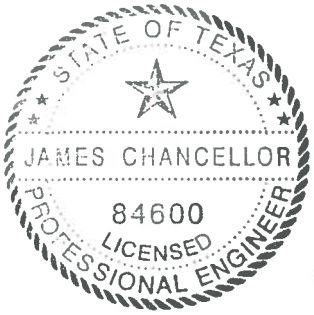
TOWN OF FAIRVIEW

Lift Station Removal

January 2018



THESE PLANS WERE PREPARED UNDER THE

RESPONSIBLE SUPERVISION OF JAMES CHANCELLOR,

LICENSED PROFESSIONAL ENGINEER #84600

372 TOWN PLACE FAIRVIEW, TX. 75069

PREPARED BY: JAMES CHANCELLOR, PE TOWN ENGINEER

DANIELLE GREGORY, EIT, ENGINEERING ASSISTANT

CONTACT INFO: 972-886-4235 jchancellor@fairviewtexas.org

TOWN OF FAIRVIEW

Lift Station Removal

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TOWN OF FAIRVIEW

NOTICE TO CONTRACTORS

1. Sealed bids (proposals) addressed to the Town of Fairview (Town), 372 Town Place, Fairview, Texas 75069, will be received at Town Hall until 2:00 p.m., January 31st 2018 for

LIFT STATION REMOVAL

At such time bids will be publicly opened and read aloud.

2. The work consists of furnishing all labor, equipment and materials (except as otherwise specified), and performing all work necessary for installing 850 feet of 8" PVC SDR 35 sewer line, seven manholes, one drop connection, one aerial crossing with two 18" concrete piers and 12" schedule 40 steel encasement, and the removal of an existing lift station saving the emergency generator and all SCADA equipment.

3. Plans and Specifications for the work may be downloaded at www.fairviewtexas.org

TOWN OF FAIRVIEW, TEXAS

James Chancellor, PE
Town Engineer

INSTRUCTIONS TO BIDDERS

1. Each proposal shall be legibly written or printed in ink, on the proposal form provided in this bound copy of proposed Contract Documents. No alterations in proposal, or in the printed forms thereof, by erasures, interpolations, or otherwise will be acceptable unless each such alteration is signed or initialed by the bidder; if initialed, the Town may require the bidder to identify any alterations so initialed. No alteration in any proposal, or in the proposal form on which it is submitted, shall be made by the person after the proposal has been submitted by the bidder. Any and all addenda to the Contract Documents on which a proposal is based, properly signed by the bidder, shall accompany the proposal when submitted. The bidder may withdraw his proposal any time prior to the bid opening date and time stipulated in the Notice to Contractors.

Each proposal submitted shall be enclosed in a sealed envelope, addressed to the Town of Fairview, 372 Town Place, Fairview, Texas 75069, identified on the outside with the words "Proposal for Lift Station Removal" and identifying the bidder. Proposals shall be delivered to the Town Engineer by 2:00 p.m., January 31st, 2018 at such time bids will be publicly opened and read aloud. **Facsimile Transmittals Will Not Be Accepted.**

All bids will be tabulated for the Town Council by the Town Engineer. The Town Council will determine the lowest responsible bid, after considering the recommendations of the Town Engineer, determine whether such bid is that of a responsible bidder, and award a contract to the Contractor determined to be the lowest responsible bidder. The Fairview Town Council will authorize the Town Manager to enter into a contract with said Contractor.

2. Each Proposal shall be accompanied by either a cashier's check, a certified check, or an acceptable bid bond in an amount of not less than five percent (5%) of the proposed bid price, made payable without conditions to "Town of Fairview, Texas", and the amount of the said proposal Guarantee may be retained by and forfeited to the Town as liquidated damages if the proposal covered thereby is accepted and a contract based thereon is awarded and the bidder should fail to enter into a contract in the form prescribed, with legally responsible sureties, within the ten (10) days after such award is made by the Town.

The proposal guarantee deposit of the unsuccessful bidders will be returned if and when their proposals are rejected. The proposal guarantee deposit of the bidder to whom a contract is awarded will be returned provided, and when, said successful bidder executes a contract and files satisfactory bonds as hereinafter stipulated. The proposal guarantee deposit of the second and third lowest responsible bidders may be retained for a period of not to exceed sixty (60) days pending the execution of the contract and bonds by the successful bidder.

3. Accompanying his proposal, each bidder shall furnish an experience list of similar work along with such other information as will tend to show the bidder's ability to prosecute the required

work. The Bidder shall have a minimum of three years experience and successful history in the performance of similar work. The Town may make such investigations as they deem necessary to determine the ability of the Bidder to perform the work. The experience list is not required for those bidders who have performed similar work for the Town of Fairview within the past 5 years.

4. Each bidder shall carefully examine the Specifications, and other Contract Documents, shall visit the site and fully inform himself of all conditions affecting the work or the cost thereof, and shall be presumed to have done so and his bid shall be based upon his own conclusions from such examination. Each bidder shall inform himself concerning all Federal, State, and local laws, ordinances or regulations which may in any manner affect his proposed construction operations, or those engaged or employed on the work or the material or equipment. Should a bidder find discrepancies in, or omissions from, the Plans, Specifications or other Contract Documents, he should at once notify the Town Engineer and obtain clarification or interpretation prior to submitting any bid.

Any interpretation of the proposed Contract Documents will be made only by addendum duly issued and a copy of such addendum will be mailed or delivered to each person obtaining a set of such documents from the Town Engineer. The Town will not be responsible for any other explanations or interpretations of the proposed Contract Documents.

5. Each bidder to whom a contract for the work is awarded will be required to furnish surety as follows:

Performance Bond: A contract bond to the Town, in an amount equal to 100 percent (100%) of the not to exceed contract price.

Payment Bond: A payment bond to the Town, in an amount equal to 100 percent (100%) of the not to exceed contract Price.

The bonds shall be executed in three (3) counterparts on the forms bound herein, signed by an acceptable surety company authorized to do business in the State of Texas as required by Article 5160 V.A.T.C.S.

Attorneys-in-fact who sign the bonds must file with each bond a certified and effective dated copy of their power of attorney.

Certificates of Insurance: Satisfactory certificates of insurance shall be filed with the Town in accordance with the GENERAL CONDITIONS and SUPPLEMENTARY CONDITIONS in the Contract Documents.

6. The Bidder's attention is directed to Texas House Bill 11 (72nd Legislature, 1st C.S.) which amended the Texas Tax Code Section 151.311. This amendment provides that by the CONTRACTOR entering into a separated contract, The CONTRACTOR will become a seller of materials purchased for the project, which will obviate paying taxes, on materials incorporated into the project.

7. No bidder may submit more that one proposal. Two proposals under different names will not be received from one firm or association.

8. No bidder may withdraw his proposal for a period of sixty (60) days after the date and hour set for the opening herewith. A bidder may modify or withdraw his proposal at any time prior to the expiration of the period during which proposals may be submitted, by written request of the same persons or person who signed the Proposal.

9. The Town reserves the right to accept the bid which, in its judgment is the lowest responsible bid; to reject any or all bids; and to waive irregularities or informalities in any bid submitted. Bids received after the specified time of closing will be returned unopened. Conditional or qualified bids will not be accepted.

10. None of the Instructions to Bidders, Proposal, Performance Bond, Payment Bond, Contract Agreement, General Conditions, Special Conditions or Specifications shall be removed from the bound copy of the Contract Documents prior to filing the proposal contained therein.

11. Each bidder shall sign his proposal, using his usual signature and giving his full business address. Bids by partnerships shall be signed with the partnership name followed by the signature of one of the members of the partnership or by an authorized representative and designation of the person signing. Bids by corporations shall be signed with the name of the corporation, followed by the signature and designation of the president, secretary, or other person authorized to bind it in the matter. The names of all persons signing should also be printed below the signature. A bid by a person who affixes to his signature the word "President", "Secretary", "Agent", or other designation, without disclosing his principal, may be held to be the individual signing. When requested by the Town, satisfactory evidence of the authority of the officer signing in behalf of a corporation shall be furnished.

12. The Notice of Award shall be accompanied by the necessary Contract Agreement and Bond forms. The Bidder to whom the Contract is awarded will be required to execute the Contract Agreement and obtain the Performance and Payment Bonds and Certificates of Insurance within ten (10) calendar days from the date when notice of Award is delivered to the bidder. In case of failure of the bidder to execute the Contract Agreement, the Town may at its option consider the bidder in default, in which case, the bid security accompanying the Proposal shall become the property of the Town.

13. The Town, within ten (10) days of receipt of acceptable Performance Bond, Payment Bond, Certificates of Insurance and Contract Agreement signed by the bidder to whom the contract was awarded, shall sign the Contract Agreement and return to the bidder two (2) executed copies of the Contract Agreement. The Bidder may withdraw his signed Agreement should the Town not execute the Agreement within the stated period by written notice to the Town.

14. The Notice to Proceed shall be issued within ten (10) days of the execution of the Contract Agreement by the Town. The time may be extended by mutual agreement between the Town and Contractor. If the Notice to Proceed has not been issued within the specified time or mutually

agreed upon extension, the Contractor may terminate the Contract Agreement without further liability on the part of either party.

15. Attention is called to the fact that not less than the federally determined prevailing wage rate, as issued by the U.S. Department of Labor, must be paid on this project.

16. The Town intends to award the Contract to a bidder that will be doing a substantial portion of the work rather than through subcontracts. The bidder must complete the item in the Proposal regarding the amount of work to be done by the Prime Contractor. The Town reserves the right to consider this breakdown in awarding the Contract.

17. Each Bidder shall list all subcontractors they propose to use on this project for which the amount of the subcontract is in excess of $10,000. The list shall include the name and address of the subcontractor, the work they will be performing and the amount of the subcontract. The Bidder shall also complete a Statement of Qualifications and Experience for each subcontractor. The Contractor shall not change subcontractors or enter into contract with subcontractors not listed without prior approval by the Town. The Town reserves the right to refuse any or all requests for changes.

LIFT STATION REMOVAL

PROPOSAL

THIS BID IS SUBMITTED TO:

Honorable Mayor and Town Council
Town of Fairview
372 Town Place
Fairview, Texas 75069

The Undersigned Bidder proposes to complete the generally described work as shown in these Specifications for the following unit prices and total price. The bidder understands that units may change in the field and that the unit prices shown here will be honored and that the final price will be based on the actual measured or approved field quantities.

DESCRIPTION	QUANTITY	UNITS	UNIT PRICE	TOTAL
4' Dia. MH 0-6ft deep (PIP or Precast)	7	EA	_____	_____
4' Dia. MH vertical depth >6 ft (PIP or Precast)	32	VLF	_____	_____
Manhole – Drop Connection	1	EA	_____	_____
8" PVC SDR 35 0-5 ft deep	165	LF	_____	_____
8" PVC SDR 35 5 ft deep and more	685	LF	_____	_____
12" Schedule 40 Steel Encasing	80	LF	_____	_____
18" Concrete Pier	2	EA	_____	_____
Cement stabilized slopes	40	SY	_____	_____
Clearing, Grubbing, and Seeding	300	SY	_____	_____
Wet Connections	2	EA	_____	_____
Trench safety	1	LS	_____	_____
Mobilization	1	LS	_____	_____
Maintenance bond (2 years, 100%)	1	LS	_____	_____
Removal of Existing lift station **The emergency generator, propane tank and all SCADA equipment is to be saved and returned to the Town	1	LS	_____	_____

TOTAL BASE BID $_____

1. The Bidder proposes and agrees, if this Bid is accepted, to enter into an Agreement with the Town in the form included in the Contract Documents to complete the Lift Station Removal

as specified or indicated in the Contract Documents for the Contract Price in this Bid and in accordance with the Contract Documents.

2. Bidder accepts all of the terms and conditions of the notice to Contractors, including without limitation those dealing with the disposition of Bid Security. This Bid will remain open for sixty (60) days after the day of Bid opening. Bidder will sign the Agreement and submit the Contract Security, Certificate of Insurance and other documents required by the Contract Documents within ten (10) days after the date of Town's Notice of Award.

3. In submitting this Bid, Bidder represents, as more fully set forth in the Agreement, that:

(a) Bidder has examined, and hereby acknowledges receipt of, copies of all the Contract Documents and the following addenda:

ADDENDUM NO:	DATE

(b) Bidder has examined the site and locality where the Work is to be performed, the legal requirements (Federal, State and local laws, ordinances, rules and regulations) and the conditions affecting cost, progress or performance of the Work and has made such independent investigations as Bidder deems necessary.

(c) Bidder intends to perform a substantial portion of the work himself in accordance with the following approximate breakdown based on percentage of Base Bid:

Portion of Work by Bidder _____ %

Portion to be Sub-Contracted _____ %

Subcontractor Information

Name	Type of Work	Amount

5. The following documents are attached to and made a condition of this Bid:

(a) Required Proposal Guarantee (cashier's check, certified check, or bid bond).

(b) Statement of Bidder's Qualifications and Experience.

(c) Statement of Subcontractors' Qualifications and Experience.

6. The terms used in this Bid which are defined in the General Conditions of Agreement included as part of the Contract Documents have the meanings assigned to them in the General Conditions.

Submitted on _____, 20___.

Individual
Partnership
_____Corporation
Firm Name

By:_____
Typed or Printed

SIGNATURE_____

TITLE_____

ADDRESS_____

_____

TELEPHONE_____

TOWN OF FAIRVIEW
LIFT STATION REMOVAL

CONTRACTOR _____

STATEMENT OF QUALIFICATIONS AND EXPERIENCE

Note: Demonstrate a minimum of three years experience. Bidders who have performed similar work for the Town of Fairview within the past 5 years are not required to complete this information.

NAME OF PROJECT:

OWNER:

TOTAL CONTRACT COST: COMPLETION DATE:

DESCRIPTION:

NAME OF PROJECT:

OWNER:

TOTAL CONTRACT COST COMPLETION DATE:

DESCRIPTION:

NAME OF PROJECT:

OWNER:

TOTAL CONTRACT COST: COMPLETION DATE:

DESCRIPTION:

NAME OF PROJECT:

OWNER:

TOTAL CONTRACT COST: COMPLETION DATE:

DESCRIPTION:

DUPLICATE THIS FORM IF THERE IS MORE THAN ONE SUBCONTRACTOR

TOWN OF FAIRVIEW
LIFT STATION REMOVAL

SUBCONTRACTOR _____

STATEMENT OF QUALIFICATIONS AND EXPERIENCE

Note: Demonstrate a minimum of three years experience. Subcontractors who have performed similar work for the Town of Fairview within the past 5 years are not required to complete this information.

NAME OF PROJECT:

OWNER:

TOTAL CONTRACT COST: COMPLETION DATE:

DESCRIPTION:

NAME OF PROJECT:

OWNER:

TOTAL CONTRACT COST COMPLETION DATE:

DESCRIPTION:

NAME OF PROJECT:

OWNER:

TOTAL CONTRACT COST: COMPLETION DATE:

DESCRIPTION:

BID BOND

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned,_____ _____as Principal, and _____ _____ as Surety, are hereby held and firmly bound unto the Town of Fairview, Texas as Owner in the penal sum of_____ _____(5% of the proposal as submitted) for payment of which, well and truly to be made, we hereby jointly and severally bind ourselves, successors and assigns.

Signed, this _____ day of _____, 2018.

The Condition of the above obligation is such that whereas the Principal has submitted to the Town of Fairview, Texas a certain Bid, attached hereto and hereby made a part hereof to enter into a contract in writing, for the construction of LIFT STATION REMOVAL in the Town of Fairview.

NOW THEREFORE,

(a) If said Bid shall be rejected, or

(b) If said Bid shall be accepted and the principal shall execute and deliver a contract in the Form of Contract attached hereto (properly completed in accordance with said Bid) and shall furnish a Bond for his faithful performance of said contract, and Certificates of Insurance and shall in all other respects perform the agreement created by the acceptance of said Bid,

then this obligation shall be void, otherwise the same shall remain in force and effect: it being expressly understood and agreed that the liability of the Surety for any and all claims hereunder shall, in no event, exceed the penal amount of this obligation as herein stated.

The Surety, for value received, hereby stipulates and agrees that the obligations of said Surety and its Bond shall be in no way impaired or affected by any extension of the time within which the Owner may accept such BID; and said Surety does hereby waive notice of any such extension.

IN WITNESS WHEREOF, the Principal and the Surety have hereunto set their hands and seals, and such of them as are corporations have caused their corporate seals to be hereto affixed and these presents to be signed by their proper officers, the day and year first set forth above.

_____L.S.
Principal

_____
Surety

By: _____

IMPORTANT - Surety companies executing BONDS must appear on the Treasury Department's most current list (Circular 570 as amended and be authorized to transact business in the State of Texas.)

TOWN OF FAIRVIEW

Lift Station Removal

CONTRACT AGREEMENT

THIS AGREEMENT, made and entered into this _____ day of _____, 2018, by and between the Town of Fairview, Collin County, Texas, Party of the First Part, hereinafter referred to as the "Town", and _____ Party of the Second Part, hereinafter referred to as the "Contractor" for Construction of LIFT STATION REMOVAL including furnishing all labor, equipment and materials (except as otherwise specified) and performing all work necessary for the construction.

ARTICLE 1. It is hereby mutually agreed that for and in consideration of the payments as provided for herein to the Contractor by the Town, the said Contractor shall furnish all labor, equipment, and material (except as otherwise specified above) and shall perform all work necessary to complete the improvements in a good and substantial manner, ready for use, before the contract time expiration. The work shall be in strict accordance with this Contract, a copy of which is filed pursuant to law in the office of the legal representative of the Town.

ARTICLE 2. It is hereby further agreed that in consideration of the faithful performance of the work by the Contractor, the Town shall pay the Contractor the compensation due him by reason of said faithful performance of the work at stated intervals and in the amount certified by the Town Engineer, in accordance with the provisions of this Contract.

ARTICLE 3. It is hereby further agreed that, at the completion of the work and its acceptance by the Town, all sums due the Contractor by reason of alterations or modifications of the original Contract or by reason of "Extra Work" authorized under this Contract, will be paid the Contractor by the Town after said completion and acceptance.

ARTICLE 4. It is hereby further agreed that any reference herein to the "Contract" shall include all "Contract Documents" as the same are listed and described in Paragraph 1.9 of SECTION: GENERAL CONDITIONS bound herein, and said "Contract Documents" are hereby made a part of this Agreement as fully as if set out at length herein, and that this Contract is limited to the items in the Proposal as signed by the "Contractor" and included in the "Contract Documents".

ARTICLE 5. The Contractor agrees to perform all of the work described in the Contract Documents for the unit prices and total contract price as submitted in the Bid, in the total amount of _____ taking into consideration additions to or deductions from the Total Bid by reason of alterations or modifications of the original quantities or by reason of "Extra Work" authorized under this Agreement in accordance with the provisions of the Contract Documents.

Contractor agrees to a substantial completion time of 120 days and final completion of 150 days from the date of the Notice to Proceed.

ARTICLE 6. The Contractor agrees that the sum of Three Hundred Dollars ($300.00) in Liquidated Damages will be deducted from the Contract price by the Town for each calendar day that the work remains incomplete beyond the Contract time for completion, or within such extra time as may have been allowed by an extension approved by the Town.

ARTICLE 7. The Contractor agrees to submit a Maintenance Bond prior to the release of final retainage for 100% of the value of the Contract Amount for a period of two years from the date of final acceptance.

IN WITNESS WHEREOF, the Party of the First Part and the Party of the Second Part, respectively, have caused this Agreement to be duly executed in day and year first herein written in three (3) copies, all of which to all intents and purposes shall be considered as the original.

ARBITRATION PROVISION:

THIS CONTRACT CONTAINS A BINDING ARBITRATION PROVISION WHICH MAY BE ENFORCED BY THE PARTIES.

CONTRACTOR, PARTY OF THE SECOND PART

By:_____

_____
(Office or Position of Signer)

OWNER, PARTY OF THE FIRST PART
TOWN OF FAIRVIEW, TEXAS

By:_____
Julie Couch, Town Manager

PERFORMANCE BOND

KNOW ALL MEN BY THESE PRESENT THAT WE, _____ of _____, hereinafter referred to as the "Contractor" and _____ _____, a Corporation organized and existing under the laws of the State of Texas, and duly authorized to transact business in the State of Texas, as "Surety" are held and firmly bound unto the Town of Fairview, Texas (Owner), their successors and assigns, hereinafter called the "Owner", in the penal sum of _____ in lawful money of the United States of America, for the payment of which well and truly to be made to said Owner with the understanding that such designation shall be held and taken to apply to them or to their successors, lessees and assigns, as the circumstances not or to any time in the future under the terms hereof shall require, we, said Contractor and Surety, do hereby bind ourselves and our respective successors, lessees and assignees, jointly and severally, forever firmly by these present.

THE CONDITION OF THE ABOVE OBLIGATION, HOWEVER IS SUCH THAT:

WHEREAS, said Contractor has entered into a certain Contract in writing bearing date of the _____ _day of _____, 2018, and designated as construction of LIFT STATION REMOVAL including furnishing all labor, equipment and materials (except as otherwise specified), and performing all work necessary for the construction.

WHEREAS, it is provided in said Contract that said Contractor shall furnish a bond in the sum hereinabove stated condition for the faithful performance of said Contract as well as any supplement or supplements in writing thereto covering additional or other work to be performed by the contractor pursuant to the terms and conditions of said Contract.

NOW, THEREFORE, if said Contractor shall in all respect faithfully and fully perform each and all of the terms, provisions, conditions, and undertakings of said Contract in writing to be by it performed, together with like performance of any an all supplements in writing thereto covering additional or other work to be performed by the Contractor, notice of any such supplement or supplements being hereby waived, then this obligation shall be null and void; otherwise it shall remain in full force, virtue and effect.

PROVIDED FURTHER, that it is expressly understood and agreed that notice of any default in or non-performance of any duty of obligation on the part of the Contractor under the terms of said Contract in writing, or any supplement in writing thereto covering additional or other work to be performed by the Contractor, is hereby expressly waived by the Surety, and that any such default or non-performance of any duty or obligation shall not absolve or release the Surety from its joint and several absolute and unconditional undertaking or indemnity, irrespective of whether Owner shall or shall not call upon the Contractor for compliance therewith or performance thereof, and that these present shall remain in full force, virtue and effect during the existence of said Contractor of any supplement in writing thereto covering additional or other work to be performed by the Contractor, and thereafter for the purpose of adjusting rights and obligations which shall have accrued during

the life of said written Contract, or any supplement in writing thereto covering additional or other work to be performed by the Contractor.

IN TESTIMONY WHEREOF, the Contractor has hereunto set his hand, and said Surety has caused these present to be executed in its name, and its corporate seal to be hereunto affixed, by its attorney-in-fact duly authorized to do so at_____, on this _____ day, of _____,20___.

SURETY COMPANY	CONTRACTOR
_____	_____
Name of Company	Name of Company
By:_____	By:_____
Attorney-in-Fact	
By:_____	_____
Title of Person Signing	Title of Person Signing
(Seal)	(Seal)

(Accompany this bond with attorney-in-fact's authority from the Surety company certified to include the date of the bond.)

PAYMENT BOND

KNOW ALL MEN BY THESE PRESENT, that _____ as "Contractor", and _____ a corporation organized under the laws of the State of _____, with general offices in _____, and authorized to transact business in the State of TEXAS as "Surety", are held and firmly bound unto the Town of Fairview, in the penal sum of _____ for the payment of which sum will and truly to be made, we bind ourselves, and our heirs, executors, administrators, successors, and assigns, jointly and severally, be these presents:

THE CONDITIONS OF THE FOREGOING OBLIGATIONS IS SUCH THAT:

WHEREAS, the Contractor has on the _____ day of _____, 2018, entered into a written contract with the Town for LIFT STATION REMOVAL in Fairview including furnishing all labor, equipment and materials (except as otherwise specified), and performing all work necessary for the construction.

NOW, THEREFORE, if the Contractor and his subcontractors shall pay all indebtedness incurred for supplies, materials, or labor furnished, used or consumed in connection with the prosecution of the work provided for in said contract, this obligation shall be void; otherwise it shall remain in full force and effect.

PROVIDED FURTHER, that the Surety, for value received, hereby stipulates and agrees that no change, extension of time, alteration, or addition to the terms of the contract or to the work to be performed thereunder, or the specifications accompanying the same, shall in any way affect its obligation on this bond, and it does hereby waive notice of any such change, extension of time, alteration, or addition to the terms of the Contract or to the specifications.

PROVIDED FURTHER, that the surety agrees that any person to whom there is due any sum for supplies, materials, or labor, hereinbefore stated, or his assigns, may bring an action on his bond for the recovery of the indebtedness; **PROVIDED,** that no action shall be brought on the bond after six months from the completion of the public improvements.

SURETY COMPANY: CONTRACTOR:

_____	_____
Name of Company	Name of Company
By:_____	_____
By:_____	_____
Title of Person Signing	Title of Person Signing
(Seal)	(Seal)

(Accompany this bond with attorney-in-fact's authority from the Surety Company certified to include the date of the bond.)

NOTICE OF AWARD

TO: _____

_____

_____

_____

Project Description: _____

_____

_____

The Fairview Town Council has considered the Proposal submitted by you on _____ for the above described work in response to its Notice to Contractors and Instructions to Bidders and on _____ voted to award you the Contract in the amount of _____. You are required by the Instructions to Bidders to execute the Contract Agreement and furnish the required Performance and Payment Bonds and Certificates of Insurance within ten (10) calendar days from the date of this Notice to you.

If you fail to execute said Contract Agreement and to furnish said Bonds and Certificates within ten (10) days from the date of this Notice, the Town of Fairview will be entitled to consider all your rights arising out of the Town's acceptance of your Proposal as abandoned and as a forfeiture of your Bid Security. The Town will be entitled to such other rights as may be granted by law.

You are required to return an acknowledged copy of this NOTICE OF AWARD to the Town.

Dated this _____ day of _____, 2018.

TOWN OF FAIRVIEW

By_____

James Chancellor, Town Engineer

ACCEPTANCE OF NOTICE

Receipt of the above NOTICE OF AWARD is hereby acknowledged by _____ _____, this the _____ day of _____ _____, 2018.

By _____

Title _____

GENERAL CONDITIONS

1. DEFINITIONS: Wherever used in the Contract Documents, the following terms shall have the meanings indicated which shall be applicable to both the singular and plural thereof:

1.1 Acceptance, Final Acceptance: The formal action by the town in accepting the Work as being complete.

1.2 Addenda: Written or graphic supplemental documents issued prior to the opening of bids which modify or interpret the Contract Documents, by additions, deletions, clarifications, or corrections.

1.3 Bid: The offer or proposal of the Bidder submitted on the prescribed form setting forth the prices for the work to be performed.

1.4 Bidder: Any individual, partnership, corporation, or combination thereof submitting a proposal for the Work contemplated, acting directly or through and authorized representative.

1.5 Bonds: Bid, performance, and payment bonds and other instruments or security, furnished by the Contractor and his surety in accordance with the Contract Documents.

1.6 Change Order: A document recommended by the Engineer which is signed by the Contractor and Town and authorizes an addition, deletion, or revision in the Work, or an adjustment in the Contract Price or the Contract Time, issued on or after the Effective Date of the Contract.

1.7 Contract: The written agreement between the town and Contractor covering the work to be performed; other Contract Documents are attached to the Contract and made a part thereof as provided therein.

1.8 Contractor: The individual, partnership, corporation, or combination thereof who has entered into the Contract (or agreement) with the town for the performance of the Work called for in the Contract Documents.

1.9 Contract Documents: The Notice to Contractors, Instructions to Bidders, Proposal, Contract Agreement, Performance Bond, Payment Bond, General Conditions, Supplementary Conditions, Technical Specifications, Plans, Addenda, Notice of Award, and Notice to Proceed are each and all included in this Contract and the Work shall be done in accordance therewith.

1.10 Contract Price: The total monies payable to the Contractor under the terms and conditions of the Contract Documents.

1.11 Contract Time: The number of calendar days stated in the Proposal for the completion of the Work. The term day as used in the Contract Documents shall mean calendar day unless specifically designated otherwise.

1.12 Effective Date of the Contract: The date indicated in the Notice to Proceed as the date of commencement of the Work, the date from which Contract Time is measured.

1.13 Engineer: The individual or firm designated, appointed, or otherwise employed or delegated by the town for this Work, or their duly authorized agents, such agents acting within the scope of the particular duties entrusted to them in each case. The Engineer on this Project is the town Engineer.

1.14 Field Order: A written order issued by the Engineer which orders minor changes in the Work but which do not involve a change in the Contract Price or the Contract Time.

1.15 Notice of Award: The written notice of the acceptance of the bid from the town to the successful Bidder.

1.16 Notice to Proceed: Written communication issued by the town to the Contractor authorizing him to proceed with the Work and establishing the date of commencement of the Work, also referred to as the Effective Date of the Contract.

1.17 Town: The Town of Fairview, Texas with whom the Contractor has entered into the Contract and for whom the Work is to be provided.

1.18 Plans: The part of the Contract Documents which shows the locations, characteristics, dimensions, and details of the Work to be performed and which have been prepared or approved by the Engineer.

1.19 Project: The total construction of which the Work to be provided under the Contract Documents may be the whole, or a part as indicated elsewhere in the Contract Documents.

1.20 Proposal: The offer or proposal of the Bidder submitted on the prescribed form bound herein, setting forth the prices for the Work to be performed.

1.21 Resident Project Representative or Inspector: The authorized representative of the Engineer who is assigned to the site or any part thereof.

1.22 Samples: Physical examples which illustrate materials, equipment or workmanship, and establish standards by which the Work will be judged

1.23 Shop Drawings: All drawings, diagrams, illustrations, schedules and other data which are specifically prepared by or for the Contractor to illustrate some portion of the Work and all illustrations, brochures, standard schedules, performance charts, instructions, diagrams and other information prepared by a Supplier and submitted by the Contractor to illustrate material or equipment for some portion of the Work.

1.24 Specifications: Those portions of the Contract Documents consisting of written technical descriptions of material, equipment, construction systems, standards and workmanship

as applied to the Work and certain administrative details applicable thereto, including these General Conditions and the Supplementary Conditions.

1.25 Subcontractor: An individual, firm or corporation having direct contract with the Contractor or with any other Subcontractor for the performance of a part of the Work at the site.

1.26 Substantial Completion: The Work (or a specified part thereof has progressed to the point where, in the opinion of Engineer as evidenced by Engineer's definitive certificate of Substantial Completion, it is sufficiently complete, in accordance with the Contract Documents, so that the Work (or specified part) can be utilized for the purposes for which it is intended.

1.27 Superintendent: The employee of the Contractor at the project site who shall have sole responsibility an authority for supervision of the Contractor's forces and construction operations.

1.28 Supplementary Conditions: The part of the Contract Documents which amends or supplements these General Conditions.

1.29 Supplier: A manufacturer, fabricator, supplier, distributor, materialman or vendor.

1.30 Underground Facilities: All pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels or other such facilities or attachments, and any encasement containing such facilities which have been installed underground to furnish any of the following services or materials: electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, sewage and drainage removal, traffic or other control systems or water.

1.31 Work: The entire completed construction or the various separately identifiable parts thereof required to be furnished under the Contract Documents. Work is the result of performing services, furnishing labor and furnishing and incorporating materials and equipment into the construction, all as required by the Contract Documents.

2. TERMS:

2.1 Whenever in these Contract Documents the works "as ordered", "as directed", "as required", "as permitted", "as allowed", or words or phrases of like import are used, it shall be understood that the order, directions, requirement, permission or allowance of the town and Engineer is intended.

2.2 Similarly the works "approved", "reasonable", "suitable" acceptable", "properly", "satisfactory", or words of like effect an import, unless otherwise particularly specified herein, shall mean approved, reasonable, suitable, acceptable, proper or satisfactory in the judgement of the town and Engineer.

2.3 Whenever any statement is made in the Contract Documents containing the expression "it is understood and agreed", or an expression of like import, such expression means the mutual

understanding and agreement of the parties executing the Contract of which these General Conditions are a part.

3. ABBREVIATIONS:

When references are made to the following abbreviations, they refer to the specifications, standards, or methods of the respective national association. All references to the above specifications, standards, or methods shall, in each instance, be understood to refer to the latest issue in effect (including all amendments).

ASSHTO	American Association of the State Highway and Transportation Officials
ACI	American Concrete Institute
AI	The Asphalt Institute
IA	American Institute of Architects
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
ANSI	American National Standards Institute (Succeeding ASA)
APWA	American Public Works Association, Inc.
AREA	American Railway Engineering Association
ASTM	American Society for Testing Materials
AWS	American Welding Society
AWWA	American Water Works Association, Inc.
CRSI	Concrete Reinforcing Steel Institute
FED SPEC	Federal Specifications
NBFU	National Board of Fire Underwriters
NEC	National Electric Code
NEMA	National Electrical Manufacturers' Association
NESC	National Electric Safety Code
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Act of 1970
PCA	Portland Cement Association
SSPC	Steel Structures Painting Council
UBC	Uniform Building Code
U/L	Underwriter's Laboratories, Inc.

4. VERBAL STATEMENTS NOT BINDING: It is understood and agreed that the written items and provisions of this Contract shall supersede all prior verbal statements of any and every official and/or other representative of the town, and such statements shall not be effective or be construed as entering into, or forming part of, or altering in any way whatsoever, the written Contract.

5. INTENT OF CONTRACT DOCUMENTS: The intent of the Contract Documents is that the Contractor shall furnish all labor, materials, tools, equipment, and transportation necessary for the proper execution of the Work in accordance with the Contract Documents are complementary, and what is called for by one shall be as binding as if called for by all.

6. INTENT OF PLANS AND SPECIFICATIONS: Certain Plans prepared by the Engineer on behalf of the town and elsewhere described and named accompany and supplement these Specifications and constitute a part of the Contract Documents. Such Plans are agreed to be constructively attached to these Specifications although convenience may prevent physical attachment.

6.1 Modifications or Additions to Plans: The town shall have the right to modify minor details of these Plans, to provide final or checked plans in lieu of any preliminary or unchecked plans, to supplement these Plans with additional plans or with additional information as the work proceeds, all of which
shall be considered as Plans accompanying these Specifications.

6.2 Organization of Specifications: The organization of the Specifications into divisions, sections, and articles, and the arrangement of Plans shall not control the Contractor in dividing the Work among subcontractors or in establishing the extent of Work to be performed by any trade.

7. PRECEDENCE OF CONTRACT DOCUMENTS: In case of conflict between the Contract Documents, the following order of precedence shall govern:

First:	Supplemental Agreements (Change Orders and Field Orders), the last in time being first in precedence
Second:	Contract
Third:	Notice to Contractors, Instructions to Bidders
Fourth:	Plans and Specifications, the order to precedence in these documents shall be Supplementary Conditions, General Conditions, Technical Specifications and Plans
Fifth:	Contractor Proposal

Figure dimensions of Plans shall govern over scale dimensions, and detailed drawings shall govern over general drawings. In all cases, where a conflict is cited, the Engineer shall be duly informed. The Engineer will notify the Contractor in writing should the above procedure be deviated from in any particular instance.

8. DISCREPANCIES, ERRORS, AND OMISSIONS: Any discrepancies, errors, omissions, or ambiguities found in the contract Documents shall be promptly reported to the Engineer. The Engineer shall clarify such discrepancies or omissions, in writing, within a reasonable amount of time. Work done by the Contractor after his discovery of such discrepancies, inconsistencies, or ambiguities shall be at his own risk in that subsequent corrective measures will be required.

9. REUSE OF DOCUMENTS: Neither the Contractor nor any Subcontractor or Supplier or other person or organization performing or furnishing any of the Work under a direct or indirect contract with the town shall have or acquire any title to or ownership rights in any of the Plans, Specifications or other documents (or copies of any thereof) prepared by or bearing the seal of the Engineer; and they shall not reuse any of them on extensions of the Project or any other project without written consent of the town.

10. PRECONSTRUCTION CONFERENCE: Before the Contractor starts work at the site, a conference attended by the Contractor, Engineer and others as appropriate will be held to discuss the procedures for handling Shop Drawings and other submittal and for processing Payment Estimates, and to establish a working understanding among the parties as to the Work.

11. SHOP DRAWINGS: Where called for in the Contract Documents, the Contractor shall submit to the Engineer for review, six (6) prints of each Shop Drawing. Shop Drawings shall be understood to include detail calculations, reinforcement bar bending diagrams, fabrication, erection and installation drawings, parts lists, graphs, wiring diagrams, operating instructions, etc. Drawings shall be submitted in sufficient time to allow the Engineer not less than ten (10) working days for review of such drawings, and to accommodate the rate of construction progress required under the Contract.

The review of Shop Drawings by the Engineer will be limited to checking for general agreement with the Contract Documents, and shall in no way relieve the Contractor of responsibility for errors or omissions contained in the Contract Documents. Fabricating dimensions, quantities of material, applicable code requirements, and other Contract requirements shall be the Contractor's responsibility. When the Shop Drawings have been reviewed by the Engineer, four (4) sets of submittals will be returned to the Contractor appropriately stamped. If major changes or corrections are necessary, the Shop Drawings may be rejected and one (1) set will be returned to the Contractor with the required changes or corrections indicated, and the Contractor shall promptly make the required changes or corrections. The Contractor shall make a complete and acceptable second submittal to the Engineer. Revisions to the Shop Drawings shall be limited to changes necessary to meet the requirements of the Contract Documents and shall not be taken as the basis of claims for extra work. The Contractor shall have no claims for extra work. The Contractor shall have no claims for damages or extension of time due to any delay resulting from the
Contractor's having to make the required revisions.

Portions of the Work requiring a Shop Drawing or sample submission shall not begin until the Shop Drawing or sample has been reviewed.

13. WORK DONE WITHOUT LINES OR GRADES: Any work done without being properly located and work established by base lines, offset stakes, bench marks, or other basic reference points not located, established, or checked by the Engineer, may be ordered removed and replaced at the Contractor's cost and expense.

14. PRESERVATION OF MONUMENTS AND STAKES: The Contractor shall carefully preserve all monuments, bench marks, reference points and stakes, and in case of willful or careless destruction of the same will be charged with the resulting expense of replacement, and shall be responsible for any mistake or loss of time that may be caused by their unnecessary loss or disturbance. In the event that the stakes and marks placed by the Engineer are destroyed through carelessness on the part of the Contractor, and that the destruction of those stakes and marks cause a delay in the Work, the Contractor shall have no claim for damages or extensions of time. In the case of any permanent monuments or bench marks which must of necessity be

removed or disturbed in the construction of the Work, the Contractor shall carefully protect and preserve the same until they can be properly referenced for relocation. The Contractor shall furnish at his own expense such materials and assistance as are necessary for the proper replacement of monuments or bench marks that have been removed or destroyed.

15. UNDERGROUND FACILITIES:

15.1 Shown or Indicated: The 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 the information and data furnished to the town by the owners of such Underground Facilities or by others. Unless it is otherwise expressly provided in the Supplementary Conditions:

(a) The town shall not be responsible for the accuracy or completeness of any such information or data; and,

(b) The Contractor shall have full responsibility for reviewing and checking all such information and data, for locating all Underground Facilities shown or indicated in the Contract Documents, for coordination of the Work with the owners of such Underground Facilities during construction, for the safety and protection thereof and repairing any damage thereto resulting from the Work, the cost of all of which will be considered as having been included in the Contract Price. This shall include any utilities owned by the town.

15.2 Not Shown or Indicated: If an Underground Facility is uncovered or revealed at or contiguous to the site which was not shown or indicated in the Contract Documents and which the Contractor could not reasonably have been expected to be aware of, the Contractor shall, promptly after becoming aware thereof and before performing any work affected thereby (except in an emergency) identify the owner of such Underground Facility and give written notice thereof to that owner and to the Engineer. The Engineer will promptly review the Underground Facility to determine the extent to which the Contract Documents should be modified to reflect and document the consequences of the existence of the Underground Facility, and the Contract Documents will be amended or supplemented to the extent necessary. During such time, the Contractor shall be responsible for the safety and protection of such Underground Facility. The Contractor shall be allowed an increase in the Contract Price or an extension of the Contract Time, or both, to the extent that they are attributable to the existence of any Underground Facility that was not shown or indicated in the Contract Documents and of which the Contractor could not reasonably have been expected to be aware. If the parties are unable to agree as to the amount of length thereof, the Contractor may make a claim therefor.

16. TOWN'S RESPONSIBILITIES:

16.1 Communications: The town shall issue all communications to the Contractor through the Engineer.

16.2 Information and Payments: The town shall promptly furnish the data required of the town under the Contract Documents and shall make payments to the Contractor promptly after they are due.

16.3 Land and Rights-of-Way: Prior to issuance of Notice to Proceed, the town will obtain all land and rights-of-way necessary for carrying out and for the completion of the work to be performed pursuant to the Contract Documents, unless otherwise mutually agreed. Nothing contained in the Plans or Specifications shall be interpreted as giving the Contractor exclusive occupancy of the land or rights-of-way provided. Land owned and rights-of-way acquired by the town are as shown on the Plans.

16.4 Encroachments: The town will secure, from the agencies having jurisdiction, the necessary permits to create obstructions, to make excavations if required under the Contract, and to otherwise encroach upon rights-of-way.

16.5 Town's Right to Retain Imperfect Work: If any part or porion of the Work done or material furnished under this contract shall prove defective and not in accordance with the Contract Documents, and if the imperfection in the same, in the opinion of the Engineer, shall not be of sufficient magnitude or importanceas to make the Work dangerous or undesirable, the town shall have the right and authority to retain such Work but shall make such deductions in the final payment therefor as may be just and reasonable.

16.6 Temporary Suspension of Work: The town may suspend the Work or any portion thereof by written notice to the Contractor for a period of not more than sixty (60) days or such further time as agreed upon by the Contractor due to financing delays, unsuitable weather and/or other unfavorable conditions for prosecution of the Work, delay in delivery of Town-furnished equipment or materials, or failure of the Contractor to carry out provisions of the Contract or to provide materials and workmanship meeting the requirements of the Specifications. Suspended work shall be resumed by the Contractor within ten (10) days of receipt of written notice from the town to resume the Work.

16.6.1 The Contractor shall have no claim for damages alleged to have been suffered by reason of any suspension of the Work without termination of the Contract, and he shall receive no additional compensation because of any such suspension.

16.6.2 If the performance of all or any portion of the Work is suspended, delayed, or interrupted as a result of a failure of the town to act within the time specified above, an adjustment in the Contract Price or an extension of the Contract Time, or both, shall be made by Change Order to compensate the Contractor for the costs and delays necessarily caused by the failure of the town to notify the Contractor to resume Work.

16.7 Termination of Contract (Contractor Not at Fault) : The town may, without cause and without prejudice to any other right or remedy, elect to abandon the Project and terminate the

Contract provided that such termination is in the best interest of the town. Any such termination shall be effected by delivery to the Contractor of a Notice of Termination specifying the extent to which termination becomes effective.

16.8 Termination of Contract (Contractor at Fault: The town may, without prejudice to any other right or remedy, terminate the Contract after ten (10) days from delivery of a written notice to the Contractor and his surety in the event of breach of theContract or of any default by the Contractor. It shall be considered a default by the Contractor whenever he shall:

(a) declare bankruptcy, become insolvent, or assign his assets for the benefit of his creditors, or if a trustee or receiver is appointed for the Contractor or for any of his property, or if he files a petition to take advantage of any debtor's act, or to reorganize under the bankruptcy or applicable laws;

(b) repeatedly fail to provide a qualified superintendent, sufficient skilled workmen, suitable materials or equipment;

(c) repeatedly fail to make prompt payments to Subcontractors or for labor, materials, or equipment delivered;

(d) disregard laws, ordinances rules, regulations, or orders of any public body having jurisdiction over the Work or if he disregards the authority of the Engineer;

(e) violates any important provisions of the Contract Documents; or

(f) repeatedly fail to prosecute work according to the approved progress schedule.

16.8.1 In the event the Contract is terminated due to defaults described above, the town may take possession of the Project and of all materials, equipment, tools, construction equipment and machinery thereon owned by the Contractor, and finish the Work by whatever method he may deem expedient. In such case, the Contractor shall not be entitled to receive any further payment until the Work is finished.

16.8.2 If the unpaid balance of the Contract Price exceeds the direct and indirect cost of completing the Project, including compensation for additional professional services, such excess will be paid to the Contractor. If such costs exceed such unpaid balance, the Contractor shall pay the difference to the town. Such costs incurred by the town will be determined by the Engineer and incorporated in a Change Order.

16.8.3 Where the Contractor's services have been so terminated by the town, said termination shall not affect any right of the town against the Contractor then existing or which may thereafter accrue. Any retention or payment of monies by the town due the Contractor will not release the Contractor from compliance with the Contract Documents.

17. ENGINEER'S AUTHORITY: The Engineer will be the town's representative during the construction period. The duties and responsibilities and the limitations of authority of the Engineer as the town's representative during construction are set forth herein and shall not be extended without written consent of the town Council.

17.1 Project Representation: The town, at its option, may furnish a Resident Project Representative and Inspector to assist the Engineer in observing the performance of the Work. The duties, responsibilities and limitations of authority of any such Resident Project Representative and Inspectors will be as provided in the Supplementary Conditions.

17.2 Clarifications and Interpretations: The Engineer will issue with reasonable promptness such written clarifications or interpretations of the requirements of the Contract Documents (in the form of drawings or otherwise) as the Engineer may determine necessary, which shall be consistent with or reasonably inferable from the overall intent of the Contract Documents. If the Contractor believes that a written clarification or interpretation justifies an increase in the Contract Price or an extension of the Contract Time and the parties are unable to agree to the amount or extent thereof, the Contractor may make a claim therefor.

17.3 Authorized Variations in Work: The Engineer may authorize minor variations in the Work from the requirements of the Contract Documents which do not involve an adjustment in the Contract Price or the Contract Time and are consistent with the overall intent of the Contract Documents. These may be accomplished by a Field Order and will be binding on the town, and also on the Contractor who shall perform the Work involved promptly. If the Contractor believes that a Field Order justifies and increase in the Contract Price or an extension of the Contract Time and the parties are unable to agree as to the amount or extent thereof, the Contractor may make a claim therefor.

17.4 Rejecting Defective Work: The Engineer will have authority to disapprove or reject Work which the Engineer believes to be defective, and will also have the authority to require special inspection or testing of the Work, whether or not the Work is fabricated, installed or completed.

17.5 Determinations for Payment: The Engineer will determine the actual quantities and classifications of Work performed by the Contractor. The Engineer will review with the Contractor the Engineer's preliminary determinations on such matters before rendering a written decision thereon (by recommendation of a Payment Estimate or otherwise). The Engineer's written decisions thereon will be final and binding upon the town and Contractor, unless, within ten (10) days after the date of any such decision, the Contractor delivers to the town written notice of intention to appeal from such a decision. The Engineer will not be responsible for the Contractor's means, methods, techniques, sequences or procedures of construction, or the safety precautions and program incident hereto, and the Engineer will not be responsible for the Contractor's failure to perform or furnish the Work in accordance with the Contract Documents. The Engineer will not be responsible for the acts or omissions of the Contractor, of any Subcontractor, of any Supplier, or of any other person or organization performing or furnishing any of the Work.

18. CONTRACTOR'S RESPONSIBILITY: By executing the Contract, the Contractor represents that he has visited the site, familiarized himself with the local conditions under which the Work is to be performed, and correlated his observations with the requirements of the Contract Documents.

18.1 Insurance Requirements: Before any work at the site is started, the Contractor shall deliver to the town certificates of insurance which the Contractor is required to purchase and maintain in accordance with the Contract Documents.

18.2 Supervision: The contractor shall supervise and direct the Work competently and efficiently, devoting such attention thereto and applying such skills and expertise as may be necessary to perform the Work in accordance with the Contract Documents. The Contractor shall be solely responsible for the means, methods, techniques, sequences and procedures of Construction, but the Contractor shall not be responsible for the negligence of others in the design or selection of a specific means, method, technique, sequence or procedure of construction which is indicated in and required by the Contract Documents. The Contractor shall be responsible to see that the finished Work complies accurately with the Contract Documents.

18.3 Superintendence of Work: The Contractor shall provide and maintain, continually on the site of the Work during its progress, adequate and competent superintendence of all operations for and in connection with the Work being performed under this Contract, either personal or by a duly authorized superintendent or representative.

18.3.1 The superintendent or other representative of the Contractor on the Work, and who has charge thereof, shall be fully authorized to act for the Contractor and to receive whatever orders as may be given by the Engineer for the proper prosecution of the Work, or notices in connection therewith.

18.3.2 The superintendent shall be a person having considerable experience on similar projects. The Contractor shall submit the name of the proposed superintendent to the town together with a list of projects on which the proposed individual has served as superintendent. Such list shall detail the size and complexity of projects and shall include references for each engagement. The Engineer shall review the submitted qualifications. No person shall serve as superintendent without approval of the town.

18.4 Labor, Materials and Equipment: The Contractor shall provide competent, suitably qualified personnel to lay out the Work and perform construction as required by the Contract Documents. The Contractor shall at all times maintain good discipline and order at the site. Except in connection with the safety or protection of persons or the Work, or property at the site or adjacent thereto, and except as otherwise indicated in the Contract Documents, all Work at the site shall be performed during regular working hours, and the Contractor will not permit overtime work or the performance of Work on Saturday, Sunday or any legal holiday without the town's prior written consent.

18.4.1 The Contractor shall furnish and assume full responsibility for all materials, equipment, labor, transportation, construction equipment and machinery, tools, appliances, fuel, power, light, heat, telephone, water, sanitary facilities, temporary facilities and all other facilities and incidentals necessary for the furnishing, performance, testing, start-up and completion of the Work.

18.4.2 All materials and equipment shall be of good quality and new, except as otherwise provided in the Contract Documents. If required by the Engineer, the Contractor shall furnish satisfactory evidence (including reports of required tests) as to the kind and quality of materials and equipment. All materials and equipment shall be applied, installed, connected, erected, used cleaned and conditioned in accordance with the instructions of the applicable Supplier except as otherwise provided in the Contract Documents; but no provision of any such instructions will be effective to assign to the Engineer, or any of the town's consultants, agents or employees, any duty or authority to supervise or direct the furnishing or performance of the Work.

18.5 Sunday, Holiday and Night Work: Except in connection with the care, maintenance or protection of equipment, or of work already done, no work shall be done between the hours of 7 P.M. and 7 A.M., or on Sundays or legal holidays, without the written consent of the town.

18.6 Prosecution and Progress: The Contractor shall, within ten (10) days after being instructed to do so in a written notice from the town, commence the Work to be done under this Contract; and the rate of progress shall be such that the Work shall have been completed in accordance with the terms of the Contract on or before the termination of the Contract Time stated in the Proposal, subject to any extension or extensions of such time made as hereinafter provided.

18.6.1 Promptly after the award of the Contract, the Contractor shall submit to the Engineer for approval an estimated progress schedule and a written program of construction outlining the proposed operations and the order of completion of the various parts in sufficient detail to demonstrate to the Engineer the adequacy of the progress to complete the construction within the time provided. No payment shall be made to the Contractor on any Payment Estimate until such progress schedule and program have been submitted and approved.

18.6.2 Should it become evident at any time during construction that construction operations will or may fall behind the schedule of this first program of construction the Contractor shall, upon request, promptly submit revised written schedules setting out operations, methods and equipment, added amount labor, or of working shifts, night work, etc., by which lost time shall be made up and shall confer with the Engineer until an approved modification of the original program and schedule have been provided by the Contractor. Execution of the Work according to the accepted program of construction, or approved modifications thereof, shall be an obligation of the Contract.

18.6.3 Should the Contractor fail to complete the Work within the Contract Time as stipulated in the Proposal or within such extra time as may have been allowed by extension, the town will deduct from any moneys due or coming due to the Contractor, the amount indicated in

the Proposal for each calendar day the Work shall remain uncompleted. This sum shall be considered and treated not as a penalty but as fixed, agreed and liquidated damages due the town from the Contractor by reason of interference with business, inconvenience to the public, added cost of engineering, administration, inspection, maintenance of detours and temporary facilities, and other items which have caused an expenditure of funds resulting from his failure to complete the Work within the Contract Time.

18.6.4 Permitting the Contractor to continue and finish the Work or any part of it after the time fixed for its completion, or after the date to which the time for completion may have been extended, shall in no way operate as a waiver on the part of the town of any of its rights under the Contract.

