FEASIBILITY STUDY

BAYOU BIENVENUE
PUMP STATION DIVERSION AND TERRACING
ORLEANS AND ST. BERNARD PARISHES
(PO–25, XPO–74A)

PREPARED FOR

STATE OF LOUISIANA
DEPARTMENT OF NATURAL RESOURCES
COASTAL RESTORATION DIVISION
DNR CONTRACT NO. 2503–00–29

HARTMAN ENGINEERING, INC.
CONSULTING ENGINEERS
BATON ROUGE AND KENNER, LOUISIANA

APRIL 2001

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Introduction

Hartman Engineering, Inc. (HEI), was originally contracted by the Louisiana Department of Natural Resources (LDNR) to provide a cost estimate for engineering services needed to provide a feasibility study, preliminary plans, and permit applications for LDNR contract No. 2503-00-29, Survey and Engineering Services Bayou Bienvenue Pump Station Diversion and Terracing. Early in the project, LDNR determined that providing the services for all of the original tasks were not warranted. HEI was asked to revise their cost estimate to provide a study of the feasibility of constructing the terraces and vegetative plantings. This report will address only the items listed in the revised task letter from Mr. Clark Allen dated September 23, 2000.

The original study area included Bayou Bienvenue and the wetlands south of the Bayou to the Chalmette Hurricane Protection Levee, including the discharge from the Orleans Parish-pump station and two pump stations located in St. Bernard Parish. The revised study area would only include the open water areas south of Bayou Bienvenue. The areas are designated Cells “A”, “B”, “C”, and “D” and are shown in Figure 1. The site consists of two shallow water ponds and an adjoining marsh area south of Bayou Bienvenue, and is approximately 2600 acres in area. The site is bordered by Paris Road to the east, the Chalmette Hurricane Protection Levee to the south, and Bayou Bienvenue to the north and west. It is located in both Orleans Parish and St. Bernard Parishes with the center at approximate coordinates of 29°59’00”N latitude and 89°58’00” W longitude.

The area under study was once a cypress forest surrounding a marsh prairie. Presently the site is primarily open water with some standing dead cypress trees in Cell “A” and scattered patches of vegetation located primarily in Cells “C” and “D” and along the southern bank of Bayou Bienvenue. Submerged cypress stumps and logs are prevalent throughout the open water areas. The intent of the study is to determine the feasibility of planting vegetation in Cell “A” and the construction of terraces for vegetative plantings in Cells “B”, “C”, and “D”. The terraces and vegetative plantings will maximize the retention of the storm water pumped into the study area by the three

FIGURE 1 – SITE LAYOUT

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pump stations. The terraces will also slow water movement through the Cells allowing suspended solids to settle out.

Data Collection

Professional Services Industries, Inc. (PSI) completed the preliminary geotechnical investigation of the subsurface conditions of cells “B”, “C”, and “D” in the Bayou Bienvenue project area. A total of ten borings (B-1 through B-10) to depths of twenty-five feet were drilled to evaluate the soil bearing capacity, settlement, slope stability, and whether or not in situ material could be used for construction of the proposed terraces. A total of four borings were taken in Cell “B” and three borings in both Cells “C” and “D”. Since there will not be any terraces constructed in Cell “A” no soil borings were taken in that area. The boring depths shown in the soils report are in reference to the existing ground surface at boring location. The number and depths of the borings were determined by PSI. The Geotechnical Engineering Report as well as the locations of the borings are included in Appendix A.

The near surface soils consist of very soft organic clay or peat with organic clay. The soil is believed to have enough bearing capacity to support the proposed terraces. It is believed that the subsoil will experience extensive subsidence and settlement due to the weight of the material used to construct the terraces. The settlement could be as high as two and half (2 ½) feet, with up to 50 percent of the settlement occurring during construction. The slope stability analysis was performed using a side slope of one vertical on ten horizontal (1V:10H). PSI performed the analysis using an initial construction elevation of +5.7 feet (NGVD). Considering that the material used to construct the terraces will come from a borrow area adjacent to the terraces, PSI recommends that the borrow area be at least 50 feet from the toe of the terraces with the borrow having a minimum side slope of one vertical to three horizontal (1V:3H).

The upper eight to ten feet of subsoil encountered in the borings consist of very soft organic clays, clay, or peat. The majority of the borrow material from the upper ten feet of the subsoil is not suitable for construction of the proposed earthen terraces. This material will have to be wasted due to the high peat and organic content of these soils. Any remaining organic clay or clays that may be useable for construction of earthen terraces should be placed in horizontal lifts not exceeding one foot and should be mechanically tamped to achieve some compaction of the material. A minimum factor of safety of 1.1 was used to calculate the slope stability of the proposed earthen terraces, which is believed to be adequate for this type of construction.

A survey of the existing bottom elevations of Cells, "A", "B", "C", and "D" was performed by Shread-Kuyrkendall and Associates (SKA). Range lines were established at 2000-foot intervals perpendicular to the Chalmette Hurricane Protection Levee. Elevations were taken at the 500-foot stations along each range line. The area occupied by BFI was not included in the geotechnical investigation or in the elevation survey.

The existing ground elevations in the study area are between one-half (+½) foot to minus one and half (-1 ½) feet in cell "A", minus one (-1) foot to minus two and half (-2 ½) feet in cell "B", and between minus one-half (-½) foot to minus one (-1) foot in cells "C" and "D". The elevation shots can be seen on the plan sheet located in Appendix B. All of the ground elevations were obtained using North American Vertical Datum 88 (NAVD 88).

Water elevation information was taken from US Army Corps of Engineers Gage 76020 Bayou Bienvenue, and was located at the Paris Road Bridge over Bayou Bienvenue. The bridge was replaced in the early 1990s, during which time the gage was removed and not replaced. Therefore, the gage data only covers the years from 1975-1992. The gage recorded the water elevation at 8:00 A.M. each day and gage zero was feet NGVD 29. The water surface elevation gage data is limited because there was only one reading at 8:00 A.M. each day, this may not accurately reflect the tidal fluctuations that occur in the project area.

This information was compiled to find the average daily and average monthly water elevations over the eighteen-year period. The graphs of the average water elevations for each month are included in Appendix C. The graphs show the daily gage reading fluctuations, as well as, the daily and monthly averages. Figure 2 shows the average monthly water elevation in feet NGVD 29. September was the peak month with

