Technical Report No. VI.

Case Study of the SELA Dwyer Road Drainage Pumping Station Improvements, Discharge Tubes and Canal

Report to

Katrina Canal Breaches Consolidated Litigation

[Civil Action Number: 05-4182 "K" (2)]

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Eastern District of Louisiana

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(No. 06-2268)

By

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Case Study of the SELA Dwyer Road Drainage Pumping Station Improvements, Discharge Tubes and Canal

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Abstract:

Several elements of the SELA Dwyer Road Drainage Pumping Station Improvements Discharge Tubes and Canal project ("Dwyer Road Canal") illustrate the roles of underseepage and soil heave in the design and construction of this and other similar facilities. These include floodwall demolition, sheet pile Temporary Retaining Structures (TRS), and other pile foundation work.

During floodwall demolition, tree root debris was found at the tip of the sheet pile of the northern adjacent remaining T-wall section, which is an example of the types of non-homogeneous conditions and buried organic material at the site. Excavation of the TRS also revealed buried roots and humus at depths between the ground surface at approximately El (+) 5.0 ft NGVD and the bottom of the excavations as deep as El (-) 14.4 ft NGVD. Soils inside many parts of the dewatered and excavated TRS were saturated despite dewatering controls and monitoring. Additional soil boring work suggested differences between the actual soil conditions and those reported in the contract solicitation and used for design purposes.

Following pulling of the existing support piles for the T-wall, the resulting voids in the soil were filled with a bentonite slurry and during this process the fluid migrated to non-filled adjacent voids, indicating highly permeable soils.

The installation of timber pile foundations for the concrete box canal coincided with soil heave inside of the TRS, as the elevation at the bottom of the excavation raised upon driving the piles, requiring additional excavation after pile driving in order to achieve the specified depth.

The documents reviewed for this report provide only the pre-planning and in some cases initial phases of the project (e.g. Submittals, start-up tests, etc.) Further research will be necessary in order to better correlate the time, events, and locations associated with this project. This includes Daily and Monthly Quality Control and Quality Assurance (CQ/QA) reports and other specific documents and the following:

- A 3-Step process for gathering information, including 1) Pre-planning (Identify activities and time periods of interest), 2) Retrieve Documents, and 3) Follow-Up with specific questions or more information.
- Chronological organization of photographs, and
- Research Survey and Elevation Data to evaluate the reliability of the given information.

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I. Introduction

This Case Study of the SELA Dwyer Road Drainage Pumping Station Improvements, Discharge Tubes and Canal (USACE-a 1999) (aka "Dwyer Road Canal") project is presented to assist the Consolidated Katrina Litigation in understanding the role of underseepage and soil heave associated with the design and construction of this and similar projects. This document is organized according to project activities, including floodwall demolition, sheet pile Temporary Retaining System (TRS), and Pile Foundations. Part I contains introductory material, including a brief history of the project beginning with authorization. Parts II, III, and IV address floodwall and embankment demolition, TRS, and Pile Foundation work, respectively, while Part V presents the Principal Findings of the case study.

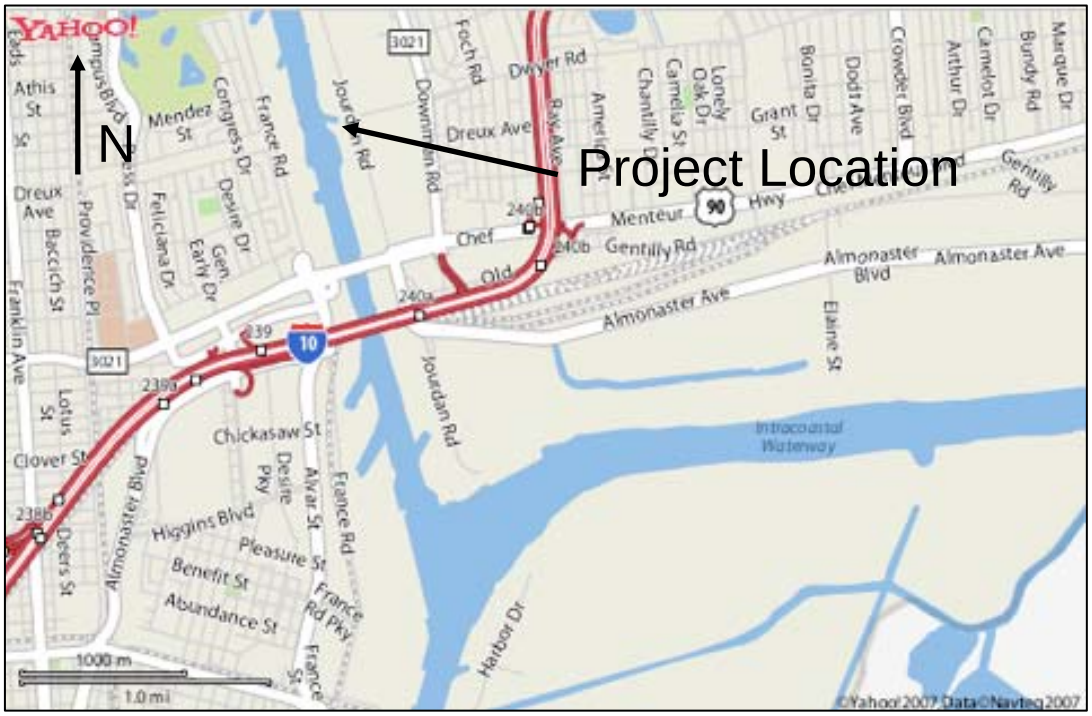


Figure 1. Project vicinity map for the SELA Dwyer Road Canal project. No Scale. (Yahoo! 2007)

1. Purpose

The purpose of this Case Study is to present information about the Dwyer Road Outfall project which contributes to understanding the roles of underseepage and soil heave on the design, construction, and performance of this and other facilities.

The study was authorized by the Consolidated Katrina Litigation- MRGO Plaintiff's Liason Council (PLC) under agreement with Risk Assessment Management Services (RAMS) and researcher David Rosenberg, PE with the assistance of the Dwyer Road Canal project Contractor, Melvin McElwee, Sr. who contributed his experiences and information about the work.

Three elements of the project are presented In order to illustrate the incidence of underseepage—the flow of water through soil media which are permeable due to the existence of interconnected voids between soil particles—and soil heave, which develops where underground seepage causes disturbance of soil on the downstream side (Das. 2006). These include floodwall demolition (I-wall, T-wall, and embankment), sheet pile Temporary Retaining Structures (TRS), and pile foundations. Additionally, these examples provide insight to how the design specifications, guidelines, and authorizations are addressed throughout the project.

2. Qualifications

This case study was prepared by researcher David Rosenberg, PE with the assistance of the Dwyer Road Canal project Contractor and Construction Quality Manager Melvin McElwee, Sr.