18.6.5 Neither by the act of taking over the Work nor by the annulment of the Contract nor by requiring the surety to complete the Contract shall the town forfeit the right to recover liquidated damages from the Contractor or his surety for failure to complete the Contract within the specified Contract Time.

18.7 Extensions of Time: The Contractor shall place orders for all principal materials to be needed in the Work within ten (10) days after award of the Contract and delivery dates shall be obtained, in writing, from the suppliers of each of these materials. One copy of each order for the primary materials in the Contract together with one copy of the suppliers reply stating the date of delivery shall be furnished to the Engineer prior to the payment of the first partial monthly Payment Estimate. Payment of partial monthly Payment Estimates shall not be commenced until these provisions have been complied with to the full satisfaction of the Engineer.

18.7.1 Should special conditions arise from war, strikes or other national emergencies wherein restrictions may prevent or delay the acquirement, delivery or use of materials and be the direct cause of specific delays, extensions of time will be granted. In such event, the Contractor shall file with the Engineer, copies of documentary evidence to substantiate the causes and extent of resultant delays at the time they are in occurrence. This evidence together with the original orders and written delivery dates will be used by the Engineer to determine the amount of extension of time to be made on account of such delays. In determining extensions of time, revised delivery dates for primary materials will be computed by extending the original Contract Time by the actual number of days which elapses during any emergency.

18.7.2 The Contractor is requested to bring to the attention of the Engineer, by letter, during the progress of the Work, the occurrence of events which the Contractor considers may warrant extensions of time under the conditions of the Contract. If the Contract is not completed within the Contract Time, the Contractor shall, at the conclusion of the Work, present to the Engineer a written statement presenting his view upon all matters of time extensions.

18.7.3 The amount of all extensions of time, for whatever reason granted, shall be determined by the Engineer with due consideration given to working seasons and working conditions.

In general, only actual and not constructive or hypothetical days of delay will be considered. The town shall have the authority to grant additional extensions of time as the town may deem advisable and justifiable.

18.8 Substitutes or "Or-Equal" Items: Whenever materials or equipment are specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular supplier, the naming of the item is intended to establish the type, function and quality required. Unless the name is followed by words indicating that no substitution is permitted, materials or equipment of other Suppliers may be accepted by the Engineer to determine that the material or equipment proposed is equivalent or equal to that named. Requests for review of substitute items of material and equipment will not be accepted by the Contractor. If the Contractor wishes to furnish or use a substitute item of material or equipment, the Contractor shall make written application to the Engineer for acceptance thereof, certifying that the proposed substitute will perform adequately the functions and achieve the results called for by the general design, be similar and of equal substance to that specified and be suited to the same use as that specified. The application will state that the evaluation and acceptance of the proposed substitute will not be prejudice the Contractor's achievement of Substantial Completion on time, whether or not acceptance of the substitute for use in the Work will require a change in any of the Contract Documents (or in the provisions of any other direct contract with the town for work on the Project) to adapt the design to the proposed substitute and whether or not incorporation or use of the substitute in connection with the Work is subject to payment of any license fee or royalty. All variations of the subject to payment of any license fee or royalty. All variations of the proposed substitute from that specified will be identified in the application and available maintenance, repair and replacement service will be indicated. The application will also contain an itemized estimate of all costs that will result directly or indirectly from acceptance of such substitute, including costs of redesign and claims of other contractors affected by the resulting change, all of which shall be considered by the Engineer in evaluating the proposed substitute. The Engineer may require the Contractor to furnish, at the Contractor's expense, additional data about the proposed substitute.

18.8.1 If a specific means, method, technique, sequence or procedure of construction is indicated in or required by the Contract Documents, the Contractor may furnish or utilize a substitute means, method, sequence, technique or procedure of construction acceptable to the Engineer, if the Contractor submits sufficient information to allow the Engineer to determine that the substitute proposed is equivalent to that indicated or required by the Contract Documents.

18.8.2 The Engineer will be allowed a reasonable time within which to evaluate each proposed substitute. The Engineer will be the sole judge of acceptability, and no substitute will be ordered, installed or utilized without the Engineer's prior written acceptance, which will be evidenced by a Change Order or an approved Shop Drawing. The town may require the Contractor to furnish , at the Contractor's expense, a special performance guarantee or other surety with respect to any substitute.

18.9 Subcontractors and Suppliers: The Contractor shall not employ any Subcontractor, Supplier or other person or organization, whether initially or as a substitute, against whom the town may have reasonable objection. The Contractor shall not be required to employ any

Subcontractor, Supplier or other person or organization to furnish or perform any of the Work against whom the Contractor has reasonable objection.

18.9.1 If the Supplementary Conditions require and identity of certain Subcontractors, Suppliers or other persons or organizations (including those who are to furnish the principal items of materials and equipment) to be submitted to the town for acceptance by the town and if the Contractor has submitted a list thereof in accordance with the Supplementary Conditions, the town's acceptance (either in writing or by failing to make written objection thereto by the date indicated for acceptance or objection in the bidding documents or the Contract Documents) of any such Subcontractor, Supplier or other person or organization so identified may be revoked on the basis of reasonable objection after due investigation, in which case the Contractor shall submit an acceptable substitute. The Contract Price will be increased by the difference in the cost occasioned by such substitution and an appropriate Change Order will be issued. No acceptance by the town of any such Subcontractor, Supplier or other person or organization shall constitute a waiver of any right of the town to reject defective Work.

18.9.2 The Contractor shall be fully responsible to the town for all acts and omissions of the Subcontractors, Suppliers and other persons and organizations performing or furnishing any of the Work under a direct or indirect contract with the Contractor just as the Contractor is responsible for the Contractor's own acts and omissions. Nothing in the Contract Documents shall create any contractual relationship between the town and any such Subcontractor, Supplier or other person or organization, nor shall it create any obligation on the part of the town to pay or to see to the payment of any moneys due any such Subcontractor, Supplier or other person or organization except as may otherwise be required by Laws and Regulations.

18.9.3 The division and sections of the Specifications and the identifications of any Plans shall not control the Contractor in dividing the Work among Subcontractors or Suppliers or delineating the Work to be performed by any specific trade.

18.9.4 All Work performed for the Contractor by a Subcontractor will be pursuant to an appropriate agreement between the Contractor and the Subcontractor, which specifically binds the Subcontractor to the applicable terms and conditions of the Contract Documents for the benefit of the town. The Contractor shall pay each Subcontractor a just share of any insurance moneys received by the Contractor on account of losses under policies issued.

18.10 Patent Fees and Royalties: The Contractor shall pay all license fees and royalties and assume all costs incident to the use in the performance of the Work or the incorporation in the Work of any invention, design, process, product or device which is the subject of patent rights or copyrights held by others. If a particular invention, design, process, product or device is specified in the Contract Documents for use in the performance of the Work and, if to the actual knowledge of the town its use in subject to patent rights or copyrights calling for the payment of any license fee or royalty to others, the existence of such rights shall be disclosed by the town in the Contract Documents. The Contractor shall indemnify and hold harmless the town and anyone directly or indirectly employed by the town from and against all claims, damages, losses and expenses (including attorney's fees and court and arbitration costs) arising out of any infringement of patent rights or copyrights incident to the use in the performance of the Work or

resulting from the incorporation in the Work of any invention, design, process, produce or device not specified in the Contract Documents, and shall defend all such claims in connection with any alleged infringement of such rights.

18.11 Permits: Unless otherwise provided in the Supplementary Conditions, the Contractor shall obtain and pay for all construction permits and licenses. The town shall assist the Contractor, when necessary, in obtaining such permits and licenses. The Contractor shall pay all charges of utility owners for connections to the Work, and the town shall pay all charges of such utility owners for capital costs related thereto such as plant investment fees.

18.12 Laws and Regulations: The Contractor shall give all notices and comply with all Laws and Regulations applicable to furnishing and performance of the Work. Except where otherwise expressly required by applicable Laws and Regulations, the town shall not be responsible for monitoring the Contractor's compliance with any Laws or regulations. If the Contractor observes that the Plans and Specifications are at variance with any Laws or Regulations, the Contractor shall give the Engineer prompt written notice thereof, and nay necessary changes will be authorized. If the Contractor performs any Work knowing or having reason to know that it is contrary to such Laws or Regulations, and without such notice to the Engineer, the Contractor shall bear all costs arising therefrom; however, it shall not be the Contractor's primary responsibility to make certain that the Plans and Specifications are in accordance with such Laws and Regulations.

18.13 Use of Premises: The Contractor shall confine construction equipment, the storage of materials and equipment and the operations of workers to the Project site and land and areas identified in and permitted by Laws and Regulations, rights-of-way, permits and easements, and shall not unreasonably encumber the premises with construction equipment or other materials or equipment. The Contractor shall assume full responsibility for any damage to any such land or area, or to the owner or occupant thereof or of any land or areas Contiguous thereto, resulting from the performance of the Work. Should any claim be made against the town by any such owner or occupant because of the performance of the Work, the Contractor shall promptly attempt to settle with such other party by agreement or otherwise resolve the claim by arbitration or at law. The Contractor shall, to the fullest extent permitted by Laws and Regulations, indemnify and hold the town harmless from and against all claims, damages, losses and expenses (including, but not limited to, fees of engineers, architects, attorneys and other professionals and court and arbitration costs) arising directly, indirectly or consequentially out of any action, legal or equitable, brought by any such other party against the town to the extent based on a claim arising out of the Contractor's performance of the Work.

18.13.1 Where the space within the project site, right-of-way or easements is not available for construction plant, the Contractor shall provide at his own expense any work area he requires, shall construct and maintain any roadway or other facilities required for this purpose and the cost thereof shall be included in the prices bid for the various items scheduled in the Proposal.

18.13.2 During the progress of the Work, the Contractor shall keep the premises free from accumulations of waste materials, rubbish and other debris resulting from the Work. at the

completion of the Work, the Contractor shall remove all waste materials, rubbish and debris from and about the premises as well as all tools, appliances, construction equipment and machinery, and surplus materials, and shall leave the site clean and ready for occupancy by the town. The Contractor shall restore to original condition all property not designated for alteration by the Contract Documents.

18.13.3 The Contractor shall not load nor permit any part of any structure to be loaded in any manner that will endanger the structure, nor shall the Contractor subject any part of the Work or adjacent property to stresses or pressures that will endanger it.

18.14 Record Documents: The Contractor shall maintain in a safe place at the site one record copy of all Plans, Specifications, Addenda, Written Amendments, Change Orders, Work Directive Changes, Field Orders and written interpretations and clarifications in good order annotated to show all changes made during construction. These record documents together with all approved samples and a counterpart of all approved Shop Drawings will be available to the Engineer for reference. Upon completion of the Work, these record documents, samples and Shop Drawings will be delivered to the town.

18.15 Safety and Protection: The Contractor shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the Work.

18.15.1 The Contractor shall comply with all applicable Laws and Regulations of any public body having jurisdiction for the safety of persons or property or to protect them from damage, injury or loss; and shall erect and maintain all necessary safeguards for such safety and protection. The Contractor shall notify owners of adjacent property and of Underground Facilities and utility owners when prosecution of the Work may affect them, and shall cooperate with them in the protection, removal, relocation and replacement of their property. All damage, injury or loss to any property referred to in these paragraphs caused, directly or indirectly, in whole or in part, by the Contractor, any Subcontractor, Supplier or any other person or organization directly or indirectly employed by any of them to perform or furnish any of the Work or anyone for whose acts any of them may be liable, shall be remedied by the Contractor. The Contractor's duties and responsibilities for the safety and protection of the Work shall continue until such time as all the Work is completed and the Engineer has issued a notice to the Contractor that the Work is acceptable (except as otherwise expressly provided in connection with Substantial Completion).

18.15.2 The Contractor shall designate a responsible representative at the site whose duty shall be the prevention of accidents. This person shall be the Contractor's superintendent unless otherwise designated in writing by the Contractor to the town.

18.16 Emergencies: In emergencies affecting the safety or protection of persons or the Work or property at the site or adjacent thereto, the Contractor, without special instruction or authorization from the Engineer, is obligated to act to prevent threatened damage, injury or loss. The Contractor shall give the Engineer prompt written notice if the Contractor believes that any significant changes in the Work or variations from the Contract Documents have been caused thereby. If the Engineer determines that a change in the Contract Documents is required because

of the action taken in response to an emergency, a Change Order will be issued to document the consequences of the changes or variations.

18.17 Loses From Natural Causes: All loss or damage arising out of the nature of the Work, to be done, or from the action of the elements, or from floods or overflows, or from groundwater, or from any unusual obstruction or difficulty, or any other natural or existing circumstances either known or unforeseen, which may be encountered in the prosecution of the Work shall be sustained and borne by the Contractor at his own cost and expense.

18.18 Continuing the Work: The Contractor shall carry on the Work and adhere to the progress schedule during all disputes or disagreements with the town. No Work shall be delayed or postponed pending resolution of any disputes or disagreements, except as the Contractor and Town may otherwise agree in writing.

18.19 Indemnification: To the fullest extent permitted by Laws and Regulations, the Contractor shall indemnify and hold harmless the town and its consultants, agents and employees from and against all claims, damages, losses and expenses, direct, indirect or consequential (including but not limited to fees and charges of engineers, architects, attorneys and other professionals and court and arbitration costs) arising out of or resulting from the performance of the Work, provided that any such claim, damage, loss or expenses:

(a) is attributable to bodily injury, sickness, disease or death, or to injury to or destruction of tangible property (other than the Work itself) including the loss of use resulting therefrom, and

(b) is caused in whole or in part by any negligent act or omission of the Contractor, any Subcontractor, any person or organization directly or indirectly employed by any of them to perform or furnish any of the Work or anyone for whose acts any of them may be liable, regardless of whether or not it is caused in part by a party indemnified hereunder or arises by or is imposed by Law and Regulations regardless of the negligence of any such party.

18.19.1 In any and all claims against the town or any of its consultants, agents or employees by any employee of the Contractor, any Subcontractor, any person or organization directly or indirectly employed by any of them to perform or furnish any of the Work or anyone for whose acts any of them may be liable, the indemnification obligation shall not be limited in any way by any limitation on the amount or type of damages, compensation or benefits payable by or for the contractor or any such Subcontractor or other person or organization under workers or workmen's compensation or benefits payable by or for the contractor or any such Subcontractor or other person or organization under workers or workmen's compensation acts, disability benefit acts or other employee benefit acts.

18.20 Contractor's Responsibility in Case of Termination: After receipt of a Notice of Termination, and except as otherwise directed by the town, the Contractor shall:

(a) stop work under the Contract on the date and to the extent specified in the Notice of Termination,

(b) place no further orders or subcontractors for materials, services or facilities, except as may be necessary for completion of such portion of the Work under the Contract that is not terminated;

(c) terminate all orders and subcontracts to the extent that they relate to the performance of the Work terminated by the Notice of Termination;

(d) assign to the town, in the manner, at the times, and to the extent directed by the town, all of the right, title, and interest of the Contractor under the orders and subcontracts;

(e) settle all outstanding liabilities and all claims arising out of such termination of orders and subcontracts, with the approval or ratification of the town, to the extent he may require, which approval or ratification shall be final for all the purposes of this clause;

(f) transfer title and deliver to the town, in the manner, at the times, and to the extent, if any, directed by the town, the fabricated or unfabricated parts, work in process, completed work, supplies, and other material produced as a performance of, and the work terminated by the Notice of Termination; and the completed or partially completed plans, drawings information, and other property which, if the Contract had been completed, would have been required to be furnished to the town.

(g) complete performance of such part of the Work as shall not have been terminated by the Notice of Termination; and

(h) take such actions as may be necessary, or as the town may direct, for the protection and preservation of the property related to this Contract which is in the possession of the Contractor and in which the town has or may acquire an interest.

18.20.1 After receipt of a Notice of Termination, the Contractor shall submit to the town his termination claim, in the form and with certification prescribed by the town. Such claim shall be submitted promptly but in no event later than one year from the effective date of termination, unless extensions in writing are granted by the town, upon request of the Contractor made in writing within such one year period or authorized extension thereof. However, if the town determines that the facts justify such actions, he may receive and act upon any such termination claim at any time after such one year period or any extension thereof. Upon failure of the Contractor to submit his termination claim within the time allowed the town may determine, on the basis of information available to him, the amount, if any, due to the Contractor by reason of the termination and shall thereupon pay to the Contractor the amount so determined.

18.20.2 Upon termination of the Contract, the Contractor shall have no claims against the town except for:

(a) the value of work performed plus profit up to the date the Contract is terminated; and

(b) the cost of materials and equipment on hand, in transit, or on definite commitment, as of the date the Contract is terminated, which would be needed in the Work and which meets the requirements of the Contract Documents.

18.20.3 The value of work performed and the cost of materials and equipment delivered to the site, as mentioned above, shall be determined in accordance with the procedure prescribed for the making of the final estimate and payment.

19. OTHER WORK: The town may perform other work related to the Project at the site by the town's own forces, have other work performed by utility owners or let other direct contracts therefor which shall contain General Conditions similar to these. If the fact that such other work is to be performed was not noted in the Contract Documents, written notice thereof will be given to the Contractor prior to starting any such other work; and, if the Contractor believes that such performance will involve additional expense to the Contractor or requires additional time and the parties are unable to agree as to the extent thereof, the Contractor may make a claim therefor.

19.1 The Contractor shall afford each utility owner and other contractor who is a party to such a direct contract (or the town, if the town is performing the additional work with the town's employees) proper and safe access to the site and a reasonable opportunity for the introduction and storage of materials and equipment and the execution of such work, and shall properly connect and coordinate the Work with theirs. The Contractor shall do all cutting, fitting and patching of the Work that may be required to make its several parts come together properly and integrate with such other work. The Contractor shall not endanger any work of others by cutting, excavating or otherwise altering their work and will only cut or alter their work with the written consent of the Engineer and the others whose work will be affected. The duties and responsibilities of the Contractor under this paragraph are for the benefit of such utility owners and other contractors to the extent that there are comparable provisions for the benefit of the Contractor in said direct contracts between the town and such utility owners and other contractors.

19.2 If any part of the Contractor's Work depends for proper execution or results upon the work of any such other contractor or utility owner (or the town), the Contractor shall inspect and promptly report to the Engineer, in writing, any delays, defects or deficiencies in such work that render it unavailable or unsuitable for such proper execution and results. The Contractor's failure so to report will constitute and acceptance of the other work as fit and proper for integration with the Contractor's Work except for latent or nonapparent defects or deficiencies in the other work.

19.3 Coordination: If the town contracts with others for the performance of other work on the Project at the site, the person or organization who will have authority and responsibility for coordination of he activities among the various prime contractors will be identified in the

Supplementary Conditions, and the specific matters to be covered by such authority and responsibility will be itemized, and the extent of such authority and responsibilities will be provided, in the Supplementary Conditions. unless otherwise provided in the Supplementary Conditions, the town shall have no authority or responsibility in respect of such coordination.

20. MISCELLANEOUS PROVISIONS:

20.1 Legal Address: The business address of the Contractor given in the Proposal upon which this Contract is founded is hereby designated as the place to which all notices, letters and other communications to the Contractor may be mailed or delivered. The business address of the town appearing in the Contract, is hereby designated as the place to which all notices, letters and other communications to the town may be mailed or delivered. The delivery by one party to the other party at an address so designated, or the depositing in any mail box regularly maintained by the post office, of any notice, letter or other communication addressed to such address, postage prepaid, registered or certified mail, with return receipt requested, shall be deemed sufficient service thereof, and the date of said service shall be the date of such delivery of mailing. Either party may change the said address or addresses at any time by an instrument in writing delivered to the other party. Nothing herein contained shall be deemed to preclude or render inoperative the service of any notice, letter or communication upon either party personally.

20.2 Independent Contractor: The right of general supervision by the town shall not make the Contractor an agent of the town, and the liability of the Contractor for all damages to persons, firms and corporations, arising from the Contractor's execution of the work, shall not be lessened because of such general supervision; but as to all such persons, firms and corporations and the damages, if any, to them or their property, the contractor herein is an independent contractor in respect to the Work.

20.3 Suggestions to Contractor Adopted at his Own Risk: Any plan or method of work suggested by the town, the Engineer, or their representatives, to the Contractor, but not specified, or required, if adopted or followed by the Contractor in whole or in part, shall be used at the risk and responsibility of the Contractor, and the town will assume no responsibility therefor.

20.4 Hindrances and Delays: In executing the Contract, the Contractor expressly covenants and agrees that, in undertaking to complete the Work within the time therein fixed, he has taken into consideration and made allowances for all hindrances and delays incident to such work, whether growing out of delays in securing materials or workmen or otherwise. No charge shall be made by the Contractor for hindrances or delays from any cause during the progress of the work, or any portion thereof, embraced in this Contract, except as provided by the town's right to suspend the Work.

20.5 Provision for Emergencies: Whenever, in the opinion of the Engineer, the Contractor has not taken sufficient precaution for the safety of the public or the protection of the Work to be constructed under this Contract or of adjacent structures or property which may be injured by processes of construction on account of such neglect, and whenever, in the opinion of

the Engineer, an emergency shall arise and immediate action shall be considered necessary in order to protect public or private personal property interests, then the Engineer, with or without notice to the Contractor, may provide (but does not have the duty to do so) suitable protection to the said interests by causing such work to be done and material to be furnished and placed as the Engineer may consider necessary and adequate. The cost and expense of such work and material so furnished shall be borne by the Contractor, and , if the same shall not be paid on presentation of the bills therefor, such costs shall be deducted from any amounts due or to become due the Contractor. The performance of such emergency work under the direction of the Engineer shall in no way relieve the Contractor of responsibility for damages which may occur during or after such precaution has been duly taken by the Engineer.

20.6 Assignment of Contract: The Contractor shall not assign the work, or any part thereof, without the previous written consent of the town, nor shall he assign, by power of attorney or otherwise, any of the money payable under this Contract unless by and with the like consent of the town to be signified in like manner. No right under this Contract, nor to any money due or to become due hereunder, shall be asserted in any manner against said Town, or persons acting for the town, by reason of any so-called assignment of this Contract or any part thereof, unless such assignment shall have been authorized by the written consent of the town. In case the Contractor assigns all, or any part of, any moneys due or to become due under this Contract, the instrument of assignment shall contain a right of the assignee in and to any moneys due or to become due or to become due under this Contract, the instrument of assignment shall contain a right of the assignee in and to any moneys due or to become due to the Contractor shall be subject to all prior liens of all persons, firms and corporations for services rendered or materials supplied for the performance of the Work called for in this Contract.

20.7 Protests: If the Contractor considers any work demanded of him to be outside the requirements of the Contract, or if he considers any order, instruction, or decision of the Engineer or of any Inspector to be unfair, he shall, immediately upon receipt of such order, instruction, or decision, ask for a written confirmation of the same, whereupon he shall proceed without delay to perform the Work or to conform to the order, instruction, or decision; but if the Contractor finds such written order, instruction, or decision unsatisfactory, he shall, within ten (10) calendar days after receipt of same, file a written protest with the town, stating clearly and in detail his objections and the reasons therefor. Except for such protests or objections to the orders, instructions, or decisions of the Engineer and hereby agrees that as to all matters not included in such protest, the orders, instructions, and decisions of the Engineer shall be considered final and binding. All orders, instructions, and decisions of the Engineer will be limited to matters properly falling within the Engineer's authority.

20.8 Arbitration; All claims, disputes, or other questions that may arise between the town and the Contractor concerning any provision or provisions of this Contract which cannot otherwise be settled and which have not been waived by the making and acceptance of final payment or any progress payment may be submitted to and be determined and settled by arbitration in the manner set forth in this paragraph if both parties agree to arbitration prior to entering into arbitration. Either party, by written notice to the other received before litigation is commenced, may demand arbitration and may appoint an arbitrator. If litigation has been commenced prior to receipt of a demand to arbitrate, arbitration shall not be held. Within five

(5) days after receipt of such notice, the other party shall, by written notice to the former, appoint another arbitrator, and in default of said second appointment, the arbitrator first appointed shall be sole arbitrator and shall proceed in the same manner as hereinafter provided for three (3) arbitrators. When two (2) arbitrators have been appointed as aforesaid, they shall, if possible, agree upon a third arbitrator and shall appoint him by notice in writing, signed by both of them given to the town and the Contractor. If fifteen (15) days shall elapse after the appointment of the second arbitrator without notice of appointment of the third arbitrator being given as aforesaid, then either party may, in writing, request that the American Arbitration Association appoint the third arbitrator. Upon appointment of the third arbitrator, the three (3) arbitrators shall meet without delay and shall proceed with determination of the dispute in accordance with the Construction Industry Rules of the American Arbitration Association. If the award sustains the position of the contractor or if the award does not sustain the position of either party, the fees and expenses of the arbitration proceedings shall be assessed equally against both parties and shall be paid one-half by the town and one-half by the Contractor. The decision of the arbitrators shall be final. The Contractor shall carry on the Work and maintain the progress schedule during any arbitration proceedings, unless otherwise mutually agreed upon in writing.

21. BONDS AND INSURANCE

21.1 Insurance: The Contractor shall secure, and maintain throughout the duration of this Contract, insurance of such types and in such amounts as may be necessary to protect himself against all hazards or risks of loss as hereinafter designated and specified. The form and limits of such insurance, together with the underwriter thereof in each case, shall be the responsibility of the Contractor to maintain such coverage shall not relieve him of any contractual responsibility or obligation. If a part of the Contract is to be sublet, the Contractor shall:

(a) Cover any and all Subcontractors in his insurance policies, or

(b) Require each Subcontractor not so covered to secure insurance which will protect said Subcontractor against all applicable hazards or risks or loss designated herein.

21.2.1 Workmen's Compensation and Employer's Liability Insurance: This insurance shall protect the Contractor against any and all claims brought under the Workmen's Compensation law for the State of Texas. It shall also protect the Contractor against claims for injury to, disease or death of workmen engaged in the Work under this Contract which, for any reason, may not fall within the provisions of the Workmen's Compensation Act. Liability limits for this insurance on this Project shall be as specified in the SECTION: SUPPLEMENTARY CONDITIONS.

21.2.3 Comprehensive General Liability Insurance: This insurance, to be on the comprehensive form, shall protect the Contractor against any and all claims arising from injuries to members of the public or damage to property or others arising out of any act or omission of the Contractor, his agents, employees, or subcontractors, in connection with the operation or performance of the Work for and in connections with this Contract.

In addition, this general liability insurance policy shall specifically insure the contractual liability of the Contractor assumed under the provisions for indemnifying the town.

21.2.4 Bodily Injury and Property Damage Insurance: The property damage liability coverage under the comprehensive general liability policy shall contain no exclusion relative to blasting, explosion, collapse of buildings, or damage to underground property. Liability limits for general liability insurance coverage under this policy on this Project shall be as specified in SECTION: SUPPLEMENTARY CONDITIONS.

21.2.5 Comprehensive Automobile Liability Insurance: This insurance, to be on the comprehensive form, shall protect the Contractor against any and all claims or injuries to members of the public and damage to property of others arising from the use of automobiles and trucks in connection with the performance of the Work under this Contract, and shall cover operation on or off the site of the Work of all motor vehicles licensed for highway use, whether they are owned, non-owned, or hired by the Contractor. The policy shall include an "all states" endorsement. Liability limits for automobile liability insurance coverage on this Project shall be as specified in the SECTION: SUPPLEMENTARY CONDITIONS.

21.2.6 Property Insurance: The Contractor shall effect and maintain Builder's Risk Insurance to the full insurable value of the Work, with extended coverage for fire, vandalism, hail, wind, storm, etc., naming the town as co-insured. The Contractor shall provide insurance certificates to the town attesting to the coverage. insurance shall not be modified or cancelled without written notification to the town of such change or cancellation at least fifteen (15) days in advance of such change or cancellation.

22. TESTS AND INSPECTIONS; DEFECTIVE WORK:

22.1 Warranty and Guarantee: The Contractor warrants and guarantees to the town that all work will be in accordance with the Contract Documents and will not be defective. Prompt notice of all defects shall be given to the Contractor. All defective Work, whether or not in place, may be rejected, corrected or accepted as provided in this Article.

22.2 Access to Work: The Engineer or other representatives of the town, testing agencies and governmental agencies with jurisdictional interests will have access to the Work at reasonable times for their observation, inspecting and testing. The Contractor shall provide proper and safe conditions for such access.

22.3 Tests and Inspections: The Contractor shall give the Engineer timely notice of readiness of the Work for all required inspections, tests or approvals. If Laws or Regulations of any public body having jurisdiction require any Work (or part thereof) to specifically be inspected, tested or approved, the Contractor shall assume full responsibility therefor, pay all costs in connection therewith and furnish the Engineer the required certificates of inspection, testing or approval, the Contractor shall also be responsible for and shall pay all costs in connection with any inspection or testing required in connection with the town's acceptance of a Supplier of materials or equipment proposed to be incorporated in the Work, or of materials or

equipment submitted for approval prior to the Contractor's purchase thereof for incorporation in the Work. The cost of all inspections, tests and approvals in addition to the above which are required by the Contract Documents shall be paid by the town (unless otherwise specified).

22.3.1 All inspections, tests or approvals other than those required by Laws or Regulations of any public body having jurisdiction shall be performed by organizations acceptable to the town.

22.3.2 If any Work (including the work of others) that is to be inspected, tested or approved is covered without written concurrence of the Engineer, it must, if requested by the Engineer, be uncovered for observation. Such uncovering shall be at the Contractor's expense unless the Contractor has given the Engineer timely notice of the Contractor's intention to cover the same, and the Engineer has not acted with reasonable promptness in response to such notice.

22.3.3 Neither observations by the Engineer nor inspections, tests or approvals by others shall relieve the Contractor form the Contractor's obligations to perform the Work in accordance with the Contract Documents.

22.4 Uncovering Work: If any portion of the Work is covered contrary to the written request of the Engineer, it must, if requested by the Engineer, be covered for the Engineer's observation and replaced at the Contractor's expense. if the Engineer considers it necessary or advisable that covered Work not contrary to Engineer's request or previously approved must be observed by the Engineer or inspected or tested by others, the Contractor, at the Engineer's request, shall uncover, expose or otherwise make available for observation, inspection or testing as the Engineer may require, that portion of the Work in question, furnishing all necessary labor, material and equipment. If it is found that such Work is defective, the Contractor shall bear all direct, indirect and consequential costs of such uncovering, exposure, observation, inspection and testing and of satisfactory reconstruction, (including, but not limited to, fees and charges of engineers, architects, attorneys and other professionals), and the town shall be entitled to an appropriate decrease in the Contract Price, and, if the parties are unable to agree as to the amount thereof, they amy make a claim therefor. If, however, such Work is not found to be defective, the Contractor shall be allowed and increase in the Contract price or an extension of the Contract Time, or both, directly attributable to such uncovering, exposure, observation, inspection, testing and reconstruction; and, if the parties are unable to agree as to the amount or extent thereof, the Contractor may make a claim therefor.

22.5 Town May Stop the Work: If the Work is defective, or the Contractor fails to supply sufficient skilled workers or suitable materials or equipment, or fails to furnish or perform the Work in such a way that the completed Work will conform to the Contractor to stop the Work, or any portion thereof, until the cause for such order has been eliminated; however, this right of the town to stop the Work shall not give rise to any duty on the part of the town to exercise this right for the benefit of the Contractor or any other party.

22.6 Correction or Removal of Defective Work: If required by the Engineer, the Contractor shall promptly, as directed, either correct all defective Work, whether or not fabricated, installed or completed, or, if the Work has been rejected by the Engineer, remove it from the site and replace it with nondefective Work. The Contractor shall bear all direct, indirect and

consequential costs of such correction or removal (including but not limited to fees and charges of engineers, architects, attorneys and other professionals) made necessary thereby.

22.7 One Year Correction Period: If within one year after the date of Substantial Completion or such longer period of time as may be prescribed by Laws or Regulations or by the terms of any applicable special guarantee required by the Contract Documents or by any specific provision of the Contract Documents, any Work is found to be defective, the Contractor shall promptly, without cost to the town and in accordance with the town's written instructions, either correct such defective Work, or, if it has been rejected by the town, remove it form the site and replace it with nondefective Work. If the Contractor does not promptly comply with the terms of such instructions, or in any emergency where delay could cause serious risk of loss or damage, the town may have the defective Work (such costs to include, but not be limited to, fees and charges of engineers, architects, attorneys and other professionals). If any such acceptance occurs prior to the Engineer's recommendation of final payment, a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and the town shall be entitled to an appropriate decrease in the Contract Price, and, if the parties are unable to agree as to the amount thereof, the town may make a claim therefor. If the acceptance occurs after such recommendation, an appropriate amount will be paid by the Contractor to the town.

22.9 Town May Correct Defective Work: If the contractor fails within a reasonable time, after written notice of the Engineer, to correct defective Work or to remove and replace rejected Work as required by the Engineer, or if the Contractor fails to perform the Work in accordance with the Contract Documents, or if the Contractor fails to comply with any other provisions of the Contract Documents, the town may, after seven (7) days written notice to the Contractor, correct and remedy any such deficiency. In exercising the rights and remedies under this paragraph, the town shall proceed expeditiously. To the extent necessary to complete corrective and remedial action, the town may exclude the Contractor from all or part of the site, take possession of all or part of the Work, and suspend the Contractor's services related thereto, take possession of the Contractor's tools, appliances, construction equipment and machinery at the site and incorporate in the Work all materials and equipment stored at the site or for which the town has paid the Contractor but which are stored elsewhere. The Contractor shall allow the town, the town's representatives, agents and employees such access to the site as may be necessary to enable the town to exercise the rights and remedies under this paragraph. All direct, indirect and consequential cost to the town in exercising such rights and remedies will be charged against the Contractor in an amount determined by the engineer, and a Change Order will be issued incorporating the necessary revisions in the Contract Documents with respect to the Work; and the town shall be entitled to an appropriate decrease in the Contract Price, and, if the parties are unable to agree as to the amount thereof, the town may make a claim therefor. Such direct, indirect and consequential costs will include but not be limited to fees and charges of engineers, architects, attorneys and other professionals, all court and arbitration costs and all costs of repair and replacement of work destroyed or damaged by correction, removal or replacement of the Contractor's defective Work. The Contractor shall not be allowed an extension of the Contract Time because of any delay in performance of the Work attributable to the exercise by the town of the town's rights and remedies hereunder.

23. CHANGES IN THE WORK:

23.1 Modifications and Alterations: The Contractor agrees that the town shall have the right to make modifications, changes and alterations in the arrangement or extent of the work, without affecting the validity of the Contract and the Bonds thereunder.

23.1.1 If the modification or alteration increases the amount of work to be done, and the added work or any part thereof is of a type and character which can be properly and fairly classified under one or more unit price items of the Proposal, then such added work or part thereof shall be paid for according to the amount actually done and at the applicable unit price or prices therefor. Otherwise, such work shall be paid for as herein provided under "Extra Work".

23.1.2 If the modification or alteration decreases the amount of work to be done, such decrease shall not constitute the basis for a claim for damages or anticipated profits on work affected by such decrease. Where the value of omitted work is not covered by applicable unit prices, the Engineer shall determine, on an equitable basis, the amount of :

(a) credit due the town for contract work not done as a result of an authorized change;

(b) allowance to the Contractor for any actual loss incurred in connection with the purchase, delivery and subsequent disposal of materials or equipment required for use on the Work as planned and which could not be used in any part of the work as actually built; and

(c) any other adjustment of the contract Price where the method to be used in making such adjustment is not clearly defined in the Contract Documents.

23.1.3 Except for minor changes or adjustments which involve no adjustment in the Contract Price or other monetary consideration, and with the exception of adjustments of estimated quantities for unit price work or materials to conform to actual pay quantities therefor as hereinafter provided under "Estimated Quantities", all changes and alterations in the terms or scope of the Contract shall be made under the authority of duly executed Change Orders issued and signed by the town and accepted and signed by the contractor.

23.2 Extra Work: The term "Extra Work", as used in this Contract, shall be understood to mean and include all work that may be required by the town to be done by the Contractor to accomplish any change or alteration in or addition to the Work shown by the Plans or reasonably implied by the Specifications and not covered by items, and which is not otherwise provided under "Modifications and Alterations".

23.2.1 It is agreed that the Contractor shall perform all extra work under the direction of the Engineer when and as so ordered in writing by the town. It is further agreed that the compensation to be paid the Contractor for performing extra work shall be determined by one or more of the following methods:

Method A: By agreed unit prices; or

Method B: By agreed lump sum; or

Method C: If neither Method A nor Method B can be agreed upon before the extra work is started, the Contractor shall be paid his actual field cost of the work plus fifteen percent (15%) for the work which he performs with his own forces and/or the Contractor shall be paid the subcontractor's actual field cost of the work plus twenty percent (20%) for work which is performed by his subcontractor or subcontractors.

23.2.2 Where extra work is performed under Method C, the actual field cost of such extra work is hereby defined to be and shall include:

(a) the payroll cost for all workmen, such as foremen, mechanics, craftsmen, laborers;

(b) the cost of all materials and supplies not furnished by the town;

(c) rental for all power-driven equipment at agreed-upon rates for the time actually employed or used in the performance of extra work;

(d) transportation charges necessarily incurred in connection with any equipment authorized by the Engineer for use on said extra work and which is not already on the job;

(e) all power, fuel, lubricants, water, and similar operating expenses;

(f) all incidental expenses incurred as a direct result of such extra work, including sales or use taxes on materials, payroll taxes, and the additional premiums for construction bonds, workmen's compensation, public liability and property damages, and other insurance required by the Contract where the premiums therefor are based on payroll and materials costs.

23.2.3 The Engineer may direct the form in which the actual field cost shall be kept, and may also specify in writing before the work commences, the method of doing the work and the type and kind of machinery and equipment, if required, which shall be used in the performance of extra work under Method C. If machinery or heavy construction equipment is required for extra work, the authorization and basis for the use thereof shall be stipulated in the written extra work order. The applicable "plus" percentage (15% or 20%) of the actual field cost to be allowed and paid to the Contractor shall constitute full compensation for profit, overhead, superintendence, field office expense, and all other elements of cost not embraced within the actual field cost as herein defined.

23.2.4 No claim for extra work of any kind will be allowed unless ordered in writing by the town prior to commencement of said extra work. In case any orders or instructions, either oral

or written, appear to the Contractor to involve extra work for which he should receive compensation, he shall make a written request to the town for a written order authorizing such extra work. Should a difference of opinion arise as to what does or does not constitute extra work, or concerning the payment thereof, and the Engineer insists on its performance, the Contractor shall proceed with the Work after making a written request for a written extra work order and shall keep an accurate account of the actual field cost thereof as provided for Method C in the foregoing paragraph.

23.3 Extra Work a Part of Contract: If extra work is performed in accordance with the provisions of this Contract, such extra work shall be considered a part hereof and subject to each and all terms and conditions of said Contract.

24. PAYMENTS TO CONTRACTOR AND COMPLETION:

24.1 Estimated Quantities: Any and all estimated quantities stipulated in the Proposal under unit price items are approximate and are to be used only:

(a) as a basis for estimating the probable cost of the Work, and

(b) for the purpose of comparing the proposals submitted for the Work.

It is understood and agreed that the actual amounts of work done and materials furnished under unit price items may differ from such estimated quantities and that the basis of payment for such work and materials shall be the actual amount of work done and materials furnished in each case. The Contractor agrees that he will make no claim for damages, anticipated profits, or otherwise on account of any difference between the amounts of work actually performed and materials actually furnished and the amounts estimated therefor in the Proposal or other Contract Documents.

24.2 Monthly Estimates and Payments: On or about the first day of each month, the Contractor will make an approximate estimate of the value of work done in conformity with the Plans and Specifications during the previous calendar month and of unused materials delivered for, and stored on the site of, the Work. The Contractor shall submit the estimate to the Engineer and furnish such detailed information as he may request to aid him in the review and recommendation for approval of monthly estimates. After each such estimate has been approved by the town (and any Federal or State funding agency), the town shall pay to the Contractor ninety percent (90%) of the amount of such estimated sum. For Contract amounts equal to or greater than $400,000, the town will either place the entire retainage in an interest bearing account, or reduce the amount of retainage to five percent (5%).

24.2.1 It shall be understood that payments made by the town for materials stored on the site shall be based only upon the actual cost of materials to the Contractor, and shall not include any overhead or profit to the Contractor.

24.2.2 Partial payment shall in general include only completed units or lump sum items. If the Contractor desires payment for partially completed lump sum items, he shall submit an

appropriate cost breakdown of such items prior to commencing Work on the Project. The Engineer will review the itemized breakdown and if he agrees with the breakdown, partial payments will be made accordingly. If the Engineer does not agree with the breakdown for any reason whatsoever, no partial payment will be make for such lump sum items.

24.3 Placing Work in Service: If desired by the town, portions of the Work may be placed in service when completed and the Contractor shall give proper access to the Work for this purpose; but such use and operation shall not constitute an acceptance of the Work, and the Contractor shall be liable for defects due to faulty construction until the entire Work under this Contract is finally accepted and for one year thereafter as stipulated under the Paragraphs hereinbefore which address defective work.

24.4 Completion and Acceptance of Work: On completion of the Work, the Engineer shall:

(a) satisfy himself, by examination and tests, that the Work has been fully and finally completed in accordance with the Plans, Specifications and Contract, and

(b) report such completion to the town Council.

24.4.1 Before final acceptance by the town of the Work, the Contractor shall submit to the town a notarized affidavit, in duplicate, stating under oath that all subcontractors, vendors and other persons or firms who have furnished or performed labor or furnished or performed labor or furnished materials for the Work have been fully paid or satisfactorily secured. Such affidavit shall bear or be accompanied by a statement, signed by the surety company who provided the Performance and Payment bonds for the Work, to the effect that said surety company consents to final payment to the Contractor being made by the town.

24.5 No Waiver of Rights: Neither the inspection by any of the town's officials, employees, or agents, nor any order by the town for payment of money, or any payment for, or acceptance of, the whole or any part of the Work by the town, nor any extension of time, nor any possession taken by the town or its employees, shall operate as a waiver of any provisions of this Contract, or of any power herein reserved to the town or any right to damages herein provided, nor shall any waiver of any breach in this Contract be held to be a waiver of any other or subsequent breach.

24.6 Final Estimate and Payment: After official approval and acceptance of the Work by the town the Contractor shall prepare a final estimate of the Work done under this Contract and the value thereof. Such final estimate shall be submitted to the town after its preparation has been approved and authorized as aforesaid; and the town shall, after said final estimate is made and certified, pay the entire sum so found to be due hereunder, after deducting all amounts to be kept and retained under any provision of this Contract. All prior estimates and payments shall be subject to correction in the final estimate and payment; but in the absence of error or manifest mistake, it is agreed that all estimates, when approved by the town, shall be conclusive evidence of the work done and materials furnished.

24.7 Release of Liability: The acceptance by the Contractor of the last payment shall operate as, and shall be, a release to the town and every officer and agent thereof, from all claims and liability hereunder for anything done or furnished for, or relating to the Work, or for any act or neglect of the town or of any person relating to or affecting the Work.

SUPPLEMENTARY CONDITIONS OF AGREEMENT

1. GENERAL DESCRIPTION OF WORK: The work to be performed under this Contract includes the furnishing of all supplies and appurtenances; providing all construction plant, equipment and tools; performing all work necessary for construction of various utility improvements in Fairview.

2. CONTRACT SPECIFICATIONS: The Specifications which are bound herewith and which shall govern the materials furnished and the work to be performed in the construction of the work under this Contract and based thereon, are identified and indexed in the Table of Contents at the beginning of this volume of the Contract Documents.

3. COPIES OF SPECIFICATIONS: The Contractor will be furnished, without cost to him, five (5) copies of all Specifications enumerated in the foregoing paragraphs 2 and 3, together with any and all addenda thereto. The Contractor shall keep one copy of all such Specifications constantly accessible on the work site.

4. LIQUIDATED DAMAGES: Should the Contractor fail to complete the work within the required annual contract time, or within such extra time as may have been allowed by extension, the Town will deduct from any moneys due or coming due the Contractor, the sum of Three Hundred Dollars ($300.00) for each calendar day that the work shall remain uncompleted. This sum shall be considered and treated not as a penalty but as fixed, agreed and liquidated damages due the Town from the Contractor for reasons of inconvenience to the public, added cost of engineering, administration, supervision, inspection and other items which have caused an expenditure of public funds resulting from his failure to complete the work within the time specified in the Contract.

6. INSURANCE: The Contractor shall provide Certificates of Insurance in accordance with Paragraph 21.2 of the GENERAL CONDITIONS. Insurance coverage shall be in the amounts specified below:

6.1 Workmen's Compensation

A. Definitions:

Certificate of cover ("certificate"). A copy of a certificate of insurance, a certificate of authority to self insure issued by the commission, or a coverage agreement (TWCC - 81, TWCC - 82, TWCC -83, or TWCC - 84), showing statutory workers' compensation insurance coverage for the person's or entity's employees providing services on a project, for the duration of the project.

Duration of the project - includes the time from the beginning of the work on the project until the contractor's/person's work on the project has been completed and accepted by Town.

Persons providing services on the project ("subcontractor" in Texas Labor Code § 406.096) - includes all persons or entities performing all or part of the services the contractor has undertaken to perform on the project, regardless of whether that person contracted directly with contractor and regardless of whether that person has employees. This includes, without limitation, independent contractors, subcontractors, leasing companies, motor carriers, owner-operators, employees of any such entity, or employees of any entity which furnishes persons to provide services on the project. "Services" include, without limitation, providing, hauling, or delivering equipment or materials, or providing labor, transportation, or other services related to a project. "Services" does not included activities unrelated to the project, such as food/beverage vendors, office supply deliveries, and delivery of portable toilets.

B. The Contractor shall provide coverage, based on proper reporting of classification codes and payroll amounts and filing of any coverage agreements, which meets the statutory requirements of Texas Labor Code, Section 401.011 (44) for all employees of the contractor providing services on the project, for the duration of the project.

C. The Contractor must provide a certificate of coverage to the Town prior to being awarded the Contract.

D. If the coverage period shown on the Contractor's current certificate of coverage ends during the duration of the project, the Contractor must, prior to the end of the coverage period, file a new certificate of coverage with the Town showing that coverage has been extended.

E. The contractor shall obtain from each person providing a service on a project, and provide to the Town:

(1) a certificate of coverage, prior to that person beginning work on the project, so the Town will have on file certificates of coverage showing coverage for all persons providing services on the project; and

(2) no later than seven days after receipt by the Contractor, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the project.

F. The Contractor shall retain all required certificates of coverage for the duration of the project and for one year thereafter.

G. The Contractor shall notify the Town in writing by certified mail or personal delivery, within 10 days after the Contractor knew or should have known, of any changes that materially affects the provision of coverage of any person providing services on the project.

H. The Contractor shall post on each project site a notice, in the text form and manner prescribed by the Texas Workers' Compensation Commission, informing all persons providing services on the project that they are required to be covered and stating how a person may verify coverage and report lack of coverage.

I. The Contractor shall contractually require each person with whom it contracts to provide services on a project, to:

(1) provide coverage, based on proper reporting of classification codes, and payroll amounts and filing of any coverage agreements, which meets the statutory requirements of Texas Labor Code, Section 401.011 (44) for all of its employees providing services on the project, for the duration of the project;
(2) provide to the Contractor, prior to that person beginning work on the project, a certificate of coverage showing that coverage is being provided for all employees of the person providing services on the project, for the duration of the project;

(3) provide the Contractor, prior to the end of the coverage period, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the project;

(4) obtain from each other person with whom it contracts, and provide to the Contractor:

(a.) a certificate of coverage, prior to the other person beginning work on the project; and

(b.) a new certificate of coverage showing extension of coverage, prior to the end of the coverage period if the coverage period shown on the current certificate of coverage ends during the duration of the project;

(5) retain all required certificates of coverage on file for the duration of the project and for one year thereafter;

(6) notify the Town entity in writing by certified mail or personal delivery, within 10 days after the person knew or should have known, of any change that materially affects the provision of coverage of any person providing services on the project; and

(7) contractually require each person with whom it contracts, to perform as required by paragraphs (1) - (7), with the certificate of coverage to be provided to the person for whom they are providing services.

J. By signing this contract or providing or causing to be provided a certificate of coverage, the Contractor is representing to the Town that all employees of the

Contractor who will provide services on the project will be covered by workers' compensation coverage for the duration of the project, that the coverage will be based on proper reporting of classification codes and payroll amounts, and that all coverage agreement will be filed with the appropriate insurance carrier or, in the case of a self-insured, with the commission's Division of Self-Insurance regulation. Providing false or misleading information may subject the Contractor to administrative penalties, criminal penalties, civil penalties, or other civil actions.

K. The Contractor's failure to comply with any of these provisions is a breach of Contract by the Contractor which entitles the Town to declare the contract void if the Contractor does not remedy the breach within ten days after receipt of notice of breach from the Town.

L. A Contractor Shall:

(1) provide coverage for its employees providing services on a project, for the duration of the project based on proper reporting of classification codes and payroll amounts and filing of any coverage agreements;

(2) provide a certificate of coverage showing workers' compensation coverage to the Town prior to beginning work on the project;

(3) provide the Town, prior to the end of the coverage period, a new certificate of coverage showing extension of coverage, if the coverage period shown on the Contractor's current certificate of coverage ends during the duration of the project;

(4) obtain from each person providing services on a project, and provide to the Town:

(a) a certificate of coverage, prior to that person beginning work on the project, so the Town will have on file certificates of coverage showing coverage for all person providing services on the project; and

(b) no later than seven days after receipt by the Contractor, a new certificate of coverage showing extension of coverage, if the coverage ends during the duration of the project;

(5) retain all required certificates of coverage on file for the duration of the project and for one year thereafter;

(6) notify the Town in writing by certified mail or personal delivery, within 10 days after the Contractor knew or should have known, of any change

that materially affects the provision of coverage of any person providing serviced on the project;

(7) post a notice on each project site informing all persons providing services on the project that they are required to be covered, and stating how a person may verify current coverage and report failure to provide coverage. This notice does not satisfy other posting requirements imposed by the Act or other commission rules. This notice must be printed with a title in at least 30 point bold type and text in at least 19 point normal type, and shall be in both English and Spanish and any other language common to the worker population. The text for the notices shall be the following text in Figure 2 provided by the commission on the sample notice, without any additional works or changes:

REQUIRED WORKERS' COMPENSATION COVERAGE

"The law requires that each person working on this site or providing services related to this construction project must be covered by workers' compensation insurance. This includes persons providing, hauling, or delivering equipment or materials, or providing labor or transportation or other service related to the project, regardless of the identity of their employer or status as an employee "
"Call the Texas Workers' Compensation Commission at 512-440-3789 to receive information on the legal requirement for coverage, to verify whether your employer has provided the required coverage, or to report an employer's failure to provide coverage"

(8) contractually require each person with whom it contracts to provide services on a project, to:

(a) provide coverage based on proper reporting of classification codes and payroll amounts and filing of any coverage agreements for all of its employees providing services on the project, for the duration of the project.

(b) provide a certificate of coverage to the Contractor prior to that person beginning work on the project;

(c) include in all Contracts to provide services on the project the language in subsection (e) (3) of this rule;

(d) provide the contractor, prior to the end of the coverage period, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the project;

(e) obtain from each other person with whom it contracts, and provide to the contractor:

(i) a certificate of coverage, prior to the other person beginning work on the project; and

(ii) prior to the end of the coverage showing extension of the coverage period, if the coverage period shown on the current certificate of coverage ends during the duration of the project;

(f) retain all required certificates of coverage on file for the duration of the project and for one year thereafter;

(g) notify the governmental entity in writing by certified mail or personal delivery, within 10 days after the person knew or should have known, of any change that materially affects the provision of coverage of any person providing services on the project; and

((h) contractually require each other person with whom it contracts, to perform as required by paragraphs (a) - (h), with the certificate of coverage to be provided to the person for whom they are providing services.

