North Harris County
REGIONAL WATER
Authority

CONTRACT DOCUMENTS
AND TECHNICAL SPECIFICATIONS
FOR CONSTRUCTION OF
60-INCH AND 54-INCH WATERLINE ALONG
GRANT ROAD AND COPELAND ROAD
PROJECT NO. 28-B

HARRIS COUNTY, TEXAS

5/18/2020

May 2020

DANNENBAUM
ENGINEERING CORPORATION

AECOM

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INVITATION TO BID

Date: May 29, 2020

North Harris County Regional Water Authority
3648 Cypress Creek Pkwy, Suite 110
Houston, Texas 77068

PROJECT TITLE: Proposed 60" and 54" Water Line Along Grant Road and Copeland Road

PROJECT NO.: 28B CONTRACT NO.: 1

LOCATION: Grant and Copeland Road, Houston, Texas, Harris County

Sealed BIDs in duplicate will be received at the office of the North Harris County Regional Water Authority, 3648 Cypress Creek Pkwy, Suite 110, Houston, Texas 77068 until 10:00 a.m. local time, Tuesday, June 23, 2020, then publicly opened and read. BIDs received after the closing time will be returned unopened. Due to the COVID-19 pandemic and the State and Federal guidelines of not gathering in groups of more than ten (10) people, members of the public who wish to attend the Bid Opening for this project must do so by telephone. To attend the Bid Opening by telephone, dial (877) 286-5733 and enter conference ID: 275 356 489#.

General Contractors are invited to attend a virtual pre-bid conference for this project. The pre-bid conference will be held on Tuesday, June 9, 2020, at 10:00 a.m. local time. To participate by video conference, go to https://tinyurl.com/NHCRWA-Project-28B. To participate by telephone conference only dial (877) 286-5733 and enter conference ID: 733 293 630#.

Bid Security in the amount not less than five percent (5%) of the total amount of the BID must accompany each BID as a guarantee that the Successful Bidder will enter into a proper Contract and execute Bonds and Guaranties on the forms provided within eight (8) days after the date Contract Documents are received by the CONTRACTOR. Bid Security shall be in accordance with Section 00100 - Instructions to Bidders and Section 00700, Paragraph 5.1.1 of the General Conditions.

Copies of the Bidding Documents may be obtained from www.civcastusa.com; search NHCRWA Project 28B. Bidders must register on this website in order to view and/or download specifications and plans for this project. There is NO charge to view or download documents. Bidders may submit questions online through CIVCAST at www.civcastusa.com.

This contract is contingent upon release of funds from the Texas Water Development Board. Any contract or contracts awarded under this Invitation for Bids is/are expected to be funded in part by a loan or grant from the Texas Water Development Board. Neither the state of Texas, nor any of its departments, agencies, or employees are or will be a party to this Invitation for Bids or any resulting contract.

The OWNER reserves the right to reject any or all BIDs and to waive technical defects in bidding.

Jimmie Schindewolf, P.E.
General Manager,
North Harris County
Regional Water Authority

INSTRUCTIONS TO BIDDERS

1. Defined Terms

Terms used in these Instructions to Bidders are defined in Section 00700 - General Conditions of the Construction Contract.

2. Copies of Bidding Documents

2.1. Complete sets of the Bidding Documents, in the number and for the payment sum stated in the Invitation to Bid, may be obtained from www.civcastusa.com.

2.2. Complete sets of Bidding Documents must be used in preparing BIDs; neither OWNER, PROJECT MANAGER, nor ENGINEER assume any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents or otherwise associated with the Bidding Documents.

2.3. OWNER, PROJECT MANAGER, and ENGINEER, in making copies of Bidding Documents available on the above terms, do so only for the purpose of obtaining BIDs for the Work and do not confer a license or grant for any other use. BIDDER may not make copies of the Bidding Documents. Ownership of the Bidding Documents shall remain with the OWNER.

3. Qualifications of BIDDERs

To demonstrate qualifications to perform the Work, each BIDDER must submit, with their BID in a separate sealed envelope, detailed written evidence such as financial data, previous experience, present commitments, and proof that the BIDDER has the personnel, equipment, and material to execute the work required by the Contract Documents or any other such data as may be called for below. Although OWNER will not ordinarily release financial data submitted to it under this paragraph, BIDDERS should expect that this information may be available for public scrutiny if it is submitted.

4. Examination of Contract Documents and Site

4.1. It is the responsibility of each BIDDER, before submitting a BID:

4.1.1. to examine thoroughly the Contract Documents and other related data identified in the Bidding Documents (including “technical data” referred to below);

4.1.2. to visit the site to become familiar with and satisfy BIDDER as to the general, local, and site conditions that may affect cost, progress, performance, or furnishing of the Work;

4.1.3. to consider federal, state, and local Laws and Regulations that may affect cost, progress, performance, or furnishing of the Work;

4.1.4. to study and carefully correlate BIDDER’s knowledge and observations with the Contract Documents and such other related data; and

4.1.5. to promptly notify PROJECT MANAGER of all conflicts, errors, ambiguities or

discrepancies which BIDDER has discovered in or between the Contract Documents and such other related documents.

4.2. Reference is made to the General and Supplementary Conditions for identification of those reports of explorations and tests of subsurface conditions at or contiguous to the site which have been utilized by ENGINEER in preparation of the Contract Documents. BIDDER may rely upon the general accuracy of the "technical data" contained in such reports but not upon other data, interpretations, opinions, or information contained in such reports or otherwise relating to the subsurface conditions at the site, nor upon the completeness thereof for the purposes of bidding or construction. **OWNER, PROJECT MANAGER, AND ENGINEER EXPRESSLY DISCLAIM ANY AND ALL WARRANTIES THAT THE INFORMATION, DATA, INTERPRETATIONS, AND OPINIONS SHOWN, INDICATED, OR CONTAINED IN THE REPORTS ARE ACCURATE, CORRECT, COMPLETE, OR FIT FOR THEIR INTENDED PURPOSES.**

Copies of such reports will be made available by OWNER to any BIDDER on request. Those reports and drawings are not part of the Contract Documents, but the "technical data" contained therein upon which BIDDER is entitled to rely as provided in Paragraph 4.2 of the General Conditions has been identified and established in Paragraph SC-4.2 of the Supplementary Conditions. BIDDER is responsible for any interpretation or conclusion drawn from any "technical data" or any such data, interpretations, opinions, or information.

4.3. Information and data shown or indicated in the Contract Documents with respect to existing Underground Facilities at or contiguous to the site is based on information and data furnished to OWNER, PROJECT MANAGER, and ENGINEER by owners of such Underground Facilities or others, and OWNER, PROJECT MANAGER, and ENGINEER do not assume responsibility for the accuracy or completeness thereof unless it is expressly provided otherwise in the Supplementary Conditions. **OWNER, PROJECT MANAGER, AND ENGINEER EXPRESSLY DISCLAIM ANY AND ALL WARRANTIES THAT THE INFORMATION, DATA, INTERPRETATIONS, AND OPINIONS SHOWN, INDICATED, OR CONTAINED IN THE PLANS ARE ACCURATE, CORRECT, COMPLETE, OR FIT FOR THEIR INTENDED PURPOSES.** It is to be anticipated by the CONTRACTOR that some of the Underground Facilities located at or contiguous to the site will be found at locations that may differ from the sites shown on the Contract Documents. It is part of the scope of CONTRACTOR's work to perform the exploratory work necessary to precisely identify the exact locations of Underground Facilities. It is also to be anticipated that these may be underground Facilities at or contiguous to the site that have not been identified in the Contract Documents and it is part of the scope of the work to be able to accommodate the likelihood of encountering some additional underground Facilities.

4.4. Provisions concerning responsibilities for the adequacy of data furnished to prospective BIDDERs with respect to subsurface conditions, other physical conditions and Underground Facilities, and possible changes in the Contract Documents due to differing or unanticipated conditions appear in Paragraphs 4.2 and 4.3 of the General Conditions.

4.5. Before submitting a BID, each BIDDER will be responsible to obtain such additional or supplementary examinations, investigations, explorations, tests, studies, and data concerning

conditions (surface, subsurface and Underground Facilities) at or contiguous to the site or otherwise, which may affect cost, progress, performance, or furnishing of the Work, or which relate to any aspect of the means, methods, techniques, sequences, or procedures of construction to be employed by BIDDER and safety precautions and programs incident thereto or which BIDDER deems necessary to determine its BID for performing and furnishing the Work in accordance with the time, price, and other terms and conditions of the Contract Documents.

4.6. On request, OWNER will provide each BIDDER access to the site to conduct such examinations, investigations, explorations, tests, and studies as each BIDDER deems necessary for submission of a BID. BIDDER must fill all holes and clean up and restore the site to its former condition upon completion of such explorations, investigations, tests, and studies.

4.7. The submission of a BID will constitute an incontrovertible representation by BIDDER that BIDDER has complied with every requirement of this Article 4, that, without exception, the BID is premised upon performing and furnishing the Work required by the Contract Documents, and applying the specific means, methods, techniques, sequences, or procedures of construction (if any) that may be shown or indicated or expressly required by the Contract Documents, the BIDDER has given PROJECT MANAGER written notice of all conflicts, errors, ambiguities, and discrepancies that BIDDER has discovered in the Contract Documents, and written resolutions thereof by PROJECT MANAGER are acceptable to BIDDER, that the Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performing and furnishing the Work, that the BIDDER has no questions regarding the Work, that the BIDDER has all information necessary to make a fully informed BID, and that the BIDDER has conducted all tests at the site it deems necessary.

4.8. The provisions of 4.1 through 4.7, inclusive of this Article, do not apply to Asbestos, Polychlorinated biphenyls (PCBs), Petroleum, Hazardous Waste, or Radioactive Material covered by Paragraph 4.5 of the General Conditions.

5. Availability of Lands for Work, etc.

The lands upon which the Work is to be performed, rights-of-way and easements for access thereto and other lands designated for use by CONTRACTOR in performing the Work are identified in the Contract Documents. All additional lands and access thereto required for temporary construction facilities, construction equipment, or storage of materials and equipment to be incorporated in the Work are to be obtained and paid for by CONTRACTOR. Easements for permanent structures or permanent changes in existing facilities are to be obtained and paid for by OWNER unless otherwise provided in the Contract Documents.

6. Interpretations and Addenda

6.1. All questions about the meaning or intent of the Bidding Documents are to be directed to PROJECT MANAGER. Interpretations or clarifications considered necessary by PROJECT MANAGER in response to such questions will be issued by Addenda mailed, transmitted by facsimile machine, or delivered to all parties recorded by PROJECT MANAGER as having received the Bidding Documents. Questions received less than ten days prior to the date for opening of Bids may not be answered. Only questions answered by formal written Addenda will

be binding. Oral and other interpretations or clarifications may not be relied upon and will not be binding upon OWNER or PROJECT MANAGER or legally effective.

6.2. Addenda may also be issued to modify the Bidding Documents as deemed advisable by OWNER or ENGINEER.

7. Bid Security

7.1. Each BID must be accompanied by Bid Security made payable to OWNER in an amount of five percent (5%) of BIDDER's maximum Bid price and in the form of a certified or cashier's check or a Bid Bond issued by a surety meeting the requirements of Paragraph 5.1.1 of the General Conditions.

7.2. The Bid Security of Successful Bidder will be retained until such BIDDER has executed the Agreement, furnished the required contract security, and met the other conditions of the Notice of Award, whereupon the Bid Security will be returned. If the Successful Bidder fails to execute and deliver the Agreement and furnish the required contract security within eight (8) days after the Notice of Award, OWNER may annul the Notice of Award, and the Bid Security of that BIDDER will be forfeited. The Bid Security of other BIDDERs whom OWNER believes to have a reasonable chance of receiving the award may be retained by OWNER until the earlier of the seventh day after the Effective Date of the Agreement or the thirty-sixth day after the BID opening, whereupon Bid Security furnished by such BIDDERs will be returned. Bid Security with Bids which are not competitive will be returned within seven (7) days after the BID opening.

8. Contract Times

The Contract Times, as defined in Paragraph 1.13 of the General Conditions, are set forth in the Agreement.

9. Liquidated Damages

Provisions for liquidated damages are set forth in the Agreement.

10. "Or-Equal" Items

The Contract, if awarded, will be on the basis of materials and equipment described in the PLANS or specified in the Specifications without consideration of possible "or-equal" items. Whenever it is indicated in the PLANS or specified in the Specifications that an "or-equal" item of material or equipment may be furnished or used by CONTRACTOR if acceptable to ENGINEER, application for such acceptance will not be considered by ENGINEER until after the Effective Date of the Agreement. The procedure for submission of any such application by CONTRACTOR to the PROJECT MANAGER for consideration by ENGINEER is set forth in Paragraphs 6.4.1, 6.4.2 and 6.4.3 of the General Conditions and may be supplemented in the Supplementary Conditions.

11. Subcontractors, Suppliers, and Others

11.1. If the Supplementary Conditions require the identity of certain Subcontractors, Suppliers, and other persons and organizations (including those who are to furnish the principal items of material and equipment) to be submitted to OWNER in advance of a specified date prior to the Effective Date of the Agreement, apparent Successful Bidder, and any other BIDDER so requested, shall, within five (5) days after BID opening, submit to OWNER a list of all such Subcontractors, Suppliers, and other persons and organizations proposed for those portions of the Work for which such identification is required. Such list shall be accompanied by an experience statement with pertinent information regarding similar projects and other evidence of qualification for each such Subcontractor, Supplier, person, or organization if requested by OWNER. OWNER who, after due investigation, has reasonable objection to any proposed Subcontractor, Supplier, other person, or organization may, before the Notice of Award is given, request the apparent Successful Bidder to submit an acceptable substitute without an increase in Bid Price.

If the apparent Successful Bidder declines to make any such substitution, OWNER may award the contract to the next lowest BIDDER that proposes to use acceptable Subcontractors, Suppliers, and other persons and organizations. Declining to make requested substitutions will not constitute grounds for sacrificing the Bid Security of any bidder. Any Subcontractor, Supplier, other person, or organization listed and to whom OWNER does not make written objection prior to the giving of the Notice of Award will be deemed acceptable to OWNER subject to revocation of such acceptance after the Effective Date of the Agreement as provided in Paragraph 6.5.2 of the General Conditions.

11.2. The apparent Successful Bidder, prior to the Notice of Award, shall identify in writing to OWNER those portions of the Work that such BIDDER proposes to subcontract and after the Notice of Award may only subcontract other portions of the Work with OWNER's written consent.

12. Bid Form

12.1. The Bid Form is included with the Bidding Documents; additional copies may be obtained from the Issuing Office described in the Invitation to Bid.

12.2. All blanks on the Bid Form must be completed by ink.

12.3. BIDs by corporations must be executed in the corporate name by the president or a vice-president (or other corporate officer accompanied by evidence of authority to sign) and the corporate seal must be affixed and attested by the secretary or an assistant secretary of the corporation. The corporate address and state of incorporation must be shown below the signature.

12.4. BIDs by partnerships must be executed in the partnership name and signed by a partner, whose title must appear under the signature, and the official address of the partnership must be shown below the signature.

12.5. All names must be typed or printed in ink below the signature.

12.6. The BID shall contain an acknowledgment of receipt of all Addenda (the numbers of which must be filled in on the Bid Form).

12.7. The street and/or post office box address and telephone and/or fax number for communications regarding the BID must be shown.

12.8. When applicable, evidence of authority to conduct business as an out-of-state corporation in the state where the Work is to be performed shall be provided in accordance with Paragraph 3 above. State contractor license number, if any, must also be shown.

13. Submission of Bids

Each BID shall be submitted at the time and place indicated in the Invitation to Bid and shall be enclosed in a sealed envelope, marked with the Project title and name and address of BIDDER and accompanied by the Bid Security and other required documents. If the BID is sent through the mail or other delivery system, the sealed envelope shall be enclosed in a separate envelope with the notation "BID ENCLOSED" on the face of it.

14. Modification and Withdrawal of Bids

14.1. BIDs may be modified or withdrawn by an appropriate document duly executed (in the manner that a BID must be executed) and delivered to the place where BIDs are to be submitted at any time prior to the opening of BIDs.

14.2. If, within twenty-four (24) hours after Bids are opened, any BIDDER files a duly signed, written notice with OWNER and promptly thereafter demonstrates to the reasonable satisfaction of OWNER that there were material and substantial mistakes in the preparation of its BID of such a nature as to warrant the withdrawal of a Bid under the common law of the State of Texas, that BIDDER may withdraw its BID and the Bid Security will be returned. Thereafter, that BIDDER will be disqualified from further bidding on the Work to be provided under the Contract Documents.

15. Opening of Bids

BIDs will be opened and read aloud publicly (unless obviously nonresponsive) at the place where BIDs are to be submitted. An abstract of the amounts of the base BIDs and major alternates (if any) will be made available to BIDDERs after the opening of BIDs.

16. Bids to Remain Subject to Acceptance

All BIDs will remain subject to acceptance for sixty (60) days after the day of the BID opening, but OWNER may, in its sole discretion, release any BID and return the Bid Security prior to that date.

17. Award of Contract

17.1. It is the intention of the OWNER to select the lowest responsible responsive BIDDER and make an effort to enter a Contract with that BIDDER. However, OWNER reserves the right

to reject any or all BIDs, including without limitation the right to reject any or all nonconforming, nonresponsive, unbalanced, or conditional BIDs and to reject the BID of any BIDDER if OWNER believes that it would not be in the best interest of the Project to make an award to that BIDDER, whether because the BID is not responsive or the BIDDER is unqualified or of doubtful financial ability or fails to meet any other pertinent standard or criteria established by OWNER. OWNER also reserves the right to waive all informalities in BIDs and to negotiate contract terms with the Successful Bidder. Discrepancies between the multiplication of units of Work and unit prices will be resolved in favor of the unit prices. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum. OWNER also reserves the right to enter a Contract with a BIDDER other than the lowest BIDDER if it does not reach an agreement with the lowest BIDDER.

17.2. In evaluating BIDs, OWNER will consider the qualifications of BIDDERs, whether or not the BIDs comply with the prescribed requirements, and such alternates, unit prices, and other data, as may be requested in the Bid Form or prior to the Notice of Award.

17.3. OWNER may consider the qualifications and experience of Subcontractors, Suppliers, and other persons and organizations proposed for those portions of the Work as to which the identity of Subcontractors, Suppliers, and other persons and organizations must be submitted as provided in the Supplementary Conditions. OWNER also may consider the operating costs, maintenance requirements, performance data, and guarantees of major items of materials and equipment proposed for incorporation in the Work when such data is required to be submitted prior to the Notice of Award.

17.4. OWNER may conduct such investigations as OWNER deems necessary to assist in the evaluation of any BID and to establish the responsibility, qualifications and financial ability of BIDDERs, proposed Subcontractors, Suppliers and other persons and organizations to perform and furnish the Work in accordance with the Contract Documents to OWNER's satisfaction within the prescribed time.

17.5. If the contract is to be awarded, it will be awarded to the lowest BIDDER whose evaluation by OWNER indicates to OWNER that the award will be in the best interests of the Project.

17.6. If the contract is to be awarded, OWNER will give Successful Bidder a Notice of Award within sixty (60) days after the day of the BID opening.

17.7. This contract is contingent upon release of funds from the Texas Water Development Board. Any contract or contracts awarded under this Invitation for Bids is/are expected to be funded in part by a loan or grant from the Texas Water Development Board. Neither the state of Texas, nor any of its departments, agencies, or employees are or will be a party to this Invitation for Bids or any resulting contract.

17.8. A governmental entity may not award a governmental contract to a nonresident BIDDER unless the nonresident underbids the lowest BID submitted by a responsible resident BIDDER by an amount that is not less than the amount by which a resident BIDDER would be required to underbid the nonresident BIDDER to obtain a comparable contract in the state in which the

nonresident's principal place of business is located. A non-resident BIDDER is a Contractor whose corporate offices or principal place of business is outside of the state of Texas (Source: Texas Government Code, Chapter 2252, Subchapter A, Nonresident Bidders, §2252.002).

The BIDDER will complete form TWDB-0459, Vendor Compliance with Reciprocity on Non-Resident Bidders, **which must be submitted with the BID.**

18. Contract Security

Paragraph 5.1.1 of the General Conditions and the Supplementary Conditions set forth OWNER's requirements as to performance, payment, and maintenance Bonds. When the Successful Bidder delivers the executed Agreement to OWNER it must be accompanied by the required Bonds.

19. Signing of Agreement

When OWNER gives a Notice of Award to the Successful Bidder, it will be accompanied by the required number (as stated in Section 00500 "Agreement") of unsigned counterparts of the Agreement with all other written Contract Documents attached. Within eight (8) days thereafter, CONTRACTOR shall sign and deliver the required number of counterparts of the Agreement and attached documents to OWNER with the required Bonds. Thereafter, OWNER shall deliver one fully signed counterpart to CONTRACTOR. Each counterpart is to be accompanied by a complete set of the PLANS with appropriate identification.

20. Prebid Conference

A prebid conference will be held as stated in Section 00020 ("Invitation to Bid").

21. Taxes

21.1. CONTRACTOR shall pay all applicable sales, consumer, use, and other similar taxes except as exempted.

21.2. Sales tax. CONTRACTOR shall obtain the necessary documentation so that any sales tax exemptions due to the nature of the Work performed by CONTRACTOR or Subcontractors pursuant to this Agreement shall be applied to this Agreement, and these cost savings due to the Project's exempted status shall be passed on to OWNER. CONTRACTOR and each of its Subcontractors or sub-Subcontractors must obtain a Texas Limited Sales, Excise and Use Tax Permit for all materials required to be purchased in connection with the Project.

22. Retainage

Provisions concerning retainage are set forth in the Agreement.

23. Supplemental Pay Items

Approximate quantity and a minimum unit price have been established for some of SUPPLEMENTAL ITEMS shown in Section 00300-BID. The CONTRACTOR may not bid a unit price less than the minimum value; however, he may increase the minimum unit price. If no entry is made in the spaces provided, the minimum unit prices shown shall apply. These Items are included to facilitate payment for changes and alterations that may be required to complete work. The actual work, as provided by the GENERAL AND SUPPLEMENTARY CONDITIONS OF CONSTRUCTION CONTRACT and TECHNICAL SPECIFICATIONS and shown on PLANS, is described in bid items excluding supplemental pay item. When work covered by SUPPLEMENTAL ITEMS is requested by the CONTRACTOR and approved by OWNER, payment will be based on the quantity actually constructed and unit prices bid in BID.

24. Ownership of Proposals

Submitted Proposals, documentation and supporting materials shall become the property of Owner. Financial data submitted under Paragraph 3 of this Instruction to Bidders will be returned to any unsuccessful BIDDER upon request following Contract award.

25. Division of Project in Unit Prices

The Contract Documents describe a complete Scope of Work to be performed. If the Work is divided for purpose of calculation of compensation into UNIT PRICES for Units of Work, it is to be understood that all aspects of the Work described in the Contract Documents are included in the total Units provided for under the Contract. The fact that the description of Units may not include an itemization of tasks incidental to the Work that are identified in the Contract Documents as parts of the Scope of Work will not relieve CONTRACTOR of the obligation to perform this incidental work for the Unit Prices.

26. HB 914 Conflict Disclosures

Effective January 1, 2006, Texas Local Government Code Section 176.001, et seq. requires that all persons who seek to contract with a local governmental entity such as North Harris County Regional Water Authority (the "Authority") complete and submit a Conflicts of Interest Questionnaire (the "Questionnaire") to the Authority. The purpose of the Questionnaire is to disclose certain relationships a potential bidder or contractor may have with Board members or consultants of the Authority. Please complete the enclosed Questionnaire and submit it with the bid. To assist with completing the Questionnaire, we have included a list of the Authority's Board members and Officers in Section 00800, Attachment “C-1”. **FAILURE TO COMPLETE AND SUBMIT THE QUESTIONNAIRE WILL RESULT IN THE BID BEING DECLARED INCOMPLETE AND COULD LEAD TO CRIMINAL LIABILITY.** In the discretion of the Authority, an incomplete bid resulting from the failure to complete and submit the Questionnaire by the bid submission deadline may be waived provided that the Questionnaire is completed and submitted prior to award of the contract by the Authority.

27. Texas Ethics Commission Form 1295

Effective January 1, 2016, pursuant to Texas Government Code § 2252.908 (the "Interested Party Disclosure Act" or the "Act"), the Authority may not award the contract to a BIDDER unless the BIDDER has provided to the Authority a completed, signed and notarized TEC Form 1295 which has been assigned a certificate number by the Texas Ethics Commission (the "TEC"). Pursuant to the rules prescribed by the TEC, the TEC Form 1295 must be completed online through the TEC's website, assigned a certificate number, printed, signed and notarized, and provided to the Authority. **THE TEC FORM 1295 SHOULD ACCOMPANY THE BID**. For purposes of completing the TEC Form 1295, the entity's name is North Harris County Regional Water Authority; the contract ID number is Project No. [___]; and the description of goods and services is [name of project]. Neither the Authority nor its consultants have the ability to verify the information included in a TEC Form 1295, and neither have an obligation nor undertake responsibility for advising any BIDDER with respect to the proper completion of the TEC Form 1295.

THE BIDDER UNDERSTANDS THAT FAILURE TO PROVIDE SAID FORM COMPLETE WITH A CERTIFICATE NUMBER ASSIGNED BY THE TEC WILL RESULT IN A NON-CONFORMING BID. In the discretion of the Authority, an incomplete bid resulting from the failure to complete and submit the completed TEC Form 1295 by the bid submission deadline may be waived provided that the form is completed and submitted prior to award of the contract by the Authority.

28. Texas Government Code Sec. 2270.002 and 2252 Compliance with Laws Prohibiting Contracts with Companies Boycotting Israel and Certain Companies Engaged in Business with Iran, Sudan or Foreign Terrorist Organizations:

By submitting a BID, BIDDER hereby verifies that BIDDER does not boycott Israel and will not boycott Israel during the term of the Contract. For purposes of this verification, "boycott Israel" means refusing to deal with, terminating business activities with, or otherwise taking any action that is intended to penalize, inflict economic harm on, or limit commercial relations specifically with Israel, or with a person or entity doing business in Israel or in an Israeli-controlled territory, but does not include an action made for ordinary business purposes, as required by Section 2270.002, Texas Government Code.

Pursuant to Chapter 2252, Texas Government Code, the BIDDER represents and certifies that, at the time of execution of this Agreement, neither the BIDDER nor any wholly owned subsidiary, majority-owned subsidiary, parent company or affiliate of the same (i) engages in business with Iran, Sudan, or any foreign terrorist organization as described in Chapters 806 or 807 of the Texas Government Code, or Subchapter F of Chapter 2252 of the Texas Government Code, or (ii) is a company listed by the Texas Comptroller of Public Accounts under Sections 806.051, 807.051, or 2252.153 of the Texas Government Code. The term "foreign terrorist organization" in this paragraph has the meaning assigned to such term in Section 2252.151 of the Texas Government Code.

BIDDER acknowledges and agrees that the verification stated above is a material term of, and material consideration for, the Contract and that Owner is expressly relying on this verification in agreeing to enter the Contract with BIDDER.

END OF SECTION

BID

Date: _____

BID of _____, an individual proprietorship, a corporation authorized to transact business in Texas, or a partnership consisting of _____, registered to transact business in Texas _____

60-INCH AND 54-INCH WATERLINE ALONG GRANT ROAD AND COPELAND ROAD

PROJECT NO. 28-B

Work of the contract is for the construction of 60-Inch and 54-Inch Waterlines along Grant Road and Copeland Road using open cut and trenchless construction.

THIS BID IS SUBMITTED TO:

North Harris County Regional Water Authority
3648 Cypress Creek Pkwy., Suite 110
Houston, Texas 77068

1. The undersigned BIDDER proposes and agrees, if this BID is accepted, to enter into an agreement with OWNER in the form included in the Contract Documents to perform and furnish all Work as specified or indicated in the Contract Documents for the Bid Price and within the Bid Times indicated in this BID and in accordance with the other terms and conditions of the Contract Documents. BIDDER accepts the terms of the form of Agreement and the Contract Documents.

2. BIDDER accepts all of the terms and conditions of the Invitation to BID and Instructions to Bidders including without limitation those dealing with the disposition of Bid Security. This BID will remain subject to acceptance for sixty (60) days after the day of BID opening. If BIDDER is the Successful Bidder, BIDDER will sign and deliver the required number of counterparts of the Agreement with the Bonds and other documents required by the Bidding Requirements within eight (8) days after the date of OWNER's Notice of Award.

3. In submitting this BID, BIDDER represents and warrants, as more fully set forth in the Agreement, that:

(a) BIDDER has examined and carefully studied the Bidding Documents and Addenda. BIDDER hereby acknowledges receipt of the following Addenda: (List Addenda by Addendum Number and Date).

Addendum No.: _____ Dated: _____

Addendum No.: _____ Dated: _____

Addendum No.: _____ Dated: _____

(b) BIDDER has visited the site, has conducted all testing at the site BIDDER deems necessary, has become familiar with, has taken into consideration in formulating its BID, and accepts the general, local and site conditions that may affect cost, progress, performance, and furnishing of the Work;

(c) BIDDER is familiar with, has taken into consideration in formulating its BID and accepts all federal, state, and local Laws and Regulations that may affect cost, progress, performance, and furnishing of the Work.

(d) BIDDER has carefully studied all reports of explorations and tests of subsurface conditions at, or contiguous to, the site which have been identified in the Supplementary Conditions as provided in Paragraph 4.2.1 of the General Conditions. BIDDER accepts the determination set forth in Paragraph SC-4.2 of the Supplementary Conditions of the extent of the "technical data" contained in such reports upon which BIDDER is entitled to rely as provided in Paragraph 4.2 of the General Conditions. BIDDER understands, acknowledges, and agrees that such reports are not Contract Documents and may not be complete for BIDDER's purposes. BIDDER understands, acknowledges, and agrees that OWNER, PROJECT MANAGER, and ENGINEER are not responsible for and make no warranties regarding the accuracy or completeness of information and data shown or indicated in the Bidding Documents with respect to surface and subsurface conditions and Underground Facilities at or contiguous to the site. BIDDER acknowledges that it has had the opportunity to obtain and study any and all such additional or supplementary examinations, investigations, explorations, tests, studies, and data concerning conditions (surface, subsurface and Underground Facilities) at or contiguous to the site or otherwise which may affect cost, progress, performance or furnishing of the Work, or which relate to any aspect of the means, methods, techniques, sequences, and procedures of construction to be employed by BIDDER, and safety precautions and programs incident thereto as may be necessary. BIDDER does not consider that any additional examinations, investigations, explorations, tests, studies or data are necessary for the determination of this BID for performance and furnishing of the Work in accordance with the times, price, and other terms and conditions of the Contract Documents.

(e) BIDDER is aware of the general nature of work to be performed by OWNER and others at the site that relates to Work for which this BID is submitted as indicated in the Contract Documents.

(f) BIDDER has correlated the information known to BIDDER, information and observations obtained from visits to the site, reports and drawings identified in the Contract Documents, and all additional examinations, investigations, explorations, tests, studies, and data with the Contract Documents.

(g) BIDDER has given PROJECT MANAGER written notice of all conflicts, errors, ambiguities, or discrepancies that BIDDER has discovered in the Contract Documents, and the written resolution thereof by ENGINEER is acceptable to BIDDER; BIDDER has no questions regarding the Work; BIDDER has all information necessary to make a fully informed BID; and the Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions

for performing and furnishing the Work for which this BID is submitted.

(h) This BID is genuine and not made in the interest of or on behalf of any undisclosed person, firm, or corporation and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation; BIDDER has not directly or indirectly induced or solicited any other BIDDER to submit a false or sham BID; BIDDER has not solicited or induced any person, firm, or corporation to refrain from bidding; and BIDDER has not sought by collusion to obtain for itself any advantage over any other BIDDER or over OWNER.

(i) The Unit Prices in the Bid are not intentionally unbalanced so as to enable CONTRACTOR to receive periodic payments that will, by percentage, significantly exceed its percentage of overall completion on the Project.

4. BIDDER is duly qualified to carry on business in the State of Texas; possesses or has the ability to possess all licenses, permits, and certificates of authority necessary to commence and to complete the Work in accordance with the Bidding Documents; is fully qualified and has experience in performing work of the same type as the Work covered by the Bidding Documents; and will provide all necessary labor, superintendance, machinery, equipment, tools, materials, services, and other means of construction to complete all work upon which BIDDER bids and complete said work within the time stated and for maintaining same as required for the following prices:

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
CLEARING AND GRUBBING ITEMS					
1	6	Acre	Clearing and Grubbing, Including Removal and Off-Site Disposal, Complete in Place @_____ _____ Per Acre	$_____	$_____
			SUBTOTAL CLEARING AND GRUBBING ITEMS	**$_____**	
EROSION CONTROL ITEMS					
2	12	Months	Pollution Prevention Implementation Including Maintenance, Inspections, and Reporting for All Pollution Prevention Measures as Shown on the Plans, Complete in Place @_____ _____ Month	$_____	$_____
3	11,660	Linear Foot	Furnish and Install Reinforced Filter Fabric Barrier per Plans and Specifications as Shown on Plans, Complete in Place @_____ _____ Linear Foot	$_____	$_____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.
**Minimum allowable prices. Bidder may choose to quote a higher price.
***Maximum allowable bid price. Bidder may not change.

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
4	400	Linear Foot	Furnish and Install Reinforced Filter Fabric Barrier per Plans and Specifications, Complete in Place @_____ _____ Linear Foot	$_____	$_____
5	2,800	Square Yard	Furnish and Install Stabilized Construction Access per Plans and Specifications, Complete in Place @_____ _____ Square Yard	$_____	$_____
6	20	Each	Furnish and Install Curb Inlet Protection Barrier as Shown on Plans, Complete in Place @_____ _____ Each	$_____	$_____
7	6	Acre	Furnish and Install Hydromulch Seeding of all Disturbed Areas, including fine grading as Shown on Plans, Complete in Place @_____ _____ Acre	$_____	$_____
			SUBTOTAL EROSION CONTROL ITEMS	**$_____**	

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.
**Minimum allowable prices. Bidder may choose to quote a higher price.
***Maximum allowable bid price. Bidder may not change.

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
WATER LINE ITEMS					
8	1,350	Linear Foot	Furnish and Install 60-Inch Pipe, Including Fittings, Restrained Joints and Appurtenances in Open Cut, With Standard Bedding and Backfill as Shown on Plans, Complete in Place @_____ _____ Linear Foot	$_____	$_____
9	250	Linear Foot	Furnish and Install 60-Inch Carrier Pipe in a Tunnel With Welded Steel Casing, Including Tunnel Shafts, Restrained Joints and Appurtenances as Shown on Plans, Complete in Place @_____ _____ Linear Foot	$_____	$_____
10	6,675	Linear Foot	Furnish and Install 54-Inch Pipe, Including Fittings, Restrained Joints and Appurtenances in Open Cut, With Standard Bedding and Backfill as Shown on Plans, Complete in Place @_____ _____ Linear Foot	$_____	$_____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.
**Minimum allowable prices. Bidder may choose to quote a higher price.
***Maximum allowable bid price. Bidder may not change.

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
11	1,675	Linear Foot	Furnish and Install 54-Inch Carrier Pipe in a Tunnel With Welded Steel Casing, Including Tunnel Shafts, Restrained Joints and Appurtenances as Shown on Plans, Complete in Place @_____ _____ Linear Foot	$_____	$_____
12	30	Linear Foot	Furnish and Install 16-Inch Pipe, Including Fittings, Restrained Joints and Appurtenances in Open Cut, With Standard Bedding and Backfill as Shown on Plans, Complete in Place @_____ _____ Linear Foot	$_____	$_____
13	20	Linear Foot	Furnish and Install 12-Inch Pipe, Including Fittings, Restrained Joints and Appurtenances in Open Cut, With Standard Bedding and Backfill as Shown on Plans, Complete in Place @_____ _____ Linear Foot	$_____	$_____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.
**Minimum allowable prices. Bidder may choose to quote a higher price.
***Maximum allowable bid price. Bidder may not change.

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
14	100	Linear Foot	Furnish and Install 12-Inch Pipe by Auger and Casing, Including All Fittings and Appurtenances as Shown on Plans, Complete in Place @_____ _____ Linear Foot	$_____	$_____
15	1	Each	Furnish and Install 60-Inch Butterfly Valve with Operator Manhole as Shown on Plans, Complete in Place @_____ _____ Each	$_____	$_____
16	5	Each	Furnish and Install 54-Inch Butterfly Valve with Operator Manhole as Shown on Plans, Complete in Place @_____ _____ Each	$_____	$_____
17	1	Each	Furnish and Install 12-Inch Gate Valve with Box as Shown on Plans, Complete in Place @_____ _____ Each	$_____	$_____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.
**Minimum allowable prices. Bidder may choose to quote a higher price.
***Maximum allowable bid price. Bidder may not change.

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
18	16	Each	Furnish and Install 4-Inch Combination Air Release and Vacuum Relief Valve Assembly with Vent Piping, 3 Bollards and Service Manhole, as Shown on Plans, Complete in Place @_____ _____ Each	$_____	$_____
19	6	Each	Furnish and Install Access Manway With Service Manhole as Shown on Plans, Complete in Place @_____ _____ Each	$_____	$_____
20	82	Vertical Foot	Furnish and Install Extra Depth on Service Manhole as Shown on Plans, Complete in Place @_____ _____ Vertical Foot	$_____	$_____
21	1	Each	Furnish and Install Connection 28-A Including Removal of 54-Inch Dish Head Plug as Shown on Plans, Complete in Place @_____ _____ Each	$_____	$_____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.
**Minimum allowable prices. Bidder may choose to quote a higher price.
***Maximum allowable bid price. Bidder may not change.

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
22	1	Each	Furnish and Install Connection 28-C Including 60-Inch Dish Head Plug, Two 16-Inch Gate Valve and Box with Blind Flange Assemblies as Shown on Plans, Complete in Place @_____ _____ Each	$_____	$_____
23	1	Each	Furnish and Install Connection 28-E Including One 16-Inch Gate Valve and Box and One 16-Inch Plug with 2-Inch Blow Off Valve as Shown on Plans, Complete in Place @_____ _____ Each	$_____	$_____
24	1	Each	Furnish and Install Connection 28-F Including Two 16-Inch Gate Valve and Box with Blind Flange Assemblies as Shown on Plans, Complete in Place @_____ _____ Each	$_____	$_____
25	1	Each	Furnish and Install 12-Inch Plug and Clamp as Shown on Plans, Complete in Place @_____ _____ Each	$_____	$_____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.
**Minimum allowable prices. Bidder may choose to quote a higher price.
***Maximum allowable bid price. Bidder may not change.

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
26	1	Each	Furnish and Install Flushing Hydrant Assembly, Including 6-Inch Gate Valve, Box and Tee as Shown on Plans, Complete in Place @_____ _____ Each	$_____	$_____
27	8,075	Linear Foot	Furnish and Install Trench Safety System for Water Line Construction, as Shown on Plans, Complete in Place @_____ _____ Linear Foot	$_____	$_____
			SUBTOTAL WATER LINE ITEMS	**$**_____	
PAVING ITEMS					
28	340	Square Yard	Remove and Dispose of Asphaltic Surfacing including Base (all thicknesses) as Shown on Plans, Complete in Place @_____ _____ Square Yard	$_____	$_____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.
**Minimum allowable prices. Bidder may choose to quote a higher price.
***Maximum allowable bid price. Bidder may not change.

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
29	340	Square Yard	Furnish and Install Recycled Crushed Concrete Base Course as Shown on Plans, Complete in Place @_____ _____ Square Yard	$_____	$_____
30	340	Square Yard	Furnish and Install Up to 2-Inch Thick Asphaltic Concrete Pavement as Shown on Plans, Complete in Place @_____ _____ Square Yard	$_____	$_____
31	405	Square Yard	Remove and Dispose of Reinforced Concrete Pavement (all thicknesses), with or without Asphalt Overlay, with or without Curb, including Base and Subgrade as Shown on Plans, Complete in Place @_____ _____ Square Yard	$_____	$_____
32	9	Ton	Furnish and Install Lime Stabilized Subgrade (dry weight) as Shown on Plans, Complete in Place @_____ _____ Ton	$_____	$_____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.
**Minimum allowable prices. Bidder may choose to quote a higher price.
***Maximum allowable bid price. Bidder may not change.

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
33	405	Square Yard	Mix 8-Inch Lime Stabilized Subgrade as Shown on Plans, Complete in Place @_____ _____ Square Yard	$_____	$_____
34	405	Square Yard	Furnish and Install up to 6-Inch Thick Reinforced Concrete Pavement as Shown on Plans, Complete in Place @_____ _____ Square Yard	$_____	$_____
35	270	Linear Foot	Furnish and Install Curbs as Shown on Plans, Complete in Place @_____ _____ Linear Foot	$_____	$_____
36	311	Square Yard	Remove and Dispose of Concrete Sidewalks (all thicknesses) and Driveways (all materials, all thicknesses) @_____ _____ Square Yard	$_____	$_____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.
**Minimum allowable prices. Bidder may choose to quote a higher price.
***Maximum allowable bid price. Bidder may not change.

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
37	311	Square Foot	Furnish and Install Concrete Sidewalks, as Shown on Plans, Complete in Place @_____ _____ Square Foot	$_____	$_____
			PAVING SUBTOTAL ITEMS	**$_____**	
MISCELLANEOUS ITEMS					
38	1	Lump Sum	Mobilization and Furnish Performance, Payment, and Maintenance Bonds in accordance with the Contract Documents _____ Lump Sum	$ 275,000***	$ 275,000***
39	1	Lump Sum	Furnish, Install, and Maintain Traffic Control Devices and Appurtenances, in Accordance With Texas Manual on Uniform Traffic Control Devices (Latest Edition), Including Flagmen, Complete in Place as Required @_____ _____ Lump Sum	$_____	$_____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.
**Minimum allowable prices. Bidder may choose to quote a higher price.
***Maximum allowable bid price. Bidder may not change.

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
40	1	Lump Sum	Furnish and Install Cathodic Protection per Specifications and as Shown on Plans, Complete in Place @_____ _____ Lump Sum	$_____	$_____
41	2,395	Linear Foot	Remove and Dispose of Existing Fence (all types), as shown on Plans @_____ _____ Linear Foot	$_____	$_____
42	1,563	Linear Foot	Furnish and Install 6-Foot Chain Link Fence to match existing as Shown on Plans, Complete in Place @_____ _____ Linear Foot	$_____	$_____
43	225	Linear Foot	Furnish and Install 10-Foot Wood Fence to replace existing 6-Foot Wood Fence along Grant Road as Shown on Plans, Complete in Place @_____ _____ Linear Foot	$_____	$_____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.
**Minimum allowable prices. Bidder may choose to quote a higher price.
***Maximum allowable bid price. Bidder may not change.

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
44	50	Linear Foot	Furnish and Install 6-Foot Wood Fence to match existing as Shown on Plans, Complete in Place @_____ _____ Linear Foot	$_____	$_____
45	165	Linear Foot	Furnish and Install 3-Strand Barb Wire Fence, to match existing, with Metal Posts and Gate, as Shown on Plans, Complete in Place @_____ _____ Linear Foot	$_____	$_____
46	338	Linear Foot	Furnish and Install 6-foot Wrought Iron Fence, with brick columns, to match existing, as Shown on Plans, Complete in Place @_____ _____ Linear Foot	$_____	$_____
47	1000	Linear Foot	Regrade Existing Ditches, Complete in Place @_____ _____ Linear Foot	$_____	$_____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.
**Minimum allowable prices. Bidder may choose to quote a higher price.
***Maximum allowable bid price. Bidder may not change.

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
48	50	Linear Foot	Furnish, Install, and Remove 24-Inch Reinforced Concrete Pipe, Complete in Place @_____ _____ Linear Foot	$_____	$_____

SUPPLEMENTAL PAY ITEMS

**Minimum allowable prices. Bidder may choose to quote a higher price.

49	100	Square Yard	Furnish, Install, and Establish Extra Solid Sod, Complete in Place @_____ _____ Square Yard	$_____ ($5.00)**	$_____
50	8	Each	Furnish and Install Crushed Stone Manhole Foundation for Wet Conditions, Complete in Place @_____ _____ Each	$_____ ($150.00)**	$_____
51	100	Linear Foot	Furnish and Install Bedding and Backfill for Wet Conditions, Complete in Place @_____ _____ Linear Foot	$_____ ($15.00)**	$_____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.
**Minimum allowable prices. Bidder may choose to quote a higher price.
***Maximum allowable bid price. Bidder may not change.

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
52	50	Cubic Yard	Furnish and Install Extra Class "A" Concrete With Reinforcing Steel, Complete in Place @_____ _____ Cubic Yard	$_____ ($265.00)**	$_____
53	50	Pound	Furnish and Install Extra Reinforcing Steel, Complete in Place @_____ _____ Pound	$_____ ($50.00)**	$_____
54	100	Cubic Yard	Furnish and Install Extra Bank Sand Backfill, Complete in Place @_____ _____ Cubic Yard	$_____ ($18.00)**	$_____
55	100	Cubic Yard	Furnish and Install Extra Cement Stabilized Sand, Complete in Place @_____ _____ Cubic Yard	$_____ ($24.00)**	$_____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.
**Minimum allowable prices. Bidder may choose to quote a higher price.
***Maximum allowable bid price. Bidder may not change.

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
56		Each	Furnish and Install Extra 54-Inch Water Line Fitting, All Angles, Complete in Place @_____ _____ Ton	$_____ ($1,000)**	$_____
57		Each	Furnish and Install Extra 60-Inch Water Line Fitting, All Angles, Complete in Place @_____ _____ Ton	$_____ ($1,000)**	$_____
58		Ton	Furnish and Install Extra 16-Inch Water Line Fitting, All Angles, Complete in Place @_____ _____ Ton	$_____ ($500.00)**	$_____
59		Ton	Furnish and Install Extra 12-Inch Water Line Fitting, All Angles, Complete in Place @_____ _____ Ton	$_____ ($500.00)**	$_____
			SUBTOTAL SUPPLEMENTAL PAY ITEMS	**$_____**	

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.
**Minimum allowable prices. Bidder may choose to quote a higher price.
***Maximum allowable bid price. Bidder may not change.

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid
CASH ALLOWANCE ITEMS ***Maximum Allowable Bid Price, Bidder may not change.					
60	NA	NA	Allowance for Harris County Permits, Reimbursed on an Actual Cost Basis @_____ _____		$20,000.00
61		NA	Cash Allowance for Approved Construction Modifications, Reimbursed in Accordance with Article 10 of Section 00700 of the General Conditions. @_____ _____		(Amount 5% of Construction Cost)***
			SUBTOTAL CASH ALLOWANCE ITEMS	**$**_____	

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.
**Minimum allowable prices. Bidder may choose to quote a higher price.
***Maximum allowable bid price. Bidder may not change.

Item No.	Approx. Qty.	Unit	Description of Item Unit Price Written in Words	Unit Price*	Total Amount Bid

TOTAL AMOUNT BID **$** _____

TOTAL AMOUNT FOR MATERIALS **$**_____

TOTAL AMOUNT FOR SKILLS, LABOR, EQUIPMENT, ETC.: **$**_____

The OWNER in its continuing partnership with the Texas Water Development Board (TWDB) is enlisting the assistance of the BIDDER in obtaining contractor cost data on the cost of compliance with TWDB-1105, Rev 11/07/2018 "United States Iron and Steel (US I&S) Guidance for Projects Funded through State Programs" (See Attachment of TWDB-1105 in Section 00800 "Supplementary Conditions"). In this regard the OWNER requires the BIDDER provide the LUMP SUM compliance cost on this Project to be used for information purposes only.

Lump Sum	Cost of Compliance with TWDB-1105, Rev 11/07/2018 - United States Iron and Steel (US I&S) Guidance for Projects Funded through State Programs @_____ _____ Lump Sum		$_____	$_____

*In the event of a discrepancy, figures in the 'UNIT PRICE' column govern.
**Minimum allowable prices. Bidder may choose to quote a higher price.
***Maximum allowable bid price. Bidder may not change.

The undersigned (Contractor) represents and warrants that (1) all tangible personal property identified as 'materials' in the Proposal will be incorporated into Project, subject only to field adjustments as to quantities, (2) the prices of such material are exclusive of sales and use taxes, and (3) all sales and use taxes regarding tangible personal property not incorporated into the work are the sole responsibility of the Contractor and the Contractor has paid or will pay such taxes regarding such property.

Acknowledge receipt of Addendum Nos. _____, _____, _____
(initial)

ALL BID PRICES SHALL INCLUDE ALL APPLICABLE SALES TAX

5. BIDDER agrees to begin work promptly after written Notice to Proceed is given by OWNER and will substantially complete the Work within 335 days in accordance with Paragraph 15.5 of the General Conditions and will complete the Work and be ready for final payment within 365 days after the date of the written Notice to Proceed in accordance with Paragraph 15.9 of the General Conditions.

BIDDER accepts all the provisions of the Agreement and the Contract Documents, including the provision for liquidated damages in the event of failure to complete the Work within the time specified in the Agreement.

6. BIDDER has enclosed with this BID the required Bid Security in the form of a _____ in the amount of $ _____. BIDDER agrees that this amount is a measure of liquidated damages which OWNER will sustain by failure of the BIDDER to execute and deliver above named Agreement and Bonds, and not a penalty, and further agrees that this Bid Security shall be collected and retained by OWNER as liquidated damages in the event this BID is accepted by OWNER within sixty (60) days after opening of Bids, and BIDDER fails to execute the Agreement and the required Bonds with OWNER within eight (8) days after Contract Documents are received by BIDDER; otherwise said Bid Security shall be returned to the BIDDER in accordance with Paragraph 7 of Section 00100 - Instruction to Bidders.

7. BIDDER has enclosed with this BID the required HB 194 Conflict Disclosures form, which is located in Section 00800 – Supplementary Conditions, Attachment C-1.

(THIS SPACE INTENTIONALLY LEFT BLANK)

ATTEST: Very truly yours

_____ By: _____
(SEAL, if Bidder is Corporation) (Signature)

_____
(Typed or Printed Name)

Title: _____

Bidder: _____
(Name of Company)

Address: _____

_____

_____

Telephone No.: _____

Facsimile No.: _____

Surety Company: _____

Address: _____

_____

_____

Telephone No.: _____

Facsimile No.: _____

AGREEMENT

THIS AGREEMENT is dated as of the _____ day of _____ in the year _____ by and between North Harris County Regional Water Authority (hereinafter called OWNER) and _____ (hereinafter called CONTRACTOR).

OWNER and CONTRACTOR, in consideration of the mutual covenants hereinafter set forth, agree as follows:

Article 1. WORK.

1.1. CONTRACTOR shall perform the Work in a good and workmanlike manner and in the best way and most expeditious and economical manner consistent with the interests of the OWNER, shall exercise the degree of care, skill, and diligence in the performance of the Work in accordance with and consistent with industry standards for similar circumstances, shall utilize its best skill, efforts, and judgment in furthering the interests of the OWNER, and shall furnish efficient business administration and supervision (collectively, CONTRACTOR's "Standard of Care").

1.2. CONTRACTOR shall complete all Work as specified or indicated in the Contract Documents. The Work is generally described as follows:

Clearing and Grubbing, construction of erosion control measures, construction of 60-Inch and 54-Inch Water Transmission Line by trenchless and open-cut methods, construction of 16-Inch District waterlines and site restoration.

Article 2. PROJECT MANAGER AND ENGINEER.

2.1 PROJECT MANAGERS.

AECOM Technical Services, Inc. has been designated as the PROJECT MANAGER and is to assume all duties and responsibilities assigned to PROJECT MANAGER in the Contract Documents in connection with completion of the Work in accordance with the Contract Documents.

2.2 ENGINEER.

The Project has been designed by Dannenbaum Engineering Corp., who is to assume all duties and responsibilities assigned to ENGINEER in the Contract Documents in connection with completion of the Work in accordance with the Contract Documents.

Article 3. CONTRACT TIMES.

3.1. The Work will be substantially completed within 335 days after the date when the Contract Times commence to run as provided in Paragraph 2.3 of the General Conditions and will be completed and ready for final payment in accordance with Paragraph 15.9 of the General Conditions within 365 days after the date when the Contract Times commence to run.

3.2. *Liquidated Damages*. OWNER and CONTRACTOR recognize that time is of the essence to this Agreement and that OWNER will suffer financial loss if the Work is not completed within the times specified in Paragraph 3.1 above, plus any extensions thereof allowed in accordance with Article 12 of the General Conditions. They also recognize the delays, expense, and difficulties involved in proving the actual loss suffered by OWNER if the Work is not completed on time. Accordingly, instead of requiring any such proof, OWNER and CONTRACTOR agree that as liquidated damages for delay (but not as a penalty), CONTRACTOR shall pay OWNER Two Thousand dollars ($2,000) for each day that expires after the time specified in Paragraph 3.1 above for Substantial Completion until the Work is substantially complete. After Substantial Completion, if CONTRACTOR shall neglect, refuse, or fail to complete the remaining Work within the time specified in Paragraph 3.1 above for completion and readiness for final payment or any proper extension thereof granted by OWNER, CONTRACTOR shall pay OWNER Two Thousand dollars ($2,000) for each day that expires after the time specified in Paragraph 3.1 for completion and readiness for final payment.

Article 4. CONTRACT PRICE.

OWNER shall pay CONTRACTOR for completion of the Work in accordance with the Contract Documents an amount in current funds equal to the sum of the amounts as indicated in the Bid, Section 00300.

As provided in Paragraph 11.4.1 of the General Conditions, estimated quantities are not guaranteed, and determinations of actual quantities and classification are to be made by PROJECT MANAGER as provided in Paragraph 9.7 of the General Conditions. Unit prices have been computed as provided in Paragraph 11.4 of the General Conditions.

Article 5. PAYMENT PROCEDURES.

CONTRACTOR shall submit Applications for Payment in accordance with Article 15 of the General Conditions. Applications for Payment will be processed by the PROJECT MANAGER as provided in the General Conditions.

5.1. *Progress Payments; Retainage*. Subject to OWNER's right to withhold payment in Paragraph 15.4.4 of the General Conditions, OWNER shall make progress payments on account of the Contract Price on the basis of CONTRACTOR's completed Applications for Payment as recommended by PROJECT MANAGER, on or about the 25th day of each month during construction as provided in Paragraphs 5.1.1. and 5.1.2. below. All such payments will

be measured by the schedule of values established in Paragraph 2.4.2.3 of the General Conditions (and in the case of Unit Price Work based on the number of units completed).

5.1.1. Prior to Substantial Completion, progress payments will be made in an amount equal to the percentage indicated below, but, in each case, less the aggregate of payments previously made and less such amounts as PROJECT MANAGER shall determine, or OWNER may withhold, in accordance with Paragraph 15.4.4 of the General Conditions.

95 percent of Work completed and included in the Application for Payment (with the balance being retainage).

85 percent (with the balance being retainage) of materials and equipment not incorporated in the Work (but delivered, suitably stored and accompanied by documentation satisfactory to OWNER as provided in Paragraph 15.2 of the General Conditions) and included in the Application for Payment.

5.1.2. Upon Substantial Completion and submission of a completed Application for Payment, in an amount sufficient to increase total payments to CONTRACTOR to 98 percent of the Contract Price (with the balance being retainage), less such amounts as PROJECT MANAGER shall determine, or OWNER may withhold, in accordance with Paragraph 15.4.4 of the General Conditions.

5.2. *Final Payment*. Upon final completion and acceptance of the Work in accordance with Paragraph 15.9 of the General Conditions and submission of a completed Application for Payment, OWNER shall pay the remainder of the Contract Price as recommended by PROJECT MANAGER as provided in said Paragraph 15.9.

Article 6. NOT USED

Article 7. CONTRACTOR'S REPRESENTATIONS.

In order to induce OWNER to enter into this Agreement, CONTRACTOR makes the following representations and warranties:

7.1. CONTRACTOR has examined and carefully studied the Contract Documents (including the Addenda listed in Article 8) and the other related data identified in the Bidding Documents including "technical data."

7.2. CONTRACTOR has visited the site, has conducted all testing at the site CONTRACTOR deems necessary, has become familiar with, has taken into consideration in formulating its BID, and accepts the general, local, and site conditions that may affect cost, progress, performance and furnishing of the Work;

7.3. CONTRACTOR is familiar with and has taken into consideration in formulating its BID and accepts all federal, state, and local Laws and Regulations that may affect cost, progress, performance, and furnishing of the Work.

7.4. CONTRACTOR has carefully studied all reports of explorations and tests of subsurface conditions at or contiguous to the site which have been identified in the Supplementary Conditions as provided in paragraph 4.2.1 of the General Conditions. CONTRACTOR accepts the determination set forth in paragraph SC-4.2 of the Supplementary Conditions of the extent of the "technical data" contained in such reports and drawings upon which CONTRACTOR is entitled to rely as provided in paragraph 4.2 of the General Conditions. CONTRACTOR understands, acknowledges, and agrees that such reports are not Contract Documents and may not be complete for CONTRACTOR's purposes. CONTRACTOR understands, acknowledges, and agrees that OWNER, PROJECT MANAGER, and ENGINEER are not responsible for and make no warranties regarding the accuracy or completeness of information and data shown or indicated in the Bidding Documents with respect to surface and subsurface conditions. CONTRACTOR has obtained and carefully studied and is responsible for obtaining and studying any and all such additional or supplementary examinations, investigations, explorations, tests, studies, and data concerning conditions (surface, subsurface and Underground Facilities) at or contiguous to the site or otherwise which may affect cost, progress, performance or furnishing of the Work or which relate to any aspect of the means, methods, techniques, sequences and procedures of construction to be employed by CONTRACTOR and safety precautions and programs incident thereto as may be necessary. CONTRACTOR does not consider that any additional examinations, investigations, explorations, tests, studies, or data are necessary for the determination of this Bid for performance and furnishing of the Work in accordance with the times, price and other terms and conditions of the Contract Documents.

7.5. CONTRACTOR is aware of the general nature of work to be performed by OWNER and others at the site that relates to Work for which this BID is submitted as indicated in the Contract Documents.

7.6. CONTRACTOR has correlated the information known to CONTRACTOR, information and observations obtained from visits to the site, reports and PLANS identified in the Contract Documents and all additional examinations, investigations, explorations, tests, studies, and data with the Contract Documents.

7.7. CONTRACTOR has given PROJECT MANAGER written notice of all conflicts, errors, ambiguities or discrepancies that CONTRACTOR has discovered in the Contract Documents, and the written resolution thereof by PROJECT MANAGER is acceptable to CONTRACTOR, CONTRACTOR has no questions regarding the Work, CONTRACTOR has all information necessary to make a fully informed BID, and the Contract Documents are generally sufficient to indicate and convey understanding of all terms and conditions for performing and furnishing the Work for which this BID is submitted.

7.8. CONTRACTOR represents and warrants that CONTRACTOR (i) is qualified and experienced, (ii) is capable of performing the Work and has available resources to perform the Work, and (iii) understands and agrees to the terms of all of the Contract Documents.

Article 8. CONTRACT DOCUMENTS.

The Contract Documents that comprise the entire agreement between OWNER and CONTRACTOR concerning the Work consist of the following:

8.1. This Agreement (pages 1 to 8, inclusive).

8.2. Bid Form (pages 1 to 23, inclusive) marked Section 00300.

8.3. Construction Performance Bond, Payment Bond, and One-Year Maintenance Bond, identified as Sections 00610, 00620, and 00630 consisting of 4, 2, and 4 pages, respectively.

8.4. Other Exhibits to this Agreement (pages N\A to N\A, inclusive) (if any).

8.5. Notice to Proceed.

8.6. General Conditions (pages i to 60, inclusive), marked Section 00700.

8.7. Supplementary Conditions (pages 1 to 6, inclusive), marked Section 00800.

8.8. Specifications, bearing the title 60-INCH AND 54-INCH WATERLINE ALONG GRANT ROAD AND COPELAND ROAD PROJECT NO. 28-B and consisting of 1 volumes, as listed in table of contents thereof.

8.9. PLANS consisting of a cover sheet and sheets numbered 1 through 99 inclusive with each sheet bearing the following general title: North Harris County Regional Water Authority, Project 28-B Proposed 60" and 54" Water Line Along Grant Road and Copeland Road.

The documents listed in Article 8.2 et seq. above are attached to this Agreement (except as expressly noted otherwise above).

There are no Contract Documents other than those listed above in this Article. The Contract Documents may only be amended, modified, or supplemented as provided in Paragraphs 3.3.1 and 3.3.2 of the General Conditions.

Article 9. MISCELLANEOUS.

9.1. Terms used in this Agreement which are defined in Article 1 of the General Conditions will have the meanings indicated in the General Conditions.

9.2. No assignment by CONTRACTOR of any rights under or interests in the Contract Documents will be binding on OWNER or effective without the prior written consent of the OWNER; and, specifically but without limitation, moneys that may become due and moneys that are due may not be assigned without such consent (except to the extent that the effect of this restriction may be limited by law), and unless specifically stated to the contrary in any written consent, no assignment will release or discharge the assignor from any duty or responsibility under the Contract Documents.

9.3. OWNER and CONTRACTOR each binds itself, its partners, successors, assigns, and legal representatives to the other party hereto, its partners, successors, assigns, and legal representatives in respect to all covenants, agreements, and obligations contained in the Contract Documents.

9.4. Any provision or part of the Contract Documents held to be void or unenforceable under any Law or Regulation shall be deemed stricken, and all remaining provisions shall continue to be valid and binding upon OWNER and CONTRACTOR, who agree that the Contract Documents shall be reformed to replace such stricken provision or part thereof with a valid and enforceable provision that comes as close as possible to expressing the intention of the stricken provision. If, however, the void or unenforceable provision is of the essence of this Agreement, nothing in this Paragraph 9.4 shall prevent this entire Agreement from being void.

9.5. OTHER PROVISIONS. As noted hereinafter:

9.5.1. The following Articles shall survive termination of this Agreement: 3 (Contract Times); 7 (Contractor's Representations); and 9 (Miscellaneous).

9.5.2. Headings and titles of Articles in this Agreement are included herein for convenience of reference only and shall not constitute a part of the Agreement for any other purpose and will not affect in any way the meaning or interpretation of this Agreement.

9.5.3. This Agreement as executed by authorized representatives of OWNER and CONTRACTOR constitutes the entire Agreement between the parties with respect to matters herein, and there are no oral or written understandings, representations, or commitments of any kind, express or implied, not expressly set forth herein.

9.5.4. This Agreement, its interpretation, and any disputes relating to, arising out of, or connected with this Agreement, shall be governed by the laws of the State of Texas, without regard to conflicts of law provisions. Any dispute relating to, arising out of, or connected with this Agreement shall be filed and maintained in the state or federal courts located in Harris County, Texas, unless otherwise agreed by the parties in connection with an Alternative Dispute Resolution Agreement.

9.5.5. Each party hereto represents and warrants that the person executing this Agreement on its behalf is duly authorized and empowered to do so and that all formalities necessary for its approval of this Agreement have been satisfied.

9.5.6. CONTRACTOR undertakes performance of the Work as an independent contractor. Nothing herein shall create a relationship of employer and employee, joint venture, or partnership between OWNER and CONTRACTOR, its agents, representatives, employees, or subcontractors for any purpose whatsoever. Nothing herein shall create a relationship of principal and agent between OWNER and CONTRACTOR, its agents, employees, representatives, or subcontractors. Neither party shall have the authority to bind or obligate the other in any manner as a result of the relationship created hereby.

9.5.7. Upon payment of a portion of the Work, CONTRACTOR shall be deemed to have sold and conveyed to OWNER, and OWNER shall be deemed to have purchased from CONTRACTOR all of CONTRACTOR's right, title, and interest in the Work. From and after the date of such payment, within fifteen (15) days of the request of OWNER, CONTRACTOR shall execute and deliver such bills of sale and other instruments of conveyance, assignment, transfer, and delivery as OWNER may reasonably request in order to convey such right, title, and interest to OWNER. From and after the date of such payment, title to the Work shall remain with OWNER.

9.5.8. CONTRACTOR fully understands, and will assure that its subcontractors and suppliers fully understand that OWNER is a public entity and thus (1) an entity against which no mechanics lien may be asserted, and (2) an entity that can be bound only by agents with actual authority and (3) an entity that can only be bound to make payments from funds actually available for the performance of this Agreement.

9.5.9. Waiver of any breach of the Contract shall not constitute waiver of a subsequent breach.

9.5.10. Although the Contract Documents have been largely drafted by OWNER, in the event of any disputes over meaning and application, the Contract Documents shall be interpreted fairly and reasonably neither more strongly for nor against either party.

IN WITNESS WHEREOF, OWNER and CONTRACTOR have signed this Agreement in triplicate. One counterpart each has been delivered to OWNER, CONTRACTOR, and PROJECT MANAGER. All portions of the Contract Documents have been signed, initialed, or identified by OWNER and CONTRACTOR or identified by PROJECT MANAGER on their behalf.

This Agreement will be effective on _____, (which is the Effective Date of the Agreement).

OWNER North Harris County	CONTRACTOR _____
Regional Water Authority	_____
By: _____	By: _____
[CORPORATE SEAL]	[CORPORATE SEAL]
Attest _____	Attest _____
Address for giving notices	Address for giving notice
3648 Cypress Creek Pkwy, Suite 110	_____
Houston, TX 77068	_____
(OWNER is public body. Evidence of authority to sign and resolution or other documents authorizing execution of Agreement is attached.)	If CONTRACTOR is a corporation, attach evidence of authority to sign).

APPROVED:

_____
Mr. Jimmie Schindewolf, P.E.
General Manager

END OF SECTION

Section 02400

TUNNEL SHAFTS

PART 1 GENERAL

1.01 SUMMARY

This Section includes construction, maintenance, and backfilling requirements of tunnel shafts.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Tunnel shafts, both those shown on Plans and those additional ones needed for Contractor's operations, are incidental to tunnel construction and no separate payment will be made for them. Manholes constructed in tunnel shafts are to be paid separately at contract unit price as specified in Section 02081 – "Cast-in-place Concrete Manholes" or Section 02082 – "Precast Concrete Manholes".

2. Removal and replacement of surface improvements necessary for shaft construction, such as sidewalks, asphaltic or concrete pavement, base and subbase, curbs, curb and gutter, driveways, topsoil, sodding, and hydro-mulch are incidental to tunnel construction and no separate payment will be made for them.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.03 REFERENCES (NOT USED)

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 – "Submittal Procedures".

B. Shaft design submittals by Contractor shall be signed and sealed by Professional Engineer registered in State of Texas. If trench box is used in tunnel shaft and such utilization is in a manner other than what is indicated and certified in manufacturers technical data, submit trench box manufacturer certification of proposed usage.

C. Submit shaft construction drawings and seal slabs. Clearly indicate allowable surcharge loads and restrictions on surcharge capacity, including live loads, on shaft construction drawings. Indicate thrust blocks or other reactions required for pipe jacking, when applicable.

1. Location of shafts by station and limits of working sites.

2. Description of site security arrangements in conformance with Paragraph 3.03.C, Shaft Construction.

3. Description of method of extending shaft above flood level in conformance with Paragraph 3.03.C, Shaft Construction.

4. Any geotechnical/boring undertaken by Contractor for whatever purpose connected to Work.

D. Shaft Monitoring Plan: Submit for review prior to construction, shaft monitoring plan that includes schedule of instrumentation design, layout of instrumentation parts, equipment installation details, manufacturer's catalog literature, and monitoring report forms.

E. Structures Assessment. Provide preconstruction and post-construction assessment reports for critical structures located within radius of shaft center equal to shaft depth plus shaft radius, measured in plan. Include photographs or video of any existing damage to structures in vicinity of shafts in assessment reports.

F. Submit shaft surface settlement monitoring plan for review prior to construction. Identify location of settlement monitoring points, reference benchmarks, survey frequency and procedures, and reporting formats on plan.

G. Submit readings of monitoring plans to Project Manager as soon as readings have been taken.

H. Submit shaft temporary deck drawings and calculations to Project Manager, signed and sealed by Contractor's Professional Engineer in event that shaft is not needed for immediate construction activity, in conformance with Paragraph 3.03.C, Shaft Construction.

1.05 RELATED REQUIREMENTS

A. Section 01300 – "Submittal Procedures"

B. Section 01504 – "Temporary Facilities and Controls"

C. Section 01555 – "Traffic Control and Regulation"

D. Section 01576 – "Waste Material Disposal"

E. Section 01578 – "Control of Ground Water and Surface Water"

F. Section 02081 – "Cast-In-Place Concrete Manholes"

G. Section 02082 – "Precast Concrete Manholes"

H. Section 02316 – "Excavation and Backfill for Structures"

I. Section 02317 – "Excavation and Backfill for Utilities"

J. Section 02321 – "Cement Stabilized Sand"

K. Section 02431 – "Tunnel Grout"

1.06 QUALITY ASSURANCE (NOT USED)

1.07 SYSTEM DESCRIPTION

A. Performance Requirements

1. Shaft design must include allowance for contractor's equipment and stored material and spoil stockpile as appropriate. Design must also allow for HS-20 highway loading if located in the vicinity of a paved area and/or allow for Cooper E-80 locomotive loading if located in the vicinity of a railroad.

2. Design shaft to withstand full hydrostatic head without failure.

3. Design shaft located within 50-year flood plain with water retaining liner extending 2 feet above 50-year flood elevation. It is acceptable when liner is stored at site for immediate installation in lieu of it being installed at shaft, provided that shaft liner extends at least 2 feet above existing ground elevation.

4. Design shaft cover for minimum 25 pounds per square foot distributed load plus 300-pound point load.

5. Design steel plate deck, if such is required, for HS-20 loading.

1.08 – 1.13 NOT USED

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 – 3.02 NOT USED

3.03 ERECTION/INSTALLATION APPLICATION AND/OR CONSTRUCTION

A. Location of Access Shafts

1. Contractor has sole responsibility for selection of shaft sites needed for construction operations unless otherwise indicated on Plans. Location will be subject to approval of the Project Manager.

2. Locate shafts and associated Work areas to avoid blocking driveways and cross streets, and to minimize disruption to business and commercial interests. Avoid shaft locations near areas identified as residential or potentially contaminated.

3. Plan shaft locations to minimize interference with storm drainage channels, ditches, water lines, sanitary sewers, storm water sewers or culverts, which, when damaged, could result in ground washout or flooding of shafts and tunnels.

B. Utility Relocation

1. Relocate utilities as shown on Plans. Utility relocations required by Contractor for shaft construction shall take into account zone of potential settlement in vicinity of shaft.

2. Obtain approval from Project Manager for permanent relocations prior to relocating.

C. Shaft Construction

1. Conform to the following for ground support systems:

a. Install liner elements, bracing and shoring structural members at locations and in method sequence and tolerances defined on shaft construction drawings as excavation progresses.

b. Ensure bracing and shoring are in contact with liner to provide full support as shown in shaft construction drawings. Evaluate and check modifications to liner, bracing, and shoring. Obtain approval from Contractor's Professional Engineer and submit to Project Manager.

c. Install seal slab as soon as final depth and stable bottom conditions have been reached and accepted by Project Manager. Construct seal slab capable of withstanding full piezometric pressure, either by pressure relief using under drains, or in case of more permeable ground condition, by use of structural reinforced slab. Construct seal slab in accordance with design provided by Contractor's Professional Engineer.

d. Design and construct entire shaft to appropriate factors of safety against yield, deformation, or instability as determined by Contractor's

Professional Engineer. Shaft must withstand full hydrostatic head without failure.

e. Special framing, bracing or shoring required around tunnel "eyes" or other penetrations shall be in-place according to shaft construction drawings before liner or any bracing or shoring at penetration is cut or removed.

f. Securely breast and shore face of starter or back tunnels to resist both soil and hydrostatic pressure.

g. When applicable, pressure grout voids or seepage paths around shafts and adjoining tunnels in accordance with Section 02431- "Tunnel Grout". Pressure grout bolted steel liner plates as they are installed, unless otherwise approved by Project Manager. Perform secondary or 'back grouting' as ground measurement, voids, or deformation of shaft liner are detected.

2. Install suitable thrust or reaction blocks as required for pipe jacking equipment.

3. Provide drainage from shafts while Work is in progress and until adjacent pipe joints have been sealed and shaft is backfilled. Conform to requirements of Section 01578 – "Control of Ground Water and Surface Water".

4. Surface Water Control. Divert surface water runoff and discharge from dewatering system away from shaft. Protect shafts from infiltration or flooding.

5. Each surface work site is to be surrounded by security fence meeting requirements of Section 01504 – "Temporary Facilities and Controls", which shall be secure any time site is unattended by Contractor's personnel.

6. Protect shaft, when not in use by second security fence at perimeter of shaft, or alternatively by cover designed in accordance with Paragraph 1.07.A, Performance Requirements.

7. Provide portable concrete traffic barriers at locations where work site is situated adjacent to highway, road, driveway, or parking lot. Angle traffic barriers in direction of lane flow. Do not place perpendicular to on-coming traffic.

8. Provide and maintain traffic control system in accordance with provision of Section 01555 – "Traffic Control and Regulation".

9. Cover shaft which is constructed more than 60 days in advance of its intended use by steel plate deck designed by Contractor's Professional Engineer, and

restore surface to permit full traffic flow during time shaft is not in use. Remove from site other material and equipment used by Contractor including portable concrete traffic barriers, traffic control system, fencing and reinstall at time shaft is re-opened for use.

10. Construct suitable guardrail barrier around periphery of shaft, meeting applicable safety standards. Properly maintain barrier throughout period shaft remains open. Repair broken boards, supports, and structural members. Provide ladder with safety cage when required by OSHA in each shaft. In addition, provide full cover or other security barrier for each access shaft in which there is no construction activity or which is unattended by Contractor's personnel.

11. Size of Shafts: Make size adequate for construction of permanent structures indicated on Plans and to provide adequate room to meet operational requirements for tunnel construction and backfill.

D. Backfill

1. Provide cement-stabilized sand to minimum depth of 10 feet above crown of pipe, but where shaft is located in paved area, cement-stabilized sand shall be used to within one foot of pavement subgrade elevation. Provide cement-stabilized sand in accordance with Section 02321 – "Cement-stabilized Sand". Compact cement-stabilized sand in accordance with Section 02317 – "Excavation and Backfill for Utilities". In locations where backfill is not subject to traffic loading, depth above initial cement-stabilized sand may be backfilled with select backfill in accordance with Section 02316 – "Excavation and Backfill of Structures". When insufficient work space exists, Grout manhole or structure annular space in accordance with Section 02431 – "Tunnel Grout".

2. Remove shaft liner above level of 8 feet below ground surface, unless otherwise indicated on Plans. Maintain sufficient ground support to meet excavation safety requirements while removing shaft structure.

E. Monitoring

1. Monitoring Instrumentation. Instrumentation specified and readings shall be accessible at all times to Project Manager.

   a. Install and maintain instrumentation system to monitor and detect movement of ground surface and adjacent structures. Establish vertical survey control points at distance from construction area that avoids disturbance due to ground settlement.

b. Project Manager may through independent contractor or consultant, install instrumentation in, on, near, or adjacent to construction work. Provide access to Work for such independent installations.

c. Install instruments in accordance with Plans and manufacturer's recommendations.

2. Surface Settlement Monitoring

a. Establish monitoring points on all critical structures.

b. Record location of settlement monitoring points with respect to construction baselines and elevations. Record elevations to an accuracy of 0.01 feet for each monitoring point location. Establish monitoring points at locations and by methods that protect them from damage by construction operations, tampering, or other external influences.

c. Monitoring points to measure ground elevation are required at distance of 10 feet and 20 feet from perimeter of shaft on each of four radial lines, at 90 degrees to each other.

d. Railroads. Monitor ground settlement of track subbase at centerline of each track when within zone of potential settlement.

3. Reading Frequency and Reporting. Submit to Project Manager, records of readings from various instruments and survey points.

a. Record all shaft monitoring readings at least once per week starting prior to shaft construction and continuing until shaft has been backfilled and until no more detectable movement occurs.

b. Immediately report to Project Manager any movement, cracking, or settlement which is detected.

c. Following substantial completion but prior to final completion, make final survey of all shaft related monitoring points.

F. Disposal of Excess Material

Remove spoil in accordance with Section 01576 – "Waste Material Disposal".

3.04 – 3.10 NOT USED

END OF SECTION

SECTION 02425

TUNNEL EXCAVATION AND PRIMARY LINER

PART 1 GENERAL

1.01 SUMMARY

This Section includes:

A. Tunnel construction operation with primary lined tunnel installed during tunnel drive followed by placement of water line inside tunnel after completion of tunnel construction. This Specification is intended to be primarily functional in nature and to define in general terms Work to be accomplished.

B. Construction Methods: Various construction methods such as TBM, hand tunneling, or shield are allowed. Liners include rib and lagging, steel liner plate, bolted steel liner etc. Liners may be expanded or grouted.

1.02 MEASUREMENT AND PAYMENT

A. No separate payment will be made for Work performed under this Section such as excavation, liner, grouting, instrumentation, or monitoring. Include cost of tunnel excavation and primary liner in accordance with Section 02511 – "Water Lines".

B. Where such effort is necessary, cost for ground water control during course of tunnel work included in unit prices for water main in tunnel.

C. Ground water control required during course of Project to lower water table for other utility installation, to remove standing water, surface drainage seepage, or to protect ongoing Work against rising waters or floods considered incidental to Work being performed.

D. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in Total Stipulated Price.

1.03 REFERENCES

A. The publications listed below form part of this specification to extent referenced. Publications are referred to in text by abbreviations only.

1. AREMA Manual for Railway Engineering (Applicable sections).

2. American Association of State Highway and Transportation Officials (AASHTO).

3. American Society for Testing and Materials (ASTM).

a. ASTM A36/A36M – Standard Specification for Carbon Structural Steel.

b. ASTM A1064/1064M – Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

c. ASTM A283/A283M – Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.

d. ASTM A307 – Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.

e. ASTM A328/A328M – Standard Specification for Steel Sheet Piling.

f. ASTM A615/A615M – Standard Specification for Deformed and Plain Carbon–Steel Bars for Concrete Reinforcement.

g. ASTM C33/C33M – Standard Specification for Concrete Aggregates.

4. ASTM C150/C150M – Standard Specification for Portland Cement. American Water Works Association (AWWA)

a. AWWA C206 – Field Welding of Steel Water Pipe.

b. AWWA C200 – Steel Water Pipe, 6-inches and Larger.

5. Occupational Safety and Health Administration (OSHA): Particular attention is called to Subpart S of OSHA Standards (29 CFR 1926/1920), published as U.S. Department of Labor Publication 2207, Revised Oct. 1, 1979. Second revision dated August 1, 1989. See Federal Register dated June 2, 1989 for revised standard and commentary.

1.04 SUBMITTALS

A. Procedures: Conform to requirements of Section 01330 – "Submittal Procedures". Project Manager will review plans, details, and data for compliance with requirements of the Specification. Such review shall not be construed to relieve Contractor of responsibilities under Contract. Contractor shall not commence work on items requiring Contractor's work plan, construction drawings, or other submittals until submittals have been reviewed and accepted by Project Manager. All structural designs and other engineered components must be signed and sealed by Professional Engineer registered in the State of Texas.

B. Tunneling Work Plan: Submit to Project Manager for review, Tunneling Work Plan with complete construction drawings, complete written description identifying details of proposed method of construction and sequence of operations to be performed during construction, as required by method of tunnel excavation and liner installation. Submit sufficiently detail construction drawings and descriptions to demonstrate to

Project Manager whether proposed materials and procedures will meet requirements of Specification, as indicated below:

1. Submit Contractor's work plan and construction drawings on following items, depending on method of construction:

    a. If use of mechanized excavating equipment (such as TBM or shielded excavators) is proposed, submit arrangement drawings and technical specifications of machine and trailing equipment (including modifications), experience record with this type of machine of both Contractor and proposed operator and copy of manufacturer's operation manual for machine.

    b. The Contractor may elect to use tunnel shield that is separate from mechanized excavation equipment or for use with hand excavation. When use of tunnel shield is proposed, submit arrangement drawings, design criteria, dimensional data, and method of excavation and operation of shield, including acceptable method for supporting, controlling, and closing face of heading.

    c. Complete details of equipment, methods and procedures to be used for ground support, including but not limited to primary liner installation, timing of installation in relation to excavation plan, bulkheads and equipment.

    d. Grouting techniques meeting requirements this Section and Section 02431 – "Tunnel Grout".

    e. Procedures for measuring excavation quantities versus forward progress during tunneling operation (for earth pressure balance TBM only).

    f. Method of controlling line and grade of excavation.

    g. Details of muck removal, including equipment type, number, and disposal location.

    h. Description of ventilation system, lighting system, and electrical system.

    i. Proposed contingency plans for critical phases and areas of tunneling.

    j. Special activities at critical utility crossings, or for Work potentially affecting other facilities and existing utilities where special precautions must be taken during construction.

2. Submit design criteria established by Contractor's Engineer for primary liner, including design calculations and installation details, and certification by qualified Professional Engineer registered in the State of Texas that structural

design of primary tunnel meets criteria and specified requirements for range of field conditions.

3. Submit layout and design of proposed access shafts and shafts for permanent installations in accordance with Section 02400 – "Tunnel Shafts".

4. Submit ground water and surface water control system details per requirements in this Section and in accordance with Section 01578 – "Control of Ground Water and Surface Water".

5. All structural designs and other engineered items must be signed and sealed by qualified Professional Engineer Registered in the State of Texas unless otherwise specified.

C. Quality Control Methods: Submit description of quality control methods Contractor proposes to use in this operation to Project Manager. Include in submittal the following items:

1. Supervision: Supervisory control to ensure that Work is performed in accordance with Plans and Specifications and Contractor's work plan and construction drawings.

2. Line and Grade: Procedures for surveying, controlling, and checking line and grade, including field forms for establishing and checking line, and grade.

3. Tunneling Observation and Monitoring: Procedures for preparing and submitting daily logs of tunneling operations, including field forms, to meet requirement of Paragraphs 3.05, Tunneling Data and 3.06, Control of Tunnel Line and Grade of this Section.

4. Monitoring Instrumentation: Conform to requirements of Paragraph 3.08A, Monitoring Instrumentation of this Section.

5. Settlement Survey Plan, to meet requirements of Paragraph 3.08C, Settlement Surveying of this Section. This plan may be submitted as part of Instrumentation Monitoring Plan.

6. Building Condition/Assessment Plans: Conform to requirements of Paragraph 3.08B, Buildings and Structures Assessment of this Section.

D. Geotechnical and Environmental Investigation: Include results of geotechnical and environmental investigations performed by Contractor as relevant to tunneling in Work Plan. Submit these reports to the Project Manager for record purposes only.

E. Safety: Submit to Project Manager procedures to meet all applicable OSHA requirements including the following as minimum: Submit these procedures for record purpose only.