David Rosenberg is a licensed Professional Civil Engineer (PE) with 10 years of experience working on heavy civil engineering and marine construction projects, including offshore oil & gas, pipeline, coastal, waterfront, and other civil engineering facilities. This includes the trades of commercial diving, pile driving, and other heavy construction and related marine operations, as well as duties as a project engineer, consulting engineer, and owner's quality assurance inspector for federally-funded public works and other projects. Mr. Rosenberg is a registered Professional Civil Engineer (CA #C67357) and is pursuing post-Bachelor's education at the University of New Orleans—College of Engineering, having received a Bachelor's of Science in Civil & Environmental Engineering at the University of California, Berkeley in 1996. Since 2006 he has assisted Experts in the Court on matters related to Katrina Litigation.

Melvin McElwee, Sr. is the President of McElwee Bros. Inc., a State of Louisiana Contactor (Class II Highway, Street, and Bridge Construction) serving the heavy civil construction market including experience with Federal, State, and Local projects. Mr. McElwee has qualified as a USACE Construction Quality Assurance Representative as well as a Construction Quality Manager for Contractors, and is a U.S. Army National Guard Engineering Officer. He has also attended the University of New Orleans as a Civil Engineering student. (CQC-a 2001)

3. Southeast Louisiana Urban Flood Control Project—SELA

The Southeast Louisiana Project (SELA) was authorized by the U.S. Congress in Fiscal Year 1996 (FY96) Legislation to provide for engineering, design, and construction of projects for flood control and drainage in Jefferson, Orleans, and St. Tammany Parishes. This was a Federal legislative response to repetitive flood losses in the region, particularly the heavy rainfalls which occurred during May 8-10, 1995. Soon after, SELA was authorized through enactment of Section 108 of the Energy and Water Development Act (US Congress-a FY96), as well as Section 533 of the Water Resources Development Act (WRDA) of 1996. (USACE-b 2007) This legislation authorized the USACE to undertake the engineering design and construction of rainfall drainage systems in Jefferson, Orleans, and St. Tammany Parishes.

In Orleans Parish the Sewerage and Water Board of New Orleans (SWBNO) is the local partner for the SELA project, which enables SWBNO to undertake portions of the work to be credited toward the local funding only if "determined by the Secretary (of the Army) to be a compatible and integral part of the projects…" (U.S. Congress-b FY96). Further language in the authorizing legislation reinforces the USACE's authority with respect to future funding to determine "…that the additional work to be carried out with such funds is technically sound, environmentally acceptable, and economic, as applicable." This language is brought to the reader's attention in order to emphasize the leadership role of the USACE in

the planning, design, and management of SELA Projects, including work by local partners.

In the case of the Dwyer Road Canal project the SWBNO contracted a private firm, Design Engineering Inc. (DEI) to produce the design while the construction contract for the project was solicited and managed by the USACE NOD Contracting Division, with at least some funding for design and/or construction coming from the Louisiana Transportation Trust Fund through the Statewide Flood Control Program. (USACE-a 1999)

4. Design of the Dwyer Road Canal Project

The Dwyer Road Pumping Station Improvements were designed to improve drainage capacity tenfold to approximately a half million gallons per minute—1,114 cfs. (SWBNO 2004) The overall scope consisted of several parts and individual contracts under the SELA program including the pumping station, intake structure, and of course the discharge tubes and canal which is the focus of this case study.

The design of the discharge tubes and canal called for replacing the existing single 54-inch diameter discharge pipe with three 84-inch diameter steel tubes to carry drainage water from the pump station and into an underground concrete box canal leading into the Inner Harbor Navigation Canal (IHNC). This routed the new 84-inch discharge tubes underneath the existing floodwall system (Figures 2 & 3),

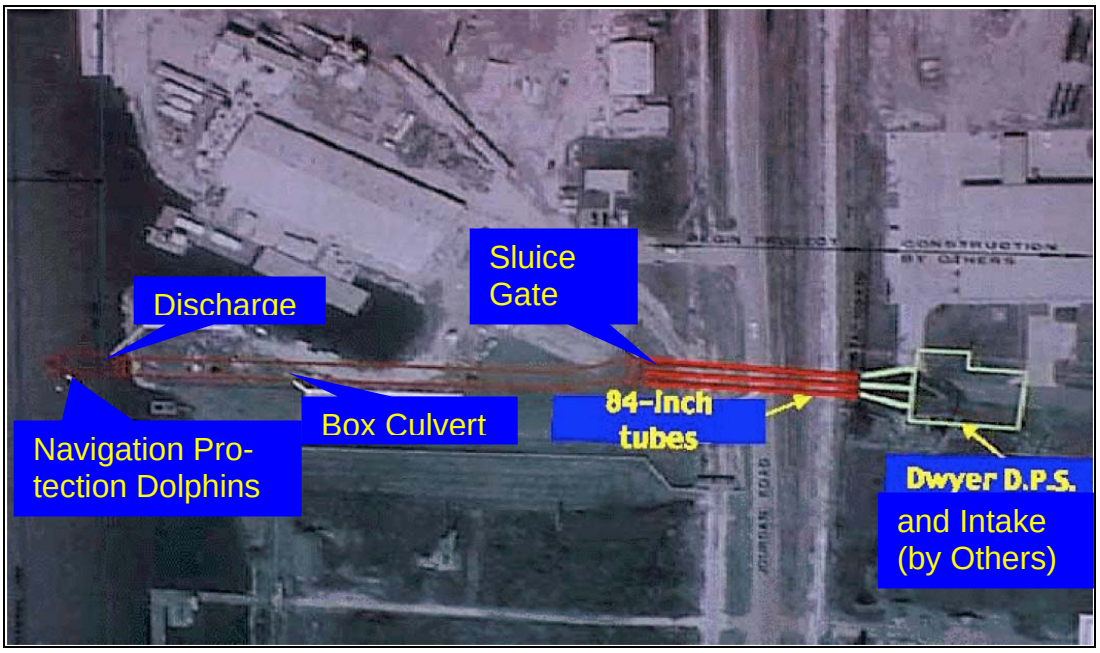


Figure 2 Site plan for the Dwyer Road Drainage Pumping Station Improvements. (adapted from SWBNO-a 2004)