6.2 Employer's Liability Insurance: Liability limits for this insurance shall be not less than the following:

Employer's Liability	$1,000,000 each person

6.3 Bodily Injury and Property Damage Insurance: Liability limits for general liability insurance coverage under this policy shall be not less than the following:

Bodily	$1,000,000 each person $1,000,000 each accident
Property Damage	$1,000,000 each accident $1,000,000 aggregate

6.4 Comprehensive Automobile Liability Insurance: Liability limits for automobile liability insurance coverage under this policy shall be not less than the following:

Bodily	$1,000,000 each person $1,000,000 each person
Property Damage	$1,000,000 each accident

7. LICENSES, PERMITS AND CERTIFICATES: All licenses, permits, certificates, etc., required for and in connection with the work to be performed under the provisions of these Contract Documents shall be secured by the Contractor entirely at his own expense except for any permits required for work to be performed within State Rights-of-Way. These permits will be obtained by the Town from the Texas Department of Transportation.

8. WATER: All water required for and in connection with the work to be performed may be obtained from the Town at no expense. The Town will provide a meter for measuring any water obtained from the Town for execution of the work. Upon completion of the work, the Contractor shall remove all of his temporary service installations. The Contractor shall inform the Utility Superintendent prior to taking water.

9. POWER: All power for lighting, operation of Contractor's plant or equipment, or for any other use as may be required in the execution of the work to be performed under the provision of these Contract Documents shall be provided by the Contractor at his expense.

10. RIGHT-OF-WAY: The Contractor shall confine his construction operations to the street right-of-way as shown on the Plans, and shall use due care in placing construction tools, equipment, excavated materials, pipe materials and supplies, so as to cause the least possible damage to property and interference with traffic. The placing of such tools, equipment and materials shall be subject to the approval of the Engineer.

Where space within the right-of-way is not available for construction plant, the Contractor shall provide, at his own expense, any working area he requires, shall construct and maintain any roadway or other facilities required for this purpose and the cost thereof shall be included in the prices bid for the various items in the Proposal.

11. DAMAGE TO EXISTING STRUCTURES, MATERIALS OR EQUIPMENT: The Contractor will be held responsible for any damage to existing structures, work, materials or equipment because of his operations and shall repair or replace any such damaged structures, work, materials or equipment to the satisfaction of the Town Engineer at no additional cost to the Town.

12. PROTECTION AND MAINTENANCE OF PUBLIC AND PRIVATE PROPERTY: The Contractor shall protect, shore, brace, support and maintain all underground construction uncovered or otherwise affected by the construction work performed by him. All surfacing, driveways, curbs, walks, buildings, utility poles, guy wires, and other surface structures affected by construction operations in connection with the performance of the Contract, together with all sod and shrubs in areas crossed by or adjacent to the right-of-way, shall be maintained and, if removed or otherwise damaged, shall be restored to the original condition thereof as determined and approved by the Town Engineer. All replacements of such underground construction and surface structures or parts thereof shall be made with new materials conforming to the requirements of these Specifications or, if not specified, as approved by the Engineer. The Contractor shall be responsible for all damage to roads, railroads, shoulders, ditches, embankments, culverts, bridges, or other public or private property or facilities, regardless of location or character, which may be caused by moving, hauling, or otherwise transporting equipment, materials or men to or from the work or any part of site thereof, whether by him or his subcontractor or subcontractors. The Contractor shall make satisfactory and acceptable

arrangements with the Town, or with the agency or authority having jurisdiction over, the damaged property or facility concerning its repair or replacement or payment of costs incurred in connection with said damage.

13. RESPONSIBILITY OF CONTRACTOR FOR EMBANKMENT AND BACKFILL SETTLEMENT: The Contractor shall be responsible, financially and otherwise, for (a) any and all settlement of trench and other backfill and embankment which may occur from the time of original placement until the expiration of a period of one year from and after the date of final acceptance of the entire Contract under which the backfilling or embankment work was performed, (b) the refilling and repair of all backfill settlement and the repair or replacement to the original or a better condition of all tracks, pavement, top surfacings, driveways, walks, surface structures, utilities, drainage facilities, sod and shrubbery which have been damaged as a result of said settlement or which have been removed or destroyed in connection with replacement operations, and (c) any and all damage claims filed with or court actions brought against the Town for and on account of any damage or damages directly or indirectly caused by said settlement. The Contractor shall make or cause to be made, all necessary backfill or embankment replacements, and repairs or replacements appurtenant thereto, within thirty (30) days from and after due notification by the Town of settlement and resulting damage at any designated locations.

14. GUARANTY: The Contractor shall insure and guarantee the satisfactory operation of all the installation, the workmanship and restoration of the project area, including backfilll settlement. The project shall be guaranteed to be complete and to function correctly for a period of one year from the date of its acceptance and the Contractor hereby agrees to repair or replace any defective items occurring within that year, free of expense to the Town.

15. BARRICADES AND LIGHTS: All open trench and other excavations shall be provided with suitable barriers, signs, and lights to the extent that adequate protection is provided to the public against accident by reason of such open construction. Obstructions, such as material piles and equipment, shall be provided with similar warning signs and lights.

16. DIVISION OF WORK: Items for this contract shall be bid as either lump sum or unit price as shown on the summary of quantities in the Proposal. Whenever two or more items abut each other, the division of work shall be as defined in the Specifications and as shown on the Plans. If the Specifications do not define the division of work, the Contractor shall make such divisions at his own discretion. It is the intent of these Specifications that the completion of all bid items shall result in the completion of all work shown on the Plans.

17. MANUFACTURER'S RECOMMENDATION: When an item of work is stated to be in accordance with or conform to manufacturer's recommendations, that item shall be submitted to the Engineer in writing for approval and shall be done in accordance with the approved method.

18. QUALITY ASSURANCE: When manufacturer's names are specified herein, they are used to establish a specific minimum requirement for materials used in construction, performance, and dimensional compatibility. The naming of one manufacture is not intended to show preference, eliminate competition or prohibit other manufacturers from offering equipment conforming to the

requirements of the Contract Documents. The use of "or equal" items shall be done in accordance with Paragraph 18.8 of the GENERAL CONDITIONS.

19. PRE-CONSTRUCTION CONFERENCE: As stated in Paragraph 10 of the GENERAL CONDITIONS, a pre-construction conference will be set to discuss scheduling and coordination of the work under this Contract.

20. EXISTING UTILITIES: Certain pipe lines, sewers, culverts, drains, cables, and other existing subsurface structures in the vicinity of the work to be done are indicated on the Plans according to the best information available to the Town. However, the town does not guarantee the accuracy of the information. Any delay to the Contractor due to encountering pipe lines or structures shall not constitute a claim for payment or an extension of time. The Contractor shall be responsible for contacting the utility companies and arranging for an on-site inspection so that the company representatives may locate all facilities endangered by construction:

The Contractor shall be responsible for protecting such existing utilities and for repairs to such facilities in case of damage to same. Should there be relocations or adjustments of utilities necessary to accommodate construction activities, the Contractor shall cooperate with the Company(s) involved and will coordinate such relocations with the schedule of work herein.

21. PARTIAL USE OF IMPROVEMENTS: The Town, at its election, may give notice to the Contractor and place in use those sections of the improvements which have been completed, inspected and can be accepted as complying with the Technical Specifications, and if in its opinion, each such section is reasonably safe, fit and convenient, for the use and accommodation for which it was intended, provided:

a. The use of such sections of the Improvements shall in no way impede the completion of the remainder of the work by the Contractor.

b. The Contractor shall not be responsible for any damages or maintenance costs due directly to the use of such sections.

c. The use of such sections shall in no way relieve the Contractor of his liability due to having used defective materials or poor workmanship.

d. The period of guarantee stipulated in the Paragraph "Guaranty" of this Section, shall not begin to run until the date of the final acceptance of all work which the Contractor is required to construct under this Contract.

22. PROTECTION OF TREES AND SHRUBBERY: No trees shall be removed on the right-of-way except where their removal is authorized in writing by the Engineer.

Main tree roots shall not be cut except where they fall within the area to be occupied by the improvements. Excavation shall be done by and where necessary to prevent injury to roots or protected from permanent damage by reason of construction operations. Trimming of standing trees where required shall be as directed by the Engineer. All shrubbery outside of the right-of-way

which is damaged or removed by the Contractor shall be replaced under the directions of and to the satisfaction of the Town Engineer and property owner, by and at the expense of the Contractor.

23. REMOVAL AND REINSTALLATION OF ITEMS: Street signs, street stop signs, mail boxes and other existing items found within construction limits shall without damage be removed, stored and reinstalled in a condition comparable to pre-existing condition. Unless approved by the town, no extra pay shall be given if existing items are damaged by the Contractor and have to be replaced.

24. MAINTENANCE OF LOCAL TRAFFIC: The Contractor shall notify the Town Engineer at least 72 hours in advance of closure to provide ample time for notifying the public and providing detours. When notice of intended closure is given, the Contractor shall give the Town Engineer an estimate of the period of time that closure of the street will be necessary. Detour signs shall be installed at the locations shown on the Plans.

25. DUST CONTROL: Adequate precaution should be taken to insure excessive dust does not become airborne during construction. No separate payment will be made for performing dust control or for the water used for this purpose. The cost of these items shall be subsidiary to other items.

26. JOB SITE CONDITION: During the construction of the work, the Contractor shall, at all times, keep the site of the work and adjacent premises as free from material, debris, and rubbish as is practicable and shall remove same from any portion of the site, if in the opinion of the Town Engineer, such material, debris, or rubbish constitutes a nuisance or is objectionable.

The Contractor shall remove from the site all of his surplus materials and temporary structures when no further need thereof develops.

27. DISPOSAL OF WASTE: All trees, stumps, existing surface, waste concrete and reinforcing and other debris, which result from the Contractor's excavation and operations, shall be removed from the property. All waste or excess earth shall be either removed from the site or neatly spread on the job site in a manner satisfactory to the Town Engineer. The disposal site for all such waste shall be the responsibility of the Contractor unless otherwise instructed by the Town Engineer.

28. FAILURE OF MATERIALS TO MEET TESTING REQUIREMENTS: Should any materials test specified herein fail to meet the minimum requirements specified, the Contractor shall furnish additional testing, by an independent laboratory approved by the Town Engineer, as necessary to satisfy the Town Engineer that the failed condition or material has been corrected.

29. CONSTRUCTION SEQUENCE: The Contractor shall submit to the Engineer for approval his proposed sequence of construction. The Construction Sequence shall be approved by the Engineer prior to starting the work, and shall be in accordance with the above sequence for placement of new facilities into service.

30. RESIDENT PROJECT REPRESENTATIVE: The Town intends to have a Project Inspector to inspect the Work. All pipe bedding will be inspected prior to backfilling, and any

backfill over pipe not inspected shall be removed for inspection. The Project Inspector will observe the construction activities and note its conformance with the Plans and Specifications as well as the progress of the Work. The Inspector will notify the Contractor and Engineer of any discrepancies. He shall not authorize any deviations from the Contract Documents or interrupt the Contractor's progression of the Work without specific instructions from the Engineer.

31. STATE AND TOWN SALES TAX: The CONTRACTOR'S attention is directed to Texas House Bill 11 (72nd Legislature, 1st C.S.) which amended the Texas Tax Code Section 151.311 This amendment provides that by the CONTRACTOR entering into a separated contract, the CONTRACTOR will become a seller of materials purchased for the project, which will obviate paying taxes on materials incorporated into the project.
As a seller, the CONTRACTOR purchases materials and issues a resale certificate in lieu of paying the sales tax at the time of purchase. The Town, as an exempt entity, will at the time of the "sale" of the materials to the Town, thereby preclude the Town, and CONTRACTOR, from paying the sales tax on the materials. Execution of the Contract Agreement by the Town shall serve as the CONTRACTOR'S authorization to issue a resale certificate.
Services are not tax exempt. The CONTRACTOR will be required to pay all appropriate taxes for all services as set forth herein.

For purposes of these Contract Documents, the following definitions are provided for Materials and Services:

> Materials: Materials are those items which are tax exempt and are items physically incorporated into the facility constructed for the Town. Materials include, but are not limited to, purchased items such as pipe, embedment, the storage tank, concrete, manhole rings and covers and barrel sections, riprap, asphalt, roadbase and subbase, etc.
>
> Services: Services are those items that are not tax exempt and are items used by the CONTRACTOR but which are not physically incorporated into the Town's facility and/or are items which are consumed by construction. Services include, but are not limited to, items such as supplies, tools, concrete forms, scaffolding, temporary storage buildings, the purchase or rental or lease of equipment, skill and labor, etc.

For further information concerning taxes as they relate to materials and services, the CONTRACTOR shall refer to House Bill 11 and/or contact the Texas Comptroller of Public Accounts, Austin, Texas at (800) 252-5555.

32. WAGE RATES: The Contractor and any subcontractors shall pay not less than the current prevailing wage rates for the Fairview area to all laborers, workmen and mechanics employed by them in the execution of this Contract. The Town will not provide wage rates for this project and will not require submission of documentation of wages.

33. CONSTRUCTION STAKING: The Engineer has established a base line on the project, which is shown on the plans. Immediately prior to beginning of construction, the Town's Surveyor shall traverse the project with the Contractor to determine location of control points and bench marks. The Surveyor shall replace any of these controls and bench marks which may have been

disturbed. By using these control points and bench marks the Contractor shall provide all additional construction staking to establish proper line and grade for this project. It shall be the Contractor's responsibility to set any offset control points and bench marks deemed desirable such that, when construction activities disturb the base line, there will remain adequate horizontal and vertical control.

During this offset control staking procedure, the Contractor shall keep the Engineer informed regarding the controls being set. The Engineer may require additional control points if, in his opinion, those being set by the Contractor are not adequate to properly establish line and grade.

DIVISION 500 UNDERGROUND CONSTRUCTION & APPURTENANCES

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ITEM 501. UNDERGROUND CONDUIT MATERIALS

501.1. GENERAL

All pipe and fittings shall be new.

The OWNER shall at all times have free access to the manufacturer's plant while production in progress, and may at any time refuse to accept pipe made when the plant is failing to follow the stipulations of the specifications in regard to workmanship, or failing in provisions to insure a uniform product coming within the permissible variations of the specifications. The OWNER may reject pipe if adequate means and methods are not provided so as to insure the manufacture of a product of uniform high quality.

Pipe shall be color coded according to the American Public Works Association Uniform Color Code (i.e. blue for water, green for wastewater or storm drain lines, violet for reclaimed water, etc.) or labeled with labeling tape identifying its specific use. Where feasible, permanent identification of the piping service shall be provided by co-extruding color stripes into the pipe outside surface. The striping shall be of the same material except for the color. For co-extruded markings, IPS sized pipe shall have four equally spaced, longitudinal color stripes and DIPS sized pipe shall have three equally spaced pairs of longitudinal color stripes. The color or marking shall be visible on top of buried pipe when pipe is excavated.

Pipe shall be acceptable by the Underwriters' Laboratories, Inc. or Factory Mutual Research when specifically requested and shall be acceptable by the State Fire Insurance Commission for use in water distribution systems when used for fire protection without penalty. Potable water pipe shall also bear the seal of approval (or "NSF" mark) of the National Sanitation Foundation Testing Laboratory for potable water pipe.

Installation shall be performed in accordance with relevant portions of Division 500 Underground Conduit Construction and Appurtenances.

501.1.1. Rejection. Pipe, joints, fittings, or coatings may be rejected for failure to meet any of the requirements of this specification or for any manufacturing, transportation and/or handling defects that may cause pipe, joints, fittings or coatings to be unsuitable for intended use(s). When approved by the OWNER, materials may be re-tested to establish conformity. All rejected materials shall be plainly marked by the Engineer and shall be replaced by the CONTRACTOR with materials which meets the requirements of these specifications. Such rejected materials shall be removed immediately from the site of the work.

501.2. CLAY WASTEWATER PIPE

501.2.1. General. Clay wastewater pipe shall conform to ASTM C700 Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated, having compression joints and bell and spigot ends or compression couplings for plain-end pipe.

501.2.2. Class. Extra strength vitrified clay wastewater pipe shall be used unless otherwise designated.

501.2.3. Fittings. Fittings shall be of the same test strength as the pipe as ordered or shown on plans.

501.2.4. Joints. Factory-fabricated compression joints and joints for fittings shall meet the requirements of ASTM C425 Compression Joints for Vitrified Clay Pipe and Fittings.

501.2.5. Pipe Tests. Tests of the pipe shall be made in accordance with ASTM C301 Test Methods for Vitrified Clay Pipe.

501.3. VITRIFIED CLAY PIPE FOR MICROTUNNELING, SLIPLINING, PIPE BURSTING, AND TUNNELS

501.3.1. General. Clay pipe for microtunneling, sliplining, pipe bursting, and tunnels shall conform to ASTM C1208 (C1208M) Vitrified Clay Pipe and Joints for Use in Microtunneling, Sliplining, Pipe Bursting, and Tunnels. The pipe shall have a minimum compressive strength of 7000-psi (492-kg/cm^2). The pipe joint collar shall be manufactured of Series 316 stainless steel or better.

501.3.2. Pipe Tests. Tests of the pipe shall be made in accordance with ASTM C1208 (C1208M).

501.4. CONCRETE PRESSURE PIPE AND FITTINGS

501.4.1. General. These specifications cover the manufacture of concrete pressure pipe designed for internal pressures from a minimum of 20-psi (1.4-kg/cm^2) to a maximum of 350-psi (24.6-kg/cm^2). Products shall conform to relevant standards as noted in Table 501.4.1. Standards for Concrete Pressure Pipe and Fittings.

Table 501.4.1. Standards for Concrete Pressure Pipe and Fittings

Item Reference No.	AWWA Standard	Description
501.4.5	C301	Prestressed Concrete Pressure Pipe, Steel-Cylinder Type
	C304	Design of Prestressed Concrete Cylinder Pipe
501.4.6	C303	Bar-Wrapped Concrete Cylinder Pipe

Items 501.4.2. through 501.4.4., inclusive, shall apply to each type of pipe in Item 501.4 Concrete Pressure Pipe and Fittings.

The type of pipe to be supplied shall be as shown on the plan and/or in the special provisions for each project.

The manufacturer shall submit a successful experience record in the design and construction of the type of concrete pressure pipe involved. Each type of pipe shall have the complete approval of the Underwriters' Laboratories, Inc., for the manufacture of the pipe specified and diameters required. Pipe shall have NSF61 standard approval for potable water applications.

Upon award of the Contract, the CONTRACTOR shall furnish OWNER with shop drawings showing the pipe and fittings to be furnished and shall include a tabulated layout schedule with reference to the stationing of the contract drawings with plan and profile drawings. Such drawings shall be subject to the approval of the OWNER and fabrication of pipe and fittings shall not be commenced until such drawings have been approved by the OWNER. Such approval by the OWNER shall not relieve the CONTRACTOR of any responsibility of providing pipe and/or fittings in accordance with the OWNER'S plans and specifications.

No cracks will be permitted in the lining of the pipe, except for minor hairline cracks. Cracks in the vicinity of the spigot of prestressed pipe and those cracks in the vicinity of the circumferential wrappers and outlets shall not be allowed, unless after inspection it is determined that they do not interfere with the performance of the pipe and they are accepted by the manufacturer so as to not void the warranty.

501.4.2. Fittings and Specials. The manufacturer shall furnish all fittings and special pieces required for closures, bends, branches, manholes, air valves, blowoffs and connections to mainline valves and other fittings shown on the contract drawings or as set out in the specifications conforming with AWWA C301, AWWA C303, or AWWA C304 as applicable. All openings in the pipe for fittings, manholes, taps, blowoffs, etc. shall have the interior and exterior surfaces of the steel lined and coated with mortar. The lining thickness shall be a minimum of 0.5-inches (12.5mm) for sizes 16-in. (400mm) and smaller, and 0.75-in. (19mm) minimum lining thickness for sizes larger than 16-in. (400mm). The minimum coating thickness shall be 1-in. (25mm). The type of fittings and details covering the design of fittings and specials shall be furnished by the manufacturer and subject to the approval of the OWNER. The fittings and specials shall comply in all respects with the requirements of AWWA with modifications as herein set forth.

501.4.3. Flanged Outlets. Flanged outlets shall be insulated at all points where external valves, pipe, fittings, etc., are connected to the line. The CONTRACTOR shall furnish an insulating flange kit, flange gaskets, insulating sleeves, and two plastic washers for each bolt approved by the OWNER. Bolts, nuts, and washers for flanged outlet connections shall be carbon steel.

501.4.4. Tests. All pipe shall be tested in accordance with applicable specifications and AWWA Standards. In addition to certification of all applicable tests required by governing AWWA Standards, the following tests or certifications of tests may be required.

501.4.4.1. Steel Cylinder Pipe. The manufacturer shall submit for approval the specified details of materials and methods of welding it proposes to use before any welding is done.

The manufacturer shall furnish one specimen for tensile tests of welds from each 3,000-ft. (900m) of pipe. If tests indicate the welding is unsatisfactory, additional samples as required shall be furnished. Two test cylinders out of each day's pour of the concrete used, or as required by the OWNER, shall be furnished for testing by an independent laboratory. The cost of such a test shall be borne by the OWNER. Certified test reports made by the manufacturer shall be acceptable in lieu of the test cylinders, provided such test certificates show that they cover pours from which the purchased pipe is made.

Mill test reports on each heat from which steel cylinders and reinforcing are rolled shall be furnished by the OWNER, if required.

Test certificates showing the physical properties of the compound used in the gaskets shall be furnished by the OWNER, if required.

501.4.4.2. Three-Edge Bearing Test. The manufacturer of concrete cylinder pipe supplied in accordance with the provisions of Item 501.4. Concrete Pressure Pipe and Fittings shall have demonstrated, or

shall demonstrate as may be required, that the pipe when tested in a three-edge bearing test as described in ASTM C497 (C497M) Concrete Pipe, Sections or Tile under a load equivalent to the design ditch load shall not deflect more than 0.1-percent. At the above specified load, there shall be no continuous cracks wider than 0.002-in. (0.7mm) for a length of 12-in. (30mm).

501.4.4.3. Concrete Cylinder Fittings. Hydrostatic testing of fittings is not required unless specifically called for in the Project Specifications.

501.4.5. Prestressed Concrete Cylinder Pipe, AWWA C301.

501.4.5.1. General. The pipe shall comply in all respects with the requirements of AWWA C301 Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids. The pipe may be of two types of prestressed concrete steel cylinder pipe as specified on the plans and/or specifications or special conditions:

(1) the lined cylinder type with a core composed of a steel cylinder lined with concrete and subsequently wire-wrapped directly on the steel cylinder and coated with the mortar.
(2) the embedded cylinder type with a core composed of a steel cylinder encased in concrete and subsequently wire-wrapped on the exterior concrete surface and coated with concrete or mortar.

501.4.5.2. Design Pressures and Stresses. Design pressure shall be that shown on plans and/or specifications. The size of the high-tensile wire and the spacing and tension under which it is wound shall be such that the conditions required by AWWA C304 Design of Prestressed Concrete Cylinder Pipe are met.

501.4.6. Bar-Wrapped Concrete Cylinder Pipe, AWWA C303.

501.4.6.1. General. The pipe shall consist of a welded sheet-steel or plate-steel cylinder, manufactured by the spiral or straight seam method with joint rings attached, inside of which a cement mortar lining is centrifugally spun; a mild steel bar spirally wrapped under measured tension on the steel cylinder and protective cement mortar coating applied to the outside of the cylinder and spirally-wrapped rod.

The manufacturer shall furnish pipe in uniform lengths except lengths ordered as specials.

The pipe shall comply in all respects with the requirements of AWWA C303, with the following addition.

501.4.6.2. Design Pressures and Stresses. Design pressure shall be that shown on the plans and/or specifications. Steel cylinder and bar reinforcement shall be designed in accordance with AWWA Manual M9, Concrete Pressure Pipe.

501.5. REINFORCED CONCRETE WASTEWATER PIPE WITH RUBBER GASKET JOINTS

501.5.1. General. Except as applicable to Item 501.5.1.1. Alternate Concrete Pipe D-Load Design, reinforced concrete pipe manufactured under these specifications shall conform to ASTM C76 (C76M) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe; or ASTM C655 (C655M) Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe, with the following additions:

(1) all pipe shall be machine made by a process which shall provide for uniform placement of zero slump concrete in the form and compaction by mechanical devices which shall assure a dense concrete in the finished product.
(2) aggregates for the concrete shall comply with requirements ASTM C33 Concrete Aggregates, with the additional requirement that the aggregate shall have a minimum of 50-percent of calcium carbonate equivalent.
(3) minimum wall thicknesses shall be as listed under Wall "B."
(4) minimum laying length of each joint shall be 6.00-ft. (1.8m) for sizes up to and including 15-in. (380mm) and 7-ft.+7-in. (2.3m) for sizes larger than 15-in. (380mm) except for bends, wyes and other special fittings which may be required, or for special radius pipe.
(5) pipe furnished under this specification shall be steam cured in accordance with methods prescribed in ASTM C76 (C76M) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe except that the steam curing time shall be not less than eight-continuous-hours. Pipe may be transported to the job three-days after the prescribed steam curing period, provided it successfully meets all physical load test requirements.
(6) the pipe and connecting joints shall be subject to the hydrostatic tests set forth in ASTM C443 (C443M) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets, both for pipes in straight alignment and for pipes in maximum deflected position without leakage either in the pipe or in the joints.
(7) all wastewater pipe shall be thick-walled or lined as approved by the OWNER.

501.5.1.1. Alternate Concrete Pipe D-Load Design. When bedding is specified in accordance with Item 504.5.2.16. Alternate Embedment for Concrete Pipe, reinforced concrete pipe shall conform to ASTM C1417 (C1417M) Manufacture of Reinforced Concrete Sewer, Storm Drain, and Culvert Pipe for Direct Design. This specification covers the manufacture and acceptance of precast concrete pipe designed to conform to the

OWNER's design requirements and to ASCE 15-93, ASTM C655 (C655M) Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe, or an equivalent design specification. Conditions 501.5.1.(1) through (6) apply to pipe provided under this specification and appropriate corrosion protection shall be furnished for pipe used in wastewater applications.

501.5.2. Thick Wall Pipe. The basic physical dimensional design for thick wall pipe shall be identical to the next larger 3-in. (75mm) increment standard pipe size covered by these specifications, reduced internally to the inside diameter as specified on the plans. The reinforcing steel shall be as listed in the tables for the next larger 3-in. (75mm) increment internal diameter unless a special design is submitted under Section 10 of ASTM C76 (C76M) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe, or under ASTM C655 (C655M) Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe. Proof of design must be submitted. The steel shall be placed as required for the next larger size to provide an additional sacrificial lining of 1.5-in. (38mm) of concrete cover over the reinforcing steel.

501.5.3. Steel Reinforcement. All steel reinforcement shall be in accordance with ASTM C76 (C76M) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe and shall be circular in shape. No elliptical reinforcement shall be permitted. Where Class III pipe of sizes larger than 30-in. (750mm) in diameter are specified, the manufacturer may, at its option, furnish pipe manufactured with either Wall "B" or Wall "C" minimum thicknesses, and the applicable minimum steel area as listed for circular cages in Table II of ASTM C76 may be substituted, at the manufacturer's option, for those listed in Table III of ASTM C76, provided test strength requirements for Class III pipe are satisfactorily met.

Where Class IV or V pipe is specified, the steel as called for in the wall as designated shall be furnished. Quadrant reinforcement shall be acceptable. As an alternate the pipe may be designed as detailed in ASTM C655 (C655M) Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe. Proof of design must be submitted.

501.5.4. Joints. Connecting joints shall be made using a flexible watertight rubber-type compression gasket. The rubber gasket shall be the sole element of the joint depended upon to provide watertightness.

501.5.4.1. Rubber Gaskets. All rubber-type gaskets shall be of the round O-ring design. The rubber gasket shall be required to meet and be tested in accordance with ASTM C443 (C443M) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

The gaskets shall be the product of a manufacturer having a successful experience record of at least five-years in the manufacture of rubber gaskets for concrete pipe joints.

501.5.4.2. Joint Design. The joint design shall consist of a bell or groove on one end of a unit of pipe, and a spigot or tongue on the adjacent end of the joining pipe. The taper on the conic surfaces of the inside of the bell or groove and the outer surfaces of the spigot or tongue shall be parallel and shall not be more than three degrees of pipe sizes up through 15-in. (375mm) diameter nor more than two degrees for larger sizes, measured from a longitudinal trace on the inside surface of the pipe. The spigot or tongue shall be so shaped as to provide a groove within which the gasket will be largely confined when compressed. The joint shall be designed such that the gasket is not required to support the weight of the pipe.

501.5.4.3. Joint Dimensions. The bell-and-spigot or tongue-and-groove of the joint shall be of such design that the joint shall withstand the forces caused by the compression of the gasket when properly jointed without cracking or fracturing. All surfaces of the joint upon or against which the gasket may bear shall be smooth, free of spalls, cracks or fractures, or imperfections that would adversely affect the performance of the joint. The thickness of the bell-and-spigot of the joints shall conform to the minimum dimensions as shown in Table 501.5.4.3.(a) Reinforced Concrete Pipe Joint Dimensions.

501.5.4.4. Joint Tolerance. The joint design shall be such that the parallel surfaces upon which the gasket may bear during closure shall extend a distance of not less than 1-inch (2.54cm) from the edge of the gasket seat toward the outer edge of the bell when the joint is in a normal fully closed position.

501.5.4.5. Deflection. The joint design shall provide for the deflection of a pipe unit by opening one side of the outside perimeter of the joint ½-inch (1.3cm) wider than the full "home" position without reducing its water tightness. Where greater deflections are required that provided by the joint design, beveled joints or elbows shall be provided.

501.5.4.6. Joint Approval. A detailed design of the joint or joints, including design and durometer hardness of the rubber gasket proposed to be furnished under this specification, shall be approved by the OWNER prior to installation. The design shall also include minimum and maximum interior joint opening in the assembled position in straight alignment and the maximum interior joint opening in the maximum deflected position.

Table 501.5.4.3.(a) Reinforced Concrete Pipe Joint Dimensions

Pipe Size, inches (mm[1])	Bell Thickness, inches (mm[1])	Spigot Thickness, inches (mm[1])
12 (300)	2.000 (50)	1.375 (35)
15 (375)	2.125 (54)	1.563 (41)
18 (450)	2.250 (57)	1.688 (43)
21 (525)	2.500 (63)	1.813 (46)
24 (600)	2.750 (69)	1.938 (48)
27 (675)	2.875 (72)	2.000 (50)
30 (750)	3.000 (75)	2.063 (52)
33 (825)	3.250 (82)	2.125 (54)
36 (900)	3.500 (88)	2.250 (57)
42 (1050)	4.250 (107)	3.563 (91)
48 (1200)	4.250 (107)	3.563 (91)
54 (1350)	4.250 (107)	3.563 (91)
60 (1500)	4.250 (107)	3.563 (91)
66 (1650)	4.250 (107)	3.563 (91)
72 (1800)	4.250 (107)	3.750 (94)
78 (1950)	4.375 (111)	3.750 (94)
84 (2100)	4.500 (113)	4.125 (105)
90 (2250)	4.750 (119)	4.500 (113)
96 (2400)	4.750 (119)	4.500 (113)
102 (2550)	5.250 (132)	4.750 (119)
108 (2700)	5.688 (144)	5.063 (127)

1. Metric measurement based on ASTM sizes (C76M)

501.5.5. Fittings and Specials. Component parts for all specials such as bends, wyes, tees, etc. shall be manufactured on machines and in the same manner as straight joint concrete wastewater pipe under these specifications, except that joint lengths may be shorter than minimum listed. The quality of the concrete, workmanship and bell-and-groove joint detail for rubber gasket joints shall be subjected to the same requirements as straight joints of pipe.

501.5.6. Coatings and Linings. Coatings and liners called for in the specifications or as indicated on the plans shall meet the requirements of Item 502.9. Corrosion-Resistant Coatings and Liners for Wastewater Conduit and Appurtenances and shall be installed or applied by the pipe manufacturer.

501.5.7. Repairs. Repairs shall be permitted as set out in ASTM C76 and/or ASTM C655 except field repairs shall be permitted only with prior approval of the OWNER. Repairs to pipe and shall be done in strict conformity with all applicable specifications, instructions and recommendations of the manufacturer to ensure material warranty. If, in the opinion of the OWNER, repairs should not be made, the section of pipe shall be rejected and removed from the construction site and not repaired or returned to any of the OWNER'S projects. Rejected pipe shall be marked in a manner mutually agreed upon by the OWNER and the pipe manufacturer.

Field repairs on damage to the gasket bearing area shall not be allowed without prior approval of the OWNER.

501.5.8. Markings. Each length of pipe shall bear the initials or name of the person, company or corporation by whom it was manufactured; date of manufacture; and the class of pipe. The markings shall be indented or stenciled on the exterior or interior of the barrel near the bell and shall be plainly legible for purpose of identification.

501.5.9. Tests. The pipe shall be required to meet and be tested in accordance with ASTM C76 (C76M) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe, or ASTM C655 (C655M) Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe, as applicable.

The connecting joints shall be subject to the hydrostatic tests set forth in ASTM C443 (C443M) Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

The rubber gasket shall be required to meet and be tested in accordance with ASTM C443 (C443M).

501.5.10. Rejection. The pipe may be rejected for having defects or failure to meet the requirements as follows:

(1) variations in any dimension exceeding the permissible variations prescribed,

(2) a piece broken out of the bell or spigot or tongue or groove end of such size that the watertightness of the joint should be impaired,
(3) a shattering or flaking of concrete or other conditions indicating an improper concrete mix,
(4) lack of uniformity in placement of steel which might preclude all joints being typical of those tested,
(5) cracks sufficient to impair the strength, durability or serviceability of the pipe,
(6) failure to conform with any of the specifications herein set forth or referenced,
(7) the complete absence of distinct web-like markings, which may be indicative of a deficiency of water in the concrete mix, from the external surface of the pipe made by any process in which the forms are removed immediately after the concrete has been placed, unless specimens submitted for test that do not have such web-like markings shall have passed the physical tests required by these specifications,
(8) failure of pipe to go completely "home" due to binding of spigot against bell or tongue against groove,
(9) failure to pass any of the tests in Item 501.5.9. Tests,
(10) joint sections with spalls, cracks, fractures, or other imperfections that could adversely affect the performance of the joint,
(11) failure to meet the requirements for coatings and linings.

501.6. REINFORCED CONCRETE CULVERT, STORM DRAIN, PIPE AND BOX SECTION

This item shall govern reinforced concrete culvert, storm drain, pipe and precast reinforced concrete box sections. Pipe shall be cured in accordance with the applicable ASTM Designations for each type of pipe as referred to below.

501.6.1. Reinforced Concrete Culvert, Storm Drain, and Pipe.

501.6.1.1. General. Except as applicable to Item 501.6.1.1.1. Alternate Concrete Pipe D-Load Design, circular reinforced concrete pipe shall conform to ASTM C76 (C76M) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe; arch pipe shall conform to ASTM C506 Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe; elliptical pipe shall conform to ASTM C507 Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe, of the class as designed on the plans subject to the following modifications:

(1) all pipe shall be machine-made by a process which shall provide for uniform placement of zero slump concrete in the form and compaction by mechanical devices which shall assure a dense concrete in the finished product.
(2) sizes larger than 60-in. (1524mm) diameter shall be manufactured using two lines of circular reinforcement.
(3) where Class III pipe of sizes larger than 60-in. (1500mm) diameter are specified, the manufacturer may at its option furnish pipe manufactured with either Wall "B" or Wall "C" minimum thicknesses and the applicable minimum steel area as listed for circular cages in Table II of ASTM C76 (C76M), provided tests strength requirements for Class III pipe are satisfactorily met.

501.6.1.1.1. Alternate Concrete Pipe D-Load Design. When bedding is specified in accordance with Item 504.5.2.16. Alternate Embedment for Concrete Pipe, reinforced concrete pipe shall conform to ASTM C1417 (C1417M) Manufacture of Reinforced Concrete Sewer, Storm Drain, and Culvert Pipe for Direct Design. This specification covers the manufacture and acceptance of precast concrete pipe designed to conform to the OWNER's design requirements and to ASCE 15-93, ASTM C655 (C655M) Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe, or an equivalent design specification. Conditions of 501.6.1.1. modifications (1) and (2) apply to pipe provided under this specification.

501.6.1.2. Sizes and Permissible Variations. Variations in diameter, size, shape, wall thickness, reinforcement, placement of reinforcement, laying length and the permissible underrun of length shall be in accordance with the applicable ASTM specification for each type of pipe as referred to previously.

Where rubber gasket pipe joints are to be used, the design of joints and permissible variations in dimensions shall be in accordance with ASTM C443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets, Sections 5 and 6.

501.6.1.3. Joints. Pipe to be placed along curves shall consist of whatever pipe joint lengths or beveled end joints of pipe or combination thereof that are required to place the pipe on the designated centerline curve with no more than one-half of the tongue length of the pipe exposed from its normal fully closed joint position. The amount of bevel, "drop" or shortening of the pipe joint length by the bevel shall not exceed the amount shown in Table 501.6.1.3.(a) Maximum Bevel or Drop for the pipe sizes indicated.

Table 501.6.1.3.(a) Maximum Bevel or Drop

Pipe Diameter	Maximum Amount of Bevel or Drop
From 12-in. (305mm) to 27-in. (685mm), inclusive	3.1875-in. (80mm)
From 30-in. (760mm) to 51-in. (1295mm), inclusive	5-in. (125mm)
From 54-in. (1370mm) to 84-in. (2135mm), inclusive	6-in. (150mm)
From 90-in. (2285mm) to 96-in. (2440mm), inclusive	6.5-in. (165mm)

501.6.1.3.1. Gaskets. Unless otherwise specified on the plans or in the special provisions, pipe joints shall be sealed with either of the following types of gaskets; Cold-applied preformed plastic gaskets or Expanded Cellular Rubber Gaskets. Each joint shall require one continuous gasket conforming to the joint shape. Gasket cross-sectional diameters shall be in accordance with the manufacturer's recommendations.

Cold-Applied Preformed Plastic Gaskets. Plastic gasket shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler and shall contain no solvents, irritating fumes, or obnoxious odors.

The gasket joint sealer shall not depend on oxidizing, evaporating nor chemical action for its adhesive or cohesive strength and shall be supplied in extruded rope-form of suitable cross section. The size of the plastic gasket joint sealer shall be in accordance with the manufacturer's recommendations and sufficient to obtain the squeeze out as described under construction methods. The gasket joint sealer shall be protected by a suitable removable two-piece wrapper. The two-piece wrapper shall be so designed that one-half may be removed longitudinally without disturbing the other half to facilitate application as noted below.

The chemical composition of the gasket joint sealing compound as shipped shall meet the requirements of Table 501.6.1.3.1.(a) Sealing Compound Chemical Composition when tested in accordance with the test methods shown. The gasket joint sealing compound when immersed for 30-days at ambient room temperature separately in 5-percent solution of caustic potash, a mixture of 5-percent hydrochloric acid, a 5-percent solution of sulfuric acid and a saturated H_2S Solution, shall show no visible deterioration.

Table 501.6.1.3.1.(a) Sealing Compound Chemical Composition

Composition	Test Method	Percent by Weight
Bitumen (petroleum plastic content)	ASTM D4 Bitumen Content	50-70
Ash-Inert Mineral Matter	AASHTO T-111	30-50
Volatile Matter at 325°F (163°C)	ASTM D6 Loss on Heating of Oil and Asphaltic Compounds	2.0 Max.

The physical properties of the gasket joint sealing compound as shipped shall meet the requirements of Table 501.6.1.3.1.(b) Sealing Compound Physical Properties when tested in accordance with the test methods shown.

Table 501.6.1.3.1.(b) Sealing Compound Physical Properties

Property	ASTM Test Method	Typical Analysis
Specific Gravity at 77°F	D71 Relative Density of Solid Pitch and Asphalt (Displacement Method)	1.20 to 1.35
Ductility at 77°F (cm)	D113 Ductility of Bituminous Materials	5.0 min.
Softening Point at 77°F	D36 Softening Point of Bitumen (Ring-and-Ball Apparatus)	320°F min.
Penetration: 32°F. (300-gms) 60-sec.	D217 Cone Penetration of Lubricating Grease	75 min.
77°F (150-gms) 5-sec.		50 to 120
115°F (150-gms) 5-sec.		150 max.
Flash Point C.O.C.	D92 Flash and Fire Points by Cleveland Open Cup Tester	600°F
Fire Point C.O.C.		625°F

Expanded Cellular Rubber Gaskets. Expanded cellular rubber gaskets shall be produced from tubular cross-sections of a blend of nitrile and vinyl polymers meeting the physical requirements of ASTM D1056 Flexible Cellular Materials-Sponge or Expanded Rubber, Class 2C1.

501.6.1.4. Workmanship and Finish. Pipe shall be substantially free from fractures, large or deep cracks and surface roughness. The ends of the pipe shall be normal to the walls and centerline of the pipe within the limits of variations allowed as stated previously.

501.6.1.5. Pipe Marking. Markings shall be indented on the pipe section or painted thereon with waterproof paint. The following information shall be clearly marked on each section of pipe:

(1) the class of pipe,
(2) the date of manufacture,
(3) the name or trademark of the manufacturer,
(4) where elliptical reinforcement is used, one end of each section or joint of pipe shall be clearly marked during the process of manufacture or immediately thereafter on the inside and the outside of opposite walls to show the location of the "top" or "bottom" of the pipe as it should be installed.
(5) "Top" and "bottom" shall be required on pipe, unless pipe has such an external shape that the correct position of the top and bottom is obvious.

501.6.1.6. Tests. The acceptability of the pipe in all diameters, strengths and classes shall be determined by such material tests performed as required in ASTM C76 (C76M), C506 or C507; by the results of the three-edge bearing test for the load to produce a 0.01-in. (0.25mm) crack and ultimate load and by absorption tests on selected samples from the wall of the pipe in accordance with ASTM C497 (C497M) Concrete Pipe, Manhole Sections, or Tile; and by inspection of the finished pipe to determine its conformance with the design prescribed in these specifications and its freedom from defects.

Testing rates shall be as follows, except that in no case fewer than two specimens shall be furnished:

(1) If subjected to three-edge-bearing tests for the 0.01-in. (0.25mm) crack only, testing shall be performed on 0.8-percent of the number of pipe sections of each size included in the order. Pipes that have been tested only to the formation of a 0.01-in. (0.25mm) crack and that meet the 0.01-in. (0.25mm) test load requirements shall be accepted for use.
(2) If subjected to three-edge-bearing tests for both the 0.01-in. (0.25mm) crack and the ultimate load, testing shall be performed on 0.2-percent of the number of pipe sections of each size included in the order.

As an alternate to the three-edge-bearing test, concrete pipe 60-in. (150cm) in diameter and over may be accepted, at the option of the manufacturer, on the basis of material tests and inspection of the completed product. Acceptability of pipe on this basis shall be determined by the results of material tests as required in ASTM C76, C506 or C507; by crushing tests on cores taken from the barrel of the completed and cured pipe; by absorption tests on samples from the wall of the pipe; and by inspection of the finished pipe, including amount and placement of reinforcement, to determine its conformance with the design prescribed in these specifications and its freedom from defects.

The manufacturer shall furnish facilities and personnel for taking the cores from the pipe barrel and for determining the compressive strength of the samples. When the cores cut from a section of pipe successfully meet the strength requirement, the core-holes shall be plugged and sealed by the manufacturer in a manner such that the pipe section shall meet all of the test requirements of ASTM C76, C506 or C507. Pipe sections, so sealed, shall be accepted for use.

Tested pipe accepted for use shall be marked "TEST" or otherwise appropriately identified. Should any of the test specimens fail to meet the test requirements, two consecutive joints in the same mix series shall be tested and results shall be a basis of accepting or rejecting the pipe of the series.

501.6.1.7. Rejection of Pipe. All rejected pipe shall be plainly marked by the Engineer and shall be replaced by the CONTRACTOR with pipe that meets the requirements of these specifications. Such rejected pipe shall be removed immediately from the site of the work.

501.6.2. Precast Reinforced Concrete Box Sections. Precast reinforced concrete box sections shall conform to ASTM C789 (C789M) Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers, or ASTM C850 (C850M) Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers With Less Than 2 Feet of Cover Subject to Highway Loadings. Two-piece box culverts, if approved by the OWNER, must meet or exceed the load requirements of ASTM C789 and ASTM C850. Materials and construction methods, unless otherwise specified, shall conform to the requirements of Item 702.8. Precast and Cast-In-Place Concrete Units.

501.7. DUCTILE-IRON PRESSURE PIPE AND FITTINGS

501.7.1. General. Ductile-iron pressure pipe 4-in. through 64-in. shall conform to the American National Standard for Ductile-Iron Pipe Centrifugally Cast for Water or Other Liquids, AWWA C151. Polyethylene encasement for ductile iron pipe systems shall conform to Item 502.8. Polyethylene Wrap for Metal Pipe and Fittings.

501.7.2. Joints. All ductile-iron pressure pipe shall be furnished with one of the types of joints indicated in Table 501.7.2.(a) Ductile Iron Pressure Pipe Joint Types and as described in the proposal or bid request.

Bolts and nuts for mechanical joints or flanged ends (if used underground) shall be of a high-strength low-alloy corrosion-resistant steel and shall conform to ASTM A325 High Strength Bolts for Standard Steel Joints, Type 3.

All threaded flanges shall be ductile iron.

Table 501.7.2.(a) Ductile Iron Pressure Pipe Joint Types

Type Joint	AWWA Standard
Push-on	AWWA C111 Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
Mechanical Joint	AWWA C111 (same as above)
Flanged Ends	AWWA C110 Ductile-Iron and Gray-Iron Fittings, 3 In.-48 In. (76 mm-1,219 mm), for Water, or AWWA C115 Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
Grooved Ends	AWWA C606 Grooved and Shouldered Joints

501.7.3. Coating and Lining. All ductile-iron pipe shall be bituminous coated outside and cement mortar lined inside with seal coat in accordance with AWWA C104 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water. Cement mortar lined ductile iron pipe can be used for water and certain wastewater applications, such as non acid-producing gravity wastewater lines and wastewater force mains that unquestionably flow full. Contact pipe manufacture for linings suitable in other applications.

501.7.4. Fittings. Fittings shall be of ductile-iron and shall conform to AWWA C110 ANSI Standard for Ductile-Iron and Gray-Iron Fittings, 3-in. Through 48-in. (76mm Through 1,219mm) for Water, or conform to AWWA C153 ANSI Standard for Ductile-Iron Compact Fittings for Water Service, 3-in. through 64-in. (76mm through 1,600mm), unless otherwise specified in the proposal, special specification or in the plans.

Welded-on outlets may be used in lieu of the tees shown on the plans. Outlet pipe shall be special thickness class 53. All weldments must be 55% nickel iron and each outlet pipe shall be air tested to 15-psi (103-kPa) to insure weld integrity. The outlet branches must be made from ductile iron pipe.

All fittings shall be rated for a minimum of 250-psi (2069-kPa) working pressure unless otherwise specified.

Special fittings using end condition combinations of bells, spigots, mechanical, integrally restrained or push-on joints, flanges, or special internally locked joints shall be dimensioned in accordance with AWWA C110 or C153.

Bolts and nuts for mechanical joints or flanged ends shall be of a high-strength, corrosion-resistant low-alloy steel and shall conform to ASTM A325 (Type 3) or shall be stainless steel in accordance with ASTM A304 Carbon and Alloy Steel Bars Subject to End-Quench Hardenability Requirements.

The OWNER shall determine whether fittings shall be bituminous coated outside and cement-mortar lined inside with seal coat in accordance with AWWA C104 Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water or whether the interior and exterior surfaces shall be protected consistent with AWWA C116 Standard for Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service.

501.7.5. Tests. All ductile-iron pipe and fittings shall be tested in accordance with the applicable provisions of the specifications relating thereto .

501.7.6. Markings. Class, weight, and casting period shall be shown on each pipe.

501.8. DUCTILE-IRON PIPE FOR PIPE REHABILITATION

501.8.1. General. This standard establishes criteria for the specification of centrifugally cast, "bell-less", ductile iron pipe sizes 3" through 16" for pressure or gravity applications up to a maximum of 50-feet of head (43-psi) (296-kPa), including the conveyance of sewage, wastewater, storm water, treated water, and raw water, installed by trenchless methods. Ductile-iron pipe for pipe reconstruction, as described in Item 601.9. Pipe Bursting with Rigid Pipe, shall meet the minimum property and testing requirements as specified herein.

Pressure and gravity "bell less" pipe shall be manufactured in accordance with AWWA C151 Standard for Ductile-Iron Pipe, Centrifugally Cast for Water, except as modified herein.

The outside diameter of ductile iron "bell less" pipe shall be in accordance with AWWA C151.

Finished pipe lengths of Rubber gasket coupled "bell less" pipe shall have a standard nominal laying length and shall have a standard manufacturing tolerance for actual laying length equal to ±0.25-in (6mm). Laying length shall be specified per project conditions.

501.8.2. Joints. Pressure and gravity "bell less" ductile iron pipe joints shall be sealed with O-ring rubber gaskets installed in a machined tongue and groove type joint. The rubber gasketed joints of gravity service shall be field air pressure tested to 5-psi (35-kPa).

501.8.3. Coating and Lining. The candidate pipe for trenchless use may be uncoated or standard asphaltic coating in accordance with AWWA C151. Lining systems for ductile iron "bell less" pipe shall be specified by the OWNER based on the corrosiveness of the liquid being conveyed and other service requirements.

501.8.4. Tests. All pipe and fittings shall be tested in accordance with the applicable provisions of the specifications relating thereto.

501.8.5. Markings. Class, weight, and casting period shall be shown on each pipe.

501.9. STEEL PIPE AND FITTINGS

501.9.1. General. Steel pipe, fittings and specials shall conform to the details as shown on the plans or included in the specifications and as specified below.

501.9.2. Applicable Standard Specifications. Except as modified or supplemented herein, all steel pipe, fittings and specials shall conform to the applicable requirements of the standard specifications indicated in Table 501.9.2.(a) Standards for Steel Pipe and Fittings.

Table 501.9.2.(a) Standards for Steel Pipe and Fittings

Standard	Designation
AWWA C200	Steel Water Pipe—6 In. (150 mm) and Larger
AWWA C203	Coal Tar Protective Coatings and Linings for Steel Water Pipeline — Enamel and Tape — Hot Applied
AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe — 4 In. (100 mm) and Larger — Shop Applied
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Service—Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm)
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipe
AWWA C210	Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C222	Polyurethane Coatings for the Interior and Exterior of Steel Water Pipelines and Fittings
AWWA C602	Cement-Mortar Lining of Water Pipelines in Place—4 In. (100 mm) and Larger
AWWA C606	Grooved and Shouldered Joints
ASTM A283	Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A139	Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)

501.9.3. Pipe and Fittings Requirements. Fabricated pipe and fittings shall be made of steel plate conforming to ASTM A283, Grade D, or ASTM A139, Grade B, C, or D in accordance with AWWA C200. Mill-type pipe and fittings shall be Grade B conforming to AWWA C200.

Nominal pipe diameter shall be as specified in the plans. Nominal diameters for steel pipe sizes under 24-in. (61cm) are outside diameters and for sizes 24-in. (61cm) and over are inside diameters per AWWA M11 Steel Pipe—A Guide for Design and Installation.

The pipe wall thickness shall be as specified in the plans.

Pipe sections shall be furnished in not less than 20 ft. (6.1 m) lengths except for specials and closures sections as may be required.

501.9.4. Joints. Steel pipe and fittings shall be joined with any of the end types as specified below, unless a particular end type is specified. Flange ends shall be used only where specifically noted on drawings.

Welded joints shall conform to and be tested in accordance with AWWA C206.

Rubber gasketed joints may be used up to 72-in. (1.8m) in diameter and shall conform to, and be tested in accordance with AWWA C200.

Grooved and shouldered joints shall conform to, and be tested in accordance with AWWA C606.

Mechanically coupled joints shall consist of Dresser Couplings Style 38 or equal or as specified on the drawings.

Flanged joints shall conform to the AWWA C207, Class D. The thickness of flanges shall be as specified in Table 1 or 2 of AWWA C207, or as specified on the drawings.

501.9.5. Lining and Coating. Steel pipe and fittings shall be lined in accordance with any of the standards indicated in Table 501.9.5.(a) Lining and Coating for Steel Pipe and Fittings, unless a particular specification is shown on the plans.

The exterior surface of steel pipe and fittings to be installed underground shall be coated in accordance with AWWA C214. If coated in accordance with AWWA C214, then the fittings will be coated in accordance with AWWA C209. The exterior surface of steel pipe and fittings to be installed above ground shall be cleaned, primed and coated, all in accordance with either AWWA C222 or C210.

