# DIVISION I

# GENERAL SPECIFICATIONS

## PART 101 – SCOPE AND LOCATION

101.1 The location of the project is in or near the City of Tulsa, Oklahoma. The character and exact location of the project are shown on the Drawings on file in the office of the City Auditor. Said Drawings clearly show the general work involved but are not intended to show all details of the work.

101.2 The site and/or rights-of-way upon which the work is to be performed is shown on the Drawings. The Contractor agrees that the site and/or rights-of-way provided is adequate for the performance of the work. If any additional working area is required, the Contractor shall, at his expense, make arrangements for such working area. The City will not be liable for additional compensation as a result of any delay in obtaining rights-of-way.

## PART 102 – SCOPE, NATURE, AND INTENT OF SPECIFICATIONS AND DRAWINGS

102.1 The Specifications and Drawings are intended to supplement, but not necessarily duplicate each other; and together constitute one complete set of Specifications and Drawings, so that any work exhibited in the one and not in the other shall be executed just as if it had been set forth in both, in order that the work shall be completed according to the complete design or designs as decided and determined by the Engineer.

102.2 The Drawings are not intended to be scaled for dimensions, and if dimensions not shown on the Drawings are required, the Contractor shall request them from the Engineer. Where existing utility lines or other sub-surface obstructions are shown on the Drawings, the same have been located as nearly as practicable from information furnished by owners of such, and from such surface indications as may exist at the work site. Such obstructions are shown for the purpose of advising the Contractor that they may interfere with the work to be done hereunder, but not for the purpose of indicating that the work can be performed without such interference.

102.3 Where soundings are shown on the drawings, the depths are determined by driving a drill rod, using the churn method with water lubrication, to a maximum depth of 9’ or to refusal, whichever is lesser in depth. By showing soundings on the drawings, the City represents only that material of hardness and character which could be penetrated by a drill rod found above the depth of sounding as shown at the point where the drill rod was driven.

102.4 Where exploratory drilling is indicated to have been performed on the plans, boring logs will be available for review at the office of the Engineer. The logs will be furnished for information purposes only and are not to be construed as a true representation of actual subsurface conditions.

102.5 Should anything be omitted from the Specifications and Drawings which is necessary to a clear understanding of the work, or should it appear various instructions are in conflict, the Contractor shall request written instructions from the Engineer before proceeding with the construction affected by such omissions or discrepancies.

102.6 The Contractor's responsibility for construction covered by conflicting requirements, not provided for by addendums prior to the time of opening bids for the work represented thereby, shall not extend beyond the construction in conformity with the cheaper of the said conflicting requirements. Any increase in cost of work requested to be done in excess of the cheaper of the conflicting requirements will be paid for as Extra Work as provided for herein.

## PART 103 – LINES AND GRADES

103.1 All work done under this Contract shall be done to the lines, grades, and elevations shown on the Drawings. All lines and grades shall be furnished by the Engineer, but the Contractor shall provide all batter boards, straight edges, and other materials for lines, levels, and measurements; and shall set all batter boards under direction of the Engineer. The Contractor shall give the Engineer at least 48 hours' notice as to the location where stakes are required.

## PART 104 – SATURDAY, SUNDAY, HOLIDAY, AND NIGHT WORK

104.1 No work shall be done between the hours of 7:00 p.m. and 7:00 a.m., nor on Saturday, Sunday, or legal holidays without the written approval or permission of the Engineer in each case, except such work as may be necessary for the proper care, maintenance, and protection of work already done, or of equipment, or in the case of an emergency.

## PART 105 – PROTECTION OF PROPERTY

105.1 The protection of City, State and Government monuments, street signs, and other City property is of prime importance, and if the same be damaged, destroyed, or removed, they shall be repaired, replaced, or paid for by the Contractor. Disturbance to this property must first be approved by the agency that controls it.

105.2 No valve or other control on any utility main or building service line shall be operated for any purpose by the Contractor without written approval or permission of the Engineer in each case.

105.3 At places where the Contractor's operations are adjacent to, or crossing, the path of railway, telegraph, telephone, cable, electric, and gas lines, or water lines, sanitary sewers, and storm sewers, damage to which might result in expense, loss or inconvenience, work shall not be commenced until all arrangements necessary for the protection thereof have been made. Contractor shall notify the Notification Center of

Oklahoma One-Call System, Inc. of any excavation or demolition prior to the commencement of such work. Notification shall be made no sooner than ten days, nor later than 48 hours prior to start of work, excluding Saturdays, Sundays, and legal holidays.