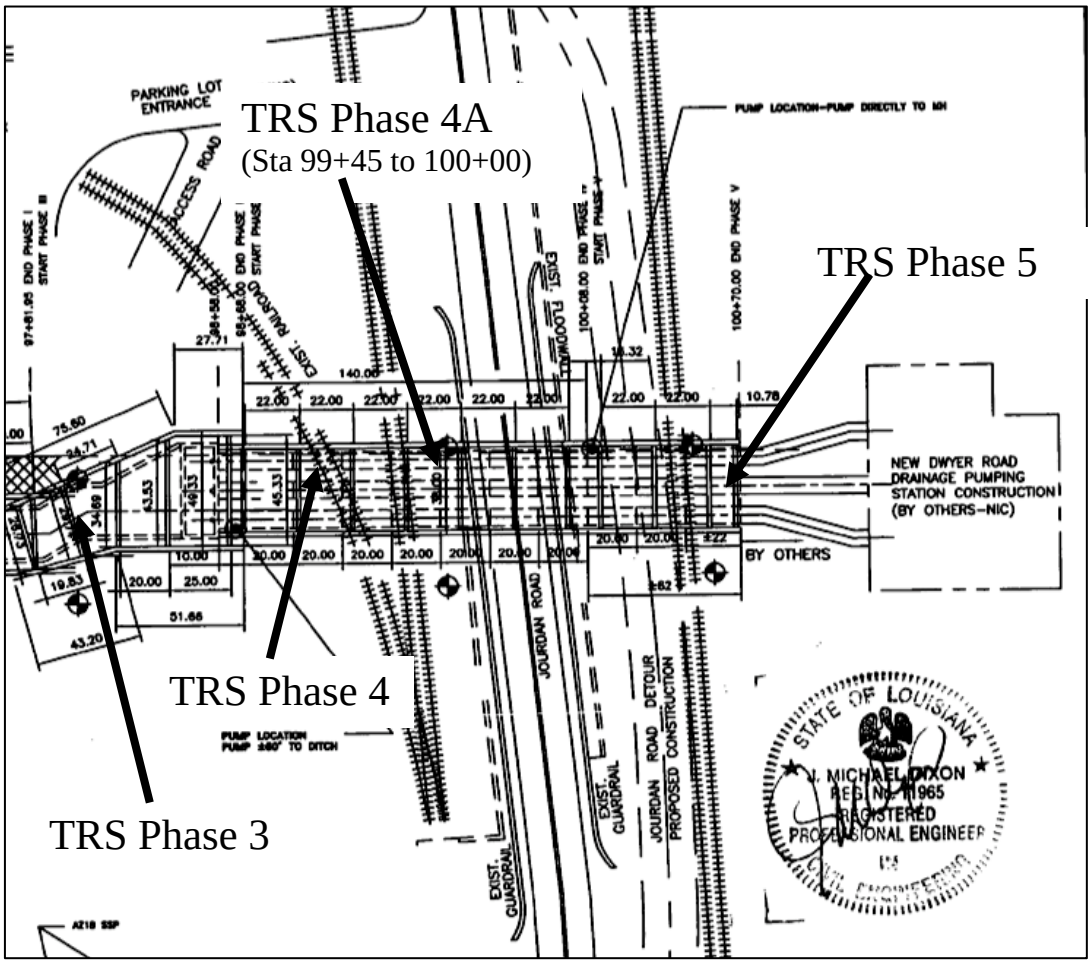


Figure 3 Partial view of the site showing the locations of TRS for Phases 3, 4, 4A, and 5 (the Sluice Gate Structure and 84-inch steel tubes.) (adapted from Dixon 2001)

Which required removing and later reconstructing a portion of T-wall and embankment. On the canal side of the floodwall, the three discharge tubes transition into a single 20-foot wide by 12-foot high underground concrete box canal via a sluice gate structure.

All of these structures are below ground, requiring extensive braced excavations up to approximately 20 ft. beneath existing grade using a sheet pile Temporary Retaining System (TRS) and wellpoint dewatering system. Various



Figure 4 Installation of pre-cast concrete outfall segments utilizing a sheet-ile Temporary Restraining System (TRS). (McElwee 2008)

phases of the TRS method were used throughout the project, including removal of a 30-inch abandoned sewer force main (30-inch SFM), as well as installation of the discharge structure, box culvert, and 84-inch steel discharge tubes as part of a jack & bore operation approved by the USACE which eliminated the need for temporary railroad bridges during construction. (USACE—Roth. 22 May 2003)

The canal is comprised of precast concrete sections (see Figures 4 and 5) placed on a slab-like base which is supported by timber piles. At one end of the canal is the sluice gate structure which receives the 84-inch diameter tubes and at the other end is the IHNC. Where the canal discharges in the IHNC several navigation protection “dolphins” were installed which are constructed of steel pipe piles joined by a concrete cap (see Figure 6.) As the construction progressed in 20 ft sections,

sand backfill was placed around the box canal and eventually the TRS was removed and a 1 ft. thick clay blanket placed a ground elevation.