1. Protection against soil instability and ground water inflow.

2. Safety for shaft access and exit including ladders, stairs, walkways, and hoists.

3. Means of mechanical and hydraulic equipment operations, and for lifting and hoisting equipment and material.

4. Ventilation, lighting, and communication systems.

5. Monitoring for hazardous gases.

6. Protection against flooding.

7. Means for emergency evacuation.

8. Protection of shaft including traffic barriers, accidental or unauthorized entry, and falling objects.

9. Emergency protection equipment and self-rescue equipment.

10. Safety supervising responsibilities.

1.05 RELATED REQUIREMENTS

A. Section 01330 – "Submittal Procedures"

B. Section 01504 – "Temporary Facilities and Controls"

C. Section 01578 – "Control of Ground Water and Surface Water"

D. Section 02400 – "Tunnel Shafts"

E. Section 02431 – "Tunnel Grout"

F. Section 02511 – "Water Lines"

G. Section 02517 – "Water Line in Tunnels"

H. Section 02518 – "Steel Pipe and Fittings for Large Diameter Water Lines"

I. Section 02621 – "Geotextile"

J. Design Criteria

1. Design primary liner for appropriate loading conditions, including but not limited to: overburden and lateral earth pressures, handling and installation stresses, loads imposed by tunnel shield or tunnel boring machine thrust jacks, subsurface soil and water loads, grouting, and all other conditions of service. Contractor responsible for design of primary liner to carry thrust of jacking or

other construction forces or loads anticipated. Contractor's Professional Engineer is responsible for design of primary tunnel liner system.

2. At railroad crossings, unless otherwise specified by railroad authority use Cooper E-80 locomotive loading distribution criteria in accordance with AREMA specifications for culverts. Account for additive loadings for multiple tracks in design. Provide liner type for railroad crossings as specified or as otherwise required by railroad authority. Acceptable monitoring devices, such as closed circuit television, which permit continuous monitoring of conditions at face by qualified observers, from outside tunnel, may be used.

3. Use HS-20 vehicle loading distributions for truck loading criteria in accordance with AASHTO.

4. Compatibility of Methods:

   a. Use compatible methods of excavation, liner, and ground stabilization and ground water control.

   b. Design primary lining, when used to provide thrust for propulsion of shield, to withstand this thrust without damage or distortion. Configure propulsion jacks on shield so that thrust is uniformly distributed and will not damage or distort primary liner.

   c. Use compatible tunneling method with possible restrictions on Work, such as influence on existing installations or potential ground water contamination.

5. Demonstrate that chosen method will prevent flow of water or soil into tunnel and provide stability of face under anticipated conditions.

1.06 – 1.08 NOT USED

1.09 PROJECT SITE CONDITIONS

A. Safety Requirements:

1. Perform Work in manner to maximize safety and avoid exposure of men and equipment to hazardous and potentially hazardous conditions, in accordance with applicable safety standards and Contractor's safety procedures.

2. Whenever there is emergency or stoppage of Work which is likely to endanger tunnel excavation or adjacent structures, operate full work force for 24 hours a day, including weekends and holidays, without intermission until potentially hazardous conditions no longer exist or jeopardizes stability and safety of Work or existing installations.

3. Perform tunnel construction in a manner that shall minimize movement of ground in front and surrounding tunnel. Prevent significant subsidence of surface and protect structures and utilities above, and in vicinity of, tunnel from damage.

4. Support ground continuously in a manner to prevent loss of ground and keep perimeters and faces of tunnel and bottoms of shafts stable. Use filter-fabric and other means as necessary behind primary liner to prevent soil migration into tunnel.

B. Surveillance of Headings: When Contractor is not able to close face of machine because of maintenance requirements, maintain qualified personnel on duty to observe conditions that might threaten stability of heading whenever tunnel excavation is suspended or shut down. Equip personnel with approved contingency plan to take appropriate action to prevent or limit damage should conditions which threaten stability of heading occur.

C. Air Quality:

1. Conduct tunneling operations by methods and with equipment which shall positively control dust, fumes, vapors, gases, or other atmospheric impurities in accordance with OSHA, Federal, State, and City requirements.

2. Provide approved mining instrumentation for testing quality of tunnel atmosphere and obtain samples, under working conditions, at prescribed intervals in accordance with above referenced requirements. Submit results of air quality tests to Project Manager.

D. Ground Conditions: Perform sufficient exploration by geotechnical and environmental borings in advance of construction to define necessary parameters for design of primary tunnel liner, planning and designing ground water control system, and for selection of tunneling method and equipment to successfully complete each tunnel reach. Present results of Contractor's geotechnical and environmental investigations in related work plans.

1.10 DEFINITIONS

A. Tunneling Work Plan is defined as written description together with sketches, drawings, schedules, and other documents defining Contractor's planned methods and procedures for tunneling operations.

B. Contractor's Construction Drawings are defined as drawings by which Contractor proposes to furnish, construct, install, and operate referenced item.

C. Primary Liner is defined as Contractor's initial construction liner and tunnel support installed by Contractor for ground stability and safety during construction in

preparation for the installation of water line. Contractor chooses method of tunnel construction in accordance with this Specification. Inclusion of various methods in specification or reviews by Project Manager of Contractor's submittals shall not be construed by Contractor as endorsement by Project Manager that all such methods are constructible or will work for specific subsurface soils encountered.

D. Carrier Pipe is referred to as water line or permanent (secondary) liner. Such water line/permanent liner is defined and installed in accordance with Section 02517 – "Water Line in Tunnels" or Section 02511 – "Water Lines".

E. Tunnel Boring Machine (TBM): Mechanized and fully shielded excavating equipment that is steerable, guided and articulated, with man entry.

F. Shield: Fabricated ground support, circular in section, proving 360 degree protection to those working in it. Shield shall have cutting edge, and be equipped with independently operated hydraulic propulsion rams, allowing it to be steered. Liner is erected within tail attached to shield.

G. Open Face: Face of heading or tunnel which is unsupported during excavation (e.g., in hand mining or shield excavation).

H. Closed Face: Face of heading or tunnel which is supported during excavation process from TBM, where cutter head allows both partial exposure of face and full closure, by means of hydraulically operated gates.

1.11 – 1.13 NOT USED

PART 2 PRODUCTS

2.01 MANUFACTURER(S) (NOT USED)

2.02 MATERIALS AND/OR EQUIPMENT

A. Primary Tunnel Liner and Supports

1. The primary tunnel liner may consist of steel ribs and lagging, steel liner plates, precast concrete segments, steel casing pipe, or combinations of these. Lagging may be timber or steel. Box tunnels with timber supports will not be allowed. Utilize additional support elements including shotcrete, additional steel sets, breasting, spilling, forepoling, crown bars, soil anchors, or fabrics, as required to provide safe, stable excavation.

2. Use steel liner plates, steel casing, or steel lagging with steel ring beams as primary liner for tunneling under Texas Department of Transportation rights-of-way.

3. Use steel casing as primary liner for tunneling under railroad rights-of-way.

4. Use steel casing as primary liner for tunneling in fault zone crossings and when tunneling under drainage channels, creeks, bayous, and gullys.

B. Material Standards

1. Where use of following materials is required, conform to requirements of following minimum standards:

Material	**Reference Standards**
Cement	ASTM C150/C150M
Structural Concrete	
Reinforcing Steel Wire	ASTM A82 or A1064/A1064M
Reinforcing Steel Wire Fabric	ASTM A1064/A1064M
Reinforcing Steel Bars	ASTM A615/A615M , Grade 60
Sand and Aggregate	ASTM C33/C33M
Structural Steel	ASTM A36/A36M
Steel Piles, Sheets	ASTM A328
Rings and Ribs	ASTM A36/A36M
Steel Plates	ASTM A36/A36M and A283/A283M
Lumber and Timber	Hardwood, sound or better, as defined by Commercial Standard C560
Steel Casing Pipe	AWWA C200

C. Steel Liner Plates

1. Except as otherwise specified, furnish materials according to applicable requirements of AREMA Manual for Railway Engineering.

2. Bolts and nuts: Conform to ASTM A307, Grade A. Use bolts no less than 1/2 inch in diameter for plate gauge 7 or thinner and no less than 5/8 inch in diameter for greater plate thicknesses.

3. Punch plates for bolting on both longitudinal and circumferential seams and fabricate to permit complete erection from inside tunnel. Use plates of uniform fabrication and use interchangeable plates for those intended for one size tunnel.

4. Use new material for construction of liner plates. Used plates shall not be acceptable.

5. Provide steel liner plates manufactured by Contech Construction Products (2-flange), Commercial Pantex Sika, Inc. (4-flange), or approved equal, and

certified by manufacturer of compliance with specifications. Provide tensile strength, yield strength, and minimum elongation of liner plates. Also, provide design calculations for either 2-or 4-flange liner plates, as appropriate for Contractor's method of construction. All steel liner plate designs shall meet following minimum factors of safety:

Seam Strength.....3

Buckling 2

Maximum Deflection .....2% (of normal tunnel diameter)

6. Maintain minimum thickness of metal for these steel plates as shown on Plans, allowing for standard mill tolerances.

7. Equip steel liner plates with approximately 2-inch-diameter grout holes furnished with plugs. Locate holes near plate centers, such that when plates are installed there shall be one line of holes along crown and along each side of tunnel, not more than 18 inches above invert. Locate holes in each line at no more than every other plate and stagger.

8. Protective coating not required for steel liner plates, unless otherwise specified or shown on Plans.

9. Install gaskets between liner plates when required to control seepage, or as specified or shown in Plans.

10. Steel ribs used with liner plates: Conform to requirements of Paragraph 2.06, Steel Beams and Lagging.

D. Steel Casing Pipe

1. Casing pipe: Provide new uncoated welded steel pipe, manufactured in accordance with AWWA C200. Comply with Section 02518 – "Steel Pipe and Fittings for Large Diameter Water Lines".

2. Design stress in pipe wall shall be no greater than 50 percent of minimum yield point of steel or 18,000 psi, whichever is less when subjected to loading conditions.

3. Design deflection to be used in determining wall thickness shall not exceed 3 percent of nominal casing pipe size.

4. Bedding constant to be used in determining wall thickness shall be 0.10. Lag factors shall be 1.0 for all live loads.

5. Casing pipe design shall also include stresses due to jacking forces when pipe is to be installed by jacking method.

6. Equip casing pipe with approximately 2-inch diameter grout holes furnished with plugs. Place holes in pattern so that each succeeding hole from top dead center is 60 degrees right, then 60 degrees left, then top dead center. Locate holes in each line no more than 9 feet apart.

7. Conform casing pipe used in fault zones to welding and weld testing requirements specified in Section 02518 – "Steel Pipe and Fittings for Large Diameter Water Lines".

8. Casing pipe used in fault zones must be plugged at each end with clay bricks around O.D. of pipe minimum of one foot thickness measured into casing to prevent infiltration of soil into annular space.

E. Steel Ribs and Lagging

1. Steel ribs and auxiliary structural members shall be free of defects which may impair or reduce their structural integrity. Ribs shall be accurately curved to proper radius of tunnel section (or shaft section) and rib segments shall fit closely for bolted connections at segmental and transverse joints. Provide steel appurtenances required for installation of ribs such as tie rods, bolts, splice plates, dutchmen and drift pins, with ribs.

2. Minimum factors of safety:

   a. Buckling 2

   b. Stiffness 3

F. Timber

1. Use new timber for primary liner ground support without defects, of true dimensions and of quality grade and wood type defined by Contractor's Engineer.

G. Filter Fabric

See Section 02621 – "Geotextile" for requirements of material and minimum installation requirements. Install fabric, and backer rods, as required to prevent loss of fine-soil sediments into tunnel.

H. Equipment

1. Use only the tunneling method or equipment which shall produce specified results for soils encountered. However, use tunneling method, whether hand or machine, with full-face closure capabilities.

2. Diesel, electrical, hydraulic, or air-powered equipment is subject to applicable Federal and State regulations. Diesel engines equipped with scrubbers are

acceptable only when tunneling in free air with adequate ventilation. Provide compressed air and electricity for Contractor's operations from source outside tunnel.

3. When TBM is used, employ equipment that shall be capable of handling various anticipated ground conditions. In addition, TBM shall:

   a. Be capable of minimizing loss of ground ahead of and around machine and providing satisfactory support of excavated face. Use TBM with, when necessary for ground control, earth-pressure balance, or slurry-shield capabilities.

   b. Conform to shape of tunnel with uniform perimeter that is free of projections that could produce over-excavation or voids. TBM shield shall be continuous around its full perimeter; open-bottom shield is not acceptable.

   c. Have tail section long enough to enable setting of initial supports within machine, while still providing at least 12-inches of overlap beyond last installed support elements when thrusting jacks are extended to fullest extent possible.

   d. Have propulsion jacks capable of moving machine in forward direction while maintaining construction tolerances with respect to line and grade, without damage to previously-installed tunnel supports. Design propulsion system so that in event of failure of any element of system, there is no movement backward and there is no overstressing or distortion of tunnel supports.

   e. Incorporate seal in TBM tail shield to prevent leakage of grout between shield and liner into tunnel space, when grout is required immediately behind shield.

   f. Have motors and operating controls protected against water inflow.

   g. Provide bi-directional drive on cutter head wheel, or fins or grippers to control roll due to rotation.

   h. Provide means for maintaining tunnel face under wet and adverse soil conditions. Use closure doors on cutter wheel or other means, such as earth-pressure balance or slurry shield, acceptable to Project Manager.

4. When a tunnel shield is used (with or without attached mechanized excavating equipment), employ shield that shall be capable of handling various anticipated ground conditions. In addition, tunnel shield shall:

a. Conform to shape of tunnel with uniform perimeter that is free of projections that could produce over excavation or voids. Appropriately sized overcutting bead or taper along length of shield may be provided to facilitate steering. Shield shall be continuous around its full perimeter; open bottom shield is not acceptable. Although it is recognized that capability to over excavate beyond perimeter of shield may be necessary under certain conditions, make provisions to prevent accidental over excavation.

b. Have hood, poling or breasting plates, shelves and breast jacks, breast tables, and combinations of these and other bracing as necessary to fully support face of tunnel excavation without loss of ground.

c. Have tail section long enough to enable setting of initial supports within shield while still providing at least 12-inches of overlap beyond last-installed support elements when shield has been pushed forward to fullest extent possible.

d. Have propulsion system for moving shield in forward direction, while maintaining construction tolerances with respect to line and grade, without damage to previously-installed tunnel support. Design propulsion system so that in event of failure of any element of system, there is no movement backward and there is no overstressing or distortion of tunnel supports.

e. Have motors and operating controls protected against water inflow.

f. Incorporate seal in tail of shield to prevent leakage of grout between shield and liner into tunnel space, when grout is required immediately behind shield.

5. Air Quality: Provide equipment to adequately ventilate entire tunnel operation during construction, in accordance with OSHA requirements.

a. Provide portable testing equipment for carbon monoxide gas, hydrogen sulfide gas, oxygen deficiency, and explosive gases. Monitoring for other constituents may be required while tunneling in potentially contaminated areas as defined in Contractor's safety plan.

b. Provide audible automatic gas alarm on TBM to detect explosive gases Locate alarm near tunnel face.

c. Equip motors and controls with automatic shutoff methane monitoring system.

6. Lighting: Provide adequate lighting with lights at 50 feet, maximum spacing in tunnel. Fixtures shall be in watertight enclosures with suitable guards. Provide separate circuits for lighting and for electrical equipment.

7. Electrical: Equip electrical systems utilized on TBM with appropriate ground fault system. Electrical systems are to be insulated, not permitting bare-wire exposures.

8. Access: Provide safe access through tunnel to TBM.

   a. Provide walkway in tunnels greater than 10 feet in diameter which is separate from tracks used by spoil removal equipment.

   b. Equip locomotives or cars used for transport of personnel with necessary safety devices.

9. Necessary equipment for tunnel excavation includes telephones, signal systems, fire extinguishers, safety equipment, and other equipment required by Contractor's method of construction, work plan, and safety plan. Maintain equipment in good repair, and readily available at place of work.

2.03 – 2.04 NOT USED

PART 3 EXECUTION

3.01 GENERAL / MANUFACTURER(S)

A. Use of various materials and construction methods for tunnel excavation and ground support, such as by tunnel boring machine (TBM), hand tunneling or shield will be allowed provided that proposed products and methods will complete Project in accordance with Specifications, this Section, applicable safety codes, and Project schedules. Contractor responsible for final constructed product, materials and tools used, and for furnishing labor and qualified superintendents necessary for selected method of construction.

B. Use tunnel liner or casing of a size so that minimum clearance at the bottom between O.D. of carrier pipe and inside of liner is minimum 4 inches, and minimum clearance at the top between O.D. of pipe and inside of liner or casing is in accordance with following:

Carrier Pipe Net I.D.	Minimum Clearance to Top
≥ 48"	9"
42"	7"
36"	5"
≤ 30"	3"

C. This clearance also applies to distance between carrier pipe and electrical conducting pipe support system.

D. Furnish all items, such as TBM or shield with excavation equipment, spoil disposal systems, muck trains, hoist, grouting, signal systems, ventilation, safety equipment, and survey controls necessary to excavate and advance tunnel and construct primary tunnel liner by selected method.

3.02 PREPARATION

A. Contractor shall be responsible for his means and methods of tunneling construction and shall ensure safety of Work, Contractor's employees, public, and adjacent property, whether public or private.

B. Execute Work of excavating, lining, grouting, and construction of tunnel so that ground settlement or loss will be minimized. Completed primary tunnel lining shall have full bearing against earth with no voids or pockets left in Work. Fill peripheral space between support elements and excavated surface no less frequently than after each shore or close by expanding support elements against ground as shield advances. Provide stability of face under anticipated conditions.

C. Maintain clean working conditions inside tunnel and remove muck, debris, material spills, unusable supports, and other material not required for tunneling.

D. Be aware that various existing soil borings, piezometers, or instrument wells may coincide with proposed tunnel alignment. These may or may not have been backfilled with grout and therefore caution should be used in tunneling through these existing borings. Take mitigating measures to counter effect these boreholes, piezometers, or instrument wells may have on tunneling operations.

E. Perform tunneling under railroad embankments, highways, or streets to prevent interference with operation of railroad, highways, or streets.

F. Do not perform any surface activities pertaining to water line construction within a tunnel area unless otherwise approved by Project Manager.

G. Conduct tunneling operations in accordance with applicable safety rules and regulations, OSHA Standards, and Contractor's Safety Plan.

H. Perform additional exploration of ground conditions by geotech borings if needed to define necessary parameters for design and for selection of tunneling method. No additional pay.

3.03 ERECTION/INSTALLATION APPLICATION AND/OR CONSTRUCTION

A. Tunnel Excavation and Primary Liner Installation

1. Tunnel Excavation:

a. The selected method of tunnel excavation is subject to review by the Project Manager.

b. Conduct tunneling operations in accordance with applicable safety rules and regulations, and Contractor's safety plan. Use methods which include due regard for safety of workmen, adjacent structures, utilities, and public.

c. Limit tunnel excavation to within easements and rights-of-way indicated on Plans, and to lines and grades designated on Plans. Perform excavation of sufficient size to allow installation of water line to lines and grades indicated on Plans.

d. Locate equipment powered by combustible fuels at suitable distances from shafts to prevent possibility of explosion and fire in shafts or tunnel.

e. During open-face excavation:

1) Excavate face commencing at crown and proceed down to invert. Excavate both sides of heading simultaneously. Keep hood buried in soil ahead where soils include sands and silts.

2) Keep face breasted or otherwise supported; employ other means as necessary to maintain face stability and prevent falls, excessive ravelling, or erosion. Maintain standby face supports for immediate use when needed.

3) During shut-down periods, support face of excavation by positive means; do not rely solely on hydraulic pressure for support. When face is untouched for more than 24 hours, and when required by Project Manager, fully breast face and shove shield tight against it.

f. During closed-face excavation:

1) Carefully control and monitor volume of spoil removed. For earth-pressure balance TBM, balance spoil removed with advance rate and excavation rate.

2) When cutting face is withdrawn, keep excavated face stabilized as required.

g. Advancing Shield: During forward movement of shield, provide sufficient support at excavation face to prevent movement of materials except materials as are physically displaced by elements of shield itself. Excavation shall not be advanced beyond the edge of the shield.

2. Size of Tunnel: Determine adequate tunnel size and section to match construction methods described in work plan. Build tunnels of sufficient size to permit efficient excavation operations, to provide sufficient working space for placing primary tunnel liner, and to allow for installation of water line as shown on Plans or indicated in Specifications. Dimensions shown on Plans do not necessarily represent size or section suitable for construction methods or operational procedures as may be proposed or conducted by Contractor.

3. Primary Liner:

a. Provide primary liner for tunnel which is capable of supporting ground and hydrostatic forces until permanent water pipe has been installed and grouted in place, and to resist construction loads.

b. Use methods that ensure full bearing of soil against primary liner without significant settlement or movement of surrounding soil. To fill void behind primary liner, either expandable liner (e.g., ring beams and timber lagging) or nonexpandable liner (e.g., bolted steel liner plates) may be used provided grout is placed behind nonexpandable liner. Grout excavation not to true shape as result of careless excavation or loss of ground.

c. The primary liner's seepage inflow for each 100-foot length of tunnel shall not exceed 3 gallons per minute, including inflow through face or shield. Localized inflow shall not exceed 0.5 gallons per minute. Provide drainage facilities to remove inflow of water from tunnels and shafts. Provide means to prevent inflow of soil fines associated with water inflow by use of filter fabrics or other approved methods.

d. Expandable liner shall be continuous and shall be expanded to limits of excavation promptly after it is out of shield.

e. During excavation of tunnel, advance TBM or shield only far enough to permit construction of one primary liner ring beam set, or rings of

bolted steel liner plates that can be assembled entirely within tail shield of TBM.

f. Install filter fabric around exterior of primary liner when using non-watertight liner and when tunneling through sandy or silty ground conditions. Install backer rods at ribs as required to control migration of fines. Close windows in lagging.

g. Provide hog rods, struts, or similar members when required to maintain roundness. After grouting, liner shall be no more than 3 percent out of round as measured by difference between maximum and minimum measured diameter divided by average diameter.

4. Hand Jacking of Casing:

a. Provide heavy-duty jacks of capacity suitable for forcing casing pipe through ground. Construct operating jacks so that even pressure is applied to all jacks used. Provide suitable jacking head, (timber, etc.), and suitable bracing between jacks and jacking head. Provide suitable jacking frame and/or back stop. Set casing pipe to be jacked on guides, (timber, etc.), properly braced together, to support section of pipe, and direct it to proper line and grade. Place whole jacking assembly so as to line up with direction and grade of casing pipe.

b. Excavate ground material just ahead of casing pipe by use of air-powered tools, excavating machine, or other acceptable means, and remove through casing pipe. Then force casing pipe through ground with jacks, into space thus provided. Dispose excavated material as specified.

c. Trim excavation in manner so that at least one third of circumference of excavation conforms to contour and grade of casing pipe. Provide clearance of not more than 2 inches for upper half of casing pipe with clearance tapering off to zero at point where excavation conforms to contour of casing pipe. Cutting edge of steel plate installed around head end of casing pipe extending short distance beyond end of casing pipe with inside angles or lugs to keep cutting edge from slipping back onto casing pipe may be used.

d. In addition to requirements set for in this specification, Contractor shall:

1) Excavate face commencing at crown and proceed down to invert. Excavate heading so that both sides of heading are excavated simultaneously.

2) At all times maintain standby face supports to allow for immediate use when needed.

3) At end of each shift and whenever excavation is suspended or shut down, install breast boards, or other approved methods, across full face of heading.

e. Distance that excavation extends beyond end of casing pipe shall not exceed three feet. Decrease this distance as directed by Project Manager, or due to character of material being excavated.

f. Jack the casing pipe, insofar as practical, from low or downstream end. Lateral or vertical variation in final position of casing pipe from line and grade as established by Project Manager will be permitted only to extent of 1 inch in 10 feet, provided that variation is regular and only in one direction and that final grade of flow line is in direction indicated on plans. Remedy overcutting by pressure grouting entire length of installation. Use of grout mix immediately behind shield tail shall have efficient tail seal to prevent flow of grout into shield.

g. Depending on character of soil encountered during jacking operation, carry on operation without interruption, insofar as practical, to prevent casing pipe from becoming firmly set in ground.

h. Remove and replace casing pipe damaged in jacking operations by Contractor at no additional cost to Owner.

i. Backfill pits or trenches which have been excavated to aid jacking operations as soon as casing pipe is complete in place, equipment and appurtenances have been removed and structure, which is to be built in excavated zone, is in place. In no case shall pits remain open without appropriate safety barricades, concrete traffic barriers (CTB's), railing, or plates.

j. When jacking casing pipe, water jetting of casing pipe bedding or backfill is not allowed. In unconsolidated soil formations, use gel-forming colloidal drilling fluid consisting of at least 10 percent of high grade fully hydrated bentonite to seal voids outside walls and furnish lubrication for installation of casing pipe.

5. Grouting:

a. Detailed requirements pertaining to grout mix design and tunnel grouting are provided in Section 02431 – “Tunnel Grout”.

b. Furnish and operate suitable equipment for grouting operations to effectively and completely fill voids outside of primary tunnel liner as quickly as possible.

c. Provide in tunneling work plan description of primary liner grouting operations, including:

1) Arrangement of grouting equipment including mixer, pumps, piping and hoses, valves, pressure gauges and injection fixtures.

2) Location, spacing, and size of grout ports and vents.

3) Grouting sequence for initial backfill of voids between liner and ground, and for second stage back grouting.

4) Grout injection pressures and estimated volumes.

5) Procedure to check for remaining voids.

6) Sampling procedures and locations for quality control testing.

7) Grout production and quality shall be in accordance with Contractor's mix design and grout production plan as required by Section 02431 – "Tunnel Grout".

d. Use care in grouting operations to prevent damage to adjacent utilities or other properties. Ensure that pressure used in grouting is not great enough to distort or imperil Work.

e. Fill voids behind non-expandable primary liner with sand-cement grout promptly after liner is out of shield. Grout pressure shall not exceed value that may cause damage or distortion to installed liner plate rings. Grout from bottom up and plug each grout hole promptly after grout has been placed. Provide seals on tail of TBM which will prevent grout from moving into shield.

f. Liner requiring grout shall be back grouted (second stage grouting) once each shift, or more often when required to ensure that all voids are filled.

g. Place grout behind tunnel liner at end of each day or at every 4 feet of tunnel installed, whichever is less, unless in opinion of Project Manager, ground conditions are such as to require each ring to be grouted immediately after erection. Upon completion of each grouting operation, sound primary liner and immediately correct voids discovered by necessary means as approved by Project Manager. After all voids are successfully filled, grout holes shall be packed, when

necessary, with dry mortar mix and threaded taps securely placed in holes.

h. Completely and immediately fill voids outside limits of tunnel excavation created by caving or collapse of earth cover over excavation, or by other cause, with sand cement grout. Perform second grouting to fill soft spots or voids which may be detected, no later than 24 hours after initial grouting of primary liner.

i. Perform quality control sampling and testing of grout.

1) Grout production shall be in accordance with Section 02431 – "Tunnel Grout".

2) Measure density of grout throughout placement procedure as directed by Project Manager. Measure grout density at discharge point and discharge grout until density is within 0.3 pounds per gallon of input density.

3) Take samples of well-mixed grout for 28-day compressive strength tests at beginning, middle, and end of each grouting operation.

B. Tunneling Data

1. Submit shift logs of construction events and observations within 24 hours of operation on at least following:

a. Location of face by station and progress of tunnel drive during shift.

b. Observation of lost ground and other signs of ground movement.

c. Location and elevation of significant soil strata boundaries and brief soil descriptions.

d. Ground water control operations, piezometric levels, ground water inflow location, and rates.

e. Completed field forms for establishing and checking line and grade and achieved tolerance relative to design alignment.

f. Operation shut-down periods or other interruptions in Work, and reason.

g. Any unusual condition or event.

h. Hours worked per shift on tunneling operation.

2. Clearly mark primary liner every 20 feet along tunnel with distance in feet from centerline of preceding shaft.

C. Tunnel Connections, Terminations, and Temporary Bulkheads

1. Connect new tunnels to existing structures by removing existing bulkheads, when necessary, and sealing junction as shown on Plans.

2. Seal terminations of tunnels, which are not connected to permanent structures, by temporary bulkhead.

3. Design temporary bulkheads where and when required and obtain Project Manager's acceptance of design prior to constructing it. Provide bulkheads capable of resisting lateral earth and hydrostatic pressures, waterproof, and capable of being removed without damaging water line or plastic liner.

D. Monitoring

1. Monitoring Instrumentation: This specification establishes minimum instrumentation requirements for tunneling. Additional instrumentation requirements for critical areas may be specified elsewhere in Specifications or on Plans. Contractor may install more extensive system at Contractor's sole expense. Instrumentation specified shall be accessible at all times to Project Manager.

a. Submit for review, prior to construction, Monitoring Plan including instrument installation design, instrumentation points location and layout, manufacturer's catalog literature, installation report formats.

b. Install and maintain system of instrumentation to monitor tunneling operation and to detect movement in soil and adjacent structures. Instruments shall consist of no less than sufficient number of inclinometers and crack monitors at bridge and adjacent structures and sufficient piezometers. Use monuments sufficiently removed from construction to avoid errors in readings due to ground settlement.

c. Installation of instrumentation by Contractor shall not preclude Project Manager, through independent contractor or consultant, from installing instrumentation in, on, near, or adjacent to construction work. Provide access to work for independent installations.

d. Install soil instruments such as piezometers, inclinometers, extensometers, and crack monitors by qualified subcontractor specializing in geotechnical work.

e. Install extensometers to depth of 5 feet above crown of water line tunnel as shown on Plans to measure vertical movements in soils during and subsequent to tunneling. Extensometer consists typically of three-prong anchor, 1/4-inch standard stainless steel inner pipe, and 1-inch standard Schedule 80 PVC outer pipe. Pipes are assembled in sections

and fastened together with standard couplings to required anchor depths. Locate top of extensometer within flush-mounted hand hole cover capable of withstanding HS-20 truck loading. Geotechnical instrumentation installation subcontractor shall provide procedures for installation of extensometers as part of Monitoring Plan.

2. Building and Structures Assessment: Submit for review prior to construction, Building and Structures Assessment Plan. Provide preconstruction and post-construction assessment reports for buildings and structures located within distance equal to depth of tunnel but at least 50 feet in plan from proposed tunnel centerline and shafts. Include photographs or video of existing damage to structures in vicinity of water line alignment in assessment reports.

3. Settlement Surveying: This specification establishes minimum settlement survey requirements for structures and ground surface monitoring points.

   a. Submit settlement surveying and monitoring plan for review prior to construction. Plan shall identify location of settlement monitoring points, reference benchmarks, survey schedules and procedures and reporting formats.

   b. Locate survey points on all structures within distance equal to depth of tunnel but at least 50 feet in plan from tunnel centerline.

   c. Record horizontal coordinates and elevations (with accuracy of 0.01 feet) for each survey point location. Reference survey points so that they may be accurately reestablished when lost or destroyed.

   d. Unless otherwise specified, record ground surface elevations on center line ahead of TBM and at 20 feet either side of center line at minimum of 100-foot intervals or at least three locations per tunnel drive. Starting 100 feet ahead of TBM and continuing until TBM is 100 feet beyond measurement point or until further movement is not detected, unless otherwise directed by Project Manager. Record cross-sectional points at 10-foot spacing for distance of 50 feet each side of center line or to ROW, whichever is less.

   e. Locate survey points at crossings under installations as follows:

      1) Roads: Centerline and each shoulder.

      2) Railroads: Track subbase at centerline of each track.

      3) Utilities and Pipelines: Directly above and 10 feet before and after intersection.

   f. For shaft settlement see Section 02400 – “Tunnel Shafts”.

4. Measure and maintain records of deformation of primary liner.

5. Reading Schedule and Reporting: Submit readings from various instruments and survey points weekly to Project Manager. Take daily Readings as required by Project Manager when construction is approaching or near critical structures (structures, bridge piers, pipelines, etc., partially or entirely located within distance equal to depth of tunnel but at least 50 feet in plan from tunnel centerline). Take initial readings of surface points before excavation or construction is started.

   a. Immediately report to Project Manager movement, cracking, or settlement which is detected and take immediate remedial action. Contractor shall be fully responsible for damage to adjacent structures.

   b. At end of construction after water line is installed, and dewatering is discontinued, make final survey of control points established for instrumentation and observation. Submit final readings to Project Manager. Make visual inspection of structures adjacent to water line and report to Project Manager condition of structures, damage incurred during construction, and corrective action taken.

E. Disposal of Excess Material

Remove spoil from job site and dispose in accordance with Section 01504 – "Temporary Facilities and Controls".

3.04 REPAIR/RESTORATION (NOT USED)

3.05 FIELD QUALITY CONTROL

A. Control of Tunnel Line and Grade

1. Construction Control:

   a. The Project Manager will establish baseline and benchmarks indicated on Plans. Check these baseline and benchmarks at beginning of Work and report errors or discrepancies to Project Manager.

   b. Use baseline and benchmarks established by Project Manager to furnish and maintain reference lines and grades for construction. Use these lines and grades to establish location of tunnel, water line, and structures.

   c. Establish and be fully responsible for accuracy of controls for construction of Project, including access shaft locations, structures, tunnel line, and grade. Utilize laser to insure line and grade are maintained during tunneling process.

d. Establish control points sufficiently removed from tunnel operation not to be affected by potential ground movement.

e. Maintain daily surveying records of alignment and grade and submit three copies of records to Project Manager by end of day after Work performed. Locate points at top, bottom, and each side of springline.

f. Check tunnel survey control against aboveground undisturbed reference at least once each week and once for each 250 feet of tunnel constructed, or more often as needed or directed by Project Manager.

2. Earth Movement: Contractor is responsible for damages due to settlement from construction-induced activities or occurrences.

a. Take precautions to avoid damage or settlement to buildings, structures, roads, and utilities to work in proximity of tunnel. Minimum precautions to include use of construction methods and equipment to minimize loss of earth at tunnel face and settlement of soil around primary tunnel liner.

b. Refer to Paragraph 3.08, Monitoring, for detecting earth movement.

c. In event movement of ground is detected, Project Manager may order work stopped and secured. Before proceeding, correct problems causing or resulting from movement.

d. Be aware that when settlement of ground surface should occur during construction of tunnel which will affect accuracy of temporary benchmarks established by Project Manager, detect and report movement. Locations of permanent NHCRWA monumentation benchmarks are indicated on Plans; Contractor may use these to verify temporary benchmark accuracy. Advise Project Manager of settlement affecting permanent monumentation benchmarks. Upon completion, submit field books pertaining to monitoring of permanent monumentation benchmarks to Project Manager.

3. Tunnel Line and Grade:

a. Survey crown, invert, and spring line on each side of primary liner at 50-foot intervals, or minimum of once per shift, or more frequently when line and grade tolerances have been exceeded, to ensure alignment is within tolerances specified. Conduct survey immediately behind tunnel excavation to allow immediate correction of misalignment.

b. Control excavation of tunnel and construction of primary liner to allow construction of carrier pipe within 6 inches on line and 4 inches on grade and to maintain circular shape of tunnel.

c. Alignment adjustments between primary tunnel liner and water main shall not encroach on minimum required clearance of 4 inches defined in Section 02517 – "Water Line in Tunnels".

d. If unable to maintain specified tolerances, bear full responsibility and expense of correction (redesign, easement acquisition, etc.). When these tolerances are exceeded and redesign of structures is required, obtain services of qualified Professional Engineer registered in the State of Texas for redesign. Submit plans showing changes to Project Manager for review.

e. Backfill (grout) and reconstruct tunnel built outside tolerance to be within tolerance when so directed by Project Manager.

B. Ground and Surface Water Control and Ground Stabilization

1. Provide necessary ground water and surface water control measures to perform Work and to provide safe working conditions. Detailed plans for ground and surface water control methods shall be executed as designed by the Contractor's Engineer. Prevent excessive inflow of water into excavation during construction of tunnel and installation of carrier pipe and grouting of annular space. Ground water control method shall provide means to prevent piping of fines into shafts or tunnel and other adverse effects due to ground water inflow. Surface water control method shall provide means to control impacts of surface water above or along tunneling operations. Additional requirements are included in Section 01578 – "Control of Ground Water and Surface Water".

2. Anticipate that portions of tunnel excavation may be below ground water table and in cohesionless soils, even when not indicated on soil borings, and in conditions which may require ground water control system for tunneling operations. Install filter fabrics, backer-rods and other means as necessary to prevent piping of fines into tunnel. Remove water that may be encountered during course of Work by pumping, well pointing, deep well pumping, or other means determined by Contractor as necessary to achieve stable conditions and applied in manner as described in Section 01578 – "Control of Ground Water and Surface Water". Standing water is not permitted at face or in tunnel.

3. The ground water control method used shall not cause damage to adjacent structures or property due to lowering of water table and subsequent ground settlement. In event damage does occur, correct damage and settle claims arising from damage at no additional cost.

4. If Contractor chooses pumping installations to control ground water level or installs pervious liner through water bearing layers, install and maintain instrumentation system to monitor water level and to detect movement in adjacent structures and property. Monitor water level by recording initial water level before dewatering is started and thereafter on weekly basis. Remove water monthly from piezometers to demonstrate that they are operable. Submit weekly reports of water levels to Project Manager. Provide access to piezometers for Project Manager to perform independent measurements.

5. Maintain dewatering system for tunnels in continuous operation until minimum of 48 hours after carrier pipe has been installed and annular space is fully grouted, or until watertight liner designed for hydrostatic pressures is installed.

6. If eductors, well points, or deep wells are used, space them adequately to provide necessary dewatering. Use sand packing, and other means to prevent pumping of fine sands or silts from subsurface and to minimize ground subsidence. Check continuously to ensure that subsurface soil is not being removed by ground water control operation or subsurface drainage into shafts or through pervious liner. Before operations begin, maintain availability of pumping equipment and other machinery on site to assure that operation of dewatering system can be maintained.

7. When groundwater control is necessary, do not begin tunneling operations until monitoring data shows that it is safe to do so. When dewatering is sole means of ground water control, draw piezometric level at least down below elevation of invert of tunnel, or to lower elevation as required for excavation face and tunnel stability.

3.06 – 3.10 NOT USED

END OF SECTION

Section 02431

TUNNEL GROUT

PART 1 GENERAL

1.01 SUMMARY

This Section includes:

A. Mix design requirements, testing, furnishing, and production of grout for:

1. Pressure grouting of bolted liner plates for shafts
2. Pressure grouting of primary tunnel liner
3. Pressure grouting of jacked-pipe
4. Annular grouting of cased or uncased sewer pipe
5. Grouting of annular space between carrier pipe and primary tunnel liner
6. Grouting voids in ground resulting from caving, loss of ground, or settlement
7. Grouting of manholes constructed in shafts

B. Compaction grouting is not part of this specification.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for Work performed under this Section. Include cost of such Work in contract unit prices for Work of which it is component part.
2. Refer to Section 01270 – "Measurement and Payment" for Unit Price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.03 REFERENCES

A. ASTM C 138. Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete

B. ASTM C 144. Standard Specification for Aggregate for Masonry Mortar.

C. ASTM C 150. Standard Specification for Portland Cement.

D. ASTM C33ASTM C 494. Standard Specification for Chemical Admixture for Concrete.

E. ASTM C 618. Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.

F. ASTM C 869. Standard Specification for Foaming Agents Used in Making Preformed Foam for Cellular Concrete.

G. ASTM C 937. Standard Specification for Grout Fluidifier for Preplaced-Aggregate Concrete.

H. ASTM C 942. Standard Test Method for Compressive Strength of Grout for Preplaced-Aggregate Concrete in the Laboratory.

I. ASTM C33ASTM C 1017. Standard Specification for Chemical Admixture for Use in Producing Flowing Concrete.

1.04 SUBMITTALS

A. Conform to requirements of Section 01330 – "Submittal Procedures".

B. Submit description of materials, grout mix, equipment, and operational procedures to accomplish each grouting operation. Description shall include sketches as appropriate, indicating type and location of mixing equipment, pumps, gauges, injection points, venting method, flow lines, pressure measurement, volume measurement, grouting sequence, schedule, and stage volumes, as well as procedures to resist movement and counteract floating the carrier pipe during grouting operations. Tests and certifications shall have been performed within last 12 months prior to date of submittal.

C. Grouting contractor shall provide a project history showing a minimum of 5 years of work and at least 10,000 linear feet of experience in grouting tunnels.

D. Submit grout mix design report, including:

1. Grout type and designation

2. Grout mix constituents and proportions, including materials by weight and volume

3. Grout densities and viscosities, including wet density at point of placement

4. Initial set time of grout

5. Bleeding, shrinkage/expansion

6. Compressive strength

7. Detailed description of grout pressure limiting equipment

8. For annular space grouting, buoyant force calculations and bulkhead designs (See Section 02517 – "Water Line in Tunnel" for further requirements)

E. For cellular grout, also submit the following:

1. Foam concentrate supplier's certification of product application for foam concentrate.

2. A description of proposed cellular grout production procedures.

F. Maintain and submit logs of grouting operations indicating pressure, density, and volume for each grout placement.

1.05 RELATED REQUIREMENTS

A. Section 01270 – "Measurement and Payment"

B. Section 01330 – "Submittal Procedures"

C. Section 02517 – "Water Line in Tunnel"

D. Section 03315 – "Concrete for Utility Construction"

1.06 – 1.09 NOT USED

1.10 DEFINITIONS

A. Pressure Grouting. Filling void behind liner or pipe with grout under pressure sufficient to ensure void is properly filled but without overstressing temporary or permanent ground support, or causing ground heave to occur.

B. Back Grouting. Secondary pressure grouting to ensure that voids have been filled between primary tunnel or shaft liners and surrounding ground.

C. Annular Grouting. Filling annular space between carrier pipe and primary tunnel liner, casing, or ground, by pumping.

D. Ground Stabilization Grouting. Filling of voids, fissures, or under-slab settlement due to caving or loss of ground by injecting grout under gravity or pressure to fill void.

E. Carrier Pipe. Sewer or water line installed inside primary tunnel support.

1.11 – 1.13 NOT USED

PART 2 PRODUCTS

2.01 MANUFACTURER(S) (NOT USED)

2.02 MATERIALS AND/OR EQUIPMENT

A. Grouting materials: Conform to Section 03315 – "Concrete for Utility Construction", except as modified in the following paragraphs.

B. Grout Type Applications:

1. Grout for pressure grouting, backfill grouting, and annular grouting: Sand-cement mortar mix.

2. Alternative grout for annular grouting of water line: Low density (cellular) grout.

3. Grout for annular grouting of sanitary sewer: Low density (cellular) grout, unless otherwise approved by Project Manager.

4. Grout for filling space around manholes in shafts: Sand-cement mortar mix.

5. Ground stabilization: Sand-cement mortar mix.

C. Do not include toxic or poisonous substances in grout mix or otherwise inject such substances underground.

D. Grout

1. Develop one or more mixes based on following criteria as applicable and provide test reports from a professional laboratory for each mix design:

a. Size of annular void between carrier pipe and liner, or size of void between primary liner and surrounding soil

b. Absence or presence of groundwater

c. Adequate retardation

d. Non-shrink characteristics

e. Pumping distances

2. Prepare mixes that satisfy required application. Provide materials conforming to the following standards:

a. Cement: ASTM C 150

b. Fly Ash: ASTM C 618. Do not use fly ash in amounts to exceed 25 percent by weight of cementitious material in mix design."

c. Water: Potable

d. Foam: ASTM C 869. The foaming agent shall maintain stability until the cement sets to form a self-supporting matrix comprising closed cells and low water absorptive characteristics.

e. Slurry: ASTM C 138

f. Cellular Grout: ASTM C 138

g. Sand for sand-cement mortar mix: ASTM C 144

h. Retarder/water reducer: ASTM C494, Type D

i. Plasticizer/water reducer: ASTM C494, Type A

j. Fine aggregate: ASTM C33

3. Provide grout meeting the following minimum requirements:

a. Low Density Cellular Grout

1) Cement content shall be no less than 200 lb/cubic yard.

2) Water content shall be no more than 65 percent.

3) Wet density shall be no less than 65 lb/cubic foot.

4) Minimum compressive strength shall be 100 psi after 7 days and 300 psi after 28 days.

b. Conventional (Mortar) Grout

1) Conventional grout shall consist of a pumpable mix of 1-part cement, 2-part clean sand, water free from organics and deleterious materials, and a small amount of bentonite for pumpability and stability. The unit weight shall not be less than 130 lb/cubic foot.

2) Minimum 28-day unconfined compressive strength shall be 1,500 psi for water lines and 1,000 psi for other carrier pipes.

3) Determine strength by ASTM C942.

4. Fluidifier. Provide fluidifier, meeting ASTM C 937 that holds solid constituents of grout in colloidal suspension and is compatible with cement and water used in grouting operations.

5. Admixtures.

   a. Use admixtures meeting ASTM C 494 and ASTM C 1017 as required, to improve pumpability, control time of set, hold sand in suspension and reduce segregation and bleeding.

   b. For cellular grout, do not use foam or admixtures that promote steel corrosion

   c. Ensure that admixtures used in mix are compatible. Provide written confirmation from admixture manufacturers of their compatibility.

   d. Admixtures shall not contain chlorides, and shall be non-toxic after 30 days.

   e. Amount of admixture added to concrete shall be in accordance with the manufacturer's recommendations.

2.03 – 2.04 NOT USED

PART 3 EXECUTION

3.01 GENERAL / MANUFACTURER(S) (NOT USED)

3.02 PREPARATION

A. Notify Project Manager at least 24 hours in advance of grouting operations.

B. Select and operate grouting equipment to avoid damage to new or existing underground utilities and structures.

C. In selection of grouting placement consider pipe flotation, length of pipe, length of tunnel, depth from surface, type of pipe, type of pipe blocking and bulkheading, grout volume and length of pipe to be grouted between bulkheads.

D. Operate dewatering systems until grouting operations are complete and grout has reached initial set.

E. Verify that locations where grout is to be placed are clean and free of standing or running water.

F. A bulkhead designed by the Contractor shall be placed in the annular space at each end of tunnel section that is to be grouted. Provide an opening in the crown in addition to other required vent outlets. Provide an opening for the tunnel invert drain and at the

casing invert to facilitate draining water away from the Work during grouting operations.

3.03 ERECTION/INSTALLATION APPLICATION AND/OR CONSTRUCTION

A. Equipment

1. Batch and mix grout in equipment of sufficient size and capacity to provide necessary quality and quantity of grout for each placement stage.

2. Use equipment for grouting of type and size generally used for work, capable of mixing grout to homogeneous consistency, and providing means of accurately measuring grout component quantities and accurately measuring pumping pressures. Use pressure grout equipment which delivers grout to injection point at steady pressure.

3. Foam Generator for Cellular Grout: Foam shall be generated by combining controlled quantities of air, water, and foaming agent under pressure in accordance with the foaming agent manufacturer's recommendations. The temperature of water used in generating the foam shall be maintained below 80°F, or as recommended by the foaming agent manufacturer. Foam shall be discharged into the mixer and blended with the cement slurry.

4. Mixing: The mixer shall be configured for compatibility with the pump to ensure continuous and uniform flow at the point of placement. The mixer shall be capable of providing a super-wetted, homogenized mix. The mixer shall be fitted with a meter with an accuracy of ±1 gallon to measure the volume of water added to dry mix ingredients. An automated system shall be provided capable of delivering a neat cement grout to the mixer and pump in the tunnel where grouting is to be performed.

5. Pumping: Pumping equipment shall be capable of pumping concrete without pulsation or segregation. Pumping equipment shall be operated to convey a continuous and uniform stream of concrete without air pockets. Pumping equipment shall be equipped with a water connection for flushing the system and a device to limit pumping pressure as required to prevent damage to pipe.

6. Agitator: A separate agitator shall be provided to serve as a holding tank between the mixer and the pump. The agitator shall be equipped with baffles to induce turbulence and rotating paddles to ensure thorough mixing of the grout before and during injection.

7. Piping, Injection Hoses, Ports, Valves and Connections: Concrete shall be conveyed to placement points using piping or rubber hoses, with all components having an internal diameter of at least 2 inches. Do not allow hardened grout or concrete to obstruct or coat pipe or hose internally. A system of valves shall be furnished in the line at or near the points of injection

to facilitate sample collection. Suitable stop valves shall be furnished at injection points for use in venting air or maintaining pressure, as required.

8. Provide certified oil-filled gauges scaled to not more than 150% of the maximum allowable pressure, accurate to within 0.5% over the full range of the gauge. Pressure gauges shall be certified and calibrated in accordance with ASME B40.1, Grade 2A. Pressure gauges shall be oil-filled type gauges attached to a saddle-type diaphragm seal (gauge saver) to prevent clogging with grout.

B. Pressure Grouting for Primary Tunnel and Shaft Liner

1. Perform grouting operations to fill voids outside of primary tunnel or shaft liner.

2. For nonexpendable primary liners installed behind shield or tunnel boring machine (TBM), fill voids with sand-cement grout promptly after each ring of liner is out of shield. Keep grout pressure below value that may cause damage or distortion to installed liner plate rings. Provide seals on tail of shield or TBM which shall prevent grout from spilling.

3. For nonexpendable primary liners installed by hand mining or in shafts, grout once every 4 feet but no later than the end of each, or more frequently when conditions dictate. Upon completion of each grouting operation, sound tunnel liner and immediately correct voids discovered by necessary means.

4. Use care in grouting operations to prevent damage to adjacent utilities or other properties. Keep grout pressure below value that may cause damage or distortion to installed tunnel liner or shaft liner. Control grout pressures so that tunnel or shaft liner is not overstressed, and ground heave is avoided.

5. For liner requiring grout, perform back grouting once each shift, or more often when required to ensure that all voids are filled.

6. Grout shall only be pumped to one hole at a time.

7. Grouting shall be performed in a progressive, methodical manner, moving from hole to hole, starting at one end of the tunnel and working to the other end. Grouting shall be from lower holes to higher holes as the case may be.

8. To the extent possible, air and groundwater shall be relieved through valved, open, and ungrouted holes downstream of the hole being grouted. Valved, open, and ungrouted holes shall not be closed until grout of the same consistency as that being injected issues forth.

9. Contractor shall remove grout valves and shall cap the grout ports after grout has reached initial set.

C. Annular Grouting for Water and Sewer Line in Tunnels and Augers

1. Methods employed shall completely fill the annular space between tunnel liner and carrier pipe with grout.

2. Placement

   a. Placement Limits: Predetermine limits of each grout placement stage by size and capacity of batching equipment and initial set time of proposed grout. Under no circumstances shall placement continue at grout port longer than that period of time for mix to take initial set. Locate grout hole spacing and locations according to number of stages necessary to grout tunnel liners. Stage or lift cannot be installed on another lift until proper set has been attained. Have placement procedures approved by admixture or additive manufacturer.

   b. Limit pressure on annular space to prevent damage or distortion to pipe or liner. Define limiting and estimated required pressure range. Provide an open ended, high point tap or equivalent vent and monitor it at bulkhead opposite to point of grouting.

   c. Pump grout until grout within 5 percent of specified density discharges from end opposite injection point, to ensure grout is not diluted by extraneous water in annulus.

   d. For sewer line in primary lined tunnel, limit length of pipe installed to 200 feet or less before grouting same length of sewer line. Repeat this cycle until all pipe is installed and grouted.

   e. Use methods as required to avoid pipe flotation and damage to pipe. Complete each lift for a particular section of tunnel being grouted before starting the next lift. Lift heights shall be limited to avoid pipe flotation and to maintain cellular grout parameters within specified limits. There shall be no fewer than 2 lifts per annular grouting operation.

3. Remove temporary bulkheads installed for grouting.

4. Batch and mix cellular grout mechanically with a colloidal mixer at the project site to ensure consistency of mix. Wet solids thoroughly before introduction of foaming agent. Operate batching system to maintain slurry density with the requirements of Paragraph 3.05.B.3. Shear foam into slurry in accordance with manufacturer’s recommendations.

5. Control ground water as necessary to permit completion of grouting without separation of grout materials.

D. Pressure Grouting for Jacked Sewer Pipe

1. For jacked pipe 60 inches in diameter or greater, pressure grout annulus after installation, displacing bentonite lubrication. Jacked pipes less than 60-inch diameter may be left ungrouted unless excavated diameter exceeds external pipe diameter by more than one inch.

2. Inject grout through grout holes in sewer pipe. Drilling holes from surface or through carrier pipe walls is not allowed. Perform grouting by injecting it at pipe invert with bentonite displacement occurring through high point tap or vent.

3. Control ground water as necessary to permit completion of grouting without separation of grout materials.

4. Limit pressures to prevent damage or distortion to pipe or to keep flexible pipe within acceptable tolerances.

5. Pump grout until material discharging is similar in consistency to that at point of injection.

E. Ground Stabilization Grouting

1. Completely fill voids outside limits of excavation caused by caving or collapse of ground with sand-cement grout. Perform second grouting to fill soft spots or voids which may be detected, no later than 24 hours after initial grouting of tunnel liner.

2. Take care in grouting operations to prevent damage to adjacent utilities or public or private property. Grout at pressure that shall not distort or imperil portion of Work or existing installations or structures.

3. Verify that void has been filled by volumetric comparisons and visual inspection. In case of settlement under existing slabs, take cores as directed by Project Manager, at no additional cost, to demonstrate that void has been filled.

3.04 REPAIR/RESTORATION (NOT USED)

3.05 FIELD QUALITY CONTROL

A. Pressure Grouting for Primary Tunnel and Shaft Liners.

1. For each shaft, make one set of four compressive test specimens for each 30-foot depth and one set for remaining portion less than 30-foot increment.

2. Make one set of four compressive test specimens for every 200 feet of primary lined, (non-expandable) tunnel requiring grout.

B. Annular Grouting for Water and Sewer Line in Tunnels and Augers.

1. Make one set of four compressive test specimens for every 200 feet of pipe installed in primary lined tunnel.

2. For augers, make one set of four compressive test specimens for each grouting operation, or for each 100 feet of pipe installed, whichever is more frequent.

3. For cellular grout, check slurry density both at point of batching and placement at least twice each hour in accordance with ASTM C 138. Record density, time, and temperature. Density must be within 3 percent of design density at point of batching and 5 percent of design density at point of placement.

4. Measure and record the volume of grout placed. Compare actual volume placed for each length of tunnel being grouted with the theoretical volume for that length of tunnel being grouted. Collect samples of fresh cellular grout at the injection point or discharge point.

5. Wet Density Test for Cellular Grout: Sample at the injection point every 30 minutes, after a change in the mix batched, and whenever compression test cylinders are made.

6. Compression Tests: Take two sets of two cylinders for every 200 cubic yard batched, but no less than two sets per day, two sets per annulus between carrier pipe and tunnel liner grouted, or two sets per lift. Test two cylinders at 28 days and test the additional two cylinders at 56 days, if fly ash is used. For testing, cylinders shall be capped with plaster of Paris; sulfur caps are not permitted.

C. Pressure Grouting for Jacked Pipe. Make one set of four compressive test specimens for every 400 feet of jacked pipe pressure grouting.

D. Ground Stabilization Grouting. Make one set of four compressive test specimens for every location where ground stabilization grouting is performed.

3.06 – 3.10 NOT USED

END OF SECTION

Section 02441

MICROTUNNELING AND PIPE-JACKED TUNNELS

PART 1 G E N E R A L

1.01 SECTION INCLUDES

A. Tunnel construction of sewers by one-pass methods with or without man entry. Construction methods involve jacking pipe following hand-shield excavation or tunnel boring machine (TBM) or micro-tunnel boring machine (MTBM), with pipe serving as both tunnel liner during construction and sewer pipe after completion of construction.

B. Select centrifugally-cast fiberglass pipe (FRP), vitrified clay pipe (VCP), reinforced concrete pipe (RCP) for storm or sanitary sewers. Use plastic-lined RCP for sanitary sewers. Unlined RCP or RCP lined with liner other than that specified in Section 02427 - Plastic Liner for Large-diameter Concrete Sewers and Structures will not be allowed for sanitary sewers.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. Length of sewer installed will be measured by linear foot along center line of completed sewer from center line to center line of manholes, as designated on Drawings; and to end of stubs or termination of pipe; and to inside face of lift station and treatment plant works. Installation of sewer within limits of structure other than manholes will not be considered for measurement and payment at unit price bid.

2. Payment will include and be full compensation for labor, equipment, materials, and supervision for construction of sewer and excavation, complete in place including disposal of excess materials, sheeting, shoring or bracing, dewatering, utility adjustments, connections to existing sewers, grouting when required, tests, backfilling, clean-up, and other related work necessary for construction as specified or as shown on Drawings.

3. Payment for installation of sewer will be authorized by Project Manager in two parts. Pay estimates for partial payments will be made as measured above according to following schedule:

   a. 95 percent payment will be made for jacked pipe installed but not yet grouted, in cases where grouting is specified.

   b. 100 percent payment will be authorized on linear foot basis for amount of jacked sewer pipe installed, including grouting when specified.

4. Monitoring will be paid for at lump sum price for installations, observations, and reporting.

B. Stipulated Price (Lump Sum): If Contract is Stipulated Price Contract, payment for work in this Section is included in total Stipulated Price.

1.03 REFERENCE STANDARDS

A. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering.

B. American Association of State Highway and Transportation Officials (AASHTO).

C. Occupational Safety and Health Administration (OSHA).

D. National Electrical Code - (NFPA 70).

1.04 DEFINITION

A. Jacked Pipe. Method for installing sewer pipe that serves as initial construction lining and tunnel support, installed for stability and safety during construction, and as sewer pipe. Pipe is shoved forward, or jacked, as tunnel is advanced.

B. Microtunneling. Method of installing pipe by jacking pipe behind microtunnel boring machine which is connected to and shoved forward by pipe being installed, generally precluding man entry.

C. Tunnel Boring Machine (TBM). Mechanized excavating equipment that is steerable, guided and articulated, connected to and shoved forward by pipe being installed, with man entry.

D. Microtunnel Boring Machine (MTBM). Mechanized excavating equipment that is remotely-controlled, steerable, guided and articulated, connected to and shoved forward by pipe being installed, usually precluding man entry.

E. Tunneling Methodology. Written description, together with supporting documentation that defines plans and procedures for microtunneling or pipe jacking operations.

F. Zone of Active Excavation. Area located within radial distance about surface point immediately above face of excavation equal to depth to bottom of excavation.

G. Critical Structure. Building, structure, bridge, pier, or similar construction partially or entirely located within zone of active excavation.

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 - Submittal Procedures.

B. Following submittals are required:

1. Tunneling Methodology. Brief description of proposed tunnel methodology. Description should be sufficient to convey following:

   a. Proposed method of tunnel construction and type of face support.

   b. Manufacturer and type of tunneling equipment proposed; type of lighting and ventilation systems.

   c. Number and duration of shifts planned to be worked each day.

   d. Sequence of operations,

   e. Locations of access shafts and work sites.

   f. Method of spoil transportation from face, surface storage, and disposal location.

   g. Capacity of jacking equipment and type of cushioning.

   h. Identify critical utility crossings and special precautions proposed.

2. Drawings and Calculations: Submit for record purposes, drawings and calculations for tunnel support system. Provide adequate drawings and installation details for construction. For pipe jacking and microtunneling, show pipe and pipe joint detail. Documents must be signed and sealed by Professional Engineer registered in State of Texas. Calculations shall include clear statement of criteria used for design as described in Paragraph 1.06, Design Criteria.

3. Quality Control: Submit for review brief description of quality control methods including:

   a. Method and frequency of survey control.

   b. Example of tunnel daily log.

4. Geotechnical Investigation: When geotechnical investigations are conducted, submit results to Project Manager for record purposes.

5. Monitoring Plans:

   a. Instrumentation Monitoring Plan: Submit for review, prior to construction, monitoring plan that includes schedule of instrumentation design, layout of instrumentation points, equipment installation details, manufacturer's catalog literature, and monitoring report forms.

   b. Surface Settlement Monitoring Plan. Submit settlement monitoring plan for review prior to construction. Identify on plan location of settlement

monitoring points, reference benchmarks, survey frequency and procedures, and reporting formats.

6. Structures Assessment. Provide preconstruction and postconstruction assessment reports for critical structures, namely those located within zone of active excavation from proposed tunnel centerline. Include photographs or video of existing damage to structures in vicinity of sewer alignment in assessment reports.

7. Readings of all monitoring shall be submitted to Project Manager.

8. Daily Reports: Maintain shift log as defined in Paragraph 3.04, Pipe-jacked Tunneling Data, and make available to Project Manager on request.

1.06 DESIGN CRITERIA

A. Assume responsibility for selection of appropriate pipe and pipe joints to carry thrust of any jacking forces or other construction loads in combination with overburden, earth and hydrostatic loads. Design of any pipe indicated on Drawings considers in-place loads only and does not take into account any construction loads. Criteria for longitudinal loading (jacking forces) on pipe and joints shall be determined, based on selected method of construction.

B. Jacked pipe shall be designed to withstand thrust from MTBM, TBM or shield and pipe advance without damage or distortion. Propulsion jacks shall be configured so that thrust is uniformly distributed and will not damage or distort pipe.

C. Take into account loads from handling and storing.

D. Criteria to be used at railroad crossings shall be Cooper E-80 locomotive loading distributions in accordance with AREMA specifications for culverts. In design, account for additive loadings due to multiple tracks.

E. Criteria to be used for truck loading shall be HS-20 vehicle loading distributions in accordance with AASHTO.

F. Provide pipes of diameter shown on Drawings. Substitution of pipe with larger diameter to suit MTBM or TBM equipment availability will only be permitted if demonstrated to satisfaction of Project Manager that design flows and velocities can be achieved.

PART 2 P R O D U C T S

2.01 SEWER PIPE

A. Assume responsibility for selecting appropriate pipes and pipe joints to safely carry loads imposed during construction, including jacking forces. Pipe joints shall be flush with outside pipe face when pipes are assembled. Pipe materials shall be selected from following:

B. Centrifugally-cast fiberglass pipe, joints, and fittings to be in accordance with Section 02504 - Centrifugally-Cast Fiberglass Pipe.

C. Vitrified clay pipe, joints, and fittings to be in accordance with Section 02508 - Extra Strength Clay Pipe.

D. Plastic-lined reinforced concrete pipe with joints and fittings to be in accordance with Section 02611 - Reinforced Concrete Pipe and Section 02427 - Plastic Liner for Large-Diameter Concrete Sewers and Structures. Plastic liner is not required for storm sewers.

E. Use pipe that is round with smooth, even outer surface, and has joints that allow for easy connections between pipes. Design pipe ends so that jacking loads are evenly distributed around entire pipe joint and such that point loads will not occur when pipe is installed. Pipe used for pipe jacking shall be capable of withstanding all forces that will be imposed by process of installation, as well as final in-place loading conditions. Protect driving ends of pipe and joints against damage.

PART 3 E X E C U T I O N

3.01 CONSTRUCTION OPERATIONS CRITERIA

A. Use methods for microtunneling and pipe-jacked tunneling operations that will minimize ground settlement. Select method which will control flow of water and prevent loss of soil into tunnel and provide stability of face under anticipated conditions.

B. Conduct tunneling operations in accordance with applicable safety rules and regulations, OSHA standards and Contractor's safety plan. Use methods which include due regard for safety of workmen, adjacent structures, utilities, and public.

C. Maintain clean working conditions wherever there is man access.

D. For tunneling under railroad embankments, highways, or streets, perform installation so as to avoid interference with operation of railroads, highways, or streets, except as approved by owner of facility.

3.02 GROUND WATER CONTROL

Provide ground water control measures in conformance with Section 01578 - Control of Ground Water and Surface Water, when necessary to perform Work.

3.03 EQUIPMENT

A. Full directional guidance of shield, TBM, or MTBM is prerequisite of this method of construction.

B. Assume responsibility for selection of tunneling equipment which, based on past experience, has proven to be satisfactory for excavation of soils to be encountered.

C. Employ tunneling equipment that will be capable of handling various anticipated ground conditions and is capable of minimizing loss of soil ahead of and around machine and shall provide satisfactory support of excavated face.

D. Tunnel Boring Machine (TBM). A TBM used for pipe-jacking shall conform to shape of tunnel with uniform perimeter that is free of projections that could produce over- excavation or voids. Appropriately sized overcutting bead may be provided to facilitate steering. In addition it shall:

1. Be capable of full face closure.

2. Be equipped with appropriate seals to prevent loss of bentonite lubricant.

3. Be capable of correcting roll by reverse drive or fins.

4. Be designed to handle adverse ground conditions including ground water ingress.

5. Be equipped with visual display to show operator actual position of TBM relative to design reference.

E. Tunnel Shield. If hand shield is used for pipe-jacked tunneling (with or without attached mechanized excavating equipment), shield must be capable of handling various anticipated ground conditions. In addition, shield shall:

1. Conform to shape of tunnel with uniform perimeter that is free of projections that could produce over-excavation or voids. Appropriately-sized overcutting bead may be provided to facilitate steering.

2. Be designed to allow face of tunnel to be closed by use of gates or breasting boards without loss of ground.

F. Microtunneling Equipment. In case of MTBM, use spoil transportation system which:

1. Balances soil and ground water pressures by use of slurry or earth pressure balance system; system shall be capable of adjustments required to maintain face stability for particular soil condition and shall monitor and continuously balance soil and ground water pressure to prevent loss of slurry or uncontrolled soil and ground water inflow, or, in case of slurry spoil transportation system:

   a. Provides pressure at excavation face by use of slurry pumps, pressure control valves, and flow meter.

   b. Includes slurry bypass unit in system to allow direction of flow to be changed and isolated, as necessary.

c. Includes separation process. Design it to provide adequate separation of spoil from slurry so that slurry with sediment content within limits required for successful tunneling can be returned to cutting face for reuse. Appropriately contain spoil at site prior to disposal.

d. Uses type of separation process suited to size of tunnel being constructed, soil type being excavated, and work space available at each work area for operating plant.

e. Allows composition of slurry to be monitored to maintain slurry weight and viscosity limits required.

2. In case of cased auger earth pressure balance system, system shall be capable of adjustments required to maintain face stability for particular soil condition to be encountered. Monitor and continuously balance soil and ground water pressure to prevent loss of soil or uncontrolled ground water inflow.

   In cased auger spoil transportation system, manage pressure at excavation face by controlling volume of spoil removal with respect to advance rate. Monitor speed of rotation of auger flight, and addition of water.

3. Remote Control System. Provide MTBM which includes remote control system with following features:

   a. Allows for operation of system without need for personnel to enter tunnel. Has display available to operator, at remote operation console, showing position of shield in relation to design reference together with other information such as face pressure, roll, pitch, steering attitude, valve positions, thrust force, and cutter head torque; rate of advance and installed length.

   b. Integrates system of excavation and removal of spoil and its simultaneous replacement by pipe. As each pipe section is jacked forward, control system shall synchronize all of operational functions of system.

4. Active Direction Control. Provide MTBM which includes active direction control system with following features:

   a. Controls line and grade by guidance system that relates actual position of MTBM to design reference (e.g., by laser beam transmitted from jacking shaft along pipe to target mounted in shield).

   b. Provides active steering information which shall be monitored and transmitted to operating console.

   c. Provides positioning and operation information to operator on control console.

5. Use generator which is suitably insulated for noise (“hospital” type) in residential or commercial areas.

G. Pipe Jacking Equipment. Provide pipe jacking system with following features:

1. Has main jacks mounted in jacking frame located in starting shaft.

2. Has jacking frame which successively pushes string of connected pipes following tunneling excavation equipment towards receiving shaft.

3. Has sufficient jacking capacity to push tunneling excavation equipment and string of pipe through ground. Incorporates intermediate jacking stations, if required.

4. Has capacity at least 20 percent greater than calculated maximum jacking load.

5. Develops uniform distribution of jacking forces on end of pipe by use of spreader rings and packing, measured by operating gauges.

6. Provides and maintains pipe lubrication system at all times to lower friction developed on surface of pipe during jacking.

7. Jack Thrust Reactions. Use reactions for pipe jacking that are adequate to support jacking pressure developed by main jacking system. Special care shall be taken when setting pipe guide rails in jacking shaft to ensure correctness of alignment, grade, and stability.

H. Air Quality. Provide equipment to maintain proper air quality of manned tunnel operations during construction in accordance with OSHA requirements.

I. Enclose lighting fixtures in watertight enclosures with suitable guards. Provide separate circuits for lighting, and other equipment.

J. Electrical systems shall conform to requirements of National Electrical Code - NFPA70.

3.04 PIPE-JACKED TUNNELING DATA

Maintain shift logs of construction events and observations. Project Manager shall have access to all logs with regard to following information:

1. Location of boring machine face or shield by station and progress of tunnel drive during shift.

2. Hours worked per shift on tunneling operations.

3. Completed field forms, such as steering control logs, for checking line and grade of tunneling operation, showing achieved tolerance relative to design alignment.

4. Maximum pipe jacking pressures per drive.

5. Location, elevation, and brief soil descriptions of soil strata.

6. Ground water control operations and piezometric levels.

7. Observation of any lost ground or other ground movement.

8. Any unusual conditions or events.

9. Reasons for operational shutdown in event drive is halted.

3.05 EXCAVATION AND JACKING OF PIPE

A. Tunnel Excavation.

1. Keep tunnel excavation within easements and rights-of-way indicated on Drawings and to lines and grades designated on Drawings.

2. Perform tunneling operations in manner that will minimize movement of ground in front of and surrounding tunnel. Prevent damage to structures and utilities above and in vicinity of tunneling operations.

3. Open-face excavations:

   a. Keep face breasted or otherwise supported and prevent falls, excessive raveling, or erosion. Maintain standby face supports for immediate use when needed.

   b. During shut-down periods, support face of excavation by positive means; no support shall rely solely on hydraulic pressure.

4. Closed-face excavation:

   a. Carefully control volume of spoil removed. Advance rate and excavation rate to be compatible to avoid over excavation or loss of ground.

   b. When cutting head is withdrawn or is open for any purpose, keep excavated face supported and stabilized.

5. Excavated diameter should be minimum size to permit pipe installation by jacking with allowance for bentonite injection into annular space.

6. Whenever there is condition encountered which could endanger tunnel excavation or adjacent structures, operate without intermission including 24-hour working, weekends and holidays, until condition no longer exists.

7. Assume responsibility for damage due to settlement from any construction-induced activities.

B. Pipe Jacking

1. Cushion pipe joints as necessary to transmit jacking forces without damage to pipe or pipe joints.

2. Maintain envelope of bentonite slurry around exterior of pipe during jacking and excavation operation to reduce exterior friction and possibility of pipe seizing in place.

3. If pipe seizes up in place and elect to construct recovery access shaft, obtain approval from Project Manager. Coordinate traffic control measures and utility adjustments as necessary prior to commencing work.

4. In event section of pipe is damaged during jacking operation, or joint failure occurs, as evidenced by inspection, visible ground water inflow or other observations, submit for approval his methods for repair or replacement of pipe.

C. Grouting. Grouting requirements are defined in Section 02431 - Tunnel Grout.

3.06 CONTROL OF LINE AND GRADE

A. Construction Control.

1. Project Manager will establish baselines and benchmarks indicated on Drawings. Check baselines and benchmarks at beginning of Work and report any errors or discrepancies to Project Manager.

2. Use baselines and benchmarks established by Project Manager to establish and maintain construction control points, reference lines and grades for locating tunnel, sewer pipe, and structures.

3. Establish construction control points sufficiently far from work so as not to be affected by ground movement caused by pipe-jacked tunneling operations.

B. Bench Mark Movement. Ensure that if settlement of ground surface occurs during construction which affects accuracy of temporary benchmarks detect and report such movement and reestablish temporary bench marks. Locations of permanent monumentation benchmarks are indicated on Drawings. Advise Project Manager of any settlement affecting permanent monumentation benchmarks.

C. Line and Grade.

1. Check and record survey control for tunnel against above-ground undisturbed reference at least once for each 250 feet of tunnel constructed.

2. Record exact position of MTBM or TBM or shield after each shove to ensure alignment is within specified tolerances. Make immediate correction to alignment before allowable tolerances are exceeded.

3. When excavation is off line or grade, make alignment corrections to avoid reverse grades in gravity sewers.

4. Acceptance criteria for sewer pipe shall be plus or minus 6 inches in horizontal alignment from theoretical at any point between manholes, including receiving end, and plus or minus 1½ inches in elevation from theoretical.

5. Pipe installed outside tolerances and subsequently abandoned shall first be fully grouted.

3.07 MONITORING

A. Instrumentation Monitoring. Instrumentation requirements are shown on Drawings. Instrumentation specified shall be accessible at all times to Project Manager. Readings shall be submitted promptly to Project Manager.

1. Install and maintain instrumentation system to monitor and detect movement of ground surface and adjacent structures. Establish vertical control points at distance from construction areas that avoids disturbance due to ground settlement.

2. Installation of instrumentation shall not preclude Project Manager, through independent contractor or consultant, from installing instrumentation in, on, near, or adjacent to construction work. Access shall be provided to work for such independent installations.

3. Instruments shall be installed in accordance with Drawings and manufacturer's recommendations.

B. Surface Settlement Monitoring

1. Establish monitoring points on all critical structures.

2. Record location of settlement monitoring points with respect to construction baselines and elevations. Record elevations to accuracy of 0.01 feet for each monitoring point location. Monitoring points should be established at locations and by methods that protect them from damage by construction operations, tampering, or other external influences.

3. Ground surface elevations shall be recorded on centerline ahead of tunneling operations at minimum of 100-foot intervals or at least three locations per tunnel drive. For sewers greater than 60-inch diameter, also record similar data at approximately 20 feet each side of centerline. Settlement monitoring points must be clearly marked by studs or paint for ease of locating.

4. Railroads. Monitor ground settlement of track subbase at centerline of each track.

5. Utilities and Pipelines. Monitor ground settlement directly above and 10 feet before and after utility or pipeline intersection.

C. Reading Frequency and Reporting. Submit to Project Manager, records of readings from various instruments and survey points.

1. Instrumentation monitoring results to be read at frequency specified and unless otherwise specified, shall be started prior to zone of active excavation reaching that point, and shall be continued until zone of active excavation has passed and until no further detectable movement occurs.

2. Surface settlement monitoring readings shall be taken:

   a. Prior to zone of active excavation reaching that point,

   b. When tunnel face reaches monitoring point (in plan), and

   c. When zone of active excavation has passed and no further movement is detected.

3. All monitoring readings shall be submitted promptly to Project Manager.

4. Immediately report to Project Manager any movement, cracking, or settlement which is detected.

5. Following substantial completion but prior to final completion, make final survey of all monitoring points.

3.08 DISPOSAL OF EXCESS MATERIAL

Remove spoil in accordance with Section 01576 - Waste Material Disposal.

3.09 ACCEPTANCE TESTING

Acceptance testing is to be carried out by methods described in Section 02533 - Acceptance Testing for Sanitary Sewer.

END OF SECTION

Section 02447

DRY AND SLURRY AUGERING OF PIPE AND CONDUIT

PART 1 GENERAL

1.01 SUMMARY

This Section includes:

A. Installing water service pipe by methods of augering or casing by jacking and boring.

B. Installing Telecommunication Conduit along or under Public Ways.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made for augering pipe for water lines under this Section. Include payment in unit price for Section 02511 – "Water Lines".

2. When open-cut construction is requested by Contractor for his convenience in areas designated for augering, and when approved in advance by Program Manager, such areas shall be paid for at Unit Price for Section 02511 – "Water Lines".

3. Refer to Section 01270 – "Measurement and Payment" for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work in this Section is included in total Stipulated Price.

1.03 REFERENCES

A. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics.

B. ASTM D 648 - Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.

C. ASTM D 695 - Standard Test Method for Compressive Properties of Rigid Plastics.

D. ASTM D 790 - Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

1.04 RELATED REQUIREMENTS

A. Section 01270 – "Measurement and Payment"

B. Section 01330 – "Submittal Procedures"

C. Section 01555 – "Traffic Control and Regulation"

D. Section 01576 – "Waste Material Disposal"

E. Section 01578 – "Control of Ground Water and Surface Water"

F. Section 02233 – "Clearing and Grubbing"

G. Section 02260 – "Trench Safety Systems"

H. Section 02317 – "Excavation and Backfill for Utilities"

I. Section 02425 – "Tunnel Excavation and Primary Liner"

J. Section 02431 – "Tunnel Grout"

K. Section 02502 – "Steel Pipe and Fittings"

L. Section 02511 – "Water Lines"

M. Section 02517 – "Waterline in Tunnels"

N. Regulatory Requirements

1. Conform to TxDOT requirements for installations under State Highways. Engineer will obtain required permits for State Highway crossings.

2. Installations Under Railroads:

a. Secure and comply with requirements of right-of-entry for crossing railroad company's easement or right-of-way from railroad companies affected. Comply with railroad permit requirements.

b. Use auger method only.

c. Damages due to delays caused by railroad requesting work to be done at hours which will not inconvenience railroad will be at no additional cost.

d. Maintain equipment and excavations minimum 35-foot clearance from centerline of tracks.

1.05 SUBMITTALS

A. Conform to requirements of Section 01330 – "Submittal Procedures".

B. Submit product data for casings, insulators / casing spacers, spacing of insulators / casing spacers for specific pipe and location on project.

C. Prior to installation of pits, submit for Program Manager's approval, pit locations, size, depth, and areas for storage, material, and spoil handling. Acceptance of Project Manager does not relieve Contractor from responsibility to obtain specified results.

D. Show actual pit locations dimensioned on as-built drawings so that they can be identified in field.

E. Submit copy of executed railroad company rights of entry to Program Manager.

F. Provide cutting head size to be used in conjunction with slurry augers.

1.06 – 1.09 NOT USED

1.10 DEFINITIONS

A. Auger Methods:

1. Dry Auger Method: Installation of steel casing by excavating soil at advancing end of casing and transporting spoil through casing by otherwise uncased auger, while advancing casing by jacking at same rate as auger excavation progresses.

2. Slurry Auger Method: Installation of steel casing or carrier pipe by first drilling small diameter pilot hole from pit to pit, followed by removing excess soil and installing casing or pipe by pull-back or jacking method.

3. Annular Space: space between carrier pipe and primary tunnel liner, casing, or ground.

PART 2 PRODUCTS

2.01 MANUFACTURER(S) (NOT USED)

2.02 MATERIALS AND/OR EQUIPMENT

A. Criteria for Selection of Material

Contractor shall be responsible for selection of casing, pipe, and pipe joints to carry anticipated thrust of jacks or loads.

B. Piping and Fittings: As required by Specification or Plans.

C. Casings: Provide steel casing in accordance with Section 02502 – “Steel Pipe and Fittings”. The size of casing shall be based on the minimum clearance between the carrier pipe and the casing as defined in Section 02425 – “Tunnel Excavation and Primary Liner”, Paragraph 2.01.B. Additionally, the sizing of casings shall exceed the O.D. of any external joint restraints. Provide casing with smooth, continuous interior surface.

D. Casing Spacer Dimensional Requirements: Provide casing spacer width 8 inches for pipe sizes up to and including 12 inches; 12 inches for pipe sizes larger than 12 inches. Wood skids or concrete "donuts" are not acceptable. Maximum pipe diameter for use of spacers is 30 inches. Additionally, the sizing of casing spacers shall exceed the O.D. of any external joint restraints.

1. For pipe materials 12 inches and smaller, use Advance Products & Systems, Inc. Model SI8-2, Pipeline Seal & Insulator Model C8G-2 or approved equal.

2. For pipe materials above 12 inches, use Advance Products & Systems, Inc. Model SI12-2, Pipeline Seal & Insulator Model C12G-2 or approved equal.

E. Casing Spacer Material Requirements: Bolt-on style with shell made of two sections of 14-gauge carbon steel, hot rolled, cleaned, and lined with PVC liner, 0.090 inch thick with Durometer A 85-90 overlapping edges to secure liner to spacer; deep embossed flanges for added strength; coated prior to installation of liner and runner with fusion-bonded PVC powder of 14 to 20 mils thickness; electroplated studs, nuts, and washers.

1. Runners: Supported by 10-gauge carbon steel MIG risers welded to shell. Total length of weld beads shall be at least 50 percent of the length of the runner. Fill bolt holes with caulk or approved equal to provide a water-tight seal. Minimum requirements: Glass reinforced plastic conforming to the following tests:

a. Tensile Strength: ASTM D 638; 17,600 psi

b. Flexural Strength: ASTM D 790; 25,300 psi

c. Compression Strength: ASTM D 695; 18,000 psi

d. Deflection Temperature at 264 psi: ASTM D 648; 405 F

e. Polyethylene runners are not acceptable.

F. Casing End Seals: Provide Advance Products & Systems, Inc. Model AC, Pipeline Seal and Insulator Model C, or approved equal.

G. Annular Grout:

1. Material: Low density (cellular) grout or sand-cement mortar mix.

2. Provide annular grout in accordance with Section 02431 – "Tunnel Grout".

2.03 – 2.04 NOT USED

PART 3 EXECUTION

3.01 GENERAL / MANUFACTURER(S) (NOT USED)

3.02 PREPARATION

A. Conform to applicable provisions of Section 02233 – "Clearing and Grubbing".

B. Utility Relocations: Relocate utility lines clear of pit and zone of potential significant settlement or other ground disturbance.

C. Install casings as required by Plans, in accordance with this Section.

D. Install temporary solid plug at open end of water line to prevent contamination.

3.03 ERECTION/INSTALLATION APPLICATION AND/OR CONSTRUCTION

A. Limits on Auger Length Without Steel

1. Do not exceed the lengths for auger holes in Table 1 when augering without steel casing between pits. See Paragraph 3.03.A.2 for restrictions.

Table 1
Acceptable Lengths for Auger Holes Without Steel Casing

Pipe Diameter	Max Length (LF)
Less than or equal to 8-inches	125
12-inches	100
16 to 20-inches	80
24 to 30-inches	60

2. If groundwater is encountered in the auger hole and the dewatering system is not able to dry up the subsurface to provide stable conditions, the lengths above should be reduced based on the field conditions as agreed to by the Project Manager. Reduced auger hole lengths shall be at least 25% of the above listed maximum length.

B. Traffic Control

1. Conform to applicable provisions of Section 01555 – "Traffic Control and Regulation".

2. Secure right-of-entry for crossing Railroad Company's easement or right-of-way.

3. During construction operations, furnish, and maintain barricades and lights to safeguard traffic and pedestrians, until such time as backfill has been

completed and removed from site. Provide additional barricades and lights as directed by Project Manager.

C. Pits

1. Locate auger pits where there is minimum interference with traffic or access to property. Avoid locating pits close to storm drainage channels, ditches, storm water lines, or culverts, or near potentially contaminated areas.

2. Pit Size: Size pits to provide adequate room to meet operational requirements for auger construction as well as structures indicated on Plans. Provide minimum 6-inch space between casing or pipe and walls of bore pit. Maximum allowable width of pit shall be no greater than 5 feet outside of the casing or pipe. Width of pit at surface shall not be less than at bottom.

3. Excavate bore pits to a finished grade of at least 6 inches lower than grade indicated by stakes.

4. Backfill in accordance with Section 02317 – "Excavation and Backfill for Utilities".

5. Auger pits that are excavated and backfilled as part of open-cut water line construction shall be in accordance with Section 02317 – "Excavation and Backfill for Utilities".

