12 feet has been selected based on the constraints listed above. Providing an intake according to this width and elevation will result in an approach velocity of 0.4 ft/s during typical pumping operations. Approach velocity calculations are provided in *Appendix A-Section IV* and further discussed in *Section 4.6.2*.

Additionally, an elevation of 12 feet is approximately 5 feet below the future anticipated minimum WSE of 16.9 and 7 feet above the channel invert at the pump station site. This elevation allows the bed load to pass downstream without entering the intake while allowing the maximum water right to be withdrawn under all flow conditions. Sediment exclusion could be improved by raising the

elevation of the intake, but doing so would increase approach velocities through the bar screen and increase the risk of having insufficient head to withdraw water during low flow conditions.

4.6 Trash Rack and Cleaning Mechanism

The purpose of this section is to discuss the preliminary engineering design of the trash rack and trash rack cleaning mechanism. This section will describe the design issue to be resolved, discuss assumptions that will be implemented to shape the design, identify equipment options, and provide a detailed discussion of the preliminary engineering resolution.

Trash racks will be utilized to prevent floating debris, trash, and aquatic wildlife from entering the intake and damaging the pumps. Trash racks will become clogged with debris if not regularly cleaned, thus reducing their ability to pass a sufficient amount of flow. A clogged trash rack could result in a decreased pump station capacity and irregular pumping conditions (as discussed in *Hydraulic Institute Standard 9.8*). A dedicated trash rack cleaning mechanism is recommended to help prevent pump station shut-downs and capacity reductions.

4.6.1 Existing Conditions

CWA personnel report that large trees and debris are regularly stopped by the trash racks at the existing Trinity River Pump Station near Liberty, Texas, and that a significant amount of manpower is needed to remove such debris. It is anticipated that the amount of debris encountered at the proposed Capers Ridge Pump Station will be greater than that of the existing Trinity River Pump Station near Liberty due to several differences inherent to river characteristics at these two locations. Due to its location on the outside bend of the river, the proposed Capers Ridge Pump Station is expected to have more debris transported into the intake due to the direction of hydraulic forces in the river bend. In addition, the erosive forces of the river are also more dramatic in the area of Capers Ridge as compared to those in the vicinity of the Trinity River Pump Station according to studies by Slattery and Phillips *(Quantifying Sediment Transportation and Delivery on the Lower Trinity River, Texas, Slattery, 2005; Sediment Retention in Stream Corridors of the Lower Trinity River Basin, Texas, Phillips, 2003).* The higher erosive forces are expected to result in increased bank erosion and intrusion of trees and debris from shorelines. Finally, in periods of extremely low flow, the depth of water at the screen will be relatively shallow (less than 5 feet), thus making it more susceptible to being clogged by debris.

The existing Trinity River Pump Station was originally equipped with a trash rack cleaning device. The device was a cable hung, grappling device, similar to others on the market today. The device was reported as being unable to remove the heavy trees and debris that would get caught by the trash rack. Furthermore, the device had no reach beyond the face of the screen and could not remove debris that was deposited immediately in front of the screen. The device was removed by CWA due to its ineffectiveness.

4.6.2 Trash Rack Design

The trash rack will be designed to prevent debris from entering the pump station and potentially damaging the pumps and mechanical equipment. Vertical bar spacing will be selected to be narrow enough to prevent potentially harmful debris from entering the pump station, but wide enough to reduce clogging, fouling, and headloss. According to the various pump manufacturers, the pumps that may be used for this project have a maximum solids passage capability of 2.3 to 4.6 inches. AECOM recommends a trash rack bar spacing of 2 inches, which should block the passage of the majority of solids that could damage the pump, but not result in high headloss. A small amount of medium-sized debris is expected to by-pass the trash rack; however, this debris will settle out in the

sedimentation zone or be stopped by either the curtain wall or by the pump's 1.5-inch intake screen. A small amount of back-flushing will occur each time the pump stops, which will help keep the pump's intake screen clean.

The trash rack width will be based on several factors, including pump bay dimensions, approach velocities, environmental concerns (threats to fish and wildlife), bar screen velocities, and headloss. Texas does not have established design requirements for raw water intakes. A commonly recommended approach velocity of 0.5 ft/s or less was used to minimize fish and wildlife getting impinged on or entrained within the screen. Approach velocities are defined as the velocity leading up to, but not necessarily through, the trash rack.

The pump station intake is expected to be approximately 118.5 feet wide with an interior width of 112.5 feet based on pump bay dimensions (see Section 4.4.5) and sediment settling considerations. The intake is expected to be at an elevation of 12 feet above MSL and submerged approximately 7.8 feet and 5.8 feet during median flow and low flow conditions (1,500 CFS) in the Trinity River, respectively. During typical pumping operations (defined as 230 MGD pumping rate and median Trinity River WSE), the resulting approach velocities are 0.4 ft/s. During extreme pumping events (defined as maximum pumping capacity of 500 MGD and low flow Trinity River conditions), the resulting approach velocity is 1.18 ft/s. These calculations are further documented in the *Appendix A-Section IV*.

AECOM recommends maintaining the pump station effective width of 112.5 feet at the trash rack. Doing so will provide approach velocities of 0.5 ft/s or less during typical conditions, and reasonable velocities during extreme conditions. The headloss through the trash rack is inconsequential based on the trash rack dimensions, bar spacing, and flow rates, which is further documented in the *Appendix A-Section IV*.

4.6.3 Trash Rack Cleaning Mechanism Design

Trash and debris will have to be removed from the trash rack on a routine basis to effectively maintain the pump station's capacity and operation. An onsite, permanent cleaning mechanism is recommended due to the anticipated frequency of cleaning operations. A highly adaptable cleaning mechanism is recommended due to the variety of loads that the trash rack will encounter, including large woody debris, mats of smaller debris, and deposits of sediment. A robust cleaning mechanism is recommended due to the size of large debris that will be encountered. It is also recommended that the cleaning mechanism has the ability to reach beyond the face of the screen because debris, especially sunken trees, are often hung slightly off the face of the screen, out of reach of some types of cleaning mechanisms.

AECOM evaluated several types of trash rack cleaning mechanisms, including Bosker type mechanisms, rotating chain-and-blade type mechanisms, and hydraulically operated articulating boom mechanisms. Hydraulically operated articulating boom mechanisms (often called hydronic cleaners in the industry) consist of a single carriage that is equipped with a hydraulic boom and hydraulic gripper. The carriage travels on rails along the entire length of the screen and cleans only one section of the screen at a time. To clean a section of the screen, the hydraulic boom extends to the bottom of the screen and then either rakes along the front of the screen (to clean mats of small debris) or grabs onto larger debris with the hydraulic gripper.

Hydronic cleaners were identified by the AECOM design team as the most effective solution available because of their ability to meet all of the criteria specified. Hydronic cleaners are robust and can be designed to lift over 10 tons. Hydronic cleaners provide the greatest degree of adaptability and are capable of grabbing and lifting large trees, raking and removing small mats of debris, and dredging sediment. Hydronic cleaners can be outfitted with a number of hydraulic gripper heads, giving

engineers greater selection in their design. Due to the articulated boom, hydronic cleaners can be designed to reach far beyond and to the bottom of the face of the screen.

Another reason AECOM recommends the hydronic cleaners is because the technology is familiar to CWA. The hydronic cleaner is similar in construction, function, and operation to a typical track hoe. CWA maintains a fleet of track hoes, which they use regularly for canal maintenance. It is expected that CWA operators will be comfortable with maintaining and operating the hydronic cleaners. Additionally, all mechanical parts are located above water at the top of the pump station. This feature should also make maintenance easier.

4.7 Pre-Pump Sediment Extraction

High levels of suspended sediment are a serious concern for some pump stations, depending on the type of pump implemented. Due to the high head present for this project, either a turbine or a mixed flow impeller with relatively tight tolerances is necessary to meet the pumping requirements. This type of impeller is more susceptible than axial flow impellers to wear and degradation due to passage of coarse sediment. Extraction of course sediment ahead of the pumps is recommended to minimize damage to the impeller, bearings, and wear rings. In addition, selection of hardened pump materials and/or special coatings is also recommended to minimize wear and extend the lifespan of pump components.

While there are no particular guidelines as to a maximum allowable particle size or a maximum allowable suspended sediment concentration, general consensus in the engineering community is to remove all coarse sands and to minimize concentrations of medium and fine sands to the maximum extent practical.

Additionally, to minimize the maintenance burden of having to dredge or clean deposited solids from the canal, it is recommended to remove all settleable solids in a sedimentation basin in front of the canal. The post-pump, pre-canal settling basin is discussed in greater detail in *Section 5.2.*

4.7.1 Pre-Pump Settling Bay Efficiency

Sediment extraction in front of the pumps is accomplished through settling inside the intake structure and pump bays. As described in *Appendix A-Section III*, a minimum distance of 40 feet is required by HI standards to transition from the pump bay invert to the intake weir elevation. This space is ideal for settling, collecting, and removing solids from the intake structure. Required settling lengths were calculated for each grain size classification assuming an approximate flow of 69,500 gpm or 100 MGD per bay (which will occur during high flow periods carrying the most sediment) and a bay width of approximately 13 feet, as shown in *Exhibit B-9*. A detailed description of these calculations is provided in *Appendix A-Section V*, and *Table 4-2* provides a summary of the results.

Table 4-2 Required Settling Length

Particle Size	Description	Settling Velocity (ft/s)	Required Settling Length (ft)
33 microns	Silt	0.0031	3,842
94 microns	Very Fine Sand	0.0223	534
188 microns	Fine Sand	0.0755	158
375 microns	Medium Sand	0.2034	59
750 microns	Coarse Sand	0.4396	27

The percentage of sediment removed for each category is calculated by dividing the length of the settling basin by the settling length required (*Table 4-2*). It is assumed that sediment is equally distributed in the water column once it enters the bar screen. Assuming a 40-foot settling chamber and an additional 10 feet of settling length immediately after the bar screen, percent removal rates for each grain size classification are estimated as shown in *Table 4-3*.

Table 4-3 Percent Sediment Removed by Settling

Particle Size	Description	Percent Removal
33.2 microns	Silt	1%
93.75 microns	Very Fine Sand	9%
187.5 microns	Fine Sand	32%
375 microns	Medium Sand	85%
750 microns	Coarse Sand	100%

4.7.2 Determination of Pre-Pump Settled Sediment Volume

A detailed analysis was performed to determine the approximate volume of sediment, which will be removed in the pre-pump intake settling chamber. Details of these calculations are included in *Appendix A-Section V*, and a brief summary of the methodology is included below.

Sediment concentration in the river was calculated from the suspended sediment rating curve discussed in Section 2.5. This curve was developed using historic sediment concentration data for low flows and model results from the Baird sediment transport model for high flows. Over 80 years of daily flow records obtained from a USGS gaging station located on the Trinity River at Romayor, TX were analyzed to determine the sediment loading rate at the pump station for an average year, a reasonably wet year, and a reasonably dry year. Total daily mass of sediment passing through the intake structure was calculated based on the flow diverted and the calculated concentration in the river. The total mass of sediment passing through the intake was divided into particle sizes (clay and silt, very fine sand, fine sand, medium sand, coarse sand), based on an analysis of suspended sediment grain size distributions determined for different flow conditions (see *Table 2-6*). Settling rates and required distance for complete settling inside the intake structure were calculated for particles in each grain size classification (see *Table 4-2*). The percentage of extracted sediment for each grain size classification was calculated by dividing the length of the settling chamber in the intake by the required settling distance (see *Table 4-3*). Total mass settled in the intake was then converted to volume using a bulk density conversion factor. Estimated extracted sediment volume was summed for each year of record, and average, minimum, and maximum yearly sediment extraction values were calculated and presented below in *Table 4-5, Table 4-6*, and *Table 4-7*.

These calculations also assume that the pump station will be shut down when flows within the river are over that of a 5-year storm (73,100 CFS) to minimize the intake of large volumes of sediment. Analysis of historic data shows that the maximum duration of flow above 73,100 CFS is 11 days. It is expected that CWA will not pump during flood conditions above 73,100 CFS and still have sufficient water in Lake Houston to meet demands. *Table 4-4* shows the future anticipated duration of various flood events as determined by the record of historic storm events. The future anticipated durations were developed as part of a theoretical exercise for planning purposes. Actual future durations may be longer or shorter.

Table 4-4 Duration of Storm Events

Scenario	Flow (CFS)	Duration of Flow (Days)			
		Full Record	**Pre-Dam** (1924-1968)	**Post-Dam** (1968-2009)	**Last 20 Years** (1988-2008)
2 Year	48,600	23	23	21	21
5 Year	73,100	11	10	11	11
10 Year	88,300	7	7	7	7
50 Year	118,000	0	0	0	0
100 Year	130,000	0	0	0	0
500 Year	159,500	0	0	0	0

The expected sediment extraction volume for a year of average Trinity River flow rates at pumping rates equal to 230 MGD and 425 MGD are shown in *Table 4-5*.

Table 4-5 Average Yearly Sediment Extraction Pre-Pump

Pumping Rate (MGD)	**Volume of Pre-Pump Sediment Extraction** (Ac-Ft)	**Volume of Pre-Pump Sediment Extraction** (ft^3)
230	1.47	64,000
425	2.72	118,500

To assess the worst case scenario, historic flow rates from a very wet year with multiple large flood events were used to determine maximum annual sediment extraction volumes. The expected sediment extraction volume for a year with relatively high Trinity River flow rates at pumping rates equal to 230 MGD and 425 MGD are shown in *Table 4-6*.

Table 4-6 Maximum Yearly Sediment Extraction Pre-Pump

Avg. Pumping Rate (MGD)	**Volume of Pre-Pump Sediment Extraction** (Ac-Ft)	**Volume of Pre-Pump Sediment Extraction** (ft^3)
230	5.19	226,100
425	9.6	418,200

During high flow events, a significant amount of sediment will be extracted daily. For example, when pumping at 230 MGD, approximately 1,024 cubic feet of sediment will settle inside the intake settling chamber each day when flow in the Trinity River is at 30,000 CFS. At 45,000 CFS, approximately 2,966 cubic feet of sediment will settle inside the intake settling chamber each day. At 120,000 CFS, approximately 9,570 cubic feet of sediment will be settled inside the intake settling chamber each day. This example further illustrates the importance of not pumping during flood events to the greatest degree practical.

To assess the best case scenario, historic flows from a very dry year with no major flood events were used to determine minimum annual sediment extraction volumes. The expected sediment extraction volume for a year with relatively low Trinity River flow rates at pumping rates equal to 230 MGD and 425 MGD are shown in *Table 4-7.*

Table 4-7 Minimum Yearly Sediment Extraction Pre-Pump

Pumping Rate (MGD)	**Volume of Pre-Pump Sediment Extraction** (Ac-Ft)	**Volume of Pre-Pump Sediment Extraction** (ft^3)
230	0.03	1,300
425	0.05	2,200

This example further illustrates that during some years there will be little need for sediment extraction and handling.

4.7.3 Pre-Pump Sediment Extraction

Throughout the year, sediment will settle within the pump station. This will be a gradual process during years with few flood events; however, the rate of sediment buildup will exponentially increase during years with long periods of wet weather or even a single flood event equal to or greater than a 2-year flood.

Allowing sediment to build-up within the pump station can lead to increased sediment passage through the pumps, causing increased wear on the pump components. Settled sediment will have to be extracted from the pump station on a periodic basis that may range from twice a week to once every six months, depending on the river conditions and pumping rates.

Design issues that must be resolved include how to efficiently remove, transport, dewater, and store sediment that has accumulated within the pump station.

4.7.3.1 Discussion of Resolution to Design Issue

Sediment can be removed and handled in a variety of ways. An optimal removal method would not require a significant amount of additional infrastructure due to the variability in the frequency of use and potential long periods of non-use. A system with minimum infrastructure would reduce the maintenance burden and capital cost of the pump station. A system that utilizes onsite infrastructure would be beneficial during the expected periods of frequent use that will occur during extremely wet years. For these two reasons, AECOM recommends a system that utilizes onsite infrastructure that would be provided and utilized whether or not it is related to sediment. For example, sump pumps and gates will be provided (regardless of sediment issues) for isolating and dewatering the pump bays. These facilities can also be utilized in the sediment removal process. See *Exhibits B-11* and B-*12* for the location and orientation of these items. Sump pumps alone will be capable of dewatering the isolated bays and, in the process, pump out a portion of the settled sediment; however, the pumps will be limited in their ability to pump out settled sediment from all areas of the pump station without additional mechanisms to move sediment within the vicinity of the pump's suction.

4.7.3.2 Sediment Re-suspension

Additional mechanisms will be provided within the pump bay that will re-suspend settled sediment and direct it towards the sump pump during the dewatering process. Re-suspending and mixing the sediment will greatly increase the sump pumps' ability to pump out sediment while the bay is being dewatered. Multiple options are available; one option is to have a system of small diameter piping within the bay to inject water, air, or a mixture of both in a pattern that fluidizes and directs sediment towards the sump pump. A second option is to have water or pressurized air connections within the bay that can be attached to handheld devices that operators use to manually flush sediment in the desired direction. At the request of the Operator, this option will only be provided in addition to the first option. A third option is to utilize mechanical mixers or other physical means to re-suspend sediment.

One advantage of re-suspending sediment and then capturing it with a sump pump is that sediment is more easily handled once introduced into the sump pump. Several options are available for disposal of the sediment once it is introduced into the sump pump. Some of these options are further described below. Depending on the efficiency of the dewatering system, the pump bay may have to be refilled by slowly opening the upstream gate and then flushed out again.

4.7.3.3 Sump Pump Design Options

Several options exist for sump pump systems, both in terms of the type of pump used and the manner in which the pump is applied. Two options are submersible pumps and self-priming pumps. Several advantages and disadvantages are inherent to each type of pumping system. The selection process for the type of pump will depend greatly on operator preference. A very basic layout for each option is provided in *Exhibits B-11* and *B-12*. In either case, the pump would be designed to handle the sediment load.

A system that utilizes submersible pumps will require typical submersible pump hardware in each bay, including slide rails, discharge shoes, discharge piping, electrical connections, and access hatches in each of the four sediment areas. One advantage of this system is that a single pump could be housed onsite and utilized in the selected bay, thus minimizing cost and maintenance. A disadvantage of this system is that the location of the pump suction is fixed and limited, thereby decreasing the efficiency of the system to remove sediment. Another disadvantage is the cost associated with the multiple electrical connections.

A system that utilizes a self-priming pump could include one or two pumps located outside of the pump bay. Suction piping would be routed from the pump to several locations within the pump bay. A valve system could be provided that would allow the operator to choose which bay and the location within the bay that is being dewatered. This results in an advantage over the submersible pump option. One disadvantage is that much of the suction piping would be buried and difficult to access if a clog were to occur. Another disadvantage is that the pump would likely have to be constructed within a dry-pit due to the substantial suction lift. A dry pit would result in increased construction cost and possibly operational concerns due to the confined space.

4.7.3.4 Sediment Disposal

Once the mixture of sediment and water (sediment slurry) is removed from the pump bay, it will have to be further dewatered and stored in some form and fashion. Four potential options for transporting and storing sediment are as follows:

- Option 1: Sediment slurry can be pumped to an onsite dewatering basin, dewatered, and then stored onsite.
- Option 2: Sediment slurry can be pumped into the 108” diameter pipeline, downstream of the pumps and then transported to the upstream settling basin where it can be removed and stored by the facilities provided in that location.
- Option 3: Sediment slurry can be pumped through a solid-liquid separator. Separated solids can then be transported offsite or stored onsite.
- Option 4: Sediment slurry can be pumped back into the river, downstream of the intake.

Each of these options has inherent advantages and disadvantages. Option 1 will require the largest foot print. Option 2 will pose concerns to pipeline operation and will likely result in greater sedimentation issues within the pipeline. Option 3 would require significantly greater capital, operation, and maintenance costs and would still require room onsite to store the separated sediment. Option 4 would be the least expensive; however, it is subject to approval by environmental permitting agencies and is possibly not an option for this reason. These options will be further discussed with CWA and a recommendation will be provided as part of the final design.

4.8 Discharge Header and Valves

The purpose of this section is to discuss preliminary engineering issues related to the discharge header design, including the associated isolation, check, and air release valves.

The proposed pump discharge and header design is shown in *Exhibits B4-B7*. Each pump is served by a 48" discharge line including an air release and vacuum assembly and 36" ball valve for flow control and backflow prevention, a 48" butterfly valve for isolation, and a flow switch assembly. Two header options are shown, one with the 84" header in a subsurface vault and the second with the 84" header at grade. Ultimate determination of the recommended header type will include consideration of operator preference. Preliminary discussions with the Operator indicated that the above ground header will be selected for final design. The header, which includes an 84" butterfly valve separating the two 108" pipelines, air release and vacuum assemblies on each side, discharges into dual 84" force mains. Each 84" pipeline includes a venturi flow meter, an 84" isolation valve on either side of the flow meter, and a 108" to 84" reducer, which transitions into the 108" pipeline. Venturi flow meters are recommended due to their simplicity, reliability, and cost.

Pipe sizes were chosen to maintain sufficient velocities through the system to minimize sedimentation while not exceeding the velocity limitations of each valve or creating excessive headloss. Approximate Phase 1 velocities expected through each 48" discharge line are between 9.4 ft/s at 53,200 gpm and 12.3 ft/s at 69,500 gpm. The recommended maximum velocity for ball valves and butterfly valves are 35 ft/s and 16 ft/s, respectively. Maximum velocities through the 36" ball valve will not exceed 22 ft/s. Approximate anticipated velocities through the 84" header are between 3.1 ft/s at 53,200 gpm (one pump through one pipeline or two pumps through two pipelines) and 4.6 ft/s at 79,850 gpm (115 MGD; half of the maximum Phase 1 capacity of 230 MGD through one pipeline or 230 MGD through two pipelines). Velocities could reach 9.3 ft/s in the header if the entire Phase 1 capacity was pumped through a single pipeline.

Multiple valves, including ball, cone, and tilting disk check valves, were evaluated for use. Ball and cone valves are typically used to control transients and/or to regulate flow. Such valves are not mandatory unless flow control is needed or problems associated with transients and surges are anticipated. Preliminary desktop surge analysis indicated an automated control valve is not necessary for surge protection and the control of transients; however, CWA Operators prefer the use of ball valves due to their higher reliability and durability as compared to tilting disk check valves. AECOM recommends that a detailed computer surge analysis be performed during final design to finalize anticipated surge/transient conditions and to confirm the correct choice and closure speed of valves. As additional surge modeling is performed, it is possible that surge relief valves and/or surge anticipators will be added to the header. Air release and vacuum breaking valve selections may also be refined as a result of further surge analysis.

Section 5 – Conveyance System

5.1 Pipeline

5.1.1 Pipeline Route and Alignment

The pipeline route begins at the proposed Capers Ridge Pump Station site, traveling approximately three (3) miles westward to the proposed sedimentation basin. In general, the pipeline follows the rise in the existing natural ground up to the high point on Capers Ridge. The horizontal alignment primarily follows the existing topographical ridge through the area with adjustments where necessary. The pipeline vertical alignment is based on a minimum of a six foot depth of cover below the existing natural ground. The vertical alignment maintains the minimum cover of the pipeline while following the existing topography along Capers Ridge. This results in a varying elevation for the vertical pipeline profile, rising and falling with the existing ground surface. Both the horizontal and vertical alignments of the pipeline are shown in the referenced exhibits.

5.1.2 Pipe Size, Number, and Spacing

The size of the pipeline is based on the best available information regarding the project demand and needs. The actual size was dictated by both pipeline cost and the desire to operate the system efficiently. The most efficient pumps and pump arrangement were selected in order to maximize operational efficiency. While it was anticipated that construction costs for larger diameter pipelines would exceed those of smaller diameter pipelines, operational costs were also anticipated to be cheaper for larger diameter pipelines compared to smaller diameter pipelines based on research conducted for the project.

Based on this analysis, the dual pipelines will be 108” in diameter unless available information during final design warrants consideration of a smaller diameter. In order to convey project flows, these two lines of equal size will be constructed parallel to each other from the proposed pump station to the sedimentation basin location. Furthermore, two pipelines will allow for one line to be taken offline for repairs or maintenance while still permitting water conveyance through the system.

The pipelines will be spaced a minimum of 20 feet apart from outside edge to outside edge and centered about the pipeline ROW, although the actual average spacing may be further apart. This spacing is based on the distance between the pipes required to allow one line to be exposed without disturbance to the other during construction, required maintenance, repairs, or replacement. A spacing distance of twice the diameter of the pipe between parallel lines is typical for larger diameter pipelines.

The sizes and number of pipelines are based on the best available information. As new information, such as revised demand information, surge concerns (as indicated as part of a transient analysis), and operational requirements, is developed, the size or number of pipelines may require modification.

5.1.3 Recommended Pipeline Material and Pressure Classification

Multiple types of pipe material and pressure classifications were evaluated for use on the project. The advantages and disadvantages of each material for use in a large diameter waterline project were analyzed. For purposes of cost estimation, a pressure rating of 150 psi was assumed for the various types of pipe materials considered. The following are the findings on each of these pipe

materials. A final recommendation of pipeline material and pressure classification will be determined during final design.

5.1.3.1 Concrete

The only type of concrete pressure pipe that is applicable for the required size pipelines is prestressed concrete cylinder pipe (PCCP). PCCP is manufactured for all of the diameters considered for this project and also has multiple options for coatings and liners, which could be used to improve the biological and chemical resistance. The following advantages and disadvantages for PCCP are:

Advantages

- Large selections of structural and pressure strengths
- Specialized work crew is not required for installation
- Capable of withstanding very high pressures
- Internal corrosion can be significantly reduced with the use of thermoplastic lining
- External corrosion may be reduced by including sacrificial wall or by using Type V sulfate-resistant Portland cement
- Concrete pipe manufacturers can establish an onsite production plant to counter the high transportation costs

Disadvantages

- Sensitivity to bedding conditions – shear failure and beam breakage may occur
- Handling and installation difficulty because of heavy weight
- Susceptible to external corrosion in acidic soil environments
- Requires cathodic protection and is highly vulnerable to hydrogen sulfide attacks and internal microbiologically induced corrosion
- Difficult to repair, particularly for joint leakage and failure in pressure pipe
- Tendency to leak because of high pipe wall porosity and shrinkage cracking
- Without additional internal lining, life span is significantly reduced
- Low abrasion resistance – internal scouring can occur if solid content and flow velocities are high
- Reinforcement within PCCP walls can corrode with little or no external evidence
- Due to the unit weight of the materials, one 8-foot section of pipe will be delivered per truck.

5.1.3.2 Steel

The type of steel pressure pipe investigated for this project was spiral welded steel. Spiral weld pipe is manufactured from steel coils formed helically into cylinders. Steel pipe is manufactured in all diameters considered for this project. Steel pipe also has multiple options for coatings and liners to improve the biological and chemical resistance. These options can be provided at an additional cost. The following advantages and disadvantages are for spiral welded steel pipe:

Advantages

- Resistant to high pressures
- Easy to install, connect, operate, and maintain
- Ideal for extension work in reservoirs and pumping stations
- Can withstand shocks and traffic vibrations
- Suitable for long distance pipelines of high pressure
- Minimum damage to pipes during transportation
- Smaller pipe thickness required, which equates to lower total weight

Disadvantages

- Additional construction cost due to welding
- Internal and external coatings are susceptible to welding damage during construction
- Susceptible to wear and corrosion in sub-surface lines, reducing their lifespan
- Low resistance to acidic and high levels of saline soils
- Requires grounding measure at additional costs
- Due to the weight of the materials, the pipe must be delivered one section per truck, the length of each section will vary depending on the diameter (10 foot is typical)

5.1.3.3 Fiberglass

Reinforced Fiberglass Pipe (RFP) is a newer material compared to PCCP and steel. Due to minimal use, this material does not have an extensive record of in-field use and is presently not an acceptable material for large diameter water lines with the City of Houston. Because RFP is not approved by the City of Houston, it was eliminated as a considered pipe material alternative. Should this approval status change prior to the project's final design phase, this material will need to be reevaluated as an option for the project.

Other pipeline materials, including bar-wrapped concrete cylinder pipe, ductile iron, high-density polyethylene, and polyvinyl chloride pipe, were investigated as part of the preliminary analysis but were not manufactured in sizes required for consideration on the project.

5.1.4 Corrosion and Cathodic Protection Overview

As outlined in section 5.1.3, the pipeline will require different cathodic protection systems depending on the type of pipeline material selected for use on the project. Once a pipeline material has been selected, the cathodic protection system will be designed to protect both pipelines during the project's final design. This system will be designed and tested to ensure that the LBITP pipelines remain cathodically isolated from all foreign utility crossings and electrical interference.

5.1.5 Pipe Flushing and Draining Method and Facilities

Flushing and draining valves will be located along the pipeline. Due to the size and location of these appurtenances, the design of these mechanisms may be devised specifically for this project (non-standard). The size, location, and design of the flushing and draining valves will be determined during the project's final design.

5.1.5.1 Pipe Cleaning and Sediment Control

Two potential problems have been identified that could impede the flow of water through the piping system of the LBITP. The first possible problem is sand. The Trinity River is a dynamic, low-gradient coastal plain river, which actively transports large quantities of sand and sediment during flood events. While some methods to remove sediment at the pump station will be utilized, it is anticipated that some quantity of sediment and sand will pass through the pumps and enter the piping system. Over time, the sand and sediment may settle in the pipe, adversely affecting the pipe friction and cross-sectional area. Secondly, it is anticipated that Asiatic clams (Corbicula fluminea) and zebra mussels (Dreissena polymorpha) could be a concern in the LBITP piping system. These organisms have been observed in other CWA pump stations and pipeline systems on the Trinity River and have caused maintenance and operational problems. Specifically, these organisms have been known to attach to the walls of the pipe system and clog these raw water transmission systems. This organic

buildup will have a similar effect on the pipe friction and cross-sectional area losses within the pipeline.

Due to the possibility of organism infiltration and sediment buildup, it is recommended that a pipeline pigging system is included as part of the final design of the project. A typical pigging system entails pushing a pig through the pipeline that is a hydraulically or pneumatically propelled flexible polyurethane foam bullet. The pig is typically sized to be slightly larger than the carrier pipe. See *Figure 5-1* for a typical pig of this type used on a larger diameter pipeline. This pig style consists of a steel barbell with two epoxy coated polyurethane foam discs on each end. Due to the epoxy coating, the pigging disks will not absorb water, which reduces its overall weight. On a pig of this size, water absorption is a concern because it can dramatically increase the overall weight of the pig and create a significant problem for removal of the pig following completion of pipe cleaning. The discs located on each end of the pig would be replaced according to directions from the manufacturer.

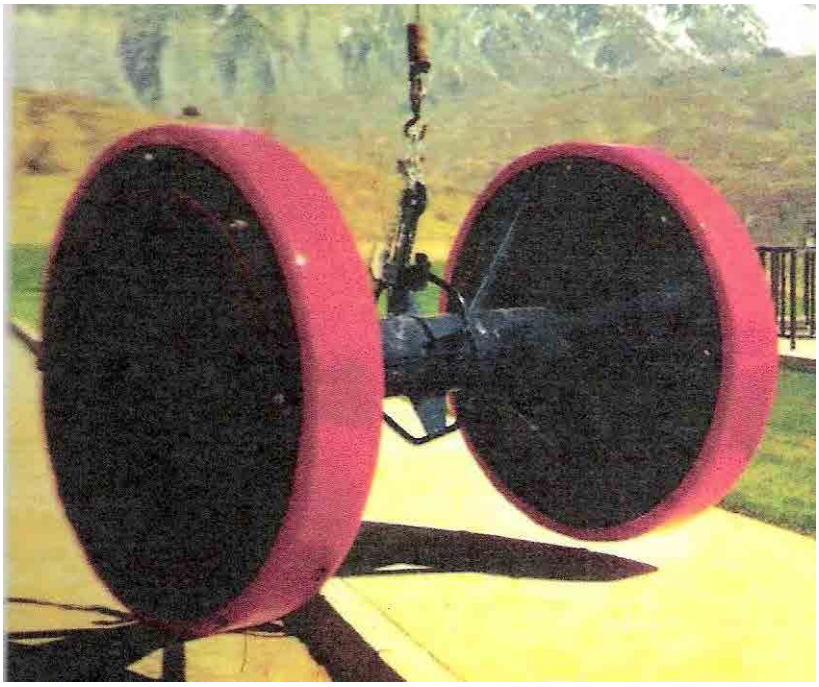


Figure 5-1 – Typical Large Diameter Pig with Foam End Disks

Incorporation of a pigging system will require the LBITP to be modified during final design to allow for pigging capabilities. This will entail integrating a launching station and a catching station into the project. To operate the system, a pig is first inserted into the launching station. The launcher is then closed and the pressure within the pipeline is used to push the pig through the pipe until it reaches the catching station. Following construction of the pipeline, an initial pigging of the pipeline will be performed. During the initial pigging, a benchmark determining optimal flow in the pipelines will be determined. The system can then be monitored to determine when future pigging will be necessary. It is anticipated that the pipeline will require cleaning every time the flow reaches an allowable loss or threshold as determined by the operator. Based on information provided by large diameter pig manufacturers, pigging cleanings are recommended at least once every three years, although more frequent intervals may be necessary.

Following the investigation into the pigging process, two preliminary launch structures were identified and are shown in *Exhibit A-4 Pipeline Pigging Exhibit*. The first launching station option consists of

an inline launch station with a removable launching barrel to load the pig. The second alternative consists of an offset launch station, which is offset from the pipeline either horizontally or vertically. This station is designed to bypass flow through the offset chamber in order to launch the pig. Following the investigation into the costs associated with fittings and valves on large diameter pipelines for this arrangement, this alternative appeared to be less economically viable when compared to option one. Catching stations or basins would also be required and would be similar to the launching station, but would include a flow bypass. Each launching and catching station will need to be equipped with a crane or have available access for a mobile crane to load and unload the pig within the pipeline. An on-site storage facility at the launching stations shall be provided to house the pig and any other equipment necessary for operation.

The dual pipelines of the LBITP will require pipeline launching and catching stations on both lines. Additionally, due to the design of the pig, any valves between the launching station and the catching station must completely clear the cross-sectional area of the pipe to allow for the pig to pass through the pipeline. This would prohibit the use of the butterfly style values between the catching and launching stations, which limits the number and location of butterfly valves that can be used on the project.

5.1.6 Type, Number, and Location of Isolation Valves

Several types of isolation valves have been considered with respect to purpose, operations and maintenance concerns, cost, and functionality within the pipeline. A large diameter butterfly-style valve was determined to be an appropriate style valve for the project. For illustrative and estimation purposes, a butterfly style valve was assumed for the project and is shown on the pipeline drawings. An example of a typical large diameter butterfly valve is shown in *Figure 5-2*. As indicated in *Section 5.1.5.1*, butterfly valves cannot be placed between pig launching and catching stations. If isolation valves are needed between these launching and catching stations, a knife-gate style valve can be used in lieu of the butterfly valve. However, the final type, number, and location of the isolation valves and devices will be determined during final design.

Figure 5-2 – Typical Large Diameter Butterfly Valve

5.1.7 Air Relief and Surge Valve Type And Locations

Air relief and surge valves will be located within the pipelines on the LBITP. In general, air relief valves (ARVs) are typically an inch to an inch and a half in size for each foot in diameter of the pipe. However, actual sizes for air relief valves for a given system must be determined using the specific conditions and parameters of the project. ARVs are typically located at the high points within a pipeline and are reflected as such on the project drawings. For illustrative purposes, a 12-inch combination vacuum/air relief valve is shown on the pipeline drawings. Since both waterline vertical alignments are identical, the combination valves were placed in the same location. Investigations into their function preliminarily indicated that a shared six inch vent pipe could be used for the valves on both lines at a given location. A complete surge and transient analysis will be required during final design to determine the actual size and location of all vacuum/air release valves for the project.

5.1.8 Drainage Along the Pipeline Corridor

A preliminary drainage area map for the pipeline portion of the project was developed and is shown in the project drawings. Existing drainage conditions and drainage conveyance will be evaluated during the project's final design and all drainage and storm water system mitigation will be designed to meet all applicable standards. Preliminary coordination with representatives from Liberty and Harris counties regarding the drainage conveyance was performed as part of the preliminary engineering for the project. This entailed meeting with the representative agencies, noting relevant drainage features that would be impacted, coordinating notification of the ROW acquisition process, and clarifying future requirements and considerations that would be necessary as part of the project's final design. The

methodology used, relevant assumptions, hydraulic model, and processes of development are explained in greater detail in Section 5.4 and Appendix E. However, no drainage analysis was performed during the preliminary engineering portion of the project and a full drainage analysis will be required as part of the final design.

5.1.9 Environmental Design Impacts

The disturbed area for the pipeline portion of the project was contained entirely within the parcel to be used for mitigation as part of the application for the project's environmental permit. As such, the area that will be impacted by the construction of the pipeline was identified and excluded from the mitigation area.

5.1.10 Recommended Depth of Cover

The recommended depth of cover for the pipeline is a minimum of six feet below natural ground. This depth is consistent with the City of Houston's Infrastructure Design Manual presently in effect for waterlines 24" and larger. Furthermore, discussions conducted with a variety of pipe supplies during the pipe material investigation revealed that this would be an appropriate recommended minimum depth. As previously noted, this depth was maintained wherever possible during preliminary engineering of the pipeline vertical alignment. However, the final pipeline depth and vertical profile may require further modification during final design as more information becomes available.

5.1.11 Pipeline Constructability Issues

Several issues were considered during the preliminary engineering portion of the project related to the future construction and commissioning of the project. Due to the limited nature of this report, these issues could not be analyzed in great detail, but several of these issues are summarized in this section. However, additional constructability issues will need to be evaluated during final design.

The pipeline will be constructed via open cut construction methods. A trench box can be employed or the side slopes of the trench can be cut at a slope that will minimize risk of trench wall failure. A trench safety investigation will be included in the geotechnical analysis to be performed during final design.

Due to the size of the pipeline, advanced scheduling will be required to ensure timely delivery of the pipe to the project site. Depending on the pipe material selected, a mobile manufacturing plant could be constructed at the project site. However, it is not anticipated that pipe manufacturing will be a problem during construction with adequate advance notice based on the information known at the time of the writing of this report.

The commissioning and testing of the pump station and pipeline will require some degree of overlap to ensure proper function and operation of the system. It is anticipated that this process may take up to a year, depending on the decisions made during final design.

Access to all construction sites was considered when determining the project alignment. This includes analysis of the necessary routes and paths that will be used by construction equipment, including ingress and egress for all site vehicular traffic. Pipeline site access following completion of the project is summarized in *Section 5.1.12*.

5.1.12 Pipeline Site Access Locations

Site access points have been identified throughout the project alignment. Due to the limited nature and location of the pipeline, the primary access point to the pipeline will be by the pump station access road. Access to the beginning of the private pump station access road will be via Timberline Road (County Road 2317) off of FM 1008. Timberline Road is an existing asphalt county road that goes to the beginning of CWA's property. This road may require reconstruction or replacement to support the heavy equipment that will be necessary during the construction phase and once the pump station becomes operational.

Access along the pipeline will be continuous via the pump station access road, which will parallel the entire pipeline alignment. This access road is shown in the project drawings.

5.1.13 Preliminary Discussion of Communication, Control, and SCADA Needs and Criteria

Detailed communications, controls, and supervisory control and data acquisition (SCADA) needs will be determined during final design. However, the need for the ability to communicate, monitor, report, and control the project systems will be imperative. The SCADA system will be incorporated into the design of the pump station, pipeline, project maintenance facility, sedimentation basin, canal, and outfall to ensure full integration of the entire project.

5.1.14 Preliminary Drawings

Preliminary typical sections, sheet layouts, plan and profile, storm water pollution prevention plans, drainage area maps, and details have been prepared for the project. They are included as part of the project drawing set.

5.2 Sedimentation Basin

5.2.1 Preliminary Sedimentation Basin Design

The purpose of the sedimentation basin will be to remove sediment that is pumped from the Trinity River through the pipelines prior to entering the canal. The basin is sized to reduce flow velocity upon entering the basin such that the majority of the conveyed sediment will settle to the bottom of the basin and thus not enter the canal portion of the project. The sediment that is contained within the basin will be removed and stored on-site before eventually being transported off-site.

A general layout of the sedimentation basin is included within the preliminary project drawings. Due to the limited nature of this report, the sedimentation basin was not designed in detail and the layout shown in the drawings is conceptual. The complete basin will be designed during final design.

5.2.2 Location

The sedimentation basin will be located at the outfall of the dual pipelines. The proposed pipelines terminate approximately three miles from the Trinity River.

Several locations for the sedimentation basin were considered during the conceptual design phase of the project. These included sites near the property boundary of Parcels 4 and 4.5 were considered as possible locations. However, placing the sedimentation basin at these locations would have increased the overall length of pipeline section of the project and increased the head against which

the pump station would need to operate. Both of these factors increased the overall cost of the project. Additionally, a greater percentage of potential wetlands were encountered the further west the sedimentation basin was located from Capers Ridge. Several sites for the sedimentation basin location in the vicinity of the pipeline outfall location were also evaluated. While there was minimal difference between these sites, the possibility of additional wetland impacts and the proximity to the access road determined the final recommended location for the sedimentation basin.

The recommended location of the basin can be seen on the project drawings.

5.2.3 Configuration, Dimensions, and Energy Dissapation Needs

The basic configuration of the sedimentation basin will include entrance and exit weir structures, the basin lining, and the basin cross section. The final dimensions of the sedimentation basin were not determined during the preliminary engineering, but will be designed to maximize the efficiency of sediment removal from the conveyed water. Lastly, it is anticipated that energy dissipation and a transition section from the pipeline to the sedimentation basin will be necessary based on the flow and existing geotechnical considerations. These needs were not included as part of the preliminary engineering phase and will be determined during final design.

5.2.4 Sediment

Upon completion of the project, it is predicted that sediment will travel from the Trinity River, through the pump station and pipeline, before being deposited in the sedimentation basin. Determination of the amount and impact of the total sediment, as well as the needed sediment removal equipment was beyond the scope of the preliminary engineering report. Additional evaluation and investigation will be required during final design. However, the sedimentation basin area is adequate to allow for temporary sediment and equipment storage as determined during final design.

5.2.5 Preliminary Drawings

A preliminary layout of the sedimentation basin has been prepared and is included in the project drawings. The layout shown in the project drawings is conceptual in nature and will be determined during final design.

5.2.6 Flow Measurement Structural and Mechanical Plan

Flow measurement structures and related mechanical plans will be required for the sedimentation basin and will be incorporated into the project's SCADA system. However, investigation into these needs was beyond the scope of this report and will be determined during final design.

5.3 Canal

5.3.1 Canal Conveyance Route

The initial canal alignment was based on Alignment 3 from the LBITP Alternative Analysis report (June 2007). Starting with this approximate location, the proposed canal alignment was determined on the basis of following the identified project standard design criteria, the desire to minimize future maintenance issues, the reduction of environmental impacts, the allowance for feasible construction, the avoidance of the division of contiguous property shared by a single ownership interest where possible, the avoidance of impacts to existing water and drainage features, the avoidance of impacts

to existing utility facilities, and the minimization of overall project construction costs. In general, the canal begins at the high point on Capers Ridge and flows downhill to the project outfall.

Adjustments were performed and the canal preliminary alignment was modified based on the following information: field investigations, property examinations, the right-of-way acquisition process, and additional research into project constructability and cost. The ultimate project alignment has yet to be finalized, pending completion of the right-of-way acquisition process. However, the various changes and alignment rationale decisions to date are described below.

Beginning with the project's initial route, the alignment was refined to follow an approximate Liberty County watershed boundary, commonly termed "the ridge." Using LiDAR data for the project corridor, the watershed boundary between Luce Bayou and both the Trinity River (for the northeastern part of the alignment) and Cedar Bayou (for the southwestern part of the alignment) was approximated. The alignment was modified to follow the ridge as closely as possible to eliminate cross drainage where feasible and to minimize the impact of the canal on overland flow from extreme rainfall events.

Following this adjustment, the route was then modified to follow existing property boundaries more closely. The purpose of this adjustment was to avoid or minimize division of any single property with the canal while remaining as close to the ridge as possible. After closely analyzing the property boundaries using aerial photography and field visits where possible, the alignment was further refined to minimize impact on the irrigation canals and other smaller drainage features. Additionally, in conjunction with the environmental investigation, alignment change decisions were made with consideration to the possible environmental impacts affected by the options under consideration. This includes potential and jurisdictional wetlands, water bodies, vegetated landscapes, potential historical and archeological sites, and wildlife.

As property and site information became available, conflicts with existing facilities and utilities were also considered in determining the project alignment. An effort was made to contact each of the private utility owners in order to discuss the project, its potential impact on the utility's operations, and the required mitigation activities. In some instances, relocation of these existing utilities may be required. A list of the pipelines found to have a potential impact on the project is described in Section 5.3.13.

Several areas of the alignment of the considered alternatives required additional investigation of the following:

- A field visit identified a conflict near the intersection of the proposed alignment at SH 321 with an existing Crown Communications cellular phone tower located in Parcel 17. Several route alternatives north and south of this location were considered, including options that would have conveyed the water via underground box culverts. However, following discussions with the tower owner and after considering the engineering constraints, land acquisition, environmental impacts, and construction costs at this location, it was determined that the recommended alignment would entail relocation of the cell tower.

- Due to potential access limitations, three alternatives from Parcels 40 to 48 were analyzed. The first option considered traveled westward before intersecting and paralleling an existing pipeline easement. While this route was shorter than the other options considered, it resulted in impacts to the greatest number of acres of potential wetlands as well as the impact to an existing water treatment plant. The second option was located along the western edge of Parcel 42 and along a natural divide through Parcel 43. However, this resulted in a large impact to potential wetlands and the division of a historic homestead located on Parcel 47 and 47.5 and a potential area of archeological significance. The recommended route was selected because of the smallest anticipated impact to potential wetlands.

- Also due to potential site access limitations, several alternatives for Parcels 50 and 51 were investigated. Routes along the northern and southern boundaries as well as across the property were considered. Following investigation into the access impacts, site drainage, and the mitigation that would be necessary to offset these impacts, an alignment along the southern boundary was recommended.

5.3.2 Canal Design Criteria and Assumptions

The project design criteria are based on existing best practices and design standards for open channel canals and discussions with CWA operations personnel. The assumptions, methodologies, and reasoning were derived from various design criteria and scenarios that provided the optimal result for this project while remaining consistent with the project's objectives and goals.

A three hundred foot wide section was determined for the project ROW. This width would allow for the construction of the canal, access roads, storm water ditches, and maintenance access and activities.

The canal section is designed to convey an ultimate flow rate of 774 cubic feet per second (cfs), the equivalent of 500 million gallons per day (MGD). A minimum flow depth of five feet is to be provided, assuming a flow rate of 356 cfs. This flow rate is based on the assumed initial volume of water the canal will deliver prior to the required ultimate demand of 500 MGD. The typical canal cross-section was designed to be 10 feet in depth and 100 feet wide with four horizontal to one vertical (4:1) side slopes. In some instances, the canal may be widened or deepened to maintain an adequate factor of safety depending upon specific hydraulic and site conditions. The average slope within the canal is 0.015 percent and the canal bottom width is 20 feet.

The information for determining the canal freeboard was taken from a recommendation found in Natural Resources Conservation Service Conservation Practice Standard, Irrigation Canal or Lateral, Code 320. The code stipulates that the required freeboard above the maximum design water level shall be at least one-third of the design flow depth or 1.33 times the flow depth and shall not be less than 0.5 feet. This resulted in the canal having an average water depth of seven to eight feet within a 10-foot deep canal for the majority of the project, as described in *Section 5.4.4*. While the canal is not intended to be a drainage conveyance system, it is open to the elements and is required to convey any precipitation that falls directly upon it. Therefore, an overall analysis of the canal was performed for a 100-year rainfall event, verifying the minimum freeboard of 0.5 feet was provided for both a 6-hour and 24-hour storm. The 24 hour 100-year event resulted in 12.5 inches of rainfall occurring over the entire length of the canal. This analysis assumes the water supply pumps were deactivated a maximum of eight hours into the rainfall event or once two inches of rainfall have occurred over the canal.

One of the project objectives was to minimize vegetation growth within the canal, which significantly contributes to canal maintenance and operation costs. The velocity of the water and depth of canal were used to deter plant growth along the canal bottom. An average canal velocity of two feet/second (ft/s) was selected for the ultimate design flow rate to limit the ability of plants to take root along the channel. A maximum velocity of three ft/s was selected to limit potential erosion along the side slopes of the canal. In areas where the velocity of the water is expected to increase above five ft/s, erosion prevention methods, such as concrete lining or armoring, will be required. These areas will be near the entrance and exits of culverts, drop structures, canal bends, and other locations as identified during final design.

In addition to the flow velocity reducing vegetation growth, minimal vegetation growth below the design water surface elevation in the canal can also be expected due to the designed flow depth limiting available sunlight. Thus, in determining the frictional loss to the flow of water, a Manning's

roughness coefficient or n-value of 0.025 was assigned to the proposed canal. An n-value of 0.025 reflects the roughness factor for a bare earthen soil cross-section.

At each roadway crossing, the canal was transitioned to a box culvert section for conveyance underneath the roadway. At the location where the proposed water surface elevation is above the existing roadway, a siphon has been designed to convey water across the roadway with minimal disruption. The box culvert dimensions required at each location varied depending on the location canal flow line and depth under which the canal would need to pass. Specific sizes of each roadway crossing are shown in the project drawings. Additionally, conveyance via the canal box culvert were used to facilitate drainage across the canal right-of-way. The descriptions of these breaks are described in greater detail in Section 5.3.7, while their purpose for use as drainage devices is outlined in Section 5.4. A Manning's n-value of 0.015 was assumed for all concrete structures, including all box culverts. The entrance to all structures will have improved inlets to limit entrance head losses that will be detailed during final design.

5.3.3 Water Level Control Structures

Constant water surface elevation within the canal is beneficial to minimize maintenance that is typically required with frequently fluctuating water surface elevations. The water level control gates are proposed to limit the maximum drop in water level within the system to no more than four feet between gates. In order to maintain this desired water surface elevation, water level control gates will be strategically installed along the canal. In general, the gates will operate using the flow in the canal against the gate structure balanced with counterweights to maintain the desired constant water surface elevation. Upon initial installation, the gates will be positioned to keep the upstream water level constant. As the flow increases, the pressure from the water will cause the gate to open. This will balance the pressure from the flow of water with the counterweights on the gate in order to maintain the pre-determined water level. As the flow decreases, less water moves through the canal, resulting in less pressure exerted on the gates. The decrease in pressure causes the gate to reposition itself (using the counterweights) to maintain a constant water level in the canal.

The gates are currently designed to operate automatically with the intention of maintaining the water surface elevation. If necessary, features that will allow the gates to be manually or mechanically operated will be included in the final design. Additionally, a safety rack or structure may need to be placed in front of the gate structures to prevent blockage of flow and allow the gate to open or close properly.

There are seven gate locations proposed along the canal. There will be two parallel gates at each location to allow for maintenance without impeding the flow in the canal. Each gate location also corresponds to a drop in the canal flow line. The periodic drops allow a slope of 0.015 percent to be maintained for the length of the canal, which keeps the velocities in the range identified in the canal design criteria and project maintenance to a minimum. The gates will also include emergency overflow weirs, permitting the canal flow to bypass the gates in the event that the gates become inoperable. The current design of the gate structure is shown in the project drawings.

5.3.4 Geotechnical Findings and Impact on Canal Design

A preliminary geotechnical investigation was performed for the project. As part of this investigation, 15 borings were taken at the proposed pump station site and along the proposed alignment. Based on the preliminary findings and as outlined above, a 4:1 side slope was recommended for slope stability on the project. Additionally, the geotechnical consultant provided a typical cross section for canal lining to be used to prevent water seepage within the canal. This includes an anticipated over excavation depth to allow for the inclusion of the canal lining varying from 18 to 24 inches. A summary of the recommended clay lining cross section is shown below in *Figure 5-3*. Through use of

the canal lining, the geotechnical investigation concluded that water losses through seepage in the canal would be minimal based on the preliminary investigation.

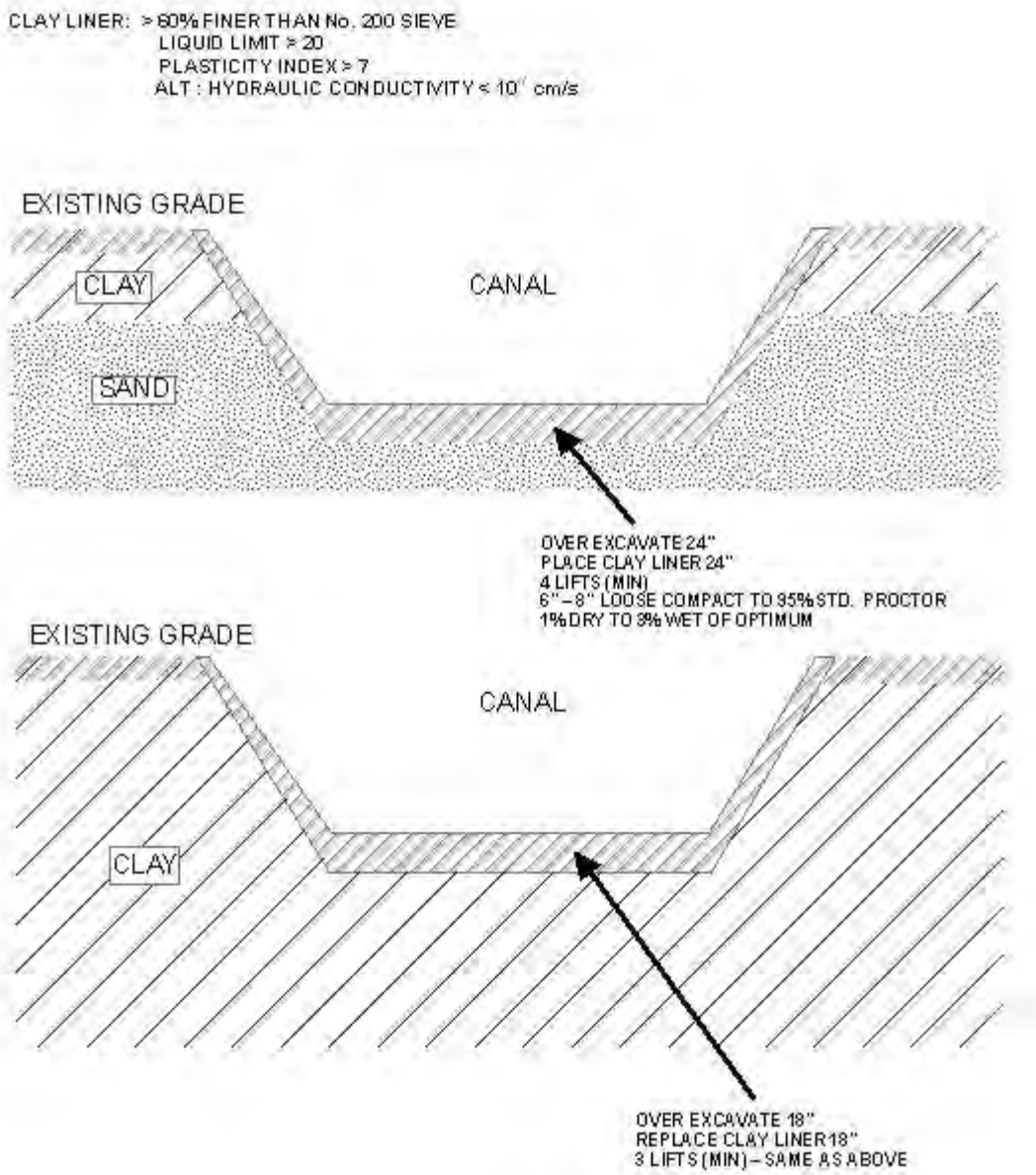


Figure 5-3 – Recommended Canal Lining for Differing Soil Conditions

Approximately 85 percent of the encountered material was composed of cohesive soils with the remaining 15 percent granular soils at depths of 10 feet. In conjunction with these borings and based on the anticipated project alignment, the geotechnical investigation indicates that enough cohesive (clay) material will be present to construct the channel lining with no need to import outside material. However, additional geotechnical investigation and borings along the canal route will be required to confirm this assumption during final design.

While enough clay material is likely present on site for construction of the channel lining, the material in specific locations will vary along the alignment. As such, it will be necessary for a geotechnical engineer to be present to supervise the testing and sorting of excavated material as suitable or unsuitable for lining material during construction. Furthermore, transportation of material for distances up to one mile within the canal right-of-way may be required, depending on the availability of clay in a particular location. Based on the preliminary findings, transportation of clay to different locations along the project is not anticipated in more than 25 percent of the canal. There will likely be excess excavated material during construction, but this excess material can be distributed within the project right-of-way without causing any adverse impacts.

The water table was generally encountered between 8 to 12 feet in depth below the existing surface. While locations potentially requiring dewatering were not observed, additional geotechnical testing and analysis during final design will be needed to confirm these conditions. However, there are locations where existing ditches, agricultural fields, and reservoirs are present and could possibly charge shallow granular soils, which could pose a problem during construction.

The cost estimate for the project was revised to incorporate recommendations based on these geotechnical findings, including the location and availability of clay, side slope stability, height of water table, over excavation depth, soil seepage rates, and other potential design considerations. The analysis of this information is ongoing and will continue to be incorporated into the project design. The preliminary geotechnical report is included in *Appendix B*.

5.3.5 Slope Stability and Erosion Protection Methods

The canal slope stability has been evaluated based on proposed soil conditions as well as the wet/dry cycles the canal slopes may experience as part of normal canal operations. Following this evaluation and in conjunction with recommendations provided by the preliminary geotechnical investigation, canal side slopes of 4:1 (V:H) are recommended. At this slope, concern for slope stabilization is minimized and without encumbering canal maintenance, such as mowing and dredging operations. Additionally, CWA expressed a specific desire to keep the canal side slopes at 4:1.

5.3.6 Canal Outfall

The preliminary project outfall was determined and is shown in the project drawings. Details related to the modeling and hydrology of the outfall structure is described in *Section 5.4.4*. The outfall is proposed to begin by transitioning the canal at a concrete drop structure and headwall. The flow is then conveyed via three 8-foot by 6-foot box culverts that will be diverted 36 degrees to the south of the project centerline near the bank of Luce Bayou/Lake Houston. The angle of diversion is to minimize the effects of erosion and scour at the existing outfall location as determined in the Baird Report and shown in the separate report developed by Baird. The box culverts will continue down towards the water before discharging below the average water surface elevation at that location. This will create an underwater outfall location. The area immediately adjacent to the outfall will be located within a concrete basin or apron beneath the existing channel bottom and surrounded by an underwater concrete weir. The purpose of this basin and weir will be to protect the lake bottom from scour and erosion.

Additionally, shoreline protection will be required to prevent and limit erosion during low water conditions in Lake Houston. Based on historical low water elevation information and existing conditions, shoreline protection is recommended to be 60 feet upstream of the outfall location and 120 feet downstream of the outfall location. Based on the preliminary findings of the outfall erosion investigation, it was not anticipated that the outfall would have an adverse affect on the opposite bank or any islands located within the existing outfall channel.

During typical canal flow conditions and water elevations within the outfall channel, the potential for scour is not significantly increased. However, during a combination of low water levels within the outfall channel and the maximum canal discharged rates, sheer stresses within the outfall could induce localized erosion and scour. The erosion and outfall investigation recommended that a permanent shoreline and bathymetric observation program is implemented to monitor the outfall for erosion and sour.

5.3.7 Drainage Along Canal Corridor

A preliminary drainage investigation and drainage area map of the canal portion of the project was developed and is shown in the project drawings. Existing drainage conditions and drainage conveyance will be evaluated during the project's final design and all drainage and storm water system mitigation will be designed to meet all applicable standards. Preliminary coordination over the drainage conveyance with representatives from Liberty and Harris counties was completed as part of the preliminary engineering for the project. This included meeting with the representative agencies and noting relevant drainage features that would be impacted, coordinating notification of the right-of-way acquisition process, and clarifying future requirements and considerations that would need to be included in the project's final design. The methodology, relevant assumptions, hydraulic model and processes of development are explained in greater detail in *Section 5.4 and Appendix E*. However, additional hydraulic and hydraulic analysis will be required as part of the final design.

5.3.7.1 Canal Siphons

One purpose of the project is to convey water via the pipeline and canal with minimal impact to the existing drainage patterns. To accomplish this, existing overland flow pattern impacts will be limited by creating breaks in the canal that will facilitate overland flow. At each break point, the flow of storm water runoff from the surrounding areas will be conveyed to a natural topographic low point. The canal siphon will convey the water in the canal below the existing grade, providing a direct path for runoff to flow across the project ROW.

The canal siphons consist of a transition from the open canal into a headwall structure and box culvert section, conveying the water beneath the existing ground surface. A safety rack may be included on the upstream side to prevent buildup or blocking of the siphon by debris. The headwall will proceed from an open transition section to a closed transition section before the box culvert section passes underneath each break location. Once the siphon emerges on the other side of the break, it would again transition into a headwall section and finally an open canal.

The drainage ditches on either side of the canal will convey runoff to each of these canal breaks. The breaks will then be sloped to facilitate drainage across the project right-of-way and away from the break location. Each siphon location results in a canal break of a minimum of 200 feet, although the overall length of each break varies. A berm would wrap around the headwall on either side of the siphon, allowing for access to either side of the canal and preventing the mixing of raw water and storm water runoff. Additionally, the drainage breaks would provide a location for wildlife to safely cross the project ROW.

At each location, the all weather maintenance road will continue across the break, permitting continuous access along the canal alignment within the project ROW. A flood gauge or other flow depth monitoring device may be put in place as a safety precaution. A bridge or low water crossing constructed of articulated concrete blocks, concrete paneling or other material capable that permits saturation of the roadway for extended periods will be constructed to facilitate this continuous access. The type of crossing that will be used will be determined during final design.

The canal siphons purpose for use as drainage devices are described in greater detail in *Section 5.4*. A typical detail and the locations of the canal siphons are shown in the project drawings.

5.3.8 Storm Water Pollution Prevention and Silt Control Measures

The canal portion of the project will have various storm water pollution prevention and silt control measures included as part of the final project design. In general, control measures include a reinforced silt filter fabric fence that will line the entire canal ROW, stabilize construction access points at all major roadways and construction access points, filter dams located as needed throughout the project, sodding and seeding to establish grass and minimize additional sediment erosion. A preliminary storm water pollution prevention plan is included in the project drawings. However, these control measures will be refined and modified as needed based on additional topographical survey and information obtained during final design.

5.3.9 Environmental Design Impacts

Environmental impacts were considered throughout the preliminary engineering phase. Minimization of impacts to existing and potential wetlands determined several aspects of the preliminary engineering. Environmental issues were used to determine the recommended project alignment as well as in the preliminary engineering of the canal siphons. The fencing used on the project also took into account the impact on the existing wildlife. Other environmental factors were also used to determine the preliminary project design.

5.3.10 Potentially Contaminated, Hazardous, and Toxic Area Concerns

In conjunction with the geotechnical and environmental investigations, research into the presence of potentially contaminated, hazardous, and toxic areas were considered. Although based on limited information, no contaminated, hazardous, or toxic soils were encountered along the project.

5.3.11 Site Access Locations

Site access points have been identified throughout the project alignment. Following extensive coordination and input from CWA, the majority of these site access points are located adjacent to areas where the project ROW is crossing an existing roadway. The roadway crossings and site access points are shown in *Exhibit A-5*.

At each roadway crossing, there will be a driveway off the existing roadway. Adjacent to this driveway inside the CWA property, there will be a loading and unloading area for use as an on-site maintenance and storage location. This stopping area will be wide enough to provide the on and off loading of heavy equipment and material storage as required by CWA. Two separate entrances from the main roadway were considered, but will require approval from the roadway owner and will be determined during the project's final design.

5.3.12 Preliminary Communication, Control, and SCADA Needs and Criteria Along Canal

Detailed communications, controls, and SCADA needs will be determined during final design. However, the need for the ability to communicate, monitor, report, and control the project systems will be imperative. The SCADA system will be incorporated into the design of the pump station, pipeline, project maintenance facility, sedimentation basin, canal, and outfall to ensure full integration of the entire project.

5.3.13 Pipeline and Private Utility Crossings

The current project alignment crosses 20 active gas and petroleum pipelines and two electrical facility easements. Coordination with these utility companies regarding verification of facilities and resolution of the potential future conflict was performed in conjunction with the preliminary engineering for the project. The following entities were contacted as part of this investigation. A summary of their existing facilities and the coordination is shown below. See *Exhibit A-5 Crossings Locations,* which shows the locations and summary table of these pipelines and utility crossing locations.

- Williams/Transco (Transcontinental Gas Pipe Line Corporation): The company owns and operates 2 - 30" steel pipelines conveying natural gas in the project area. They provided their crossing requirements handbook and maps showing exact horizontal alignment for the existing pipelines. No relocation costs have been provided.

- ConocoPhillips Pipeline Company: The company operates a 24" pipeline that transports petroleum products in the project area. Additional information about the existing utility has been requested, but has not yet been obtained. No relocation costs have been provided.

- Kinder Morgan: The current project alignment crosses three high pressure natural gas pipelines that are owned by this company. Crossing requirements, easement information, as well as maps showing horizontal alignment for all of the affected pipelines have been provided. No relocation costs have been provided.

- Sunoco Logistics: The company owns and operates a 10" high pressure pipeline crossing the existing alignment. The company provided a map showing the horizontal alignment, engineering and general restrictions manuals, as well as an approximate relocation cost.

- Chevron Pipeline Company: The company operates 2 - 10" liquefied petroleum gas pipelines that are crossing the proposed alignment. During the utility coordination process, the company provided horizontal alignment plans, approximate depth of the lines varying from 3'6" to 4'6" in depth, as well as an approximate cost estimate for relocating the affected pipelines.

- TEPPCO - Enterprise Products: Company owns and operates a 10" and a 12" steel pipeline, which are crossing the proposed alignment. The company has provided detailed alignment sheets for the affected lines, encroachment guidelines, approximate depth of their lines buried between 2.5 and 3.5 feet, as well as an approximate relocation cost.

- BP Pipelines (North America) Inc.: The company owns and operates 2 - 12" inactive pipelines in the project area. The company will be interested in maintaining one of the two pipelines for their future use. Information has been received on their pipeline's horizontal alignment information and construction guidelines. No relocation costs have been provided.

- Mustang Pipeline Company (Eastman Chemical Company): The company owns and operates one 6.625" propylene carbon steel pipeline and one 10.75" propane steel pipeline in the project corridor. Information has been received on their horizontal alignment, approximate vertical depth of 42" and an approximate relocation cost.

- Oneok NGL Pipeline, LP: This company owns and operates three liquefied petroleum gas steel pipelines of 8", 12" and 14" in diameter, which are crossing the proposed alignment. The horizontal alignment information on these pipelines has been provided along with an encroachment agreement. No relocation costs have been provided.

- Buckeye Gulf Coast Pipelines, LP: The company operates a 10" ethylene line for Westlake Ethylene Pipeline. Right-of-way use restrictions specifications, horizontal alignment maps, and approximate relocation cost have been provided.

- KOCH/Grande Pipelines: Pipelines were reported to have been abandoned/salvaged. No additional information has been received.

- Sam Houston Electric Cooperative: The company previously provided a general area utility location map for Liberty and Harris Counties. Letters requesting updated information for the current project alignment have been sent, but no information has been received to date.

- Entergy Gulf States: Two electrical easements and power lines owned by Entergy have been identified as crossing the project alignment. The company has provided detailed information about their existing utilities as well as approximate cost for relocation of these affected utilities. Based on the preliminary information, it appears that relocation of only one of the existing conflicts will be required.

- B&G Energy Corporation: Numerous attempts have been made to obtain information about existing utilities from this company within the project location. To date, no information has been received.

- Verizon Communications: The company provided a general area utility location map. A detailed description of the project was sent as part of a request for more information on a potential conflict location, but a response has not been provided.

- CenterPoint Energy: Numerous attempts have been made to obtain information on existing utilities from this company. No information has been received to date.

As part of the utility investigation, the following pipeline and utility companies were contacted and reported no existing facilities or conflict between their facilities and the proposed project alignment:

- Mobil Pipeline Co.

- Trunkline Gas Company

- Shell Pipeline Company, LP

- Energy Transfer - Houston Pipe Line Company, LP

- Comcast Communications

On Parcel 43, the proposed alignment crosses an existing Entergy easement. Following several coordination meetings, Entergy requested that the access roads meet their design specification for safe access to the electrical towers by their equipment and vehicles. Entergy provided the minimum design standards that would be required for access roads to their easement. These standards specified that the access road would need to be 20' wide and graded to drain at 2% slope. The surface of the access road needs to have a minimum of five inches of compacted crushed limestone. If the existing subgrade is poor, Entergy would require the removal of existing soil and replacement with more stable fill. All fill used for the access road would need to be placed in a maximum of six inch layers. All fill, base course, and ground covering are to be compacted to 95 percent of maximum density obtained by a Modified Proctor Test (ASTM D-1557).

On Parcel 23.6, the proposed injection point for the Enstor Houston Hub Storage Facility, a natural gas storage facility, was identified during the right-of-way acquisition process. While details are unknown at this time, the LBITP will be designed to avoid impacts to this future facility.

5.3.14 State Highway and County Roadway Crossings

The current project alignment crosses six roadways. Notification and coordination with the Texas Department of Transportation, Liberty County, and Harris County regarding these roadway crossings has been completed as part of the preliminary engineering. Meetings were held with each entity to indicate the project's alignment and to determine impacts with existing roadways, proposed future roadways, or roadway expansions.

In Liberty County, a master thoroughfare plan has been developed and provided by the county. This thoroughfare plan identified proposed freeways, major thoroughfares, and collector roads that were part of the county master plan. The project alignment was overlaid to determine what the potential future impacts were. Based on this analysis, it was determined that the project alignment affected 10 future major collector roads, four future major thoroughfares, and one proposed future freeway. However, Liberty County indicated they were in the very early planning stages of all of these roadways and projected expansion. The construction dates or right-of-way widths are unknown at present. *Exhibit A-6* shows the Liberty County Master Thoroughfare Plan as well as the project alignment in the affected portion of the county.

5.3.15 Preliminary Drawings

Preliminary typical sections, sheet layouts, plan and profile sheets, storm water pollution prevention plans, drainage area maps, traffic control plans, and details have been prepared for the project. They are included as part of the project drawing set, which is Volume II of the PER.

5.4 Project Drainage, Hydrology, and Hydraulics

5.4.1 Drainage Summary

A drainage area map, drainage lines, and catchment area boundaries were determined based on LiDAR and the limited topographical information available during the project's preliminary engineering. Throughout the project alignment, drainage breaks were inserted along the canal to permit drainage across the project right-of-way to maintain existing drainage patterns where possible and practical. The process for development of the project drainage, hydrology, and hydraulics is described in detail in the sections below.

5.4.2 Off-Site Drainage Crossings

Conceptual level modeling was performed to estimate the size and number of crossings required to convey off-site drainage across the proposed canal alignment. Detailed modeling to size collection ditches and confirm preliminary crossing sizes will be required in the design phase of the project.

Conceptual design consisted of drainage ditches paralleling the canal alignment along both ROWs. The ditches will drain toward the low point in the subbasin and will be interconnected by a culvert(s) crossing the canal alignment. The canal will be siphoned below the culvert crossing, allowing for extreme events to flow over the maintenance road. Less extreme events will be capable of passing through the culvert at each crossing.

The parallel ditches will act as spreader ditches, allowing flow to leave in a sheet flow pattern where applicable. A majority of the alignment does not have significant existing drainage facilities that collect existing runoff. The proposed ditches will have a depth sufficient for allowing the cross culvert to be below natural grade and provide sufficient cover. However, this design will result in some of the ditch flow lines to be below the natural grade at outfalls and resulting in the ditches remaining wet for extended periods of time.

5.4.3 Hydrology

Arc-Hydro, an extension of ArcMap, was utilized to calculate drainage lines for the area surrounding the proposed alignment using topographical information from a digital elevation model (DEM). Subbasin area boundaries were delineated from these drainage lines using a minimum basin size of 100 acres. For the purpose of determining drainage break locations, only subbasin areas that were intersected or affected by the proposed alignment were examined in the HEC-HMS model.

The methods utilized to develop the inputs into the HEC-HMS model are the Soil Conservation Service (SCS) Curve Number Method and SCS Unit Hydrograph Method. The SCS method for calculating peak discharge was selected for Liberty County hydrology, as no criteria could be found recommending a methodology to be used. The SCS method is appropriate for smaller watersheds and provided the rate and volume of the runoff. A list of provided runoff curve numbers (CN) based on a summary of those presented in TR-55 was used for the analysis. However, for the portion of the project within Harris County, Harris County hydrologic criteria were utilized.

The SCS Curve Number Method requires land use data, which was estimated visually from aerial photos. From the land use types, a weighted runoff coefficient was determined for each subbasin area. The project area contains soils in hydrologic soil group D. ArcGIS was used to calculate the total area for each subbasin. The percentage of the impervious area was modeled as 0 percent as the Curve Number was utilized to handle land use types.

The SCS Unit Hydrograph Method evaluates the lag time for each subbasin based on the time of concentration and travel time for sheet flow. The following values were selected for estimating the travel time for sheet flow: Manning's n-value of 0.3; 2-yr, 24-hr rainfall event of 5.25 in; flow length of 100 ft; and a slope of 0.0005 ft/ft. The longest flow path length was calculated and then the slope was estimated by taking the elevation at 15 percent and 85 percent of the flow path length.

The velocity for each subbasin was selected from the TxDOT Hydraulics Manual. The velocity selected was based on the weighted average of the Manning's n-value for each subbasin ranging from 0.1 to 0.15. The travel time for sheet flow and the quotient of drainage flow path and velocity were converted into minutes to calculate the time of concentration. The SCS calculation of lag time, Tlag =0.6*Tc, was utilized for each subbasin and input into HEC-HMS. The model performed simulations for the 1 percent and 50 percent Annual Exceedance Probability (AEP) storm events.

For the hydrology of the project roadways, the roadway drainage criteria from Liberty County's subdivision regulations were used for roadway drainage. The 2-year storm event was selected for these agricultural areas, as this is consistent with typical road side ditch design capacity. The event duration is the primary concern, compared to the depth of flooding for agricultural or undeveloped areas.

5.4.4 Hydraulics

Because the Luce Bayou canal is a raised canal, it will impede natural drainage paths of overland and channelized flow. To remedy this, a series of siphons in conjunction with collector ditches and culverts will be utilized along the alignment ROW. Ditches on the upstream and downstream side of the alignment will slope toward designated crossing points. These crossing points were determined based on natural drainage paths and existing low points along the alignment. Water will be collected in the upstream ditch and directed across the canal at the siphons via culvert and overland flow to the downstream ditch where it will fill uniformly and flow out, as described in *Section 5.3.7*. This will allow the water to resume sheet flow, thus replicating existing conditions.

The crossing points consist of a culvert-weir structure as shown in the project drawings. The culverts are sized to pass flows up to and including the 50 percent AEP storm event without overtopping the canal maintenance road. For larger events, a shallow flow depth is allowed to overtop the roadway to minimize increased ponding depths upstream of the canal. Flow from the culvert and weir will be collected in the downstream ditches and spread as previously described.

To model the proposed conditions, both one-dimensional and two-dimensional models are used in parallel.

A hydrograph representing rainfall is introduced in a two-dimensional overland flow model, which models the behavior of the shallow sheet flow. From this model, a stage hydrograph is obtained at the downstream right-of-way for each crossing.

In the one-dimensional model, each crossing is modeled as a separate reach. Under existing conditions, cross-sections along the reach represent the elevation data at the upstream and downstream right-of-way as well as the centerline of the canal. Under proposed conditions, the centerline cross-section is replaced with and inline structure containing a culvert and a weir representing the crossing structure. The watershed on the upstream side is modeled by a storage area with an elevation-volume curve obtained from the DEM and connected to the reach as the upstream boundary.

A runoff hydrograph is introduced to the upstream storage area and the stage hydrograph obtained from the two-dimensional model is applied as the downstream boundary condition. The resulting stage hydrograph measured in the storage area from the model was compared to the existing and proposed conditions to measure project impacts.

The typical measured impact on the upstream side of the alignment for the 100-year event is an increased depth of 3-4” for 5-16 hours. For the 2-year event, the adjacent ditches and culvert crossings are shown to have sufficient capacity to have no increase over the existing 2-year peak flooding depths.

5.4.5 Hydraulic Model Results

HEC-RAS Version 4.0 was used to model the proposed canal. The model was setup for unsteady state modeling of time varied flow rates.

The canal is designed to convey 774 cfs, maintaining a water level in the canal between seven and eight feet of flow depth. A total of seven water level control gates are proposed. These gates serve to limit the drop in water level to a maximum of four feet when the flow rate is reduced below 774 cfs as described in Section 5.3.3. The gates are located so that the maximum grade drop between gates

is four feet or less. At this spacing, a maximum drop in water level of approximately four feet can be maintained for a zero flow rate condition.

The canal has six roadway crossings. At these crossings, three 8-foot x 7-foot box culverts are proposed. The canal grades at these crossings have been set to minimize impact to the roadway profile over the canal. Concrete lining will be provided at a minimum of 20-feet upstream and downstream of the crossing to minimize erosion potential due to increased velocities in the canal as flow enters and exits the culverts.

The culvert entrances are to be designed to minimize entrance losses by providing flared wing walls and beveled top edges.

A total of 19 siphons are proposed along the canal. The siphons are required to allow off-site runoff the ability to cross the canal alignment approximating current drainage patterns without causing prolonged flooding or ponding of properties adjacent to the canal alignment. The siphon locations are preliminarily sited at locations where overland sheet flow is expected to concentrate and where exisiting drainage facilities cross the alignment. The siphons are assumed to be two barrels of 10-foot x 7-foot box culverts and two barrels of 5-foot x 7-foot box culverts. The siphon flow line will drop approximately 10 feet below the canal flow line. This provides approximately five to six feet of depth between natural ground and the top of the box culverts. This depth will be used to provide surface flow across drainage structures, which is discussed in greater detail in Section 5.3.7. Each siphon is assumed to be 400 feet in length and each barrel of the siphon has a velocity of 3.7 fps, which exceeds the typical minimum scour velocity of 3 fps. This velocity will keep sediment deposition to a minimum within the siphon.

Initial demands indicate an expected flow rate of 230 MGD or 356 cfs after the canal is constructed. This interim flow rate will result in lower velocities through the siphons. It is recommended that only one 10-foot x 7-foot and one 5-foot x 7-foot barrel will be used for the interim flow of 356 cfs. This flow rate provides a velocity within the siphon of approximately 3.4 fps.

Flow depth within the canal varies between seven and eight feet, depending on the location in relation to water level control gates, existing roadways, and siphon crossings. The normal water level depth in the canal is approximately 7.3 feet. By providing a typical canal depth of 10 feet, an average freeboard of 2.7 feet is provided. There are several reaches along the canal where the roadway and siphon crossing are spaced fairly close together, causing incremental head losses between the structures to raise the depth of flow in the canal to approximately eight feet. It is recommended that in these reaches the canal should be constructed to a depth of 11-feet, providing the recommended 1.33 x depth of flow freeboard.

The extreme event analysis shows that assuming the pumps are turned off for a maximum of eight hours into a 100-yr, 24-hour rainfall event, the canal has capacity to carry the event and maintain a minimum of 1.2 feet of freeboard. Should the pumps not be turned off during a 100-year event, the canal has capacity to convey the event with a minimum freeboard of 0.3 feet. This minimum freeboard is most likely to occur within the portion of the proposed canal where the 11-foot depth is recommended.

Unsteady state modeling of the canal shows that with the canal operating at its ultimate capacity of 774 cfs, it would take approximately eight hours for the water level control gates to completely shut down the flow to Lake Houston after the pumps have been turned off. Returning the canal to the 774 cfs flow rate is shown to take approximately 13 hours. Flow begins to arrive at the outfall approximately three hours after the pumps are turned on, assuming the water level control gates are holding water in the canal.

The outfall structure into Lake Houston is assumed to be three 8-foot x 6-foot box culverts. The approximately 640-foot long culverts have 28.8 feet of fall from the inlet elevation of 62.8 to the outlet elevation of 34.0. The outlet is submerged below the 43.5-foot normal pool elevation of Lake Houston. By submerging the outfall, a hydraulic jump is forced to occur within the culverts, reducing the velocity of the discharge into the lake. The velocity is further diminished by discharging the flow into a concrete stilling basin. The submerged basin has a top of wall elevation of approximately 39.5 or 1.5 feet above the Lake bed elevation at the outfall. The top of the wall functions as a submerged weir with an effective length of approximately 90 feet. The stilling basin will allow the discharge to swell up within it and uniformly distribute into the lake.

The culverts are at a very steep slope and critical depth is achieved within the culverts. This combined with the submerged outfall forces a hydraulic jump to occur within the culverts. The entire capacity of the culvert is not used where flow is flowing at a critical depth. The entrance will be designed so that open channel flow occurs within the culvert upstream of the hydraulic jump to prevent air from being trapped within the culvert.

When the canal is running at ultimate capacity, approximately 975 acre feet of water is contained within the canal portion of the project. With a zero flow condition, approximately 600 acre feet of water remains in the system stored behind the water level control gates.

While the model calculations are correct for the assumptions used in this report, changes from these original assumptions will occur as new information becomes available. Further hydraulic analysis will be required in final design to verify the effects of the actual roadway crossing designs, siphon lengths, water level control gates design and location, etc.

5.5 Project Access Roads, Security, and Safety

5.5.1 Access Roads and Roadside Ditches

The proposed access road will be constructed to provide access from FM 1008 to the sedimentation basin and the pump station. CWA intends to construct an improved roadway from FM 1008 to the proposed Capers Ridge Pump Station. A portion of the roadway is maintained by Liberty County as described in *Section 5.1.12*. The road is designed to be a 26-foot wide asphalt road with two way direction traffic and designed to withstand use by maintenance trucks and medium traffic. The access road is shown in the project drawings. Due to the limited nature of the preliminary engineering report and the information available, only the horizontal roadway alignment is shown.

The access road will be drained by road side ditches on each side of the road. These ditches shall be designed to meet Liberty County standards. The ditches will be v-shaped with a minimum depth of 0.5 feet below the edge of the road pavement or 0.5 feet below the natural ground elevation at the right-of-way, whichever is lower. The ditch side slopes shall not be steeper than three horizontal to one vertical (3:1) and the minimum grade shall be 0.1 foot per foot with the maximum design velocity of 3.0 feet per second during the design event. Due to the limited nature of the preliminary engineering report and the information available, only the horizontal ditch alignments are shown.

5.5.2 All-Weather Maintenance Road

The all-weather maintenance road will begin at the sedimentation basin and continue along the northern and western sides of the canal. This road will be designed to permit continued access under varying weather conditions. The width of this road is 14 feet and is shown on the project drawings. The cross section and composition of this roadway will be determined during final design.

5.5.3 Project Security and Safety

One of the outcomes of the U.S. Public Health Security and Bioterrorism Preparedness and Response of 2002 was the development of the "Guidelines for Physical Security of Water Utilities" in December of 2006 by the American Society of Civil Engineers and the American Water Works Association for the Environmental Protection Agency (EPA). The EPA in turn provided these guidelines to water utilities to assist them with the upgrading of the security at their facilities. Currently, the responsibility for providing security for the water resides with the utility. There are two bills in congress, H.R. 3258 Drinking Water System Security Act of 2009 and H.R. 2868 Chemical and Water Security Act of 2009, that, if enacted, will require water utilities to perform vulnerability assessments of their facilities, develop emergency response plans, develop plans for upgrading security, etc. It will also allow EPA and Department of Homeland Security (DHS) to inspect these facilities for compliance of these plans. Failure of such inspections could lead to EPA and/or DHS taking over responsibility for the security of these facilities. Until such legislation becomes law, it is prudent to use the guidelines to upgrade security of these facilities. As such, we have determined the general requirements needed to meet these possible requirements.

The pipeline is buried six feet below grade and, therefore, does not require any additional protection. Any above ground valves or controls will need to be locked with shrouded locks as described in the pump station section.

Along the general canal portion of the project, the preliminary engineering incorporates the use of a 4-strand barb wire fence along the entire project, except at major roadways and easement crossings. In these locations, a six foot high chain link fence is recommended to minimize access concerns along the project to the canal ROW in areas immediately visible to passersby at each roadway. Additional security may also be necessary at the water level control structures. Any programmable logic controller (PLC) cabinets, manual controls, and valves are recommended to be locked using shrouded locks. Beyond this, there are no additional security enhancements recommended to be made to the canal itself. The length of the canal and its general remoteness preclude the use of high security fencing, Closed Circuit Television (CCTV) cameras, etc., in a cost effective manner.

It is recommended that the canal maintenance facility have increased site security. This facility will likely need to be surrounded by a perimeter fence. This perimeter fence will be constructed to resist climbing or cutting and the fabric will be a heavy gauge chain link or welded wire fabric construction. It should be at least six feet tall with double outriggers on top with either three strands of barbed wire on both sets of outriggers or coiled razor wire. The entrance gate into this area will be an automated type sliding gate. The gate providing direct access to the canal will be secured with a shrouded lock. Access through the main gate will be controlled by the access control functions of the integrated security system at the site that will be developed during final design. All manholes, valves, vault hatches, equipment control cabinets, control devices, etc. will be secured with shrouded locks. All personnel doors into the facilities at this site are recommended to be equipped with tamper resistant security hinges and key-locked doors. The main entrances into each building are also recommended to be equipped with an access control card reader and associated hardware. Any roof hatches or exterior roof access ladders will need to be locked. Recommended electronic security for this facility consists of access control for the main gate and each of the main buildings, specifically the offices, vehicle maintenance bays, parts storage, general maintenance, and used oil storage. It can also include CCTV coverage of the entrances into each of these buildings/facilities and the main gate. The CCTV coverage of the building entrances would be from the inside of the buildings looking out in order to obtain a usable image for identifying who is entering the building. The camera at the entry gate will require lighting for continual use. Communication between these systems and the monitoring point at the CWA will be by the same media used to communicate with the pump station. Any PLC cabinets, control valves, etc. associated with the canal will need to be secured with shrouded locks.

Lastly, the project outfall may require some additional security. The project right-of-way and outfall location may require fencing to prohibit unauthorized access of the site from the Lake Houston/Luce Bayou waterway. Furthermore, the outfall concrete apron located under the water surface may require piers or buoys demarcating the outer edge of the safe swimming and waterborne vehicle distance. However, all project security measures for the entire project will be reevaluated to determine their necessity and applicability during final design.

Appendix A

Calculations

APPENDIX A - CALCULATIONS

I SYSTEM CURVE CALCUATIONS

A PURPOSE

The purpose of this section is to document the equations and assumptions used to generate the system curve for the project.

B STATIC HEAD

a Maximum:

	107.22 feet	Maximum WSE at Settling Basin
	- 17.80 feet	Low water elevation in the Trinity River (see below)
	89.42 feet	

b Average:

	107.22 feet	Maximum WSE at Settling Basin
	- 19.80 feet	Median water elevation in the Trinity River
	87.42 feet	

c Minimum:

	107.22 feet	Maximum WSE at Settling Basin
	- 44.00 feet	High water elevation (100 Year Flood) in the Trinity River
	63.22 feet	

d Minimum water surface elevation discussion:

Minimum future Trinity River water surface elevations are greatly dependent on the pumping rates of the Capers Ridge and existing Trinity River Pump Station. A large percentage of the total flow in the Trinity River is comprised of flow that will be diverted from the pump stations during periods of high pumping rates and otherwise low natural conditions. As discussed in more detail in Chapter 3, the Trinity River Authority will release water from Lake Livingston to ensure that water rights are met; therefore, during periods of extremely low flow, additional water will be released into the Trinity River. Based on modeling performed by AECOM, the minimum water surface elevation is expected to be 16.9 feet; however, during periods of high pumping operations and low natural flow, the minimum water surface elevation is expected to be no less than 17.8 feet. In this PER, different minimum water surface elevations are assumed and presented (either 16.9 or 17.8 feet) according to the situation being evaluated.

C PUMP STATION CAPACITY

The pump station will be provided with an initial pumping capacity necessary to meet contractual water demands for the year 2020, which should satisfy co-participant water demands up to the year 2040. Pumps will be selected to have their best efficiency points at flow rates close to average day conditions. Owner requested operational constraints also include a recommendation that the single-pump pumping rate to be less than the minimum anticipated 2020 project demand. Subsequent phases will expand the pump station to meet peak project demand for the year 2040 and then the maximum withdrawal rate allowed by the City of Houston's Water Right.

Pumps will be selected to ensure that the Phase 2 capacity can be achieved through the addition of three similar pumps and then the maximum project firm capacity (with one redundant pump) can be achieved through impeller changes or the addition of no more than two additional pumps. The maximum project capacity is defined by the maximum withdrawal rate allowed by the City of Houston's Water Right. The following is a list of some key pumping criteria:

a Phase 1 (2020) required total capacity: 230 MGD

b Phase 2 (2040) required total capacity: 425 MGD

c Maximum project firm capacity: 500 MGD

D SYSTEM CURVE HEADLOSS EQUATIONS

a Darcy-Weisbach Equation (fluid friction equation)

$$H_L = f \times \frac{L}{D} \times \frac{V^2}{2g} + \sum k \frac{V^2}{2g}$$

H_L	Head loss (feet)
F	Friction factor from Moody diagram
V	Fluid velocity (ft/s)
L	Pipe length (ft)
D	Pipe diameter (ft)
g	Gravity constant (ft/sec^2)
k	Minor loss coefficient

b Hazen-Williams Equation

$$H_L = 10.44 \times L \times \left(\frac{Q}{C}\right)^{1.85} \times \left(\frac{1}{D}\right)^{4.87} + \frac{\sum k}{2g} \times \left(\frac{0.4085 \times Q}{D^2}\right)^2$$

H_L	Head loss (feet)
Q	Fluid flow (gpm)
L	Pipe length (feet)
D	Pipe diameter (inches)
C	Hazen-Williams roughness coefficient
Σk	Minor loss factor

E HEAD LOSS FOR THE PUMP COLUMN, DISCHARGE PIPE, AND HEADER

a Summary of K-values:

Table A-I-1: COLUMN

Qty	Description	Dimension	k	Sum of k
1	Pump Entrance Loss	N/A	0.5	0.5

Table A-I-2: DISCHARGE PIPE

Qty	Description	Dimension	k	Sum of k
1 or 3	90 degree elbow	48"	0.3	0.9
1	Tee Branch	48"	0.6	0.6
1	Butterfly Valve	48"	0.3	0.3
1	Ball Valve	36"	0.04	0.04
1	Gradual Contraction	48”-36”	0.05	0.05
1	Gradual Expansion	36”-48”	0.06	0.06
	Sum of Minor Losses			**1.95**

Table A-I-3: HEADER

Qty	Description	Dimension	k	Sum of k
1	Tee Branch	84"	0.3	0.3
2	Tee Thru	84"	0.1	0.2
	Sum of Minor Losses			**0.5**

b Sample Calculation:

Q_{total}	: 230 MGD	
No. of Pumps	: 3	
Q_{pump}	: 53,240 gpm	
C	: 110 (Steel Pipe)	
Σk	: Column	: 0.5
	: Discharge Pipe	: 1.95
	: Header Pipe	: 0.5
Length of pipe	: Column	: 45 ft
	: Discharge Pipe	: 65 ft
	: Header Pipe	: 35.25 ft (Effective)

$$H_L\,(\text{Column}) = 10.44 \times 45\text{ft} \times \left(\frac{53{,}240\text{ gpm}}{110}\right)^{1.85} \times \left(\frac{1}{42\text{ in}}\right)^{4.87} + \frac{0.5}{64.4} \times \left(\frac{0.4085 \times 53{,}240\text{gpm}}{(42\text{ in})^2}\right)^2$$

$$H_L\,(\text{Discharge}) = 10.44 \times 65\text{ ft} \times \left(\frac{53{,}240\text{ gpm}}{110}\right)^{1.85} \times \left(\frac{1}{48\text{ in}}\right)^{4.87} + \frac{1.95}{64.4} \times \left(\frac{0.4085 \times 53{,}240\text{gpm}}{(48\text{ in})^2}\right)^2$$

$$H_L\,(\text{Header}) = 10.44 \times 35.25\text{ ft} \times \left(\frac{53{,}240\text{ gpm}}{110}\right)^{1.85} \times \left(\frac{1}{84\text{ in}}\right)^{4.87} + \frac{0.50}{64.4} \times \left(\frac{0.4085 \times 53{,}240\text{ gpm}}{(84\text{ in})^2}\right)^2$$

$$H_L\,(\text{Column}) = 1.72\text{ ft}$$
$$H_L\,(\text{Discharge}) = 3.11\text{ ft}$$
$$H_L\,(\text{Header}) = 0.09\text{ ft.}$$

F HEAD LOSS FOR PIPELINE

a Minor losses:

Table A-I-4: PIPELINE

Qty	Description	Dimension	k	Sum of k
1	Gradual Expansion	84"-108"	0.05	0.05
1	Butterfly Valve	84"	0.3	0.3
7	Butterfly Valve	108"	0.3	2.1
15	45 Degree Bend	108"	0.1	1.5
17	22.5 Degree Bend	108"	0.05	0.85
1	Exit Loss	N/A	1	1
	Sum of Minor Losses			**5.8**

b Pipeline operation discussion:

The design is made by taking into consideration 2 parallel pipes of 108 inches in diameter. In case of the low flow condition or when all the pumps are not running to the capacity, the numbers of pipelines in operation depend on the velocity of water through the pipe. When the flow exceeds the velocity of 4 ft/s in Pipe-1, then Pipe-1 and Pipe-2 should be used simultaneously. At times, pump station operators will operate the pumping system at velocities greater than 5 ft/s to flush sediment out of the pipes. This will be done as needed, but not under typical situations.

c Sample Calculation:

Q_{total}	: 230 MGD
No. of pipes	: 2
Q per pipeline	: 79,861 gpm
Pipeline length	: 16,051 feet
Nominal pipe diameter	: 108 inches
C	: 110 (steel pipe)
Σk	: 5.8

$$H_L\,(\text{Pipeline}) = 10.44 \times 16{,}051\,\text{ft} \times \left(\frac{79{,}861\,\text{gpm}}{110}\right)^{1.85} \times \left(\frac{1}{108\,\text{in}}\right)^{4.87} + \frac{5.8}{64.4} \times \left(\frac{0.4085 \times 79{,}861\,\text{gpm}}{(108\,\text{in})^2}\right)^2$$

$$H_{L\,(\text{Pipeline})} = 4.82\ \text{ft.}$$

G TOTAL DYNAMIC HEAD

a Total Dynamic Head (TDH) at 230 MGD

TDH = Static Head + Total Pipeline Friction Head

i At low water elevation in the Trinity River

TDH = 89.42 + 1.72 + 3.11 + 0.09 + 4.82 = 99.16 ft

ii At median water elevation in the Trinity River

TDH = 87.42 + 1.72 + 3.11 + 0.09 + 4.82 = 97.16 ft

iii At high water elevation (100 Year Flood) in the Trinity River

TDH = 63.22 + 1.72 + 3.11 + 0.09 + 4.82 = 72.96 ft

H PUMP SELECTIONS

The pump station will be provided with an initial pumping capacity of 230 MGD. Three duty pumps and no redundant pumps will be provided. Each pump will meet two design points.:

1) 53,200 gpm (76.7 MGD) at 97' TDH
   (3 duty pumps producing 230 MGD)
2) ≥ 49,200 gpm (70.8 MGD) at 108.5' TDH
   (6 duty pumps producing greater than 425 MGD)

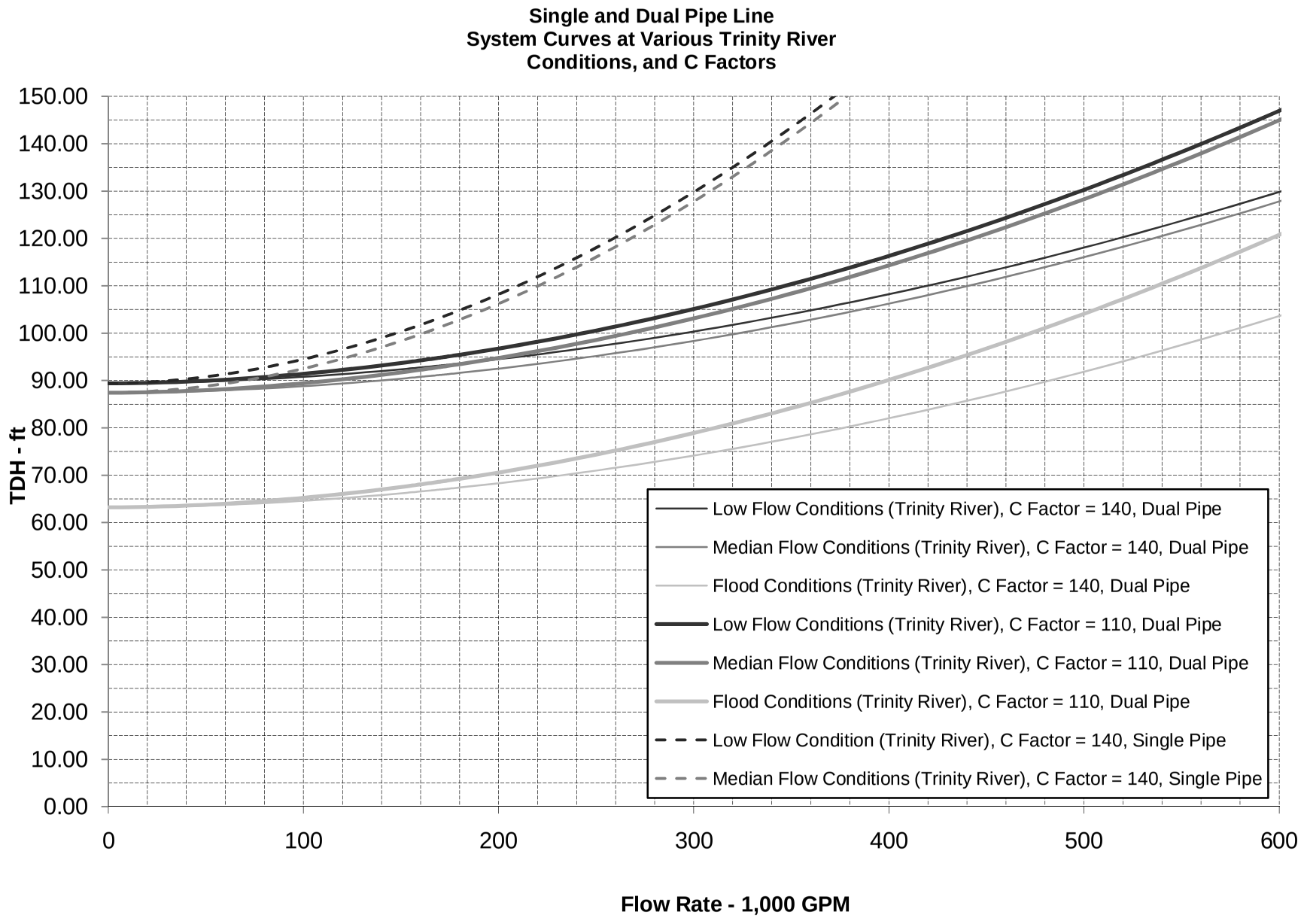
In addition, the pump shall be selected to accommodate the following Future Condition:

1) ≥ 49,600 gpm (71.4 MGD) at 114' TDH
   (7 duty pumps producing 500 MGD. Pumps must be capable of meeting Future Condition with only an impeller change)

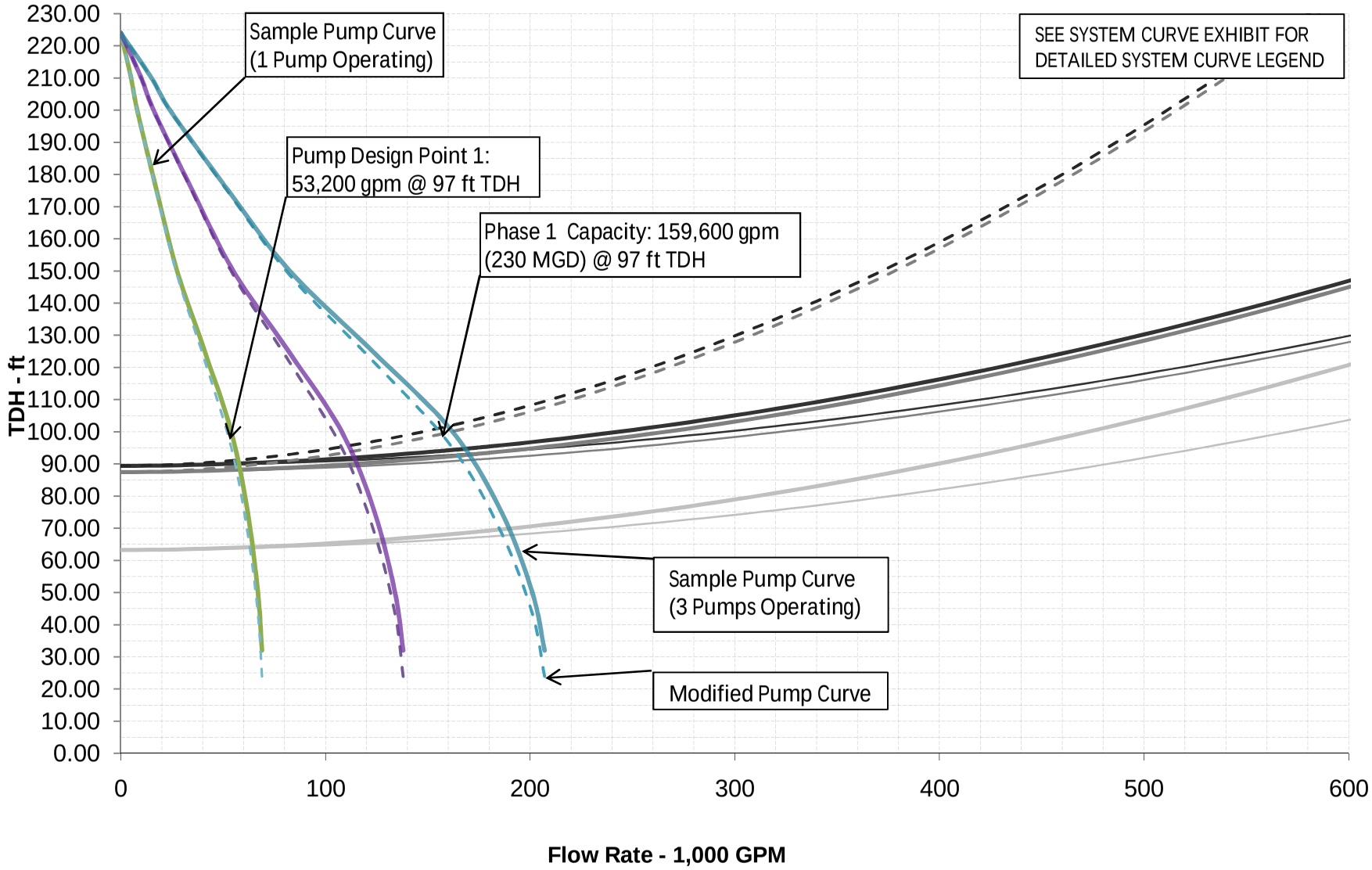
Pumps will be selected based on their best efficiency points at flow rates between 49,000 - 57,000 gpm, which will result in highly efficient pumps during projected average day flows throughout the first two phases of operation. This pump strategy will also accommodate owner requested operational constraints and will allow an easy expansion to ultimate flows, if necessary.

I SYSTEM CURVES

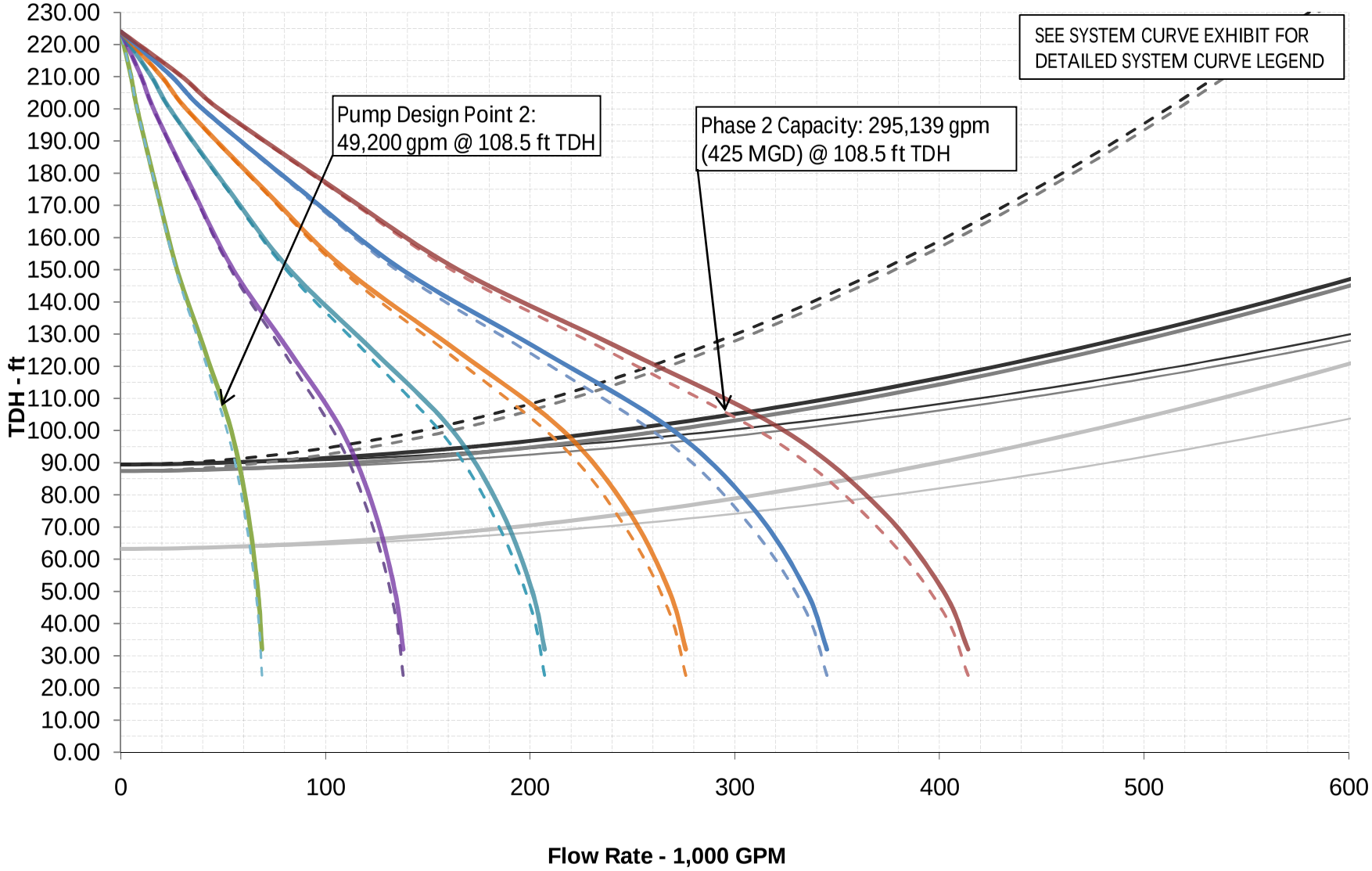
The following system curves were generated using the equations, parameters, and assumptions listed above. System curves are preserved for multiple C-factors, Trinity River conditions, and the number of pipelines in operation.


Single and Dual Pipe Line
System Curves at Various Trinity River
Conditions, and C Factors
150.00
140.00
130.00
120.00
110.00
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
TDH - ft
0
100
200
300
400
500
600
Flow Rate - 1,000 GPM
Low Flow Conditions (Trinity River), C Factor = 140, Dual Pipe
Median Flow Conditions (Trinity River), C Factor = 140, Dual Pipe
Flood Conditions (Trinity River), C Factor = 140, Dual Pipe
Low Flow Conditions (Trinity River), C Factor = 110, Dual Pipe
Median Flow Conditions (Trinity River), C Factor = 110, Dual Pipe
Flood Conditions (Trinity River), C Factor = 110, Dual Pipe
Low Flow Condition (Trinity River), C Factor = 140, Single Pipe
Median Flow Conditions (Trinity River), C Factor = 140, Single Pipe

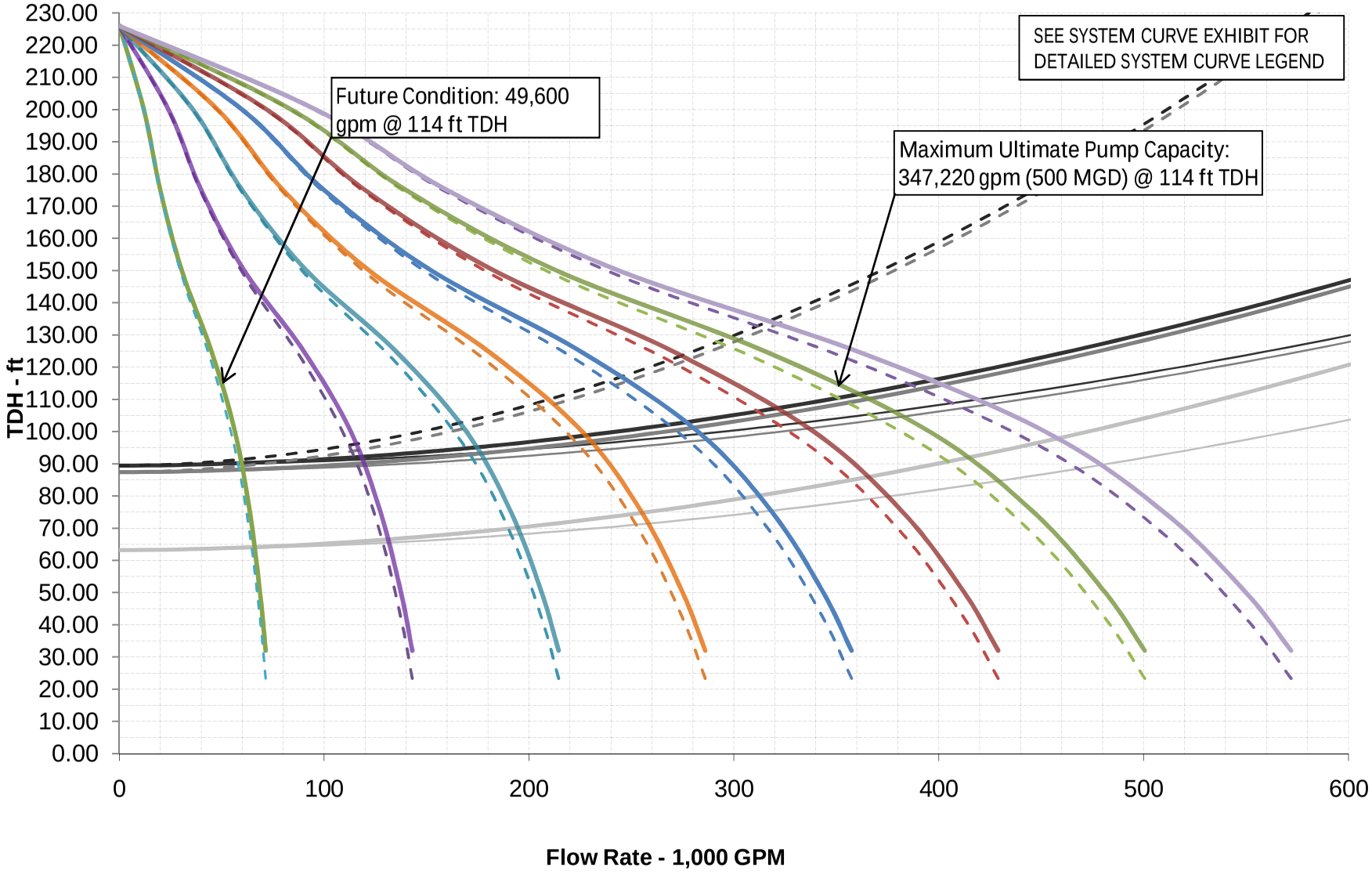
Phase 1 Pump Design Points and Sample Pump Curves with System Curves at Various Trinity River Conditions, and C Factors



Phase 2 Pump Design Points and Sample Pump Curves with System Curves at Various Trinity River Conditions, and C Factors



Ultimate Pump Design Points and Sample Pump Curves with System Curves at Various Trinity River Conditions, and C Factors



APPENDIX A- CALCULATIONS

II PUMPING COST CALCULATIONS

A PURPOSE

Lifetime pumping costs were evaluated for several different pump configurations. This exercise was conducted to evaluate how increasing or decreasing the number of pumps in the pump strategy effects operational costs. Included below is a description of the equations used, the assumptions made, a sample calculation, and a summary table that lists the results of the exercise. Lifetime pumping costs were estimated according to hypothetical water demands projected from the total project capacity.

B EQUATIONS

$$\text{Cost of Pumping} = \left(\frac{\text{Q} \times \text{H} \times \text{SG}}{3960 \times \text{Pump Eff.}}\right) \times \left(\frac{0.7457\ \text{KW/BHP}}{\text{Motor Eff.}}\right) \times \text{Pumping Time} \times \$/\text{KW/Hr}$$

Q : Discharge in cfs
H : Head loss in ft
SG : Specific gravity of water
BHP : Brake Horse Power

C SAMPLE CALCULATIONS

Example 1: 3 Pumps Provided, Each with a 76.7 MGD Capacity.

a Working Hours:
Assumed Demand = 120 MGD
Considering 15% losses through the canal, the net demand is 141 MGD.
For this example, assume 3 pumps are installed, each with a capacity of of 76.7 MGD
To meet the demand, 2 of 3 pumps would be operated; providing a total flow rate of 153.4 MGD.
Actual hours of operation of the pump are as follows:

$$WorkingHours = \frac{141MGD}{153.4MGD} \times 24hrs/day = 22.06hrs/day$$

b Velocity through the pipe:

$$V = \frac{Q(cfs)}{A(ft^2)}$$

$$V = \frac{153.4 \times 10^6}{86400 \times 7.481 \times \left(\frac{\pi}{4}\right)\left(\frac{108}{12}\right)^2} = 3.73 \text{ ft/s}$$

Split between two pipes, the velocity in each pipe becomes:

$$V = \frac{3.73}{2} = 1.87\, ft/s$$

c Head Loss:

Hazen-Williams Equation (modified Darcy-Weisbach)

$$H_L = 10.44 \times L \times \left(\frac{Q}{C}\right)^{1.85} \times \left(\frac{1}{D}\right)^{4.87} + \frac{\sum k}{2g} \times \left(\frac{0.4085 \times Q}{D^2}\right)^2$$

H_L – Head loss (feet)

Pump Column:

Q	Fluid flow (gpm)	= 53,240 gpm
L	Pipe length (feet)	= 45 ft
D	Pipe diameter (inches)	= 42 in
C	Hazen-Williams roughness coefficient,	C_{max} = 140 and C_{min} = 110
Σ	Minor loss factor	= 0.5

Discharge Pipe:

Q	Fluid flow (gpm)	= 53,240 gpm
L	Pipe length (feet)	= 65 ft
D	Pipe diameter (inches)	= 48 in
C	Hazen-Williams roughness coefficient,	C_{max} = 140 and C_{min} = 110
Σ	Minor loss factor	= 1.95

Header Pipe:

Q	Fluid flow (gpm)	= 53,240 gpm

L	Pipe length (feet)	= 35.25 ft
D	Pipe diameter (inches)	= 84 in
C	Hazen-Williams roughness coefficient,	C_{max} = 140 and C_{min} = 110
Σ	Minor loss factor	= 0.5

Force Main:

Q	Fluid flow (gpm)	= 106,480 gpm
L	Pipe length (feet)	= 16,051 ft
D	Pipe diameter (inches)	= 108 in
C	Hazen-Williams roughness coefficient,	C_{max} = 140 and C_{min} = 110
Σ	Minor loss factor	= 5.80

$$H_L = 10.44 \times L \times \left(\frac{Q}{C_{max} - \frac{(C_{max} - C_{min}) \times No.ofYears}{40}} \right)^{1.85} \times \left(\frac{1}{D} \right)^{4.87} + \frac{\sum k}{2g} \times \left(\frac{0.4085 \times Q}{D^2} \right)^2 + StaticHead$$

$$H_L = 10.44 \times 45 \times \left(\frac{53{,}240}{140 - \frac{(140-110)\times 10}{40}} \right)^{1.85} \times \left(\frac{1}{42} \right)^{4.87} + \frac{0.5}{2 \times 32.2} \times \left(\frac{0.4085 \times 53{,}240}{42^2} \right)^2 +$$

$$10.44 \times 65 \times \left(\frac{53{,}240}{140 - \frac{(140-110)\times 10}{40}} \right)^{1.85} \times \left(\frac{1}{48} \right)^{4.87} + \frac{1.95}{2 \times 32.2} \times \left(\frac{0.4085 \times 53{,}240}{48^2} \right)^2 +$$

$$10.44 \times 35.25 \times \left(\frac{53{,}240}{140 - \frac{(140-110)\times 10}{40}} \right)^{1.85} \times \left(\frac{1}{84} \right)^{4.87} + \frac{0.5}{2 \times 32.2} \times \left(\frac{0.4085 \times 53{,}240}{84^2} \right)^2 +$$

$$10.44 \times 16051 \times \left(\frac{106{,}480/2}{140 - \frac{(140-110)\times 10}{40}} \right)^{1.85} \times \left(\frac{1}{108} \right)^{4.87} + \frac{5.8}{2 \times 32.2} \times \left(\frac{0.4085 \times 106{,}480/2}{108^2} \right)^2$$

$$+ 87.42$$

$H_L = 93.74$ ft

d Brake Horse Power:

$$Bhp = \frac{Q(gpm) \times H_l(ft) \times Specific\ Gravity}{3960 \times Pump\ Efficiency}$$

$$Bhp = \frac{106{,}480 \times 93.74 \times 1.0}{3960 \times 0.86} = 2931$$

e Kilowatt input to motor:

$$\text{input to motor} = \frac{\text{pump bhp} \times 0.7457}{\text{motor efficiency}}$$

$$\text{input to motor} = \frac{2931 \times 0.7457}{0.90} = 2428.5KW$$

f Total KW-hr input to motor:

$$\text{Total KW - hr input to motor} = \text{KW input} \times \text{Hours of operation}$$

= 2428.5 x 22.06

= 53,572 KW-hr

g Cost of pumping per month:

Rate per KW-hr = $ 0.13

Considering a 3% annual inflation rate, the cost for the year 2020 = $0.13(1+0.03)^{10}$ = $0.175

Cost of pumping per month = Inflated rate per KW x Total KW input to motor x Number of days

= 0.175 x 53,572 x 30 = $281,253

Example 2: 2 Pumps Provided, Each with a 115 MGD Capacity

a Working Hours:

Assumed Demand = 120 MGD

Considering 15% losses through the pipe network, the net demand is 141 MGD.

Assume 2 pumps working a 115 MGD

To meet the demand, both pumps would be running.

Actual hours of operation of the pump are as follows:

$$WorkingHours = \frac{141}{230} \times 24hrs/day = 14.71hrs$$

b Velocity through the pipe:

$$V = \frac{Q(cfs)}{A(ft^2)}$$

$$V = \frac{230 \times 10^6}{86400 \times 7.481 \times \left(\frac{\pi}{4}\right)\left(\frac{108}{12}\right)^2} = 5.6 \text{ ft/s}$$

Split between the two pipes, the velocity in each pipe becomes:

$$V = \frac{5.6}{2} = 2.8\, ft/s$$

c Head Loss:

Hazen-Williams Equation (modified Darcy-Weisbach)

$$H_L = 10.44 \times L \times \left(\frac{Q}{C}\right)^{1.85} \times \left(\frac{1}{D}\right)^{4.87} + \frac{\sum k}{2g} \times \left(\frac{0.4085 \times Q}{D^2}\right)^2$$

H_L – Head loss (feet)

Column:

Q	Fluid flow (gpm)	= 79,900 gpm
L	Pipe length (feet)	= 45 ft
D	Pipe diameter (inches)	= 42 in
C	Hazen-Williams roughness coefficient,	C_{max} = 140 and C_{min} = 110
Σ	Minor loss factor	= 0.5 ft

Discharge Pipe:

Q	Fluid flow (gpm)	= 79,900 gpm
L	Pipe length (feet)	= 65 ft
D	Pipe diameter (inches)	= 48 in
C	Hazen-Williams roughness coefficient,	C_{max} = 140 and C_{min} = 110
Σ	Minor loss factor	= 1.95 ft

Header Pipe:

Q	Fluid flow (gpm)	= 159,800 gpm
L	Pipe length (feet)	= 35.25 ft
D	Pipe diameter (inches)	= 84 in
C	Hazen-Williams roughness coefficient,	C_{max} = 140 and C_{min} = 110
Σ	Minor loss factor	= 0.5 ft

Force Main:

Q	Fluid flow (gpm)	= 79,900 gpm
L	Pipe length (feet)	= 16051 ft
D	Pipe diameter (inches)	= 108 in
C	Hazen-Williams roughness coefficient,	C_{max} = 140 and C_{min} = 110
Σ	Minor loss factor	= 5.8 ft

$$H_L = 10.44 \times L \times \left(\frac{Q}{C_{max} - \frac{(C_{maz} - C_{min}) \times No.ofYears}{40}} \right)^{1.85} \times \left(\frac{1}{D} \right)^{4.87} + \frac{\sum k}{2g} \times \left(\frac{0.4085 \times Q}{D^2} \right)^2$$

$$H_L = 10.44 \times 45 \times \left(\frac{79{,}900}{140 - \frac{(140-110) \times 10}{40}} \right)^{1.85} \times \left(\frac{1}{42} \right)^{4.87} + \frac{0.5}{2 \times 32.2} \times \left(\frac{0.4085 \times 79{,}900}{42^2} \right)^2 +$$

$$10.44 \times 65 \times \left(\frac{79{,}900}{140 - \frac{(140-110) \times 10}{40}} \right)^{1.85} \times \left(\frac{1}{48} \right)^{4.87} + \frac{1.95}{2 \times 32.2} \times \left(\frac{0.4085 \times 79{,}900}{48^2} \right)^2 +$$

$$10.44 \times 35.25 \times \left(\frac{159{,}800}{140 - \frac{(140-110) \times 10}{40}} \right)^{1.85} \times \left(\frac{1}{84} \right)^{4.87} + \frac{0.5}{2 \times 32.2} \times \left(\frac{0.4085 \times 159{,}800}{84^2} \right)^2 +$$

$$10.44 \times 16051 \times \left(\frac{79{,}900}{140 - \frac{(140-110) \times 10}{40}} \right)^{1.85} \times \left(\frac{1}{108} \right)^{4.87} + \frac{5.8}{2 \times 32.2} \times \left(\frac{0.4085 \times 79{,}900}{108^2} \right)^2 +$$

87.42

H_L = 101.94 ft

d Brake Horse Power:

$$Bhp = \frac{Q(gpm) \times H_l(ft) \times SpecificGravity}{3960 \times efficiency}$$

$$Bhp = \frac{159{,}800 \times 101.94 \times 1.0}{3960 \times 0.86} = 4{,}783$$

e Kilowatt input to motor:

$$\text{input to motor} = \frac{\text{pump bhp} \times 0.7457}{\text{motor efficiency}}$$

$$\text{input to motor} = \frac{4783 \times 0.7457}{0.9} = 3963KW$$

f Total KW-hr input to motor:

Total KW - hr input to motor = KW input × Hours of operation

= 3963 x 14.71

= 58,295 KW-hr

g Cost of pumping per month:

Rate per KW-hr = $ 0.13

Considering a 3% annual inflation rate, the cost for the year 2020 = $0.13(1+0.03)^{10}$ = $0.175

Cost of pumping per month = Inflated rate per KW x Total KW input to motor x Number of days

= 0.175 x 58,295 x 30 = $306,048

h Cost difference for the two scenarios:

2 Pumps at 115 MGD costs: $306,048 / month

3 Pumps at 76.7 MGD costs: $281,253 / month

Difference in the cost: $24,795 / month

D SUMMARY TABLE

The following is a summary table of the values generated using a spreadsheet that incorporated the equations and assumptions presented in the example above, and approximated monthly demand projections for the 2020 to 2040 period. This analysis shows the impact on operating costs when modifying pump size and number of pumps utilized.

Table A-II-1: Cost for different pump scenarios

Number of Pumps (Firm)	Individual Pump Capacity (MGD)	Total Pump Capacity (MGD)	20 Yr Operating Cost (2020-2040)	
			82 % Efficient Pump	86% Efficient Pump
6	38.3	230	$96,200,000	$91,700,000
5	46.0	230	$96,600,000	$92,100,000
4	57.5	230	$97,400,000	$92,900,000
3	76.7	230	$101,000,000	$96,000,000
2	115.0	230	$106,800,000	$102,000,000

III PUMP BAY CALCULATIONS

A PURPOSE

The purpose of this section is to determine the dimensions of the pump bay and flow guide vanes. The Hydraulic Institute provides guidance for sizing pump bay dimensions. Various pump bay dimensions and the pump submergence are calculated with respect to the selected pump bell diameter.

B CALCULATIONS

If the pump has not been selected, as per the Hydraulic Institute, it is recommended that the inlet bell diameter is chosen based on achieving the bell inlet velocity that provides acceptable inflow conditions to the pump. As per the Hydraulic Institute, the bell inlet velocity should be in the range of 4.0 ft/s to 7.0 ft/s with a recommended velocity of 5.5 ft/s in average flow conditions.

a Design Pump Bell Diameter:

The design pump bell diameter can be determined based on recommended inlet velocities as specified by the Hydraulic Institute.

Maximum anticipated flow rate	: 69,500 gpm	: 154.8 cfs
Average anticipated flow rate	: 53,200 gpm	: 118.6 cfs
Minimum anticipated flow rate	: 49,190 gpm	: 109.6 cfs

Based on the analysis of the range of flow rates above, a design pump bell diameter of 5.5 ft was selected, which resulted in the following set of velocities.

At Q = 154.8 cfs, V = 6.5 ft/s
At Q = 118.6 cfs, V = 5.0 ft/s
At Q = 109.6cfs, V = 4.6 ft/s

The calculated velocities are in general conformance with range specified in the Hydraulic Institute Standards.

b Pump Bell Submergence:

Another important aspect of the pump bay design is the submergence of the pump bell to reduce the probability of strong free-surface air core vortices occurring.

The Hydraulic Institute provides two equations to determine submergence. For calculation, a velocity of 5.00 ft/s at the pump bell inlet has been considered. For this project, the worst case condition related to submergence results during low flow conditions in the Trinity River. During low flow conditions, the inlet velocities at the pumps will not exceed 5.00 ft/s.

i Equation 1:

$$S = D(1 + 2.3F_D)$$

F_D : Froude number (dimensionless)

D : Outside diameter of bell or pipe inlet

S : Minimum Submergence

$$F_D = \frac{V}{\sqrt{gD}}$$

$$F_D = \frac{5.00}{\sqrt{32.2 \times 5.5}} = 0.376$$

$$\therefore S = 5.5(1 + 2.3 \times 0.376) = 10.26 \text{ ft}$$

OR

ii Equation 2:

$$S = D + \frac{0.574 \times Q}{D^{1.5}}$$

Note: S is in inches, g = 32.2 ft/sec^2, Q in gpm and D in inches.

$$Q = V \times A$$

$$Q = 5.00 \times \frac{\pi \times 5.5^2}{4} = 118.79 \text{ cfs} = 53{,}322 \text{ gpm}$$

$$\therefore S = 66 + \frac{0.574 \times 53{,}322}{66^{1.5}} = 123.08 \text{ in} = 10.26 \text{ ft.}$$

Approximately 12 ft of submergence will be provided to ensure that submergence related problems do not arise.

c Pump Bay Dimensions:

Pump bay dimensions were determined according to Hydraulic Institute recommendations, which are primarily dictated by proportions of the pump bell diameter. Additional dimensions are recommended by Jones in *Pump Station Design* (Copyright 2008). Table A-IV-1 summarizes the recommended dimensions. Figures A-1 and A-2 provide illustrations depicting the various dimensions.

Table A-IV-1 – Summary of Recommended Dimensions

Dimension Variable	Description	Recommended Valve	Dimension (ft)
A	Distance from the pump inlet bell centerline to the intake structure entrance	A = 5D minimum, assuming no significant cross-flow at the entrance to the intake structure	27.5
B	Distance from the back wall to the pump inlet	B = 0.75D	4.12
C	Distance between the inlet bell and floor	C = 0.3D to 0.5D	1.65-2.75
D	Inlet bell design outside diameter		5.5
H	Minimum liquid depth	H = S + C	13.15

h	Minimum height of constricted bay section near the pump inlet bell submergence	h = (greater of H or 2.5D)	13.75
S	Minimum pump inlet bell submergence	$S = D(1.0 + 2.3F_D)$	10.26
W	Pump inlet bay entrance width	W = 2D minimum	11
w	Constricted bay width near the pump inlet bell	w = 2D	11
X	Pump inlet bay length	X = 5D minimum, assuming no significant cross-flow at the entrance to the intake structure	27.5
Y	Distance from pump inlet bell centerline to the through-flow traveling screen	Y = 4D minimum. Dual flow screens require a model study	22
Z_1	Distance from pump inlet bell to diverging walls	Z_1 = 5D minimum, assuming no significant cross-flow at the entrance to the intake structure.	27.5
Z_2	Distance from inlet bell centerline to sloping floor	Z_2 = 5D minimum	27.5
α	Angle of floor slope	α = -10 to +10 degrees	10°
β	Angle of wall convergence	β = 0 to +10 degrees	N/A
Φ	Angle of convergence from constricted area to bay walls	Φ = 10 degrees maximum	N/A

Reference: ANSI/HI 9.8-1998 American National Standard for Pump Intake Design

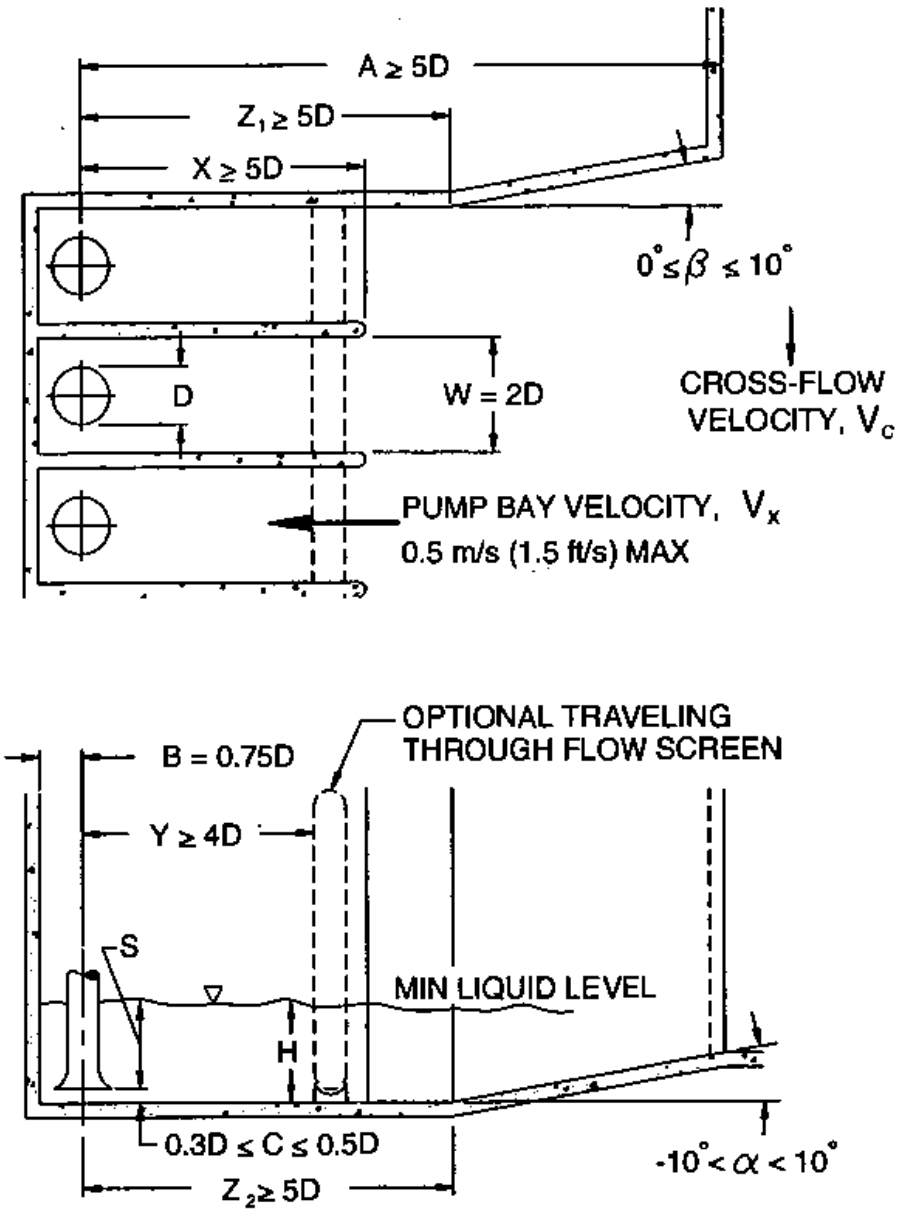


Figure A-1 - Recommended intake structure layout

Reference: ANSI/HI 9.8-1998 American National Standard for Pump Intake Design

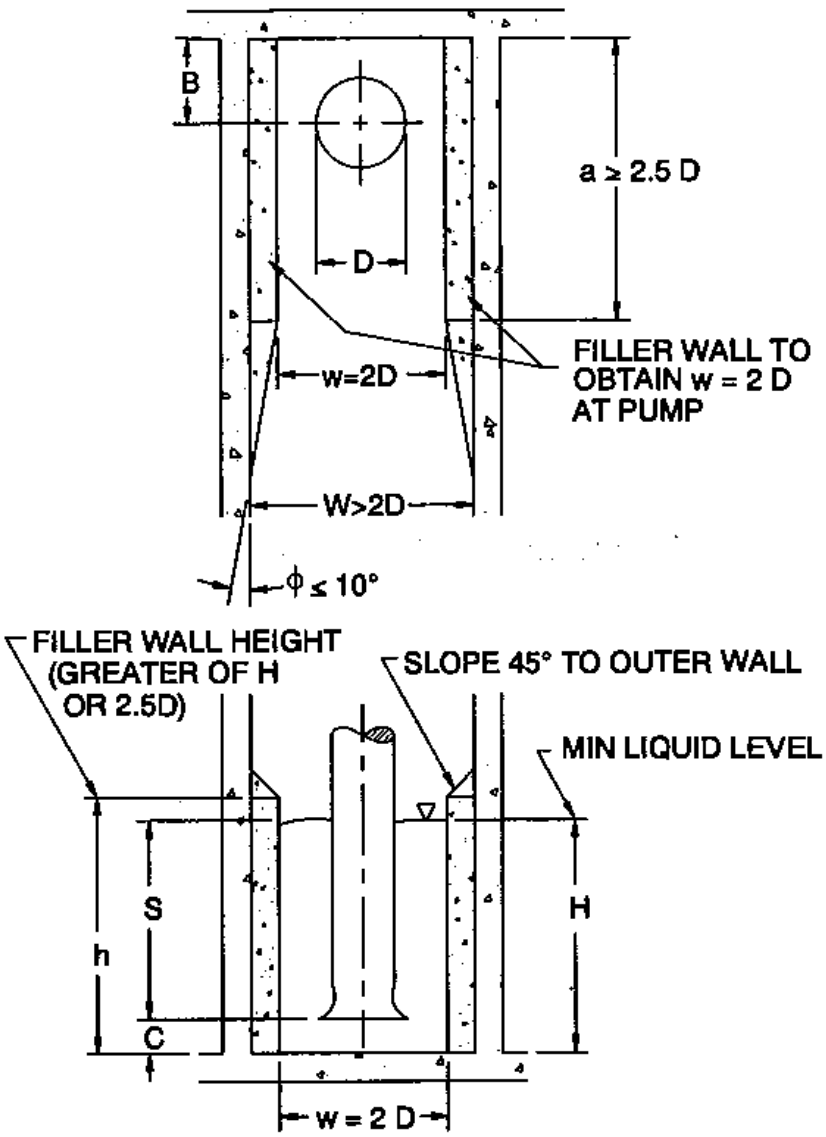


Figure A-2 - Filler wall details for proper bay width

Reference: ANSI/HI 9.8-1998 American National Standard for Pump Intake Design

IV TRASH RACK CALCULATIONS

A INTRODUCTION

The trash rack width will be based on several factors, including predetermined pump station dimensions, approach velocities, environmental concerns (threats to fish and wildlife), bar screen velocities, and headloss. Texas does not have established design requirements for raw water intakes. An approach velocity of 0.5 ft/s or less is commonly recommended to ensure that fish and wildlife do not get impinged on the screen. Approach velocities are defined as the velocity leading up to, but not necessarily through the trash rack. AECOM will design the trash rack to achieve approach velocities of approximately 0.5 ft/s during typical operating conditions and less than 1.5 ft/s during extreme operating conditions. Screen velocities and headloss will be determined to confirm that excessive conditions do not result from the design. Headloss calculations assume a 60% blockage of the screens, a conservative estimate which would only occur in the event of a trash rack cleaning mechanism failure.

B CALCULATIONS

a Flow rate through the trash rack:

i Design Flow = Average day flow = 230 MGD

ii Extreme Flow = Maximum instantaneous withdrawal rate = 500 MGD

$$\text{Design Flow} = 230\ \text{MGD} \times 1.5472\ \frac{\text{cfs}}{\text{mgd}} = 355.85\ \text{cfs}$$

$$\text{Extreme Flow} = 500\ \text{MGD} \times 1.5472\ \frac{\text{cfs}}{\text{mgd}} = 773.60\ \text{cfs}$$

b Calculation of bar screen efficiency co-efficient, K:

Net wet area through bars = (wet area of channel) x (efficiency coefficient of bars, K)

$$\text{Efficiency (K)} = \frac{A}{W + A}$$

$$\text{Where A = minimum screen opening} = 2''$$

$$\text{W = maximum bars width facing flow} = \left(1/2\right)''$$

$$K = \frac{2''}{1/2'' + 2''} = 0.8$$

c Calculation of water depth:

Average day (median) flow water surface elevation	: 19.80 ft
Low flow (1500 cfs) water surface elevation	: 17.80 ft
Intake channel (bottom) elevation	: 12.00 ft
Effective intake channel width	: 112.5 ft

Water depth during average flow = 19.80 – 12.00 = 7.80 ft

Water depth during low flow = 17.80 – 12.00 = 5.80 ft

d Design flow condition:

i Approach Velocity:

$$\text{Approach Velocity} = \frac{\text{flowrate (cfs)}}{\text{Length of weir (ft)} \times \text{Depth of water (ft)}}$$

$$\text{Approach Velocity} = \frac{355.85 \text{ cfs}}{112.5 \text{ ft} \times 7.80 \text{ ft}} = 0.4 \text{ ft/s}$$

ii Screen Velocity:

$$\text{Screen Velocity} = \frac{\text{flowrate (cfs)}}{\text{Channel width (ft)} \times \text{Depth of water (ft)} \times K \times (1 - \textit{Blockage})}$$

Average day flow	: 355.85 cfs
Effective intake channel width	: 112.50 ft
Depth of Water (Avg. Condition)	: 7.80 ft
Blockage	: 60 %
Efficiency (K)	: 80 %

$$\text{Screen Velocity} = \frac{355.85\,\text{cfs}}{112.5\,\text{ft} \times 7.8\,\text{ft} \times 0.8 \times (1 - 0.6)}$$

Screen Velocity = 1.27 ft/s

iii Head loss through the screen:

$$h_{headloss} = \frac{V^2 - v^2}{2g} \times \frac{1}{0.7}$$

V = Velocity Through Bars

v = Approach Velocity

0.7 = Screen Coefficient

$$h_{headloss} = \frac{1.27^2 - 0.4^2}{2 \times 32.2} \times \frac{1}{0.7} = 0.032\ \text{ft}$$

e Extreme flow condition:

i Approach Velocity:

$$\text{Approach Velocity} = \frac{\text{flowrate (cfs)}}{\text{Length of weir (ft)} \times \text{Depth of water (ft)}}$$

$$\text{Approach Velocity} = \frac{773.60\ \text{cfs}}{112.5\,\text{ft} \times 5.80\,\text{ft}} = 1.18\ \text{ft/s}$$

ii Screen Velocity:

$$\text{Screen Velocity} = \frac{\text{flowrate (cfs)}}{\text{Channel width (ft)} \times \text{Depth of water (ft)} \times \text{K} \times (1 - \textit{Blockage})}$$

Maximum flow rate	: 773.60 cfs
Effective intake channel width	: 112.5 ft
Depth of Water (1500 cfs)	: 5.80 ft
Blockage	: 60 %
Efficiency (K)	: 80 %

$$\text{Screen Velocity} = \frac{773.60 \text{ cfs}}{112.5 \text{ ft} \times 5.8 \text{ ft} \times 0.8 \times (1 - 0.6)}$$

Screen Velocity = 3.7 ft/s

iii Head loss through the screen:

$$h_{headloss} = \frac{V^2 - v^2}{2g} \times \frac{1}{0.7}$$

V = Velocity Through Bars

v = Approach Velocity

$$0.7 = \text{Screen Coefficient } h_{headloss} = \frac{3.7^2 - 1.18^2}{2 \times 32.2} \times \frac{1}{0.7} = 0.273 \text{ ft}$$

V SOLIDS SETTLING CALCULATIONS

A PURPOSE

The purpose of this section is to evaluate the ability of the pre-pump sediment settling zone to remove sediment from the raw river water. Sediment settling depends on the size and density of the particle, the type of fluid, and the velocity of the flow in the basin. Different sized particles have different settling time, hence, in this exercise we determine the distance required for different sized particles to settle.

B EQUATIONS

a Newton's Law:

Newton's Law yields the terminal particle velocity by equating the gravitational force of the particle to the frictional resistance or drag. The settling force is given as follows:

$$V_t = \sqrt{\frac{4g}{3C_d}\left(\frac{\rho_p - \rho_w}{\rho_w}\right)d_p}$$

V_t : Particle settling velocity

ρ_p : Density of particle

ρ_w : Density of water

g : Acceleration due to gravity

C_d : Drag coefficient

d_p : Particle diameter

The coefficient C_d takes on different values depending on whether the flow regime surrounding the particle is laminar or turbulent. There are three distinct regions depending on Reynolds number: laminar (Re' <0.2), transitional (Re' = 0.2 to 2000), and turbulent (Re' > 2000).

b Reynolds Number:

Reynolds number (Re') is the ratio of inertial forces to viscous forces and is given by the formula below.

$$Re' = \frac{xU\rho}{\mu}$$

Re' : Reynolds number

x : Particle diameter

U : Velocity

ρ : Density of the fluid

μ : Viscosity of water

c Drag Coefficient:

The *drag coefficient* (C_d), for particles that are approximately spherical, is approximated by the following equation:

$$C_d = \frac{24}{Re'} + \frac{3}{\sqrt{Re'}} + 0.34$$

C_d : Drag coefficient

Re' : Reynolds number

d Stokes Law:

Stokes Law is a simplification of Newton's Law for settling in the laminar region (the first term of the drag coefficient predominates and the other terms can be left out). For small particles with a Reynolds Number less than 0.2, the settling velocity (or terminal velocity) is given by the following equation:

$$V_t = \frac{gd^2 \left(\rho_p - \rho_m\right)}{18\,\mu}$$

V_t : Particle settling velocity

g : Acceleration due to gravity

d : Diameter of the particle

ρ_p : Density of the particle

ρ_m : Density of water

μ : Viscosity of water

e Settling in the Transition Region

For particles with a Reynolds Number greater than 0.2 and less than 2000, known as the transition region, the complete form of the drag equation must be used to determine the settling velocity. Because of the nature of the drag equation, finding the settling velocity is an iterative process. An approximate settling velocity is chosen and based on that velocity a Reynolds Number, drag coefficient, and new settling velocity is calculated in sequential steps. This new settling velocity is then used in the same process until the resultant settling velocity is equal to the input settling velocity.

C ASSUMPTIONS

Flow : 69,500 gpm	: 154.83 cfs
Width of the Channel	: 12.75 ft
Depth of the Channel	: 1 ft (Depth of channel is not consequential. Determined using a unit depth of 1 ft)
Number of Pump per channel	: 1 No.
Acceleration due to gravity	: 9.81 m/s^2
Particle Diameter	: 0.000375 m (Medium Sand), See Table A-V
Particle Density	: 2650 kg/m^3
Density of Water	: 1000 kg/m^3
Viscosity of Water	: 0.00105 Pa-s at average water temp. of 68°F

D SAMPLE CALCULATIONS

a Channel Velocity:

$$V = \frac{Q}{A \times No.ofChannel}$$

$$V = \frac{154.83\,\text{cfs}}{12.75\,ft \times 1\,ft \times 1} = 11.91\ \text{ft/s}$$

b Stokes Settling Velocity:

$$V_t = \frac{gd^2\left(\rho_p - \rho_m\right)}{18\,\mu}$$

$$V_t = \frac{9.81\,\text{m/s}^2 \times 0.000375^2\left(2650\,\text{kg/m}^3 - 1000\,\text{kg/m}^3\right)}{18 \times 0.00105\,\text{Pa - s}}$$

$V_t = 0.1204$ m/s = 0.3950 ft/s

c Stokes Reynolds Number:

$$Re' = \frac{xU\rho}{\mu}$$

$$Re' = \frac{0.000375\,\text{m} \times 0.1204\,\text{m/s} \times 1000\,\text{kg/m}^3}{0.00105} = 43.01$$

d Newton's Law Calculation for Settling in the Transition Zone:

Since the Reynolds Number is greater that 0.2, the full drag equation must be used to calculate the settling velocity. After iteration, the resulting Reynolds Number, drag coefficient, and settling velocity is calculated:

$$\text{Re}' = \frac{xU\rho}{\mu} = \frac{0.000375m \times 0.062m/s \times 1000kg/m^3}{0.00105} = 22.14$$

$$C_d = \frac{24}{\text{Re}'} + \frac{3}{\sqrt{\text{Re}'}} + 0.34 = \frac{24}{22.14} + \frac{3}{\sqrt{22.14}} + 0.34 = 2.061$$

$$V_t = \sqrt{\frac{4g}{3C_d}\left(\frac{\rho_p - \rho_w}{\rho_w}\right)d_p} = \sqrt{\frac{4 \times 9.81}{3 \times 2.061}\left(\frac{2650 - 1000}{1000}\right)} \times 0.000375 = 0.0062m/s$$

V_t = 0.203 ft/s

e Settling Distance Required:

$$= \frac{\text{Water Depth} \times \text{Channel Velocity}}{SettlingVelocity}$$

$$= \frac{1\text{ft} \times 11.91\text{ ft}}{0.203\,ft/s} = 58.60 \text{ ft}$$

Table A-V-1: Settling Distance for Different Particles at Various Flow Rates

Particle Size	**Description**	**Channel Flow Rate (GPM X 1000)/ Settling Distance (ft)**				
		30	**40**	**50**	**60**	**70**
		Settling Distance (feet)				
33.2 microns	Silt	1693	2257	2821	3385	3949
93.75 microns	Very Fine Sand	235	313	392	470	548
187.5 microns	Fine Sand	69	93	116	139	162
375 microns	Medium Sand	26	34	43	52	60
750 microns	Coarse Sand	12	16	20	24	28

E SEDIMENT VOLUME REMOVED

The sediment removal will be done in both the pre-pump intake settling chamber and the post-pipeline sedimentation basin.

For this sample calculation, we assume the flow of a 2-year flow in the Trinity River at 48,600 cfs, a pumping rate or 230 mgd and a 50 ft settling chamber. The sediment transport model developed by Baird predicts a concentration of approximately 700 mg/l in the Trinity River at the intake location.

For Medium Sand:

a Concentration:

From the Baird data (see Appendix C-1 Figure 6), the approximate percentage of Medium Sand is 7%.

$$\text{Concentration of Medium Sand} = 700\ \text{mg/lit} \times 0.07 = 49\ \text{mg/lit}$$

b Mass of medium sand in pump station flow:

Pumping Rate = 230 mgd = 870.64 mld

$$\text{Mass of medium sand} = \frac{49\ \text{mg/lit} \times 870.64 \times 10^6\ lit/day}{10^6\ mg/kg} = 42{,}661.36\ \text{kg}$$

c Mass Removed:

$$\text{Percentage removed} = \frac{\text{Settling distance provided}}{\text{Settling distance required}} = \frac{50\ \text{ft}}{59\ \text{ft}} = 84.7\%$$

$$\text{Mass removed} = 42{,}661.36\ \text{kg} \times \frac{84.7}{100} = 36{,}134.17\ \text{kg}$$

d Volume of Solids:

Bulk Density = 1470 kg/m^3

$$\text{Volume of Solids} = \frac{36{,}134.17\ \text{kg}}{1470\ \text{kg/m}^3} = 24.58\ \text{m}^3\ \text{per day}$$

F AVERAGE YEARLY SEDIMENT EXTRACTION PRE-PUMP

The table below expands on the calculation methodology described above to analyze 80 years of historic flow data to determine an average annual sediment extraction estimate based on a pumping rate of 230 MGD and 425 MGD.

Table A-V-2: Average Yearly Sediment Extraction Pre-Pump

Pumping Rate (MGD)	Volume of Pre-Pump Sediment Extraction (Ac-Ft)	Volume of Sed-Basin Sediment Extraction (Ac-Ft)	Total Sediment Volume (Ac-Ft)
230	2.75	1.47	4.4
425	5.16	2.76	8.24

VI HYDRAULIC PROFILE CALCULATIONS

A PURPOSE

Water passes through the trash rack, isolation gates, and sedimentation area when entering from the river into the pump. The obstructions to the flow cause head loss that should be taken into account when determining appropriate pump elevations and amount of submergence.

B CALCULATIONS

a Minimum water surface elevation discussion:

Minimum future Trinity River water surface elevations are greatly dependent on the pumping rates of the Capers Ridge and existing Trinity River Pump Station. A large percentage of the total flow in the Trinity River is comprised of flow that will be diverted from the pump stations during periods of high pumping rates and otherwise low natural conditions. As discussed in more detail in Chapter 2, the Trinity River Authority will release water from Lake Livingston to ensure that water rights are met; therefore, during periods of extremely low flow, additional water will be released into the Trinity River. Based on modeling performed by AECOM, the future minimum water surface elevation is expected to be 16.9 feet during periods of low pumping operations and low natural flow; however, during periods of high pumping operations and low natural flow, the minimum water surface elevation is expected to be 17.8 feet. In this PER, different minimum water surface elevations are assumed and presented (either 16.9 or 17.8 feet) according to the situation being evaluated. Head loss calculations assume a 60% blockage of the screens, a conservative estimate which would only occur in the event of a trash rack cleaning mechanism failure.

b **Case 1: 2 Pumps operating at 69,500 gpm**

i. Head loss through the trash rack:

(a) Approach Velocity:

Maximum flow rate	: 154.83 X 2 = 309.66 cfs
Intake channel width	: 112.5 ft
Depth of Water (1000 cfs)	: 4.90 ft

$$\text{Approach Velocity} = \frac{\text{flowrate (cfs)} \times \text{No. of pumps}}{\text{Length of weir (ft)} \times \text{Depth of water (ft)}}$$

$$\text{Approach Velocity} = \frac{154.83 \text{ cfs} \times 2 \text{ nos.}}{112.5 \text{ ft} \times 4.9 \text{ ft}} = 0.56 \text{ ft/s}$$

(b) Screen Velocity:

Blockage	: 60 %
Efficiency (K)	: 80 %

$$\text{Screen Velocity} = \frac{\text{flowrate (cfs)} \times \text{No. of pumps}}{\text{Channel width (ft)} \times \text{Depth of water (ft)} \times K \times (1 - \text{Blockage})}$$

$$\text{Screen Velocity} = \frac{154.83 \text{ cfs} \times 2 \text{ nos.}}{112.5 \text{ ft} \times 4.9 \text{ ft} \times 0.8 \times (1 - 0.6)}$$

Screen Velocity = 1.76 ft/s

(c) Head loss through the screen:

$$h_{headloss} = \frac{V^2 - v^2}{2g} \times \frac{1}{0.7}$$

V = Velocity Through Bars

V = Approach Velocity

0.7 = Screen Coefficient

$$h_{headloss} = \frac{1.76^2 - 0.56^2}{2 \times 32.2} \times \frac{1}{0.7} = 0.062 \text{ ft}$$

ii. Head loss through Gate 1:

$$Q\ \text{cfs} = 3.3 \times L\ \text{ft} \times h_a^{3/2} \left[1 - \left(\frac{h_d}{h_a} \right)^{3/2} \right]^{0.385}$$

$$154.83\ \text{cfs} = 3.3 \times 11\ \text{ft} \times 16.9^{3/2} \left[1 - \left(\frac{h_d}{16.9} \right)^{3/2} \right]^{0.385}$$

$h_d = 16.892$ ft

$h_a - h_d = 0.008$ ft

iii. Head loss through Gate 2:

$$H\ \text{ft} = \left(\frac{Q\ \text{cfs}}{0.61 \times A\ \text{ft}^2} \right)^2 \times \frac{1}{2g}$$

$$H\ \text{ft} = \left(\frac{154\ \text{cfs}}{0.61 \times 11\ \text{ft} \times 13\ \text{ft}} \right)^2 \times \frac{1}{2 \times 32.2\ ft/s^2}$$

H = 0.0489 ft

Table A-VI-1: WSEs when 2 pumps operating at 69,500 gpm

WSE in the Trinity River	16.90 ft
WSE after the Trash Rack	16.9 – 0.062 = 16.838 ft
WSE after the Sluice Gate 1	16.838 – 0.008 = 16.830 ft
WSE after the Sluice Gate 2	16.830 - 0.0489 = 16.781 ft

c **Case 2: All the pumps operating at 49,600 gpm for design capacity of 500 MGD**

i. Head loss through the trash rack:

(a) Approach Velocity:

Maximum flow rate	: 773.56 cfs
Intake channel width	: 112.5 ft
Depth of Water (1500 cfs)	: 5.80 ft

$$\text{Approach Velocity} = \frac{\text{flowrate (cfs)} \times \text{No. of pumps}}{\text{Length of weir (ft)} \times \text{Depth of water (ft)}}$$

$$\text{Approach Velocity} = \frac{773.56\ \text{cfs}}{112.5\ \text{ft} \times 5.80\ \text{ft}} = 1.18\ \text{ft/s}$$

(b) Screen Velocity:

Blockage	: 60 %
Efficiency (K)	: 80 %

$$\text{Screen Velocity} = \frac{\text{flowrate (cfs)} \times \text{No. of pumps}}{\text{Channel width (ft)} \times \text{Depth of water (ft)} \times \text{K} \times \text{Blockage}}$$

$$\text{Screen Velocity} = \frac{773.56\ \text{cfs}}{112.5\ \text{ft} \times 5.8\ \text{ft} \times 0.8 \times (1 - 0.6)}$$

Screen Velocity = 3.70 ft/s

(c) Head loss through the screen:

$$h_{headloss} = \frac{V^2 - v^2}{2g} \times \frac{1}{0.7}$$

V = Velocity Through Bars

V = Approach Velocity

0.7 = Screen Coefficient

$$h_{headloss} = \frac{3.70^2 - 1.18^2}{2 \times 32.2} \times \frac{1}{0.7} = 0.273 \text{ ft}$$

i. Head loss through Gate 1:

$$Q \text{ cfs} = 3.3 \times L \text{ ft} \times h_a^{3/2} \left[1 - \left(\frac{h_d}{h_a} \right)^{3/2} \right]^{0.385}$$

$$110.52 \text{ cfs} = 3.3 \times 11 \text{ ft} \times 17.8^{3/2} \left[1 - \left(\frac{h_d}{17.8} \right)^{3/2} \right]^{0.385}$$

$h_d = 17.797$ ft

$h_a - h_d = 0.003$ ft

ii. Head loss through Gate 2:

$$H \text{ ft} = \left(\frac{Q \text{ cfs}}{0.61 \times A \text{ ft}^2} \right)^2 \times \frac{1}{2g}$$

$$H \text{ ft} = \left(\frac{110.52 \text{ cfs}}{0.61 \times 11 \text{ ft} \times 13 \text{ ft}} \right)^2 \times \frac{1}{2 \times 32.2}$$

$H = 0.025$ ft

Table A-VI-2: WSEs when all the pumps operating at 43,400 gpm

WSE in the Trinity River	17.80 ft
WSE after the Trash Rack	17.80 – 0.273 = 17.527 ft
WSE after the Sluice Gate 1	17.527 – 0.003 = 17.5246 ft
WSE after the Sluice Gate 2	17.7524 - 0.025 = 17.499 ft

VII SIMPLIFIED SURGE CALCULATIONS

A PURPOSE

The purpose of analyzing the potential for hydraulic transients in a pipeline system is important as they can cause unnecessary pressure during the pump station operation, such as (1) opening or closing of the valve, (2) change in the flow demand, (3) controlled pump shutdown, (4) pump failure, (5) air venting from pipelines, (6) failure of flow or pressure regulators and (7) pipe rupture. The equations utilized in this appendix are meant to provide an estimate of maximum theoretical pressure surges associated with hydraulic transients. Further hydraulic transient analysis is proposed for the final design phase for the purpose of obtaining a refined understanding of probable maximum pressures.

A figure is provided at the end of this appendix that shows a hydraulic profile, inverted hydraulic profile, and pipeline profile. The figure was developed as part of an exercise to determine possible locations along pipeline that may be subject to negative pressures and water column separation in the event that an extreme hydraulic transient is created by a sudden change in pipeline velocity. Locations along the pipeline that may have a higher likelihood of this occurring are identified as those areas at which the inverted hydraulic profile crosses the pipeline profile. It is recommended that these areas be further inspected through hydraulic transient modeling during the final design phase. Surge control equipment, such as air release and vacuum breaking valves may be required at these locations.

B ASSUMPTIONS

Number of pipes: 2 no.

Pipe Diameter: 108 in = 9 ft

Cross-section area of pipe: 64 ft^2

Pipe Material: PCCP or steel

Pipe length: 16,051 ft

Maximum static head: 89 ft

C value: 110

Bulk modulus of elasticity, K (lb/ft^2): 4.49E+07

Water Density, ρ (slugs/ft^3): 1.93

Table A-VII-1: Pipe Specifications

	PCCP	Steel
Pipe Size (ft)	9	9
Pipe Length (ft)	16051	16051
Pipe Wall Thickness, e (ft)	0.667	0.0416
Modulus of Elasticity, E (lb/sq.ft.)	1.25E+09	4.32E+09
Poisson's Ratio, μ	0.25	0.30
$C_1 = 1.25 - \mu$	1	0.95
$C_2 = 1 - \mu^2$	0.9375	0.91
$C_3 = 1$	1	1

C CALCULATIONS

a Sample Calculation 1: For the flow of 230 MGD

i Wave Speed:

$$a = \sqrt{\frac{K/\rho}{1 + C\left(\frac{K}{E}\right)\left(\frac{D}{e}\right)}}$$

For PCC Pipe:

C = 1 (pipe anchored at the upstream end only)

$$a = \sqrt{\frac{4.49\times10^7/1.93}{1+1\left(\frac{4.49\times10^7}{1.25\times10^9}\right)\left(\frac{9}{0.667}\right)}} = 3958\,ft/\sec$$

For Steel Pipe:

C = 1 (pipe anchored at the upstream end only)

$$a = \sqrt{\frac{4.49\times10^{7}/1.93}{1+1\left(\frac{4.49\times10^{7}}{4.32\times10^{9}}\right)\left(\frac{9}{0.0416}\right)}} = 2676\,ft/\sec$$

ii Critical Time:

$$t_c = \frac{2L}{a}$$

For PCC Pipe:

$$t_c = \frac{2\times16051}{3958} = 8\,\sec$$

For Steel Pipe:

$$t_c = \frac{2\times16051}{2676} = 12\,\sec$$

iii Head:

$$h = \frac{a\times V}{g}$$

$$V = \frac{\text{Flow through 1 pipe (cfs)}}{\text{Area of pipe (ft}^2)}$$

$$V = \frac{356/2}{63.61} = 2.8\,\text{ft/sec}$$

For PCC Pipe:

$$h = \frac{3958 \times 2.8}{32.2} = 344 \text{ ft}$$

For Steel Pipe:

$$h = \frac{2676 \times 2.80}{32.2} = 234 \text{ ft}$$

iv Total Head:

H = h + Static head

For PCC Pipe:

H = 344+ 89 = 434 ft

For Steel Pipe:

H = 232 + 89 = 322 ft

v Total Pressure:

For PCC Pipe:

$$P = \frac{434}{2.31} = 188 \text{ psi}$$

For Steel Pipe:

$$P = \frac{322}{2.31} = 140 \text{ psi}$$

b **Sample Calculation 2: For the flow of 500 MGD**

i Wave Speed:

$$a = \sqrt{\frac{K/\rho}{1 + C\left(\frac{K}{E}\right)\left(\frac{D}{e}\right)}}$$

For PCC Pipe:

C = 1 (pipe anchored at the upstream end only)

$$a = \sqrt{\frac{4.49 \times 10^7 / 1.93}{1 + 1\left(\frac{4.49 \times 10^7}{1.25 \times 10^9}\right)\left(\frac{9}{0.667}\right)}} = 3958\, ft/\sec$$

For Steel Pipe:

C = 1 (pipe anchored at the upstream end only)

$$a = \sqrt{\frac{4.49 \times 10^7 / 1.93}{1 + 1\left(\frac{4.49 \times 10^7}{4.32 \times 10^9}\right)\left(\frac{9}{0.0416}\right)}} = 2676\, ft/\sec$$

ii Critical Time:

$$t_c = \frac{2L}{a}$$

For PCC Pipe:

$$t_c = \frac{2 \times 16051}{3958} = 8\sec$$

For Steel Pipe:

$$t_c = \frac{2 \times 16051}{2676} = 12 \text{ sec}$$

iii Head:

$$h = \frac{a \times V}{g}$$

$$V = \frac{\text{Flow through 1 pipe (cfs)}}{\text{Area of pipe (ft}^2\text{)}}$$

$$V = \frac{774/2}{63.61} = 6 \text{ ft/sec}$$

For PCC Pipe:

$$h = \frac{3958 \times 6.08}{32.2} = 747 \text{ ft}$$

For Steel Pipe:

$$h = \frac{2676 \times 6.08}{32.2} = 505 \text{ ft}$$

iv Total Head:

H = h + Static head

For PCC Pipe:

H = 747+ 89 = 837 ft

For Steel Pipe:

H = 505 + 89= 594 ft

v Total Pressure:

For PCC Pipe:

$$P = \frac{837}{2.31} = 363 \text{ psi}$$

For Steel Pipe:

$$P = \frac{594}{2.31} = 258 \text{ psi}$$

D CONCLUSIONS

This exercise is based on simplified equations that typically result in conservative values for maximum potential surge pressure. The purpose of this exercise is to determine the potential for elevated pipeline pressures resulting from hydraulic transients and to determine if additional evaluation is warranted. The equations used in this exercise yield relatively high potential pressures, higher than those typically designed for within this region. Based on the results of this exercise, AECOM strongly recommends further evaluation and computer modeling of hydraulic transients within the proposed pipeline.

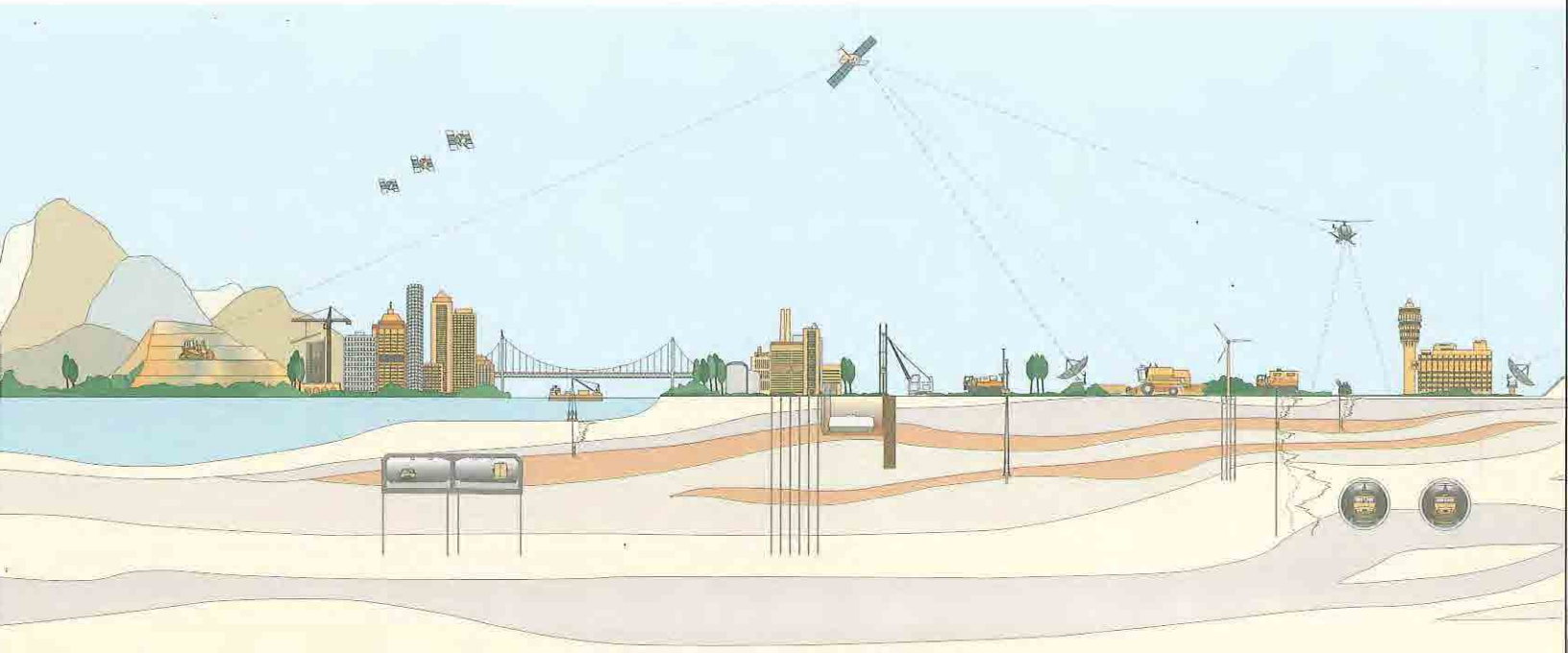
Appendix B

Geotechnical Information

FUGRO CONSULTANTS, INC.

PRELIMINARY GEOTECHNICAL STUDY
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HARRIS AND LIBERTY COUNTIES, TEXAS

AECOM
HOUSTON, TEXAS



FUGRO CONSULTANTS, INC.

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Report No. 0412-09-0031-2
September 29, 2009

AECOM
5757 Woodway
Suite 101 West
Houston, Texas 77057

Attention: Mr. Jeff Eversberg P.E.
Project Manager

Preliminary Geotechnical Study
Luce Bayou Interbasin Trasnfer Project
Coastal Water Authority
Harris and Liberty Counties, Texas

Fugro Consultants, Inc. is pleased to present the results of our geotechnical study for the above-referenced project. Mr. Todd L. Papes, P.E. of AECOM authorized our services under Task No. 14301, Work Order Nos. 1, 2, and 3 described as follows.

- Work Order No. 1 – Review existing geotechnical data and develop scope for preliminary geotechnical study for current alignment as developed by AECOM.
- Work Order No. 2 – Perform services in general accordance with Fugro Cost Estimate No. 0409-9950-0072 dated March 17, 2009. Collect geotechnical information and develop preliminary recommendations for the proposed pump station, pipeline, and canal.
- Work Order No. 3 – Perform services in general accordance with Fugro Cost Estimate No. 0409-9950-0132 dated May 6, 2009. Collect geotechnical information to develop stratigraphic information and pertinent physical properties of the soil along the river at the pump station for Baird to perform erosion and bank stabilization analyses.

This report contains the results of our field and laboratory investigation as well as preliminary geotechnical recommendations for the design of the pump station, pipeline, canal, and associated ancillary structures. Information contained in previous studies by others for this project were incorporated into the development of our recommendations. Results of the laboratory test results for the sediment samples collected by Baird are presented in Fugro Report No. 0412-09-0031-1 dated July 22, 2009.

We appreciate the opportunity to be of continued service to AECOM and the Coastal Water Authority. Please call us if you have any questions concerning this report or when we may be of further assistance.

Sincerely,
FUGRO CONSULTANTS, INC.
TBPE Firm Registration No. F-299

29 SEPT 2009

Scott A. Marr, P.E., LEED AP
Project Manager

Robert P. Ringholz, P.E.
Chief Engineer

Copies: Addressee (6)
SAM/RPR/sam
R:\04120\2009 Projects\0001-0099\0412-09-0031 LuceBayou\Reporting\0412-09-0031-2.doc

29 Sept 2009

EXECUTIVE SUMMARY

The Luce Bayou Project will convey surface water from the Trinity River in Liberty County to Lake Houston in Harris County. The project will include a pump station, approximately 16,062 ft of pipeline and 124,400 ft of open canal for a total of 26.6 miles of conveyance. There will be a number of road, stream, and pipeline crossings.

This water conveyance system was first considered in the 1970's and earlier 1980's, at which a substantial amount to geotechnical information was collected. The original plan was to convey water from the pump station, through a pipeline and a canal to Luce Bayou. Current plans are to keep the pump station and pipeline near their originally planned locations. However, a much longer canal is planned and the use of Luce Bayou has been essentially eliminated. The pipeline will consist of two 108-inch diameter pipes with about 5-foot of cover. The canal will be partially cut below grade 5 to 10 feet with levees on each side.

Borings FB-1 through FB-9, drilled along the canal alignment west of Cappers Ridge to Lake Houston generally encountered cohesive soils consisting of clay, sandy clay, and silty clay within the proposed depth of the canal (up to 10 ft below grade). Intermittent layers of granular soils consisting of sandy silt and silty sand were observed in several borings including near surface sandy silts within the proposed depth of the canal. On a footage basis, we encountered approximately 85 percent cohesive soils and 15 percent granular soils within a depth of 10 ft from the ground surface in the borings drilled for this study. However, the amount of cohesive soils and granular soils could vary along the alignment. Using the soils excavated along the proposed alignment, we recommend designing 4-horizontal to 1-vertical slope for constructing the proposed canal and levee slopes. We have provided additional recommendations for lining the canal, erosion control and weir structures in the report.

Borings FB-10 through FB-15, drilled along the high bank at the proposed pump station site generally encountered alternating strata of cohesive and granular soils. We recommend that spread footings for the buildings be placed at a depth of 5 feet below existing grade, and be founded on competent cohesive soils. We recommend designing the foundations for a net allowable bearing pressure of 5,000 psf for foundations bearing on stiff to very stiff natural cohesive soils. The bearing pressure can be increased to 6,600 psf for infrequent transient loading conditions. We recommend designing the foundations for a net allowable bearing pressure of 2,000 psf for foundations bearing on properly placed and compacted fill soils. The bearing pressure can be increased to 2,600 psf for infrequent transient loading conditions. Movement sensitive structures should be placed on a structural slab. Structures that are not movement sensitive can be designed for a conventional slab-on-grade placed on a properly prepared building pad of structural clay fill.

Water was generally encountered between 8 and 12 ft below grade in the borings along the project alignment. Nearby drainage ditches, rice fields, and water detention ponds will likely provide a source of water to charge the shallow granular soils along the pipeline and canal

alignment. The Trinity River and Lake Houston will influence the groundwater levels during construction of the structures at each site. Given that excavations to construct the intake structure will extend to about El. -2, groundwater control will be an essential aspect of construction of the intake structure at the pump station. We have provided preliminary recommendations for groundwater control, temporary and permanent retention systems.

We have provided recommendations for general pavement sections throughout the project alignment. We can provide additional recommendations for the Lake Houston Outfall structure when details are provided.

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1.0 INTRODUCTION

1.1 Project Description

The Luce Bayou Project will convey surface water from the Trinity River in Liberty County to Lake Houston in Harris County. The project will include a pump station, approximately 16,062 ft of pipeline and 124,400 ft of open canal for a total of 26.6 miles of conveyance. There will be a number of road, stream, and pipeline crossings.

This water conveyance system was first considered in the 1970's and earlier 1980's, at which a substantial amount to geotechnical information was collected. The original plan was to convey water from the pump station, through a pipeline and a canal to Luce Bayou. Current plans are to keep the pump station and pipeline near their originally planned locations. However, a much longer canal is planned and the use of Luce Bayou has been essentially eliminated. The pipeline will consist of two 108-inch diameter pipes with about 5-foot of cover. The canal will be partially cut below grade 5 to 10 feet with levees on each side.

1.2 Purposes and Scope

The purpose of this study was to develop preliminary design recommendations for the water conveyance project including the pump station, pipeline, canal, and associated ancillary structures based on existing and new geotechnical data. The specifics of our scope included:

- Reviewing existing information provided by the AECOM;
- Meeting with AECOM to develop a geotechnical program;
- Drilling 15 soil borings to explore subsurface conditions and obtain samples for geotechnical laboratory testing;
- Performing laboratory tests on selected soil samples to assess pertinent engineering properties;
- Analyzing the geotechnical data to develop preliminary engineering recommendations; and
- Summarizing our findings, recommendations, and conclusions in a geotechnical engineering report.

Environmental assessments, compliance with state and federal regulatory requirements, and/or environmental analyses were beyond the scope of our services. A geologic fault study was also beyond the scope of our services.

1.3 Applicability of Report

The geotechnical exploration and analyses for this report were selected and developed based on our understanding of the project as described herein. We prepared this report exclusively for

AECOM and CWA for design consideration and information purposes only. We conducted our services using the standard level of care and diligence normally practiced by recognized engineering firms now performing similar services under similar circumstances. We intend for this report, including all illustrations, to be used in its entirety. This report is not intended for final design and thus additional investigations will be required. It should not be construed to represent a warranty of subsurface conditions nor used as a construction specifications document. It is also important to note that the subsurface conditions encountered in our exploration and reported herein do not represent an absolute condition.

1.4 Previous Geotechnical Studies

AECOM provided the following documents for our review during the course of our study.

- *Preliminary Soils Investigation, Luce Bayou Diversion Project.* National Soil Services, Inc. Report No. 72-288 dated February 7, 1973.
- *Soils and Foundation Investigation – 96 inch Diameter Water Conveyance Pipeline, Luce Bayou Diversion Project.* National Soil Services, Inc. Report No. 72-288-2 dated November 11, 1975.
- *Soils and Foundation Investigation – Trinity River Pump Station, Luce Bayou Diversion Project.* National Soil Services, Inc. Report No. 72-288-3 dated November 14, 1975.
- *Soils and Foundation Investigation – Luce Bayou Rectification.* National Soil Services, Inc. Report No. 72-288-4 dated October 28, 1975.
- *Luce Bayou Diversion Project – Reidland Dam, Liberty County.* NFS/National Soil Services, Inc. Report No. H-72-288-4 dated January 28, 1981.
- *Geotechnical Engineering Study – Slope Stability and Pipe Anchors.* NFS Services, Inc. Report No. 72-288-7 dated July 12, 1982.

2.0 FIELD INVESTIGATION

2.1 Site Visits and Pre-Project Planning

Prior to performing our field investigation, representatives of Fugro and AECOM performed several site visits and held several meetings to discuss boring locations, site access, and overall goals of the geotechnical study. Borings were located at the proposed pump station along the Trinity River, at the transition from pipes to open canal, spaced along the canal alignment, and at the outfall structure at Lake Houston. Through the course of our study, we performed site visits to stake boring locations and identify the steps needed to access several boring locations. Site clearing needed to be performed to drill borings near the pump station. Borings along the canal alignment were on a different properties. AECOM surveyors and field representatives helped direct and provide access to each property.

2.2 Geotechnical Field Exploration

Table 2-1 presents a summary of the borings, purpose, and depth, and location.

Table 2-1. Boring Locations

Boring	*Northing*	*Easting*	*Approximate Elevation (ft)*	*Approximate Station*	*Purpose*
FB-1	N 30°02'58"	W 95°06'06"	46	10+20 R562	Lake Houston Outfall
FB-2	N 30°03'04"	W 95°05'15"	73	55+13 R13	Canal
FB-3	N 30°03'40"	W 95°02'55"	75	225+84 R56	
FB-4	N 30°06'15"	W 95°02'39"	81	399+18 L75	
FB-5	N 30°07'50"	W 95°01'38"	83	547+75 L91	
FB-6	N 30°08'05"	W 94°58'36"	85	709+37 L66	
FB-7	N 30°09'15"	W 94°55'45"	99	937+46 R260	
FB-8	N 30°10'33"	W 94°53'59"	102	1075+86 R55	
FB-9	N 30°12'40"	W 94°52'07"	104	1242+83 L76	Pipe Discharge to Canal
FB-10	N 94°49'22"	W 30°13'27"	42	2154+25 R228	Pump Station
FB-11	N 30°13'23"	W 94°49'16"	41	2162+42 R549	High Bank of Trinity River
FB-12	N 30°13'25"	W 94°49'16"	41	2161+72 R360	
FB-13	N 30°13'28"	W 94°49'14"	27	2162+33 R15	
FB-14	N 30°13'31"	W 94°49'13"	48	2162+11 L300	
FB-15	N 30°13'33"	W 94°49'13"	50	2161+41 L490	

The approximate boring locations are shown on the *Plan of Borings* on Plate 2a (Canal) and 2b (Pump Station). Detailed descriptions of soils encountered in each boring are presented on the boring logs on Plates A-1 through A-15 in Appendix A. A key identifying the terms and symbols on the borings is presented on Plates A-16a and A-16b in Appendix A. The coordinates presented on the boring logs and in Table 2-1 were determined using a handheld GPS device. Boring elevations were provided by AECOM.

2.3 Site Clearing

We performed limited site clearing to access the locations near the pump station for Borings FB-10 through FB-15. Due to restrictions from the property owner, we were limited to using chainsaws to clear paths through the dense vegetation. Debris from the site clearing operations was left onsite.

2.4 Drilling Methods

We performed our geotechnical field exploration services for Borings FB-2 through FB-8 using truck-mounted drilling equipment. Borings FB-1 and FB-9 through FB-15 were drilled using all terrain-mounted drilling equipment. The borings were drilled using dry-auger and wet-rotary drilling methods. Our Senior Specialist Technician directed the field operations.

2.5 Sampling Methods

The borings were generally sampled at 2-foot intervals to a depth of 16 ft below grade and at 5-ft intervals below 16 ft. Undisturbed samples of cohesive soils were generally obtained by hydraulically pushing a 3-inch-diameter, thin-walled tube to a distance of about 24 inches in general accordance with ASTM D1587 (*Standard Practice for Thin-Walled Tube Sampling of Soils*). The samples were extruded in the field and visually classified by our field technician. We obtained field estimates of the undrained shear strength of the recovered samples using a hand penetrometer. The field estimates were modified for stiff to hard, over-consolidated natural cohesive soils, as described on Plate A-16b. Granular soil samples were obtained using the Standard Penetration Test (SPT) as described on Plate A-16b. Our field procedure for granular soil sampling was conducted in general accordance with the ASTM D1586 (*Standard Method for Penetration Test and Split-Barrel Sampling of Soils*). Our field technician recorded the hammer blows for each sampling interval. The SPT N-values, as described on Plate A-16b, are recorded on the boring logs. In each case, portions of the recovered soil samples were packaged and transported to our laboratory for testing.

2.6 Depth-to-Water Observations

Most borings drilled for this study were initially drilled using dry-auger methods in an attempt to identify the depth to water in the open borehole. When free-water was encountered in the open borehole, drilling was temporarily halted and the depth-to-water in the open borehole was recorded. Drilling then continued to the boring completion depth of the borings using wet-rotary methods. Temporary piezometers were installed in Borings FB-2 and FB-8 and near FB-13. Further discussion on our depth-to-water observations and the onsite groundwater conditions is presented later in Section 4.2.

2.7 Borehole Completion

After completing the field activities, Borings FB-1 and FB-9 through FB-15 were backfilled with cement-bentonite grout. The boreholes were grouted from the bottom up, using a tremie pipe. When the grout level reached within approximately 4 to 6 inches of the surface, the tremie pipe was removed and the boreholes were topped-off by pouring grout from the surface. Borings FB-3 through FB-7 (shallow borings) were backfilled with soil cuttings and bentonite chips (*i.e.* holeplug). The holeplug/cuttings were placed into the open boreholes and tamped in place by our field technician. Temporary piezometers were installed in Borings FB-2 and FB-8.

3.0 LABORATORY TESTING

3.1 Testing Program

The laboratory testing program for this study was directed primarily toward evaluating the classification properties of the cohesive and granular soils. We also performed tests to evaluate the undrained shear strength and dispersion potential of the cohesive soils along the canal alignment and along the high bank along the Trinity River. We performed tests to evaluate the drained shear strength and corrosion potential of the soils near the proposed pump station as well. Our laboratory tests were performed in general accordance with the appropriate standards as tabulated at the end of this section. The laboratory test results are presented on the boring logs in Appendix A.

3.2 Classification Tests

The classification tests included tests for natural moisture content, liquid and plastic limits (collectively termed Atterberg limits) and grain size analyses, including sieve analysis and material finer than the No. 200 sieve (percent fines). These tests aid in classifying the soils and are used to correlate the results of other test performed on samples taken from different borings and/or different depths. The results of the classification tests are recorded on the boring logs in Appendix A. Grain size curves are presented in Appendix B on Plate B-1 through B-4.

3.3 Shear Strength Tests

We measured the undrained shear strength from selected undisturbed samples of cohesive soils by performing unconfined compression tests and unconsolidated-undrained triaxial compression tests. The natural water content and dry unit weights were determined as routine parts of the shear strength tests. The results of the laboratory shear strength tests, along with the field estimates of shear strength, are presented on the boring logs in Appendix A.

In addition, the drained shear strength parameters of selected undisturbed samples of cohesive soils were determined by conducting two multi-stage consolidated-undrained triaxial compression tests with pore pressure measurements and one direct shear test. The results of the consolidated-undrained triaxial compression tests, presented as Mohr's circles and as stress paths, are presented in Appendix B on Plates B-5 and B-6. The results of the direct shear test are presented on Plate B-7. Natural water content and dry unit weight were determined as routine portions of the drained strength tests. Summaries of the results of drained strength tests are presented Table 3-1.

Table 3-1. Drained Shear Strength Test Results

Boring No.	*Depth (ft)*	*Description*	*Test Method*	*LL*	*PL*	*PI*	*Cohesion, c' (psf)*	*Friction Angle, ϕ' (degrees)*
13	12	Clay	CU Triaxial	64	15	49	320	24
13	35	Clay	CU Triaxial	43	11	32	450	26
13	20	Sand	Direct Shear	NP	NP	NP	0	30

3.4 Corrosion Potential Tests

The corrosion potential of the subsurface soils within the vicinity of proposed pump station was evaluated using a series of analytical laboratory tests, which included pH, sulfate ion concentration, chloride ion concentration, and electrical resistivity tests.

Steel and concrete elements in contact with soil are subject to degradation due to corrosion or chemical attack. Therefore, buried steel and concrete elements should be designed to resist corrosion and degradation based on accepted practices.

Soil pH, resistivity, and chloride and sulfate ion concentration tests were performed on three samples collected at different depths in Boring B-13. These tests were performed to assess the corrosion potential of the on-site near-surface soils on buried steel and concrete. The potential for corrosion of buried steel and degradation of buried concrete based on a comparison of the laboratory test results with published guidelines is discussed. The guidelines used to evaluate corrosion and degradation potential are presented in Appendix C.

The results of the corrosion series testing are given in Table 3-2.

Table 3-2. Corrosion Series Test Results

Boring No.	*Depth (ft)*	*Material Description*	*pH*	*Resistivity (ohm-cm)*	*Ion Concentration, ppm*	
					Chloride	*Sulfate*
13	4.5	Clay	8.07	1,600	< 100	< 100
13	12.5	Clay	8.10	2,000	< 100	< 100
13	40	Clay	7.9	160	< 100	< 100

The results of sulfate tests on the selected soil samples from this study indicate ***mild*** potential for deterioration of concrete. The chloride tests indicate a ***mild*** to ***moderate*** potential for corrosion of steel. The pH tests indicate a ***mild*** potential for corrosion of steel. Electrical resistivity tests indicate a ***high*** to ***very high*** potential for corrosion of steel.

3.5 Dispersion Potential Tests

Table 3-3 presents the results of the crumb dispersion tests on selected soil samples. General guidelines for estimating the dispersive potential from crumb test results are presented in Appendix D. The implication of these test results as they relate to erosion is discussed in Section 5.3 of this report.

Table 3-3. Crumb Test Results

Boring No.	*Depth, (ft)*	*Material Description*	*Crumb Test Grade*		
			@ 5 min	*@ 10 min*	*@ 60 min*
1	5	Siltv Clav	1	1	1
1	14	Sandy Silt	3	3	4
2	5	Sandy Clay	1	1	1
3	8	Clay	1	1	1
4	3	Clay	1	1	1
5	3	Clay	1	1	1
6	7	Clay	1	1	1
7	3	Clay	1	1	1
8	2	Sandy Clay	3	4	4
9	5.5	Clay	1	2	4
11	3	Clay	1	1	1
11	19	Clay	1	1	1
12	5	Clay	1	1	1
12	11	Clay	1	1	1
12	24	Clay	1	1	1
13	7	Clay	1	1	2
13	29	Clay	1	1	1
13	49	Clay	1	1	1
14	3	Clay	1	1	1
14	13	Sandy Clay	2	3	3
15	4	Clay	1	1	1

3.6 Summary

Table 3-4 presents the type and number of laboratory tests as well as the test method standard.

Table 3-4. Laboratory Test Summary

Laboratory Test	*Quantity*	*Testing Standard*
Moisture Content	68	ASTM D2216
Atterberg Limits	42	ASTM D4318
Sieve Analysis	16	ASTM D422
Percent Passing the No. 200 Sieve	59	ASTM D1140
Dry Unit Weight	38	ASTM D2166
Unconfined Compression	18	ASTM D2166
Unconsolidated-Undrained Triaxial Compression	20	ASTM D2850
Consolidated-Undrained Triaxial Compression	2	ASTM D4767
Direct Shear	1	ASTM D2852
Crumb	21	ASTM D6572
PH	3	ASTM G51
Sulfate	3	ASTM D516
Chloride	3	ASTM D512
Electrical Resistivity	3	ASTM G57

Note that sieve analyses were performed on 27 samples of soil sediment collected by Baird. The results of the analyses were presented in Fugro Report No. 0412-09-0031-1 dated July 22, 2009.

4.0 GENERAL SITE CONDITIONS

4.1 Site Description and Subsurface Conditions

4.1.1 Canal and Pipeline. The boring locations along the canal and pipeline alignment ranged from heavily wooded areas to pastures and farmland to roads. Generally, the sites were relatively flat with areas that slope to drainage ditches and at FB-1 the area sloped towards Lake Houston.

Borings FB-1 through FB-9, drilled along the canal alignment from Lake Houston to west of Cappers Ridge generally encountered cohesive soils consisting of clay, sandy clay, and silty clay within the proposed depth of the canal (up to 10 ft below grade). Undrained shear strengths of the cohesive soils ranged from firm to very stiff. Intermittent layers of granular soils consisting of sandy silt and silty sand were observed in several borings including near surface sandy silts within the proposed depth of the canal. On a footage basis, we encountered approximately 85 percent cohesive soils and 15 percent granular soils within a depth of 10 ft from the ground surface in the borings drilled for this study. However, the amount of cohesive soils and granular soils could vary along the alignment. Borings FB-1, FB-4, FB-6, FB-8, and FB-9 encountered granular soils below a depth of about 10 ft below grade. The granular soils consisted of sand, silty sand, and clayey sand. We have superimposed the borings drilled for this study along the proposed canal alignment as provided by AECOM and presented the subsurface profiles on Plates 3a through 3__. Detailed descriptions of soils encountered in each boring are presented on the boring logs on Plates A-1 through A-9 in Appendix A. A key identifying the terms and symbols on the borings is presented on Plates A-16a and A-16b in Appendix A.

During excavation and prior to placement of fill soils, we expect a bulking/swell/fluff of about 20 to 35 percent in clay soils, and about 10 to 15 percent in sandy soils.

4.1.2 Pump Station. The location of the proposed pump station along Cappers Ridge is heavily wooded. The site is generally flat along the high bank of the Trinity River with a relatively steep drop of about 20 ft to the water surface. Borings FB-10 through FB-15, drilled along the high bank at the proposed pump station site generally encountered alternating strata of cohesive and granular soils. At the ground surface, we encountered up to 2 ft of sandy silt and clayey silt. Below the surficial soils, we encountered stiff to hard, moderate to very high plasticity cohesive soils (Stratum I) to about El. 30. We encountered medium dense to very dense granular soils (Stratum II) consisting of sand and silty sand beneath the cohesive soils to El. 15. Beneath the granular soils, we encountered stiff to very stiff cohesive soils (Stratum III) to El. -5. The cohesive soils consisted of clay, sandy clay, and silty clay. Beneath the cohesive soils we encountered granular soils (Stratum IV) consisting of dense to very dense sand and silty sand to about El. -41. Beneath the granular soils, we encountered stiff to very stiff clay (Stratum V) to El. -80, the deepest we drilled for this study. We have superimposed the borings drilled for this study along

with borings drilled for previous studies at the site near the proposed pump station as provided by AECOM and presented the subsurface profile on Plate 3b.

Detailed descriptions of soils encountered in each boring are presented on the boring logs on Plates A-10 through A-15 in Appendix A. A key identifying the terms and symbols on the borings is presented on Plates A-16a and A-16b in Appendix A.

4.2 Depth-to-Water Conditions

Water was generally encountered between 8 and 12 ft below grade in the borings along the project alignment. Groundwater was not encountered in some borings along the alignment. Water level measurements in the temporary piezometer in Boring FB-2 indicate the water fluctuates between 8 and 10 ft below grade. Water has not been observed in the temporary piezometer in Boring FB-8. We have not taken water level measurements since drilling in the piezometer installed adjacent to Boring FB-13 due to restricted site access.

Short-term depth-to-water observations recorded in open boreholes should ***not*** be considered to represent a long-term condition. The time associated with short-term observations may not be sufficient for the conditions in the open borehole to reach equilibrium. More accurate determinations of the groundwater level are usually made using long-term standpipe piezometer readings. Groundwater levels will fluctuate with seasonal variations in rainfall and surface runoff, especially during extended periods of heavy rainfall or dry weather. Also, perched water may be encountered within the shallow granular soils encountered in the borings. The Trinity River and Lake Houston will influence the groundwater levels during construction of the structures nearby. Nearby drainage ditches, rice fields, and water detention ponds will likely provide a source of water to charge the shallow granular soils along the pipeline and canal alignment.

4.3 Variations in Subsurface Conditions

Our interpretations of soil conditions, as described in this report, are based on data obtained from our visual observations, geophysical data, sample borings, laboratory tests, and our experience. Although we have allowed for minor variations in the subsurface conditions, our descriptions may not be appropriate for subsurface conditions other than those reported herein. It is likely that variations in soil conditions are present outside the boring locations, especially given the spacing between boring locations along the project alignment. We recommend that additional borings be drilled at approximately 500 ft spacing along the proposed alignment to further identify subsurface conditions for final design.

5.0 TRINITY RIVER PUMP STATION

Based on the information provided by AECOM, we have developed recommendations for the proposed pump station, control building, and maintenance building in this section. We have included recommendations for shallow foundations including spread and strip footings, intake and pump wells including temporary retention system and earth pressures for permanent walls, general discussion of erosion control and bank stability.

5.1 Shallow Foundations

A foundation system should satisfy two basic and independent design criteria. First, the bearing pressure transmitted to the foundation soils should not exceed the net allowable soil bearing capacity, which includes an appropriate safety factor. Second, settlements during the operating life should not be of a magnitude that will cause structural damage to the structure or their utility connections. Settlements are a function of, among other things, the underlying soil conditions, the foundation size and shape, and the sustained applied foundation pressures of the foundation elements.

Based on our review of the field and laboratory tests performed on the soils encountered in the borings drilled, as well as our experience with similar projects, we believe that the proposed structures may be supported on shallow foundations. We consider shallow spread footings founded in the natural cohesive soils suitable the proposed structures. We recommend using a structural slab for the first floor slab for structures that are movement sensitive. However, a ground supported slab-on-grade may be used if the Owner is willing to accept the risk of potential movements from shrink-swell soils. We have included recommendations to reduce the potential for shrink-swell movement by constructing the first floor slab on properly placed and compacted structural clay fill or lime-stabilized clay fill pad. Recommendations for the placement of structural clay fill and lime-stabilized clay fill are provided in the Sections 9.3 and 9.4 of this report.

5.1.1 Spread and Strip Footings. We recommend that spread footings for the buildings be placed at a depth of 5 feet below existing grade, and be founded on competent cohesive soils. If weak, soft, or otherwise unsuitable soils are encountered at the proposed foundation depth, these soils should be over-excavated and replaced with flowable fill or lean concrete. Alternatively, the foundation depth could be increased. However, if greater foundation depths are desirable or required, we ***should*** be contacted to reevaluate the recommendations presented herein.

The allowable net bearing pressure for shallow foundations is a function of, among other items, the bearing surface, the strength of the foundation soils, the location of the foundation, the shape of the foundation, and the recommended factor of safety. Foundations should be proportioned so that the maximum contact pressure under various load combinations does not exceed the allowable net bearing pressure. We recommend designing the foundations for a net allowable

bearing pressure of 5,000 psf for foundations bearing on stiff to very stiff natural cohesive soils. The bearing pressure can be increased to 6,600 psf for infrequent transient loading conditions. We recommend designing the foundations for a net allowable bearing pressure of 2,000 psf for foundations bearing on properly placed and compacted fill soils. The bearing pressure can be increased to 2,600 psf for infrequent transient loading conditions. Bearing pressure, as used in this report, is defined on Plate 4. To calculate values of W_e, W_s, and W_f from Plate 4, use effective unit weights of 60 pcf for soil and 90 pcf for concrete.

A detailed settlement analysis was beyond the scope of this preliminary study. However, based on our experience with similar soils under similar loads, we expect consolidation settlements of shallow foundations placed on natural cohesive soils will be less that about 1 inch. We estimate foundations placed on fill soils will settle 1 to 2 percent of the height of the fill soils plus about 1 inch. The estimated settlement is based on uniformly loaded foundations with sustained bearing pressures that are no greater that the recommended allowable net bearing pressures. In addition, these preliminary estimates assume the foundations act as isolated foundations, that is, the clear spacing between adjacent foundations is equal to at least the width of the larger foundation. Differential settlements between new footings should be expected and may be on the order of one-half of the total settlement.

The soil conditions encountered during construction should be of similar consistency and strength of the soil conditions reported on the boring logs. All foundation excavations should be observed by the Geotechnical Engineer-of-Record or their qualified representative prior to placement of concrete. Structural clay fill should be used to backfill against spread and strip footings.

5.1.2 Slab-on-Grade. Proper design and installation of the floor slab is an essential aspect of construction similar to that planned at this site. Failure to properly design and install the first floor slab can contribute to the development of significant foundation distress. Foundation distress can lead to serviceability problems including, but not limited to, additional structural distress, floor slab movements, and various aesthetic concerns. As such, if the planned structure will be sensitive to such movements, a structural slab should be used.

We recommend that site preparation include the stripping of the top 2 feet of existing subgrade until competent cohesive soils are exposed at the proposed structure location. The site preparation activities should extend to at least 5 feet beyond the edge of the footprint of the proposed structures.

Once the existing surface soils have been stripped, the exposed subgrade should be proofrolled using a heavy (20-ton) rubber-tired vehicle, if accessible. The Geotechnical Engineer-of-Record or their qualified representative should observe the proofrolling activities. Areas of weak, wet, or otherwise unsuitable soil conditions should be identified and over-excavated to expose competent soils under the guidance of the Geotechnical Engineer-of-Record or their qualified representative.

After the completion of proofrolling activities, design grade should then be achieved using properly compacted structural clay fill or lime-stabilized clay. The placement of approximately 2 feet of structural clay fill or lime-stabilized clay fill will assist in developing the required design grade. The objective of the removal and replacement activities will be to create a uniform, low permeable, relatively homogeneous building pad thereby reducing the PVR of the foundations soils from 0.5 to 2 inches to on the order of less than an inch.

Some settlement of the placed fill material should be expected over the life of structure. Generally, settlement on the order of 1 to 2 percent of the fill height can be expected for the proposed backfill soils. Hence, we anticipate that consolidation settlement on the order of 0.5 inch may occur due to the self-weight of the fill if structural clay fill is used. A lower magnitude of settlement should be expected if lime-stabilized fill is used.

We recommend limiting the applied pressure beneath slabs-on-grade supported on structural clay fill and lime-stabilized clay to 1,200 psf. Applied pressures greater than 1,200 psf will likely require the use of supplemental foundations.

Exterior grade beams (or turned down edges) and interior grade beams should be used to support loads between footings and to stiffen slab-on-grade foundations. The depth of exterior and interior grade beams can be varied according to the structural requirements of the slab. However, we recommend that exterior grade beams (or turned down edges) for the slab-on-grade foundations extend at least 36 inches below lowest adjacent exterior grade to serve as a moisture barrier. Exterior and interior grade beams should be designed using an allowable net bearing pressure of 1,500 psf. We do ***not*** recommend the use of void boxes below grade beams for slab-on-grade foundations because of the potential to collect free water within the void space.

Positive drainage should be provided away from the buildings. We recommend using structural clay fill as backfill outside the building footprint. The low permeability of structural clay fill will help reduce the potential for moisture fluctuations along the building perimeter foundation. Moisture fluctuations can adversely affect floor slab performance.

5.2 Intake Structure and Pump Wells

We expect the proposed intake structure and pump wells will be constructed using an open-cut excavation. Recommendations for open-cut excavations are presented in Section 9.2. However, if open-cut excavations are not used, a temporary excavation retention system will be required to complete the construction excavations. Regardless of the construction methods used, surface and groundwater control will need to be implemented before, during, and after construction. We have also provided recommendations for the design of the permanent intake structure and pump wells. The following provides our recommendations for a temporary excavation retention system at this site.

5.2.1 Groundwater Control. We expect groundwater to be on the order of 8 to 12 feet below grade (about El. 30) in the vicinity of the proposed pump station. Information from AECOM

indicates the water in the Trinity River on average is at El. 24.6. Fluctuations should be expected during construction as well as over the life of the structure.

Given that excavations to construct the intake structure will extend to about El. -2, groundwater control will be an essential aspect of construction. Site grading at the surface should be established to promote surface drainage away from the excavation. Dewatering should be implemented during construction to reduce the potential disturbance to the excavation subgrade and to reduce the potential for slope failures as excavations progress. We recommend the dewatering system used during construction be permanently installed for use after construction for maintenance operations of the pump wells and intake structure. We expect dewatering to primarily occur in the Stratum II (about El. 30 to El. 15) and Stratum IV (El. -5 to El. -41) granular soils. We recommend a dewatering contractor be contracted to design and implement the required groundwater control. We anticipate that a wellpoint system will be required to facilitate the groundwater control.

A groundwater control system should be capable of lowering and maintaining (continuously without interruption) the water level at least 3 feet below the lowest excavation depth (or below the bottom of the pump wells over the life of the structure. During construction, we expect temporary diversion berms or sheet piles will be used to keep water from the Trinity River from flooding the excavation. Pumps should be used in excavations to remove any water that enters the excavation. We recommend providing backup power sources to maintain the groundwater control during power outages.

It will be critical to monitor the piezometric levels around the excavation by installing piezometers in both the Stratum II and Stratum IV granular soils. If the water level/pressure is not lowered in the bearing subgrade beneath the excavation, bottom instability is likely to occur, resulting in potential construction difficulties and movements greater than expected. We recommend underfloor drains (as discussed in Section 5.2.3) and foundation concrete be placed soon after the final excavation depth is achieved. We expect open excavations that extend below the surrounding water level to heave on the order of several inches within a couple of days if foundations are not placed within a day or two if proper groundwater control is not maintained.

Groundwater control will need to be installed and implemented at least a month before excavation occurs to dewater/depressurize the Stratum II granular soils at the site. Due to the close proximity of the Trinity River and the constant source of water, we do not believe it will be possible to completely dewater and depressurize the Stratum IV soils. However, during periods of constant pumping we believe the water level can be controlled sufficiently to facilitate construction of the proposed foundations, pump wells, and intake structures. We recommend that previous experience constructing the existing CWA pump station along the Trinity River be reviewed for design considerations.

5.2.2 Temporary Excavation System. A temporary retention system may be used to construct the proposed intake structure and pump wells. The temporary retention system may consist of

driven sheet piles or soldier pile and lagging. It should be noted that the design and construction of temporary excavation systems, similar to those described in this report, are often considered proprietary products. If this is the case, we recommend we be allowed to review the plan prepared by the excavation system contractor for the planned system prior to implementation.

Short-Term Lateral Pressures. The excavation retention system will experience lateral earth pressures resulting from a combination of soil pressure and surcharge loads. The system should be designed to resist lateral earth pressures imposed by the surrounding retained soil and any surcharge loads. A discussion of the distribution of lateral earth pressures on the proposed temporary excavation retention systems for preliminary estimation purposes is illustrated on Plate 5. In analyzing the retention system, it should be noted that the lateral pressures acting on the wall may be computed assuming that the pressures on Plate 5 are on a per-foot-of-wall basis. We recommend the passive resistance has been neglected in the upper 5 ft of soil beneath the bottom of the excavation to account for soil disturbance from construction activities. It also assumes that the groundwater control is implemented and the surrounding water is at least 3 ft below the excavation bottom.

The effects of surcharge loads from construction equipment, concrete trucks, and other heavy equipment should also be evaluated during the design of the temporary excavation retention system. Surcharge loads located near the temporary retention system will also impose lateral loads on the temporary retention system. As such, the temporary retention system should be designed to accommodate all transient and sustained surcharge loads. The lateral pressure distribution for surcharge loads is presented on Plate 6. Lateral earth pressures due to surcharge loads, as determined on Plate 6, should be added to the pressure distribution on Plate 5 when designing the retention system.

Furthermore, it should also be noted that ground surface movements, as a result of changes in lateral stresses within the subsurface soils, should be anticipated. As such, the potential for ground surface movements should be addressed during the design of the temporary retention system. The effects of potential ground surface movements on adjacent structures should also be evaluated during the design of the retention system.

Soldier or sheet piles for the retention system should be installed to a depth below adjacent excavation grade to provide sufficient resistance against lateral earth pressures and provide moment equilibrium as described above. Furthermore, piles should be sized such that their penetration below adjacent excavation grade is sufficient to provide resistance for all vertically applied loads including, but not limited to, the weight of the concrete and reinforcing steel, tiebacks and components, and wall weight.

Global Stability. Global stability about the excavation bottom should be addressed during the design of the retention systems. The stability analysis should address the effects of adjacent structures and groundwater control activities on the overall stability of the proposed excavation. The global stability analysis should also address the proposed penetration of soldier piles. Should

global stability movements occur, significant structural distress may be induced in adjacent structures and within the temporary retention system. If penetrations are not long enough, the soldier piles may rotate out of plane as a result of soil pressure. We would be pleased to assist in the global stability analysis of the proposed excavation and retention system once the excavation and loading conditions are determined.

5.2.3 Earth Pressures on Permanent Walls. Intake structure and pump well walls should be designed to withstand permanent lateral earth pressures resulting from a combination of soil pressure, hydrostatic pressure, and surcharge loads. The distribution of lateral earth pressures and surcharge loads on permanent non-yielding walls is presented on Plate 7. Proper drainage should be provided to help prevent the development of hydrostatic pressures behind the intake structure walls. Should hydrostatic pressures develop, the lateral earth pressure should be recalculated to account for the additional fluid pressures.

As discussed earlier, we understand that a sloped excavation may be used to construct the intake structure. If this is the case, care should be taken during backfill operations not to over compact the backfill soils. Over compaction may induce significant stresses on the walls. Settlement due to self-weight should be expected if structural clay fill is used. Our experience indicates that a properly placed and compacted structural clay backfill may settle on the order of 1 to 2 percent of its height under self-weight. Where granular backfill soils are used, the granular fill should be capped with at least 2 to 3 ft of low permeability structural clay fill. Granular fill soils should also be compatible with the basement wall drain system and natural soils. We expect granular soils to settle on the order of 0.5 percent of its height and soon after placement assuming a placement relative density of greater than 90 percent. Surface drainage should be diverted away from all basement walls.

Groundwater at this site will be subject to seasonal fluctuations and the water level in the Trinity River. For future maintenance purposes, it should be anticipated that the groundwater level will exist above the intake structure for extended periods of time during periods of wet weather. In addition, shallower perched water may also be present at higher elevations.

Wall and Underfloor Drain System. We recommend installing wall and underfloor drains along intake structure walls. We understand that CWA has observed distress at an existing pump station along the Trinity River due to excessive piezometric pressures behind the intake structure walls. We recommend evaluation of the system at the existing pump station be considered when designing the proposed wall drain system. Wall drains are generally installed to reduce hydrostatic pressures acting on the walls and to reduce the potential for seepage through the walls. The wall drain should consist of a 2- to 3-ft-wide wall of sand encircling the intake structure wall with a 4-inch-diameter slotted collector pipe at the base of the sand drain. A schematic of the wall drain and underfloor drain system is presented on Plate 8a. Recommendations for filter and collector pipe materials are presented on Plate 8b. The effects of long-term deterioration of timber lagging (if used) should also be addressed when designing wall drains.

The collector pipe or pipes should be sloped no flatter than 1/16 inch for every foot and should discharge into a sump or system of sumps. The end of the discharge pipe at the sump should be fitted with a backflow valve to help prevent flow back into the wall drain system. The collector pipe should be surrounded by at least 6 inches of filter sand. A 2- to 3-ft-thick clay cap should be installed over the sand to help reduce surface water infiltration into the wall drain system. An adequate number of cleanouts should be provided so that all collector pipes can be cleaned and flushed.

The wall drain system should be an independent system. The wall drain collector pipe should not be connected to other drainage systems that handle surface water runoff. The wall drain system should be periodically cleaned and preventative maintenance should be performed on a routine basis.

The underfloor drain beneath the pump wells and intake should consist of a series a lateral drain lines tied to primary collector lines that discharge into a sump or series of sumps. The drains should not be tied into the surface drainage system. The drainage layer beneath the slab should be at least 8 to 12 inches thick and consist of clean well-graded sand (ASTM C33) or well-graded crush stone. Collector pipes for the underfloor system should be sloped no flatter than 1/16 inch for every foot. Recommendations for filter and collector pipe materials are presented on Plate 8b.

Bearing Capacity. Based on information provided by AECOM, we expect the foundations of the intake structure and pump wells to bear at El. 0 to El. 3. From the borings drilled for this study, we expect the foundations to bear on cohesive soils or on the underfloor drain system. We recommend designing the foundations for a net allowable bearing pressure of 5,000 psf. The bearing pressure can be increased to 6,600 psf for infrequent transient loading conditions. Bearing pressure, as used in this report, is defined on Plate 4. To calculate values of W_e, W_s, and W_f from Plate 4, use effective unit weights of 60 pcf for soil and 90 pcf for concrete.

5.3 Erosion Control and Bank Stabilization

We understand Baird is performing a scour evaluation and will be providing bank stabilization recommendations. The following presents our general thoughts regarding slope stability and erosion protection along the Trinity River.

In all of our analyses, we have assumed that the soil between the pump station and the river will be relatively permanent and will not be allowed to erode with time. These soils, especially the granular soils encountered in our borings, should be protected from erosion by various means. We recommend that proper erosion control should be established around the pump station and intake structure. We believe that the erosion control be flexible and durable enough to accommodate some movement. Erosion control could include gabion baskets or rock filled mattresses along the surface of the slope and extend upstream and downstream some distance. Baird's recommendations and Fugro's recommendations should be reviewed for compatibility. Regardless of the erosion control implemented, a monitoring and maintenance plan should be developed for routine maintenance.

6.0 PAVEMENT RECOMMENDATIONS

The following section provides our general pavement recommendations for this project. We were not provided specific traffic loading conditions for the proposed pavements. As such, the following are general recommendations for the soil conditions at the pump station site.

6.1 Subgrade Preparation

The performance of an asphalt or concrete pavement ultimately depends on the underlying subgrade. Subgrade preparation for pavements should include clearing and stripping all significantly organic material, debris, and other deleterious materials from the site. Subgrade preparation for the proposed pavements should include the clearing and removal of any existing vegetation, in addition to the upper 6 inches of surficial soils. We recommend the surficial silty soils be treated with lime-fly ash or removed and replaced with structural clay fill.

After removing deleterious materials and stripping, the exposed subgrade should be proofrolled with a fully loaded dump truck or other heavy (20-ton), rubber-tired vehicle and observed to evaluate the condition of the subgrade. We recommend scheduling these activities during a relatively dry period. We do not recommend that subgrade preparation activities begin during or immediately after a significant rain event. It may be necessary to wait for the site to dry prior to restarting site preparation activities depending on the effectiveness of onsite drainage.

Areas of the subgrade that are observed to be soft, wet, weak, or contain deleterious materials or roots should be over-excavated to expose competent natural soils. Areas of the subgrade in which pumping or significant deflections are observed should also be over-excavated to expose competent natural soils or stabilized with lime-fly ash. Over-excavated areas should be backfilled with properly placed and compacted structural clay fill to attain rough site grade.

Grading activities should be conducted such that the recommended pavement sections, *i.e.* layer thickness, are adhered to across the pavement profile. We recommend that the Geotechnical Engineer-of-Record or their qualified representative be present onsite to observe all subgrade preparation for pavements.

6.2 Pavement Sections

Specific traffic loading information for the proposed pavements were not available at the time of this report. Table 6-1 provides typical pavement sections based on our experience with similar subsurface conditions. These sections are ***not*** based on a specific loading conditions (*e.g.* equivalent-single-axle-loads, *ESALs*) or pavement life expectancy.

Table 6-1. Typical Pavement Sections

Pavement Type and Recommended Use	*Material*	*Thickness*	*Reference or Specification*
Flexible Pavement (parking areas for cars and light-duty trucks)	Hot-Mix Asphaltic Concrete over	2 to 3 inches(1)	TxDOT Item 340 Type C or D
	Crushed Limestone Base over	6 inches	TxDOT Item 247 Type A, Grade 1
	Stabilized Subgrade	8 inches	See Text
Rigid Pavement (parking areas for cars and light duty trucks)	Portland Cement Concrete over	6 inches	TxDOT Item 360
	Stabilized Subgrade	8 inches	See Text
Rigid Pavement (truck and heavy traffic areas)	Portland Cement Concrete over	8 inches	TxDOT Item 360
	Stabilized Subgrade	8 inches	See Text

Notes:

1. Asphalt thickness will vary depending on actual traffic volume. In main drive areas, 3 inches of asphalt is more appropriate where as in parking areas with significantly less traffic volume, 2 inches may be suitable.

6.3 Stabilized Subgrade

If the surficial granular soils are left in place (*i.e.* not removed and replaced with structural clay fill during site preparation or to provide site access), we recommend stabilizing the subgrade using lime-fly ash. If the surficial granular soils are removed, we recommend placing lime-stabilized clay fill. The stabilized subgrade should be compacted to at least 95 percent of the maximum dry density as determined by ASTM D698 (Standard Proctor) at a moisture content within 1 percent "dry" to 3 percent "wet" of optimum moisture. Additional recommendations for lime-stabilization and lime-fly ash stabilization are discussed in the *Construction Considerations* Section of this report.

6.4 Crushed Limestone

The crushed limestone base should be in accordance with Texas Department of Transportation (TxDOT) *Standard Specifications for Construction of Highways, Streets, and Bridges*[1] Item 247.

[1] Texas Department of Transportation, *Standard Specifications for Construction of Highways, Streets, and Bridges*, 1993.

Crushed limestone should be compacted to 98 percent of the maximum dry density as determined by TxDOT Test Method Tex-113-E.

6.5 Asphalt

Hot mix asphaltic concrete (HMAC) should be placed in accordance with TxDOT Item 340. The HMAC should be either a Type D or Type C surface course mix. The HMAC should be compacted to between 91 and 95 percent of the theoretical density as described by TxDOT Item 340 Specifications.

6.6 Concrete

Portland cement concrete pavement should be in accordance with TxDOT Item 360. The concrete should have a compressive strength of 3,000 psi or greater at 28 days and be placed in accordance with American Concrete Institute (ACI) guidelines. The Structural Engineer-of-Record for the project should evaluate reinforcement and joint spacing for the concrete section. We recommend that the Portland cement concrete pavement be steel reinforced and that the concrete slabs have sufficient joints to allow for contraction and expansion of the concrete.

6.7 Drainage

The importance of drainage to the proper operation and function of any pavement cannot be overemphasized. The pavement and subgrade surface should be raised above adjacent grade and properly sloped into drainage inlets or lateral ditches. Water should not be allowed to pond on or adjacent to the pavement whereby the subgrade may become saturated. If the pavement subgrade does become saturated, the bearing capacity will be greatly reduced and the useful life of the pavement will be decreased. Periodic inspections and repair of cracks in pavement sections should be performed as part of routine facility maintenance.

6.8 Additional Considerations

We recognize that some of the surficial soils at this project site are moderate to highly plastic. These soils therefore have a moderate to high potential to exhibit shrink-swell behavior with moisture content fluctuations. We recommend that sand ***not*** be used as a leveling course beneath any pavements. The higher permeable granular soils may provide an avenue for moisture to penetrate into the plastic subgrade soils. Pavement distress may result from shrink-swell behavior as well as localized differential settlements of the subgrade fill soils. Thus, pavement maintenance should be performed on a routine basis and include, but not be limited to, the repair of significant stress cracks and joint separations.

7.0 CANAL RECOMMENDATIONS

We understand that the proposed canal could be as much as 10 ft below existing grade and perimeter embankment/levees could be as much as 10 ft above grade. The following provides some general geotechnical recommendations for a conceptual design of the proposed canal and embankments. We believe that the most critical geotechnical design and construction concerns for the encountered subsurface conditions are: 1) the stability of the proposed slopes, 2) shallow groundwater conditions and seepage control, 3) dispersive soils, and 4) erosion protection. Discussion and recommendations addressing each of these concerns is presented below.

7.1 Slope Stability

Canal and embankment/levee slopes should be designed and constructed to be stable with an appropriate factor of safety under short-term (undrained), long-term (drained), and rapid drawdown conditions. Undrained conditions model the slope immediate after construction before internal pore pressures have dissipated, and drained conditions model the slope after internal pore pressures have had sufficient time to dissipate. Rapid drawdown conditions refer to the conditions where the operational canal is drained, after being filled with water, rapidly without allowing time for seepage forces to dissipate. In each case, soil conditions should be based on the generalized site stratigraphy obtained during our field exploration, and the results of field and laboratory tests. The recommendations presented herein are for levees that are on the order of less than 10 feet above surrounding grade.

Based on our review of the soil conditions (*i.e.* predominantly high plasticity cohesive soils) and the assumption that the onsite soils will be reused, we recommend using 4-horizontal to 1-vertical slope when constructing the proposed canal to obtain the acceptable factors of safety. We recommend the top of the levee be on the order of 8 to 10 ft wide to be used as a maintenance road. This will also increase and improve the stability and reduce the potential seepage through the embankment/levee. Slopes should be constructed under "dry" conditions and be observed by the Geotechnical Engineer-of-Record or their qualified representative.

7.2 Groundwater Conditions and Seepage Control

We understand that the proposed canal will have a excavation depth no greater than about 10 ft below existing grade. As noted earlier, we observed depth-to-water levels as shallow as about 8 ft below existing grade in some cases. Thus, the presence of groundwater will be a major facet of construction and operations of the canal. If excavation is to proceed under dry conditions, the project contractor should be prepared to implement temporary groundwater control measures during the canal construction.

The soil conditions within the proposed excavation depths generally consist of natural cohesive soils with layers of granular soils. The encountered granular layers may provide a path for lateral

(side-slope) seepage. This could become a particular concern during construction if the water levels in the adjacent canals or ditches are higher than the depth of the canal excavation. Additionally, hydrostatic uplift on the clay liner and vertical seepage may also be encountered through the bottom of the canal excavation depending on the groundwater conditions at the time of construction. The contractor could have issues with bottom instability if water levels are shallower than the canal bottom before filling the canal. The Contractor should be prepared to address lateral and vertical seepage during the construction of the canal. We expect that sump areas with pumps will be able to handle most of the seepage. If unusual groundwater conditions are encountered along the alignment, the Geotechnical Engineer-of-Record should be consulted to observe the onsite conditions and provide additional recommendations as necessary.

7.3 Presence of Dispersive Soils

Laboratory tests generally did not indicate presence of dispersive soils. However, our experience in this area indicates they can be found in isolated areas that do not extend across the entire site. Ultimately, the degree that the project design addresses the presence of dispersive soils will be dependent upon how much risk the CWA is willing to accept. Thus, CWA may select to treat the presence of possible dispersive soils as a maintenance issue rather than a design issue. We can provide recommendations if CWA wishes to address the issue.

7.4 Erosion Protection

The performance of the canal will be dependent upon the ability of the slopes to maintain their integrity over the life of the canal. Therefore, the slopes will require erosion protection. The aim of erosion protection should be to reduce surface erosion from runoff. We expect that natural grass cover should be sufficient in providing adequate erosion protection for the slopes along the proposed canal. A layer of topsoil, usually on the order of 6 inches, will be required to promote grass growth. The grass cover should be properly maintained and the canal should be monitored for signs of distress. An operations plan should be developed to schedule periodic maintenance and provide procedures for addressing isolated erosion or other distress.

7.5 Construction of Canal and Embankment

7.5.1 Canal Excavation. We understand that within the canal alignment, the soils to a depth of up to 10 ft will be excavated and used for construction for the embankment/levees. While we expect the majority of the canal alignment to be excavated to expose primarily cohesive soils, there will be locations where the canal excavations will expose granular soils. Plate 9 presents a schematic cross-section of excavations exposing cohesive sols and granular soils. Where granular soils are encountered, we recommend over-excavating 24 inches and placing a clay liner. Recommendations for the properties of the clay liner are presented on Plate 9. Where cohesive soils are encountered, we recommend over-excavating 18 inches and placing a clay liner.

7.5.2 Embankment. As noted on the boring logs, the soils to a depth of up to 10 ft primarily consist of a mixture of high plasticity clays, moderate plasticity clays, and silts and silty sands. The clay soils generally have a very low hydraulic conductivity (*i.e.* seepage is less than granular soils). However, highly plastic clay soils also have a greater potential for shrink-swell and can develop shrinkage cracks and eventually develop zones of weakness in the embankments. These soils may be suitable for clay fill and used to construct the levees/embankments as long as CWA is aware of the potential risks associated with the use of such soils. We recommend that field observation and/or confirmatory laboratory tests be performed on potential fill soils prior to their use. To reduce the risk of shrinkage cracks, where possible, the contractor should use the higher plasticity cohesive soils near the core and interior of the levee and use lower plasticity cohesive soils near the surface and exterior of the levee. Plate 10 presents a general cross-section of the proposed embankment sections and recommendations for the soil properties and compaction requirements.

In the footprint of the embankment/levees, we recommend that clearing and grubbing to a depth of 12 to 18 inches to remove silty soils, organic, and deleterious material. We recommend cutting a key at least 24 inches deep along the center of the levee at least 4 ft wide. The area should be proofrolled and areas of loose or soft soil, organics, granular soil, or otherwise incompetent soils, should be removed and replaced with properly placed and compacted clay fill. Prior to placing the fill, the exposed surface should be scarified to a depth of 3 to 6 inches. The embankment/levees should be constructed to design grade using properly placed and compacted clay fill. Grass cover should be planted on the completed slopes as soon as possible to reduce the potential for erosion.

7.5.3 Fill Soils. Clay fill should be free of deleterious matter and should have an effective clod diameter less than 3 inches. Clay fill should ***not*** include dispersive soils. Clay fill should be placed in 6- to 8-inch-thick loose lifts and uniformly compacted to 95 percent of the maximum dry density at a moisture content of 1 percent "dry" to 3 percent "wet" of optimum as determined by ASTM D698 (Standard Proctor). Clay fill should be compacted by a sheepsfoot or padfoot type roller or by alternative methods that provide a "kneading" compaction equivalent to the sheepsfoot or padfoot roller. The earthwork contractor should scarify the top couple of inches of the underlying material before placing the next lift. Note that highly plastic soils are more difficult to place and compact properly. Therefore, good moisture control, quality control, and testing should be performed.

Soils used for the clay liner should have greater than 60 percent passing the No. 200 sieve, a liquid limit (LL) greater than 20 and a plasticity index (PI) greater 7, and a hydraulic conductivity less than 10^{-7} cm/s. We would expect embankments constructed out of properly placed and compacted fill to settle on the order of 1 to 3 percent of the levee height. For a 10-foot high levee, we would expect long-term consolidation settlements on the order of 1 to 3 inches.

7.6 Weir Structures

Through discussions with AECOM, we understand weir structures may be constructed along the canal alignment to maintain water levels throughout the canal. Although we have not been provided with the final locations or the type of weir structure, the following presents general considerations and preliminary recommendations for the design of the weirs.

Prior to final design, we recommend drilling a boring at each weir location to identify the subsurface conditions and to develop geotechnical recommendations. Generally, we recommend weirs be founded at least 3 feet below the base of the deepest part of the canal and extending 5 feet into the soils surrounding the canal. The weir should be designed to resist the lateral forces applied by the active earth pressure (150 psf) and water. We recommend using a preliminary bearing capacity of 2,500 psf for the weir foundation. We also recommend using a preliminary value of 300 psf for the passive pressure for cohesive soil to provide lateral support to the weir structure. These pressures include a factor of safety of 2.0. Proper erosion control should be provided upstream and downstream of the wear structure.

8.0 LAKE HOUSTON OUTFALL STRUCTURE

Current plans indicate there will be an outfall structure where the canal drains to Lake Houston. We have not been provided with any information by AECOM with regards to the type of structure that will be constructed at the proposed outfall. However, we expect a weir type structure may be constructed along with a metering or power generation facility. General recommendations for a weir structure is presented in Section 7.6. We can provide additional recommendations for other structures once details are developed by AECOM.

9.0 ADDITIONAL CONSTRUCTION CONSIDERATIONS

The following subsections provide our construction considerations for general site preparation including tree removal and general site access, shallow open-cut excavations, structural clay fill, lime stabilization, and lime fly-ash stabilization, and construction monitoring.

9.1 General Site Preparation Recommendations and Considerations

Several areas along the project alignment, including areas near the pump station, transition between pipeline and canal, and at the discharge into Lake Houston are heavily wooded and site preparation will be an essential aspect of construction. The following sections provide general recommendations for tree removal and site preparation.

9.1.1 Tree Removal. We recommend that the removal of trees within the footprint of the proposed structures and pavements and along the proposed alignment be conducted as soon as possible to allow the onsite soil moisture conditions to reach a new equilibrium. The potential for the onsite soils to exhibit expansive behavior, *i.e.* shrinkage and swelling, is a function of the soil moisture conditions at the time of construction and the degree that the moisture profile changes with time. The removal of trees should include the removal of all rootballs and roots associated with the root structures of the removed trees. The excavations should be filled with properly placed and compacted structural clay fill. We recommend any burning of site debris be performed outside of any potentially developed areas.

9.1.2 General Site Access. In addition, general site preparation should include clearing and grubbing all significant surficial vegetation, organic materials, debris, and other deleterious materials below and extending at least 5 feet beyond the edges of the footprint of the proposed developed areas. Moisture conditioning may be required depending on the moisture condition at the time of construction. Surficial granular soils may be encountered in these areas following site-clearing operations. The surficial granular soils, if encountered, may be problematic in their natural state during the proposed construction activities. These soils can be relatively strong and stable when they are dry, but when they become wet, they can quickly lose their strength and load carrying ability.

If site access becomes problematic, we recommend stripping the upper 6 inches of the existing granular soils below developed areas. If the remaining granular soils are dry at the time of construction, we recommend stabilizing all granular soils below developed with a combination of lime and fly ash. As much as 2 ft of soil may require stabilization. This will require a staging area where the soils can be stabilized before being replaced and compacted. Soil stabilization is discussed in more detail in the following sub-sections. If surficial stabilization is not effective, or the granular soils are wet at the time of construction, we recommend removing the granular soils completely and replacing them with properly placed and compacted structural clay fill.

9.2 Shallow Open-Cut Excavations

Excavation safety systems should be in accordance with federal OSHA Standards, 29 CFR Part 1926 (Revised July 1992), Subpart P, Excavations. Details for open-cut slopes and excavation shoring based on soil type and groundwater conditions are provided in the latest amended OSHA federal regulations.

Excavations should be designed in accordance with all applicable local, state, and federal trenching regulations. Based on our interpretation of the regulations and the subsurface conditions indicated in the borings drilled at this site, we classify the natural cohesive soils as Type B soils and the surficial granular soils and any fill soils as Type C soils. Excavations deeper than about 4 feet should be either braced or sloped back no steeper than 1-horizontal to 1-vertical in Type B soils and 1.5-horizontal to 1-vertical in Type C soils. Flatter slopes or bracing should be used if sloughing or raveling is observed.

We recommend that the Geotechnical Engineer-of-Record or their qualified representative observe foundation excavations immediately prior to placing concrete. The engineer should compare the soils exposed with those encountered in the soil test borings and document the results. Any significant differences should be brought to the attention of the Owner's representative.

Foundation soils exposed by the excavations should be protected from disturbance due to construction activities. We recommend that the foundations be placed the same day the excavation is completed. Consideration should be given to placing a seal slab of lean concrete to protect the bottom of excavations from disturbance. Good surface drainage away from all excavations should be established to prevent surface runoff from either flooding the excavations or ponding around the completed foundations. Pumps should be available onsite to handle any runoff or seepage into excavations. The contractor should separate excavated materials into stockpiles with similar properties for future use.

9.3 Structural Clay Fill

Structural clay fill may be used as backfill after the removal of the surficial soils and to attain design grade, to construct building pad, and as otherwise directed in this report. We recommend using low plasticity cohesive soils for structural clay fill. Structural clay fill should have a liquid limit of less than 40, and a plasticity index between 10 and 20. Structural clay fill should be free of deleterious matter and should have an effective clod diameter less than 3 inches. ***We do <u>not</u> recommend mixing moderate or high plasticity clays with sand to achieve the requirements of structural clay fill.*** We recommend that swell tests be performed to evaluate suitability of the material as structural clay fill especially in areas of the building pad.

Structural clay fill should be placed in 6- to 8-inch-thick loose lifts and uniformly compacted to 95 percent of the maximum dry density at a moisture content of 1 percent "dry" to 3 percent "wet" of optimum as determined by ASTM D698. Structural clay fill should be compacted by a

sheepsfoot or padfoot type roller, or by alternative methods that provide a "kneading" compaction equivalent to the sheepsfoot or padfoot roller. We recommend using hand-operated compaction equipment and 4-inch-thick loose lifts adjacent to foundations and in confined areas.

If wet weather or extended dry periods deteriorate the surface whereby a good bond cannot be formed between successive lifts, the earthwork Contractor should prepare the surface as necessary. This preparation may include removing or scarifying the top couple of inches of the underlying material before placing the next lift.

Some of the onsite cohesive soils meet the plasticity requirements for structural clay fill. We recommend that confirmatory tests should be conducted prior to the use of the onsite cohesive soils as structural clay fill.

9.4 Lime-Stabilized Clay Fill

Lime-stabilization may be used to modify potential clay fill materials. Laboratory tests should be conducted at the time of construction to determine the optimum lime content. The optimum lime content is the amount of lime necessary to achieve a pH of 12.4 (which represents lime fixation), while trying to achieve a plasticity (PI) of less than 20. For estimation purposes, about 4 to 6 percent lime, by dry weight, may be required to stabilize the onsite moderate to high plasticity clay soils. Organics, chemical fertilizers, and some clay minerals can modify the amount of lime necessary for lime fixation. We recommend that a lime series be performed using the specific soil samples and proposed lime additive.

Lime-stabilization should be done in accordance with the Lime Association recommendations. Key items for lime-stabilizing the clay soils include placing the proper percentage of lime, thoroughly mixing the lime into the clay soils, bringing the stabilized soil to the proper moisture content, allowing the stabilized soil to cure for at least 48 hours, adjusting the moisture content from 1 percent dry to 3 percent wet of optimum moisture content, pulverizing the soils again until the lime is thoroughly blended, then placing the stabilized soil in accordance with the recommendations discussed herein.

The moisture-density relationship should be established based on a material sample obtained on-site after stabilization with lime. A combination of sheepsfoot or padfoot rollers and pneumatic rollers is recommended to compact the lime-stabilized clay fill. We recommend using hand-operated compaction equipment and 4-inch-thick loose lifts adjacent to foundations and in confined areas. Care should be taken not to over-compact next to basement walls. Excessive compaction could induce lateral pressures that are greater than the design pressures.

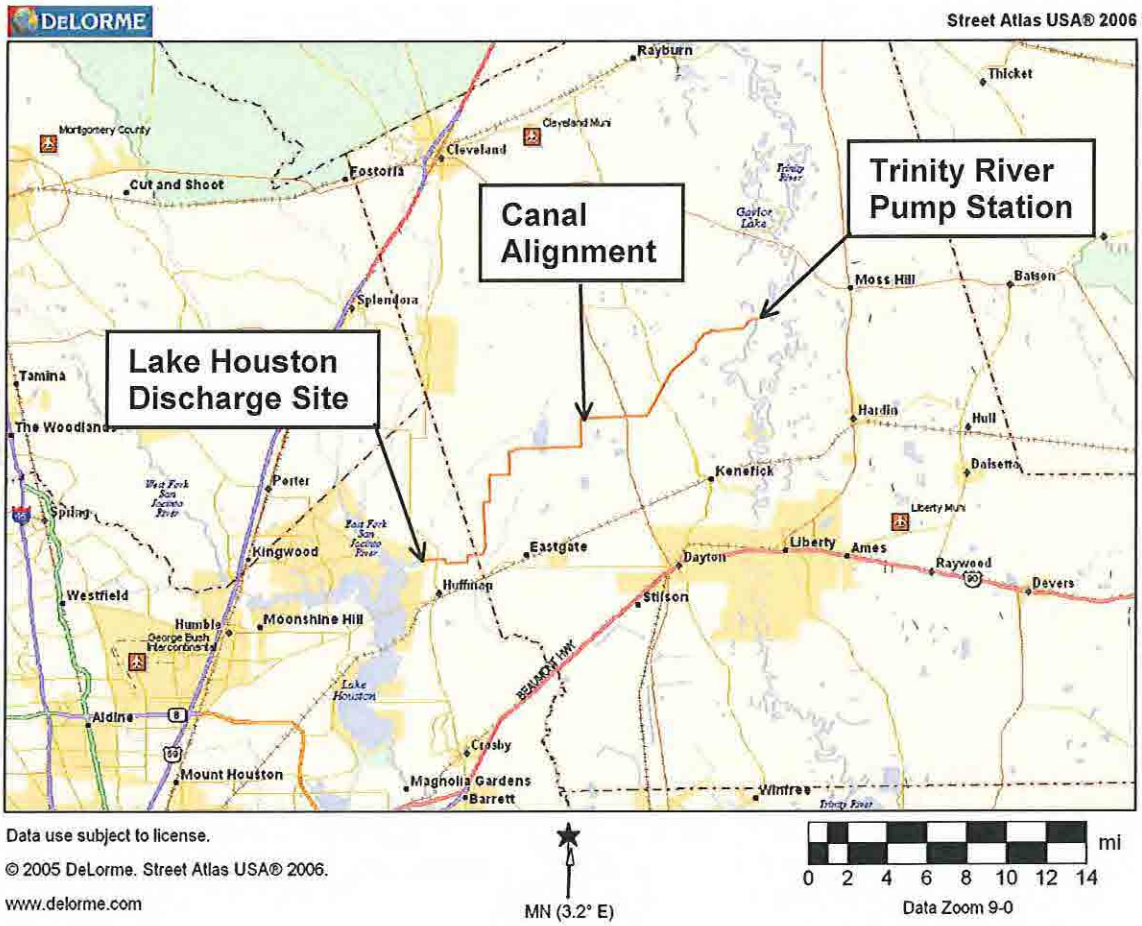
The percentages of lime usually required to stabilize clay is detrimental to vegetation. Vegetation generally does not thrive well in or around lime-stabilized clay. To support vegetation, a thick layer of topsoil is usually placed on top of the stabilized clay.

9.5 Lime-Fly Ash Stabilization

Lime-fly ash stabilization may be performed to treat the onsite granular soils. Laboratory tests should be performed at the time of construction to determine the optimum lime-fly ash content and the ratio to be applied to the silty clay soils. We estimate about 3 percent lime and 6 percent fly ash by dry weight may be required to stabilize the onsite silty soils. Generally, the recommended ratio of lime to fly ash is between 1-to-2 and 1-to-3. The actual amount of lime-fly ash required will vary depending on the type of fly ash available, the gradation of the silty clay soils, and the plasticity of the silty clay soils. Fly ash should conform to the requirements of ASTM C618 and meet the following requirements: 1) have a minimum CaO content of 20 percent, 2) loss on ignition should not exceed 3 percent, and 3) contain no lignite.

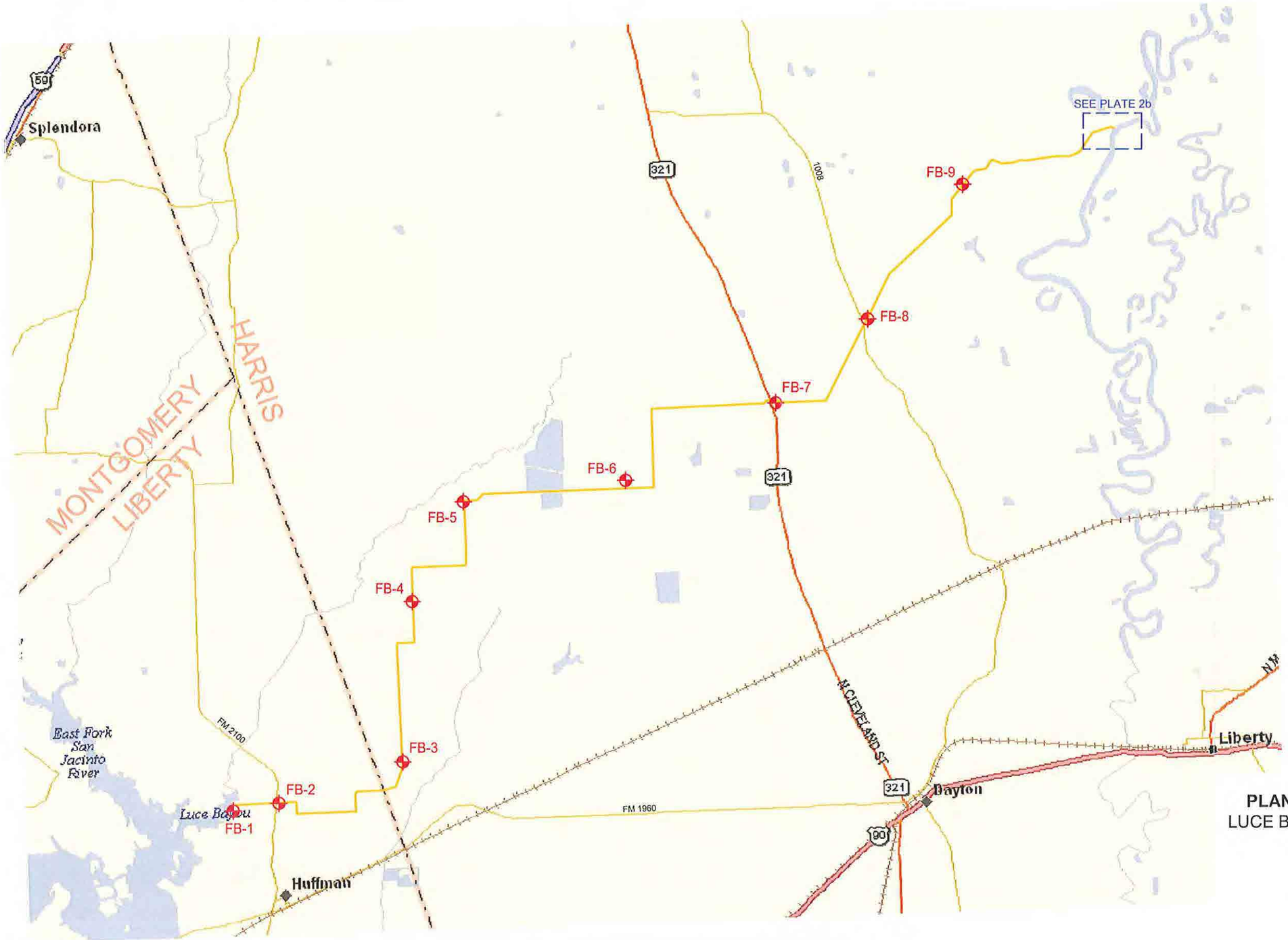
The lime-fly ash stabilized soil subgrade should be thoroughly mixed and then recompacted to 95 percent of maximum dry density determined by Standard Proctor (ASTM D698). Mixing should be performed using an approved single-pass or multiple-pass rotary speed mixer to obtain a homogenous mixture. The moisture-density relationship should be established based on a material sample obtained from the on-site silty soils after stabilization with lime-fly ash has taken place.

ILLUSTRATIONS



VICINITY MAP

LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HARRIS AND LIBERTY COUNTIES, TEXAS



LEGEND

FB-1 GEOTECHNICAL BORING

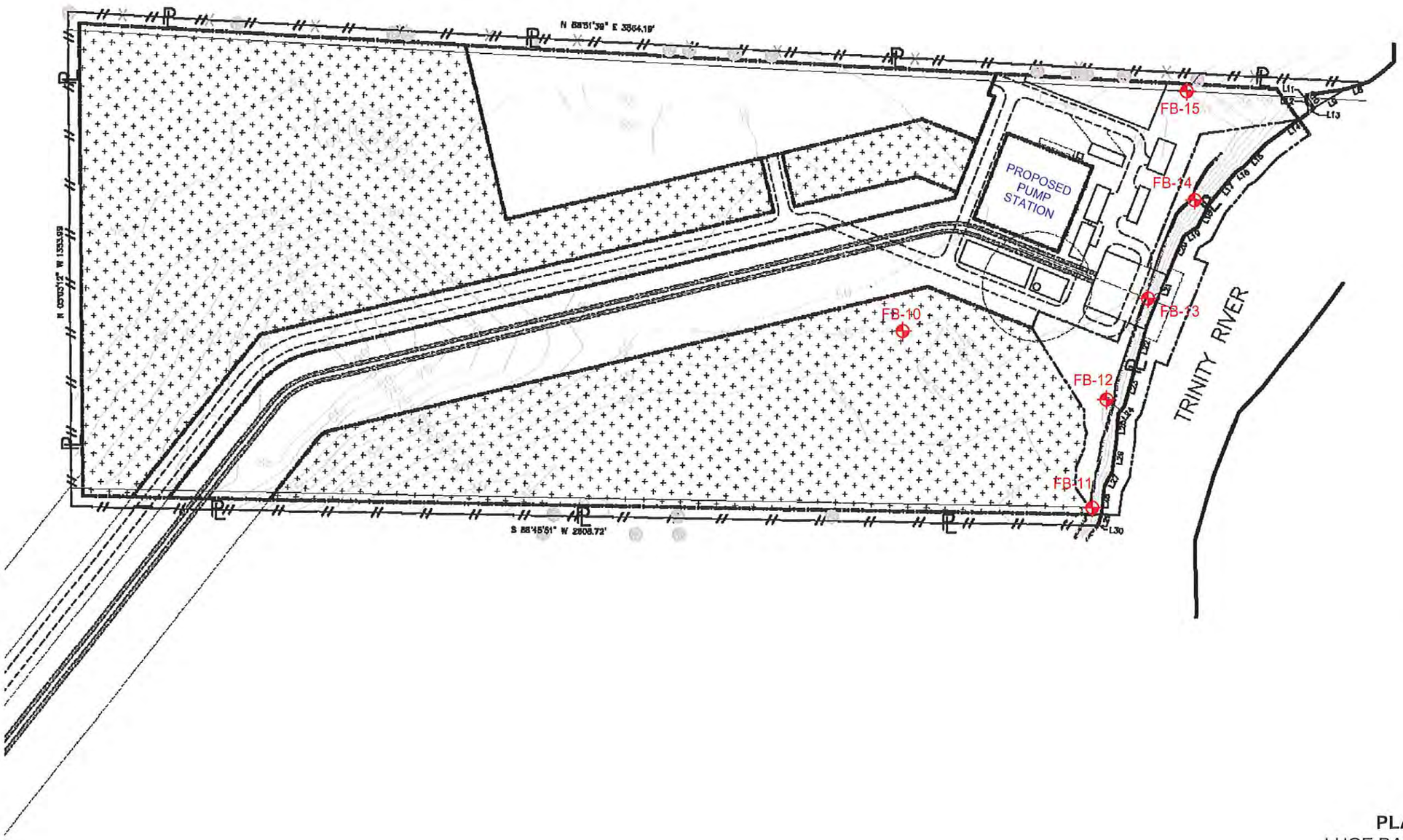
CANAL ALIGNMENT

NOTES:
1. BORING LOCATIONS ARE APPROXIMATE.
2. BASE DRAWING PROVIDED BY AECOM.

PLAN OF BORINGS - PROJECT ALIGNMENT
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
LIBERTY COUNTY, TEXAS

0 5,000 10,000 FEET

PLATE 2a



LEGEND

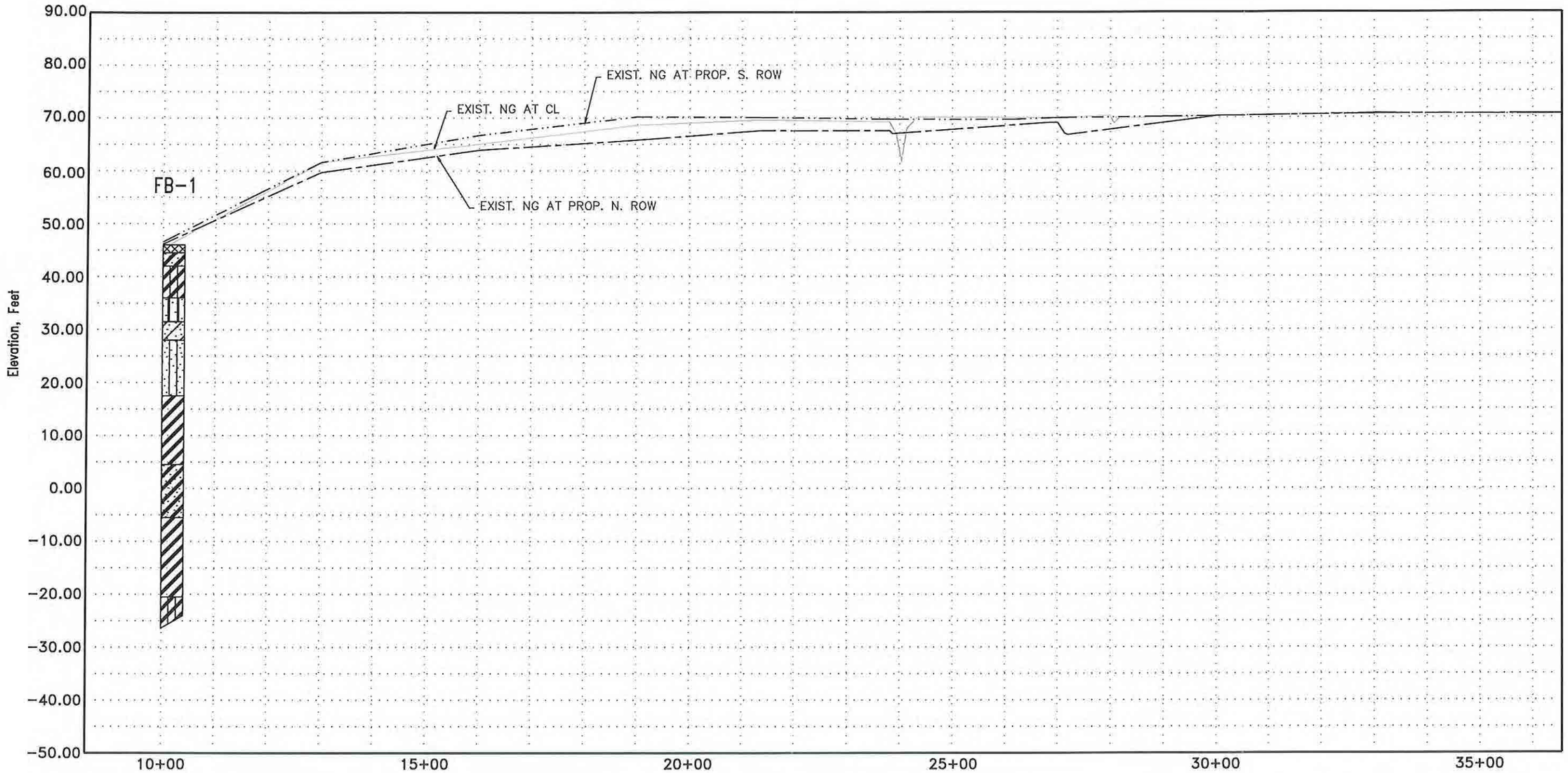
FB-1	GEOTECHNICAL BORING
	UNDISTURBED AREA
	PROPOSED STRUCTURE
	PROPOSED PLANT ROAD
	PROPOSED PIPELINE
	PROPERTY LINE
	PROPOSED FENCE
	EXISTING FENCE
	EXISTING CONTOUR

NOTES:
1. BASE DRAWING PROVIDED BY AECOM.

PLAN OF BORINGS - PUMP STATION
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
LIBERTY COUNTY, TEXAS

0 300 600 FEET

PLATE 2b



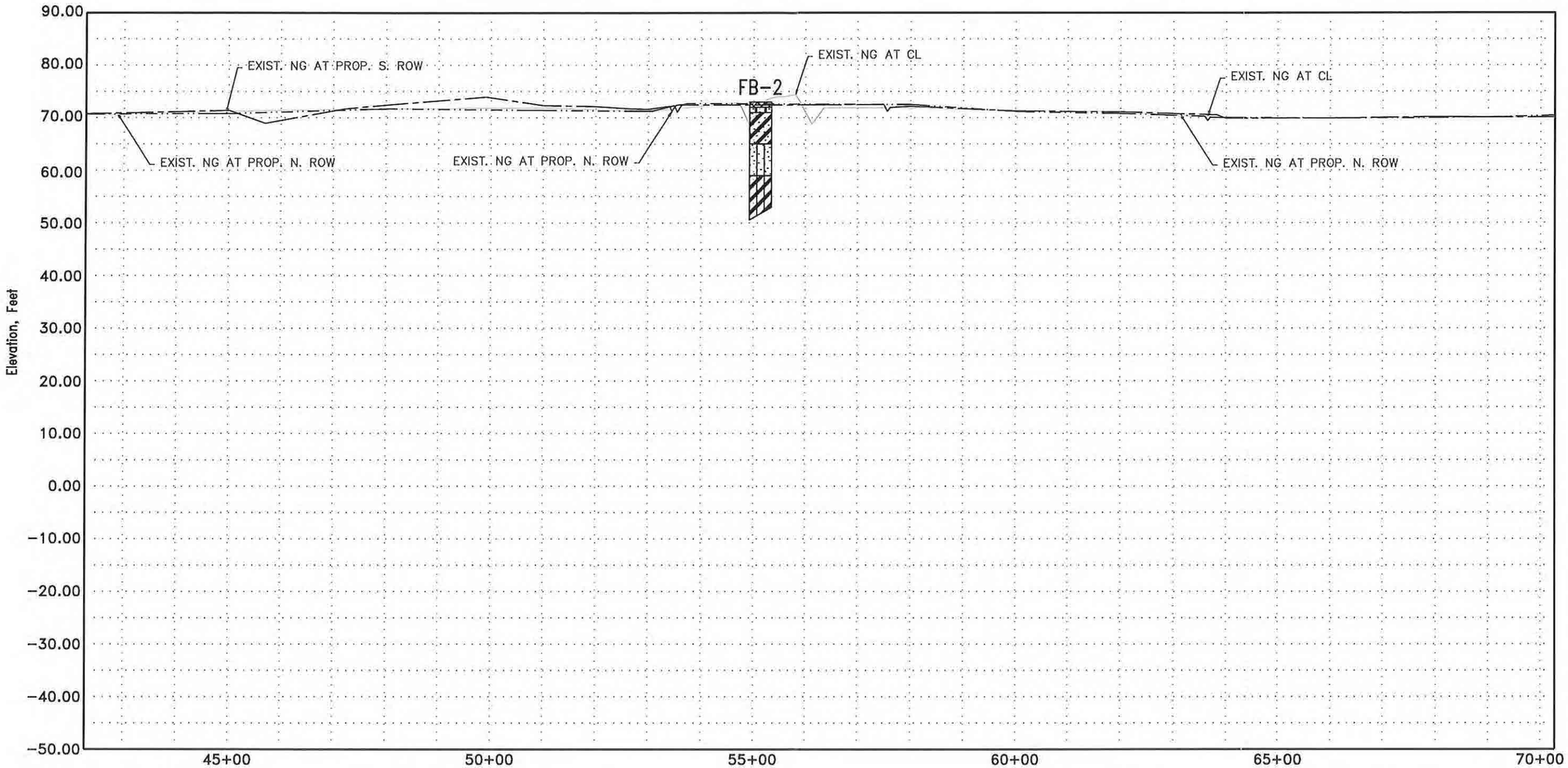
LEGEND

SAND, SILT, CLAY, FILL, SILTY SAND, SANDY SILT, SANDY CLAY, CLAYEY SAND, CLAYEY SILT, SILTY CLAY

Notes:
1. Data concerning subsurface conditions was obtained at boring locations only.
2. Alignment data provided by AECOM.

SUBSURFACE PROFILE - ALONG ALIGNMENT

VERTICAL SCALE
0 20 40 FEET
0 200 400 FEET
HORIZONTAL SCALE



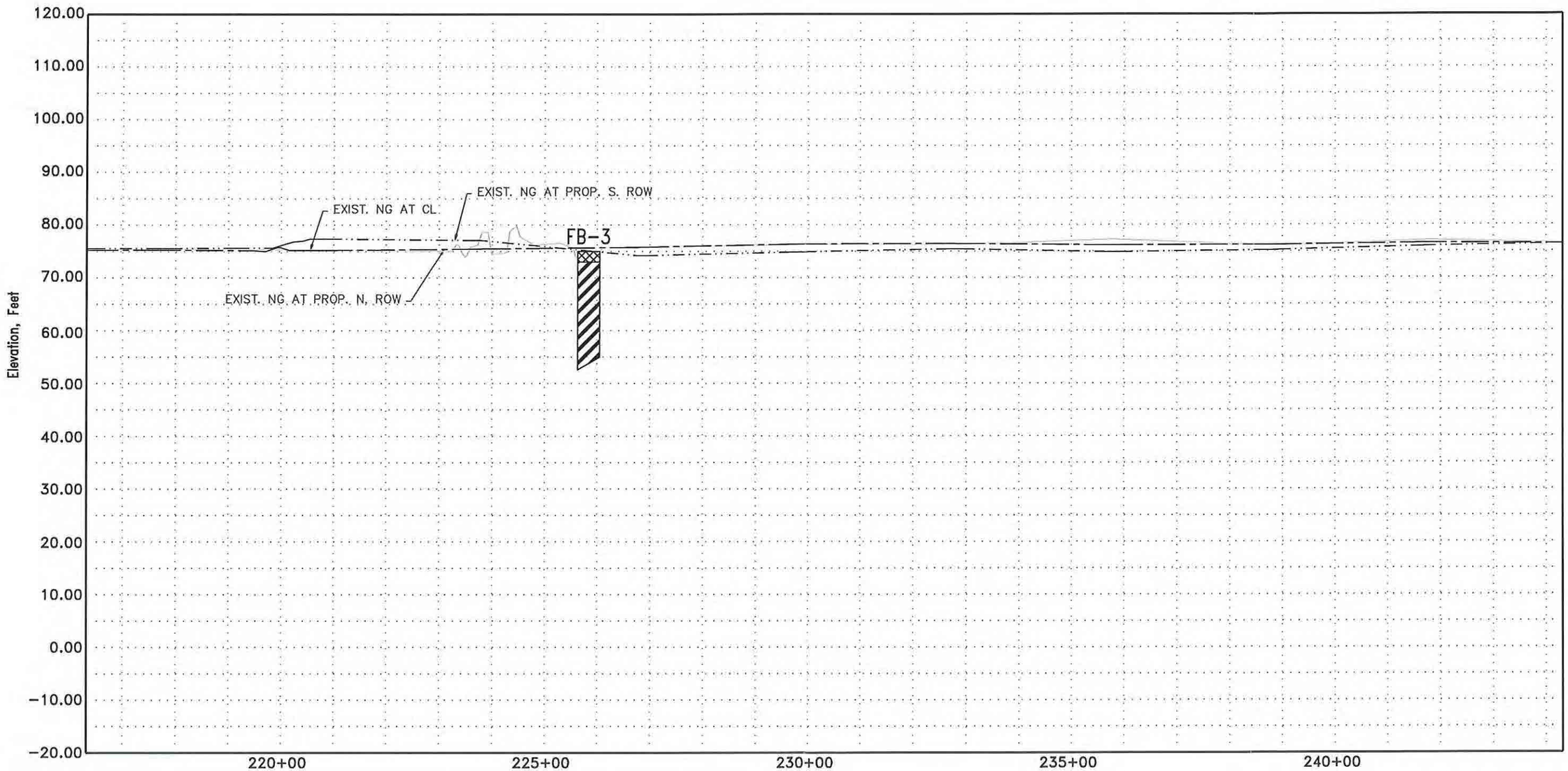
LEGEND

SAND	SILT	CLAY	FILL
SILTY SAND	SANDY SILT	SANDY CLAY	
CLAYEY SAND	CLAYEY SILT	SILTY CLAY	

Notes:
1. Data concerning subsurface conditions was obtained at boring locations only.
2. Alignment data provided by AECOM.

SUBSURFACE PROFILE - ALONG ALIGNMENT

VERTICAL SCALE
0 20 40 FEET
0 200 400 FEET
HORIZONTAL SCALE



LEGEND

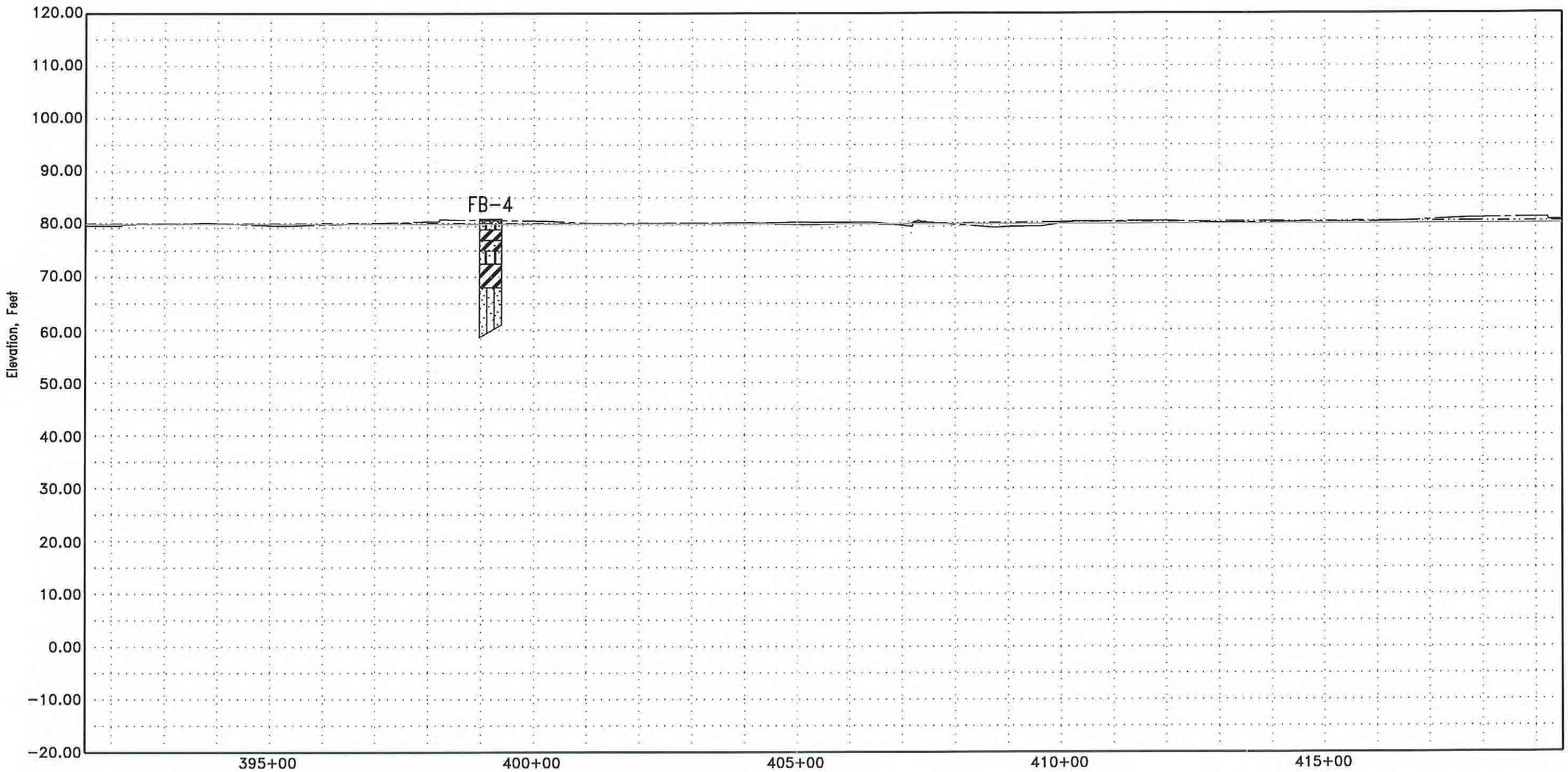
SAND	SILT	CLAY	FILL
SILTY SAND	SANDY SILT	SANDY CLAY	
CLAYEY SAND	CLAYEY SILT	SILTY CLAY	

Notes:
1. Data concerning subsurface conditions was obtained at boring locations only.
2. Alignment data provided by AECOM.

SUBSURFACE PROFILE - ALONG ALIGNMENT

VERTICAL SCALE
0 20 40 FEET
0 200 400 FEET
HORIZONTAL SCALE

PLATE 3c



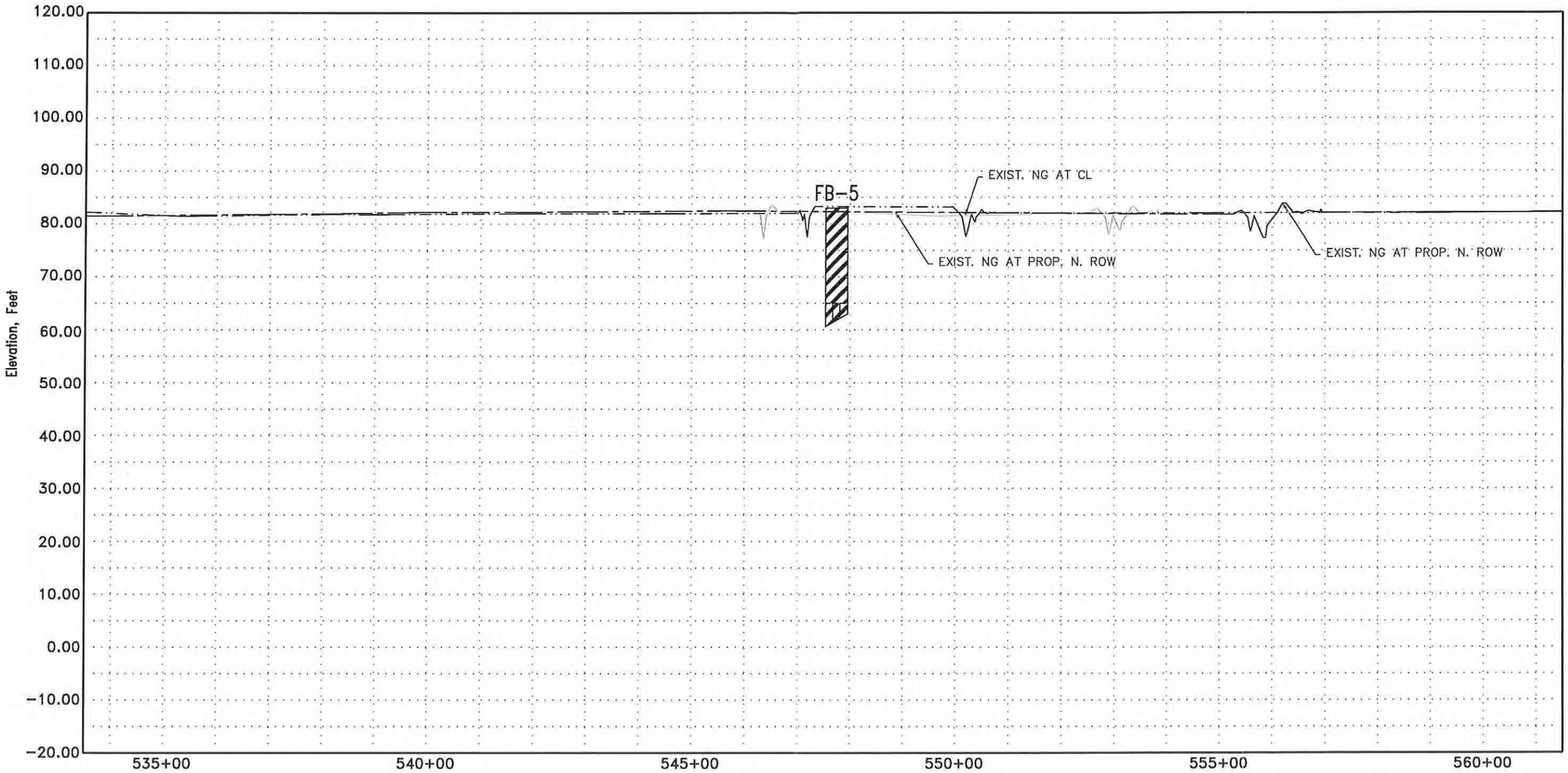
LEGEND

SAND	SILT	CLAY	FILL
SILTY SAND	SANDY SILT	SANDY CLAY	
CLAYEY SAND	CLAYEY SILT	SILTY CLAY	

Notes:
1. Data concerning subsurface conditions was obtained at boring locations only.
2. Alignment data provided by AECOM.

SUBSURFACE PROFILE - ALONG ALIGNMENT

VERTICAL SCALE
0 20 40 FEET
0 200 400 FEET
HORIZONTAL SCALE



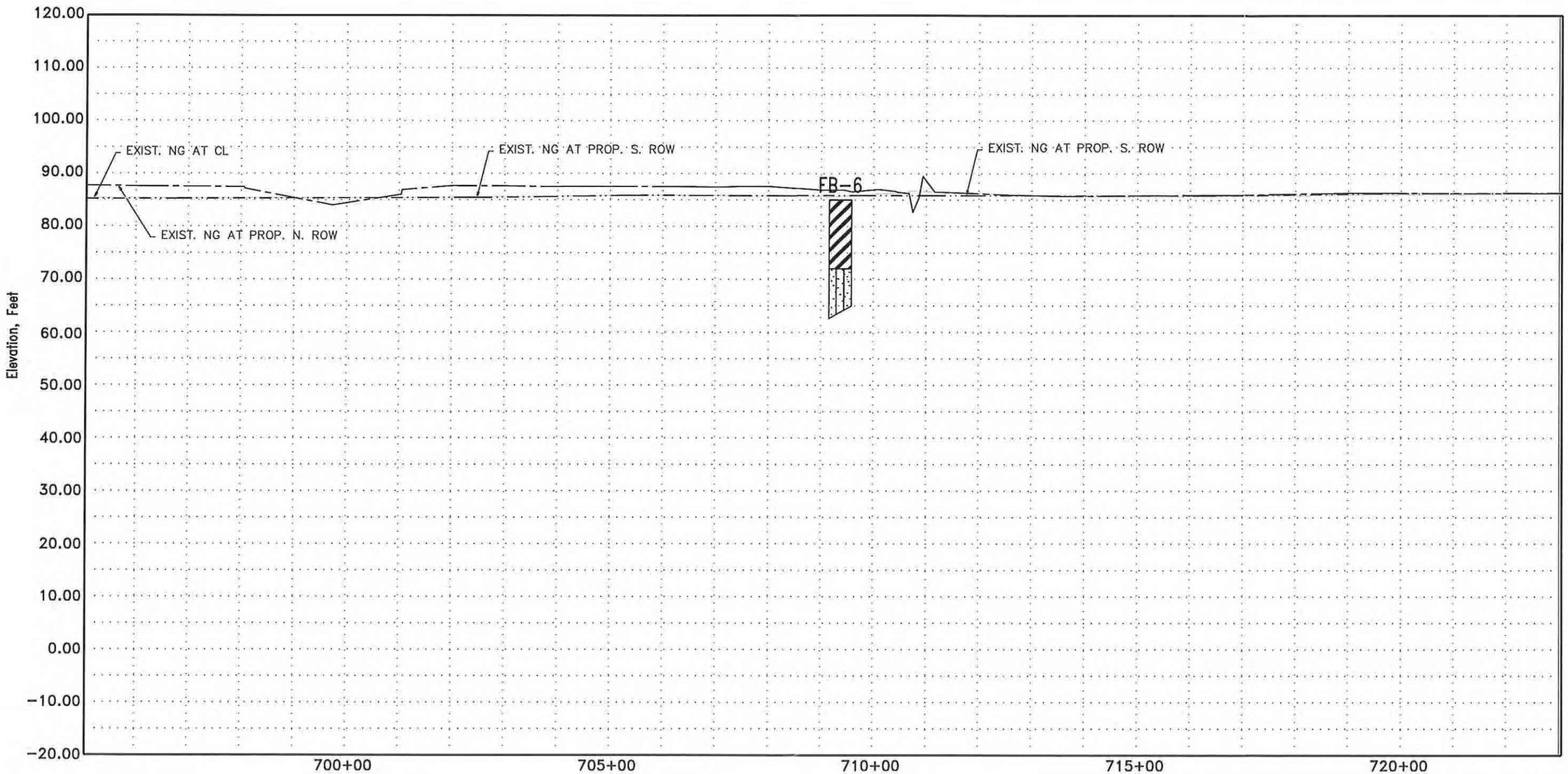
LEGEND

SAND	SILT	CLAY	FILL
SILTY SAND	SANDY SILT	SANDY CLAY	
CLAYEY SAND	CLAYEY SILT	SILTY CLAY	

Notes:
1. Data concerning subsurface conditions was obtained at boring locations only.
2. Alignment data provided by AECOM.