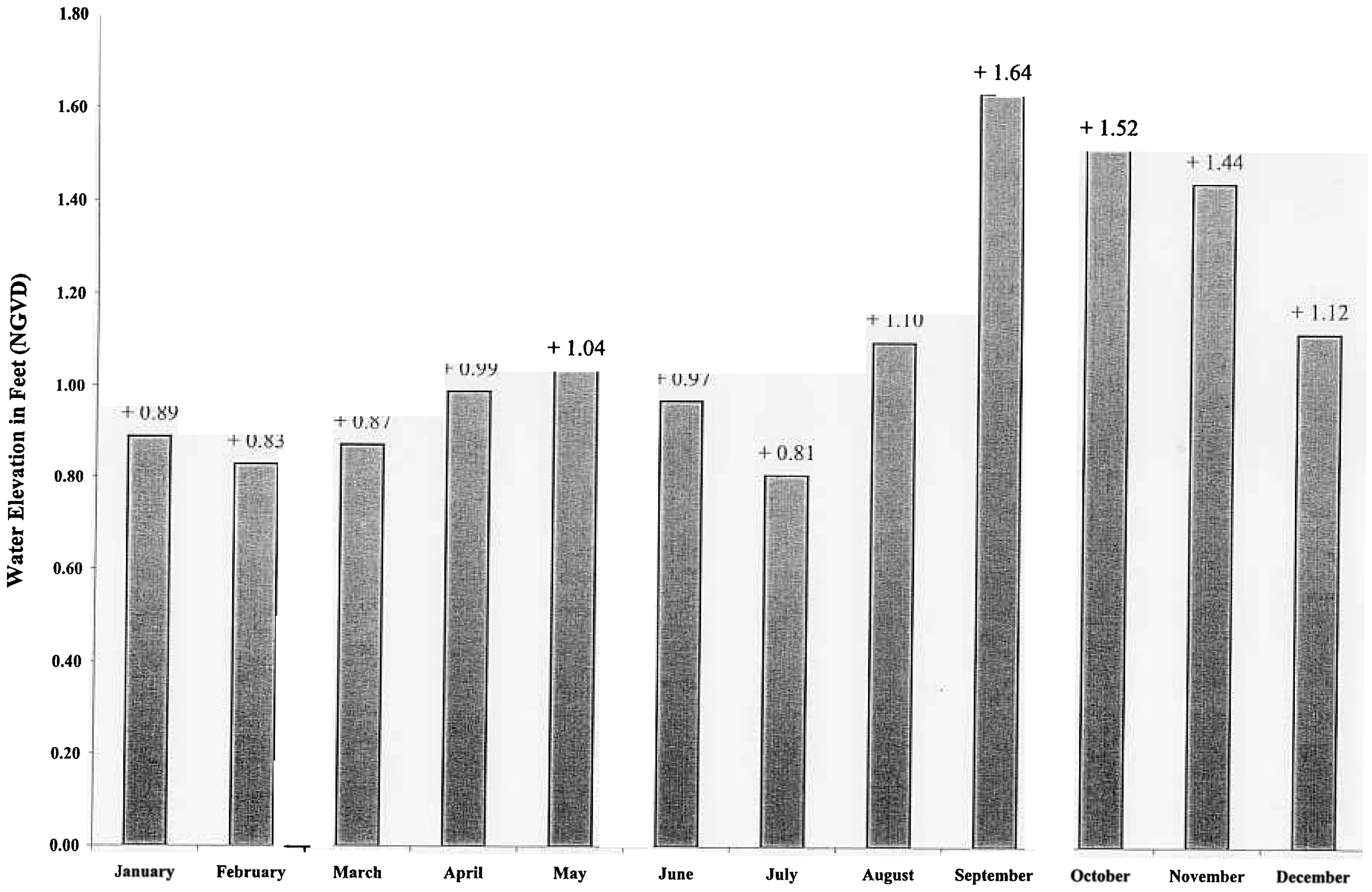


Figure 2 - Average Monthly Water Elevations

an average water elevation of +1.64 feet. This elevation was used in determining the finished crown height of the proposed earthen terraces. Although the peak water height of +1.64 NGVD 29 was used, it may not be the actual highest water elevation. If the peak tide or elevation was at different time it was not recorded, because the gage only took one reading a day at 8:00 AM.

Because the gage is located at the eastern most end of the project area, the gage data might not apply accurately to the western most part or Cell “A”. If the tides were primarily driven by wind, the depth of water in Cell “A” may differ from the depths in the Cells closer to the gage. This was not felt to be a significant factor for the feasibility study.

Wind data was obtained from the Louisiana Office of State Climatology wind gage at the New Orleans International Airport (MSY). Standard National Weather Service (NWS) wind instruments at a height of twenty feet above the surface were used to collect data over the period from 1961-1980. The average maximum two minute sustained wind was found to be 37.2 miles per hour, with a mean speed of 8.3 miles per hour. The wind varies over the project area significantly, but primarily the winds are northerly and southerly. The seasonal wind roses and the normals, means, and extremes can be found in Appendix D. The wind data from the New Orleans Lakefront Airport (NEW) was not considered because it was recorded over a shorter period, roughly four years. In addition, the Lakefront Airport is not a primary collection site, so the data is not as accurate. If the data from the Lakefront Airport were used it would show more of a northerly component, which is one of the primary components of the New Orleans Airport as well. The depth of water varies significantly over the project area and is effected more by wind action than tidal action. This varying depth could limit the effectiveness of the vegetative plantings on the terraces.

LDNR specified that *Spartina alterniflora* (smooth cordgrass) be used for the plantings on the proposed terrace slopes and in Cell “A”. Smooth cordgrass prefers tidal conditions, with an upper/ lower elevation range of one inch to one foot of submergence. Smooth cordgrass cannot be chronically inundated, but can handle short-term inundation for three to fours days. The smooth cordgrass would be planted one year after the construction of the terraces and allowed to migrate over the slopes of the terraces.

Design Feasibility

The first step in the feasibility study was to determine the top of terrace elevation. The task letter asked if the existing material could be stacked to one foot above mean low water. Since the tide gage used had only one reading a day, a mean low water elevation and mean high water elevation could not be determined. Therefore the water elevation used was the average for each month. The lowest monthly average water elevation is July at +0.81 feet. If the terraces were built to one foot above this elevation the top would be at +1.81 feet. The tide data and the graphs in Appendix C show that the water surface will exceed this elevation frequently by as much as one foot for as long as one week. Smooth cord grass will not grow in these water depths when submerged for this length of time. The area where the terraces will be placed is open water subject to varying water elevations and wave conditions. It was determined that the initial terrace elevation would be established using the maximum wave height for the month with the highest average monthly water elevation. The highest average monthly water elevation is September with an elevation of +1.64 NGVD 29. The initial wave height was established using the equation for wave height from the Federal Emergency Management Agency, Coastal Construction Manual

$$d/h = 1.28$$

Where h = maximum wave height
d = depth of water

The depth of water was determined using the lowest average bottom elevation in Cell "B" which is –2.5 NAVD 88. Since the two sets of data were in different datum, the VERTCON program was used to determine the difference in the two datum. The elevation deference between NGVD 29 and NAVD 88 at this latitude and longitude is approximately 0.20 feet. The NAVD 88 elevations would be 0.20 feet higher when converted to NGVD 29. Since this is a feasibility study and the field data taken was minimal, the elevation difference was not judged to be significant and was not taken into account.

Using a bottom elevation of –2.5 feet and a water surface elevation of +1.64 feet, the water depth is 4.14 feet. The wave equation gives a total wave height of 3.23 feet.

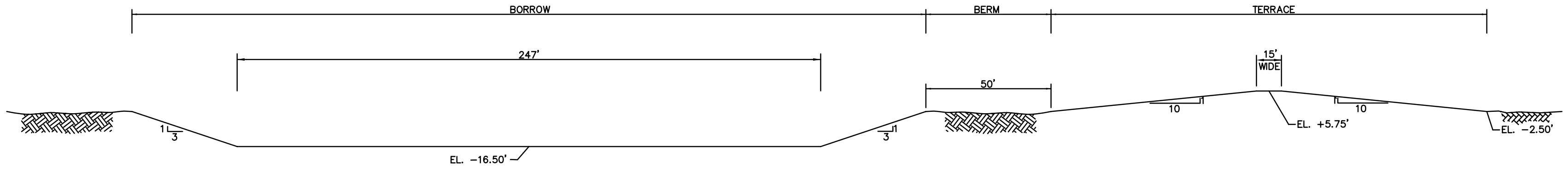
4.14’/h = 1.28

h = 3.23’

½ wave height = 1.62’

Taking half of the wave height and adding it to the average monthly high water elevation of 1.64 feet the elevation of the maximum wave is 3.26 feet. An initial top of terrace elevation of 3.75 feet was established allowing for approximately six inches above the maximum wave height. This elevation was used for the initial terrace layouts and the geotechnical investigation.

Based on the existing bottom elevation (-2.5 feet) and the top of terrace elevation (3.75 feet) the terrace height will be approximately 6.25 feet above the existing bottom. The initial construction height of the terraces will need to be 2 feet higher to allow for settlement. This means that the terraces will need to be built 8.25 feet above the existing bottom to allow for settlement and maintain the desired final elevation over the life of the terraces. The existing material that will be used for construction will require the terraces to be built with a 1V:10H side slope. The geotechnical report also requires that a 50 foot berm be used between the toe of the terrace and the top of the borrow area to ensure the stability of the terrace and the top of the borrow area. If a 15-foot terrace top is used as discussed in the Proposed Project Information Sheet, the total terrace width from toe of terrace to toe of terrace is 179 feet. A typical section of the terrace and borrow area is shown in Figure 3. Using this typical section, several different layouts for the terraces were investigated. All of the proposed layouts are shown in Appendix E. Orientations 2 and 3 were rejected for further study because the distance between the ends of each were too great to hinder the movement of water between them which is one of the objectives of the terraces. It was felt that these layouts would not maximize the terrace length for a given area. Also, the layouts might be too intricate to construct and this would raise the



TYPICAL TERRACE PROFILE SECTION

SCALE: N.T.S.