Table 501.9.5.(a) Lining and Coating for Steel Pipe and Fittings

Standard	Topic
AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe — 4 In. and Larger — Shop Applied
AWWA C210	Liquid-Epoxy Coating Systems for Interior and Exterior of Steel Water Pipelines
AWWA C222	Polyurethane Coatings for the Interior and Exterior of Steel Water Pipelines and Fittings
AWWA C602	Cement-Mortar Lining of Water Pipeline — 4 In. and Larger — in Place

501.9.6. Testing. All steel pipe shall be hydrostatically tested to a pressure that will induce a stress of 75% of the minimum yield strength of the steel in accordance with AWWA C200. Fittings fabricated from hydrostatically tested pipe shall not require shop hydrostatic testing. Welds for fittings that were not previously hydrostatically tested shall require hydrostatic testing, air testing, or other ASTM nondestructive testing.

501.10. SEAMLESS COPPER TUBING

501.10.1. General. These specifications pertain only to Type K, annealed (soft) copper water tubing for use with solder, flared, or compression-type fittings. The copper tubing shall conform to ASTM B88 Seamless Copper Water Tube.

501.10.2. Quality. The vendor shall be responsible for submission of a laboratory analysis of the products supplied. The manufacturer's own laboratory analysis is acceptable. The certificate of analysis shall state size and type of analysis and results obtained. A statement shall be made and validated that tests confirm compliance with the requirements of this specification.

The OWNER reserves the right to conduct or cause to have conducted independent laboratory tests. Where the results of such tests prove the quality requirements have not been met: (1) the costs of tests shall be charged to the vendor's account, and (2) the entire shipment may be rejected on the basis of such tests.

501.11. CORRUGATED METAL PIPE OR PIPE ARCH SHAPES

501.11.1. General. This item shall govern the furnishing of corrugated metal pipe for culverts and storm water conduit for the locations and designations as shown on the plans and contract specifications as herein outlined.

Pipe having a design hydraulic head exceeding 5-ft. (1.5m) of water will have helical corrugations and the lock seam shall be either continuously welded or caulked with a neoprene or mastic seal during fabrication. Caulked helical pipe shall be fabricated by applying a uniform bead of neoprene or mastic compound to the lock seam in such a manner that the inner surfaces of the lock seam are free of voids.

Shell Data shall specify diameter, classification (Type), material, gage and corrugation. This information shall be designated on the plans and/or contract specifications.

501.11.2. Pipe Manufacture. Corrugated metal pipe or pipe arch shapes shall meet the requirements of ASTM A760 (A760M) Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains, ASTM B745 (B745M) Corrugated Aluminum Pipe for Sewers and Drains, or ASTM A742 (742M) Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe. All pipe shall be manufactured with a minimum of two re-rolled ends.

501.11.2.1. Steel Pipe. Galvanized or aluminized steel pipe shall be full circle or arch pipe conforming to AASHTO Designation M36, Type I, Type II or Type III as specified in the plans.

501.11.2.2. Aluminum Pipe. Aluminum pipe shall conform to the requirements of AASHTO Designation M196, Type I, Type II or Type III pipe arch as specified on the plans.

Aluminum pipe may be placed bare of any precoating, but any portions of aluminum pipe that are to be in contact with a metal other than aluminum or in contact with concrete containing chlorides, shall be insulated from

this other metal or concrete by a coating of bituminous material or a plastic coating, such as asphalt mastic or polymeric coating. The coating applied to the aluminum pipe or pipe arch to provide an insulation between the aluminum and other metal shall extend a minimum distance of 1 ft. beyond the area of contact.

501.11.2.3. Precoated Galvanized or Aluminized Steel Pipe. Pipe shall be full circle or arch pipe conforming to AASHTO Designation M245, Type I, Type II or Type III as specified in the plans.

501.11.3. Classification (Type). Corrugated metal pipe shall be classified on the plans and/or specifications with the notations as set forth in ASTM A760 (A760M), ASTM B745 (B745M) and ASTM A742 (A742M) and indicated in Table 501.11.3.(a) Corrugated Metal Pipe Type.

Table 501.11.3.(a) Corrugated Metal Pipe Type

Type	Description
Type I	Pipe with a full circular cross section with a singular thickness of corrugated sheet, fabricated with annular or helical corrugations.
Type IA	Pipe with a full circular cross section, with an outer shell of corrugated sheet fabricated with helical corrugations and an inner liner of smooth (uncorrugated) sheet attached to the shell at helical lock seams. Unless otherwise shown on the plans or contract specifications, the inner liner of smooth (uncorrugated) sheets shall be 18-gage, polymer coated per ASTM A762 (A762M) Grade 10/10 or 20-gage, polymer coated per ASTM A762 (A762M) Grade 10/10.
Type IR	Pipe with a full circular cross section, with a single thickness of smooth sheet, fabricated with helical ribs projecting outward.
Type II	Type I pipe which has been reformed into a pipe-arch, having an approximately flat bottom.
Type IIA	Type IA pipe which has been reformed into a pipe-arch, having an approximately flat bottom.
Type IIR	Type IR pipe which has been reformed into a pipe-arch, having an approximately flat bottom.
Type III	Type I pipe which has been perforated to permit the inflow and outflow of water, intended for use as underdrains.
Type IIIA	Pipe shall consist of semi-circular cross section having a smooth bottom with a corrugated top shield which has been perforated, intended for use as deck drains.

501.11.4. Material. Corrugated metal pipe or pipe arch shapes shall be fabricated from corrugated sheets conforming to one of the styles indicated in Table 501.11.4.(a) Corrugated Sheets for Pipe or Pipe Arch Shapes.

Table 501.11.4.(a) Corrugated Sheets for Pipe or Pipe Arch Shapes

Metal		Standards
GALV	Galvanized Steel	ASTM A760 (A760M) Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ALT2	Aluminized Type 2 Steel	ASTM A760 (A760M) (same as above)
POLY	Polymeric Steel	ASTM A762 (A762M) Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains (Grade 10/10)
ALUM	Aluminum Alloy	ASTM B744 (B744M) Aluminum Alloy Sheet for Corrugated Aluminum Pipe

501.11.5. Gage. Where reference is made to gage of metal, the reference is to U.S. Standard Gage for uncoated sheets in ASTM A929 (A929M) Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe. Unless otherwise shown on the plans or contract specifications, minimum gages shall be as required by TxDOT *Standard Specifications for Construction of Highways, Streets and Bridges*, Item 460.4. Selection of Gages.

501.11.6. Corrugation. Corrugated configurations shall be governed by dimensional tolerances set forth in ASTM A760 (A760M). The corrugations as shown in Table 501.11.6.(a) Corrugation Configurations shall only be valid with their respective classifications (type).

Table 501.11.6.(a) Corrugation Configurations

Type	Configuration
Type 1	2□-in. x ½-in.; 3-in. x 1-in.; 5-in. x 1-in. (68mm x 13mm; 75mm x 25mm; 125mm x 25mm)
Type IA	2□-in. x ½-in.; 3-in. x 1- in. (68mm x 13mm; 75mm x 25mm)
Type IR	¾-in. x ¾-in. x 7½-in.; ¾-in. x 1-in. x 11½-in. (19mm x 19mm x 190mm; 19mm x 25mm x 292mm)
Type II	2□-in. x ½-in.; 3-in. x 1-in.; 5-in. x 1-in. (68mm x 13mm; 75mm x 25mm; 125mm x 25mm)
Type IIA	2□-in. x ½-in.; 3-in. x 1-in. (68mm x 13mm; 75mm x 25mm)
Type IIR	¾-in. x ¾-in. x 7½-in.; ¾-in. x 1-in. x 11½-in. (19mm x 19mm x 190mm; 19mm x 25mm x 292mm)
Type III	2□-in. x ½-in.; 3-in. x 1-in. (68mm x 13mm; 75mm x 25mm)

501.11.7. Repairs. All damage incurred in fabrication will be repaired at the fabrication location. Damage incurred during handling and placement will be repaired, inspected and approved by the OWNER prior to backfilling the pipe.

501.11.7.1. Galvanized Steel Pipe. Damaged spelter coating shall be repaired by thoroughly wire brushing the damaged area and removing all loose, cracked or weld burned spelter coating. The cleaned area shall be painted with a zinc dust-zing oxide paint conforming to Federal Specifications TT-P-641.

501.11.7.2. Aluminized Steel Pipe. Damaged areas of aluminized coating, including saw cut ends and welds, shall be cleaned and repaired by brush coating of aluminized paint to the damaged, cut or welded area to a minimum thickness of 0.005-in. (0.13mm).

501.11.7.3. Precoated Pipe. Damaged or cut areas of polymeric coatings shall be repainted by the application of a polymeric coating similar and compatible with the polymeric coating on the pipe and to a minimum 10-mil (0.25mm) thickness.

Damaged areas of bituminous coated galvanized steel shall be repaired by repair of any damaged areas of spelter coatings in accordance with Item 501.11.8.1. Galvanized Steel Pipe before repairing the bituminous coating by applying asphalt mastic to the same thickness as the original coating.

501.11.8. Pipe Marking. The following information shall be clearly marked on each section of pipe:

(1) Date of manufacture of the pipe.
(2) The name or trademark of the manufacturer of the pipe.
(3) Gage or thickness of metal.
(4) Alloy number (aluminum pipe only).

501.11.9. Couplings.

501.11.9.1. Coupling Bands. Except as may be otherwise required, coupling bands shall be of the same base material(s) as the pipe. Coupling bands shall lap evenly on each of the pipes being connected and shall fit securely into a least one full circumferential corrugation to form a tightly closed joint. Pipe end circumferential corrugations shall be the corrugation width and depth as shown on the plans or as specified by the Engineer.

All pipe shall be field jointed with corrugated locking bands. Coupling bands shall not be more than three nominal sheet thicknesses lighter than the pipe to be connected and in no case thinner than 0.052-in. (1.32mm). The minimum width of the corrugated locking bands shall be as shown in Table 501.11.9.1.(a) Corrugated Locking Band Width for the corrugation which corresponds to the end circumferential corrugations on the pipe being joined.

Table 501.11.9.1.(a) Corrugated Locking Band Width

Corrugation	Minimum Band Width
2□-in. x ½-in. (68mm x 13mm)	10½-in. (267mm)
3-in. x 1-in. (75mm x 25mm)	12-in. (305mm)
6-in. x 1-in. (152mm x 25mm)	18-in. (457mm)

When it is necessary to join a new pipe of helical corrugations to an existing pipe which was installed with no circumferential end corrugations, the two pipes shall be field jointed with helically corrugated bands. The width of helically corrugated bands shall conform to the minimum widths in Table 501.11.9.1.(b) Helically Corrugated Band Width.

Table 501.11.9.1.(b) Helically Corrugated Band Width

Helical End Corrugation	Minimum Band Width
½-in. (13mm) deep	12-in. (305mm)
1-in. (25mm) deep	14-in. (356mm)

All coupling bands 12-in. (305mm) wide or less shall be drawn together by means of a minimum of two ½-in. (13mm) diameter bolts through angles or bar and strap device suitably welded; coupling bands greater than 12-in. (305mm) wide shall have a minimum of three ½-in. (13mm) diameter bolts.

501.11.9.2. Bell-and-Spigot Coupling. Except as may otherwise be required, bell-and-spigot couplings shall be of the same base material as the pipe, and in no case thinner than 0.052-in. (1.32mm).

Couplings shall be bell and spigot type. The bell shall have a corrugation to engage the rerolled annular corrugation in the pipe, with a flare to receive the spigot end of the next section of pipe. The bell shall have factory-welded lap(s) applied after snugging the bell corrugation into the pipe rerolled annular corrugation.

Gaskets, if required, shall be polyisoprene (or similar) with a durometer of 45 ±5. The gasket on the spigot end shall be fluted with two flutes to prevent rolling when assembled in the field and to resist pull out from the bell.

501.12. STRUCTURAL PLATE STRUCTURES

501.12.1. General. Structural plate conduit, pipe arch, box culverts and special shapes shall meet the requirements of TxDOT *Standard Specifications for Construction of Highways, Streets and Bridges* Item 461 Structural Plate Structures and be in accordance with ASTM A761 Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches for galvanized steel structures or ASTM B221 Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes, for aluminum alloy structures.

501.12.2. Plates. Steel plates shall consist of structural units of corrugated galvanized metal. Single plates shall be furnished in standard sizes to permit structure length increments of 2-ft. (0.6m). Aluminum plate shall consist of structural units of corrugated aluminum alloy. For aluminum alloy structures, cut plates shall be furnished on structure ends to permit structure length increments of 1-ft. (0.3m).

Plates shall be formed to provide bolted lap joints. The bolt holes shall be so punched that all plates having like dimensions, curvature, and the same number of bolts per foot of seam shall be interchangeable. Each plate shall be curved to the proper radius so that the cross-sectional dimensions of the finished structure will be as indicated on the plans. Joints shall be staggered so that not more than 3 plates are joined at any one point. Unless otherwise specified, bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be:

(1) staggered in rows 2-inches (5cm) apart, with one row in the valley and one in the crest of the corrugations and not less than 4-bolts-per-foot for galvanized steel structures, or
(2) in rows 1¾-in. (4.5cm) apart with 2 bolts in each valley and on each crest and not less than 16-bolts-per-3-feet for aluminum alloy structures.

Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than 12-in. (30cm). The minimum distance from center of hole to edge of the plate shall be not less than 1¾-times the diameter of the bolt. The diameter of the bolt holes in the longitudinal seams shall not exceed the diameter of the bolt by more than ¼-in. (6mm). Plates for forming skewed or sloped ends shall be cut so as to give the angle of skew or slope specified. Burned edges shall be free from oxide and burrs and shall present a workmanlike finish and legible identification numerals shall be placed on each plate to designate its proper position in the finished structure.

501.12.3. Corrugations. Permissible corrugations of metal plates to be furnished for each structure shall be shown on the plans. Corrugations for steel structures shall have a pitch of 6-in. (150mm) with a tolerance of ¼-in. (6mm) and a depth of 2-in. (50mm) with a tolerance of ⅛-in. (3mm). The radius on the inside of the corrugations shall be at least $1^{1}/_{16}$-in. (26mm) for steel structures. Corrugations for aluminum alloy structures shall have a pitch of 9-in. (229mm) with a tolerance of ⅜-in. (9.5mm) and a depth of 2½-in. (64mm) with a tolerance of ⅛-in. (3mm). The radius of the inside of the corrugation shall be at least 2-in. (50mm) for aluminum alloy structures.

501.12.4. Gauge Determination and Tolerances. The gage or minimum thickness of metal plates to be furnished for each structure shall be shown on the plans.The gauge and tolerances of aluminum plates shall

conform to those in ASTM B221 Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes. The thickness of galvanized steel plates shall conform to those in ASTM A929/A929M Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe.

501.12.5. Metal Headwalls. The material for metal headwalls shall comply with requirements shown on plans. When required, aluminum alloy inverts, toewalls footings and closure plates shall conform to the material requirements herein. Extruded aluminum transverse stiffeners shall conform to ASTM B221 Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes, Alloy 6061-T6.

501.12.6. Fasteners. Fasteners for steel structural plate shapes shall be high strength bolts ¾-in. (19mm) diameter, hot-dip galvanized, meeting ASTM A449 Quenched and Tempered Steel Bolts and Studs. Nuts shall conform to ASTM A563 Carbon and Alloy Steel Nuts, Grade C. Fasteners for aluminum structural plate shapes shall be ¾-in. (19mm) diameter, hot-dip galvanized steel, meeting ASTM A307 Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength with the zinc coating in accordance with ASTM A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware. Nuts shall conform to ASTM A563, Grade A.

Bolt lengths shall be such as to result in at least "full nuts" when tightened in place.

501.12.7. Anchor Bolts. Anchor bolts for anchoring the ends of structural plate conduits into concrete headwall, footings or toewalls, as shown on the plans, shall be ¾-in. (19mm) diameter conforming to ASTM A307 Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength with the zinc coating in accordance with ASTM A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware. The length, shape and placement of these anchor bolts shall be as shown on the plans or approved by the Engineer.

501.12.8. Identification. No plates shall be accepted unless the metal is identified by a stamp on each plate in accordance with AASHTO M167 for Steel Structural Plate or AASHTO M219 for Aluminum Alloy Structural Plates.

501.12.9. Inspections. If the Engineer so elects, it may have the material inspected and sampled in the rolling mill or in the shop where fabricated. Engineer may require from the mill the chemical analysis of any plate. The inspection, either in the mill or in the shop, shall be under the directions of the Engineer. The Engineer or its representative shall have free access to the mill or shop for inspection and every facility shall be extended to the Engineer or representative for this purpose. Any material which has been previously rejected at the mill or shop and included in a later lot will be cause for rejection unless it has been satisfactorily repaired.

The CONTRACTOR shall furnish an itemized statement of the number and size of plates in each shipment. From this list a visual inspection shall include an examination of the plates for deficiency in size, radius of curvature specified, and any evidence of poor workmanship as outlined herein. The inspection may include the taking of samples for chemical analysis and determination of weight of spelter coating on steel plates. The plates making up the shipment shall fully meet the requirements of these specifications. Any plates failing to do so will be rejected.

501.12.10. Rejection. In addition to the provisions of Item 501.1. Rejection, structures shall be rejected on which the spelter coating has been bruised or broken either in the shop or in shipping, or which shows defective workmanship. The requirement applies not only to the individual plates but also to the shipment on any contract as a whole. Among others, the following defects are specified as constituting poor workmanship, and the presence of any or all of them in any individual culvert plate or in general in any shipment shall constitute sufficient cause for rejection:

(1) elliptical shaping,
(2) variation from a straight centerline,
(3) ragged edges,
(4) unevenly lined or spaced bolt holes,
(5) illegible brands,
(6) bruised, scaled or broken spelter coating,
(7) dents or bends in the metal itself, or
(8) uneven laps.

501.13. TUNNEL LINER PLATES

501.13.1. General. This specification covers the material, galvanizing, coating, shapes and gauge requirements of tunnel liner plates for use in tunneling under railroads, highways and streets.

501.13.2. Plates. The plates shall be fabricated from steel sheets conforming to the requirements of ASTM A1011 Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability. In addition, the flat plates before cold forming shall have mechanical properties indicated in Table 501.13.2.1.(a) Tunnel Liner Plate Requirements.

501.13.2.1.(a) Tunnel Liner Plate Requirements

Property	Minimum Value
Tensile Strength	42,000-psi (2953-kg/cm^2)
Yield Strength	28,000-psi (1967-kg/cm^2)
Elongation, 2-in. (51mm)	30-percent

501.13.3. Bolts and Nuts. Bolts used with lapped seam type (2 flange) liner plates shall be not less than $^5/_8$-in. (15mm) diameter. Bolts shall conform to ASTM A449 Quenched and Tempered Steel Bolts and Studs for plate thickness equal to or greater than 0.209-in. (5mm) and to ASTM A307 Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength for plate thickness less than 0.209-in. (5mm). Nuts shall conform to ASTM A307.

Bolts and nuts used with the four-flanged type shall be not less than $^1/_2$-in. (12mm) for 7-gauge plates and lighter and not less than $^5/_8$-in. (15mm) diameter for plats heavier than 7-gauge. The bolts and nuts shall be quick acting coarse thread and shall conform to ASTM A307, Grade A.

501.13.4. Fabrication. The plates shall be new and unused prior to fabrication. All plates shall be punched for bolting on both longitudinal and circumferential seams or joints and shall be so fabricated as to permit complete erection from the inside of the tunnel. All plates shall be of uniform fabrication and those intended for one size tunnel shall be interchangeable.

501.13.5. Grout Holes. One-half of the total number of the top plates shall be equipped with 2-in. (50mm) diameter grout holes to facilitate grouting above and around the tunnel liner conduit. All grout holes shall be equipped with screw type galvanized plugs for final watertight closure of the grout holes.

501.13.6. Galvanizing. After the plates are formed to shape and after all holes are punched, the plates shall be galvanized on all surfaces by the hot-dip process. A coating of prime western spelter or equal shall be applied in accordance with ASTM A123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products. Spelter coating shall be of first-class commercial quality free from injurious defects such as blisters, flux and uncoated spots. All nuts shall be galvanized to conform to ASTM A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

501.13.7. Bituminous Coating. The plates shall be given a bituminous coating meeting the current American Railway Engineering & Maintenance of Way Association specification or ASTM A849 Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe. Bituminous protected corrugated metal pipe or plates may be spray-coated in the field with a minimum dry film thickness of 0.05-in. (1.3mm) prior to installation.

501.13.8. Section Properties. Section properties shall conform to those specified in AASHTO Standard Design Specifications for Highway Bridges, Section 16, Steel Tunnel Liner Plates.

501.13.9. Rejection. Structures on which the spelter coating has been bruised or broken either in the shop or in shipping or which shows defective workmanship shall be rejected. The requirement applies not only to the individual plates but also to the shipment on any contract as a whole. Among others, the following defects are specified as constituting poor workmanship, and the presence of any or all of them in any individual liner plate or in general in any shipment shall constitute sufficient cause for rejection:

(1) uneven laps,
(2) elliptical shaping,
(3) variation from a straight centerline,
(4) ragged edges,
(5) unevenly lined or spaced bolt holes,
(6) illegible brands,
(7) bruised, scaled or broken spelter coating, or
(8) dents or bends in the metal itself.

501.14. POLYVINYL CHLORIDE (PVC) WATER PIPE

501.14.1. General. Unplasticized polyvinyl chloride (PVC) water pipe shall meet the requirements of AWWA Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. through 12 In., For Water, AWWA C900 with cast-iron outside dimensions or AWWA C905 Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameter 14 in. through 48 in., with cast-iron outside dimensions. Laying lengths shall be 20-ft ±1-in. (6m ±2.5cm).

501.14.2. Approvals. PVC water pipe shall be approved by the Underwriters' Laboratories and shall be accepted by the State Fire Insurance Commission for use in water distribution systems in cities and towns of Texas. PVC water pipe shall also bear the seal of approval (or "NSF" mark) of the National Sanitation Foundation Testing Laboratory for potable water pipe.

501.14.3. Dimension Ratio. PVC water pipe shall meet the dimension ratios (DR's) and physical dimensions as shown in AWWA C900 or C905. The pressure classification refers to the maximum hydrostatic pressure to

which the pipe shall be subject in normal operations. DR 21 is a non-standard product in pipe sizes 18-, 20- and 24-inch. 42- and 48-in pipe DRs of 41 and 51 shall not be used for water applications.

501.14.4. Joints. PVC water pipe shall be furnished with gasketed joints. Lubricant used for pipe and fittings assembly shall be nontoxic and shall have no detrimental effect to either gasket or pipe.

501.14.5. Fittings. Fittings for PVC water pipe shall conform to one of the standards Table 501.14.5.(a) PVC Water Pipe Fittings unless otherwise specified. Fittings joints shall be push-on, integrally restrained, or mechanical. Bolts and nuts for mechanical and integrally restrained fittings joints shall be of a high-strength, corrosion-resistant, low-alloy steel and shall conform to ASTM A325 High Strength Bolts for Standard Steel Joints (Type 3) or shall be stainless steel in accordance with ASTM A304.

Table 501.14.5.(a) PVC Water Pipe Fittings Standards

Standard	Topic
AWWA C110 (ANSI A21.10)	Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (76 mm Through 1,219 mm) for Water
AWWA C153	ANSI Standard for Ductile-Iron Compact Fittings for Water Service
AWWA C907	Polyvinyl Chloride (PVC) Pressure Fittings for Water—4 In. Through 8 In. (100 mm Through 200 mm)
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm) for Water Distribution
AWWA C905	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In. (350 mm Through 1,200 mm), for Water Transmission and Distribution

501.15. POLYVINYL CHLORIDE (PVC) PRESSURE-RATED PIPE (SDR SERIES)

501.15.1. General. PVC pressure-rated pipe shall conform to the current ASTM D2241, Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

501.15.2. Material. The pipe shall be made of PVC plastic having cell classifications of 12454, 12454 or 14333.

501.15.3. Joints. Joint tightness shall be tested in accordance with ASTM D3139, Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

501.15.4. Testing. All pipe shall meet ASTM requirements for sustained pressure test, accelerated regression test, burst pressure, flattening and impact resistance.

501.16. MOLECULARLY ORIENTED POLYVINYL CHLORIDE (PVCO) WATER PIPE

501.16.1. General. Unplasticized (PVCO) Water pipe shall meet the requirements of AWWA Standard C909 Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 In. – 12 In. (100 mm-300 mm), for Water Distribution. Laying length shall be 20ft ± 1 inch (6m ± 2.5cm).

501.16.2. Material. PVCO water pipe starting stock shall be made from ASTM D1784 cell class 12454 material, having an Hydrostatic Design Basis (HDB) of 4000-psi (281-kg/cm^2). When orientation is achieved, PVCO pipe will have an HDB of 7100-psi (500-kg/cm^2). The pressure classifications refer to the maximum hydrostatic pressure to which the pipe shall be subject in normal operations.

501.16.3. Dimensions. Dimensions shall conform to the requirements in AWWA C909.

501.16.4. Joints. PVCO water pipe shall be furnished with gasketed joints, meeting ASTM D3139 Joints for Plastic Pressure Pipes using Elastomeric Seals. Lubricant used for pipe and fittings assembly shall be nontoxic and shall have no detrimental effect to either gasket or pipe. Solvent cement shall not be used with PVCO pipe.

501.16.5. Fittings. Fittings for PVCO water pipe shall conform to American National Standard for Gray-Iron and Ductile-Iron Fittings, 3 In. through 48 In., For Water and Other Liquids, AWWA Standard C110 (ANSI A21.10) or AWWA C907 for Polyvinyl Chloride (PVC) Pressure Fittings for Water, 4 In. through 8 In., or AWWA C153 ANSI Standard for Ductile-Iron Compact Fittings for Water Service unless otherwise specified. Fittings joints shall be push-on or mechanical joints. Bolts and nuts for mechanical joints shall be of a high-strength, corrosion-resistant, low-alloy steel and shall conform to High Strength Bolts for Standard Steel Joints, ASTM A325 (Type 3) or stainless steel in accordance with ASTM A304.

501.17. POLYVINYL CHLORIDE (PVC) WASTEWATER PIPE & FITTINGS WITH DIMENSION CONTROL

501.17.1. General. PVC Wastewater Pipe and Fittings shall conform to ASTM D3034 Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings for 4 in. through 15 in. diameter and ASTM F679 Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings for greater than 15 in. diameter.

501.17.2. Material. The pipe shall be made of PVC plastic having cell classification of 12454, 12454 or 12364, and fittings shall be made of PVC plastic having cell classifications of 12454, 12454 or 13343 as defined in ASTM D1784 Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds. Pipe type shall be determined by size as shown in Table 501.17.2.(a) PVC Wastewater Pipe Type.

501.17.2.(a) PVC Wastewater Pipe Type

Pipe Size (diameter)	Type	Standard
4-in. through 15-in. (10cm - 38cm), inclusive	PSM SDR-35 or SDR-26	ASTM D3034
greater than 15-in. (38cm)	T-1 A or T-2 B	ASTM F679

501.17.3. Dimensions. Dimensions shall conform to requirements of ASTM D3034 or F679.

501.17.4. Testing. All pipe shall meet ASTM requirements for flattening, impact resistance, stiffness, joint tightness and extrusion quality as specified in ASTM D3034 or F679.

501.18. POLYVINYL CHLORIDE (PVC) PROFILE GRAVITY WASTEWATER PIPE AND FITTINGS – FOR DIRECT BURY AND SLIPLINING APPLICATIONS

501.18.1. General. This specification designates requirements for PVC plastic gravity wastewater pipe for the conveyance of domestic wastewater with various modified wall profiles and performance requirements.

501.18.2. Stiffness. Minimum pipe stiffness at five percent deflection shall be 46-psi (3.2-kg/cm^2) for wastewater conduit as specified for all sizes when calculated in accordance with ASTM D2412 Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

501.18.3. Pipe Classification. Pipe as indicated on the plans shall conform to one of the standards in Table 501.18.3. PVC Profile Gravity Pipe Standards.

Table 501.18.3. PVC Profile Gravity Pipe Standards

Standard	Topic	Notes
ASTM F789	Type PS-46 PVC Plastic Gravity Flow Sewer Pipe and Fittings, size 4 in. to 18 in.	Pipe conforming to ASTM F789 shall be joint compatible to ASTM D3034 pipe joint dimensions
ASTM F794	PVC Ribbed Gravity Sewer Pipe and Fitting Based on Controlled Inside Diameter, sizes 4 in. through 48 in.	--
ASTM F949	PVC Corrugated Sewer Pipe with Smooth Interior and Fittings, sizes 4 in. through 36 in. (46 psi pipe stiffness) or sizes 8 in. through 15 in. (115 psi pipe stiffness)	--
ASTM F1803	PVC Closed Profile Gravity Pipe and Fittings Based on Controlled Inside Diameter, sizes 18 in. through 60 in.	--

501.18.4. Joints. Joint tightness shall be tested in accordance with ASTM D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

501.18.5. Testing. Pipe shall be tested for flattening, impact resistance and extrusion quality as specified in the applicable ASTM Designations.

501.19. PVC COMPOSITE PIPE FOR WASTEWATER CONDUITS

501.19.1. General. PVC composite pipe shall conform to ASTM D2680 Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping for 8 in. through 15 in diameter. Acylonitrile-Butadiene-Styrene (ABS) shall not be allowed.

501.19.2. Joints, Couplings and Fittings. Wyes or tees with saddle shall be provided as indicated on the plans. Adapters to other types of pipe shall be supplied as indicated on the plans.

501.19.2.1. Chemically Welded Joints. If the pipe is plane ended with couplings, the pipe shall be delivered prebelled. Sufficient primer and solvent cement shall be provided. The solvent cement shall conform to ASTM D2564 Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.

501.19.2.2. O-Ring Joints. If the pipe is prebelled with an enlarged coupling, an O-Ring shall be provided for each joint. The physical properties of the gasket shall be at least equal to the requirements of ASTM C443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

501.19.3. Tests. The pipe stiffness at five-percent vertical deflection shall be at best equal to or exceed 200-lb./in. (3612-g/cm) of deflection for each diameter as determined by ASTM D2412 Test Method for Determination

of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading. The physical test may be the 3-Edge Bearing Method under applicable ASTM Designation if preferred.

501.20. POLYVINYL CHLORIDE (PVC) CORRUGATED STORM WATER PIPE WITH A SMOOTH INTERIOR AND FITTINGS

501.20.1. General. PVC Corrugated storm water pipe and PVC Perforated Corrugated drainpipe shall conform to ASTM F949 Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings (4"-36").

501.20.2. Material. The storm water conduit/drainpipe shall be of PVC compound having a minimum cell classification of 12454 in accordance with ASTM D1784 Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds. The fittings shall be made of PVC compound having a cell classification of 12454 or 13343 as defined in ASTM D1784.

501.20.3. Stiffness. Constant minimum pipe stiffness at five-percent deflection shall be 46-psi (3.2-kg/cm^2) for storm conduit as specified for all sizes when calculated in accordance with ASTM D2412 Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

501.20.4. Joints. Joints shall be an integral bell-gasketed joint. When the joint is assembled, it shall prevent misalignment of adjacent pipes and form either a soil tight joint (2-psi hydrostatic test per AASHTO Standard Specification for Highway Bridges, Section 26.4.2.4) or a watertight joint (10.8-psi test per ASTM D3212 Standard Specification for Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals) as required.

501.20.5. Testing. Pipe shall be tested for flattening, impact resistance and extrusion quality as specified in the applicable ASTM Designations.

501.21. SOLID WALL POLYETHYLENE PLASTIC PIPE FOR WATER, WASTEWATER, AND PIPE REHABILITATION

501.21.1. General. Pipe and fittings shall conform to the material and physical properties as described in ASTM F714 Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter, unless otherwise specified herein or in the special specifications. Standard Lengths shall be 40-ft (12m) or 50-ft (15m) for straight pipe. Coiled pipe may be obtained in reels of 500-ft (152m), 1000-ft (305m) or 1500-ft (457m) depending on outside diameter and Dimension Ratio (DR) requested.

Solid wall high density polyethylene pipe (HDPE) for pressure water pipe shall meet the requirements of AWWA C901 Polyethylene (PE) Pressure Pipe and Tubing, ½ In. (13 mm) Through 3 In. (76 mm), for Water Service or AWWA C906 Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,575 mm), for Water Distribution.

501.21.2. Material. Pipe and fittings shall be made of high density, high molecular weight polyethylene pipe PE3408 material, polyethylene resin which conforms to Polyethylene Plastics Molding and Extrusion Materials, meeting the requirements of Type III, Grade P33, as defined in ASTM D3350 Polyethylene Plastics Pipe and Fittings Materials. The polyethylene plastic shall meet the Cell Classification requirements of 345464C or 345464E as defined in ASTM D3350. Pipe for non-pressure applications shall have a light colored interior, unless otherwise specified in the plans, contract documents or purchase request.

501.21.3. Dimensions. The polyethylene (PE) pipe shall meet the dimension ratios and outside diameter, wall thickness and tolerances as provided in the reference specifications of manufacture as listed in Table 501.21.3.(a) Solid Wall PE Pipe Dimension Standards. Diameters and wall thickness other than those shown in the standards may be used if specifically called for in the plans, contract documents or purchase request, and if they are mutually agreed upon by the manufacturer and OWNER.

Table 501.21.3.(a) Solid Wall PE Pipe Dimension Standards.

Standard	Topic
AWWA C901	Polyethylene (PE) Pressure Pipe and Tubing, ½ in Through 3 in for Water Service
AWWA C906	Polyethylene (PE) Pressure Pipe and Fittings, 4in through 63in for Water Distribution and Transmission
ASTM D2239	Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
ASTM D2737	Polyethylene (PE) Plastic Tubing
ASTM D3035	Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM F714	Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter

501.21.4. Joints. Dependent upon installation requirements, site location, and weather conditions, joining shall be performed within or outside the excavation.

Sections of polyethylene pipe and fittings shall be joined by the butt fusion process, unless one of the alternate methods is approved by the OWNER. The butt (heat) fusion method shall be performed in accordance with the pipe manufacturer's recommendations. Electrofusion fittings may be used. Mechanical joint adapters, flanges, unions, grooved-couplers, transition fittings, and some mechanical couplings may be used to mechanically connect PE pipe/tubing and fittings. Extrusion welding or hot gas welding of PE shall not be used for pressure pipe application or fabrications where shear or structural strength is important.

501.21.4.1. Alternate Methods. When approved by the OWNER, pipe may be joined to one another and to polyethylene fittings by electrofusion or socket thermal fusion joints in accordance with ASTM D2657 Heat Joining of Polyolefin Pipe and Fittings, ASTM F1290 Electrofusion Joining of Polyolefin Pipe and Fittings, and as recommended by the pipe manufacturer.

501.21.5. Tests and Requirements. Tests for compliance with this specification shall be made as specified herein and according to the applicable ASTM or AWWA Standard(s). All polyethylene pipe shall be tested for brittleness, joint separation, quality and ring stiffness as specified in the applicable ASTM or AWWA Standard(s). A certification of compliance with this specification shall be furnished by the manufacturer for all material furnished under this specification. In addition, the OWNER may, at its own expense, witness inspection and test of the materials.

501.21.5.1. Tensile Properties. The tensile strength, yield strength, elongation and elastic modulus of the material shall be determined in accordance with Tensile Properties for Plastics, ASTM D638 (D 638M).

501.21.5.2. Hydrostatic Properties. The long term hydrostatic strength rating shall be listed in the name of the pipe and fittings manufacturer in PPI (Plastic Pipe Institute) TR-4, Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Pipe and Fittings compounds, with a standard grade HDB rating of 1600-psi (112-kg/cm^2) at 73°F (23°C).

501.21.5.3. Melt Index. The melt index of the polyethylene plastic, as determined in accordance with ASTM D1238 Flow Rates of Thermoplastics by Extrusion Plastometer, shall meet the requirements as specified in ASTM D3350 Cell Classification of 4.

501.21.5.4. Density. The density of the polyethylene plastic, as determined in accordance with ASTM D1505 Density of Plastics by the Density - Gradient Technique shall have specific base resin densities meeting the requirements as specified in ASTM D3350 Cell Classification 3.

501.21.5.5. Environmental Stress Cracking Resistance. The environmental stress cracking resistance (ESCR) of the material shall meet the requirements as specified in ASTM D3350 Cell Classification of 6 using ASTM F1473 (PENT) or meet a Cell Classification of 4 according to ASTM D1693.

501.21.5.6. Wastewater Pipe Stiffness. Minimum pipe stiffness at five-percent deflection shall be 46-psi (3.2-kg/cm^2) for all sizes of gravity and pressure wastewater conduits as specified in Section XI "Deflection Control In Unpressurized Polyethylene Piping Systems," Table X1.1 "Pipe Stiffness Ranges for Specified Materials" and DR's of ASTM F714.

501.22. POLYETHYLENE (PE) LARGE DIAMETER WASTEWATER PIPE WITH MODIFIED WALL PROFILES AND PERFORMANCE STANDARDS

501.22.1. General. High Density Polyethylene gravity wastewater pipe and fittings in nominal sizes 18-in. through 120-in. (46cm – 305cm) with integral bell joints shall conform to current ASTM F894 Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe.

501.22.2. Materials. The pipe and fittings shall be made of high density, high molecular weight polyethylene pipe material meeting the requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D3350 Polyethylene Plastics Pipe and Fittings Materials with a minimum cell classification of 345444C.

501.22.3. Stiffness. Minimum pipe stiffness at five-percent deflection shall be 10-psi (0.7-kg/cm^2) for wastewater as specified for all sizes when calculated according to Appendix XI, "Relation of RSC To Pipe Properties and Pipe Stiffness" of ASTM F894.

501.22.4. Joints. Joint tightness shall be tested in accordance with ASTM D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

501.22.5. Testing. Pipe shall be tested for flattening, quality and ring stiffness as specified in the applicable ASTM Designations.

501.23. POLYETHYLENE (PE) CORRUGATED DRAINAGE TUBING AND CORRUGATED SMOOTH LINED STORM WATER PIPE AND FITTINGS

501.23.1. General. High Density Corrugated and Corrugated Smooth Lined Polyethylene storm water tube/pipe and fittings shall conform to current AASHTO Designations as follows: AASHTO M-252, Corrugated Polyethylene Drainage Tubing (3"-10" (75 mm – 250 mm)) or AASHTO M-294, Corrugated Polyethylene Pipe (12"- 48" (300 mm-1200 mm)). Profile wall HDPE pipe shall conform to ASTM F894 Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe.

501.23.2. Materials. The tube/pipe and fittings shall be made of virgin polyethylene which conforms with the requirements of cell class 335400C as defined and described in ASTM D3350 Polyethylene Plastics Pipe and Fittings Materials.

501.23.3. Stiffness. Minimum tube/pipe stiffness at 5-percent deflection shall be 50-psi (3.5-kg/cm^2) for 3-in. through 10-in. (76mm – 254mm) diameters and as outlined in Section 7.4 of AASHTO M-294 for other diameters. Profile wall HDPE pipe shall have minimum RSC Class equal to 40.

501.23.4. Joints. Joint integrity shall be tested in accordance with ASTM F667 Large Diameter Corrugated Polyethylene Pipe and Fittings, Section 9.6 for PE corrugated pipe up to 24" or AASHTO M-294 and M-252 for smooth-lined corrugated pipe. Profile wall HDPE pipe joints shall be made and tested in accordance with ASTM D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

501.23.5. Testing. All polyethylene tubing/piping shall be tested for elongation, brittleness, joint separation, quality and ring stiffness as specified in the applicable AASHTO M-294, AASHTO M-252 or ASTM F894, as applicable.

501.24. FIBERGLASS (GLASS-FIBER-REINFORCED THERMOSETTING-RESIN) WASTEWATER PIPE

501.24.1. General. This specification designates requirements for fiberglass glass-fiber reinforced thermosetting-resin pipe (RTRP) sizes from 8-in. to 144-in. (20cm – 366cm) for the conveyance of wastewater. Pipe for gravity application shall conform to ASTM D3262 for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe. Pipe for force main applications shall conform to or ASTM D3754 for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe. If ASTM D3754 pipe is selected, its actual outside diameter shall be in accordance with AWWA C950 Fiberglass Pressure Pipe.

501.24.2. Stiffness. Minimum pipe stiffness at 5-percent deflection shall be 46-psi (3.2-kg/cm^2) for gravity and pressure wastewater conduit and 36-psi (2.5-kg/cm^2) for gravity sliplining applications as specified for all sizes when calculated in accordance with ASTM D2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

501.24.3. Joints. Joint tightness shall be tested in accordance with ASTM D4161 for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals.

501.24.4. Fittings. Fittings shall conform to ASTM D5685 Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe Fittings or D3840 Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Nonpressure Applications.

501.24.5. Testing. Pipe shall be tested for inside and outside diameter, wall thickness, squareness of pipe ends, chemical requirements, stiffness, beam strength as specified in the respective ASTM D3681 Test Method for Chemical Resistance of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe in a Deflected Condition, ASTM D2412 Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading, and ASTM D3262 Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.

ITEM 502. APPURTENANCES

502.1. MANHOLES

502.1.1. Manhole Materials. Manholes shall be fabricated in different configurations to meet the specific needs required in the water or wastewater or storm water system.

502.1.1.1. Precast Reinforced Concrete Manhole Sections. These specifications cover precast reinforced concrete manhole sections, which shall conform to ASTM C478 (C478M) Precast Reinforced Concrete Manhole Sections, with the following additions:

(1) All pipe shall be machine made by a process that shall provide for uniform placement of zero slump concrete in the form and compaction by mechanical devices which shall assure a dense concrete in the finished product, except that reducer cones may be wet-cast.

(2) Aggregates for the concrete shall comply with requirements of ASTM C33 Concrete Aggregates, with the additional requirement that the aggregate shall have a minimum of 50-percent of calcium carbonate equivalent.

(3) Minimum wall thickness for the manhole risers shall be as listed under Wall "B" in the "Class Tables" of ASTM C76 (C76M) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.

(4) Unless otherwise noted, manhole steps shall not be furnished. If required, the steps shall be of the noncorrosive plastic or rubber coated steel type, with a clear cleat space of 10 in. (25.4 cm) minimum that shall support a concentrated load of 300 pounds (136.2 kg), and be in accordance with applicable OSHA specifications.

(5) Resilient connectors between reinforced concrete manhole structures and pipes shall meet the requirements of ASTM C923 Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals or ASTM C443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets. The resilient connector shall provide an airtight seal that eliminates infiltration and exfiltration.

502.1.1.1.1. Joints. Joints shall conform to the joint specification ASTM C478 Precast Reinforced Concrete Manhole Sections (C478M). All joints shall have rubber gaskets. Rubber gaskets shall meet the requirements of Item 501.5.4.1. Rubber Gaskets.

502.1.1.1.2. Coatings and Linings. Coatings and linings called for in the specifications or shown on the plans shall meet the requirements as specified by the OWNER and shall be installed or applied by the manufacturer.

502.1.1.1.3. Lifting Devices. Manhole sections and cones may be furnished with lift lugs or lift holes. If lift lugs are provided, they shall be 180° apart. Cast-in-place nuts must have clean threads capable of inserting lug bolts. OWNER shall approve the lift lug design. If lift holes are provided, they shall be plugged with a nonmetallic nonshrink grout approved by the OWNER. Field repairs shall not be allowed.

502.1.1.1.4. Rejection. Manhole sections shall be subject to rejection on account of failure to conform to any of the requirements specified herein or having defects as follows:

(6) Variations in any dimensions exceeding the permissible variation prescribed.

(7) A piece broken out of the bell, spigot, tongue or groove in such size that the watertightness of the joint should be impaired.

(8) Any shattering or flaking of concrete or other conditions indicating an improper concrete mix.

(9) Lack of uniformity in placement steel which might preclude all joints being typical of those tested.

(10) Cracks sufficient to impair the strength, durability, or serviceability of the pipe.

(11) Joint sections with spalls, cracks, fractures, or other imperfections that could adversely affect the performance of the joint.

502.1.1.2. Fiberglass Manholes. Fiberglass manholes shall conform to all ASTM standards governing plastic laminations and ASTM D3753, Glass-Fiber-Reinforced Polyester Manholes and Wetwells, with supplementary details or additions as set forth in these specifications.

502.1.1.2.1. Manufacturing. The barrel and cone shall each be produced in a continuous manufacturing process that insures continuous reinforcement and uniform strength and composition. The cone section, if produced separately, shall be affixed to the barrel section at the factory with a reinforced glass resin joint resulting in a one-piece unit. Field made joints shall not be acceptable.

502.1.1.2.2. Manhole Configuration. The manhole shall be a circular cylinder with a minimum internal diameter of 4-ft. (1.2m). The cone of the manhole shall have a bearing surface wide enough to facilitate the placement of adjustment rings. The ring and cover shall not be placed directly on the manhole. The manway reducer shall be concentric with respect to the manhole cylinder. Eccentric manway reducers shall not be permitted. Manhole gaskets shall be used to ensure a watertight assembly.

502.1.1.2.3. Testing. All tests included in Glass Fiber-Reinforced Polyester Manholes, ASTM D3753, shall be required. Manufacturer shall provide OWNER a product certification if requested. This certification shall confirm the fiberglass manhole provided is in compliance with the testing requirements outlined in the ASTM standard.

502.1.1.2.4. Rejection. Any fiberglass manhole shall be subject to rejection for failure to conform to any of the requirements of these specifications. Any manhole found to be defective or damaged resulting from improper handling or installation shall be removed and replaced at no additional expense to the OWNER. Patching shall not be acceptable.

502.1.2. Grade Adjustment Risers. Casting may be raised or final grade adjustment of access covers and frame assemblies made using adjustment risers. Risers may be concrete, polyethylene, metal, or rubber meeting requirements below or other materials as approved by the OWNER. OWNER shall specify material. Adjustment risers shall be tested to assure compliance with impact and loading requirements of the AASHTO Standard Specification for Highway Bridges. To determine the suitability of a specific ring or frame and to insure a proper fit, the dimensions of the existing frames, grates and covers must be verified by the CONTRACTOR and provided to the supplier prior to fabrication of the adjustment rings and frames.

Installed grade adjustment risers and riser assemblies shall fit within the existing casting without interference, cause no binding to the manhole lid, be immobile and watertight. Manhole lids shall have bearing on all of the surface of inner ring(s).

502.1.2.1. Precast Concrete Adjustment Riser. Concrete adjustment risers shall be precast, reinforced concrete meeting requirements of ASTM C478 Precast Reinforced Concrete Manhole Sections. Preformed flexible gaskets shall be used below each riser.

502.1.2.2. HDPE Adjustment Riser. The HDPE adjustment risers shall be manufactured from high density polyethylene plastic as identified in ASTM D1248 Polyethylene Plastic Molding and Extrusion Materials. They may be molded from 100% recycled HDPE material or have other recycled HDPE material content. Material properties shall be tested and qualified for usage according to the test methods in ASTM D1248. HDPE risers shall be manufactured using the injection molding process as defined by the Society of Plastic Engineers.

502.1.2.3. Metal Adjustment Riser.

502.1.2.3.1. Steel. Inner riser rings shall consist of ¾" (1.9cm) thick domestic steel meeting the requirements of ASTM A36 Carbon Structural Steel. Intermediate and outer rings shall be one of the combinations indicated in Table 502.1.2.3.1.(a) Steel Adjustment Risers, as specified by the OWNER.

Table 502.1.2.3.1.(a) Steel Adjustment Risers

Intermediate ring	Outer ring	Type
none	ASTM A36 steel ½" thick	solid
ASTM A36 12-gauge steel	½" x ½" surrounding intermediate ring at finished elevation	solid
none	ASTM A36 steel ½" thick	Adjustable[1]
ASTM A36 steel ⅛" thick	½" x ½" surrounding intermediate ring at finished elevation	Adjustable[1]

1. Adjustment devices for adjustable steel risers shall be fabricated from stainless steel, have a positive lock, and be in line with the lower bearing bar. It shall be capable of adjustment ±⅜" from nominal.

Rings shall be fabricated to $\pm^{1}/_{16}$" concentricity. The outer riser ring shall have an inside diameter no greater than $^{3}/_{16}$" larger than the outside diameter of the manhole lid. All materials shall be bituminous asphalt coated.

Certified welders shall securely weld rings in accordance with American Welding Society D1.5 Bridge Code to prevent differential movement between rings under traffic loads.

502.1.2.3.2. Iron. Gray iron adjustment risers shall be manufactured from iron conforming to ASTM A48 Gray Iron Castings, Class 35B, in accordance with AASHTO M306. Ductile iron adjustment risers shall be manufactured from iron conforming to ASTM A536 Ductile Iron Castings, Grade 70-50-05.

502.1.2.4. Rubber Adjustment Riser. The adjustment risers shall be manufactured from a mixture of rubber and appropriate additives to create a flexible product that will not rot, chip or break, and is resistant to moisture, oil and other common automotive chemicals. Product shall be stable under a wide range of temperatures and resistant to temperature fluctuations. Rubber adjustment risers may be produced with recycled rubber content. Results of the tests listed in Table 502.1.2.4.(a) Rubber Adjustment Riser Tests shall be provided to the OWNER.

Table 502.1.2.4.(a) Rubber Adjustment Riser Tests

Property	ASTM Test Method	Topic
Density	C642	Test Method for Density, Absorption, and Voids in Hardened Concrete
Durometer hardness, molded and interior surfaces	D2240	Rubber Property-Durometer Hardness
Tensile strength	D412	Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers-Tension
Compression deformation, initial and final	D575	Rubber Properties in Compression
Compression set	D395	Rubber Property-Compression Set
Freeze and thaw when exposed to deicing chemicals	C672	Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals
Coefficient of thermal expansion	C531	Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes
Weathering (70 hours at 70 C)	D573	Rubber-Deterioration in an Air Oven

502.1.3. Frame and Cover. Frame (Ring) and cover shall meet the requirements of Item 806.4.1.2. Iron Castings.

502.1.4. Manhole Construction. TCEQ regulations shall take precedence in the case of conflict between these specifications and TCEQ regulations.

Manholes shall be of sufficient inside diameters to allow personnel to work within them and to allow proper joining of the pipes in the manhole wall. Unless otherwise specified, manholes shall have an inside diameter of 48-inches (1.2m). The inside diameter of manholes shall be not less than 48-inches (1.2m).

Manholes constructed in advance of paving projects shall be constructed with the top of the concrete portion of the manhole 23-inches (58cm) below the final finished grade. The ring and cover shall be placed on a built-up section of approved grade rings and approved sealers between rings and between rings and other materials. Manholes shall be watertight. The type and size, if greater than 4-feet (1.2m) inside diameter, shall be shown on the plans for each location. The CONTRACTOR shall furnish all appropriate equipment and access required for inspection.

502.1.4.1. Manhole Types and Requirements. Manholes in water lines shall be Cast-In-Place or Precast as described below and as shown in Division 5000 Standard Drawings. Manholes in wastewater service lines may be any of those described below, also shown in Division 5000 Standard Drawings. Manholes in storm sewers shall be Cast-In-Place, Precast, or constructed according to Standard Drawing 6010A-B. Storm sewer junction boxes shall be constructed according to Standard Drawing 6010A-B or constructed according to engineered plans. Manholes may be standard or shallow, as specified by the OWNER.

502.1.4.1.1. Cast-In-Place. The base, wall and cone shall be Class F or Class PF concrete as specified by the OWNER, in conformance with Item 702. Concrete Structures, poured and vibrated to assure a monolithic structure free from infiltration. Typical requirements are shown in Standard Drawing 5030. Manufacturer shall submit shop drawings for OWNER approval. Construction joints with waterstops must be approved by the OWNER.

502.1.4.1.2. Precast. Precast manholes shall conform to the requirements of Item 502.1.1.1. Precast Reinforced Concrete Manhole Sections. Typical requirements are shown in Standard Drawing 5020. The base shall be Class F or Class PF concrete as specified by the OWNER, in conformance with Item 702. Concrete Structures. The precast sections shall be of the bell-and-spigot design incorporating tapped O-ring gaskets, or tongue-and-groove with a trapped gasket (water or storm water) or premolded joint sealing compound (wastewater.) Premolded joint sealing compound may be used for water line manholes only when approved by the OWNER. Prior to placing each section of manhole riser or cone, the bells and spigots to be joined shall be thoroughly cleaned, the gasket properly placed, lubricated and the joint pushed home. Combination of joints shall be selected to minimize the number of individual segments. Long joints shall be used in the bottom and shorter segments utilized for top adjustments. Lift holes may be used but must be filled with a nonshrink grout after the section is in place.