105.4 The City has attempted to locate all storm sewers, culverts, buried telephone or electrical conduits, sanitary sewers, water mains, and gas mains that might interfere with the construction of this project. The Contractor shall cooperate with the owners of any underground or overhead utility lines in their removal and rearrangement operations in order that these operations may progress in a reasonable manner and duplication or rearrangement work may be reduced to a minimum, and that services rendered by those parties will not be unnecessarily interrupted. The revision and crossings of the various types of lines shall be made as follows:

A) Storm sewers and culverts may be removed at the time of crossing or may be adequately braced and held in position while the pipe is placed beneath them. If the storm sewer or culvert is removed, it shall be replaced with pipe of the same type and size as that removed, and it shall be re-joined to the undisturbed line with a joint satisfactory to the Engineer. Backfill over the main, up to and around the storm sewer, shall be thoroughly compacted in order that no settlement will occur. The revision and crossing shown on the Drawing shall be at the expense of the Contractor. In the event lines, other than those shown on the Drawings, are encountered and fall within the standard trench limit and, in the opinion of the Engineer, revision of the line is necessary for the construction of the project, the Contractor will be reimbursed for the extra cost of the crossing or revision under the "Extra Work" clause of the Contract.

B) All overhead and buried telephone cable and electrical conduits, and gas mains to be revised or crossed by the construction of this project shall be protected in accordance with the directions of the utility company owning the conduits and/or mains. The Contractor shall notify the companies and obtain their permission before making any crossing or revisions. The revision and crossing shown on the Drawing shall be at the expense of the Contractor. In the event lines other than those shown on the Drawing are encountered and fall within the standard trench limit and, in the opinion of the Engineer, revision of the line is necessary for the construction of the project, the Contractor will be reimbursed for the extra cost of the crossings or revision under the "Extra Work" clause of the Contract. Any overhead cables or buried cables or conduits or gas mains damaged by the Contractor shall be repaired at his expense to the satisfaction of the Engineer and of the owner.

C) The Contractor shall not remove any water or sanitary sewer lines except as directed by the Engineer or as required by the Drawings and Specifications and shall adequately brace and protect them from any damage during construction. Any existing water main or sewer main or lateral damaged by the Contractor's operation will be repaired by the City's maintenance forces. The Contractor shall notify the City immediately after damaging any pipe. The repairs will be made at the Contractor's expense.

105.5 The location of utility service lines serving individual properties may or may not be shown on the Drawings, but the Contractor shall assume that such service lines exist whether or not they are shown on the Drawings, and it shall be the responsibility of the Contractor to make any necessary changes in the line and/or grade of such services, or to secure the necessary changes therein to be made by the particular utility company involved or other owner thereof, or by an agent or individual contractor approved by such utility company or other owner. Contractor shall pay the cost of all such revisions whether performed by contractor, the utility company, or other owner, or an approved contractor. In the event of interruption of a utility service as a result of accidental breakage, Contractor shall promptly notify the Engineer and the owner of the utility, and shall repair or cause the same to be repaired, in the same manner as necessary changes above provided for, and the Contractor shall do all things necessary to see to the restoration of services as promptly as may be reasonably done. All sanitary sewer service lines damaged shall be replaced with cast iron pipe, regardless of type or kind damaged.

105.6 In the event the Contractor in any way fails to comply with the requirements of protecting, repairing, and restoring of any utility or utility service, the Engineer may, upon 48 hours' written notice, proceed to protect, repair, rebuild or otherwise restore such utility or utility service as may be deemed necessary, and the cost thereof will be deducted from any money due or which may become due the Contractor pursuant to the terms of his contract.

## PART 106 – CONNECTIONS

106.1 All connections to existing water mains shall be made by the Contractor, unless noted otherwise. The Contractor shall perform his work so that these connections may be readily made. All transfer of building service line connections from the existing to the new main shall be made by the Contractor after the main has been backfilled, tested, and chlorinated, but before any sidewalks, driveways, curbs, and/or paved roadways, are replaced.

106.2 The Contractor shall not make any unauthorized connections to a sewer, nor shall he permit any such connections to be made. If the Contractor is properly authorized by the Engineer to make connections by installing tees in the sewer under construction, such installation shall conform to the regulation of the City.