TERRACE WIDTH (FEET)	TERRACE ELEVATION (FEET)	GROUND ELEVATION (FEET)	THEORETICAL VOLUME REQUIRED TO CONSTRUCT ONE LINEAR FOOT OF TERRACE (CUBIC YARDS)		INCLUDING 30% SWELL (CUBIC YARDS)		BORROW DEPTH (FEET)	OVERBURDEN BORROW AREA (CUBIC YARDS)		BORROW WIDTH (FEET)	
			10:1 SIDESLOPE	6:1 SIDESLOPE	10:1 SIDESLOPE	6:1 SIDESLOPE		10:1 SIDESLOPE	6:1 SIDESLOPE	10:1 SIDESLOPE	6:1 SIDESLOPE
15.00	+ 5.70	− 2.50	29.5	19.5	38.3	25.3	14.00	111.5	78.9	247.00	159.00
10.00	+ 5.70	− 2.50	27.9	18.0	36.3	23.4	14.00	106.3	74.1	233.00	146.00
5.00	+ 5.70	− 2.50	26.4	16.5	34.4	21.4	14.00	101.5	68.9	220.00	132.00
0.00	+ 5.70	− 2.50	24.9	14.9	32.4	19.4	14.00	96.7	64.7	207.00	119.00

TERRACE WIDTH (FEET)	TERRACE ELEVATION (FEET)	GROUND ELEVATION (FEET)	VOLUME FOR 100,000 LINEAR FEET OR TERRACES (CUBIC YARDS)	
			10:1 SIDESLOPE	6:1 SIDESLOPE
15.00	+ 5.70	− 2.50	3,830,000	2,530,000
10.00	+ 5.70	− 2.50	3,630,000	2,340,000
5.00	+ 5.70	− 2.50	3,430,000	2,140,000
0.00	+ 5.70	− 2.50	3,240,000	1,940,000

FIGURE 3 — TYPICAL SECTION SHOWING VOLUME OF REMOVED EARTH

NO.	DATE	REVISION DESCRIPTION	BY

TERRACE PROFILE

BAYOU BIENVENUE

Hartman
Engineering
Inc.

DESIGNED	JRS	PARISH	ORLEANS/ ST. BERNARD
CHECKED	DCB		
DETAILED	JDB	DNR PROJECT	(PO-25, XPO-74A)
CHECKED	DCB		
DATE	APR. 2001		
SHEET	9		

cost of construction. Orientation 1 was used to determine the maximum linear footage that could be constructed in Cells “B”, “C”, and “D”. Figure 4 shows the layout of Orientation 1 in these Cells. The only restrictions of the layout were that there would be no terrace construction over the Bridgeline Gasline or on top of existing vegetation. Using the layout shown in Figure 4 approximately 90,000 linear feet of terraces could be constructed in open water. This amount of terrace was achieved by putting a terrace every where there appeared to be open water. The actual footage of terrace that could be constructed would be less than this length, because of access problems in Cells “C” and “D” where there is existing vegetation. While Orientation No. 1 comes closest to achieving the 100,000 feet of terrace, it is constructed by dredging a straight channel between the terraces. The channel depth will vary from 4 feet to 14 feet depending on whether the unsuitable material is hauled from the site or dumped back into the borrow area. The orientation of the terraces would allow for a longer fetch and a greater water depth for wind driven waves which would increase erosion of the terraces. The advantages in terrace length achieved with this orientation are negated by the length and depth of channel required for construction.

Figure 3 also shows the cubic yards of material required to construct one linear foot of terrace. This number does not include the top 10 feet of material that is not suitable for construction of terraces and allows for a 30% spillage or waste factor during construction. The terraces will require approximately 38.3 cubic yards of material per linear foot to build, or 3,447,000 cubic yards for 90,000 feet of terrace.

The Proposed Project Information Sheet assumed that the terraces could be constructed by a marsh buggy using a borrow area adjacent to the proposed terraces. This will not be possible for the Bayou Bienvenue project. The top 10 feet of the existing material is not suitable for building terraces, it will have to be removed and disposed of outside the terrace and berm area. This presents a problem of what to do with the material. It can not be placed on the berm because of the danger of causing the borrow side slope to fail, which in turn will cause a failure of the terrace side slope. It will need to be temporarily placed on barges and dumped back into the borrow once the suitable material is removed. Because of the width of the terraces and the borrow area, marsh buggies do not have the reach to move the material from the borrow area to the terraces.

FIGURE 4 – AERIAL LAYOUT SHOWING TERRACE ORIENTATION 1
APPROXIMATELY 30,000 LINEAR FEET OF TERRACES SHOWN

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DNR No. 2503-00-39
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The material will need to be placed on barges and moved to the terrace location and unloaded to build the terraces. This means that all the material will have to be handled twice. In addition, during periods of low water a floatation canal for the barge will need to be dug, or construction would have to be suspended.

A dragline could be used to construct the terraces and might have the reach to throw the material from the borrow area to the terraces, but a flotation canal will have to be dug for the barge so that it could operate at all water levels. Once the barge is in Cell "B" the borrow area could be used as the floatation canal.

Estimates on construction cost were limited to the cost of excavating and moving the borrow material per cubic yard. Marsh buggy contractors indicated that for estimating purposes a marsh buggy would cost approximately $1500.00 per day to operate, and it could move approximately 300 cubic yards per day, giving a per cubic yard cost of $5.00. This cost is conservative because it is based on excavation only. Due to the large number of cypress logs and stumps in the top 10 feet of material, the cost per cubic yard for excavation could be much higher.

This study was also tasked with determining whether smooth cordgrass could be planted in Cell "A" without constructing terraces. The existing elevations shown in Appendix B, for Cell "A" vary between +0.5 feet and –1.3 feet, with the majority of the Cell being between –0.5 feet and –1.0 feet, (NAVD 88). Using the month with the lowest average water elevation (July, elevation of +0.81 feet, NGVD 29), the water depth will vary between 1.1' and 1.4' allowing for the different datum. Smooth cordgrass can tolerate water depths of up to one foot of submergence. This means that the success rate for the plantings would be minimal because the average standing water depth would be more than the plants can tolerate.

Recommendations and Conclusions

At the initial meeting for this study, it was stated that the goal for the project would be to construct 100,000 linear feet of terraces in Cells "B", "C", and "D". This work was estimated to cost approximately $335,000.00 in the Proposed Project Information Sheet, which did not include the cost of any vegetative plantings. These two objectives, linear footage of terraces constructed and earthwork, costs were used to determine the feasibility of the project.

After reviewing the geotechnical data, existing bottom elevation survey, the tide data, and the discussion in the Design Feasibility section, only 90,000 linear feet of terrace could be constructed in Cells “B”, “C”, and “D”. This would require the excavation and placing of 3,447,000 cubic yards of material. Based on a price of $5.00 per cubic yard, the cost for constructing the terraces would be $17,235,000. The cost of $5.00 per yard for excavating and placing the material is a low estimate because most of the material will need to be handled twice during construction and the large number of submerged cypress stumps and logs located in the Cells which will hinder construction. Also, this amount does not include the cost to excavate the top 10 feet of borrow, place it on barges, and dump back into the borrow after the terrace material is excavate.

Using the parameters set out in the Proposed Project Information Sheet and outlined in the task letter for the study, the project does appear feasible based on the criteria outlined. Do to the existing soil conditions and limitations, the required 100,000 linear feet of terraces can not be constructed. The cost for the terraces that can be constructed exceeds the original estimate for the terrace work. It also exceeds the total project budget including the outfall channel for the pump station, boat bay with weir, earthen plugs, and vegetative plantings. Therefore, we do not think the work is feasible based on the original project parameters.

Even if the terraces were built with a zero top width and only one foot above the low water elevation, the cost would exceed the original estimate. The initial top of terrace elevation would have to be built at +3.81 feet to allow for settlement. Using this terrace section, would still involve the excavation and placement of approximately 19.2 cubic yards of material per linear foot of terrace. To construct 90,000 linear feet of terraces would require 1,728,000 cubic yards of excavation. At the conservative unit price of $5.00 per cubic yard, the excavation would cost $8,640,000.00. Again, this does not include any cost for handling the unsuitable material in the top 10 foot of the borrow.

This price would also exceed the $335,000.00 cost outlined in the Proposed Project Information Sheet for construction of the terraces.

We do not feel that this project is feasible because of the cost required to construct the terraces. The 100,000 feet of terraces proposed to be built can not be achieved. Although, Orientation No. 1 would provide 90,000 feet of terraces by dredging a channel between the terraces that will be approximately 179 feet wide and vary from 4 feet to 14 feet deep. This channel would allow the same north-south wave action that now exists. The depth of the channel will increase the amount of sediment required to build the marsh between the terraces. These disadvantages out weigh the benefits that the terraces would provide.