502.1.4.1.3. Fiberglass. Fiberglass manholes shall conform to the requirements of Item 502.1.1.2. Fiberglass Manholes. The fiberglass portion of the manhole shall be delivered in one piece. Field jointing shall not be permitted. Fiberglass manholes shall be installed in accordance with the manufacturer's recommendation and with supplementary details, additions or exceptions as directed by the OWNER and/or as shown on the plans. Typical requirements are shown in Standard Drawing 5040. The base shall be Class F or Class PF concrete as specified by the OWNER. A minimum of 8 holes ⅝-in. (1.6cm) in diameter shall be drilled equi-distantly around the periphery of the manholes at a distance 4-in. (10cm) from the bottom for use in inserting #4 reinforcing bars to be keyed into the concrete base to prevent the manhole from floating. All holes shall be sealed around the reinforcing steel to prevent leakage.

502.1.4.1.4. Drop. Drop manholes shall be constructed in accordance with details on the plans. Typical requirements are shown in Standard Drawings 5070 and 5080. The basic construction for drop manholes shall be identical to that described for standard manholes preceding with special provisions incorporated to provide drop piping and appurtenances as detailed.

502.1.4.1.5. Pressure Type. Pressure type manholes (sealed manholes) shall be constructed in accordance with Standard Drawing 5050 unless otherwise shown on the plans.

502.1.4.1.6. Standard Manhole. Standard manholes shall be constructed to the proper elevation as required and to a depth of at least 6-ft. (1.8m) above the invert of the main(s) or lateral(s) in the system.

502.1.4.1.7. Shallow Manhole. Shallow manholes shall be constructed for specific locations in a storm sewer system for depth less than 6-ft. (1.8m) when specifically designated on the project plans, or when so directed by the OWNER.

502.1.4.2. Vents. When specified, vents shall be constructed as shown in Standard Drawing 5060 unless the OWNER provides details for vent construction.

502.1.4.3. Invert. The invert of standard manholes shall be formed in a typical pattern regardless of the wall construction.

502.1.4.3.1. Flow Channel. When specified in the special provisions or in the plans, the pipe shall be laid through the manhole stations where possible, prior to concreting, so that the full depth of the pipe is embedded in concrete to form the flow channel.

502.1.4.3.2. Flow Channel Alternate. Where pipe cannot be used through the manhole due to intersecting flow channels, flow channels equivalent to the top of pipe shall be formed with concrete, then troweled to a smooth, even finish with a steel trowel.

502.1.4.3.3. Manhole Bottom. The manhole bottom from wall line to flow channels shall be sloped and troweled smooth on a grade of 1-in.-per-foot (2.5cm-per-30cm) with a liberal radius applied at flow channel intercepts.

502.1.4.4. First Full Joint. The first full joint of pipe extending from the manhole shall be cradled in concrete to the pipe joint in the same pour as that for the manhole base slab as shown on the plans.

502.1.4.5. Grade Adjustment Risers. Installation of risers shall be shown on the plans. Grade risers and sealers shall be approved by the OWNER. Risers may be of concrete, polyethylene, metal, rubber or other materials meeting the requirements of Item 502.1.2. Grade Adjustment Risers. The minimum number of risers required of the type approved shall be used. The manhole and grade adjustment shall form a watertight assembly. Tapered adjustment risers shall be used to match road grade. The annular space between risers and cone basin, between risers and cover frame, and between multiple risers shall be sealed using an approved sealant. Butyl sealant shall be used for HDPE.

502.1.4.6. Covers. Manhole covers shall be detailed on the plans. Manhole covers of nominal 24-inch (61cm) or larger diameter are required for all manholes where personnel entry is anticipated. Manholes located within the 100-year floodplain shall have gasketed and bolted covers, or have another means of preventing inflow.

Installation of covers shall be shown on the plans. For all manhole installations in the streets, the manhole covers shall be provided with pick slots or bars in lieu of pick holes. If the rim elevation above surrounding ground is prohibited by land use or other reasons, a cover with a pick slot or bar as described for use in street locations shall be used.

502.1.4.7. Concrete Pad. A 5-ft. by 5-ft. (1.5m x 1.5m) square concrete pad shall be constructed as shown on the plans for manhole installation outside of paved areas.

502.1.5. Manhole Testing. Manholes shall be tested by hydrostatic exfiltration or vacuum testing, or other method as approved by TCEQ and determined by the OWNER. Manholes shall be tested after installation with all connections (existing and/or proposed) in place. Drop-connections and gas sealing connections shall be installed prior to testing.

502.1.5.1. Exfiltration Testing Manholes. The rate of exfiltration for manhole testing shall not exceed 0.025-gallons per foot diameter per foot of manhole depth per hour (1L per m diameter per meter depth per hour).

Alternative test methods shall ensure compliance with the above allowable leakage. Hydrostatic exfiltration testing shall be performed as follows: All wastewater lines coming into the manhole shall be sealed with an internal pipe plug, then the manhole shall be filled with water, and maintained full for at least 1-hour. For concrete manholes a wetting period of 24-hours may be used prior to testing in order to allow saturation of the concrete. If the manhole fails the hydrostatic test, the manhole shall be repaired and retested until it passes the test.

502.1.5.2. Vacuum Testing Manholes. Vacuum testing of manholes shall be performed by the CONTRACTOR in compliance with these specifications. All lift holes and exterior joints shall be plugged with a non-shrink grout. No grout shall be placed in horizontal joints prior to testing. All pipes entering the manhole shall be plugged. Stubouts, manhole boots, and pipe plugs shall be secured to prevent movement while the vacuum is drawn. A minimum 60-inch/lb (336-cm/kg) torque wrench shall be used to tighten the external clamps that secure the test cover to the top of the manhole. The test head shall be placed at the inside of the top of the cone section, and the seal inflated in accordance with the manufacturer's recommendations. A vacuum of 10-inches-of-mercury (34-kPa) shall be drawn, and the vacuum pump shut off. With all valves closed, the time for the vacuum to drop to 9-inches-of-mercury (30-kPa) shall not be less than the time indicated in Table 502.1.5.2.(a) Vacuum Drop Minimum Time.

Table 502.1.5.2.(a) Vacuum Drop Minimum Time

Depth of MH (feet)	Depth of MH (m)	Manhole Diameter		
		48" (1.2m)	60" (1.5m)	72" (1.8m)
		Minimum Time Required for a Vacuum Drop of 1" Hg (4-kPa) (min:sec)		
0 – 20	0 – 6	0:40	0:50	1:00
22	6.7	0:44	0:55	1:06
24	7.3	0:48	1:00	1:12
26	7.9	0:52	1:05	1:18
28	8.5	0:56	1:10	1:24
30	9.1	1:00	1:15	1:30
See note 1.	See note 1.	0:04	0:05	0:06

1. Additional 2-ft. (0.6m) depths, add indicated time for each 2-ft. (0.6m).

Manholes shall be accepted with relation to vacuum test requirements if they meet the criteria above. Any manhole that fails the initial test must be repaired with a non-shrink grout or other suitable material based on the material from which the manhole is constructed. The manhole shall be retested as described above until a successful test is made. After a successful test, the temporary plugs shall be removed.

502.1.6. Measurement and Payment of Manholes. Measurement and payment for manholes shall be on a per each basis and shall cover all costs for the structure complete in place as designed. Included shall be all excavation, castings, reinforcing steel, concrete, backfill, and other materials, and all appurtenances for a complete and functional unit.

Payment for grade adjustment for existing manholes shall be measured and paid per each manhole.

The payment for extra depth in excess of the basic manhole depth shall be made under a separate item of bid as defined herein. If a separate bid item is not established in the contract, there shall not be any payment for extra depth, and the manhole shall be paid for as per each regardless of the depth. Unless specified otherwise, only one bid item shall provide payment for extra depth of manhole structures in excess of the basic depth for all types of manholes under consideration. Such extra depth shall be allocated on the total depth of all manholes, excluding shallow manholes, specified for the project. Payment for extra depth of the various types of manholes shall be at a unit price bid per linear foot (m) of additional depth, measured to the nearest $^{1}/_{10}$ ft. (3 cm) over the basic depth stipulated for the type manholes under bid. A standard manhole is 6-ft. (1.8m) deep measured form the top of the manhole cover to the flow line of the invert. A shallow manhole is less than 6-ft. (1.8m) deep as measured above.

The contract price shall be the total compensation for the furnishing of all labor, materials, tools, equipment and incidentals necessary to complete the work, including earth excavation, disposal of surplus materials and backfill, all in accordance with the plans and these specifications.

502.2. WASTEWATER MAIN CLEANOUTS

Cleanouts shall be constructed in accordance with the plans and these specifications for materials and construction.

502.2.1. Typical Cleanout. Typical cleanout requirements are shown in Standard Drawing 5110.

502.2.2. Access (Cleanout/Sampling) Chambers. An access chamber may be specified in a wastewater or storm drainage situation that requires access for maintenance and inspection equipment without human entry. Chamber may be used in lieu of cleanouts, dead-end manholes or sampling ports.

The chamber body shall be a one-piece, rotational molded polyethylene unit that is corrosion resistant, lightweight, and designed for use in traffic and non-traffic locations where sewer pipe is 6", 8", 10" or 12" (15-, 20-, 25-, or 30-cm) in diameter. The chamber shall be adaptable to clay, cast iron, ductile iron, PVC, and/or concrete pipe through use of an eccentric coupling. Such coupling shall be provided with the chamber or recommended by the chamber manufacturer and readily obtainable.

502.2.2.1. Composition and Characteristics. The wastewater access chamber shall be rotational molded of 100% virgin, hexane-based, Linear Low Density Polyethylene meeting the minimum standards in Table 502.2.2.1.(a) Access Chamber Requirements.

Table 502.2.2.1.(a) Access Chamber Requirements

Characteristic	Test Method	Value
Density	ASTM D1505	0.936-grams/cm^3 (0.03-lb/in^3)
Tensile Strength @ Yield	ASTM D638	2490-psi (175-kg/cm^2)
Flexural Modulus	ASTM D790	87,000-psi (6120-kg/cm^2)
Heat Distortion @ 66psi Load	ASTM D648	151°F (66°C)
Low Temp. Impact @ 125 mils Thick	ARM Std. (B)	45-ft.-lbs. (6.2-m-kg)
Environmental Stress Corrosion Cracking (ESCR), 100% Igepal	ASTM D1693	> 1000-Hours
Wall thickness	-	minimum 0.375" (9.5mm)

Additionally, at minimum, size and dimensions shall be sufficient to accommodate insertion of 36" (91cm) long, standard tractor type closed-circuit TV cameras and manufactured within a 0.50-inch (1.3cm) tolerance of required dimensions. Chamber shall be manufactured with no seams or welds. Chamber interior shall be white or cream color for visibility. Bottom of chamber shall form a channel (invert) with minimal flow disruption. Top of chamber shall have capability of accepting 18" (46cm) sewer pipe and gasket. Outlets and inlets shall be male (spigot) type extensions connecting to existing or new piping systems with eccentric reducing couplings. Spigot sizes of chamber shall be in accordance with ASTM D3034 Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings, SDR 35 Sewer Pipe sizing.

502.2.2.2. Access Chamber Installation. Installation shall conform to manufacturer recommendations, with supplemental requirements contained herein. Chamber assembly including lid shall be watertight. Appropriate flexible couplings shall be used between chamber coupling and pipe. Couplings shall be attached and sized prior to lowering chamber into trench. All gaskets including those included with lid shall be properly seated, and CONTRACTOR shall insure that gaskets are not rolled or twisted. Embedment (bedding and backfill) material as provided for surrounding pipe shall be provided for chamber compacted to a minimum 80% Proctor Density, unless the OWNER specifies otherwise. Embedment material shall be prevented from entering chamber.

Two 3" (7.6cm) minimum thickness grade rings shall be included in the access chamber assembly. If standard manhole ring and cover is to be used, it shall be set on grade rings according to normal specified standards to meet local codes. If chamber is to be installed in backyard or easement location where it may be undesirable to have a manhole cover visible, the polyethylene, sealed lid of the chamber may be fitted with a non-ferrous metal disk. Once the disk is epoxy bonded to lid and covered with earth or other ground cover, the metal will allow the chamber to be located with a typical metal locator if access is required.

502.2.2.2.1. Installation on existing pipe. The OWNER may specify special conditions in addition to those listed above.

502.2.2.2.2. Installation in new construction. In addition, installation in new construction shall also meet these provisions. Excavation shall be performed in accordance with Item 203. Site Preparation or Item 701.2. Structural Excavation, as determined by the OWNER. The excavation shall provide a minimum of 6" (15cm) outside the widest dimension of the chamber allowing enough space for installation workers to function. Normally, the trench width for the chamber will be no wider than the trench excavated for the pipe being laid. The

chamber shall be lowered into trench and connected to pipe as the pipe is laid. Enough crushed stone shall be placed around the lower portion of the chamber to support it and prevent it from leaning.

502.2.3. Measurement and Payment of Cleanouts. Measurement and payment for cleanout structures shall be on a per each basis and shall cover all costs for the structure complete in place as designed. Included shall be all excavation, castings, reinforcing steel, concrete, backfill, and other materials, and all appurtenances for a complete and functional unit.

Cleanouts shall not be measured and paid for according to depth.

The contract price shall be the total compensation for the furnishing of all labor, materials, tools, equipment and incidentals necessary to complete the work, including earth excavation, disposal of surplus materials and backfill, all in accordance with the plans and these specifications.

502.3. FIRE HYDRANTS

502.3.1. Materials. Fire hydrants which are to be installed as shown on the plans or to be furnished for general installation shall be dry-barrel traffic model that conform to AWWA C502 Standard for Dry-Barrel Fire Hydrants, except for changes and/or additions specified as follows or as shown on the plans or in the contract specifications. All hydrant components covered by NSF-61 must comply with NSF-61 requirements.

502.3.1.1. Supplementary Details Specified.

The type of shut-off may be either of the following:

(1) compression type with the flow.
(2) compression type against the flow.

The valve action shall provide positive shut-off at minimum closing torque. Wedge action closing gates shall not be permitted, and the scissors type main valves shall not be permitted unless approved by the OWNER.

Inlet connection shall be mechanical joint unless otherwise specified and shall be for a 6-in. (15cm) cast iron pipe with minimum net valve opening of 5¼-in. (13cm) unless otherwise specified.

Delivery classification: number and size of pumper and hose nozzles shall be as shown on the plans and contract specifications.

Bury length: ground to bottom of connecting pipe shall be 4-feet (1.2m) or as specified by the OWNER.

Diameter outlet connections: hose and pumper nozzle threads shall be of the size and type shown on the plans.

Gaskets shall be furnished on all nozzle caps and shall be long life, black rubber meeting ASTM D2000, Classification System for Rubber Products in Automotive Applications, or equal.

Unless otherwise specified in the special provisions or in the plans, the operating and nozzle cap nuts shall be tapered pentagon nuts with faces not less than 1-in. (2.5cm) high.

Drain valve and outlet: hydrants shall be equipped with a minimum of two drainholes and provided with an automatic and positively operating noncorrodible drain or dip valve so as to drain the hydrant completely when the main valve is shut.

Direction to open is to be specified in the contract specifications. Number of turns to open shall be in accordance with AWWA Standard C502.

The outside of the hydrant above the finished ground line shall be thoroughly cleaned and thereafter painted in the shop with one coat of primer. After shop priming, a finish coat of colored paint as specified by OWNER shall be applied to the exterior above ground surfaces.

502.3.1.2. Breakable Type Hydrants. Breakable or Sleeve Type Couplings. The barrel of the hydrant between the base and the nozzle section must be made in two parts connected by a swivel flange or breakable flange which shall permit facing of the nozzles in any desired direction in increments of 45° or less. The complete hydrant shall be of such design that when the hydrant barrel is broken through traffic collision or otherwise, it may be replaced without disturbing the base of the hydrant.

The materials used for gaskets between the upper and lower barrels and the base and nozzle section shall be compounded to conform to ASTM D2000 or an equal material that shall have OWNER approval prior to substitution unless otherwise specified in the plans.

Provision shall be made in the design of the stem to disconnect the stem from the hydrant parts above the standpipe break point in the event of traffic accidents. Design of the coupling shall be such that when the coupling is broken, no parts shall come loose and fall into the hydrant barrel, and the break shall not occur through the pins or bolts holding the coupling to the stem.

502.3.1.3. Main Valve Seats. Main valve seats shall be of such design that incorrect positioning is impossible.

502.3.1.4. Nozzle Cap Chains. When required by the OWNER, the nozzle cap chains shall be in accordance with AWWA C502 Dry-Barrel Fire Hydrants.

502.3.1.5. Flanges. All flanges other than barrel flanges shall be equipped with mechanical joints. Gland bolts shall be high-strength, low-alloy, corrosion-resistant steel conforming to ASTM A325 Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength, Type 3.

502.3.1.6. Operating Stems. The spindle of the operating stem and the stem nuts for hydrants having the operating threads located in the barrel or waterway shall be manganese bronze, Everdur or other high-quality noncorrodible metal. Barrel bolts and nuts shall meet the requirements of ASTM A307 Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.

All working parts in the waterway, except for sliding stem support mechanisms, shall be bronze-to-bronze or bronze-to-iron unless otherwise specified in the special provisions or in the plans.

502.3.1.7. O-Ring. Hydrant stem packing boxes, where needed, shall be provided with O-ring grooves and sealed with O-rings. O-rings shall be furnished in lieu of stem packing. They shall be of the double O-ring type designed so that the rubber rings shall move against a bronze, stainless steel or other noncorrodible metal surface. O-ring shall be in accordance with ASTM D2000, Classification System for Rubber Products in Automotive Applications.

502.3.1.8. Extensions. Fire hydrants shall be designed to accept a 6 in, 12 in. or 18 in. extension.

502.3.1.9. Hydrant Heads. The hydrant shall be constructed so that the nozzles may be faced in any desired direction.

502.3.1.10. Drawings. Proposals shall be accompanied by catalogue cuts, photographs or drawings in duplicate showing complete detailed dimensions of the hydrants when requested by the OWNER.

502.3.1.11. Upperstem Thread Lubrication. Upperstem thread lubrication may be accomplished with oil or grease. When oil is used, it shall be in conjunction with a functional oil reservoir and an oil filler port. The hydrant shall be factory filled with a USP white mineral oil such as Lubriplate No. 3-V (SAE 20), Mobile Whiterex 425 or equal. Means for field check of oil lubrication level shall be provided. When grease is used, the hydrant shall be factory lubricated with a food grade grease such as Lubriplate No. 630-AA (medium soft), or equal. Means for field lubrication without disassembly shall be provided.

502.3.1.12. Tests and Affidavit of Compliance. Manufacturers shall be required to furnish the OWNER certificate of compliance with AWWA C502 and this specification.

Technical manufacturing drawings or certificate of tests relating to fire hydrants for contract installation must be supplied by the CONTRACTOR to OWNER not later than two weeks after beginning construction when identical hydrants have previously been approved by the OWNER, or prior to installation when identical hydrants have not previously been approved by the OWNER. Technical manufacturing drawings or certificate of tests must be supplied for all hydrants purchased by the OWNER. Technical drawings or certificates shall have the OWNER'S approval before final payment shall be made.

502.3.1.13. Sample Hydrant. The OWNER may purchase one sample hydrant for verification of compliance with these and manufacturer's specifications. The OWNER may test this sample; and, if it fails to meet any of the specifications, the hydrant shall be returned to CONTRACTOR at CONTRACTOR'S expense. CONTRACTOR shall refund to the OWNER the full purchase price of the hydrant.

502.3.1.14. Rejection. Fire hydrants or materials specified in this section may be rejected for failure to meet any of the provisions of this specification or for any defects causing them to be unsuitable for their intended use.

502.3.2. Installation. Fire hydrants shall be installed as shown in Standard Drawing 4120, on the appurtenance sheets or as directed by the OWNER.

Set fire hydrant on the lot line extended when possible. The horizontal center of the hydrant shall be placed not less than 3-feet (0.9m) and not more than 8-feet (2.4m) from the nearest curb, no closer than 18-inches (0.5m) to existing or proposed sidewalks, and located at least 1-foot (0.3m) outside of the area between the Points of Curvature of the corner turning radii at intersections unless otherwise indicated on the plans.

The hydrant shall set truly vertical and be securely braced and blocked on well-compacted or undisturbed soil surrounded by a minimum of 7-CF (0.2-m^3)) clean gravel or stone to permit free draining of the hydrant, with the large pumper nozzle facing the nearest curb.

Fire hydrants shall be braced and blocked on a Class A or Class PA (as specified by the OWNER) concrete slab not less than 4-in. (10cm) thick and not less than 3-ft. by 3-ft. (09m x 0.9m) square buried to a depth between 6- and 12-inches (15cm – 30cm) below finished grade. A splash pad that extends to the sidewalk, or to curb in the absence of a sidewalk, shall be installed if directed by the OWNER. Hydrant shall be set perpendicular with the pumper nozzle facing the nearest curb, and to a depth such that the center of the nozzle is between 18- and 28-inches (46cm – 71cm) from the top of finished grade.

Any adjustment needed after installation shall be made by the CONTRACTOR without extra compensation.

502.3.3. Measurement and Payment. Fire hydrants shall be paid for at the contract unit price per each, complete in place, as provided in the proposal and contract. The contract price shall be the total compensation for the furnishing of all labor, material, tools, equipment, hydrant extensions and incidentals necessary to complete the work.

The hydrant lead shall be paid for at the unit price bid for installing pipe. The gate valve and box installed in leads shall be paid for at the unit price bid for installing gate valves and boxes, or as specified by OWNER.

Fire hydrant extensions shall be paid for at the unit price bid per foot if a separate pay item is established in the contract.

502.4. THRUST RESTRAINT

Each change in direction of a pressure conduit, fittings, and plugs in pressure conduits shall be restrained in such a manner as shall substantially brace the same against undisturbed trench walls. Type of thrust restraint shall be as specified on the plans.

502.4.1. Concrete Blocking. Standard thrust blocking shall conform to appropriate details and tables of Standard Drawings 4010A through 4040. Special blocking shall be accomplished with Class B or Class PB (as specified by the OWNER) concrete as detailed on the appurtenance sheet or as may be detailed on the plans.

502.4.2. Mechanical Joint Restraint. Mechanical joint restraint may be used on ductile iron or PVC pipe. Installation shall follow manufacturers recommendations.

Restraining mechanisms for PVC pipe and fittings shall be tested and pressure rated in accordance with ASTM F1674 Standard Test Method for Joint Restraint Products for Use with PVC Pipe.

502.4.2.1. Ring and Wedging. Ring and wedging mechanical joint restraint shall be incorporated into the design of the follower gland. The restraint shall be sized and selected for material compatibility according to manufacturers instructions. The restraining mechanism shall consist of individually actuated wedges that increase their resistance to pull-out as pressure or external forces increase. The device shall be capable of full mechanical joint deflection during assembly and the flexibility of the joint shall be maintained after burial. The joint restraint ring and its wedging components shall be of grade 60-42-10 ductile iron conforming to ASTM A536 Ductile Iron Castings. The wedges shall be ductile iron heat treated to a minimum hardness of 370 BHN. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell conforming to AWWA C111 Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings and AWWA C153 Ductile-Iron Compact Fittings for Water Service. Torque limiting twist-off nuts shall be used to insure proper actuation of the restraining wedges. Necessary spacers, gaskets and bolts shall be supplied by the manufacturer of ring and wedging restraint. Ring and wedging shall be coated as specified for pipe and fittings.

Restraint for nominal pipe sizes greater than 48-inches (122cm) shall be engineered.

502.4.2.2. Integrally Restrained Mechanical Joints. In addition to specifications for Ductile Iron fittings in Item 501.7. Ductile-Iron Pressure Pipe and Fittings or Item 501.14. Polyvinyl Chloride (PVC) Water Pipe, integrally restrained mechanical joints shall conform to the applicable provisions of the standards listed in Table 502.4.2.2.(a) Integrally Restrained Mechanical Joint Standards.

Table 502.4.2.2.(a) Integrally Restrained Mechanical Joint Standards

Standard	Topic
AWWA C111	Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C116	Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service
ASTM D3139	Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM F477	Elastomeric Seals (Gaskets) for Joining Plastic Pipe

502.4.3. Welding. Reinforced Concrete Cylinder Pipe (RCCP) may be internally or externally welded, as specified by the OWNER, according to manufacturer criteria in conformance with appropriate AWWA Standards.

502.4.4. Measurement and Payment. No separate payment shall be made for restraint, unless specified otherwise by the OWNER.

502.5. FITTINGS

502.5.1. Brass Stops, Cocks, and Fittings for Waterworks Service.

502.5.1.1. General. Stops, cocks and other fittings furnished under these specifications shall be in accordance with AWWA C800 Standards for Underground Service Line Valves and Fittings of the size and type specified, except cast solder-joint fittings shall conform to alloy 83-4-6-7, ASTM B584 Practice for Copper Alloy

Sand Castings for General Applications. All stops, cocks and fittings shall be full size throughout the size specified.

502.5.1.2. Physicals. Any pipe, fitting, solder or flux used in the installation or repair of any public water system shall be lead-free. For purposes of this section, "lead-free" means solders and flux containing not more than 0.2-percent lead; and pipes and pipe fittings containing not more than 8.0-percent lead.

Brass used shall have a tensile strength (as determined from test bars) of not less than 30,000-psi (206,820-kPa) when tested as prescribed by ASTM B208 Practice for Preparing Tension Test Specimens for Copper-Base Alloys for Sand, Permanent Mold, Centrifugal, and Continuous Castings (Fig. 5).

Fittings shall be designed for 200-psi (1,380-kPa) working pressure and, when subjected to hydrostatic test pressures 1½ times working pressure or when subjected to a minimum of 85-psi (586-kPa) air pressure while submerged in water, shall not leak or show signs of structural failure.

Stops and cocks containing brass parts shall be shipped prelubricated with a light fluid lubricant between key and body. Lubricant shall remain fluid indefinitely, either in storage or in service.

502.5.1.3. Design Features of Stops and Cocks. Seating surfaces of the ground key type shall be tapered and shall be accurately fitted together by turning the key and reaming the body. Seating surfaces shall be lapped together using suitable abrasives to insure accurate fit. The large end to the tapered surface of the key shall be reduced in diameter for a distance that shall bring the largest end of the seating surface of the key into the largest diameter of the seating surface of the body, and the taper seat in the body shall be relieved on the small end, so that the small end of the key may extend through to prevent wearing of a shoulder and to facilitate proper seating of the key. The stem end of the key, key nut and washer shall be so designed that if the key nut is tightened to failure point, the stem of the key shall not fracture. The nut and the stem shall withstand a torque on the nut of at least three-times the necessary effort to properly seat the key without failure in any manner.

The ball stop shall have a full-size round-way opening with straight-through flow, teflon coated bronze ball with a minimum of 0.5-mil (0.0005-in.) (0.01mm) thickness coating. The stop must be so constructed that it may be disassembled and the ball removed without special tools.

Plug type stop shall have full size round way opening with straight-through flow. Seating surfaces shall be brass (or teflon coated brass) to rubber O-rings, providing positive pressure seal without mechanical means. The stop must be so constructed that the plug may be removed without special tools. Rubber O-rings should conform to requirements of ASTM D2000 Classification System for Rubber Products in Automotive Applications and test method shall conform to ASTM D1414 for Test Methods for Rubber O-Rings.

Inlet and outlet threads, of the types specified, shall conform to the applicable tables of AWWA Standard C300 Reinforced Concrete Pressure Pipe, Steel-Cylinder Type, and inlet threads shall be protected in shipment by a plastic coating or other equally satisfactory means. If used, coupling nuts shall have a bearing skirt machined to fit the outside diameter of the pipe for a length at least equal to the outside of the pipe.

Corporation stops shall be so designed as to rotate about the axis of the flow passageway within a circle of rotation small enough to properly clear the inside of any standard tapping machine of appropriate size.

The outlet side of ¾-in. (1.9cm) brass curb stops shall be female iron pipe with flared copper pipe, compression or female iron pipe thread on the inlet, as specified. The outlet side of 1-in. (2.5cm) , 1½-in. (3.8cm) and 2-in. (5.1cm) brass curb stops shall be female iron pipe with compression, streamline or female iron pipe thread on the inlet, as specified.

The outlet side of ¾-in. (1.9cm) and 1-in. (2.5cm) corporation stops shall be flared copper pipe or compression with male AWWA "tapered" thread or male iron pipe thread on inlet side, as specified. The outlet side of 1½-in. (3.8cm) and 2-in. (5.1cm) corporation stops shall be compression or streamline with male AWWA "tapered" thread or male iron pipe thread on inlet side, as specified.

502.5.1.4. Design Features of Fittings. All castings shall be smooth, free from burrs, scales, sand holes and defects of every nature which would make them unfit for the use for which they are intended.

Nuts shall be smooth cast and shall have symmetrical hexagonal wrench flats.

Flare-joint fittings shall be smooth cast. Seating surfaces for metal-to-metal seal shall be machined to proper taper or curve, free from any pits or protrusions.

Solder-joint fittings shall be smooth cast. Inside surfaces of solder-joint ends shall be machined smooth to proper inside diameter.

All thread fittings, of all types, shall have N.P.T. threads, and male threaded ends shall be protected in shipment by a plastic coating or other equally satisfactory means.

Compression tube fittings shall have a Buna-N beveled gasket or equal. Compression nut shall have:

(1) for plastic or copper pipe and tubing, an approved restraining device.
(2) for iron pipe, a stainless steel set screw to bite in and lock on the pipe.

502.5.1.5. Tests. All brass stops, cocks and fittings included in this section shall be tested in accordance with the applicable provisions of the specifications relating thereto.

502.5.1.6. Rejection. Brass stops, cocks, and fittings may be rejected for failure to meet any of the requirements of this specification.

502.5.2. All Other Fittings. All other fittings shall conform to respective provisions of Item 501. Underground Conduit Materials, listed according to conduit type. In water pipe, Ductile Iron or Ductile Iron Compact fittings shall consist of standard crosses, tees, bends, reducers, sleeves, plugs, blind flanges, etc. Fittings for reinforced concrete pressure pipe, steel cylinder type, shall consist of special crosses, tees, bends, reducers, dished plugs, closure sections, flanged outlets, blind flanges, bored flanges, etc.

502.5.3. Measurement and Payment. Payment for fittings shall be made only if a separate bid item is established in the Contract. If a separate bid item is not established, the fittings shall be included in the price of the pipe bid item.

Ductile Iron and Ductile Iron Compact Fittings shall be measured for payment per ton if a separate bid item is established in the Contract. Special fittings for reinforced concrete pressure pipe, steel cylinder type, shall be measured for payment per each, grouped as to size and kind. Fittings that are an integral part of a special item, such as a bored flange in an air valve installation, shall not be measured for payment per each, but shall be included in the contract unit price for that special item.

502.6. VALVES

502.6.1. Metal Seated Gate Valves for Ordinary Waterworks Service

502.6.1.1. General Description. All gate valves 3-in. (7.6cm) through 48-in. (122cm) shall conform to AWWA Standards C500 Metal-Seated Gate Valves for Water Supply Service, except for changes or specified alternatives as detailed in this specification or as shown on the plans and contract documents. Materials must comply with NSF Standard 61 – Drinking Water System Components – Health Effects. Tests and design data may be as designated on the plans and contract specifications.

Gate valves larger than 48-in. (122cm) shall be a special consideration. The OWNER shall hydrostatically test all gate valves larger than 48-in. (122cm) for a reasonable period after receipt of a specified test pressure.

All gate valves shall be iron body, bronze mounted, double disc, parallel seat, nonrising stem, internal wedging type. Valves must embody the best workmanship and finish. Valve design shall provide minimum torque designs effectively reducing friction and drag through thrust collar design and tracks for gates.

502.6.1.2. Bonnet Bolting. Body bolts, studs and nuts shall be 304 stainless steel.

502.6.1.3. Ends. Valves shall have flanged, push-on, or mechanical-joint ends, or any combination of these as may be specified.

Mechanical-joint ends shall conform to AWWA C111 (ANSI A21.11) American National Standard for Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings. Push-on joint ends shall conform to AWWA C111 (ANSI A21.11). Flanged ends shall conform to AWWA C110 (ANSI A21.10) American National Standard for Gray-Iron and Ductile-Iron Fittings, 3 In. through 48 In. for Water and Other Liquids, Class 125-lb. (862-kPa). Bolts and nuts for mechanical joints shall be of a high-strength, low-alloy corrosion-resistant steel conforming to ASTM A325 (A325M) High-Strength Bolts for Structural Steel Joints (Type 3). All mechanical-joint glands shall be ductile iron.

502.6.1.4. Gates and Rings. Gates and rings shall conform to AWWA Standards C500 except as follows: All gates above 4-in. (10cm) shall be cast iron with bronze-gate rings, and 4-in. (10cm) gates may be solid bronze. Gates 3-in. (7.6cm) and smaller shall be solid bronze.

502.6.1.5. Wedging Device. Wedging devices shall conform to the requirements of AWWA C500, except as follows: Gate valves 4-in. (10cm) and smaller shall have solid bronze wedges. Wedges for valves above 4-in. (10cm) may be solid bronze or cast-iron with an integral bronze nut. Wedging surfaces may be bronze, monel, or stainless steel cast integral with the wedge. Stem nuts or wedging surfaces that are attached with fasteners are not acceptable. Wedging surfaces on valves up to 16-in. (41cm) shall be bronze-, monel-, or stainless-steel- to-iron. Wedging surfaces on valves 16-in. (41cm) and larger shall be bronze-to-bronze, monel-to-monel, or stainless-to- stainless. Other moving surfaces integral to the wedging action shall be bronze to iron.

502.6.1.6. Rollers and Tracks and Scrapers for Horizontal Valves. Rollers and tracks and scrapers for horizontal valves shall conform to AWWA Standards C500, with the following exception: Babbit tracks shall not be acceptable.

502.6.1.7. Valve Stems and Nuts. Stem and nuts shall be in accordance with AWWA Standards C500, except as follows: Stem nuts shall be of a nongalling, high-grade brass or bronze and shall have threads of sufficient length to develop the full strength of the stem. Stems as received shall meet the minimum strengths as

specified. Upset stems on valves larger than 16-in. (41cm) shall not be permitted under these specifications. Upset stems shall conform to the requirements of AWWA C500.

502.6.1.8. Stuffing Boxes. Stuffing boxes shall conform to the requirements of AWWA Standards C500 with the following exceptions: All valves 2-in. (5cm) through 16-in. (41cm) shall be equipped with double O-rings, provided arrangement is made for replacement under pressure of the upper O-ring when the valve is fully open. All geared valves shall be equipped with double O-rings in the main stuffing box. All horizontal valves shall have attached stuffing boxes as per the above AWWA Standards. Stuffing box bolts and nuts shall be 304 stainless steel.

502.6.1.9. Follower Glands and Gland Bolts and Nuts. Glands, gland bolts and nuts shall conform to the requirements of AWWA Standards C500 with the following exceptions: Gland flanges or followers that are a separate part may be cast iron or bronze. Glands for valves over 12-in. (31cm) in diameter shall be solid bronze or cast-iron bronze bushed. Gland bolts and nuts shall be either bronze or Type 302 stainless steel. For either choice both bolts and nuts shall be of the same material.

502.6.1.10. Hand Wheels and Operating Nuts. All valves 2-in. (5cm) in diameter and above shall be nut operated unless otherwise ordered. All operating nuts shall be ductile iron or cast iron. Handwheels shall be furnished only when called for on plans or in the contract specifications. All valves shall open by turning counterclockwise.

502.6.1.11. Gearing. Gearing shall be in accordance with AWWA C500. Spur or bevel gearing as called for on the plans or as applicable shall be provided on all valves 18-in. (46cm) in diameter and larger.

502.6.1.12. Gear Cases. Gear cases shall be furnished on all geared valves. All geared valves shall be equipped with extended type gear cases, with cast iron side plates. Stuffing boxes shall be located on top of the bonnet and shall be outside the gear case. Gear cases shall be lubricated and enclosed with oil seal or O-ring at all shaft openings to prevent the entrance of water which may be in the manhole. Valves equipped with ball or roller type thrust bearings inside the grease case shall have all shaft openings sealed with double O-rings. Gear cases shall be cast iron.

502.6.1.13. By-Pass Valves. By-pass valves shall conform to the requirements of AWWA C500 with the following exceptions: By-pass valves are required on all 18-in. (46cm) valves and larger AWWA C500 valves. Properties, construction and design requirements herein specified are applicable to by-pass valves, except stems on by-pass valves over 4-in. (10cm) shall have the same physical qualities as for 30-in. (76cm) and larger.

502.6.1.14. Cast Iron. All gray cast iron shall conform to the requirements of ASTM A126 Gray Iron Castings for Valves, Flanges, and Pipe Fittings, Class B or ductile iron shall conform to ASTM A536 Ductile Iron Castings.

502.6.1.15. Horizontal Valves. All valves over 16-in. (41cm) in diameter shall be designated for horizontal installation in a horizontal pipeline unless shown otherwise on the plans. All other valves shall be vertical.

502.6.1.16. Valves for Installation in Vertical Pipeline. Valves 14-in. (36cm) and larger AWWA C500 valves ordered for installation in vertical pipeline shall be equipped with disc face tracks and wedge springs to prevent pre-wedging. Valves 4 in. (10.2 cm) through 12 in. (30.5 cm) shall be double disc, square-bottom valves.

502.6.1.17. Tapping Valves. Tapping valves shall conform to the requirements of AWWA C500, and the other requirements of this section with the following exceptions: Tapping valves shall have oversize seat rings to permit entry of standard tapping machine cutters. In the open position, valve gates shall be clear of the ports so that the cutter shall pass through without making contact with the gates. Valves shall have an inlet flange conforming to AWWA C110 (ANSI A21.10) Class 125, with a machined projection to mate with tapping sleeve outlet flange recess to assure correct alignment. This alignment ring shall comply with MSS Standard SP-60 Connecting Flange Joint Between Tapping Sleeves and Tapping Valves. Valves shall have standard mechanical joint outlet and shall fit any standard tapping machine.

502.6.1.18. Tests and Inspection. All valves shall be tested by the manufacturer in accordance with AWWA C500. Any leaking at the test pressure through any casting or between the bronze ring and the cast iron body shall cause the said casting to be rejected. No plugging or patching to stop any leakage shall be allowed.

When requested at any time, notarized certificates of material and test compliance for these valves shall be provided. Such reports furnished shall be identified by purchase order or contract. The material shall also be identified as to location within the valve and specification or composition.

502.6.2. Resilient-Seated Gate Valves for Ordinary Waterworks Service.

502.6.2.1. General Description. All gate valves 3-in. (7.6cm) through 36-in. (91cm) shall conform to AWWA Standards C515 for Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service, or C509 for Resilient-Seated Gate Valves for Water-Supply Service, except for changes or specified alternatives as detailed in this specification or as shown on the plans and contract documents. Materials must comply with NSF Standard

61 – Drinking Water System Components – Health Effects. Tests and design data may be as designated on the plans and contract specifications.

Gate valves larger than 36-in. (91cm) shall be a special consideration. The OWNER shall hydrostatically test all gate valves larger than 36-in. (91cm) for a reasonable period after receipt.

All gate valves shall be iron body, resilient seated, nonrising bronze stem and bronze stem nut. Valves must have the resilient seat bonded and vulcanized to the wedge and employ the best workmanship and finish. Valve design shall provide minimum torque designs effectively reducing friction and drag through thrust collar design and guide tracks for the gate.

502.6.2.2. Bonnet Bolting. Bonnet Bolting shall conform to Item 502.6.1.2. Bonnet Bolting.

502.6.2.3. Ends. Ends shall conform to Item 502.6.1.3. Ends.

502.6.2.4. Gate. Gate shall be encapsulated with an elastomer that meets all requirements of AWWA C515 or C509. The bonding of the rubber to the gate shall meet the requirements of ASTM D429, Test Method A or Method B. Gates 3-in. (7.6cm) and smaller shall be rubber encapsulated bronze.

502.6.2.5. Valve Stems and Nuts. Stem and nuts shall be in accordance with AWWA Standards C515 or C509 except as follows: Stem nuts shall be of a nongalling, high-grade brass or bronze and shall have threads of sufficient length to develop the full strength of the stem. Stems as received shall meet the minimum strengths as specified. Upset stems on valves larger than 16-in. (41cm) shall not be permitted under these specifications.

502.6.2.6. Stuffing Boxes. Stuffing boxes shall conform to the requirements of AWWA Standards C515 or C509 with the following exceptions: Arrangement is made for replacement under pressure of the upper O-ring when the valve is fully open. All geared valves shall be equipped with double o-rings in the main stuffing box. All horizontal valves shall have attached stuffing boxes as per the above AWWA Standards.

502.6.2.7. Follower Glands and Gland Bolts and Nuts. Glands, gland bolts and nuts shall conform to the requirements of AWWA Standards C515 or C509 with the following exceptions: Gland flanges or followers, if used, that are a separate part may be cast iron or bronze. Glands for valves over 12-in. (30cm) in diameter shall be solid bronze or cast-iron bronze bushed. Gland bolts and nuts shall be either bronze or Type 302 stainless steel. For either choice both bolts and nuts shall be of the same material.

502.6.2.8. Hand Wheels and Operating Nuts. Hand wheels and operating nuts shall conform to Item 502.6.1.10.

502.6.2.9. Gearing. Gearing shall be in accordance with AWWA Standards C515 or C509. Spur or bevel gearing as called for on the plans or as applicable shall be provided on all valves 18-in. (46cm) in diameter and larger.

502.6.2.10. Gear Cases. Gear cases shall be furnished on all geared valves. Gear cases shall be lubricated and enclosed with oil seal or O-ring at all shaft openings to prevent the entrance of water which may be in the manhole. Valves equipped with ball or roller type thrust bearings inside the grease case shall have all shaft openings sealed with double O-rings. Gear cases shall be gray iron or ductile iron.

502.6.2.11. By-Pass Valves. By-pass valves are not required on resilient seated gate valves.

502.6.2.12. Cast Iron. Cast iron shall conform to Item 502.6.1.14.

502.6.2.13. Horizontal Valves. Valves for horizontal installation shall be equipped with wedge guide caps or inserts to guide and support the wedge during travel. All valves over 16-in. (41cm) in diameter shall be designated for horizontal installation in a horizontal pipeline unless shown otherwise on the plans. All other valves shall be vertical.

502.6.2.14. Valves for Installation in Vertical Pipeline. All resilient seated gate valves shall be suitable for horizontal mounting in a vertical pipeline without special modifications.

502.6.2.15. Tapping Valves. Tapping valves shall conform to the requirements of AWWA Standards C515 or C509 and the other requirements of this section with the following exceptions: Tapping valves shall have a port opening to permit entry of standard tapping machine cutters. In the open position, valve gates shall be clear of the ports so that the cutter shall pass through without making contact with the gate. Valves shall have an inlet flange conforming to AWWA C110 (ANSI A21.10) Class 125, with a machined projection to mate with tapping sleeve outlet flange to assure correct alignment. This alignment ring shall comply with MSS Standard SP-60 Connecting Flange Joint Between Tapping Sleeves and Tapping Valves. Valves shall have standard mechanical joint outlet and shall fit any standard tapping machine.

502.6.2.16. Tests and Inspection. All valves shall be tested by the manufacturer in accordance with AWWA Standards C515 or C509. Any leaking at the test pressure through any casting shall cause the said casting to be rejected. No plugging or patching to stop any leakage shall be allowed.

When requested at any time, notarized certificates of material and test compliance for these valves shall be provided. Such reports furnished shall be identified by purchase order or contract. The material shall also be identified as to location within the valve and specification or composition.

502.6.3. Air Valves.

502.6.3.1. General. Unless otherwise indicated in the plans or contract specifications, air valves shall meet the requirements of AWWA C512 Air Release, Air/Vacuum and Combination Air Valves for Water Works Service with exceptions specified herein. Only wastewater air valves shall be used for wastewater applications.

502.6.3.2. Description. Air valves shall be of two types as follows:

(1) An air valve called for on the plans shall mean an air and vacuum valve of the ball type designed to permit the escape of air from a pipeline when the line is being filled and to permit air to enter the pipeline when the line is being emptied.

(2) A combination air valve called for on the plans shall mean a combination air and vacuum and air release valve designed to fulfill the functions of air and vacuum valve and also designed to permit the escape of air accumulated in the line at the high point when the line is under pressure while in operation. Air valves 3-in. (7.6cm) and smaller shall be self-contained in one unit. Air valves larger than 3-in. (7.6cm) may be a combination of two valves.

502.6.3.3. Material. The valves shall be stainless steel or iron body, stainless steel, brass or bronze fulcrum levers and links, stainless steel ball floats and pins, steel flange bolts and nuts, Buna-N synthetic rubber seats or equal against bronze or stainless steel, and brass for other parts.

502.6.3.4. Inlets and Outlets. Inlets shall be threaded for 2-in. (5cm) and smaller and flanged for 3-in. (7.6cm) and larger. Outlets shall be threaded through 4-in. (10cm).

502.6.3.5. Operating Pressure and Testing. The valves shall be designed to operate under an operating pressure of 200-psi (1380-kPa) and shall be tested to 1½ times that pressure.

502.6.4. Brass Wheel Valves.

502.6.4.1. General. Valves furnished under this specification shall be wedge disc, non-rising stem gate valves with screwed ends. They shall be equipped with bronze hand wheels and nuts and shall have bronze packing gland followers. They shall be of all brass and/or bronze construction.

502.6.4.2. Pressure Rating. Valves shall be rated for 125-psi (862-kPa) saturated steam working pressure and 200-psi (1,380-kPa) for liquids and gases up to 150°F (65.6°C).

502.6.4.3. Tests. Each valve furnished under these specifications shall be tested at a hydrostatic pressure of 250-psi (1,724-kPa) with the valve open. Under this test the valve shall not show any indication of leakage at the packing or anywhere on the body. Each valve shall also be tested at hydrostatic pressure of 250-psi (1,724-kPa) applied to one end only with the valve closed. There shall be no indication of leakage by the gate or through the packing under this test.

502.6.4.4. Direction to Open. Valve shall open by turning the handwheel counterclockwise.

502.6.4.5. Material Specifications. The materials used in the manufacture of these valves shall equal or exceed the specifications shown in Table 502.6.4.5.(a) Brass Wheel Valve Materials.

Table 502.6.4.5.(a) Brass Wheel Valve Materials

Part	Material	Designation/Specification
Packing	Teflon impregnated asbestos or approved equal	
Body	Bronze	ASTM B62 Standard Specification for Composition Bronze or Ounce Metal Castings
Bonnet	Bronze	ASTM B62
Gates	Bronze	ASTM B62
Handwheel	Bronze	ASTM B62
Handwheel Nut	Bronze	ASTM B62
Gland & Packing Nut	Brass	ASTM B16/B16M Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines
Stem	Bronze	ASTM B62, 50,000-psi (344,700-kPa) minimum tensile strength

502.6.4.6. Stem. Stem shall be completely free of visible flaw, and matching shall be smooth and free of defect. A back seating surface shall be provided on the wedge or on the lifting nut to seat tightly against the bonnet when the valve is open to seal the packing gland against line pressure so that the valve may be repacked against line pressure.

502.6.4.7. Screwed Ends. Valve ends shall be threaded internally with American National Taper pipe threads. Thread shall be clean, smooth, true to form and concentric with the axis of the valve. Variations in alignment of thread shall not exceed $^{1}/_{16}$-in.-per-foot (0.5-cm-per-m). Thread shall be chamfered approximately to the major diameter of the thread at the face of the valve at an angle approximately 45° with the axis of the thread for the purpose of easy entrance in making a joint and for protection of the thread.

502.6.4.8. Valve Body. The body of the valve shall offer sufficient support to the gate while it is moving to keep the gate wedge in place and to accurately align the gate on the body seat. The waterway opening shall be equal to or greater than the nominal pipe size.

502.6.4.9. Gate. The gate shall be of wedge design and may be furnished either solid or two-piece. Two-piece or "split" disc gates shall be equipped with lifting nut. Gate faces shall be accurately machined and fitted into the valve body in such a manner that the center of the gate circle is very slightly above the center of the seat circle when the valve is tightly closed.

502.6.4.10. Workmanship. All valve parts shall be true to form, free from injurious defects and shall be seated and finished in a workmanlike manner. Casting shall be free from blow holes, porosity, hard spots, excessive shrinkage, cracks or other injurious defects. They shall be smooth and well cleaned both inside and outside, and all fins and similar roughness shall be removed. Castings shall not be repaired, plugged, brazed or burned in.

502.6.4.11. Packaging. Valve shall be closed for shipment and wrapped or packaged in accordance with best commercial practice as necessary for mechanical protection and ease in handling.

502.6.5. Butterfly Valves.

502.6.5.1. General. Butterfly valves and actuators shall conform to AWWA C504 Rubber-Seated Butterfly Valves and to these specifications:

(1) Type of body shall be short body, flanged.
(2) Body material shall be cast iron or ductile iron.
(3) Class shall be as specified on the plans or contract specifications.
(4) Shafts shall be Type 304 or 316 stainless steel.
(5) Flange holes shall be drilled full size.
(6) Valve seats shall be natural rubber or Buna-N and polished stainless steel, Type 304 or 316, 90° seating angle only, with a 360° uninterrupted seating surface.
(7) Shaft seals shall be standard split-V packing or double O-ring seal cartridges.
(8) Discs shall be ductile iron, cast iron, or fabricated steel.
(9) Operating nuts shall be ductile iron.

502.6.5.2. Submittals. The following shall be furnished to the OWNER. Incomplete data shall be cause for rejection of bid.

(1) Weights and drawings in accordance with AWWA C504.
(2) Guaranteed delivery time after receipt of purchase order.
(3) Number of turns of handwheel required to close valve.
(4) The required actuator torque (To) in foot-pounds for each butterfly valve based on the specified operating conditions of pressure and flows.
(5) Seating-unseating torque (To) in foot-pounds required for each butterfly valve.
(6) Rated torque capability of each butterfly valve actuator.

The following data shall be furnished if not previously available to the OWNER:

(7) Experience: evidence of at least five years satisfactory experience building butterfly valves to AWWA Standards.
(8) Torque tests in accordance with rubber seated butterfly valves AWWA C504.
(9) Proof of design tests in accordance with AWWA C504.

502.6.5.3. Ends. Valves shall have flanged ends. Flanged ends shall conform to AWWA C110 (ANSI A 21.10), Class 250-lb. (112.5-kg).

502.6.5.4. Actuators.

502.6.5.4.1. Manual Actuators:

Location. All actuators shall be located at the right end of a horizontal shaft with the input shaft vertical and upward looking in the direction of flow, unless otherwise noted.

Closure. The valve shall close by turning the input shaft clockwise. All handwheels shall turn clockwise to close the valve. All operators shall be equipped with a disc position indicator with each valve. The indicator shall be highly visible, clearly showing the legends "Open" and "Closed" at the ends of a 90° arc, with a pointer to show the disc position (Closed — 0° and Open —90°). The arc shall be graduated in degrees.

Type. All manual actuators shall be totally enclosed worm gear type and traveling-nut type. All manual worm gear type actuators shall be Limitorque, Type HBC or approved equal.

Sizing. Each valve actuator shall be sized for the maximum valve torque requirements based on the operating pressures and flow rates as specified.

502.6.5.4.2. Electric Motor Actuator. Each electric actuator shall conform to AWWA C504 and shall be of sufficient size to open and close the valve against maximum differential pressure and maximum required torque conditions when voltage at motor terminals is 90-percent of nominal voltage and shall have totally enclosed worm gear reducer with spur gear attached. Limit switches shall be of the four traingear with switches adjustable to operate at any point in the opening or closing cycle of the valve.

Limit switches and torque switches shall be located in a special compartment that is an integral part of the actuator and shall be readily accessible. Each limit switch shall have two normal closed contacts. Limit switch gearing shall be in step at all times whether in power or manual operation. Limit switch gearing shall be stainless steel or high-grade bronze. Two torque switches shall be furnished, one for opening direction and one for closing direction. The torque switches shall be connected in series so that they will operate regardless of the phasing of the power.