## PART 107 – REFERENCES TO OTHER SPECIFICATIONS

107.1 Where a standard such as American Society for Testing Materials, American Concrete Institute, American Standards Association, American Water Works Association, or other agency designation is specified for a material, that designation shall be the current revision, either tentative or adopted. If a referenced specification is in conflict with these specifications, the City of Tulsa specifications shall govern.

## PART 108 – PROTECTION OF MATERIALS

108.1 All materials delivered to the site of the work shall be adequately housed and protected against deterioration according to the standard accepted procedures. The Contractor shall keep his storage yards in good order, pile his materials neatly, and protect them from damage.

## PART 109 – TESTING

109.1 Materials: All materials required to be tested shall be tested by a laboratory of good reputation, previously approved by the City. No material shall be accepted for construction unless it bears the approval of the laboratory. Reports of tests shall be forwarded to the City. Before final acceptance of the project, all materials shall be tested and shall be found in good and proper condition or shall be placed in such condition.

109.2 Testing of Manholes: All manholes will be tested using the vacuum test method, following the manufacturer's recommendations for proper and safe procedures. The vacuum tester shall be as manufactured by Cherne Industries or equal.

All pipes for vacuum testing entering the manhole shall be installed at the top access point of the manhole.

A vacuum of 10" of mercury (Hg) (5.0 psi) shall be drawn on the manhole and the time shall be measured for the vacuum to drop to 9" of mercury (Hg) (4.5 psi). The manhole shall pass the test if the time measurement exceeds the values indicated in the following table:

Vacuum Test Timetable
Manhole Diameter – Inches

| Depth-Feet | 48 Inches | 60 Inches | 72 Inches | 96 Inches | 144 Inches |
|---|---|---|---|---|---|
| 4 | 10 sec. | 13 sec. | 16 sec. | 19 sec. | 21 sec. |
| 8 | 20 sec. | 26 sec. | 32 sec. | 38 sec. | 44 sec. |
| 12 | 30 sec. | 39 sec. | 48 sec. | 57 sec. | 65 sec. |
| 16 | 40 sec. | 52 sec. | 64 sec. | 76 sec. | 88 sec. |
| 20 | 50 sec. | 65 sec. | 80 sec. | 95 sec. | 110 sec. |
| 24 | 60 sec. | 78 sec. | 96 sec. | 114 sec. | 132 sec. |
| + Each 2' | +5.0 sec. | +6.5 sec. | +8.0 sec. | +9.5 sec. | +11.0 sec. |

Manhole depth shall be rounded to the nearest foot. Intermediate values shall be interpolated. For depths above 24', add the values listed on the last line of the table for each 2' of additional depth.

If the manhole fails the vacuum test, the contractor shall perform additional repairs and repeat the test procedures until satisfactory results are obtained.

All repairs and testing are the responsibility of the Contractor and will be performed at no additional cost to the City.

No payment will be made for any manholes which have not passed the vacuum test.

109.3 Testing and Chlorinating Water Mains: Testing and chlorinating water mains will be performed by the City, but the Contractor shall lend such assistance as may be required. Water mains shall be testing in accordance with the Standard Specifications for "Installation of Ductile Iron Water Mains and Their Appurtenances," AWWA Designation C600. The pressure test of 150 psi shall be for thirty minutes' duration. If the line passes the test without significant pressure drop, a leakage test shall be made at the normal operating pressures under which the line is to operate for two hours' duration. Before being placed in service, all mains shall be chlorinated in accordance with "AWWA Standard for Disinfecting Water Mains," AWWA Designation C651. Where temporary plugs are required for pressure testing, the contractor shall furnish and install the plug and temporary blocking and remove after testing is complete. The cost shall be included in the unit price bid for pipe. No additional payment will be made.

## PART 110 – "OR APPROVED EQUAL" CLAUSE

110.1 When a material is specified or shown on the Drawings by brand or manufacturer's name, any other material that will adequately perform the same function, in the opinion of the City, may be accepted for use.

## PART 111 – DEWATERING

111.1 The Contractor shall provide all necessary pumps, drains, dams, well points, and other means for removing water from, or preventing water from entering the trench or other excavation until the project is completed. Sufficient pumps or other works shall be made available at all times to hold the water at a safe level as determined by the Engineer. Water from the excavation shall be properly disposed of so that no damage or interference results to public health, public or private property, completed or uncompleted work, other projects, or streets.

## PART 112 – SAFETY

112.1 Excavations: The Contractor shall adequately shore, or sheet, and brace the excavation, or shall slope the sides of the trench in accordance with the State of Oklahoma Department of Labor requirements, and all other applicable requirements.