SUBSURFACE PROFILE - ALONG ALIGNMENT

VERTICAL SCALE
0 20 40 FEET
0 200 400 FEET
HORIZONTAL SCALE



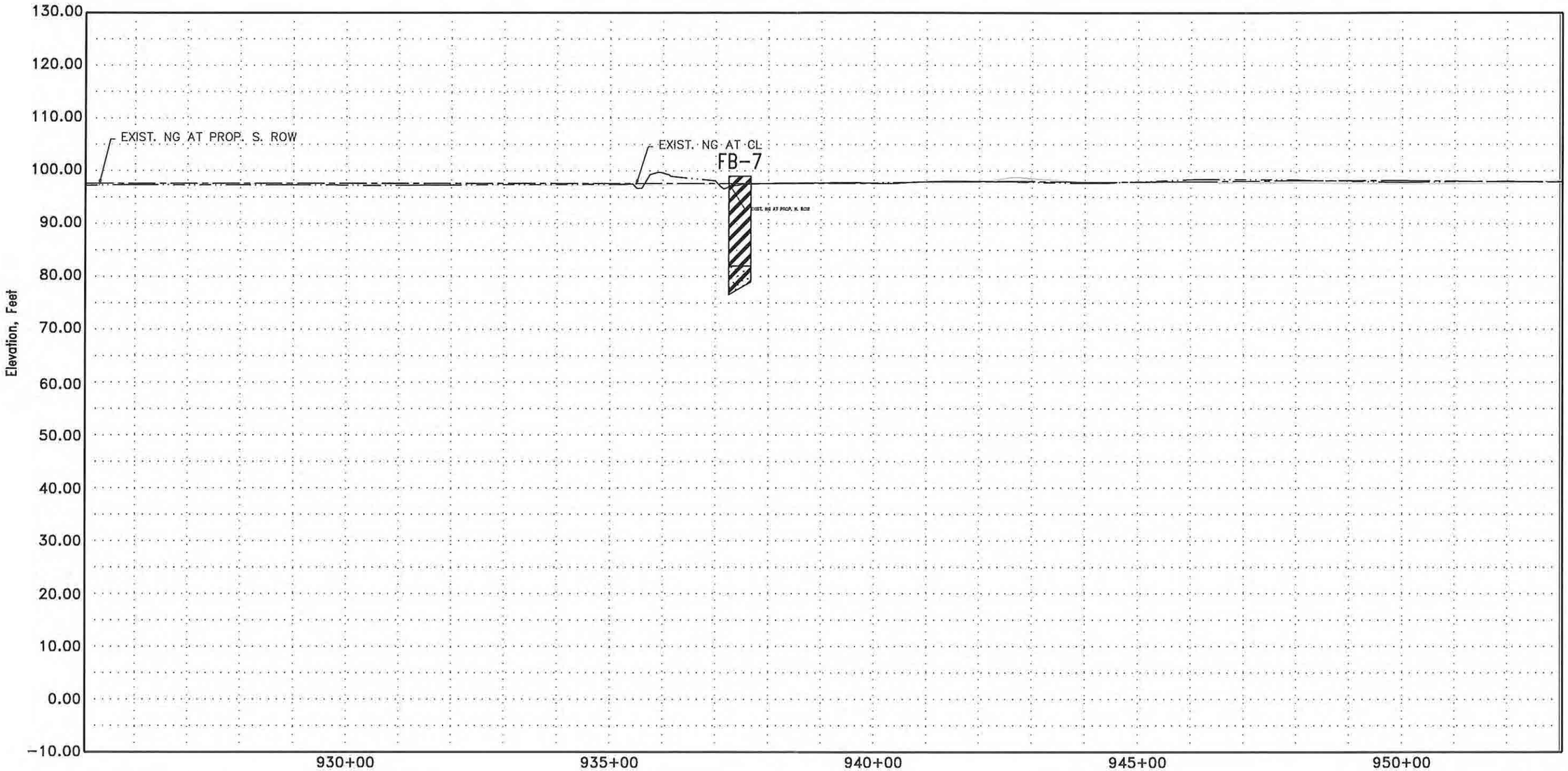
LEGEND

SAND	SILT	CLAY	FILL
SILTY SAND	SANDY SILT	SANDY CLAY	
CLAYEY SAND	CLAYEY SILT	SILTY CLAY	

Notes:
1. Data concerning subsurface conditions was obtained at boring locations only.
2. Alignment data provided by AECOM.

SUBSURFACE PROFILE - ALONG ALIGNMENT

VERTICAL SCALE
0 20 40 FEET
0 200 400 FEET
HORIZONTAL SCALE



LEGEND

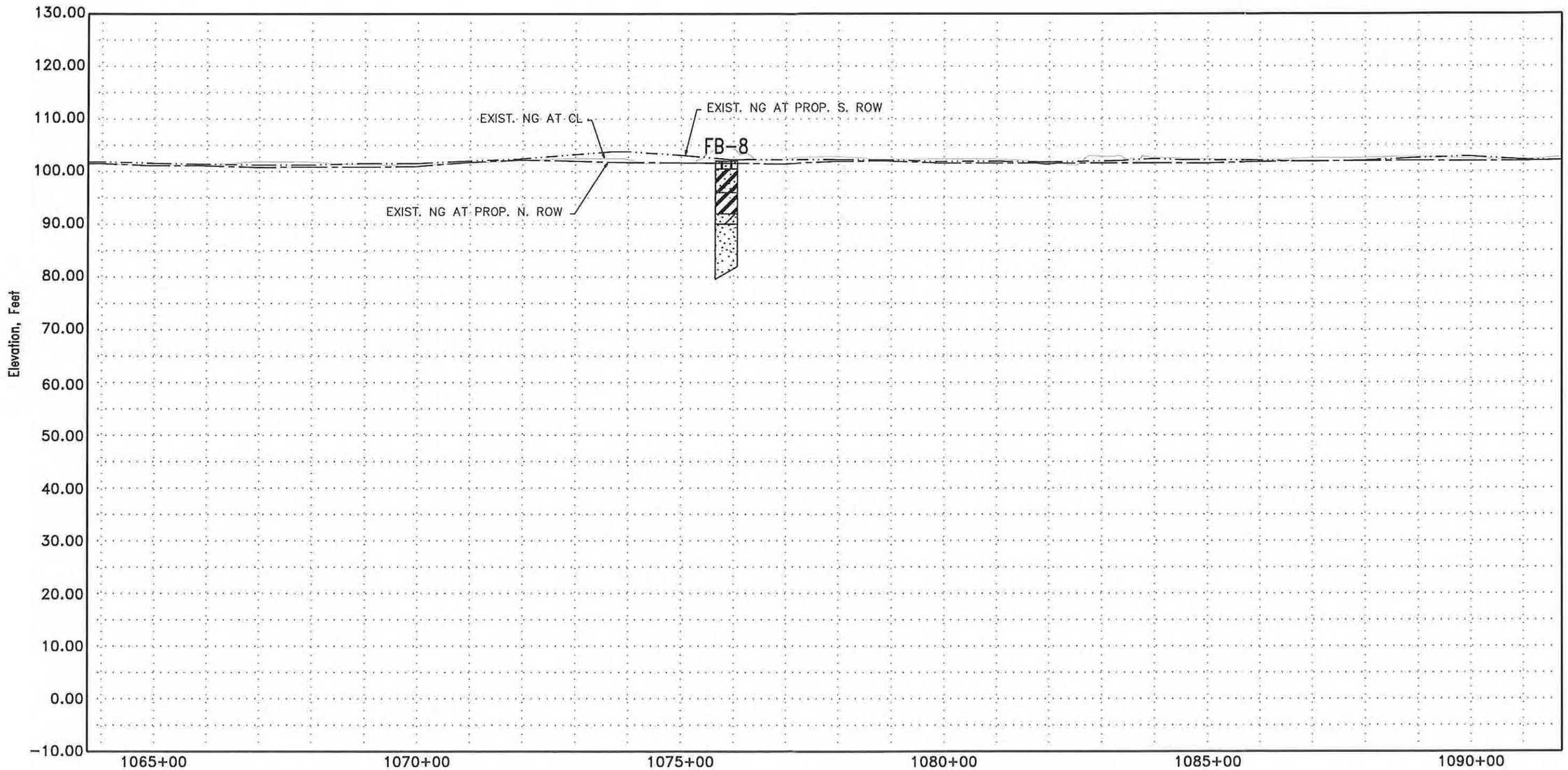
SAND	SILT	CLAY	FILL
SILTY SAND	SANDY SILT	SANDY CLAY	
CLAYEY SAND	CLAYEY SILT	SILTY CLAY	

Notes:
1. Data concerning subsurface conditions was obtained at boring locations only.
2. Alignment data provided by AECOM.

SUBSURFACE PROFILE - ALONG ALIGNMENT

VERTICAL SCALE
0 20 40 FEET
0 200 400 FEET
HORIZONTAL SCALE

PLATE 3g



LEGEND

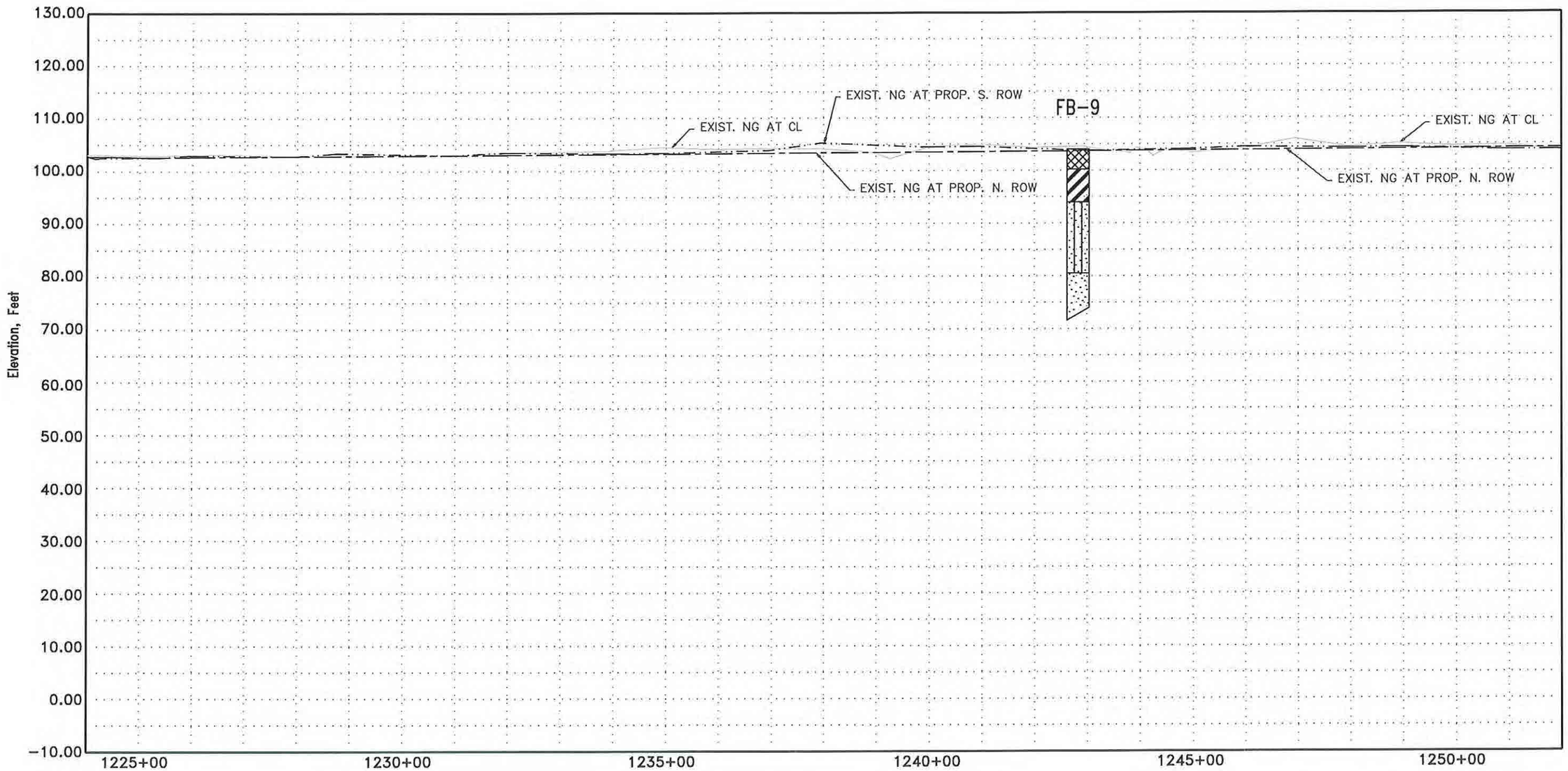
SAND	SILT	CLAY	FILL
SILTY SAND	SANDY SILT	SANDY CLAY	
CLAYEY SAND	CLAYEY SILT	SILTY CLAY	

Notes:
1. Data concerning subsurface conditions was obtained at boring locations only.
2. Alignment data provided by AECOM.

SUBSURFACE PROFILE - ALONG ALIGNMENT

VERTICAL SCALE
0 20 40 FEET
0 200 400 FEET
HORIZONTAL SCALE

PLATE 3h



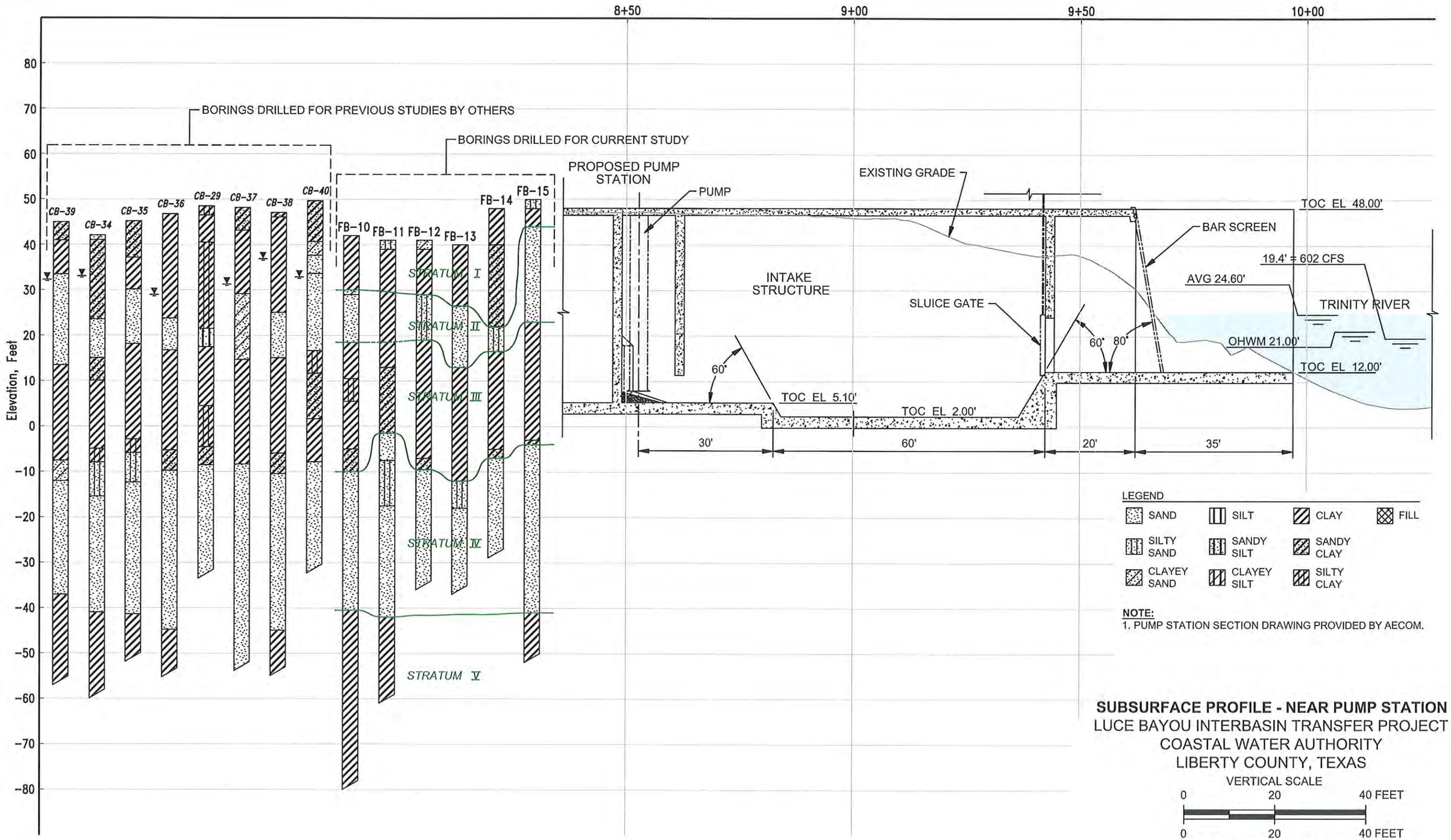
LEGEND

SAND, SILT, CLAY, FILL
SILTY SAND, SANDY SILT, SANDY CLAY
CLAYEY SAND, CLAYEY SILT, SILTY CLAY

Notes:
1. Data concerning subsurface conditions was obtained at boring locations only.
2. Alignment data provided by AECOM.

SUBSURFACE PROFILE - ALONG ALIGNMENT

VERTICAL SCALE
0 20 40 FEET
0 200 400 FEET
HORIZONTAL SCALE



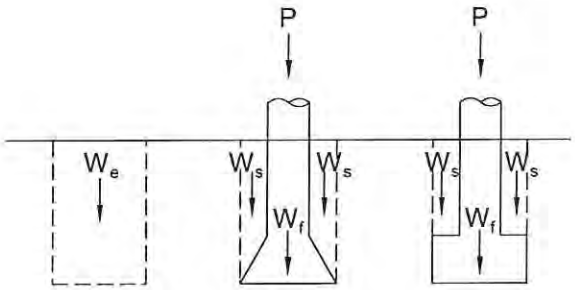
SUBSURFACE PROFILE - NEAR PUMP STATION
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
LIBERTY COUNTY, TEXAS

PLATE 3j

FOUNDATION DESIGN CRITERIA

A properly-sized foundation must satisfy the two following criteria with respect to the supporting soil.

1. For soil strength. The bearing pressure created on the base of the foundation by the maximum design load must be less than that which would cause shear failure in the soil. A factor of safety of 2 or more with respect to the soil shear strength is generally used.
2. For soil compressibility. The bearing pressure created on the base of the foundation by the sustained load must not produce sufficient consolidation in the underlying soil to result in foundation settlement that is detrimental to the safety or utility of the structure.



SYMBOLS

TERMS AND SYMBOLS

P = Column load (subscript can be used to denote character of load: P_s = sustained load, P_n = normal operating load, P_m = maximum design load).

W_e = Weight of soil located above base of foundation excavation and lowest adjacent grade.*

W_s = Weight of soil located above foundation.*

W_f = Weight of foundation.*

A = Area of base of foundation.

p = Average bearing pressure acting on soil (subsript can be used to correspond to column load: P_s, P_n, P_m).

* Position of groundwater level must be considered in determining weights. Effective, or buoyant, unit weights should be used below the highest expected groundwater level.

BEARING PRESSURES

Gross Bearing Pressure, p, for any column load is the total pressure acting on the base of the foundation.

$$p = 1/A\ (P + W_s + W_f)$$

Net Bearing Pressure, p', for any column load is the difference between the gross bearing pressure acting on the base of the foundation and the soil pressure existing at that elevation from the lowest overlying or adjacent soils.

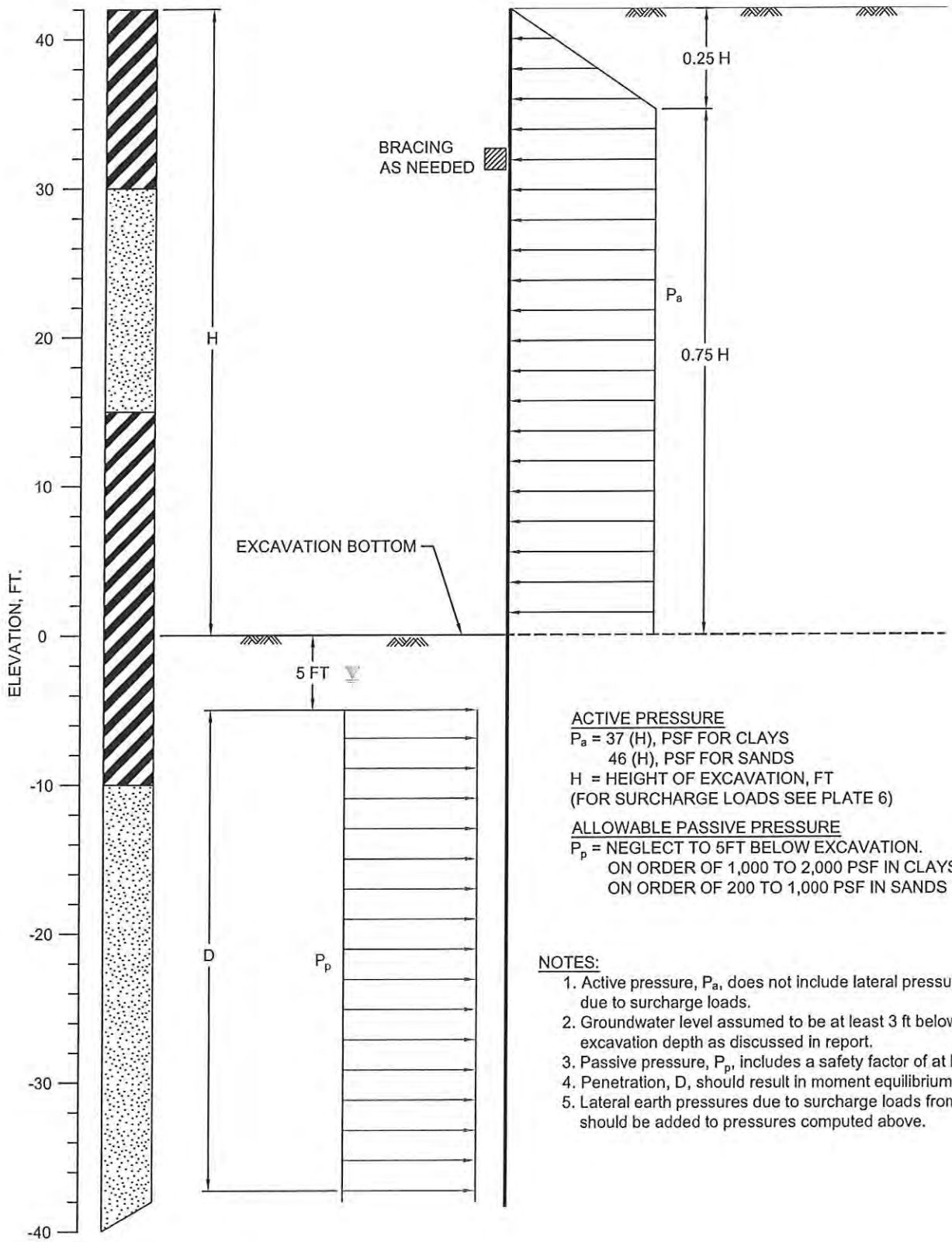
$$p' = 1/A\ (P + W_s + W_f - W_e)$$

For analysis with regard to the first design criterion, soil strength, the column load in the above equations should usually be the maximum design load, P_m . Occasionally, the normal operating load, P_n , may also be used. If footing is loaded eccentrically, the increase in edge bearing pressure due to the eccentricity should be computed in the usual manner.

For analysis with regard to the second design criterion, soil compressibility, the column load in the above equations should be the sustained load, P_s. This load is the dead load plus the sustain live load.

For further references, see pp. 506 - 512, "Soil Mechanics in Engineering Practice" by Karl Terzaghi and Ralph B. Peck (2nd edition); and pp. 564 - 565, "Fundamentals of Soil Mechanics" by Donald W. Taylor.

COMPUTATION OF BEARING PRESSURES
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

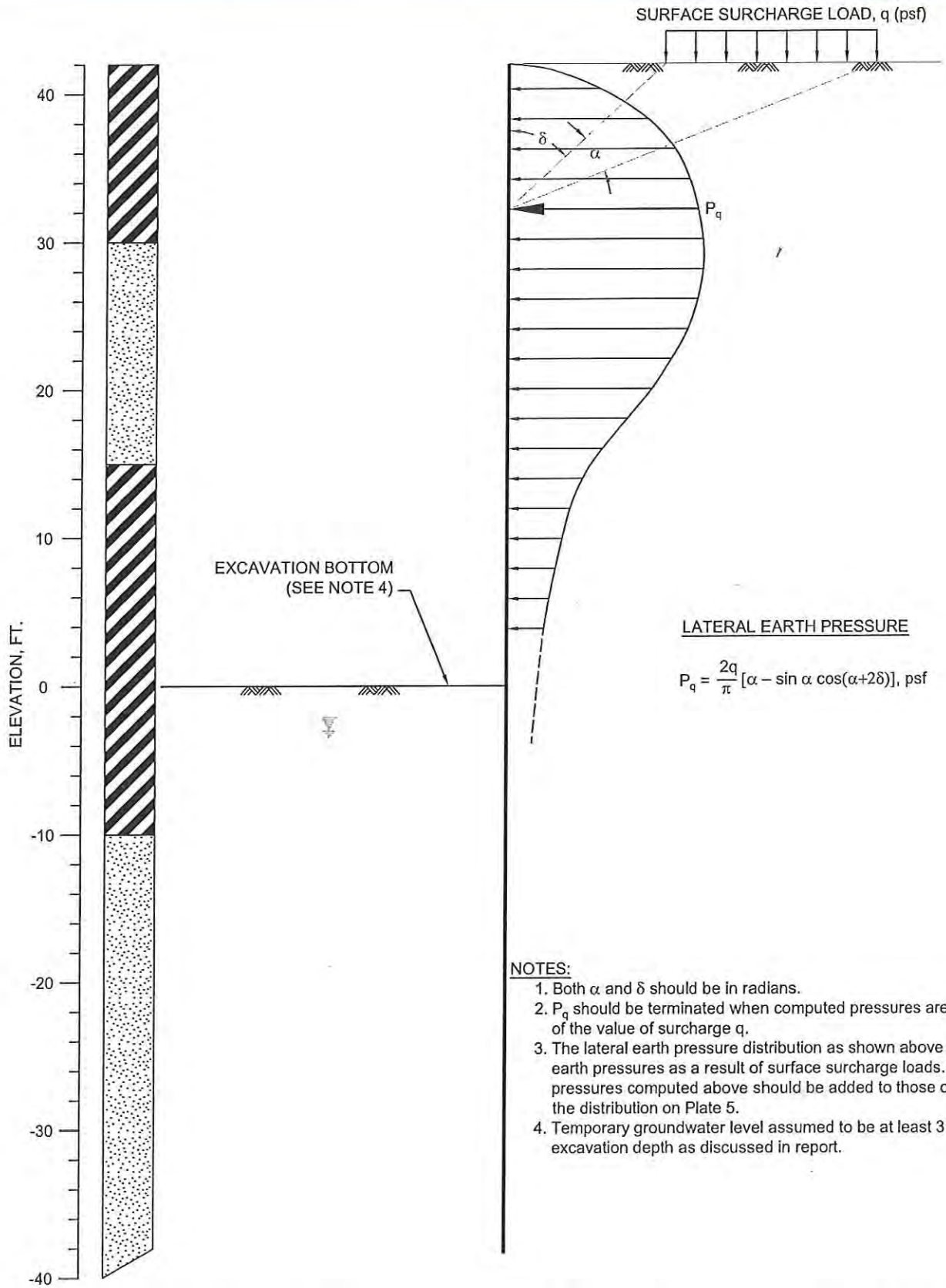


ACTIVE PRESSURE
P_a = 37 (H), PSF FOR CLAYS
46 (H), PSF FOR SANDS
H = HEIGHT OF EXCAVATION, FT
(FOR SURCHARGE LOADS SEE PLATE 6)

ALLOWABLE PASSIVE PRESSURE
P_p = NEGLECT TO 5FT BELOW EXCAVATION.
ON ORDER OF 1,000 TO 2,000 PSF IN CLAYS
ON ORDER OF 200 TO 1,000 PSF IN SANDS

NOTES:
1. Active pressure, P_a, does not include lateral pressure due to surcharge loads.
2. Groundwater level assumed to be at least 3 ft below excavation depth as discussed in report.
3. Passive pressure, P_p, includes a safety factor of at least 2.0.
4. Penetration, D, should result in moment equilibrium.
5. Lateral earth pressures due to surcharge loads from Plate 6 should be added to pressures computed above.

TEMPORARY LATERAL EARTH PRESSURES
(TEMPORARY EXCAVATION RETENTION SYSTEM)



LATERAL EARTH PRESSURE

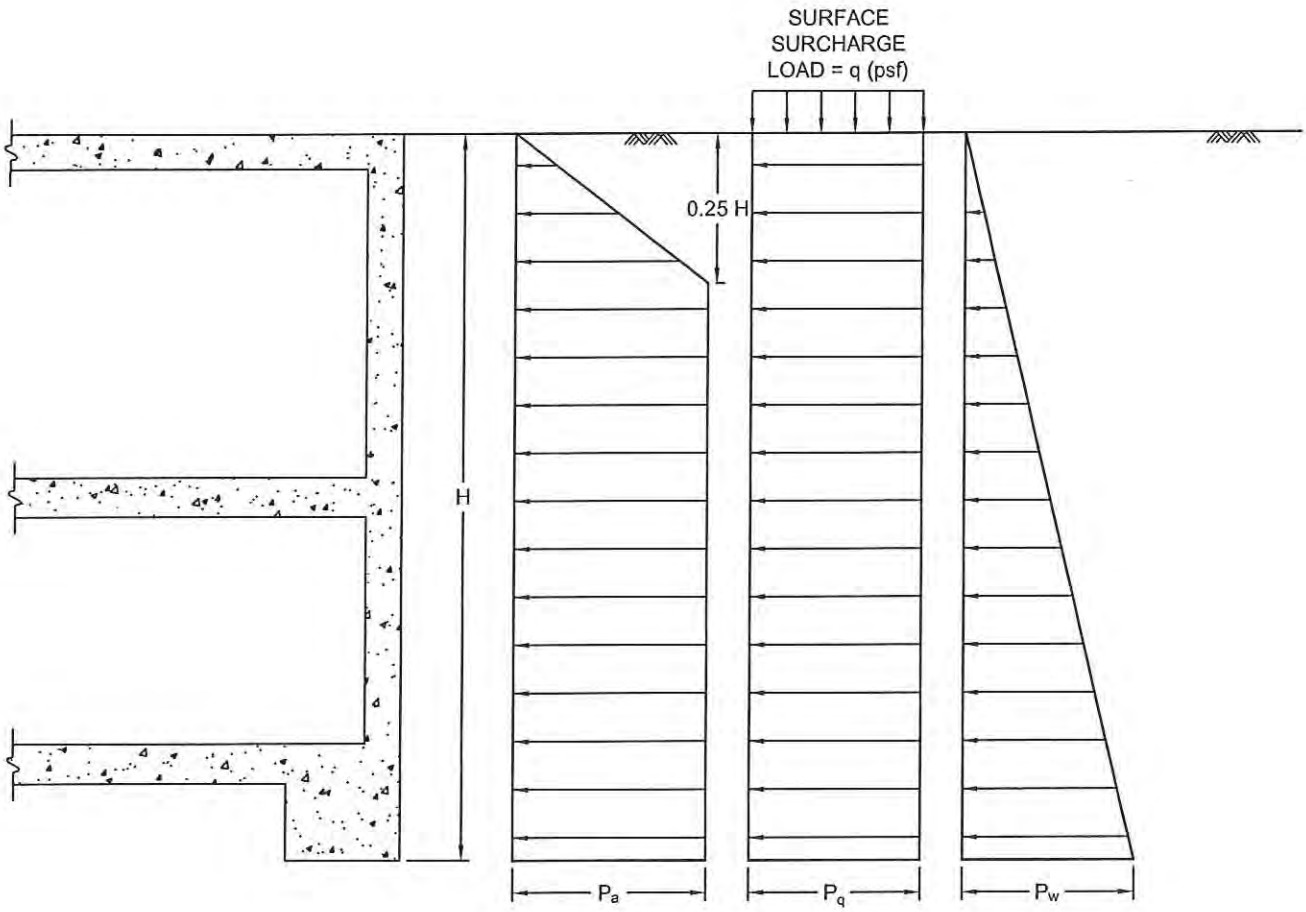
$$P_q = \frac{2q}{\pi}[\alpha - \sin\alpha\cos(\alpha+2\delta)], \text{ psf}$$

NOTES:

1. Both α and δ should be in radians.
2. P_q should be terminated when computed pressures are less than 10% of the value of surcharge q.
3. The lateral earth pressure distribution as shown above is solely for earth pressures as a result of surface surcharge loads. The earth pressures computed above should be added to those computed from the distribution on Plate 5.
4. Temporary groundwater level assumed to be at least 3 ft below excavation depth as discussed in report.

TEMPORARY LATERAL EARTH PRESSURES FROM SURFACE SURCHARGE LOADS

(TEMPORARY EXCAVATION RETENTION SYSTEM)



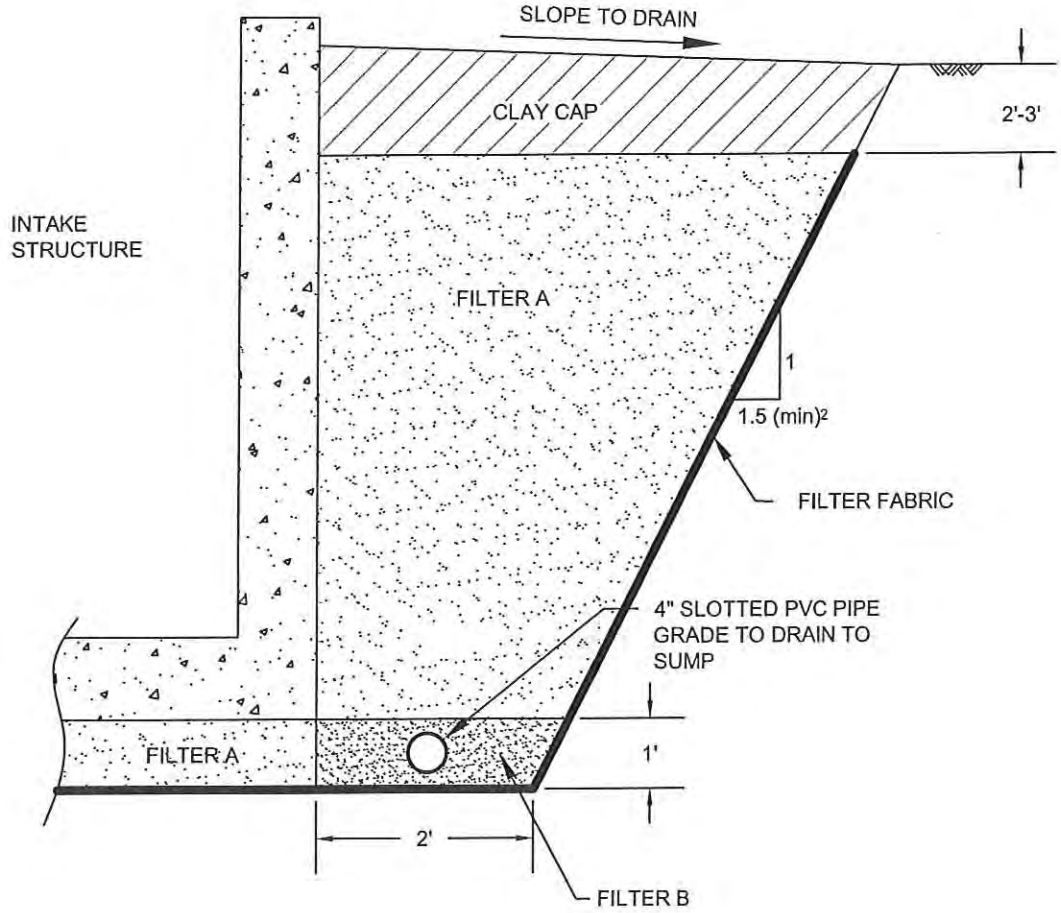
ACTIVE PRESSURE
Soil: P_a = 37 (H), psf for sand
46 (H), psf for clay
Surcharge: P_q = 0.5 (q), psf
Water: P_w = 62.4 (H), psf

H = Excavation Depth, ft
q = Surcharge Load, psf

NOTES:

1. The lateral earth pressures shown above are for properly placed fill soils in contact with permanent walls.
2. Refer to report text for recommendations relating to wall drains.
3. See report text for additional details.

LATERAL EARTH PRESSURES FOR PERMANENT PUMP STATION WALLS
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
LIBERTY COUNTY, TEXAS
(NOT TO SCALE)



NOTES:
1. Filter fabric and gradation of filter material presented on Plate 8b.
2. Slope in accordance with OSHA requirements for construction purposes.
3. See report text for additional drainage recommendations.

SCHEMATIC OF WALL DRAIN SYSTEM
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
LIBERTY COUNTY, TEXAS
(NOT TO SCALE)

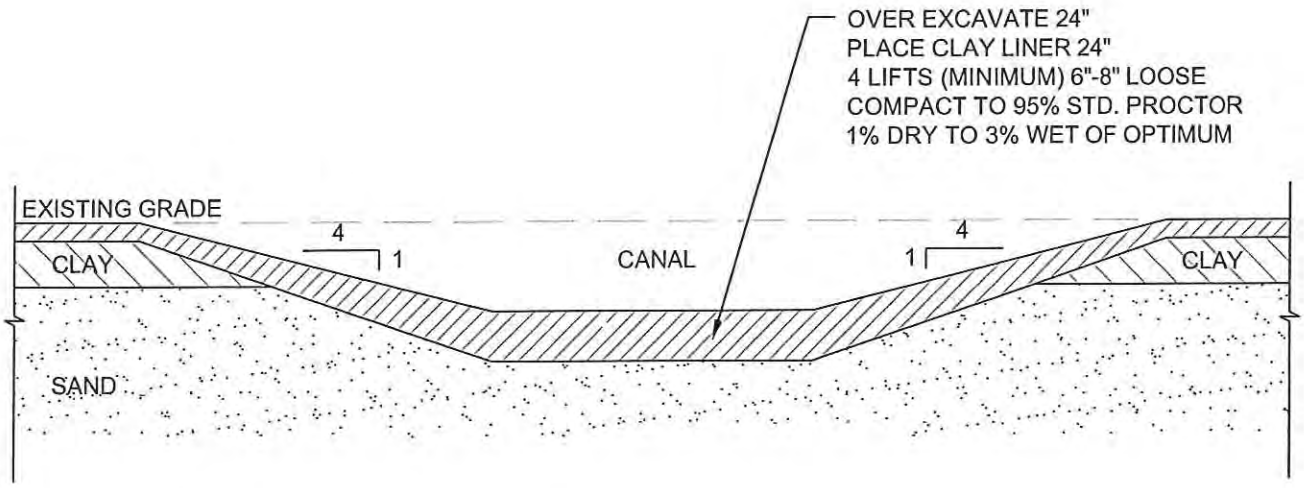
Sieve No.	Percentage Passing	
	Filter A	Filter B
1 inch	-	100
3/4 inch	-	90 - 100
1/2 inch	-	55 - 95
3/8 inch	100	20 - 85
4	95 - 100	0 - 60
8	80 - 100	-
16	50 - 85	0 - 6
30	25 - 60	-
50	10 - 30	-
100	2 - 10	-
200	0 - 3	-

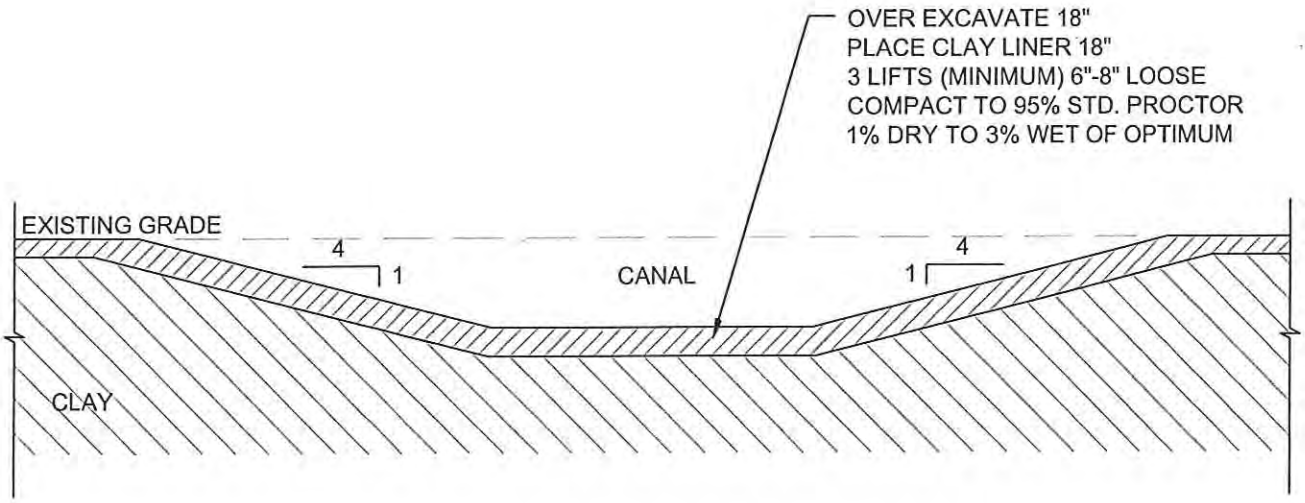
Notes:

1. Filter A gradation is the same as the gradation for concrete fine sand aggregate given in ASTM C33.
2. Filter B gradation can be satisfied by materials meeting the specifications for Size No. 67 concrete coarse aggregate (3/4 inch to No. 4) given in ASTM C33.
3. All collector pipes should be Schedule 80 PVC.
4. Slotted collector pipes should consist of 0.100 inch slots.
5. Cleanouts should be provided to permit periodic cleaning and flushing of collector pipes.
6. Slotted collector pipes should be covered in Filter B material.
7. Filter Fabric should be polyester nonwoven needlepoint filter cloth, Mirafi 140N or equivalent.

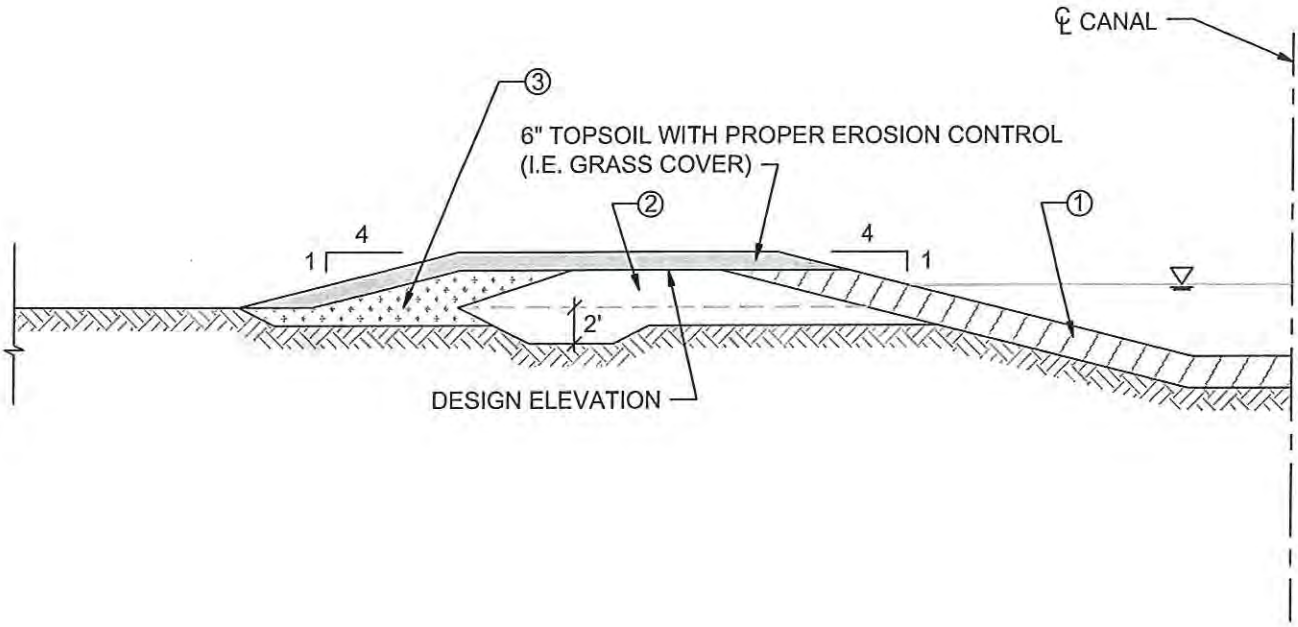
GRADATION OF FILTER MATERIALS
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
LIBERTY COUNTY, TEXAS

CLAY LINER: > 60% FINER THAN No. 200 SIEVE
LIQUID LIMIT > 20
PLASTICITY INDEX > 7
HYDRAULIC CONDUCTIVITY < 10 cm/s^{-7}





CANAL EXCAVATION
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HARRIS AND LIBERTY COUNTIES, TEXAS
(NOT TO SCALE)



ZONE	TYPICAL SOIL	K	LIQUID LIMIT	PLASTICITY INDEX	% FINES	COMPACTION (STD. PROCTOR)
1	CLAY LINER	10^{-7} cm/s	>20	>7	>60	>95% OPT. DENSITY 1% DRY TO 3% WET
2	CLAY FILL	NA	>20	>12	>60	>95% OPT. DENSITY 1% DRY TO 3% WET
3	GENERAL FILL	NA	NA	NA	NA	>90% OPT. DENSITY 1% DRY TO 3% WET

* ALL FILL FREE OF DEBRIS, ORGANICS, AND OTHER DELITERIOUS MATERIAL.

EMBANKMENT CONSTRUCTION

LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HARRIS AND LIBERTY COUNTIES, TEXAS
(NOT TO SCALE)

APPENDIX A – LOGS OF BORINGS

LOCATION: See Plate 2a
COORDINATES: N 30°02'58"
W 95°06'06"
SURFACE EL.: 46' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
					FILL: SANDY SILT, tan, with shell fragments	1.5						
					SANDY CLAY, very stiff, brown and gray	4.0			11	37	18	19
5					SILTY CLAY, stiff, brown and gray, with silt pockets and calcareous nodules - with sandy silt seams below 6'	10.0	97		22	36	19	17
10				43 33	SANDY SILT, very dense, brown and gray, with clay pockets	14.5	105	59	19	17	14	3
15				28	CLAYEY SAND, medium dense, light gray and tan	18.0		49				
20 25				26	SILTY SAND, medium dense, brown and light gray, with sandy clay seams	28.5		17				
30 35				23	CLAY, very stiff to hard, red, brown, and gray - with sand pockets to 35' - brown and gray below 33'		113		18	39	18	21

SHEAR STRENGTH

□ Penetrometer ◇ Torvane △ Field Vane
Unconfined ▼ Triaxial ● Miniature Vane ▲

KIPS PER SQ FT
0.5 1.0 1.5 2.0 2.5

NOTES:
1. ▽: Water First Noticed. ▼: Depth To Water after 30 minutes.
2. Terms and symbols defined on Plate A-16.
3. Crumb test result, Grade 1 at 5', Grade 4 at 14'.
4. Coordinates obtained with hand held GPS in field.

DATE: July 2, 2009
TOTAL DEPTH: 70'
CAVED DEPTH: 10.2'
DRY AUGER: Surface to 12'
WET ROTARY: 12' to 70'
BACKFILL: Cement-Bentonite Grout
LOGGER: T. Mireles

R:\0412\2009 PROJECTS\0001-0099\0412-09-0031 LUCEBAYOU\DRAFTING_FUGRO\NEW_0412-09-0031.GPJ FUGRO_SO (LAB DATA)_INDUSTRIAL GROUP 9/28/2009

LOG OF BORING NO. FB-1
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2a
COORDINATES: N 30°02'58"
W 95°06'06"

SURFACE EL.: 46' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)	SHEAR STRENGTH (KIPS PER SQ FT)
					CLAY, very stiff to hard, brown and gray								
					SANDY CLAY, very stiff to hard, gray and brown, with sand pockets	41.5							
45							115		17				□+ 5.5●
					- with sandy silt pockets below 48'								□+
50						51.5							
					CLAY, stiff to very stiff, gray and brown, slickensided								□
55							104		24				●
60													□
					- brown and gray below 63'								□
65						66.5							
					SILTY CLAY, very stiff, brown and gray, with calcareous nodules and silt pockets								□
70						70.0	102		24				●
75													

Penetrometer □ Unconfined ▼
Torvane ◇ Triaxial ●
Field Vane △ Miniature Vane ▲

NOTES:
1. ▽: Water First Noticed. ▼: Depth To Water after 30 minutes.
2. Terms and symbols defined on Plate A-16.
3. Crumb test result, Grade 1 at 5', Grade 4 at 14'.
4. Coordinates obtained with hand held GPS in field.

DATE: July 2, 2009
TOTAL DEPTH: 70'
CAVED DEPTH: 10.2'
DRY AUGER: Surface to 12'
WET ROTARY: 12' to 70'
BACKFILL: Cement-Bentonite Grout
LOGGER: T. Mireles

R:\0412\2009 PROJECTS\0001-0099\0412-09-0031 LUCEBAYOU\DRAFTING_FUGRO\NEW_0412-09-0031.GPJ FUGRO_SO (LAB DATA)_INDUSTRIAL GROUP 9/28/2009

LOG OF BORING NO. FB-1
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2a
COORDINATES: N 30°03'04"
W 95°05'15"

SURFACE EL.: 73' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)	SHEAR STRENGTH (□ Penetrometer, ◇ Torvane, △ Field Vane; Unconfined ▼, Triaxial ●, Miniature Vane ▲; KIPS PER SQ FT 0.5 1.0 1.5 2.0 2.5)
					FILL: SILTY CLAY, gray, with shell fragments	1.0							
					SANDY SILT, tan	2.0		63					
5					SANDY CLAY, stiff, tan and gray, with sand pockets and ferrous nodules	8.0		70	16	37	9	28	
10	▼ ▽			23 26 22	SILTY SAND, medium dense, fine-grained, brown and gray	14.0		25					
15					SILTY CLAY, firm to very stiff, brown and light gray, with sand pockets	20.0		91	26	30	15	15	
20				22									
25													
30													
35													

NOTES:
1. ▽: Water First Noticed. ▼: Depth To Water after 10 minutes.
2. Terms and symbols defined on Plate A-16.
3. Crumb test result, Grade 1 at 5'.
4. Coordinates obtained with hand held GPS in field.

DATE: June 19, 2009
TOTAL DEPTH: 20'
CAVED DEPTH: 11'
DRY AUGER: Surface to 12'
WET ROTARY: 12' to 20'
BACKFILL: Temporary Piezometer
LOGGER: T. Mireles

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LOG OF BORING NO. FB-2
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2a
COORDINATES: N 30°03'40"
W 95°02'55"
SURFACE EL.: 75' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)	SHEAR STRENGTH (KIPS PER SQ FT)
					FILL: CLAY, hard, dark gray, with shell fragments	2.0		88	20	59	12	47	4.5
					CLAY, stiff, gray and tan, with calcareous nodules			90	22	59	11	48	
5					- with sand and silt pockets below 6'			67	15	47	12	35	
10	▼				- with silt seams, 10' to 14'				22				
				21									
15									26				
20	▽					20.0							
25													
30													
35													

CLASSIFICATION

SHEAR STRENGTH

□ Penetrometer ◇ Torvane △ Field Vane — Unconfined ▼ Triaxial ● Miniature Vane ▲

KIPS PER SQ FT: 0.5 1.0 1.5 2.0 2.5

NOTES:
1. ▽: Water First Noticed. ▼: Depth To Water after 20 minutes.
2. Terms and symbols defined on Plate A-16.
3. Crumb test result, Grade 1 at 8'.
4. Coordinates obtained with hand held GPS in field.

DATE: June 19, 2009
TOTAL DEPTH: 20'
CAVED DEPTH: 11.3'
DRY AUGER: Surface to 20'
WET ROTARY: Not Applicable
BACKFILL: Holeplug
LOGGER: T. Mireles

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LOG OF BORING NO. FB-3
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2a
COORDINATES: N 30°06'15"
W 95°02'39"

SURFACE EL.: 81' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)	SHEAR STRENGTH (KIPS PER SQ FT)
					FILL: CLAY, gray and tan	1.0							
					SANDY SILT, gray	2.0							
					CLAY, very stiff, gray, with silt pockets	4.0	110		9	31	11	20	□+ 4.7▼ □+
5					SANDY CLAY, very stiff, tan and light gray, with calcareous nodules	6.0		55					
					SANDY SILT, brown	8.5							
10				13	CLAY, firm, brown and gray, with calcareous nodules and silt pockets	13.0			20	34	10	24	□
15	▽				SILTY SAND, medium dense, tan and light gray, with silty clay seams	20.0		48					
20				25									
25													
30													
35													

Shear strength legend: □ Penetrometer, ◇ Torvane, △ Field Vane, Unconfined ▼, Triaxial ●, Miniature Vane ▲

NOTES:
1. ▽: Water First Noticed.
2. Terms and symbols defined on Plate A-16.
3. Coordinates obtained with hand held GPS in field.
4. Crumb test result, Grade 1 at 3'.

DATE: August 5, 2009
TOTAL DEPTH: 20'
CAVED DEPTH: Not Applicable
DRY AUGER: Surface to 20'
WET ROTARY: Not Applicable
BACKFILL: Holeplug
LOGGER: T. Mireles

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LOG OF BORING NO. FB-4
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

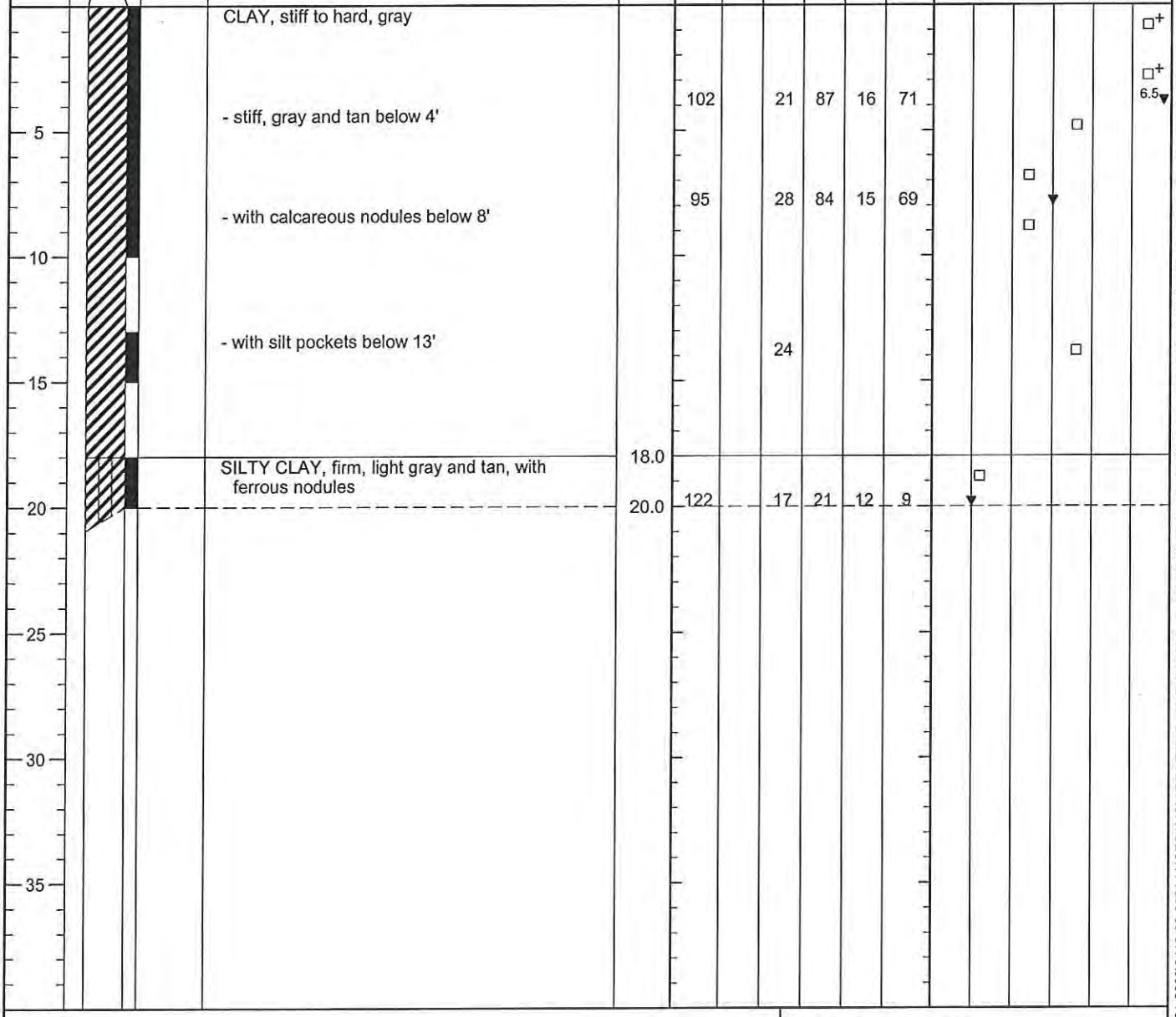
LOCATION: See Plate 2a
COORDINATES: N 30°07'50"
W 95°01'38"
SURFACE EL.: 83' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
					CLAY, stiff to hard, gray							
					- stiff, gray and tan below 4'		102		21	87	16	71
					- with calcareous nodules below 8'		95		28	84	15	69
					- with silt pockets below 13'				24			
					SILTY CLAY, firm, light gray and tan, with ferrous nodules	18.0	122		17	21	12	9
						20.0						

SHEAR STRENGTH

□ Penetrometer ◇ Torvane △ Field Vane
Unconfined ▼ Triaxial ● Miniature Vane ▲

KIPS PER SQ FT
0.5 1.0 1.5 2.0 2.5



NOTES:
1. Free water not encountered during drilling.
2. Terms and symbols defined on Plate A-16.
3. Coordinates obtained with hand held GPS in field.
4. Crumb test result, Grade 1 at 3'.

DATE: August 4, 2009
TOTAL DEPTH: 20'
CAVED DEPTH: Not Applicable
DRY AUGER: Surface to 20'
WET ROTARY: Not Applicable
BACKFILL: Holeplug
LOGGER: T. Mireles

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LOG OF BORING NO. FB-5
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2a
COORDINATES: N 30°08'05"
W 94°58'36"
SURFACE EL.: 85' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
					CLAY, very stiff, gray		108		14	44	10	34
					- stiff below 3'							
					- gray and tan, 4' to 13'							
5					- with calcareous nodules and sand pockets below 6'			78				
					- with ferrous nodules below 8'							
10							103		23	57	11	46
					SILTY SAND, medium dense, brown and gray, with clay seams	13.0		39				
15												
20				25		20.0						
25												
30												
35												

SHEAR STRENGTH

□ Penetrometer ◇ Torvane △ Field Vane
Unconfined ▼ Triaxial ● Miniature Vane ▲

KIPS PER SQ FT
0.5 1.0 1.5 2.0 2.5

□+ 3.9▼

NOTES:
1. Free water not encountered during drilling.
2. Terms and symbols defined on Plate A-16.
3. Coordinates obtained with hand held GPS in field.
4. Crumb test result, Grade 1 at 7'.

DATE: August 5, 2009
TOTAL DEPTH: 20'
CAVED DEPTH: Not Applicable
DRY AUGER: Surface to 20'
WET ROTARY: Not Applicable
BACKFILL: Holeplug
LOGGER: T. Mireles

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LOG OF BORING NO. FB-6
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2a
COORDINATES: N 30°09'15"
W 94°55'45"

SURFACE EL.: 99' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
					CLAY, stiff, gray - with sand pockets to 9'			84		66	14	52
					- tan and gray, with calcareous nodules below 4'		102	90	23	56	11	45
5												
								100	27	67	13	54
10												
					- very stiff below 12'							
					- with sand pockets below 14'							
15												
					SANDY CLAY, stiff, tan and light gray, with sand pockets	17.0						
20						20.0						
25												
30												
35												

CLASSIFICATION

SHEAR STRENGTH

□ Penetrometer ◇ Torvane △ Field Vane
Unconfined ▼ Triaxial ● Miniature Vane ▲

KIPS PER SQ FT
0.5 1.0 1.5 2.0 2.5

NOTES:
1. Free water not encountered during drilling.
2. Terms and symbols defined on Plate A-16.
3. Crumb test result, Grade 1 at 3'.
4. Coordinates obtained with hand held GPS in field.

DATE: June 19, 2009
TOTAL DEPTH: 20'
CAVED DEPTH: Not Applicable
DRY AUGER: Surface to 20'
WET ROTARY: Not Applicable
BACKFILL: Holeplug
LOGGER: T. Mireles

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LOG OF BORING NO. FB-7
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2a
COORDINATES: N 30°10'33"
W 94°53'59"

SURFACE EL.: 102' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
					SANDY SILT, tan	1.5						
					SANDY CLAY, stiff, gray, with sand seams			63	11	18	13	5
5				11		6.0						
					CLAY, stiff to very stiff, brown and gray, with sand pockets			69	20	46	11	35
10					CLAYEY SAND, brown and gray	10.0						
					SAND, medium dense, fine-grained, tan, with silt pockets	12.0		12				
				30								
15				23								
					- very dense below 18'							
				50								
20						20.0						
25												
30												
35												

SHEAR STRENGTH

□ Penetrometer ◇ Torvane △ Field Vane Unconfined▼ Triaxial● Miniature Vane▲

KIPS PER SQ FT: 0.5 1.0 1.5 2.0 2.5

NOTES:
1. Free water not encountered during drilling.
2. Terms and symbols defined on Plate A-16.
3. Crumb test result, Grade 4 at 2.5'.
4. Coordinates obtained with hand held GPS in field.

DATE: June 19, 2009
TOTAL DEPTH: 20'
CAVED DEPTH: Not Applicable
DRY AUGER: Surface to 20'
WET ROTARY: Not Applicable
BACKFILL: Temporary Piezometer
LOGGER: T. Mireles

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LOG OF BORING NO. FB-8
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2a
COORDINATES: N 30°12'40"
W 94°52'07"
SURFACE EL.: 104' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)	SHEAR STRENGTH (□ Penetrometer, ◇ Torvane, △ Field Vane; Unconfined ▼, Triaxial ●, Miniature Vane ▲; KIPS PER SQ FT 0.5 1.0 1.5 2.0 2.5)
					FILL: SANDY SILT, tan			66					
					CLAY, very stiff to hard, gray and red	3.8							□+
5					- gray and tan below 6'								□+
					- with sand pockets below 8'		116	82	13	49	10	39	□+ 7.4▼ □+
10				43	SILTY SAND, medium dense to dense, tan	10.0							
				24				43					
15				40									
20				45									
25				29	SAND, medium dense to dense, tan, with silt pockets	23.5		7					
30				35		30.0		10					
35													

NOTES:
1. Free water not encountered to a depth of 14' during drilling.
2. Terms and symbols defined on Plate A-16.
3. Crumb test result, Grade 4 at 5.5'.
4. Coordinates obtained with hand held GPS in field.

DATE: July 16, 2009
TOTAL DEPTH: 30'
CAVED DEPTH: Not Applicable
DRY AUGER: Surface to 14'
WET ROTARY: 14' to 30'
BACKFILL: Cement-Bentonite Grout
LOGGER: E. Schulak

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LOG OF BORING NO. FB-9
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2b
COORDINATES: N 94°49'22"
W 30°13'27"
SURFACE EL.: 42' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)	SHEAR STRENGTH (KIPS PER SQ FT)
					CLAY, very stiff, gray and tan								
							97		24	77	15	62	
5					- brown and gray, with sand pockets below 6'								
					- very stiff to hard below 8'								
10					- with calcareous nodules below 10'		110	90	19	63	14	49	
					CLAYEY SAND, brown and gray	12.0							
					SAND, dense, fine to medium-grained, brown	13.0							
15				47				8					
20				50/10"	- very dense, fine to coarse below 18'								
				19	CLAY, very stiff, brown and gray	23.5							
25													
30							110		20	58	14	44	
					SILTY CLAY, very stiff, gray and brown	31.5							
35									21				
					CLAY, very stiff, brown and gray, slickensided, with calcareous nodules	36.5			24				

SHEAR STRENGTH: □ Penetrometer, ◇ Torvane, △ Field Vane, Unconfined ▼, Triaxial ●, Miniature Vane ▲; KIPS PER SQ FT 0.5 1.0 1.5 2.0 2.5

NOTES:
1. Depth-to-water measurements not performed during drilling.
2. Terms and symbols defined on Plate A-16.
3. Coordinates obtained with hand held GPS in field.

DATE: July 8, 2009
TOTAL DEPTH: 120'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: Surface to 120'
BACKFILL: Cement-Bentonite Grout
LOGGER: T. Mireles

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LOG OF BORING NO. FB-10
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2b
COORDINATES: N 94°49'22"
W 30°13'27"

SURFACE EL.: 42' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
					CLAY, very stiff, brown and gray, slickensided, with calcareous nodules							
45												
					SANDY CLAY, stiff, gray, with sand pockets	47.0						
50							97		30			
					SAND, very dense, fine- to coarse-grained, tan	52.0						
55				50/9"								
60				50/9"				6				
65				50/8"								
70				50/9"								
75				50/7"								
				50	- gray below 78'			11				

CLASSIFICATION

SHEAR STRENGTH

□ Penetrometer ◇ Torvane △ Field Vane

Unconfined ▼ Triaxial ● Miniature Vane ▲

KIPS PER SQ FT

0.5 1.0 1.5 2.0 2.5

NOTES:

1. Depth-to-water measurements not performed during drilling.
2. Terms and symbols defined on Plate A-16.
3. Coordinates obtained with hand held GPS in field.

DATE: July 8, 2009
TOTAL DEPTH: 120'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: Surface to 120'
BACKFILL: Cement-Bentonite Grout
LOGGER: T. Mireles

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LOG OF BORING NO. FB-10
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2b
COORDINATES: N 94°49'22"
W 30°13'27"

SURFACE EL.: 42' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)	SHEAR STRENGTH (□ Penetrometer, ◇ Torvane, △ Field Vane; Unconfined ▼, Triaxial ●, Miniature Vane ▲; KIPS PER SQ FT 0.5 1.0 1.5 2.0 2.5)
					SAND, very dense, fine- to coarse-grained, gray	82.5							
					CLAY, stiff to very stiff, gray - with sand pockets and sand seams to 85'								□
85													
					- brown and gray, 88' to 98' - slickensided below 88'								□
90					- very stiff below 90'		88		34	75	23	52	●
													□+
95													
					- gray and brown below 98'				29				□+
100													
105													
					- with silt pockets below 108'								□
110							97		27				3.8●
115													
				50/9"				20					

NOTES:
1. Depth-to-water measurements not performed during drilling.
2. Terms and symbols defined on Plate A-16.
3. Coordinates obtained with hand held GPS in field.

DATE: July 8, 2009
TOTAL DEPTH: 120'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: Surface to 120'
BACKFILL: Cement-Bentonite Grout
LOGGER: T. Mireles

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LOG OF BORING NO. FB-10
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2b
COORDINATES: N 30°13'23"
W 94°49'16"

SURFACE EL.: 41' Approx.

DEPTH, FT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
	SILTY SAND, tan, with clay and roots			51				
	CLAY, very stiff, tan, with sand pockets - with roots to 6'	2.0			12			
5	- dark gray and tan							
	- gray and tan, 6' to 8'							
	- stiff, dark gray below 8'		95	77	28	94	17	77
10	- with sand and organic material, 10' to 12'							
			88	92	34	82	18	64
15								
	- with organic material, slickensided, 18' to 20'				41			
20								
25								
	SANDY CLAY, firm, greenish gray - with shell fragments to 35' - with sand pockets to 40'	28.0						
30								
	- with sand seams, 33' to 40'							
35			94	54	30			

SHEAR STRENGTH

□ Penetrometer ◇ Torvane △ Field Vane
Unconfined ▼ Triaxial ● Miniature Vane ▲

KIPS PER SQ FT
0.5 1.0 1.5 2.0 2.5

NOTES:
1. Depth-to-water measurements not performed during drilling.
2. Terms and symbols defined on Plate A-16.
3. Crumb test results, Grade 1 at 3' and 19'.
4. Coordinates obtained with hand held GPS in field.

DATE: July 15, 2009
TOTAL DEPTH: 100'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: Surface to 100'
BACKFILL: Cement-Bentonite Grout
LOGGER: E. Schulak

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LOG OF BORING NO. FB-11
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2b
COORDINATES: N 30°13'23"
W 94°49'16"
SURFACE EL.: 41' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
					SANDY CLAY, greenish gray - (Washed boring, 40' to 42.5')	42.5						
45				50/9"	SAND, very dense, fine- to coarse-grained, tan, with fine gravel	48.5		5				
50				13	SILTY SAND, medium dense, light brown							
55				20		58.5		19				
60				50/11"	SAND, very dense, fine to medium-grained, light brown, with silt							
65				50/5"								
70				50/5"								
75				50/4"				7				

CLASSIFICATION

SHEAR STRENGTH

□ Penetrometer ◇ Torvane △ Field Vane
Unconfined ▼ Triaxial ● Miniature Vane ▲

KIPS PER SQ FT
0.5 1.0 1.5 2.0 2.5

NOTES:
1. Depth-to-water measurements not performed during drilling.
2. Terms and symbols defined on Plate A-16.
3. Crumb test results, Grade 1 at 3' and 19'.
4. Coordinates obtained with hand held GPS in field.

DATE: July 15, 2009
TOTAL DEPTH: 100'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: Surface to 100'
BACKFILL: Cement-Bentonite Grout
LOGGER: E. Schulak

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LOG OF BORING NO. FB-11
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2b
COORDINATES: N 30°13'23"
W 94°49'16"

SURFACE EL.: 41' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)	SHEAR STRENGTH (KIPS PER SQ FT)
					SAND, very dense, fine- to medium-grained, light brown, with silt								
					CLAY, very stiff, greenish gray, with shell fragments	83.0							
85													
90							102		24	47	13	34	□ ●
95													□+
100						100.0							
105													
110													
115													

SHEAR STRENGTH: □ Penetrometer, ◇ Torvane, △ Field Vane, Unconfined ▼, Triaxial ●, Miniature Vane ▲; KIPS PER SQ FT 0.5 1.0 1.5 2.0 2.5

NOTES:
1. Depth-to-water measurements not performed during drilling.
2. Terms and symbols defined on Plate A-16.
3. Crumb test results, Grade 1 at 3' and 19'.
4. Coordinates obtained with hand held GPS in field.

DATE: July 15, 2009
TOTAL DEPTH: 100'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: Surface to 100'
BACKFILL: Cement-Bentonite Grout
LOGGER: E. Schulak

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LOG OF BORING NO. FB-11
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2b
COORDINATES: N 30°13'25"
W 94°49'16"

SURFACE EL.: 41' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)	SHEAR STRENGTH (□ Penetrometer, ◇ Torvane, △ Field Vane; Unconfined ▼, Triaxial ●, Miniature Vane ▲; KIPS PER SQ FT 0.5 1.0 1.5 2.0 2.5)
					CLAYEY SAND, with roots				6				□+
					CLAY, very stiff, brown	2.0							□+
					- brown and gray, 4' to 10'			76	21	58	13	45	□
5					- with roots, 4' to 6'								□
					- with sand partings below 8'		111		18				3.5▼ □
10					- tan and gray below 10'				18				□+
					SILTY SAND, medium dense to dense, fine-grained, tan, with clay pockets	12.0							
15				33									
20				24				20					
					CLAY, stiff to very stiff, tan and gray	22.0							
25							100		25	66	15	51	□ ●
					- gray and brown, 28' to 38'								□
30													
					- with calcareous nodules below 33'				24				□
					- with silt pockets, 33' to 35'								
35													
					- brown and gray below 38'								□

NOTES:
1. Depth-to-water measurements not performed during drilling.
2. Terms and symbols defined on Plate A-16.
3. Crumb test results, Grade 1 at 5', 11', and 24'.
4. Coordinates obtained with hand held GPS in field.

DATE: July 14, 2009
TOTAL DEPTH: 75'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: Surface to 75'
BACKFILL: Cement-Bentonite Grout
LOGGER: E. Schulak

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LOG OF BORING NO. FB-12
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2b
COORDINATES: N 30°13'25"
W 94°49'16"
SURFACE EL.: 41' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)	SHEAR STRENGTH (□ Penetrometer, ◇ Torvane, △ Field Vane; Unconfined ▼, Triaxial ●, Miniature Vane ▲; KIPS PER SQ FT 0.5 1.0 1.5 2.0 2.5)
					CLAY, stiff to very stiff, brown and gray, with calcareous nodules				35				□
45													
					SANDY CLAY, stiff, greenish gray	48.0			20				□
50					SAND, very dense, fine-grained, tan, with silt pockets	50.5							
55				50/8"				9					
60				50/6"									
65				50/10"									
70				50/11"				7					
75				50	- gray, with clay seams below 73'	75.0							

NOTES:
1. Depth-to-water measurements not performed during drilling.
2. Terms and symbols defined on Plate A-16.
3. Crumb test results, Grade 1 at 5', 11', and 24'.
4. Coordinates obtained with hand held GPS in field.

DATE: July 14, 2009
TOTAL DEPTH: 75'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: Surface to 75'
BACKFILL: Cement-Bentonite Grout
LOGGER: E. Schulak

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LOG OF BORING NO. FB-12
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2b
COORDINATES: N 30°13'28"
W 94°49'14"
SURFACE EL.: 27' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)	SHEAR STRENGTH (□ Penetrometer, ◇ Torvane, △ Field Vane; Unconfined ▼, Triaxial ●, Miniature Vane ▲; KIPS PER SQ FT 0.5 1.0 1.5 2.0 2.5)
					CLAY, very stiff to hard, red, brown and gray								□+
					- brown and gray below 2'								□+
							102		16	68	15	53	4.5▼
5					- brown, with silt pockets below 4'								□+
					- with calcareous nodules below 6'								□+
							102	62	11	37	14	23	5.8▼
					- very stiff, with silt seams below 8'								□+
				28									
10													□+
							108	97	18	64	15	49	□+
					SAND, very dense to dense, fine- to medium-grained, brown, with silt	13.5							
15				50/9"									
				39				5					
20													
				33									
25													
					CLAY, stiff to very stiff, gray and red, slickensided	27.0							□
30					- very stiff, 30' to 48'		106		21				●
					- with sand pockets below 33'								□+
35							110	86	18	43	11	32	
					- brown and gray below 38'				25				□

NOTES:

1. Depth-to-water measurements not performed during drilling.
2. Terms and symbols defined on Plate A-16.
3. Crumb tests results, Grade 2 at 7' and Grade 1 at 29' and 49'.
4. Corrosion potential tests performed at 4.5', 12.5', and 40'.
5. Consolidated undrained triaxial tests performed at 12' and 35'.
6. Direct shear test performed at 20'.

DATE: July 9, 2009
TOTAL DEPTH: 75'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: Surface to 75'
BACKFILL: Cement-Bentonite Grout
LOGGER: T. Mireles

R:\04120\2009 PROJECTS\0001-0099\0412-09-0031 LUCEBAYOU\DRAFTING_FUGRO\NEW_0412-09-0031.GPJ FUGRO_SO (LAB DATA)_INDUSTRIAL GROUP 9/28/2009

LOG OF BORING NO. FB-13
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2b
COORDINATES: N 30°13'28"
W 94°49'14"
SURFACE EL.: 27' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
					CLAY, very stiff, brown and gray, slickensided, with sand pockets							
					- with calcareous nodules below 43'							
45					- stiff below 44'							
					- gray and brown below 46.5'							
					- stiff to very stiff below 48'							
50							92	88	23	61	17	44
					SILTY SAND, dense, fine-grained, gray	52.0						
55				38				17				
					SAND, very dense, fine-grained, brown	58.0						
60				50/8"								
65				50/7"								
					- gray below 68'							
70				50/7"				4				
					- with clay seams and organic material below 73'							
75				46		75.0						

SHEAR STRENGTH

□ Penetrometer ◇ Torvane △ Field Vane ▼ Unconfined ● Triaxial ▲ Miniature Vane

KIPS PER SQ FT: 0.5 1.0 1.5 2.0 2.5

NOTES:

1. Depth-to-water measurements not performed during drilling.
2. Terms and symbols defined on Plate A-16.
3. Crumb tests results, Grade 2 at 7' and Grade 1 at 29' and 49'.
4. Corrosion potential tests performed at 4.5', 12.5', and 40'.
5. Consolidated undrained triaxial tests performed at 12' and 35'.
6. Direct shear test performed at 20'.

DATE: July 9, 2009
TOTAL DEPTH: 75'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: Surface to 75'
BACKFILL: Cement-Bentonite Grout
LOGGER: T. Mireles

R:\0412\2009 PROJECTS\0001-0099\0412-09-0031 LUCEBAYOU\DRAFTING_FUGRO\NEW_0412-09-0031.GPJ FUGRO_SO (LAB DATA)_INDUSTRIAL GROUP 9/28/2009

LOG OF BORING NO. FB-13

LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2b
COORDINATES: N 30°13'31"
W 94°49'13"
SURFACE EL.: 48' Approx.

DEPTH, FT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	BLOWS PER FOOT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
	CLAY, very stiff to hard, brown, with organic material								
				108	94	19	85	16	69
5	- stiff, 5' to 7'								
	- with silt pockets below 6'								
	- hard below 7'			109	88	17	48	14	34
	SANDY CLAY, very stiff, brown	8.0							
	- with calcareous pockets to 10'								
10	- tan and gray, with silt pockets below 10'								
					79		35	15	20
	- with sand seams below 14'								
15			23						
	- stiff below 16'								
					64	19	27	18	9
20									
	- brown and gray, with calcareous nodules below 23'								
25				102		24			
	SILTY SAND, medium dense, fine- to coarse-grained, tan, with clay seams	26.0							
			18		13				
30									
	CLAY, very stiff, gray and tan	31.5							
35									
	- slickensided below 38'			97		29			

SHEAR STRENGTH: □ Penetrometer, ◇ Torvane, △ Field Vane, Unconfined ▼, Triaxial ●, Miniature Vane ▲; KIPS PER SQ FT 0.5 1.0 1.5 2.0 2.5

NOTES:
1. Depth-to-water measurements not performed during drilling.
2. Terms and symbols defined on Plate A-16.
3. Crumb test results, Grade 1 at 3' and Grade 3 at 13'.
4. Coordinates obtained with hand held GPS in field.

DATE: July 10, 2009
TOTAL DEPTH: 75'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: Surface to 75'
BACKFILL: Cement-Bentonite Grout
LOGGER: E. Schulak

R:\0412\2009 PROJECTS\0001-0099\0412-09-0031 LUCEBAYOU\DRAFTING_FUGRO\NEW_0412-09-0031.GPJ FUGRO_SO (LAB DATA)_INDUSTRIAL GROUP 9/28/2009

LOG OF BORING NO. FB-14
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2b
COORDINATES: N 30°13'31"
W 94°49'13"

SURFACE EL.: 48' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
					CLAY, very stiff, gray and tan, slickensided							
					- brown and gray, 43' to 48'							
45												
					- greenish gray and brown below 48'							
					- firm below 49'		89		34			
50												
					SANDY CLAY, stiff, gray	53.0		77				
55					SAND, very dense, fine-grained, tan	55.0						
				50/8"								
60												
				50/7"	- light gray below 63'			4				
65												
				50/6"								
70												
				50/5"								
75						75.0						

CLASSIFICATION

SHEAR STRENGTH

□ Penetrometer ◇ Torvane △ Field Vane

Unconfined ▼ Triaxial ● Miniature Vane ▲

KIPS PER SQ FT

0.5 1.0 1.5 2.0 2.5

NOTES:

1. Depth-to-water measurements not performed during drilling.
2. Terms and symbols defined on Plate A-16.
3. Crumb test results, Grade 1 at 3' and Grade 3 at 13'.
4. Coordinates obtained with hand held GPS in field.

DATE: July 10, 2009
TOTAL DEPTH: 75'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: Surface to 75'
BACKFILL: Cement-Bentonite Grout
LOGGER: E. Schulak

R:\04120\2009 PROJECTS\0001-0099\0412-09-0031 LUCEBAYOU\DRAFTING_FUGRO\NEW_0412-09-0031.GPJ FUGRO_SO (LAB DATA)_INDUSTRIAL GROUP 9/28/2009

LOG OF BORING NO. FB-14
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2b
COORDINATES: N 30°13'33"
W 94°49'13"
SURFACE EL.: 50' Approx.

DEPTH, FT	BLOWS PER FOOT	STRATUM DEPTH, FT	STRATUM DESCRIPTION	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)	SHEAR STRENGTH (□ Penetrometer, ◇ Torvane, △ Field Vane; Unconfined ▼, Triaxial ●, Miniature Vane ▲; KIPS PER SQ FT 0.5 1.0 1.5 2.0 2.5)
			SILTY SAND, tan, with organic material							
		2.0	CLAY, very stiff, tan, with sand partings							□+
5			- stiff below 4'		73	13	44	14	30	□
		6.0	SAND, medium dense, fine-grained, tan, with silt							
	12				11					
10	13									
	15									
	28									
15	25		- light gray, 15' to 18'		9					
			- tan below 18'							
20	15									
			- dense below 23'							
25	38									
		27.0	CLAY, very stiff to hard, gray, tan and red							
30				112		18	56	12	44	□ 3.8●
			- gray and tan, slickensided below 33'							□
35						25				□

NOTES:
1. Depth-to-water measurements not performed during drilling.
2. Terms and symbols defined on Plate A-16.
3. Coordinates obtained with hand held GPS in field.

DATE: July 13, 2009
TOTAL DEPTH: 100'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: Surface to 100'
BACKFILL: Cement-Bentonite Grout
LOGGER: E. Schulak

R:\04120\2009 PROJECTS\0001-0099\0412-09-0031 LUCEBAYOU\DRAFTING_FUGRO\NEW_0412-09-0031.GPJ FUGRO_SO (LAB DATA)_INDUSTRIAL GROUP 9/28/2009

LOG OF BORING NO. FB-15
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2b
COORDINATES: N 30°13'33"
W 94°49'13"
SURFACE EL.: 50' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)	SHEAR STRENGTH (KIPS PER SQ FT)
					CLAY, very stiff, gray and tan, slickensided								
					- brown and gray, 43' to 48'								
45					- stiff to very stiff below 44'		99		26				
					- greenish gray and brown below 48'								
50													
					SANDY CLAY, stiff, gray	53.0							
					SAND, dense to very dense, fine-grained, gray, with silt	54.0							
55													
				50/8"				8					
60													
					- tan, 63' to 73'								
				50/11"									
65													
				31				7					
70													
					- gray below 73'								
				50/10"									
75													
				50/6"									

CLASSIFICATION

SHEAR STRENGTH

□ Penetrometer ◇ Torvane △ Field Vane — Unconfined ▼ Triaxial ● Miniature Vane ▲

KIPS PER SQ FT: 0.5 1.0 1.5 2.0 2.5

NOTES:

1. Depth-to-water measurements not performed during drilling.
2. Terms and symbols defined on Plate A-16.
3. Coordinates obtained with hand held GPS in field.

DATE: July 13, 2009
TOTAL DEPTH: 100'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: Surface to 100'
BACKFILL: Cement-Bentonite Grout
LOGGER: E. Schulak

R:\0412\2009 PROJECTS\0001-0099\0412-09-0031 LUCEBAYOU\DRAFTING_FUGRO\NEW_0412-09-0031.GPJ FUGRO_SO (LAB DATA)_INDUSTRIAL GROUP 9/28/2009

LOG OF BORING NO. FB-15
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

LOCATION: See Plate 2b
COORDINATES: N 30°13'33"
W 94°49'13"
SURFACE EL.: 50' Approx.

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)	SHEAR STRENGTH (□ Penetrometer, ◇ Torvane, △ Field Vane, Unconfined ▼, Triaxial ●, Miniature Vane ▲; KIPS PER SQ FT 0.5 1.0 1.5 2.0 2.5)
					SAND, dense to very dense, fine-grained, gray, with silt								
				40	- with fine gravel and sandy clay seams below 83'								
85													
				50/4"									
90													
					CLAY,stiff to very stiff, olive gray	91.0							
							87		35				● □
95													
					- with calcareous nodules below 98'								□
100						100.0							
105													
110													
115													

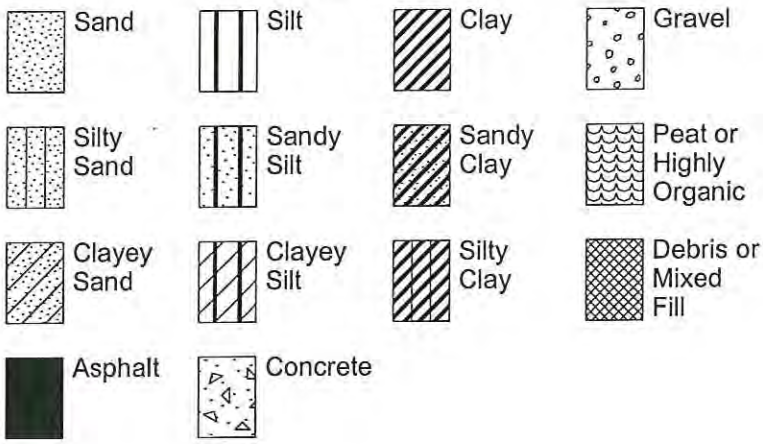
NOTES:
1. Depth-to-water measurements not performed during drilling.
2. Terms and symbols defined on Plate A-16.
3. Coordinates obtained with hand held GPS in field.

DATE: July 13, 2009
TOTAL DEPTH: 100'
CAVED DEPTH: Not Applicable
DRY AUGER: Not Applicable
WET ROTARY: Surface to 100'
BACKFILL: Cement-Bentonite Grout
LOGGER: E. Schulak

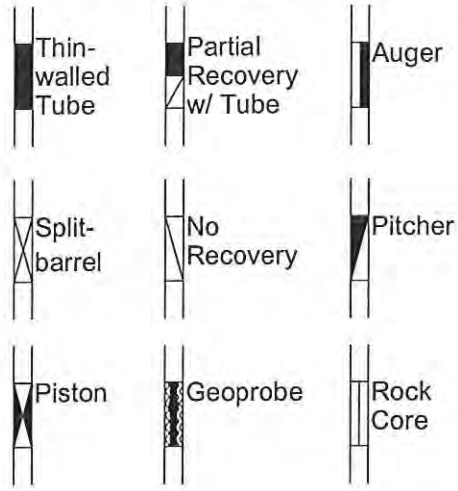
R:\04120\2009 PROJECTS\0001-0099\0412-09-0031 LUCEBAYOU\DRAFTING_FUGRO\NEW_0412-09-0031.GPJ FUGRO_SO (LAB DATA)_INDUSTRIAL GROUP 9/28/2009

LOG OF BORING NO. FB-15
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

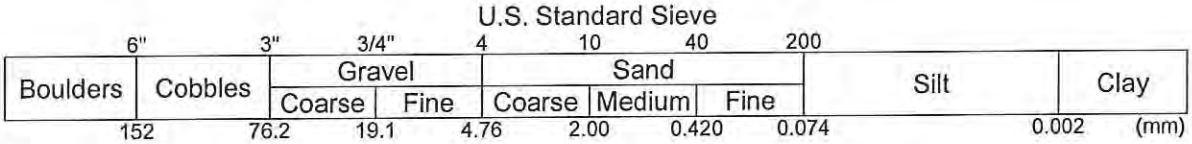
SOIL TYPES



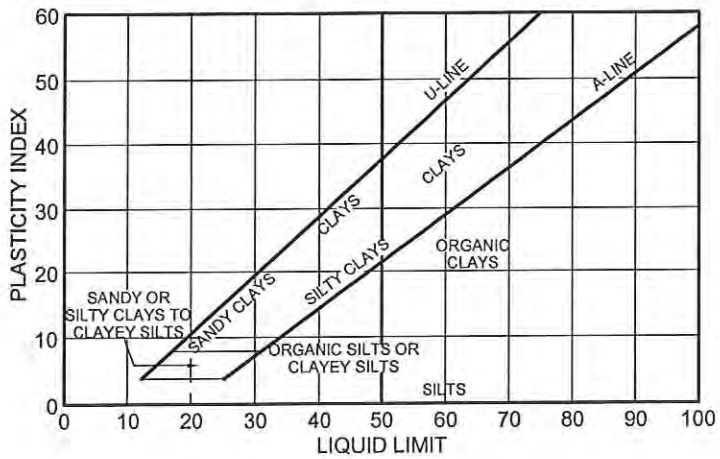
SAMPLER TYPES



SOIL GRAIN SIZE



PLASTICITY CHART



SOIL STRUCTURE

Slickensided ..... Having planes of weakness that appear slick and glossy.
Fissured ..... Containing shrinkage or relief cracks, often filled with fine sand or silt; usually more or less vertical.
Pocket ..... Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting ..... Inclusion less than 1/8 inch thick extending through the sample.
Seam ..... Inclusion 1/8 inch to 3 inches thick extending through the sample.
Layer ..... Inclusion greater than 3 inches thick extending through the sample.
Laminated ..... Soil sample composed of alternating partings or seams of different soil type.
Interlayered ..... Soil sample composed of alternating layers of different soil type.
Intermixed ..... Soil sample composed of pockets of different soil type and layered or laminated structure is not evident.
Calcareous ..... Having appreciable quantities of carbonate.
Carbonate ..... Having more than 50% carbonate content.

TERMS AND SYMBOLS USED ON BORING LOGS

SOIL CLASSIFICATION (1 of 2)

STANDARD PENETRATION TEST (SPT)

A 2-in.-OD, 1-3/8-ID split spoon sampler is driven 1.5 ft into undisturbed soil with a 140-pound hammer free falling 30 in. After the sampler is seated 6 in. into undisturbed soil, the number of blows required to drive the sampler the last 12 in. is the Standard Penetration Resistance or "N" value, which is recorded as blows per foot as described below.

SPLIT-BARREL SAMPLER DRIVING RECORD

Blows Per Foot	Description
25	25 blows drove sampler 12 inches, after initial 6 inches of seating.
50/7"	50 blows drove sampler 7 inches, after initial 6 inches of seating.
Ref/3"	50 blows drove sampler 3 inches during initial 6-inch seating interval.

NOTE: To avoid damage to sampling tools, driving is limited to 50 blows during or after seating interval.

DENSITY OF GRANULAR SOILS

Descriptive Term	*Relative Density, %	**Blows Per Foot (SPT)
Very Loose	< 15	0 to 4
Loose	15 to 35	5 to 10
Medium Dense	35 to 65	11 to 30
Dense	65 to 85	31 to 50
Very Dense	> 85	> 50

*Estimated from sampler driving record.
**Requires correction for depth, groundwater level, and grain size.

STRENGTH OF COHESIVE SOILS

Term	Undrained Shear Strength, ksf	Blows Per Foot (SPT) (approximate)
Very Soft	< 0.25	0 to 2
Soft	0.25 to 0.50	2 to 4
Firm	0.50 to 1.00	4 to 8
Stiff	1.00 to 2.00	8 to 16
Very Stiff	2.00 to 4.00	16 to 32
Hard	> 4.00	> 32

SHEAR STRENGTH TEST METHOD

U - Unconfined Q = Unconsolidated - Undrained Triaxial

P = Pocket Penetrometer T = Torvane V = Miniature Vane F = Field Vane

HAND PENETROMETER CORRECTION

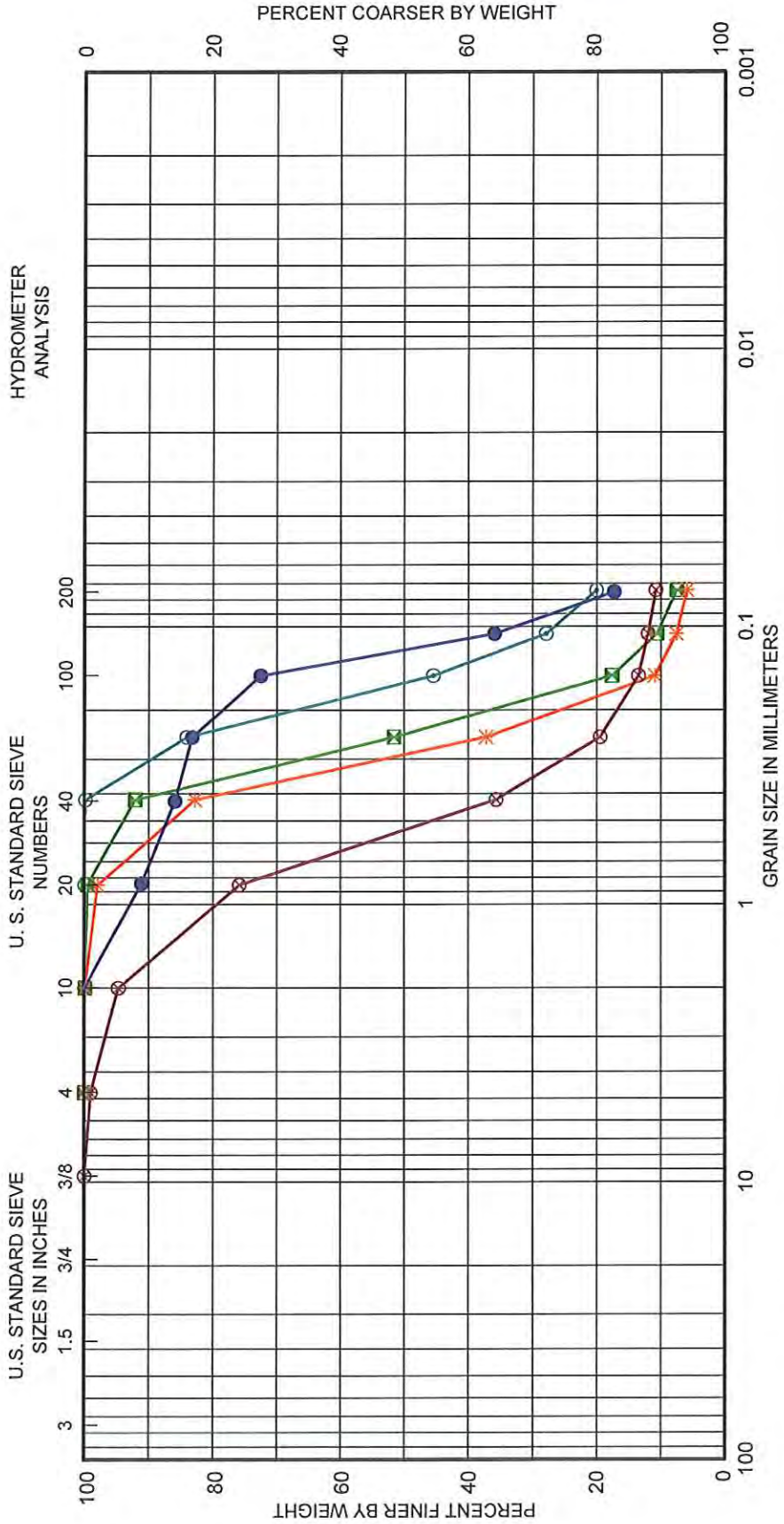
Our experience has shown that the hand penetrometer generally overestimates the in-situ undrained shear strength of over consolidated Pleistocene Gulf Coast clays. These strengths are partially controlled by the presence of macroscopic soil defects such as slickensides, which generally do not influence smaller scale tests like the hand penetrometer. Based on our experience, we have adjusted these field estimates of the undrained shear strength of natural, overconsolidated Pleistocene Gulf Coast soils by multiplying the measured penetrometer reading by a factor of 0.6. These adjusted strength estimates are recorded in the "Shear Strength" column on the boring logs. Except as described in the text, we have not adjusted estimates of the undrained shear strength for projects located outside of the Pleistocene Gulf Coast formations.

Information on each boring log is a compilation of subsurface conditions and soil or rock classifications obtained from the field as well as from laboratory testing of samples. Strata have been interpreted by commonly accepted procedures. The stratum lines on the logs may be transitional and approximate in nature. Water level measurements refer only to those observed at the time and places indicated, and can vary with time, geologic condition, or construction activity.

TERMS AND SYMBOLS USED ON BORING LOGS

SOIL CLASSIFICATION (2 of 2)

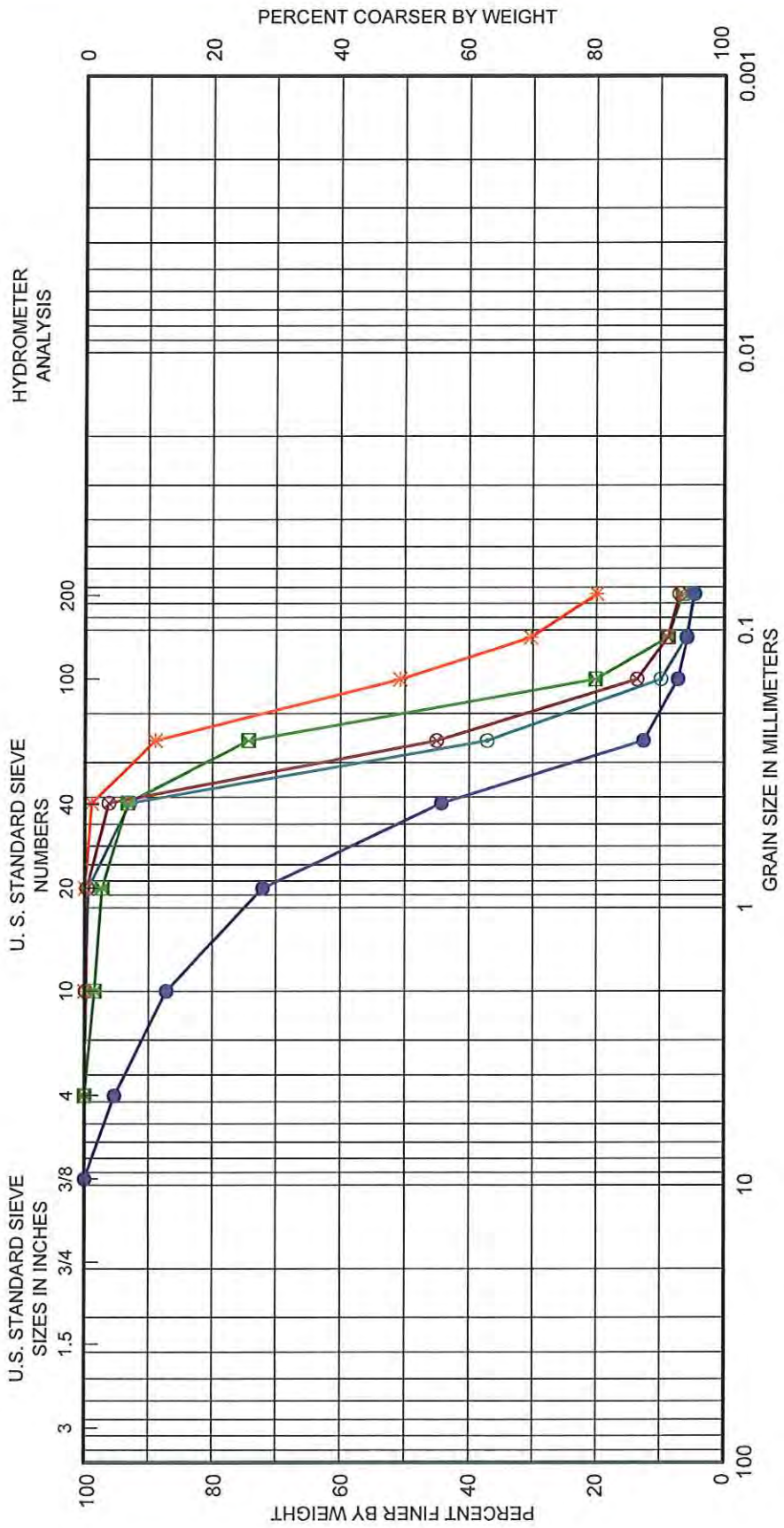
APPENDIX B – LABORATORY TEST RESULTS



GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	BORING	DEPTH, FT	CLASSIFICATION
●	FB-1	20	SILTY SAND, brown, fine- to medium-grained
⊠	FB-10	16	SAND, tan, fine- to medium-grained
✳	FB-10	59.9	SAND, tan, fine- to medium-grained
⊗	FB-10	80	SAND, gray, fine- to medium-grained
⊙	FB-10	119.9	SILTY SAND, gray, fine-grained

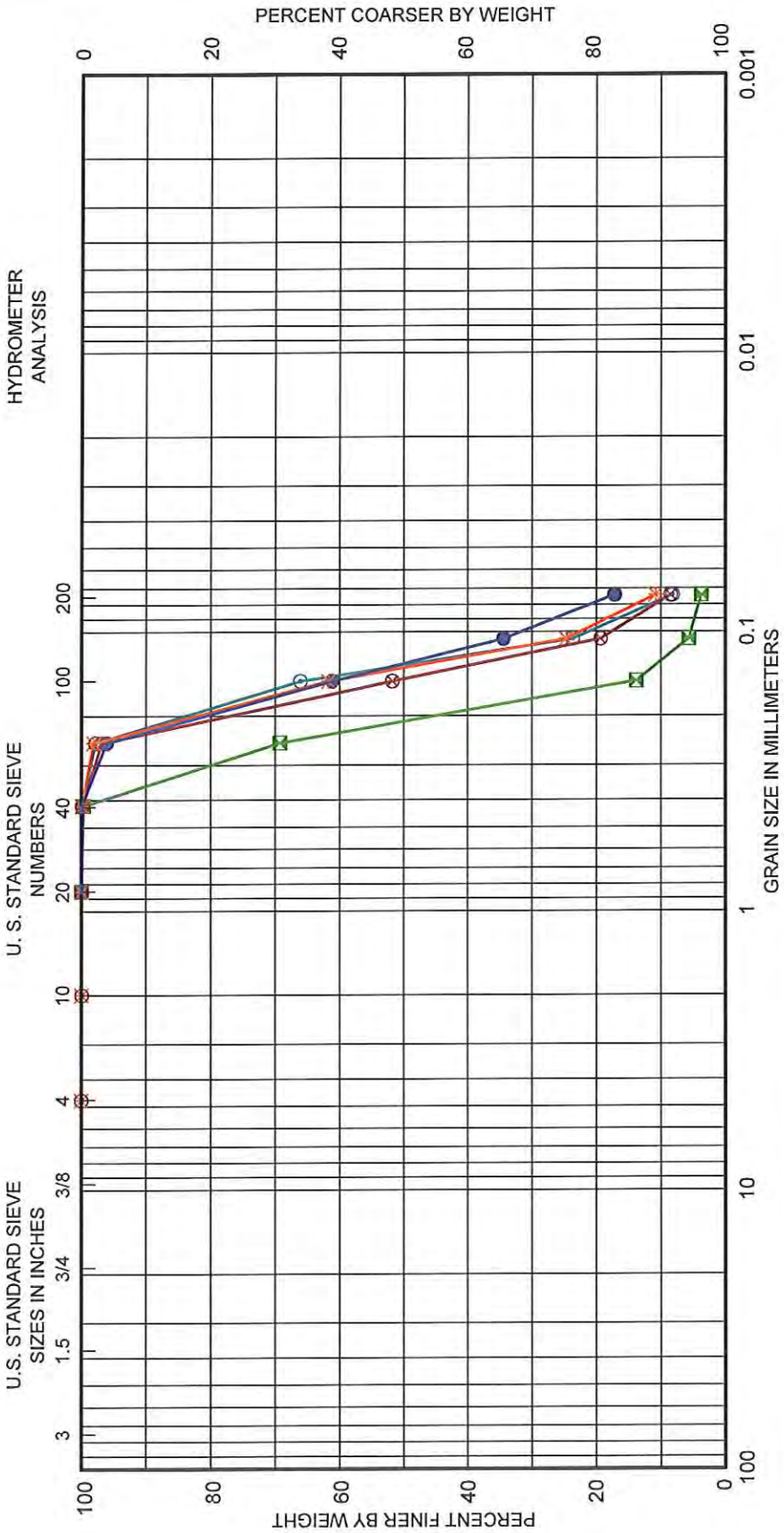
GRAIN SIZE CURVES
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS



GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	BORING	DEPTH, FT	CLASSIFICATION
●	FB-11	45	SAND, red, fine- to coarse-grained with fine gravel
▣	FB-11	80	SAND, gray, fine- to medium-grained
✳	FB-12	20	SILTY SAND, tan, fine-grained
⊗	FB-12	70	SAND, gray, fine-grained, with silt
⊙	FB-13	20	SAND, tan, fine- to medium-grained with silt

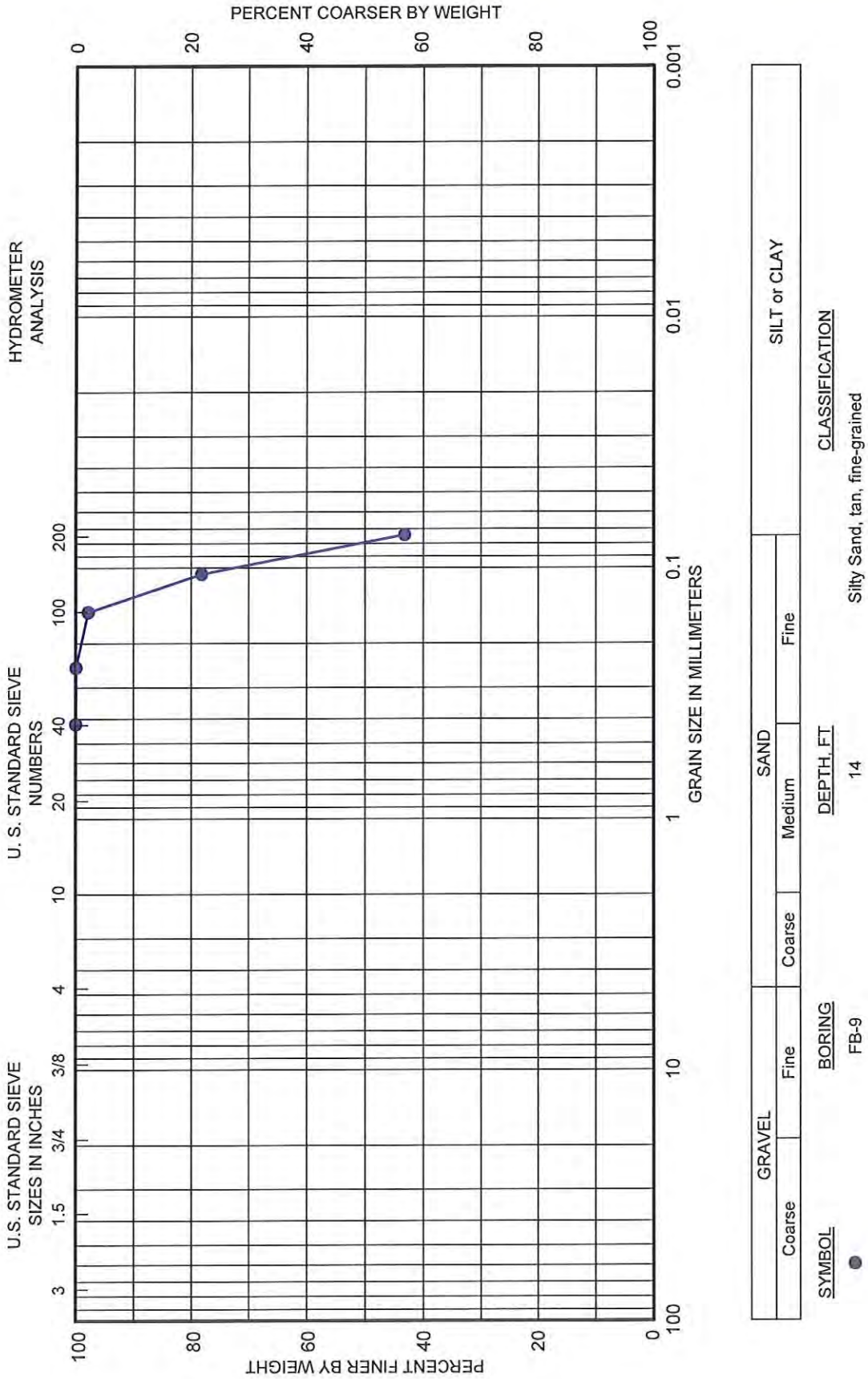
GRAIN SIZE CURVES
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS



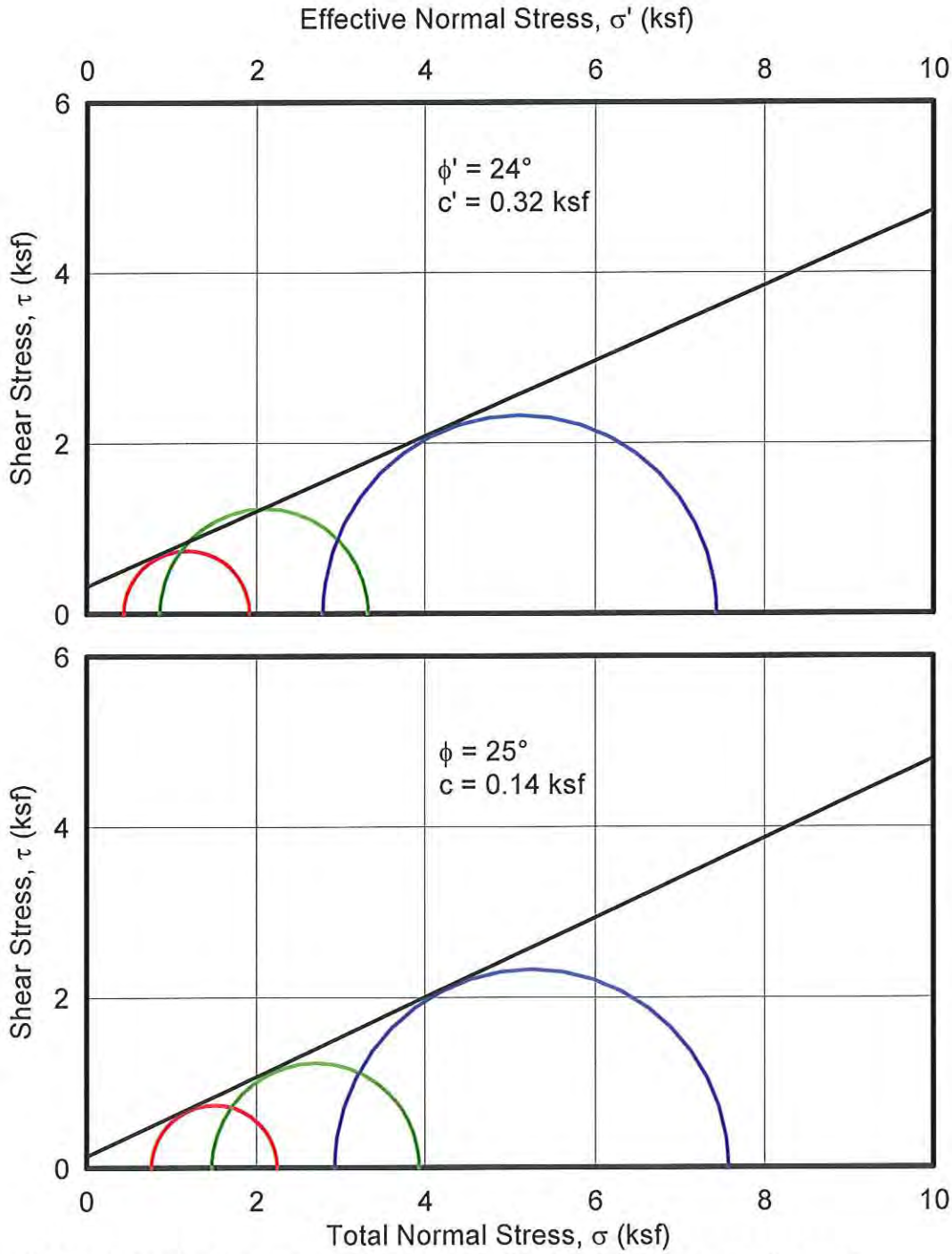
GRAVEL		SAND			SILT or CLAY
Coarse	Fine	Coarse	Medium	Fine	

SYMBOL	BORING	DEPTH, FT	CLASSIFICATION
●	FB-13	55	SILTY SAND, gray, fine-grained
⊠	FB-14	65	SAND, brown, fine-grained
✳	FB-15	8	SAND, tan, fine-grained, with silt
⊗	FB-15	16	SAND, brown, fine-grained, with silt
⊙	FB-15	60	SAND, gray, fine-grained, with silt

GRAIN SIZE CURVES
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS



GRAIN SIZE CURVES
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

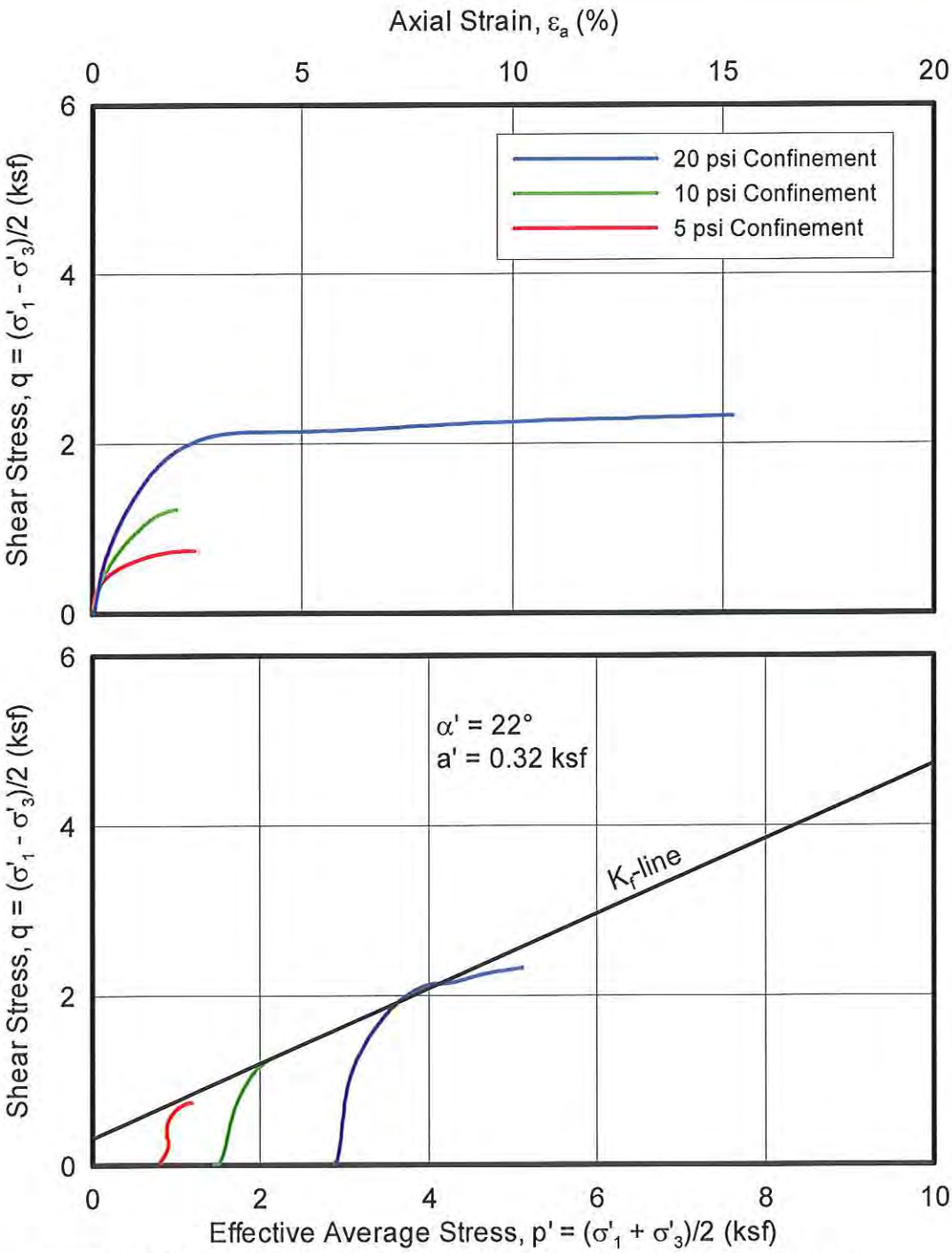


MATERIAL: CLAY, brown, with calcareous nodules, silt pockets, and silt seams

INITIAL WATER CONTENT: 18 %	LIQUID LIMIT: 64
INITIAL WET UNIT WEIGHT: 127 pcf	PLASTIC LIMIT: 15
INITIAL DRY UNIT WEIGHT: 108 pcf	PLASTICITY INDEX: 49
INITIAL VOID RATIO: 0.59	SPECIFIC GRAVITY: 2.75 (assumed)

MULTI STAGE CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST RESULTS

ISOTROPICALLY CONSOLIDATED - MOHR'S CIRCLES
BORING B-13, 12 FT DEPTH
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS



MATERIAL: CLAY, brown, with calcareous nodules, silt pockets, and silt seams

INITIAL WATER CONTENT: 18 %	LIQUID LIMIT: 64
INITIAL WET UNIT WEIGHT: 127 pcf	PLASTIC LIMIT: 15
INITIAL DRY UNIT WEIGHT: 108 pcf	PLASTICITY INDEX: 49
INITIAL VOID RATIO: 0.59	SPECIFIC GRAVITY: 2.75

MULTI STAGE CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST RESULTS

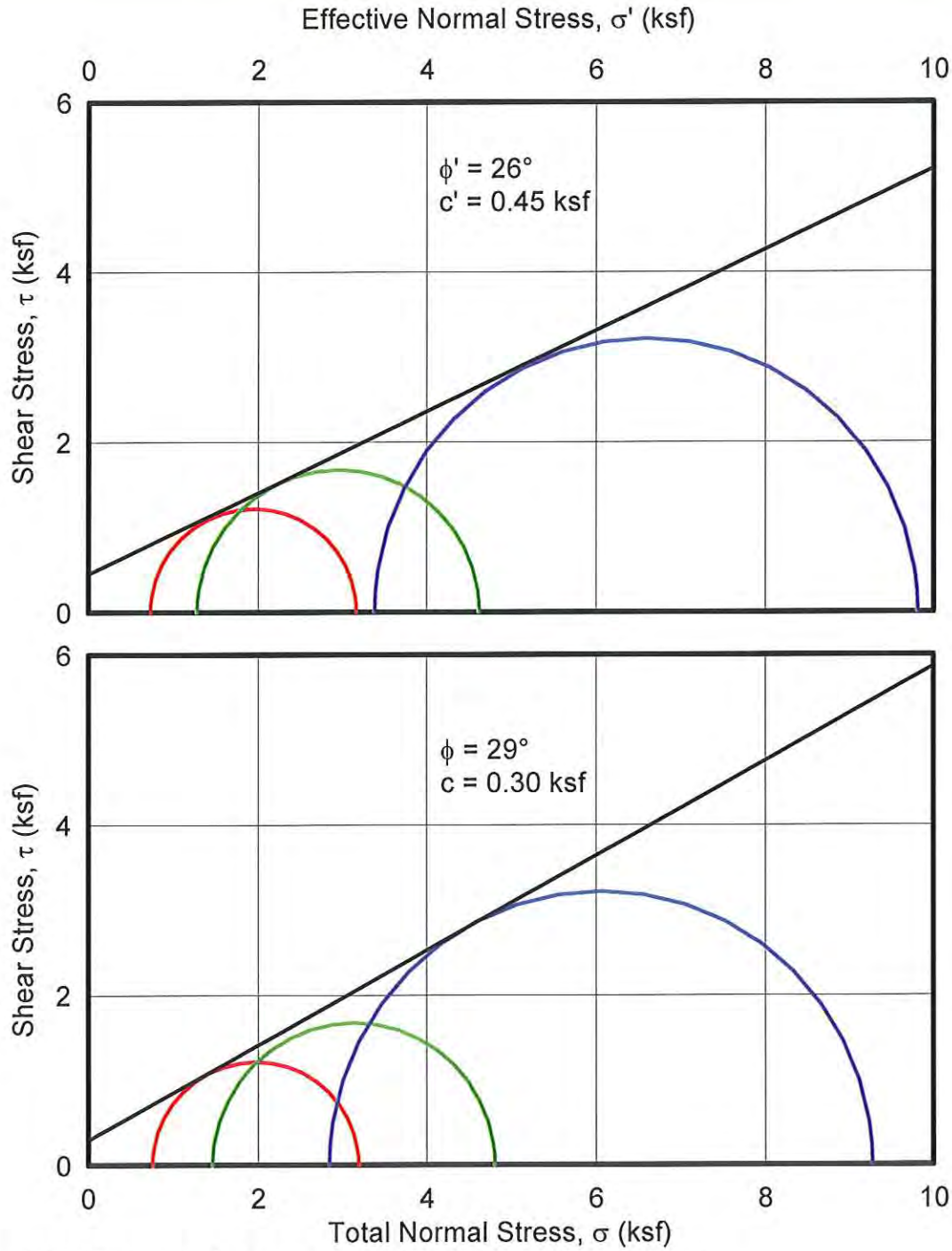
ISOTROPICALLY CONSOLIDATED - STRESS AND STRAIN CURVES

BORING B-13, 12 FT DEPTH

LUCE BAYOU INTERBASIN TRANSFER PROJECT

COASTAL WATER AUTHORITY

HOUSTON, TEXAS

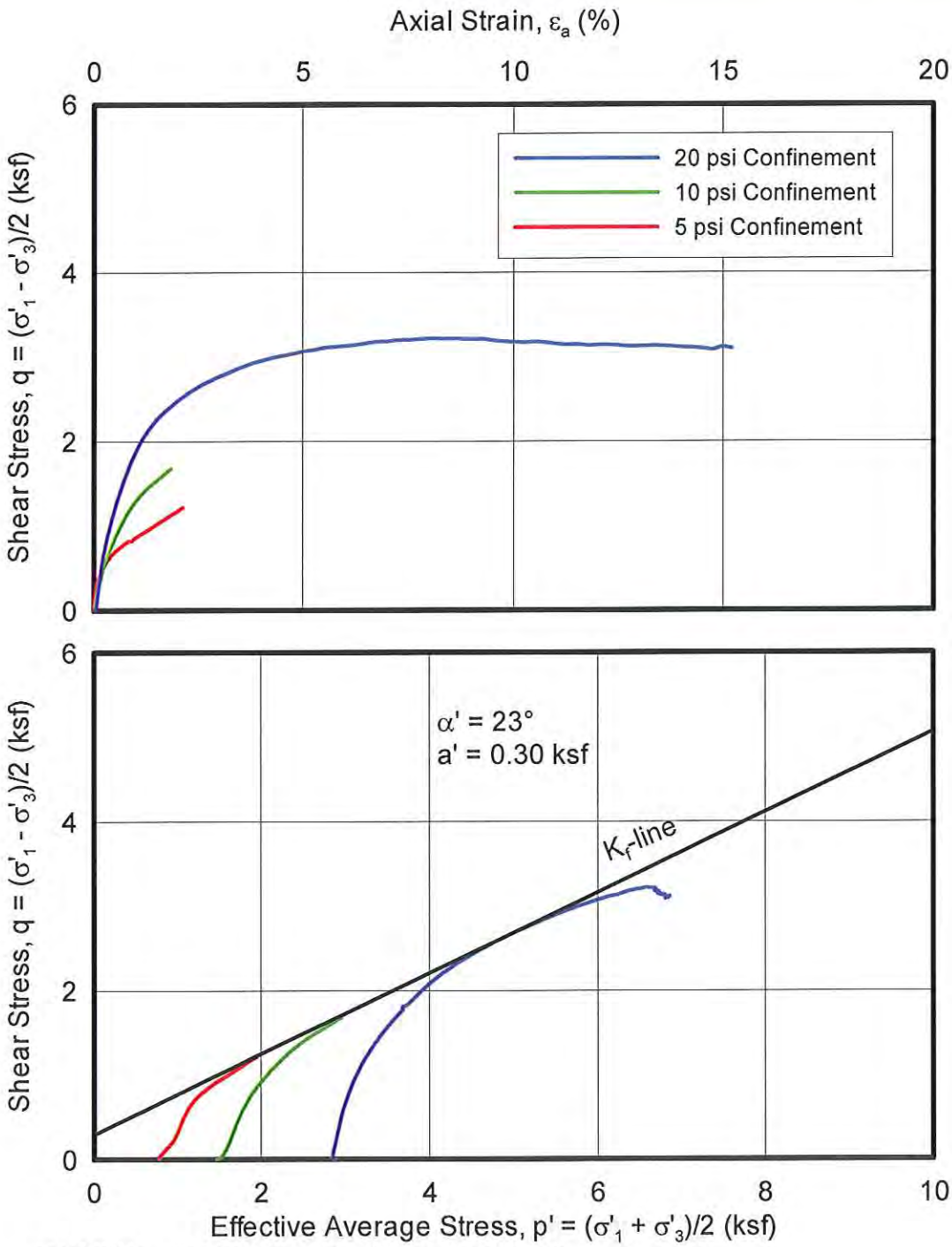


MATERIAL: CLAY, gray and red, slickensided, with sand pockets

INITIAL WATER CONTENT: 18 %	LIQUID LIMIT: 43
INITIAL WET UNIT WEIGHT: 130 pcf	PLASTIC LIMIT: 11
INITIAL DRY UNIT WEIGHT: 110 pcf	PLASTICITY INDEX: 32
INITIAL VOID RATIO: 0.56	SPECIFIC GRAVITY: 2.75 (assumed)

MULTI STAGE CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST RESULTS

ISOTROPICALLY CONSOLIDATED - MOHR'S CIRCLES
BORING B-13, 35 FT DEPTH
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS



MATERIAL: CLAY, gray and red, slickensided, with sand pockets

INITIAL WATER CONTENT: 18 %	LIQUID LIMIT: 43
INITIAL WET UNIT WEIGHT: 130 pcf	PLASTIC LIMIT: 11
INITIAL DRY UNIT WEIGHT: 110 pcf	PLASTICITY INDEX: 32
INITIAL VOID RATIO: 0.56	SPECIFIC GRAVITY: 2.75

MULTI STAGE CONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION TEST RESULTS

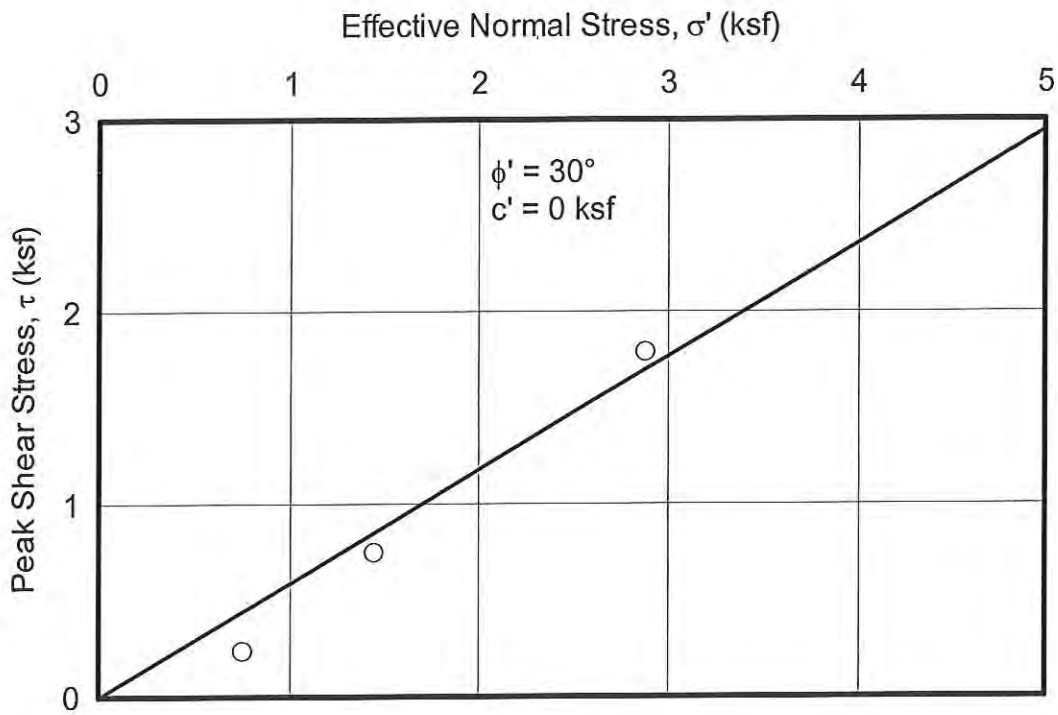
ISOTROPICALLY CONSOLIDATED - STRESS AND STRAIN CURVES

BORING B-13, 35 FT DEPTH

LUCE BAYOU INTERBASIN TRANSFER PROJECT

COASTAL WATER AUTHORITY

HOUSTON, TEXAS



MATERIAL: SAND, fine- to medium-graded, brown, with silt
INITIAL WATER CONTENT: 18 %
INITIAL WET UNIT WEIGHT: 116 pcf
INITIAL DRY UNIT WEIGHT: 99 pcf
INITIAL VOID RATIO: 0.73

Note:

1. Sample was remolded in the laboratory to initial unit weight and water content shown as noted.

DIRECT SHEAR TEST RESULTS
BORING B-13, 20 FT DEPTH
LUCE BAYOU INTERBASIN TRANSFER PROJECT
COASTAL WATER AUTHORITY
HOUSTON, TEXAS

APPENDIX C – CORROSION POTENTIAL GUIDELINES

CORROSION POTENTIAL GUIDELINES

Corrosion of Steel. Corrosion is a major factor in the life of steel elements in contact with soil. Corrosion is caused by migration of electrons from the steel into the surrounding soil. Three measurable soil properties that indicate the corrosion potential for steel in contact with soil are: 1) chloride ion concentration, 2) pH, and 3) electrical resistivity. It is generally accepted that corrosion of steel is most likely in environments that have chloride ions (even in low concentrations), low pH, and/or low resistivity.

The following table presents some general guidelines concerning the corrosion potential of a soil as a function of chloride ion concentration, pH, and electrical resistivity[1]. Each of the columns in this table should be used independently of the others when evaluating soil corrosion potential. For example, it is not necessary to have a resistivity between 0 and 1,000 Ohm-cm ***and*** a pH between 0 and 4.5 to indicate a very high potential for corrosion.

Resistivity (Ohm-cm)	Chloride Ion Concentration (ppm)	pH	Corrosion Potential
0 – 1,000	> 500	0 - 4.5	Very High
1,000 – 2,000		4.5 - 5.5	High
2,000 – 5,000	< 500	5.5 - 6.5	Moderate
> 5,000		> 6.5	Mild

Degradation of Concrete. The degradation of concrete is caused by chemical agents in the soil or groundwater that react with concrete to either dissolve the cement paste or precipitate larger compounds which cause cracking and flaking. The concentration of water-soluble sulfates in the soils is a good indicator of the potential for chemical attack of concrete. Sulfate concentrations in soil can be used to evaluate the need for protection of concrete based on the following table[2].

Sulfate Ion Concentration (ppm)	Aggressiveness
> 20,000	Very Severe
2,000 to 20,000	Severe
1,000 to 2,000	Moderate
< 1,000	Mild

[1] Palmer, J. F., Soil Resistivity Measurements and Analysis, Materials Performance, Vol. 13, January 1974.

[2] ACI Manual of Concrete Practice, Part 1, Section 201.2R-12, American Concrete Institute, 1992.

APPENDIX D – GENERAL GUIDELINES FOR CRUMB TESTS

GENERAL GUIDELINES FOR CRUMB TESTS

Most clayey soils are moderately to highly resistant to erosion by water. To a large extent, this is due to the surface chemistry of the clay particles, causing them to attract to each other in the presence of water. However, some clayey soils have the tendency for individual particles to repel each other in the presence of water. Particles of these clayey soils, when exposed to freshwater, have a tendency to go into suspension in water by a process called "dispersion." Such clayey soils are collectively called "dispersive clays."

The crumb dispersion test is an empirical laboratory test used to qualitatively identify the presence of dispersive clays. We conducted crumb dispersion tests on selected soil samples within the vicinity of the proposed outfall structure. The results of this qualitative test can vary from "no reaction" (no evidence of dispersion properties) to "strong reaction" (definite indication of dispersive properties). The following table presents general guidelines for estimating the dispersive potential from crumb test results.

Grade	Reaction	Description	Dispersion Potential
1	None	Crumb may slake and run out of the beaker in flat pile but no sign of cloudy water caused by colloids in suspension.	Low
2	Slight	Bare hint of cloud in water at the surface of crumb. (If the cloud is easily visible, use Grade 3).	Moderate
3	Moderate	Easily recognizable cloud of colloids in suspension. Usually spreading out in thin streaks on bottom of beaker.	High
4	Strong	Colloidal cloud covers nearly whole bottom (at least 85 percent) of beaker, usually in a very thin skin. In extreme cases all the water in the beaker becomes cloudy.	Very High

Appendix C

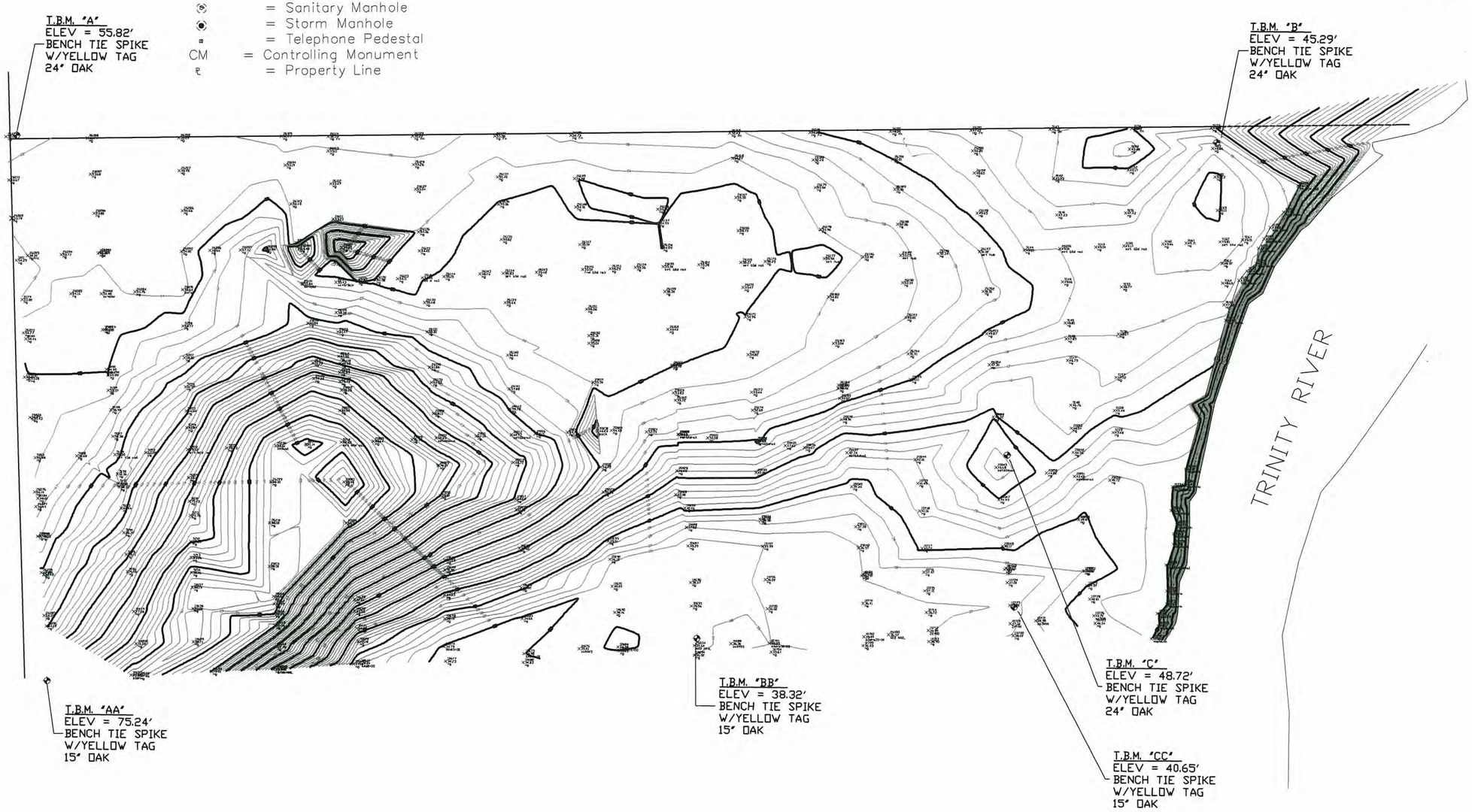
Topographic and Bathymetric Survey

LEGEND

= Elect. Pad Mount Transformer
= Found 5/8" Iron Rod w/Cap
= Point
= Power Pole
= Overhead Electrical Line
= Water Valve/Meter
= Fence
= Electrolier
= Flush Valve
= Curb Inlet
= Sanitary Manhole
= Storm Manhole
= Telephone Pedestal
CM = Controlling Monument
= Property Line

N
W E
S

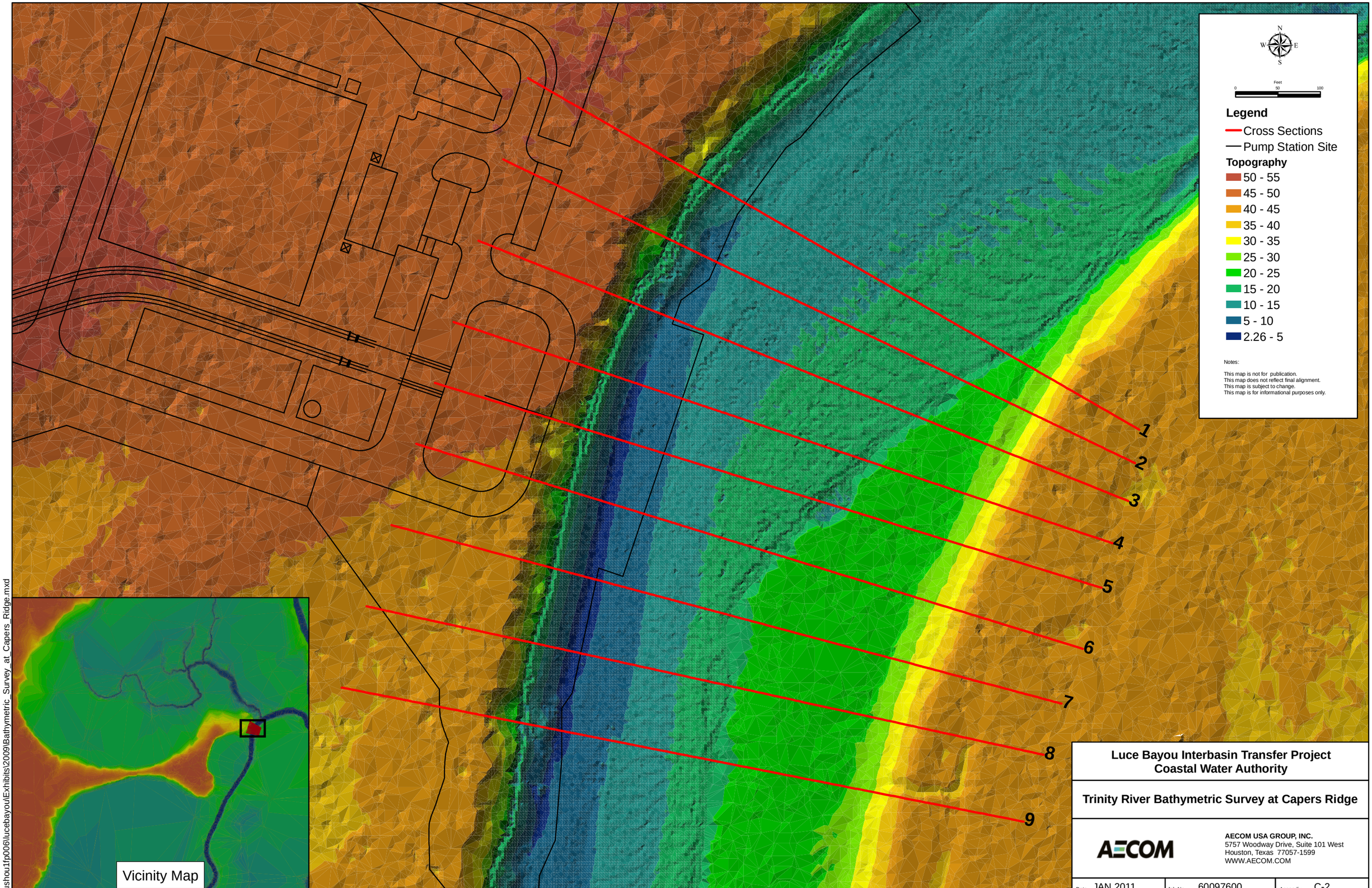
SCALE IN FEET
0 100 200
1 INCH = 100 FEET



RATNALA & BAHL, INC.
11767 Katy Frwy, Suite 510
HOUSTON, TEXAS 77079

TOPOGRAPHIC SURVEY
OF
LUCE 96 ACRES TRACT

SCALE: 1" = 100'	JOB NO. 2838	FN
DATE: 02/27/09	FIELD BOOK NO.: 544-545	
DRAWN BY: MSC	DRAWING NO.: N/A	



Luce Bayou Interbasin Transfer Project
Coastal Water Authority

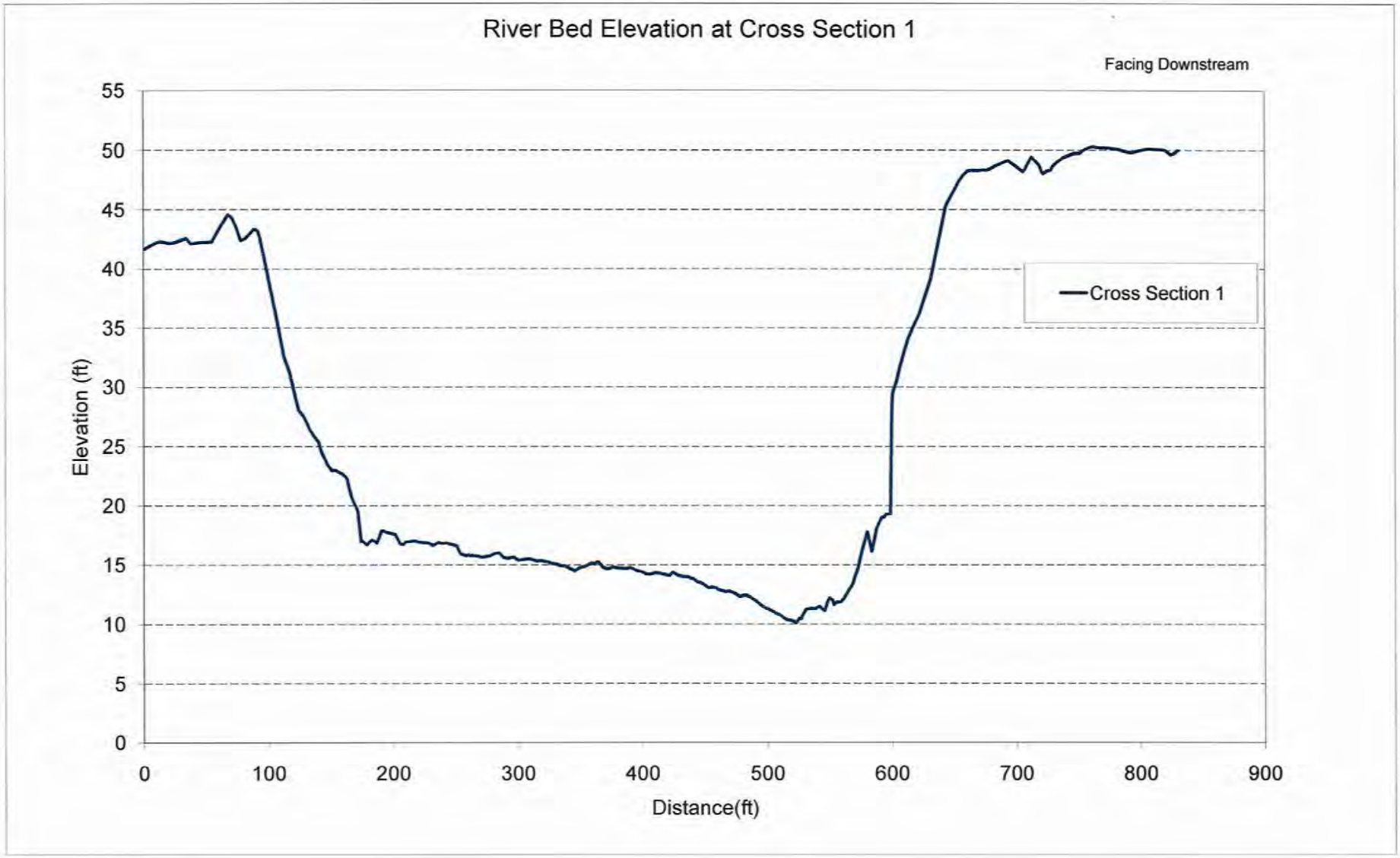
Trinity River Bathymetric Survey at Capers Ridge

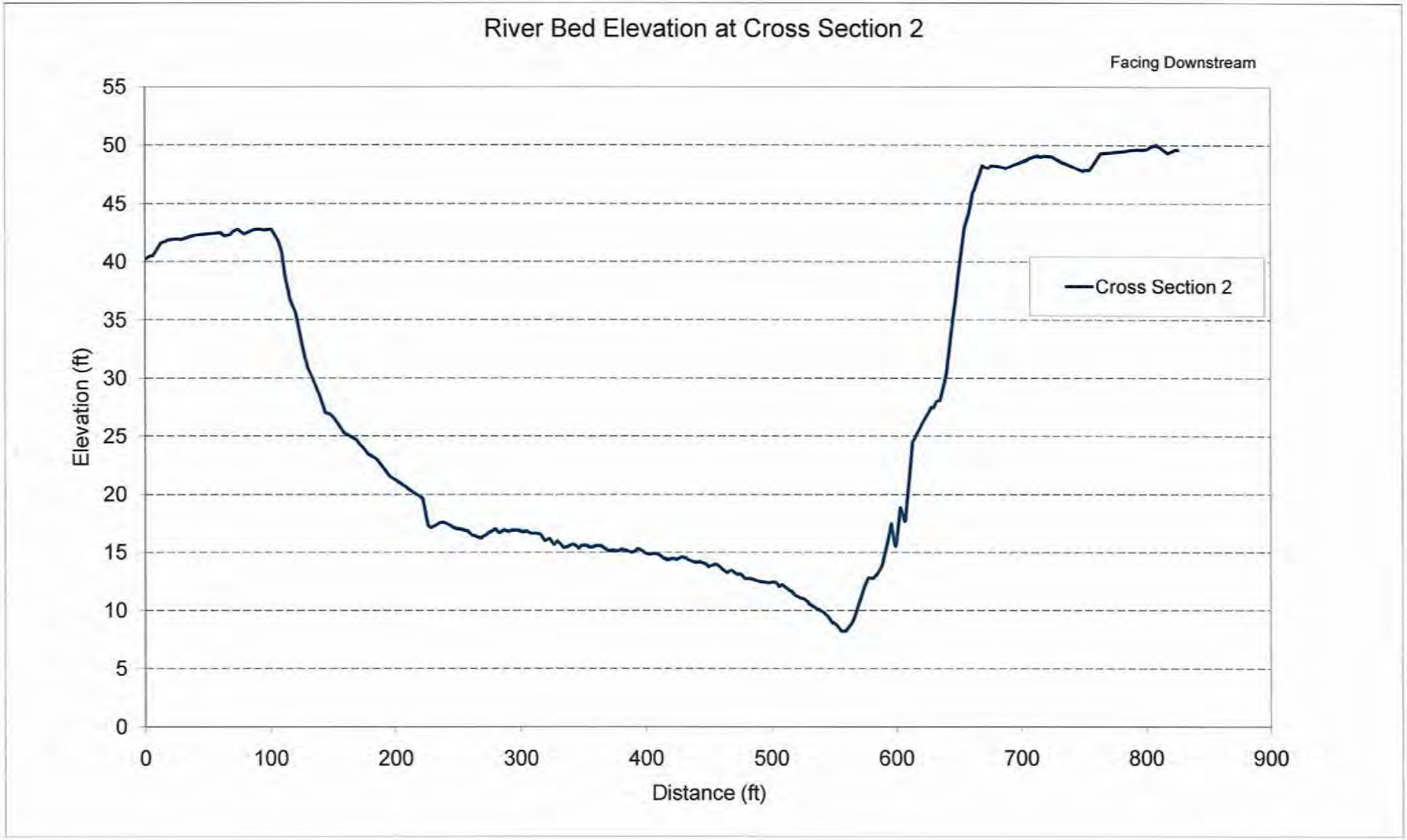
AECOM

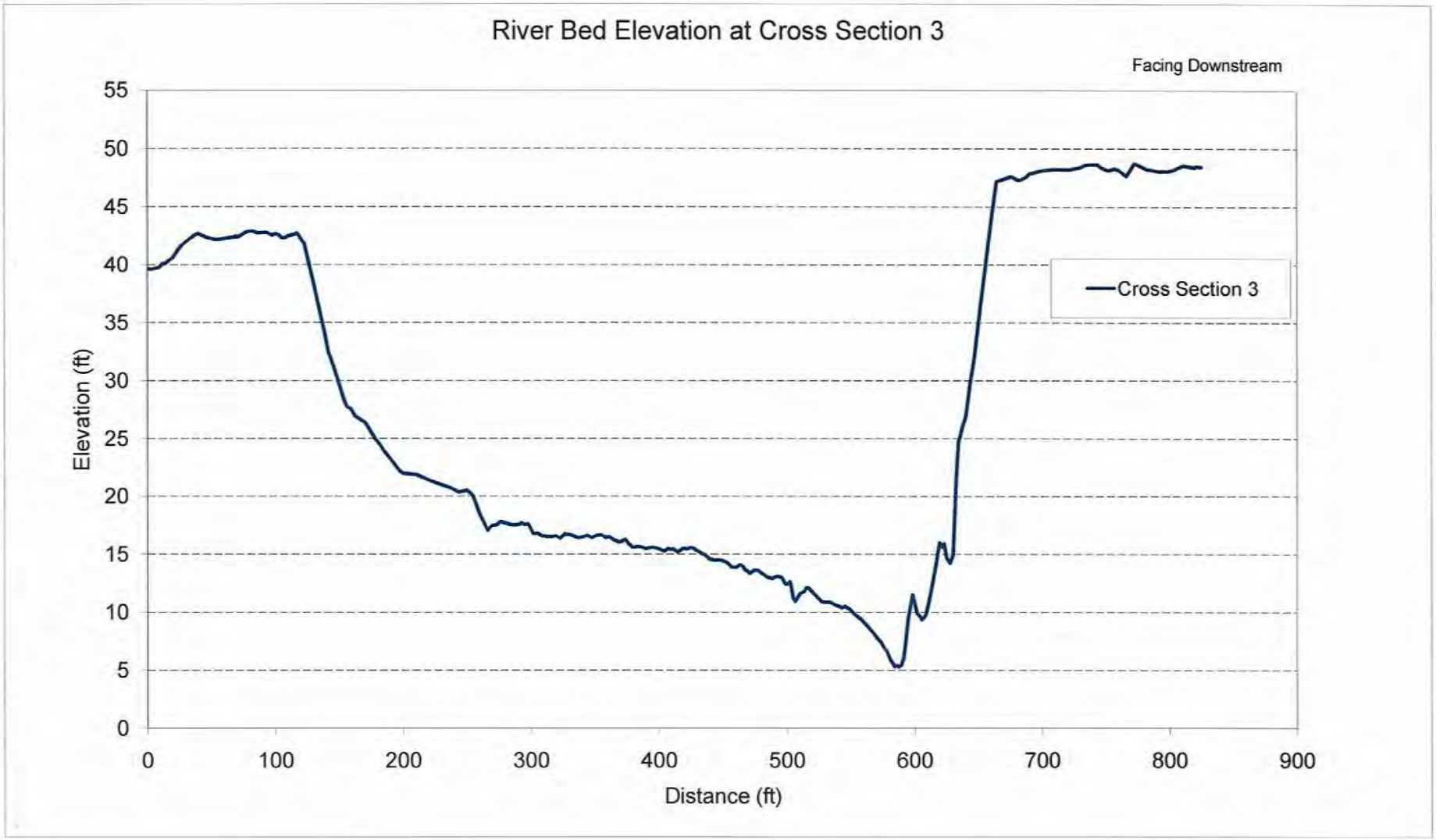
AECOM USA GROUP, INC.
5757 Woodway Drive, Suite 101 West
Houston, Texas 77057-1599
WWW.AECOM.COM

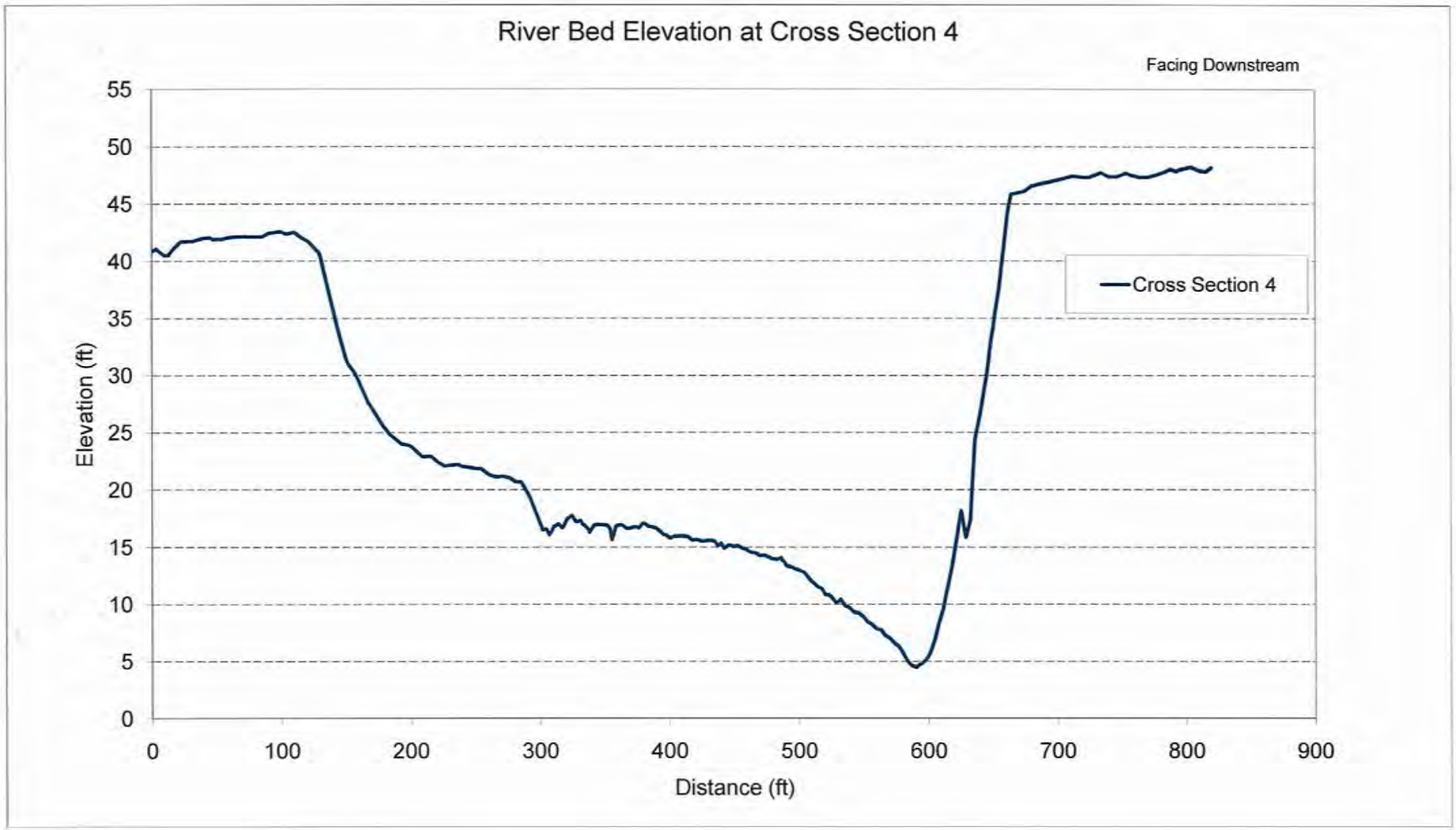
Date	Job No.	Appendix
JAN 2011	60097600	C-2

\\ushou1fp006\lucebayou\Exhibits\2009\Bathymetric_Survey_at_Capers_Ridge.mxd


River Bed Elevation at Cross Section 1
Facing Downstream
Cross Section 1
Elevation (ft)
Distance(ft)
55
50
45
40
35
30
25
20
15
10
5
0
0
100
200
300
400
500
600
700
800
900


River Bed Elevation at Cross Section 2
Facing Downstream
Cross Section 2
Elevation (ft)
Distance (ft)
0
5
10
15
20
25
30
35
40
45
50
55
0
100
200
300
400
500
600
700
800
900


River Bed Elevation at Cross Section 3
Facing Downstream
Cross Section 3
Elevation (ft)
Distance (ft)
0
5
10
15
20
25
30
35
40
45
50
55
0
100
200
300
400
500
600
700
800
900


River Bed Elevation at Cross Section 4
Facing Downstream
Cross Section 4
Elevation (ft)
Distance (ft)
55
50
45
40
35
30
25
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15
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5
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0
100
200
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800
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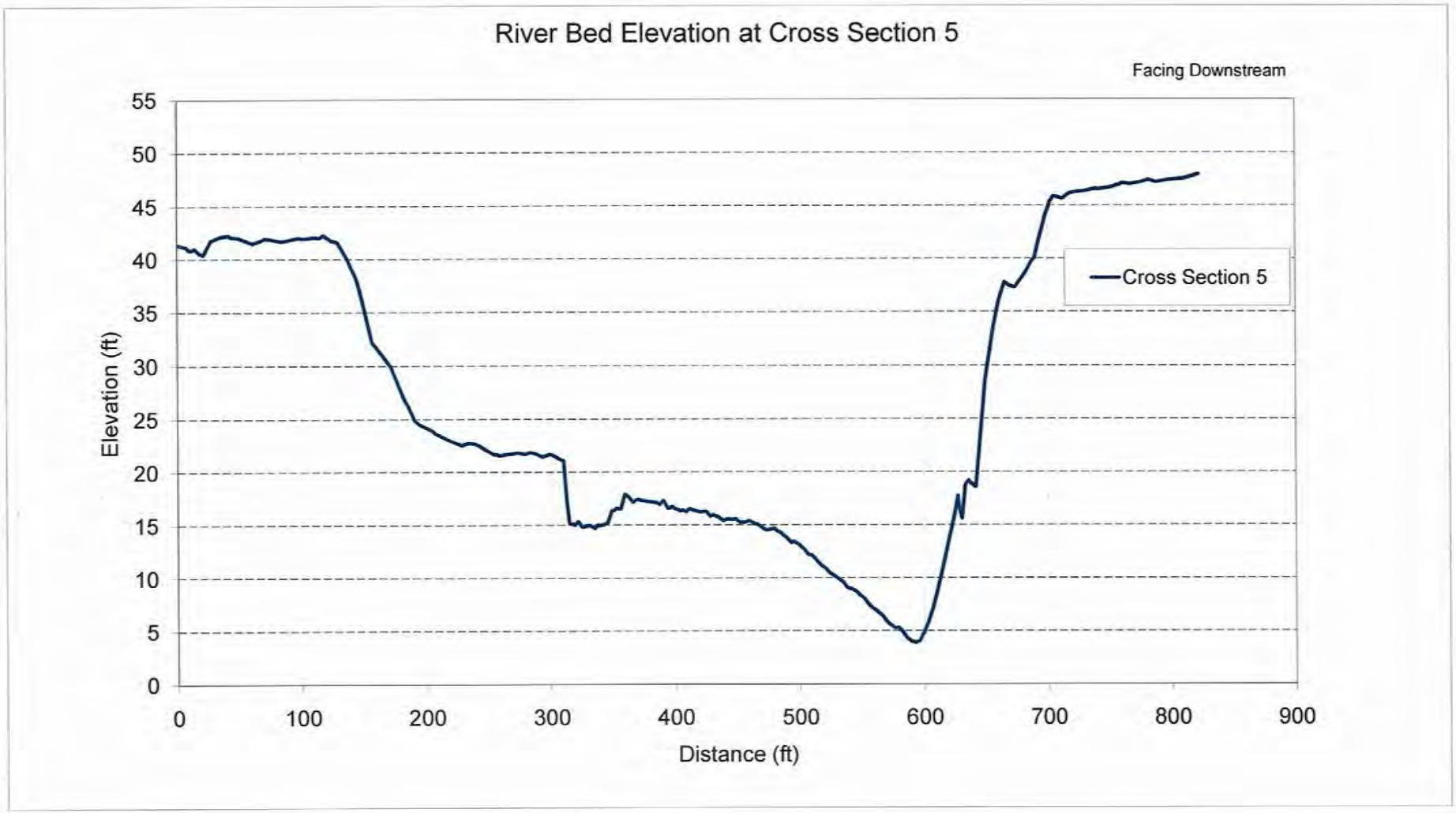
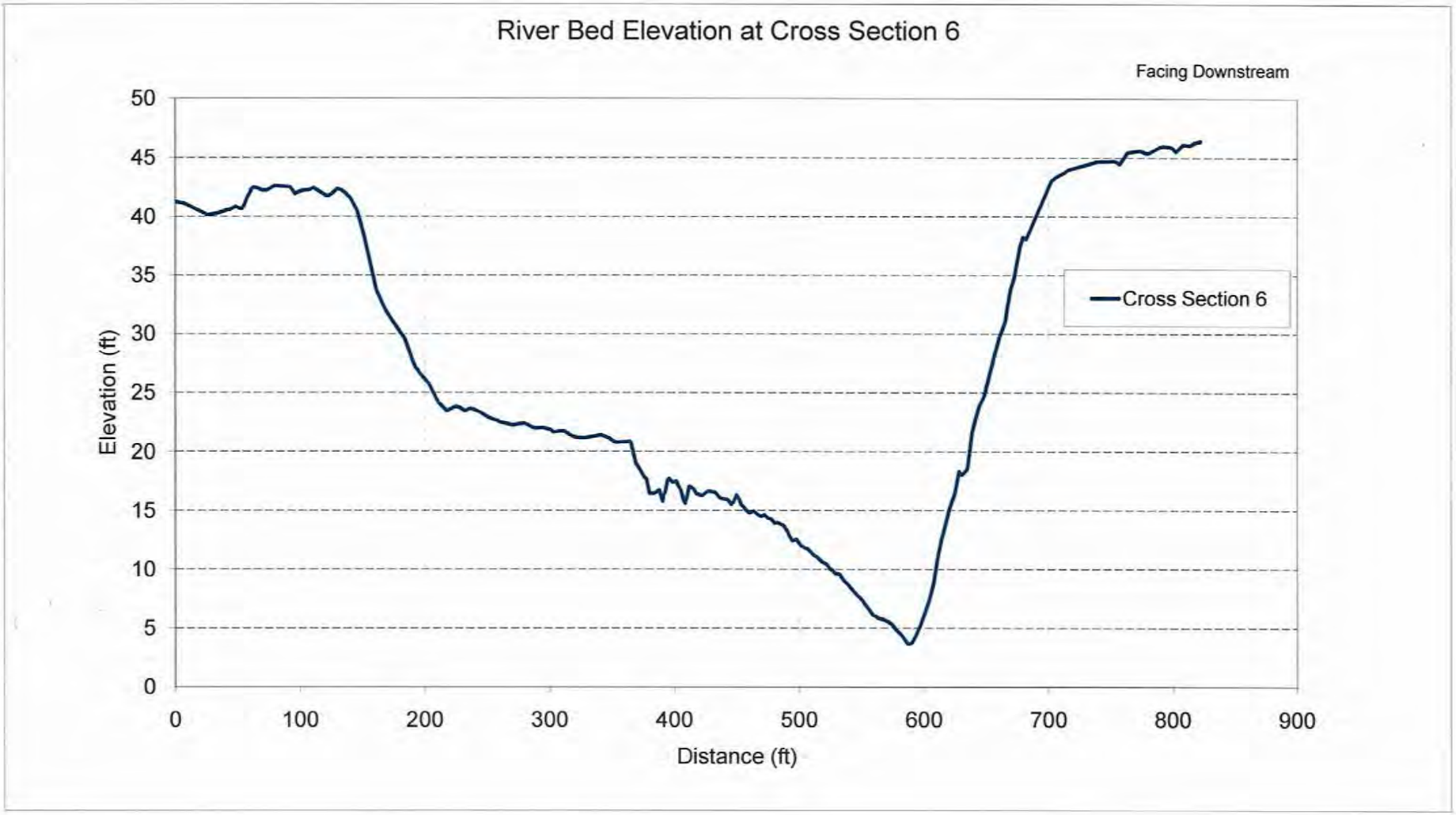

River Bed Elevation at Cross Section 5
Facing Downstream
Elevation (ft)
55
50
45
40
35
30
25
20
15
10
5
0
0
100
200
300
400
500
600
700
800
900
Distance (ft)
Cross Section 5


River Bed Elevation at Cross Section 6
Facing Downstream
Elevation (ft)
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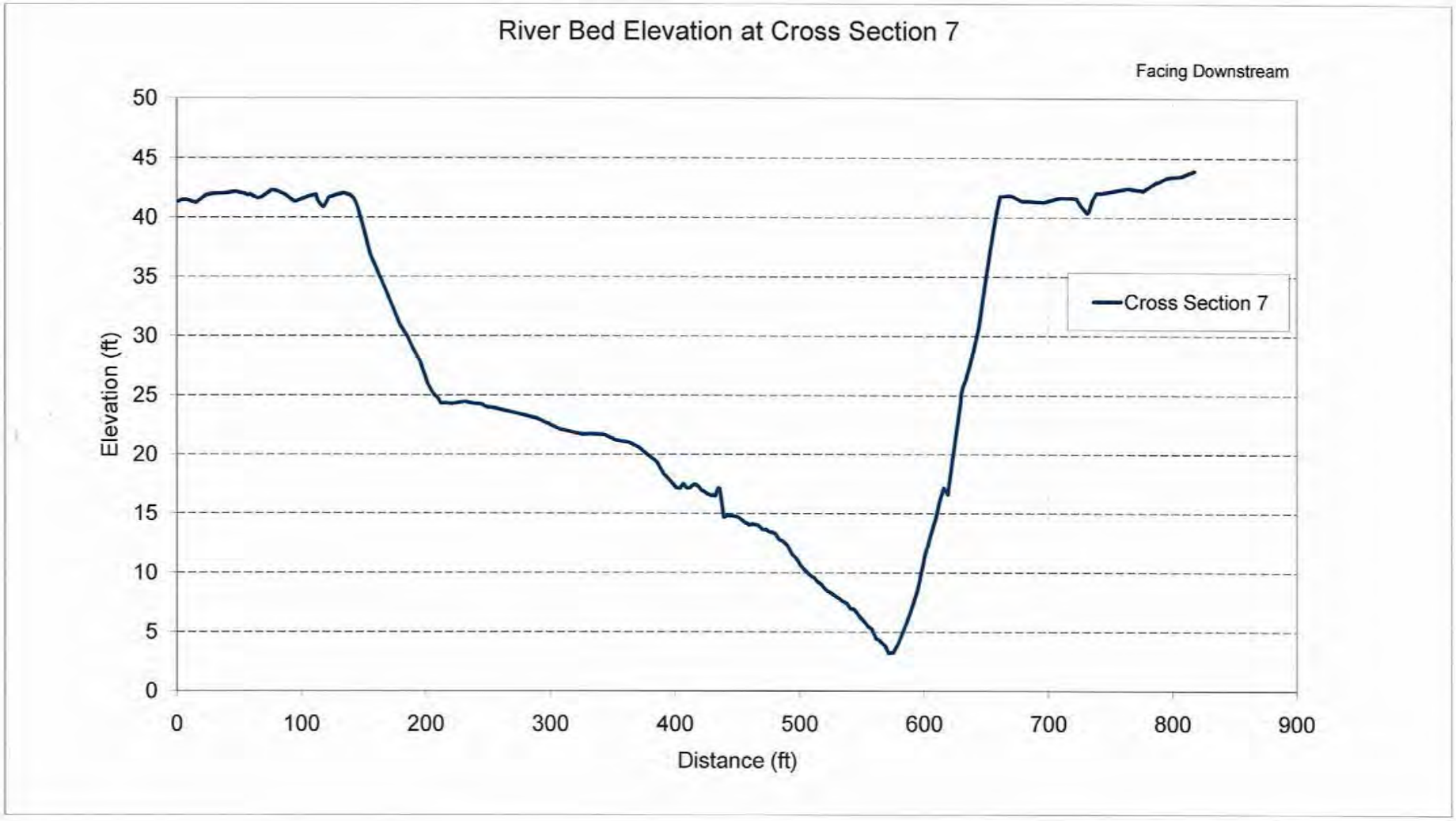
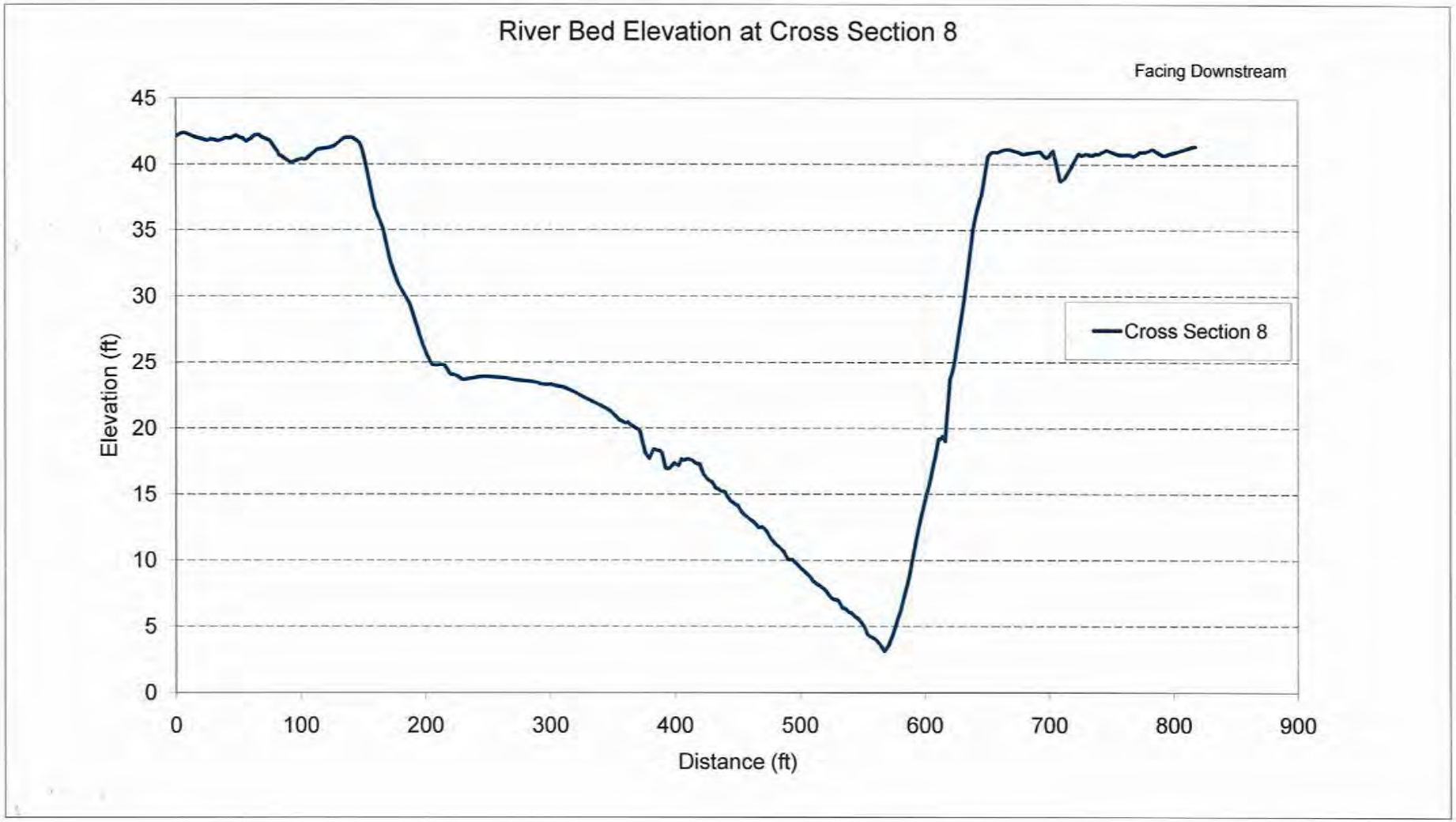
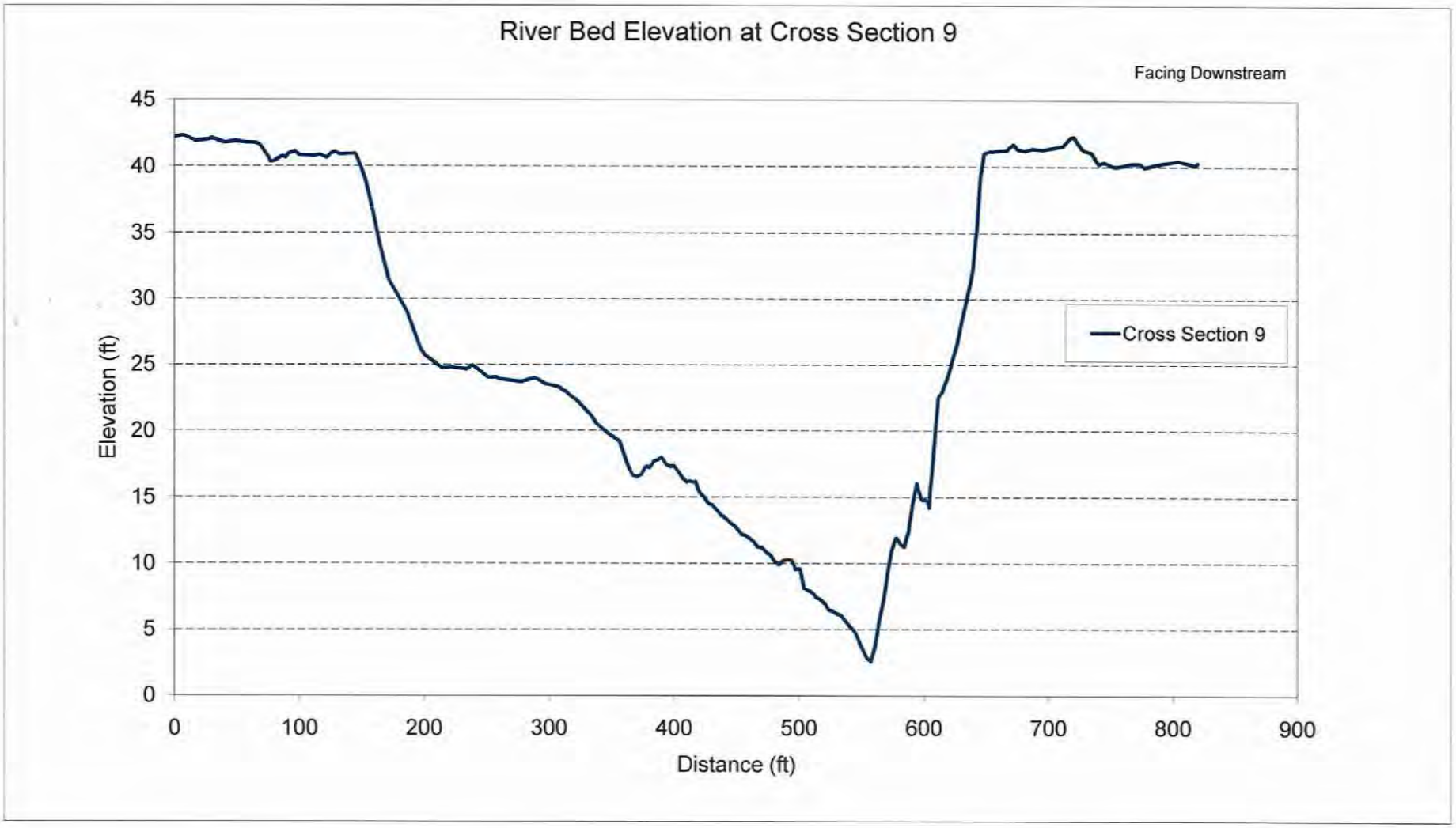
45
40
35
30
25
20
15
10
5
0
0
100
200
300
400
500
600
700
800
900
Distance (ft)
Cross Section 6


River Bed Elevation at Cross Section 7
Facing Downstream
Elevation (ft)
50
45
40
35
30
25
20
15
10
5
0
0
100
200
300
400
500
600
700
800
900
Distance (ft)
Cross Section 7

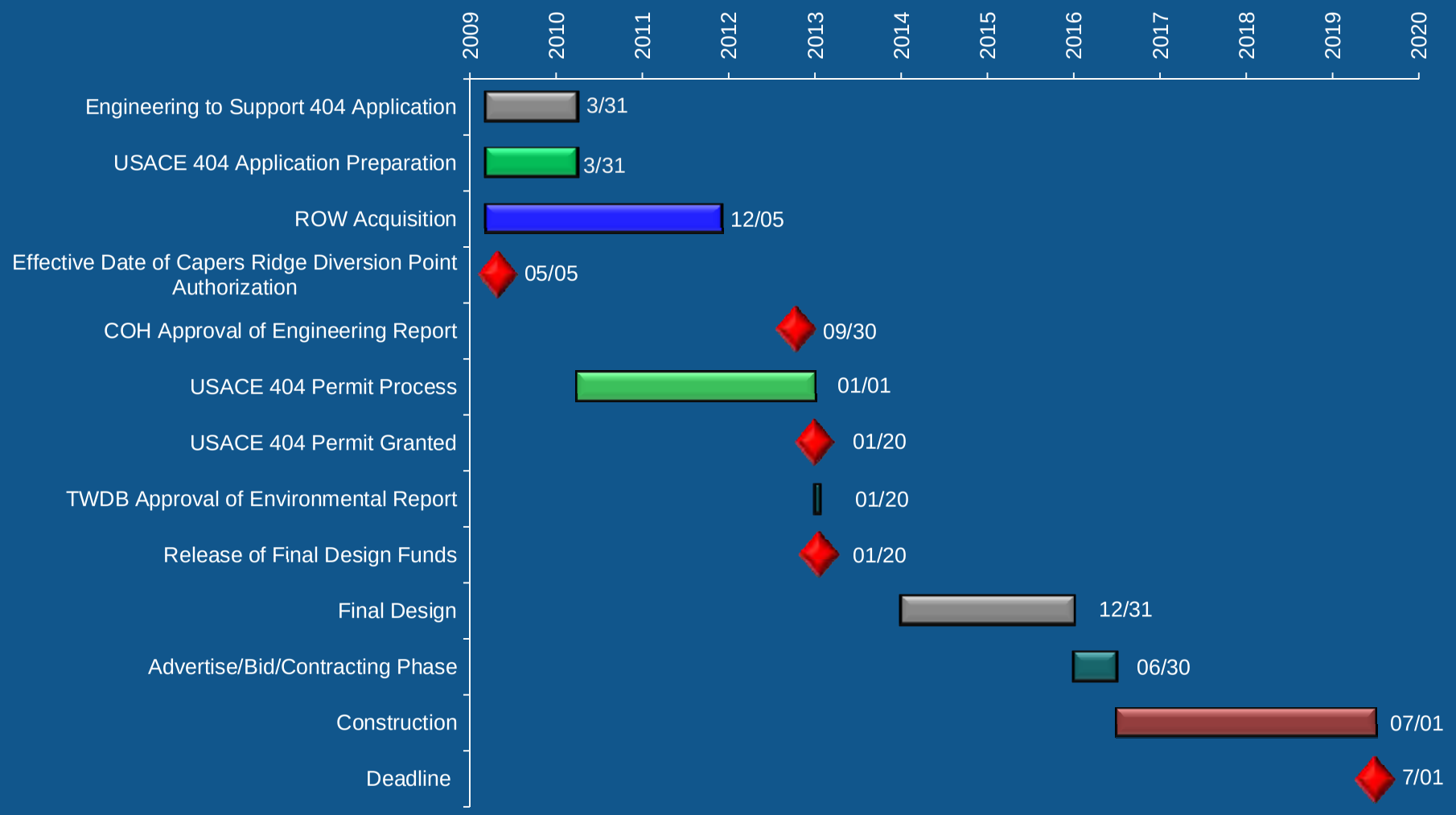

River Bed Elevation at Cross Section 8
Facing Downstream
Elevation (ft)
45
40
35
30
25
20
15
10
5
0
0
100
200
300
400
500
600
700
800
900
Distance (ft)
Cross Section 8


River Bed Elevation at Cross Section 9
Facing Downstream
Elevation (ft)
45
40
35
30
25
20
15
10
5
0
0
100
200
300
400
500
600
700
800
900
Distance (ft)
Cross Section 9

Appendix D

Project Schedule and Cost Estimate

Implementation Schedule



LUCE BAYOU INTERBASIN TRANSFER PROJECT
PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST

Item description	Unit	Quantity	Unit price	Total price
Canal[1, 2]	Mi	23.46	$4,856,000	$113,900,000
Pipeline[2, 3]	Ft	16,000	$2,818	$45,100,000
Pump Station Facility[2, 4]	LS	1	$49,716,000	$49,700,000
Electrical Transmission Service[2, 5]	LS	1	$12,815,400	$12,800,000
Land Acquisition and Environmental Mitigation Costs[6, 7]	LS	1	$14,500,000	$14,500,000
Engineering, Legal, and Financial Services[8]	LS	1	$59,000,000	$59,000,000

GRAND TOTAL[9, 10, 11] **$295,000,000**

Notes & Assumptions:

[1] Includes cost for the canal, canal maintenance facility, and settling basin

[2] Includes 30% contingency to cover unforeseen project changes or additions. A lower level of contingency (20%) was used in the OPCC provided in the 2007 Alternatives Analysis

[3] Includes cost for two 108" pipelines; assumes open cut construction; depth of cover 6'; material cost of $540/LF

[4] Includes cost for the pump station structure, electrical building, control building, maintenance building, Phase 1 pumps, and associated Phase 1 piping and valves. Also includes auxiliary power generation facilities based on vender quote plus markup for installation, overhead, and profit, which were not included in the OPCC provided in the 2007 Alternatives Analysis.

[5] Cost based on information provided by Sam Houston Electrical Cooperative. Similar costs were not included in the OPCC provided in the 2007 Alternatives Analysis

[6] Acreages derived from County Appraisal District records and recent survey data, where available; includes all project area and 3,126.9 acres for mitigation

[7] Includes 20% contingency to cover unforeseen damages and may include some litigation; actual total litigation cost subject to determination by CWA Counsel

[8] Estimate based on 25% of Construction, Land, and Mitigation Costs

[9] Grand Total based on Construction, Land, Mitigation, and Engineering, Legal, and Financial service costs

[10] 2010 dollars; no escalation or inflation applied

[11] The above Engineer's Estimate is only an estimate of possible construction costs for budgeting purposes. This estimate is limited to the conditions existing at its issuance and is not a guaranty of actual price or cost. Uncertain market conditions such as, but not limited to: local labor or contractor availability, wages, other work, material market fluctuations, price escalations, force majeure events, and developing bidding conditions etc may affect the accuracy of this estimate. AECOM is not responsible for any variance from this estimate or actual prices and conditions obtained.

CANAL CONVEYANCE COST

Item No	Item description	Unit	Quantity	Unit price	Total price
1	Excavation & Grading	CY	2,996,691	$5.00	$ 14,983,500
2	Clearing & Grubbing	AC	846	$10,000.00	$ 8,462,300
3	Hydromulch Seeding	AC	768	$1,500.00	$ 1,152,600
4	8" Crushed Aggregate (maintenance road)	SY	172,044	$14.50	$ 2,494,600
5	6" Lime Stabilized Subgrade (maintenance road)	SY	199,572	$3.00	$ 598,700
6	6% Lime (maintenance road)	Ton	2,694	$145.00	$ 390,700
7	Compacted Embankment	CY	722,264	$5.00	$ 3,611,300
8	Clay Lining	CY	1,021,896	$2.00	$ 2,043,800
9	Transportation of soil	CY/Mile	204,379	$2.80	$ 572,300
10	Fill in Waste Area	CY	1,635,164	$2.00	$ 3,270,300
11	Outfall Structure	Ea	1	$1,018,000.00	$ 1,018,000
12	4 Strand-Barbed Wire Fence (including posts and wires)	LF	242,600	$7.00	$ 1,698,200
13	6'-Chain Link Fence at Crossing Locations (including gates and posts)	LF	6,000	$15.00	$ 90,000
14	6" Concrete Lining (canal bends)	SY	44,240	$50.00	$ 2,212,000
15	Canal Maintenance Facility	LS	1	$4,512,000.00	$ 4,512,000
16	Water Level Control Gates (dual gates per each)	Ea	7	$329,000.00	$ 2,303,000
17	Electrical Easements Crossings	LS	1	$896,000.00	$ 896,000
18	Temporary Pavement (road crossings)	SY	3,800	$14.00	$ 53,200
19	Set Type 1 (road crossings)	Ea	1	$8,000.00	$ 8,000
20	Trench Protection (road crossings)	LF	1,500	$10.00	$ 15,000
21	Concrete Box Culverts- 7' x 5' (road crossings)	LF	500	$200.00	$ 100,000
22	Concrete Box Culverts- 8' x 7' (road crossings)	LF	738	$295.00	$ 217,710
23	Concrete Box Culverts- 9' x 5' (road crossings)	LF	2,400	$302.00	$ 724,800
24	Concrete Box Culverts- 10' x 5' (road crossings)	LF	396	$410.00	$ 162,360
25	Cast-in-place Headwall/Wingwalls- 10' (road crossings)	Ea	2	$18,000.00	$ 36,000
26	Cast-in-place Headwall/Wingwalls- 9' (road crossings)	Ea	4	$18,500.00	$ 74,000
27	Cast-in-place Headwall/Wingwalls- 8' (road crossings)	Ea	5	$15,000.00	$ 75,000
28	Cut & Restoring Pavemnet (ASPH)	SY	1,688	$50.00	$ 84,400
29	Concrete Box Culverts- 10' x 7' (canal siphon)	LF	15,200	$600.00	$ 9,120,000
30	Concrete Box Culverts- 5' x 7' (canal siphon)	LF	15,200	$200.00	$ 3,040,000
31	Concrete Box Culvert- 6' x 3' (canal siphon)	LF	5,700	$200.00	$ 1,140,000
32	Cast-in-place Headwall/Wingwalls- 10' x 7' (canal siphon)	Ea	38	$38,500.00	$ 1,463,000
33	Pipeline Adjustment/Relocation	LS	1	$14,598,000.00	$ 14,598,000
34	Bridge (private access)	Ea	5	$233,750.00	$ 1,168,800

CANAL CONVEYANCE COST

Item No	Item description	Unit	Quantity	Unit price	Total price
35	Clearing & Grubbing (sedimentation basin area)	AC	28	$9,071.00	$ 254,000
36	Excavation & Grading (sedimentation basin area)	CY	60,592	$5.00	$ 303,000
37	12" Type I Sand (sedimentation basin)	SY	2,495	$20.00	$ 49,900
38	8" Concrete Lining (sedimentation basin)	SY	2,646	$55.00	$ 145,500
39	Storm Water Pollution Prevention	LS	1	$1,127,000	$ 1,127,000
40	Mobilization	LS	1	$3,371,000.00	$ 3,371,000

Total Cost	*$*	*87,639,970*
30% Contingency	*$*	*26,291,991*
Total Canal Construction Cost	*$*	*113,931,961*
Total Canal Distances (miles)		23.46
Total Estimated Cost per Mile (rounded to nearest thousand $)	**$**	**4,856,000**

Notes & Assumptions:

1. Cost estimation based on historical material and construction costs available, including recent bid tabulations
2. Quantities based on the PER canal design
3. Assumed 6 road crossings, 19 canal siphons and 1 electrical crossing
4. Assumed two water level control gates at each proposed gate location
5. Clearing and grubbing cost was weighted based on approx. % of cleared vs. vegetated areas
6. Assumed one maintenance facility per direction from CWA
7. Chain link fences assumed at all road crossings, remaining ROW enclosed in barbed wire fence
8. Sedimentation basin area and material based on preliminary design; inflow and outflow weir concrete lined; remaining area grass lined
9. Dewatering costs are assumed to not be substantial at this time and are covered by contingency per geotechnical subconsultant preliminary findings
10. Line Item 33 based on 20 identified pipeline crossings, based on limited response/data received from pipeline companies in response to request for information
11. Mobilization was assumed to be 4% of the total cost
12. Assumed 20% of the clay lining will require transportation per geotechnical subconsultant preliminary findings

PIPELINE OPEN CUT CONVEYANCE COST

Item No	Item description	Unit	Quantity	Unit price	Total price
1	Clearing & Grubbing	Ac	141	$ 10,000.00	$ 1,408,200
2	Excavation & Grading	CY	88,775	$ 5.00	$ 443,900
3	Grading and Compaction of Waste Area	CY	227,627	$ 2.00	$ 455,300
4	108-inch Steel Pipe, Open Cut (Includes 2 separate pipes)	LF	15,520	$ 1,600.00	$ 24,832,000
5	108-inch Butterfly Valve & Manhole (6000' cc)	Ea	6	$ 260,000.00	$ 1,560,000
6	Access Manholes	Ea	6	$ 20,000.00	$ 120,000
7	Access Manhole for Drainage	Ea	6	$ 25,000.00	$ 150,000
8	Cathodic Protection System, including test stations, insulating joints, etc. assuming electricity is available	LS	1	$ 245,000.00	$ 245,000
9	12" Combination Air Valve Assembly with Vent piping, Bollards and Service Manhole, Complete in Place	Ea	18	$ 50,000.00	$ 900,000
10	6" Flushing Valve Assembly	Ea	8	$ 3,500.00	$ 28,000
11	2" Hot Mix Asphalt Concrete (access road)	Ton	16,439	$ 112.00	$ 1,841,200
12	6" Stabilized Subgrade (access road)	SY	107,296	$ 3.00	$ 321,900
13	6% Lime (access road)	Ton	1,448	$ 145.00	$ 210,000
14	6" Crushed Aggregate Base (access road)	SY	103,464	$ 4.27	$ 441,800
15	Block Sodding	SY	6,898	$ 5.00	$ 34,500
16	Storm Water Pollution Prevention	LS	1	$ 355,214.67	$ 355,200
17	Mobilization	LS	1	$ 1,334,000.00	$ 1,334,000

Total Cost	*$ 34,681,000*
30% Contingency	*$ 10,404,300*
Total Pipeline Construction Cost	*$ 45,085,300*
Total Pipeline Distance (miles)	3.03
Total estimated cost per mile (rounded to nearest thousand $)	**$ 14,880,000**

Notes & Assumptions:

1. Cost estimation based on historical material and construction cost available, including recent bid tabulations
2. Valves, fittings and, manholes quantities based on the PER pipeline design
3. Cathodic protection is assumed to be 0.75% of total pipeline construction cost
4. Pipeline cost includes pipe material, delivery, installation, excavation and backfill
5. Excavation and grading reflects values for ditches and access road
6. Mobilization was assumed to be 4% of total cost

CAPERS RIDGE PUMP STATION COST

Item No	Item description	Unit	Quantity	Unit price	Total price
Civil Items					
1	Clearing and Grubbing	AC	20	$10,000.00	$ 200,000
2	Site Grading	AC	10	$3,600.00	$ 36,000
3	Storm Water Retention Pond	CY	8,300	$6.24	$ 52,000
4	Storm Water Outfalls	EA	2	$41,500.00	$ 83,000
5	Drainage Swale	LF	4,000	$5.00	$ 20,000
6	8" Reinforced Concrete Roadway	SY	8,667	$35.00	$ 303,000
7	Stabilized Subgrade (8")	SY	8,667	$3.40	$ 29,000
8	6' Chain Link Fence w/ 3 Strands BW - Pump Station	LF	2,080	$20.00	$ 42,000
9	6' Chain Link Fence w/ 3 Strands BW - Site Boundary	LF	7,050	$20.00	$ 141,000
10	Excavation and Hauling - PS Foundation	CY	25,185	$6.24	$ 157,000
11	Excavation and Hauling - Roadways	CY	7,079	$6.24	$ 44,000
12	Excavation and Hauling - Sediment Ponds	CY	16,667	$6.24	$ 104,000
13	Grading and Compaction of Fill Areas	CY	43,631	$2.00	$ 87,000
14	Hydromulch	MSF	170	$23.00	$ 4,000
15	Landscaping	LS	1	$10,000.00	$ 10,000
16	Filter Fabric Erosion Control Silt Fence & Maintenance	LF	5,000	$3.00	$ 15,000
17	Pollution Prevention - Misc.	LS	1	$5,000.00	$ 5,000
Structural Items					
18	Pump Station Control Building	SF	4,500	$210.00	$ 945,000
19	Pump Station Electrical Building	SF	2,900	$160.00	$ 464,000
20	Pump Station Maintenance Building	SF	2,660	$160.00	$ 426,000
21	Pump Station Foundation Slab	CY	1,704	$400.00	$ 682,000
22	Pump Station Concrete Walls	CY	2,605	$650.00	$ 1,693,000
23	Pump Station Concrete Top Slab	CY	625	$550.00	$ 344,000
24	Pump Station Catwalks	SF	74	$550.00	$ 41,000
25	Pump Station Concrete Stairs	EA	2	$4,290.00	$ 9,000
26	Pump Station Access Doors	EA	9	$5,000.00	$ 45,000
27	Pump Station Hand Rails	LF	1,200	$62.00	$ 74,000
28	Header Concrete Slab	CY	306	$400.00	$ 122,000
29	Rip Rap at Intake Structure Bottom, 24" thick	SY	711	$124.00	$ 88,000
30	Slope Protection - Rip Rap 18" thick	SY	2,667	$93.00	$ 248,000
31	Pump Station Exterior Wall Waterproofing	SF	23,000	$10.00	$ 230,000
32	Grout at Bottom of Pump Intake Basin	CY	67	$200.00	$ 13,000
Mechanical Items					
33	Verticle Turbine Pumps	EA	3	$893,228.00	$ 2,680,000
34	Electrical Motor	EA	3	$665,332.50	$ 1,996,000
35	Ball Valve with Electro-hydraulic Actuator	EA	3	$211,312.50	$ 634,000
36	48" coupling with restraint rods	EA	16	$3,306.25	$ 53,000
37	Air release and vacuum assembly (pumps)	EA	16	$6,037.50	$ 97,000

CAPERS RIDGE PUMP STATION COST

Item No	Item description	Unit	Quantity	Unit price	Total price
38	Pipe Supports (48")	EA	28	$1,500.00	$ 42,000
39	48" Butterfly Valve	EA	3	$30,187.50	$ 91,000
40	84" Header	LS	1	$400,000.00	$ 400,000
41	108" to 84" Reducer	EA	2	$40,000.00	$ 80,000
42	Air release and vacuum assembly (header)	EA	2	$24,150.00	$ 48,000
43	84" Butterfly valve	EA	5	$108,675.00	$ 543,000
44	Pipe Supports (84")	EA	12	$5,000.00	$ 60,000
45	84" Coupling with Restraint Rods	EA	2	$7,273.75	$ 15,000
46	48" Long Radius Dual Elbow	EA	8	$25,000.00	$ 200,000
47	Asiatic Clam Control System	LS	1	$1,000,000.00	$ 1,000,000
48	Flow Metering Station	LS	1	$590,281.04	$ 590,000
49	Dual 108" Steel Pipe - Open Cut	LF	400	$1,600.00	$ 640,000
50	Dual 84" Steel Pipe - Open Cut	LF	100	$1,000.00	$ 100,000
51	Trash Rack (2" Bar Screen)	LS	1	$650,832.84	$ 651,000
52	Trash Rack Cleaning Mechanism	LS	1	$3,201,709.00	$ 3,202,000
53	Sluice Gate - 10' by 10' with Electric Actuator	EA	8	$225,000.00	$ 1,800,000
54	Sluice Gate - 11' by 7' with Electric Actuator	EA	8	$225,000.00	$ 1,800,000
55	Pump Station Sump with rails and hardware	EA	8	$50,000.00	$ 400,000
56	Sump Hatch	EA	8	$5,000.00	$ 40,000
57	Sump Piping / header	LF	1,500	$76.00	$ 114,000
58	Sediment Handling - return piping	LF	1,500	$44.50	$ 67,000
59	Water Well	LS	1	$200,000.00	$ 200,000
60	Potable Water Tank	Gal	23,000	$0.75	$ 17,000
61	Potable Water Pump House	SF	500	$50.00	$ 25,000
62	Process Water Pumps	EA	3	$30,000.00	$ 90,000
63	Pressure Tank	EA	1	$10,000.00	$ 10,000
64	Chlorination System	LS	1	$20,000.00	$ 20,000
65	4" Potable Water Lines	LF	1,000	$24.20	$ 24,000
66	2" Potable Water Lines	LF	1,720	$25.00	$ 43,000
67	8" Sanitary Sewer Lines	LF	1,000	$28.40	$ 28,000
68	Sanitary Sewer Manholes	EA	4	$2,500.00	$ 10,000
69	Fire Suppression System	SF	7,160	$6.41	$ 46,000
70	Fire Alarm System	SF	10,060	$3.00	$ 30,000
71	Septic Tank and Drain Field	LS	1	$12,250.00	$ 12,000
72	Dual Post Hoist	EA	2	$18,650.00	$ 37,000
73	Overhead Crane (monorail)	EA	2	$15,000.00	$ 30,000
74	Automatic Gate	EA	2	$5,000.00	$ 10,000
75	Miscellaneous Mechanical	LS	1	$200,000.00	$ 200,000
Electrical Items					
76	Power Transformers	LS	2	$1,376,320.00	$ 2,753,000
77	3000 amp Main circuit Breaker	LS	2	$95,634.00	$ 191,000
78	TIE Circuit Breaker	LS	1	$95,634.00	$ 96,000
79	1900 Motor Starters	LS	6	$119,542.50	$ 717,000
80	5 KV station switch for facility distribution	LS	2	$26,565.00	$ 53,000

CAPERS RIDGE PUMP STATION COST

Item No	Item description	Unit	Quantity	Unit price	Total price
81	Station service and facility service transfromers	LS	3	$35,420.00	$ 106,000
82	Low Voltage Motor Control Center	LS	1	$61,985.00	$ 62,000
83	Dry type transformers	LS	4	$2,656.50	$ 11,000
84	5 KV Conduit	LF	3500	$18.98	$ 66,000
85	600 volt conduit	LF	7500	$6.33	$ 47,000
86	Site Lighting Poles	EA	10	$3,795.00	$ 38,000
87	Instrument devices (not including flow meters)	EA	20	$1,897.50	$ 38,000
88	Gate operator + associated devices	EA	2	$10,752.50	$ 22,000
89	Pump Station Structure Lighting and Miscellanous	LF	1	$28,462.50	$ 28,000
90	5 KV conductors	LF	11375	$7.59	$ 86,000
91	600 volt conductors	LF	22500	$1.27	$ 28,000
92	Instrurmentation conductors	LF	3800	$1.90	$ 7,000
93	Security sensors	EA	40	$253.00	$ 10,000
94	Miscellaneous Electrical	LS	1	$300,000.00	$ 300,000
95	Communciation system to CWA	LS	1	$284,625.00	$ 285,000
96	Pump Station Control System	LS	1	$442,750.00	$ 443,000
97	HMI development at CWA and Pump Station	LS	1	$202,400.00	$ 202,000
98	Report generation	LS	1	$134,090.00	$ 134,000
99	Software Development and Programming	LS	1	$695,750.00	$ 696,000
Construction Methods					
100	Concrete Batch Plant	LS	1	$250,000.00	$ 250,000
101	Construction Dewatering	LS	1	$300,000.00	$ 300,000
102	Pump Station Barge	LS	1	$50,000.00	$ 50,000
103	Cofferdam	LS	1	$1,450,312.50	$ 1,450,000
Other Items					
104	Project Remoteness Mark-up (1.5%)	LS	1	$501,000.00	$ 501,000
105	Mobilization & De-Mobilization (10%)	LS	1	$3,340,000.00	$ 3,340,000
106	Bonds & Insurance (3%)	LS	1	$1,002,000.00	$ 1,002,000

Total Cost	*$ 38,243,000*
30% Contingency	*$ 11,473,000*
Total Capers Ridge Pump Station Construction Cost	*$ 49,716,000*

PUMP STATION ELECTRICAL TRANSMISSION COST

Item No	Item description	Unit	Quantity	Unit price	Total price
Electrical Transmission					
1	Transmission Service Tap	LS	1	$2,000,000.00	$ 2,000,000
2	Transmission Lines	MILE	8.4	$614,000.00	$ 5,158,000
3	Electrical Substation	LS	1	$2,700,000.00	$ 2,700,000

Total Cost	*$ 9,858,000*
30% Contingency	*$ 2,957,400*
Total Electrical Transmission Construction Cost	*$ 12,815,400*

CANAL MAINTENANCE FACILITY

Item No	Item description	Unit	Quantity	Unit price	Total price
Civil Items					
1	Clearing and Grubbing	AC	2.65	$5,000.00	$ 13,000
2	Site Grading	AC	2.65	$3,600.00	$ 10,000
3	Excavation	CY	2180.00	$6.24	$ 14,000
4	6" Crushed Aggregate Base (Staging Area)	SY	2723.00	$9.60	$ 26,000
5	8" Lime Stabilized Subgrade (Staging Area)	SY	2723.00	$3.40	$ 9,000
6	Storm Water Retention Pond	CY	1613.00	$6.24	$ 10,000
7	Storm Water Outfall Structure (24")	EA	1.00	$3,000.00	$ 3,000
8	Drainage Swale	LF	1100.00	$5.00	$ 6,000
9	8" Reinforced Concrete Paving	SY	4360.00	$35.00	$ 153,000
10	8" Lime Stabilized Subgrade	SY	4360.00	$3.40	$ 15,000
11	6' Chain Link Fence w/ 3 Strands Barbed Wire	LF	1608.00	$20.00	$ 32,000
12	Pollution Prevention	LS	1.00	$10,000.00	$ 10,000
13	Hydromulch	LS	1.00	$5,000.00	$ 5,000
14	Landscaping	LS	1.00	$10,000.00	$ 10,000
15	Miscellaneous Civil	LS	1.00	$50,000.00	$ 50,000
Mechanical Items					
16	Vehicle Wash (including oil water separator)	EA	1.00	$10,000.00	$ 10,000
17	Gas/Diesel Fuel Tank (12,000 gallons)	EA	1.00	$42,000.00	$ 42,000
18	Gas/Diesel Fuel Pump	EA	1.00	$5,000.00	$ 5,000
19	Automatic Gate	EA	2.00	$5,000.00	$ 10,000
20	2" Potable Water Lines	LF	570.00	$25.00	$ 14,000
21	8" Sanitary Sewer Lines	LF	300.00	$28.40	$ 9,000
22	Septic Tank and Drain Field	EA	1.00	$2,244.00	$ 2,000
23	Natural Gas Line	LF	570.00	$30.00	$ 17,000
24	Dual Post Vehicle Lifts	EA	3.00	$18,650.00	$ 56,000
25	Overhead Bridge Crane (50 ft span - 10 ton)	2. Valves, fittings	1.00	$72,000.00	$ 72,000
26	Water Well	LS	1	$200,000.00	$ 200,000
27	Potable Water Tank	Gal	28,171	$0.75	$ 21,000
28	Potable Water Pump House	SF	300	$50.00	$ 15,000
29	Process Water Pumps	EA	2	$20,000.00	$ 40,000
30	Pressure Tank	EA	1	$10,000.00	$ 10,000

Item No	Item description	Unit	Quantity	Unit price	Total price
31	Chlorination System	LS	1	$10,000.00	$ 10,000
26	Fire Alarm System	SF	7560.00	$3.00	$ 23,000
27	Fire Suppression System	SF	7560.00	$6.41	$ 48,000
28	Miscellaneous Mechanical	LS	1.00	$75,000.00	$ 75,000
Structural Items					
29	Canal Maint. Facility - Maintenance (36' x 166.5')	SF	5,994	$150.00	$ 899,000
30	Canal Maint. Facility - Office Space (36' x 43.5')	SF	1,566	$200.00	$ 313,000
31	Vehicle Shed	SF	1,875	$50.00	$ 94,000
Electrical Items					
32	Electrical (20%)	LS	1.00	$470,200.00	$ 470,000
33	Backup Generator (500 kW)	EA	1.00	$229,957.00	$ 230,000
34	Transfer Switch	EA	1.00	$21,226.80	$ 21,000
Other Items					
35	Mobilization & De-Mobilization (10%)	LS	1.00	$307,200.00	$ 307,000
36	Bonds & Insurance (3%)	LS	1.00	$92,160.00	$ 92,000

Total Cost	*$ 3,471,000*
30% Contingency	*$ 1,041,000*
Total Maintenance Facility Construction Cost	*$ 4,512,000*

Appendix E

Hydraulic Output Data

Table E-1

	Canal Station	Q Total (cfs)	W.S. Elev (ft)	Flow Line (ft)	Depth	Vel Chnl (ft/s)
	124000	774	105.66	97.99	7.67	1.99
	123500	774	105.59	97.89	7.7	1.98
	123000	774	105.52	97.79	7.73	1.97
	122000	774	105.38	97.6	7.78	1.94
	121827	774	105.18	97.79	7.39	3.74
Siphon	121727	774	105.13	87.7	17.43	3.69
	121527	774	105.03	87.7	17.33	3.69
	121427	774	104.97	97.7	7.27	3.69
	121327	774	105.07	97.6	7.47	2.08
	120500	774	104.95	97.3	7.65	2
	120174	774	104.9	97.25	7.65	2
	120074	774	104.73	97.5	7.23	3.69
Siphon	119974	774	104.68	87.5	17.18	3.69
	119774	774	104.58	87.5	17.08	3.69
	119674	774	104.54	97.3	7.24	3.58
	119574	774	104.63	97.1	7.53	2.05
	119000	774	104.54	97.01	7.53	2.05
	118816	774	104.51	97.01	7.5	2.06
	118716	774	104.33	97.21	7.12	3.8
Siphon	118616	774	104.29	87.01	17.28	3.69
	118416	774	104.18	87.01	17.17	3.69
	118316	774	104.13	97.01	7.12	3.69
	118216	774	104.22	96.85	7.37	2.12
	118000	774	104.19	96.82	7.37	2.12
	117500	774	104.1	96.72	7.38	2.12
	117000	774	104.02	96.62	7.4	2.11
	116500	774	103.93	96.52	7.41	2.1
	115500	774	103.77	96.33	7.44	2.09
	115271	774	103.73	96.33	7.4	2.11
	115171	774	103.56	96.42	7.14	3.74
Siphon	115071	774	103.51	86.33	17.18	3.69
	114871	774	103.4	86.33	17.07	3.69
	114771	774	103.35	96.33	7.02	3.69
	114671	774	103.45	96.13	7.32	2.15

Table E-1

	Canal Station	Q Total (cfs)	W.S. Elev (ft)	Flow Line (ft)	Depth	Vel Chnl (ft/s)
	114500	774	103.42	96.13	7.29	2.16
	113500	774	103.24	95.94	7.3	2.15
	113419	774	103.08	96.13	6.95	3.74
Siphon	113319	774	103.03	86.03	17	3.69
	113119	774	102.92	86.03	16.89	3.69
	113019	774	102.87	96.03	6.84	3.77
	113000	774	103	95.84	7.16	2.22
	112500	774	102.9	95.74	7.16	2.22
	111500	774	102.71	95.54	7.17	2.22
	111394	774	102.54	95.74	6.8	3.8
Siphon	111294	774	102.51	85.64	16.87	3.69
	111094	774	102.4	85.64	16.76	3.69
	110994	774	102.33	95.64	6.69	3.86
	110894	774	102.45	95.38	7.07	2.27
	110500	774	102.36	95.35	7.01	2.3
	110000	774	102.26	95.25	7.01	2.3
	109500	774	102.15	95.15	7	2.3
	109372	**Water Level Control Gate**				
	109000	774	101.82	93.77	8.05	1.84
	108500	774	101.76	93.73	8.03	1.85
	108000	774	101.7	93.68	8.02	1.85
	107770	774	101.67	93.64	8.03	1.85
	107750	774	101.55	93.64	7.91	3.5
	107656	**FM 2326 Culvert**				
	107650	774	101.27	93.64	7.63	3.62
	107630	774	101.4	93.64	7.76	1.95
	107500	774	101.39	93.64	7.75	1.96
	107000	774	101.32	93.59	7.73	1.97
	106980	774	101.18	93.59	7.59	3.64
	106940	**FM 1008 Culvert**				
	106880	774	100.89	93.59	7.3	3.79
	106860	774	101.02	93.59	7.43	2.09
	106500	774	100.96	93.55	7.41	2.1
	106000	774	100.88	93.5	7.38	2.12

Table E-1

	Canal Station	Q Total (cfs)	W.S. Elev (ft)	Flow Line (ft)	Depth	Vel Chnl (ft/s)
	105500	774	100.79	93.46	7.33	2.14
	104500	774	100.61	93.36	7.25	2.18
	104123	774	100.54	93.36	7.18	2.22
	104023	774	100.37	93.41	6.96	3.71
Siphon	103923	774	100.33	83.36	16.97	3.69
	103723	774	100.23	83.36	16.87	3.69
	103623	774	100.17	93.36	6.81	3.79
	103500	774	100.27	93.27	7	2.31
	103171	**Water Level Control Gate**				
	103000	774	98.85	91.24	7.61	2.02
	102500	774	98.78	91.18	7.6	2.02
	102000	774	98.7	91.12	7.58	2.03
	101500	774	98.62	91.06	7.56	2.03
	101000	774	98.55	91	7.55	2.04
	100500	774	98.47	90.94	7.53	2.05
	100000	774	98.39	90.88	7.51	2.06
	99500	774	98.31	90.82	7.49	2.07
	99000	774	98.23	90.76	7.47	2.08
	98000	774	98.07	90.64	7.43	2.07
	97873	774	97.89	90.76	7.13	3.72
Siphon	97773	774	97.84	80.7	17.14	3.69
	97573	774	97.73	80.7	17.03	3.69
	97473	774	97.68	90.7	6.98	3.7
	97373	774	97.78	90.52	7.26	2.17
	97000	774	97.71	90.52	7.19	2.21
	96500	774	97.61	90.46	7.15	2.22
	96000	773	97.52	90.4	7.12	2.24
	95500	773	97.41	90.34	7.07	2.26
	95150	767	97.34	90.34	7	2.28
	95122	**Water Level Control Gate**				
	95000	767	93.39	86	7.39	2.09
	94500	775	93.32	85.9	7.42	2.1
	94000	773	93.23	85.8	7.43	2.09
	93500	774	93.15	85.7	7.45	2.08

Table E-1

	Canal Station	Q Total (cfs)	W.S. Elev (ft)	Flow Line (ft)	Depth	Vel Chnl (ft/s)
	93140	774	93.1	85.62	7.48	2.07
	93120	774	92.95	85.6	7.35	3.76
	93030	**FM 321 Culvert**				
	92970	774	92.64	85.6	7.04	3.92
	92950	774	92.79	85.6	7.19	2.21
	92500	774	92.7	85.5	7.2	2.2
	92000	774	92.61	85.4	7.21	2.2
	91500	774	92.52	85.3	7.22	2.19
	91000	774	92.42	85.2	7.22	2.19
	90500	774	92.33	85.1	7.23	2.19
	90000	774	92.24	85	7.24	2.18
	89500	774	92.15	84.9	7.25	2.18
	89000	774	92.06	84.8	7.26	2.17
	88500	774	91.97	84.7	7.27	2.17
	88000	774	91.87	84.6	7.27	2.17
	87500	774	91.79	84.5	7.29	2.16
	86500	774	91.61	84.3	7.31	2.15
	86247	774	91.56	84.3	7.26	2.17
	86147	774	91.38	84.4	6.98	3.8
Siphon	86047	774	91.34	74.2	17.14	3.69
	85847	774	91.24	74.2	17.04	3.69
	85747	774	91.15	84.2	6.95	3.71
	85647	774	91.21	84.1	7.11	2.24
	85500	774	91.18	84.1	7.08	2.26
	85000	774	91.08	84	7.08	2.26
	84500	774	90.98	83.9	7.08	2.26
	84000	774	90.88	83.8	7.08	2.26
	83500	774	90.78	83.7	7.08	2.26
	83000	774	90.68	83.6	7.08	2.26
	82500	774	90.57	83.5	7.07	2.27
	82000	774	90.47	83.4	7.07	2.27
	81500	774	90.37	83.3	7.07	2.27
	81000	774	90.27	83.2	7.07	2.27
	80500	774	90.16	83.1	7.06	2.27

Table E-1

	Canal Station	Q Total (cfs)	W.S. Elev (ft)	Flow Line (ft)	Depth	Vel Chnl (ft/s)
	80000	774	90.06	83	7.06	2.27
	79500	774	89.96	82.9	7.06	2.27
	79000	774	89.86	82.8	7.06	2.27
	78500	774	89.75	82.7	7.05	2.28
	78000	774	89.65	82.6	7.05	2.28
	77500	774	89.55	82.5	7.05	2.28
	77000	773	89.44	82.4	7.04	2.28
	76500	774	89.34	82.3	7.04	2.28
	76000	774	89.23	82.2	7.03	2.28
	75500	774	89.13	82.1	7.03	2.29
	75000	775	89.02	82	7.02	2.29
	74500	775	88.92	81.9	7.02	2.3
	74000	775	88.81	81.82	6.99	2.31
	73501	**Water Level Control Gate**				
	73500	775	86.95	79.43	7.52	2.06
	73000	775	86.87	79.35	7.52	2.06
	72500	775	86.79	79.28	7.51	2.06
	72000	775	86.71	79.21	7.5	2.07
	71500	775	86.63	79.14	7.49	2.07
	71000	774	86.55	79.06	7.49	2.07
	70500	774	86.47	78.99	7.48	2.07
	70000	774	86.39	78.92	7.47	2.08
	69500	773	86.31	78.84	7.47	2.08
	69000	773	86.22	78.77	7.45	2.08
	68500	773	86.14	78.7	7.44	2.09
	68000	773	86.06	78.63	7.43	2.09
	67500	774	85.98	78.55	7.43	2.1
	67000	774	85.89	78.48	7.41	2.1
	66500	774	85.81	78.41	7.4	2.11
	66000	774	85.73	78.33	7.4	2.11
	65500	774	85.64	78.26	7.38	2.12
	65000	774	85.56	78.19	7.37	2.12
	64500	774	85.47	78.12	7.35	2.13
	64000	774	85.38	78.04	7.34	2.14

Table E-1

	Canal Station	Q Total (cfs)	W.S. Elev (ft)	Flow Line (ft)	Depth	Vel Chnl (ft/s)
	63500	774	85.29	77.97	7.32	2.14
	63000	774	85.21	77.9	7.31	2.15
	62500	774	85.12	77.82	7.3	2.16
	62000	774	85.03	77.75	7.28	2.17
	61500	774	84.93	77.68	7.25	2.18
	61000	774	84.84	77.61	7.23	2.19
	60500	774	84.75	77.53	7.22	2.19
	60000	774	84.65	77.46	7.19	2.21
	59500	774	84.56	77.39	7.17	2.22
	59000	774	84.46	77.31	7.15	2.23
	58500	774	84.36	77.24	7.12	2.24
	58000	774	84.26	77.17	7.09	2.26
	57000	774	84.05	77.02	7.03	2.29
	56708	774	83.99	77.02	6.97	2.32
	56608	774	83.81	77.17	6.64	3.88
Siphon	56508	774	83.79	67.1	16.69	3.69
	56308	774	83.69	67.1	16.59	3.69
	56208	774	83.61	77.1	6.51	3.97
	56108	774	83.72	76.88	6.84	2.39
	56000	774	83.69	76.88	6.81	2.4
	55500	774	83.57	76.8	6.77	2.43
	55000	774	83.44	76.73	6.71	2.46
	54500	774	83.31	76.66	6.65	2.5
	54000	774	83.17	76.59	6.58	2.54
	53500	774	83.03	76.51	6.52	2.58
	53000	774	82.87	76.44	6.43	2.63
	52500	774	82.71	76.37	6.34	2.69
	52000	775	82.54	76.29	6.25	2.76
	51500	775	82.35	76.22	6.13	2.84
	51000	762	82.26	75.25	7.01	2.26
	50994	**Water Level Control Gate**				
	50500	762	81.59	73.92	7.67	1.96
	50000	774	81.53	73.84	7.69	1.98
	49500	775	81.46	73.77	7.69	1.99

Table E-1

	Canal Station	Q Total (cfs)	W.S. Elev (ft)	Flow Line (ft)	Depth	Vel Chnl (ft/s)
	49000	775	81.39	73.69	7.7	1.98
	48000	774	81.24	73.54	7.7	1.98
	47657	774	81.19	73.54	7.65	2
	47557	774	81.02	73.61	7.41	3.72
Siphon	47457	774	80.97	63.54	17.43	3.69
	47257	774	80.86	63.54	17.32	3.69
	47157	774	80.81	73.54	7.27	3.69
	47057	774	80.91	73.38	7.53	2.05
	47000	774	80.9	73.38	7.52	2.05
	46500	774	80.82	73.3	7.52	2.05
	46000	774	80.75	73.23	7.52	2.06
	45500	774	80.67	73.15	7.52	2.06
	45000	774	80.59	73.07	7.52	2.06
	44500	774	80.51	72.99	7.52	2.06
	44000	774	80.43	72.92	7.51	2.06
	43500	774	80.35	72.84	7.51	2.06
	42500	774	80.2	72.68	7.52	2.06
	42223	774	80.15	72.68	7.47	2.08
	42123	774	79.98	72.76	7.22	3.73
Siphon	42023	774	79.93	62.68	17.25	3.69
	41823	774	79.82	62.68	17.14	3.69
	41723	774	79.77	72.68	7.09	3.69
	41623	774	79.87	72.53	7.34	2.14
	41500	774	79.84	72.53	7.31	2.15
	41000	774	79.76	72.45	7.31	2.15
	40500	774	79.67	72.37	7.3	2.16
	40000	774	79.58	72.3	7.28	2.17
	39500	774	79.48	72.22	7.26	2.17
	39000	774	79.39	72.14	7.25	2.18
	38500	774	79.3	72.06	7.24	2.18
	38000	774	79.21	71.99	7.22	2.19
	37500	774	79.11	71.91	7.2	2.2
	37000	774	79.02	71.83	7.19	2.21
	36500	774	78.92	71.75	7.17	2.22

Table E-1

	Canal Station	Q Total (cfs)	W.S. Elev (ft)	Flow Line (ft)	Depth	Vel Chnl (ft/s)
	36000	774	78.82	71.68	7.14	2.23
	35500	774	78.72	71.6	7.12	2.24
	35000	774	78.62	71.52	7.1	2.25
	34500	774	78.52	71.45	7.07	2.27
	34000	774	78.42	71.37	7.05	2.28
	33500	774	78.31	71.29	7.02	2.29
	33000	774	78.21	71.21	7	2.31
	32500	774	78.1	71.14	6.96	2.33
	31500	774	77.87	70.98	6.89	2.36
	31200	774	77.8	70.98	6.82	2.4
	31100	774	77.62	71.14	6.48	3.98
Siphon	31000	774	77.61	60.98	16.63	3.69
	30800	774	77.5	60.98	16.52	3.69
	30700	774	77.41	70.98	6.43	4.01
	30600	774	77.54	70.52	7.02	2.29
	30500	774	77.52	70.52	7	2.3
	30472	**Water Level Control Gate**				
	30000	774	75.76	67.71	8.05	1.84
	29500	774	75.7	67.64	8.06	1.84
	29000	774	75.64	67.56	8.08	1.83
	28500	774	75.58	67.48	8.1	1.82
	28000	774	75.53	67.4	8.13	1.81
	27500	774	75.47	67.33	8.14	1.81
	27000	774	75.42	67.25	8.17	1.8
	26500	774	75.36	67.17	8.19	1.79
	26000	774	75.31	67.1	8.21	1.78
	25000	774	75.21	66.94	8.27	1.76
	24925	774	75.2	66.94	8.26	1.77
	24825	774	75.02	67.1	7.92	3.74
Siphon	24725	774	74.97	57	17.97	3.69
	24325	774	74.76	57	17.76	3.69
	24225	774	74.71	67	7.71	3.69
	24125	774	74.82	66.79	8.03	1.85
	24000	774	74.8	66.79	8.01	1.86

Table E-1

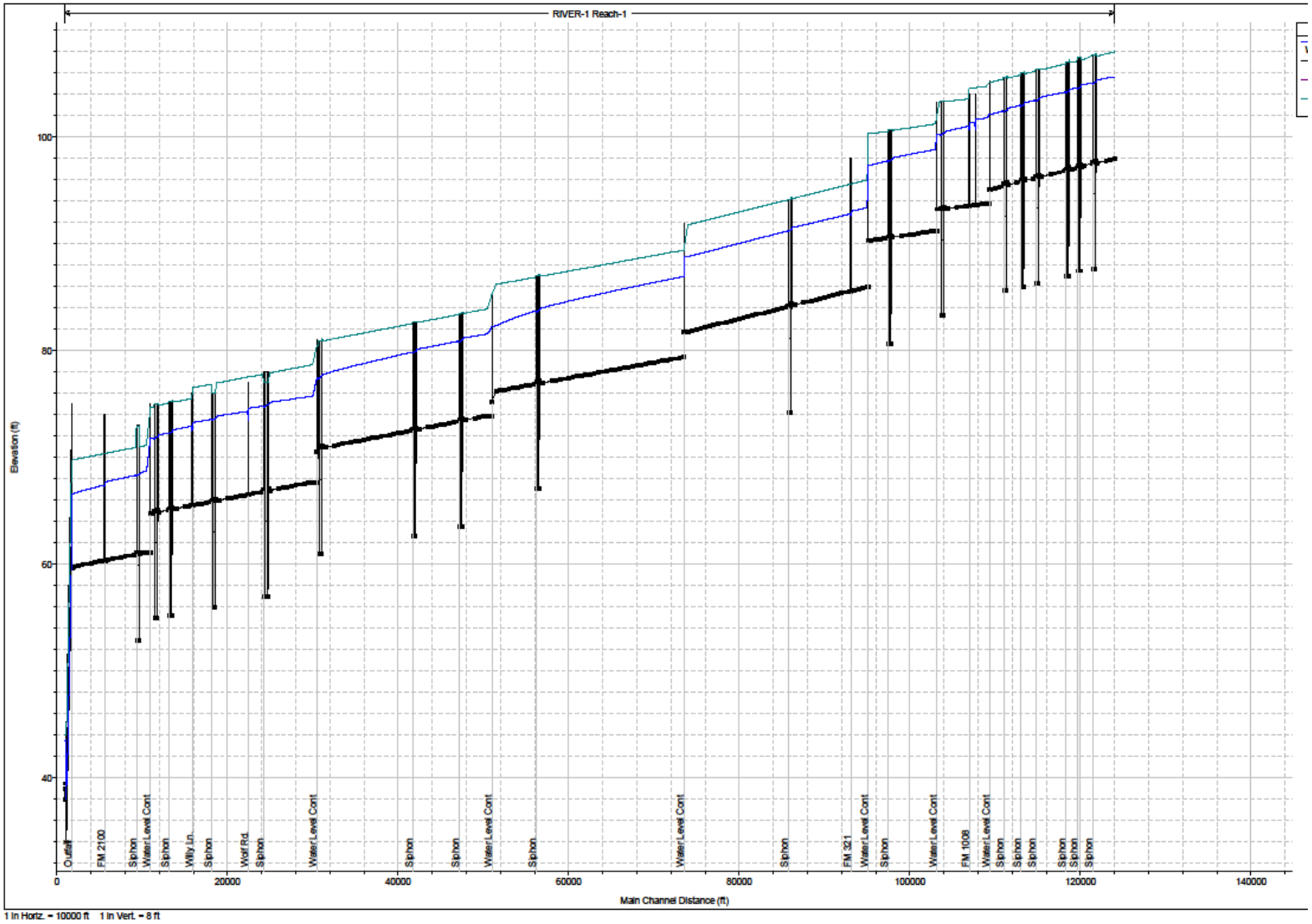
	Canal Station	Q Total (cfs)	W.S. Elev (ft)	Flow Line (ft)	Depth	Vel Chnl (ft/s)
	23500	774	74.74	66.71	8.03	1.85
	23000	774	74.68	66.63	8.05	1.84
	22500	774	74.63	66.56	8.07	1.84
	22450	774	74.5	66.56	7.94	3.48
	22400	**Wolf Rd. Culvert**				
	22380	774	74.22	66.56	7.66	3.61
	22360	774	74.35	66.56	7.79	1.94
	22000	774	74.3	66.48	7.82	1.93
	21500	774	74.23	66.4	7.83	1.92
	21000	774	74.17	66.32	7.85	1.93
	20500	774	74.1	66.25	7.85	1.93
	20000	774	74.04	66.17	7.87	1.91
	19000	774	73.91	66.02	7.89	1.9
	18715	774	73.87	66.02	7.85	1.92
	18615	774	73.7	66.09	7.61	3.72
Siphon	18515	774	73.65	56.02	17.63	3.69
	18315	774	73.54	56.02	17.52	3.69
	18215	774	73.49	66.02	7.47	3.69
	18115	774	73.59	65.86	7.73	1.97
	18000	774	73.58	65.86	7.72	1.97
	17500	774	73.51	65.78	7.73	1.97
	17000	774	73.44	65.71	7.73	1.96
	16500	774	73.37	65.63	7.74	1.95
	16000	774	73.3	65.55	7.75	1.96
	15960	774	73.16	65.55	7.61	3.64
	15860	**Willy Ln. Culvert**				
	15810	774	72.82	65.55	7.27	3.81
	15770	774	72.96	65.55	7.41	2.11
	15500	774	72.91	65.47	7.44	2.09
	15000	774	72.83	65.4	7.43	2.1
	14000	774	72.66	65.24	7.42	2.1
	13649	774	72.6	65.24	7.36	2.13
	13549	774	72.43	65.32	7.11	3.73
Siphon	13449	774	72.38	55.24	17.14	3.69

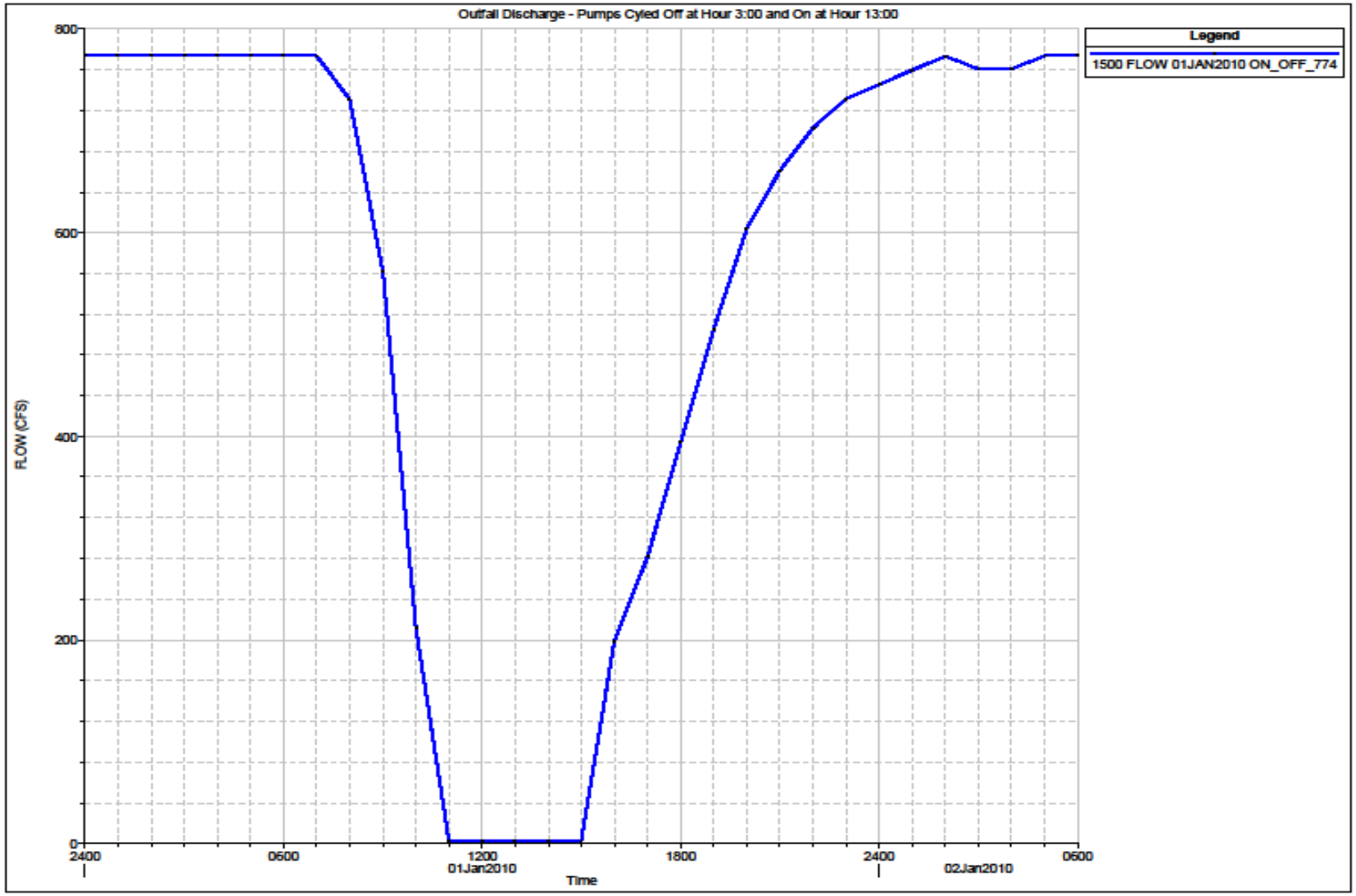
Table E-1

	Canal Station	Q Total (cfs)	W.S. Elev (ft)	Flow Line (ft)	Depth	Vel Chnl (ft/s)
	13249	774	72.28	55.24	17.04	3.69
	13149	774	72.23	65.24	6.99	3.69
	13000	774	72.31	65.09	7.22	2.19
	12000	774	72.12	64.94	7.18	2.21
	11931	774	72.11	64.94	7.17	2.22
	11831	774	71.94	65.09	6.85	3.76
Siphon	11731	774	71.91	55.01	16.9	3.69
	11531	774	71.8	55.01	16.79	3.69
	11431	774	71.74	65.01	6.73	3.83
	11331	774	71.85	64.78	7.07	2.27
	11000	774	71.78	64.78	7	2.3
	10522	**Water Level Control Gate**				
	10500	774	68.71	61.14	7.57	2.03
	10000	774	68.64	61.07	7.57	2.03
	9845	774	68.61	61.07	7.54	2.04
	9745	774	68.48	61	7.48	3.45
Siphon	9645	774	68.41	52.92	15.49	3.7
	9445	774	68.3	52.92	15.38	3.7
	9345	774	68.25	61.14	7.11	3.71
	9245	774	68.35	60.91	7.44	2.09
	9000	774	68.31	60.91	7.4	2.11
	8500	774	68.22	60.83	7.39	2.11
	8000	774	68.14	60.76	7.38	2.12
	7500	774	68.05	60.68	7.37	2.12
	7000	774	67.97	60.6	7.37	2.12
	6500	774	67.88	60.52	7.36	2.13
	6000	774	67.79	60.44	7.35	2.13
	5657	774	67.73	60.37	7.36	2.12
	5637	774	67.59	60.37	7.22	3.84
	5563	**FM 2100 Culvert**				
	5487	774	67.28	60.37	6.91	4.01
	5467	774	67.43	60.37	7.06	2.27
	5000	774	67.34	60.29	7.05	2.28
	4500	774	67.23	60.21	7.02	2.29

Table E-1

	Canal Station	Q Total (cfs)	W.S. Elev (ft)	Flow Line (ft)	Depth	Vel Chnl (ft/s)
	4000	774	67.12	60.13	6.99	2.31
	3500	774	67.02	60.05	6.97	2.32
	3000	774	66.9	59.98	6.92	2.34
	2500	775	66.79	59.9	6.89	2.37
	2000	773	66.67	59.82	6.85	2.38
	1814	772	66.64	59.64	7	2.3
	1750	**Water Level Control Gate**				
	1739	772	64.33	59.63	4.7	5.51
	1738	772	64.33	59.63	4.7	5.51
	1500	**Outfall Pipe**				
	1096	772	43.5	34	9.5	2.72
	996	771	43.49	34	9.49	2.72
	995	771	43.57	34	9.57	0.9
	994.5	**Stilling Basin**				
	994	771	43.49	39	4.49	1.91
	993	771	43.49	39	4.49	1.91
	923	771	43.5	38	5.5	1.6


RIVER-1 Reach-1
Elevation (ft)
100
80
60
40
Outlet
FM 2100
Siphon
WaterLevel Cont
Siphon
Willy Ln
Siphon
Wolf Rd.
Siphon
WaterLevel Cont
Siphon
Siphon
WaterLevel Cont
Siphon
WaterLevel Cont
Siphon
FM 321
WaterLevel Cont
Siphon
WaterLevel Cont
FM 1008
WaterLevel Cont
Siphon
Siphon
Siphon
Siphon
Siphon
Siphon
0
20000
40000
60000
80000
100000
120000
140000
Main Channel Distance (ft)
1 In Horiz. = 10000 ft 1 In Vert. = 8 ft


Outfall Discharge - Pumps Cyled Off at Hour 3:00 and On at Hour 13:00
Legend
1500 FLOW 01JAN2010 ON_OFF_774
FLOW (CFS)
800
600
400
200
0
2400
0600
1200
01Jan2010
1800
2400
02Jan2010
0600
Time

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

PRELIMINARY ENGINEERING REPORT
VOLUME II

LOCATION MAP
NTS

EXECUTIVE OFFICERS

GARY N. ORADAT, P.E.
JOHN J. BALDWIN
JERRY L. BERRY

BOARD OF DIRECTORS

KURT F. METYKO, P.E.
F. WILLIAM OTHON, P.E.
ALAN D. CONNER
DOUGLAS E. WALKER
ZEBULUN NASH
JOHN ODIS COBB, P.E.
GITI ZARINKELK, P.E., F. SAME

SHT. NO.	SHT. TITLE
	EXHIBIT A: GENERAL
A-1	PROJECT OVERVIEW
A-2	PROJECT OVERVIEW – DETAIL
A-3	PRELIMINARY OPERATIONS PLAN – OVERVIEW
A-4	PIPELINE PIGGING EXHIBIT
A-5	CROSSINGS LOCATIONS
A-6	LIBERTY COUNTY MASTER THOROUGHFARE PLAN
	EXHIBIT B: PUMP STATION
B-1	PRELIMINARY MECHANICAL FLOW DIAGRAM
B-2	PRELIMINARY EXISTING SITE PLAN
B-3.1	PRELIMINARY PROPOSED SITE PLAN
B-3.2	PRELIMINARY PROPOSED ENLARGED SITE PLAN
B-4	PRELIMINARY PUMP STATION PLAN, OPTION 1 ABOVEGROUND HEADER
B-5	PRELIMINARY PUMP STATION PLAN, OPTION 2 HEADER IN VALVE VAULT
B-6	PRELIMINARY PUMP STATION SECTION, OPTION 1 ABOVEGROUND HEADER
B-7	PRELIMINARY PUMP STATION SECTION, OPTION 2 HEADER IN VALVE VAULT
B-8	PRELIMINARY PUMP STATION HYDRAULIC PROFILE
B-9	PRELIMINARY PUMP BAY AREA PLAN
B-10	PRELIMINARY PUMP BAY AREA SECTIONS
B-11	PRELIMINARY SEDIMENT HANDLING FACILITY SCHEMATIC OPTION 1
B-12	PRELIMINARY SEDIMENT HANDLING FACILITY SCHEMATIC OPTION 2
B-13	SUBSTATION PRELIMINARY ONE LINE DIAGRAM
B-14	PRELIMINARY ONE LINE DIAGRAM SHEET 1 OF 4
B-15	PRELIMINARY ONE LINE DIAGRAM SHEET 2 OF 4
B-16	PRELIMINARY ONE LINE DIAGRAM SHEET 3 OF 4
B-17	PRELIMINARY ONE LINE DIAGRAM SHEET 4 OF 4
	EXHIBIT C: CANAL AND WATER LINE SYSTEM
C-1 THRU C-245	SEE EXHIBIT FOR SHEET LISTING

ISSUE DATE: JANUARY, 2011

AECOM
AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1599
WWW.AECOM.COM
TBPE REG. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

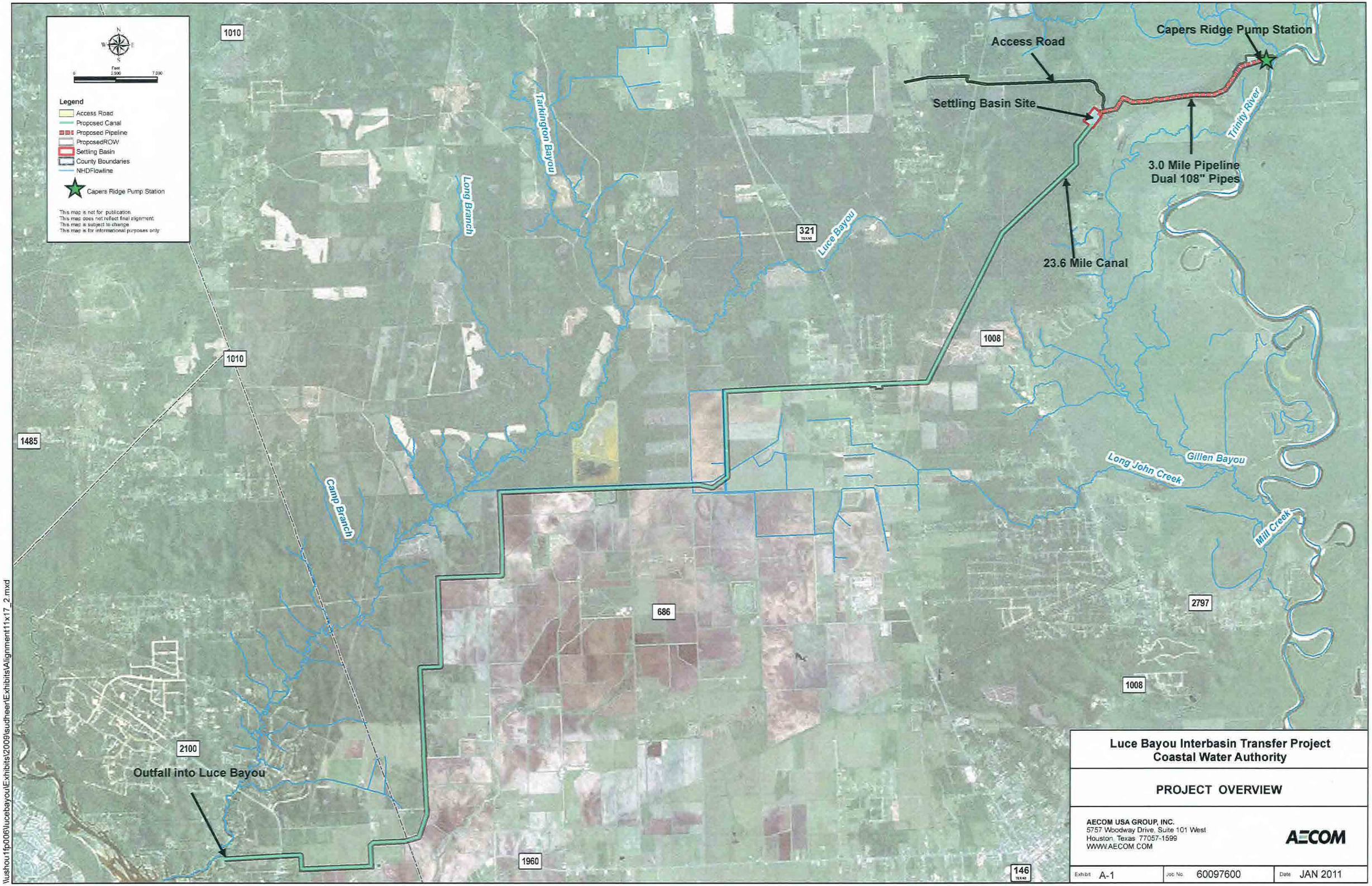
SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

DRAWING SCALE
AS SHOWN

EXHIBIT:
SHEET NO. OF

DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: Cover-OVERALL.dwg



Luce Bayou Interbasin Transfer Project
Coastal Water Authority

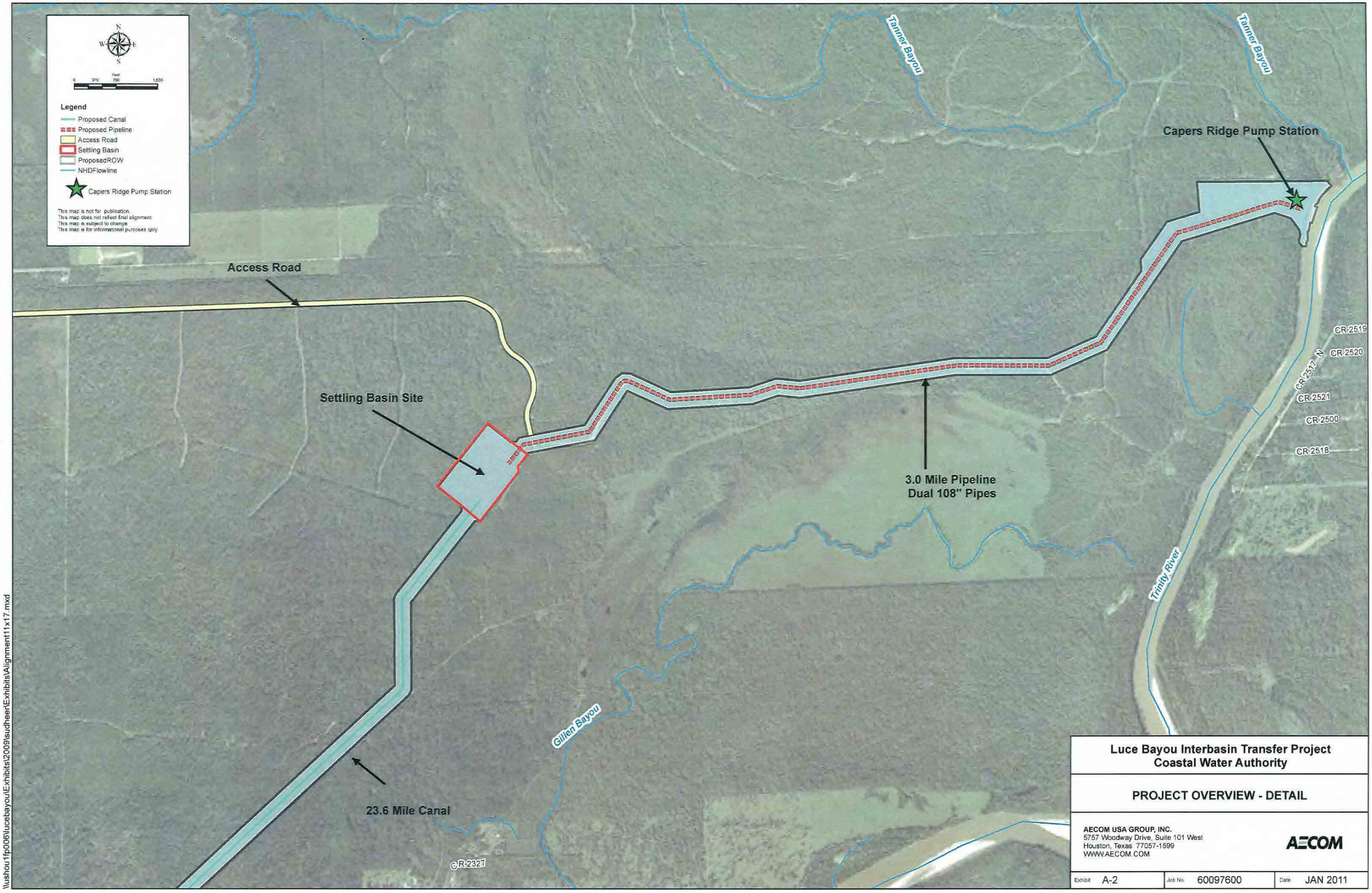
PROJECT OVERVIEW

AECOM USA GROUP, INC.
5757 Woodway Drive, Suite 101 West
Houston, Texas 77057-1599
WWW.AECOM.COM

AECOM

Exhibit	Job No.	Date
A-1	60097600	JAN 2011

\\ushou1fp006\lucebayou\Exhibits\2009\sudheer\Exhibits\Alignment11x17_2.mxd



Luce Bayou Interbasin Transfer Project
Coastal Water Authority

PROJECT OVERVIEW - DETAIL

AECOM USA GROUP, INC.
5757 Woodway Drive, Suite 101 West
Houston, Texas 77057-1599
WWW.AECOM.COM

AECOM

Exhibit	Job No.	Date
A-2	60097600	JAN 2011

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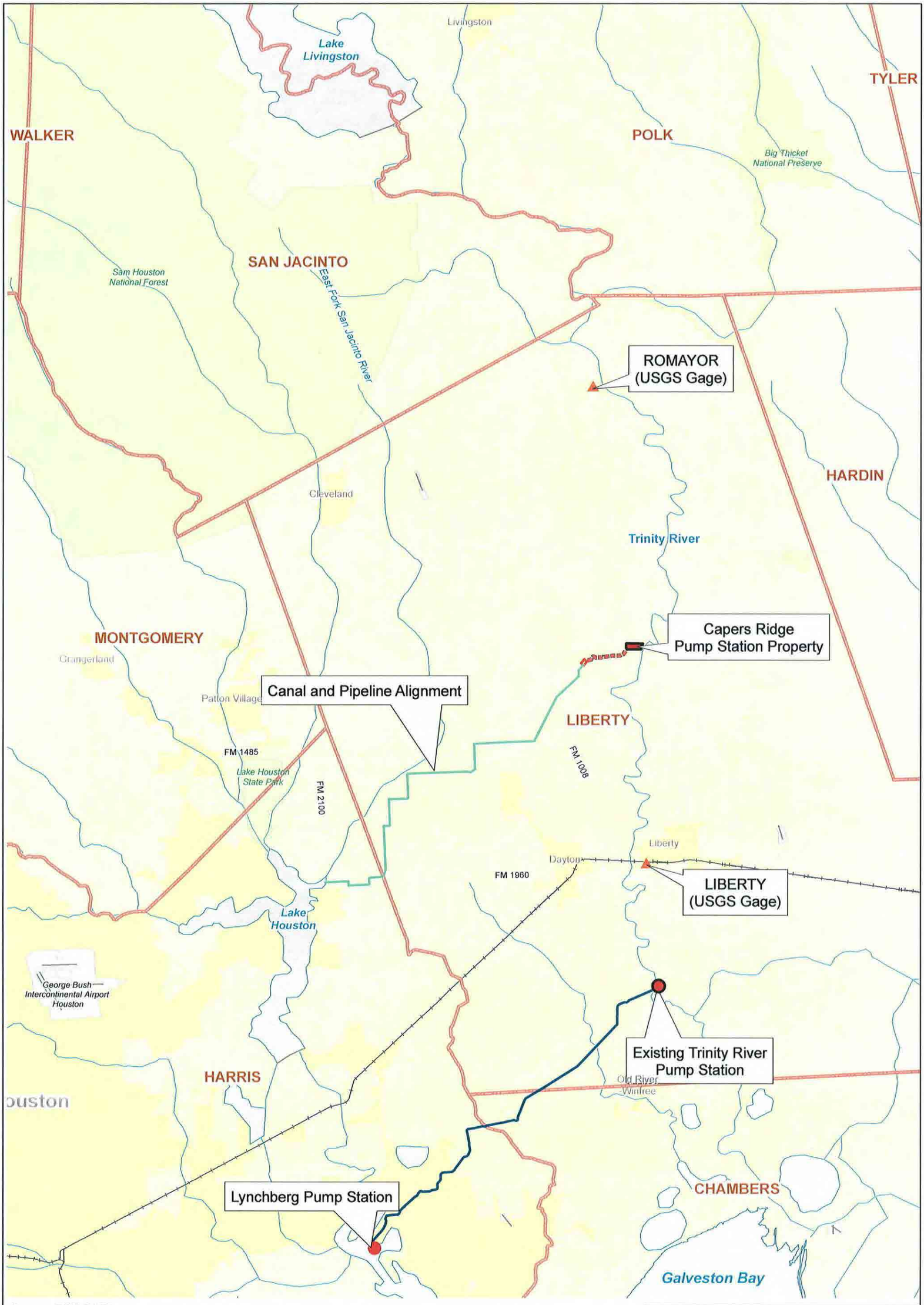

Source - ESRI (2002)

Legend

- Proposed Canal
- Proposed Pipeline
- Existing Canal
- USGS Gage
- County Boundary

N

0 25,000 Feet

Luce Bayou Interbasin Transfer Project
Coastal Water Authority

Preliminary Operations Plan - Overview

AECOM USA Group, Inc.
5757 Woodway Drive, Suite 101W
Houston, Texas 77057-1599
www.aecom.com
TBPE Reg. No. F-3082

AECOM

Exhibit	Job No	Date
A-3	60097600	JAN 2011

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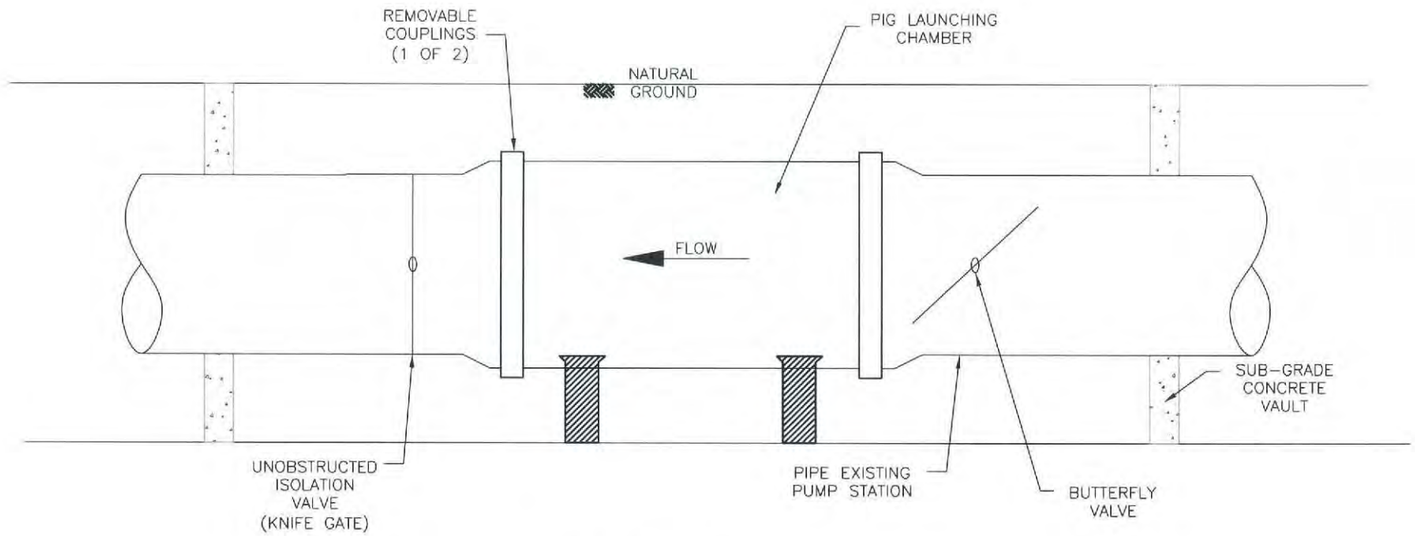
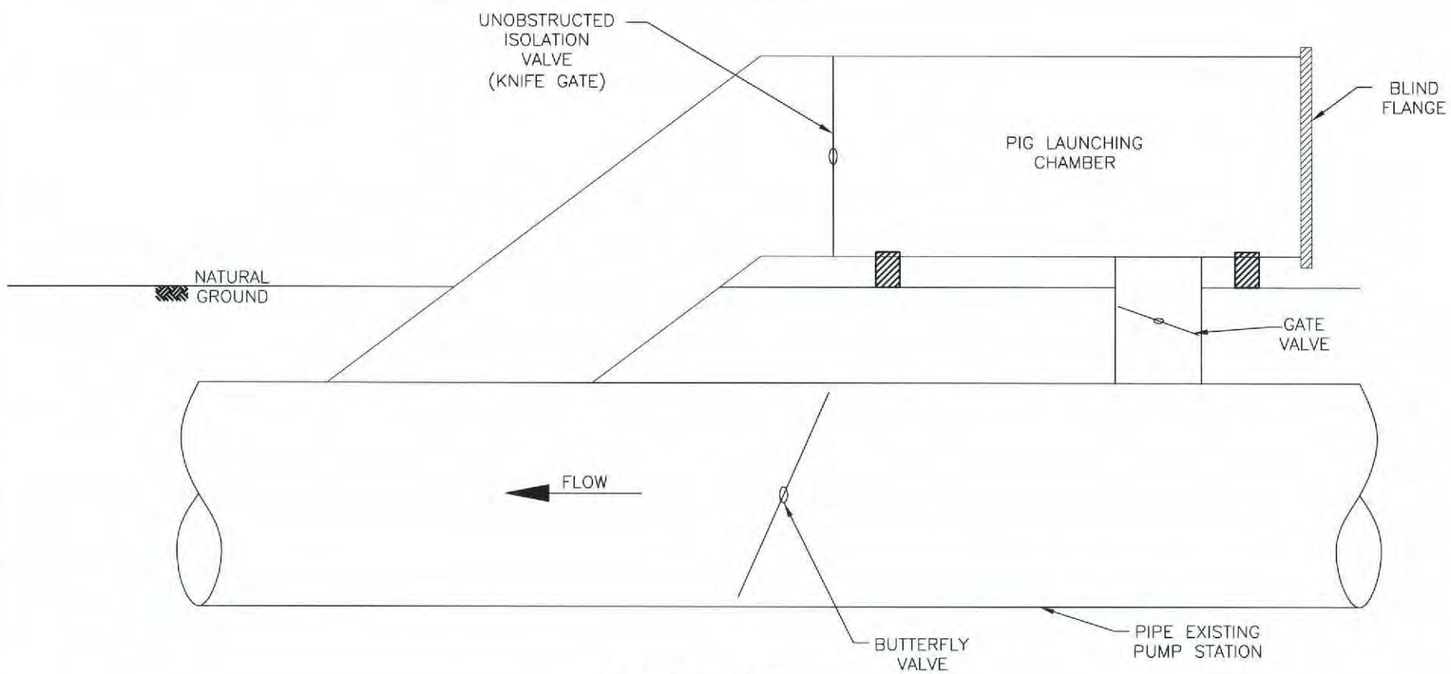


DETAIL 1 – INLINE LAUNCH STATION
SCALE: N.T.S.

NOTES:
1. INLINE SYSTEM TO BE CONSTRUCTED WITH AN ACCESS VAULT AT THE BEGINNING AND END OF THE PIPELINE.
2. REMOVABLE PIG LAUNCHING CHAMBER IS DESIGNED TO INCLUDE TRACKS TO SIMPLIFY INSTALLATION



DETAIL 2 – OFFSET LAUNCH STATION
SCALE: N.T.S.

NOTES:
1. LAUNCH STATION CAN BE ROTATED AROUND CENTERLINE OF PIPE TO ALLOW FOR A HORIZONTALLY LEVEL LAUNCH. HOWEVER, THIS WILL REQUIRE A SUBGRADE CONC. VAULT.

No.	Date	Revisions	App.

AECOM
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TBPE REG. NO. F-3580

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713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

PIPELINE PIGGING EXHIBIT

DRAWING SCALE
AS SHOWN

EXHIBIT A-4

LAST MODIFIED: Jan 26, 2011 – 9:20am BY USER: rojavarapuus
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\Details\
DWG. NAME: pipelinepigging.dwg

CROSSINGS TABLE

PIPELINE CROSSINGS

	COMPANY THAT OWNS/ OPERATES THE PIPELINE	PIPE SIZE (INCHES)	TYPE OF MATERIAL CARRIED BY PIPELINE	PARCEL ID
1P	BP PIPELINES (NORTH AMERICA),INC	12.75	CRUDE OIL	PARCEL 50
2P	KINDER MORGAN TEXAS PIPELINE LLC	24.00	NATURAL GAS	PARCEL 50
3P	KINDER MORGAN TEXAS PIPELINE LLC	16.00	NATURAL GAS	PARCEL 50
4P	SUNOCO PIPELINE L.P.	10.75	CRUDE OIL	PARCEL 50
5P	MUSTANG PIPELINE COMPANY	10.75	PROPANE	PARCEL 50
6P	MUSTANG PIPELINE COMPANY	6.63	PROPYLENE	PARCEL 50
7P	TEPPCO	12.75	LIQUID PETROLEUM PRODUCTS	PARCEL 50
8P	CONOCOPHILLIPS PIPE LINE COMPANY	24.00	PROPYLENE	PARCEL 43
9P	KINDER MORGAN TEXAS PIPELINE LLC	24.00	NATURAL GAS	PARCEL 39.8
10P	WILLIAMS/ TRANSCONTINENTAL GAS P.	30.00	NATURAL GAS	PARCEL 39.8
11P	WILLIAMS/ TRANSCONTINENTAL GAS P.	30.00	NATURAL GAS	PARCEL 39.8
12P	KINDER MORGAN TEXAS PIPELINE LLC	30.00	NATURAL GAS	PARCEL 23.4
13P	KINDER MORGAN TEXAS PIPELINE LLC	30.00	NATURAL GAS	PARCEL 23.4
14P	ONEOK NGL PIPELINE, L.P.	14.00	LIQUIFIED PETROLEUM GAS	PARCEL 22
15P	ONEOK NGL PIPELINE, L.P.	12.00	LIQUIFIED PETROLEUM GAS	PARCEL 22
16P	ONEOK NGL PIPELINE, L.P.	8.00	LIQUIFIED PETROLEUM GAS	PARCEL 22
17P	CHEVRON PIPE LINE COMPANY	10.75	LIQUEFIED PETROLEUM GAS	PARCEL 12
18P	CHEVRON PIPE LINE COMPANY	10.75	LIQUEFIED PETROLEUM GAS	PARCEL 12
19P	TEPPCO	10.75	LIQUID PETROLEUM PRODUCTS	PARCEL 12
20P	BUCKEYE GULF COAST PIPELINES,LP	10.75	ETHYLENE	PARCEL 12
	BP PIPELINES (NORTH AMERICA),INC	Inactive		PARCEL 52
	KOCH PIPELINE COMPANY, L.P.	All pipelines in the area were sold to various other companies , all pipelines in the area were abandoned and/or salvage.		

ROAD CROSSINGS

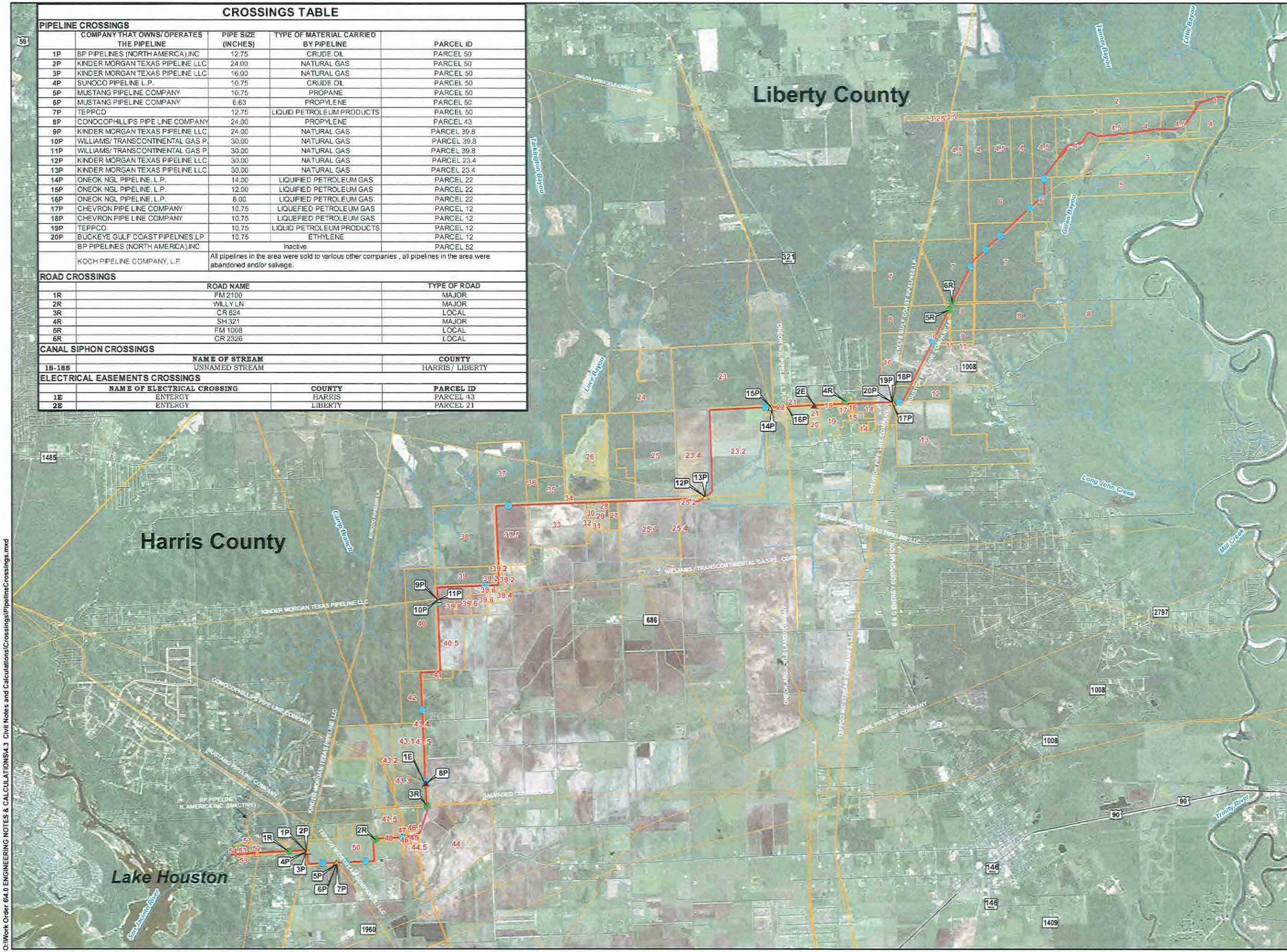
	ROAD NAME	TYPE OF ROAD
1R	FM 2100	MAJOR
2R	WILLY LN	MAJOR
3R	CR 624	LOCAL
4R	SH 321	MAJOR
5R	FM 1008	LOCAL
6R	CR 2326	LOCAL

CANAL SIPHON CROSSINGS

	NAME OF STREAM	COUNTY
1S-18S	UNNAMED STREAM	HARRIS/ LIBERTY

ELECTRICAL EASEMENTS CROSSINGS

	NAME OF ELECTRICAL CROSSING	COUNTY	PARCEL ID
1E	ENTERGY	HARRIS	PARCEL 43
2E	ENTERGY	LIBERTY	PARCEL 21



This map is not for publication.
This map does not reflect final alignment.
This map is subject to change.
This map is for informational purposes only.

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FB NO.