References

U.S. Army Corps of Engineers (1984). Shore Protection Manuel. Volume II: Waterways Experiment Station. Vicksburg, MS: Coastal Engineering Research Center, U.S. Army Corps of Engineers.

U.S. Federal Emergency Management Agency (2000). Wave Heights and Wave Crest Elevations. *Coastal Construction Manuel: Principles and Practices of Planning, Siting, Designing, Construction and Maintaing Residential Buildings in Coastal Areas*, *Volume 1*, (Third Edition), 10-11.

National Oceanic and Atmospheric Administration/ National Geodetic Survey. *VERTCON.* Retrieved April 5, 2001 from the World Wide Web: http://www.ngs.noaa.gov/cgi-bin/VERTCON/vert_con.prl

APPENDIX A

GEOTECHNICAL ENGINEERING REPORT

PROPOSED EARTHEN TERRACES
CELLS “B”, “C”, AND “D”
BAYOU BIENVENUE PUMP STATION CANAL
NEW ORLEANS, LOUISIANA

PSI FILE NUMBER 254-05208-1 (REVISED)

PREPARED FOR

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JUNE 6, 2001

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June 6, 2001

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Re: Geotechnical Engineering Services
Proposed Earthen Terraces
Cells "B", "C", and "D"
Bayou Bienvenue Pump Station Canal
New Orleans, Louisiana
PSI File Number 254-05208-1 (Revised)

Dear Mr. Smith:

Professional Service Industries, Inc. is pleased to transmit our Preliminary Geotechnical Engineering Services Report for the referenced project. This report includes the results of field and laboratory testing, and recommendations for the proposed Earthen Terraces.

We appreciate the opportunity to perform this Geotechnical Study and look forward to continued participation during the design and construction phases of this project. If you have any questions pertaining to this report, or if we may be of further service, please contact our office.

Respectfully submitted,
PROFESSIONAL SERVICE INDUSTRIES, INC.

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GEOTECHNICAL ENGINEERING REPORT

PROPOSED EARTHEN TERRACES
CELLS "B", "C", AND "D"
BAYOU BIENVENUE PUMP STATION CANAL
NEW ORLEANS, LOUISIANA

PSI FILE NUMBER 254-05208-1 (Revised)

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EXECUTIVE SUMMARY

A preliminary exploration and evaluation of the subsurface conditions to determine the feasibility of the proposed earthen terraces has been completed in Cells "B", "C", and "D" in Bayou Bienvenue in New Orleans, Louisiana. The originally proposed scope of work included twenty six (26) borings to twenty five (25) feet and fourteen (14) borings to sixty (60) feet for the proposed earthen terraces as well as for other structures including a wier, boat bay and other developments. However, since the earthen terraces are of primary importance to the Louisiana Department of Natural Resources and as such the entire project is dependent upon the feasibility of constructing these terraces, the scope was reduced to a preliminary study to evaluate the feasibility of constructing the earthen terraces. A total of ten (10) soil test borings (B-1 thru B-10) have been drilled to a depth of 25 feet below mudline and selected soil samples tested in the laboratory. The subsoils encountered in the borings generally consisted of dark brown peat or very soft gray organic clay to a depth of about 10 feet. This is underlain by very soft gray clay to at least the 25 foot depth, the maximum depth explored.

It is understood that the proposed earthen terraces will have a crown elevation of +5.7 (NGVD) and a toe elevation of -1.5 to -2.5 (NGVD). Consideration is being given to use the on-site material in the bayou by dredging or excavating in order to build the proposed earthen terraces. The purpose of these terraces will be to slow the wave action in the bayou and to allow for marsh grass to grow in this area. In view of this, analyses were performed with regard to slope stability, bearing capacity and settlements for the proposed earthen terraces and the results are given in the subsequent sections.

The owner/designer should not rely solely on this Executive Summary and must read and evaluate the entire contents of this report prior to utilizing our engineering recommendations in preparation of design/construction documents.

PROJECT INFORMATION

Project Authorization

Professional Service Industries, Inc. (PSI) has completed a preliminary geotechnical exploration for the proposed earthen terraces in Bayou Bienvenue cells "B", "C", and "D", in New Orleans, Louisiana. Our services were authorized by Mr. Jim Smith of Hartman Engineering, Inc., Consulting Engineers, for the Project. This exploration was accomplished in general accordance with PSI Proposal Nos. 254-0134 (2nd revision) dated October 19, 2000.

Project Description

It is understood that the proposed construction will consist of approximately 100,000 linear feet of earthen terraces in cells "B", "C", and "D" in Bayou Bienvenue. Furnished information indicates that the crown width of the proposed terraces will be 15 feet and will have an elevation of +5.7 (NGVD). The mudline in Bayou Bienvenue cells "B", "C", and "D" in the area of the proposed terraces is at EL.-1.5 to EL.-2.5 (NGVD). It is further understood that construction of terraces will consist of dredging or excavating the bayou adjacent to the area of the proposed terraces and use this on-site material to build the terraces. Furnished information also indicates that the water level in the cells is about 3 to 6 feet and the low water level could reach the mudline elevation of -1.5 to -2.5 (NGVD).

The geotechnical recommendations presented in this report are based on the available project information, proposed terraces cross section and locations and the subsurface materials described in this report. If any of the noted information is incorrect, please inform PSI in writing so that we may amend the recommendations presented in this report if appropriate and if desired by the client. PSI will not be responsible for the implementation of its recommendations when it is not notified of changes in the project.

Purpose and Scope of Services

The purpose of this study was to explore the subsurface conditions at the site to enable an evaluation of bearing capacity, settlement and slope stability for the proposed earthen terraces. Our scope of services included drilling ten (10) borings (B-1 thru B-10) to a depth of 25 feet below mudline, select laboratory testing and preparation of this geotechnical report. Boring B-11, which was part of our scope of work, was not drilled since the southeast corner of the site was not accessible due to stumps, logs, etc. This report briefly outlines the testing procedures, presents available project information, describes the site and subsurface conditions and presents preliminary recommendations regarding the following:

- Bearing capacity, slope stability and estimates of settlements for the proposed earthen terraces;
- Constructability and use of on-site material for construction of the proposed earthen terraces;
- Comments regarding factors that will impact construction and performance of the proposed construction.

The scope of services did not include an environmental assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, surface water, groundwater, or air on or below, or around this site. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes. Prior to development of this site, an environmental assessment is advisable.

SUBSURFACE CONDITIONS

Field Exploration

The field exploration, which was performed to evaluate the engineering characteristics of the foundation materials, included a reconnaissance of the project site, drilling test borings and recovering undisturbed and representative disturbed soil samples. Water level measurements of any groundwater encountered in the test borings were also observed and recorded.

As discussed above, ten (10) soil borings (B-1 thru B-10) were drilled to depths of 25 feet in cells "B", "C", and "D". This included four (4) borings in cell "B" and three (3) borings in each of the cells "C" and "D". The boring depths are in reference to the existing ground surface at the time of the field exploration. The number and depth of the borings were determined by PSI. The approximate location of the borings are indicated on the plan included in Appendix I. Also, given in this Appendix are the latitude and longitude of the boring locations.

Drilling and Sampling Procedures

All borings were drilled with a barge mounted drilling rig equipped with a rotary head. Hollow-stem auger and wet rotary techniques were used to advance the boreholes. Samples were generally obtained contiguously from the ground surface to a depth of ten feet and at maximum five foot intervals thereafter.

Undisturbed samples of cohesive soils were generally obtained using thin-wall tube sampling procedures in general accordance with the procedures for "Thin-Walled Tube Geotechnical Sampling of Soils" (ASTM D 1587). These samples were extruded in the field with a hydraulic ram. Undisturbed and disturbed samples were identified according to boring number and depth, were placed in polyethylene plastic wrapping to protect against moisture loss, and were transported to the laboratory in special containers to prevent disturbance.

All of the samples obtained from the field exploration were identified and evaluated by experienced geotechnical personnel upon arrival at the laboratory.

Laboratory Testing Program

In addition to the field exploration, a supplemental laboratory testing program was conducted to evaluate additional pertinent engineering characteristics of the foundation materials necessary in analyzing the behavior of the proposed earthen terraces with regard to bearing capacity, slope stability and settlement.