6. Provide and properly maintain safety protection against traffic, and accidental or unauthorized entry. Provisions shall include concrete traffic barriers or other suitable barrier around periphery of pit as appropriate.

7. Fully cover and secure pits with steel plates where no construction activity is in progress.

8. Install sheeting, lining, shoring, and bracing required for protection of workmen and public in accordance with Section 02260 – "Trench Safety Systems".

9. Provide groundwater control and drainage from pits while Work is in progress and until pit is properly backfilled. Conform to requirements of Section 01578 – "Control of Ground Water and Surface Water".

D. Slurry Augering

1. Auger from approved pit locations. Excavate for pits and install shoring as outlined above under Paragraph 3.03.C, Pits. Auger mechanically with use of pilot hole entire length of crossing and check for line and grade. Diameter of auger hole not to exceed pipe bell diameter plus 2 inches. Place excavated material outside working pit and dispose of as specified. Use water or other

fluids in connection with boring operation only to lubricate cuttings; jetting is not permitted.

2. In unconsolidated soil formations, gel-forming colloidal drilling fluid may be used. Fluid is to consist of at least 10 percent of high-grade processed bentonite and shall consolidate cuttings of bit, seal walls of hole, and shall furnish lubrication for subsequent removal of cuttings and installation of pipe.

3. Depending on character of soil encountered during augering operation, conduct operations without interruption, insofar as practical, to prevent hole from collapsing or pipe from seizing up in hole before installation is complete.

4. Cover the open end of pipe before inserting into the auger hole.

5. Allowable variation from line and grade shall be as specified under Paragraph 3.03.G, Jacking.

6. Remove and replace pipe damaged in augering operations.

E. Dry Augering of Steel Casing

1. Provide jacks, mounted on frame or against backstop, of capacity suitable for forcing excavating auger and casing through soil conditions to be encountered. Operate jacks so that even pressure is applied to casing.

2. Provide steerable front section of casing to allow vertical grade adjustments. Provide water level or other means to allow monitoring of grade elevation of auger casing.

3. Bentonite slurry may be used to lubricate casing during installation. Use of water to facilitate removal of spoil and to lubricate exterior casing is permitted; however, water jetting for excavation of soil is not allowed when jacking casing.

4. The annular space of dry augers shall be grouted when necessary in accordance with Sections 02431 – “Tunnel Grout” and 02517 – “Waterline in Tunnels”.

F. Filling Annular Space When Using Slurry Auger Method

1. For pipe diameters up to 16 inches, for installation of water line, block void space around pipe in augered hole with approximately 12 inches of packed clay or approved equal material to prevent bedding or backfill from entering void around pipe in augered hole when compacted. For pipe diameters 4 inches through 8 inches use minimum ½-cubic-foot clay; for pipe diameters 12 inches through 16 inches use minimum ¾-cubic- foot clay.

2. When diameter of auger hole exceeds diameter of bell by more than 2-inches, grout the annular space between the pipe and the excavated hole.

3. For pipe diameter greater than or equal to 20 inches, grout the annular space between pipe and excavated hole.

4. Refer to the Material Applications for Tunnel & Auger Construction table under Paragraph 3.03.K.

G. Jacking

1. Comply with Section 02260 – "Trench Safety Systems" for all pits, end trenches, and other excavations relating to Work required by specifications. Dewater as required to provide safe working conditions.

2. Wherever end trenches are cut into sides of embankment or beyond it, sheath securely and brace such work to prevent earth caving.

3. Make up only one joint at time in pit or trench prior to jacking.

4. Do not interfere with operation of railroad, street, highway, or other facility, nor to weaken or damage embankment or structure.

5. Use heavy-duty jacks sized for forcing casing through embankment. Use appropriate jacking head, usually of timber, and bracing between jacks and jacking head and jacking frame or backstop. Apply jacking pressure uniformly around ring of casing. Set casing to be jacked on guides, properly braced together, to support section of casing and to direct it in proper line and grade. Place jacking assembly in line with direction and grade of casing. Excavate embankment material just ahead of casing and remove material through casing. Force casing through embankment with jacks into excavated auger hole.

6. Conform excavation for underside of casing to contour and grade of casing, for at least one third of circumference of casing. Provide clearance of not more than 2 inches for upper half of casing. Taper off upper clearance to zero at point where excavation conforms to contour of casing.

7. Excavation may extend beyond end of casing depending on character of material, but shall not exceed 2 feet. Decrease advance excavation at direction of Program Manager, when character of material being excavated makes it desirable to keep advance excavation closer to end of casing.

8. Jack casing from low or downstream end. Lateral or vertical variation in final position of casing from line and grade as shown on Plans will be permitted only to extent of 1 inch in 10 feet, provided such variation is regular and only in one direction and that final grade of flow line is in direction indicated on Plans.

Section 02517

WATER LINE IN TUNNELS

PART 1 GENERAL

1.01 SUMMARY

This Section includes handling, transporting, and installing water line in primary liner tunnels, including invert cleanup and blocking and water line in casings that will be backfilled with concrete or grout.

1.02 MEASUREMENT AND PAYMENT

A. Unit Prices.

1. No separate payment will be made under this section. Include payment in Unit Price for Section 02511 – "Water Lines".

2. Payment for installation of water line constructed according to Section 02425 – "Tunnel Excavation and Primary Liner" will be authorized by Project Manager in three parts. Pay estimates for partial payments will be made as measured above according to following schedule:

   a. 60 percent of installation will be authorized when excavation and primary liner installation is complete.

   b. 95 percent of installation will be authorized when water line installation and grouting is complete.

   c. 100 percent of installation will be authorized when section successfully hydrostatically tested.

3. Refer to Section 01270 – "Measurement and Payment" for unit price procedures.

B. Stipulated Price (Lump Sum). If Contract is Stipulated Price Contract, payment for Work is in this Section is included in total Stipulated Price.

1.03 REFERENCES

ASME B40.100 - Pressure Gauge and Gauge Attachments.

1.04 SUBMITTALS

A. Submit work plan including following information in accordance with Section 01330 – "Submittal Procedures".

1. Method of transporting pipes into tunnel

2. Method of hoisting and positioning pipe in tunnel

3. Method of jointing and aligning pipe

4. Method of supporting and blocking pipe

5. Tunnel ventilation while setting pipe and completing joints, when applicable

6. Material, equipment and procedures for grout placement and other information required by Section 02431 – "Tunnel Grout".

B. Submit results of tunnel primary liner survey in accordance with Paragraph 3.03.E, Tunnel Survey.

C. Submit results of installed water line survey in accordance with Paragraph 3.03.M, As-built Survey and Installation Tolerances.

1.05 RELATED REQUIREMENTS

A. Section 01270 – "Measurement and Payment"

B. Section 01330 – "Submittal Procedures"

C. Section 02425 – "Tunnel Excavation and Primary Liner"

D. Section 02431 – "Tunnel Grout"

E. Section 02447 – "Dry and Slurry Augering of Pipe and Conduit"

F. Section 02511 – "Water Lines"

G. Section 03315 – "Concrete for Utility Construction"

1.06 QUALITY ASSURANCE (NOT USED)

1.07 SYSTEM DESCRIPTION

A. Procedures

1. Joints: Prepare joints as recommended by pipe manufacturer and in accordance with Section 02511 – "Water Lines".

2. Handling: Handle, store, and transport pipe in accordance with pipe manufacturer's recommendations and to prevent damage to pipe ends, pipe barrel, steel reinforcement, and pipe protective linings.

3. Grouting: Perform grouting of annular space between water line and tunnel liner to fill voids with grout, without dislocating or damaging pipe.

1.08 – 1.13 NOT USED

PART 2 PRODUCTS

2.01 MANUFACTURER(S) (NOT USED)

2.02 MATERIALS AND/OR EQUIPMENT

A. Annular Grout

Specified in Section 02431 – "Tunnel Grout"

B. Concrete

Meeting requirement of Section 03315 – "Concrete for Utility Construction", Class B concrete.

C. Pipe Material and Fittings

Manufacture and deliver pipe material and fittings as described in Section 02511 – "Water Lines".

D. Spacers

Unless otherwise noted on Plans, use casing spacers between water line and casing tunnel liner for water lines less than 36 inches in diameter. See Section 02447 – "Dry and Slurry Augering of Pipe and Conduit" for spacer requirements and installation.

PART 3 EXECUTION

3.01 – 3.02 NOT USED

3.03 ERECTION/INSTALLATION APPLICATION AND/OR CONSTRUCTION

A. Grout in place tunnels for water lines with diameters of 36 inches or greater.

B. When tunnel liner plate is used, grout water line in place regardless of water line diameter.

C. Grout water lines in accordance with Section 02447 –"Dry and Slurry Augering of Pipe and Conduit", Paragraph 3.03.K Material Applications for Tunnel & Auger Construction.

D. Tunnel Survey

Prior to installing water line in tunnel: Perform survey of tunnel in accordance with Paragraph 3.03.M.2. Verify tunnel has been constructed within specified tolerances for line, grade, and roundness and water line to be placed in tunnel can be placed in

conformance with tolerances specified. Should misalignment of tunnel preclude proper installation of water line, notify Project Manager of proposed correction method. Project Manager will make final decision on acceptability of correction.

E. Pipe Transport in Tunnel

Transport pipe in tunnel for final placement so that no damage occurs to pipe ends or pipe barrel and interior lining or exterior coating due to contact with primary liner or point loading from pipe blocking system. Repair pipe damaged during transport or final placement in tunnel in manner acceptable to Project Manager prior to joining. Remove damaged pipe from tunnel and replace, when directed by Project Manager, at no additional cost.

F. Tunnel Cleanup

1. Remove temporary tunnel utilities, loose material, dirt, and debris prior to pipe placement. Broom clean concrete invert. Control seepage and remove standing water in invert.

2. Temporary construction tracks or pipe skids may be left in place when they do not interfere with alignment of water line, short circuit cathodic protection system, or interfere with final placement of annular grout.

G. Invert Pipe Support

Construct invert pipe support of screeded concrete or other method, as approved, to final grade of outside of water line. Secure invert support to primary liner to prevent movement. Cure concrete support minimum of 48 hours prior to setting pipe. Maintain minimum of 4 inches clearance between outside of water line and primary liner.

H. Joining Pipe in Tunnels

Lay pipe in accordance with pipe manufacturer's recommendations, and as specified in this Section. Join pipe segments so as to properly compress gaskets and allow for correct final positioning of pipe for line and grade. Closely align pipe and bring loosely together by means of hydraulic jacks, locomotives, pipe mobiles, or winches. Once pipes have been loosely joined, pull home by means of hydraulic tugger or other similar methods suitably protecting pipe and joints against damage. Impact joining, such as ramming with locomotives or other mechanical equipment, is not permitted.

I. Blocking Pipe in Tunnel and Bulkheads

1. Develop and submit pipe blocking system that shall prevent water line from floating and deforming beyond specified limits. Loads imposed on pipe, primary liner and surrounding soil during grouting shall be determined by Registered Professional Engineer in State of Texas. Show essential details in

plan for supporting system. Position water line in tunnel to allow minimum of 4 inches of grout to be placed between water line and tunnel primary liner or casing.

2. Prevent pipe from floating during backfill operations by properly installed blocking. Remove and replace segment of pipe which is distorted or moved from final line and grade.

3. Secure blocking in place so that it cannot be dislodged during adjacent pipe laying and during grouting operations.

4. Construct bulkheads of material, compatible with grout, to withstand imposed grout pressure without leakage. Provide bulkheads at frequency to allow completion of grouting in continuous operation and to permit timely removal of pipe and grout which may be needed as result of pipe distortion or movement. Modifications to bulkhead spacing will be reviewed by Project Manager. Provide adequate venting for bulkheads.

J. Annular Grout

1. Fill annular void between water line and tunnel primary liner or casing with grout, in accordance with Section 02431 – "Tunnel Grout".

2. Delay grouting until all significant differential movement has stopped as determined by monitoring.

3. Test annular grout material, equipment, and procedures in accordance with approved submittal. Perform test on first 200 feet of water line to be backfilled. When grout does not totally fill annular space or other problems occur, correct defects in first test section and adjust method or mix and rerun test on next 200 feet. Repeat procedure as necessary.

4. Placement:

a. Placement Limits: Predetermine limits of each grout placement stage by size and capacity of batching equipment and initial set time of proposed grout. Under no circumstances shall placement at grout port continue longer than period of time for mix to take initial set. Locate grout hole spacing and locations according to number of stages necessary to backfill tunnel liner. Do not install another lift until proper set has been attained. Placement procedures shall be approved by admixture or additive manufacturers.

b. Equipment - Pumps: Pumping equipment must be of sufficient size and capacity to place grout to distances, velocities and volumes compatible with batching and mixing equipment. Maintain equipment and clean thoroughly each day. No hydrocarbons shall enter pumping chamber.

Under no circumstances shall grout be pumped in excess of 1000 linear feet without prior approval by Project Manager. Pumping test and verification testing of resulting grout quality shall be required for approval.

c. Slickline: Convey grout to point of placement in clean steel or rubber hoses designed to handle safely pump pressure and volumes during placement. Do not allow hardened grout or concrete to obstruct or coat steel pipe or hose internally.

d. Grout Connections: Grout connections shall be sized minimum of 2-inch inside diameter, consisting of grout hose attached immediately to pressure gauge. Ensure gauges are in proper working order prior to commencing grouting operations. Gauged pumping pressure shall not exceed water line manufacturer's recommendations. Monitor grout pressure.

e. Gauges:

1) Type: Instrument oil-filled and attached to saddle-type diaphragm seal (gauge saver) to prevent clogging with grout.

2) Calibration: Certified and calibrated in accordance with ASME B40.1.

3) Range: Provide gauge with 100 percent greater than pipe manufacturer’s design collapse pressure.

4) Accuracy: No more than one-half percent error over full range of gauge.

5) Fitting: Attach gauge to valve immediately attached to grout port in tunnel liner. Provide T-fitting in injection line for sampling.

f. Limit pressure on annular space to prevent damage to pipe or liner. Define limiting and estimated required pressure range. Provide and monitor open ended, high point tap or equivalent vent at bulkhead opposite point of grouting.

g. Pump grout until grout within 5 percent of specified density discharges from end opposite injection point to ensure grout is not diluted by extraneous water in annulus.

h. Drilling of access holes from surface to facilitate grouting shall not be allowed.

i. Communication: There shall be constant communications via telephone between headerman at point of injection and pump, batch plant, and supervisor. Under no circumstance shall grouting continue without continuity of communications.

j. The headerman at point of placement shall advise batch plant of variations of density and make corrections as necessary. Record and submit to Project Manager for each days pour variations and corrections.

5. Remove bulkheads unless constructed of masonry.

6. Repair or replace damage or distortion to water line.

K. Grouting Joints

Materials and procedures for filling interior joint recesses shall conform to Section 02511 – "Water Lines".

L. As-Built Survey and Installation Tolerances

1. Perform as-built survey on installed water line. Determine horizontal and vertical location for invert of each pipe joint.

2. Acceptable tolerances: Within plus or minus 3 inches of horizontal alignment, within plus or minus 2 inches of vertical alignment.

3. Correct pipe section outside acceptable tolerances.

3.04 – 3.06 NOT USED

3.07 CLEANING

Clean interior of pipe after interior work is completed. Remove loose material, dirt, and debris from completed pipeline. Maintain the condition of the pipe free of dirt, water, and other debris after the completion of Work inside the pipe for the internal inspection and until the time that the pipe is ready to be filled for testing and placing in service.

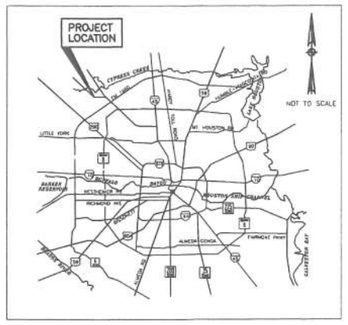
3.08 – 3.10 NOT USED

END OF SECTION

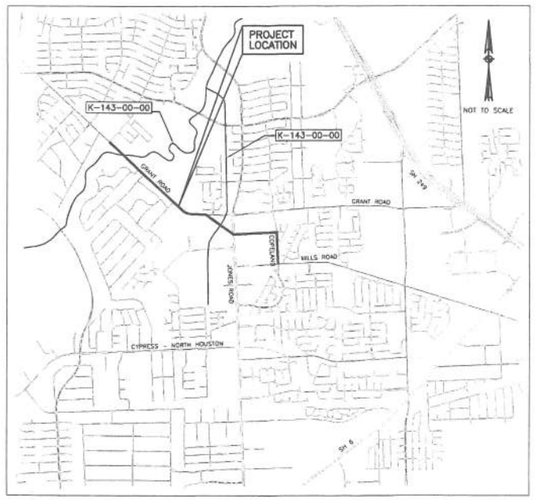
NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY

PROJECT 28-B

PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD



LOCATION MAP



VICINITY MAP

KEY MAP NO 000
GIMS MAP NO 00000

North Harris County REGIONAL WATER Authority

TEXAS WATER DEVELOPMENT BOARD
REVIEWED: Matthew J young P.E.
APPROVED: Matthew J young P.E.
DATE: May 21, 2020

48 Hour Notice: Contractor shall notify Harris County prior To Commencing Construction and/or Backfilling any utilities. Contractor(S) to contact Public Review Department @ (713-274-3931) or public.review@hcpid.org

A Notification issued by HC Infrastructure Department-Permits Office- is required for proposed work within Harris County Right-of-Way. The project must be approved prior to obtaining the required Notificatiop. A Notification must be obtained separately from a site development permit package. For additional information please visit: http://hcpid.org/permits/pr_notification_of_construction.html or contact Public Review Inspections Department @ (713)274-3931

GENERAL MANAGER

JIMMIE SCHINDEWOLF, P.E.

BOARD MEMBERS

ALAN J. RENDL
KELLY P. FESSLER
LENOX A. SIGLER
RON GRAHAM
JAMES D. PULLIAM

*Construction in Harris County Flood Control District right-Of-Way

Site plans must be approved prior to obtaining the required HCFCD Right-of-way Notification. Be advised that the HCFCD Right-of-way Notification is separated from the site development permit package

1.) HCFCD Right-of-Way Notification (permit)
2.) HCFCD 48-hr Pre-Construction Notice

Both are required prior to entering or working within Harris County Flood Control District right-of-way. The HCFCD Right-of-Way Notification and 48-hour notice must be provided to HCFCD at dcid@hcfcd.org.

To apply for the HCFCD Right-of-Way Notification please go to http://apps.harriscountytx.gov/EPermits and apply for the HCFCD ROW under ROW Notification.

Failure to provide both items could result in project delays.

ISSUE DATE: MAY, 2020

AECOM
AECOM TECHNICAL SERVICES, INC.
19219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094-1009
281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F-3580

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

STATE OF TEXAS
CARL D. McCONNELL
97585
LICENSED PROFESSIONAL ENGINEER
5/8/2020

GENERAL MANAGER, NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY

REF. NO. 01

SHEET No: 1 OF 99

PROJECT 28-B

REVISION DATE: 1/12/17

1. PAVING

(FOR H.C. PUBLIC R.O.W. ONLY)

DESIGN THICKNESS OF PAVING	STABILIZED SUBGRADE DEPTH	DESIGN STRENGTH OF CONCRETE	STEEL SPACING	
			LONG.	TRANS.
(IN.)	(IN.)	(PSI)	(IN.)	(IN.)

DRIVEWAYS (in H.C. ROW only)

I. NUMBER OF DRIVEWAY APPROACHES PROPOSED INCLUDE WIDENING OR REPAVING EXISTING DRIVEWAYS AS WELL AS NEW DRIVEWAYS

DRWY	WIDTH	MATERIAL	CULVERT?	CULVERT LENGTH	NEAREST X-STREET	DIST. TO X-STREET
1						
2						
3						
4						
5						

II. HARRIS COUNTY STANDARD DRIVEWAY DETAIL APPEARS ON SHEET _____

FIRE APPARATUS ACCESS ROAD

☐ REQUIRED AND SHOWN ON SHEET(S) _____
☐ NOT REQUIRED DUE TO _____

CURBING

I. ISLANDS AND MEDIANS REQUIRE STANDARD 6" CURBING

II. ☐ STANDARD 6" CURBING PROPOSED
☐ 4" x 12" CURBING PROPOSED EXCEPT AT MEDIANS AND ISLANDS

TRAFFIC CONSIDERATIONS

I. MEDIAN CUTS
☐ NO MEDIAN CUT OR RELOCATION IS PROPOSED
☐ MEDIAN MODIFICATIONS ARE SHOWN ON SHEET _____

II. LEFT / RIGHT TURN LANE
☐ NO LEFT / RIGHT TURN LANE IS PROPOSED
☐ LEFT / RIGHT TURN LANE IS SHOWN ON SHEET _____

III. TRAFFIC CONTROL PLAN
☐ NO WORK IN THE RIGHT OF WAY IS PROPOSED THAT WOULD INTERFERE WITH TRAFFIC FLOW
☒ TRAFFIC CONTROL SHOWN ON SHEET 94-96

IV. TRAFFIC SIGNAL
☐ NO TRAFFIC SIGNAL IS EXISTING / PROPOSED
☐ EXISTING TRAFFIC SIGNAL DEVICES (T.C. BOXES AND LOOPS) SHOWN ON SHEET _____
☐ PROPOSED TRAFFIC SIGNAL (BY OTHERS)

V. TRAFFIC IMPACT ANALYSIS
☐ NO TRAFFIC IMPACT ANALYSIS IS REQUIRED
☐ TRAFFIC IMPACT ANALYSIS HAS BEEN APPROVED ON DATE:_____
PLAN TITLE: _____
HCPID PROJECT NO.: _____

2. RESIDENTIAL / SUBDIVISION DRAINAGE

I. PROPOSED DRAINAGE SYSTEM TYPE
☐ STORM SEWER
☐ ROADSIDE DITCH
☐ LOW IMPACT DEVELOPMENT (LID)

II. DESIGN METHOD USED
☐ CITY OF HOUSTON _____ YEAR FREQUENCY
☐ OTHER: _____

III. DRAINAGE SYSTEM OUTFALLS DIRECTLY TO EXISTING
☐ DETENTION POND (APPROVED H.C. PRJ NO.): _____
DETENTION POND MAINTAINED BY: _____
☐ HCFCD DRAINAGE DITCH UNIT NO.: _____
☐ H.C. ROADSIDE DITCH (ROAD NAME): _____
☐ H.C. STORM SEWER (APPROVED H.C. PRJ NO.): _____

IV. H.C. OUTFALL CALCULATIONS
☐ ROADSIDE DITCH OUTFALL:
ALLOWABLE OUTFALL RATE: 0.002 x _____ LF Frontage = _____ (CFS)
PROPOSED OUTFALL RATE: _____ (CFS), CALCULATIONS PROVIDED ON SHEET ___
☐ STORM SEWER OUTFALL
CAPACITY ALLOCATED TO TRACT FROM D.A. MAP: _____ (CFS)
FROM DRAINAGE AREA MAP DATED: _____
PREPARED BY: _____
APPROVED H.C. PROJECT NO.: _____
ACTUAL OUTFALL RATE: _____ (CFS), CALCULATIONS PROVIDED ON SHEET ___

V. DETENTION PROVIDED BY
☐ DETENTION BASIN IS PART OF THIS PLAN SET. SERVICE AREA MAP IS ON SHEET ___
☐ REGIONAL DETENTION BASIN SYSTEM (APPROVED H.C. PRJ NO.): _____

PROPOSED STORM SEWER IS SUBMERGED (AGREEMENT MUST BE PROVIDED).
STATIC W.S.E. @ OUTFALL IS _____.

OFFSITE SHEET FLOW: (100 YEAR)

OFFSITE SHEET FLOW MAPPING, TOTAL DISCHARGE CALCULATIONS AND DESIGN ACCOMMODATIONS ARE SHOWN ON SHEET ___ OR AS PRESENTED IN THE APPROVED DRAINAGE STUDY ENTITLED _____

TOTAL ACREAGE = _____
TOTAL DISCHARGE = _____

NOTE: ALL OFFSITE SHEET FLOW FROM ADJACENT PROPERTIES MUST BE IDENTIFIED AND PROPERLY ACCOUNTED FOR IN THE PROJECT. THE SIGNING ENGINEER HEREBY CERTIFIES THAT THESE AREAS HAVE BEEN ADDRESSED.

3. COMMERCIAL / OTHER SITE DRAINAGE

I. PROPOSED DRAINAGE AREA
☐ NEW DEVELOPMENT AREA: _____
☒ RE-DEVELOPMENT AREA (AMOUNT INCREASED IMPERVIOUS AREA): 0.0___
☐ LOW IMPACT DEVELOPMENT (LID)

II. DETENTION VOLUME
NEW AREA _____ * _____ = _____ ACRE FEET
DETENTION REQUIRED: N/A
PROPOSED DETENTION VOLUME = _____ ACRE FEET
PROPOSED DETENTION VOLUME CALCULATIONS ARE SHOWN ON SHEET _____
* ☐ .55 (CHANNEL)
* ☐ .65 (STM SWR)
* ☐ 1.00 (RD. DITCH)
* ☐ OTHER: _____

DETENTION VOLUME PROVIDED BY EXISTING DETENTION POND
APPROVED H.C. PROJECT NO.: _____
DETENTION POND SERVICE AREA MAP IS PROVIDED ON SHEET ____

III. OUTFALL
OUTFALL TO ☐ H.C. ROADSIDE DITCH
☐ EXISTING H.C. STORM SEWER
☒ OTHER TxDOT DITCH
☐ ROADSIDE DITCH OUTFALL:
ALLOWABLE OUTFALL RATE: 0.0027 x _____ LF Frontage = _____ (CFS)
PROPOSED OUTFALL RATE: _____ (CFS), CALCULATIONS PROVIDED ON SHEET ___
☒ STORM SEWER OUTFALL
CAPACITY ALLOCATED TO TRACT FROM D.A. MAP: _____ (CFS)
FROM DRAINAGE AREA MAP DATED: _____
PREPARED BY: _____
APPROVED H.C. PROJECT NO.: _____
ACTUAL OUTFALL RATE: _____ (CFS), CALCULATIONS PROVIDED ON SHEET ___

IV. PUMPED DETENTION FACILITIES
VOLUME THAT GRAVITY FLOWS: _____ ACRE FEET
VOLUME THAT IS PUMPED: _____ ACRE FEET
ENTRANCE VELOCITY INTO ROADSIDE DITCH OR STORM SEWER: _____
PUMP SPECIFICATIONS AND AUTOMATIC SHUTOFF PLANS FOR ROADSIDE DITCH & STORM SEWER OUTFALLS APPEAR ON SHEET _____

V. FLOW RESTRICTOR SIZE
OUTFALL PIPE SIZE: _____
RESTRICTOR PIPE SIZE: _____

NOTE: ALL ROADSIDE DITCH OUTFALLS REQUIRE EROSION CONTROL MEASURES. RIP RAP IS NOT ALLOWED AS AN EROSION CONTROL MEASURE IN HARRIS COUNTY ROW. ALL PUMPED DETENTION OUTFALLS TO ROADSIDE DITCHES REQUIRE MANHOLE W/ LEADS.

4. WATER AND WASTEWATER

I. COMMERCIAL PROJECTS

DOES PROPERTY HAVE EXISTING AND/OR PROPOSED UTILITIES?
☐ YES ☐ NO

IF YES, CHECK THE BOX THAT APPLIES TO THIS PROJECT
☐ PUBLIC WATER & SANITARY
☐ PRIVATE WATER WELL & SEPTIC SYSTEM
☐ PUBLIC WATER & PRIVATE SEPTIC SYSTEM
☐ PRIVATE WATER WELL & PUBLIC SANITARY

NOTE: PUBLIC UTILITIES REQUIRE A LETTER FROM THE DISTRICT/ MUNICIPALITY AUTHORIZING SERVICE & CONNECTION. THIS IS REQUIRED FOR PLAN APPROVAL.

UTILITY DISTRICT/MUNICIPALITY NAME: _____

NOTE: SEPTIC SYSTEMS REQUIRE H.C. WASTE WATER REVIEW

H.C. SEPTIC PERMIT/REQUEST NO. _____

H.C. WASTE WATER REVIEWER APPROVAL
NAME & DATE: _____
REVIEWER COMMENTS: _____

NOTE: ALL EXISTING AND PROPOSED UTILITIES MUST BE ACCURATELY SHOWN & LABELED ON THE SITE PLANS.

II. SUBDIVISION PROJECTS (NO NEW SERVICE OR DEMAND)

☒ UTILITY DISTRICT/MUNICIPALITY NAME: N.H.C.R.W.A.
☒ PRIVATE WATER & WASTE WATER SYSTEMS
☐ PRIVATE WATER & INDIVIDUAL OSSF
☐ INDIVIDUAL WATER WELL & OSSF

NOTE: A COPY OF TCEQ APPROVAL FOR PRIVATE WATER & WASTE WATER SYSTEMS IS REQUIRED FOR PLAN APPROVAL.

5. DESCRIPTION OF PROPERTY

I. LEGAL DESCRIPTION
A. ACREAGE: _____
B. ☐ SUBDIVISION: _____
☒ SURVEY & ABSTRACT: _____
C. ADJACENT ROADS: GRANT ROAD, COPELAND ROAD

II. PLATTING
A. SUBDIVISION PLAT
☐ PROPOSED PLAT / REPLAT
☐ RECORDED PLAT / REPLAT
PLAT NAME: _____
H.C. PLAT NUMBER: _____
B. STREETS PROPOSED
☐ PUBLIC
☐ PRIVATE
☐ PUBLIC & PRIVATE
☒ NONE

III. JURISDICTIONS
☐ CITY OF _____
☒ ETJ, CITY OF HOUSTON
☐ ETJ, CITY OF _____
☐ NO ETJ

IV. HCAD ACCOUNT NOS. (ALL) KEY MAP PAGE _____

V. UNOBSTRUCTED VISIBILITY EASEMENT (U.V.E.)
☐ REQUIRED AND SHOWN ON SHEET(S) _____
☒ NOT REQUIRED

NOTE: ALL APPROVED, FINAL PLATS AND ASSOCIATED CPC101 FORMS MUST BE INCLUDED WITH PLAN SUBMITTAL.

6. STORM WATER QUALITY

I. SWPPP: CONSTRUCTION MEASURES. (Complete for ALL projects)
☒ DISTURBS >1AC. SITE PLAN & DETAILS ON SHEET(S) 74-78
☐ DISTURBS <1AC. N/A

II. APPLICABILITY FOR PERMANENT FEATURES. (must be completed on all projects)
EXEMPT NEW DEVELOPMENT:
☐ PROJECT IS ON A PARCEL LESS THAN 5 ACRES. (must be verified with plat)
EXEMPT REDEVELOPMENT:
☒ PROJECT DOES NOT MEET THE DEFINITION OF SIGNIFICANT REDEVELOPMENT (Part A, Sec. 2.41 of Regulations of Harris County, Texas for Stormwater Quality Management)
EXEMPT GRANDFATHERED:
☐ EXEMPT "GRAND FATHERED" BY AN EXISTING DRAINAGE SYSTEM PRIOR TO OCT. 2001. (FOR VERIFICATION: PROVIDE ORIGINAL DRAINAGE AREA MAP INCLUDING CALCULATIONS)
GENERAL:
☐ PROJECT'S SWQ REQUIREMENTS LIE IN AN INCORPORATED CITY OF _____
☐ STORM WATER QUALITY PERMIT REQUIREMENT FOR THIS PROJECT IS COVERED BY PROJECT TITLE: _____
HARRIS COUNTY PROJECT NO. _____ & SWQ PERMIT NO. _____
STORMWATER QUALITY MANAGEMENT PLAN:
☐ SITE PLAN ON SHEET(S) _____

III. PERMANENT SWQ FEATURES. (COMPLETE IF NOT EXEMPT)
☐ VEGETATIVE CONTROLS USED: (FILTER STRIP, GRASSY SWALE, URBAN FORESTRY) DETAILS AND CALCULATIONS APPEAR ON SHEET(S) _____
☐ POND STRUCTURE USED (WET, DRY, WETLANDS) DETAILS AND CALCULATIONS APPEAR ON SHEET(S) _____
☐ HYDRODYNAMIC TYPE SEPARATOR MODEL: _____
☐ OTHER(S): _____

7. FLOOD CONTROL DISTRICT CRITERIA

I. DETENTION SUMMARY

STORMWATER DETENTION BASIN ROUTING TABLE

DETENTION BASIN DRAINAGE AREA = _____ ACRES MAX BASIN DRAIN TIME (100-YR EVENT) = _____ HOURS

RAINFALL EVENT PROBABILITY	PRE-DEVELOPED PEAK RUNOFF (CFS)	POST-DEVELOPED PEAK RUNOFF (CFS)	DETENTION BASIN PEAK OUTFLOW (CFS)	MAXIMUM WATER SURFACE ELEVATION	PEAK STORAGE VOLUME (AC-FT)	STORAGE RATE (AC-FT PER AC)
10% EXCEEDANCE (10-YEAR)						
1% EXCEEDANCE (100-YEAR)						

ADDITIONAL CRITERIA FOR PUMPED DETENTION BASINS:
VOLUME OF PUMPED 1% EXCEEDANCE STORAGE VOLUME _____AC-FT _____ % OF TOTAL VOLUME
MAXIMUM DESIGN OUTFLOW VELOCITY INTO HCFCD CHANNEL _____FT./SEC.
DRAIN TIME FOR BASIN = _____ HOURS BASED ON _____ HEAD CONDITIONS.

STORMWATER DRAINAGE DESIGN REPORT
REPORT TITLE _____
REPORT DATE _____ ENGINEERING FIRM _____
DATE OF ACCEPTANCE BY HCFCD OR FLOODPLAIN ADMINISTRATOR_____ HCFCD PROJECT #_____

STORMWATER DETENTION FOR THE PROPOSED WORK CONTAINED IN THESE PLANS IS PROVIDED BY OTHER PLANS:
PLAN TITLE _____
ENGINEERING FIRM _____ DATE SIGNED BY HCFCD _____ HCFCD PROJECT # _____

II. HCFCD STANDARD NOTES: SEE SHEET 4 OF THESE PLANS.

III. HCFCD STANDARD DETAILS: SEE SHEET_____ OF THESE PLANS.

IV. REFER TO PLAN SHEETS 8-10 FOR EXISTING AND PROPOSED RIGHT OF WAY DELINEATION AND COMPLETE RECORDING INFORMATION TO INCLUDE CLERK'S FILE NUMBERS, TYPE OF ESTATE (e.g., DRAINAGE EASEMENT, FEE STRIP, ETC.) AND GRANTEE (e.g. COH, HCFCD, PUBLIC, TXDOT, ETC.)

NOTES:
I. COMPLETE ONLY IF HCFCD OR HARRIS COUNTY IS REQUIRING DETENTION.
II. COMPLETE ONLY IF PROJECT HAS WITHIN IT OR IS IMMEDIATELY ADJACENT TO AN EXISTING OR PROPOSED HCFCD MAINTAINED CHANNEL OR DETENTION BASIN.
III. COMPLETE ONLY IF PROJECT INCLUDES NEW OUTFALL, BACKSLOPE INTERCEPTOR OR OTHER RELATED WORK WITHIN AN EXISTING OR PROPOSED HCFCD MAINTAINED CHANNEL OR DETENTION BASIN.
IV. COMPLETE ONLY OF PROJECT HAS WITHIN OR IMMEDIATELY ADJACENT TO IT AN EXISTING OR PROPOSED PUBLIC DRAINAGE CHANNEL OR DETENTION BASIN.

8. FLOOD PLAIN STATUS

I. GENERAL INFORMATION
FIRM PANEL(S) FOR PROPERTY: 48201C0430M
FIRM PANEL(S) DATE: OCT. 16, 2013
STATUS OF PROPERTY ON MAP
☐ ENTIRELY LOCATED IN UNSHADED ZONE "X"
☒ LOCATED PARTIALLY OR ENTIRELY IN ANY "A" ZONE OR SHADED ZONE "X", DELINEATE FLOODPLAIN BOUNDARY ON CONSTRUCTION DRAWINGS (DRAINAGE LAYOUT PG. NO._____) (BASE FLOOD LEVEL_____)
☐ LOCATED IN THE 10-YEAR FLOODPLAIN
☐ SITE REMOVED FROM FLOODPLAIN BY LOMR, LOMR-F, LOMA CASE NO._____ REVISED FLOODPLAIN IS SHOWN ON SHEET_____
ELEVATION INFORMATION
BENCHMARK USED
☒ HARRIS COUNTY FLOODPLAIN REFERENCE MARK
☐ HARRIS-GALVESTON COASTAL SUBSIDENCE DISTRICT BENCHMARK (FOR COASTAL AREAS)
DESCRIPTION OF BENCHMARK INCLUDING ELEVATION, DATUM AND YEAR OF ADJUSTMENT FLOODPLAIN REFERENCE MARK NUMBER 110125 IS AN HCFCD BRASS DISK STAMPED K100 BM10 ON EAST SIDEWALK OF GRANT ROAD BRIDGE OVER CYPRESS CREEK APPROXIMATLEY 0.90 MILE WEST OF JONES ROAD IN KEYMAP 369A IN THE CYPRESS WATERSHED NEAR STREAM K100-00-00
ELEV. 127.25 FEET NAVD 1988 2001 ADJUSTMENT

II. FLOOD PLAIN DETERMINATION BASED ON GROUND ELEVATION
☐ PROPERTY LIES ENTIRELY ABOVE THE BASE FLOOD LEVEL AND IN SHADED ZONE "X"
☒ PROPERTY LIES PARTIALLY OR ENTIRELY BELOW THE BASE FLOOD LEVEL

III. FLOODPLAIN STORAGE SUMMARY (APPLIES ONLY TO PORTION OF LAND LOCATED WITHIN FLOODPLAIN AS DELINEATED BY FIRM PANEL).
A. TOTAL VOLUME OF MATERIAL PROPOSED TO BE MOVED OR PLACED WITHIN THE FIRM DELINEATED FLOODPLAIN (FILL, BASE, CONCRETE, ASPHALT, ETC.): i.e., BELOW ELEVATION _____ (2001 ADJ.) _____ CUBIC YARDS
B. TOTAL VOLUME OF MATERIAL PROPOSED TO BE REMOVED FROM THE FIRM DELINEATED FLOODPLAIN: i.e., BELOW ELEVATION _____ (2001 ADJ.) _____ CUBIC YARDS
C. FILL AREA & VOLUME CALCULATIONS ARE SHOWN ON SHEET _____

NOTES:
I. COMPLETE FOR ALL PROJECTS
II. COMPLETE ONLY IF PROJECT IS ADJACENT TO 100-YEAR FLOOD PLAIN

IV. ☐LOMR REQUIRED ☐CLOMR REQUIRED VERIFIED BY: AE

FOR PROJECTS LOCATED IN ANY FLOODPLAIN

Development constructed or placed in accordance with these plans will comply with all provisions of the Regulations of Harris County, Texas for Floodplain Management.

No net fill is allowed in the flood plain and no fill is allowed in the floodway.

FOUNDATION NOTES: (Applies to only buildings or building additions requiring a class II permit)

All water heaters, furnaces, air conditioning units, electrical distribution panels, and any other mechanical or electrical equipment must be elevated in accordance with Section 4.05 of Harris County Floodplain regulations.

Any electrical circuit serving a light switch or outlet located below the base (100-year) flood elevation shall be dropped from above and be on a separate breaker.

All materials used below the (100-year) base flood elevation are on approved FEMA Technical Bulletin 2-08 as Class 5 water-resistant, and approved in accordance with FEMA Technical Bulletin 1-08 for foundation openings.

If the property is located within the designated 10% floodplain or ten-year floodplain all construction up to twenty-four (24) inches above the base flood elevation must use masonry, concrete or steel. These materials must be used for piers, columns and foundation walls.

Construction of critical care facilities on land located below the base (100-year) flood elevation in the 500 year flood plain or within the base (100-year) flood plain shall have the lowest floor elevated to three feet or more above the base flood elevation.

Floodproofing and sealing measures must be taken to ensure that toxic substances will not be displaced by or released into floodwaters.

Access routes elevated to or above the level of the base flood shall be provided to all critical facilities to the extent possible.

*Completed **"Elevation Certificates** to be submitted: one at permitting, a second after the slab is poured or sub-floor is installed and before the framing starts, and a third is required once construction is finished. *(*VIPER CURRENT FIRM PANEL) to the Harris County Engineering Department, 10555 Northwest Freeway, Suite 120, Houston, TX 77092*

A completed as-built certificate must be submitted after the structure is complete and before it is occupied.

The County Engineer's Office will post a final inspection notice on the structure once all requirements have been met.

9. WORK IN HCFCD RIGHT-OF-WAY

I. TYPE OF WORK TO BE PERFORMED IN CHANNEL
☐ OUTFALL
☒ UTILITY CROSSING
☐ ROADWAY BRIDGE / CULVERT CROSSING
☐ FILL ACTIVITY
☐ REHABILITATION OF CHANNEL
☐ MAINTENANCE
☐ TEMPORARY CROSSING
☐ OTHER

II. USACE ENVIRONMENTAL PERMIT
☐ US ARMY CORPS ENGINEERS NATIONWIDE PERMIT NUMBER(S) _____
☐ US ARMY CORPS OF ENGINEERS INDIVIDUAL PERMITS
☐ OTHER
☒ NO PERMITS REQUIRED
EXPLAIN: _____

III. REFERENCE / BASIS OF DETERMINATION
☐ ENVIRONMENTAL CONSULTANT REPORT
BY _____
REPORT TITLE _____
REPORT DATE _____
☐ OTHER _____

NOTES:
I. – III. REQUIRED ON PROJECTS WITH WORK IN A HCFCD CHANNEL. PLEASE REFERENCE SECTION 17 OF THE FLOOD CONTROL DISTRICT POLICY, CRITERIA, AND PROCEDURE MANUAL FOR MORE INFORMATION.

10. PERMITS REQUIRED

DOES THE PROPERTY HAVE ANY VIOLATIONS? IF SO PLEASE PROVIDE ALL VIOLATION NUMBERS. _____

TO BE FILLED OUT BY HARRIS COUNTY
☒ STORM WATER QUALITY
☐ SEPTIC (EXISTING) ☐ SEPTIC (PROPOSED)
☐ CIVIL SITE WORK (PHASE II PERMIT CLASS I (non-floodplain))
☒ CIVIL SITE WORK (PHASE II PERMIT CLASS II (floodplain))
☐ DRIVEWAY WITH CULVERT _____ CURB AND GUTTER _____
☐ BUILDING PERMITS (NO. OF BUILDINGS = _____) ☐ CRITICAL FACILITY
☐ SUBDIVISION INFRASTRUCTURE PHASE II (NO. OF LOTS = _____)
☐ NOTICE OF DETENTION AFFIDAVIT REQUIRED
☐ MUD MAINTENANCE AGREEMENT REQUIRED
☒ HCFCD ROW NOTIFICATION PERMIT REQUIRED
NOTES: WATER LINES INSTALLATION

WORK IN HARRIS COUNTY R.O.W.
☒ UTILITY WORK 3 WATER LINE CROSSINGS
☐ LEFT TURN LANE _____
☐ OTHER CONSTRUCTION _____

NOTES:
A PERMIT IS REQUIRED FOR EACH SCOPE OF WORK ON SITE.
A NOTIFICATION IS REQUIRED FOR EACH SCOPE OF WORK IN HC OR HCFCD ROW.
REFER TO www.eng.hctx.net/permits FOR EACH SCOPE OF WORK IN HC OR IN HCFCD ROW.

11. CURB RAMPS

A. ARE CURB RAMPS THAT CONNECT TO PUBLIC STREETS PROPOSED IN THIS SET OF PLANS? [ ]YES [X]NO

12. LANDSCAPING

☐ REQUIRED AND SHOWN ON SHEET(S) _____
☒ NOT REQUIRED

HCED SIGNATURE BLOCK

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY,
PROJECT 28-B, PROPOSED 60" AND 54" WATER LINE

PROJECT NAME: ALONG GRANT ROAD AND COPELAND ROAD
ADDRESS: GRANT ROAD, MATZKE ROAD AND COPELAND ROAD

WAS ACCEPTED BY THE FOLLOWING GROUPS FOR THE PURPOSES LISTED BELOW:

ENGINEERING DIVISION

BY INTERPOSE NO OBJECTION — DATE
BY AS TO LOCATION OF ITEMS IN COUNTY RIGHT OF WAY — DATE
BY AS TO PAVING AND/OR DRAINAGE ONLY — DATE
BY No PSWQF Required AS TO STORM WATER QUALITY — DATE 10/25/2019
ADDITIONAL COMMENTS: AB

HARRIS COUNTY FLOOD CONTROL DISTRICT

INTERPOSE NO OBJECTION
BY _____ FOR ITEMS LOCATED OUTSIDE OF HCFCD RIGHT-OF-WAY — DATE _____
APPROVED:
BY _____ FOR ITEMS LOCATED WITHIN EXISTING HCFCD RIGHT-OF-WAY — DATE _____
APPROVED:
BY _____ FOR ITEMS LOCATED WITHIN PROPOSED HCFCD RIGHT-OF-WAY — DATE WCB
ADDITIONAL COMMENTS:

THE PROJECT WAS REVIEWED, HOWEVER, THIS DOES NOT MEAN THE ENTIRE PROJECT, INCLUDING ALL SUPPORTING DATA AND CALCULATIONS HAVE BEEN COMPLETELY CHECKED AND VERIFIED. THESE DRAWINGS ARE SIGNED, DATED AND SEALED BY A PROFESSIONAL ENGINEER LICENSED TO PRACTICE IN THE STATE OF TEXAS, WHICH THEREFORE CONVEYS THE ENGINEER'S RESPONSIBILITY AND ACCOUNTABILITY. THIS DOES NOT RELIEVE ANY PARTY FROM COMPLYING WITH APPROPRIATE FEDERAL, STATE AND LOCAL ENVIRONMENTAL RULES, LAWS, AND REGULATIONS AND ANY OTHER LEGALLY ADOPTED REGULATION OR ORDINANCE RELATED TO LAND DEVELOPMENT. IF THE CITY SIGNATURES ARE REQUIRED BY ORDINANCE, COUNTY PERMITS WILL NOT BE ISSUED UNTIL SUCH SIGNATURES ARE OBTAINED. THESE SIGNATURES ARE VALID FOR A MAXIMUM OF TWO YEARS.

ENGINEER'S CERTIFICATION

I, CARL D. McCONNELL, A LICENSED PROFESSIONAL ENGINEER IN THE STATE OF TEXAS, DO HEREBY CERTIFY THAT THE INFORMATION PRESENTED ON THIS SHEET IS TRUE AND CORRECT TO THE BEST OF MY KNOWLEDGE AND THAT I AM NOT VIOLATING ANY PROVISION OF THE CURRENT TEXAS ENGINEERING PRACTICE ACT AND RULES CONCERNING THE PRACTICE OF ENGINEERING AND PROFESSIONAL ENGINEERING LICENSURE.

ANY VIOLATIONS WILL BE FORWARDED TO THE HARRIS COUNTY DISTRICT ATTORNEY'S OFFICE FOR PROSECUTION.

THE COMPLETED PROJECT CONSISTS OF DRAWING SHEETS 1 THRU 99

SIGNATURE _____ DATE _____

SEAL: STATE OF TEXAS — CARL D. McCONNELL — 87585 — LICENSED PROFESSIONAL ENGINEER

REVISIONS

NOTE: REVISION BLOCK IS TO BE USED ONLY FOR CHANGES MADE AFTER PLANS HAVE BEEN APPROVED BY HARRIS COUNTY.

DATE	SHEET NO.	DESCRIPTION	P.E. INITIAL	H.C. APPROVED DATE

HARRIS COUNTY PROJECT NO. 1810010060 — SHEET NUMBER 2 OF 99

HARRIS COUNTY
ENGINEERING DEPARTMENT
REVIEW SHEET

VERSION 13.0 JANUARY 20, 2016

LAST MODIFIED: Oct 03, 2019 - 7:49am BY USER: yimvy
DWG. LOCATION: G:\1110\4876-01 NHCRWA PROJECT 28-B\ACAD\Drawings\General\
DWG. NAME: 4876-01_02.dwg

No.	Date	Revisions	App.

GENERAL CONSTRUCTION NOTES

1. THERE WILL BE NO SEPARATE PAYMENT FOR WORK SHOWN ON THESE PLANS, UNLESS SPECIFICALLY ESTABLISHED IN THE BID SECTION OF THE CONTRACT DOCUMENTS. CONTRACTOR SHALL INCLUDE COST OF THIS WORK IN THE CONTRACT UNIT PRICE FOR ITEMS OF WHICH THIS WORK IS A COMPONENT OR INCIDENTAL.
2. CONTRACTOR SHALL VERIFY LOCATION AND ELEVATION OF EXISTING FACILITIES PRIOR TO CONSTRUCTION OF PROPOSED FACILITIES. ANY DAMAGE TO EXISTING FACILITIES, INCLUDING PUBLIC OR PRIVATE UTILITIES, INCURRED AS A RESULT OF CONSTRUCTION OPERATIONS SHALL BE REPAIRED BY THE CONTRACTOR AT HIS EXPENSE.
3. CONTRACTOR SHALL VERIFY LOCATION OF UNDERGROUND UTILITY LINES AND SHALL NOTIFY THE FOLLOWING AGENCIES 48 HOURS PRIOR TO EXCAVATING NEAR EXISTING FACILITIES:

   A) TEXAS ONE CALL SYSTEM AT 1-800-245-4545
   B) LONE STAR NOTIFICATION CENTER AT 713-223-4567
   C) TEXAS EXCAVATION SAFETY SYSTEM INC. AT 1-800-344-8377
4. CONTRACTOR SHALL COMPLY WITH ALL FEDERAL, STATE, AND LOCAL LAWS AND ALL REGULATIONS OF UTILITY COMPANIES CONCERNING SAFETY AND HEALTH PRACTICES.
5. OWNER SHALL PERFORM INITIAL LABORATORY TESTS. SUBSEQUENT TESTING DUE TO FAILED DENSITIES SHALL BE AT CONTRACTOR'S EXPENSE. A COPY OF ALL TEST RESULTS SHALL BE SUBMITTED TO THE PROJECT MANAGER.
6. CONTRACTOR SHALL REMOVE ALL MUD, DIRT AND DEBRIS DEPOSITED OR DROPPED ON EXISTING PAVEMENT DUE TO HIS CONSTRUCTION ACTIVITY DAILY. MATERIAL THAT IS HAZARDOUS TO TRAFFIC SHALL BE REMOVED IMMEDIATELY.
7. THESE PLANS DO NOT EXTEND TO OR INCLUDE DESIGNS OR SYSTEMS PERTAINING TO THE SAFETY OF THE CONTRACTOR OR ITS EMPLOYEES, AGENTS, OR REPRESENTATIVES IN THE PERFORMANCE OF THE WORK. THE SEAL OF THE REGISTERED PROFESSIONAL ENGINEER(S) HEREON DOES NOT EXTEND TO ANY SUCH SAFETY SYSTEMS THAT MAY NOW OR HEREAFTER BE INCORPORATED IN THESE PLANS. THE CONTRACTOR SHALL PREPARE OR OBTAIN THE APPROPRIATE SAFETY SYSTEM (S).
8. CONTRACTOR SHALL PROTECT ALL TREES ADJACENT TO WORK AREA. NO TREES OUTSIDE THE WORK AREA SHALL BE REMOVED WITHOUT PERMISSION OF OWNER.
9. CONTRACTOR SHALL GIVE NOTICE TO ALL AUTHORIZED INSPECTORS, SUPERINTENDENTS, OR PERSONS IN CHARGE OF PRIVATE AND PUBLIC UTILITIES OR RAILROADS AFFECTED BY HIS OPERATIONS PRIOR TO COMMENCEMENT OF WORK. CONTRACTOR SHALL OBTAIN ALL CONSTRUCTION PERMITS PRIOR TO STARTING CONSTRUCTION.
10. CONTRACTOR SHALL OBTAIN ALL PERMITS REQUIRED BY REGULATION OF HARRIS COUNTY, TEXAS FOR FLOOD PLAIN MANAGEMENT PRIOR TO STARTING CONSTRUCTION.
11. CONTRACTOR WILL OBTAIN ALL PERMITS REQUIRED BY HARRIS COUNTY, TEXAS PRIOR TO STARTING CONSTRUCTION OF UTILITIES AND/OR CULVERTS WITHIN COUNTY ROAD RIGHTS-OF-WAY, IF APPLICABLE.

    NOTE: AUTHORIZATION NOTICE ISSUED BY HARRIS COUNTY PUBLIC INFRASTRUCTURE ENGINEERING DEPARTMENT PERMIT OFFICE REQUIRED PRIOR TO CONSTRUCTION OF UTILITIES OR LEFT TURN LANES WITHIN HARRIS COUNTY RIGHT OF WAY. CONTACT HARRIS COUNTY PERMIT OFFICE (713-956-3000).
12. CONTRACTOR SHALL NOTIFY THE NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY (281-440-3924) AT LEAST 48 HOURS PRIOR TO START OF CONSTRUCTION.

WATER LINE CONSTRUCTION NOTES

1. CONTRACTOR SHALL ALLOW A MINIMUM OF 2-FOOT VERTICAL AND 4-FOOT HORIZONTAL CLEARANCE BETWEEN PROPOSED WATER LINES AND OTHER UTILITIES UNLESS OTHERWISE SHOWN ON PLANS. IF EXISTING UTILITIES ARE FOUND IN A LOCATION OTHER THAN WHERE SHOWN ON PLANS AND MINIMUM SEPARATION DISTANCE CAN NOT BE MET, CONTRACTOR SHALL NOTIFY PROJECT MANAGER.
2. SEPARATION DISTANCES FOR INSTALLATION OF POTABLE WATER DISTRIBUTION LINES AND WASTEWATER COLLECTION LINES, WASTEWATER FORCE MAINS AND OTHER CONVEYANCES/APPURTENANCES IDENTIFIED AS POTENTIAL SOURCES OF CONTAMINATION MUST CONFORM TO CURRENT COMMISSION (TCEQ) RULES.
3. ALL WATER LINES WITHIN THE DEDICATED EASEMENTS SHALL HAVE A MINIMUM 6-FOOT COVER FROM THE NATURAL GROUND.
   ALL WATER LINES WITHIN THE RIGHT OF WAY (ROW) WITH IMPROVED ROADWAY SHALL HAVE A MINIMUM 6-FOOT COVER FROM THE EXISTING OR PROPOSED TOP OF CURB (TOC).
   ALL WATER LINES WITHIN THE ROW WITH UNIMPROVED ROADWAY SHALL HAVE A MINIMUM 8-FOOT COVER FROM THE NATURAL GROUND.
4. CONSTRUCT WATER LINES WITH ONE JOINT OF PIPE BEYOND VALVES AND PLUG FOR FUTURE LINES, UNLESS SHOWN ON PLANS OTHERWISE.
5. VALVES SHALL BE EQUIPPED WITH OPERATING NUT EXTENSIONS TO WITHIN FOUR FEET OF NATURAL GROUND.
6. BACKFILL OF EXISTING STORM SEWER: WHEN CROSSING AN EXISTING STORM SEWER USING THE OPEN CUT METHOD, THE WATER LINE TRENCH ZONE SHALL BE BACKFILLED FOR 3 TO 5 FEET EITHER SIDE OF THE STORM SEWER WITH CEMENT STABILIZED SAND TO THE SPRING LINE OF THE STORM SEWER.
7. ALL WATER LINES 20-INCHES AND SMALLER SHALL BE PVC PIPE OR DUCTILE IRON PIPE.
8. ALL WATER LINES 24-INCHES TO 30-INCHES SHALL BE PRESTRESSED CONCRETE CYLINDER PIPE, BAR-WRAPPED CONCRETE CYLINDER PIPE, STEEL PIPE, DUCTILE IRON PIPE, OR PVC PIPE.
9. ALL WATER LINES 36-INCHES AND LARGER SHALL BE PRESTRESSED CONCRETE CYLINDER PIPE OR STEEL PIPE.

CONTRACTOR WORK ZONE NOTES

1. DRIVEWAY ACCESS WILL BE MAINTAINED OPEN AFTER WORKING HOURS. A MINIMUM OF ONE DRIVEWAY ACCESS WILL BE MAINTAINED OPEN AT ALL TIMES TO COMMERCIAL, APARTMENTS, AND/OR NON-RESIDENTIAL DEVELOPMENTS.
2. THE LENGTH OF THE WORK ZONE MUST BE MINIMIZED WITHIN THE HARRIS COUNTY ROW OR EASEMENTS. THERE SHALL NOT BE MORE THAN 200-FEET OF TRENCH OPEN AT ANY ONE TIME. THE CONSTRUCTION ZONE WILL BE A ROLLING CONSTRUCTION ZONE WITH APPROPRIATE TRANSITIONS ON EACH END UNLESS OTHERWISE SHOWN IN PLANS AND SPECIFICATIONS.
3. SIGNALIZED INTERSECTIONS: LANES WILL NOT BE CLOSED AT A SIGNALIZED INTERSECTION, UNLESS APPROVED BY THE COUNTY ENGINEER AND SHOWN IN THE PLANS AND SPECIFICATIONS.
4. TEMPORARY PAVEMENT MARKERS: TEMPORARY EPOXY-GLUED BUTTONS OR "CONSTRUCTION GRADE" TAPE PAVEMENT MARKERS SHOULD BE USED ON PERMANENT PAVEMENT TO ELIMINATE GRINDING AND SCARRING OF THE SURFACE.
5. PEDESTRIAN TRAFFIC: CARE SHALL BE TAKEN TO PROVIDE FOR TEMPORARY PEDESTRIAN TRAFFIC AND CROSSING AT AREAS SUCH AS SCHOOLS, PARKS, AND SHOPPING AREAS.

SANITARY SEWER CONSTRUCTION NOTES

1. ALL SANITARY SEWER MODIFICATION OR REPAIRS SHALL BE IN ACCORDANCE WITH TCEQ RULES AND REGULATIONS AS CURRENTLY AMENDED. CONTRACTOR SHALL NOTIFY PROJECT MANAGER OF ANY NEED FOR MODIFICATIONS OR REPAIRS TO EXISTING SANITARY SEWERS.

STORM WATER QUALITY PRE-CONSTRUCTION INSPECTION REQUIREMENTS

1. THE CONTRACTOR SHALL CONTACT THE HARRIS COUNTY STORM WATER QUALITY PERMITTING SECTION AT 713-956-3000 FOR A PRE-CONSTRUCTION INSPECTION PRIOR TO COMMENCING ANY CLEARING OR CONSTRUCTION ACTIVITIES ON THE SITE.

STORM SEWER CONSTRUCTION NOTES

1. ALL STORM SEWERS SHALL BE INSTALLED IN ACCORDANCE WITH HARRIS COUNTY RULES, REGULATIONS AND REQUIREMENTS, AS CURRENTLY AMENDED.
2. ALL STORM SEWER MANHOLE RIMS LOCATED OUTSIDE THE PAVED AREAS SHALL BE SET TO MATCH FINISHED GROUND ELEVATION.
3. ALL STORM SEWERS AND LEADS SHALL BE REINFORCED CONCRETE PIPE (RCP),CLASS III,(ASTM, C76), WITH RUBBER GASKET JOINTS (ASTM C443), UNLESS OTHERWISE NOTED ON PLANS.
4. ADEQUATE DRAINAGE SHALL BE MAINTAINED AT ALL TIMES DURING CONSTRUCTION AND ANY DRAINAGE DITCH OR STRUCTURE DISTURBED DURING CONSTRUCTION SHALL BE RESTORED TO THE SATISFACTION OF THE OWNING AUTHORITY. ALL CONSTRUCTION STORM RUNOFF SHALL COMPLY WITH THE STORM WATER MANAGEMENT HANDBOOK FOR CONSTRUCTION ACTIVITIES AS PREPARED BY HARRIS COUNTY, HCFCD AND THE CITY OF HOUSTON AND SHALL BE IN COMPLIANCE WITH THE NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM (NPDES) REQUIREMENTS.

PAVING CONSTRUCTION NOTES

1. CONCRETE PAVEMENT TO BE CONSTRUCTED IN ACCORDANCE WITH HARRIS COUNTY RULES, REGULATIONS AND REQUIREMENTS, AS CURRENTLY AMENDED.
2. ALL ROAD WIDTHS, CURB RADII AND CURVE ALIGNMENT SHOWN INDICATE BACK OF CURB. T.C. INDICATES TOP OF CURB ELEVATION AND T.P. INDICATES TOP OF PAVEMENT ELEVATION.
3. CONTRACTOR SHALL USE CONTINUOUS LONGITUDINAL REINFORCING BAR FOR 6 INCH CURB.
4. SUBGRADE STABILIZATION SHALL BE PERFORMED AS PER STANDARD SPECIFICATIONS AS ESTABLISHED BY LABORATORY TESTING OF SUBGRADE MATERIAL.
5. WHERE PROPOSED PAVEMENT IS TO MATCH EXISTING PAVEMENT, EXISTING REBARS OR DOWELS PROJECTING FROM EXISTING PAVEMENT TO BE CLEANED AND TIED INTO PROPOSED PAVEMENT. IF NO REINFORCING STEEL EXISTS, USE HORIZONTAL DOWELS. HORIZONTAL DOWELS SHALL BE #6 BARS, 24 INCHES LONG, DRILLED AND EMBEDDED 8 INCHES INTO THE CENTER OF THE EXISTING SLAB WITH "PO ROC" OR EQUAL AT 18 INCHES CENTER TO CENTER.

CYPRESS-FAIRBANKS INDEPENDENT SCHOOL DISTRICT (CFISD) WATERLINE & TEMPORARY CONSTRUCTION EASEMENT AGREEMENT NOTES

1. THE AUTHORITY AGREES TO PERFORM THE PRIMARY WATER LINE CONSTRUCTION, SUCH AS TRENCH EXCAVATION, LAYING OF PIPE, AND FILLING THE TRENCH WITH SOIL, WHEN SCHOOL IS NOT IN SESSION.
2. EXCEPT FOR EMERGENCY SITUATIONS, NO OPEN EXCAVATION WILL OCCUR DURING THE DAY WHILE CHILDREN ARE IN ATTENDANCE.
3. ANY OPEN EXCAVATION WILL BE SECURED BY COVERING WITH STEEL PLATES OR SURROUNDED WITH TEMPORARY FENCING BY THE CONTRACTOR AT THE END OF EACH WORK DAY.
4. FINAL GRADING, VEGETATION RESTORATION AND UNDERGROUND TESTING WILL TAKE PLACE AFTER PRIMARY WATER LINE CONSTRUCTION HAS OCCURRED AND MAY TAKE PLACE DURING PERIODS WHEN SCHOOL IS IN SESSION, PROVIDED THERE IS NO INTERRUPTION TO ANY SCHOOL OPERATIONS.
5. WORK AREAS ALONG THE COMMON PROPERTY LINE WITH THE HARRIS COUNTY PARK WILL HAVE TEMPORARY CONSTRUCTION FENCING ALONG BOTH SIDES OF THE EASEMENT DURING CONSTRUCTION. A TEMPORARY CONSTRUCTION FENCE WILL ALSO BE PLACED AND MAINTAINED ALONG THE SCHOOL SIDE OF THE EASEMENT ALONG COPELAND DRIVE. TEMPORARY FENCING ALONG THE RIGHT OF WAY SIDE WILL BE INSTALLED BUT WILL BE REMOVED AND REPLACED DAILY AS NECESSARY TO ACCOMMODATE CONSTRUCTION.

10/23/18 Update

STANDARD HCFCD NOTES FOR CONSTRUCTION DRAWINGS

1. Obtain and comply with all applicable City, County, State, and Federal permits and approvals, with assistance from Engineer, if necessary. Obtain permit (certification) from Harris County Engineer to enter Harris County Flood Control District right-of-way.
2. Notify the Harris County Flood Control District's Development Coordination and Inspection Department in writing at least 48 hours prior to construction. Submit the HCFCD 48 Hour Pre-Construction Notification form, a copy of the approved construction drawings, and a copy of the Corps of Engineers Individual Section 404 Permit or compliance with Nationwide Permit, if applicable, to HCFCD, 9900 Northwest Freeway, Houston, Texas 77092, Attn: Development Coordination and Inspection Dept. by hand delivery, by email DCID@hcfcd.org, or fax to 713-684-4125 (fax number).
3. Engineer shall submit certification letter and record drawings to the Harris County Flood Control District's Development Coordination and Inspection Section requesting inspection of items constructed in Harris County Flood Control District right-of-way. Prior to requesting inspection, the drainage right-of-way and/or easements shall be staked and flagged.
4. Protect, maintain, and restore existing backslope drainage systems.
5. Backslope swale and interceptor structure elevations and locations shown on plans are approximate. Final elevations and locations shall be field verified by the Engineer prior to installation.
6. Establish turf grass on all disturbed areas within the channel or detention right-of-way, except the channel bottom and where structural erosion measures are used. Minimum acceptance criteria are 75% coverage of live Bermuda grass and no erosion or rills deeper than 4".
7. Perform all activities within Harris County Flood Control District right-of-way in accordance with the most recent Harris County Flood Control District Standard Specifications Book.
8. Excavate channel flowline to design elevation as shown on plans and downstream, as necessary, to ensure no water remains in the facility (storm sewer, lateral channel, or dry bottom detention basin) during normal water surface conditions in the channel, so the facility will function as intended. For wet bottom detention basins, ensure no water is above the design level in the wet bottom during normal water surface conditions in the channel.
9. Maintain flow in channel during construction and restore channel to original condition.
10. Remove all excavated material from the Harris County Flood Control District or drainage right-of-way. No fill is to be placed within a designated flood plain area without first obtaining a fill permit from the appropriate jurisdictional authority.

Harris County Flood Control District Policy, Criteria, and Procedure Manual D-3

TEXAS WATER DEVELOPMENT BOARD NOTES

PRIOR TO CONSTRUCTION WITHIN A 100-YEAR FLOODPLAIN, A FLOODPLAIN PERMIT ~~OR WAIVER~~ MUST BE OBTAINED FROM THE LOCAL FLOODPLAIN ADMINISTRATOR (NATIONAL FLOOD INSURANCE PROGRAM). (TWDB Project No. 38280)

AS PER AGREEMENT WITH THE TEXAS PARKS AND WILDLIFE DEPARTMENT AND TO ENSURE COMPLIANCE WITH THE MIGRATORY BIRD TREATY ACT, CLEARING WILL BE CONDUCTED OUTSIDE THE MIGRATORY BIRD NESTING SEASON WHERE POSSIBLE. IF CLEARING MUST BE PERFORMED DURING NESTING SEASON (MARCH 15TH – SEPTEMBER 15TH), NEST SURVEYS WILL BE CONDUCTED PRIOR TO CLEARING, AND A 25-FOOT BUFFER ZONE WILL BE ESTABLISHED AROUND ANY OBSERVED ACTIVE NESTS UNTIL THE YOUNG HAVE FLEDGED.

THE OWNER WILL COMPLY WITH THE TERMS AND CONDITIONS OF THE U.S. ARMY CORPS OF ENGINEERS' NATIONWIDE PERMIT 12, UTILITY LINE ACTIVITIES DURING CONSTRUCTION OF THE PROPOSED PIPELINES. THE PROJECT IS DESIGNED SUCH THAT CONSTRUCTION ACTIVITIES SHOULD NOT RESULT IN THE LOSS OF GREATER THAN 0.5 ACRE OF JURISDICTIONAL WATERS OF THE UNITED STATES, INCLUDING WETLANDS, FOR EACH SINGLE AND COMPLETE PROJECT. SIDE-CASTED EARTHEN MATERIAL GENERATED FROM TRENCH EXCAVATION IS NOT ANTICIPATED TO DISPERSE FROM THE PROJECT SITE. EXPOSED AREAS RESULTING FROM CONSTRUCTION ACTIVITIES WILL BE STABILIZED AS SOON AS PRACTICABLE, AND SURFACE CONTOURS WILL BE RETURNED TO PRE-CONSTRUCTION CONDITIONS AS NEAR AS POSSIBLE. SHOULD ONE OR MORE OF THE CRITERIA DESCRIBED IN THE 'NOTIFICATION' SECTION OF NATIONWIDE PERMIT 12 BE ANTICIPATED, THE OWNER WILL PREPARE AND SUBMIT A PRE-CONSTRUCTION NOTIFICATION TO THE U.S. ARMY CORPS OF ENGINEERS AND AWAIT PERMIT AUTHORIZATION PRIOR TO INITIATING PROJECT CONSTRUCTION ACTIVITIES.

THE OWNER HAS PREVIOUSLY COORDINATED WITH THE APPROPRIATE AGENCIES AND IMPACTS TO KNOWN CULTURAL OR ARCHEOLOGICAL DEPOSITS HAVE BEEN AVOIDED OR MITIGATED. HOWEVER, THE CONTRACTOR MAY ENCOUNTER UNANTICIPATED CULTURAL OR ARCHEOLOGICAL DEPOSITS DURING CONSTRUCTION. IF ARCHEOLOGICAL SITES OR HISTORIC STRUCTURES WHICH MAY QUALIFY FOR DESIGNATION AS A STATE ARCHEOLOGICAL LANDMARK ACCORDING TO THE CRITERIA IN 13 TAC CHAPTER 26, OR THAT MAY BE ELIGIBLE FOR LISTING ON THE NATIONAL REGISTER OF HISTORIC PLACES IN ACCORDANCE WITH 36 CFR PART 800, ARE DISCOVERED AFTER CONSTRUCTION OPERATIONS ARE BEGUN, THE CONTRACTOR SHALL IMMEDIATELY CEASE OPERATIONS IN THAT PARTICULAR AREA AND NOTIFY THE OWNER, THE TWDB, AND THE TEXAS HISTORICAL COMMISSION, 1511 N. COLORADO ST., P. O. BOX 12276, CAPITOL STATION, AUSTIN, TEXAS 78711-2276. THE CONTRACTOR SHALL TAKE REASONABLE STEPS TO PROTECT AND PRESERVE THE DISCOVERIES UNTIL THEY HAVE BEEN INSPECTED BY THE OWNER'S REPRESENTATIVE AND THE TWDB. THE OWNER WILL PROMPTLY COORDINATE WITH THE STATE HISTORIC PRESERVATION OFFICER AND ANY OTHER APPROPRIATE AGENCIES TO OBTAIN ANY NECESSARY APPROVALS OR PERMITS TO ENABLE THE WORK TO CONTINUE. THE CONTRACTOR SHALL NOT RESUME WORK IN THE AREA OF THE DISCOVERY UNTIL AUTHORIZED TO DO SO BY THE OWNER.

NO ACTIVITY IS AUTHORIZED THAT IS LIKELY TO JEOPARDIZE THE CONTINUED EXISTENCE OF A THREATENED OR ENDANGERED SPECIES AS LISTED OR PROPOSED FOR LISTING UNDER THE FEDERAL ENDANGERED SPECIES ACT (ESA), AND/OR THE STATE OF TEXAS PARKS AND WILDLIFE CODE ON ENDANGERED SPECIES, OR TO DESTROY OR ADVERSELY MODIFY THE HABITAT OF SUCH SPECIES. IF A THREATENED OR ENDANGERED SPECIES IS ENCOUNTERED DURING CONSTRUCTION, THE CONTRACTOR SHALL IMMEDIATELY CEASE WORK IN THE AREA OF THE ENCOUNTER AND NOTIFY THE OWNER, WHO WILL IMMEDIATELY IMPLEMENT ACTIONS IN ACCORDANCE WITH THE ESA AND APPLICABLE STATE STATUTES. THESE ACTIONS SHALL INCLUDE REPORTING THE ENCOUNTER TO THE TWDB, THE U.S. FISH AND WILDLIFE SERVICE, AND THE TEXAS PARKS AND WILDLIFE DEPARTMENT, OBTAINING ANY NECESSARY APPROVALS OR PERMITS TO ENABLE THE WORK TO CONTINUE, OR IMPLEMENT OTHER MITIGATION ACTIONS. THE CONTRACTOR SHALL NOT RESUME CONSTRUCTION IN THE AREA OF THE ENCOUNTER UNTIL AUTHORIZED TO DO SO BY THE OWNER.

CENTERPOINT ENERGY (GAS FACILITIES)

1. CONTRACTOR SHALL NOTIFY CENTERPOINT ENERGY GAS AT (281) 672-4816 AFTER UNCOVERING ANY GAS LINES NOT SHOWN ON THESE DRAWINGS. GAS LINES SHALL NOT BE DISTURBED BY THE CONTRACTOR UNTIL CENTERPOINT ENERGY GAS HAS VERIFIED THE STATUS OF THE LINE AND APPROPRIATE ACTION APPROVED.
2. LOCATION OF CENTERPOINT ENERGY MAIN LINES (TO INCLUDE CENTERPOINT ENERGY, INTRASTATE PIPELINE LLC WHERE APPLICABLE) ARE SHOWN IN AN APPROXIMATE LOCATION ONLY. SERVICE LINES ARE USUALLY NOT SHOWN. OUR SIGNATURE ON THESE PLANS ONLY INDICATES THAT OUR FACILITIES ARE SHOWN IN APPROXIMATE LOCATION. IT DOES NOT IMPLY THAT A CONFLICT ANALYSIS HAS BEEN MADE.
   THE CONTRACTOR SHALL CONTACT THE UTILITY COORDINATING COMMITTEE AT ~~713-223-4567~~ OR ~~1-800-669-8344~~ (1-800-545-6005) A MINIMUM OF 48 HOURS PRIOR TO CONSTRUCTION TO HAVE MAIN AND SERVICE LINES FIELD LOCATED.
   - WHEN CENTERPOINT ENERGY PIPE LINE MARKINGS ARE NOT VISIBLE, CALL ~~713-967-8037~~ (713-207-5463) (7:00 AM TO 4:30 PM) FOR STATUS OF LINE LOCATION REQUEST BEFORE EXCAVATION BEGINS.
   - WHEN EXCAVATING WITHIN EIGHTEEN INCHES (18") OF THE INDICATED LOCATION OF CENTERPOINT ENERGY FACILITIES, ALL EXCAVATION MUST BE ACCOMPLISHED USING NON-MECHANIZED EXCAVATION PROCEDURES.
   - WHEN CENTERPOINT ENERGY FACILITIES ARE EXPOSED, SUFFICIENT SUPPORT MUST BE PROVIDED TO THE FACILITIES TO PREVENT EXCESSIVE STRESS ON THE PIPING.
   - FOR EMERGENCIES REGARDING GAS LINES CALL (713) 659-3552 OR (713) 207-4200

   THE CONTRACTOR IS FULLY RESPONSIBLE FOR ANY DAMAGES CAUSED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE THESE UNDERGROUND FACILITIES.
3. CENTERPOINT ENERGY GAS ASSUMES NO RESPONSIBILITY FOR THE OWNERSHIP OR THE ACCURACY OF THE ABANDONED GAS LINES SHOWN ON THESE PLANS. THE CONTRACTOR SHALL NOTIFY CENTERPOINT ENERGY GAS AT (281) 672-4816 AFTER EXPOSING ANY ABANDONED OR ACTIVE GAS LINES. THE GAS LINES SHALL NOT BE DISTURBED BY THE CONTRACTOR UNTIL CENTERPOINT ENERGY GAS HAS VERIFIED THE STATUS OF THE LINE.

SBC FACILITIES

1. THE LOCATIONS OF SBC FACILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION BEFORE COMMENCING WORK. HE AGREES TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY HIS FAILURE TO EXACTLY LOCATE AND PRESERVE THESE UNDERGROUND UTILITIES.
2. THE CONTRACTOR SHALL CALL 1-800-344-8377 A MINIMUM OF 48 HOURS PRIOR TO CONSTRUCTION TO HAVE UNDERGROUND LINES FIELD LOCATED.
3. WHEN EXCAVATING WITHIN EIGHTEEN INCHES (18") OF THE INDICATED LOCATION OF SBC FACILITIES, ALL EXCAVATIONS MUST BE ACCOMPLISHED USING NON-MECHANIZED EXCAVATION PROCEDURES. WHEN BORING, THE CONTRACTOR SHALL EXPOSE THE SBC FACILITIES.
4. WHEN SBC FACILITIES ARE EXPOSED, THE CONTRACTOR WILL PROVIDE SUPPORT TO PREVENT DAMAGES TO THE CONDUIT DUCTS OR CABLES. WHEN EXCAVATING NEAR TELEPHONE POLES, THE CONTRACTOR SHALL BRACE THE POLE FOR SUPPORT.

UTILITY NOTES
CENTERPOINT ENERGY (ELECTRICAL FACILITIES)

1. OVERHEAD LINES MAY EXIST ALONG THE PROJECT ROUTE. WE HAVE NOT ATTEMPTED TO MARK THOSE LINES SINCE THEY ARE CLEARLY VISIBLE. CONTRACTOR SHALL LOCATE THEM PRIOR TO BEGINNING ANY CONSTRUCTION. TEXAS LAW, SECTION 752, HEALTH AND SAFETY CODE, FORBIDS ALL ACTIVITIES IN WHICH PERSONS OR THINGS MAY COME WITHIN SIX (6) FEET OF LIVE OVERHEAD HIGH VOLTAGE LINES. PARTIES RESPONSIBLE FOR THE WORK INCLUDING CONTRACTORS, ARE LEGALLY RESPONSIBLE FOR THE SAFETY OF CONSTRUCTION WORKERS UNDER THIS LAW. THIS LAW CARRIES BOTH CRIMINAL AND CIVIL LIABILITY. TO ARRANGE FOR LINES TO BE TURNED OFF OR REMOVED CALL "CENTER POINT" ENERGY AT 713-207-2222.
   (OPERATING CRANE, DERRICK, POWER SHOVEL, DRILLING RIG, PILE DRIVER, HOISTING EQUIPMENT, OR SIMILAR APPARATUS WITHIN 10 FEET OF LIVE OVERHEAD HIGH VOLTAGE LINES.)
2. CONTRACTOR SHALL COORDINATE WITH CENTERPOINT ENERGY ELECTRIC BEFORE WORKING WITHIN TEN (10) FEET OF OVERHEAD POWER LINES. CONTACT CENTERPOINT ENERGY ELECTRIC REPRESENTATIVES AT (713) 207-7777 OR (713) 923-3292 FOR POLES TO BE BRACED AND LINES TO BE DE-ENERGIZED AND/OR MOVED. CONTRACTOR SHALL BE RESPONSIBLE TO 'CENTER POINT' ENERGY ELECTRIC FOR ANY COSTS ASSOCIATED WITH BRACING OF POWER POLES OR DE-ENERGIZING AND/OR MOVING ANY CONFLICTING OVERHEAD POWER LINES.
3. TO STAKE CENTERPOINT ENERGY ELECTRIC UNDERGROUND FACILITIES, PLEASE CALL THE LONE STAR INFORMATION CENTER AT (713) 223-4567, OR TOLL FREE AT (800) 669-8344, AT LEAST 48 HOURS BEFORE STARTING EXCAVATION.
4. PRIVATE UNDERGROUND ELECTRICAL FACILITIES MAY EXIST IN THE AREA AND THESE WILL NOT BE STAKED BY CENTERPOINT ENERGY ELECTRIC PERSONNEL.

ACTIVITIES OVER/ACROSS CENTERPOINT ENERGY FEE OR EASEMENT PROPERTY: NO APPROVAL TO USE, CROSS OR OCCUPY CENTERPOINT FEE OR EASEMENT PROPERTY IS GIVEN. IF YOU NEED TO USE CENTERPOINT PROPERTY, PLEASE CONTACT OUR SURVEYING & RIGHT OF WAY DIVISION AT (713) 207-6348 or (713) 207-5769.

AT&T TEXAS/SWBT FACILITIES

1. THE LOCATIONS OF AT&T TEXAS/SWBT FACILITIES ARE SHOWN IN AN APPROXIMATE WAY ONLY. THE CONTRACTOR SHALL DETERMINE THE EXACT LOCATION BEFORE COMMENCING WORK. HE AGREES TO BE FULLY RESPONSIBLE FOR ANY AND ALL DAMAGES WHICH MIGHT BE OCCASIONED BY THIS FAILURE TO EXACTLY LOCATE AND PRESERVE THESE UNDERGROUND UTILITIES.
2. THE CONTRACTOR SHALL CALL 1-800-344-8377 (TEXAS 811) A MINIMUM OF 48 HOURS PRIOR TO CONSTRUCTION TO HAVE UNDERGROUND LINES FIELD LOCATED.
3. WHEN EXCAVATING WITHIN EIGHTEEN INCHES (18") OF THE INDICATED LOCATION OF AT&T TEXAS/SWBT FACILITIES, ALL EXCAVATIONS MUST BE ACCOMPLISHED USING NON-MECHANIZED EXCAVATION PROCEDURES. WHEN BORING, THE CONTRACTOR SHALL EXPOSE THE AT&T TEXAS/SWBT FACILITIES.
4. WHEN AT&T TEXAS/SWBT FACILITIES ARE EXPOSED, THE CONTRACTOR WILL PROVIDE SUPPORT TO PREVENT DAMAGE TO THE CONDUIT DUCTS OR CABLES. WHEN EXCAVATING NEAR TELEPHONE POLES THE CONTRACTOR SHALL BRACE THE POLE FOR SUPPORT.
5. THE PRESENCE OR ABSENCE OF AT&T TEXAS/SWBT UNDERGROUND CONDUIT FACILITIES OR BURIED CABLE FACILITIES SHOWN ON THESE PLANS DOES NOT MEAN THAT THERE ARE NO DIRECT BURIED CABLES OR OTHER CABLES IN CONDUIT IN THE AREA.
6. PLEASE CONTACT THE AT&T TEXAS DAMAGE PREVENTION MANAGER ROOSEVELT LEE JR. AT (713)567-4552 OR E-MAIL HIM AT RL7259@ATT.COM, IF CABLE LOCATE REQUEST(S) ARE NOT COMPLETED FOR OUR AT&T TEXAS/SWBT FACILITIES.

PRIVATE UTILITY LINES SHOWN

Date: 1-23-20
Date: 1-22-20
Date: 1-23-20
THIS SIGNATURE NOT TO BE USED FOR CONFLICT VERIFICATION/CONSTRUCTION. VALID FOR 12 MONTHS.