LUCE BAYOU INTERBASIN TRANSFER PROJECT

COASTAL WATER AUTHORITY

Crossings Locations

DRAWING SCALE

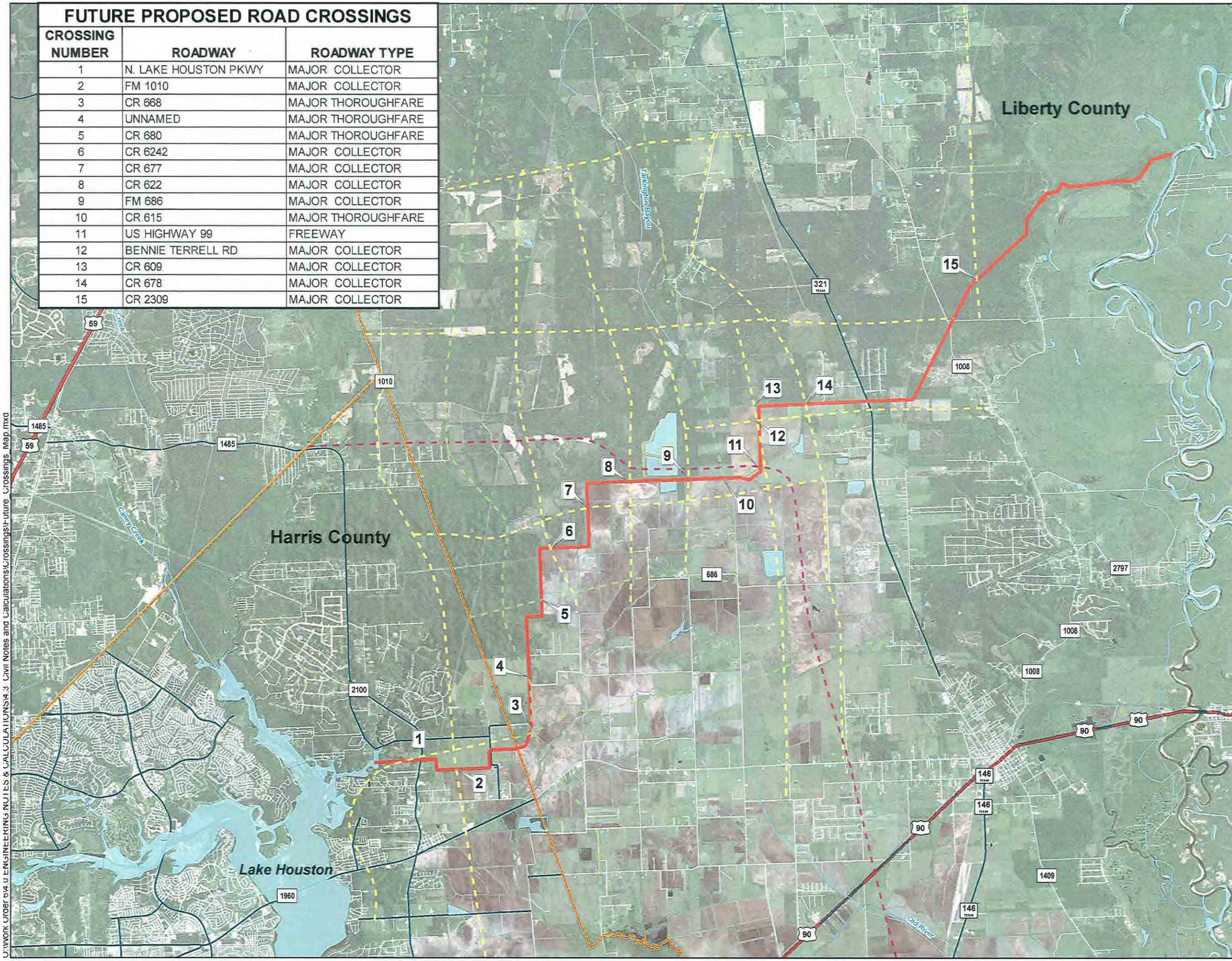
AS SHOWN

EXHIBIT A - 5

Q:\Work Order 64.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Crossings\PipelineCrossings.mxd

FUTURE PROPOSED ROAD CROSSINGS

CROSSING NUMBER	ROADWAY	ROADWAY TYPE
1	N. LAKE HOUSTON PKWY	MAJOR COLLECTOR
2	FM 1010	MAJOR COLLECTOR
3	CR 668	MAJOR THOROUGHFARE
4	UNNAMED	MAJOR THOROUGHFARE
5	CR 680	MAJOR THOROUGHFARE
6	CR 6242	MAJOR COLLECTOR
7	CR 677	MAJOR COLLECTOR
8	CR 622	MAJOR COLLECTOR
9	FM 686	MAJOR COLLECTOR
10	CR 615	MAJOR THOROUGHFARE
11	US HIGHWAY 99	FREEWAY
12	BENNIE TERRELL RD	MAJOR COLLECTOR
13	CR 609	MAJOR COLLECTOR
14	CR 678	MAJOR COLLECTOR
15	CR 2309	MAJOR COLLECTOR



Legend

- Proposed Major Collector
- Proposed Major Thoroughfare or Collector
- Proposed Freeway
- Luce Bayou ITP Centerline
- County Boundaries

N W E S

0 10,000 20,000
Feet

Notes: Proposed future road crossings shown were provided by Liberty County. Begining and ending roadway improvement locations are approximate and were provided by Liberty County Engineering Department.

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This map does not reflect final alignment.
This map is subject to change.
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COASTAL WATER AUTHORITY

Liberty County Master Thoroughfare and Collector Plan

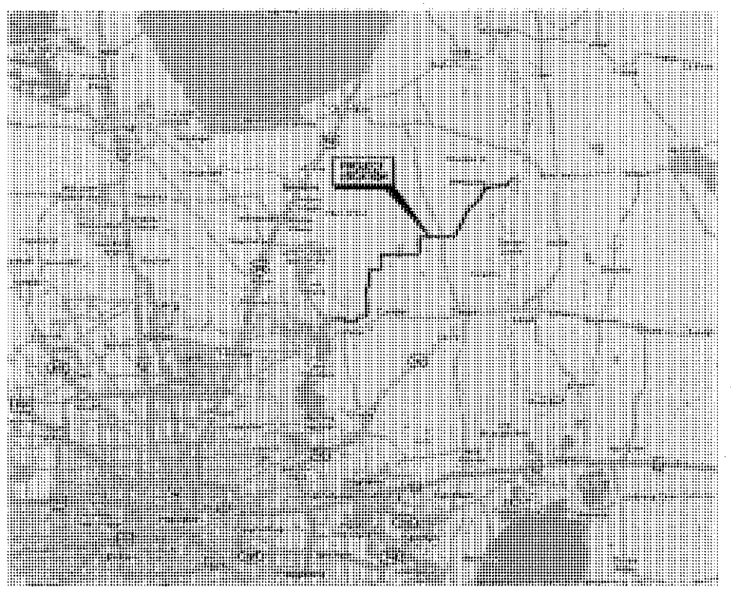
DRAWING SCALE

AS SHOWN

EXHIBIT A - 6

D:\work Order 64 U ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Crossings\Future Crossings_Map.mxd

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT
PROPOSED PUMP STATION



LOCATION MAP
NTS

CWA

EXECUTIVE OFFICERS

GARY N. ORADAT, P.E.
JOHN J. BALDWIN
JERRY L. BERRY

BOARD OF DIRECTORS

KURT F. METYKO, P.E.
F. WILLIAM OTHON, P.E.
ALAN D. CONNER
DOUGLAS E. WALKER
ZEBULUN NASH
JOHN ODIS COBB, P.E.
CITI ZARINKELK, P.E., F. SAME

ISSUE DATE: JANUARY, 2011

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

DRAWING SCALE
AS SHOWN

EXHIBIT:
SHEET NO. OF

LAST MODIFIED: Jan 28, 2011 - 7:10am BY USER: ThompsonBl
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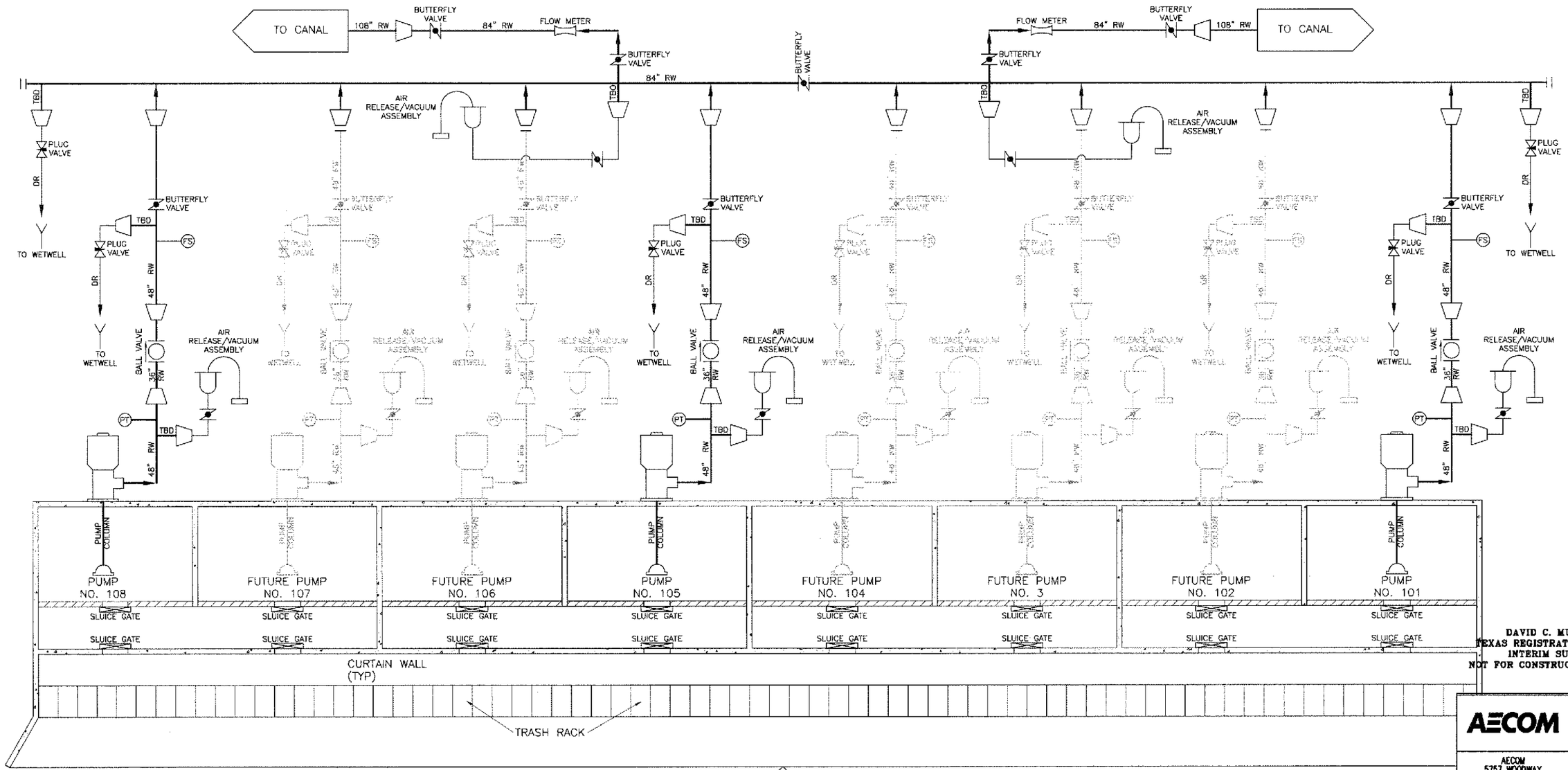

LEGEND

- (FS) FLOW SWITCH
- (PT) PRESSURE SWITCH
- DENOTES PIPE SIZE CHANGE
- DR DRAIN
- RW RAW WATER
- TBD TO BE DETERMINED

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COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

PRELIMINARY MECHANICAL FLOW DIAGRAM

DRAWING SCALE
AS SHOWN

SHEET NO. OF

EXHIBIT: B-1

LAST MODIFIED: Jan 27, 2011 - 3:10pm BY USER: garnerj
DWG. LOCATION: G:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PumpStation\
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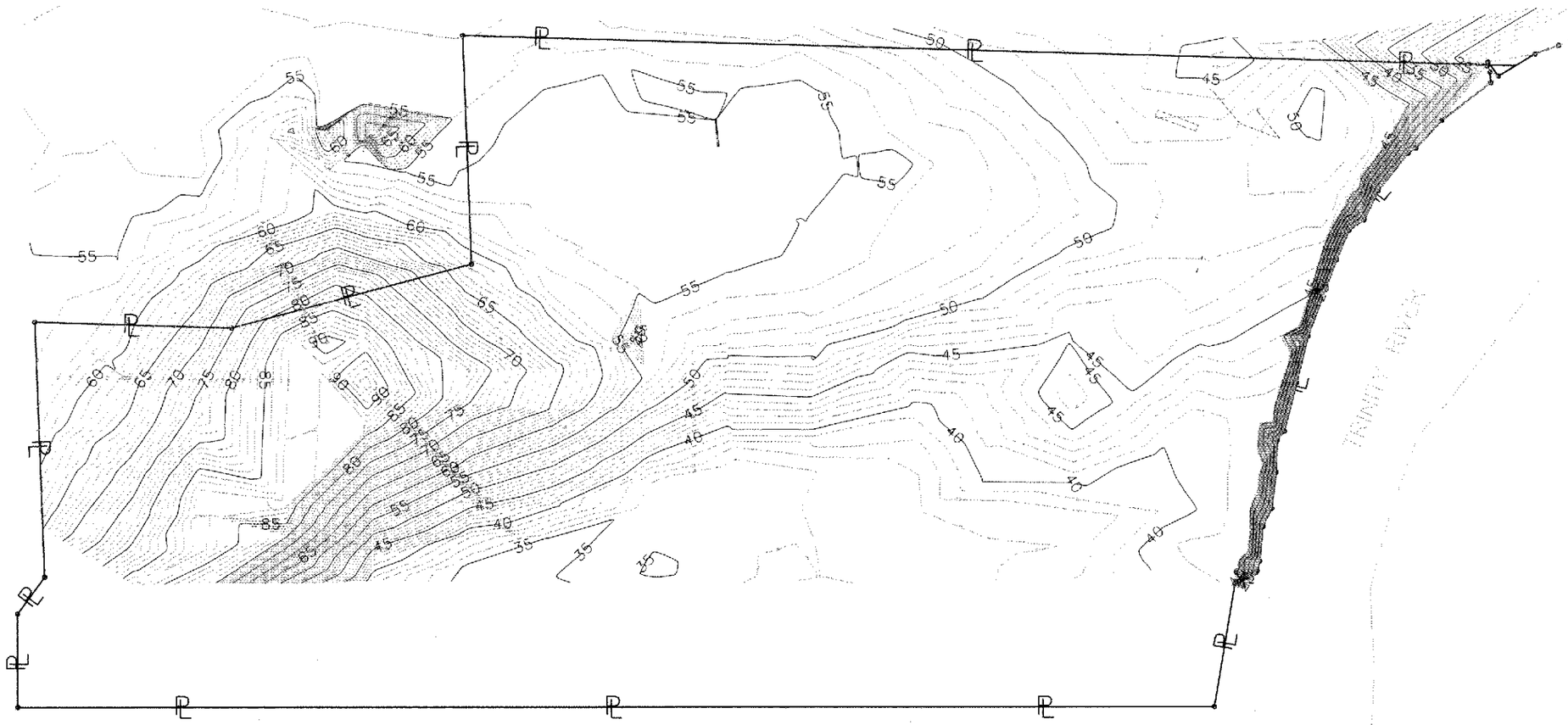

LEGEND:

PROPERTY LINE

EXISTING FENCE

53 EXISTING CONTOUR

0 300

SCALE IN FEET

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

PRELIMINARY EXISTING SITE PLAN

DRAWING SCALE
AS SHOWN

EXHIBIT: B-2

SHEET NO. OF

LAST MODIFIED: Jan 27, 2011 - 3:11pm BY USER: garnerj
DWG. LOCATION: G:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PumpStation\
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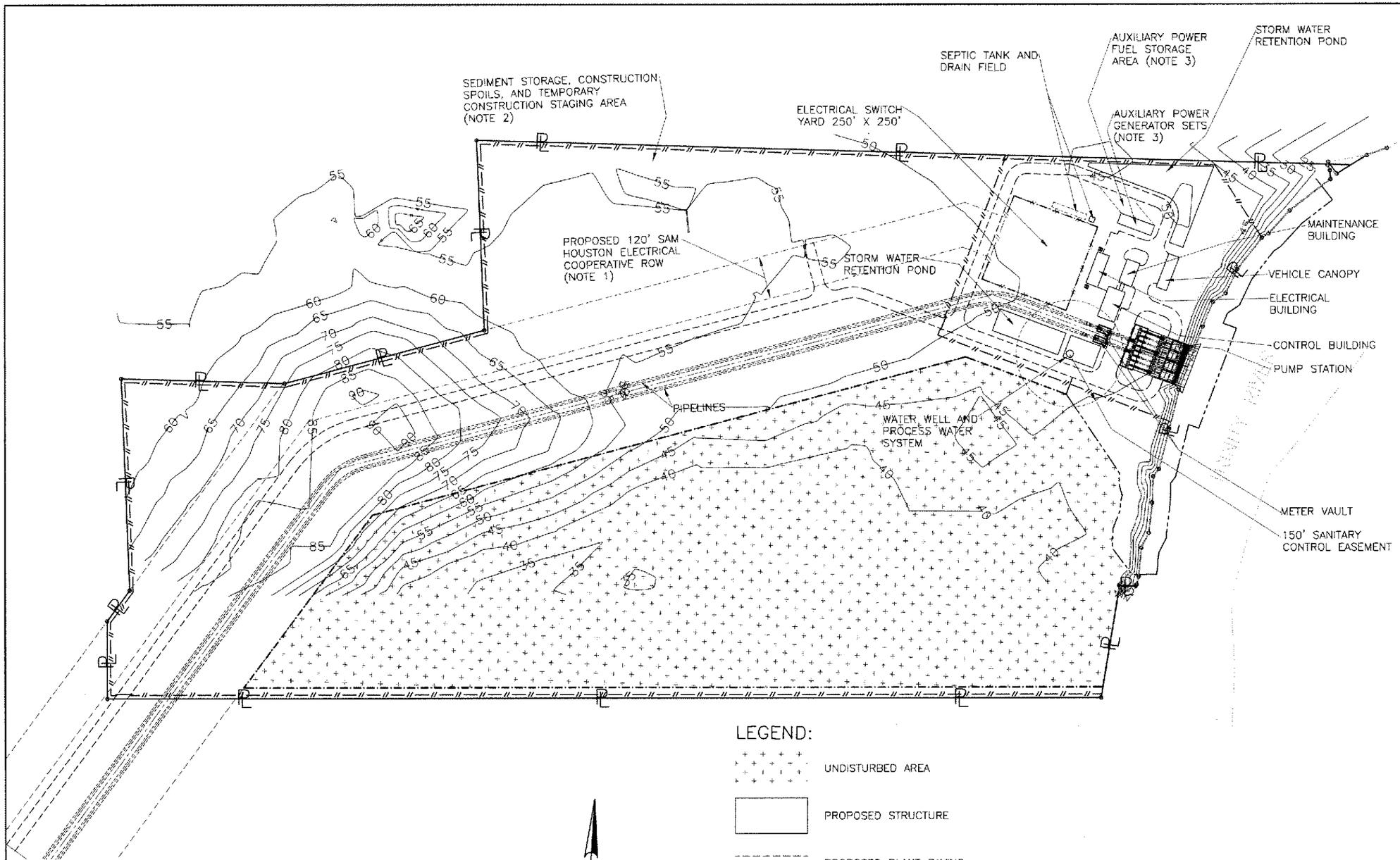

NOTES:

1. EXACT ROW LOCATION FOR UTILITY CONNECTION HAS NOT YET BEEN DETERMINED BY SAM HOUSTON ELECTRICAL COOPERATIVE.
2. ACTUAL AREA REQUIRED FOR SEDIMENT STORAGE WILL DEPEND ON THE FINAL DESIGN OF THE INTAKE STRUCTURE, PUMP SELECTION, AND SEDIMENT EXTRACTION SYSTEM.
3. USE OF AUXILIARY POWER HAS NOT YET BEEN CONFIRMED.

0 300
SCALE IN FEET

LEGEND:

- UNDISTURBED AREA
- PROPOSED STRUCTURE
- PROPOSED PLANT PAVING
- PROPOSED PIPELINE
- PROPERTY LINE
- PROPOSED FENCE
- EXISTING FENCE
- 53 EXISTING CONTOUR

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COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

PRELIMINARY PROPOSED SITE PLAN

DRAWING SCALE
AS SHOWN

EXHIBIT: B-3.1

SHEET NO. OF

LAST MODIFIED: Jan 27, 2011 - 3:11pm BY USER: garnerj
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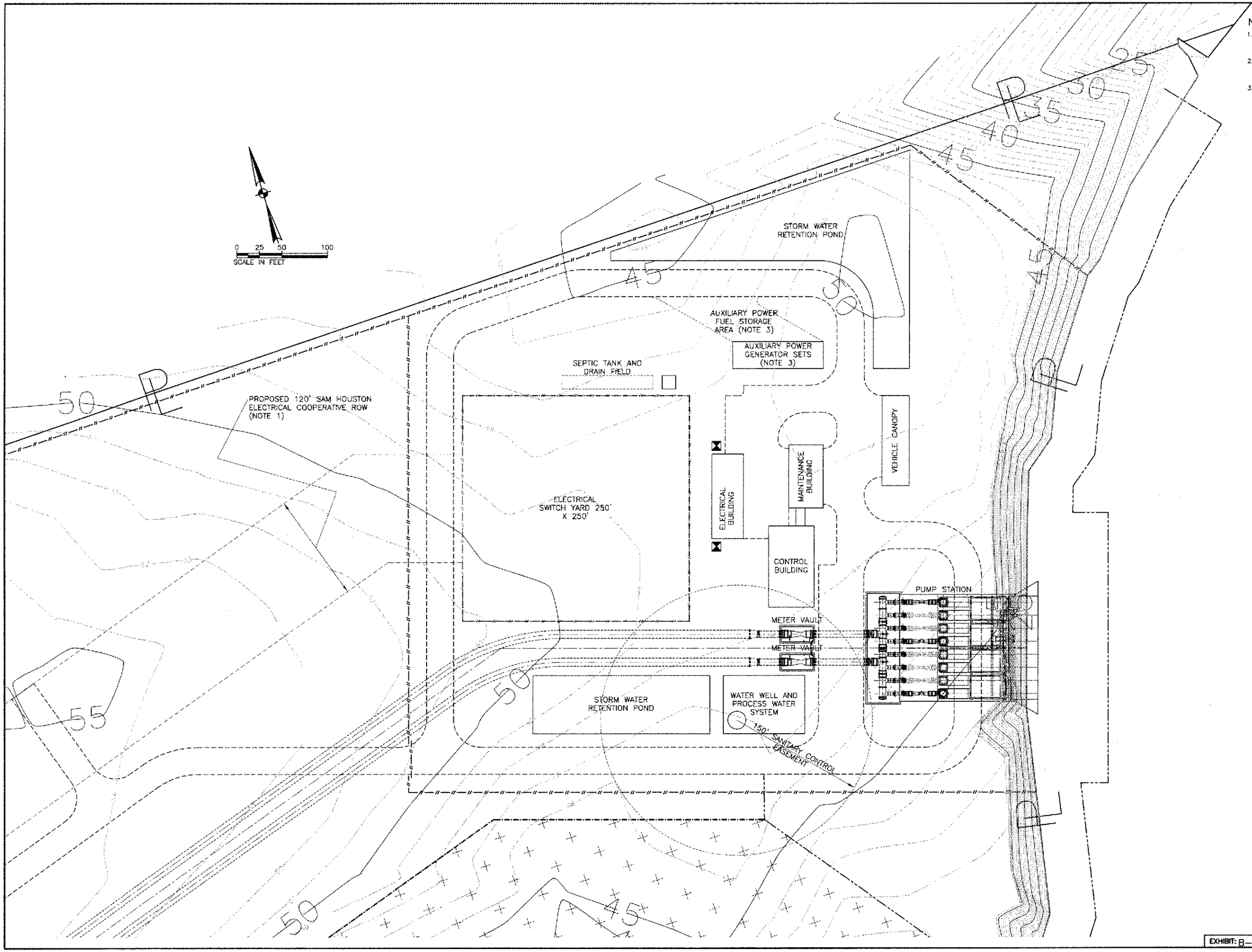

NOTES:

1. EXACT ROW LOCATION FOR UTILITY CONNECTION HAS NOT YET BEEN DETERMINED BY SAM HOUSTON ELECTRICAL COOPERATIVE.
2. ACTUAL AREA REQUIRED FOR SEDIMENT STORAGE WILL DEPEND ON THE FINAL DESIGN OF THE INTAKE STRUCTURE, PUMP SELECTION, AND SEDIMENT EXTRACTION SYSTEM.
3. USE OF AUXILIARY POWER HAS NOT YET BEEN CONFIRMED.

DAVID C. MUNN, P.E.
TEXAS REGISTRATION NO. 101193
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LUCE BAYOU INTERBASIN TRANSFER PROJECT

PRELIMINARY PROPOSED ENLARGED SITE PLAN

DRAWING SCALE
AS SHOWN

SHEET NO. OF

EXHIBIT: B-3.2

LAST MODIFIED: Jan 27, 2011 - 3:11pm BY USER: garnerj
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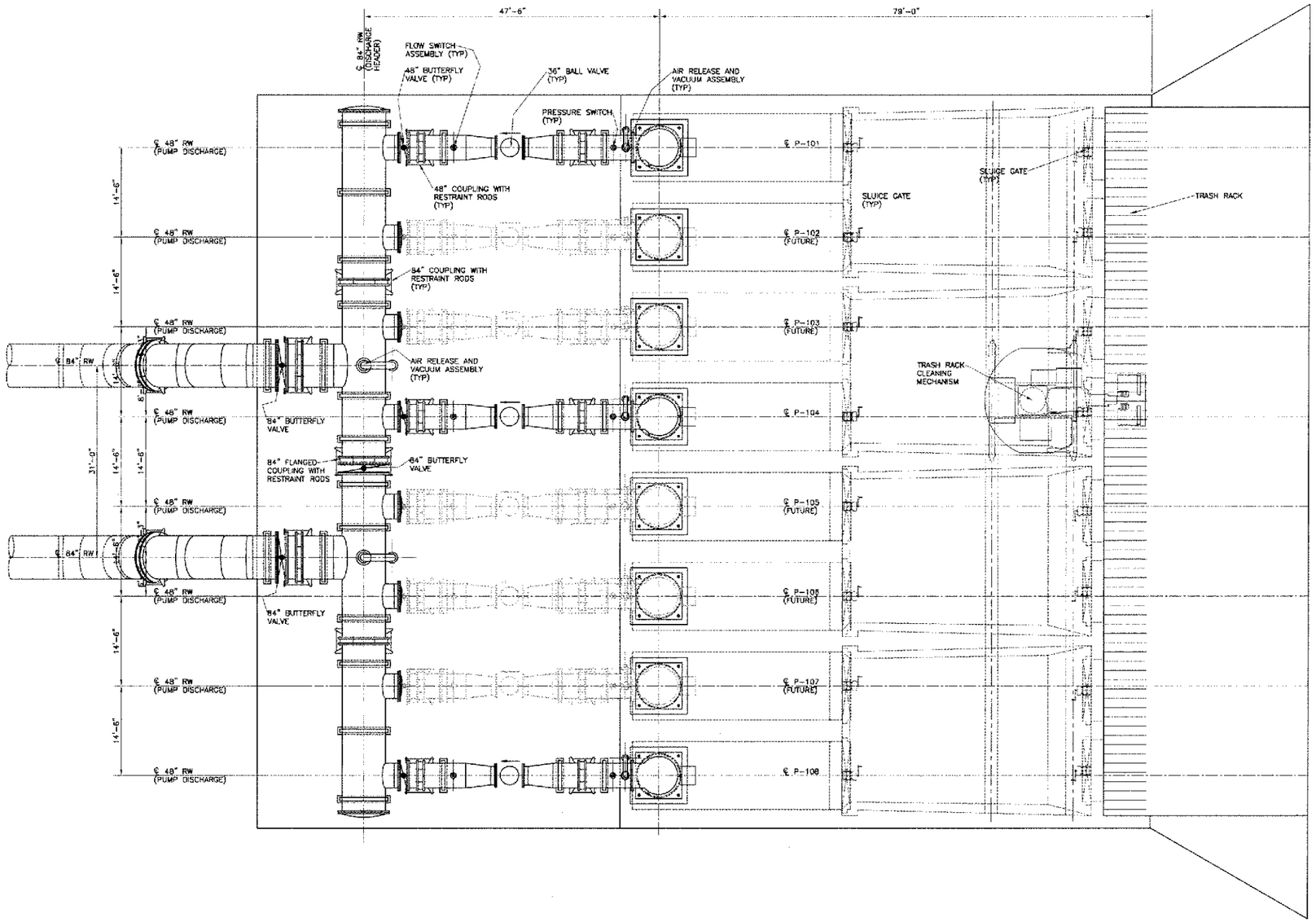

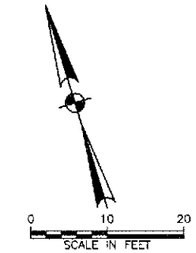

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SURVEYED BY:
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CWA

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

PRELIMINARY PUMP STATION PLAN, OPTION 1 ABOVEGROUND HEADER

DRAWING SCALE
AS SHOWN

SHEET NO. OF

EXHIBIT: B-4

LAST MODIFIED: Jan 27, 2011 – 3:11pm BY USER: garnerj
DWG. LOCATION: Q:\Work Order 61.4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PumpStation\
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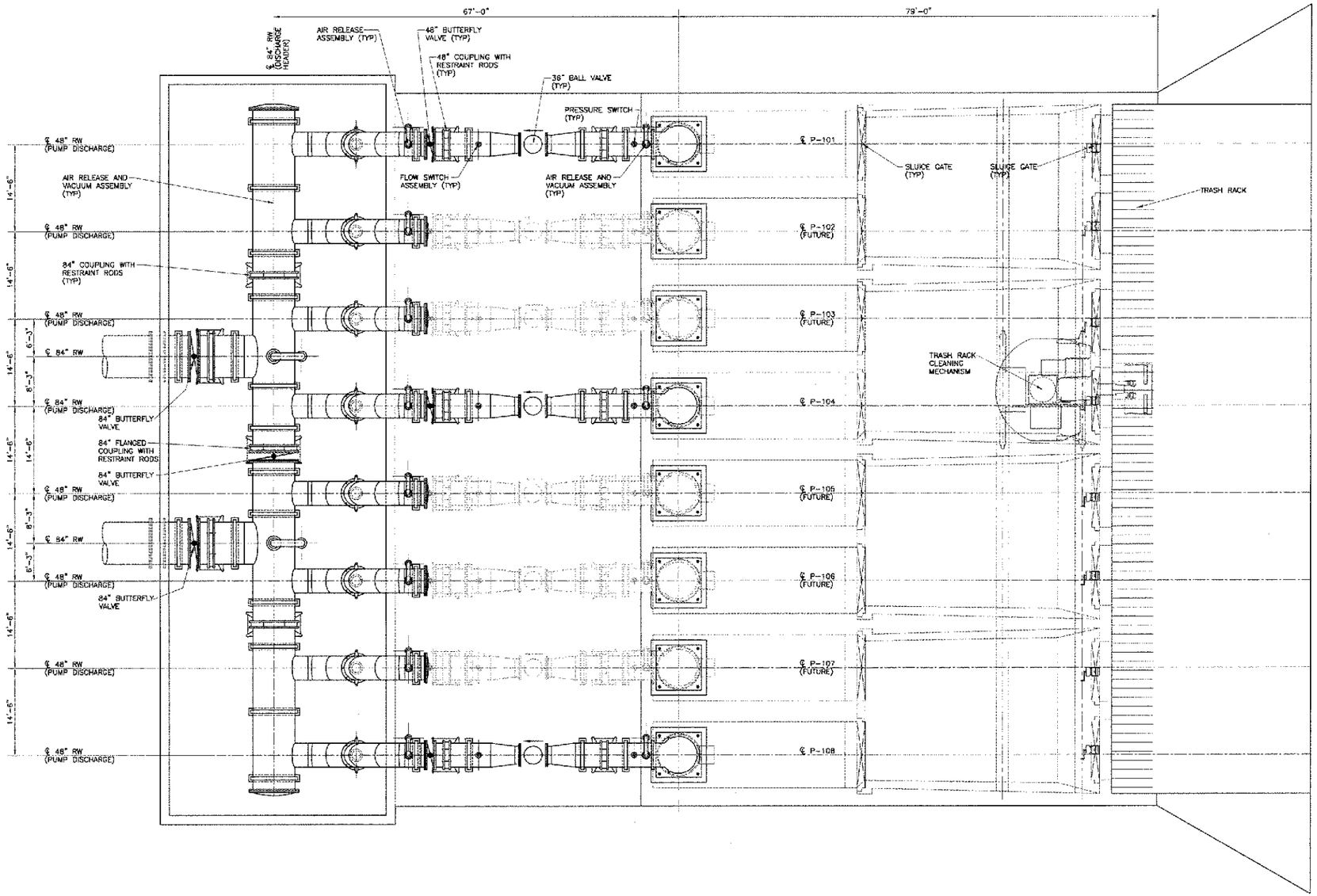

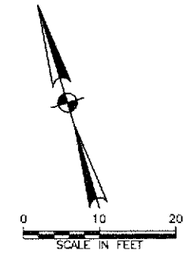

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CWA

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

PRELIMINARY PUMP STATION
PLAN, OPTION 2
HEADER IN VALVE VAULT

DRAWING SCALE
AS SHOWN

EXHIBIT: B-5

SHEET NO. OF

LAST MODIFIED: Jan 27, 2011 - 3:11pm BY USER: garnerj
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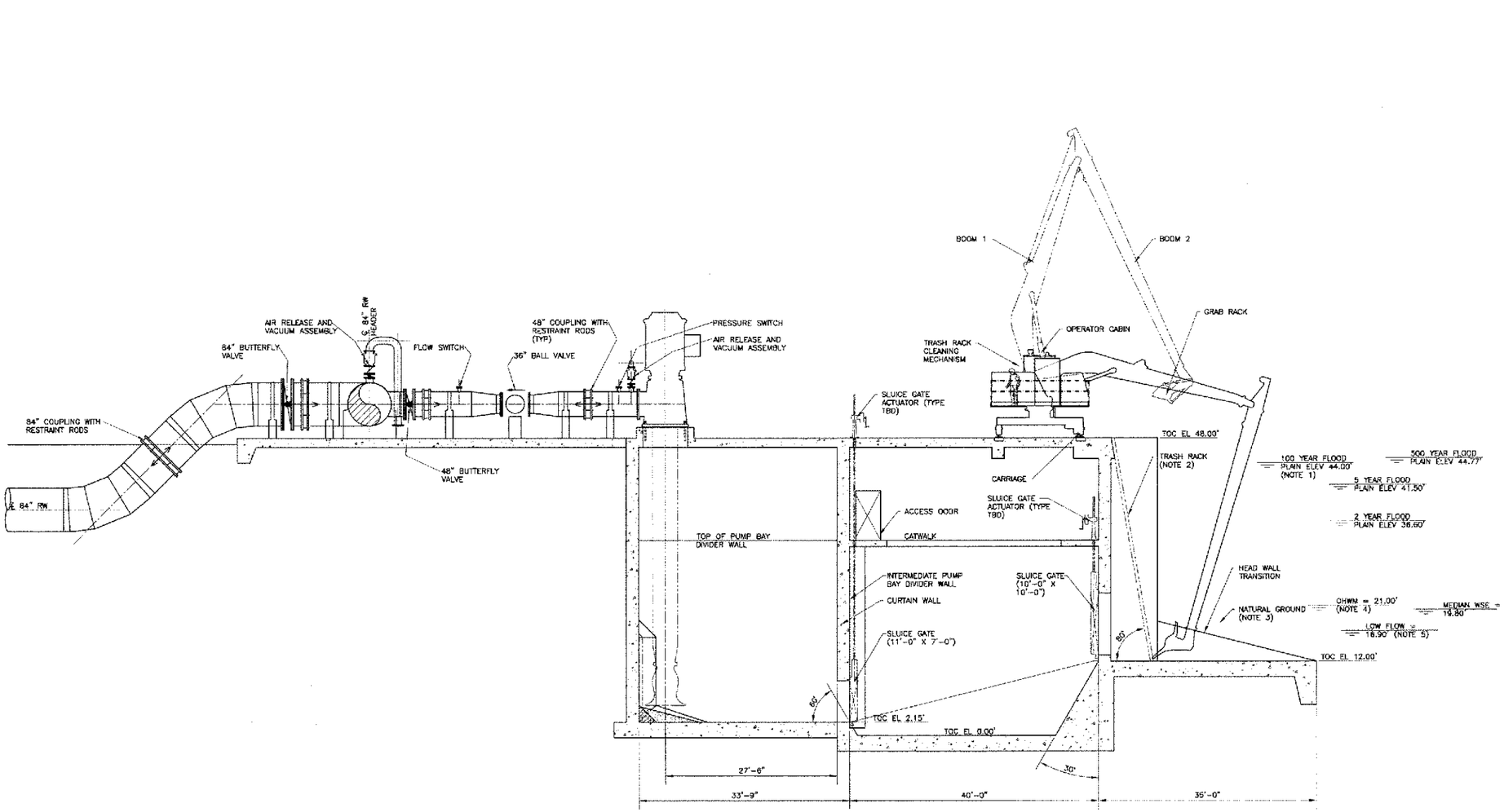

NOTES:

1. 100 YEAR FLOOD PLAIN ELEVATION AS SHOWN BASED ON FIRM PANEL 48291C0325C, EFFECTIVE DATE: MAY 2, 2008, REFERENCED TO NAGVD 88, 2001 ADJUSTMENT.
2. PRELIMINARY TRASH RACK DESIGN CONSIST OF 1/2" WIDE BARS SPACED 2-INCHES APART (OUTSIDE EDGE TO OUTSIDE EDGE). DEPTH AND HORIZONTAL BRACING TO BE DETERMINED LATER.
3. NATURAL GROUND ELEVATION SHOWN AT CENTERLINE OF PUMP STATION. REFERENCED TO NAGVD 88, 2001 ADJUSTMENT.
4. OHWM = ORDINARY HIGH WATER MARK.
5. LOW FLOW WATER SURFACE ELEVATION ASSUMES A FLOW RATE OF 1,000 CFS..

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COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

PRELIMINARY PUMP STATION SECTION, OPTION 1 ABOVEGROUND HEADER

DRAWING SCALE
AS SHOWN

EXHIBIT: B-6

SHEET NO. OF

LAST MODIFIED: Jan 27, 2011 – 3:12pm BY USER: garnerj
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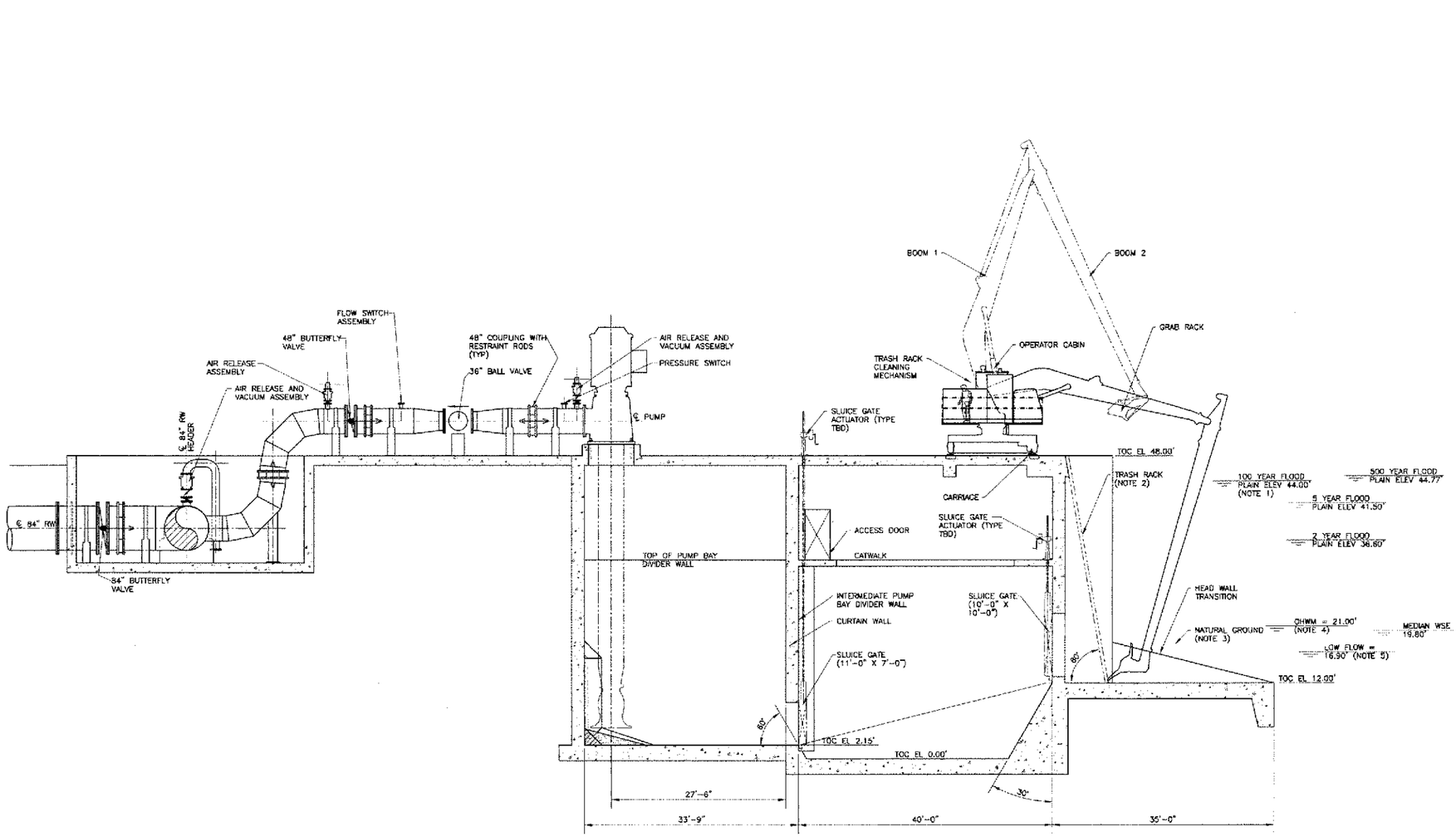

NOTES:

1. 100 YEAR FLOOD PLAIN ELEVATION AS SHOWN BASED ON FIRM PANEL 48291C0325C, EFFECTIVE DATE: MAY 2, 2009, REFERENCED TO NAGVD 88, 2001 ADJUSTMENT.
2. PRELIMINARY TRASH RACK DESIGN CONSIST OF 1/2" WIDE BARS SPACED 2-INCHES APART (OUTSIDE EDGE TO OUTSIDE EDGE). DEPTH AND HORIZONTAL BRACING TO BE DETERMINED LATER.
3. NATURAL GROUND ELEVATION SHOWN AT CENTERLINE OF PUMP STATION. REFERENCED TO NAGVD 88, 2001 ADJUSTMENT.
4. OHWM = ORDINARY HIGH WATER MARK.
5. LOW FLOW WATER SURFACE ELEVATION ASSUMES A FLOW RATE OF 1,000 CFS..

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713.780.0838 fax.

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

PRELIMINARY PUMP STATION SECTION, OPTION 2 HEADER IN VALVE VAULT

DRAWING SCALE
AS SHOWN

EXHIBIT: 8-7

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DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PumpStation\
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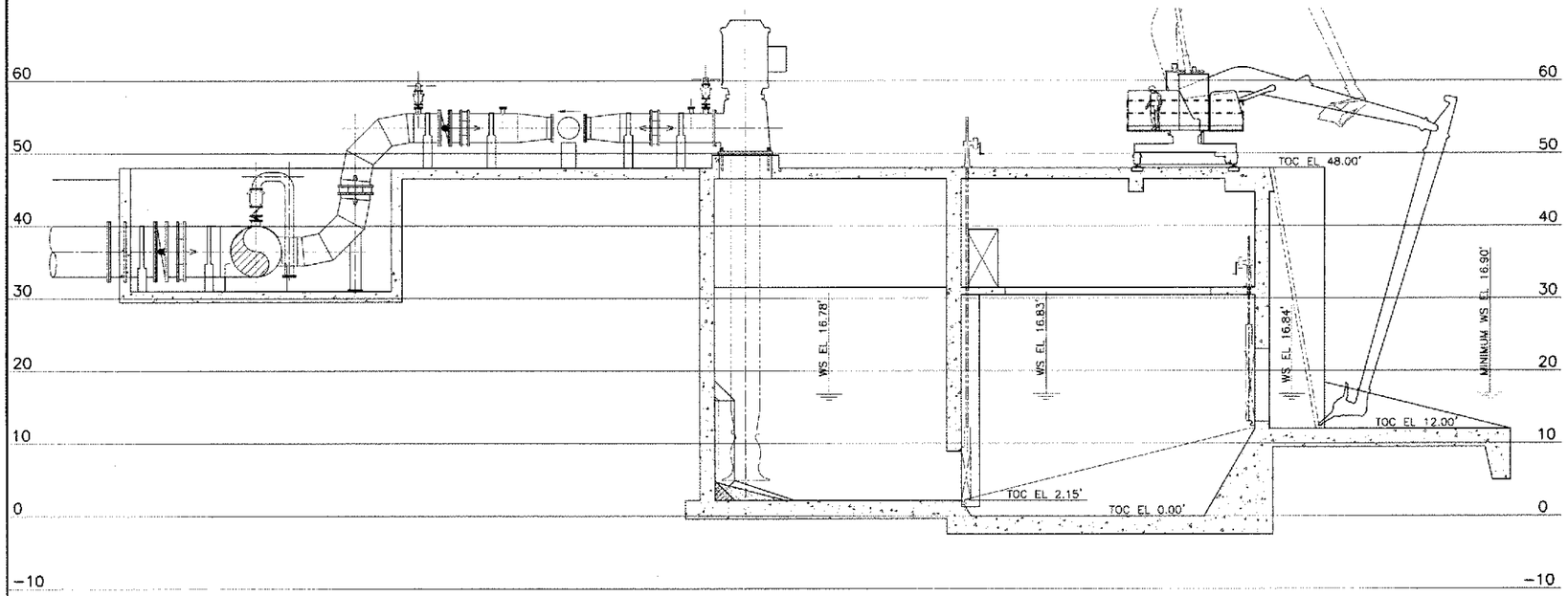
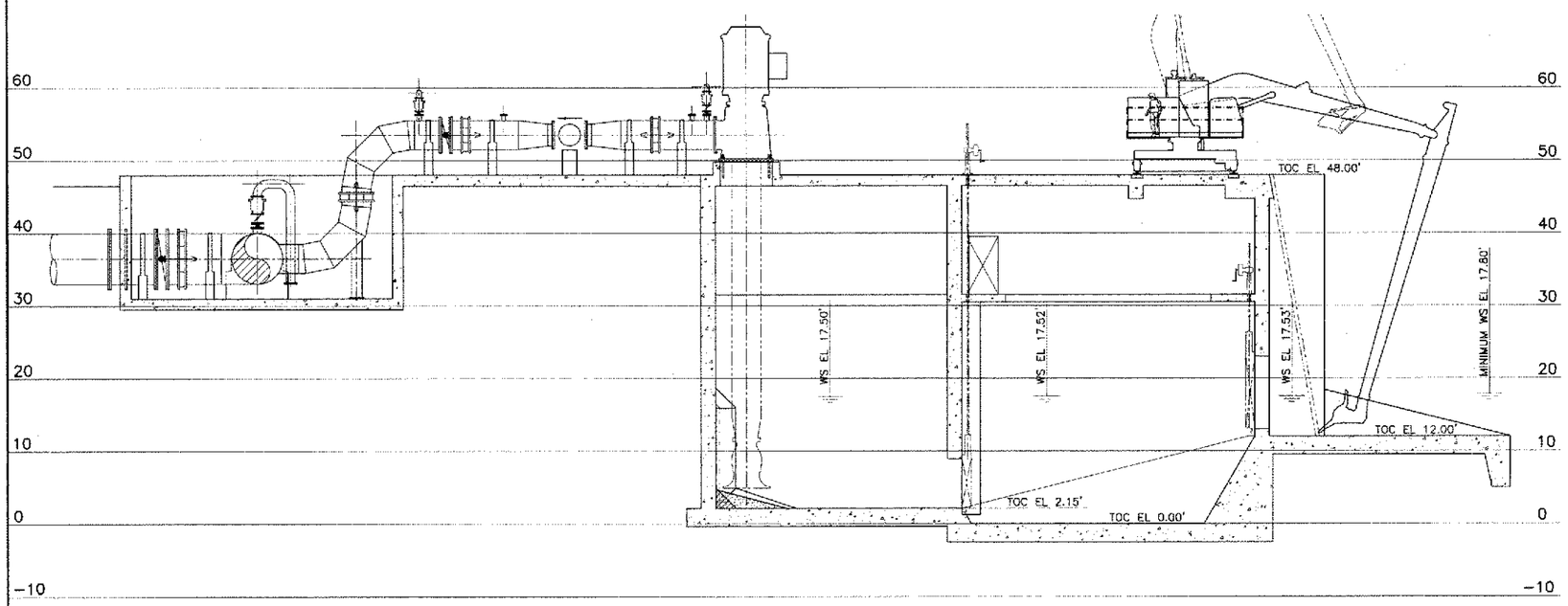


HYDRAULIC PROFILE TWO PUMPS OPERATING AT 49,600 GPM



HYDRAULIC PROFILE ALL PUMPS OPERATING AT 49,400 GPM

WSE AT VARIOUS FLOWRATES

FLOW (CFS)	COMMENTS	WSE (FT)
1,000	LOW FLOW SCENARIO 1	16.9
1,500	LOW FLOW SCENARIO 2	17.8
3,000	APPROXIMATE MEDIAN FLOW	19.8
6,000	FLOW SCENARIO 3	22.3
48,600	2 YEAR DESIGN FLOW	35.6
73,100	5 YEAR DESIGN FLOW	41.5
86,300	10 YEAR DESIGN FLOW	42.1
130,000	100 YEAR DESIGN FLOW	44.0
159,500	500 YEAR DESIGN FLOW	44.7

NOTE:
DURING LOW PUMPING OPERATIONS, THE MINIMUM ANTICIPATED WATER SURFACE ELEVATION IN THE TRINITY RIVER IS 16.90 FEET. DURING HIGH PUMPING OPERATIONS (500 MGD), THE MINIMUM ANTICIPATED WATER SURFACE ELEVATION IN THE TRINITY RIVER WILL BE 17.80 FEET. MINIMUM TRINITY RIVER ELEVATIONS ARE CONTROLLED BY THE TRA THROUGH RELEASES FROM LAKE LIVINGSTON, WHICH ARE PROVIDED TO MEET DOWNSTREAM WATER RIGHT DEMANDS.

0 10 20
SCALE IN FEET

DAVID C. MUNN, P.E.
TEXAS REGISTRATION NO. 101193
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

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SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

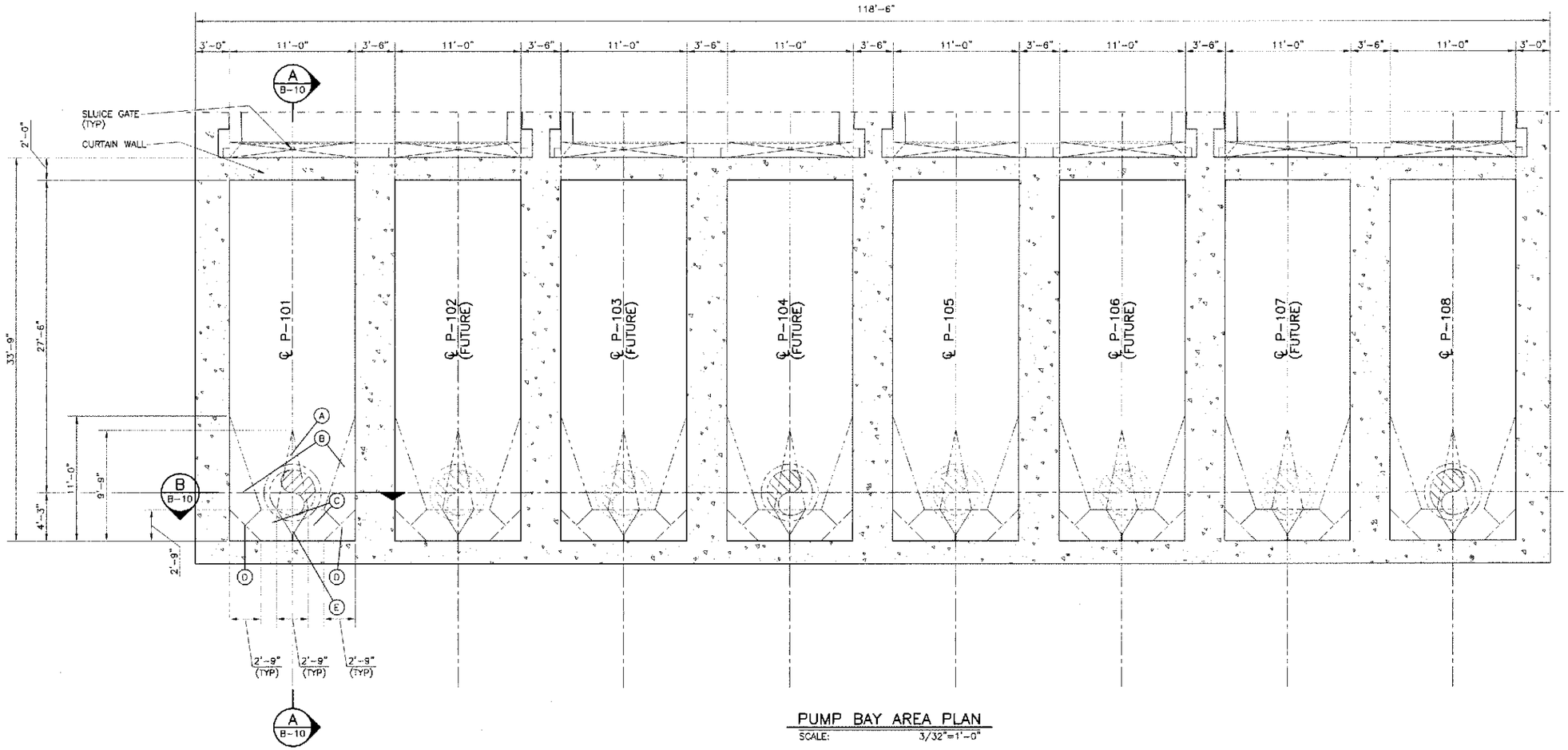
PRELIMINARY PUMP STATION
HYDRAULIC PROFILE

DRAWING SCALE
AS SHOWN

EXHIBIT: B-8

SHEET NO. OF

LAST MODIFIED: Jan 27, 2011 - 3:12pm BY USER: gamerj
DWG. LOCATION: G:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PumpStation\
DWG. NAME: WO6B8PumpHydPro.dwg



PUMP BAY AREA PLAN

SCALE: 3/32"=1'-0"

ITEM	DESCRIPTION
A	CENTER GUIDE VANE
B	SIDE GUIDE VANE
C	BACK GUIDE VANE
D	VERTICAL GUIDE VANE
E	CENTER VERTICAL GUIDE VANE

NOTE

1. GUIDE VANE DIMENSIONS ARE ONLY BASED ON PRELIMINARY INFORMATION AND SHOULD BE REFINED DURING FINAL DESIGN THROUGH PHYSICAL MODELING AND CONSULTATION WITH PUMP MANUFACTURERS.

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COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

PRELIMINARY PUMP BAY AREA PLAN

DRAWING SCALE
AS SHOWN

EXHIBIT: B-9

SHEET NO. OF

LAST MODIFIED: Jan 27, 2011 – 3:12pm By USER: garnerj
DWG. LOCATION: O:\Work Order B\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PumpStation\
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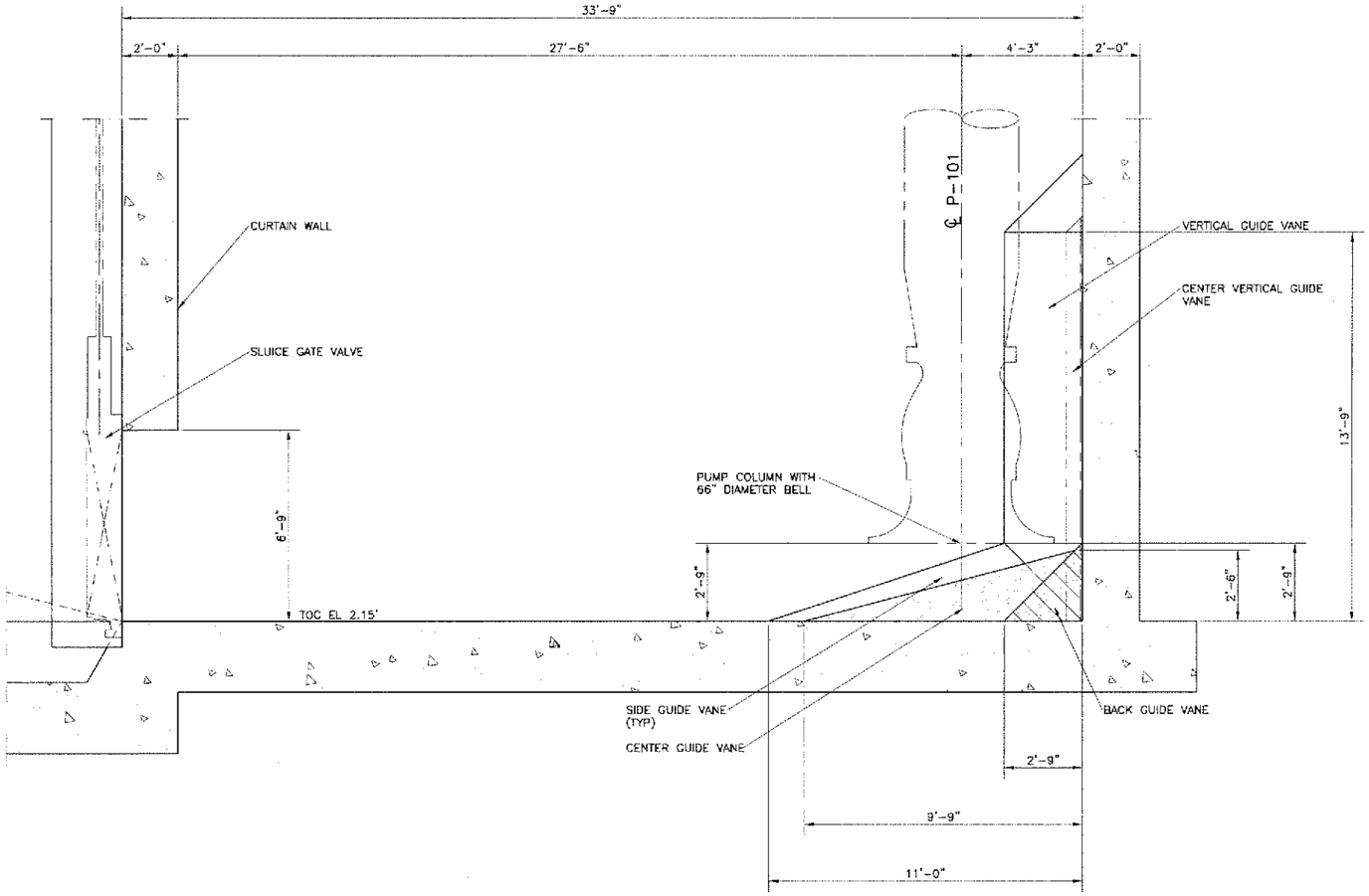
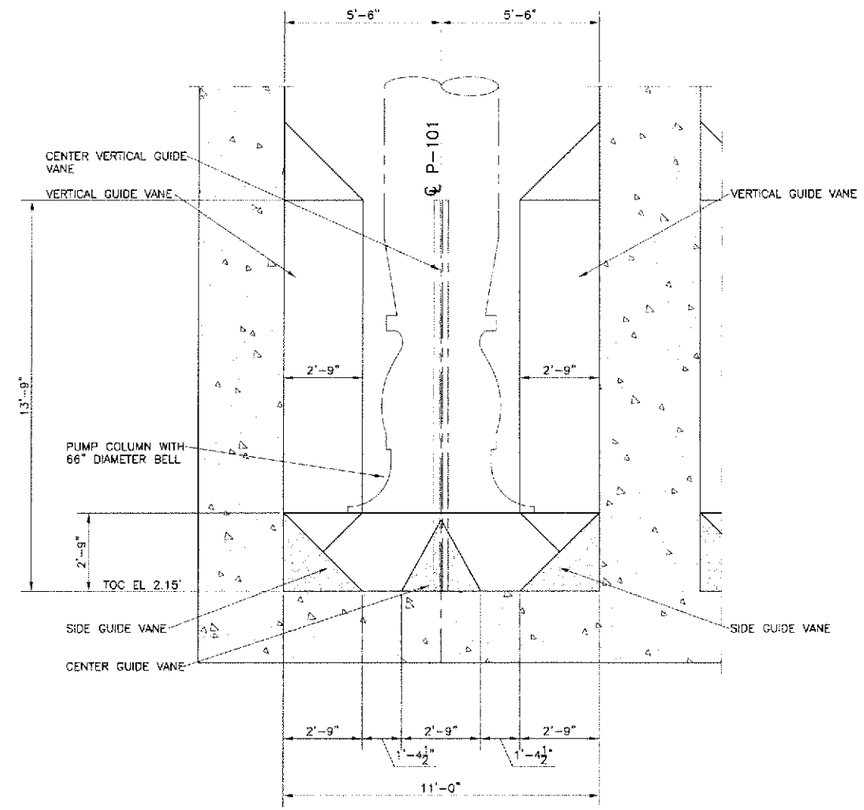


SECTION A B-9
SCALE: 3/16"=1'-0"



SECTION B B-9
SCALE: 3/16"=1'-0"

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

PRELIMINARY PUMP BAY AREA SECTIONS

DRAWING SCALE
AS SHOWN

EXHIBIT: B-10

SHEET NO. OF

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DWG. LOCATION: G:\Work Order B\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PumpStation\
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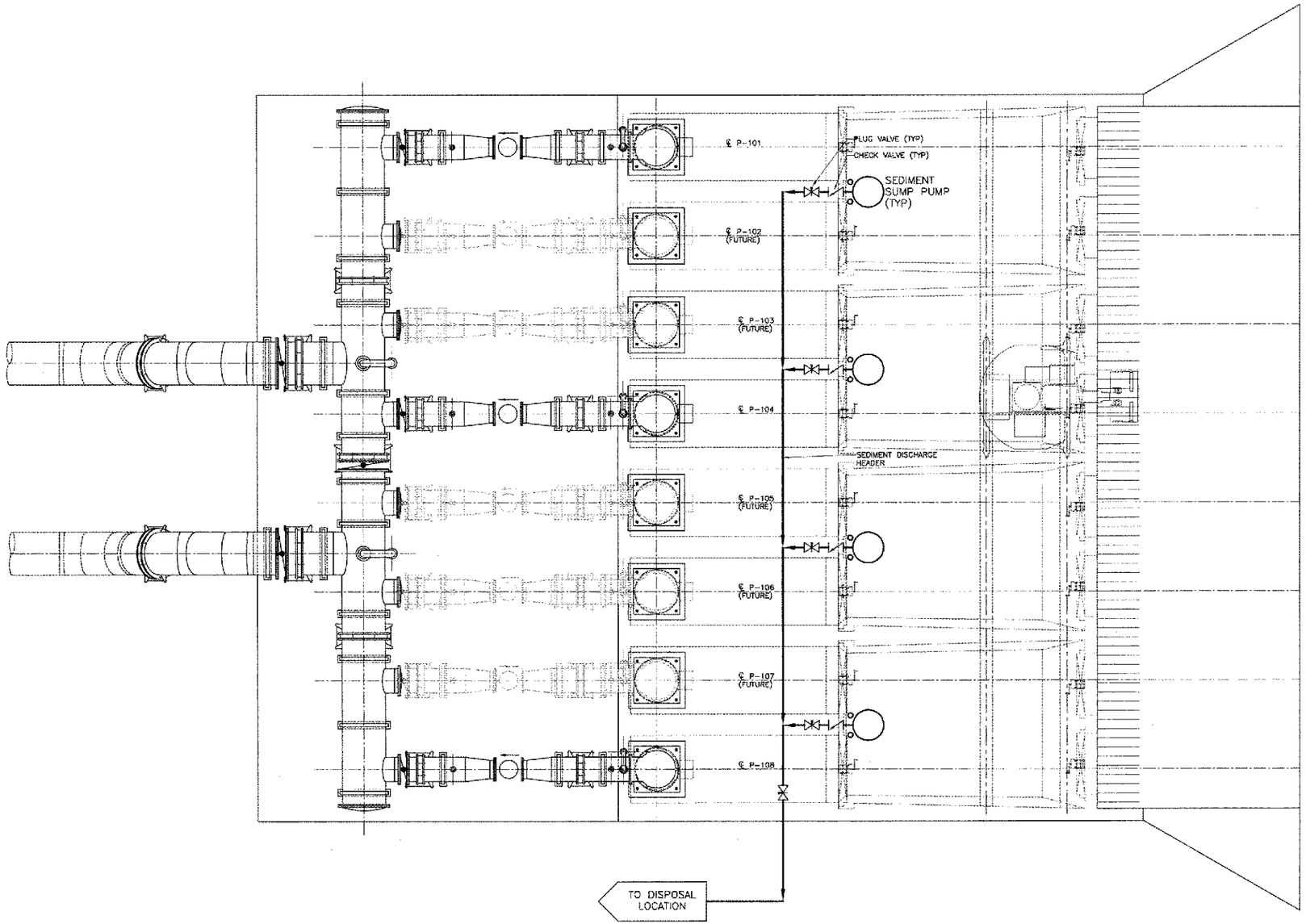

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

PRELIMINARY SEDIMENT HANDLING FACILITY SCHEMATIC OPTION 1

DRAWING SCALE
NOT TO SCALE

EXHIBIT: 8-11

SHEET NO. OF

LAST MODIFIED: Jan 27, 2011 - 3:25pm BY USER: garnerj
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PumpStation\
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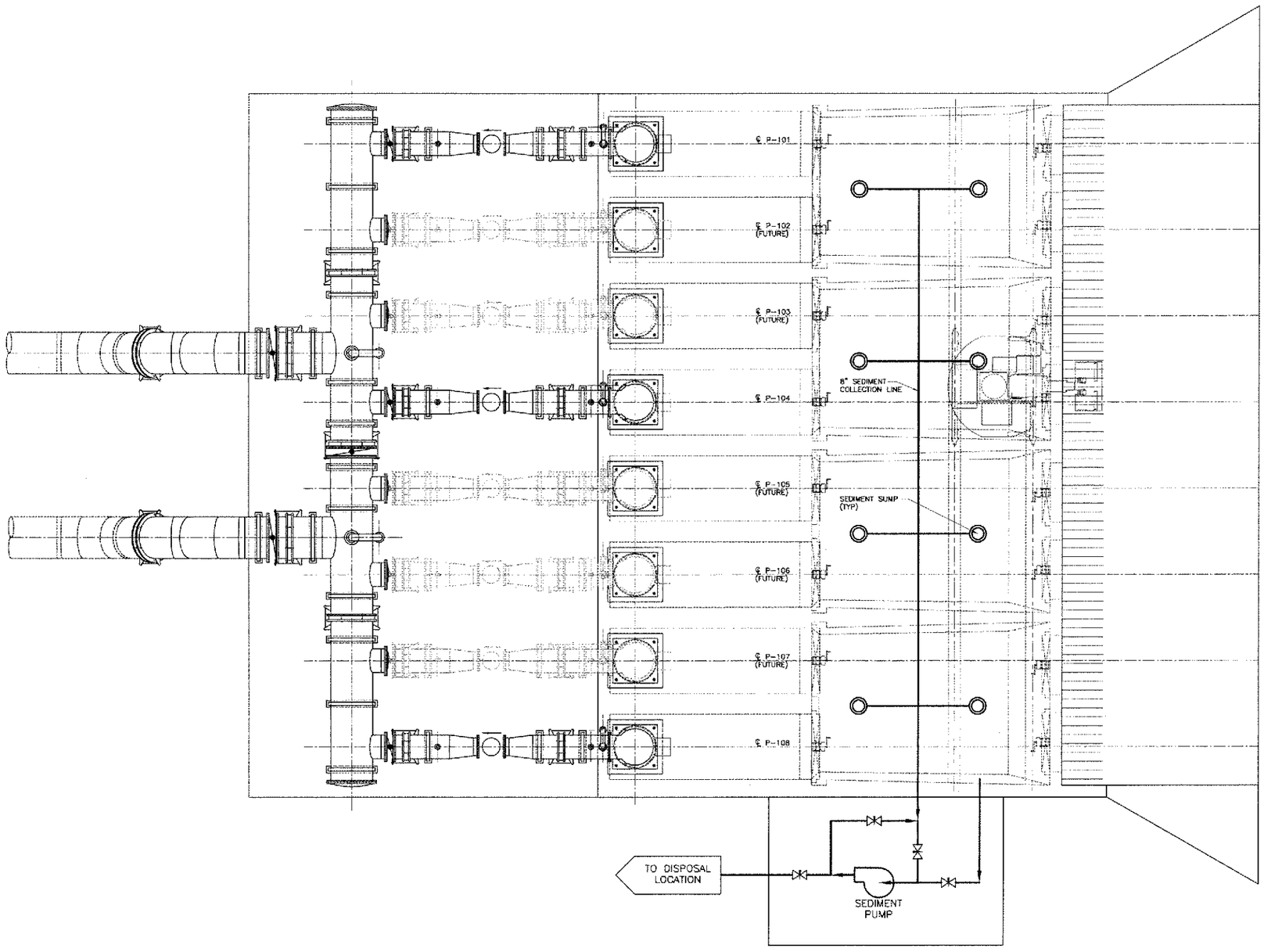

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

PRELIMINARY SEDIMENT HANDLING FACILITY SCHEMATIC OPTION 2

DRAWING SCALE
NOT TO SCALE

SHEET NO. OF

EXHIBIT: B-12

LAST MODIFIED: Jan 27, 2011 - 3:25pm BY USER: gorner
DWG. LOCATION: G:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PumpStation\
DWG. NAME: WOBB12PumpStaSedPlan2.dwg

CARRIER PRIMARY RELAYS

DEVICE NO.	TYPE	FUNCTION
21-Z2P	KD-10	ZONE 2 - PRIMARY
21-Z3P	KD-11	ZONE 3 - PRIMARY
50-P	ITH	FAULT DETECTOR
62-P	TD-4	TIMER FOR PRIMARY RELAYS
67N-P	KRP	GROUND RELAY - PRIMARY
85-P	KA-4	CARRIER AUXILIARY RELAY

NON CARRIER BACKUP RELAYS

DEVICE NO.	TYPE	FUNCTION
21-Z1B	KD-10	ZONE 1 - BACKUP
21-Z2B	KD-10	ZONE 2 - BACKUP
50-B	ITH	FAULT DETECTOR
62-B	TD-5	TIMER FOR BACKUP RELAYS
67N-B	IRP-8	GROUND RELAY BACKUP

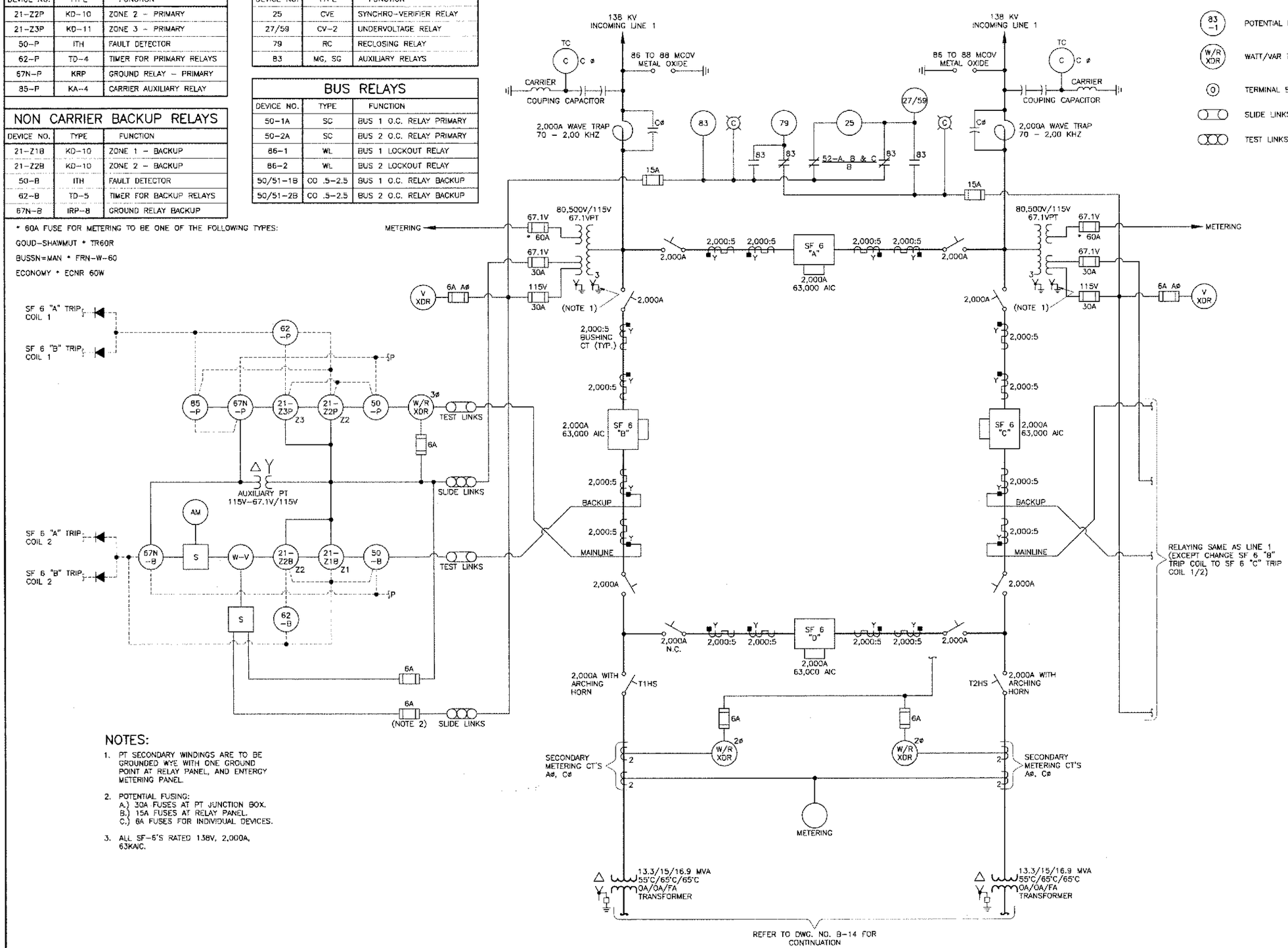
* 60A FUSE FOR METERING TO BE ONE OF THE FOLLOWING TYPES:
GOUD-SHAWMUT * TR60R
BUSSN=MAN * FRN-W-60
ECONOMY * ECNR 60W

CLOSING SCHEME RELAYS

DEVICE NO.	TYPE	FUNCTION
25	CVE	SYNCHRO-VERIFIER RELAY
27/59	CV-2	UNDERVOLTAGE RELAY
79	RC	RECLOSING RELAY
83	MG, SG	AUXILIARY RELAYS

BUS RELAYS

DEVICE NO.	TYPE	FUNCTION
50-1A	SC	BUS 1 O.C. RELAY PRIMARY
50-2A	SC	BUS 2 O.C. RELAY PRIMARY
86-1	WL	BUS 1 LOCKOUT RELAY
86-2	WL	BUS 2 LOCKOUT RELAY
50/51-1B	CO .5-2.5	BUS 1 O.C. RELAY BACKUP
50/51-2B	CO .5-2.5	BUS 2 O.C. RELAY BACKUP



NOTES:

1. PT SECONDARY WINDINGS ARE TO BE GROUNDED WYE WITH ONE GROUND POINT AT RELAY PANEL, AND ENTERGY METERING PANEL.
2. POTENTIAL FUSING:
   A.) 30A FUSES AT PT JUNCTION BOX.
   B.) 15A FUSES AT RELAY PANEL.
   C.) 6A FUSES FOR INDIVIDUAL DEVICES.
3. ALL SF-6'S RATED 138V, 2,000A, 63KA/C.

LEGEND CONTINUATION:

- 83 -1 — POTENTIAL ROLLOVER
- W/R XDR — WATT/VAR TRANSDUCER
- TERMINAL BLOCK
- SLIDE LINKS
- TEST LINKS OR TEST TERMINALS

LEGEND:

- SF 6 "A" — CIRCUIT BREAKER
- FUSE(S)
- TRANSFORMER, TWO WINDING AUXILIARY
- CURRENT TRANSFORMER MULTI RATIO
- 138 KV DISCONNECT SWITCH WITH ARC HORNS
- LIGHTING ARRESTOR
- SS-2 — SELECTOR SWITCH
- C — INDICATOR LIGHT, C - CLEAR LENS
- AM — AMMETER
- W-V — WATTMETER-VARMETER
- 21 — PROTECTION RELAY; "21" DENOTES IEEE DEVICE
- C — TC POWER LINE CARRIER

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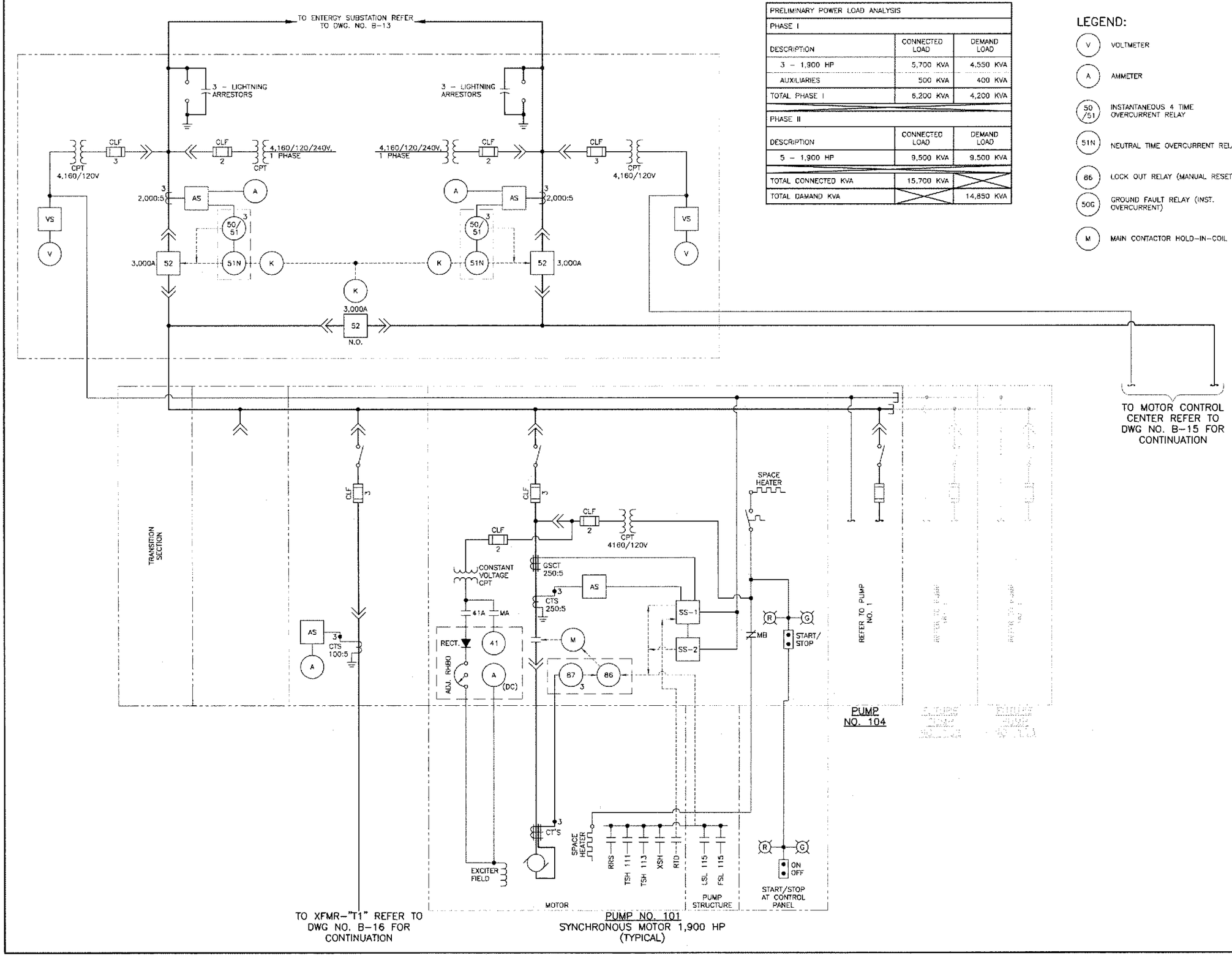
LUCE BAYOU INTERBASIN TRANSFER PROJECT

SUBSTATION PRELIMINARY ONE LINE DIAGRAM

DRAWING SCALE
NOT TO SCALE

EXHIBIT: B-13
SHEET NO. OF

LAST MODIFIED: Jan 27, 2011 - 3:23pm BY USER: garnerj
DWG. LOCATION: Q:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PumpStation\
DWG. NAME: WO6B1314151617PumpStaOneLine.dwg



PRELIMINARY POWER LOAD ANALYSIS		
PHASE I		
DESCRIPTION	CONNECTED LOAD	DEMAND LOAD
3 - 1,900 HP	5,700 KVA	4,550 KVA
AUXILIARIES	500 KVA	400 KVA
TOTAL PHASE I	6,200 KVA	4,200 KVA
PHASE II		
DESCRIPTION	CONNECTED LOAD	DEMAND LOAD
5 - 1,900 HP	9,500 KVA	9,500 KVA
TOTAL CONNECTED KVA	15,700 KVA	
TOTAL DAMAND KVA		14,850 KVA

LEGEND:

- V — VOLTMETER
- A — AMMETER
- 50/51 — INSTANTANEOUS 4 TIME OVERCURRENT RELAY
- 51N — NEUTRAL TIME OVERCURRENT RELAY
- 86 — LOCK OUT RELAY (MANUAL RESET)
- 50G — GROUND FAULT RELAY (INST. OVERCURRENT)
- M — MAIN CONTACTOR HOLD-IN-COIL

LEGEND: (CONTINUATION)

- 41 — FIELD APPLICATION TIMER RELAY
- 87 — MOTOR DIFFERENTIAL RELAY
- CS — CONTROL SWITCH
- AS — AMMETER SWITCH
- VS — VOLTMETER SWITCH
- 52 — DRAWOUT AIR CIRCUIT BREAKER
- SS-1 — SOLID STATE MOTOR PROTECTION MALFUNCTION UNIT WITH:
  1. OVERTEMPERATURE/OVERLOAD
  2. PHASE BALANCE
  3. GROUND FAULT
- SS-2 — SOLID STATE SLIP PULLOUT RELAY

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PRELIMINARY ONE LINE DIAGRAM SHEET 1 OF 4

DRAWING SCALE
NOT TO SCALE

EXHIBIT: B-14
SHEET NO. OF

LAST MODIFIED: Jan 27, 2011 - 3:23pm BY USER: gernerj
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Code\PumpStation\
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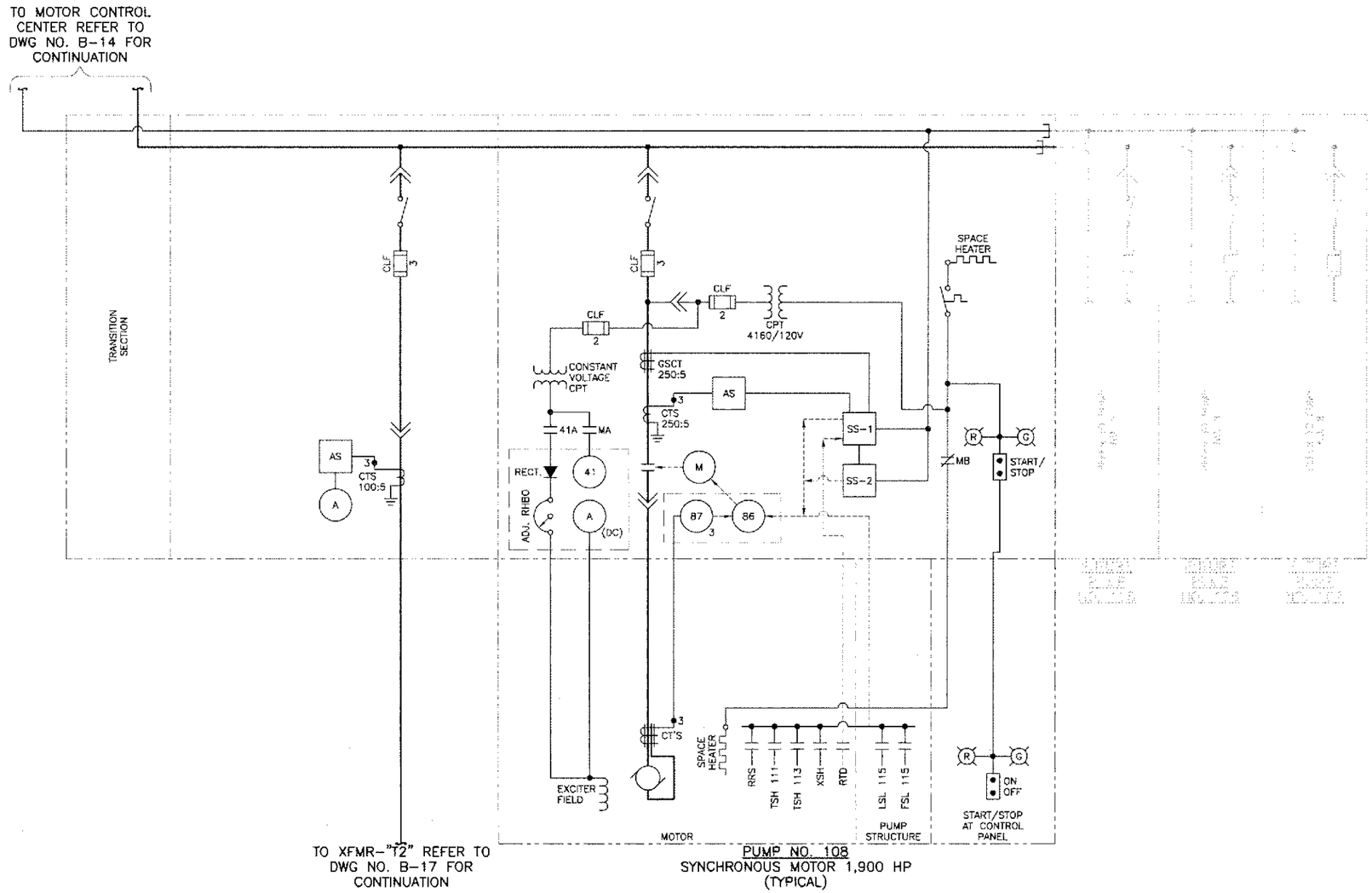

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

PRELIMINARY ONE LINE DIAGRAM SHEET 2 OF 4

DRAWING SCALE
NOT TO SCALE

EXHIBIT: B-15

SHEET NO. OF

LAST MODIFIED: Jan 27, 2011 - 3:24pm BY USER: garnerj
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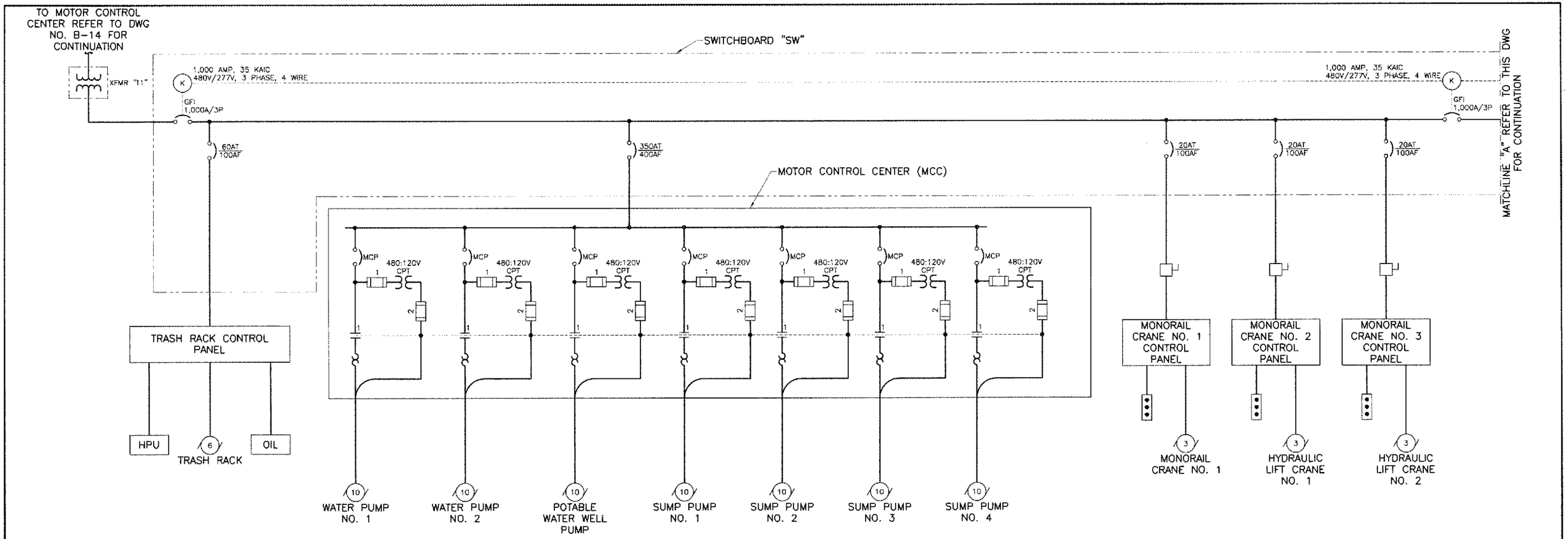

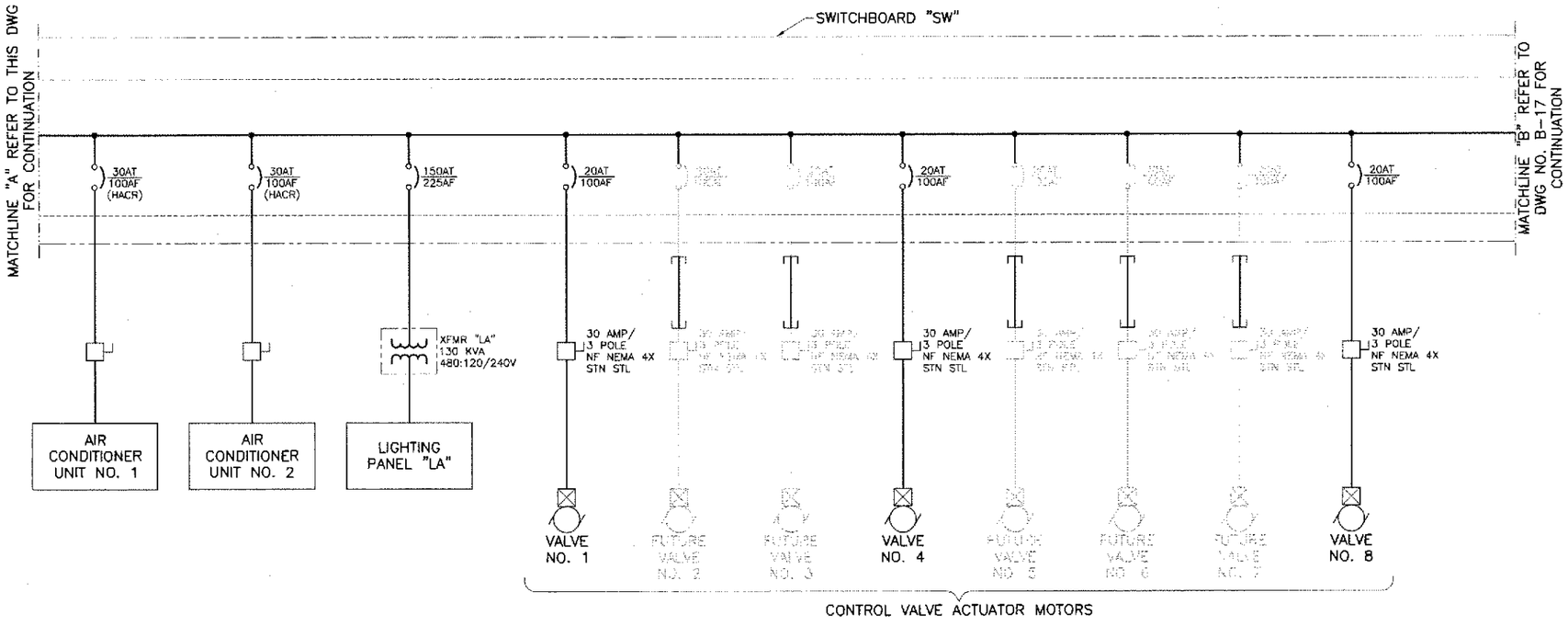

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

PRELIMINARY ONE LINE DIAGRAM SHEET 3 OF 4

DRAWING SCALE
NOT TO SCALE

EXHIBIT: B-16

SHEET NO. OF

LAST MODIFIED: Jan 27, 2011 - 3:24pm BY USER: garnerj
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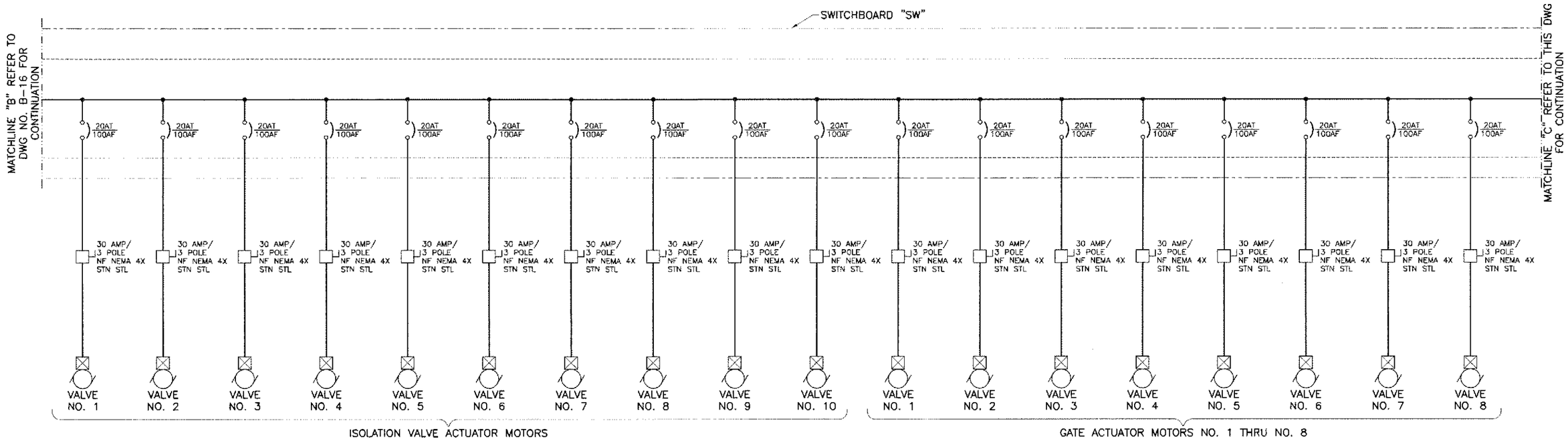

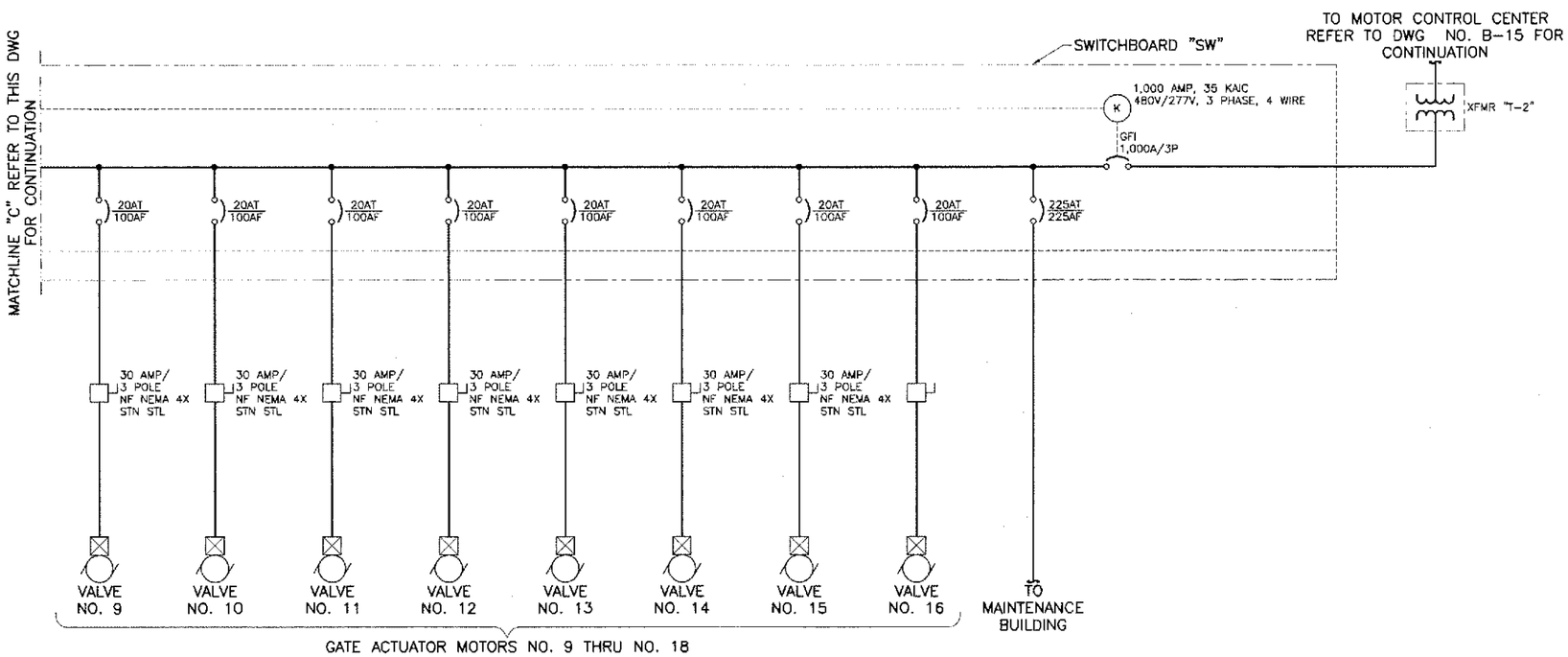

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

PRELIMINARY ONE LINE DIAGRAM SHEET 4 OF 4

DRAWING SCALE
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EXHIBIT: B-17

SHEET NO. OF

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DWG. LOCATION: C:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PumpStation\
DWG. NAME: WO6B1314151617PumpStaOneLine.dwg

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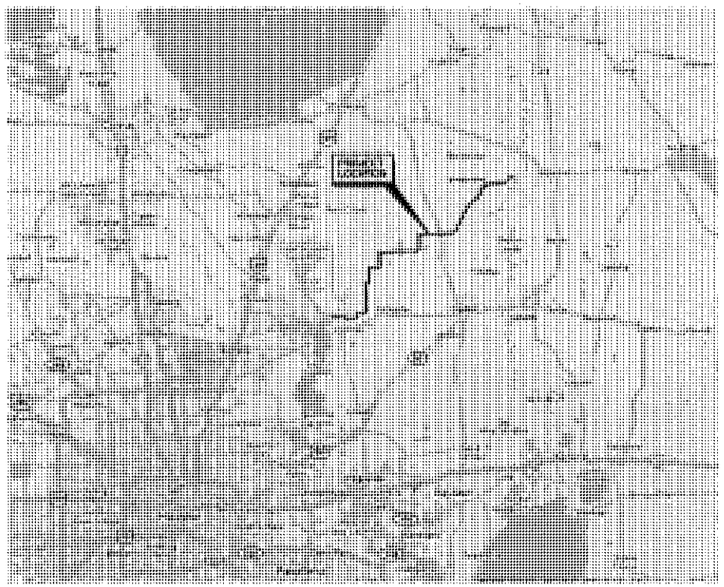
LUCE BAYOU INTERBASIN TRANSFER PROJECT
PROPOSED CANAL AND WATER LINE SYSTEM



LOCATION MAP
NTS

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JOHN J. BALDWIN
JERRY L. BERRY

BOARD OF DIRECTORS

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F. WILLIAM OTHON, P.E.
ALAN D. CONNER
DOUGLAS E. WALKER
ZEBULUN NASH
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ISSUE DATE: JANUARY, 2011

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

DRAWING SCALE
AS SHOWN

EXHIBIT:

SHEET NO. 1 OF 245

LAST MODIFIED: Jan 28, 2011 - 7:04am BY USER: ThompsonBi
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: Cover.dwg

SHT. NO.	GENERAL
01	COVER SHEET
02	SHEET INDEX
03	CANAL TYPICAL CROSS SECTIONS
04	PIPELINE AND ACCESS ROAD TYPICAL CROSS SECTIONS
05	PROPOSED SIPHON DETAIL AND CROSS SECTION
06	PROPOSED ROAD CROSSING DETAIL

SHT. NO.	DRAINAGE AND STORM SEWER
07	OVERALL PROJECT DRAINAGE AREA MAP
08	PROJECT DRAINAGE AREA MAP (SHEET 1 OF 5)
09	PROJECT DRAINAGE AREA MAP (SHEET 2 OF 5)
10	PROJECT DRAINAGE AREA MAP (SHEET 3 OF 5)
11	PROJECT DRAINAGE AREA MAP (SHEET 4 OF 5)
12	PROJECT DRAINAGE AREA MAP (SHEET 5 OF 5)

SHT. NO.	SHEET AND BORING LAYOUTS
13	CANAL SHEET LAYOUT AND BORING PLAN (SHEET 1 OF 13)
14	CANAL SHEET LAYOUT AND BORING PLAN (SHEET 2 OF 13)
15	CANAL SHEET LAYOUT AND BORING PLAN (SHEET 3 OF 13)
16	CANAL SHEET LAYOUT AND BORING PLAN (SHEET 4 OF 13)
17	CANAL SHEET LAYOUT AND BORING PLAN (SHEET 5 OF 13)
18	CANAL SHEET LAYOUT AND BORING PLAN (SHEET 6 OF 13)
19	CANAL SHEET LAYOUT AND BORING PLAN (SHEET 7 OF 13)
20	CANAL SHEET LAYOUT AND BORING PLAN (SHEET 8 OF 13)
21	CANAL SHEET LAYOUT AND BORING PLAN (SHEET 9 OF 13)
22	CANAL SHEET LAYOUT AND BORING PLAN (SHEET 10 OF 13)
23	CANAL SHEET LAYOUT AND BORING PLAN (SHEET 11 OF 13)
24	CANAL SHEET LAYOUT AND BORING PLAN (SHEET 12 OF 13)
25	CANAL SHEET LAYOUT AND BORING PLAN (SHEET 13 OF 13)
26	PIPELINE SHEET LAYOUT AND BORING PLAN (SHEET 1 OF 2)
27	PIPELINE SHEET LAYOUT AND BORING PLAN (SHEET 2 OF 2)
28	ACCESS ROAD SHEET LAYOUT AND BORING PLAN (SHEET 1 OF 4)
29	ACCESS ROAD SHEET LAYOUT AND BORING PLAN (SHEET 2 OF 4)
30	ACCESS ROAD SHEET LAYOUT AND BORING PLAN (SHEET 3 OF 4)
31	ACCESS ROAD SHEET LAYOUT AND BORING PLAN (SHEET 4 OF 4)

SHT. NO.	PLAN AND PROFILES
32	CANAL PLAN & PROFILE STA 5+50 TO STA 18+00
33	CANAL PLAN & PROFILE STA 18+00 TO STA 26+00
34	CANAL PLAN & PROFILE STA 26+00 TO STA 35+00
35	CANAL PLAN & PROFILE STA 35+00 TO STA 47+50
36	CANAL PLAN & PROFILE STA 47+50 TO STA 60+00
37	CANAL PLAN & PROFILE STA 60+00 TO STA 70+00
38	CANAL PLAN & PROFILE STA 70+00 TO STA 80+00
39	CANAL PLAN & PROFILE STA 80+00 TO STA 90+00
40	CANAL PLAN & PROFILE STA 90+00 TO STA 102+50
41	CANAL PLAN & PROFILE STA 102+50 TO STA 112+00
42	CANAL PLAN & PROFILE STA 112+00 TO STA 119+00
43	CANAL PLAN & PROFILE STA 119+00 TO STA 127+50
44	CANAL PLAN & PROFILE STA 127+50 TO STA 140+00
45	CANAL PLAN & PROFILE STA 140+00 TO STA 152+50
46	CANAL PLAN & PROFILE STA 152+50 TO STA 163+50
47	CANAL PLAN & PROFILE STA 163+50 TO STA 176+00
48	CANAL PLAN & PROFILE STA 176+00 TO STA 188+50
49	CANAL PLAN & PROFILE STA 188+50 TO STA 201+00
50	CANAL PLAN & PROFILE STA 201+00 TO STA 213+50
51	CANAL PLAN & PROFILE STA 213+50 TO STA 226+00
52	CANAL PLAN & PROFILE STA 226+00 TO STA 238+50
53	CANAL PLAN & PROFILE STA 238+50 TO STA 251+00
54	CANAL PLAN & PROFILE STA 251+00 TO STA 263+50
55	CANAL PLAN & PROFILE STA 263+50 TO STA 276+00
56	CANAL PLAN & PROFILE STA 276+00 TO STA 288+50
57	CANAL PLAN & PROFILE STA 288+50 TO STA 301+00
58	CANAL PLAN & PROFILE STA 301+00 TO STA 313+50
59	CANAL PLAN & PROFILE STA 313+50 TO STA 326+00
60	CANAL PLAN & PROFILE STA 326+00 TO STA 338+50
61	CANAL PLAN & PROFILE STA 338+50 TO STA 350+00

SHT. NO.	PLAN AND PROFILE CONTINUED
62	CANAL PLAN & PROFILE STA 350+00 TO STA 361+50
63	CANAL PLAN & PROFILE STA 361+50 TO STA 374+00
64	CANAL PLAN & PROFILE STA 374+00 TO STA 386+50
65	CANAL PLAN & PROFILE STA 386+50 TO STA 399+00
66	CANAL PLAN & PROFILE STA 399+00 TO STA 411+50
67	CANAL PLAN & PROFILE STA 411+50 TO STA 424+00
68	CANAL PLAN & PROFILE STA 424+00 TO STA 435+00
69	CANAL PLAN & PROFILE STA 435+00 TO STA 447+50
70	CANAL PLAN & PROFILE STA 447+50 TO STA 460+00
71	CANAL PLAN & PROFILE STA 460+00 TO STA 472+50
72	CANAL PLAN & PROFILE STA 472+50 TO STA 482+50
73	CANAL PLAN & PROFILE STA 482+50 TO STA 492+50
74	CANAL PLAN & PROFILE STA 492+50 TO STA 505+00
75	CANAL PLAN & PROFILE STA 505+00 TO STA 517+50
76	CANAL PLAN & PROFILE STA 517+50 TO STA 530+00
77	CANAL PLAN & PROFILE STA 530+00 TO STA 542+50
78	CANAL PLAN & PROFILE STA 542+50 TO STA 551+00
79	CANAL PLAN & PROFILE STA 551+00 TO STA 562+50
80	CANAL PLAN & PROFILE STA 562+50 TO STA 575+00
81	CANAL PLAN & PROFILE STA 575+00 TO STA 587+50
82	CANAL PLAN & PROFILE STA 587+50 TO STA 600+00
83	CANAL PLAN & PROFILE STA 600+00 TO STA 612+50
84	CANAL PLAN & PROFILE STA 612+50 TO STA 625+00
85	CANAL PLAN & PROFILE STA 625+00 TO STA 637+50
86	CANAL PLAN & PROFILE STA 637+50 TO STA 650+00
87	CANAL PLAN & PROFILE STA 650+00 TO STA 662+50
88	CANAL PLAN & PROFILE STA 662+50 TO STA 675+00
89	CANAL PLAN & PROFILE STA 675+00 TO STA 687+50
90	CANAL PLAN & PROFILE STA 687+50 TO STA 700+00
91	CANAL PLAN & PROFILE STA 700+00 TO STA 712+50
92	CANAL PLAN & PROFILE STA 712+50 TO STA 725+00
93	CANAL PLAN & PROFILE STA 725+00 TO STA 737+50
94	CANAL PLAN & PROFILE STA 737+50 TO STA 750+00
95	CANAL PLAN & PROFILE STA 750+00 TO STA 762+50
96	CANAL PLAN & PROFILE STA 762+50 TO STA 775+00
97	CANAL PLAN & PROFILE STA 775+00 TO STA 787+50
98	CANAL PLAN & PROFILE STA 787+50 TO STA 800+00
99	CANAL PLAN & PROFILE STA 800+00 TO STA 810+00
100	CANAL PLAN & PROFILE STA 810+00 TO STA 822+50
101	CANAL PLAN & PROFILE STA 822+50 TO STA 835+00
102	CANAL PLAN & PROFILE STA 835+00 TO STA 847+50
103	CANAL PLAN & PROFILE STA 847+50 TO STA 855+00
104	CANAL PLAN & PROFILE STA 855+00 TO STA 862+50
105	CANAL PLAN & PROFILE STA 862+50 TO STA 872+50
106	CANAL PLAN & PROFILE STA 872+50 TO STA 885+00
107	CANAL PLAN & PROFILE STA 885+00 TO STA 897+50
108	CANAL PLAN & PROFILE STA 897+50 TO STA 910+00
109	CANAL PLAN & PROFILE STA 910+00 TO STA 921+00
110	CANAL PLAN & PROFILE STA 921+00 TO STA 932+00
111	CANAL PLAN & PROFILE STA 932+00 TO STA 941+00
112	CANAL PLAN & PROFILE STA 941+00 TO STA 953+50
113	CANAL PLAN & PROFILE STA 953+50 TO STA 966+00
114	CANAL PLAN & PROFILE STA 966+00 TO STA 978+50
115	CANAL PLAN & PROFILE STA 978+50 TO STA 991+00
116	CANAL PLAN & PROFILE STA 991+00 TO STA 1003+50
117	CANAL PLAN & PROFILE STA 1003+50 TO STA 1016+00
118	CANAL PLAN & PROFILE STA 1016+00 TO STA 1028+50
119	CANAL PLAN & PROFILE STA 1028+50 TO STA 1041+00
120	CANAL PLAN & PROFILE STA 1041+00 TO STA 1053+50
121	CANAL PLAN & PROFILE STA 1053+50 TO STA 1066+00
122	CANAL PLAN & PROFILE STA 1066+00 TO STA 1078+50
123	CANAL PLAN & PROFILE STA 1078+50 TO STA 1090+00
124	CANAL PLAN & PROFILE STA 1090+00 TO STA 1102+50
125	CANAL PLAN & PROFILE STA 1102+50 TO STA 1115+00
126	CANAL PLAN & PROFILE STA 1115+00 TO STA 1127+50
127	CANAL PLAN & PROFILE STA 1127+50 TO STA 1140+00
128	CANAL PLAN & PROFILE STA 1140+00 TO STA 1152+50
129	CANAL PLAN & PROFILE STA 1152+50 TO STA 1165+00
130	CANAL PLAN & PROFILE STA 1165+00 TO STA 1177+50
131	CANAL PLAN & PROFILE STA 1177+50 TO STA 1187+50
132	CANAL PLAN & PROFILE STA 1187+50 TO STA 1200+00
133	CANAL PLAN & PROFILE STA 1200+00 TO STA 1209+00
134	CANAL PLAN & PROFILE STA 1209+00 TO STA 1218+00
135	CANAL PLAN & PROFILE STA 1218+00 TO STA 1227+50
136	CANAL PLAN & PROFILE STA 1227+50 TO STA 1240+00
137	CANAL PLAN & PROFILE STA 1235+00 TO SEDIMENTATION BASIN

SHT. NO.	PLAN AND PROFILE CONTINUED
138	SEDIMENTATION BASIN DETAILED PLAN
139	PIPELINE PLAN & PROFILE STA 2000+00 TO STA 2012+50
140	PIPELINE PLAN & PROFILE STA 2012+50 TO STA 2025+00
141	PIPELINE PLAN & PROFILE STA 2025+00 TO STA 2037+50
142	PIPELINE PLAN & PROFILE STA 2037+50 TO STA 2050+00
143	PIPELINE PLAN & PROFILE STA 2050+00 TO STA 2062+50
144	PIPELINE PLAN & PROFILE STA 2062+50 TO STA 2075+00
145	PIPELINE PLAN & PROFILE STA 2075+00 TO STA 2087+50
146	PIPELINE PLAN STA 2087+50 TO STA 2100+00
147	PIPELINE PROFILE STA 2087+50 TO STA 2100+00
148	PIPELINE PLAN STA 2100+00 TO STA 2112+50
149	PIPELINE PROFILE STA 2100+00 TO STA 2112+50
150	PIPELINE PLAN & PROFILE STA 2112+50 TO STA 2125+00
151	PIPELINE PLAN & PROFILE STA 2125+00 TO STA 2137+50
152	PIPELINE PLAN STA 2137+50 TO STA 2150+00
153	PIPELINE PROFILE STA 2137+50 TO STA 2150+00
154	PIPELINE PLAN & PROFILE STA 2150+00 TO PUMP STATION
155	ACCESS ROAD PLAN & PROFILE STA 3000+00 TO STA 3012+50
156	ACCESS ROAD PLAN & PROFILE STA 3012+50 TO STA 3025+00
157	ACCESS ROAD PLAN & PROFILE STA 3025+00 TO STA 3037+50
158	ACCESS ROAD PLAN & PROFILE STA 3037+50 TO STA 3050+00
159	ACCESS ROAD PLAN & PROFILE STA 3050+00 TO STA 3062+50
160	ACCESS ROAD PLAN & PROFILE STA 3062+50 TO STA 3075+00
161	ACCESS ROAD PLAN & PROFILE STA 3075+00 TO STA 3087+50
162	ACCESS ROAD PLAN & PROFILE STA 3087+50 TO STA 3100+00
163	ACCESS ROAD PLAN & PROFILE STA 3100+00 TO STA 3112+50
164	ACCESS ROAD PLAN & PROFILE STA 3112+50 TO STA 3125+00
165	ACCESS ROAD PLAN & PROFILE STA 3125+00 TO STA 3137+50
166	ACCESS ROAD PLAN & PROFILE STA 3137+50 TO STA 3150+00
167	ACCESS ROAD PLAN & PROFILE STA 3150+00 TO STA 3162+50
168	ACCESS ROAD PLAN & PROFILE STA 3162+50 TO STA 3175+00
169	ACCESS ROAD PLAN & PROFILE STA 3175+00 TO STA 3187+50
170	ACCESS ROAD PLAN & PROFILE STA 3200+00 TO STA 3212+50
171	ACCESS ROAD PLAN & PROFILE STA 3212+50 TO STA 3225+00
172	ACCESS ROAD PLAN & PROFILE STA 3225+00 TO STA 3237+50
173	ACCESS ROAD PLAN & PROFILE STA 3237+50 TO STA 3250+00
174	ACCESS ROAD PLAN & PROFILE STA 3250+00 TO STA 3262+50
175	ACCESS ROAD PLAN & PROFILE STA 3262+50 TO STA 3275+00
176	ACCESS ROAD PLAN & PROFILE STA 3275+00 TO STA 3287+50
177	ACCESS ROAD PLAN & PROFILE STA 3287+50 TO STA 3300+00
178	ACCESS ROAD PLAN & PROFILE STA 3300+00 TO STA 3312+50
179	ACCESS ROAD PLAN & PROFILE STA 3312+50 TO STA 3325+00
180	ACCESS ROAD PLAN & PROFILE STA 3325+00 TO STA 3337+50
181	ACCESS ROAD PLAN & PROFILE STA 3337+50 TO STA 3350+00
182	ACCESS ROAD PLAN & PROFILE STA 3350+00 TO STA 3357+81

SHT. NO.	TRAFFIC CONTROL PLANS
183	PROP CANAL AT FM 2100 – TRAFFIC CONTROL TYPICAL SECTIONS
184	TRAFFIC CONTROL LAYOUT FM 2100 – PHASE I – STAGE 1 & STAGE 2
185	TRAFFIC CONTROL LAYOUT FM 2100 – PHASE II – STAGE 1 & STAGE 2
186	PROP CANAL AT SCOTT RD – TRAFFIC CONTROL TYPICAL SECTIONS
187	TRAFFIC CONTROL LAYOUT AT SCOTT RD – PHASE I – STAGE 1 & STAGE 2
188	TRAFFIC CONTROL LAYOUT AT SCOTT RD – PHASE II – STAGE 1 & STAGE 2
189	TRAFFIC CONTROL LAYOUT AND TYPICAL SECTIONS AT WOLFE RD
190	PROP CANAL AT SH 321 – TRAFFIC CONTROL TYPICAL SECTIONS
191	TRAFFIC CONTROL LAYOUT AND TYPICAL SECTIONS AT SH 321 – PHASE I
192	TRAFFIC CONTROL LAYOUT SH 321 – PHASE II – STAGE 1 & STAGE 2
193	PROP CANAL AT FM 1008 – TRAFFIC CONTROL TYPICAL SECTIONS
194	TRAFFIC CONTROL LAYOUT FM 1008 – PHASE I – STAGE 1 & STAGE 2
195	TRAFFIC CONTROL LAYOUT FM 1008 – PHASE II – STAGE 1 & STAGE 2
196	PROP CANAL AT CR 2326 – TRAFFIC CONTROL TYPICAL SECTIONS
197	TRAFFIC CONTROL LAYOUT CR 2326 – PHASE I – STAGE 1 & STAGE 2
198	TRAFFIC CONTROL LAYOUT CR 2326 – PHASE II – STAGE 1 & STAGE 2
199	PROP CANAL TRAFFIC CONTROL – TCP (1-1)-98
200	PROP CANAL TRAFFIC CONTROL – TCP (1-2)-98
201	PROP CANAL TRAFFIC CONTROL – TCP (1-3)-98

SHT. NO.	DETAILS
202	CANAL MAINTENANCE FACILITY CONCEPTUAL LAYOUT
203	CONCEPTUAL BRIDGE DETAIL
204	WATER CONTROL STRUCTURE DETAIL
205	TYPICAL EROSION PROTECTION AT 90 DEGREE BEND

SHT. NO.	POLLUTION PREVENTION PLANS
206	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 1 OF 25)
207	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 2 OF 25)
208	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 3 OF 25)
209	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 4 OF 25)
210	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 5 OF 25)
211	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 6 OF 25)
212	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 7 OF 25)
213	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 8 OF 24)
214	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 9 OF 25)
215	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 10 OF 25)
216	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 11 OF 25)
217	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 12 OF 25)
218	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 13 OF 25)
219	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 14 OF 25)
220	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 15 OF 25)
221	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 16 OF 25)
222	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 17 OF 25)
223	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 18 OF 25)
224	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 19 OF 25)
225	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 20 OF 25)
226	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 21 OF 25)
227	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 22 OF 25)
228	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 23 OF 25)
229	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 24 OF 25)
230	STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 25 OF 25)
231	STORM WATER POLLUTION PREVENTION PLAN – PIPELINE (SHEET 1 OF 4)
232	STORM WATER POLLUTION PREVENTION PLAN – PIPELINE (SHEET 2 OF 4)
233	STORM WATER POLLUTION PREVENTION PLAN – PIPELINE (SHEET 3 OF 4)
234	STORM WATER POLLUTION PREVENTION PLAN – PIPELINE (SHEET 4 OF 4)
235	STORM WATER POLLUTION PREVENTION PLAN – ACCESS ROAD (SHEET 1 OF 4)
236	STORM WATER POLLUTION PREVENTION PLAN – ACCESS ROAD (SHEET 2 OF 4)
237	STORM WATER POLLUTION PREVENTION PLAN – ACCESS ROAD (SHEET 3 OF 4)
238	STORM WATER POLLUTION PREVENTION PLAN – ACCESS ROAD (SHEET 4 OF 4)
239	SWPPP LAYOUT – FM 2100
240	SWPPP LAYOUT – SCOTT RD
241	SWPPP LAYOUT – WOLFE RD
242	SWPPP LAYOUT – SH 321
243	SWPPP LAYOUT – FM 1008
244	SWPPP LAYOUT – CR 2326
245	STORM WATER POLLUTION PREVENTION PLAN DETAILS

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COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

SHEET INDEX

DRAWING SCALE

SHEET NO. 2 OF 245

LAST MODIFIED: Jan 28, 2011 – 7:03am BY USER: ThompsonBI
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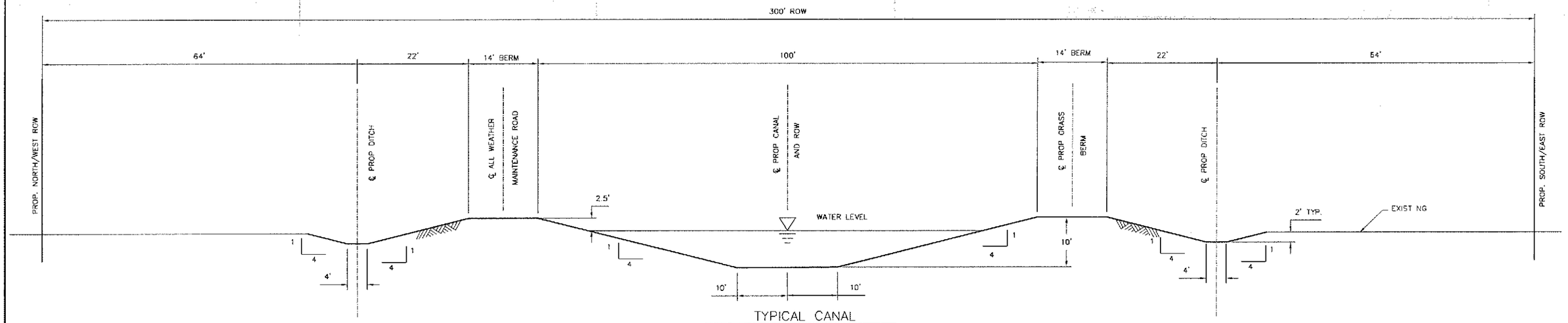
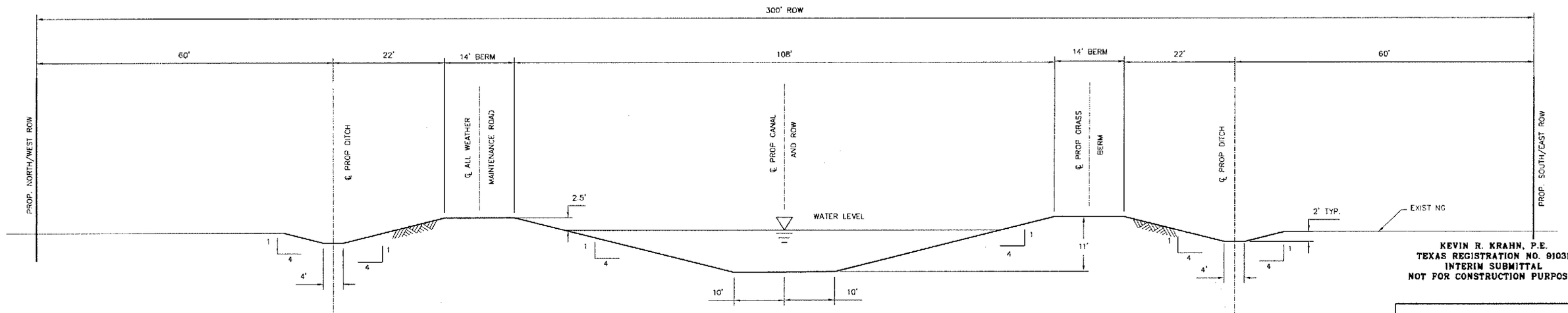


TYPICAL CANAL
CROSS SECTION
(STA 5+00 TO STA 162+00, STA 303+00 TO STA 1074+00, AND
STA 1095+00 TO SEDIMENTION BASIN



TYPICAL CANAL
CROSS SECTION
(STA 162+00 TO STA 303+00 AND
STA 1074+00 TO STA 1095+00)

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CANAL TYPICAL CROSS SECTIONS

DRAWING SCALE
NTS

SHEET NO. 3 OF 245

LAST MODIFIED: Jan 28, 2011 - 6:40am BY USER: ThompsonBl
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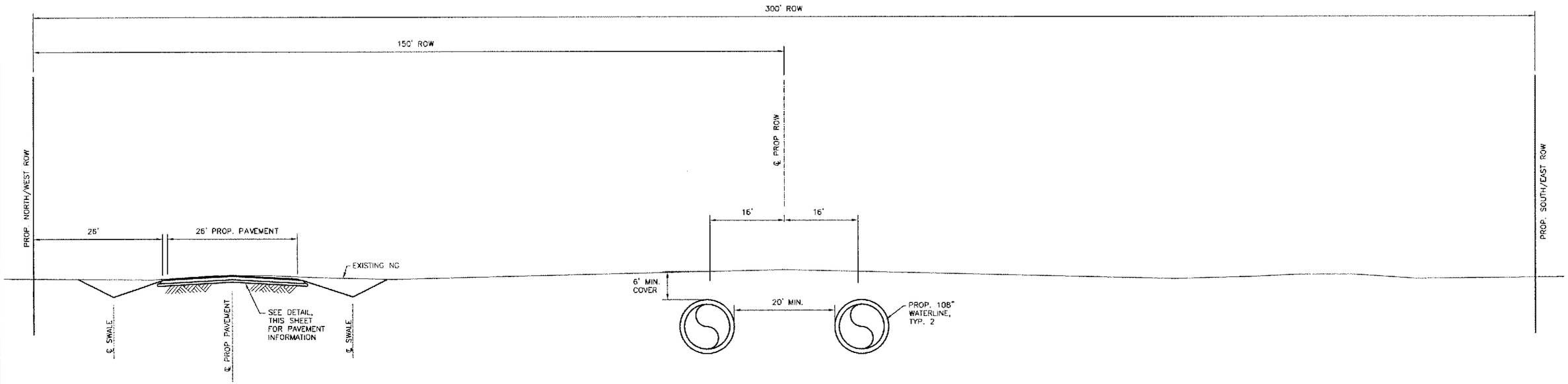

TYPICAL PIPELINE SECTION

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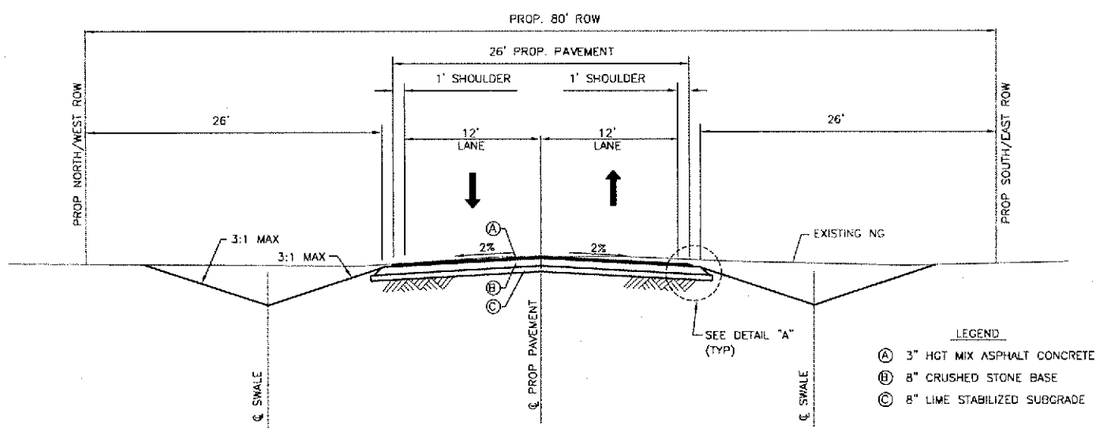

TYPICAL ASPHALT PAVEMENT SECTION – ACCESS ROAD

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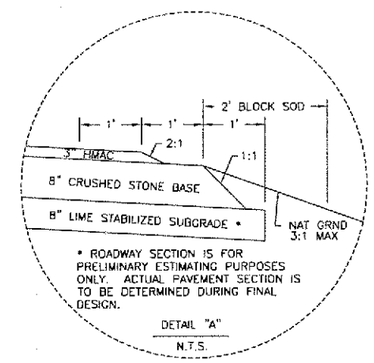

DETAIL "A"

N.T.S.

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

PIPELINE AND ACCESS ROAD
TYPICAL CROSS SECTIONS

DRAWING SCALE
AS SHOWN

SHEET NO. 4 OF 245

LAST MODIFIED: Jan 28, 2011 – 6:41am BY USER: Thompson8i
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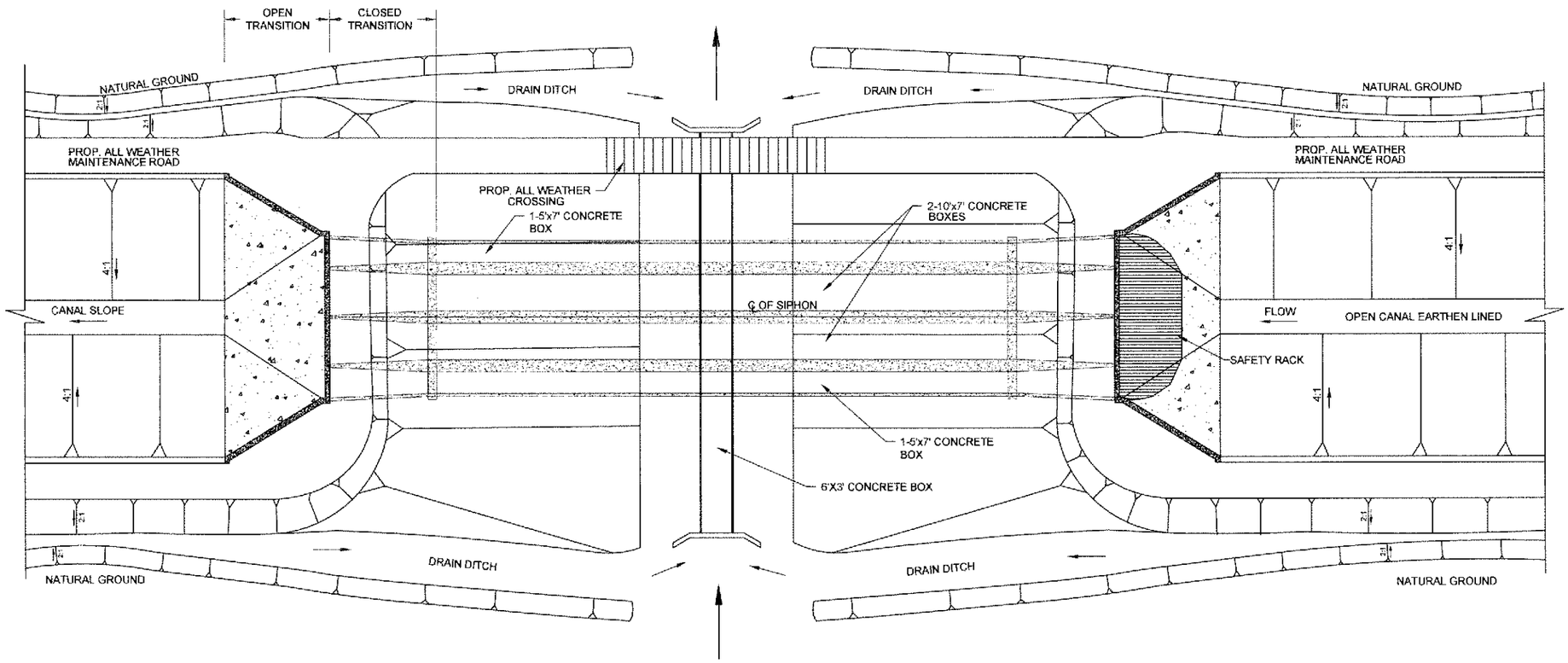
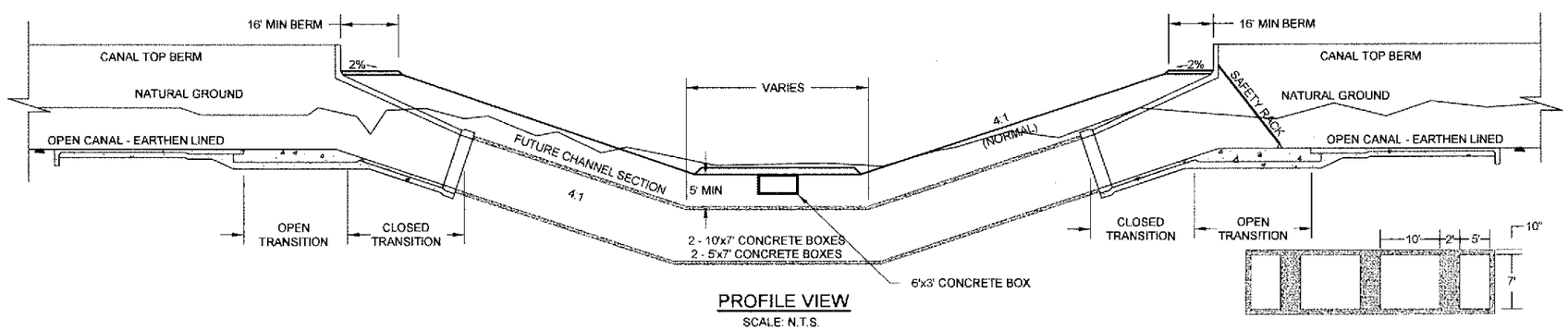


PLAN VIEW

SCALE: N.T.S.



PROFILE VIEW

SCALE: N.T.S.

SIPHON CROSS SECTION

SCALE: N.T.S.

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

LUCE BAYOU INTERBASIN TRANSFER PROJECT

PROPOSED SIPHON DETAIL AND CROSS SECTION

DRAWING SCALE
AS SHOWN

SHEET NO. 5 OF 245

LAST MODIFIED: Apr 28, 2011 - 8:40am BY USER: Thompsonm
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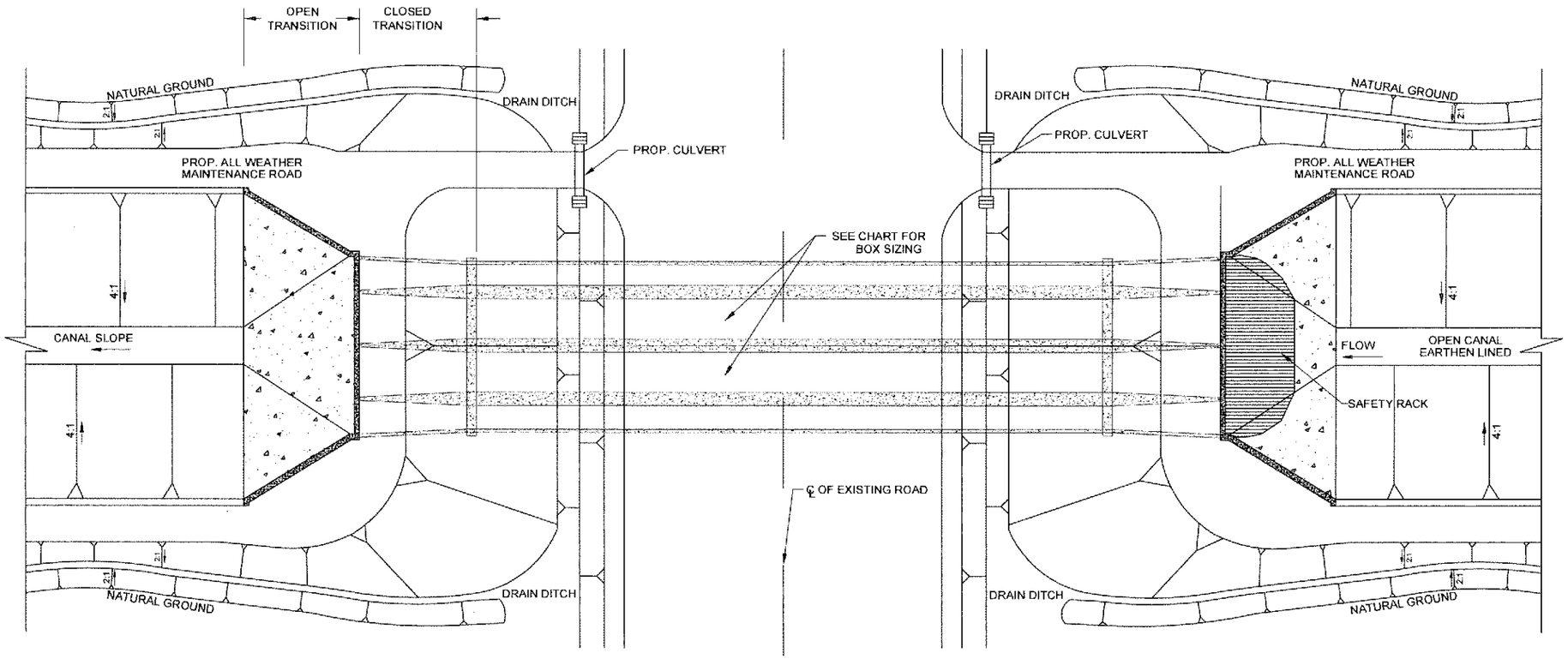
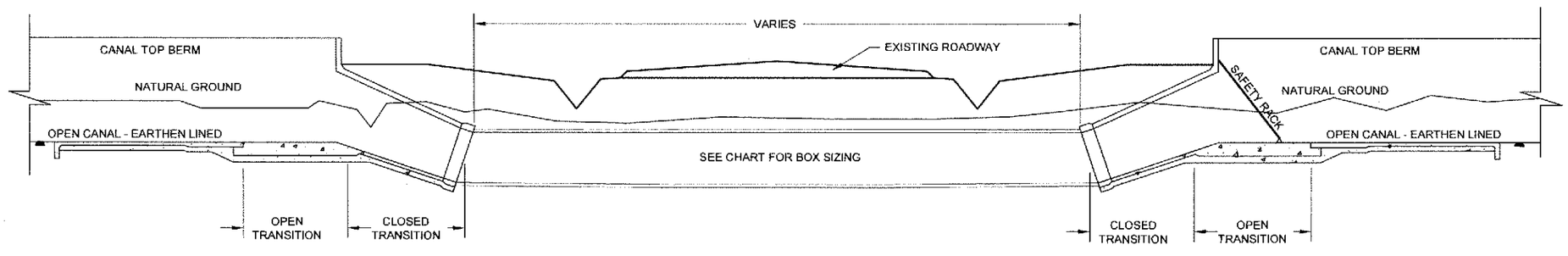


PLAN VIEW

SCALE: N.T.S.

NOTE:
FENCING AND ACCESS CONTROL TO BE DETERMINED DURING FINAL DESIGN

ROADWAY	BOX CULVERTS
FM 2100	3 - 9'X5', 1 - 7'X5'
WOLFE RD	3 - 9'X5', 1 - 7'X5'
SH 321	3 - 8'X7'
FM 1008	3 - 9'X5', 1 - 7'X5'
CR 2326	3 - 9'X5', 1 - 7'X5'



PROFILE VIEW

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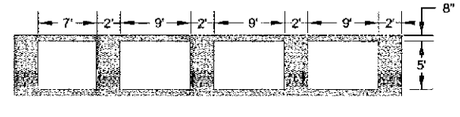
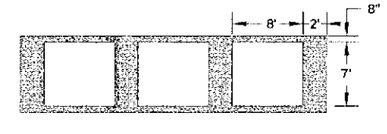


TYPICAL SIPHON CROSS SECTION

SCALE: N.T.S.



SIPHON CROSS SECTION - SH 321

SCALE: N.T.S.

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COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

LUCE BAYOU INTERBASIN TRANSFER PROJECT

PROPOSED ROAD CROSSING DETAIL

DRAWING SCALE
AS SHOWN

SHEET NO. 6 OF 245

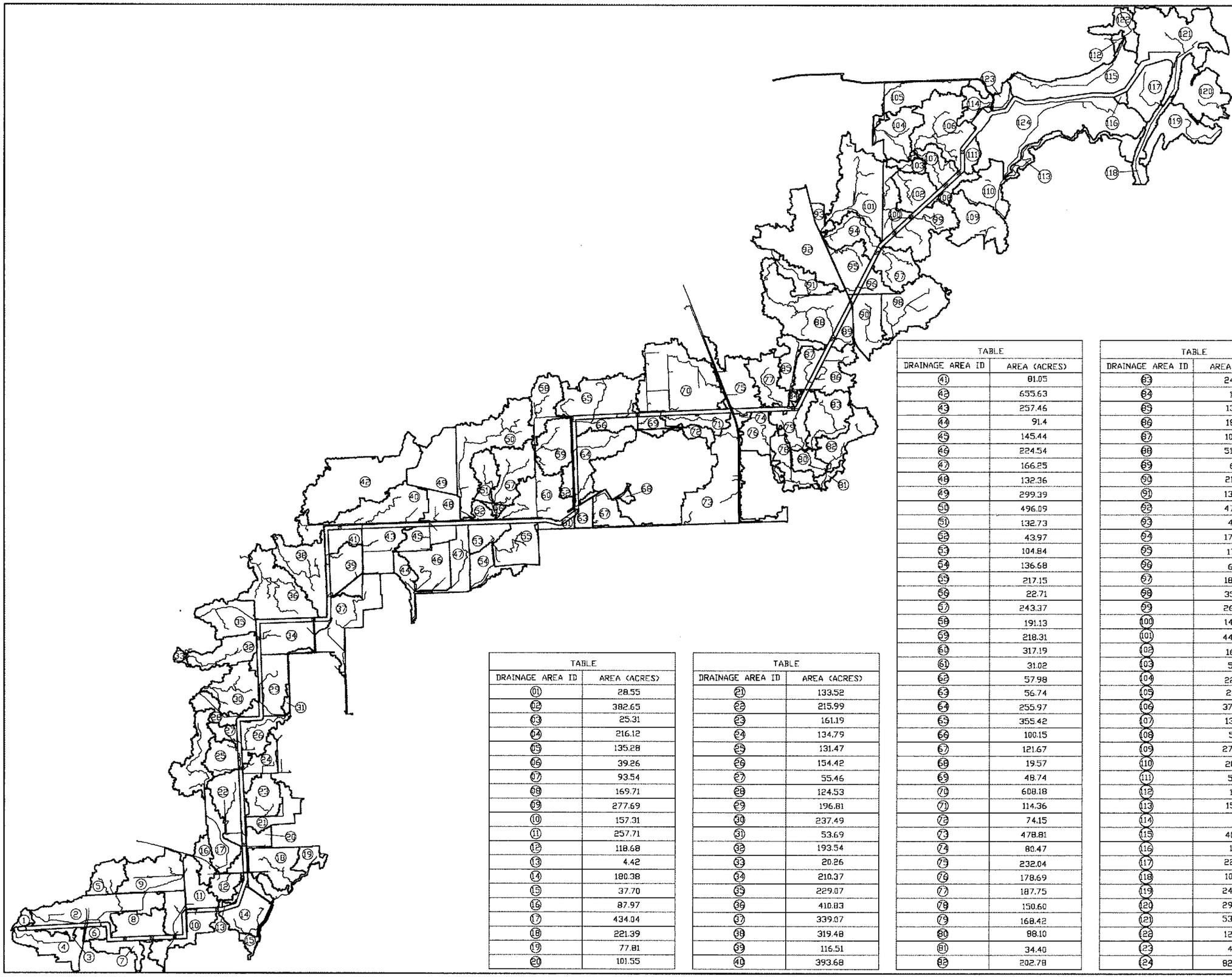

TABLE	
DRAINAGE AREA ID	AREA (ACRES)
01	28.55
02	382.65
03	25.31
04	216.12
05	135.28
06	39.26
07	93.54
08	169.71
09	277.69
10	157.31
11	257.71
12	118.68
13	4.42
14	180.38
15	37.70
16	87.97
17	434.04
18	221.39
19	77.81
20	101.55

TABLE	
DRAINAGE AREA ID	AREA (ACRES)
21	133.52
22	215.99
23	161.19
24	134.79
25	131.47
26	154.42
27	55.46
28	124.53
29	196.81
30	237.49
31	53.69
32	193.54
33	20.26
34	210.37
35	229.07
36	410.83
37	339.07
38	319.48
39	116.51
40	393.68

TABLE	
DRAINAGE AREA ID	AREA (ACRES)
41	81.05
42	655.63
43	257.46
44	91.4
45	145.44
46	224.54
47	166.25
48	132.36
49	299.39
50	496.09
51	132.73
52	43.97
53	104.84
54	136.68
55	217.15
56	22.71
57	243.37
58	191.13
59	218.31
60	317.19
61	31.02
62	57.98
63	56.74
64	255.97
65	355.42
66	100.15
67	121.67
68	19.57
69	48.74
70	608.18
71	114.36
72	74.15
73	478.81
74	80.47
75	232.04
76	178.69
77	187.75
78	150.60
79	168.42
80	88.10
81	34.40
82	202.78

TABLE	
DRAINAGE AREA ID	AREA (ACRES)
83	248.71
84	15.82
85	131.89
86	181.99
87	109.79
88	519.77
89	62.71
90	216.04
91	135.42
92	470.07
93	47.46
94	178.69
95	171.03
96	68.36
97	186.73
98	357.19
99	268.08
100	149.86
101	446.62
102	164.13
103	55.67
104	223.15
105	241.00
106	375.36
107	130.46
108	50.94
109	275.22
110	203.19
111	52.58
112	19.82
113	155.71
114	91.10
115	405.81
116	14.69
117	226.71
118	104.57
119	242.25
120	292.62
121	534.73
122	122.38
123	49.28
124	825.66

LEGEND

- CATCHMENT AREA
- DRAINAGE LINE
- PROPOSED ROW
- DRAINAGE AREA ID

N.T.S

Note: Drainage Area maps are for preliminary use only. A full drainage analysis will be required during final design.

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COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

OVERALL PROJECT
DRAINAGE AREA MAP

DRAWING SCALE
AS SHOWN

SHEET NO. 7 OF 245

LAST MODIFIED: Jan 25, 2011 - 2:02pm BY USER: rajoverapuus
DWG. LOCATION: D:\Work Order 61\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\ref\Proposed\Drainage Analyses\
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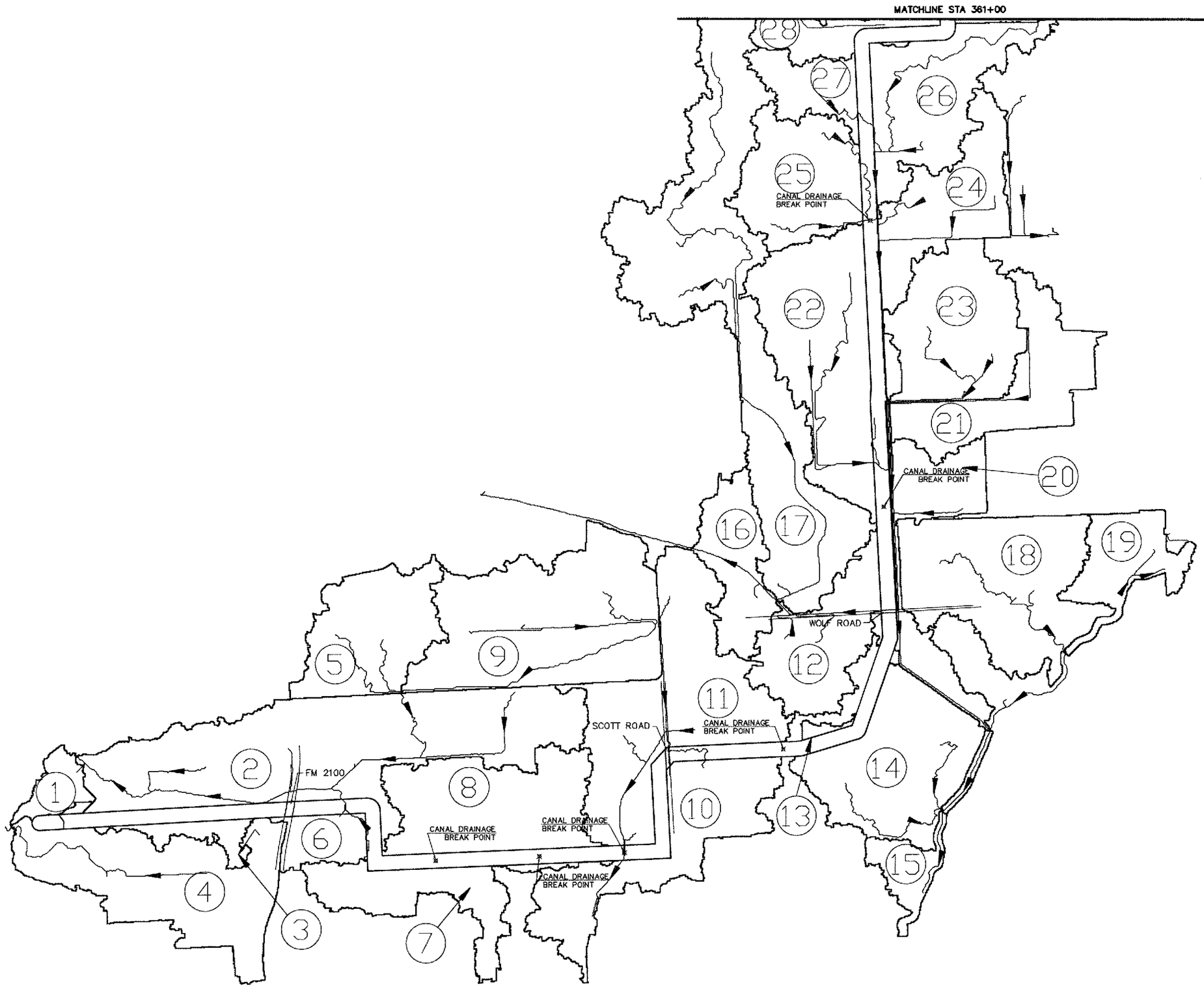

LEGEND

- CATCHMENT AREA
- DRAINAGE LINE
- PROPOSED ROW
- DRAINAGE AREA ID
- FLOW DIRECTION

1000 0 1000 2000
HORIZONTAL SCALE: 1" = 2000'

Note: Drainage Area maps are for preliminary use only. A full drainage analysis will be required during final design.

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

PROJECT
DRAINAGE AREA MAPS
(SHEET 1 OF 5)

DRAWING SCALE
AS SHOWN

SHEET NO. 8 OF 245

LAST MODIFIED: Jan 25, 2011 – 11:46am BY USER: rajavarapus
DWG. LOCATION: O:\Work Order 8\1.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\ref\Proposed\Drainage Analysis\
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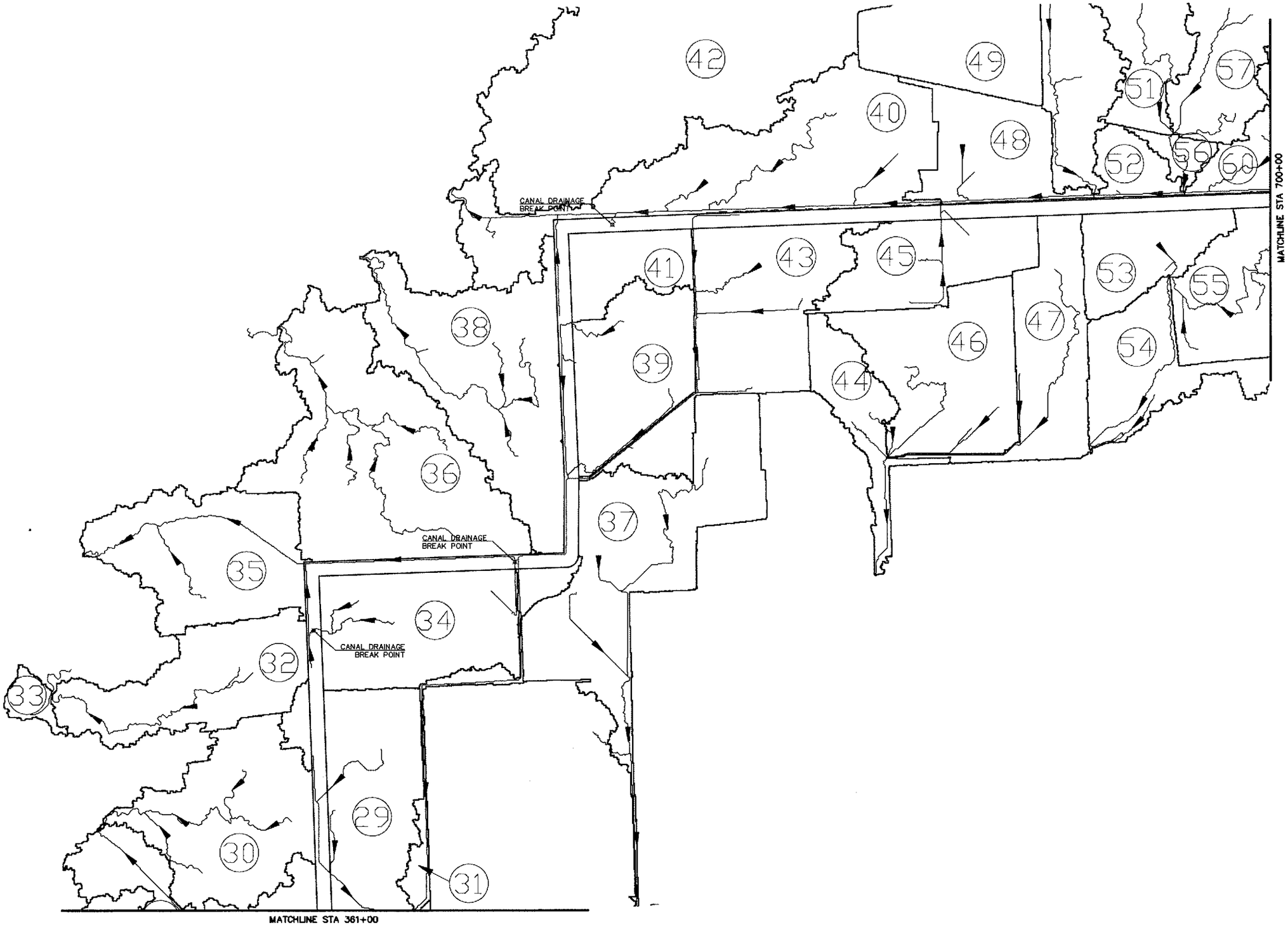

LEGEND

- CATCHMENT AREA
- DRAINAGE LINE
- PROPOSED ROW
- DRAINAGE AREA ID
- FLOW DIRECTION

1000 0 1000 2000
HORIZONTAL SCALE: 1" = 2000'

Note: Drainage Area maps are for preliminary use only. Additional analysis will be required during final design.

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

PROJECT
DRAINAGE AREA MAPS
(SHEET 2 OF 5)

DRAWING SCALE
AS SHOWN

SHEET NO. 9 OF 245

LAST MODIFIED: Jan 25, 2011 - 11:50am BY USER: rajavarapuus
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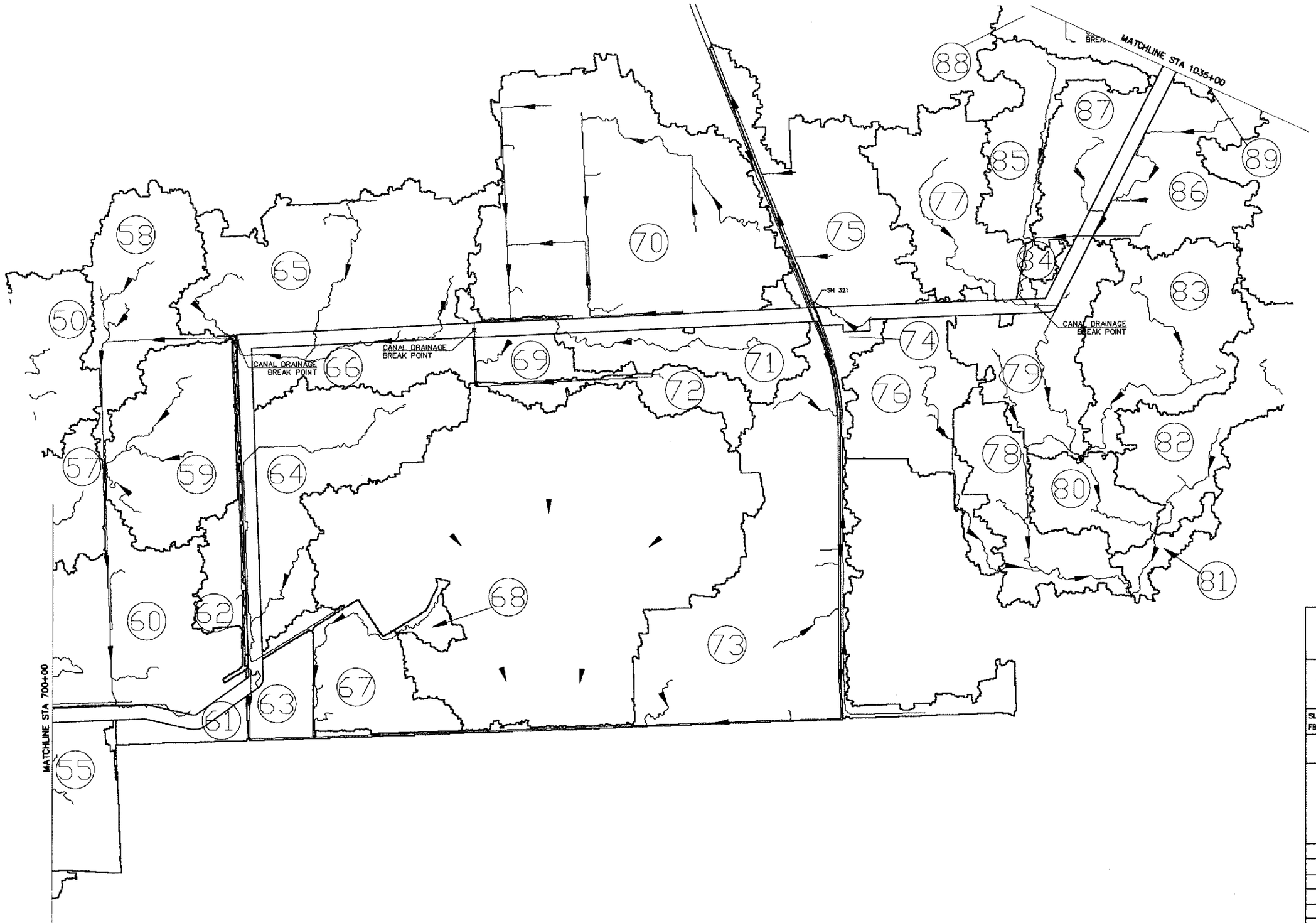

LEGEND

CATCHMENT AREA

DRAINAGE LINE

PROPOSED ROW

DRAINAGE AREA ID

FLOW DIRECTION

1000 0 1000 2000

HORIZONTAL SCALE 1" = 2000'

Note: Drainage Area maps are for preliminary use only. A full drainage analysis will be required during final design.

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

PROJECT
DRAINAGE AREA MAPS
(SHEET 3 OF 5)

DRAWING SCALE
AS SHOWN

SHEET NO. 10 OF 245

LAST MODIFIED: Jan 25, 2011 - 11:53am BY USER: rajavarapuus
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\ref\Proposed\Drainage Analysis\
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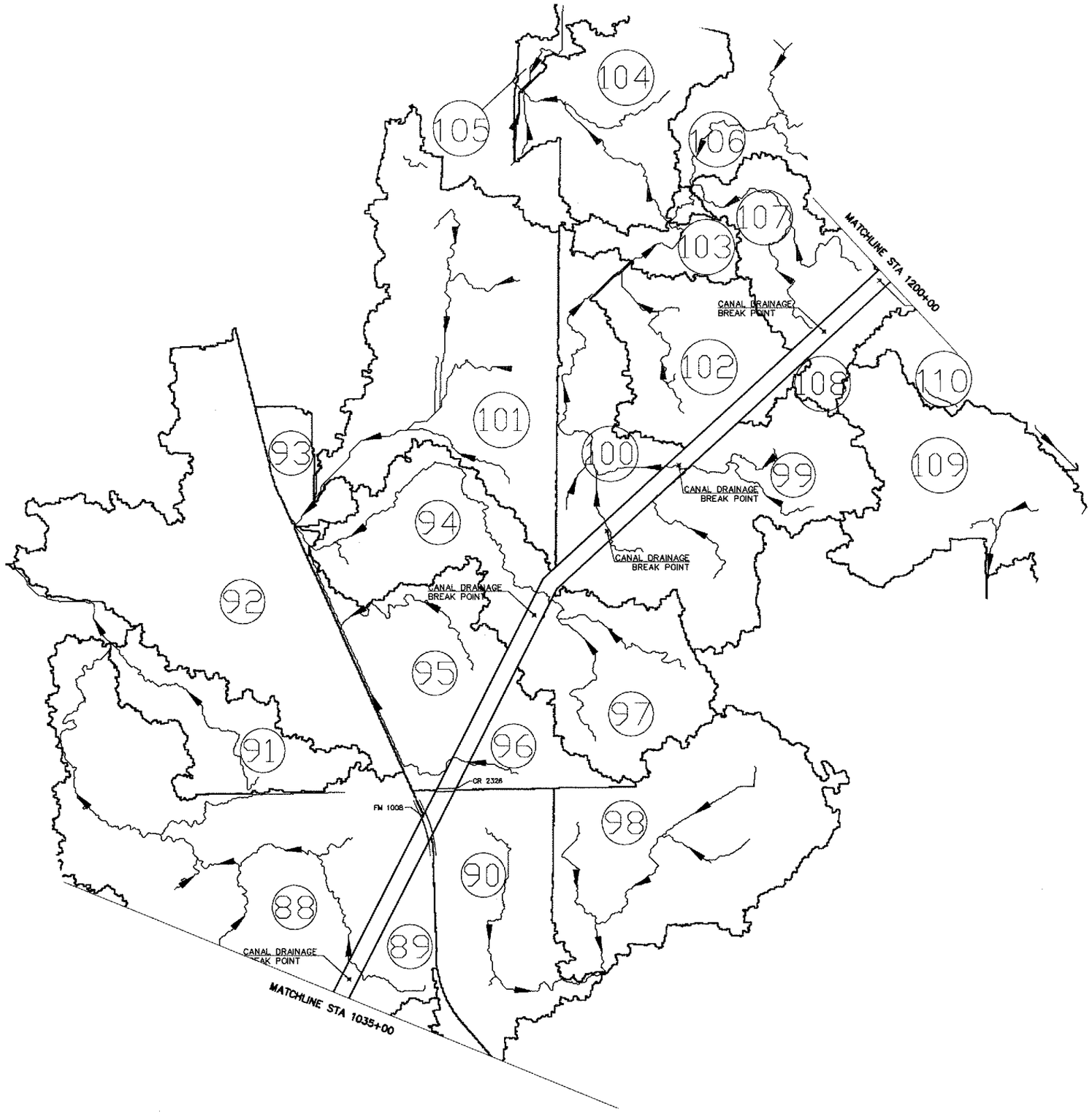

LEGEND

- CATCHMENT AREA
- DRAINAGE LINE
- PROPOSED ROW
- DRAINAGE AREA ID
- FLOW DIRECTION

1000 0 1000 2000
HORIZONTAL SCALE: 1" = 2000'

Note: Drainage Area maps are for preliminary use only. A full drainage analysis will be required during final design.

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

PROJECT
DRAINAGE AREA MAPS
(SHEET 4 OF 5)

DRAWING SCALE
AS SHOWN

SHEET NO. 11 OF 24

LAST MODIFIED: Jan 25, 2011 – 12:00pm BY USER: rajavarapu.s
DWG LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\ref\Proposed\Drainage Analysis\
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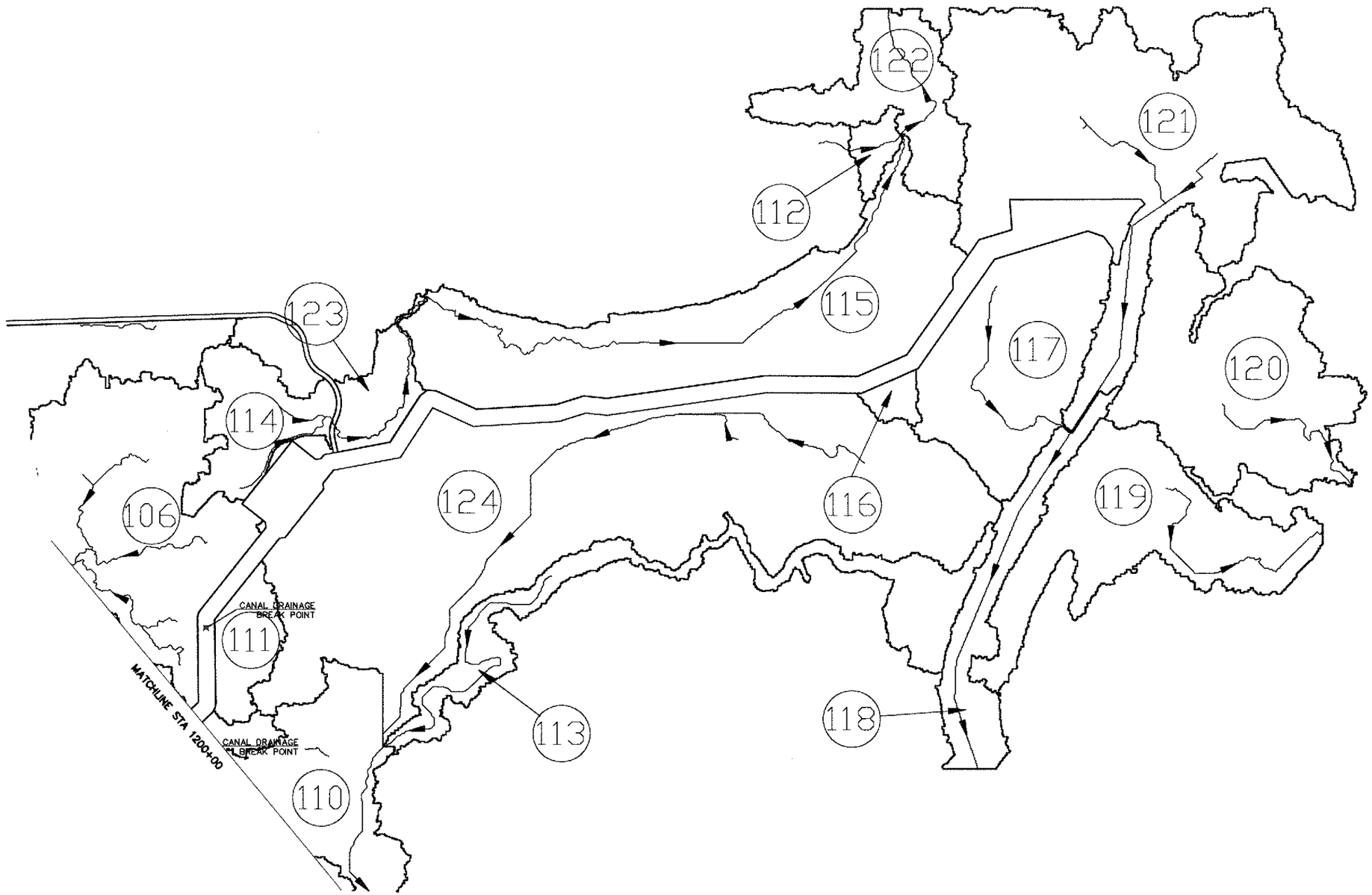

LEGEND

CATCHMENT AREA

DRAINAGE LINE

PROPOSED ROW

DRAINAGE AREA ID

FLOW DIRECTION

1000 0 1000 2000

HORIZONTAL SCALE: 1" = 2000'

Note: Drainage Area maps are for preliminary use only. A full drainage analysis will be required during final design.

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

PROJECT
DRAINAGE AREA MAPS
(SHHET 5 OF 5)

DRAWING SCALE
AS SHOWN

SHEET NO. 12 OF 245

LAST MODIFIED: Jan 25, 2011 - 11:57am BY USER: rajavarapuus
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\ref\Proposed\Drainage Analysis\
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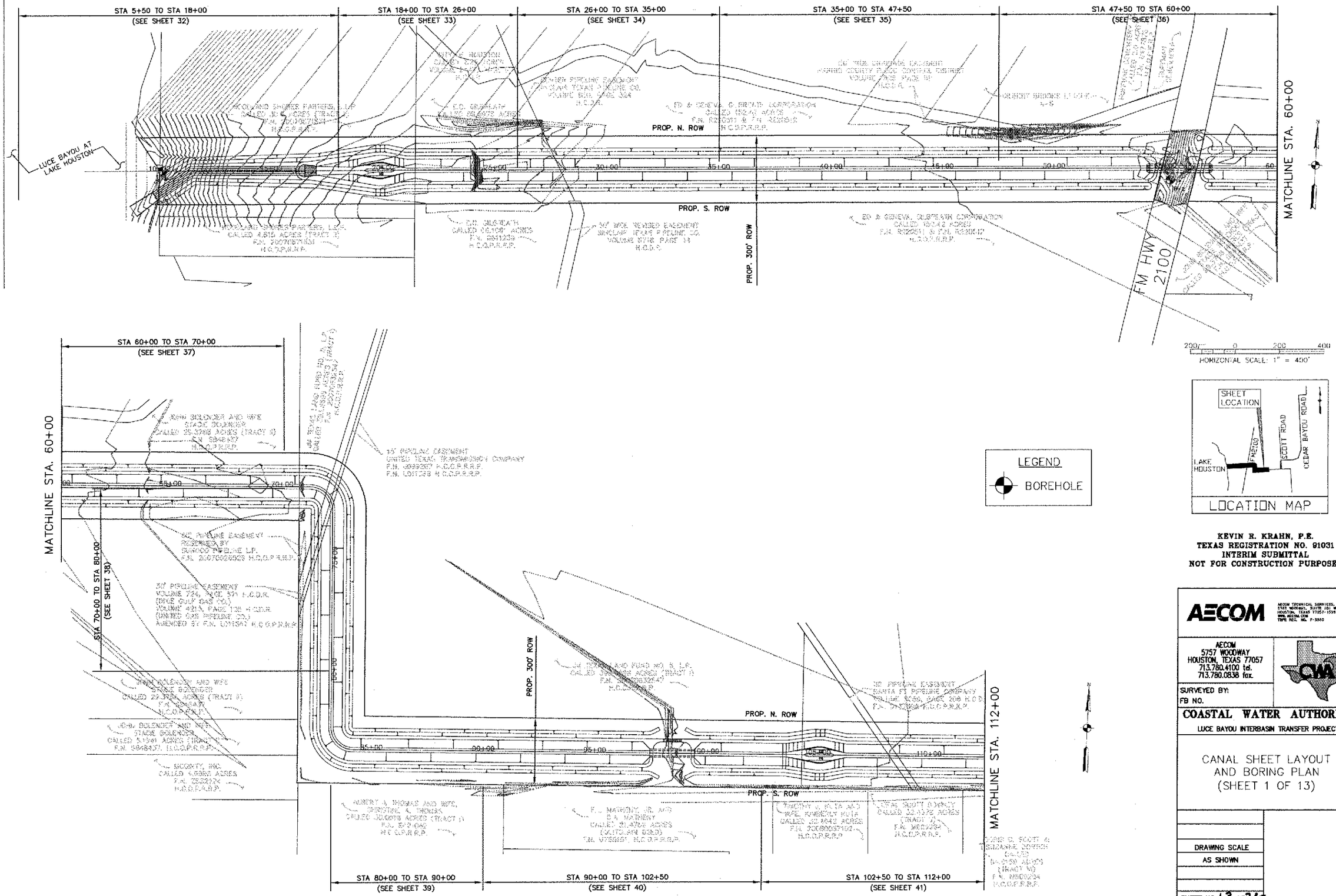

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL SHEET LAYOUT
AND BORING PLAN
(SHEET 1 OF 13)

DRAWING SCALE
AS SHOWN

SHEET NO. 13 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:30pm BY USER: ThompsonBI
DWG. LOCATION: D:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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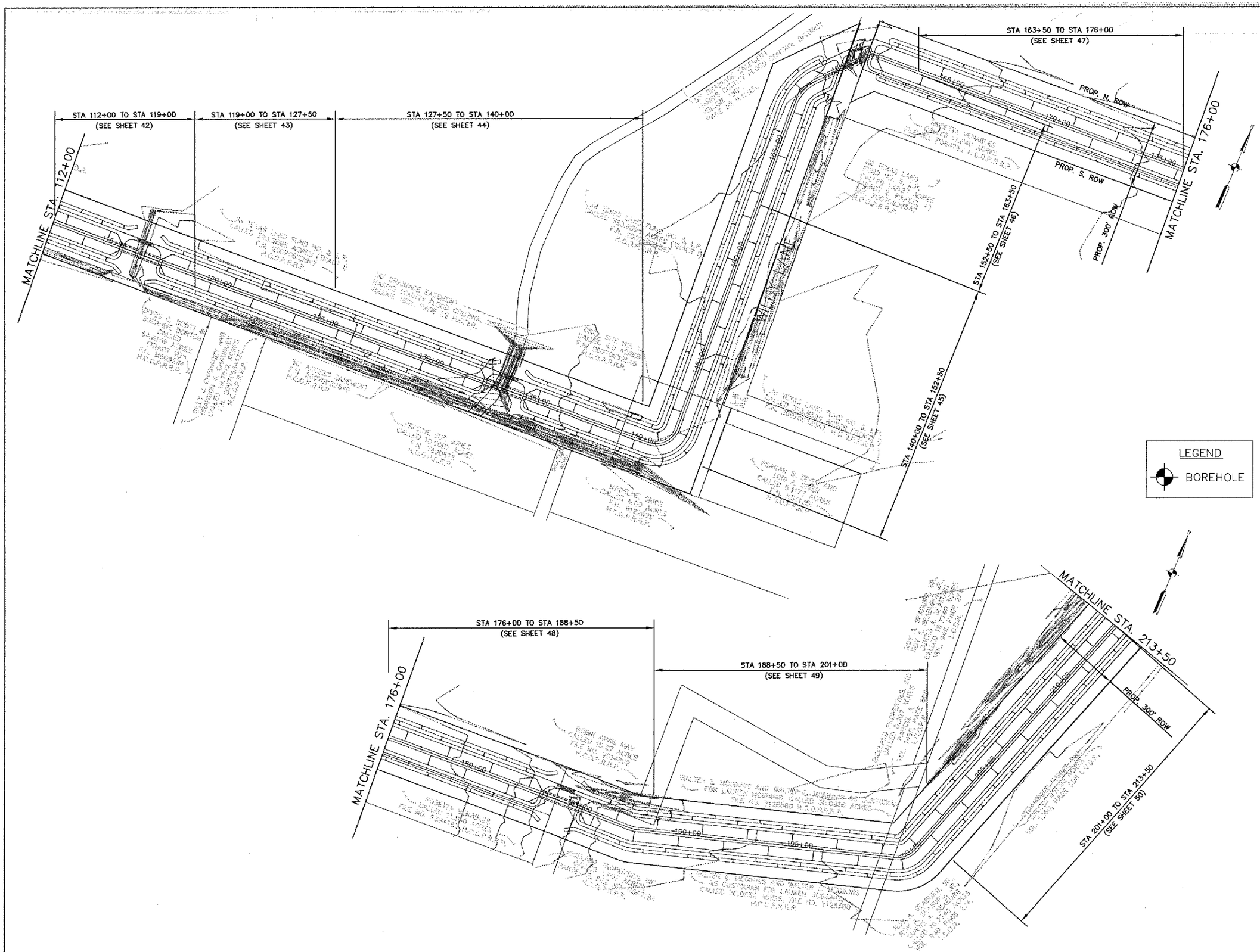
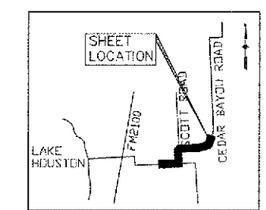


200 0 200 400
HORIZONTAL SCALE: 1" = 400'

LEGEND

BOREHOLE



LOCATION MAP

KEVIN R. KRAHN, P.E.
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713.780.0838 fax.

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL SHEET LAYOUT
AND BORING PLAN
(SHEET 2 OF 13)

DRAWING SCALE
AS SHOWN

SHEET NO. 14 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:31pm BY USER: ThompsonBI
DWG. LOCATION: G:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: overallloyoutcanal2.dwg

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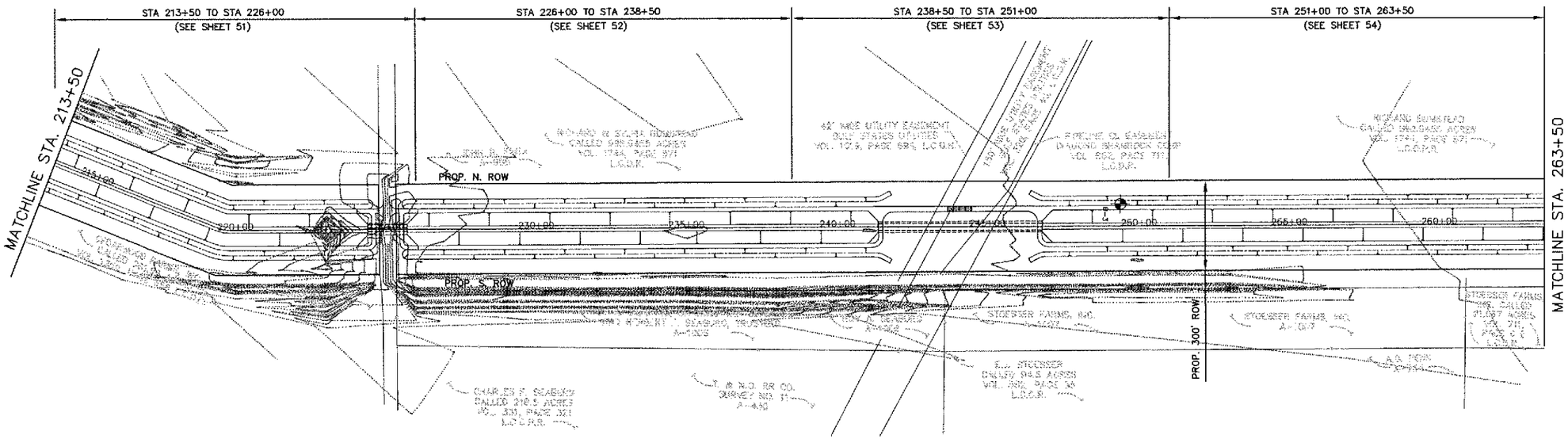
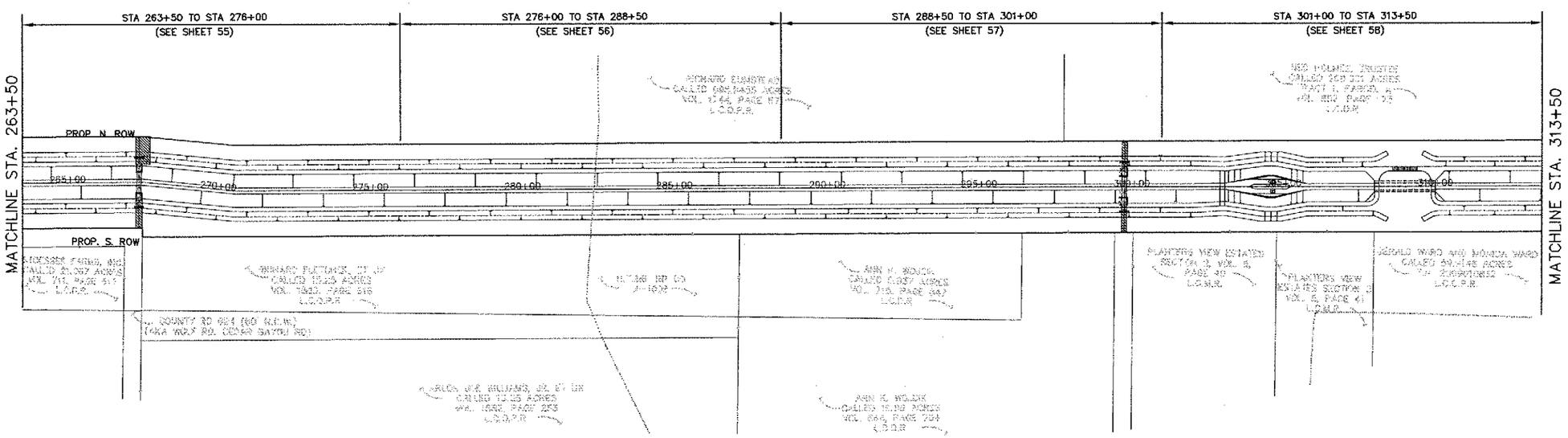
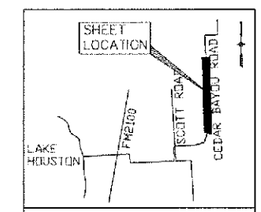
HORIZONTAL SCALE: 1" = 400'





LEGEND

BOREHOLE



LOCATION MAP

KEVIN R. KRAHN, P.E.
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LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL SHEET LAYOUT
AND BORING PLAN
(SHEET 3 OF 13)

DRAWING SCALE
AS SHOWN

SHEET NO. 15 OF 245

LAST MODIFIED: Jan 27, 2011 – 5:32pm BY USER: ThompsonBl
DWG. LOCATION: D:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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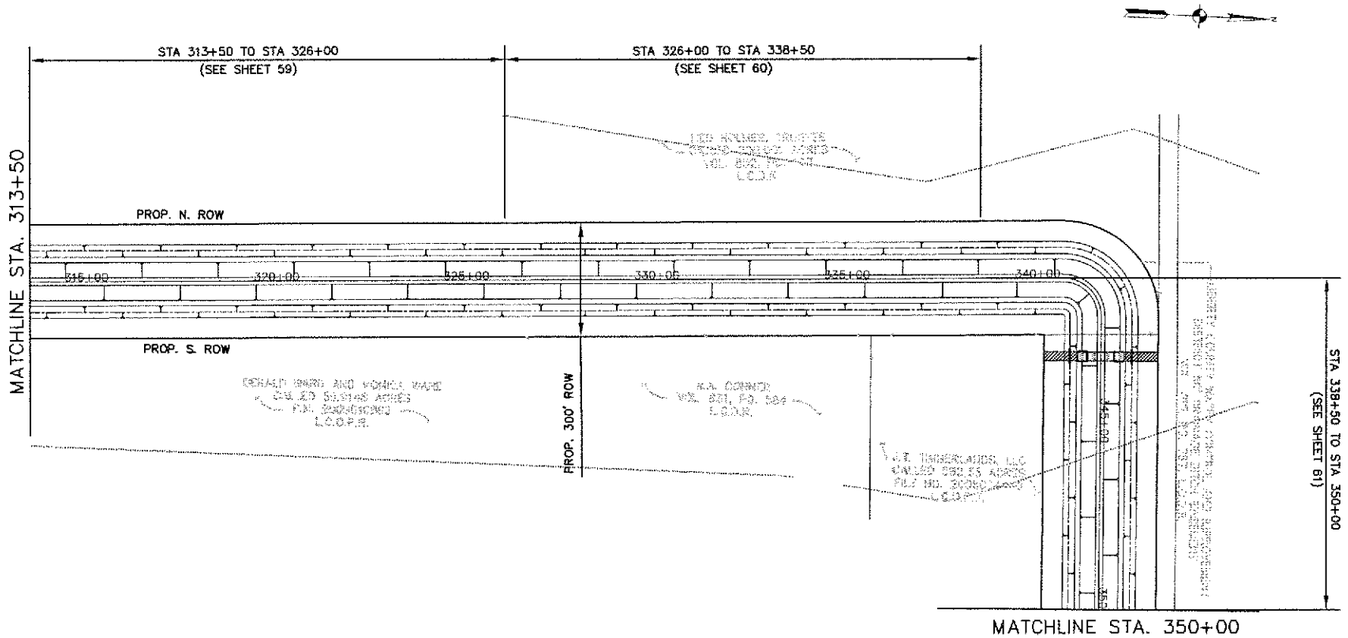
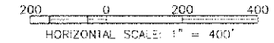
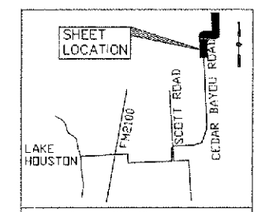


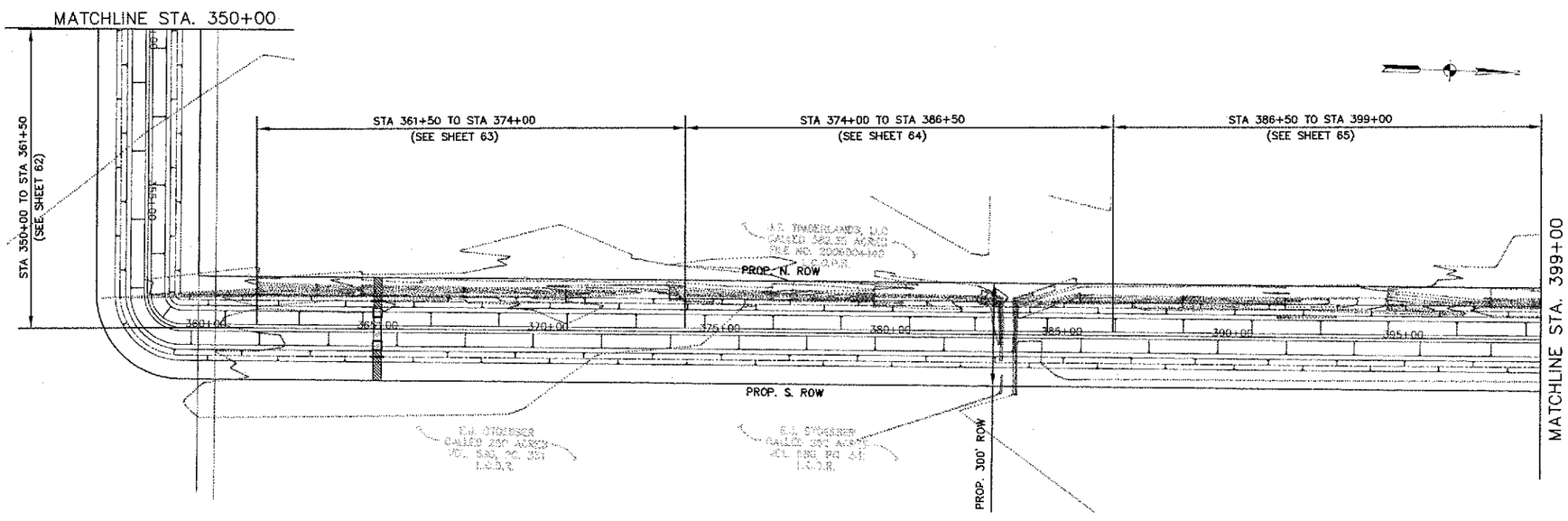


LEGEND

BOREHOLE



LOCATION MAP



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LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL SHEET LAYOUT
AND BORING PLAN
(SHEET 4 OF 13)

DRAWING SCALE
AS SHOWN

SHEET NO. 16 OF 245

LAST MODIFIED: Jan 27, 2011 – 5:33pm BY USER: ThompsonBI
DWG. LOCATION: Q:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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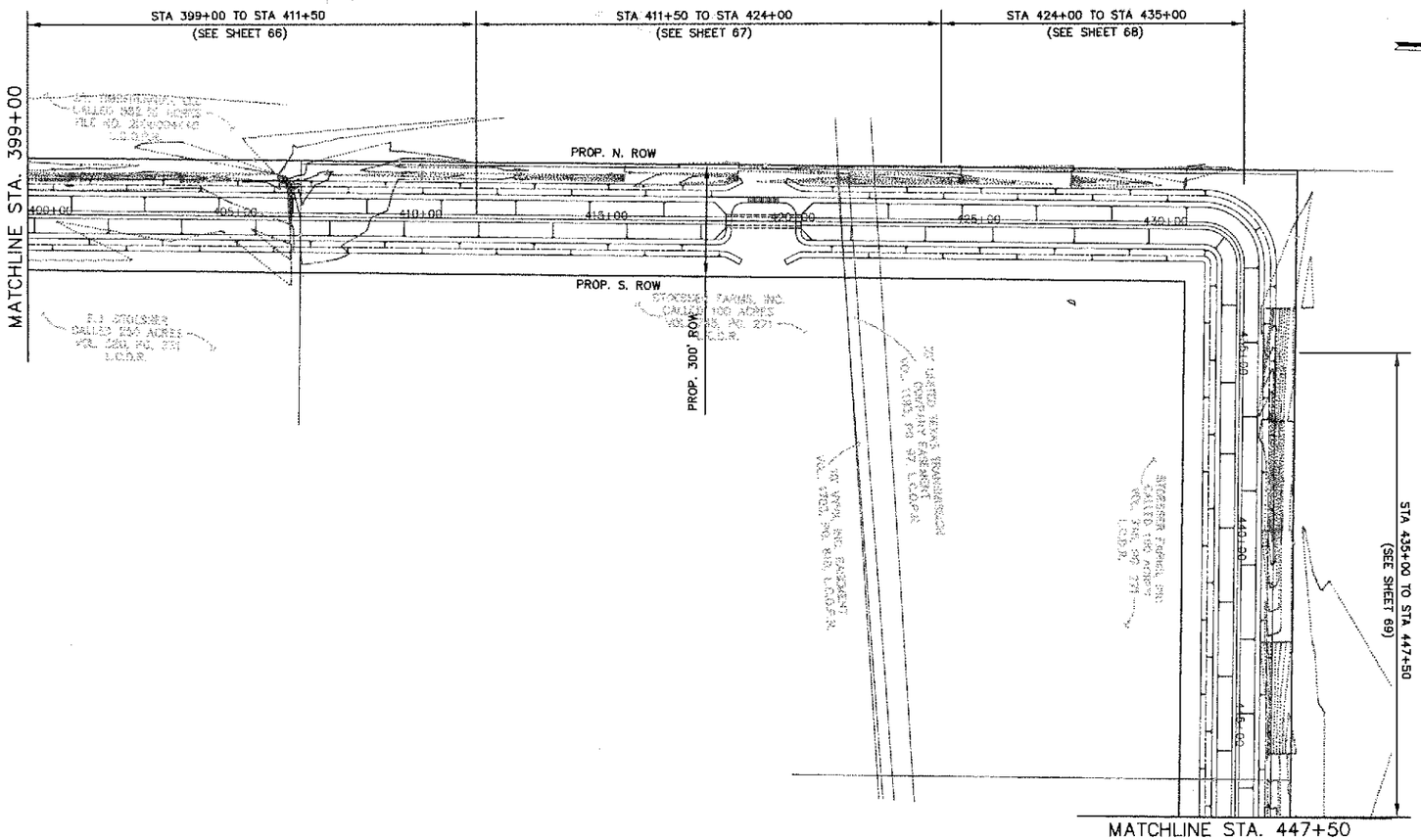
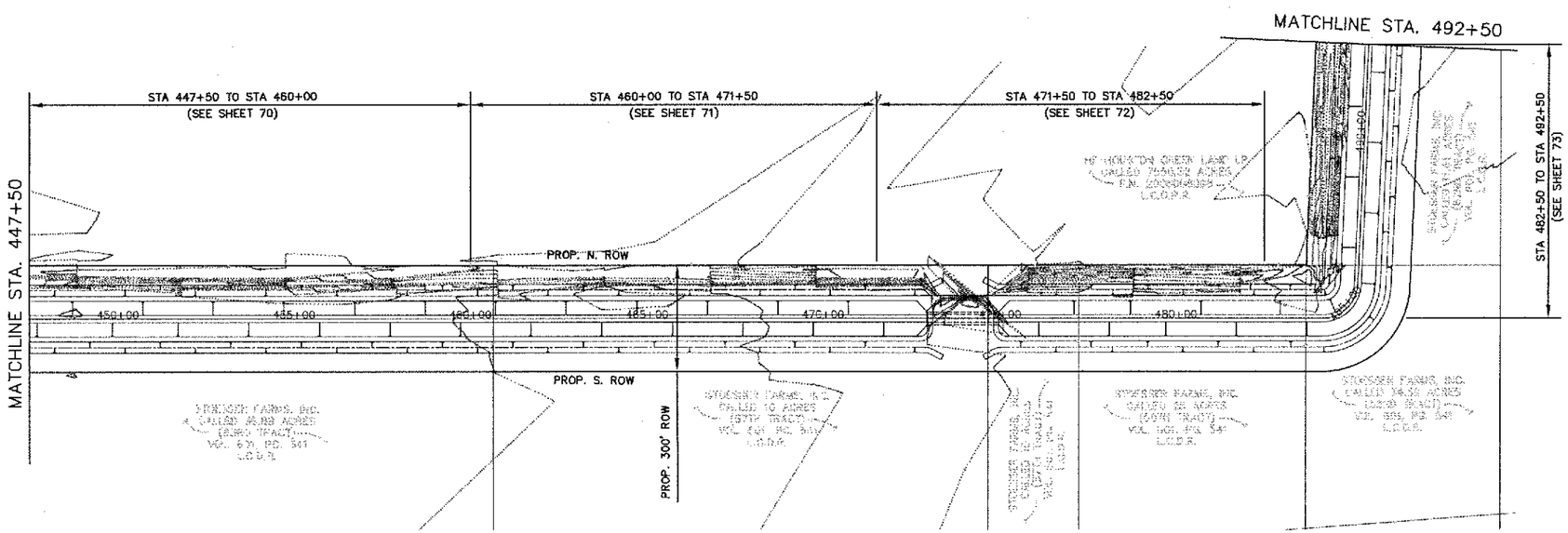
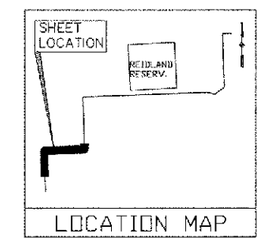




200 0 200 400
HORIZONTAL SCALE: 1" = 400'

LEGEND

BOREHOLE



LOCATION MAP

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL SHEET LAYOUT
AND BORING PLAN
(SHEET 5 OF 13)

DRAWING SCALE
AS SHOWN

SHEET NO. 17 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:33pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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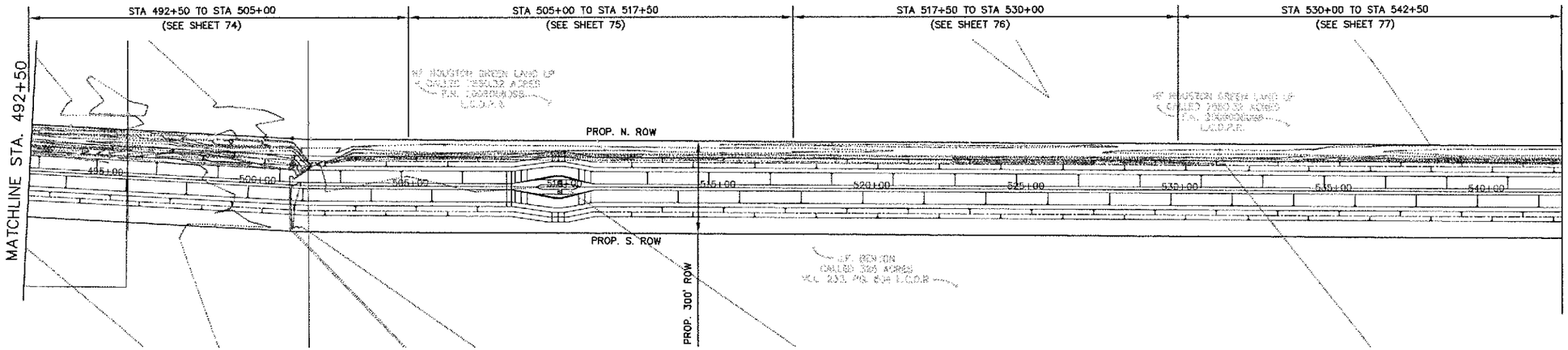
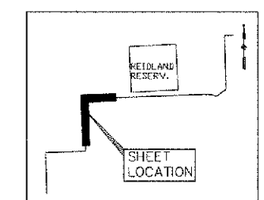
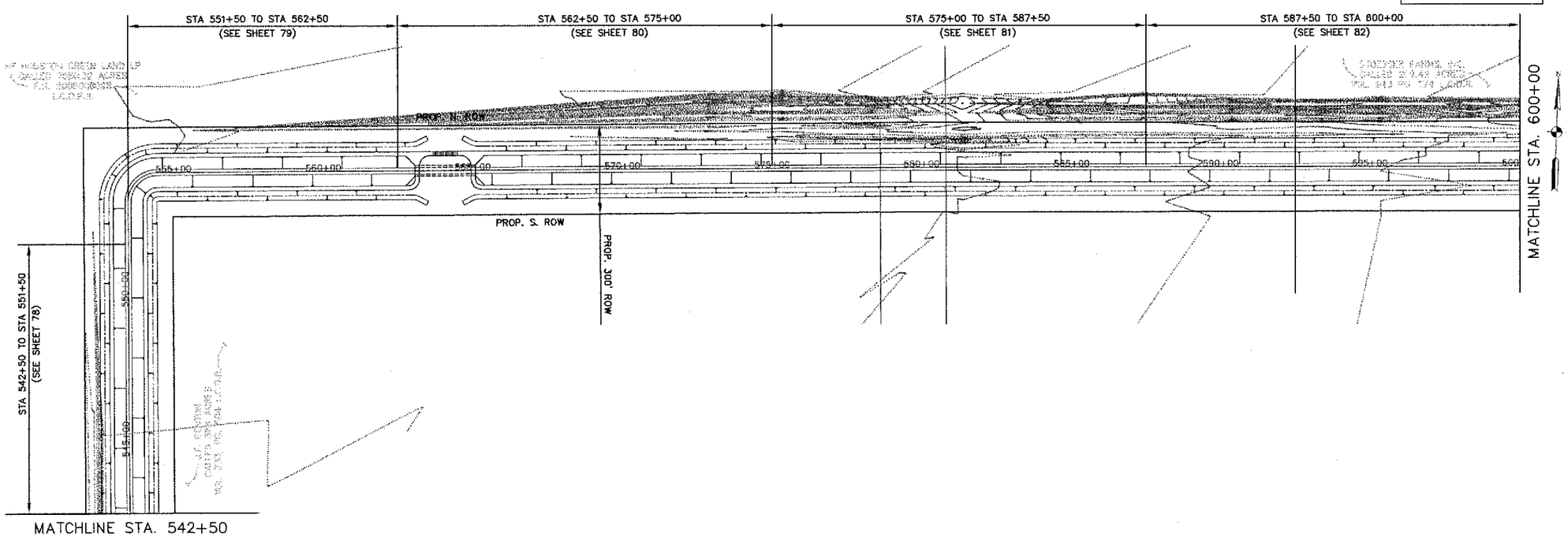
200 0 200 400
HORIZONTAL SCALE: 1" = 400'



LEGEND
BOREHOLE



LOCATION MAP



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LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL SHEET LAYOUT
AND BORING PLAN
(SHEET 6 OF 13)

DRAWING SCALE
AS SHOWN

SHEET NO. 18 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:34pm BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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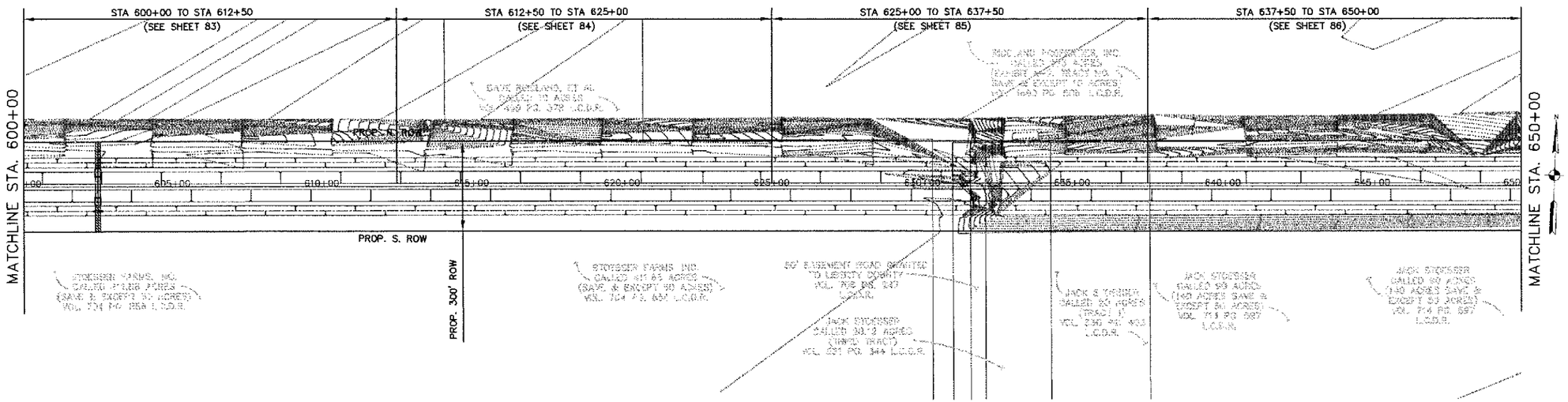
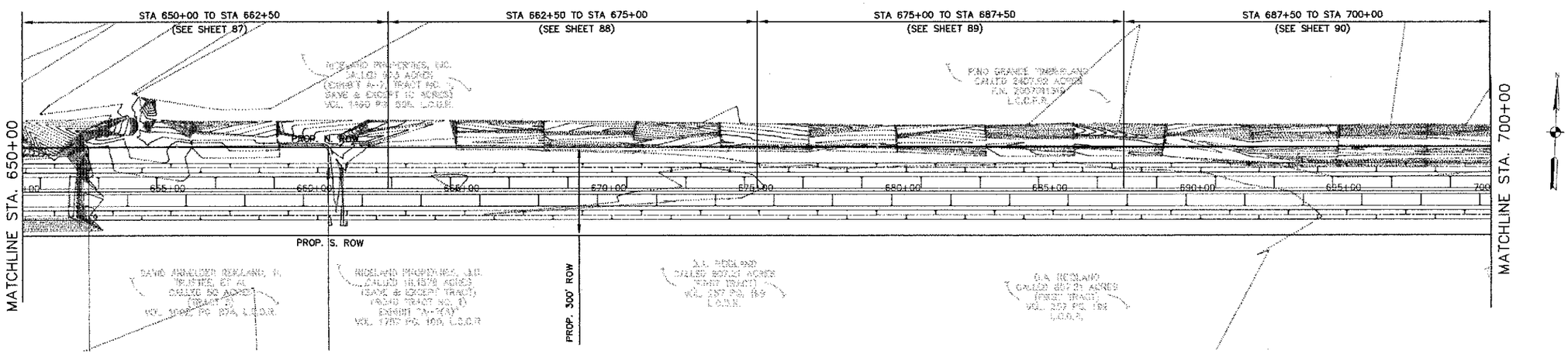
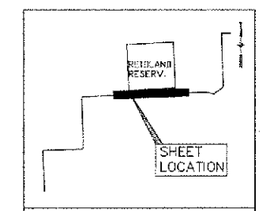




HORIZONTAL SCALE: 1" = 400'

LEGEND

BOREHOLE



LOCATION MAP

KEVIN R. KRAHN, P.E.
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LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL SHEET LAYOUT
AND BORING PLAN
(SHEET 7 OF 13)

DRAWING SCALE
AS SHOWN

SHEET NO. 19 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:35pm BY USER: ThompsonBI
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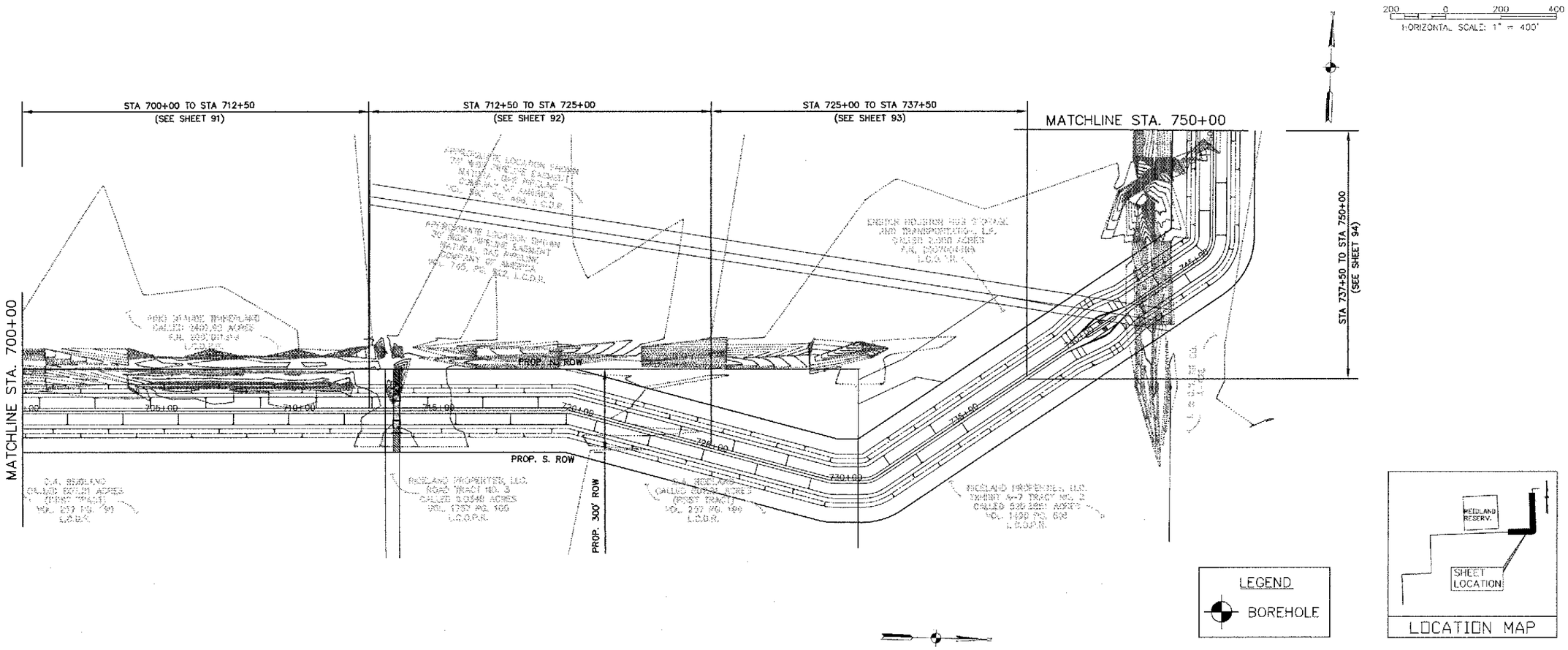

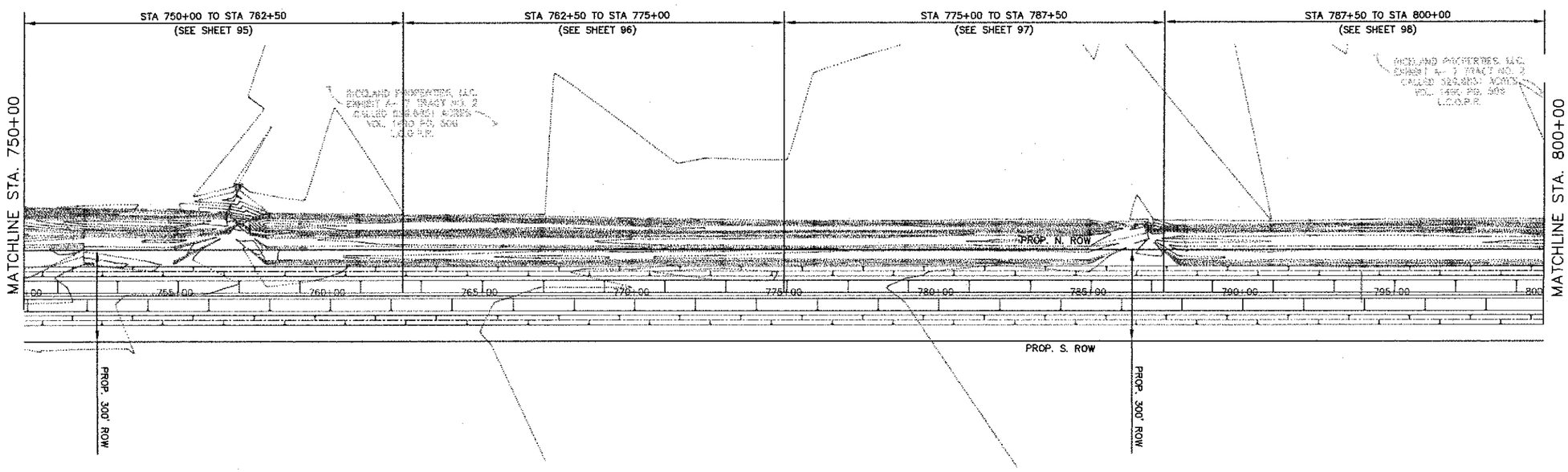

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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713.780.0838 fax.

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COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL SHEET LAYOUT
AND BORING PLAN
(SHEET 8 OF 13)

DRAWING SCALE
AS SHOWN

SHEET NO. 20 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:36pm BY USER: ThompsonBI
DWG. LOCATION: G:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\FWD\Sheets\
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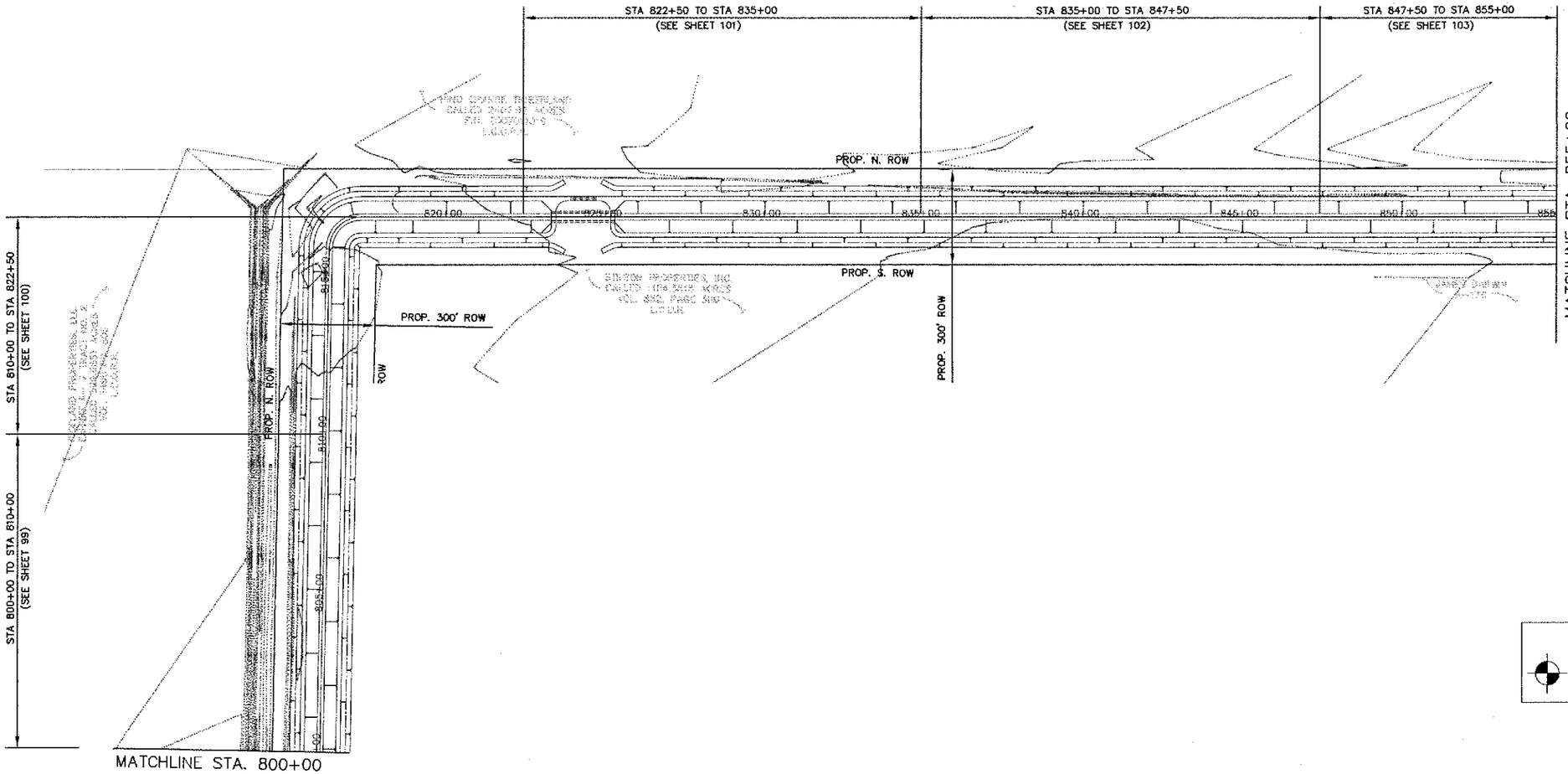

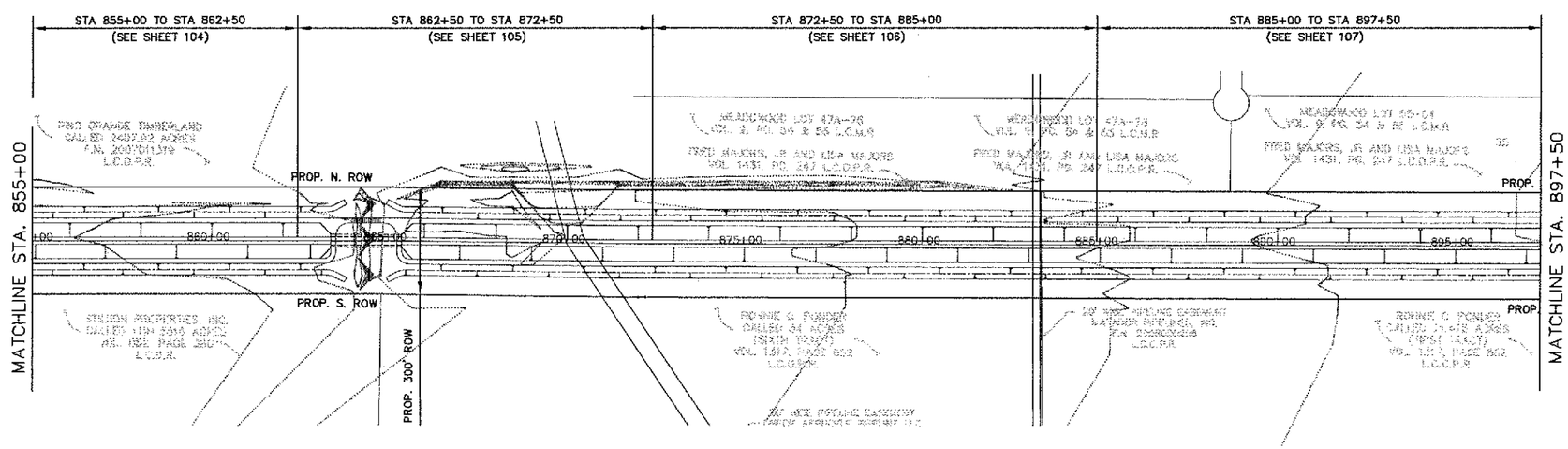

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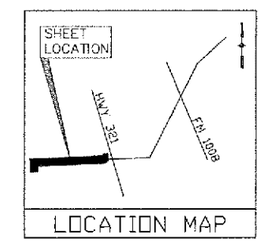
HORIZONTAL SCALE: 1" = 400'

LEGEND

BOREHOLE



LOCATION MAP

KEVIN R. KRAHN, P.E.
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AECOM

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL SHEET LAYOUT
AND BORING PLAN
(SHEET 9 OF 13)

DRAWING SCALE
AS SHOWN

SHEET NO. 21 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:37pm BY USER: ThompsonBl
DWG. LOCATION: C:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.5 Civil Notes and Calculations\Cadd\PWD\Sheets\
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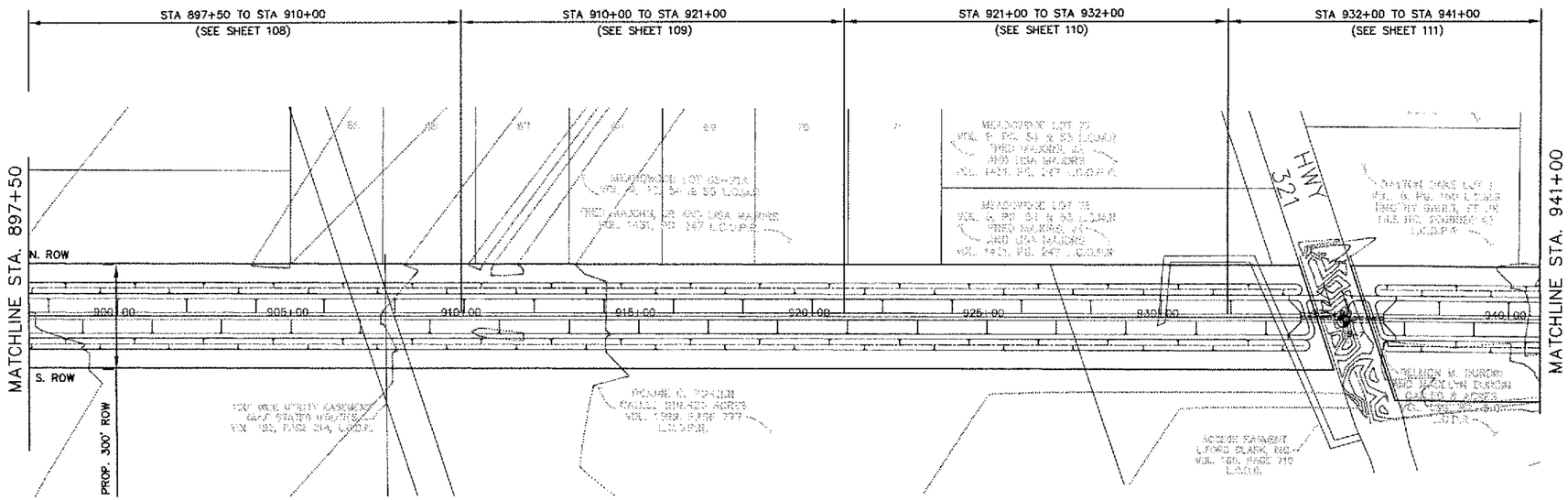
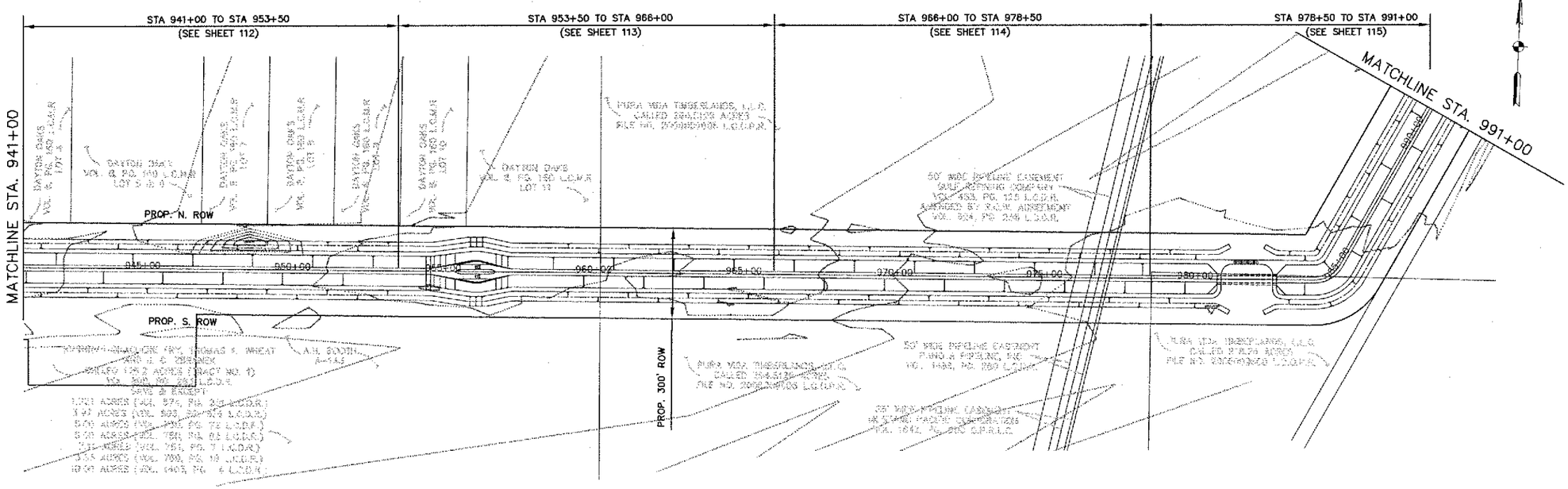
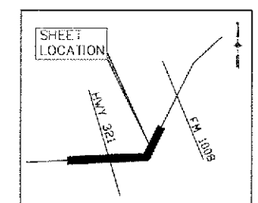




HORIZONTAL SCALE: 1" = 400'

LEGEND

BOREHOLE



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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AECOM

AECOM TECHNICAL SERVICES, INC.
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LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL SHEET LAYOUT
AND BORING PLAN
(SHEET 10 OF 13)

DRAWING SCALE
AS SHOWN

SHEET NO. 22 OF 245

LAST MODIFIED: Jan 27, 2011 – 5:37pm BY USER: ThompsonBI
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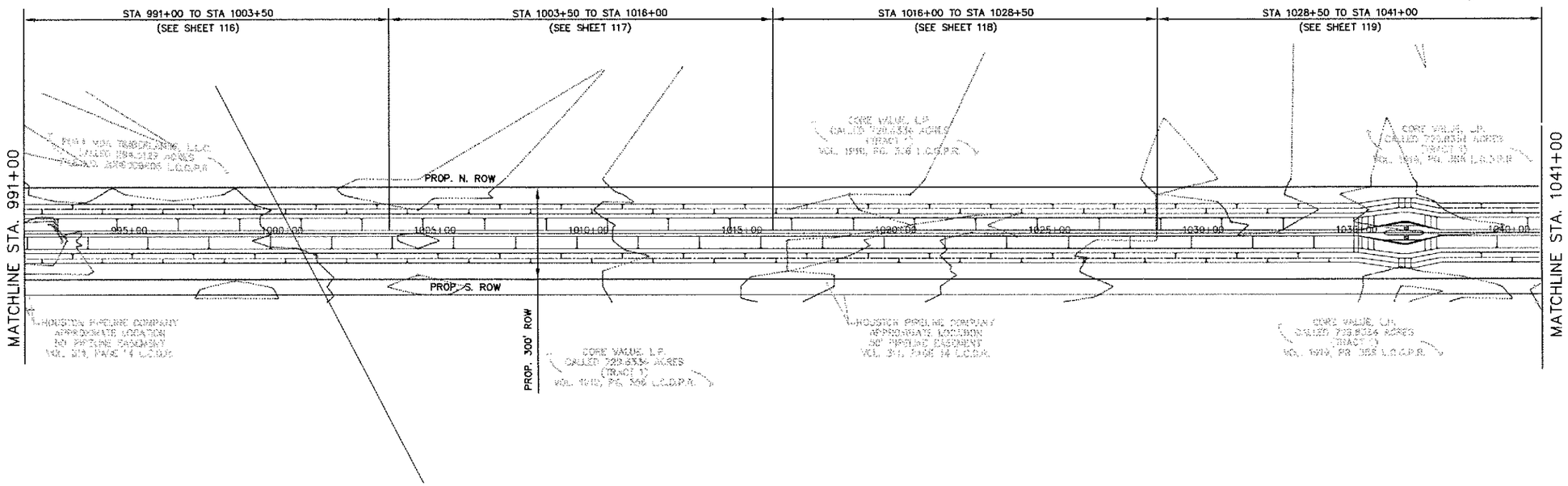

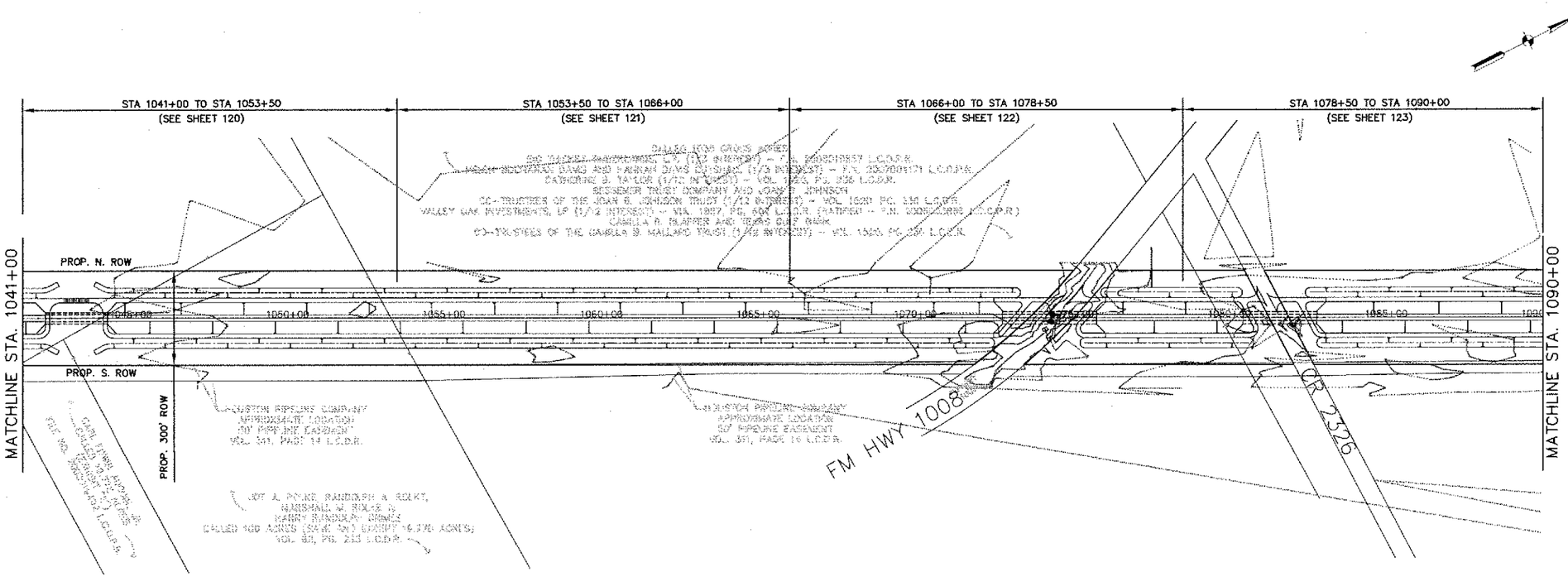

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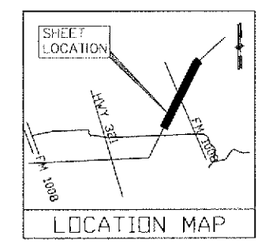
HORIZONTAL SCALE: 1" = 400'

LEGEND

BOREHOLE



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
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AECOM

AECOM TECHNICAL SERVICES, INC.
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LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL SHEET LAYOUT
AND BORING PLAN
(SHEET 11 OF 13)

DRAWING SCALE
AS SHOWN

SHEET NO. 23 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:38pm BY USER: ThompsonBi
DWG LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Codd\PWD\Sheets\
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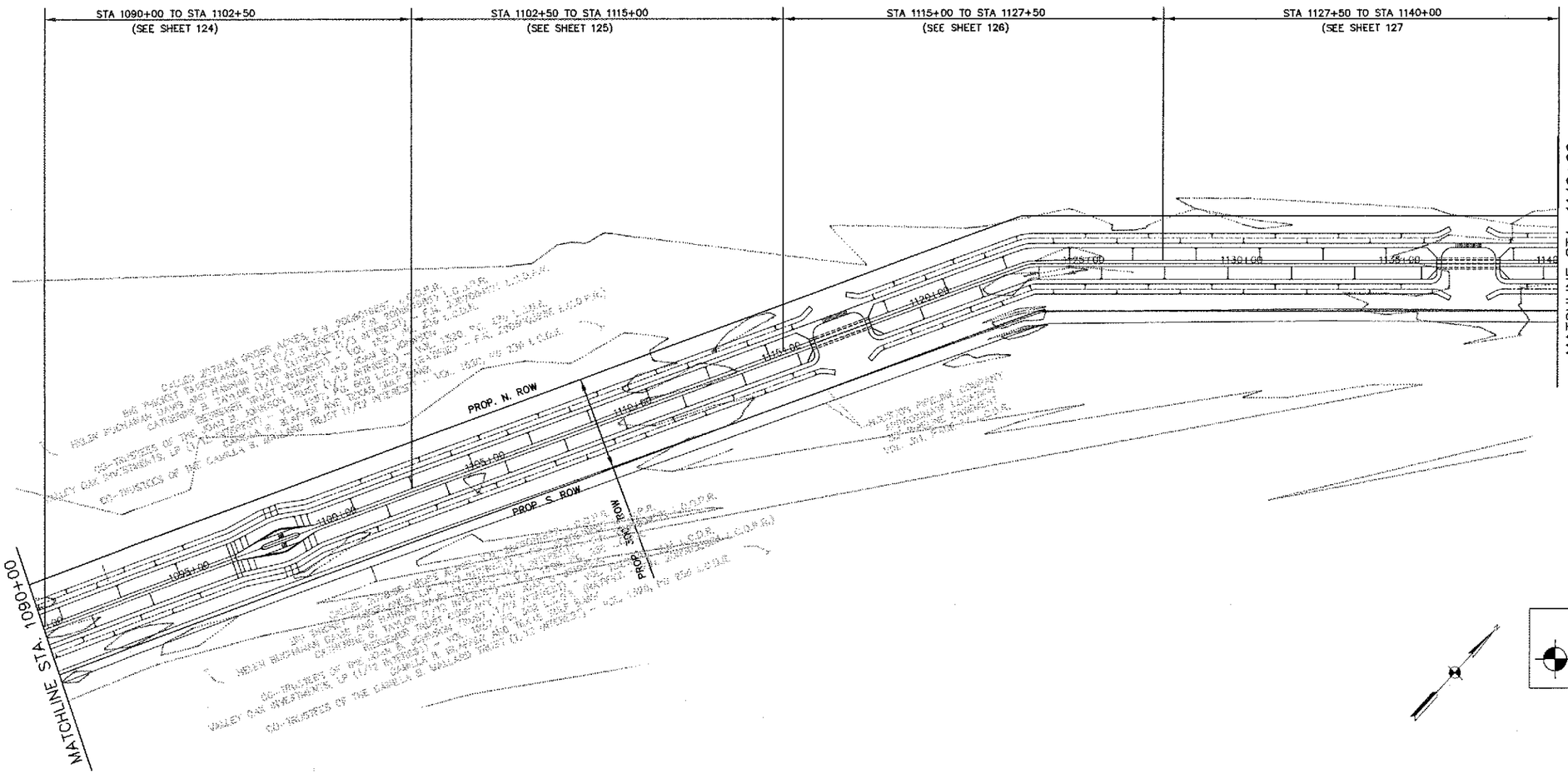
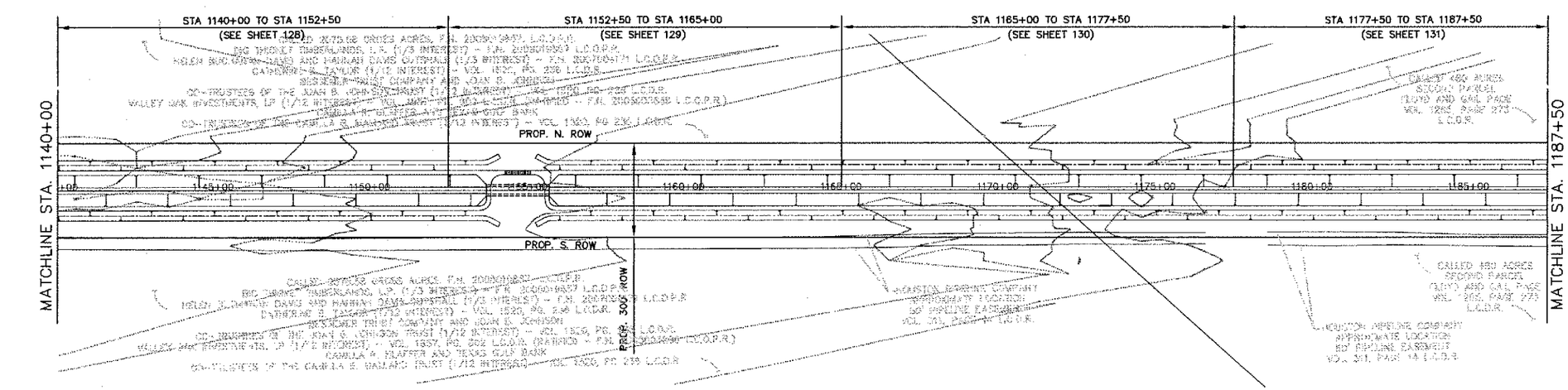
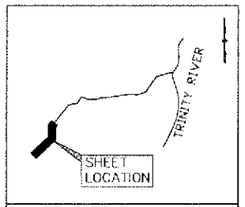




HORIZONTAL SCALE: 1" = 400'

LEGEND

BOREHOLE



LOCATION MAP

KEVIN R. KRAHN, P.E.
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LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL SHEET LAYOUT
AND BORING PLAN
(SHEET 12 OF 13)

DRAWING SCALE
AS SHOWN

SHEET NO. 24 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:39pm BY USER: ThompsonBI
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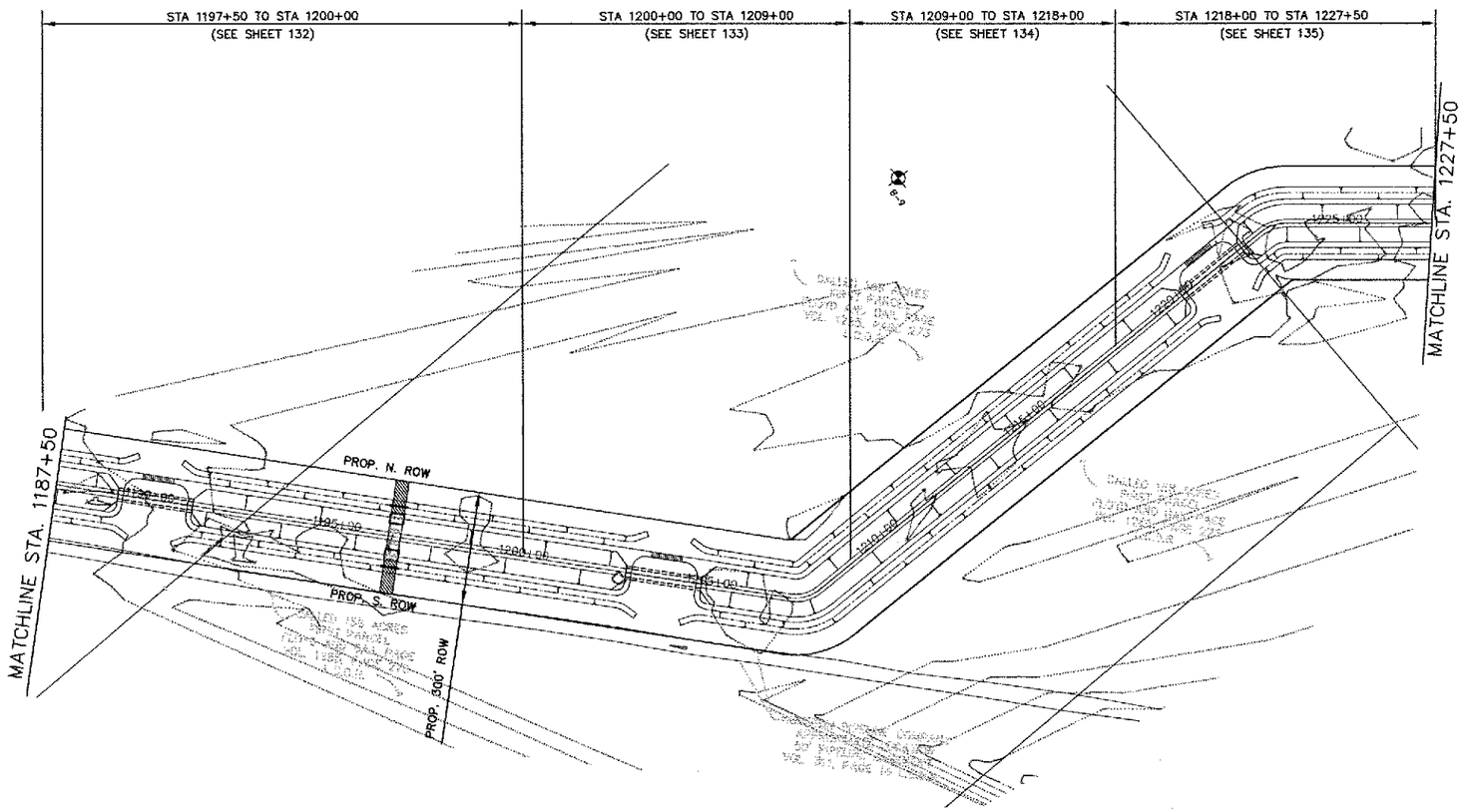
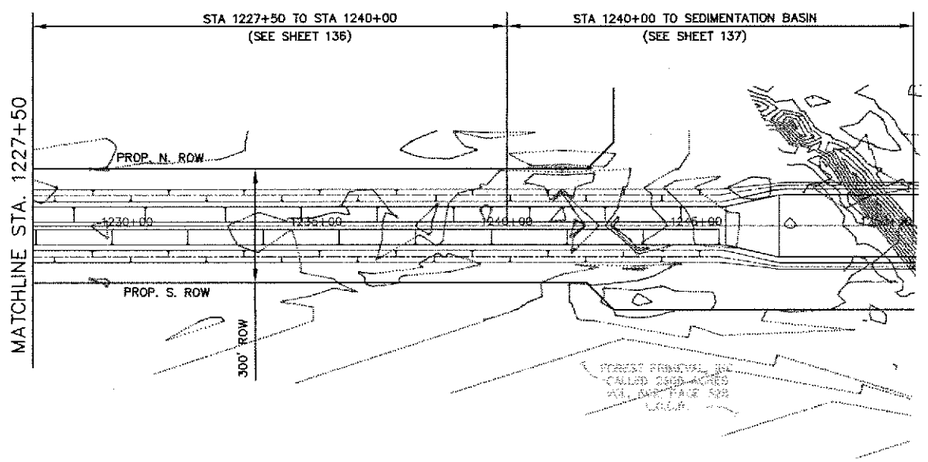
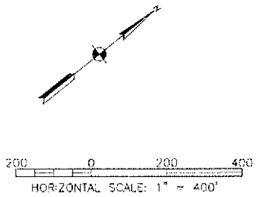
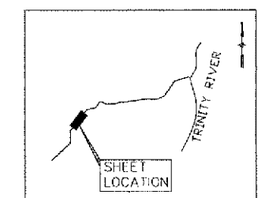






LEGEND

BOREHOLE



LOCATION MAP

KEVIN R. KRAHN, P.E.
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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL SHEET LAYOUT
AND BORING PLAN
(SHEET 13 OF 13)

DRAWING SCALE
AS SHOWN

SHEET NO. 25 OF 245

LAST MODIFIED: Jan 27, 2011 – 5:40pm BY USER: ThompsonBI
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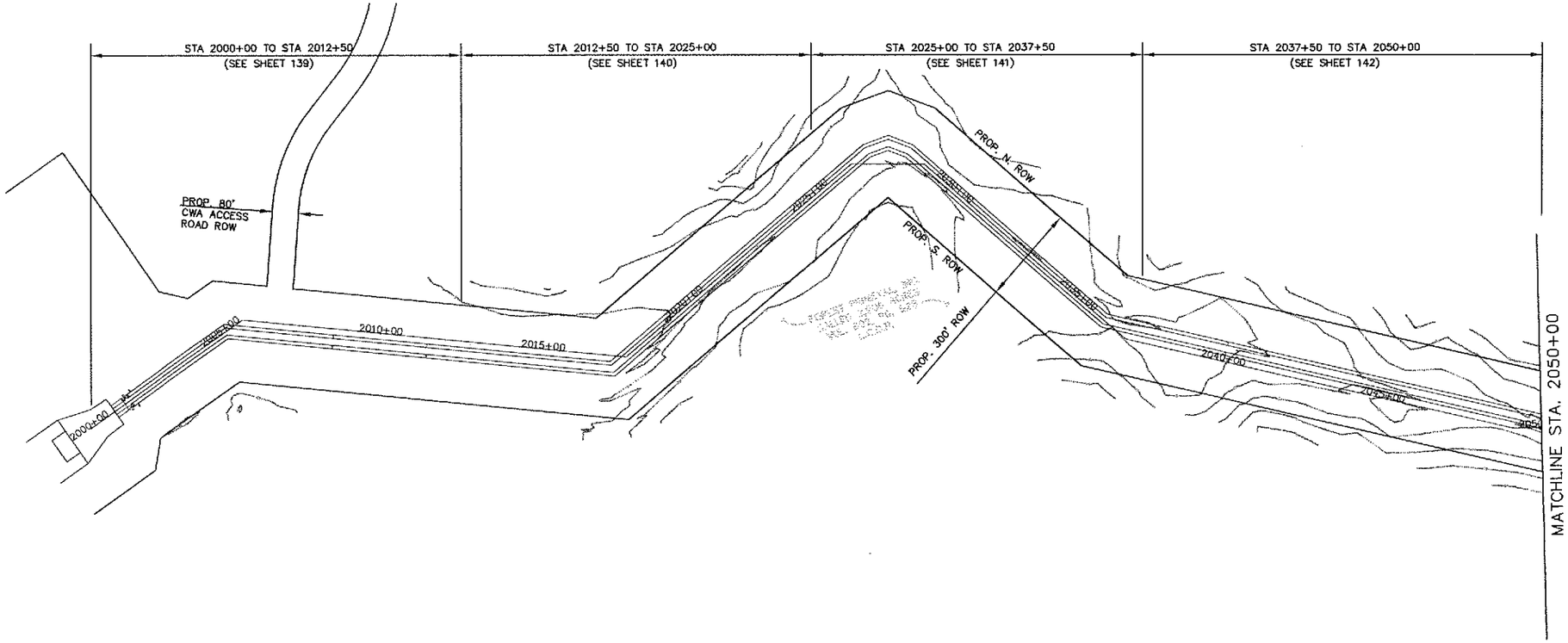

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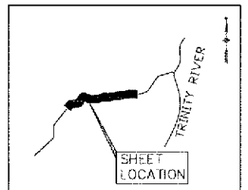
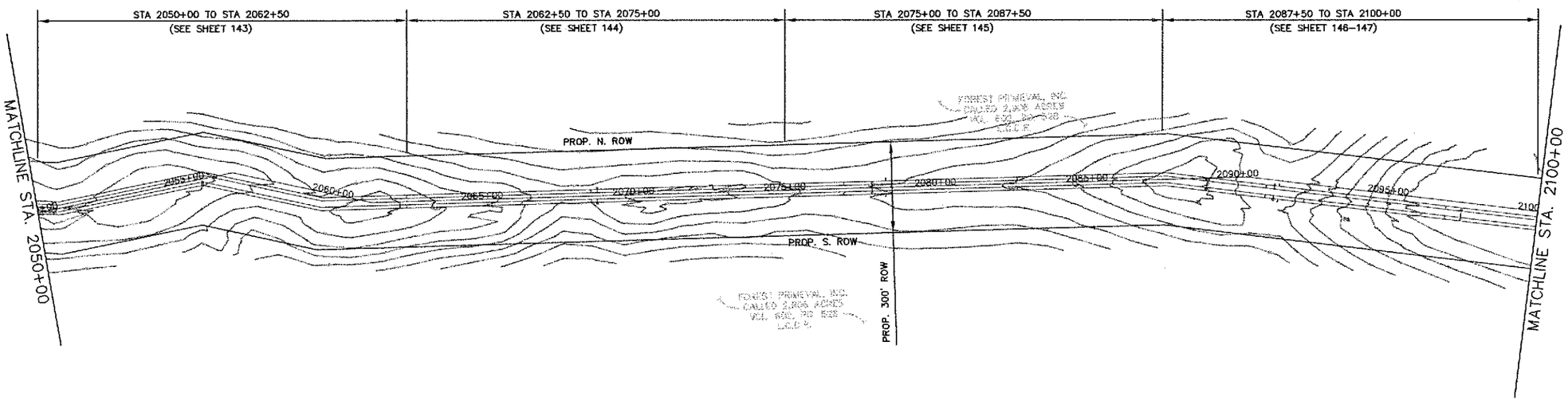
HORIZONTAL SCALE: 1" = 400'

LEGEND
BOREHOLE



LOCATION MAP



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AECOM

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COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

PIPELINE SHEET
LAYOUT AND BORING
PLAN (SHEET 1 OF 2)

DRAWING SCALE
AS SHOWN

SHEET NO. 26 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:40pm BY USER: Thompson8i
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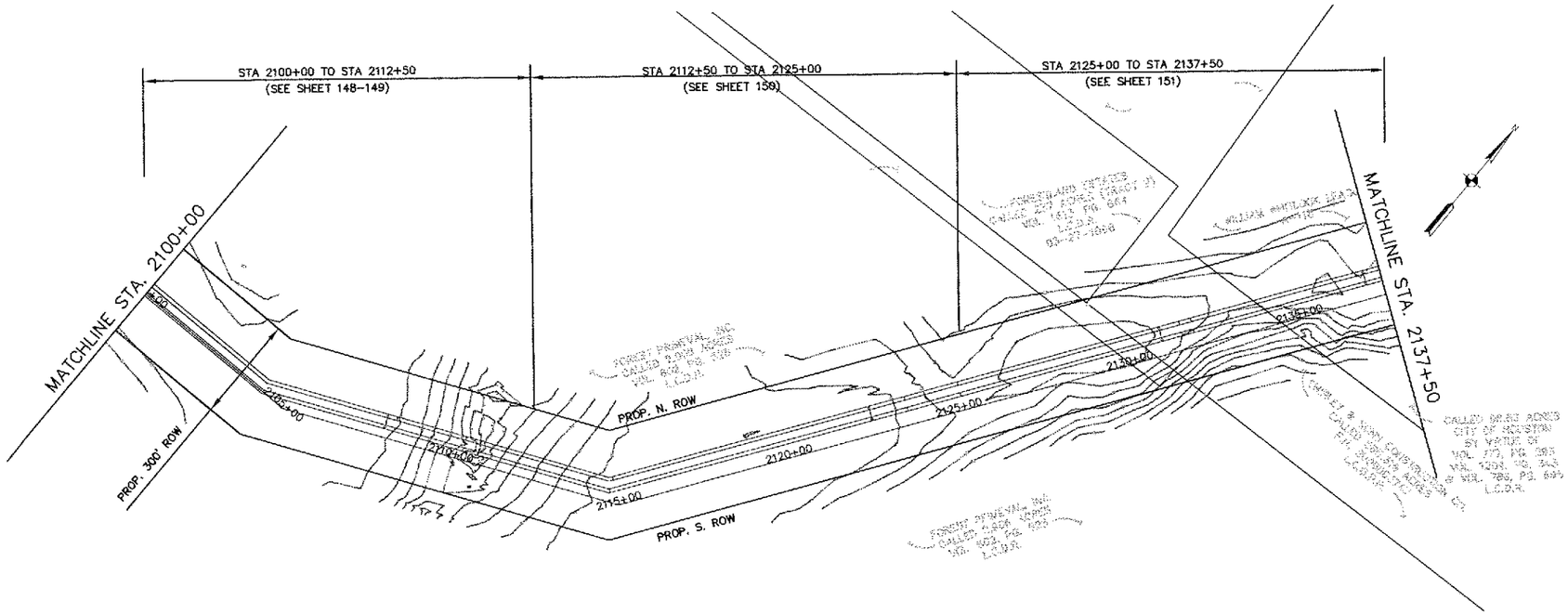

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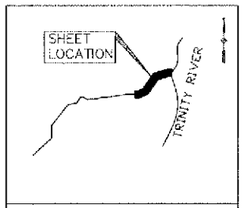
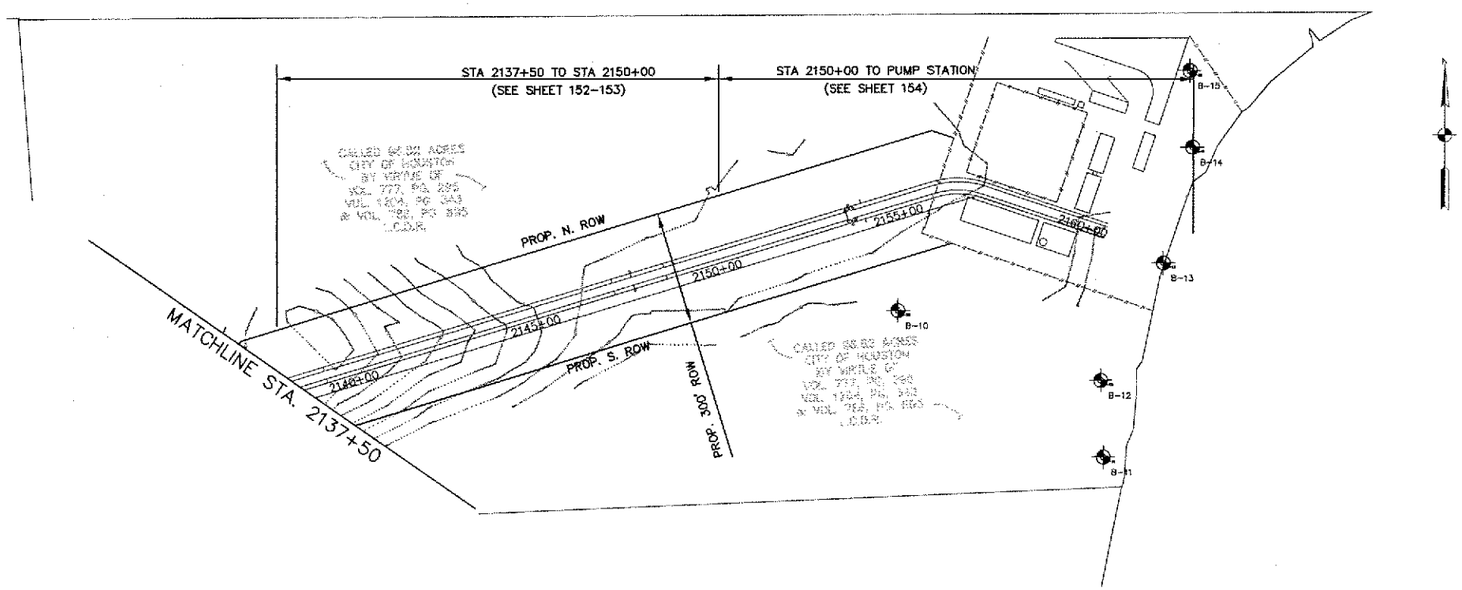
HORIZONTAL SCALE: 1" = 400'

LEGEND

BOREHOLE



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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AECOM TECHNICAL SERVICES, INC.
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5757 WOODWAY
HOUSTON, TEXAS 77057
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713.780.0838 fax.

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COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

PIPELINE SHEET
LAYOUT AND BORING
PLAN (SHEET 2 OF 2)

DRAWING SCALE
AS SHOWN

SHEET NO. 27 OF 245

LAST MODIFIED: Jan 27, 2011 — 5:40pm BY USER: ThompsonBI
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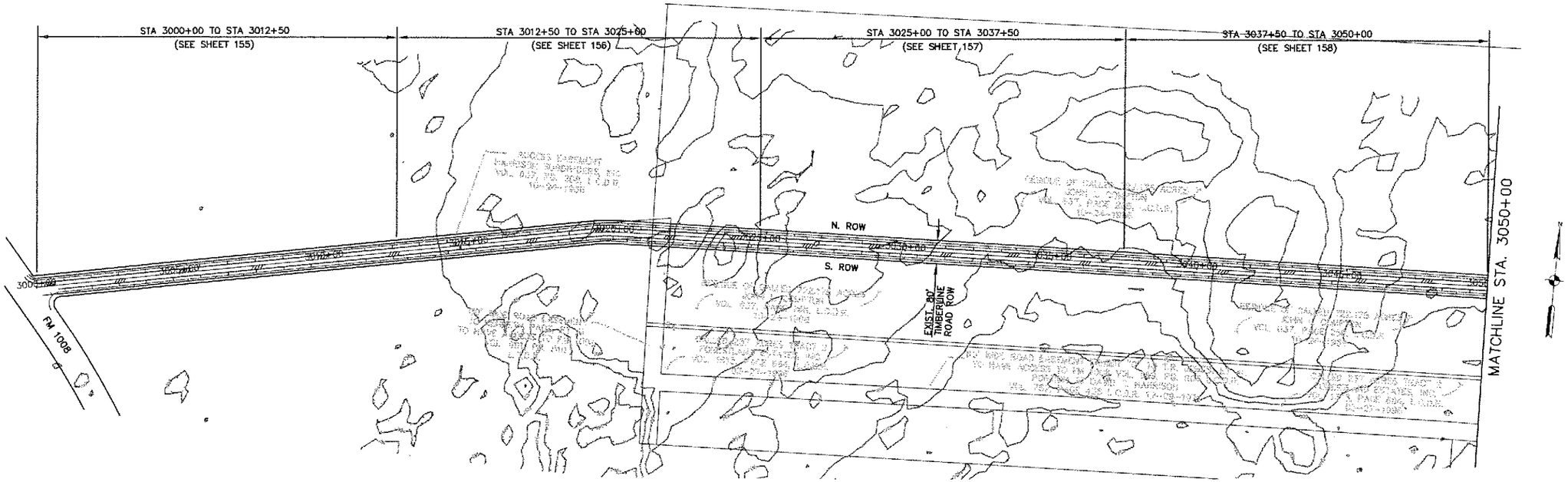

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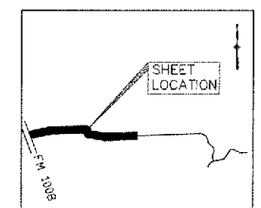
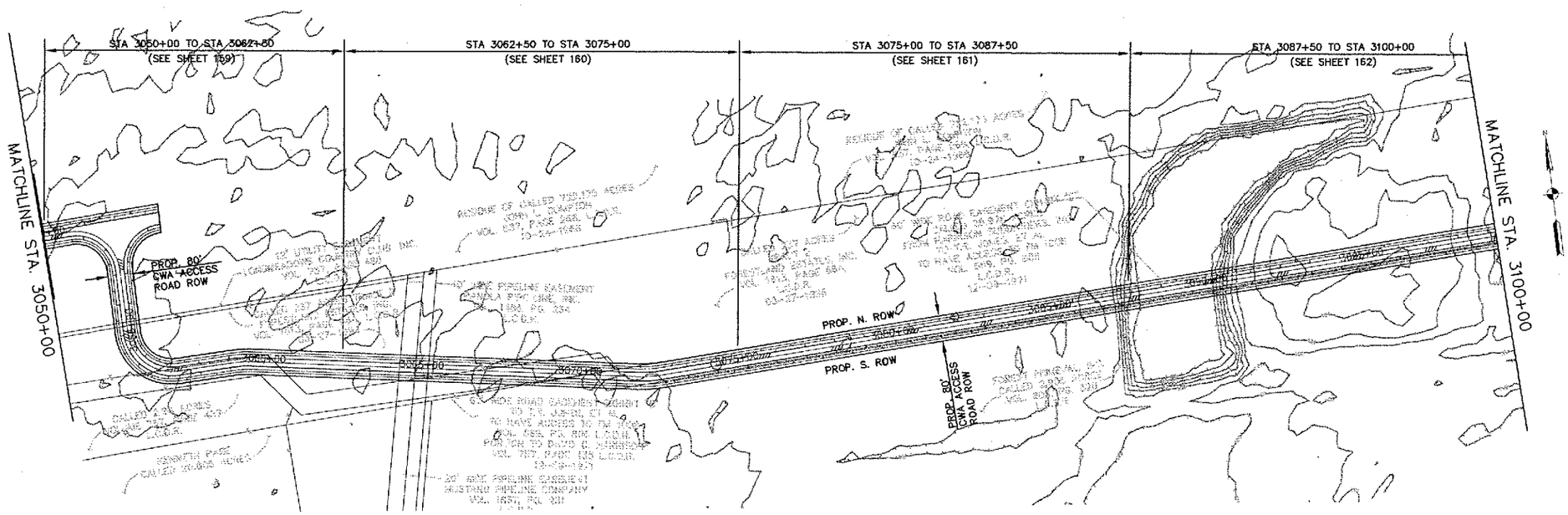


LOCATION MAP

LEGEND

BOREHOLE



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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AECOM

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HOUSTON, TEXAS 77057-1509
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LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD SHEET LAYOUT AND BORING PLAN (SHEET 1 OF 4)

DRAWING SCALE
AS SHOWN

SHEET NO. 28 OF 245

LAST MODIFIED: Jan 27, 2011 – 5:41pm BY USER: ThompsonBI
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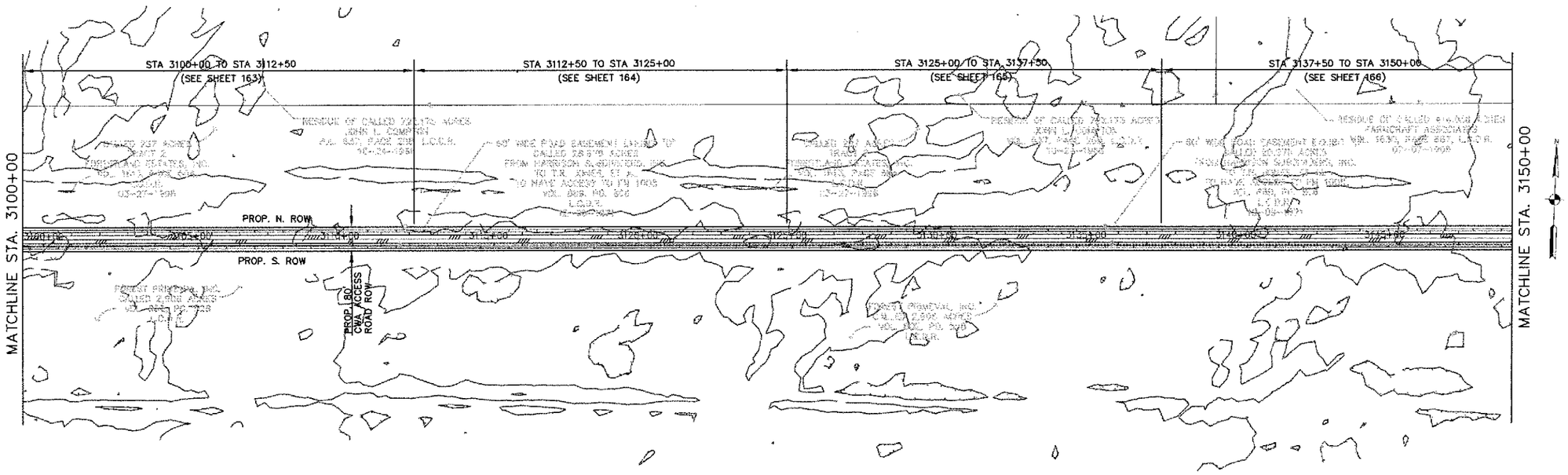

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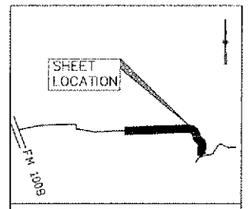
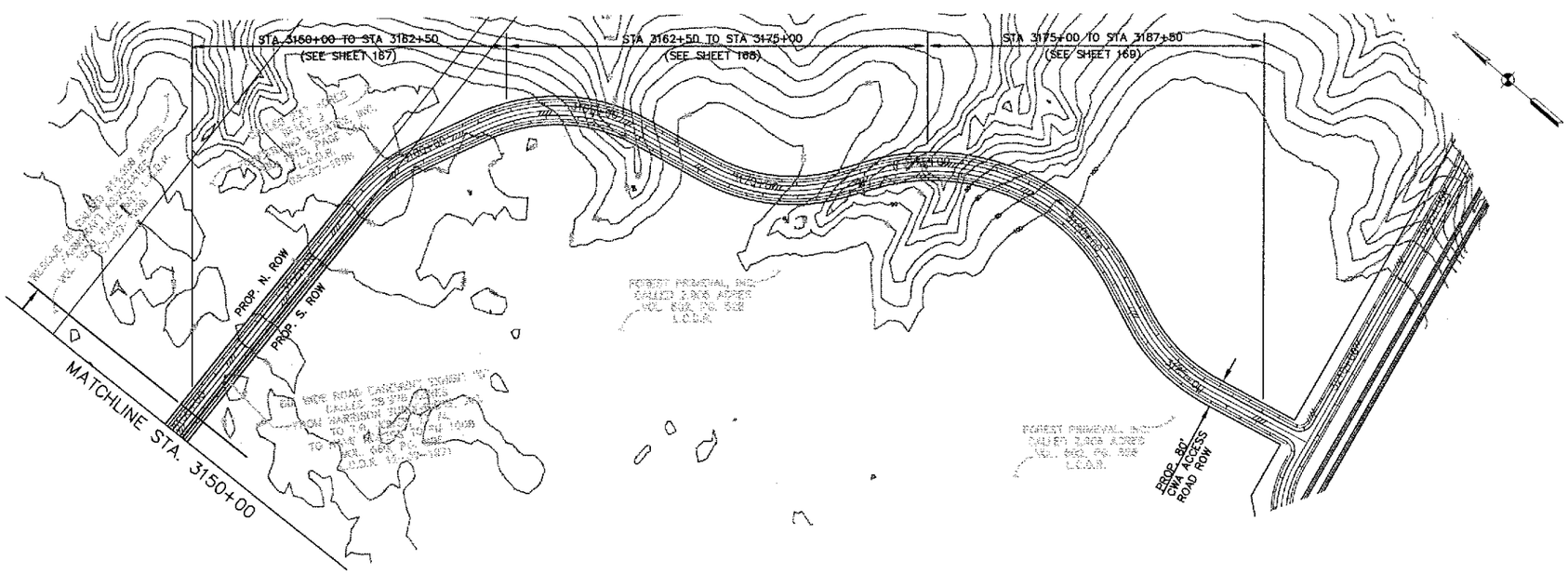


LOCATION MAP



LEGEND

BOREHOLE

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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AECOM

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713.780.0838 fax.

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CWA

COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD SHEET LAYOUT AND BORING PLAN (SHEET 2 OF 4)

DRAWING SCALE
AS SHOWN

SHEET NO. 29 OF 245

LAST MODIFIED: Jan 27, 2011 – 5:41pm BY USER: Thompsonjl
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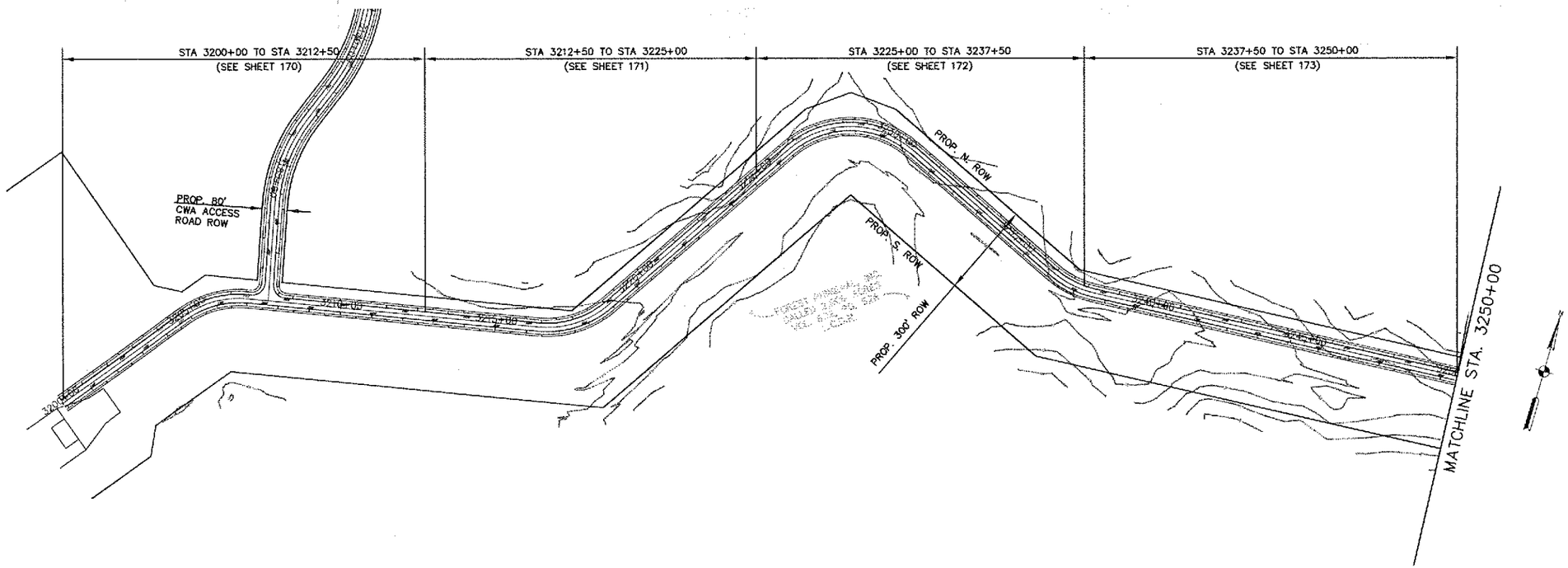

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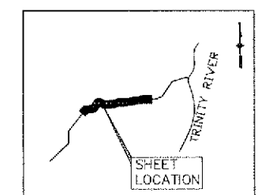
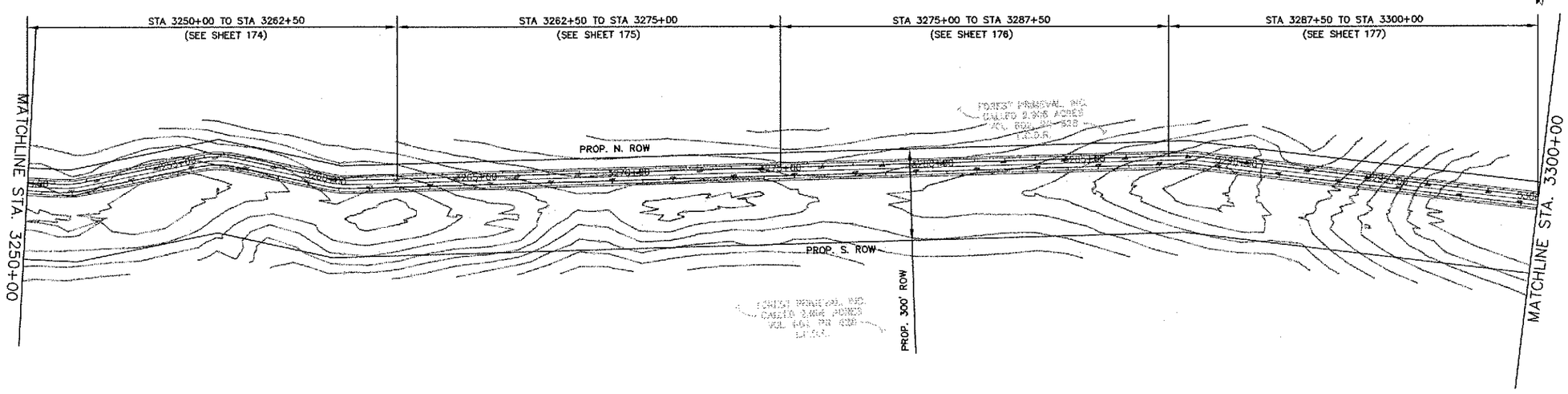
HORIZONTAL SCALE: 1" = 400'

LEGEND

BOREHOLE



LOCATION MAP



KEVIN R. KRAHN, P.E.
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NOT FOR CONSTRUCTION PURPOSES

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713.780.0838 fax.