The laboratory testing program included supplementary visual classification and water content tests on the soil samples. In addition, selected samples were subjected to unconfined compression testing, and Atterberg Limits and consolidation tests. Additional estimates of shear strength were also determined through the use of a hand torvane.

The laboratory testing program was conducted in general accordance with applicable ASTM Specifications. The results of these tests can be found on the accompanying boring logs located in Appendix II. The consolidation test results are also given in Appendix II.

Subsurface Condition

Reference to the logs of borings shows that beginning at the ground surface there is very soft to soft gray organic clay or dark brown peat with organic clay to a depth of about 10 feet. This is underlain by very soft gray clays to at least the 25 foot depth, the maximum depth explored.

The above subsurface description is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The boring logs included in the appendix should be reviewed for specific information at the boring locations. These records include soil descriptions, stratifications, penetration resistances, locations of the samples and laboratory test data. The stratifications shown on the boring logs represent the conditions only at the actual boring locations. Variation may occur and should be expected between the boring locations. The stratifications represent the approximate boundary between subsurface materials and the actual transition may be gradual. Water level information obtained during field operations is also shown on the boring logs. The samples, which were not altered by laboratory testing will be retained for 60 days from the date of this report and then will be discarded.

Groundwater Information

The water depth to the mudline at the boring locations in cells "B", "C", and "D" of the Bayou Bienvenue area at the time of drilling ranged from 2 to 4 feet. The water depth in the Bayou Bienvenue can fluctuate due to precipitation, tidal fluctuation, etc.

RECOMMENDATIONS

General

As discussed previously, it is understood that the proposed construction will consist of approximately 100,000 linear feet of earthen terraces in cells "B", "C", and "D" in Bayou Bienvenue. Furnished information indicates that the crown of the earthen terraces will be 15 feet in width at EL.+5.7 NGVD. The bottom or toe of terraces will be at EL.-1.5 to -2.5 NGVD and the terraces will have side slopes of one (1) vertical on ten (10) horizontal. It is further understood that the area near the proposed terraces will be dredged and the dredged material will be used to build the terraces. Analyses were performed based on the above design parameters and the subsurface data from our borings for bearing capacity, slope stability and settlement of the proposed terraces and the results are given below in the subsequent sections.

Soil Bearing Capacity

The soil bearing value varies depending on the type of soil which is present at or below the bottom of the proposed terraces. The near surface soils generally consist of very soft organic clay or peat with organic clays at the subject site and is believed to have enough bearing capacity to support the proposed terraces; however, this will result in some immediate and long term substantial subsidence.

Estimated Settlements

Based on the borings, laboratory test data and furnished load conditions, it is believed that the subsoils will experience extensive subsidence and settlements. It is believed that that settlement of the proposed terraces will be as high as 2½ feet with up to 50 percent of this settlement occurring during construction.

Slope Stability Analyses

Slope stability analyses were performed for the proposed terraces having a side slope of one (1) vertical on ten (10) horizontal (IV:10H). The crown elevation of the terraces is understood to be at EL.+5.7 and toe elevation of terraces at EL.-1.5 to E.L.-2.5 NGVD. Considering that the dredged material near the proposed terraces will be used for construction of terraces, it is recommended that the dredge area be at least 50 feet from toe of the terraces and the dredge channel should have a minimum side slope of 1V:3H.

The upper 8 to 10 feet of the subsoils encountered in the borings consist of very soft organic clays, clay or peat. It is believed that most of the dredged material from the upper 10 feet of the subsoils may have to be wasted due to high peat and organic content of these soils which are not suitable for construction of the proposed earthen terraces. Any remaining organic clays or clays that may be usable for construction of earthen terraces should be placed in horizontal lifts not exceeding one (1) foot and should be mechanically tamped to achieve some compaction of the material.

In view of this, slope stability analyses were performed based on the "wedge method" to determine the stability of the proposed terraces. It is understood that the low water could be near the toe elevation of the proposed terraces at EL.-1.5 to -2.5 NGVD.

Results of slope stability are given in Figures 1 and 2 of the Appendix III. A minimum factor of safety of 1.1 is calculated for the proposed terraces, which is believed to be adequate for this type of construction. It is important to note that this is based on the dredged area being at least 50 feet from the toe of the proposed terraces.

REPORT LIMITATIONS

The recommendations submitted in this report are preliminary and based on the available subsurface information obtained by PSI and design details furnished by Hartman Engineering, Inc. Before final design and preparation of plans and specifications, PSI should be retained to perform a detailed design level geotechnical report. If PSI is not notified of such changes, PSI will not be responsible for the impact of those changes on the project.

The geotechnical engineer warrants that the findings, recommendations, specifications, or professional advice contained herein have been made in accordance with generally accepted professional geotechnical engineering practices in the local area. No other warranties are implied or expressed.

After the plans and specifications are more complete, the geotechnical engineer should be retained and provided the opportunity to review the final design plans and specifications to check that our engineering recommendations have been properly incorporated into the design documents. At that time, it may be necessary to submit supplementary recommendations. If PSI is not retained to perform these functions, PSI will not be responsible for the impact of those conditions on the project. This report has been prepared for the exclusive use of Hartman Engineering, Inc. for the specific application to the proposed earthen terraces in Bayou Bienvenue in New Orleans, Louisiana.

APPENDIX I

Bayou Bienvenue – Boring Location

Boring No.	Latitude	Longitude
B-1	N 29° 58' 51"	W 89° 58' 52"
B-2	N 29° 58' 17"	W 89° 58' 42"
B-3	N 29° 58' 32"	W 89° 58' 28"
B-4	N 29° 58' 30"	W 89° 58' 3"
B-5	N 29° 59' 00"	W 89° 57' 47"
B-6	N 29° 59' 6"	W 89° 57' 40"
B-7	N 29° 59' 16"	W 89° 57' 50"
B-8	N 29° 58' 45"	W 89° 57' 17"
B-9	N 29° 58' 39"	W 89° 57' 20"
B-10	N 29° 58' 24"	W 89° 57' 31"

APPENDIX II

LOG OF BORING B-1

BAYOU BIENVENUE TERRACING
NEW ORLEANS, LOUISIANA

TYPE OF BORING: ROTARY WASH **LOCATION:** SEE APPENDIX **PSI PROJECT NO.** 254-05208

DEPTH, FT.	SOIL TYPE	SAMPLES	DESCRIPTION SURFACE ELEV.: EXISTING MUDLINE	N-BLOWS/FT.	UNCONFINED COMPRESSIVE STRENGTH tsf	HAND PENETROMETER tsf	TORVANE tsf	UNIT DRY WEIGHT pcf	MOISTURE CONTENT %	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200 SIEVE
	▨	■	Very soft dark gray organic clay with peat				0.05		335			
					0.06				223			
5					0.09				163			
	▒	■	Dark brown peat									
10									575			
	▨	■	Very soft gray clay with peat and wood fragments				0		135			
15												
	▨	■	Very soft gray clay									
20												
25							0.05		88	87	63	
			Boring terminated at 25 feet									
30												
35												
40												
45												
50												

DEPTH OF BORING: 25 Feet **WATER DEPTH TO MUDLINE:** 3'

DATE: 11-29-00

LOG OF BORING B-2

BAYOU BIENVENUE TERRACING
NEW ORLEANS, LOUISIANA

TYPE OF BORING: ROTARY WASH LOCATION: SEE APPENDIX PSI PROJECT NO. 254-05208

DEPTH, FT.	SOIL TYPE	SAMPLES	DESCRIPTION SURFACE ELEV.: EXISTING MUDLINE	N-BLOWS/FT.	UNCONFINED COMPRESSIVE STRENGTH tsf	HAND PENTROMETER tsf	TORVANE tsf	UNIT DRY WEIGHT pcf	MOISTURE CONTENT %	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200 SIEVE
	▨	■	Very soft gray clay with organic		0.16		0.1		74.2			
	▨	■	-with wood				0.02		85.7			
5	▨	■			0.02		0.05		147			
	▓	■	Dark brown peat						551			
10	▓											
	▨		Very soft gray clay with silt seams, 13' to 15'									
15	▨	■							90			
20	▨	■	-with sand						41			
25	▨	■			0.13		0.05		80			
			Boring terminated at 25 feet									
30												
35												
40												
45												
50												

DEPTH OF BORING: 25 Feet WATER DEPTH TO MUDLINE: 3'