North Harris County REGIONAL WATER Authority

AECOM TECHNICAL SERVICES, INC
19219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094-1009
281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F-3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28-B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

CONSTRUCTION NOTES

STATE OF TEXAS — CARL D. McCONNELL — 97585 — LICENSED PROFESSIONAL ENGINEER

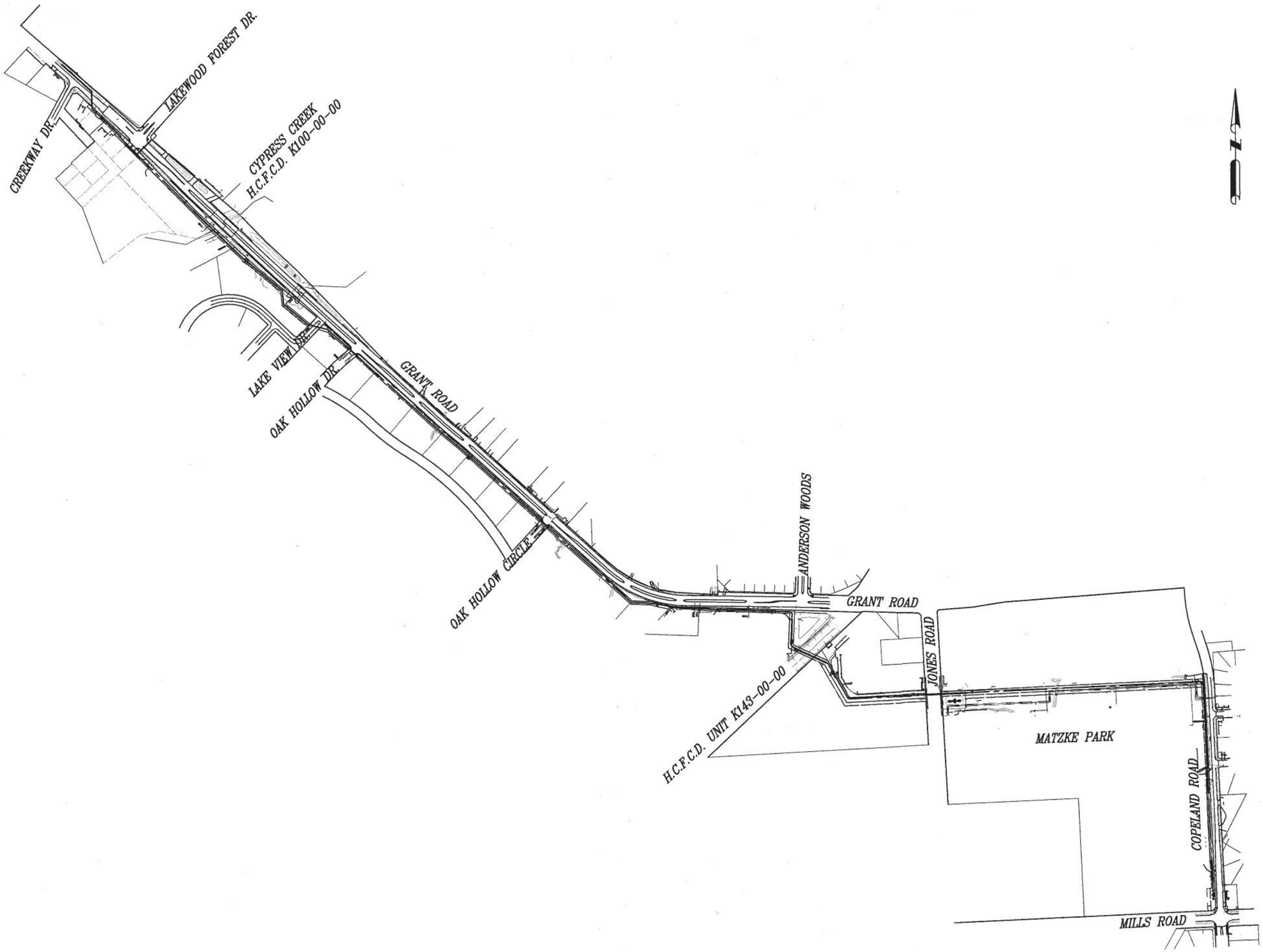
DRAWN BY: CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

SHEET No: 4 OF 99

LAST MODIFIED: Jan 22, 2020 – 8:20am BY USER: [illegible]
DWG LOCATION: [illegible]
DWG NAME: [illegible]

No.	Date	Revisions	App.



BENCHMARK:

FLOODPLAIN REFERENCE MARK NUMBER 110125 IS A HCFCD BRASS DISK STAMPED K100 BM10 ON EAST SIDEWALK OF GRANT ROAD BRIDGE OVER CYPRESS CREEK APPROXIMATLEY 0.90 MILE WEST OF JONES ROAD IN KEYMAP 369A IN THE CYPRESS WATERSHED NEAR STREAM K100-00-00
ELEV. 127.25 FEET NAVD 1988 2001 ADJUSTMENT

HORIZONTAL DATUM:

ALL HORIZONTAL COORDINATES ARE BASED ON TEXAS STATE PLANE COORDINATE SYSTEM, SOUTH CENTRAL ZONE, NAD83. THE COORDINATES & DISTANCES SHOWN ARE SURFACE AND MAY BE CONVERTED TO GRID BY MULTIPLYING BY A SCALE FACTOR OF 0.999870017 (TxDOT factor).
100 YR FL=125.00'

0 300' 600'
1"=300'

North Harris County REGIONAL WATER Authority

AECOM
AECOM TECHNICAL SERVICES, INC.
10219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77024-1009
281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F-3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28-B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

PROJECT OVERALL LAYOUT SHEET

STATE OF TEXAS
CARL D. McCONNELL
97585
LICENSED PROFESSIONAL ENGINEER
1/21/2020

DRAWN BY:	CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

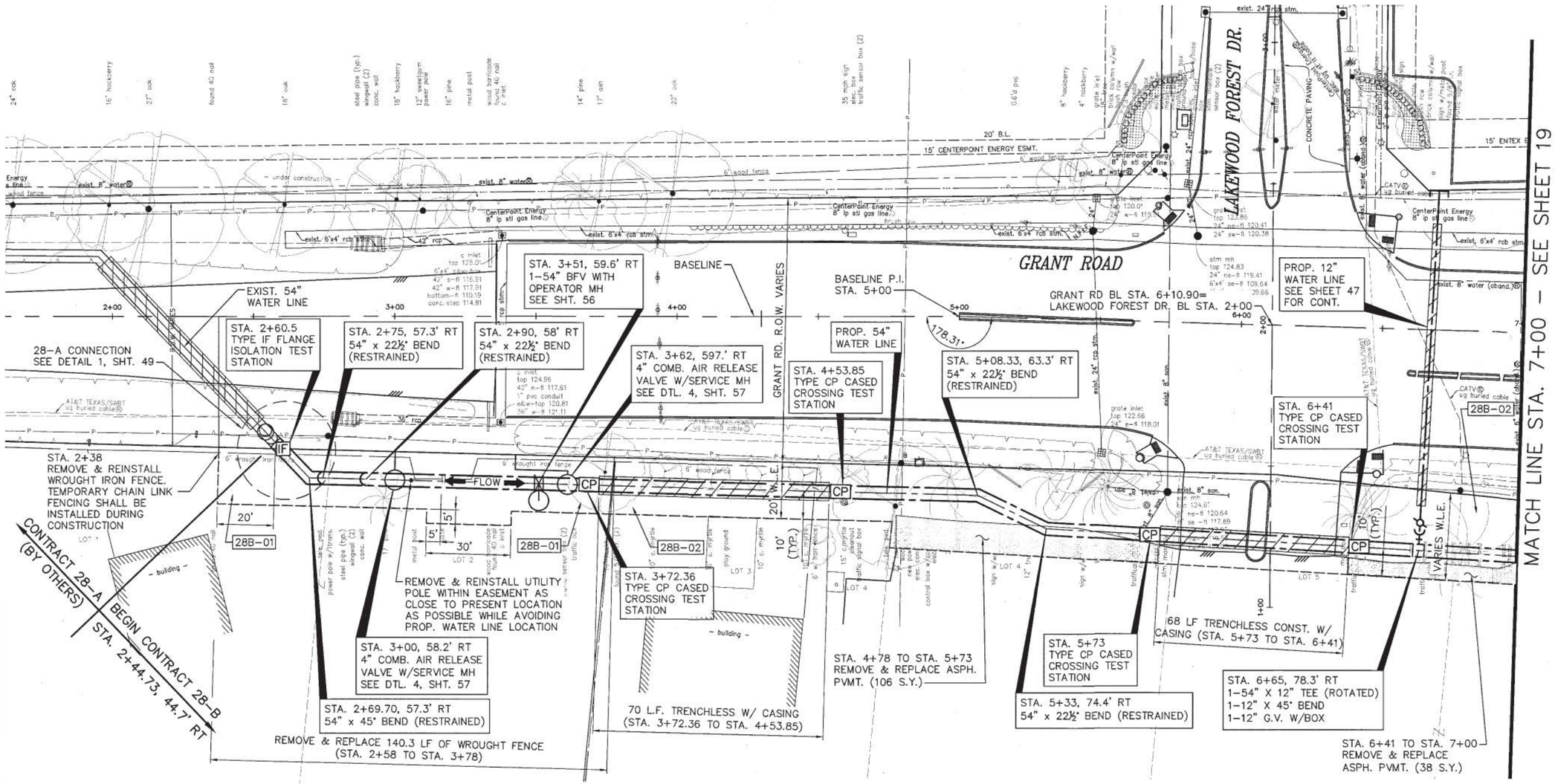
SHEET No: 5 OF 99

LAST MODIFIED: Jan 21, 2020 - 9:50am BY USER: yimvy
DWG. LOCATION: G:\1101\4876-01 NHCRWA PROJECT 28-B\ACAD\Drawings\General\
DWG. NAME: 4876-01_05.dwg

CAUTION:
EXISTING GAS PIPELINE LOCATIONS AND ELEVATIONS HAVE NOT BEEN VERIFIED. CONTRACTOR RESPONSIBLE FOR FIELD VERIFICATION OF UNDERGROUND PIPELINES.

THE LOCATION OF THE BURIED CABLES WITHIN THE PROJECT LIMITS HAVE NOT BEEN VERIFIED. BEFORE COMMENCING WORK CALL 1-800-344-8377 A MINIMUM OF 48 HOURS PRIOR TO CONSTRUCTION TO HAVE UNDERGROUND LINES FIELD-LOCATED.

CAUTION:
OVERHEAD POWER LINES



PROJECT 28-A PLANS WERE PREPARED USING NGDV 1929, 1973 ADJ. NGDV 1988, 2001 ADJ = NGDV 1929, 1973 ADJ - 2.45 FEET
(PROJECT 28-B) (PROJECT 28-A)

No.	Date	Revisions	App.

BENCHMARK:

FLOODPLAIN REFERENCE MARK NUMBER 110125 IS A HCFCD BRASS DISK STAMPED K100 BM10 ON EAST SIDEWALK OF GRANT ROAD BRIDGE OVER CYPRESS CREEK APPROXIMATLEY 0.90 MILE WEST OF JONES ROAD IN KEYMAP 369A IN THE CYPRESS WATERSHED NEAR STREAM K100-00-00
ELEV. 127.25 FEET NAVD 1988 2001 ADJUSTMENT

HORIZONTAL DATUM:

ALL HORIZONTAL COORDINATES ARE BASED ON TEXAS STATE PLANE COORDINATE SYSTEM, SOUTH CENTRAL ZONE, NAD83. THE COORDINATES & DISTANCES SHOWN ARE SURFACE AND MAY BE CONVERTED TO GRID BY MULTIPLYING BY A SCALE FACTOR OF 0.999870017 (TxDOT factor).
100 YR FL=125.00'

TO ARRANGE FOR LINES TO BE TURNED OFF OR MOVED CALL CENTERPOINT ENERGY AT 713-207-2222.

NOTICE:
FOR YOUR SAFETY, YOU ARE REQUIRED BY TEXAS LAW TO CALL 811 AT 48 HOURS BEFORE YOU DIG SO THAT UNDERGROUND LINES CAN BE MARKED. THIS VERIFICATION DOES NOT FULFILL YOUR OBLIGATION TO CALL 811.

PRIVATE UTILITY LINES SHOWN

Date: 1-23-20
CENTERPOINT ENERGY/UNDERGROUND ELECTRICAL FACILITIES VERIFICATION ONLY
(THE SIGNATURE VERIFIES EXISTING UNDERGROUND FACILITIES - NOT TO BE USED FOR CONFLICT VERIFICATION.) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-23-20
CENTERPOINT ENERGY/NATURAL GAS FACILITIES VERIFICATION ONLY.
(THIS SIGNATURE VERIFIES THAT YOU HAVE SHOWN CNP NATURAL GAS LINES CORRECTLY - NOT TO BE USED FOR CONFLICT VERIFICATION.)
(GAS SERVICE LINES ARE NOT SHOWN.) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-22-20
Approved for AT&T Texas/SWBT underground conduit facilities only. SIGNATURE VALID FOR ONE YEAR

North Harris County REGIONAL WATER Authority

AECOM
AECOM TECHNICAL SERVICES, INC.
19219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094-1009
281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F-3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28-B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

GRANT ROAD BASELINE PLAN STA. 2+00 TO 7+00

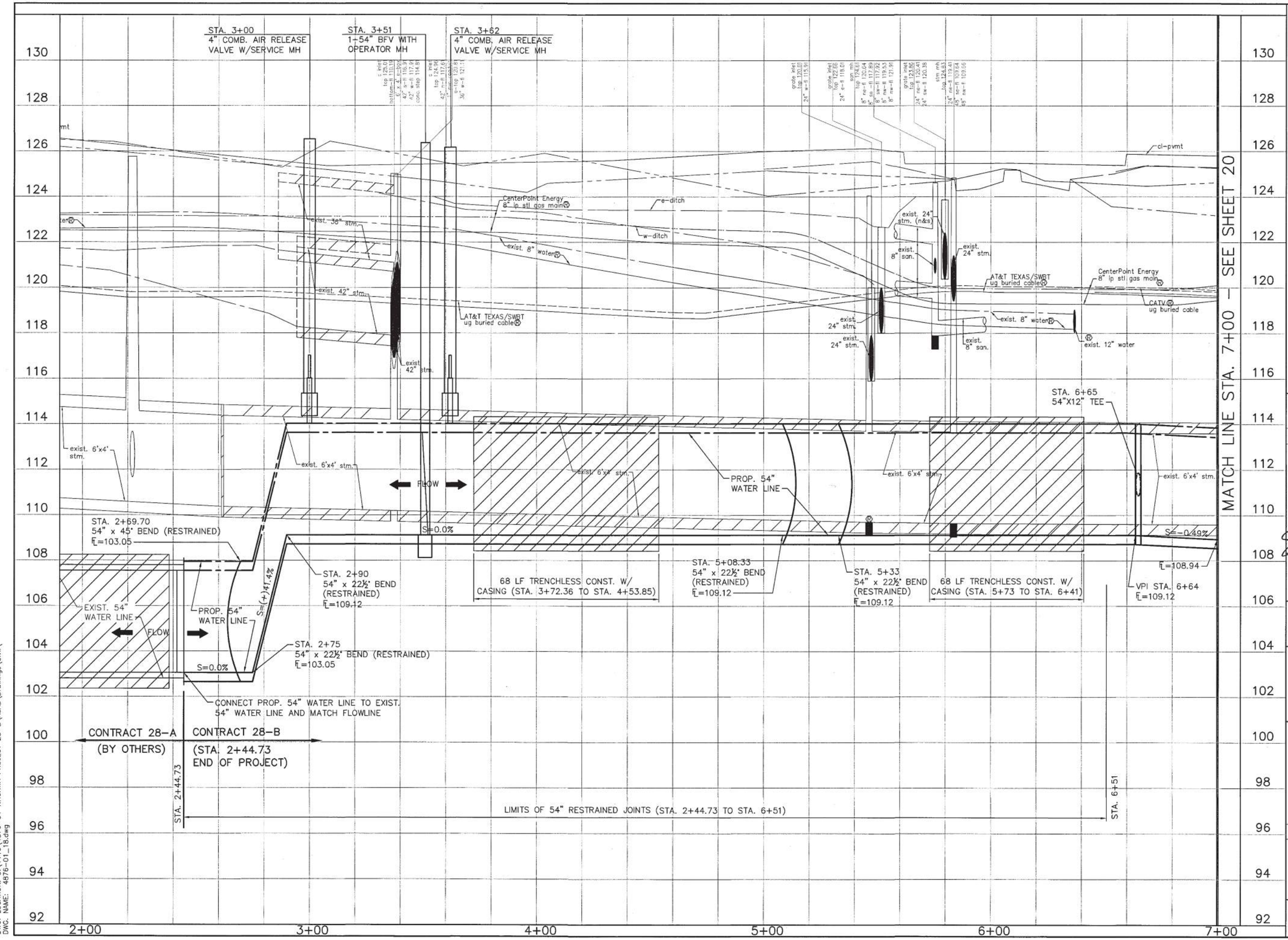
STATE OF TEXAS
CARL D. McCONNELL
97585
LICENSED PROFESSIONAL ENGINEER
11/24/2020

DRAWN BY:
CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

SHEET No: 17 OF 99

LAST MODIFIED: Jan 21, 2020 - 9:50am BY USER: yimvy
DWG. LOCATION: G:\1110\4876-01 NHCRWA PROJECT 28-B\ACAD\Drawings\Civil\
DWG. NAME: 4876-01_17.dwg



No.	Date	Revisions	App.

HORIZ 0 10' 20' 40' 1"=20'

VERT 0 1' 2' 4' 1"=2'

TO ARRANGE FOR LINES TO BE TURNED OFF OR MOVED CALL CENTERPOINT ENERGY AT 713-207-2222.

NOTICE:

FOR YOUR SAFETY, YOU ARE REQUIRED BY TEXAS LAW TO CALL 811 AT 48 HOURS BEFORE YOU DIG SO THAT UNDERGROUND LINES CAN BE MARKED. THIS VERIFICATION DOES NOT FULFILL YOUR OBLIGATION TO CALL 811.

PRIVATE UTILITY LINES SHOWN

Date: 1-23-20
CENTERPOINT ENERGY/UNDERGROUND ELECTRICAL FACILITIES VERIFICATION ONLY
(THE SIGNATURE VERIFIES EXISTING UNDERGROUND FACILITIES – NOT TO BE USED FOR CONFLICT VERIFICATION.) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-23-20
CENTERPOINT ENERGY/NATURAL GAS FACILITIES VERIFICATION ONLY.
(THIS SIGNATURE VERIFIES THAT YOU HAVE SHOWN CNP NATURAL GAS LINES COMPARISON – NOT TO BE USED FOR CONFLICT VERIFICATION.)
(GAS SERVICE LINES ARE NOT SHOWN.) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-22-20
APPROVED for AT&T Texas/SWBT underground conduit facilities only. SIGNATURE VALID FOR ONE YEAR

North Harris County REGIONAL WATER Authority

AECOM
AECOM TECHNICAL SERVICES, INC.
19219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094–1009
281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F–3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28–B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

GRANT ROAD BASELINE PROFILE
STA. 2+00 TO 7+00

STATE OF TEXAS
CARL D. McCONNELL
97585
LICENSED PROFESSIONAL ENGINEER
12/22/20

DRAWN BY:
CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

SHEET No: 18 OF 99

LAST MODIFIED: Jan 21, 2020 – 9:50am BY USER: yimvy
DWG. LOCATION: G:\1110\4876-01 NHCRWA PROJECT 28-B\ACAD\Drawings\Civil\
DWG. NAME: 4876-01_18.dwg

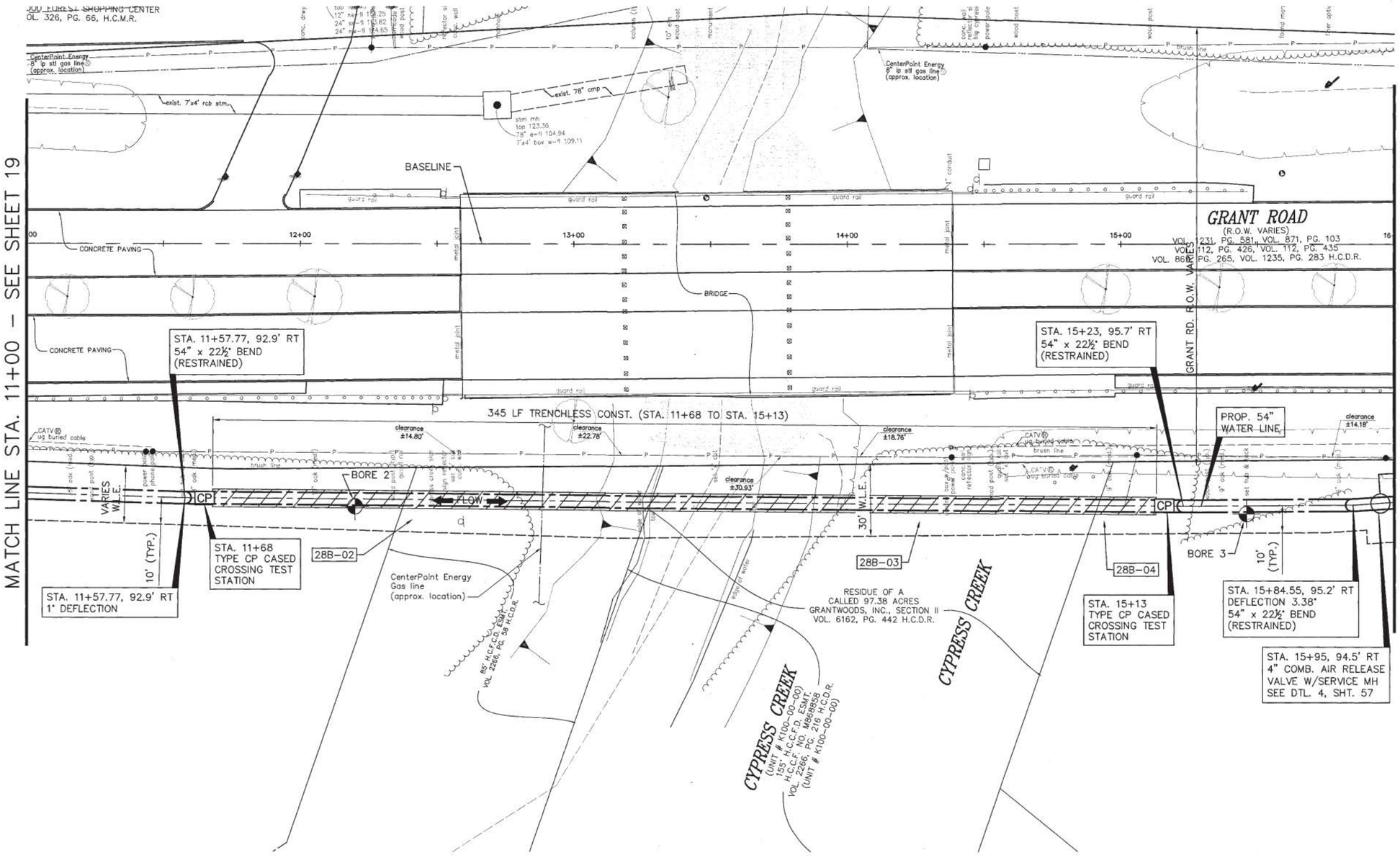
No.	Date	Revisions	App.

BENCHMARK:

FLOODPLAIN REFERENCE MARK NUMBER 110125 IS A HCFCD BRASS DISK STAMPED K100 BM10 ON EAST SIDEWALK OF GRANT ROAD BRIDGE OVER CYPRESS CREEK APPROXIMATLEY 0.90 MILE WEST OF JONES ROAD IN KEYMAP 369A IN THE CYPRESS WATERSHED NEAR STREAM K100-00-00
ELEV. 127.25 FEET NAVD 1988 2001 ADJUSTMENT

HORIZONTAL DATUM:

ALL HORIZONTAL COORDINATES ARE BASED ON TEXAS STATE PLANE COORDINATE SYSTEM, SOUTH CENTRAL ZONE, NAD83. THE COORDINATES & DISTANCES SHOWN ARE SURFACE AND MAY BE CONVERTED TO GRID BY MULTIPLYING BY A SCALE FACTOR OF 0.999870017 (TxDOT factor).
100 YR FL=125.00'



CAUTION:
EXISTING GAS PIPELINE LOCATIONS AND ELEVATIONS HAVE NOT BEEN VERIFIED. CONTRACTOR RESPONSIBLE FOR FIELD VERIFICATION OF UNDERGROUND PIPELINES.

THE LOCATION OF THE BURIED CABLES WITHIN THE PROJECT LIMITS HAVE NOT BEEN VERIFIED. BEFORE COMMENCING WORK CALL 1-800-344-8377 A MINIMUM OF 48 HOURS PRIOR TO CONSTRUCTION TO HAVE UNDERGROUND LINES FIELD-LOCATED.

CAUTION:
OVERHEAD POWER LINES.

0 10' 20' 40'
1"=20'

TO ARRANGE FOR LINES TO BE TURNED OFF OR MOVED CALL CENTERPOINT ENERGY AT 713-207-2222.

NOTICE:

FOR YOUR SAFETY, YOU ARE REQUIRED BY TEXAS LAW TO CALL 811 AT 48 HOURS BEFORE YOU DIG SO THAT UNDERGROUND LINES CAN BE MARKED. THIS VERIFICATION DOES NOT FULFILL YOUR OBLIGATION TO CALL 811.

PRIVATE UTILITY LINES SHOWN

Date: 1-23-20
CENTERPOINT ENERGY/UNDERGROUND ELECTRICAL FACILITIES VERIFICATION ONLY
(THE SIGNATURE VERIFIES EXISTING UNDERGROUND FACILITIES – NOT TO BE USED FOR CONFLICT VERIFICATION.) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-23-20
CENTERPOINT ENERGY/NATURAL GAS FACILITIES VERIFICATION ONLY.
(THIS SIGNATURE VERIFIES THAT YOU HAVE SHOWN CNP NATURAL GAS LINES COMPANY – NOT TO BE USED FOR CONFLICT VERIFICATION.)
(GAS SERVICE LINES ARE NOT SHOWN.) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-22-20
Approved for AT&T Texas/SWBT underground conduit facilities only. SIGNATURE VALID FOR ONE YEAR

North Harris County
REGIONAL WATER Authority

AECOM
AECOM TECHNICAL SERVICES, INC.
19219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094-1009
281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F-3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28-B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

GRANT ROAD BASELINE PLAN
STA. 11+00 TO 16+00

STATE OF TEXAS
CARL D. McCONNELL
97585
LICENSED
PROFESSIONAL ENGINEER
Carl McConnell 1/27/2020

DRAWN BY:	CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

SHEET No: 21 OF 99

LAST MODIFIED: Jan 21, 2020 – 9:51am BY USER: yimvy
DWG. LOCATION: G:\1110\4876-01 NHCRWA PROJECT 28-B\ACAD\Drawings\Civil\
DWG. NAME: 4876-01_21.dwg

HCFCD ULTIMATE ROW LIMITS

e-pvmt

w-curb

e-curb

e-row

CenterPoint Energy Gas line (Approx. location)

CenterPoint Energy 8" ip stl gas main

CYPRESS CREEK

w-curb

STA. 15+95
4" COMB. AIR RELEASE VALVE W/SERVICE MH

126 124 122 120 119 114 112 110 108 106 104 102 100 98 96 95 88 86 84 82 80 78

MATCH LINE STA. 11+00 – SEE SHEET 20

exist. 7'x4' stm.

exist. 78" stm.

℄=104.93

S=(-)41.4%

PROP. 54" WATER LINE

FUTURE ULTIMATE CHANNEL (WEST R.O.W.)

STA. 15+84.55
54" x 22½° BEND
(RESTRAINED)
℄=107.00

℄=107.00

S=0.0%

S=(+)41.4%

PROP. 54" WATER LINE

MATCH LINE STA. 16+00 – SEE SHEET 24

10' MIN. COVER

STA. 11+57.77
54" x 22½° BEND
(RESTRAINED)
℄=81.00

FLOW

S=0.0%

STA. 15+23
54" x 22½° BEND
(RESTRAINED)
℄=81.00

345 LF TRENCHLESS CONST. (STA. 11+68 TO STA. 15+13)

LIMITS OF 54" RESTRAINED JOINTS . (STA. 11+00 TO STA. 16+00)

11+00 12+00 13+00 14+00 15+00 16+00

LAST MODIFIED: Jan 21, 2020 – 9:51am BY USER: jvmy
DWG. LOCATION: G:\1110\4876-01 NHCRWA PROJECT 28-B\CAD\Drawings\Civil\
DWG. NAME: 4876-01_22.dwg

No.	Date	Revisions	App.

HORIZ 0 10' 20' 40' 1"=20'

VERT 0 1' 2' 4' 1"=2'

TO ARRANGE FOR LINES TO BE TURNED OFF OR MOVED CALL CENTERPOINT ENERGY AT 713-207-2222.

NOTICE:

FOR YOUR SAFETY, YOU ARE REQUIRED BY TEXAS LAW TO CALL 811 AT 48 HOURS BEFORE YOU DIG SO THAT UNDERGROUND LINES CAN BE MARKED. THIS VERIFICATION DOES NOT FULFILL YOUR OBLIGATION TO CALL 811.

PRIVATE UTILITY LINES SHOWN

Date: 1-23-20
CENTERPOINT ENERGY/UNDERGROUND ELECTRICAL FACILITIES VERIFICATION ONLY

(THIS SIGNATURE VERIFIES EXISTING UNDERGROUND FACILITIES – NOT TO BE USED FOR CONFLICT VERIFICATION.) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-23-20
CENTERPOINT ENERGY/NATURAL GAS FACILITIES VERIFICATION ONLY. (THIS SIGNATURE VERIFIES THAT YOU HAVE SHOWN CNP NATURAL GAS LINES CURRENTLY – NOT TO BE USED FOR CONFLICT VERIFICATION.) (GAS SERVICE LINES ARE NOT SHOWN.) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-23-20
Approved for AT&T Texas/SWBT underground conduit facilities only. SIGNATURE VALID FOR ONE YEAR

North Harris County REGIONAL WATER Authority

AECOM TECHNICAL SERVICES, INC.
19219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094–1009
281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F-3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28-B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

GRANT ROAD BASELINE PROFILE
STA. 11+00 TO 16+00

STATE OF TEXAS
CARL D. McCONNELL
97585
LICENSED PROFESSIONAL ENGINEER
1/24/2020

DRAWN BY: CHECKED BY:

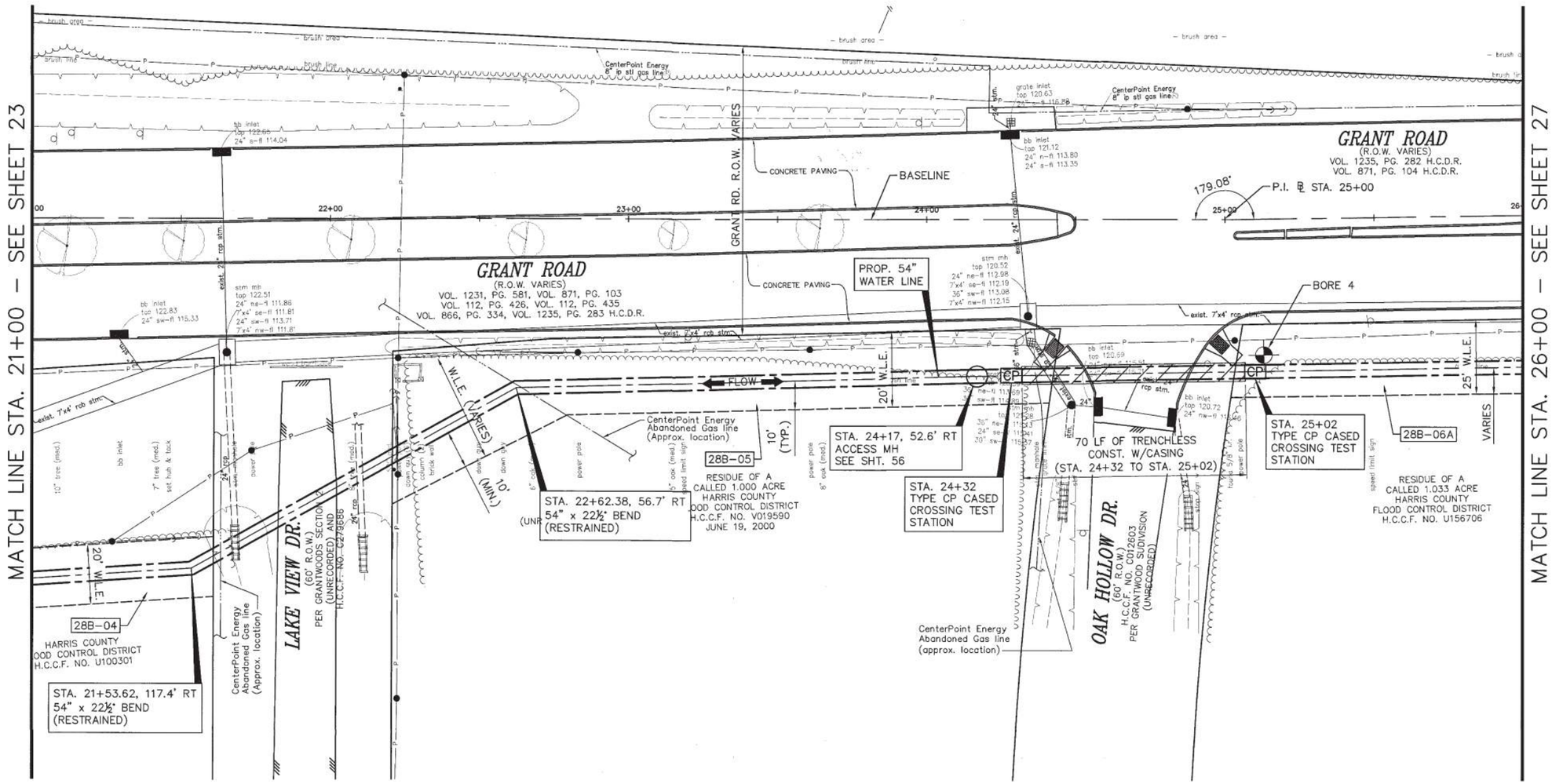
DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

SHEET No: 22 OF 99

CAUTION:
EXISTING GAS PIPELINE LOCATIONS AND ELEVATIONS HAVE NOT BEEN VERIFIED. CONTRACTOR RESPONSIBLE FOR FIELD VERIFICATION OF UNDERGROUND PIPELINES.

THE LOCATION OF THE BURIED CABLES WITHIN THE PROJECT LIMITS HAVE NOT BEEN VERIFIED. BEFORE COMMENCING WORK CALL 1-800-344-8377 A MINIMUM OF 48 HOURS PRIOR TO CONSTRUCTION TO HAVE UNDERGROUND LINES FIELD-LOCATED.

CAUTION:
OVERHEAD POWER LINES.



No.	Date	Revisions	App.

BENCHMARK:

FLOODPLAIN REFERENCE MARK NUMBER 110125 IS A HCFCD BRASS DISK STAMPED K100 BM10 ON EAST SIDEWALK OF GRANT ROAD BRIDGE OVER CYPRESS CREEK APPROXIMATLEY 0.90 MILE WEST OF JONES ROAD IN KEYMAP 369A IN THE CYPRESS WATERSHED NEAR STREAM K100-00-00
ELEV. 127.25 FEET NAVD 1988 2001 ADJUSTMENT

HORIZONTAL DATUM:

ALL HORIZONTAL COORDINATES ARE BASED ON TEXAS STATE PLANE COORDINATE SYSTEM, SOUTH CENTRAL ZONE, NAD83. THE COORDINATES & DISTANCES SHOWN ARE SURFACE AND MAY BE CONVERTED TO GRID BY MULTIPLYING BY A SCALE FACTOR OF 0.999870017 (TxDOT factor).
100 YR FL=125.00'

0 10' 20' 40'
1"=20'

TO ARRANGE FOR LINES TO BE TURNED OFF OR MOVED CALL CENTERPOINT ENERGY AT 713-207-2222.

NOTICE

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PRIVATE UTILITY LINES SHOWN

Date: 1-23-20
CENTERPOINT ENERGY/UNDERGROUND ELECTRICAL FACILITIES VERIFICATION ONLY

(THE SIGNATURE VERIFIES EXISTING UNDERGROUND FACILITIES – NOT TO BE USED FOR CONFLICT VERIFICATION.) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-23-20
CENTERPOINT ENERGY/NATURAL GAS FACILITIES VERIFICATION ONLY.
(THIS SIGNATURE VERIFIES THAT YOU HAVE SHOWN CNP NATURAL GAS LINES CORRECTLY – NOT TO BE USED FOR CONFLICT VERIFICATION.)
(GAS SERVICE LINES ARE NOT SHOWN.) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-22-20
Approved for AT&T Texas/SWBT underground conduit facilities only. SIGNATURE VALID FOR ONE YEAR

North Harris County REGIONAL WATER Authority

AECOM TECHNICAL SERVICES, INC.
19219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094-1009
281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F-3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28-B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

GRANT ROAD BASELINE PLAN
STA. 21+00 TO 26+00

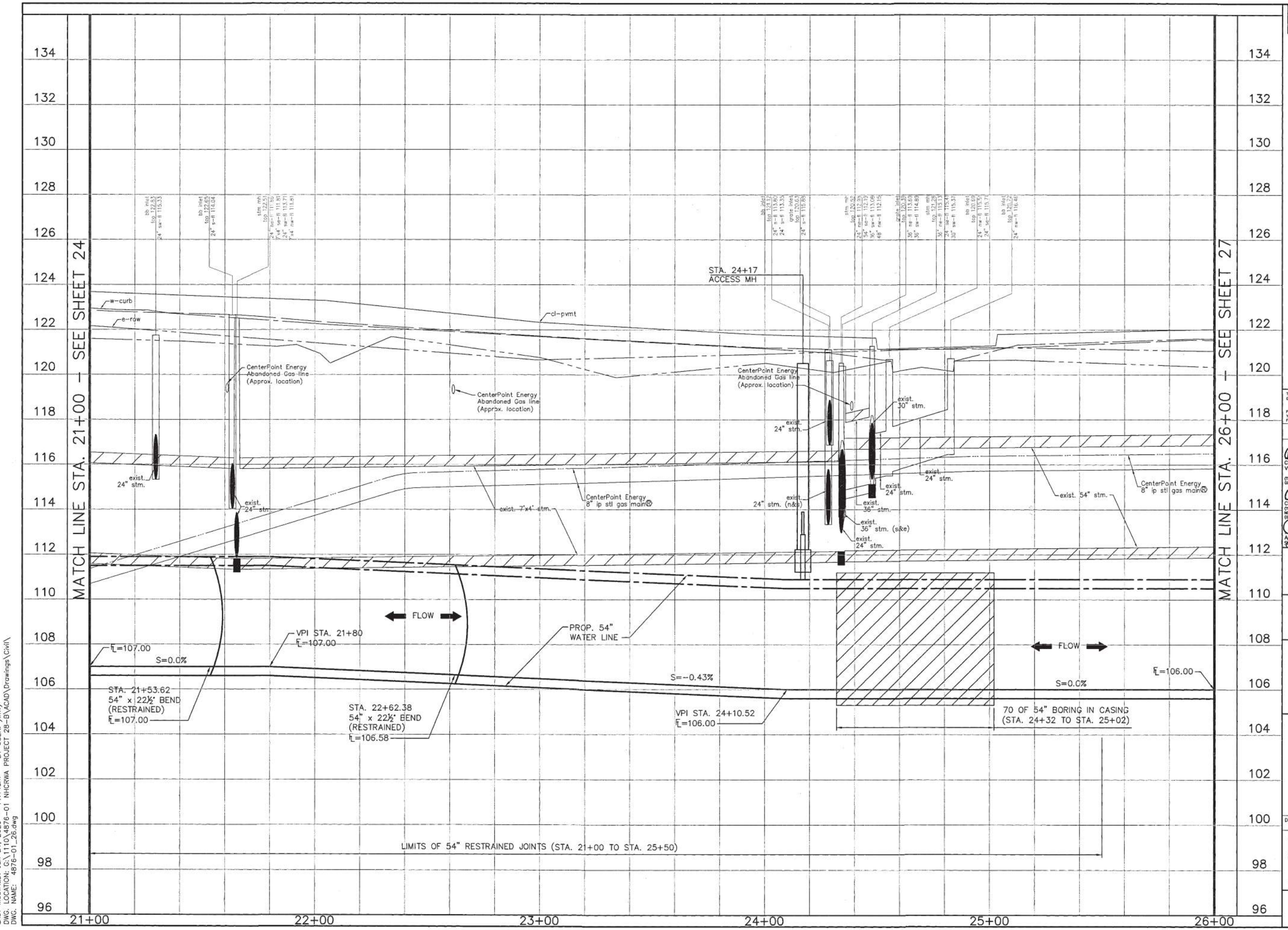
STATE OF TEXAS
CARL D. McCONNELL
97585
LICENSED PROFESSIONAL ENGINEER
1/22/2020

DRAWN BY:	CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

SHEET No: 25 OF 99

LAST MODIFIED: Jan 21, 2020 – 11:14am BY USER: ymvy
DWG. LOCATION: G:\1110\4876-01 NHCRWA PROJECT 28-B\ACAD\Drawings\Civil\
DWG. NAME: 4876-01_25.dwg



No.	Date	Revisions	App.

HORIZ 0 10' 20' 40' 1"=20'

VERT 0 1' 2' 4' 1"=2'

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PRIVATE UTILITY LINES SHOWN

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CENTERPOINT ENERGY/UNDERGROUND ELECTRICAL FACILITIES VERIFICATION ONLY
(THE SIGNATURE VERIFIES EXISTING UNDERGROUND FACILITIES – NOT TO BE USED FOR CONFLICT VERIFICATION.) SIGNATURE VALID FOR SIX MONTHS.

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Date: 1-22-20
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North Harris County REGIONAL WATER Authority

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NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28-B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

GRANT ROAD BASELINE PROFILE
STA. 21+00 TO 26+00

STATE OF TEXAS
CARL D. McCONNELL
97585
LICENSED
PROFESSIONAL ENGINEER
Carl D. McConnell 1/27/2020

DRAWN BY: | CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

SHEET No: 26 OF 99

LAST MODIFIED: Jan 21, 2020 – 11:14am BY USER: yimvy
DWG. LOCATION: G:\1110\4876-01 NHCRWA PROJECT 28-B\CADD\Drawings\Civil\
DWG. NAME: 4876-01_26.dwg

MATCH LINE STA. 26+00 – SEE SHEET 25

MATCH LINE STA. 31+00 – SEE SHEET 28

STA. 26+70
TYPE CP CASED
CROSSING TEST
STATION

20 LF TRENCHLESSCONST. W/CASING
(STA. 26+70 TO STA. 26+90)

ANODE
GROUNDBED

NEGATIVE
CABLE

STA. 26+25
ICCP RECTIFIER CABINET
W/ANODE GROUNDBED
& NEGATIVE CABLE
SEE SHT. 61 & 66

GRANTWOODS
(UNRECORDED SUBDIVISION)

STA. 26+90
TYPE CP CASED
CROSSING TEST
STATION

BASELINE

PROP. 54"
WATER LINE

GRANT RD. R.O.W. VARIES

0.044 ACRE R.O.W. DEDICATION
H.C.C.F. NO. X871586

CALLED 0.191 ACRE
CONT. FOR ROW
H.C.C.F. NO. Y103180

HARRIS COUNTY FLOOD
CONTROL DISTRICT
H.C.C.F. NO. X977072
AUG. 3, 2004

RESIDUE OF A
CALLED 1.242 ACRES
HARRIS COUNTY FLOOD
CONTROL DISTRICT
H.C.C.F. NO. U126950
OCT. 6, 1999

28B–06A

28B–06A

W.L.E. (VARIES)

VARIES

10' (TYP.)

20' W.L.E.

FLOW

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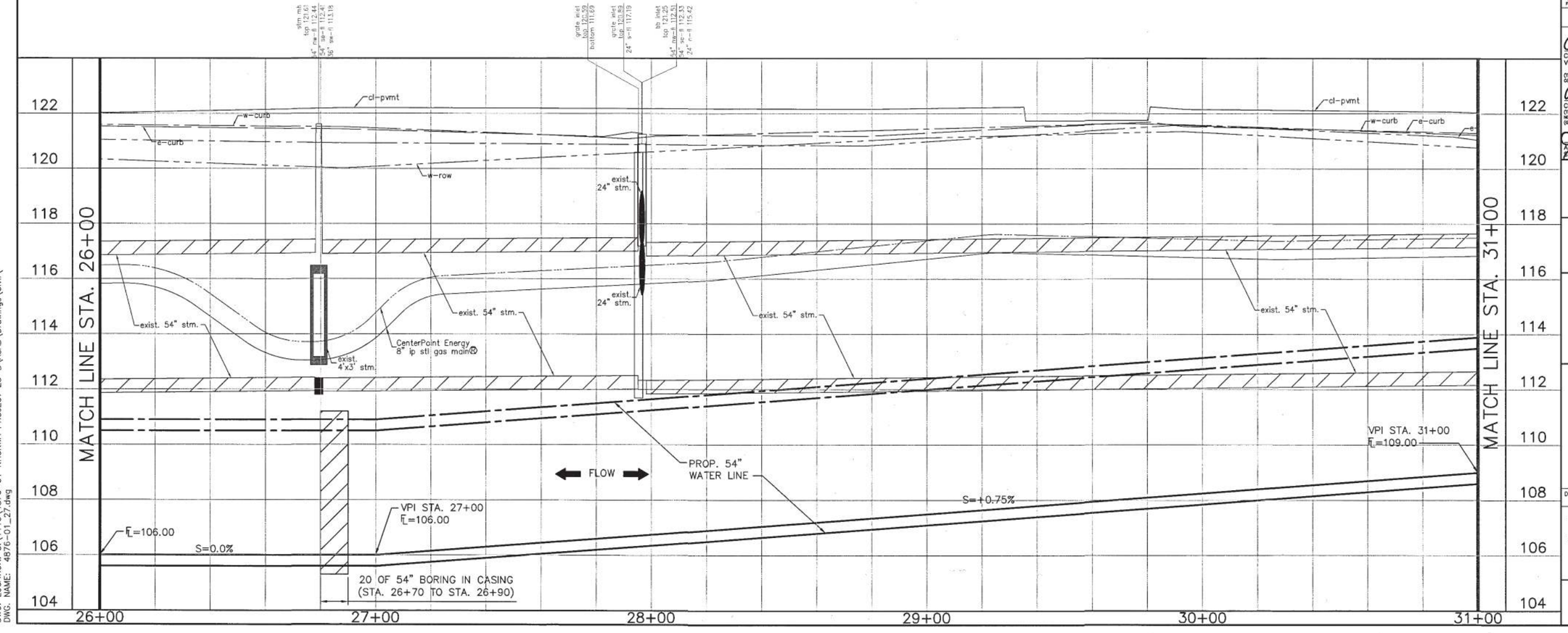
CAUTION:
OVERHEAD POWER LINES.



No.	Date	Revisions	App.

BENCHMARK:

FLOODPLAIN REFERENCE MARK NUMBER 110125 IS A HCFCD BRASS DISK STAMPED K100 BM10 ON EAST SIDEWALK OF GRANT ROAD BRIDGE OVER CYPRESS CREEK APPROXIMATLEY 0.90 MILE WEST OF JONES ROAD IN KEYMAP 369A IN THE CYPRESS WATERSHED NEAR STREAM K100–00–00
ELEV. 127.25 FEET NAVD 1988 2001 ADJUSTMENT

HORIZONTAL DATUM:

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100 YR FL=125.00'

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VERT 0 1' 2' 4' 1"=2'

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PRIVATE UTILITY LINES SHOWN

Date: 1-23-20
CENTERPOINT ENERGY/UNDERGROUND ELECTRICAL FACILITIES VERIFICATION ONLY

(THE SIGNATURE VERIFIES EXISTING UNDERGROUND FACILITIES – NOT TO BE USED FOR CONFLICT VERIFICATION.) SIGNATURE VALID FOR SIX MONTHS.

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Date: 1-22-20
Approved for AT&T Texas/SWBT underground conduit facilities only. SIGNATURE VALID FOR ONE YEAR

North Harris County
REGIONAL WATER
Authority

AECOM TECHNICAL SERVICES, INC.
19219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094–1009
281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F–3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28–B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

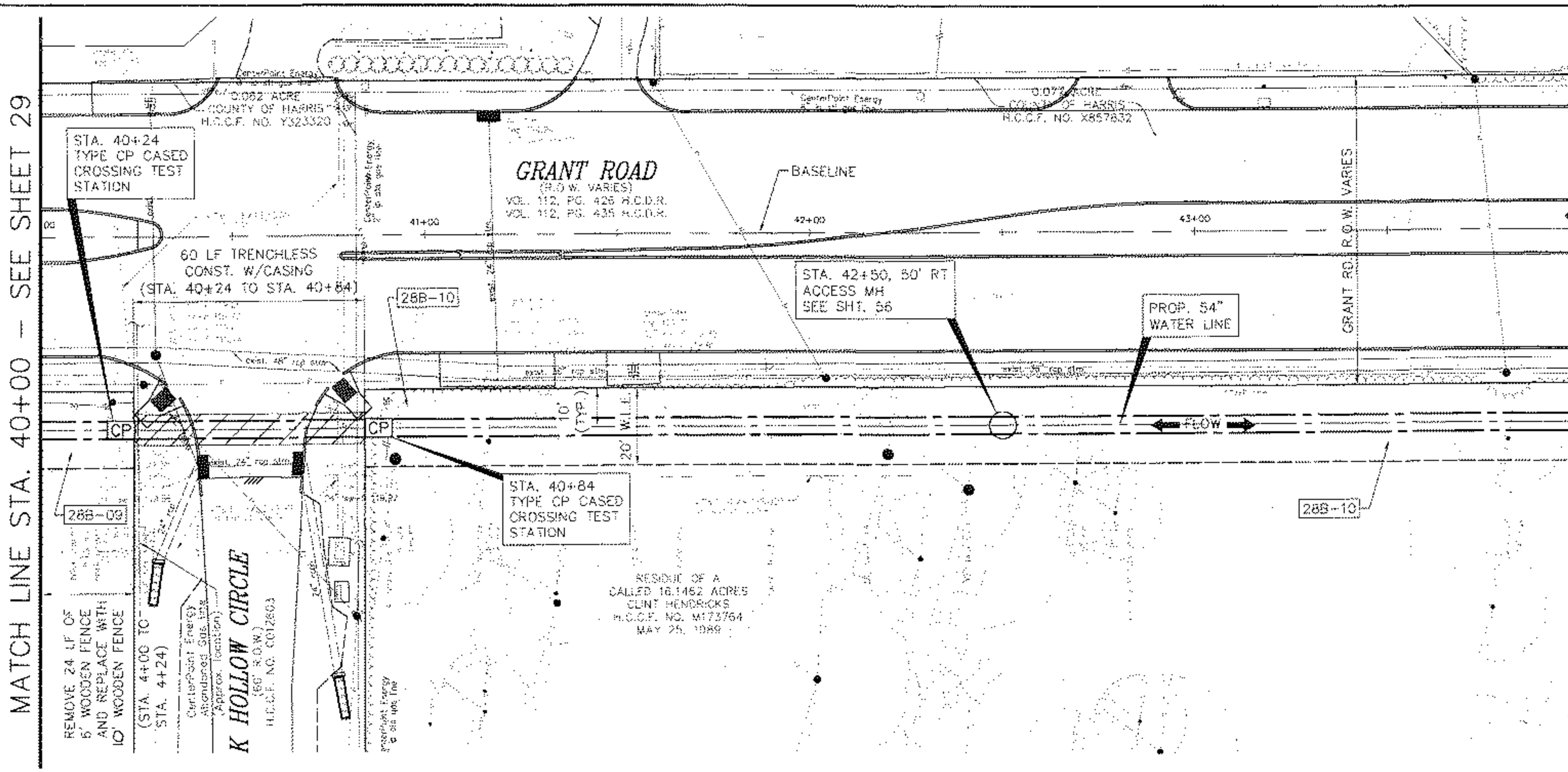
GRANT ROAD BASELINE PLAN AND PROFILE STA. 26+00 TO 31+00

STATE OF TEXAS
CARL D. McCONNELL
97585
LICENSED
PROFESSIONAL ENGINEER
11/22/2020

DRAWN BY: | CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

LAST MODIFIED: Jan 21, 2020 – 11:15am BY USER: yimvy
DWG. LOCATION: G:\1110\4876–01 NHCRWA PROJECT 28–B\ACAD\Drawings\Civil\
DWG. NAME: 4876–01_27.dwg


MATCH LINE STA. 40+00 — SEE SHEET 29
MATCH LINE STA. 44+00 — SEE SHEET 31
GRANT ROAD
(R.O.W. VARIES)
VOL. 112, PG. 426 H.C.D.R.
VOL. 112, PG. 435 H.C.D.R.
BASELINE
0.062 ACRE
COUNTY OF HARRIS
H.C.C.F. NO. Y323320
0.077 ACRE
COUNTY OF HARRIS
H.C.C.F. NO. X857632
STA. 40+24
TYPE CP CASED
CROSSING TEST
STATION
60 LF TRENCHLESS
CONST. W/CASING
(STA. 40+24 TO STA. 40+84)
288-10
288-09
STA. 42+50, 50' RT
ACCESS MH
SEE SHT. 56
PROP. 54"
WATER LINE
GRANT RD. R.O.W. VARIES
FLOW
STA. 40+84
TYPE CP CASED
CROSSING TEST
STATION
RESIDUE OF A
CALLED 16.1462 ACRES
CLINT HENDRICKS
H.C.C.F. NO. M173764
MAY 25, 1989
REMOVE 24 LF OF
5' WOODEN FENCE
AND REPLACE WITH
10' WOODEN FENCE
(STA. 4+00 TO
STA. 4+24)
CenterPoint Energy
Abandoned Gas line
(Approx. location)
K HOLLOW CIRCLE
(60' R.O.W.)
H.C.C.F. NO. C012603
10' (TYP.)
20'
W.L.E.
CP

CAUTION:
OVERHEAD POWER LINES.

CAUTION:
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RIGHT OF WAY AND EASEMENT AGREEMENT PARCEL 28B-09

1. THE PORTIONS OF THE FENCE RUNNING ALONG THE WESTERLY BOUNDARY OF PARCEL 28B-09, ADJACENT TO OAK HOLLOW DR, AND THE PORTIONS OF THE FENCE RUNNING ALONG THE WESTERLY BOUNDARY OF PARCEL 28B-09 ADJACENT TO THE PARK THAT ARE REMOVED BY THE AUTHORITY FOR CONSTRUCTION OF THE WATER PIPELINE SHALL BE REPLACED WITH A WOODEN FENCES THE SAME HEIGHT AND SIMILAR IN KIND TO THE EXISTING FENCES.

No.	Date	Revisions	App.

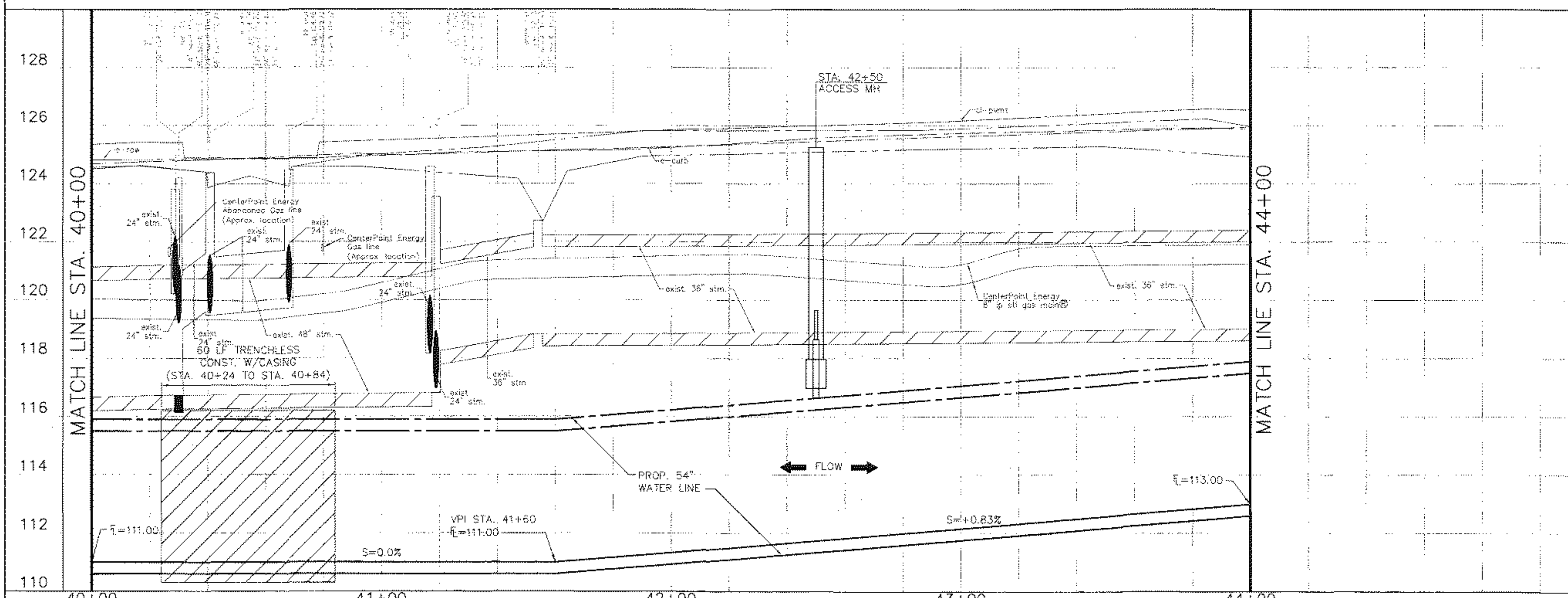
BENCHMARK:

FLOODPLAIN REFERENCE MARK NUMBER 110125 IS A HCFCD BRASS DISK STAMPED K100 BM10 ON EAST SIDEWALK OF GRANT ROAD BRIDGE OVER CYPRESS CREEK APPROXIMATLEY 0.90 MILE WEST OF JONES ROAD IN KEYMAP 369A IN THE CYPRESS WATERSHED NEAR STREAM K100-00-00
ELEV. 121.25 FEET NAVD 1988 2001 ADJUSTMENT

HORIZONTAL DATUM:

ALL HORIZONTAL COORDINATES ARE BASED ON TEXAS STATE PLANE COORDINATE SYSTEM, SOUTH CENTRAL ZONE, NAD83. THE COORDINATES & DISTANCES SHOWN ARE SURFACE AND MAY BE CONVERTED TO GRID BY MULTIPLYING BY A SCALE FACTOR OF 0.999870017 (TxDOT factor).
100 YR FL=125.00'

HORIZ 0 10' 20' 40' 1"=20'
VERT 0 1' 2' 4' 1"=2'


MATCH LINE STA. 40+00
MATCH LINE STA. 44+00
STA. 42+50
ACCESS MH
CenterPoint Energy
Abandoned Gas line
(Approx. location)
CenterPoint Energy
Gas line
(Approx. location)
exist. 24" stm.
exist. 36" stm.
exist. 48" stm.
CenterPoint Energy
8" ф stl gas main
60 LF TRENCHLESS
CONST. W/CASING
(STA. 40+24 TO STA. 40+84)
PROP. 54"
WATER LINE
FLOW
VPI STA. 41+60
FL=111.00
FL=111.00
FL=113.00
S=0.0%
S=+0.83%
128
126
124
122
120
118
116
114
112
110
40+00
41+00
42+00
43+00
44+00

PRIVATE UTILITY LINES SHOWN

Date: 1-23-20
CENTERPOINT ENERGY/UNDERGROUND ELECTRICAL FACILITIES VERIFICATION ONLY
(THE SIGNATURE VERIFIES EXISTING UNDERGROUND FACILITIES - NOT TO BE USED FOR CONFLICT VERIFICATION) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-23-20
CENTERPOINT ENERGY/NATURAL GAS FACILITIES VERIFICATION ONLY.

Date: 1-22-20
Approved for AT&T Texas/SWBT underground conduit facilities only
SIGNATURE VALID FOR ONE YEAR

North Harris County REGIONAL WATER Authority

AECOM
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19219 KATY FREEWAY, SUITE 100
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281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F-3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28-B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

GRANT ROAD BASELINE PLAN AND PROFILE STA. 40+00 TO 44+00

STATE OF TEXAS
CARL D. McDONALD
97585
LICENSED
PROFESSIONAL ENGINEER

DRAWN BY:
CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

SHEET No. 30 OF 99

CAUTION:
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MATCH LINE STA. 48+00
SEE SHEET 31

MATCH LINE STA. 53+00
SEE SHEET 33

0.013 ACRE
COUNTY OF HARRIS
H.C.C.F. NO. Y052567

GRANT ROAD
(R.O.W. VARIES)
VOL. 5617, PG. 527 H.C.D.R.
VOL. 112, PG. 427 H.C.D.R.

BASELINE

GRANT ROAD
(R.O.W. VARIES)
VOL. 112, PG. 427 H.C.D.R.

CALLED 0.0024 ACRES
COY L. BASKIN, SR.
H.C.C.F. NO. RP-2016-316941
JULY 20, 2016

CenterPoint Energy
8" ip stl gas line

PT STA.
49+09.18, 49.8' RT

℄ R=1000'

28B-10

NEGATIVE CABLE

STA. 49+76
TYPE CP CASED
CROSSING TEST
STATION

240 LF TRENCHLESS CONSTRUCTION W/CASING (STA. 49+71 TO STA. 52+05)

0.043 ACRE
COUNTY OF HARRIS
H.C.C.F. NO. 20193379

0.093 ACRE R.O.W. DEDICATION
H.C.C.F. NO. X932190

28B-12

STA. 52+05
TYPE CP CASED
CROSSING TEST
STATION

STA. 52+63
TYPE CP CASED
CROSSING TEST
STATION

20' W.L.E.

6'

10' (TYP.)

ANODE GROUNDBED

BORE 6

PC STA. 48+08.14, 70.4' RT

STA. 49+00
ICCP RECTIFIER CABINET
W/ANODE GROUNDBED
& NEGATIVE CABLE

RESIDUE OF A
CALLED 16.1462 ACRES
CLINT HENDRICKS
H.C.C.F. NO. M173764
MAY 25, 1989

STA. 49+40, 48.4' RT
ACCESS MH
(SEE SHT. 57)

STA. 49+66.22, 54' RT
54" x 22½° BEND (RESTRAINED)

STA. 49+49.03, 49.7' RT
54" x 22½° BEND (RESTRAINED)

PROP. 54"
WATER LINE

28B-11

FLOW

RESIDUE OF A
CALLED 1.0929 ACRES
MICHAEL P. CZICHOS, SR. &
SANDRA K. CZICHOS
H.C.C.F. NO. 20150105656
MARCH 2, 2015

CenterPoint Energy
Abandoned Gas line
(Approx. location)

CenterPoint Energy
Gas line
(Approx. location)

16" SAN. SEWER ESMT.
VOL. 427, PG. 147, H.C.M.R.

STA. 52+59.26, 60' RT
1.3° DEFLECTION

37 LF TRENCHLESS
CONST. W/CASING

STA. 52+63

CAUTION:
OVERHEAD POWER LINES.

HORIZ 0 10' 20' 40'
1"=20'

VERT 0 1' 2' 4'
1"=2'

No.	Date	Revisions	App.

BENCHMARK:

FLOODPLAIN REFERENCE MARK NUMBER 110125 IS A HCFCD BRASS DISK STAMPED K100 BM10 ON EAST SIDEWALK OF GRANT ROAD BRIDGE OVER CYPRESS CREEK APPROXIMATLEY 0.90 MILE WEST OF JONES ROAD IN KEYMAP 369A IN THE CYPRESS WATERSHED NEAR STREAM K100-00-00
ELEV. 127.25 FEET NAVD 1988 2001 ADJUSTMENT

HORIZONTAL DATUM:

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100 YR FL=125.00'

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PRIVATE UTILITY LINES SHOWN

Date: 1-22-20
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TBPE REG. NO. F-3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28-B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

GRANT ROAD BASELINE PLAN AND PROFILE STA. 48+00 TO 53+00

STATE OF TEXAS
CARL D. McCONNELL
97585
LICENSED PROFESSIONAL ENGINEER
1/27/2020

DRAWN BY: | CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

SHEET No: 32 OF 99

LAST MODIFIED: Jan 21, 2020 – 10:00am BY USER: jimvy
DWG. LOCATION: G:\1101\4876-01 NHCRWA PROJECT 28-B\ACAD\Drawings\Civil\
DWG. NAME: 4876-01_32.dwg

MATCH LINE STA. 48+00

STA. 49+40
ACCESS MH

s-row
s-curb
n-curb
cl-pvmt
CenterPoint Energy
8" ip stl gas main
exist. 24" stm. (n&s)
exist. 24" stm.

CenterPoint Energy
Abandoned Gas line
(Approx. location)

CenterPoint Energy
Gas line
(Approx. location)

37 LF TRENCHLESS
W/CASING CONST.
(STA. 52+63 TO STA. 53+00)

STA. 49+49.03
54" x 22½° BEND (RESTRAINED)
℄=115.00

PROP. 54"
WATER LINE

FLOW

S=0.0%

STA. 49+66.22
54" x 22½° BEND (RESTRAINED)
℄=115.00

LIMITS OF 54" RESTRAINED JOINTS (STA. 48+00 TO STA. 49+71)

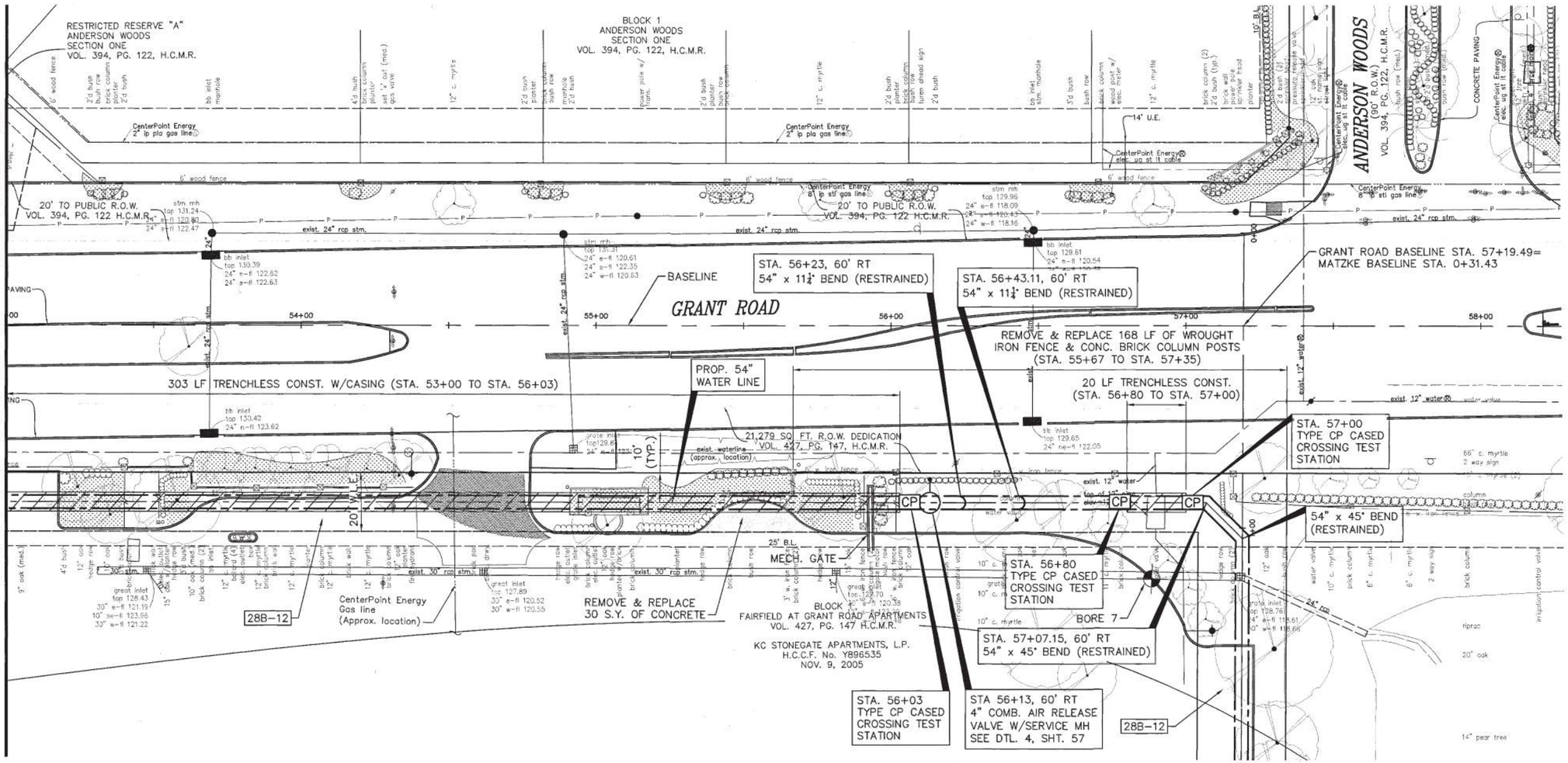
240 LF TRENCHLESS CONST. W/CASING (STA. 49+71 TO STA. 52+05)

℄=115.00

MATCH LINE STA. 53+00

130 128 126 124 122 120 118 116 114 112

48+00 49+00 50+00 51+00 52+00 53+00



CAUTION:
EXISTING GAS PIPELINE LOCATIONS AND ELEVATIONS HAVE NOT BEEN VERIFIED. CONTRACTOR RESPONSIBLE FOR FIELD VERIFICATION OF UNDERGROUND PIPELINES.

THE LOCATION OF THE BURIED CABLES WITHIN THE PROJECT LIMITS HAVE NOT BEEN VERIFIED. BEFORE COMMENCING WORK CALL 1–800–344–8377 A MINIMUM OF 48 HOURS PRIOR TO CONSTRUCTION TO HAVE UNDERGROUND LINES FIELD–LOCATED.

CAUTION:
OVERHEAD POWER LINES.

No.	Date	Revisions	App.

BENCHMARK:

FLOODPLAIN REFERENCE MARK NUMBER 110125 IS A HCFCD BRASS DISK STAMPED K100 BM10 ON EAST SIDEWALK OF GRANT ROAD BRIDGE OVER CYPRESS CREEK APPROXIMATLEY 0.90 MILE WEST OF JONES ROAD IN KEYMAP 369A IN THE CYPRESS WATERSHED NEAR STREAM K100–00–00
ELEV. 127.25 FEET NAVD 1988 2001 ADJUSTMENT

HORIZONTAL DATUM:

ALL HORIZONTAL COORDINATES ARE BASED ON TEXAS STATE PLANE COORDINATE SYSTEM, SOUTH CENTRAL ZONE, NAD83. THE COORDINATES & DISTANCES SHOWN ARE SURFACE AND MAY BE CONVERTED TO GRID BY MULTIPLYING BY A SCALE FACTOR OF 0.999870017 (TxDOT factor).
100 YR FL=125.00'

0 10' 20' 40'
1"=20'

TO ARRANGE FOR LINES TO BE TURNED OFF OR MOVED CALL CENTERPOINT ENERGY AT 713–207–2222.

NOTICE:
FOR YOUR SAFETY, YOU ARE REQUIRED BY TEXAS LAW TO CALL 811 AT 48 HOURS BEFORE YOU DIG SO THAT UNDERGROUND LINES CAN BE MARKED. THIS VERIFICATION DOES NOT FULFILL YOUR OBLIGATION TO CALL 811.

PRIVATE UTILITY LINES SHOWN

Date: 1-23-20
CENTERPOINT ENERGY/UNDERGROUND ELECTRICAL FACILITIES VERIFICATION ONLY
(THIS SIGNATURE VERIFIES EXISTING UNDERGROUND FACILITIES – NOT TO BE USED FOR CONFLICT VERIFICATION.) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-23-20
CENTERPOINT ENERGY/NATURAL GAS FACILITIES VERIFICATION ONLY.
(THIS SIGNATURE VERIFIES THAT YOU HAVE SHOWN CNP NATURAL GAS LINES CURRENTLY – NOT TO BE USED FOR CONFLICT VERIFICATION.)
(GAS SERVICE LINES ARE NOT SHOWN.) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-22-20
Approved for AT&T Texas/SWBT underground conduit facilities only. SIGNATURE VALID FOR ONE YEAR

North Harris County REGIONAL WATER Authority

AECOM
AECOM TECHNICAL SERVICES, INC.
19219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094–1009
281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F–3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28–B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

GRANT ROAD BASELINE PLAN STA. 53+00 TO 58+00

STATE OF TEXAS
CARL D. McCONNELL
97585
LICENSED
PROFESSIONAL ENGINEER
1/24/2020

DRAWN BY:	CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

SHEET No: 33 OF 99

LAST MODIFIED: Jan 21, 2020 – 10:01am BY USER: yimxy
DWG. LOCATION: G:\11104876-01 NHCRWA PROJECT 28-B\ACAD\Drawings\Civil\
DWG. NAME: 4876-01_33.dwg

MATCH LINE STA. 53+00 – SEE SHEET 32

STA. 56+13
4" COMB. AIR RELEASE VALVE W/SERVICE MH

great inlet top 128.43 30" e-fl 121.19 30" w-fl 121.22
24" n-fl 121.22
bb inlet top 130.62 24" n-fl 123.62
24" n-fl 122.62 24" s-fl 122.63
slm mh top 131.74 24" e-fl 123.62 24" s-fl 122.47
great inlet top 129.89 30" e-fl 120.57 30" w-fl 120.99
slm mh top 131.31 24" e-fl 122.61 24" s-fl 122.35 24" w-fl 120.65
grate inlet top 127.33 24" n-fl 123.36
great inlet top 129.70 30" e-fl 120.38 12" s-fl 123.29 30" w-fl 120.48
bb inlet top 129.65 24" n-fl 122.05
bb inlet top 129.61 24" n-fl 120.54 24" s-fl 120.34
slm mh top 129.96 24" e-fl 120.74 24" s-fl 120.43 24" w-fl 118.16
grate inlet top 126.92 24" e-fl 119.83 30" w-fl 119.66

d-pvmt
n-row
s-row
n-curb
n-curb
CenterPoint Energy Gas line (Approx. location)
CenterPoint Energy 8" ip stl gas main
CenterPoint Energy 8" ip stl gas main
exist. 10" stm.
exist. 24" stm.
exist. 30" stm.
exist. 30" stm.
exist. 24" stm.
exist. 24" stm.
exist. 12" stm.
exist. 30" stm.
exist. 24" stm.
exist. 24" stm. (n&s)
exist. 12" water
exist. 12" water
exist. 12" water
exist. 24" stm.
exist. 30" stm.
exist. 24" stm.
exist. 24" stm.
exist. 24" stm.
exist. 30" stm.
exist. 24" stm.
exist. 24" stm.
exist.

FLOW
S=0.0%
PROP. 54" WATER LINE
20 LF TRENCHLESS CONST. (STA. 56+80 TO STA. 57+00)
℄=115.00
303 LF TRENCHLESS CONST. W/CASING (STA. 53+00 TO STA. 56+03)
STA. 56+23
54" x 11¼° BEND (RESTRAINED)
℄=115.00
S=-19.89%
S=0.0%
℄=111.00
STA. 56+43.11
54" x 11¼° BEND (RESTRAINED)
℄=111.00
STA. 57+12.14
54" x 45° BEND (RESTRAINED)
℄=111.00
FOR CONT. (SEE SHEET 36)
LIMITS OF 54" RESTRAINED JOINTS (STA. 56+18 TO STA. 57+19)

53+00 54+00 55+00 56+00 57+00 58+00

100 102 104 106 108 110 112 114 116 118 120 122 124 126 128 130 132 134 136 138

No.	Date	Revisions	App.

HORIZ 0 10' 20' 40' 1"=20'
VERT 0 1' 2' 4' 1"=2'

TO ARRANGE FOR LINES TO BE TURNED OFF OR MOVED CALL CENTERPOINT ENERGY AT 713-207-2222.

NOTICE:
FOR YOUR SAFETY, YOU ARE REQUIRED BY TEXAS LAW TO CALL 811 AT 48 HOURS BEFORE YOU DIG SO THAT UNDERGROUND LINES CAN BE MARKED. THIS VERIFICATION DOES NOT FULFILL YOUR OBLIGATION TO CALL 811.

PRIVATE UTILITY LINES SHOWN

Date: 1-23-20
CENTERPOINT ENERGY/UNDERGROUND ELECTRICAL FACILITIES VERIFICATION ONLY
(THE SIGNATURE VERIFIES EXISTING UNDERGROUND FACILITIES – NOT TO BE USED FOR CONFLICT VERIFICATION.) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-23-20
CENTERPOINT ENERGY/NATURAL GAS FACILITIES VERIFICATION ONLY. (THIS SIGNATURE VERIFIES THAT YOU HAVE SHOWN CNP NATURAL GAS LINES CORRECTLY – NOT TO BE USED FOR CONFLICT VERIFICATION.) GAS SERVICE LINES ARE NOT SHOWN. SIGNATURE VALID FOR SIX MONTHS.

Date: 1-22-20
Approved for AT&T Texas/SWBT underground conduit facilities only. SIGNATURE VALID FOR ONE YEAR

North Harris County REGIONAL WATER Authority

AECOM
AECOM TECHNICAL SERVICES, INC.
19219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094-1009
281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F-3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28-B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

GRANT ROAD BASELINE PROFILE
STA. 53+00 TO 58+00

STATE OF TEXAS
CARL D. McCONNELL
97585
LICENSED PROFESSIONAL ENGINEER
1/24/2020

DRAWN BY: CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

SHEET No: 34 OF 99

LAST MODIFIED: Jan 21, 2020 – 10:01am BY USER: yimvy
DWG. LOCATION: G:\1110\4876-01 NHCRWA PROJECT 28-B\ACAD\Drawings\Civil\
DWG. NAME: 4876-01_34.dwg

CAUTION:
EXISTING GAS PIPELINE LOCATIONS AND ELEVATIONS HAVE NOT BEEN VERIFIED. CONTRACTOR RESPONSIBLE FOR FIELD VERIFICATION OF UNDERGROUND PIPELINES.

THE LOCATION OF THE BURIED CABLES WITHIN THE PROJECT LIMITS HAVE NOT BEEN VERIFIED. BEFORE COMMENCING WORK CALL 1-800-344-8377 A MINIMUM OF 48 HOURS PRIOR TO CONSTRUCTION TO HAVE UNDERGROUND LINES FIELD-LOCATED.

CAUTION:
OVERHEAD POWER LINES

No.	Date	Revisions	App.

BENCHMARK:

FLOODPLAIN REFERENCE MARK NUMBER 110125 IS A HCFCD BRASS DISK STAMPED K100 BM10 ON EAST SIDEWALK OF GRANT ROAD BRIDGE OVER CYPRESS CREEK APPROXIMATLEY 0.90 MILE WEST OF JONES ROAD IN KEYMAP 369A IN THE CYPRESS WATERSHED NEAR STREAM K100-00-00
ELEV. 127.25 FEET NAVD 1988 2001 ADJUSTMENT

HORIZONTAL DATUM:

ALL HORIZONTAL COORDINATES ARE BASED ON TEXAS STATE PLANE COORDINATE SYSTEM, SOUTH CENTRAL ZONE, NAD83. THE COORDINATES & DISTANCES SHOWN ARE SURFACE AND MAY BE CONVERTED TO GRID BY MULTIPLYING BY A SCALE FACTOR OF 0.999870017 (TxDOT factor).
100 YR FL=125.00'

0 10' 20' 40'
1"=20'

MATCH LINE STA. 6+00 – SEE SHEET 37

GRANT ROAD (R.O.W. VARIES) VOL. 172, PG. 427 H.C.D.R.

ANDERSON ROAD (90' R.O.W.) VOL. 394, PG. 122, H.C.M.R.

MATZKE BASELINE STA. 0+31.43= GRANT ROAD BASELINE STA. 57+19.49

STA. 1+03.59
54" x 45° BEND
(RESTRAINED)

REMOVE & REPLACE
375 S.Y. OF
CONC. PVMT.

BASELINE

BORE 7

FOR CONT. (SEE SHEET 33)

STA. 2+65
4" COMB. AIR RELEASE VALVE W/SERVICE MH
(SEE DETAIL 4, SHT. 57)

STA. 2+75
1-54" BFV WITH OPERATOR MH
SEE SHT. 56

STA. 2+85
4" COMB. AIR RELEASE VALVE W/SERVICE MH
(SEE DETAIL 4, SHT. 57)

PROP. 54" WATER LINE

STA. 2+95.64
54" x 45° BEND, RJ
(ROTATED)

STA. 3+24.50
54" x 22½° BEND, RJ
(ROTATED)

STA. 3+31.29
1-54" X 16" TEE
(RESTRAINED)

BORE 8

200 LF TRENCHLESS CONST. W/CASING
(STA. 3+40 TO STA. 5+40)

28B-12

28B-13

28B-13TCE

PROP. 16" WATER LINE

STA. 3+40
TYPE CP CASED CROSSING TEST STATION

28-E CONNECTION
SEE DETAIL 3, SHEET 49

PROP. 54" WATER LINE

STA. 5+92.87, 20.6' LT
54" x 22½° BEND
(RESTRAINED)

STA. 5+40
TYPE CP CASED CROSSING TEST STATION

STA. 5+55.53, 20.6' LT
54" x 45° BEND
(RESTRAINED) (ROTATED)

BORE 9

H.C.F.C.D. UNIT K143-00-00

10' DRAINAGE ESMT. VOL. 427, PG. 147, H.C.M.R.

100' DRAINAGE ESMT. H.C.C.F. NO. F616230

60' PIPELINE ESMT. NATURAL GAS PIPELINE CONTRACT G-387, VOL. 5180, PG. 196, H.C.D.R. VOL. 6113, PG. 567, H.C.D.R.

10' SAN. SEWER ESMT. H.C.C.F. NO. H541091

14' SQ. FT R.O.W. DEDICATION VOL. 427, PG. 147, H.C.M.R.

BLOCK 1, FAIRFIELD AT GRANT ROAD APARTMENTS VOL. 427, PG. 147 H.C.M.R.

KC STONECATE APARTMENTS, L.P. H.C.C.F. No. Y806535 NOV. 9, 2005

TO ARRANGE FOR LINES TO BE TURNED OFF OR MOVED CALL CENTERPOINT ENERGY AT 713-207-2222.

NOTICE:

FOR YOUR SAFETY, YOU ARE REQUIRED BY TEXAS LAW TO CALL 811 AT 48 HOURS BEFORE YOU DIG SO THAT UNDERGROUND LINES CAN BE MARKED. THIS VERIFICATION DOES NOT FULFILL YOUR OBLIGATION TO CALL 811.

PRIVATE UTILITY LINES SHOWN

CENTERPOINT ENERGY/UNDERGROUND ELECTRICAL FACILITIES VERIFICATION ONLY — Date 1-23-20

(THE SIGNATURE VERIFIES EXISTING UNDERGROUND FACILITIES – NOT TO BE USED FOR CONFLICT VERIFICATION.) SIGNATURE VALID FOR SIX MONTHS.