SURVEYED BY:
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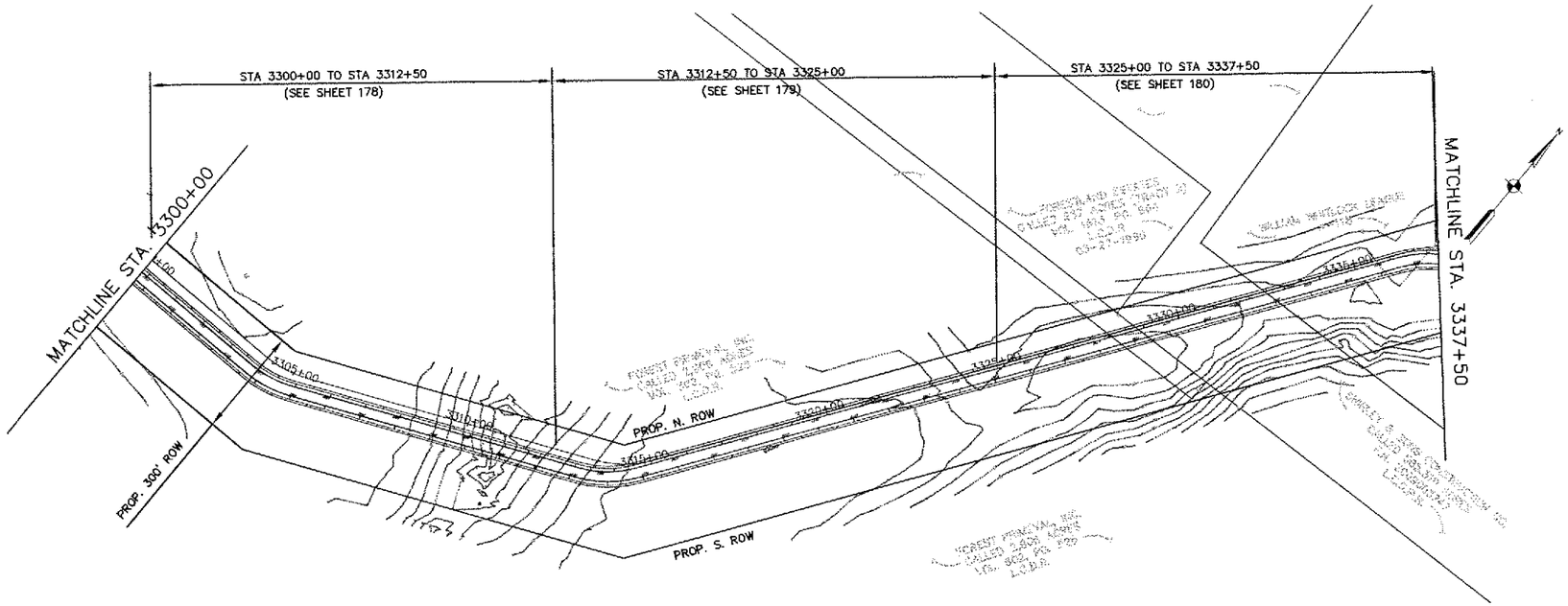
LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD SHEET LAYOUT AND BORING PLAN (SHEET 3 OF 4)

DRAWING SCALE
AS SHOWN

SHEET NO. 30 OF 245

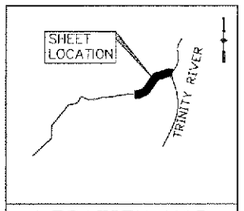
LAST MODIFIED: Jan 27, 2011 - 5:41pm BY USER: ThompsonBl
DWG. LOCATION: D:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: overallaycutroad3.dwg



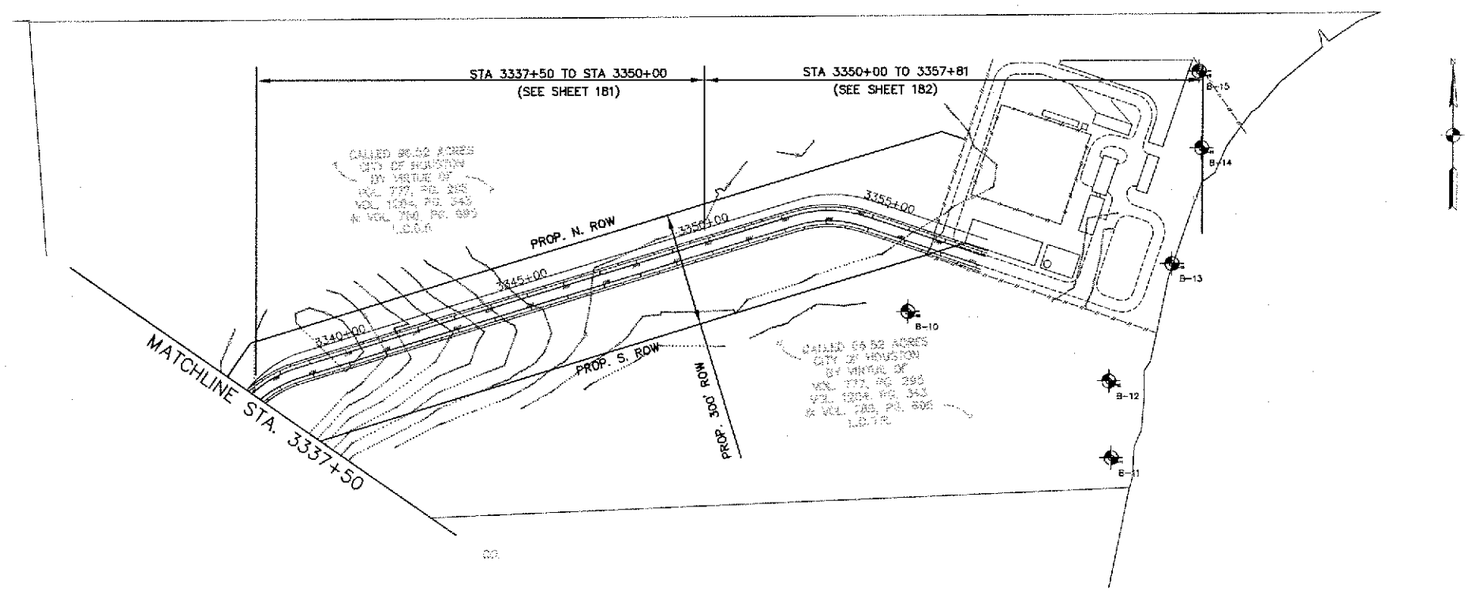
200 0 200 400
HORIZONTAL SCALE: 1" = 400'

LEGEND

BOREHOLE



LOCATION MAP



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TBPE REGISTRATION
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713.780.0838 fax.

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COASTAL WATER AUTHORITY

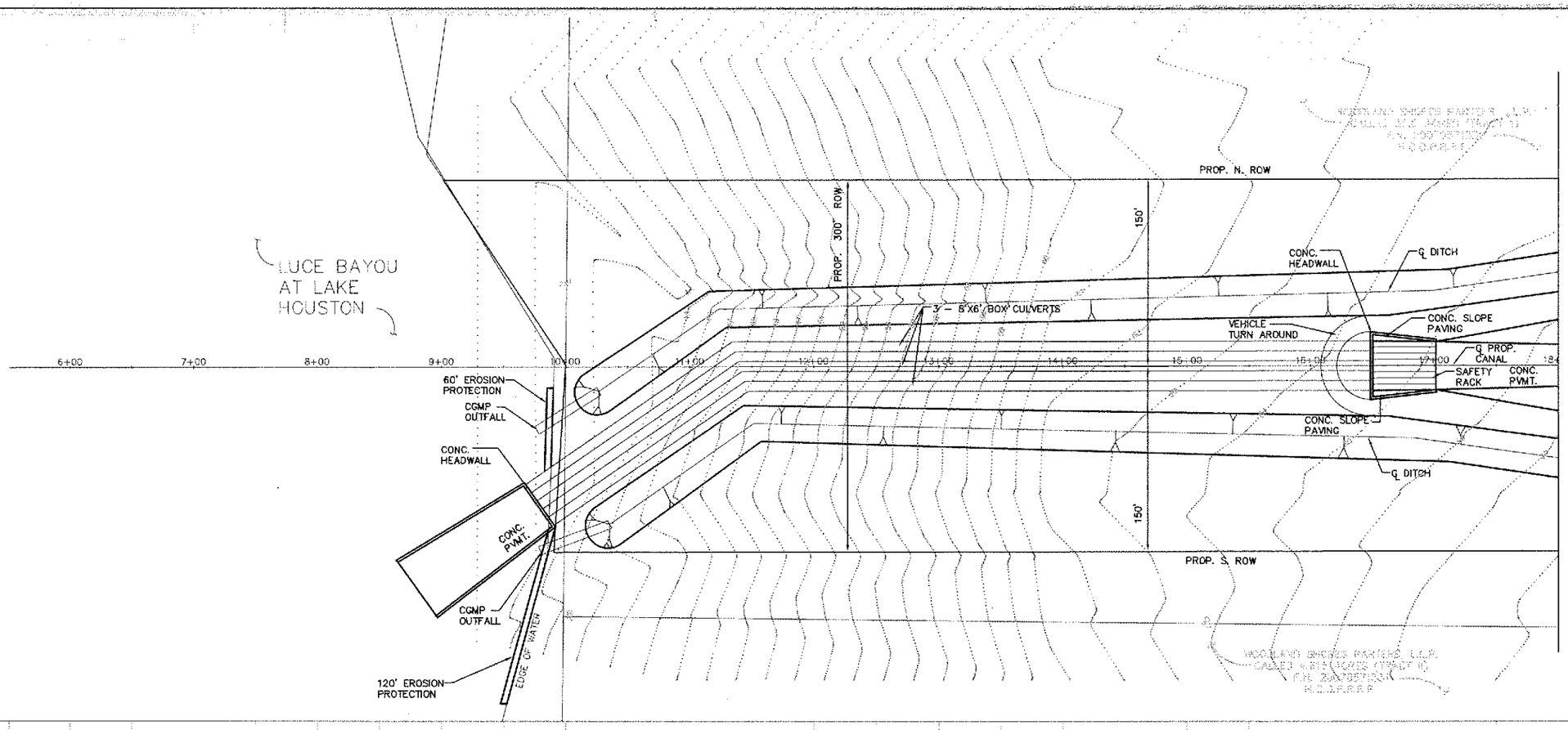
LUCE BAYOU INTERBASIN TRANSFER PROJECT

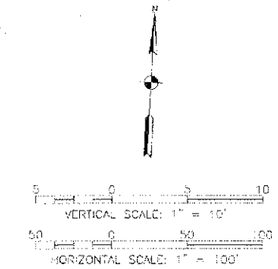
ACCESS ROAD SHEET
LAYOUT AND BORING
PLAN (SHEET 4 OF 4)

DRAWING SCALE
AS SHOWN

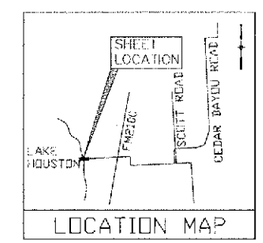
SHEET NO. 31 OF 245

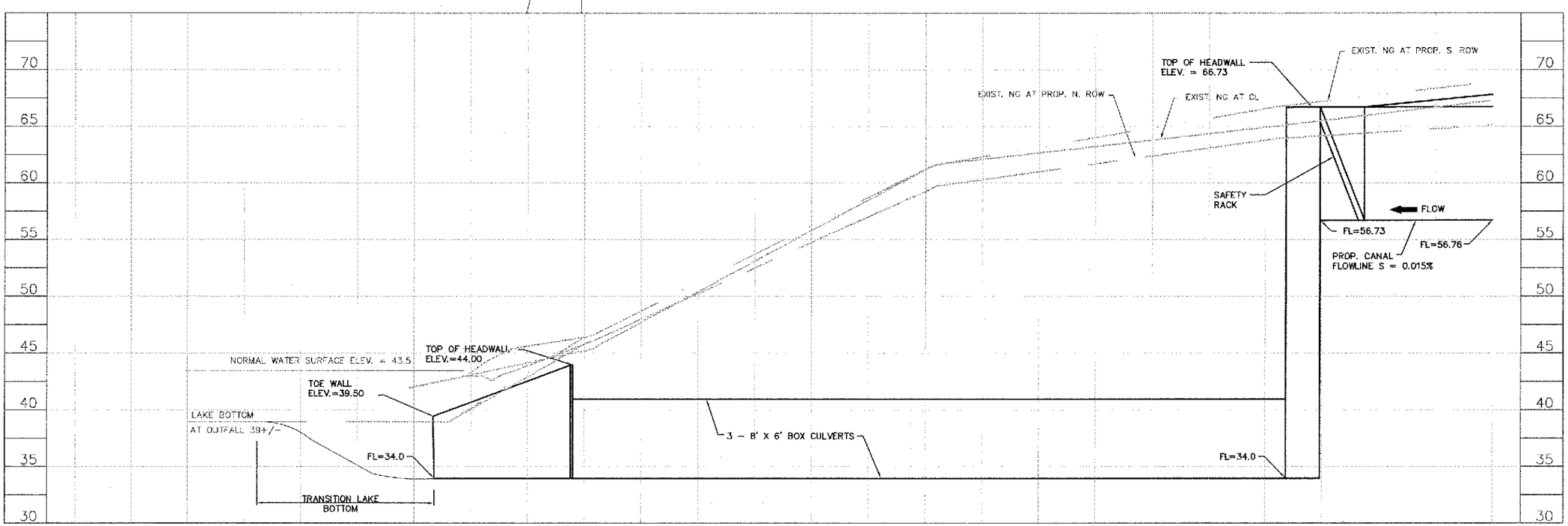
LAST MODIFIED: Jan 27, 2011 – 5:42pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: overallloyoutroad4.dwg





NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN





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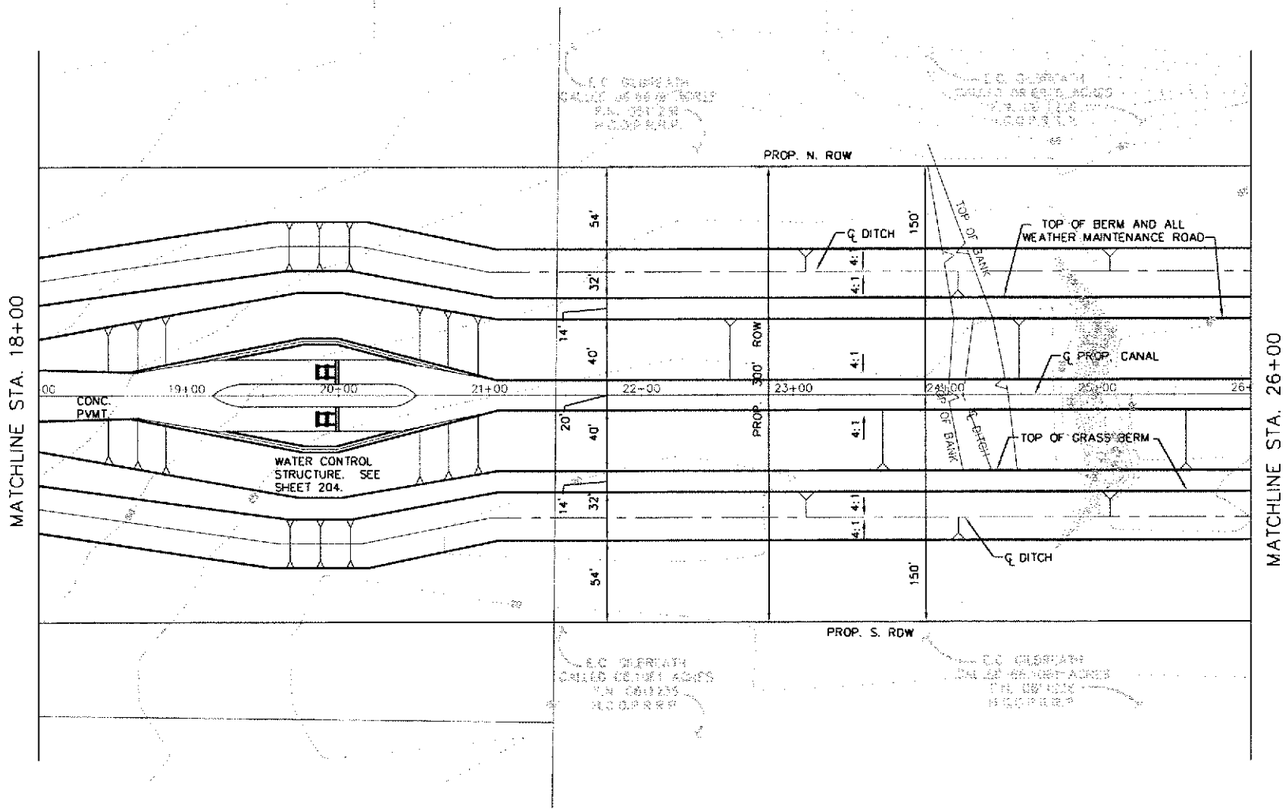
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

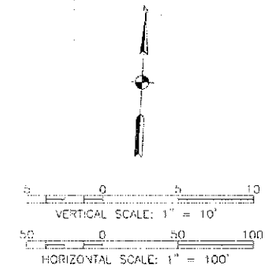
CANAL PLAN & PROFILE STA 5+50 TO STA 18+00

DRAWING SCALE
AS SHOWN

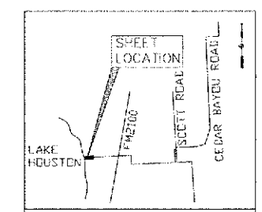
SHEET NO. 32 OF 245

LAST MODIFIED: Jan 27, 2011 – 3:33pm BY USER: Thompson(B)
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: ConcIP&PO.dwg

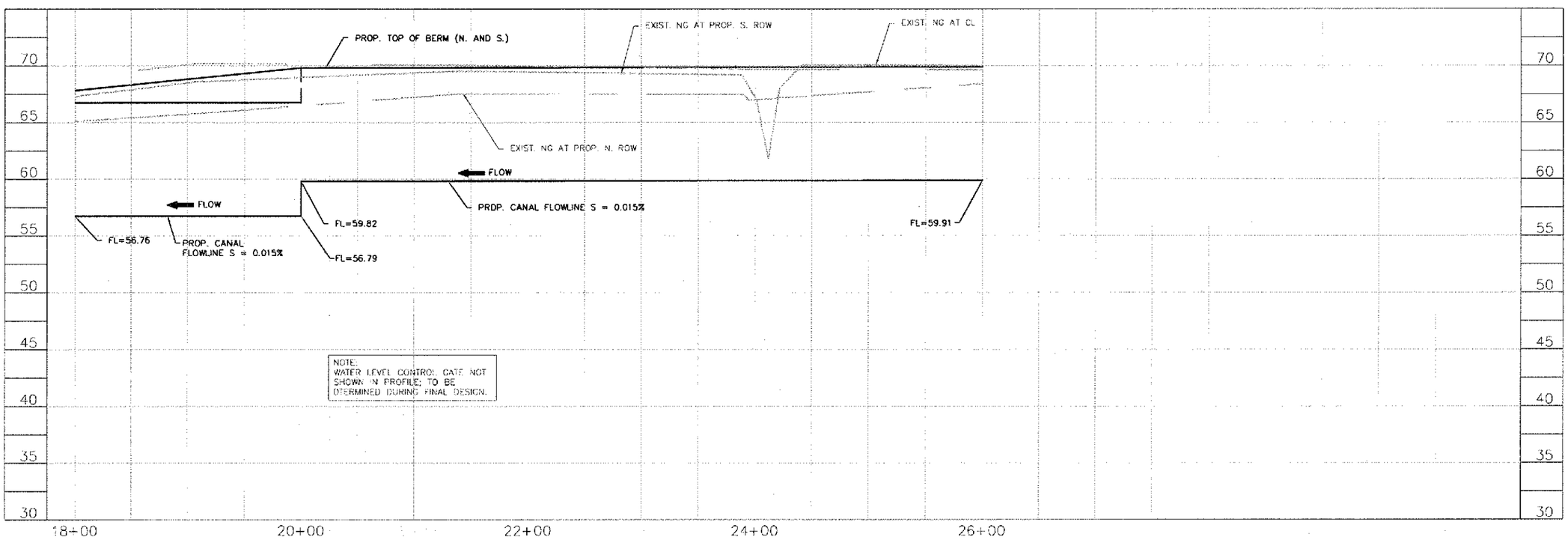




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



NOTE:
WATER LEVEL CONTROL GATE NOT SHOWN IN PROFILE; TO BE DTERMINED DURING FINAL DESIGN.

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COASTAL WATER AUTHORITY

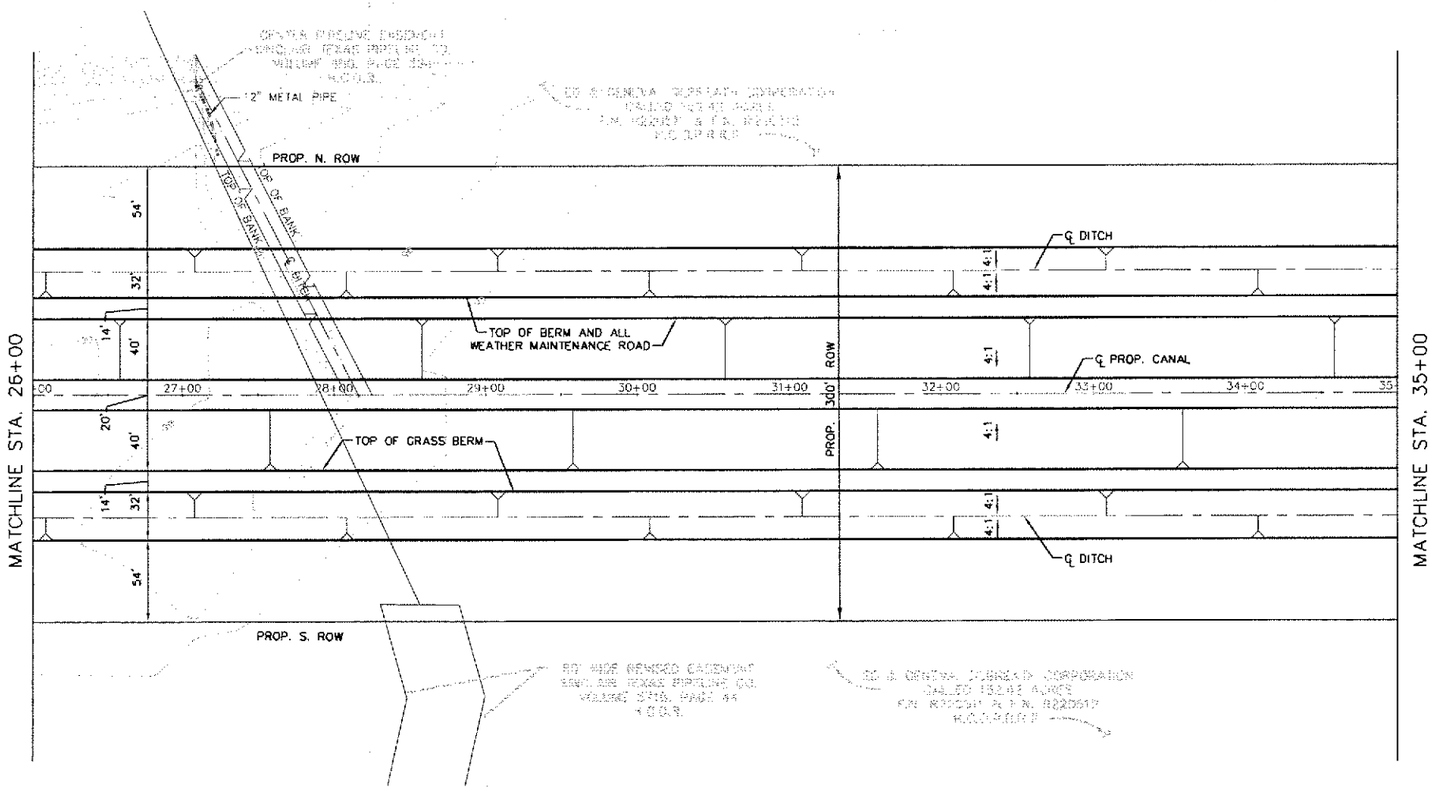
LUCE BAYOU INTERBASIN TRANSFER PROJECT

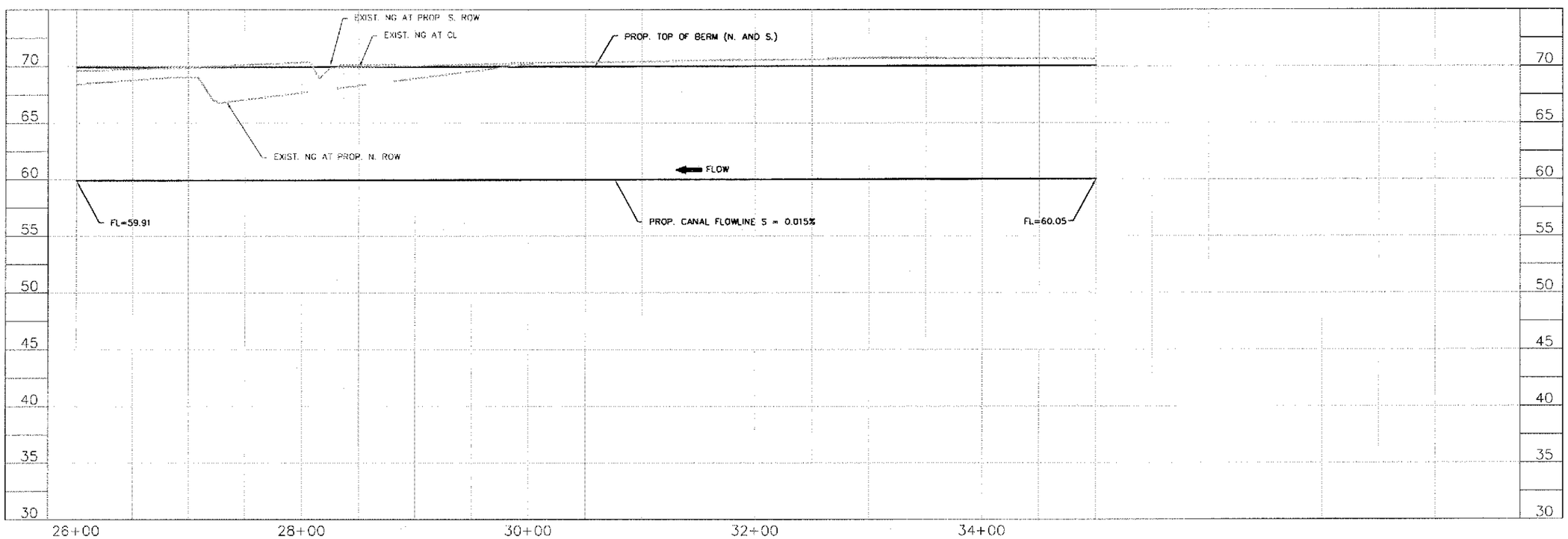
CANAL PLAN & PROFILE STA 18+00 TO STA 26+00

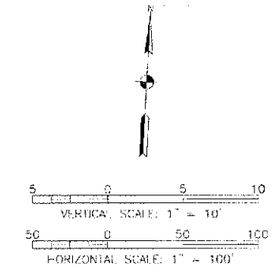
DRAWING SCALE
AS SHOWN

SHEET NO. 33 OF 245

LAST MODIFIED: Jan 27, 2011 - 3:34pm BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 61410 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: ConcPlan1.dwg

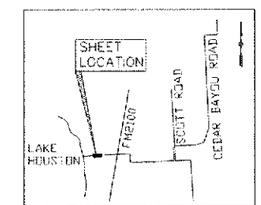






NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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713.780.0838 fax.

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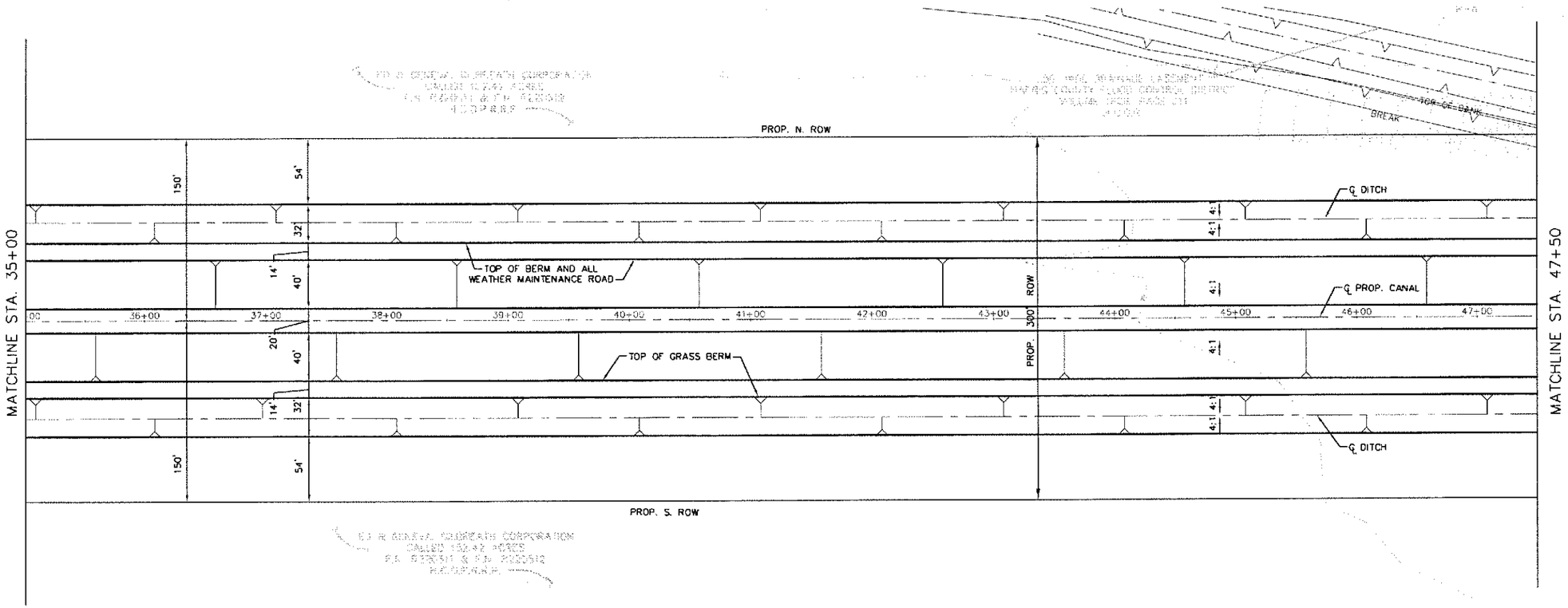
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

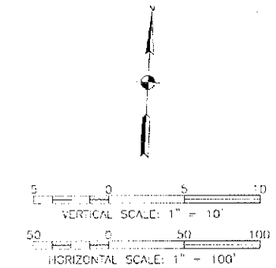
CANAL PLAN &
PROFILE STA 26+00
TO STA 35+00

DRAWING SCALE
AS SHOWN

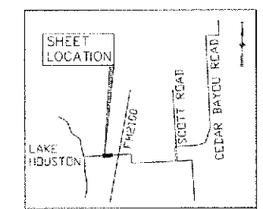
SHEET NO. 34 OF 245

LAST MODIFIED: Jan 27, 2011 - 3:35pm BY USER: ThompsonBI
DWG. LOCATION: Q:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P2.dwg

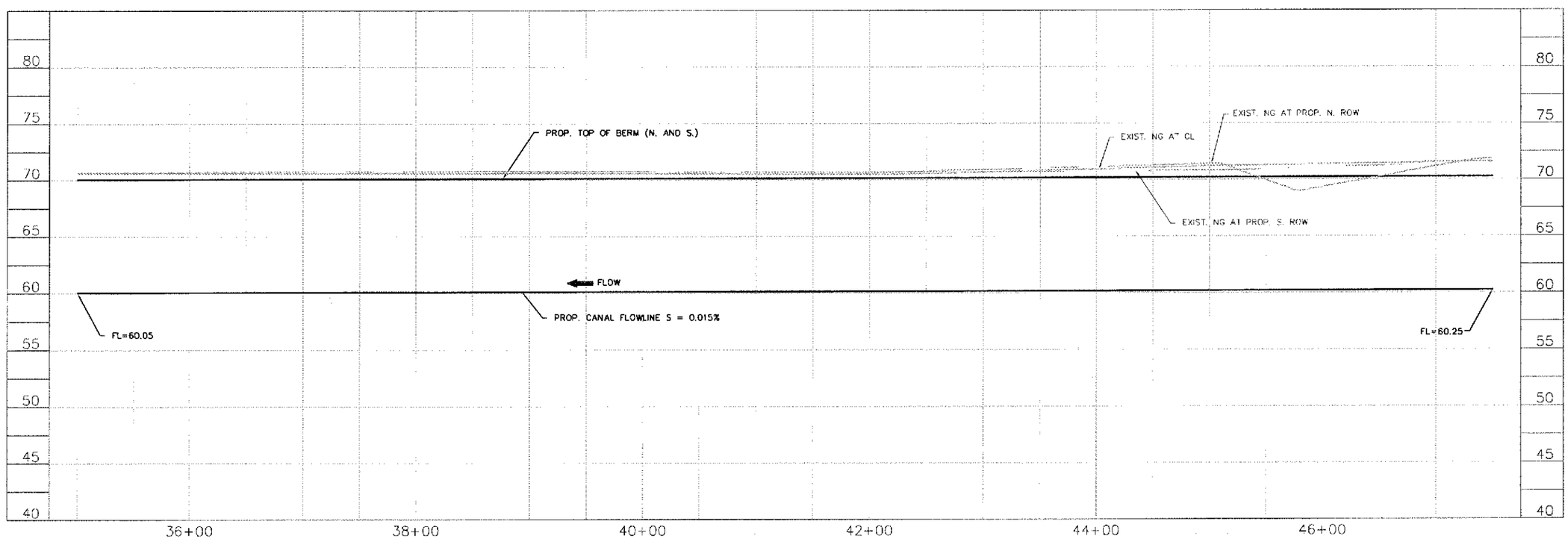




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



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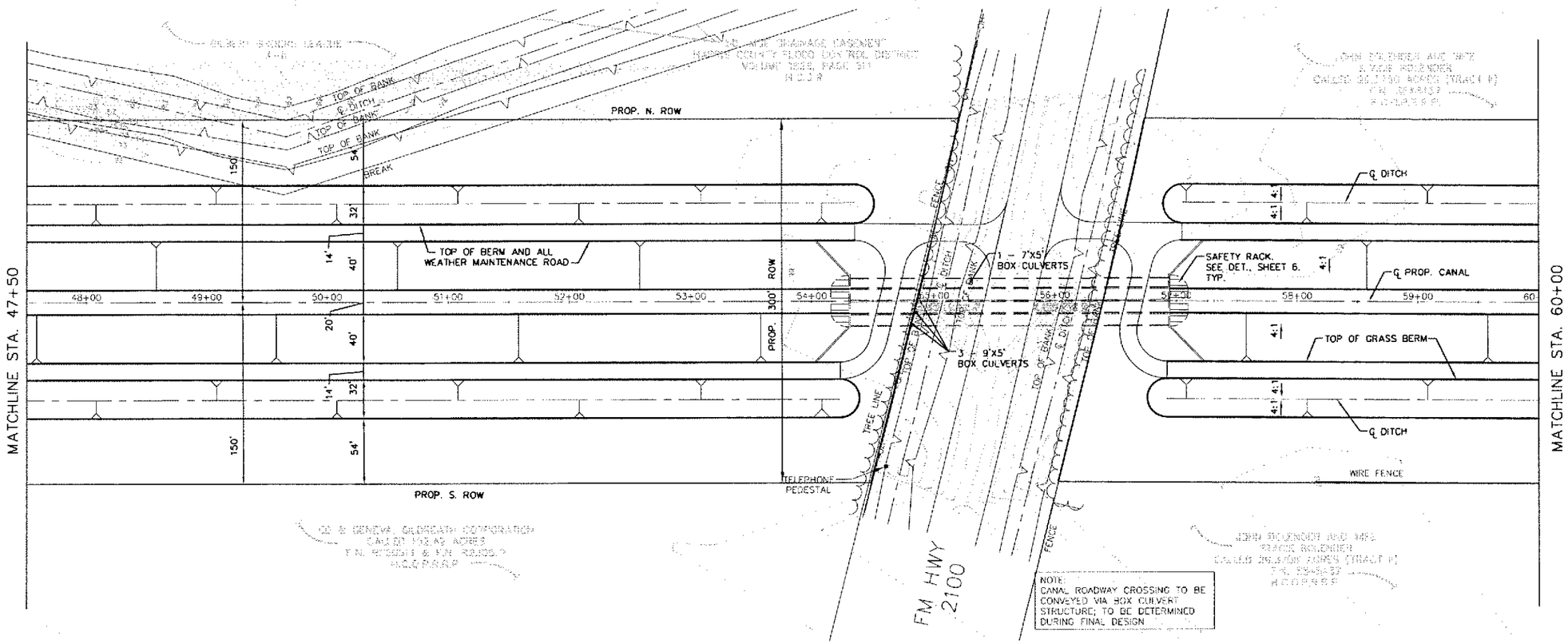
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN &
PROFILE STA 35+00
TO STA 47+50

DRAWING SCALE
AS SHOWN

SHEET NO. 35 OF 245

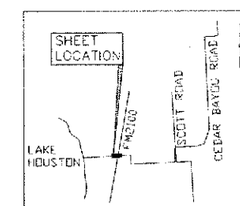
LAST MODIFIED: Jan 27, 2011 - 3:35pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P3.dwg



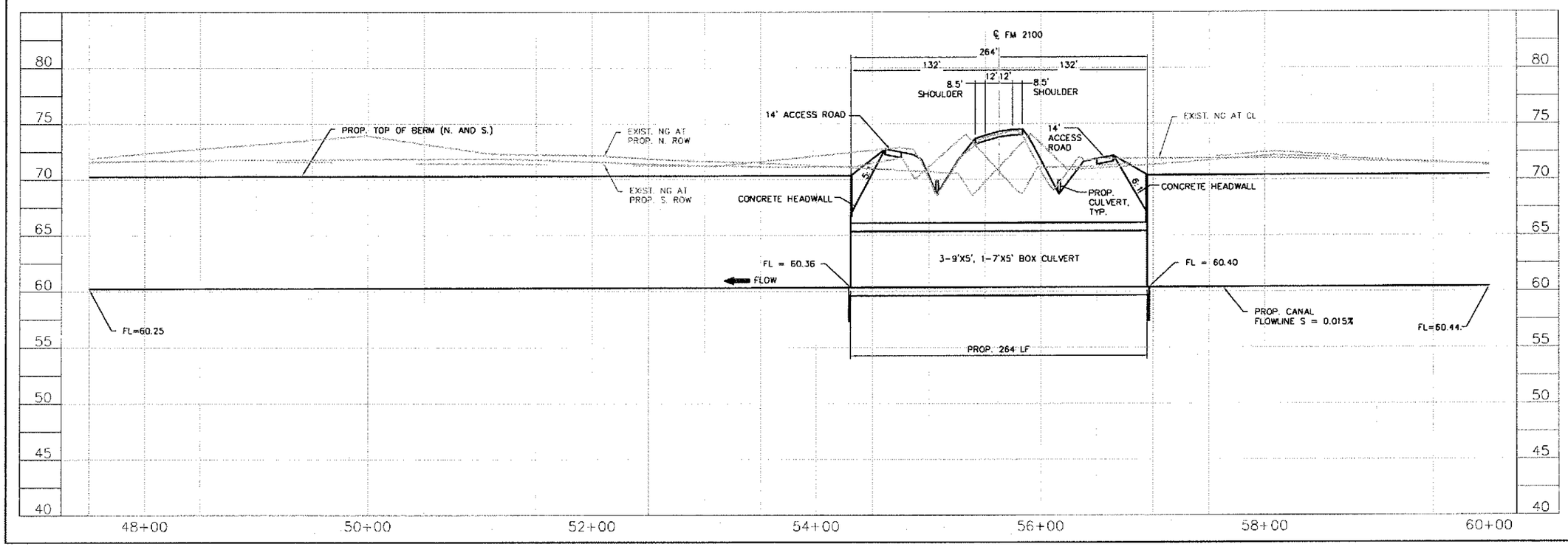
VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE: DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



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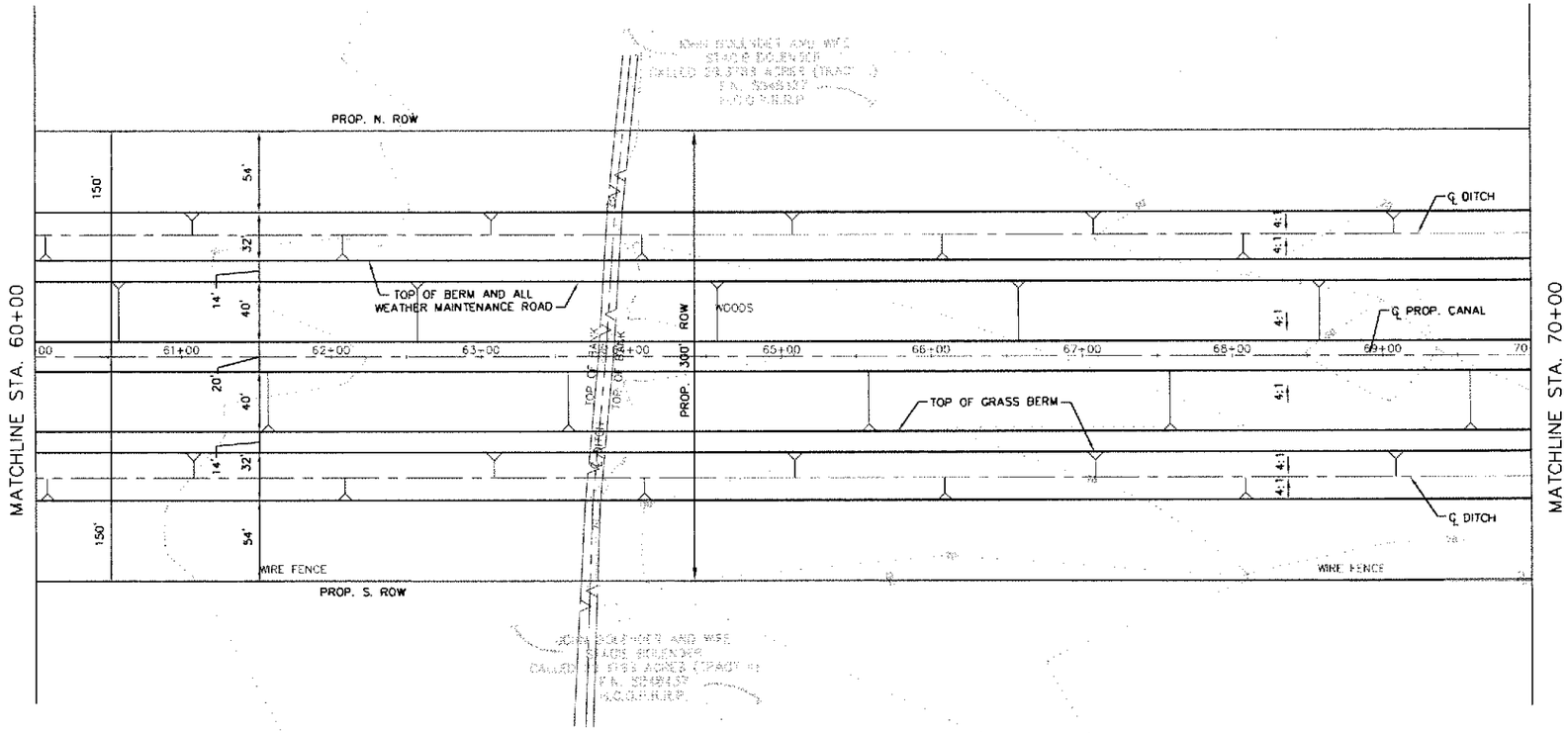
LUCE BAYOU INTERBASIN TRANSFER PROJECT

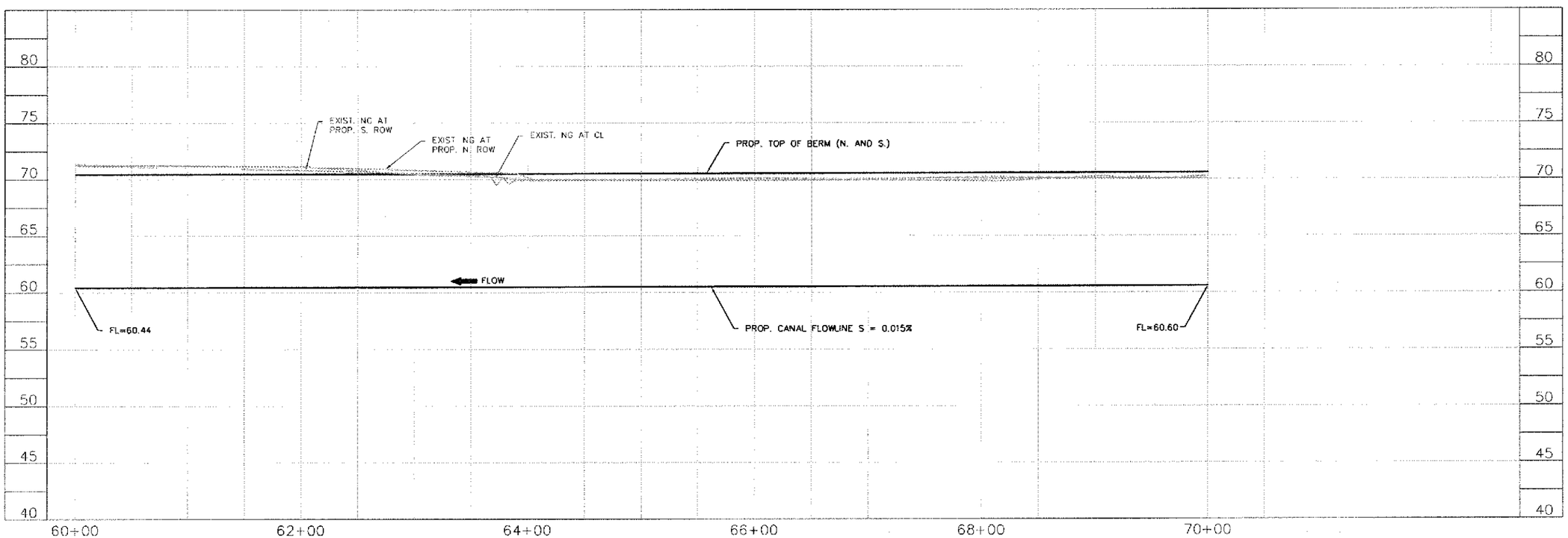
CANAL PLAN & PROFILE STA 47+50 TO STA 60+00

DRAWING SCALE
AS SHOWN

SHEET NO. 36 OF 245

LAST MODIFIED: Jan 27, 2011 - 3:36pm BY USER: ThompsonBi
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P4.dwg

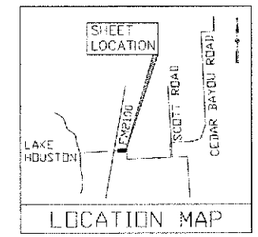




VERTICAL SCALE 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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AECOM

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713.780.0838 fax.

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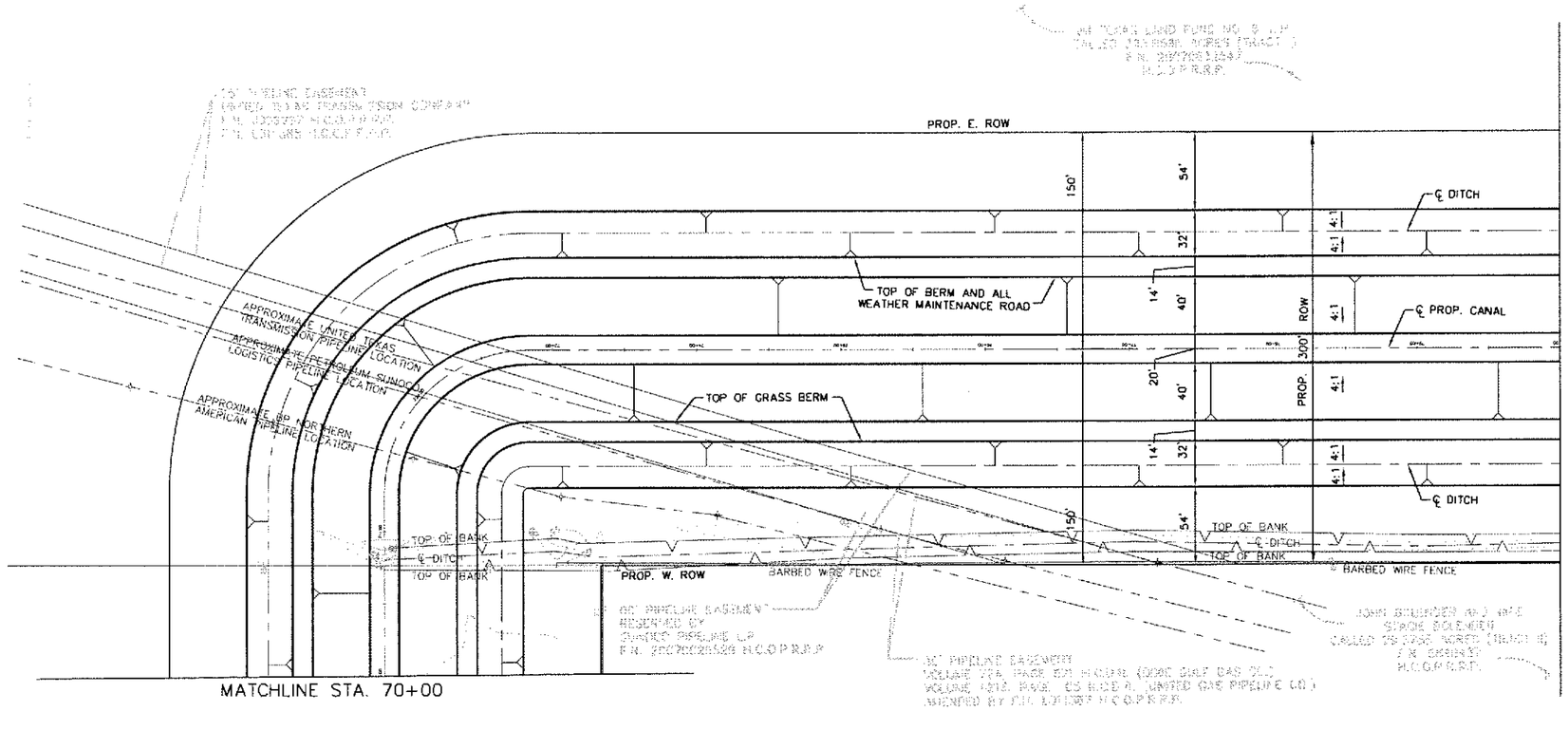
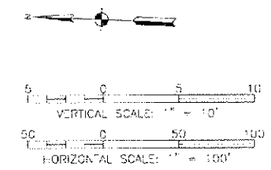
CANAL PLAN & PROFILE STA 60+00 TO STA 70+00

DRAWING SCALE
AS SHOWN

SHEET NO. 37 OF 245

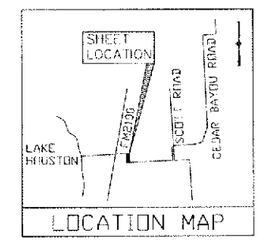
LAST MODIFIED: Jan 27, 2011 - 3:36pm BY USER: ThompsonBI
DWG. LOCATION: D:\Work Order 61\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWO\Sheets\
DWG. NAME: Canal\P&P5.dwg



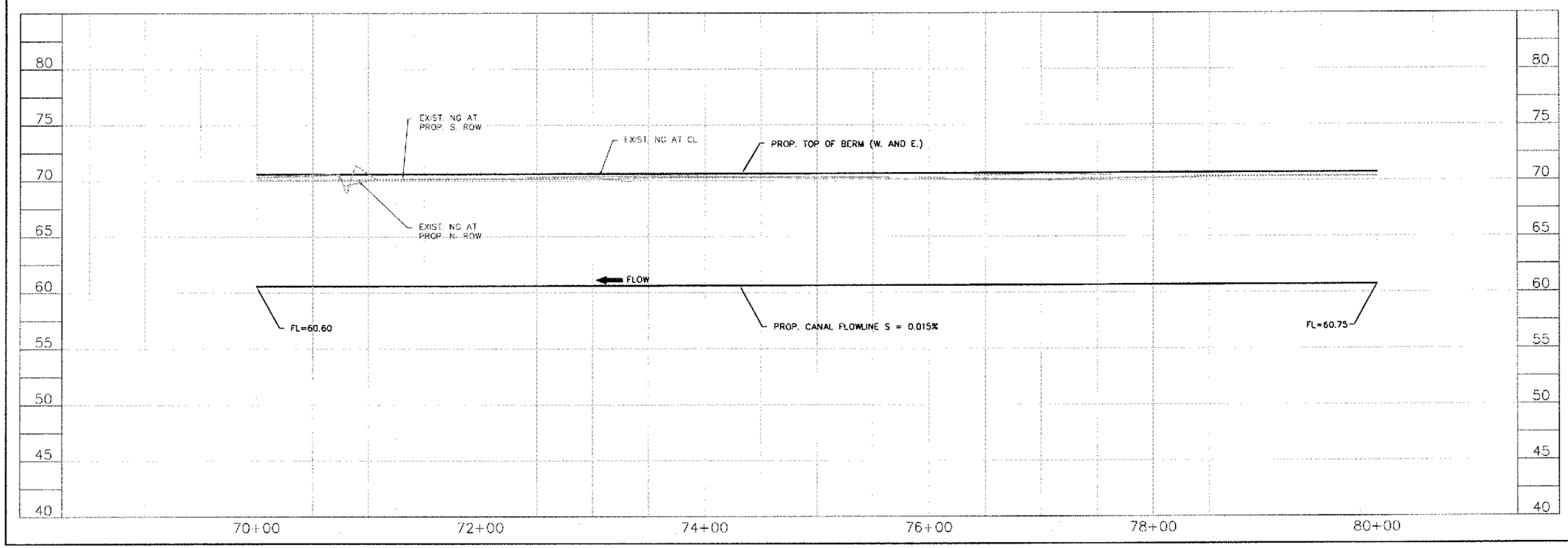


NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP



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713.780.0838 fax.

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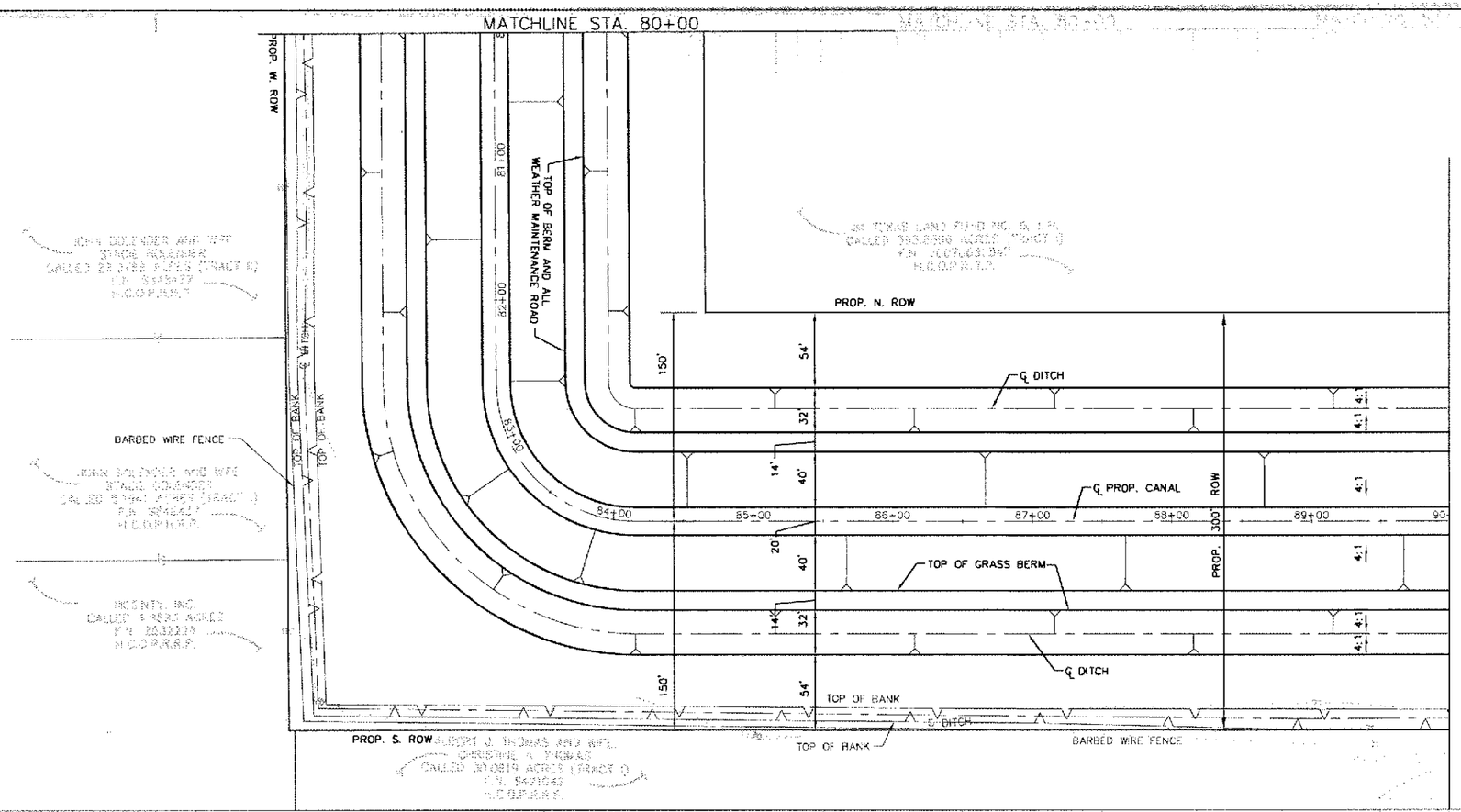
LUCE BAYOU INTERBASIN TRANSFER PROJECT

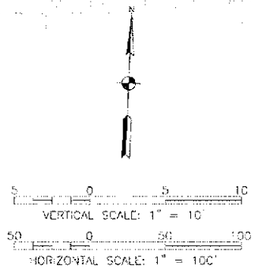
CANAL PLAN & PROFILE STA 70+00 TO STA 80+00

DRAWING SCALE
AS SHOWN

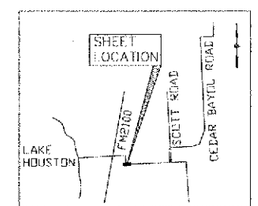
SHEET NO. 38 OF 245

LAST MODIFIED: Jan 27, 2011 - 3:37pm BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PW2\Sheets\
DWG. NAME: CanalP&P6.dwg

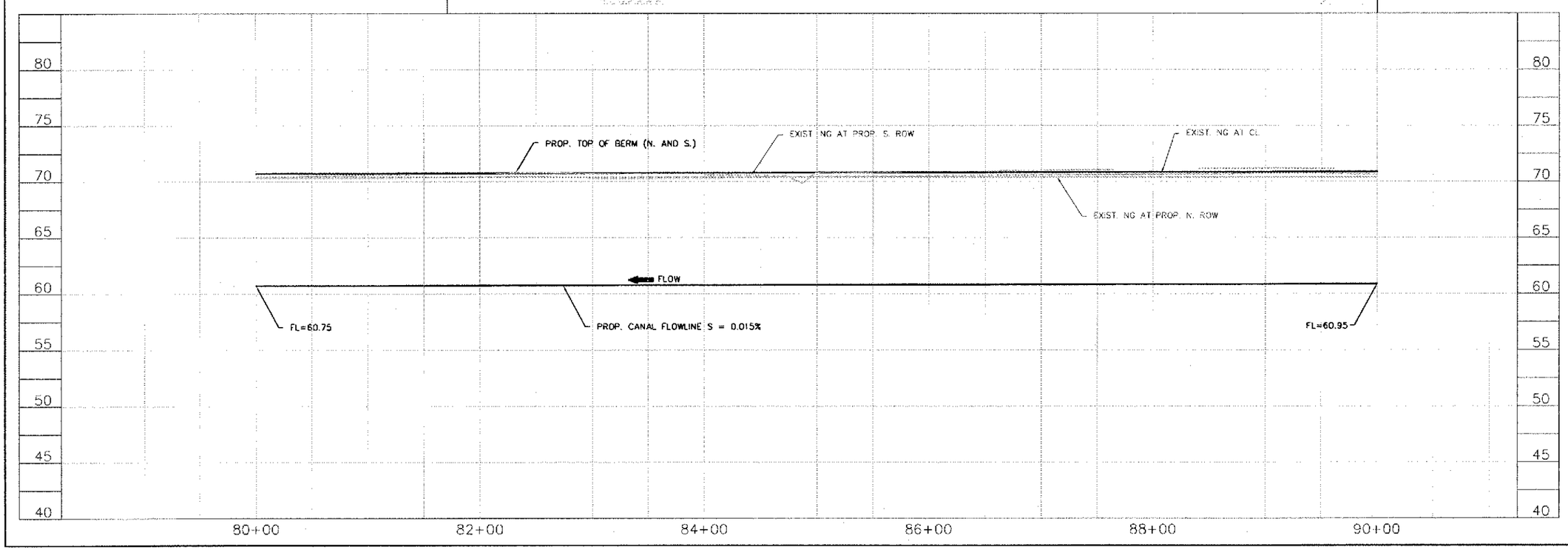




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



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713.780.0838 fax.

SURVEYED BY:
FB NO.

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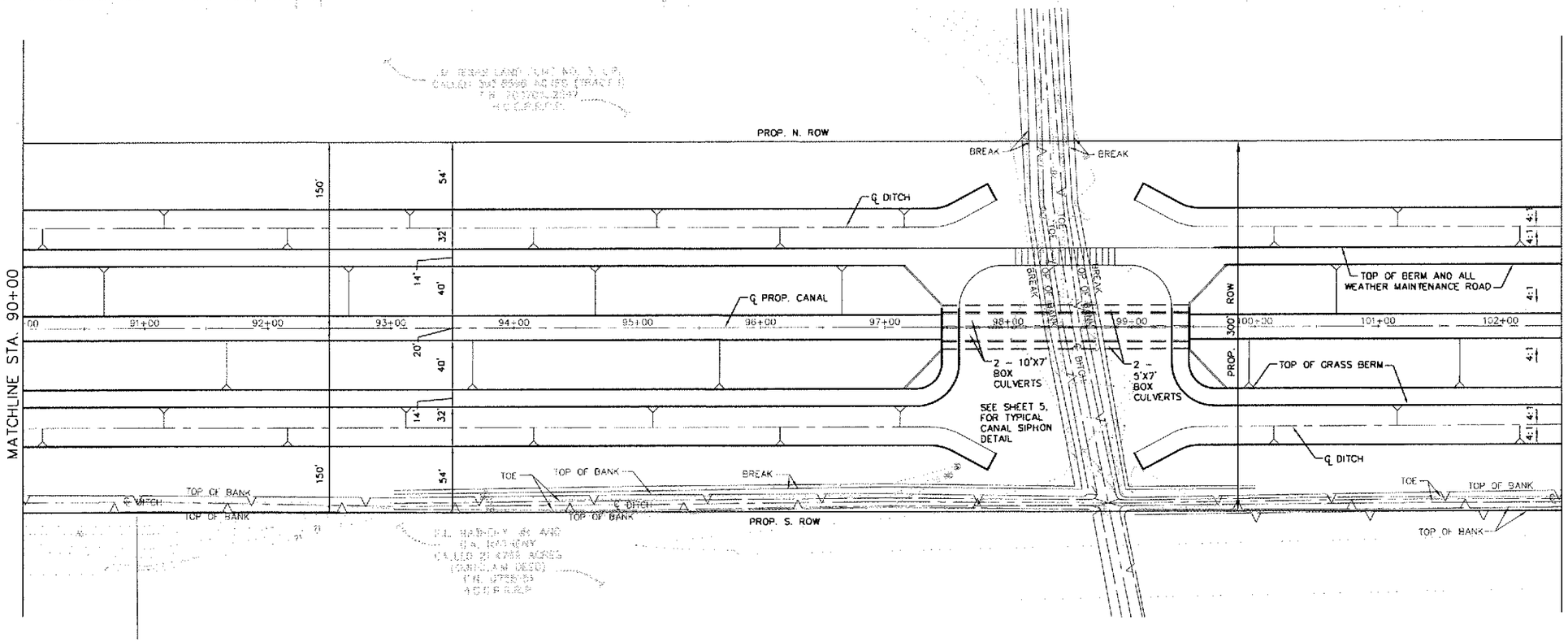
LUCE BAYOU INTERBASIN TRANSFER PROJECT

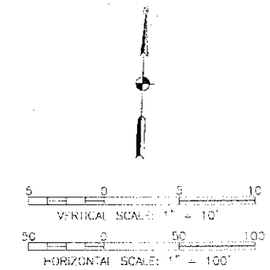
CANAL PLAN &
PROFILE STA 80+00
TO STA 90+00

DRAWING SCALE
AS SHOWN

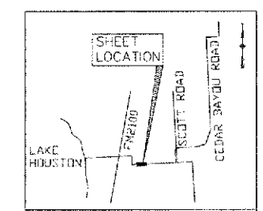
SHEET NO. 39 OF 245

LAST MODIFIED: Jan 27, 2011 – 3:37pm BY USER: ThompsonBl
DWG. LOCATION: G:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cad\PWD\Sheets\
DWG. NAME: CanalPlp27.dwg

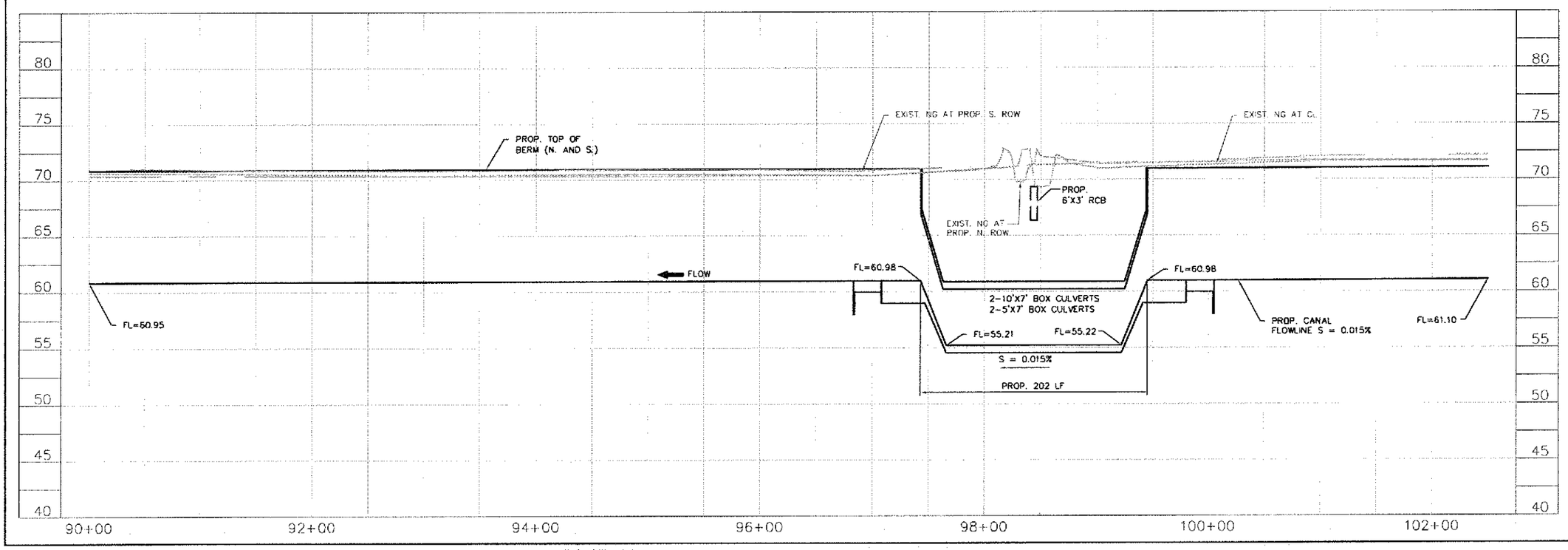




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



KEVIN R. KRAHN, P.E.
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HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax

SURVEYED BY:
FB NO.

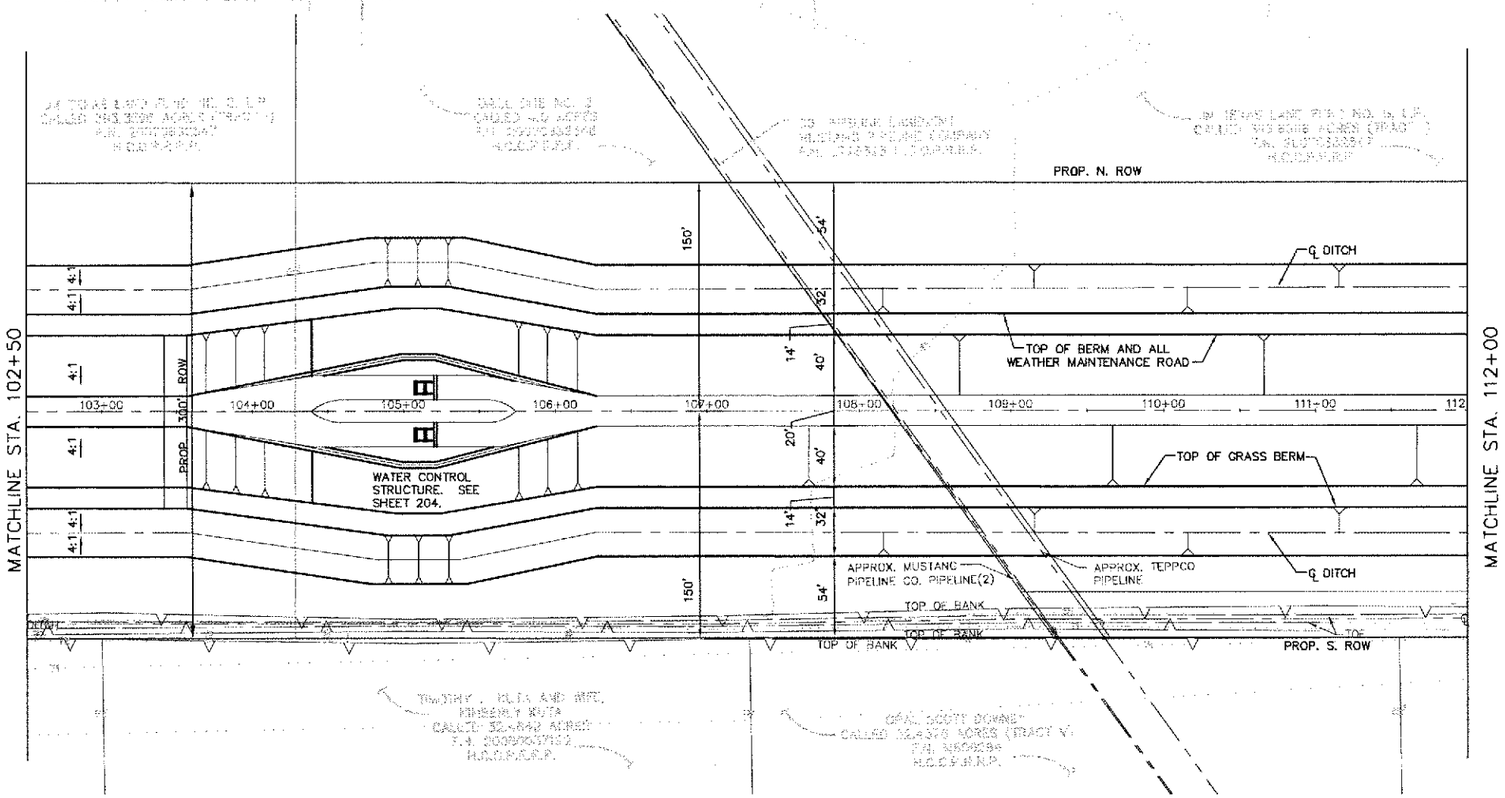
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

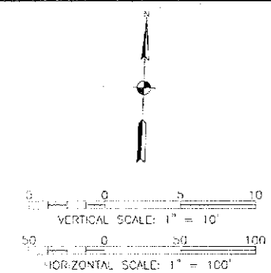
CANAL PLAN & PROFILE STA 90+00 TO STA 102+50

DRAWING SCALE
AS SHOWN

SHEET NO. 40 OF 245

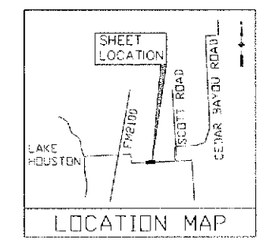
LAST MODIFIED: Jan 27, 2011 - 3:38pm, BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&PB.dwg



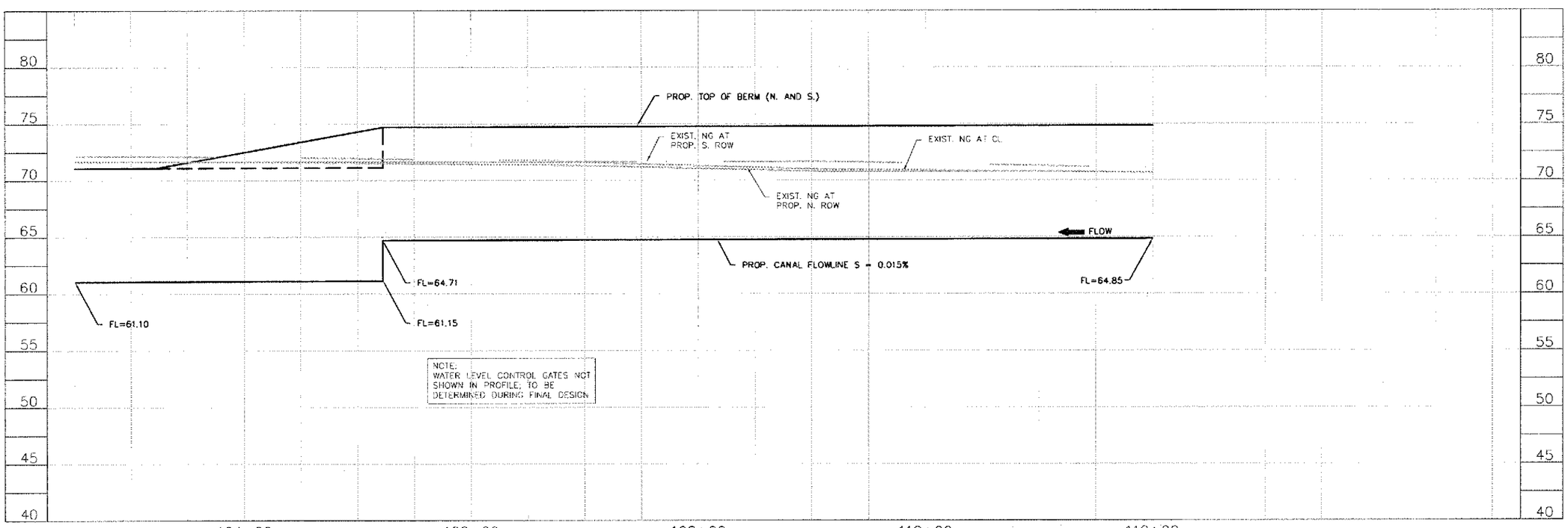


NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP



NOTE:
WATER LEVEL CONTROL GATES NOT SHOWN IN PROFILE; TO BE DETERMINED DURING FINAL DESIGN

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

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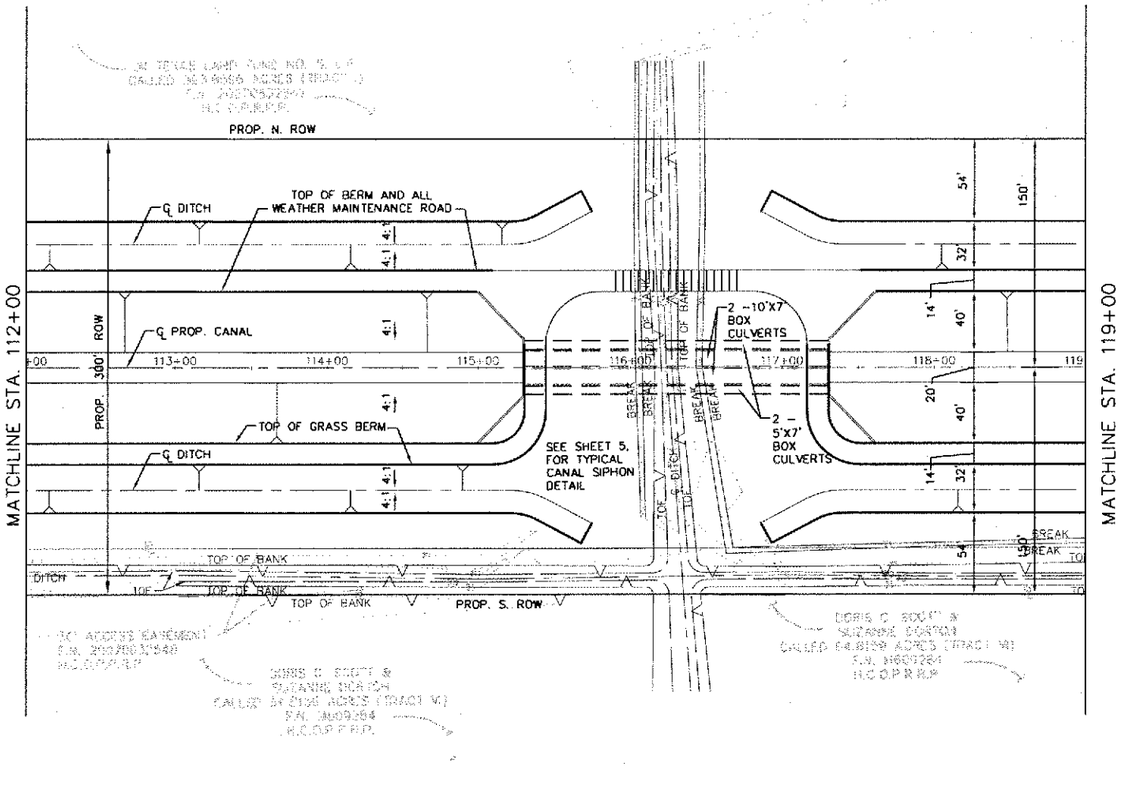
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

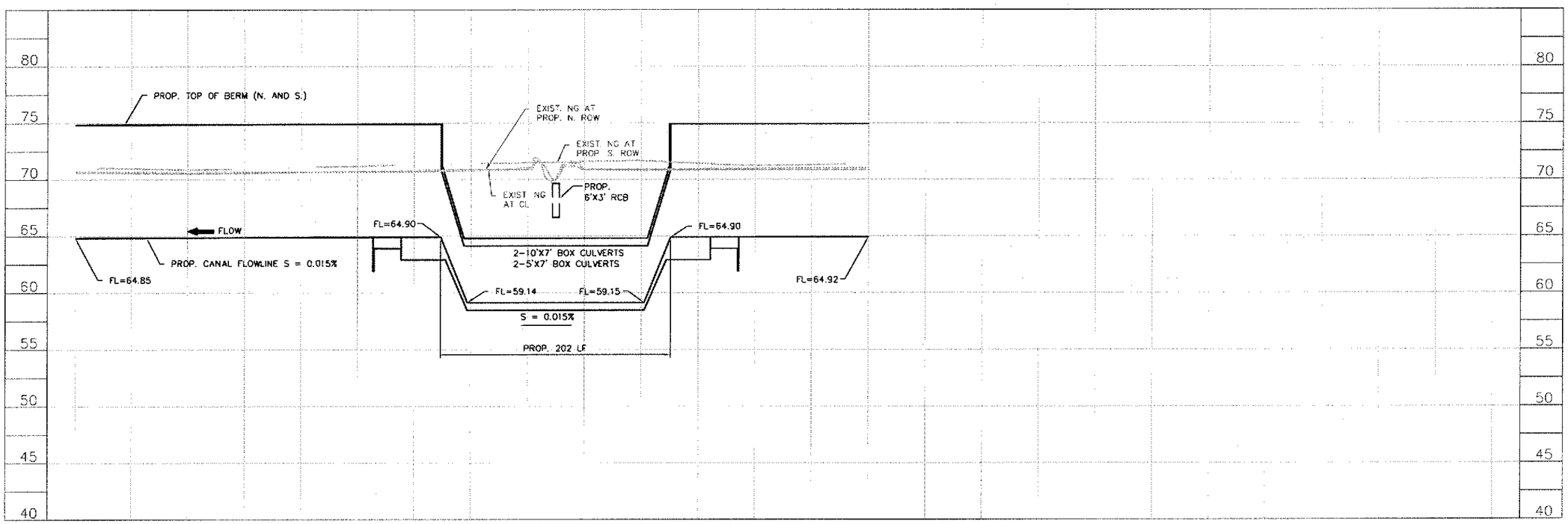
CANAL PLAN &
PROFILE STA 102+50
TO STA 112+00

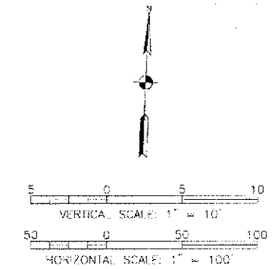
DRAWING SCALE
AS SHOWN

SHEET NO. 41 OF 245

LAST MODIFIED: Jan 27, 2011 - 3:39pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P9.dwg

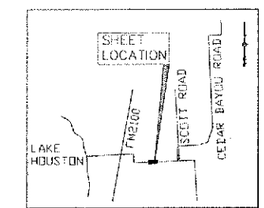






NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



KEVIN R. KRAHN, P.E.
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AECOM

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TBPE REG. NO. F-25490

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713.780.0838 fax.

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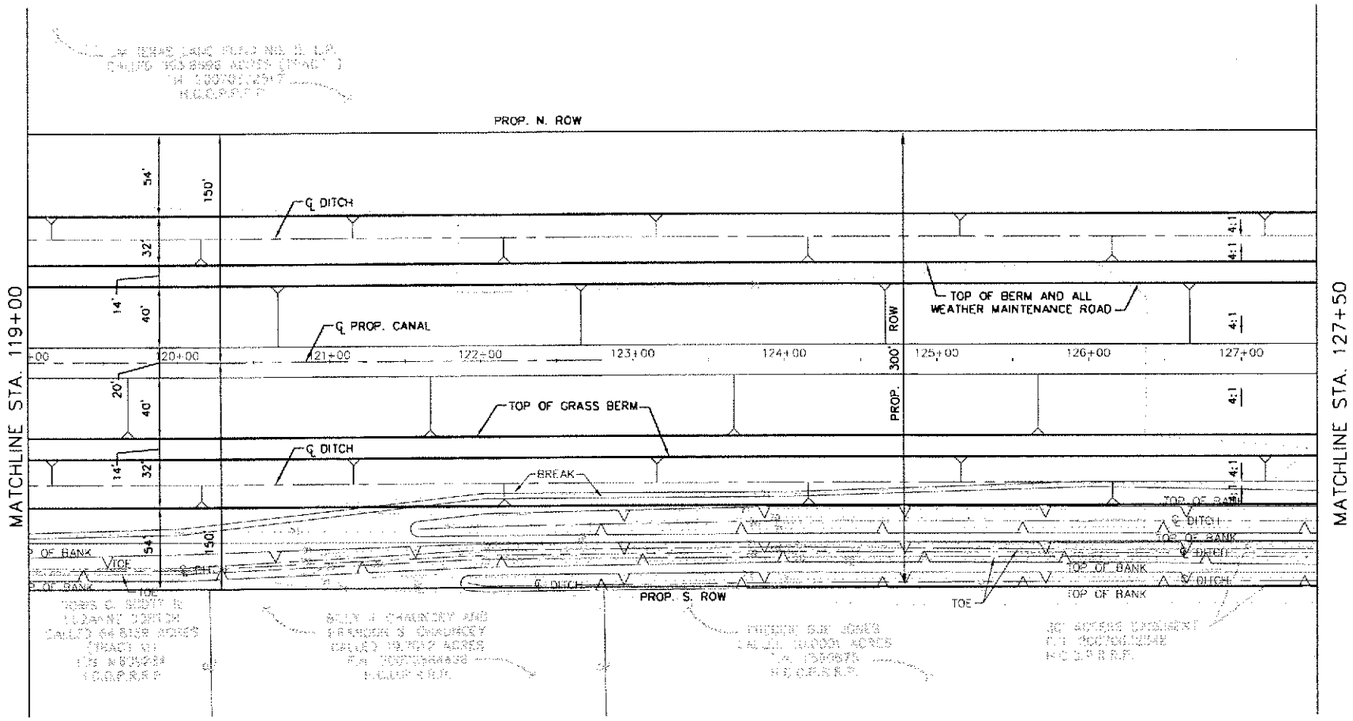
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

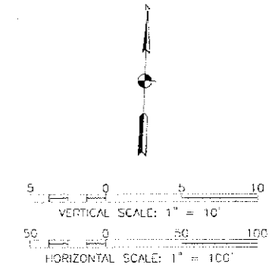
CANAL PLAN & PROFILE STA 112+00 TO STA 119+00

DRAWING SCALE
AS SHOWN

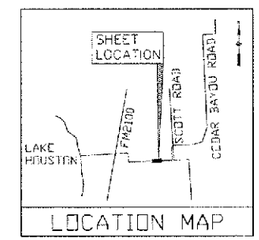
SHEET NO. 42 OF 245

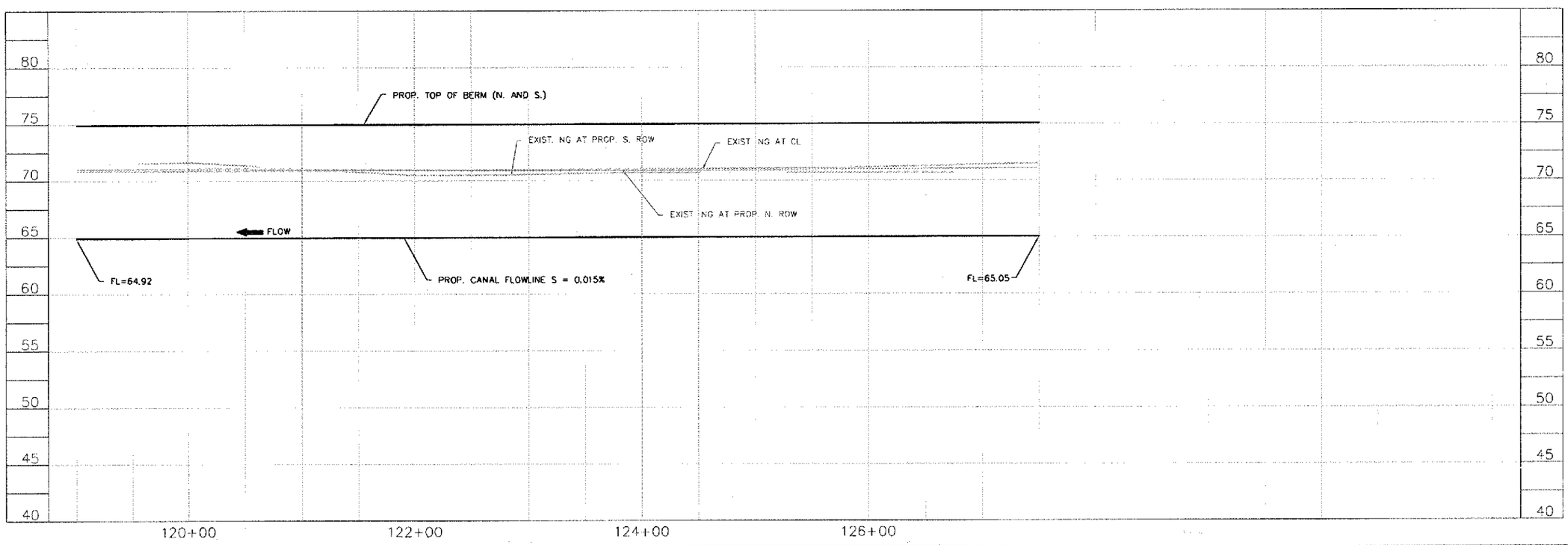
LAST MODIFIED: Jan 27, 2011 - 3:39pm BY USER: Thompsonjl
DWG. LOCATION: O:\Work Order 5\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Coddl\PWD\Sheets\
DWG. NAME: CanalP&PSb.dwg





NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN





KEVIN R. KRAHN, P.E.
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INTERIM SUBMITTAL
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AECOM
AECOM TECHNICAL SERVICES, INC.
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FB NO.

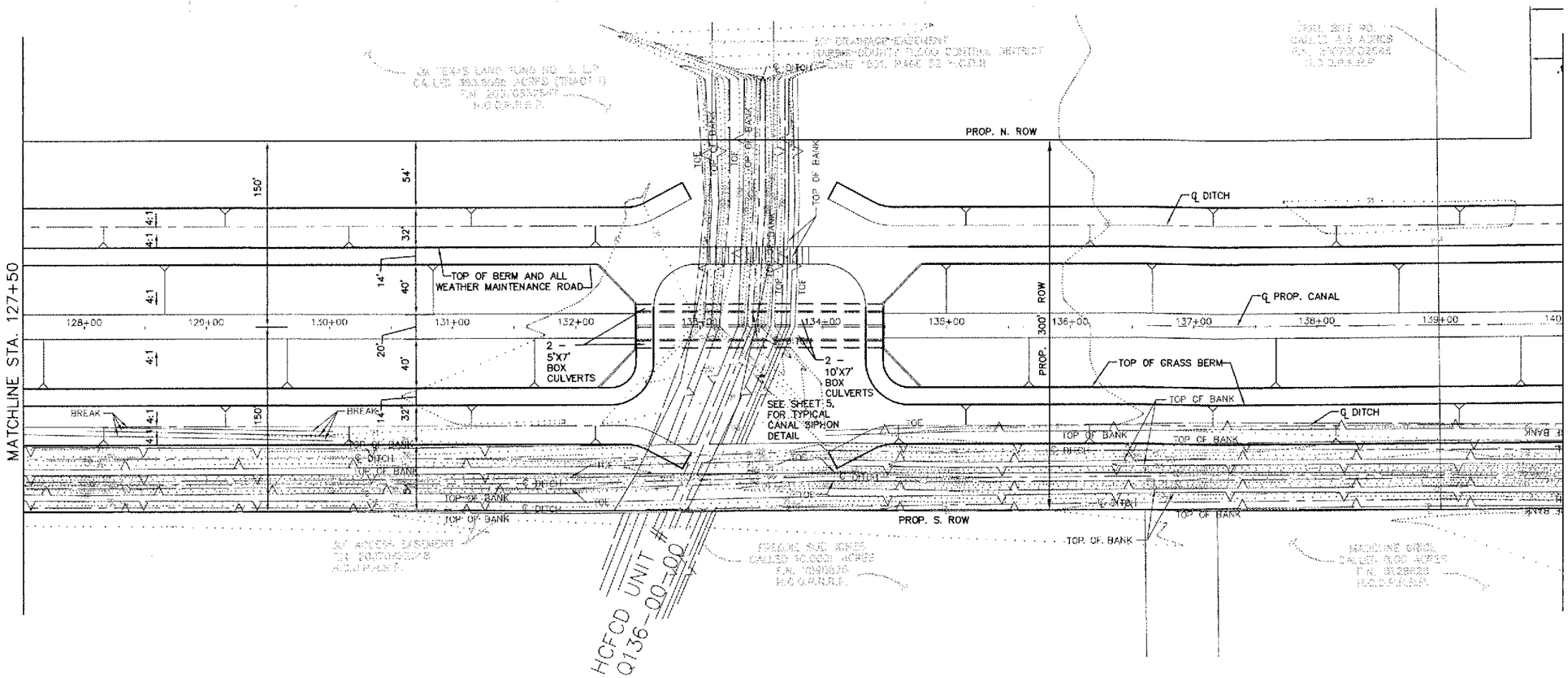
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

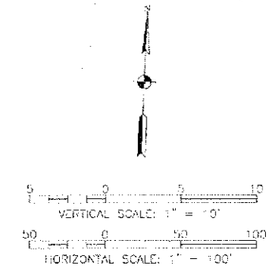
CANAL PLAN & PROFILE STA 119+00 TO STA 127+50

DRAWING SCALE
AS SHOWN

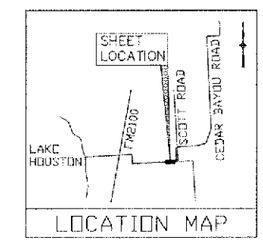
SHEET NO. 43 OF 245

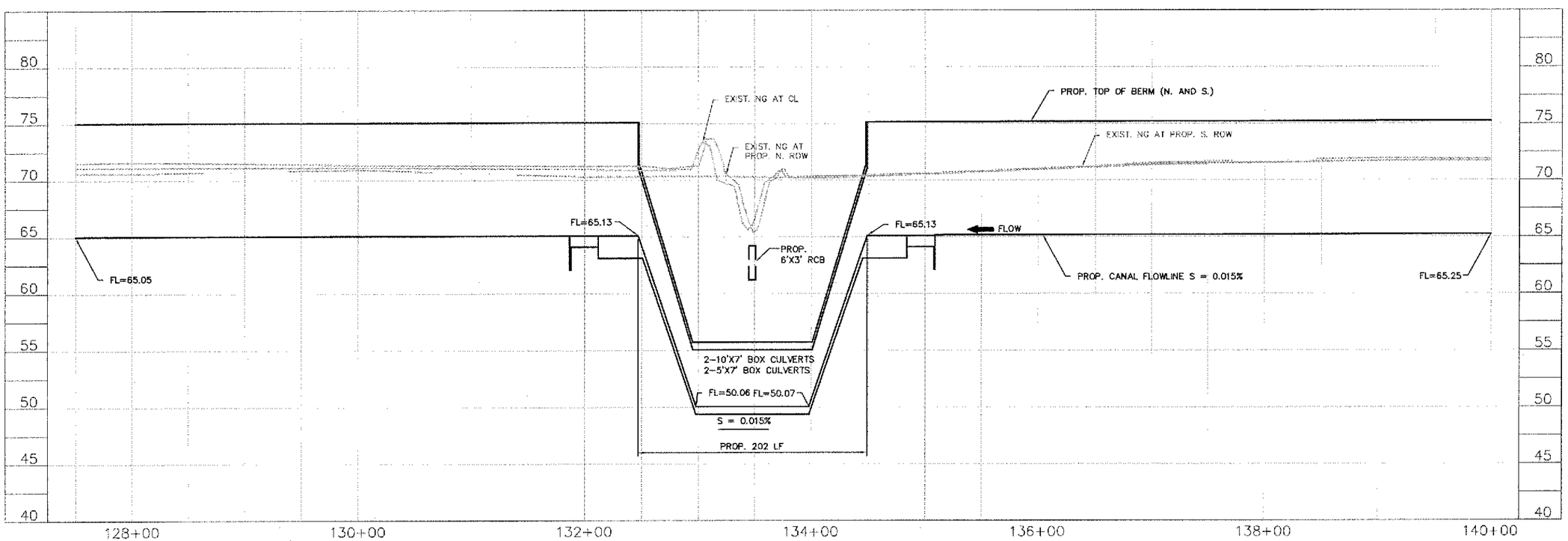
LAST MODIFIED: Jan 27, 2011 – 3:40pm BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWO\Sheets\
DWG. NAME: CanalP&P10.dwg





NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN





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AECOM

AECOM TECHNICAL SERVICES, INC.
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713.780.0838 fax.

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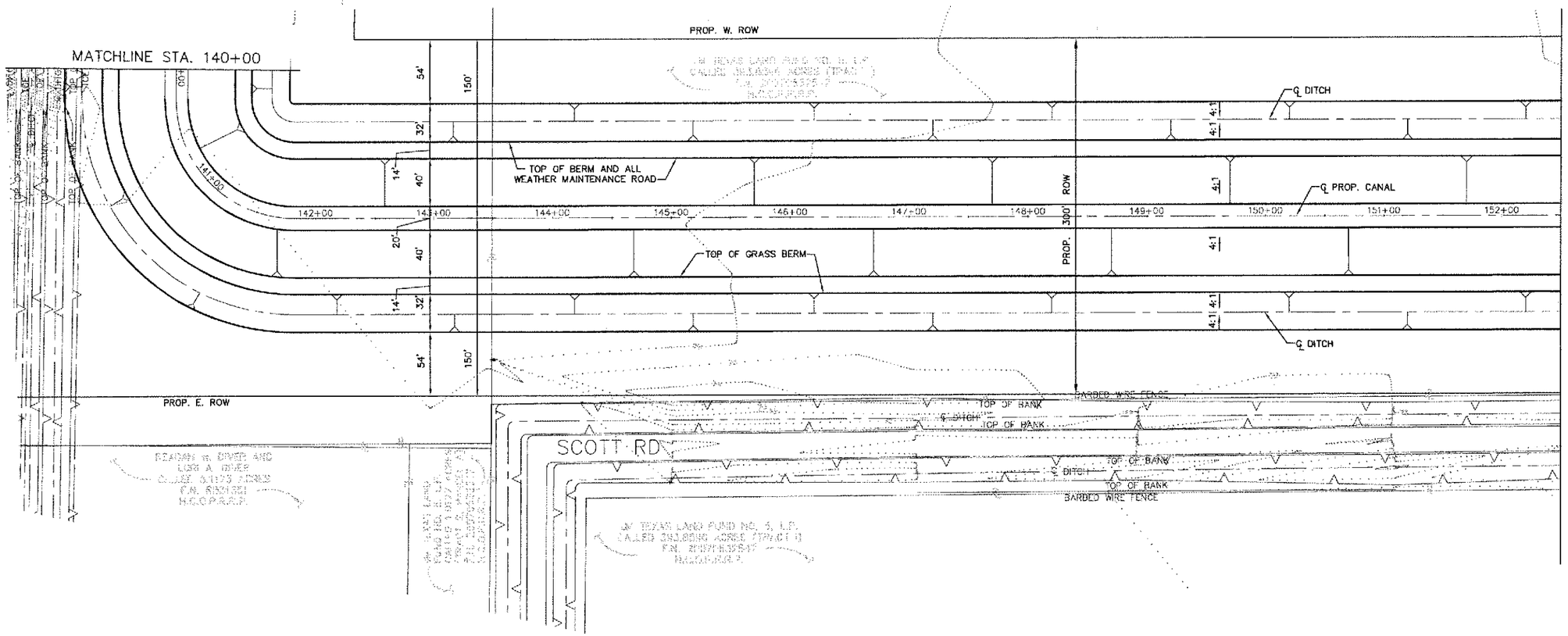
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

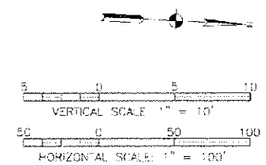
CANAL PLAN & PROFILE STA 127+50 TO STA 140+00

DRAWING SCALE
AS SHOWN

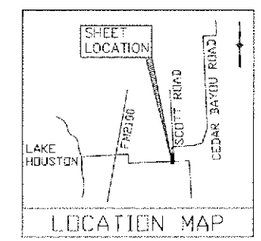
SHEET NO. 44 OF 245

LAST MODIFIED: Jan 27, 2011 – 3:47pm BY USER: ThompsonBI
DWG. LOCATION: D:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P11.dwg

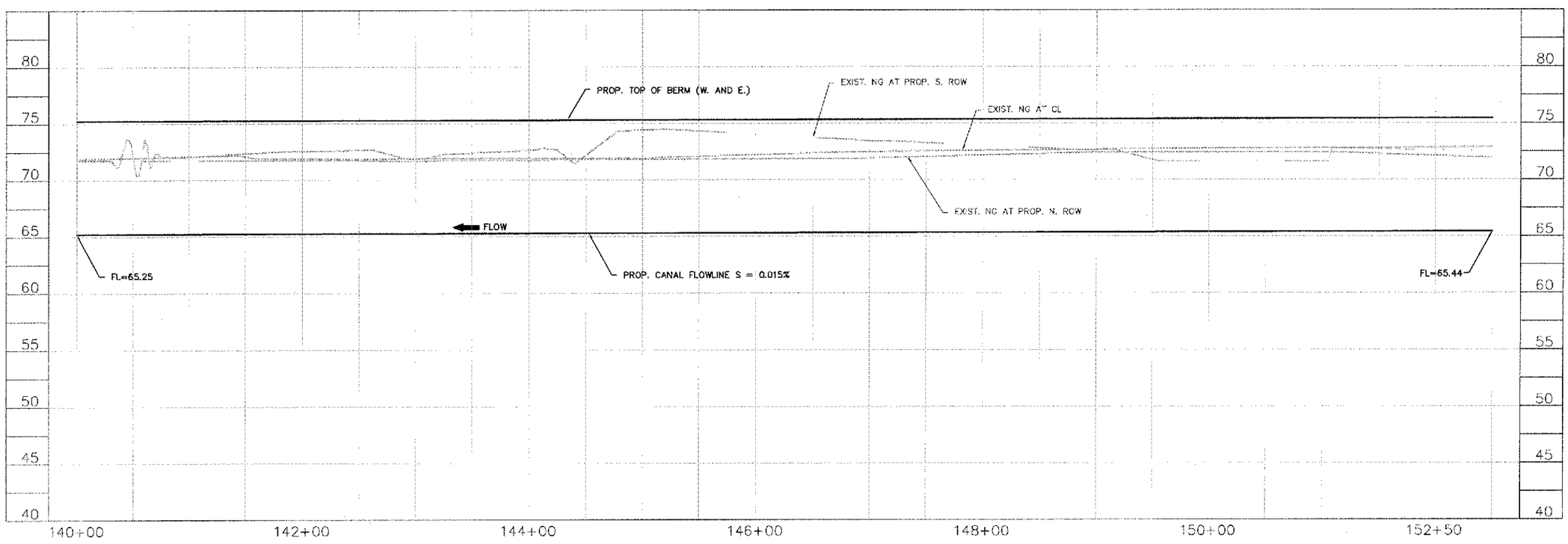




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



KEVIN R. KRAHN, P.E.
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AECOM

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HOUSTON, TEXAS 77057
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713.780.0838 fax.

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COASTAL WATER AUTHORITY

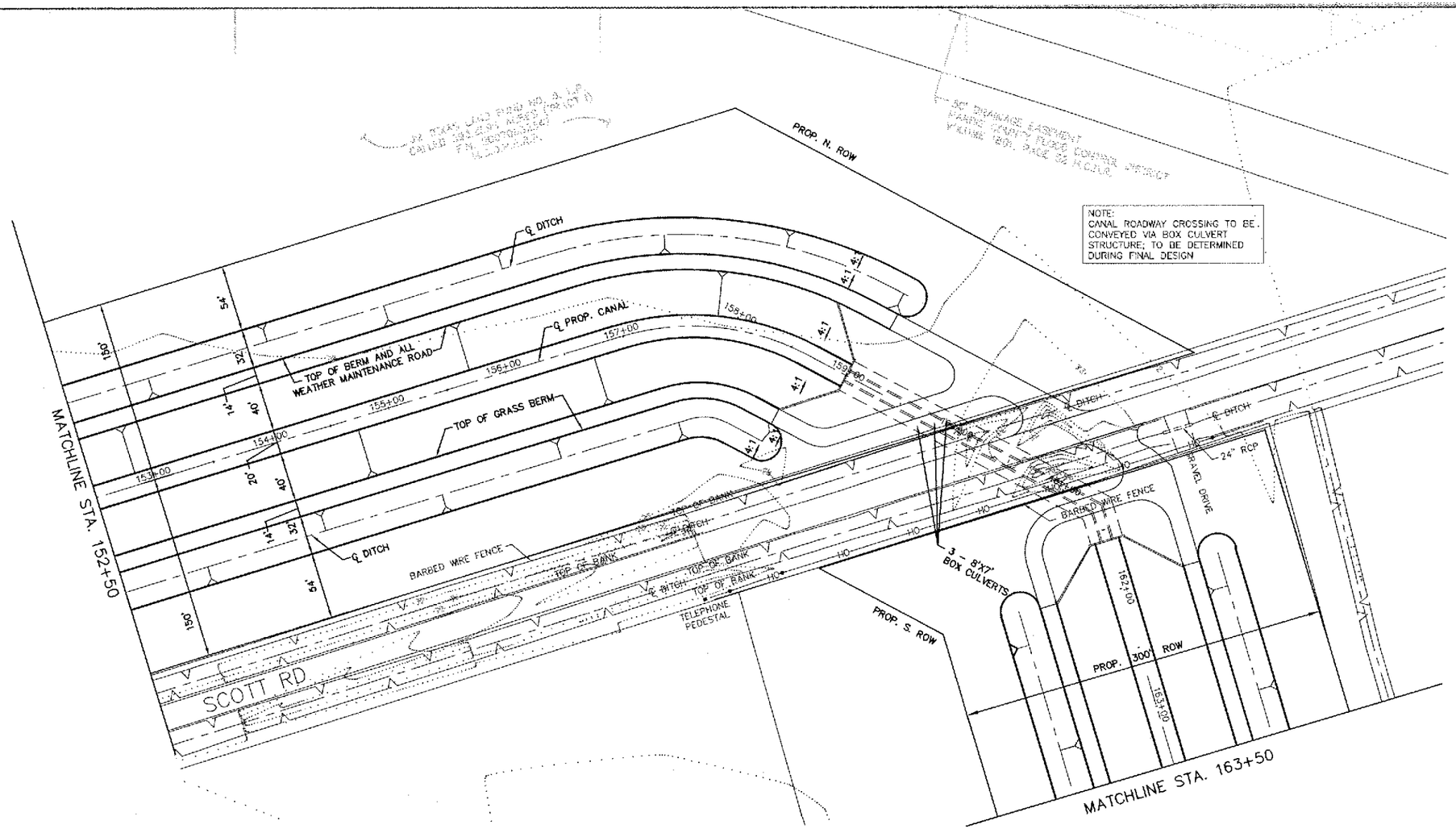
LUCE BAYOU INTERBASIN TRANSFER PROJECT

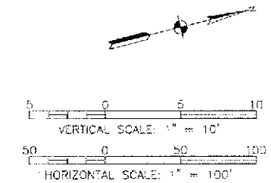
CANAL PLAN &
PROFILE STA 140+00
TO STA 152+50

DRAWING SCALE
AS SHOWN

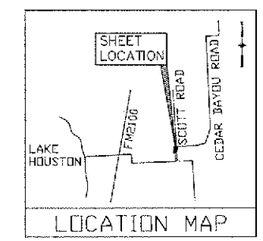
SHEET NO. 45 OF 245

LAST MODIFIED: Jan 27, 2011 - 3:48pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\FWD\Sheets\
DWG. NAME: CanalP&P12.dwg

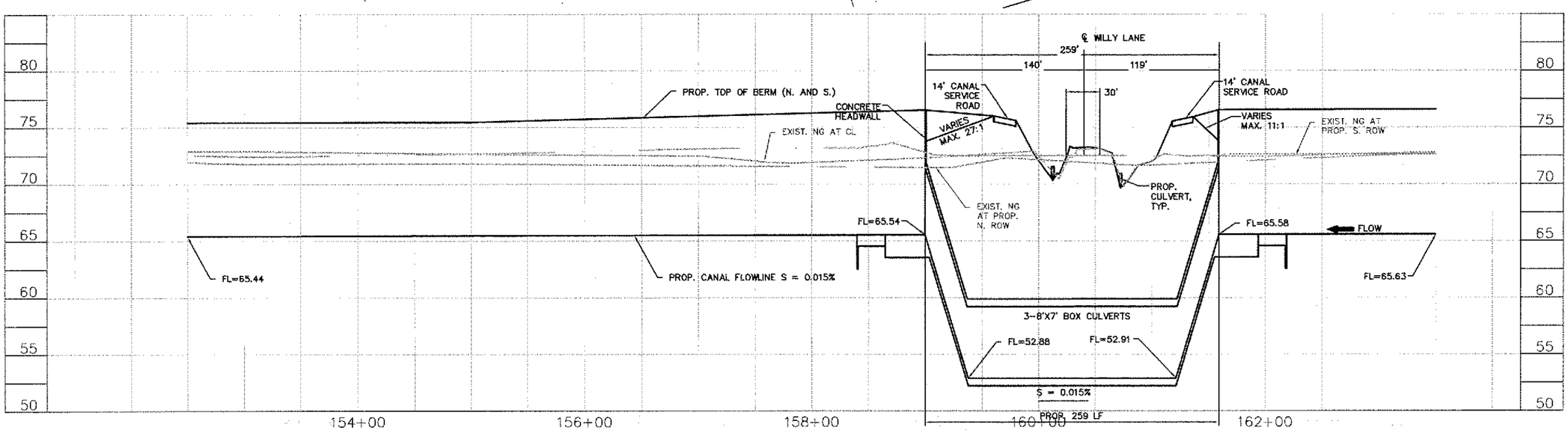




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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AECOM

AECOM TECHNICAL SERVICES, INC.
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TBPE REG. NO. F-3580

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HOUSTON, TEXAS 77057
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713.780.0838 fax.

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FB NO.

COASTAL WATER AUTHORITY

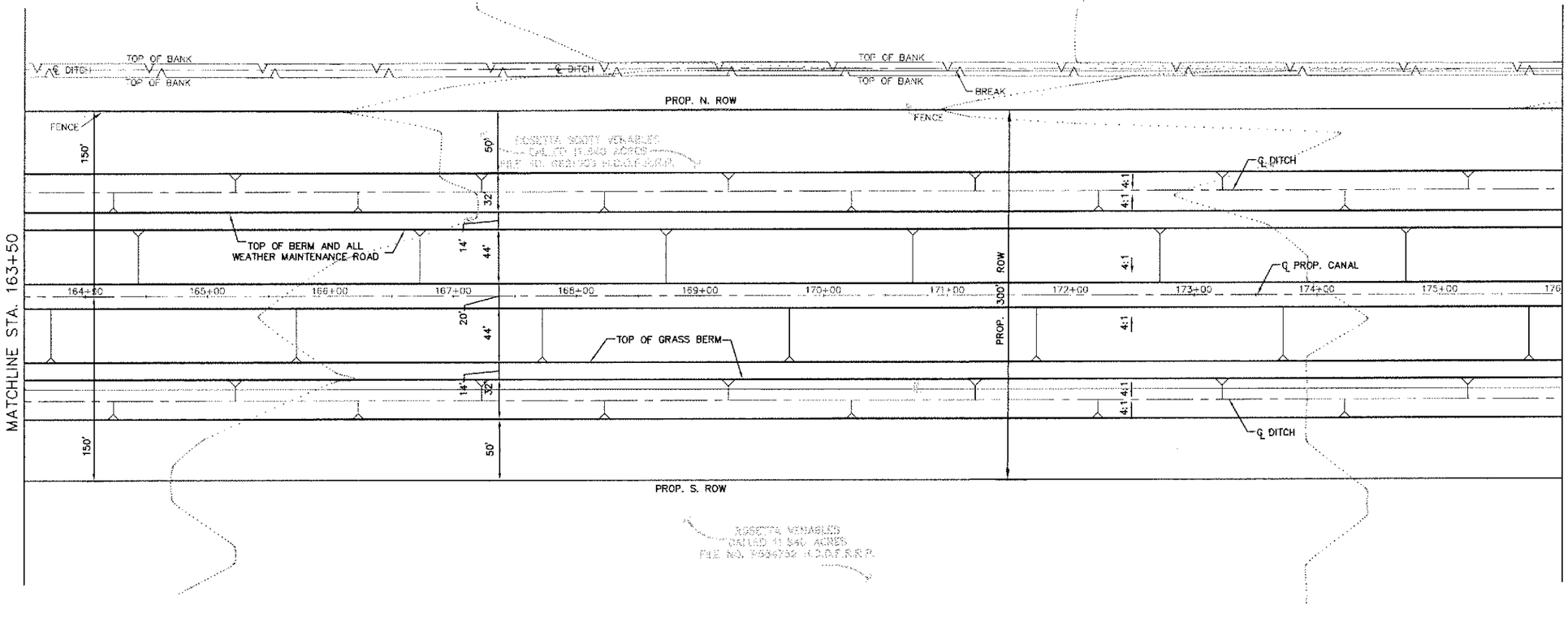
LUCE BAYOU INTERBASIN TRANSFER PROJECT

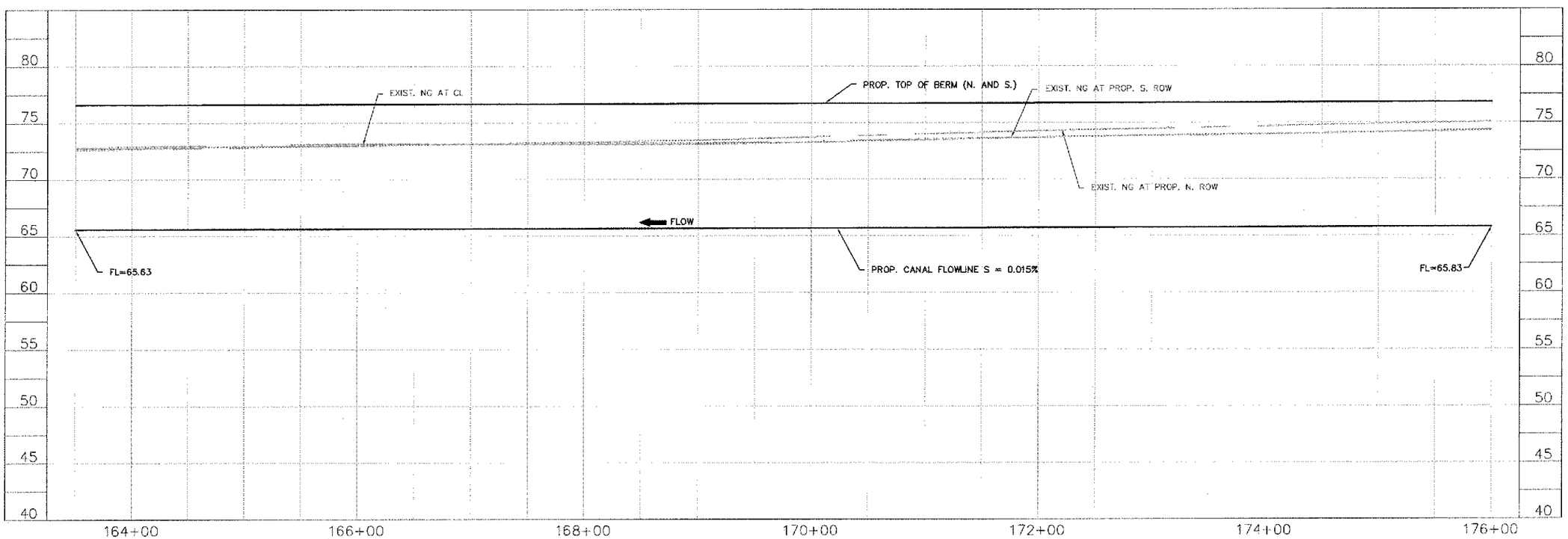
CANAL PLAN & PROFILE STA 152+50 TO STA 163+50

DRAWING SCALE
AS SHOWN

SHEET NO. 46 OF 245

LAST MODIFIED: Jan 28, 2011 - 6:35am BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P13.dwg

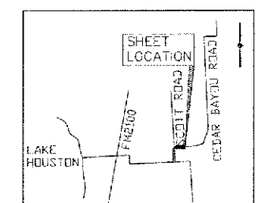




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
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WWW.AECOM.COM
TBPE REG. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

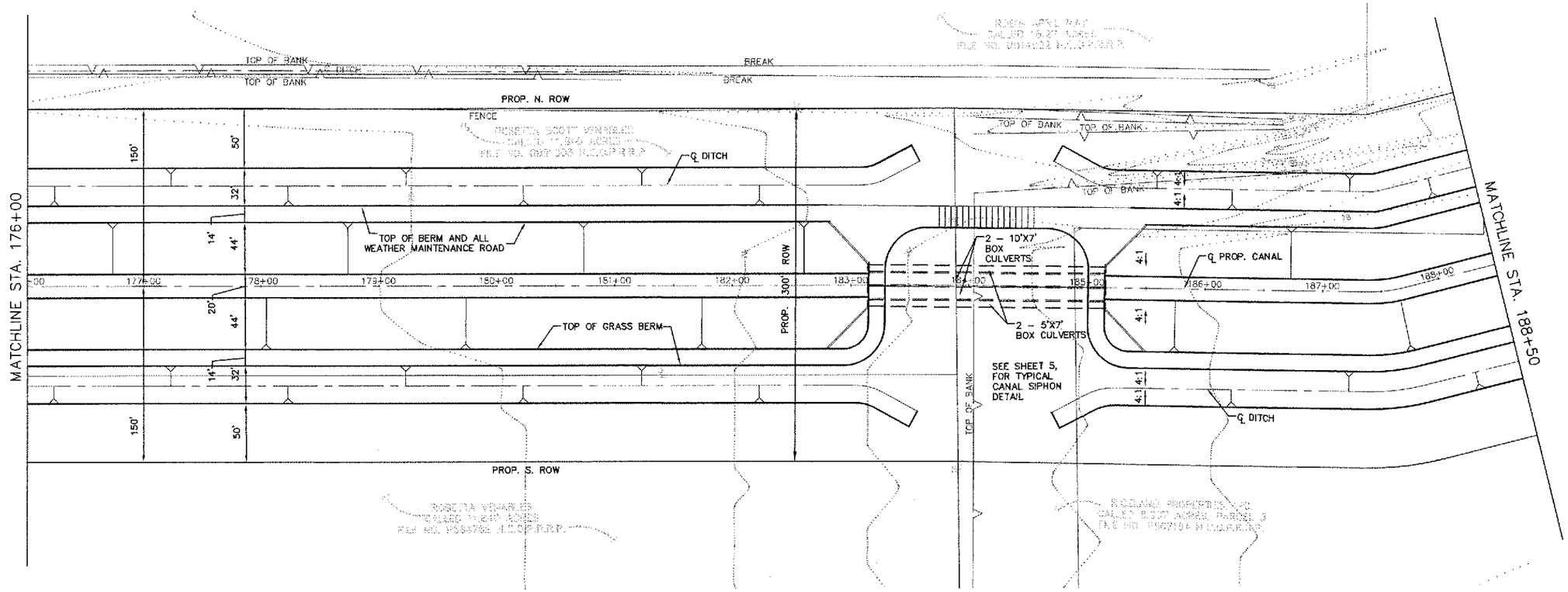
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

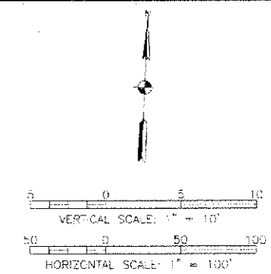
CANAL PLAN &
PROFILE STA 163+50
TO STA 176+00

DRAWING SCALE
AS SHOWN

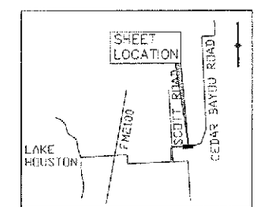
SHEET NO. 47 OF 245

LAST MODIFIED: Jan 27, 2011 - 3:50pm BY USER: Thompson91
DWG. LOCATION: Q:\Work Order 6\X-0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P14.dwg

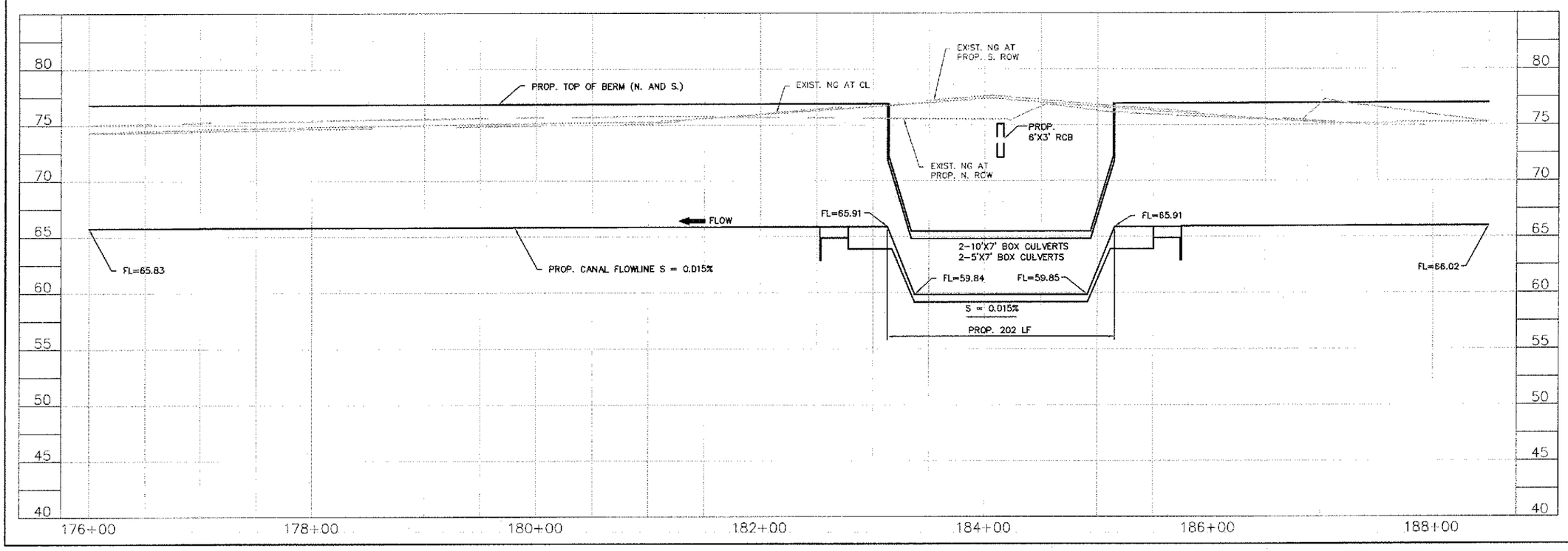




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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NOT FOR CONSTRUCTION PURPOSES

AECOM

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AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

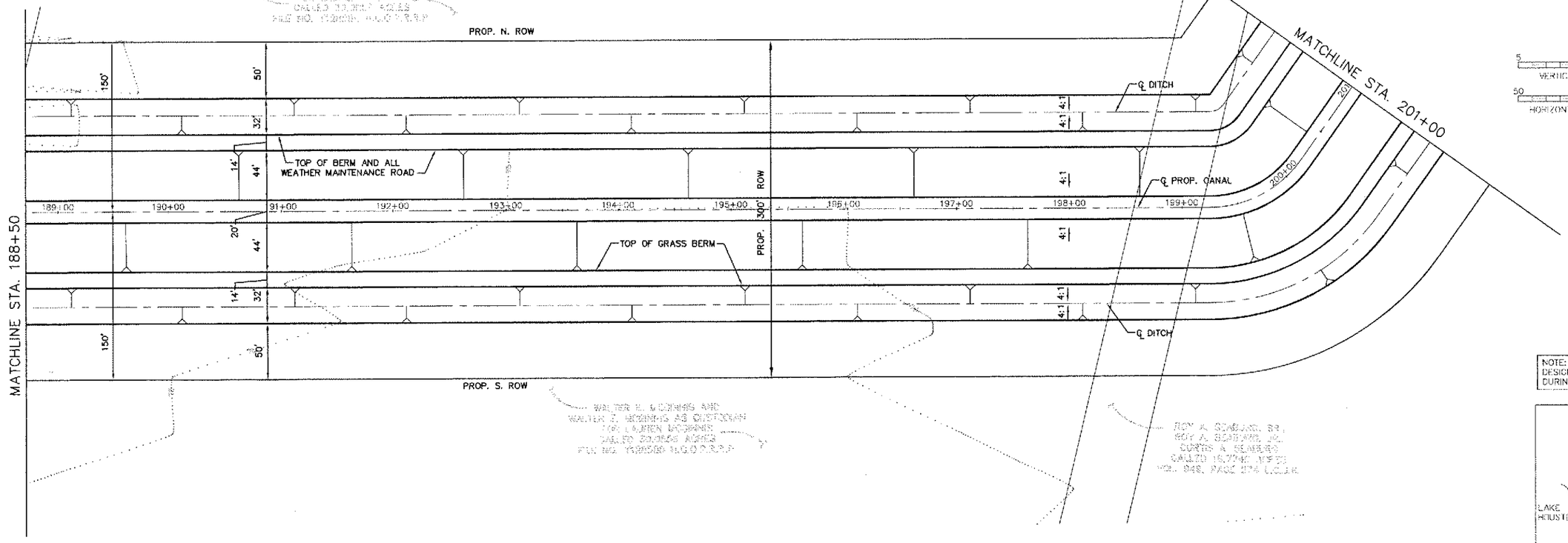
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN & PROFILE STA 176+00 TO STA 188+50

DRAWING SCALE
AS SHOWN

SHEET NO. 48 OF 245

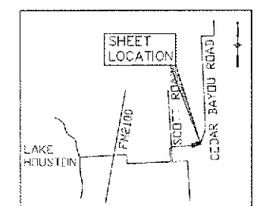
LAST MODIFIED: Jan 27, 2011 - 3:51pm BY USER: ThompsonBi
DWG. LOCATION: O:\Work Order 8\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Codd\PWD\Sheets\
DWG. NAME: CanalP&P15.dwg



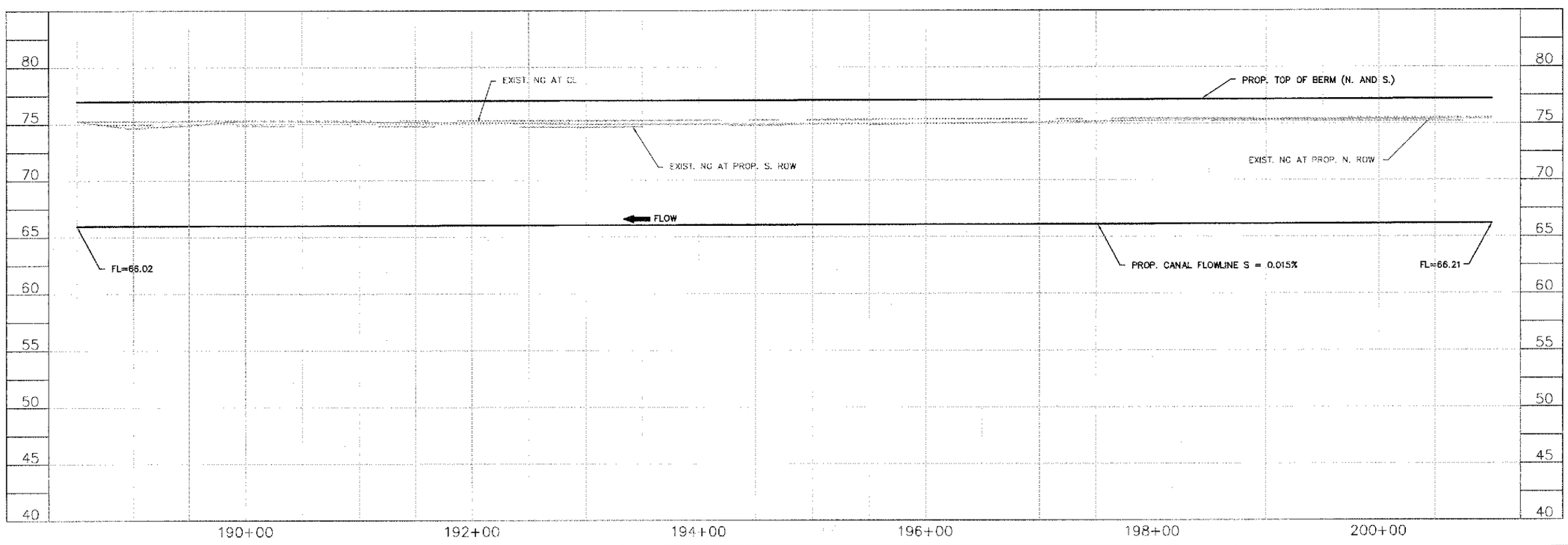
VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
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TBPE REG. NO. F-3580

AECOM
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HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

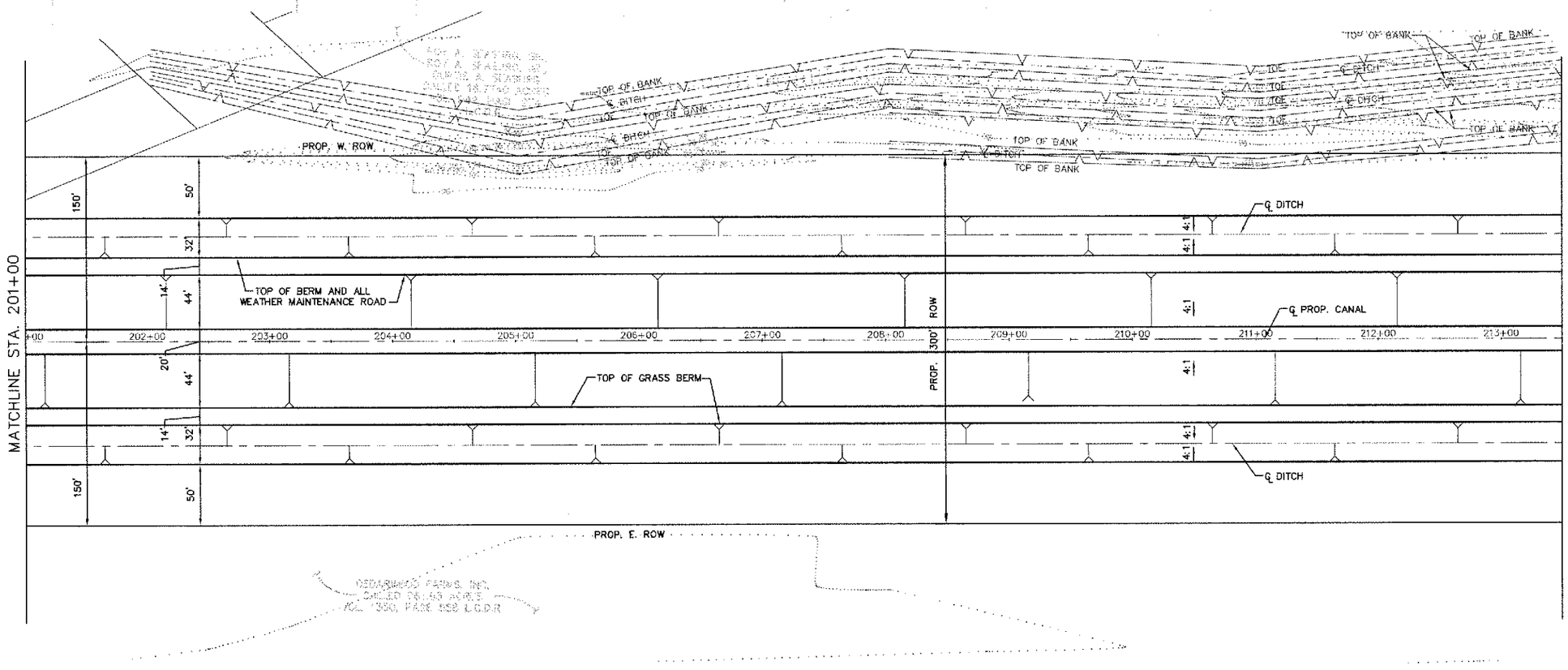
LUCE BAYOU INTERBASIN TRANSFER PROJECT

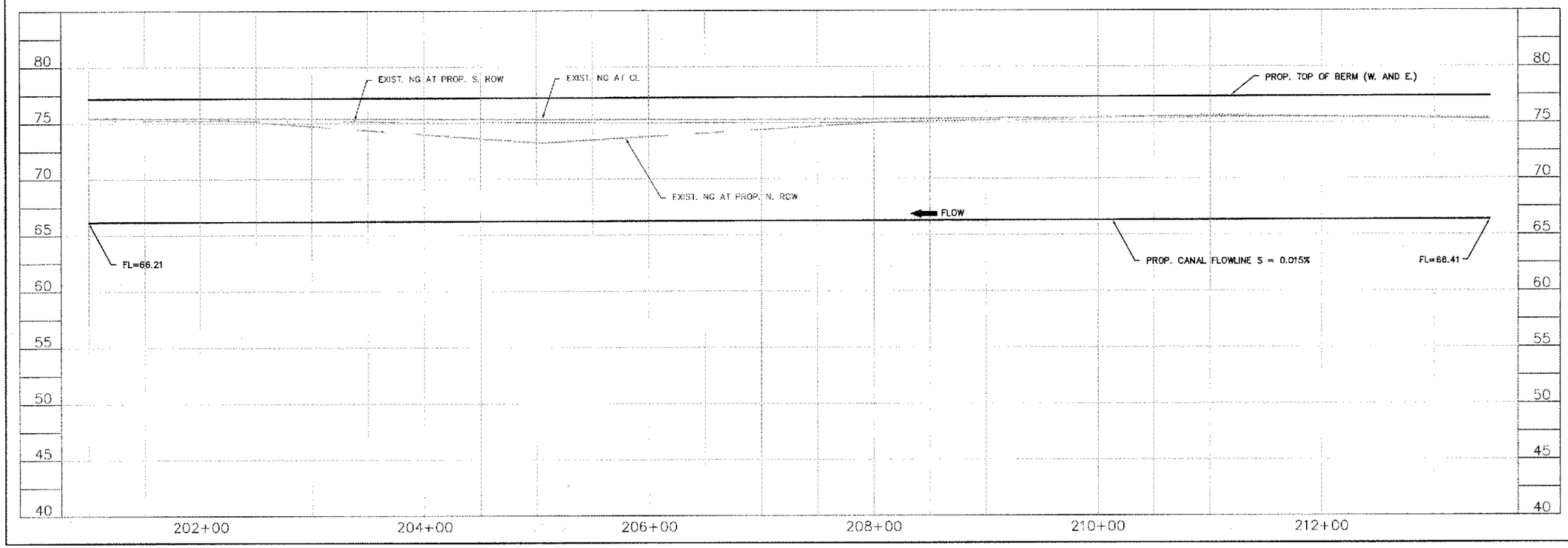
CANAL PLAN & PROFILE STA 188+50 TO STA 201+00

DRAWING SCALE
AS SHOWN

SHEET NO. 49 OF 245

LAST MODIFIED: Jan 27, 2011 - 3:51pm BY USER: ThompsonBl
DWG LOCATION: D:\Work Greer 6\V4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Coastal\PWD\Sheets\
DWG NAME: CanalP&P18.dwg

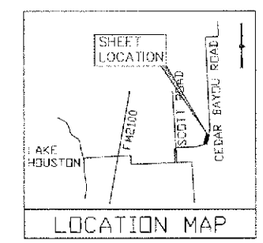




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 EAST
HOUSTON, TEXAS 77057-1559
WWW.AECOM.COM
TBPE REG. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

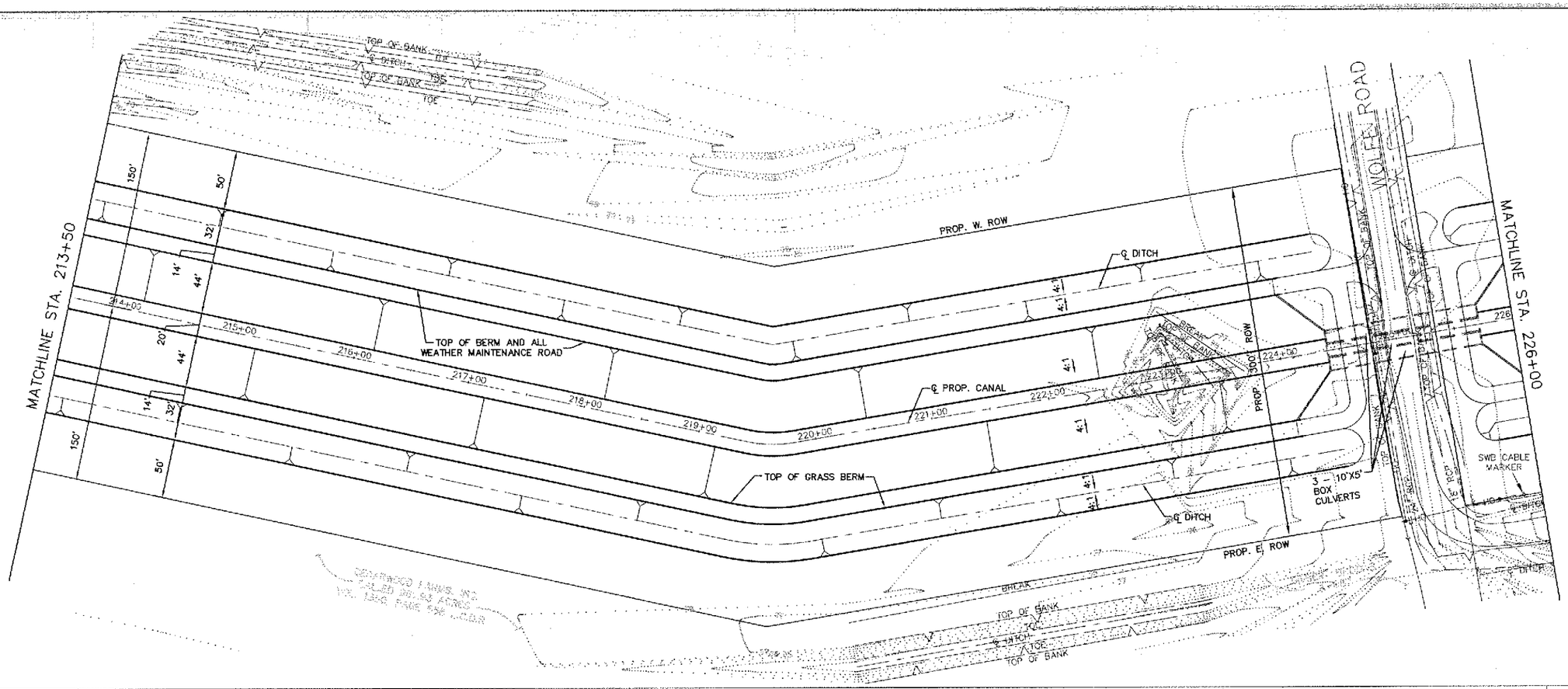
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

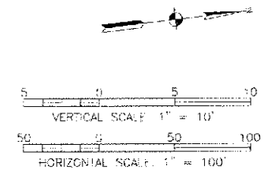
CANAL PLAN & PROFILE STA 201+00 TO STA 213+50

DRAWING SCALE
AS SHOWN

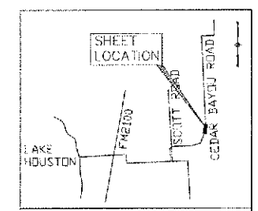
SHEET NO. 50 OF 245

LAST MODIFIED: Jan 27, 2011 - 3:52pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: Canal-P&P17.dwg

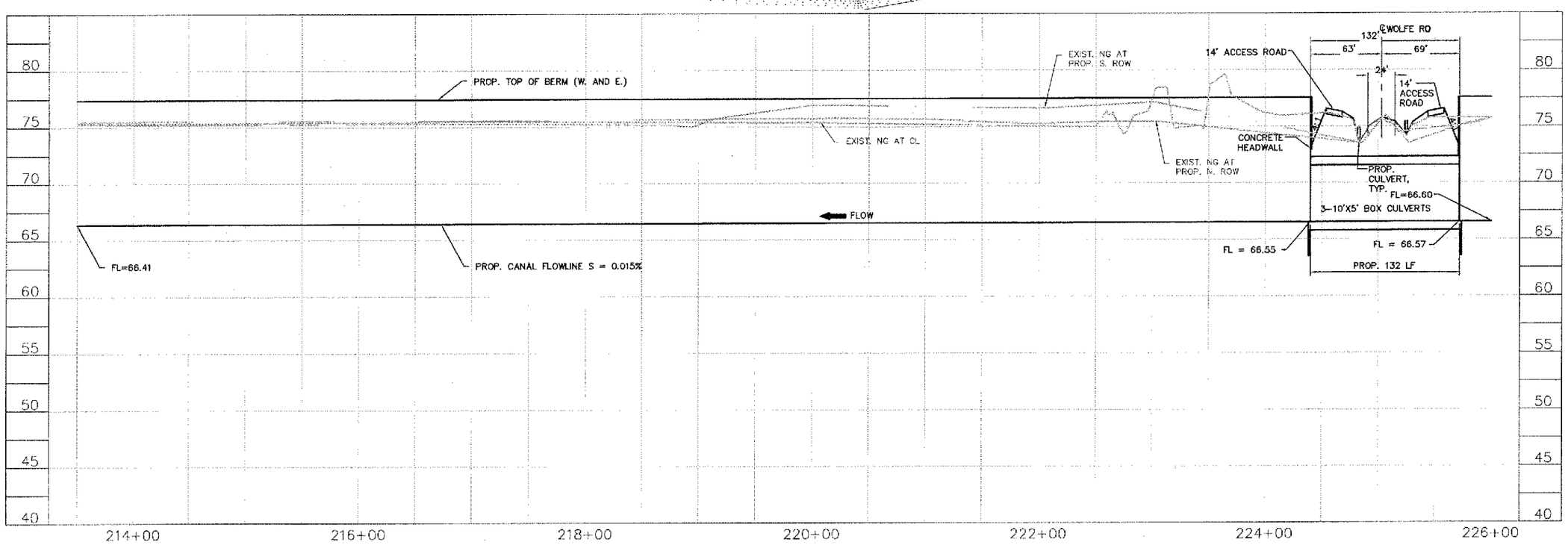




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1599
WWW.AECOM.COM
TBPE REG. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

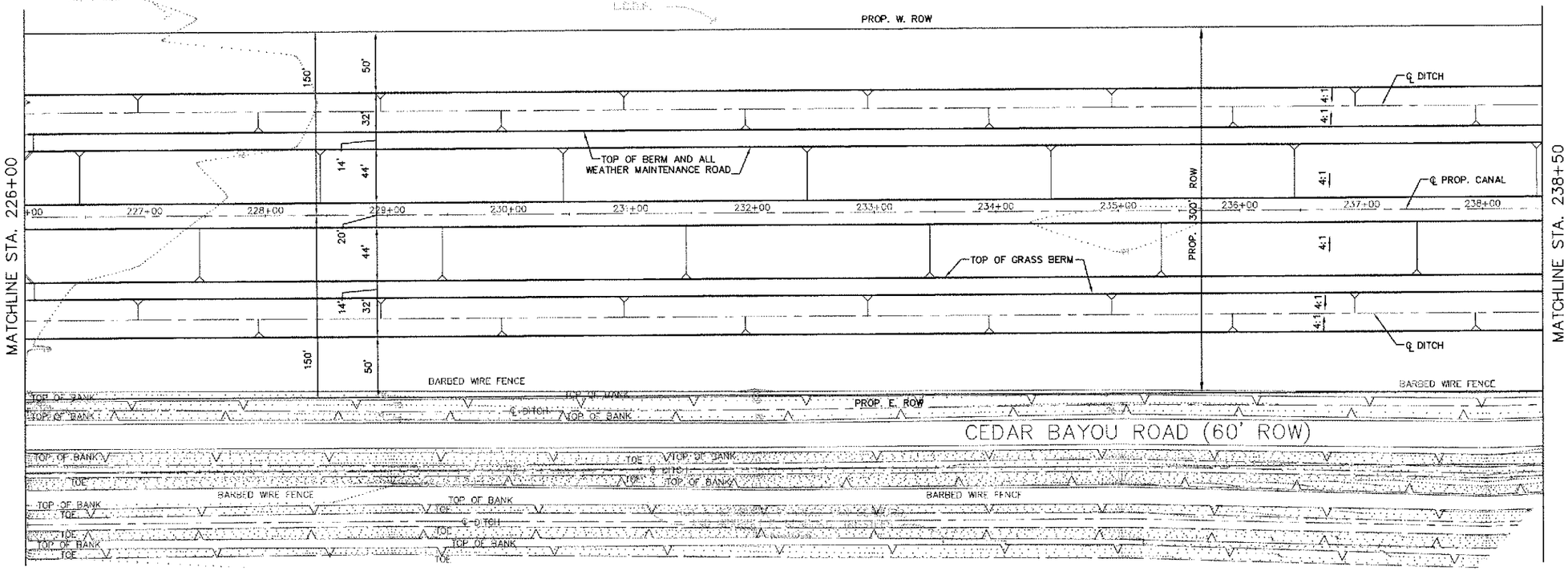
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

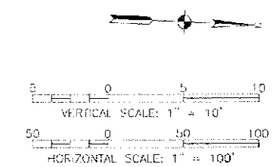
CANAL PLAN &
PROFILE STA 213+50
TO STA 226+00

DRAWING SCALE
AS SHOWN

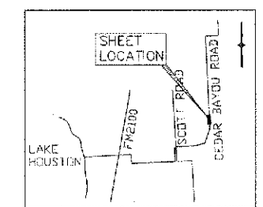
SHEET NO. 51 OF 245

LAST MODIFIED: Jan 27, 2011 – 3:52pm BY USER: Thompsonbi
DWG. LOCATION: G:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cade\PWG\Sheets\
DWG. NAME: CanalP&P18.dwg

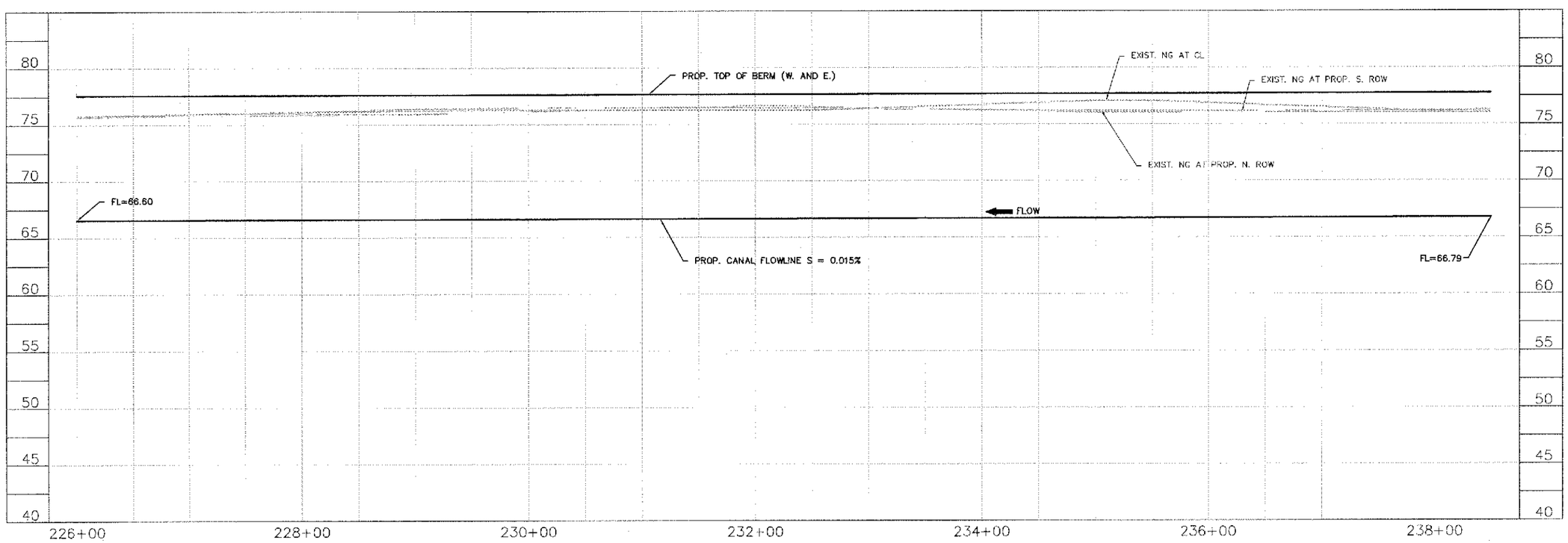




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1589
WWW.AECOM.COM
TBPE REG. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

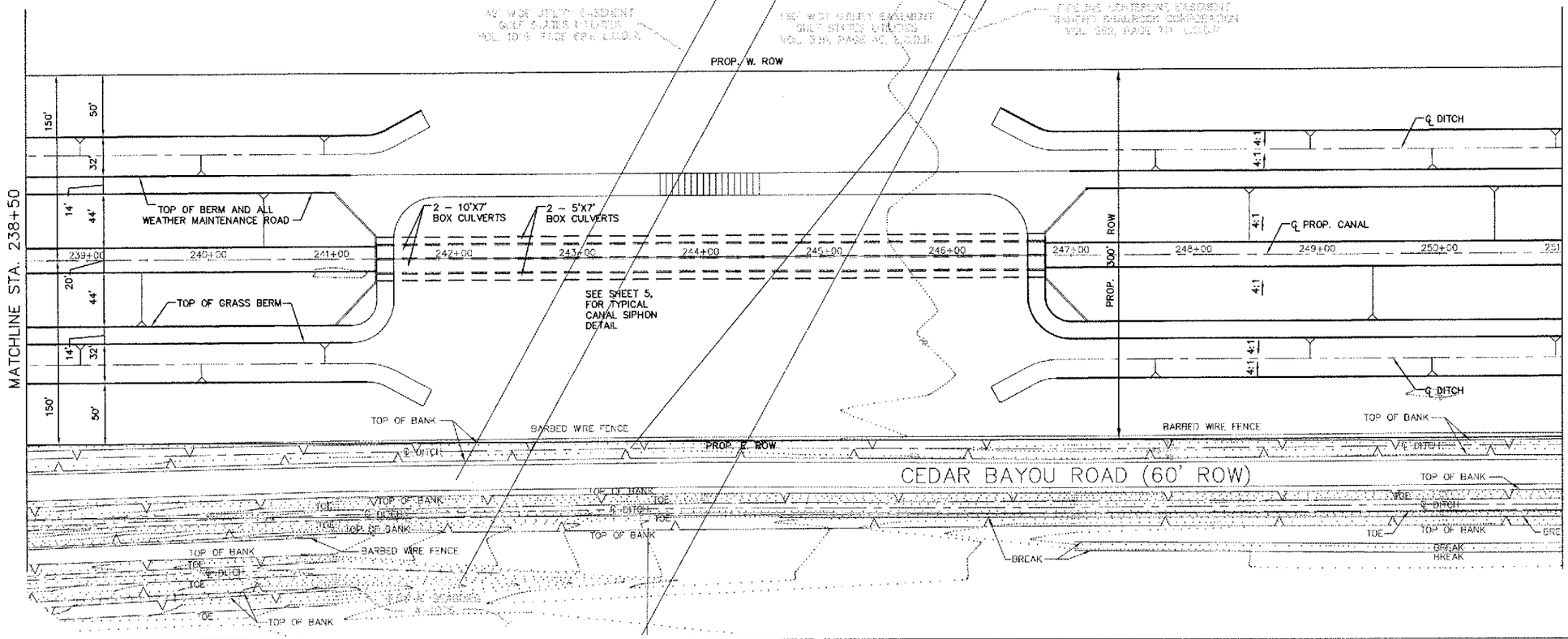
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

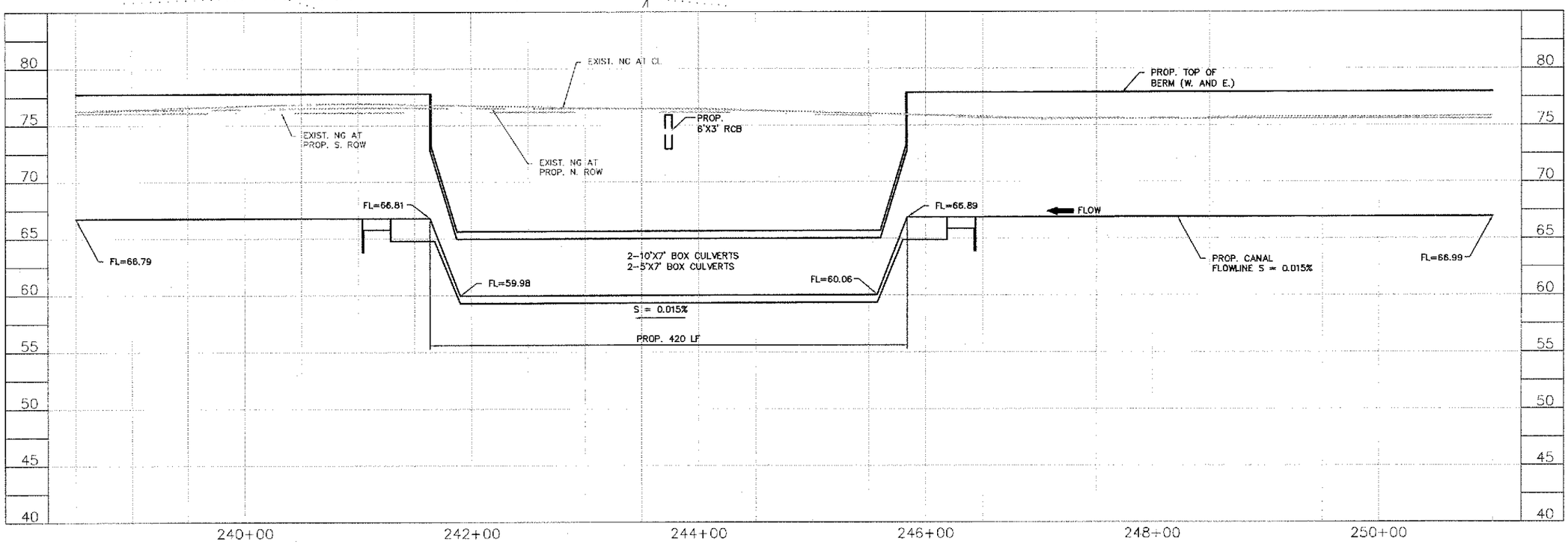
CANAL PLAN &
PROFILE STA 226+00
TO STA 238+50

DRAWING SCALE
AS SHOWN

SHEET NO. 52 OF 245

LAST MODIFIED: Jan 27, 2011 – 3:53pm BY USER: Thompson91
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P19.dwg



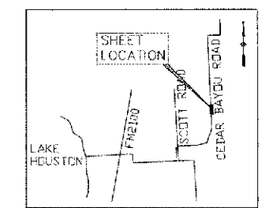


VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1599
WWW.AECOM.COM
TBPE REG. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

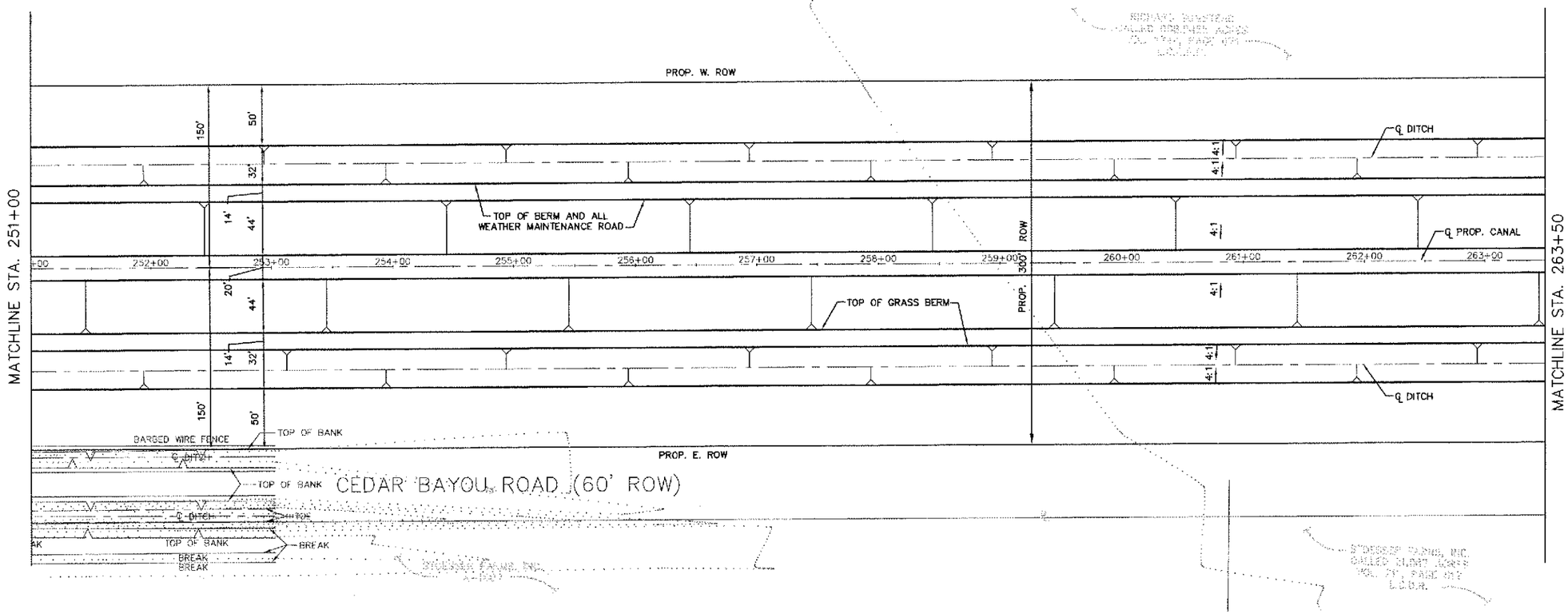
LUCE BAYOU INTERBASIN TRANSFER PROJECT

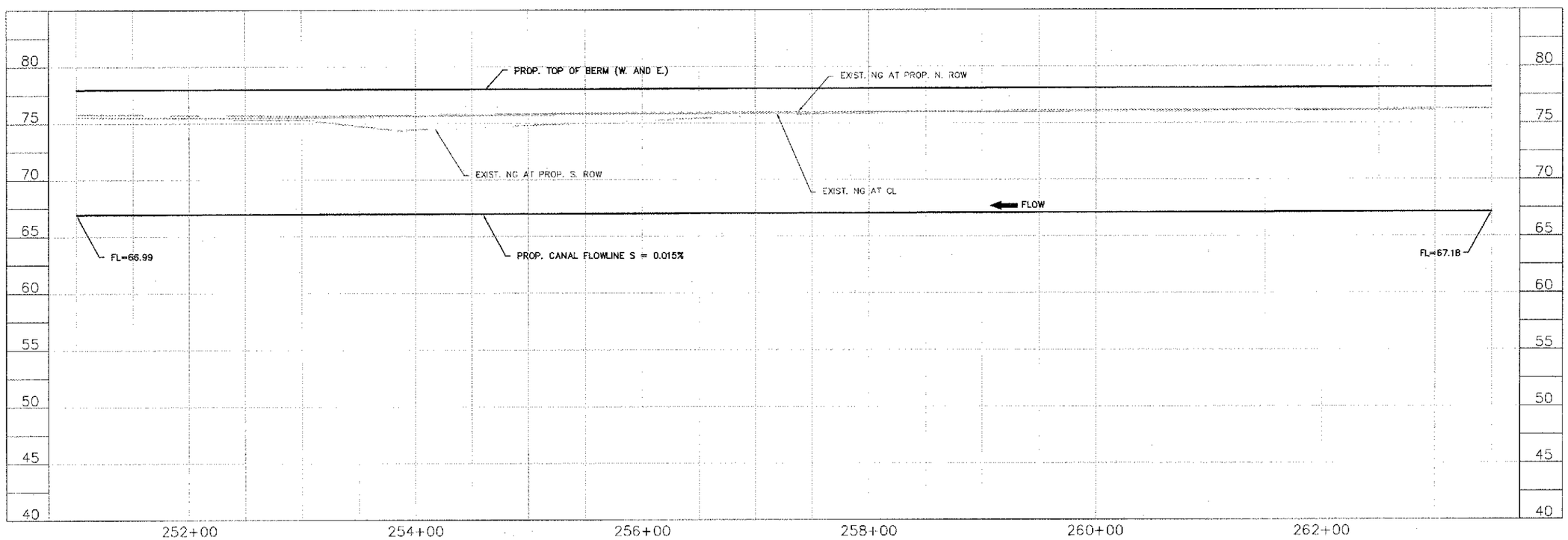
CANAL PLAN & PROFILE STA 238+50 TO STA 251+00

DRAWING SCALE
AS SHOWN

SHEET NO. 53 OF 249

LAST MODIFIED: Jan 27, 2011 – 3:55pm BY USER: ThompsonBi
DWG. LOCATION: D:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P20.dwg

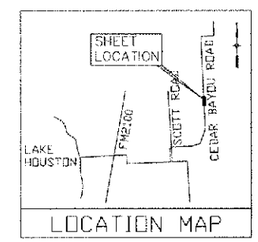




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1599
WWW.AECOM.COM
TBPE REG. NO. F-15560

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN &
PROFILE STA 251+00
TO STA 263+50

DRAWING SCALE
AS SHOWN

SHEET NO. 54 OF 245

LAST MODIFIED: Jan 27, 2011 - 3:56pm BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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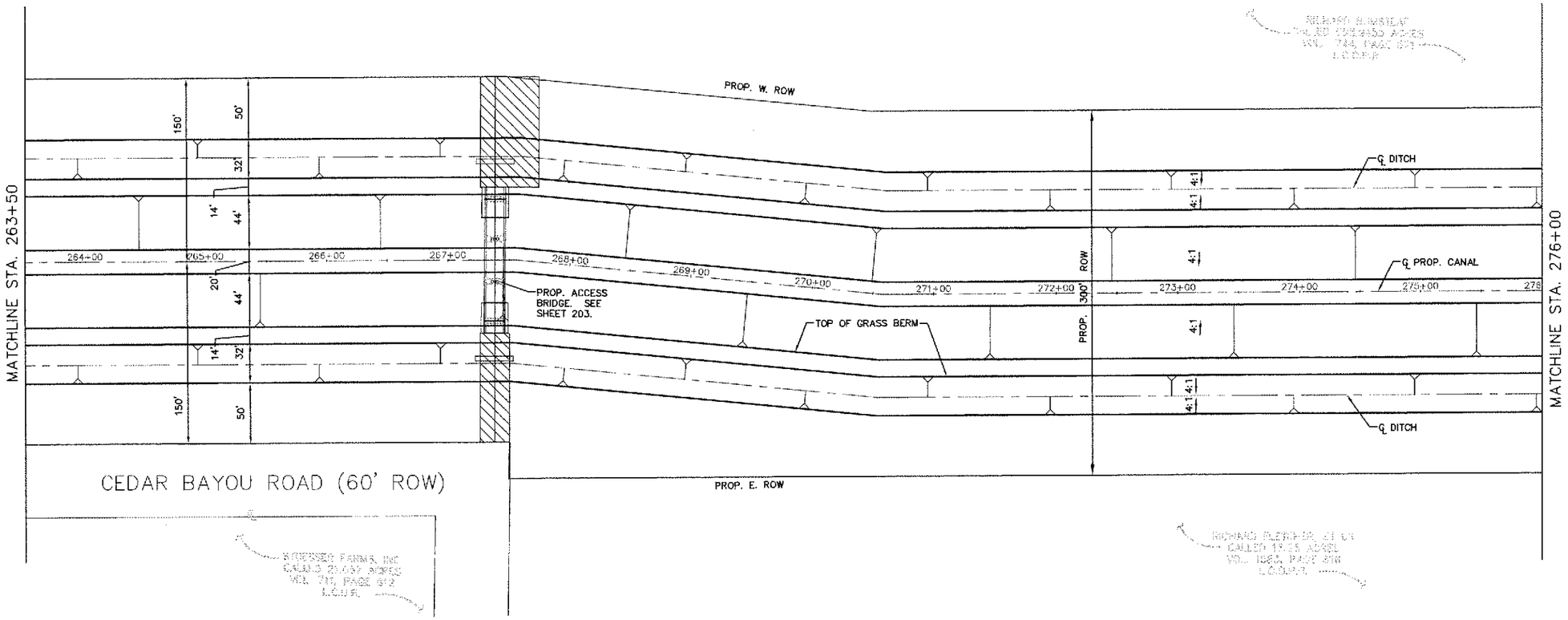
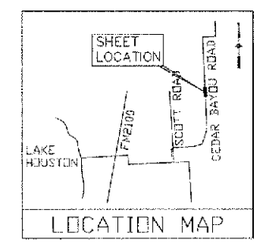


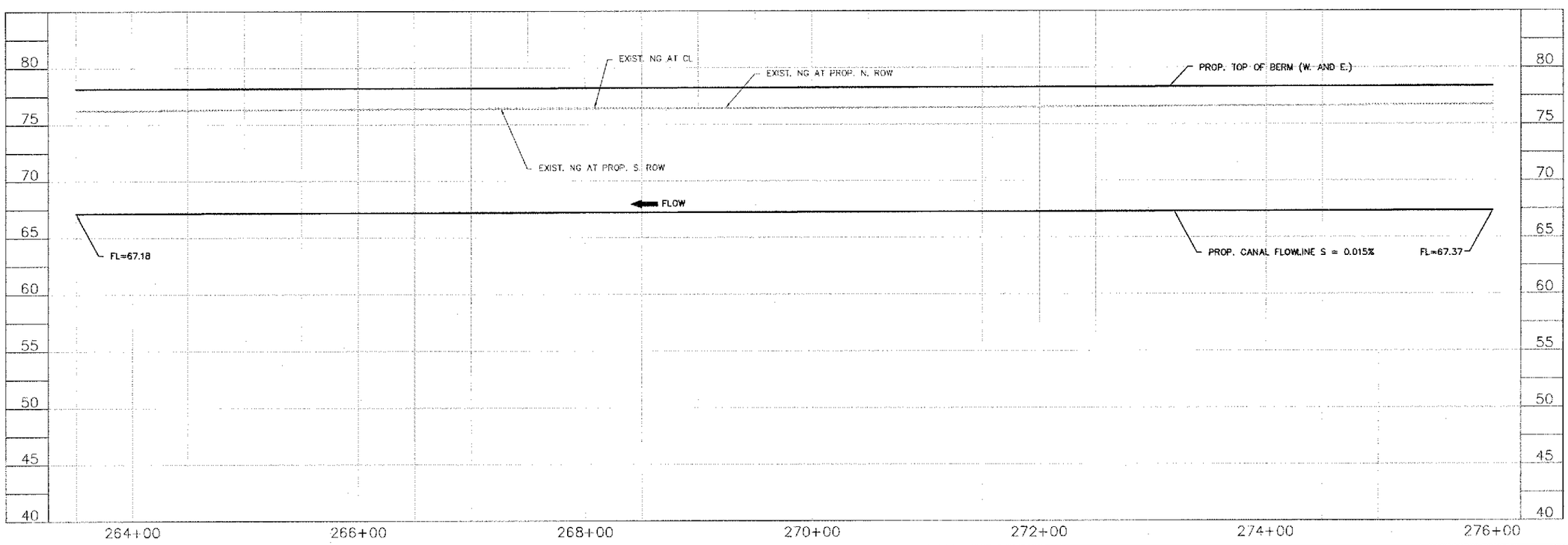
VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031

INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM
AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 100 WEST
HOUSTON, TEXAS 77057-1595
WWW.AECOM.COM
TBPE REG. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

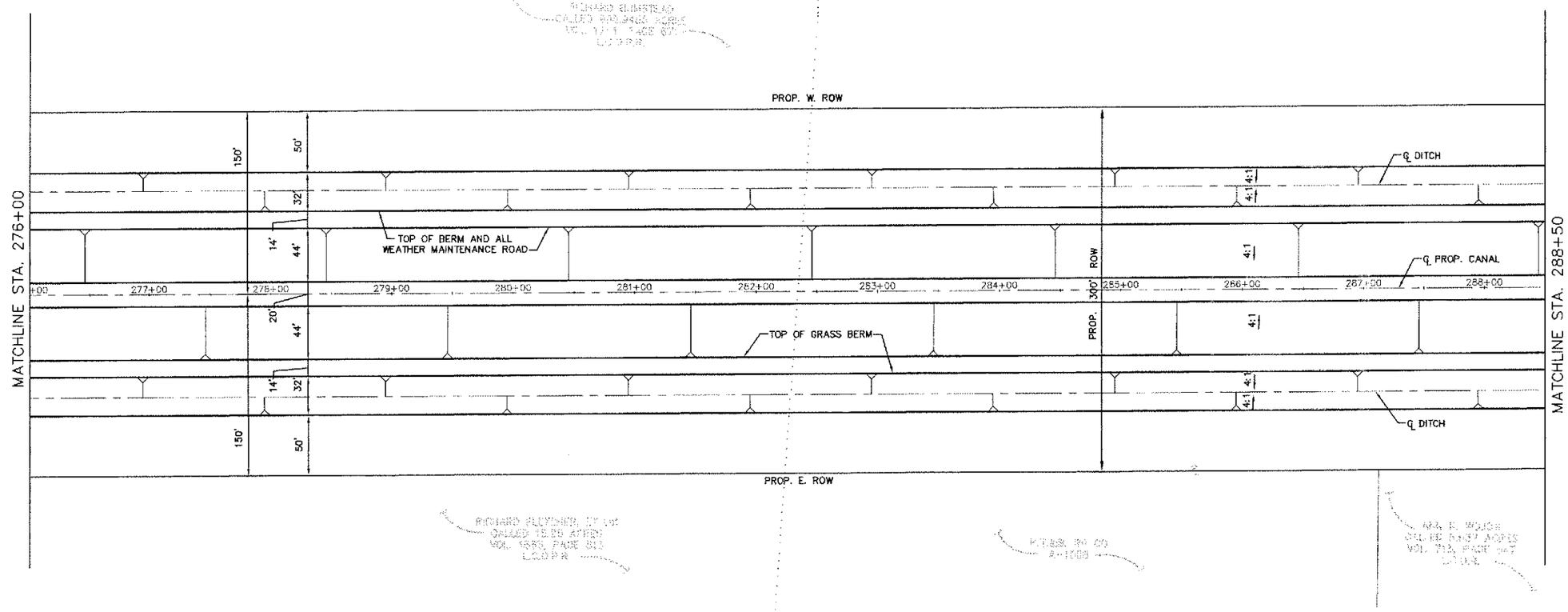
LUCE BAYOU INTERBASIN TRANSFER PROJECT

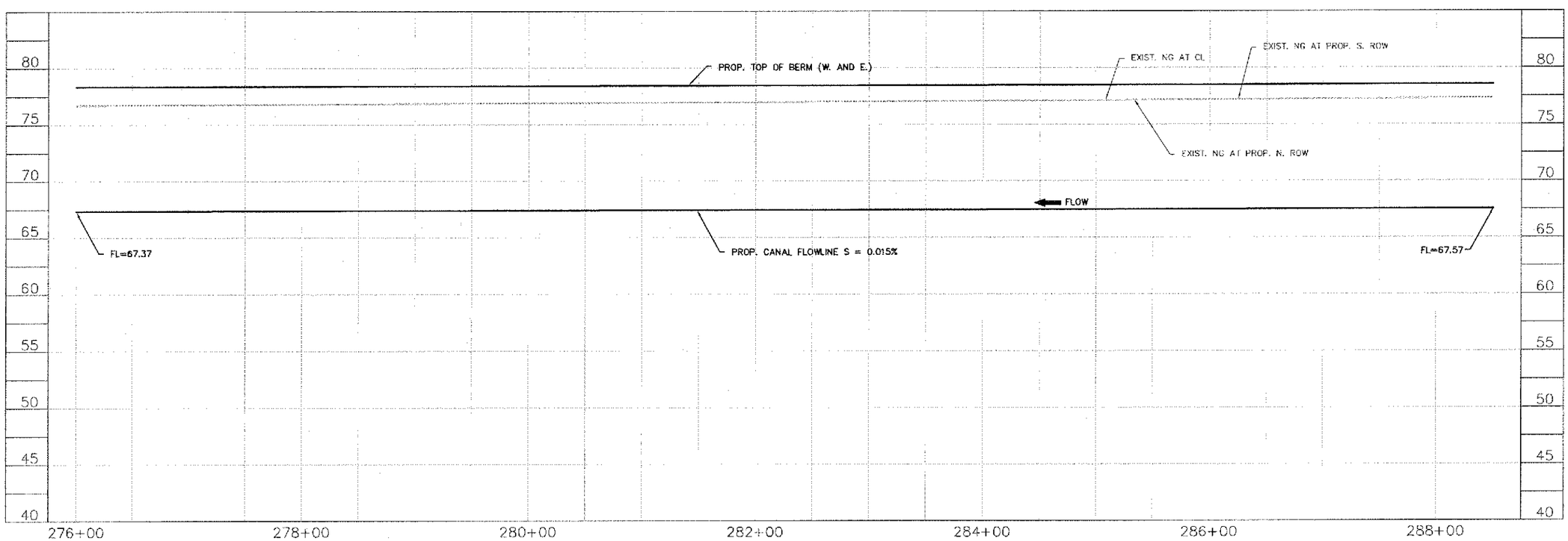
CANAL PLAN & PROFILE STA 263+50 TO STA 276+00

DRAWING SCALE
AS SHOWN

SHEET NO. 55 OF 245

LAST MODIFIED: Jan 27, 2011 - 3:55pm BY USER: ThompsonBil
DWG. LOCATION: D:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalPlan22.dwg

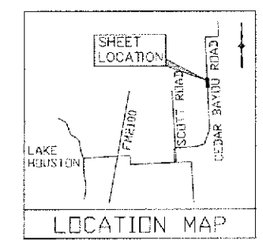




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1599
WWW.AECOM.COM
TBPE REG. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

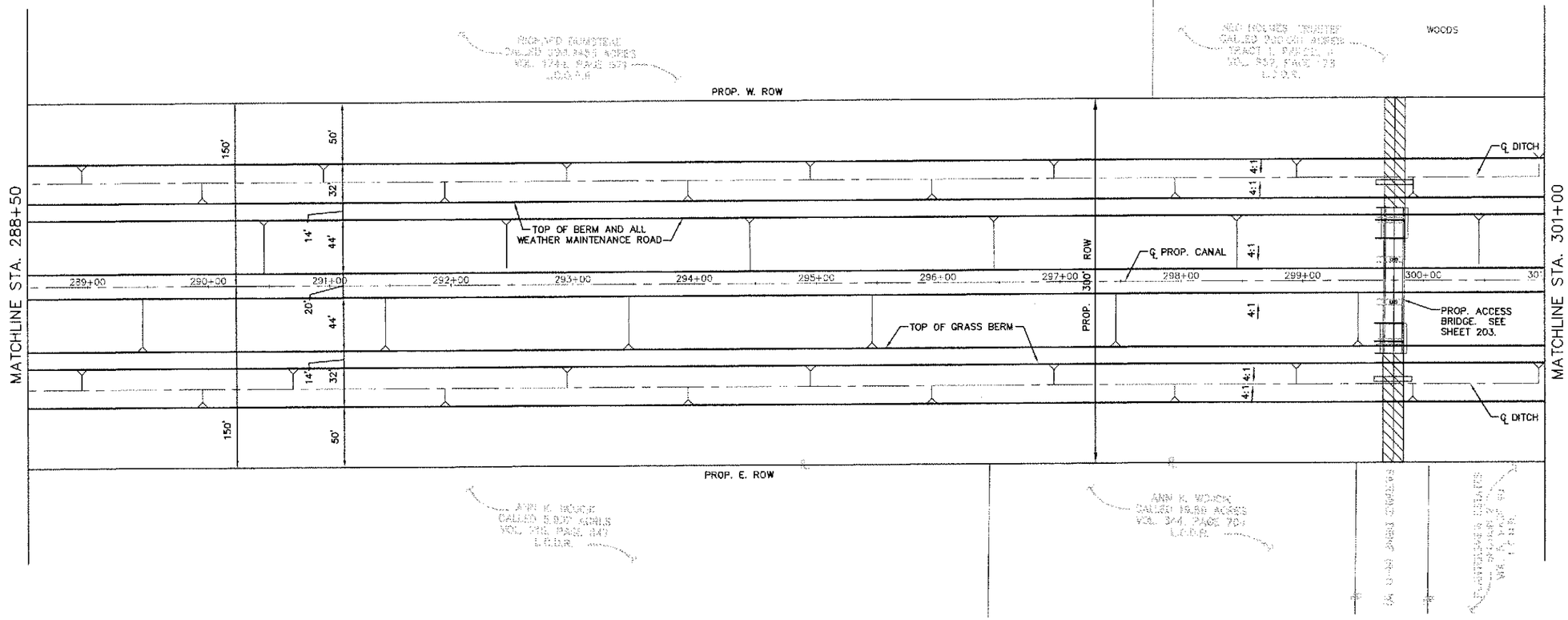
LUCE BAYOU INTERBASIN TRANSFER PROJECT

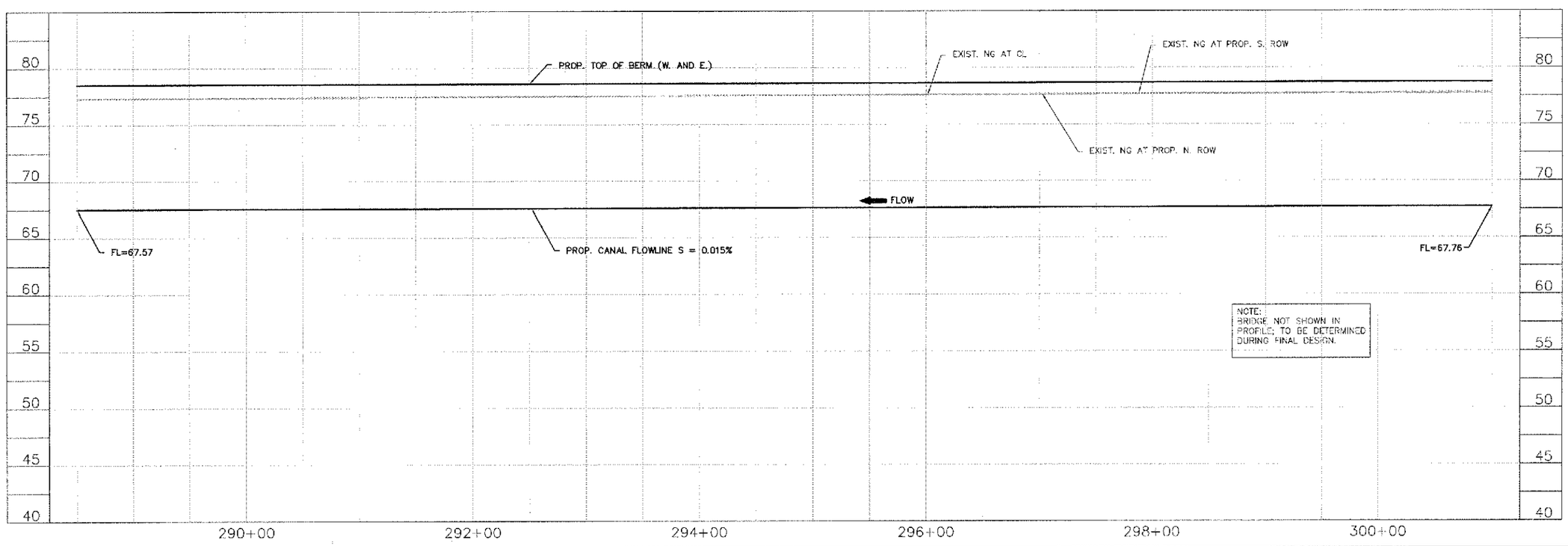
CANAL PLAN &
PROFILE STA 276+00
TO STA 288+50

DRAWING SCALE
AS SHOWN

SHEET NO. 56 OF 245

LAST MODIFIED: Jan 27, 2011 - 3:57pm BY USER: ThompsonBJ
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P23.dwg



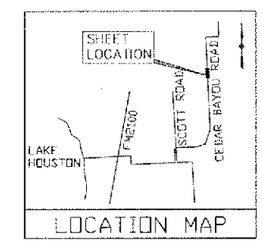


NOTE:
BRIDGE NOT SHOWN IN PROFILE; TO BE DETERMINED DURING FINAL DESIGN.

VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1503
WWW.AECOM.COM
TBPE REG. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax

SURVEYED BY:
FB NO.

CWA

COASTAL WATER AUTHORITY

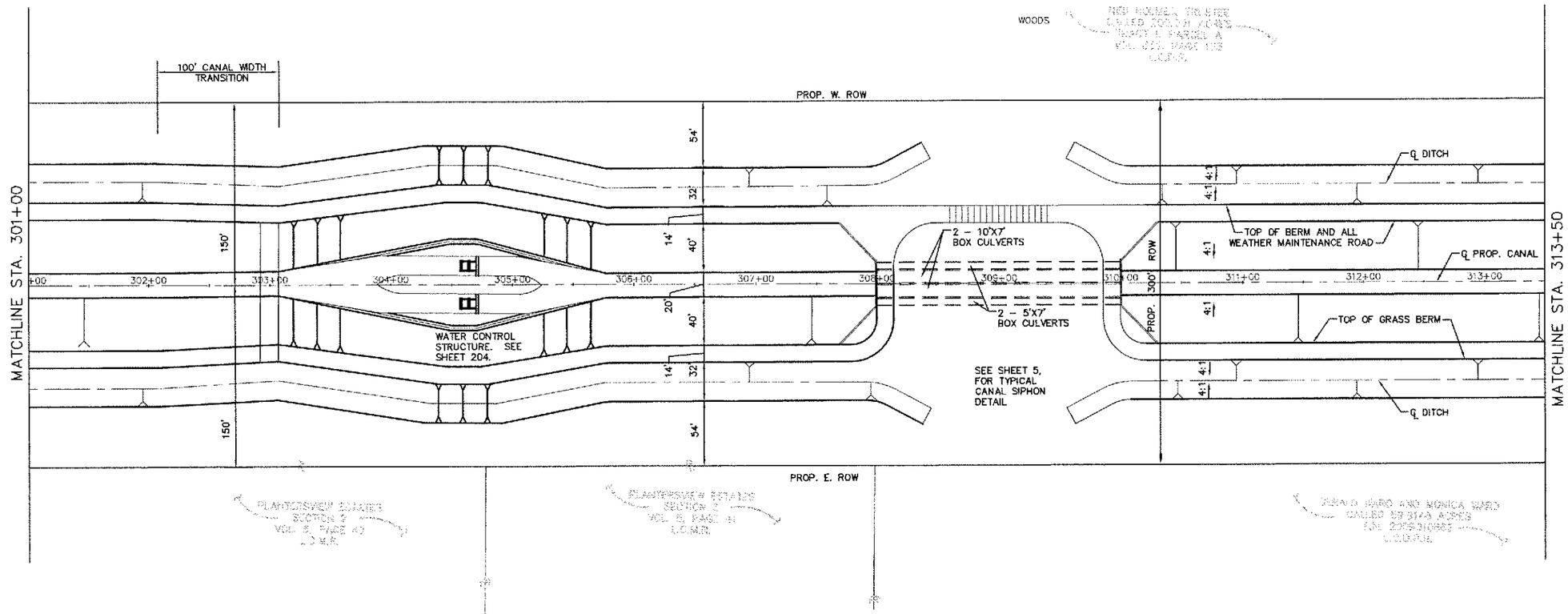
LUCE BAYOU INTERBASIN TRANSFER PROJECT

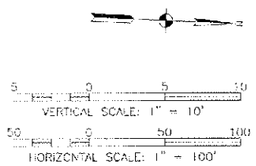
CANAL PLAN & PROFILE STA 288+50 TO STA 301+00

DRAWING SCALE
AS SHOWN

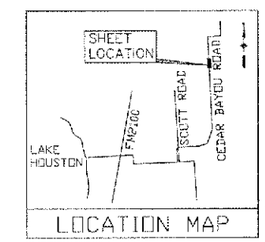
SHEET NO. 57 OF 245

LAST MODIFIED: Jan 22, 2011 – 3:57pm BY USER: Thompson(S)
DWG. LOCATION: O:\Work Order 6\V4.0 ENGINEERING NOTES & CALCULATIONS\V4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: Canal\P4P24.dwg

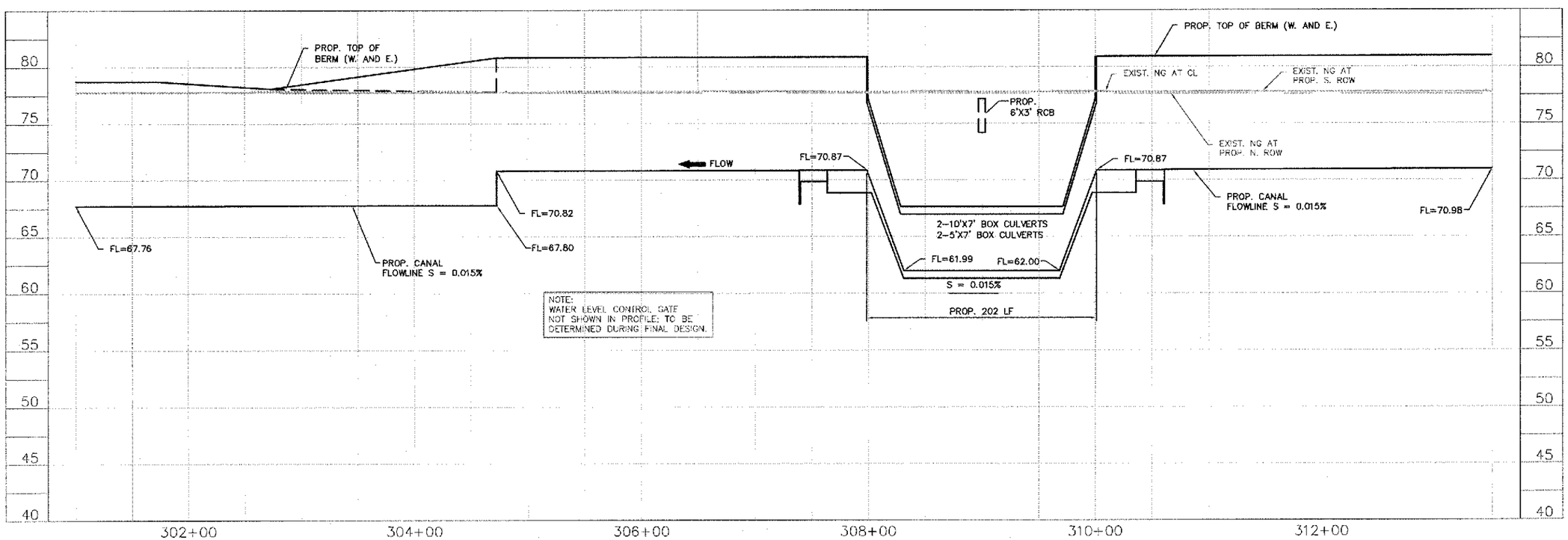




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



NOTE:
WATER LEVEL CONTROL GATE NOT SHOWN IN PROFILE; TO BE DETERMINED DURING FINAL DESIGN.

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

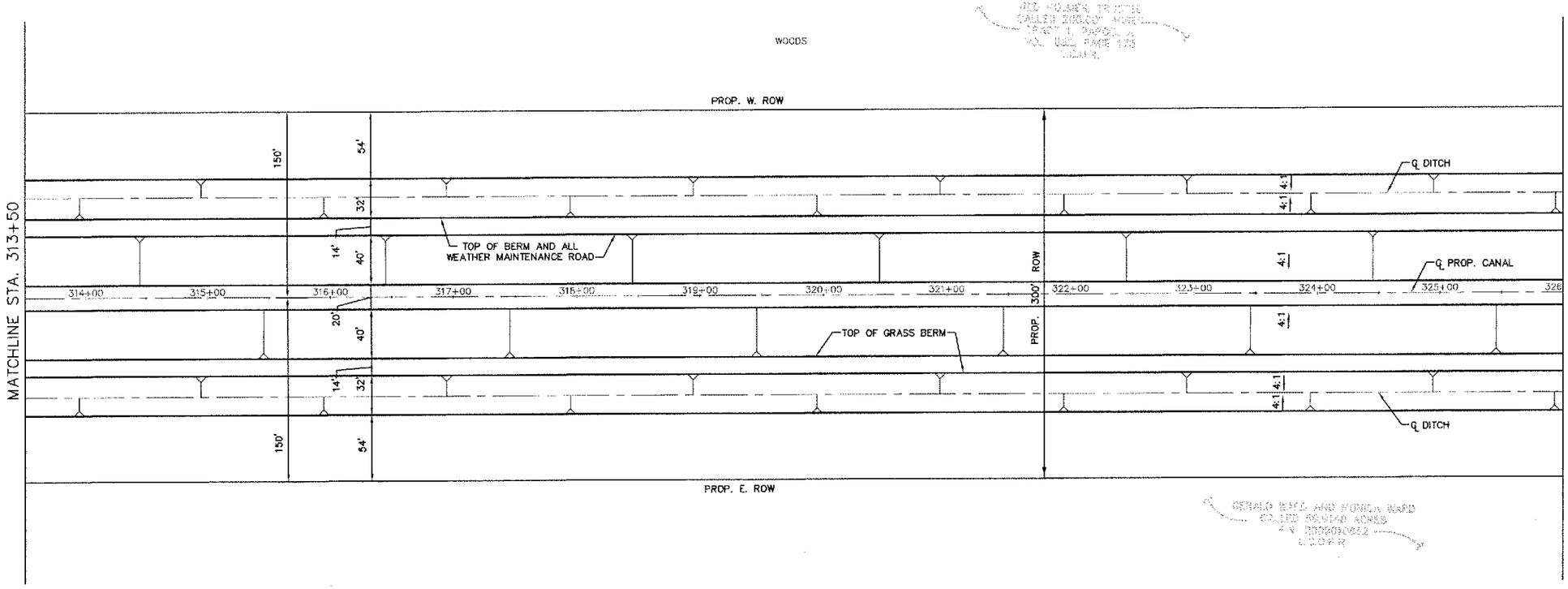
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

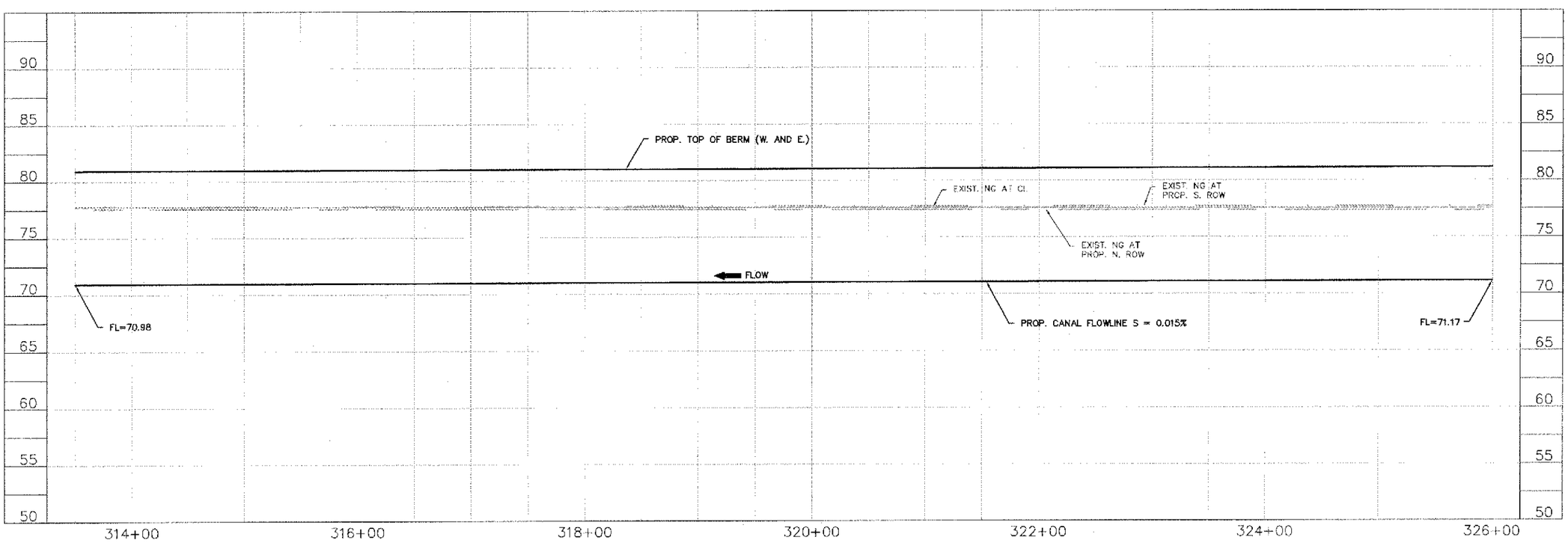
CANAL PLAN & PROFILE STA 301+00 TO STA 313+50

DRAWING SCALE
AS SHOWN

SHEET NO. 58 OF 245

LAST MODIFIED: Jan 27, 2011 - 3:57pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P25.dwg

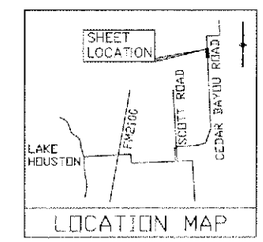




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1599
WWW.AECOM.COM
TBPE REG. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

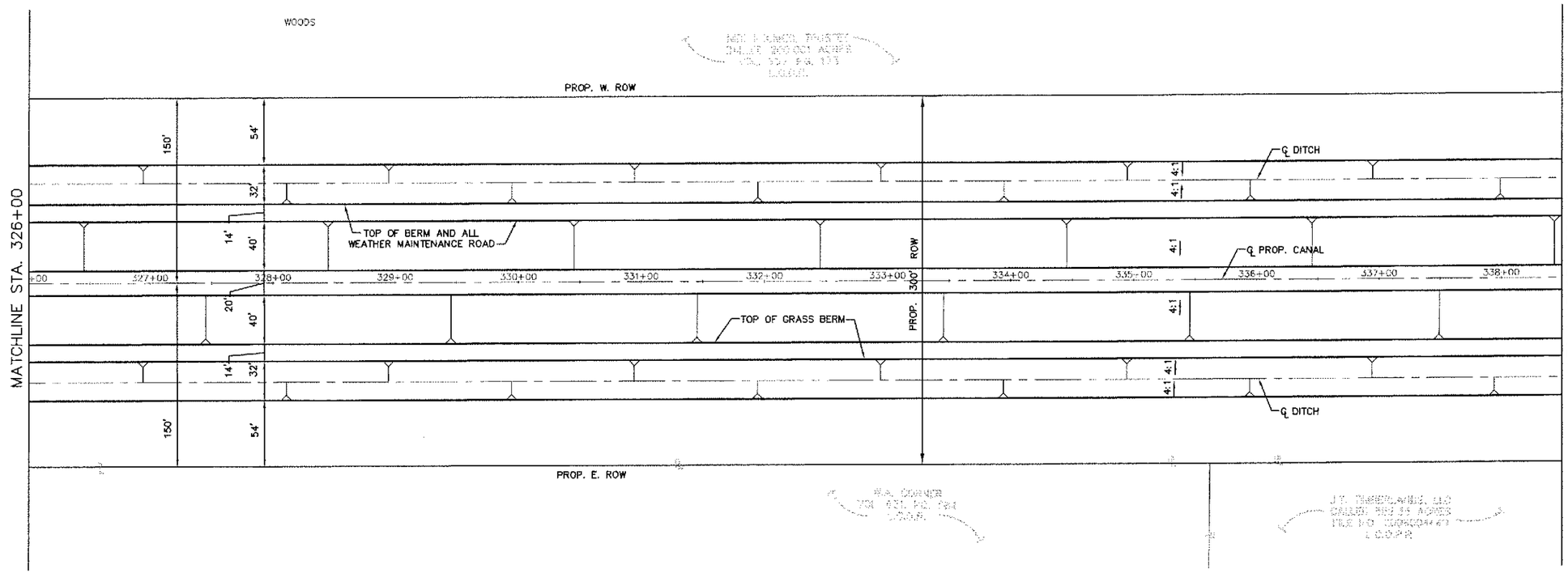
LUCE BAYOU INTERBASIN TRANSFER PROJECT

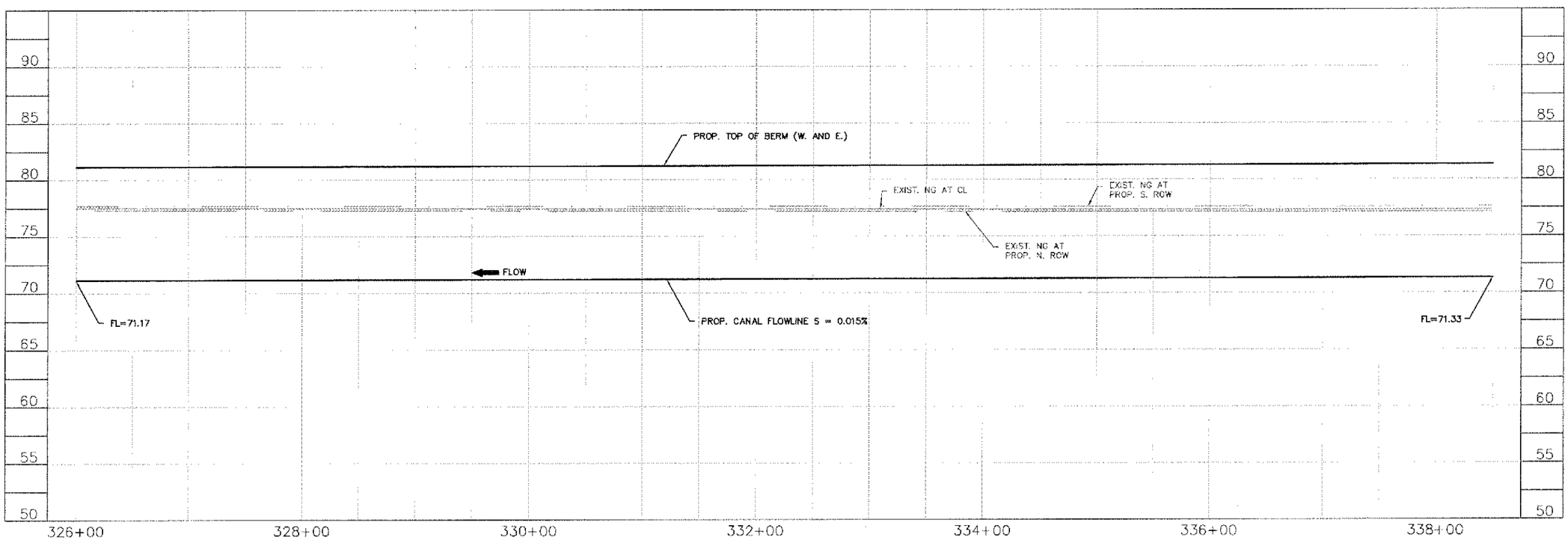
CANAL PLAN & PROFILE STA 313+50 TO STA 326+00

DRAWING SCALE
AS SHOWN

SHEET NO. 59 OF 249

LAST MODIFIED: Jan 27, 2011 - 3:58pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: ConalP&P26.dwg

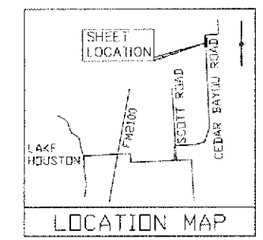




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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FB NO.

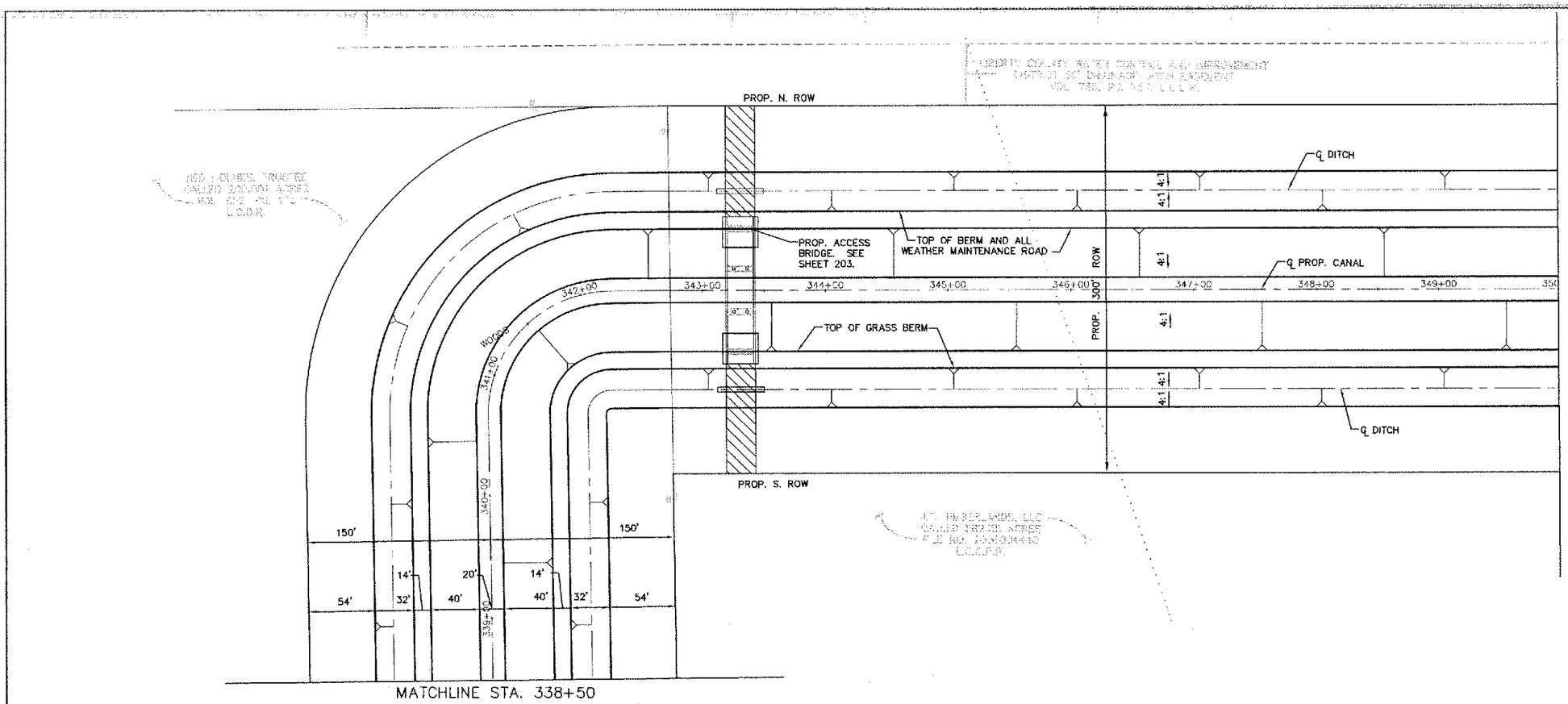
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

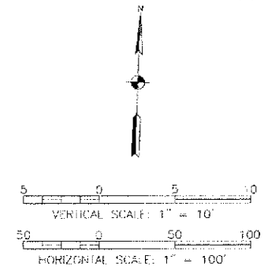
CANAL PLAN & PROFILE STA 326+00 TO STA 338+50

DRAWING SCALE
AS SHOWN

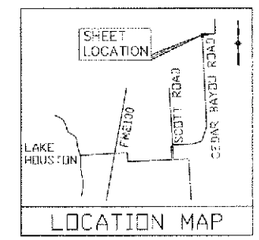
SHEET NO. 60 OF 245

LAST MODIFIED: Jan 27, 2011 – 3:58pm BY USER: ThompsonBi
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Code\PWD\Sheets\
DWG. NAME: CanalP&P27.dwg

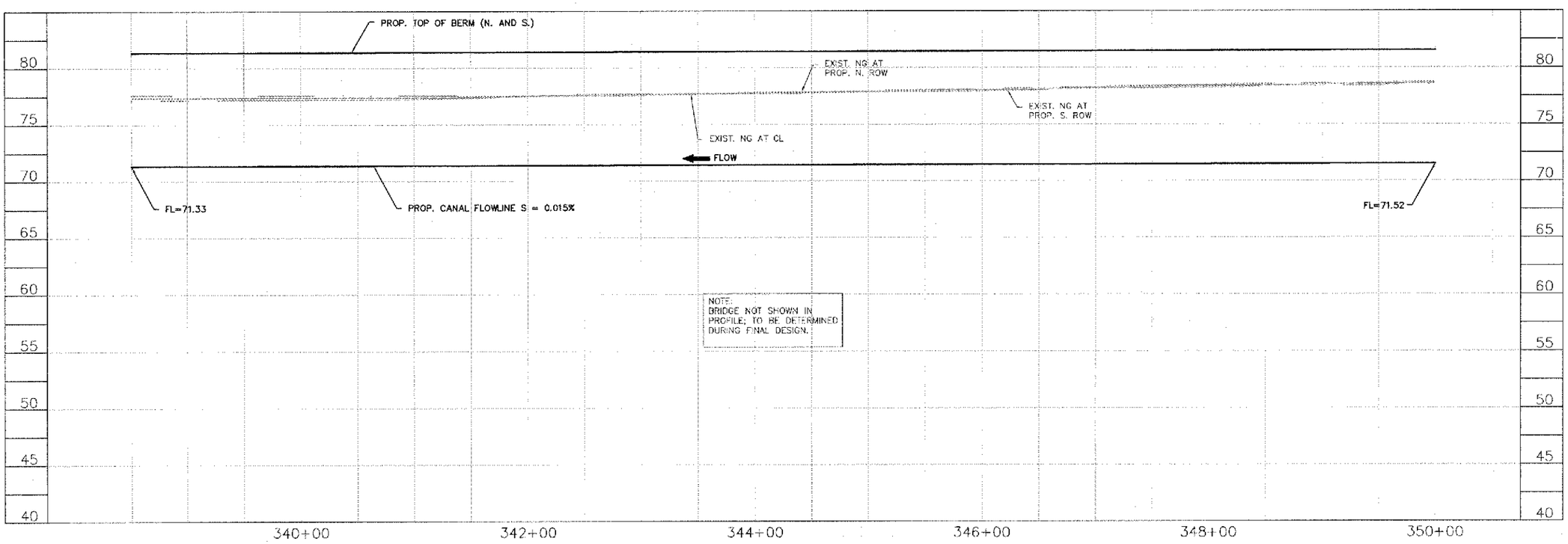




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



NOTE:
BRIDGE NOT SHOWN IN PROFILE; TO BE DETERMINED DURING FINAL DESIGN.

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TEXAS REGISTRATION NO. 91031

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN & PROFILE STA 338+50 TO STA 350+00

DRAWING SCALE
AS SHOWN

SHEET NO. 61 OF 295

LAST MODIFIED: Jan 27, 2011 - 3:59pm BY USER: ThompsonBi
DWG. LOCATION: O:\Work Order B\V4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cordt\PWO\Sheets\
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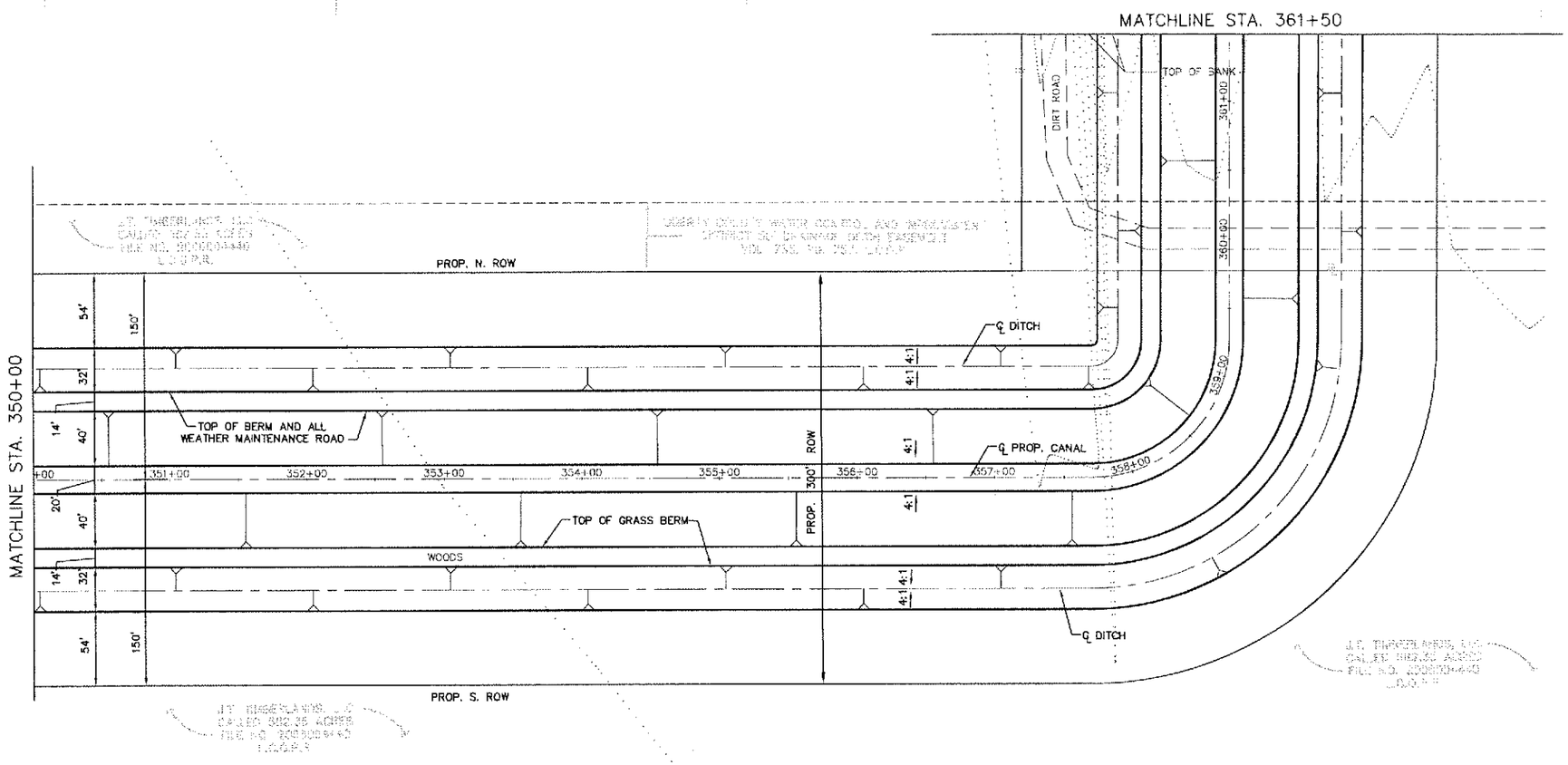
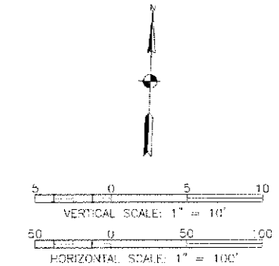
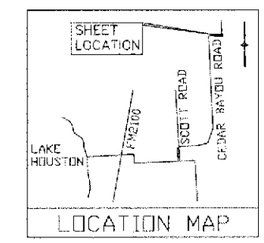
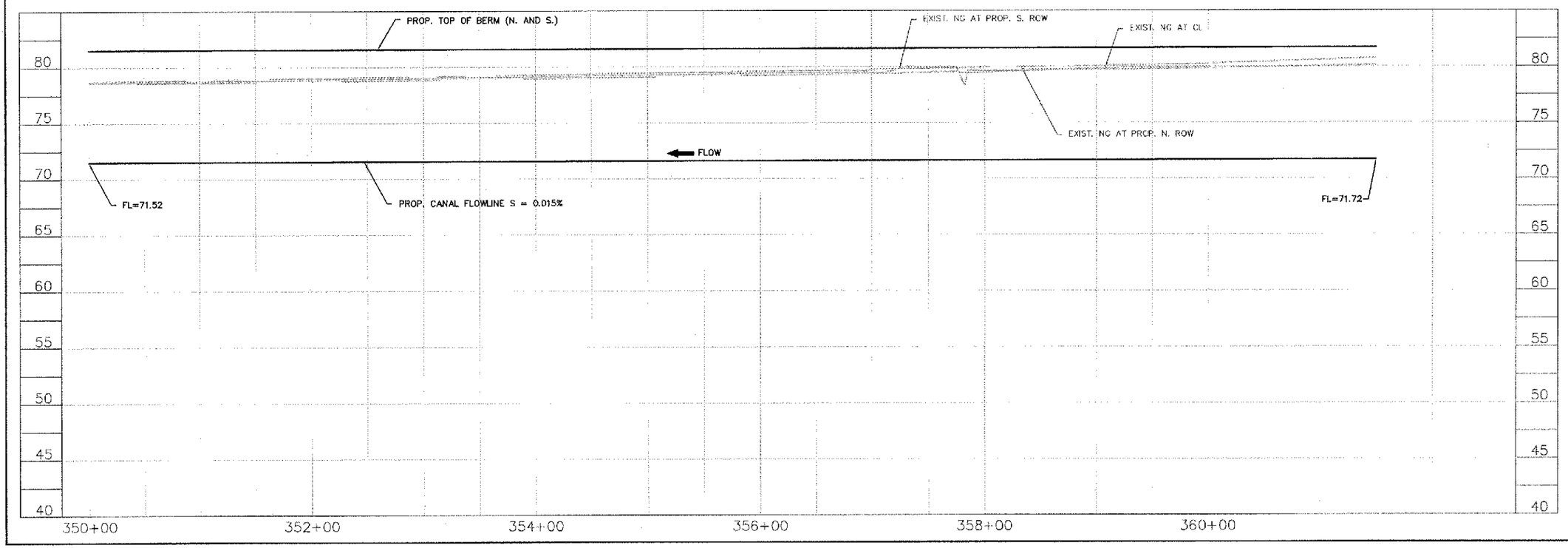




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031

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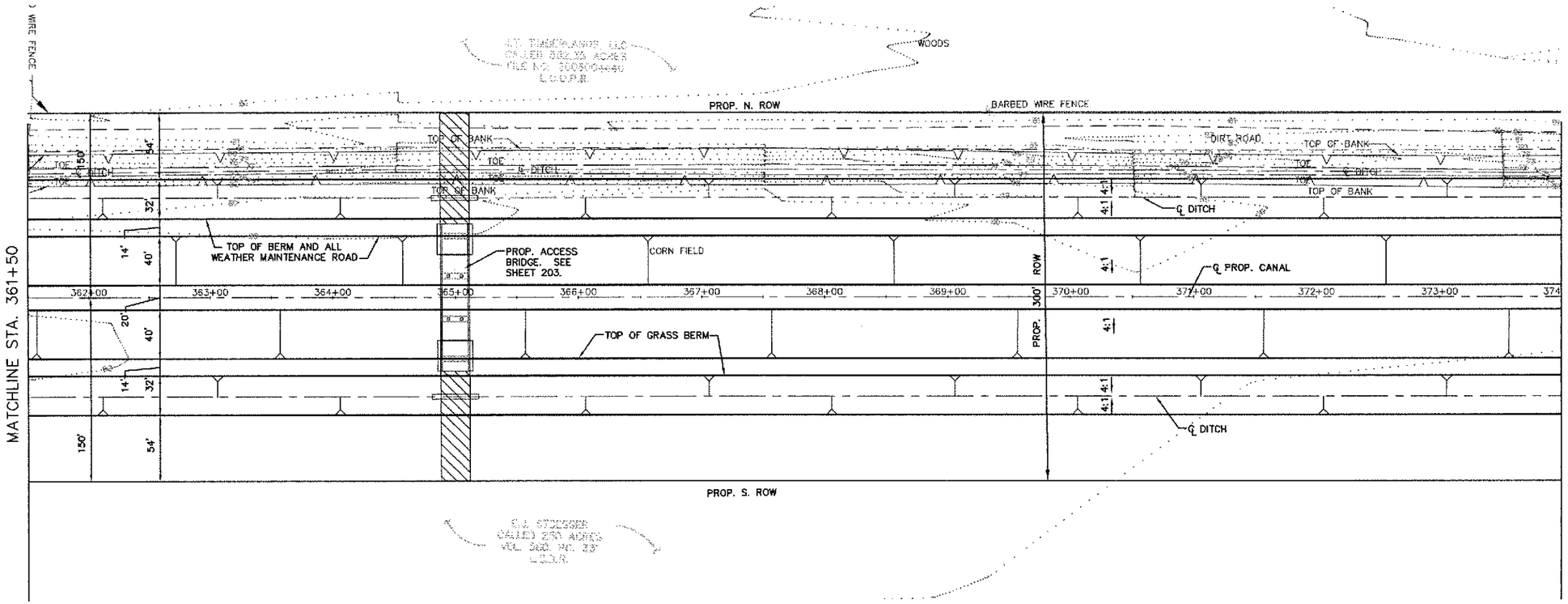
SURVEYED BY:
FB NO.

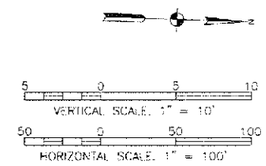
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN &
PROFILE STA 350+00
TO STA 361+50

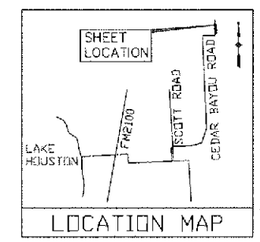
DRAWING SCALE
AS SHOWN

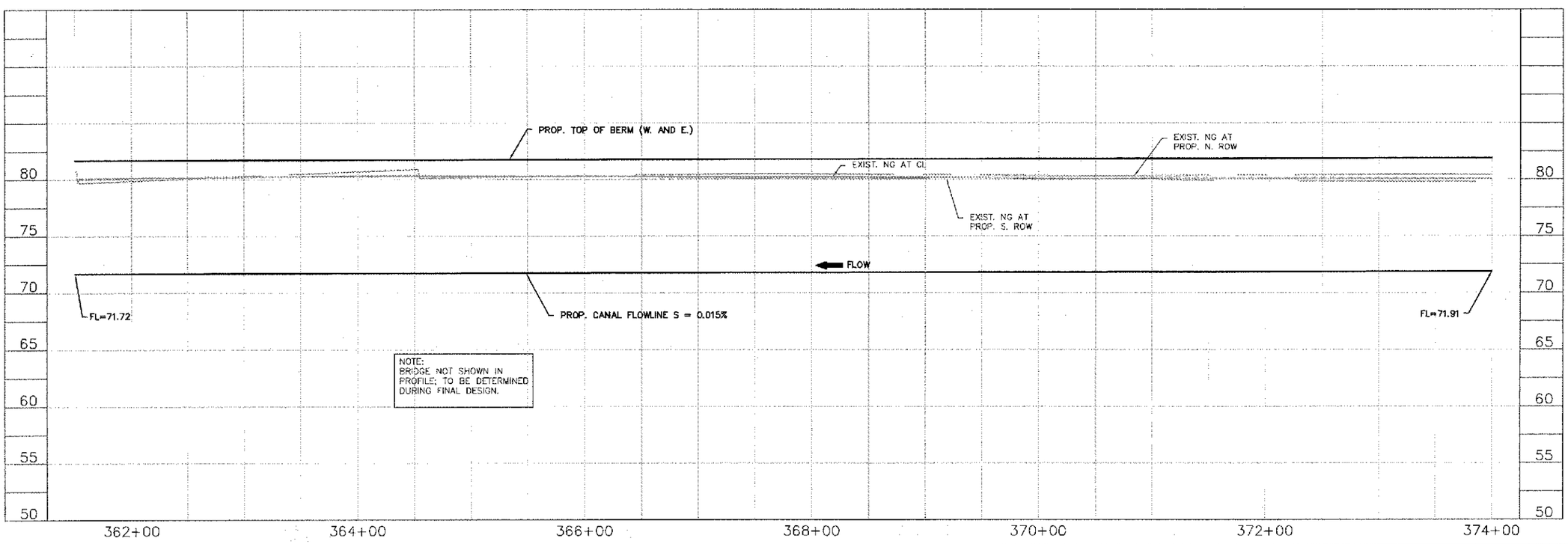
LAST MODIFIED: Jan 27, 2011 - 3:59pm BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 5\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P29.dwg





NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN





NOTE:
BRIDGE NOT SHOWN IN PROFILE; TO BE DETERMINED DURING FINAL DESIGN.

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN & PROFILE STA 361+50 TO STA 374+00

DRAWING SCALE
AS SHOWN

SHEET NO. 63 OF 245

LAST MODIFIED: Jan 28, 2011 – 7:35am BY USER: ThompsonBl
DWG. LOCATION: G:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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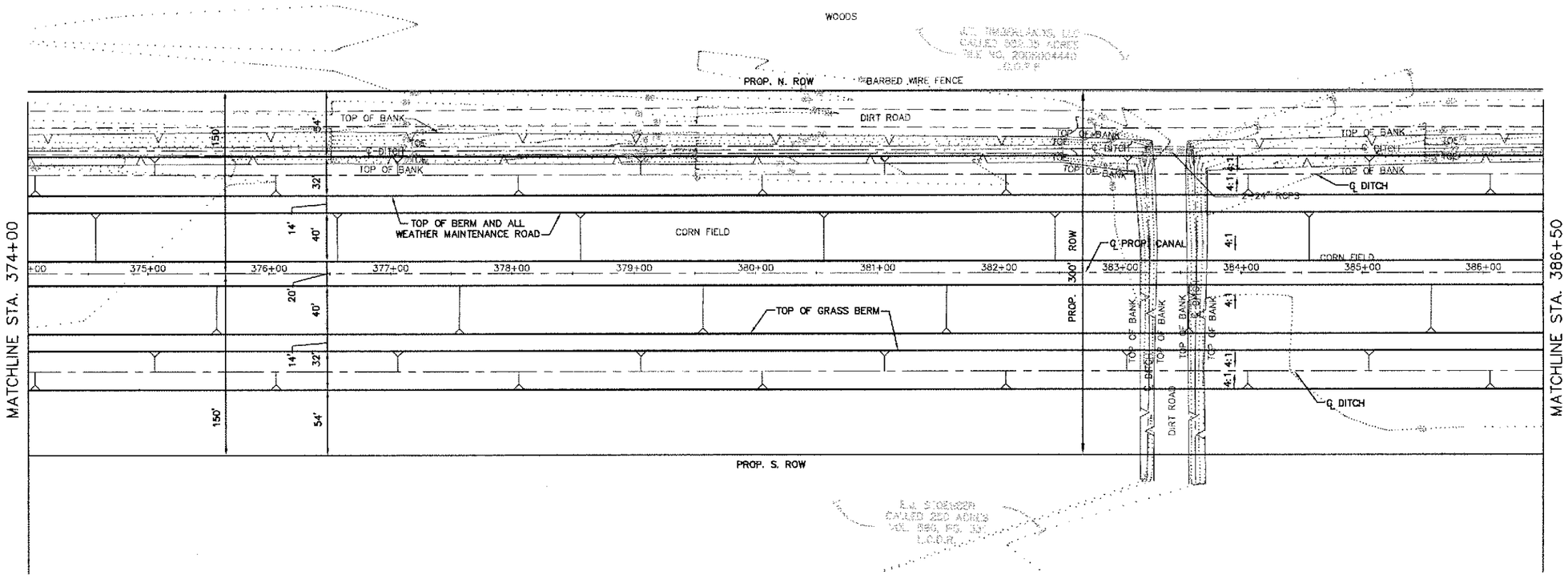
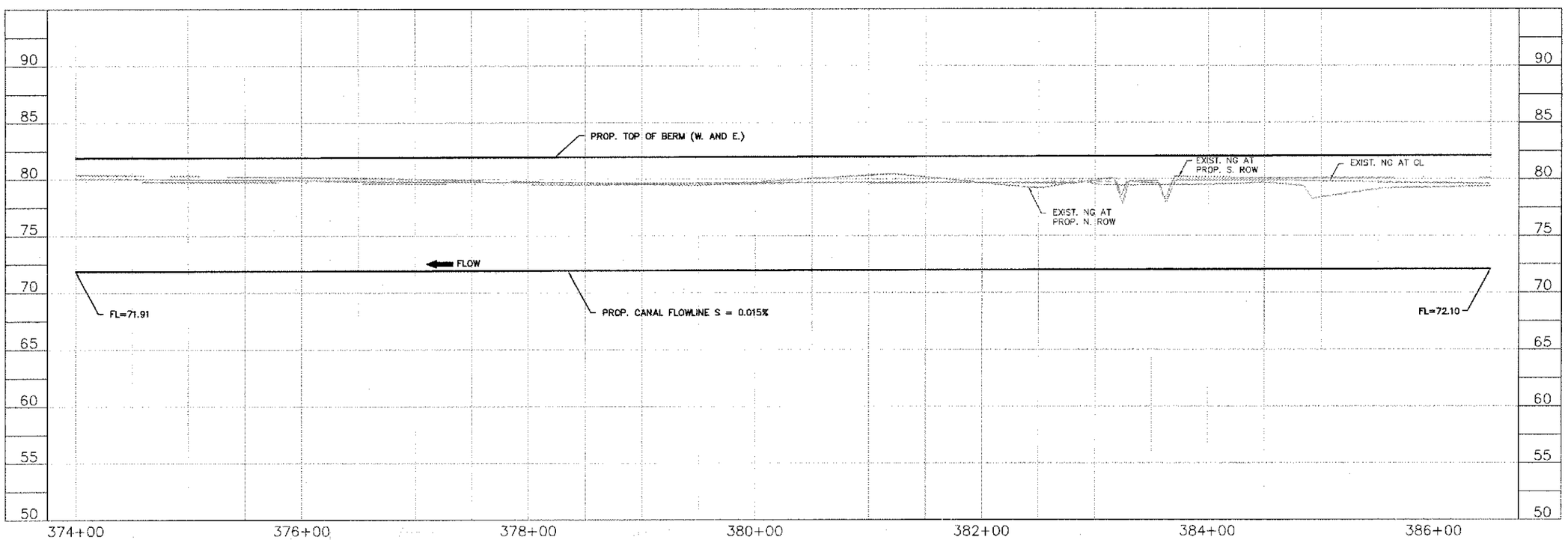
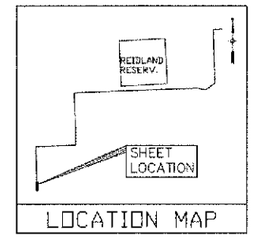




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
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AECOM

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FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN & PROFILE STA 374+00 TO STA 386+50

DRAWING SCALE
AS SHOWN

SHEET NO. 64 OF 295

LAST MODIFIED: Jan 28, 2011 - 7:36am BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 8\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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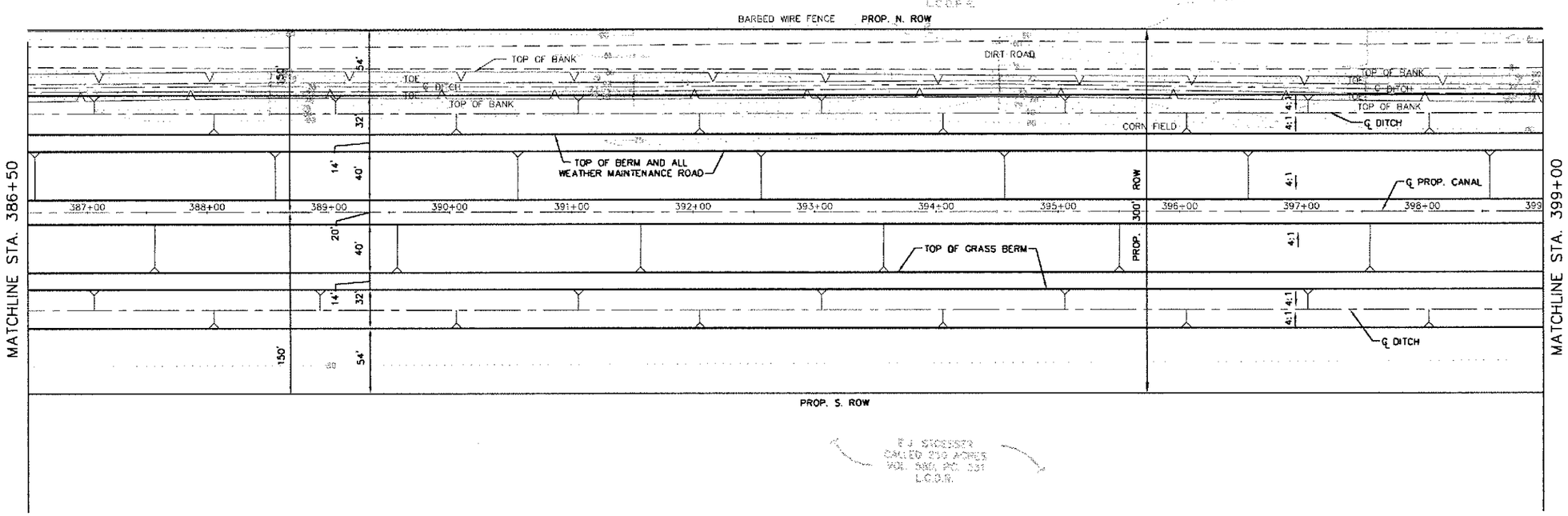
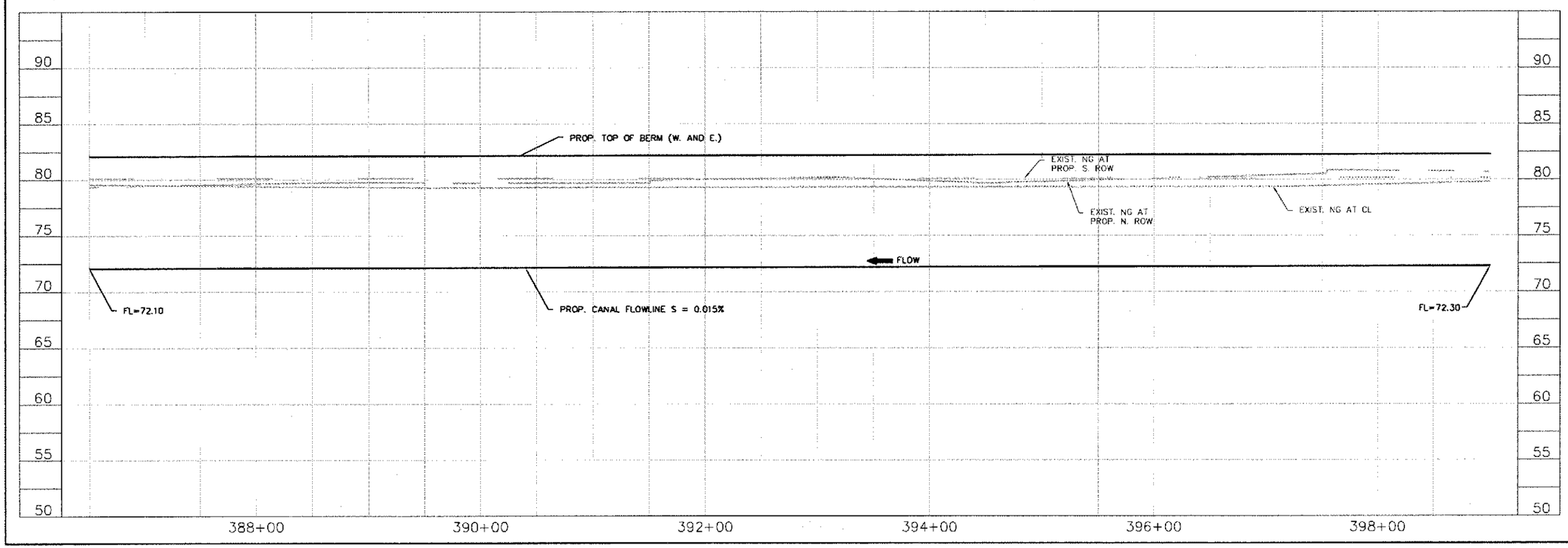
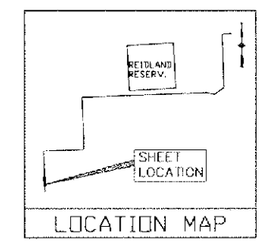




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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713.780.0838 fax.

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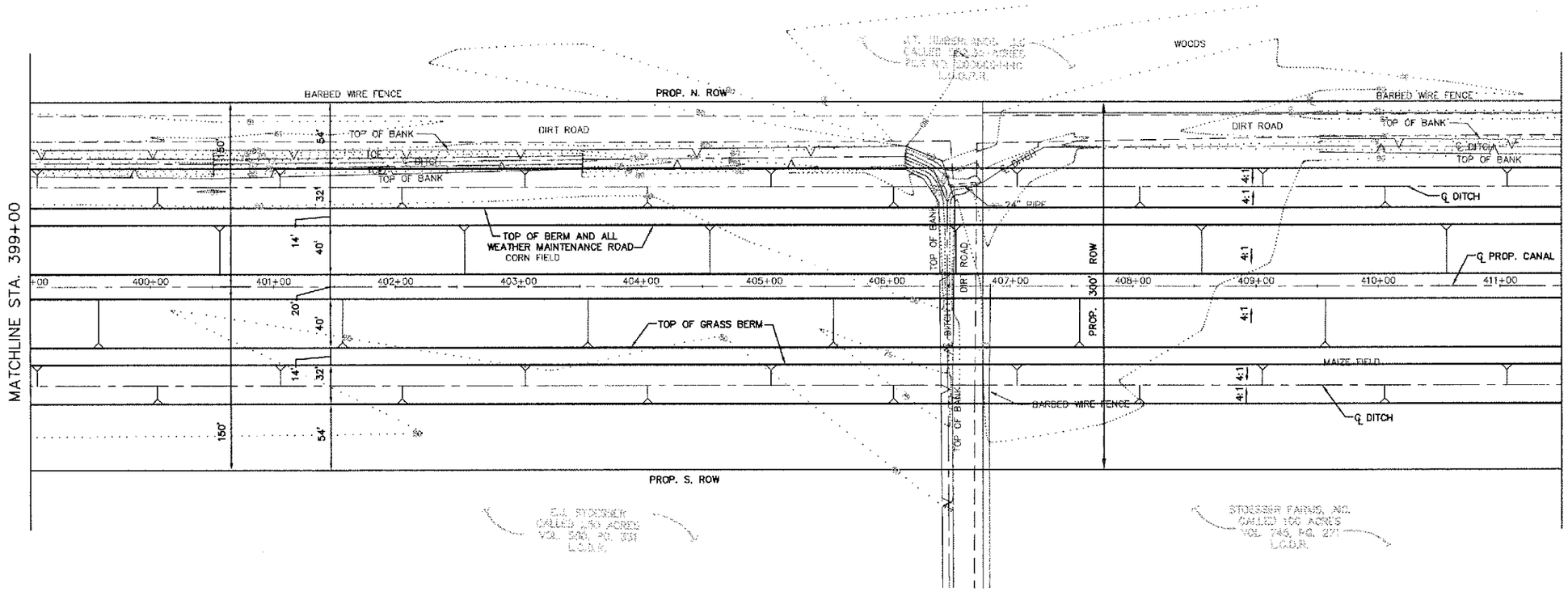
LUCE BAYOU INTERBASIN TRANSFER PROJECT

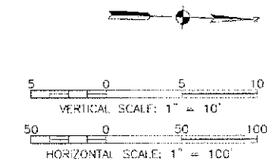
CANAL PLAN & PROFILE STA 386+50 TO STA 399+00

DRAWING SCALE
AS SHOWN

SHEET NO 65 OF 245

LAST MODIFIED: Jan 28, 2011 - 7:44am BY USER: ThompsonBl
DWG. LOCATION: G:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PMO\Sheets\
DWG. NAME: CanalP&P32.dwg





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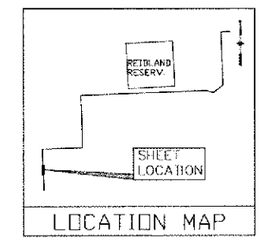
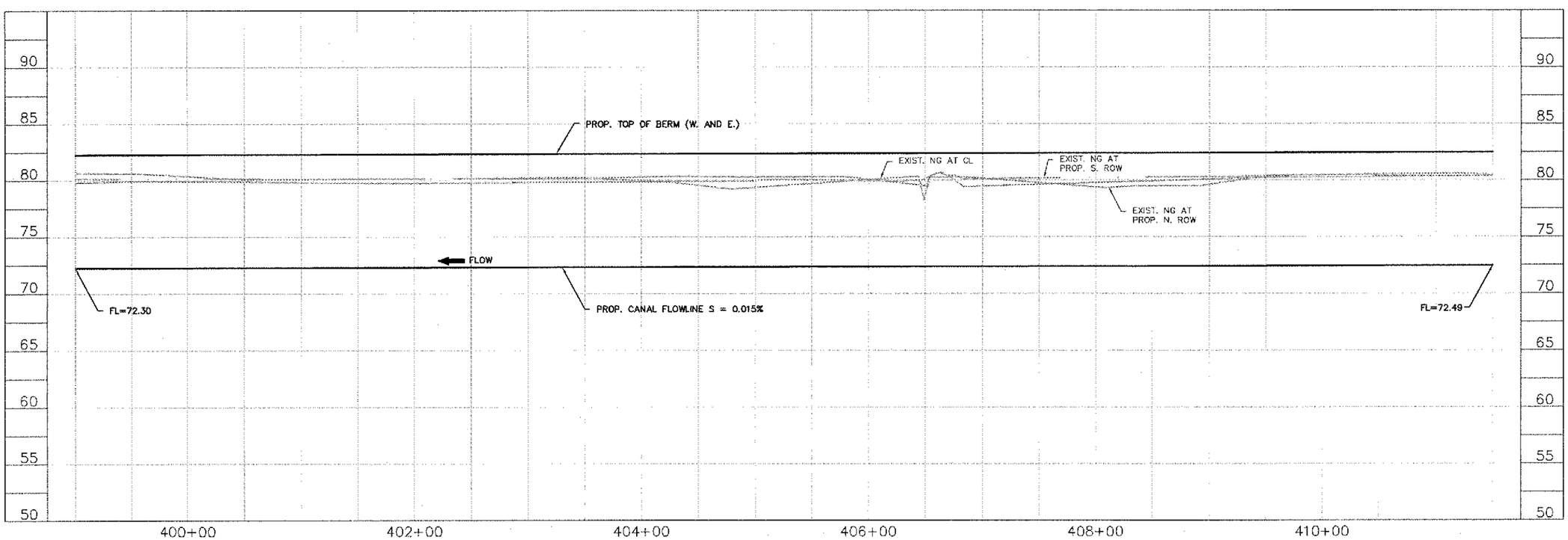


LOCATION MAP



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713.780.0838 fax.

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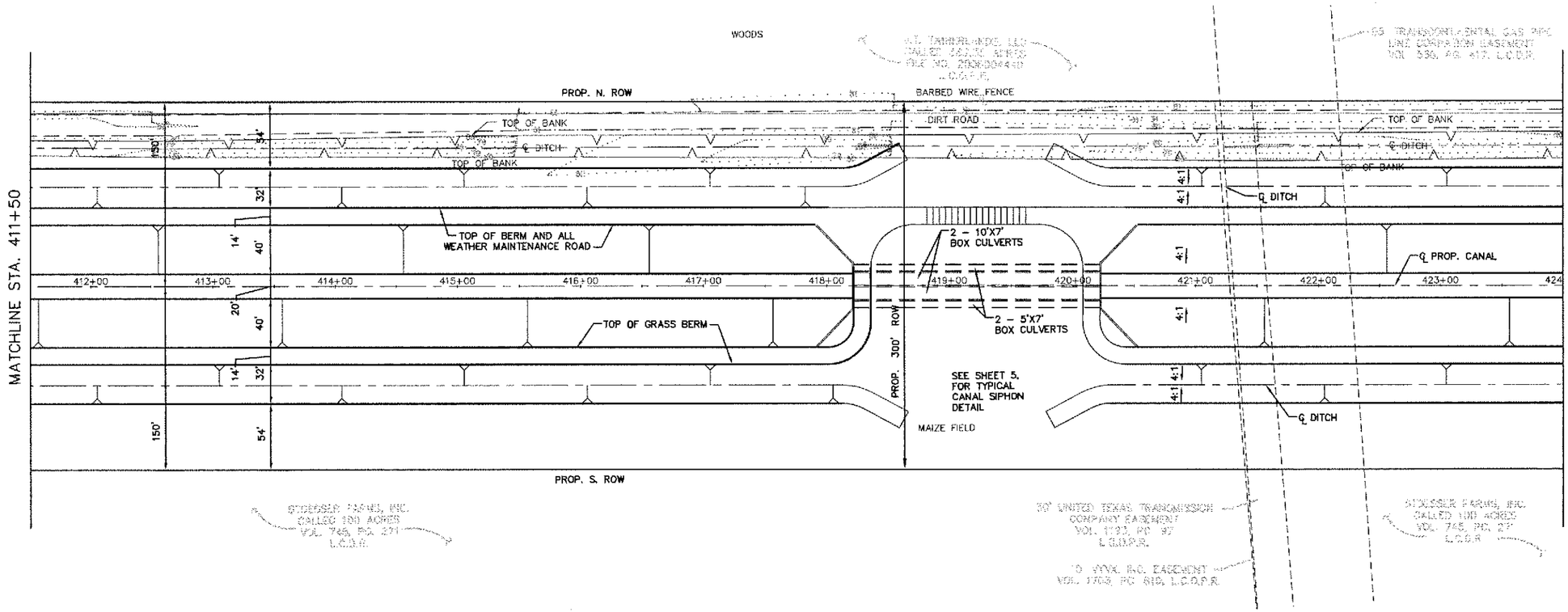
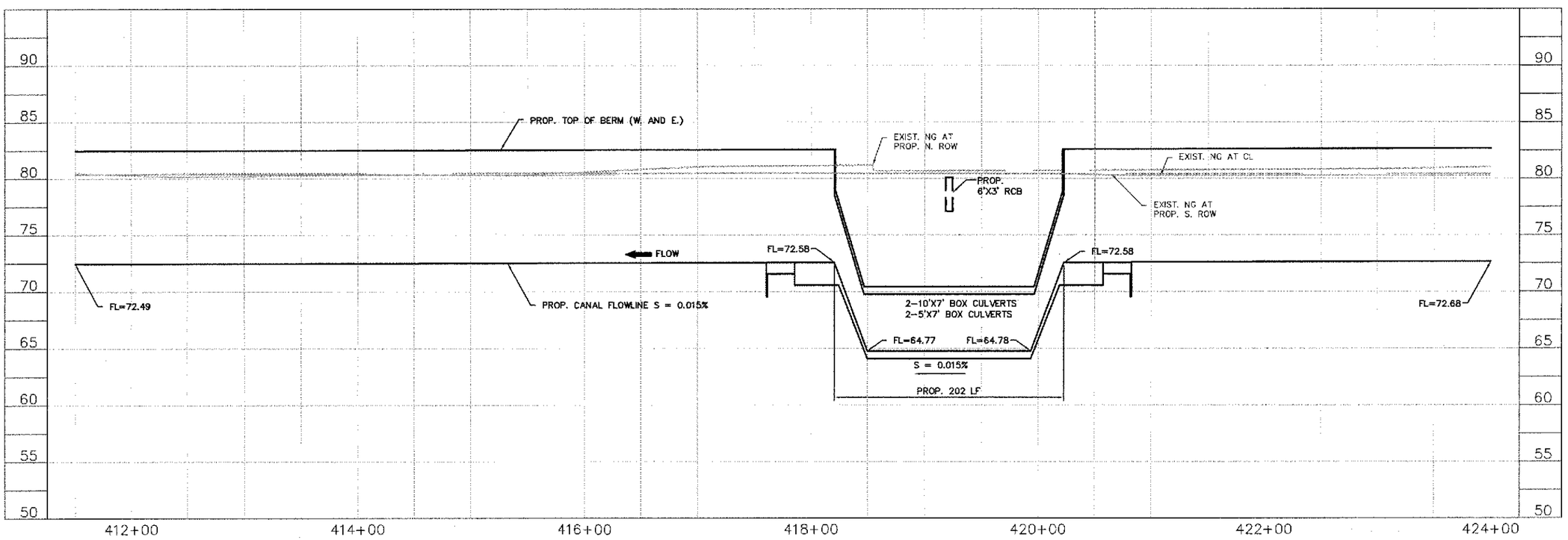
CANAL PLAN &
PROFILE STA 399+00
TO STA 411+50

DRAWING SCALE
AS SHOWN

SHEET NO. 66 OF 245

LAST MODIFIED: Jan 28, 2011 - 7:39am BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P33.dwg



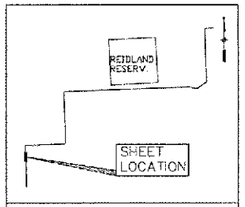


VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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AECOM

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713.780.0838 fax.

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FB NO.

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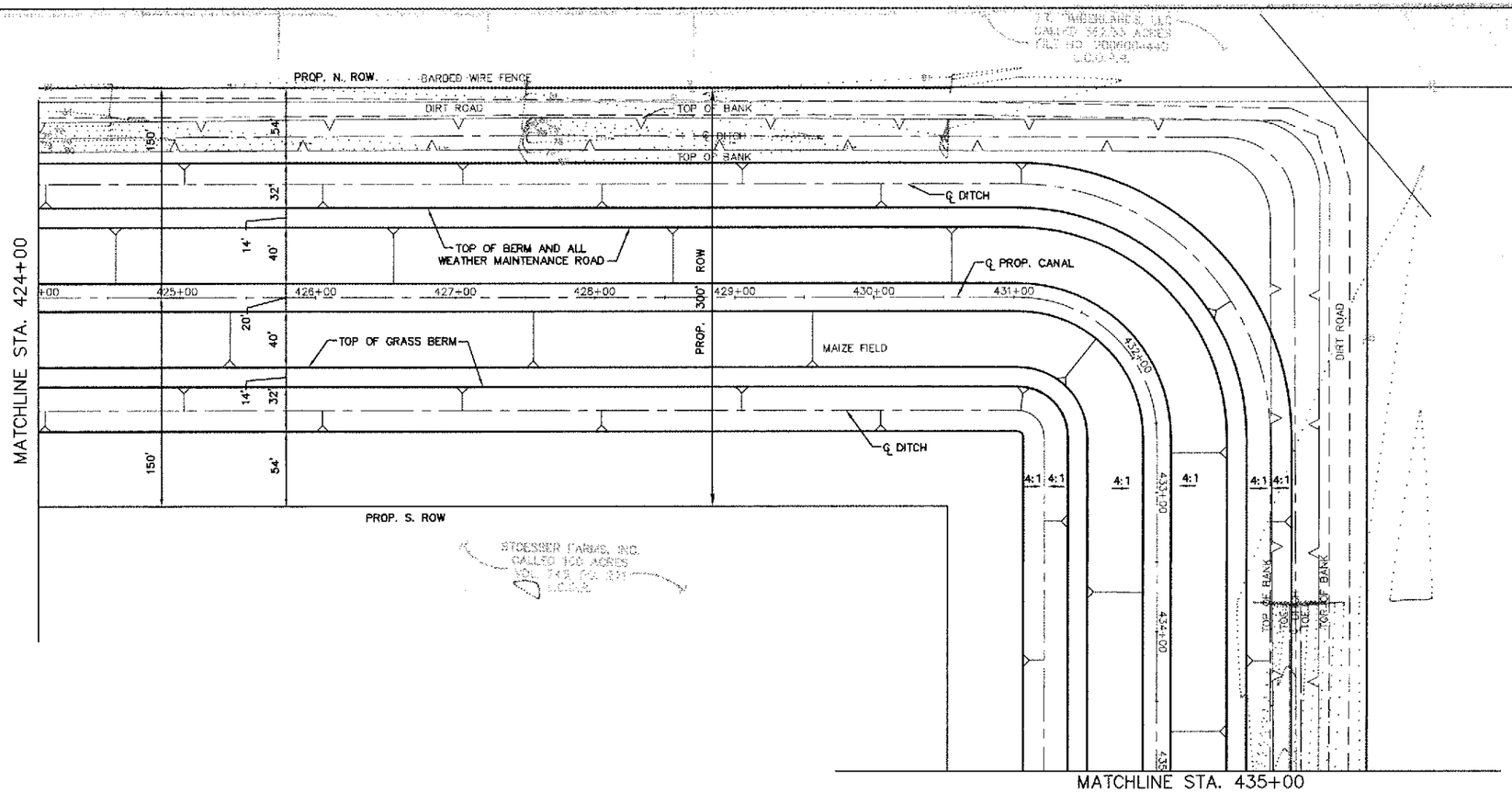
LUCE BAYOU INTERBASIN TRANSFER PROJECT

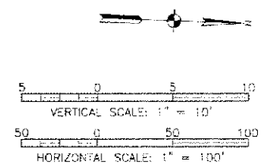
CANAL PLAN & PROFILE STA 411+50 TO STA 424+00

DRAWING SCALE
AS SHOWN

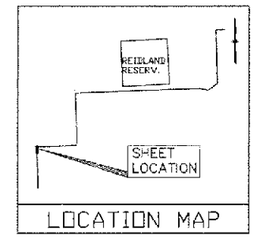
SHEET NO. 67 OF 245

LAST MODIFIED: Jan 28, 2011 - 7:40am BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P34.dwg

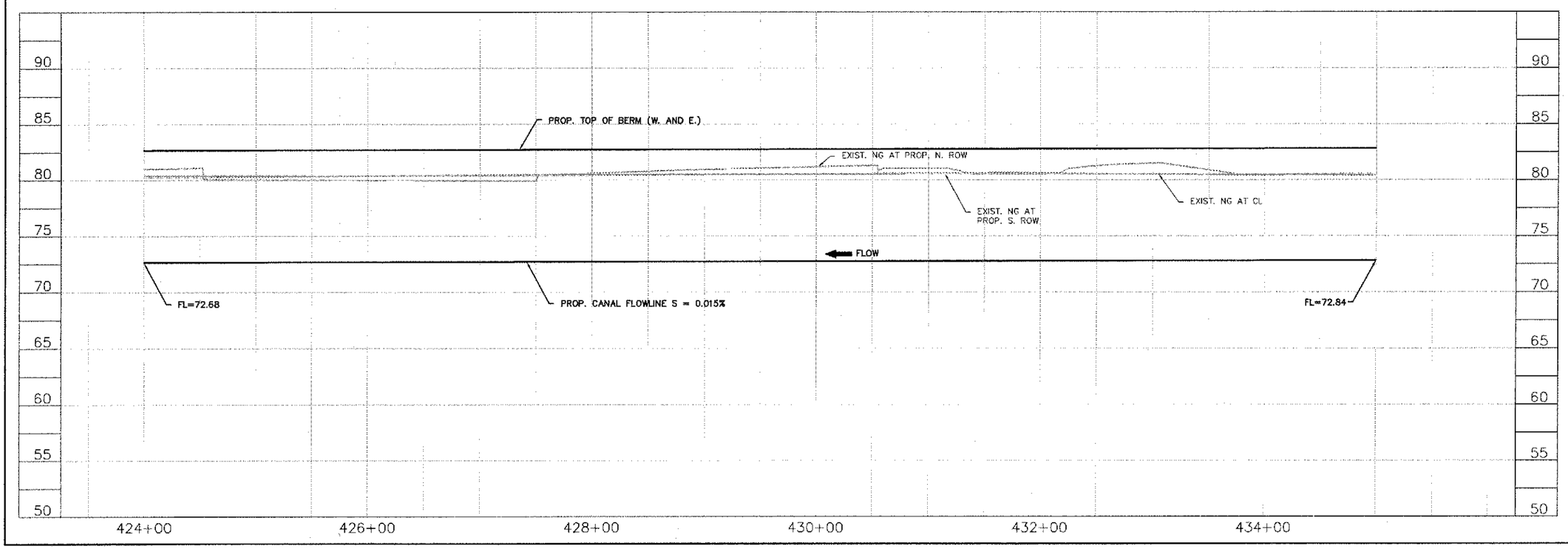




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



KEVIN R. KRAHN, P.E.
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AECOM

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713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN &
PROFILE STA 424+00
TO STA 435+00

DRAWING SCALE
AS SHOWN

SHEET NO. 68 OF 245

LAST MODIFIED: Jan 28, 2011 - 7:41am BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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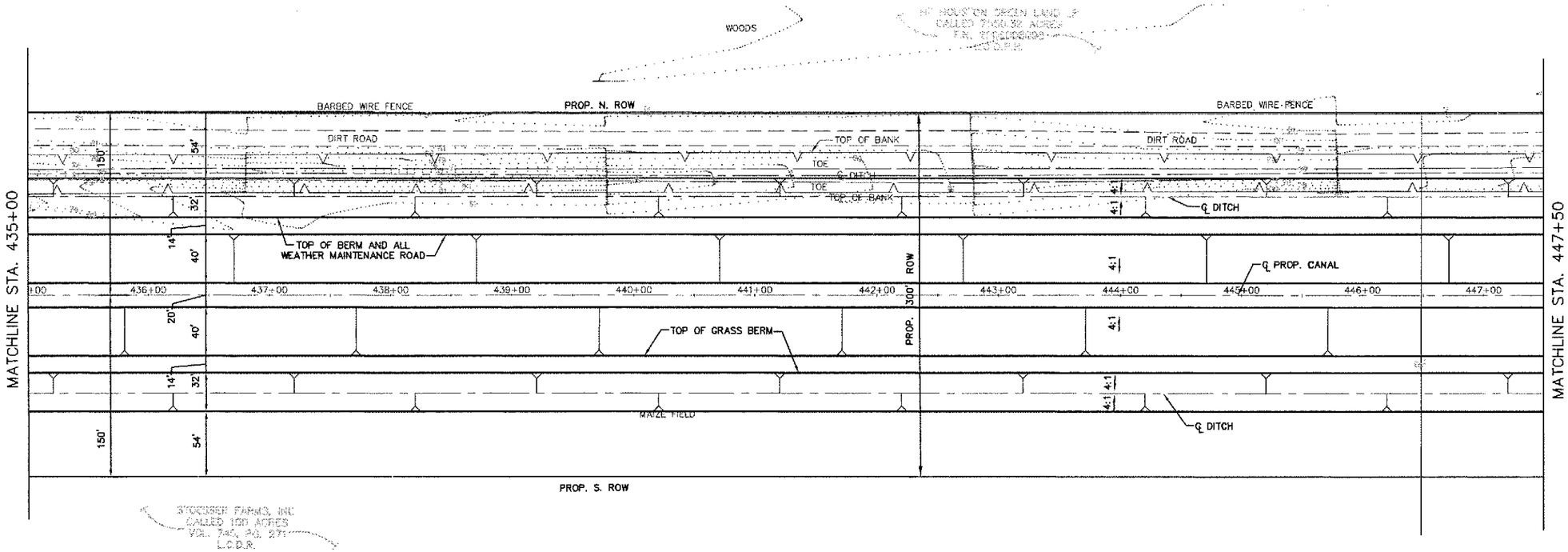
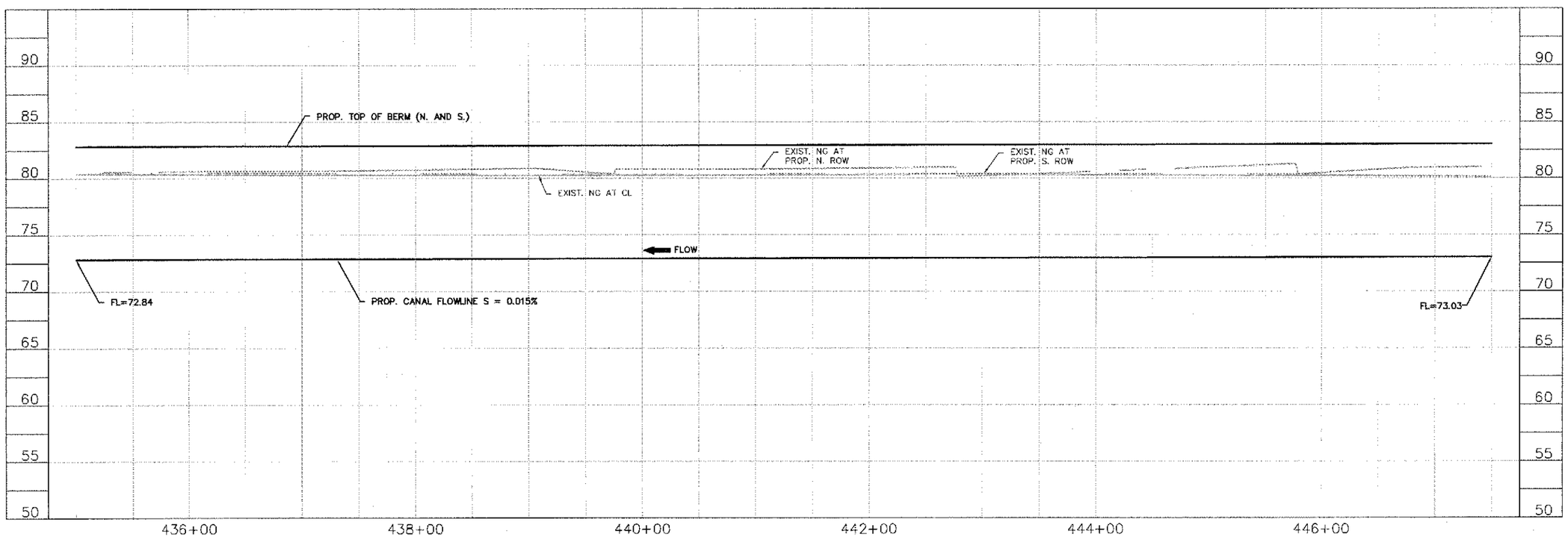
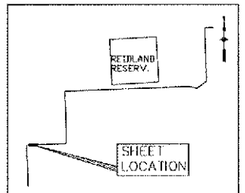




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

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HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

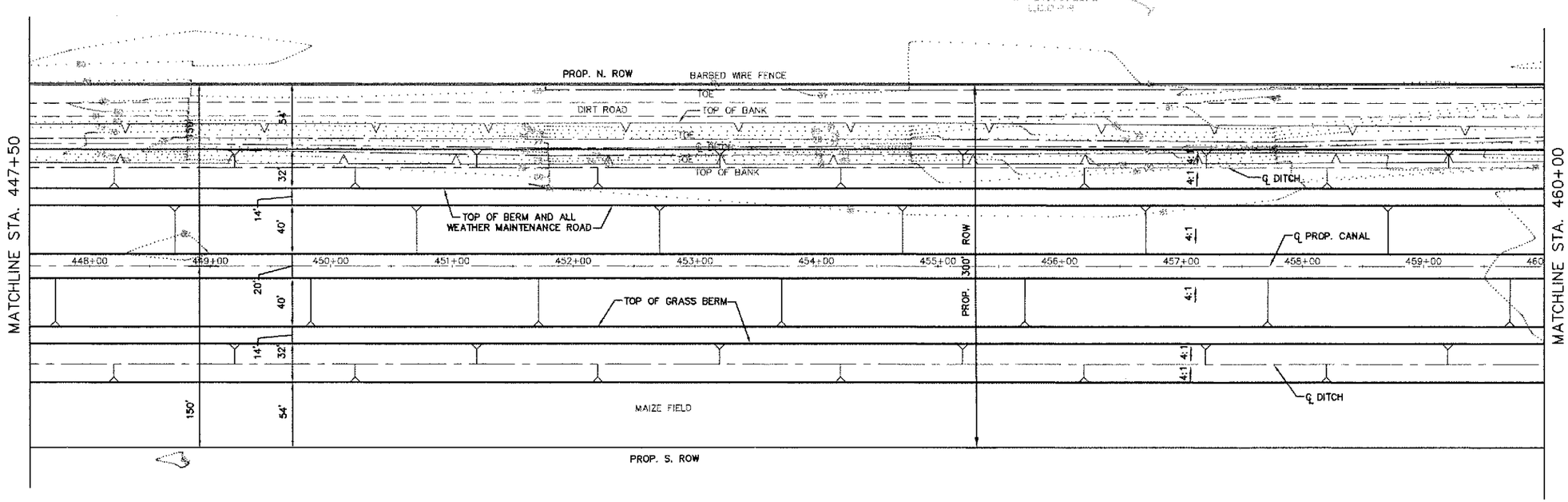
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

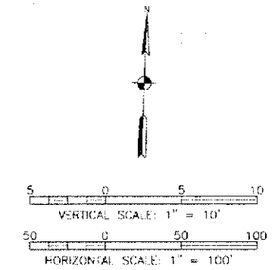
CANAL PLAN & PROFILE STA 435+00 TO STA 447+50

DRAWING SCALE
AS SHOWN

SHEET NO. 69 OF 245

LAST MODIFIED: Jan 28, 2011 - 7:41am BY USER: Thompson91
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P35.dwg





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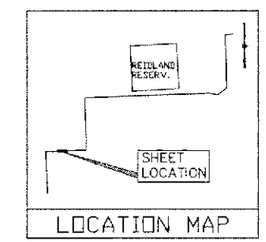
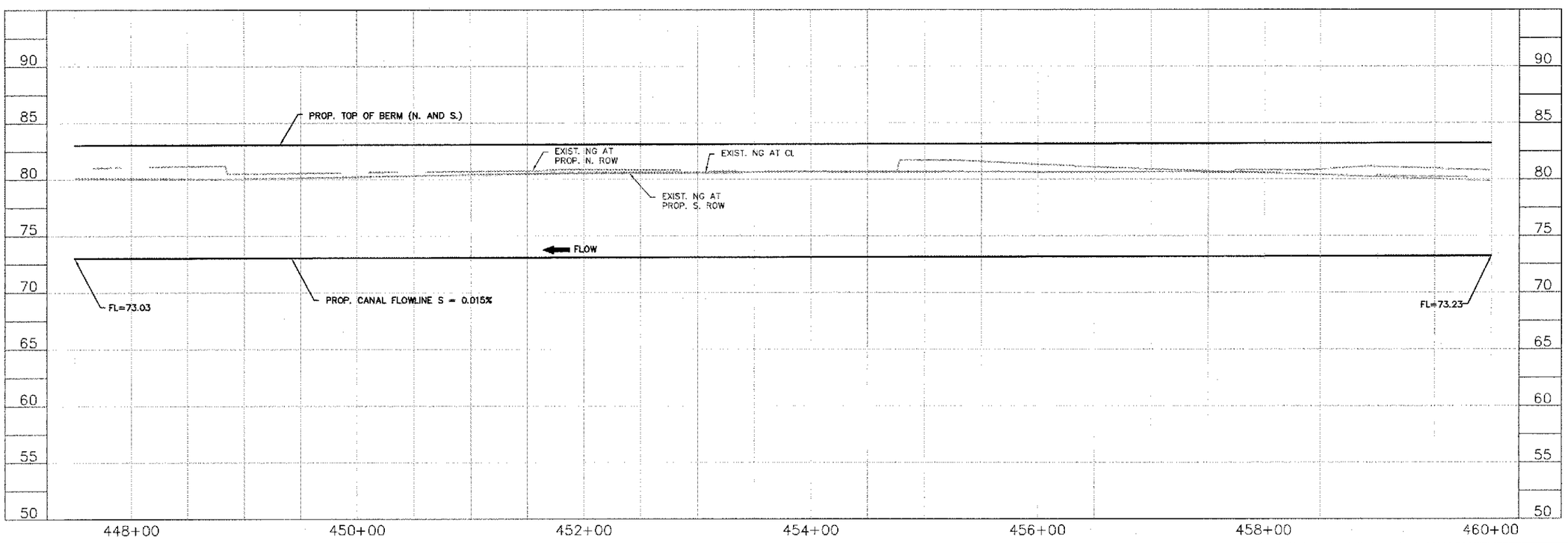
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1545
WWW.AECOM.COM
TBPE REGI. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

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FB NO.