Torque and thrust loads in both closing and opening directions shall be limited by torque switches. Each torque switch shall be provided with a micrometer adjustment and reference setting indicator. The adjustment shall permit a variation of approximately 40-percent in torque setting. Switches shall have a rating of not less than 6-amperes at 120-volts-a.c. and 2.2-amperes at 115-d.c. The torque switches shall be in series with the opening and closing coils of the starter.

The torque switches shall be factory adjusted by the manufacture for this application.

A handwheel for manual operation shall be provided. Motor shall not rotate when handwheel is in use. A fused motor shall not interfere with manual operation. For valve control, furnish for each valve a reversing starter in watertight enclosure that is integral with the actuator housing. Furnish a push-button station NEMA-4 with red and green indicating lights separate from the valve actuator. Space heaters shall be provided to protect the motor, reversing starter and limit switch compartments from moisture condensation. Valve control wiring diagrams shall be furnished with submittal data.

Valve actuators shall conform to latest revision of AWWA C504 and shall be designed to hold the valve in any intermediate position between fully opened and fully closed without creeping and fluttering.

502.6.5.4.3. Other Actuators. Other types of actuators shall conform to AWWA C504.

502.6.5.5. Shipment and Storage Requirements. Electric motor actuated valves shall be shipped to bonded covered warehouse storage to be designated by the OWNER. Valves shall be stored indoors and shall have space heaters energized. Full face flange protectors of waterproof plywood shall be at least one-inch (2.5cm) thick.

502.6.5.6. Tests. All butterfly valves shall be tested by the manufacturer in accordance with AWWA C504. Test results shall be furnished to the OWNER.

502.6.6. Line Valve Installation. At locations shown on the plans, CONTRACTOR shall furnish and install valves of the type and size indicated. Valve vaults shall be furnished as provided in the special contract documents and constructed in accordance with Item 702.4.8.8. Vaults and applicable Division 4000 Standard Drawings.

502.6.6.1. Gate Valves. Valves shall be carefully handled and lowered into position in such a manner as to prevent damage to any part of the valve. The valve shall be placed in the proper position and held securely until all connections have been made. Where valves are to be placed in a concrete structure, the floor shall be completed before installing the valve. The valve shall be securely blocked so that its weight is carried by the floor rather than being supported by connected piping. See also Standard Drawing 4050.

502.6.6.2. Air Release Valves. The term "air release valve" as used in this section shall apply to the installation of both air release valve and combination air and vacuum release valves. Vaults shall be furnished as an integral part of either air release valve or combination air and vacuum release valve installation.

Air valves shall be installed in the manner shown in Standard Drawings 4090 – 4100B and on the appurtenance sheet unless otherwise indicated on the plans. The proper valve and fitting sizes shall be installed on mains in accordance with the schedule in Table 502.6.6.2.(a) Air Release Valve Sizing unless otherwise specified.

Table 502.6.6.2.(a) Air Release Valve Sizing

I.D. of Main		Size of Valve and Fitting	
Inches	Centimeter equivalent	Inches	Centimeter equivalent
16 and smaller	41 and smaller	1	2.5
18 through 36	46 through 91	2	5.1
42 and larger	107 and larger	3	7.6

Matching taps shall be provided for and made in accordance with Item 502.10. Connections to Conduit for Service. Fittings required for mounting air valves shall be as specified in Item 502.5. Fittings. All fittings shall be tight, leak free and plumbed true to the required position.

502.6.7. Rejection. Any valve may be rejected for failure to meet its respective requirements of this specification or referenced specifications.

502.6.8. Measurement and Payment. Where valves are furnished by the OWNER, the valves shall be measured for payment for handling, placing, installing, jointing, testing and all incidentals per each, grouped by size. Where the valves are to be furnished by the CONTRACTOR, the valves shall be measured for payment for furnishing, hauling, handling, placing, installing, jointing, testing and all incidentals per each, grouped by size. The price bid for valves shall include vault, roadway box, cover, extension pipe and pad supports since separate pay items shall not be set up for these items. Manholes for valve gear boxes shall be paid for at the contract unit price per each, grouped by sizes, complete in place, if provided in the proposal and contract. The contract unit price shall be the total compensation for labor, materials, tools, equipment and incidentals necessary to install valves complete in place in strict accordance with drawings, specifications, and/or instructions of the OWNER.

502.7. PREFORMED FLEXIBLE CONDUIT JOINT SEALANT

502.7.1. General. This specification covers a cold-applied preformed flexible butyl rubber or plastic sealing compound for sealing interior and/or exterior space on concrete sewer pipe and manhole sections, where infiltration or exfiltration is a factor in the design.

502.7.2. Applicable Standards. Except as modified or supplemented herein, all preformed flexible joint sealants shall conform to the applicable requirements of the standard specifications listed in Table 502.7.2.(a) Conduit Joint Sealant Standards.

Table 502.7.2.(a) Conduit Joint Sealant Standards

Publisher	Standard
Federal Specification	SS - S - 210A(1) Sealing Compound, Preformed Plastic, For Expansion Joints
American Association for State Highway and Transportation Officials (AASHTO)	M198

502.7.3. Basis of Acceptance. The acceptability of the preformed flexible joint sealant shall be determined by the results of physical tests, by inspection and by approval of its experience record.

502.7.4. Material. The joint sealer shall be supplied in either extruded rope form of suitable cross-sectional area or flat tape form and shall be sized as recommended by the manufacturer and approved by the Engineer. The joint sealer shall be protected by a suitable removable wrapper. The joint sealer shall not in any way depend on oxidation, evaporation, or any other chemical action for either its adhesive properties or cohesive strength. The joint sealer shall remain totally flexible without shrinking, hardening, or oxidizing regardless of the length of time it is exposed to the elements.

The manufacturer shall furnish an affidavit attesting to the successful use of the product as a preformed flexible joint sealant on concrete pipe and manhole sections for a period of at least 5-years.

If requested by the OWNER, the CONTRACTOR shall provide results of above specified tests to insure product compliance with these specifications or shall supply an affidavit of compliance from the manufacturer insuring compliance with these specifications.

502.7.5. Installation of Joint Sealant. All surfaces to be in contact with the joint sealant shall be thoroughly cleaned of dirt, sand, mud or other foreign matter. A primer shall be applied to all surfaces prior to installing the joint sealant in accordance with recommendations by the manufacturer. The protective paper wrapper shall remain on the joint sealant until immediately prior to placement of the pipe in the trench. After removal of the protective paper wrapper, the joint sealant shall be kept clean.

Backfilling of pipe laid with this joint sealer may proceed after the joint has been inspected by the OWNER.

502.7.6. Rejection. The preformed flexible joint sealant may be rejected for failure to meet any of the requirements of this specification.

502.7.7. Measurement and Payment. Joint sealant shall not be paid for separately, but shall be considered subsidiary to furnishing and installing conduit.

502.8. POLYETHYLENE WRAP FOR METAL PIPE AND FITTINGS

These specifications cover polyethylene film used as a wrap to protect cast iron and other metals in a corrosive soil environment.

502.8.1. Material. Unless otherwise specified, encasement material, sizing, and marking shall conform to AWWA C105 Polyethylene Encasement for Ductile-Iron Pipe Systems.

502.8.2. Installation. Unless otherwise specified, encasement installation shall conform to AWWA C105. Polyethylene wrapping of pipe, fittings or hydrants shall precede blocking or restraint.

Fittings such as bends and reducers shall be wrapped similarly to pipe. Specials such as but not limited to valves, hydrants, and crosses shall be wrapped by splitting, tucking and overlapping the polyethylene tube, then closing the field-made splices with the required tape. All seams shall be folded twice prior to taping in accordance with AWWA C105.

Material to cover valves may be acquired from the overlapping excess polyethylene tub on the adjacent pipe lengths. The tubing shall be drawn over the bell of pipe on either side and insulated with field-made seams as described above.

Hydrants shall be encased with the polyethylene tubing slipped over the hydrant and extended to a point 2-in. to 3-in. (5cm – 7.5cm) above the ground line. The wrap shall be excluded from the drain region to allow normal drain function of the hydrant.

502.8.3. Rejection. Failure to meet any of the specifications contained in this section shall be cause for rejection of the materials.

502.8.4. Measurement and Payment. No separate payment shall be made for polyethylene wrap. It shall be considered subsidiary to the bid items on which the polyethylene wrapping is required.

502.9. CORROSION-RESISTANT COATINGS AND LINERS FOR WASTEWATER CONDUIT AND APPURTENANCES

502.9.1. General. Coatings and liners are used as a protective barrier attached to the interior walls of concrete, ductile iron, or steel pipe or manhole sections, special concrete appurtenances for protection against the corrosive chemical elements which may occur in certain domestic wastewater environments and for protection against certain corrosive wastes from industry.

All work for and in connection with the installation of the coatings and linings, including interlocking liner plates and epoxy lining in concrete pipe and the field sealing and welding of joints, shall be done in strict conformity with all applicable specifications, instructions and recommendations of the manufacturer.

502.9.2. Basis of Acceptance. The acceptability of the protective material and its attachment to the pipe or appurtenance shall be determined by the results of tests, by inspection and by approval of its experience record. The tests are designed to prove, demonstrate and insure:

(1) whether or not the protective material is the same as used in the tests,
(2) surface continuity and lack of holidays,
(3) adhesion,
(4) resistance to temperature changes,
(5) resistance to abrasion,
(6) resistance to fire, and
(7) chemical resistance.

The inspection at the manufacturing plant or in the field is to determine:

(8) whether or not the protective material is the same as used in the tests,
(9) that it is attached in the same manner, and as uniformly, as it is attached to the concrete in the tests,
(10)that the joint areas are adequately protected.

The experience record of the protective material attached to the pipe or appurtenances must be acceptable.

To qualify the material and the attachment of the material to the pipe or appurtenances for acceptance, all tests must be met or certified for the specific protection intended, all conditions to be evaluated by inspection must be met, and the experience record must be submitted and approved.

502.9.3. Testing Requirements. Unless otherwise specified, the manufacturer of the protective material is responsible for meeting the testing, inspection standards and experience records as described herein, except in

the case of a pipe manufacture electing to procure the protective material and applying the material as the pipe is manufactured. In such a case the pipe manufacturer would be responsible.

The test results shall be certified by a recognized testing laboratory acceptable to the OWNER and do not necessarily have to be made on each project.

The inspection results shall be attested to in writing by a licensed Professional Engineer or witnessed by the Engineer representing the OWNER. The experience record shall be documented with dates, locations, actual number of feet (m) of protected conduit in the ground, length of time in the ground, the nature of the environment against which the conduit is being protected and the names and addresses of responsible references who shall verify the facts in the experience record.

502.9.4. Physical Requirements.

502.9.4.1. Chemical Resistance. The OWNER may designate which of the solutions mentioned may be used or may designate others.

The chemical resistance test shall be made as follows:

(1) The specimens, approximately 5-in. long, 2¼-in. wide and 1-in. thick (125 mm x 56 mm x 25 mm), shall be cut from the pipe. The protective material shall be attached to these test specimens in the same manner as it would be attached to the pipe. The protective material shall be to manufacturer's specified minimum thickness. If curing is required, the protective material shall be cured to the manufacturer's recommendations.

(2) The protective material on the prepared test specimens shall be tested for indentation hardness in accordance with the requirements of ASTM D2240 Test Method for Rubber Property—Durometer Hardness and the hardness recorded.

(3) The prepared test specimens shall then be placed in wide mouth glass containers half submerged in the following solutions:

5%	sulphuric acid
5%	hydrochloric acid
3%	salt (NaCl) water
1%	phenol
5%	alum
5%	phosphoric acid
10%	biodegradable detergent
100%	motor oil

(4) The containers shall be closed and held at 100°F (37.7°C) for six-months.

(5) After six months the specimens shall be taken from the containers and tested again for indentation hardness in accordance with the requirements of ASTM D2240. The test durometer hardness shall be made in both the area exposed to the liquid and in the area exposed to the vapor above the liquid. There shall be no loss of indentation hardness either in the area below the liquid or in the area above the liquid.

502.9.4.2. Surface Continuity and Holidays. Voids or holidays shall be cause for rejection. The surface continuity and holiday test shall be made as follows:

(1) An electrical holiday detector, capable of producing and maintaining a voltage equal to 800 times the square root of the specified minimum protective thickness expressed in mils, shall be used to determine the complete continuity of the protective surface.

(2) The electrical holiday detector shall be used on a full size piece the protective material taken from a production run.

502.9.4.3. Adhesion to the Pipe or Appurtenances.

502.9.4.3.1. Adhesion to Concrete. Where the protective material adheres directly to the concrete, adhesion test shall be made as follows:

(1) Make a test specimen by drilling a core hole through the protective material and the pile to produce a core sample 1-in. (2.5cm) in diameter by ¾-in. (1.9cm) or more in depth. (This hole may be repaired and the pipe from which the sample was taken may be used.)

(2) Check the protective material for thickness.

(3) Cement the test specimens onto a solid wooden block at least 2-in. x 2-in. x 1-in. (5cm x 5cm x 2.5cm) in thickness so that the protective material is cemented onto the wooden block.

(4) Allow sufficient time for the cement to set.

(5) Support the wooden block so that the test specimen is on its underside and hang a 40-pound (18-kg) weight on the test specimen. This can be done using an ordinary wooden clamp.

(6) This test should be made at an ambient temperature of between 60°F and 90°F (15°C - 32°C).

(7) The protective material shall adhere to the material for a minimum of two-hours.

502.9.4.3.2. Anchored to Concrete. Where the protective material is anchored to the concrete by fins embedded or dovetailed into the concrete adhesion test shall be made as follows:

(1) Using a large enough square footage (m^2) of the protective material to be a representative sample, the fins shall not be capable of being pulled out of the material, usually concrete, nor the protective material torn away from the embedded fins using less than a pull equal to 50-psi (3.6-kg/m^2).

(2) For the adhesion test, either Item 502.9.4.3. Adhesion to the Pipe or Appurtenances or paragraph (1) above shall be used, but not both.

502.9.4.4. Resistance to Temperature Changes. The test for resistance to temperature changes for those materials that adhere directly to the concrete shall be made in accordance with the latest ASTM Method when required by the OWNER.

502.9.4.5. Resistance to Abrasion. The test for resistance to abrasion shall be made as follows:

(1) A 1-foot (30cm) length of pipe which has been lined with the protective material shall be suitably capped and arranged on rollers so that it can be revolved at high speeds. A door shall be left in one end so that access can be had to the interiors of the test section.

(2) A slurry shall be made composed of six-pounds (2700-grams) of gravel and three-pounds (1360-grams) of water, and it shall be placed inside the test section and the test section shall be rotated so that the protective material has peripheral speed of four-feet-per-second (122-cm-per-second). After 1,500,000 revolutions, the protective material shall not show visible signs of wear or abrasion.

502.9.4.6. Resistance to Fire. The protective material, if plastic, shall be tested for resistance to fire by meeting the requirements of ASTM D635 Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position. The material shall be self-extinguishing or nonburning according to ASTM D635.

502.9.5. Appurtenance Protection. Adequate protection shall be provided at the ends of joints.

All special shapes such as tees and wyes, branches, slants and curves shall be protected with the protective material, and they shall be given the same degree of protection provided to the production run of pipe. Lift holes, if called for on the plans or in the specifications, shall be sealed with epoxy or sealant recommended by the coating or liner manufacturer that shall pass the tests as set out in this Item 502.9. Corrosion-Resistant Coatings and Liners for Wastewater Conduit and Appurtenances.

502.9.6. Inspection. The tests required under the physical test requirements section of this specification need only be made once on any one project. Each length of pipe or special may be subject to visual inspection during manufacture, transportation or laying by the OWNER in order to cull and reject pipe as specified in Item 502.9.8. Rejection.

502.9.7. Repair of Coatings and Liners. Where the protective material is damaged or where the adhesion of the protective material to the concrete is damaged, repairs may be made at the discretion of the OWNER.

502.9.8. Rejection. The protective material shall be rejected if:

(1) Any the tests described under physical test requirements are not met,

(2) The manufacturing method of applying, adhering and curing the protective material differs from that used on the test samples,

(3) The protective material thickness as used on the test samples exceeds the minimum specified in the manufacturer's specification by more than five-percent, or

(4) It cannot be adequately repaired in the field.

502.9.9. Measurement and Payment. No separate payment shall be made for coating or lining unless otherwise specified by the OWNER. It shall be considered subsidiary to the bid items on which the coating or lining is required.

502.10. CONNECTIONS TO CONDUIT FOR SERVICE

502.10.1. Definitions. "Service" shall be defined as a service line to an individual customer. "Bullheads" shall be defined as an individual service line with branches at the end to serve two or more customers.

502.10.2. Materials.

502.10.2.1. Service Clamps. Service clamps shall be designed for tapping water pipe under normal service pressure. The clamp shall consist of a contoured saddle fastened to the pipe by one U-bolt for the single strap clamp for pipes less than 4-inches (10cm) I.D., and by two U-bolts for double strapped clamps or shall consist of two sections or halves that shall be fastened together with a minimum of two bolts and nuts for pipes 4-inches (10cm) I.D. and larger. The saddle shall be sealed against the pipe with a rubber gasket and shall have a heavy hub tapped with a corporation stop thread. The clamp shall be designed for 150-psi (1034-kPa) water working pressure.

502.10.2.1.1. Saddles. The saddles shall be shaped so as to provide approximately 180° coverage around the pipe. Saddle shall be material conforming to ASTM B62 Composition Bronze or Ounce Metal Castings. Casting shall conform to AWWA C800.

Saddle Hubs. The saddle hub for single and double strap clamps shall have a wall thickness of not less than ½-in. (13mm) including threads. The hub shall be tapped with a corporation stop thread of the size specified.

The thread shall have a taper and pitch in accordance with AWWA Standard C800 for Threads for Underground Service Line Fittings. The hub shall be reinforced so that threads shall not be distorted by bending movements.

Open slots for bolts shall not be allowed.

Clamps. Double strapped clamps 4-in. (10cm) through 12-in. (31cm) shall have not less than the thickness from the point of the built-up hub segment to the segment immediately adjoining the holes for the saddle straps specified in Table 502.10.3.1.1.(a) Clamp Minimum Thickness.

Table 502.10.3.1.1.(a) Clamp Minimum Thickness

Clamp Size		Minimum Thickness	
in.	(cm)	in.	(cm)
4	(10.2)	0.190	(0.5)
6	(15.2)	0.195	(0.5)
8	(20.3)	0.195	(0.5)
10	(25.4)	0.195	(0.5)
12	(30.5)	0.215	(0.5)

Markings. Saddles shall be distinctly marked with cast letters showing manufacturer's name, type pipe saddle as designed for (cast iron, ductile, etc.) and minimum/maximum o.d. ranges.

502.10.2.1.2. Straps. Straps shall be of materials conforming to ASTM B124 Copper and Copper Alloy Forging Rod, Bar, and Shapes, or ASTM B98 Copper-Silicon Alloy Rod, Bar, and Shapes, or A276 Stainless Steel Bars and Shapes. Straps shall be formed flat on one side to fit uniformly against the wall of the pipe. Rod diameter shall be not less than ⅝-in. (16mm) flattened to ¾-in. (19mm) on one side.

Straps shall be threaded ⅝-in. (16mm) 11-NC-2A for a distance such that ½-in. (13mm) remains after clamp is fully tightened on pipe.

502.10.2.1.3. Gaskets. Gaskets shall be of neoprene rubber. Shore hardness shall be 65 ± 5. Gasket shall be of O-ring type, $^{3}/_{16}$ in. (5mm) thick and securely fastened to the saddle to facilitate installation.

502.10.2.1.4. Nuts. Nuts shall be of the same material as saddles or straps. Nuts are to be semi-finished heavy hexagon tapped ⅝-in. (16mm) 11-NC-2B.

502.10.2.1.5. Hydrostatic Test. All products not previously approved for use shall be subject to hydrostatic test. Service clamps shall not leak or show any structural deformation under a hydrostatic test pressure of 300-psi (2068-kPa) for 30-days.

502.10.2.1.6. Rejection. All service clamps furnished under these specifications shall be subject to inspection by the OWNER. If any products are found not to conform to the specifications, the lot or any portion thereof may be rejected.

502.10.2.2. Tapping Valves. Tapping valves shall conform to the requirements of Item 502.6.1.17. Tapping Valves.

502.10.2.3. Tapping Sleeves. The material for tapping sleeve bodies shall be cast iron or ductile iron in accordance with AWWA C110 (ANSI 21.10) or ASTM A285 Pressure Vessel Plates, Carbon Steel, Low-and Intermediate-Tensile Strength, Grade C carbon steel, in two sections or halves to be bolted together with high-strength, corrosion-resistant, low-alloy steel bolts conforming to AWWA C111 (ANSI A21.11). Branch outlet of tapping sleeves shall be flanged with a machined projection or recess to mate with tapping valve inlet flange to assure correct alignment.

Cast-iron and ductile-iron tapping sleeves shall be mechanical joint, or as specified, with dimensions to secure proper fit on the type and class of pipe on which they are to be used. Bolts, nuts and glands for mechanical-joint ends shall conform to the requirements of Item 502.6.1.3. Ends.

Steel sleeves shall be restricted to use on pipe sizes 12-in. (31cm) and larger and subject to the following additional specifications:

(1) Flange shall conform to AWWA Standard C207 for Steel Pipe Flanges for Waterworks Service — Sizes 4 In. through 144 in. Class D, ANSI 150 lb. (68.0 kg) drilling. Gasket shall be affixed around the recess of the tap opening in such a manner as to preclude rolling or binding during installation.
(2) All steel sleeves shall be fusion bonded epoxy coated to an average of 12-mil (0.012-in.) (0.3mm) thickness. Finished epoxy coat shall be free of laminations and blisters, shall not peel and shall remain pliable and resistant to impact.
(3) Steel sleeves shall be provided with a ¾-in. (19mm) NPT test opening so that test can be made prior to tapping. Opening shall be provided with a ¾-in. (19mm) bronze plug.

502.10.2.4. Meter Boxes. The meter box shall be constructed for impact strength and corrosion resistance. The meter box may not be constructed of a material known to degrade in wet, acidic or alkaline soil. Materials specified by the OWNER may include, but are not limited to, cast or ductile iron, precast polymer concrete, corrugated galvanized sheet metal, and plastics such as HDPE, LDPE and LMDPE.

Cast iron shall meet ASTM A48 Gray Iron Castings, Class 30B. Ductile iron shall meet ASTM A536 Ductile Iron Castings. Corrugated galvanized sheet metal (minimum thickness of .036 inches) made with G-90 galvanized coating shall be minimum 20 gauge and galvanized according to requirements of Item 804.3. Galvanizing. Plastics may be black or white and shall be UV stabilized.

All meter box rings and covers shall be solid, made of gray cast iron conforming to ASTM A48 Class 30B or ductile iron conforming to ASTM A536 and shall bear the MFG ID, casting product number, and Country of Origin.

Where traffic is anticipated, the meter box, with cover installed, shall be able to bear a minimum of 16,000-lb load in a wheel load (H-20) style test.

Box dimensions shall be specified by OWNER. The OWNER may specify boxes compatible with remote meter reading. Meter boxes shall be clearly marked with manufacturers ID and model number.

502.10.3. Water Conduit Connections. This section and Item 506.6. Connections to Existing Water Conduits shall govern for the construction of connections to water conduits.

502.10.3.1. Taps and Tap Assemblies in Water Conduit. Taps and/or tap assemblies of the specified size shall be installed in locations as detailed and indicated on the plans or as specified.

502.10.3.1.1. Taps. Taps for transmission of water or air from the main into system service accessories can be either of two types as follows:

(1) Standard internal pipe threaded holes in wall of water mains. These taps may be either manufactured into the pipe or installed in the field.
(2) Tap installations that are made by clamping a service saddle equipped with a sealed threaded port on the periphery of the main and then drilling through the pipe wall to complete each service port. Taps may be made either on an uncharged system or into a main under pressure.

502.10.3.1.2. Tap Assemblies. The tap assembly shall consist of a corporation stop and an iron to copper connection attached to a hard copper (Type K) tubing terminating approximately 1-ft. (30cm) below ground surface with a brass gate valve as shown and detailed on the plans to serve as additional air release.

When tap assemblies are an integral part of an air valve installation, measurement and payment shall be in accordance with Item 502.6. Valves.

Tap assemblies may be required by the project plans and specifications adjacent to gate valve installations. Tap assemblies so required shall be installed in the water main on either side of the valve. Payment for the tap assemblies shall be included in the unit price bid for furnishing and installing the gate valve complete in place.

When taps are required for flushing, chlorination and/or testing, the CONTRACTOR shall locate the taps in accordance with Standard Drawing 4110 or other detail drawings, plans or in locations directed by the OWNER. No separate payment shall be made for taps required for testing, flushing, and/or chlorination.

Upon completion of the testing and purification, the CONTRACTOR shall return to the job site, remove the blow-off down to the corporation stop, backfill leaving the corporation stop in place, and replace all pavement. The CONTRACTOR'S removal of the blow-off shall include all labor, materials, tools, equipment and incidentals necessary to complete the work, including excavation, backfill and disposal of surplus materials without additional compensation.

502.10.3.1.3. Tapping Sleeves. Steel sleeves shall not be used for taps greater than 75-percent of the pipe diameter. Use of steel sleeves for "size-on-size" taps is prohibited.

All steel sleeves shall be crated in wooden crates that shall provide protection from damage to epoxy coating during transport and storage.

502.10.3.1.4. Tapping Ductile Iron Pipe. Service taps, unless otherwise specified, shall be made in cast iron pipe by direct tapping of the pipe wall (without use of tap saddles) for tap sizes relative to pipe diameters as shown in Table 502.10.3.1.4.(a) Tapping Ductile Iron Pipe.

Table 502.10.3.1.4.(a) Tapping Ductile Iron Pipe

Tap Diameter	Pipe Diameter
¾-in. and 1-in.	4-in. through less than 12-in.
1½-in. and 2-in.	12-in. and larger

When direct tapping of cast iron pipe cannot be made within the limits as provided above, taps shall be made as set forth in this specification, utilizing service saddles.

502.10.3.1.5. Tapping Concrete Pipe. Tap location shall be provided to the pipe manufacturer, when available, and taps shall be made by the manufacturer during the fabrication phase of the pipe when locations are so furnished. Taps fabricated during manufacture with a diameter less than or equal to 2-in. (5cm) shall be provided with brass or bronze insert bushings. Taps greater than 2-in. (5cm) shall be provided as flanged outlets with flange to thread insulator adapter kits. When taps are required to be made in the field, the taps shall be made in accordance with the pipe manufacturer's recommended procedures and to the satisfaction of the OWNER.

502.10.3.1.6. Tapping Asbestos or Asbestos Cement Pipe.

If a tap to existing asbestos pipe is necessary, use EXTREME CAUTION to avoid the airborne release of asbestos fibers.

Taps to asbestos cement pipe can be made with bronze double strap tapping saddles, tapping tees, or pre-tapped couplings with brass insert bushings. A tapping tee shall be paid for as a fitting. If pre-tapped couplings are called for in the contract and proposal, a separate pay item shall be provided for each, classified as to size.

502.10.3.1.7. Tapping PVC Pipe. Service taps in AWWA C900 PVC pressure pipe shall be made with a shell cutter assembly and the coupon removed for tap sizes relative to pipe class and diameter as shown in Table 502.10.3.1.7.(a) Tapping PVC Pipe.

Table 502.10.3.1.7.(a) Tapping PVC Pipe

Tap Diameter	Pipe Diameter	Pressure Class
¾-in. and 1-in.	6-in. to 12-in.	150 and 200

When direct tapping of PVC pipe cannot be made within the limits as hereinbefore provided, taps shall be made as set forth in this specification, utilizing service saddles.

502.10.3.1.8. Measurement and Payment. Measurement shall be for individual taps made by size, and payment shall be absorbed under Item 506. Water Conduit Installation or Item 502.6. Valves unless otherwise specified.

502.10.3.2. Services and Bullheads. The details on installation and materials required are shown in applicable Division 4000 Standard Drawings or on the appurtenance sheets attached to the plans.

The end of each water service connection shall be marked with heavy gauge polyethylene tape, 6-inches (15cm) in width with a thickness of 0.004-inches (0.1mm). The tape should be blue in color on which has been printed "Caution Buried Water Line Below" in continuous print. The tape should have a minimum tensile strength of 1700-psi (120-kg/cm^2) lengthwise and 1200-psi (85-kg/cm^2) crosswise.

Meter boxes shall be buried to protect the meter from unauthorized access, damage and freezing.

502.10.3.2.1. Procedures for Transferring Service. The CONTRACTOR will inform the customer that the service is being transferred.

Short Service. A water service shall be classified as a "Short Service" if the existing service line to the water meter is on the same side of the street as the new main and requires the existing service line to be replaced to complete the installation as indicated on the plans and specified herein. A curb stop will be installed on the end of the service line.

Long Service. A water service shall be classified as a "Long Service" if the existing service line to the meter is on the opposite side of the street as the new main and requires a new service line to be installed under the street to complete the installation as indicated on the plans and specified herein. Splices in service lines shall not be permitted.

All new services will be flushed according to Item 506.7. Purging and Disinfection of Water Conduits. The main will then be hydrostatically tested and disinfected. After a good sample is received, the CONTRACTOR will then begin transferring the services.

The water serving the customer through the existing water service will be stopped by closing a corp or curb stop on the existing water service. The existing customer line and new service line will then be cut at the property line and connected. Galvanized customer lines will not be threaded for connection, but will be cut and connected with a coupling.

Any meter box located within a driveway or sidewalk shall be relocated and placed in the parkway or behind the sidewalk as directed by the OWNER. Reuse of the existing water meter box shall be as determined by the OWNER. The connection of the new service water lines to the meter shall be considered subsidiary to the service installation.

502.10.3.2.2. Measurement and Payment. Where water services have to be transferred from a line to be replaced, killed or salvaged to a line being constructed, they shall be paid for per each, as set out in the proposal and contract.

Bullheads or water services shall be measured and paid for at the contract price per each, in accordance with size and location, complete in place, as provided in the proposal and contract. The tapping saddle shall be measured and paid for as part of the service. There shall be no extra pay for extra depth in the installation of service leads (deadheads).

Meter boxes shall be paid for per meter box.

The contract price shall be the total compensation for the furnishing of all labor, materials, tools, equipment and incidentals necessary to complete the work.

502.10.4. Wastewater Conduit Connections. This section shall govern for the construction of connections to wastewater conduits. Connections of wastewater pipe to existing wastewater conduits or wastewater appurtenances shall be as shown on the plans or as directed by the Engineer. Details of construction shall be shown on the plans.

The end of each wastewater service connection shall be marked with heavy gauge polyethylene tape, 6-inches (15cm) in width with a thickness of 0.004-inches (0.1mm) unless a cleanout is present. The tape should be green in color on which has been printed "Caution Buried Wastewater Line Below" in continuous print. The tape should have a minimum tensile strength of 1700-psi (120-kg/cm^2) lengthwise and 1200-psi (85-kg/cm^2) crosswise.

502.10.4.1. Service Connection. Service pipe shall be of the same pipe material as the main wastewater conduit unless otherwise specified on the plans or in the contract or approved by the OWNER. Connections shall be made to prevent the occurrence of bi-metallic corrosion or any other corrosion that can result by joining incompatible materials.

Wastewater service connections shall be defined as a service line connecting the customer's wastewater system at the property line or utility easement to the main wastewater conduit and shall consist of the service combination tee wye, the necessary Class B or Class PB (as specified by the OWNER) concrete cradle or crushed stone for the tee wye, the service pipe necessary to extend the line from the main wastewater conduit to the customer's property line and a plug placed in the end of the service line.

Services for single-family residence shall normally be 4-inches (10cm) in diameter. Standard 4-inch (10cm) laterals shall consist of a standard wye and bend and the necessary pipe and cleanout as shown on the plans or directed by the OWNER. Larger laterals shall consist of a manhole and the necessary minimum 6-inch (15cm) pipe as shown on the plans or directed by the OWNER. If the CONTRACTOR is required to connect or reconnect the service line to the customer's wastewater system, the connection shall be as shown on the plans. If the CONTRACTOR is not required to connect to the customer's wastewater system, the service line shall be plugged and sealed.

Extra depth service connections shall be installed when the wastewater main is at a depth greater than that necessary to serve the abutting property. The service is identical to a standard connection except that pipe risers will be installed at a maximum 45-degree angle into the trench walls to connect the combination tee wye and 45-degree bend to the service pipe. Where possible, a minimum slope of ¼-in.-per-foot (equivalent to a 2% slope) will be maintained. Where the wastewater main is located in the street and the abutting property slopes to the street, the wastewater service shall normally have a minimum depth of 5-feet below the top of the curb at the point where it passes beneath the curb. Where abutting property slopes away from the wastewater main, service connections shall be placed at a depth adequate to serve the normally expected use of the property.

Where water and wastewater service connections cross, they shall be treated in accordance with TCEQ regulations.

502.10.4.2. Cleanouts. Service line cleanouts shall conform to Standard Drawing 5120. If service line cleanouts are required, they shall be installed at the property line. When specified in the special provisions or in the plans, a test tee shall be installed at the end of the service line (located in the parkway), with the branch in a vertical position.

502.10.4.3. Measurement and Payment. Wastewater conduit connections shall be measured at the contract unit price per each, complete in place. The contract unit price shall be total compensation for the furnishing of all labor, materials, tools, equipment and incidentals necessary to complete the work, including excavation, concrete encasement, if required, disposal of excess material, backfill, embedment, concrete blocking, paving and sod, all in accordance with the plans and specifications.

502.11. MISCELLANEOUS CONDUIT CONNECTIONS

502.11.1. Pitot Outlets. Pitot outlets shall be of the type indicated on the plans or appurtenance sheet. Pitot outlets shall be measured for payment for each. Pitot outlets shall be paid for at the contract unit price per each.

502.11.2. Facilities for Dewatering of Water Lines. There shall be constructed, at the location shown and detailed in the plans, permanent standard blow-offs and drains and special dewatering facilities to permit the blowing off and/or the dewatering of lines or sections of line.

Permanent blow-offs and drains shall be measured as complete units. Payment shall be made for permanent blow-off and drain at the unit price bid which shall be full compensation for the complete installation. Payment for permanent blow-offs with dewatering sump manhole shall be made on a lump sum basis at the unit price bid, which shall be full compensation for complete installation, including excavation and backfill from blow-off fitting to manhole, furnishing and installing sump manhole and other items needed for complete installation exclusive of items for which there are bid items in the proposal.

502.11.3. Wastewater Connections. Connection of wastewater mains to existing manholes and to other wastewater mains where constructing a manhole is not feasible or not required shall be watertight. The use of pipe hammers or jackhammers is prohibited.

502.12. STRUCTURES

502.12.1. Description. This section shall govern for the construction of all miscellaneous structures such as junctions, transitions, and utility supports, and for the construction of appurtenances such as deep-cut connections, wyes, stoppers and bulkheads, and such other miscellaneous structures or appurtenances which may be shown on the plans. Construction shall conform with any applicable provisions of Division 700. Structures.

Unless otherwise specified on the plans, all storm sewer structures such as junctions, transitions, manholes, cleanouts, wyes, elbows, tees, stoppers and such other miscellaneous structures or appurtenances which may be shown on the plans shall be made of the same base metal and coating (metallic or otherwise) as the pipe on which it is connected. All such structures or appurtenances field fabricated or otherwise will be repaired in accordance with Item 502.9.7. Repair of Coatings and Liners or Item 804.3.5. Repair of Damaged Zinc Coating, as applicable.

In general there shall not be a pay item for pipe support when a temporary part of conduit installation, but the contract prices for the new or re-laid pipe, shall be the total compensation for the furnishing of all labor, tools, materials, equipment and incidentals necessary to complete the work including excavation, installation and removal of the temporary piping, construction of piers, stripping of forms, disposal of surplus materials, in accordance with the plans and specifications. Where a pay item is included, the contract price shall be the additional compensation for all excavation, labor, tools, and materials over and above the bid price for furnishing and installing the conduit.

502.12.2. Permanent Concrete Structures. The construction of reinforced concrete structures, including junctions, transitions, vaults, piers and beam supports, and such other similar structures as may be covered by this specification, shall be performed in accordance with the requirements of Item 702. Concrete Structures, applicable Division 1000-5000 Standard Drawings, and the following additional requirements. Unless otherwise specified, all concrete shall have an average compressive strength at 28-days equal or greater than 3000-psi (210-kg/cm^2). Excavation shall be made to the required depth and of sufficient width to construct the work to grade, form and dimensions. All soft and yielding materials shall be removed and replaced with acceptable materials. The subgrade shall be moistened to a minimum depth of 2-in. (5cm) before placing concrete. All formed surfaces of the concrete exposed to public view shall be given a textured finish as shown on the plans. All other formed surfaces shall be given the "Type 1 Finish," as described in Item 702.4.13. Finishing Exposed Surfaces. Corrosion protection shall be applied as may be called for on the plans or the proposal and shall be measured for payment and paid for at the contract price as detailed in Item 502.9. Corrosion-Resistant Coatings and Liners for Wastewater Conduit and Appurtenances.

Permanent concrete structures shall be measured and paid for in accordance with Item 702. Concrete Structures, as provided for in the contract documents. No measurement or payment shall be made for reinforcing steel.

502.12.3. Miscellaneous Pipe Structures. Riprap and miscellaneous pipe structures that may be necessary shall be designed in detail on the plans.

The structures shall be measured for payment per each or in linear feet between the limits set out on the plans as provided for in the proposal and contract. Miscellaneous concrete shall be measured for payment paid for at the contract unit price as provided in the proposal and contract, typically in cubic yards (m^3). The contract price shall be the total compensation for the furnishing of all labor, materials, tools, equipment and incidentals necessary to complete the work, including all excavation, disposal of surplus materials and backfill, in accordance with the plans and these specifications.

502.12.4. Connections to Existing Structures. The bottom of the existing structure shall be mortared or concreted, if necessary, to eliminate any drainage pockets by the new connection in general accord with details for the new structure as shown on the plans. Where conduit is connected into old structures that are to remain in service, any damage to the structure resulting from the work of making the connection shall be restored by the CONTRACTOR to the satisfaction of the Engineer.

502.12.5. Waterstops. Waterstops shall be of the type and kind and of materials designated on the plans. Care shall be taken that the waterstop is properly located and held in position during placement of concrete. For particular material, the following shall apply:

(1) PVC Material. Splices of waterstop shall be performed by fusing the material, using a heat device thermostatically controlled in accordance with the manufacturer's recommendations.

(2) Copper Material. Any copper sheets which are damaged under construction operations shall be repaired or replaced. Splices shall be made by lapping and soldering or other approved method.

No separate payment shall be made for waterstop material or for installation of this item. The costs shall be included in the price bid for the completed structure into which the materials are incorporated.

502.12.6. Water Migration Barrier. Water migration barrier prevents water flow along an embedded conduit. A 3-ft. ±1-ft. (0.9m ±0.3m) long clay barrier (30< P.I. <40) shall be placed at 200-ft. (60m) intervals along all water mains. This clay barrier shall be for the full width and depth of the trench, replacing all bedding, embedment and backfill materials, and shall be placed at the mid-point of a length of pipe being placed, but not at a location where a lateral or service connects with the water main.

ITEM 503. TRENCHLESS INSTALLATION

503.1. CONDUIT MATERIALS

Conduit materials shall be indicated on the plans and shall conform to the specifications of Item 501. Underground Conduit Materials.

503.2. TUNNEL/CASING PIPE SPACERS

503.2.1. General. This specification covers the materials and requirements for pipe restraining system for pipe installation in tunnels or casing pipe under railroads, highways, streets or other trenchless situations. Restraining systems shall prevent pipe joint separation during and after installation and shall provide dielectric insulation between the carrier pipe and the tunnel liner/casing pipe and shall be resistant to corrosion.

503.2.2. Types.

503.2.2.1. Steel Rib and Wood Lagging System. Steel ribs shall conform to ASTM A36 Carbon Structural Steel. The ribs shall be of the size shown on the plans, special provisions or approved from a design load submittal. The ribs shall be bent by cold pressing in dies.

Wood lagging shall have a minimum thickness of 2.75-in. (7.0cm) and a minimum average ultimate stress capacity of 5,000-psi (34,470-kPa). The ultimate stress capacity to be determined according to ASTM D198 Static Tests of Lumber in Structural Sizes, flexure test on five randomly selected timbers from each shipment of lagging. The maximum load carried by each timber disregarding the highest and lowest one of the five timbers tested shall be averaged to determine the ultimate stress capacity of that shipment.

Nuts shall conform to ASTM A307 Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength. The bolts shall conform to ASTM A449 Quenched and Tempered Steel Bolts and Studs for rib thickness equal to or greater than 0.209-in. (0.5cm) and to ASTM A307 Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength for rib thickness less than 0.209-in. (0.5cm).

503.2.2.2. PVC Restrained Casing Spacer System. PVC Restrained Casing Spacers shall be provided at all pipe bell joints and not more than 10-feet (3.0m) apart to support pipe and its contents.

Casing spacer runners shall be an ultra high molecular weight polymer with a minimum tensile impact of 600-ft-lbs/sq.in. (1290-kg-cm/cm^2). Restrainer body and runner supports shall conform to ASTM A536 High Strength Ductile Iron Grade 65-45-12. Connecting rods and nuts shall conform to high strength, low alloy steel as designated in ANSI/AWWA Standard C-111/A21.11

503.2.2.3. HDPE Casing Spacers. Spacers shall provide full circumferential support in case the carrier pipe twists as it is pushed through the casing. Casing spacers shall have a minimum projection height necessary to clear the bell of the carrier pipe or as otherwise indicated on the plans. Casing spacers shall fasten tightly onto the carrier pipe to prevent spacer movement during installation. The span between spacers should result in conservative long-term load safety factors with carrier pipe full of fluid. Manufacturer shall provide the load carrying capacity of the spacer assembly and maximum spacing shall conform to manufacturer's recommendations.

503.2.2.4. Alternate Casing Spacers. When approved by the OWNER, Nylon, Stainless Steel, Ductile Iron, or Carbon Steel Casing Spacers may be used. Such alternate systems shall conform to all requirements as stated in the plans.

503.2.3. Tests. Tests for compliance with this specification shall be as specified herein. A certification of compliance with this specification along with a report of each test shall be furnished to the OWNER.

503.2.4. Rejection. Tunnel/casing spacers and related materials may be rejected for failure to meet any of the requirements of this specification.

503.3. METHODS OF JACKING, BORING OR TUNNELING

503.3.1. Description. This specification shall govern for the provision of the required opening for the installation of conduits by the methods of jacking, boring or tunneling as shown on the plans and in conformity with this specification.

503.3.2. Materials. The encasement and carrier pipe shall be of the type and strength as indicated on the plans. All necessary materials shall conform to the applicable sections of these specifications or as specified by the OWNER or Engineer.

503.3.3. Construction Methods.

503.3.3.1. General. The CONTRACTOR may request to perform the work by jacking, boring, or tunneling in lieu of open cut.

Where encasement or carrier pipe is required to be installed under railroad embankments or under highways, streets or other facilities by jacking, boring or tunneling methods, construction shall be made in a manner that shall not interfere with the operation of the railroad, highway or other facility and shall not weaken or damage any embankment or structure. The CONTRACTOR shall notify all railroad companies or TxDOT at least 48-hours prior to construction. The CONTRACTOR shall provide insurance as required by the governing authority.

During construction operations, barricades and lights to safeguard traffic and pedestrians shall be furnished and maintained around the excavation, equipment, and materials as required in Item 107.19. Protection of Work and of Persons and Property, until such time as the backfill has been completed and then shall be removed from the site. All excavations shall be safely secured at all times to prevent unauthorized access to the excavation site.

The CONTRACTOR shall take the proper precautions to avoid excavating earth or rock or shattering rock beyond the limits of excavation needed to install the conduit. All damages caused by excavating or blasting, either to surface or subsurface structures, shall be repaired or replaced by the CONTRACTOR at the CONTRACTOR'S own cost and expense. The CONTRACTOR shall dispose of all surplus materials at its own expense.

The drilling of pilot holes for the alignment of pipe prior to its installation by jacking, boring, or tunneling shall not be a requirement but may be necessary to maintain grade.

503.3.3.2. Construction by Jacking. If the grade of the pipe at the jacking end is below the ground surface, suitable pits or trenches shall be excavated for the purpose of conducting the jacking operations and for placing end joints of the pipe. This excavation shall not be carried to a greater depth than is required for placing of the guide and jacking timbers and a horizontal distance no nearer the roadbed than the minimum distance shown on the plans.

At the other end of the pipe, an approach trench shall be excavated accurately to grade. All open trenches and pits shall be braced and shored or their walls sloped in such a manner as shall adequately prevent caving or sliding of the walls into the open trench or pit and be in accordance with the requirements of Item 107.19. Protection of Work and of Persons and Property.

Heavy-duty jacks suitable for forcing the pipe through the embankment shall be provided by the CONTRACTOR. In operating jacks, even pressure shall be applied to all jacks used. Suitable bracing between jacks and the jacking head shall be provided so that pressure shall be applied to the pipe uniformly around the ring of the pipe. The jacking head shall be of such weight and dimensions that it shall not bend or deflect when full pressure is applied at the jack. The jacking head shall be provided with an opening for the removal of excavated material as the jacking proceeds. A suitable jacking frame or backstop shall be provided. The pipe to be jacked shall be set on guides which are straight and securely braced together in such manner as to support the section of pipe and to direct it in the proper line and grade. All timber and other materials used in the construction of the jacking assembly shall be of such quality and dimensions that they shall withstand all stresses to which they are subjected in such a manner as to insure even pressures on the pipe during jacking operations. The whole jacking assembly shall be placed so as to line up with the direction and grade of the pipe.

As the jacking proceeds, the embankment material shall be excavated slightly in advance of the pipe in such a manner as to avoid making the excavation larger than the outside diameter of the pipe, with the excavated material being removed through the pipe. The excavation for the underside of the pipe, for at least $^1/_3$ of the circumference of the pipe, shall conform to the contour and grade of the pipe. The excavation for the top half of the pipe shall conform closely to the outside diameter of the pipe and a clearance greater than 2-in. (5cm) shall not be permitted. All voids between the pipe and the earth shall be filled with grout per ASTM C476 Grout for Masonry. Grout holes may be provided in the pipe, or grouting may be made through drill holes from the ground surface if practicable. The grouting shall follow immediately upon completion of the jacking operation. Grout shall have a maximum compressive strength of 100-psi (7-kg/cm^2) at 28-days.

All carrier pipe installed by jacking shall be supported by a quarter point cradle of Class B or Class PB concrete as specified by the OWNER across the jacking pit and to the first joint in the ditch section on each end.

The distance that the excavation shall extend beyond the end of the pipe depends on the character of the material, but it shall generally not exceed 2-ft. (0.6m). The pipe preferably shall be jacked from the low or downstream end. Lateral or vertical variation in the final position of the pipe from the line and grade established by the OWNER shall be permitted only to the extent of 1-in. per 10-ft. (25mm per 3m), provided that such variation shall be regular and only in one direction and that the final grade of the flow line shall be in the direction indicated on the plans.

Once jacking of pipe is begun, the operation shall be carried on without interruption, insofar as practicable to prevent the pipe from becoming firmly set in the embankment.

Any pipe damaged in jacking operations shall be repaired if approved by the OWNER or removed and replaced by the CONTRACTOR at the CONTRACTOR'S entire expense.

The pits or trenches excavated to facilitate jacking operations shall be filled as soon as practicable or as directed by the OWNER. The pits or trenches shall then be backfilled in accordance with the location and conditions as are covered elsewhere in these specifications.

If a carrier pipe is laid through an encasement pipe, the bedding of crushed rock, concrete, grout or granular material, if any, shall be considered a part of the unit price of the jacking operation.

503.3.3.3. Construction by Boring. The hole shall be bored mechanically with a suitable boring assembly designed to produce a smooth, straight shaft and so operated that the completed shaft shall be at the established line and grade. The size of the bored hole shall be of such diameter to provide ample clearance for bells or other joints. The holes are to be bored mechanically. The boring shall be done by using either a pilot hole or a dry bore method.

A pilot hole boring shall be constructed by the following method: An approximate 2- in. (5cm) pilot hole shall be bored the entire length of the crossing and shall be checked for line and grade on the opposite end of the bore from the work pit. The pilot hole shall serve as the centerline of the larger diameter hole to be bored.

The dry bore shall be constructed as follows: The casing pipe shall be advanced as the soil is removed by augers. Bentonite may only be used as a lubricant. Casing shall be new or used steel conduit approved by the OWNER, with a minimum inside diameter sufficiently larger than the outside diameter of the carrier pipe or ducts to accommodate placement or removal.

All carrier pipe installed by boring shall be supported by a quarter point cradle of Class B or Class PB concrete as specified by the OWNER across the boring pit and to the first joint in the ditch section on each end. All pits should have crushed rock and sump areas to remove water. Where groundwater is found, pits shall be lined with filter fabric.

All voids shall be grouted per ASTM C476 Grout for Masonry and shall be considered a part of the unit price of the boring operation.

In addition to the requirements stated above, the applicable provisions of Item 503.3.3.2. Construction by Jacking in regard to the construction of trench, tolerance in line and cradle, method of operations, backfilling, etc. shall govern for construction by boring.

503.3.3.4. Construction by Guided Boring or Directional Drilling. Guided boring or directional drilling shall be accomplished according to the standards in *Trenchless Technology Guidelines* published by the International Society for Trenchless Technology.

503.3.3.5. Construction by Tunneling. The tunnel shall be excavated in such a manner and to such dimensions so as to permit placing of the proper supports necessary to protect the excavation. The CONTRACTOR shall take the proper precautions to avoid excavating earth or rock or shattering rock beyond the limits of excavation shown on the plans. All damages caused by excavating and blasting, either to surface or subsurface structures, shall be repaired or replaced by the CONTRACTOR at its own cost and expense. Adequate provisions shall be made for safety and health of the workers. All equipment operated in the tunnel shall be powered by either air or electricity. No equipment shall be permitted in the tunnel that uses a petroleum product such as fuel.

Electric lights shall be used for illumination of completed portions of the tunnel used for passage and wherever lighting is needed for inspection of the work. A sufficient number of lamps shall be used to properly illuminate the work, and all wiring for electric power and lights shall be installed and maintained in a safe and secure manner in accordance with the current applicable electrical specifications of the OWNER. CONTRACTOR shall maintain the tunnel air in a condition suitable for the health of the workers and sufficiently clear for surveying operations. A sufficient supply of fresh air shall be provided and maintained at all times in all underground places. Provisions shall be made for the quick and complete removal of gases and dust resulting from blasting or other tunnel operations. Except when unnecessary due to natural ventilation, artificial ventilation shall be maintained in the tunnel by ventilating plants of ample capacity operated when needed to meet the preceding requirements.

If required by the plans or if required for safety, suitable steel or timber sheeting, shoring and bracing in accordance with Item 107.19.3. Trench Safety shall be used to support the sides and roof of the excavation. When the installation is completed, and if approved by the OWNER, supports may be left in place, provided that they clear the encasement or carrier pipe. No separate payment shall be made for supports left in place. Nothing contained herein shall prevent the CONTRACTOR from placing such temporary or permanent supports as it shall deem necessary, nor shall anything contained herein be construed as relieving the CONTRACTOR from its full responsibility for the safety of workers and for all damages to personal property caused by its operations.

If the tunnel is to be lined with concrete as a monolithic structure, then the overbreak, if any, or voids shall be poured with Class A or Class PA concrete as specified by the OWNER. The CONTRACTOR shall not be compensated for overbreaks.

No pipe shall be placed until the foundation is in a condition satisfactory to the OWNER. Tunnel dimensions shown on the plans are minimum dimensions. Any excess excavation and subsequent backfill,

concrete or grout fill shall be at the expense of the CONTRACTOR. The pipe shall be laid in the tunnel true to line and grade. Tolerance in line and grade shall be as specified in Item 503.3.3.2. Construction by Jacking.

If indicated or specified, the entire void between the outside of the pipe and the tunnel walls or the inside face of the tunnel lining shall be grouted per ASTM C476 Grout for Masonry unless the permanent sheeting, bottom, sides and roof of the tunnel are in a condition satisfactory to the OWNER. The minimum thickness of grout backfill where specified shall be maintained throughout. Grout required for backfill in excess of the minimum dimensions shown on the plans shall be at the entire expense of the CONTRACTOR.