CENTERPOINT ENERGY/NATURAL GAS FACILITIES VERIFICATION ONLY. (THIS SIGNATURE VERIFIES THAT YOU HAVE SHOWN CNP NATURAL GAS LINES (MAINS/ONLY – NOT TO BE USED FOR CONFLICT VERIFICATION.) (GAS SERVICE LINES ARE NOT SHOWN.) SIGNATURE VALID FOR SIX MONTHS. — Date 1-22-20

Approved for AT&T Texas/SWBT underground conduit facilities only. SIGNATURE VALID FOR ONE YEAR

North Harris County REGIONAL WATER Authority

AECOM

AECOM TECHNICAL SERVICES, INC.
19219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094-1009
281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F-3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28-B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

MATZKE PARK BASELINE PLAN
STA. 1+00 TO 6+00

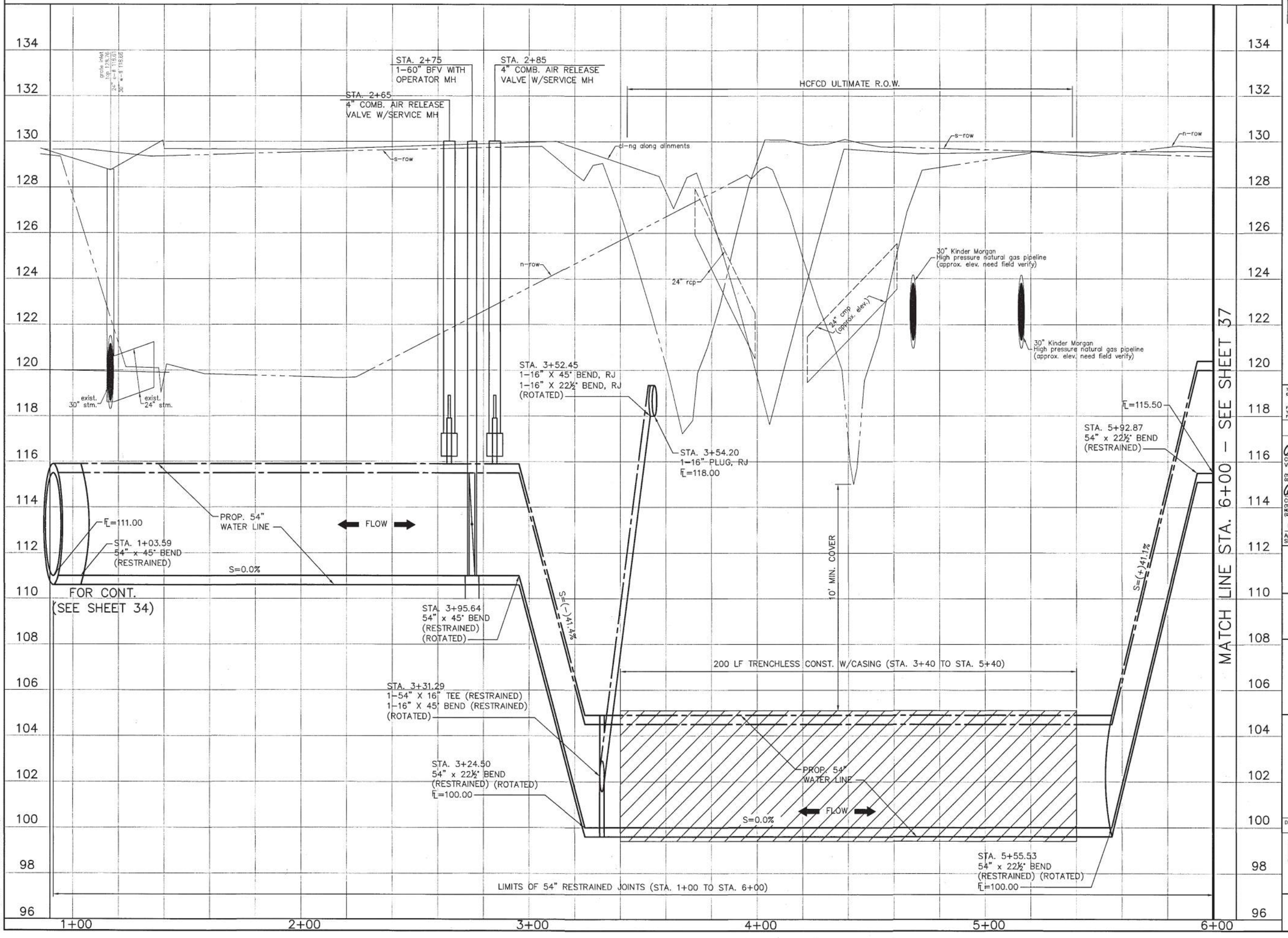
STATE OF TEXAS
CARL D. McCONNELL
97585
LICENSED PROFESSIONAL ENGINEER
1/22/2020

DRAWN BY: | CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

SHEET No: 35 OF 99

LAST MODIFIED: Jan 21, 2020 – 10:01am BY USER: yimvy
DWG. LOCATION: G:\1110\4876-01 NHCRWA PROJECT 28-B\ACAD\Drawings\Civil\
DWG. NAME: 4876-01_35.dwg



No.	Date	Revisions	App.

HORIZ 0 10' 20' 40' 1"=20'

VERT 0 1' 2' 4' 1"=2'

TO ARRANGE FOR LINES TO BE TURNED OFF OR MOVED CALL CENTERPOINT ENERGY AT 713-207-2222.

NOTICE:

FOR YOUR SAFETY, YOU ARE REQUIRED BY TEXAS LAW TO CALL 811 AT 48 HOURS BEFORE YOU DIG SO THAT UNDERGROUND LINES CAN BE MARKED. THIS VERIFICATION DOES NOT FULFILL YOUR OBLIGATION TO CALL 811.

PRIVATE UTILITY LINES SHOWN

Date: 1-23-20
CENTERPOINT ENERGY/UNDERGROUND ELECTRICAL FACILITIES VERIFICATION ONLY

(THE SIGNATURE VERIFIES EXISTING UNDERGROUND FACILITIES -- NOT TO BE USED FOR CONFLICT VERIFICATION.) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-23-20
CENTERPOINT ENERGY/NATURAL GAS FACILITIES VERIFICATION ONLY. (THIS SIGNATURE VERIFIES THAT YOU HAVE SHOWN CNP NATURAL GAS LINES CORRECTLY -- NOT TO BE USED FOR CONFLICT VERIFICATION.) (GAS SERVICE LINES ARE NOT SHOWN.) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-22-20
Approved for AT&T Texas/SWBT underground conduit facilities only. SIGNATURE VALID FOR ONE YEAR

North Harris County REGIONAL WATER Authority

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19219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094–1009
281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F–3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28–B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

MATZKE PARK BASELINE PROFILE STA. 1+00 TO 6+00

STATE OF TEXAS
CARL D. McCONNELL
97585
LICENSED PROFESSIONAL ENGINEER
1/27/2020

DRAWN BY: | CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

SHEET No: 36 OF 99

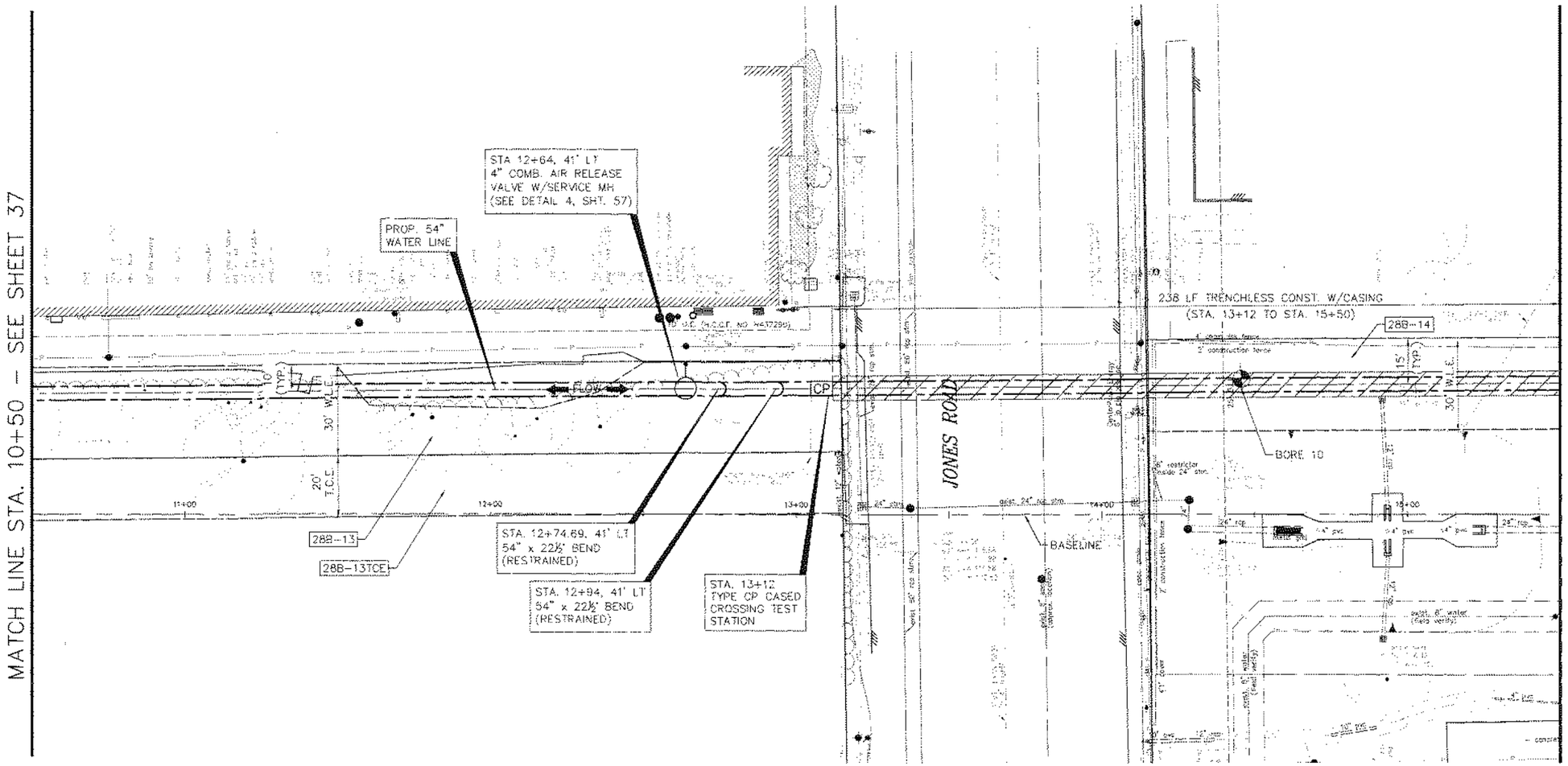
LAST MODIFIED: Jan 21, 2020 – 10:02am BY USER: yimvy
DWG. LOCATION: G:\1110\4876-01 NHCRWA PROJECT 28-B\ACAD\Drawings\Civil\
DWG. NAME: 4876-01_36.dwg

No.	Date	Revisions	Appr.

CAUTION:
EXISTING GAS PIPELINE LOCATIONS AND ELEVATIONS HAVE NOT BEEN VERIFIED. CONTRACTOR RESPONSIBLE FOR FIELD VERIFICATION OF UNDERGROUND PIPELINES.

THE LOCATION OF THE BURIED CABLES WITHIN THE PROJECT LIMITS HAVE NOT BEEN VERIFIED. BEFORE COMMENCING WORK CALL 1-800-344-8377 A MINIMUM OF 48 HOURS PRIOR TO CONSTRUCTION TO HAVE UNDERGROUND LINES FIELD-LOCATED.

CAUTION:
OVERHEAD POWER LINES



BENCHMARK:

FLOODPLAIN REFERENCE MARK NUMBER 115125 IS A HCFCD BRASS DISK STAMPED K100 BM10 ON EAST SIDEWALK OF GRANT ROAD BRIDGE OVER CYPRESS CREEK APPROXIMATELY 0.90 MILE WEST OF JONES ROAD IN KEYMAP 365A IN THE CYPRESS WATERSHED NEAR STREAM K100-00-00
ELEV. 127.25 FEET NAVD 1988 2001 ADJUSTMENT

HORIZONTAL DATUM:

ALL HORIZONTAL COORDINATES ARE BASED ON TEXAS STATE PLANE COORDINATE SYSTEM, SOUTH CENTRAL ZONE, NAD83. THE COORDINATES & DISTANCES SHOWN ARE SURFACE AND MAY BE CONVERTED TO GRID BY MULTIPLYING BY A SCALE FACTOR OF 0.999870017 (TxDOT factor).
100 YR FL=125.00'

SEE CONSTRUCTION NOTES ON SHEET 4 FOR CONSTRUCTION REQUIREMENTS ON CYPRESS-FAIRBANKS ISD PROPERTY.

0 10' 20' 40'
1"=20'

TO ARRANGE FOR LINES TO BE TURNED OFF OR MARKED CALL TEXAS ONE-CALL TOLL FREE AT 811 OR 1-800-245-4545

NOTICE:
FOR YOUR SAFETY, YOU ARE REQUIRED BY TEXAS LAW TO CALL 811 AT LEAST 48 HOURS BEFORE YOU DIG SO THAT UNDERGROUND LINES CAN BE MARKED. THIS VERIFICATION DOES NOT FULFILL YOUR OBLIGATION TO CALL 811.

PRIVATE UTILITY LINES SHOWN

Date: 1-22-20
CENTERPOINT ENERGY/UNDERGROUND ELECTRICAL FACILITIES VERIFICATION ONLY

(THE SIGNATURE VERIFIES EXISTING UNDERGROUND FACILITIES -- NOT TO BE USED FOR CONFLICT VERIFICATION) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-22-20
CENTERPOINT ENERGY/NATURAL GAS FACILITIES VERIFICATION ONLY.
(THIS SIGNATURE VERIFIES THAT YOU HAVE SHOWN CNP NATURAL GAS LINES COMMENSURATE - NOT TO BE USED FOR CONFLICT VERIFICATION)
(GAS SERVICE LINES ARE NOT SHOWN) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-22-20
Approved for AT&T Texas/SWBT underground conduit facilities only
SIGNATURE VALID FOR ONE YEAR

North Harris County REGIONAL WATER Authority

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19219 KATY FREEWAY, SUITE 100
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281.646.2400
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TBPE REG. NO. F-3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28-B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

MATZKE PARK BASELINE PLAN
STA. 10+50 TO 15+50

STATE OF TEXAS
CARL D. McCONNELL
97585
LICENSED PROFESSIONAL ENGINEER

DRAWN BY: | CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 529-0573

SHEET No: 38 OF 99

LAST MODIFIED: Jan 21, 2020 - 11:12am BY USER: ybevy
DWG. LOCATION: G:\1101\4878-01 NHCRWA PROJECT 28-B\ACAD\Drawings\Civil\
DWG. NAME: 4878-01_38.dwg

MATCH LINE STA. 10+50 — SEE SHEET 37

MATCH LINE STA. 15+50 — SEE SHEET 40

STA 12+64
4" COMB. AIR RELEASE
VALVE W/SERVICE MH

grate inlet
top 127.33
24" s-fl 123.73

grate inlet
top 126.80
24" e-fl 122.99

stm mh
top 129.08
60" n-fl 115.68
24" e-fl 115.98
60" s-fl 115.58
24" w-fl 122.52

grate inlet
top 126.88
24" w-fl 116.42

n-row

s-row

cl-ng along alignments

exist.
24" stm.

exist. 12" water
(approx. location)

exist. 8" san.

CenterPoint Energy
6" ip pla gas main

AT&T TEXAS/SWBT
15-4" mcdt

exist. 24" stm.

exist.
60" stm. (n&s)

PROP. 54"
WATER LINE

FLOW

℄=115.50

S=0.0%

S=(-)41.2%

STA. 12+74.69
54" x 22½° BEND
(RESTRAINED)
℄=115.50

238 LF TRENCHLESS CONST.
(STA. 13+12 TO STA. 15+50)

2' MIN. CLR.

STA. 12+94
54" x 22½° BEND
(RESTRAINED)
℄=107.50

PROP. 54"
WATER LINE

FLOW

S=0.0%

S=0.0%

℄=107.50

LIMITS OF 54" RESTRAINED JOINTS (STA. 12+15 TO STA. 15+50)

140 138 136 134 132 130 128 126 124 122 120 118 116 114 112 110 108 106 104 102

11+00 12+00 13+00 14+00 15+00

No.	Date	Revisions	App.

HORIZ 0 10' 20' 40'
1"=20'

VERT 0 1' 2' 4'
1"=2'

TO ARRANGE FOR LINES TO BE TURNED OFF OR MOVED CALL CENTERPOINT ENERGY AT 713-207-2222.

NOTICE:

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PRIVATE UTILITY LINES SHOWN

Date: 1-23-20
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(THE SIGNATURE VERIFIES EXISTING UNDERGROUND FACILITIES – NOT TO BE USED FOR CONFLICT VERIFICATION.) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-23-20
CENTERPOINT ENERGY/NATURAL GAS FACILITIES VERIFICATION ONLY.
(THIS SIGNATURE VERIFIES THAT YOU HAVE SHOWN CNP NATURAL GAS LINES CORRECTLY – NOT TO BE USED FOR CONFLICT VERIFICATION.)
(GAS SERVICE LINES ARE NOT SHOWN.) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-22-20
Approved for AT&T Texas/SWBT underground conduit facilities only. SIGNATURE VALID FOR ONE YEAR

North Harris County
REGIONAL WATER
Authority

AECOM
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281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F-3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28-B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

MATZKE PARK BASELINE PROFILE
STA. 10+50 TO 15+50

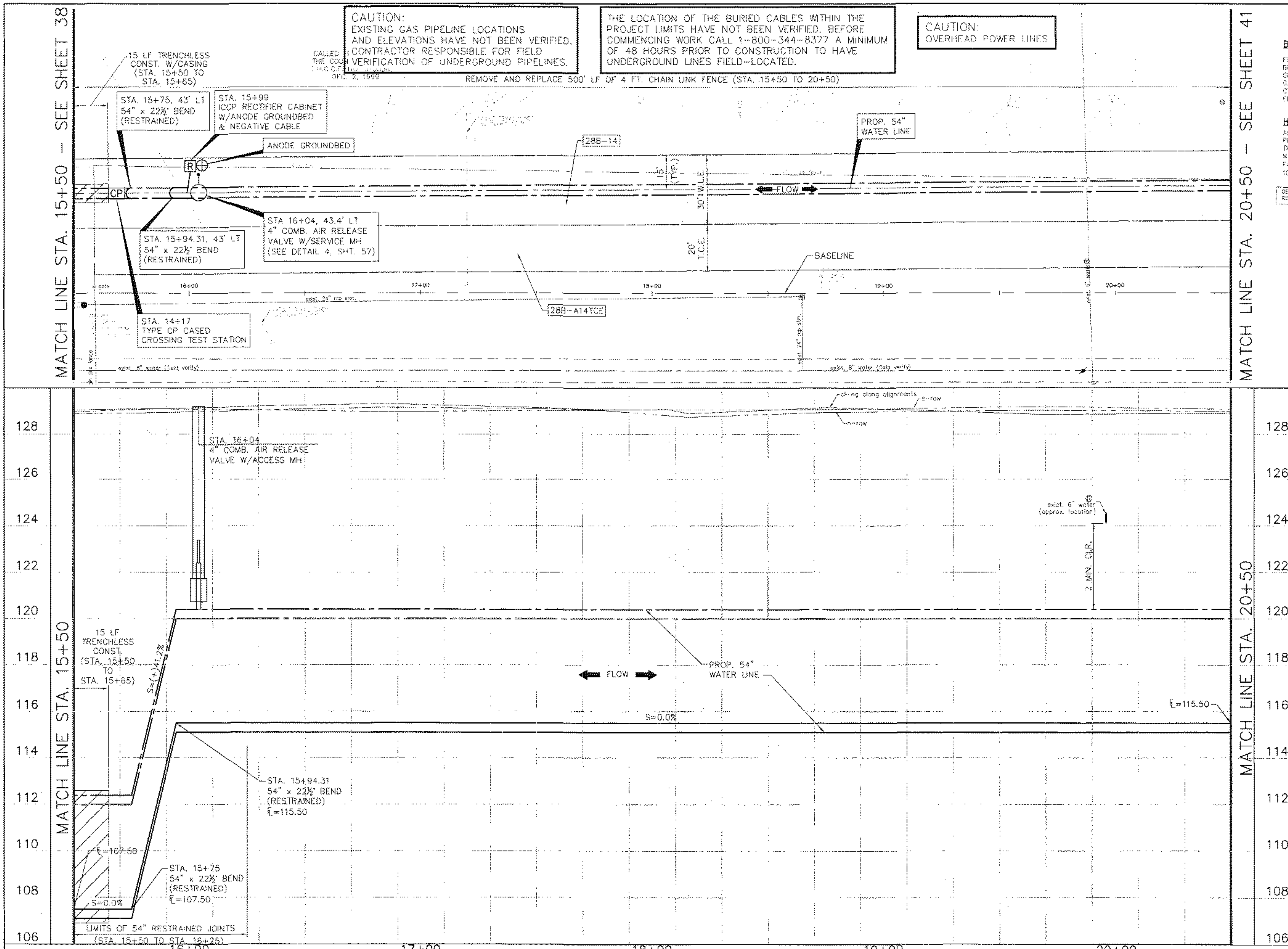
STATE OF TEXAS
CARL D. McCONNELL
97585
LICENSED
PROFESSIONAL ENGINEER
1/22/2020

DRAWN BY: | CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

SHEET No: 39 OF 99

LAST MODIFIED: Jan 21, 2020 – 11:17am BY USER: yimvy
DWG. LOCATION: G:\1110\4876-01 NHCRWA PROJECT 28-B\ACAD\Drawings\Civil\
DWG. NAME: 4876-01_39.dwg


MATCH LINE STA. 15+50 — SEE SHEET 38
MATCH LINE STA. 20+50 — SEE SHEET 41
CAUTION:
EXISTING GAS PIPELINE LOCATIONS AND ELEVATIONS HAVE NOT BEEN VERIFIED. CONTRACTOR RESPONSIBLE FOR FIELD VERIFICATION OF UNDERGROUND PIPELINES.
THE LOCATION OF THE BURIED CABLES WITHIN THE PROJECT LIMITS HAVE NOT BEEN VERIFIED. BEFORE COMMENCING WORK CALL 1-800-344-8377 A MINIMUM OF 48 HOURS PRIOR TO CONSTRUCTION TO HAVE UNDERGROUND LINES FIELD-LOCATED.
CAUTION:
OVERHEAD POWER LINES
REMOVE AND REPLACE 500' LF OF 4 FT. CHAIN LINK FENCE (STA. 15+50 TO 20+50)
15 LF TRENCHLESS CONST. W/CASING (STA. 15+50 TO STA. 15+65)
STA. 15+75, 43' LT 54" x 22½° BEND (RESTRAINED)
STA. 15+99 ICCP RECTIFIER CABINET W/ANODE GROUNDBED & NEGATIVE CABLE
ANODE GROUNDBED
28B-14
PROP. 54" WATER LINE
15' (TYP.)
30' W.L.E.
FLOW
20' T.C.E.
STA. 15+94.31, 43' LT 54" x 22½° BEND (RESTRAINED)
STA. 16+04, 43.4' LT 4" COMB. AIR RELEASE VALVE W/SERVICE MH (SEE DETAIL 4, SHT. 57)
BASELINE
28B-A14TCE
STA. 14+17 TYPE CP CASED CROSSING TEST STATION
16+00
17+00
18+00
19+00
20+00
exist. 8" water (field verify)
STA. 16+04 4" COMB. AIR RELEASE VALVE W/ACCESS MH
exist. 6" water (approx. location)
2' MIN. CLR.
15 LF TRENCHLESS CONST. (STA. 15+50 TO STA. 15+65)
S=(+)41.2%
FLOW
PROP. 54" WATER LINE
S=0.0%
℄=115.50
STA. 15+94.31 54" x 22½° BEND (RESTRAINED) ℄=115.50
℄=107.50
STA. 15+75 54" x 22½° BEND (RESTRAINED) ℄=107.50
S=0.0%
LIMITS OF 54" RESTRAINED JOINTS (STA. 15+50 TO STA. 16+25)
128
126
124
122
120
118
116
114
112
110
108
106
HORIZ 0 10' 20' 40' 1"=20'
VERT 0 1' 2' 4' 1"=2'

No.	Date	Revisions	App.

BENCHMARK:

FLOODPLAIN REFERENCE MARK NUMBER 110125 IS A HCFCD BRASS DISK STAMPED K100 BM10 ON EAST SIDEWALK OF GRANT ROAD BRIDGE OVER CYPRESS CREEK APPROXIMATELY 0.90 MILE WEST OF JONES ROAD IN KEYMAP 369A IN THE CYPRESS WATERSHED NEAR STREAM K100-00-00 ELEV. 127.25 FEET NAVD 1988 2001 ADJUSTMENT

HORIZONTAL DATUM:

ALL HORIZONTAL COORDINATES ARE BASED ON TEXAS STATE PLANE COORDINATE SYSTEM, SOUTH CENTRAL ZONE, NAD83. THE COORDINATES & DISTANCES SHOWN ARE SURFACE AND MAY BE CONVERTED TO GRID BY MULTIPLYING BY A SCALE FACTOR OF 0.999870017 (TXDOT factor).
100 YR FL=125.00'

SEE CONSTRUCTION NOTES ON SHEET 4 FOR CONSTRUCTION REQUIREMENTS ON CYPRESS-FAIRBANKS ISD PROPERTY

NOTICE:

PRIVATE UTILITY LINES SHOWN

Date 1-22-20
CENTERPOINT ENERGY/UNDERGROUND ELECTRICAL FACILITIES VERIFICATION ONLY

Date 1-22-20
CENTERPOINT ENERGY/NATURAL GAS FACILITIES VERIFICATION ONLY.

Date 1-22-20
Approved for AT&T Texas/SWBT underground conduit facilities only. SIGNATURE VALID FOR ONE YEAR

North Harris County REGIONAL WATER Authority

AECOM
AECOM TECHNICAL SERVICES, INC.
19219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094-1009
281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F-3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28-B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

MATZKE PARK BASELINE PLAN AND PROFILE STA. 15+50 TO 20+50

STATE OF TEXAS
CARL D. McCONNELL
97585
LICENSED PROFESSIONAL ENGINEER

DRAWN BY: | CHECKED BY:

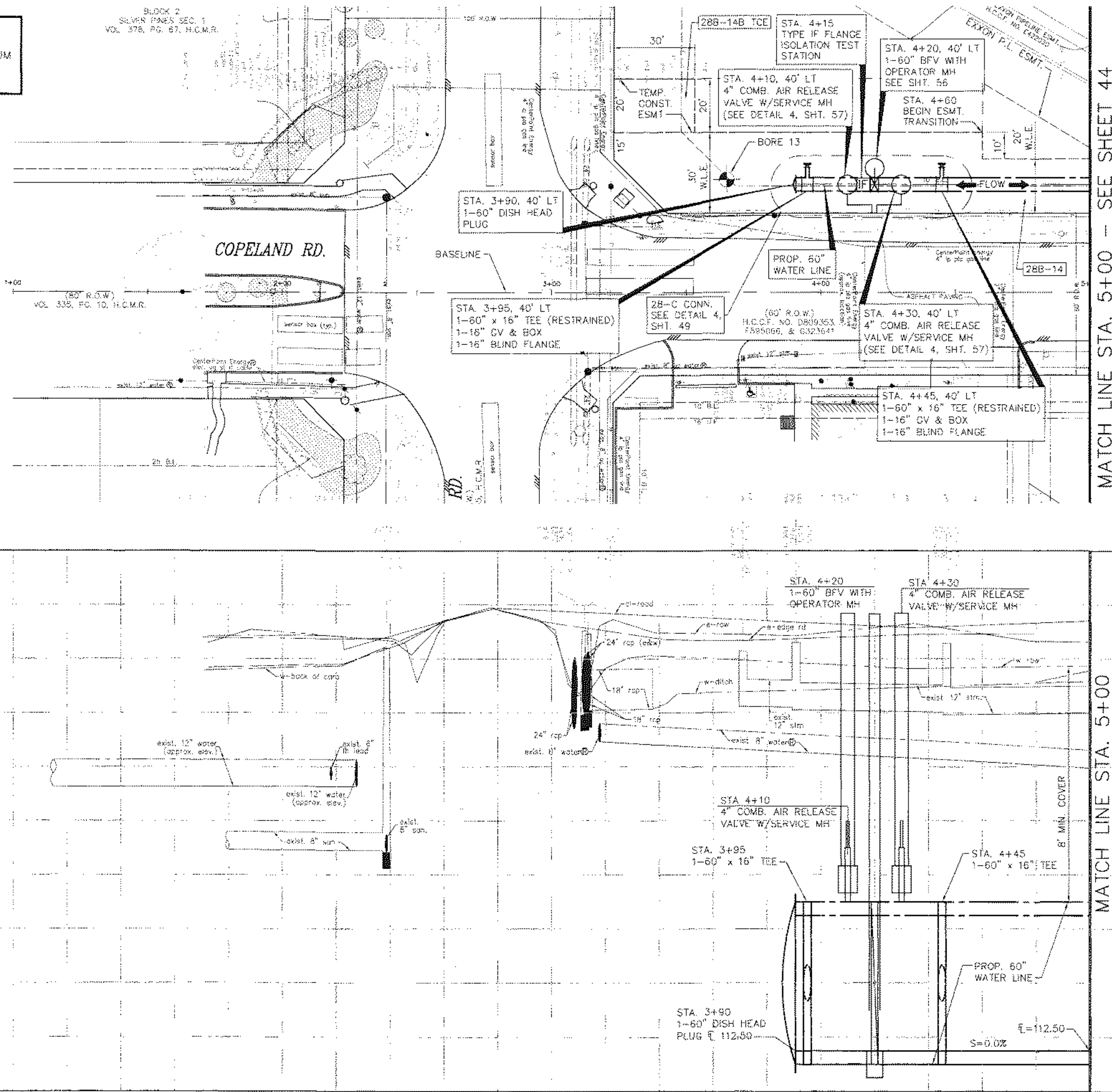
DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392

SHEET No: 40 OF 99

THE LOCATION OF THE BURIED CABLES WITHIN THE PROJECT LIMITS HAVE NOT BEEN VERIFIED. BEFORE COMMENCING WORK CALL 1-800-344-8377 A MINIMUM OF 48 HOURS PRIOR TO CONSTRUCTION TO HAVE UNDERGROUND LINES FIELD-LOCATED.

CAUTION:
EXISTING GAS PIPELINE LOCATIONS AND ELEVATIONS HAVE NOT BEEN VERIFIED. CONTRACTOR RESPONSIBLE FOR FIELD VERIFICATION OF UNDERGROUND PIPELINES.

CAUTION:
OVERHEAD POWER LINES



No.	Date	Revisions	App.

BENCHMARK:

FLOODPLAIN REFERENCE MARK NUMBER 110125 IS A HCFCD BRASS DISK STAMPED K100 BM10 ON EAST SIDEWALK OF GRANT ROAD BRIDGE OVER CYPRESS CREEK APPROXIMATELY 0.90 MILE WEST OF JONES ROAD IN KEYMAP 369A IN THE CYPRESS WATERSHED NEAR STREAM K100-00-00
ELEV. 127.25 FEET NAVD 1988 2001 ADJUSTMENT

HORIZONTAL DATUM:

ALL HORIZONTAL COORDINATES ARE BASED ON TEXAS STATE PLANE COORDINATE SYSTEM, SOUTH CENTRAL ZONE, NAD83. THE COORDINATES & DISTANCES SHOWN ARE SURFACE AND MAY BE CONVERTED TO GRID BY MULTIPLYING BY A SCALE FACTOR OF 0.99987001? (TxDOT factor)
100 YR FL=125.00'

SEE CONSTRUCTION NOTES ON SHEET 4 FOR CONSTRUCTION REQUIREMENTS ON CYPRESS-FAIRBANKS ISD PROPERTY

HORIZ 0 10' 20' 40' 1"=20'
VERT 0 1' 2' 4' 1"=2'

PRIVATE UTILITY LINES SHOWN

1-23-20
CENTERPOINT ENERGY/UNDERGROUND ELECTRICAL FACILITIES VERIFICATION ONLY

1-23-20
CENTERPOINT ENERGY/NATURAL GAS FACILITIES VERIFICATION ONLY

1-22-20
Approved for AT&T Texas/SWBT underground conduit facilities only. SIGNATURE VALID FOR ONE YEAR

North Harris County
REGIONAL WATER Authority

AECOM
AECOM TECHNICAL SERVICES, INC.
19219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094-1009
281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F-3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28-B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

COPELAND ROAD BASELINE
PLAN AND PROFILE
STA. 1+00 TO 5+00

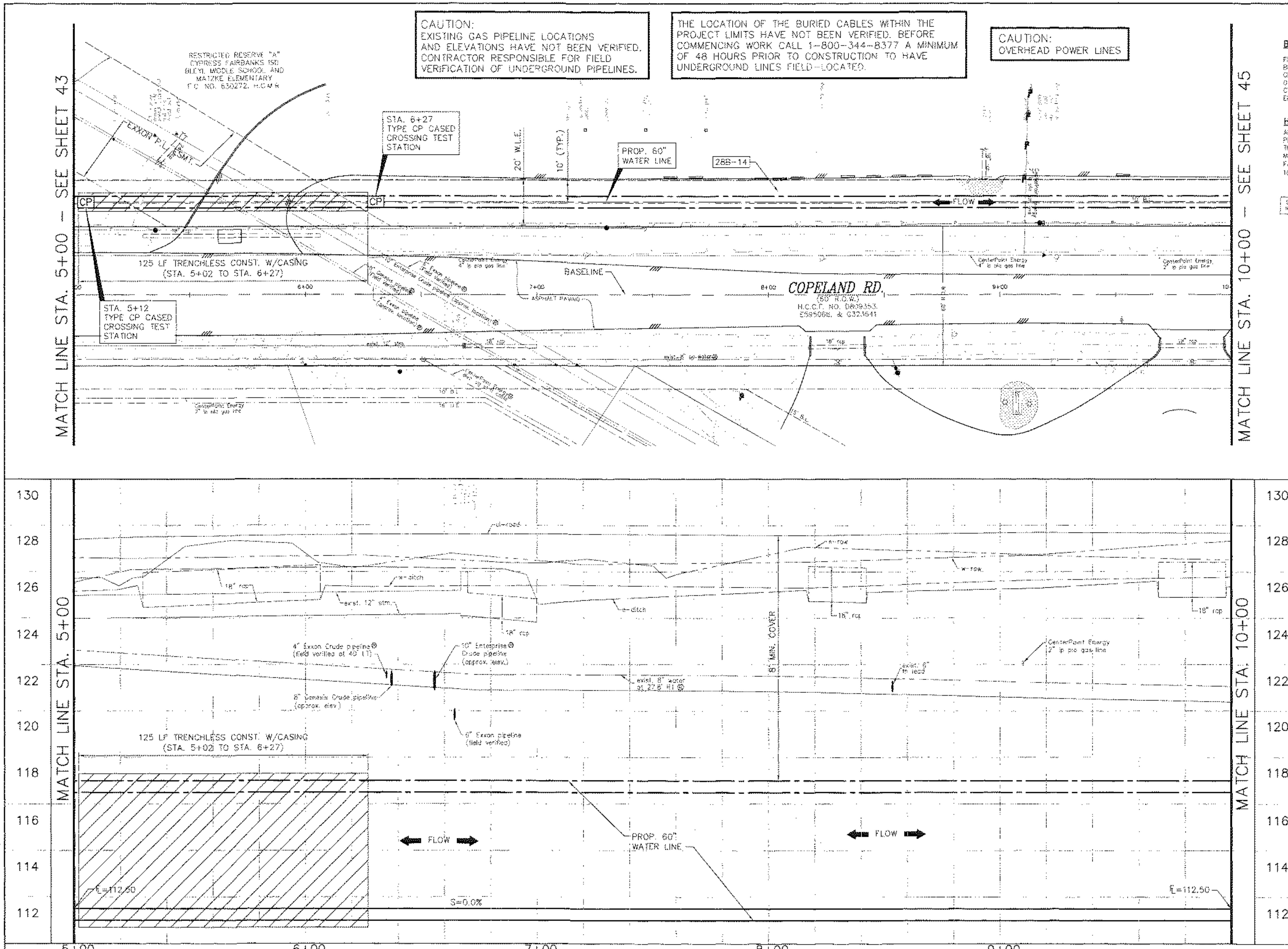
STATE OF TEXAS
CARL D. McCONNELL
97585
LICENSED PROFESSIONAL ENGINEER

DRAWN BY: CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

SHEET No: 43 OF 99

LAST MODIFIED: Jan 21, 2020 — 11:24am BY USER: ymiyy
DWG LOCATION: G:\1110\4876-01 NHCRWA PROJECT 28-B\ACAD\Drawings\Civil
DWG NAME: 4876-01_43.dwg



BENCHMARK:

FLOODPLAIN REFERENCE MARK NUMBER 110125 IS A HCFCD BRASS DISK STAMPED K100 RM10 ON EAST SIDEWALK OF GRANT ROAD BRIDGE OVER CYPRESS CREEK APPROXIMATLEY 0.90 MILE WEST OF JONES ROAD IN KEYMAP 369A IN THE CYPRESS WATERSHED NEAR STREAM K100-00-00
ELEV. 127.25 FEET NAVD 1988 2001 ADJUSTMENT

HORIZONTAL DATUM:

ALL HORIZONTAL COORDINATES ARE BASED ON TEXAS STATE PLANE COORDINATE SYSTEM, SOUTH CENTRAL ZONE, NAD83. THE COORDINATES & DISTANCES SHOWN ARE SURFACE AND MAY BE CONVERTED TO GRID BY MULTIPLYING BY A SCALE FACTOR OF 0.999870017 (1x001 factor)
100 YR FL=125.00'

SEE CONSTRUCTION NOTES ON SHEET 4 FOR CONSTRUCTION REQUIREMENTS ON CYPRESS-FAIRBANKS ISD PROPERTY.

HORIZ 1"=20'
VERT 1"=2'

PRIVATE UTILITY LINES SHOWN

CENTERPOINT ENERGY/UNDERGROUND ELECTRICAL FACILITIES VERIFICATION ONLY

CENTERPOINT ENERGY/NATURAL GAS FACILITIES VERIFICATION ONLY.

Approved for AT&T Texas/SWBT underground conduit facilities only. SIGNATURE VALID FOR ONE YEAR

North Harris County REGIONAL WATER Authority

AECOM
AECOM TECHNICAL SERVICES, INC.
15219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094-1009
281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F-3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28-B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

COPELAND ROAD BASELINE PLAN AND PROFILE STA. 5+00 TO 10+00

CARL D. McCONNELL 97585 LICENSED PROFESSIONAL ENGINEER

DRAWN BY: CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA, HOUSTON, TEXAS 77098 (713) 520-9570

SHEET No: 44 OF 99

MATCH LINE STA. 10+00 – SEE SHEET 44

MATCH LINE STA. 15+00 – SEE SHEET 46

RESTRICTED RESERVE "A"
CYPRESS FAIRBANKS ISD
BLEYL MIDDLE SCHOOL AND
MATZKE ELEMENTARY
F.C. NO. 0.00272, H.C.M.R.

STA. 10+53
TYPE CP CASED
CROSSING TEST
STATION

130 LF TRENCHLESS CONST. W/CASING
(STA. 10+53 TO STA. 11+83)

BORE 12"

STA. 11+83
TYPE CP CASED
CROSSING TEST
STATION

REMOVE AND REPLACE
CULVERT AS NEEDED
TO FACILITATE CONST.

288-14

PROP. 60"
WATER LINE

20' W.L.E.

10' (TYP.)

REMOVE AND REPLACE
200 S.Y. OF SIDEWALK
(STA. 11+68 TO 15+00)

CAUTION:
EXISTING GAS PIPELINE LOCATIONS
AND ELEVATIONS HAVE NOT BEEN VERIFIED.
CONTRACTOR RESPONSIBLE FOR FIELD
VERIFICATION OF UNDERGROUND PIPELINES.

CP

CP

FLOW

BASELINE

ASPHALT PAVING

COPELAND RD.
(60' R.O.W.)
H.C.C.F. NO. D809383,
E959066, & G323847

CAUTION:
OVERHEAD POWER LINES

SEE CONSTRUCTION NOTES ON SHEET 4 FOR CONSTRUCTION REQUIREMENTS ON CYPRESS-FAIRBANKS ISD PROPERTY

HORIZ 0 10' 20' 40'
1"=20'

VERT 0 1' 2' 4'
1"=2'

THE LOCATION OF THE BURIED CABLES WITHIN THE PROJECT LIMITS HAVE NOT BEEN VERIFIED. BEFORE COMMENCING WORK CALL 1-800-344-8377 A MINIMUM OF 48 HOURS PRIOR TO CONSTRUCTION TO HAVE UNDERGROUND LINES FIELD-LOCATED.

130
128
126
124
122
120
118
116
114
112

MATCH LINE STA. 10+00

MATCH LINE STA. 15+00

w-row
e-row
18" rcp
18" rcp
18" rcp
w-ditch
e-ditch
e-ditch
e-road
existing 24" storm
8' MIN. COVER
existing 24" storm
existing 8" water
existing 8" water
existing 8" water
130 LF TRENCHLESS CONST. W/CASING
(STA. 10+53 TO STA. 11+83)
PROP. 60"
WATER LINE
FLOW
E=112.50
S=0.0%
VPI STA. 14+50
E=112.50
E=113.10
S=1.20%

10+00 11+00 12+00 13+00 14+00 15+00

BENCHMARK:

FLOODPLAIN REFERENCE MARK NUMBER 1101125 IS A HCFCD BRASS DISK STAMPED K100 6MID ON EAST SIDEWALK OF GRANT ROAD BRIDGE OVER CYPRESS CREEK APPROXIMATELY 0.80 MILE WEST OF JONES ROAD IN KEYMAP 369A IN THE CYPRESS WATERSHED NEAR STREAM K100-00-00. ELEV. 127.25 FEET. NAVD 1988 2001 ADJUSTMENT

HORIZONTAL DATUM:

ALL HORIZONTAL COORDINATES ARE BASED ON TEXAS STATE PLANE COORDINATE SYSTEM, SOUTH CENTRAL ZONE, NAD83. THE COORDINATES & DISTANCES SHOWN ARE SURFACE AND MAY BE CONVERTED TO GRID BY MULTIPLYING BY A SCALE FACTOR OF 0.99987000? (TxDOT factor).
100 YR FL=125.00'

TO ARRANGE FOR LINES TO BE TURNED OFF OR MARKED CALL CENTERPOINT ENERGY AT 713-207-2222.

NOTICE:

FOR YOUR SAFETY, YOU ARE REQUIRED BY TEXAS LAW TO CALL 811 AT 48 HOURS BEFORE YOU DIG SO THAT UNDERGROUND LINES CAN BE MARKED. THIS NOTIFICATION DOES NOT FULFILL YOUR OBLIGATION TO CALL 811.

PRIVATE UTILITY LINES SHOWN

CENTERPOINT ENERGY/UNDERGROUND ELECTRICAL FACILITIES VERIFICATION ONLY
Date 1-23-20

ONE SIGNATURE VERIFIES EXISTING UNDERGROUND FACILITIES – NOT TO BE USED FOR CONFLICT VERIFICATION) SIGNATURE VALID FOR SIX MONTHS.

CENTERPOINT ENERGY/NATURAL GAS FACILITIES VERIFICATION ONLY.
(THIS SIGNATURE VERIFIES THAT YOU HAVE SHOWN CNP NATURAL GAS LINES SUBMITTED – NOT TO BE USED FOR CONFLICT VERIFICATION.)
GAS SERVICE LINES ARE NOT SHOWN.) SIGNATURE VALID FOR SIX MONTHS.
Date 1-22-20

Accepted for AT&T Texas/SWBT underground conduit facilities only
SIGNATURE VALID FOR ONE YEAR

North Harris County
REGIONAL WATER
Authority

AECOM

AECOM TECHNICAL SERVICES, INC.
19219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094-1009
281.646.5400
WWW.AECOM.COM
TBPE REG. NO. F-3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28-B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

COPELAND ROAD BASELINE
PLAN AND PROFILE
STA. 10+00 TO 15+00

STATE OF TEXAS
CARL D. McCONNELL
97559
LICENSED
PROFESSIONAL ENGINEER

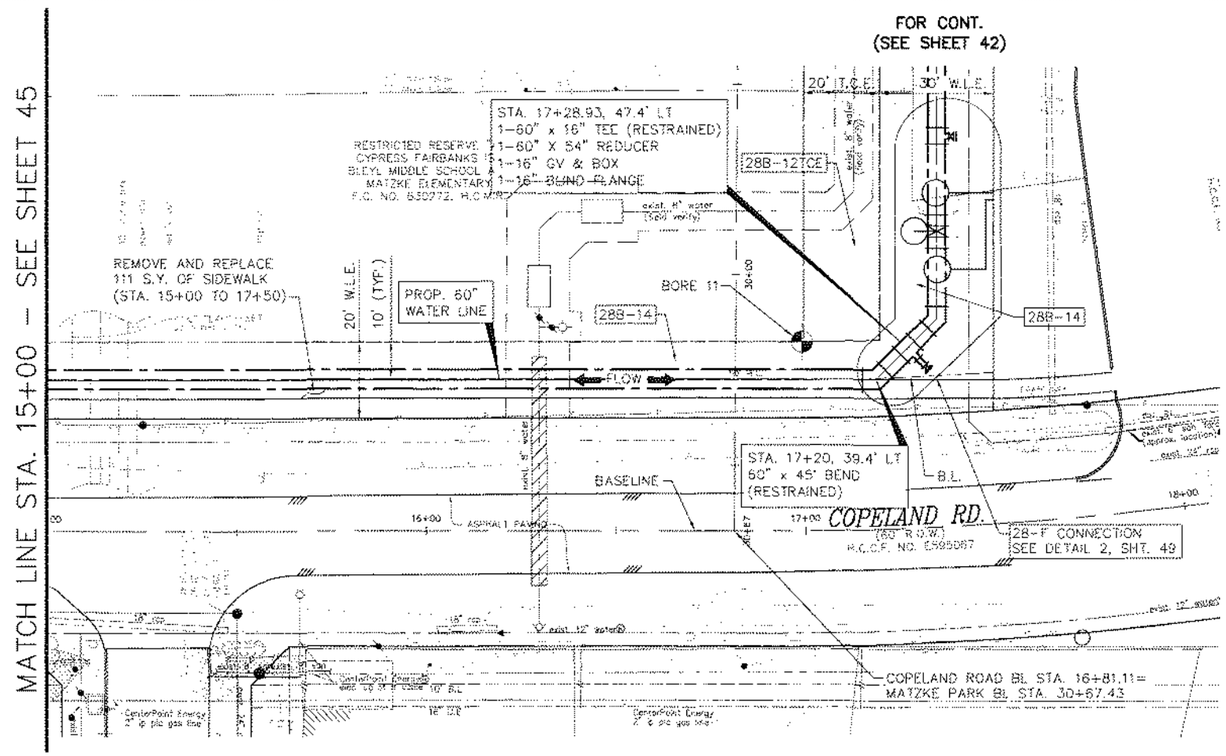
DRAWN BY:

CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

SHEET No: 45 OF 99

LAST MODIFIED: Jan 21, 2020 - 11:25am BY USER: jmay
DWG LOCATION: S:\1101\0\4975-01 NHCRWA PROJECT 28-B\ACAD\Drawings\Civil\
DWG NAME: 4975-01-45.dwg



THE LOCATION OF THE BURIED CABLES WITHIN THE PROJECT LIMITS HAVE NOT BEEN VERIFIED. BEFORE COMMENCING WORK CALL 1-800-344-8377 A MINIMUM OF 48 HOURS PRIOR TO CONSTRUCTION TO HAVE UNDERGROUND LINES FIELD-LOCATED.

CAUTION:
EXISTING GAS PIPELINE LOCATIONS AND ELEVATIONS HAVE NOT BEEN VERIFIED. CONTRACTOR RESPONSIBLE FOR FIELD VERIFICATION OF UNDERGROUND PIPELINES.

CAUTION:
OVERHEAD POWER LINES.

No.	Date	Revision	App.

BENCHMARK:

FLOODPLAIN REFERENCE MARK NUMBER 110125 IS A HCFCD BRASS DISK STAMPED K100 BMD ON EAST SIDEWALK OF GRANT ROAD BRIDGE OVER CYPRESS CREEK APPROXIMATELY 0.90 MILE WEST OF JONES ROAD IN KEYMAP 489A IN THE CYPRESS WATERSHED NEAR STREAM K100-00-00
ELEV. 127.25 FEET NAVD 1988 2001 ADJUSTMENT

HORIZONTAL DATUM:

ALL HORIZONTAL COORDINATES ARE BASED ON TEXAS STATE PLANE COORDINATE SYSTEM, SOUTH CENTRAL ZONE, NAD83. THE COORDINATES & DISTANCES SHOWN ARE SURFACE AND MAY BE CONVERTED TO GRID BY MULTIPLYING BY A SCALE FACTOR OF 0.99987917 (TxDOT factor).
100 YR FLOW=125 CFS

SEE CONSTRUCTION NOTES ON SHEET 4 FOR CONSTRUCTION RESTRICTIONS ON CYPRESS-FAIRBANKS ISD PROPERTY.

HORIZ 0 10' 20' 40'
1"=20'

VERT 0 1' 2' 4'
1"=2'

TO ARRANGE FOR LINES TO BE LOCATED OFF OF MONET ONE CENTERPOINT ENERGY AT 713-207-2224.

NOTICE:
FOR YOUR SAFETY, YOU ARE REQUIRED BY TEXAS LAW TO CALL 811 AT LEAST 48 HOURS BEFORE YOU DIG SO THAT UNDERGROUND LINES CAN BE MARKED. FAILURE/REFUSAL TO CALL 811.

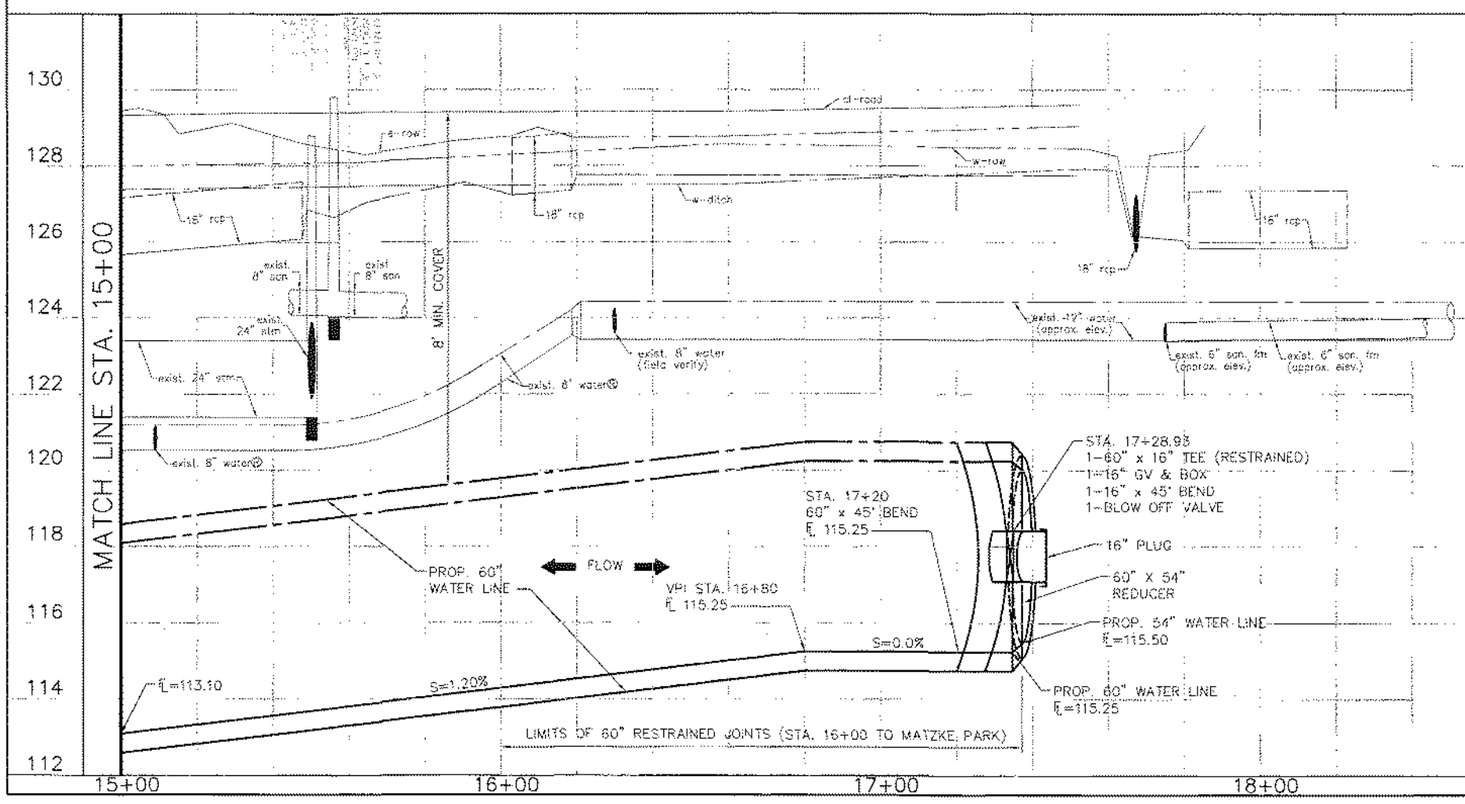
PRIVATE UTILITY LINES SHOWN

Date 1-23-20
CENTERPOINT ENERGY/UNDERGROUND ELECTRICAL FACILITIES VERIFICATION ONLY

(THIS SIGNATURE VERIFIES EXISTING UNDERGROUND FACILITIES - NOT TO BE USED FOR CONFLICT VERIFICATION.) SIGNATURE VALID FOR SIX MONTHS.

Date 1-23-20
CENTERPOINT ENERGY/NATURAL GAS FACILITIES VERIFICATION ONLY. (THIS SIGNATURE VERIFIES THAT YOU HAVE SHOWN OUR NATURAL GAS LINES CORRECTLY - NOT TO BE USED FOR CONFLICT VERIFICATION.) GAS SERVICE LINES ARE NOT SHOWN. SIGNATURE VALID FOR SIX MONTHS.

Date 1-22-20
Approved for AT&T Texas/SWBT underground conduit facilities only SIGNATURE VALID FOR ONE YEAR



North Harris County
REGIONAL WATER
Authority

AECOM TECHNICAL SERVICES, INC.
19219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094-1009
281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F-3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28-B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

COPELAND ROAD BASELINE PLAN AND PROFILE STA. 15+00 TO 18+00

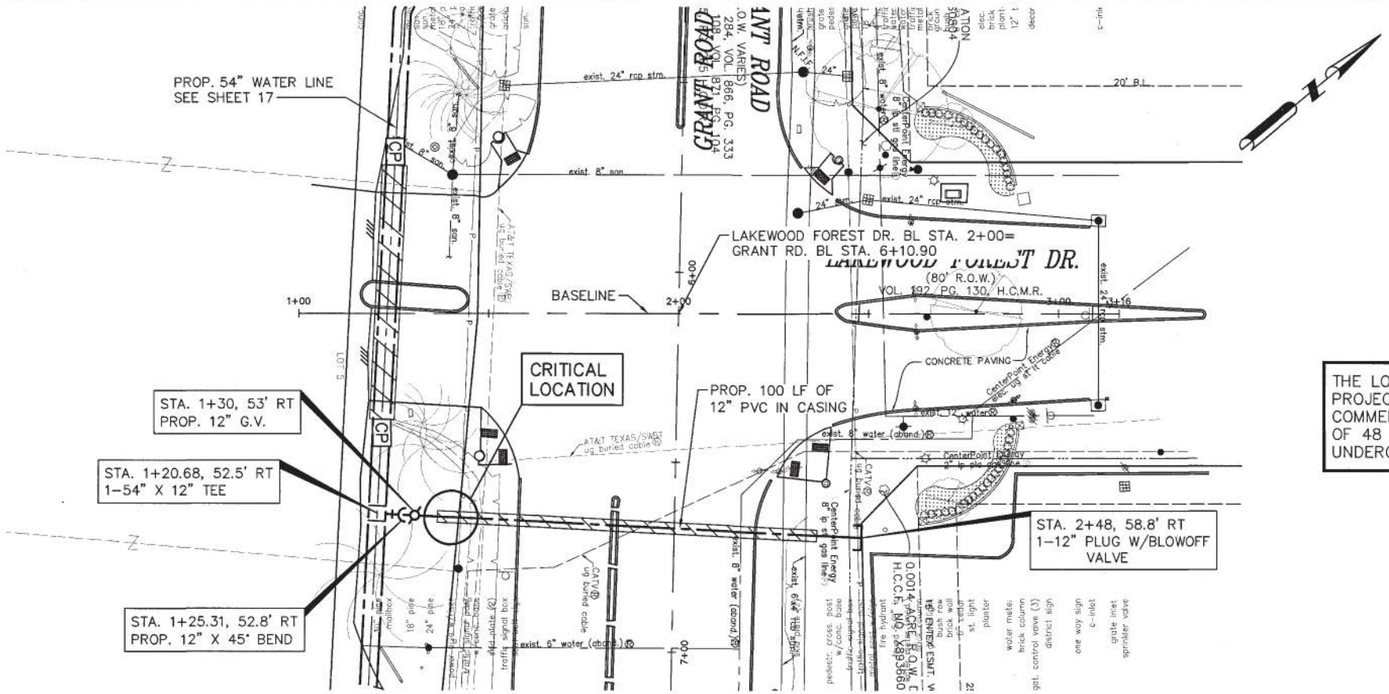
STATE OF TEXAS
CARL D. McCONNELL
97885
LICENSED
PROFESSIONAL ENGINEER

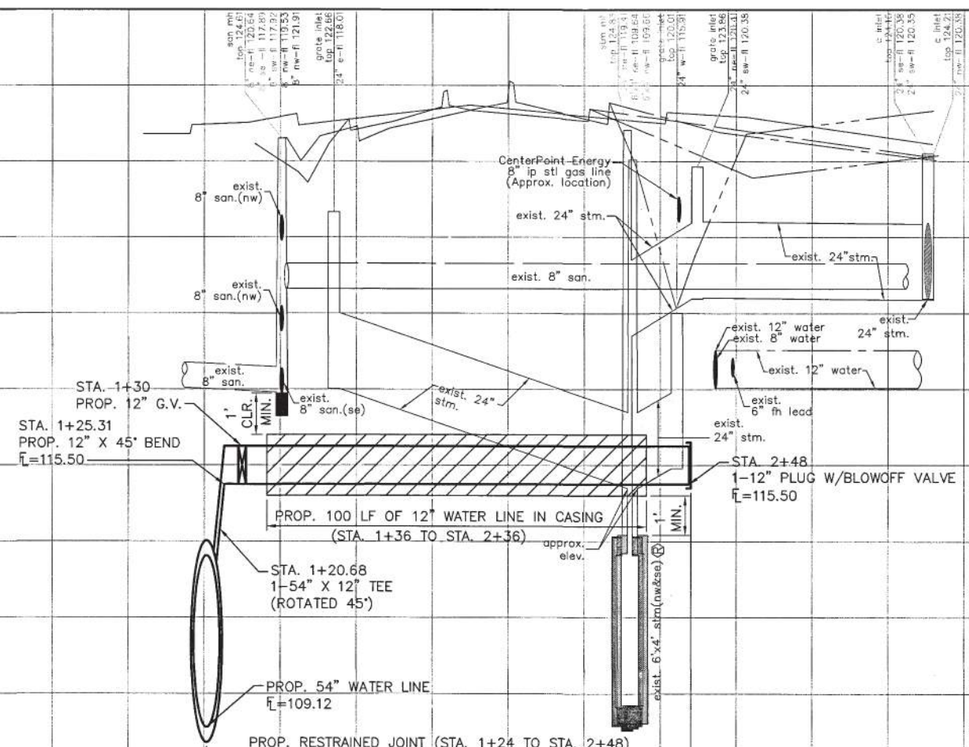
DRAWN BY: | CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 526-9573

SHEET No: 46 OF 99

LAST MODIFIED: Jan 21, 2020 - 11:26am BY USER: jerry
DWG LOCATION: G:\1101\4876-01 N-HCRWA PROJECT 28-B\ACAD\Drawings\Civil\
DWG NAME: 4876-01_46.dwg





CAUTION:
OVERHEAD POWER LINES.

CAUTION:
EXISTING GAS PIPELINE LOCATIONS AND ELEVATIONS HAVE NOT BEEN VERIFIED. CONTRACTOR RESPONSIBLE FOR FIELD VERIFICATION OF UNDERGROUND PIPELINES.

THE LOCATION OF THE BURIED CABLES WITHIN THE PROJECT LIMITS HAVE NOT BEEN VERIFIED. BEFORE COMMENCING WORK CALL 1-800-344-8377 A MINIMUM OF 48 HOURS PRIOR TO CONSTRUCTION TO HAVE UNDERGROUND LINES FIELD-LOCATED.

No.	Date	Revisions	App.

BENCHMARK:

FLOODPLAIN REFERENCE MARK NUMBER 110125 IS A HCFCD BRASS DISK STAMPED K100 BM10 ON EAST SIDEWALK OF GRANT ROAD BRIDGE OVER CYPRESS CREEK APPROXIMATLEY 0.90 MILE WEST OF JONES ROAD IN KEYMAP 369A IN THE CYPRESS WATERSHED NEAR STREAM K100-00-00
ELEV. 127.25 FEET NAVD 1988 2001 ADJUSTMENT

HORIZONTAL DATUM:

ALL HORIZONTAL COORDINATES ARE BASED ON TEXAS STATE PLANE COORDINATE SYSTEM, SOUTH CENTRAL ZONE, NAD83. THE COORDINATES & DISTANCES SHOWN ARE SURFACE AND MAY BE CONVERTED TO GRID BY MULTIPLYING BY A SCALE FACTOR OF 0.999870017 (TxDOT factor).
100 YR FL=125.00'

HORIZ 0 10' 20' 40' 1"=20'

VERT 0 1' 2' 4' 1"=2'

TO ARRANGE FOR LINES TO BE TURNED OFF OR MOVED CALL CENTERPOINT ENERGY AT 713-207-2222.

NOTICE:

FOR YOUR SAFETY, YOU ARE REQUIRED BY TEXAS LAW TO CALL 811 AT 48 HOURS BEFORE YOU DIG SO THAT UNDERGROUND LINES CAN BE MARKED. THIS VERIFICATION DOES NOT FULFILL YOUR OBLIGATION TO CALL 811.

PRIVATE UTILITY LINES SHOWN

Date: 1-23-20
CENTERPOINT ENERGY/UNDERGROUND ELECTRICAL FACILITIES VERIFICATION ONLY
(THE SIGNATURE VERIFIES EXISTING UNDERGROUND FACILITIES – NOT TO BE USED FOR CONFLICT VERIFICATION.) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-23-20
CENTERPOINT ENERGY/NATURAL GAS FACILITIES VERIFICATION ONLY.
(THIS SIGNATURE VERIFIES THAT YOU HAVE SHOWN CNP NATURAL GAS LINES CORRECTLY – NOT TO BE USED FOR CONFLICT VERIFICATION.)
(GAS SERVICE LINES ARE NOT SHOWN.) SIGNATURE VALID FOR SIX MONTHS.

Date: 1-22-20
Approved for AT&T Texas/SWBT underground conduit facilities only. SIGNATURE VALID FOR ONE YEAR

North Harris County REGIONAL WATER Authority

AECOM
AECOM TECHNICAL SERVICES, INC.
19219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094-1009
281.646.2400
WWW.AECOM.COM
TBPE REG. NO. F-3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28-B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

LAKEWOOD FOREST DR. BASELINE PLAN AND PROFILE STA. 1+00 TO 3+00

STATE OF TEXAS
CARL D. McCONNELL
97585
LICENSED
PROFESSIONAL ENGINEER
1/27/2020

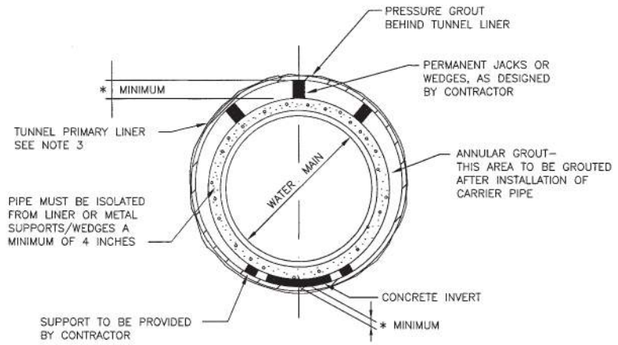
DRAWN BY: | CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

SHEET No: 47 OF 99

LAST MODIFIED: Jan 21, 2020 – 10:12am BY USER: yimvy
DWG. LOCATION: G:\1110\4876-01 NHCRWA PROJECT 28-B\ACAD\Drawings\Civil\
DWG. NAME: 4876-01_47.dwg

No.	Date	Revisions	App.



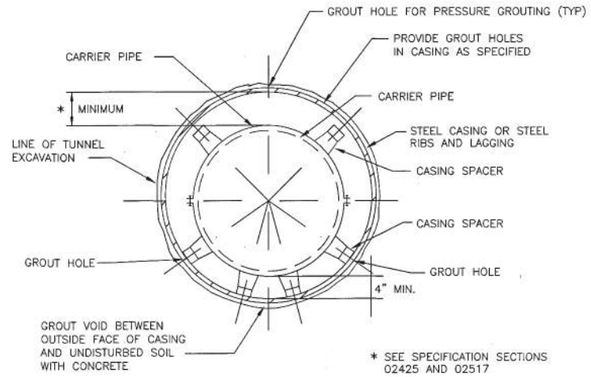
* SEE SPECIFICATION SECTIONS 02425 AND 02517

NOTES:

1. DETAIL IS FOR PRESTRESSED CONCRETE CYLINDER PIPE (STEEL PIPE AND D.I.P. ALTERNATE SIMILAR).
2. MINMUM CLEARANCES SHOWN ON THE PLAN & PROFILE DRAWINGS ARE TO THE O.D. OF TUNNEL LINER. ADJUST PROFILE AS REQUIRED TO MAINTAIN CLEARANCES IDENTIFIED. NO SEPARATE PAY.
3. CONTRACTOR TO PROVIDE SUBMITTAL OF THE TUNNEL LINER DESIGN SIGNED AND SEALED BY A PROFESSIONAL ENGINEER.

(1) TUNNEL DETAIL

(FOR WATER MAINS 36 INCHES AND LARGER)



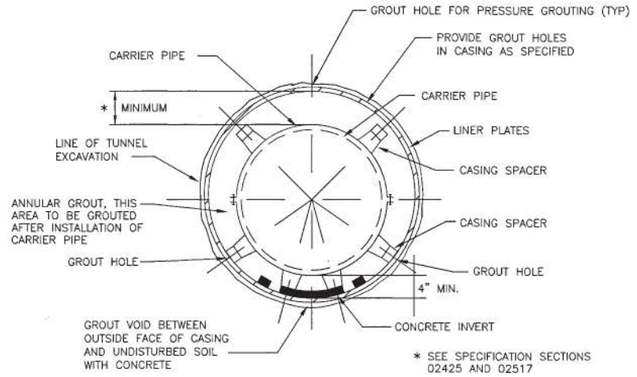
* SEE SPECIFICATION SECTIONS 02425 AND 02517

NOTES:

1. DETAIL IS FOR PVC PIPE (PRESTRESSED CONCRETE CYLINDER PIPE, STEEL PIPE, AND D.I.P. ALTERNATE SIMILAR).
2. MINMUM CLEARANCES SHOWN ON THE PLAN & PROFILE DRAWINGS ARE TO THE O.D. OF TUNNEL LINER. ADJUST PROFILE AS REQUIRED TO MAINTAIN CLEARANCES IDENTIFIED. NO SEPARATE PAY.
3. CONTRACTOR TO PROVIDE SUBMITTAL OF THE TUNNEL LINER DESIGN SIGNED AND SEALED BY A PROFESSIONAL ENGINEER.

(2) TUNNEL DETAIL

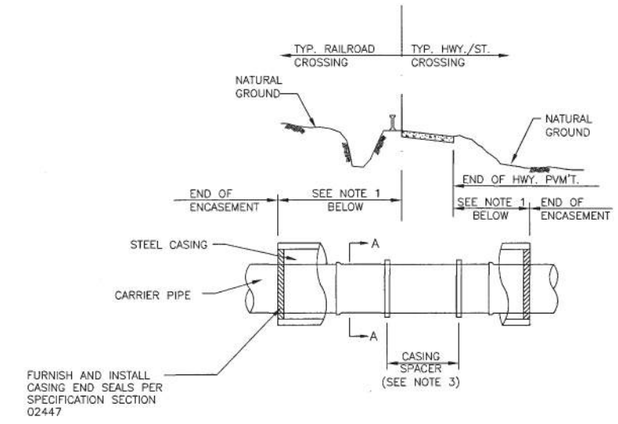
(FOR WATER MAINS LESS THAN 36 INCHES WITH STEEL CASING OR STEEL RIBS AND LADDING)



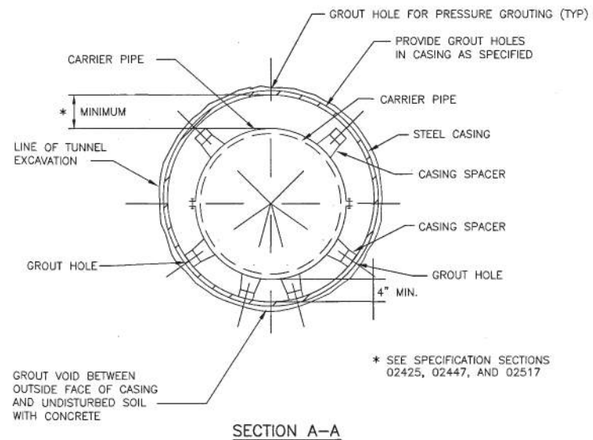
* SEE SPECIFICATION SECTIONS 02425 AND 02517

(3) TUNNEL DETAIL

(FOR WATER MAINS LESS THAN 36 INCHES WITH LINER PLATES)



ELEVATION



* SEE SPECIFICATION SECTIONS 02425, 02447, AND 02517

SECTION A–A

NOTES:

1. LENGTH OF ENCASEMENT SHALL BE AS SHOWN ON THE PLAN & PROFILE DRAWINGS.
2. LAY CASING PIPE IN OPEN CUT, TUNNEL OR BORE, AS NOTED ON PLAN & PROFILE DRAWINGS.
3. SEE SPECIFICATION SECTIONS 02447 AND 02517 FOR APPROPRIATE MODEL ACCORDING TO PIPE DIAMETER.

NOTE

1. ALL CASING IN PPCM AREA TO BE GROUTED.

(4) CASING DETAIL FOR DRY SLURRY AUGERING OF PIPE AND CONDUIT

(FOR WATER MAINS LESS THAN 36-INCHES IN DIAMETER)

North Harris County REGIONAL WATER Authority

AECOM
AECOM TECHNICAL SERVICES, INC.
19219 KATY FREEWAY, SUITE 100
HOUSTON, TEXAS 77094-1009
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TBPE REG. NO. F-3580

NORTH HARRIS COUNTY REGIONAL WATER AUTHORITY
PROJECT 28-B
PROPOSED 60" AND 54" WATER LINE ALONG GRANT ROAD AND COPELAND ROAD

TUNNEL AND CASING DETAILS

STATE OF TEXAS
CARL D. McCONNELL
97585
LICENSED PROFESSIONAL ENGINEER
11/2/2020

DRAWN BY:	CHECKED BY:

DANNENBAUM
ENGINEERING CORPORATION
T.B.P.E. FIRM REGISTRATION #392
3100 WEST ALABAMA HOUSTON, TEXAS 77098 (713) 520-9570

SHEET No: 54 OF 99

REVISION DATE: 6/26/14

REPORT
GEOTECHNICAL INVESTIGATION
PROPOSED NHCRWA CONTRACT NO. 28-B
2025 WATER DISTRIBUTION
AND TRANSMISSION SYSTEM
HARRIS COUNTY, TEXAS

PREPARED FOR:

Dannenbaum Engineering Corporation
3100 West Alabama
Houston, Texas 77098

PREPARED BY:

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091-3312

HTS Project No. 16-S-299

December 30, 2016

HTS, Inc. Consultants
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Excellence in Engineering, Consulting, Testing and Inspection

May 27, 2020

Dannenbaum Engineering Corporation
3100 West Alabama
Houston, Texas 77098

Attn: Mr. Carl D. McConnell, P.E. PMP
Ms. Kathy Bender

Re: Report
Geotechnical Investigation
Proposed NHCRWA Contract No. 28-B
2025 Water Distribution and Transmission System
Harris County, Texas

HTS Project No.: 16-S-299

Dear Mr. McConnell:

HTS, Inc. Consultants is pleased to submit our final geotechnical investigation report for the above referenced project. This report includes the results of field and laboratory testing as well as geotechnical recommendations pertaining to the proposed project.

We appreciate the opportunity to perform this geotechnical investigation 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 us at your convenience.

Respectfully submitted,
HTS, Inc. Consultants

Jubair Hossain, Ph.D., P.E.
Vice President

5-27-20

HTS, Inc. Consultants
F-3478

BFM:ba:JH/cg

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GEOTECHNICAL INVESTIGATION
PROPOSED NHCRWA CONTRACT NO. 28-B
2025 WATER DISTRIBUTION AND TRANSMISSION SYSTEM
HARRIS COUNTY, TEXAS

1.0 INTRODUCTION AND SUMMARY

1.1 Introduction

This report presents the results of a geotechnical investigation pertaining to the design and construction of the proposed 2025 water distribution and transmission system which includes approximately ±9,800 l.f. of 54-inch and 60-inch water line replacement along Grant Road starting from Lakewood Forest Drive, crossing Cypress Creek (HCFCD Unit No. K100-00-00), to Anderson Wood Drive, then crossing Anderson Ditch (HCFCD Unit No. K143-00-00), Jones Road, and Matzke Park, then along Copeland Drive to Mills Road in Harris County, Texas. The site location is shown in Figures 1 and 2A through 2D.

This geotechnical investigation was performed by HTS, Inc. Consultants (HTS) for North Harris County Regional Water Authority (NHCRWA) and Dannenbaum Engineering Corporation (DEC) in accordance with HTS Proposal No. DEC-3852 Revised dated February 6, 2015 and authorization by DEC through a contract for professional engineering services dated July 21, 2016.

The scope of work for this geotechnical investigation consisted of:

- **drilling and sampling a total of 13 geotechnical borings (Boring Nos.1 through 13) where 9 geotechnical borings (Boring Nos. 1, 4 through 7, and 10 through 13) were drilled to a depth of 20 feet along the proposed pipeline alignment, 2 geotechnical borings (Boring Nos. 2 and 3) were drilled to depths of 50 and 55 feet at the embankments of Cypress Creek, and 2 geotechnical borings (Boring Nos. 8 and 9) were drilled to depths of 50 and 55 feet at the embankments of Anderson Ditch, as shown in Figure 2A through 2D,**

- **performing field tests during drilling and recovering both disturbed and relatively undisturbed soil samples,**

- **measuring the depth to groundwater during drilling, approximately 10 minutes after the water is initially encountered, as applicable, and after the completion of drilling, as applicable,**

- **installing piezometers in Boring Nos. 2 and 9, and measuring the groundwater levels 2 weeks and 1 month after the installation of the piezometers,**

- **backfilling the borings with cement grout after the completion of the groundwater measurements,**

- **visually classifying samples obtained from the borings and conducting laboratory tests to determine the physical and mechanical properties of the soils,**

- **analyzing the field and laboratory test data,**

- **preparing gINT boring logs and soil profiles based on visual soil classifications and the results of laboratory tests,**

- **completing engineering analyses to develop recommendations pertaining to dewatering requirements for the water line excavations, water line trench shoring and bracing requirements, OSHA soil type classifications pertinent to trench shoring and bracing design, utility excavation/backfill requirements, and utility bedding requirements in accordance with the City of Houston or NHCRWA construction specifications/ design manuals,**

- **completing engineering analyses for the purpose of developing and providing recommendations for tunneling at the roadway/pipeline crossings, as applicable,**

- **developing/providing recommendations concerning lateral earth pressures that may be used for design of below ground structures,**

- **submitting a pdf file of the final report which presents the results of the geotechnical investigation, and**

- **submitting a final report of the geotechnical investigation.**

1.2 Description of Proposed Facilities

The proposed 2025 water distribution and transmission system includes approximately ±9,800 l.f. of 54-inch and 60-inch water line replacement along Grant Road starting from Lakewood Forest Drive to Anderson Wood Drive, then crossing Anderson Ditch, Jones Road, and Matzke Park, then along Copeland Drive to Mills Road in Harris County, Texas. Pipe installation at the roadways, Anderson Ditch (HCFCD Unit No. K143-00-00), and Cypress Creek (HCFCD Unit No. K100-00-00) crossings will include underground tunneling with steel casings. The water line material type, and invert depths were not available at the time of this geotechnical investigation.

1.3 Summary of Findings

The pertinent findings of this geotechnical investigation are provided below.

1.3.1 Subsurface Soil Strata

The subsurface soil strata at the locations of the 13 geotechnical borings are described by the soil properties provided in Tables 1 through 4B, Figures 4 through 13, on the Log of Borings provided in Appendix A, and the soil profiles shown in Figures 3A and 3B.

Data from the borings suggest that the upper 50 feet of overburden soils along the proposed water pipeline route consist of 5 soil layers. HTS has designated these 5 soil layers as Layers I through V as described below.

LAYER	DEPTH BELOW GROUND SURFACE (FT)	SOIL DESCRIPTION
I	0 – 8	Light gray, dark gray, gray, tan, and light tan CLAYEY SAND, SILTY SAND, and SILTY CLAYEY SAND, loose to dense with ferrous nodules, clay pockets, concrete and brick pieces, and roots (not encountered in Boring No. 7).
IIa	1 – 18	Light gray, gray, light tan, and tan SANDY LEAN CLAY, LEAN CLAY, SANDY SILTY CLAY, and LEAN CLAY WITH SAND, stiff to hard with ferrous nodules, calcareous nodules, sand fissures, silt pockets, sand seams, and sand pockets. Note: A layer of fill material consisting of gray, light gray, and tan SANDY LEAN CLAY, stiff with roots was encountered in Boring No. 7 from the surface to a depth of 6 feet below the ground surface.
IIb	8 – 18	Light gray, reddish brown, and tan FAT CLAY, stiff to very stiff with sand fissures, sand pockets, sand seams, and silt seams (only encountered in Boring Nos. 1, 7, 11, and 12).
III	10 – 38	Light gray, reddish brown, tan, and light tan CLAYEY SAND, SILTY SAND, and POORLY GRADED SAND WITH SILT, very loose to very dense with ferrous nodules, calcareous nodules, clay seams, clay pockets, clay seams, and gravel.
IVa	28 – 48	Light gray, reddish tan, and tan FAT CLAY and FAT CLAY WITH SAND, stiff to hard with ferrous nodules, silt pockets, and slickensides (only encountered in Boring Nos. 2, 3, 8, and 9).
IVb	38 – 55	Gray, light gray, light tan, reddish brown, and tan LEAN CLAY and SANDY LEAN CLAY, stiff to hard with ferrous nodules, sand seams, sand pockets, and sand fissures (only encountered in Boring Nos. 2, 8, and 9).
V	43 – 55	Light tan and tan SILTY SAND, dense to very dense.

Laboratory testing was performed on samples of the subsurface materials obtained to classify the soils in accordance with ASTM D 2487 and to define the engineering properties of the soils. Portions of the test results indicating the high and low values of specific testing are provided in the table below:

LAYER	DEPTH (FT)	LIQUID LIMIT (%)		PLASTICITY INDEX (%)		MOISTURE CONTENT (%)		PASSING NO. 200 SIEVE (%)		UNCONFINED COMPRESSIVE STRENGTH (TSF)	
		HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW
I	0 – 8	21	NP	6	NP	16.8	3.2	42.9	16.8	0.5*	
IIa	1 – 18	47	24	30	9	22.1	9.5	74.0	51.3	10.1	1.3
IIb	8 – 18	63		42		24.4	18.8	95.8		3.8	2.4
III	10 – 38	37	NP	21	NP	19.6	3.9	43.8	11.2	4.3*	0.7*
IVa	28 – 48	85	76	61	53	35.3	15.4	90.1	80.6	1.9	1.1
IVb	38 – 55	45	22	26	8	25.8	13.2	91.2	63.3	3.7	2.2

NP - Non Plastic * Test was performed on clayey sand and silty clayey samples only.

Note: The sandy lean clay fill layer encountered in Boring No. 7 has a liquid limit of 28%, a plasticity index of 13%, a moisture content of 17.1%, and a percent soil passing the No. 200 sieve of 61.7%.

Consolidated Undrained (CU) Triaxial Soil Test Results

Given below is a table of the total and effective strength parameters of site soil samples based on the results of our laboratory testing. The results of the CU triaxial testing are provided in Figures 12 and 13 of this report.

BORING NO. (DEPTH)	TYPE OF MATERIAL	WET DENSITY (PCF.)	SAT. DENSITY (PCF.)	TOTAL STRENGTH PARAMETERS	EFFECTIVE STRENGTH PARAMETERS
B-9 (6' – 8')	LEAN CLAY WITH SAND	133.5	135.7	C =380.9 PSF Φ = 17.4°	C =289.3 PSF Φ= 22.5°
B-3 (16' – 18')	SANDY LEAN CLAY	124.9	131.7	C =406.5 PSF Φ = 19.6°	C =313.2 PSF Φ = 25.4°

Results of the Pinhole Testing

A pinhole dispersion testing was performed on selected soil samples obtained from the field investigation. The results of pinhole "dispersion" testing performed on the site soils for the current study are summarized below and are shown on the boring logs provided in Appendix A as well as in Tables 1 and 2.

BORING NO.	DEPTH (FT.)	SOIL LAYER NO.	TYPE OF MATERIAL	DISPERSION CHARACTERISTIC
3	10 – 12	IIA	SANDY LEAN CLAY (CL)	ND2 (SLIGHTLY DISPERSIVE)
9	4 – 6	IIA	SANDY LEAN CLAY (CL)	ND2 (SLIGHTLY DISPERSIVE)

The results of the pinhole dispersion testing on selected undisturbed soil samples obtained from the geotechnical borings revealed that the lean clay soils exhibited slightly dispersive characteristic (classified as ND2). The results of the pinhole testing are provided in Tables 3A and 3B of this report.

Results of the Crumb Testing on Clayey Soils

The results of the crumb testing on selected disturbed soil samples obtained from the geotechnical borings revealed that the sandy lean clay and lean clay with sand soils exhibited non-dispersive characteristics (classified as Grade 1). The results of the crumb testing are provided in Table 2 of this report.

Results of the Permeability Testing on Clayey Soils

Given below is a table of the permeability coefficients of site soil samples. The results of the permeability testing are provided in Tables 4A and 4B of this report.