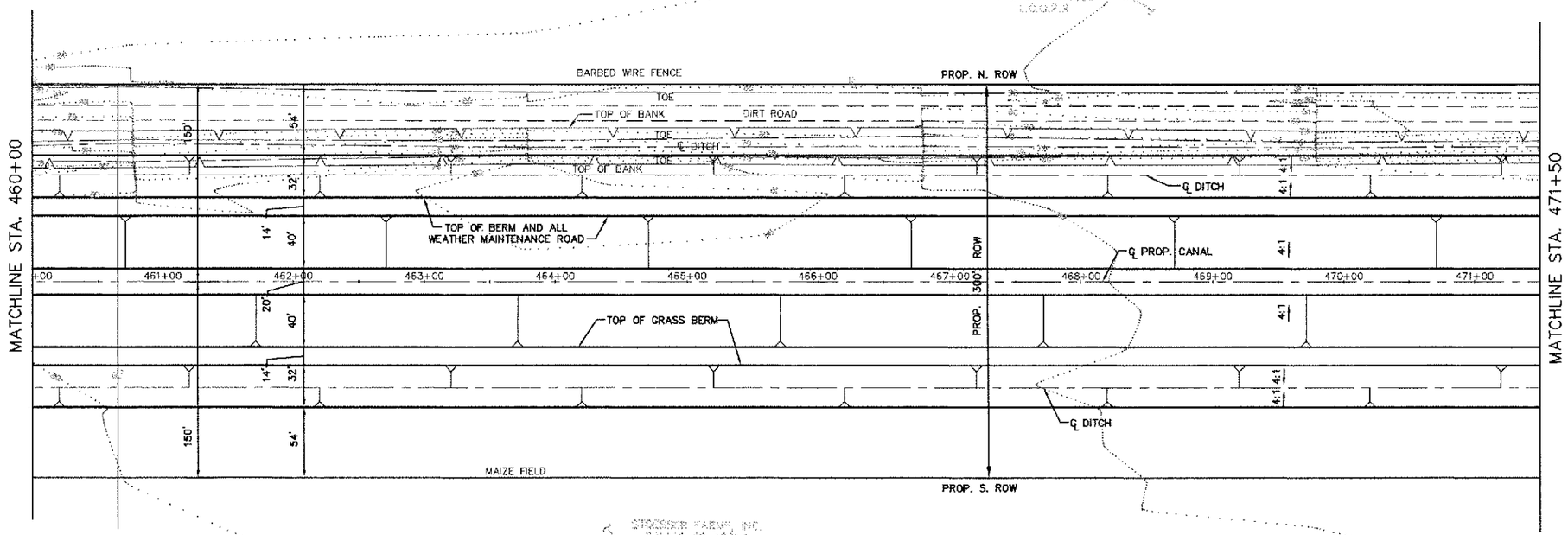
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN &
PROFILE STA 447+50
TO STA 460+00

DRAWING SCALE
AS SHOWN

SHEET NO. 70 OF 245

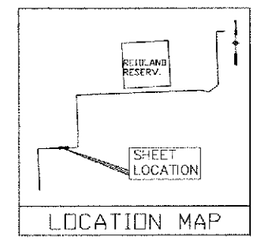
LAST MODIFIED: Jan 28, 2011 – 7:42am BY USER: ThompsonBI
DWG. LOCATION: D:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PND\Sheets\
DWG. NAME: CanalP&P37.dwg



VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



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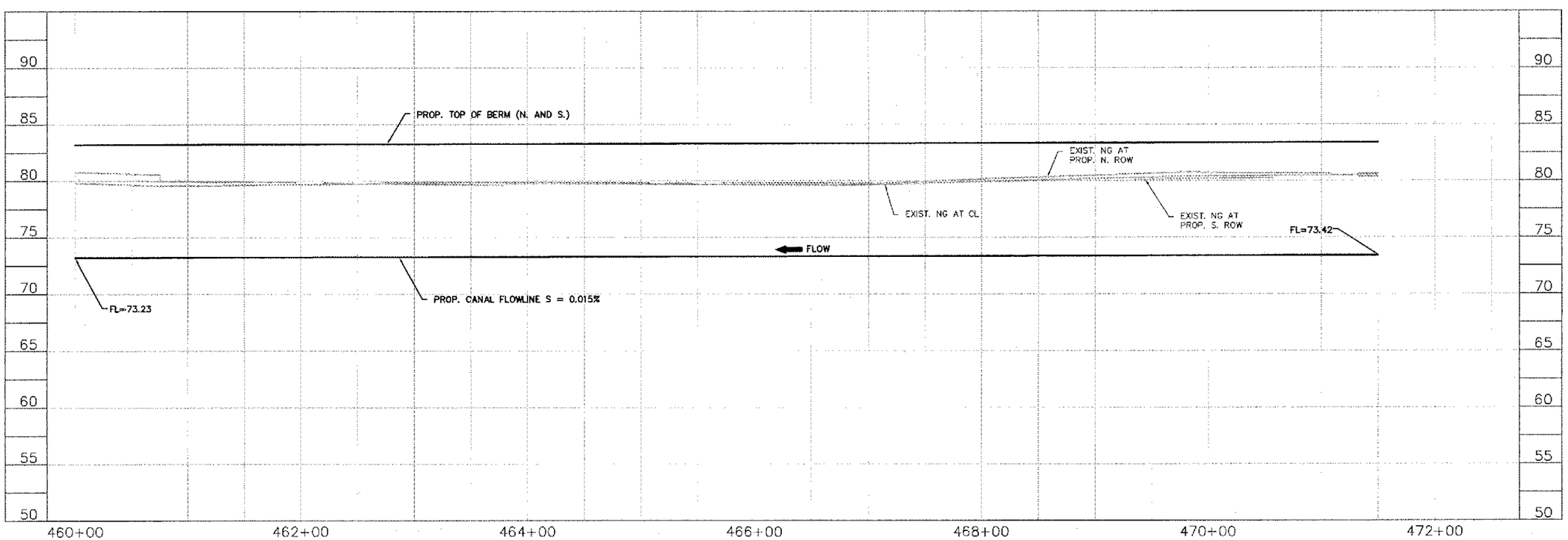

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TEXAS REGISTRATION NO. 91031
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AECOM

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713.780.0838 fax.

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN & PROFILE STA 460+00 TO STA 471+50

DRAWING SCALE
AS SHOWN

SHEET NO. 71 OF 245

LAST MODIFIED: Jan 28, 2011 – 7:42am BY USER: ThompsonBI
DWG. LOCATION: G:\Work Order 6\V4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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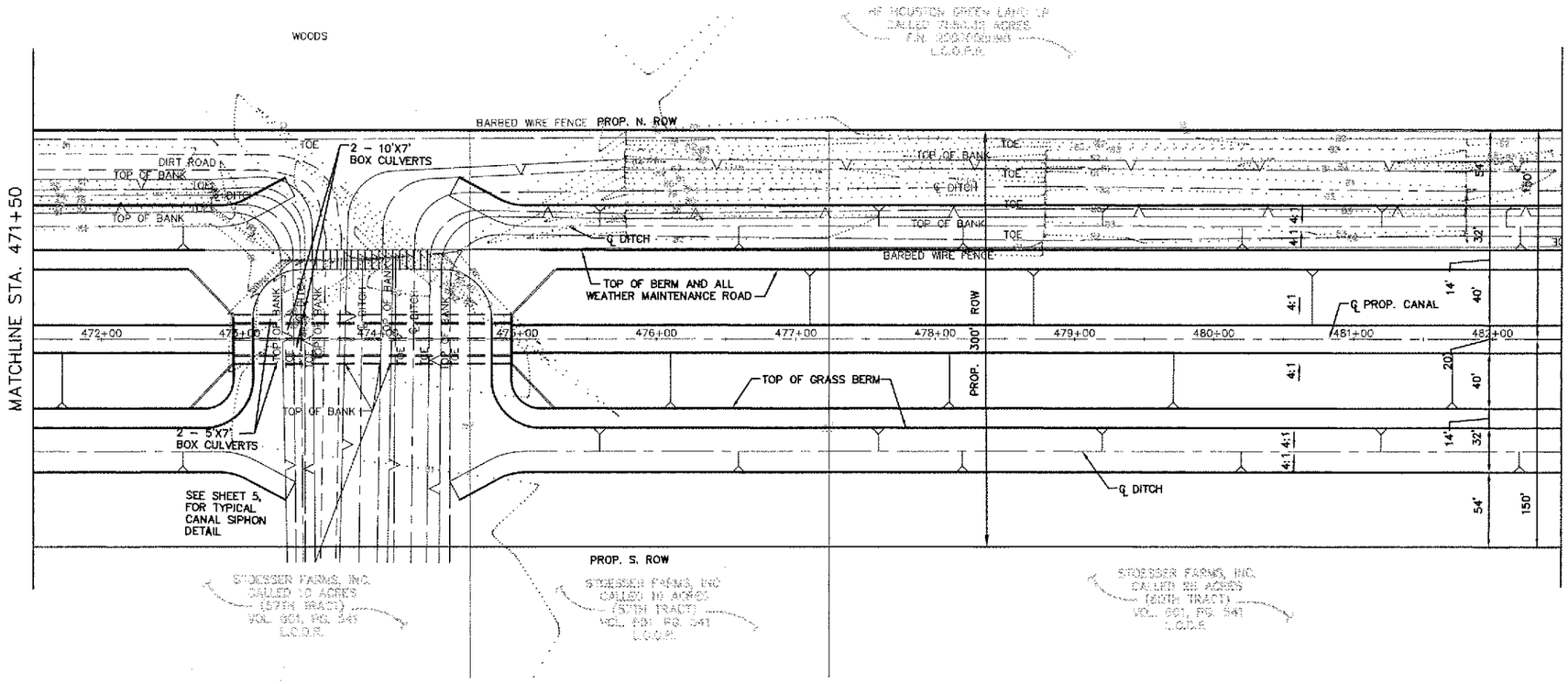

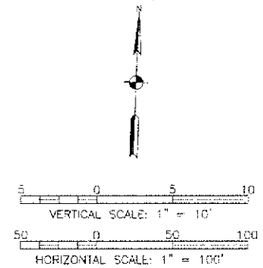

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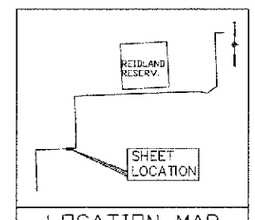
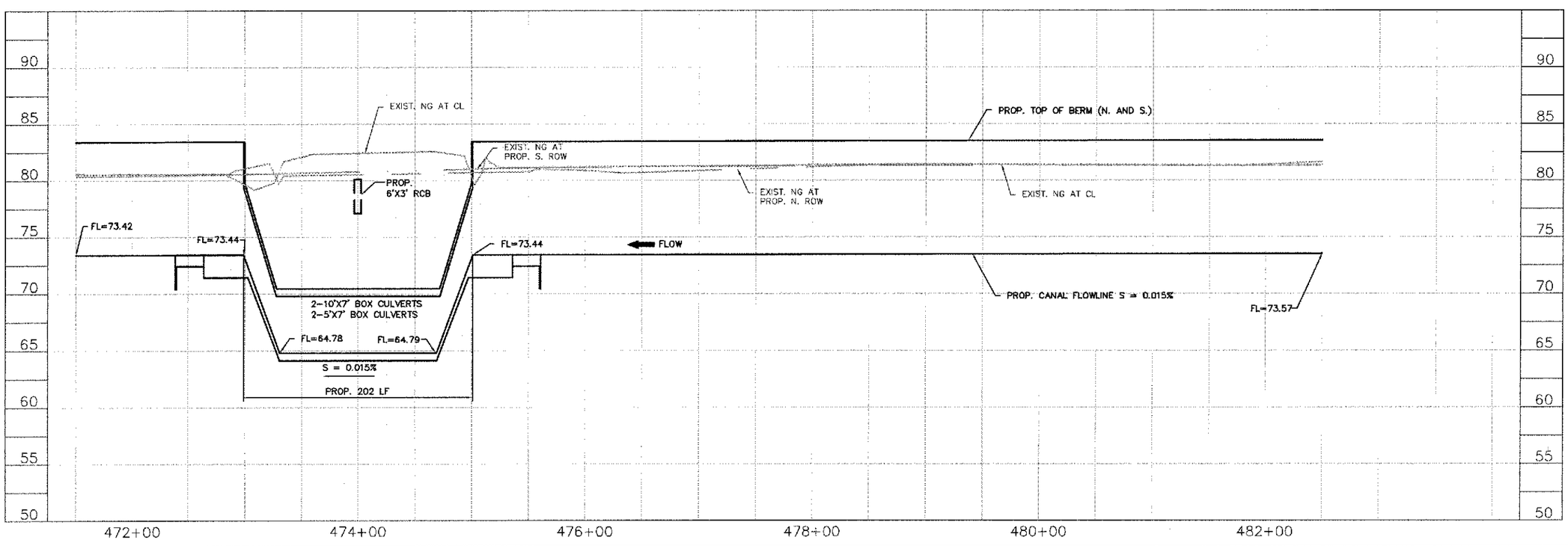
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



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713.780.0838 fax.

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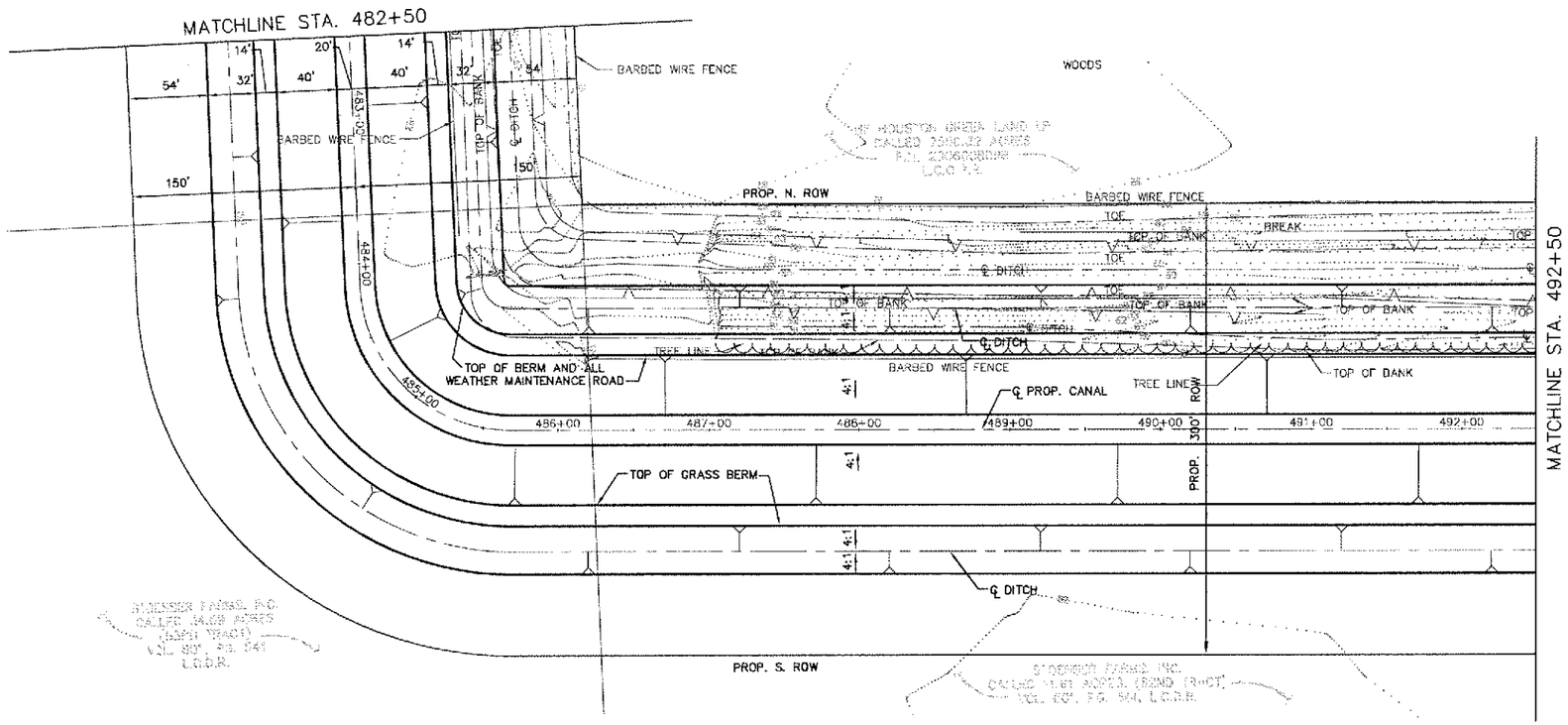
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

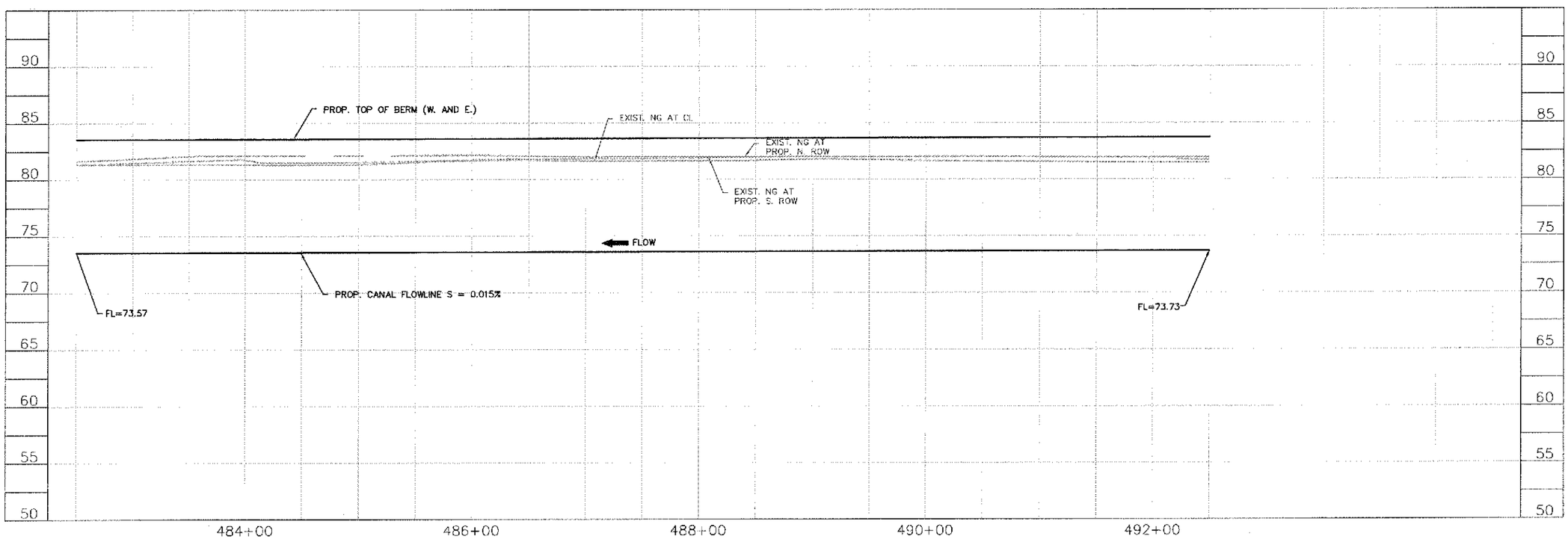
CANAL PLAN & PROFILE STA 471+50 TO STA 482+50

DRAWING SCALE
AS SHOWN

SHEET NO. 72 OF 245

LAST MODIFIED: Jan 28, 2011 - 7:43am BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P-39.dwg

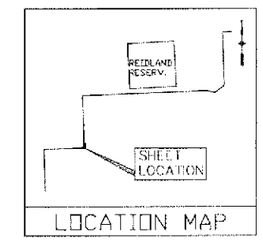




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
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HOUSTON, TEXAS 77057
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713.780.0838 fax.

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FB NO.

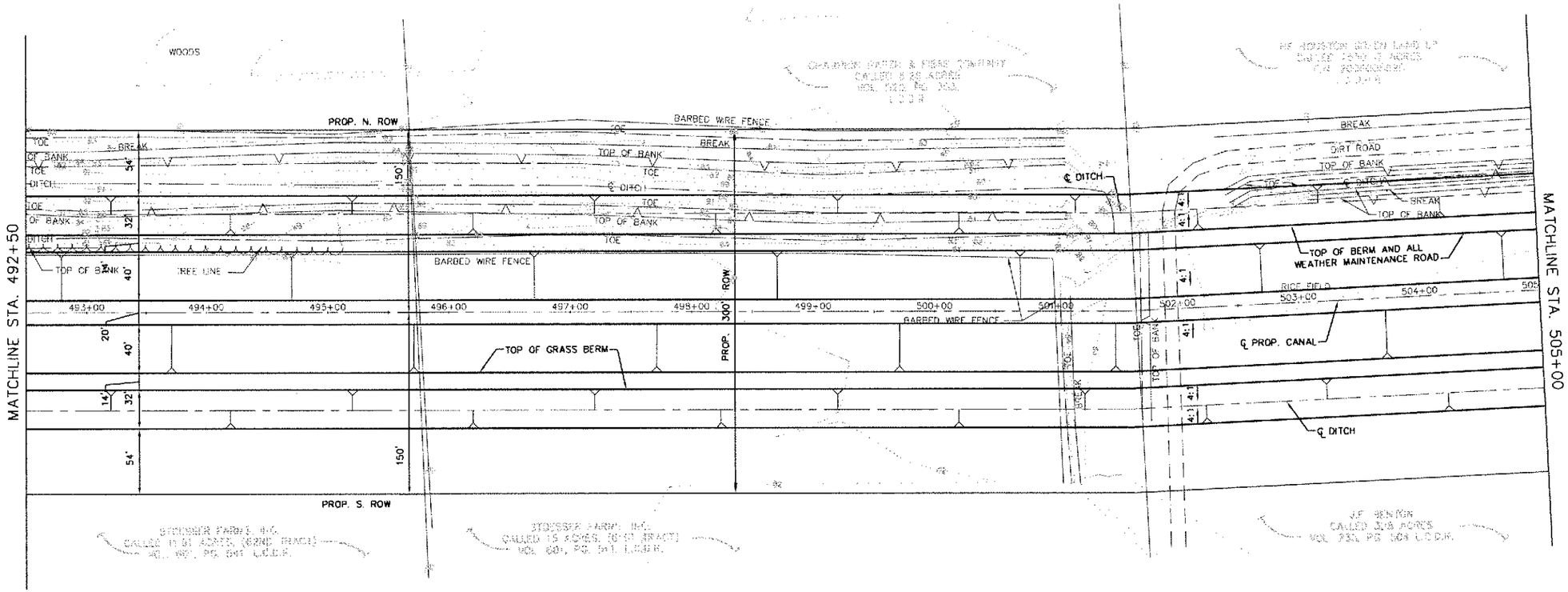
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

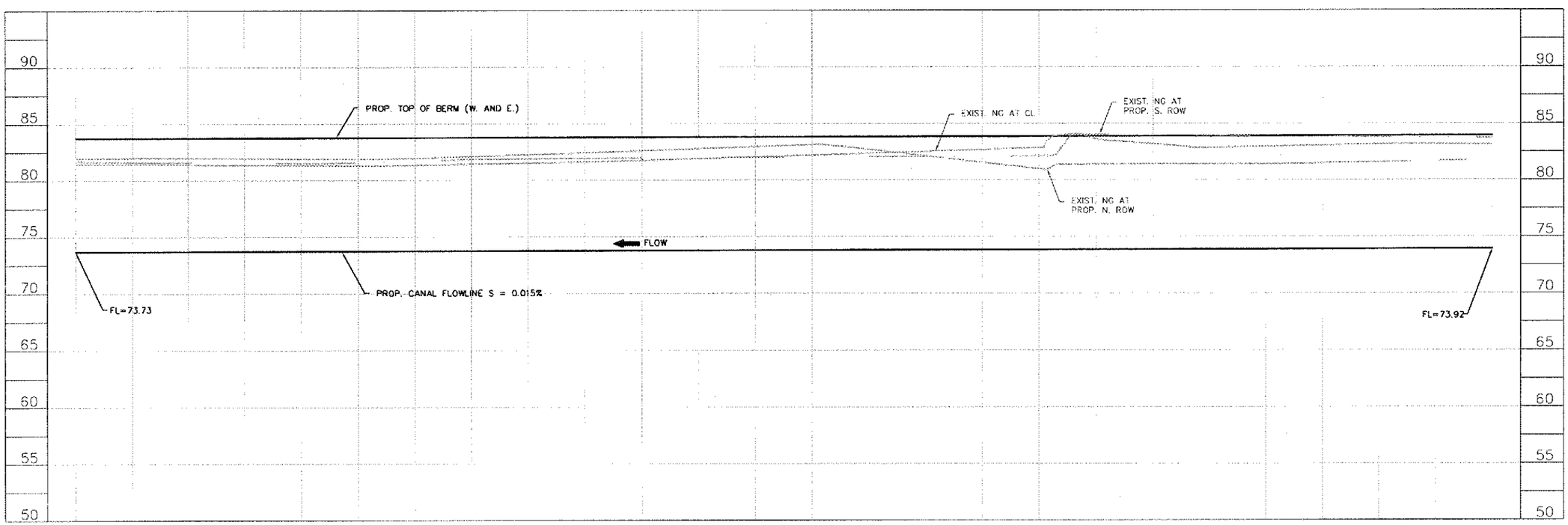
CANAL PLAN &
PROFILE STA 482+50
TO STA 492+50

DRAWING SCALE
AS SHOWN

SHEET NO. 73 OF 245

LAST MODIFIED: Jan 27, 2011 – 4:03pm BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P40.dwg

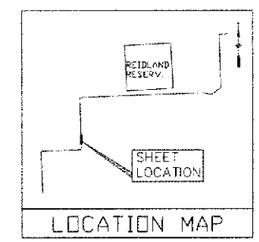




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
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COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN & PROFILE STA 492+50 TO STA 505+00

DRAWING SCALE
AS SHOWN

SHEET NO. 74 OF 145

LAST MODIFIED: Jan 27, 2011 - 4:04am BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 6\V4.0 ENGINEERING NOTES & CALCULATIONS\V4.3 Civil Notes and Calculations\Cross\PW21\Sheets\
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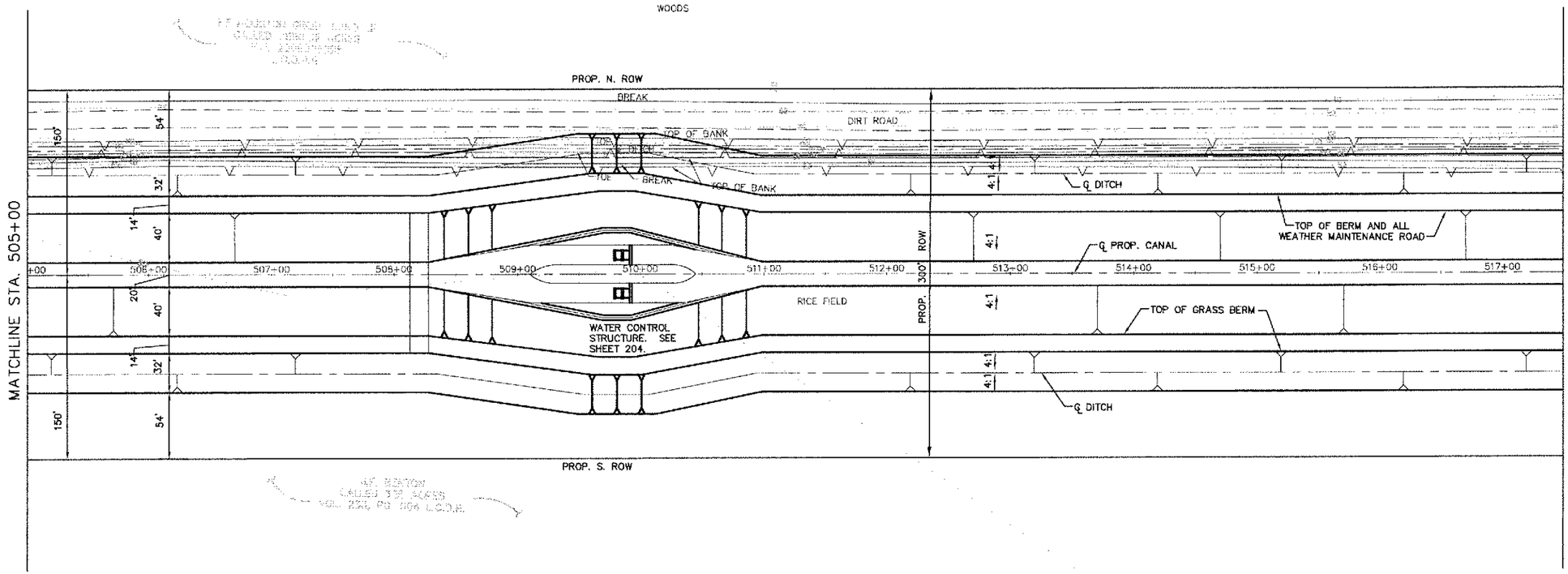
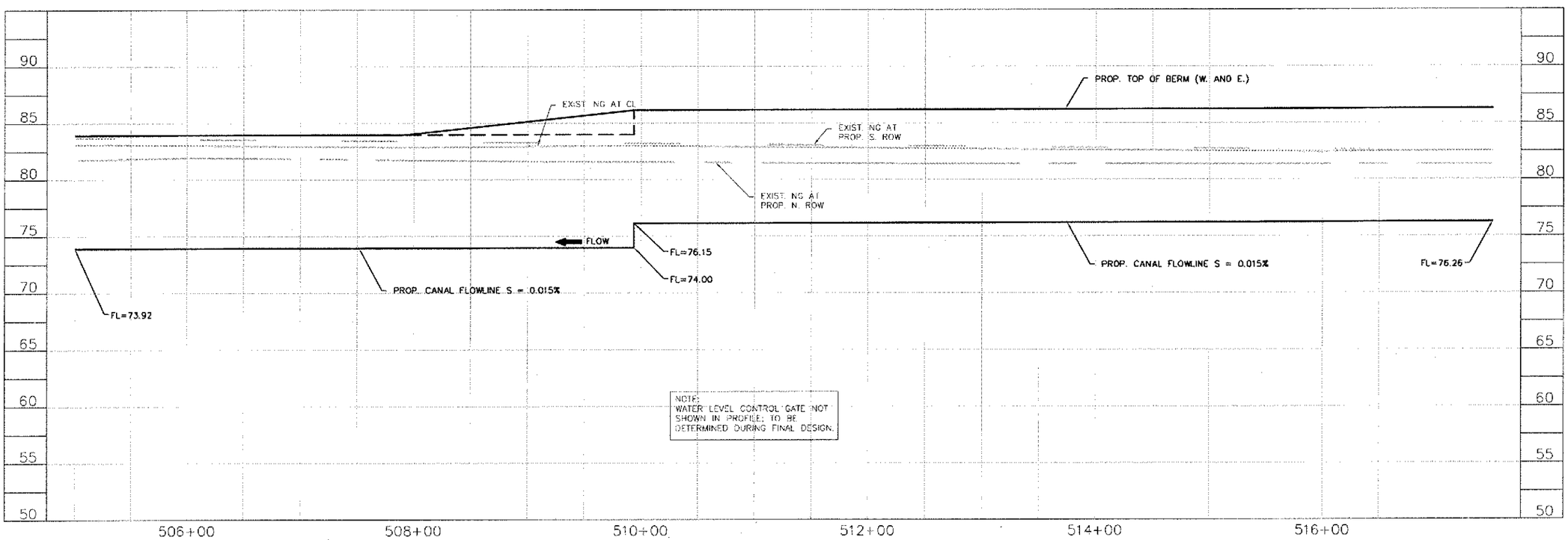


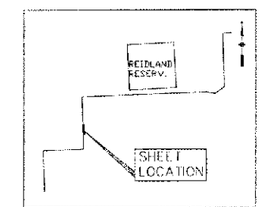


NOTE:
WATER LEVEL CONTROL GATE NOT SHOWN IN PROFILE; TO BE DETERMINED DURING FINAL DESIGN.

VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
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AECOM

AECOM TECHNICAL SERVICES, INC.
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713.780.4100 tel.
713.780.0838 fax.

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FB NO.

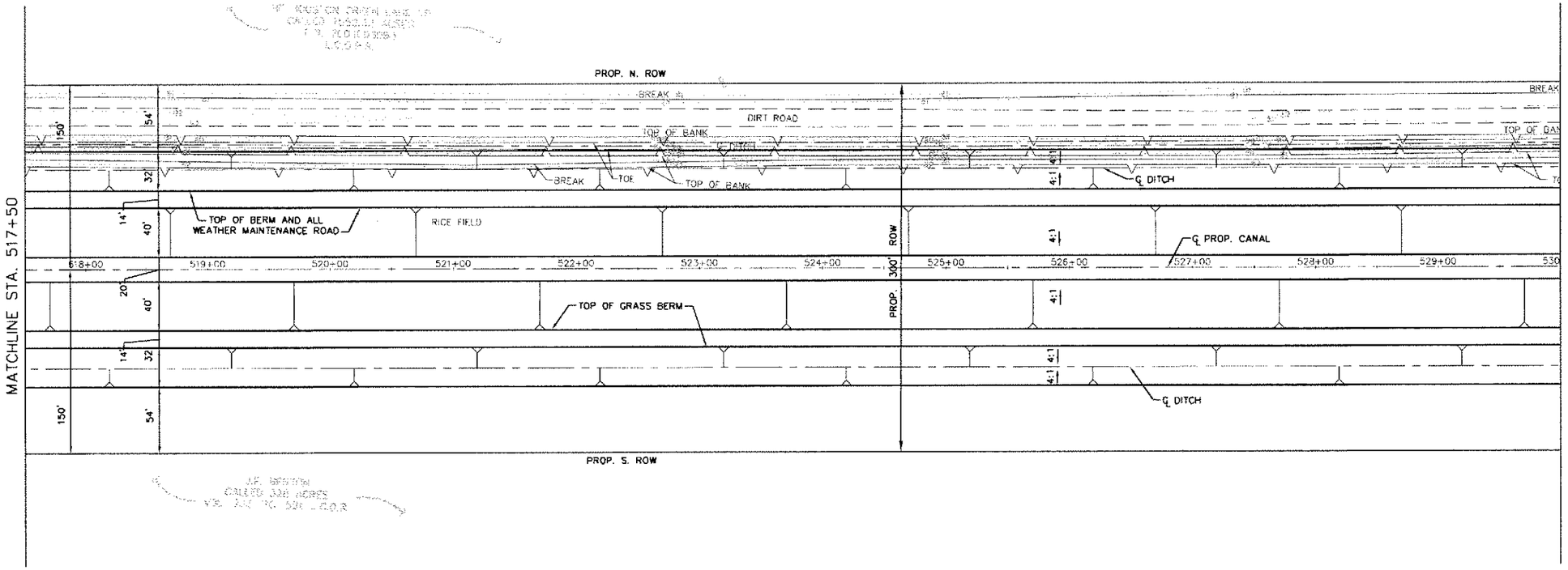
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

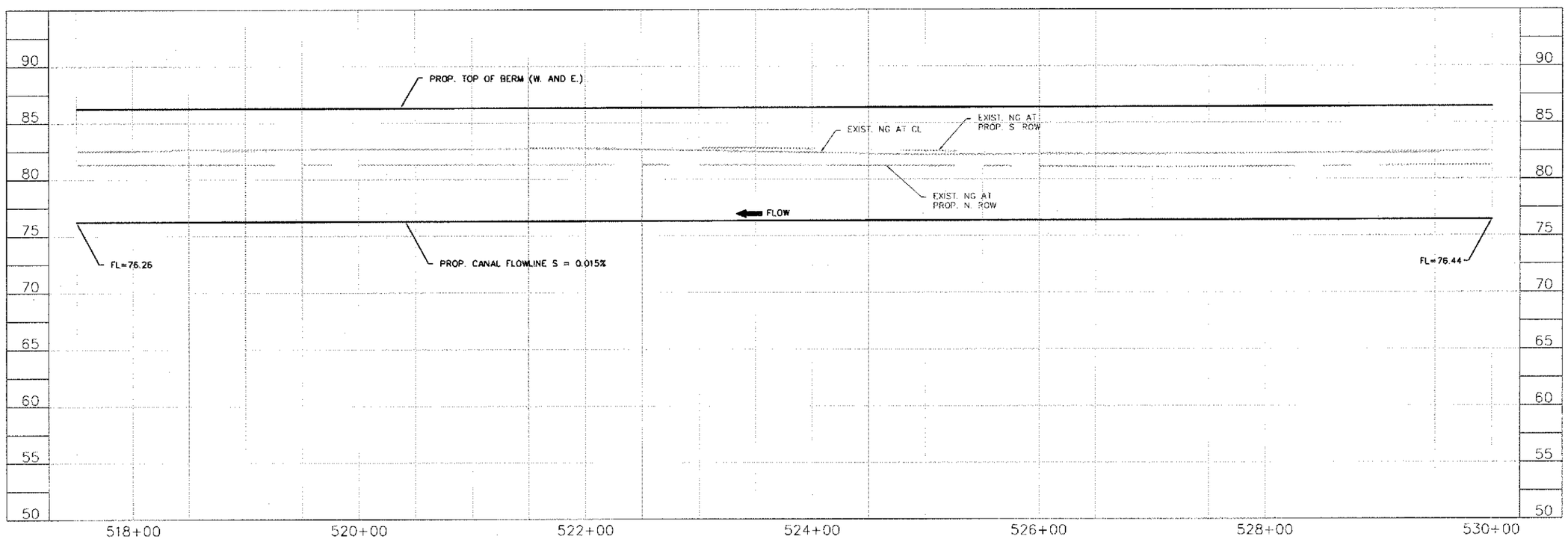
CANAL PLAN & PROFILE STA 505+00 TO STA 517+50

DRAWING SCALE
AS SHOWN

SHEET NO. 75 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:04pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 5\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWO\Sheets\
DWG. NAME: CanalP&P42.dwg

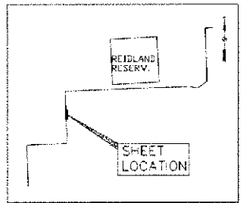




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 10-WEST
HOUSTON, TEXAS 77057-1599
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TBPE REG. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

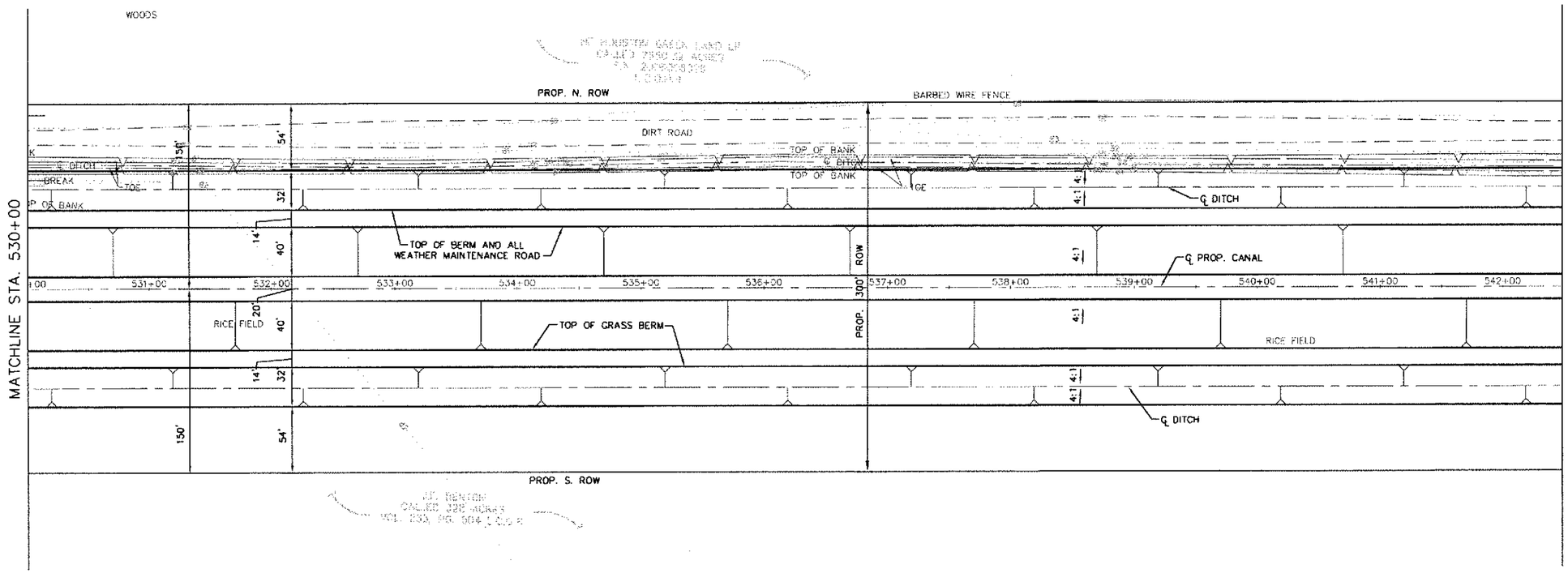
LUCE BAYOU INTERBASIN TRANSFER PROJECT

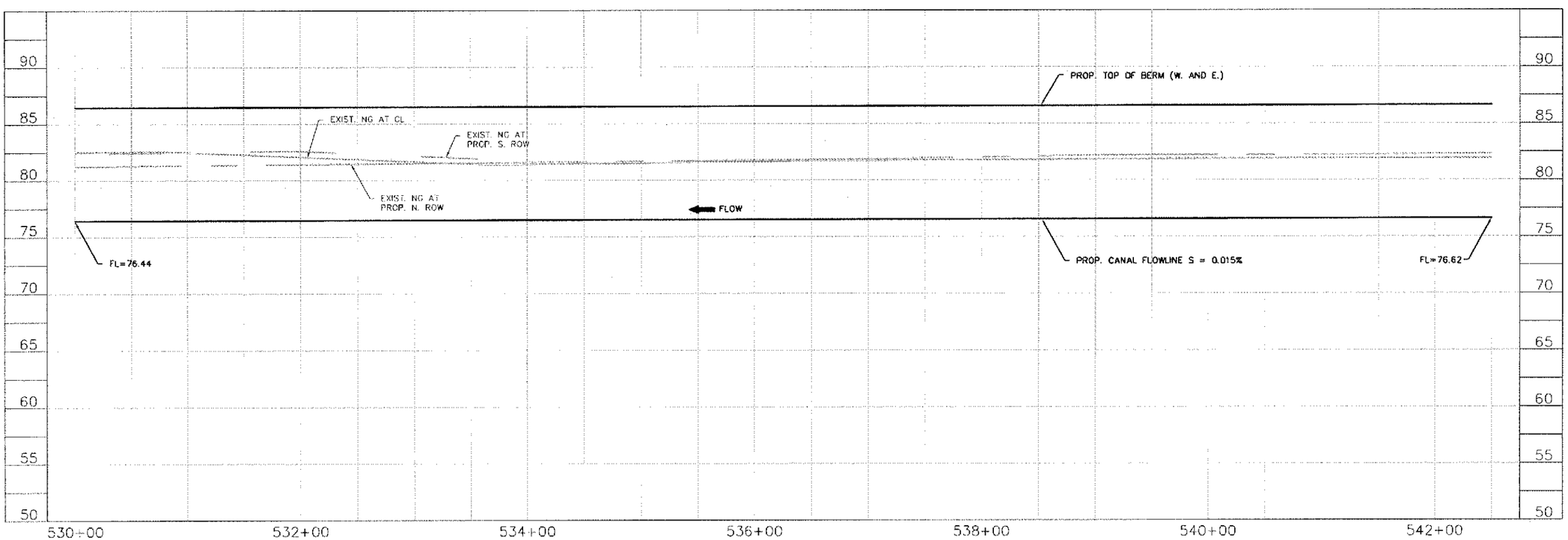
CANAL PLAN & PROFILE STA 517+50 TO STA 530+00

DRAWING SCALE
AS SHOWN

SHEET NO. 76 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:05pm BY USER: ThompsonBil
DWG LOCATION: O:\Work Order 6\V4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG NAME: ConalP&P43.dwg

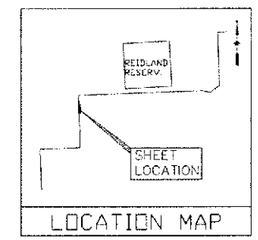




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
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AECOM

AECOM TECHNICAL SERVICES, INC.
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713.780.0838 fax.

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FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN &
PROFILE STA 530+00
TO STA 542+50

DRAWING SCALE
AS SHOWN

SHEET NO. 77 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:05pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\V4.0 ENGINEERING NOTES & CALCULATIONS\V4.3 Civil Notes and Calculations\Cadd\PWO\Sheets\
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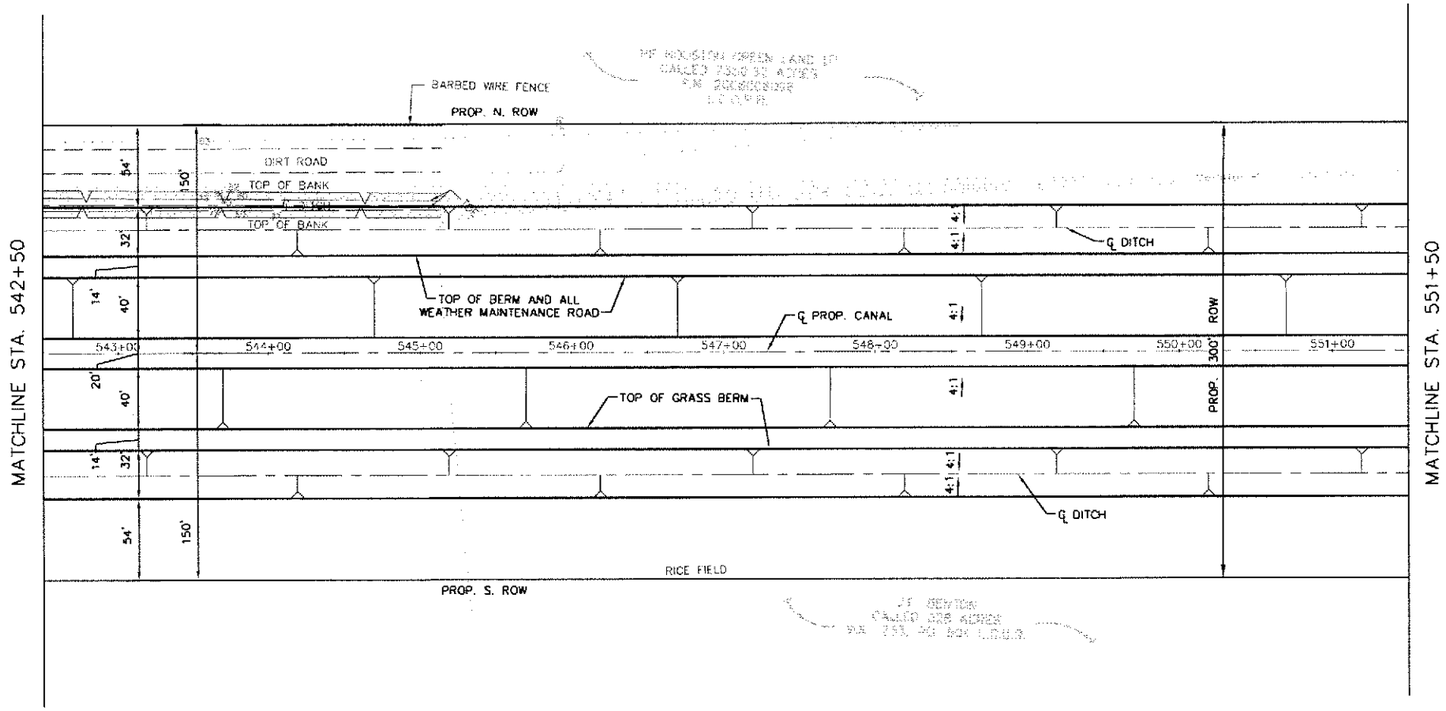

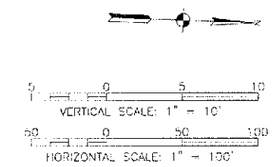

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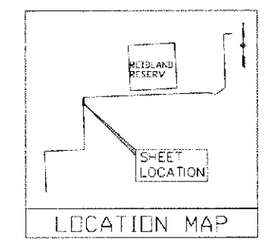
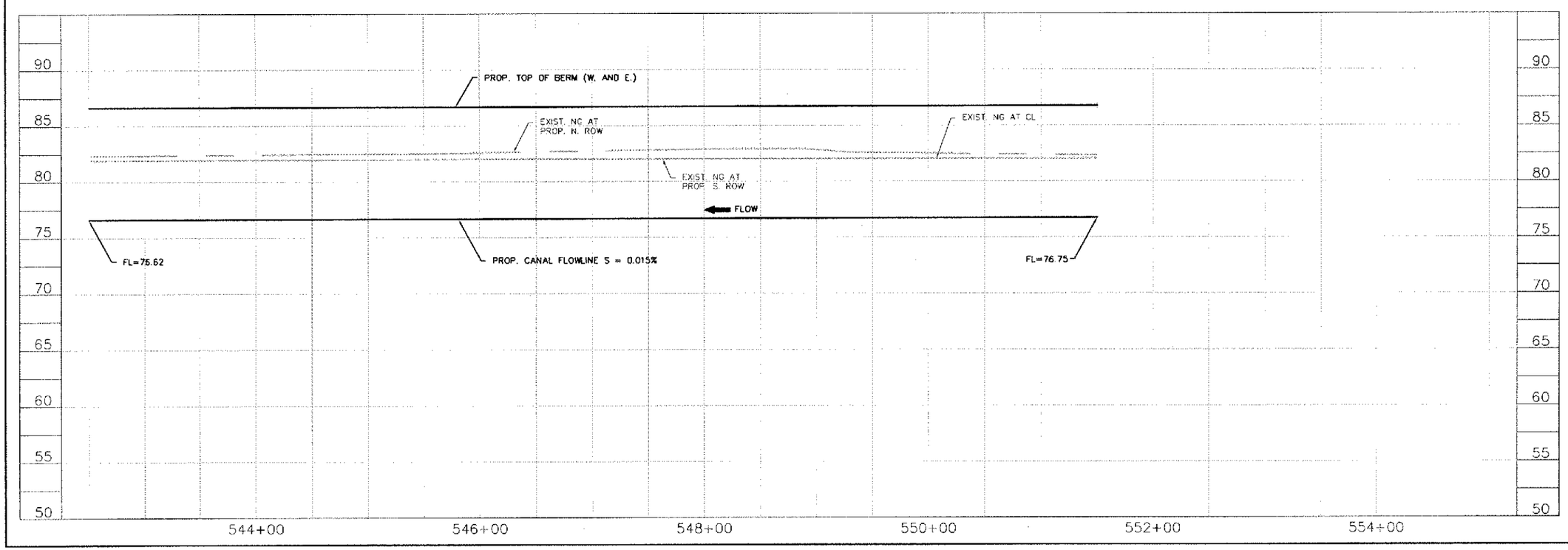
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
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713.780.0838 fax.

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FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN &
PROFILE STA 542+50
TO STA 551+50

DRAWING SCALE
AS SHOWN

SHEET NO. 78 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:06pm BY USER: ThompsonDi
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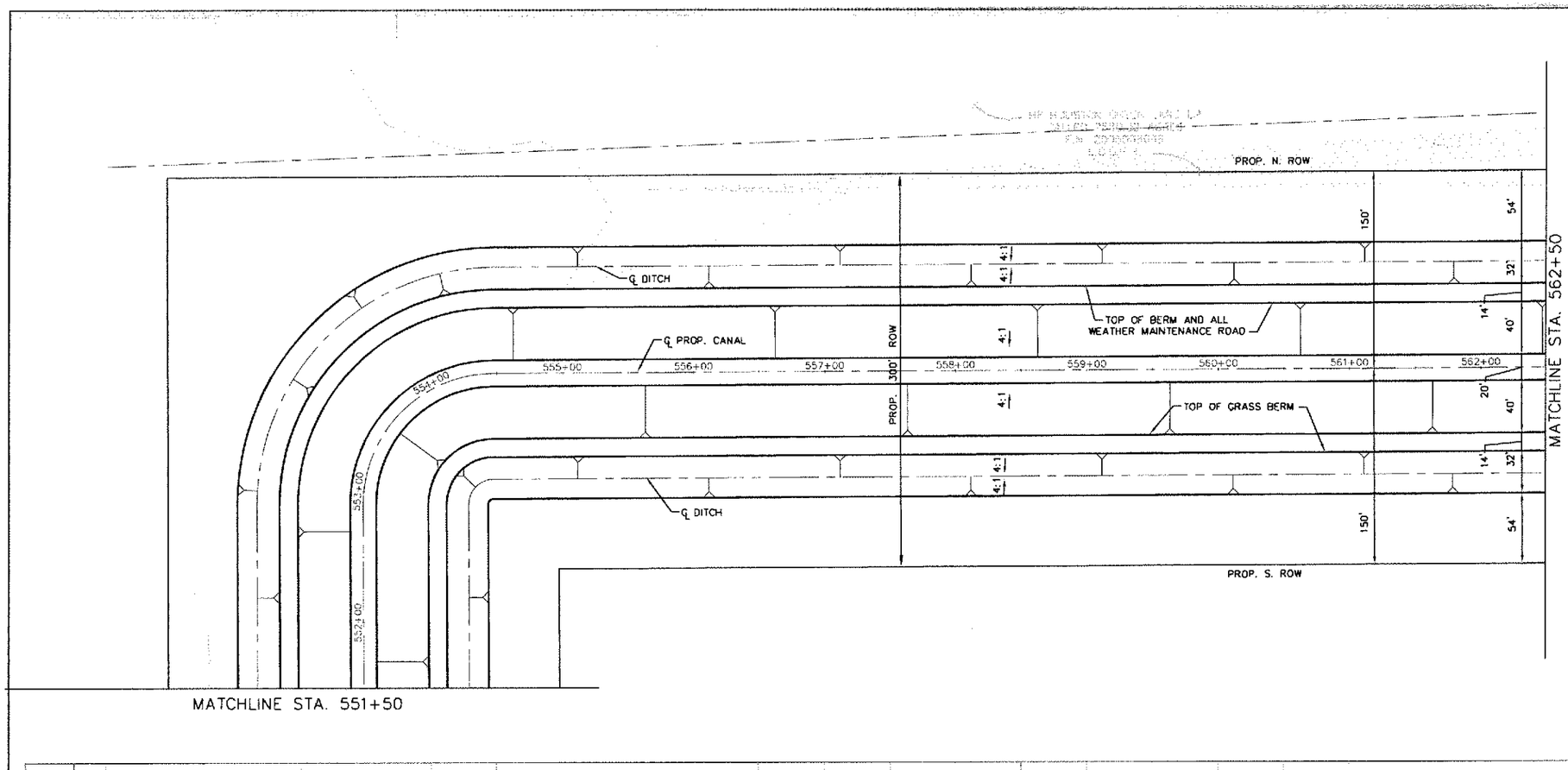
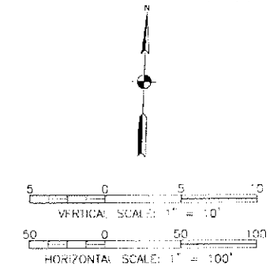
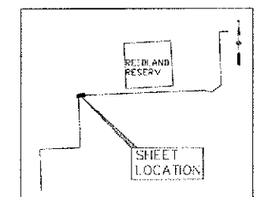
DWG NAME: Canal P&P45.dwg

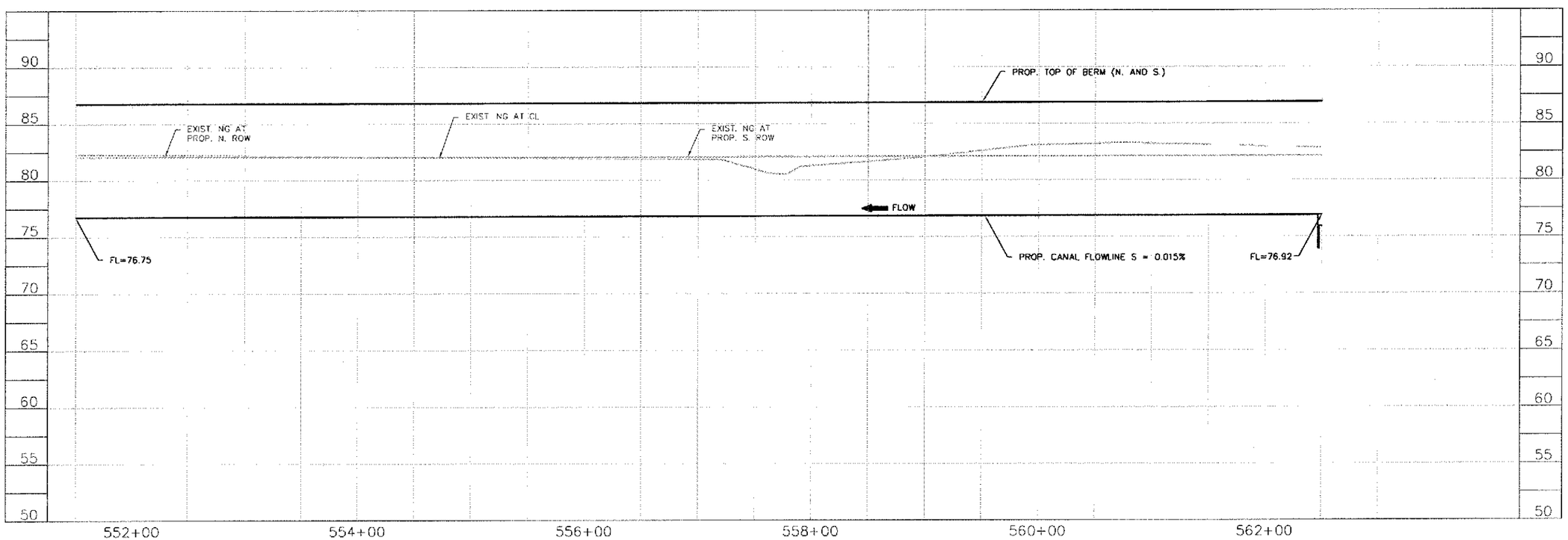




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



KEVIN R. KRAHN, P.E.
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TBPE REG. NO. F-3580

AECOM
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HOUSTON, TEXAS 77057
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713.780.0838 fax.

CWA

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN &
PROFILE STA 551+50
TO STA 562+50

DRAWING SCALE
AS SHOWN

SHEET NO. 79 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:07pm BY USER: thompsonBl
DWG. LOCATION: D:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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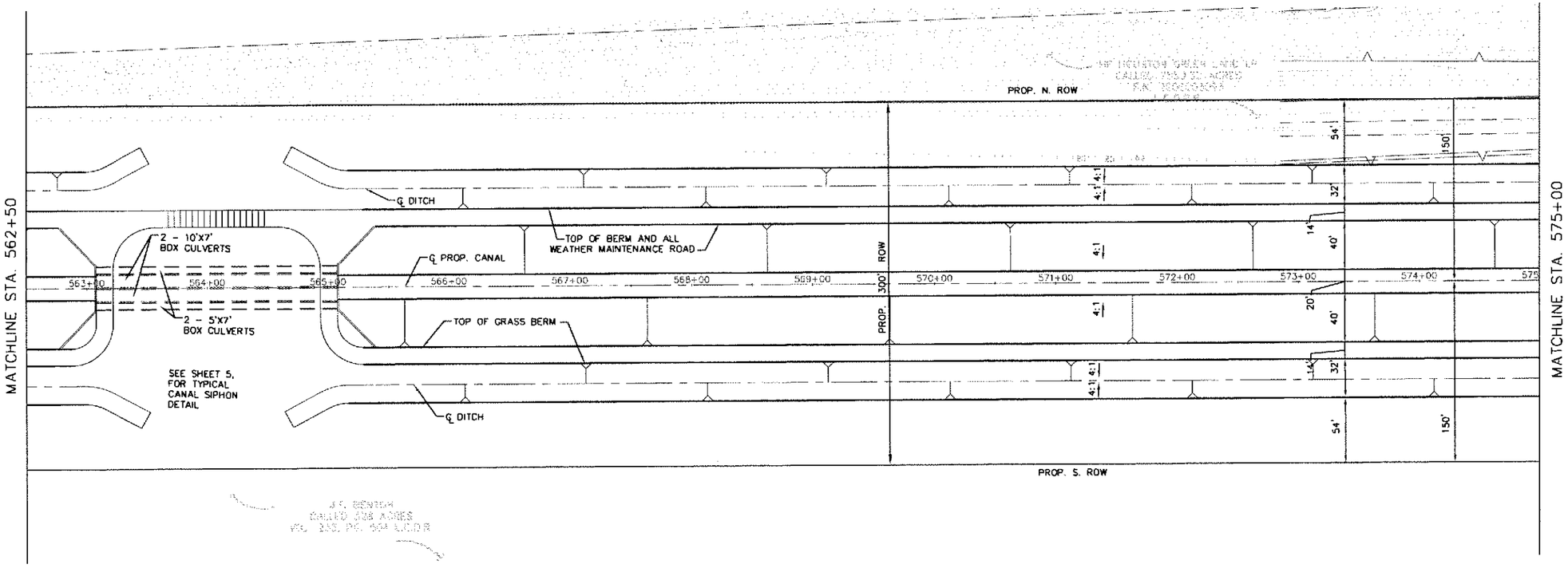
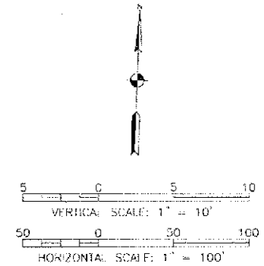
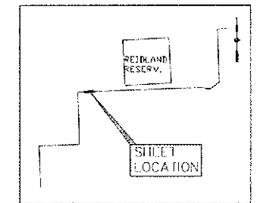
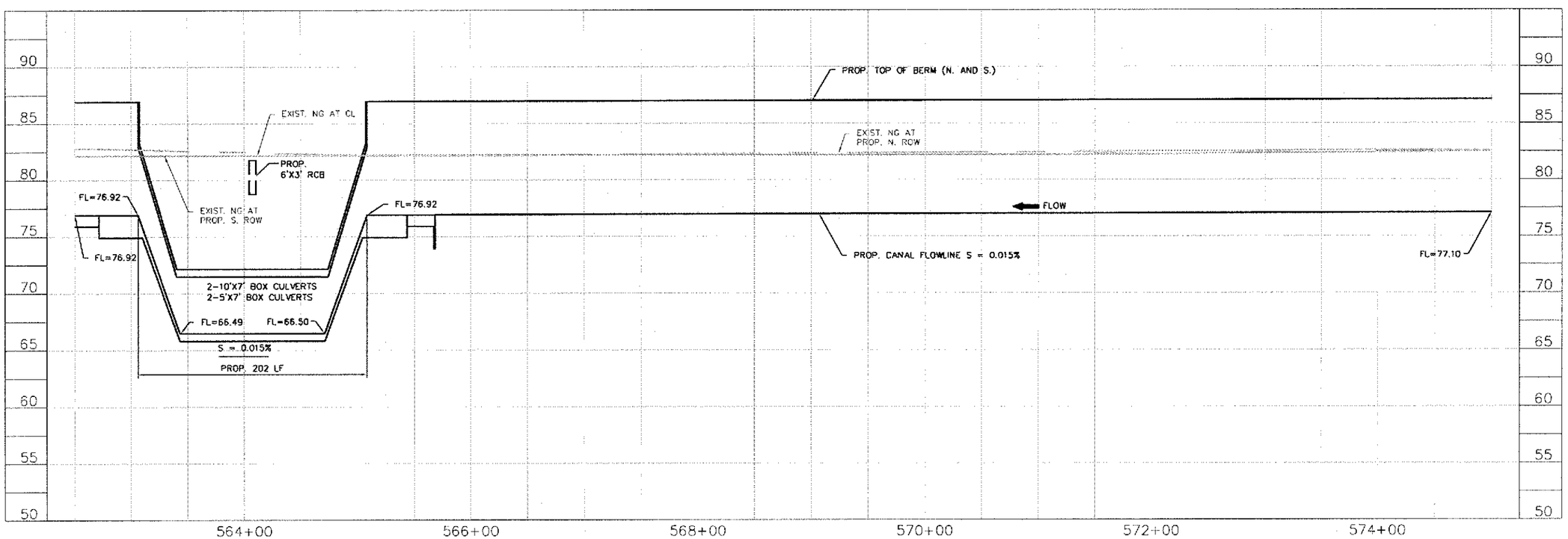




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



KEVIN R. KRAHN, P.E.
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713.780.4100 tel.
713.780.0838 fax.

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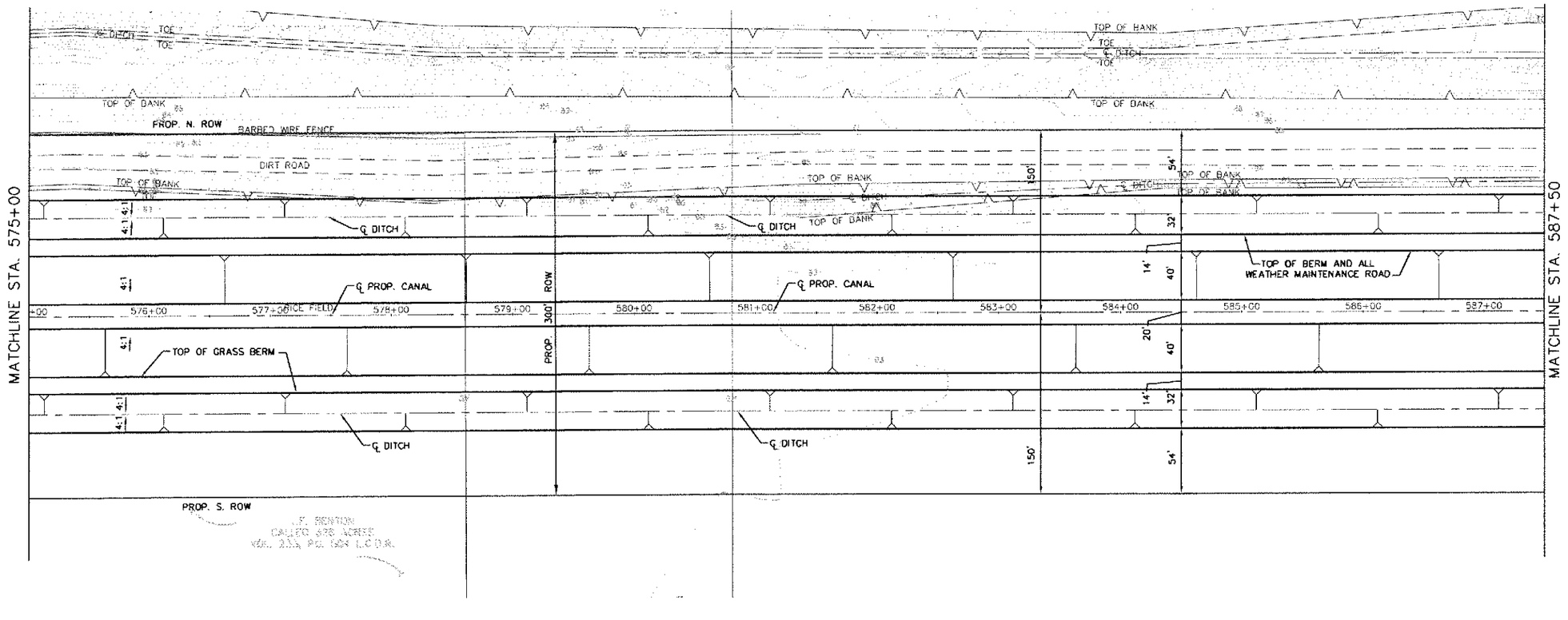
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

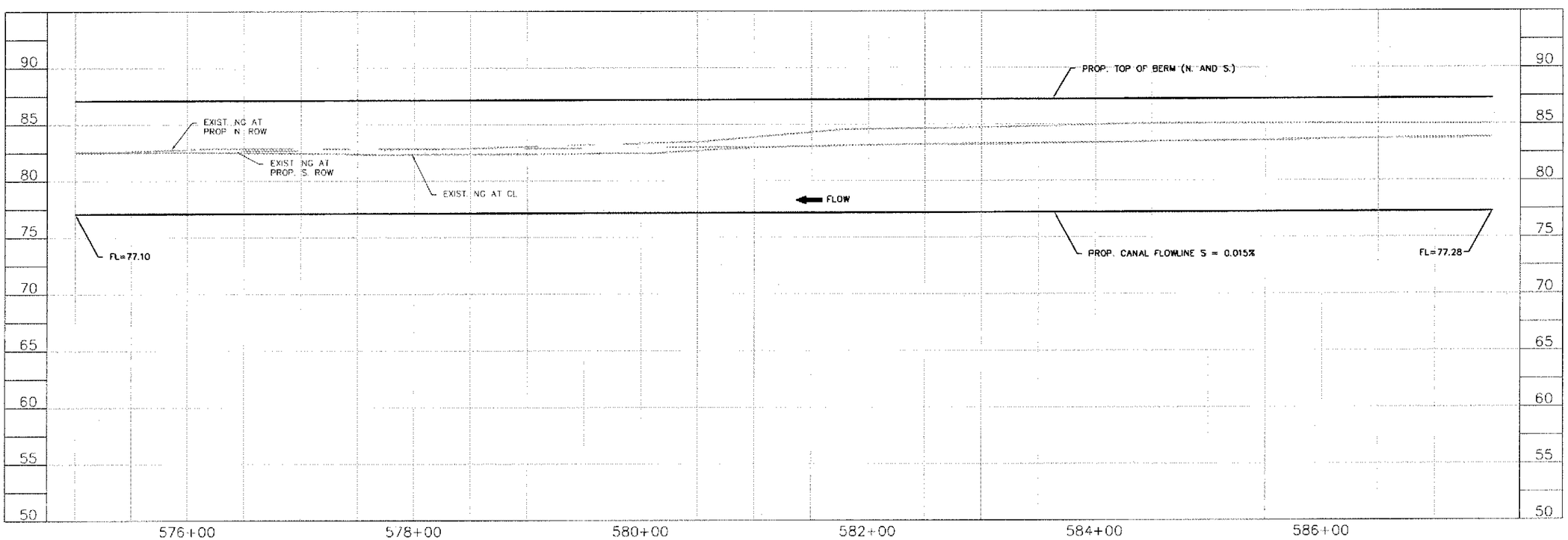
CANAL PLAN & PROFILE STA 562+50 TO STA 575+00

DRAWING SCALE
AS SHOWN

SHEET NO 80 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:07pm BY USER: ThompsonBl
DWG LOCATION: O:\Work Order 6\v4.0 ENGINEERING NOTES & CALCULATIONS\v4.3 Civil Notes and Calculations\Cadd\PWO\Sheets\
DWG NAME: CanalP&P47.dwg

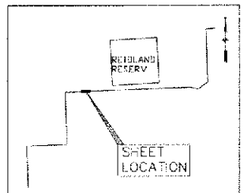




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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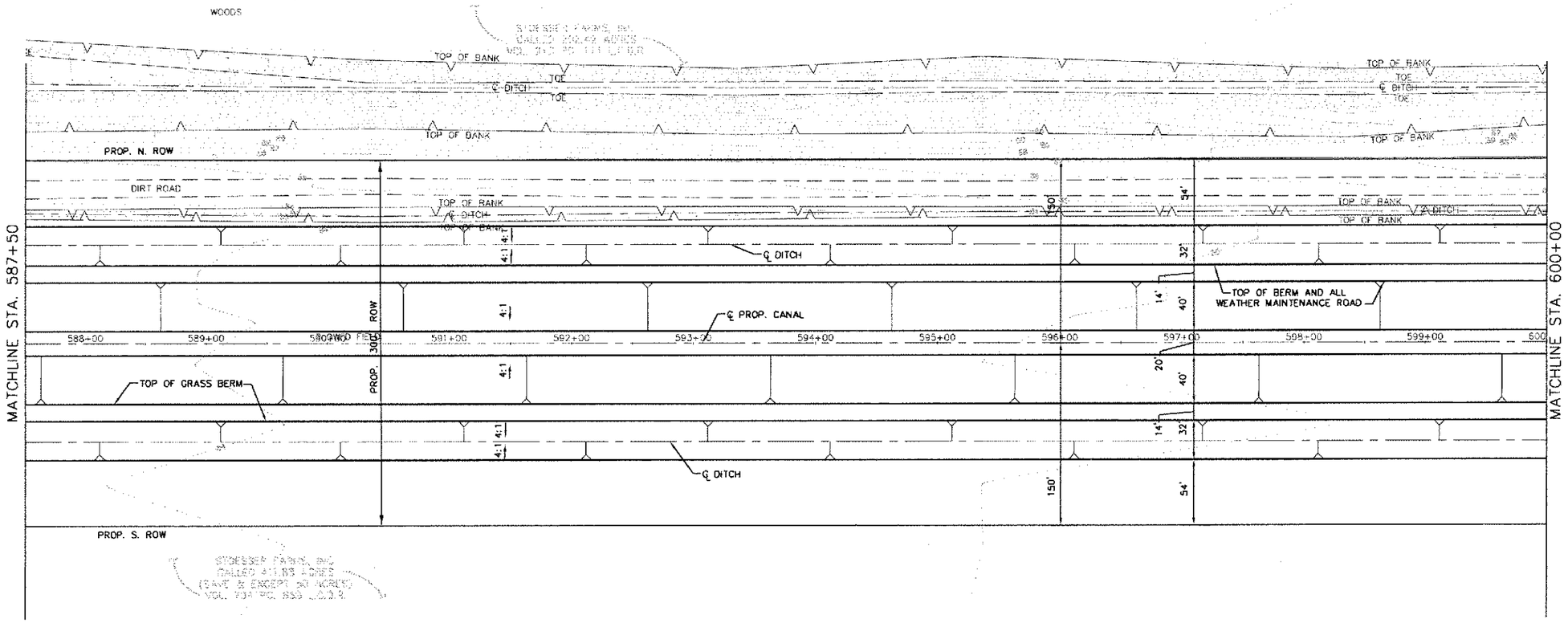
LUCE BAYOU INTERBASIN TRANSFER PROJECT

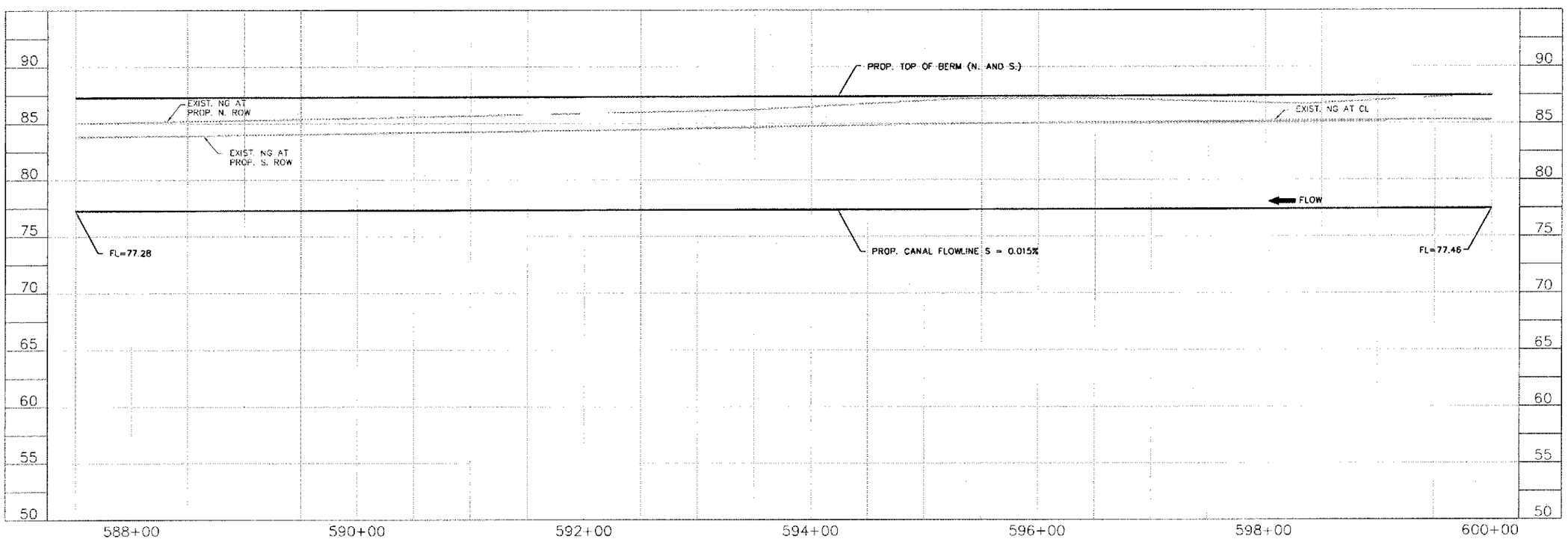
CANAL PLAN & PROFILE STA 575+00 TO STA 587+50

DRAWING SCALE
AS SHOWN

SHEET NO. 81 OF 245

LAST MODIFIED: Jan 27, 2011 – 4:08pm BY USER: ThompsonBI
DWG. LOCATION: Q:\Work Order B\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWG\Sheets\
DWG. NAME: CanalP&P48.dwg

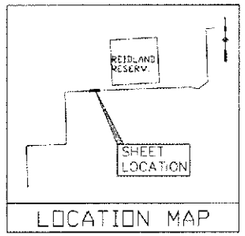




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
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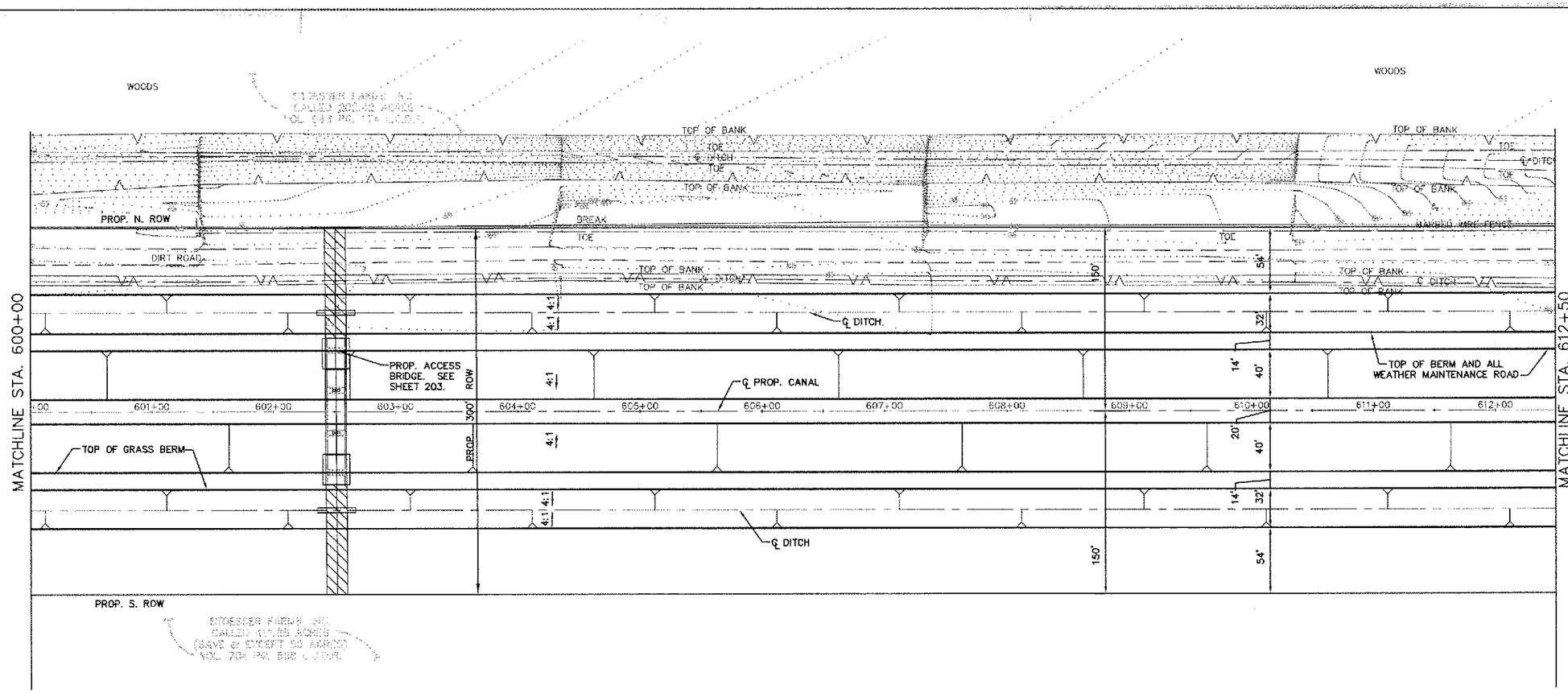
LUCE BAYOU INTERBASIN TRANSFER PROJECT

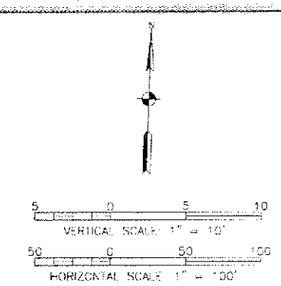
CANAL PLAN &
PROFILE STA 587+50
TO STA 600+00

DRAWING SCALE
AS SHOWN

SHEET NO. 8 2 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:08am BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\v.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\FWD\Sheets\
DWG. NAME: CanalP&P45.dwg





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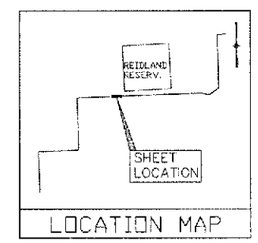
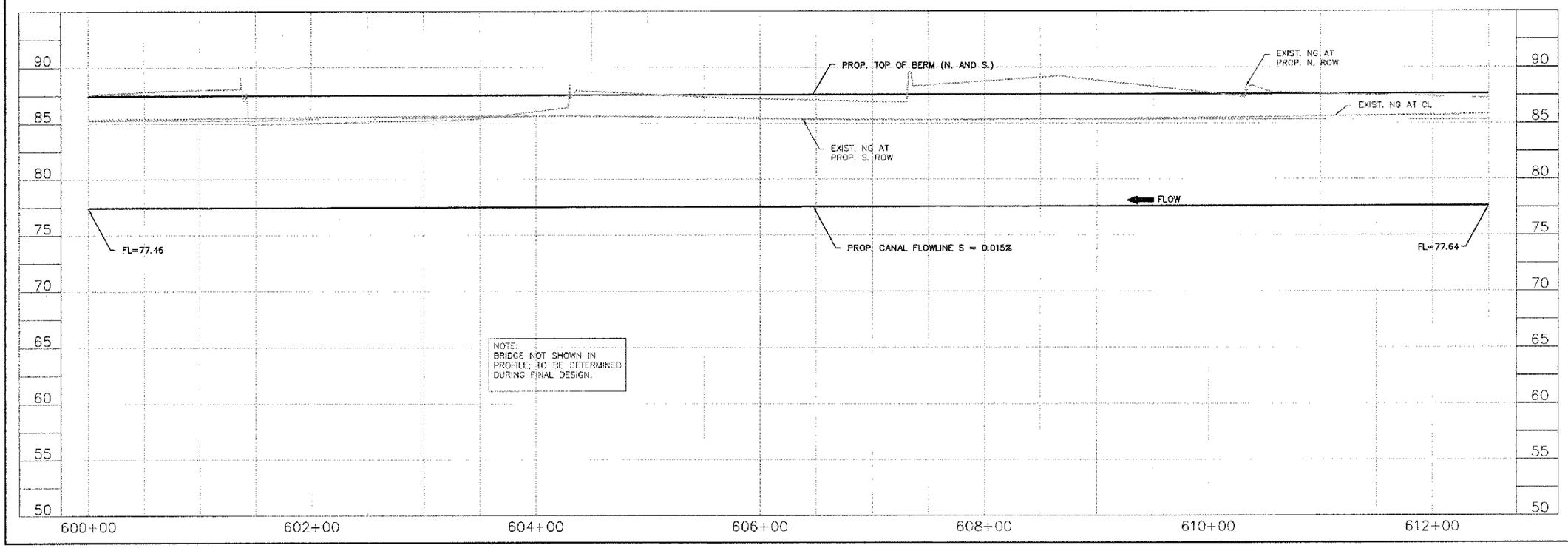


LOCATION MAP



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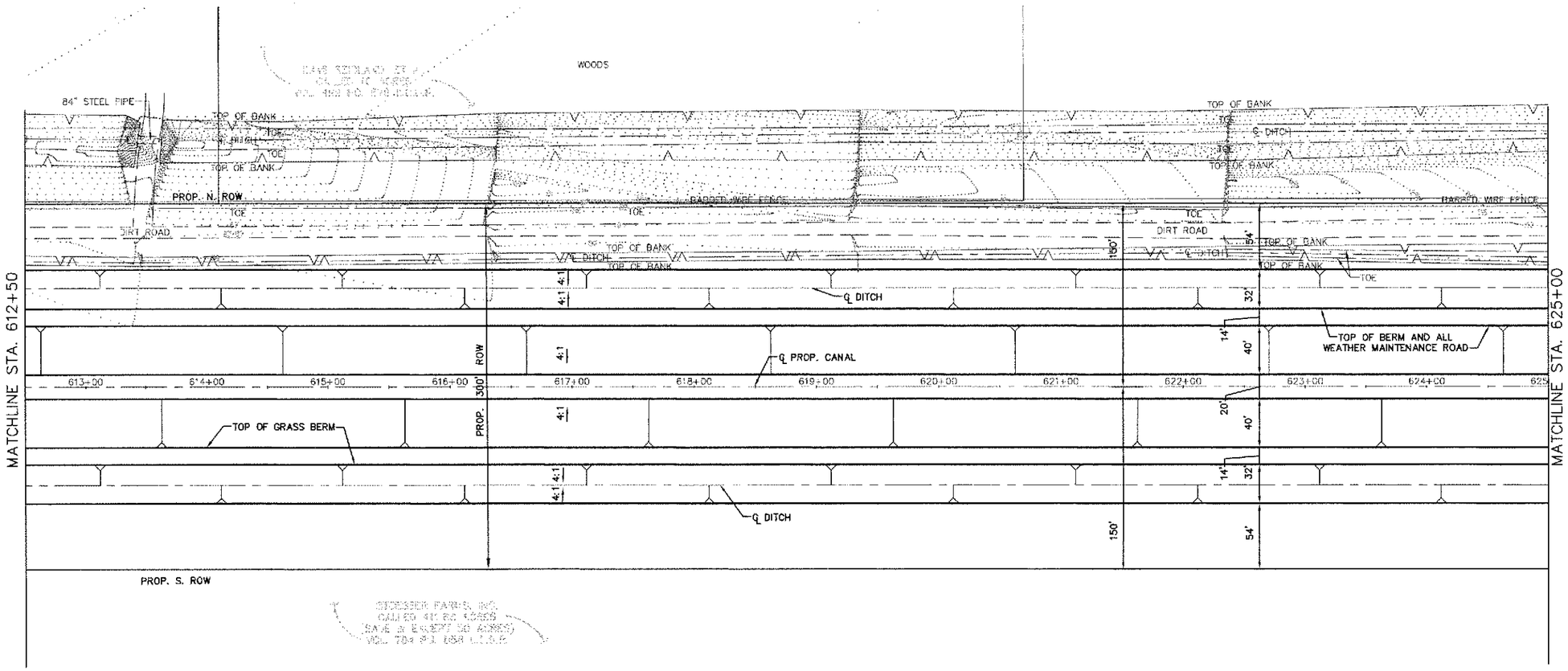
LUCE BAYOU INTERBASIN TRANSFER PROJECT

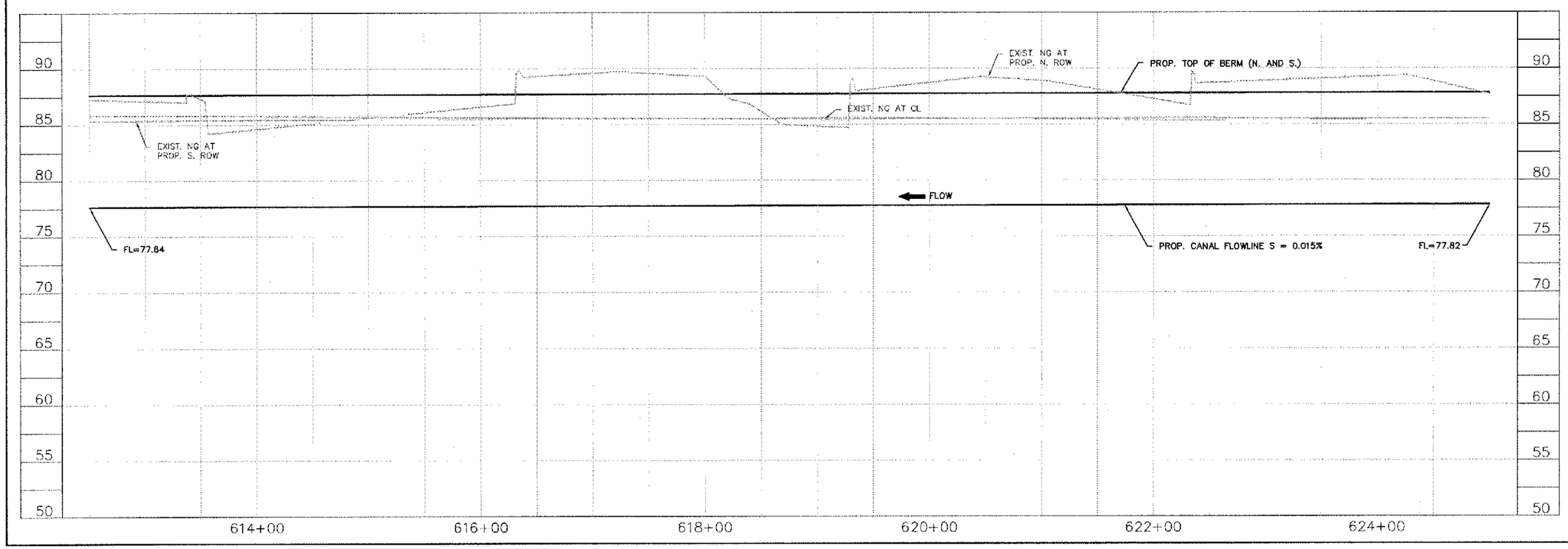
CANAL PLAN & PROFILE STA 600+00 TO STA 612+50

DRAWING SCALE
AS SHOWN

SHEET NO. 83 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:10pm BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Codd\FWG\Sheets\
DWG. NAME: CanalP&P50.dwg

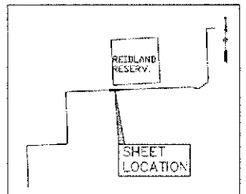




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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AECOM

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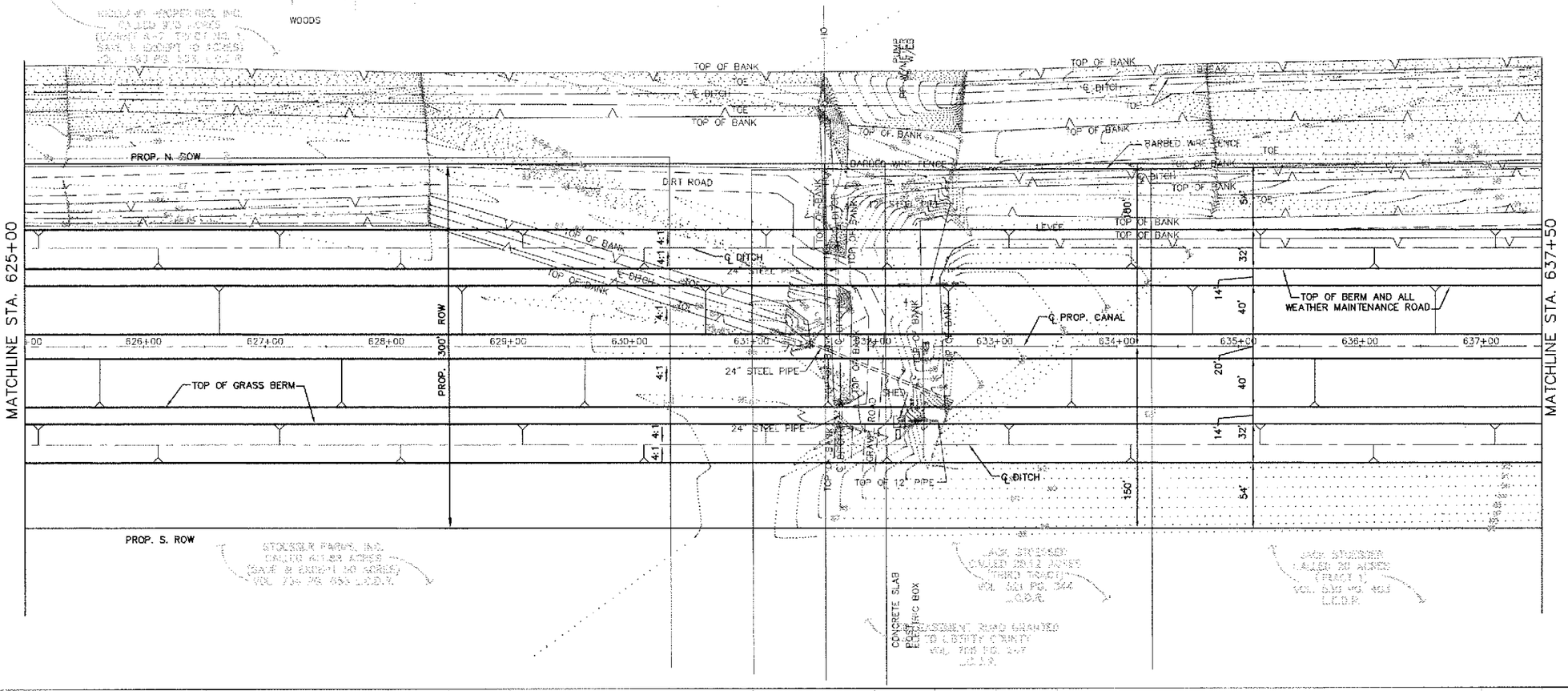
LUCE BAYOU INTERBASIN TRANSFER PROJECT

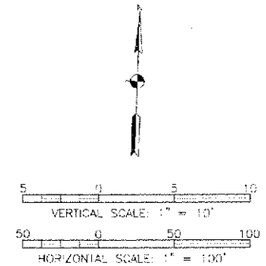
CANAL PLAN & PROFILE STA 612+50 TO STA 625+00

DRAWING SCALE
AS SHOWN

SHEET NO. 84 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:11pm BY USER: ThompsonBI
DWG. LOCATION: Q:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Canal\PWD\Sheets\
DWG. NAME: Canal-P&P-51.dwg





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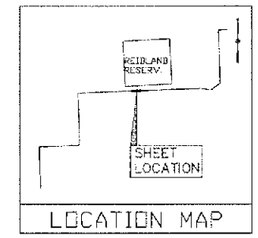
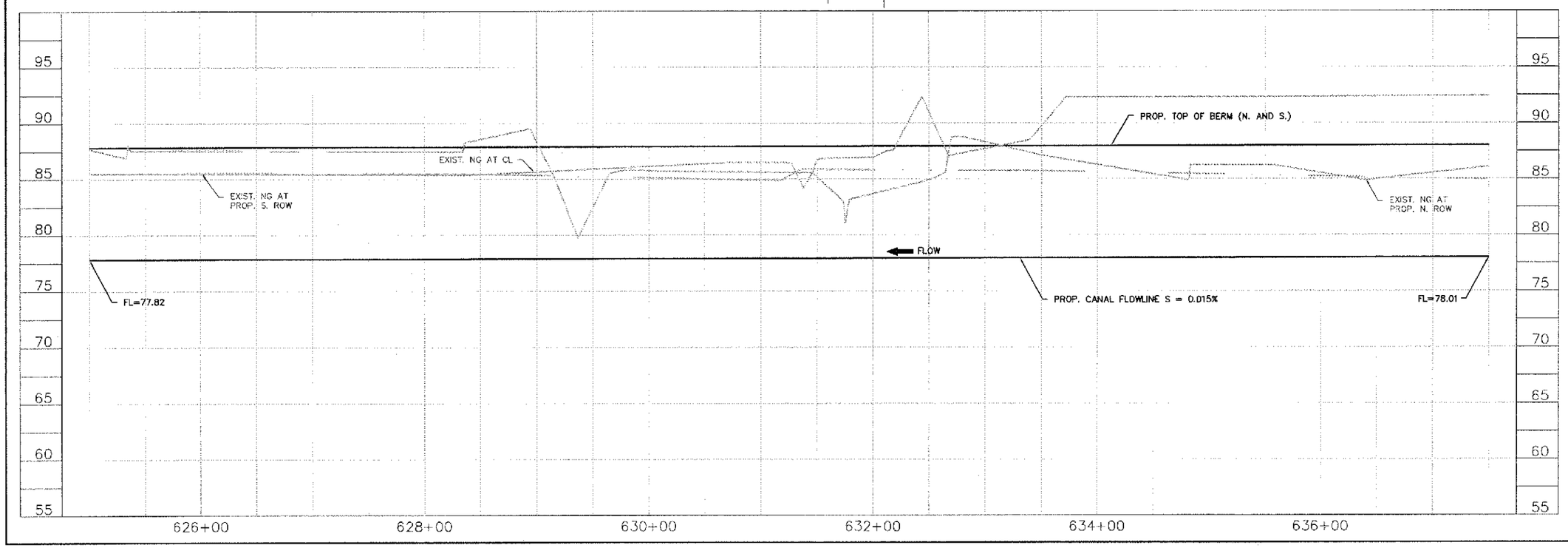


LOCATION MAP



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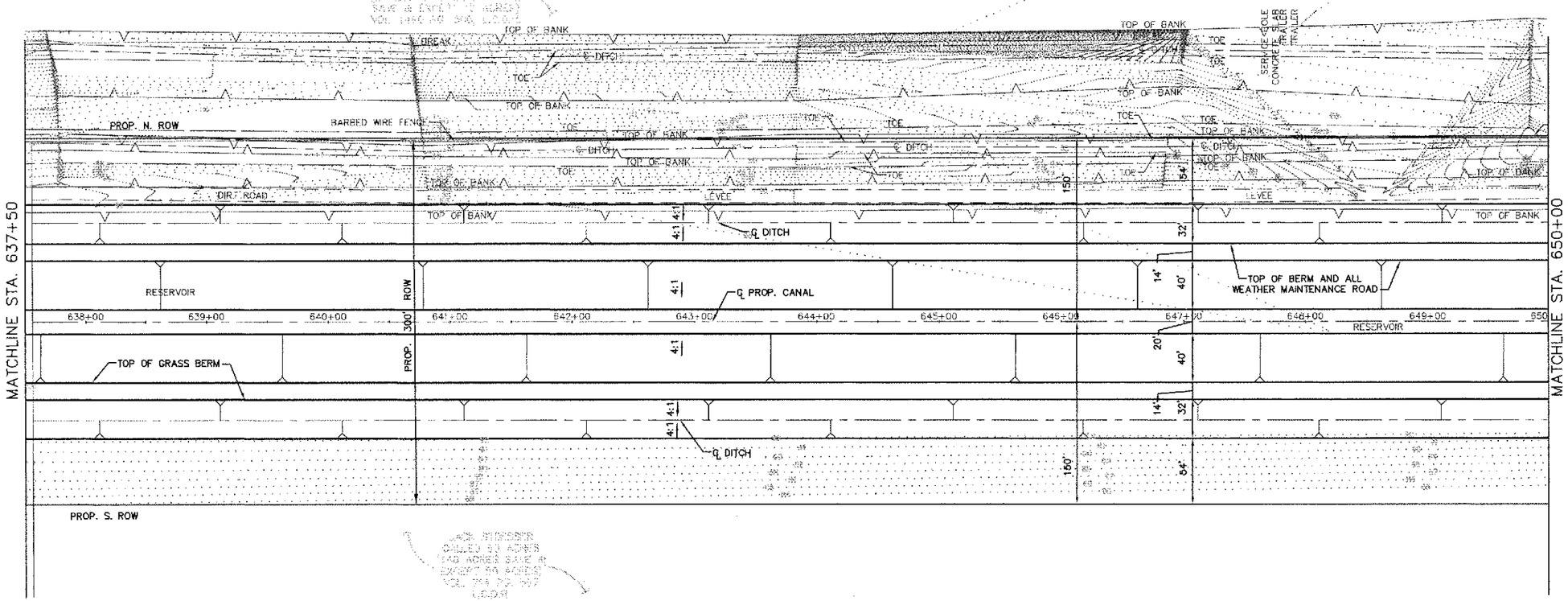
LUCE BAYOU INTERBASIN TRANSFER PROJECT

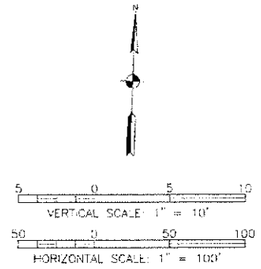
CANAL PLAN &
PROFILE STA 625+00
TO STA 637+50

DRAWING SCALE
AS SHOWN

SHEET NO. 85 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:11am BY USER: ThompsonBI
DWG LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Coca\PWO\Sheets\
DWG NAME: CanalP&P52.dwg





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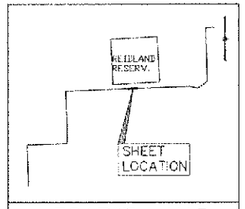

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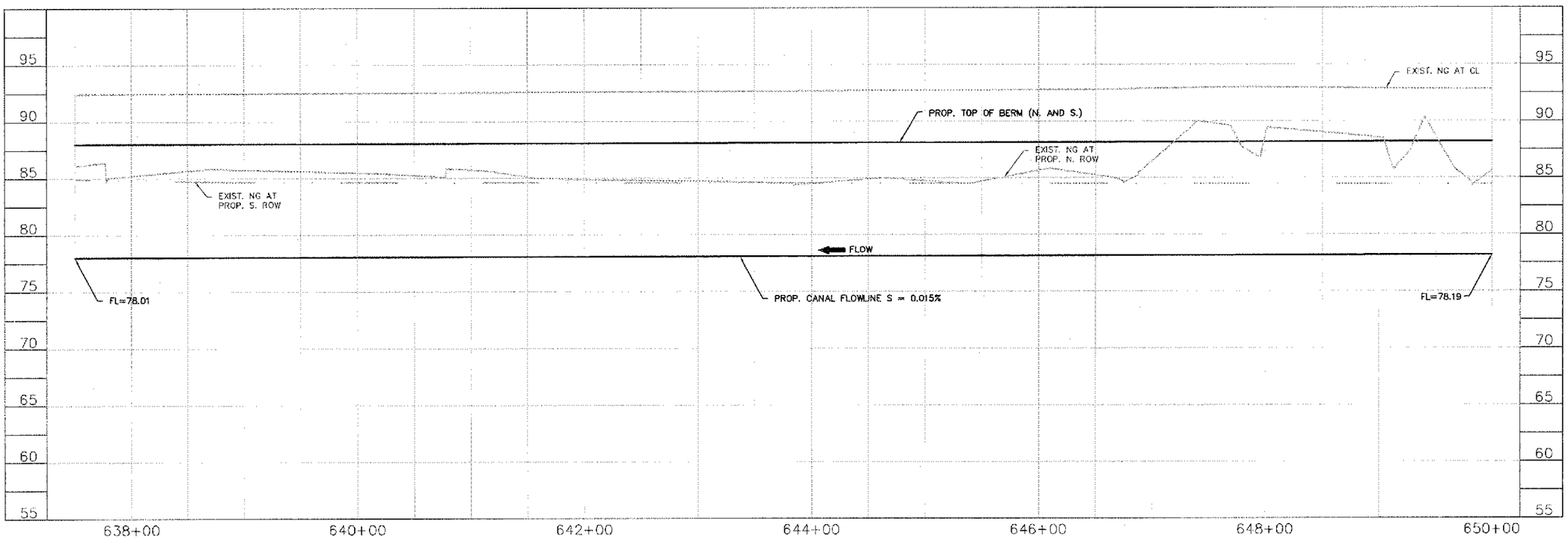

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AECOM TECHNICAL SERVICES, INC.
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HOUSTON, TEXAS 77057-1549
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FB NO.

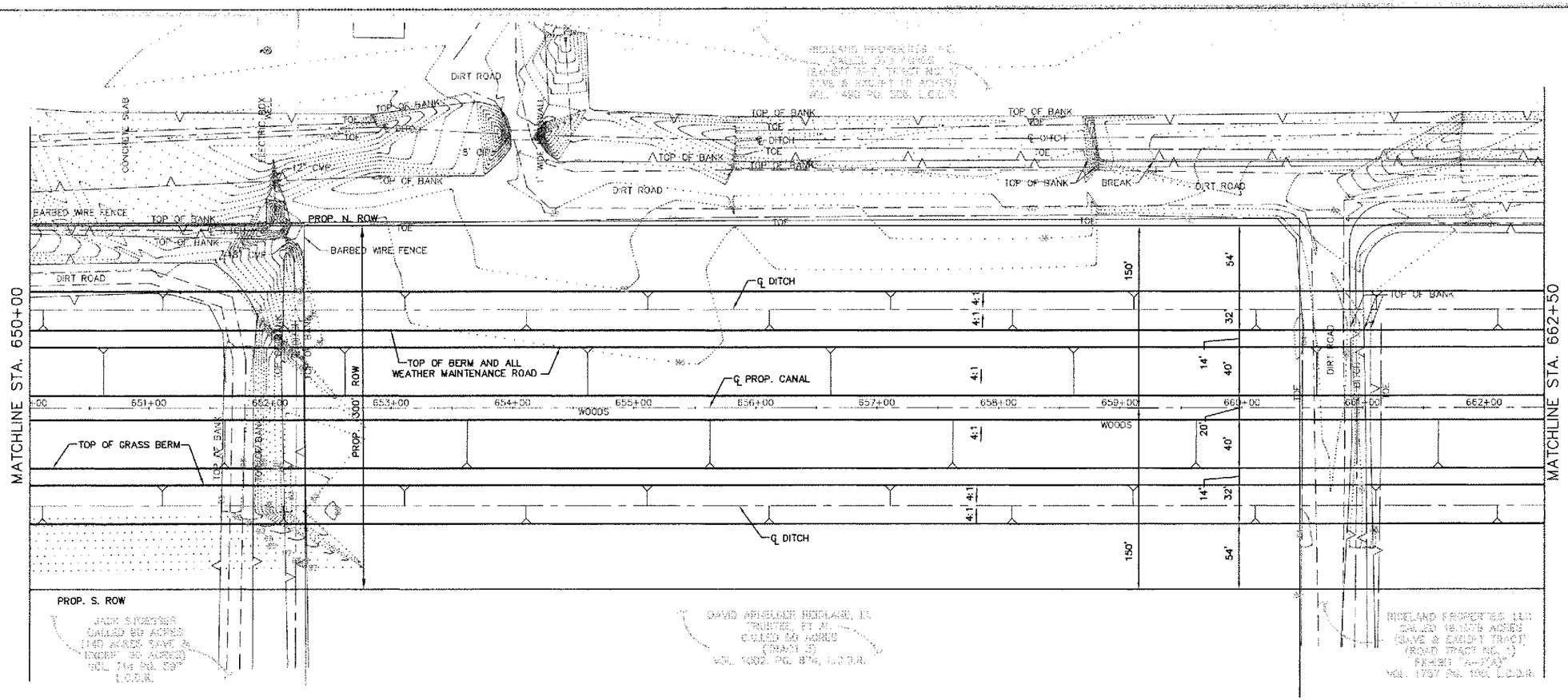
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

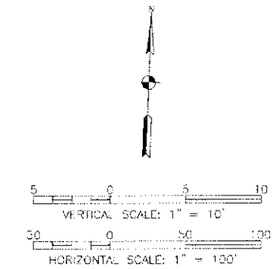
CANAL PLAN &
PROFILE STA 637+50
TO STA 650+00

DRAWING SCALE
AS SHOWN

SHEET NO. 86 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:12pm BY USER: ThompsonBl
DWG. LOCATION: Q:\Work Order 61.4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalPlnPfl53.dwg





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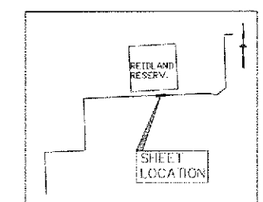
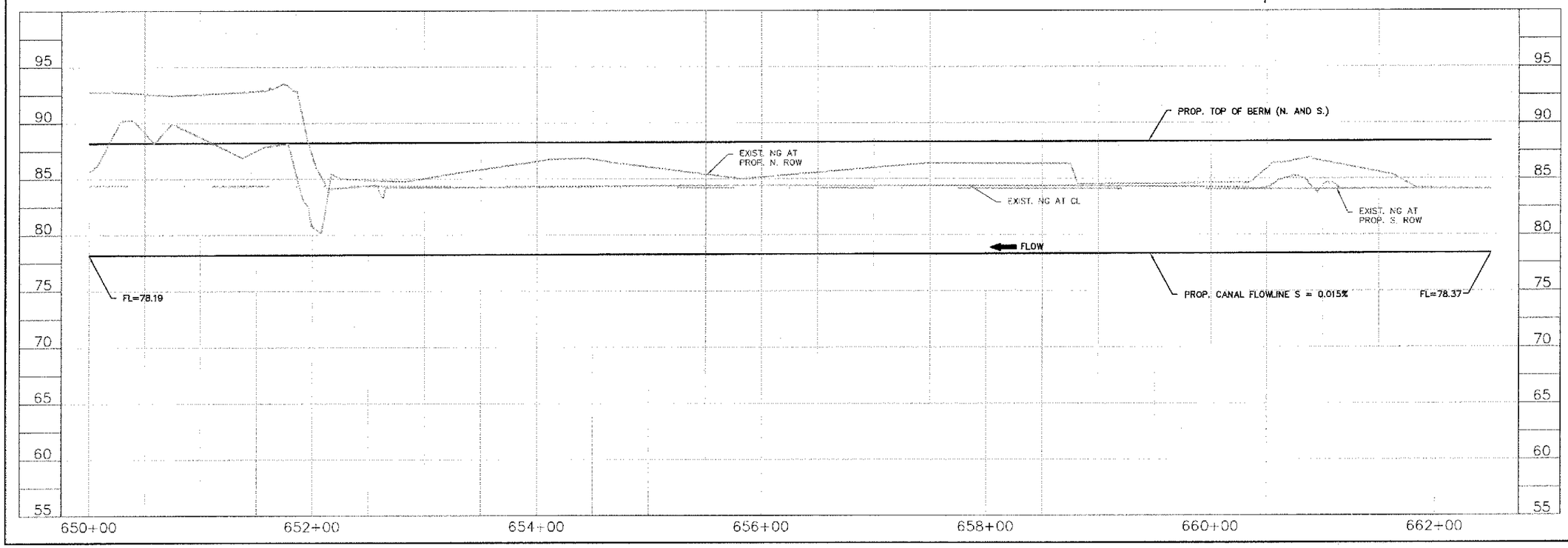


LOCATION MAP



KEVIN R. KRAHN, P.E.
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INTERIM SUBMITTAL
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AECOM

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713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN &
PROFILE STA 650+00
TO STA 662+50

DRAWING SCALE
AS SHOWN

SHEET NO. 87 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:12pm BY USER: ThompsonBi
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cacd\PW3\Sheets\
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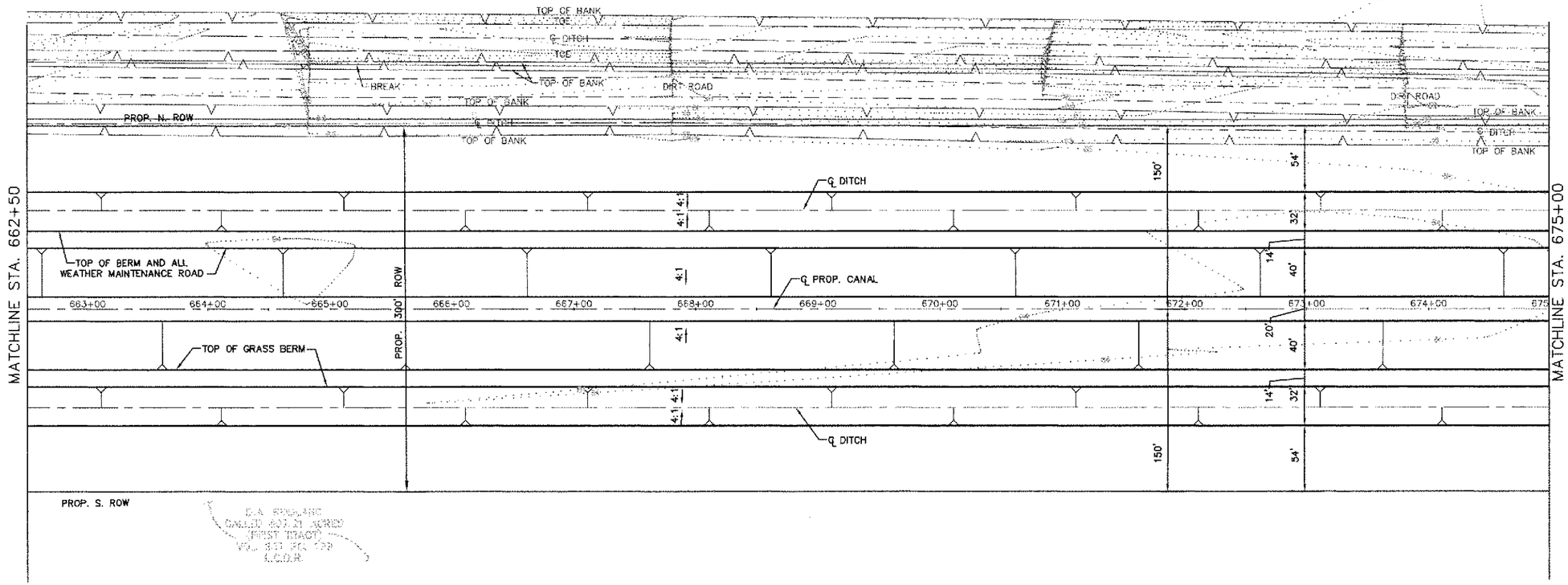

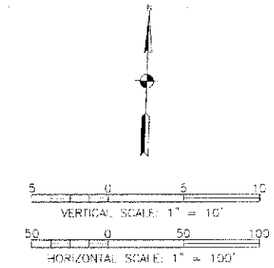

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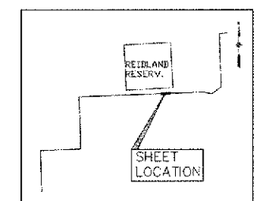
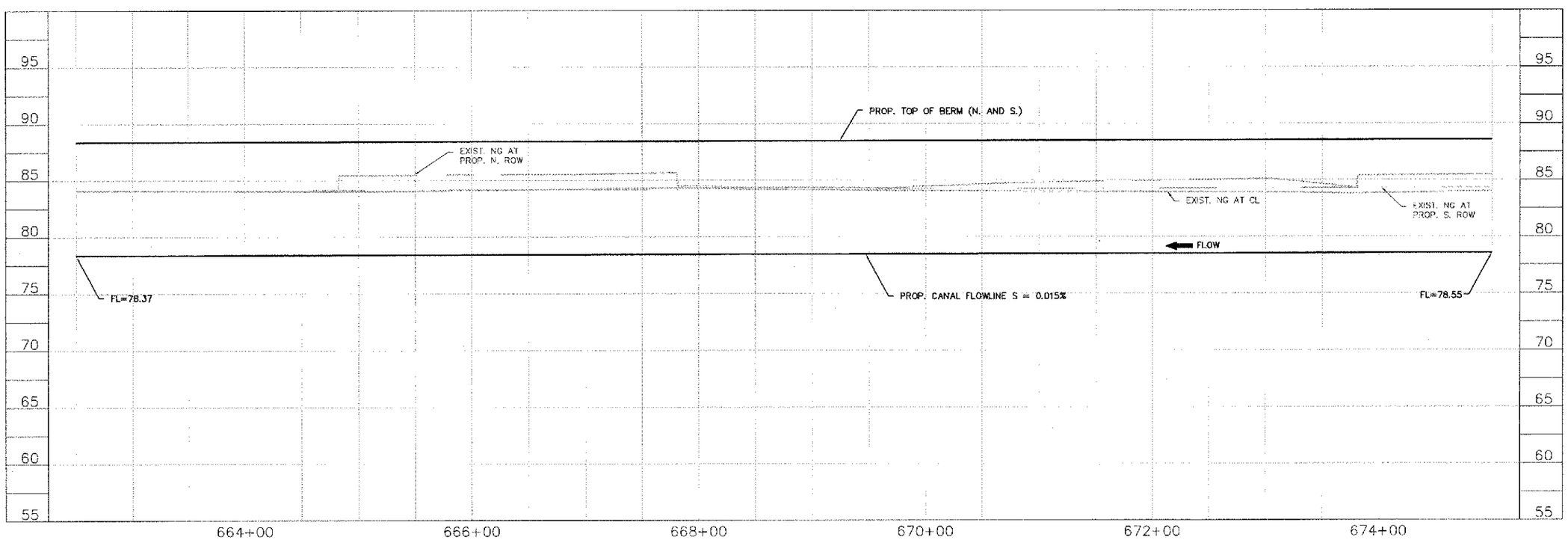


LOCATION MAP



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AECOM

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713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN &
PROFILE STA 662+50
TO STA 675+00

DRAWING SCALE
AS SHOWN

SHEET NO. 88 OF 145

LAST MODIFIED: Jan 27, 2011 - 4:13pm BY USER: ThompsonBI
DWG. LOCATION: D:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Coda\PWD\Sheets\
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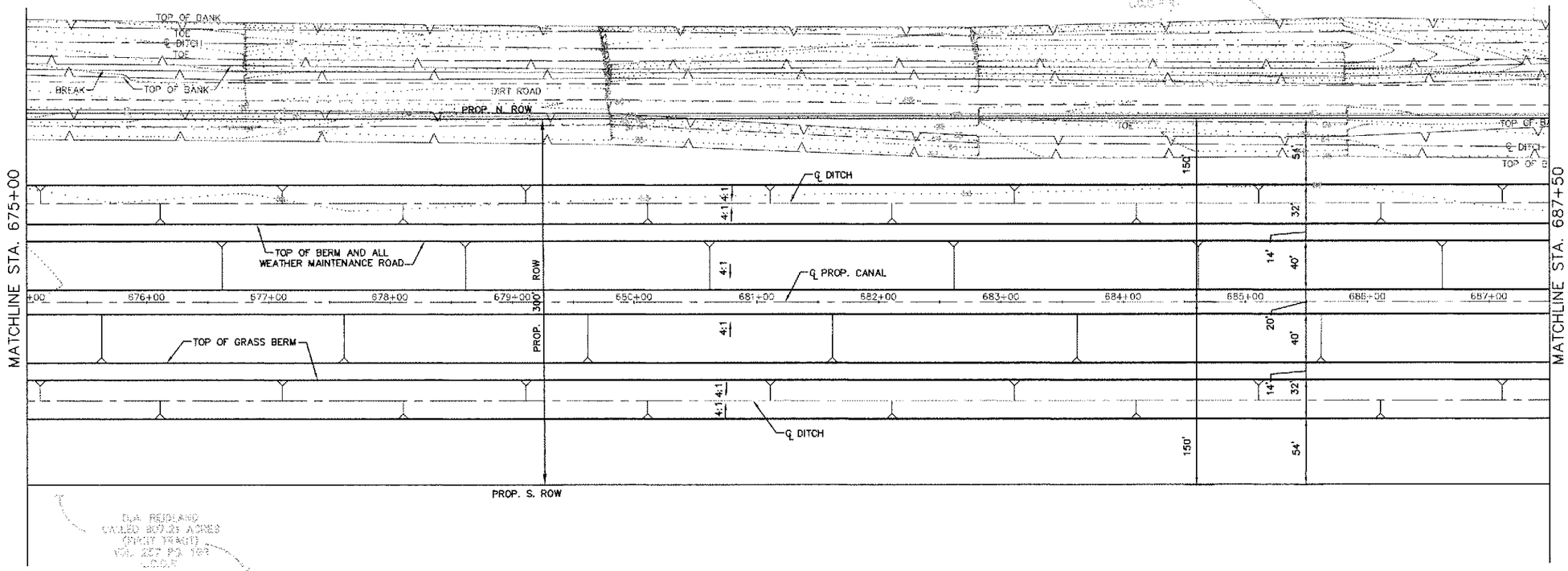
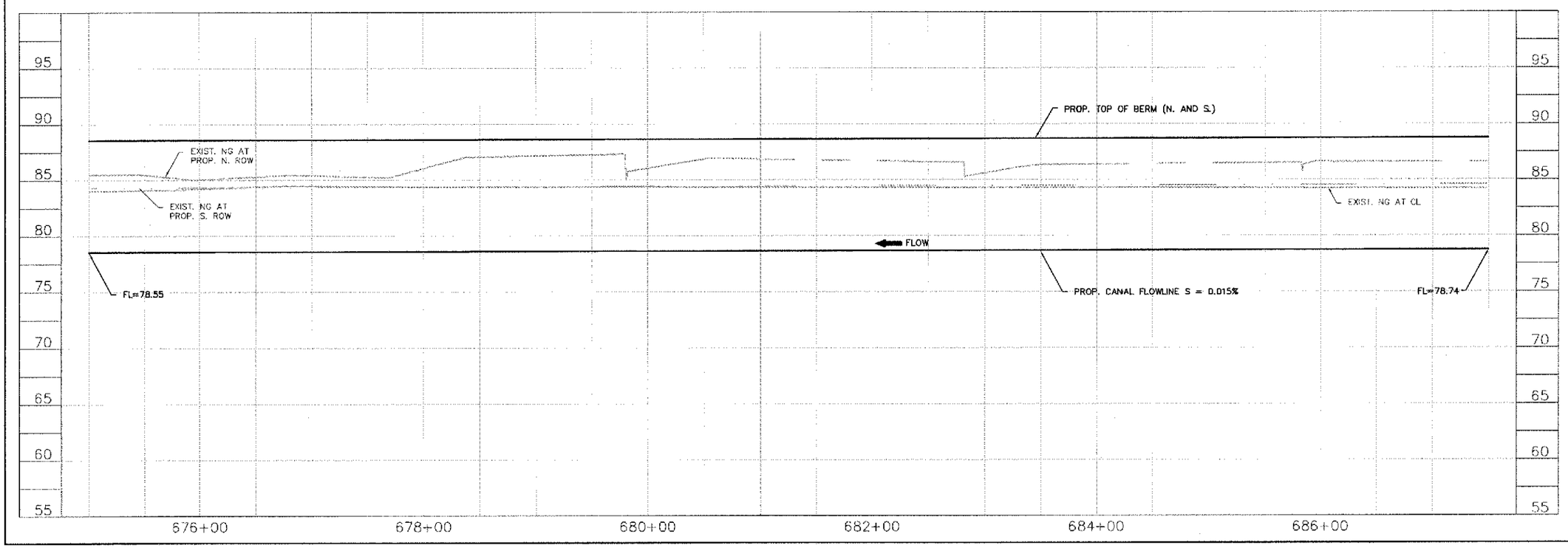
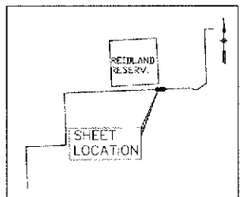




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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NOT FOR CONSTRUCTION PURPOSES

AECOM

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HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN & PROFILE STA 675+00 TO STA 687+50

DRAWING SCALE
AS SHOWN

SHEET NO. 89 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:14pm BY USER: Thompson81
DWG. LOCATION: Q:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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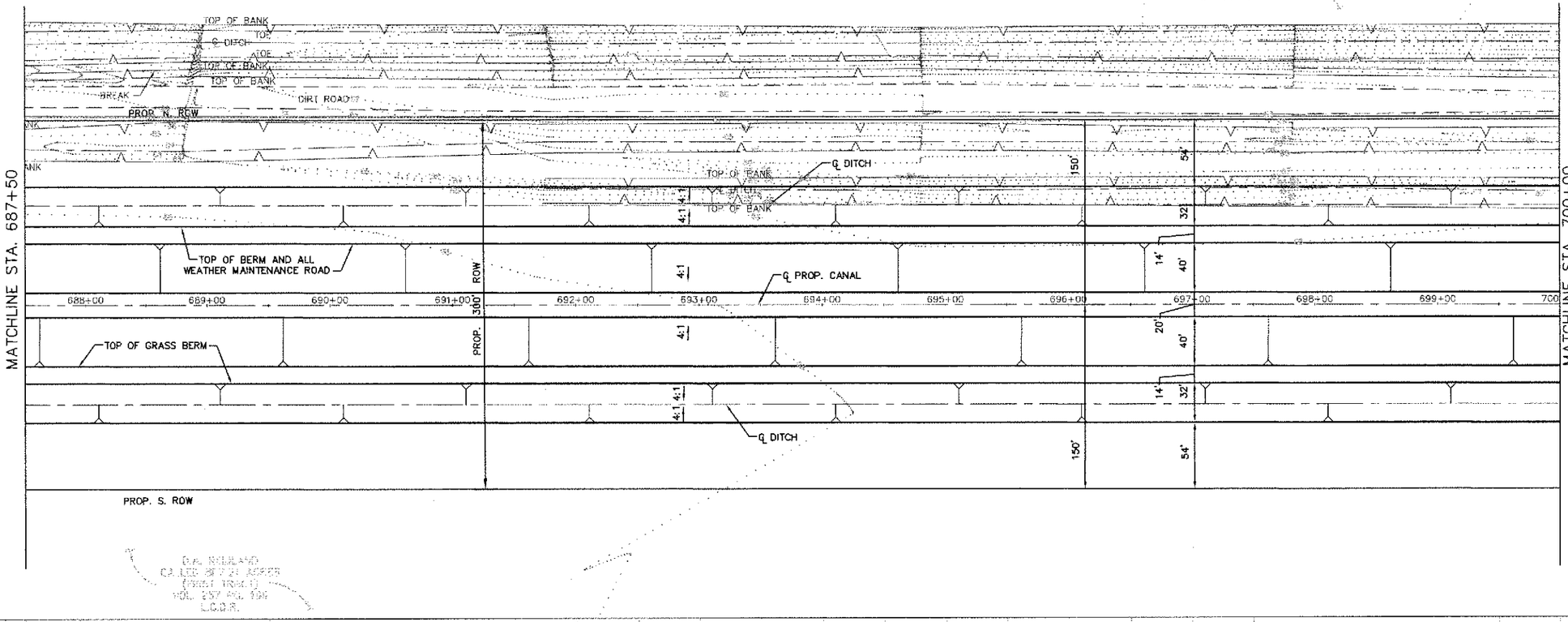
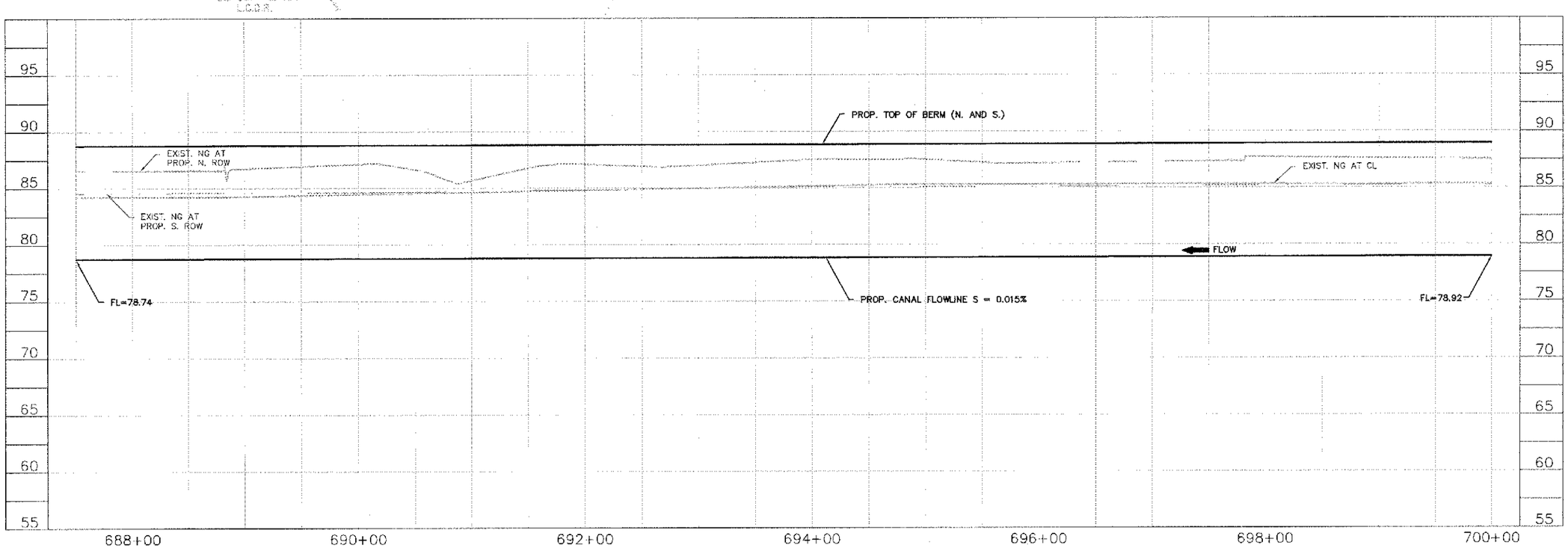
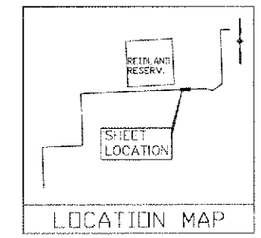




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 100 WEST
HOUSTON, TEXAS 77057-1593
WWW.AECOM.COM
TBPE REG. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

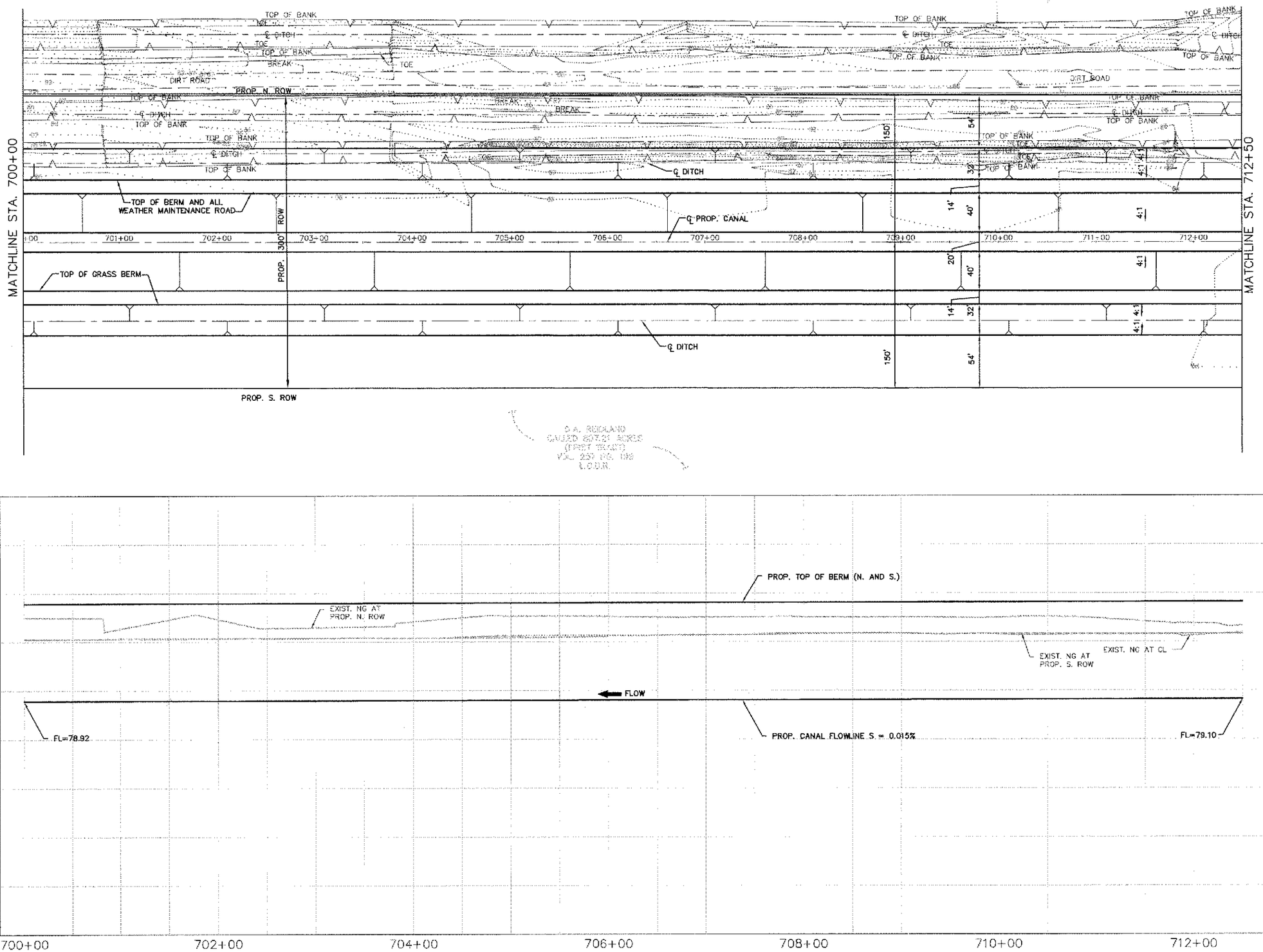
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN & PROFILE STA 687+50 TO STA 700+00

DRAWING SCALE
AS SHOWN

SHEET NO. 90 OF 245

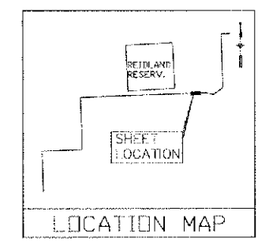
LAST MODIFIED: Jan 27, 2011 – 4:14pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P57.dwg



VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
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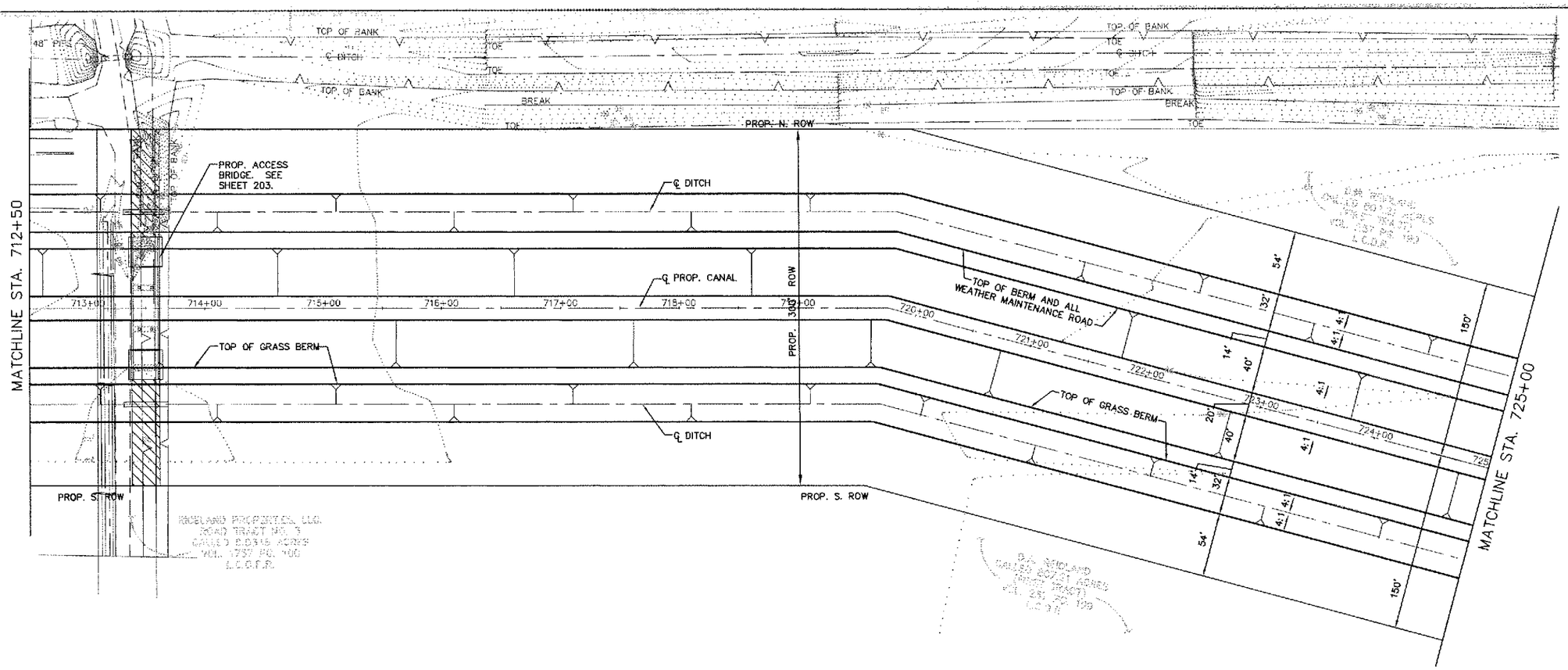
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN &
PROFILE STA 700+00
TO STA 712+50

DRAWING SCALE
AS SHOWN

SHEET NO. 91 OF 245

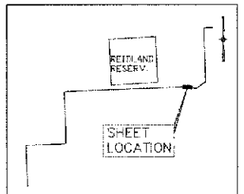
LAST MODIFIED: Jan 27, 2011 – 4:15pm BY USER: Thompson31
DWG. LOCATION: D:\Work Order 6\v4.0 ENGINEERING NOTES & CALCULATIONS\v4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P56.dwg



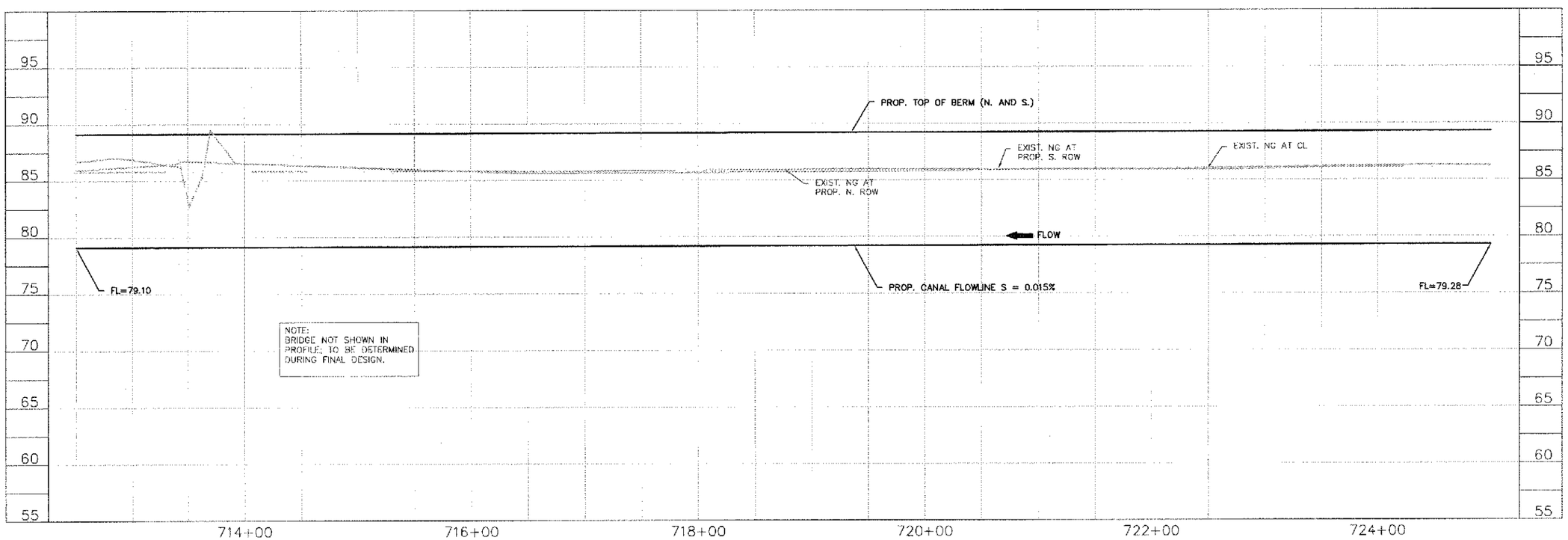
VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



NOTE:
BRIDGE NOT SHOWN IN PROFILE; TO BE DETERMINED DURING FINAL DESIGN.

KEVIN R. KRAHN, P.E.
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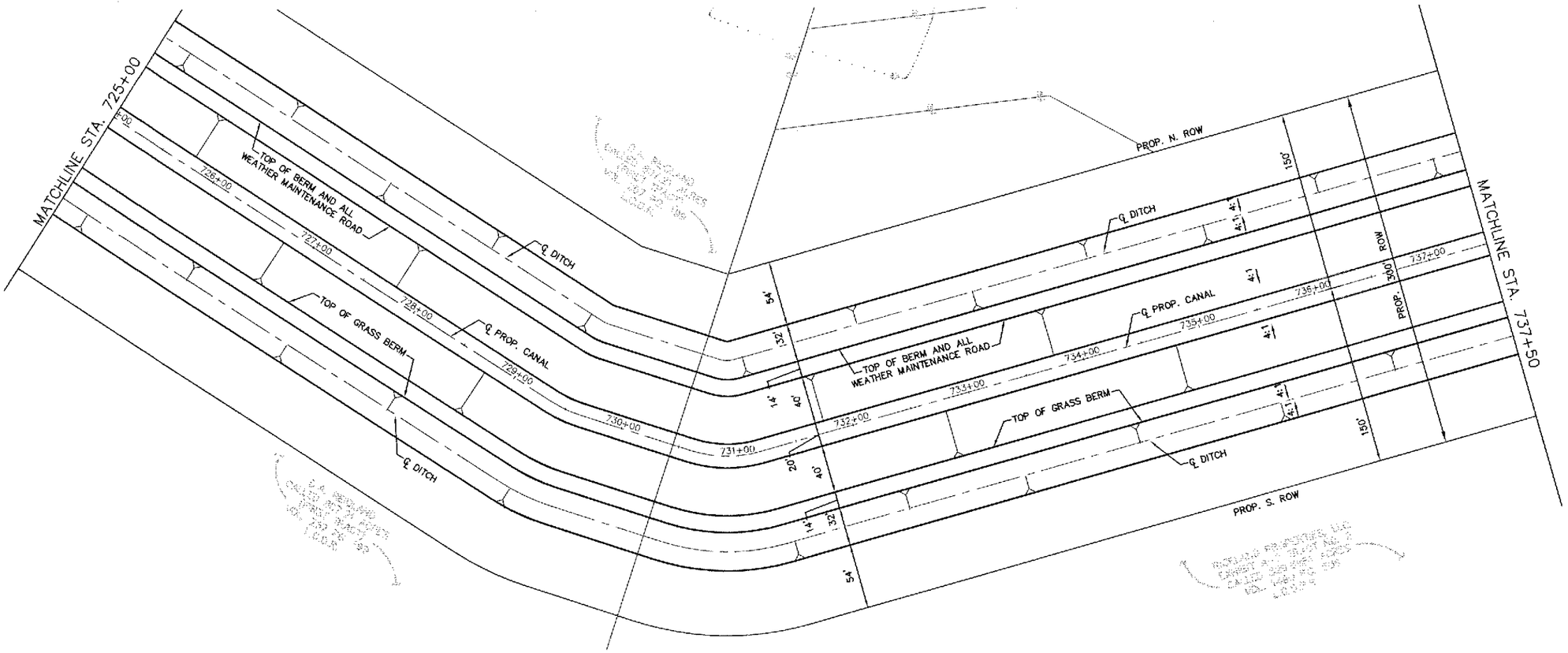
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN & PROFILE STA 712+50 TO STA 725+00

DRAWING SCALE
AS SHOWN

SHEET NO. 92 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:15pm BY USER: Thompson151
DWG LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: Canal P&P59.dwg

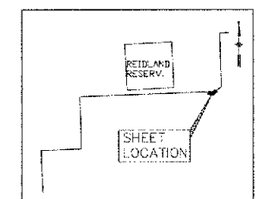


VERTICAL SCALE: 1" = 10'

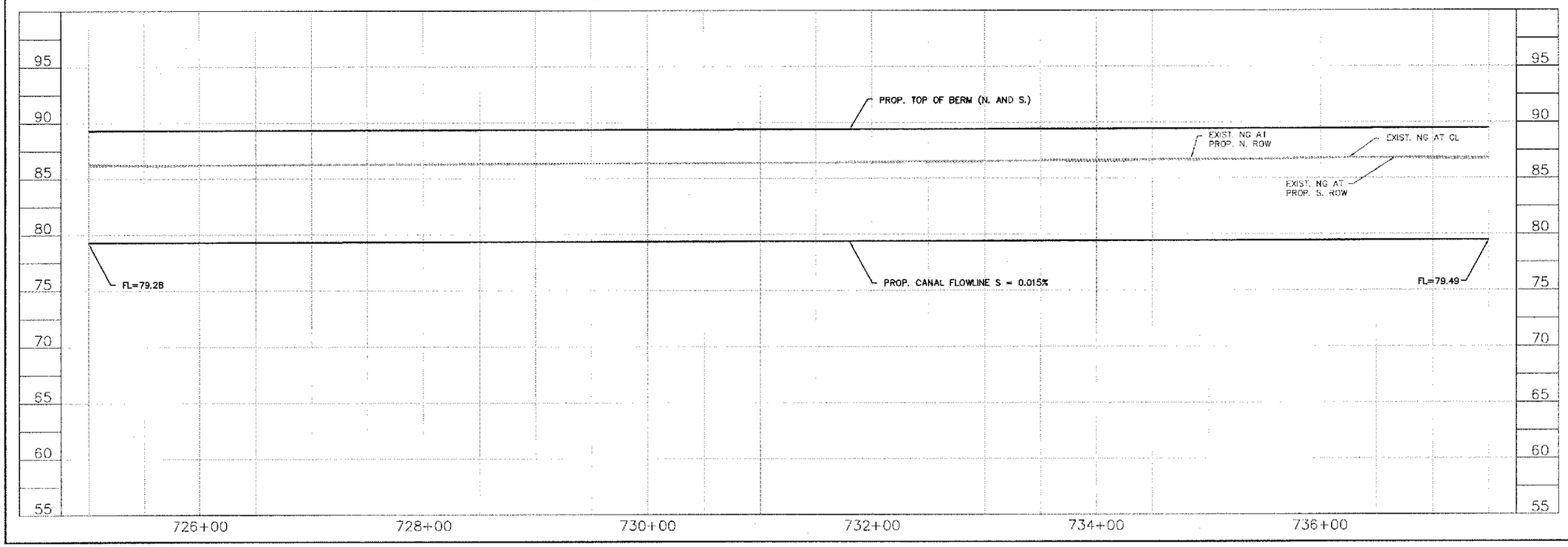
HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP



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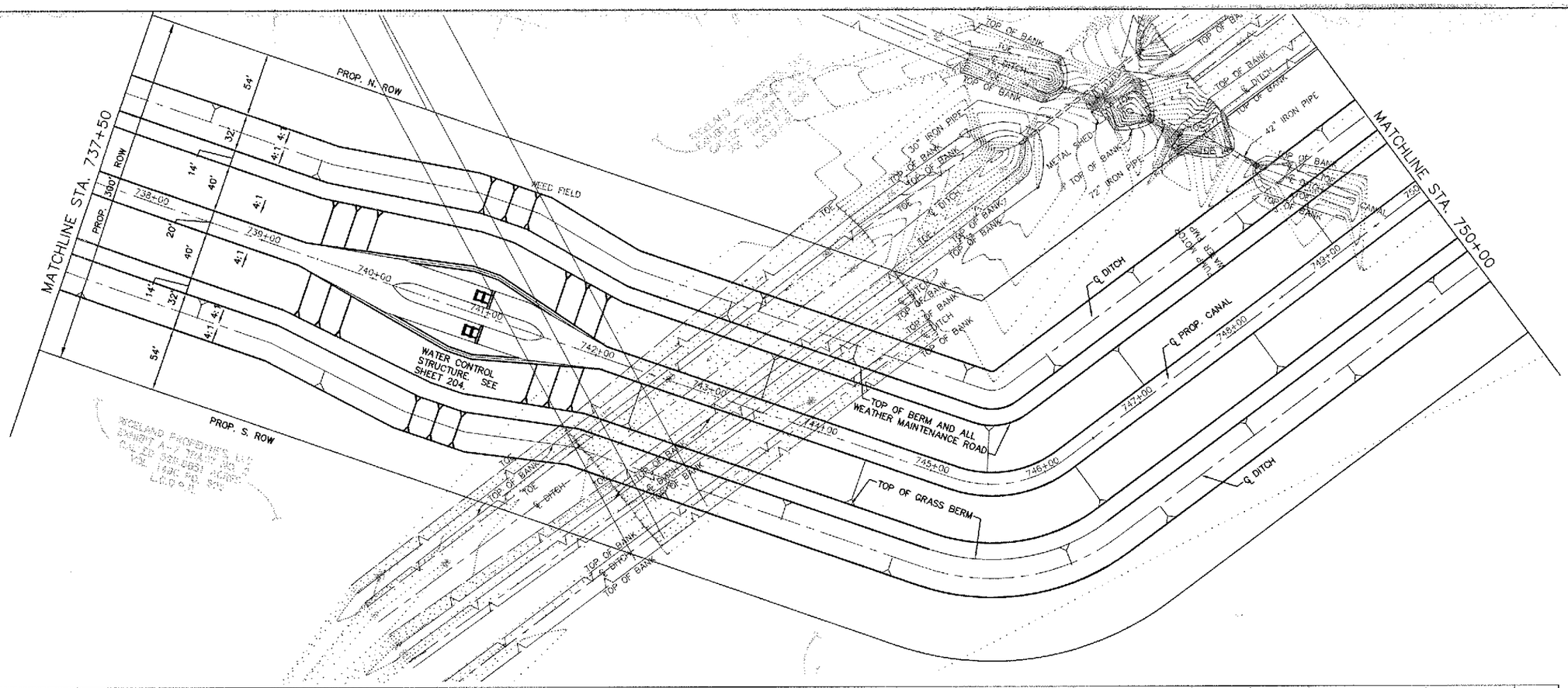
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN & PROFILE STA 725+00 TO STA 737+50

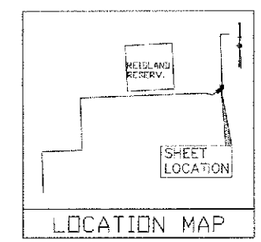
DRAWING SCALE
AS SHOWN

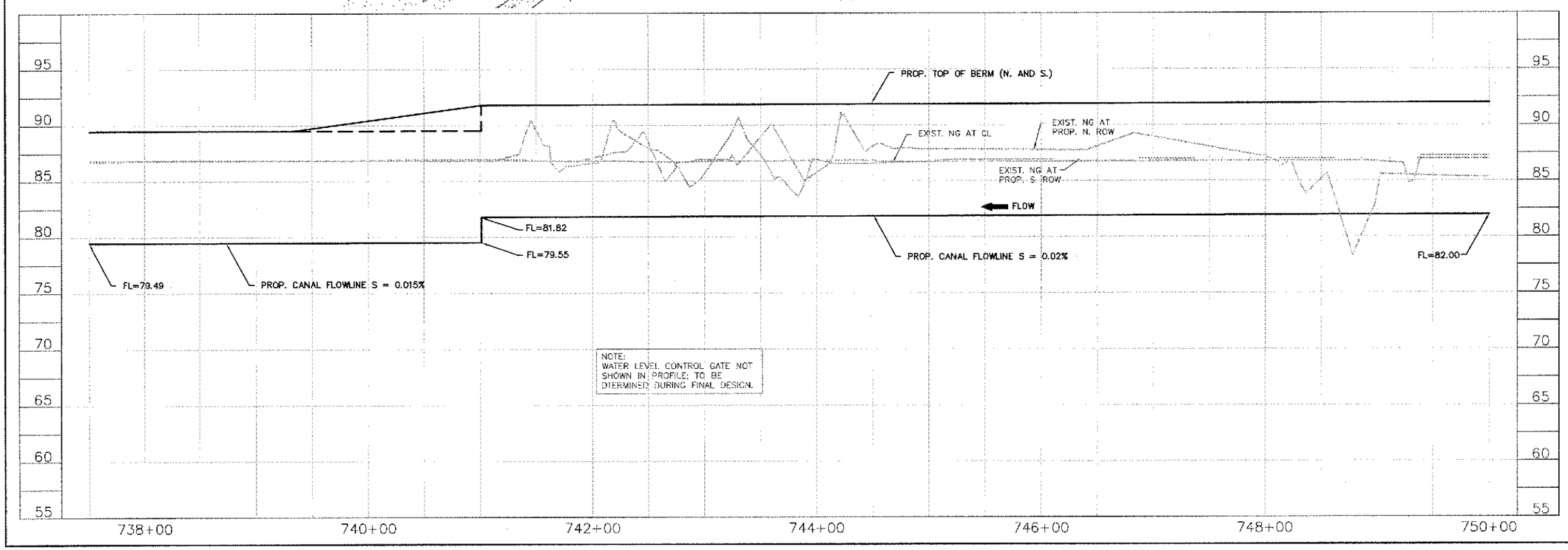
SHEET NO. 93 OF 245

LAST MODIFIED: Jan 27, 2011 – 4:17pm BY USER: ThompsonBI
DWG LOCATION: G:\Work Order: 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG NAME: Canal P&P50.dwg



NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN





NOTE:
WATER LEVEL CONTROL GATE NOT SHOWN IN PROFILE; TO BE DTERMINED DURING FINAL DESIGN.

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
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TBPE REG. NO. F-9580

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HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

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COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN & PROFILE STA 737+50 TO STA 750+00

DRAWING SCALE
AS SHOWN

SHEET NO. 94 OF 295

LAST MODIFIED: Jan 27, 2011 - 4:18pm BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cano\PWD\Sheets\
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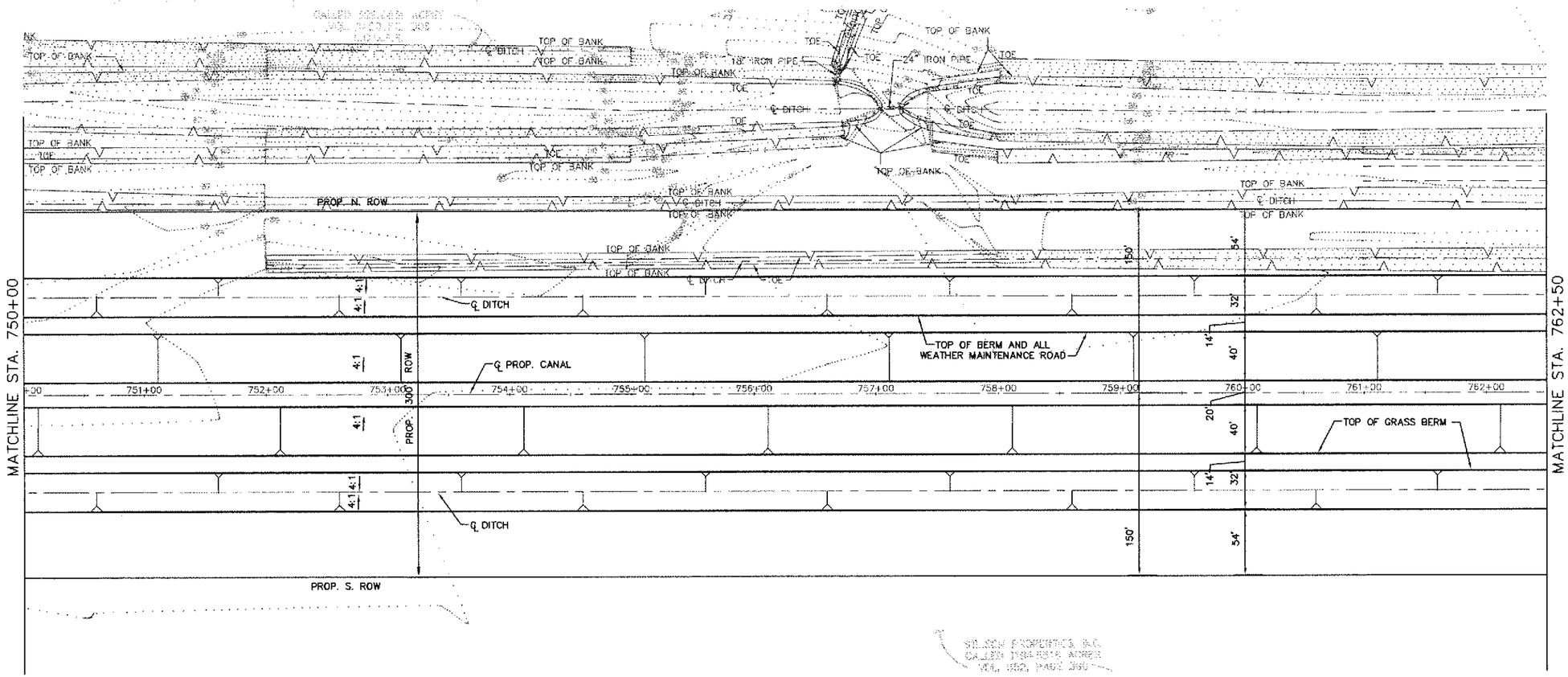
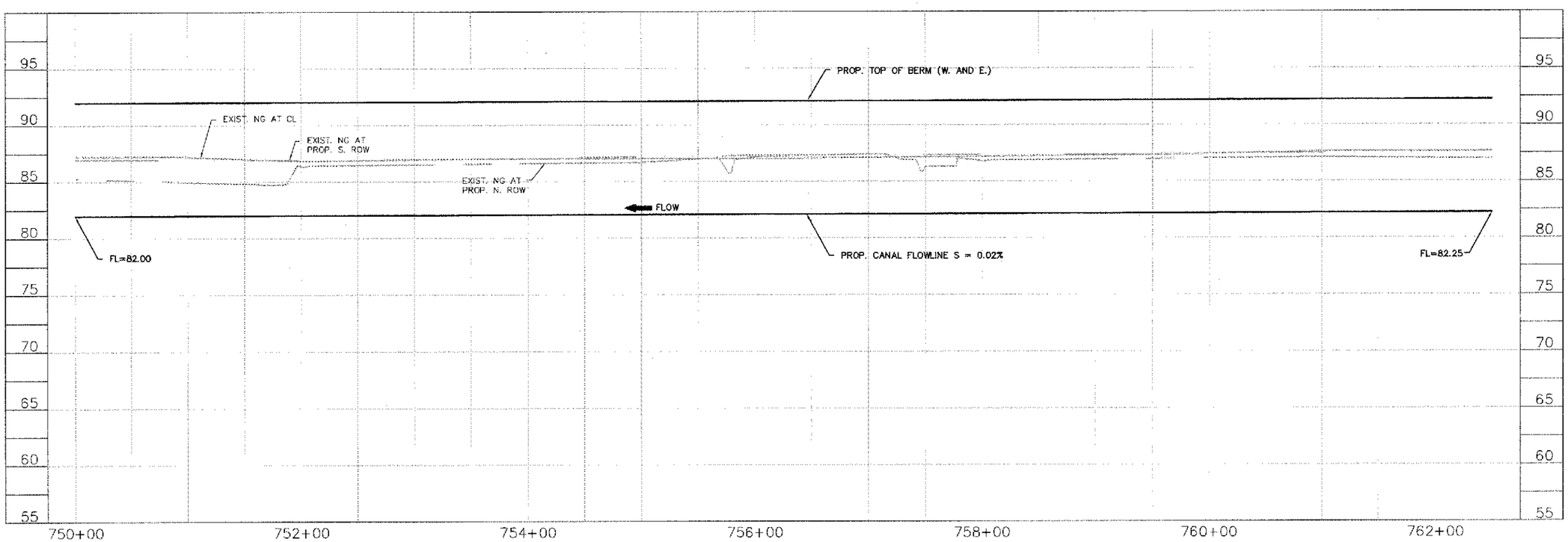
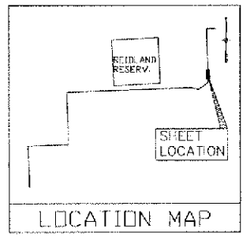




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
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HOUSTON, TEXAS 77057-1599
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5757 WOODWAY
HOUSTON, TEXAS 77057
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713.780.0838 fax.

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CWA

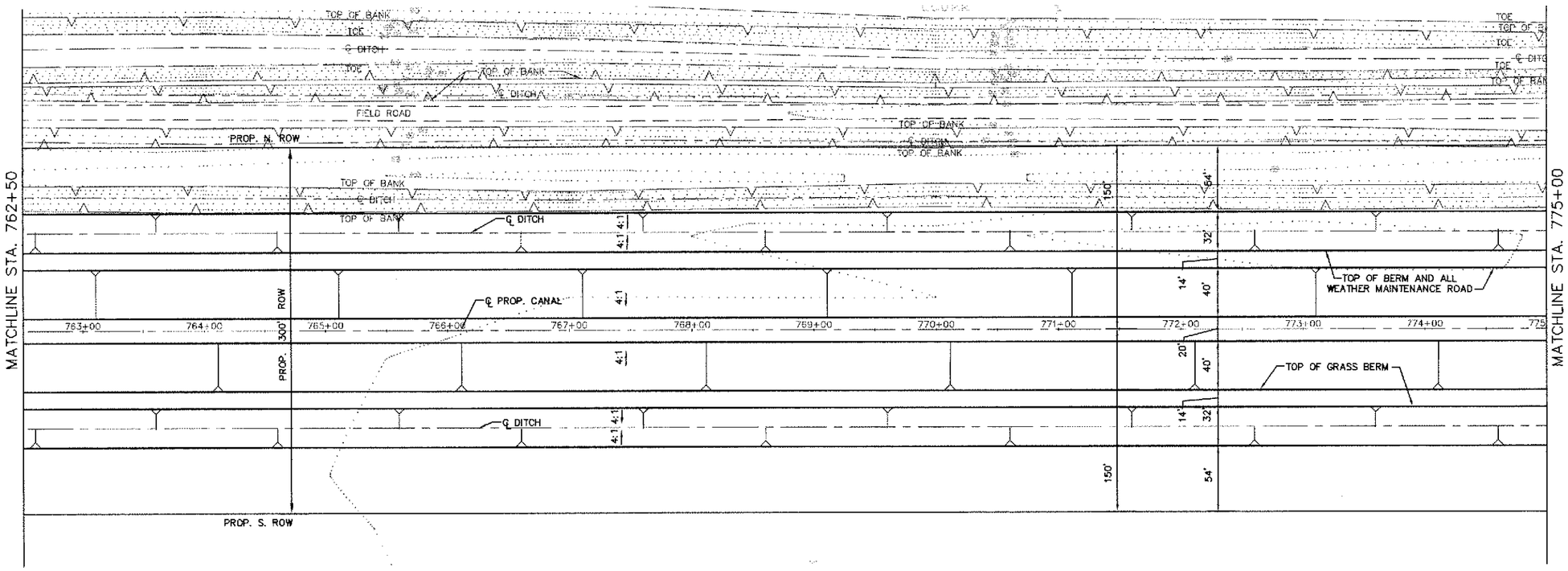
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

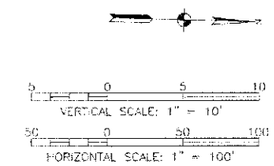
CANAL PLAN &
PROFILE STA 750+00
TO STA 762+50

DRAWING SCALE
AS SHOWN

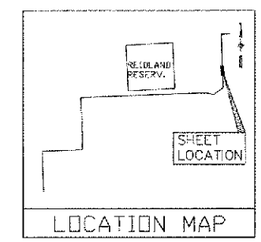
SHEET NO. 95 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:18pm BY USER: ThompsonBI
DWG. LOCATION: G:\Work Order 614.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalPlan762.dwg

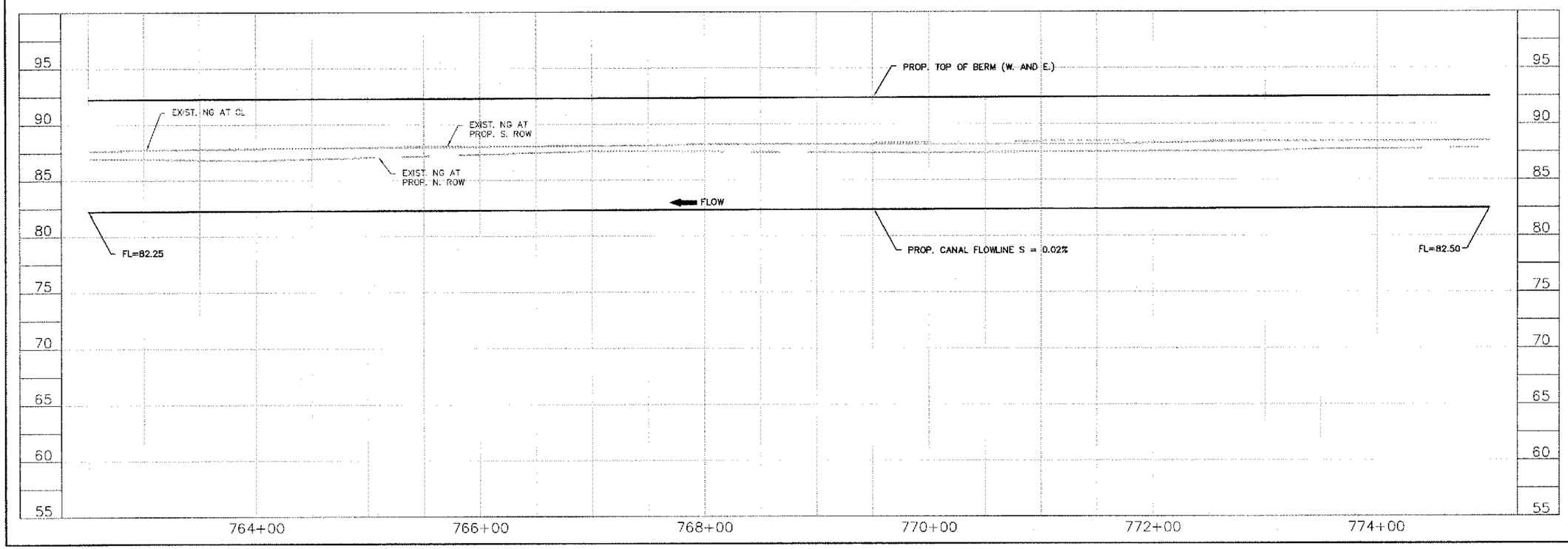




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
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5757 WOODWAY
HOUSTON, TEXAS 77057
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713.780.0838 fax.

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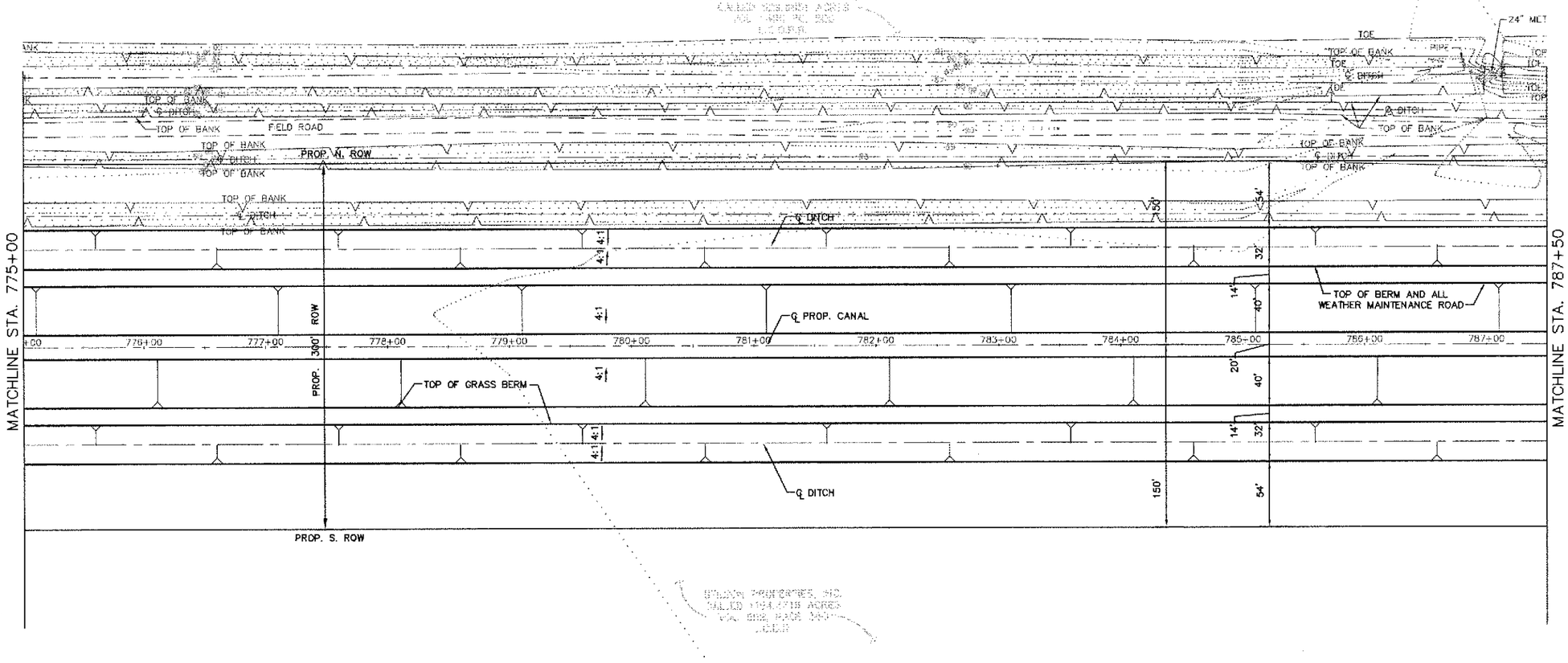
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN &
PROFILE STA 762+50
TO STA 775+00

DRAWING SCALE
AS SHOWN

SHEET NO. 96 OF 245

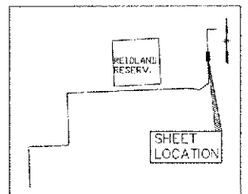
LAST MODIFIED: Jan 27, 2011 - 4:19pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P63.dwg



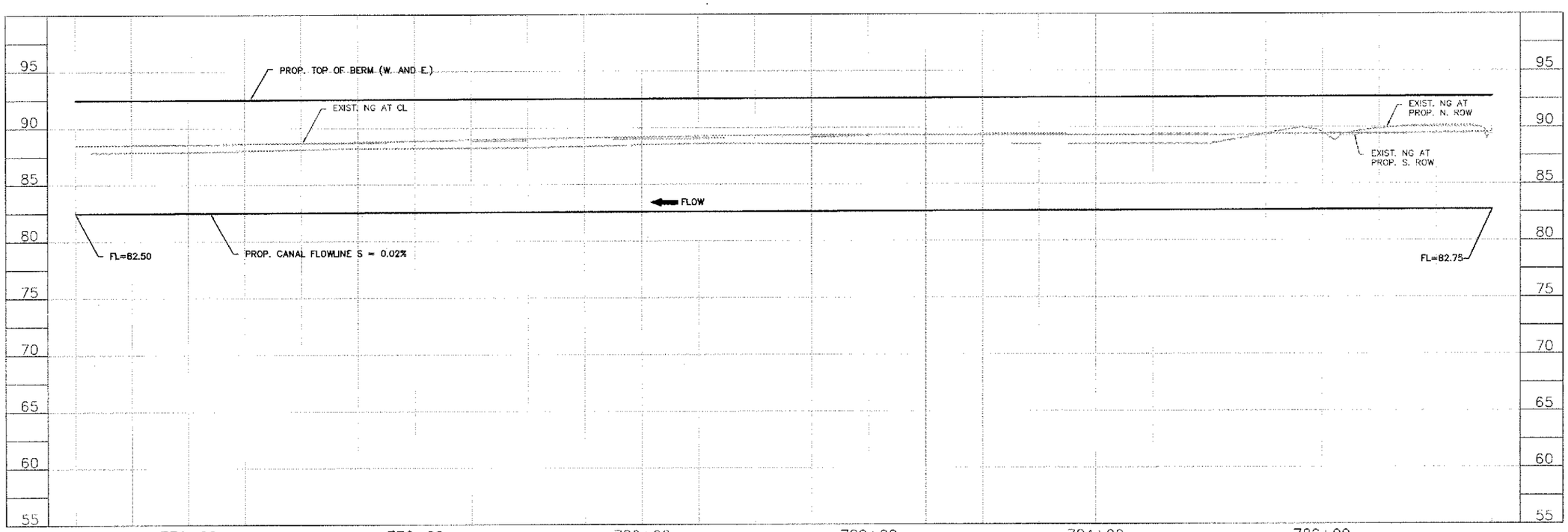
VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
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AECOM
AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
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5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

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FB NO.

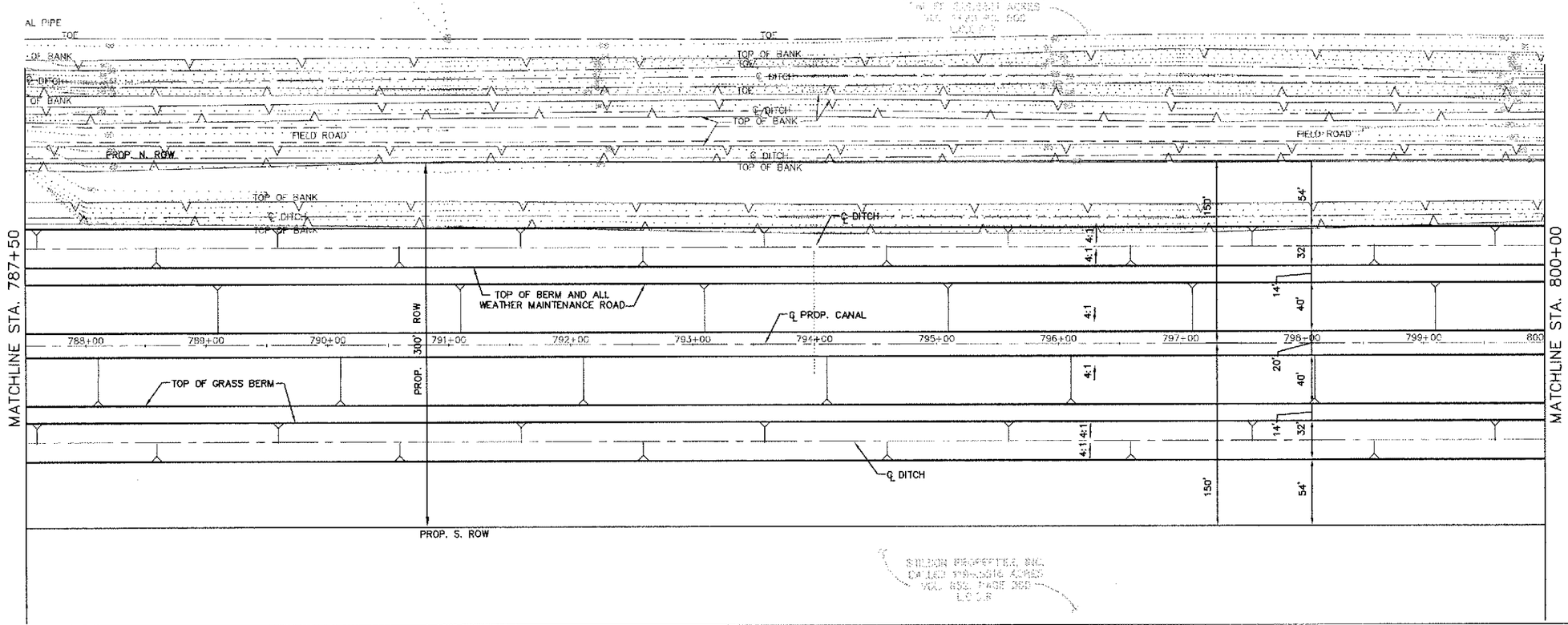
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

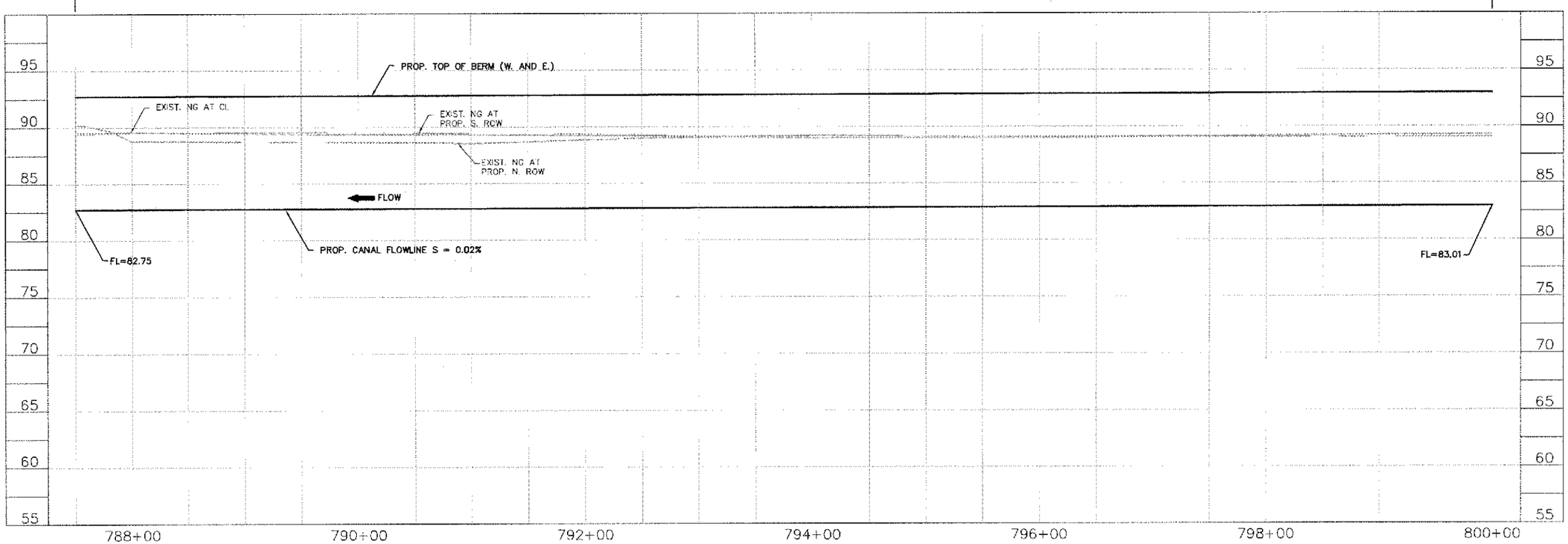
CANAL PLAN &
PROFILE STA 775+00
TO STA 787+50

DRAWING SCALE
AS SHOWN

SHEET NO. 97 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:19pm BY USER: ThompsonBl
DWG. LOCATION: S:\Work Order 614.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: Canal\P&P54.dwg

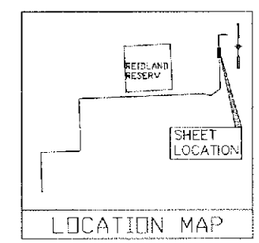




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM
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TBPE REG. NO. F-5580

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HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

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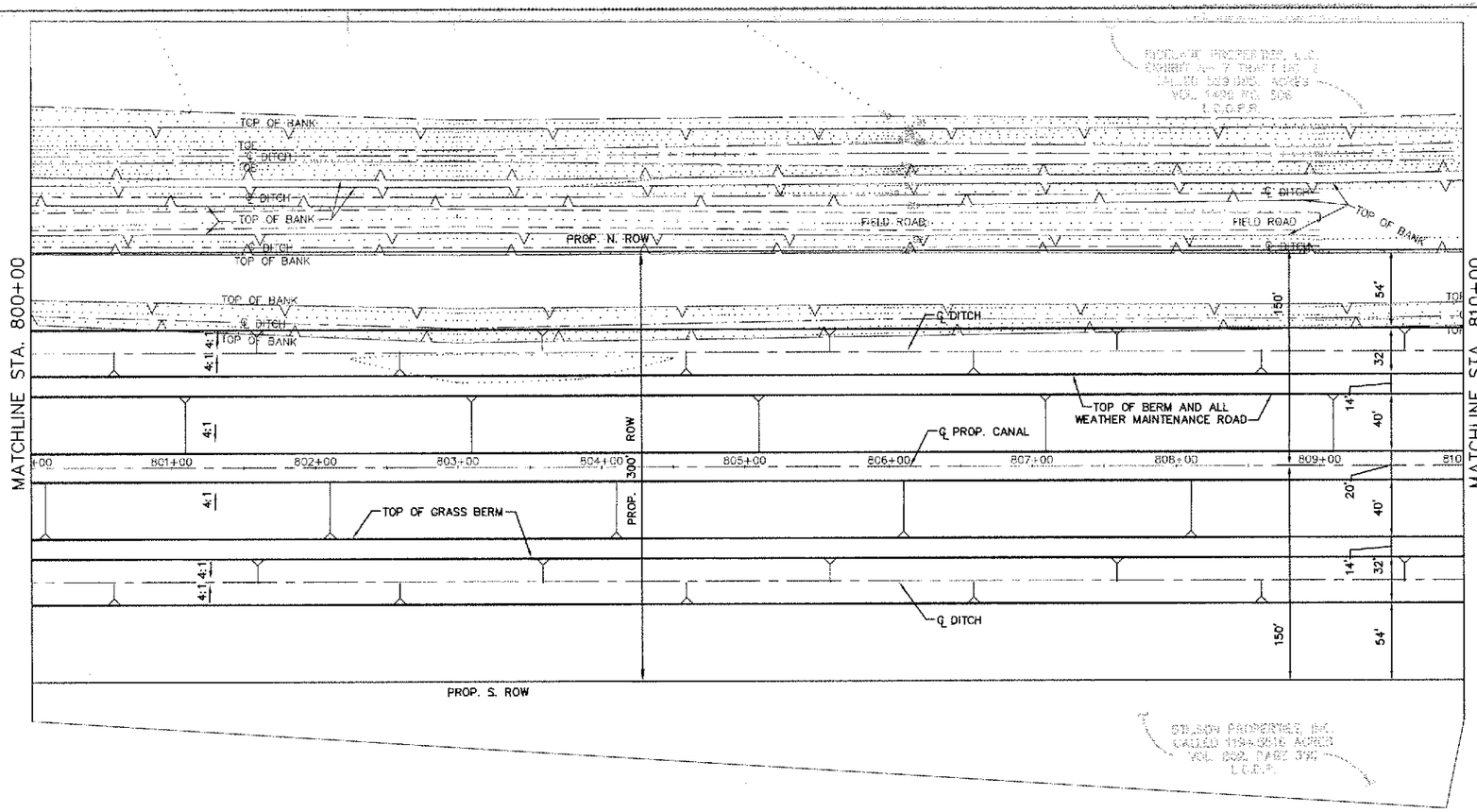
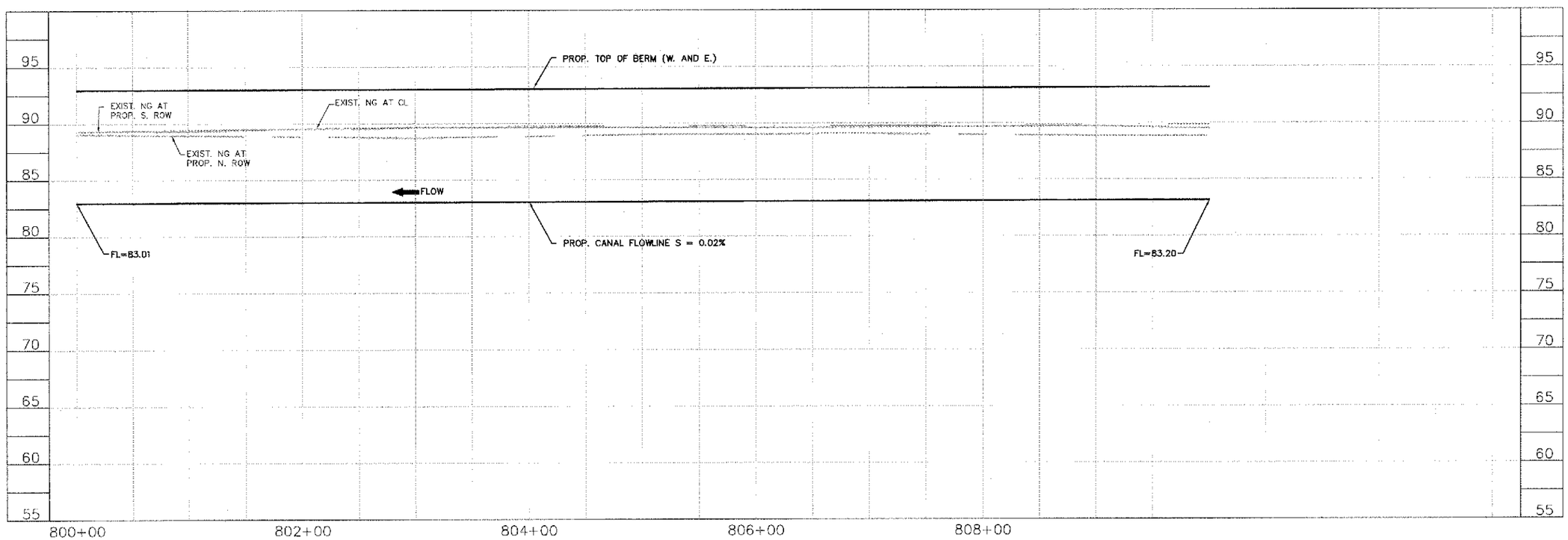
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN &
PROFILE STA 787+50
TO STA 800+00

DRAWING SCALE
AS SHOWN

LAST MODIFIED: Jan 27, 2011 - 4:20pm BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P85.dwg

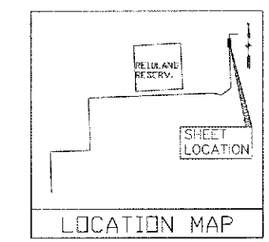




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
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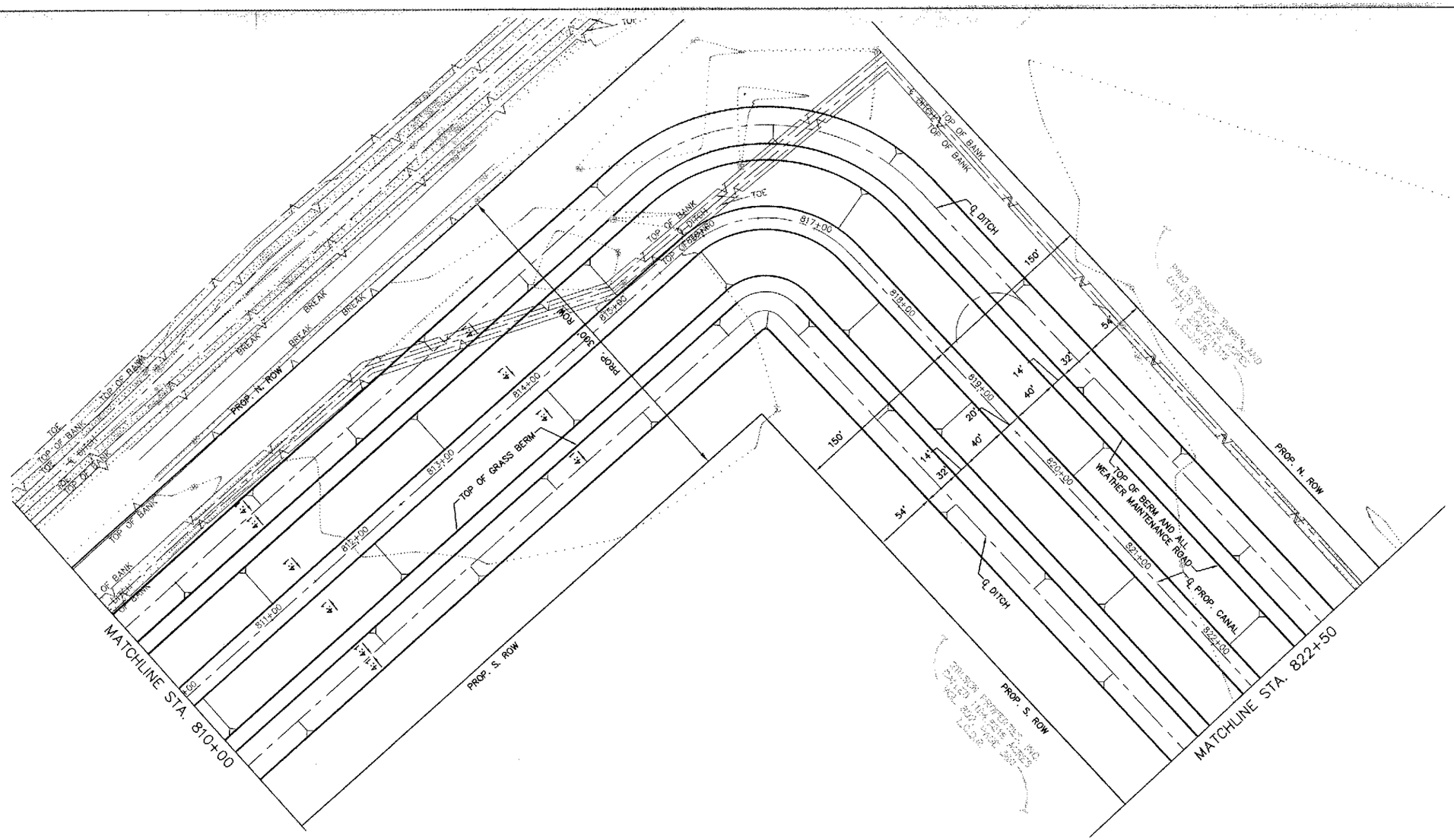
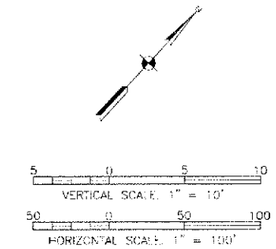
CANAL PLAN &
PROFILE STA 800+00
TO STA 810+00

DRAWING SCALE
AS SHOWN

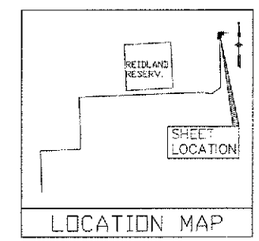
SHEET NO. 99 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:20pm BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P66.dwg



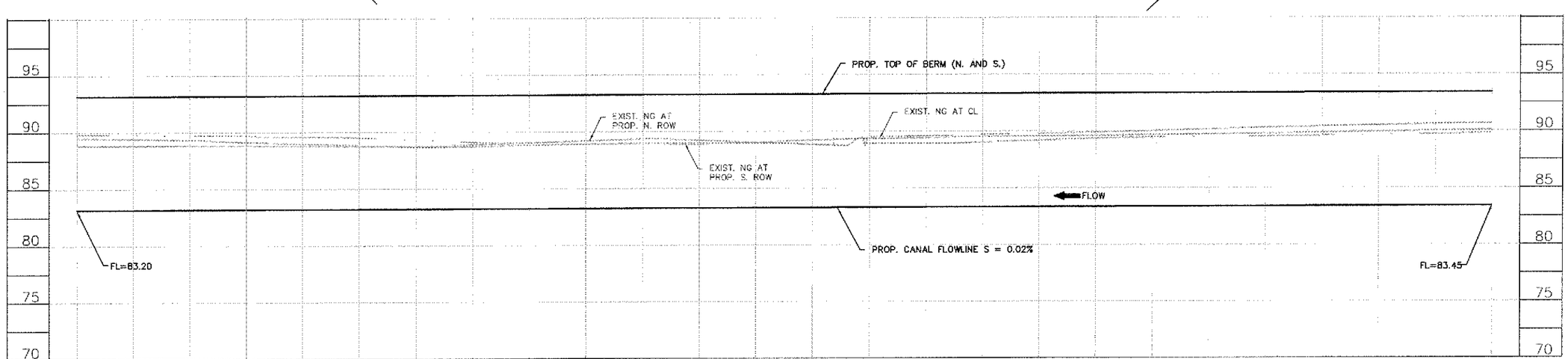


NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES



AECOM
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HOUSTON, TEXAS 77057-1598
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TBPE REG. NO. F-3580

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5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
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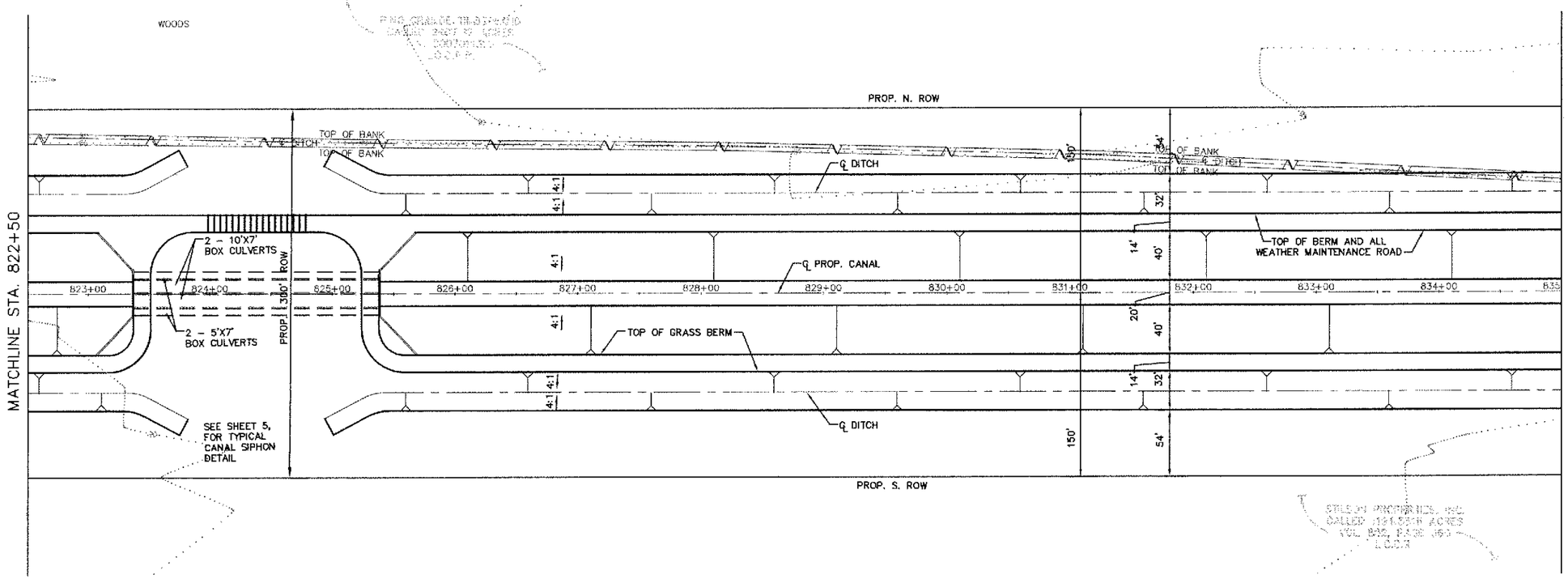
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

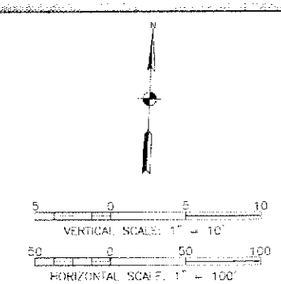
CANAL PLAN & PROFILE STA 810+00 TO STA 822+50

DRAWING SCALE
AS SHOWN

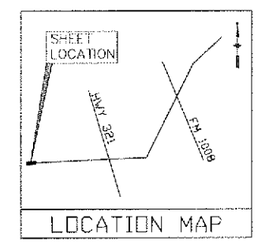
SHEET NO. 100 OF 245

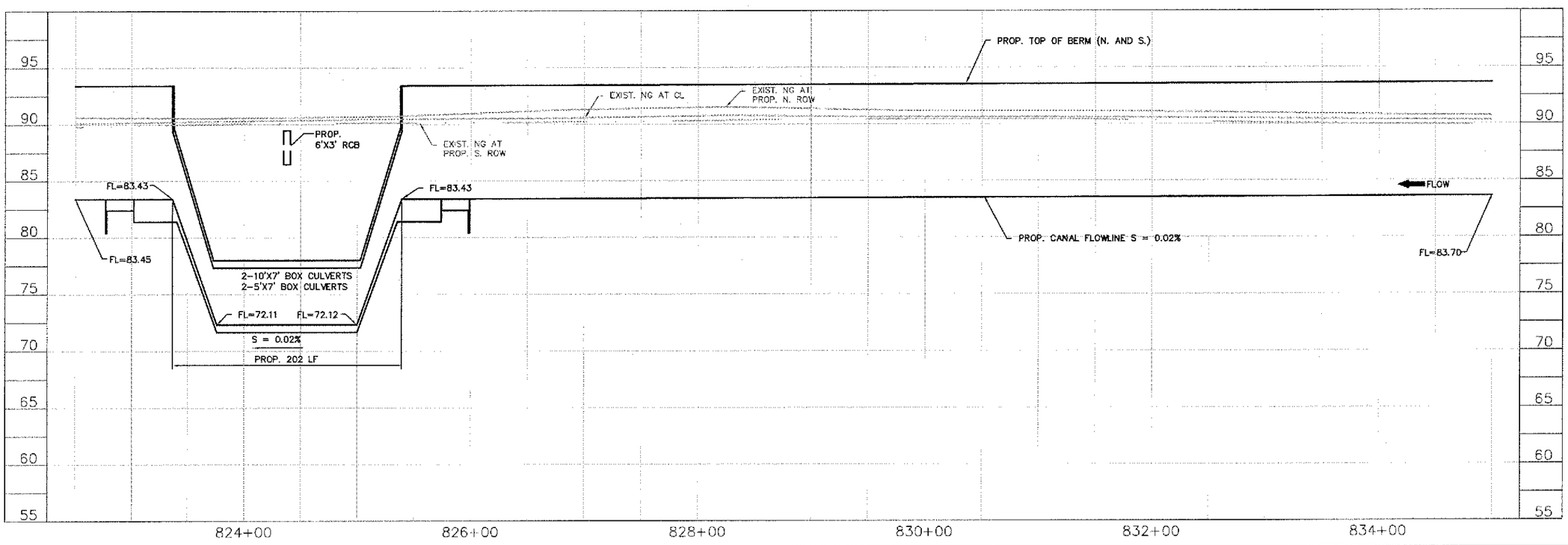
LAST MODIFIED: Jan 27, 2011 - 4:21pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P67.dwg





NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN





KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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AECOM

AECOM TECHNICAL SERVICES, INC.
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HOUSTON, TEXAS 77057-1559
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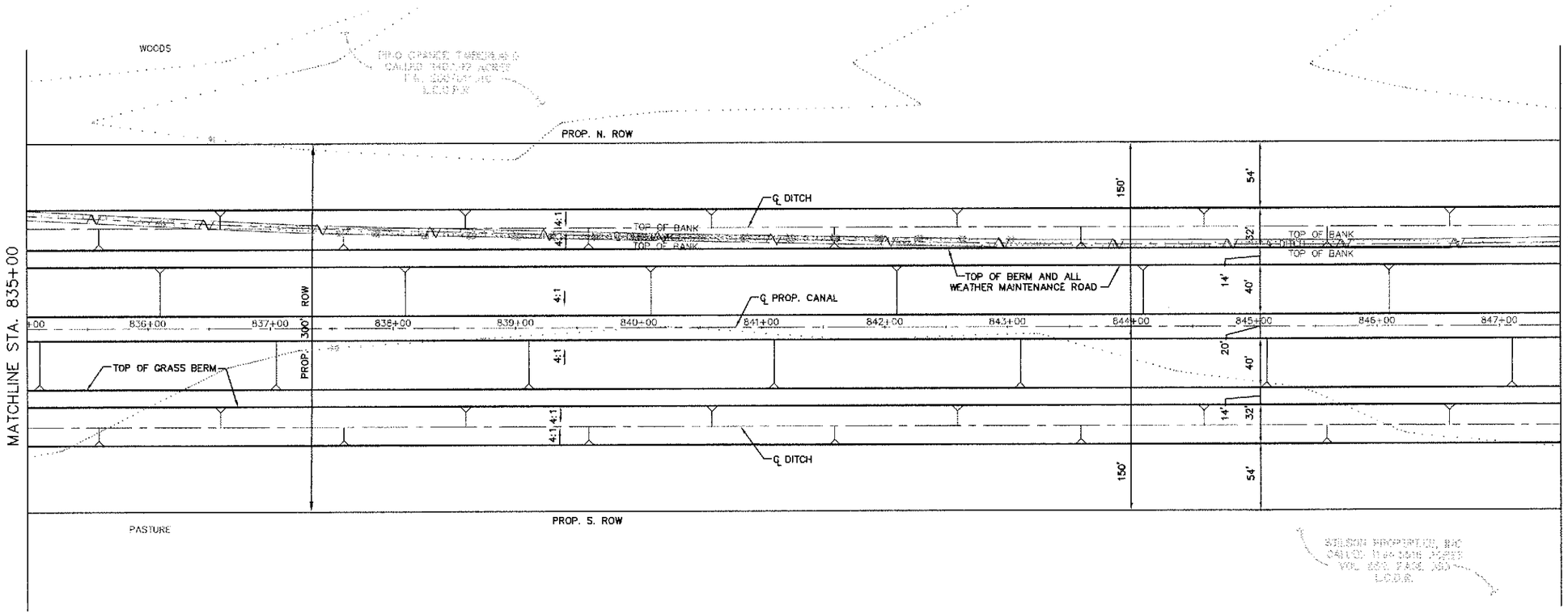
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

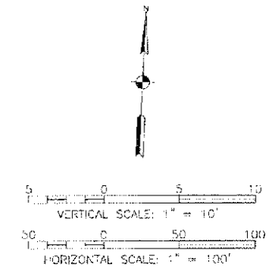
CANAL PLAN & PROFILE STA 822+50 TO STA 835+00

DRAWING SCALE
AS SHOWN

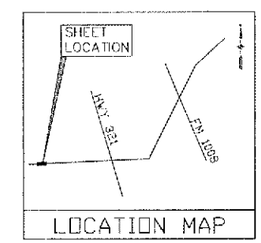
SHEET NO. 161 OF 245

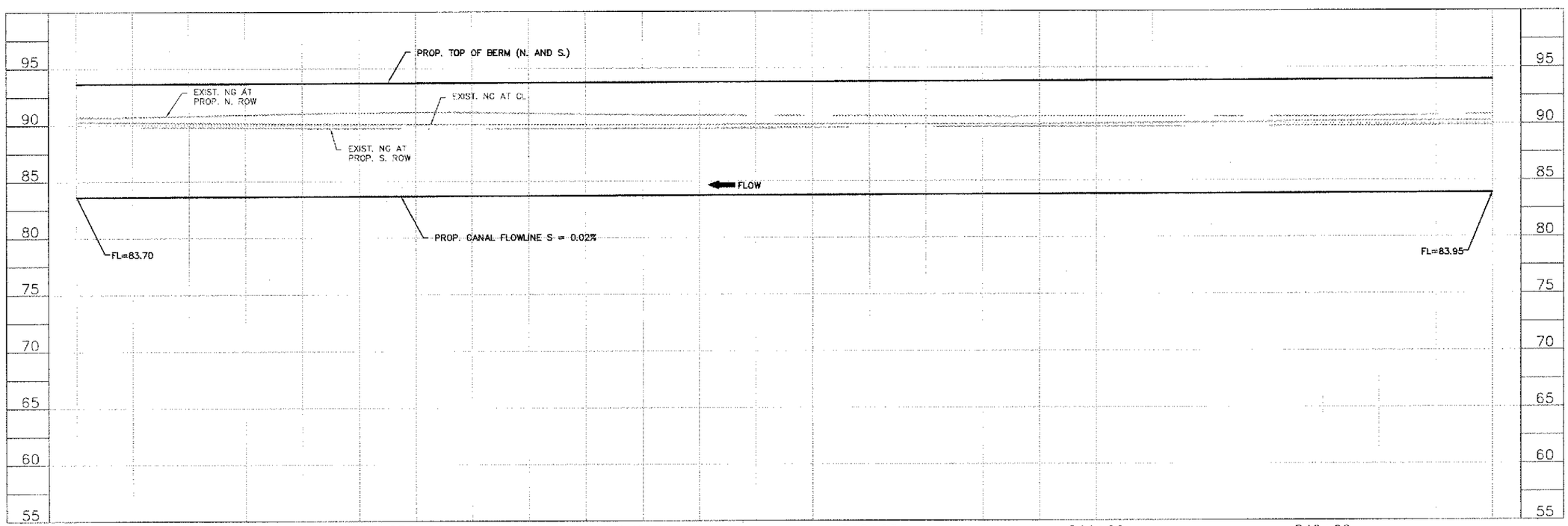
LAST MODIFIED: Jan 27, 2011 - 4:22pm BY USER: ThompsonBI
DWG. LOCATION: D:\Work Order 8\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&PSB.dwg





NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN





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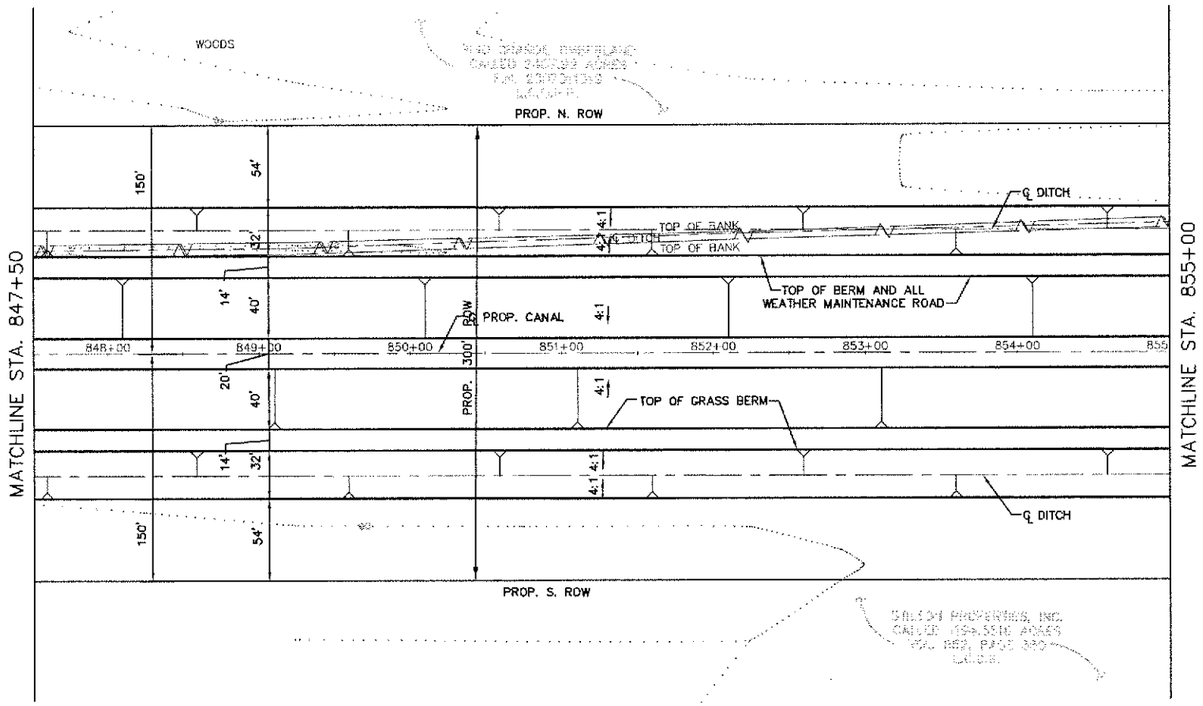
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

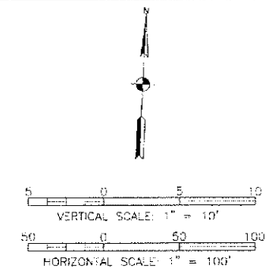
CANAL PLAN &
PROFILE STA 835+00
TO STA 847+50

DRAWING SCALE
AS SHOWN

SHEET NO. 102 OF 245

LAST MODIFIED: Jan 27, 2011 – 4:22pm BY USER: Thompsonbl
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWO\Sheets\
DWG. NAME: CanalP&P89.dwg





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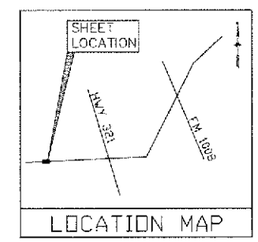
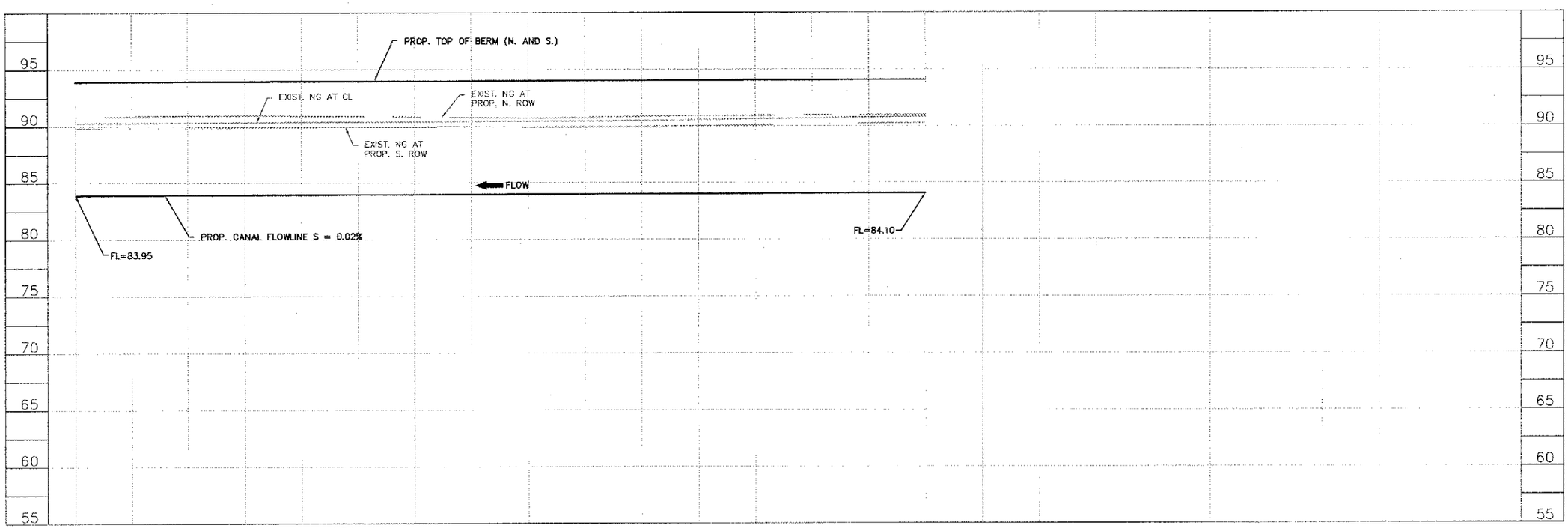
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



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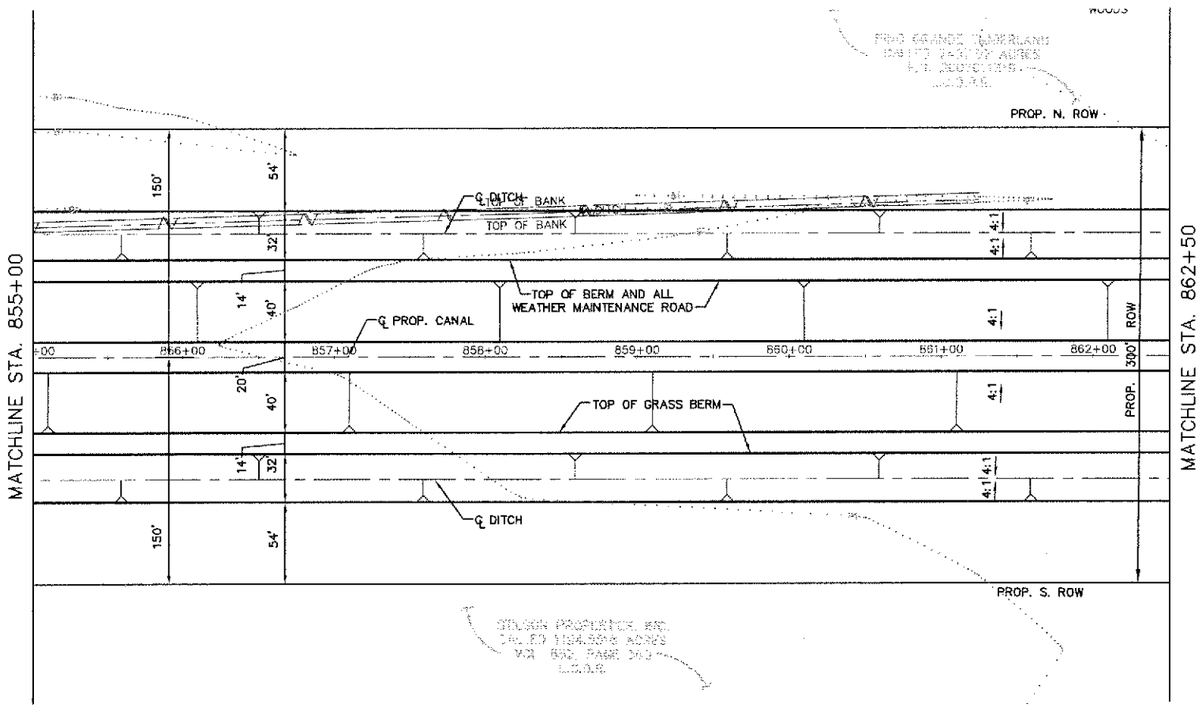
LUCE BAYOU INTERBASIN TRANSFER PROJECT

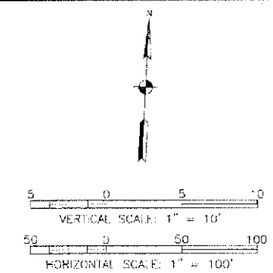
CANAL PLAN &
PROFILE STA 847+50
TO STA 855+00

DRAWING SCALE
AS SHOWN

SHEET NO. 103 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:25pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P70.dwg





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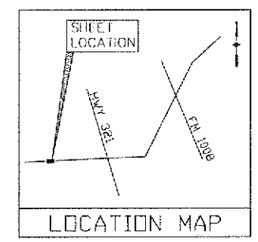
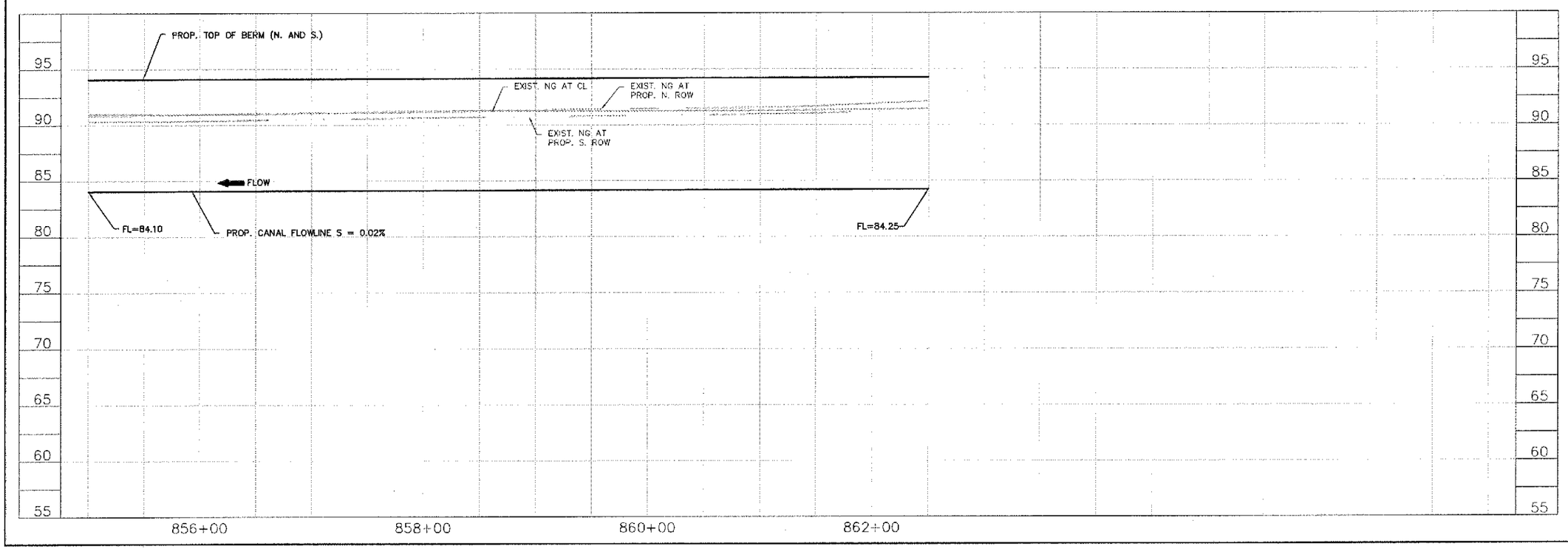
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN





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AECOM

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713.780.0838 fax.

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN & PROFILE STA 855+00 TO STA 862+50

DRAWING SCALE
AS SHOWN

SHEET NO. 104 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:25pm BY USER: ThompsonBI
DWG. LOCATION: D:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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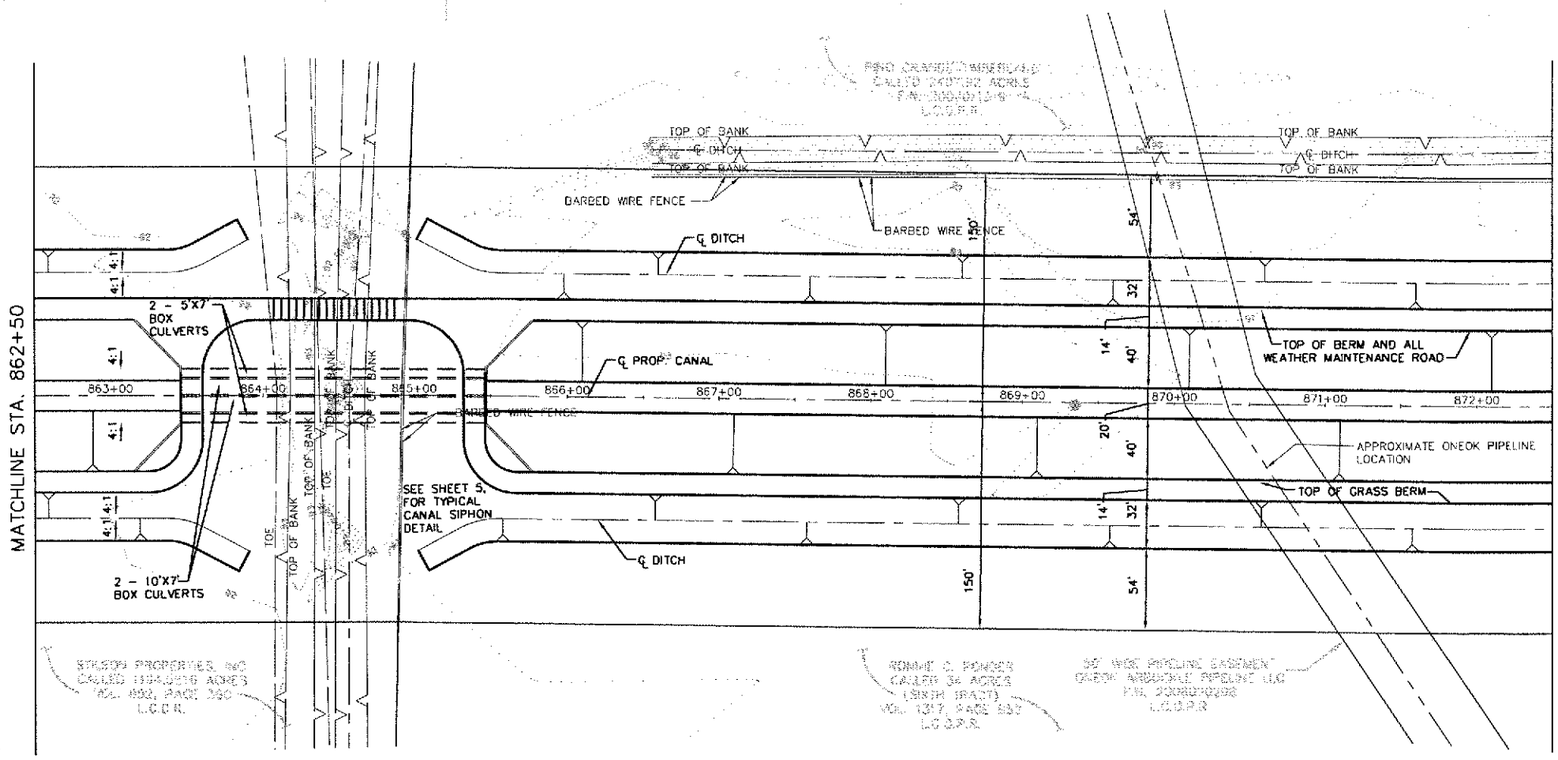
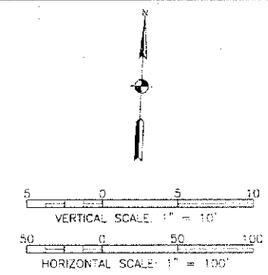
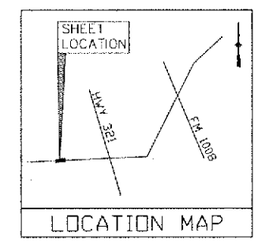
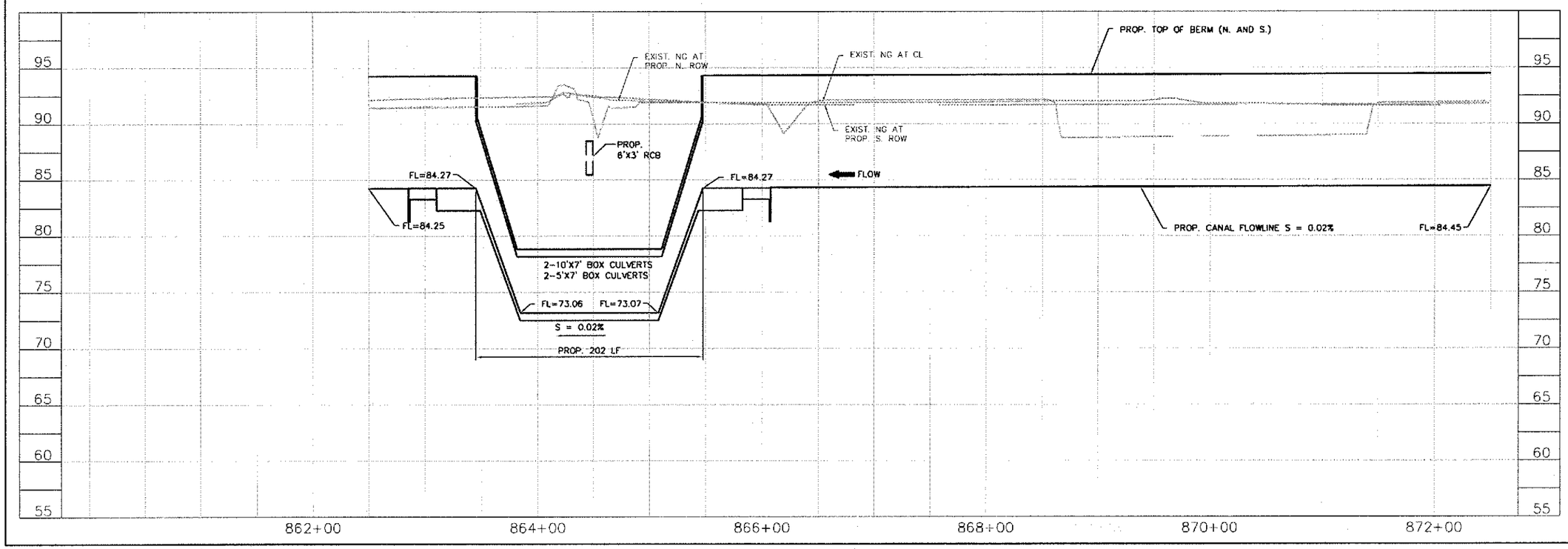




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.





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LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN & PROFILE STA 862+50 TO STA 872+50

DRAWING SCALE
AS SHOWN

SHEET NO. 105 OF 244

LAST MODIFIED: Jan 28, 2011 - 6:36am BY USER: ThompsonBI
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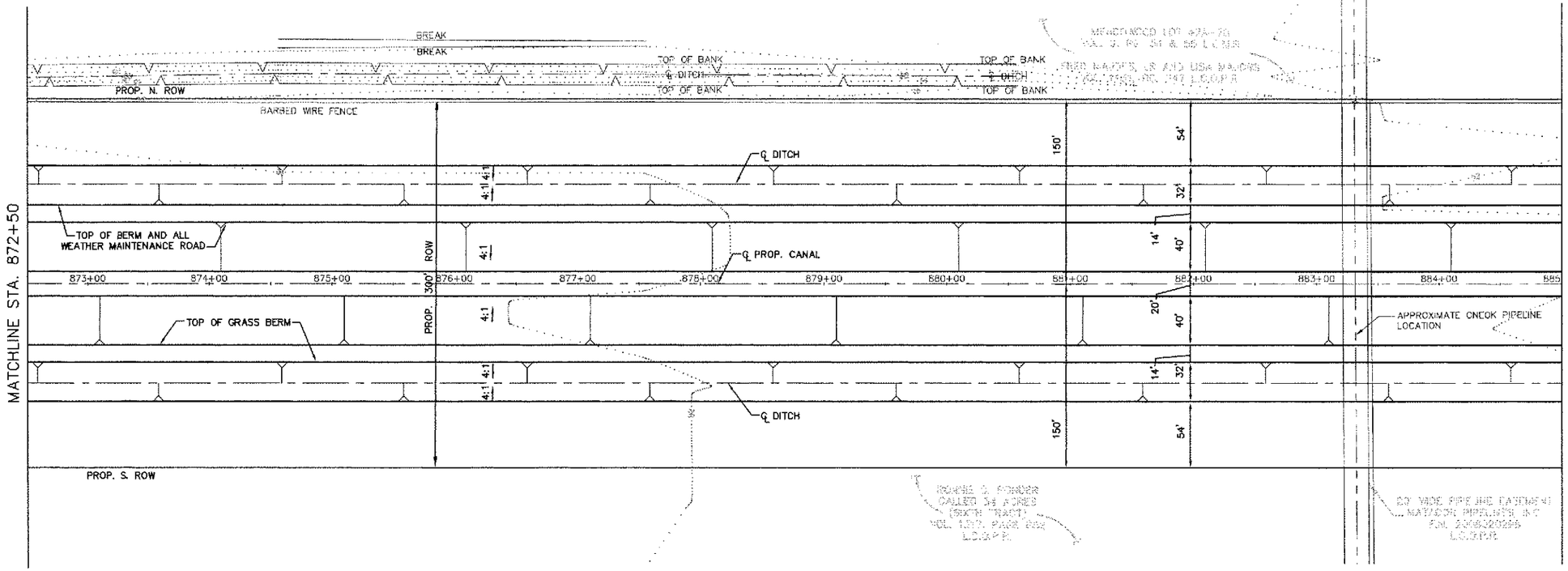
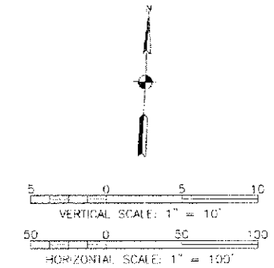
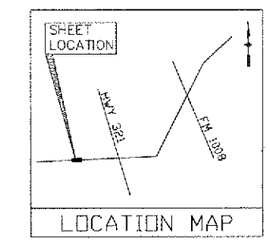
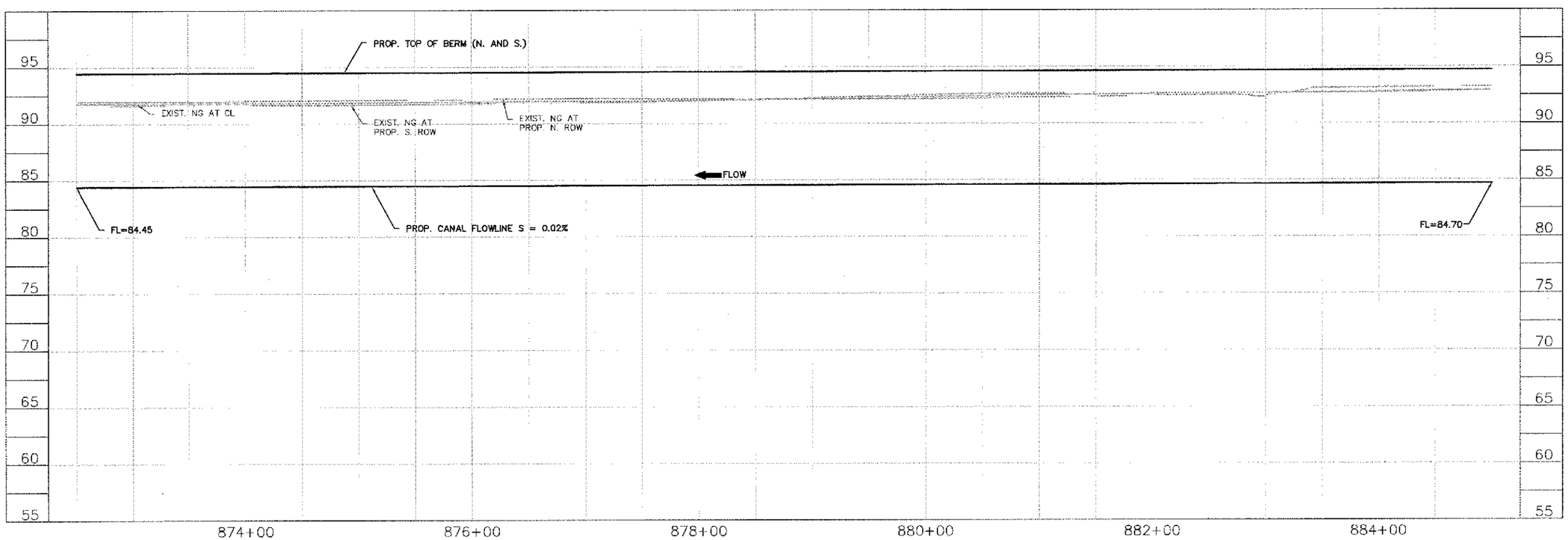




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.





KEVIN R. KRAHN, P.E.
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AECOM

AECOM TECHNICAL SERVICES, INC.
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LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN &
PROFILE STA 872+50
TO STA 885+00

DRAWING SCALE
AS SHOWN

SHEET NO. 106 OF 295

LAST MODIFIED: Jan 27, 2011 – 4:28pm BY USER: ThompsonBl
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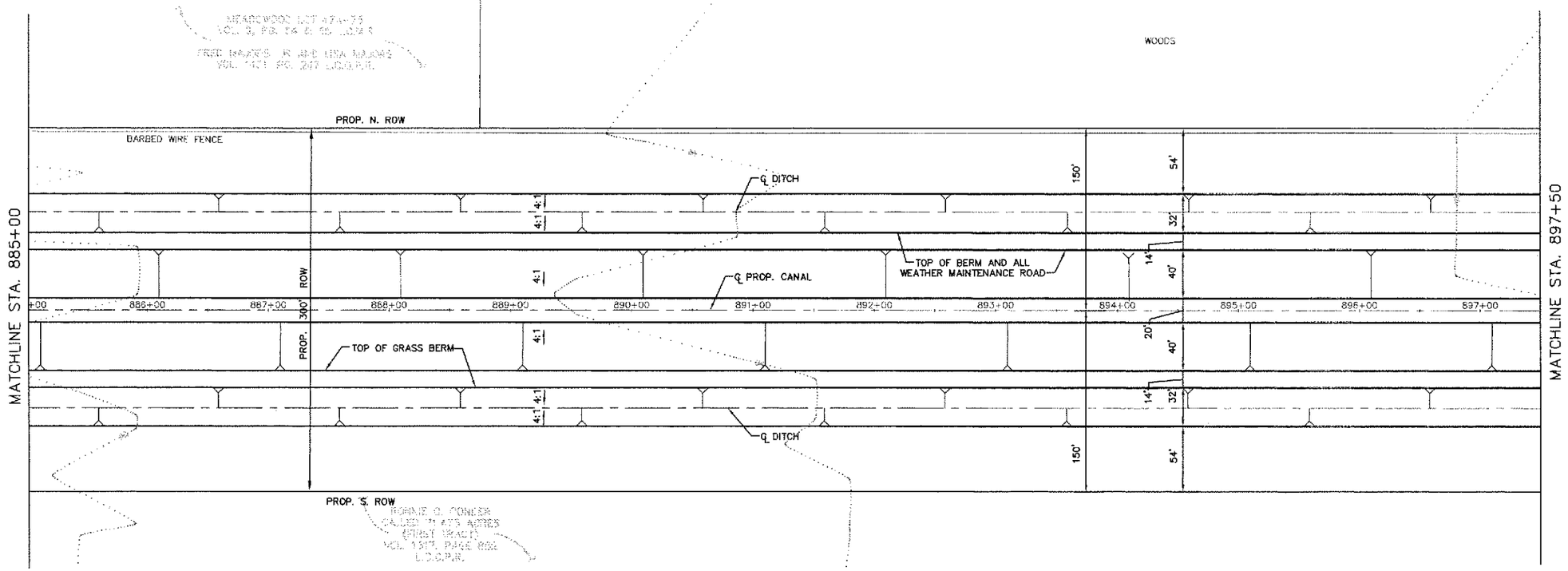
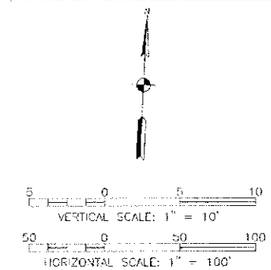
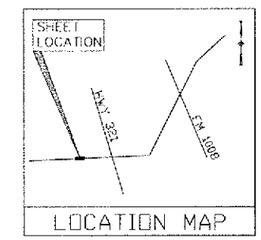
DWG. NAME: CanalP&P72.dwg

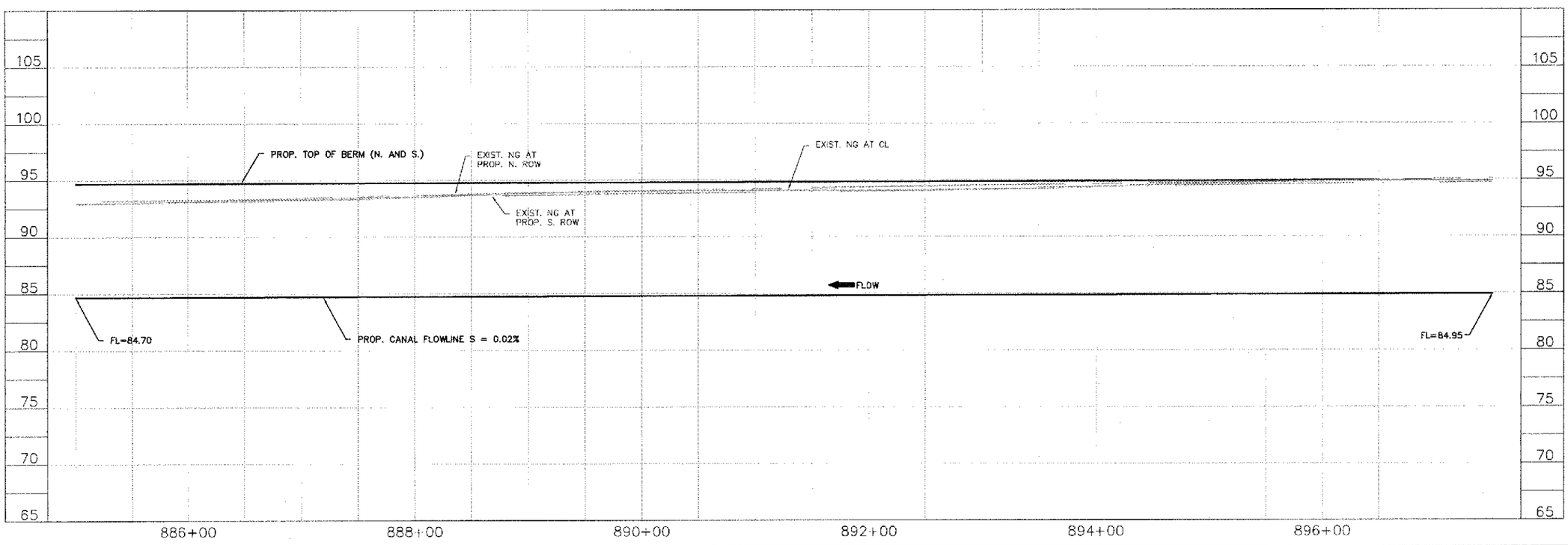




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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AECOM
AECOM TECHNICAL SERVICES, INC.
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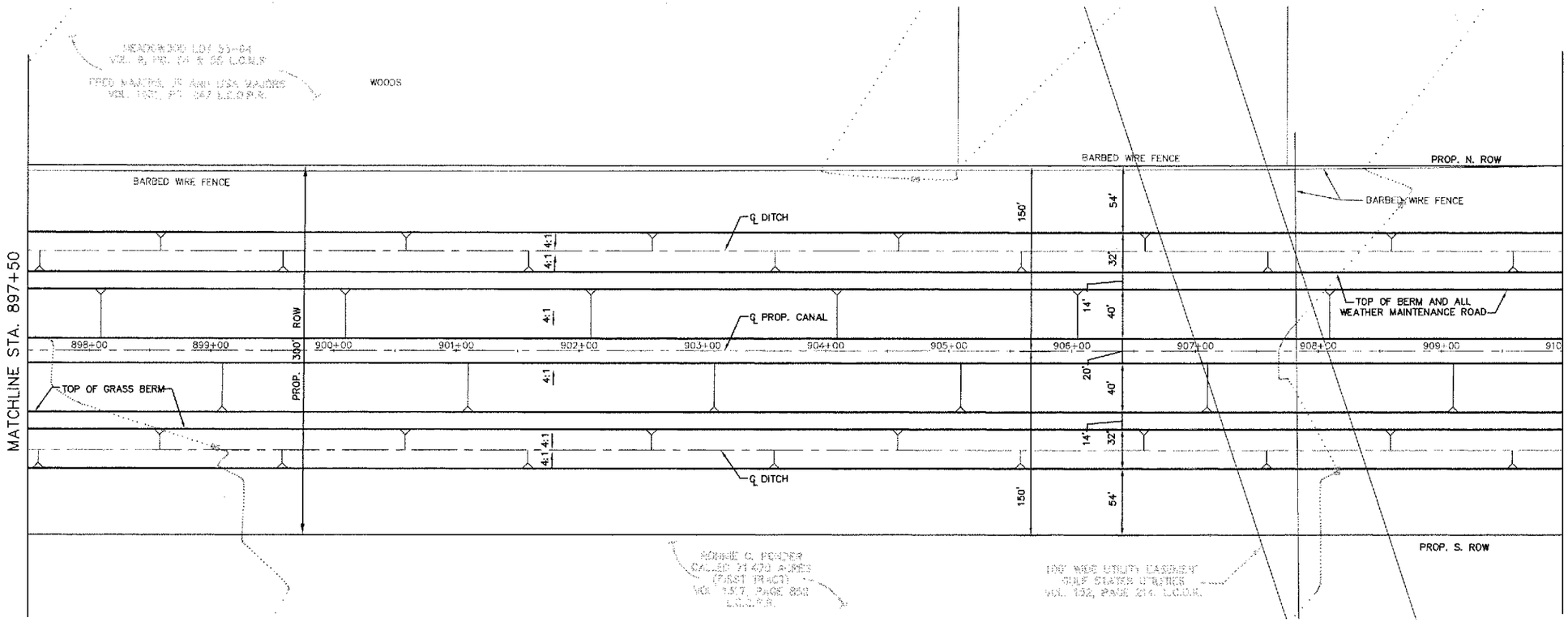
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

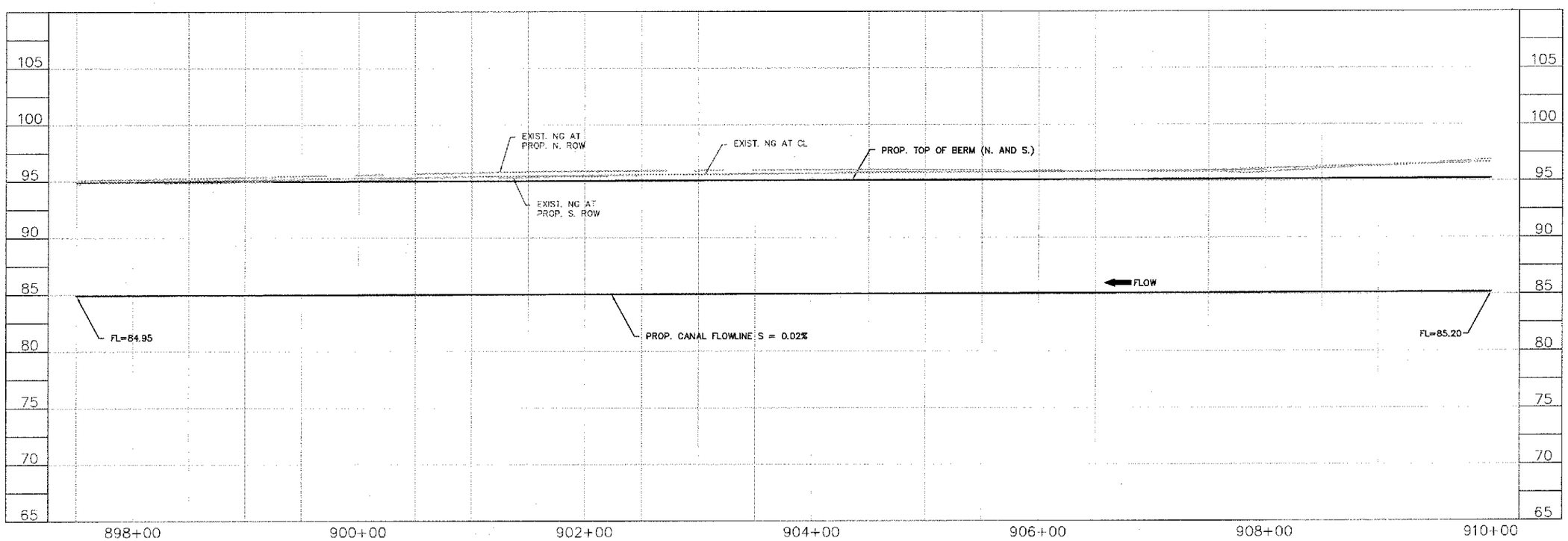
CANAL PLAN &
PROFILE STA 885+00
TO STA 897+50

DRAWING SCALE
AS SHOWN

SHEET NO. 167 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:28pm BY USER: Thompson91
DWG. LOCATION: D:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P73.dwg



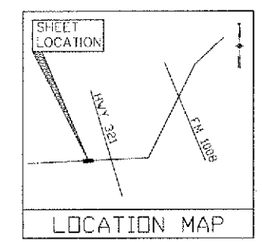


VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
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AECOM

AECOM TECHNICAL SERVICES, INC.
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HOUSTON, TEXAS 77057
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713.780.0838 fax.

SURVEYED BY:
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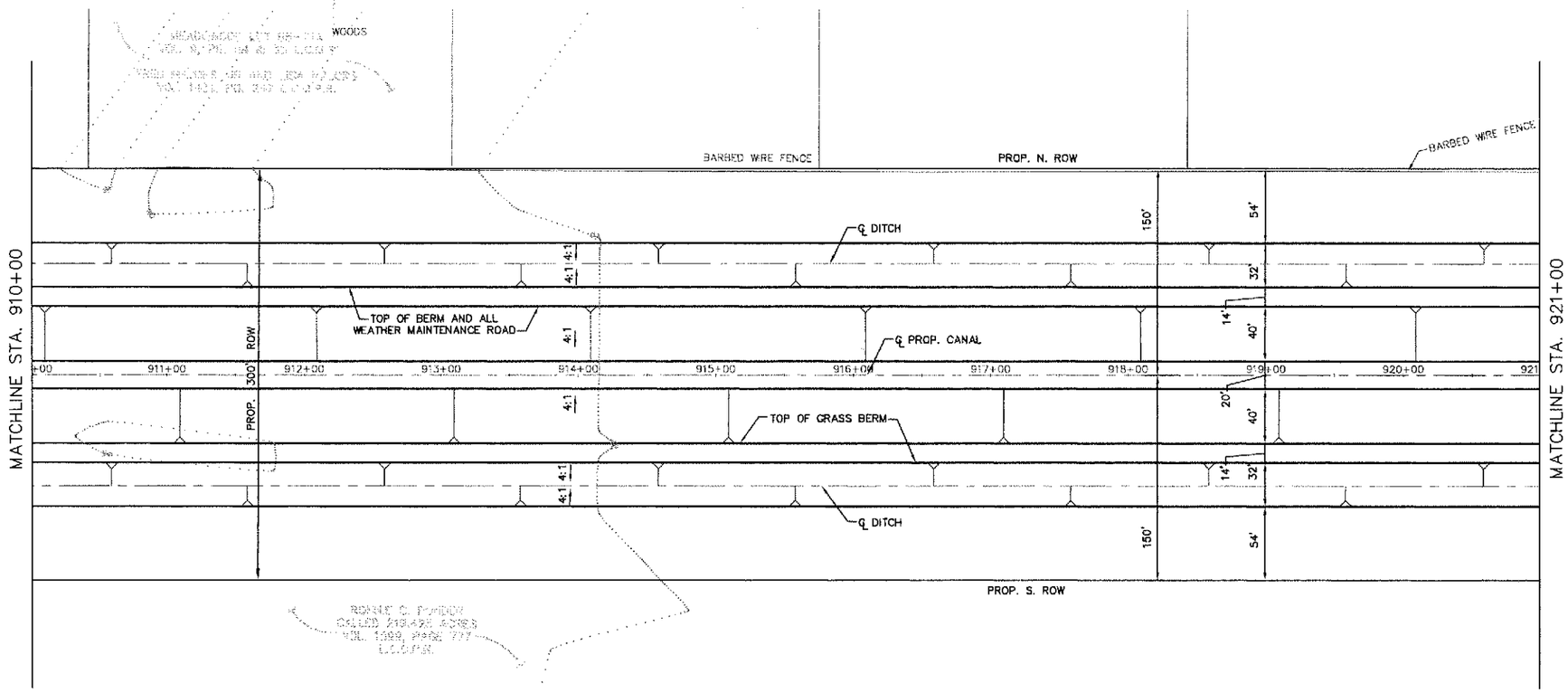
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

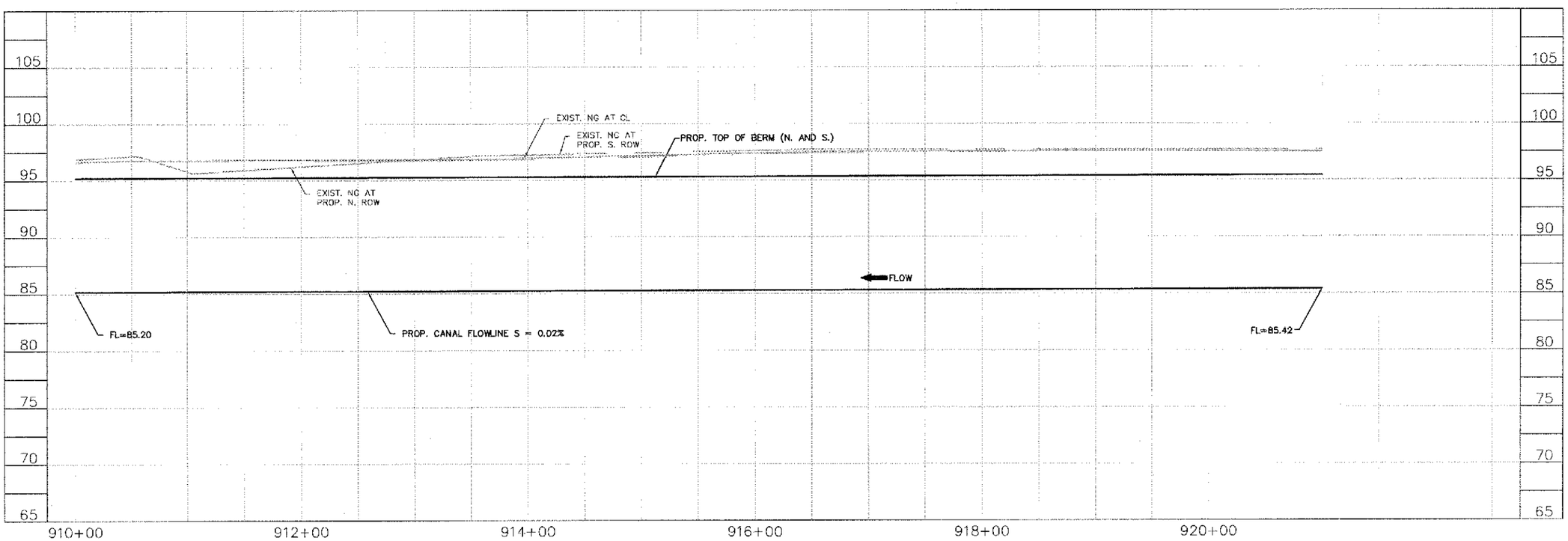
CANAL PLAN & PROFILE STA 897+50 TO STA 910+00

DRAWING SCALE
AS SHOWN

SHEET NO. 108 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:29pm BY USER: ThompsonBi
DWG. LOCATION: O:\Work Order 6\1.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWO\Sheets\
DWG. NAME: CanalP&P74.dwg

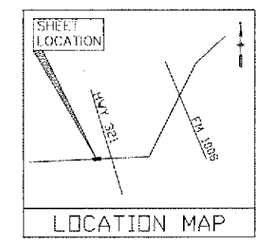




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

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713.780.0838 fax.

SURVEYED BY:
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COASTAL WATER AUTHORITY

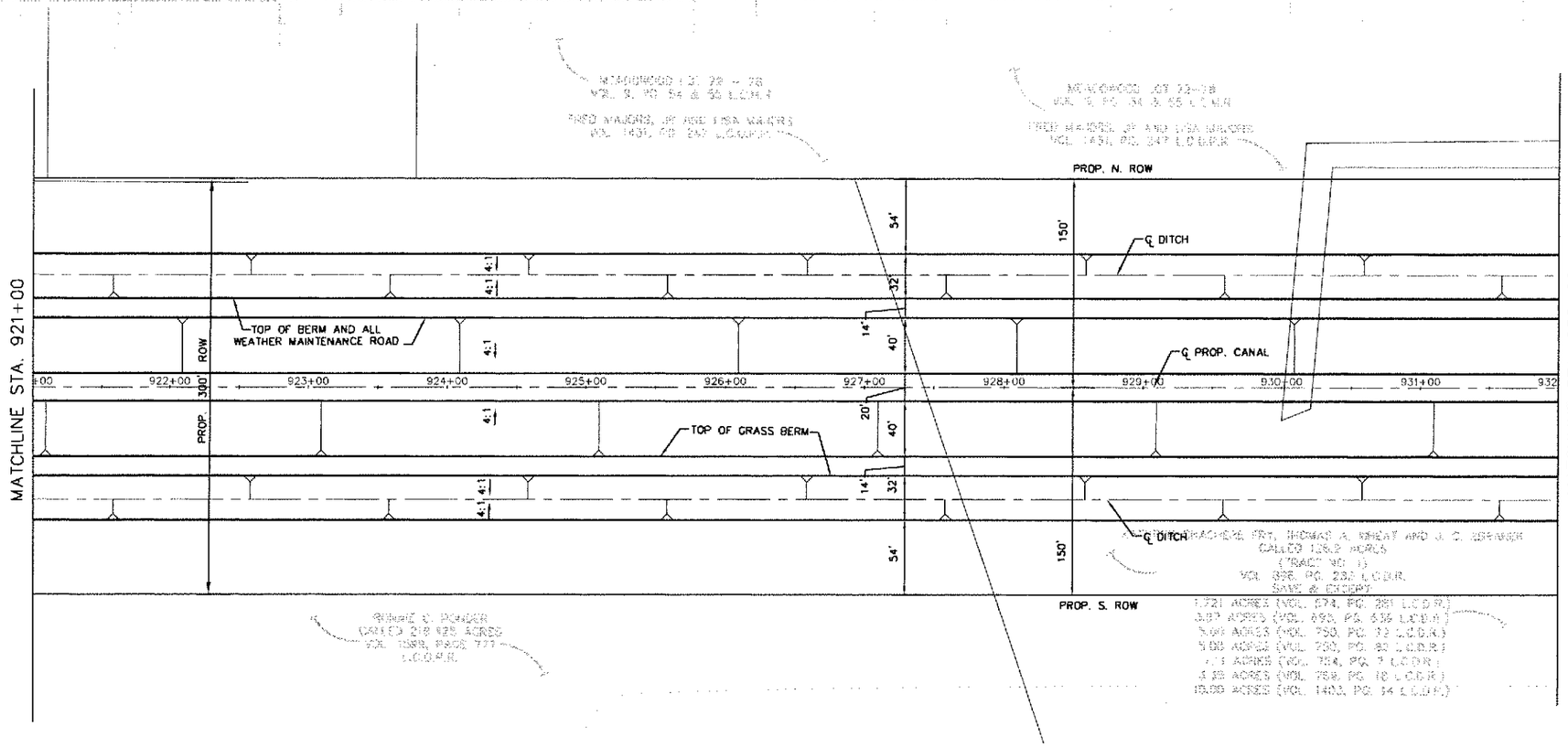
LUCE BAYOU INTERBASIN TRANSFER PROJECT

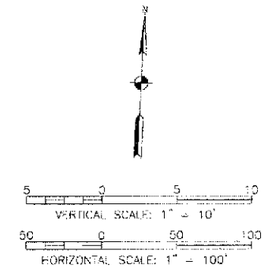
CANAL PLAN & PROFILE STA 910+00 TO STA 921+00

DRAWING SCALE
AS SHOWN

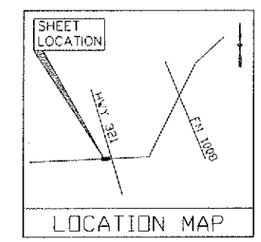
SHEET NO. 109 OF 245

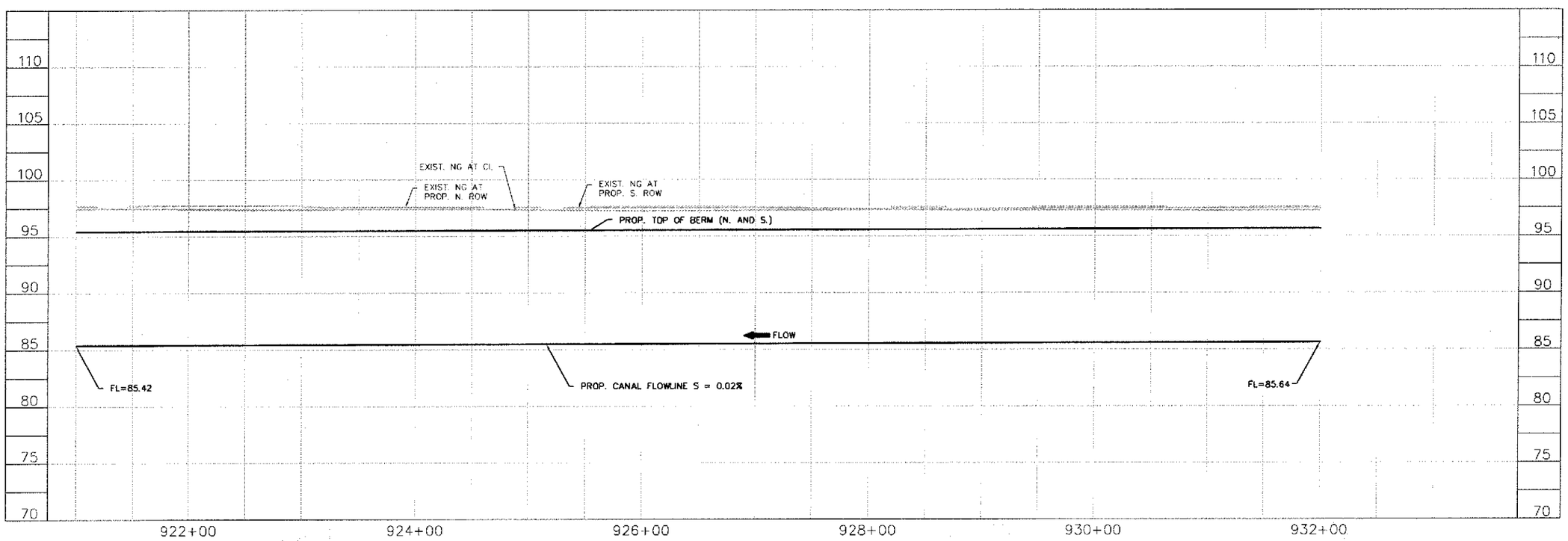
LAST MODIFIED: Jan 27, 2011 – 4:29pm BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 6\V4.0 ENGINEERING NOTES & CALCULATIONS\V4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: Canal P&P75.dwg





NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN





KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1599
WWW.AECOM.COM
TBPE REG. NO. F-1580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

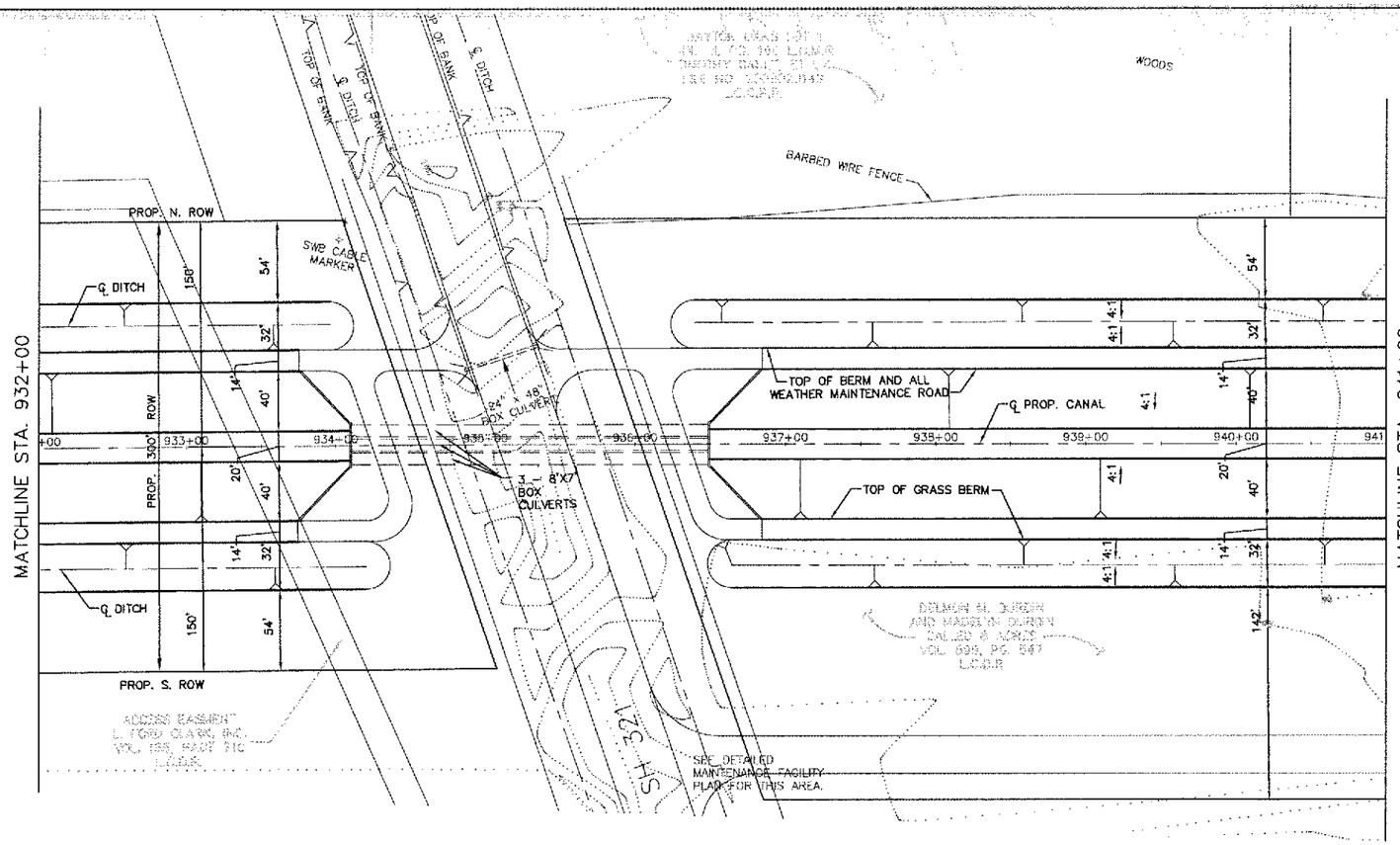
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

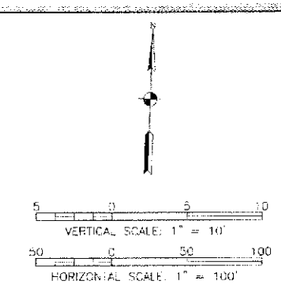
CANAL PLAN & PROFILE STA 921+00 TO STA 932+00

DRAWING SCALE
AS SHOWN

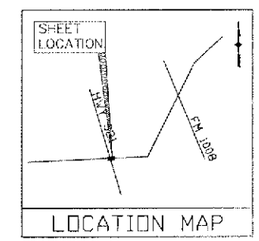
SHEET NO. 110 OF 295

LAST MODIFIED: Jan 28, 2011 - 6:37am BY USER: ThompsonBl
DWG. LOCATION: G:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalPlnPr76.dwg

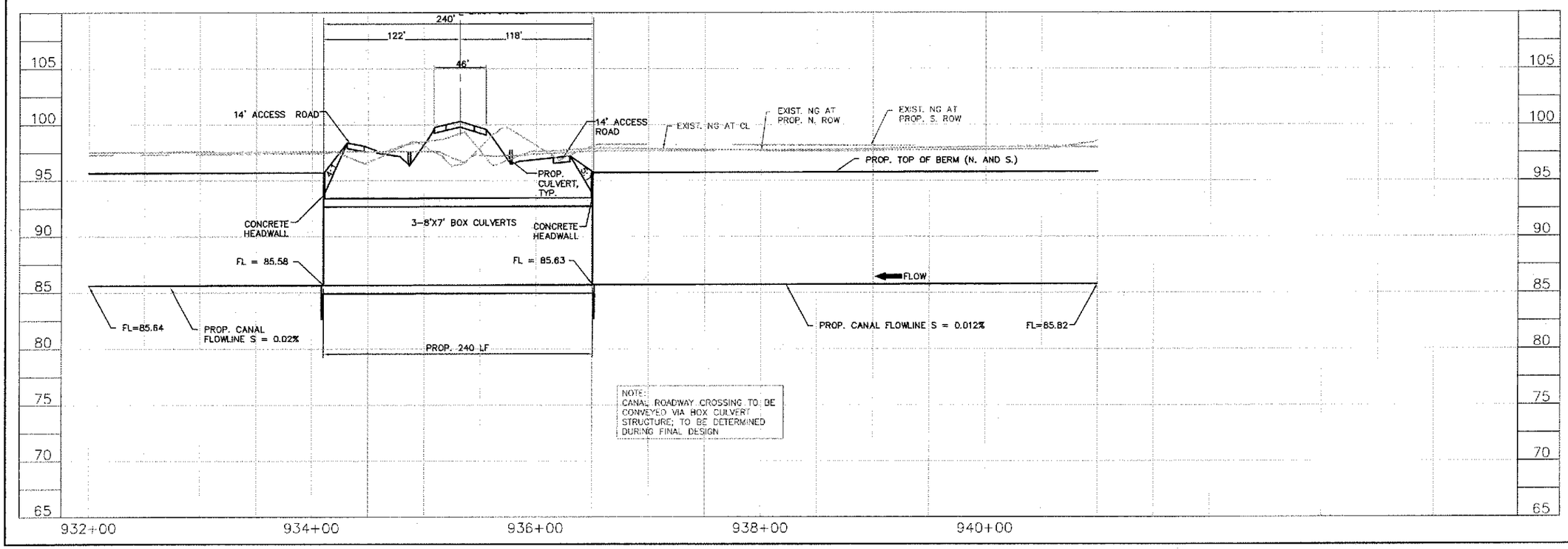




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



NOTE:
CANAL ROADWAY CROSSING TO BE CONVEYED VIA BOX CULVERT STRUCTURE; TO BE DETERMINED DURING FINAL DESIGN

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

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713.780.0838 fax.

SURVEYED BY:
FB NO.