All pipe damaged during construction operations shall be repaired, if approved by the OWNER, or removed and replaced by the CONTRACTOR at the CONTRACTOR'S entire expense.

503.3.3.6. Joints. If corrugated galvanized metal pipe is used, joints may be made by field bolting or by connecting bands, whichever is feasible. When reinforced concrete pipe 24-in. (0.6m) and larger in diameter with tongue-and-groove joints is used for the encasement pipe, the interior joints for the full circumference shall be sealed, packed with mortar and finished smooth and even with the adjacent section of pipe.

503.4. MEASUREMENT AND PAYMENT

Jacking, boring or tunneling shall be measured for payment in linear feet (m) along the centerline of the pipe measured from face to face of the trench ends or pit walls between which the jacking, boring or tunneling traverses and shall not be classified for payment according to depth. The carrier pipe, when required, shall be measured for payment as provided in the contract documents. Jacking, boring or tunneling shall be paid for at the contract unit price per linear foot (m) complete in place, as provided in the proposal and contract. Open pits required for jacking, boring or tunneling shall be considered incidental and shall not be paid for separately. The contract unit price shall be the total compensation for furnishing and placing all materials including encasement pipe, if required, and grout backfill; for all jacking, boring, tunneling, excavation and backfill; for all sheeting, shoring, bracing and drainage; for disposal of all surplus materials; and for all labor, tools, equipment and incidentals necessary to complete the work, all in accordance with the plans and these specifications. The carrier pipe, when required, shall be paid for as provided in the contract documents.

No additional compensation will be provided for jacking, boring, or tunneling in lieu of open cut approved by the OWNER. The removal of any obstruction that conflicts with the placing of the pipe will not be measured for payment or paid for as a separate contract pay item. The removal of any such obstruction will be included in such contract pay items as are provided in the proposal and contract. The drilling of pilot holes will be considered as incidental work and the cost thereof shall be included in such contract pay items as are provided in the proposal and contract. The CONTRACTOR shall only be paid for the limits as shown on the plans. Any overrun, except as approved by the OWNER, shall be at the CONTRACTOR'S expense.

ITEM 504. OPEN CUT – BACKFILL

504.1. GENERAL

Backfill shall mean embedment and final backfill. Embedment shall mean bedding and initial backfill. Bedding shall mean the material upon which a pipe rests. Initial backfill shall mean material that covers the wastewater collection system and water lines. Final backfill shall mean the material required to fill the trench from the top of the initial backfill to ground elevation or subgrade of a street.

Work shall include:

(1) Pollution Prevention shall be performed in accordance with Item 201. Temporary Erosion, Sedimentation, and Water Pollution Prevention and Control;
(2) Site preparation as part of open cut installation shall be performed in accordance with Item 203. Site Preparation, except shall be considered as incidental work and the cost thereof shall be included in such contract pay item as provided in the proposal and contract;
(3) Excavation shall be performed in accordance with Item 203.5. Unclassified Channel Excavation.
(4) Landscaping shall be performed in accordance with Item 202. Landscaping;
(5) Trench safety shall be performed in accordance with Item 107.19. Protection of Work and of Persons and Property;
(6) Restoration of disturbed areas shall be performed in accordance with Item 107.26. Restoration of Property.

504.2. MATERIALS

504.2.1. Pipe Embedment Material for Storm Sewers. The pipe shall be embedded in accordance with details shown on the plans for the type of embedment indicated or specified. In general, if no particular type of embedment is shown on the plans nor specified, CONTRACTOR shall use material according to pipe manufacturer recommendation.

504.2.2. Pipe Embedment Material for Water And Wastewater Mains.

504.2.2.1. Crushed Stone Embedment. The aggregates shall consist of durable particles of crushed stone, free from frozen material or injurious amounts of salt, alkali, organic matter or other material either free or as adherent coating, and its quality shall be reasonably uniform throughout. It shall have a wear of not more than 40-percent when tested in accordance with TxDOT Test Method Tex-410-A Abrasion of Coarse Aggregate Using the Los Angeles Machine.

When tested by standard laboratory methods, crushed stone embedment for each gradation shall meet the requirements of Table 504.2.2.1.(a) Crushed Stone Embedment Gradations.

Table 504.2.2.1.(a) Crushed Stone Embedment Gradations

Passing or Retained on Sieve	Percent by Weight
Standard Crushed Stone — Aggregate Grade 4	
Retained on 1½-in. sieve	0%
Retained on 1-in. sieve	0 to 5%
Retained on ½-in. sieve	40 to 75%
Retained on No. 4 sieve	90 to 100%
Retained on No. 8 sieve	95 to 100%
Blended Crushed Stone — Aggregate Grade 48	
Retained on 1½-in. sieve	0%
Retained on 1-in. sieve	0 to 5%
Retained on ½-in. sieve	40 to 75%
Retained on No. 4 sieve	75 to 100%
Retained on No. 8 sieve	90 to 100%
Fine Crushed Stone — Aggregate Grade 8	
Retained on ½-in. sieve	0%
Retained on ⅜-in. sieve	0 to 5%
Retained on No. 4 sieve	35 to 60%
Retained on No. 8 sieve	90 to 100%
Coarse Crushed Stone	
Passing 1½-in. sieve	100%
Retained on ¾-in. sieve	100%

504.2.2.2. Granular Material. Granular material shall be free flowing, such as sand or hydraulically graded crushed stone fines, or mixed sand and gravel, or sandy loam. The material shall be free from lumps, stones over two inches in diameter, clay and organic matter.

504.2.2.3. Select Material. Select material shall be gravel, fine stone cuttings, sand, sandy loam or loam free from excessive clay. Stone cuttings shall have no dimension greater than two-inches (5cm).

504.2.2.4. Crushed Stone for Foundation. Crushed stone for foundation shall meet the requirements for Item 504.2.2.1. Crushed Stone Embedment except the gradation shall be according to Table 504.2.2.4.(a) Crushed Stone for Foundation Gradation.

Table 504.2.2.4.(a) Crushed Stone for Foundation Gradation

Passing or Retained on Sieve	Percent by Weight
Passing 5-in. sieve	100%
Retained on 2-in. sieve	100%

504.2.2.5. Natural Gravel. Natural gravel shall consist of uncrushed stones meeting the requirements for wear as outlined in Item 504.2.2.1. Crushed Stone Embedment. The material shall be washed and screened and not have by weight more than one-percent organic matter, clays or loam and not more than five-percent by weight of any one of or combination of slate, shale, schist or soft particles of sandstone. The gradation shall be according to Table 504.2.2.5.(a) Natural Gravel Gradation.

Table 504.2.2.5.(a) Natural Gravel Gradation

Passing or Retained on Sieve	Percent by Weight
Passing 1½-in. sieve	100%
Retained on ¾-in. sieve	100%

504.2.2.6. Sand. Sand shall consist of clean, hard, durable, uncoated grains, free from lumps and organic material. All particles must pass a No. 8 sieve.

504.2.3. Final Backfill. The trench shall be backfilled in accordance with details shown on the plans for the type of backfill indicated or specified.

504.2.3.1. Type "A" Backfill. Type "A" backfill shall meet the following requirements:

504.2.3.1.1. Tests. The liquid limit shall not exceed 35 when tested in accordance with ASTM D4318 Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils. The plasticity index shall not exceed 10 when calculated in accordance with ASTM D4318. The linear shrinkage shall not exceed six-percent when Type "A" backfill is used for pavement base material.

504.2.3.1.2. Gradation. The material when tested by standard laboratory methods shall meet the gradation in Table 504.2.3.1.2.(a) Type "A" Gradation.

Table 504.2.3.1.2.(a) Final Backfill Type "A" Gradation

Passing or Retained on Sieve	Percent by Weight
Passing 2-in. sieve (50 mm)	100%
Passing ½-in. sieve (12.5 mm)	50 to 85%
Passing No. 4 sieve (4.75 mm)	20 to 65%
Passing No. 100 sieve (150 um)	0 to 5%

504.2.3.2. Alternate Allowable Type "A". Field sand having the following requirements may be used in lieu of Type "A" backfill for filling trenches. The field sand material shall be obtained from approved sources; shall consist of durable particles; and shall be free of thin or elongated pieces, lumps of clay, soil, loam or vegetable matter. The material shall be required to meet the gradation in Table 504.2.3.2.(a) Alternate Allowable Type "A" Gradation when tested from source of supply test samples.

Table 504.2.3.2.(a) Alternate Allowable Type "A" Gradation

Passing or Retained on Sieve	Percent by Weight
Passing No. 4 sieve (4.75 mm)	100%
Passing No. 16 sieve (1.18 mm)	80 to 100%
Passing No. 50 sieve (300 um)	20 to 60%
Passing No. 100 sieve (150 um)	10 to 40%
Passing No. 200 sieve (75 um)	0 to 10%

504.2.3.3. Type "B" Backfill. Type "B" backfill is native or imported material. Type "B" backfill shall at minimum meet the following quality requirements.

504.2.3.3.1. Tests. The liquid limit shall not exceed 35 when tested in accordance with ASTM D4318. The plasticity index shall not exceed 12 when tested in accordance with ASTM D4318.

504.2.3.3.2. Gradation. Type "B" backfill shall meet the requirements in Table 504.2.3.3.2.(a) Final Backfill Type "B" Requirements.

Table 504.2.3.3.2.(a) Final Backfill Type "B" Requirements

Description	Limits
Stone. All stone must be reasonably uniform in distribution throughout the backfill material in order to be considered acceptable for use, regardless of the width of trench in which the material is to be used.	
Maximum amount of stone permitted, regardless of trench width, as a percent of final backfill volume	50%
Largest dimension of stone allowed in trenches 4-ft. (1.2m) or less in width	3-in. (7cm)
Largest dimension stone to total final backfill volume, regardless of trench width	3%
Largest dimension of stone allowed in trenches greater than 4 ft. (1.2m) in width	6-in. (15cm) Total volume not to exceed 1% of backfill
Lumps. All lumps must be reasonably uniform in distribution throughout the backfill material in order to be considered acceptable for use, regardless of the width of trench in which the material is to be used	
Maximum amount of clay or gumbo lumps permitted, regardless of trench width, as a percent of final backfill volume	25%
Largest dimension of clay or gumbo lumps in trenches 4-ft. (1.2m) or less in width	6-in. (15cm)
Largest dimension of clay or gumbo lumps permitted in trench greater than 4-ft. (1.2m) in width.	10-in. (25cm) Total volume not to exceed 1% of backfill

504.2.3.3.3. Additional Requirements. Additional requirements for Type "B" backfill when used in streets:

(1) 35 percent or less shall pass the No. 200 (75 um) sieve.
(2) Material otherwise meeting specifications requirements and having a PI greater than 15 shall be considered as suitable for use only when compaction procedure includes mechanical compaction.
(3) Material shall be of such characteristics that it shall stabilize without the use of lime or other similar additive and form an acceptable street subbase material.

504.2.3.4. Flowable Backfill. Flowable backfill shall consist of a mixture of native soils or manufactured materials, cement and/or fly ash, and water which produces a material with unconfined compressive strength of between 250-psi and 450-psi (18- to 32-kg/cm^2) after 28-days. Any materials used shall be primarily granular, with a plasticity index <12 and with 100% passing a ¾-in. sieve. The flowable mixture shall be mixed in a pug mill, concrete mixer, or transit mixer and shall have a minimum slump of 5-in. (13cm). The flowable mixture must be allowed to set prior to the placement of any overlying material.

504.2.3.5. Modified Flowable Backfill. Modified flowable backfill in areas of possible future excavation such as utility installations shall consist of a mixture of native soils or manufactured materials, cement and/or fly ash, air-entraining material, and water which produces a material with unconfined compressive strength of between 50-psi and 150-psi (4- to 11-kg/cm^2) after 28-days. Modified flowable backfill in permanent areas such

as abandoned pipe closures, abutments and embankments shall contain similar materials and shall have an unconfined compressive strength of greater than 150-psi (11-kg/cm^2) after 28 days. Any materials used shall be primarily granular, with a plasticity index <12 and with 100% passing a ¾-in. sieve. The flowable mixture shall be mixed in a pug mill, concrete mixer, or transit mixer and shall have a minimum slump of 5-in (13cm). The flowable mixture must be allowed to set prior to the placement of any overlying material.

504.2.4. Rejection. Materials that fail to meet the requirements of these specifications may be rejected by the OWNER. Such rejection shall incur no cost to the OWNER. Material sources, from which materials with properties not meeting these specifications are delivered, may be rejected as further supply sources to the project by the OWNER. Such rejection shall incur no cost to the OWNER.

504.3. EXCAVATION AND FOUNDATION

504.3.1. Excavation. Excavation shall be performed in accordance with Item 203. Site Preparation.

504.3.2. Foundation. During the progress of the work, should the foundation for the conduits be in material unsuitable for the subgrade of the conduit, which is not the result of the CONTRACTOR'S negligence to make proper provisions for adequate drainage of the excavation, the CONTRACTOR shall remove such unsuitable subgrade material to the depth directed by the OWNER. The space thus created shall be filled with stone as described in Item 504.2.2.4. Crushed Stone for Foundation, coarse crushed stone as described in Item 504.2.2.1. Crushed Stone Embedment, or Class B or Class PB concrete (as specified by the OWNER) as described in Item 702.2. Mix Design and Mixing Concrete for Structures. The type of material to be used for the foundation shall be determined by the OWNER. In lieu of removing the subgrade material or in conjunction with placement of the foundation material, the OWNER may require a geotextile material as described in the contract documents to be placed between the bedding and the subgrade or between the foundation material and the subgrade.

The entire foundation area in the bottom of all excavation shall be firm, stable and at uniform density as nearly as practicable. Unless necessary, materials shall not be disturbed. The final cleaning off and preparing of the foundation area shall be done immediately prior to the placing of the embedment materials or structures.

504.3.2.1. Foundation Measurement. Foundation material shall be measured for payment complete in place to the dimensions prescribed by the OWNER. Geotextile material, if used, shall be measured for payment complete in place to the dimensions prescribed by the OWNER.

504.3.2.2. Foundation Payment. Foundation material shall be paid for at the contract unit bid price in cubic yards (cubic meters) as provided for in the contract. Geotextile material shall be paid for at the contract unit bid price per square yard (square meter) as provided for in the contract. If a bid item is not established in the contract for foundation material and/or geotextile material, it shall be paid for as an extra.

In case of failure to make adequate pumping, draining and bailing provisions, resulting in unstable subgrade conditions, and which shall require any of the hereinbefore described foundations, such foundations shall be placed at the entire cost of the CONTRACTOR and shall not be measured or paid for as separate contract pay items.

The contract unit price shall be total compensation for furnishing all labor, tools, materials, equipment and incidentals necessary to complete the work, including all excavation and disposal of surplus material.

504.4. BACKFILL – GENERAL REQUIREMENTS

504.4.1. Description. This specification shall govern construction of all types of storm drain, wastewater collection systems, and water structures except where the requirements are revised by another governing specification. All structures shall be constructed in accordance with the design requirements, with the details shown on the plans, and with the requirements herein provided. Other applicable sections or parts of these specifications shall govern for such miscellaneous and incidental construction necessary to complete the work in accordance with the plans and specifications.

Backfill is divided into embedment and final backfill, as follows, where "embedment" is subdivided into bedding and initial backfill:

(1) Embedment is the bedding and initial backfill.
(2) Bedding is the material upon which the pipe rests.
(3) Initial backfill is the material that covers the wastewater collection system and water lines.
(4) Final backfill material is the material required to fill the trench from the top of the initial backfill to ground elevation or subgrade of a street.

504.4.2. Materials and Equipment. All materials used in the construction of work specified in this division shall conform to the applicable sections of these specifications and approved by the OWNER. Any materials placed before approval of the OWNER shall be removed, if directed by the OWNER, and replaced with approved materials.

All machinery and equipment necessary for the construction of the work specified herein shall be on the project and shall be maintained in good condition to insure the completion of the work without excessive delays for repairs and replacements. Equipment used for disposal of surplus materials beyond the limits of the work shall be such as to avoid spilling or wasting of materials along the line of haul. The CONTRACTOR shall immediately clean up all materials spilled or wasted along the line of haul. The OWNER reserves the right to approve the location and methods of disposal for surplus material.

504.4.2.1. Water for Construction. Unless otherwise specified in the contract, water required for construction and furnished from the OWNER's distribution system shall be paid and accounted for as prescribed by the OWNER. The CONTRACTOR shall make and bear the cost of all necessary arrangements and means for hauling the water. Water shall be furnished free of charge from the OWNER'S main, if available, for filling newly constructed water mains for flushing, sterilizing and hydrostatic testing. Construction water, if delivered through a fire hydrant meter, shall be protected by a reduced pressure zone assembly provided at the CONTRACTOR'S expense.

504.4.2.1.1. Use of Fire Hydrant and Valves. The CONTRACTOR shall not operate any fire hydrant or valve in the existing water system without the permission of the OWNER. If permission is granted, the CONTRACTOR shall use only approved fire hydrant and valve wrenches. The OWNER shall inspect all fire hydrants and/or valves operated by the CONTRACTOR prior to final acceptance of the project. All repairs or replacements required to restore satisfactory operation of fire hydrants and/or valves shall be at the expense of the CONTRACTOR.

504.4.2.2. Material and Equipment Storage. The CONTRACTOR shall confine equipment, storage of materials, and construction operations to the area shown on the Contract Drawings or as directed by OWNER. Storage shall not unreasonably encumber the site or public right-of-way with construction equipment or materials. Materials shall be stored in a manner to best protect and preserve the material to the satisfaction of the OWNER. Materials shall be sorted and stored neatly and accessibly. Materials not properly stored shall not be eligible for inclusion in partial pay estimates. Storage shall also comply with all requirements of Item 106. Control of Material.

504.4.3. Sequence. The sequence of operations to be followed shall be prepared by the CONTRACTOR for approval by the OWNER. The sequence shall meet the job requirements for completion time, avoid interference with plant operations and conform to plan and specification requirements. The construction of all storm drain and wastewater collection systems shall begin at the outlet or lower end, unless otherwise directed by the OWNER. Tributary lines for storm drain and wastewater collection systems shall not be started until the main line has been built to their junction points.

504.4.4. Layout. The CONTRACTOR shall construct the work in the locations and to the grades and elevations shown on the plans from base lines and bench marks as established by the OWNER.

504.4.5. Project Signs. Project signs shall be furnished, constructed, and erected by the CONTRACTOR as required by Item 107.20. Project Signs.

504.4.6. Grades. The grade line shown on the profile is the elevation of the invert or flow line of the conduit. The OWNER shall establish benchmarks, base lines and other principal control points for use in construction. It shall be at the CONTRACTOR'S expense to establish all working or construction lines and grades as required and determined from the base measurements and control points set by the OWNER and shall be solely responsible for the accuracy thereof. Wherever an offset needs to be over 10-ft. (3m), the CONTRACTOR shall be required to furnish a survey type tripod level or its equivalent in order to accurately transfer the grade to the trench or excavation. Where construction operations require the removal of the OWNER'S stakes, the CONTRACTOR shall reference such points in an approved manner. If they cannot be referenced, the CONTRACTOR must obtain authorization for their removal. In the case of their destruction or unauthorized removal, they shall be replaced by the OWNER at the CONTRACTOR'S expense.

The CONTRACTOR shall notify the OWNER 48-hours prior to the beginning of construction to allow the OWNER sufficient time to stake the alignment. Where the starting point is an end of an existing pipe, the CONTRACTOR shall uncover the same; the OWNER shall then provide the CONTRACTOR with grade stakes unless otherwise specified.

The full responsibility for holding to alignment and grade shall rest upon the CONTRACTOR.

The lines and grades shall be set by the OWNER, as the work progresses, in such a manner as to cause the least possible inconvenience in the execution of the work. The CONTRACTOR shall so stockpile excavation and other materials as to cause no inconvenience in the use of the lines and grades given. The CONTRACTOR shall remove any obstruction created contrary to this provision.

If a profile is not furnished for a water main, the main shall be constructed with a minimum cover as shown in Table 504.4.6.(a) Water Main Minimum Cover, unless directed otherwise by the OWNER.

Table 504.4.6.(a) Water Main Minimum Cover

Main Size	Minimum Cover (ft.)[1]	
	Unimproved Streets	Improved Streets
4-in. through 12-in. (10cm – 31cm)	5-ft. (1.5m)	4-ft. (1.2m)
14-in. through 18-in. (36cm – 46cm)	6-ft. (1.8m)	5-ft. (1.5m)
20-in. (50cm) and larger	7-ft. (2.1m)[2]	6-ft. (1.8m)[2]

1. The minimum cover requirement shall be measured from a point as designated on the plans.
2. May be greater if Air Relief and Vacuum Control Valves are on the main.

The CONTRACTOR shall keep the OWNER informed at a reasonable time in advance as to need for line and grade. When necessary, working operations shall be suspended for such reasonable time as the OWNER may require for the establishment of the same.

504.4.7. Connections. The connections of conduits or appurtenances to conduits shall be made in accordance with the plans and as directed by the OWNER. This work shall be done in such a manner so as not to damage any of the structures involved. Any damage to the structures due to the connection shall be repaired at the CONTRACTOR'S expense. No connecting conduit shall project beyond the inside surface of other conduits or appurtenances, except in case of pipe laid through a manhole.

504.5. EMBEDMENT

Embedment is the bedding and initial backfill. The type of embedment to be used for storm water collection systems, wastewater collection systems or water mains shall be specified in the contract documents or on the plans.

504.5.1. General.

504.5.1.1. Terms.

D — Inside diameter of the pipe.

OD — Outside diameter of the pipe.

B_c — Outside diameter of the pipe.

B_d — Trench width.

Stone cuttings are rock trench excavated material. The maximum allowable dimension of the stone to be used for embedment is 1-in. (2.5cm).

Densities shall be shown as a percent of the maximum dry density at not less than 2% below optimum moisture of samples of the material as determined by the ASTM D698 Maximum Density Optimum Moisture Test.

504.5.1.2. Flexible Pipe. 16-in. or greater diameter flexible pipe may be strutted horizontally and vertically prior to backfilling. After backfilling, the struts shall be removed and the deflection checked to verify that excessive deflection as specified has not occurred. If excessive deflection has occurred, the pipe shall be removed and reinstalled.

504.5.1.3. Trench Dimensions. Trench dimensions shall be determined according to Table 504.5.1.3.(a) Trench Dimensions unless otherwise specified as greater.

Table 504.5.1.3.(a) Trench Dimensions

Pipe size	Trench Dimensions
Minimum Depth of Trench Below the Pipe	
27-in. (69cm) and smaller	3-in. (8cm)
30-in. to 60-in. (76cm - 152cm)	4-in. (10cm)
66-in. (168cm) and larger	6-in. (15cm)
Limiting Trench Width	
24-in. (60cm) pipe and smaller	24-in. (60cm) or O.D. of the pipe plus 16-in. (40cm), whichever is greater
Greater than 24-in. (60cm), to and including 72-in. (180cm)	O.D. of the pipe installed plus 24-in. (60cm)
Larger than 72 in. (1.8 m)	O.D. times 1.25 plus 1-ft. (30cm)

504.5.2. Embedment Classes.

504.5.2.1. Class "A" Embedment. See Standard Drawing 3010. The embedment consists of concrete bedding and initial backfill of granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of ¼D, minimum of 3-in. (8cm) (minimum of 6-in. (15cm) in rock) measured from the outside of the pipe bell, the pipe shall be laid to grade on supporting brick or concrete block and jointed as specified. A compressible strip shall be placed between the pipe and the support. The pipe shall be restrained, if required, to prevent flotation. Class B or Class PB concrete as specified by the OWNER shall be poured on either side of the pipe to form the bedding under the pipe and up the sides of the pipe ¼B_c. The concrete placed under the pipe shall have a sufficient fluidity so it can flow under the haunches and be puddled to insure even support.

The initial backfill layer shall be granular material and shall be brought to a point 12-in. (30cm) above the top of the pipe.

504.5.2.2. Class "A-1" Embedment. See Standard Drawing 3010. The embedment consists of crushed stone bedding and a cap of concrete as initial backfill.

After the trench has been cut to a depth below the barrel of the pipe a distance of ¼B_c, minimum of 3-in. (8cm) (minimum of 6-in. (15cm) in rock) measured from the outside of the pipe bell, the bedding layer shall be brought to a point slightly above grade with compacted standard gradation crushed stone. Bell holes shall be formed, if required, a trough scooped out to grade, and the pipe laid and jointed as specified. The stone shall then be brought up in uniform layers on either side of the pipe ½B_c.

Class B or Class PB concrete as specified by the OWNER, plain or reinforced as specified in the plans, shall be poured over the top of the pipe and bells to cover the pipe with a thickness of ¼D, 4-in. (10cm) minimum to form the initial backfill layer.

504.5.2.3. Class "B" Embedment. See Standard Drawing 3020. The embedment consists of crushed stone bedding and initial backfill of select material or granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of ⅛B_c, minimum of 3-in. (8cm) (minimum of 6-in. (15cm) in rock) measured from the outside of the pipe bell, the bedding shall be brought up to a point slightly above the grade with stone cuttings or crushed stone, standard gradation. Bell holes shall be formed, a trough scooped out to grade and the pipe laid and joined as specified. The crushed stone or stone cuttings shall then be brought up the sides of the pipe in uniform layers ½B_c.

The initial backfill shall consist of granular material. The material shall be placed on top of the crushed stone in uniform layers on either side of the pipe to a point above the pipe as shown on the plans and compacted to at least 90-percent of maximum density as determined by ASTM D698.

504.5.2.4. Class "B+" Embedment. See Standard Drawing 3020. The embedment consists of fine crushed stone bedding and initial backfill of granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of ⅛B_c, minimum of 3-in. (8cm) (minimum of 6-in. (15cm) in rock) measured from the outside of the pipe bell, the bedding shall be brought up to a point slightly above grade with fine crushed stone. Bell holes shall be formed, a trough scooped out to grade and the pipe laid and jointed as specified. The stone shall then be brought up in uniform layers on either side of the pipe ½B_c.

The initial backfill shall consist of granular material. The material shall be placed on top of the stone and shall be brought up in uniform layers on either side of the pipe to a point 12-in. (30cm) above the top of the pipe.

504.5.2.5. Class "B-1" Embedment. See Standard Drawing 3020. The embedment consists of fine crushed stone bedding and initial backfill of select material or granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of ⅛B_c, minimum 3-in. (8cm) for PVC pipe or 4-in. (10cm) for RCP pipe (6-in. (15cm) minimum in rock) measured from the outside of the pipe bell, the bedding shall be brought up to a point slightly above grade with fine crushed stone. Bell holes shall be formed and the pipe laid and jointed as specified. The stone shall then be brought up in uniform layers on either side of the pipe ¾B_c.

The initial backfill shall consist of compacted granular material brought up to a point 6-in. (15cm) above the top of the pipe. Density shall be at least 90-percent of maximum density as determined by ASTM D698.

504.5.2.6. Class "B-2" Embedment. See Standard Drawing 3030. The embedment consists of fine crushed stone bedding and initial backfill of select material or granular material.

After the trench has been cut to a depth below the barrel of the pipe 3-in. (8cm) for PVC pipe or 4-in. (10cm) for RCP pipe (6-in. (15cm) minimum in rock) measured from the outside of the pipe bell, the bedding layer shall be brought to a point slightly above grade with compacted fine crushed stone. Bell holes shall be formed, if required, a trough scooped out to grade, and the pipe laid and jointed as specified. The stone bedding layer shall then be brought up in uniform layers on either side of the pipe ¾B_c.

The initial backfill shall consist of compacted granular material and shall be brought to a point 12-in. (30cm) above the top of the pipe. Density shall be at least 90-percent of maximum density as determined by ASTM D698.

504.5.2.7. Class "B-3" Embedment. See Standard Drawing 3030. The embedment consists of fine sand.

After the trench has been cut to a depth below the barrel of the pipe a distance of minimum of 3-in. (8cm) (minimum of 6-in. (15cm) in rock) measured from the outside of the pipe bell, the bedding shall be brought to a point slightly above grade with compacted fine sand. Bell holes shall be formed, if required, a trough scooped out to grade, and the pipe laid and jointed as specified. The sand shall then be brought up in uniform layers on either side of the pipe and over the pipe to a point 12-in. (30cm) above the top of the pipe.

504.5.2.8. Class "B-4" Embedment. See Standard Drawing 3030. The embedment consists of sand, standard gradation.

After the trench has been cut to a depth below the barrel of the pipe a distance of minimum of 3-in. (8cm) (minimum of 6-in. (15cm) in rock) measured from the outside of the pipe bell, the bedding shall be brought to a point slightly above grade with compacted sand. Bell holes shall be formed, if required, a trough scooped out to grade and the pipe laid and jointed as specified. The sand shall then be brought up to uniform layers on either side of the pipe and over the pipe to a point 6-in. (15cm) above the top of the pipe.

504.5.2.9. Class "C" Embedment. See Standard Drawing 3040. The embedment is a bedding of crushed stone or stone cuttings and initial backfill of select material or granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of $\frac{1}{8}B_c$, minimum of 3-in. (8cm) (minimum of 6-in. (15cm) in rock) measured from the outside of the pipe bell, the bedding shall be brought up to a point slightly above grade with stone cuttings or standard crushed stone. Bell holes shall be formed, a trough scooped out to grade, and the pipe laid and jointed as specified. The stone shall then be brought up in uniform compacted layers on either side of the pipe $\frac{1}{6}B_c$.

The initial backfill shall be granular material and shall be brought up in uniform compacted layers to a point 6-in. (15cm) above the top of the pipe. Density shall be at least 90-percent of maximum density as determined by ASTM D698.

504.5.2.10. Class "C+" Embedment. See Standard Drawing 3040. The embedment consists of fine crushed stone bedding and initial backfill of granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of $\frac{1}{8}B_c$, minimum of 3-in. (8cm) (minimum of 6-in. (15cm) in rock) measured from the outside of the pipe bell, the bedding layer shall be brought up to a point slightly above grade with fine crushed stone. Bell holes shall be formed, a trough scooped out to grade, and the pipe laid and jointed as specified. The stone shall then be brought up in uniform, compacted layers on either side of the pipe $\frac{1}{6}B_c$.

The initial backfill shall be granular material and shall be brought up in uniform, compacted layers to a point 6-in. (15cm) above the top of the pipe. Density shall be at least 90-percent of maximum density as determined by ASTM D698.

504.5.2.11. Class "C-1" Embedment. See Standard Drawing 3040. The embedment shall consist of fine sand bedding and initial backfill of granular material.

After the trench has been cut to a depth below the barrel of the pipe a distance of $\frac{1}{8}B_c$ minimum of 3-in. (8cm) (minimum of 6-in. (15cm) in rock) measured from the outside of the pipe bell, the bedding layer shall be brought up to a point slightly above grade with fine sand. Bell holes shall be formed, a trough scooped out to grade and the pipe laid and jointed as specified. The sand shall then be brought up in uniform compacted layers on either side of the pipe $\frac{1}{6}B_c$.

The embedment backfill shall be granular material and shall be brought up in uniform, compacted layers to a point 6-in. (15cm) above the top of the pipe. Density shall be at least 90-percent of maximum density as determined by ASTM D698.

504.5.2.12. Class "D+" Embedment. See Standard Drawing 3050. The embedment consists of select material.

After the trench has been cut to a depth below the barrel of the pipe a distance of $\frac{1}{8}B_c$, minimum of minimum of 3-in. (8cm) (minimum of 6-in. (15cm) in rock) measured from the outside of the pipe bell, the embedment shall be brought up to a point slightly above grade with select material. Bell holes shall be formed, a trough scooped out to grade and the pipe laid and jointed as specified. The material shall then be brought up in uniform compacted layers to a point 6-in. (15cm) over the top of the pipe. Density shall be at least 90-percent of maximum density as determined by ASTM D698.

504.5.2.13. Class "G" Embedment. See Standard Drawing 3050. The embedment consists of Class B or Class PB concrete as specified by the OWNER.

After the trench has been cut to a depth below the barrel of the pipe a distance of ¼D, 4-in. (10cm) minimum (6-in. (15cm) minimum in rock) measured from the outside of the pipe bell, the pipe shall be laid and jointed as specified. The pipe shall be supported by brick or concrete block. A compressible strip shall be placed between the pipe and support. The pipe shall be restrained, if required, to prevent flotation. Class B or Class PB concrete as specified by the OWNER shall be poured on either side of the pipe to form the embedment under the pipe, up the sides and over the top of the pipe and bells with a minimum thickness of 4-in. (10cm). The concrete placed under the bell shall have a sufficient fluidity so it can flow under the haunches and be puddled to insure even support.

504.5.2.14. Class "G-1" Embedment. See Standard Drawing 3060. The embedment consists of Class "G" embedment as specified above and a trench backfill of Class B or Class PB concrete as specified by the OWNER or stabilized backfill, whichever is specified in the plans, and a 6-in. (15cm) thick Class B or Class PB (as specified by the OWNER) concrete cap as initial backfill. This embedment class is for use in rock ditches in creeks.

504.5.2.15. Class "H" Embedment. See Standard Drawing 3060. The embedment consists of a completely encased pipe with standard Crushed Stone, Grade 4. After the trench has been cut to a depth below the barrel of the pipe a distance of $\frac{1}{8}B_c$, 3-in. (8cm) minimum and 6-in. (15cm) maximum, the bedding layer shall be brought to a point slightly above grade with compacted crushed stone. Bell holes shall be formed, a trough scooped out to grade and the pipe laid and jointed as specified. The material shall then be brought up in uniform compacted layers of 6-in. (15cm) to a point 6-in. (15cm) over the top of the pipe.

504.5.2.16. Alternate Embedment for Concrete Pipe. The Engineer may design alternate embedment for concrete pipe. Such embedment shall be designed according to Design Data 40, Standard Installations and Bedding Factors for the Indirect Design Method written by the American Concrete Pipe Association. Such embedment shall be constructed as shown on the plans.

504.5.3. Initial Backfill.

504.5.3.1. General. Initial backfill is the material that covers the wastewater collection system and water lines. Backfill procedure is that procedure required to return trenches or excavated areas to a condition satisfactory to the OWNER. Such backfilling occurs in two general areas. They are: (1) areas not subject to vehicular traffic; and (2) areas subjected directly to, or influenced by, vehicular traffic.

The methods of backfilling to be used shall vary with the width of trench, the character of the materials excavated, the method of excavation, the type of conduit and the degree of compaction required. The placing of backfill shall not begin until the pipe structure has been properly bedded and jointed and until approval has been given by the OWNER. The excavation shall be backfilled only with approved material.

504.5.3.2. Compaction. Compaction of all backfill material shall be performed in a manner that shall not crack, crush and/or cause the installed pipe to be moved from the established grade and/or alignment, as shown on the plans. Satisfactory density shall be obtained at various depths on all backfill material as indicated from random selected test points prior to the required exfiltration or pressure tests that are to be performed on lines being constructed. The required moisture content shall be at not less than 2% below nor more than 4% above the optimum moisture of the material or as specified by the OWNER. In-place density/moisture content shall be tested and verified as specified by the OWNER, or at an average frequency of once per 300-linear-feet (90m) per 1-foot (0.3m) of compacted depth.

504.5.3.2.1. Densities — Areas Subjected to or Influenced by Vehicular Traffic. The trench backfill shall be mechanically compacted to the top of the subgrade in 6-in. (15cm) loose lifts to at least 95-percent of maximum density as determined by ASTM D698 Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)). The embedment shall be compacted by a method approved by the OWNER to a density as specified under the description of the embedment as outlined in Item 504.5. Embedment.

504.5.3.2.2. Densities — Areas Not Subjected to or Influenced by Vehicular Traffic. The trench backfill shall be placed in layers not more than 10-in. (25cm) loose depth and shall be compacted by mechanical means, subject to the restrictions outlined in Item 504.5.3.2.5. Compaction Methods to at least 90-percent of maximum density as determined by ASTM D698. The embedment shall be compacted by a method approved by the OWNER to a density as specified under the description of the embedment required as outlined in Item 504.5. Embedment.

504.5.3.2.3. Special Situations. In areas specifically designated in the plans and specifications, the entire backfill shall be backfilled and compacted to the density specified.

504.5.3.2.4. Limitations. Densities as specified shall be obtained as the project progresses. No more than 75-percent of the pipe installation on the project is to be completed until specified compaction and density requirements have been ascertained on backfill material for at least 25-percent of the pipe laid, or until an approval to proceed with pipe installation has been given by the OWNER.

504.5.3.2.5. Compaction Methods. The method of compaction shall be left to the discretion of the CONTRACTOR with the following exception, unless otherwise specified, provided the degree of compaction is obtained and provided that the pipe is not damaged in the process. If any potential damage to the pipe due to a method of compaction exists, in the opinion of the OWNER, that method of compaction shall not be allowed.

Compaction of any backfill material by flooding or jetting shall not be permitted.

Hand-operated mechanical tampers may be used with approval of the OWNER for compacting backfill.

504.5.3.3. Rejection. If the backfill does not meet the specified density and optimum moisture requirements throughout its depth, the OWNER shall require its removal and replacement to meet the above requirements at the CONTRACTOR'S expense.

504.6. FINAL BACKFILL

Final backfill material is the material required to fill the trench from the top of the initial backfill to ground elevation or subgrade of a street.

504.6.1. Excavated Material. Excavated material may be used in the trench backfill, provided (1) it meets the requirements of Item 504.2.3.3. Type "B" backfill, and (2) the material is approved for backfill by the OWNER.

504.6.2. Stabilized Backfill. Stabilized backfill shall consist of a mixture of native soils including the trench excavation, approved for use by the OWNER, and two sacks of cement per cubic-yard. All material shall be mixed in a concrete mixer or transit mix unless approved otherwise by the OWNER. The stabilized backfill shall be compacted in a moist condition or water added to provide a free flowing mixture. If a free flowing mixture is used, the initial set must be permitted prior to placement of any material on the surface of the stabilized backfill.

504.6.3. Concrete Backfill. Concrete backfill shall consist of selected stone material or granular material mixed with a minimum of two sacks of cement per cubic-yard. All material shall be mixed in a concrete mixer or transit mixed unless approved otherwise by the OWNER.

504.6.4. Granular Material Backfill. Granular material backfill shall meet the requirements of Item 504.2.2.2. Granular Material.

504.6.5. Sand Backfill. Sand backfill shall meet the requirements of Item 504.2.2.6. Sand.

504.6.6. Flowable Backfill. Flowable backfill shall meet the requirements of Item 504.2.3.4. Flowable Backfill.

504.6.7. Modified Flowable Backfill. Modified flowable backfill shall meet the requirements of Item 504.2.3.5. Modified Flowable Backfill.

504.7. MEASUREMENT AND PAYMENT OF BACKFILL

The following items and/or other items not covered by specific bid items shall be included in the price bid per foot (m) of various storm drain, water and/or wastewater collection system pipe installed: excavation; furnishing, placing and compacting embedment material; disposal of excess material; placing backfill; compaction of backfill; labor, materials, and equipment; taking density samples and restoring the trench afterwards; cleanup; replacing finish trench surfaces; sheeting, shoring and bracing; sod and pavement and other incidental work required by the specifications, plans or standards.

504.7.1. Measurement of Backfill Material. Measurement of backfill, which includes embedment and final backfill, shall be made per linear-foot (m) of pipe only if a separate bid item is established in the Contract.

504.7.2. Payment of Backfill Material. Payment for backfill shall be made at the contract unit price per linear-foot (m) of pipe only if a separate bid item is established in the Contract. This shall include furnishing and placing all materials and for all labor, tools, equipment and incidentals necessary to complete the work, all in accordance with the plans and specifications. No allowance for waste shall be made.

504.7.2.1. Special Embedment. If the OWNER orders an embedment material other than that specified in the Contract, it shall be paid for as an extra in price per linear foot (m) of pipe, as compacted in place, except if another class embedment is ordered by the OWNER because the CONTRACTOR has over-excavated the trench width.

If the CONTRACTOR over-excavates the trench width and the OWNER orders another class of embedment to be used, the embedment shall be paid per linear-foot (m) of pipe, compacted in place for the embedment originally specified if the original embedment was specified to be paid as a separate bid item. In lieu of another class of embedment, the CONTRACTOR may elect to use another class pipe if approved by the OWNER. The pipe shall be paid for as specified in relevant Items of Division 500 Underground Conduit Construction and Appurtenances at the unit price per linear-foot (m) for the pipe originally specified if the original pipe was specified to be paid as a separate bid item.

If the CONTRACTOR elects to use another class embedment and the use of the embedment is approved by the OWNER, but not directed by the OWNER, the embedment shall be paid per linear-foot (m) of pipe, compacted in

place for the embedment originally specified if the original embedment was specified to be paid as a separate bid item.

504.7.2.2. Final Trench Backfill. If the CONTRACTOR elects to use a material other than the excavated material as trench backfill and the use of the material is approved by the OWNER, but not directed by the OWNER, the material shall be furnished and placed at no cost to the OWNER. The excavated material shall be disposed of at no cost to the OWNER.

If the OWNER orders the excavated material to be removed and disposed of and replaced with another material and a separate bid item is not established, the material shall be paid as an extra. The disposal of the rejected excavated material shall be at no cost to the OWNER.

If the OWNER orders the excavated material to be removed and disposed of and replaced with another material because of neglect of the CONTRACTOR to properly remove or store the material, or if the CONTRACTOR fails to compact the excavated material in the trench to the density requirements and the OWNER orders the material removed, the excavated material shall be replaced with a material approved by the OWNER at no cost to the OWNER. The disposal of the rejected material shall be at no cost to the OWNER.

504.7.2.3. Trench Safety. Payment for trench safety shall be according to the provisions of Item 107.19. Protection of Work and of Persons and Property.

ITEM 505. OPEN CUT - GENERAL CONDUIT INSTALLATION

505.1. GENERAL

505.1.1. Conduit Location. The location of conduit to be installed will be determined by the Engineer using generally accepted design criteria, which includes the current guidelines of the TCEQ.

505.1.2. Location and Protection of Existing Utilities. Location and protection of existing utilities shall be carried out in accordance with Item 107.23. Existing Structures, Facilities and Appurtenances.

505.1.3. Street Cut Permit. If required by the OWNER, the CONTRACTOR shall obtain a street cut permit prior to beginning the work. The CONTRACTOR shall have the executed permit available on the job site during the duration of the work.

505.1.4. Handling and Protection of Materials. All pipe, fittings and specials shall be handled in such a manner as not to damage the material. All dirt and trash shall be removed from the pipe prior to installation. All pipe and fittings handled with clamps or slings must meet with the approval of the OWNER; no hooks shall be permitted.

When it becomes necessary to deflect the pipe to avoid obstructions, the deflection of each joint must be within the limits provided by the manufacturer and be approved by the OWNER.

The pipe is to be kept clean during the laying operation and free of all dirt and trash. At the close of each operating day, the open end of the pipe is to be effectively sealed against the entrance of all objects and especially water.

505.1.5. Stringing of Pipe. Unless prior approval from the OWNER is granted to do otherwise, stringing of pipe in advance of the laying operation shall be restricted to one week's laying and shall be done in such a manner as to create no hazard to nor interference with traffic. Ready access shall be provided to all streets, alleys and driveways. The pipe shall be protected with barricades and warning signs at all times. Any damage to the pipe shall be corrected at the expense of the CONTRACTOR.

505.1.6. Laying Underground Conduit. Prior to being lowered into the trench, each pipe shall be carefully inspected; those not meeting specifications shall be rejected and either destroyed or removed from the job. All lumps or excrescences on the ends of conduit shall be removed before it is lowered into the trench. No pipe shall be laid except in the presence of the OWNER, unless otherwise specified, and the OWNER may order the removal of and re-laying of any pipe not so laid. The pipe and specials shall be so laid in the trench that after the project is completed the interior surface shall conform accurately to the grade and alignment indicated on the plans. Bell holes shall be excavated and all pipe shall be carefully adjusted to fit snugly in cradling or bedding so that the entire length bears on cradling or bedding material with no wedging or blocking to hold up the bell. All pipe shall be laid in the dry, regardless of the type of joint used.

Pipes shall be laid with the bell or groove end upgrade unless otherwise approved by the OWNER and, in any event, shall be laid with the bell or collar away from the last section placed. Pipe must be swabbed clean before placement in the ditch.

Before laying the pipe, the interior of the joints shall be carefully bored smooth and clean and the annular space shall be kept free from dirt, stones or water. Pipe shall be installed and joints made up in complete conformance with the instructions and recommendations regarding proper installation and assembly furnished by the manufacturer. Proper facilities shall be provided for hoisting and lowering the section of the pipe into the trench without disturbing the prepared foundation and the sides of the trench. All pipe shall be so laid that the contact in the joint between two lengths of pipe shall be uniform throughout the circumference of the joint. Where curves in the alignment are indicated on the drawings, standard pipe (short sections of pipe or bevels) shall be used with the outside edge of the joint pulled away from the seat to make a smooth curve.

When work is suspended on the line for any reason, the end of the line shall be properly closed with an effective watertight seal or plug manufactured for this purpose.

505.2. GENERAL INSTALLATION REQUIREMENTS FOR PIPE TYPES

505.2.1. Clay Wastewater Pipe Installation. Clay wastewater pipe used in open-cut shall be installed in accordance with ASTM C12 Standard Practice for Installing Vitrified Clay Pipe Lines.

505.2.2. Concrete Pressure Pipe. When required in the project specifications, the pipe manufacturer shall furnish a factory-trained, job-experienced field representative who shall visit the project periodically during the course of installation. The project visiting schedule shall be approved by the OWNER. The field representative shall also be subject to call by the CONTRACTOR and/or OWNER to advise and assist with the solution of field problems. During visits, the representative shall observe all phases of the project including location and condition of pipe, stockpiled and installed pipe, trench width, if applicable, bedding and backfill, assembly of pipe joints and

protection of steel. If, in the opinion of the representative, any phase of the installation is unsatisfactory to the extent of jeopardizing the performance of the pipe, representative shall so advise the CONTRACTOR'S superintendent and the OWNER.

After installation, flanged outlets shall be encased with mortar in a pipe diaper.

Test stations shall be provided at the appropriate locations as indicated on the plans to insure proper bonding and effectiveness of cathodic protection measures for concrete pressure pipe.

505.2.3. Concrete Gravity Pipe. Pipe shall be installed in accordance with ASTM C1479 Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations.

505.2.4. Ductile Iron Pipe. Unless otherwise specified by the OWNER, ductile iron pipe shall be protected with a polyethylene encasement that conforms to Item 502.8. Polyethylene Wrap for Metal Pipe and Fittings.

505.2.5. PVC Water Pipe. Pipe produced to the specifications of Item 501.14. Polyvinyl Chloride (PVC) Water Pipe shall be installed in accordance with AWWA C605 Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.

505.2.6. PVC Pressure-Rated Pipe Installation. Pipe produced to the specifications of Item 501.15. Polyvinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series) shall be installed in accordance with ASTM D2774 Practice for Underground Installation of Thermoplastic Pressure Piping. An engineering evaluation of specific installation requirements is recommended.

505.2.7. PVCO Installation and Special Conditions. Installation of pipe meeting specifications of Item 501.16. Molecularly Oriented Polyvinyl Chloride (PVCO) Water Pipe shall be accomplished according to AWWA C605 Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water with the following conditions/exceptions:

(1) Solvent cement shall not be used with PVCO pipe.
(2) PVCO pipe must be tapped through a saddle. Direct tapping the wall is not permitted.
(3) The maximum recommended operating temperature is 130°F (54°C.)

505.2.8. PVC Wastewater Pipe Installation. Pipe produced to the specifications of Item 501.17. Polyvinyl Chloride (PVC) Wastewater Pipe & Fittings With Dimension Control shall be installed in accordance with ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications. Engineering evaluations of specific installation requirements is recommended.

505.2.9. PVC Profile Gravity Pipe Installation. Pipe produced to the specifications of Item 501.18. Polyvinyl Chloride (PVC) Profile Gravity Pipe and Fittings – for Direct Bury and Sliplining Applications shall be installed in accordance with ASTM D2321 Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications. Engineering evaluations of specific installation requirements is recommended.

505.2.10. PVC Composite Pipe Installation. Pipe produced to the specifications of Item 501.19. PVC Composite Pipe for Wastewater Conduits shall be installed in accordance with ASTM D2321 Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications, with the allowable exceptions as noted in ASTM D2680 Appendix X1, Underground Installation. Engineering evaluations of specific installation requirements is recommended.

505.2.11. PVC Corrugated Pipe. Pipe produced to the specifications of Item 501.20. Polyvinyl Chloride (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings shall be installed in accordance with ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications or AASHTO Section 30 for any drainage application. Engineering evaluations of specific installation requirements is recommended.

505.2.12. Solid Wall Polyethylene Pipe Installation. Engineering evaluations of specific installation requirements are recommended.

Water pipe produced to the specifications of Item 501.21. Solid Wall Polyethylene Plastic Pipe for Water, Wastewater, and Pipe Rehabilitation shall be installed according to the standard practice of ASTM D2774 Underground Installation of Thermoplastic Pressure Piping, ASTM F1962 Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings, and/or to appropriate engineered pipe bursting techniques.

Wastewater pipe produced to the specifications of Item 501.21. shall be installed according to the standard practice of ASTM D2321 Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications, ASTM D2774, ASTM F1962, and/or to appropriate engineered pipe bursting techniques.

505.2.13. Polyethylene (PE) Large Diameter Wastewater Pipe With Modified Wall Profiles and Performance Standards Installation. Pipe produced to the specifications of Item 501.22. Polyethylene (PE) Large Diameter Wastewater Pipe With Modified Wall Profiles and Performance Standards shall be installed utilizing an envelope of standard crushed rock bedding materials, Item 504.2.2. Pipe Embedment Material for

Water And Wastewater Mains to a minimum of 6-in. (15cm) above the crown of the pipe. Engineering evaluations of specific installation requirements are recommended.

505.2.14. Polyethylene (PE) Corrugated Drainage Tubing And Corrugated Smooth Lined Storm Water Pipe And Fittings. Engineering evaluations of specific installation requirements and pipe type selection are recommended.

Tube/pipe produced to the specifications of Item 501.23. Polyethylene (PE) Corrugated Drainage Tubing and Corrugated Smooth Lined Storm Water Pipe and Fittings shall be installed according to the standard practice of ASTM D2321 Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications or AASHTO Section 30 except where installations are under proposed or existing paving. Installations under proposed or existing paving must utilize an envelope of standard crushed rock bedding materials, Item 504.2.2. Pipe Embedment Material for Water And Wastewater Mains, to a minimum of 6-in. (15cm) above the crown of the pipe. In either case, the internal diameter of the installed barrel of the tube/pipe must not be reduced by more than 5-percent of its base inside diameter when measured not less than 30-days following completion of installment.

505.2.15. Fiberglass Pipe Installation. Installed pipe produced to the specifications of Item 501.24. Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Wastewater Pipe shall be installed utilizing an envelope of standard crushed rock bedding materials, Item 504.2.2. Pipe Embedment Material for Water And Wastewater Mains to a minimum of 6-in. (15cm) above the crown of the pipe. Engineering evaluations of specific installation requirements are recommended. The internal diameter of the installed barrel of the pipe must not be reduced by more than 3-percent of its base inside diameter when measured not less than 30-days following completion of installation. Long term deflection shall not exceed 5-percent.

ITEM 507. OPEN CUT – WASTEWATER CONDUIT INSTALLATION

507.1. DESCRIPTION

This work shall include the installation and construction, complete in place, of wastewater conduits and appurtenances as specified herein and in conformity with the lines, grades, dimensions, materials and designs shown on the plans.

507.2. MATERIALS

The pipe shall be of the kind and strength shown on the plans and provided in the proposal and contract. Unless otherwise specified, materials shall meet the requirements of Item 501. Underground Conduit Materials and Item 502. Appurtenances.

507.3. LAYING WASTEWATER CONDUIT

CONTRACTOR shall follow the same standard of care and general sequence as that described in Item 506.3. Laying Water Conduit. Appurtenance installation shall meet the requirements of Item 502. Appurtenances.