BORING NO.	DEPTH (FT.)	SOIL LAYER NO.	TYPE OF MATERIAL	PERMEABILITY COEFFICIENT (K, CM/S)
3	18 – 20	III	CLAYEY SAND (SC)	1.46E-07
8	8 – 10	IIA	SANDY LEAN CLAY (CL)	6.33E-08

1.3.2 Groundwater

Groundwater measurements were obtained during drilling and after completion of drilling as applicable. Due to use of wet rotary, groundwater readings were obtained 10 minutes after water was initially encountered, as applicable, for Boring Nos. 2, 3, 8, and 9. The results of the groundwater measurements are presented in the table below:

BORING NO.	TOTAL DEPTH OF BORING (FT.)	DEPTH TO WATER DURING DRILLING (FT.)	DEPTH TO WATER APPROXIMATELY 10 MINUTES AFTER WATER WAS INITIALLY ENCOUNTERED (FT.)	DEPTH TO WATER AFTER COMPLETION OF DRILLING (FT.)	DEPTH TO OBSTRUCTION AFTER SECOND GROUNDWATER MEASUREMENT (FT.)
1	20	Dry	--	Dry	19.2
2	55	Dry to 20*	--	16.5**	24.9
3	50	24.3	23.7	14.5**	23.4
4	20	16.0	15.1	Dry	15.9
5	20	Dry	--	Dry	18.8
6	20	Dry	--	Dry	19.2
7	20	Dry	--	Dry	19.2
8	55	23.0	22.3	18.0**	21.8
9	50	23.0	23.5	16.9**	22.8
10	20	Dry	--	Dry	18.6
11	20	Dry	--	Dry	19.0
12	20	Dry	--	Dry	19.0
13	20	Dry	--	Dry	18.8

Note: Depths are referenced from the existing ground surface elevation at the time the borings were drilled.
* Prior to the use of the drilling fluid.
** Likely influenced by drilling fluid used to keep an open boring.
-- Not applicable.

The borings were backfilled with cement grout after the groundwater measurements were obtained.

Piezometers were installed at the locations of Boring Nos. 2 and 9 to define ground water level conditions in a longer period of time. The water levels were measured at 2 weeks and 1 month after installation and the results are as provided below and in Figures 14 and 15:

BORING NO. (PIEZOMETER NO.)	2-WEEKS AFTER INSTALLATION		1 MONTH AFTER INSTALLATION	
	DEPTH TO GROUNDWATER (FT.)	ELEVATION (FT.-MSL)	DEPTH TO GROUNDWATER (FT.)	ELEVATION (FT.-MSL)
2 (PZ-1)	27.7	+18.71	30.0	+16.41
9 (PZ-2)	23.7	+19.94	23.8	+19.84

1.4 Summary of Recommendations

The recommendations as summarized below are provided for use in the design and construction of the proposed water distribution and transmission system.

1.4.1 Water Line Design, Bedding, and Backfill Requirements

Water lines may be designed by using conventional conduit formulas and assuming a negative projection condition for the computation of loadings.

The total load on water lines will consist of the weight of the compacted backfill above the pipe, the weight of the pavement, and live loadings where applicable. The wet unit weight of compacted backfill is estimated to be 130 pounds per cubic foot (pcf) for clayey sand/lean clay backfill material.

Earthwork should conform to applicable provisions of Section 02317 titled "Excavation and Backfill for Utilities" and Section 02447 titled "Augering Pipe and Conduit" from the most recent version of City of Houston Department of Public Works and Engineering (COH-DPWE) "Standard Construction Specifications for Wastewater Collection Systems, Water Lines, Storm Drainage, Street Paving, and Traffic" (most recent COH-DPWE Standard Specifications).

Water line trenches should be excavated with trench widths that comply with the requirements of Subsection 3.05, Subparagraph C, page 02317-11 of Section 02317 of the above-referenced COH-DPWE Standard Specifications. Trench foundation for water lines should be prepared in accordance with Subsection 3.07 of Section 02317 of the above-referenced COH-DPWE Standard Specifications.

Bedding for the proposed water lines should be designed and installed as specified by Section 02317, Section 02447, Section 02511, Section 02512, and Drawing Nos. 02317-04 and 02447-01 of the above-referenced COH-DPWE Standard Specifications.

Backfill for water line excavations should consist of bank run sand or suitable earth fill as specified in Section 02320 of the above-referenced COH-DPWE Standard Specifications. Backfill should be placed in accordance with Section 02317 of the above-referenced COH-DPWE Standard Specifications.

1.4.2 Water Line Excavation Dewatering Requirements

Groundwater was encountered at depths ranging from 16.0 to 24.3 feet during drilling in only 4 of the 13 borings. Groundwater was encountered only in Boring Nos. 3, 4, 8, and 9 and the rest of the borings were dry, except in Boring No. 2 where the boring was dry to 20 feet and caved in before drilling fluid was used. Approximately 10 minutes after water was initially encountered, groundwater was measured at depths ranging from 15.1 to 23.7 feet beneath

the existing surface in the same 4 borings. Accordingly, it is not expected that groundwater will be present for excavations that are no deeper than about 14 feet beneath the surface. However, the Layer III sands may be part of a water bearing stratum that could hold water after prolonged wet periods or after heavy rainfall events. The use of sumps and pumps may be adequate for clayey soil above the groundwater levels previously provided. The use of well points, vacuum well points, or a comparable dewatering system may be required to dewater the excavations extending below the groundwater levels where the exposed soils consist of the site sands. Control of groundwater and surface water during the installation of the underground utilities should be performed in accordance with Section 01578 of the most recent version of COH-DPWE Standard Specifications.

1.4.3 Temporary Shoring and Bracing Requirements for Water Line Excavations

The contractor should ensure designing and constructing stable protection systems for excavations such as support systems, sloping and benching systems, shield systems, and other systems that provide protection.

Temporary special shoring, for use in the installation of structures or utilities that will require excavations deeper than 5 feet, should consist of vertical or sloped cuts, benches, shields, support systems, or other systems that will provide necessary protection in accordance with OSHA Standards and Interpretations, 29 CFR 1926, Subpart P, "Excavations".

If OSHA Standards and Interpretations, 29 CFR 1926, Subpart P, "Excavations" is used for the design of temporary excavation protection systems, the site Layers II and IV clays should be categorized as Type B soils while the Layers I and III sands should be categorized as Type C soils. The definitions of Type B and Type C soils are provided in Appendix A of the OSHA Standards and Interpretations, 29 CFR 1926, Subpart P, "Excavations" (www.osha.gov). In order to eliminate the potential for caving of trench excavations, trench safety shall be implemented for trench excavations that are deeper than 5 feet. The data, parameters, and recommendations provided in Appendix B titled "Trench Excavation Report" may be used.

1.4.4 Pipe Installation Under Roadway Right-of-Ways, Anderson Ditch, and Cypress Creek (Jacking, Boring, or Tunneling)

It is our understanding that the waterline installation at the roadways, existing pipelines, Anderson Ditch, and Cypress Creek crossings will be performed using underground tunneling with steel casing. Depending on tunneling depths and ground water fluctuations, groundwater could be expected within the tunneling path during the installation of the casing. It is recommended that the groundwater levels within the installation areas be monitored prior to the installation activities. Additionally, test pits on both ends of the installation

alignment may also be excavated prior to the construction activities in order to determine the actual groundwater levels. If the groundwater level is within the path of the tunneling operation, the water level must be lowered to at least 2 feet beneath the bottom of the proposed casing. Groundwater dewatering may be accomplished using well points, vacuum well points, or any other suitable dewatering system where sandy materials are encountered.

Tunneling operations for the installation of the proposed water line under the roadways, existing pipelines, Anderson Ditch, and Cypress Creek shall conform with applicable guidelines and regulations of the governing agency within the project area; and/or the guidelines and requirements of Item 431 titled "Jacking, Boring or Tunneling Pipe" and Item 432 titled "Tunnel Construction" of the most recent Harris County Engineering Department (HCED) Specifications titled "Specifications for the Construction of Roads and Bridges within Harris County, Texas" or subchapter F titled "Water Line Crossings" in Chapter 7 titled " Water Line Design Requirements" of City of Houston Infrastructure Design Manual dated July 01, 2016 and in accordance with the Section 02425 entitled "Tunnel Excavation and Primary Liner" of the 2016 COH-DPWE Standard Specifications.

In trenchless excavation for the portion of the water line under the existing roadway, tunnel shafts will be required. These shafts need to be shored because the side walls are normally cut vertical because of space limitation and/or to conserve space. Tunnel shafts should be designed as braced excavations in accordance with the applicable previous sections for open cut excavations. Tunnel shafts should be constructed in accordance with Section 02400 entitled "Tunnel Shafts" of the 2016 COH-DPWE Standard Specifications.

1.4.5 Earth Pressure Design Parameters for Long Term Conditions

Earth pressure coefficients may be used to define the lateral loads exerted by the overburden soils on underground structures. Earth pressure coefficients, as provided in this report, were computed by using Rankines' methods. Earth pressure design parameters provided in this report for use in designing below ground structures, are based on effective stress, shear strength parameters. Long term, effective stress, shear strength parameters should be used for the design of permanent underground structures. Below ground structures at the proposed site may be designed by using the following design parameters:

ON SITE SOILS	WEIGHT OF EQUIVALENT FLUID FOR ACTIVE CASE (PCF)	WEIGHT OF EQUIVALENT FLUID FOR PASSIVE CASE (PCF)	ACTIVE EARTH PRESSURE COEFFICIENT (K_A)	PASSIVE EARTH PRESSURE COEFFICIENT (K_P)	EFFECTIVE STRESS ANGLE OF INTERNAL FRICTION (°)*	EFFECTIVE STRESS COHESION (PSF)*	WET UNIT WEIGHT (PCF)
Sands	86	276	0.33	3.00	30	0	134
Lean Clays	95	271	0.45	2.88	22.5**	290**	135
Fat Clays	98	218	0.53	2.32	18	200	129

* Estimated Value.
** Values obtained from CU triaxial testing.

The weights of equivalent fluid shown above, include hydrostatic forces but do not include surcharge forces imposed by construction equipment or vehicular loadings. Surcharge forces must be considered in order to compute maximum stresses for use in the design of below ground structures.

The weights of equivalent fluid for the passive case and the passive earth pressure coefficients shown above do not include a safety factor. It is recommended that for design purposes, a factor of safety of 2 be applied to the effective stress angle of internal friction to calculate for the passive case and the passive earth pressure coefficients. With the use of a safety factor of 2, the weights of equivalent fluid for the passive case will be 166, 189, and 183 pcf for the site fat clays, lean clays, and sands, respectively. The passive earth pressure coefficients will be 1.55, 1.75, and 1.70 pcf for the site fat clays, lean clays, and sands, respectively.

2.0 FIELD INVESTIGATION

A total of 13 geotechnical borings were drilled for this current geotechnical investigation on October 3, 7, 10, 11, 13, 28, and 29, 2016. The boring locations, as shown in Figures 2A through 2D, were selected by DEC and located/staked in the field by HTS. Drilling, sampling, and testing were performed in accordance with applicable ASTM procedures by using a truck-mounted drill rig and conventional auger and wet rotary methods. Van and Sons Drilling Company performed drilling under contract to HTS and under the supervision of an HTS engineering technician.

Soil sampling during the drilling of the geotechnical borings consisted of continuous sampling to between 12 and 20 feet, depending on the purpose of the boring, and intermittent sampling thereafter, with both disturbed and relatively undisturbed samples being obtained.

Disturbed soil samples were taken from the auger of the sampler or in conjunction with standard penetration test procedures. The standard penetration test (SPT) blow count is defined as the number of SPT hammer blows that are required to advance a split spoon sampler 1 foot into the soil. One SPT hammer blow consists of a 140-pound hammer free

falling for a distance of 30 inches. The results of the standard penetration test provide a basis for estimating the relative strength and compressibility of the soil profile components. The samples recovered were removed from the auger of the sampler or the split spoon sampler and placed into airtight plastic bags.

Relatively undisturbed samples were obtained by hydraulically forcing sections of 3-inch O.D. tubing (Shelby tube) into the subsoils. The tube samples were extruded in the field, sealed with foil, and placed into airtight plastic bags. Estimates of the unconfined compressive strengths and undrained shear strengths of the cohesive soils were obtained with pocket penetrometer readings being taken on the tube samples.

The soils samples were visually classified in accordance with ASTM D 2488 standards and methods. All samples were transported to HTS' laboratory for purposes of performing laboratory tests on selected samples.

3.0 LABORATORY TESTING

A laboratory testing program was conducted to obtain engineering properties for use in performing engineering analyses and to adjust field soil classifications. The following laboratory tests were performed:

LABORATORY TEST	TEST STANDARD
Moisture Content of Soils	ASTM D 2216
Dry Density of Soils	ASTM D 2937
Percent Soil Particles Passing a No. 200 Sieve	ASTM D 1140
Liquid Limit, Plastic Limit, and Plasticity Index	ASTM D 4318
Unconfined Compressive Strength of Cohesive Soils	ASTM D 2166
Unconsolidated Undrained Triaxial Compression Test	ASTM D 2850
Consolidated Undrained Triaxial Compression Test (with pore pressure measurements – 3 stages)	ASTM D 4767
Crumb Testing	ASTM D 6572
Pinhole Testing	ASTM D 4647
Permeability Testing (Falling Head Method)	ASTM D 5084

The number of tests and the test results are presented in the attached Tables 1 through 4B and Figures 4 through 13. All tests were performed in accordance with applicable ASTM standards and methods and soil classifications were completed in accordance with the guidelines and requirements of ASTM D 2487 and ASTM D 2488.

4.0 SUBSURFACE CONDITIONS

4.1 Subsoils

The subsurface soil conditions as determined from the drilling of the geotechnical borings are provided in:

- **Section 1.3.1 of this report,**
- **the Log of Borings in Appendix A, and**
- **Figures 3A and 3B.**

The boring logs were prepared by using both field visual classifications and the results of laboratory testing. The stratification lines shown on the boring logs represent the approximate boundaries between soil types and the transitions between soil types may be gradual.

4.2 Groundwater

Groundwater conditions are described in Section 1.3.2 of this report and in the boring logs provided in Appendix A of this report. The depth to groundwater was obtained by:

- **observing the drilling operations and the free moisture contained in the samples recovered during drilling, measuring water level depths during drilling and approximately 10 minutes after water was initially encountered, and after completion of drilling, as applicable, and**

- **obtaining water level measurements in the piezometers in about 2 weeks and 1 month after the installations of the piezometers.**

It is possible that seasonal variations will cause fluctuations in the water levels measured at the time of our field investigation. We recommend that the contractor determine the actual groundwater level at the site at the time of the construction activities in order to assess the impact, if any, of the groundwater to the construction activities. It should be noted that recommendations contained in this report are based on groundwater depths at the time of this geotechnical investigation and that an accurate determination of the true groundwater level may require several days or even months of observations.

5.0 ENGINEERING ANALYSES

Engineering analyses were performed in order to determine design parameters that can be used for the construction of the proposed water transmission and distribution system for the NHCRWA in the Harris County, Texas. Analyses performed included:

- **analyses of subsurface soil grain size and plasticity characteristics and site groundwater levels as necessary to identify potential dewatering requirements,**

- **analyses of subsurface soil grain size, plasticity, and shear strength properties as necessary to categorize the site subsurface soil and groundwater conditions with regard to OSHA requirements for trench shoring/bracing, and**

- **analyses to determine lateral earth pressure design parameters which can be used in the design of permanent below ground structures and temporary below ground structures such as trench shoring/bracing.**

5.1 Potential Dewatering Requirements

Potential dewatering requirements were developed based upon measured groundwater level depths, the types of subsurface soils encountered, and the grain size characteristics of the subsurface soils. A dewatering system will most likely be required for sandy soils that occur below the groundwater table. The use of well points, vacuum well points, or a comparable dewatering system should provide for the effective dewatering of sandy soils which occur below the groundwater table and are found to contain less than 15 to 20% soil particles passing a No. 200 sieve. Sumps and sump pumps may be used to effectively dewater soils that occur below the groundwater table and contain more than 20% soil particles passing a No. 200 sieve.

5.2 OSHA Guidelines for Trench Shoring/Bracing

The site soils were categorized as Type B and C soils in accordance with OSHA requirements as referenced in Section 1.4.3 of this report. The site soils were categorized based upon the site groundwater conditions, the results of laboratory tests (moisture content determinations, Atterberg Limits, percent soil particles passing a No. 200 sieve, and unconfined compression tests) and pocket penetrometer values measured during drilling.

5.3 Earth Pressure Analyses for Design of Below Ground Structures

Earth pressure coefficients may be used to define the lateral loads exerted by the overburden soils on underground structures. The earth pressure coefficients for the soils, as provided in this report, were computed by using Rankine's methods. The recommended lateral earth pressure coefficients and equivalent fluid weight values, provided in this report, are based on soil properties as summarized in Section 1.4.5 of this report. Earth pressure design parameters provided in this report for use in designing permanent below ground structures are based on effective stress and shear strength parameters.

6.0 CONSTRUCTION CONSIDERATIONS

The following recommendations should be followed with regard to construction of the proposed water transmission and distribution system:

- **Construction dewatering should be performed in order to result in the lowering of the groundwater table to a depth of at least 3 feet below the bottoms of excavations.**

- **Utility backfill criteria should comply with the recommendations provided in Section 1.4.1 of this report.**

- **Construction operations should be monitored by a representative of the geotechnical engineer.**

- **Materials testing should be performed to assure that acceptable materials and construction methods are provided by the contractor.**

7.0 CLOSING REMARKS

HTS has performed a geotechnical investigation and provided recommendations pertaining to the design and construction of the proposed water transmission and distribution system for the NHCRWA in Harris County, Texas. This report has been prepared for the exclusive use of DEC and the NHCRWA in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

In the event that changes are made in the nature, design, or location of the proposed facilities, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the findings/recommendations of this report are modified or verified in writing. The analyses and recommendations presented in this report are based upon data obtained from 13 geotechnical borings drilled October 3, 7, 10, 11, 13, 28, and 29, 2016. The nature and extent of variations within the subsurface materials may not become evident until after construction is initiated. If significant variations in the subsurface materials are encountered during construction, it may be necessary to re-evaluate the recommendations provided in this report.

TABLES

TABLE 1

LABORATORY TEST SUMMARY

PROJECT: Proposed NHCRWA Contract No. 28-B
20252 Water Distribution and Transmission System
HTS PROJECT NO.: 16-S-299

LOCATION: Harris County, Texas

CLIENT: Dannenbaum Engineering Corporation

Boring No.	Sample Depth (feet)	Type of Material	Moisture Content (%)	Dry Density (pcf)	Atterberg Limits (%)			-200 Sieve (%)	Deviator Stress (tsf)	Strain (%)	Lateral Pressure (psi)	Remarks
					LL	PL	PI					
1	4-6	Sandy Lean Clay (CL)	16.8	114.4	31	15	16	61.6	1.3 (1)	9.6	0	(1) Sample bulged at failure.
	10-12	Sandy Lean Clay (CL)	17.3	115.0	24	15	9	63.5	1.7 (1)	8.3	0	(2) Sample failed along slickensides.
												(3) Sample failed along sand fissures.
2	2.5-4	Silty Sand (SM)	3.2		Non Plastic			16.8				
	13.5-15	Silty Sand (SM)	11.2		Non Plastic			23.3				
	33-35	Fat Clay (CH)	28.4	92.0	85	24	61	88.8	1.8 (2)	11.6	34	33'-35': UU Triaxial Test
	38-40	Sandy Lean Clay (CL)	20.3	107.7	45	19	26	63.3	2.2 (1)	15.0	0	
3	4-6	Silty Clayey Sand (SC-SM)	16.8	110.2	20	14	6	38.8	0.5 (3)	1.8	0	
	10-12	Sandy Lean Clay (CL)	15.7		32	15	17	56.5				10'-12': Pinhole Test
	16-18	Sandy Lean Clay (CL)	22.1		47	17	30	59.7				16'-18': Crumb Testing-Grade 1 (ND)
	18-20	Clayey Sand (SC)	16.7		37	16	21	37.1				16'-18': CU Triaxial Test
	23-25	Clayey Sand (SC)	15.7	116.7	28	15	13	22.8	4.3 (1)	15.0	24	18'-20': Permeability Test- K=1.46E-07 cm/s
	38-40	Fat Clay (CH)	28.2	96.6					1.1 (2)	2.6	0	23'-25': UU Triaxial Test
	43-45	Fat Clay (CH)	35.3	87.1	76	23	53	90.1	1.9 (2)	15.0	44	43'-45': UU Triaxial Test
4	2-4	Sandy Lean Clay (CL)	10.0	119.8	32	14	18	60.6	3.1 (1)	3.7	0	
	14.5-16	Silty Sand (SM)	19.6		Non Plastic			22.7				
5	6-8	Sandy Lean Clay (CL)	10.7	124.0	37	15	22	65.8	6.9 (3)	3.2	0	
6	4-6	Sandy Lean Clay (CL)	11.3	129.0	42	17	25	63.4	10.1 (3)	6.0	0	
	10-12	Sandy Lean Clay (CL)	9.7	117.8	34	16	18	51.3	6.6 (1)	5.9	11	10'-12': UU Triaxial Test

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TABLE 1

LABORATORY TEST SUMMARY

PROJECT: Proposed NHCRWA Contract No. 28-B
20252 Water Distribution and Transmission System
HTS PROJECT NO.: 16-S-299

LOCATION: Harris County, Texas

CLIENT: Dannenbaum Engineering Corporation

Boring No.	Sample Depth (feet)	Type of Material	Moisture Content (%)	Dry Density (pcf)	Atterberg Limits (%)			-200 Sieve (%)	Deviator Stress (tsf)	Strain (%)	Lateral Pressure (psi)	Remarks
					LL	PL	PI					
7	0-2	Sandy Lean Clay (FILL)	17.1		28	15	13	61.7				
	8-10	Lean Clay With Sand (CL)	16.2	116.8	46	18	28	74.0	3.3 (1)	7.8	0	
8	6-8	Sandy Lean Clay (CL)	9.5		40	17	23	63.3				6'-8': Crumb Testing- Grade 1 (ND)
	8-10	Sandy Lean Clay (CL)	10.8		42	18	24	68.1				8'-10': Permeability Test- K= 6.33E-08 cm/s
	10-12	Sandy Lean Clay (CL)	10.8		39	17	22	62.1				
	16.5-18	Clayey Sand (SC)	6.3		25	16	9	43.8				
	33.5-35	Fat Clay With Sand (CH)	17.3					80.6				
	38-40	Lean Clay (CL)	17.6	112.9	43	18	25	91.2	3.7 (1)	14.8	39	38'-40': UU Triaxial Test
	43-45	Sandy Lean Clay (CL)	13.2	122.0	24	15	9		2.4 (3)	11.3	0	
	53-55	Lean Clay (CL)	25.8	105.0					3.0 (2)	14.9	54	53'-55': UU Triaxial Test
9	4-6	Lean Clay With Sand (CL)	11.3		33	17	16	70.1				4'-6': Pinhole Test
	6-8	Lean Clay With Sand (CL)	12.4		43	19	24	73.1				6'-8': CU Triaxial Test
	10-12	Lean Clay With Sand (CL)	13.2	117.3	43	19	24	72.5	5.9 (1)	14.8	11	10'-12': UU Triaxial Test
	18.5-20	Clayey Sand (SC)	3.9		37	17	20	21.7				18'-20': Crumb Testing- Grade 1 (ND)
	28.5-30	Silty Sand (SM)	19.4		Non Plastic			18.9				
	43-45	Lean Clay (CL)	13.7		22	14	8					
	48-50	Lean Clay (CL)	15.4	115.6					1.2 (1)	6.0	0	
10	2-4	Lean Clay With Sand (CL)	11.4	122.4	29	16	13	72.4	4.7 (3)	4.2	0	
	8-10	Sandy Lean Clay (CL)	15.0	119.1	42	17	25	69.7	5.9 (3)	4.9	0	
	16.5-18	Poorly Graded Sand With Silt (SP-SM)	6.0		Non Plastic			11.2				

TABLE 1

LABORATORY TEST SUMMARY

PROJECT: Proposed NHCRWA Contract No. 28-B
20252 Water Distribution and Transmission System
HTS PROJECT NO.: 16-S-299
LOCATION: Harris County, Texas

CLIENT: Dannenbaum Engineering Corporation

Boring No.	Sample Depth (feet)	Type of Material	Moisture Content (%)	Dry Density (pcf)	Atterberg Limits (%)			-200 Sieve (%)	Deviator Stress (tsf)	Strain (%)	Lateral Pressure (psi)	Remarks
					LL	PL	PI					
11	2-4	Sandy Lean Clay (CL)	12.8	120.6					2.1 (3)	8.1	0	
	6-8	Lean Clay With Sand (CL)	14.8	108.9	39	18	21	71.6	4.3 (3)	5.9	0	
	13-15	Fat Clay (CH)	24.4	110.2	63	21	42	95.8	2.4 (1)	7.2	0	
12	0-2	Silty Clayey Sand (SC-SM)	4.2		21	17	4	42.9				
	4-6	Sandy Lean Clay (CL)	15.5	118.6	46	20	26	62.3	1.8 (3)	7.9	0	
	8-10	Fat Clay (CH)	18.8	116.2					3.8 (1)	9.2	0	
13	4-6	Lean Clay With Sand (CL)	15.1	116.9	42	19	23	70.7	3.5 (1)	14.3	5	4'-6': UU Triaxial Test
	6-8	Lean Clay With Sand (CL)	12.8	124.6					4.6 (1)	12.0	0	
	10-12	Clayey Sand (SC)	17.0	112.9	28	15	13	39.8	0.7 (3)	5.7	0	

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TABLE 2

CRUMB TEST FOR DETERMINATION OF DISPERSIBILITY OF CLAYEY SOILS (ASTM D 6572, METHOD A)

PROJECT: Proposed NHCRWA Contract No. 28-B
2025 Water Distribution and Transmission System
LOCATION: Harris County, Texas

HTS PROJECT NO.: 16-S-299
DATE: November 7, 2016

CLIENT: Dannenbaum Engineering Corporation

Specimen Data:

☑ Disturbed ☐ Undisturbed

Specimen type: ☑ Natural irregularly shaped crumb ☐ Remolded crumb cube

Moisture content: ☑ Natural moisture ☐ Air-dried ☐ Distilled water added to remold specimen

Curing time _____ min. Water used: ☑ Distilled ☐ Distilled and demineralized

Initial water temperature 23.4 °C

Time at beginning of test 9:22 ☑ am ☐ pm

Tested by: E.R. Date tested: 11/07/16

Checked by: _____ Date: _____

TEST CONDITIONS:

Boring Number	Depth (feet)	2-Minute		1-Hour		6-Hour	
		Grade*	°C	Grade*	°C	Grade*	°C
3	16 - 18	1	23.3	1	22.8	1	22.6
8	6 - 8	1	23.4	1	22.8	1	22.5
9	10 - 12	1	23.3	1	22.9	1	22.6

* Grade 1 - Non Dispersive
Grade 2 - Intermediate
Grade 3 - Dispersive
Grade 4 - Highly Dispersive

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TABLE 3A
PINHOLE DISPERSION TEST
METHOD A
(ASTM D 4647)

PROJECT: Proposed NHCRWA Contract No. 28-B
2025 Water Distribution and Transmission System
HTS PROJECT NO.: 16-S-299

LOCATION: Harris County, Texas
DATE OF TEST: November 11, 2016

CLIENT: Dannenbaum Engineering Corporation

BORING NO: 3
DEPTH: 10' - 12'
TYPE OF MATERIAL: Sandy Lean Clay (CL)
CLASSIFICATION: ND-2

SPECIMEN DATA:

Specimen Curing Time	Water Content (%)	Unit Dry Weight (pcf)	Liquid Limit	Plastic Limit	Plasticity Index	-200 Sieve (%)
None	15.7	116.5	32	15	17	56.5

TEST CONDITIONS:

Hydraulic Head (mm)	Rate of Flow (ml/sec)	Cloudiness of Flow		Length of Test (min)	Needle Punch Hole (mm)	Effluent
		Side	Top			
1020	1.74	Slightly Cloudy	Slightly Cloudy	25	1.74	Distilled Water

TABLE 3B
PINHOLE DISPERSION TEST
METHOD A
(ASTM D 4647)

PROJECT: Proposed NHCRWA Contract No. 28-B
2025 Water Distribution and Transmission System
HTS PROJECT NO.: 16-S-299

LOCATION: Harris County, Texas
DATE OF TEST: November 11, 2016

CLIENT: Dannenbaum Engineering Corporation

BORING NO: 9
DEPTH: 4' - 6'
TYPE OF MATERIAL: Sandy Lean Clay (CL)
CLASSIFICATION: ND-2

SPECIMEN DATA:

Specimen Curing Time	Water Content (%)	Unit Dry Weight (pcf)	Liquid Limit	Plastic Limit	Plasticity Index	-200 Sieve (%)
None	11.3	127.5	33	17	17	70.1

TEST CONDITIONS:

Hydraulic Head (mm)	Rate of Flow (ml/sec)	Cloudiness of Flow		Length of Test (min)	Needle Punch Hole (mm)	Effluent
		Side	Top			
1020	3.1	Completely Clear	Completely Clear	25	1.06	Distilled Water

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TABLE 4A: FALLING HEAD / RISING TAIL HYDRAULIC CONDUCTIVITY TEST

(ASTM D-5084-03)

Project No:	16-S-299	Sample Identification:	B-3 (18'-20')
Technician:	M. Coronado	Sample Description:	Clayey Sand (SC)
			LL = 37, PL = 21, PI = 37.1

Project : Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission

INITIAL CONDITIONS				FINAL CONDITIONS			
WATER CONTENT		SPECIMEN DATA		WATER CONTENT		SPECIMEN DATA	
Tare No.:	K-7	Length, in:	2.195	Tare No.:	51	Length (L), in:	2.197
Wet+Tare, gms:	591.45	Diameter, in:	2.762	Wet+Tare, gms:	162.01	Diameter, in:	2.764
Dry+Tare, gms:	569.67	Wet mass, gms:	458.09	Dry+Tare, gms:	142.08	Wet mass, gms:	461.09
Tare Weight, gms:	438.86	Area, cm^2:	38.66	Tare Weight, gms:	30.50	Area (A), cm^2:	38.71
Moisture, %	16.7	Volume, cc:	215.5	Moisture, %	17.9	Volume, cc:	216.0
		Unit wet wt, pcf:	132.6			Unit wet wt, pcf:	133.2
Specific Gravity:	2.70	Unit dry wt, pcf:	113.7	Specific Gravity:	2.70	Unit dry wt, pcf:	113.0
Saturation, %:	93.3	Void Ratio:	0.482	Saturation, %:	98.2	Void Ratio:	0.491
Perm. Cell No.:	3	Burret diam, cm:	1.06	Burret area (a), cm^2.:	0.882	Burret factor,cm/cc:	1.009
Cell Pressure, psi:	5	Head Pressure, psi:	3.0	Tail Pressure, psi:	2.0	Hydraulic Gradient:	15.9

PERMEABILITY MEASUREMENTS

Date	Time	Elapsed Time (Δt) (sec)	Temp (C)	Pressure Diff. (psi)	Head Rdg (cc)	Tail Rdg (cc)	Head Change (cm)	Tail Change (cm)	Total Head (h_1, h_2) (cm)	Permeability Kt (cm/sec)	Permeability K_{20} (cm/sec)
11/4/2016	08:45 AM	0	22.9	1.0	2.0	20.0	0.000	0.000	88.46	0.00E+00	0.00E+00
11/4/2016	09:15 AM	1800	22.9	1.0	2.2	19.8	0.202	0.202	88.06	1.62E-07	1.51E-07
11/4/2016	09:45 AM	1800	22.9	1.0	2.3	19.7	0.101	0.101	87.86	8.10E-08	7.56E-08
11/4/2016	10:15 AM	1800	22.9	1.0	2.5	19.3	0.202	0.404	87.25	2.44E-07	2.28E-07
11/4/2016	10:45 AM	1800	22.9	1.0	2.6	19.1	0.101	0.202	86.95	1.23E-07	1.15E-07
11/4/2016	11:15 AM	1800	22.9	1.0	2.7	18.9	0.101	0.202	86.65	1.23E-07	1.15E-07
11/4/2016	11:45 AM	1800	22.9	1.0	2.9	18.6	0.202	0.303	86.14	2.06E-07	1.93E-07
11/4/2016	12:15 PM	1800	22.9	1.0	3.1	18.3	0.202	0.303	85.64	2.07E-07	1.94E-07

Coefficient of Permeability, k = **1.46E-07** cm/sec

Computed By: GEV Date: 6/6/2016 Checked By: GEV Date: 06/06/16

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TABLE 4B: FALLING HEAD / RISING TAIL HYDRAULIC CONDUCTIVITY TEST

(ASTM D-5084-03)

Project No:	16-S-299	Sample Identification:	B-8 (8'-10')
Technician:	M. Coronado	Sample Description:	Sandy Lean Clay (CL)
			LL = 42, PL = 22, PI = 68.1

Project : Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission

INITIAL CONDITIONS				FINAL CONDITIONS			
WATER CONTENT		SPECIMEN DATA		WATER CONTENT		SPECIMEN DATA	
Tare No.:	P2	Length, in:	2.195	Tare No.:	58	Length (L), in:	2.201
Wet+Tare, gms:	574.39	Diameter, in:	2.816	Wet+Tare, gms:	159.36	Diameter, in:	2.867
Dry+Tare, gms:	556.72	Wet mass, gms:	485.34	Dry+Tare, gms:	142.09	Wet mass, gms:	507.98
Tare Weight, gms:	392.87	Area, cm^2:	40.18	Tare Weight, gms:	30.80	Area (A), cm^2:	41.65
Moisture, %	10.8	Volume, cc:	224.0	Moisture, %	15.5	Volume, cc:	232.8
		Unit wet wt, pcf:	135.2			Unit wet wt, pcf:	136.1
Specific Gravity:	2.70	Unit dry wt, pcf:	122.0	Specific Gravity:	2.70	Unit dry wt, pcf:	117.8
Saturation, %:	76.5	Void Ratio:	0.381	Saturation, %:	97.5	Void Ratio:	0.430
Perm. Cell No.:	7	Burret diam, cm:	1.06	Burret area (a), cm^2.:	0.882	Burret factor,cm/cc:	1.009
Cell Pressure, psi:	5	Head Pressure, psi:	3.0	Tail Pressure, psi:	2.0	Hydraulic Gradient:	15.9

PERMEABILITY MEASUREMENTS

Date	Time	Elapsed Time (Δt) (sec)	Temp (C)	Pressure Diff. (psi)	Head Rdg (cc)	Tail Rdg (cc)	Head Change (cm)	Tail Change (cm)	Total Head (h_1, h_2) (cm)	Permeability Kt (cm/sec)	Permeability K_{20} (cm/sec)
11/4/2016	08:50 AM	0	22.9	1.0	2.0	20.0	0.000	0.000	88.46	0.00E+00	0.00E+00
11/4/2016	09:15 AM	1500	22.9	1.0	2.1	19.9	0.101	0.101	88.26	9.01E-08	8.41E-08
11/4/2016	09:45 AM	1800	22.9	1.0	2.2	19.7	0.101	0.202	87.96	1.13E-07	1.05E-07
11/4/2016	10:15 AM	1800	22.9	1.0	2.3	19.5	0.101	0.202	87.65	1.13E-07	1.06E-07
11/4/2016	11:15 AM	3600	22.9	1.0	2.4	19.4	0.101	0.101	87.45	3.79E-08	3.54E-08
11/4/2016	01:55 PM	9600	22.9	1.0	2.5	19.3	0.101	0.101	87.25	1.42E-08	1.33E-08
11/4/2016	02:55 PM	3600	22.9	1.0	2.6	19.2	0.101	0.101	87.05	3.81E-08	3.55E-08

Coefficient of Permeability, k = **6.33E-08** cm/sec

Computed By: GEV Date: 6/6/2016 Checked By: GEV Date: 06/06/16

FIGURES

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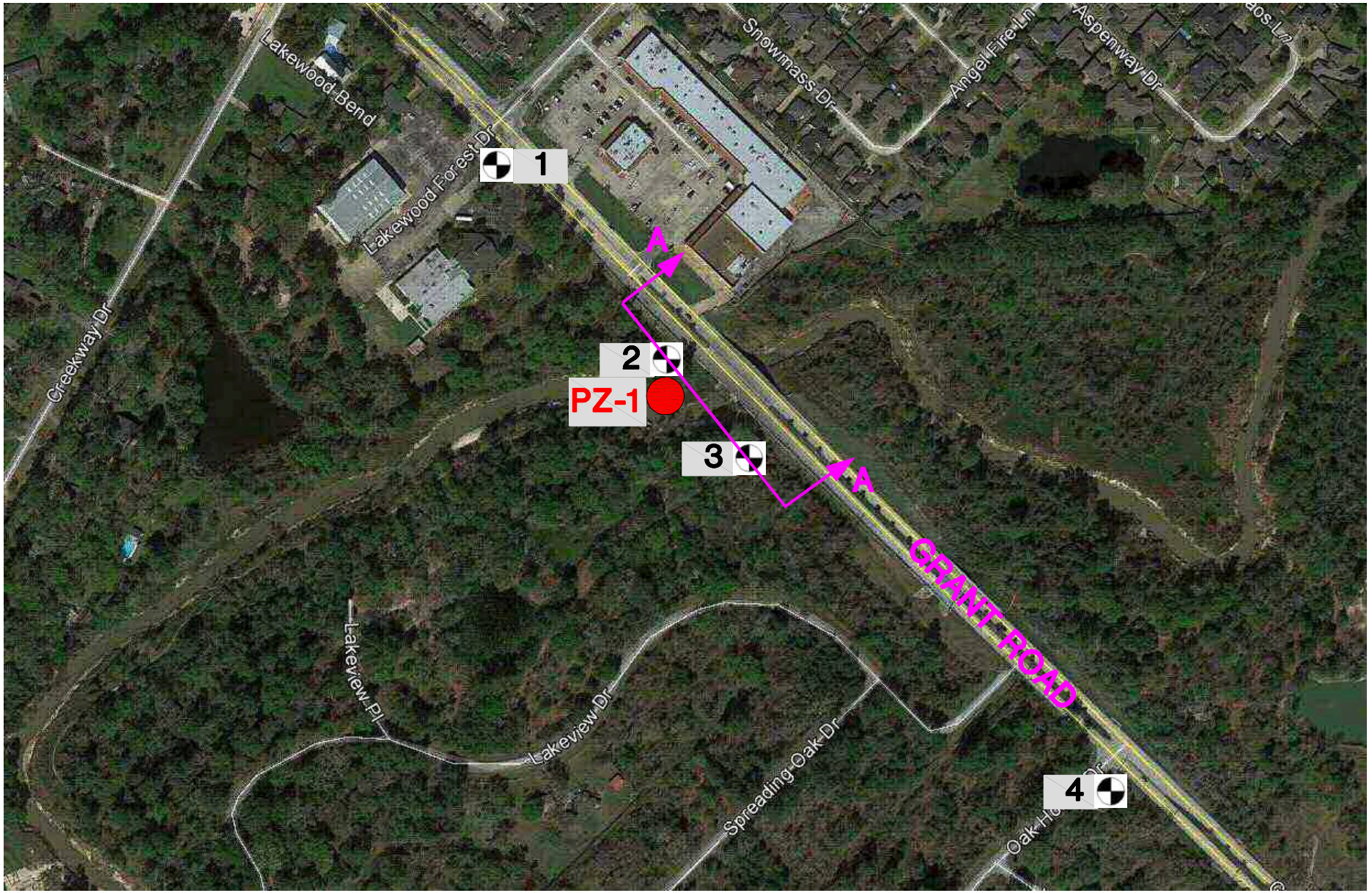
Proposed NHCRWA Contract No. 28-B
2025 Water Distribution
and Transmission System
Harris County, Texas

DRAWN BY:	IAT	DATE:	11-21-16	SCALE: NTS
CHECKED BY:	BFM	DATE:	11-21-16	
HTS PROJECT NO.:	16-S-299			FIGURE: 1

VICINITY MAP



Legend

- Geotechnical borings included in the study
- Piezometer location

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Proposed NHCRWA Contract No. 28-B
2025 Water Distribution and Transmission System
Harris County, Texas

DRAWN BY:	IAT	DATE:	11/15/16	SCALE: NTS
CHECKED BY:	BFM	DATE:	11/15/16	
HTS PROJECT NO.:	16-S-299			FIGURE: 2A

BORING LOCATIONS

Legend

Geotechnical Borings included in the study

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Proposed NHCRWA Contract No. 28-B
2025 Water Distribution and Transmission System
Harris County, Texas

DRAWN BY:	IAT	DATE:	7/26/16	SCALE: NTS
CHECKED BY:	BFM	DATE:	7/26/16	
HTS PROJECT NO.:	16-S-299			FIGURE: 2B

BORING LOCATIONS

Legend

- Geotechnical borings included in the study
- Piezometer location

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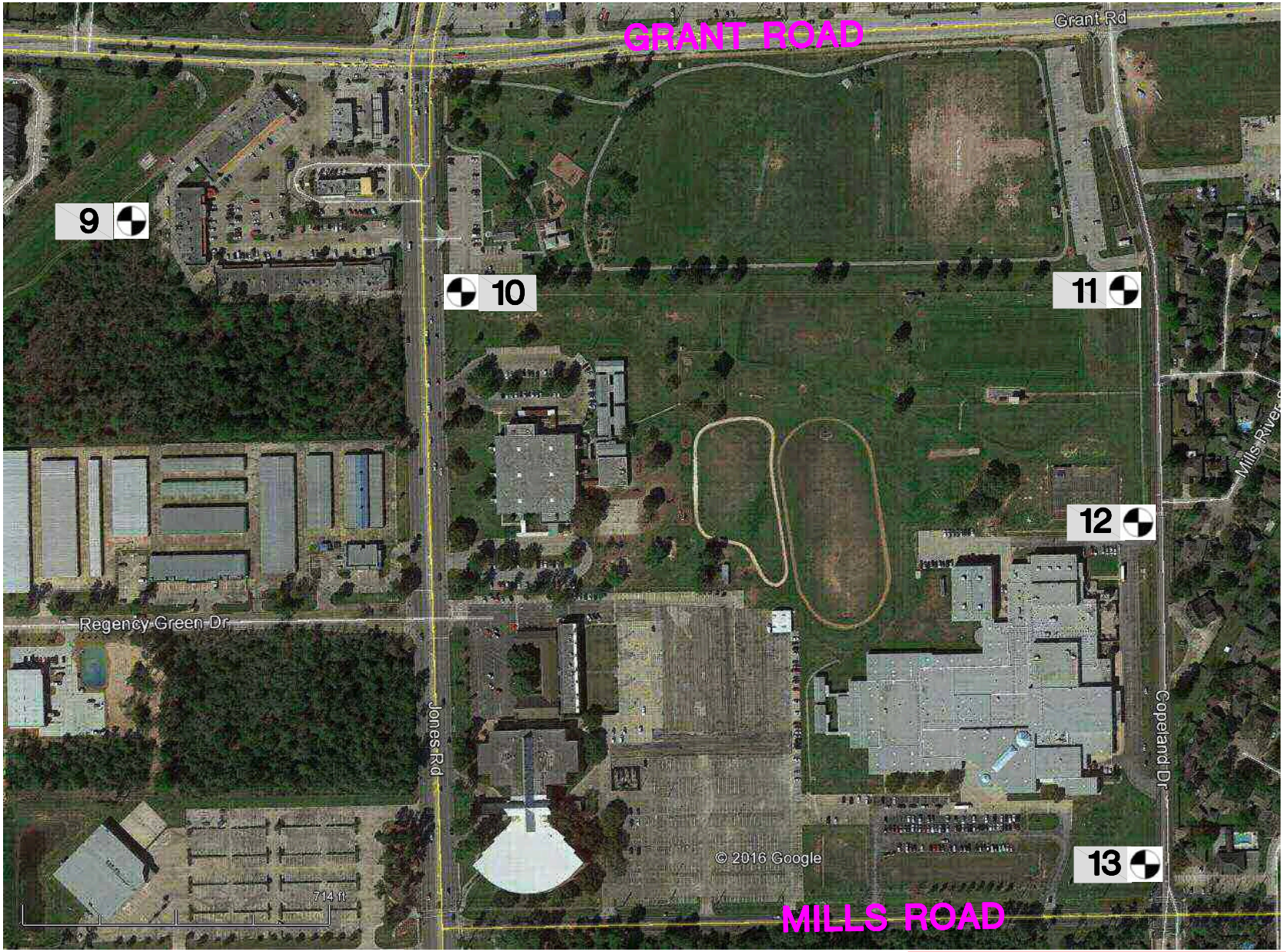
Proposed NHCRWA Contract No. 28-B
2025 Water Distribution and Transmission System
Harris County, Texas

DRAWN BY:	IAT	DATE:	11/15/16	SCALE: NTS
CHECKED BY:	BFM	DATE:	11/15/16	
HTS PROJECT NO.:	16-S-299			FIGURE: 2C

BORING LOCATIONS



Legend

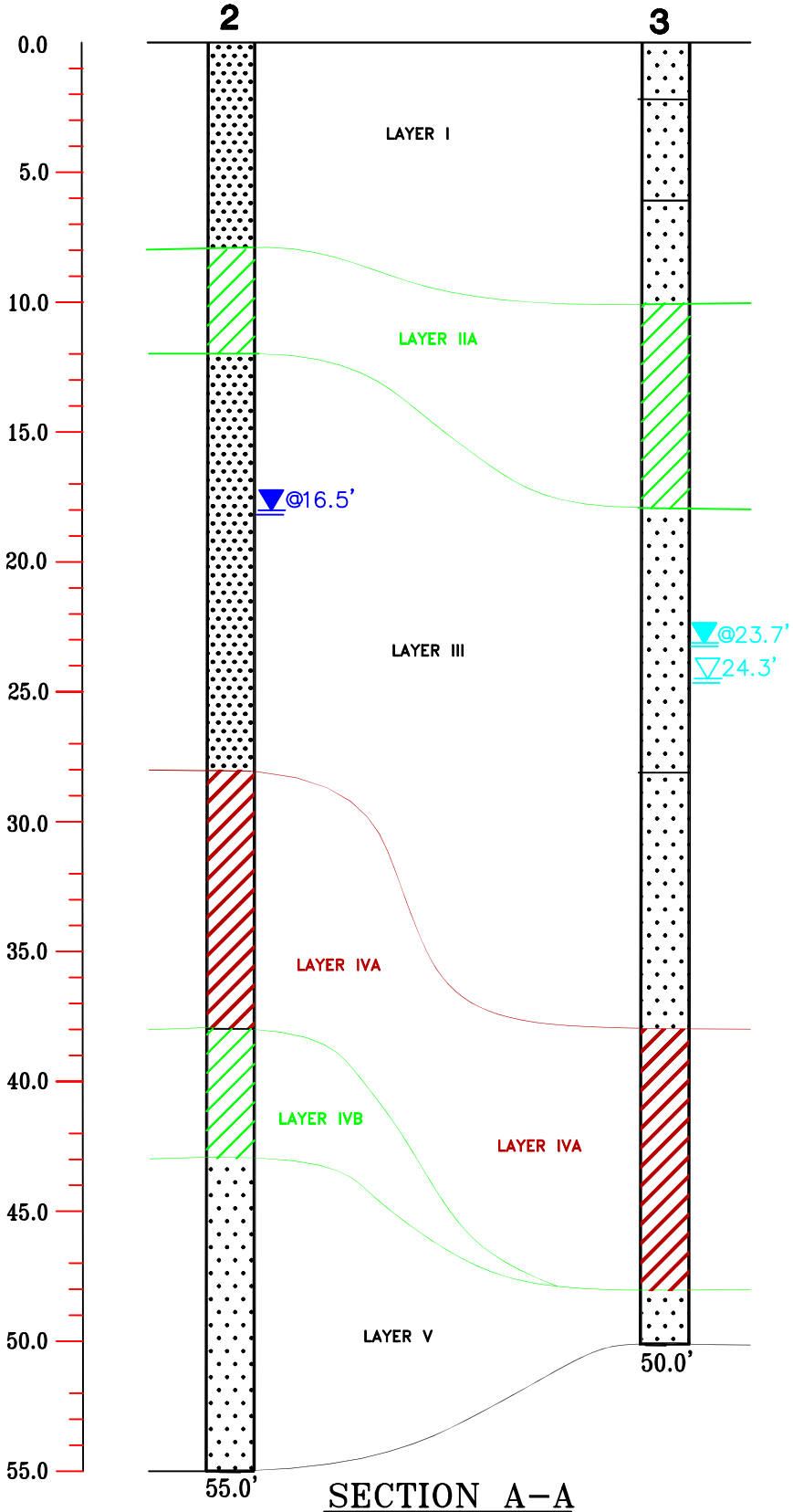
- Geotechnical borings included in the study

HTS, Inc. Consultants

Proposed NHCRWA Contract No. 28-B
2025 Water Distribution and Transmission System
Harris County, Texas

DRAWN BY:	IAT	DATE:	11/15/16	SCALE: NTS
CHECKED BY:	BFM	DATE:	11/15/16	
HTS PROJECT NO.:	16-S-299			FIGURE: 2D

BORING LOCATIONS



SECTION A–A

LAYER I

SANDY SOILS CONSISTING OF CLAYEY SAND, SILTY SAND, AND SILTY CLAYEY SAND, LOOSE TO DENSE.

LAYER II

CLAYEY SOILS CONSISTING OF SANDY LEAN CLAY, LEAN CLAY, SILTY CLAY, AND LEAN CLAY WITH SAND, STIFF TO HARD.

LAYER III

SANDY SOILS CONSISTING OF CLAYEY SAND, SILTY SAND, AND POORLY GRADED SAND WITH SILT, VERY LOOSE TO VERY DENSE.

LAYER IVA

CLAYEY SOILS CONSISTING OF FAT CLAY AND FAT CLAY WITH SAND, STIFF TO HARD.

LAYER IVB

CLAYEY SOILS CONSISTING OF LEAN CLAY AND SANDY LEAN CLAY, STIFF TO HARD.

LAYER V

SANDY SOILS CONSISTING OF SILTY SAND, DENSE TO VERY DENSE.

LEGEND

- GROUNDWATER MEASUREDD DURING DRILLING
- GROUNDWATER MEASURED 10 MINUTES AFTER IT WAS INITIALLY ENCOUNTERED
- GROUNDWATER MEASURED AFTER COMPLETION OF DRILLING

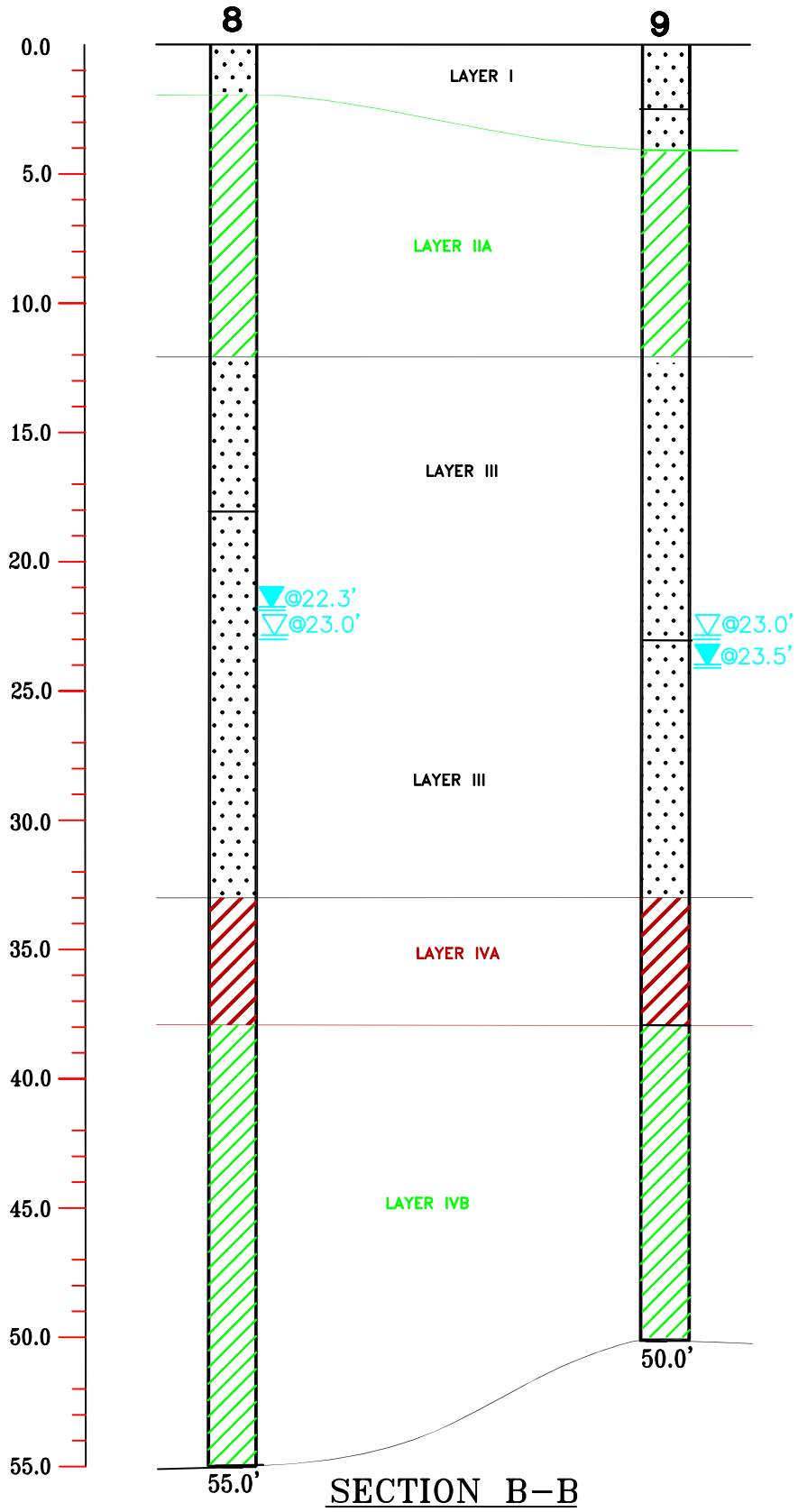
NOTES

1) SEE FIGURE 2A FOR LOCATION OF SECTION A–A.
2) THE STRATIFICATION LINES SHOWN ARE OUR ESTIMATION BETWEEN BORINGS AND DO NOT REPRESENT ACTUAL SUBSOIL CONDITIONS BETWEEN BORINGS.
3) SEE CORRESPONDING BORING LOGS FOR DETAILED SUBSOIL AND GROUNDWATER INFORMATION.

HTS, Inc. Consultants

Propose NHCRWA Contract No. 28-B
2025 Water Distribution and Transmission System
Harris County, Texas

DRAWN BY: IAT	DATE: 12–15–16	SCALE: Hor.: NTS Vert.: As Shown	
CHECKED BY: BFM	DATE: 12–15–16		
HTS PROJECT NO.: 16-S-299		FIGURE: 3A	
Soil Profile Section A-A			



SECTION B–B

LAYER I

SANDY SOILS CONSISTING OF CLAYEY SAND, SILTY SAND, AND SILTY CLAYEY SAND, LOOSE TO DENSE.

LAYER II

CLAYEY SOILS CONSISTING OF SANDY LEAN CLAY, LEAN CLAY, SILTY CLAY, AND LEAN CLAY WITH SAND, STIFF TO HARD.

LAYER III

SANDY SOILS CONSISTING OF CLAYEY SAND, SILTY SAND, AND POORLY GRADED SAND WITH SILT, VERY LOOSE TO VERY DENSE.

LAYER IVA

CLAYEY SOILS CONSISTING OF FAT CLAY AND FAT CLAY WITH SAND, STIFF TO HARD.

LAYER IVB

CLAYEY SOILS CONSISTING OF LEAN CLAY AND SANDY LEAN CLAY, STIFF TO HARD.

LEGEND

- GROUNDWATER MEASUREDD DURING DRILLING
- GROUNDWATER MEASURED 10 MINUTES AFTER IT WAS INITIALLY ENCOUNTERED

NOTES

1) SEE FIGURE 2C FOR LOCATION OF SECTION B–B.
2) THE STRATIFICATION LINES SHOWN ARE OUR ESTIMATION BETWEEN BORINGS AND DO NOT REPRESENT ACTUAL SUBSOIL CONDITIONS BETWEEN BORINGS.
3) SEE CORRESPONDING BORING LOGS FOR DETAILED SUBSOIL AND GROUNDWATER INFORMATION.

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Propose NHCRWA Contract No. 28-B
2025 Water Distribution and Transmission System
Harris County, Texas

DRAWN BY: IAT	DATE: 12–15–16	SCALE: Hor.: NTS Vert.: As Shown	
CHECKED BY: BFM	DATE: 12–15–16		
HTS PROJECT NO.: 16-S-299		FIGURE: 3B	
Soil Profile Section B-B			

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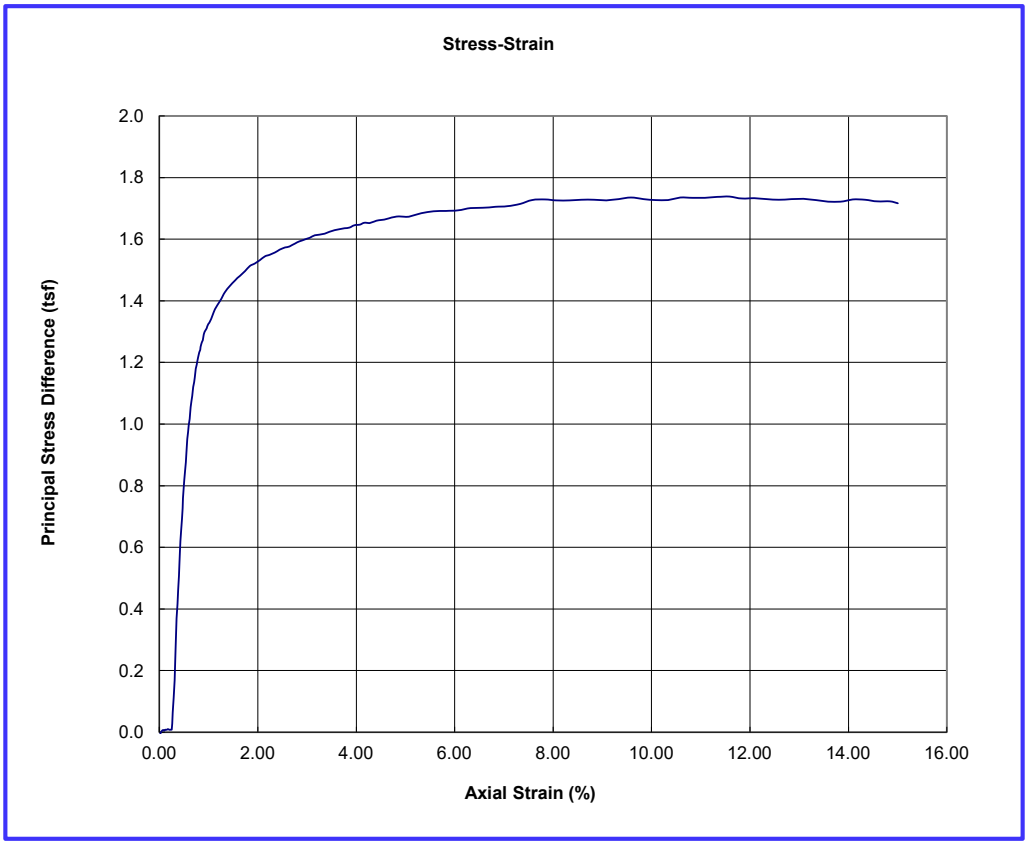
UNCONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

(ASTM D-2850)



Shear Stress (tsf)	**1.7**	**Strain rate (%/min)**	**1.0**
Failure Strain (%)	**11.6**	**Moisture Content (%)***	**28.4**
Dry Density (pcf)	**92**	**Lateral Pressure (psi)**	**34**
Remarks: Sample failed along slickensides.			

Project:	**Proposed NHCRWA Contract No. 28-B**	Liquid Limit:	**85**	% Pass No. 200:	**88.8**
Client:	**NHCRWA and Dannenbaum Engineering Corp.**	Plastic Limit:	**24**	Nat. Moisture (%):	**28.4**
Project No.:	**16-S-299**	Plasticity Index:	**61**	Test Method:	**ASTM D-2850**
Sample ID:	**Boring No. 2 (33'-35')**	Tested By:	**MC**	Date Tested:	**11/4/2016**
Remarks:		Checked By:	**BHA**	**FIGURE 4**	
Description:	**FAT CLAY (CH)**	Date Checked:	**11/10/2016**		

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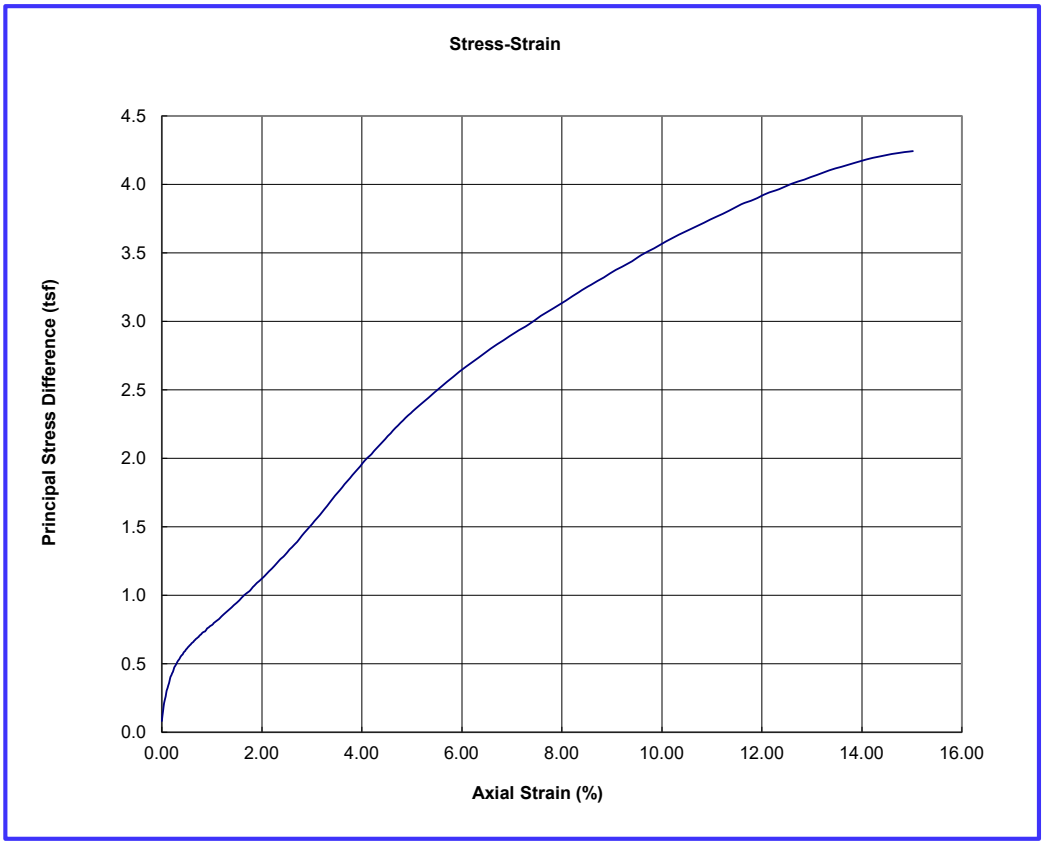
UNCONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

(ASTM D-2850)



Shear Stress (tsf)	**4.2**	**Strain rate (%/min)**	**1.0**
Failure Strain (%)	**15.0**	**Moisture Content (%)***	**15.7**
Dry Density (pcf)	**116.7**	**Lateral Pressure (psi)**	**24**
Remarks: Sample bulged at failure.			

Project:	**Proposed NHCRWA Contract No. 28-B**	Liquid Limit:	**28**	% Pass No. 200:	**22.8**
Client:	**NHCRWA and Dannenbaum Engineering Corp.**	Plastic Limit:	**15**	Nat. Moisture (%):	**15.7**
Project No.:	**16-S-299**	Plasticity Index:	**13**	Test Method:	**ASTM D-2850**
Sample ID:	**Boring No. 3 (23'-25')**	Tested By:	**MC**	Date Tested:	**11/4/2016**
Remarks:		Checked By:	**BHA**	**FIGURE 5**	
Description:	**Clayey Sand (SC)**	Date Checked:	**11/10/2016**		

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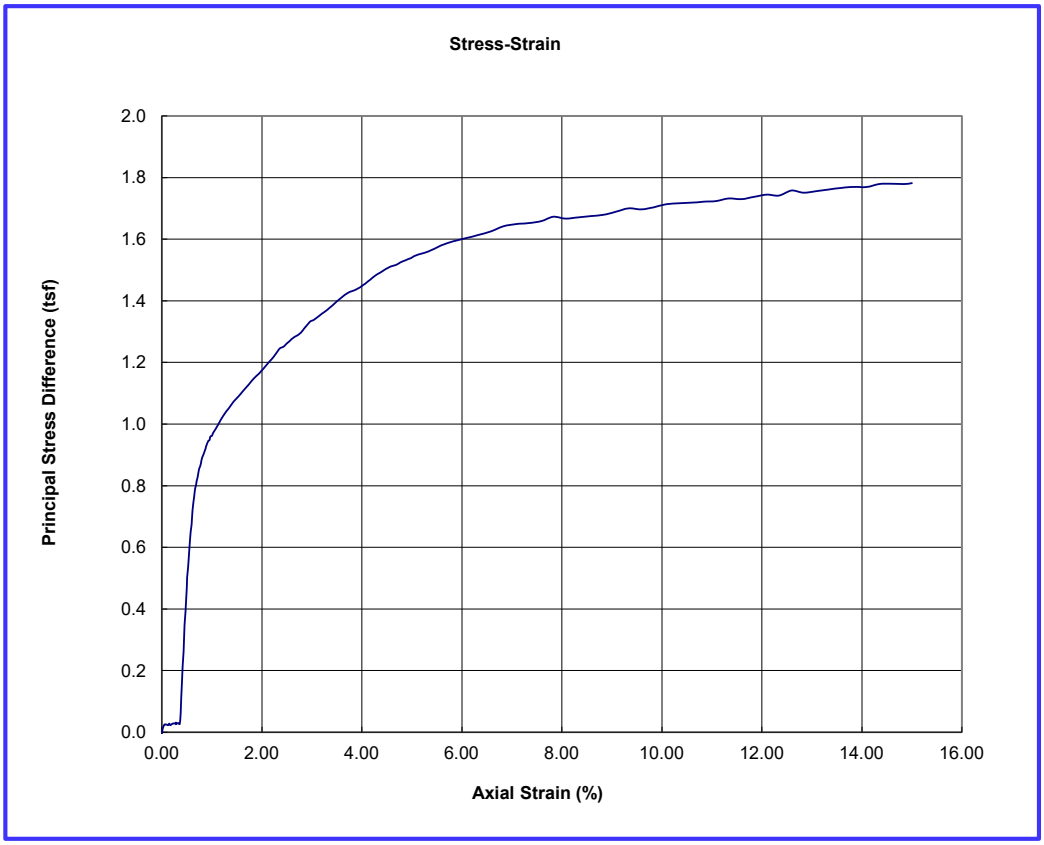
UNCONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

(ASTM D-2850)



Shear Stress (tsf)	**1.8**	**Strain rate (%/min)**	**1.0**
Failure Strain (%)	**15.0**	**Moisture Content (%)***	**35.3**
Dry Density (pcf)	**87.1**	**Lateral Pressure (psi)**	**44**
Remarks: Sample failed along slickensides.			

Project:	**Proposed NHCRWA Contract No. 28-B**	Liquid Limit:	**76**	% Pass No. 200:	**90.1**
Client:	**NHCRWA and Dannenbaum Engineering Corp.**	Plastic Limit:	**23**	Nat. Moisture (%):	**35.3**
Project No.:	**16-S-299**	Plasticity Index:	**53**	Test Method:	**ASTM D-2850**
Sample ID:	**Boring No. 3 (43'-45')**	Tested By:	**MC**	Date Tested:	**11/4/2016**
Remarks:		Checked By:	**BHA**	**FIGURE 6**	
Description:	**Fat Clay (CH)**	Date Checked:	**11/10/2016**		

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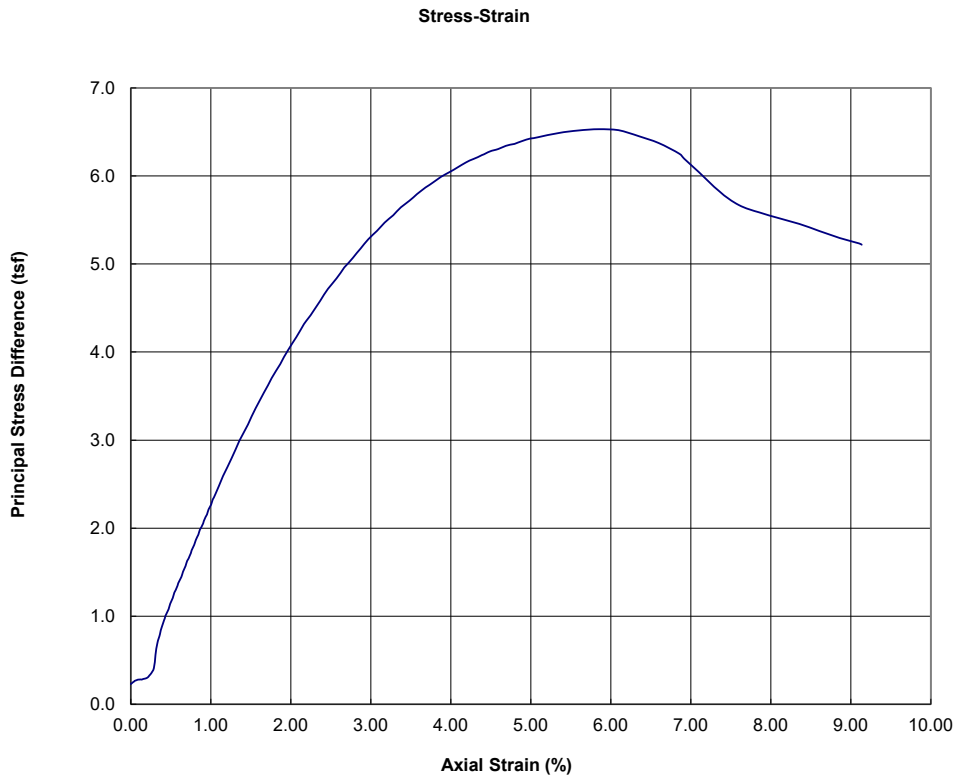
UNCONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

(ASTM D-2850)



Shear Stress (tsf)	**6.5**	**Strain rate (%/min)**	**1.0**
Failure Strain (%)	**5.6**	**Moisture Content (%)***	**35.3**
Dry Density (pcf)	**117.8**	**Lateral Pressure (psi)**	**44**
Remarks: Sample bulged at failure.			

Project:	**Proposed NHCRWA Contract No. 28-B**	Liquid Limit:	**34**	% Pass No. 200:	**51.3**
Client:	**NHCRWA and Dannenbaum Engineering Corp.**	Plastic Limit:	**16**	Nat. Moisture (%):	**9.7**
Project No.:	**16-S-299**	Plasticity Index:	**18**	Test Method:	**ASTM D-2850**
Sample ID:	**Boring No. 6 (10'-12')**	Tested By:	**MC**	Date Tested:	**11/4/2016**
Remarks:		Checked By:	**BHA**	**FIGURE 7**	
Description:	**Sandy Lean Clay (CL)**	Date Checked:	**11/10/2016**		

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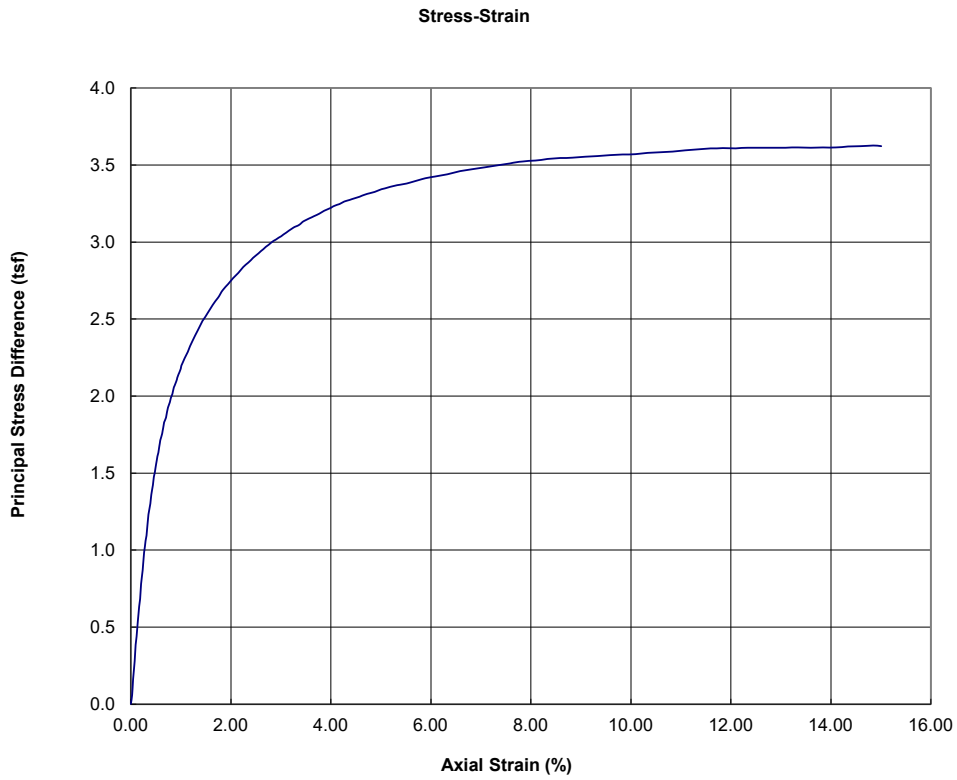
UNCONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

(ASTM D-2850)



Shear Stress (tsf)	**3.6**	**Strain rate (%/min)**	**1.0**
Failure Strain (%)	**14.9**	**Moisture Content (%)***	**17.6**
Dry Density (pcf)	**112.9**	**Lateral Pressure (psi)**	**39**
Remarks: Sample bulged at failure.			

Project:	**Proposed NHCRWA Contract No. 28-B**	Liquid Limit:	**43**	% Pass No. 200:	**91.2**
Client:	**NHCRWA and Dannenbaum Engineering Corp.**	Plastic Limit:	**21**	Nat. Moisture (%):	**17.6**
Project No.:	**16-S-299**	Plasticity Index:	**22**	Test Method:	**ASTM D-2850**
Sample ID:	**Boring No. 8 (38'-40')**	Tested By:	**MC**	Date Tested:	**11/4/2016**
Remarks:		Checked By:	**BHA**	**FIGURE 8**	
Description:	**Lean Clay (CL)**	Date Checked:	**11/10/2016**		

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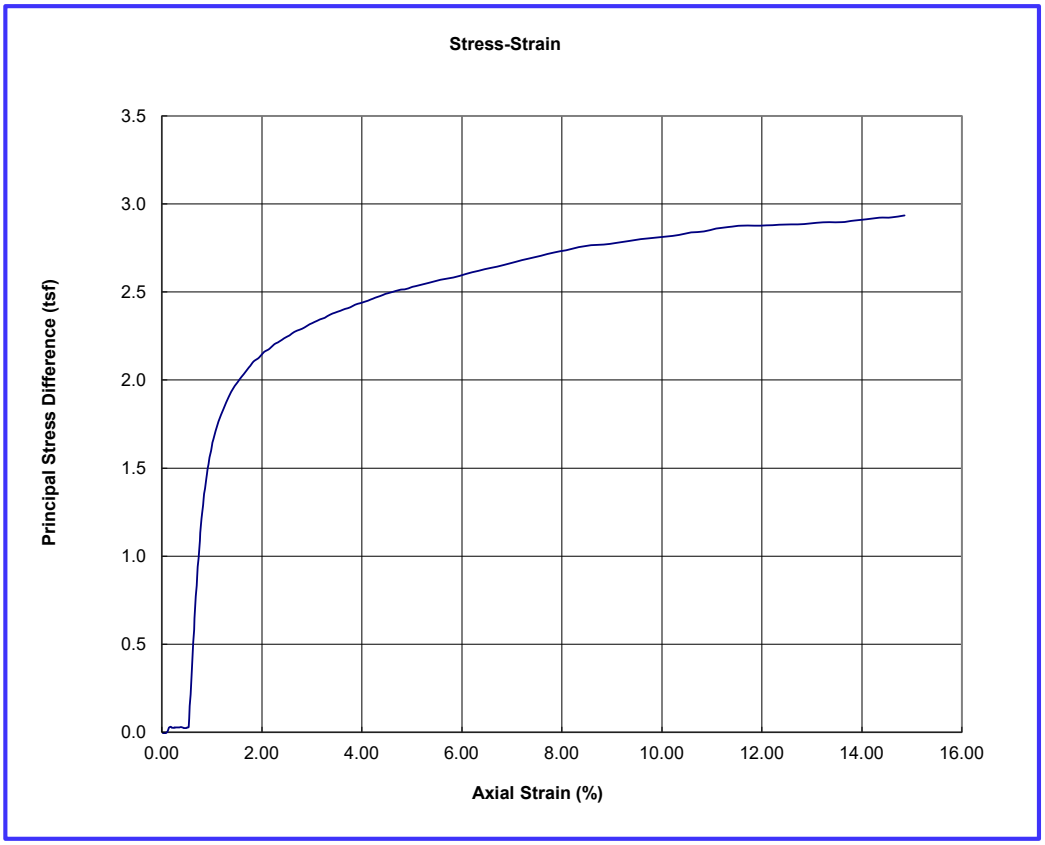
UNCONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

(ASTM D-2850)



Shear Stress (tsf)	**3.0**	**Strain rate (%/min)**	**1.0**
Failure Strain (%)	**14.9**	**Moisture Content (%)***	**25.8**
Dry Density (pcf)	**105**	**Lateral Pressure (psi)**	**54**
Remarks: Sample failed along slickensides.			

Project:	**Proposed NHCRWA Contract No. 28-B**	Liquid Limit:		% Pass No. 200:	
Client:	**NHCRWA and Dannenbaum Engineering Corp.**	Plastic Limit:		Nat. Moisture (%):	**25.8**
Project No.:	**16-S-299**	Plasticity Index:		Test Method:	**ASTM D-2850**
Sample ID:	**Boring No. 8 (53'-55')**	Tested By:	**MC**	Date Tested:	**11/4/2016**
Remarks:		Checked By:	**BHA**	**FIGURE 9**	
Description:	**Lean Clay (CL)**	Date Checked:	**11/10/2016**		

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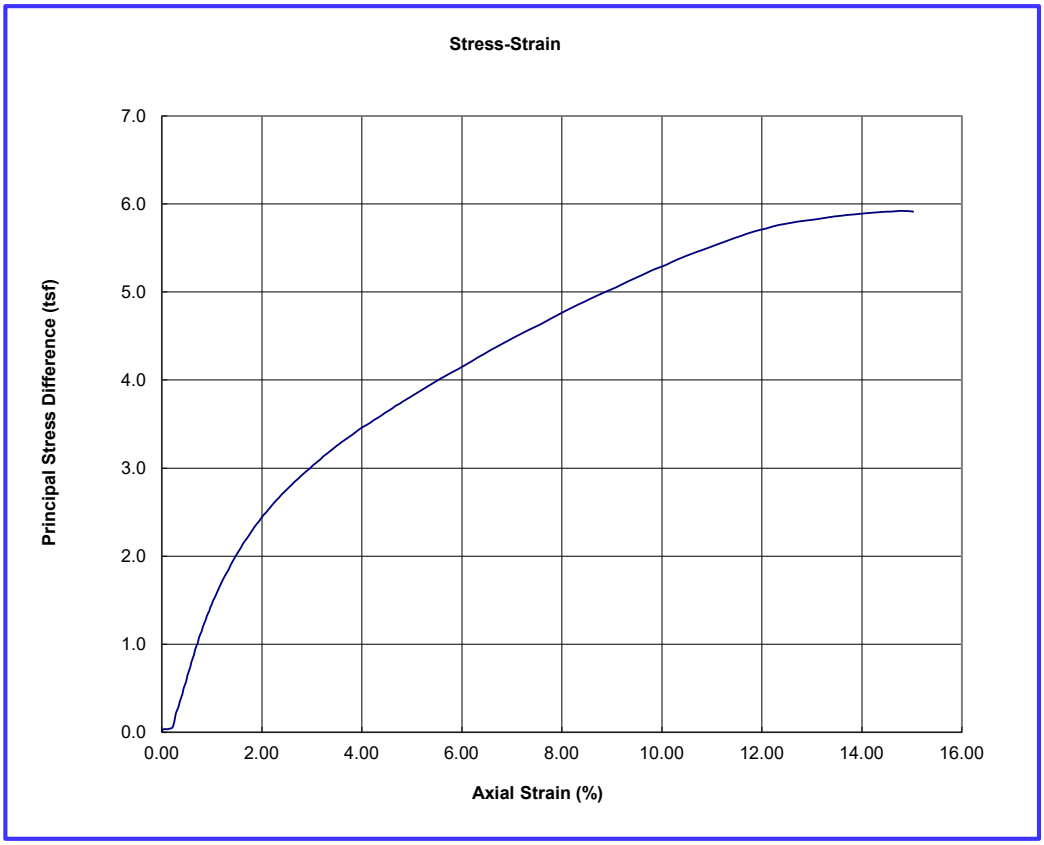
UNCONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

(ASTM D-2850)



Shear Stress (tsf)	**5.9**	**Strain rate (%/min)**	**1.0**
Failure Strain (%)	**14.8**	**Moisture Content (%)***	**13.2**
Dry Density (pcf)	**117.3**	**Lateral Pressure (psi)**	**11**
Remarks: Sample bulged at failure.			