112.2 Explosives: In handling explosives used during the construction of the project, the Contractor shall adhere to all Federal and State Laws and City Ordinances regulating

the purchase, transportation, storage, handling, and use of such explosives. All blasting shall be done in strict accordance with City Ordinance #19947. No blasting shall be done without obtaining a "Blasting Permit" from the City and presence of the Inspector. All equipment, tools, and materials used shall be of the correct type and in good conditions for the operation. The Contractor shall take all necessary precautions to avoid damage to property resulting from the transportation, storage, handling and use of explosives. Before blasting, the Contractor shall cover the area to be blasted with steel mesh mat or other suitable material, reinforced with timbers of sufficient weight so that rock and debris will be confined to the excavation. Any blasting within 10' of a water, sewer, pipe, or gas line shall be done with very light charges, and utmost care should be taken to avoid disturbance to these lines. All locations for blasting shall be subject to approval of the Engineer.

112.3 Danger Signals and Protection: When the Contractor is performing any type of construction or excavation work, or is stockpiling or storing any materials or equipment upon or adjacent to any street, alley, sidewalk, residence, public ground, or other location that is likely to be subject to pedestrian or vehicular traffic, he shall furnish, erect, and maintain substantial guard rails, safety fencing, lights, and traffic control devices around the project to protect pedestrians, animals, and vehicles from injury or damage. All traffic control shall be in accordance with the City of Tulsa Traffic Engineering Division's Standards and Procedures for Street Use and Temporary Traffic Control. Safety and traffic control devices shall be installed and removed only at the direction of the Engineer. The Contractor shall provide sufficient proper signals and flagmen for warning during construction, excavation, and blasting operations.

112.4 Power Lines: No person, materials, or equipment shall come within 6' of any power line carrying more than 440 volts unless the electric power services have been first discontinued.

112.5 Fire Prevention and Protection: The Contractor shall take all necessary measures to prevent fire and shall provide satisfactory firefighting means at the location of work.

112.6 Interference with Traffic: The Contractor shall construct and maintain adequate and safe bridges or crosswalks over excavations, where required. When a roadway or sidewalk is not closed, the Contractor shall provide a safe substitute route for any portion obstructed by his operations. If a roadway or sidewalk is closed to traffic, the Contractor shall provide and mark detours. As directed by the Engineer, construction across roadways or sidewalks may be done by open excavation.

112.7 Condition of Equipment and Materials: All equipment, tools, appliances, and materials used in connection with the project shall be handled and operated only when they are in safe operating condition and in accordance with a standard safety procedure.

## PART 113 – REMOVAL OF CONDEMNED MATERIALS AND STRUCTURES

113.1 The Contractor shall remove from the site of the work, without delay, all rejected and condemned materials or structures of any kind brought to or incorporated in the work.

Upon his failure to do so, or to make satisfactory progress in so doing, within 48 hours after the service of a written notice from the Engineer ordering such removal, the condemned material or structure may be removed by the City and the cost of such removal will be taken out of the money that may be due or may become due the Contractor. No such rejected or condemned material shall again be offered for use by the Contractor.

## PART 114 – REMOVAL AND SALVAGE OF CASTINGS

114.1 All water, sanitary sewer, and storm sewer manhole castings, lids, frames, curb hoods, grates, hydrants, valves, and other fittings removed as part of any construction project are property of the City of Tulsa. Contractor will not take ownership.

114.2 All storm sewer and sanitary sewer castings shall be salvaged and delivered by the contractor to the Underground Collections North Sewer Base Stockyard at 9319 East 42nd Street North. Contractor will coordinate the return of such items with the Stockyard personnel at 918.669.6130.

114.3 All hydrants, valves, and other fittings from abandoned water mains shall be salvaged and delivered by the contractor to the South Yard at 2317 South Jackson Avenue. Contractor will coordinate the return of such items with the South Yard personnel at 918.596.9401.

## PART 115 – CLEAN-UP

115.1 Immediately upon installation of any portion of the work, the Contractor shall restore all fills, topsoil, and utilities to their location and condition prior to construction.

115.2 Immediately upon installation of any block in length of the work herein contemplated, the Contractor shall remove all materials, tools, debris, excess excavated material, and equipment; and restore the site in a manner satisfactory to the Engineer.