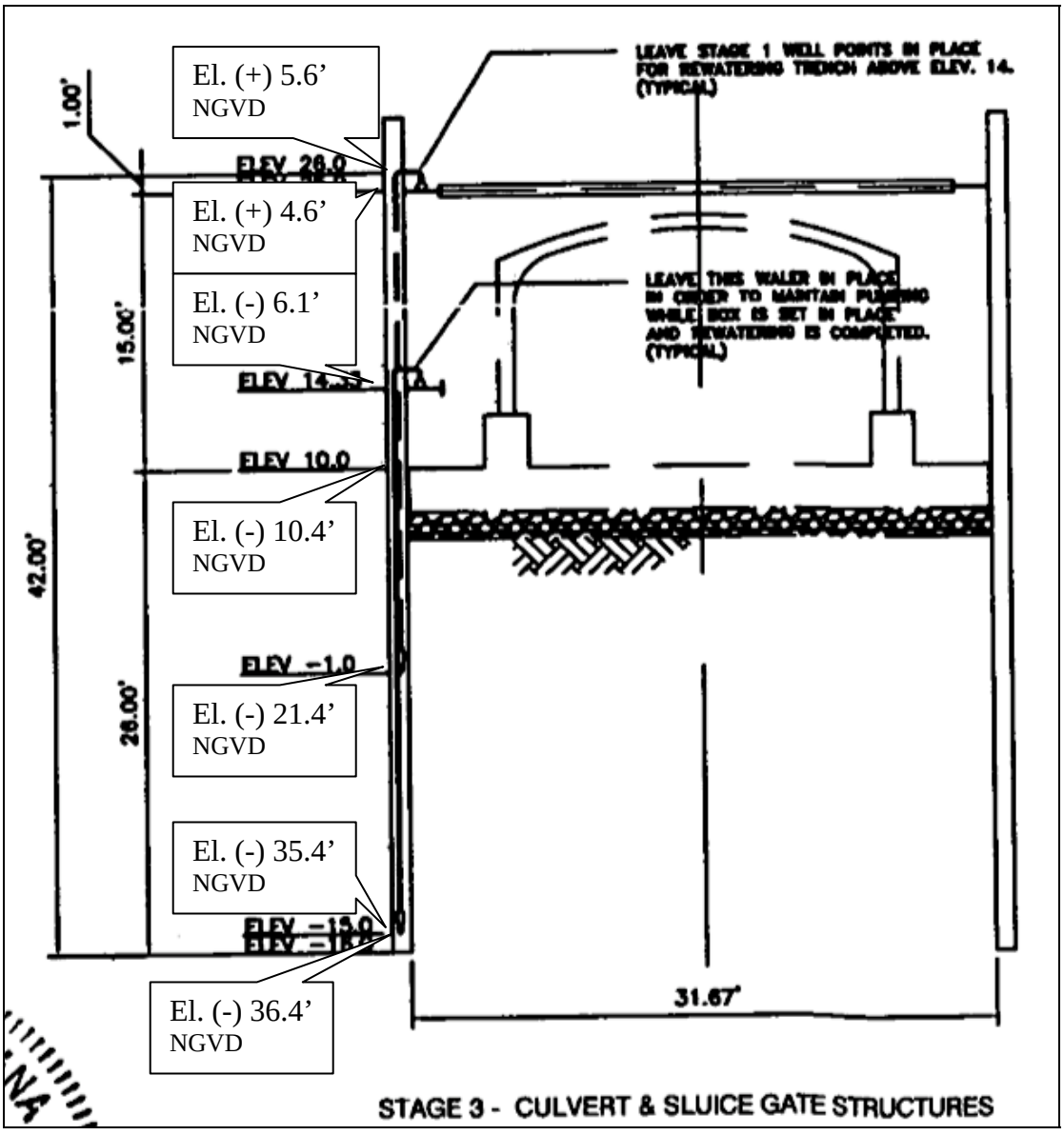


Figure 5 Design section view of TRS Stage 3 for the Box Culvert and Sluice Gate Structures installation (TRS Phases 1 and 3). (adapted from Dixon 2001)



Figure 6 View of the discharge location for the Dwyer Road Canal in the IHNC with construction TRS cofferdam in place and navigation protection dolphins installed looking south. (McElwee 2002)

While DEI was hired by the SWBNO to produce designs and documents for bid solicitation and construction (USACE-a) Eustis Engineering Company, in a Geotechnical Investigation report prepared for DEI specifically for the Dwyer Road Canal project, presented soil borings and lab testing results, Foundation Analyses, as well as recommendations for Preconstruction and Monitoring Considerations, and Geotechnical Services During Construction. (Eustis 1997)

Additional engineering design and analysis was performed throughout the project by these and other Professional Engineers retained by the Contractor, including J. Michael Dixon (TRS and other civil engineering) and Gore Engineers (Gore 2001, 2003) Some of this work was necessary as part of the original project

scope (e.g. TRS design, dewatering, and excavation plans) while other work was used to supplement information for value engineering proposals, ambiguities, changes, or disputes. Additionally, the initials or signatures & registrations designations of government employees appearing on the project documents are with in the scope of their employment as required by ER 1110-1-8152 (USACE-a 1999) This regulation, "Engineering and Design Professional Registration," requires professional registration for "key positions." (USACE-c 1995)

5. Solicitation of the Project

The Dwyer Road Canal project, USACE Solicitation No. DACW-99-B-0048, was advertised by the USACE for fixed-price construction bid in 2000 for 8(a) Small Disadvantaged Businesses (SDB). The U.S. Small Business Administration grants 8(a) status to qualifying firms and certain Federal contracts, including the Dwyer Road Canal project, are designated exclusively for 8(a) participation. McElwee Bros., Inc., as a qualified 8(a) SDB, was eligible to respond to the solicitation.

The solicitation process includes interested, available, and qualified bidders in a competitive bidding process at the lowest cost to the government. All prospective bidders work from the same information provided by the USACE Contracting Division and are notified of clarifying information and addendums as they arise. For the Dwyer Road Canal project the USACE issued the plans produced by DEI, which includes soil boring information from the Eustis Engineering Company's 1997 report for the Dwyer Road Canal project. (USACE-a 1999) The report itself was not a part of the solicitation, as Eustis' recommendation was that "This report should not be

included in the contract plans and specifications. However, the results of the soil borings and laboratory tests contained in Appendix A of this report may be included…" (Eustis 1997)

The solicitation process concludes with the submission and review of sealed bids from responsive bidders (e.g. those who meet all of the requirements.). A unique requirement of 8(a) solicitations is a review of the technical and financial capability of the firm in order to evaluate their ability to perform the work. McElwee Bros., Inc successfully responded to the Dwyer Road Canal solicitation, and was deemed to be technically capable of performing the work based on the Government's review of the company's capabilities and experience. In order to meet financial requirements, McElwee Bros., Inc. entered into a Joint Venture agreement with Tri-State Design Construction Company and was subsequently awarded the contract. (McElwee 2008)

6. Quality Control/ Quality Assurance and Submittals

In order to administer the USACE construction contract, a Contracting Officer (CO) is assigned by the Contracting Division of the USACE's New Orleans District (NOD), which "exercises the full breadth of authority through participation in acquisition planning, contract formulation, partnering, administration, resolution of disputes and claims by means of issuing Contracting Officer decisions and subsequent contract modifications… The Chief of Contracting is the principal advisor to the District Engineer and technical/support staff on policy and procedural matters pertaining to contracting activities " (USACE-d 2008)

Submittals are addressed in Engineering Regulation (ER) 415-10 "Contractor

Submittal Procedures" where "Submittal" is a term used to describe "all shop drawings, samples, letters of certification, tests, and other engineering information that may be required for quality control and assurance." The regulation also explains "Submittals are classified as 'government approved' or 'information only'. Submittals which will always require government approval are: extensions of design, critical materials, deviations... All submittals not requiring government approval are for information only. Within the terms of the Contract Clause entitled 'Specifications and Drawings for Construction', government approved submittals are considered to be 'shop drawings' whereas information only submittals are not." (USACE-e 1997)

The regulation further states under Government Responsibilities, "The designer will prepare a list of submittals required for each contract. This list must be very specific to allow the construction contractor to know exactly what it is that is required to be submitted." Likewise, the Contactor "is responsible for total management of his/her work, including the scheduling, control, and certification of all submittals." (

A list of the project submittals for the Dwyer Road Canal, as well as reference to the definable work item, is included as "Amendment 0002 Activity List" in correspondence from the Contractor to the USACE under the same reference. (CQC-b. 2001) Selected submittals which pertain to the work items which are the focus of this case study are addressed in Parts II, III, and IV.

The review period for submittals is scheduled far enough in advance of the planned work so as not to delay the start of the work, however if not timely or if revisions or additional information is required this process can impact the overall project schedule.

For USACE projects, the project Contractor Quality Control (CQC) plan outlines the Contractor's plan to manage the construction for each definable feature of work using the three phase control concept, which includes the preparatory phase, initial phase, and follow-up phase. (USACE-f 1990) The preparatory phase includes pre-job planning and Submittals (see below), while the initial and follow-up phases are implemented in the field to establish a level of quality and maintain it on an ongoing basis throughout the project.

Quality Assurance is provided by the representatives of the contracting officers, known as Quality Assurance Representatives. (USACE-g 1992) The USACE Quality Assurance Representative works on-site with the Contractor to construct the project safely and according to the plans and specifications. Engineer Pamphlet (EP) 715-1-2 "A Guide to Effective Contractor Quality Control (CQC) summarizes the responsibilities of each the Contractor and the Government as follows:

The **Contractor** is responsible for:

1) Producing the quality product on time and in compliance with the terms of the contract, 2) Establishing and utilizing a construction quality control program of the scope and character necessary to achieve the quality of construction outlined in the contract; and 3) Producing and maintaining acceptable records of its quality control activities.