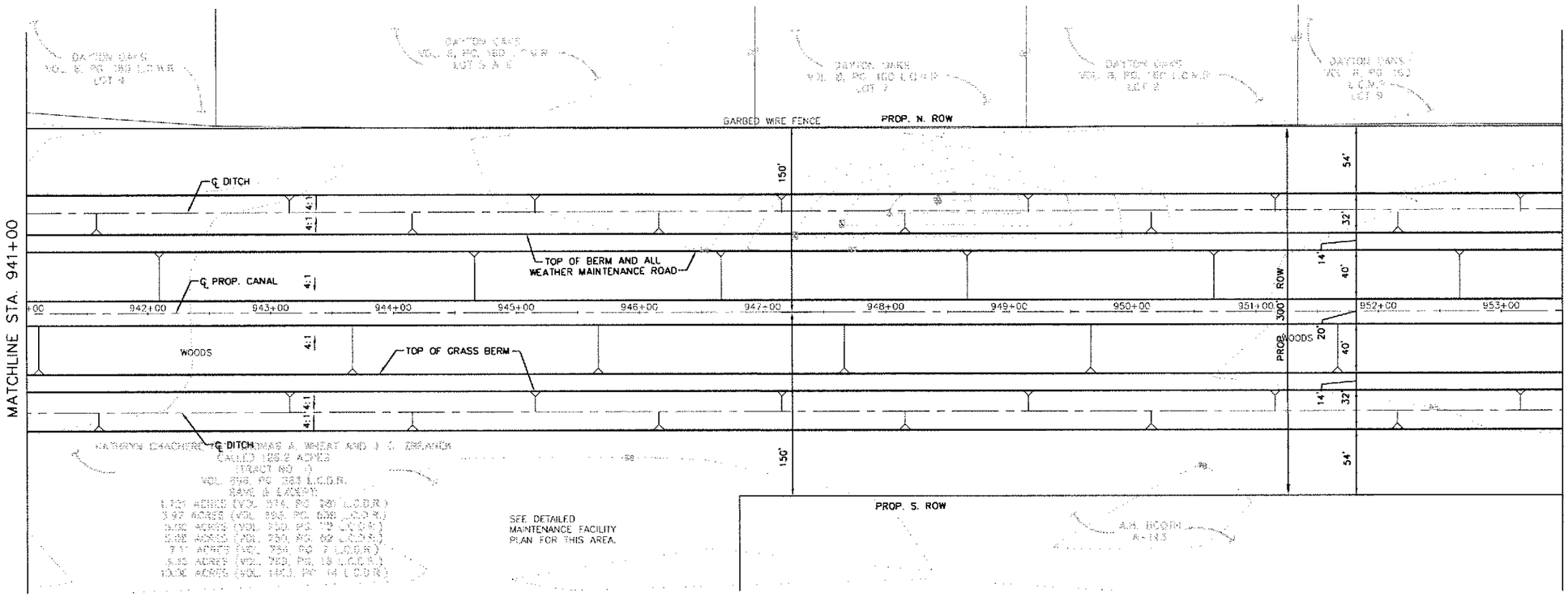
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN &
PROFILE STA 932+00
TO STA 941+00

DRAWING SCALE
AS SHOWN

SHEET NO. 111 OF 245

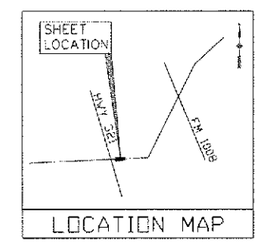
LAST MODIFIED: Jan 27, 2011 - 4:32pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P77.dwg



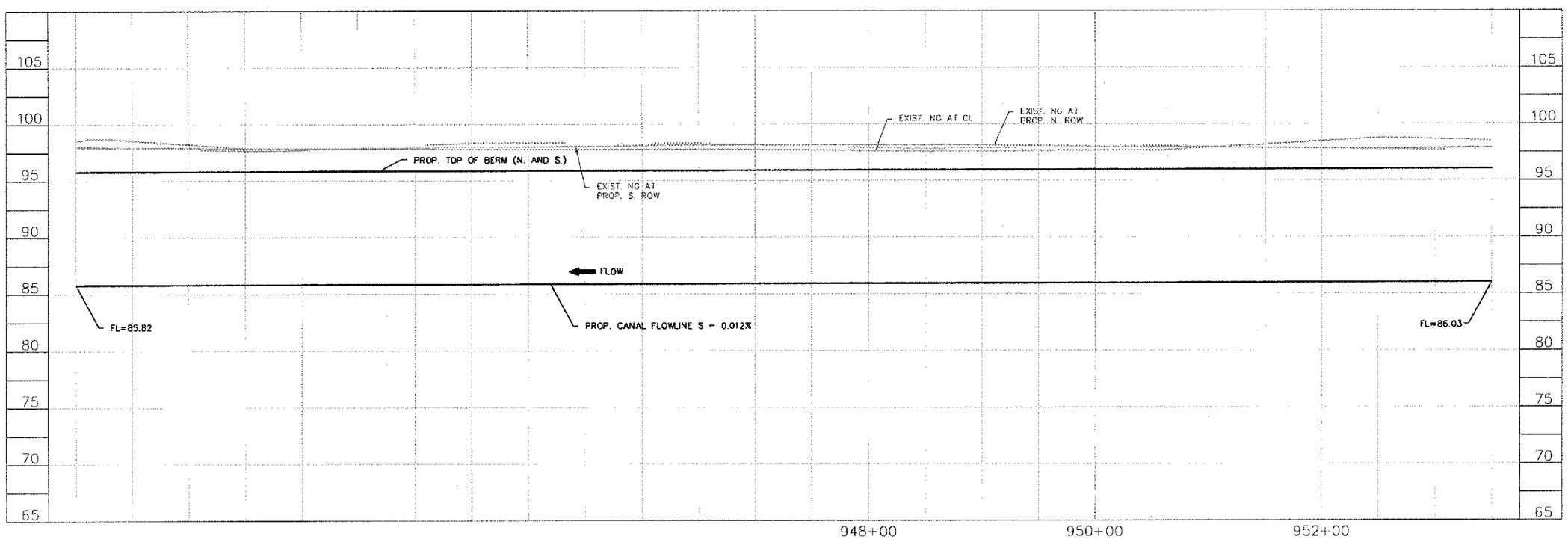
VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
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HOUSTON, TEXAS 77057
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713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

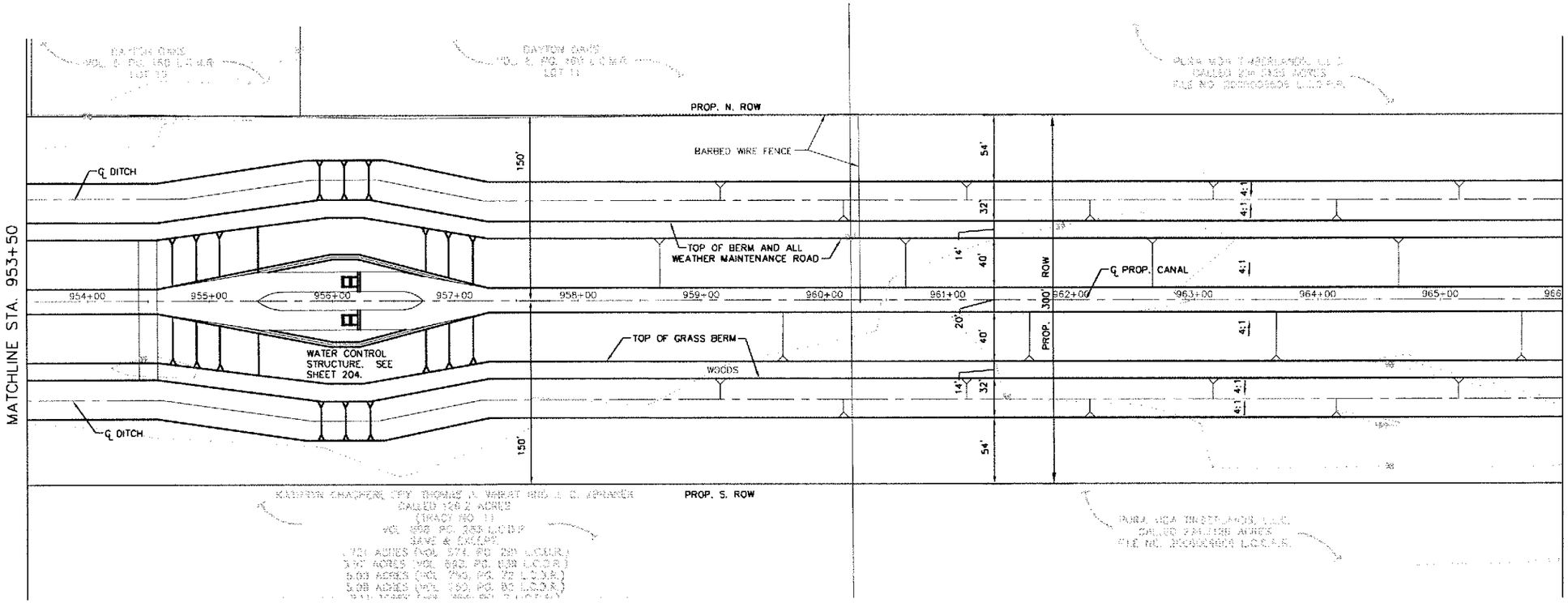
LUCE BAYOU INTERBASIN TRANSFER PROJECT

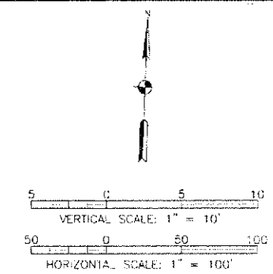
CANAL PLAN & PROFILE STA 941+00 TO STA 953+50

DRAWING SCALE
AS SHOWN

SHEET NO. 112 OF 245

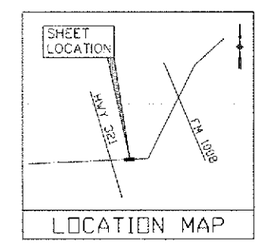
LAST MODIFIED: Jan 27, 2011 - 4:33pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: Canal P&P78.dwg



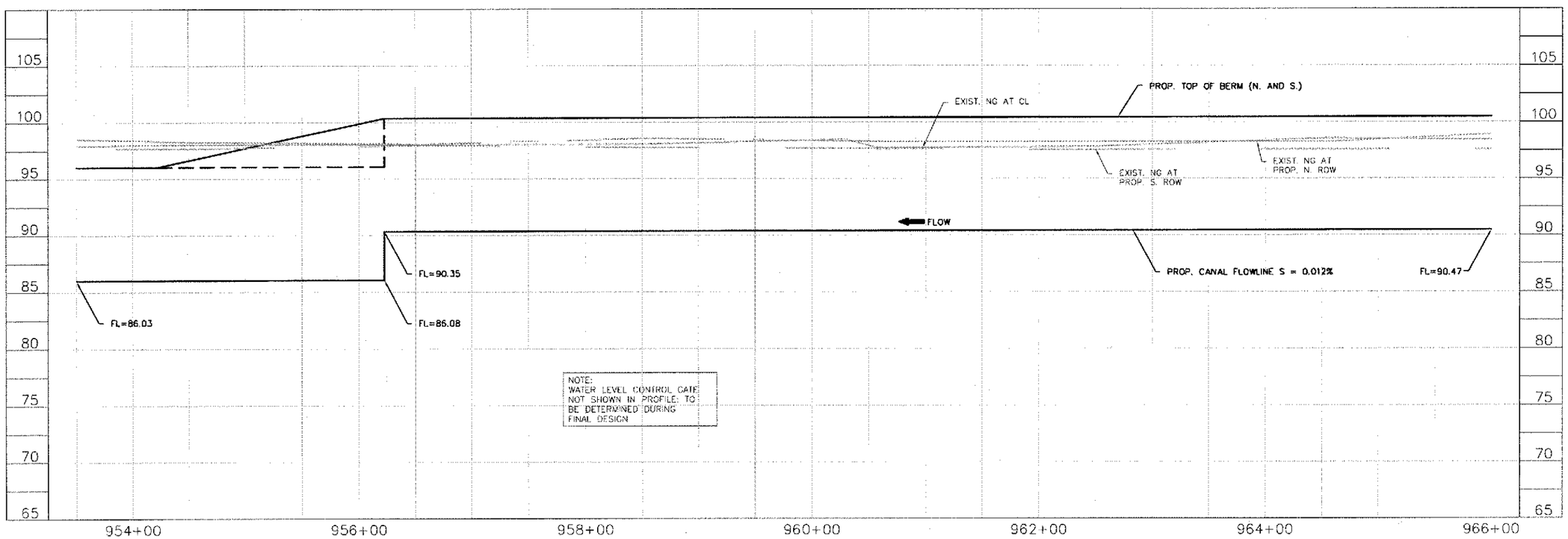


NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP



NOTE:
WATER LEVEL CONTROL GATE NOT SHOWN IN PROFILE; TO BE DETERMINED DURING FINAL DESIGN

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
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AECOM

AECOM TECHNICAL SERVICES, INC.
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HOUSTON, TEXAS 77057-1999
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713.780.0838 fax.

SURVEYED BY:
FB NO.

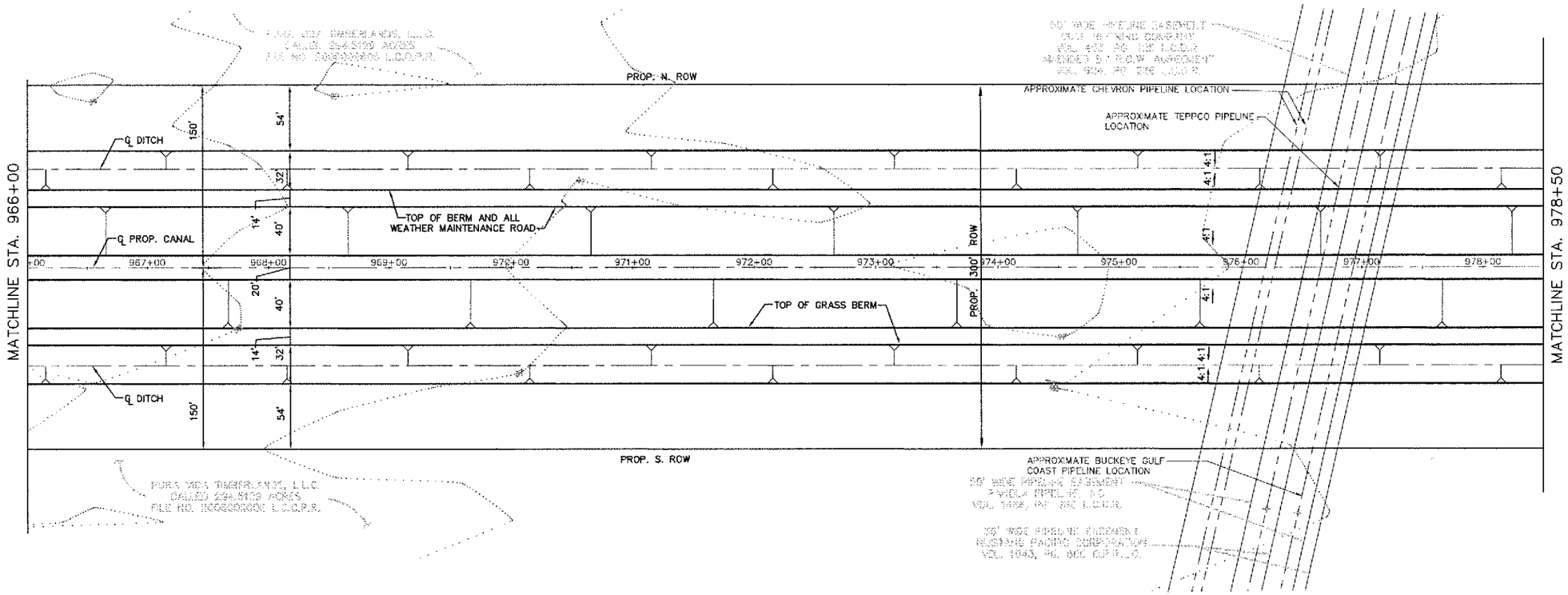
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

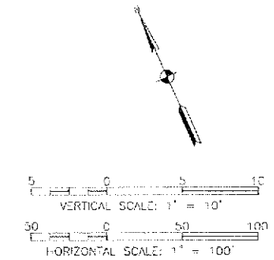
CANAL PLAN &
PROFILE STA 953+50
TO STA 966+00

DRAWING SCALE
AS SHOWN

SHEET NO. 113 OF 245

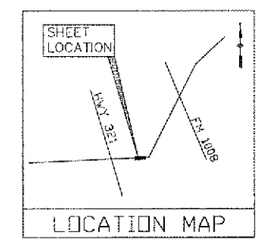
LAST MODIFIED: Jan 27, 2011 - 4:34pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P79.dwg

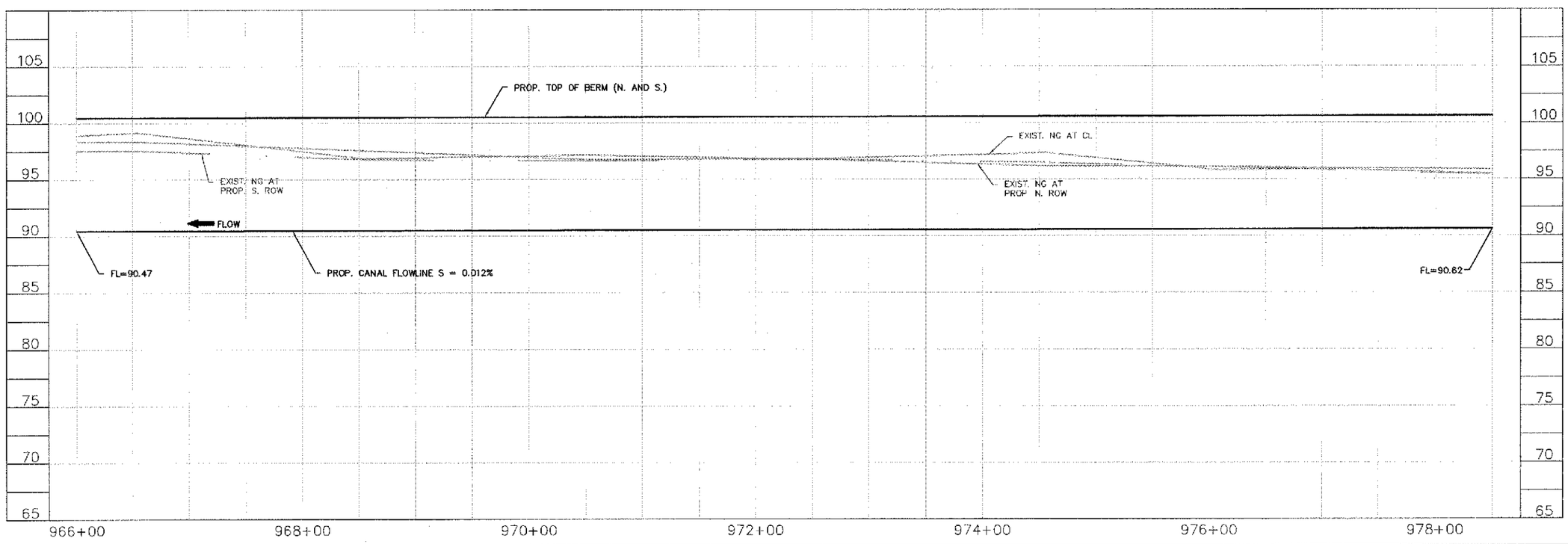




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.





KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
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713.780.0838 fax.

SURVEYED BY:
FB NO.

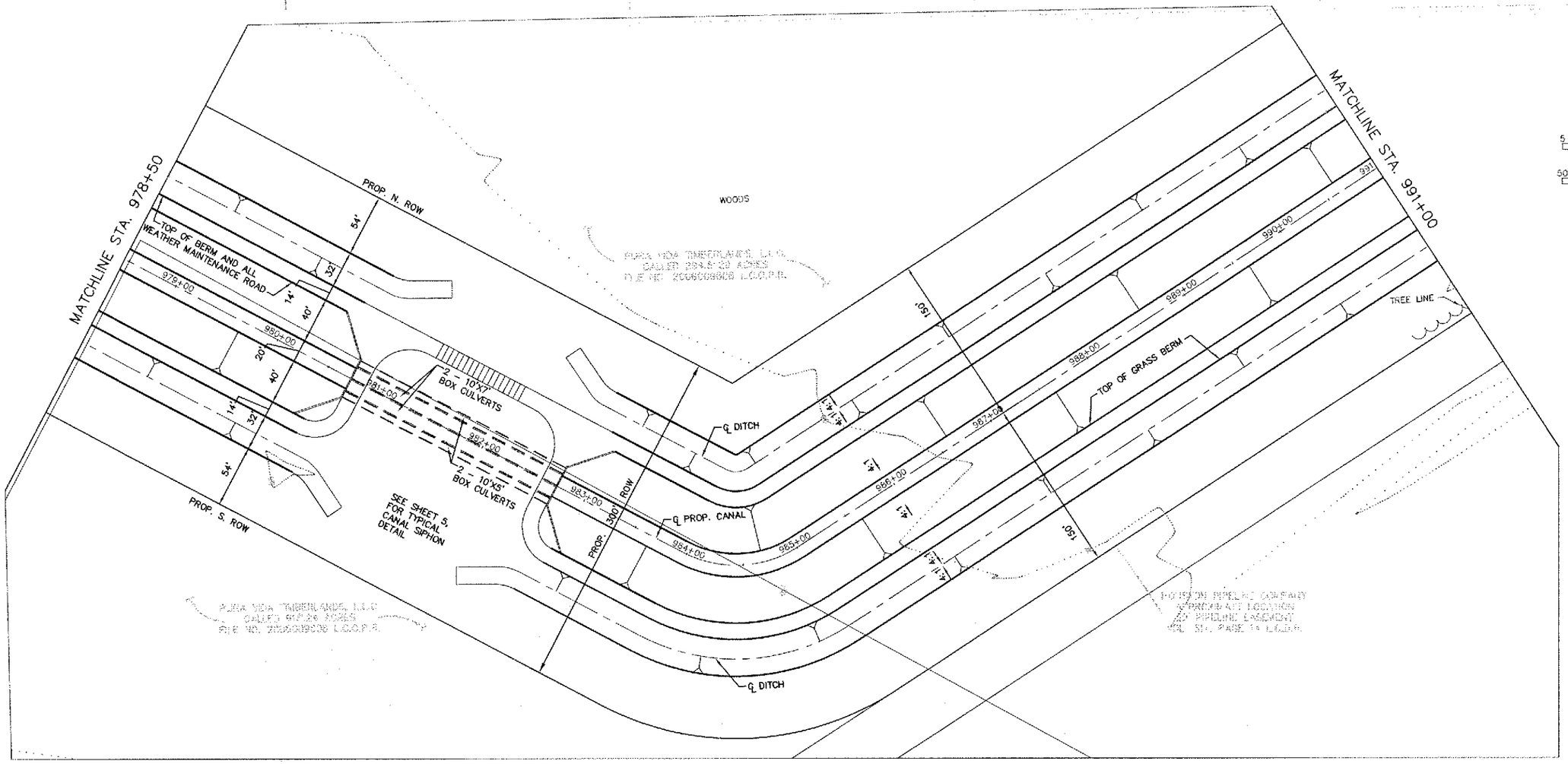
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

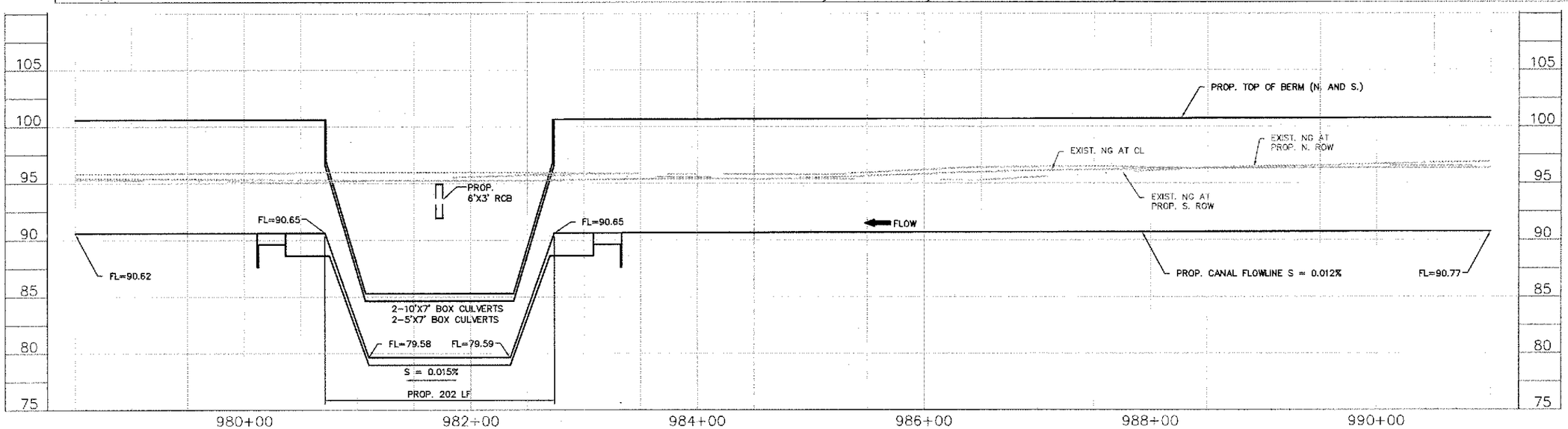
CANAL PLAN & PROFILE STA 966+00 TO STA 978+50

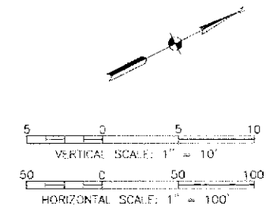
DRAWING SCALE
AS SHOWN

SHEET NO. 114 OF 245

LAST MODIFIED: Jan 27, 2011 – 4:38pm BY USER: ThompsonBl
DWG LOCATION: O:\Work Order 6\4.3 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG NAME: CanalP&P50.dwg

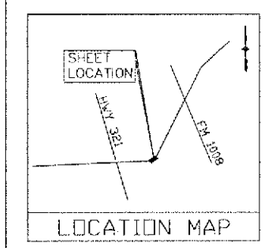






NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

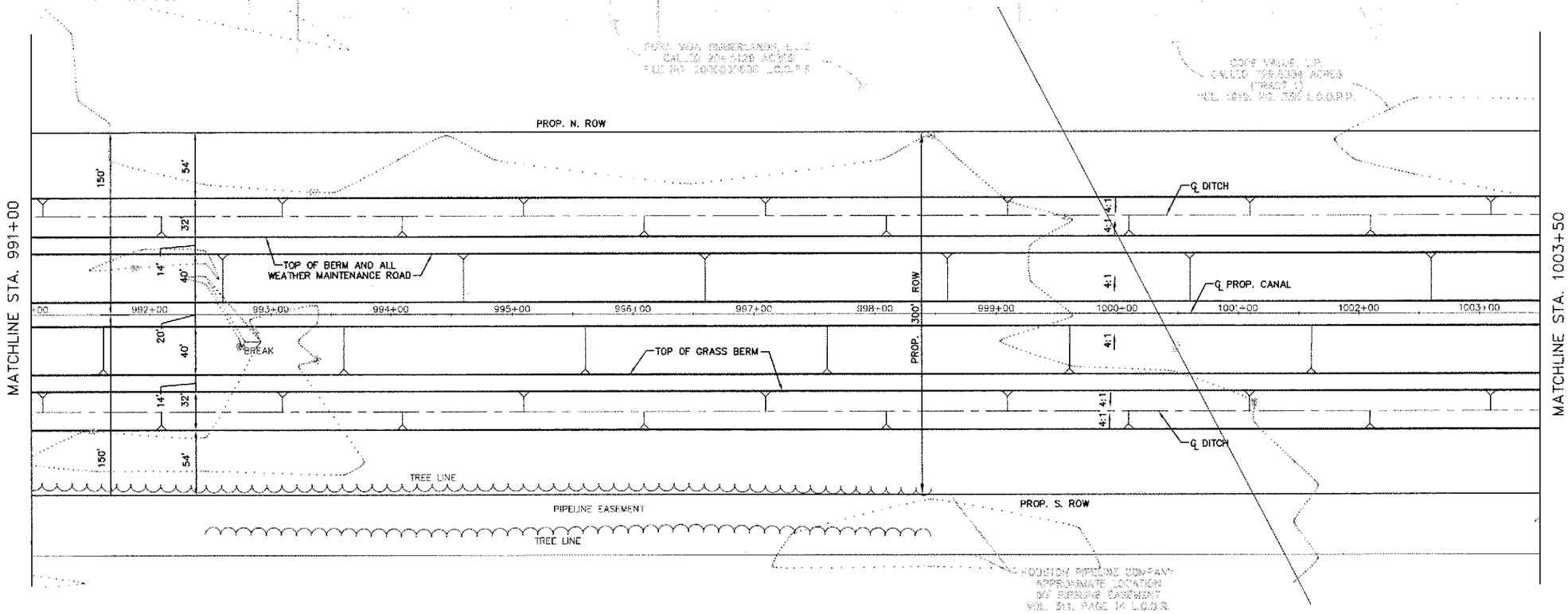
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

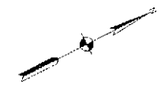
CANAL PLAN &
PROFILE STA 978+50
TO STA 991+00

DRAWING SCALE
AS SHOWN

SHEET NO. 115 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:36pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P81.dwg



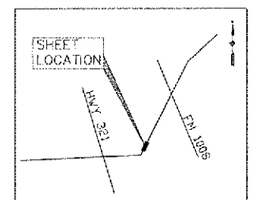


VERTICAL SCALE: 1" = 10'

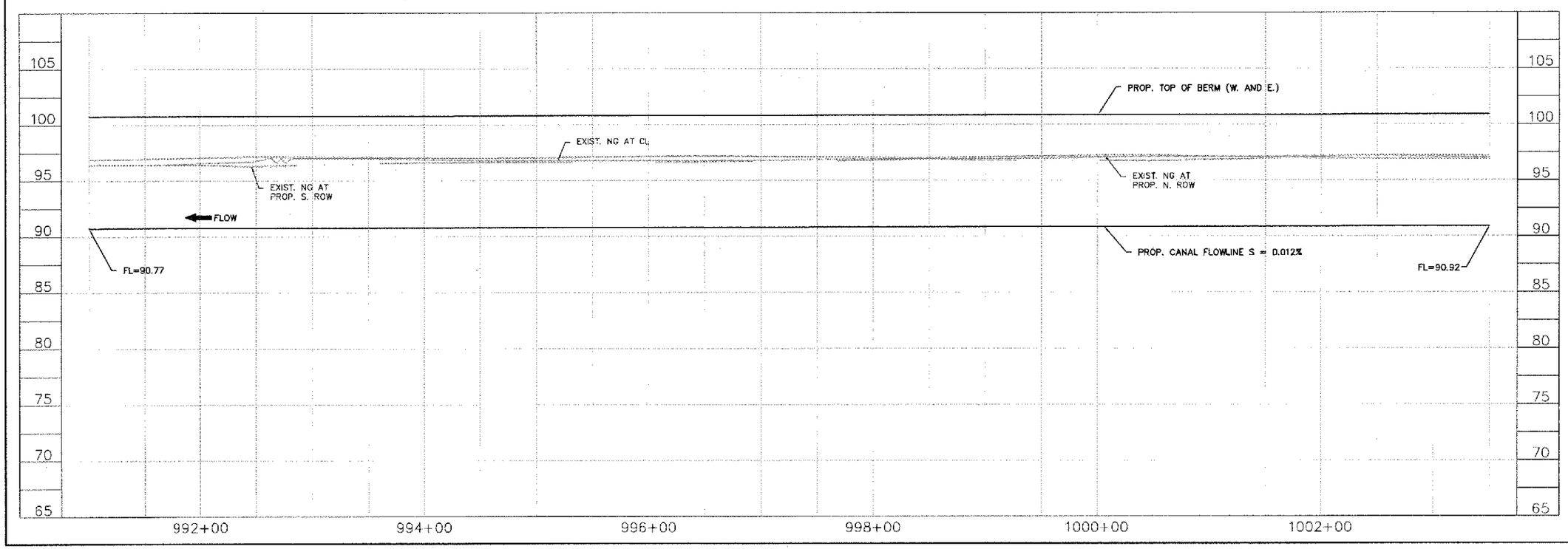
HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1599
WWW.AECOM.COM
TBPE REG. NO. F-5580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

CWA

COASTAL WATER AUTHORITY

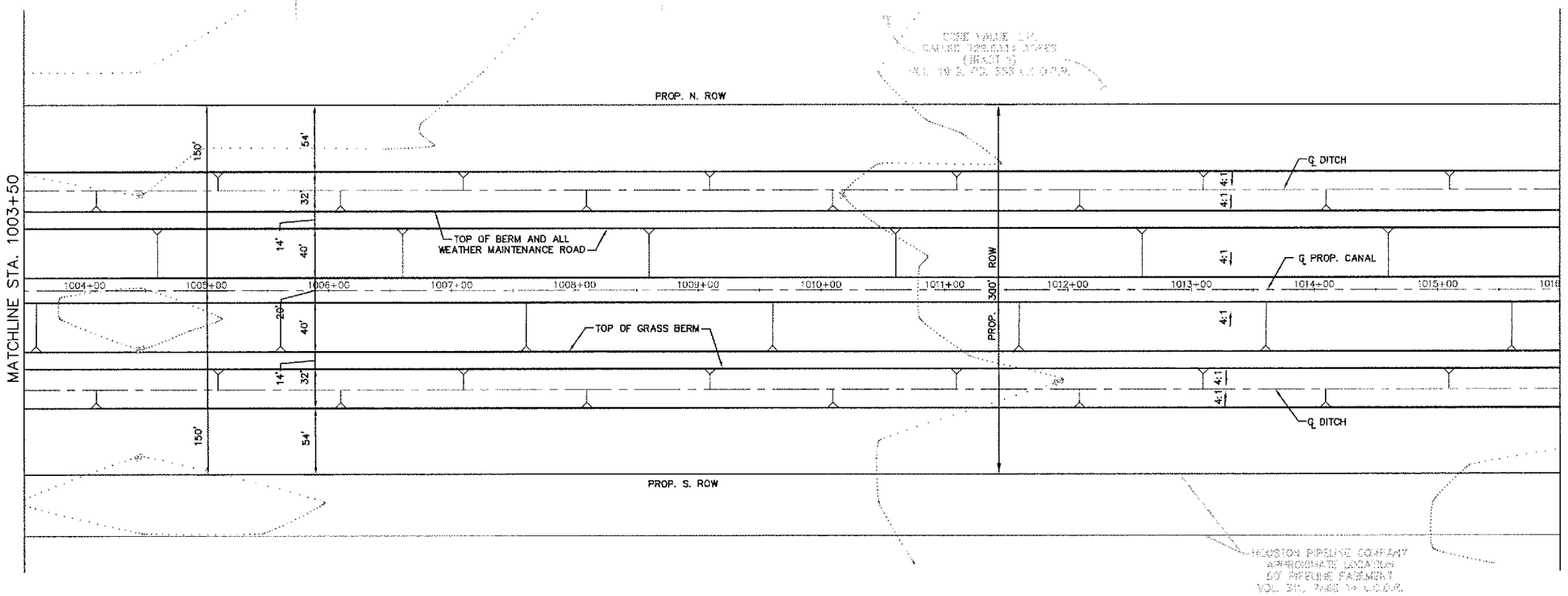
LUCE BAYOU INTERBASIN TRANSFER PROJECT

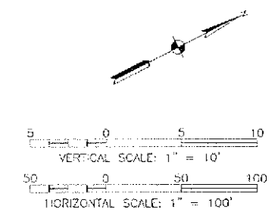
CANAL PLAN &
PROFILE STA 991+00
TO STA 1003+50

DRAWING SCALE
AS SHOWN

SHEET NO. 116 OF 295

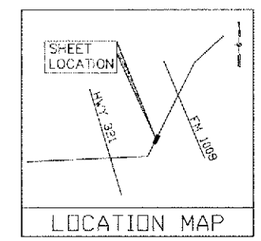
LAST MODIFIED: Jan 27, 2011 – 4:37am BY USER: Thompson51
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: Canal P&P82.dwg



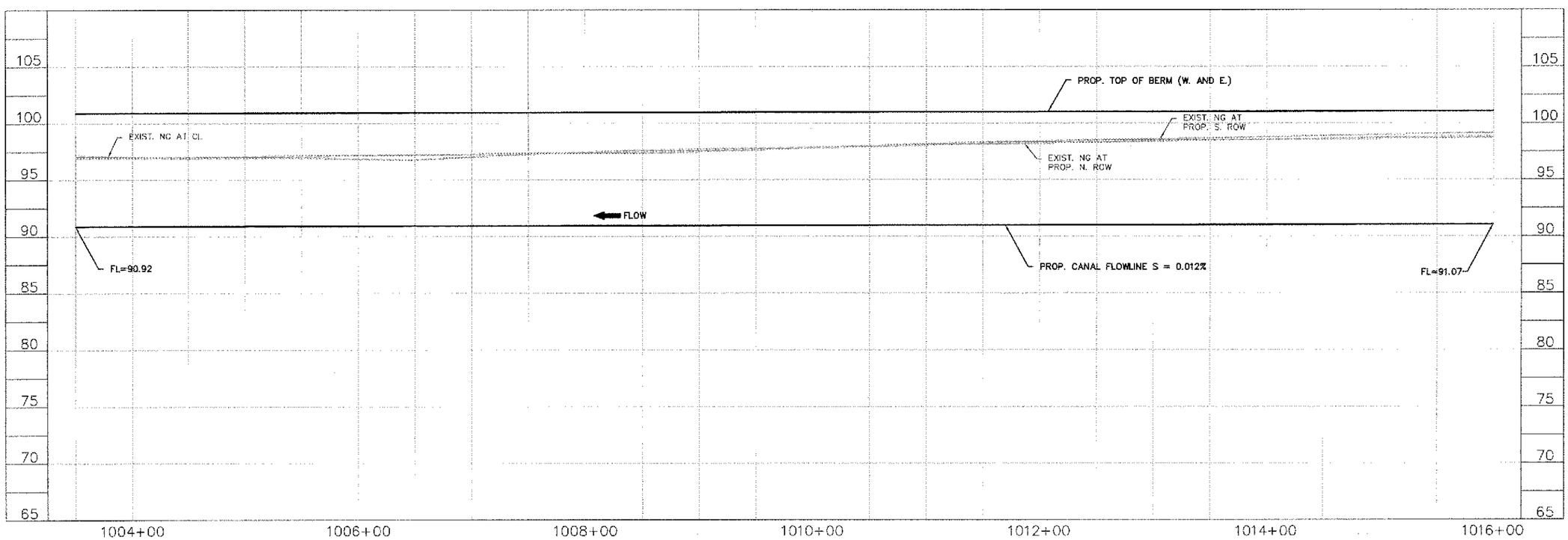


NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1509
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TBPE REGN. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

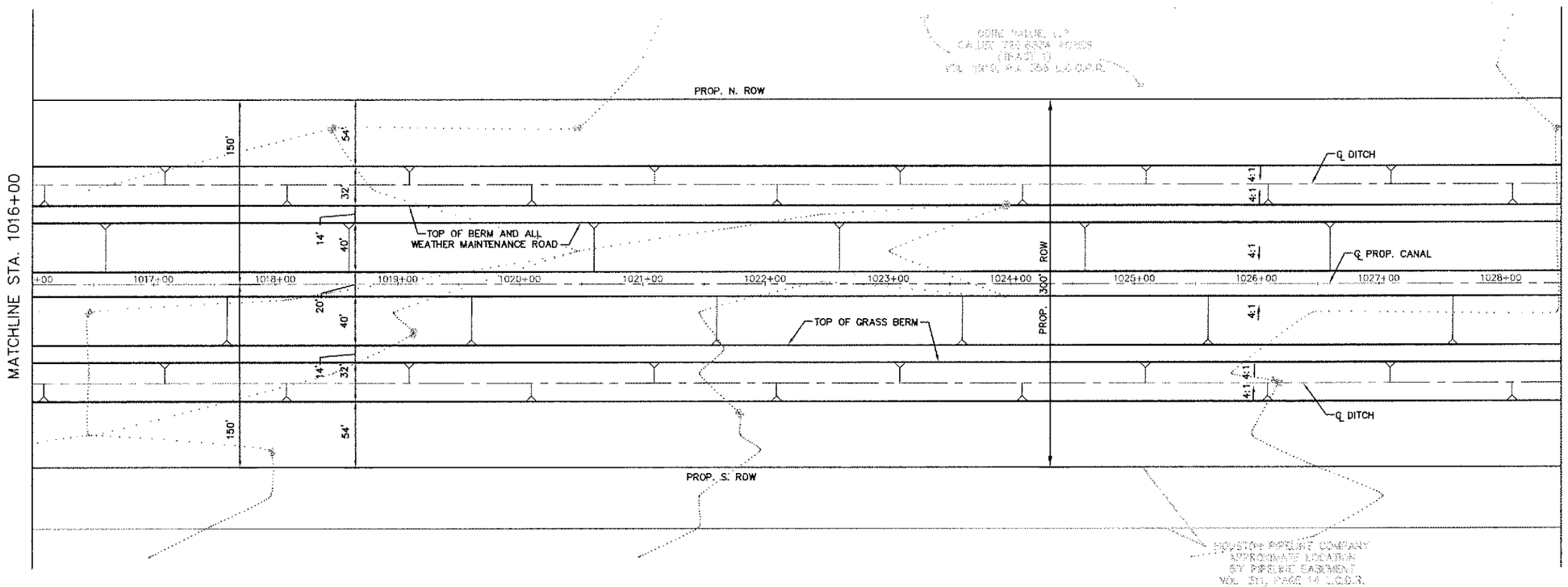
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

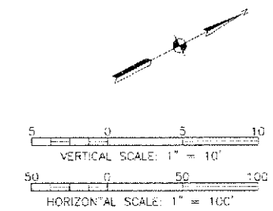
CANAL PLAN &
PROFILE STA 1003+50
TO STA 1016+00

DRAWING SCALE
AS SHOWN

SHEET NO. 117 OF 245

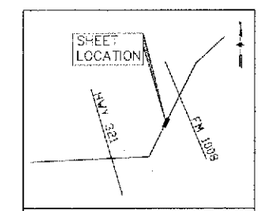
LAST MODIFIED: Jan 27, 2011 – 4:37pm BY USER: ThompsonBl
DWG LOCATION: D:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: Canal P&PB3.dwg



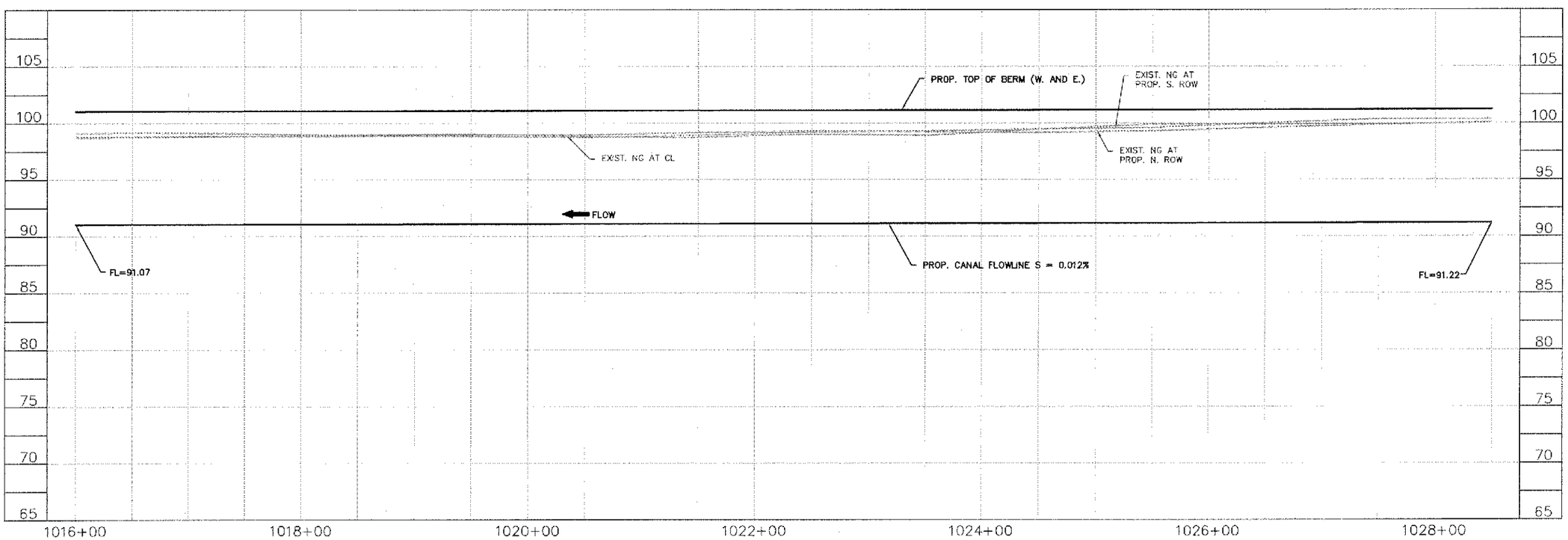


NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

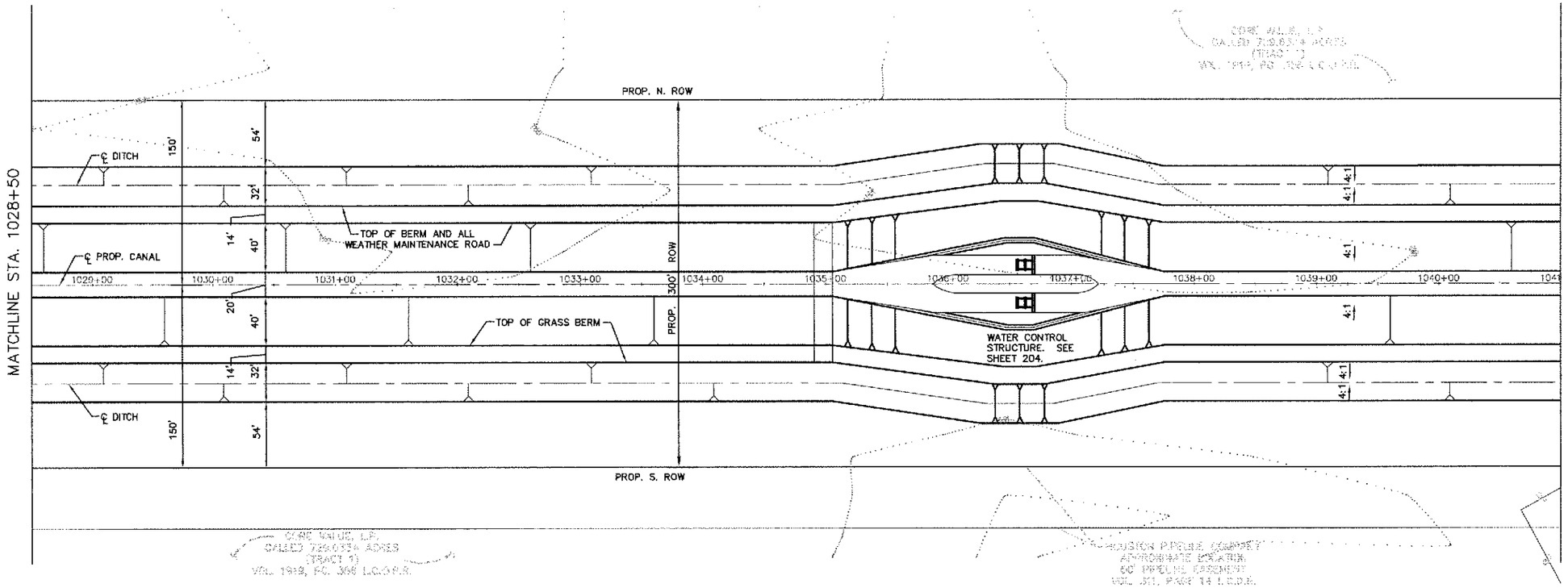
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

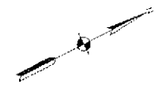
CANAL PLAN &
PROFILE STA 1016+00
TO STA 1028+50

DRAWING SCALE
AS SHOWN

SHEET NO. 118 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:38pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&PB4.dwg



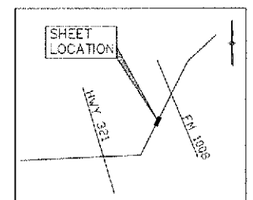


VERTICAL SCALE: 1" = 10'

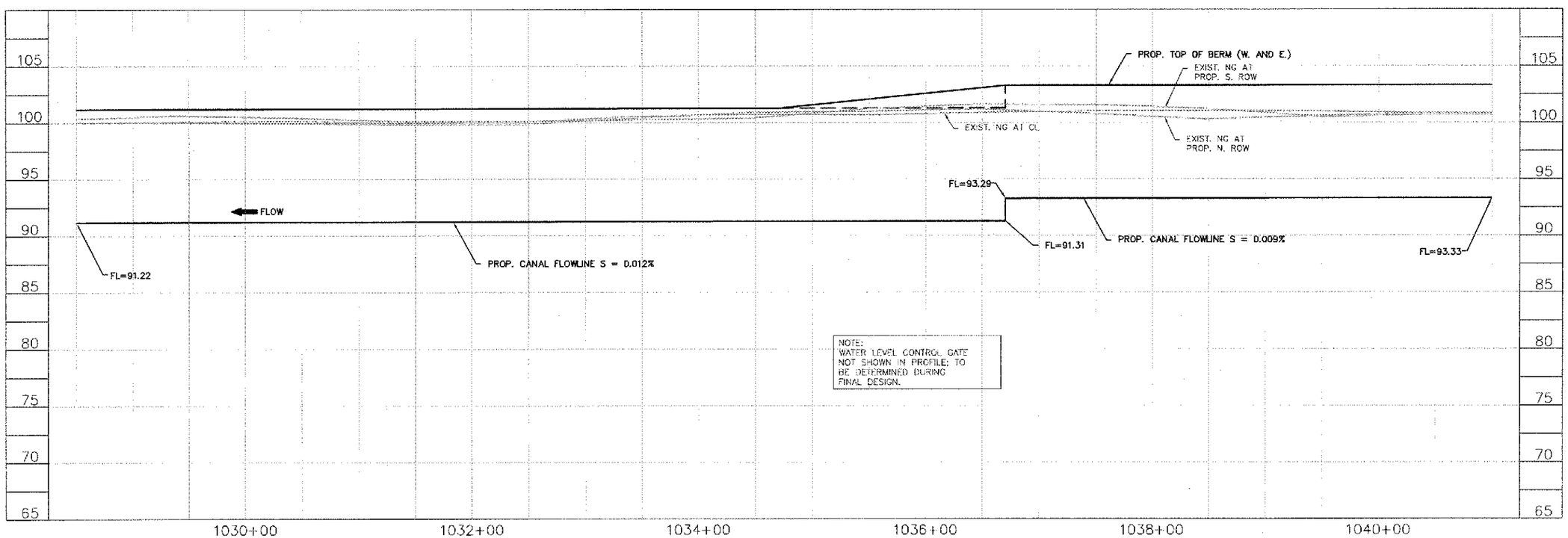
HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP



NOTE:
WATER LEVEL CONTROL GATE NOT SHOWN IN PROFILE; TO BE DETERMINED DURING FINAL DESIGN.

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031

INTERIM SUBMITTAL
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AECOM
AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1599
WWW.AECOM.COM
TBPE REG. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

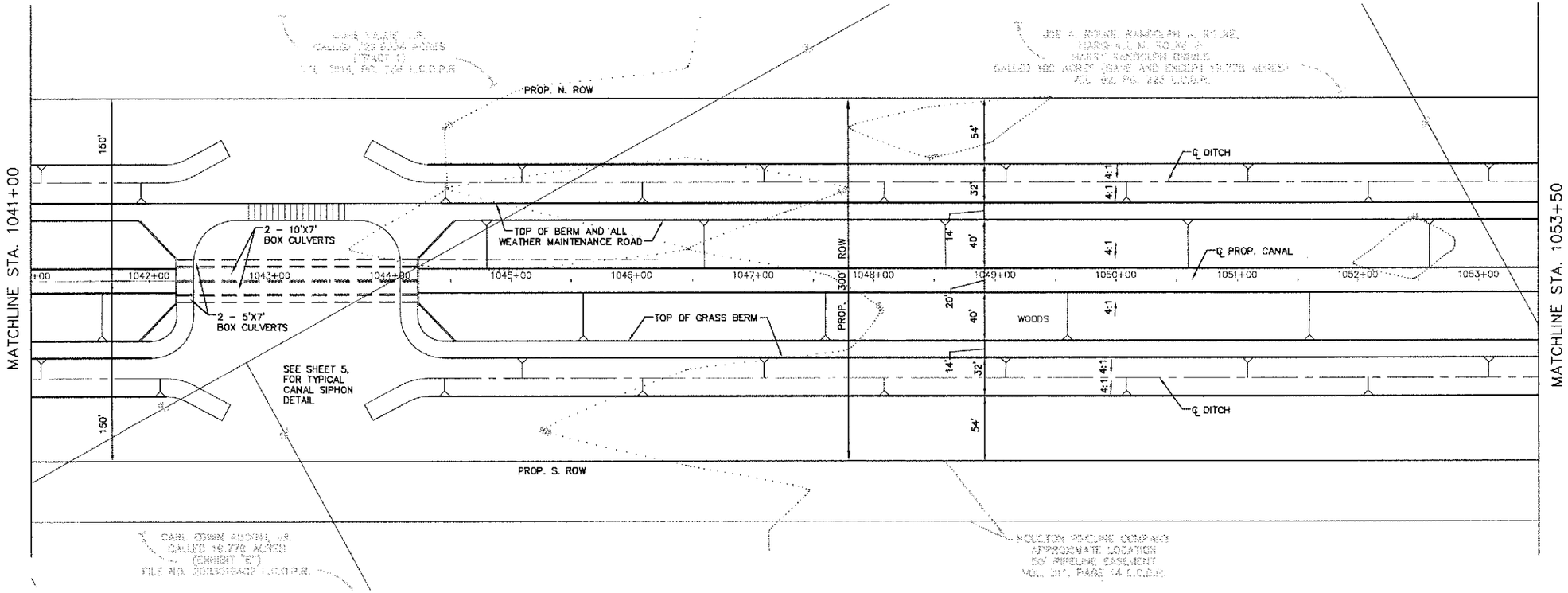
COASTAL WATER AUTHORITY

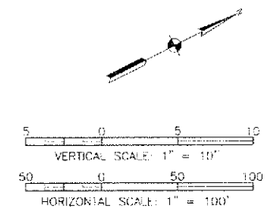
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN & PROFILE STA 1028+50 TO STA 1041+00

DRAWING SCALE
AS SHOWN

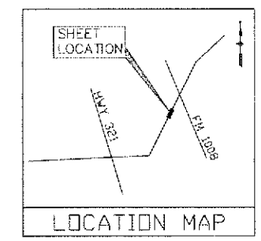
LAST MODIFIED: Jan 27, 2011 – 4:38pm BY USER: ThompsonBl
DWG LOCATION: G:\Work Order G\4.3 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Code\PWD\Sheets\
DWG. NAME: CanalP&P85.dwg

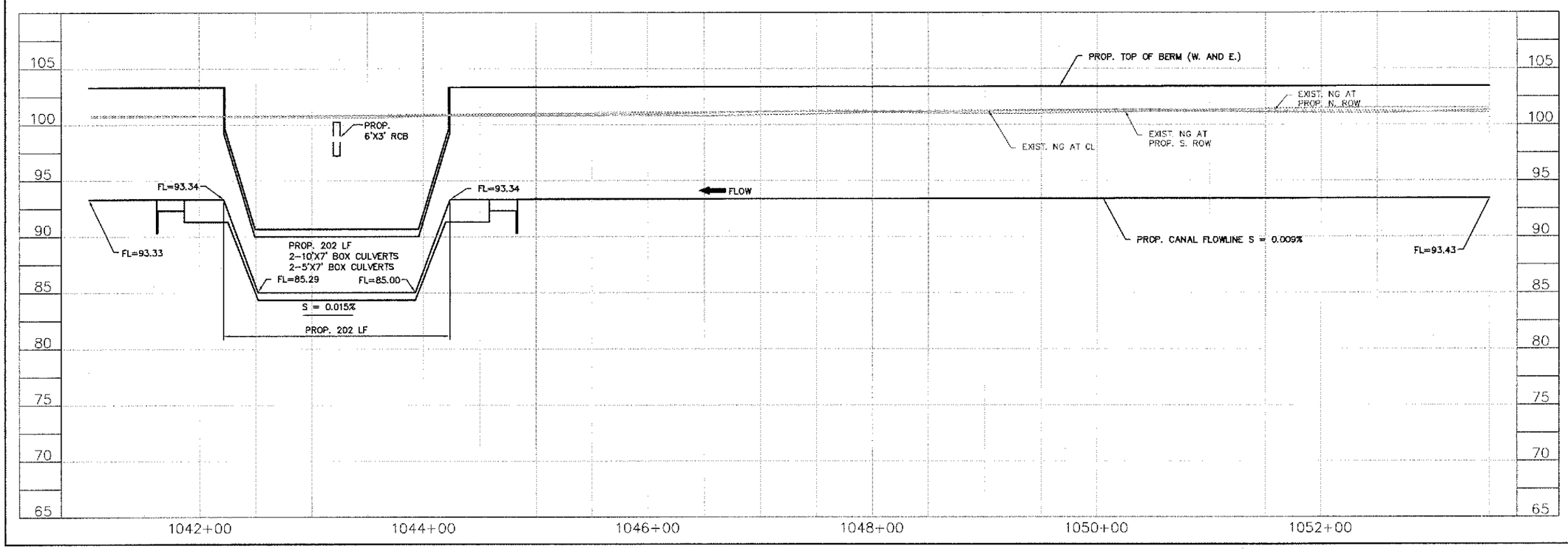




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.





KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
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SURVEYED BY:
FB NO.

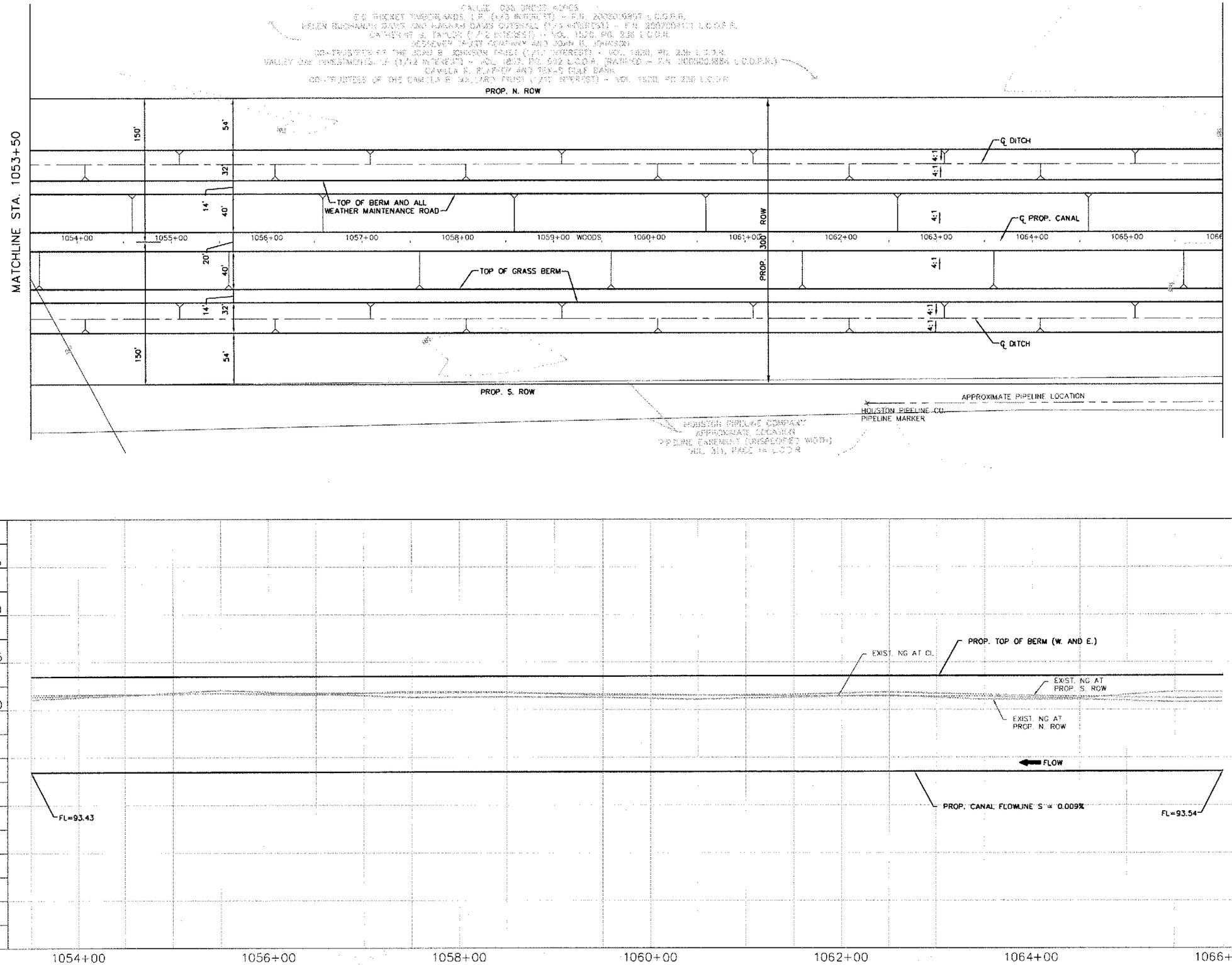
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN & PROFILE STA 1041+00 TO STA 1053+50

DRAWING SCALE
AS SHOWN

SHEET NO. 120 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:39pm BY USER: ThompsonBl
DWG. LOCATION: D:\Work Order S\4.3 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalPlanP86.dwg

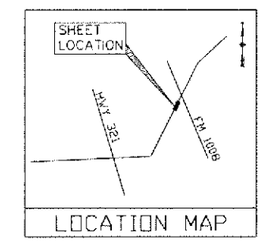


VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
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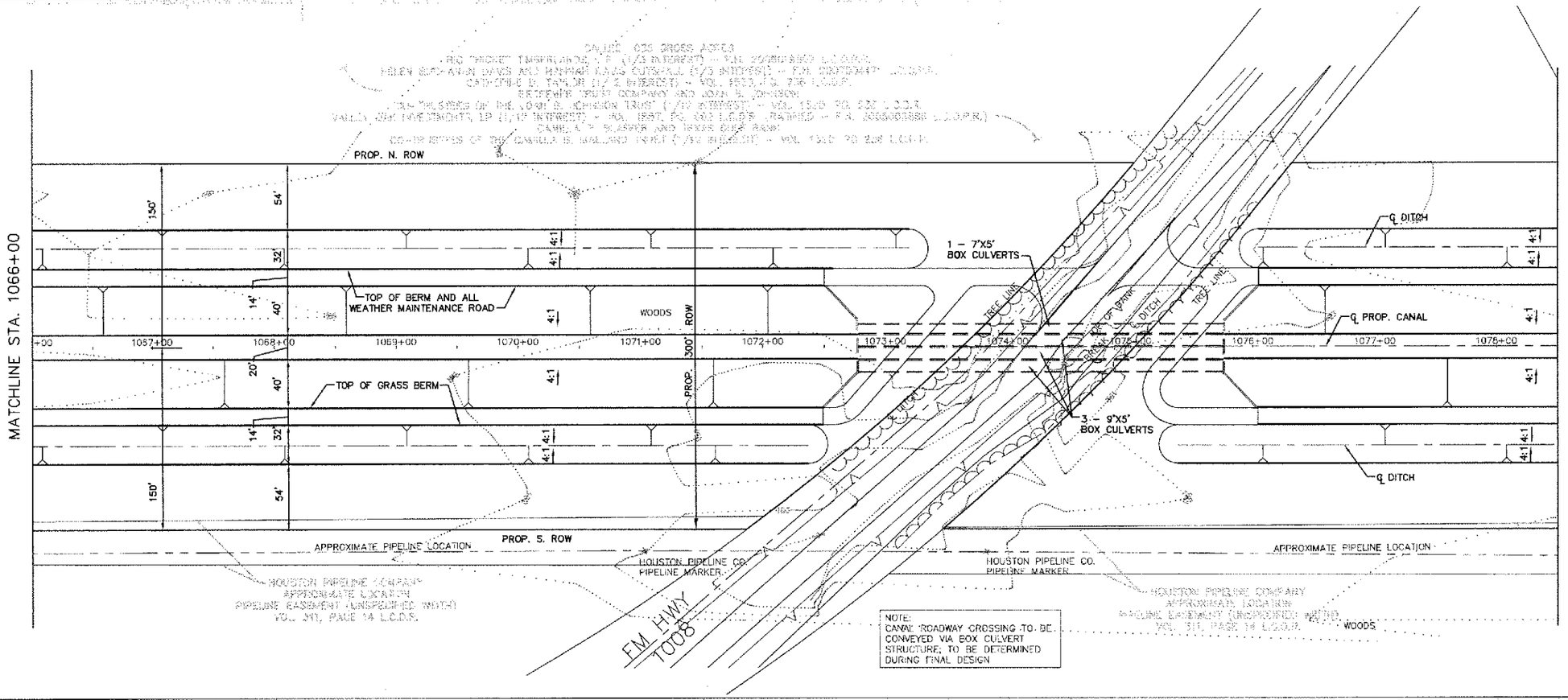
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

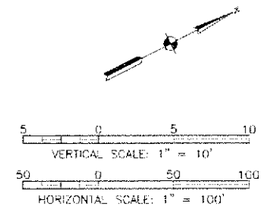
CANAL PLAN & PROFILE STA 1053+50 TO STA 1066+00

DRAWING SCALE
AS SHOWN

SHEET NO. 121 OF 245

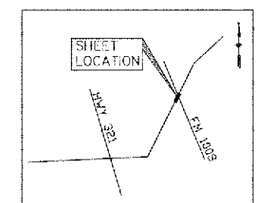
LAST MODIFIED: Jan 28, 2011 - 6:38am BY USER: ThompsonBI
DWG. LOCATION: G:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P87.dwg



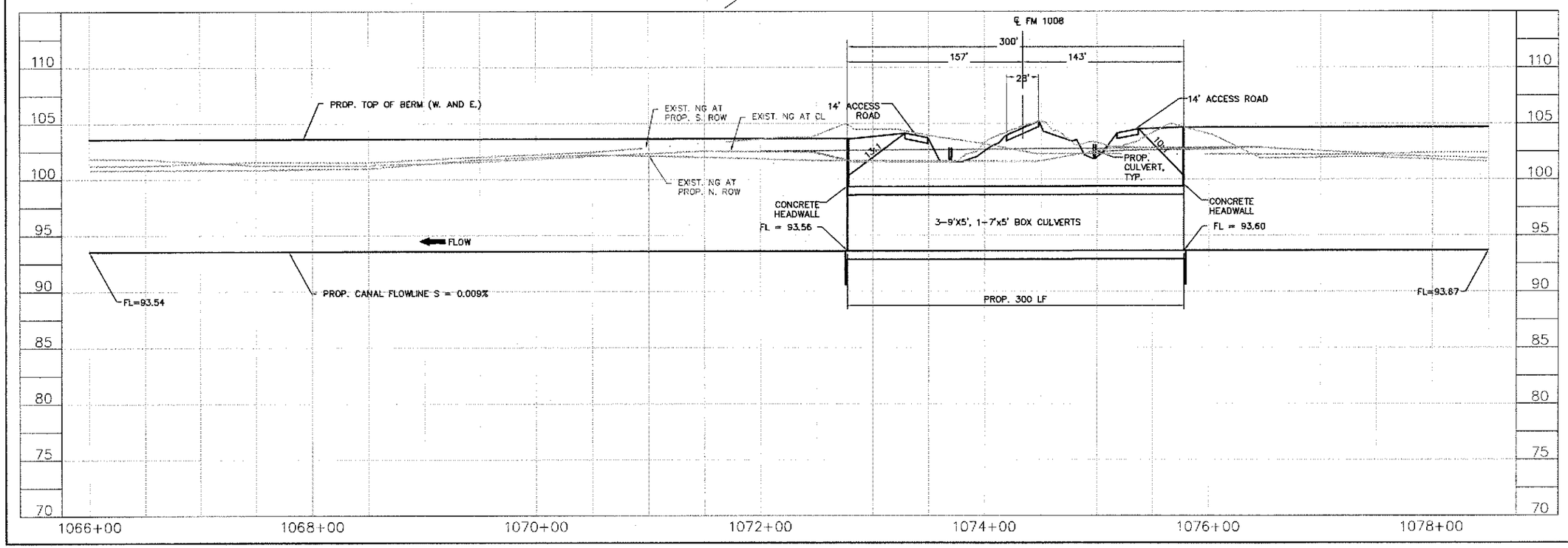


NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
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AECOM

AECOM TECHNICAL SERVICES, INC.
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713.780.0838 fax.

SURVEYED BY:
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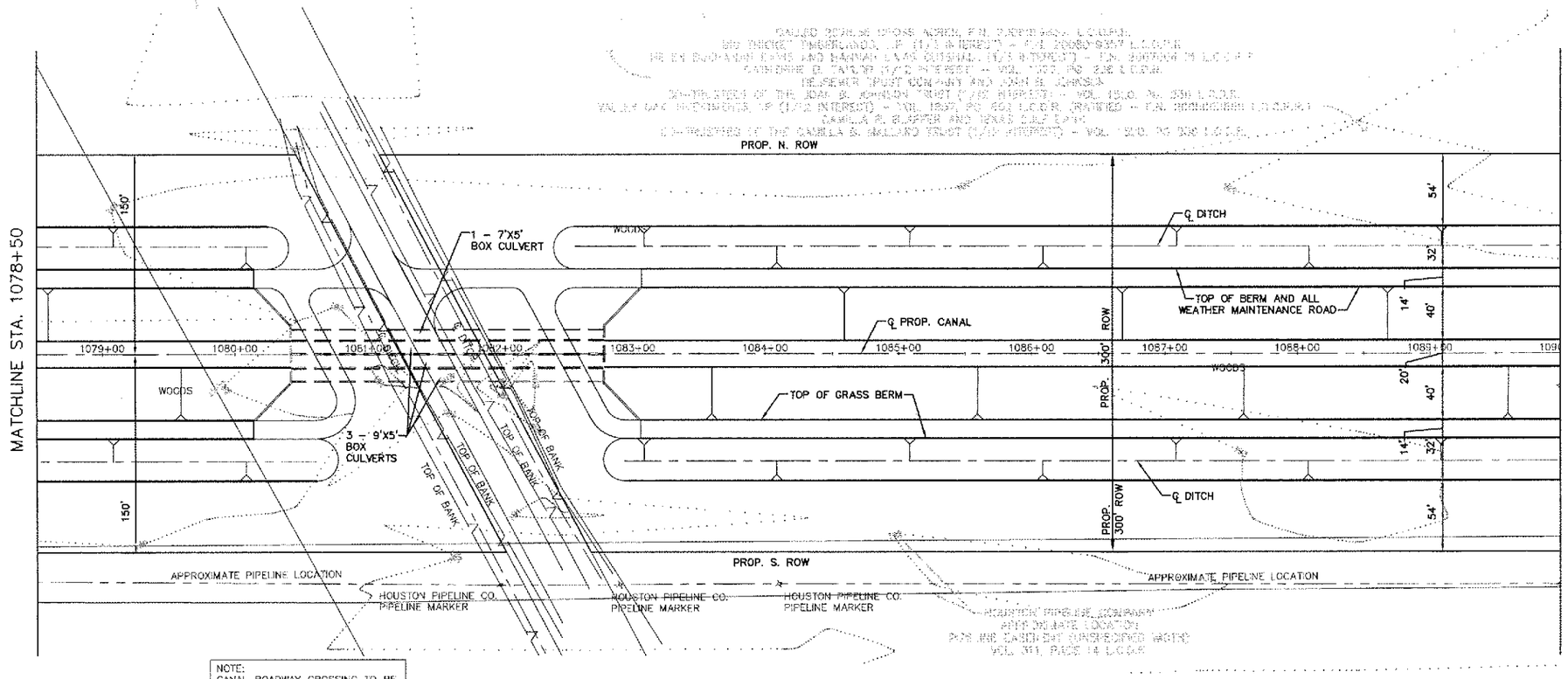
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN & PROFILE STA 1066+00 TO STA 1078+50

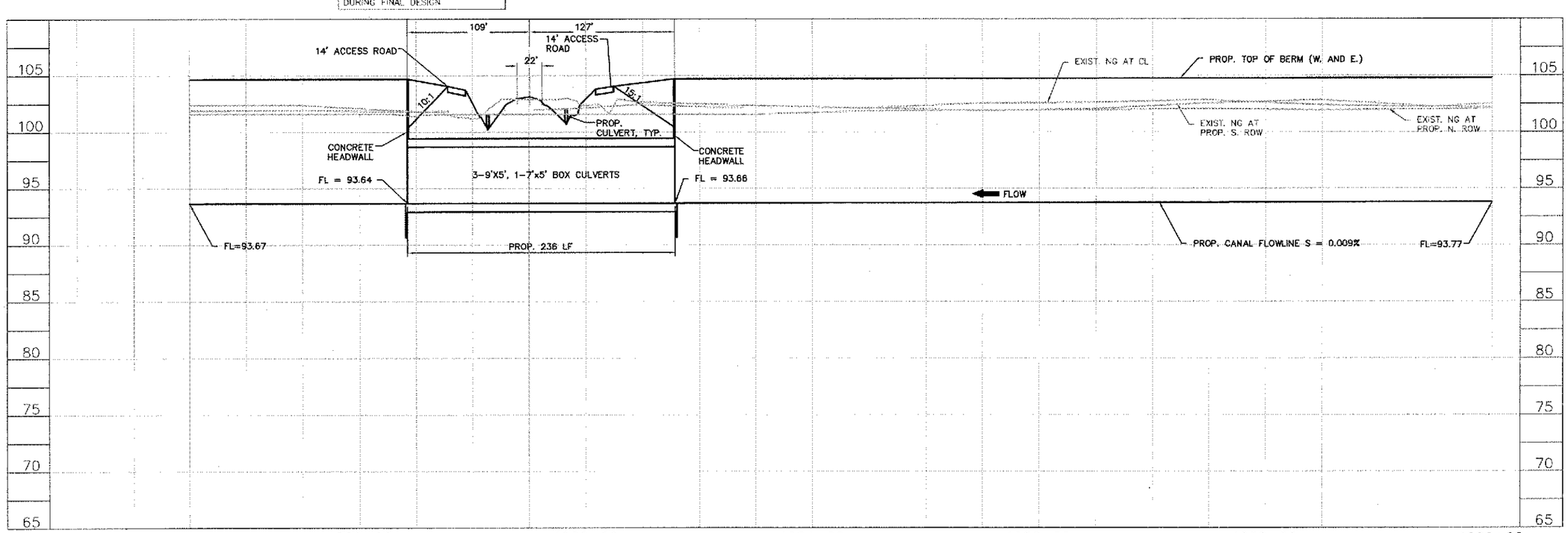
DRAWING SCALE
AS SHOWN

SHEET NO. 122 OF 244

LAST MODIFIED: Jan 27, 2011 - 4:42pm BY USER: ThompsonJil
DWG LOCATION: D:\Work Order 5\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG NAME: CanalPxP98.dwg



NOTE:
CANAL ROADWAY CROSSING TO BE CONVEYED VIA BOX CULVERT STRUCTURE; TO BE DETERMINED DURING FINAL DESIGN

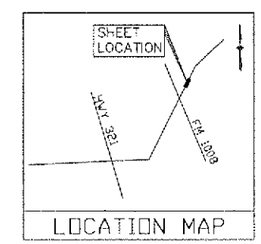


VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
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AECOM

AECOM TECHNICAL SERVICES, INC.
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HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

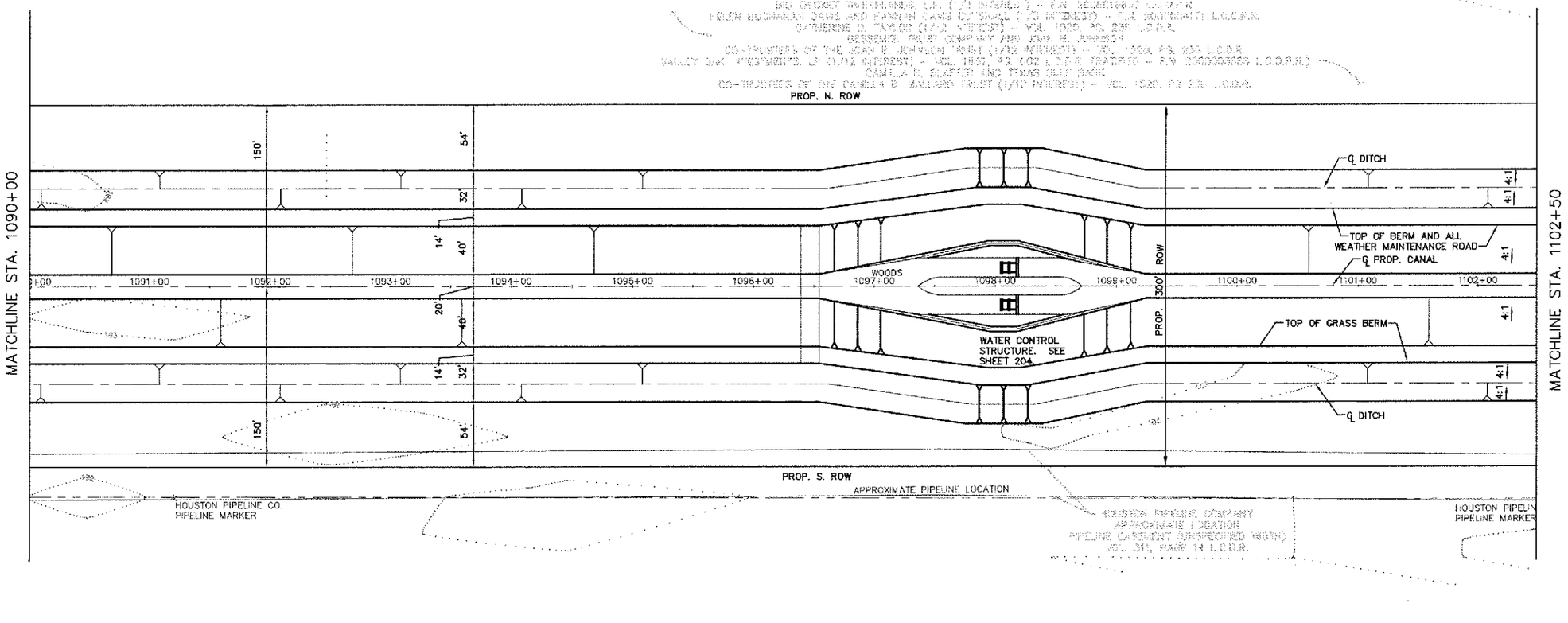
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

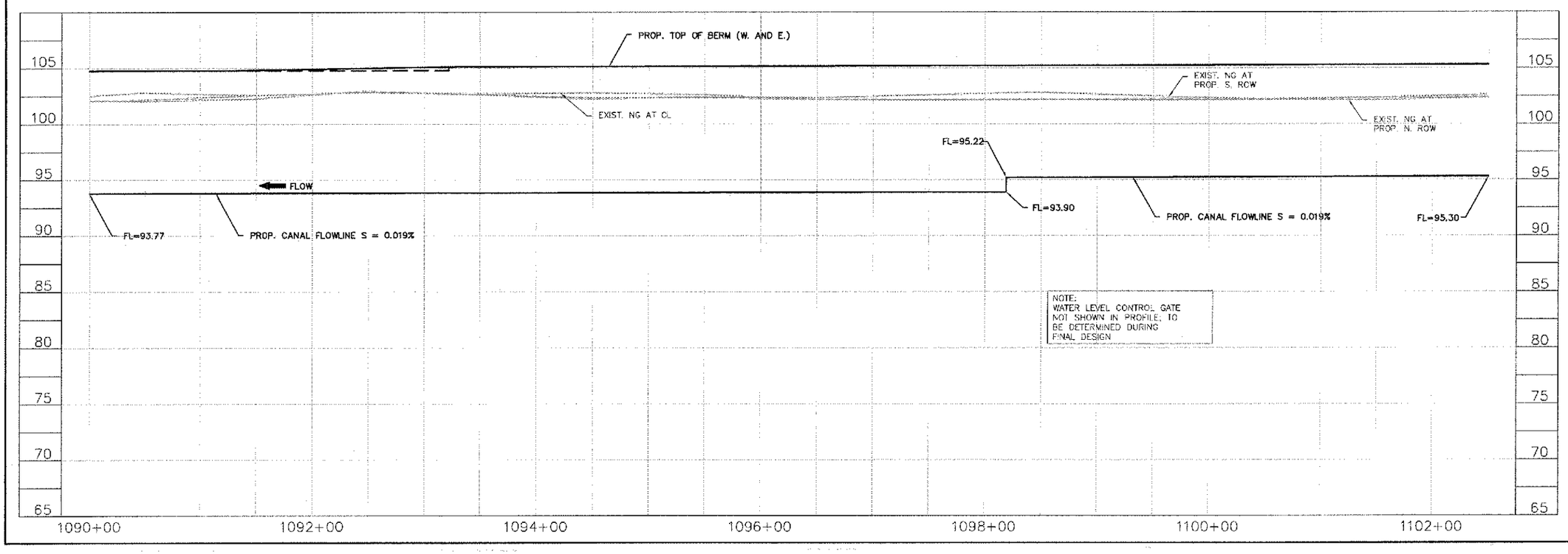
142 CANAL PLAN & PROFILE STA 1078+50 TO STA 1090+00

DRAWING SCALE
AS SHOWN

SHEET NO. 123 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:42pm BY USER: ThompsonBl
DWG. LOCATION: G:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P88b.dwg





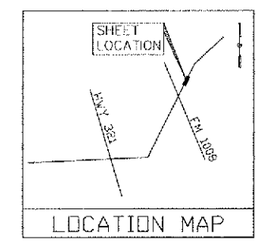
NOTE:
WATER LEVEL CONTROL GATE NOT SHOWN IN PROFILE; TO BE DETERMINED DURING FINAL DESIGN

VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
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HOUSTON, TEXAS 77057-1505
713.780.4100 TEL
TBPE REG. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

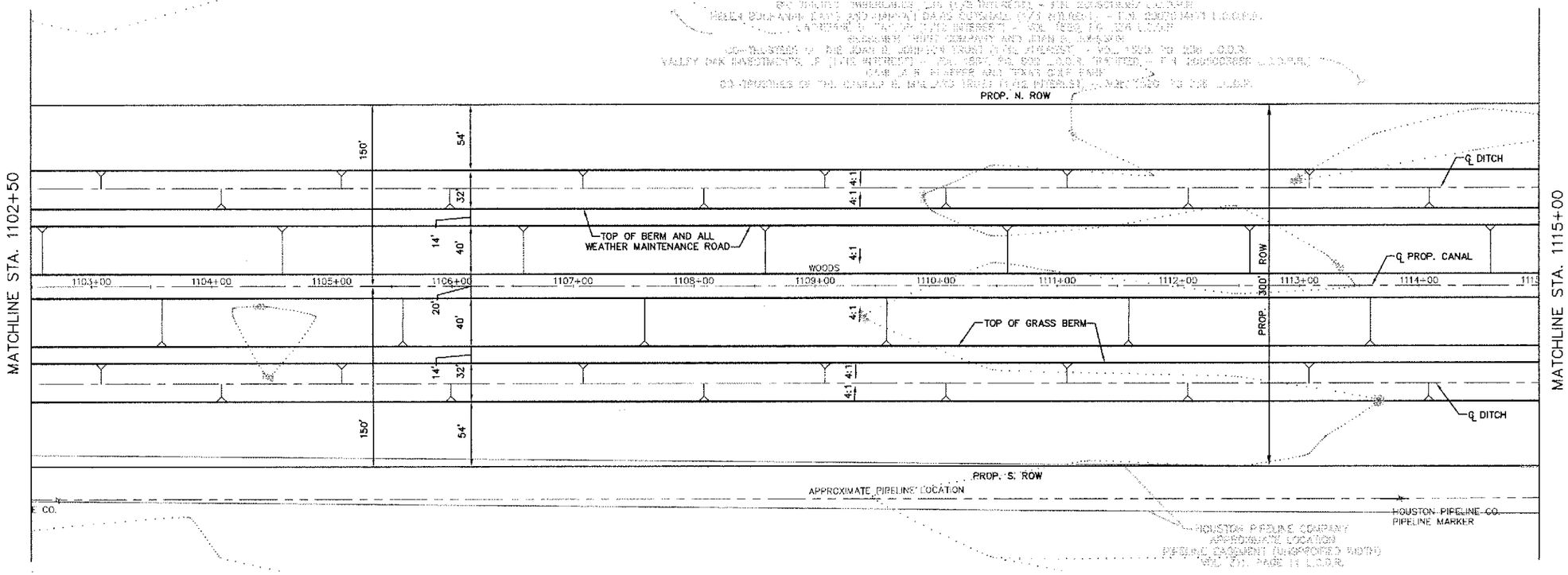
LUCE BAYOU INTERBASIN TRANSFER PROJECT

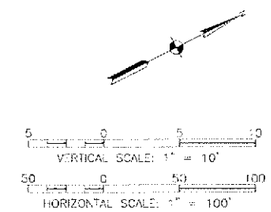
CANAL PLAN & PROFILE STA 1090+00 TO STA 1102+50

DRAWING SCALE
AS SHOWN

SHEET NO. 124 OF 245

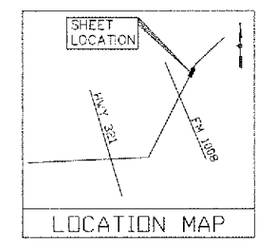
LAST MODIFIED: Jan 27, 2011 - 4:43pm BY USER: ThompsonBI
DWG. LOCATION: U:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalPlaxP59.dwg

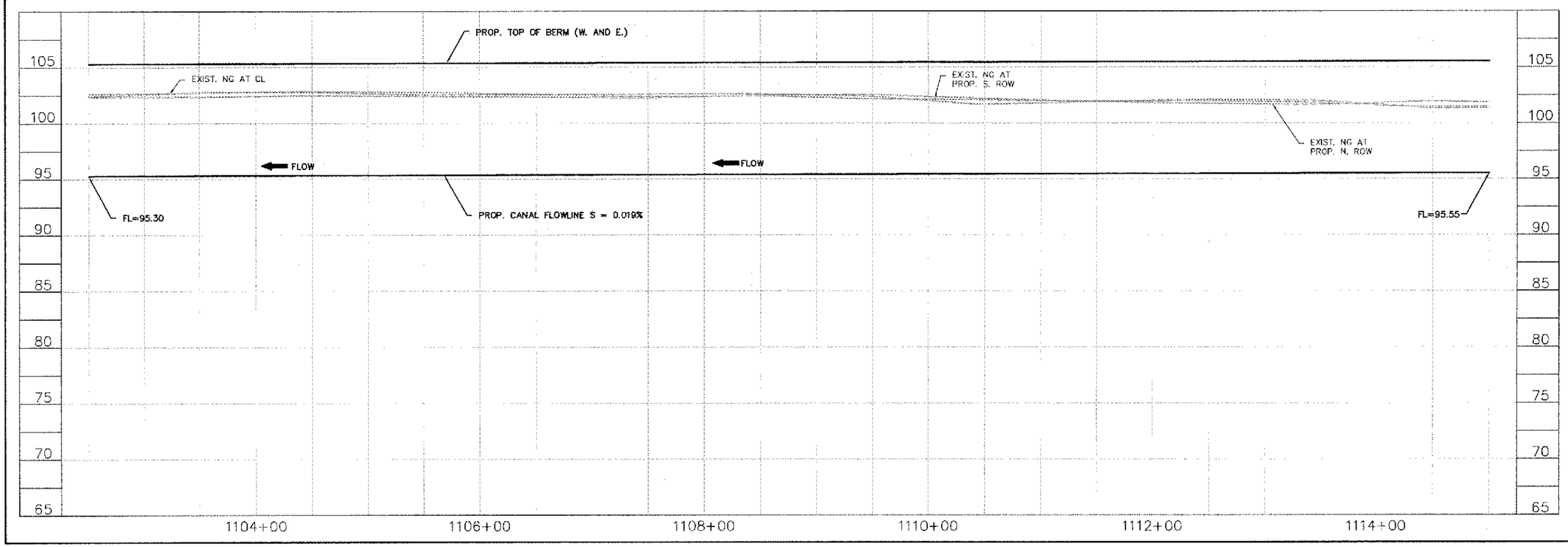




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.





KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
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AECOM

AECOM TECHNICAL SERVICES, INC.
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HOUSTON, TEXAS 77057-1589
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AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

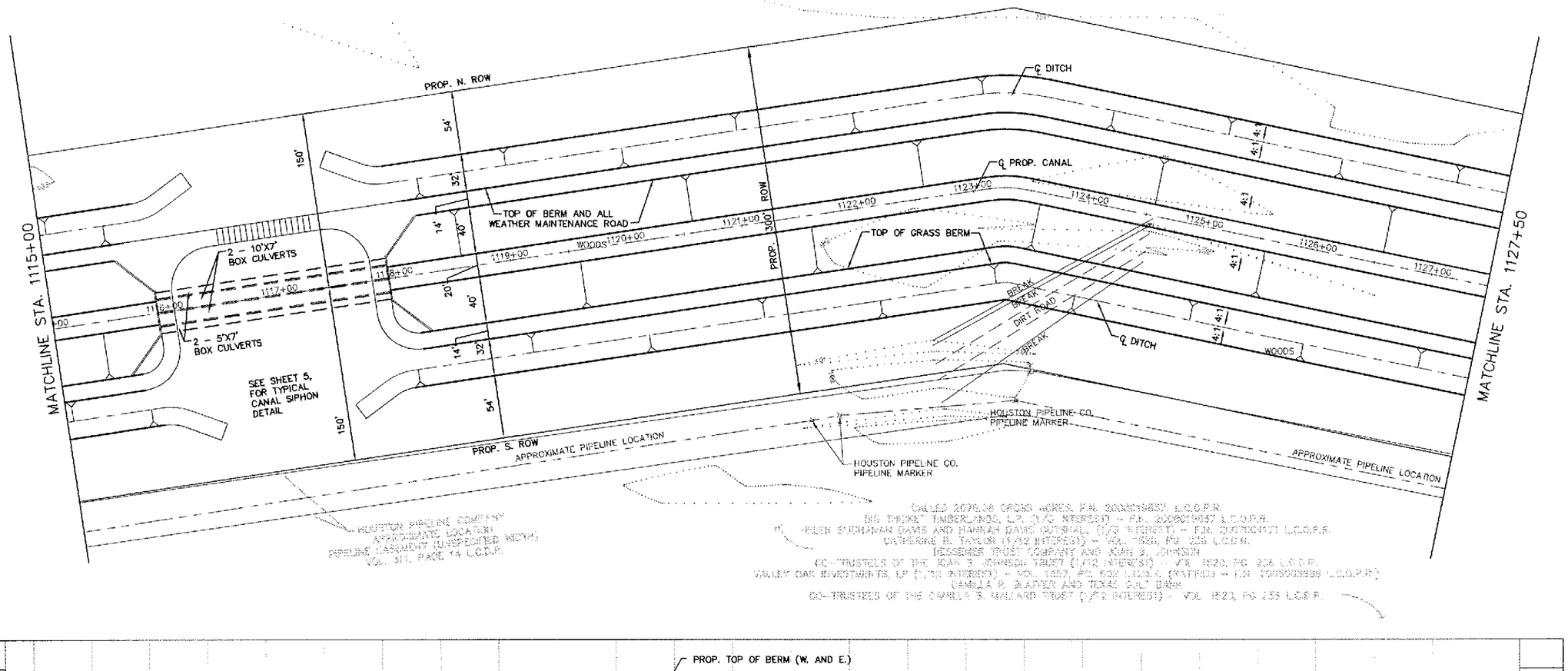
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

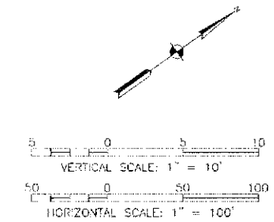
CANAL PLAN & PROFILE STA 1102+50 TO STA 1115+00

DRAWING SCALE
AS SHOWN

SHEET NO. 125 OF 245

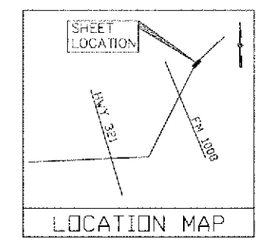
LAST MODIFIED: Jan 27, 2011 – 4:43pm BY USER: ThompsonBl
DWG. LOCATION: D:\Work Order 5\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P90.dwg



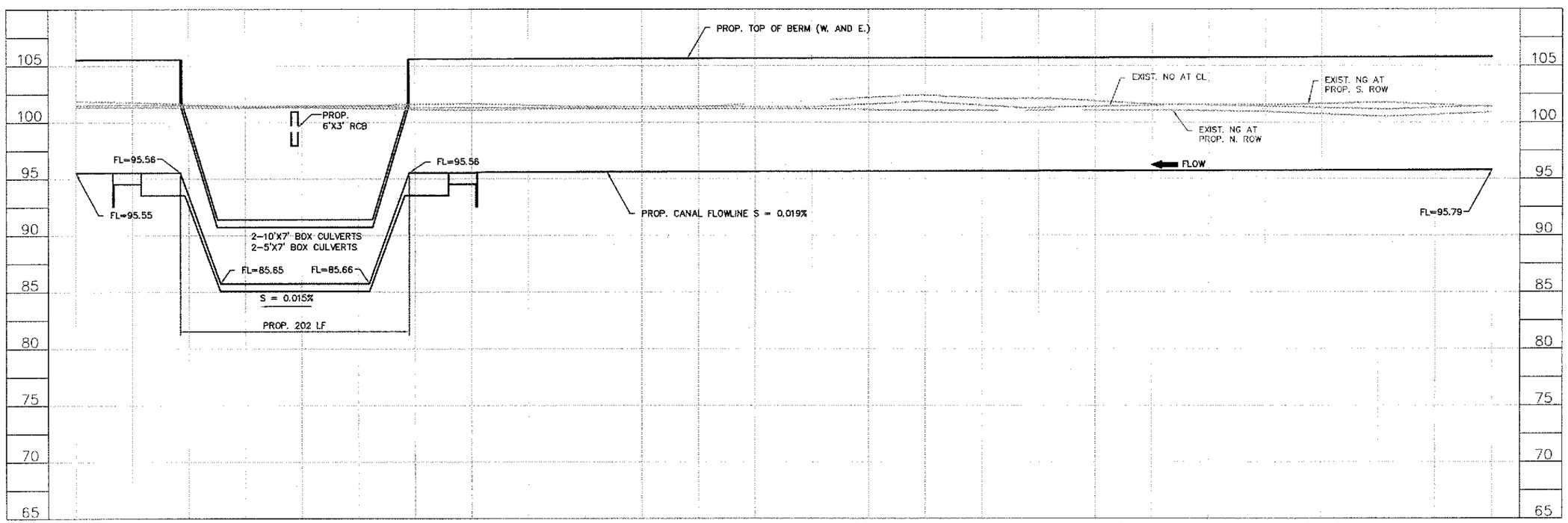


NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

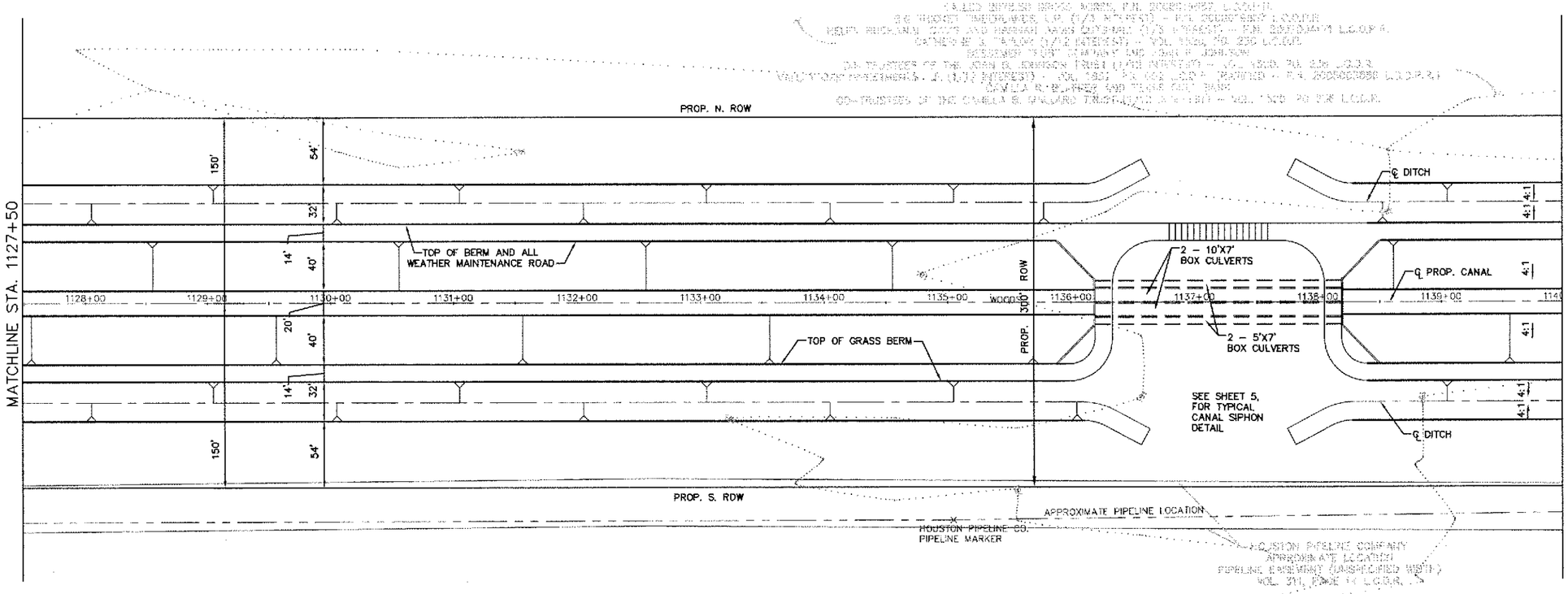
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN &
PROFILE STA 1115+00
TO STA 1127+50

DRAWING SCALE
AS SHOWN

SHEET NO. 126 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:44pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P91.dwg

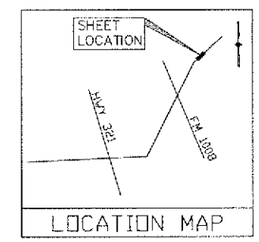


VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
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HOUSTON, TEXAS 77057
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713.780.0838 fax.

SURVEYED BY:
FB NO.

CWA

COASTAL WATER AUTHORITY

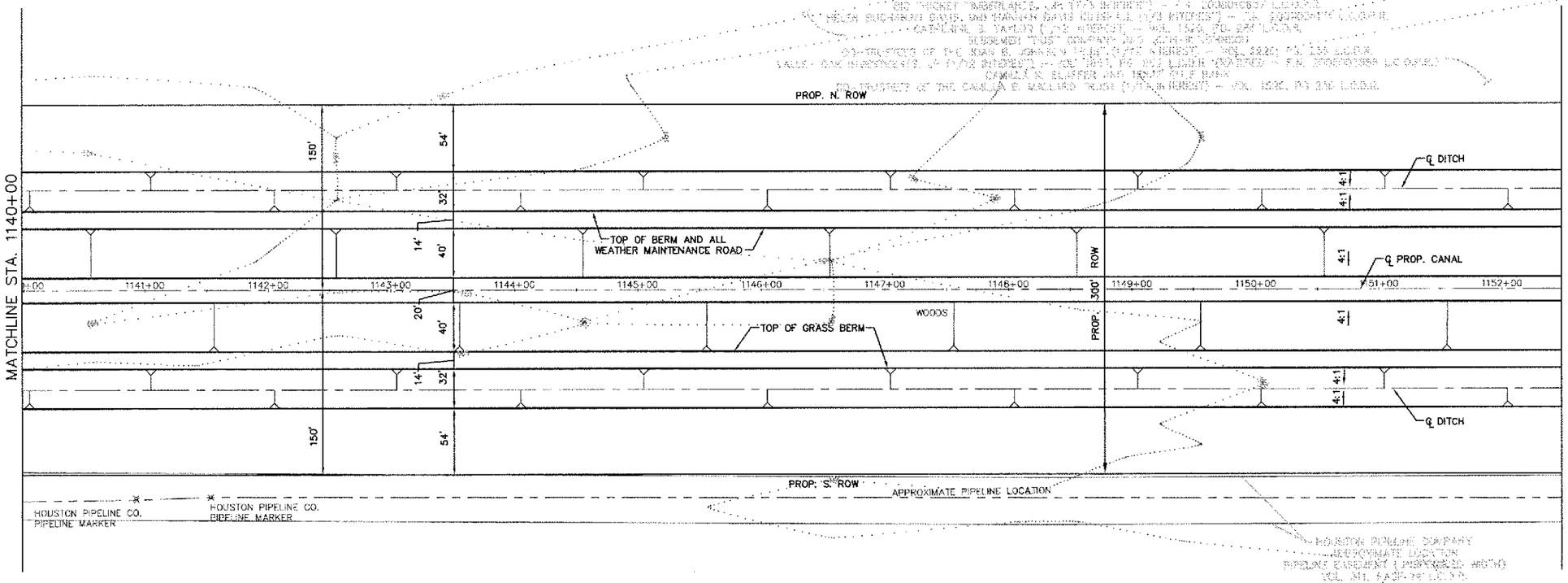
LUCE BAYOU INTERBASIN TRANSFER PROJECT

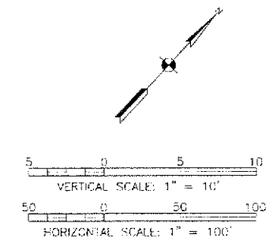
CANAL PLAN & PROFILE STA 1127+50 TO STA 1140+00

DRAWING SCALE
AS SHOWN

SHEET NO. 127 OF 245

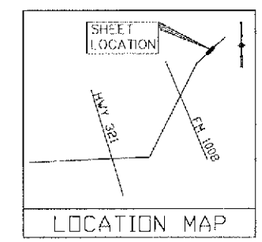
LAST MODIFIED: Jan 27, 2011 – 4:45pm BY USER: ThompsonBI
DWG. LOCATION: Q:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P92.dwg



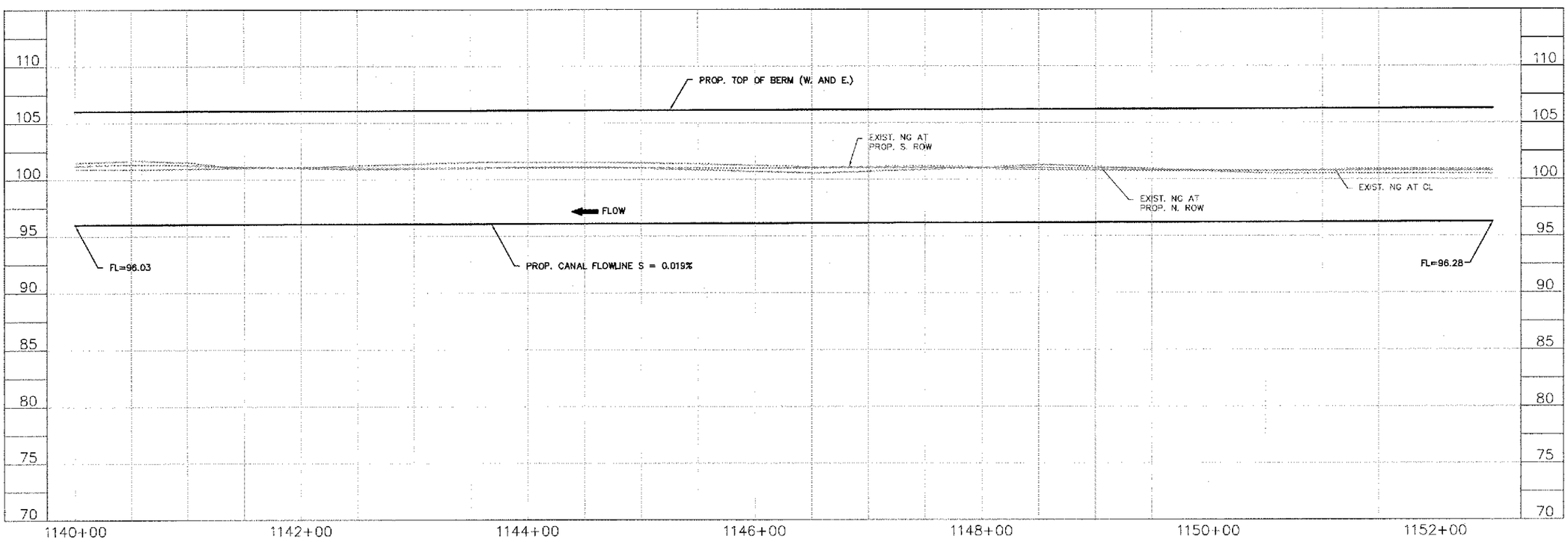


NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031

INTERIM SUBMITTAL
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AECOM
AECOM TECHNICAL SERVICES, INC.
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AECOM
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713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

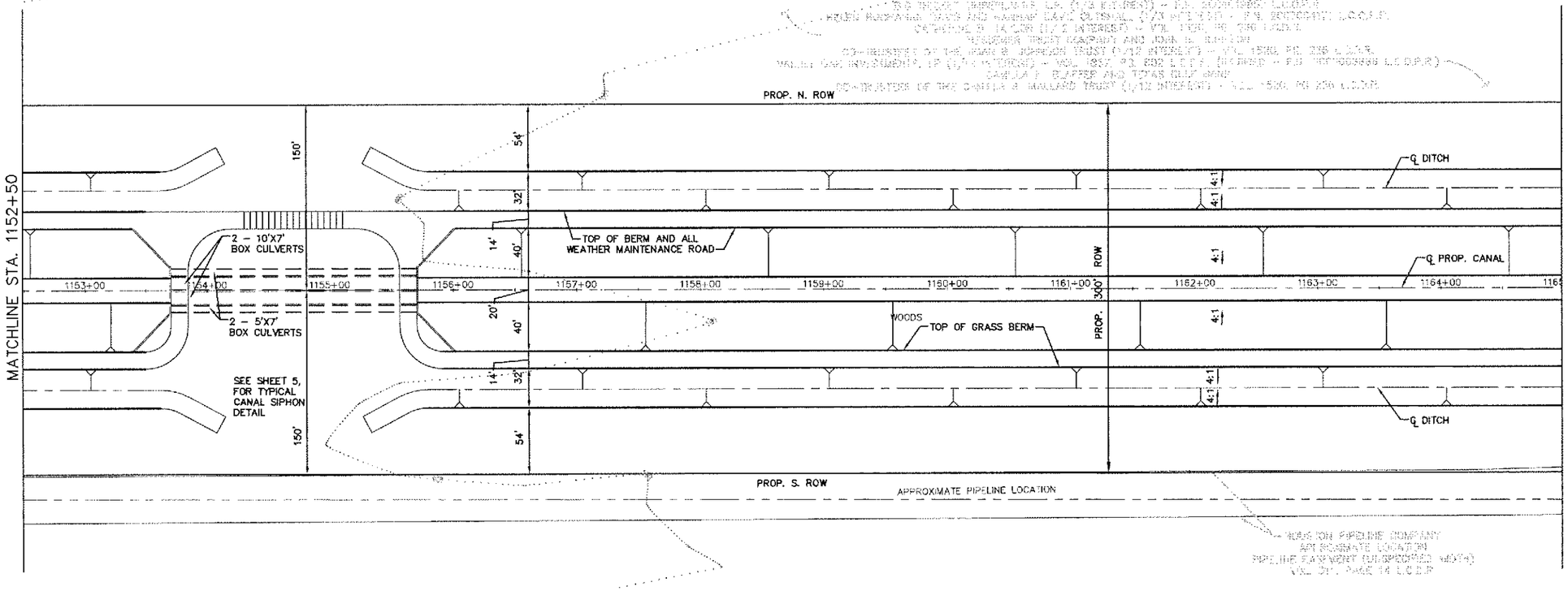
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

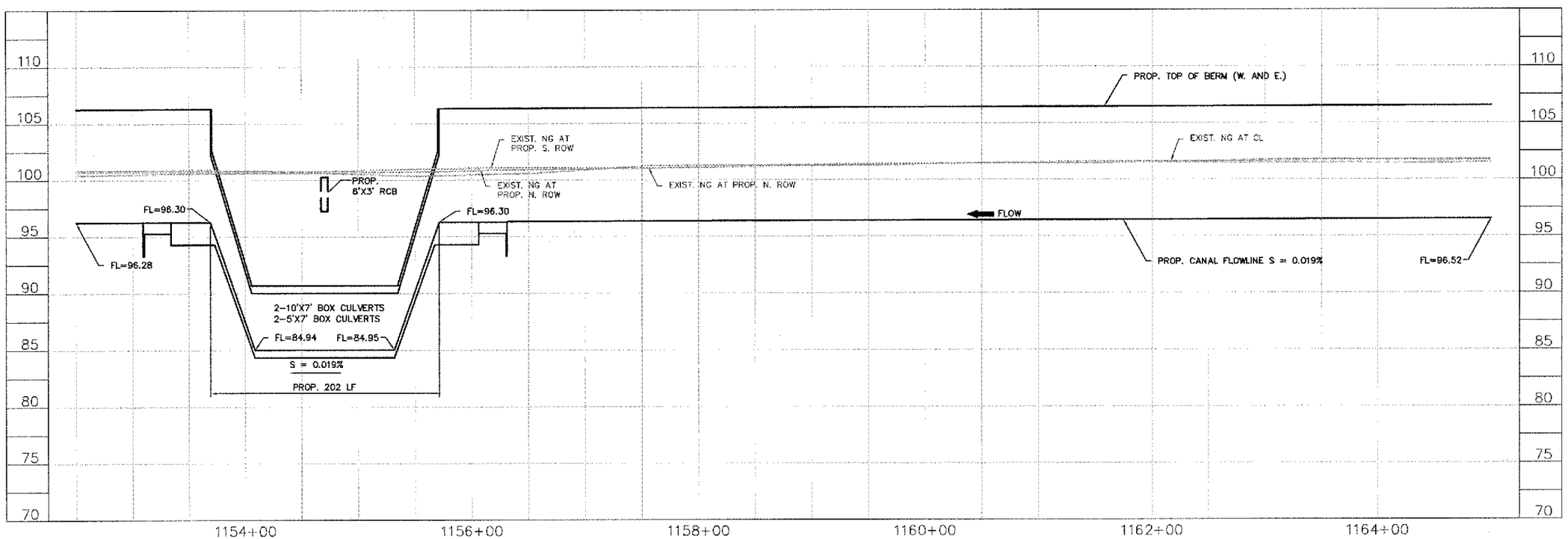
CANAL PLAN & PROFILE STA 1140+00 TO STA 1152+50

DRAWING SCALE
AS SHOWN

SHEET NO. 128 OF 245

LAST MODIFIED: Jan 27, 2011 – 4:45pm BY USER: ThompsonBI
DWG LOCATION: G:\Work Order 5\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P93.dwg



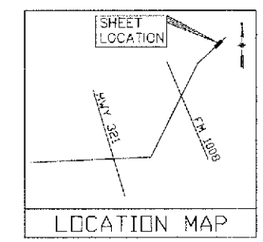


5 0 5 10
VERTICAL SCALE: 1" = 10'

50 0 50 100
HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 100 WEST
HOUSTON, TEXAS 77057-1599
WWW.AECOM.COM
TBPE REG. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

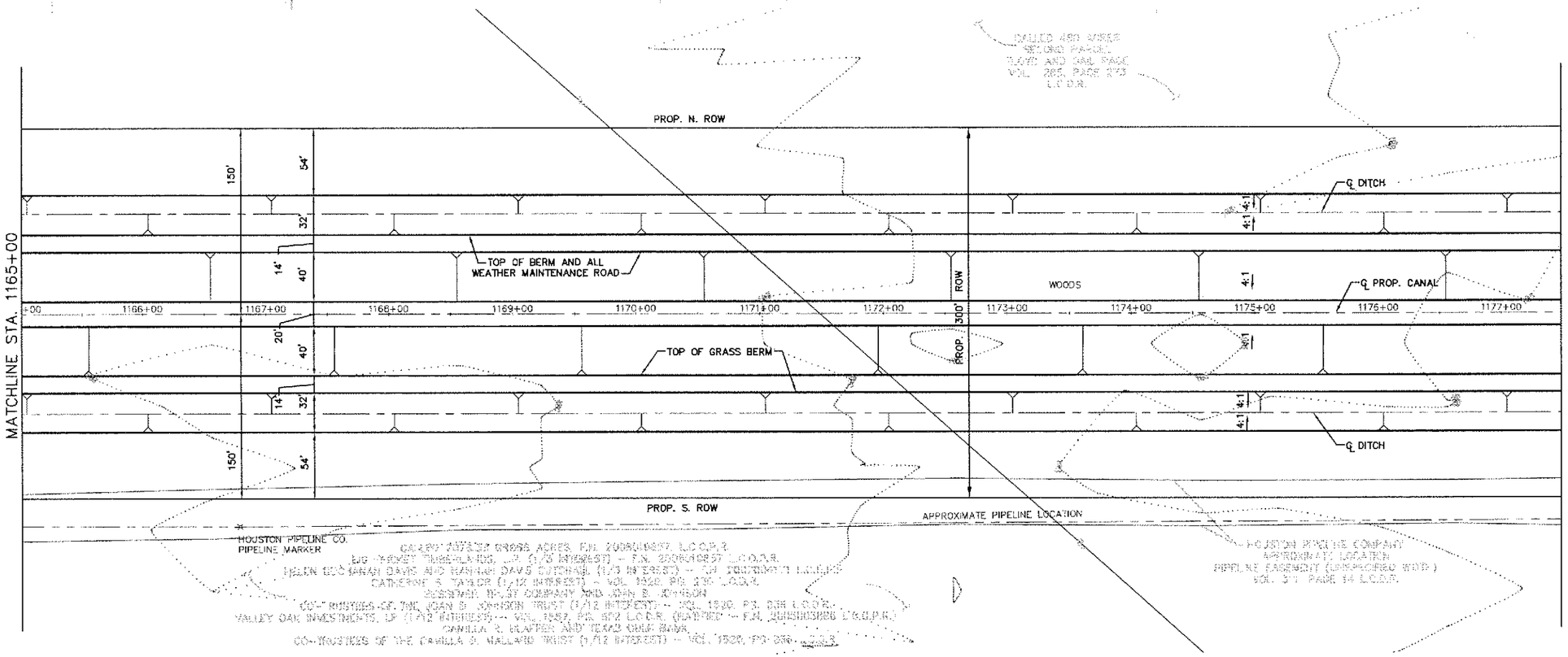
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN & PROFILE STA 1152+50 TO STA 1165+00

DRAWING SCALE
AS SHOWN

SHEET NO. 129 OF 245

LAST MODIFIED: Jan 27, 2011 – 4:46pm BY USER: ThompsonBI
DWG LOCATION: D:\Work Order 6V4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\FWD\Sheets\
DWG NAME: CanalP&P94.dwg

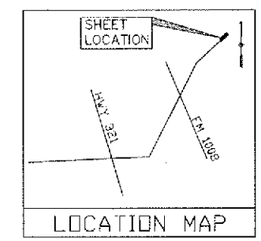


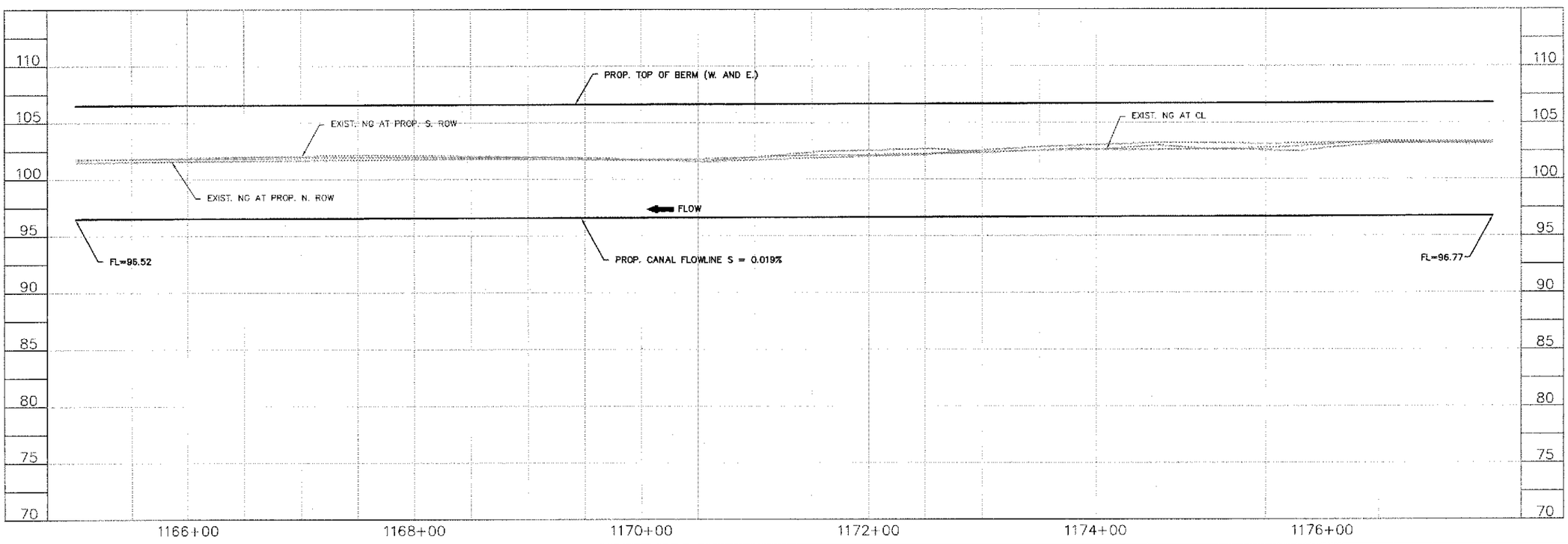
VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.





KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
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713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

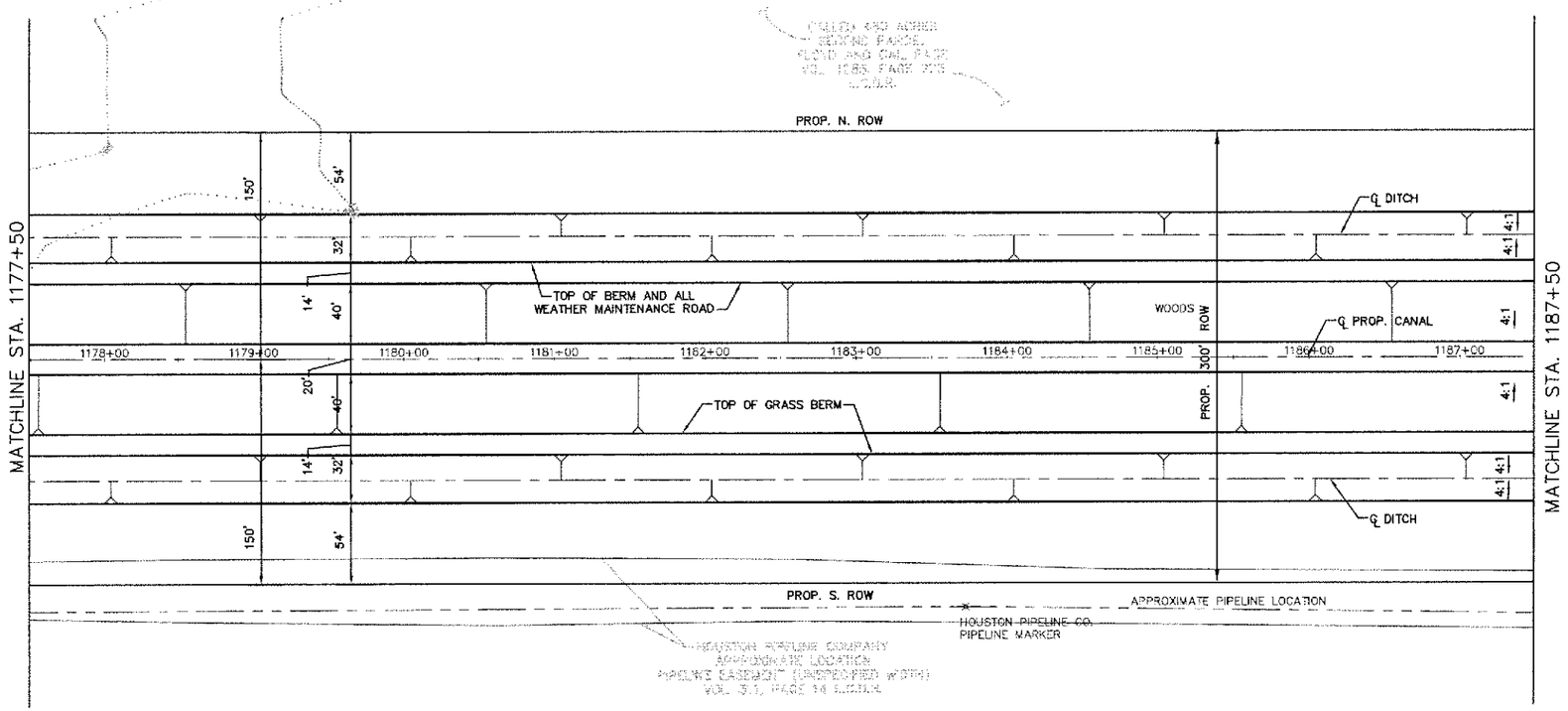
LUCE BAYOU INTERBASIN TRANSFER PROJECT

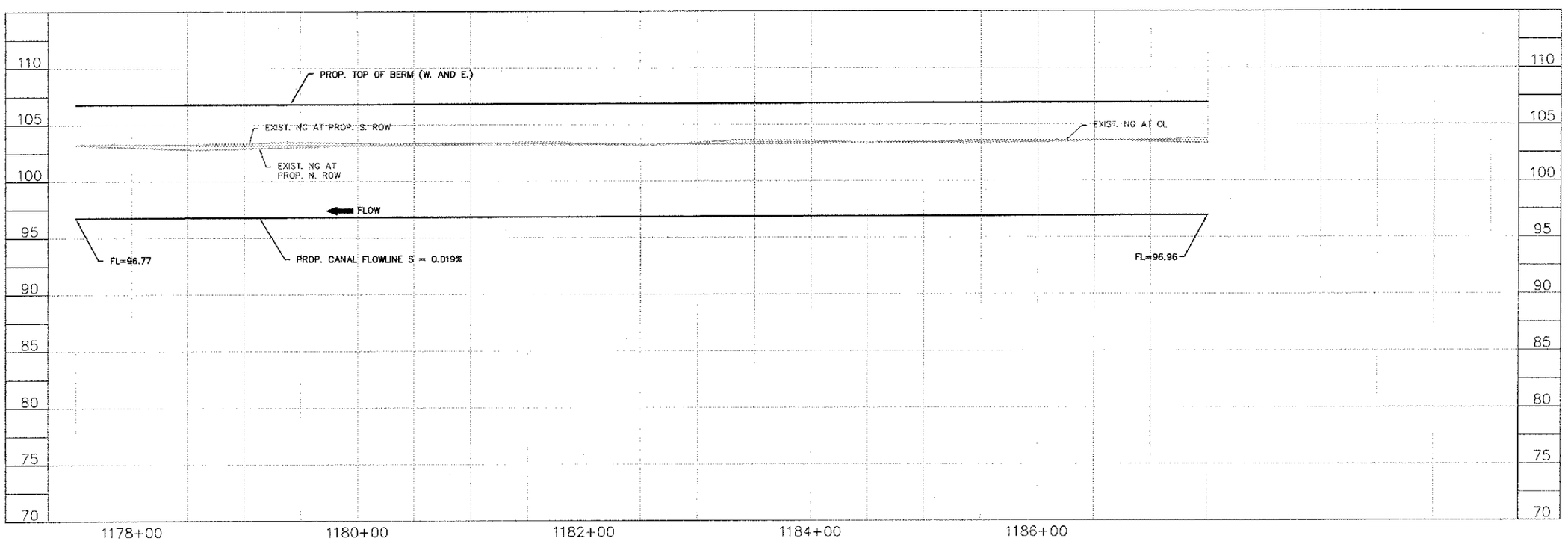
CANAL PLAN & PROFILE STA 1165+00 TO STA 1177+50

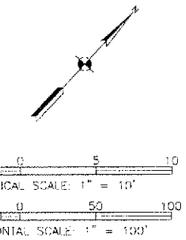
DRAWING SCALE
AS SHOWN

SHEET NO. 130 of 245

LAST MODIFIED: Jan 27, 2011 – 4:47pm BY USER: Thompson81
DWG. LOCATION: G:\Work Order 614.01 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalPS295.dwg

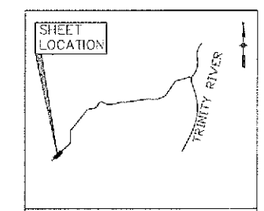






NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

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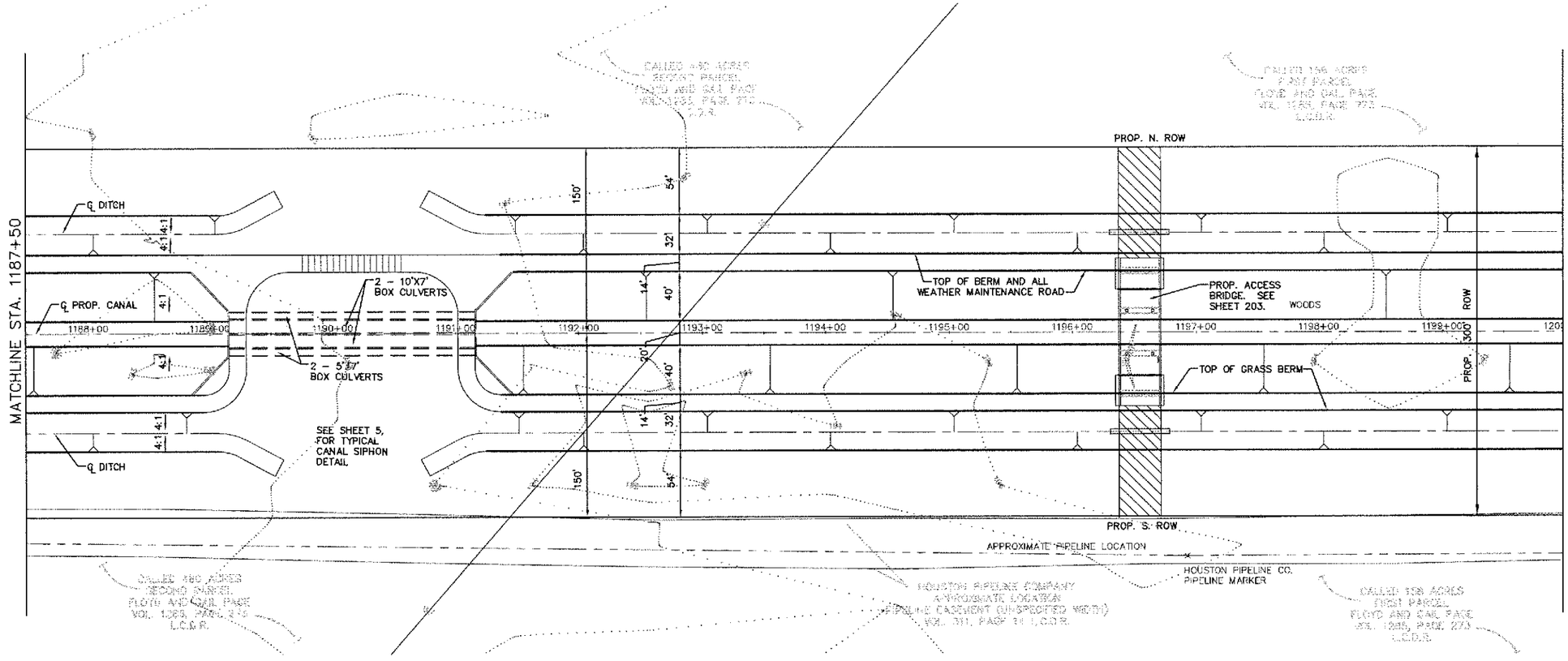
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

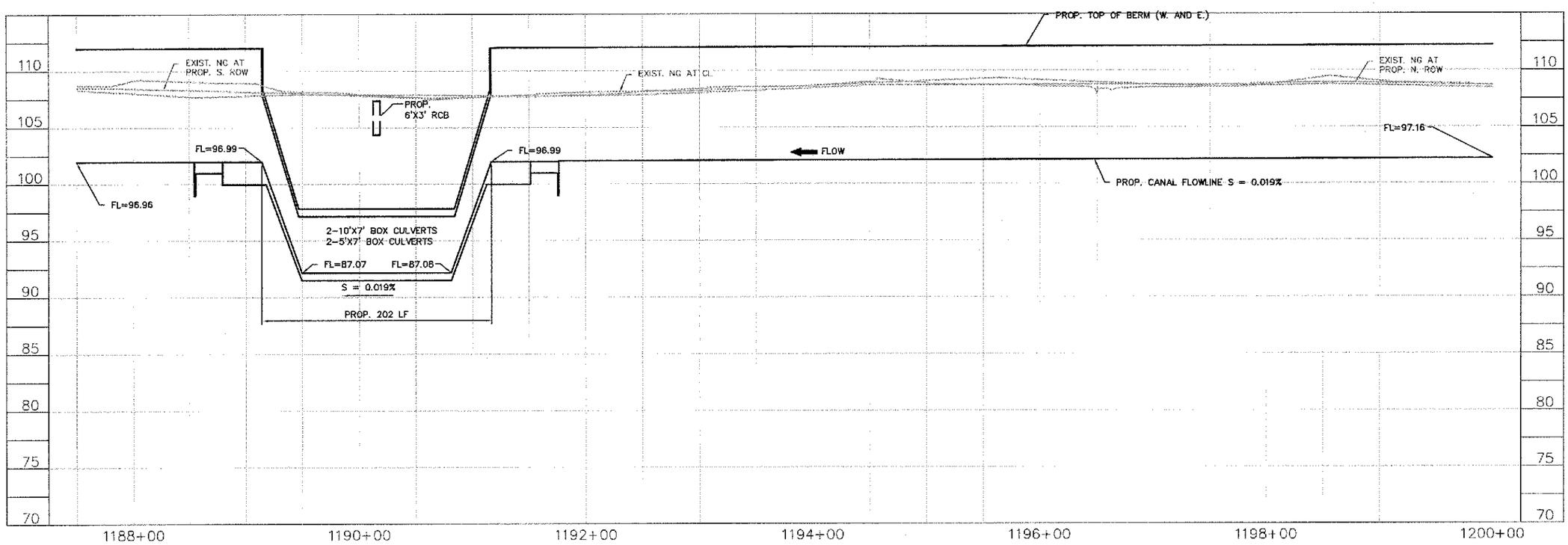
CANAL PLAN &
PROFILE STA 1177+50
TO STA 1187+50

DRAWING SCALE
AS SHOWN

SHEET NO. 131 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:47pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 5\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P95.dwg



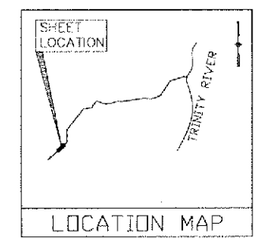


VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1591
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713.780.0838 fax.

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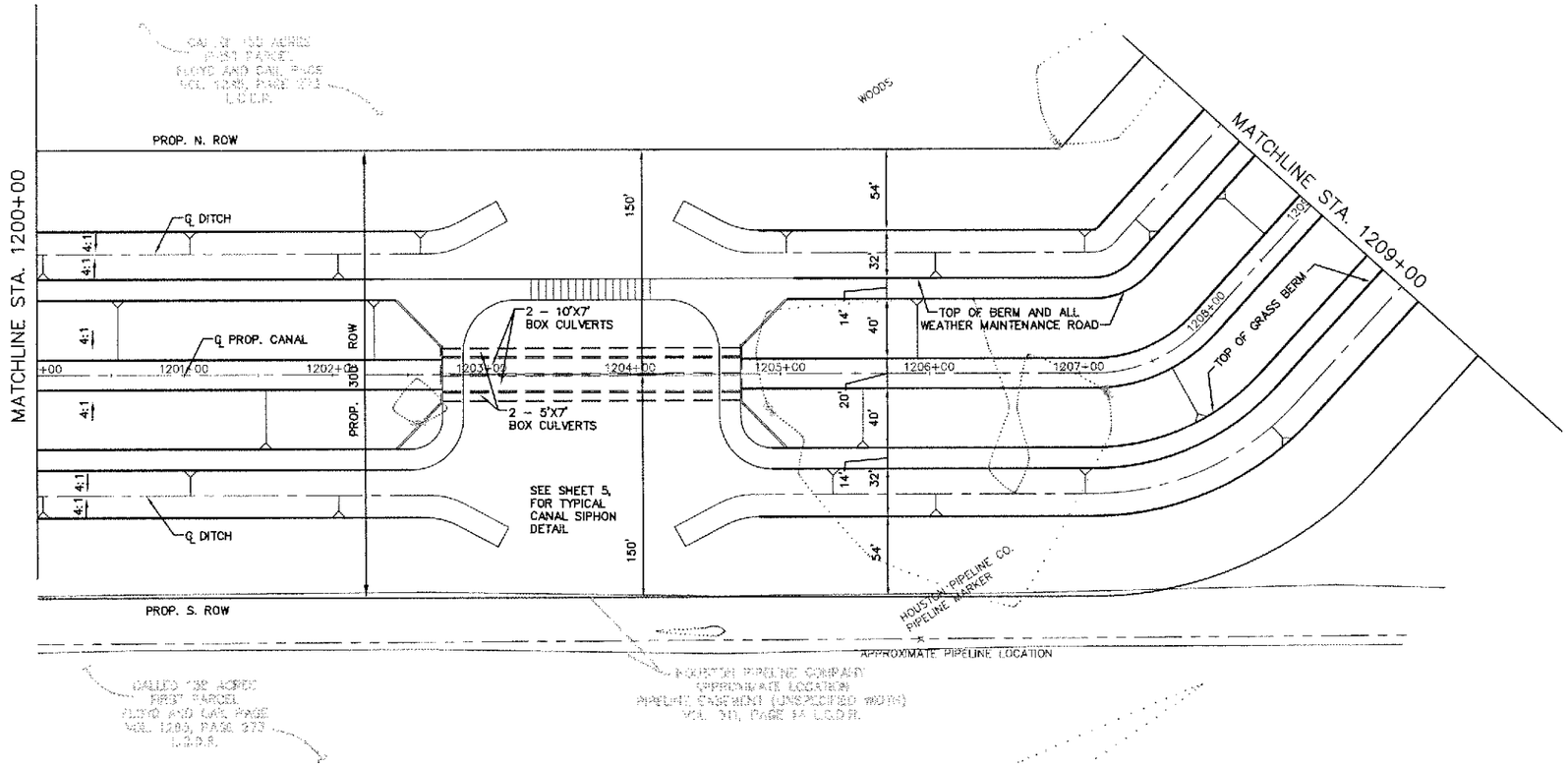
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

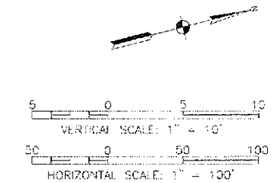
CANAL PLAN & PROFILE STA 1187+50 TO STA 1200+00

DRAWING SCALE
AS SHOWN

SHEET NO. 132 OF 245

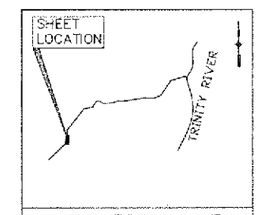
LAST MODIFIED: Jan 27, 2011 - 4:48pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P97.dwg



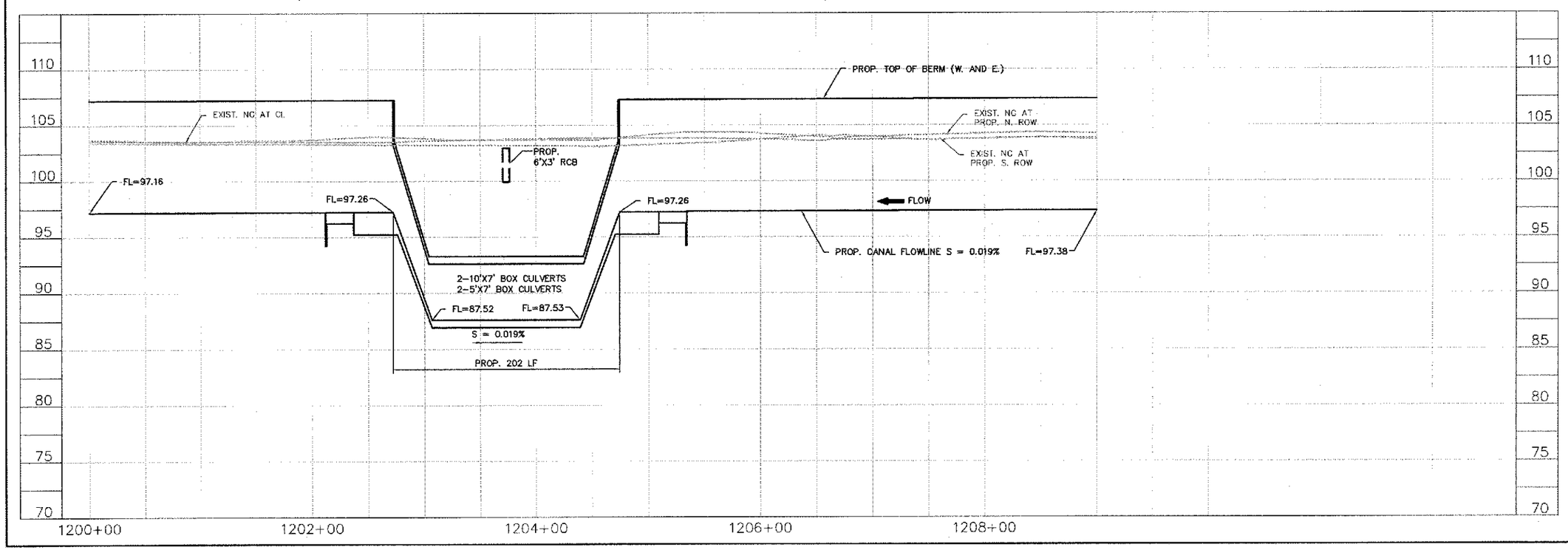


NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN

NOTE:
THERE ARE EXISTING PIPELINES IN THIS AREA. THESE ARE NOT SHOWN IN PROFILE VIEW DUE TO LACK OF INFORMATION.



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
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AECOM

AECOM TECHNICAL SERVICES, INC.
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TBPE REGN. NO. F-3580

AECOM
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HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

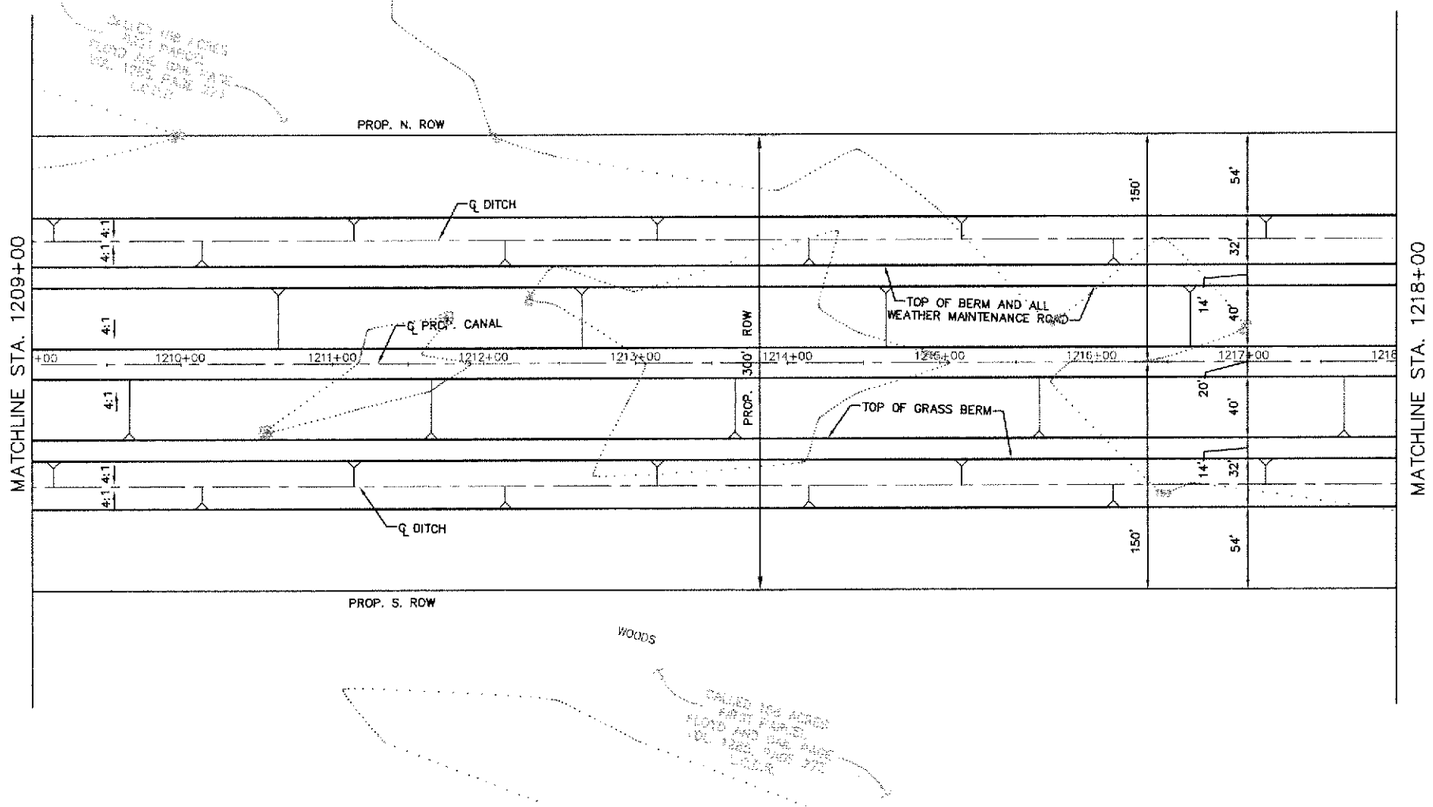
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

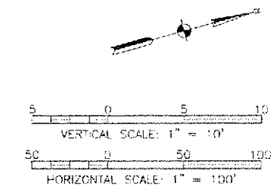
CANAL PLAN & PROFILE STA 1200+00 TO STA 1209+00

DRAWING SCALE
AS SHOWN

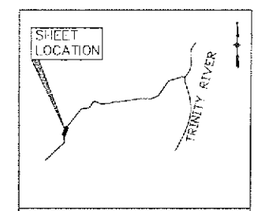
SHEET NO. 133 OF 245

LAST MODIFIED: Jan 27, 2011 – 4:46pm BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&F96.dwg

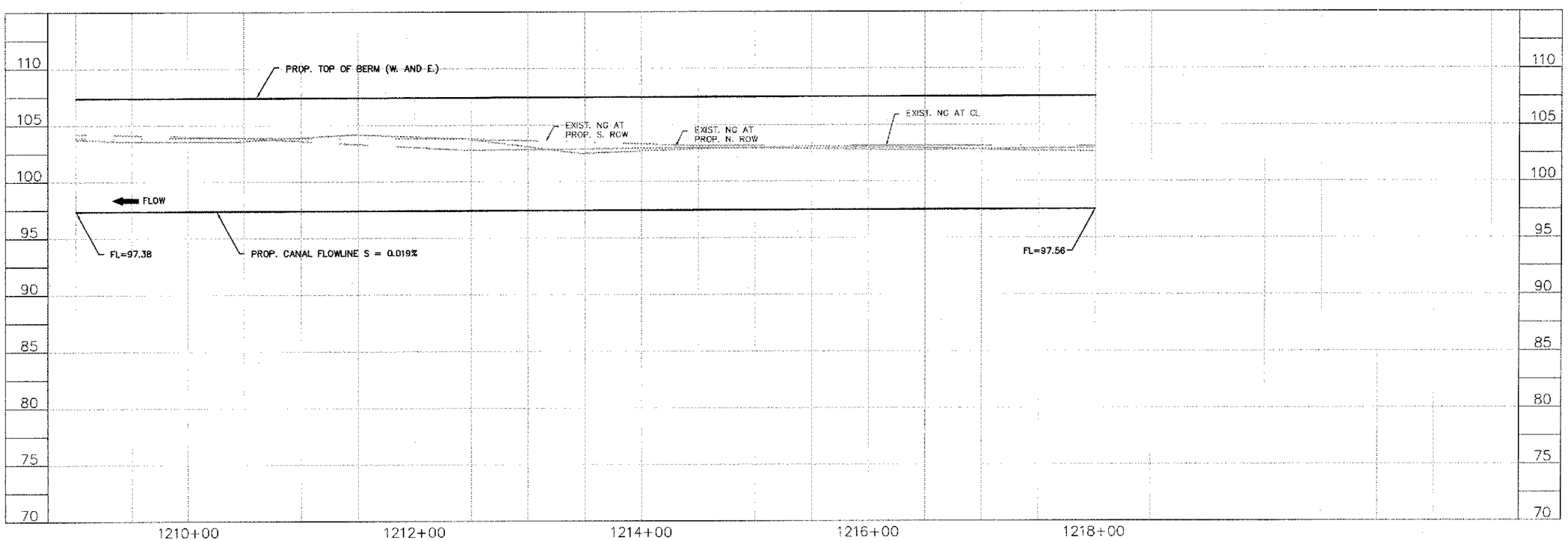




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1595
WWW.AECOM.COM
TBPE REG. NO. F-9580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

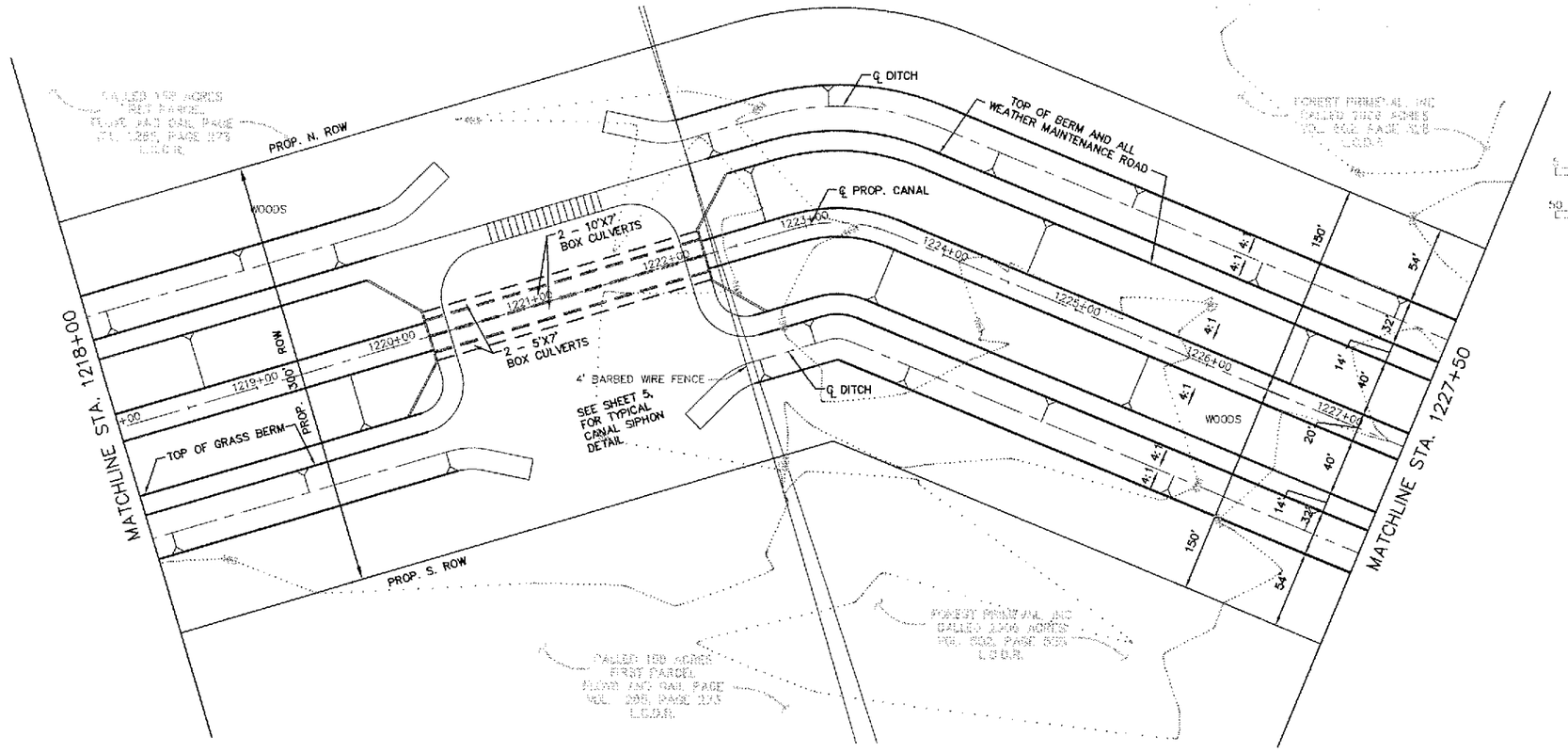
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

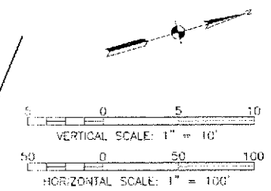
CANAL PLAN &
PROFILE STA 1209+00
TO STA 1218+00

DRAWING SCALE
AS SHOWN

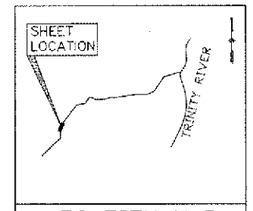
SHEET NO. 134 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:49pm BY USER: Thompson3l
DWG. LOCATION: O:\Work Order 8\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P38b.dwg

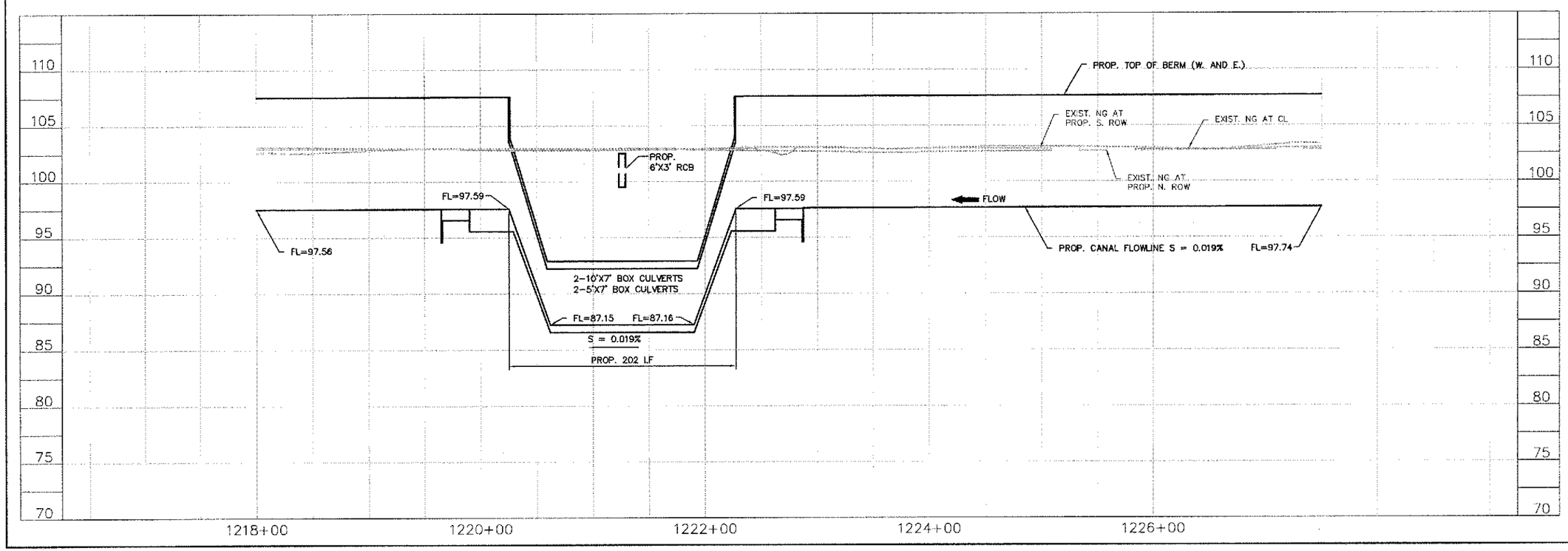




NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1593
WWW.AECOM.COM
TBPE REG. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

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CWA

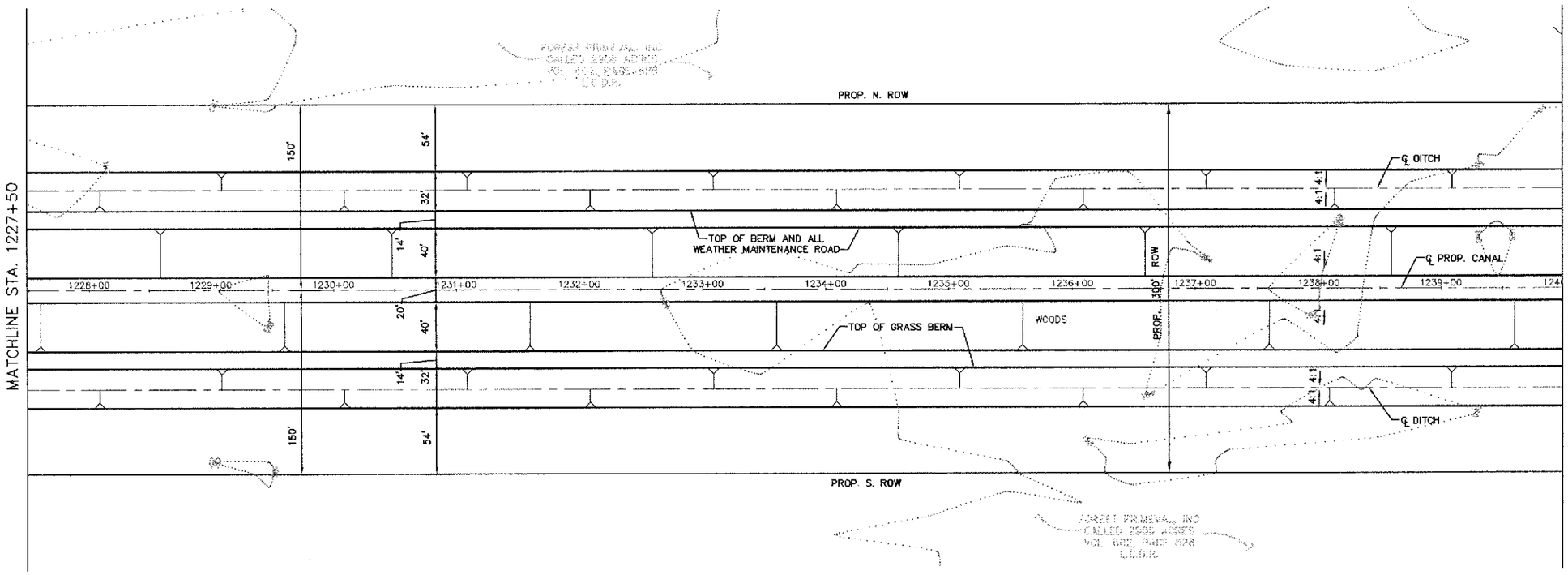
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

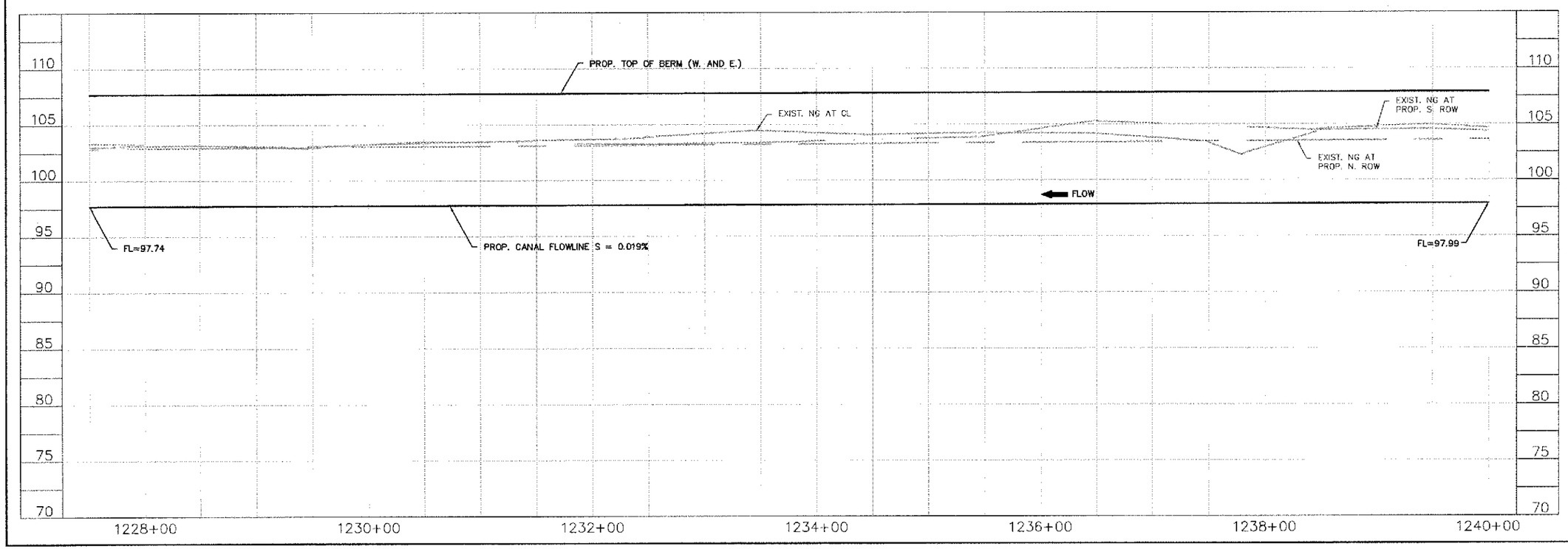
CANAL PLAN & PROFILE STA 1218+00 TO STA 1227+50

DRAWING SCALE
AS SHOWN

SHEET NO. 135 of 245

LAST MODIFIED: Jan 27, 2011 – 4:50pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order D\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: CanalP&P39.dwg

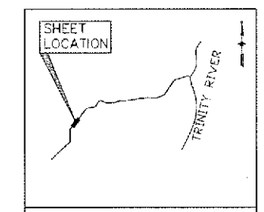




VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1596
WWW.AECOM.COM
TBPE REG. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

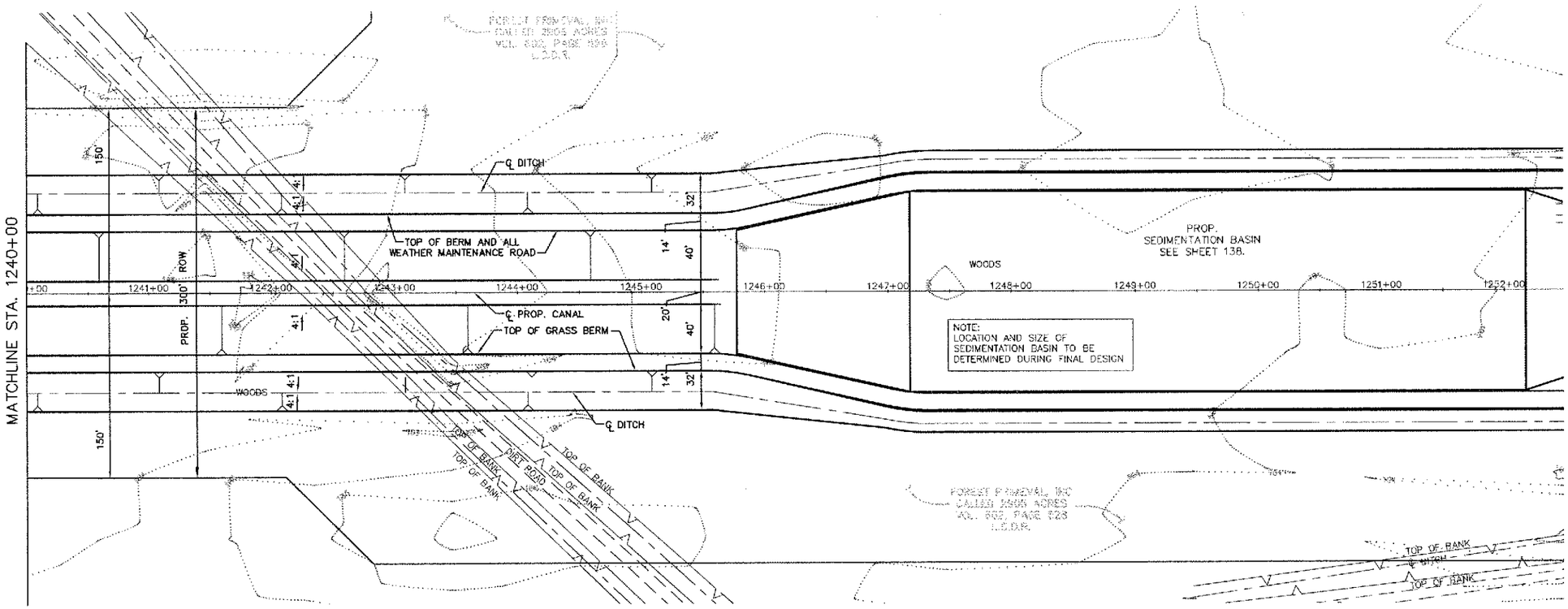
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

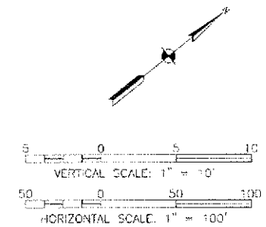
CANAL PLAN &
PROFILE STA 1227+50
TO STA 1240+00

DRAWING SCALE
AS SHOWN

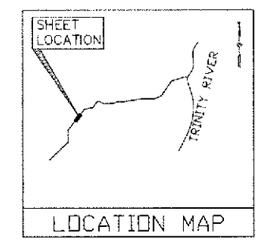
SHEET NO. 36 OF 245

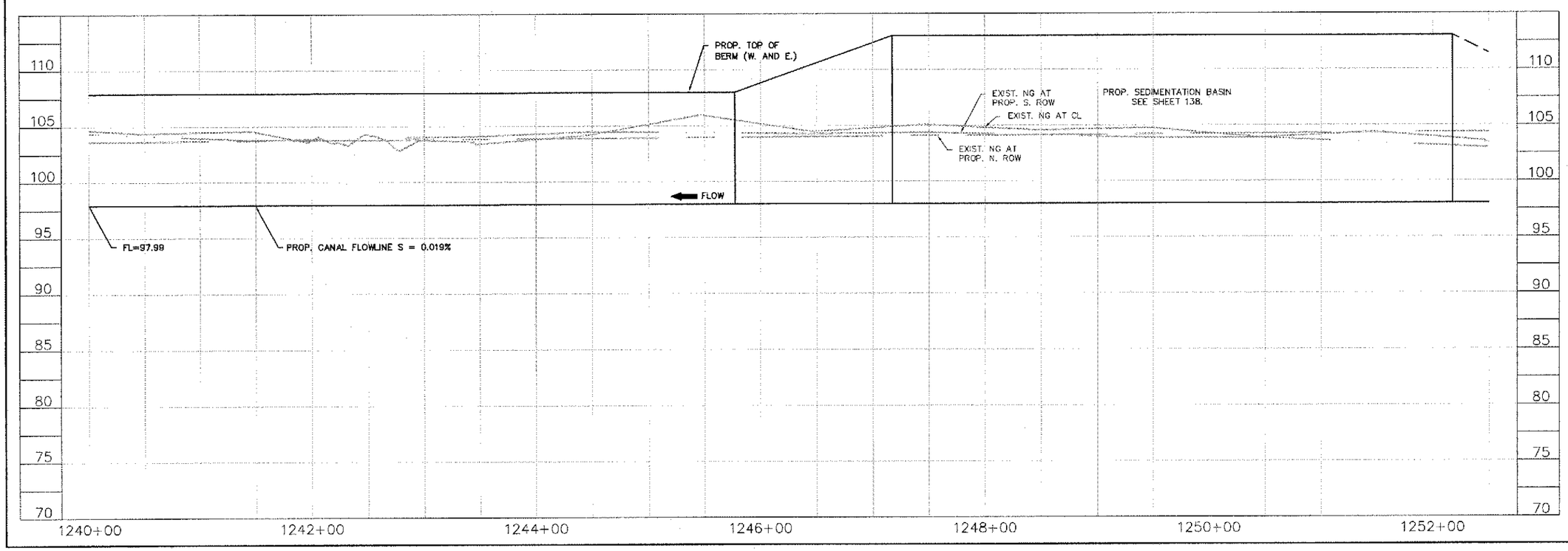
LAST MODIFIED: Jan 27, 2011 – 4:50pm BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: Curve\P&P100.dwg





NOTE:
DESIGN OF DRAINAGE TO OCCUR DURING FINAL DESIGN





KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1593
WWW.AECOM.COM
TBPE REG. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

CWA

COASTAL WATER AUTHORITY

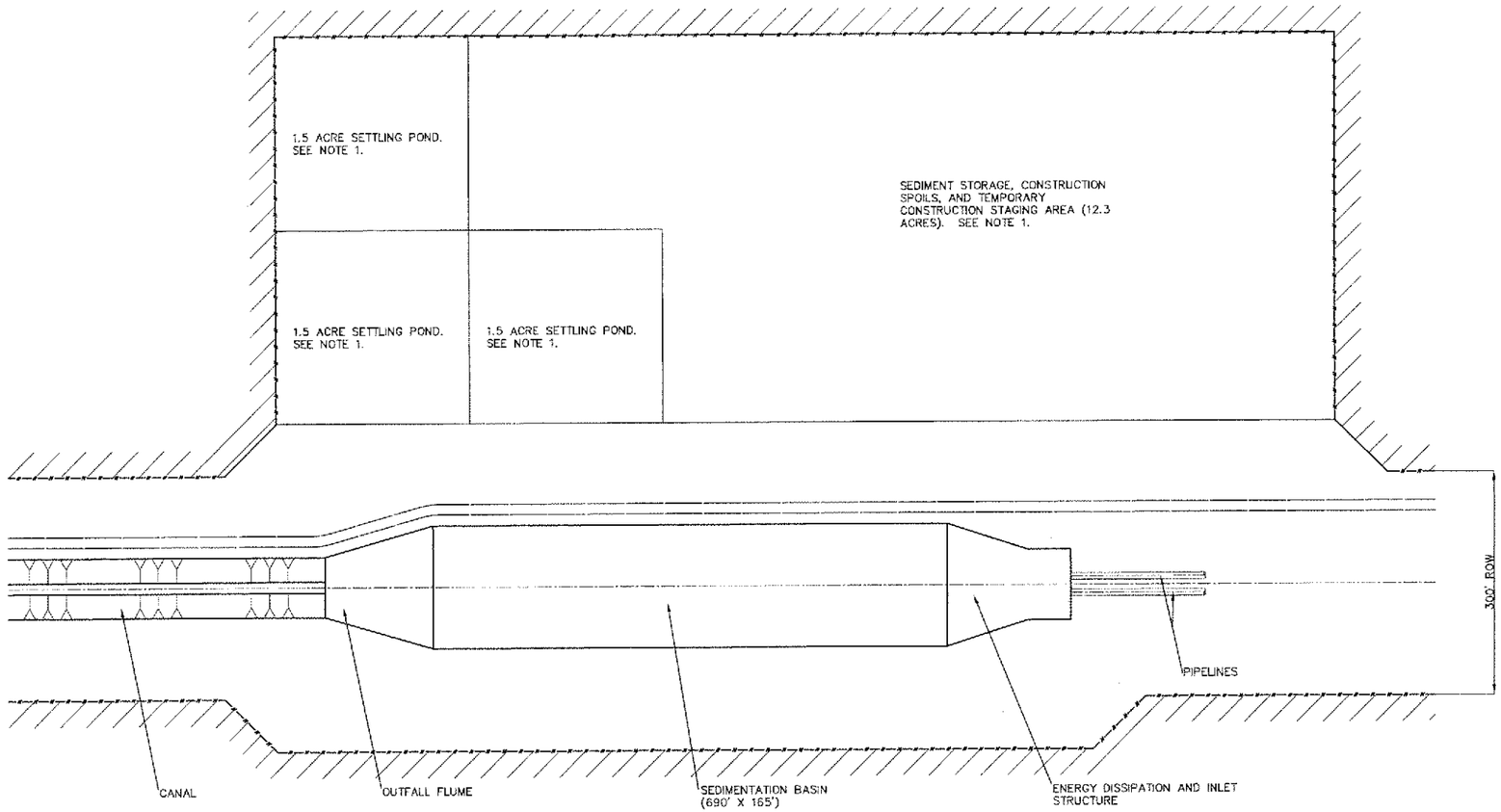
LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL PLAN & PROFILE STA 1240+00 TO SEDIMENTATION BASIN

DRAWING SCALE
AS SHOWN

SHEET NO. 137 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:53pm BY USER: ThompsonBI
DWG. LOCATION: G:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWO\Sheets\
DWG. NAME: CanalPlan1101.dwg



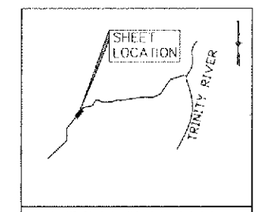
100 0 100 200
HORIZONTAL SCALE: 1" = 200'

CWA DISTURBED AREA CALCULATIONS

ADDITIONAL DISTURBED AREA FOR SEDIMENTATION BASIN	15.01 ACRES
SEDIMENT STORAGE, SETTLING PONDS, CONSTRUCTION SPOILS, AND TEMPORARY CONSTRUCTION STAGING AREA	16.95 ACRES
TOTAL AREA DISTURBED BY CWA	31.96 ACRES

NOTES:

1. SYSTEM OF THREE (3) 1.50 ACRE PONDS ARE USED TO SEPARATE SOLIDS FROM DREDGE SPOILS PRIOR TO PERMANENT DISPOSAL IN THE SEDIMENT STORAGE AREA. AFTER SEPARATION, CLARIFIED WATER IS RETURNED TO THE CANAL.
2. SEDIMENTATION BASIN LAYOUT BASED ON CONCEPTUAL DESIGN. ACTUAL SIZE AND DIMENSIONS TO BE DETERMINED DURING FINAL DESIGN.



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

LEGEND

- UNDISTURBED AREA
- PROPOSED STRUCTURE
- PROPOSED PIPELINE
- PROPOSED ROADWAY
- PROPOSED FENCE

AECOM
AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1559
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TBPE REG. NO. F-9363

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5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

SEDIMENTATION BASIN
DETAILED PLAN

DRAWING SCALE
AS SHOWN

SHEET NO. 138 OF 295

LAST MODIFIED: Jan 27, 2011 - 4:53pm BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\FWD\Sheets\
DWG. NAME: Sed-BasinP&P.dwg

SEE ACCESS ROAD PLAN & PROFILES

PROP. N. ROW

STA 2005+20.63
15.40' LT
1-108"x40.77° BEND

STA 2001+65.00 26.00' LT
PROP FLUSHING HYDRANT

STA 2001+50.00 16.00' LT
SERVICE MANHOLE

STA 2001+40.00 26.00' LT
108" BUTTERFLY VALVE
W/ SERVICE MANHOLE

STA 2001+30.00 00.00' LT
6" AIR VENT PIPE
W/ BOLLARD

STA 2001+30.00 16.00' LT
12" COMBINATION AIR RELEASE
W/ SERVICE MANHOLE

STA 2005+08.74
14.81' RT
1-108"x40.77° BEND

STA 2001+65.00 26.00' RT
PROP FLUSHING HYDRANT

STA 2001+50.00 16.00' RT
SERVICE MANHOLE

STA 2001+40.00 26.00' RT
108" BUTTERFLY VALVE
W/ SERVICE MANHOLE

STA 2001+30.00 16.00' RT
12" COMBINATION AIR RELEASE
W/ SERVICE MANHOLE

PROP. SEDIMENTATION BASIN
SEE SHEET 138
2000+00

2005+00

20' MIN.

2010+00

24'

56'

134'

CL PROP. 108" WL

ROW

300'

PROP.

STA 2008+52.00

STA 2011+41.00

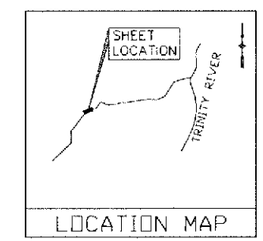
MATCHLINE STA. 2012+50

PROP. S. ROW

VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



LOCATION MAP

STA 2005+95.94
℄ 108" BUTTERFLY VALVE
W/ ACTUATOR MANHOLE

STA 2005+85.94
12" COMBINATION
AIR RELEASE VALVE
W/ SERVICE MANHOLE

STA 2006+05.94
SERVICE MANHOLE

STA 2006+20.00
PROP FLUSHING
HYDRANT ASSEMBLY

PROP. SEDIMENTATION BASIN. SEE SHEET 138.

6' MIN. COVER

EXIST. NG AT PROP. N. ROW

EXIST. NG AT CL

EXIST. NG AT PROP. S. ROW

PROP. DUAL 108" WATER LINES

S=-0.10%

FLOW

S=-0.24%

S=-0.86%

EL=85.51

VPI STA 2008+52.00
FL=87.15
1-108"x1.31° BEND

VPI STA 2011+41.00
FL=86.45
1-108"x3.55° BEND

110 105 100 95 90 85 80 75 70

2000+00 2002+00 2004+00 2006+00 2008+00 2010+00 2012+00

KEVIN R. KRAHN, P.E.
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713.780.0838 fax.

SURVEYED BY:
FB NO.

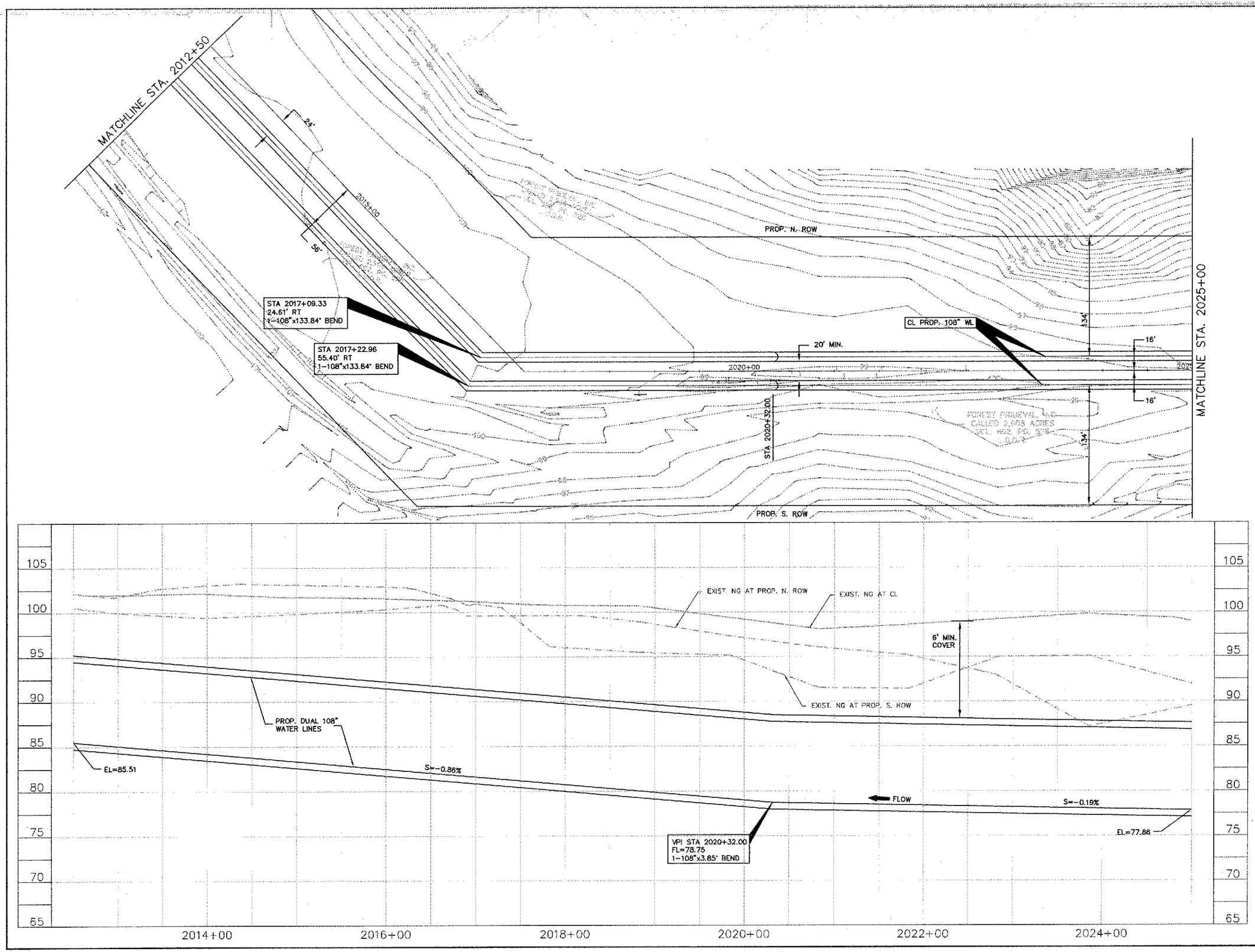
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

PIPELINE PLAN &
PROFILE STA 2000+00
TO STA 2012+50

DRAWING SCALE
AS SHOWN

SHEET NO. 139 OF 295

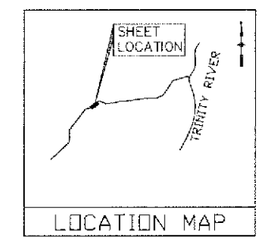
LAST MODIFIED: Jan 28, 2011 - 6:39am BY USER: ThompsonBI
DWG LOCATION: D:\Work Order 5\V4.0 ENGINEERING NOTES & CALCULATIONS\V4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: P&P1.dwg



VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



LOCATION MAP

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

PIPELINE PLAN & PROFILE STA 2012+50 TO STA 2025+00

DRAWING SCALE
AS SHOWN

SHEET NO. 40 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:35pm BY USER: Thompson31
DWG. LOCATION: D:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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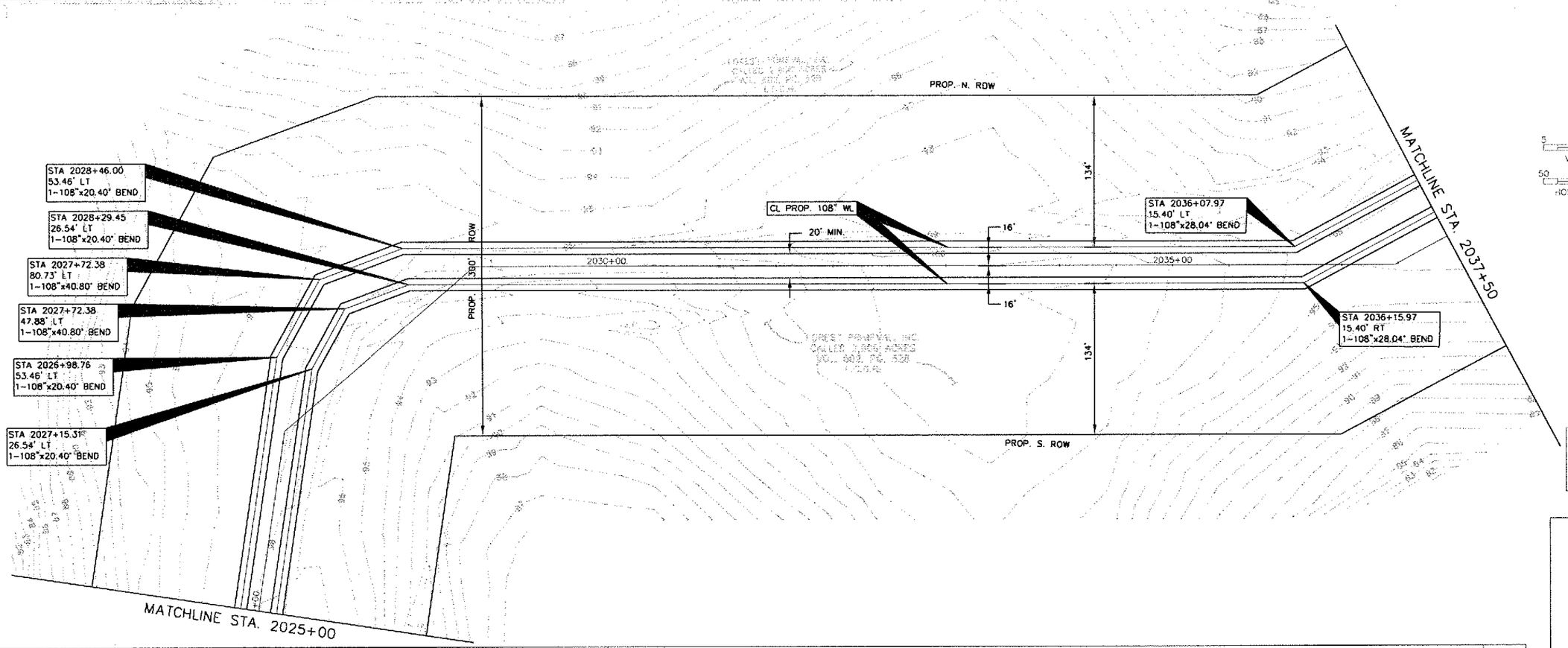
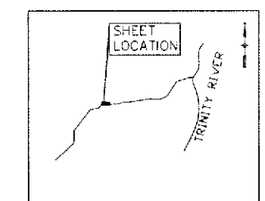
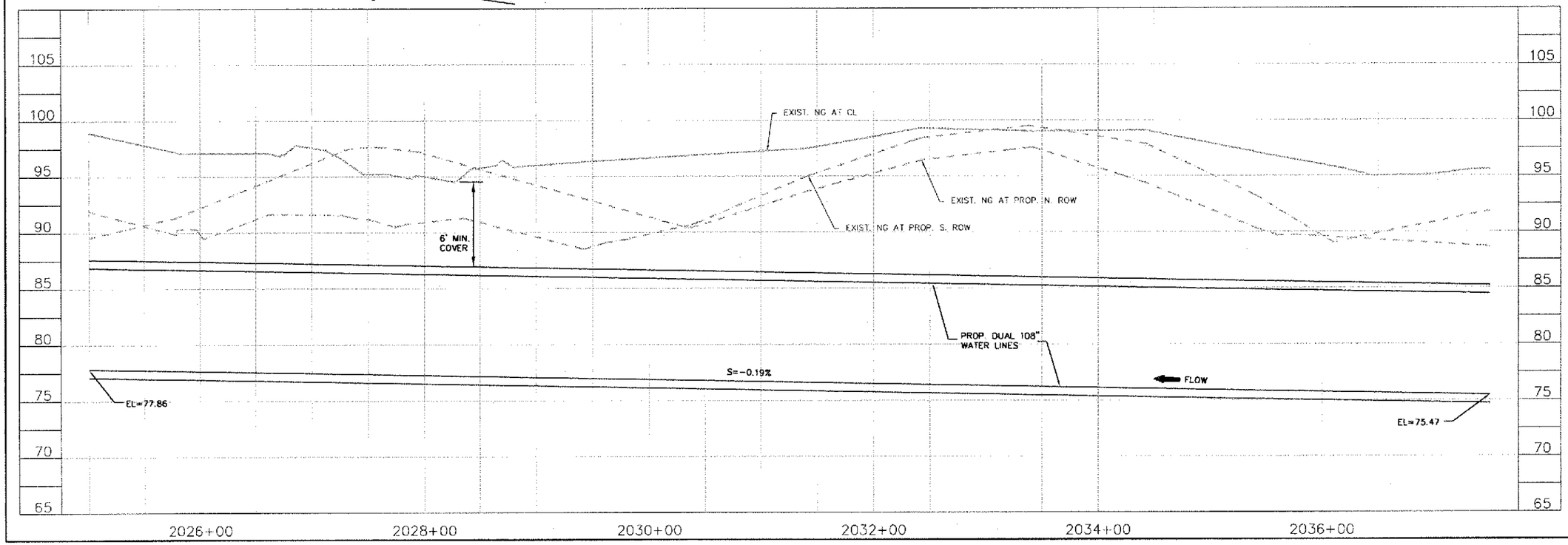


NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



LOCATION MAP



KEVIN R. KRAHN, P.E.
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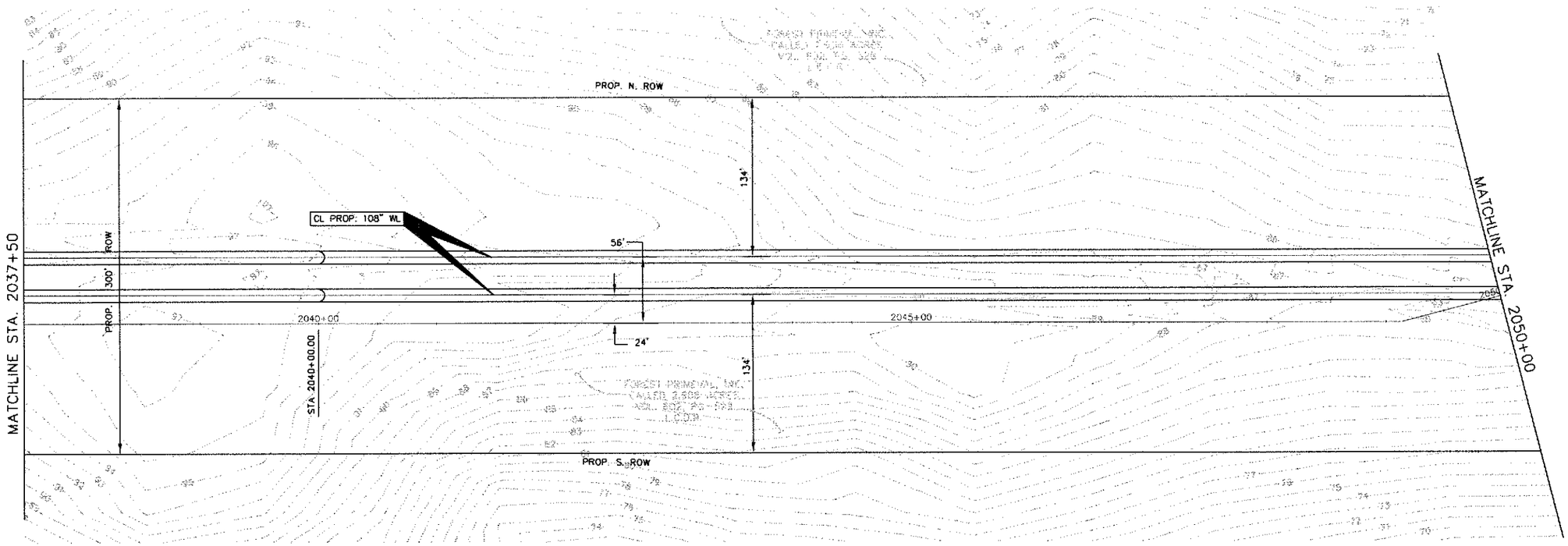
LUCE BAYOU INTERBASIN TRANSFER PROJECT

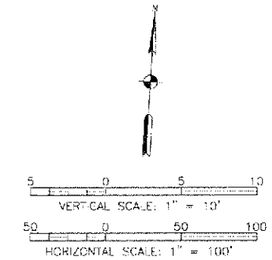
PIPELINE PLAN &
PROFILE STA 2025+00
TO STA 2037+50

DRAWING SCALE
AS SHOWN

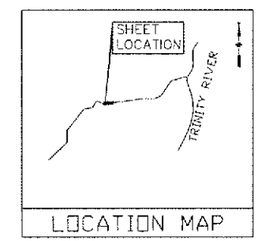
SHEET NO. 141 OF 245

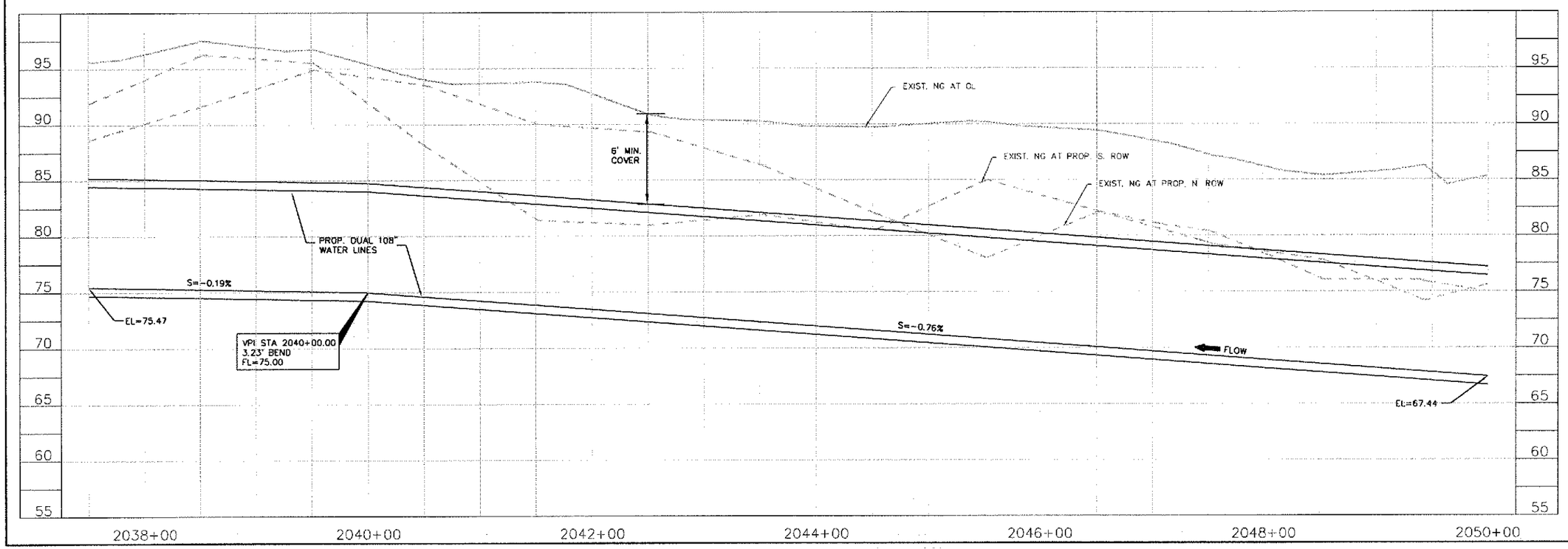
LAST MODIFIED: Jan 27, 2011 - 4:56pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: P&P3.dwg





NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS





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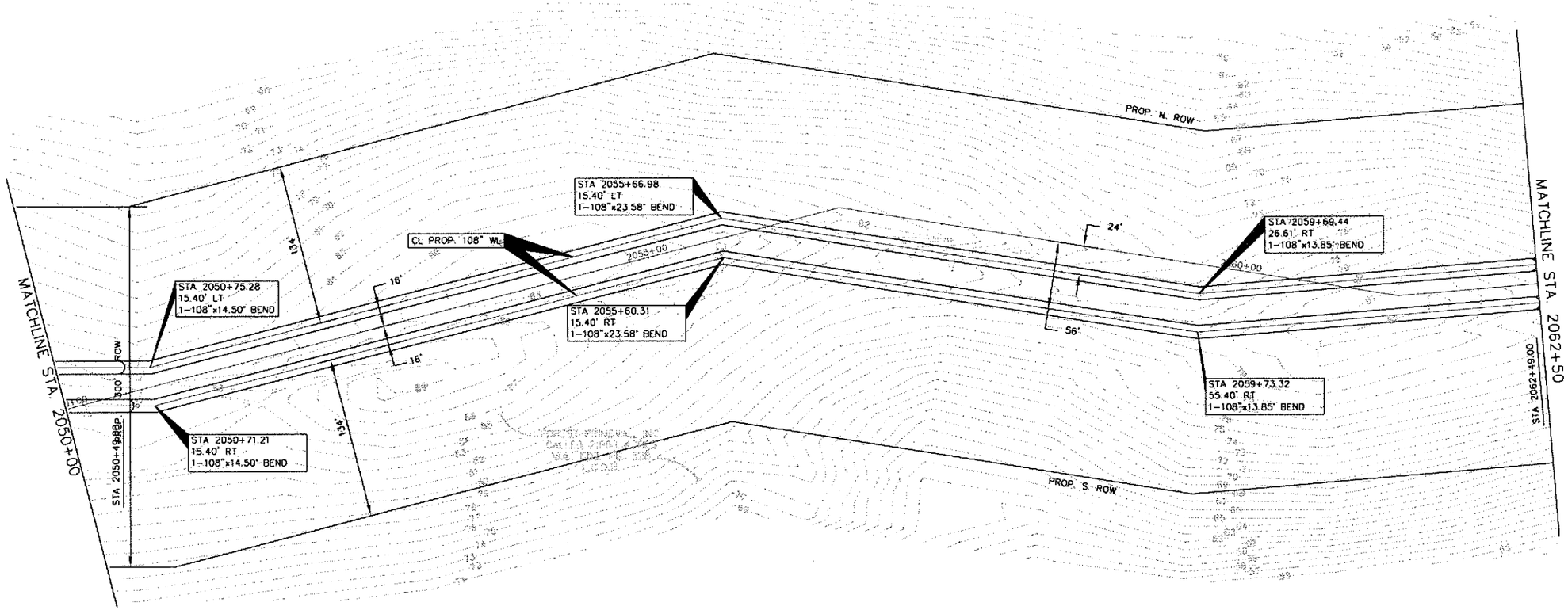
LUCE BAYOU INTERBASIN TRANSFER PROJECT

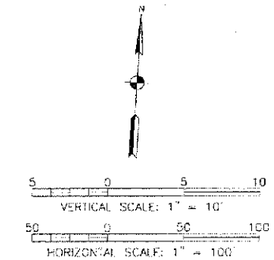
PIPELINE PLAN & PROFILE STA 2037+50 TO STA 2050+00

DRAWING SCALE
AS SHOWN

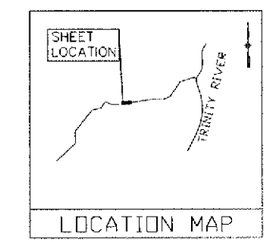
SHEET NO. 142 OF 249

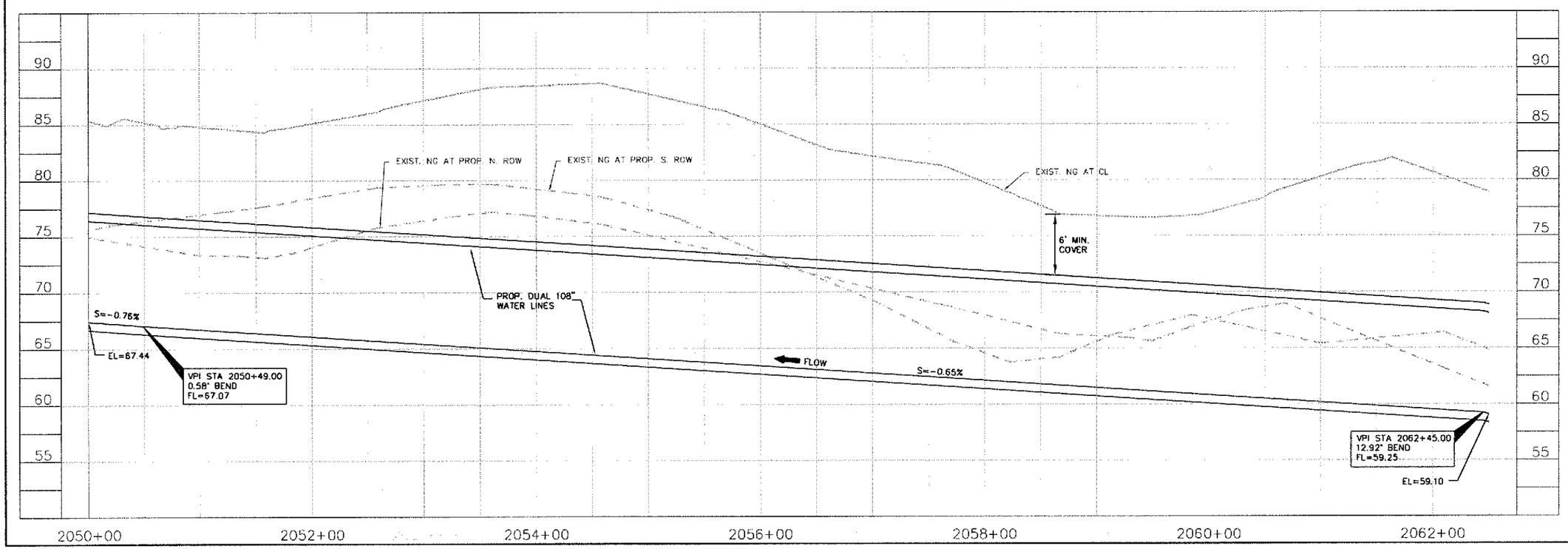
LAST MODIFIED: Jan 27, 2011 - 4:56pm BY USER: ThompsonEl
DWG LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG NAME: P&P4.dwg





NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS





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713.780.0638 fax.

SURVEYED BY:
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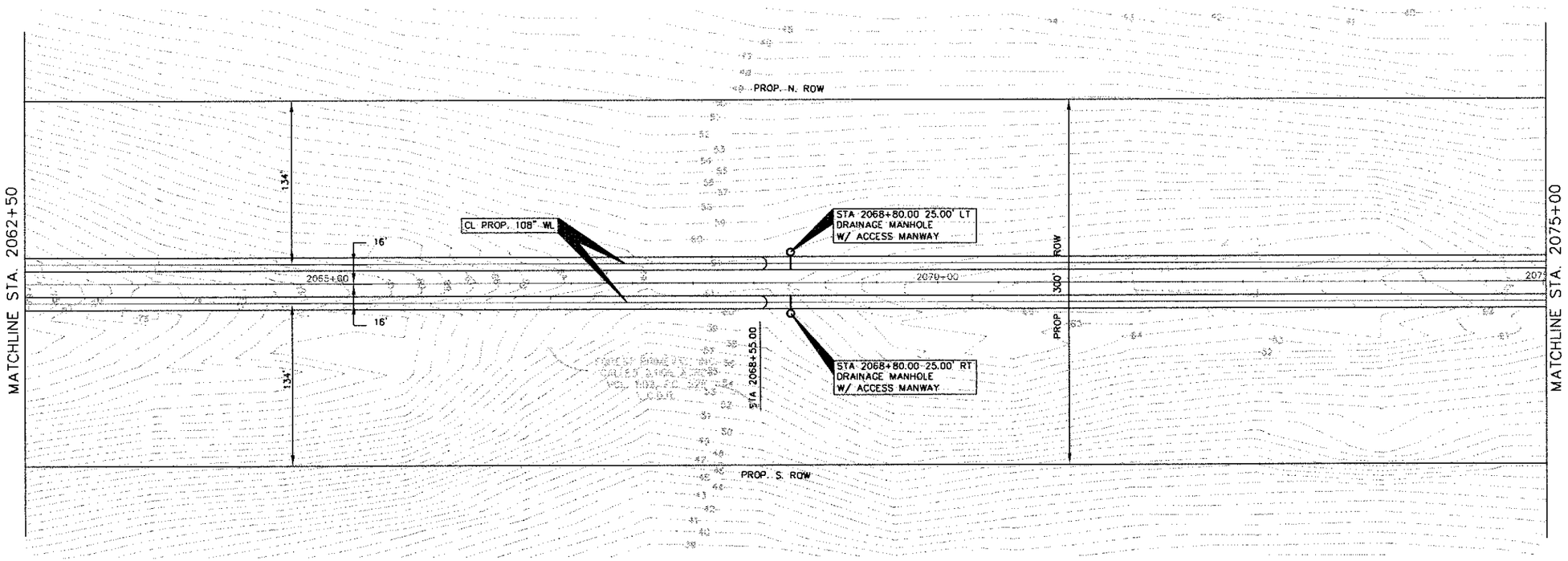
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

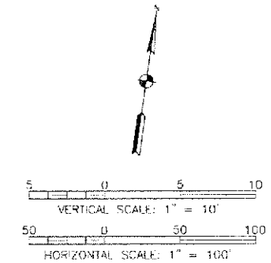
PIPELINE PLAN & PROFILE STA 2050+00 TO STA 2062+50

DRAWING SCALE
AS SHOWN

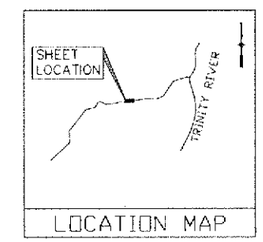
SHEET NO. 143 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:56pm BY USER: ThompsonBi
DWG LOCATION: D:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG NAME: P&P5.dwg

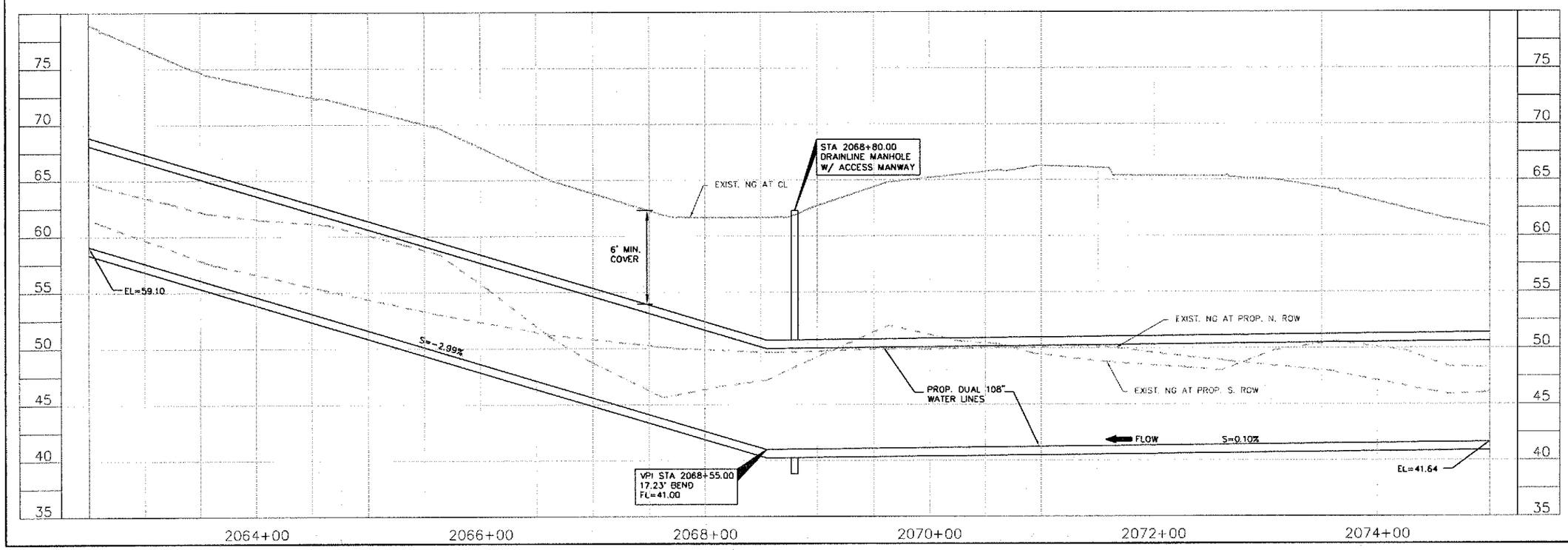




NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



LOCATION MAP



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CWA

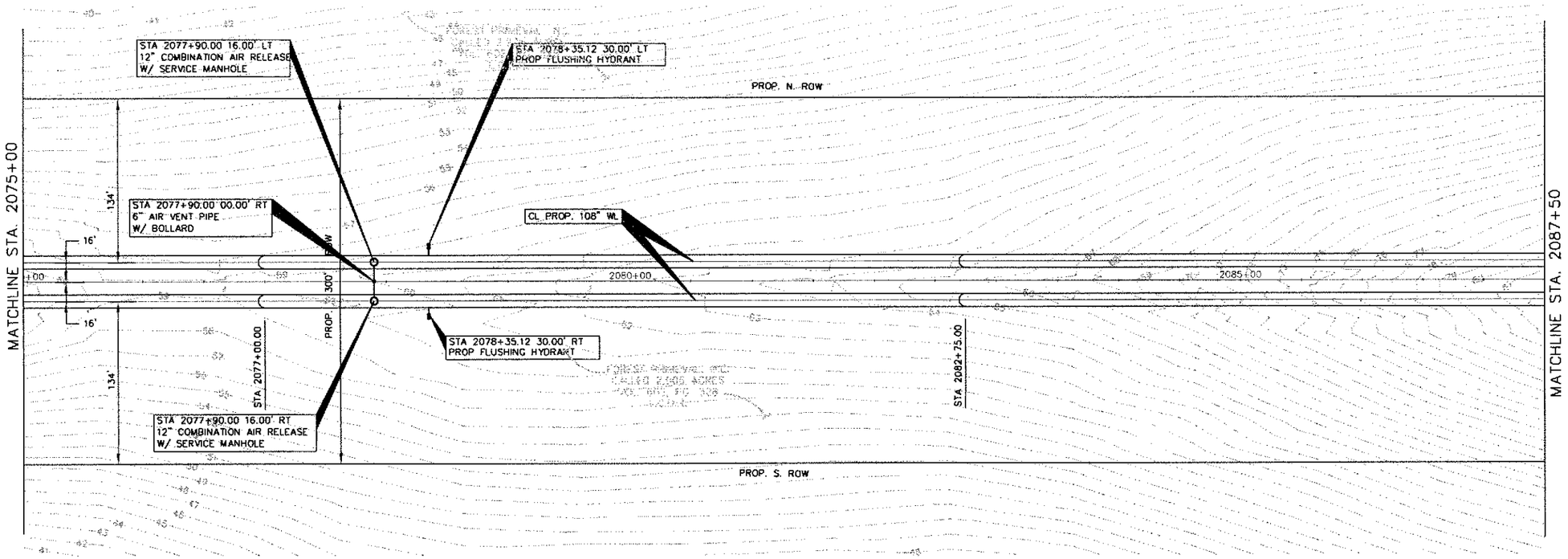
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

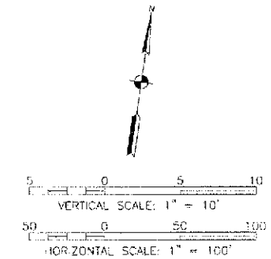
PIPELINE PLAN &
PROFILE STA 2062+50
TO STA 2075+00

DRAWING SCALE
AS SHOWN

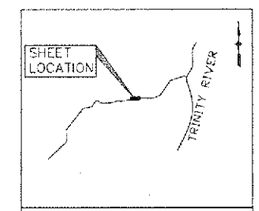
SHEET NO. 44 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:57am BY USER: ThompsonBl
DWG. LOCATION: D:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: P&P5.dwg

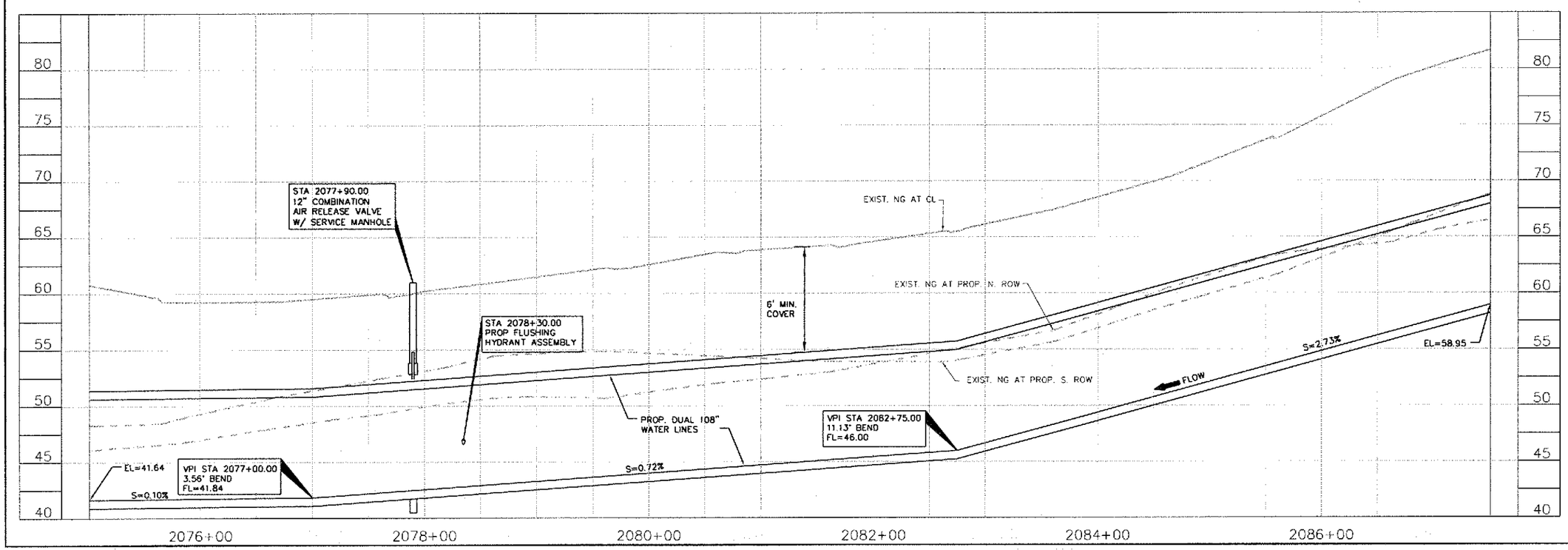




NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



LOCATION MAP



KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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713.780.0838 fax.

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CWA

COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

PIPELINE PLAN &
PROFILE STA 2075+00
TO STA 2087+50

DRAWING SCALE
AS SHOWN

SHEET NO. 145 OF 243

LAST MODIFIED: Jan 27, 2011 - 4:57pm BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 5\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Code\PWD\Sheets\
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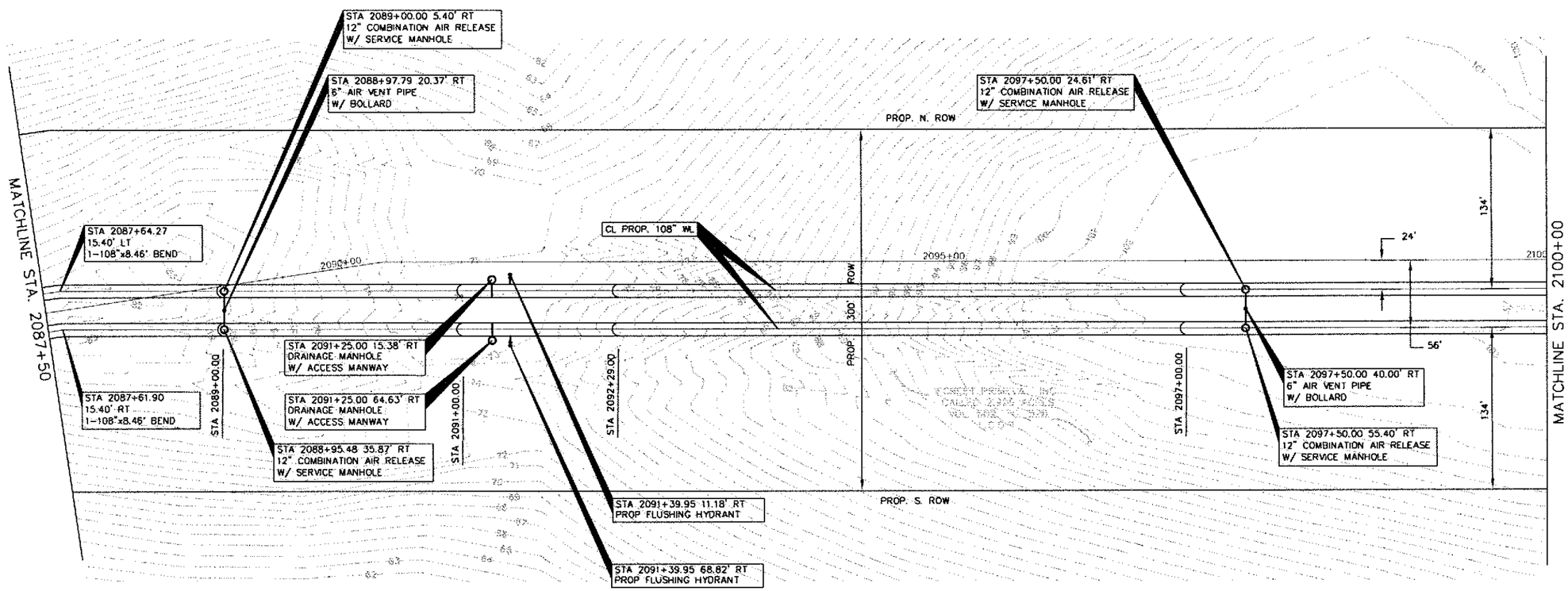
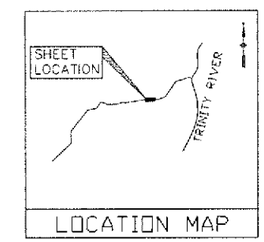


50 0 50 100
HORIZONTAL SCALE: 1" = 100'

NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



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SURVEYED BY:
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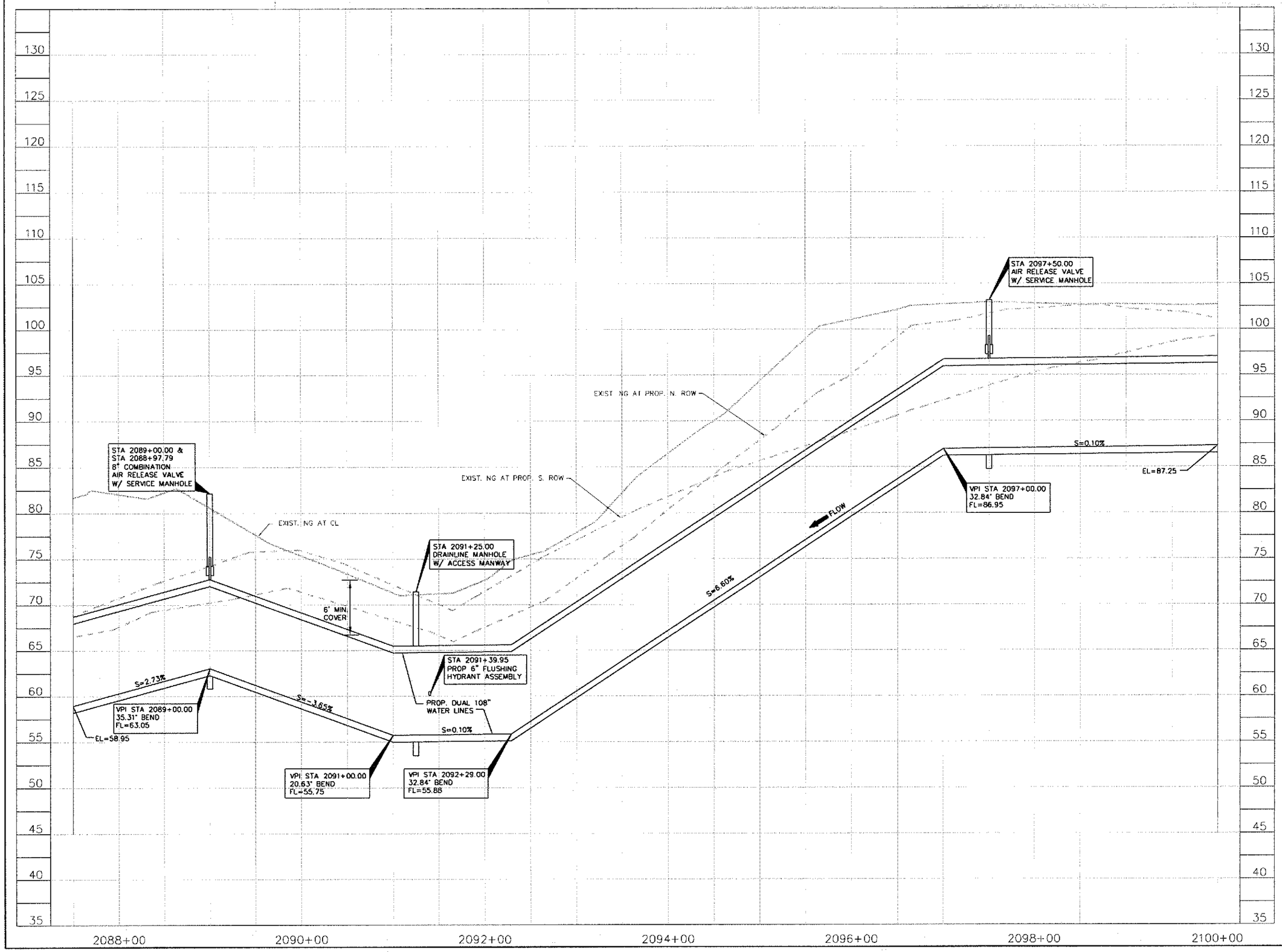
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

PIPELINE PLAN STA
2087+50 TO STA
2100+00

DRAWING SCALE
AS SHOWN

SHEET NO. 146 OF 245

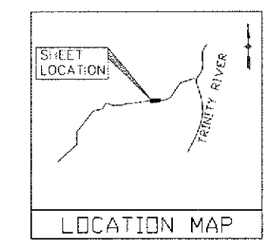
LAST MODIFIED: Jan 27, 2011 - 4:57pm BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: P&PB.dwg



VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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NOT FOR CONSTRUCTION PURPOSES

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SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

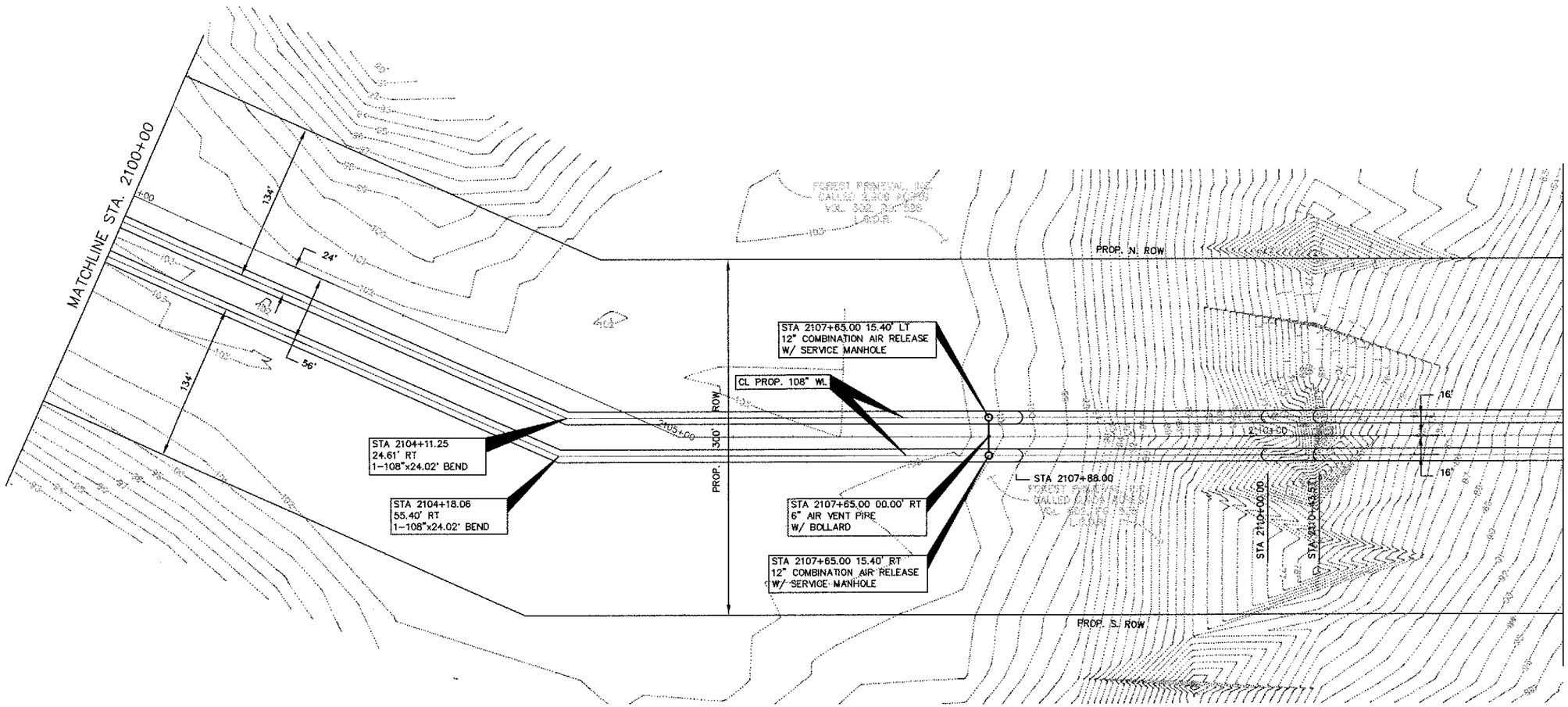
PIPELINE PROFILE STA
2087+50 TO STA
2100+00

DRAWING SCALE
AS SHOWN

SHEET NO. 147 OF 295

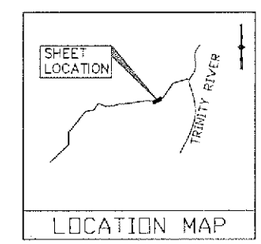
No.	Date	Revisions	App.

LAST MODIFIED: Jan 27, 2011 – 4:57pm BY USER: ThompsonBI
DWG. LOCATION: D:\Work Order 6\4.3 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: P&PB-2.dwg



HORIZONTAL SCALE: 1" = 100'

NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

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713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

PIPELINE PLAN STA
2100+00 TO STA
2112+50

DRAWING SCALE
AS SHOWN

SHEET NO. 148 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:59pm BY USER: ThompsonBl
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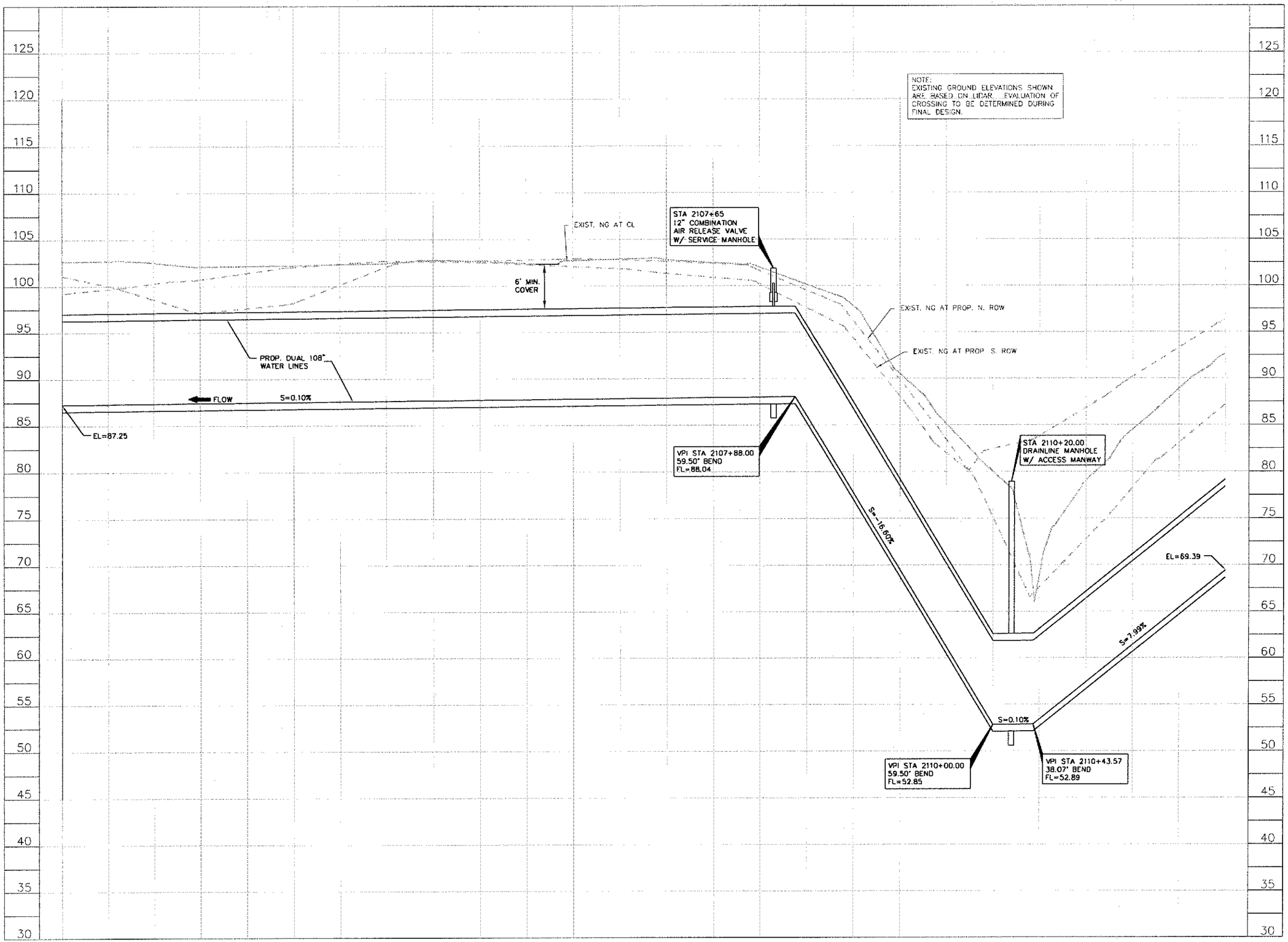
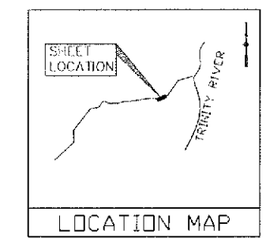


NOTE:
EXISTING GROUND ELEVATIONS SHOWN ARE BASED ON LIDAR. EVALUATION OF CROSSING TO BE DETERMINED DURING FINAL DESIGN.

5 0 5 10
VERTICAL SCALE: 1" = 10'

50 0 50 100
HORIZONTAL SCALE: 1" = 100'

NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1599
WWW.AECOM.COM
TBPE REG. NO. F-9580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

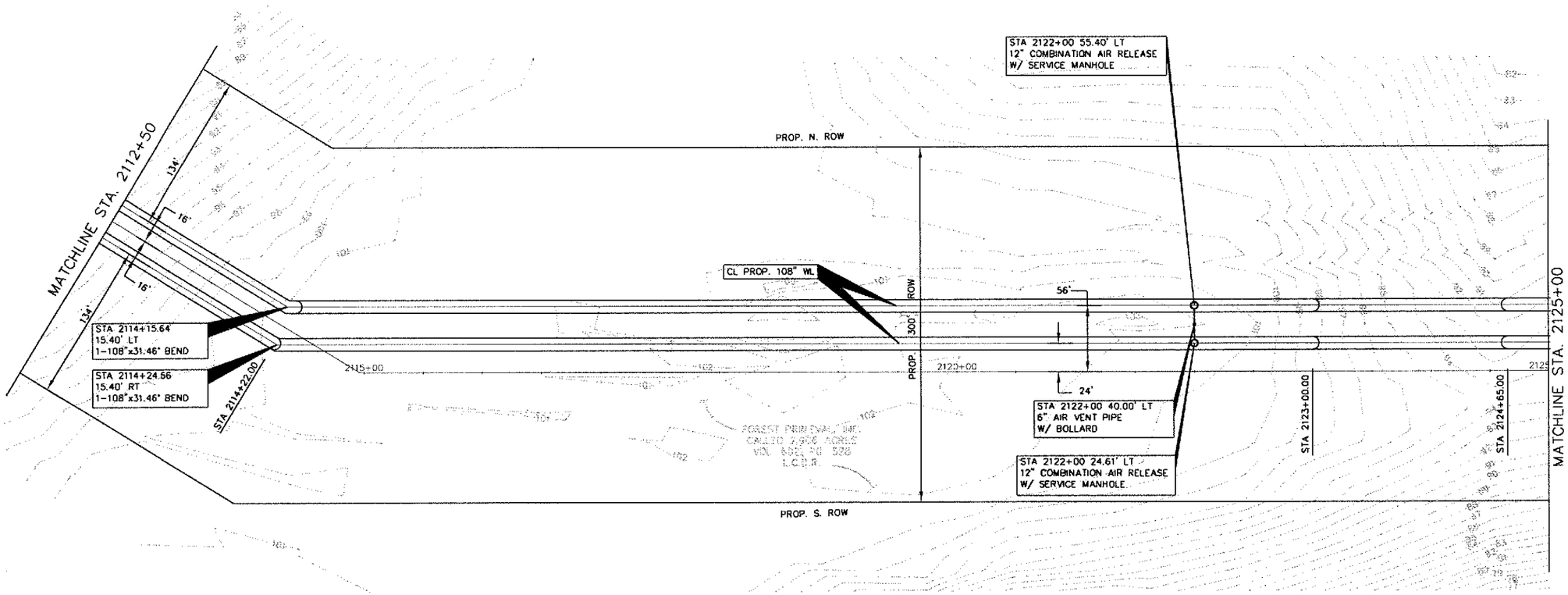
PIPELINE PROFILE STA
2100+00 TO STA
2112+50

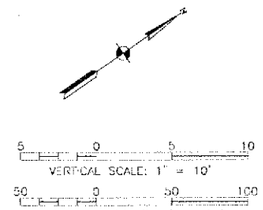
DRAWING SCALE
AS SHOWN

SHEET NO. 149 OF 295

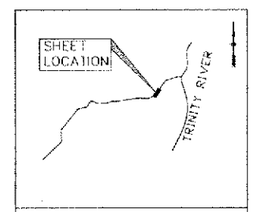
Revisions
No. Date App.

LAST MODIFIED: Jan 27, 2011 - 4:59pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\V4.0 ENGINEERING NOTES & CALCULATIONS\V4.3 Civil Notes and Calculations\Cadd\PWO\Sheets\
DWG. NAME: P&PG-2.dwg

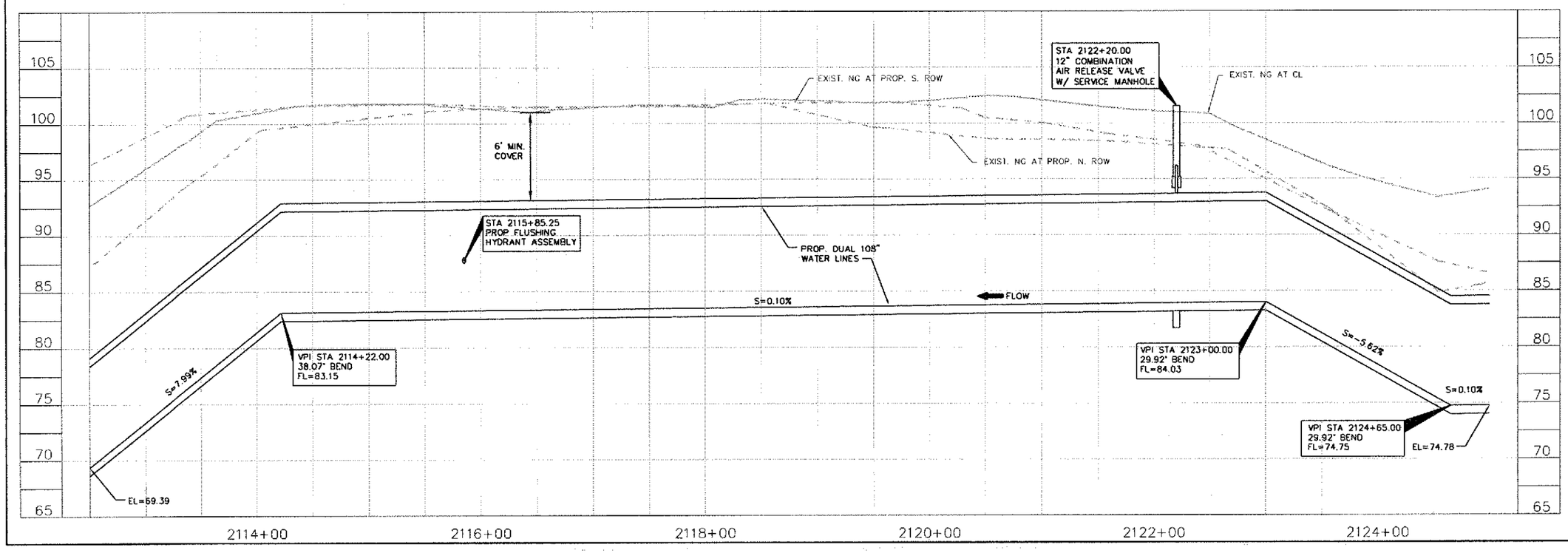




NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



LOCATION MAP



KEVIN R. KRAHN, P.E.
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AECOM TECHNICAL SERVICES, INC.
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713.780.0838 fax.

SURVEYED BY:
FB NO.

CWA

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

PIPELINE PLAN &
PROFILE STA 2112+50
TO STA 2125+00

DRAWING SCALE
AS SHOWN

SHEET NO. 150 OF 245

LAST MODIFIED: Jan 27, 2011 - 4:59pm BY USER: ThompsonBl
DWG. LOCATION: Q:\Work Order 614.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Code\PWD\Sheets\
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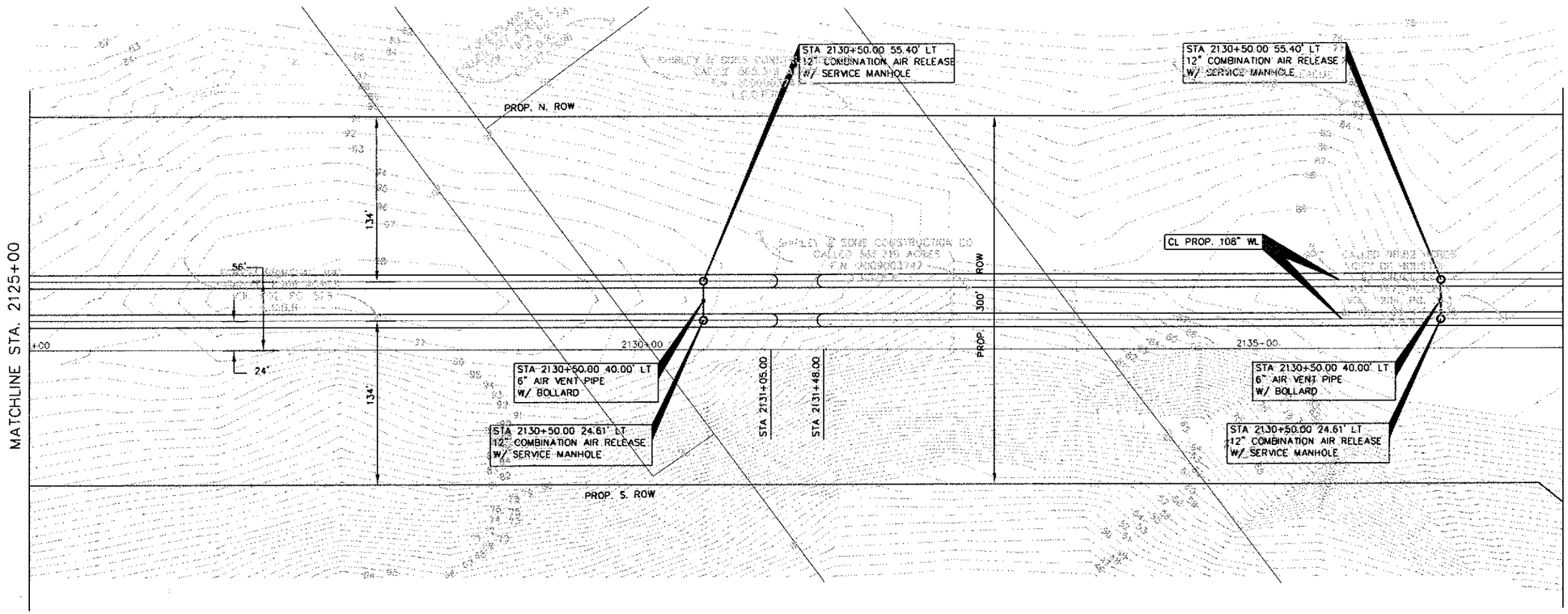
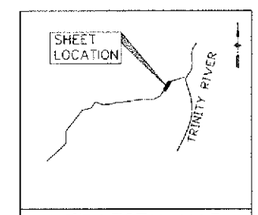


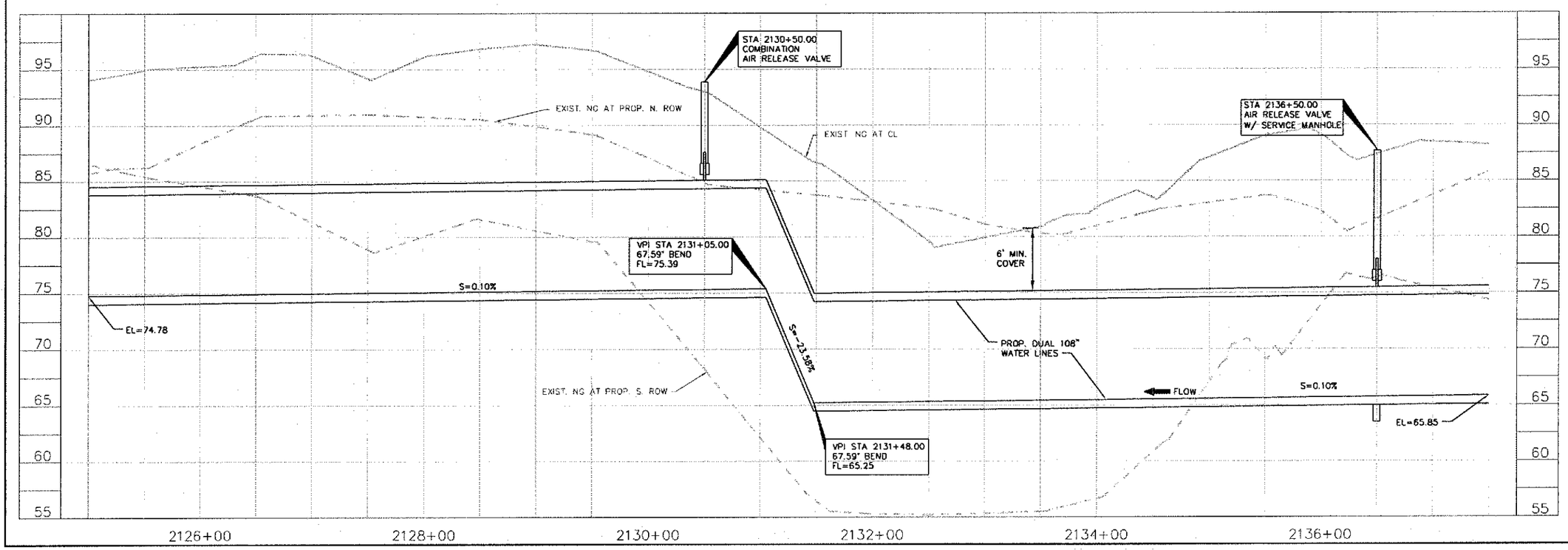
VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



LOCATION MAP



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713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

PIPELINE PLAN &
PROFILE STA 2125+00
TO STA 2137+50

DRAWING SCALE
AS SHOWN

SHEET NO. 151 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:00pm BY USER: Thompson3l
DWG. LOCATION: O:\Work Order 6\6.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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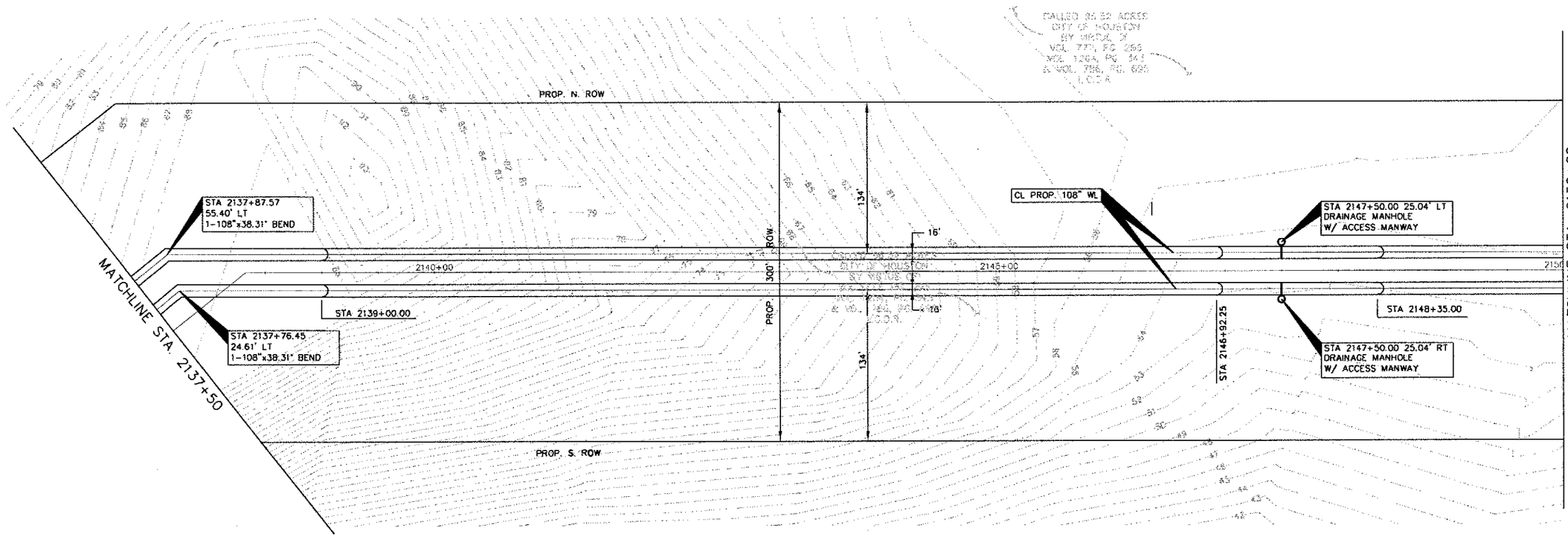
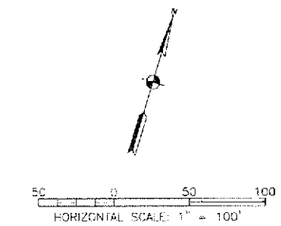
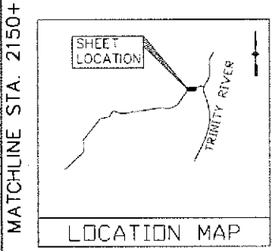




NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
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AECOM TECHNICAL SERVICES, INC.
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SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

PIPELINE PLAN STA
2137+50 TO STA
2150+00

DRAWING SCALE
AS SHOWN

SHEET NO. 132 OF 243

LAST MODIFIED: Jan 27, 2011 - 5:00pm BY USER: Thompson(B)
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWO\Sheets\
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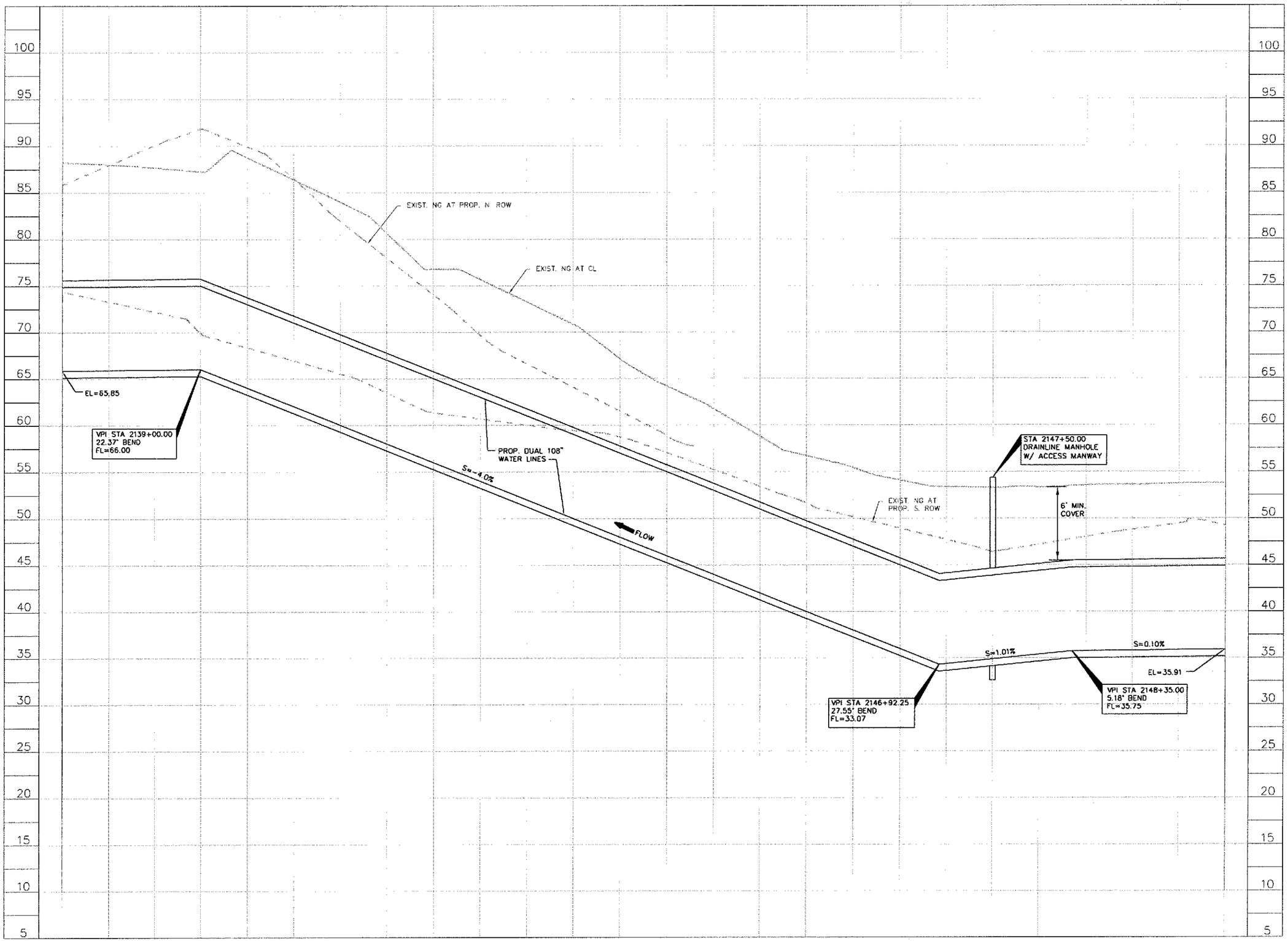
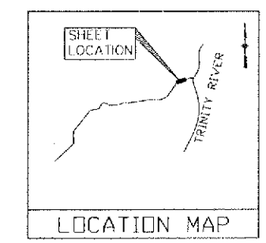


VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
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AECOM

AECOM TECHNICAL SERVICES, INC.
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713.780.0838 fax.

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

PIPELINE PROFILE STA 2137+50 TO STA 2150+00

DRAWING SCALE
AS SHOWN

SHEET NO. 153 OF 245

No.	Date	Revisions

LAST MODIFIED: Jan 27, 2011 - 5:00pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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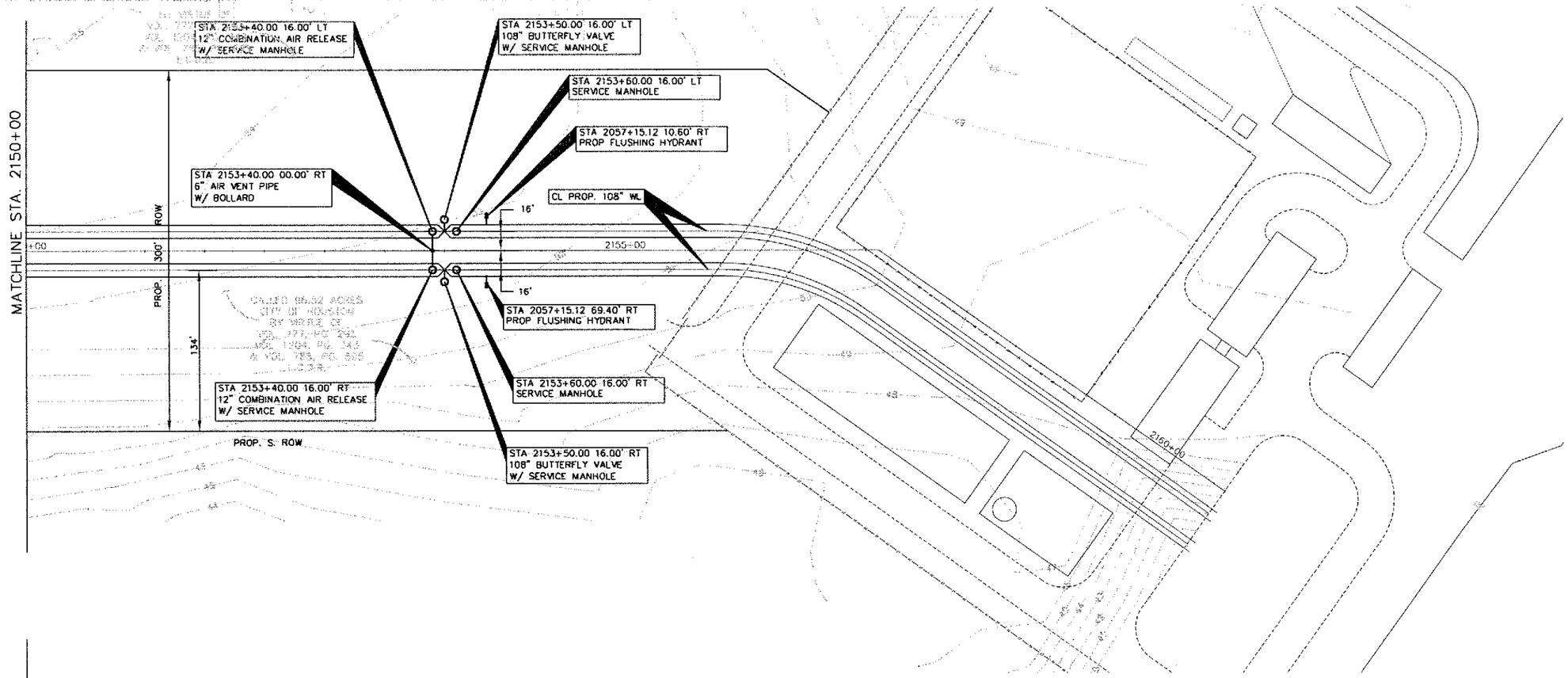
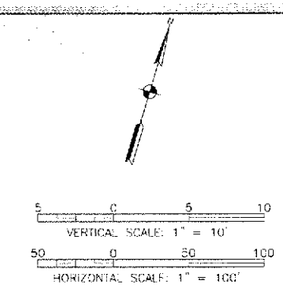
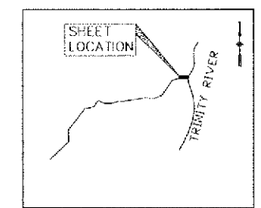
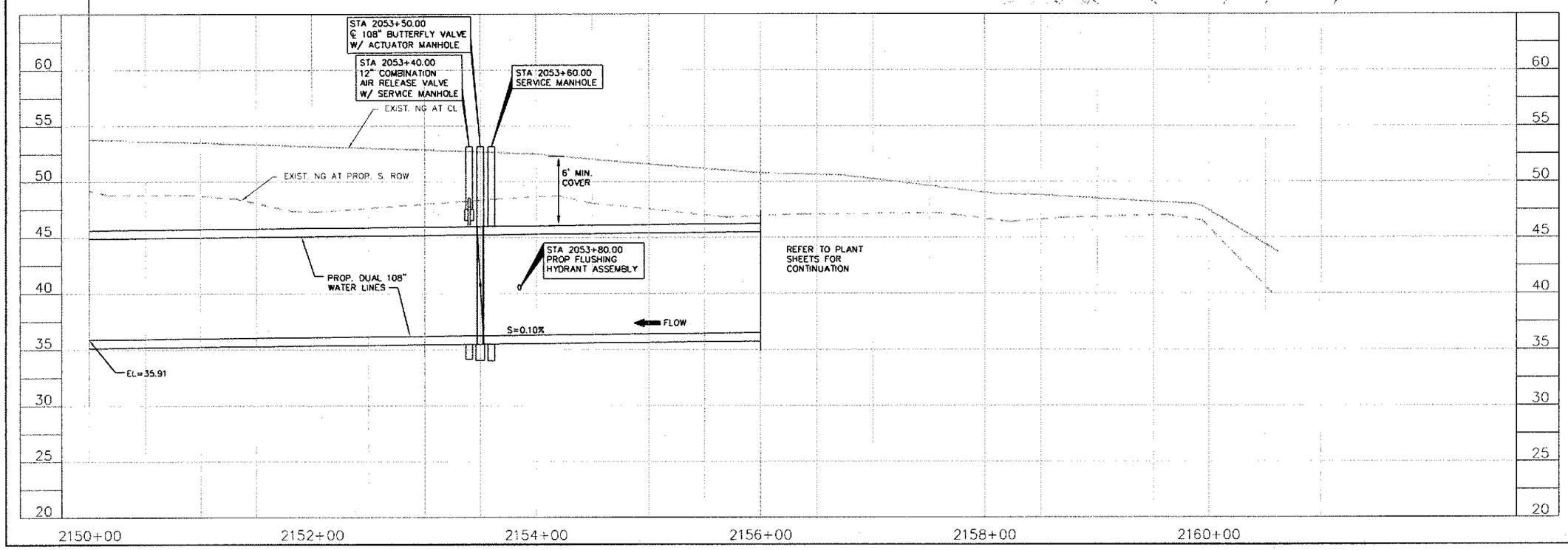




NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



LOCATION MAP



KEVIN R. KRAHN, P.E.
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INTERIM SUBMITTAL
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AECOM TECHNICAL SERVICES, INC.
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HOUSTON, TEXAS 77057-1599
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HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

PIPELINE PLAN &
PROFILE STA 2150+00
TO PUMP STATION

DRAWING SCALE
AS SHOWN

SHEET NO. 154 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:00pm BY USER: Thompsonbl
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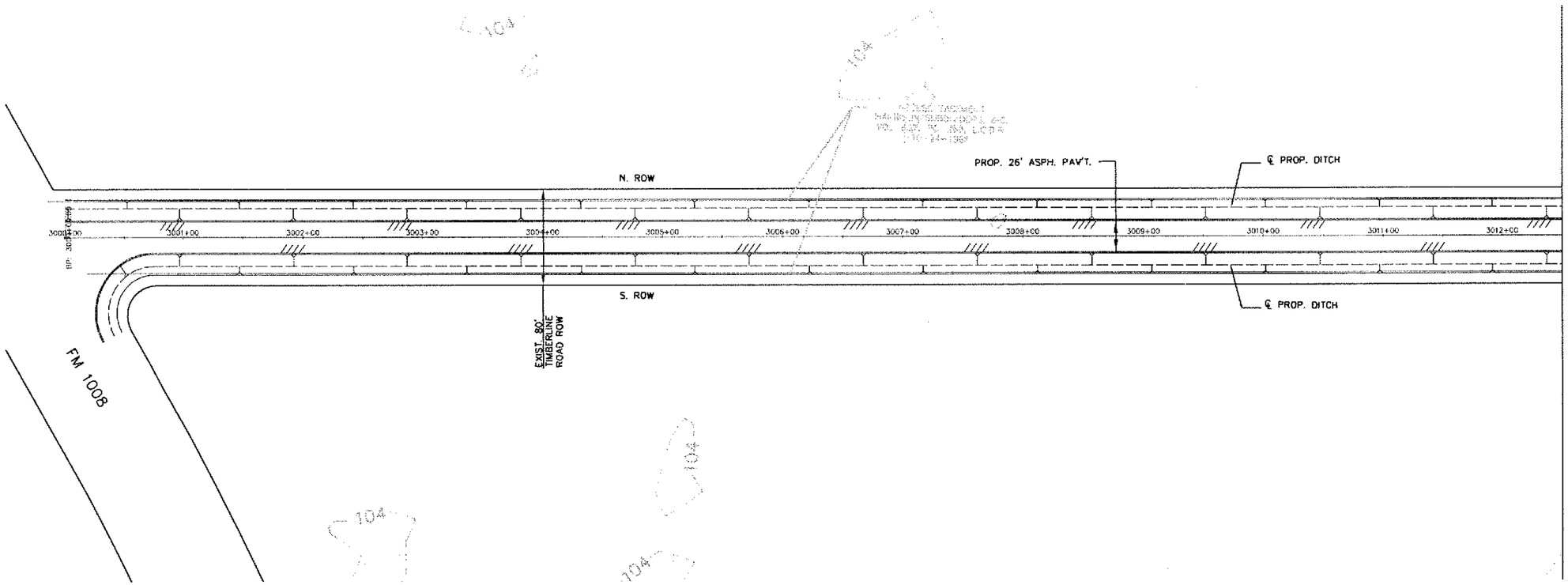
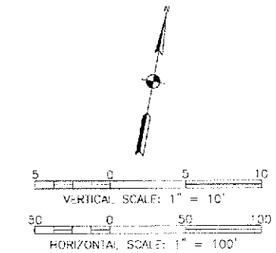
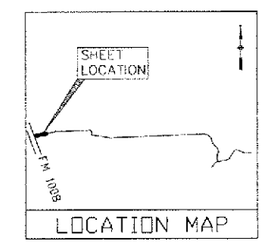
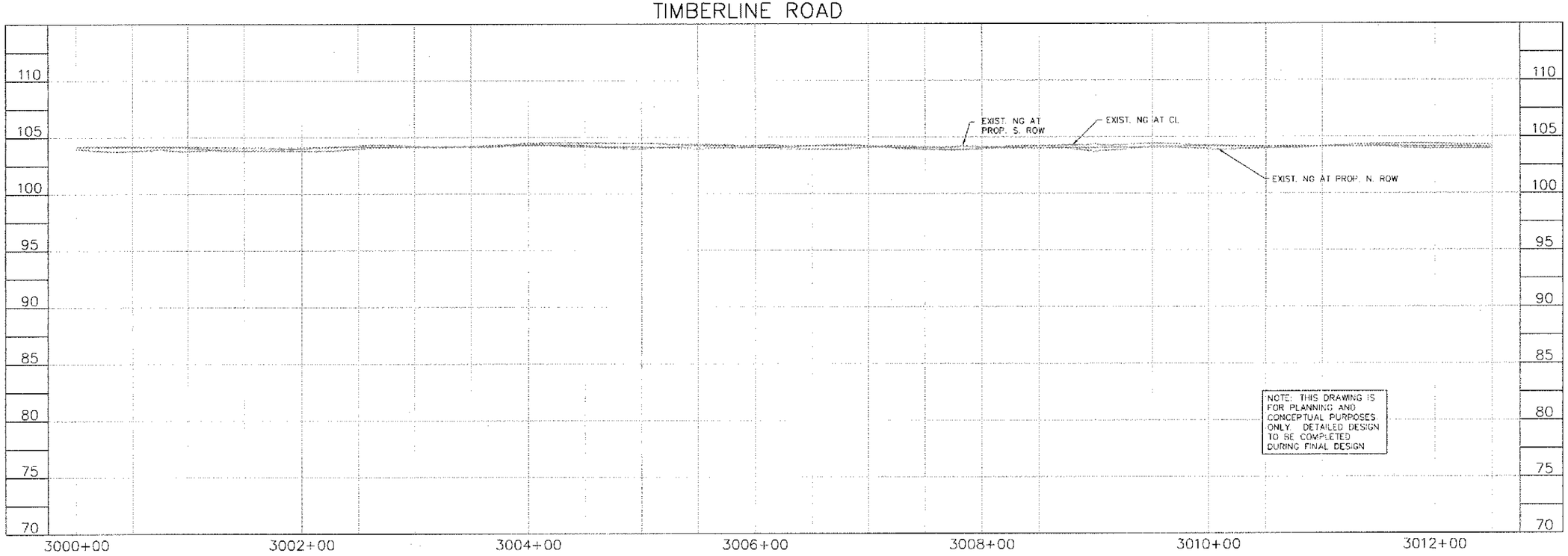






LOCATION MAP

TIMBERLINE ROAD



NOTE: THIS DRAWING IS FOR PLANNING AND CONCEPTUAL PURPOSES ONLY. DETAILED DESIGN TO BE COMPLETED DURING FINAL DESIGN

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
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AECOM

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HOUSTON, TEXAS 77057-1599
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HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD PLAN & PROFILE STA 3000+00 TO STA 3012+50

DRAWING SCALE
AS SHOWN

SHEET NO. 155 OF 245

LAST MODIFIED: Jan 27, 2011 – 3:01pm BY USER: ThompsonBi
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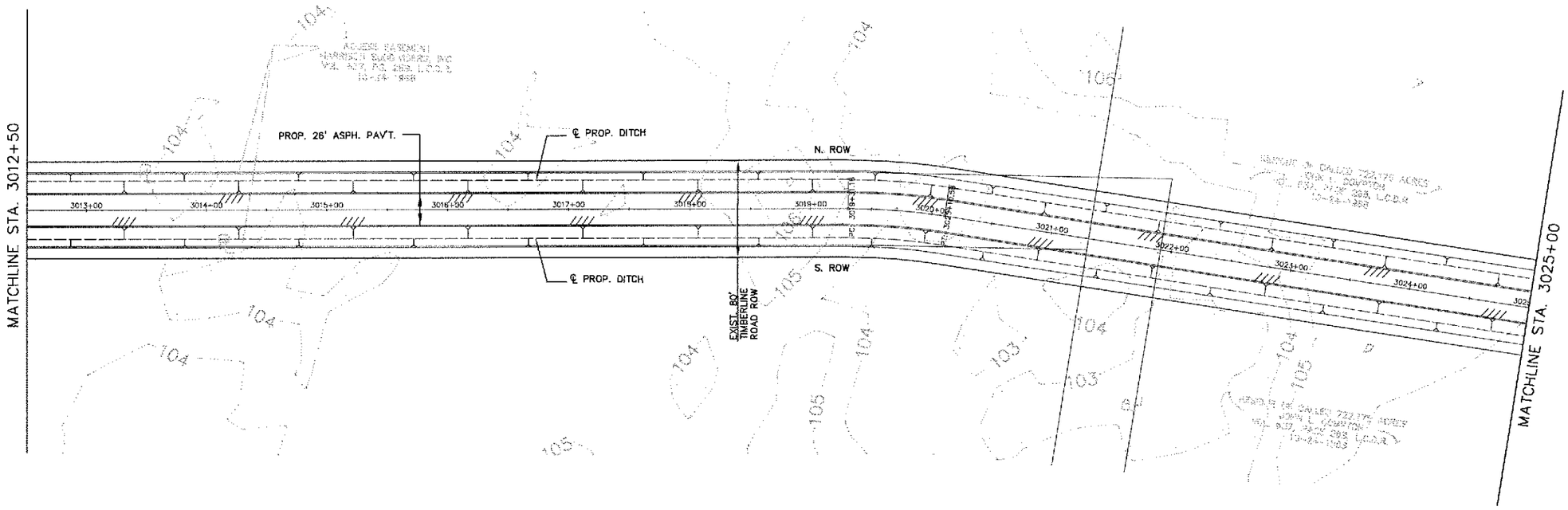

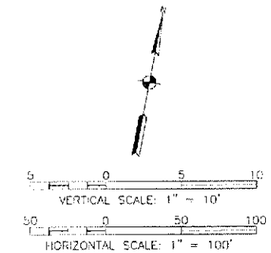

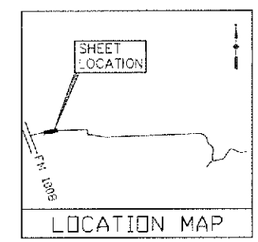

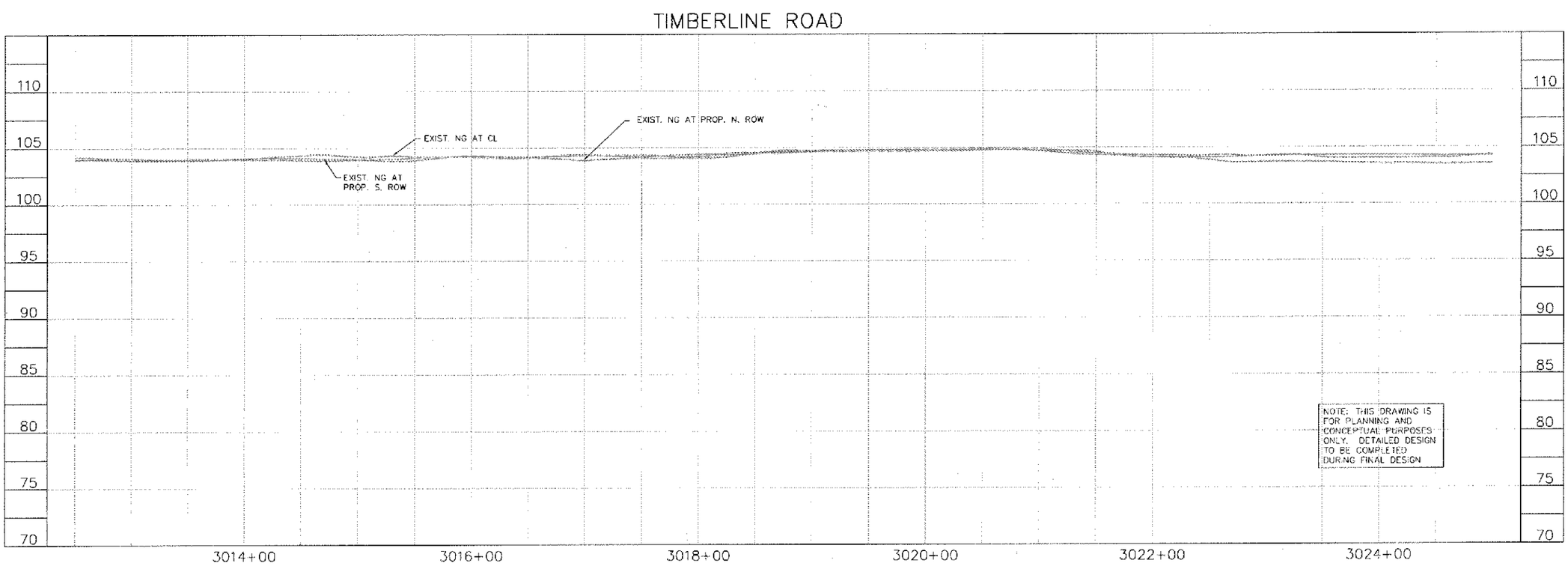

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
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HOUSTON, TEXAS 77057-1589
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TBPE REG. NO. F-3580

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HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

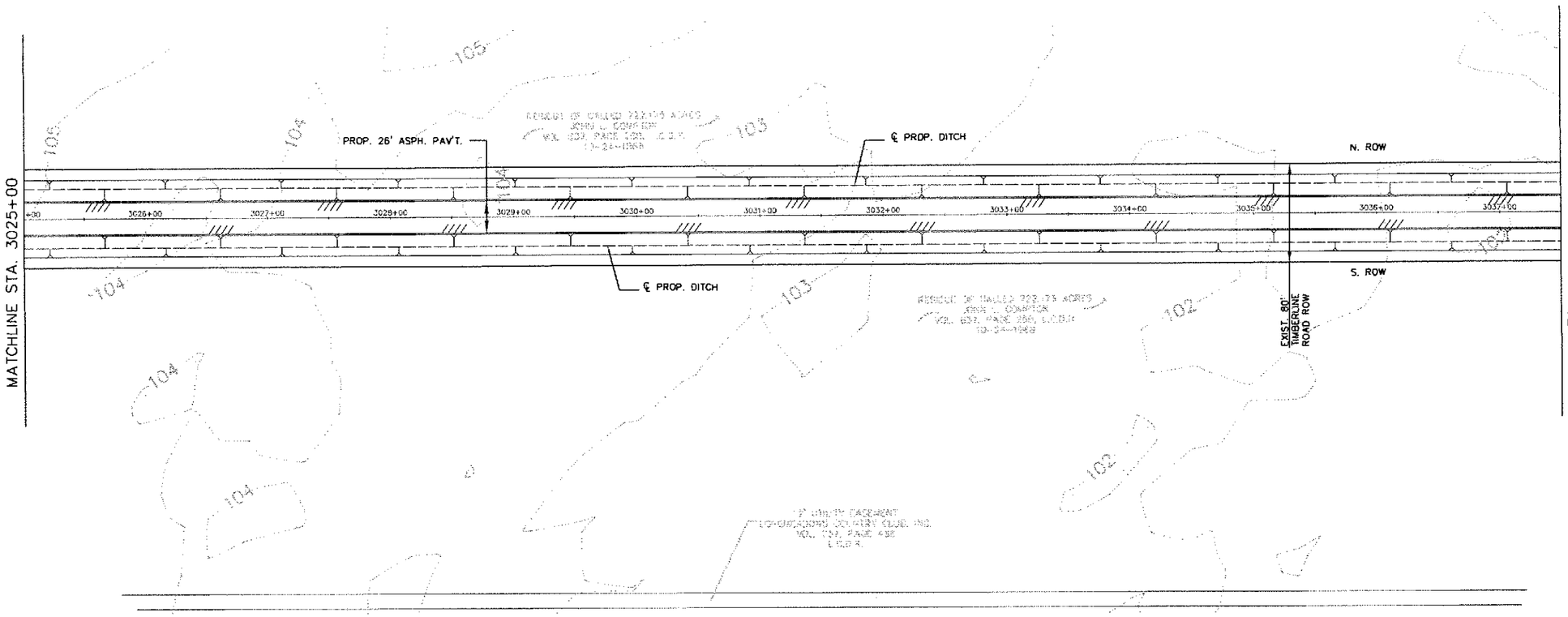
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

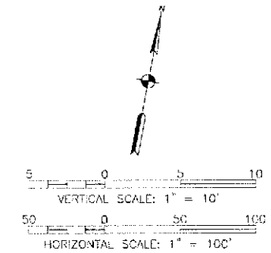
ACCESS ROAD PLAN & PROFILE STA 3012+50 TO STA 3025+00

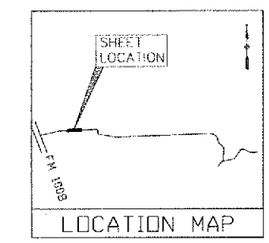
DRAWING SCALE
AS SHOWN

SHEET NO. 156 OF 245

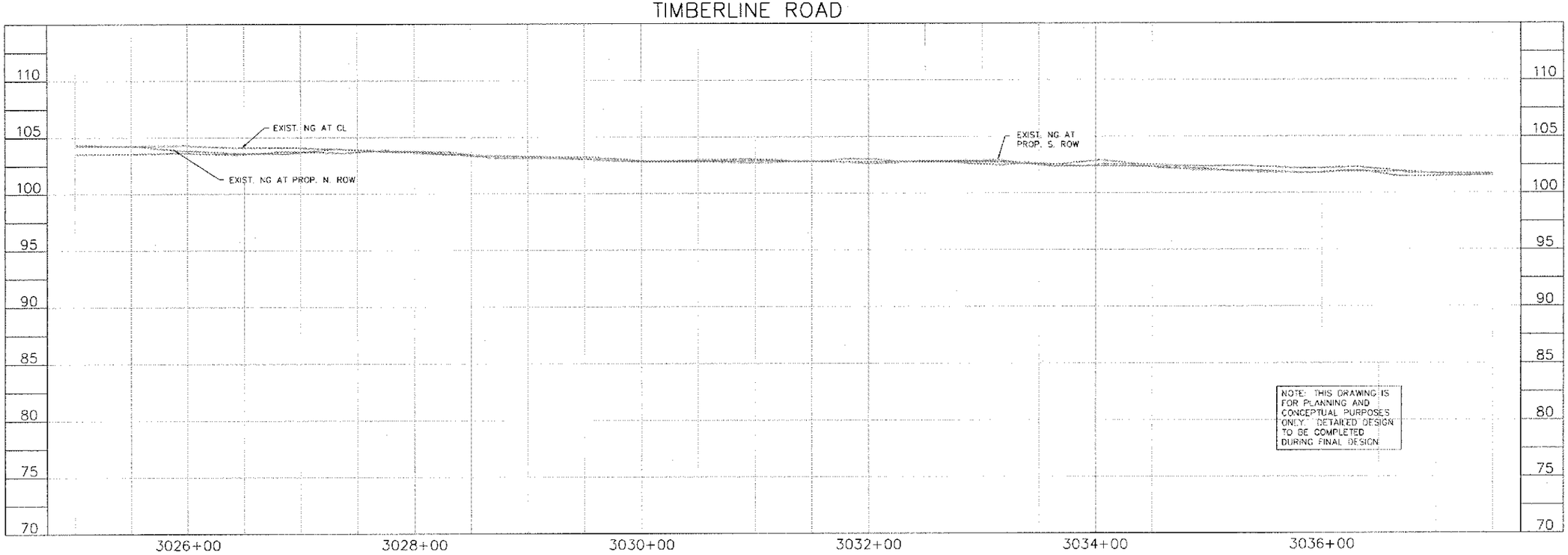
LAST MODIFIED: Jan 27, 2011 - 5:01pm BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 6\6.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: ART&P2.dwg







TIMBERLINE ROAD



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KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD PLAN & PROFILE STA 3025+00 TO STA 3037+50

DRAWING SCALE
AS SHOWN

SHEET NO. 157 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:01pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWC\Sheets\
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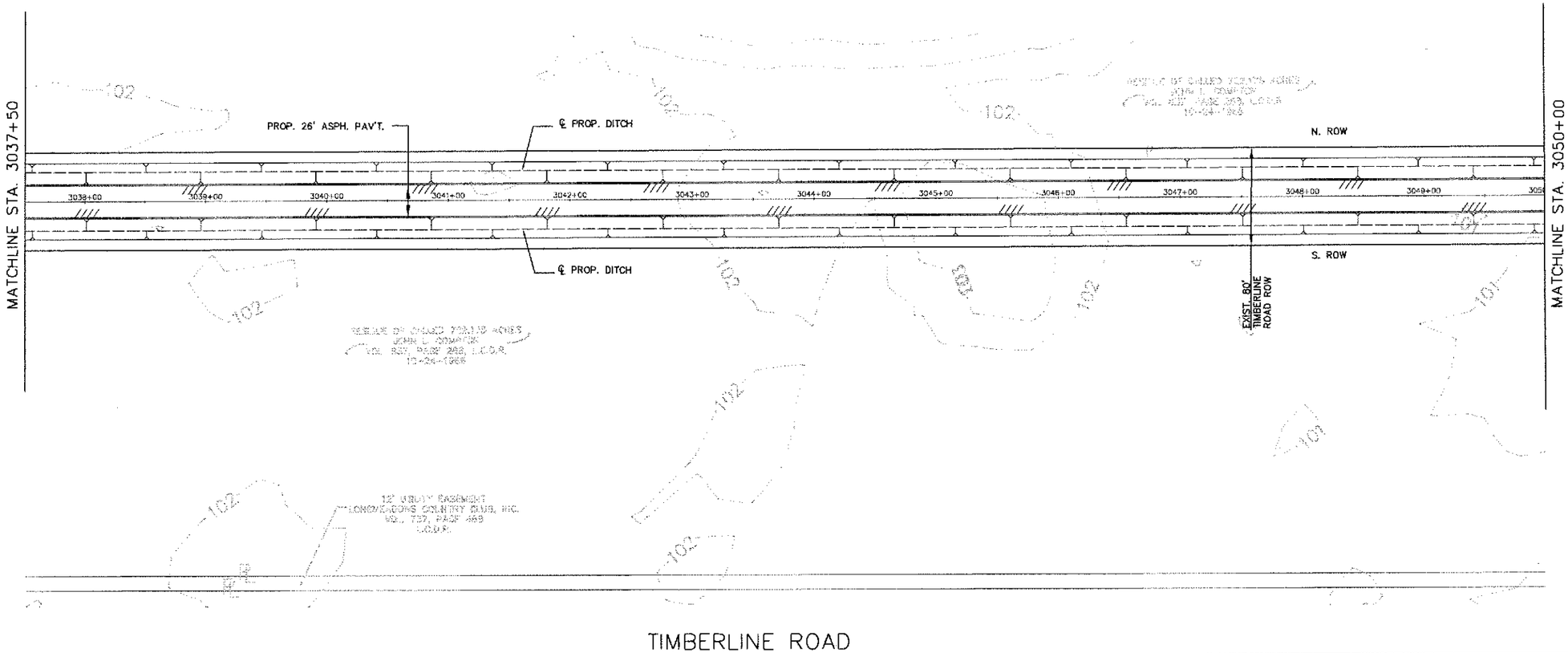
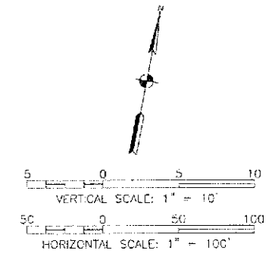
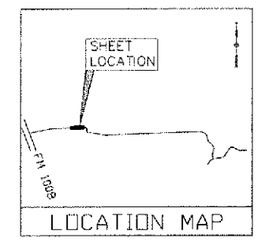
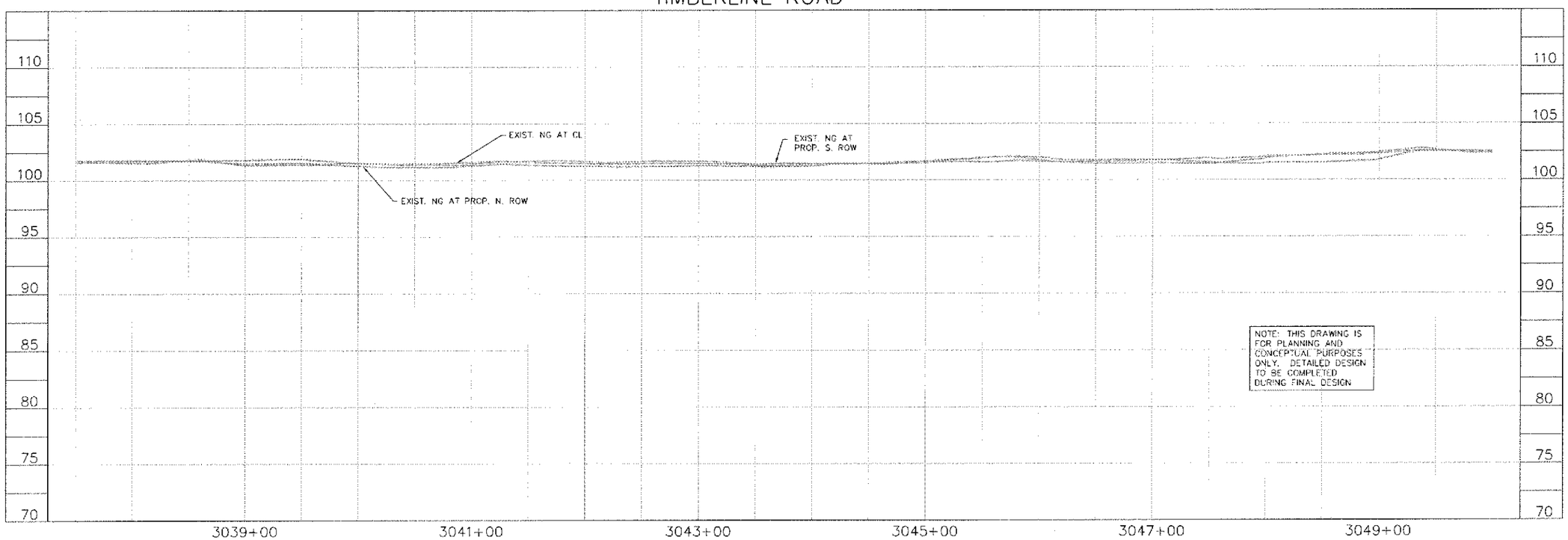






TIMBERLINE ROAD



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KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031

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TBPE REG. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

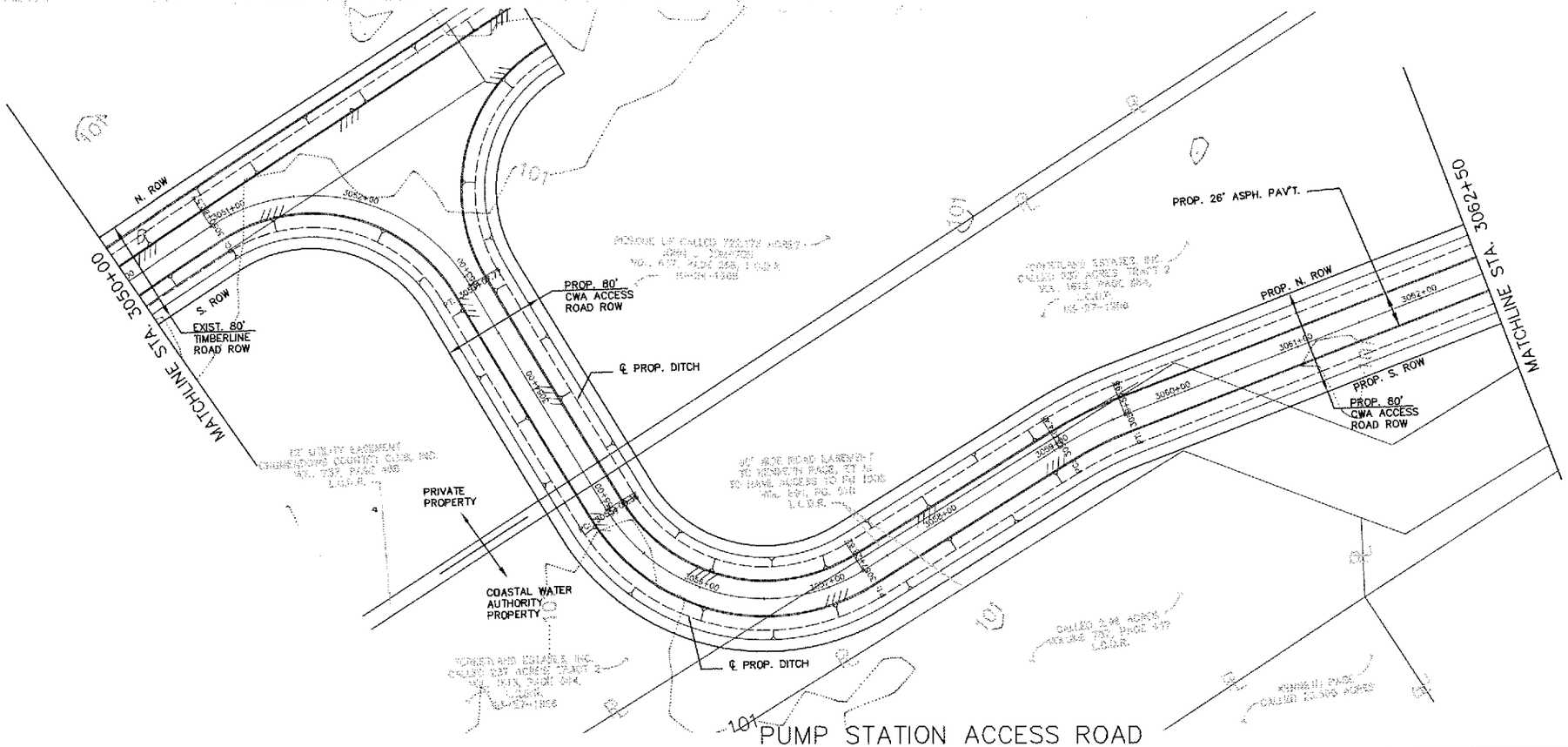
SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

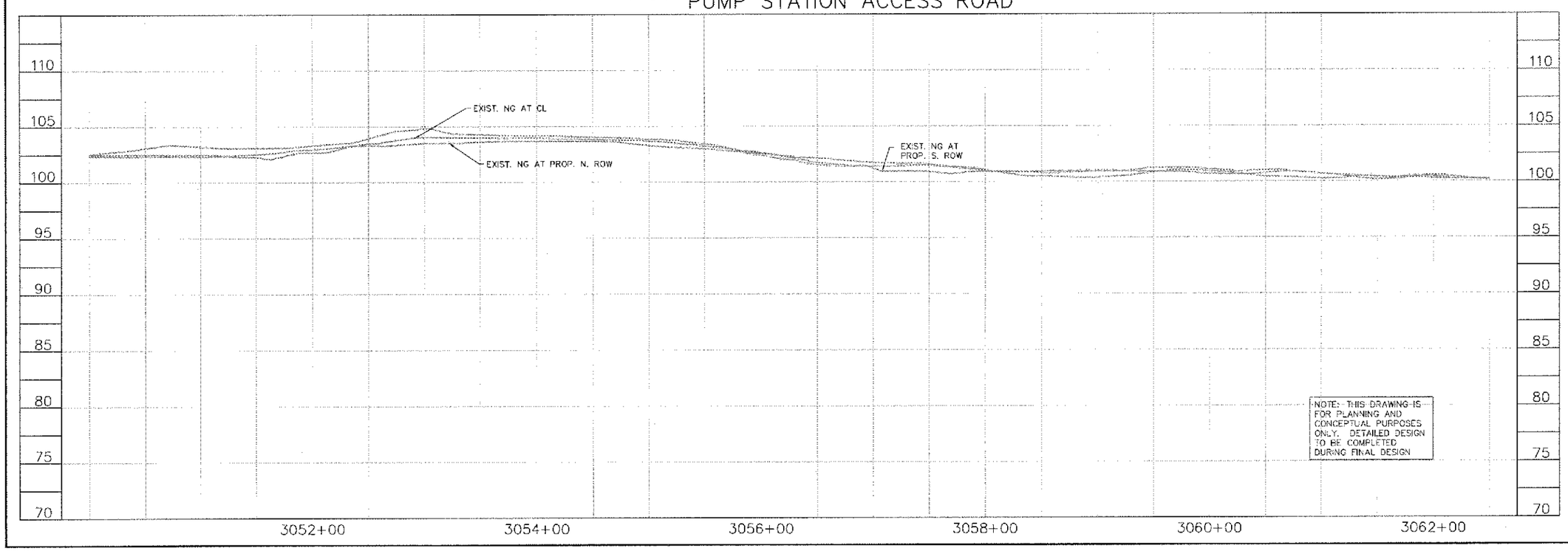
ACCESS ROAD PLAN & PROFILE STA 3037+50 TO STA 3050+00

DRAWING SCALE
AS SHOWN

LAST MODIFIED: Jan 27, 2011 - 5:02pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\V4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: AR1P&P4.dwg



PUMP STATION ACCESS ROAD

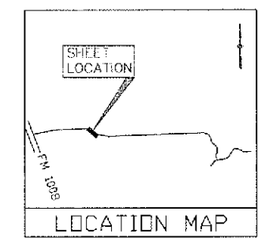


NOTE: THIS DRAWING IS FOR PLANNING AND CONCEPTUAL PURPOSES ONLY. DETAILED DESIGN TO BE COMPLETED DURING FINAL DESIGN

VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE: SURVEY FIELD NOTES SHOWN FOR REFERENCE PURPOSES ONLY. THE COASTAL WATER AUTHORITY IS THE UNDERLYING FEE OWNER.