DATE: 11-29-00

psi *Geotechnical Consulting Services*
Jefferson, Louisiana

LOG OF BORING B-3

BAYOU BIENVENUE TERRACING
NEW ORLEANS, LOUISIANA

TYPE OF BORING: ROTARY WASH

LOCATION: SEE APPENDIX

PSI PROJECT NO. 254-05208

DEPTH, FT.	SOIL TYPE	SAMPLES	DESCRIPTION	N-BLOWS/FT.	UNCONFINED COMPRESSIVE STRENGTH tsf	HAND PENTROMETER tsf	TORVANE tsf	UNIT DRY WEIGHT pcf	MOISTURE CONTENT %	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200 SIEVE
			SURFACE ELEV.: EXISTING MUDLINE									
	▨	■	Very soft gray organic clay with peat				0.05		112			
	▨	■					0.1		192			
5	▓	■	Dark brown peat with organic clay				0		400			
	▓	■							397			
	▓	■					0		151			
10	▨	■	Very soft gray clay with organic									
15	▨	■										
20	▨	■					0.04		70			
25	▨	■			0.07		0.05		52			
			Boring terminated at 25 feet									
30												
35												
40												
45												
50												

DEPTH OF BORING: 25 Feet

WATER O LINE: 3'

DATE 11-29-00

psi

Geotechnical Consulting Services
Jefferson, Louisiana

LOG OF BORING B-4

BAYOU BIENVENUE TERRACING
NEW ORLEANS, LOUISIANA

TYPE OF BORING: ROTARY WASH **LOCATION:** SEE APPENDIX **PSI PROJECT NO.** 254-05208

DEPTH, FT.	SOIL TYPE	SAMPLES	DESCRIPTION SURFACE ELEV.: EXISTING MUDLINE	N-BLOWS/FT.	UNCONFINED COMPRESSIVE STRENGTH tsf	HAND PENTROMETER tsf	TORVANE tsf	UNIT DRY WEIGHT pcf	MOISTURE CONTENT %	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200 SIEVE
	▨		Very soft gray clay with organic and peat				0.05		140			
	▒		Dark brown peat with roots						402			
5									277			
									511			
									242			
10												
	▨		Very soft gray clay with silt seams, 13' to 15'									
					0.09				76	50	32	
15												
							0.05		62			
20												
					0.22		0.1		76	85	62	
25												
			Boring terminated at 25 feet									
30												
35												
40												
45												
50												

DEPTH OF BORING: 25 Feet **WATER DEPTH TO MUDLINE:** 3'

DATE: 11-29-00

LOG OF BORING B-5

BAYOU BIENVENUE TERRACING
NEW ORLEANS, LOUISIANA

TYPE OF BORING: ROTARY WASH   LOCATION: SEE APPENDIX   PSI PROJECT NO. 254-05208

DEPTH, FT.	SOIL TYPE	SAMPLES	DESCRIPTION SURFACE ELEV.: EXISTING MUDLINE	N-BLOWS/FT.	UNCONFINED COMPRESSIVE STRENGTH tsf	HAND PENTROMETER tsf	TORVANE tsf	UNIT DRY WEIGHT pcf	MOISTURE CONTENT %	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200 SIEVE
	▒	■	Dark brown peat with roots with organic clay				0.05		353			
	▒	■							361			
5	▒	■							538			
	▒	■							258			
10	▒											
	▨		Very soft gray clay with silt seams, 13' to 15'									
	▨	■					0.05		80	67	47	
15	▨											
	▨	■			0.19				89			
20	▨											
	▨	■					0.05		89			
25	▨											
			Boring terminated at 25 feet									
30												
35												
40												
45												
50												

DEPTH OF BORING: 25 Feet   WATER DEPTH TO MUDLINE: 2'

DATE: 11-29-00

psi *Geotechnical Consulting Services*
Jefferson, Louisiana

LOG OF BORING B-6

BAYOU BIENVENUE TERRACING
NEW ORLEANS, LOUISIANA

TYPE OF BORING: ROTARY WASH LOCATION: SEE APPENDIX PSI PROJECT NO. 254-05208

SURFACE ELEV.: EXISTING MUDLINE

DEPTH, FT.	SOIL TYPE	SAMPLES	DESCRIPTION	N-BLOWS/FT.	UNCONFINED COMPRESSIVE STRENGTH tsf	HAND PENTROMETER tsf	TORVANE tsf	UNIT DRY WEIGHT pcf	MOISTURE CONTENT %	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200 SIEVE
	▦		Dark brown peat with roots									
									694			
5	▨		Very soft dark gray organic clay with peat						333			
					0.06		0.05		279			
									252			
10												
	▨		Very soft gray clay with silt seams, 13' to 15'									
					0.11		0.05		83			
15												
20												
					0.14		0.1		77			
25												
			Boring terminated at 25 feet									
30												
35												
40												
45												
50												

DEPTH OF BORING: 25 Feet WATER DEPTH TO MUDLINE: 2'

DATE: 11-29-00

psi *Geotechnical Consulting Services*
Jefferson, Louisiana

LOG OF BORING B-7

BAYOU BIENVENUE TERRACING
NEW ORLEANS, LOUISIANA

TYPE OF BORING: ROTARY WASH
LOCATION: SEE APPENDIX
PSI PROJECT NO. 254-05208

DEPTH, FT.	SOIL TYPE	SAMPLES	DESCRIPTION SURFACE ELEV.: EXISTING MUDLINE	N-BLOWS/FT.	UNCONFINED COMPRESSIVE STRENGTH tsf	HAND PENTROMETER tsf	TORVANE tsf	UNIT DRY WEIGHT pcf	MOISTURE CONTENT %	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200 SIEVE
			Dark brown peat with roots with organic clay									
									473			
5									374			
									300			
10												
			Very soft gray clay with organics, 13' to 15'									
					0.06				97			
15												
							0.05		88	61	40	
20												
							0.05		83			
25												
			Boring terminated at 25 feet									
30												
35												
40												
45												
50												

DEPTH OF BORING: 25 Feet
WATER DEPTH TO MUDLINE: 2'
DATE: 11-29-00

psi *Geotechnical Consulting Services*
Jefferson, Louisiana

LOG OF BORING B-8

BAYOU BIENVENUE TERRACING
NEW ORLEANS, LOUISIANA

TYPE OF BORING: ROTARY WASH | LOCATION: SEE APPENDIX | PSI PROJECT NO. 254-05208

DEPTH, FT.	SOIL TYPE	SAMPLES	DESCRIPTION SURFACE ELEV.: EXISTING MUDLINE	N-BLOWS/FT.	UNCONFINED COMPRESSIVE STRENGTH tsf	HAND PENTROMETER tsf	TORVANE tsf	UNIT DRY WEIGHT pcf	MOISTURE CONTENT %	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200 SIEVE
	▒	■	Dark brown peat with roots				0.05		390			
	▒	■	-with trace of clay, 2' to 10'				0.05		137			
5	▨	■	Very soft dark gray organic clay				0.05		94			
	▨	■					0.05		140	123	93	
	▨	■							138			
10	▨											
	▨		Very soft gray clay with silt seams, 13' to 15'									
	▨	■							66	46	26	
15	▨											
	▨	■			0.18		0.1		95			
20	▨											
	▨	■					0.05		74	68	46	
25			Boring terminated at 25 feet									
30												
35												
40												
45												
50												

DEPTH OF BORING: 25 Feet

WATER DEPTH TO MUDLINE: 4'

DATE: 11-29-00

psi *Geotechnical Consulting Services*
Jefferson, Louisiana

LOG OF BORING B-9

BAYOU BIENVENUE TERRACING
NEW ORLEANS, LOUISIANA

TYPE OF BORING: ROTARY WASH LOCATION: SEE APPENDIX PSI PROJECT NO. 254-05208

DEPTH, FT.	SOIL TYPE	SAMPLES	DESCRIPTION SURFACE ELEV.: EXISTING MUDLINE	N-BLOWS/FT.	UNCONFINED COMPRESSIVE STRENGTH tsf	HAND PENTROMETER tsf	TORVANE tsf	UNIT DRY WEIGHT pcf	MOISTURE CONTENT %	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200 SIEVE
			Dark brown peat with roots with organic clay									
									602			
5									538			
									455			
									500			
10												
			Very soft gray clay with silt seams, 13' to 15'									
					0.03				71			
15												
							0.05		73	81	58	
20												
					0.17				65			
25												
			Boring terminated at 25 feet									
30												
35												
40												
45												
50												