The **Government** is responsible for:

1) Establishing construction standards and quality control requirements, 2) Construction management activities including, among others, checking adequacy of contractor's control (quality assurance for acceptance),

performing specified tests and inspection as designated in the contract, determining that reported construction deficiencies have been corrected; 3) Determining payments due to the contractor; and 4)assuring timely completion. (USACE-f 1990)

In addition to the USACE CO and QA Representatives, the design engineers usually remain involved in the construction to consult on technical matters, as well as visiting the site when necessary. For example, the 1997 Eustis Engineering report for the Dwyer Road Canal project recommends that "Eustis should be retained to monitor the geotechnical work performed by the contractor. This permits the geotechnical engineer that prepared the report to be on hand and quickly evaluate unanticipated conditions, conduct additional tests if required, and when necessary, recommend alternative solutions to problems. This is recommended to avoid major construction cost overruns or contractual disputes on the project." (Eustis 1997)

When information is not available or ambiguities exist in the plans and specifications, the Contractor generates a written Request For Information (RFI) to the USACE for clarification. During the course of the project, an RFI may lead to an additional scope of work, Change In Contract (CIN), or a Claim depending on the outcome and determination of the USACE.

Contract changes that are part of this case study include backfill of voids from pile extraction underneath the T-Wall, the excavation of a previously unknown abandoned 30-inch diameter sewer force main (SFM), the value engineering change proposal (VECP) to jack and bore the 84-inch tubes underneath the railroad lines. (Figure 7)



Figure 7 View of the jack and bore installation of 84 inch diameter steel discharge tubes utilizing a TRS excavation. (McElwee 2008)

When conflicts cannot be resolved a claim may result in which the Contractor attempts to recoup schedule time or additional costs resulting from changes to the work. All claims have their roots in the quadrangle of issues comprising time, cost, quality, or scope and a claim on a project which includes all of these element is defective design. (Berman 1996)

As construction progresses and completed work is accepted by the USACE QA Representative and CO, monthly progress payments are made to the contractor which reflect the quantity of work that is complete, materials purchased, or other definable quantities as stipulated in the contract

7. Work Relevant to Underseepage and Soil Heave

The portions of the Dwyer Road Canal project that are examined for the purposes of this case study are floodwall demolition, sheet pile Temporary Retaining Structures (TRS), and pile foundations. In addition to providing unique access to the subsurface conditions during excavation (see Figure 8) as well as experiences during examples provide insight to how the design specifications, guidelines, and authorizations are addressed throughout the project.

The demolition of a portion of the existing T-wall in order to install the three 84-inch diameter discharge tubes underneath included saw cutting a portion of the wall, removing the piles, and filling the voids with bentonite slurry and a soil cap.



Figure 8 View of TRS excavation. Note the standing water in the bottom of the excavation and dry bank material. (McElwee 2008)

Excavation in this area provided unique access to view conditions below ground level, and the bentonite backfill of pile voids demonstrated the permeable soil conditions in this area. Section II further details the experiences associated with Floodwall Demolition.

Construction of the underground box canal required excavating approximately 500 linear feet between the floodwall and the IHNC using a sheet pile Temporary Retaining Structure (TRS) (see Figure 9). The TRS design, construction, and dewatering process relates to the mechanisms of underseepage and soil through the evaluation of soils and groundwater. Section III addresses TRS experiences including design submittals, construction dewatering and excavation, as well as general observations of the site conditions.



Figure 9 View looking away from the IHNC of the TRS and partially completed box canal. (McElwee 2008)

Pile foundations, including the timber pile grid which supports the concrete canal (Figure 10), navigation protection dolphins, and concrete piles are the addressed in Section III. This includes observations of soil heave associated with the timber pile grid as well as construction techniques and the required submittals, authorizations, and acceptance of work.

This is not an exhaustive or prioritized list of all possibly relevant activities, but rather an attempt to organize these topics for the purposes of this case study. The above items were selected because they illustrate the mechanisms of underseepage and soil heave as well as the conditions that contribute to them. The project documentation, including transmittals of submittals and other QC/QA requirements can be used to evaluate the site conditions as well as designs, specifications, and authorizations for the work.



Figure 10 View of the excavated TRS and timber pile grid (McElwee 2008)

II. Floodwall Demolition

Section II addresses the demolition of parts of the existing I-wall, T-wall, and flood protection embankments in order to allow installation of discharge tubes underneath.

8. I-Wall, T-Wall, and Embankment Demolition

Installing the three 84-inch discharge tubes underneath the flood protection system at the Dwyer Road site required demolition of I-Wall, T-Wall, and the embankment where Jourdan Road crossed this location (Figure 11). The concrete wall sections were cut with a wire saw in order to remove the structures, allowing



Figure 11 View of wire cutting on the T-wall where Jourdan Road embankment has been removed (McElwee 2008)

pulling of the existing piles (Figures 12 and 13) as well as excavation. Excavation in this location provided unique access to view subsurface conditions, as well as to view the adjacent intact floodwall, including the sheet pile and embankment section.

As a change in the contract (CIN), the USACE approved filling and capping the resulting pile voids underneath the T-Wall location with a bentonite slurry mix and soil cap. This process, discussed below (Sec. 10), illustrated the transmission of the slurry between pile voids.



Figure 12 View of the T-wall demolition site looking south. Note the concrete piles still in the ground. (McElwee 2008)

9. Floodwall Demolition Submittals and CIN

T-Wall demolition submittals included details for pile extraction equipment as well as for the bentonite slurry backfill as directed by the CO as part of CIN 003. Submittal No. 0049, Concrete Pile Extraction Equipment (Transmittal No. 0057. 2002) specified the equipment to be used for this purpose, (see Figure 9) as well as a note that "Pulled Piles will be at the direction of the Contracting Officer…" The Contractor previously sought to leave in place those piles which did not conflict with the improvements in order to not unnecessarily disturb the soils. (McElwee 2008) As an addition to the scope of work, the USACE directed the Contractor to fill the resulting voids with a bentonite mixture and a 3 ft. soil cap.



Figure 13 View of crew pulling square concrete piles at the floodwall location using an extractor. Note the pile void (middle right) full of water; the bentonite fill experience was similar, as material flowed out of adjacent voids. (McElwee 2008)

Aspects of the project related to the staging of work, interim flood protection, and completion of modifications to the facility are addressed throughout the contract and project documents. For example regarding the Jourdan Road embankment that allowed traffic to cross over the flood protection system, according to a general note in the plans, “The excavated shell base material from degrading of Jourdan Road (see Figure 5) shall be stock piled in the staging area designated on Dwg. G-5 and will be used to reconstruct the embankment on Jourdan Road.” Clay material for T-wall and I-wall embankments (including the 5 ft. wide clay plug to be placed in the Jourdan Road embankment), appears to be described in Submittal No. 0021 Embankment Clay Blanket (Transmittal No. 0092), which reports moisture-density test results for a sample of the clay.