Project:	**Proposed NHCRWA Contract No. 28-B**	Liquid Limit:	**43**	% Pass No. 200:	**72.5**
Client:	**NHCRWA and Dannenbaum Engineering Corp.**	Plastic Limit:	**19**	Nat. Moisture (%):	**13.2**
Project No.:	**16-S-299**	Plasticity Index:	**24**	Test Method:	**ASTM D-2850**
Sample ID:	**Boring No. 9 (10'-12')**	Tested By:	**MC**	Date Tested:	**11/4/2016**
Remarks:		Checked By:	**BHA**	**FIGURE 10**	
Description:	**Lean Clay With Sand (CL)**	Date Checked:	**11/10/2016**		

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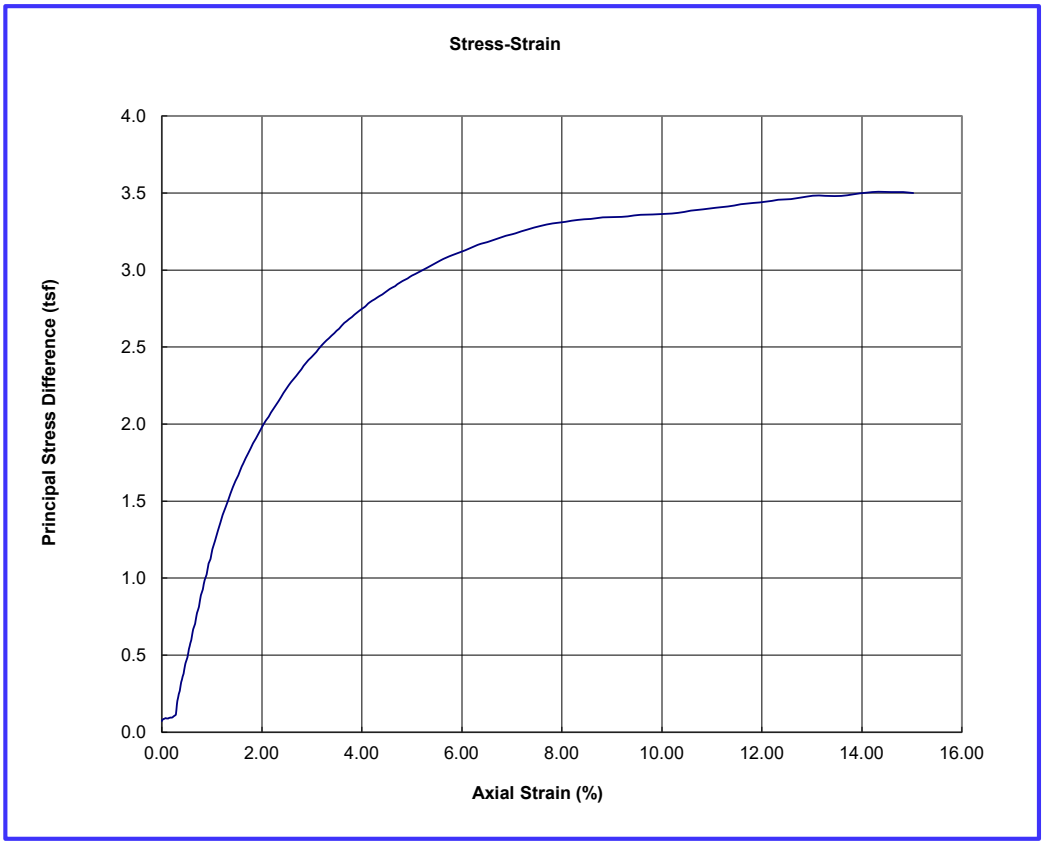
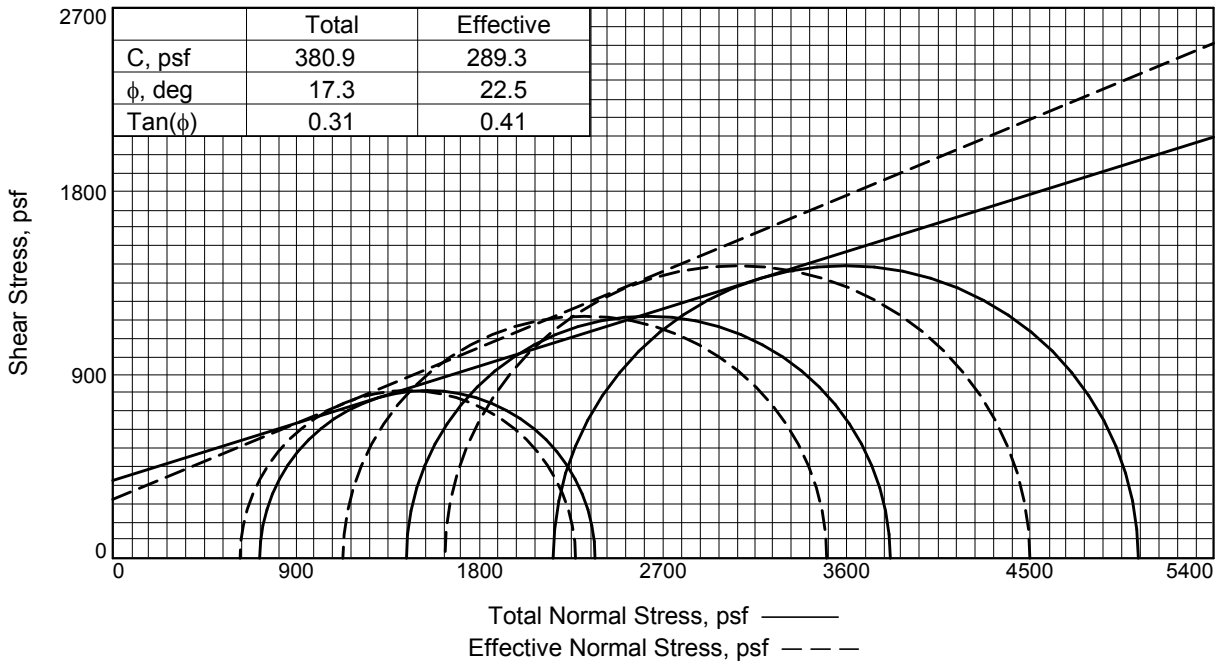
UNCONSOLIDATED UNDRAINED TRIAXIAL TEST RESULTS

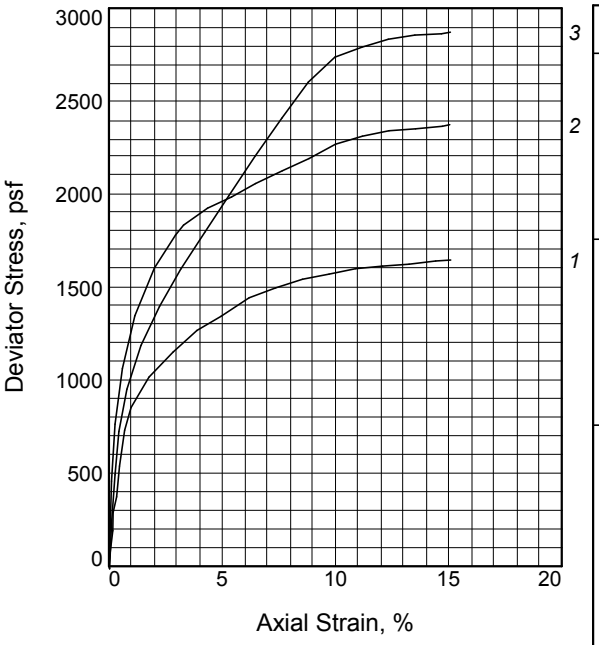
(ASTM D-2850)



Shear Stress (tsf)	**3.5**	**Strain rate (%/min)**	**1.0**
Failure Strain (%)	**14.3**	**Moisture Content (%)***	**15.1**
Dry Density (pcf)	**116.9**	**Lateral Pressure (psi)**	**5**
Remarks: Sample bulged at failure.			

Project:	**Proposed NHCRWA Contract No. 28-B**	Liquid Limit:	**42**	% Pass No. 200:	**70.7**
Client:	**NHCRWA and Dannenbaum Engineering Corp.**	Plastic Limit:	**20**	Nat. Moisture (%):	**15.1**
Project No.:	**16-S-299**	Plasticity Index:	**22**	Test Method:	**ASTM D-2850**
Sample ID:	**Boring No. 13 (4'-6')**	Tested By:	**MC**	Date Tested:	**11/4/2016**
Remarks:		Checked By:	**BHA**	**FIGURE 11**	
Description:	**Lean Clay With Sand (CL)**	Date Checked:	**11/10/2016**		





Sample No.		1	2	3
Initial	Water Content, %	12.2	12.4	14.5
	Dry Density, pcf	122.2	121.0	111.7
	Saturation, %	87.0	85.1	76.9
	Void Ratio	0.3793	0.3925	0.5093
	Diameter, in.	2.77	2.79	2.78
	Height, in.	5.70	5.72	5.69
At Test	Water Content, %	16.6	15.6	17.3
	Dry Density, pcf	116.3	118.7	114.9
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.4490	0.4205	0.4675
	Diameter, in.	3.08	3.06	2.97
	Height, in.	4.84	4.86	4.85
Strain rate, %/min.		0.01	0.01	0.01
Back Pressure, psi		38.000	38.000	38.000
Cell Pressure, psi		43.000	48.000	53.000
Fail. Stress, psf		1645.9	2374.0	2870.8
Total Pore Pr., psf		5567.9	5783.0	6003.5
Ult. Stress, psf		1645.9	2374.0	2870.8
Total Pore Pr., psf		5567.9	5783.0	6003.5
$\bar{\sigma}_1$ Failure, psf		2270.0	3502.9	4499.3
$\bar{\sigma}_3$ Failure, psf		624.1	1129.0	1628.5

Type of Test:
CU with Pore Pressures

Sample Type: Shelby Tubes

Description: Lean Clay With Sand (CL)
-200 Sieve=73.1%

LL= 43 **PL=** 19 **PI=** 24

Assumed Specific Gravity= 2.70

Remarks: Tested by: MC Date: 11/11/16
Checked by: GEV Date: 11/14/13

Figure 12

Client: Dannenbaum Engineering Corporation

Project: Proposed NHCRWA Contract NO. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

Sample Number: Boring No. 9 **Depth:** 6'-8'

Proj. No.: 16-S-299 **Date Sampled:** 10/10/16

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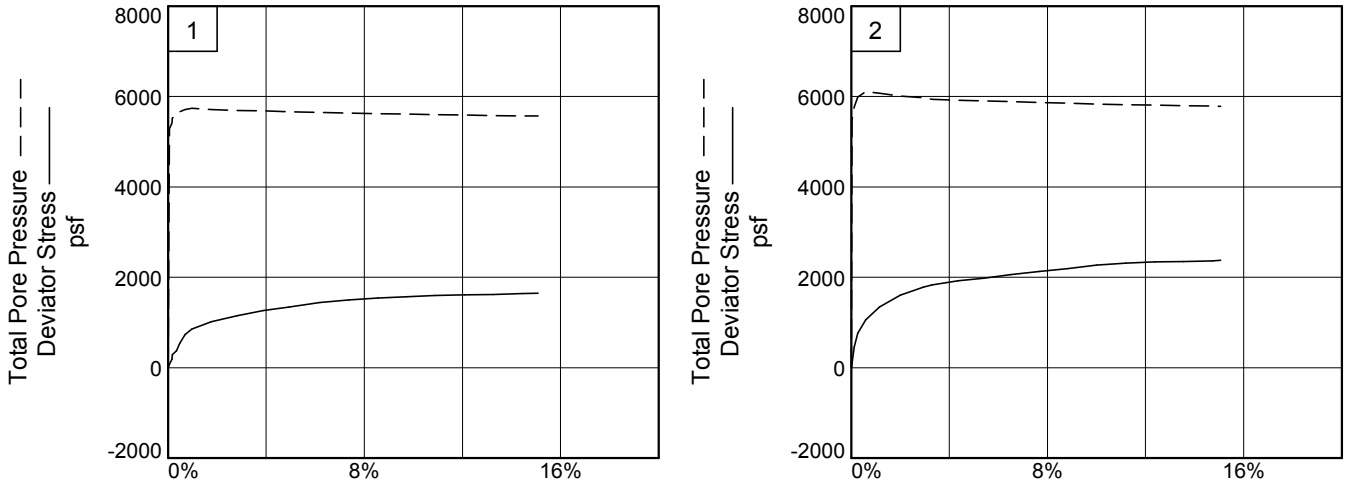

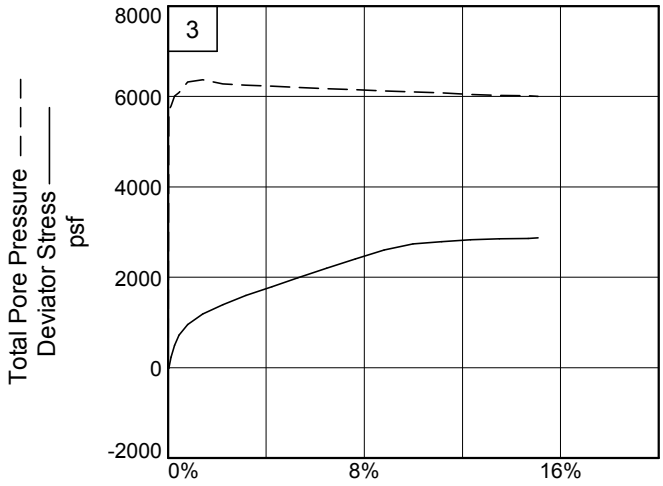

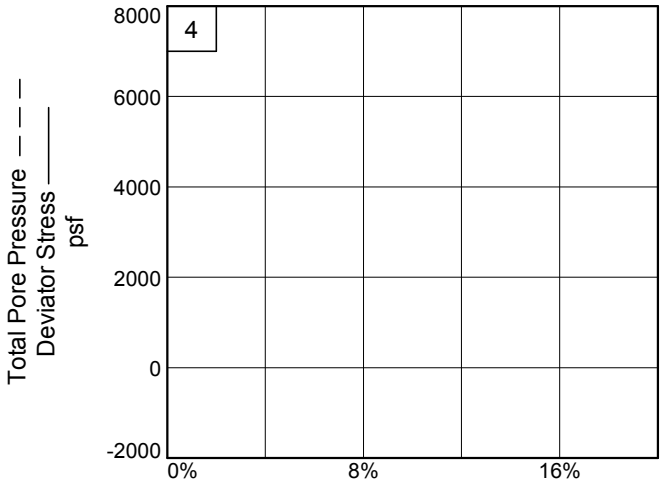

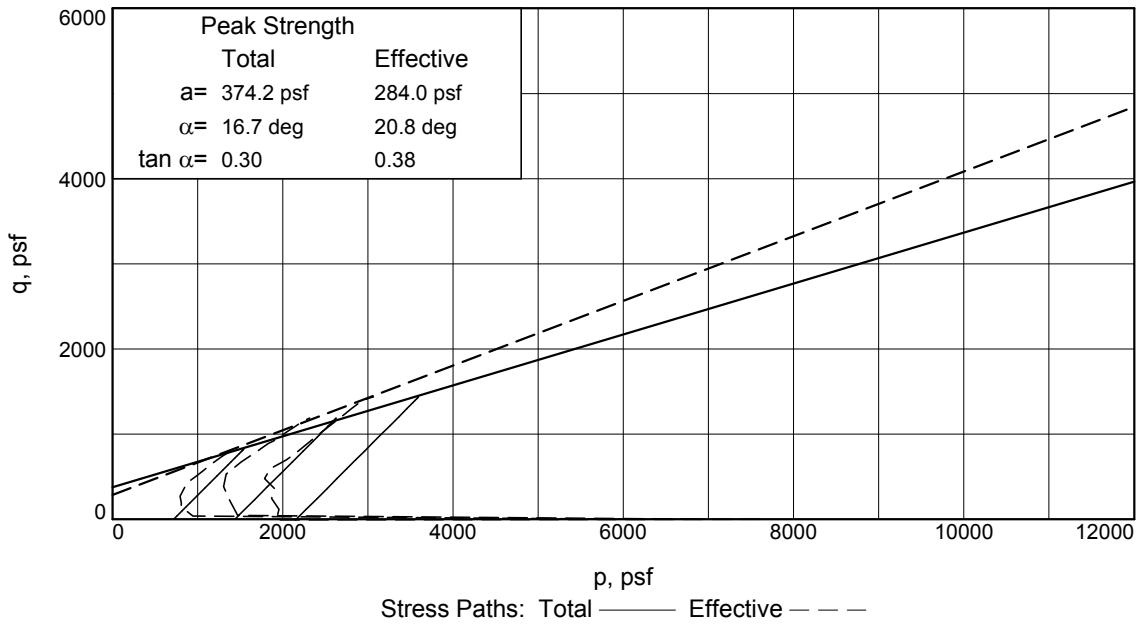

Client: Dannenbaum Engineering Corporation

Project: Proposed NHCRWA Contract NO. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

Depth: 6'-8' **Sample Number:** Boring No. 9

Project No.: 16-S-299 **Figure** 12A

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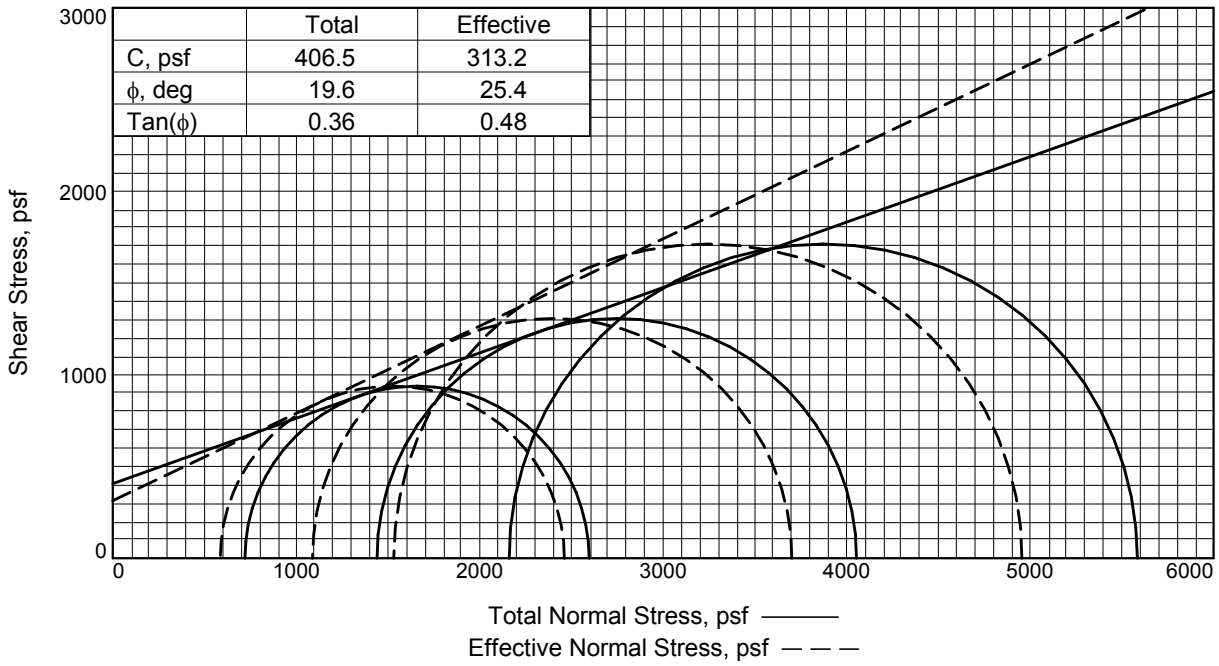

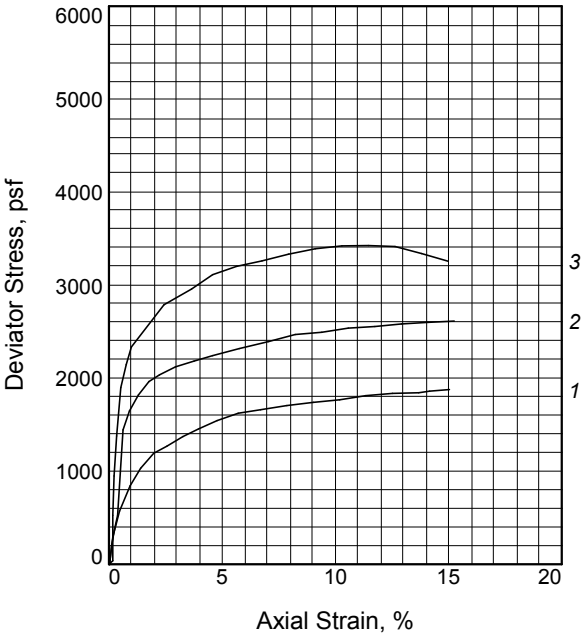

Sample No.		1	2	3
Initial	Water Content, %	15.7	22.1	16.7
	Dry Density, pcf	116.8	105.3	116.0
	Saturation, %	95.8	99.1	99.2
	Void Ratio	0.4436	0.6005	0.4534
	Diameter, in.	2.77	2.75	2.75
	Height, in.	5.78	5.49	5.76
At Test	Water Content, %	17.5	23.7	18.3
	Dry Density, pcf	114.6	102.7	112.7
	Saturation, %	100.0	100.0	100.0
	Void Ratio	0.4713	0.6409	0.4952
	Diameter, in.	3.02	3.02	3.03
	Height, in.	4.96	4.67	4.90
Strain rate, %/min.		0.01	0.01	0.01
Back Pressure, psi		38.000	38.000	38.000
Cell Pressure, psi		43.000	48.000	53.000
Fail. Stress, psf		1876.1	2614.1	3425.5
Total Pore Pr., psf		5606.6	5824.1	6101.1
Ult. Stress, psf		1876.1	2614.1	3425.5
Total Pore Pr., psf		5606.6	5824.1	6101.1
$\bar{\sigma}_1$ Failure, psf		2461.4	3702.0	4956.4
$\bar{\sigma}_3$ Failure, psf		585.4	1087.9	1530.9

Type of Test:
CU with Pore Pressures

Sample Type: Shelby Tube

Description: Sandy Lean Clay (CL)
-200 Sieve=59.7%

LL= 47 **PL=** 17 **PI=** 30

Assumed Specific Gravity= 2.70

Remarks: Tested by: MC Date: 11/11/16
Checked by: GEV Date: 11/14/16

Figure 13

Client: Dannenbaum Engineering Corporation

Project: Proposed NHCRWA Contract NO. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

Sample Number: Boring No. 3 **Depth:** 16'-18'

Proj. No.: 16-S-299 **Date Sampled:** 10/13/16

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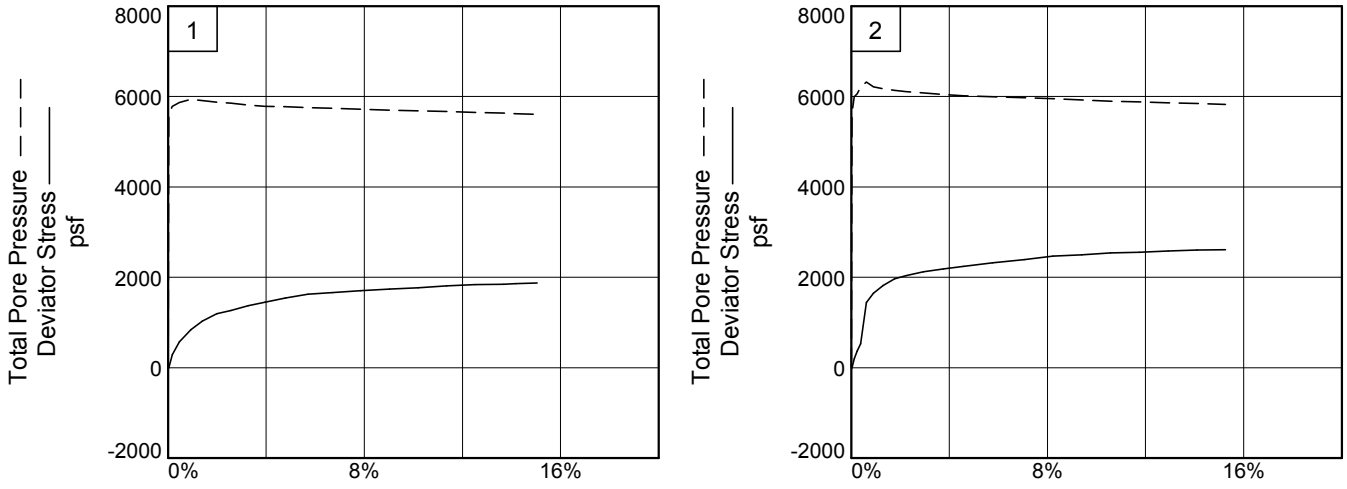
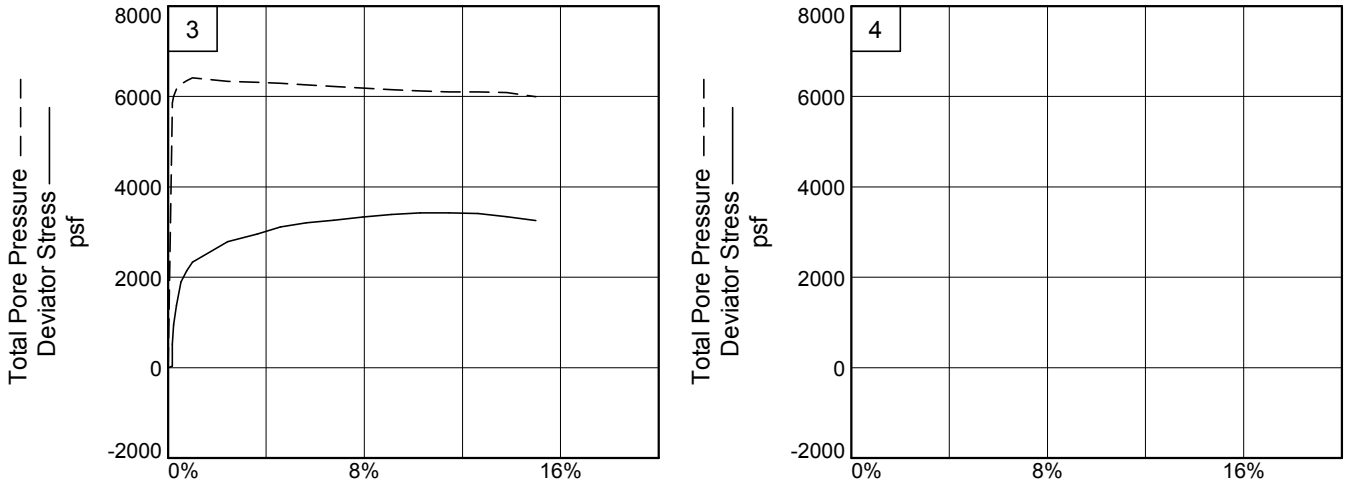
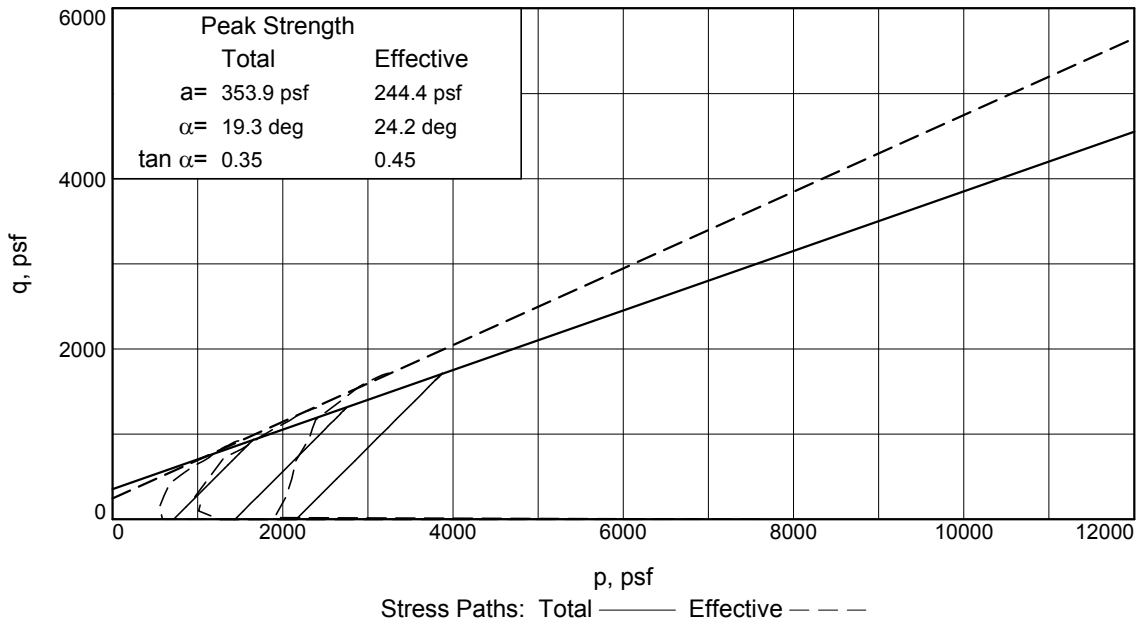






Client: Dannenbaum Engineering Corporation

Project: Proposed NHCRWA Contract NO. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

Depth: 16'-18' **Sample Number:** Boring No. 3

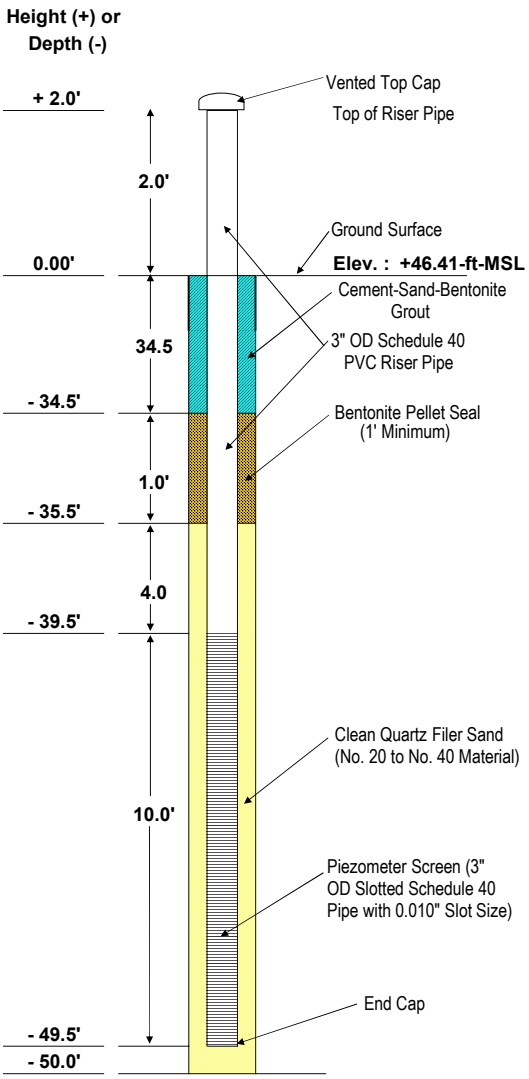
Project No.: 16-S-299 **Figure** 13A

HTS, Inc.

HTS, Inc. Consultants

416 Pickering, Houston, Texas 77091
Tel: (713) 692-8373 Fax: (713) 692-8502

PIEZOMETER INSTALLATION DATA



Installation and Development Details

Piezometer No:	**PZ-1**	
Location:	**See Figure 2A**	
Installation Date:	**10/10/16**	
Drilling Method:	**Dry Auger**	x
	Wet Rotary	x
Development Date:	**11/09/16**	
Development Method:	**Pumping**	

Water Level Data	Depth Below Grade (ft)	Elevation (ft-MSL)
During Drilling:	**18.0**	**28.4**
11/9/2016	**27.7**	**18.7**
12/2/2016	**30.0**	**16.4**

NOTES: **Height above the ground surface is shown as a positive number (+) and depth below ground is shown as a negative number (-).**

Piezometer Installation Data

Proposed 2025 Water Distribution and Transmission System, NHCRWA Contract No. 28
Harris County, Texas

Drawn By: BHA	Date: 12/28/2016	Scale: Not To Scale
Checked By: BFM	Date: 12/28/2016	**Figure 14**
HTS Project No:	16-S-299	

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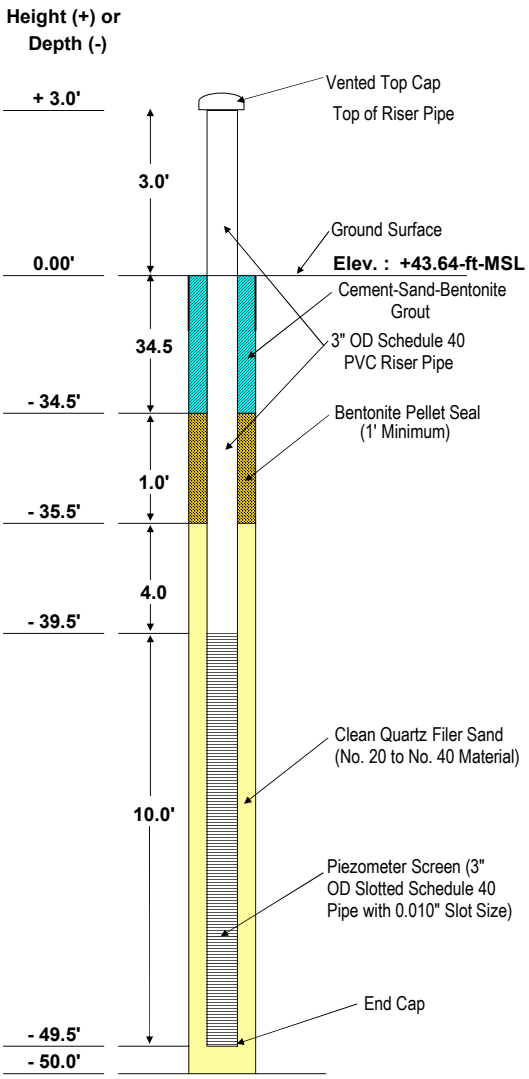
Tel: (713) 692-8373 Fax: (713) 692-8502

PIEZOMETER INSTALLATION DATA



Installation and Development Details

Piezometer No:	**PZ-2**	
Location:	**See Figure 2D**	
Installation Date:	**10/10/16**	
Drilling Method:	**Dry Auger**	x
	Wet Rotary	x
Development Date:	**10/25/16**	
Development Method:	**Pumping**	

Water Level Data	Depth Below Grade (ft)	Elevation (ft-MSL)
During Drilling:	**23.8**	**19.8**
########	**23.7**	**19.9**
########	**23.8**	**19.8**

NOTES: **Height above the ground surface is shown as a positive number (+) and depth below ground is shown as a negative number (-).**

Piezometer Installation Data

Proposed 2025 Water Distribution and Transmission System, NHCRWA Contract No. 28
Harris County, Texas

Drawn By: BHA	Date: 12/28/2016	Scale: Not To Scale
Checked By: BFM	Date: 12/28/2016	**Figure 15**
HTS Project No:	16-S-299	

APPENDIX A

BORING LOGS
(Boring Nos. 1 through 13)

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 1

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' -20':

DATE 10/28/16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 58' 28.9" N
95° 36' 1.3" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SC	**CLAYEY SAND (SC),** dense, light gray	P = 4.50										
2'			P = 1.75										
	CL	**SANDY LEAN CLAY (CL),** stiff to very stiff, light gray and tan	P = 1.75	114.4	0.65	9.6	0	16.8	31	15	16	61.6	(1)
5			P = 1.75										
			P = 1.50										
10													
12'	CH	**FAT CLAY (CH),** stiff to very stiff, light gray and tan, w/ sand pockets - w/ sand seams at 14'	P = 2.00	115.0	0.85	8.3	0	17.3	24	15	9	63.5	(1)
			P = 2.75										
15			P = 2.25										
16'	SM	**SILTY SAND (SM),** medium dense, light gray, w/ clay seams	P = 1.75										
18'	SC	**CLAYEY SAND (SC),** medium dese, light gray and tan	P = 1.75										
20'													
20		Boring terminated at 20'											

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW was not encountered during drilling. After completion of drilling, the boring was dry and open to a depth of 19.2'.

Sample Key: ☒ SPT ⧄ Shelby Tube ▤ Disturbed ▣ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure.

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LOG OF BORING NO. 2

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 20': Rotary: 20'-55'

DATE 10/10//16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 58' 25.3" N
95° 35' 57.7" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SM	**SILTY SAND (SM),** loose to dense, light gray	N = 9	3.2				16.8	Non Plastic
			N = 12						
			N = 13						
8'	CL ML	**SANDY SILTY CLAY (CL-ML),** very stiff, light gray	N = 23						
12'	SM	**SILTY SAND (SM),** medium dense to dense, light gray	N = 29						
			N = 18	11.2				23.3	Non Plastic
		- w/ clay seams at 18'	N = 25						
			N = 31						
			N = 30						
			N = 22						
28'	CH	**FAT CLAY (CH),** stiff to very stiff, reddish brown and light gray	N = 17						

Field Strength Data: ● BLOW COUNT ● (20 40 60 80); ▲ C_u (tsf) ▲ (1.0 2.0 3.0 4.0); ■ SS (tsf) ■ (1.0 2.0 3.0 4.0); ◆ Torvane (psf) ◆ (200 400 600 800)

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20 40 60 80)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW was not encountered prior to use of slurry during drilling. After completion, the water level was at 16.5' and boring was open to 24.9'.

Sample Key: ☒ SPT ⧄ Shelby Tube ▤ Disturbed ▣ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (2) Sample failed along slickensides. (*) See Figures for UU Triaxial Test (ASTM D 2850).

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LOG OF BORING NO. 2

DATE 10/10//16

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

SURFACE ELEVATION

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 20': Rotary: 20'-55'

LOCATION

GPS Coordinates:
29° 58' 25.3" N
95° 35' 57.7" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
30		**FAT CLAY (CH),** stiff to very stiff, reddish brown and light gray - w/ slickensides at 33'											
35			P = 2.75	92.0	0.90	11.6	34	28.4	85	24	61	88.8	(2) * 33'-35' UU
38'	CL	**SANDY LEAN CLAY (CL),** stiff to very stiff, light gray and tan, w/ sand seams, sand pockets, and ferrous nodules											
40			P = 1.75	107.7	1.10	15.0	0	20.3	45	19	26	63.3	(1)
43'	SM	**SILTY SAND (SM),** dense to very dense, light tan											
45			N = 60										
50			N = 42										
55'			N = 73										
		Boring terminated at 55'											

FIELD STRENGTH DATA: ● BLOW COUNT ● 20 40 60 80; ▲ C_u (tsf) ▲ 1.0 2.0 3.0 4.0; ■ SS (tsf) ■ 1.0 2.0 3.0 4.0; ◆ Torvane (psf) ◆ 200 400 600 800

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit; 20 40 60 80

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW was not encountered prior to use of slurry during drilling. After completion, the water level was at 16.5' and boring was open to 24.9'.

Sample Key: ☒ SPT ⧄ Shelby Tube ▤ Disturbed ▣ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (2) Sample failed along slickensides. (*) See Figures for UU Triaxial Test (ASTM D 2850).

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LOG OF BORING NO. 3

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' -25' Rotary: 25'-50'

DATE 10/13//16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 58' 23" N
95° 35' 54.9" W
See Figure 2

DEPTH (ft.)	SAMPLES	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA (● BLOW COUNT 20 40 60 80; ▲ C_u (tsf) 1.0 2.0 3.0 4.0; ■ SS (tsf) 1.0 2.0 3.0 4.0; ◆ Torvane (psf) 200 400 600 800)	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	Natural Moisture Content and Atterberg Limits (Plastic Limit / Moisture Content / Liquid Limit; 20 40 60 80)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		SM	**SILTY SAND (SM),** loose w/ concrete and brick pieces and roots, dark gray	P = 1.50											
2'		SC	**SILTY CLAYEY SAND (SC-SM),** loose to medium dense, light gray and light tan, w/ roots and concrete pieces - gray and light gray at 4'	P = 1.50	110.2	0.25	1.8	0		16.8	20	14	6	38.8	(3)
8'		CL	**SANDY LEAN CLAY (CL),** stiff to very stiff, light tan and light gray, w/ ferrous nodules - light gray w/ silt pockets at 14' - tan and light gray w/ sand pockets at 16'	N = 22											
10				N = 16											
				P = 2.50						15.7	32	15	17	56.5	
				P = 1.75											
15				N = 8											16'-18' Grade 1 Non Dispersive ** 16'-18' CU $C_{eff.}$=313.2 psf $Ø_{eff}$=25.4° $C_{Tot.}$=406.5 psf $Ø_{Tot.}$=19.6°
18'		SC	**CLAYEY SAND (SC),** medium dense to dense, reddish brown, tan, and light gray	P = 3.00	**			**		22.1	47	17	30	59.7	
20				P = 3.50						16.7	37	16	21	37.1	18'-20' K=1.46E-07cm/s
			- light tan and light gray with gravel at 23'												
25				P = 4.50	116.7	2.15	15.0	24		15.7	28	15	13	22.8	(1) *23'-25' UU
28'		SM	**SILTY SAND (SM),** dense to very dense, light gray	N = 34											

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW = 24.3' during drilling and rose to 23.7' after 10 minutes. After completion, water was at 14.5' and boring was open to 23.4'.

Sample Key: ☒ SPT ☐ Shelby Tube ▤ Disturbed ▣ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (2) Sample failed along slickensides. (3) Sample failed along sand fissures. (*) See Figures for UU Triaxial Test (ASTM D 2850). See Figures for CU Triaxial Test (ASTM D 4767).

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LOG OF BORING NO. 3

DATE 10/13//16

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

SURFACE ELEVATION

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' -25' Rotary: 25'-50'

LOCATION

GPS Coordinates:
29° 58' 23" N
95° 35' 54.9" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
30		**SILTY SAND (SM),** dense to very dense, light gray	N >50										
35													
38'	CH	**FAT CLAY (CH),** stiff to very stiff, reddish brown and tan, w/ ferrous nodules and slickensides	P = 4.00	96.6	0.55	2.6	0	28.2					(2)
40													
45			P = 4.00	87.1	0.95	15.0	44	35.3	76	23	53	90.1	(2) *43'-45' UU
48'	SM	**SILTY SAND (SM),** very dense, tan											
50'			N = 63										
50		Boring terminated at 50'											

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW = 24.3' during drilling and rose to 23.7' after 10 minutes. After completion, water was at 14.5' and boring was open to 23.4'.

Sample Key: ☒ SPT ⧄ Shelby Tube ▤ Disturbed ◎ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (2) Sample failed along slickensides. (3) Sample failed along sand fissures. (*) See Figures for UU Triaxial Test (ASTM D 2850). See Figures for CU Triaxial Test (ASTM D 4767).

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LOG OF BORING NO. 4

PAGE 1 OF 1

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' -20'

DATE 10/28//16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 58' 16.6" N
95° 35' 46.7" W
See Figure 2

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		SM		**SILTY SAND (SM),** medium dense, light gray	P = 2.50										
2'															
		CL		**SANDY LEAN CLAY (CL),** very stiff to hard, light gray and tan	P = 4.50	119.8	1.55	3.7	0	10.0	32	14	18	60.6	(1)
5															
6'					P = 4.50										
		CL		**LEAN CLAY WITH SAND (CL),** very stiff to hard, light gray and tan, w/ ferrous nodules - w/ sand seams at 8'	P = 4.00										
10					P = 2.50										
12'					P = 4.50										
		SM		**SILTY SAND (SM),** loose to medium dense, light gray and tan	P = 1.00										
15			▼		N = 15					19.6				22.7	Non Plastic
			▽	- reddish brown and light gray w/ clay seams at 18'	N = 13										
20'					N = 21										
20				Boring terminated at 20'											

MATERIAL DESCRIPTION

FIELD STRENGTH DATA: ● BLOW COUNT ● 20 40 60 80; ▲ C_u (tsf) ▲ 1.0 2.0 3.0 4.0; ■ SS (tsf) ■ 1.0 2.0 3.0 4.0; ◆ Torvane (psf) ◆ 200 400 600 800

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit; 20 40 60 80

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW = 16.0' during drilling and rose to 15.1' after 10 minutes. After completion of drilling, the boring caved at depth of 15.9'.

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed ☐ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure.

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LOG OF BORING NO. 5

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 20'

DATE 10/28//16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 58' 10.5" N
95° 35' 39.5" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SM	**SILTY SAND (SM),** medium dense, light gray	P = 3.75										
2'													
	SC	**CLAYEY SAND (SC),** dense, light gray and tan, w/ ferrous nodules	P = 4.50										
4'													
	CL	**SANDY LEAN CLAY (CL),** hard, light gray and tan, w/ ferrous nodules and calcareous nodules - w/ sand fissures at 6'	P = 4.50										
5			P = 4.50	124.0	3.45	3.2	0	10.7	37	15	22	65.8	(3)
10'			P = 4.50										
	SC	**CLAYEY SAND (SC),** dense, light gray and tan, w/ ferrous nodules and calcareous nodules	P = 4.50										
12'													
	SM	**SILTY SAND (SM),** medium dense to dense, light gray, w/ clay seams	P = 4.50										
15			P = 4.50										
		- light gray and tan at 18'	N = 28										
20'			N = 37										
20		Boring terminated at 20'											

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW was not encountered during drilling. After completion of drilling, the boring was dry and open to a depth of 18.8'.

Sample Key: ☒ SPT ☒ Shelby Tube ☒ Disturbed ☒ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(3) Sample failed along sand fissures.

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LOG OF BORING NO. 6

DATE 10/07//16

SURFACE ELEVATION

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 20'

LOCATION

GPS Coordinates:
29° 58' 0.1" N
95° 35' 25.9" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SM	**SILTY SAND (SM),** loose, light tan, w/ roots	P = 0.50										
2'													
	CL	**SANDY LEAN CLAY (CL),** hard, light gray and tan, w/ sand fissures	P = 4.50										
5			P = 4.50	>>4.5	29.0	5.05	6.0	0	11.3	42	17	25	63.4	(3)
		- light gray and light tan at 10'	P = 4.50										
10			P = 4.50										
12'			P = 4.50		117.8	3.30	5.9	11	9.7	34	16	18	51.3	(1) *10'-12' UU
	SM	**SILTY SAND (SM),** medium dense, light gray and light tan	N = 27										
15			N = 21										
			N = 25						22.1	47	17	30	59.7	
20'			N = 22						16.7	37	16	21	37.1	
20		Boring terminated at 20'												

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW was not encountered during drilling. After completion of drilling, the boring was dry and open to a depth of 19.2'.

Sample Key: ☒ SPT ⧄ Shelby Tube ▤ Disturbed ▣ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (3) Sample failed along sand fissures.

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LOG OF BORING NO. 7

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0'-20'

DATE 10/29/16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 58' 0" N
95° 35' 17.2" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		**SANDY LEAN CLAY (FILL),** stiff, gray, light gray, and tan, w/ roots	P = 1.75					17.1	28	15	13	61.7	
			P = 1.75										
5		6'	P = 1.75										
	CL	**LEAN CLAY WITH SAND (CL),** very stiff to hard, light gray and tan, w/ sand fissures	P = 4.25										
		10'	P = 4.50	116.8	1.65	7.8	0	16.2	46	18	28	74.0	(1)
10	CH	**FAT CLAY (CH),** stiff to very stiff, light gray and tan, w/ sand pockets and sand fissures											
		12'	P = 2.00										
	SC	**CLAYEY SAND (SC),** medium dense, light gray											
		14'	P = 2.25										
15	SM	**SILTY SAND (SM),** very loose to medium dense, light gray and tan	P = 0.25										
		- w/ clay seams at 18'	N = 21										
		20'	N = 18										
20		Boring terminated at 20'											

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

BLOW COUNT ● 20 40 60 80
C_u (tsf) ▲ 1.0 2.0 3.0 4.0
SS (tsf) ■ 1.0 2.0 3.0 4.0
Torvane (psf) ◆ 200 400 600 800

Water Level Est.: ▽ Measured: ▼ Perched: ▼
Water Observations: GW was not encountered during drilling. After completion, the boring was dry and open to a depth of 19.2'.

Sample Key: ☒ SPT ☒ Shelby Tube ☒ Disturbed ☒ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure.

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 8

DATE 10/11/16

SURFACE ELEVATION

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 23': Rotary: 23'-55'

LOCATION

GPS Coordinates:
29° 57' 58.2" N
95° 35' 16.2" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SM	**SILTY SAND (SM),** loose, gray, w/ clay pockets											
2'													
	CL	**SANDY LEAN CLAY (CL),** hard, tan, light tan, and light gray, w/ sand pockets, ferrous nodules, and sand fissures	P = 4.50										
5		- tan and light gray at 6'	P = 4.50										
		- gray, tan, and light gray at 8'	P = 4.50					9.5	40	17	23	63.3	6'-8' Grade 1 Non Dispersive
10			P = 4.50					10.8	42	18	24	68.1	8'-10' K=6.33E-08cm/s
12'			P = 4.50					10.8	39	17	22	62.1	
	SC	**CLAYEY SAND (SC),** medium dense to dense, tan, light tan, and light gray	N = 34										
15		- tan and light gray at 14'	N = 26										
		- w/ clay pockets at 16'	N = 32					6.3	25	16	9	43.8	
18'													
	SM	**SILTY SAND (SM),** medium dense to very dense, tan and light gray	N = 26										
20													
			N = 21										
25		- tan at 28'											
			N = 83										

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW = 23' during drilling and rose to 22.3' after 10 minutes. After completion, the water was at 18' and boring was open to 21.8'.

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed ☐ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (2) Sample failed along slickensides. (3) Sample failed along sand fissures. (*) See Figures for UU Triaxial Test (ASTM D 2850).

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 8

DATE 10/11/16

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

SURFACE ELEVATION

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 23': Rotary: 23'-55'

LOCATION

GPS Coordinates:
29° 57' 58.2" N
95° 35' 16.2" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
30		**SILTY SAND (SM),** medium dense to dense, tan and light gray											
33'													
	CH	**FAT CLAY WITH SAND (CH),** hard, tan and light gray	N = 39					17.3				80.6	
35													
38'													
	CL	**LEAN CLAY (CL),** very srtiff to hard, light tan and light gray, w/ ferrous nodules and sand seams	P = 4.50	112.9	1.85	14.8	39	17.6	43	18	25	91.2	(1) *38'-40' UU
40													
43'													
	CL	**SANDY LEAN CLAY (CL),** very stiff to hard, gray and light tan, w/ sand fissures	P = 4.50	122.0	1.20	11.3	0	13.2	24	15	9		(3)
45													
48'													
	CH	**LEAN CLAY (CL),** very stiff to hard, gray and light tan, w/ ferrous nodules	P = 4.50										
50													
		- reddish brown and light gray at 53'											
55'			N = 73	105.0	1.50	14.9	54	25.8					(2) *53'-55' UU
		Boring terminated at 55'											

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW = 23' during drilling and rose to 22.3' after 10 minutes. After completion, the water was at 18' and boring was open to 21.8'.

Sample Key: ☒ SPT ☒ Shelby Tube ☒ Disturbed ☒ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (2) Sample failed along slickensides. (3) Sample failed along sand fissures. (*) See Figures for UU Triaxial Test (ASTM D 2850).

LOG OF BORING NO. 9

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 23' Rotary: 23'-55'

DATE 10/10/16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 57' 56.7" N
95° 35' 14.5" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SM	**SILTY SAND (SM),** loose, gray and light gray, w/ roots											
2'													
	SC	**CLAYEY SAND (SC),** medium dense, light gray and tan											
4'			N = 27										
	CL	**LEAN CLAY WITH SAND (CL),** hard, light gray and tan, w/ sand fissures											
5		- w/ ferrous nodules at 6'	P = 4.50					11.3	33	17	16	70.1	
			P = 4.50					12.4	43	19	24	73.1	** 6'-8' CU $C_{eff.}$=289.3 psf $Ø_{eff}$=22.5° $C_{Tot.}$=380.9 psf $Ø_{Tot.}$=17.4° (1)
		- light gray at 10'	P = 4.50										
10			P = 4.50	117.3	2.95	14.8	11	13.2	43	19	24	72.5	*10'-12' UU
12'													
	SC	**CLAYEY SAND (SC),** medium dense to dense, light gray	N = 38										
15		- w/ clay seams at 16'	N = 40										
			N = 31										
20			N = 28					3.9	37	17	20	21.7	18'-20' Grade 1 Non Dispersive
23'													
	SM	**SILTY SAND (SM),** medium dense to very dense, tan											
25			N = 22										
			N = 50					19.4				18.9	Non Plastic

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW = 23.0' during drilling and dropped to 23.5' after 10 minutes. After completion, the water was at 16.9' and boring was open to 22.8'.

Sample Key: ☒ SPT ⧄ Shelby Tube ▤ Disturbed ▣ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (*) See Figures for UU Triaxial Test (ASTM D 2850).

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416 Pickering Street
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LOG OF BORING NO. 9

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 23' Rotary: 23'-55'

DATE 10/10/16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 57' 56.7" N
95° 35' 14.5" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
30		**SILTY SAND (SM),** medium dense to very dense, tan											
33'													
	CH	**FAT CLAY (CH),** very stiff, light gray and tan, w/ silt pockets	N = 29										
35													
38'													
	CL	**LEAN CLAY (CL),** stiff to hard, light gray and tan	N >50										
40													
			P = 4.50					13.7	22	14	8		
45		- w/ sand pockets and sand fissures at 48'											
50'			P = 4.50	115.6	0.60	6.0	0	15.4					(1)
50		Boring terminated at 50'											

FIELD STRENGTH DATA: ● BLOW COUNT ● (20 40 60 80); ▲ C_u (tsf) ▲ (1.0 2.0 3.0 4.0); ■ SS (tsf) ■ (1.0 2.0 3.0 4.0); ◆ Torvane (psf) ◆ (200 400 600 800)

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20 40 60 80)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW = 23.0' during drilling and dropped to 23.5' after 10 minutes. After completion, the water was at 16.9' and boring was open to 22.8'.

Sample Key: ☒ SPT ⧄ Shelby Tube ▤ Disturbed ▣ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (*) See Figures for UU Triaxial Test (ASTM D 2850).

HTS, Inc. Consultants
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Houston, Texas 77091

LOG OF BORING NO. 10

PAGE 1 OF 1

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 20'

DATE 10/07/16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 57' 54.96" N
95° 35' 6.17" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION
0	SM	**SILTY SAND (SM),** medium dense, gray, w clay pockets
2'	CL	**LEAN CLAY WITH SAND (CL),** hard, gray and tan, w/ sand fissures
4'	CL	**SANDY LEAN CLAY (CL),** hard, light gray and tan, w/ sand fissures
10'	SC	**CLAYEY SAND (SC),** medium dense to dense, light gray and light tan - light tan at 12'
14'	SP SM	**POORLY GRADED SAND WITH SILT (SP-SM),** medium dense, light tan
20'		Boring terminated at 20'

FIELD STRENGTH DATA: ● BLOW COUNT ● (20 40 60 80); ▲ C_u (tsf) ▲ (1.0 2.0 3.0 4.0); ■ SS (tsf) ■ (1.0 2.0 3.0 4.0); ◆ Torvane (psf) ◆ (200 400 600 800)

Natural Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80)

FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
P = 3.00										
P = 4.50	122.4	2.35	4.2	0	11.4	29	16	13	72.4	(3)
P = 4.50										
P = 4.50										
P = 4.50	119.1	2.95	4.9	0	15.0	42	17	25	69.7	(3)
P = 4.50										
P = 2.75										
N = 13										
N = 15					6.0				11.2	Non Plastic
N = 15										

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW was not encountered during drilling. After completion of drilling, the boring was dry and open to a depth of 18.6'.

Sample Key: ☒ SPT ☒ Shelby Tube ☒ Disturbed ☒ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(3) Sample failed along sand fissures.

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416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 11

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 20'

DATE 10/03/16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 57' 54.9" N
95° 34' 48.3" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SC	**CLAYEY SAND (SC),** dense, gray and light gray	P = 4.50										
2'	CL	**SANDY LEAN CLAY (CL),** very stiff, light gray and tan, w/ sand fissures	P = 3.25	120.6	1.05	8.1	0	12.8					(3)
4'	CL	**LEAN CLAY WITH SAND (CL),** hard, light gray and tan, w/ sand fissures	P = 4.50										
8'	CH	**FAT CLAY (CH),** very stiff, light gray and tan, w/ sand pockets and sand fissures - w/ silt seams at 10' - light gray and reddish brown at 13'	P = 4.50	108.9	2.15	5.9	0	14.8	39	18	21	71.6	(3)
			P = 3.25										
			P = 2.75										
			P = 2.75	110.2	1.20	7.2	0	24.4	63	21	42	95.8	(1)
18'	SM	**SILTY SAND (SM),** very loose, light gray, w/ clay seams											
20'		Boring terminated at 20'	P = 0.25										

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW was not encountered during drilling. After completion, of drilling, the boring was dry and open to a depth of 19.0'.

Sample Key: SPT, Shelby Tube, Disturbed, No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (3) Sample failed along sand fissures.

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 12

PAGE 1 OF 1

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 20'

DATE 10/03/16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 57' 49.8" N
95° 34' 48.1" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SM	**SILTY CLAYEY SAND (SC-SM),** dense, gray and light gray	P = 4.50					4.2	21	17	4	42.9	
2'	CL	**SANDY LEAN CLAY (CL),** stiff to very stiff, gray and tan, w/ sand fissures	P = 2.25										
5			P = 3.25	118.6	0.90	7.9	0	15.5	46	20	26	62.3	(3)
8'	CH	**FAT CLAY (CH),** very stiff, light gray and tan, w/ sand fissures	P = 2.75										
10			P = 3.25	116.2	1.90	9.2	0	18.8					(1)
13'	SM	**SILTY SAND (SM),** very loose to medium dense, light gray, w/ clay seams	P = 2.50										
15			P = 2.00										
			P = 0.25										
20'		Boring terminated at 20'	P = 0.25										
20													

FIELD STRENGTH DATA: ● BLOW COUNT ● (20 40 60 80); ▲ C_u (tsf) ▲ (1.0 2.0 3.0 4.0); ■ SS (tsf) ■ (1.0 2.0 3.0 4.0); ◆ Torvane (psf) ◆ (200 400 600 800)

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20 40 60 80)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW was not encountered during drilling. After completion of drilling, the boring was dry and open to a depth of 19.0'.

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed ☐ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (3) Sample failed along sand fissures.

LOG OF BORING NO. 13

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 20'

DATE: 10/03/16

SURFACE ELEVATION:

LOCATION

GPS Coordinates:
29° 57' 41.7" N
95° 34' 47.9" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SM	1' **SILTY SAND (SM),** loose, light gray, w/ roots	P = 1.50										
	CL	**LEAN CLAY WITH SAND (CL),** very stiff to hard, tan and light gray - w/ sand fissures at 4'	P = 2.50										
5			P = 4.00	116.9	1.75	14.3	5	15.1	42	19	23	70.7	(1)*4'-6' UU
			P = 4.50	124.6	2.30	12.0	0	12.8					(1)
10	SM	10' **SILTY SAND (SM),** very loose to medium dense, light gray, w/ clay seams	P = 3.00										
			P = 2.00	112.9	0.35	5.7	0	17.0	28	15	13	39.8	(3)
15			P = 0.25										
20		20' Boring terminated at 20'	P = 0.25										

FIELD STRENGTH DATA: ● BLOW COUNT ● 20 40 60 80; ▲ C_u (tsf) ▲ 1.0 2.0 3.0 4.0; ■ SS (tsf) ■ 1.0 2.0 3.0 4.0; ◆ Torvane (psf) ◆ 200 400 600 800

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit; 20 40 60 80

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW was not encountered during drilling. After completion of drilling, the boring was dry and open to a depth of 18.8'.

Sample Key: ☒ SPT ☒ Shelby Tube ☒ Disturbed ☒ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (3) Sample failed along sand fissures. See Figures for UU Triaxial Test (ASTM D 2850).

APPENDIX B

TRENCH EXCAVATION REPORT

TRENCH EXCAVATION REPORT
PROPOSED NHCRWA CONTRACT NO. 28-B
2025 WATER DISTRIBUTION AND TRANSMISSION SYSTEM
HARRIS COUNTY, TEXAS

PREPARED FOR:

Dannenbaum Engineering Corporation
3100 West Alabama
Houston, Texas 77098

PREPARED BY:

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091-3312

HTS Project No. 16-S-299

May 27, 2020

TABLE OF CONTENTS

ATTACHMENTS

TRENCH EXCAVATION REPORT
PROPOSED NHCRWA CONTRACT NO. 28-B
2025 WATER DISTRIBUTION AND TRANSMISSION SYSTEM
HARRIS COUNTY, TEXAS

1.0 INTRODUCTION

This report presents HTS, Inc. Consultants (HTS) trench excavation report for the above referenced project. The geotechnical investigation report pertaining to the design and construction of a portion of the water distribution and transmission system planned by the North Harris County Regional Water Authority (NHCRWA) in Harris County, Texas is presented in the main geotechnical report.

Based on information provided by Dannenbaum Engineering Corporation (DEC), the proposed waterline project will require the construction of approximately ±9,800 l.f. of 54-inch and 60-inch water line replacement along Grant Road starting from Lakewood Forest Drive, crossing Cypress Creek (HCFCD Unit No. K100-00-00), to Anderson Wood Drive, then crossing Anderson Ditch (HCFCD Unit No. K143-00-00), Jones Road, and Matzke Park, then along Copeland Drive to Mills Road in Harris County, Texas. The proposed water transmission and distribution system will generally be installed by open-cut methods except where it crosses underground pipelines, roadway crossings, and water channels where tunneling will be used for installation. The location of the proposed water distribution and transmission system is shown in the attached Plates 1 and 2A through 2D.

The scope of this report is to present general information and safety guidelines for the proposed excavations and trenching associated with open cut and tunneling construction for the proposed water transmission line.

2.0 FIELD INVESTIGATION

2.1 Geotechnical Borings

A total of 13 geotechnical borings (Boring Nos. 1 through 13) were drilled for this geotechnical investigation on October 3, 7, 10, 11, 13, 28, and 29, 2016 at the locations shown on Plates 2A through 2D. Piezometers were installed at the locations of Boring Nos. 2 and 9 to a depth of 50 feet beneath the existing ground surface. Piezometer installation details are provided in the attached Plates 4A and 4B.

2.2 Drilling and Sampling Methods

Drilling, sampling, and testing were performed in accordance with applicable ASTM procedures by using a truck-mounted drill rig and conventional auger and wet rotary methods. Van and Sons Drilling Company performed drilling under contract to HTS and under the supervision of an HTS engineering technician.

Soil sampling during the drilling of the geotechnical borings consisted of continuous sampling to between 12 and 20 feet, depending on the purpose of the boring, and intermittent sampling thereafter, with both disturbed and relatively undisturbed samples being obtained.

Disturbed samples of soil were taken from the auger of the sampler or in conjunction with standard penetration test procedures. The standard penetration test (SPT) blow count is defined as the number of SPT hammer blows that are required to advance a split spoon sampler 1 foot into the soil. One SPT hammer blow consists of a 140-pound hammer free falling for a distance of 30 inches. The results of the standard penetration test provide a basis for estimating the relative strength and compressibility of the soil profile components. The samples recovered were removed from the auger of the sampler or the split spoon sampler and placed into airtight plastic bags.

Relatively undisturbed samples were obtained by hydraulically forcing sections of 3-inch O.D. tubing (Shelby tube) into the subsoils. The tube samples were extruded in the field, sealed with foil, and placed into airtight plastic bags. Estimates of the unconfined compressive strengths and undrained shear strengths of the cohesive soils were obtained with pocket penetrometer readings being taken on the tube samples.

The soils samples were visually classified in accordance with ASTM D 2488 standards and methods. All samples were transported to HTS' laboratory for purposes of performing laboratory tests on selected samples.

3.0 LABORATORY TESTING

For the current geotechnical study, a laboratory testing program was conducted to obtain engineering properties for use in performing engineering analyses and to adjust field soil classifications. The following laboratory tests were performed:

LABORATORY TEST	TEST STANDARD
Moisture Content of Soils	ASTM D 2216
Dry Density of Soils	ASTM D 2937
Percent Soil Particles Passing a No. 200 Sieve	ASTM D 1140
Liquid Limit, Plastic Limit, and Plasticity Index	ASTM D 4318
Unconfined Compressive Strength of Cohesive Soils	ASTM D 2166
Unconsolidated Undrained Triaxial Compression Test	ASTM D 2850
Consolidated Undrained Triaxial Compression Test (with pore pressure measurements – 3 stages)	ASTM D 4767
Crumb Testing	ASTM D 6572

LABORATORY TEST	TEST STANDARD
Pinhole Testing	ASTM D 4647
Permeability Testing (Falling Head Method)	ASTM D 5084

The test results are presented on the attached Boring Logs (presented herein as Plates 5 through 17) as well as in Tables 1 through 4B and Figures 4 through 13 in the main geotechnical investigation report.

4.0 SUBSURFACE SOIL AND GROUND WATER CONDITIONS

The subsurface soils and ground water conditions along the route of the proposed water distribution and transmission system are defined in our geotechnical borings and are discussed below.

4.1 Subsurface Soil Conditions

Based on our geotechnical borings that were drilled along the route of the proposed water transmission line, the subsurface soils encountered can be generalized into 5 separate layers as described below:

LAYER	DEPTH BELOW GROUND SURFACE (FT)	SOIL DESCRIPTION
I	0 – 8	Light gray, dark gray, gray, tan, and light tan CLAYEY SAND, SILTY SAND, and SILTY CLAYEY SAND, loose to dense with ferrous nodules, clay pockets, concrete and brick pieces, and roots (not encountered in Boring No. 7).
IIa	1 – 18	Light gray, gray, light tan, and tan SANDY LEAN CLAY, LEAN CLAY, SANDY SILTY CLAY, and LEAN CLAY WITH SAND, stiff to hard with ferrous nodules, calcareous nodules, sand fissures, silt pockets, sand seams, and sand pockets. Note: A layer of fill material consisting of gray, light gray, and tan SANDY LEAN CLAY, stiff with roots was encountered in Boring No. 7 from the surface to a depth of 6 feet below the ground surface.
IIb	8 – 18	Light gray, reddish brown, and tan FAT CLAY, stiff to very stiff with sand fissures, sand pockets, sand seams, and silt seams (only encountered in Boring Nos. 1, 7, 11, and 12).

LAYER	DEPTH BELOW GROUND SURFACE (FT)	SOIL DESCRIPTION
III	10 – 38	Light gray, reddish brown, tan, and light tan CLAYEY SAND, SILTY SAND, and POORLY GRADED SAND WITH SILT, very loose to very dense with ferrous nodules, calcareous nodules, clay seams, clay pockets, clay seams, and gravel.
IVa	28 – 48	Light gray, reddish tan, and tan FAT CLAY and FAT CLAY WITH SAND, stiff to hard with ferrous nodules, silt pockets, and slickensides (only encountered in Boring Nos. 2, 3, 8, and 9).
IVb	38 – 55	Gray, light gray, light tan, reddish brown, and tan LEAN CLAY and SANDY LEAN CLAY, stiff to hard with ferrous nodules, sand seams, sand pockets, and sand fissures (only encountered in Boring Nos. 2, 8, and 9).
V	43 – 55	Light tan and tan SILTY SAND, dense to very dense.

Detailed subsurface soil information is presented in the individual boring logs presented in the attached Plates 5 through 17. The general subsurface soil stratigraphy along the proposed water transmission line alignment is shown in the soil profiles presented in the attached Plate 3.

4.2 Ground Water Conditions

Groundwater measurements were obtained during drilling, and after completion of drilling as applicable. Due to use of wet rotary, groundwater readings were obtained 10 minutes after water was initially encountered, as applicable, for Boring Nos. 2, 3, 8, and 9. The results of the groundwater measurements are presented in the table below:

BORING NO.	TOTAL DEPTH OF BORING (FT.)	DEPTH TO WATER DURING DRILLING (FT.)	DEPTH TO WATER APPROXIMATELY 10 MINUTES AFTER WATER WAS INITIALLY ENCOUNTERED (FT.)	DEPTH TO WATER AFTER COMPLETION OF DRILLING (FT.)	DEPTH TO OBSTRUCTION AFTER SECOND GROUNDWATER MEASUREMENT (FT.)
1	20	Dry	--	Dry	19.2
2	55	Dry to 20*	--	16.5**	24.9
3	50	24.3	23.7	14.5**	23.4
4	20	16.0	15.1	Dry	15.9
5	20	Dry	--	Dry	18.8
6	20	Dry	--	Dry	19.2
7	20	Dry	--	Dry	19.2

BORING NO.	TOTAL DEPTH OF BORING (FT.)	DEPTH TO WATER DURING DRILLING (FT.)	DEPTH TO WATER APPROXIMATELY 10 MINUTES AFTER WATER WAS INITIALLY ENCOUNTERED (FT.)	DEPTH TO WATER AFTER COMPLETION OF DRILLING (FT.)	DEPTH TO OBSTRUCTION AFTER SECOND GROUNDWATER MEASUREMENT (FT.)
8	55	23.0	22.3	8.0**	21.8
9	50	23.0	23.5	6.9**	22.8
10	20	Dry	--	Dry	18.6
11	20	Dry	--	Dry	19.0
12	20	Dry	--	Dry	19.0
13	20	Dry	--	Dry	18.8

Note: Depths are referenced from the existing ground surface elevation at the time the borings were drilled.
* Prior to the use of the drilling fluid.
** Likely influenced by drilling fluid used to keep an open boring.
-- Not applicable.

The borings were backfilled with cement grout after the groundwater measurements were obtained.

Piezometers were installed at the locations of Boring Nos. 2 and 9 to define ground water level conditions in a longer period of time. The water levels were measured at 2 weeks and 1 month after installation and the results are as provided below:

BORING NO. (PIEZOMETER NO.)	2-WEEKS AFTER INSTALLATION		1 MONTH AFTER INSTALLATION	
	DEPTH TO GROUNDWATER (FT.)	ELEVATION (FT.-MSL)	DEPTH TO GROUNDWATER (FT.)	ELEVATION (FT.-MSL)
2 (PZ-1)	27.7	+18.71	30.0	+16.41
9 (PZ-2)	23.7	+19.94	23.8	+19.84

Groundwater depths will fluctuate depending on seasonal rainfall and other climatic events. In the event that there is heavy rain prior to or during construction, the groundwater table may be higher than indicated in this report; higher seepage is also likely and may require a more extensive groundwater control program.

The need for groundwater control will depend on the depth of excavation relative to the groundwater depth at the time of construction. The contractor should be responsible for selecting, designing, constructing, maintaining and monitoring a groundwater control system and adapting his operations to ensure the stability of the excavations. We recommend that the contractor verify the groundwater depths and seepage rates and existence of pressurized groundwater prior to and during construction and retain the services of a dewatering expert to assist him/her in identifying the most suitable and cost-effective method of controlling groundwater. The contractor should take necessary precautions to avoid distressing existing structures as a result of dewatering. Groundwater control should be in accordance with Section 01578 titled "Control of Ground and Surface Water" of the most recent version of COH-DPWE Specifications.

4.3 Subsurface Variations

The information in this report summarizes conditions found on the dates the geotechnical borings were drilled and the dates the ground water levels were monitored. It should be noted that the ground water data and soil moisture contents will vary with environmental variations/fluctuations such as the frequency, duration, and magnitude of rainfall as well as the time of year when construction is in progress.

Clay soils in the Harris County area typically exhibit secondary features such as slickensides and sand or silt fissures/lenses/pockets/seams. Data gathered and presented in our boring logs are based on a 3-inch diameter soil samples obtained during our field investigation. Due to the sampling size, a detailed description of the secondary features may not have been observed/encountered and not indicated on the boring logs. Therefore, while some of our boring logs show soil secondary features, it should not be assumed that these secondary features are absent where not indicated on the boring logs.

5.0 EXCAVATION SAFETY RECOMMENDATIONS

This project will consist of the installation of approximately ±9,800 l.f. of 54-inch and 60-inch water line. The proposed water transmission and distribution line will generally be installed by open-cut methods except where it crosses underground pipelines, roadway crossings, and water channels where tunneling will be used for installation.

5.1 OSHA Soil Types

The Occupational Safety and Health Administration (OSHA) requires that an adequate protective system be designed to protect workers in an excavation from cave-ins. Excavations less than 5 feet deep should be checked by a competent person to have no cave-in potential and should be appropriately protected when an indication of hazardous ground movement is anticipated. Trench excavations with depths between 5 and 20 feet should be shored, sheeted and braced, or laid back to a stable slope for the safety of workers, public and adjacent structures. For trenches deeper than 20

feet, OSHA requires that shoring or bracing be designed by a licensed professional engineer.

If OSHA Standards and Interpretations, 29 CFR 1926, Subpart P, "Excavations" are used for the design of temporary excavation protection systems, the clay layers should be categorized as Type B soils while the fill materials and the sands/silts should be categorized as Type C soils. The definitions of Type B and Type C soils are provided in Appendix A of the OSHA Standards and Interpretations, 29 CFR 1926, Subpart P, "Excavations" (www.osha.gov). In order to eliminate the potential for caving of trench excavations, trench safety shall be implemented for trench excavations that are deeper than 5 feet.

Recommended design soil parameters, including OSHA Soil Types are presented on the attached Plates 18 through 20. HTS recommends that excavated materials should not be allowed to stockpile near the excavation wall. We recommend that excavated materials should be placed away a distance of half the excavation depth on both sides of the trench. The maximum allowable slopes in OSHA Soil Types A, B and C for excavations less than 20 feet are illustrated on the attached Plate 21. If space is limited for the required open trench side slopes, anticipated to apply to the entire route of the proposed water transmission line project, the trench excavations may be protected using a combination of bracing and open-cut as illustrated in the attached Plate 22.

5.2 Critical Height

Critical Height is defined as the height a slope will stand unsupported for a short time in cohesive soils, it is used to estimate the maximum depth of open-cuts at given side slopes. Critical Height may be calculated using the soil cohesion. Values for various slopes and cohesion are shown in the attached Plate 23. Cautions listed below should be exercised in use of Critical Height applications.

1. **No more than 50 percent of the Critical Height computed should be used for vertical slopes. Unsupported vertical slopes are not recommended where granular soils or soils that will slough when not laterally supported are encountered within the excavation depth.**

2. **If tension cracks occur, no cohesion should be assumed for the soils within the depth of the crack. The depth of the first waler should not exceed the depth of the potential tension crack. Struts should be installed before lateral displacement occurs.**

3. **Shoring should be provided for excavations where limited space precludes adequate side slopes, e.g., where granular soils will not stand on stable slopes and/or for deep open cuts.**

4. **All excavation, trenching and shoring should be designed and constructed by qualified professionals and personnel in accordance with Occupational Safety and Health Administration (OSHA) requirements.**

5.3 Computation of Bracing Pressures

Lateral pressures resulting from construction equipment, traffic loads, or other surcharge loads should be taken into account by adding the equivalent uniformly distributed surcharge to the design lateral pressures. Hydrostatic pressure, if any, should also be considered. The active earth pressure at depth z can be determined by Equation (1) as provided below using the design soil parameters presented in the attached Plates 18 through 20.

$$p_a = (q_s + \gamma h_1 + \gamma' h_2)\, K_a - 2c\sqrt{K_a} + \gamma_w h_2 \qquad \text{Equation (1)}$$

where,

p_a	=	active earth pressure, psf.
q_s	=	uniform surcharge pressure, psf.
γ, γ'	=	wet unit weight and buoyant unit weight of soil.
h_1	=	depth from ground surface to ground water table.
h_2	=	$z-h_1$, depth from ground water table to the point under consideration.
z	=	depth below ground surface for the point under consideration.
K_a	=	coefficient of active earth pressure.
c	=	cohesion of clayey soils.
γ_w	=	unit weight of water, 62.4 pcf.

Pressure distribution for the design of struts in open cuts for clays and sands are illustrated in the attached Plates 24 through 26. If there is water behind the bracing, hydrostatic pressure should be included in the design.

If excavations are located close to existing structures, we recommend using the coefficient of at-rest earth pressure (K_0) for design instead of the use of active earth pressure coefficient (K_a) to reduce the potential for distress to the existing structures. The active earth pressure at depth (z) can be determined by the same Equation (1) above.

5.4 Excavation Bottom Stability

In open-cuts, the possibility of the bottom failing by heaving, due to the removal of the weight of excavated soils, must be considered. In clays, heave normally does not occur unless the ratio of Critical Height to Depth of Cut approaches one. In silty clays and granular soils, heave can occur if an artificially large head of water is created through the use of impervious sheeting in bracing the cut. This can be mitigated if the ground water is lowered below the excavation by dewatering the area. Equations and parameters for evaluating bottom stability are presented on the attached Plate 27.

If the excavation is carried out below the ground water table and a significant amount of the soils at or near the bottom of the excavation are sands or silts or low-plasticity clays, the bottom can fail by blow-out (boiling) at the bottom when a sufficient hydraulic head exists. The potential for boiling or in-flow of granular soils increases where the ground water level is high. If this condition is present during the construction activities, it is recommended that the ground water level be lowered to at least 3 feet below the excavation in order to reduce the potential for boiling of excavation terminating in granular soils below ground water. In extreme conditions, mechanical or chemical stabilization of the granular soils may be required.

5.5 Excavation Dewatering

Groundwater was encountered at depths ranging from 16.0 to 24.3 feet during drilling in only 4 of the 13 borings. Groundwater was encountered only in Boring Nos. 3, 4, 8, and 9 and the rest of the borings were dry, except in Boring No. 2 where the boring was dry to 20 feet and caved in before drilling fluid was used. Approximately 10 minutes after water was initially encountered, groundwater was measured at depths ranging from 15.1 to 23.7 feet below the existing surface in the same 4 borings. Accordingly, it is not expected that groundwater will be present for excavations that are no deeper than about 14 feet beneath the surface. However, the Layer III sands may be part of a water bearing stratum that could hold water after prolonged wet periods or after heavy rainfall events. The use of sumps and pumps may be adequate for clayey soil above the groundwater levels previously provided. The use of well points, vacuum well points, or a comparable dewatering system may be required to dewater the excavations extending below the groundwater levels where the exposed soils consist of the site sands. Control of groundwater and surface water during the installation of the underground utilities should be performed in accordance with Section 01578 of the most recent version of COH-DPWE Standard Specifications.

5.6 Trenchless Excavation

It is our understanding that the waterline installation at the roadways, existing pipelines, Anderson Ditch, and Cypress Creek crossings will be performed using underground tunneling with steel casing. Depending on tunneling depths and ground water fluctuations, groundwater could be expected within the tunneling path during the installation of the casing. It is recommended that the groundwater levels within the installation areas be monitored prior to the installation activities. Additionally, test pits on both ends of the installation alignment may also be excavated prior to the construction activities in order to determine the actual groundwater levels. If the groundwater level is within the path of the tunneling operation, the water level must be lowered to at least 2 feet beneath the bottom of the proposed casing. Groundwater dewatering may be accomplished using well points, vacuum well points, or any other suitable dewatering system where sandy materials are encountered.

Tunneling operations for the installation of the proposed water line under the roadways, existing pipelines, Anderson Ditch, and Cypress Creek shall conform with applicable guidelines and regulations of the governing agency within the project area; and/or the guidelines and requirements of Item 431 titled "Jacking, Boring or Tunneling Pipe" and Item 432 titled "Tunnel Construction" of the most recent Harris County Engineering Department (HCED) Specifications titled "Specifications for the Construction of Roads and Bridges within Harris County, Texas" or Subchapter F titled "Water Line Crossings" in Chapter 7 titled " Water Line Design Requirements" of City of Houston Infrastructure Design Manual dated July 01, 2016 and in accordance with the Section 02425 entitled "Tunnel Excavation and Primary Liner" of the 2016 COH-DPWE Standard Specifications.

5.7 Tunnel Shafts in Trenchless Excavation

In trenchless excavation for the portion of the water line under the existing roadway, tunnel shafts will be required. These shafts need to be shored because the side walls are normally cut vertical because of space limitation and/or to conserve space. Tunnel shafts should be designed as braced excavations in accordance with the applicable previous sections for open cut excavations. Tunnel shafts should be constructed in accordance with Section 02400 entitled "Tunnel Shafts" of the 2016 COH-DPWE Standard Specifications.

6.0 CLOSING REMARKS

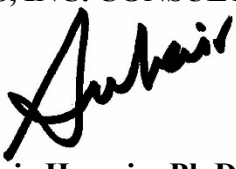
HTS, Inc. Consultants has prepared this trench excavation report pertaining to the design and construction of a portion of the water distribution and transmission system planned by the NHCRWA in Harris County, Texas. This report has been prepared for the exclusive use of DEC and NHCRWA in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

In the event that changes are made in the nature, design, or location of the proposed facilities, the conclusions, parameters, and recommendations contained in this report shall not be considered valid unless the changes are reviewed and the findings/recommendations of this report are modified or verified in writing. The analyses and recommendations presented in this report are based upon data obtained from 13 geotechnical borings drilled on October 3, 7, 10, 11, 13, 28, and 29, 2016. The nature and extent of variations within the subsurface materials may not become evident until after construction is initiated. If significant variations in the subsurface materials are encountered during construction, it may be necessary to re-evaluate the recommendations provided in this report.

It was a pleasure being of service to you on this project. Should you have any questions or require clarification of this report, please do not hesitate to contact us at your convenience.