507.4. WASTEWATER CONDUIT JOINTS

507.4.1. Rubber Gasket Joints. Rubber gaskets shall conform to applicable specifications under which the pipe is supplied. Loose gaskets shall be protected from sunlight, contamination and contact with gasoline or fuels. On pipe for which the gasket is not fixed in place by the manufacturer, the bell-and-spigot or tongue-and-groove shall be thoroughly cleaned by wire brushing and wiping until clean and dry. On pipe which does not require the rubber gasket to be cemented in place, the rubber gasket shall be placed in position on the spigot ring just prior to laying the pipe. The lower edge of the gasket shall be placed under the spigot, in the seat and stretched evenly upward on each side to fit over the top of the spigot, and the rubber gasket shall fit snugly and not have uneven tensile stresses.

After checking to be sure that the bell-and-spigot are thoroughly clean, the inside surface of the bell shall be lubricated with a suitable solution (flax soap) to facilitate the telescoping of the joint. Petroleum lubrication shall not be permitted. The spigot end of the pipe shall be entered into the bell of the adjoining pipe until it contacts the gasket uniformly. The pipe shall then be pushed into the bell to the reference mark (a distinct circumferential line), which is placed on the pipe's spigot end by the manufacturer to indicate the correct depth of penetration. If undue resistance to insertion of the pipe end is encountered, or if the reference mark does not position properly, CONTRACTOR shall dissemble the joint and check the position of the gasket. If the gasket is twisted or pushed out of its seat, CONTRACTOR shall inspect components, repair or replace damaged items, clean the components, and repeat the assembly steps. Exceptional care shall be taken in making the field joint. Bumping of the pipe shall not be permitted. On small pipe, if the bottom of the trench is firm enough, a bar having a blade on the end may be pushed into the ground; then the bar may be used as a lever to push the pipe home. However, if trench conditions are too unstable or are in rock, it shall be necessary to use mechanical means to bring the pipe together positively. Each joint shall be partially backfilled or suitably blocked to prevent creeping.

Unless otherwise specified in the special provisions or in the plans, for all sizes of concrete pipe larger than 24-in. (0.6m) in diameter, the inside annular space provided for that purpose shall be completely filled with a plastic Portland cement mortar (composed of 1-part-cement to 2½-parts-sand), preformed flexible joint sealant in rope form, or toweling type.

Where the pipe has been corrosion protected and an annular space is open, only the bottom half of the inside annular space shall be filled with mortar, and a ready-mix cold-pour compound shall be used in the upper half, as hereinbefore described, that is resistant to acid alkalis and gases and is compatible with rubber. The joint shall be finished smoothly and all surface materials removed.

507.4.2. Chemically Welded Joints. The joint materials shall conform to the applicable specifications under which the pipe is supplied. The joint shall be installed per recommendations of the manufacturer. The ditch embedment should be to grade, with the advance bell hole scooped out prior to laying so that the pipe shall be to grade as the joint is made.

507.4.3. Compression Joints. The joint materials shall conform to the applicable specifications under which the pipe is supplied. The bells and spigots must be thoroughly clean. Extreme care must be exercised to prevent damage to the joint. The spigot end shall be inserted into the bell and pushed home after a suitable lubricant, as recommended by the pipe manufacturer, is applied. Petroleum lubrication shall not be permitted. The ditch embedment should be to grade, with the advance bell hole scooped out prior to laying so that the pipe should be to grade as the joint is made.

507.4.4. Joints for Closure Sections. Spigot-to-spigot closures: clay pipe (4-, 6- and 8-in.) (10-, 15- and 20-cm) to clay pipe (4-, 6- and 8-in.) (10-, 15- and 20-cm), cast iron soil pipe (4-, 5- and 6-in.) (10-, 12.5- and 20-cm) to clay pipe (4- and 6-in.) (10- and 15-cm) and asbestos-cement pipe (4-, 6- and 8-in.) (10-, 15- and 20-cm) to clay pipe (4-, 6- and 8-in.) (10-, 15- and 20-cm) shall be made using a synthetic rubber or plastic compressible type coupling as detailed on the appurtenance sheet that shall conform to Item 501.2.4. Joints. The two bands for patching the coupling shall be corrosion-resistant steel or stainless steel. The band shall be tensioned to provide a residual compression of at least 30-psi (2.1-kg/cm^2) between coupling and the pipe.

Closures of 4-in. (10cm) clay bell to 4-in. (10cm) cast iron spigot (for lateral cleanouts) and of 6-in. (15cm) clay spigot to 6-in. (15cm) concrete bell (rubber gasket type joint) shall be made, using compression type, wedge shaped synthetic rubber or plastic adapter rings, as detailed on the appurtenance sheet that shall conform to Item 501.2.4. Joints. The adapter shall be lubricated to facilitate making the joint after the ends and bells have been thoroughly cleaned. All closure section and sections jointed shall be sawed at right angles to the centerline of the section.

507.4.5. Other Joints. Other type joints should be installed as per instructions from the pipe or joint manufacturer, after approval of the joint by the OWNER.

507.5. TESTS AND INSPECTIONS

In order to ascertain that the main shall perform the function for which it was designed and constructed, performance tests shall be routinely executed. Inspection by closed circuit television shall be performed when so desired by the OWNER. Infiltration or exfiltration or air tests, as determined by the OWNER, may be made on sections of the contract work to assure that contract performance is satisfactory. All wastewater pipe shall be air tested upon completion of backfill. Wastewater force mains shall be hydrostatically tested.

507.5.1. Pipe Testing. Tunneled, bored or jacked sections of all pipe shall be tested by a method to be determined by the OWNER.

Testing shall be performed by the CONTRACTOR in the presence of the OWNER after all backfilling and compaction are complete. All sections between manholes or between a manhole and a dead end shall be tested separately. In the making of all tests, the CONTRACTOR shall furnish the required equipment and labor, under the direction of the OWNER. Tests may be repeated until each wastewater conduit individually meets the specifications as to quantity of allowable infiltration or exfiltration or air leakage as set out below. All testing work shall be included in the bid price.

If a gravity main is specified to be hydrostatically tested, the test shall be in accordance with Item 506.5. Hydrostatic Test, except that the test pressure, duration of the test, and allowable leakage shall be specified. The CONTRACTOR shall remove the test water from the main after the test if required by the OWNER.

507.5.1.1. Infiltration Test. The total seepage in infiltration of ground water as determined by test shall in no case exceed 50-gallons-per-inch of nominal diameter of pipe per mile (0.05-cubic-meters-per-centimeter of nominal diameter of pipe per kilometer) over a 24-hour period, and shall be the same regardless of piping material used. The allowable leakage of each manhole, or other structure, shall be as specified on the plans. An infiltration test or tests shall be made on all sections of the project where air testing could not be adequately performed or if ordered by the OWNER and on each manhole individually before placing the system in service and before any connections are made to other wastewater conduits. If the quantity of the effluent into the conduit or conduits is in excess of the maximum quantity as hereinbefore specified, the joints shall be repaired or the wastewater conduit relayed, if necessary, or other remedial construction shall be performed by and at the expense of the CONTRACTOR, in order to reduce the quantity of ground water infiltration to an amount within limits as specified.

The test shall be made by utilizing ground water, if any, or flooding a section at a time. Observation from jetting is not acceptable.

It is the intent of the OWNER that no allowance shall be made for seepage of ground water at the time the test is performed (zero infiltration). The actual connection to the existing system will not be permitted without prior approval of the OWNER. It is the intent of the OWNER to complete the construction of new wastewater mains and test the system prior to any connection to the existing system. Exceptions may be made by the OWNER in the event an existing main is to be connected to the new main upstream of the outfall of the new main. A stopper may be used until a tie-in is approved by the OWNER.

507.5.1.1.1. Using Existing High Ground Water. Where the natural ground water, after well points are removed, is above the top of the pipe for a section, the flowing of water in the pipe and the rate of seepage and infiltration for the section so submerged can be measured.

507.5.1.1.2. Flooding by Sections. Backfill shall be brought up to at least 1-ft. (30cm) over the pipe on the section to be tested. More cover may be required on larger pipes to prevent the pipe from floating out of

grade. Dams or dikes are placed tightly around pipe at either end and the ditch filled with water to an average depth of 4-ft. (1.2m) over the pipe. Flow at the lower end is measured for the section so submerged.

Dikes shall be placed around each manhole, and the area adjacent to the manhole shall be flooded to the top of the manhole and the flow into the manhole measured

507.5.1.2. Exfiltration. A section of pipe below a manhole is bulkheaded at either end with a 6-in. (15cm) pipe inserted into lower bulkhead and by use of a 90-degree bend. The 6-in. (15cm) pipe is set in a vertical position. A 2-in. (5cm) vent pipe is inserted in lower end and extended upward 4-ft. (1.2m). The 6-in. (15cm) pipe is filled with water, filling the wastewater conduit until all air is forced out through the vent tube. When the water levels are level in the 2-in. (5cm) and 6-in. (15cm) pipes, the drop in the 6-in. (15cm) pipe due to exfiltration over a specific time shall be measured and the loss of water due to exfiltration calculated. This amount shall be reduced by 25-percent to obtain equivalent infiltration over a specific time and the loss of water due to exfiltration calculated. Conditions encountered in construction may vary this procedure slightly, but essentially this method shall be used.

507.5.1.3. Low Pressure Air Testing. The CONTRACTOR shall furnish adequate personnel and equipment required to perform the tests. This test covers procedures for testing wastewater pipelines when using the low pressure air test method to demonstrate the integrity of the installed pipe line and the construction procedures. This test is used for testing 4-in. to 33-in. (10cm – 84cm) circular wastewater pipelines utilizing gasketed joints. Lines with a 27-in. (69cm) and larger inside diameter may be tested by the individual joint method.

The low pressure air test was developed to enable detection of damaged pipe or improper jointing and is a test which determines the rate at which air under pressure escapes from an isolated section of wastewater conduit. The rate of air loss is intended to indicate the presence or absence of pipe damage and whether or not the joints have been properly constructed. The test is not intended to indicate water leakage limits and cannot be used as a measure of infiltration or exfiltration leakage under service conditions.

507.5.1.3.1. Preparation of the Wastewater Line to be Tested. The section of wastewater line to be tested shall be flushed and cleaned prior to conducting the low pressure air test. This serves to clean out the debris, wet the pipe and produces the most consistent results.

507.5.1.3.2. Low Pressure Air Line Test Procedures. The procedure for the low pressure air test shall conform to the procedures described in ASTM C828 Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines, ASTM C924 Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method, ASTM F1417 Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air, or other appropriate procedures, except for testing times. Testing times shall be as outlined in this Item.

Isolate the section of wastewater line to be tested by means of inflatable stoppers or other suitable test plugs. The ends of all branches, laterals, tees, wyes and stubs to be included in the test should be plugged to prevent air leakage. All plugs should be securely braced to prevent possible blow out due to the internal air pressure. One of the plugs should have an inlet tap, or other provision for connecting a hose to a portable air control source.

Connect the air hose to the inlet tap and a portable air control source. The air equipment shall consist of necessary valves and pressure gauges to control the rate at which air flows into the test section and to enable monitoring of the air pressure within the test section. The testing apparatus shall be equipped with a pressure relief device to prevent the possibility of loading the test section with the full capacity of the compressor.

Add air slowly to the test section until the pressure inside the pipe is raised to 3.5-psi (24-kPa) greater than the pressure exerted by groundwater above the pipe.

After adequate pressure is obtained, regulate the air supply so that the pressure is maintained for a period of 2-minutes. This allows the air temperature to stabilize in equilibrium with the temperature of the pipe walls. The pressure will normally drop slightly until equilibrium is obtained. During this period all assessable plugs shall be checked with soap solution to detect any plug leakage.

Once the pressure is stabilized, the minimum time allowable for the pressure to drop from 3.5-psig to 2.5-psig (24- to 17-KPa gauge pressure) shall be computed from the following equation:

$$T = (0.0850 \times D \times K) \div Q$$

where
- T = time, seconds
- K = 0.000419 DL, but not less than 1.0
- D = average inside pipe diameter, in.
- L = length of line of same pipe size being tested, ft.
- Q = rate of loss, 0.0015 cu. ft./min./sq. ft. internal surface shall be used

Minimum holding times required according to pipe diameter are shown in Table 507.5.1.3.2.(a) Duration Requirements for Air Testing. The test may be stopped if no pressure loss has occurred during the first 25% of the calculated testing time. If any pressure loss or leakage has occurred during the first 25% of the testing period, then the test shall continue for the entire test duration, as outlined in Table 507.5.1.3.2.(a), or until failure.

Upon completion of the test, the bleeder valve is opened and all air is allowed to escape. Plugs shall not be removed until all air pressure in the test section has been released. No one shall be allowed in the trench or manhole while the test is being conducted.

Table 507.5.1.3.2.(a) Duration Requirements for Air Testing

Time Required for Loss of Pressure from 3.5 psig to 2.5 psig for Size and Length of Pipe Indicated for Q = 0.0015 and initial K = 1.0

Pipe Dia. (in.)	Minimum Time[1] (sec.)	Length for Min. Time (ft.)	X for Longer Length[2]	Test Time (sec.) for Length (L) (ft.) Shown							
				100 ft.	150 ft.	200 ft.	250 ft.	300 ft.	350 ft.	400 ft.	450 ft.
4	227	597	0.380	227	227	227	227	227	227	227	227
6	340	398	0.855	340	340	340	340	340	340	342	385
8	453	298	1.520	453	453	453	453	456	532	608	684
10	567	239	2.374	567	567	567	567	712	831	950	1068
12	680	199	3.419	680	680	684	855	1026	1197	1368	1539
15	850	159	5.342	850	850	1068	1336	1603	1870	2137	2404
18	1020	133	7.693	1020	1020	1539	1923	2308	2692	3077	3462
21	1190	114	10.471	1190	1571	2094	2618	3141	3665	4188	4712
24	1360	99	13.676	1368	2051	2735	3419	4103	4787	5470	6154
27	1530	88	17.309	1731	2596	3462	4327	5193	6058	6924	7789
30	1700	80	21.369	2137	3205	4274	5342	6411	7479	8548	9616
33	1870	72	25.856	2586	3878	5171	6464	7757	9050	10343	11635

1. The test may be stopped if no pressure loss has occurred during the first 25% of the calculated testing time. If any pressure loss or leakage has occurred during the first 25% of the testing period, then the test shall continue for the entire test duration, as outlined above, or until failure.
2. X is a factor used to find test duration time (t) for total length (L), where L must be greater than minimum length in the following equation: $t = X(L)$

507.5.1.3.3. Individual Joint Test Method. All wastewater conduit 36-in. (91cm) and larger in diameter shall be 100% air tested at each joint connection only. A visual inspection of each joint shall be performed immediately after testing. The method of testing shall be described in Item 507.5.1.3.2. except for test time. The time allowed for the pressure drop from 3.5 psig to 2.5 psig (24- to 17-KPa gauge pressure) shall be 10-seconds. No joint shall be air tested until the pipe has been backfilled. Air testing shall be performed as pipe installation progresses. At no time shall pipe installation exceed 100-feet (30m) from the last joint tested. If the joint fails to pass the joint air test, necessary repairs as recommended by the pipe manufacturer may be made if approved by the OWNER and the joint retested. Failure to pass the air test after repairs have been made may be cause for rejection.

507.5.1.4. Flexible Pipe (Deflection) Testing. Upon completion of flexible wastewater pipe installation, the CONTRACTOR shall test pipe for vertical deflection. Deflection tests shall be performed no sooner than 30-days after complete pipe placement and densification of backfill. The pipe shall be cleaned and inspected for offsets and obstructions prior to testing.

Deflection testing shall be performed by the CONTRACTOR at no cost to the OWNER. No payment will be made for delays that result from the CONTRACTOR 's performance of deflection testing.

Nominal inner diameter 27-in. (69cm) or smaller shall be tested by mandrel. For all pipes 27-in. (69cm) ID or smaller, the mandrel shall be pulled through the pipe by hand to ensure that maximum allowable deflections have not been exceeded. Pipe with nominal ID larger than 27-in. (69cm) up to and including 36-in. (91cm) nominal ID may be tested by an alternate method as approved by the OWNER. If a mandrel is selected to test pipe between 27-in. (69cm) up to and including 36-in. (91cm), the minimum diameter, length and other requirements shall conform to the dimensions and requirements as stated below. Deflection measurement for ID's nominally larger than 36-in. (91cm) shall be determined using a 1-in. (2.5cm) diameter rigid, nonadjustable metal bar approved by the OWNER; a minimum-radius rigid template; or by a method approved by the OWNER.

507.5.1.4.1. Mandrel. Prior to use, the mandrel shall be certified by the Engineer or by another entity approved by the Engineer. Use of an uncertified mandrel or a mandrel altered or modified after certification will invalidate the deflection test. Mandrel requirements are as follows:

(1) odd-number of legs with 9 legs minimum

(2) effective length not less than its nominal diameter
(3) fabricated of rigid and nonadjustable steel
(4) fitted with pulling rings at each end
(5) stamped or engraved on some segment other than a runner indicating the pipe material specification, nominal size, and mandrel OD (e.g., PVC D3034-200nim-187.10mm; PVC D3034-8"-7.366")
(6) furnished in a suitable carrying case labeled with the same data as stamped or engraved on the mandrel.
(7) minimum diameter at any point along the full length as indicated in Table 507.5.1.4.1.(a) Mandrel Sizing.

Table 507.5.1.4.1.(a) Mandrel Sizing

Pipe Material	Nominal Size		Minimum Mandrel Diameter[1]	
	Inches	mm	Inches	mm
PVC-ASTM D3034 (SDR 26)	6	150	5.50	140
	8	200	7.37	187
	10	250	9.21	234
	12	300	10.96	278
	15	375	13.56	344
PVC-ASTM D3034 (SDR 35)	6	150	5.62	143
	8	200	7.52	191
	10	250	9.41	239
	12	300	11.19	284
	15	375	13.85	352
PVC-ASTM F679 (T-1 Wall)	18	450	16.92	430
	21	525	19.95	507
	24	600	22.45	570
	27	675	25.30	643
	30	750	28.50	724
PVC Composite Pipe ASTM D2680	6	150	5.64	143
	8	200	7.66	195
	10	250	9.58	243
	12	300	11.48	291
	15	375	14.36	365
CCFRPM ASTM D3262 46 psi (318 Kpa)	12	300	11.82	300
	18	450	17.73	450
	20	500	19.66	499
	24	600	23.53	598
	30	750	29.23	742
	36	900	35.40	899

1. Metric mandrel diameters are rounded conversions of mandrel diameters in U.S. Standard Measures. If and when the types of pipe are available and specified by the appropriate ASTM in metric dimensions as the primary measure, the Engineer shall determine the appropriate mandrel diameter according to the requirements of this subsection.

507.5.1.4.2. Maximum allowable deflections. The maximum average ID shall be equal to the average OD per applicable ASTM Standard minus two minimum wall thicknesses per applicable ASTM Standards. Manufacturing and other tolerances shall not be considered for determining maximum allowable deflections.

Maximum allowable deflections shall be governed by the mandrel requirements as stated above and shall nominally be as follows, except that deflections of up to 6.5% of the nominal inside diameter are acceptable for drainage applications:

(1) Three (3) percent of the maximum average ID for PVC Composite Pipe.
(2) For all plastic pipe other than PVC Composite Pipe, the percentage listed of maximum average ID shall be as in Table 507.5.1.4.2.(a) Maximum Percentage Deflection Allowed.

Table 507.5.1.4.2.(a) Maximum Percentage Deflection Allowed

Nominal Pipe Size		Percentage Deflection Allowed
Inches	mm	
Up to and including 12	Up to and including 300	5.0
Over 12, up to and including 30	Over 300, up to and including 750	4.0
Over 30, up to and including 60	Over 750, up to and including 1500	3.0
Over 60, up to and including 90	Over 1500, up to and including 2250	2.5
Over 90, up to and including 120	Over 2250, up to and including 3000	2.0
Over 120	Over 3000	1.5

If the mandrel fails to pass, the pipe shall be considered to be overdeflected. Any overdeflected pipe shall be uncovered and, if not damaged, reinstalled. Damaged pipe shall not be reinstalled, but shall removed and replaced. Any pipe subjected to any method or process other than removal, which attempts, even successfully, to reduce or cure any overdeflection, shall be uncovered, removed and replaced with new pipe.

507.5.2. Television Inspection. If television inspection is not performed by the OWNER, it shall be performed by the CONTRACTOR in accordance with these specifications.

Experienced personnel shall perform the inspection by closed circuit color television. A video tape and suitable log shall be submitted to the OWNER after installation of the pipe. Video tape shall include voice description, as appropriate with stationing of services indicated. Data and stationing shall be included on video. The OWNER'S representative must be present during the CONTRACTOR'S television inspection, unless otherwise authorized by the OWNER. Generally, the representative will be present for at least a portion of the television inspection.

All videos and run sheets shall be given to the OWNER'S representative for storage and inspection by the OWNER. All videos and run sheets will become the property of the OWNER. Should any portion of the inspection tapes be of inadequate quality or coverage, as determined by the OWNER, the CONTRACTOR will have the portion reinspected and video taped at no additional expense to the OWNER.

If repairs are required, another television inspection must be made after the repairs are complete at no cost to the OWNER.

The CONTRACTOR may employ a firm qualified in this type of work to make the television inspection. The video(s) and run sheets should be furnished directly to the OWNER not the CONTRACTOR. The firm must attach a decal to the video(s) that states the following and signed by the officer of the firm: "I certify this video represents all or a part of the television inspection performed on Contract No. XXXXX and has not been altered or changed in any manner."

507.5.2.1. Equipment, Video and Run Sheet Requirements. Video must be compatible with the OWNER'S equipment. All information gathered must be legible, easily read or viewed, and of high quality. All television equipment used shall have at least 250 lines of horizontal resolution. The picture shall be in color. By voice on the video the operator must:

(1) Note the date and time the recording was made.
(2) Note the CONTRACTOR'S name, project name, and contract number.
(3) Note the name of the company performing the television inspection and the name of the operator.
(4) Note the location, designation, and size of the main and the direction in which the test was made.
(5) Identify every 50-foot station.
(6) Identify the station of each manhole.
(7) Identify the location and station of deficiencies.
(8) Identify the location and direction of entry of laterals.

A run sheet, compatible with the video, must be made noting deficiencies.

507.5.2.2. Television Inspection Special Procedures. Camera lens path shall follow the center of the pipeline. If the test is being run from manhole to manhole, the camera shall move downstream. If the test is being run from manhole to cleanout, the camera shall move upstream.

All wastewater conduit must be laced with enough water to fill all low points. The television inspection must be done immediately following the lacing of the conduit with no water flow. The depths of standing water allowable for mains that are greater than 24-in. (61cm) in diameter shall be evaluated by the OWNER and the OWNER will determine if corrective action is required. Allowable standing water depths at the end of construction for 6-in. through 24-in. (15cm – 61cm) conduits shall be no greater than indicated in Table 507.5.2.2.(a) Allowable Depth of Standing Water.

Table 507.5.2.2.(a) Allowable Depth of Standing Water

Grade	Maximum Depth of Standing Water
Less than 0.7%	½-in. (13mm)
0.7% and greater	0

507.5.2.3. Criteria for Acceptance of TV-Inspected Pipe. The OWNER shall decide if repairs are required, which decision shall be final. Repairs shall be no additional cost to the OWNER. Acceptance criteria are as follows unless otherwise specified.

(1) No pulled or slipped joints.
(2) No water infiltration.
(3) No cracked or damaged pipe.
(4) No structural damage to the pipe.
(5) Wastewater lines are clean.

507.6. MEASUREMENT AND PAYMENT FOR WASTEWATER CONDUIT INSTALLATION

507.6.1. Measurement. Pipe, including corrosion protection, if in place on the pipe, or unless otherwise covered by a special bid item, shall be measured for payment in linear feet (m) along the centerline of the pipe measured from centerline of manhole to centerline of manhole or to the end of the line in a case where no manhole exists. Deductions shall be made for special structures. Pipe which extends only through the wall of the structure shall be measured to the actual end of the pipe. No deductions shall be made for fittings, measurements being from center to center of fitting. Conduits shall not be classified for payment according to depth unless a separate trenching item is not included.

507.6.2. Payment. Pipe, including corrosion protection in place on the pipe, or unless otherwise covered by a separate bid item, shall be paid for at the contract unit price per linear foot (m), complete in place, as provided by the contract. The contract price per linear foot (m) shall be the total compensation for furnishing of all labor, materials, tools, equipment, and incidentals necessary to complete the work in accordance with the plans and these specifications.

ITEM 509. CROSSINGS

509.1. GENERAL

This specification shall govern for the construction of water or wastewater mains on or across streets, alleys, highways or railroads, creeks or rivers as detailed in the plans. The CONTRACTOR shall provide and employ adequate warning signs, barricades, lights, watchmen, etc. to fully protect its workers and the traveling public as required in Item 107.19. Protection of Work and of Persons and Property and Item 107.18. Public Convenience and Safety. No changes shall be made in location as shown on the plans without prior authorization of the appropriate agency and the OWNER.

509.2. STATE HIGHWAY CROSSINGS

All crossings shall conform to the TxDOT *Utility Accommodation Policy Manual Special Specifications.* Permits from TxDOT are required for all highway crossings. A copy of permits obtained from TxDOT shall be at the construction site available for the OWNER to review.

509.3. STREET AND ALLEY CROSSINGS

The construction of underground conduits on or across street and alley rights-of-way and the removal and replacement of pavement, curb and gutter, etc., shall be in accordance with the following requirements.

The CONTRACTOR shall protect the street and alley surface and all existing improvements from excavated materials, equipment operations and other construction operations. If jacking, boring or tunneling is indicated or specified, the work shall be performed in accordance with the requirements of Item 503. Trenchless Installation. If open-cut method is indicated or specified, the construction operations shall be conducted in accordance with the requirements in Item 504. Open Cut – Backfill.

509.4. RAILROAD CROSSINGS

All railroad crossings shall conform to the respective railroad company's requirements. The CONTRACTOR must obtain insurance and other requirements of the railroad company prior to beginning any work within the railroad right-of-way.

509.5. CREEK AND RIVER CROSSINGS

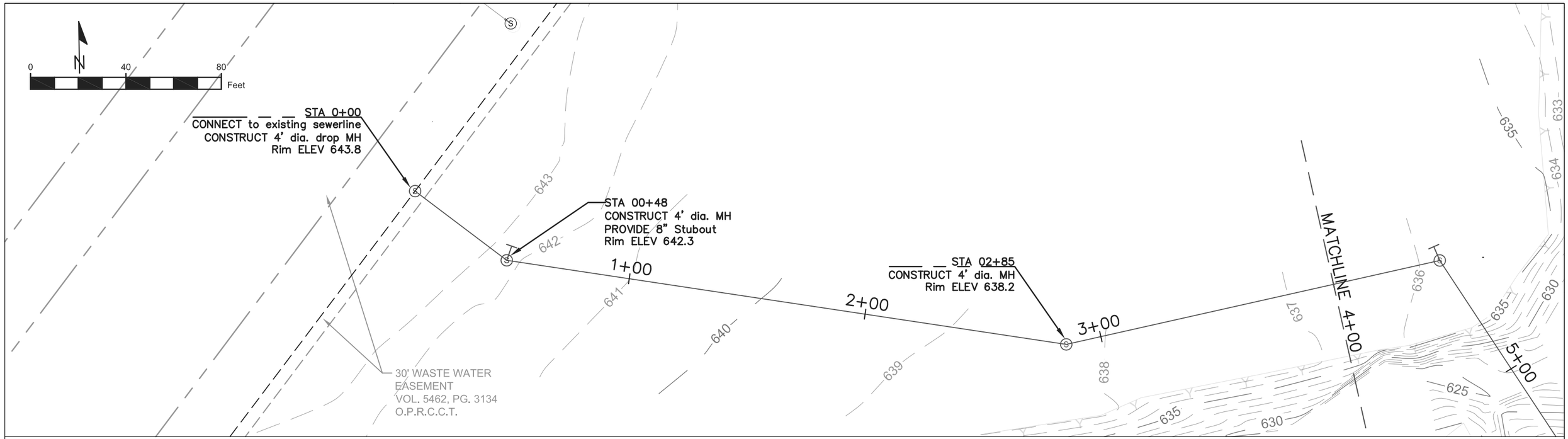
Creek crossing using pier construction shall be made in accordance with the details shown on the plans. River crossings, siphons and miscellaneous pipe structures as may be necessary shall be designed in detail on the plans.

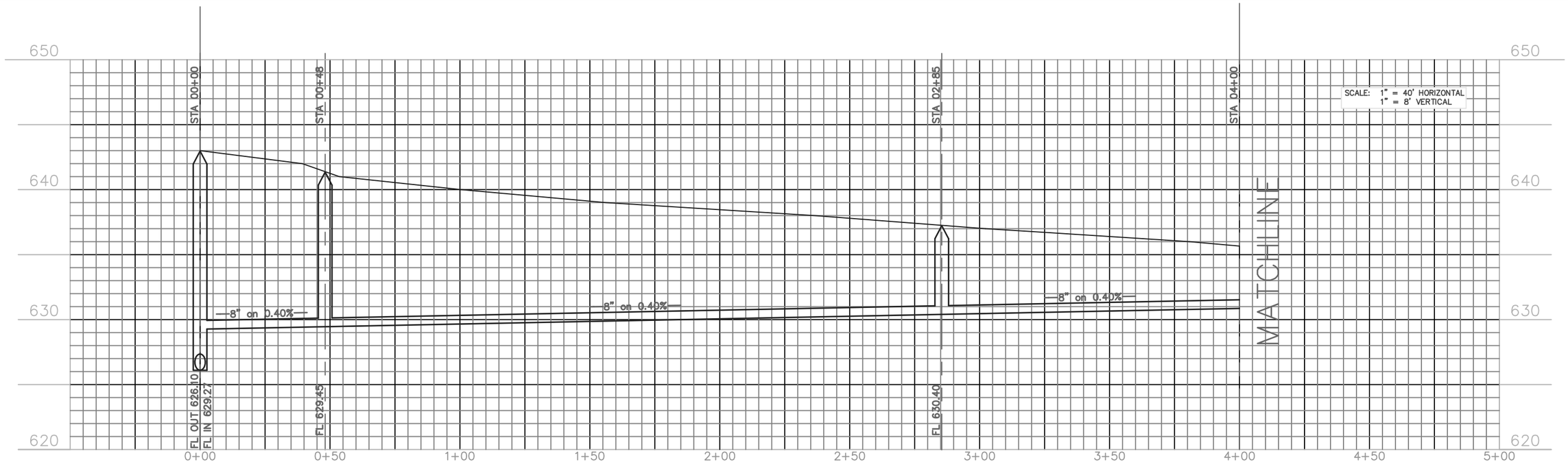
509.6. MEASUREMENT AND PAYMENT OF CROSSINGS

Each crossing within the limits noted on the plans and/or set forth in the proposal shall constitute a separate pay item where indicated on the plans and specifications and shall be paid for as shown in the proposal. The contract price shall be the total compensation for the furnishing of all labor, materials, tools, equipment and incidentals necessary to complete the work, including all excavation, disposal of surplus materials and backfill, in accordance with the plans and these specifications. The contract price or combination of prices includes compensation for excavation for piers, erecting piers, stripping forms, erecting pipe and supporting pipe (if required), in accordance with the plans and specifications.

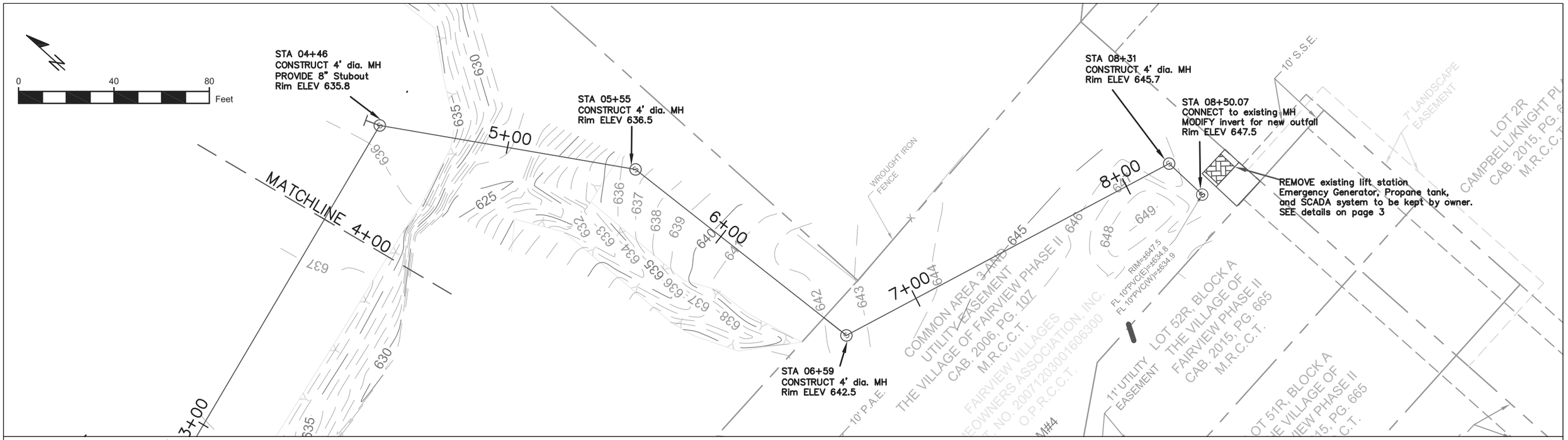
509.6.1. Creek Crossings. Creek crossings shall be measured for payment as a lump sum or in linear feet (m) of pipe furnished and placed, plus the cubic yard (m^3) of concrete in place, or a combination of the two methods as may be set out in the contract and proposal.

509.6.2. River Crossings, Siphons and Miscellaneous Pipe Structures. The structures shall be measured for payment per each or in linear feet (m) between the limits set out on the plans. Miscellaneous concrete shall be measured for payment and paid for at the contract unit price as provided in the proposal and contract. Each pipe structure shall be paid for at the contract unit price, complete in place, as provided in the proposal and contract.





	TOWN OF FAIRVIEW	DRAWN BY: DANIELLE OGLESBEE, EIT	DATE: 1-15-2018
	Lift Station Removal	REVIEWED BY: JAMES CHANCELLOR, PE	SCALE 1"=40'
			Page 1 of 4



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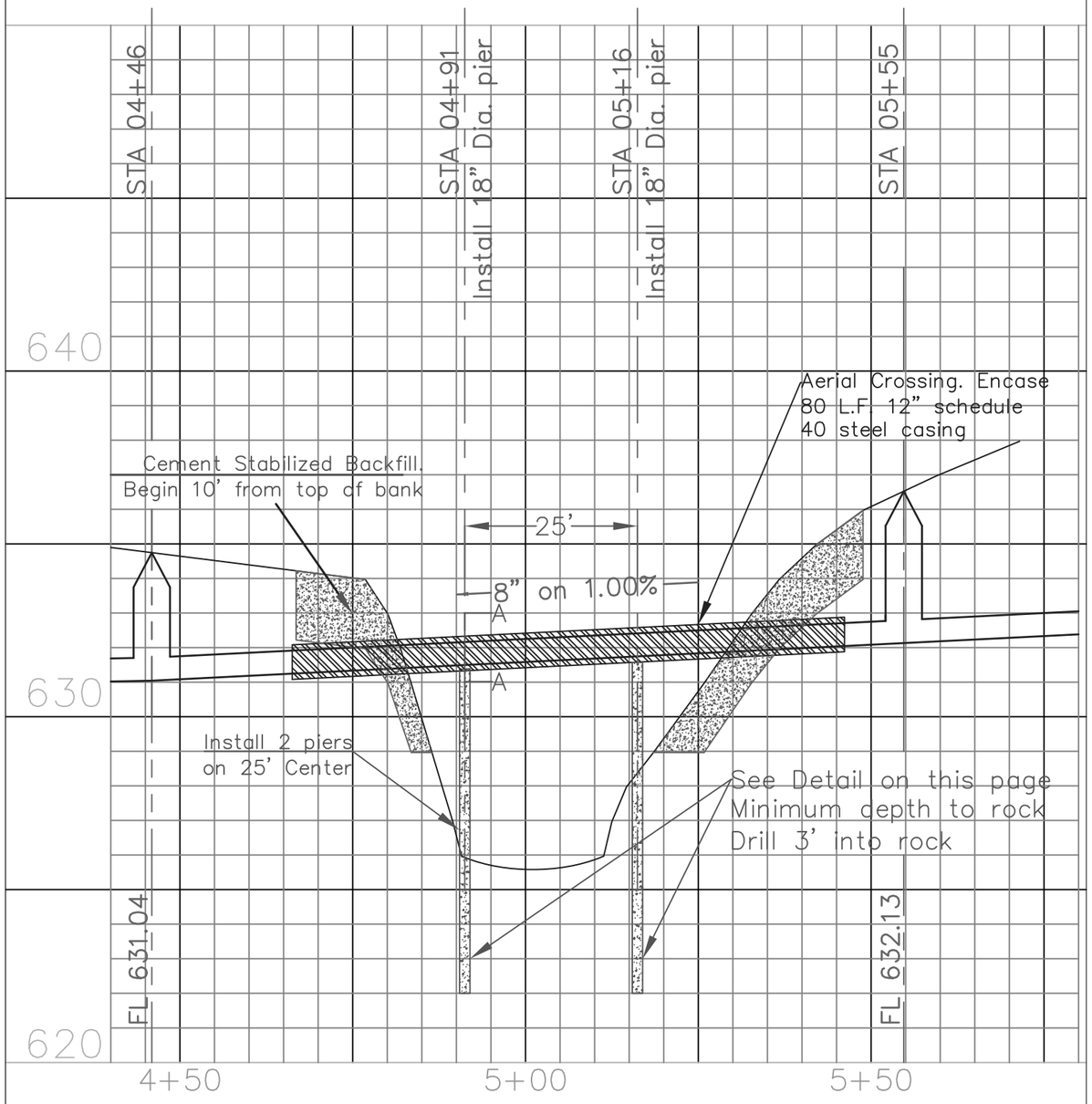
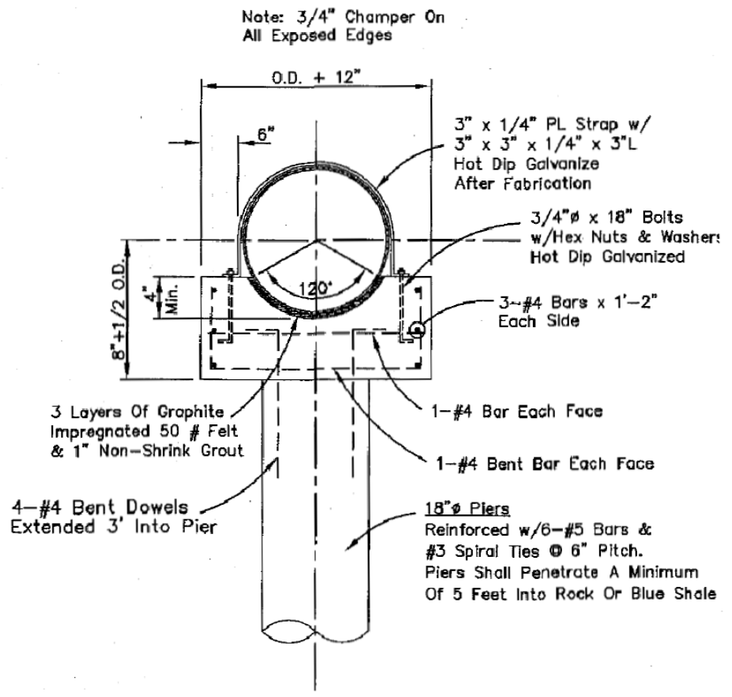


GENERAL NOTES • SANITARY SEWER SYSTEM

1. All sanitary sewer pipes four inches (4") to fifteen inches (15") nominal size shall be PVC SDR 35 meeting ASTM D3034.
2. All pipes shall be "green" in color as per Town Specifications and be laid on a minimum of class "B3" embedment.
3. Detectable Metallic Tape ("Green-Caution Burled Sewer Below" or approved other) shall be installed. after initial backfill on approximate centerline of pipe prior to final backfill.
4. The Contractor shall be responsible for providing "As-Recorded" plans to the engineer of record. Copies of these "As-Recorded" plans shall be furnished to the Town as required showing the location of sewer services.
5. TV inspections, low pressure air testing, vacuum testing of the manholes, and deflection testing are required on all sewer lines.
6. All Sanitary sewer manhole lids shall include the words "Town of Fairview"
7. Testing for sanitary sewer system shall be per North Central Texas Council of Governments Standard Specifications.
8. The Contractor shall furnish a maintenance bond for the amount of 100% of the total contract price to the Town to run two (2) years from the date at final acceptance of the system by the Town
9. The size and location of all underground utilities identified on these plans were obtained from record available and are approximate. The Contractor, prior to construction, must determine the exact location and elevation of all public utilities and shall be responsible for contacting franchise and Town utilities. The Town does not assume responsibility for utilities not shown or not in the location shown.
10. It is the responsibility of the Contractor to protect public utilities during the length of this project. Any removal or damage done to existing improvements shall be replaced or repaired by the Contractor at his expense.
11. New sewerline and manholes are to be tested and put into service before lift station abandonment.

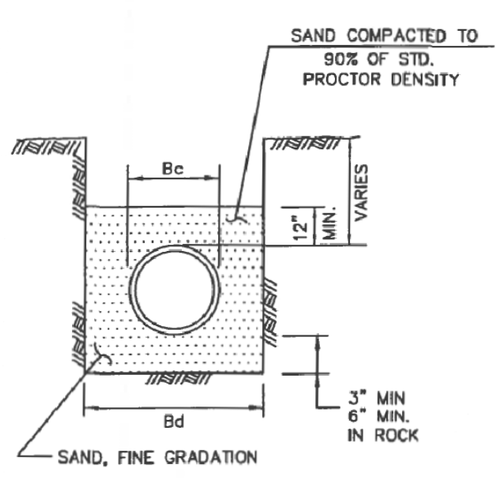
GENERAL NOTES • LIFT STATION REMOVAL

1. Remove existing fencing.
2. Remove concrete slab.
3. Remove fiberglass tank.
4. Emergency generator and propane tank to be kept by owner.
5. All SCADA equipment to be kept by owner.



Section A-A

N.T.S.



CLASS "B-3"

N.T.S.

	TOWN OF FAIRVIEW	DRAWN BY: DANIELLE OGLESBEE, EIT	DATE: 1-12-2018
	Lift Station Removal	REVIEWED BY: JAMES CHANCELLOR, PE	SCALE 1"=40'
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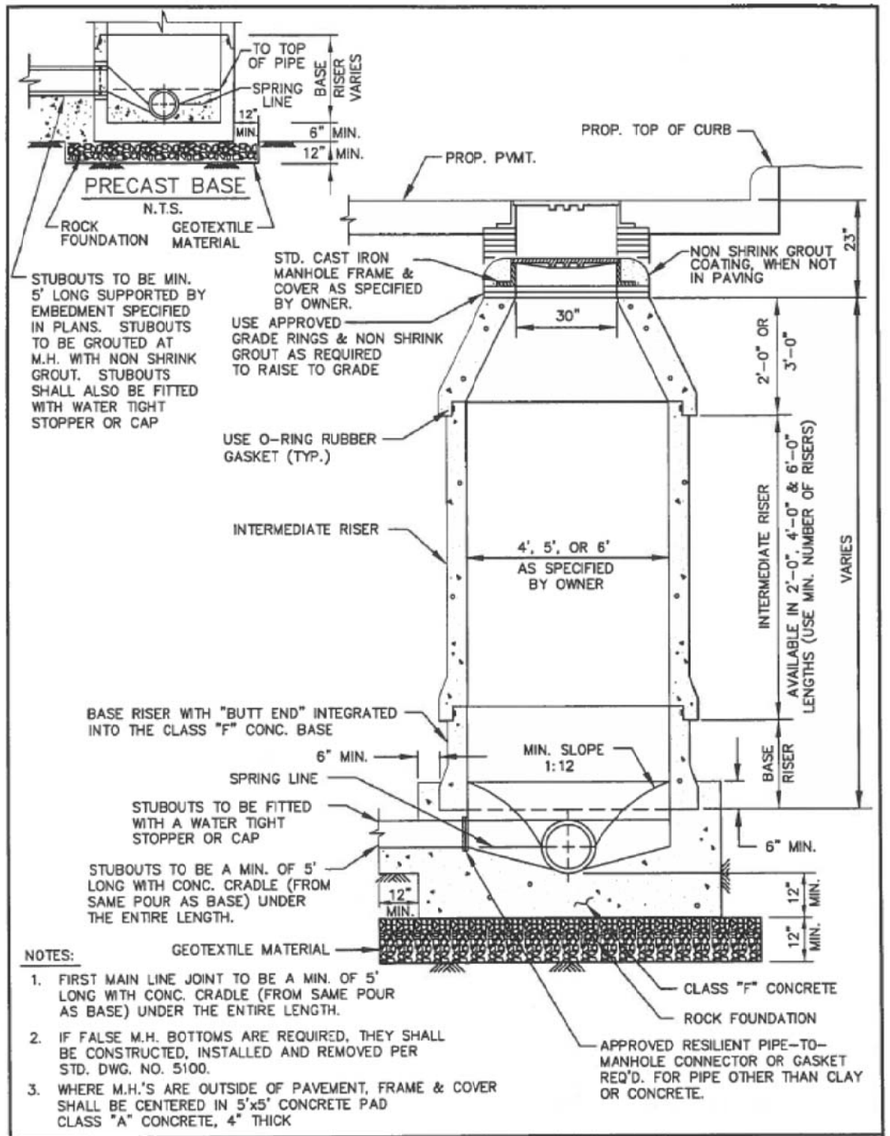
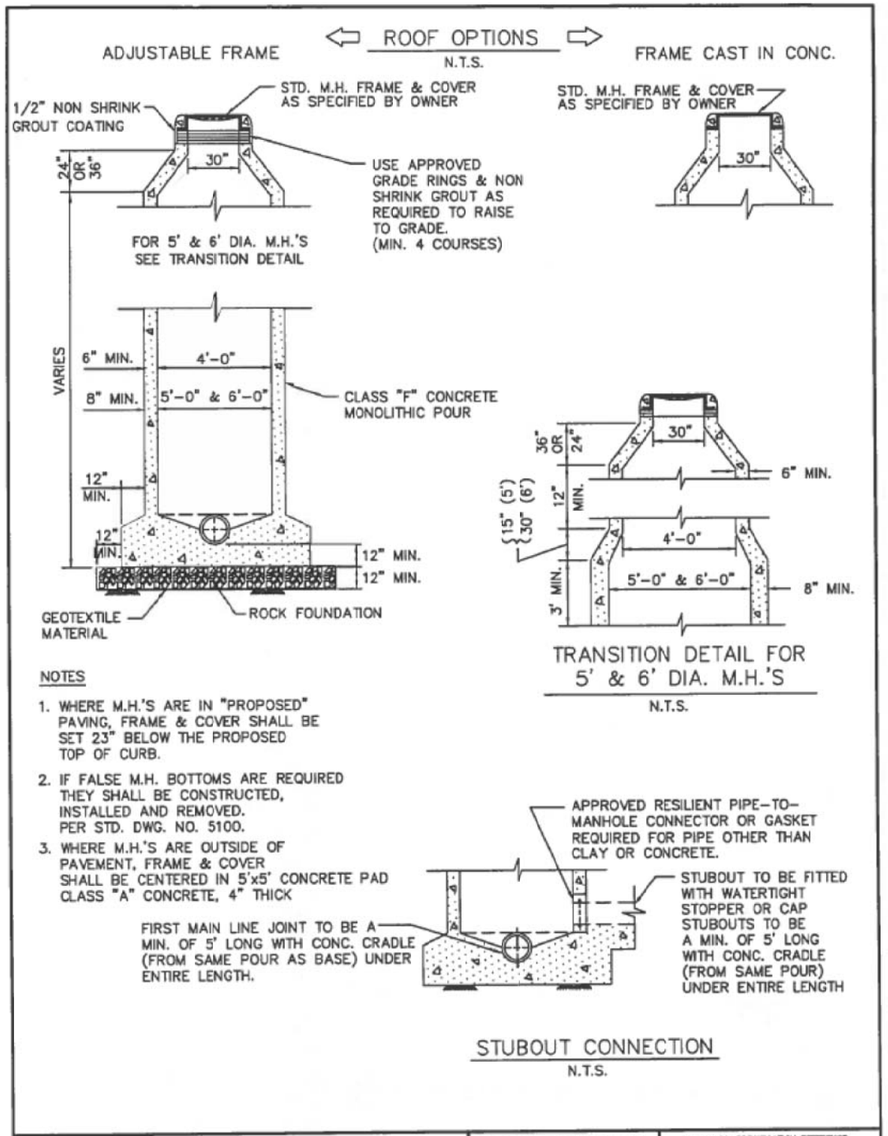


NOTES:

1. FIRST MAIN LINE JOINT TO BE A MIN. OF 5' LONG WITH CONC. CRADLE (FROM SAME POUR AS BASE) UNDER THE ENTIRE LENGTH.
2. IF FALSE M.H. BOTTOMS ARE REQUIRED, THEY SHALL BE CONSTRUCTED, INSTALLED AND REMOVED PER STD. DWG. NO. 5100.
3. WHERE M.H.'S ARE OUTSIDE OF PAVEMENT, FRAME & COVER SHALL BE CENTERED IN 5'x5' CONCRETE PAD CLASS "A" CONCRETE, 4" THICK

WASTEWATER MANHOLE	North Central Texas Council of Governments	STANDARD SPECIFICATION REFERENCE 502.1	
PRECAST		DATE OCT. '04	STANDARD DRAWING NO. 5020

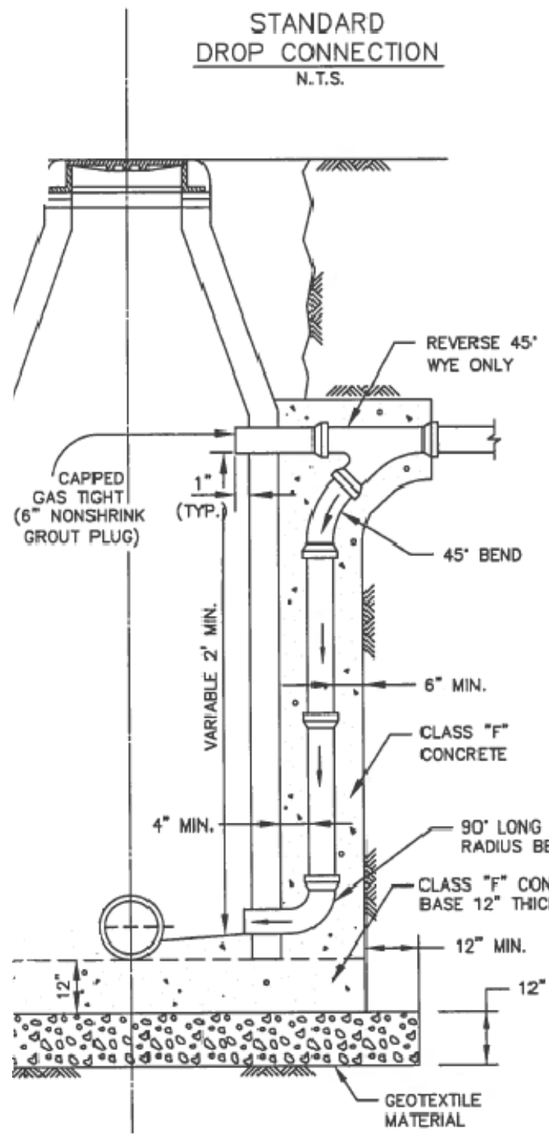


NOTES

1. WHERE M.H.'S ARE IN "PROPOSED" PAVING, FRAME & COVER SHALL BE SET 23" BELOW THE PROPOSED TOP OF CURB.
2. IF FALSE M.H. BOTTOMS ARE REQUIRED THEY SHALL BE CONSTRUCTED, INSTALLED AND REMOVED. PER STD. DWG. NO. 5100.
3. WHERE M.H.'S ARE OUTSIDE OF PAVEMENT, FRAME & COVER SHALL BE CENTERED IN 5'x5' CONCRETE PAD CLASS "A" CONCRETE, 4" THICK

STUBOUT CONNECTION
N.T.S.

WASTEWATER MANHOLE	North Central Texas Council of Governments	STANDARD SPECIFICATION REFERENCE 502.1	
CAST-IN-PLACE		DATE OCT. '04	STANDARD DRAWING NO. 5030



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