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
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WWW.AECOM.COM
TBPE REG. NO. F-3580

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713.780.0838 fax.

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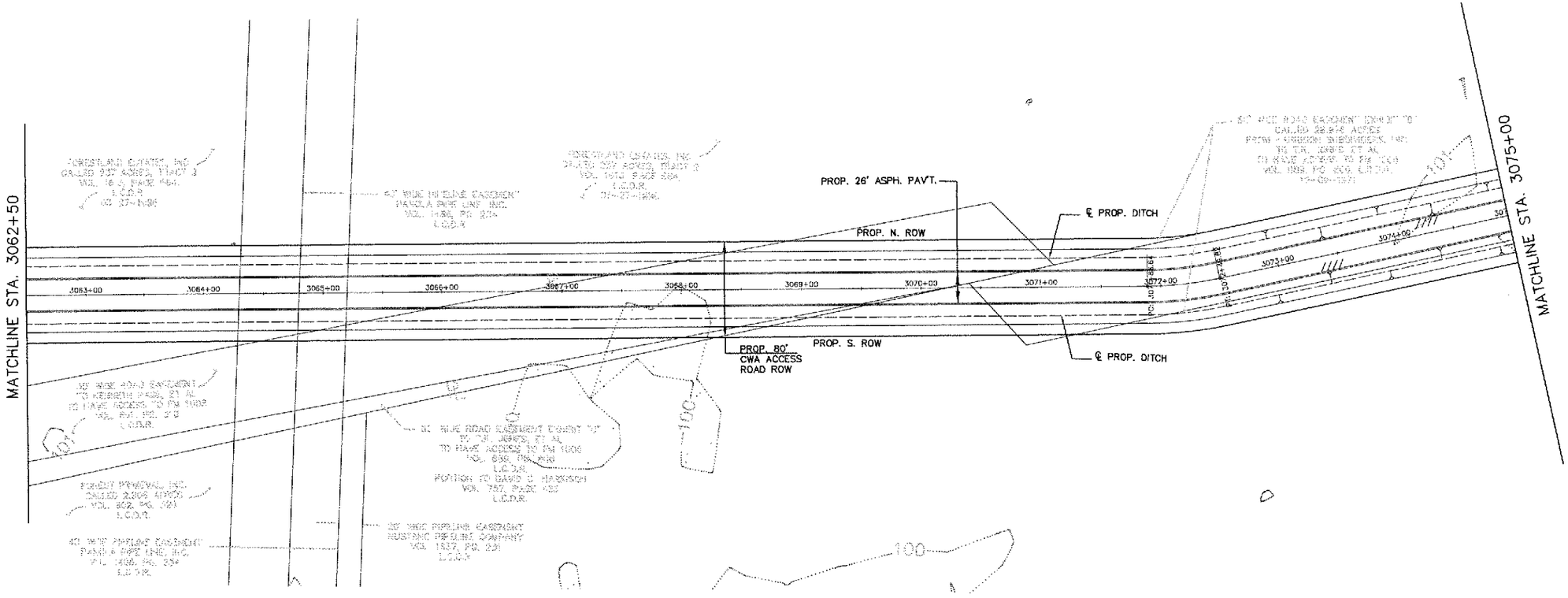
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

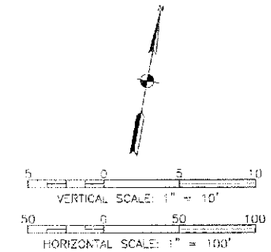
ACCESS ROAD PLAN & PROFILE STA 3050+00 TO STA 3062+50

DRAWING SCALE
AS SHOWN

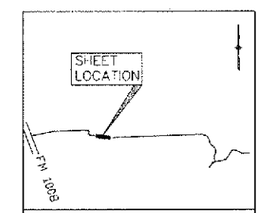
SHEET NO. 159 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:03pm BY USER: ThompsonBi
DWG. LOCATION: G:\Work Order 614.03 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: AR1P&P5.dwg



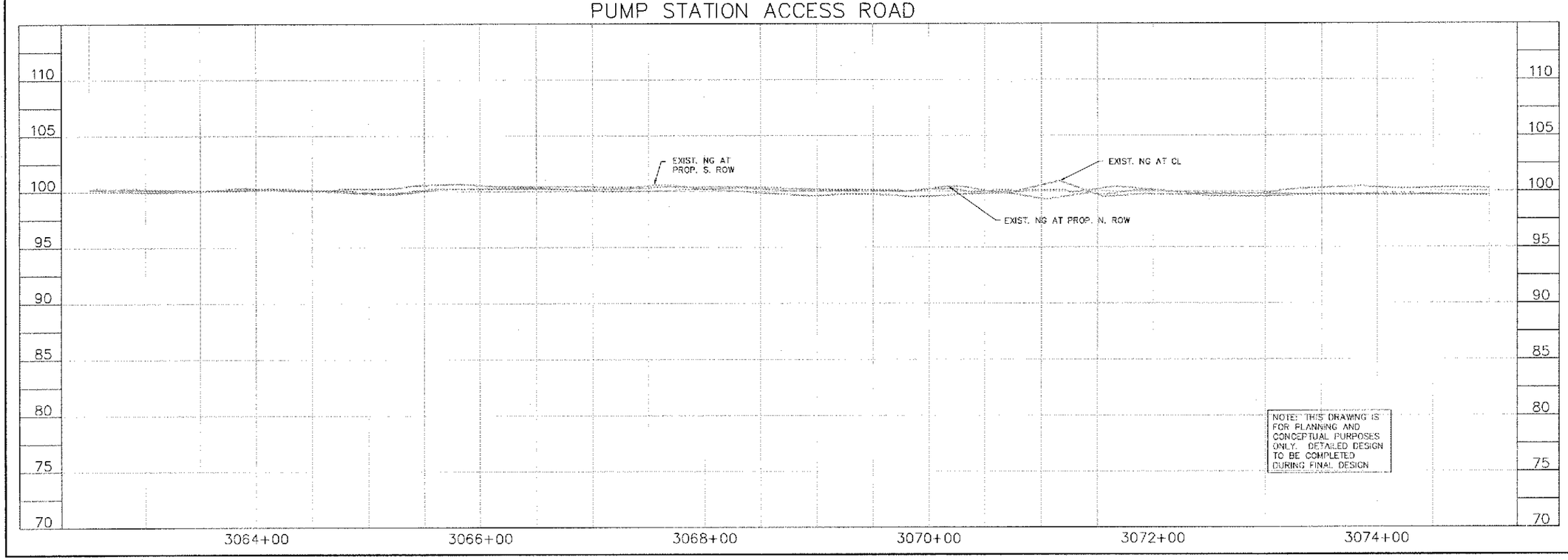


NOTE: SURVEY FIELD NOTES SHOWN FOR REFERENCE PURPOSES ONLY. THE COASTAL WATER AUTHORITY IS THE UNDERLYING FEE OWNER.



LOCATION MAP

PUMP STATION ACCESS ROAD



NOTE: THIS DRAWING IS FOR PLANNING AND CONCEPTUAL PURPOSES ONLY. DETAILED DESIGN TO BE COMPLETED DURING FINAL DESIGN

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031

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SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

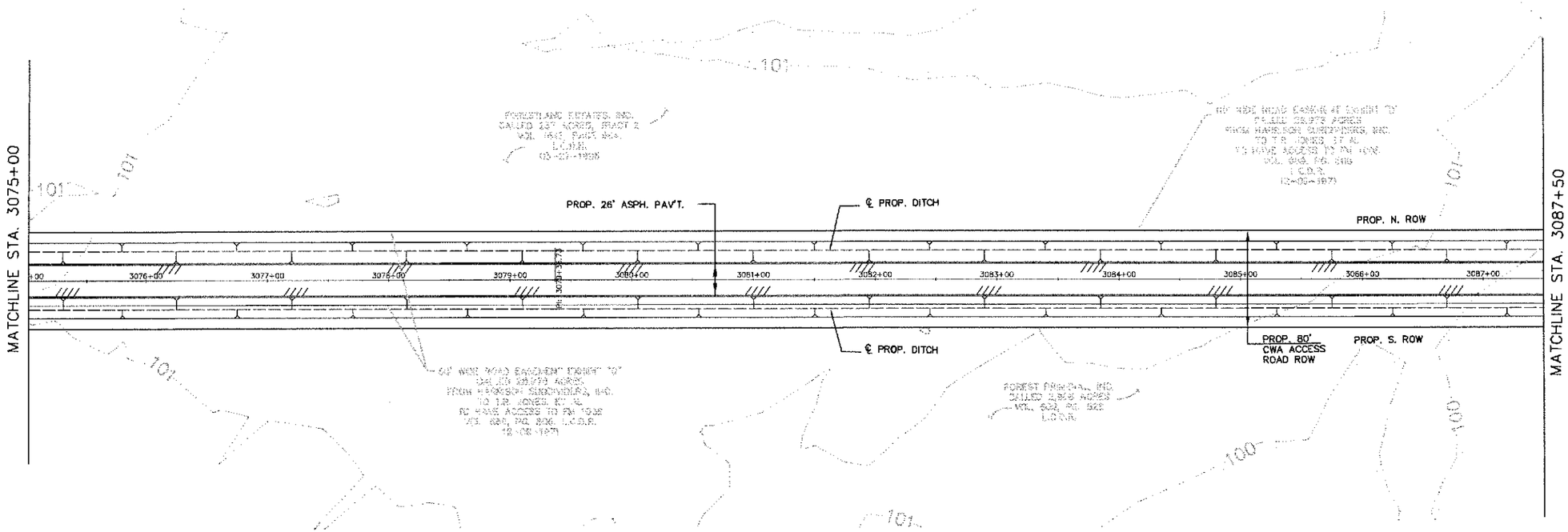
LUCE BAYOU INTERBASIN TRANSFER PROJECT

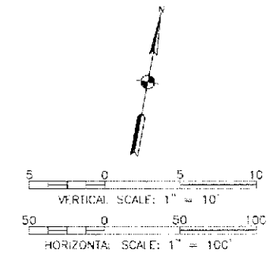
ACCESS ROAD PLAN & PROFILE STA 3062+50 TO STA 3075+00

DRAWING SCALE
AS SHOWN

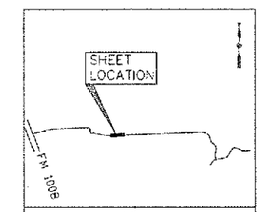
SHEET NO. 160 OF 245

LAST MODIFIED: Jan 27, 2011 – 5:04pm BY USER: ThompsonBl
DWG. LOCATION: G:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: AR1P&P8.dwg



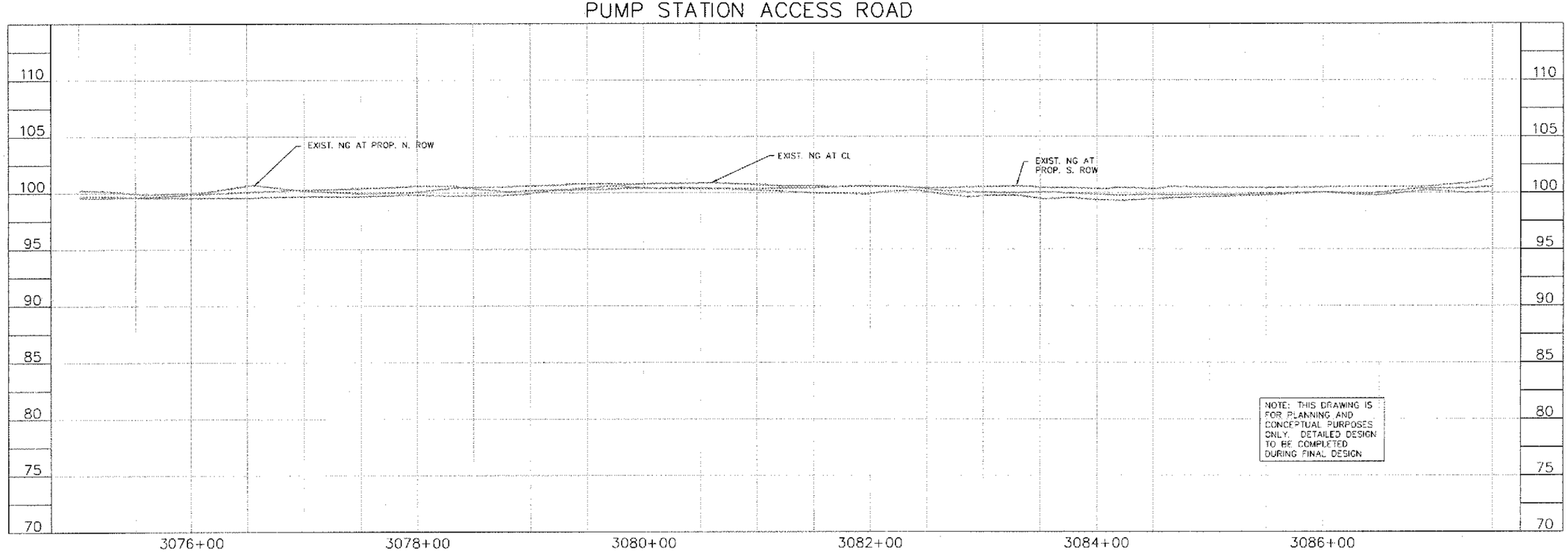


NOTE: SURVEY FIELD NOTES SHOWN FOR REFERENCE PURPOSES ONLY. THE COASTAL WATER AUTHORITY IS THE UNDERLYING FEE OWNER.



LOCATION MAP

PUMP STATION ACCESS ROAD



NOTE: THIS DRAWING IS FOR PLANNING AND CONCEPTUAL PURPOSES ONLY. DETAILED DESIGN TO BE COMPLETED DURING FINAL DESIGN

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

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5757 WOODWAY
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713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

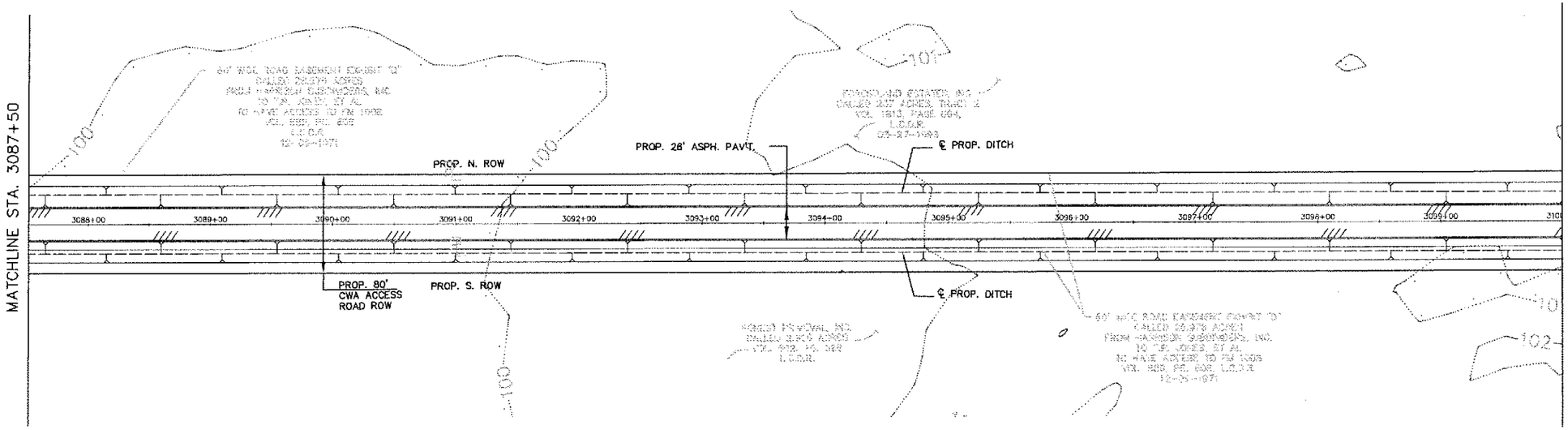
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

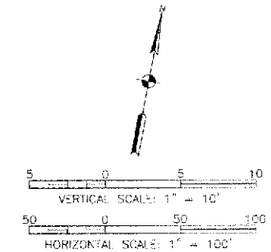
ACCESS ROAD PLAN & PROFILE STA 3075+00 TO STA 3087+50

DRAWING SCALE
AS SHOWN

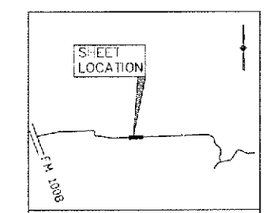
SHEET NO. 161 OF 245

LAST MODIFIED: Jun 28, 2011 -- 6:40am BY USER: ThompsonBI
DWG LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG NAME: AR1PRP7.dwg



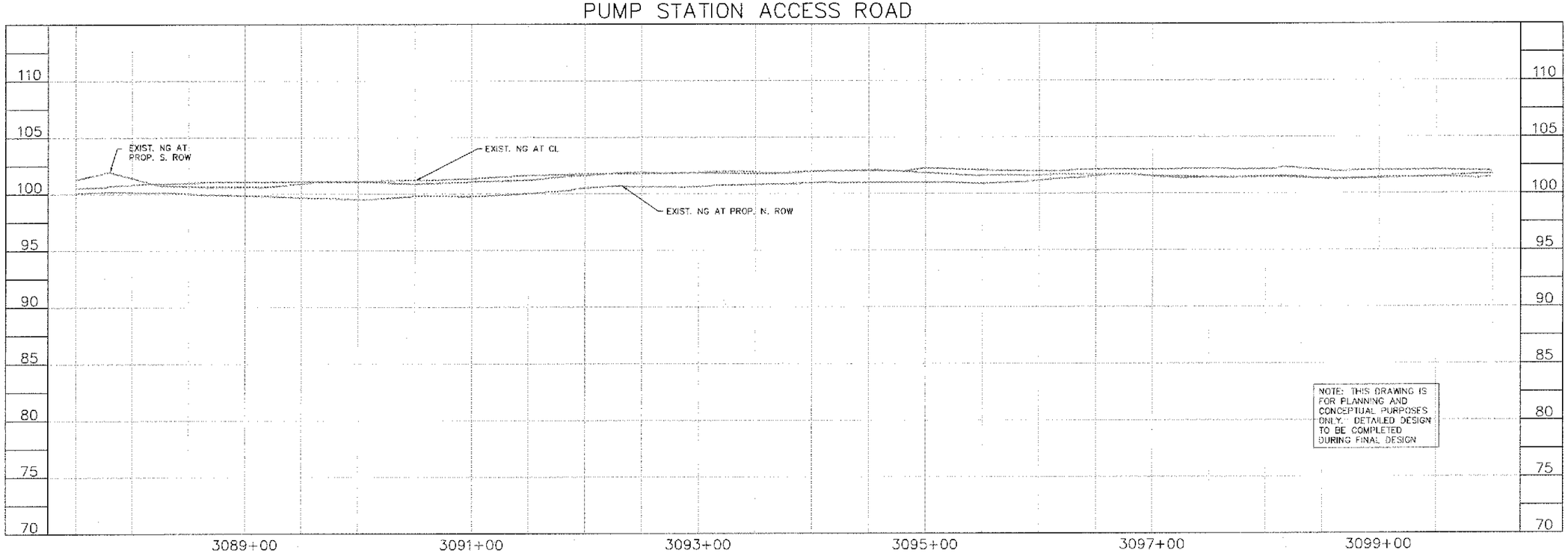


NOTE: SURVEY FIELD NOTES SHOWN FOR REFERENCE PURPOSES ONLY. THE COASTAL WATER AUTHORITY IS THE UNDERLYING FEE OWNER.



LOCATION MAP

PUMP STATION ACCESS ROAD



NOTE: THIS DRAWING IS FOR PLANNING AND CONCEPTUAL PURPOSES ONLY. DETAILED DESIGN TO BE COMPLETED DURING FINAL DESIGN

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM
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5757 WOODWAY
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713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

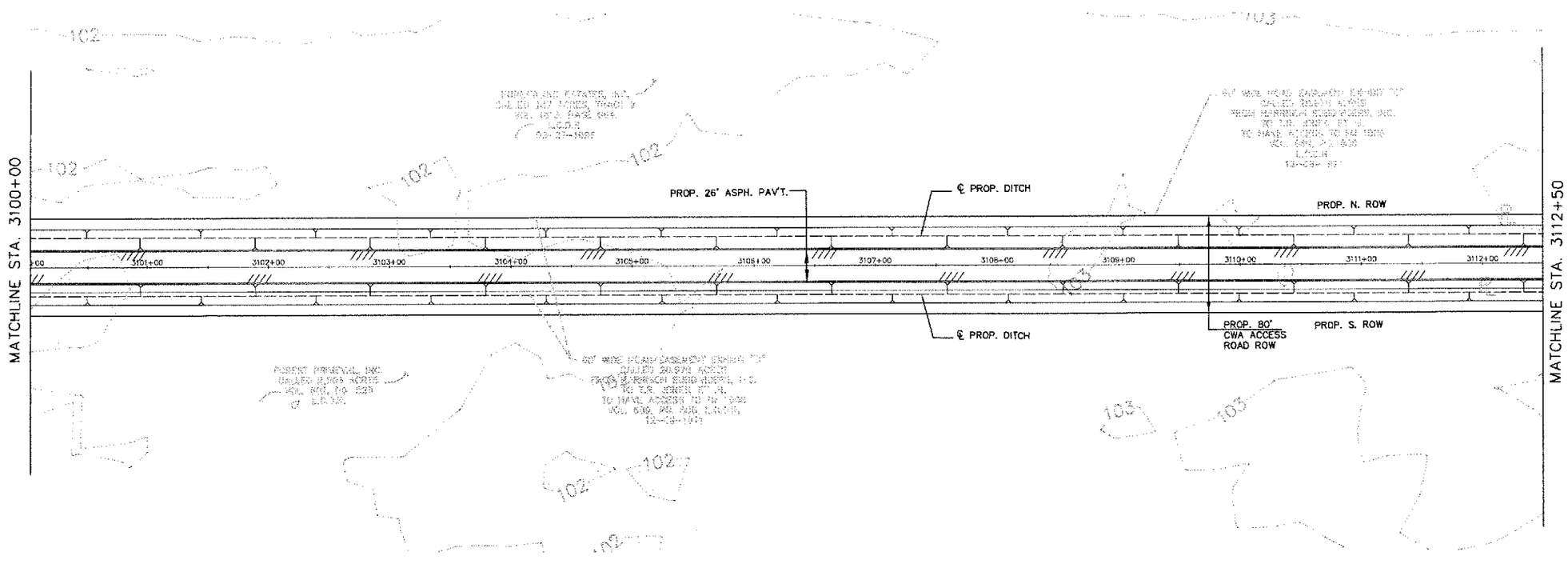
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

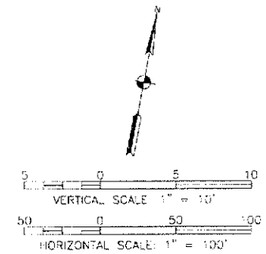
ACCESS ROAD PLAN & PROFILE STA 3087+50 TO STA 3100+00

DRAWING SCALE
AS SHOWN

SHEET NO. 112 OF 245

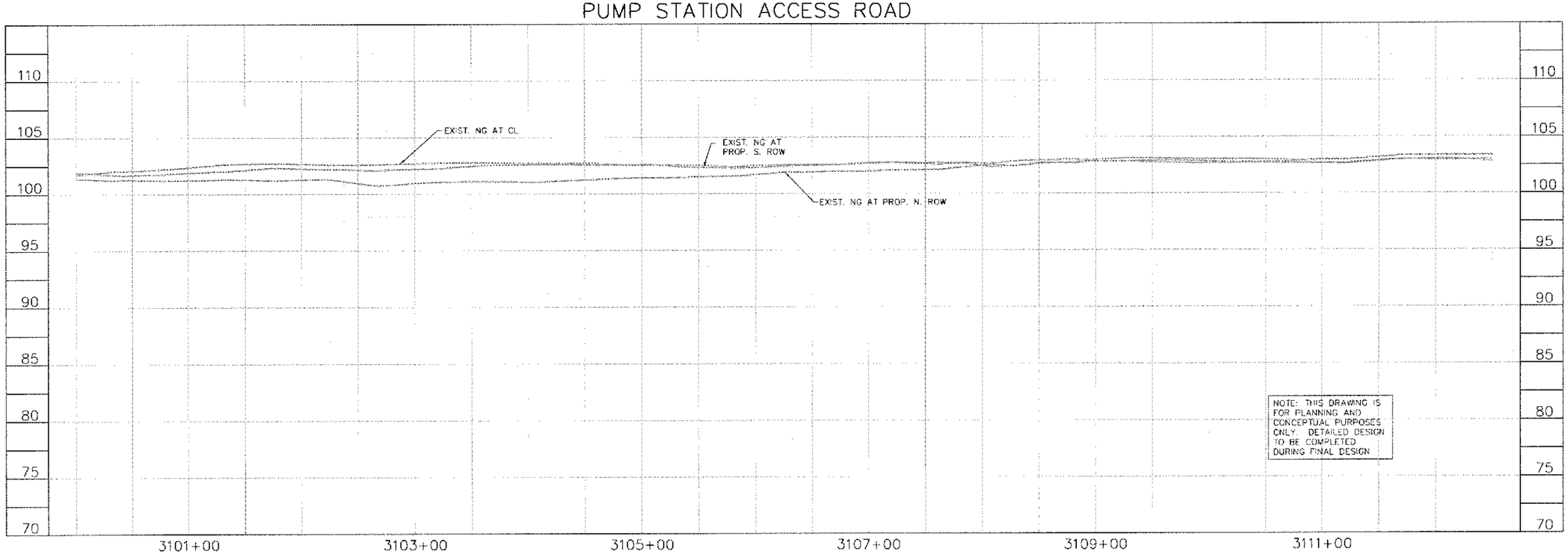
LAST MODIFIED: Jan 27, 2011 - 5:06pm BY USER: ThompsonBI
DWG. LOCATION: G:\Work Order 6\V4.0 ENGINEERING NOTES & CALCULATIONS\V4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: A81P&PB.dwg



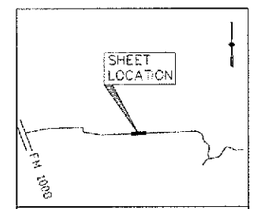


NOTE: SURVEY FIELD NOTES SHOWN FOR REFERENCE PURPOSES ONLY. THE COASTAL WATER AUTHORITY IS THE UNDERLYING FEE OWNER.

PUMP STATION ACCESS ROAD



NOTE: THIS DRAWING IS FOR PLANNING AND CONCEPTUAL PURPOSES ONLY. DETAILED DESIGN TO BE COMPLETED DURING FINAL DESIGN



LOCATION MAP

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1599
WWW.AECOM.COM
TBPE REG. NO. F-3580

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5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD PLAN & PROFILE STA 3100+00 TO STA 3112+50

DRAWING SCALE
AS SHOWN

SHEET NO. 163 OF 245

LAST MODIFIED: Jun 27, 2011 - 5:05pm BY USER: ThompsonBI
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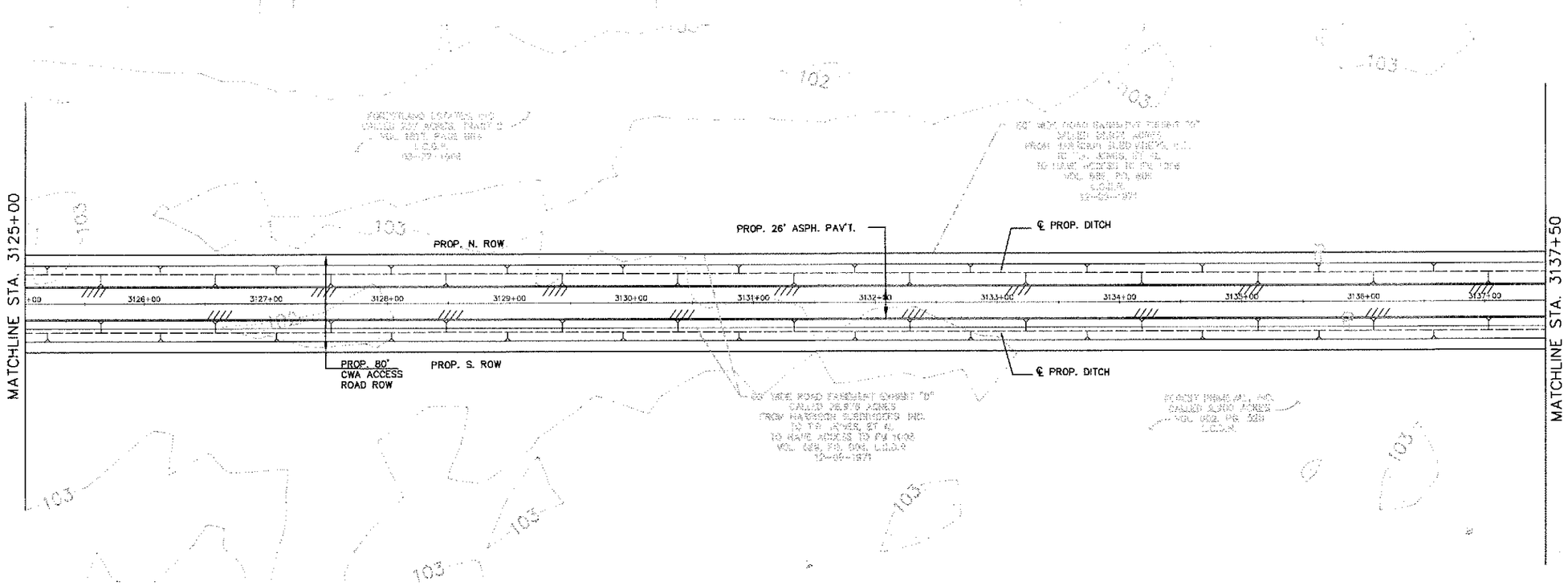
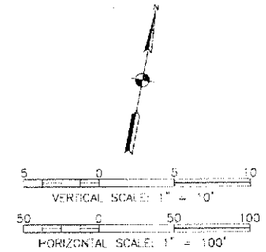
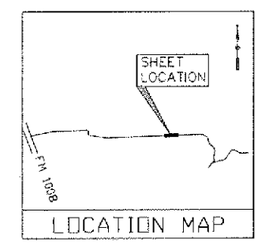
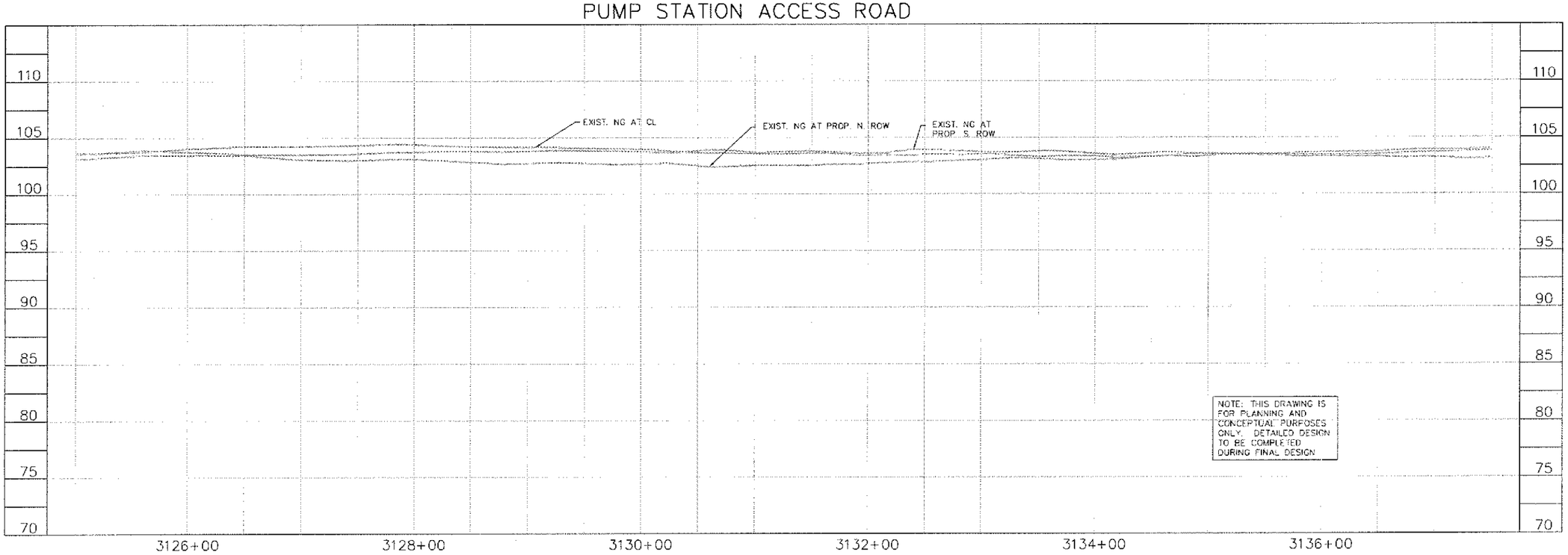




NOTE: SURVEY FIELD NOTES SHOWN FOR REFERENCE PURPOSES ONLY. THE COASTAL WATER AUTHORITY IS THE UNDERLYING FEE OWNER.



PUMP STATION ACCESS ROAD



NOTE: THIS DRAWING IS FOR PLANNING AND CONCEPTUAL PURPOSES ONLY. DETAILED DESIGN TO BE COMPLETED DURING FINAL DESIGN

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 100 WEST
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TBPE REG. NO. F-3580

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5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD PLAN & PROFILE STA 3112+50 TO STA 3125+00

DRAWING SCALE
AS SHOWN

SHEET NO. 169 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:07pm BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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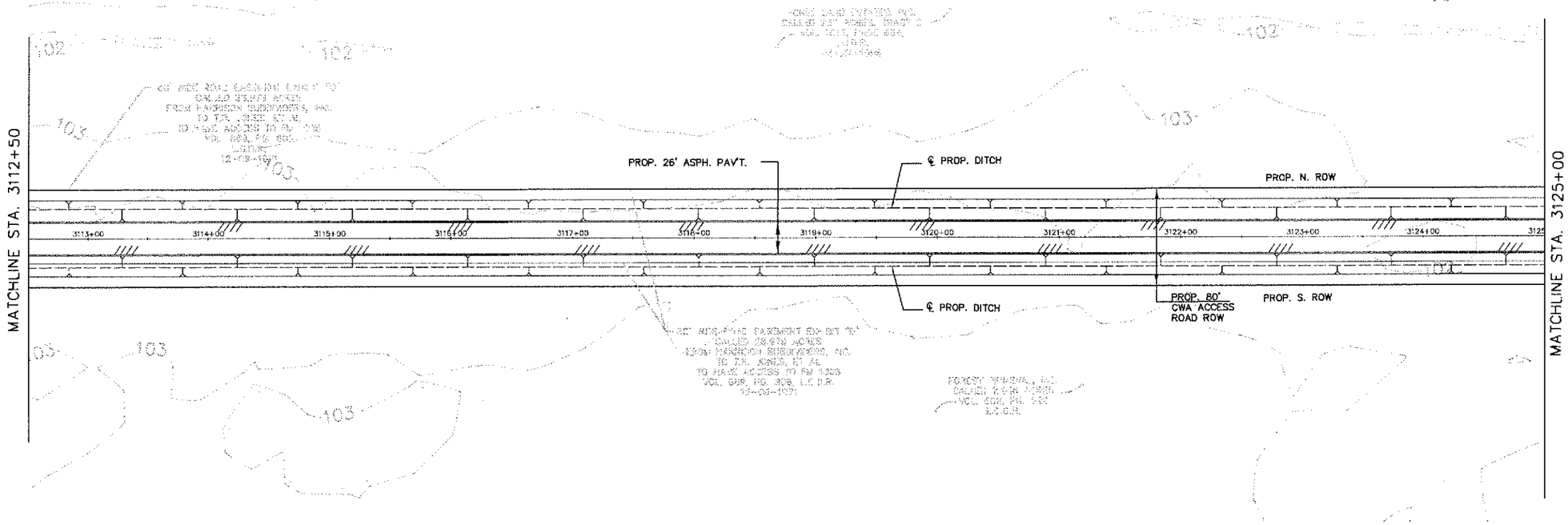
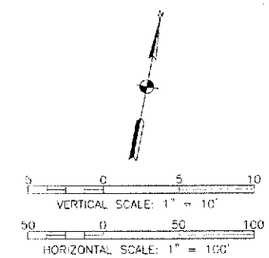
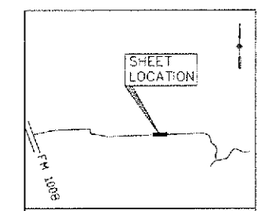


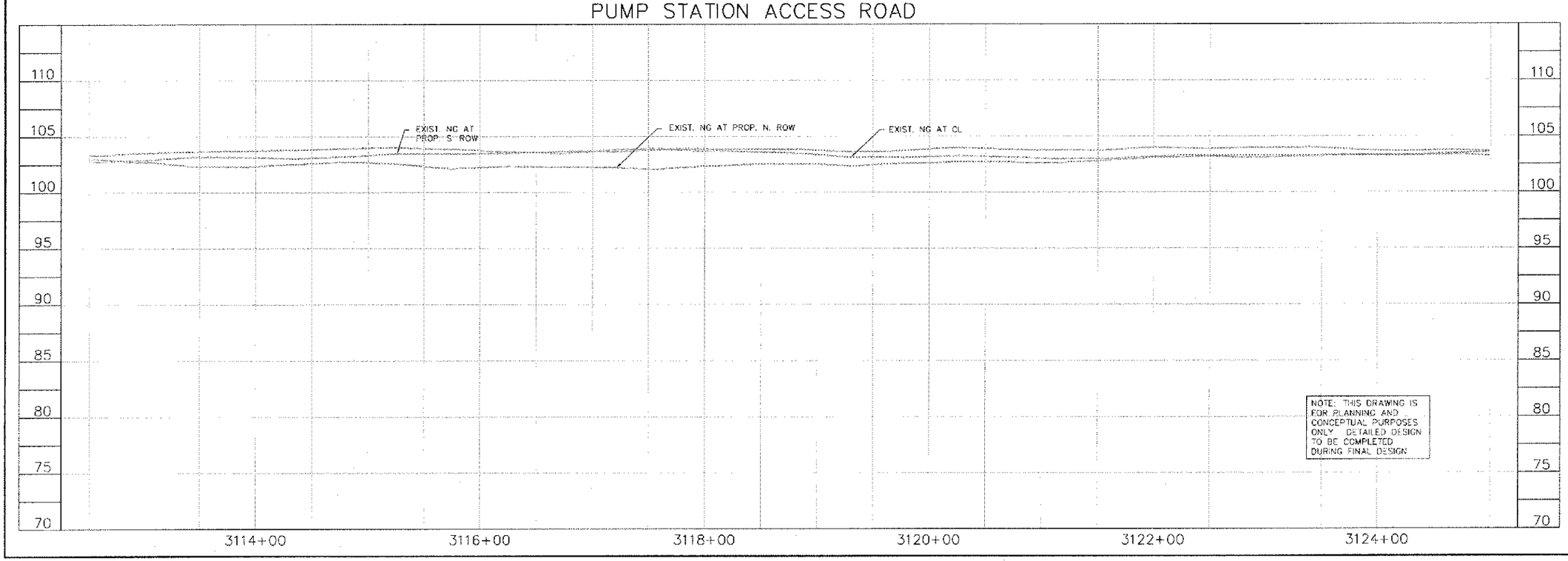


NOTE: SURVEY FIELD NOTES SHOWN FOR REFERENCE PURPOSES ONLY. THE COASTAL WATER AUTHORITY IS THE UNDERLYING FEE OWNER.



LOCATION MAP

PUMP STATION ACCESS ROAD



NOTE: THIS DRAWING IS FOR PLANNING AND CONCEPTUAL PURPOSES ONLY. DETAILED DESIGN TO BE COMPLETED DURING FINAL DESIGN

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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NOT FOR CONSTRUCTION PURPOSES

AECOM

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5757 WOODWAY, SUITE 101 WEST
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TBPE REG. NO. F-3580

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HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD PLAN & PROFILE STA 3125+00 TO STA 3137+50

DRAWING SCALE
AS SHOWN

SHEET NO. 165 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:07pm BY USER: ThompsonBI
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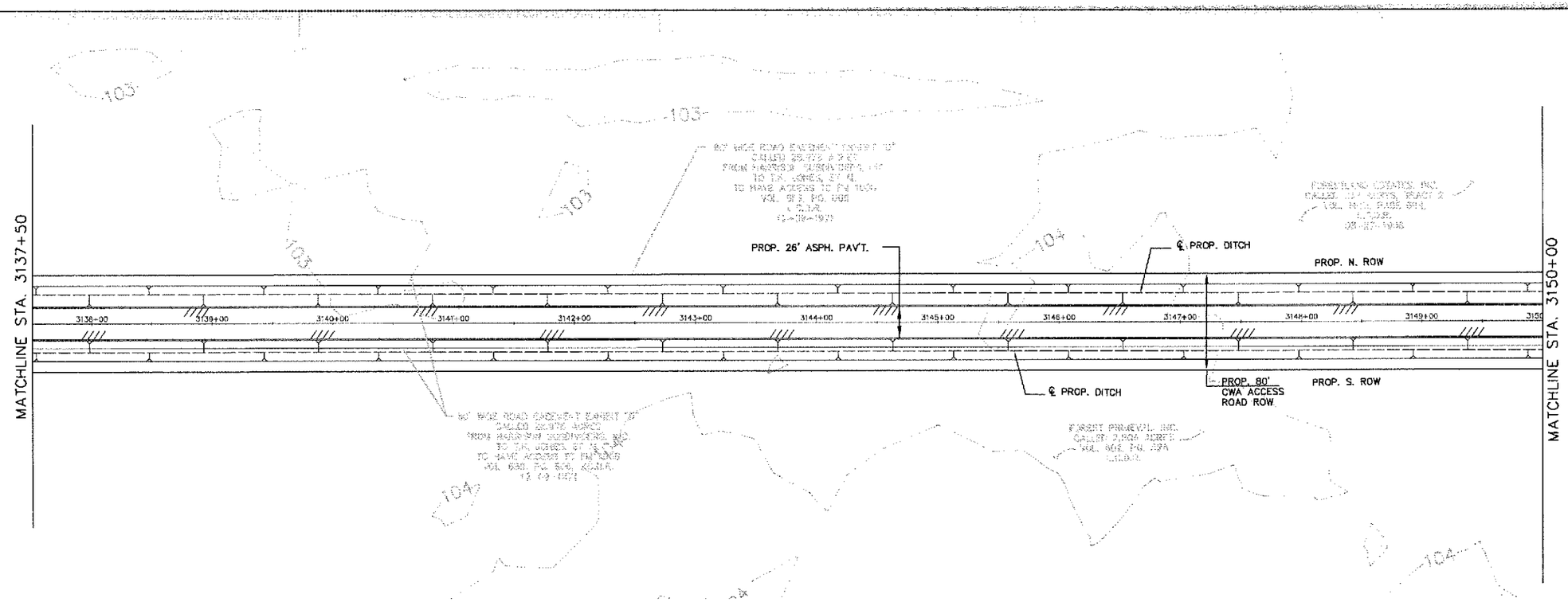
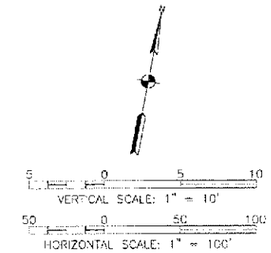
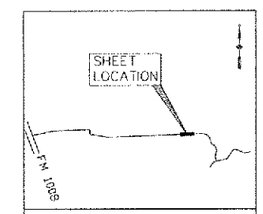


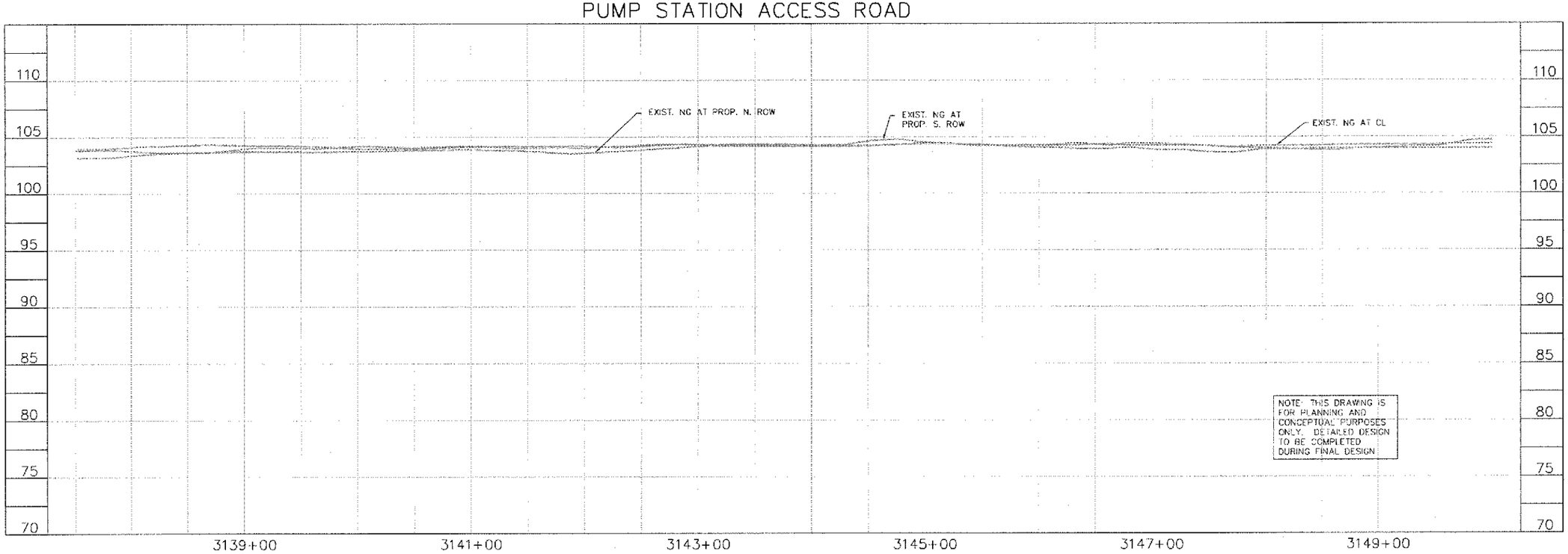


NOTE: SURVEY FIELD NOTES SHOWN FOR REFERENCE PURPOSES ONLY. THE COASTAL WATER AUTHORITY IS THE UNDERLYING FEE OWNER.



LOCATION MAP

PUMP STATION ACCESS ROAD



NOTE: THIS DRAWING IS FOR PLANNING AND CONCEPTUAL PURPOSES ONLY. DETAILED DESIGN TO BE COMPLETED DURING FINAL DESIGN

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

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HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

CWA

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD PLAN & PROFILE STA 3137+50 TO STA 3150+00

DRAWING SCALE
AS SHOWN

SHEET NO. 166 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:07pm BY USER: ThompsonBi
DWG. LOCATION: O:\Work Order 614.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Coda\PMD\Sheets\
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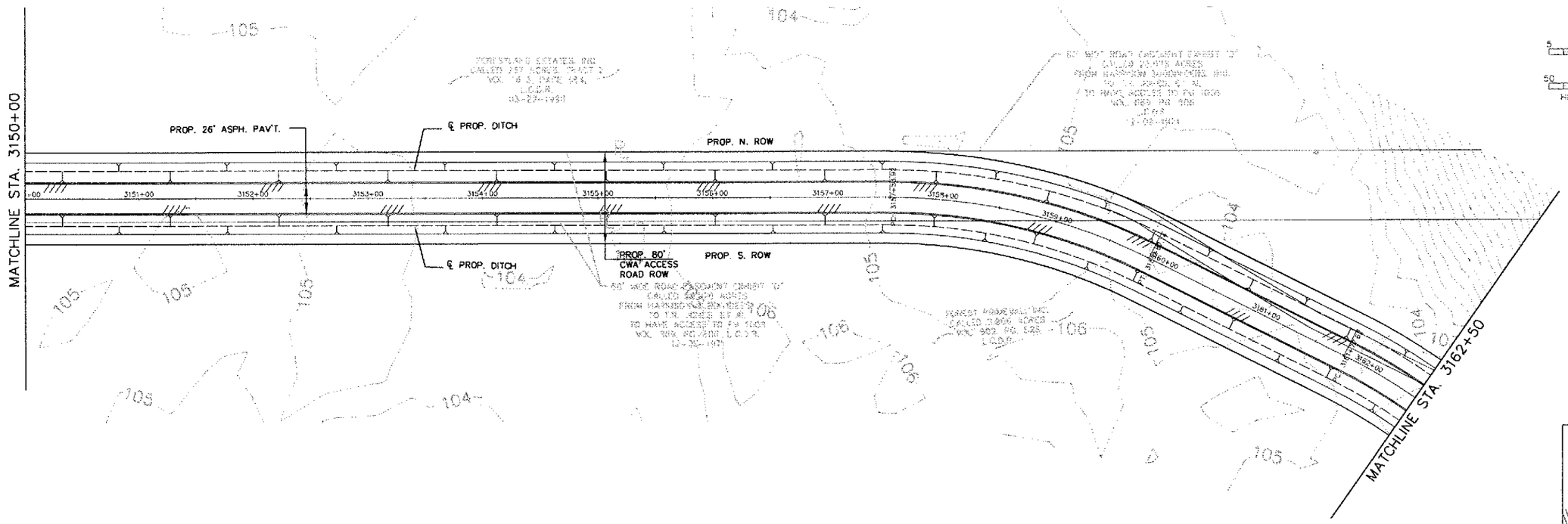
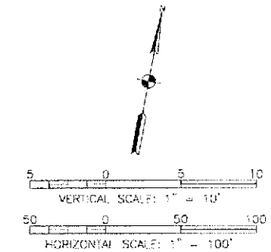
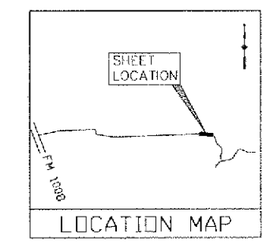
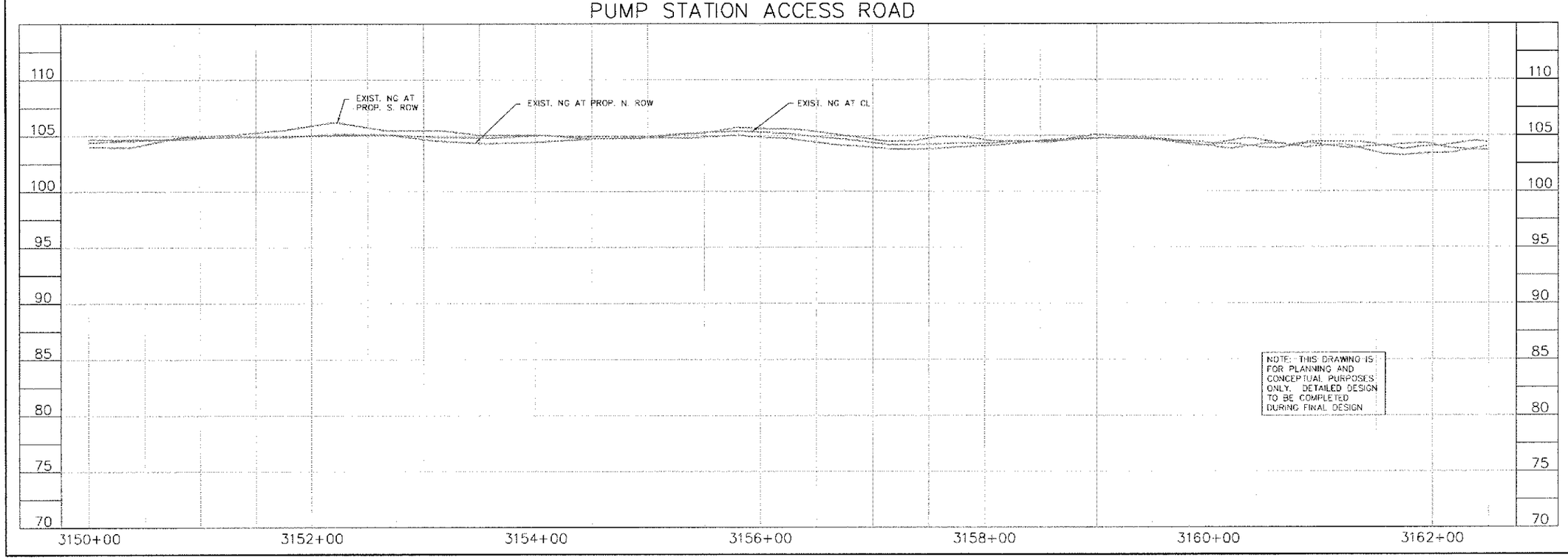




NOTE: SURVEY FIELD NOTES SHOWN FOR REFERENCE PURPOSES ONLY. THE COASTAL WATER AUTHORITY IS THE UNDERLYING FEE OWNER.



PUMP STATION ACCESS ROAD



NOTE: THIS DRAWING IS FOR PLANNING AND CONCEPTUAL PURPOSES ONLY. DETAILED DESIGN TO BE COMPLETED DURING FINAL DESIGN

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713.780.0838 fax.

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD PLAN & PROFILE STA 3150+00 TO STA 3162+50

DRAWING SCALE
AS SHOWN

SHEET NO. 167 OF 245

LAST MODIFIED: Jan 27, 2011 – 5:08pm BY USER: ThompsonSl
DWG LOCATION: Q:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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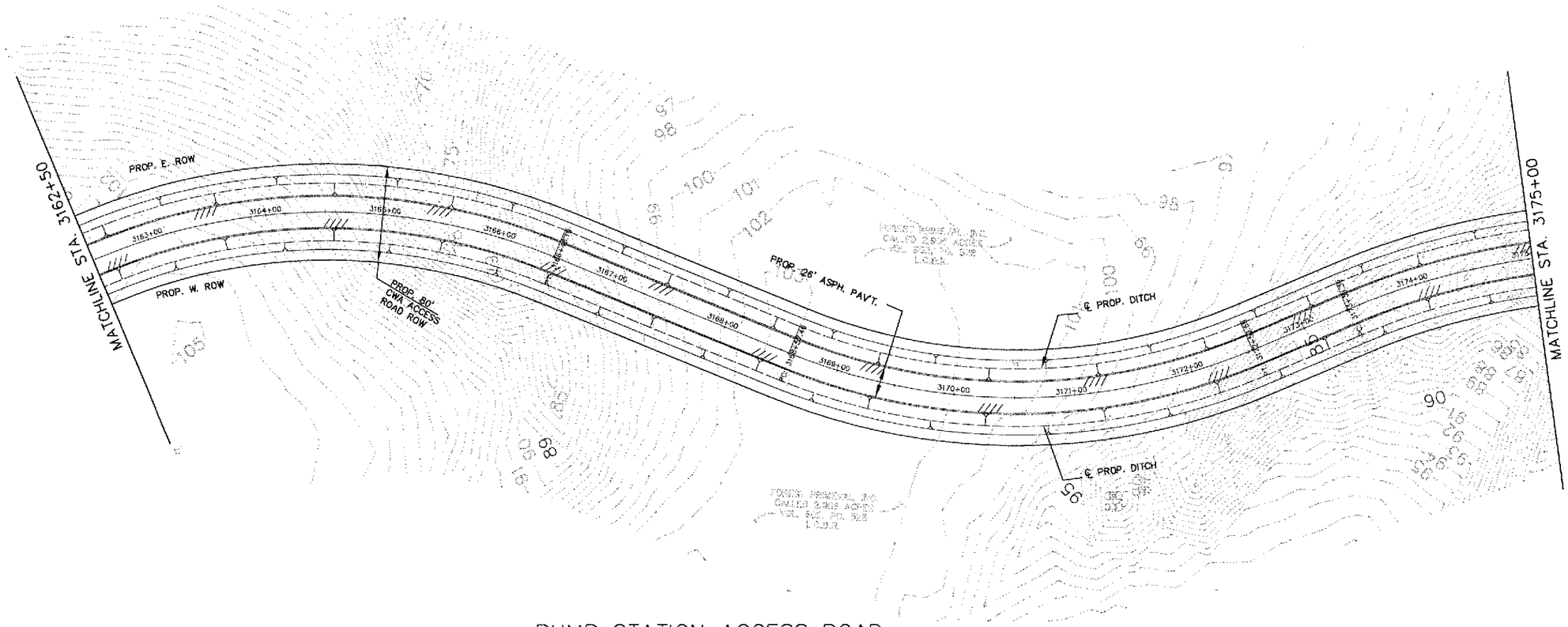
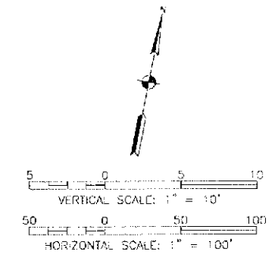
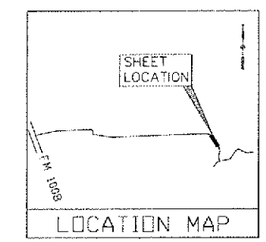


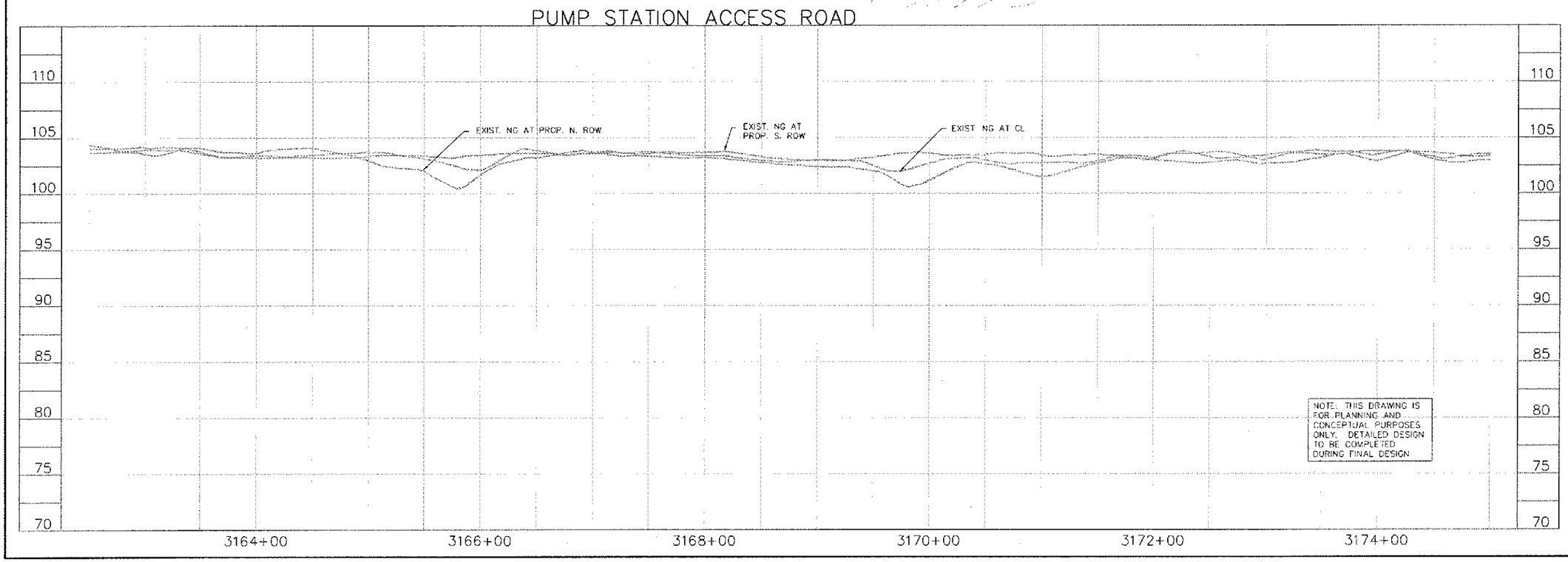


NOTE: SURVEY FIELD NOTES SHOWN FOR REFERENCE PURPOSES ONLY. THE COASTAL WATER AUTHORITY IS THE UNDERLYING FEE OWNER.



LOCATION MAP

PUMP STATION ACCESS ROAD



NOTE: THIS DRAWING IS FOR PLANNING AND CONCEPTUAL PURPOSES ONLY. DETAILED DESIGN TO BE COMPLETED DURING FINAL DESIGN

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD PLAN & PROFILE STA 3162+50 TO STA 3175+00

DRAWING SCALE
AS SHOWN

SHEET NO. 168 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:08pm BY USER: ThompsonGI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWO\Sheets\
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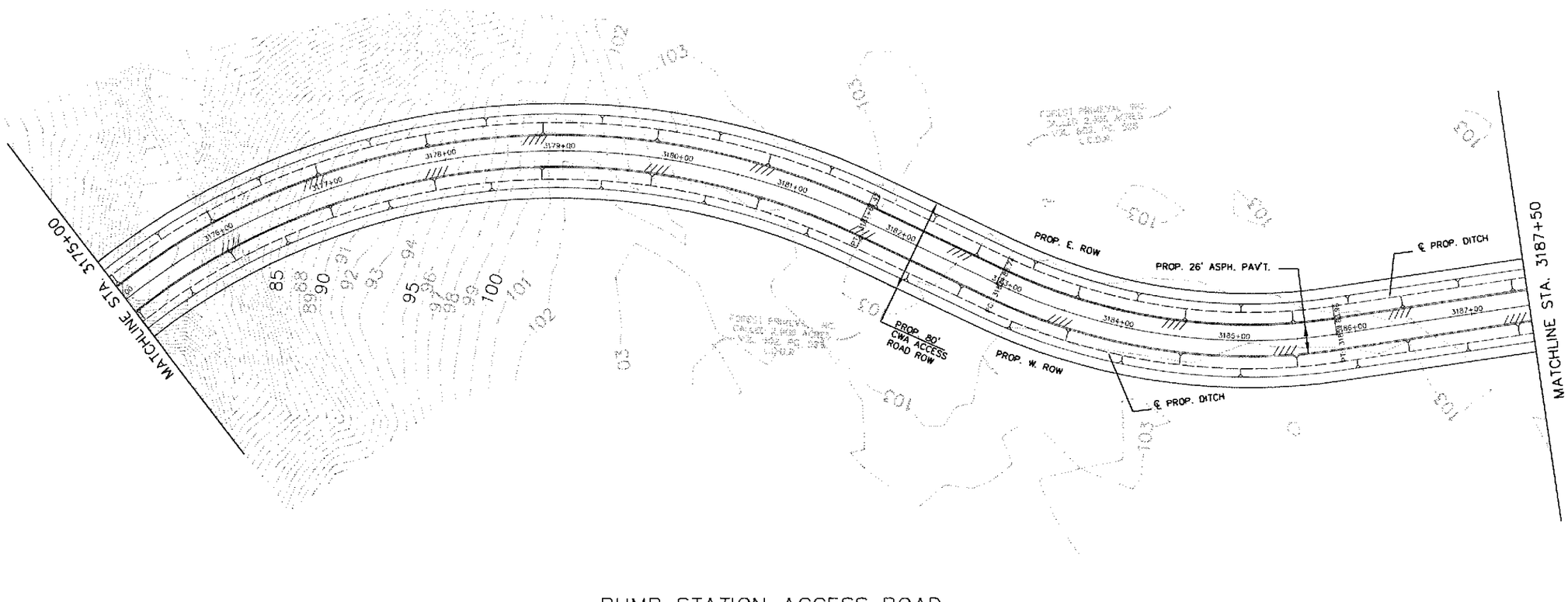
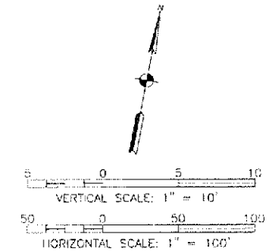
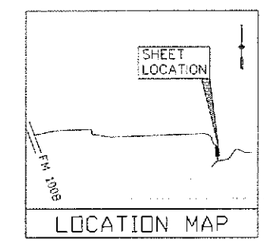


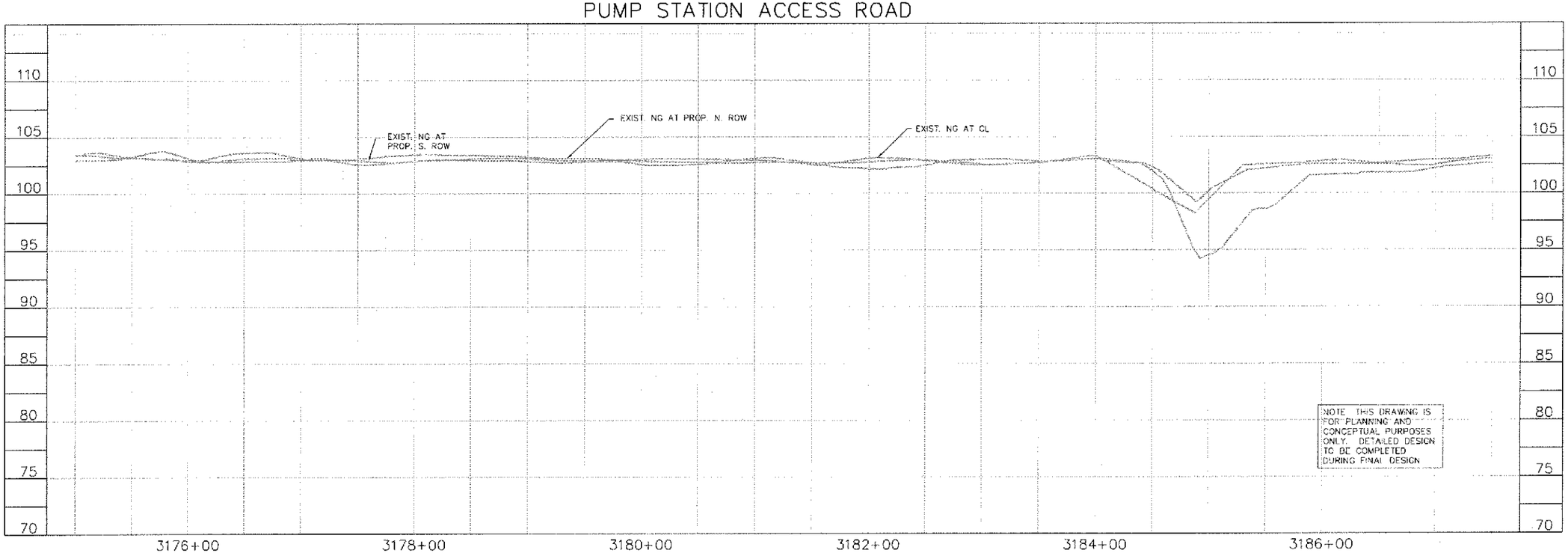


NOTE: SURVEY FIELD NOTES SHOWN FOR REFERENCE PURPOSES ONLY. THE COASTAL WATER AUTHORITY IS THE UNDERLYING FEE OWNER.



LOCATION MAP

PUMP STATION ACCESS ROAD



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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

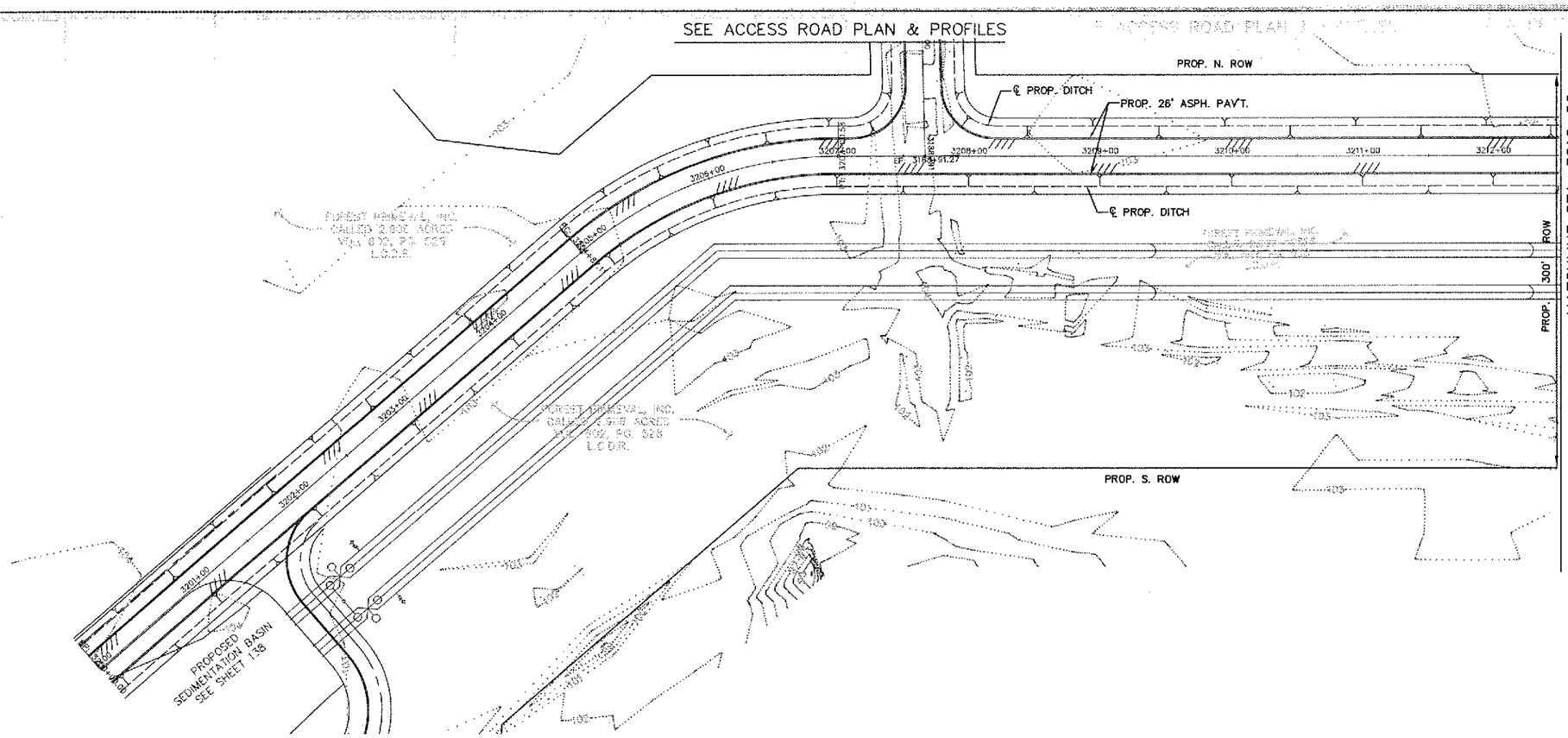
ACCESS ROAD PLAN & PROFILE STA 3175+00 TO STA 3187+50

DRAWING SCALE
AS SHOWN

SHEET NO. 169 OF 295

LAST MODIFIED: Jan 27, 2011 - 5:08pm BY USER: ThompsonBi
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: AR1P&P15.dwg

SEE ACCESS ROAD PLAN & PROFILES

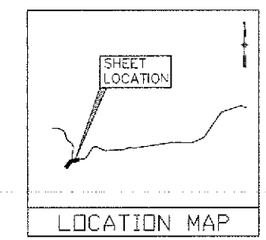


VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

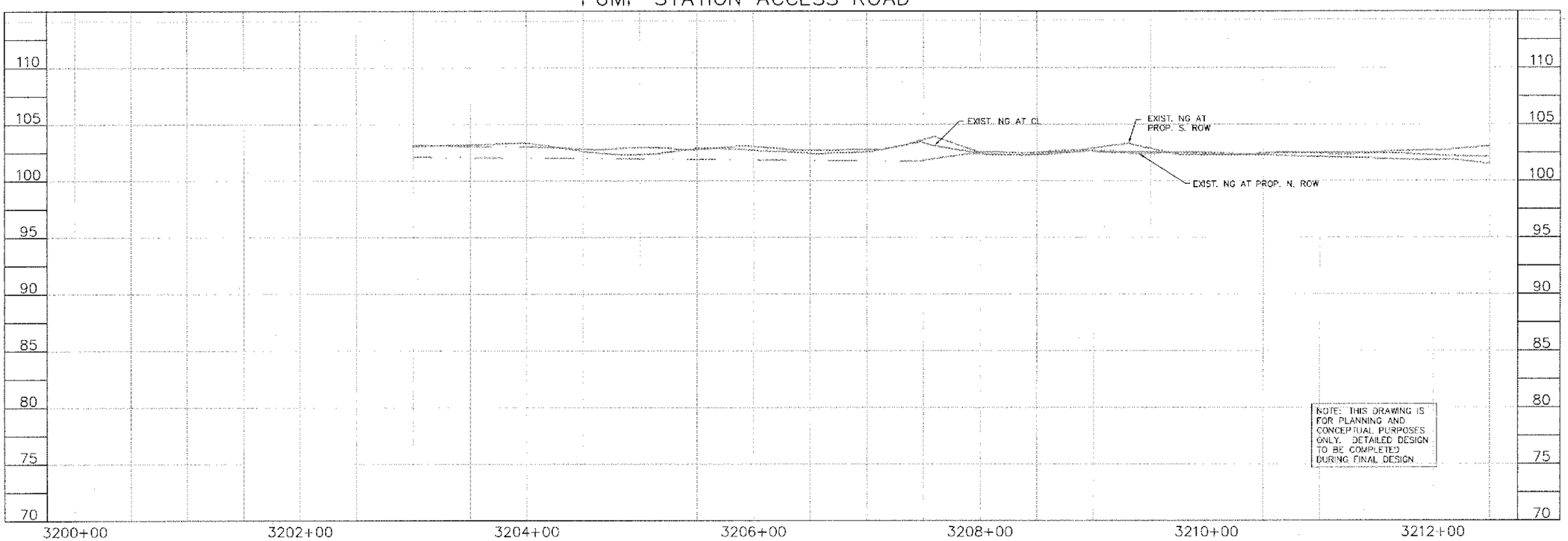
NOTE: SURVEY FIELD NOTES SHOWN FOR REFERENCE PURPOSES ONLY. THE COASTAL WATER AUTHORITY IS THE UNDERLYING FEE OWNER.

NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



LOCATION MAP

PUMP STATION ACCESS ROAD



NOTE: THIS DRAWING IS FOR PLANNING AND CONCEPTUAL PURPOSES ONLY. DETAILED DESIGN TO BE COMPLETED DURING FINAL DESIGN.

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD PLAN & PROFILE STA 3200+00 TO STA 3212+50

DRAWING SCALE
AS SHOWN

LAST MODIFIED: Jan 27, 2011 - 5:10pm BY USER: ThompsonBl
DWG. LOCATION: D:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Codd\PWD\Sheets\
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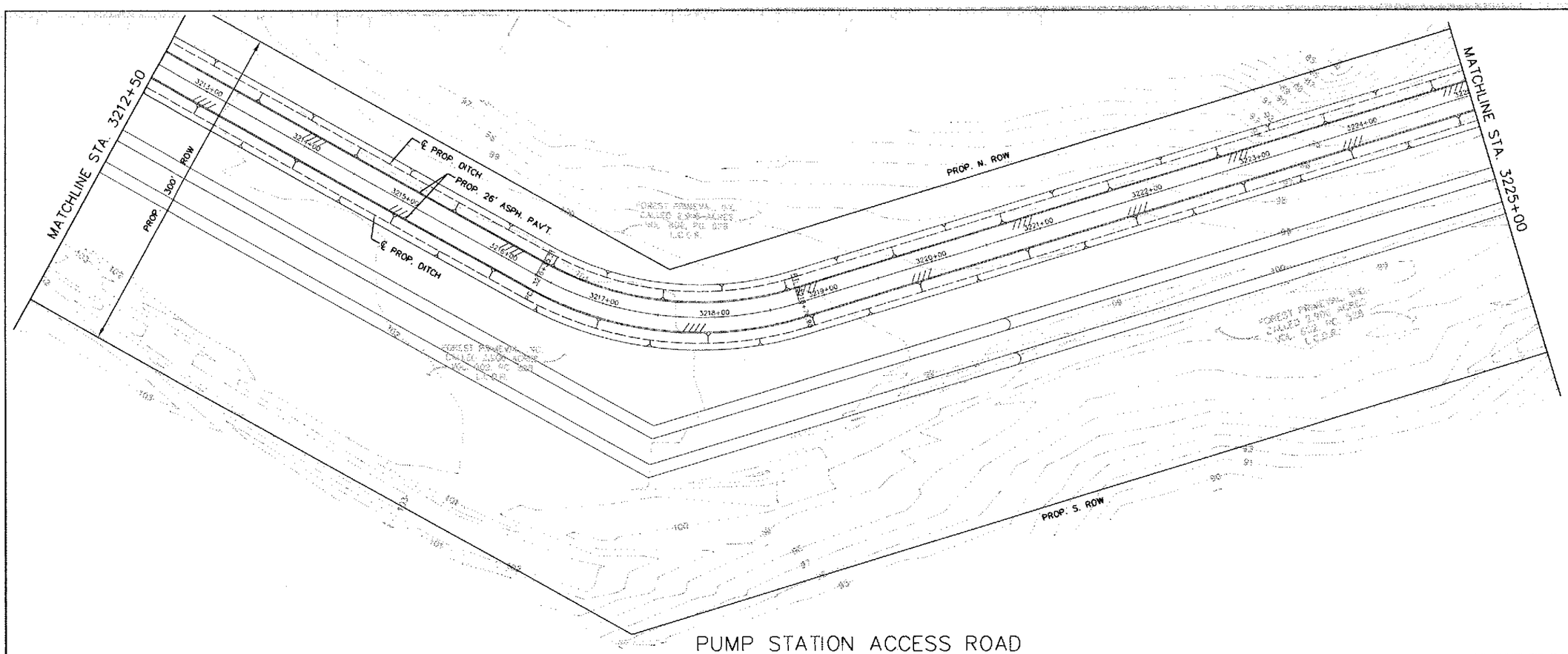
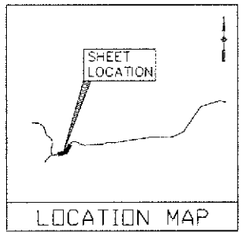


VERTICAL SCALE: 1" = 10'

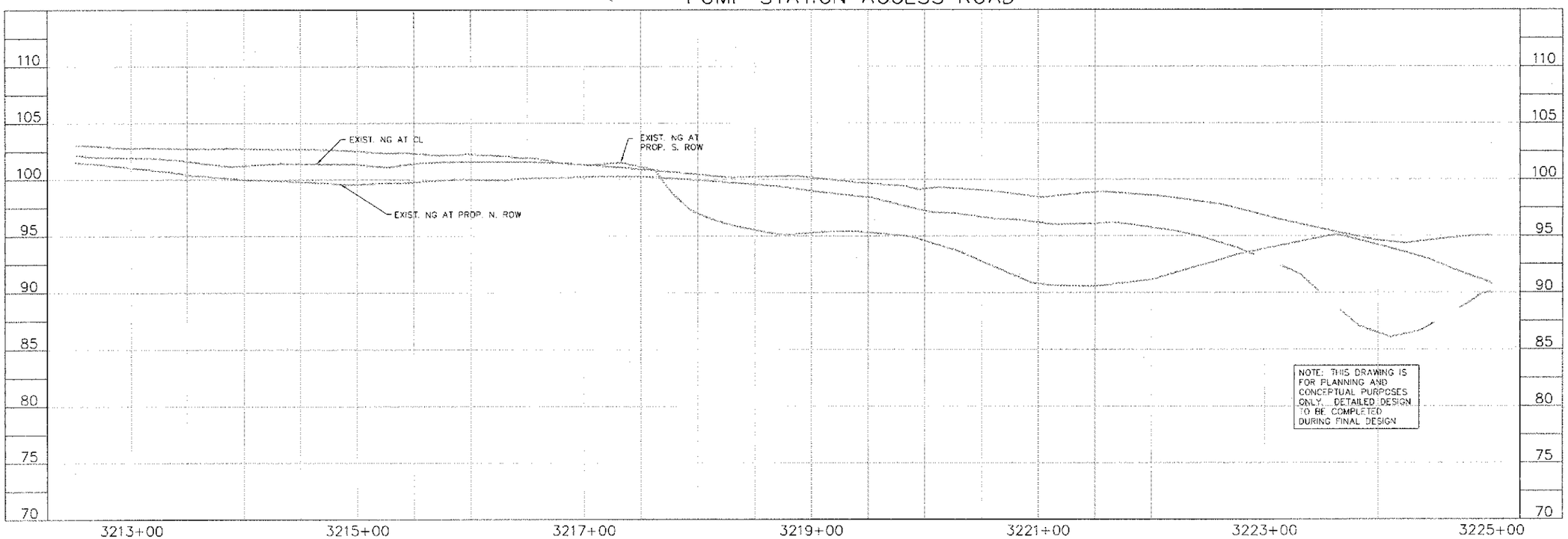
HORIZONTAL SCALE: 1" = 100'

NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



LOCATION MAP

PUMP STATION ACCESS ROAD



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LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD PLAN & PROFILE STA 3212+50 TO STA 3225+00

DRAWING SCALE
AS SHOWN

SHEET NO. 171 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:10pm BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cond\PWD\Sheets\
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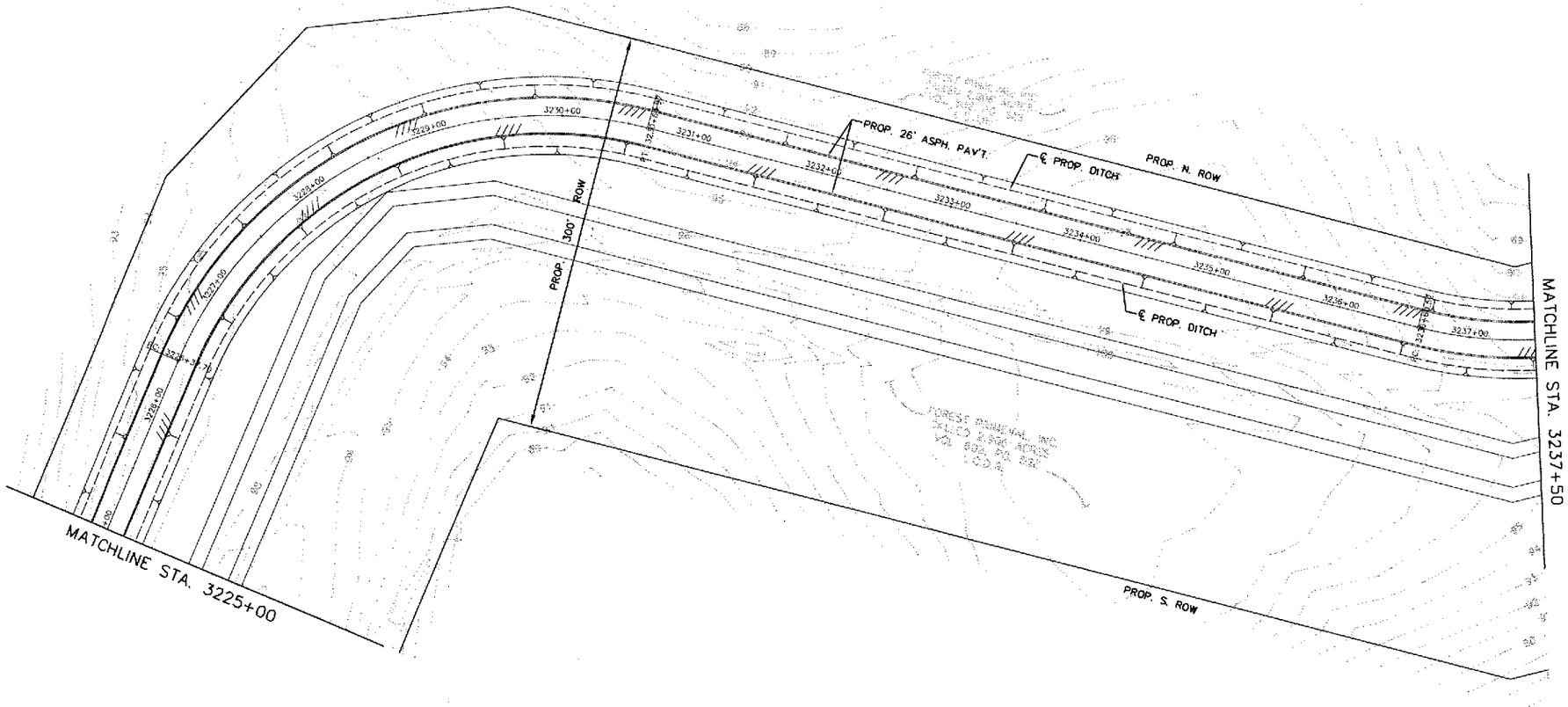
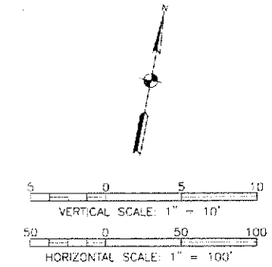
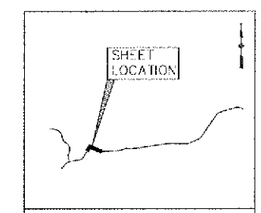


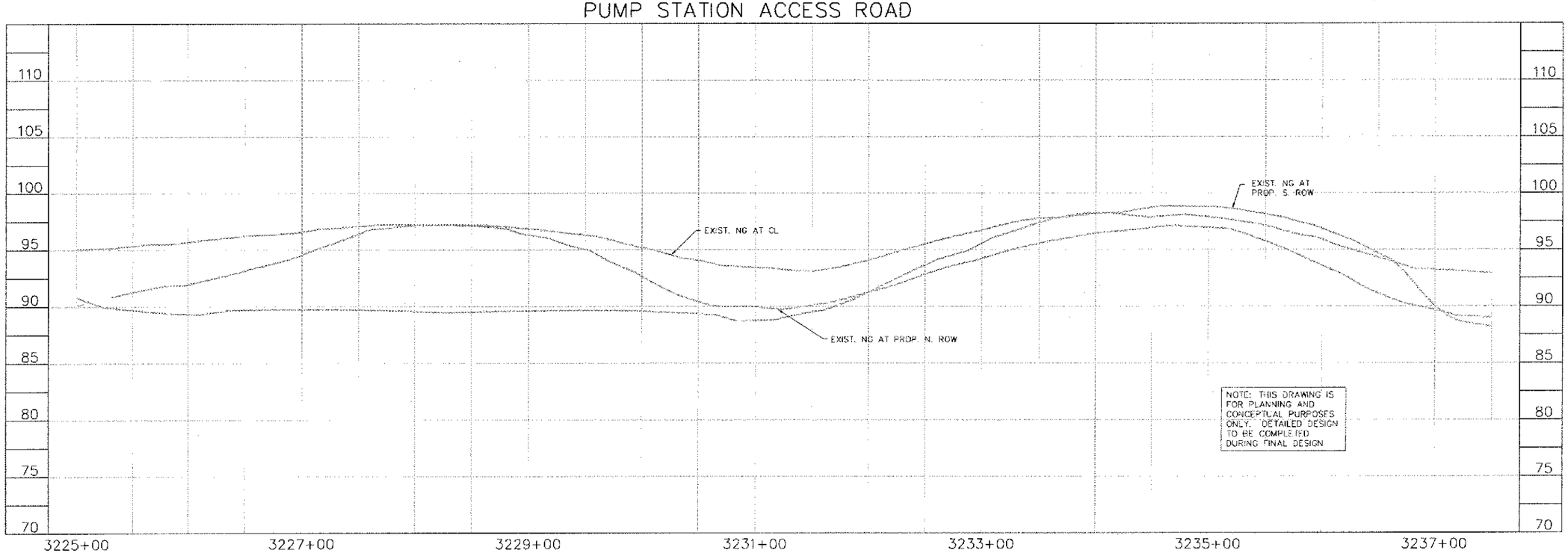


NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



LOCATION MAP

PUMP STATION ACCESS ROAD



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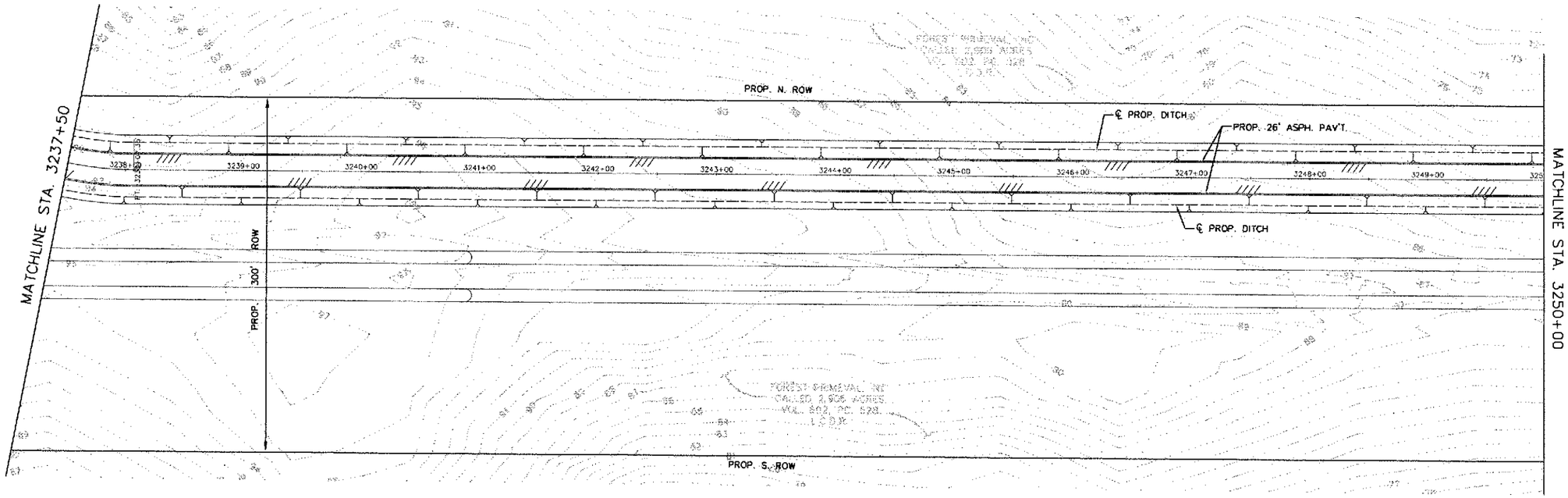
LUCE BAYOU INTERBASIN TRANSFER PROJECT

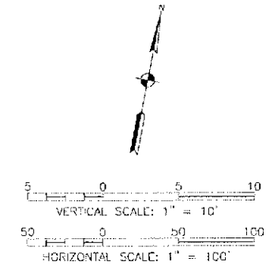
ACCESS ROAD PLAN & PROFILE STA 3225+00 TO STA 3237+50

DRAWING SCALE
AS SHOWN

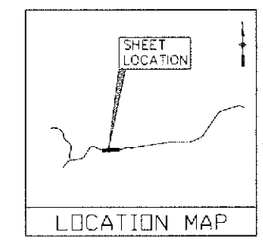
SHEET NO. 172 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:10pm BY USER: ThompsonBi
DWG LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Codd\PWD\Sheets\
DWG NAME: AR2-P&P3.dwg



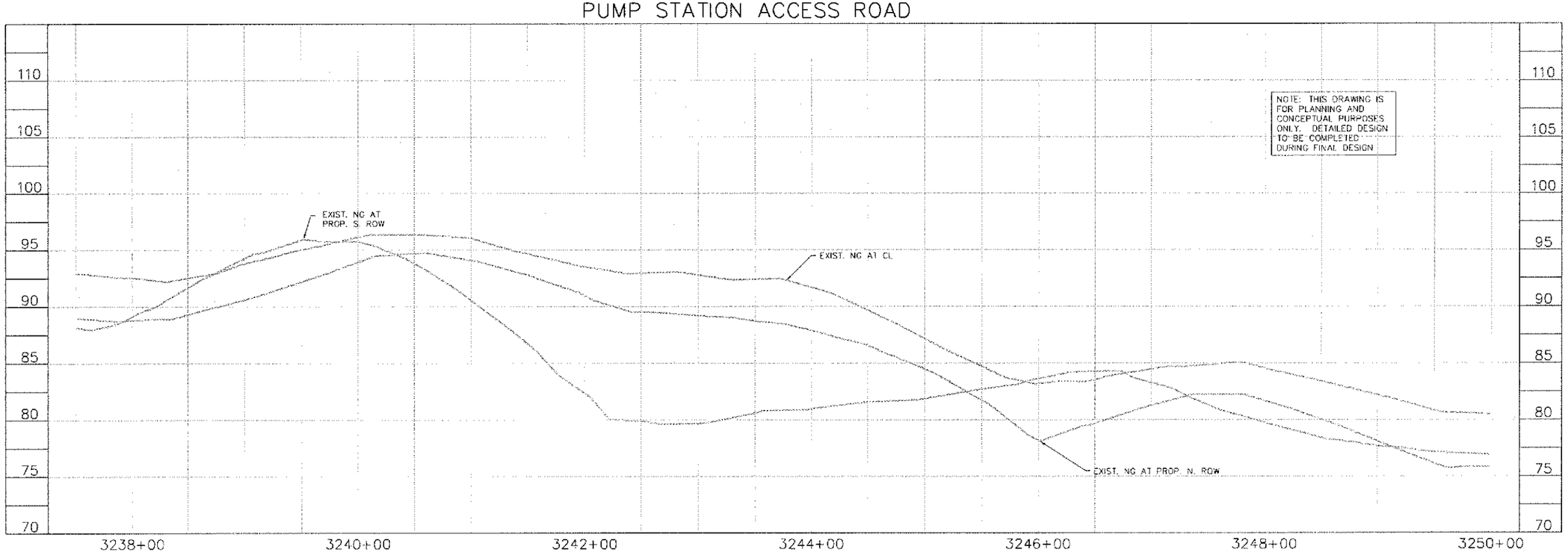


NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



LOCATION MAP

PUMP STATION ACCESS ROAD



NOTE: THIS DRAWING IS FOR PLANNING AND CONCEPTUAL PURPOSES ONLY. DETAILED DESIGN TO BE COMPLETED DURING FINAL DESIGN

KEVIN R. KRAHN, P.E.
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713.780.0838 fax.

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD PLAN & PROFILE STA 3237+50 TO STA 3250+00

DRAWING SCALE
AS SHOWN

SHEET NO. 173 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:11pm BY USER: ThompsonBl
DWG. LOCATION: Q:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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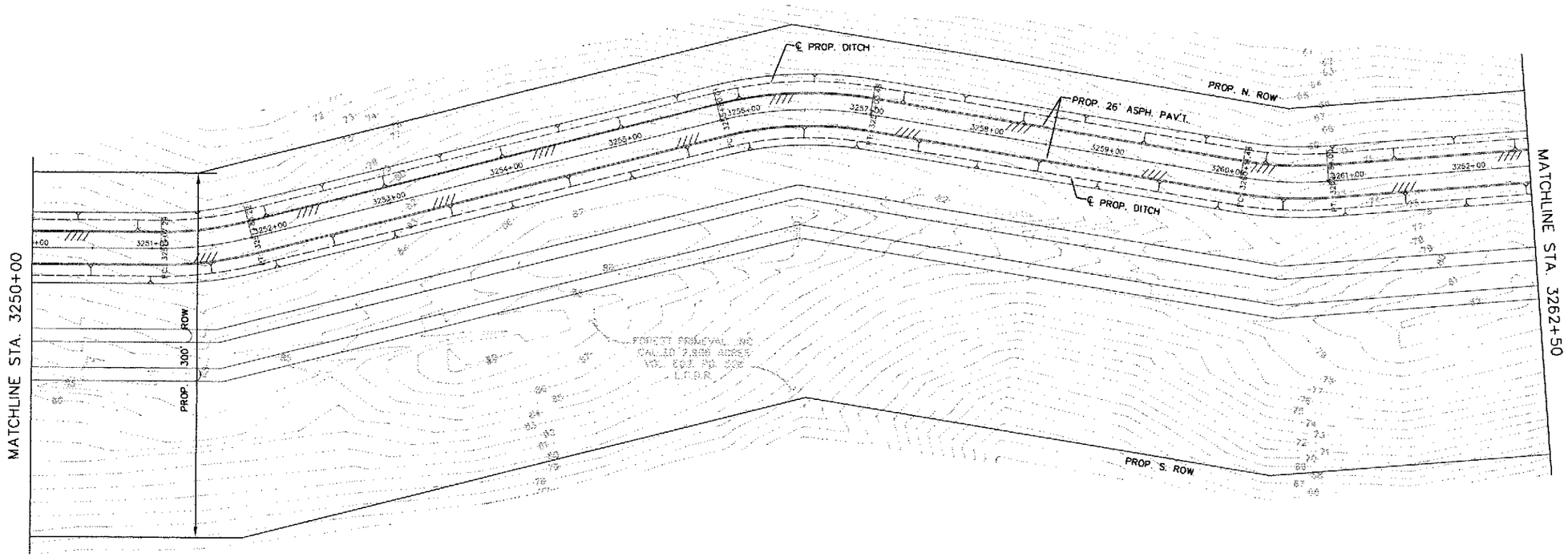
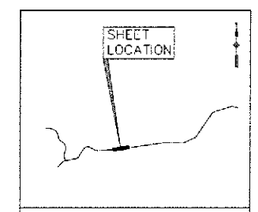


VERTICAL SCALE: 1" = 10'

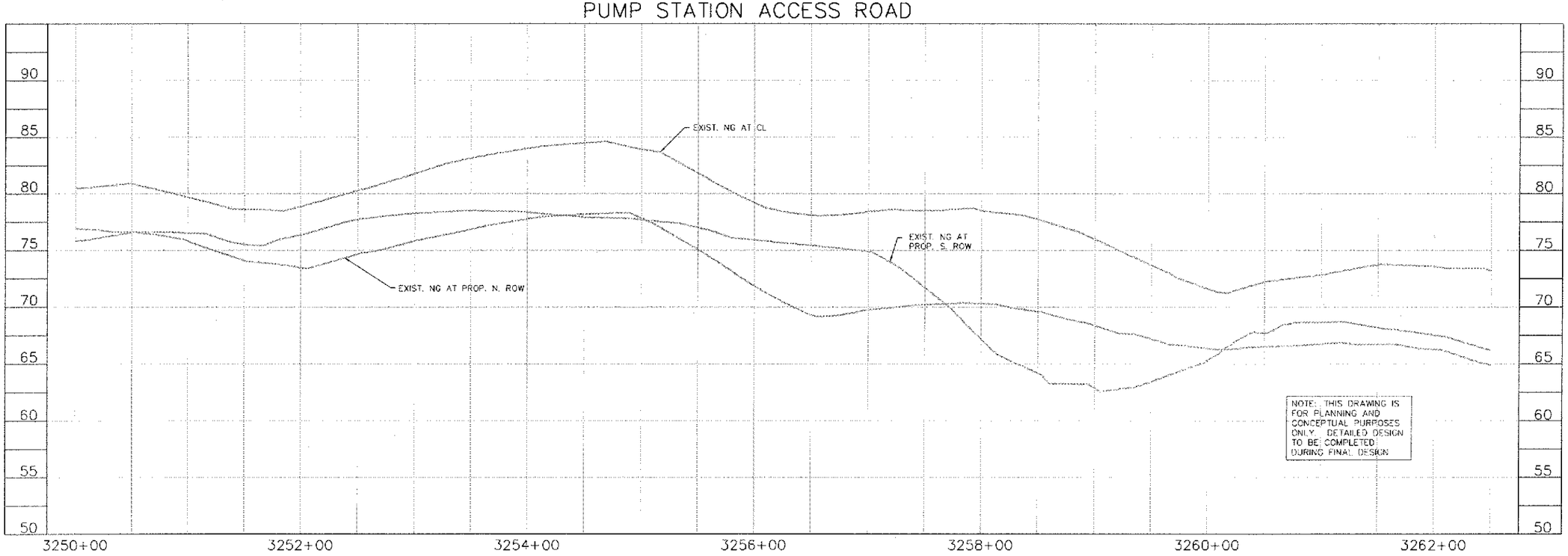
HORIZONTAL SCALE: 1" = 100'

NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



LOCATION MAP

PUMP STATION ACCESS ROAD



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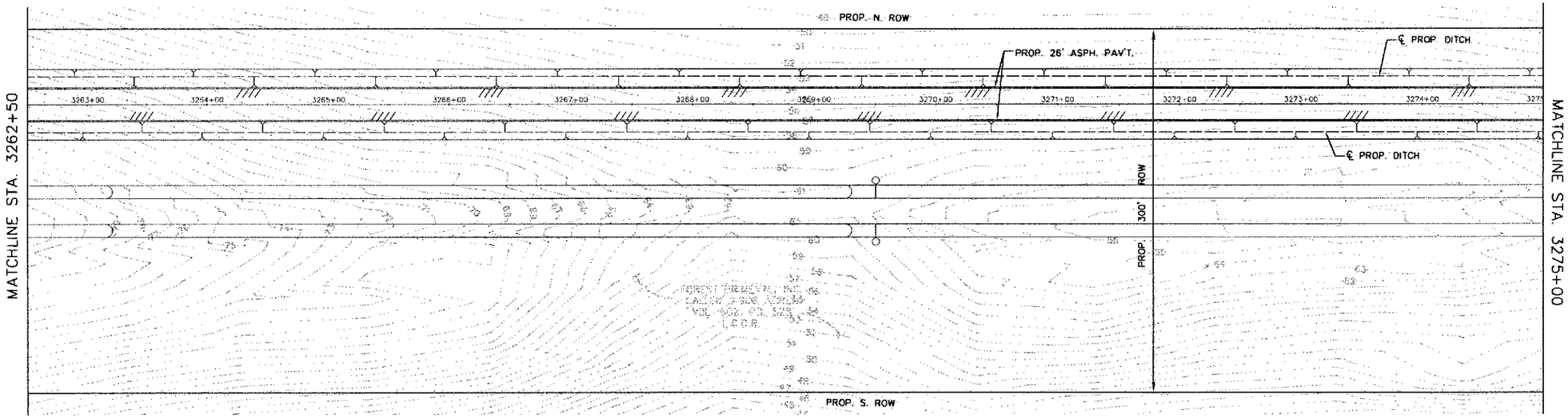
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

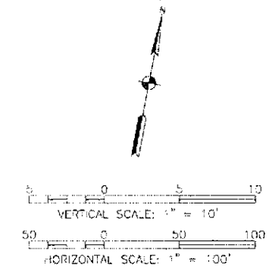
ACCESS ROAD PLAN & PROFILE STA 3250+00 TO STA 3262+50

DRAWING SCALE
AS SHOWN

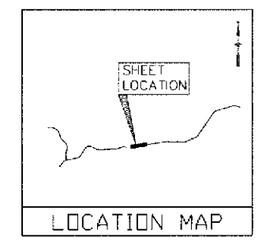
SHEET NO. 174 OF 245

LAST MODIFIED: Jan. 27, 2011 - 5:11pm BY USER: ThompsonBI
DWG: LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\Pwd\Sheets\
DWG NAME: AR2-P&PS.dwg

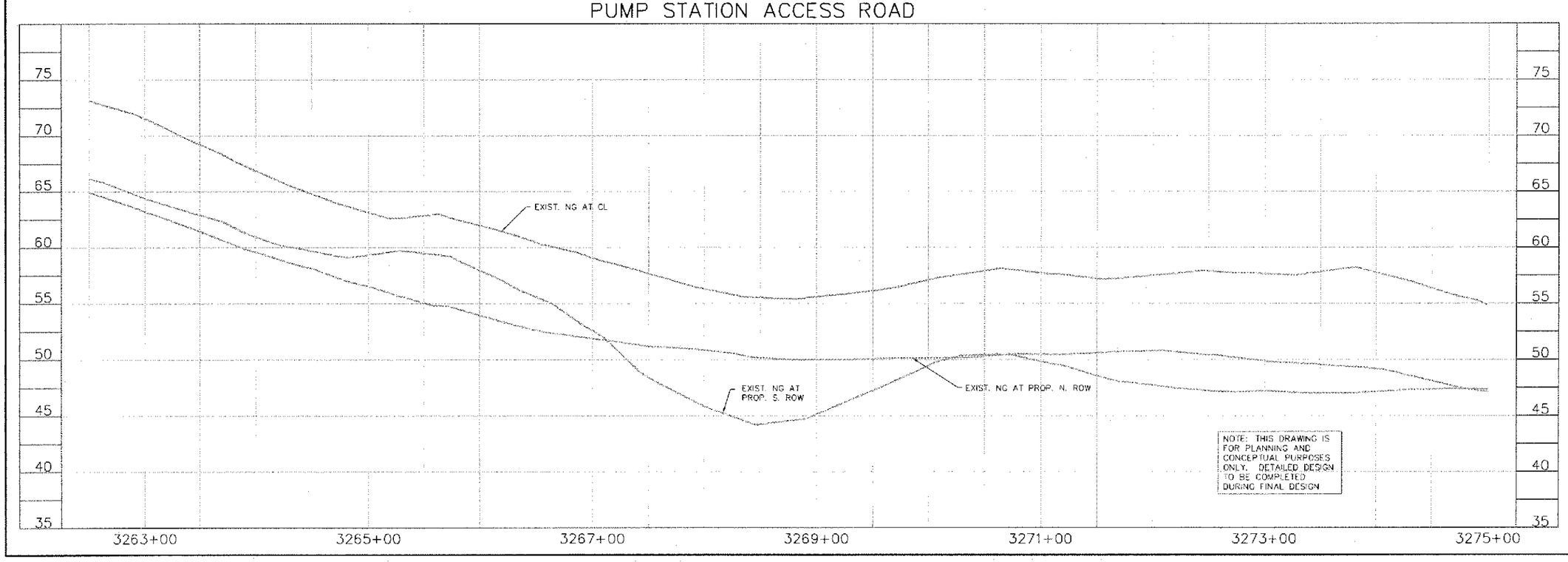




NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



PUMP STATION ACCESS ROAD



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713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD PLAN & PROFILE STA 3262+50 TO STA 3275+00

DRAWING SCALE
AS SHOWN

SHEET NO. 175 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:11pm BY USER: ThompsonBl
DWG LOCATION: Q:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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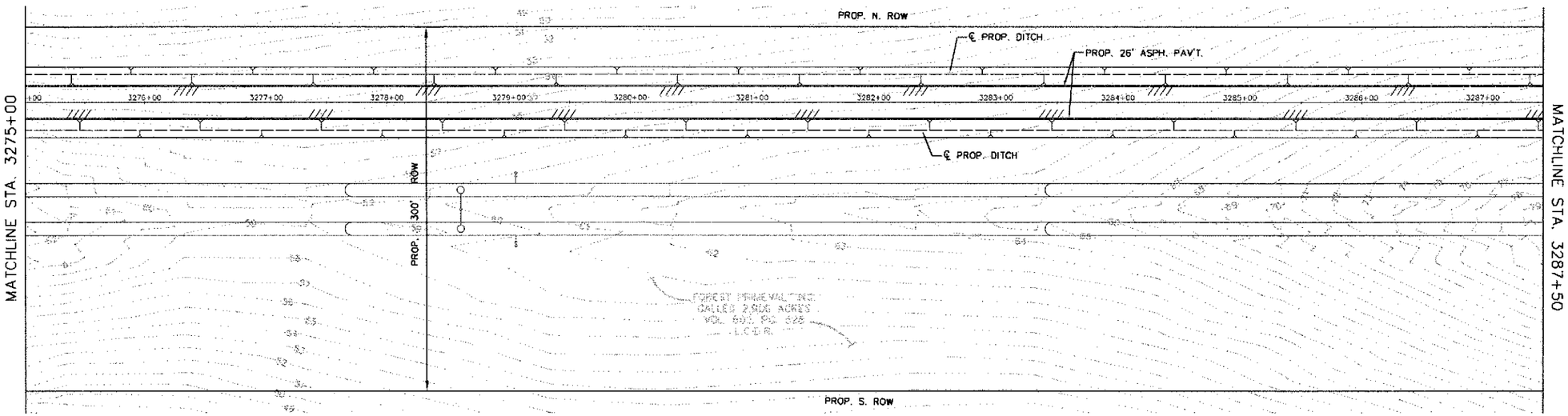
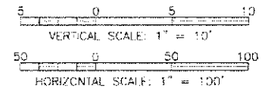
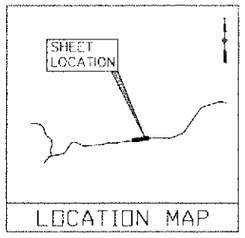




NOTE
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



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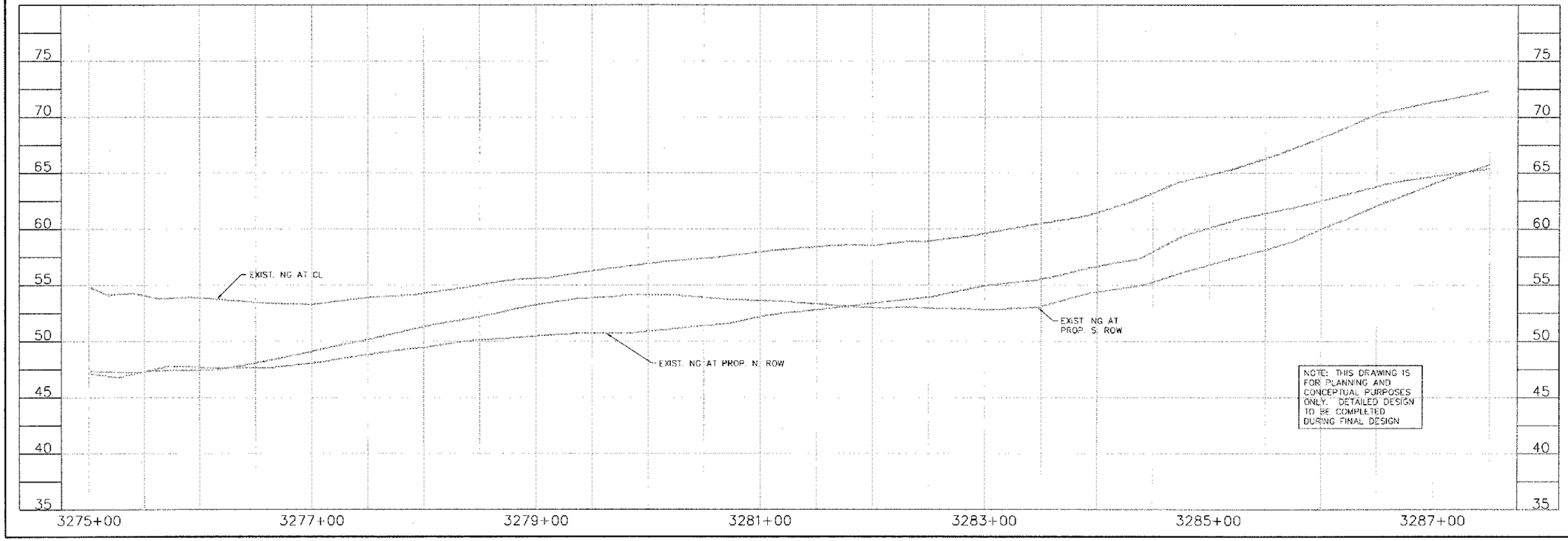

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

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AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1599
WWW.AECOM.COM
TBPE REG. NO. F-2580

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HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD PLAN & PROFILE STA 3275+00 TO STA 3287+50

DRAWING SCALE
AS SHOWN

SHEET NO. 176 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:11pm BY USER: ThompsonBl
DWG. LOCATION: D:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PM01\Sheets\
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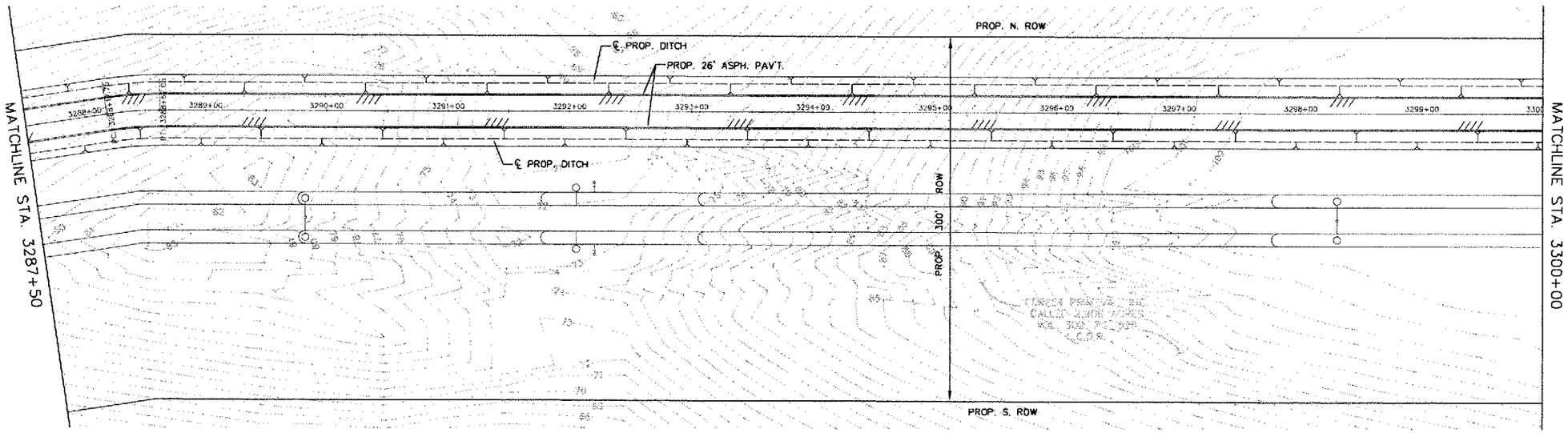
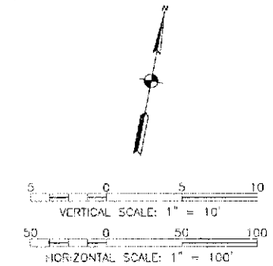
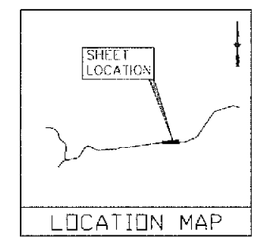




NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



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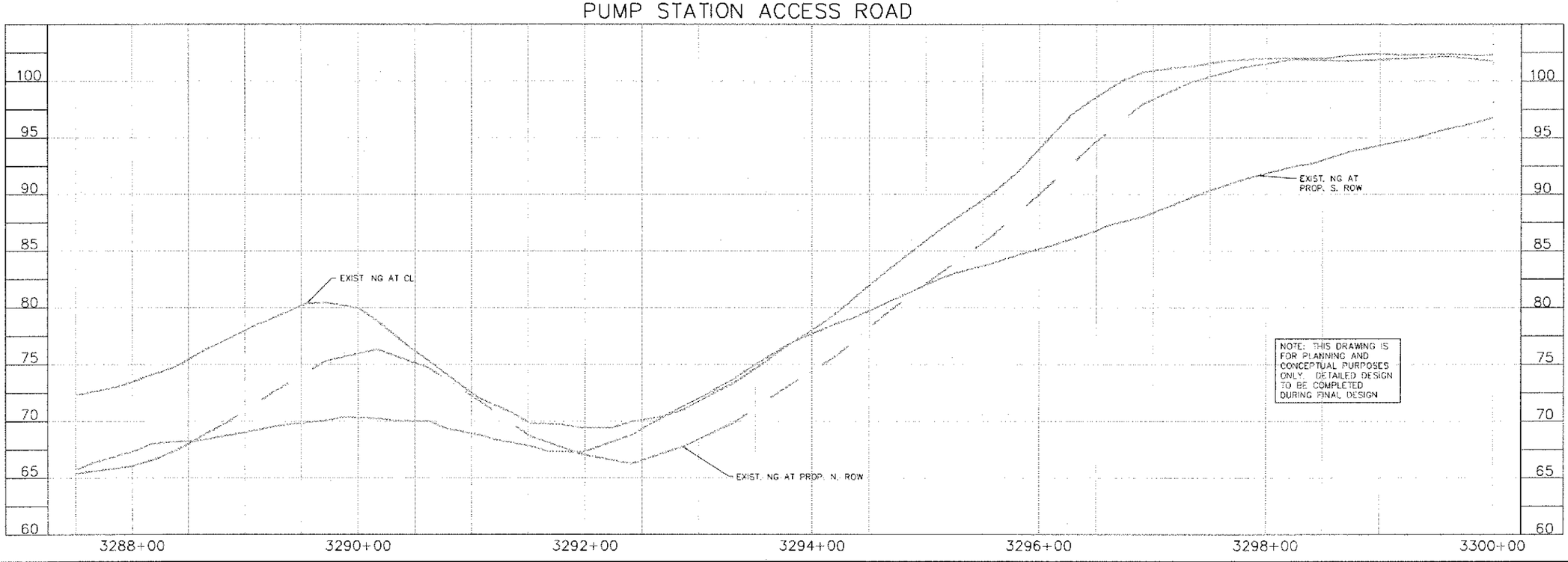

NOTE: THIS DRAWING IS FOR PLANNING AND CONCEPTUAL PURPOSES ONLY. DETAILED DESIGN TO BE COMPLETED DURING FINAL DESIGN

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD PLAN & PROFILE STA 3287+50 TO STA 3300+00

DRAWING SCALE
AS SHOWN

LAST MODIFIED: Jan 27, 2011 - 5:12pm BY USER: ThompsonBl
DWG LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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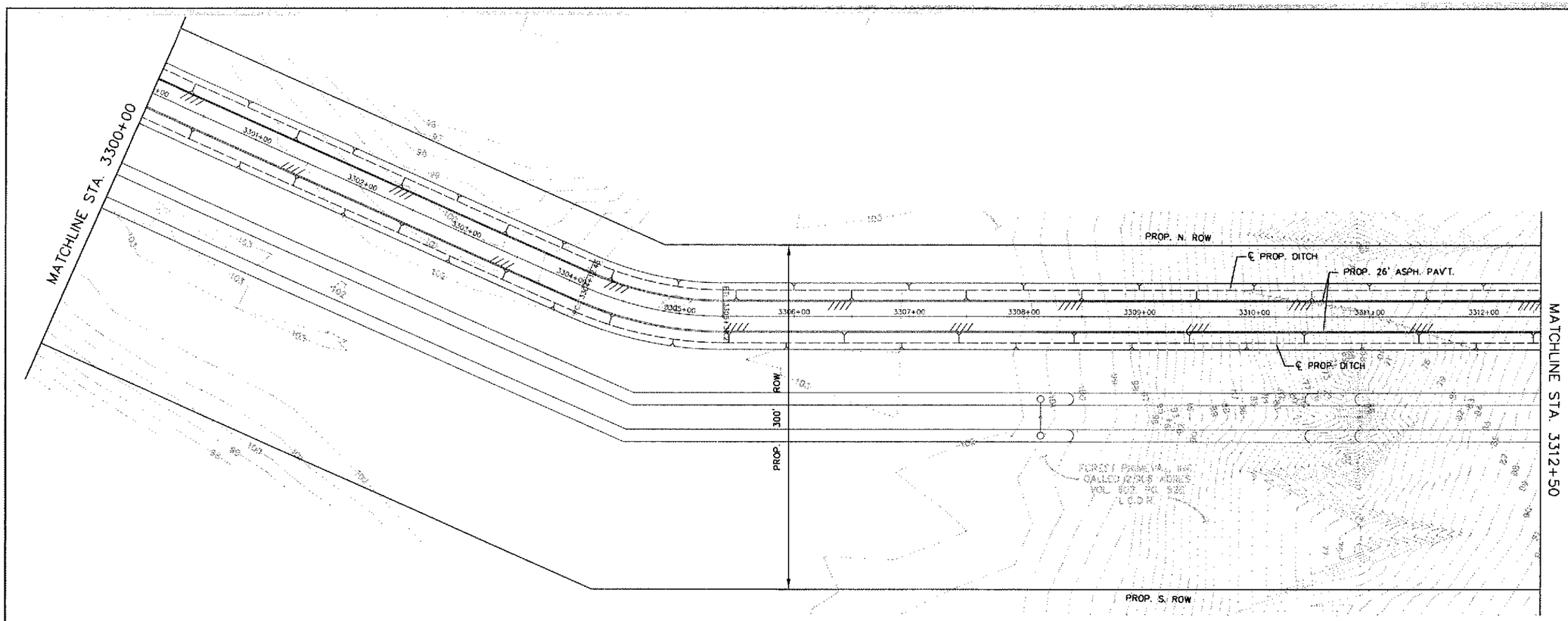
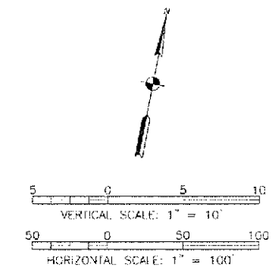
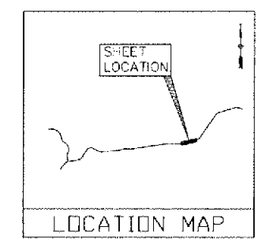




NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



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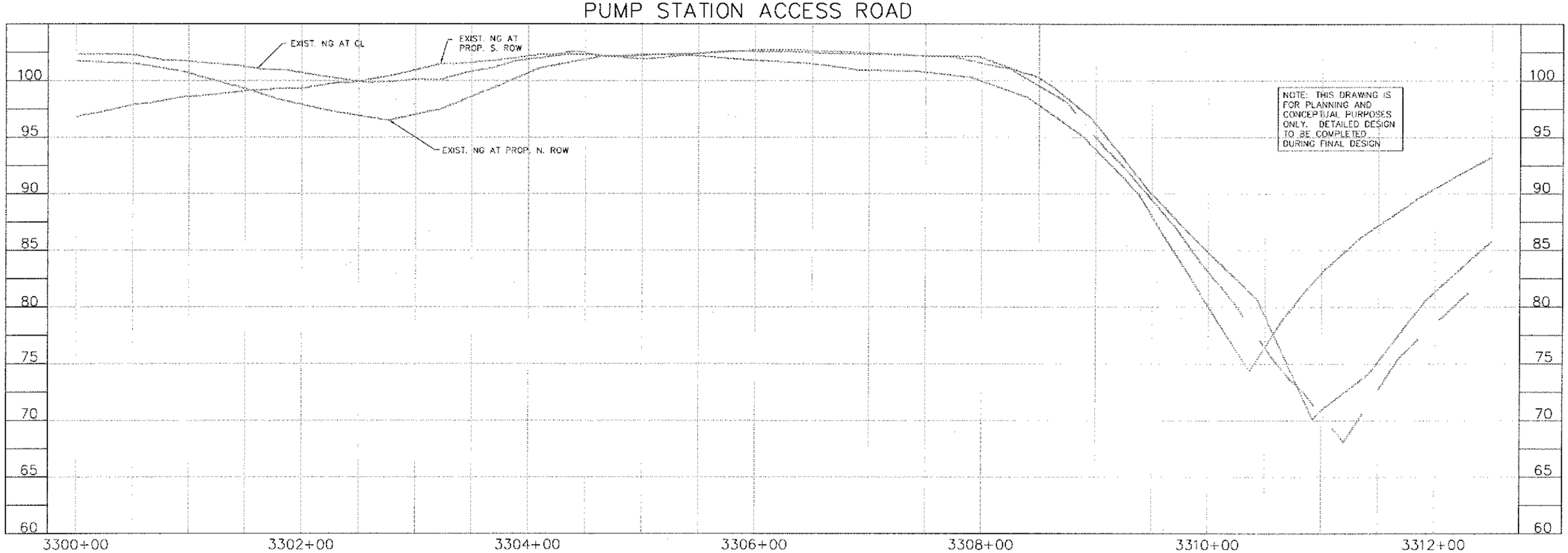

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
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FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD PLAN & PROFILE STA 3300+00 TO STA 3312+50

DRAWING SCALE
AS SHOWN

SHEET NO. 178 OF 295

LAST MODIFIED: Jan 27, 2011 - 5:12pm BY USER: ThompsonBi
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWO\Sheets\
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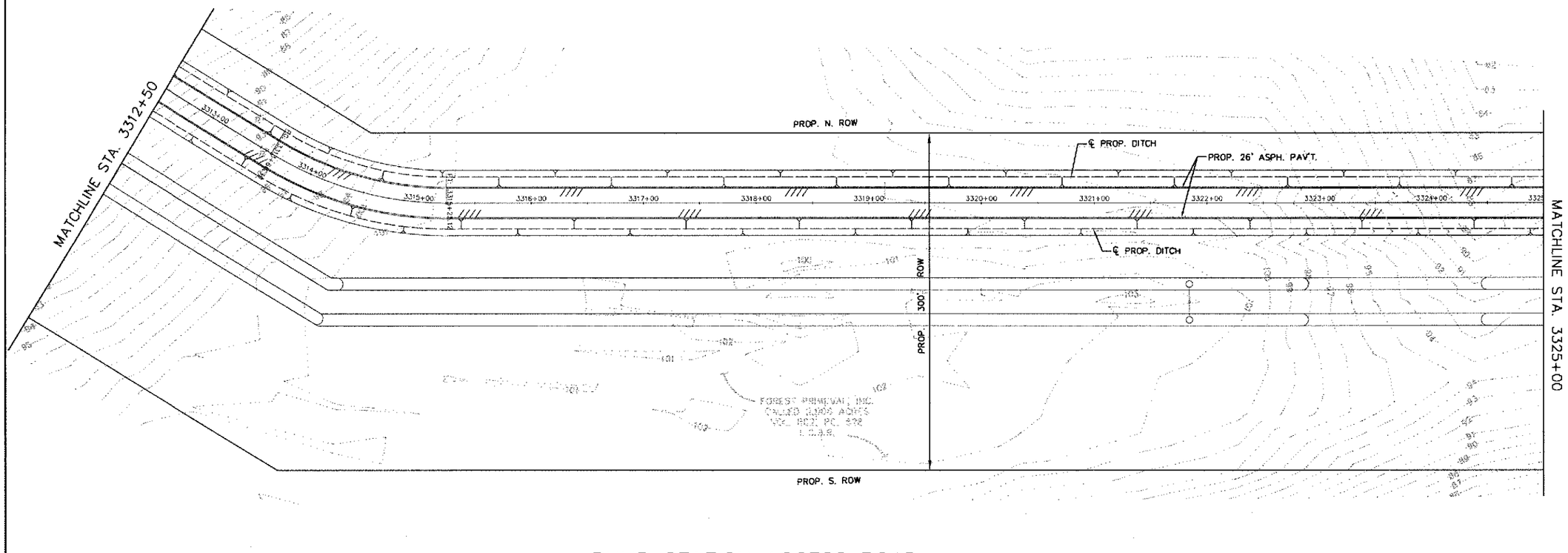
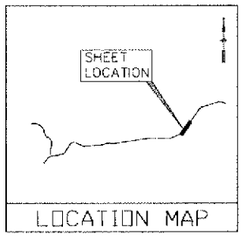


VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



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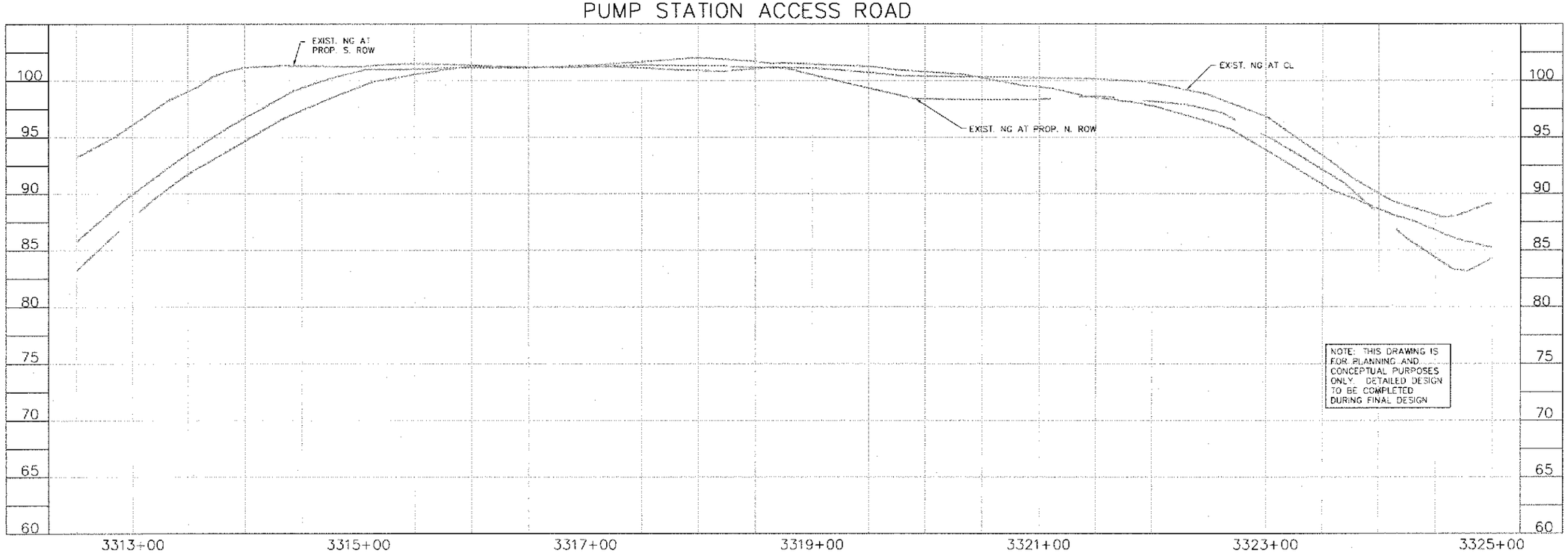

NOTE: THIS DRAWING IS FOR PLANNING AND CONCEPTUAL PURPOSES ONLY. DETAILED DESIGN TO BE COMPLETED DURING FINAL DESIGN

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD PLAN & PROFILE STA 3312+50 TO STA 3325+00

DRAWING SCALE
AS SHOWN

SHEET NO. 179 OF 295

LAST MODIFIED: Jan 27, 2011 - 5:12pm BY USER: ThompsonBl
DWG. LOCATION: Q:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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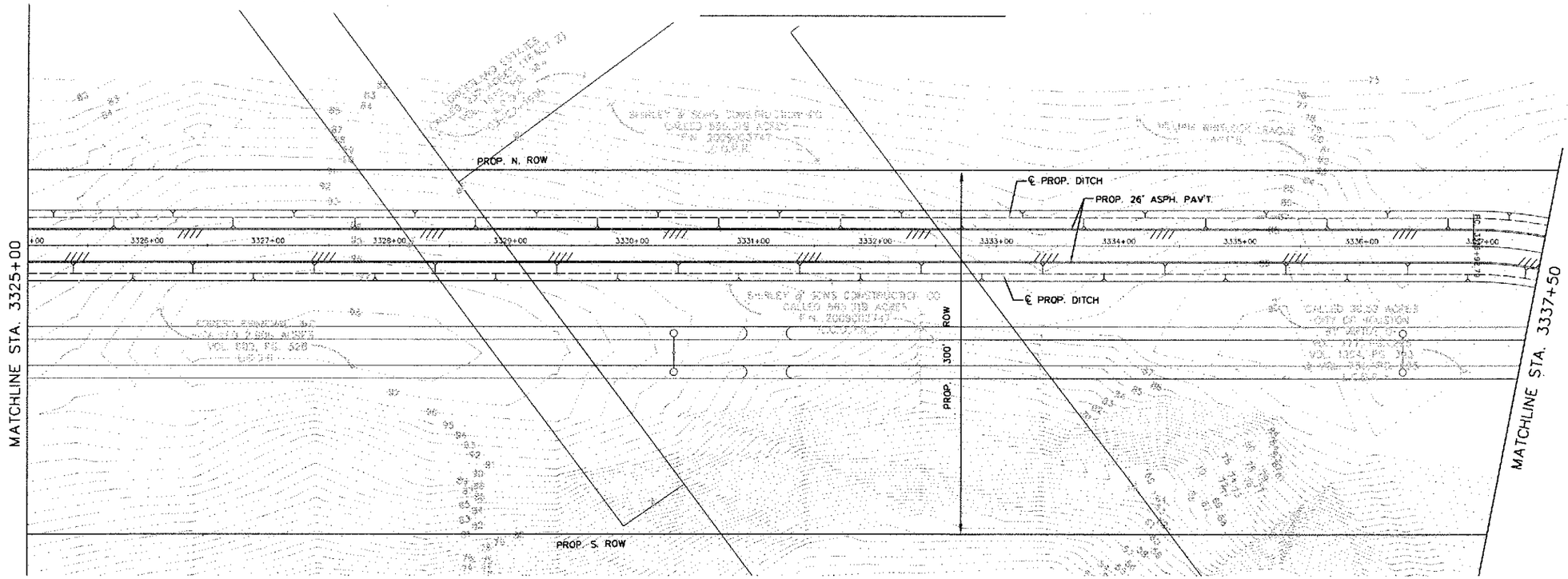
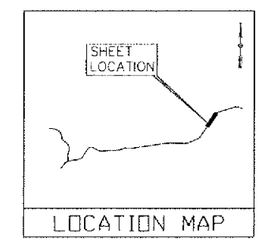


VERTICAL SCALE: 1" = 10'

HORIZONTAL SCALE: 1" = 100'

NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



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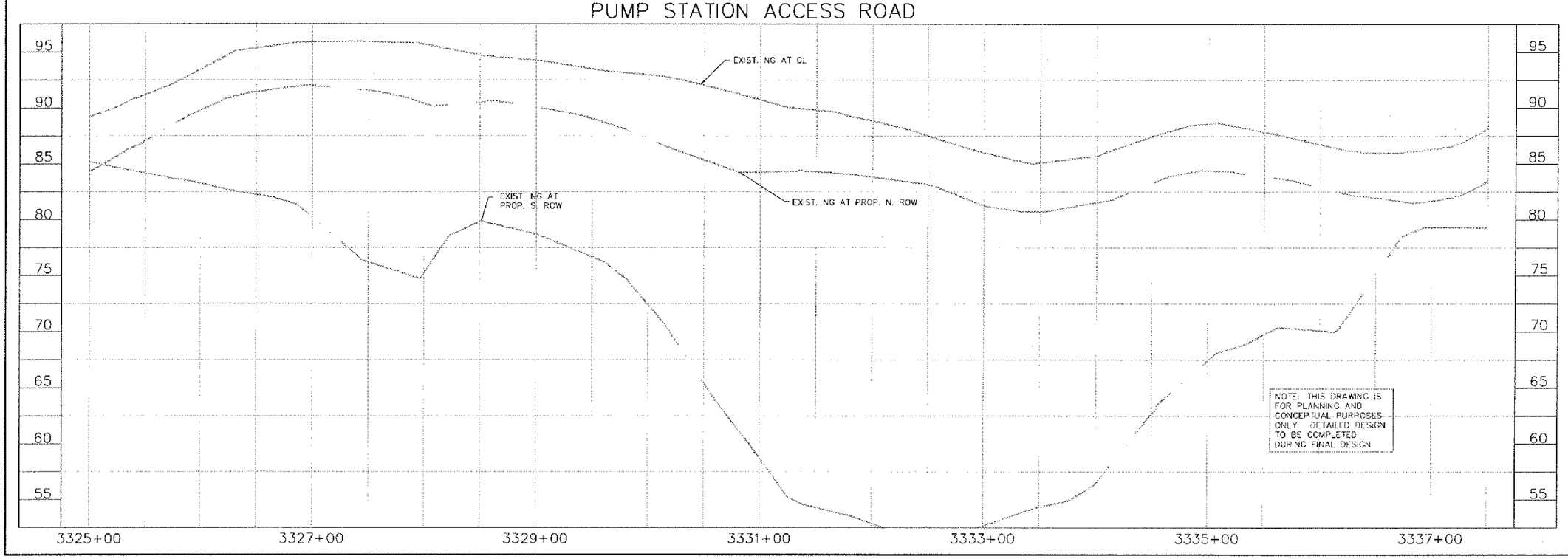

NOTE: THIS DRAWING IS FOR PLANNING AND CONCEPTUAL PURPOSES ONLY. DETAILED DESIGN TO BE COMPLETED DURING FINAL DESIGN

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TEXAS REGISTRATION NO. 91031
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LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD PLAN & PROFILE STA 3325+00 TO STA 3337+50

DRAWING SCALE
AS SHOWN

SHEET NO. 180 OF 295

LAST MODIFIED: Jan 27, 2011 - 5:12pm BY USER: ThompsonBl
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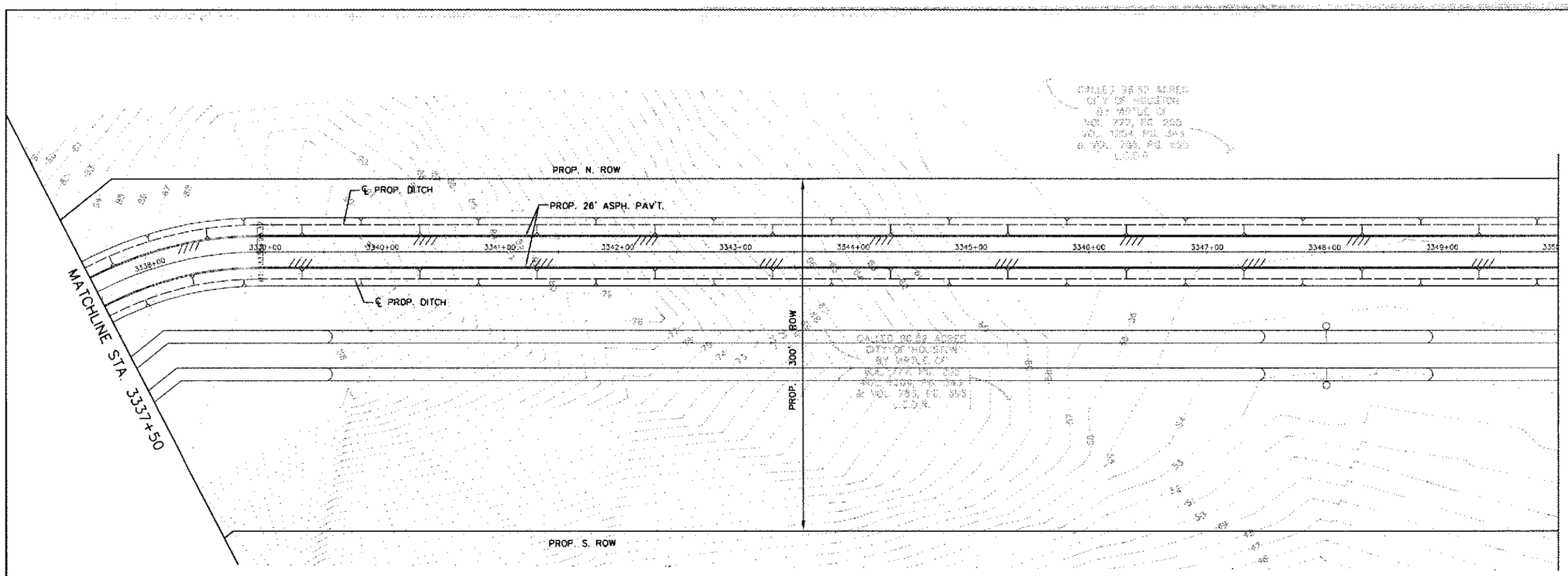
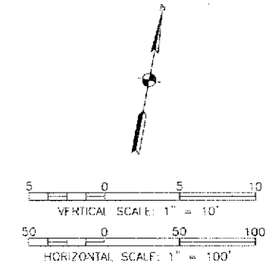
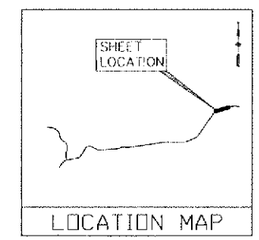
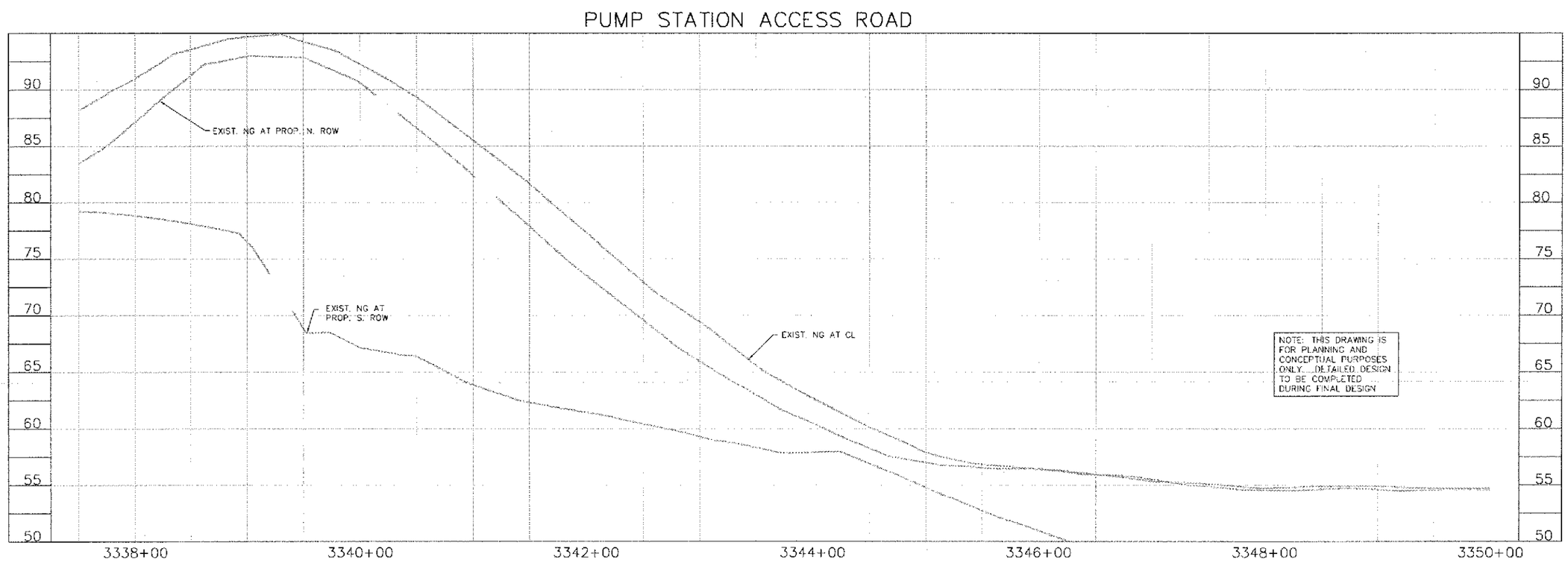




NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS





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TEXAS REGISTRATION NO. 91031
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AECOM TECHNICAL SERVICES, INC.
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713.780.0838 fax.

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD PLAN & PROFILE STA 3337+50 TO STA 3350+00

DRAWING SCALE
AS SHOWN

SHEET NO. 181 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:13pm BY USER: Thompson(B)
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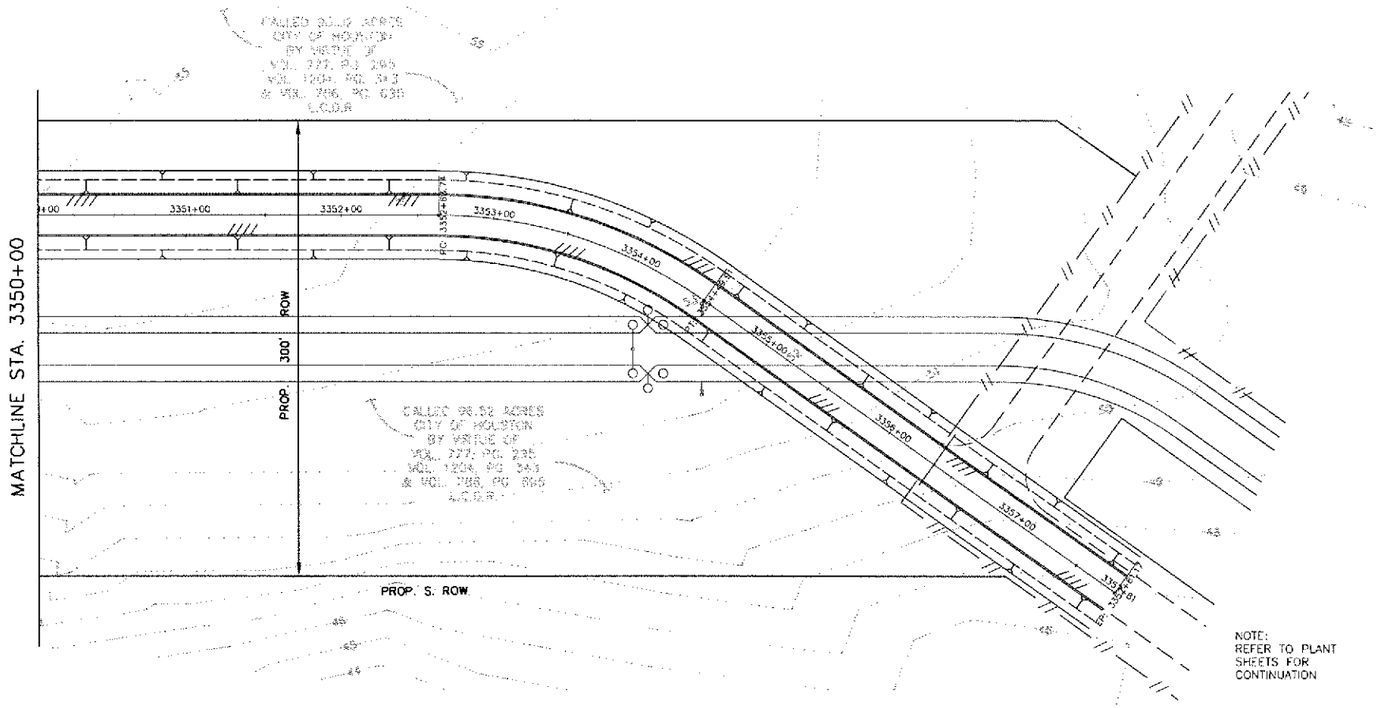
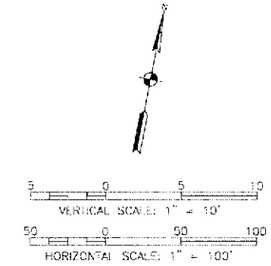
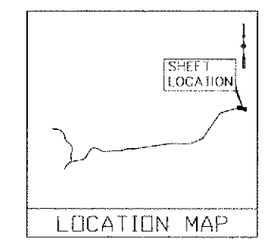




NOTE:
LOCATION, SPACING, AND SIZES OF WATERLINE VALVES AND OTHER APPURTENANCES TO BE REVISED FOLLOWING FUTURE INVESTIGATION AND TRANSIENT ANALYSIS



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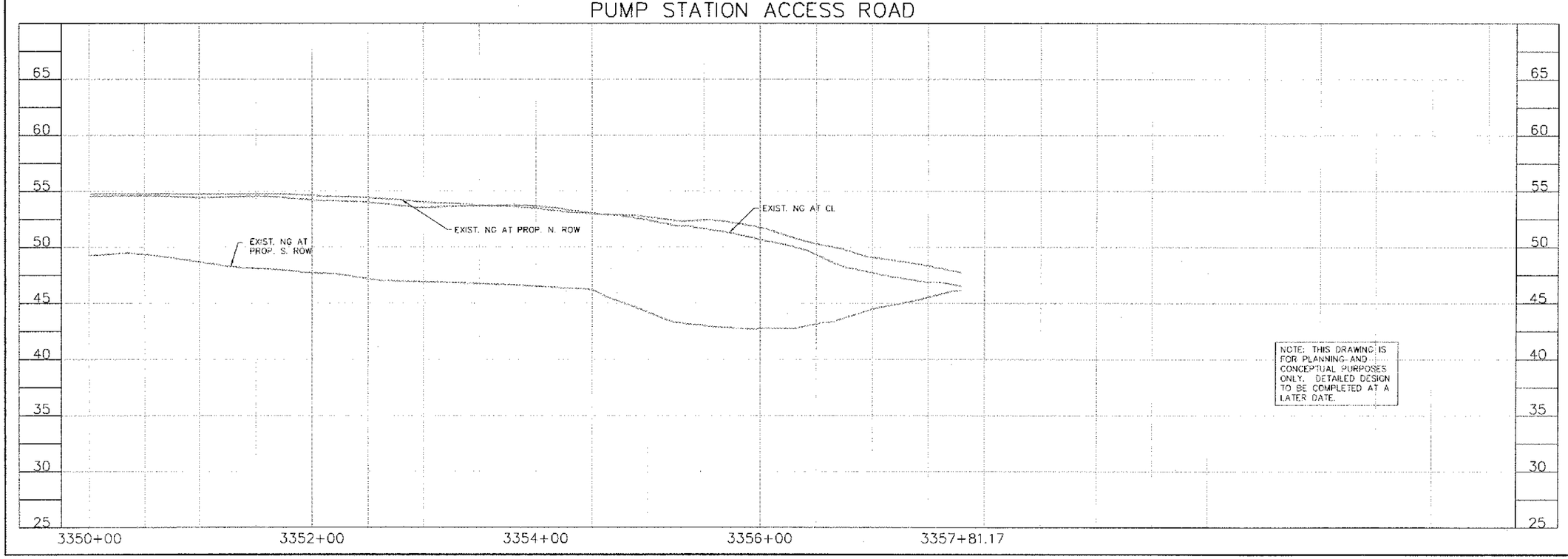

NOTE: THIS DRAWING IS FOR PLANNING AND CONCEPTUAL PURPOSES ONLY. DETAILED DESIGN TO BE COMPLETED AT A LATER DATE.

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD PLAN & PROFILE STA 3350+00 TO STA 3357+81

DRAWING SCALE
AS SHOWN

SHEET NO. 182 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:13pm BY USER: ThompsonBl
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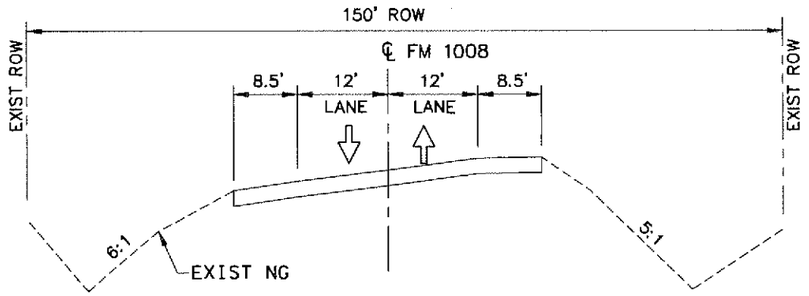

EXIST. TYP SECTION
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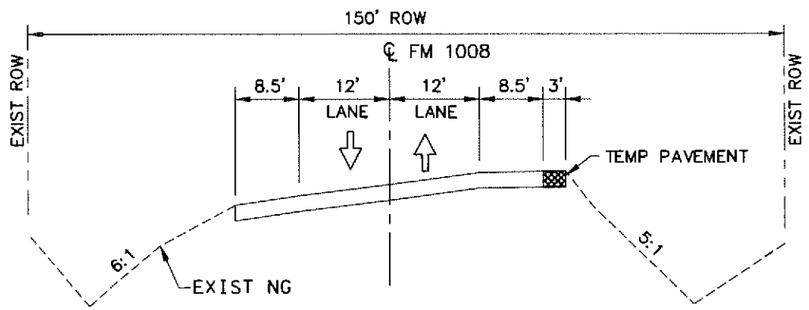
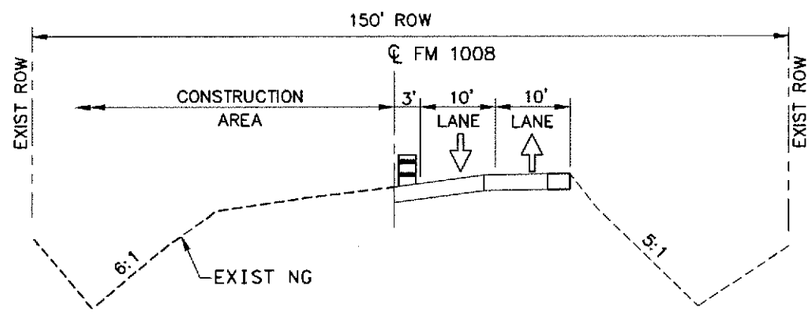
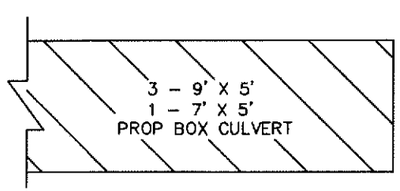
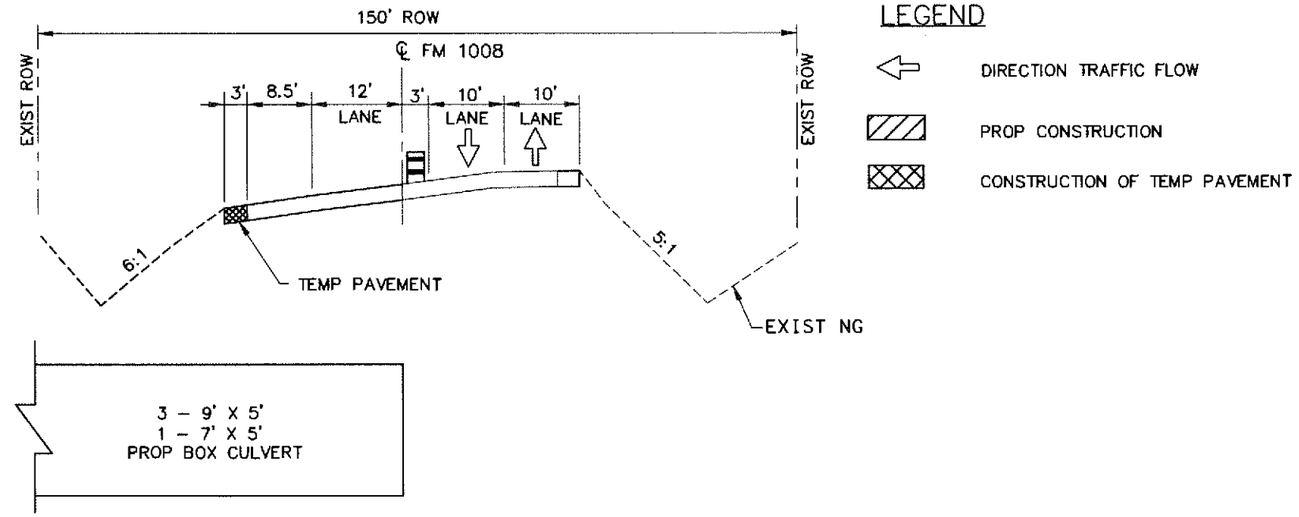


SECTION A–A
NTS





SECTION B–B
NTS



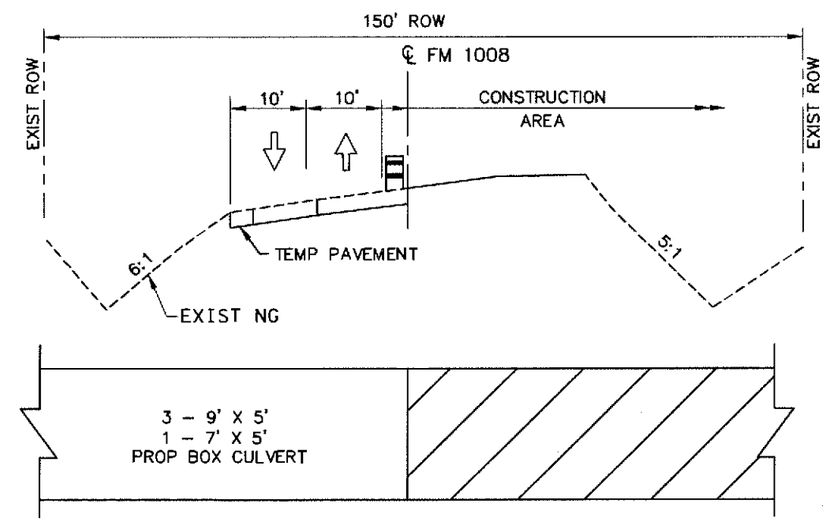
SECTION C–C
NTS

LEGEND

DIRECTION TRAFFIC FLOW

PROP CONSTRUCTION

CONSTRUCTION OF TEMP PAVEMENT



SECTION D–D
NTS

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.

J. A. GELACIO
56190
Date: MARCH 22, 2010

FINTECH CIVIL ENGINEERS, INC.
F-6932

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AECOM USA GROUP, INC.
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HOUSTON, TEXAS 77057-1696
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TBPE REG. NO. F-3580

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713.780.0836 fax.

SURVEYED BY:
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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

PROP CANAL AT FM 2100
TRAFFIC CONTROL TYPICAL SECTIONS

SHEET 1 OF 16

DRAWING SCALE
AS SHOWN

SHEET NO. 182 OF 245

LAST MODIFIED: Mar 30, 2010 – 4:03pm BY USER: rmaiko
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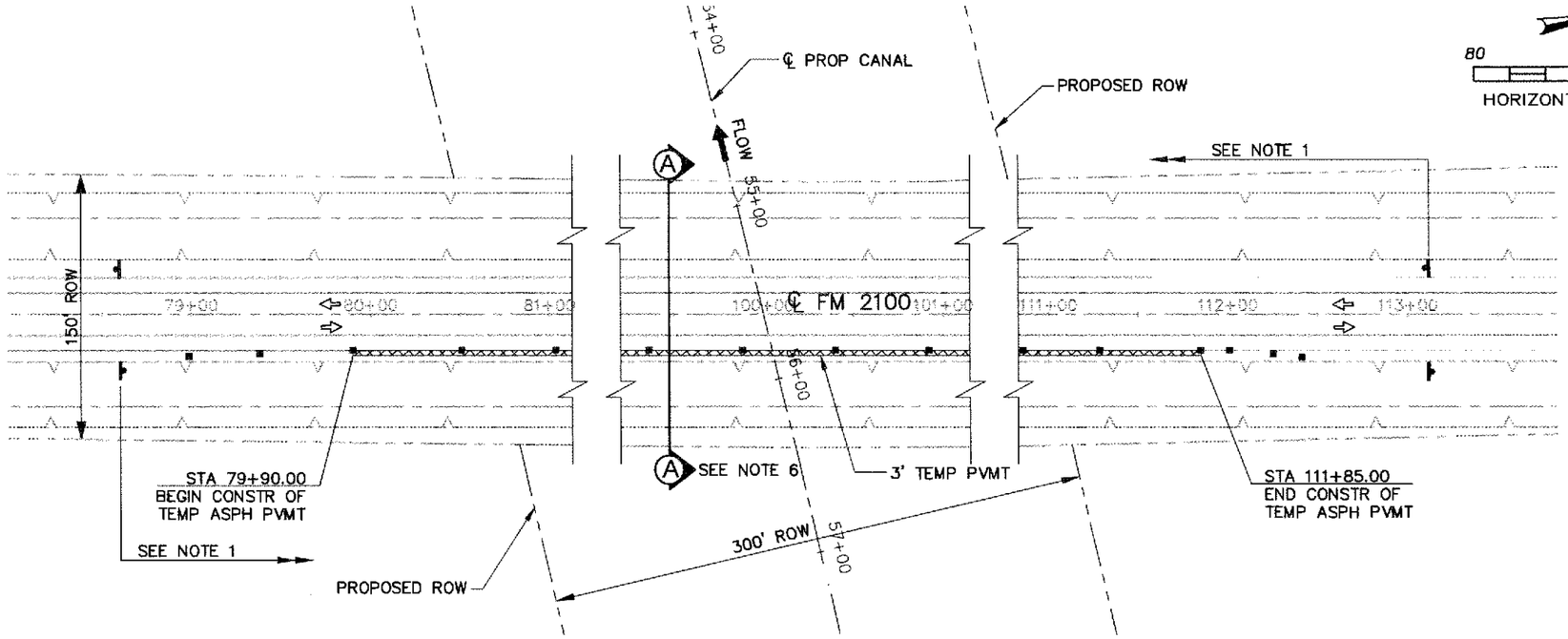
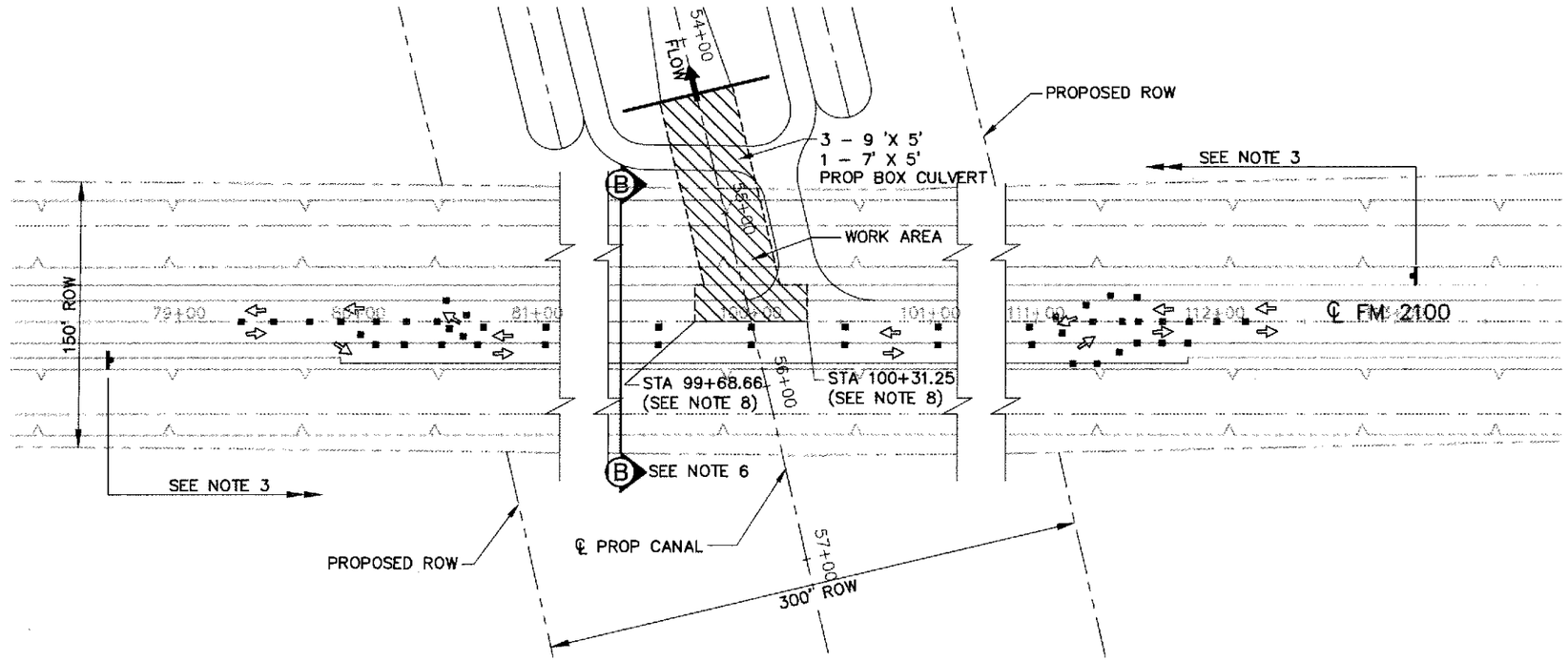
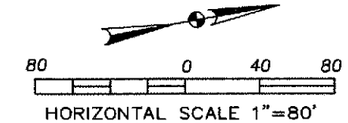


TRAFFIC CONTROL LAYOUT
STAGE 1



TRAFFIC CONTROL LAYOUT
STAGE 2



LEGEND

- TRAFFIC FLOW
- CHANNELIZING DEVICE
- SIGN
- WORK AREA
- TEMPORARY PAVEMENT

NOTE:

1. SEE TRAFFIC CONTROL PLAN "TCP (1-1)-98" STANDARD FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
2. SEE TRAFFIC CONTROL PLAN "TCP (1-2)-98" STANDARD FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
3. SEE TRAFFIC CONTROL PLAN "TCP (1-3)-98" FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
4. ANY CONFLICTING SIGNS SHALL BE COVERED AS DIRECTED BY ENGINEER.
5. CONTRACTOR TO MAINTAIN ACCESS TO ALL ADJACENT DRIVEWAYS.
6. SEE SHEET 01, "PROP CANAL AT FM 2100 TRAFFIC CONTROL TYPICAL SECTIONS" FOR SECTION A-A AND B-B DETAILS.
7. CONTRACTOR MAY ESTABLISH STATIONING AS SHOWN IN PLANS OR MAY FIELD MEASURE ALL DISTANCES NECESSARY TO ESTABLISH TEMP PVMT NEEDED AND TO LOCATE TRAFFIC CONTROL SIGNS USING THE INTERSECTION OF ℄ OF PROP CANAL AND ℄ OF FM 2100 AS THE REFERENCE POINT.
8. LIMITS OF CUT AND RESTORE PVMT

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.
J. A. GELACIO
56190
Date: MARCH 22, 2010

ENTECH CIVIL ENGINEERS, INC.
F-6932

AECOM

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713.780.0838 fax.

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

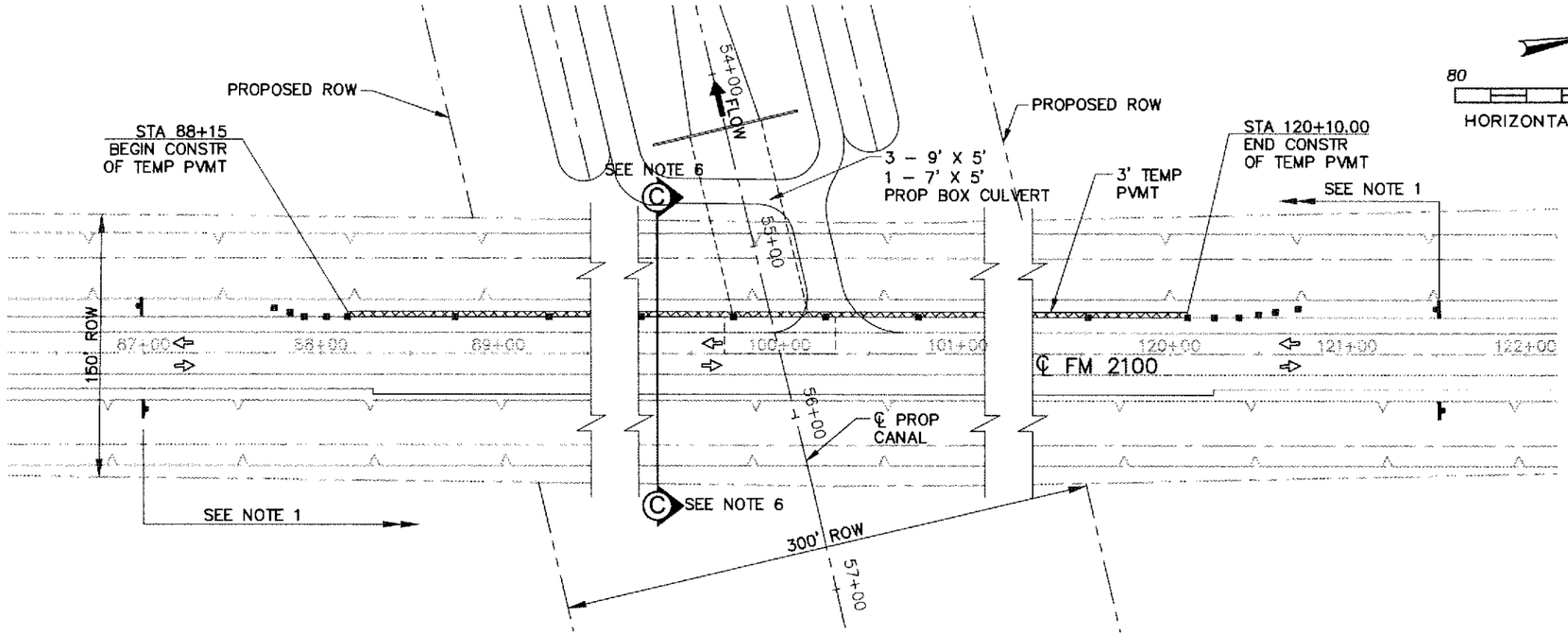
TRAFFIC CONTROL LAYOUT
FM 2100
PHASE I
STAGE 1 & STAGE 2

SHEET 2 OF 16

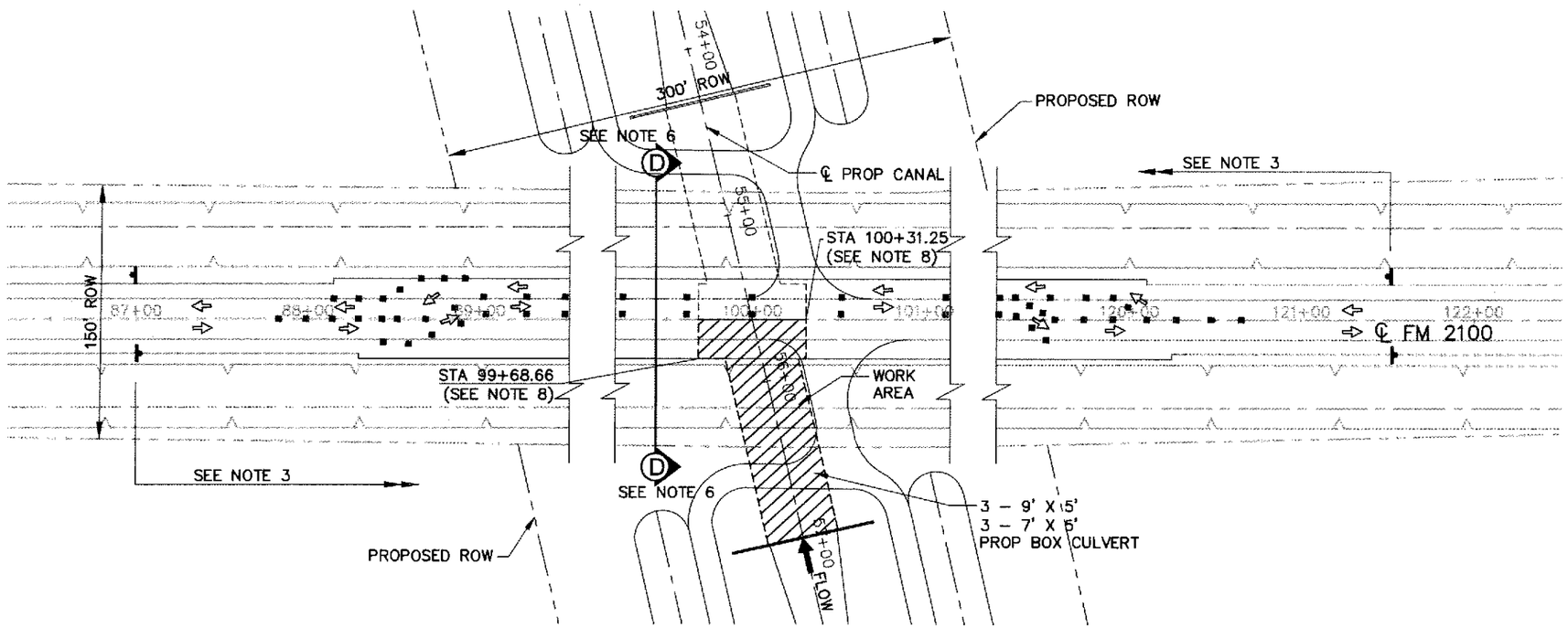
DRAWING SCALE
AS SHOWN

SHEET NO. 184 OF 295

LAST MODIFIED: Mar 30, 2010 - 3:39pm BY USER: rmalla
DWG. LOCATION: N:\5745-09-001\dwg\TCP\
DWG. NAME: TCP_FM2100_Ph1.dwg



TRAFFIC CONTROL LAYOUT
STAGE 1



TRAFFIC CONTROL LAYOUT
STAGE 2

80 0 40 80
HORIZONTAL SCALE 1"=80'

LEGEND

- TRAFFIC FLOW
- CHANNELIZING DEVICE
- SIGN
- WORK AREA
- TEMPORARY PAVEMENT

NOTE:

1. SEE TRAFFIC CONTROL PLAN "TCP (1-1)-98" STANDARD FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
2. SEE TRAFFIC CONTROL PLAN "TCP (1-2)-98" STANDARD FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
3. SEE TRAFFIC CONTROL PLAN "TCP (1-3)-98" FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
4. ANY CONFLICTING SIGNS SHALL BE COVERED AS DIRECTED BY ENGINEER.
5. CONTRACTOR TO MAINTAIN ACCESS TO ALL ADJACENT DRIVEWAYS.
6. SEE SHEET 01, "PROP CANAL AT FM 2100 TRAFFIC CONTROL TYPICAL SECTIONS" FOR SECTION C-C AND D-D DETAILS.
7. CONTRACTOR MAY ESTABLISH STATIONING AS SHOWN IN PLANS OR MAY FIELD MEASURE ALL DISTANCES NECESSARY TO ESTABLISH TEMP PVMT NEEDED AND TO LOCATE TRAFFIC CONTROL SIGNS USING THE INTERSECTION OF ℄ OF PROP CANAL AND ℄ OF FM 2100 AS THE REFERENCE POINT.
8. LIMITS OF CUT AND RESTORE PVMT

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.
J. A. GELACIO
56190
Date: MARCH 22, 2010

ENTECH CIVIL ENGINEERS, INC.
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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

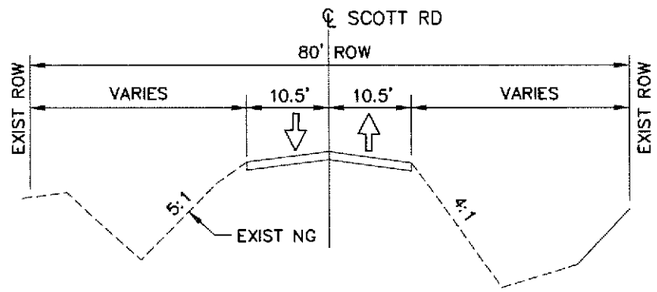
TRAFFIC CONTROL LAYOUT
FM 2100
PHASE II
STAGE 1 & STAGE 2

SHEET 3 OF 16

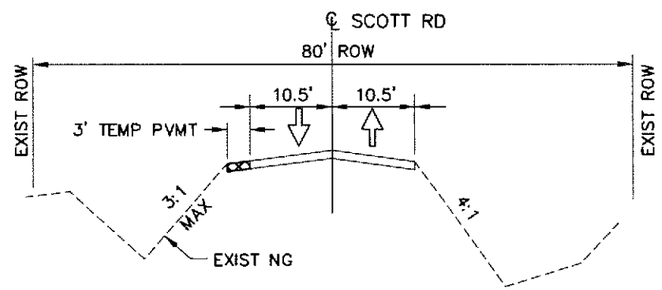
DRAWING SCALE
AS SHOWN

SHEET NO. 185 OF 245

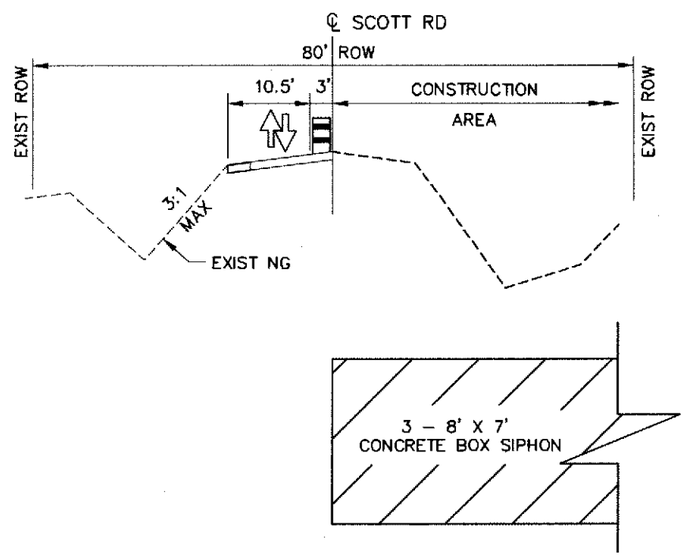
LAST MODIFIED: Mar 30, 2010 - 4:01pm BY USER: rmalla
DWG. LOCATION: N:\5745-09-001\dwg\TCP\
DWG. NAME: TCP_FM2100_Ph2.dwg



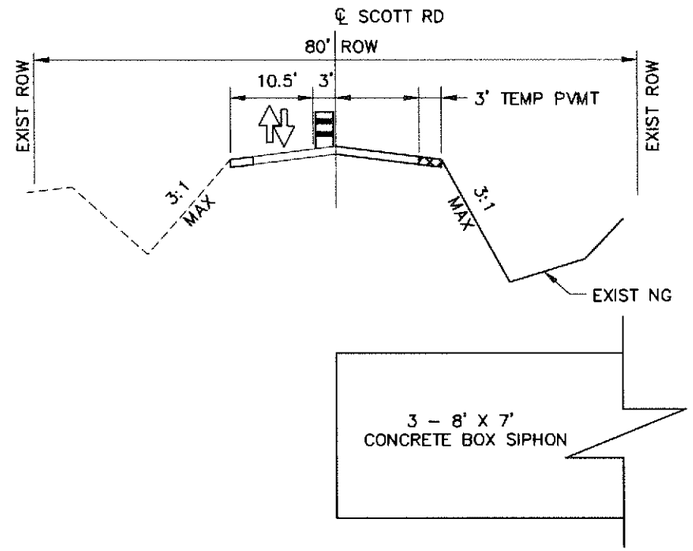
EXIST. TYP SECTION
NTS



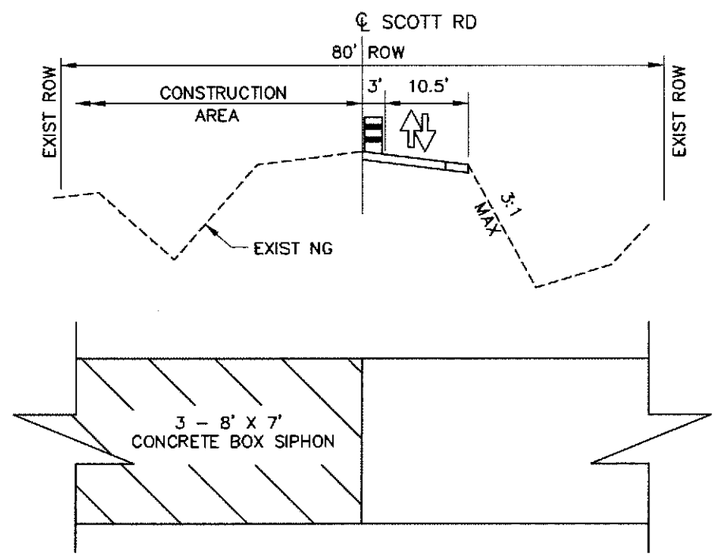
SECTION A–A
NTS



SECTION B–B
NTS



SECTION C–C
NTS



SECTION D–D
NTS

LEGEND

- TRAFFIC FLOW
- PROP CONSTRUCTION
- CONSTRUCTION OF TEMP PVMT

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.
J. A. GELACIO
56190
Date: MARCH 22, 2010

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

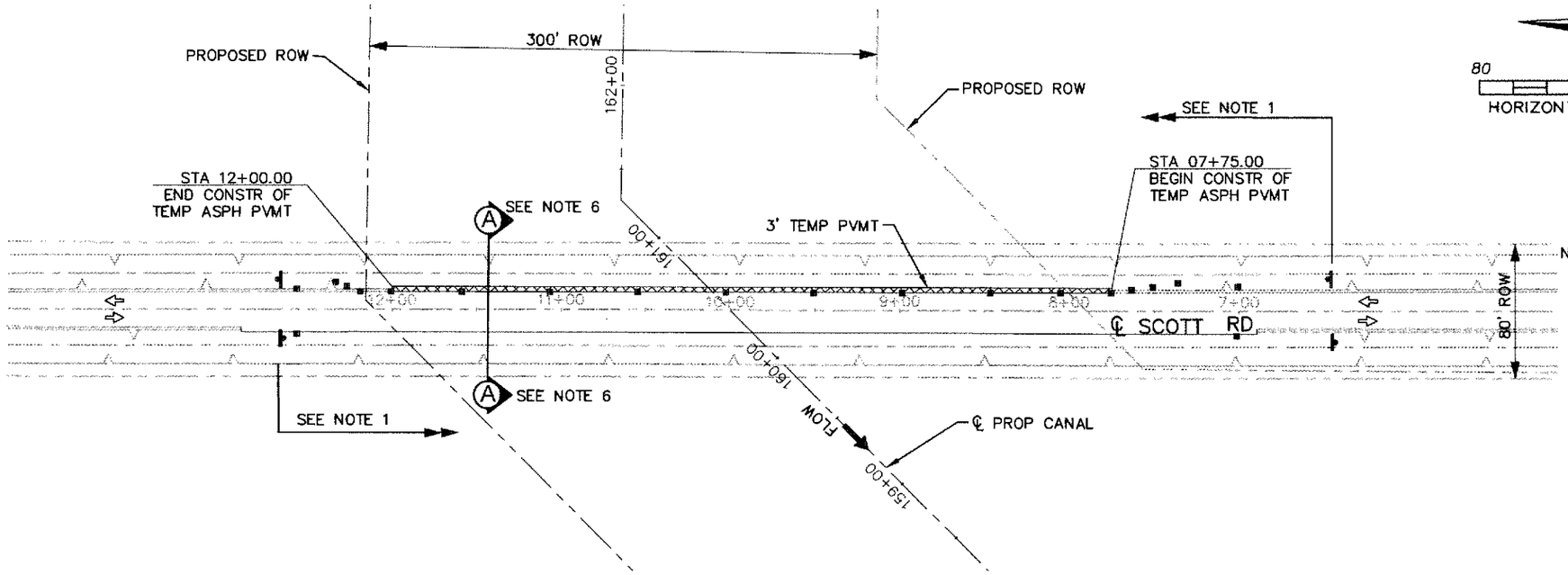
PROP CANAL AT SCOTT RD
TRAFFIC CONTROL TYPICAL SECTIONS

SHEET 4 OF 16

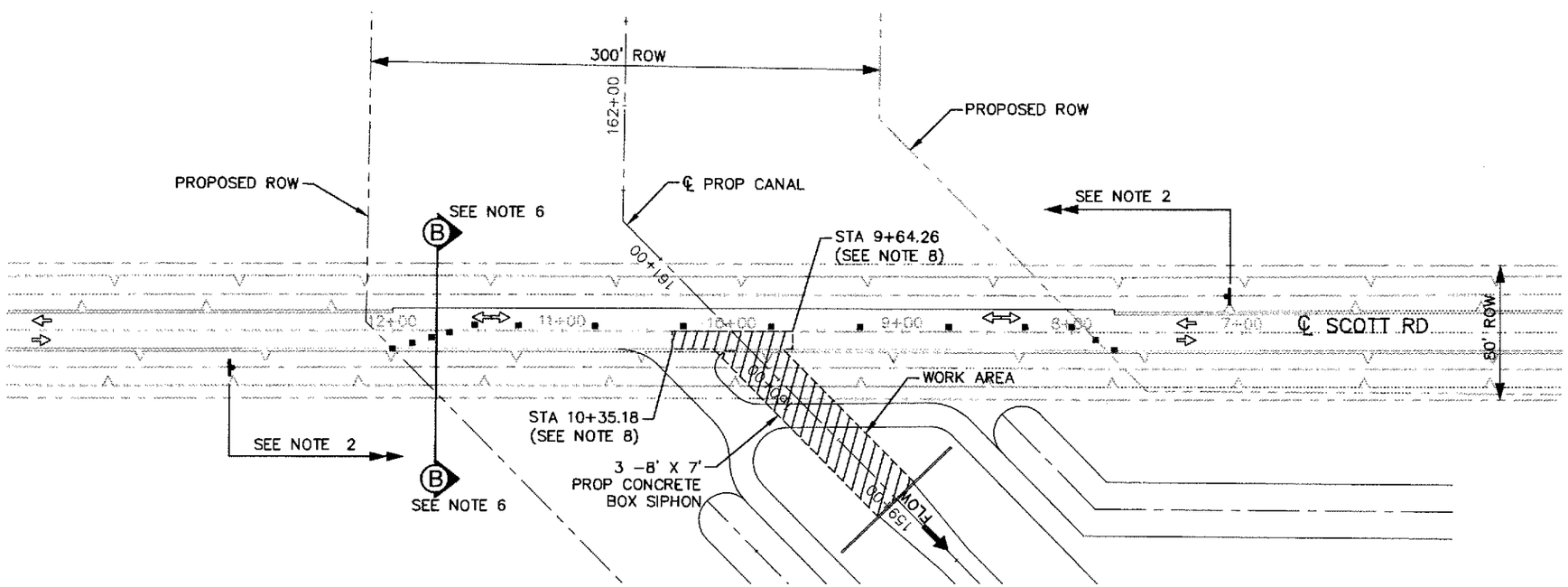
DRAWING SCALE
AS SHOWN

SHEET NO. 186 OF 245

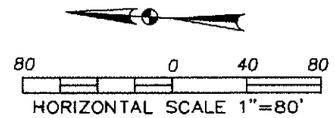
LAST MODIFIED: Mar 30, 2010 – 4:10pm BY USER: rmalla
DWG. LOCATION: N:\5745-09-001\dwg\TCP\
DWG. NAME: TCP_SCOTT RD_Cross Sections.dwg



TRAFFIC CONTROL LAYOUT
STAGE 1



TRAFFIC CONTROL LAYOUT
STAGE 2



LEGEND

- TRAFFIC FLOW
- CHANNELIZING DEVICE
- SIGN
- WORK AREA
- TEMPORARY PAVEMENT

NOTE:

1. SEE TRAFFIC CONTROL PLAN "TCP (1-1)-98" STANDARD FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
2. SEE TRAFFIC CONTROL PLAN "TCP (1-2)-98" STANDARD FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
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5. CONTRACTOR TO MAINTAIN ACCESS TO ALL ADJACENT DRIVEWAYS.
6. SEE SHEET 04, "PROP CANAL AT SCOTT RD TRAFFIC CONTROL TYPICAL SECTIONS" FOR SECTION A-A AND B-B DETAILS.
7. CONTRACTOR MAY ESTABLISH STATIONING AS SHOWN IN PLANS OR MAY FIELD MEASURE ALL DISTANCES NECESSARY TO ESTABLISH TEMP PVMT NEEDED AND TO LOCATE TRAFFIC CONTROL SIGNS USING THE INTERSECTION OF ℄ OF PROP CANAL AND ℄ OF SCOTT RD AS THE REFERENCE POINT.
8. LIMITS OF CUT AND RESTORE PVMT

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.
J. A. GELACIO
56190
Date: MARCH 22, 2010

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

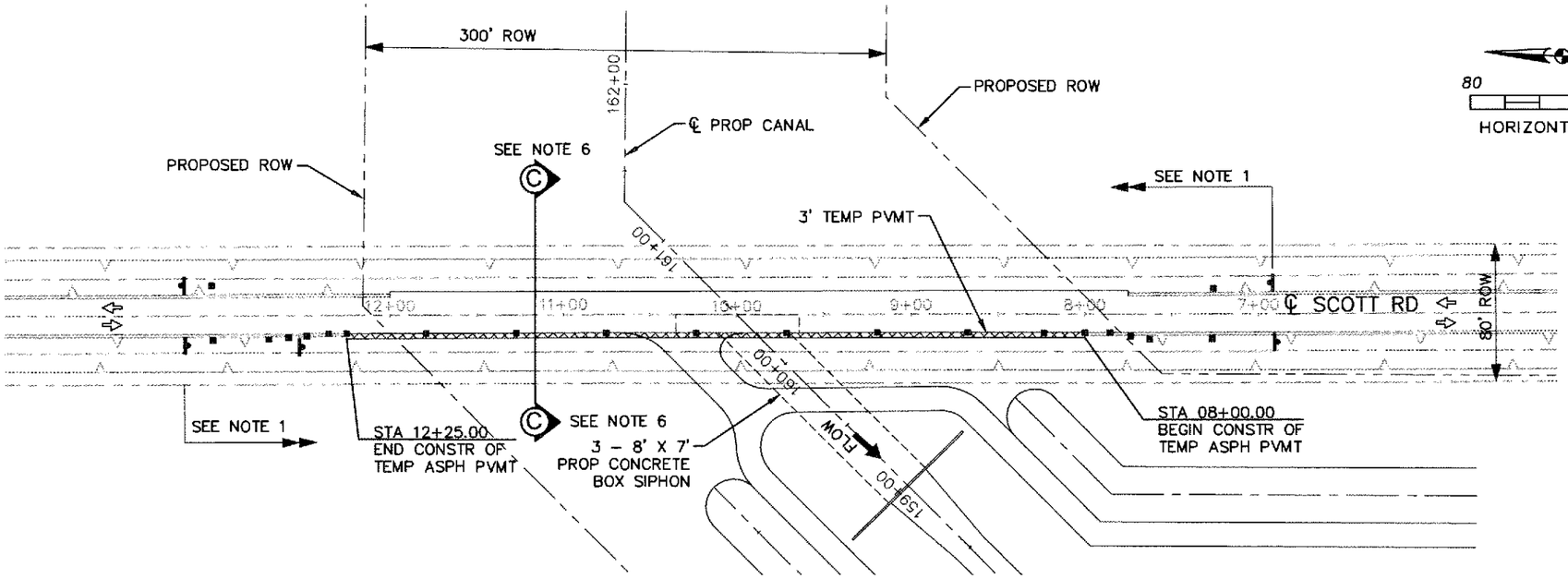
TRAFFIC CONTROL LAYOUT
AT SCOTT RD
PHASE I
STAGE 1 & STAGE 2

SHEET 5 OF 16

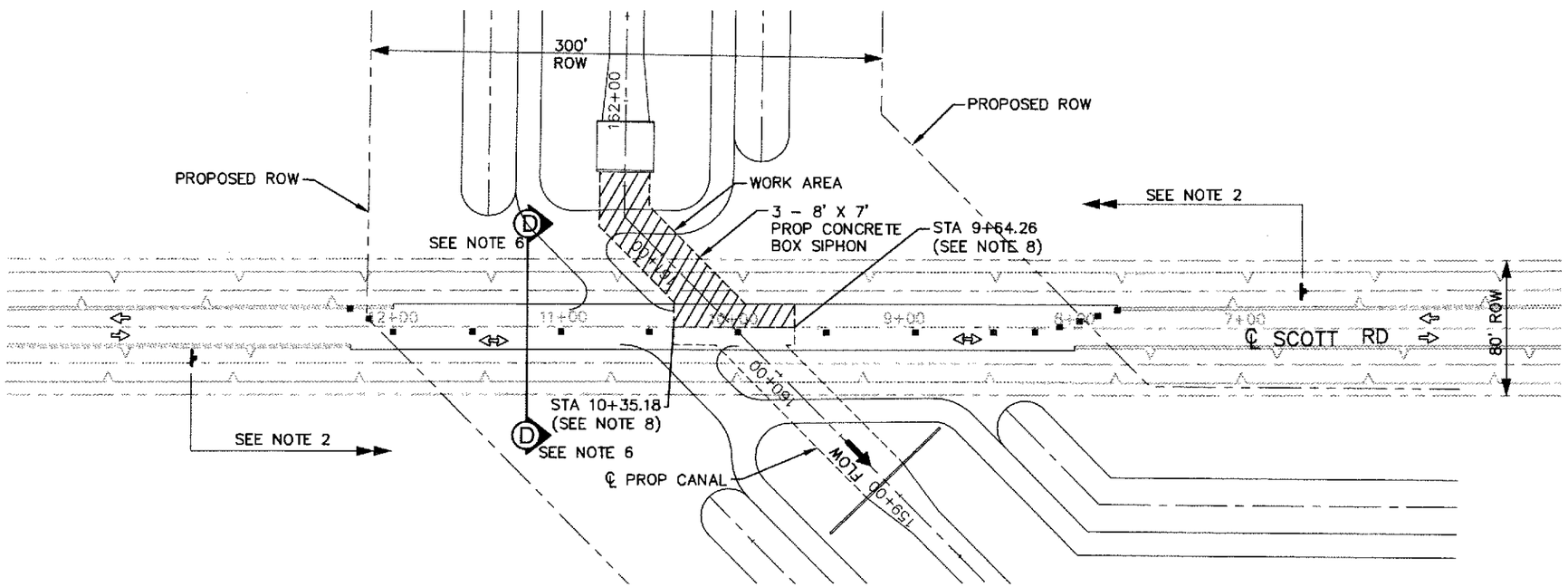
DRAWING SCALE
AS SHOWN

SHEET NO. 167 OF 245

LAST MODIFIED: Mar 30, 2010 - 4:11pm BY USER: rmalla
DWG. LOCATION: N:\5745-09-001\dwg\TCP\
DWG. NAME: TCP_SCOTT RD_PH1.dwg



TRAFFIC CONTROL LAYOUT
STAGE 1



TRAFFIC CONTROL LAYOUT
STAGE 2

80 0 40 80
HORIZONTAL SCALE 1"=80'

LEGEND

- TRAFFIC FLOW
- CHANNELIZING DEVICE
- SIGN
- WORK AREA
- TEMPORARY PAVEMENT

NOTE:

1. SEE TRAFFIC CONTROL PLAN "TCP (1-1)-98" STANDARD FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
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8. LIMITS OF CUT AND RESTORE PVMT

PRELIMINARY
Document incomplete: not intended for permit, bidding or construction.
J. A. GELACIO
56190
Date: MARCH 22, 2010

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

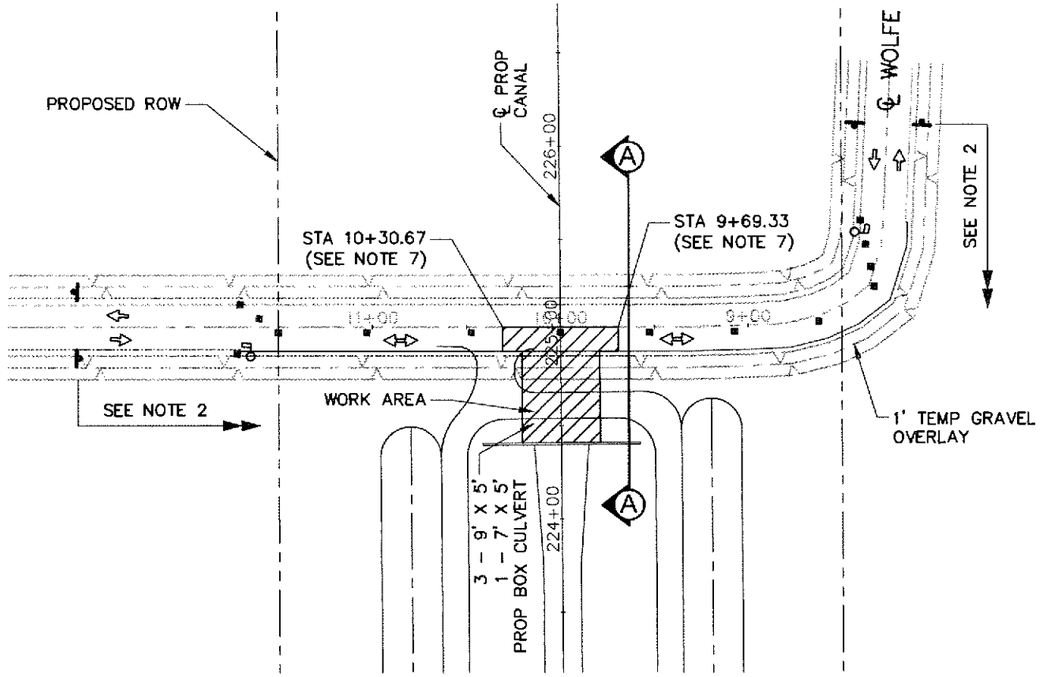
TRAFFIC CONTROL LAYOUT
AT SCOTT RD
PHASE II
STAGE 1 & STAGE 2

SHEET 6 OF 16

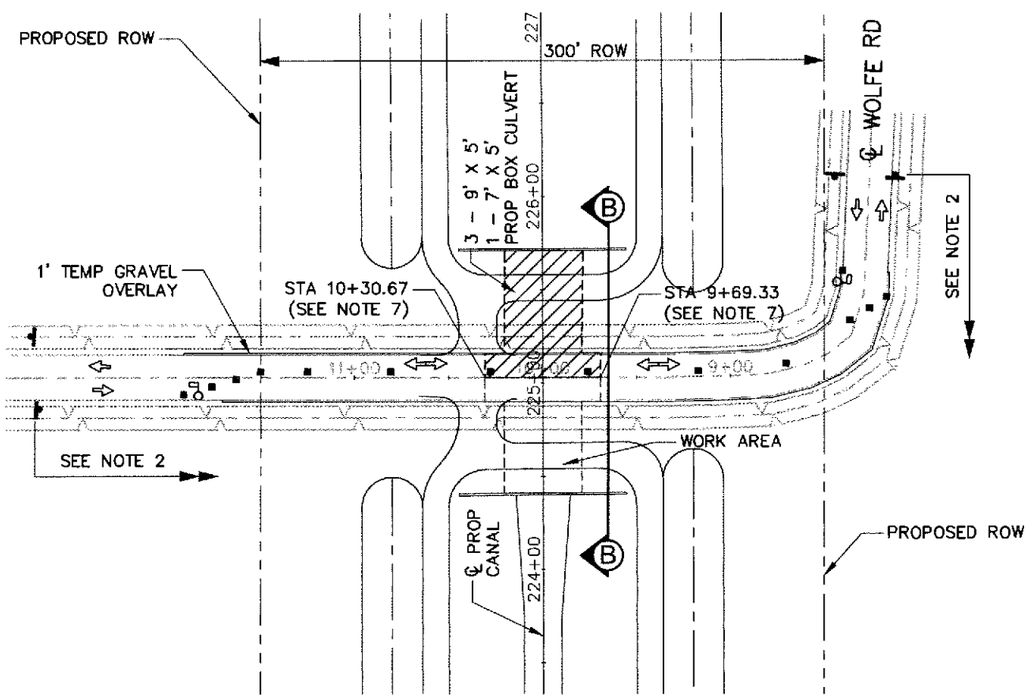
DRAWING SCALE
AS SHOWN

SHEET NO. 188 OF 245

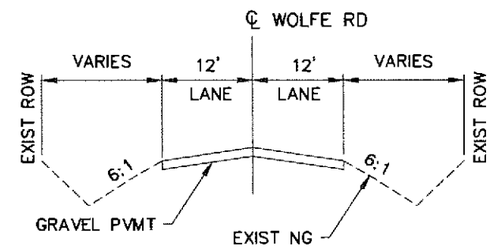
LAST MODIFIED: Mar 30, 2010 - 4:12pm BY USER: rmalla
DWG. LOCATION: N:\5745-09-001\dwg\TCP\
DWG. NAME: TCP_SCOTT RD_PH2.dwg



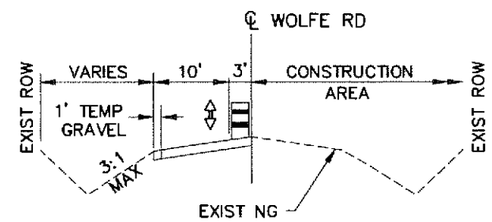
TRAFFIC CONTROL LAYOUT
PHASE 1

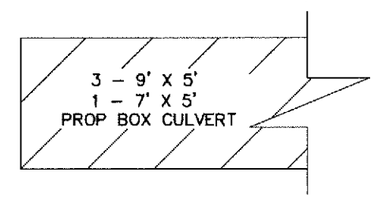


TRAFFIC CONTROL LAYOUT
PHASE 2

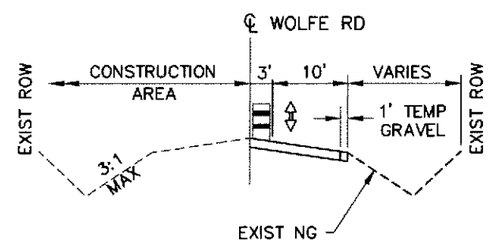


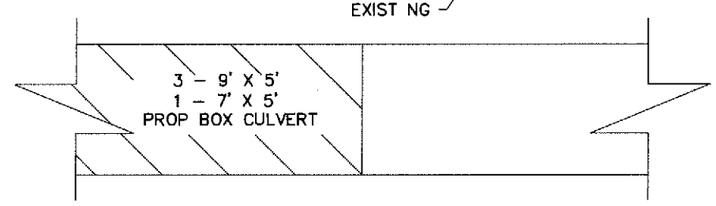
EXIST. TYP SECTION
NTS





SECTION A-A
NTS





SECTION B-B
NTS

LEGEND

- TRAFFIC FLOW
- CHANNELIZING DEVICE
- SIGN
- WORK AREA
- TEMPORARY PAVEMENT

NOTE:

1. SEE TRAFFIC CONTROL PLAN "TCP (1-1)-98" STANDARD FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
2. SEE TRAFFIC CONTROL PLAN "TCP (1-2)-98" STANDARD FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
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7. LIMITS OF CUT AND RESTORE PVMT

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.
J. A. GELACIO
56190
Date: MARCH 22, 2010

ENTECH CIVIL ENGINEERS, INC.
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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

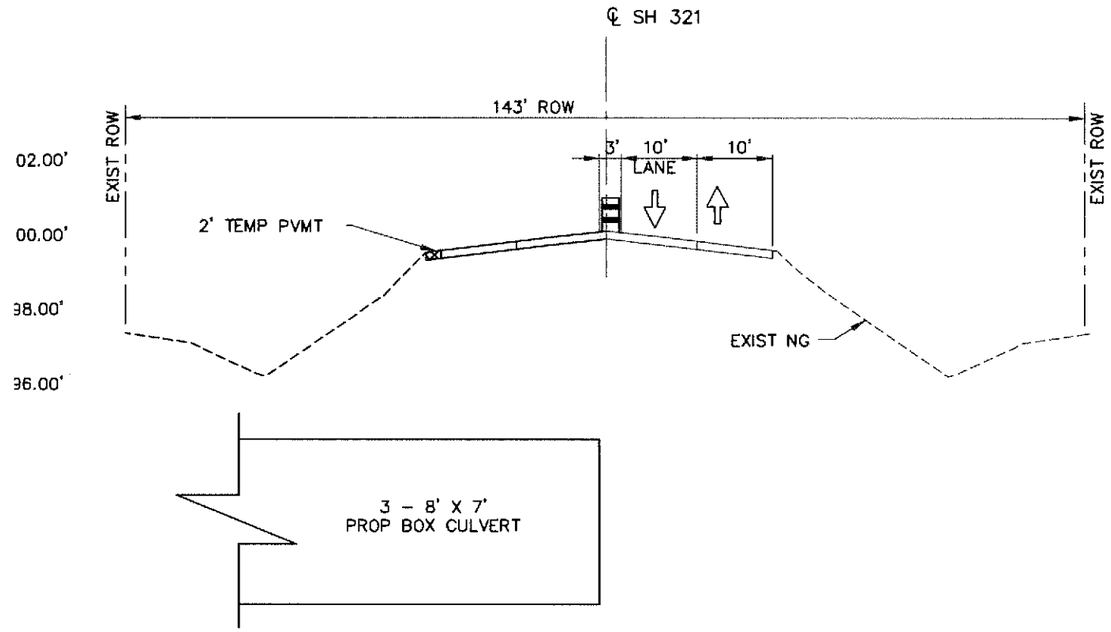
TRAFFIC CONTROL LAYOUT AND TYPICAL SECTIONS AT WOLFE RD

SHEET 7 OF 16

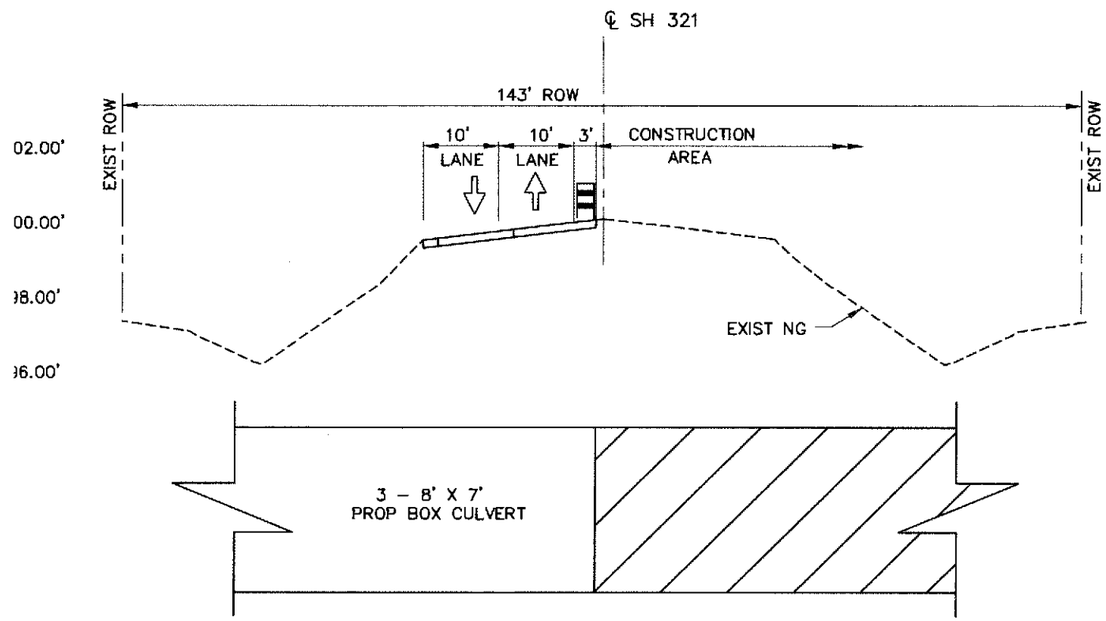
DRAWING SCALE
AS SHOWN

SHEET NO. 189 OF 245

LAST MODIFIED: Mar 30, 2010 - 4:13pm BY USER: rmalla
DWG. LOCATION: N:\5745-09-001\dwg\TCP\
DWG. NAME: TCP_WOLFE RD_PH1.dwg



SECTION B-B
NTS



SECTION C-C
NTS

LEGEND

- TRAFFIC FLOW
- PROP CONSTRUCTION
- CONSTRUCTION OF TEMP PVMT

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.

J. A. GELACIO
56190
Date: MARCH 3, 2010

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

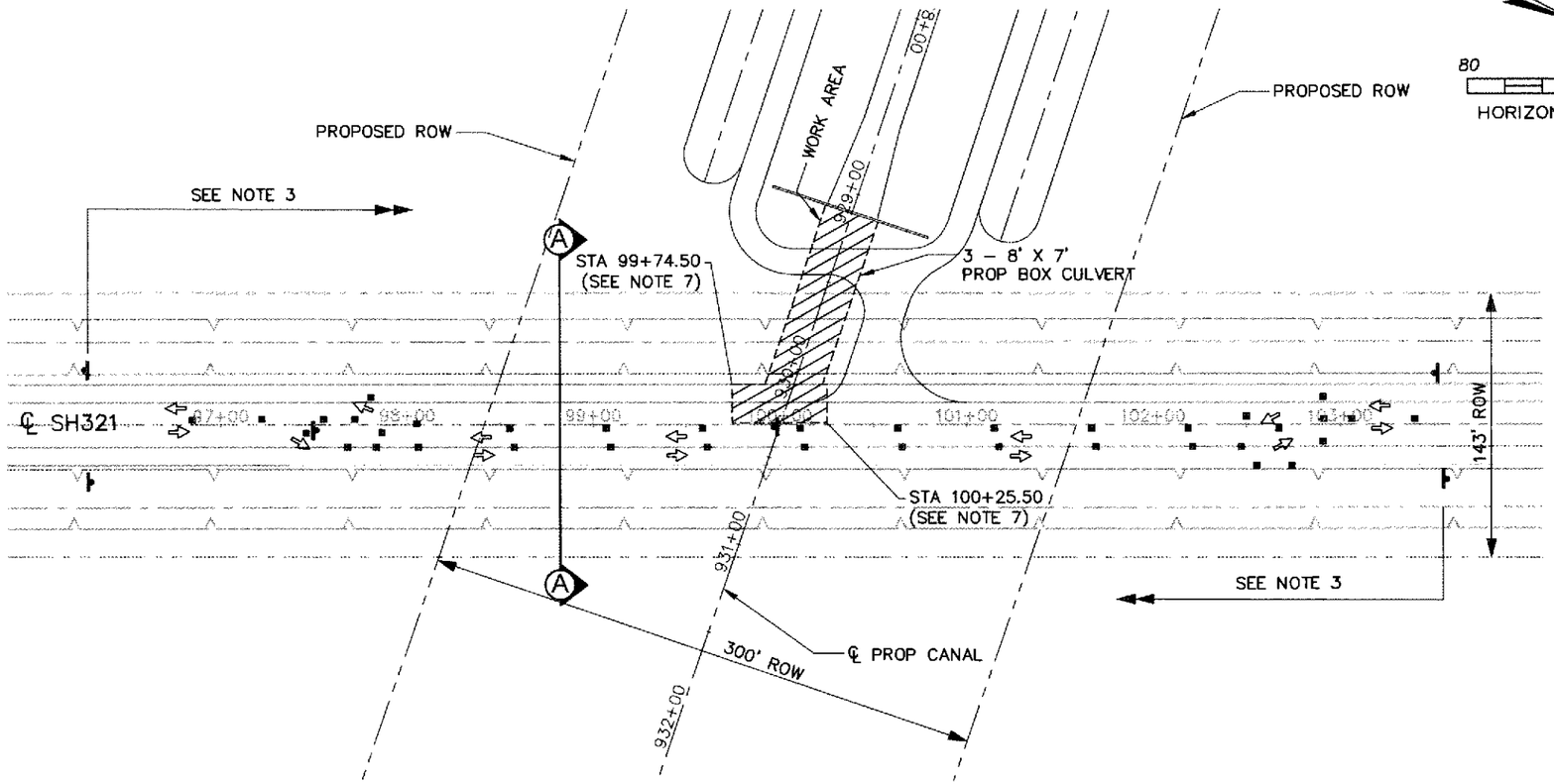
PROP CANAL AT SH 321
TRAFFIC CONTROL TYPICAL SECTIONS

SHEET 8 OF 16

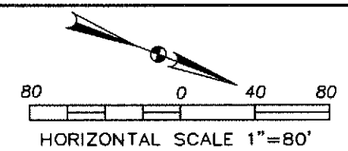
DRAWING SCALE
AS SHOWN

SHEET NO. 190 OF 245

LAST MODIFIED: Mar 30, 2010 - 4:14pm BY USER: rmalla
DWG. LOCATION: N:\5745-09-001\dwg\TCP\
DWG. NAME: TCP_SH321_Cross Sections.dwg



TRAFFIC CONTROL LAYOUT
PHASE 1



LEGEND

- TRAFFIC FLOW
- CHANNELIZING DEVICE
- SIGN
- WORK AREA
- TEMPORARY PAVEMENT

NOTE:

1. SEE TRAFFIC CONTROL PLAN "TCP (1–1)–98" STANDARD FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
2. SEE TRAFFIC CONTROL PLAN "TCP (1–2)–98" STANDARD FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
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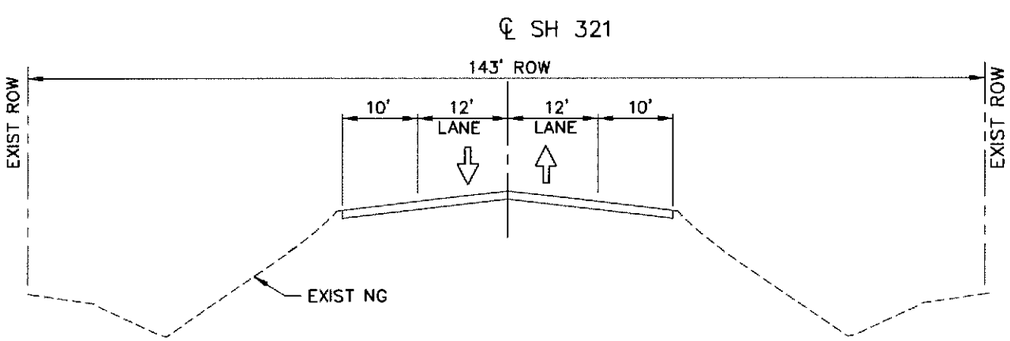
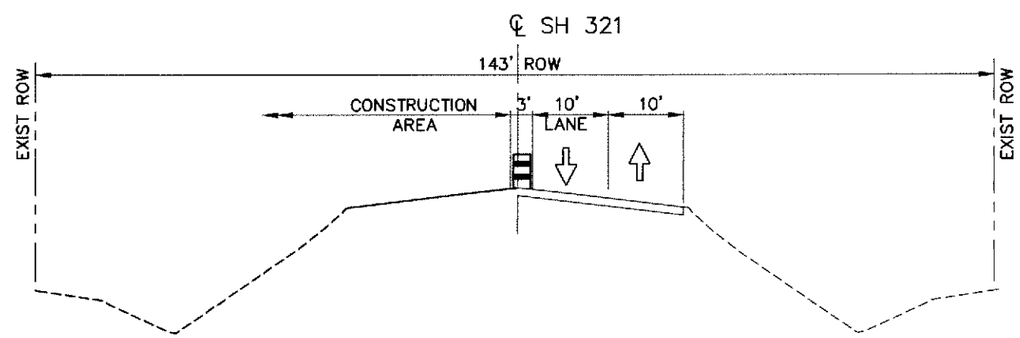
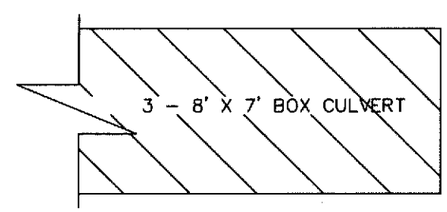
7. LIMITS OF CUT AND RESTORE PVMT



EXIST. TYP SECTION
NTS





SECTION A–A
NTS

PRELIMINARY
Document incomplete: not intended for permit, bidding or construction.

J. A. GELACIO
56190
Date: MARCH 22, 2010

FINTECH CIVIL ENGINEERS, INC
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SURVEYED BY:
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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

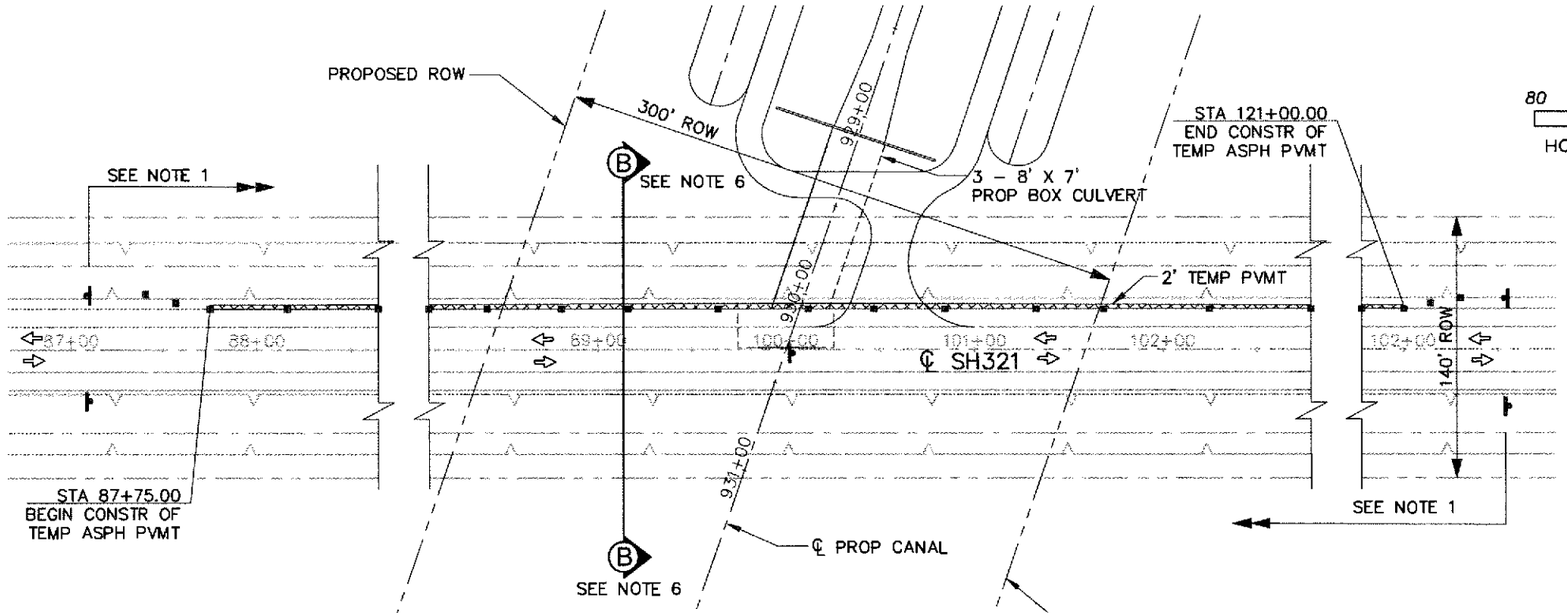
TRAFFIC CONTROL LAYOUT AND TYPICAL SECTIONS AT SH 321 PHASE I

SHEET 9 OF 16

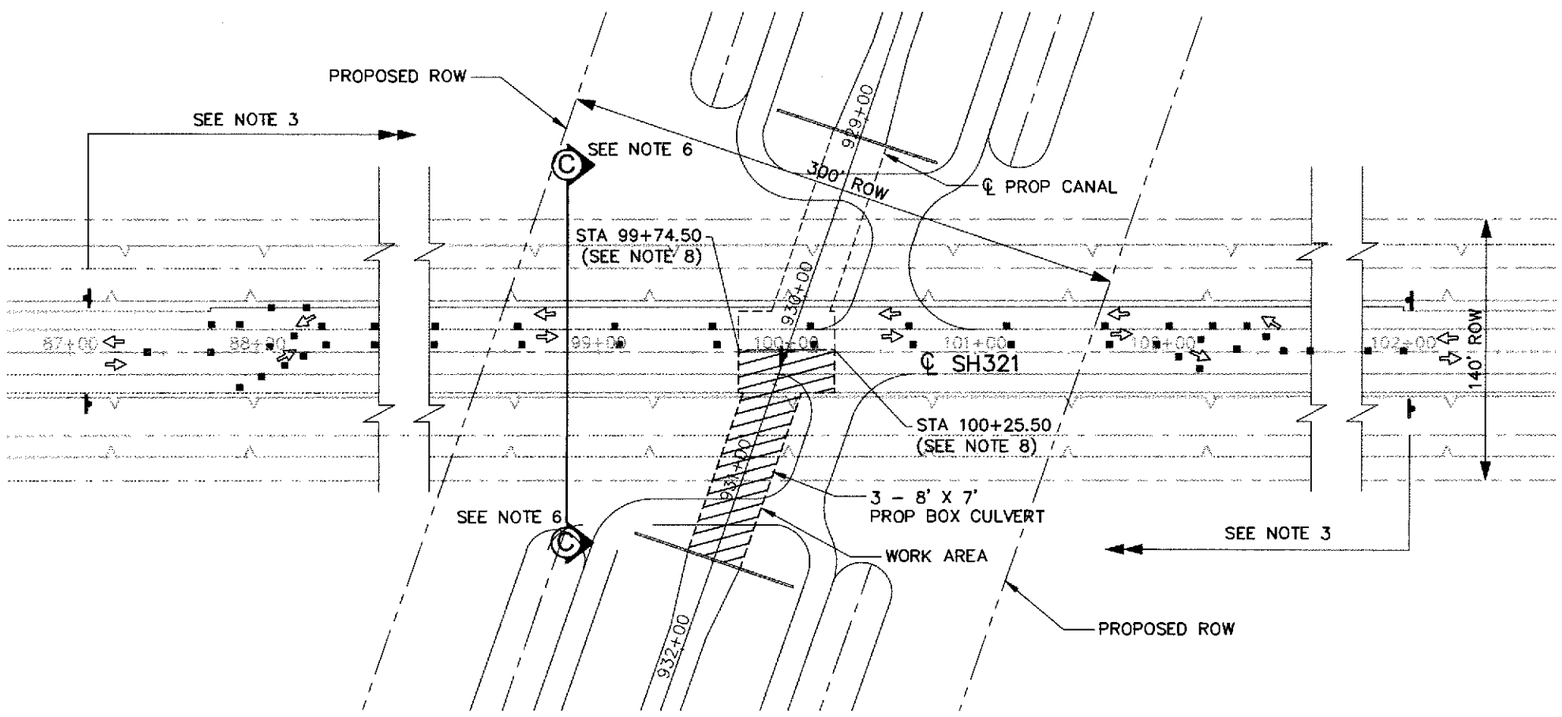
DRAWING SCALE
AS SHOWN

SHEET NO. 191 OF 245

LAST MODIFIED: Mar 30, 2010 – 4:16pm BY USER: rmolla
DWG. LOCATION: N:\5745-09-001\dwg\TCP\
DWG. NAME: TCP_SH321_PH1.dwg



TRAFFIC CONTROL LAYOUT
STAGE 1



TRAFFIC CONTROL LAYOUT
STAGE 2

HORIZONTAL SCALE 1"=80'

80 0 40 80

LEGEND

- TRAFFIC FLOW
- CHANNELIZING DEVICE
- SIGN
- WORK AREA
- TEMPORARY PAVEMENT

NOTE:

1. SEE TRAFFIC CONTROL PLAN "TCP (1-1)-98" STANDARD FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
2. SEE TRAFFIC CONTROL PLAN "TCP (1-2)-98" STANDARD FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
3. SEE TRAFFIC CONTROL PLAN "TCP (1-3)-98" FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
4. ANY CONFLICTING SIGNS SHALL BE COVERED AS DIRECTED BY ENGINEER.
5. CONTRACTOR TO MAINTAIN ACCESS TO ALL ADJACENT DRIVEWAYS.
6. SEE SHEET 8, "PROP CANAL AT SH 321 TRAFFIC CONTROL TYPICAL SECTIONS" FOR SECTION B-B AND C-C DETAILS.
7. CONTRACTOR MAY ESTABLISH STATIONING AS SHOWN IN PLANS OR MAY FIELD MEASURE ALL DISTANCES NECESSARY TO ESTABLISH TEMP PVMT NEEDED AND TO LOCATE TRAFFIC CONTROL SIGNS USING THE INTERSECTION OF ℄ OF PROP CANAL AND ℄ OF SH 321 AS THE REFERENCE POINT.
8. LIMITS OF CUT AND RESTORE PVMT

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.

J. A. GELACIO
56190
Date: MARCH 22, 2010

FINTECH CIVIL ENGINEERS, INC.
F-6932

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SURVEYED BY:
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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

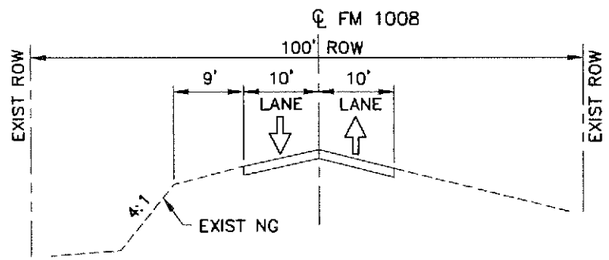
TRAFFIC CONTROL LAYOUT
SH 321
PHASE II
STAGE 1 & STAGE 2

SHEET 10 OF 16

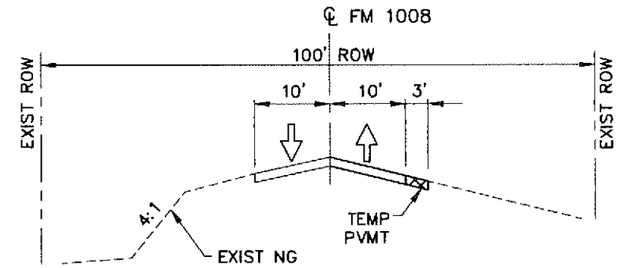
DRAWING SCALE
AS SHOWN

SHEET NO. 192 OF 245

LAST MODIFIED: Mar 30, 2010 - 4:28pm BY USER: rmolla
DWG. LOCATION: N:\5745-09-001\dwg\TCP\
DWG. NAME: TCP_SH321_PH2.dwg



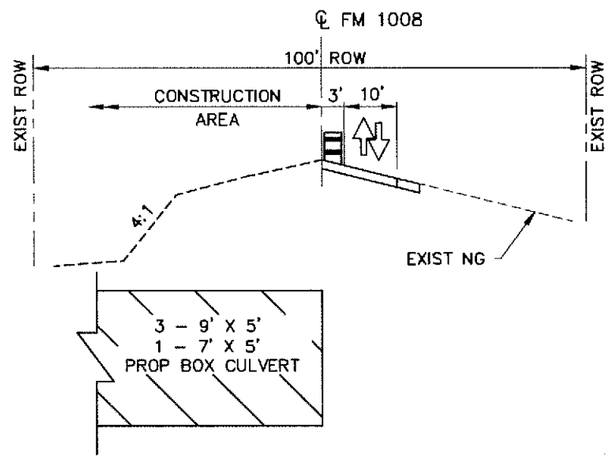
EXIST. TYP SECTION
NTS



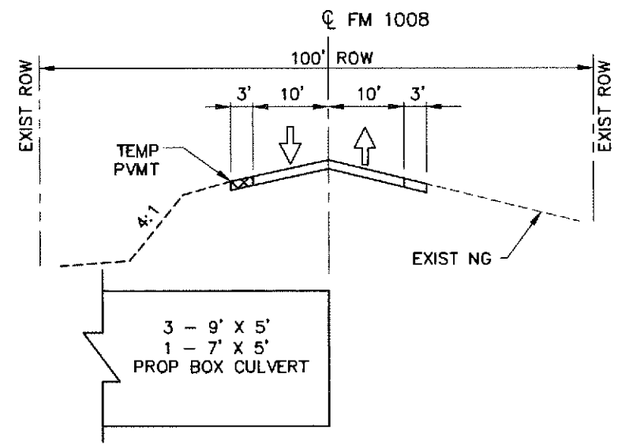
SECTION A–A
NTS

LEGEND

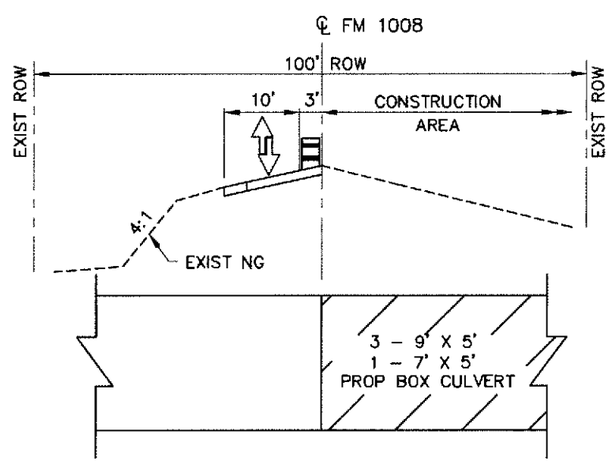
- DIRECTION TRAFFIC FLOW
- PROP CONSTRUCTION
- CONSTRUCTION OF TEMP PVMT



SECTION B–B
NTS



SECTION C–C
NTS



SECTION D–D
NTS

PRELIMINARY
Document incomplete: not intended for permit, bidding or construction.

J. A. GELACIO
56190
Date: MARCH 22, 2010

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

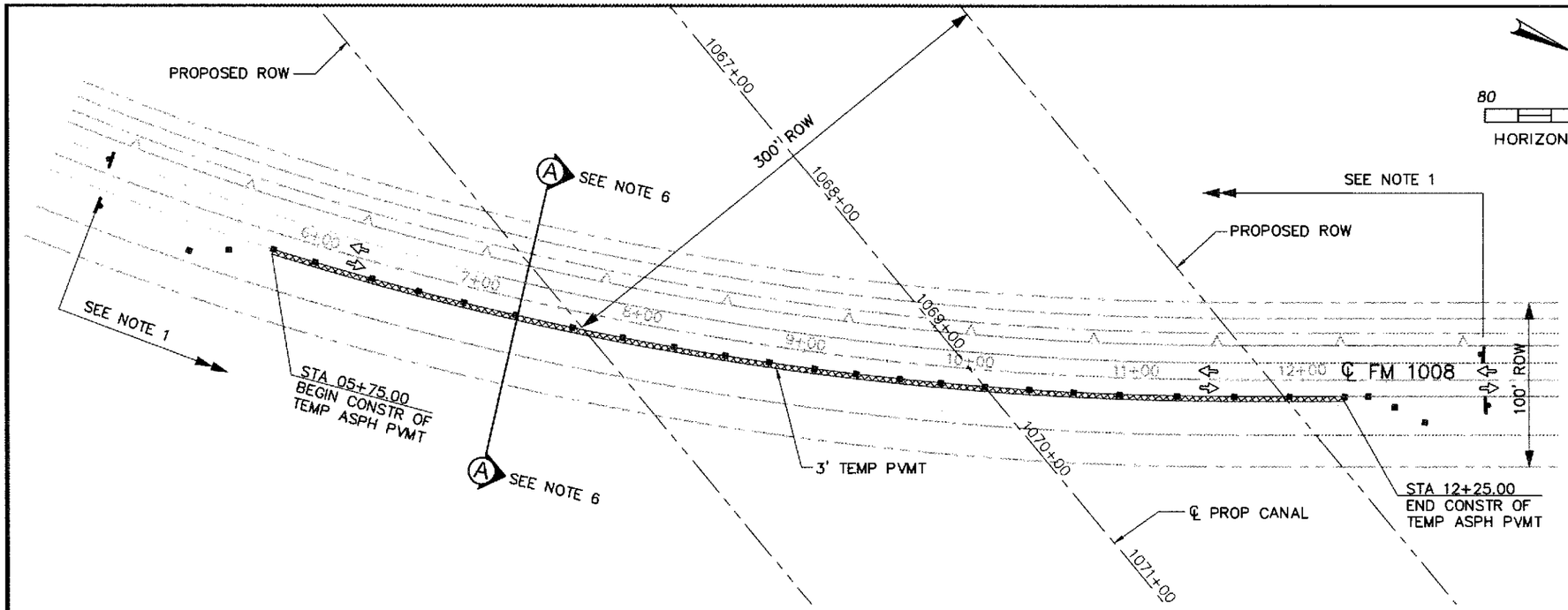
PROP CANAL AT FM 1008
TRAFFIC CONTROL TYPICAL SECTIONS

SHEET 11 OF 16

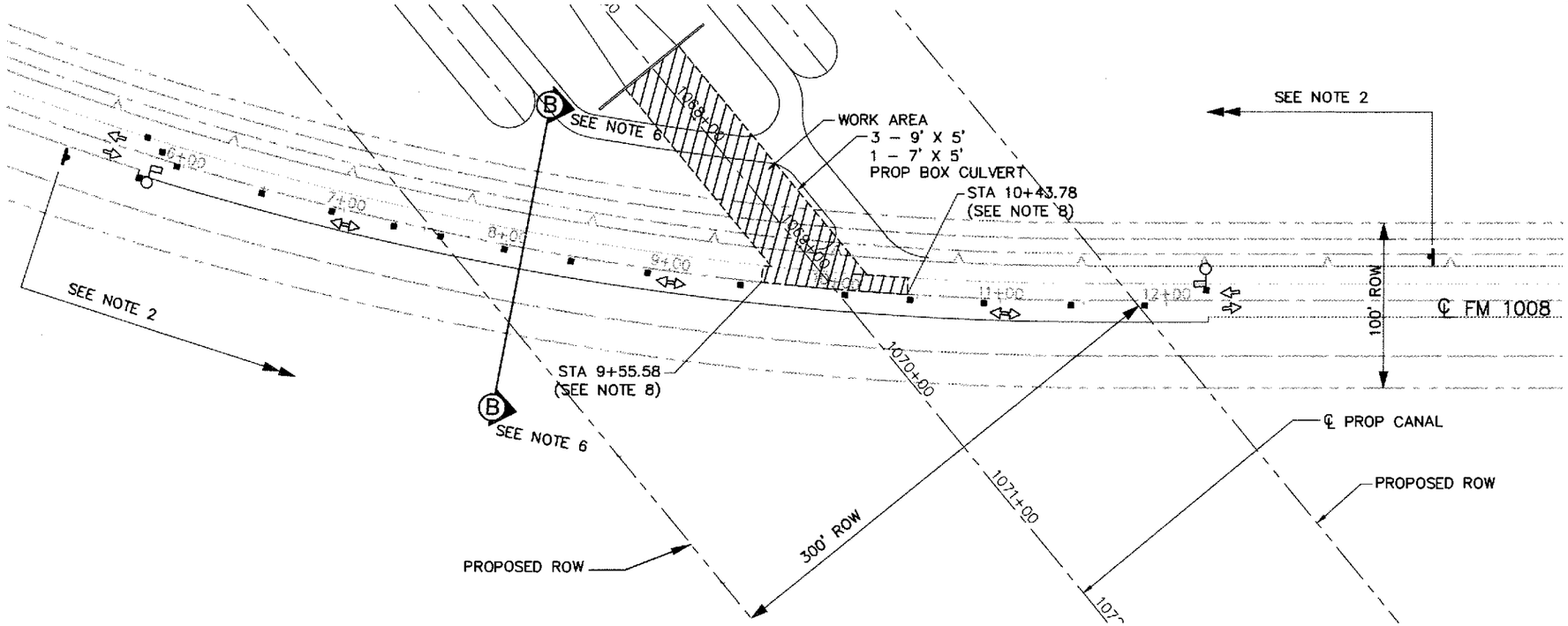
DRAWING SCALE
AS SHOWN

SHEET NO. 193 OF 245

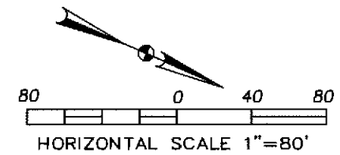
LAST MODIFIED: Mar 30, 2010 – 4:29pm BY USER: rmolla
DWG. LOCATION: N:\5745-09-001\dwg\TCP\
DWG. NAME: TCP_FM1008_Cross Sections.dwg



TRAFFIC CONTROL LAYOUT
STAGE 1



TRAFFIC CONTROL LAYOUT
STAGE 2



LEGEND

- TRAFFIC FLOW
- CHANNELIZING DEVICE
- SIGN
- WORK AREA
- TEMPORARY PAVEMENT

NOTE:

1. SEE TRAFFIC CONTROL PLAN "TCP (1-1)-98" STANDARD FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
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5. CONTRACTOR TO MAINTAIN ACCESS TO ALL ADJACENT DRIVEWAYS.
6. SEE SHEET 11, "PROP CANAL AT FM 1008 TRAFFIC CONTROL TYPICAL SECTIONS" FOR SECTION A-A AND B-B DETAILS.
7. CONTRACTOR MAY ESTABLISH STATIONING AS SHOWN IN PLANS OR MAY FIELD MEASURE ALL DISTANCES NECESSARY TO ESTABLISH TEMP PVMT NEEDED AND TO LOCATE TRAFFIC CONTROL SIGNS USING THE INTERSECTION OF ℄ OF PROP CANAL AND ℄ OF FM 1008 AS THE REFERENCE POINT.
8. LIMITS OF CUT AND RESTORE PVMT

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.
J. A. GELACIO
56190
Date: MARCH 22, 2010

ENTECH CIVIL ENGINEERS, INC.
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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

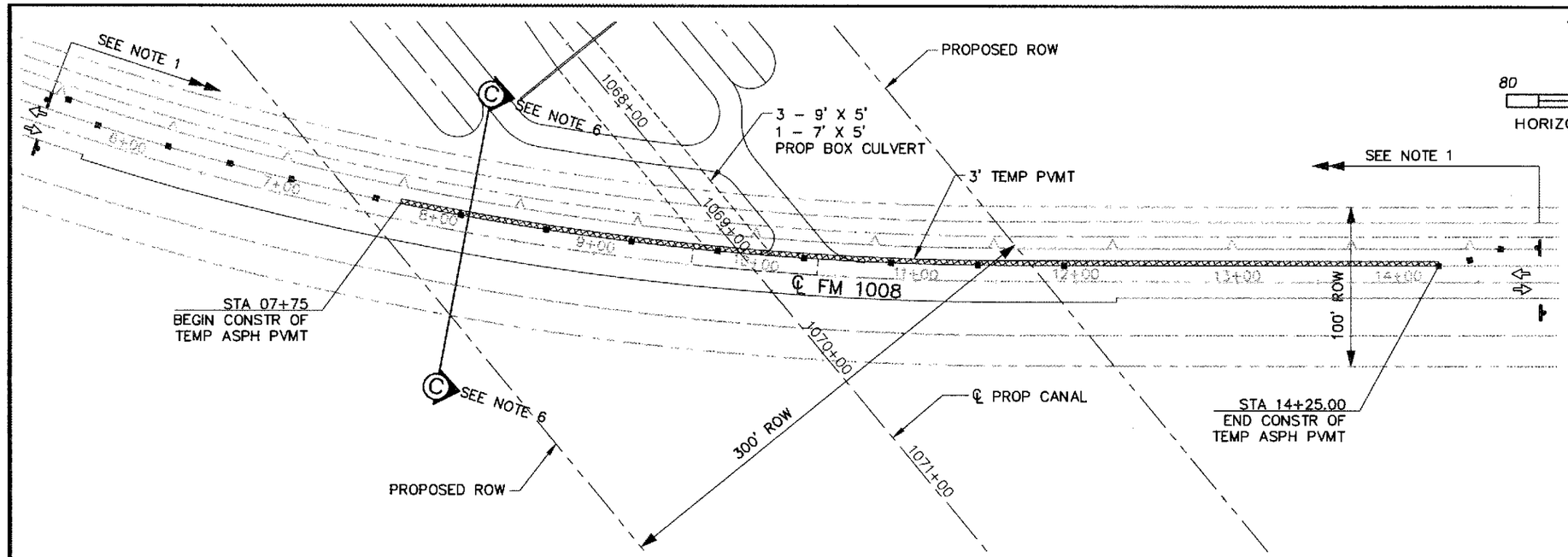
TRAFFIC CONTROL LAYOUT
FM 1008
PHASE I
STAGE 1 & STAGE 2

SHEET 12 OF 16

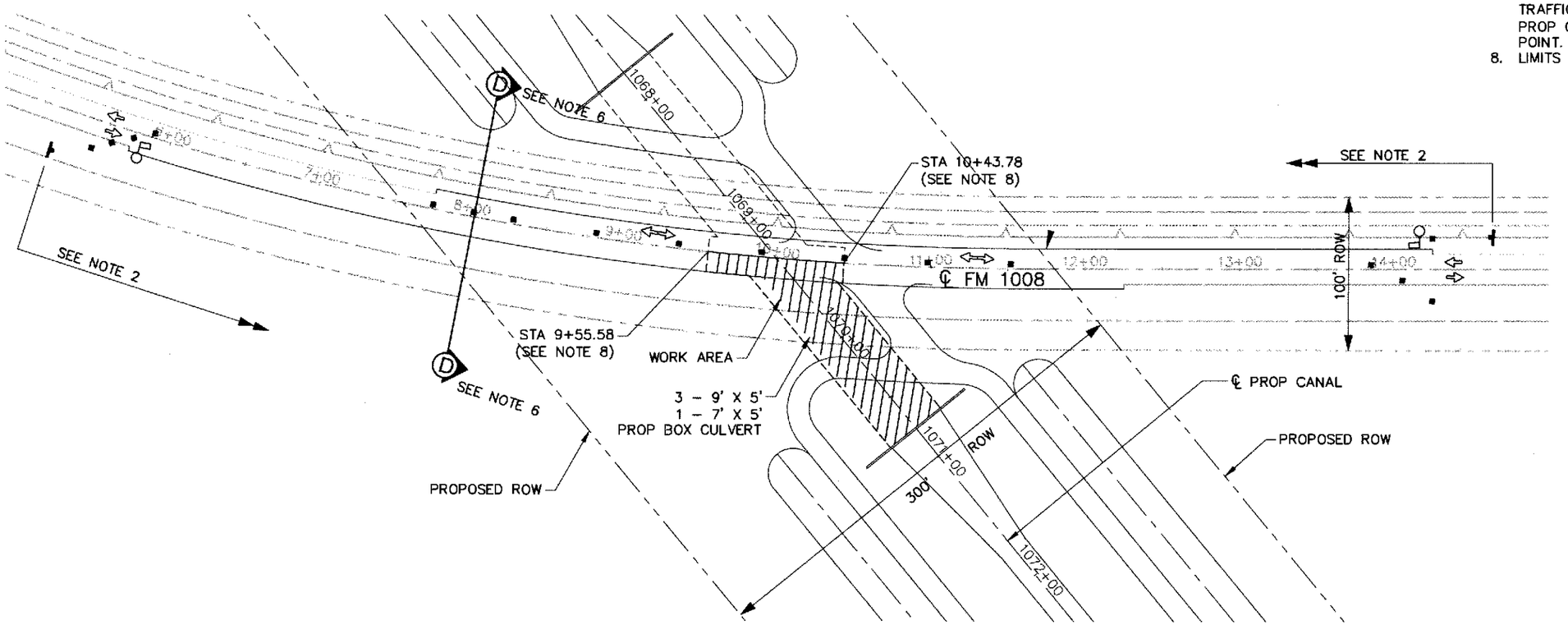
DRAWING SCALE
AS SHOWN

SHEET NO. 194 OF 245

LAST MODIFIED: Mar 30, 2010 – 4:30pm BY USER: rmalia
DWG. LOCATION: N:\5745-09-001\dwg\TCP\
DWG. NAME: TCP_FM1008_PH1.dwg



TRAFFIC CONTROL LAYOUT
STAGE 1



TRAFFIC CONTROL LAYOUT
STAGE 2

LEGEND

- TRAFFIC FLOW
- CHANNELIZING DEVICE
- SIGN
- WORK AREA
- TEMPORARY PAVEMENT

80 0 40 80
HORIZONTAL SCALE 1"=80'

NOTE:

1. SEE TRAFFIC CONTROL PLAN "TCP (1-1)-98" STANDARD FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
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7. CONTRACTOR MAY ESTABLISH STATIONING AS SHOWN IN PLANS OR MAY FIELD MEASURE ALL DISTANCES NECESSARY TO ESTABLISH TEMP PVMT NEEDED AND TO LOCATE TRAFFIC CONTROL SIGNS USING THE INTERSECTION OF ℄ OF PROP CANAL AND ℄ OF FM 1008 AS THE REFERENCE POINT.
8. LIMITS OF CUT AND RESTORE PVMT

PRELIMINARY
Document incomplete: not intended for permit, bidding or construction.