10. T-Wall Demolition Work Outcomes and Observations

The excavations near the T-Wall allowed unique access to view the subsurface conditions. While excavating underneath the T-wall at the north end of the excavation, the contractor encountered tree roots and organic debris (Figure 14) at El. (-) 12.0 ft NGVD (see Table 1, Loc. I), which is a potential path for underseepage.

The experiences filling pile voids demonstrated the transmission of fluid (bentonite slurry mix) through the soils. As the mix was injected, the material flowed from other pile voids as far as 60 feet away—indicating subsurface transmission through the soils (McElwee 2008)



Figure 14 View of the T-wall cut-off sheet pile (center) showing tree root debris at the tip of the existing sheet. Note what appears to be a sheet of plywood for scale, upper left. (McElwee 2008)

III. TRS

This section examines the design and construction of the sheet pile Temporary Retaining System (TRS) used in order to safely excavate the work. The design and construction of the TRS and dewatering system addresses underseepage, both in designing the components of the system as well as observations of the work—e.g. underseepage and dewatering control.

11. TRS General Description

The purpose of the cofferdam Temporary Retaining System (TRS) is to allow safe excavation for installation of items below original grade. The TRS consists of rows of interlocking steel sheet pile with bracing between in order to prevent the



Figure 15 View inside of the TRS at full excavation depth with timber support piles driven through the base material (bottom left) and formwork in place for the concrete canal base (bottom right). (McElwee 2008)

movement or collapse of the sheet pile wall as excavation proceeds on one side and soil and groundwater are retained on the unexcavated side. This required an engineering design of the sheet pile type and embedment as well as size and location of structural steel bracing elements for various stages of the excavation.

There were several different arrangements, or phases of TRS construction, each tailored to specific applications and conditions. These included installation of the concrete box canal (Phases 1, 1A, and 2), the sluice gate structure (Phase 3), and the 84-inch steel discharge tubes (Phases 4, 4A, and 5)—see Figures 3 and 16. The general construction of each type of TRS is similar, and the sheet piles must penetrate far enough to develop sufficient bearing capacity to hold up the weight of the pile, bracing frame, and other equipment, as well as penetrate far enough below the lowest level of excavation to prevent the soil from running in underneath. (Gerwick 1996)

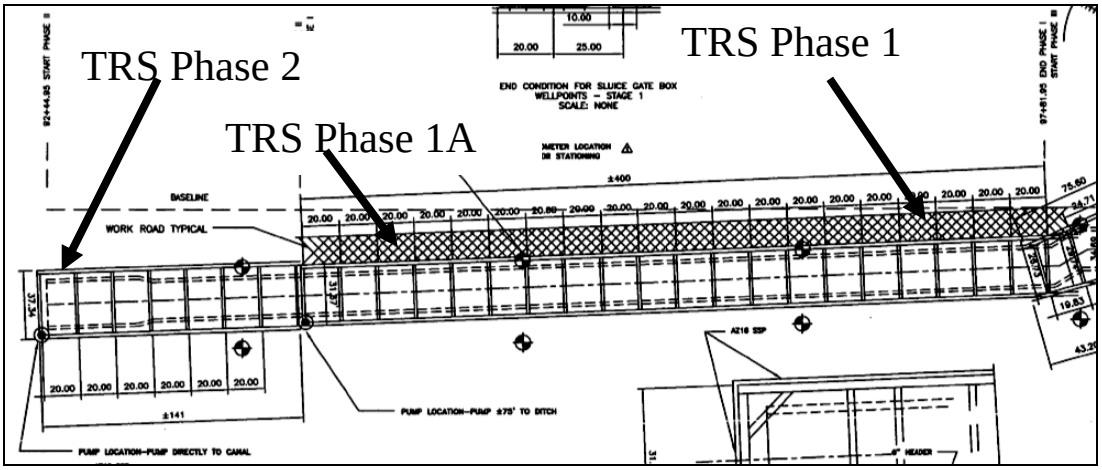


Figure 16 Plan view of TRS Phases 1, 1A, and 2 (adapted from Dixon 2001)

In order to control the effects of groundwater, dewatering the soils surrounding the TRS is important to this method of excavation. Dewatering is

necessary in order to keep the work area inside of the excavated TRS, and this is accomplished by installing a series of wellpoints and monitors (see Figure 17). This system must be designed in order to prevent disturbing the site soils—particularly fine particles that can be carried away by seepage flow, altering the characteristics of the remaining soil. A filter media is used, such as a certain size of sand particles that will mitigate these effects by allowing water to pass but not the soil particle. (Das 2006) Dewatering will be discussed in more detail below.



Figure 17 View of TRS excavation in the same location as Figure 8. (McElwee 2008)

Once groundwater has been controlled, excavation inside of the TRS is completed in stages (Figure 18) as determined in an approved TRS Design submittal. As excavation progresses beams known as walers and struts are used for bracing to

counteract the unbalanced forces on the sheet pile that result from excavating. When the excavation depth progresses even further, additional rows of bracing are added as required by the design and wellpoints are lowered correspondingly.

As construction progressed in increments such that only 20 ft along the length of the TRS was fully excavated at any time, the completed canal was backfilled with sand. Eventually the TRS was rewatered, sheet piles were removed, and a 1 ft. thick clay blanket placed at ground elevation. (Transmittal 0092)



Figure 18. View of a progress check of the excavation inside of the TRS—note the marked measuring pole (McElwee 2008)



Figure 19 View of humus soil layer revealed by the TRS excavation at approximately El. (-) 12.5 ft NGVD (Loc. P- Table 1) (McElwee 2008)

12. TRS Design & Submittals

The required project submittals for TRS construction include structural design (sheet pile size, embedment, and bracing details), staged excavation analysis, as well as a dewatering plan. Submittal Nos. 9 & 10, "Temporary Retaining Structure Design Calculations, Layout, & Excavation Plan" (Transmittal No. 0015) contains design calculations for sheet pile using CWALSHT software, as well as hand calculations for structural steel members and shop drawings for construction.



Figure 20 View of tree roots exposed by the TRS excavation at approximately El. (-) 14.3 NGVD (Loc. O- Table 1). (McElwee 2008)

Dewatering details such as wellpoints and filter selection, layout, intake "straw" detail, and a dewatering plan are found in Submittal No. 8 Dewatering (Transmittal No. 0026, No. 0048) In Transmittal 0026, the Dewatering Plans states "We have requested, but not received, particle size distributions for the sand strata that will be encountered in Stage 1…" As a result, the Contractor retained Gore Engineering, Inc. to take two soil borings, one at each end of the job site. (Gore 2001)

Groundwater monitoring during dewatering included 6 piezometers, as well as an initial sanding test (See Submittal in order to determine that the soils remained

stable during dewatering. Despite these controls, however, the bottom of the TRS was often saturated due to groundwater underseepage, which increased noticeably in the event of a wellpoint system pump shut-down. (McElwee 2008) Details pertaining to the initial sand test and other dewatering performance are included in Transmittal 0058, Submittal No. 8 Dewatering; Initial Testing, as well as in project correspondence from J. Michael Dixon, PE (Dixon 18-March, 19-March 2003).