DEPTH OF BORING: 25 Feet WATER DEPTH TO MUDLINE: 4'

DATE: 11-29-00

LOG OF BORING B-10

BAYOU BIENVENUE TERRACING
NEW ORLEANS, LOUISIANA

TYPE OF BORING: ROTARY WASH **LOCATION:** SEE APPENDIX **PSI PROJECT NO.** 254-05208

DEPTH, FT.	SOIL TYPE	SAMPLES	DESCRIPTION SURFACE ELEV.: EXISTING MUDLINE	N-BLOWS/FT.	UNCONFINED COMPRESSIVE STRENGTH tsf	HAND PENTROMETER tsf	TORVANE tsf	UNIT DRY WEIGHT pcf	MOISTURE CONTENT %	LIQUID LIMIT	PLASTICITY INDEX	% PASSING #200 SIEVE
			Dark brown peat with roots									
5												
10			Very soft gray clay with silt seams, 13' to 20'		0.06				96			
15					0.11				65			
20							0.1		40			
25					0.13		0.1		72			
			Boring terminated at 25 feet									
30												
35												
40												
45												
50												

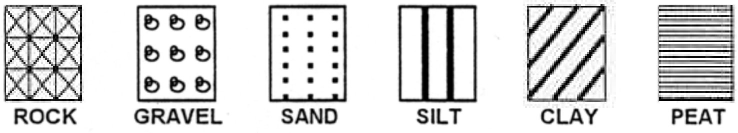
DEPTH OF BORING: 25 Feet **WATER DEPTH TO MUDLINE:** 4'

DATE: 11-29-00

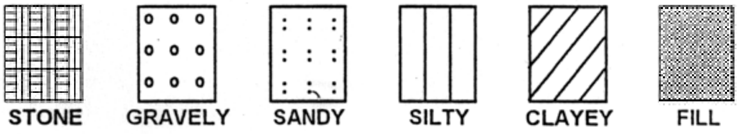
psi *Geotechnical Consulting Services*
Jefferson, Louisiana

KEY TO TERMS AND SYMBOLS USED ON LOGS

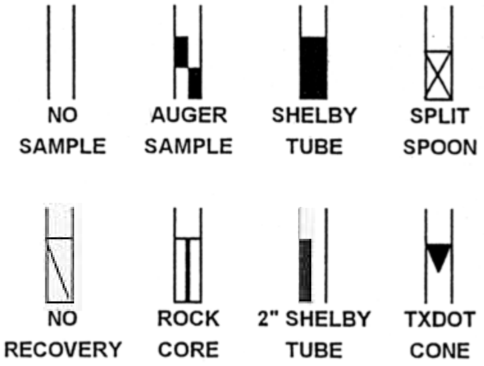
SOIL TYPE



MODIFIERS



SAMPLER TYPE



UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D 2487 (1980)

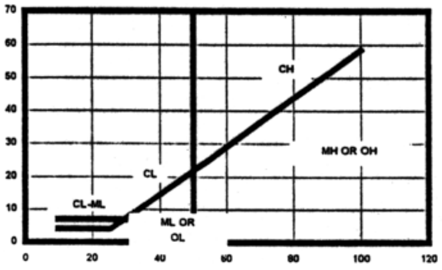
MAJOR DIVISIONS			LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS LESS THAN 50% PASSING NO. 200 SIEVE	GRAVEL & GRAVELY SOILS LESS THAN 50% PASSING NO. 4 SIEVE	CLEAN GRAVEL (LITTLE OR NO FINES	GW	WELL GRADED GRAVEL, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
			GP	POORLY GRADED GRAVEL, GRAVEL-SAND MIXTURES WITH LITTLE OR NO FINES
		W/ APPRECIA BLE FINES	GM	SILTY GRAVEL, GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES
	SANDS MORE THAN 50% PASSING NO. 4 SIEVE	CLEAN SANDS LITTLE FINES	SW	WELL GRADED SAND, GRAVELY SAND (LITTLE FINES)
			SP	POORLY GRADED SANDS, GRAVELY SAND (L.FINES)
		SANDS WITH APPREA. FINES	SM	SILTY SANDS, SAND-SILT MIXTURES
			SC	CLAYEY SANDS,SAND-CLAY MIXTURES
FINE GRAINED SOILS MORE THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS & VERY FINE SANDS,ROCK FLOUR SILTY OR CLAYEY FINE SANDS OR CLAYEY SILT W/ LOW PI
			CL	INORGANIC CLAY OF LOW TO MEDIUM PI LEAN CLAY GRAVELY CLAYS, SANDY CLAYS, SILTY CLAYS
			OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PI
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY FAT CLAYS
			OH	ORGANIC CLAYS OF MED TO HIGH PI, ORGANIC SILT
HIGHLY ORGANIC SOIL			PT	PEAT AND OTHER HIGHLY ORGANIC SOILS
UNCLASSIFIED FILL MATERIALS			ARTIFICIALLY DEPOSITED AND OTHER UNCLASSIFIED SOILS AND MAN-MADE SOIL MIXTURES	

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	SHEAR STRENGTH IN TONS/FT^2
VERY SOFT	0. TO 0.125
SOFT	0.125 TO 0.25
FIRM	0.25 TO 0.5
STIFF	0.5 TO 1.0
VERY STIFF	1.0 TO 2.0
HARD	> 2.0 OR 2.0+

RELATIVE DENSITY - GRANULAR SOILS

CONSISTENCY	N-VALUE (BLOWS/FOOT)
VERY LOOSE	0-4
LOOSE	4-9
MEDIUM DENSE	10-29
DENSE	30-49
VERY DENSE	> 50 OR 50+



ABBREVIATIONS

HP - HAND PENETROMETER

TV - TORVANE

MV - MINIATURE VANE

UC - UNCONFINED COMPRESSION TEST

UU - UNCONSOLIDATED UNDRAINED TRAIXIAL

CU - CONSOLIDATED UNDRAINED

NOTE: PLOT INDICATES SHEAR STRENGTH AS OBTAINED BY ABOVE TESTS

▼ HYDRO-STATIC WATER LEVEL

▽ WATER LEVEL UNDER HYDRO - STATIC PRESSURE HEAD

CLASSIFICATION OF GRANULAR SOILS

U.S. STANDARD SIEVE SIZE(S)

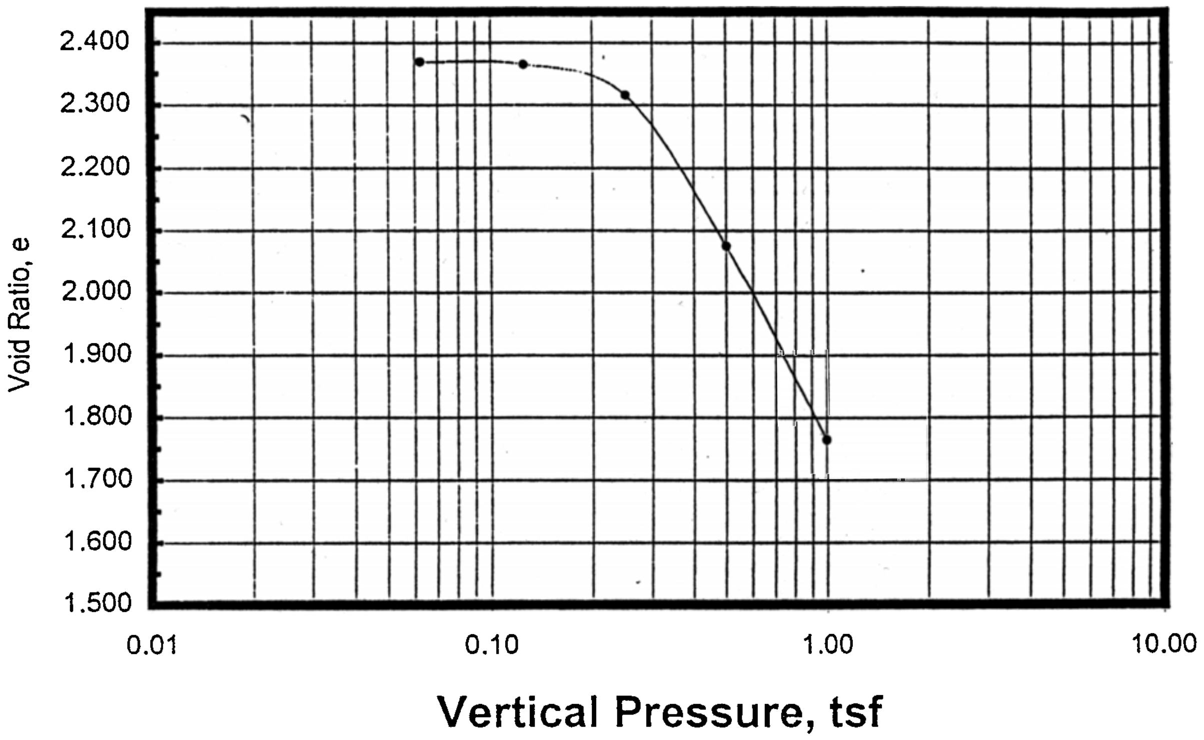
6" 3" 3/4" 4 10 40 200

BOUL- -DERS	COBBLES	GRAVEL		SAND			SILT OR CLAY	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		