Sincerely,

HTS, INC. CONSULTANTS



Jubair Hossain, Ph.D., P.E.`
Vice President

5-27-20

HTS, Inc. Consultants
F-3478

BFM/ba/JH:cg

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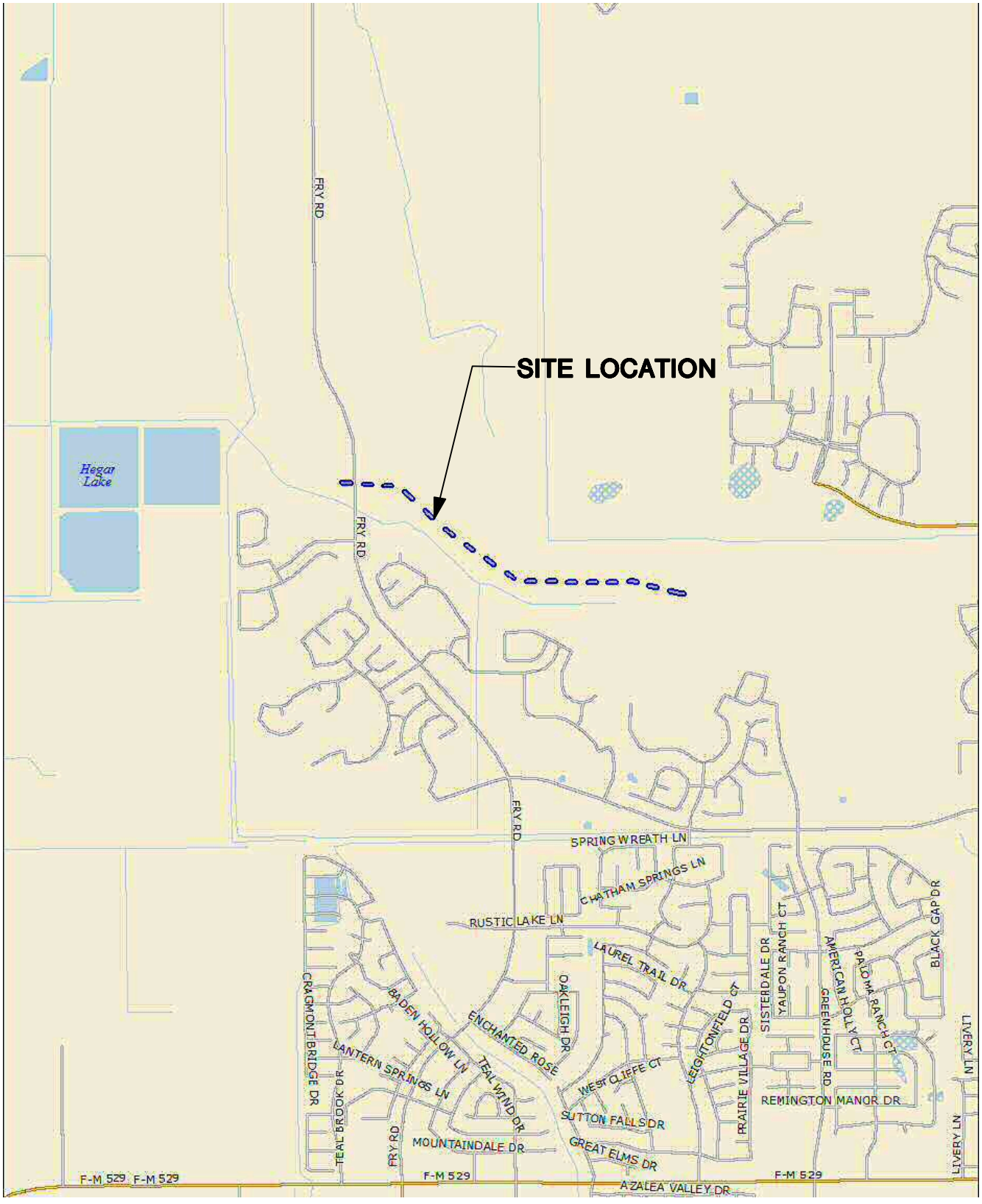
ATTACHMENTS

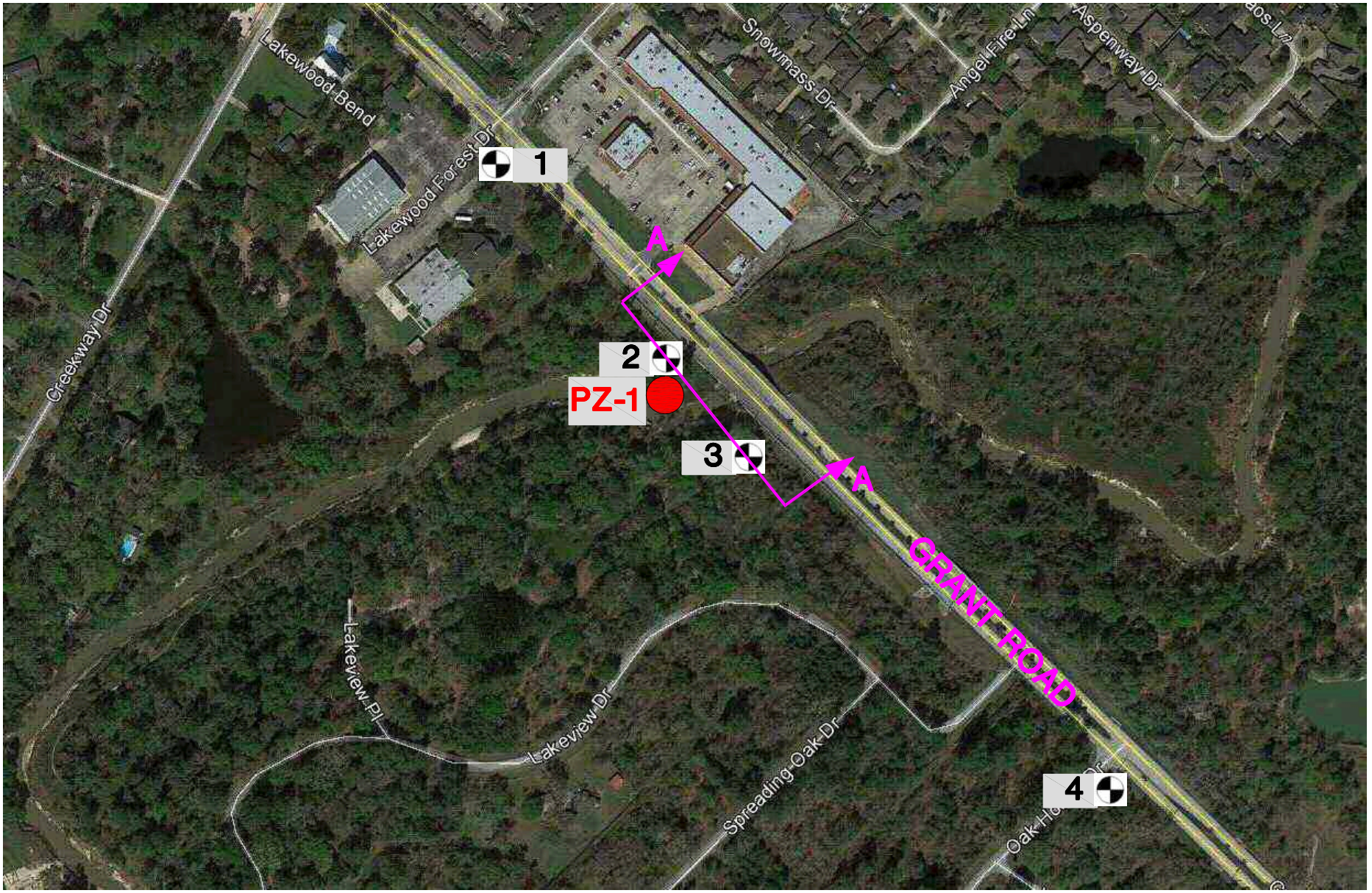


HTS, Inc. Consultants

Proposed NHCRWA Contract No. 28-B
2025 Water Distribution
and Transmission System
Harris County, Texas

DRAWN BY:	IAT	DATE:	11-21-16	SCALE: NTS
CHECKED BY:	BFM	DATE:	11-21-16	
HTS PROJECT NO.:	16-S-299			PLATE: 1

VICINITY MAP



Legend

- Geotechnical borings included in the study
- Piezometer location

HTS, Inc. Consultants

Proposed NHCRWA Contract No. 28-B
2025 Water Distribution and Transmission System
Harris County, Texas

DRAWN BY:	IAT	DATE:	11/15/16	SCALE: NTS
CHECKED BY:	BFM	DATE:	11/15/16	
HTS PROJECT NO.:	16-S-299			PLATE: 2A

BORING LOCATIONS

Legend

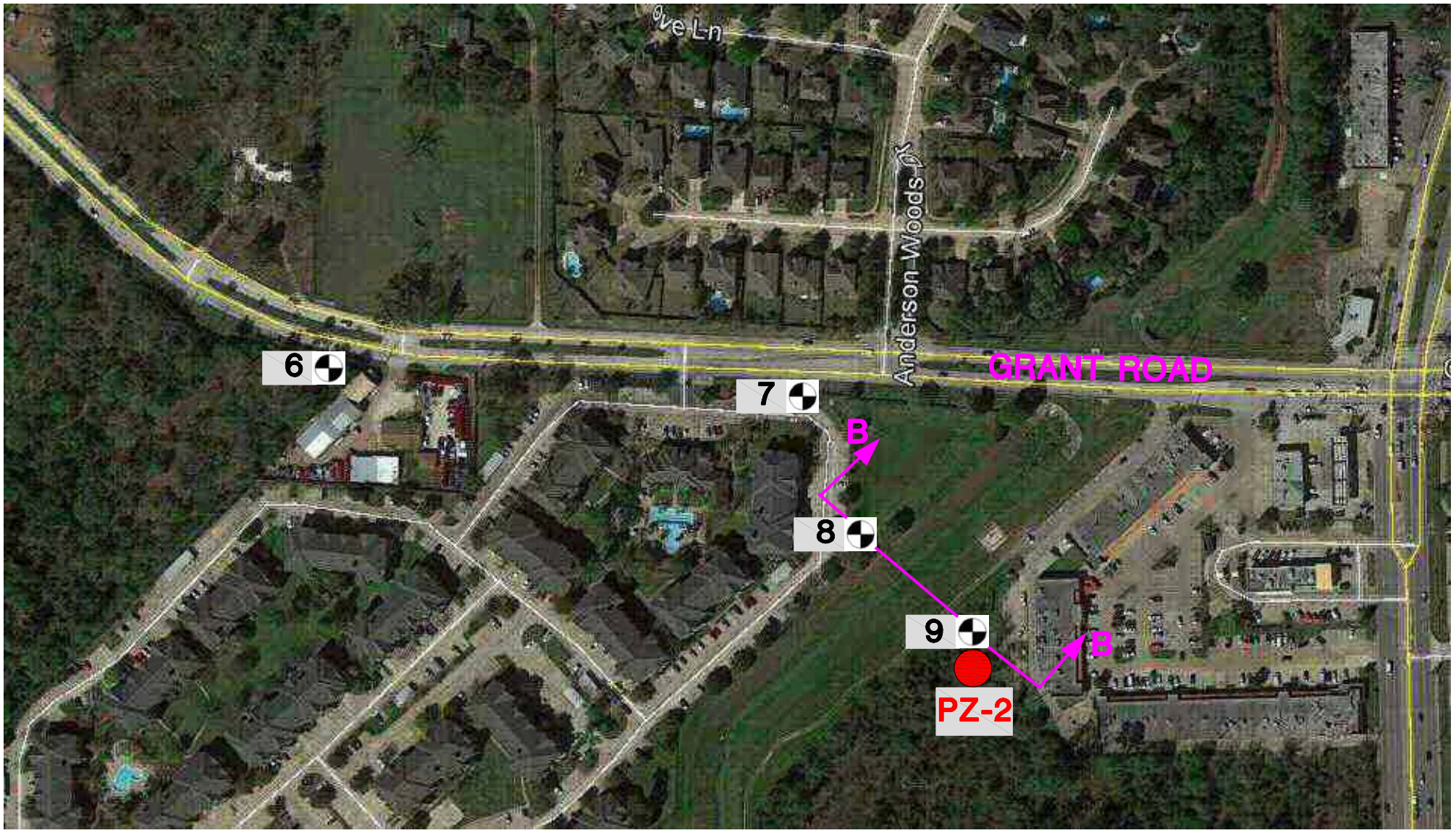
Geotechnical Borings included in the study

HTS, Inc. Consultants

Proposed NHCRWA Contract No. 28-B
2025 Water Distribution and Transmission System
Harris County, Texas

DRAWN BY:	IAT	DATE:	7/26/16	SCALE: NTS
CHECKED BY:	BFM	DATE:	7/26/16	
HTS PROJECT NO.:	16-S-299			PLATE: 2B

BORING LOCATIONS



Legend

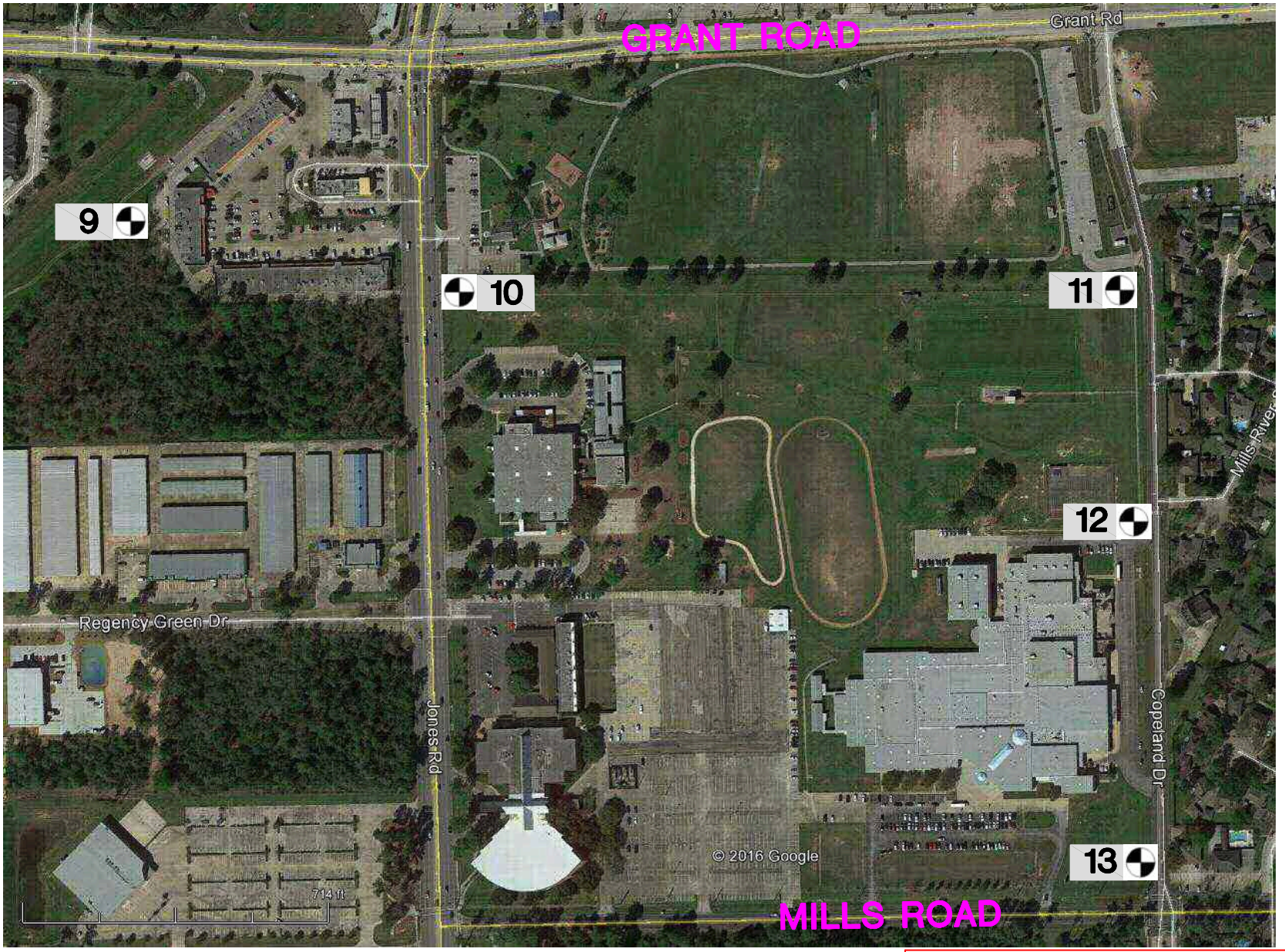
- Geotechnical borings included in the study
- Piezometer location

HTS, Inc. Consultants

Proposed NHCRWA Contract No. 28-B
2025 Water Distribution and Transmission System
Harris County, Texas

DRAWN BY:	IAT	DATE:	11/15/16	SCALE: NTS
CHECKED BY:	BFM	DATE:	11/15/16	
HTS PROJECT NO.:	16-S-299			PLATE: 2C

BORING LOCATIONS



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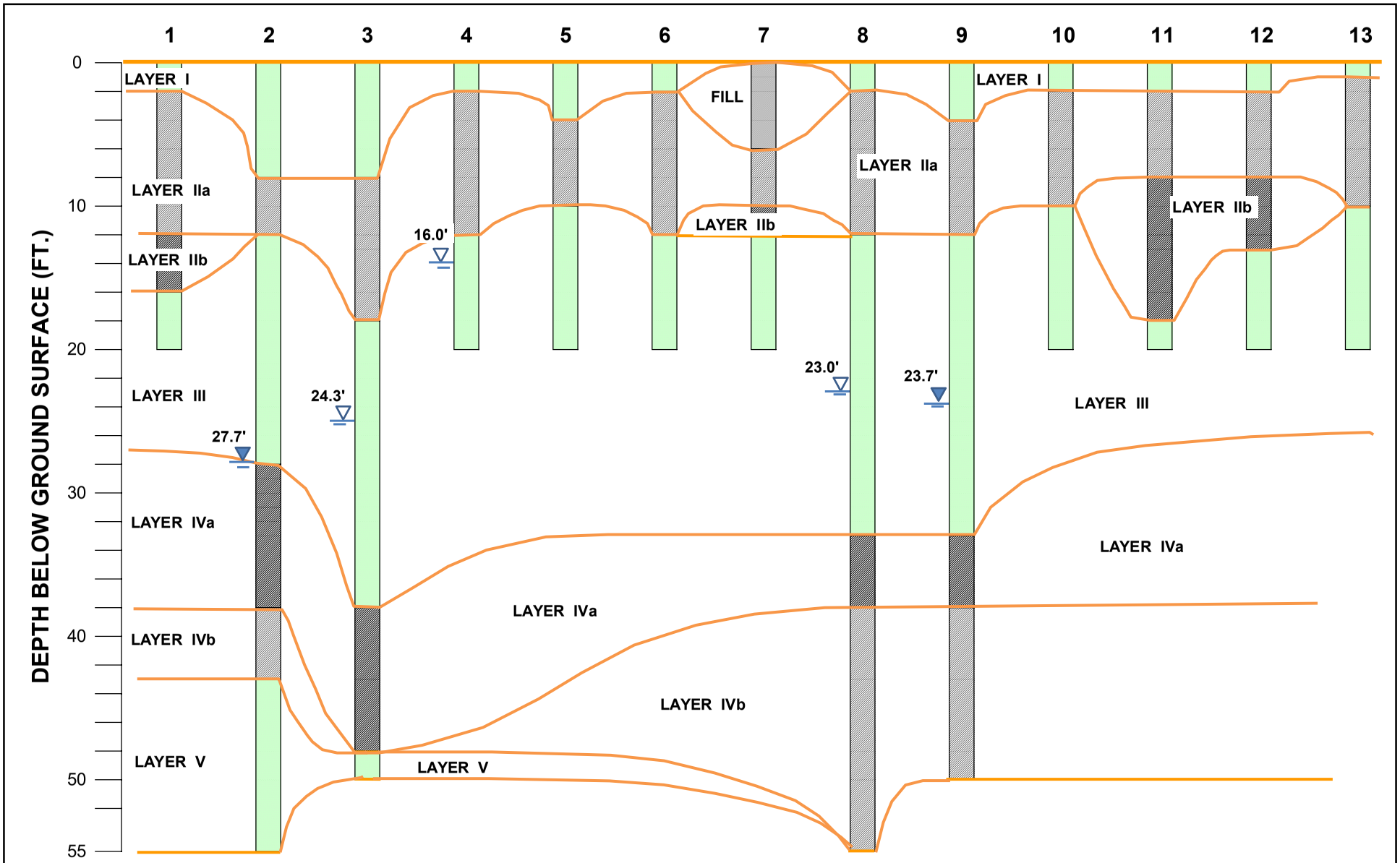
Proposed NHCRWA Contract No. 28-B
2025 Water Distribution and Transmission System
Harris County, Texas

DRAWN BY:	IAT	DATE:	11/15/16	SCALE: NTS
CHECKED BY:	BFM	DATE:	11/15/16	
HTS PROJECT NO.:	16-S-299			PLATE: 2D

BORING LOCATIONS

Legend

- Geotechnical borings included in the study



HTS, INC. Consultants

LEGENDS:

- Clayey Sands and Silty Sands
- Lean Clays and Silty Clays
- Fat Clays
- Fill
- Piezometer Reading
- Groundwater Reading During Drilling

SOIL PROFILE

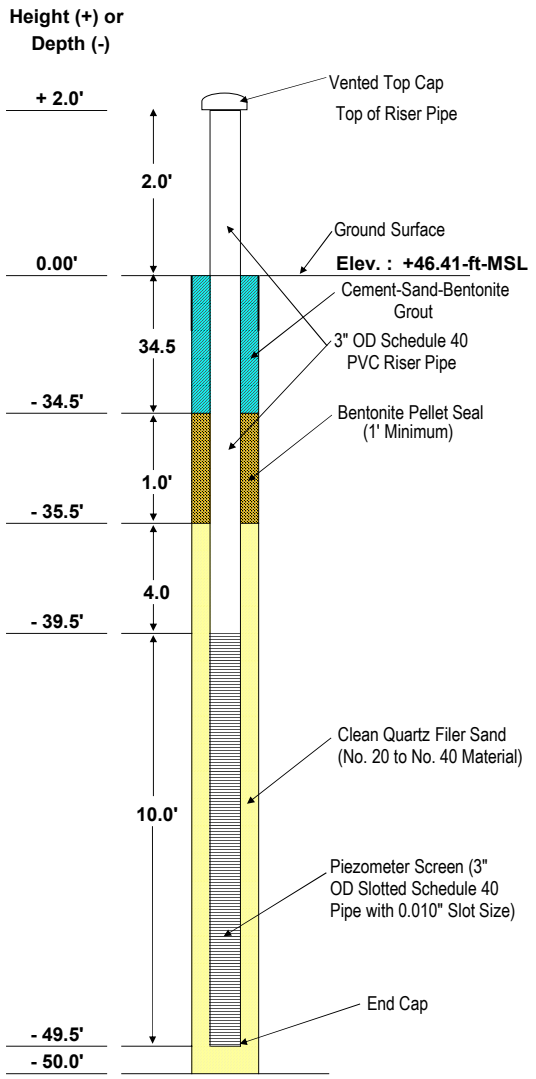
Proposed NHCRWA Contract No. 28-B
2025 Water Distribution and Transmission System
Harris County, Texas

Date: 12/30/2016	Report No: 16-S-299	Plate 3

HTS, Inc. Consultants

416 Pickering, Houston, Texas 77091
Tel: (713) 692-8373 Fax: (713) 692-8502

PIEZOMETER INSTALLATION DATA



Installation and Development Details

Piezometer No:	**PZ-1**	
Location:	**See Plate 2A**	
Installation Date:	**10/10/16**	
Drilling Method:	**Dry Auger**	x
	Wet Rotary	x
Development Date:	**11/09/16**	
Development Method:	**Pumping**	

Water Level Data	Depth Below Grade (ft)	Elevation (ft-MSL)
During Drilling:	**18.0**	**28.4**
11/9/2016	**23.7**	**22.7**
12/2/2016	**30.0**	**16.4**

NOTES: **Height above the ground surface is shown as a positive number (+) and depth below ground is shown as a negative number (-).**

Piezometer Installation Data

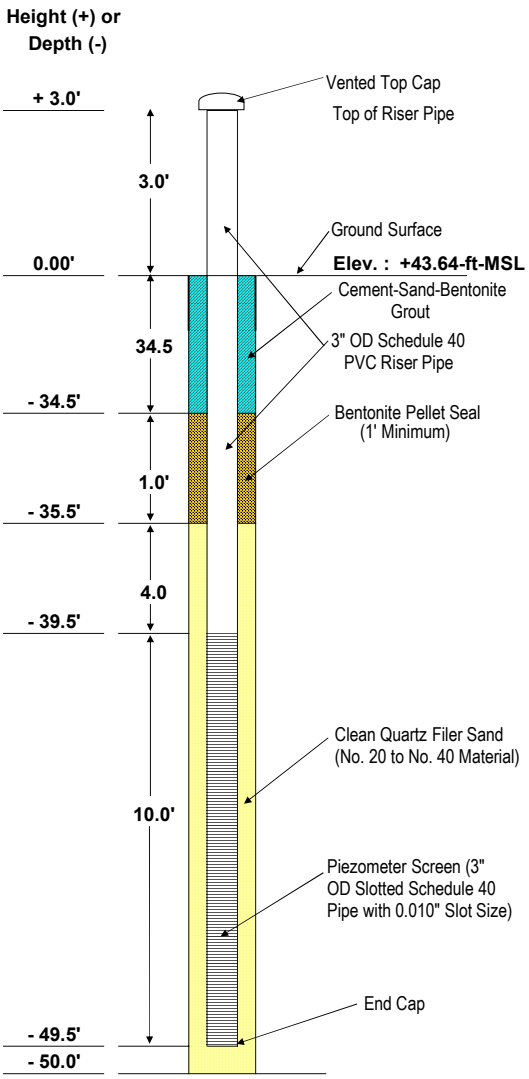
Proposed NHCRWA Contract No. 28-B
2025 Water Distribution and Transmission System
Harris County, Texas

Drawn By: BHA	Date: 12/28/2016	Scale: Not To Scale
Checked By: BFM	Date: 12/28/2016	**Plate 4A**
HTS Project No:	16-S-299	

HTS, Inc. Consultants

416 Pickering, Houston, Texas 77091
Tel: (713) 692-8373 Fax: (713) 692-8502

PIEZOMETER INSTALLATION DATA



Installation and Development Details

Piezometer No:	**PZ-2**	
Location:	**See Plate 2D**	
Installation Date:	**10/10/16**	
Drilling Method:	**Dry Auger**	x
	Wet Rotary	x
Development Date:	**10/25/16**	
Development Method:	**Pumping**	

Water Level Data	Depth Below Grade (ft)	Elevation (ft-MSL)
During Drilling:	**23.8**	**19.8**
########	**23.7**	**19.9**
########	**23.8**	**19.8**

NOTES: **Height above the ground surface is shown as a positive number (+) and depth below ground is shown as a negative number (-).**

Piezometer Installation Data

Proposed NHCRWA Contract No. 28-B
2025 Water Distribution and Transmission System
Harris County, Texas

Drawn By: BHA	Date: 12/28/2016	Scale: Not To Scale
Checked By: BFM	Date: 12/28/2016	**Plate 4B**
HTS Project No:	16-S-299	

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 1

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' -20':

DATE 10/28/16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 58' 28.9" N
95° 36' 1.3" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SC	**CLAYEY SAND (SC),** dense, light gray	P = 4.50										
2'			P = 1.75										
	CL	**SANDY LEAN CLAY (CL),** stiff to very stiff, light gray and tan	P = 1.75	114.4	0.65	9.6	0	16.8	31	15	16	61.6	(1)
5			P = 1.75										
			P = 1.50										
10													
12'	CH	**FAT CLAY (CH),** stiff to very stiff, light gray and tan, w/ sand pockets - w/ sand seams at 14'	P = 2.00	115.0	0.85	8.3	0	17.3	24	15	9	63.5	(1)
			P = 2.75										
15			P = 2.25										
16'	SM	**SILTY SAND (SM),** medium dense, light gray, w/ clay seams	P = 1.75										
18'	SC	**CLAYEY SAND (SC),** medium dese, light gray and tan	P = 1.75										
20'													
20		Boring terminated at 20'											

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW was not encountered during drilling. After completion of drilling, the boring was dry and open to a depth of 19.2'.

Sample Key: ☒ SPT ⧄ Shelby Tube ▤ Disturbed ▣ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure.

PLATE 5

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 2

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 20': Rotary: 20'-55'

DATE 10/10//16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 58' 25.3" N
95° 35' 57.7" W
See Figure 2

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA (BLOW COUNT / C_u (tsf) / SS (tsf) / Torvane (psf))	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	Natural Moisture Content and Atterberg Limits	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SM	**SILTY SAND (SM),** loose to dense, light gray	N = 9						3.2				16.8	Non Plastic
5			N = 12											
			N = 13											
8'	CL ML	**SANDY SILTY CLAY (CL-ML),** very stiff, light gray	N = 23											
10			N = 29											
12'	SM	**SILTY SAND (SM),** medium dense to dense, light gray	N = 18						11.2				23.3	Non Plastic
15			N = 25											
		- w/ clay seams at 18'	N = 31											
20			N = 30											
25			N = 22											
28'	CH	**FAT CLAY (CH),** stiff to very stiff, reddish brown and light gray	N = 17											

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW was not encountered prior to use of slurry during drilling. After completion, the water level was at 16.5' and boring was open to 24.9'.

Sample Key: SPT Shelby Tube Disturbed No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (2) Sample failed along slickensides. (*) See Figures for UU Triaxial Test (ASTM D 2850).

PLATE 6

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 2

DATE 10/10//16

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

SURFACE ELEVATION

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 20': Rotary: 20'-55'

LOCATION

GPS Coordinates:
29° 58' 25.3" N
95° 35' 57.7" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
30		**FAT CLAY (CH),** stiff to very stiff, reddish brown and light gray - w/ slickensides at 33'											
35			P = 2.75	92.0	0.90	11.6	34	28.4	85	24	61	88.8	(2) * 33'-35' UU
38'	CL	**SANDY LEAN CLAY (CL),** stiff to very stiff, light gray and tan, w/ sand seams, sand pockets, and ferrous nodules	P = 1.75	107.7	1.10	15.0	0	20.3	45	19	26	63.3	(1)
43'	SM	**SILTY SAND (SM),** dense to very dense, light tan	N = 60										
45													
50			N = 42										
55'		Boring terminated at 55'	N = 73										

FIELD STRENGTH DATA: ● BLOW COUNT ● 20 40 60 80; ▲ C_u (tsf) ▲ 1.0 2.0 3.0 4.0; ■ SS (tsf) ■ 1.0 2.0 3.0 4.0; ◆ Torvane (psf) ◆ 200 400 600 800

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit; 20 40 60 80

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW was not encountered prior to use of slurry during drilling. After completion, the water level was at 16.5' and boring was open to 24.9'.

Sample Key: ☒ SPT ⧄ Shelby Tube ▤ Disturbed ▣ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (2) Sample failed along slickensides. (*) See Figures for UU Triaxial Test (ASTM D 2850).

PLATE 6

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 3

DATE 10/13//16

SURFACE ELEVATION

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' -25' Rotary: 25'-50'

LOCATION

GPS Coordinates:
29° 58' 23" N
95° 35' 54.9" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SM	**SILTY SAND (SM),** loose w/ concrete and brick pieces and roots, dark gray											
2'	SC	**SILTY CLAYEY SAND (SC-SM),** loose to medium dense, light gray and light tan, w/ roots and concrete pieces - gray and light gray at 4'	P = 1.50										
5			P = 1.50	110.2	0.25	1.8	0	16.8	20	14	6	38.8	(3)
8'	CL	**SANDY LEAN CLAY (CL),** stiff to very stiff, light tan and light gray, w/ ferrous nodules - light gray w/ silt pockets at 14' - tan and light gray w/ sand pockets at 16'	N = 22										
			N = 16										
10			P = 2.50					15.7	32	15	17	56.5	
			P = 1.75										
15			N = 8										16'-18' Grade 1 Non Dispersive ** 16'-18' CU $C_{eff.}$=313.2 psf $Ø_{eff}$=25.4° $C_{Tot.}$=406.5 psf $Ø_{Tot.}$=19.6°
18'	SC	**CLAYEY SAND (SC),** medium dense to dense, reddish brown, tan, and light gray	P = 3.00	**			**	22.1	47	17	30	59.7	
			P = 3.50					16.7	37	16	21	37.1	18'-20' K=1.46E-07cm/s
20		- light tan and light gray with gravel at 23'											
			P = 4.50	116.7	2.15	15.0	24	15.7	28	15	13	22.8	(1) *23'-25' UU
25													
28'	SM	**SILTY SAND (SM),** dense to very dense, light gray	N = 34										

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

BLOW COUNT (20 40 60 80); C_u (tsf) (1.0 2.0 3.0 4.0); SS (tsf) (1.0 2.0 3.0 4.0); Torvane (psf) (200 400 600 800)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW = 24.3' during drilling and rose to 23.7' after 10 minutes. After completion, water was at 14.5' and boring was open to 23.4'.

Sample Key: SPT, Shelby Tube, Disturbed, No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (2) Sample failed along slickensides. (3) Sample failed along sand fissures. (*) See Figures for UU Triaxial Test (ASTM D 2850). See Figures for CU Triaxial Test (ASTM D 4767).

PLATE 7

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 3

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' -25' Rotary: 25'-50'

DATE 10/13//16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 58' 23" N
95° 35' 54.9" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
30		**SILTY SAND (SM),** dense to very dense, light gray	N >50										
35													
38'	CH	**FAT CLAY (CH),** stiff to very stiff, reddish brown and tan, w/ ferrous nodules and slickensides	P = 4.00	96.6	0.55	2.6	0	28.2					(2)
40													
45			P = 4.00	87.1	0.95	15.0	44	35.3	76	23	53	90.1	(2) *43'-45' UU
48'	SM	**SILTY SAND (SM),** very dense, tan											
50'			N = 63										
50		Boring terminated at 50'											

FIELD STRENGTH DATA: ● BLOW COUNT ● 20 40 60 80; ▲ C_u (tsf) ▲ 1.0 2.0 3.0 4.0; ■ SS (tsf) ■ 1.0 2.0 3.0 4.0; ◆ Torvane (psf) ◆ 200 400 600 800

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit; 20 40 60 80

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW = 24.3' during drilling and rose to 23.7' after 10 minutes. After completion, water was at 14.5' and boring was open to 23.4'.

Sample Key: ☒ SPT ☒ Shelby Tube ☒ Disturbed ☒ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (2) Sample failed along slickensides. (3) Sample failed along sand fissures. (*) See Figures for UU Triaxial Test (ASTM D 2850). See Figures for CU Triaxial Test (ASTM D 4767).

PLATE 7

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416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 4

PAGE 1 OF 1

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' -20'

DATE 10/28//16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 58' 16.6" N
95° 35' 46.7" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SM	**SILTY SAND (SM),** medium dense, light gray	P = 2.50										
2'													
	CL	**SANDY LEAN CLAY (CL),** very stiff to hard, light gray and tan	P = 4.50	119.8	1.55	3.7	0	10.0	32	14	18	60.6	(1)
5													
6'			P = 4.50										
	CL	**LEAN CLAY WITH SAND (CL),** very stiff to hard, light gray and tan, w/ ferrous nodules - w/ sand seams at 8'	P = 4.00										
10			P = 2.50										
12'			P = 4.50										
	SM	**SILTY SAND (SM),** loose to medium dense, light gray and tan	P = 1.00										
15			N = 15					19.6				22.7	Non Plastic
		- reddish brown and light gray w/ clay seams at 18'	N = 13										
20'			N = 21										
20		Boring terminated at 20'											

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW = 16.0' during drilling and rose to 15.1' after 10 minutes. After completion of drilling, the boring caved at depth of 15.9'.

Sample Key: SPT, Shelby Tube, Disturbed, No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure.

PLATE 8

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416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 5

PAGE 1 OF 1

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 20'

DATE 10/28//16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 58' 10.5" N
95° 35' 39.5" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION
0	SM	**SILTY SAND (SM),** medium dense, light gray
2'	SC	**CLAYEY SAND (SC),** dense, light gray and tan, w/ ferrous nodules
4'	CL	**SANDY LEAN CLAY (CL),** hard, light gray and tan, w/ ferrous nodules and calcareous nodules - w/ sand fissures at 6'
10'	SC	**CLAYEY SAND (SC),** dense, light gray and tan, w/ ferrous nodules and calcareous nodules
12'	SM	**SILTY SAND (SM),** medium dense to dense, light gray, w/ clay seams - light gray and tan at 18'
20'		Boring terminated at 20'

FIELD STRENGTH DATA: ● BLOW COUNT ● 20 40 60 80; ▲ C_u (tsf) ▲ 1.0 2.0 3.0 4.0; ■ SS (tsf) ■ 1.0 2.0 3.0 4.0; ◆ Torvane (psf) ◆ 200 400 600 800

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit; 20 40 60 80

DEPTH (ft.)	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	P = 3.75										
	P = 4.50										
5	P = 4.50										
	P = 4.50	124.0	3.45	3.2	0	10.7	37	15	22	65.8	(3)
10	P = 4.50										
	P = 4.50										
	P = 4.50										
15	N = 28										
	N = 37										
20											

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW was not encountered during drilling. After completion of drilling, the boring was dry and open to a depth of 18.8'.

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed ☐ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(3) Sample failed along sand fissures.

PLATE 9

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 6

DATE 10/07//16

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

SURFACE ELEVATION

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 20'

LOCATION

GPS Coordinates:
29° 58' 0.1" N
95° 35' 25.9" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SM	**SILTY SAND (SM),** loose, light tan, w/ roots	P = 0.50										
2'													
	CL	**SANDY LEAN CLAY (CL),** hard, light gray and tan, w/ sand fissures	P = 4.50										
5			P = 4.50	>>4.5	29.0	5.05	6.0	0	11.3	42	17	25	63.4	(3)
		- light gray and light tan at 10'	P = 4.50										
10			P = 4.50										
12'			P = 4.50		117.8	3.30	5.9	11	9.7	34	16	18	51.3	(1) *10'-12' UU
	SM	**SILTY SAND (SM),** medium dense, light gray and light tan	N = 27										
15			N = 21										
			N = 25						22.1	47	17	30	59.7	
20'			N = 22						16.7	37	16	21	37.1	
20		Boring terminated at 20'												

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW was not encountered during drilling. After completion of drilling, the boring was dry and open to a depth of 19.2'.

Sample Key: ☒ SPT ⧄ Shelby Tube ▤ Disturbed ▣ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (3) Sample failed along sand fissures.

PLATE 10

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 7

PAGE 1 OF 1

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0'-20'

DATE 10/29/16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 58' 0" N
95° 35' 17.2" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA (BLOW COUNT / C_u (tsf) / SS (tsf) / Torvane (psf))	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	Natural Moisture Content and Atterberg Limits	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		**SANDY LEAN CLAY (FILL),** stiff, gray, light gray, and tan, w/ roots	P = 1.75						17.1	28	15	13	61.7	
			P = 1.75											
5			P = 1.75											
6'	CL	**LEAN CLAY WITH SAND (CL),** very stiff to hard, light gray and tan, w/ sand fissures	P = 4.25											
10'			P = 4.50	116.8	1.65	7.8	0		16.2	46	18	28	74.0	(1)
10	CH	**FAT CLAY (CH),** stiff to very stiff, light gray and tan, w/ sand pockets and sand fissures												
12'	SC	**CLAYEY SAND (SC),** medium dense, light gray	P = 2.00											
14'	SM	**SILTY SAND (SM),** very loose to medium dense, light gray and tan	P = 2.25											
15			P = 0.25											
		- w/ clay seams at 18'	N = 21											
20'			N = 18											
20		Boring terminated at 20'												

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW was not encountered during drilling. After completion, the boring was dry and open to a depth of 19.2'.

Sample Key: ☒ SPT ☒ Shelby Tube ☒ Disturbed ☒ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure.

PLATE 11

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 8

DATE 10/11/16

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

SURFACE ELEVATION

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 23': Rotary: 23'-55'

LOCATION

GPS Coordinates:
29° 57' 58.2" N
95° 35' 16.2" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SM	**SILTY SAND (SM),** loose, gray, w/ clay pockets											
2'													
	CL	**SANDY LEAN CLAY (CL),** hard, tan, light tan, and light gray, w/ sand pockets, ferrous nodules, and sand fissures	P = 4.50										
5		- tan and light gray at 6'	P = 4.50										
		- gray, tan, and light gray at 8'	P = 4.50					9.5	40	17	23	63.3	6'-8' Grade 1 Non Dispersive
10			P = 4.50					10.8	42	18	24	68.1	8'-10' K=6.33E-08cm/s
12'			P = 4.50					10.8	39	17	22	62.1	
	SC	**CLAYEY SAND (SC),** medium dense to dense, tan, light tan, and light gray	N = 34										
15		- tan and light gray at 14'	N = 26										
		- w/ clay pockets at 16'	N = 32					6.3	25	16	9	43.8	
18'													
	SM	**SILTY SAND (SM),** medium dense to very dense, tan and light gray	N = 26										
20													
			N = 21										
25		- tan at 28'											
			N = 83										

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW = 23' during drilling and rose to 22.3' after 10 minutes. After completion, the water was at 18' and boring was open to 21.8'.

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed ☐ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (2) Sample failed along slickensides. (3) Sample failed along sand fissures. (*) See Figures for UU Triaxial Test (ASTM D 2850).

PLATE 12

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 8

DATE 10/11/16

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

SURFACE ELEVATION

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 23': Rotary: 23'-55'

LOCATION

GPS Coordinates:
29° 57' 58.2" N
95° 35' 16.2" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
30		**SILTY SAND (SM),** medium dense to dense, tan and light gray											
		33'											
	CH	**FAT CLAY WITH SAND (CH),** hard, tan and light gray	N = 39					17.3				80.6	
35													
		38'											
	CL	**LEAN CLAY (CL),** very srtiff to hard, light tan and light gray, w/ ferrous nodules and sand seams	P = 4.50	112.9	1.85	14.8	39	17.6	43	18	25	91.2	(1) *38'-40' UU
40													
		43'											
	CL	**SANDY LEAN CLAY (CL),** very stiff to hard, gray and light tan, w/ sand fissures	P = 4.50	122.0	1.20	11.3	0	13.2	24	15	9		(3)
45													
		48'											
	CH	**LEAN CLAY (CL),** very stiff to hard, gray and light tan, w/ ferrous nodules	P = 4.50										
50													
		- reddish brown and light gray at 53'											
		55'	N = 73	105.0	1.50	14.9	54	25.8					(2) *53'-55' UU
55		Boring terminated at 55'											

FIELD STRENGTH DATA: ● BLOW COUNT ● 20 40 60 80; ▲ C_u (tsf) ▲ 1.0 2.0 3.0 4.0; ■ SS (tsf) ■ 1.0 2.0 3.0 4.0; ◆ Torvane (psf) ◆ 200 400 600 800

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit; 20 40 60 80

ATTERBERG LIMITS(%): LL, PL, PI

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW = 23' during drilling and rose to 22.3' after 10 minutes. After completion, the water was at 18' and boring was open to 21.8'.

Sample Key: ☒ SPT ☐ Shelby Tube ▤ Disturbed ▣ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (2) Sample failed along slickensides. (3) Sample failed along sand fissures. (*) See Figures for UU Triaxial Test (ASTM D 2850).

PLATE 12

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 9

DATE 10/10/16

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

SURFACE ELEVATION

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 23' Rotary: 23'-55'

LOCATION

GPS Coordinates:
29° 57' 56.7" N
95° 35' 14.5" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA (BLOW COUNT / C_u (tsf) / SS (tsf) / Torvane (psf))	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	Natural Moisture Content and Atterberg Limits	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SM	**SILTY SAND (SM),** loose, gray and light gray, w/ roots												
2'														
	SC	**CLAYEY SAND (SC),** medium dense, light gray and tan	N = 27											
4'														
	CL	**LEAN CLAY WITH SAND (CL),** hard, light gray and tan, w/ sand fissures	P = 4.50						11.3	33	17	16	70.1	
5		- w/ ferrous nodules at 6'	P = 4.50						12.4	43	19	24	73.1	** 6'-8' CU $C_{eff.}$=289.3 psf $Ø_{eff}$=22.5° $C_{Tot.}$=380.9 psf $Ø_{Tot.}$=17.4° (1)
			P = 4.50											
10		- light gray at 10'	P = 4.50											
12'														
	SC	**CLAYEY SAND (SC),** medium dense to dense, light gray	P = 4.50	117.3	2.95	14.8	11		13.2	43	19	24	72.5	*10'-12' UU
			N = 38											
15		- w/ clay seams at 16'	N = 40											
			N = 31											
20			N = 28						3.9	37	17	20	21.7	18'-20' Grade 1 Non Dispersive
23'														
	SM	**SILTY SAND (SM),** medium dense to very dense, tan	N = 22											
25														
			N = 50						19.4				18.9	Non Plastic

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW = 23.0' during drilling and dropped to 23.5' after 10 minutes. After completion, the water was at 16.9' and boring was open to 22.8'.

Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed ☐ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (*) See Figures for UU Triaxial Test (ASTM D 2850).

PLATE 13

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 9

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 23' Rotary: 23'-55'

DATE 10/10/16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 57' 56.7" N
95° 35' 14.5" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
30		**SILTY SAND (SM),** medium dense to very dense, tan											
33'													
35	CH	**FAT CLAY (CH),** very stiff, light gray and tan, w/ silt pockets	N = 29										
38'													
40	CL	**LEAN CLAY (CL),** stiff to hard, light gray and tan	N >50										
45		- w/ sand pockets and sand fissures at 48'	P = 4.50					13.7	22	14	8		
50'													
50		Boring terminated at 50'	P = 4.50	115.6	0.60	6.0	0	15.4					(1)

FIELD STRENGTH DATA: ● BLOW COUNT ● (20 40 60 80); ▲ C_u (tsf) ▲ (1.0 2.0 3.0 4.0); ■ SS (tsf) ■ (1.0 2.0 3.0 4.0); ◆ Torvane (psf) ◆ (200 400 600 800)

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit (20 40 60 80)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW = 23.0' during drilling and dropped to 23.5' after 10 minutes. After completion, the water was at 16.9' and boring was open to 22.8'.

Sample Key: ☒ SPT ☒ Shelby Tube ☒ Disturbed ☒ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (*) See Figures for UU Triaxial Test (ASTM D 2850).

PLATE 13

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 10

PAGE 1 OF 1

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 20'

DATE 10/07/16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 57' 54.96" N
95° 35' 6.17" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SM	**SILTY SAND (SM),** medium dense, gray, w clay pockets	P = 3.00										
2'	CL	**LEAN CLAY WITH SAND (CL),** hard, gray and tan, w/ sand fissures	P = 4.50	122.4	2.35	4.2	0	11.4	29	16	13	72.4	(3)
4'	CL	**SANDY LEAN CLAY (CL),** hard, light gray and tan, w/ sand fissures	P = 4.50										
5			P = 4.50										
			P = 4.50										
10'	SC	**CLAYEY SAND (SC),** medium dense to dense, light gray and light tan - light tan at 12'	P = 4.50	119.1	2.95	4.9	0	15.0	42	17	25	69.7	(3)
10			P = 4.50										
14'	SP SM	**POORLY GRADED SAND WITH SILT (SP-SM),** medium dense, light tan	P = 2.75										
15			N = 13										
			N = 15					6.0				11.2	Non Plastic
20'			N = 15										
20		Boring terminated at 20'											

FIELD STRENGTH DATA: ● BLOW COUNT ● (20 40 60 80); ▲ C_u (tsf) ▲ (1.0 2.0 3.0 4.0); ■ SS (tsf) ■ (1.0 2.0 3.0 4.0); ◆ Torvane (psf) ◆ (200 400 600 800)

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW was not encountered during drilling. After completion of drilling, the boring was dry and open to a depth of 18.6'.

Sample Key: ☒ SPT ☐ Shelby Tube ▤ Disturbed ▣ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(3) Sample failed along sand fissures.

PLATE 14

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 11

PAGE 1 OF 1

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 20'

DATE 10/03/16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 57' 54.9" N
95° 34' 48.3" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SC	**CLAYEY SAND (SC),** dense, gray and light gray	P = 4.50										
2'	CL	**SANDY LEAN CLAY (CL),** very stiff, light gray and tan, w/ sand fissures	P = 3.25	120.6	1.05	8.1	0	12.8					(3)
4'	CL	**LEAN CLAY WITH SAND (CL),** hard, light gray and tan, w/ sand fissures	P = 4.50										
5			P = 4.50	108.9	2.15	5.9	0	14.8	39	18	21	71.6	(3)
8'	CH	**FAT CLAY (CH),** very stiff, light gray and tan, w/ sand pockets and sand fissures - w/ silt seams at 10'	P = 3.25										
10			P = 2.75										
		- light gray and reddish brown at 13'	P = 2.75	110.2	1.20	7.2	0	24.4	63	21	42	95.8	(1)
15													
18'	SM	**SILTY SAND (SM),** very loose, light gray, w/ clay seams	P = 0.25										
20'		Boring terminated at 20'											
20													

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW was not encountered during drilling. After completion, of drilling, the boring was dry and open to a depth of 19.0'.

Sample Key: ☒ SPT ⧄ Shelby Tube ▤ Disturbed ▣ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (3) Sample failed along sand fissures.

PLATE 15

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 12

PAGE 1 OF 1

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 20'

DATE 10/03/16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 57' 49.8" N
95° 34' 48.1" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SM	**SILTY CLAYEY SAND (SC-SM),** dense, gray and light gray	P = 4.50					4.2	21	17	4	42.9	
2'	CL	**SANDY LEAN CLAY (CL),** stiff to very stiff, gray and tan, w/ sand fissures	P = 2.25										
5			P = 3.25	118.6	0.90	7.9	0	15.5	46	20	26	62.3	(3)
8'	CH	**FAT CLAY (CH),** very stiff, light gray and tan, w/ sand fissures	P = 2.75										
10			P = 3.25	116.2	1.90	9.2	0	18.8					(1)
13'	SM	**SILTY SAND (SM),** very loose to medium dense, light gray, w/ clay seams	P = 2.50										
15			P = 2.00										
			P = 0.25										
20'		Boring terminated at 20'	P = 0.25										
20													

FIELD STRENGTH DATA: ● BLOW COUNT ● 20 40 60 80; ▲ C_u (tsf) ▲ 1.0 2.0 3.0 4.0; ■ SS (tsf) ■ 1.0 2.0 3.0 4.0; ◆ Torvane (psf) ◆ 200 400 600 800

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit; 20 40 60 80

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW was not encountered during drilling. After completion of drilling, the boring was dry and open to a depth of 19.0'.

Sample Key: ☒ SPT ☒ Shelby Tube ☒ Disturbed ☒ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (3) Sample failed along sand fissures.

PLATE 16

HTS, Inc. Consultants
416 Pickering Street
Houston, Texas 77091

LOG OF BORING NO. 13

PROJECT: Proposed NHCRWA Contract No. 28-B, 2025 Water Distribution and Transmission System, Harris County, Texas

PROJECT NO.: 16-S-299 BORING TYPE: Auger: 0' - 20'

DATE 10/03/16

SURFACE ELEVATION

LOCATION

GPS Coordinates:
29° 57' 41.7" N
95° 34' 47.9" W
See Figure 2

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	FIELD STRENGTH DATA	DRY DENSITY (pcf)	SHEAR STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SM	1' **SILTY SAND (SM),** loose, light gray, w/ roots											
	CL	**LEAN CLAY WITH SAND (CL),** very stiff to hard, tan and light gray - w/ sand fissures at 4'	P = 1.50										
			P = 2.50										
5			P = 4.00	116.9	1.75	14.3	5	15.1	42	19	23	70.7	(1)*4'-6' UU
			P = 4.50	124.6	2.30	12.0	0	12.8					(1)
10	SM	10' **SILTY SAND (SM),** very loose to medium dense, light gray, w/ clay seams	P = 3.00										
			P = 2.00	112.9	0.35	5.7	0	17.0	28	15	13	39.8	(3)
15			P = 0.25										
20		20' Boring terminated at 20'	P = 0.25										

FIELD STRENGTH DATA: ● BLOW COUNT ● 20 40 60 80; ▲ C_u (tsf) ▲ 1.0 2.0 3.0 4.0; ■ SS (tsf) ■ 1.0 2.0 3.0 4.0; ◆ Torvane (psf) ◆ 200 400 600 800

Natural Moisture Content and Atterberg Limits: Plastic Limit — Moisture Content — Liquid Limit; 20 40 60 80

Water Level Est.: ▽ Measured: ▼ Perched: ▼

Water Observations: GW was not encountered during drilling. After completion of drilling, the boring was dry and open to a depth of 18.8'.

Sample Key: ☒ SPT ☒ Shelby Tube ☒ Disturbed ☒ No Recovery

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
C_u - Undrained Cohesion (tsf)
SS - Shear Strength (P/2, tsf)

Notes:
(1) Sample bulged at failure. (3) Sample failed along sand fissures. See Figures for UU Triaxial Test (ASTM D 2850).

PLATE 17

Recommended Geotechnical Design Parameters

RECOMMENDED GEOTECHNICAL DESIGN PARAMETERS

Geotechnical Sub Consultant: HTS, Inc. Consultants

PROJECT NAME: 2025 Water Transmission and Ditribution System
NHCRWA Contract No. 28, Harris County, Texas
HTS PROJECT No.: 16-S-299

Boring No.	Sample Depth (feet)	Type of Material	OSHA TYPE	γ (pcf)	γ' (pcf)	SHORT TERM					LONG TERM
						C (psf)	ϕ (deg)	K_a	K_o	K_p	For Long Term Condition, refer to Section 1.4.5 of the report.
1	0-2	Dense: SC	C	129	67	0	32	0.31	0.45	3.25	
	2-6	Stiff: CL	B	134	71	1300	0	1.00	1.00	1.00	
	6-12	Stiff: CL	B	135	73	1700	0	1.00	1.00	1.00	
	12-16	Very stiff: CH	B	138	76	2000	0	1.00	1.00	1.00	
	16-20	Medium dense: SM, SC	C	134	72	0	30	0.33	1.99	3.00	
2	0-8	Loose to Medium Dense: SM	C	132	70	0	28	0.36	0.73	2.77	
	8-12	Very stiff: CL-ML	B	134	72	1800	0	1.00	1.00	1.00	
	13.5-15	Medium dense to dense: SM	C	134	72	0	30	0.33	1.99	3.00	
	28-38	Stiff to very stiff: CH	B	129	67	1800	0	1.00	1.00	1.00	
	38-43	Stiff to very stiff: CL	B	130	67	2200	0	1.00	1.00	1.00	
	43-55	Dense to very dense: SM	C	134	72	0	32	0.31	0.45	3.25	
3	0-8	Loose to medium dense, SM, SC-SM	C	129	66	0	28	0.36	0.73	2.77	
	8-16	Stiff to very stiff: CL	B	135	72	1800	0	1.00	1.00	1.00	
	16-18	Very stiff: CL	B	135	72	2500	0	1.00	1.00	1.00	
	18-23	Medium dense: SC	C	135	72	0	30	0.33	1.99	3.00	
	23-25	Dense to very dense: SC, SM	C	135	73	0	32	0.31	0.45	3.25	
	38-40	Stiff to very stiff: CH	B	124	61	1100	0	1.00	1.00	1.00	
	40-48	Stiff to very stiff: CH	B	118	55	1900	0	1.00	1.00	1.00	
	48-50	Very dense: SM	C	134	72	0	32	0.31	0.45	3.25	
4	0-2	Medium dense: SM	C	129	67	0	30	0.33	1.99	3.00	
	2-12	Very stiff to hard: CL	B	132	70	3000	0	1.00	1.00	1.00	
	14.5-16	Loose to medium dense: SM	C	132	70	0	28	0.36	0.73	2.77	

Note:

1) γ = Unit Weight for soil above water level,
2) CL = Lean Clays; CH = Fat Clays
3) Cu = Ultimate cohesion of soil, ϕu = friction angle of soil, for short term;
4) Ka = Coefficient of active earth pressure Ko = Coefficient of static earth pressure
   Kp = Coefficient of passive earth pressure
5) OSHA Soil Types:
   - A: Cohesive soils with q_u = 1.5 tsf or greater (q_u = Unconfined Compressive Strength of the soil)
   - B: Cohesive soils with q_u = 0.5 tsf or greater
   - C: Cohesive soils with q_u = less than 0.5 tsf, granular soils, submerged soils or soils with significant weak secondary structure.

PLATE 18

Recommended Geotechnical Design Parameters

RECOMMENDED GEOTECHNICAL DESIGN PARAMETERS Geotechnical Sub Consultant: HTS, Inc. Consultants						PROJECT NAME: 2025 Water Transmission and Ditribution System NHCRWA Contract No. 28, Harris County, Texas HTS PROJECT No.: 16-S-299					Page: 2 of 3
Boring No.	Sample Depth (feet)	Type of Material	OSHA TYPE	γ (pcf)	γ' (pcf)	SHORT TERM					LONG TERM
						C (psf)	ϕ (deg)	K_a	K_o	K_p	For Long Term Condition, refer to Section 1.4.5 of the report.
5	0-4	Medium dense to dense: SM, SC	C	129	67	0	30	0.33	1.99	3.00	
	4-10	Hard: CL	B	137	75	3000	0	1.00	1.00	1.00	
	10-20	Medium dense to dense: SM, SC	C	129	67	0	30	0.33	1.99	3.00	
6	0-2	Loose: SM	C	129	67	0	28	0.36	0.73	2.77	
	2-12	Hard: CL	B	144	82	3000	0	1.00	1.00	1.00	
	12-20	Medium dense: SM	C	129	67	0	30	0.33	1.99	3.00	
7	0-6	Stiff: CL FILL	C	134	72	1700	0	1.00	1.00	1.00	
	6-10	Very stiff to hard: CL	B	136	74	3000	0	1.00	1.00	1.00	
	10-12	Stiff to very stiff: CH	B	118	56	2000	0	1.00	1.00	1.00	
8	0-2	Loose: SM	C	129	67	0	28	0.36	0.73	2.77	
	2-12	Hard: CL	B	134	72	3000	0	1.00	1.00	1.00	
	12-33	Medium dense to very dense: SC, SM	C	132	70	0	32	0.31	0.45	3.25	
	33-38	Hard: CH	B	120	58	3000	0	1.00	1.00	1.00	
	38-55	Very stiff to hard: CL	B	138	76	2400	0	1.00	1.00	1.00	
9	0-4	Loose to Medium: SM, SC	C	129	67	0	28	0.36	0.73	2.77	
	4-12	Hard: CL	B	134	72	3000	0	1.00	1.00	1.00	
	12-33	Medium dense to very dense: SC, SM	C	132	70	0	32	0.31	0.45	3.25	
	33-38	Very Stiff: CH	B	120	58	2500	0	1.00	1.00	1.00	
	38-50	Stiff to hard: CL	B	133	71	1200	0	1.00	1.00	1.00	

Note:

1) γ = Unit Weight for soil above water level,
2) CL = Lean Clays; CH = Fat Clays
3) Cu = Ultimate cohesion of soil, ϕu = friction angle of soil, for short term;
4) Ka = Coefficient of active earth pressure Ko = Coefficient of static earth pressure
   Kp = Coefficient of passive earth pressure
5) OSHA Soil Types:
   - A: Cohesive soils with q_u = 1.5 tsf or greater (q_u = Unconfined Compressive Strength of the soil)
   - B: Cohesive soils with q_u = 0.5 tsf or greater
   - C: Cohesive soils with q_u = less than 0.5 tsf, granular soils, submerged soils or soils with significant weak secondary structure.

PLATE 19

Recommended Geotechnical Design Parameters

RECOMMENDED GEOTECHNICAL DESIGN PARAMETERS Geotechnical Sub Consultant: HTS, Inc. Consultants						PROJECT NAME: 2025 Water Transmission and Ditribution System NHCRWA Contract No. 28, Harris County, Texas HTS PROJECT No.: 16-S-299					Page: 3 of 3
Boring No.	Sample Depth (feet)	Type of Material	OSHA TYPE	γ (pcf)	γ' (pcf)	SHORT TERM					LONG TERM
						C (psf)	ϕ (deg)	K_a	K_o	K_p	For Long Term Condition, refer to Section 1.4.5 of the report.
10	0-2	Medium dense: SM	C	132	70	0	30	0.33	1.99	3.00	
	2-10	Hard: CL	B	137	75	3000	0	1.00	1.00	1.00	
	10-20	Medium dense to dense: SC, SP-SM	C	132	70	0	30	0.33	1.99	3.00	
11	0-2	Dense: SC	C	132	70	0	32	0.31	0.45	3.25	
	2-8	Very stiff to hard: CL	B	135	73	2100	0	1.00	1.00	1.00	
	8-18	Very stiff: CH	B	137	75	2400	0	1.00	1.00	1.00	
	18-20	Very loose: SM	C	132	70	0	28	0.36	0.73	2.77	
12	0-2	Very dense: SC-SM	C	132	70	0	32	0.31	0.45	3.25	
	2-8	Stiff to very stiff: CL	B	134	72	1800	0	1.00	1.00	1.00	
	8-13	Very stiff: CH	B	138	76	3000	0	1.00	1.00	1.00	
	13-20	Very loose to medium dense: SM	C	132	70	0	28	0.36	0.73	2.77	
13	0-1	Loose: SM	C	132	70	0	28	0.36	0.73	2.77	
	1-10	Very stiff to hard: CL	B	141	78	3000	0	1.00	1.00	1.00	
	10-20	Very loose to medium dense: SM	C	132	70	0	28	0.36	0.73	2.77	

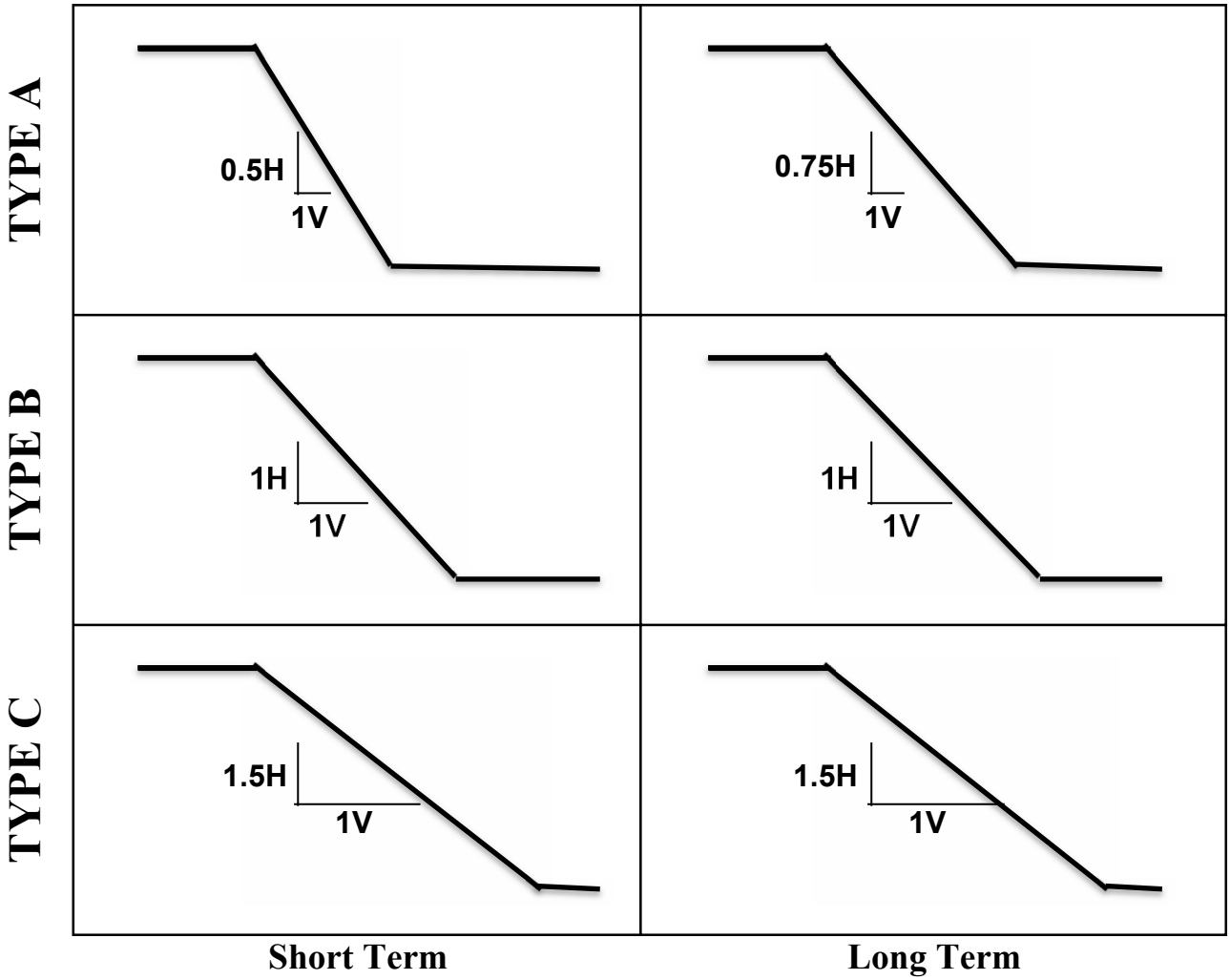
Note:

1) γ = Unit Weight for soil above water level,
2) CL = Lean Clays; CH = Fat Clays
3) Cu = Ultimate cohesion of soil, ϕu = friction angle of soil, for short term;
4) Ka = Coefficient of active earth pressure Ko = Coefficient of static earth pressure
   Kp = Coefficient of passive earth pressure
5) OSHA Soil Types:
   - A: Cohesive soils with q_u = 1.5 tsf or greater (q_u = Unconfined Compressive Strength of the soil)
   - B: Cohesive soils with q_u = 0.5 tsf or greater
   - C: Cohesive soils with q_u = less than 0.5 tsf, granular soils, submerged soils or soils with significant weak secondary structure.

PLATE 20

MAXIMUM ALLOWABLE SLOPES

For Open Trench Excavation



NOTES:

(1) For Type A soils, a short term maximum allowable slope of 0.5 H : 1 V is allowed in excavations that are 12 feet or less in depth; short term maximum allowable slopes for excavations greater than 12 feet in depth shall be 0.75 H : 1 V.

(2) Maximum depth for above slopes is 20 feet, For slopes greater than 20 feet, trench protection should be designed by the Contractor's professional engineer.

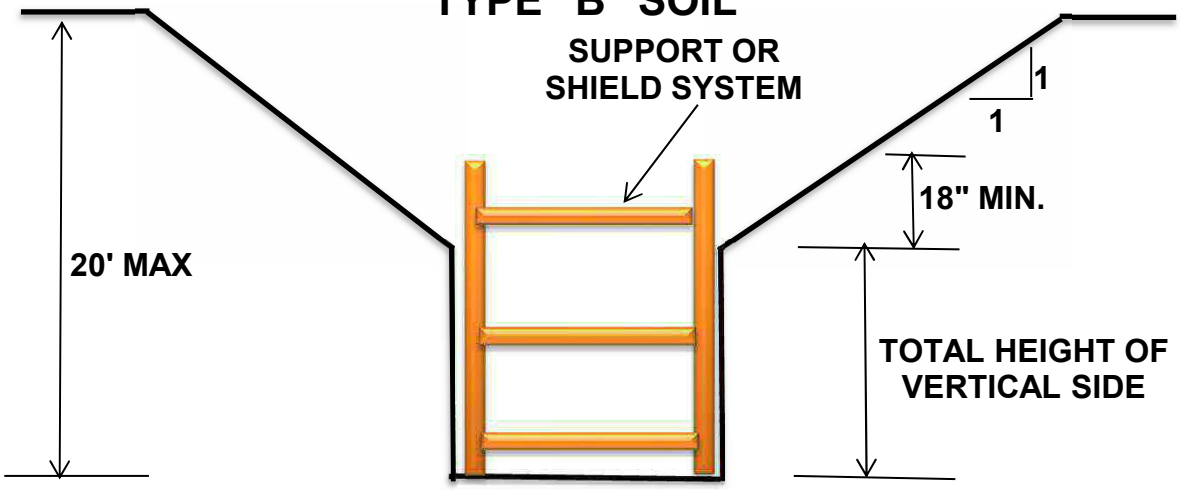
Reference: OSHA, Safety and Health Regulations for Construction, 1926, Subpart A

Maximum Allowable Slopes for Open Trench Excavation	
Proposed NHCRWA Contract No. 28-B 2025 Water Transmission and Distribution System Harris County, Texas	
HTS Project No.: 16-S-299	PLATE 21

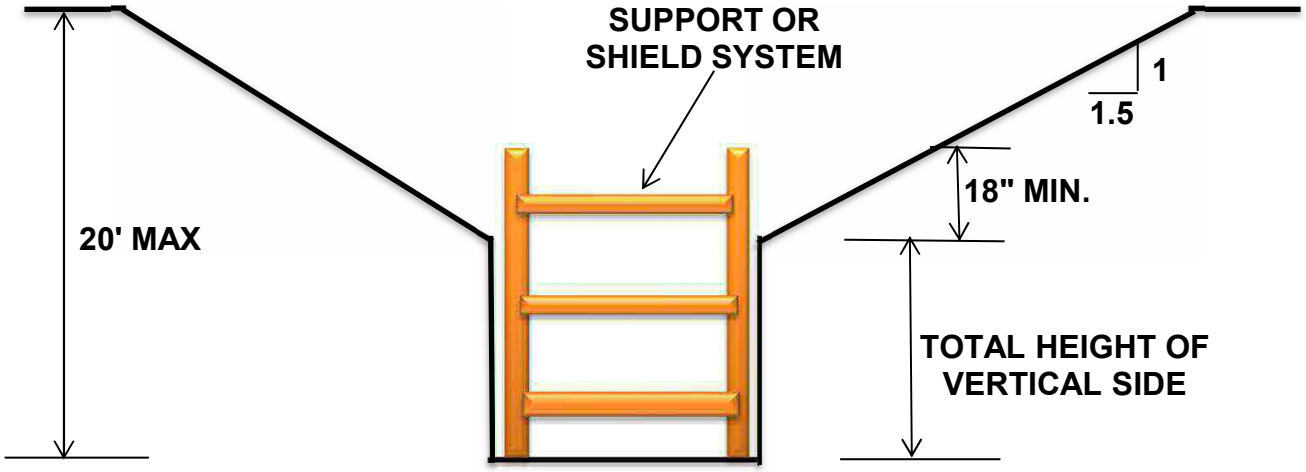
COMBINATION OF BRACING AND OPEN CUTS

For Open Trench Excavation

TYPE "B" SOIL



TYPE "C" SOIL



Reference: OSHA, Safety and Health Regulations for Construction, 1926, Subpart A

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Combination of Bracing and Open Cuts for Open Trench Excavation	
Proposed NHCRWA Contract No. 28-B 2025 Water Transmission and Distribution System Harris County, Texas	
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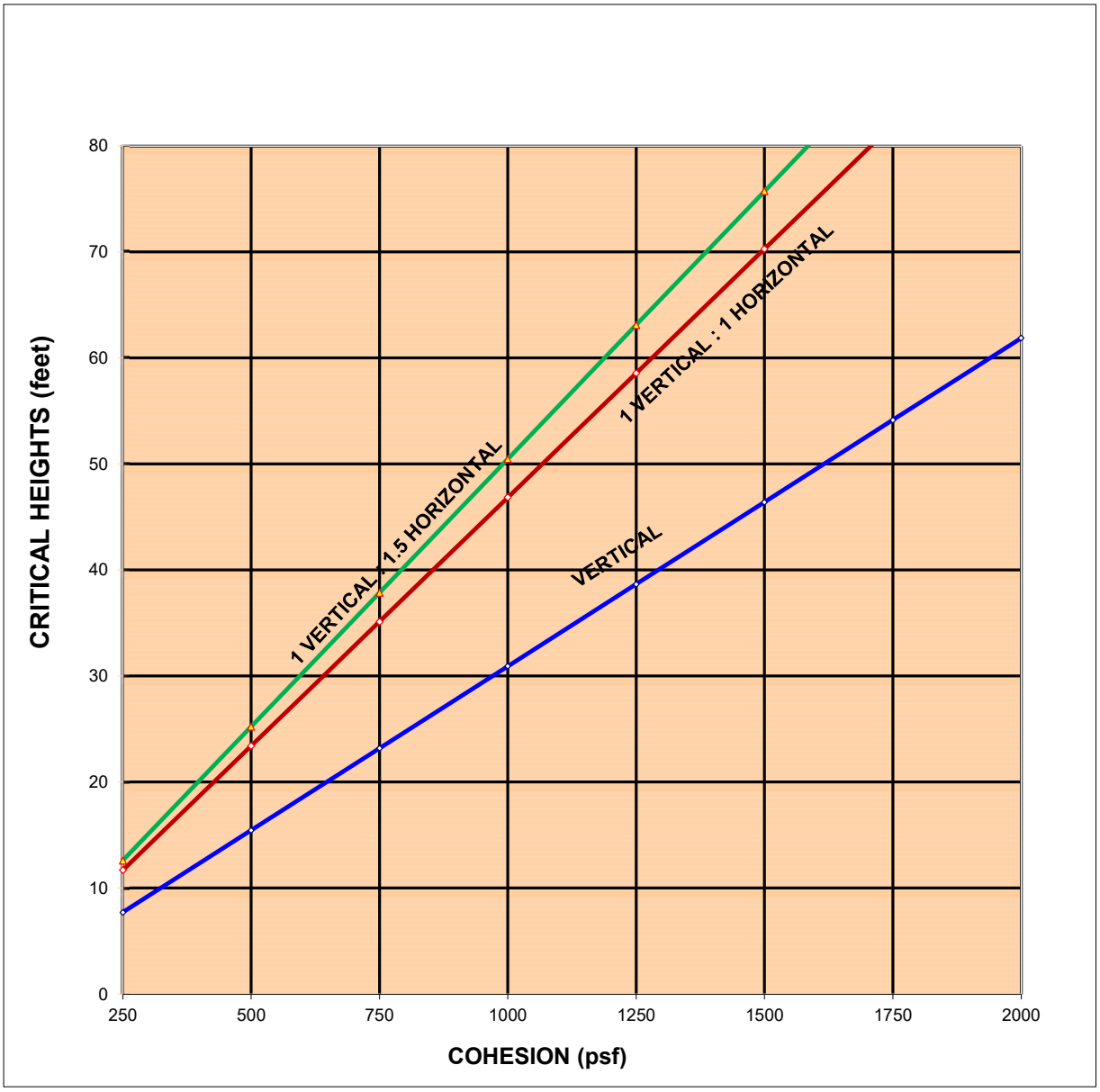
CRITICAL HEIGHTS OF CUT IN NONFISSURED CLAYS



Note: The charts are calculated based on NAVFAC DM-7.1, Page-319, assuming the circles are toe circles and the unit wet weight of soils = 125 pcf

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Critical Heights of Cut in Non-Fissured Clays	
Proposed NHCRWA Contract No. 28-B 2025 Water Transmission and Distribution System Harris County, Texas	
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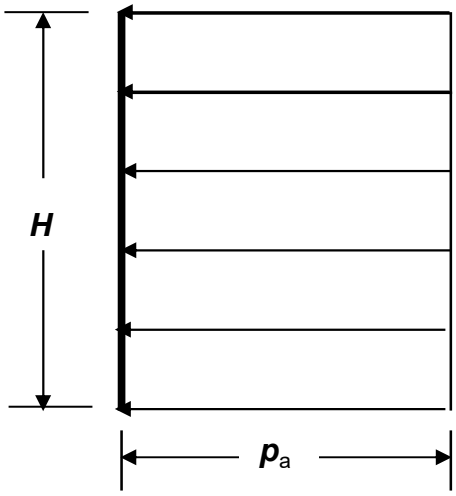
PRESSURE ENVELOPES FOR BRACED-CUT DESIGN

Cuts in Sands

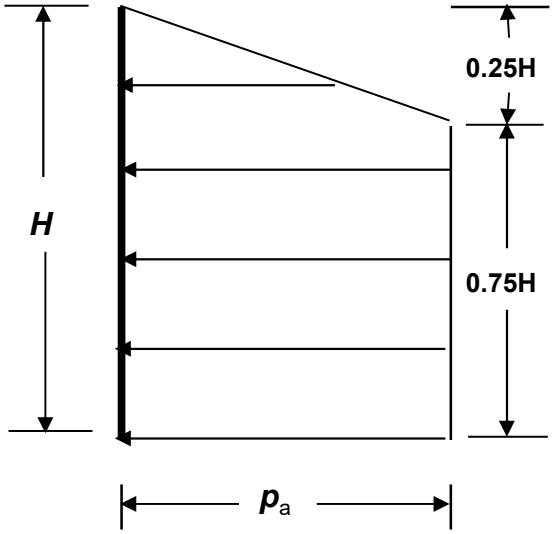


$$p_a = 0.65 * \gamma * H * K_a$$

where:

H = height of the cut
Ka = Rankine active pressure coefficient
= $\tan^2 (45 - \phi / 2)$
γ = unit weight of soil
ϕ = 30° (recommended)

Cuts in Soft to Medium Clays



Condition: $\frac{\gamma H}{c} > 4$

$$p_a = \gamma * H \left[1 - \left(\frac{4c}{\gamma * H} \right) \right]$$

OR

$$p_a = 0.3 * \gamma * H$$

whichever is larger

where: c = undrained cohesion ($\phi = 0$)
γ = unit weight of clay

Reference: Pages 521 - 523, Principles of Foundation Engineering, 4th Edition, Braja Das

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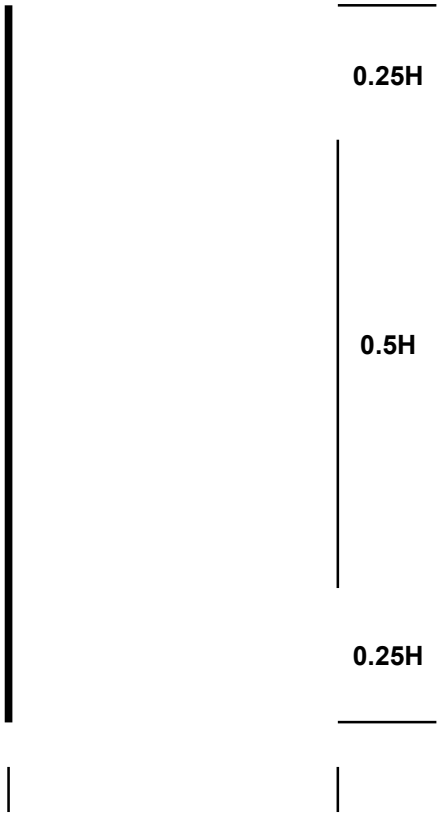
Pressure Envelopes for Braced-Cut Design (Cuts in Sands and Soft to Medium Clays)	
Proposed 2025 Water Transmission and System, NHCRWA Contract No. 28 Harris County, Texas	
HTS Project No.: 16-S-299	PLATE 24

PRESSURE ENVELOPE FOR BRACED-CUT DESIGN

Cuts in Stiff Clays



Condition: γ H / c

$p_a = 0.2 * \gamma * H$ to $0.4 * \gamma * H$

(with an average of 0.3 γ H)

where: c = undrained cohesion ($\phi = 0$)

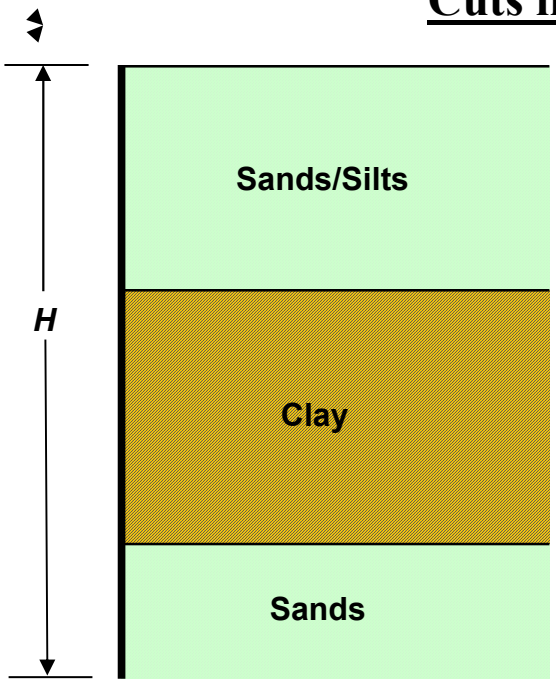
γ = unit weight of clay

Reference: Pages 522 and 523, Principles of Foundation Engineering, 4th Edition, Braja Das

Pressure Envelope for Braced-Cut Design (Cuts in Stiff Clays)	
Proposed 2025 Water Transmission and System, NHCRWA Contract No. 28 Harris County, Texas	
HTS Project No.: 16-S-299	PLATE 25

PRESSURE ENVELOPE FOR BRACED-CUT DESIGN

Cuts in Layered Soils



When layers of both sands and clays are encountered and a braced cut is being constructed, it is proposed that an equivalent value of cohesion ($\phi = 0$ concept) should be determined in accordance with the following manner.

$$c_{av} = \frac{1}{2H}[\gamma_s K_s H_s \tan \phi_s + (H - H_s) n' q_u]$$

where: H = total height of the cut
γ_s = unit weight of sand
H_s = height of the sand layer
K_s = a lateral earth pressure coefficient for the sand layer (≈1.0)
ϕ_s = angle of friction of sand
q_u = unconfined compression strength of clay
n' = a coefficient of progressive failure (ranging from 0.5 to 1.0; average value of 0.75)

The average unit weight, γ_a, of the layers may be obtained using the following equation:

$$\gamma_a = \frac{1}{H}[\gamma_s H_s + (H - H_s) \gamma_c]$$

where: γ_c = saturated unit weight of clay layer

Once the average values of cohesion and unit weight are determined, the pressure envelopes in clay can be used to design the cuts.

When several clay layers are encountered in the cut, the average undrained cohesion becomes

$$c_{av} = \frac{1}{H}(c_1 H_1 + c_2 H_2 + \ldots + c_n H_n)$$

The average unit weight, γ_a, is

$$\gamma_a = \frac{1}{H}(\gamma_1 H_1 + \gamma_2 H_2 + \ldots + g_n H_n)$$

Reference: Pages 524 and 525, Principles of Foundation Engineering, 4th Edition, Braja Das

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Pressure Envelope for Braced-Cut Design (Cuts in Layered Soils)	
Proposed 2025 Water Transmission and System, NHCRWA Contract No. 28 Harris County, Texas	
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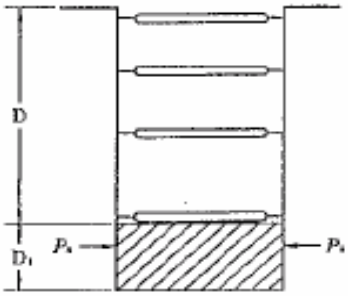
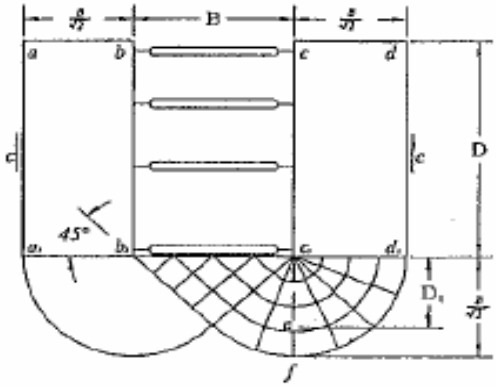




Factor of Safety against bottom of heave,

$$F.S = \frac{NcC}{(\gamma D+q)}$$

where, Nc = Coefficient depending on the dimension of the excavation (see Figure at the bottom)
C = Undrained shear strength of soil in zone immediately around the bottom of the excavation,
γ = Unit weight of soil,
D = Depth of excavation,
q = Surface surcharge.

If F.S < 1.5, sheeting should be extended further down to achieve stability

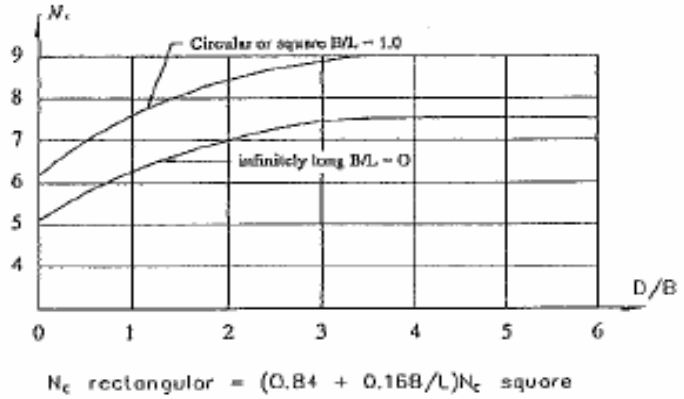
$$\text{Depth of Buried Length, } (D_1) = \frac{1.5(\gamma D+q)-NcC}{(C/B)-0.5\gamma} \; ; D_1 \geq 5 \text{ ft.}$$

Pressure on buried length, P_a

For $D_1 < 0.47B$; $P_a = 1.5\, D_1(\gamma D - 1.4\, CD/B - 3.14C)$

For $D_1 > 0.47B$; $P_a = 0.7\, (\gamma DB - 1.4\, CD - 3.14CB)$

where; B = width of excavation



N_c rectangular = $(0.84 + 0.16B/L)N_c$ square

Bottom Stability of Braced Excavations in Clays	
Proposed NHCRWA Contract No. 28-B 2025 Water Distribution and Transmission System Harris County, Texas	
HTS Project No.: 16-S-299	PLATE 27

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