During the course of the project, three Tropical Storms—Isadore, Hanna, and Lili hit South Louisiana and inundated the job site due to rise of the IHNC. The TRS was flooded in advance of the storms in order to reduce the risk of collapse, however a CIN was initiated as a result of damage lost productivity because of these Storms.



Figure 21 View of the IHNC during one of the storms that hit South Louisiana during the 2002 season. (McElwee 2002)

Location and elevation references for the project were based on a monument called out in the plans named “Benchmark, (NOPSI Reset 1970)” and labeled Loc. C on Table 1- Location Data for Selected References. The Survey notes and baseline control and topographic notes for the project are contained in correspondence from DEI to McElwee/ Tri-State JV dated 10-May 2001 (DEI-a) and 29-June 2001 (DEI-b). Furthermore, the plans also give a correlation between Cairo Datum (CD) and National Geodetic Vertical Datum (NGVD) as 20.43 ft CD = 0.0 ft NGVD. This relationship is used to approximate the elevations referenced in this case study in the NGVD datum, however note that the project documents predominately reference CD. A study of this relationship between CD and NGVD, as well as the monument or any of the work was not within the scope of the study, however may be relevant to the overall findings.

IV. Pile Foundations

At the Dwyer Road Canal site, there are several different uses of pile foundations and this case study will focus on three—timber, steel pipe, and precast concrete piles. Additionally, specific submittals and correspondence that highlights various site conditions is presented.

13. Pile Foundation Work General Description

The three types of pile foundations at the Dwyer Road Canal that are part of this study are the timber pile mat inside of the TRS, steel pipe piles, and the square concrete piles supporting the T-wall. The 12 inch timber support piles which support the canal were driven in a 4’-6” x 7’ grid at the bottom of the excavation inside of the TRS (Figure 22), first using a pre-bore in order to pass the piles through sand layers.

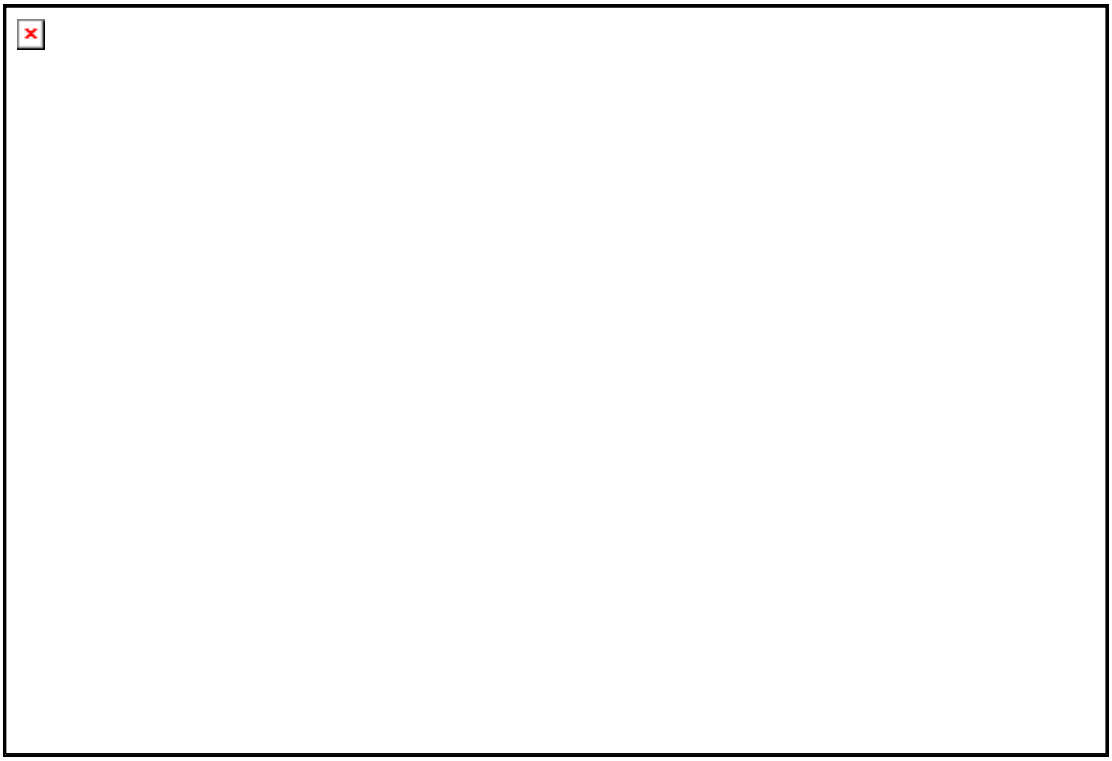


Figure 22 View of timber pile driving in the TRS. (McElwee 2008)

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Figure 22 View of timber pile driving in the TRS. (McElwee 2008)

The navigation protection dolphins are constructed of 20-inch diameter steel pipe piles using a crane barge and a positioning template (Figure 23.) The 80-foot long piles were made up of two spliced 40-foot sections and tied together with a concrete cap. Piles supporting the replacement section of T-wall were 14-inch square prestressed concrete, 75 ft. long driven on a 2V to 1H batter.

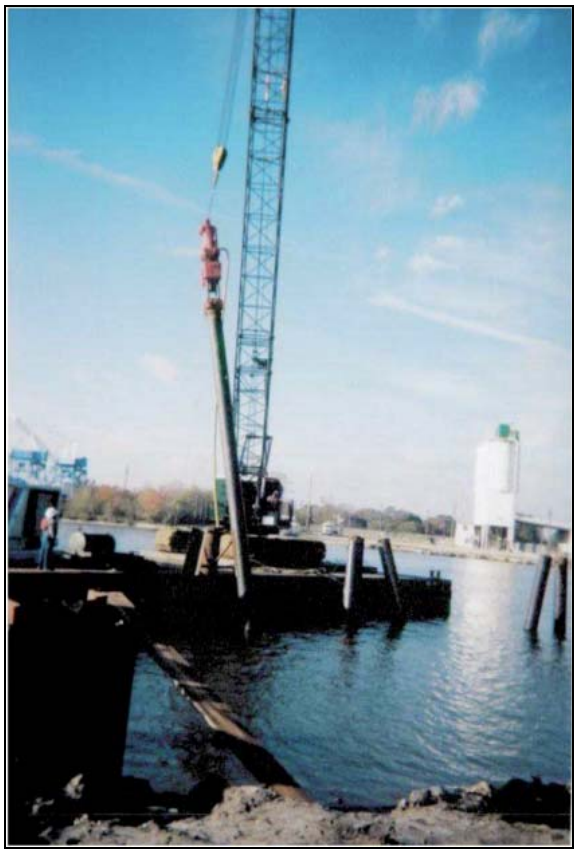


Figure 23 View of installation of 20-inch steel pile piles using a crane barge and driving template. (McElwee 2008)

Submittal 49, Wood, H, and Pipe Pile Driving Equipment—addresses the selection of equipment for installing the piles (Figure 24) based on the requirements and representations in the contract. (Transmittal Nos. 0030, 0054, 0084, and 0104). The *Handbook of Heavy Construction* describes the Unique Relationship Among Engineer, Contractor, and Owner in Pile Foundations: "There is always an element of uncertainty in the installation of pile foundation. This is due to the inherent heterogeneity of the subsurface conditions of most sites where piling is to be installed. In addition, there is the competitive nature of the design and construction industry, which pressures both designers and contractors to minimize total construction costs." (Taylor 1996)



Figure 24 View of timber pile being lofted into the driving leader. (McElwee 2008)

14. Pile Foundation Outcomes and Observations

The installation of the timber pile grid caused the bottom of the TRS excavation to rise, or heave, requiring re-grading in order to achieve the target depth for installation of the box canal.