152 76.2 19.1 4.76 2.0 0.42 0.074 0.002

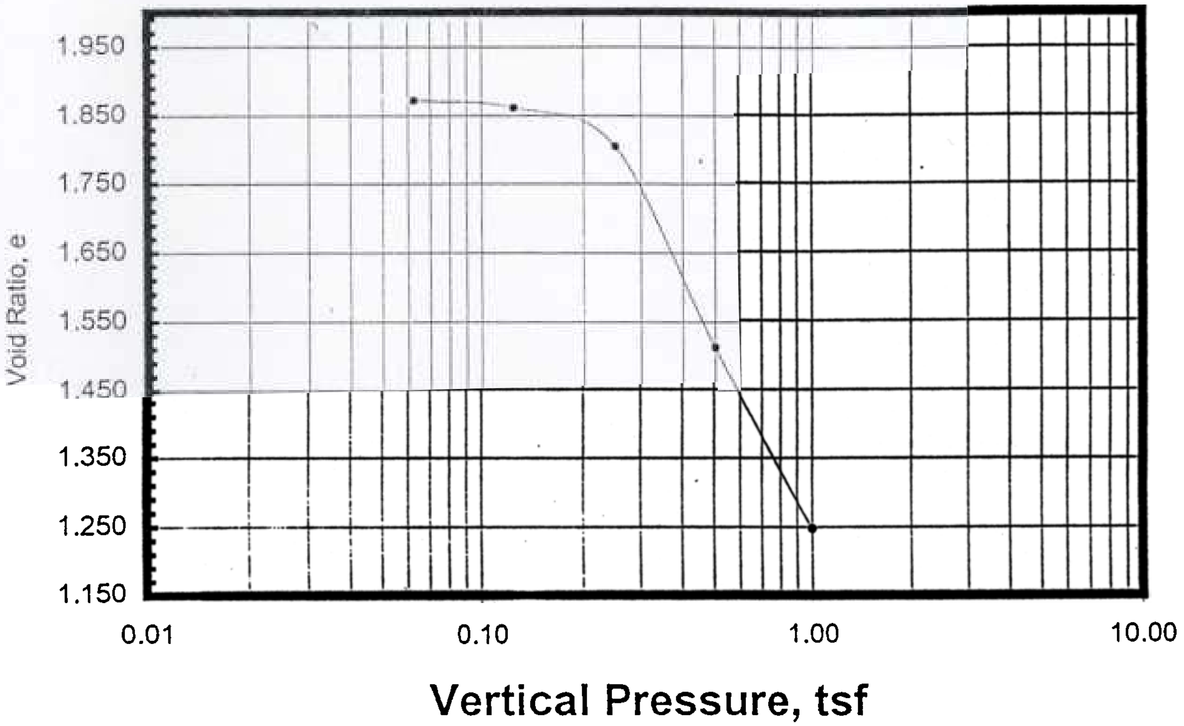
GRAIN SIZE IN MM

CONSOLIDATION TEST RESULTS - ASTM D2435



Moisture Content (Before):	87.6%	Boring B-1 Depth: 23-25 feet Material: Gray Fat Clay
Moisture Content (After):	--	
Dry Density:	40.3 lb/ft^3	
Initial Void Ratio, e_o:	2.371	**Bayou Bienvenue** **PSI File No.: 254-05209** **Date: 1-09-01**
Est. Pre-Consolidation Press. P_c:	0.5 ksf	
Est. Lab Re-Compression Index, C_r:	--	
Est. Lab Compression Index, C_c:	0.80	

CONSOLIDATION TEST RESULTS - ASTM D2435



Moisture Content (Before):	75.5%
Moisture Content (After):	--
Dry Density:	46.7 lb/ft^3

Boring B-4
Depth: 13-15 feet
Material: Gray Fat Clay with silt seams

Initial Void Ratio, $e_{o:}$	1.876
Est. Pre-Consolidation Press. P_c:	0.5 ksf
Est. Lab Re-Compression Index, C_r:	--
Est. Lab Compression Index, C_c:	0.97

Bayou Bienvenue
PSI File No.: 254-05209
Date: 1-09-01

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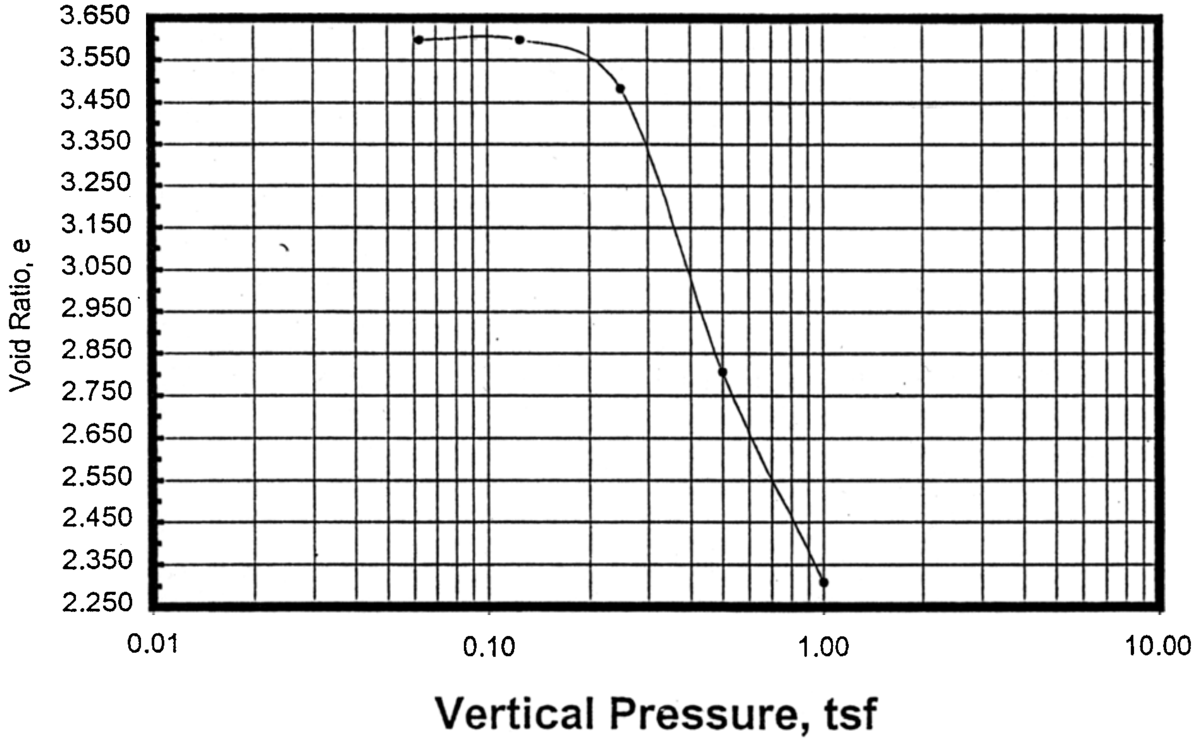

Moisture Content (Before):	140.3%
Moisture Content (After):	--
Dry Density:	34.1 lb/ft^3

Boring B-8
Depth: 6- 8 feet
Material: Dark Brown Clay with Peat

Initial Void Ratio, e_o:	3.599
Est. Pre-Consolidation Press. P_c:	0.4 ksf
Est. Lab Re-Compression Index, C_r:	--
Est. Lab Compression Index, C_c:	2.25

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