J. A. GELACIO
56190
Date: MARCH 22, 2010

ENTECH CIVIL ENGINEERS, INC.
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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

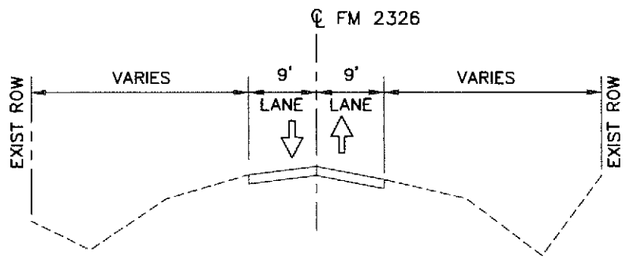
TRAFFIC CONTROL LAYOUT
FM 1008
PHASE II
STAGE 1 & STAGE 2

SHEET 13 OF 16

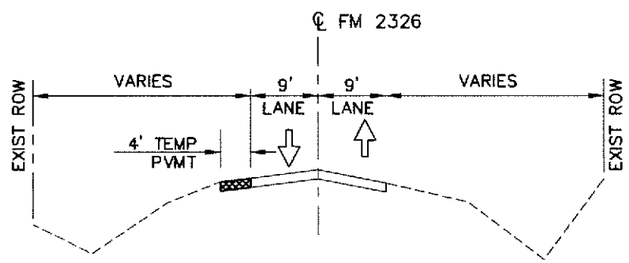
DRAWING SCALE
AS SHOWN

SHEET NO. 195 OF 295

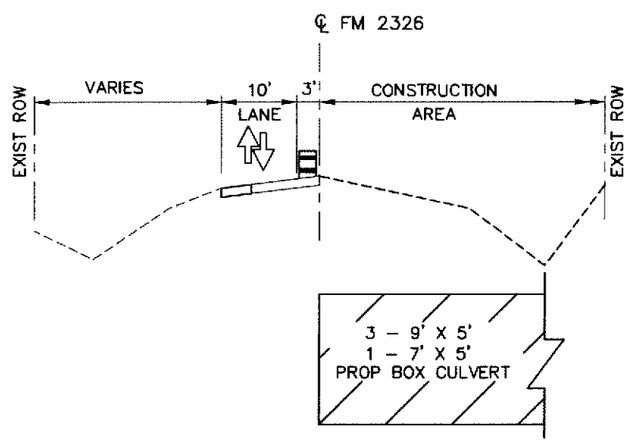
LAST MODIFIED: Mar 30, 2010 - 4:32pm BY USER: rmalla
DWG. LOCATION: N:\5745-09-001\dwg\TCP\
DWG. NAME: TCP_FM1008_PH2.dwg



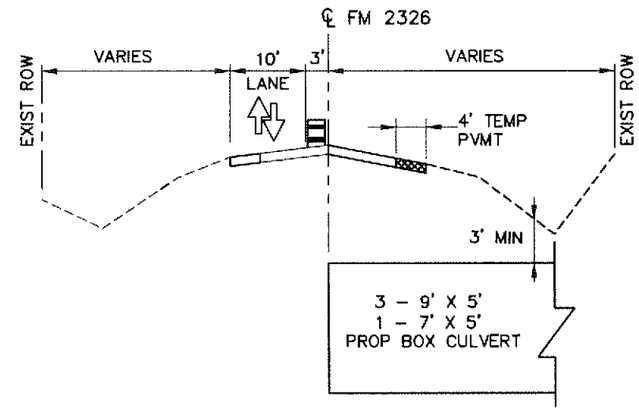
EXIST. TYP SECTION
NTS



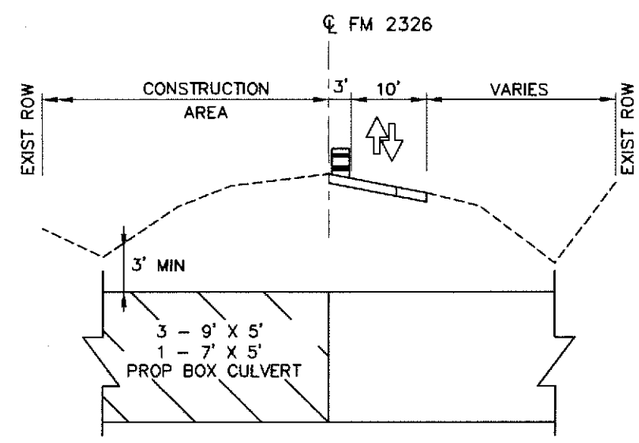
SECTION A–A
NTS



SECTION B–B
NTS



SECTION C–C
NTS



SECTION D–D
NTS

LEGEND

- TRAFFIC FLOW
- PROP CONSTRUCTION
- CONSTRUCTION OF TEMP PVMT

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.
J. A. GELACIO
56190
Date: MARCH 22, 2010

ENTECH CIVIL ENGINEERS, INC.
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SURVEYED BY:
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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

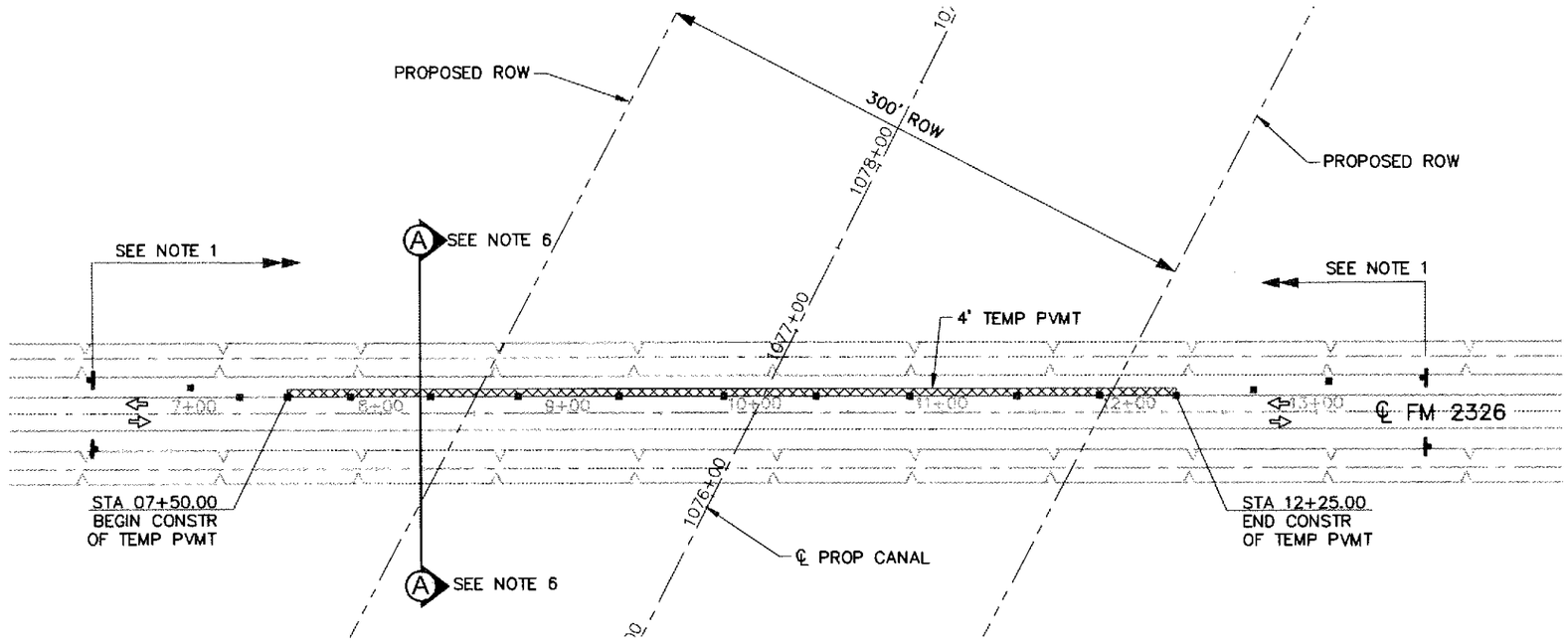
PROP CANAL AT CR 2326
TRAFFIC CONTROL TYPICAL SECTIONS

SHEET 14 OF 16

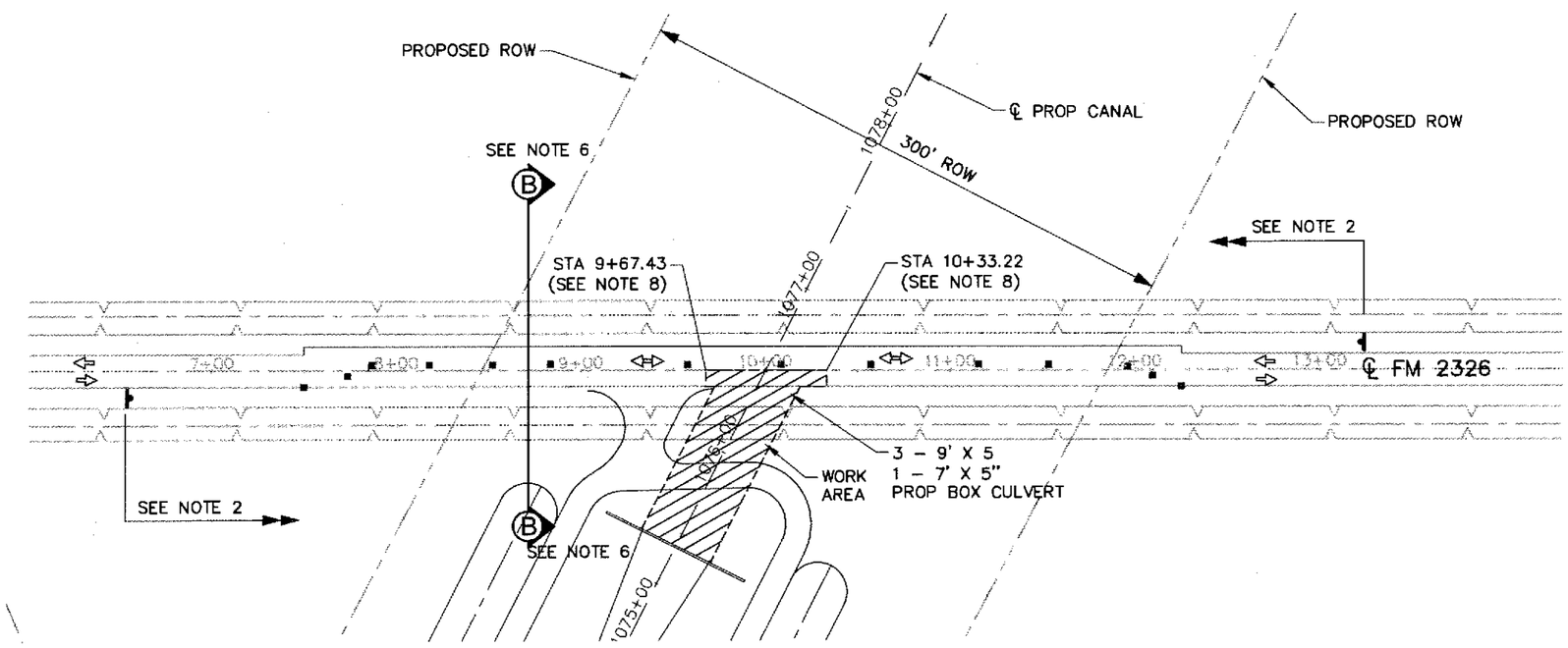
DRAWING SCALE
AS SHOWN

SHEET NO. 196 OF 245

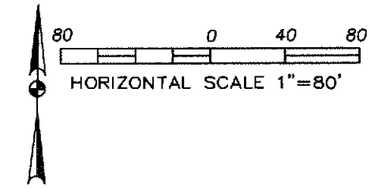
LAST MODIFIED: Mar 30, 2010 – 4:39pm BY USER: rmalla
DWG. LOCATION: N:\5745-09-001\dwg\TCP\
DWG. NAME: TCP_FM2326_Cross Sections.dwg



TRAFFIC CONTROL LAYOUT
STAGE 1



TRAFFIC CONTROL LAYOUT
STAGE 2



LEGEND

- TRAFFIC FLOW
- CHANNELIZING DEVICE
- SIGN
- WORK AREA
- TEMPORARY PAVEMENT

NOTE:

1. SEE TRAFFIC CONTROL PLAN "TCP (1-1)-98" STANDARD FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
2. SEE TRAFFIC CONTROL PLAN "TCP (1-2)-98" STANDARD FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
3. SEE TRAFFIC CONTROL PLAN "TCP (1-3)-98" FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
4. ANY CONFLICTING SIGNS SHALL BE COVERED AS DIRECTED BY ENGINEER.
5. CONTRACTOR TO MAINTAIN ACCESS TO ALL ADJACENT DRIVEWAYS.
6. SEE SHEET 14, "PROP CANAL AT CR 2326 TRAFFIC CONTROL TYPICAL SECTIONS" FOR SECTION A-A AND B-B DETAILS.
7. CONTRACTOR MAY ESTABLISH STATIONING AS SHOWN IN PLANS OR MAY FIELD MEASURE ALL DISTANCES NECESSARY TO ESTABLISH TEMP PVMT NEEDED AND TO LOCATE TRAFFIC CONTROL SIGNS USING THE INTERSECTION OF ℄ OF PROP CANAL AND ℄ OF CR 2326 AS THE REFERENCE POINT.
8. LIMITS OF CUT AND RESTORE PVMT

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.
J. A. GELACIO
56190
Date: MARCH 22, 2010

ENTECH CIVIL ENGINEERS, INC.
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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

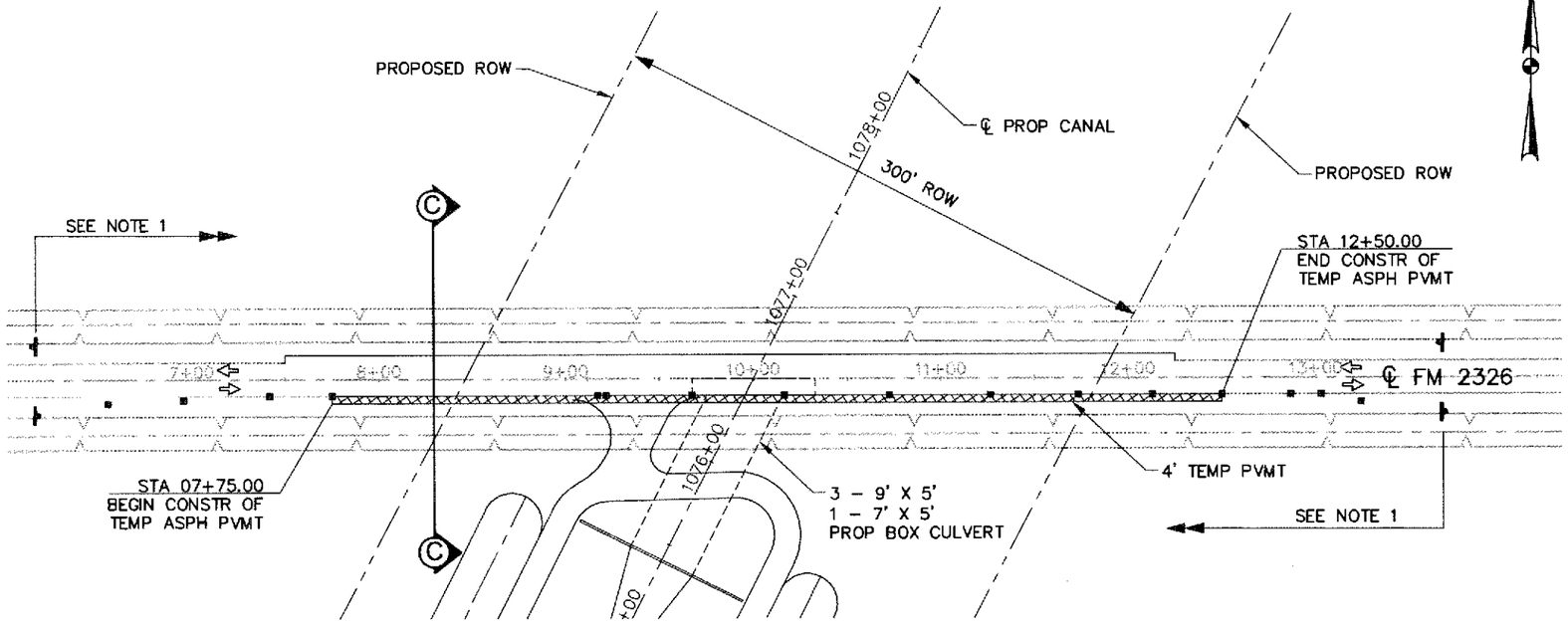
TRAFFIC CONTROL LAYOUT
CR 2326
PHASE I
STAGE 1 & STAGE 2

SHEET 15 OF 16

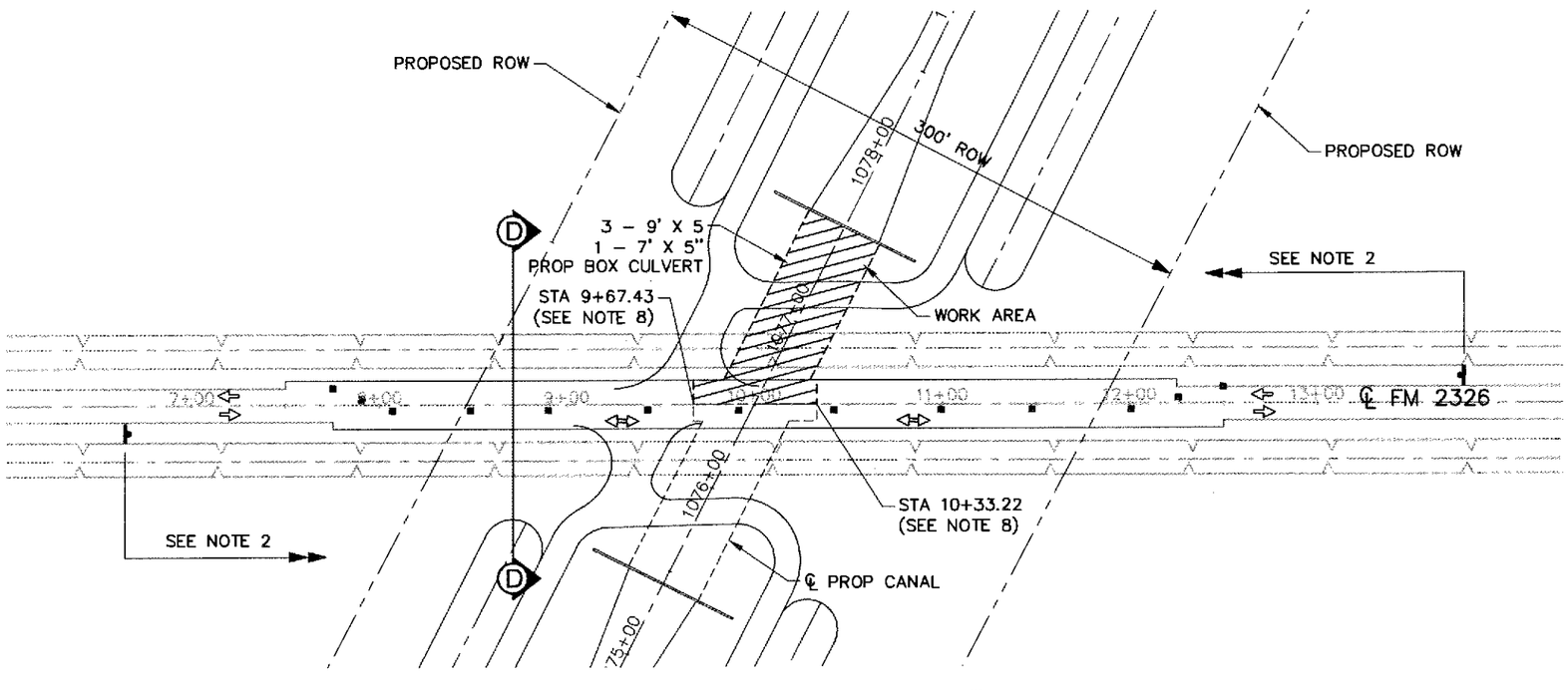
DRAWING SCALE
AS SHOWN

SHEET NO. 197 OF 245

LAST MODIFIED: Mar 30, 2010 - 4:42pm BY USER: rmalla
DWG. LOCATION: N:\5745-09-001\dwg\TCP\
DWG. NAME: TCP_FM2326_PH1.dwg



TRAFFIC CONTROL LAYOUT
STAGE 1



TRAFFIC CONTROL LAYOUT
STAGE 2

80 0 40 80
HORIZONTAL SCALE 1"=80'

LEGEND

- TRAFFIC FLOW
- DRUM
- SIGN
- WORK AREA
- TEMPORARY PAVEMENT

NOTE:

1. SEE TRAFFIC CONTROL PLAN "TCP (1-1)-98" STANDARD FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
2. SEE TRAFFIC CONTROL PLAN "TCP (1-2)-98" STANDARD FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
3. SEE TRAFFIC CONTROL PLAN "TCP (1-3)-98" FOR ADDITIONAL SIGNING, TAPERS, SPACING & LOCATION, CHANNELIZATION DEVICES, STRIPING, TABLES AND ADDITIONAL NOTES.
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5. CONTRACTOR TO MAINTAIN ACCESS TO ALL ADJACENT DRIVEWAYS.
6. SEE SHEET 14, "PROP CANAL AT CR 2326 TRAFFIC CONTROL TYPICAL SECTIONS" FOR SECTION C-C AND D-D DETAILS.
7. CONTRACTOR MAY ESTABLISH STATIONING AS SHOWN IN PLANS OR MAY FIELD MEASURE ALL DISTANCES NECESSARY TO ESTABLISH TEMP PVMT NEEDED AND TO LOCATE TRAFFIC CONTROL SIGNS USING THE INTERSECTION OF ℄ OF PROP CANAL AND ℄ OF CR 2326 AS THE REFERENCE POINT.
8. LIMITS OF CUT AND RESTORE PVMT

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.
J. A. GELACIO
56190
Date: MARCH 22, 2010

ENTECH CIVIL ENGINEERS, INC.
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713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

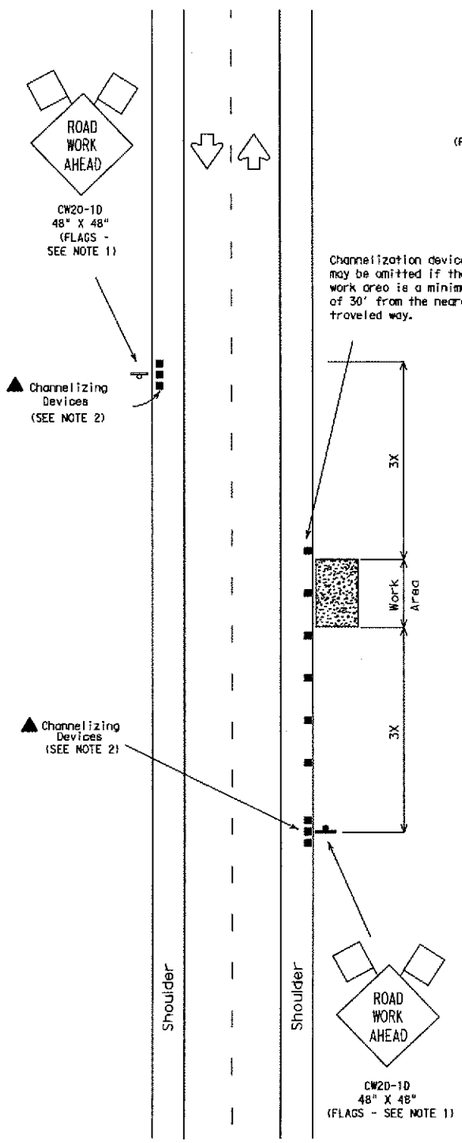
TRAFFIC CONTROL LAYOUT
CR 2326
PHASE II
STAGE 1 & STAGE 2

SHEET 16 OF 16

DRAWING SCALE
AS SHOWN

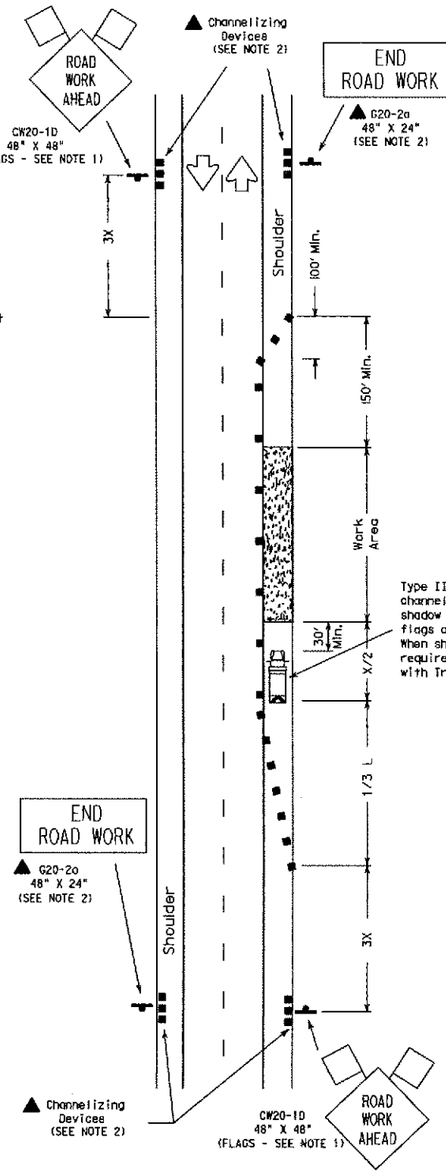
SHEET NO. 198 OF 245

LAST MODIFIED: Mar 30, 2010 - 4:45pm BY USER: rmalla
DWG. LOCATION: N:\5745-09-001\dwg\TCP\
DWG. NAME: TCP_FM2326_PH2.dwg



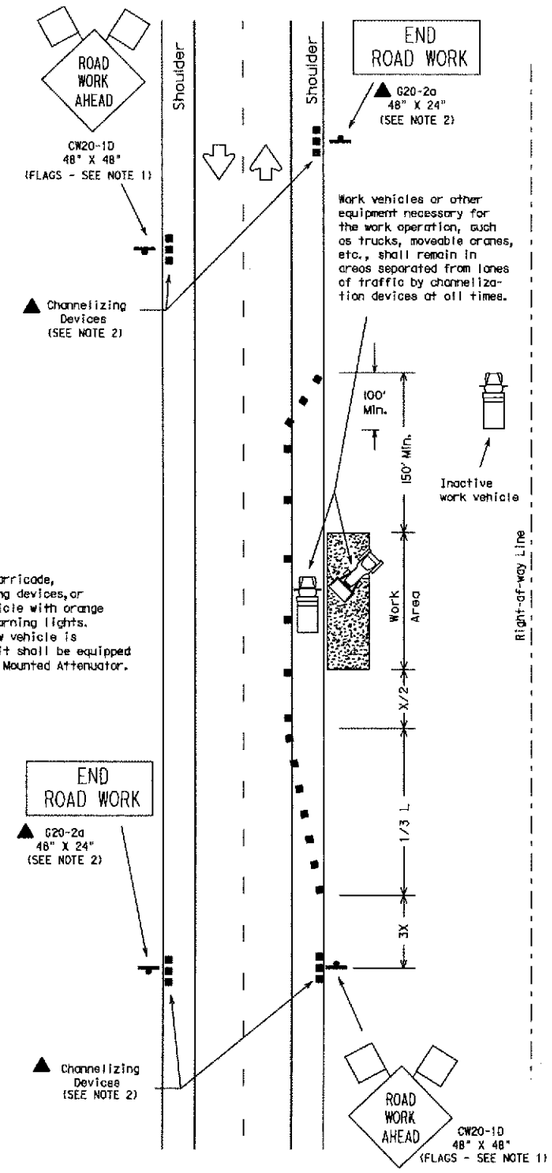
TCP (1-1a)

Work Area Near Shoulder



TCP (1-1b)

Work Area on Shoulder



TCP (1-1c)

Work Vehicles on Shoulder

LEGEND

Type III Barricade ■ ■ Channelizing Devices Flag

Heavy Work Vehicle Truck Mounted Attenuator

Trailer Mounted Flashing Arrow Panel Portable Changeable Message Sign

Flagger Sign Post

Posted Speed✱	Formula	Minimum Desirable Taper Lengths ✱✱ 10' Offset	11' Offset	12' Offset	Suggested Maximum Spacing of Device On a Taper	On a Tangent	Minimum Sign Spacing X Distance
30	$L = \frac{WS^2}{60}$	150'	165'	180'	30'	60'-75'	120'
35		205'	225'	245'	35'	70'-90'	160'
40		265'	295'	320'	40'	80'-100'	240'
45	L=WS	450'	495'	540'	45'	90'-110'	320'
50		500'	550'	600'	50'	100'-125'	400'
55		550'	605'	660'	55'	110'-140'	500'
60		600'	660'	720'	60'	120'-150'	✱600'
65		650'	715'	780'	65'	130'-165'	✱700'
70		700'	770'	840'	70'	140'-175'	✱800'

✱ Conventional Roads Only

✱✱ Taper lengths have been rounded off.
L=Length of Taper (FT.) W=Width of Offset (FT.) S=Posted Speed (MPH)

TYPICAL USAGE:				
MOBILE	SHORT DURATION	SHORT TERM STATIONARY	INTERMEDIATE TERM STATIONARY	LONG TERM STATIONARY
	✓	✓		

GENERAL NOTES:

1. Unless otherwise stated in the plans, flags attached to signs are REQUIRED.
2. All traffic control devices illustrated are REQUIRED, except those denoted with the triangle symbol may be omitted when stated elsewhere in the plans.
3. On high speed facilities advance warning signs should be installed approximately 3X from the work area or from the beginning of a lane or shoulder taper. On low speed facilities the advance warning signs should be placed based on the "X" minimum distance.
4. Inactive work vehicles or other equipment should be parked near the right-of-way line and not parked on the paved shoulder.

Only pre-qualified products shall be used. A list of compliant products and their sources may be obtained by writing or faxing:

Standards Engineer
Traffic Operations Division - TE
Texas Department of Transportation
125 East 11th Street
Austin, Texas 78701-2483
Phone (512) 416-3335
Fax (512) 416-3161
E-mail TRF-STANDARD@mailgw.dot.state.tx.us

The requirement for shadow vehicles will be listed in the project GENERAL NOTES, Item 502, Barricades, Signs and Traffic Handling.

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.
J. A. GELACIO
56190
Date: FEB 16, 2010

FINTECH CIVIL ENGINEERS, INC.
F-6932

AECOM
AECOM USA GROUP, INC.
5757 WOODWAY, SUITE 100, WEST
HOUSTON, TEXAS 77057-1589
WWW.TCB.AECOM.COM
TBPE REG. NO. F-3402

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

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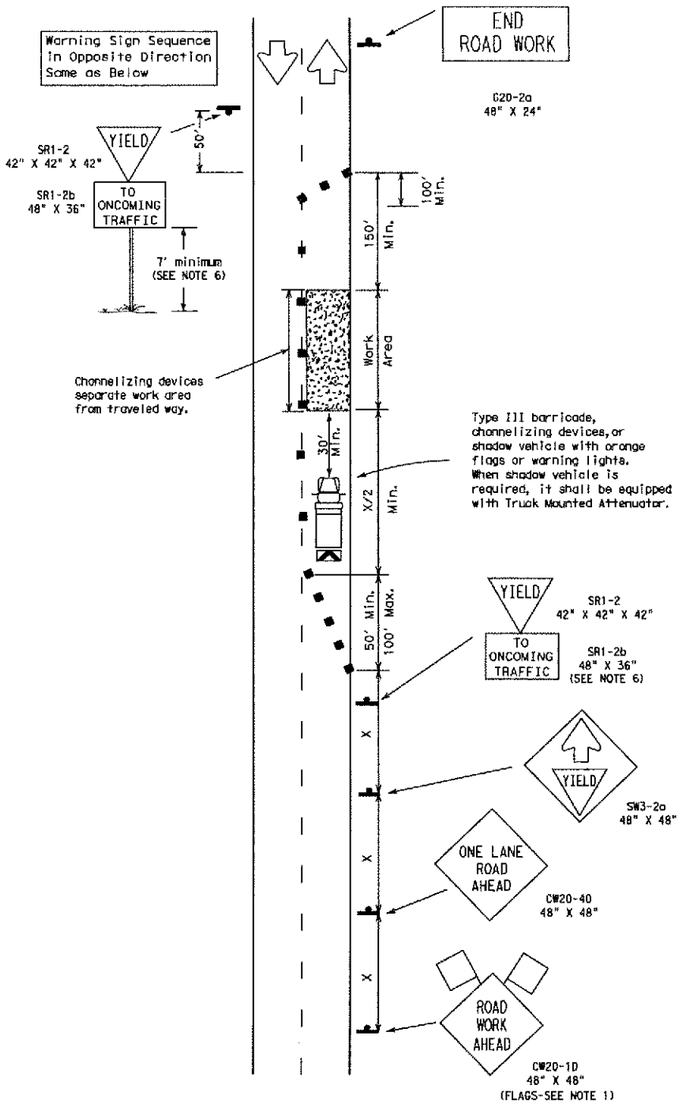
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

PROP CANAL
TRAFFIC CONTROL

TCP (1-1)-98

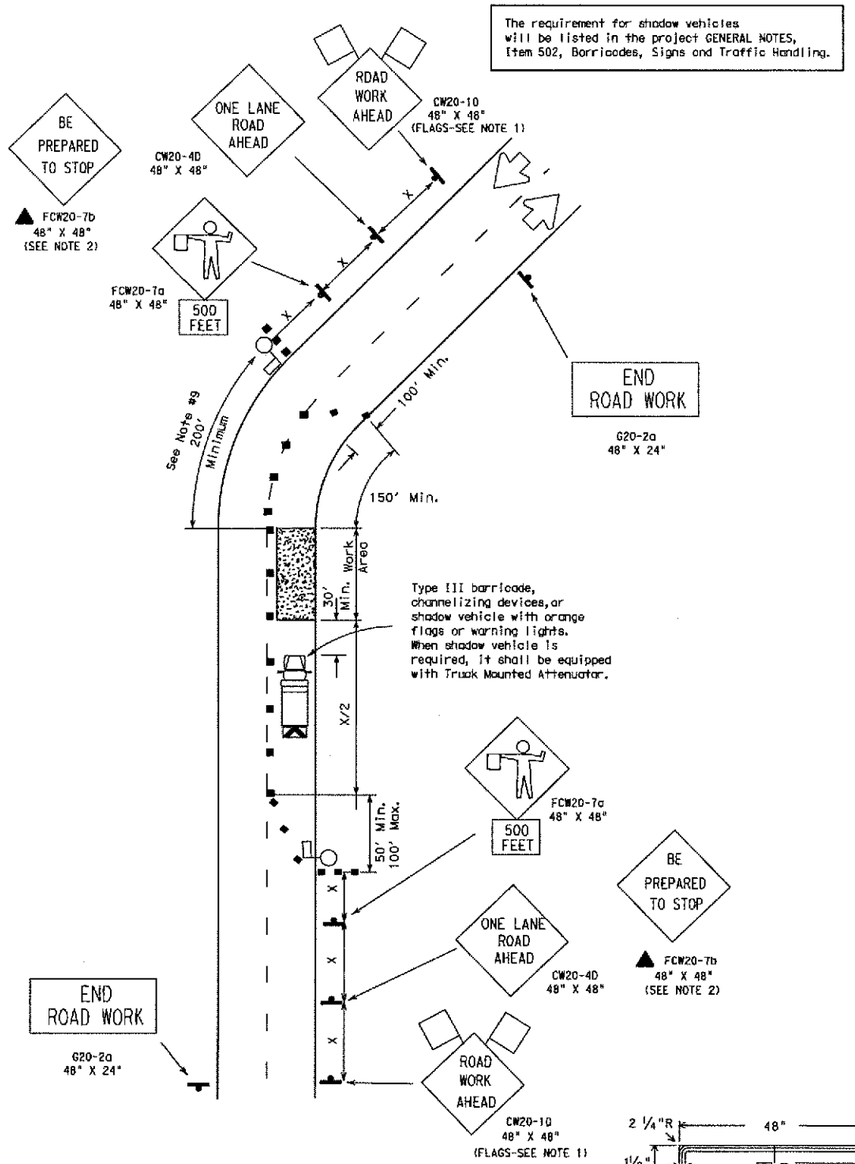
DRAWING SCALE
AS SHOWN

SHEET NO. 199 OF 245



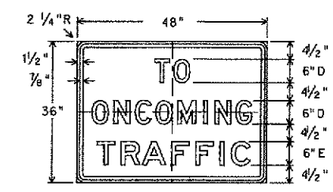
TCP (1-2a)

One Lane Closed
Adequate Field of View



TCP (1-2b)

One Lane Closed
Inadequate Field of View



SR1-2b
48" x 36"

Letters - Black
Background - White
Reflective

LEGEND

- Type III Barricade
- Channelizing Devices
- Flag
- Heavy Work Vehicle
- Truck Mounted Attenuator
- Trailer Mounted Flashing Arrow Panel
- Portable Changeable Message Sign
- Flagger
- Sign Post

Posted Speed ✱	Formula	Minimum Desirable Taper Lengths ✱✱ 10' Offset	11' Offset	12' Offset	Suggested Maximum Spacing of Device On a Taper	On a Tangent	Minimum Sign Spacing X Distance
30	$L=\frac{WS^2}{60}$	150'	165'	180'	30'	60'-75'	120'
35		205'	225'	245'	35'	70'-90'	160'
40		265'	295'	320'	40'	80'-100'	240'
45	L=WS	450'	495'	540'	45'	90'-110'	320'
50		500'	550'	600'	50'	100'-125'	400'
55		550'	605'	660'	55'	110'-140'	500'
60		600'	660'	720'	60'	120'-150'	✱600'
65		650'	715'	780'	65'	130'-165'	✱700'
70		700'	770'	840'	70'	140'-175'	✱800'

✱ Conventional Roads Only

✱✱ Taper lengths have been rounded off.
L=Length of Taper (FT.) W=Width of Offset (FT.) S=Posted Speed (MPH)

TYPICAL USAGE: MOBILE	SHORT DURATION	SHORT TERM STATIONARY	INTERMEDIATE TERM STATIONARY	LONG TERM STATIONARY
	✓	✓		

GENERAL NOTES:

1. Flags attached to signs are REQUIRED.
2. All traffic control devices illustrated are REQUIRED, except those denoted with the triangle symbol may be omitted when stated elsewhere in the plans.
3. The BE PREPARED TO STOP sign may be installed after the ONE LANE ROAD AHEAD sign, but proper sign spacing shall be maintained.
4. ROAD WORK AHEAD sign may be repeated if the visibility of the work zone is less than 1500'.

TCP(1-2a)

5. YIELD sign traffic control may be used on projects with approaches that have adequate sight distance. For projects in urban areas, work zones should be no longer than one half city block. In rural areas on roadways with less than 4000 ADT, work areas should be no longer than 400'.
6. YIELD TO ONCOMING TRAFFIC sign shall be placed on a support at a 7' minimum mounting height.

TCP(1-2b)

7. Flaggers should use two-way radios or other methods of communication to control traffic.
8. Length of work area should be based on the ability of flaggers to communicate.
9. Distance along curve of work area should be adequate length for motorists to identify and react to flagger signals.

Only pre-qualified products shall be used. A list of compliant products and their sources may be obtained by writing or faxing:

Standards Engineer
Traffic Operations Division - TE
Texas Department of Transportation
125 East 11th Street
Austin, Texas 78701-2483
Phone (512) 416-3335
Fax (512) 416-3161
E-mail TRF-STANDARDS@mail.dot.state.tx.us

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.

J. A. CELACIO
56190
Date: FEB 16, 2010

ENTECH CIVIL ENGINEERS, INC.
F-6932

AECOM
AECOM USA GROUP, INC.
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WWW.PSD.AECOM.COM
TBPE REGN. NO. F-2082

AECOM
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713.780.0838 fax.

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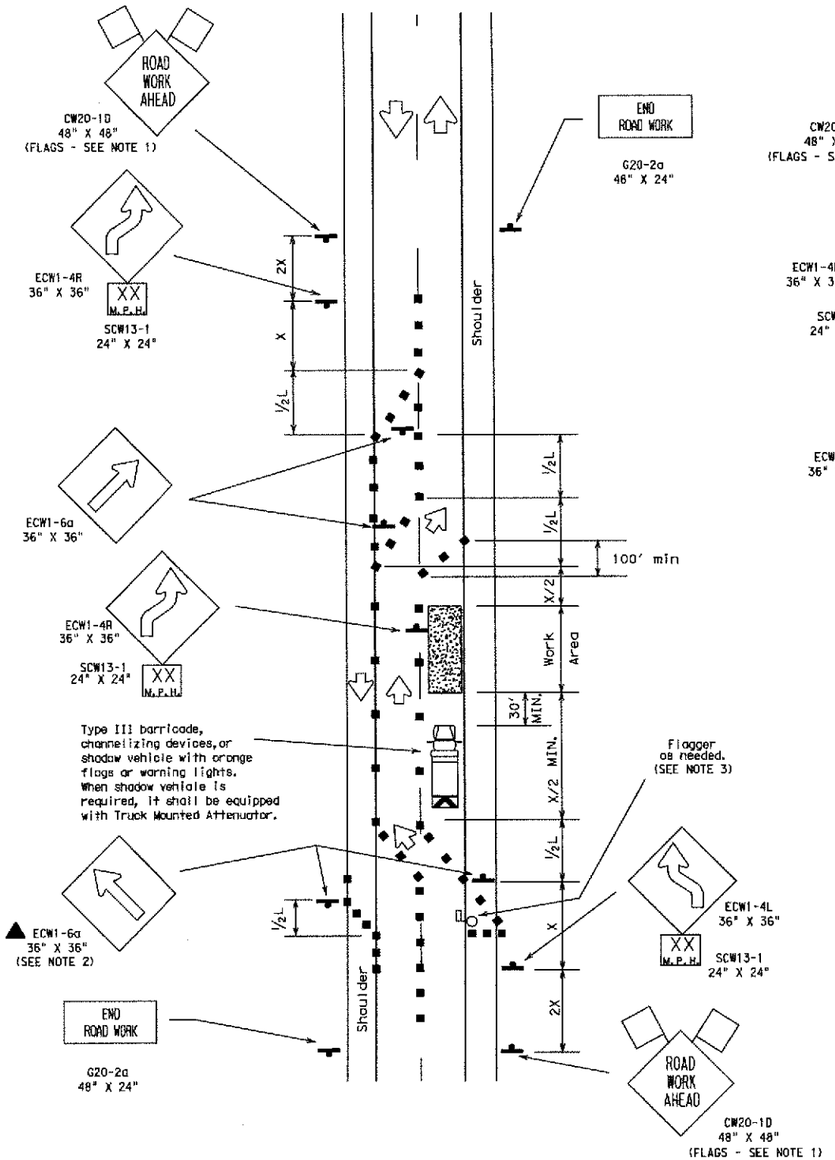
COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

PROP CANAL
TRAFFIC CONTROL

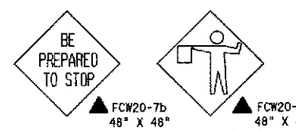
TCP (1-2)-98

DRAWING SCALE
AS SHOWN

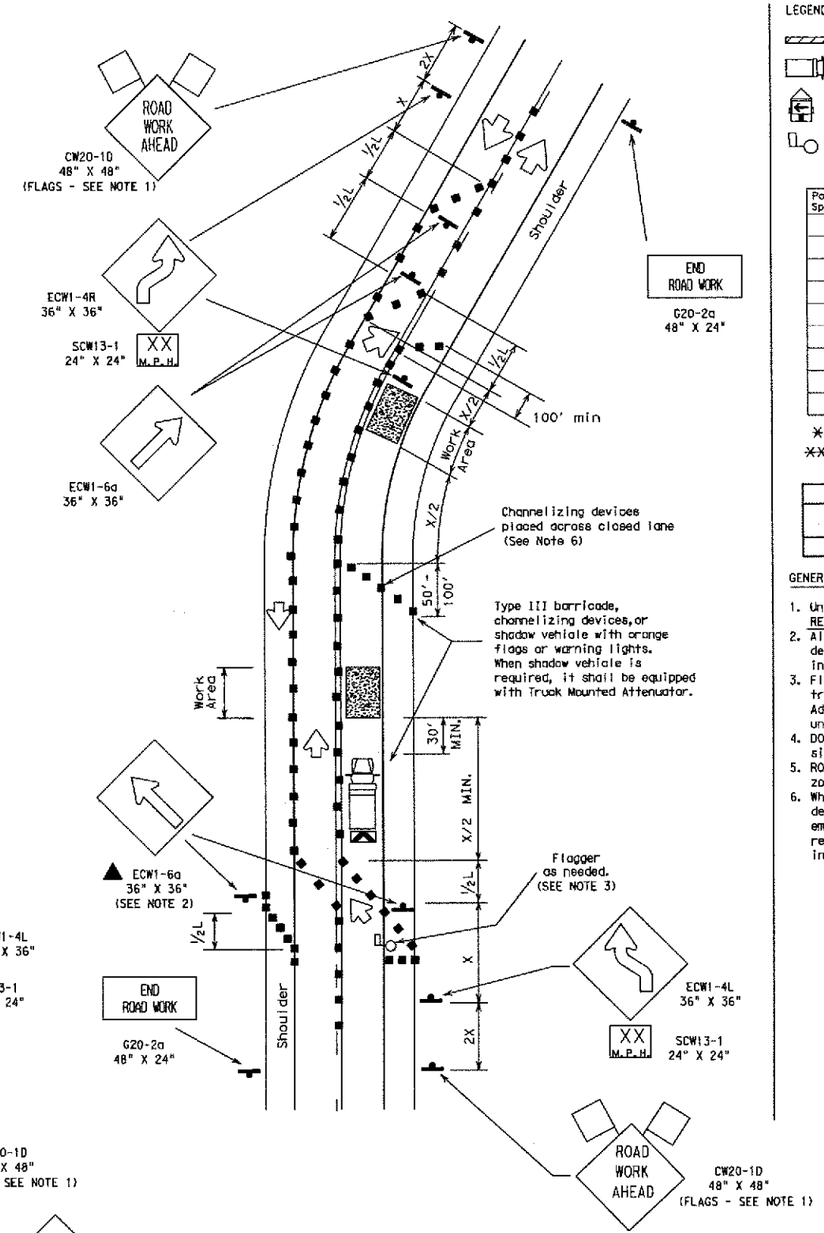
SHEET NO. 200 OF 295



TCP (1-3a)
2-Lane Roadway With Paved Shoulders
One Lane Closed
Adequate Field of View



Use Only When Flaggers Control Traffic
(SEE NOTE 2)



TCP (1-3b)
2-Lane Roadway With Paved Shoulders
One Lane Closed
Inadequate Field of View

LEGEND

- Type III Barricade
- Channelizing Devices
- Flag
- Heavy Work Vehicle
- Truck Mounted Attenuator
- Trailer Mounted Flashing Arrow Panel
- Portable Changeable Message Sign
- Flagger
- Sign Post

Posted Speed ✱	Formula	Minimum Desirable Taper Lengths ✱✱ 10' Offset	11' Offset	12' Offset	Suggested Maximum Spacing of Device On a Taper	On a Tangent	Minimum Sign Spacing X Distance
30	$L = \frac{WS^2}{60}$	150'	165'	180'	30'	60'-75'	120'
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45	L=WS	450'	495'	540'	45'	90'-110'	320'
50		500'	550'	600'	50'	100'-125'	400'
55		550'	605'	660'	55'	110'-140'	500'
60		600'	660'	720'	60'	120'-150'	✱600'
65		650'	715'	780'	65'	130'-165'	✱700'
70		700'	770'	840'	70'	140'-175'	✱800'

✱ Conventional Roads Only

✱✱ Taper lengths have been rounded off.
L=Length of Taper (FT.) W=Width of Offset (FT.) S=Posted Speed (MPH)

TYPICAL USAGE: MOBILE	SHORT DURATION	SHORT TERM STATIONARY	INTERMEDIATE TERM STATIONARY	LONG TERM STATIONARY
	✓	✓		

GENERAL NOTES:

1. Unless otherwise stated in the plans, flags attached to signs are REQUIRED.
2. All traffic control devices illustrated are REQUIRED, except those denoted with the triangle symbol may be omitted when stated elsewhere in the plans.
3. Flagger control should NOT be used unless roadway conditions or heavy traffic volume require additional emphasis to safely control traffic. Additional flaggers should be positioned at end of traffic queues unless 24" x 24" STOP/SLOW paddle is used.
4. DO NOT PASS, PASS WITH CARE, and construction regulatory speed zone signs may be installed downstream of the ROAD WORK AHEAD signs.
5. ROAD WORK AHEAD sign may be repeated if the visibility of the work zone is less than 1500'.
6. When the work zone is made up of several work areas, channelizing devices should be placed laterally across the closed lane to re-emphasize closure. Laterally placed channelizing devices should be repeated every 500' to 1000' in urban areas and every 1/4 to 1/2 mile in rural areas.

Only pre-qualified products shall be used. A list of compliant products and their sources may be obtained by writing or faxing:

Standards Engineer
Traffic Operations Division - TE
Texas Department of Transportation
125 East 11th Street
Austin, Texas 78701-2483
Phone (512) 416-3335
Fax (512) 416-3161
E-mail TRF-STANDARDS@mail.dot.state.tx.us

The requirement for shadow vehicles will be listed in the project GENERAL NOTES, Item 502, Barricades, Signs and Traffic Handling.

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.
J. A. GELACIO
56190
Date: FEB 16, 2010

ENTECH CIVIL ENGINEERS, INC.
F-6932

AECOM
AECOM USA GROUP, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1049
WWW.TCEI.NET/AECOM
TBPE REG. NO F-3062

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

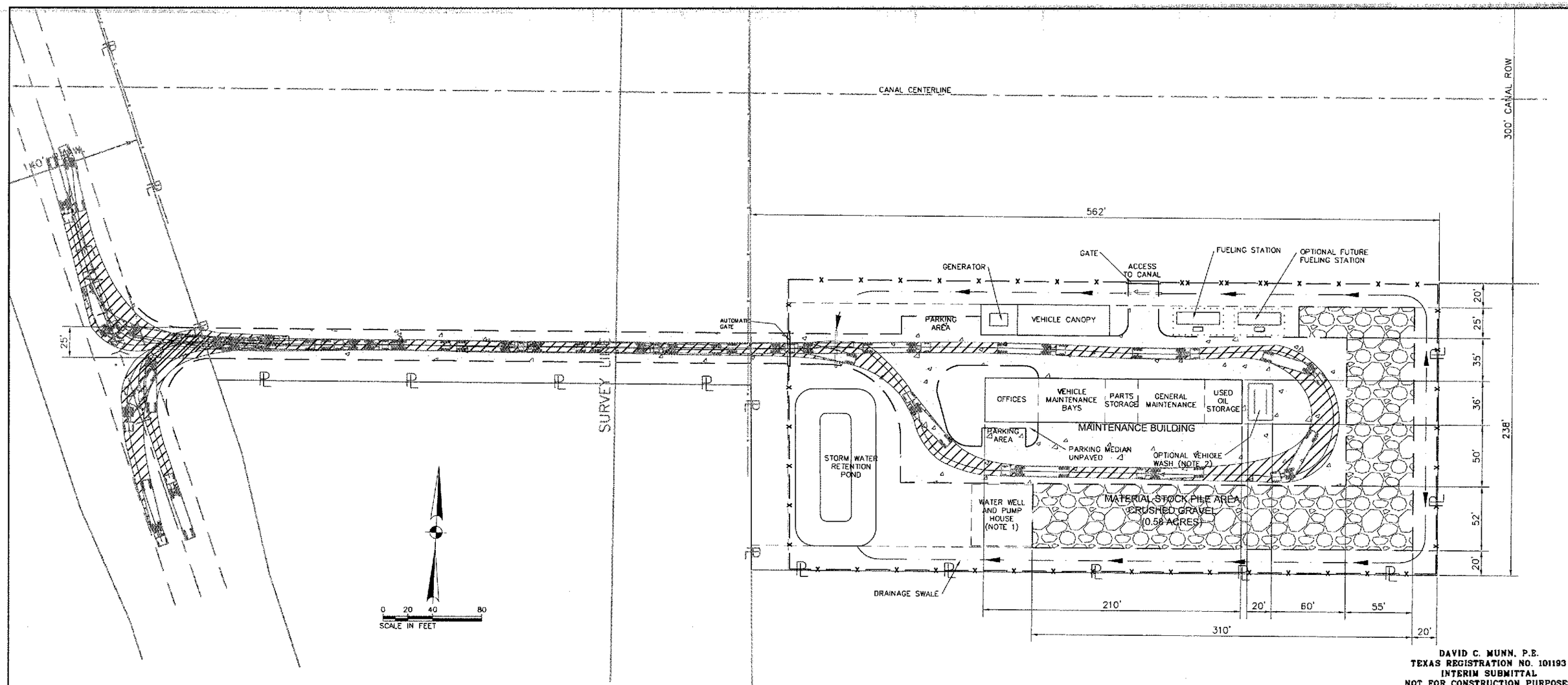
PROP CANAL
TRAFFIC CONTROL

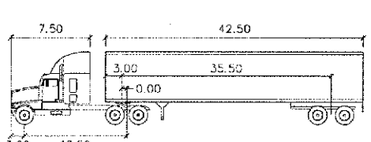
TCP (1-3)-98

DRAWING SCALE
AS SHOWN

SHEET NO 201 OF 245

No.	Date	Revisions	App.





WB-50 feet

Tractor Width	: 8.00	Lock to Lock Time	: 6.00
Trailer Width	: 8.50	Steering Angle	: 17.70
Tractor Track	: 8.00	Articulating Angle	: 70.00
Trailer Track	: 8.50		

NOTES:

1. WATER WELL PUMP FACILITY MAY BE NECESSARY IF POTABLE WATER IS NOT AVAILABLE.
2. VEHICLE WASH MAY NOT BE FEASIBLE IF SANITARY SEWER CONNECTION IS NOT AVAILABLE.
3. TOTAL AREA: 3.96 ACRES.

DAVID C. MUNN, P.E.
TEXAS REGISTRATION NO. 101193
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 150 WEST
HOUSTON, TEXAS 77057-1599
WWW.AECOM.COM
TBPE REG. NO. F-2580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

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COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL MAINTENANCE FACILITY
CONCEPTUAL LAYOUT

DRAWING SCALE
AS SHOWN

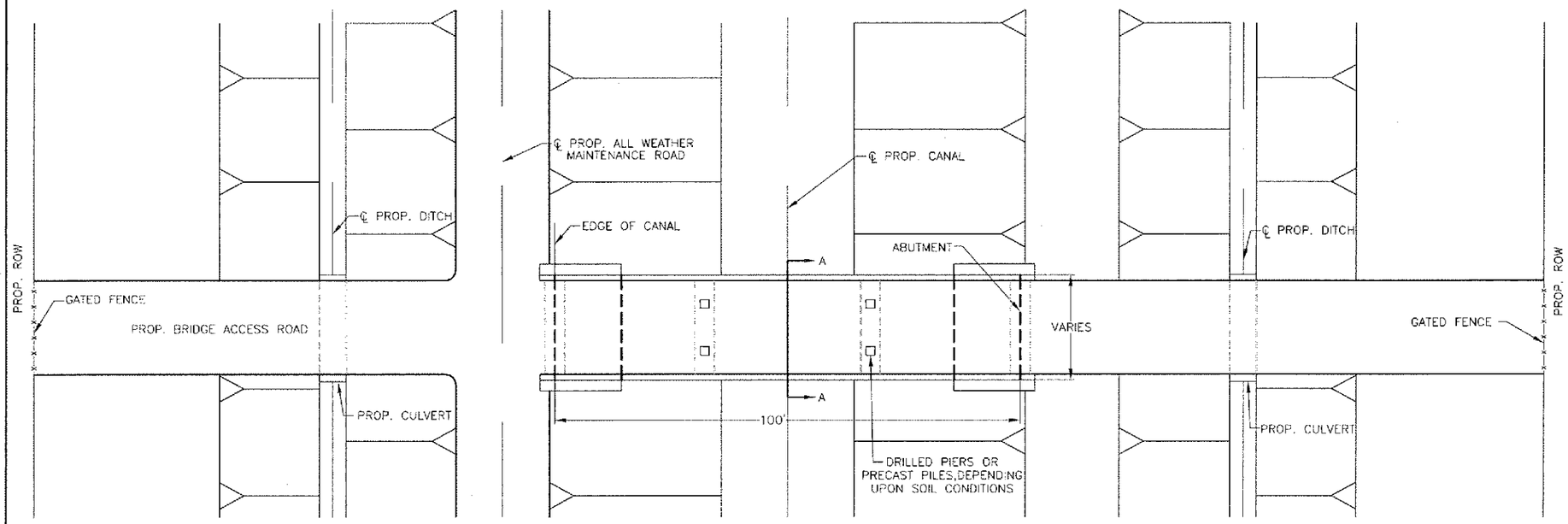
EXHIBIT:

SHEET NO. 202 OF 295

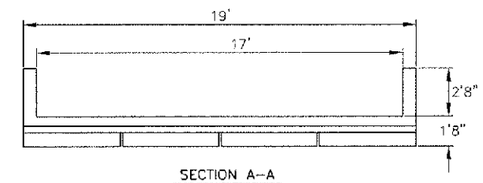
LAST MODIFIED: Jan 24, 2011 - 11:11am BY USER: ThompsonBl
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\Canal_Maint_Bldg\
DWG. NAME: NewMaintSite.dwg

NOTES:

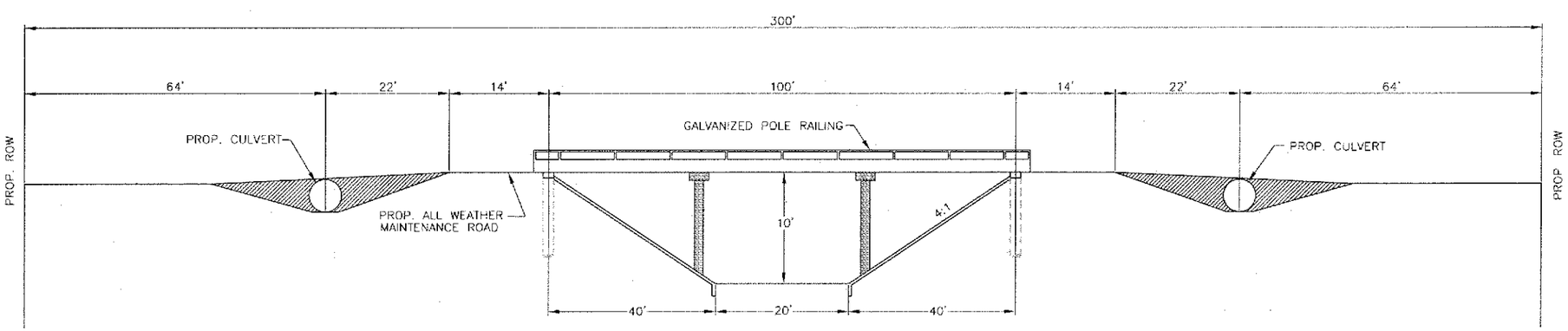
1. THIS DRAWING IS FOR CONCEPTUAL USE ONLY AND IS SUBJECT TO CHANGE.
2. IT IS NOT INTENDED FOR DESIGN AND IS ONLY PRELIMINARY IN NATURE.
3. OTHER BRIDGE PLAN AND SIPHONS MAY VARY FROM THIS GENERAL DESIGN AND MAY BE WIDER TO MEET SPECIFIC REQUIREMENTS AT A PARTICULAR LOCATION.



BRIDGE PLAN VIEW
(N.T.S.)



SECTION A–A
(N.T.S.)



BRIDGE PROFILE VIEW
(N.T.S.)

WALLY R. BURNS, P.E.
TEXAS REGISTRATION NO. 44162
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1599
WWW.TCB.AECOM.COM
TBPE REG. NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

CONCEPTUAL
BRIDGE DETAIL

DRAWING SCALE
AS SHOWN

SHEET NO. 20 OF 205

LAST MODIFIED: Jan 28, 2011 – 7:01am BY USER: ThompsonBl
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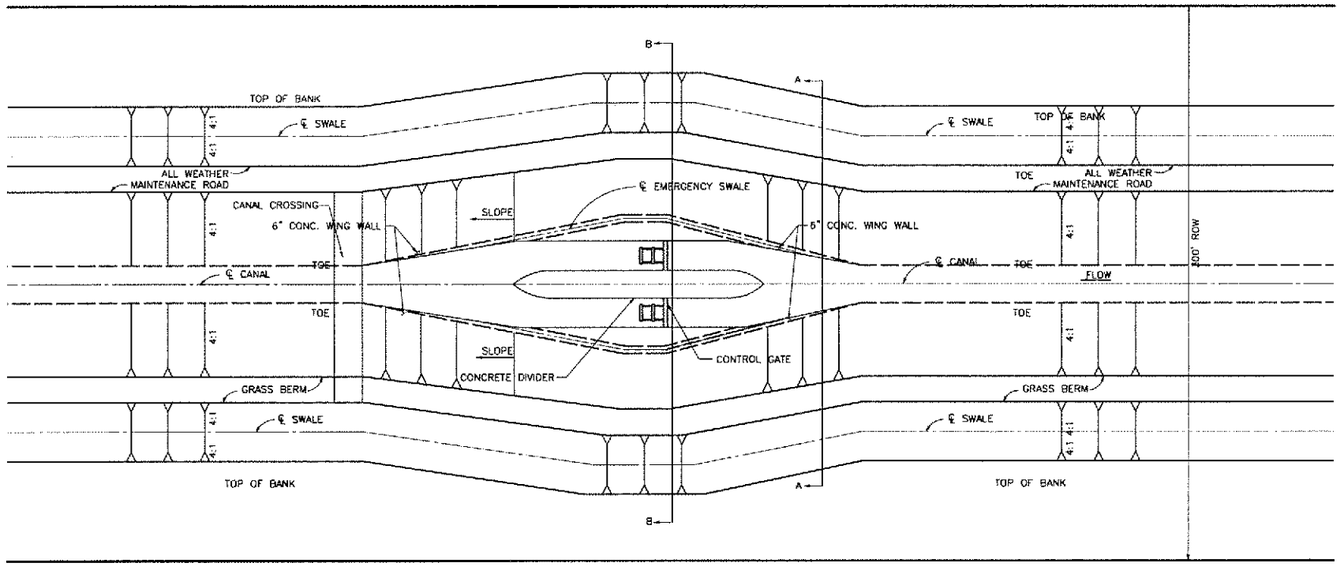
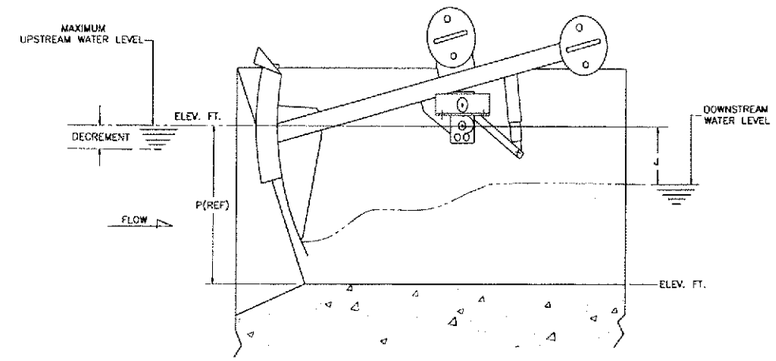
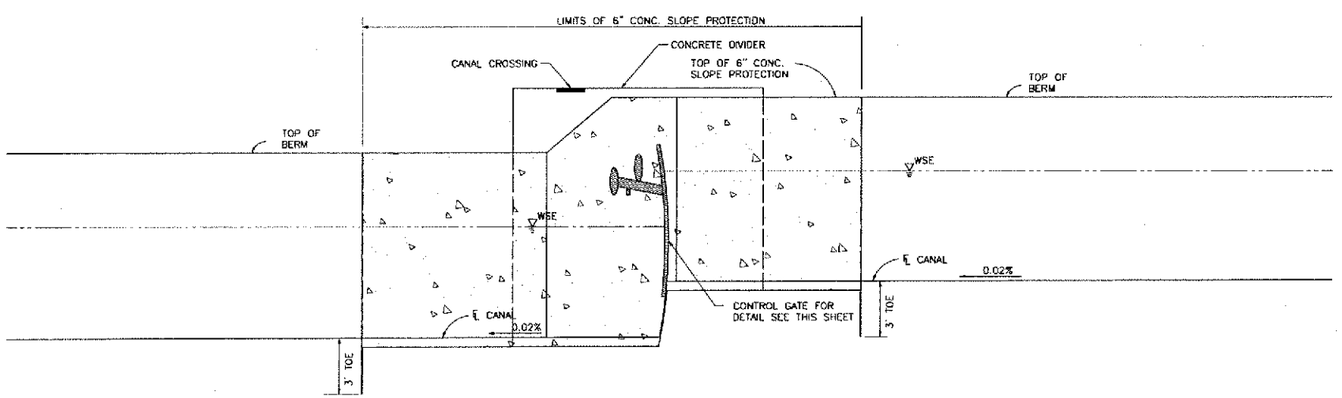


PLAN VIEW
SCALE: N.T.S.



CONTROL GATE DETAIL
SCALE: N.T.S



PROFILE VIEW
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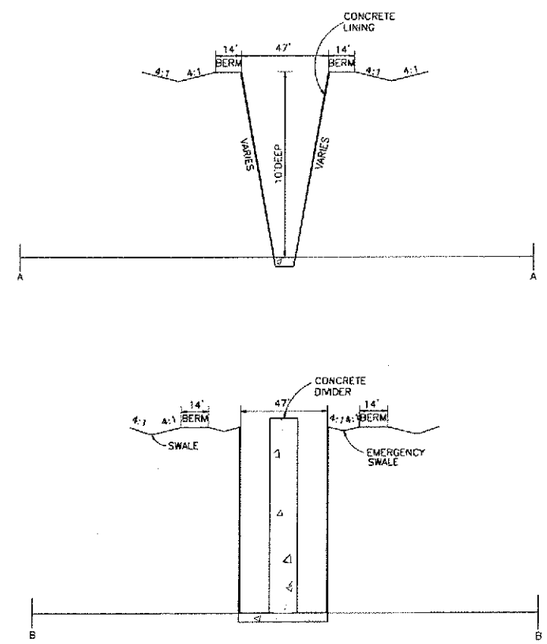

CROSS SECTIONAL VIEW
SCALE: N.T.S.

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
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AECOM

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5757 WOODWAY
HOUSTON, TEXAS 77057
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713.780.0838 fax.

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

WATER CONTROL STRUCTURE DETAIL

DRAWING SCALE
AS SHOWN

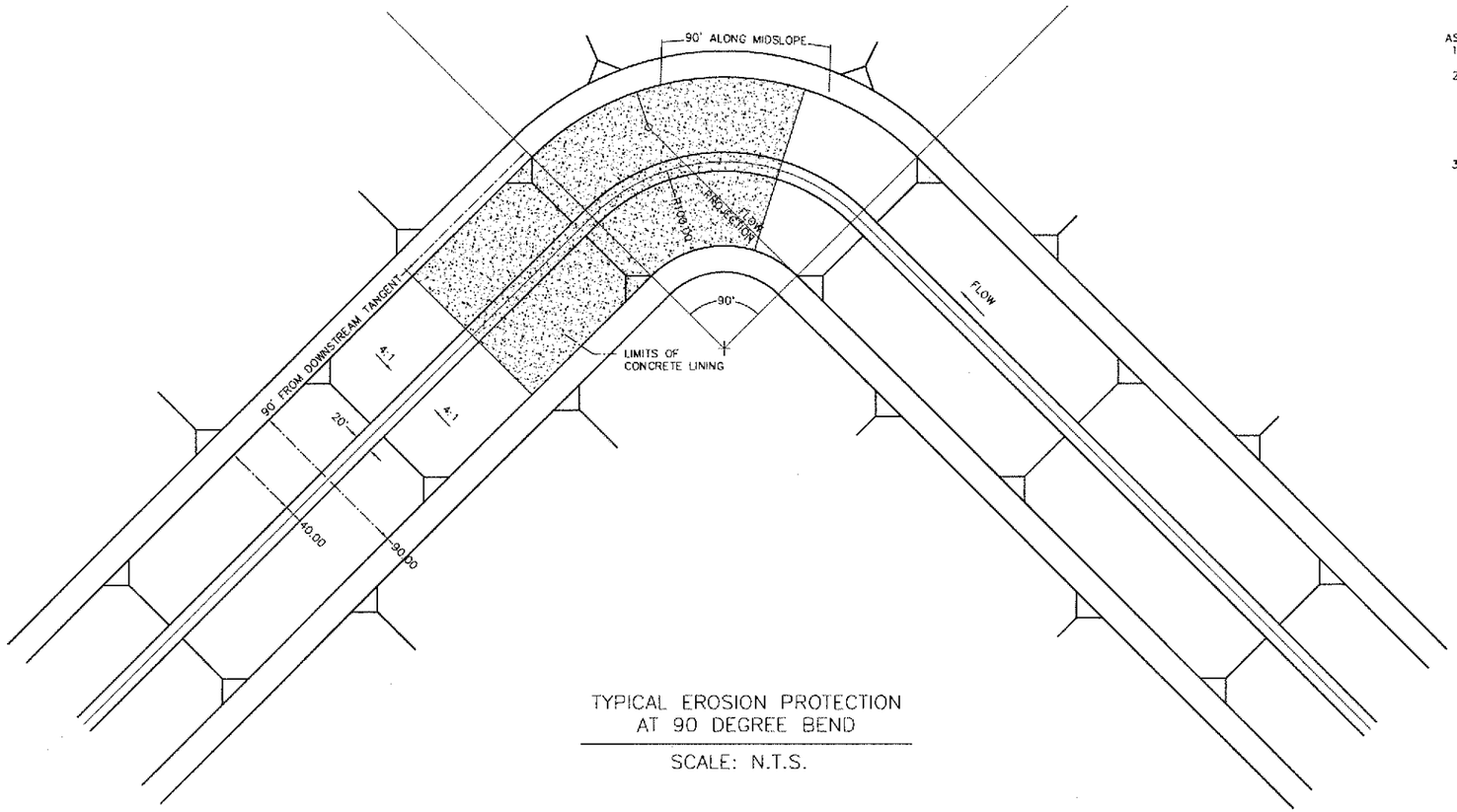
SHEET NO. 204 OF 245

No.	Date	Revisions	App.

LAST MODIFIED: Jan 28, 2011 - 7:00am BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: GATE_DETAIL.dwg

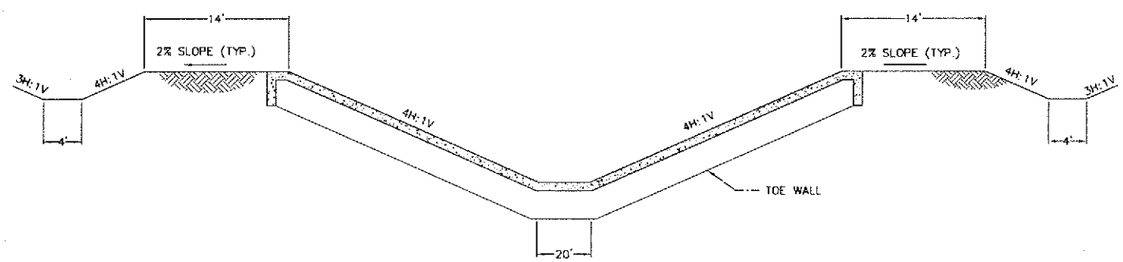
NOTES:
1. DESIGN IS BASED ON ASSUMPTIONS. MODIFICATIONS WILL BE MADE AS DETAILED GEOTECHNICAL INFORMATION BECOMES AVAILABLE DURING FINAL DESIGN.

ASSUMPTIONS:
1. WSEL IN CANAL HELD CONSTANT.
2. THIS DETAIL IS A MODIFIED VERSION OF HARRIS COUNTY FLOOD CONTROL DISTRICT'S TYPICAL CONCRETE-LINED TRAPEZOIDAL CHANNEL SECTION. IT HAS BEEN ALTERED TO REFLECT PROJECT SPECIFIC INFORMATION.
3. A VELOCITY OF 4 FEET PER SECOND IN THE CANAL WAS ASSUMED BASED ON INFORMATION OBTAINED FROM EM 110-2-1601, PLATE B-33. PLATE B-33 INDICATES APPROXIMATELY A 1.4 TO 1.5 INCREASE IN AVERAGE VELOCITY THROUGH A 90-DEGREE BEND. CONSERVATIVELY A FACTOR OF 2.0 WAS USED.



TYPICAL EROSION PROTECTION AT 90 DEGREE BEND

SCALE: N.T.S.



TYPICAL CONCRETE-LINED CHANNEL SECTION

SCALE: N.T.S.

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

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SURVEYED BY:
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LUCE BAYOU INTERBASIN TRANSFER PROJECT

TYPICAL EROSION PROTECTION AT 90 DEGREE BEND

DRAWING SCALE
AS SHOWN

SHEET NO. 205 OF 245

LAST MODIFIED: Jan 28, 2011 - 6:42am BY USER: ThompsonBJ
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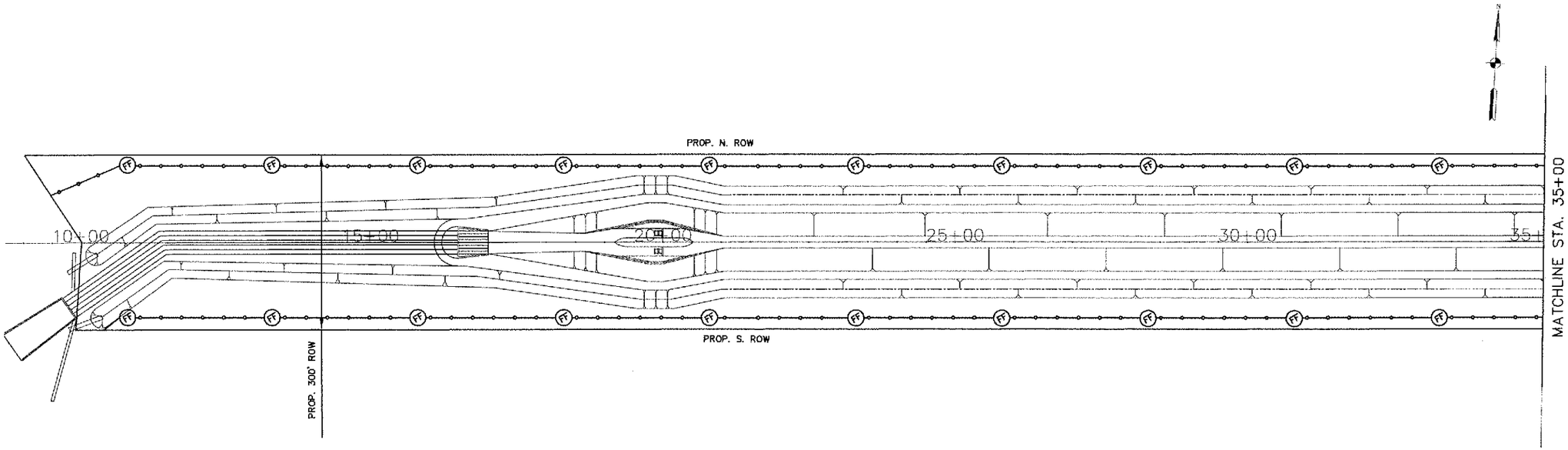

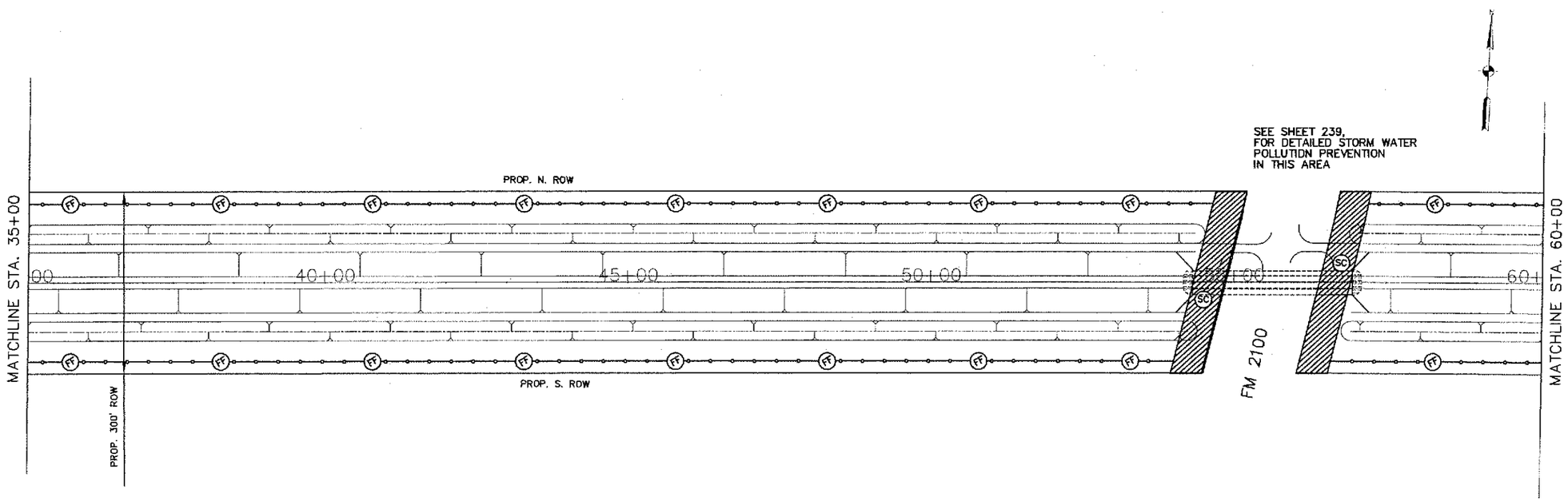

100 0 100 200
HORIZONTAL SCALE: 1" = 200'

LEGEND

- FF — FILTER FABRIC FENCE
- SC — STABILIZED CONTRUCTION ACCESS
- STABILIZED CONTRUCTION ZONE

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

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AECOM TECHNICAL SERVICES, INC.
5757 WOODWAY, SUITE 101 WEST
HOUSTON, TEXAS 77057-1599
TBPE REGISTRATION NO. F-3580

AECOM
5757 WOODWAY
HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
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COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

STORM WATER
POLLUTION PREVENTION
PLAN – CANAL
(SHEET 1 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 206 OF 245

LAST MODIFIED: Jan 27, 2011 – 5:19pm BY USER: Thompson5l
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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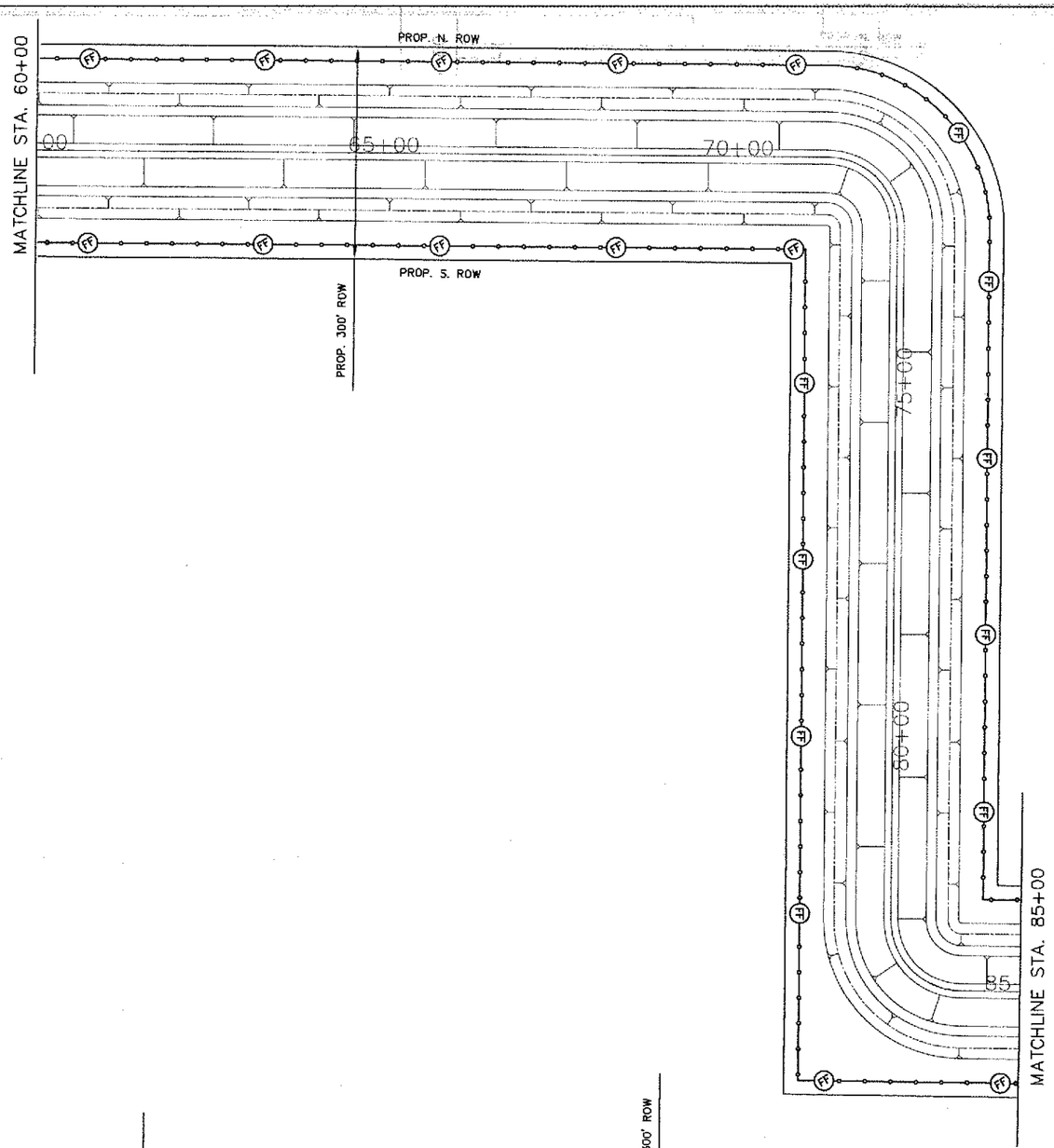

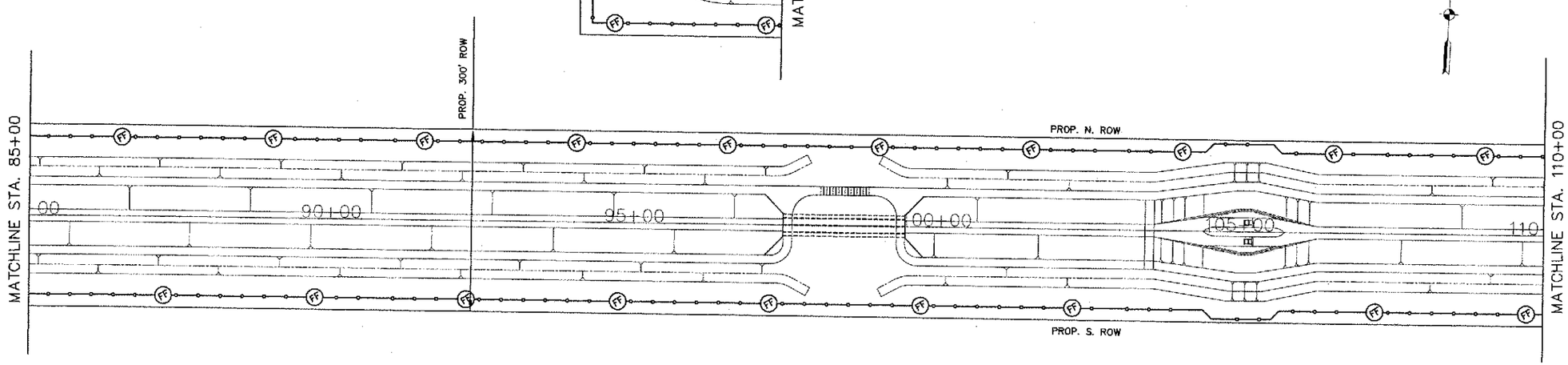

100 0 100 200
HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

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5757 WOODWAY, SUITE 101 WEST
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TBPE REG. NO. F-3580

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HOUSTON, TEXAS 77057
713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

STORM WATER
POLLUTION PREVENTION
PLAN – CANAL
(SHEET 2 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 207 OF 246

LAST MODIFIED: Jan 27, 2011 – 5:19pm BY USER: ThompsonBl
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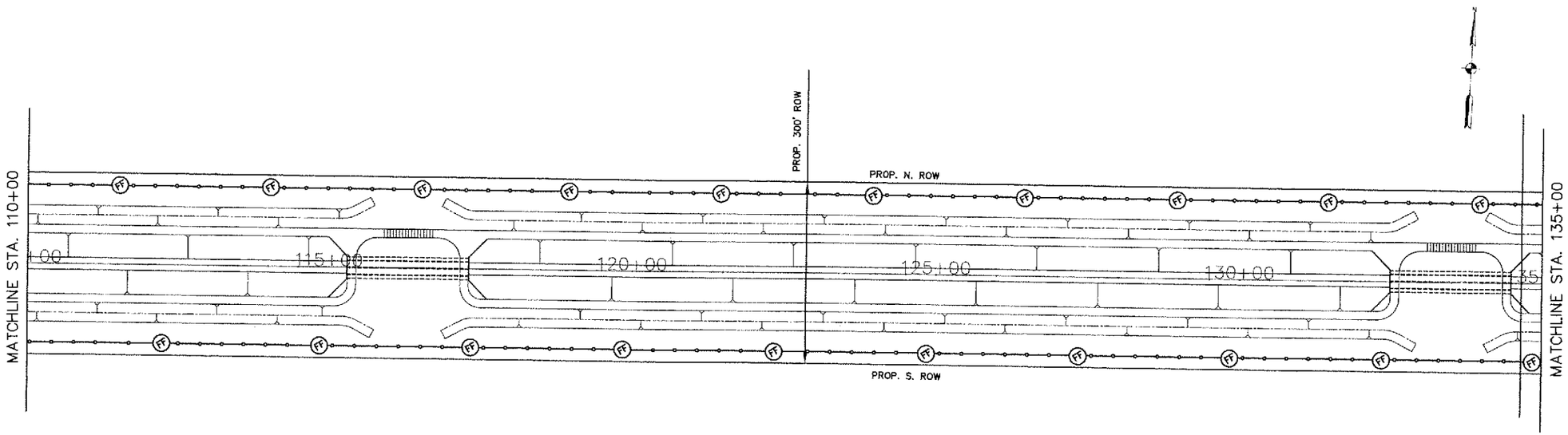

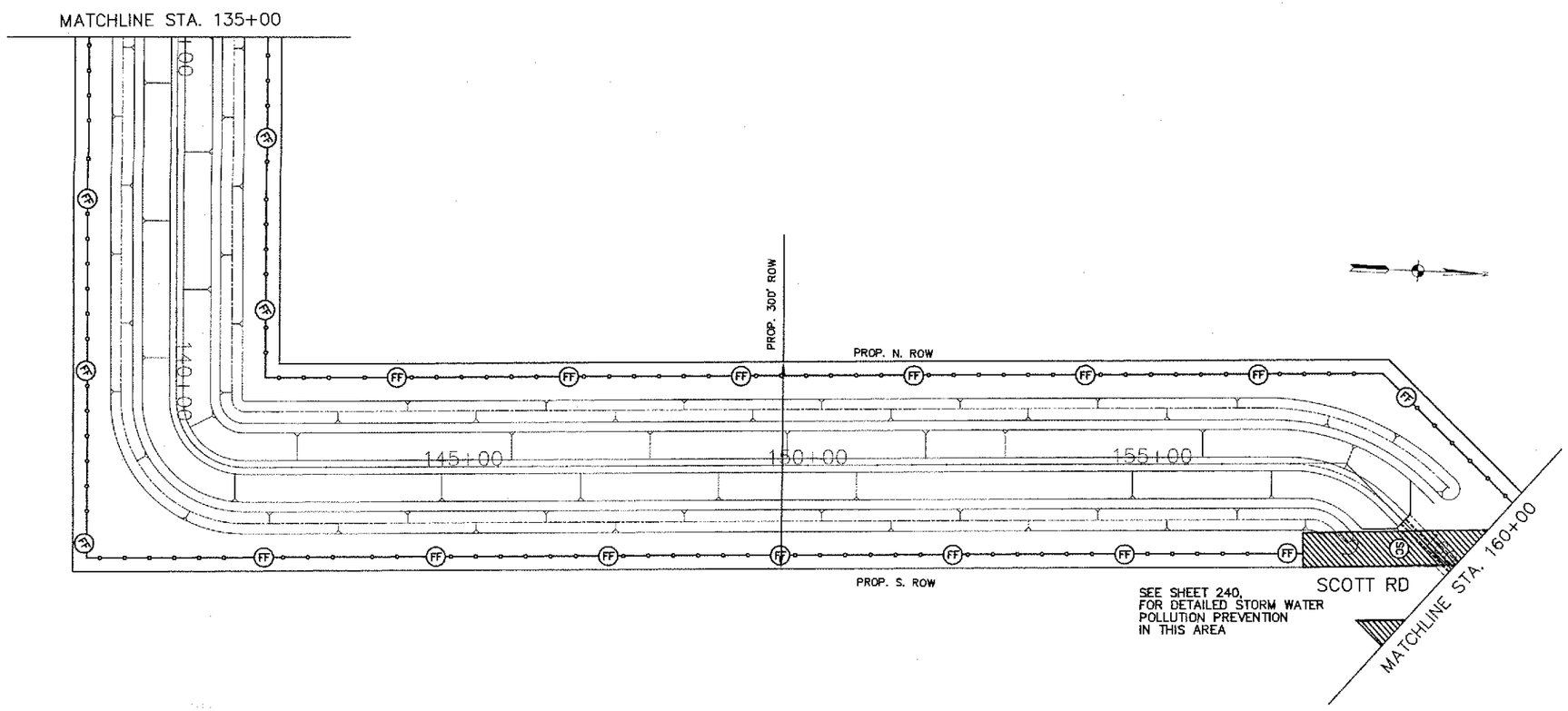

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HORIZONTAL SCALE: 1" = 200'

LEGEND

- FF — FILTER FABRIC FENCE
- SC — STABILIZED CONTRUCTION ACCESS
- STABILIZED CONTRUCTION ZONE

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

STORM WATER
POLLUTION PREVENTION
PLAN – CANAL
(SHEET 3 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 208 OF 246

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DWG. LOCATION: O:\Work Order 8\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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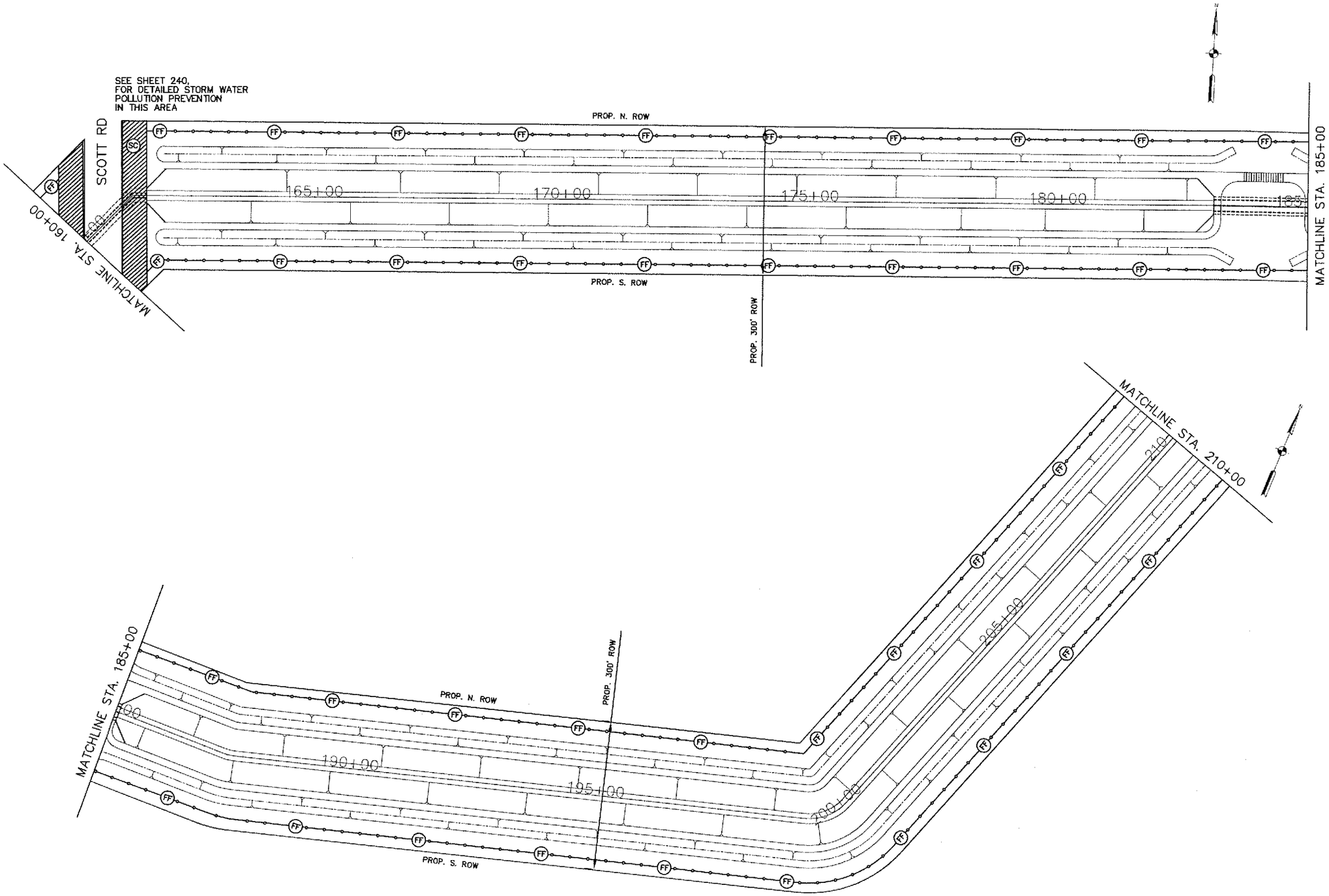

HORIZONTAL SCALE: 1" = 200'

LEGEND

- FF — FILTER FABRIC FENCE
- SC — STABILIZED CONTRUCTION ACCESS
- STABILIZED CONTRUCTION ZONE

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STORM WATER
POLLUTION PREVENTION
PLAN – CANAL
(SHEET 4 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 209 OF 245

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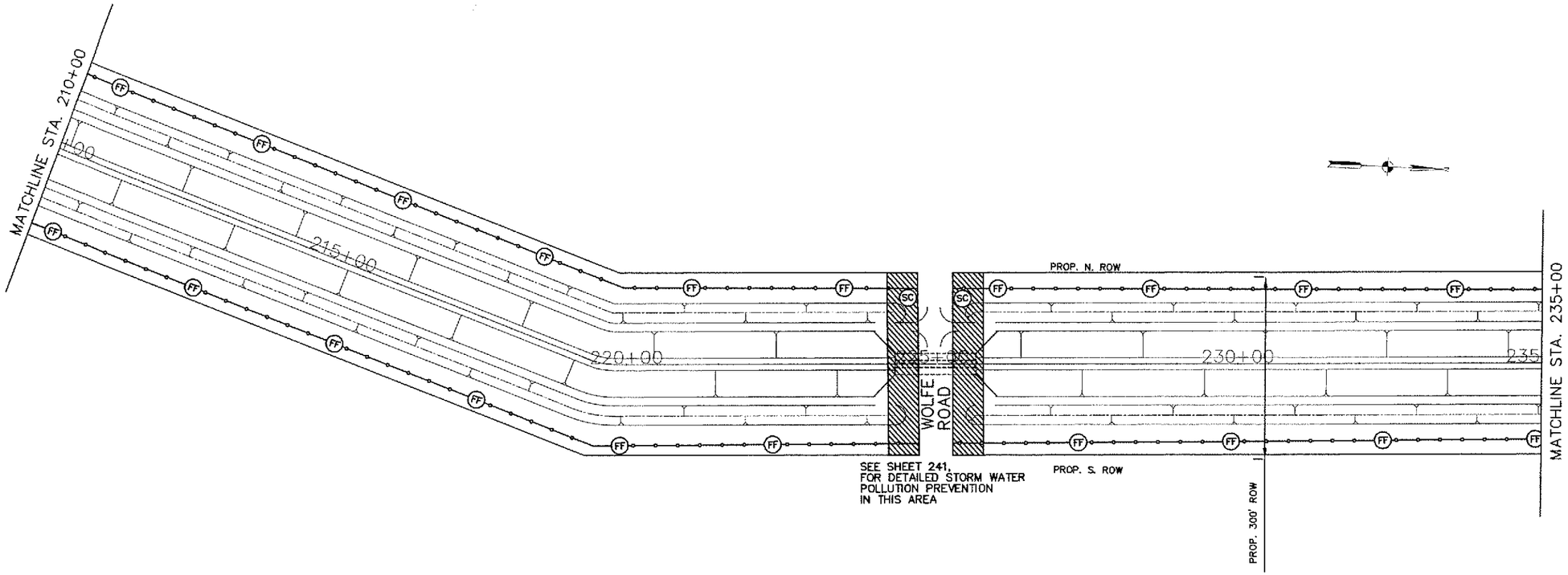

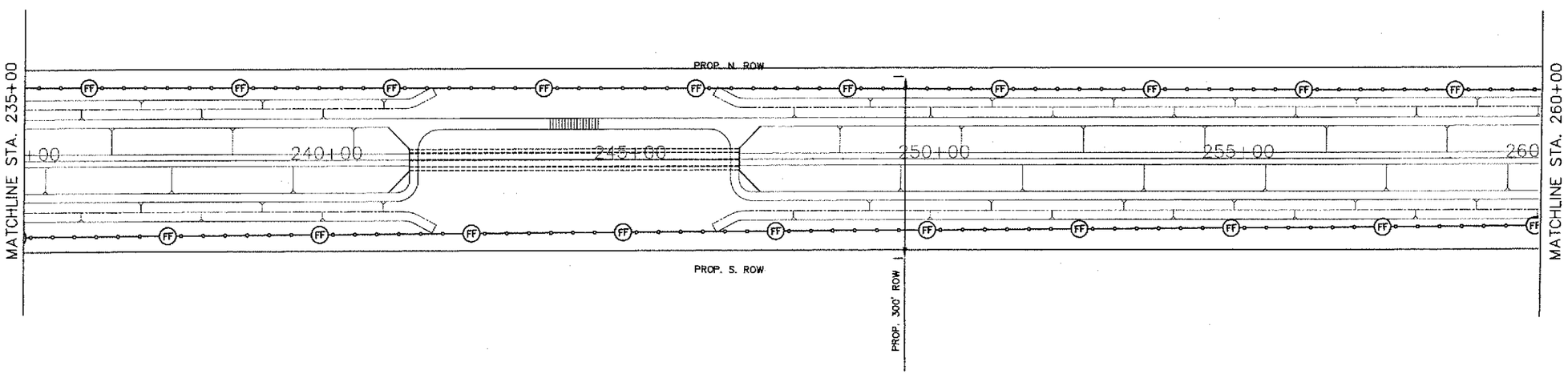

HORIZONTAL SCALE: 1" = 200'

LEGEND

- FF — FILTER FABRIC FENCE
- SC — STABILIZED CONTRUCTION ACCESS
- STABILIZED CONTRUCTION ZONE

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STORM WATER POLLUTION PREVENTION PLAN – CANAL (SHEET 5 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 210 OF 245

LAST MODIFIED: Jan 27, 2011 – 3:20pm BY USER: Thompson3l
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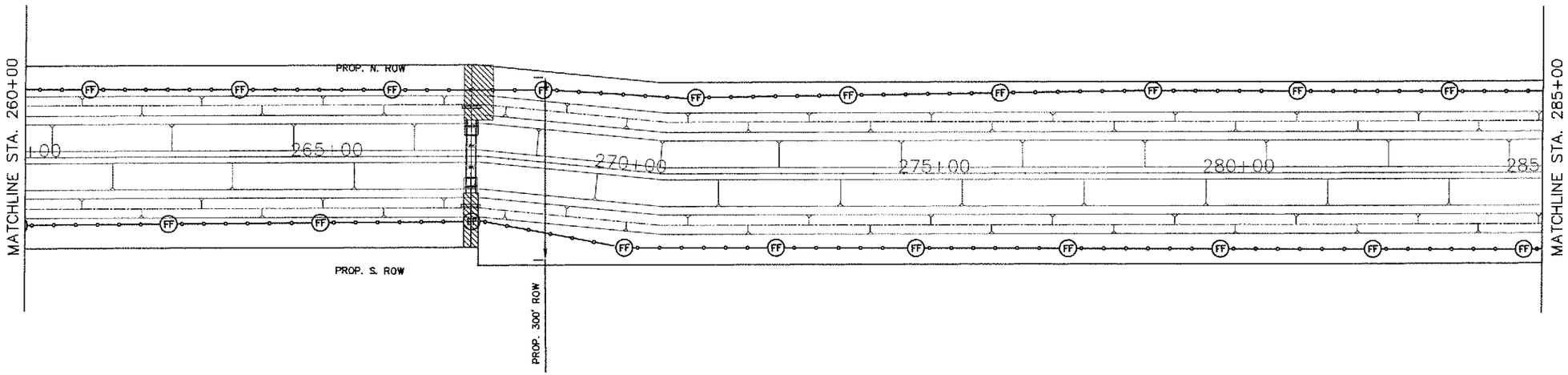

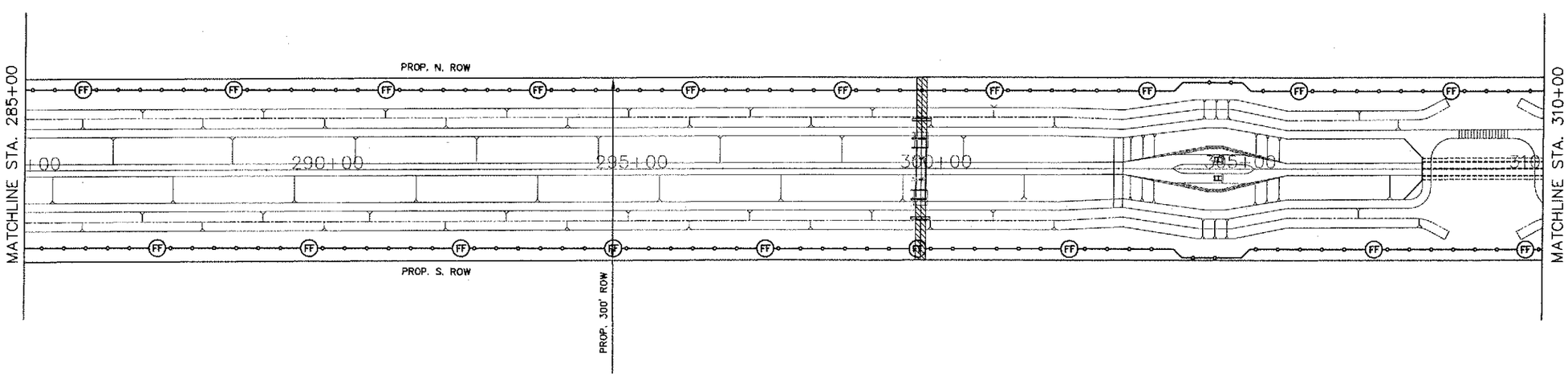

100 0 100 200
HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

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STORM WATER
POLLUTION PREVENTION
PLAN – CANAL
(SHEET 6 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 211 OF 245

LAST MODIFIED: Jan 27, 2011 – 5:20pm BY USER: ThompsonBl
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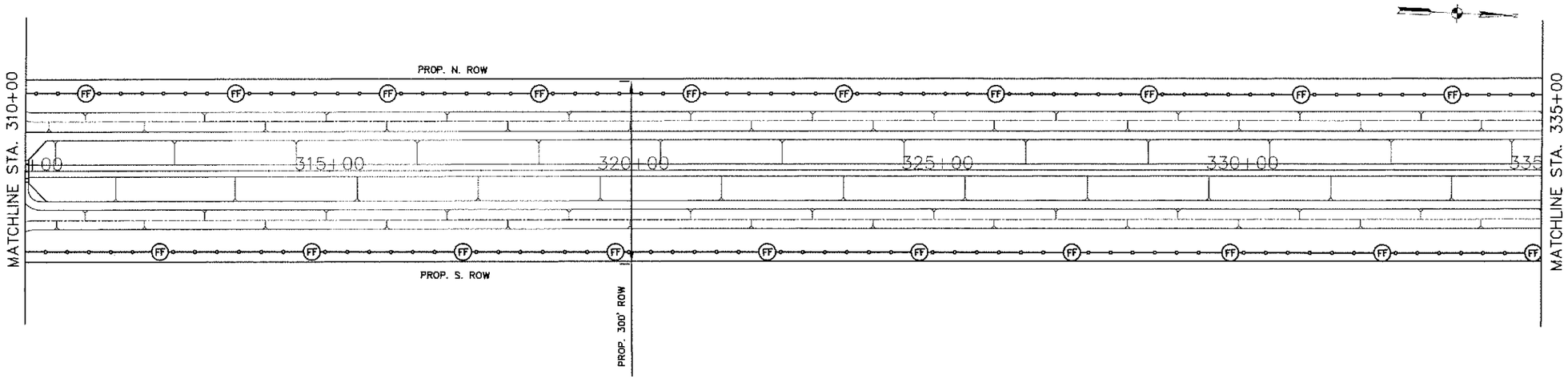

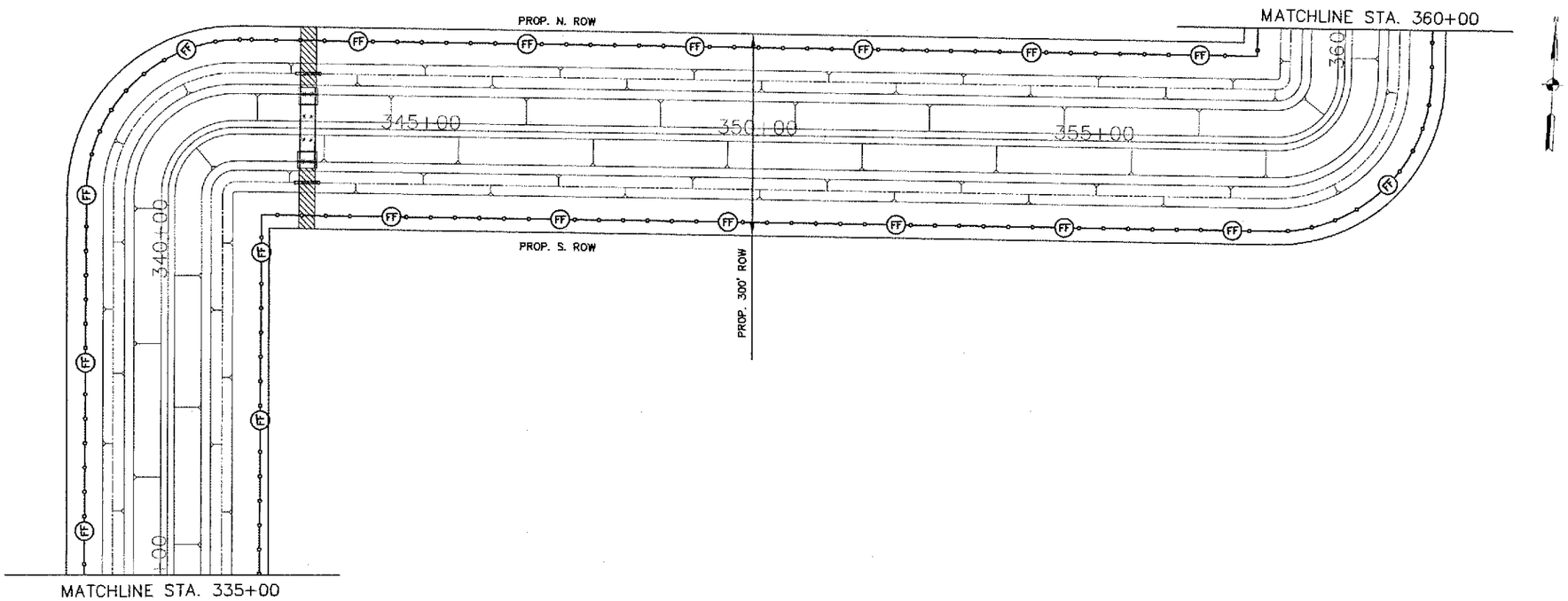

100 0 100 200
HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

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STORM WATER
POLLUTION PREVENTION
PLAN – CANAL
(SHEET 7 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 212 OF 295

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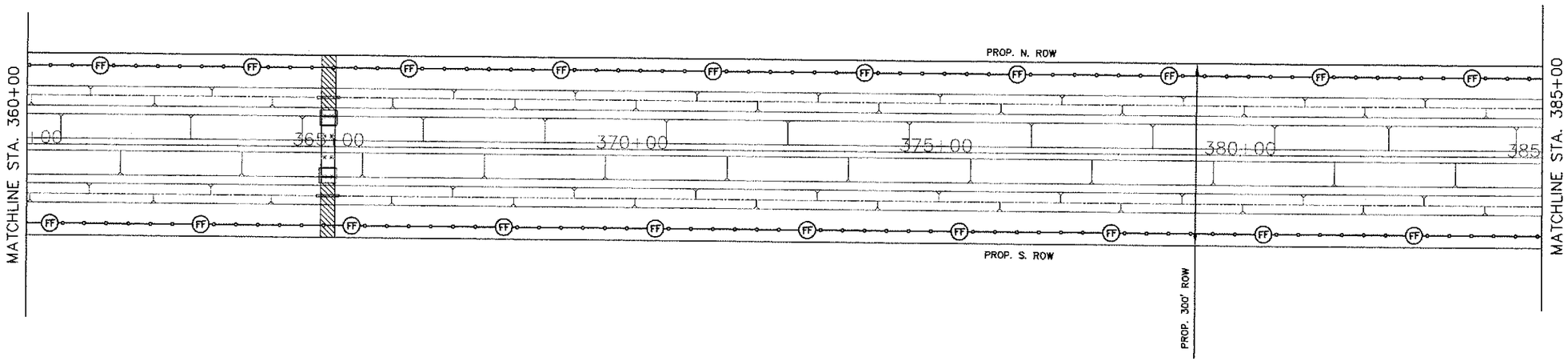

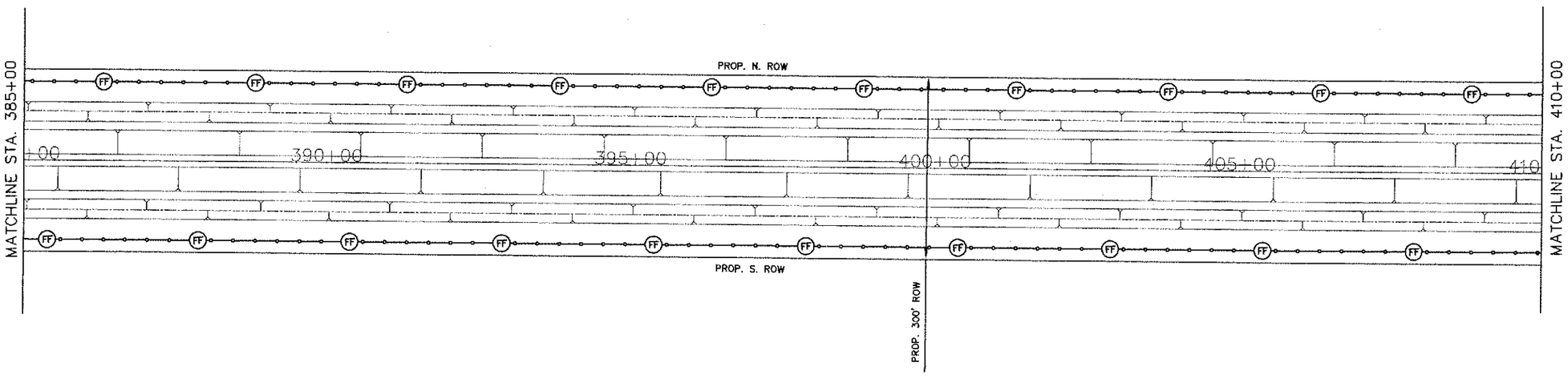

100 0 100 200
HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

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STORM WATER
POLLUTION PREVENTION
PLAN – CANAL
(SHEET 8 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 213 OF 246

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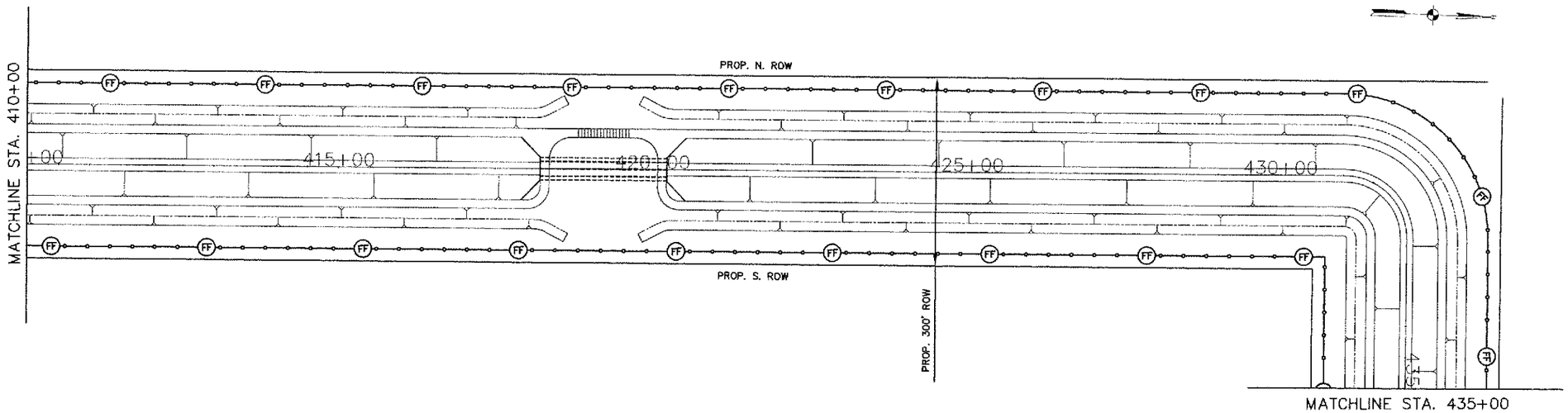

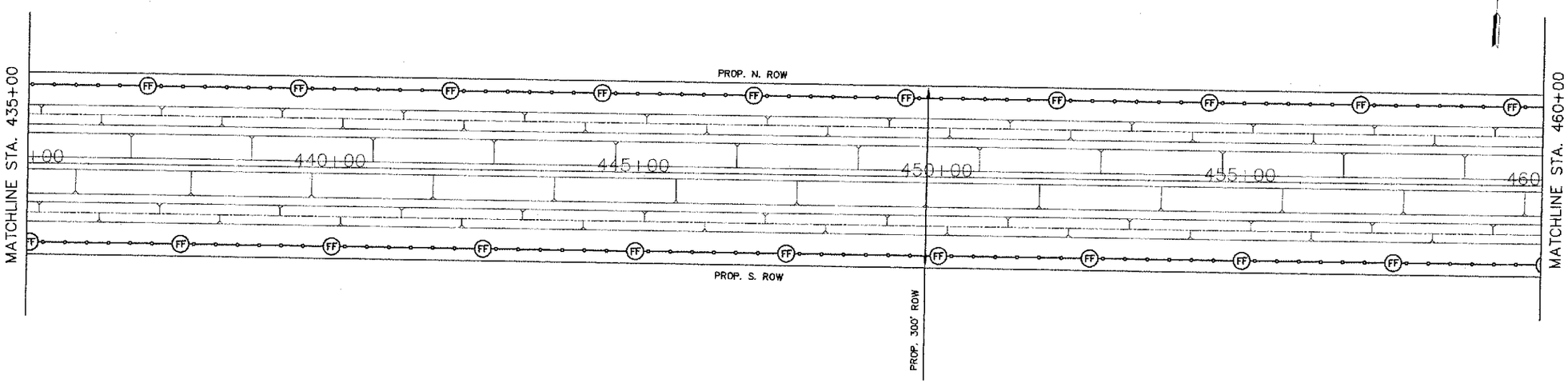

HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

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STORM WATER
POLLUTION PREVENTION
PLAN – CANAL
(SHEET 9 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 214 OF 245

LAST MODIFIED: Jan 27, 2011 – 5:21pm BY USER: ThompsonBl
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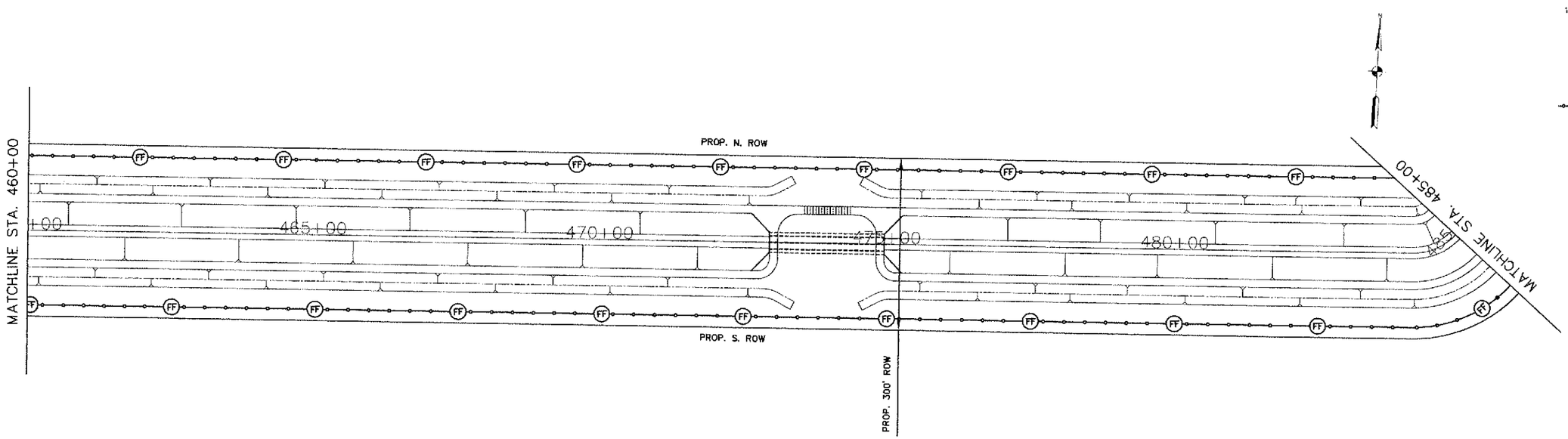

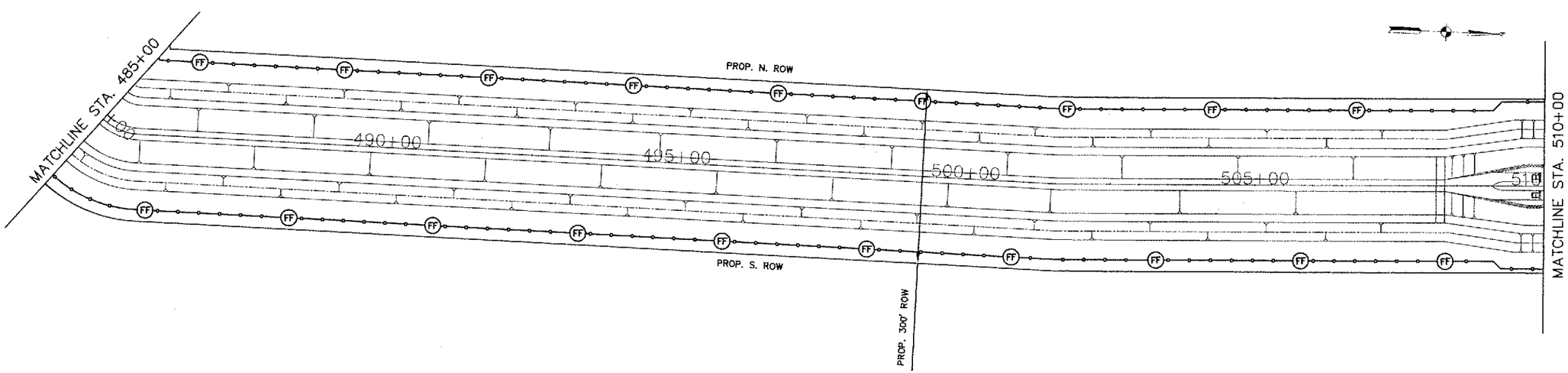

100 0 100 200
HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

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STORM WATER
POLLUTION PREVENTION
PLAN – CANAL
(SHEET 10 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 215 OF 245

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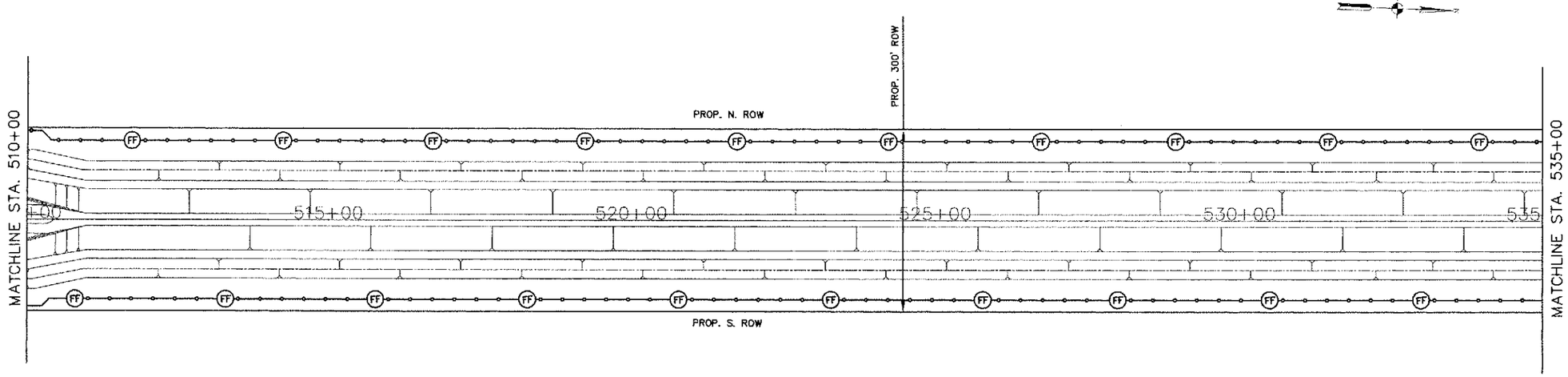

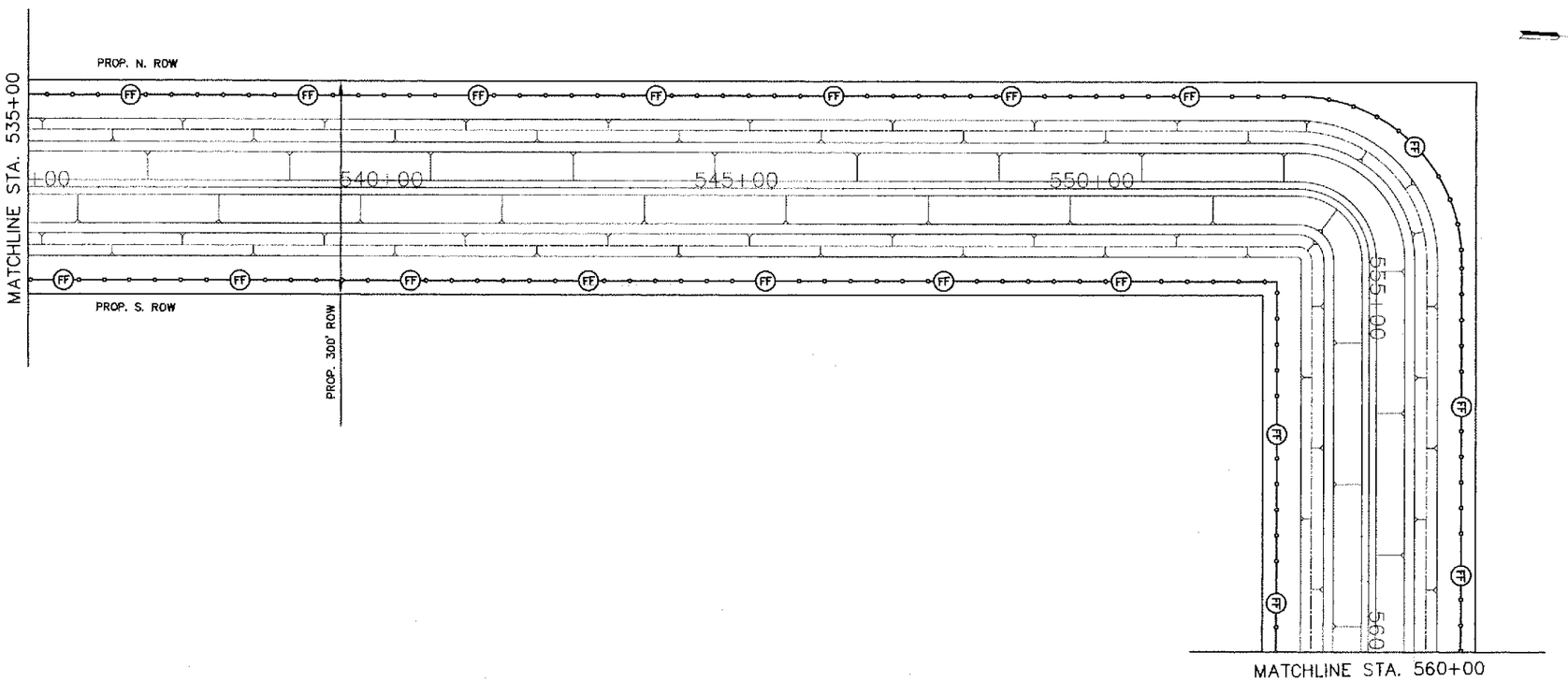

100 0 100 200
HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

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STORM WATER
POLLUTION PREVENTION
PLAN – CANAL
(SHEET 11 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 216 OF 245

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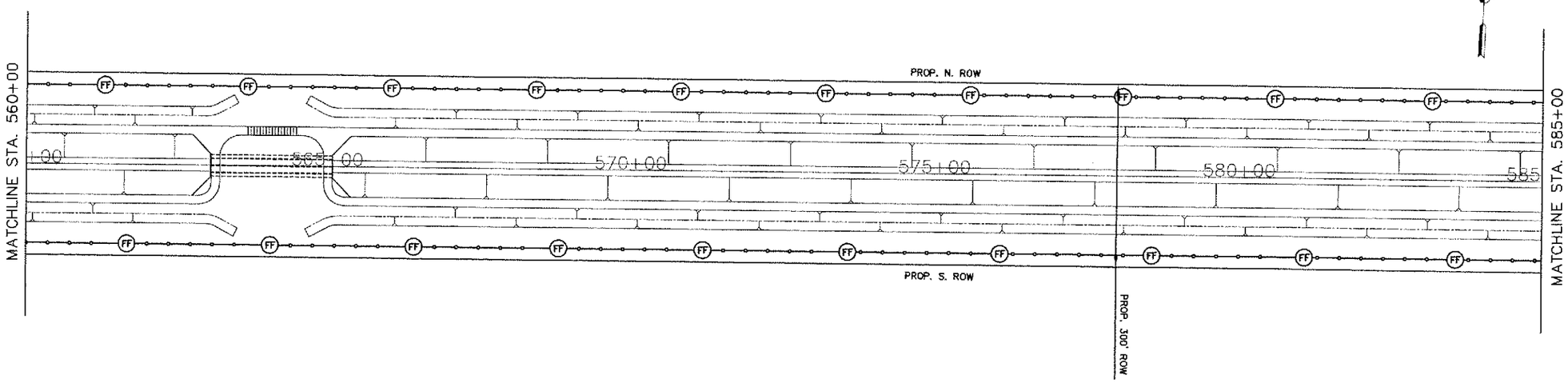

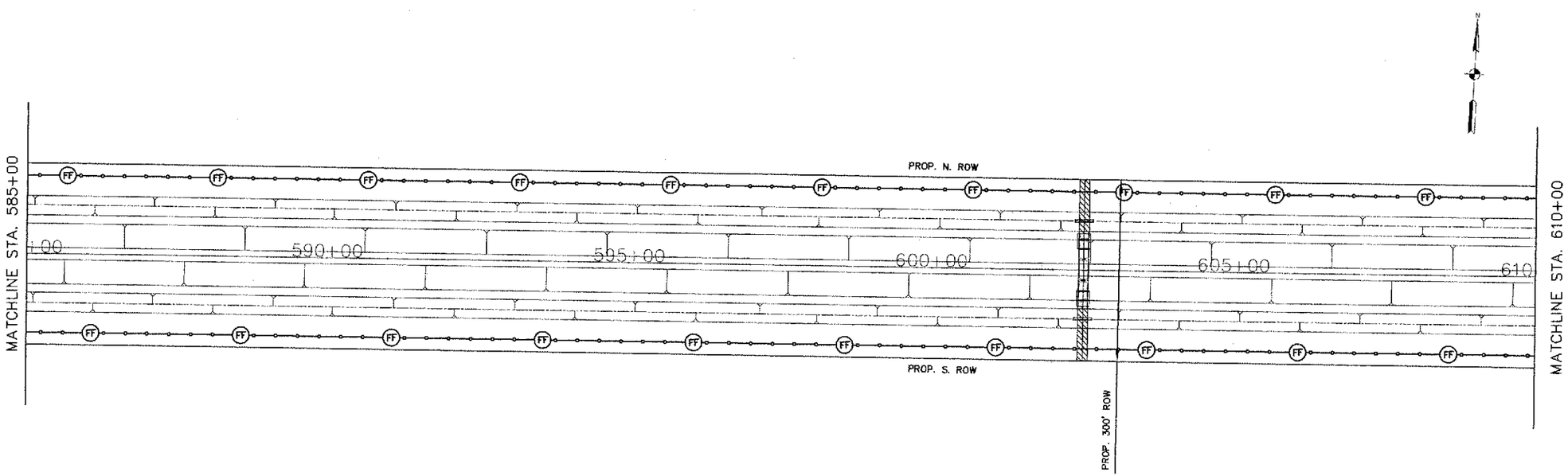

HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

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STORM WATER
POLLUTION PREVENTION
PLAN – CANAL
(SHEET 12 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 217 OF 245

LAST MODIFIED: Jan 27, 2011 – 5:21pm BY USER: ThompsonBI
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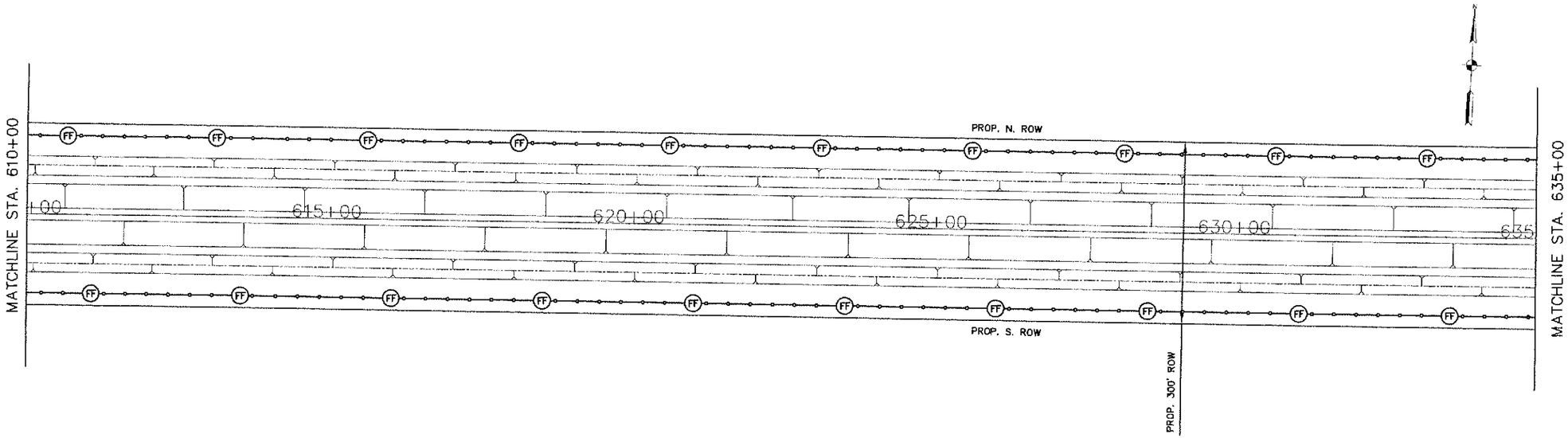

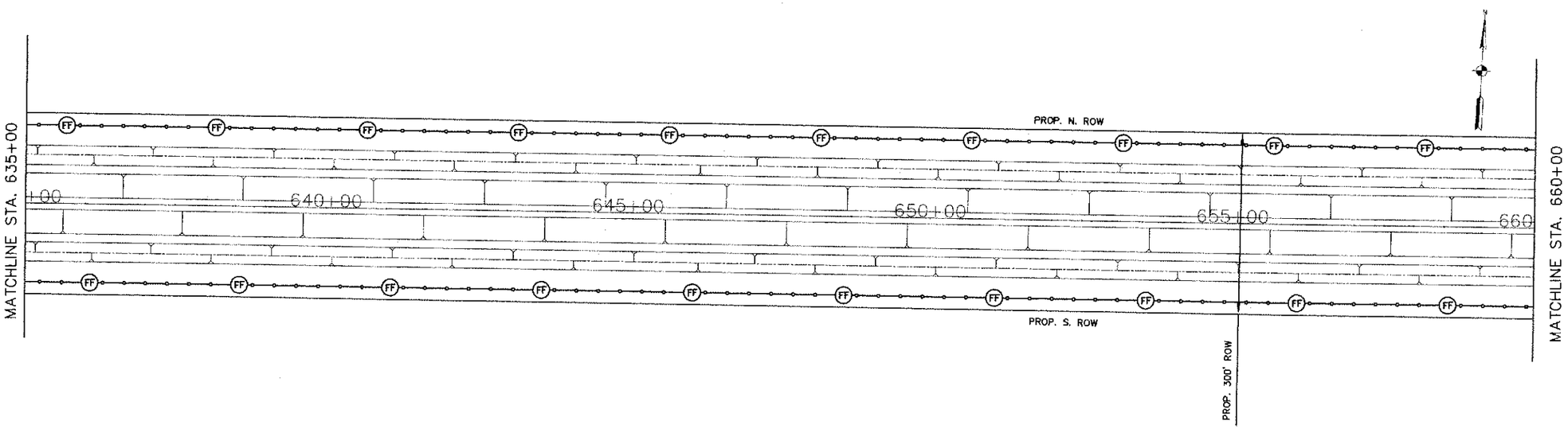

100 0 100 200
HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

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STORM WATER
POLLUTION PREVENTION
PLAN – CANAL
(SHEET 13 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 218 OF 245

LAST MODIFIED: Jan 27, 2011 – 5:22pm BY USER: ThompsonBl
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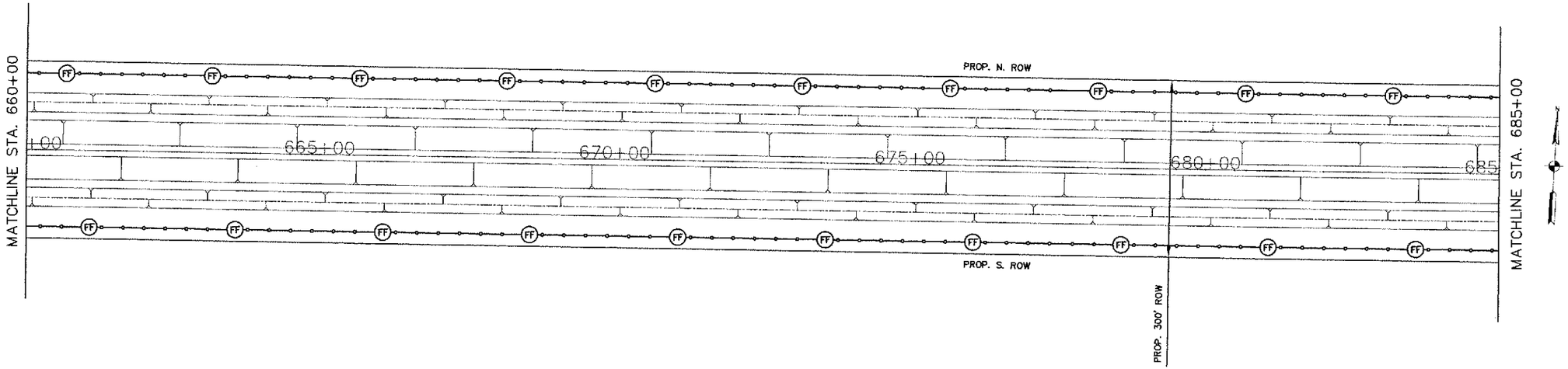

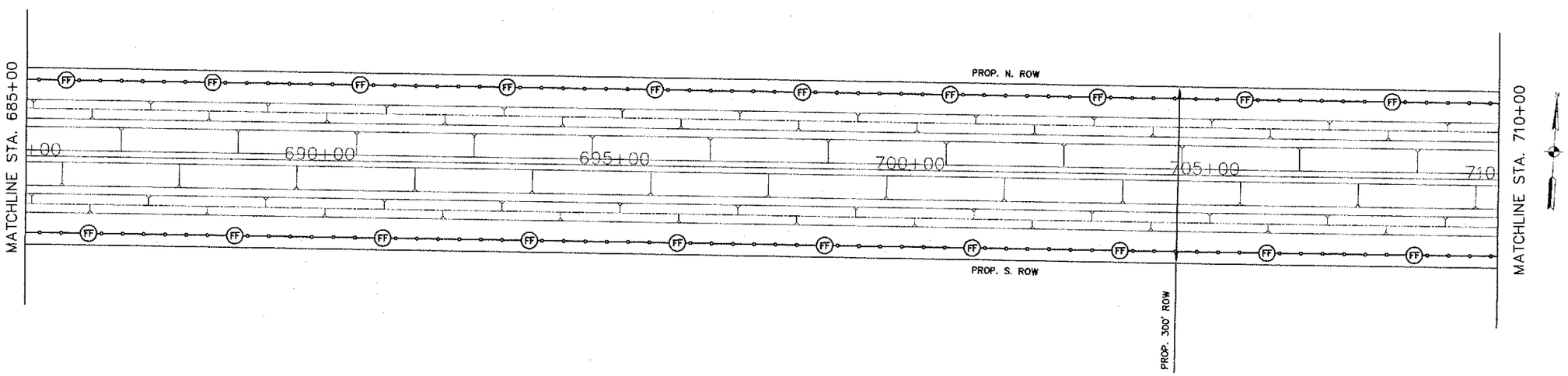

HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

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STORM WATER
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PLAN – CANAL
(SHEET 14 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 219 OF 246

LAST MODIFIED: Jan 27, 2011 – 5:22pm BY USER: ThompsonBl
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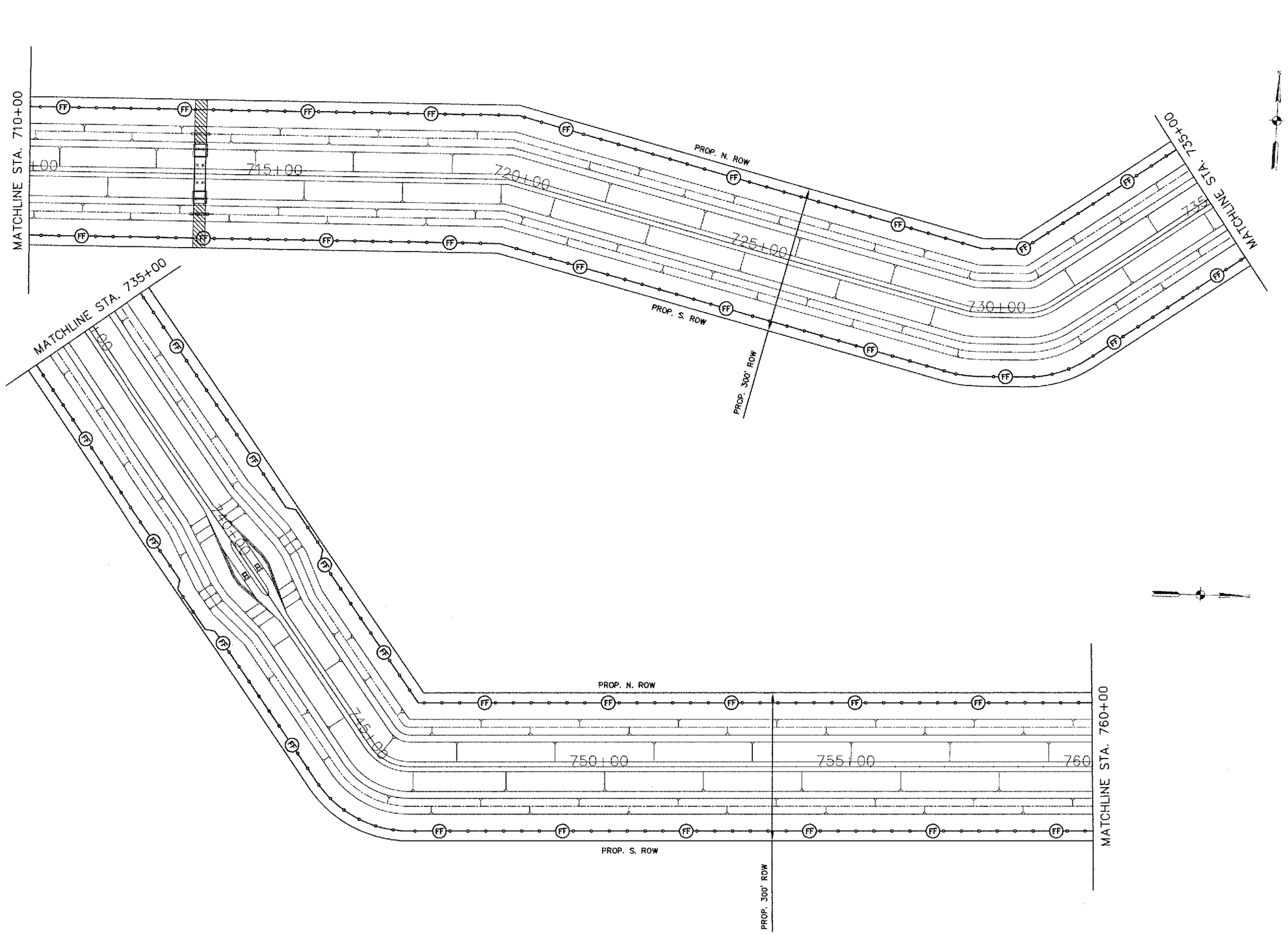

100 0 100 200
HORIZONTAL SCALE: 1" = 200'

LEGEND

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STORM WATER
POLLUTION PREVENTION
PLAN – CANAL
(SHEET 15 OF 25)

DRAWING SCALE
AS SHOWN

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LAST MODIFIED: Jan 27, 2011 – 5:23pm BY USER: ThompsonBl
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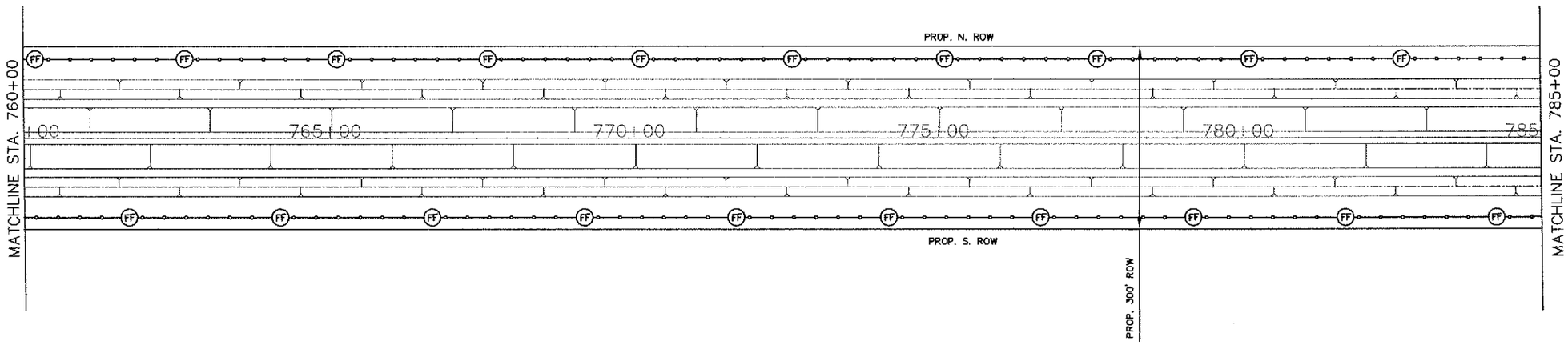

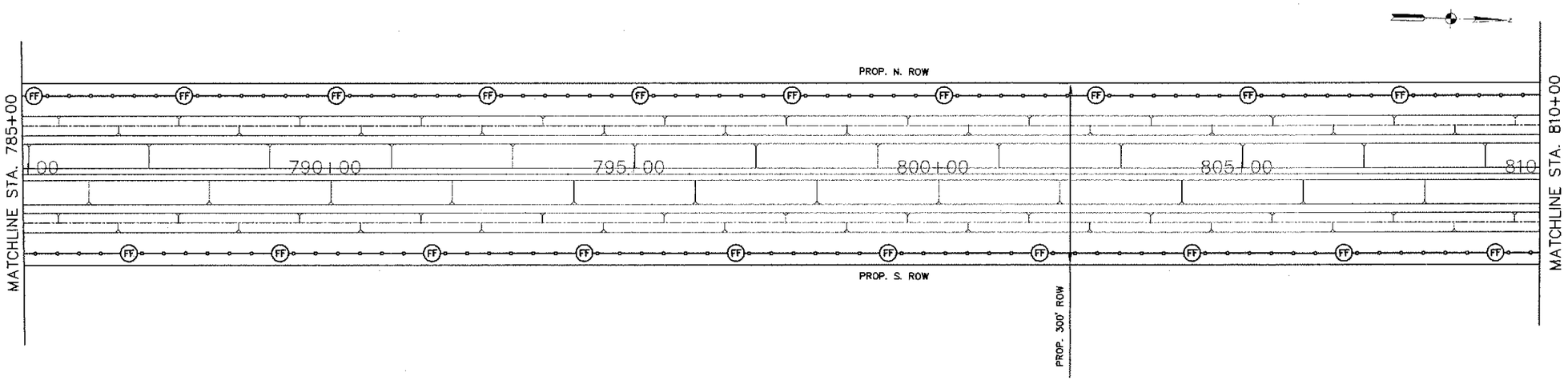

HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

KEVIN R. KRAHN, P.E.
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LUCE BAYOU INTERBASIN TRANSFER PROJECT

CANAL
STORM WATER POLLUTION
PREVENTION PLAN
(SHEET 16 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 221 OF 245

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DWG. LOCATION: O:\Work Order 61\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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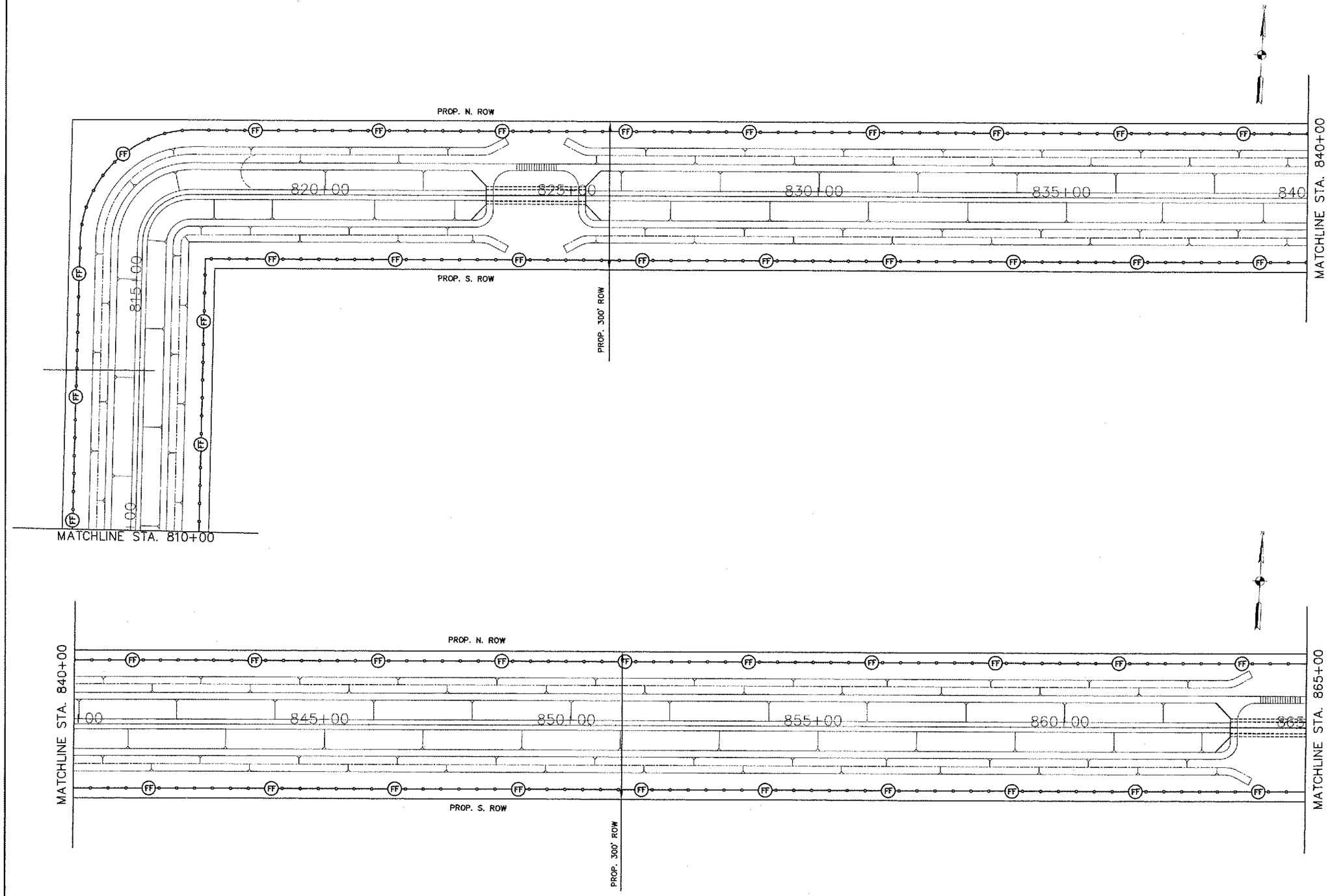

HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

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CANAL
STORM WATER POLLUTION
PREVENTION PLAN
(SHEET 17 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 222 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:24pm BY USER: ThompsonBI
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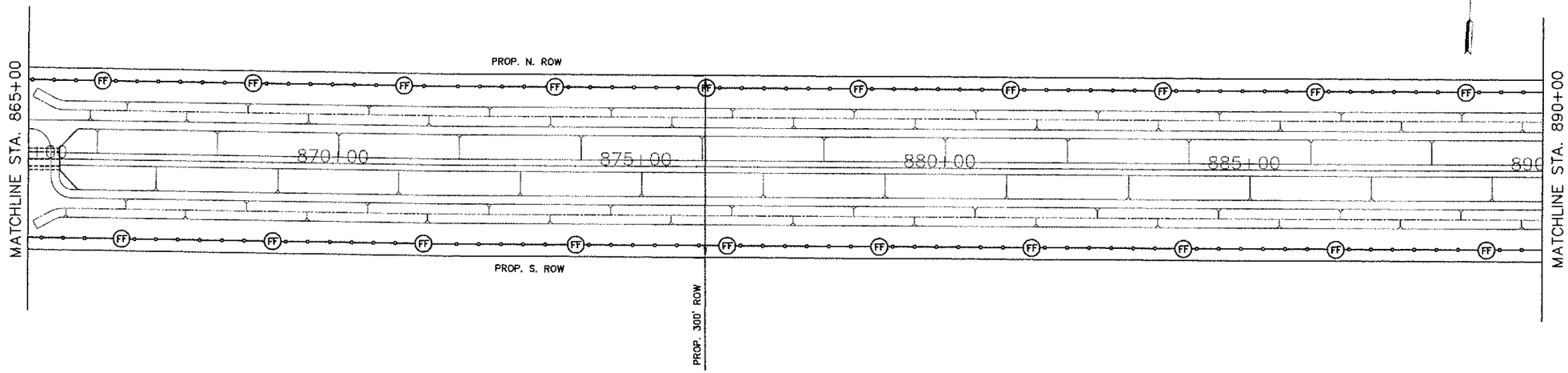

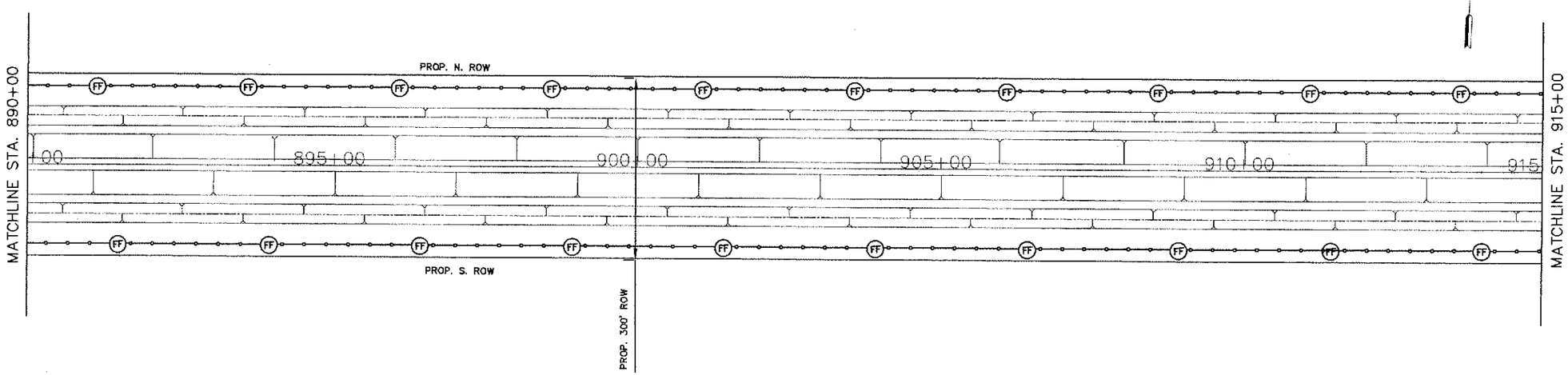

100 0 100 200
HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

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CANAL
STORM WATER POLLUTION
PREVENTION PLAN
(SHEET 18 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 223 OF 295

LAST MODIFIED: Jan 27, 2011 - 5:24pm BY USER: ThompsonBl
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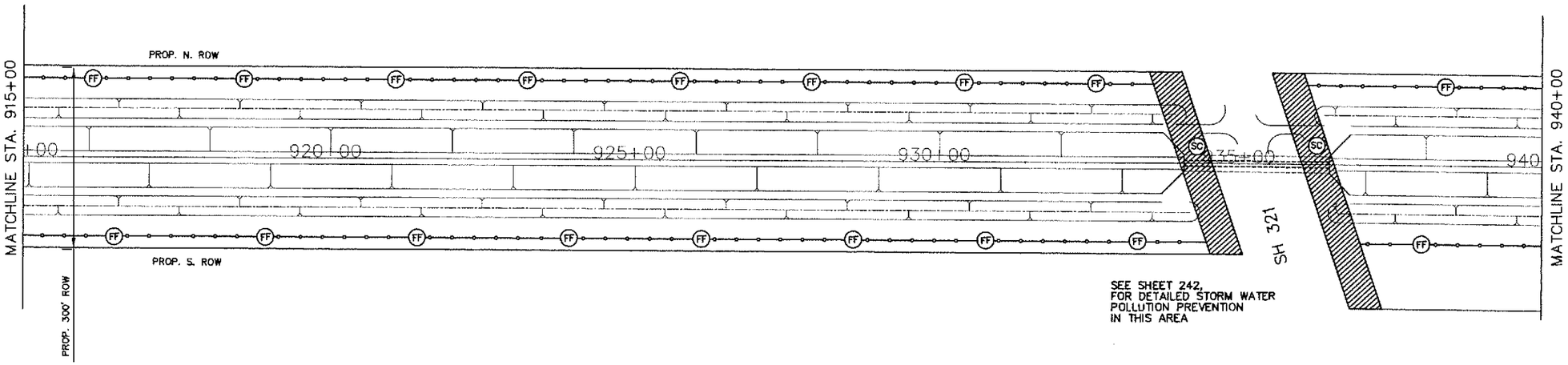

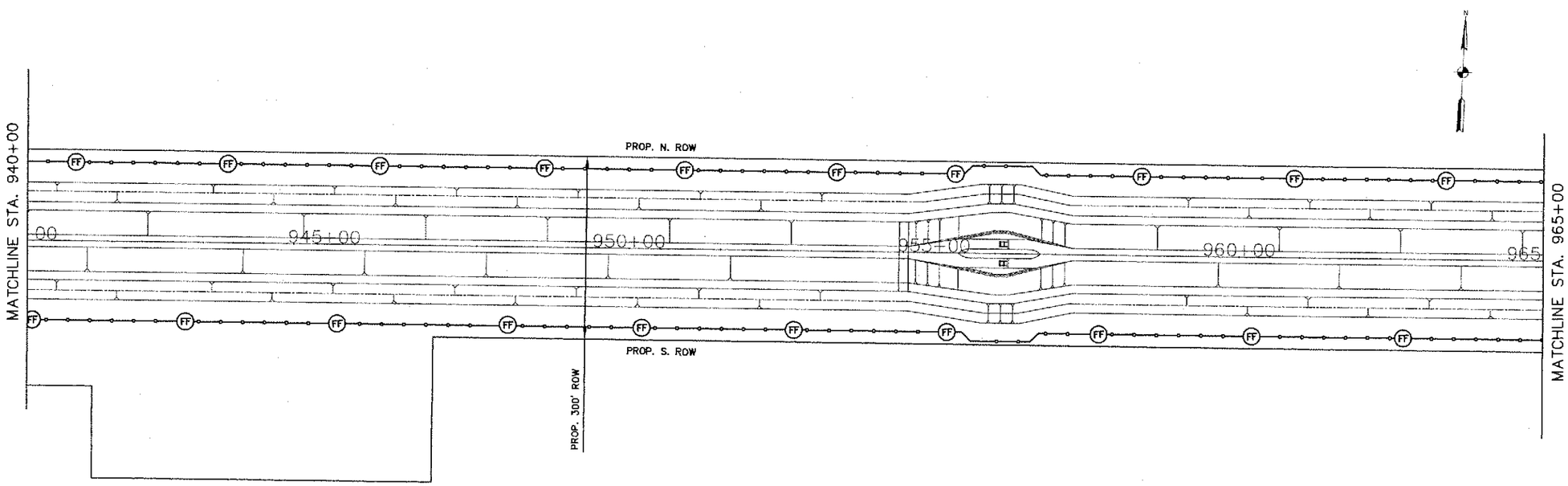

HORIZONTAL SCALE: 1" = 200'

LEGEND

- FF — FILTER FABRIC FENCE
- SC — STABILIZED CONTRUCTION ACCESS
- STABILIZED CONTRUCTION ZONE

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CANAL
STORM WATER POLLUTION
PREVENTION PLAN
(SHEET 19 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 224 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:24pm BY USER: Thompson3l
DWG. LOCATION: D:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Codd\PWD\Sheets\
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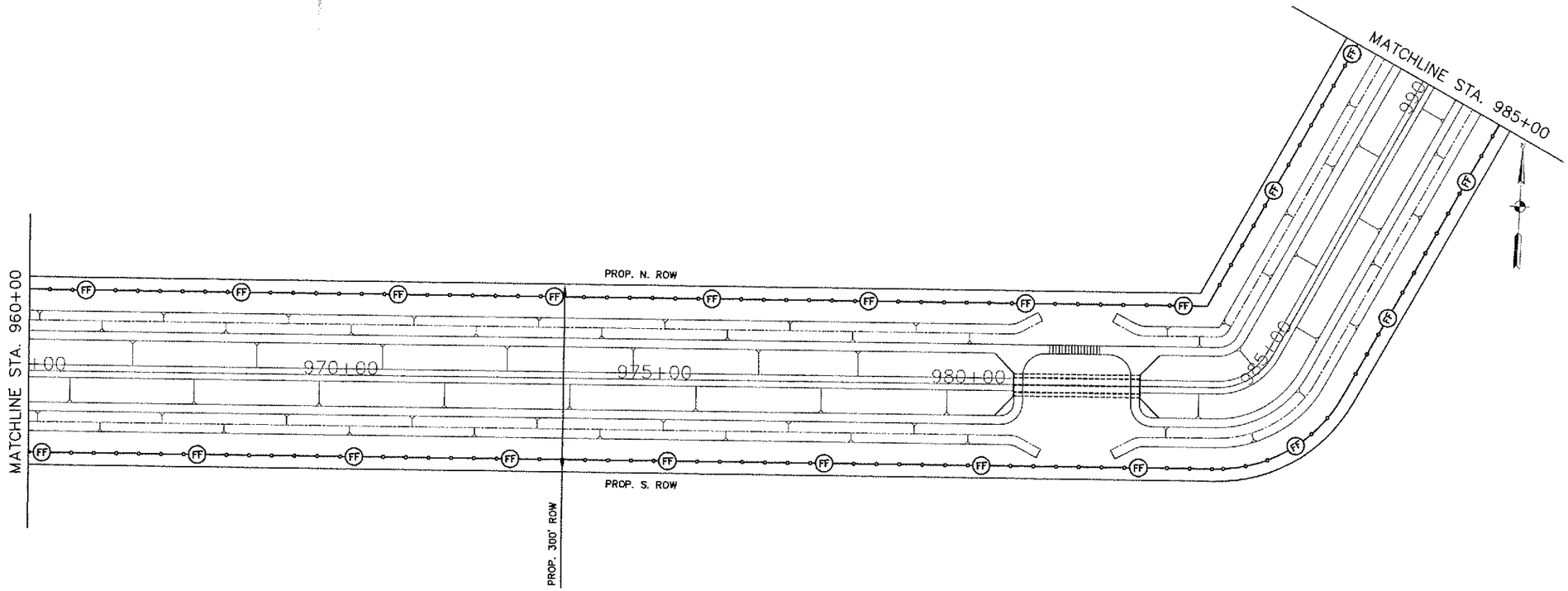

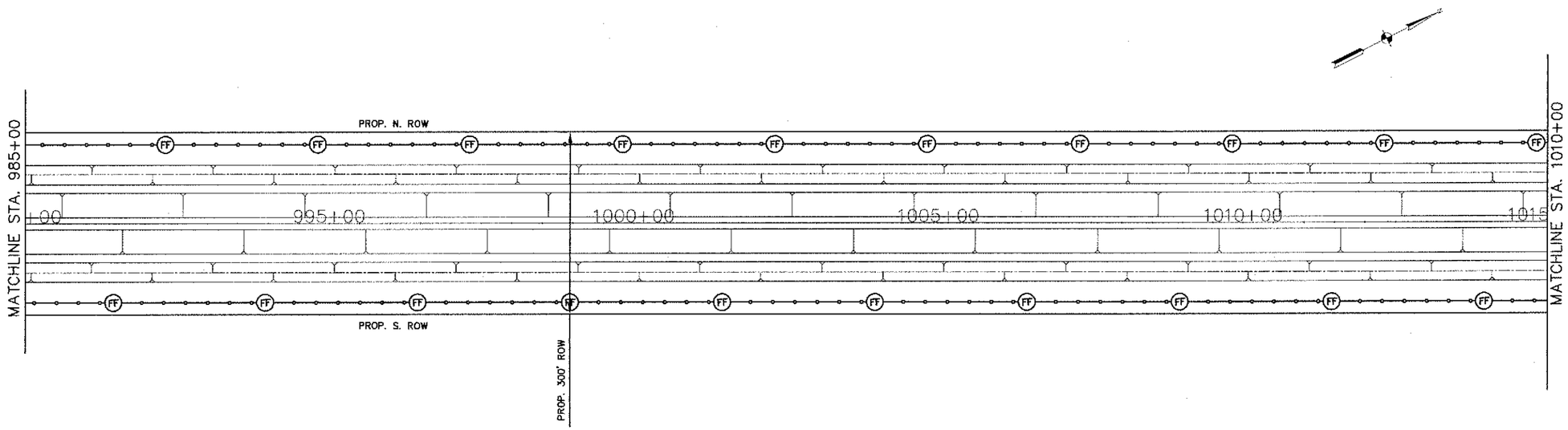

100 0 100 200
HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

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CANAL
STORM WATER POLLUTION
PREVENTION PLAN
(SHEET 20 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 225 OF 295

LAST MODIFIED: Jan 27, 2011 - 5:24pm BY USER: Thompsonbl
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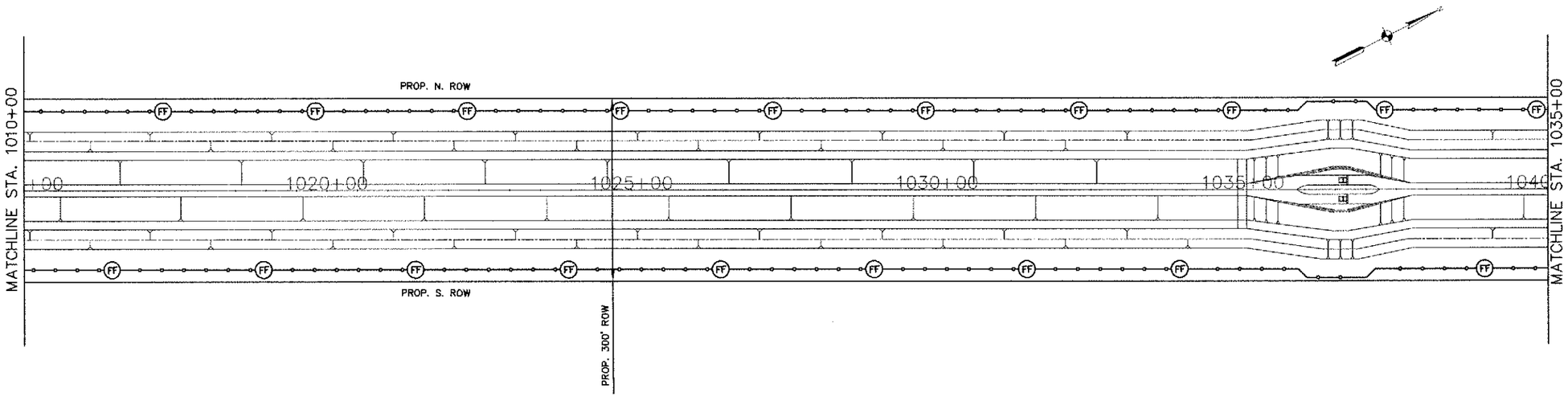

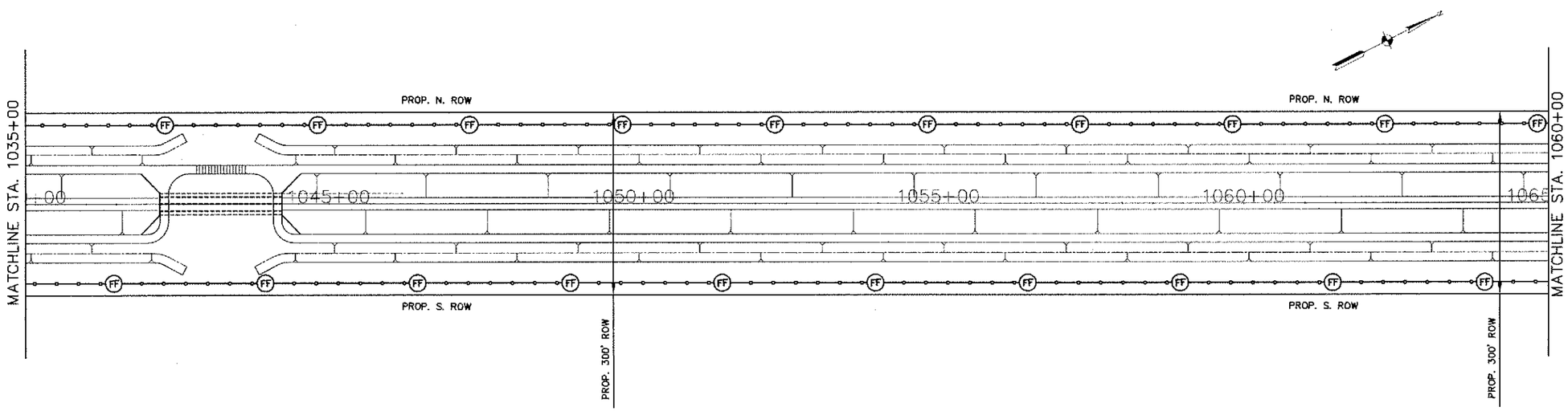

HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

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CANAL
STORM WATER POLLUTION
PREVENTION PLAN
(SHEET 21 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 226 OF 245

LAST MODIFIED: Jan 27, 2011 – 5:25pm BY USER: ThompsonBi
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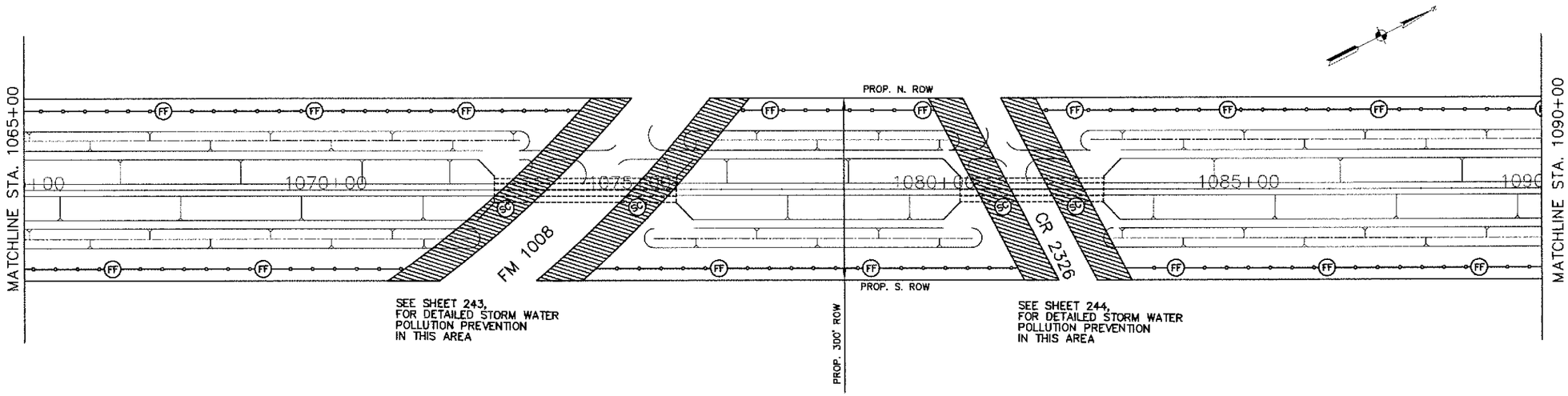

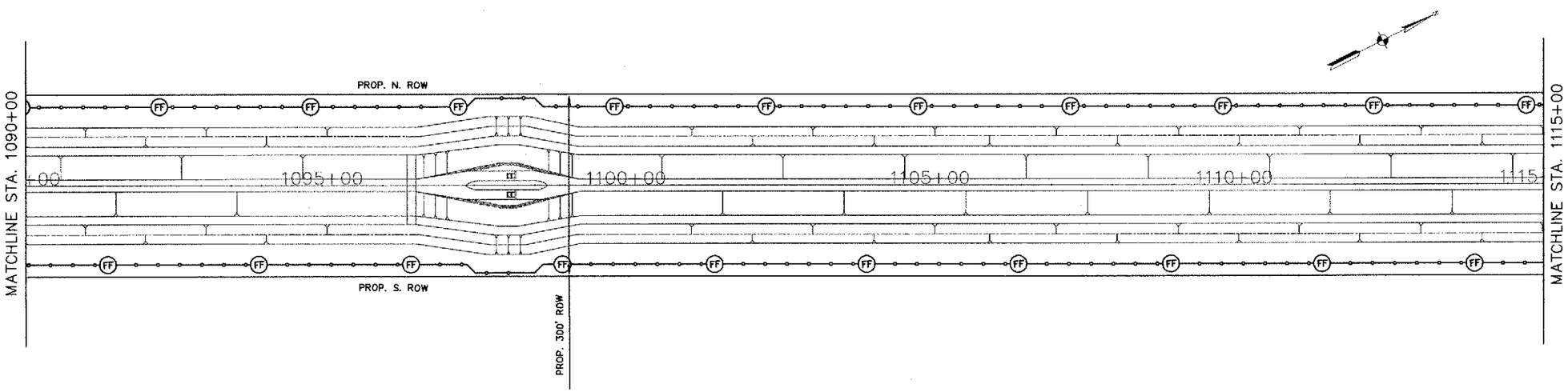

HORIZONTAL SCALE: 1" = 200'

LEGEND

- FF — FILTER FABRIC FENCE
- SC — STABILIZED CONTRUCTION ACCESS
- STABILIZED CONTRUCTION ZONE

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CANAL
STORM WATER POLLUTION
PREVENTION PLAN
(SHEET 22 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 227 OF 245

LAST MODIFIED: Jan 27, 2011 – 5:25pm BY USER: ThompsonBl
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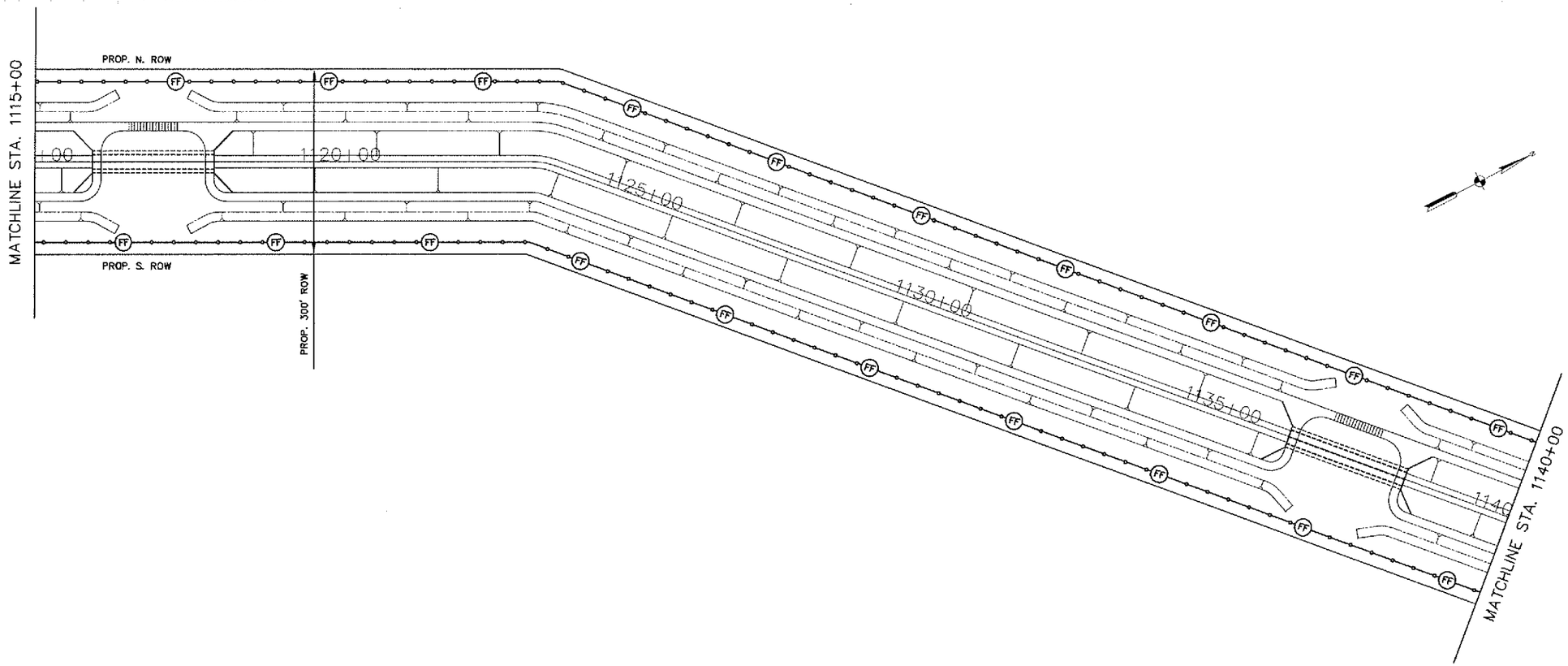

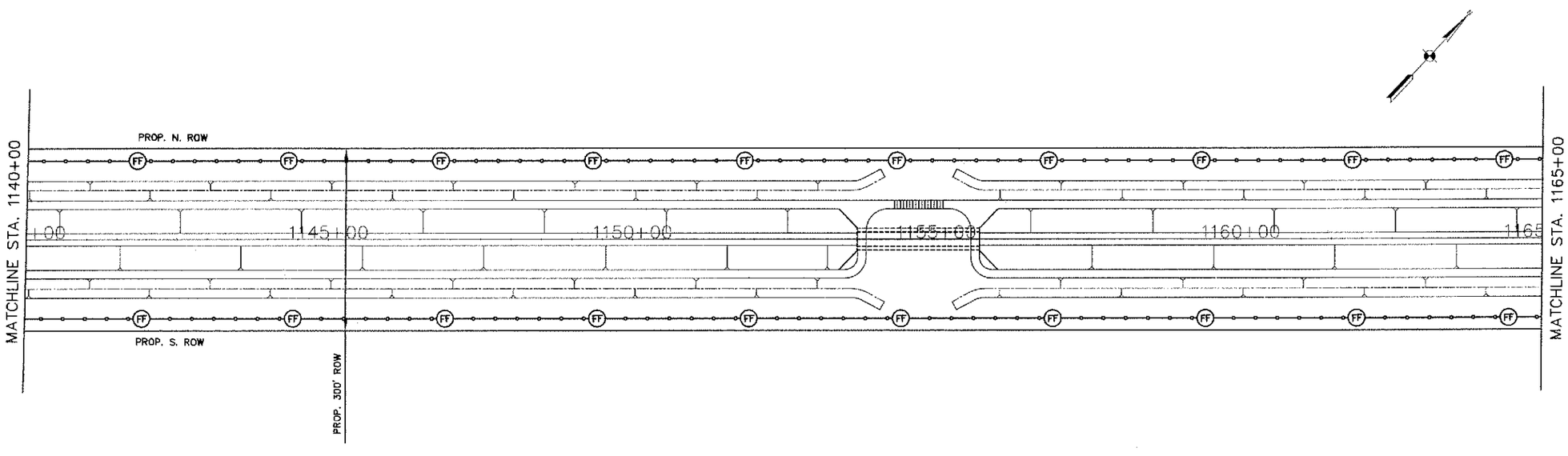

HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

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CANAL
STORM WATER POLLUTION
PREVENTION PLAN
(SHEET 23 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 23 OF 24

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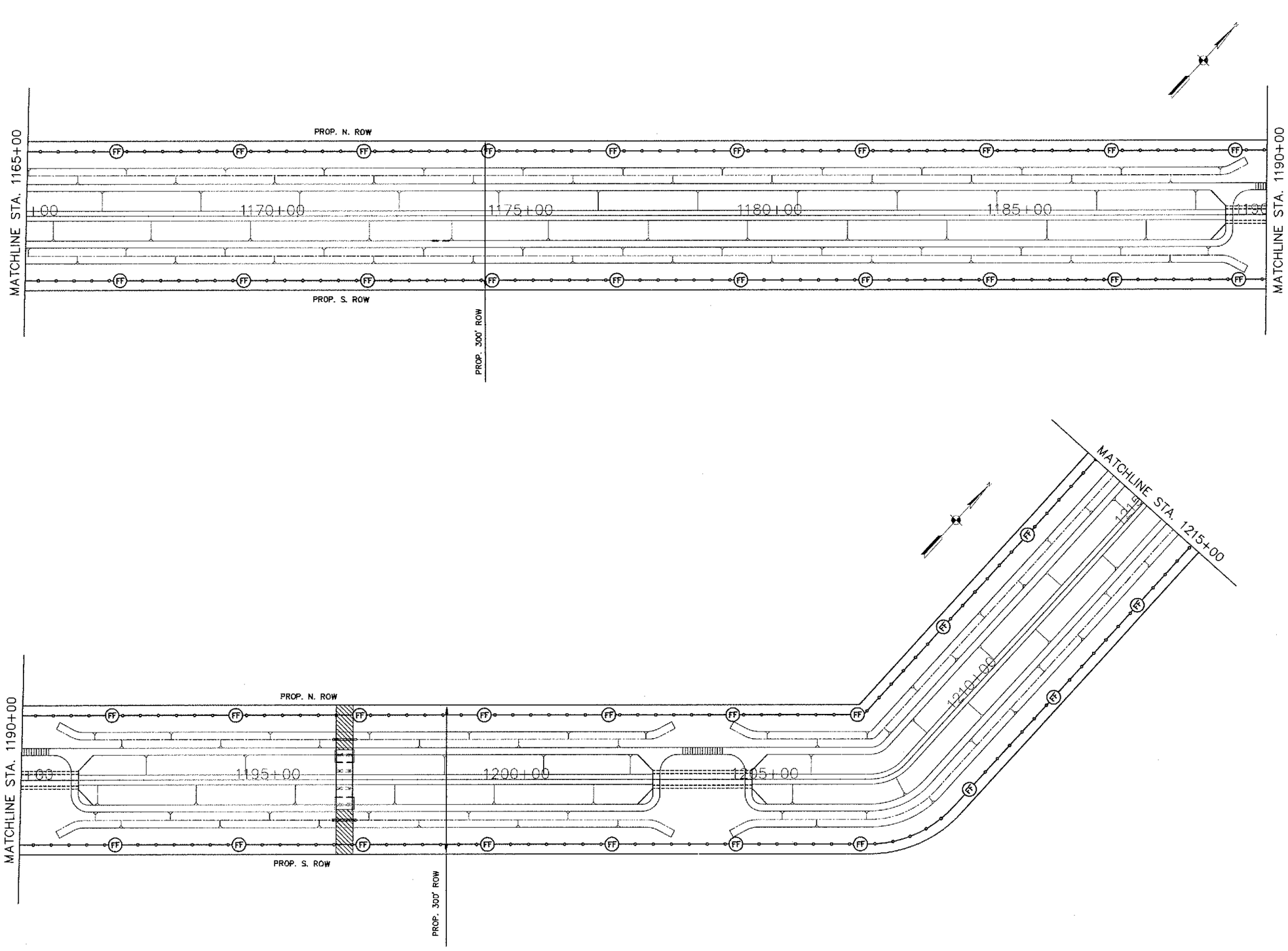

100 0 100 200
HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

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CANAL
STORM WATER POLLUTION
PREVENTION PLAN
(SHEET 24 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 229 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:25pm BY USER: ThompsonBI
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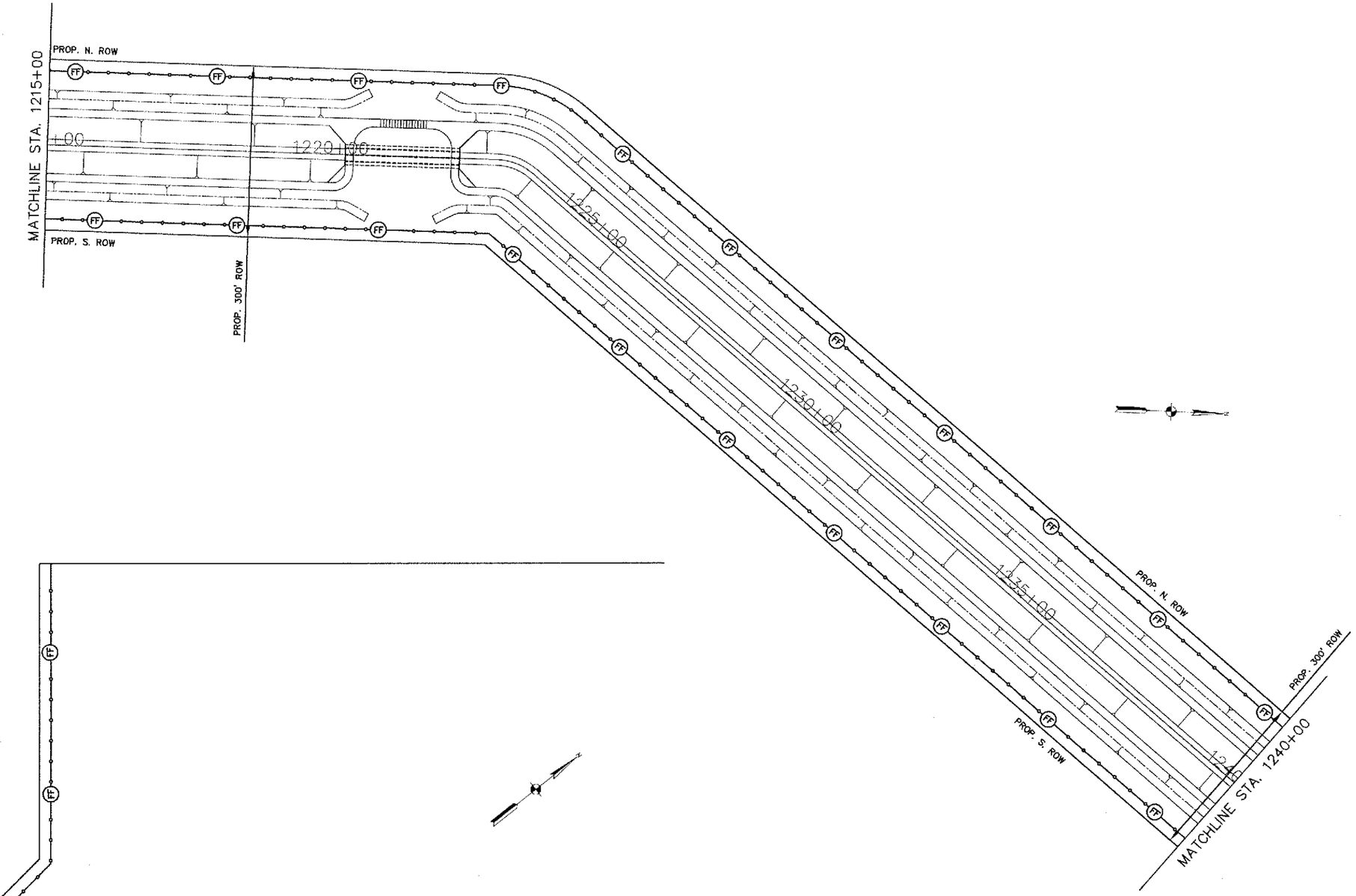

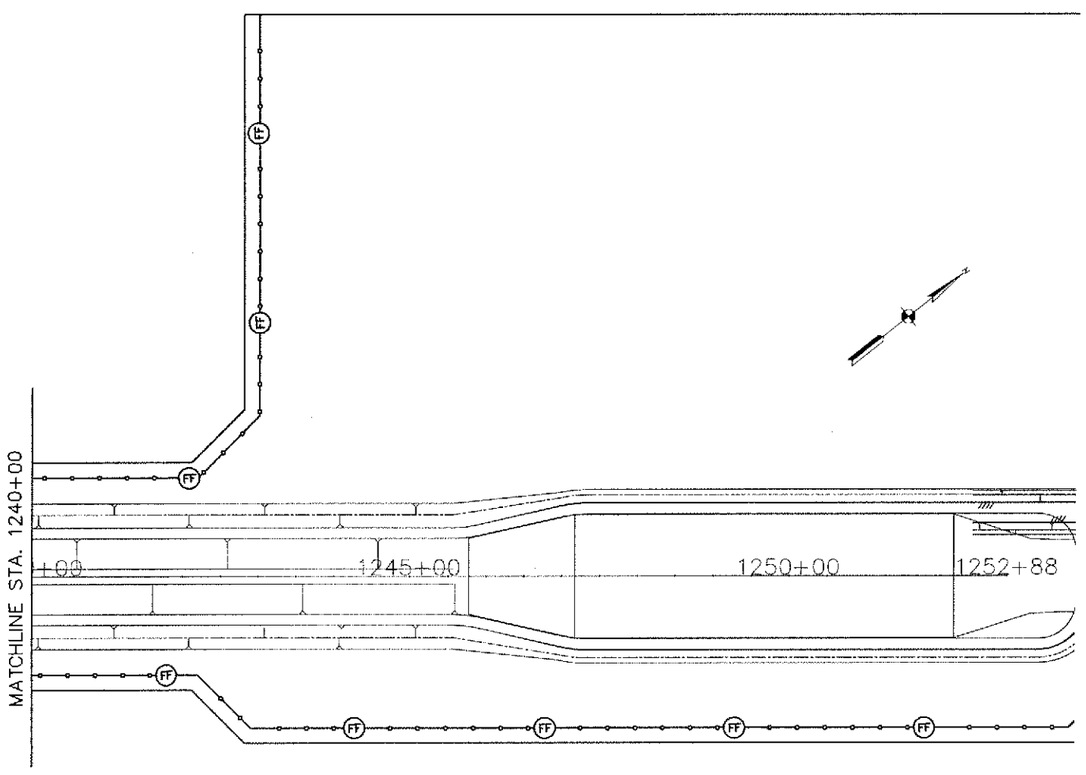

HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

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CANAL
STORM WATER POLLUTION
PREVENTION PLAN
(SHEET 25 OF 25)

DRAWING SCALE
AS SHOWN

SHEET NO. 230 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:26pm BY USER: ThompsonBl
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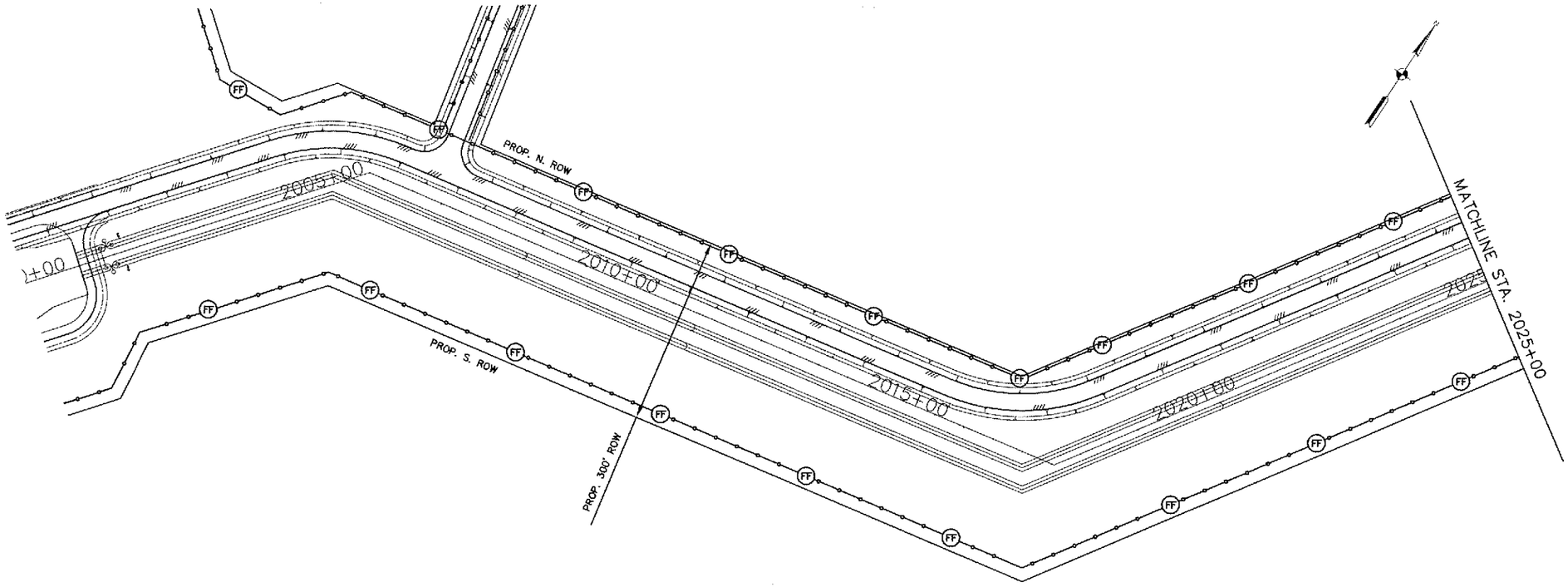

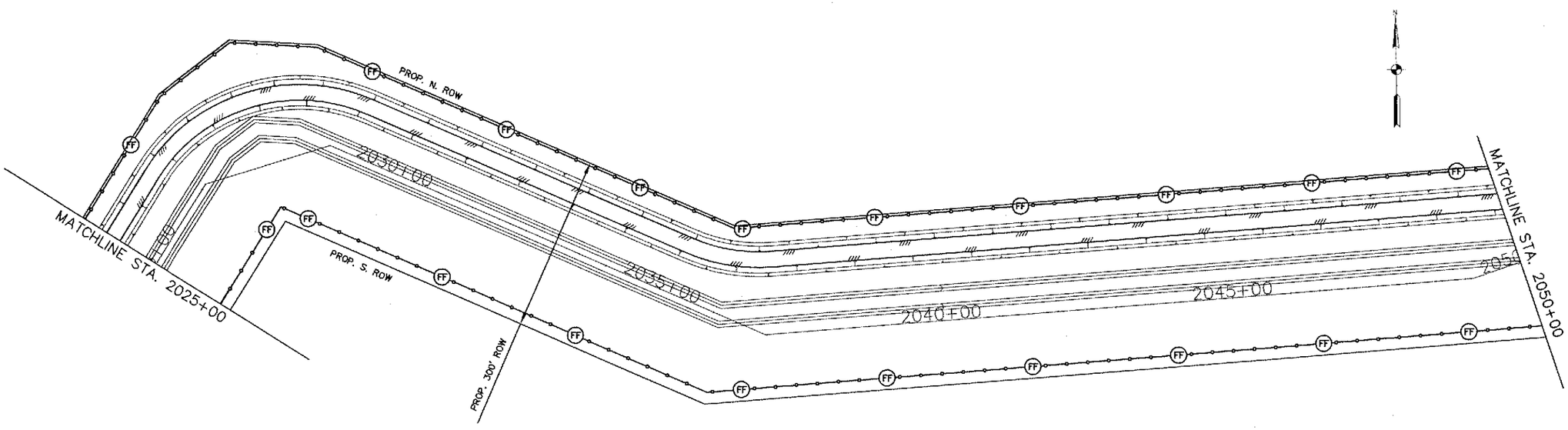

100 0 100 200
HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

PIPELINE
STORM WATER POLLUTION
PREVENTION PLAN
(SHEET 1 OF 4)

DRAWING SCALE
AS SHOWN

SHEET NO. 231 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:26pm BY USER: ThompsonBl
DWG. LOCATION: D:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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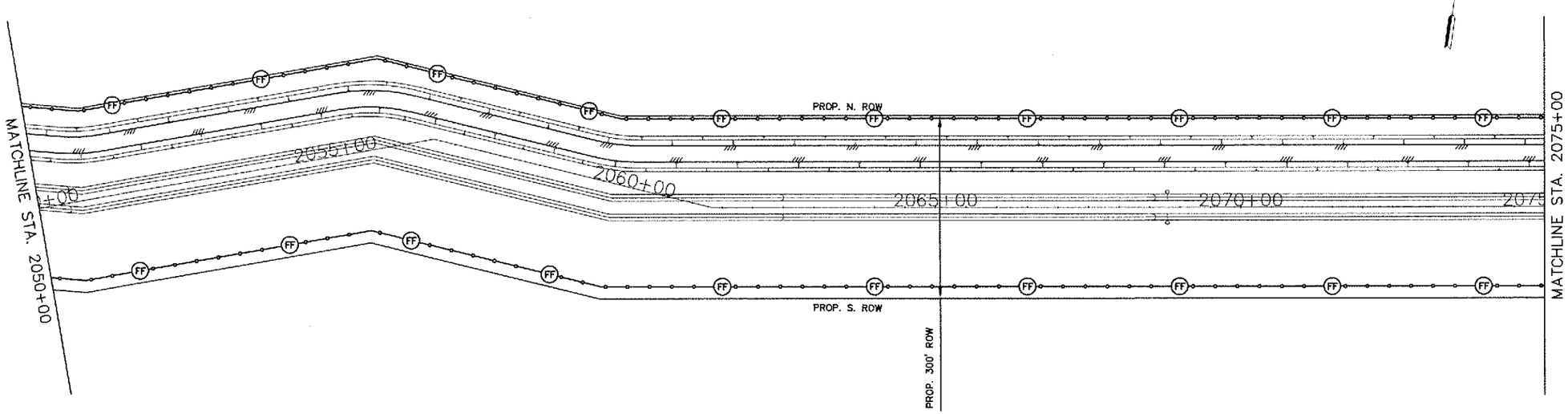

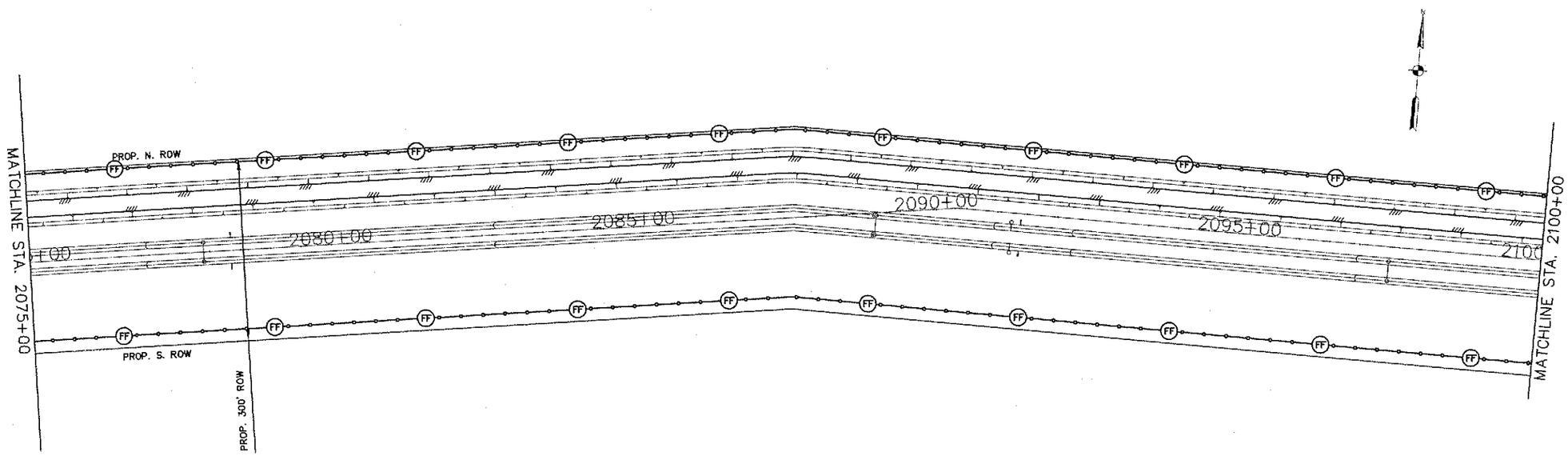

100 0 100 200
HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

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LUCE BAYOU INTERBASIN TRANSFER PROJECT

PIPELINE
STORM WATER POLLUTION
PREVENTION PLAN
(SHEET 2 OF 4)

DRAWING SCALE
AS SHOWN

SHEET NO. 232 OF 245

LAST MODIFIED: Jan 27, 2011 – 5:26pm BY USER: ThompsonBi
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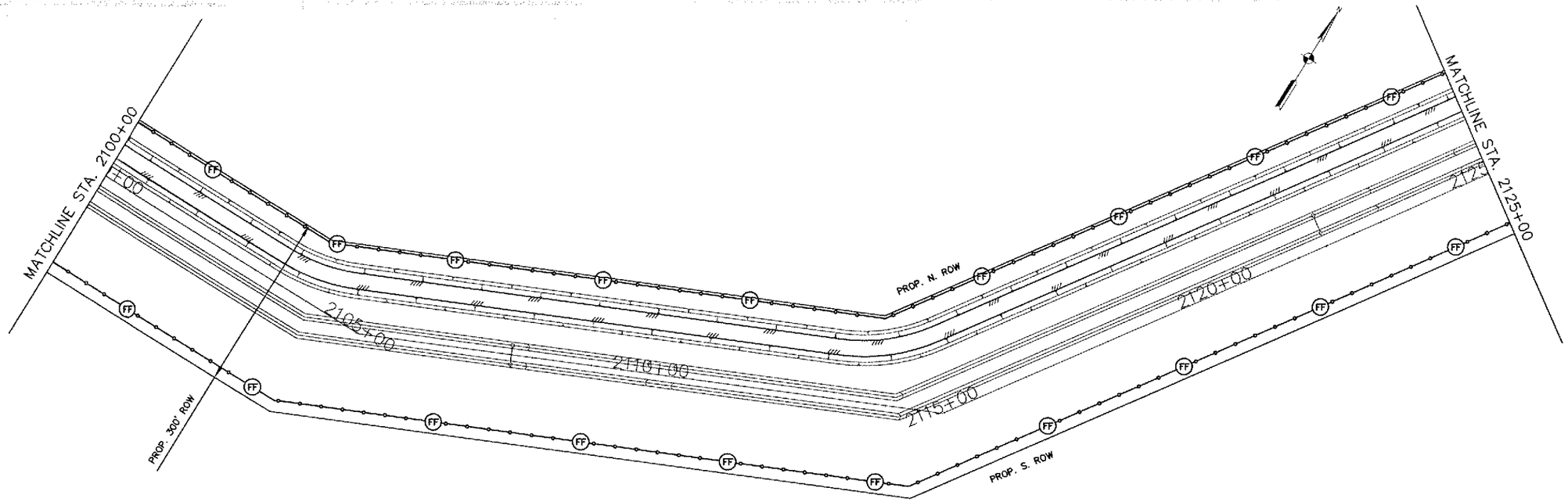

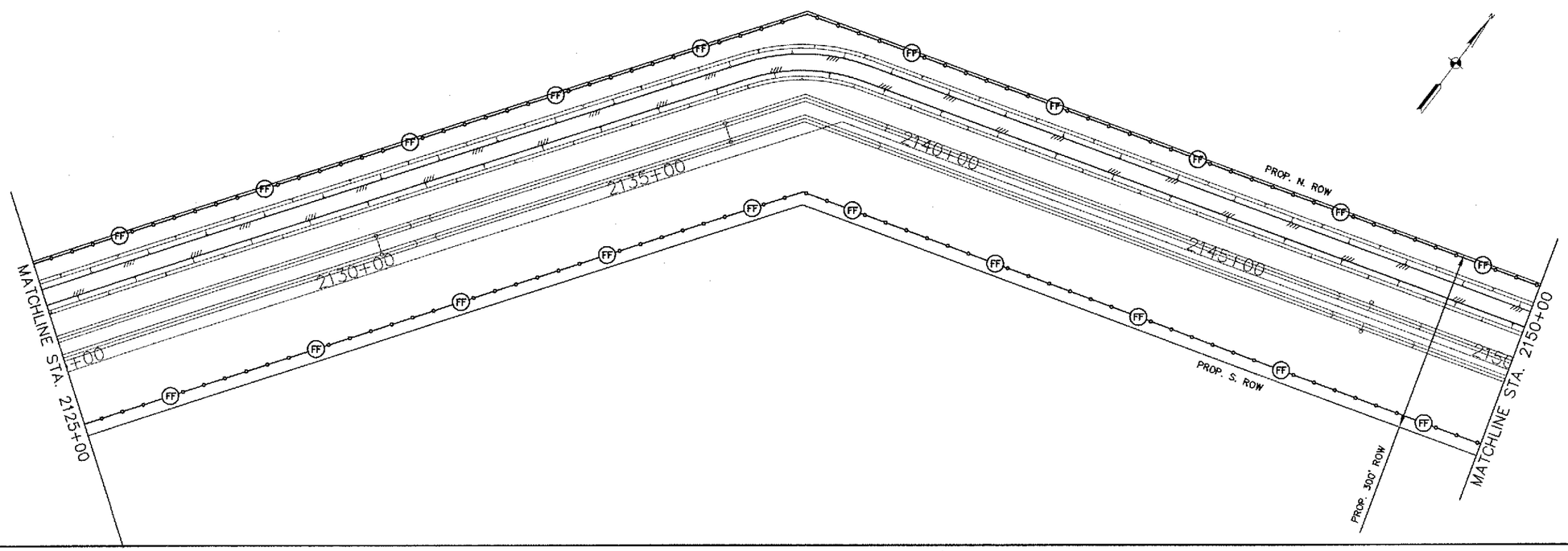

HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

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PIPELINE
STORM WATER POLLUTION
PREVENTION PLAN
(SHEET 3 OF 4)

DRAWING SCALE
AS SHOWN

SHEET NO. 233 OF 215

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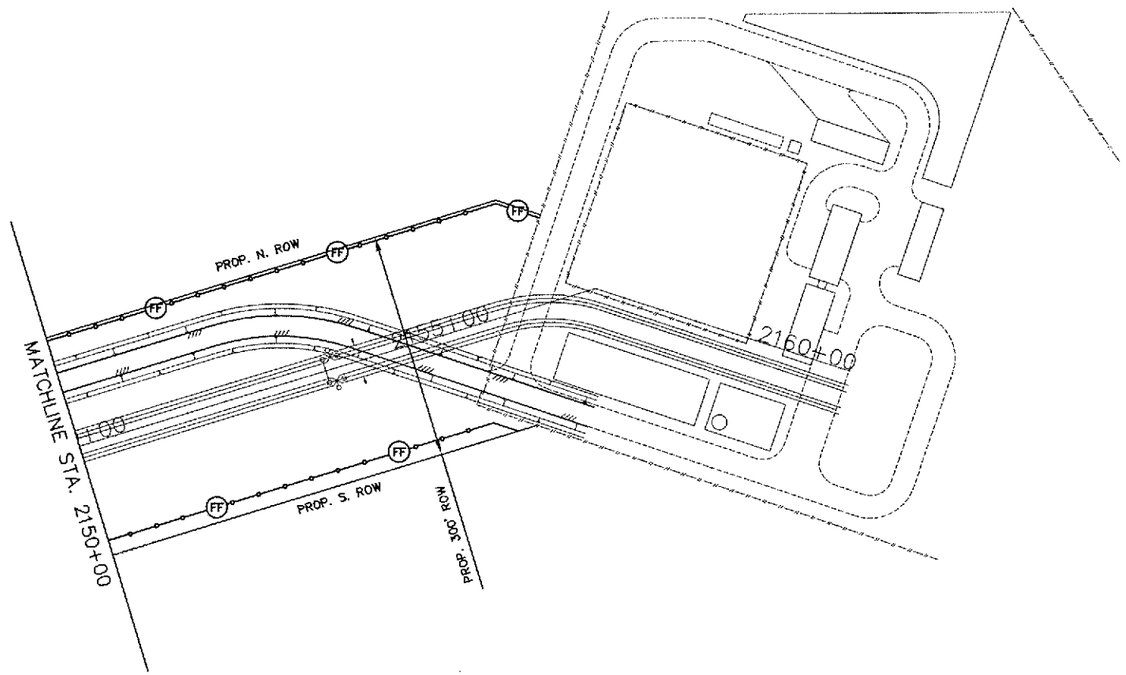

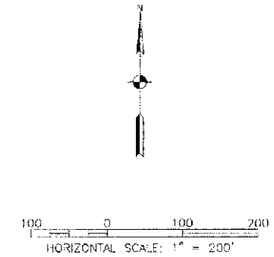

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

AECOM TECHNICAL SERVICES, INC.
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713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

PIPELINE
STORM WATER POLLUTION
PREVENTION PLAN
(SHEET 4 OF 4)

DRAWING SCALE
AS SHOWN

SHEET NO. 234 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:25pm BY USER: ThompsonBl
DWG. LOCATION: Q:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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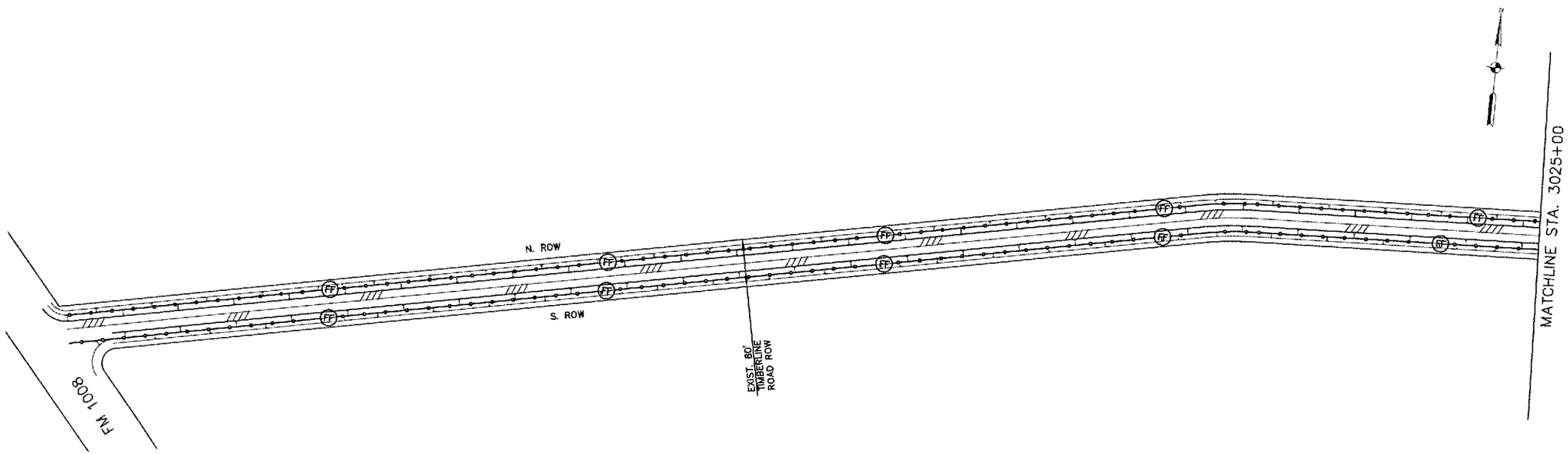

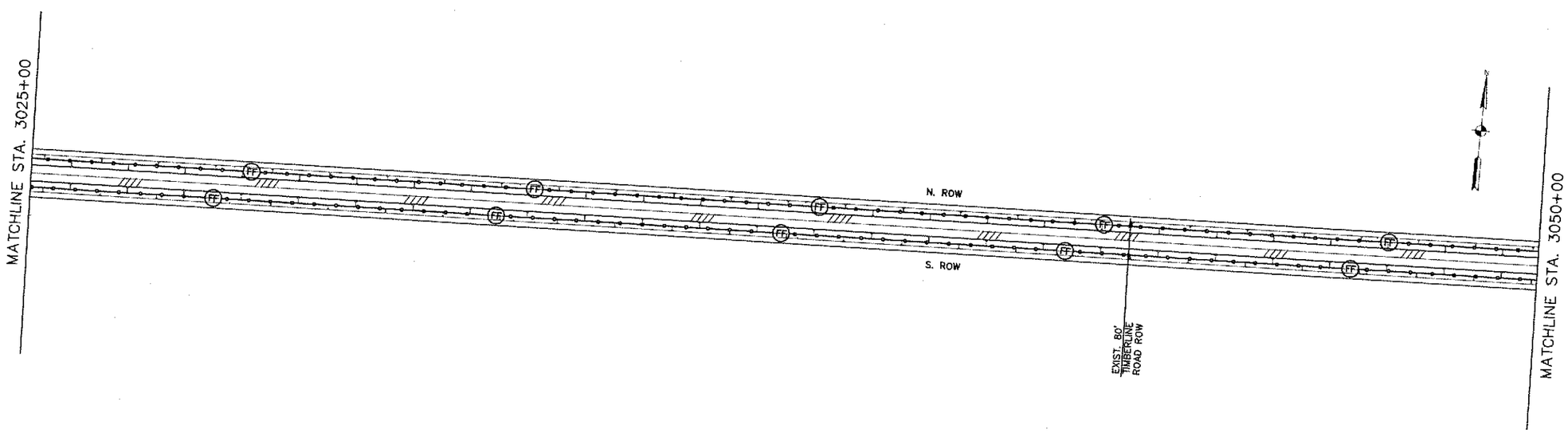

100 0 100 200
HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

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SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD
STORM WATER POLLUTION
PREVENTION PLAN
(SHEET 1 OF 4)

DRAWING SCALE
AS SHOWN

SHEET NO. 235 OF 245

LAST MODIFIED: Jan 27, 2011 -- 5:27pm BY USER: ThompsonBI
DWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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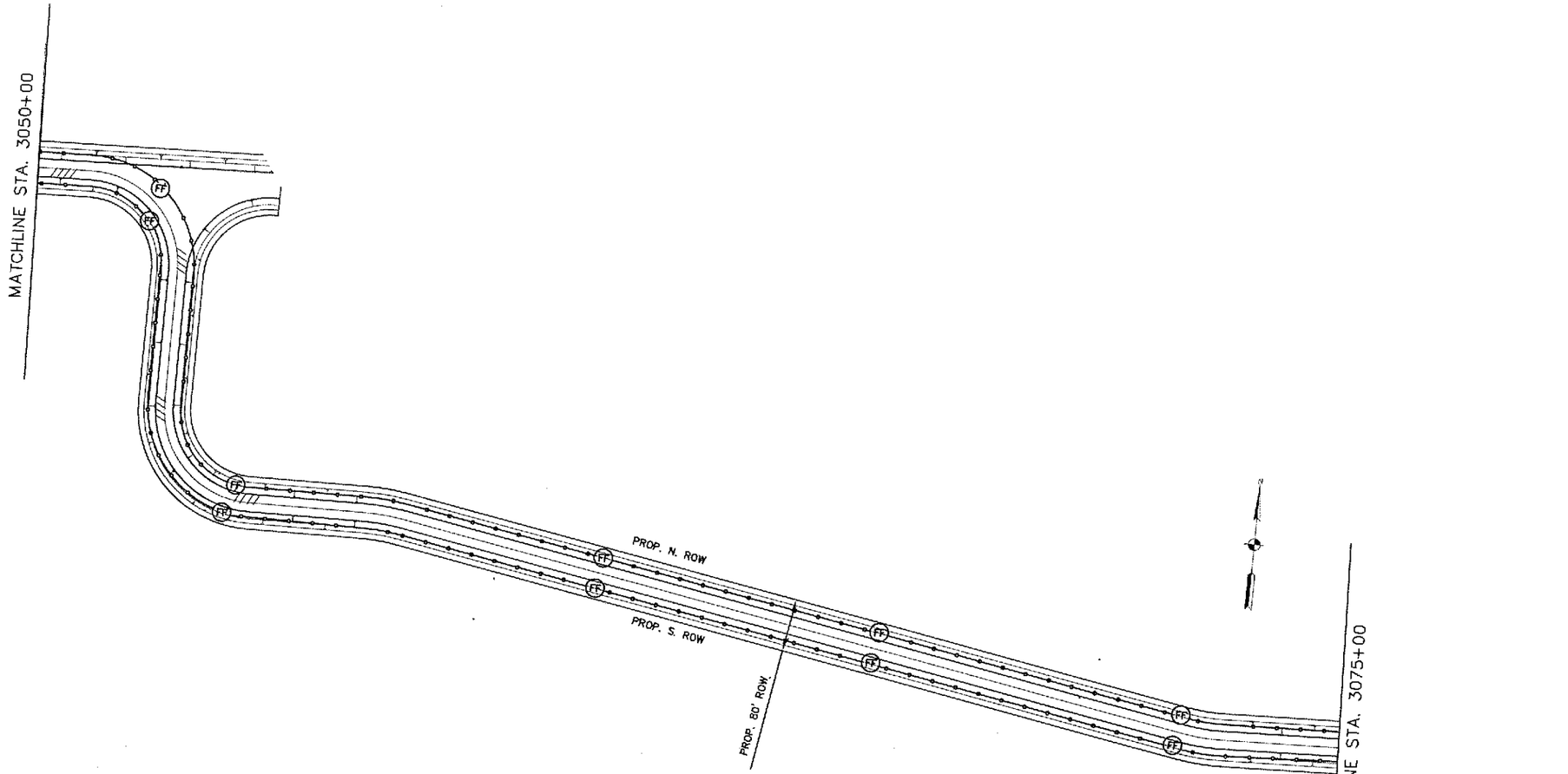

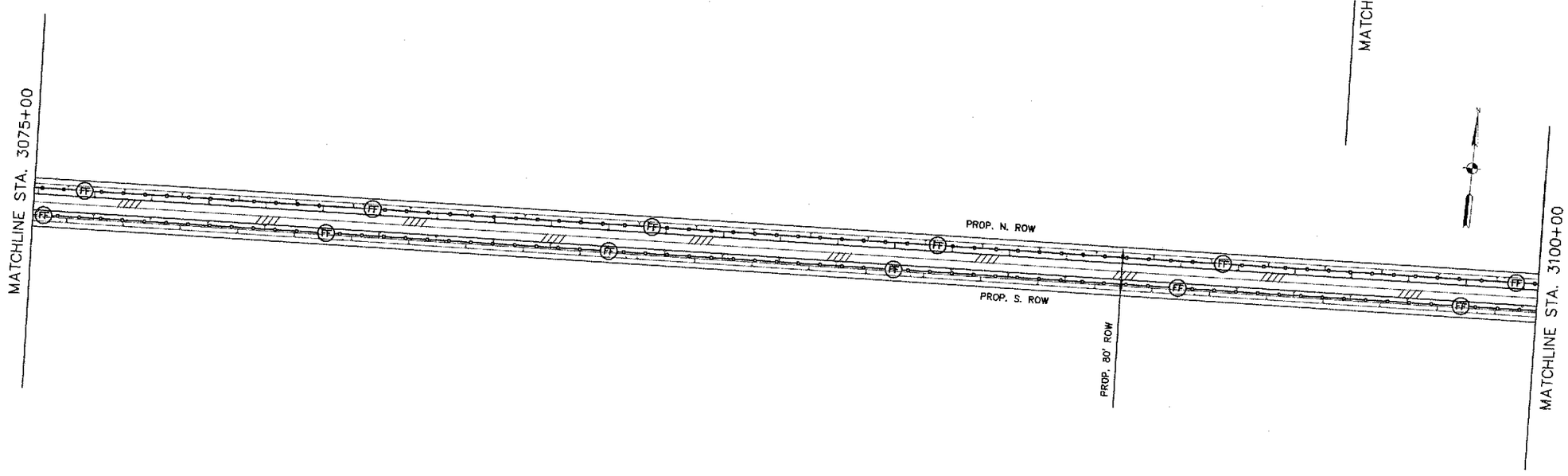

100 0 100 200
HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

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713.780.0838 fax.

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COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD
STORM WATER POLLUTION
PREVENTION PLAN
(SHEET 2 OF 4)

DRAWING SCALE
AS SHOWN

SHEET NO. 236 OF 245

LAST MODIFIED: Jan 27, 2011 - 5:27pm BY USER: ThompsonBl
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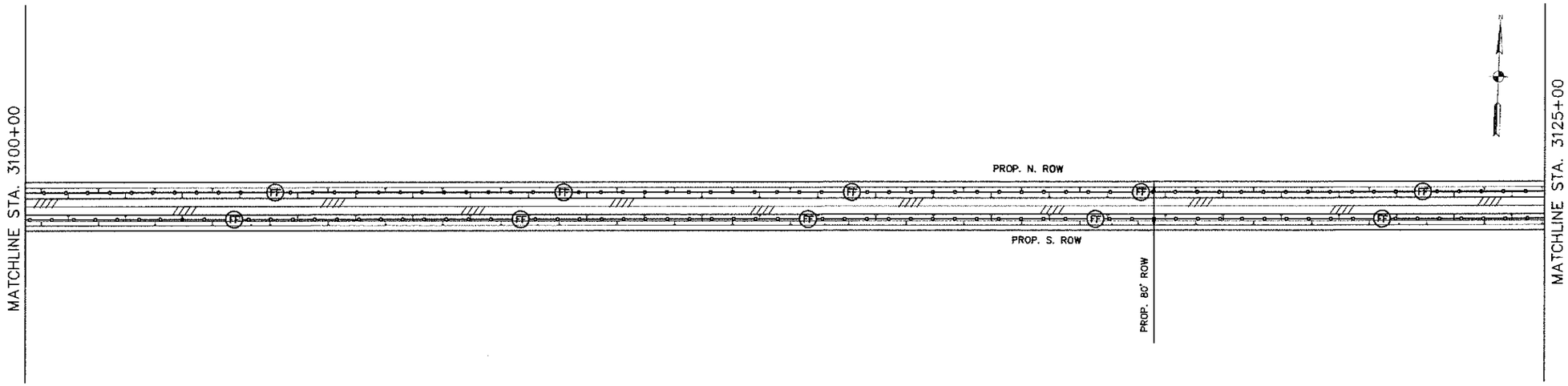

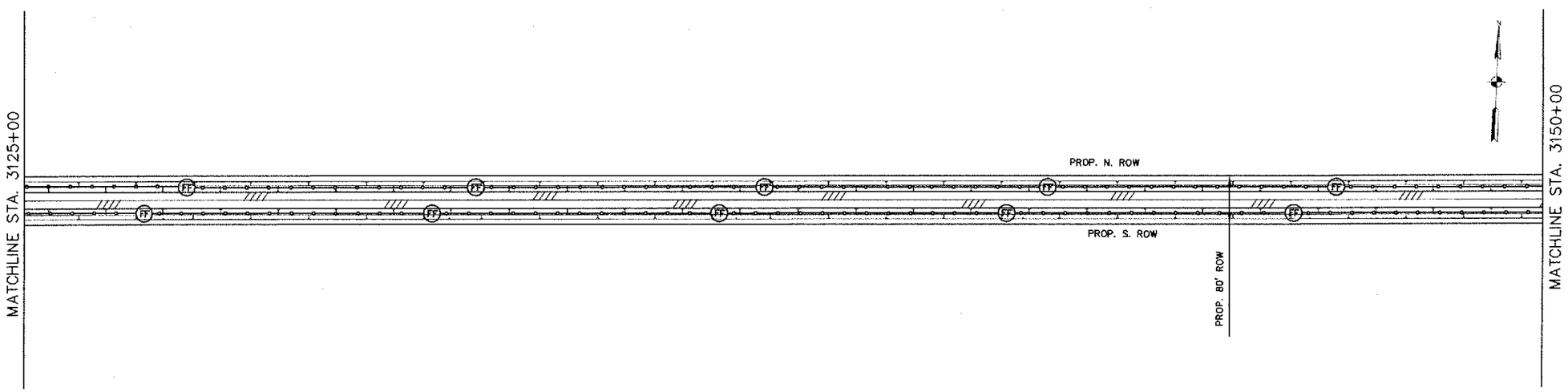

100 0 100 200
HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

KEVIN R. KRAHN, P.E.
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SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD
STORM WATER POLLUTION
PREVENTION PLAN
(SHEET 3 OF 4)

DRAWING SCALE
AS SHOWN

SHEET NO. 232 OF 245

LAST MODIFIED: Jan 27, 2011 -- 5:27pm BY USER: ThompsonBJ
DWG. LOCATION: Q:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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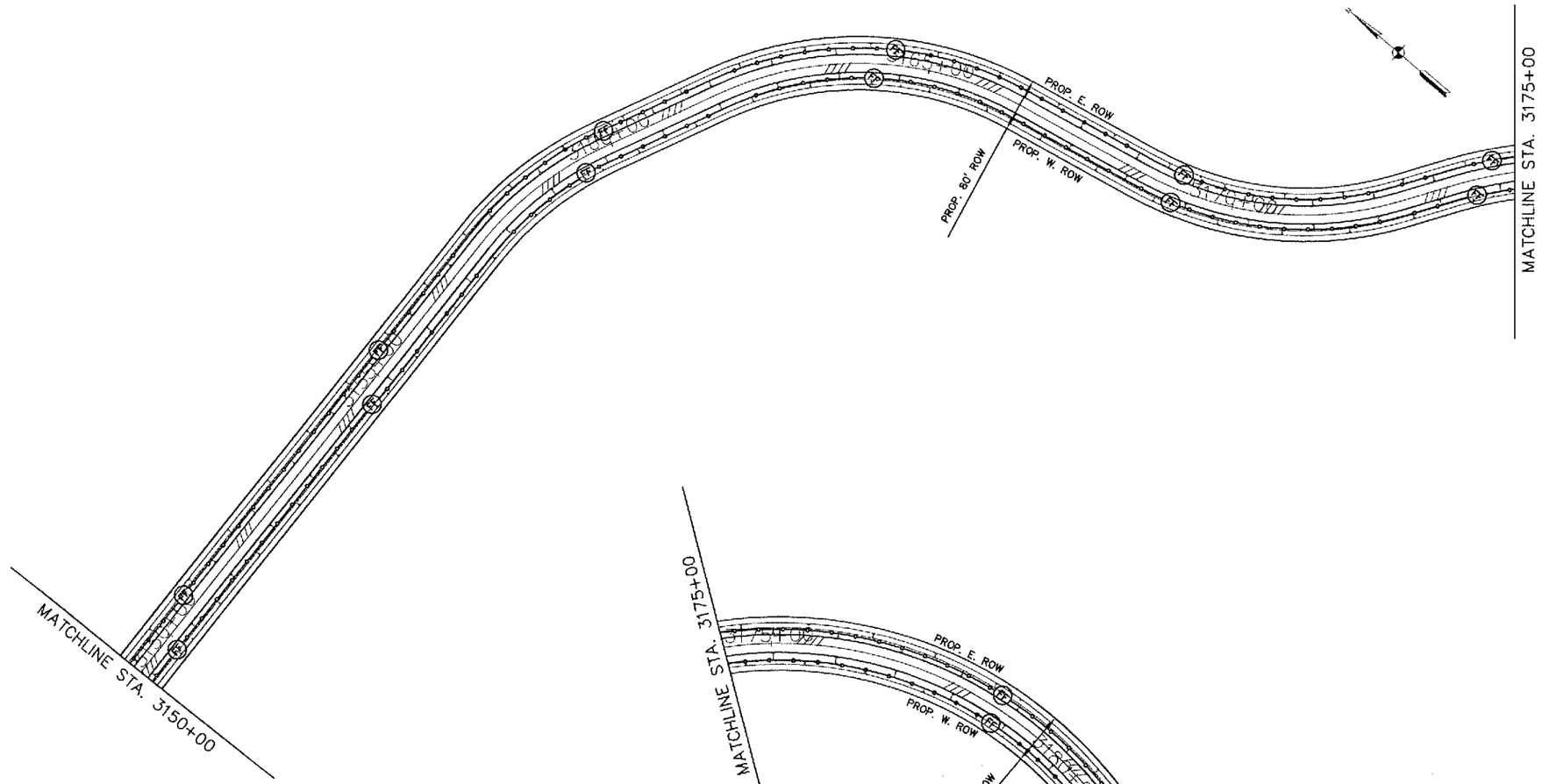

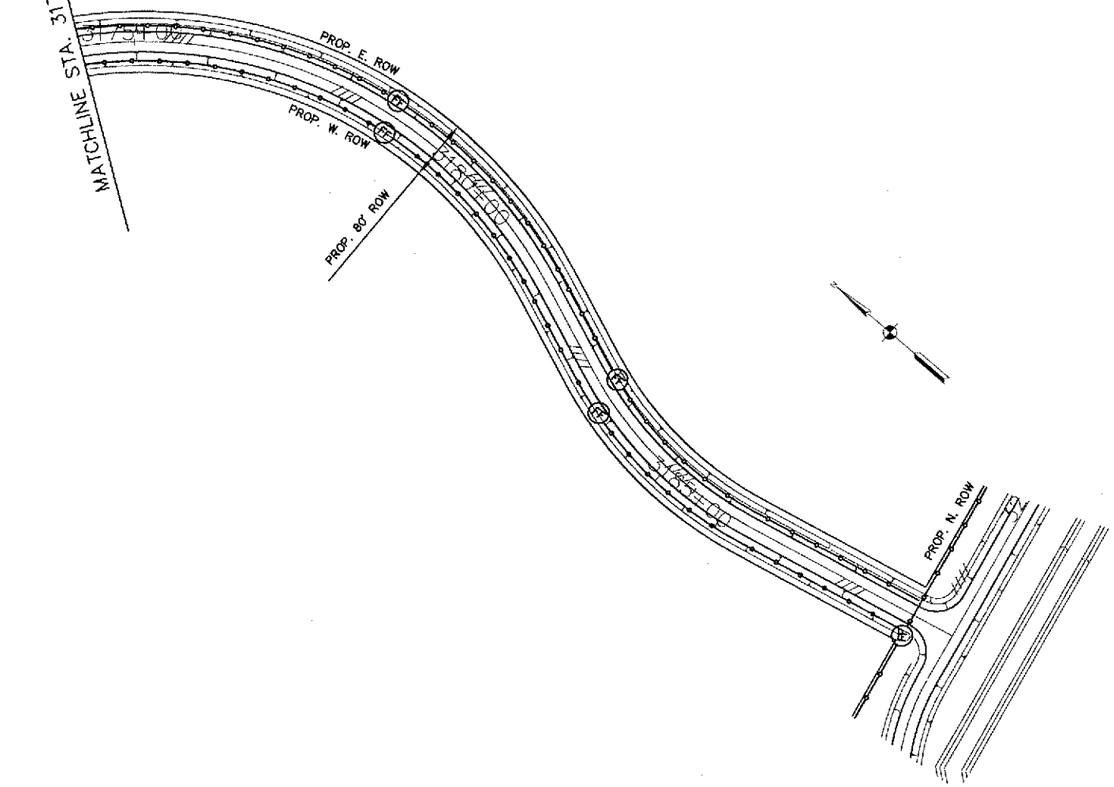

100 0 100 200
HORIZONTAL SCALE: 1" = 200'

LEGEND

FF — FILTER FABRIC FENCE

SC — STABILIZED CONTRUCTION ACCESS

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

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SURVEYED BY:
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COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

ACCESS ROAD
STORM WATER POLLUTION
PREVENTION PLAN
(SHEET 4 OF 4)

DRAWING SCALE
AS SHOWN

SHEET NO. 233 OF 245

LAST MODIFIED: Jan 27, 2011 – 5:27pm BY USER: ThompsonBl
DWG. LOCATION: Q:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
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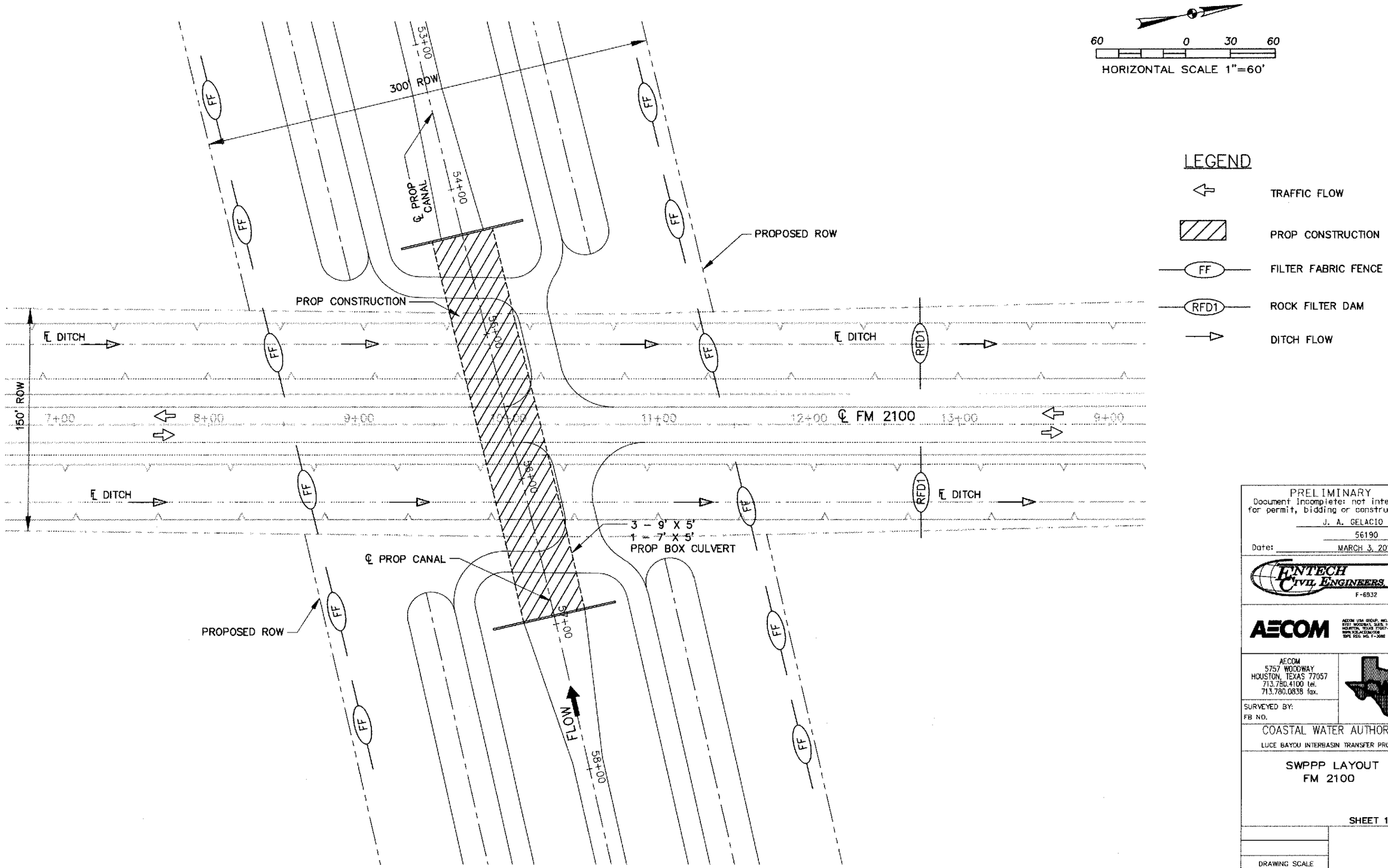

SWPPP PLAN

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.
J. A. GELACIO
56190
Date: MARCH 3, 2010

ENTECH CIVIL ENGINEERS, INC.
F-6932

AECOM

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713.780.4100 tel.
713.780.0838 fax.

SURVEYED BY:
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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

SWPPP LAYOUT
FM 2100

SHEET 1 OF 6

DRAWING SCALE
AS SHOWN

SHEET NO. 239 OF 245

LAST MODIFIED: Mar 31, 2010 - 8:21am BY USER: rmalla
DWG. LOCATION: N:\5745-09-001\dwg\SWPPP\2-15\
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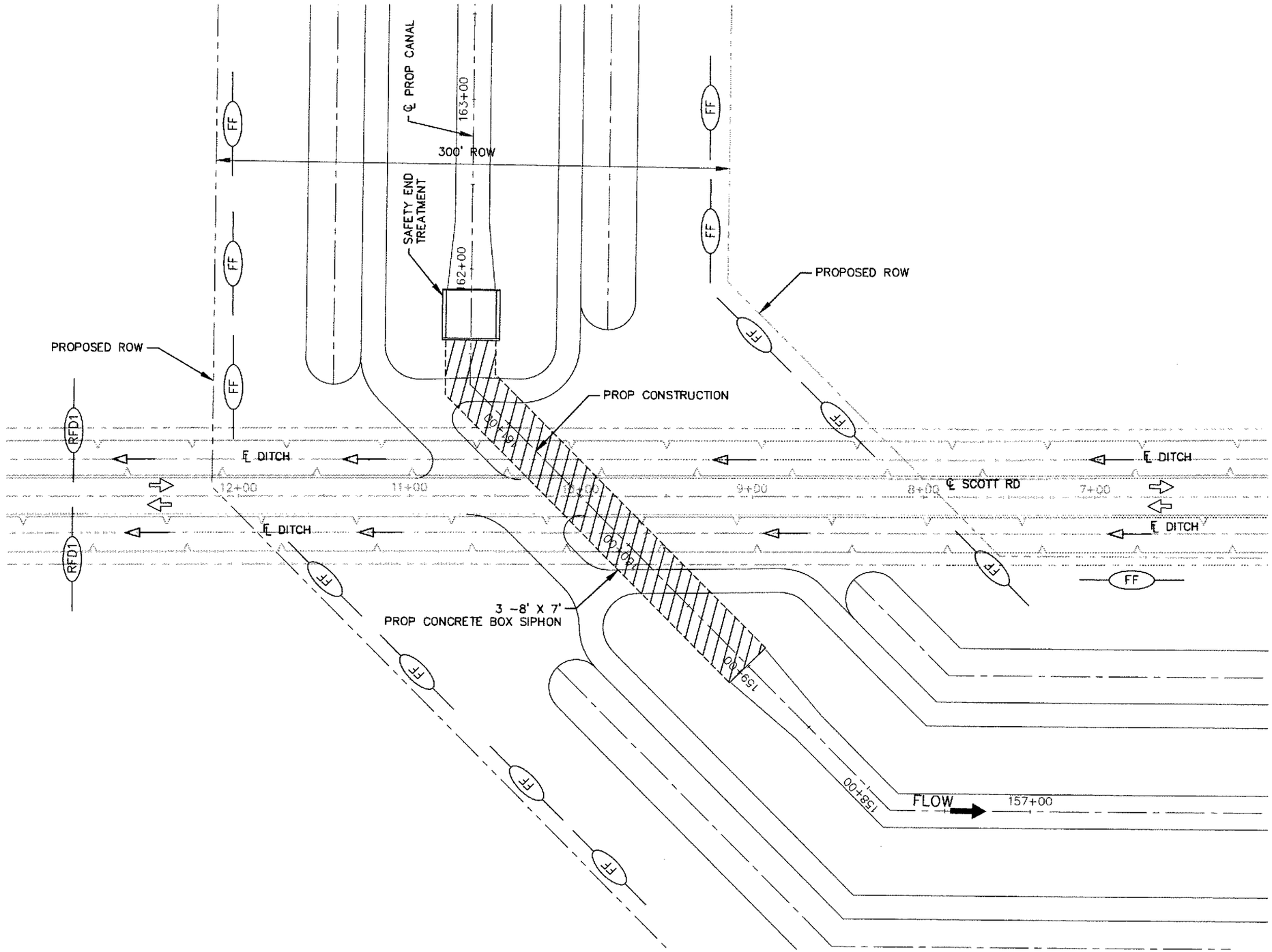

SWPPP PLAN

60 0 30 60
HORIZONTAL SCALE 1"=60'

LEGEND

- TRAFFIC FLOW
- PROP CONSTRUCTION
- FF — FILTER FABRIC FENCE
- RFD1 — ROCK FILTER DAM
- DITCH FLOW

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.

J. A. GELACIO
56190
Date: MARCH 3, 2010

FENTECH CIVIL ENGINEERS, INC.
F-6932

AECOM
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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

SWPPP LAYOUT
SCOTT RD

SHEET 2 OF 6

DRAWING SCALE
AS SHOWN

SHEET NO. 240 OF 245

LAST MODIFIED: Mar 31, 2010 - 8:23am BY USER: rmolla
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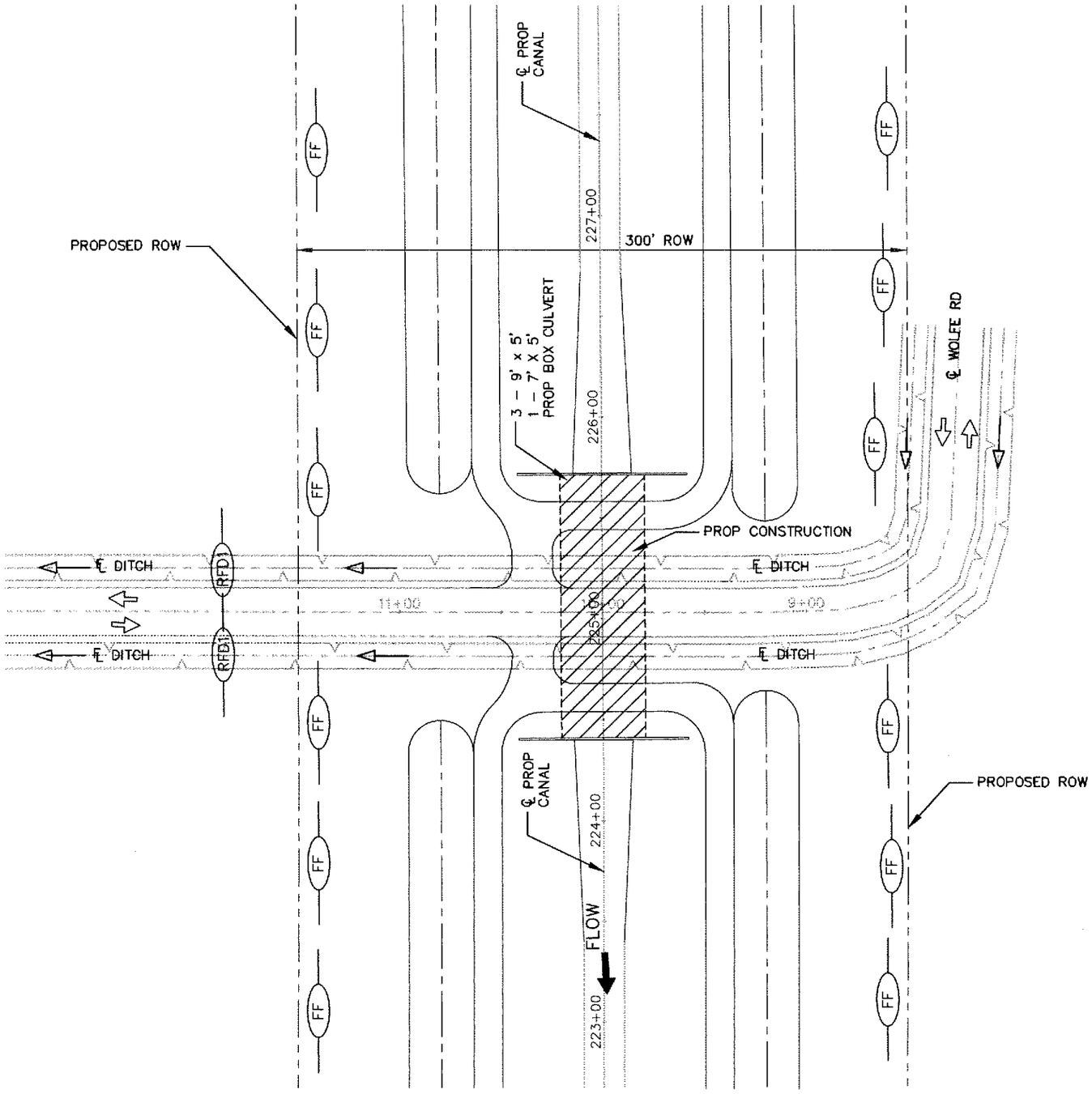
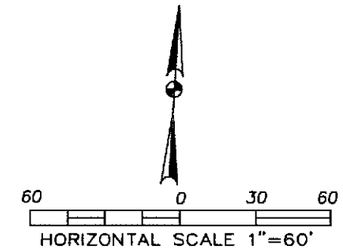


SWPPP PLAN



LEGEND

- TRAFFIC FLOW
- PROP CONSTRUCTION
- FF — FILTER FABRIC FENCE
- RFD1 — ROCK FILTER DAM
- DITCH FLOW

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.

J. A. GELACIO
56190
Date: MARCH 3, 2010

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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

SWPPP LAYOUT
WOLFE RD

SHEET 3 OF 6

DRAWING SCALE
AS SHOWN

SHEET NO. 241 OF 245

LAST MODIFIED: Mar 31, 2010 - 8:25am BY USER: rmalia
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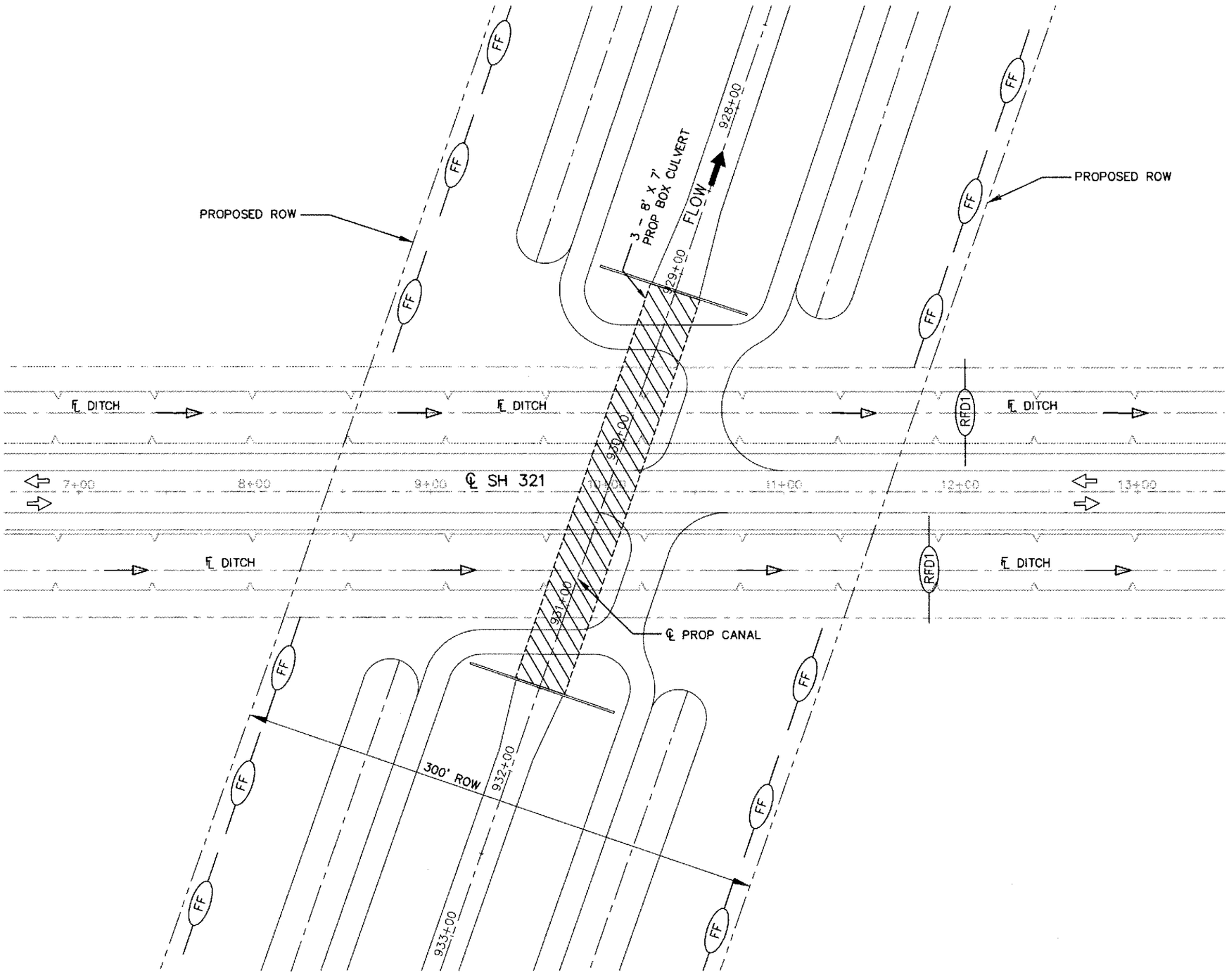
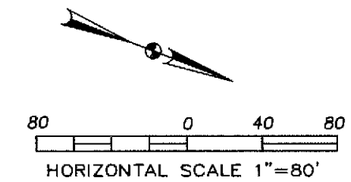


SWPPP PLAN



LEGEND

- TRAFFIC FLOW
- PROP CONSTRUCTION
- FF — FILTER FABRIC FENCE
- RFD1 — ROCK FILTER DAM
- DITCH FLOW

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.
J. A. GELACIO
56190
Date: MARCH 3, 2010

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713.780.0838 fax.

SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

SWPPP LAYOUT
SH 321

SHEET 4 OF 6

DRAWING SCALE
AS SHOWN

SHEET NO. 242 OF 245

LAST MODIFIED: Mar 31, 2010 - 8:27am BY USER: rmalla
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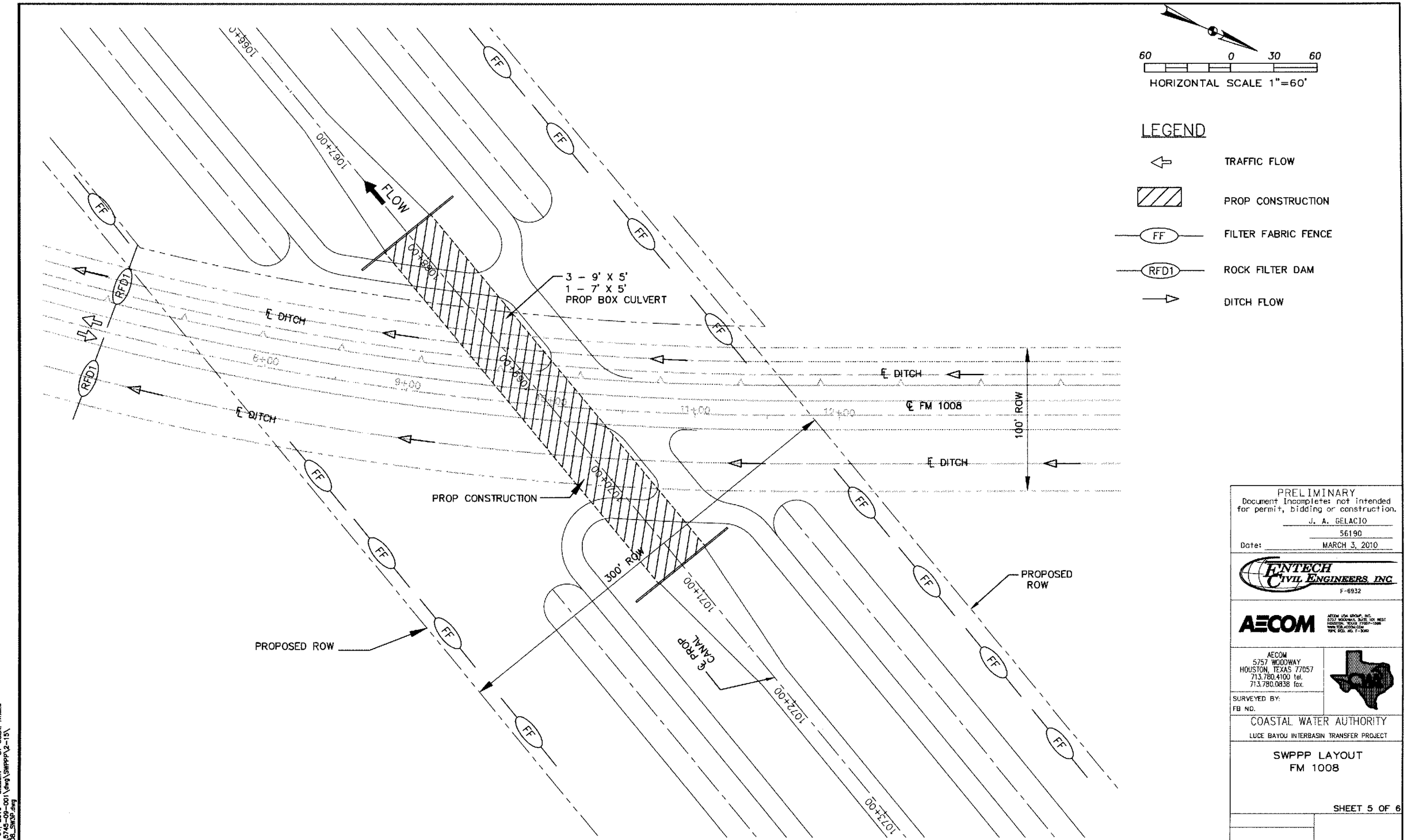

SWPPP PLAN

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.
J. A. GELACIO
56190
Date: MARCH 3, 2010

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FB NO.

COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

SWPPP LAYOUT
FM 1008

SHEET 5 OF 6

DRAWING SCALE
AS SHOWN

SHEET NO. 243 OF 245

LAST MODIFIED: Mar 31, 2010 - 8:28am BY USER: rmalla
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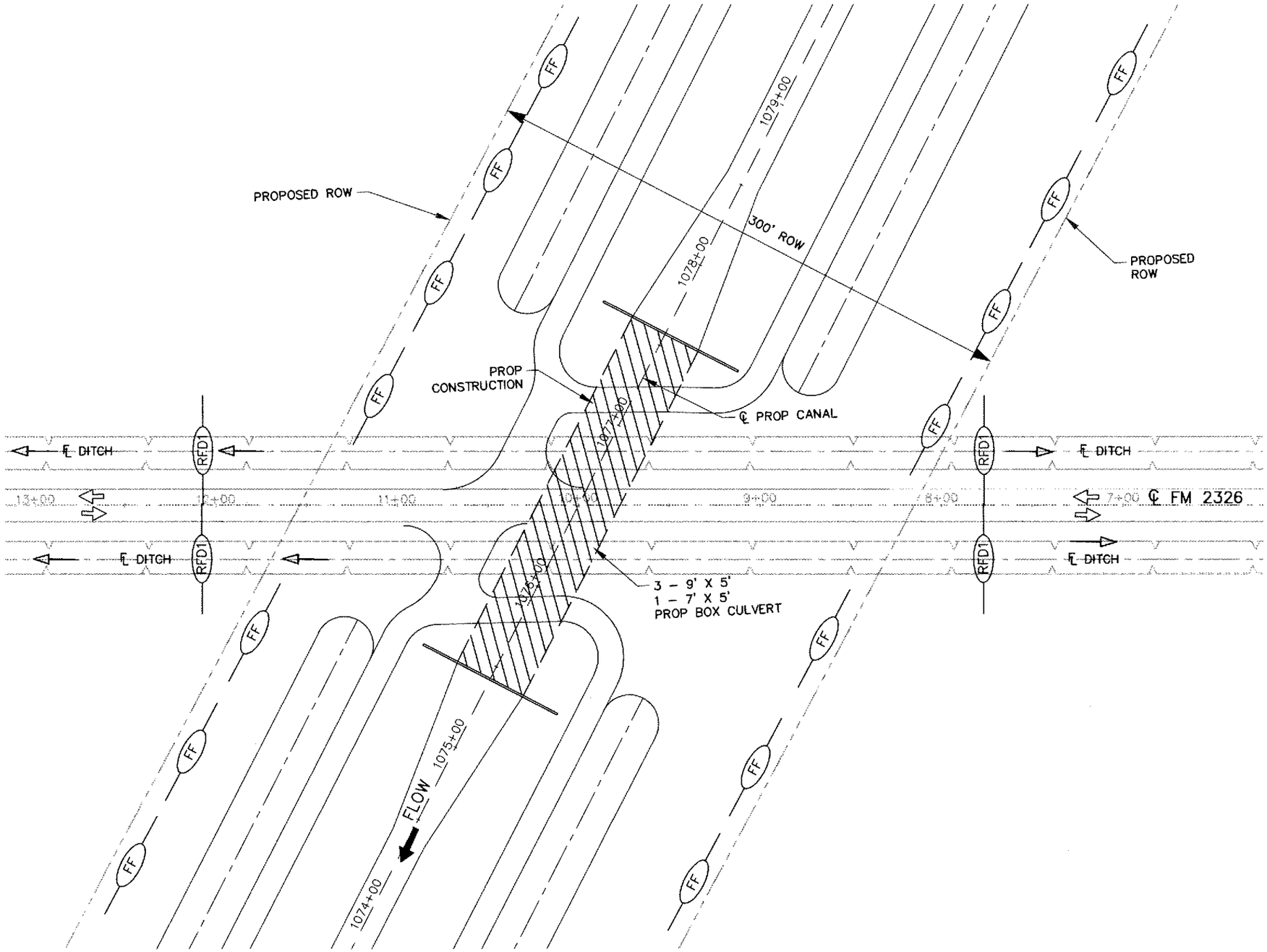
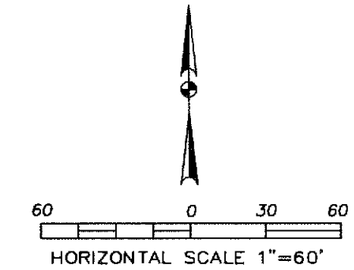


SWPPP PLAN



LEGEND

- TRAFFIC FLOW
- PROP CONSTRUCTION
- FF — FILTER FABRIC FENCE
- RFD1 — ROCK FILTER DAM
- DITCH FLOW

PRELIMINARY
Document Incomplete: not intended for permit, bidding or construction.

J. A. GELACIO
56190
Date: MARCH 3, 2010

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F-6932

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713.780.0838 fax.

SURVEYED BY:
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COASTAL WATER AUTHORITY
LUCE BAYOU INTERBASIN TRANSFER PROJECT

SWPPP LAYOUT
CR 2326

SHEET 6 OF 6

DRAWING SCALE
AS SHOWN

SHEET NO. 244 OF 245

LAST MODIFIED: Mar 31, 2010 - 8:31am BY USER: rmalla
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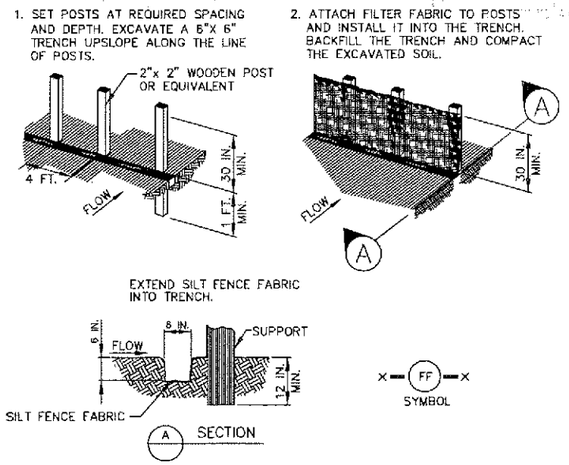
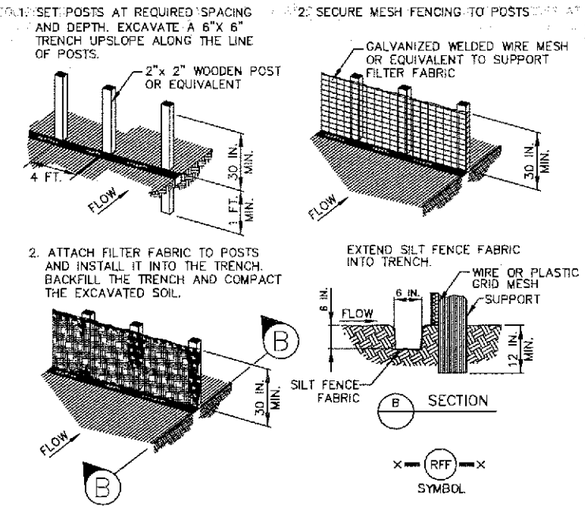


CONSTRUCTION NOTES:

1. SET POSTS AT 4-FEET MAXIMUM SPACING. IF FACTORY PREASSEMBLED FENCE WITH SUPPORT NETTING IS USED, SPACING OF POST MAY BE INCREASED TO 8 FEET MAXIMUM.
2. WHEN TWO SECTIONS OF FILTER FABRIC ADJOIN EACH OTHER, OVERLAP 6 INCHES AT THE POST, FOLD TOGETHER, AND ATTACH TO THE POSTS.
3. REMOVE SEDIMENT DEPOSITS WHEN SILT DEPTH REACHES ONE-THIRD OF THE HEIGHT OF THE FENCE.

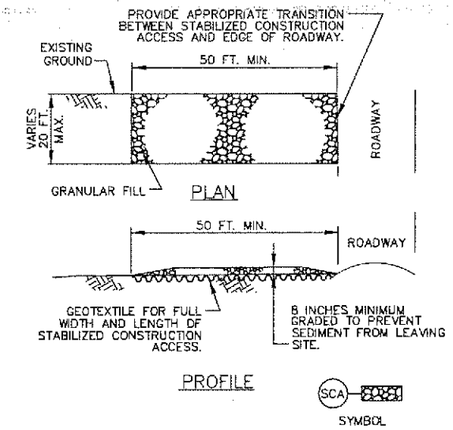
1 FILTER FABRIC FENCE



CONSTRUCTION NOTES:

1. SECURELY FASTEN MESH FENCING TO POSTS WITH STAPLES OR TIE WIRES.
2. SECURELY FASTEN FILTER FABRIC FENCE TO MESH.
3. WHEN TWO SECTIONS OF FILTER FABRIC ADJOIN EACH OTHER, OVERLAP 6 INCHES AT THE POST, FOLD TOGETHER, AND ATTACH TO THE POSTS.
4. REMOVE SEDIMENT DEPOSITS WHEN SILT DEPTH REACHES ONE-THIRD OF THE HEIGHT OF THE FENCE.

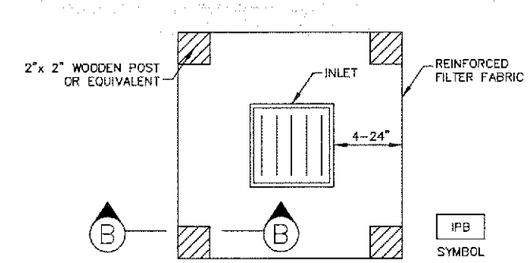
2 REINFORCED FILTER FABRIC FENCE



CONSTRUCTION NOTES:

1. MINIMUM LENGTH IS AS SHOWN ON CONSTRUCTION DRAWINGS OR 50 FEET, WHICHEVER IS GREATER.
2. CONSTRUCT AND MAINTAIN CONSTRUCTION ACCESS WITH CONSTANT WIDTH ACROSS ITS LENGTH, INCLUDING ALL POINTS OF INGRESS OR EGRESS.
3. UNLESS SHOWN ON THE CONSTRUCTION DRAWINGS, STABILIZATION FOR OTHER AREAS WILL HAVE THE SAME AGGREGATE THICKNESS AND WIDTH REQUIREMENTS.
4. WHEN SHOWN ON THE CONSTRUCTION DRAWINGS, WIDEN OR LENGTHEN STABILIZED AREA TO ACCOMMODATE A TRUCK WASHING AREA, PROVIDE OUTLET SEDIMENT TRAP FOR THE TRUCK WASHING AREA.
5. PROVIDE PERIODIC DRESSING WITH ADDITIONAL COARSE AGGREGATE TO MAINTAIN THE REQUIRED DEPTH OR WHEN SURFACE BECOMES PACKED WITH MUD.
6. PERIODICALLY TURN AGGREGATE TO EXPOSE A CLEAN DRIVING SURFACE.

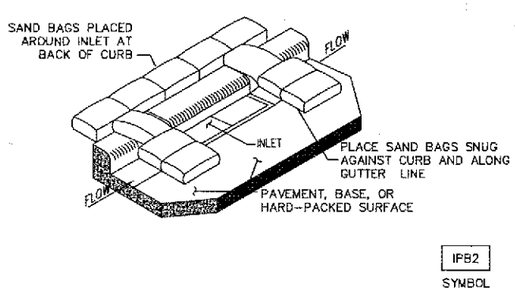
3 STABILIZED CONSTRUCTION ACCESS



CONSTRUCTION NOTES:

1. SECURELY FASTEN MESH FENCING TO POSTS WITH STAPLES OR TIE WIRES.
2. SECURELY FASTEN FILTER FABRIC FENCE TO MESH.
3. WHEN TWO SECTIONS OF FILTER FABRIC ADJOIN EACH OTHER, OVERLAP 6 INCHES AT THE POST, FOLD TOGETHER, AND ATTACH TO THE POSTS.
4. REMOVE SEDIMENT DEPOSITS WHEN SILT DEPTH REACHES ONE-THIRD OF THE HEIGHT OF THE FENCE.

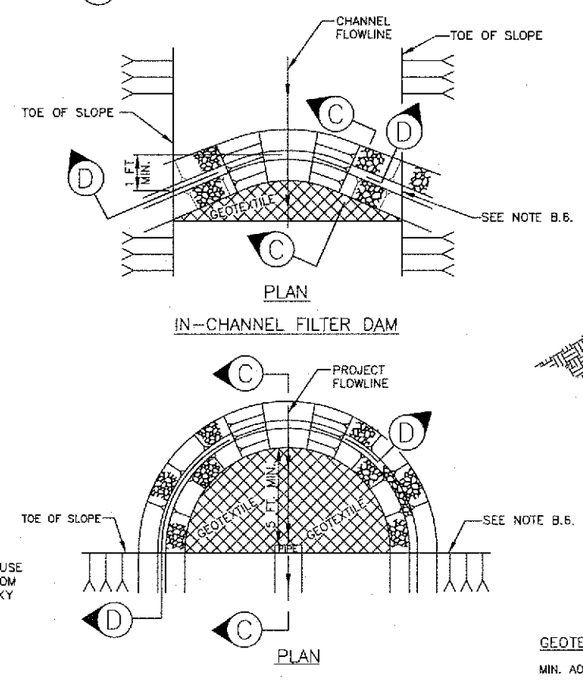
4 INLET PROTECTION BARRIER



CONSTRUCTION NOTES:

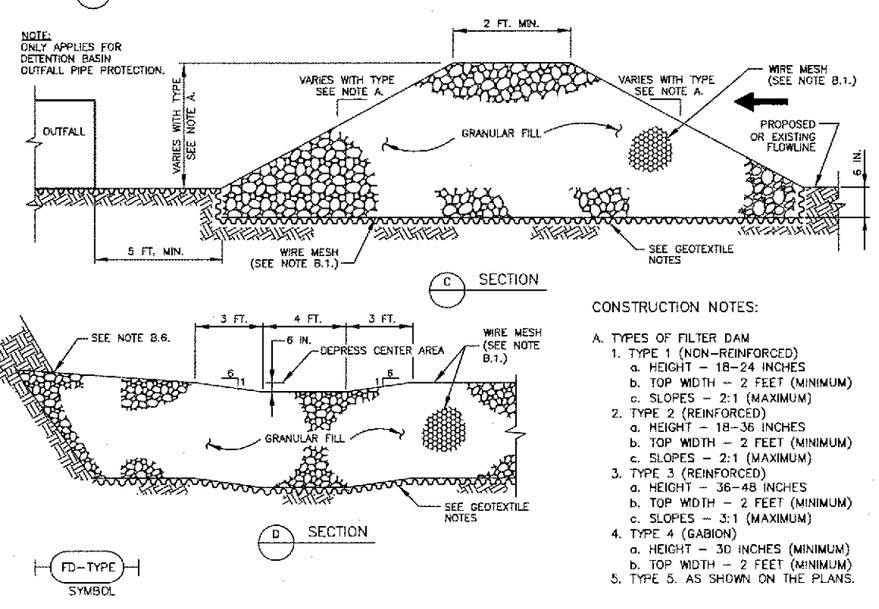
1. BAGS OR WATTLES CAN BE USED FOR THIS APPLICATION
2. PROVIDE WOVEN OR UNWOVEN GEOTEXTILE FILTER FABRIC FOR BAGS.
3. PROVIDE COARSE SAND AND AGGREGATE MIX FOR FILL MATERIAL FOR BAGS. USE ONLY PARTICLES CONSISTING OF CLEAN, HARD, DURABLE MATERIALS FREE FROM ADHERENT COATINGS, SALT, ALKALI, DIRT, CLAY, LOAM, SHALE, SOFT OR FLAKY MATERIALS, OR ORGANIC AND INJURIOUS MATTER.
4. REMOVE SEDIMENT DEPOSIT WHEN THE SEDIMENT HAS ACCUMULATED TO ONE-THIRD THE HEIGHT OF THE BARRIER.

5 INLET PROTECTION BARRIERS FOR STAGE II INLETS



GEOTEXTILE NOTES:

MIN. AOS	SIEVE NO.	120 MIN
MAX. AOS	SIEVE NO.	50 MAX
WEIGHT	OZ/SY	4 OZ. MIN



CONSTRUCTION NOTES:

A. TYPES OF FILTER DAM
1. TYPE 1 (NON-REINFORCED)
   a. HEIGHT - 18-24 INCHES
   b. TOP WIDTH - 2 FEET (MINIMUM)
   c. SLOPES - 2:1 (MAXIMUM)
2. TYPE 2 (REINFORCED)
   a. HEIGHT - 18-36 INCHES
   b. TOP WIDTH - 2 FEET (MINIMUM)
   c. SLOPES - 2:1 (MAXIMUM)
3. TYPE 3 (REINFORCED)
   a. HEIGHT - 36-48 INCHES
   b. TOP WIDTH - 2 FEET (MINIMUM)
   c. SLOPES - 3:1 (MAXIMUM)
4. TYPE 4 (GABION)
   a. HEIGHT - 30 INCHES (MINIMUM)
   b. TOP WIDTH - 2 FEET (MINIMUM)
5. TYPE 5. AS SHOWN ON THE PLANS.

B. CONSTRUCT FILTER DAMS ACCORDING TO THE FOLLOWING CRITERIA UNLESS SHOWN OTHERWISE ON THE PLANS.
1. TYPE 2 AND 3 FILTER DAMS: SECURE WITH 20 GAUGE GALVANIZED WOVEN WIRE MESH WITH 1-INCH DIAMETER HEXAGONAL OPENINGS.
2. GRANULAR FILL
   a. PLACE ON MESH TO HEIGHT AND SLOPES SHOWN ON PLANS.
   b. 3-5 INCHES FOR ROCK FILTER DAM TYPES 1, 2, AND 4
   c. 4-8 INCHES FOR ROCK FILTER DAM TYPE 3.
3. WIRE MESH: FOLD AT UPSTREAM SIDE OVER GRANULAR FILL AND TIGHTLY SECURE TO ITSELF ON THE DOWNSTREAM SIDE USING WIRE TIES OR HOG RINGS.
4. IN STREAMS: SECURE OR STAKE MESH TO STREAM BED PRIOR TO AGGREGRATE PLACEMENT.
5. EMBED ONE FOOT MINIMUM INTO SLOPE AND AT SLOPE RAISE ONE FOOT HIGHER THAN CENTER OF DEPRESSED AREA.

6 FILTER DAM

KEVIN R. KRAHN, P.E.
TEXAS REGISTRATION NO. 91031
INTERIM SUBMITTAL
NOT FOR CONSTRUCTION PURPOSES

AECOM

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SURVEYED BY:
FB NO.

COASTAL WATER AUTHORITY

LUCE BAYOU INTERBASIN TRANSFER PROJECT

STORM WATER POLLUTION PREVENTION PLAN DETAILS

DRAWING SCALE
AS SHOWN

SHEET NO. 245 OF 245

LAST MODIFIED: Jan 24, 2011 - 9:22am BY USER: Thompson8l
CWG. LOCATION: O:\Work Order 6\4.0 ENGINEERING NOTES & CALCULATIONS\4.3 Civil Notes and Calculations\Cadd\PWD\Sheets\
DWG. NAME: sw3pdetail.dwg