Figure 25. View of TRS after timber pile driving. The elevation of the excavated bottom rose, requiring re-grading (the bobcat loader is being used to remove material.) (McElwee 2008)

Driving the prestressed concrete piles was easier than anticipated, as observed by the USACE and reported in correspondence from the SELA Orleans Resident Office (Tim Roth) to McElwee Bros./ Tri-State JV, which stated "We have evaluated the driving logs for the 14-inch square pre-cast, pre-stressed concrete piles and have concerns that several of the piles may be damaged and unacceptable as noted by the low blow counts recorded in the field." (Roth May 2003)

McElwee Bros./ Tri-State disagreed with this interpretation of the ease of pile driving, and further analysis ensued using Dynamic Pile Driving Analysis (PDA) which indicated that there was at least some damage (cracking) in some of the piles.

Additional geotechnical investigation by Gore Engineering (Gore 2003) suggested differences between the actual soil conditions and those reported in the contract solicitation and used for design purposes. The soil conditions in at least some parts of the Dwyer Road Canal site appear to vary from the information presented in the contract documents. A comparison of the Eustis B-2 and Gore Engineering B-3 boring was the subject of comments by Tony Last from International Construction Equipment, as reported in correspondence from Bill Spatz (ICE) to the McElwee Bros./ Tri-State JV: "Tony Last is our design engineer and has over 35 years of experience in designing pile driving equipment… I provided him with the data provided by Gore Engineering, dated 6/3/03. Tony Last immediately remarked about the differences between the Gore Engineering soil data provided on 6/3/03 and the original data provided, as part of the hammer evaluation and submittal process." (Spatz 2003).

Nonetheless, the USACE requested that the Contractor re-design the floodwall structure to accommodate for cracked piles. (Pecoul 2003) After the McElwee Bros./ Tri-State JV expressed concern about assuming responsibility for design of the flood protection system, the contract was terminated. (McElwee 2008)

V. Principal Findings

Section V contains principal findings from this case study, including general site conditions and incidence of underseepage and soil heave.

15. Observed Site Conditions

The subsurface conditions observed during construction were highly variable, and buried organic material such as roots and humus layers were prevalent. During floodwall demolition, tree root debris was found at the tip of the sheet pile of the northern adjacent remaining T-wall section, which is an example of the types of non-homogeneous conditions and buried organic material at the site. Excavation of the TRS also revealed buried roots and humus at depths between the ground surface at approximately El (+) 5.0 ft NGVD and the bottom of the excavations as deep as El (-) 14.4 ft NGVD. The additional soil boring work and evaluation by Tony Last and others suggests differences between the actual soil conditions and those reported in the contract solicitation and used for design purposes.

16. Underseepage

The observations of migrating slurry mix during backfill of pile voids at the demolished T-wall location suggest that the surrounding soils are highly permeable and thus susceptible to underseepage. Likewise, the wet conditions inside of the TRS excavations indicate similar mechanisms, as soils were saturated despite dewatering controls and monitoring.

17. Soil Heave

The installation of timber pile foundations for the concrete box canal coincided with soil heave inside of the TRS, as the open grade elevation at the bottom of the excavation raised upon driving the piles and required re-grading. This suggests that the underlying soils are susceptible to movement due to the mechanisms of soil heave, and this is consistent with the saturated and soft soils observed many places in the excavations.

18. Recommendations

The documents reviewed for this report provide only the pre-planning and in some cases initial phases of the project (e.g. Submittals, start-up tests, etc.) In order to better correlate the time, events, and locations associated with this project further research may be necessary. This includes Daily and Monthly Quality Control and Quality Assurance (CQ/QA) reports and other specific documents and the following:

1. A 3-Step process for gathering information, including 1) Pre-planning (Identify activities and time periods of interest), 2) Retrieve Documents, and 3) Follow-Up with specific questions or more information.
2. Chronological organization of photographs, and
3. Study of Survey and Elevation Data to evaluate the reliability of the given information

Tables

Table 1- Location Data for Selected References

Location		Elevation		
Loc. ID	Description	CD	NGVD	Reference Doc.
A	Correlation CD to NVGD, given on Contract Plans	20.43	0.0	Dwg. G-2
B	IHNC Avg. Water Surface Elevation (Sheet G-14)	21.5		Dwg. G-14
C	Monument: "Benchmark, (NOPSI Reset 1970)	17.4	-3.02	Dwg. I-1 of 58
D	Eustis Soil Boring B-1 Ground Elevation	25.0	4.6	Eustis 1997
E	Eustis Soil Boring B-2 Ground Elevation	26.0	5.6	Eustis 1997
F	Gore Soil Boring B-1 Ground Elevation			Gore 2001
G	Gore Soil Boring B-2 Ground Elevation			(See Gore 2001)
H	Gore Soil Boring B-3 Ground Elevation			(See Gore 2003)
I	Figure 10. Tip of existing sheet pile under the T-Wall	8.4	-12.03	Eustis 1997, Fig 2 Location of Borings
J	Tip of Sheet Pile for TRS Structures (Dixon 2001)	-16.0	-36.4	Dewatering Details, Dixon 19 Nov 2001
K	Excavation Bottom Depth for Stage 1- Discharge	13.8	-6.6	Dewatering Details, Dixon 19 Nov 2001
L	Excavation Bottom Depth for Stage 1- Steel Tubes	16.0	-4.4	Dewatering Details, Dixon 19 Nov 2001
M	Excavation Bottom Depth for Stage 2 Box Culvert, Discharge, and Sluice Gate	6.17	-14.26	Dewatering Details, Dixon 19 Nov 2001
N	Excavation Bottom Depth for Stage 2, Steel Tubes	6.0	-14.4	Dewatering Details, Dixon 19 Nov 2001
O	Excavation Bottom Depth for Stage 3, Box Culvert, Discharge Structure, and Steel Tubes	6.2	-14.3	Dewatering Details, Dixon 19 Nov 2001
P	Elevation (est.) of Humus Layer shown in Figure 19.	8.0	-12.4	Figure 19. De-watering Details

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