115.3 Clean-up and restoration of service line transfers shall be made immediately following each transfer installation.

## PART 116 – PLACING WORK IN SERVICE

116.1 If desired by the City, portions of the work may be placed in service when completed and the Contractor shall give prior access to the work for this purpose, but such use and operation shall not constitute an acceptance of the work.

## PART 117 – SUBMITTALS

117.1 The Contractor shall submit to the Engineer, six copies of material submittals for all material he proposes to use. Construction shall not begin until the Engineer has approved the submittals in writing.

117.2 Submittals for pipe shall consist of notarized certifications, from the manufacturer, that the pipe was manufactured and tested in accordance with the applicable specifications. The certifications shall indicate the pipe diameter, the pressure rating, and the batch number from which the pipe was manufactured. For concrete and steel pipelines 16" and larger, a detailed laying schedule prepared by the manufacturer shall be submitted, along with the detail design calculations.

117.3 Submittals for material other than pipe shall consist of manufacturer's product literature or shop drawings, indicating dimensions and material specifications. Submittals shall include reference to compliance with AWWA, ASTM, NSF, and other applicable standards.

117.4 All delivery tickets, including factory certification of ductile iron pipe, shall be surrendered to City Inspector or their representative.

**SECTION END**

# DIVISION II

# MATERIAL SPECIFICATION APPROVED FITTINGS MANUFACTURERS

## PART 201 – CONCRETE

201.1 CEMENT

201.1.1 All cement used in the work shall be a well-known brand of true Portland Cement and shall conform to the Standard Specifications for Portland Cement, ANSI/ASTM Designation C150. Unless otherwise permitted, the Contractor shall use only one brand of cement in the work and under no condition shall he use more than one brand of cement in the same structure. Cement, which for any reason has become partially set or contains lumps or cakes will be rejected and shall be removed from the site.

201.1.2 The acceptance or rejection of cement shall rest with the Engineer. All rejected cement shall be plainly marked for identification, shall be immediately removed from the work, and shall not be offered for inspection again. Cement kept in storage for several months may be subject to repeated tests, as directed by the Engineer.

201.1.3 The cement shall be delivered in strong cloth or paper bags. No cement shall be used or inspected unless delivered in the original package with the brand and name of the manufacturer plainly marked thereon. Each bag of cement shall contain approximately 94 pounds of cement, net weight, and four bags shall be the equivalent of one barrel. Packages received in broken or damaged condition will be rejected or accepted only as fractional packages.

201.1.4 The Contractor shall provide, at the site of the work, a suitable weather tight building, or buildings, having a tight floor properly blocked or raised from the ground, for the storage of cement. The building shall be large enough to permit keeping on hand a supply of cement in quantity sufficient to prevent delays or interruptions to the work, which might be due to the lack of cement. The cement shall be stored in such manner to permit easy access for the proper inspection and identification of each shipment. Cement in bags shall not be piled to a height in excess of 7'. Suitable accurate scales shall be provided by the Contractor for weighing the cement. After it has been delivered to the job, the Contractor will not be permitted to remove or dispose of the cement in any way without the consent of the Engineer.

201.1.5 At the beginning of operations and at all other times while cement is required, the Contractor shall have, at the site of the work, an ample supply of acceptable cement and shall carefully guard against possible shortage on account of rejection, irregular deliveries, or any other cause.

201.2 WATER

201.2.1 All water used in mixing mortar or concrete shall be free from acid, alkali, oil, salt, vegetable, or other matter in sufficient quantity to be injurious to the finished product and shall be from an approved source.

201.3 AGGREGATE

201.3.1 Fine aggregate for concrete shall be clean, hard, durable, uncoated grains of Arkansas River sand or other sand acceptable to the Engineer. It shall be free from injurious amounts of dust, clay balls, soft or flaky particles, shale, alkali, organic matter, loam, or other deleterious substances. It shall not contain more than 3%, by weight, of material, which can be removed by standard decantation tests. If the color of the supernatant liquid is darker than that of the reference standard color solution when subjected to the Standard Test For Organic Impurities in Sands for Concrete ANSI/ASTM C40, the fine aggregate shall be rejected unless it passes the Standard Test for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar ANSI/ASTM C87.

201.3.2 Fine aggregate shall be graded approximately within the limits shown in the following table. If there are not enough fines are available in the natural sands, limestone dust, or other approved fines shall be added:

Percent Passing Standard Square Mesh Screens

| No. 4 | No. 20 | No. 50 | No. 100 |
|---|---|---|---|
| 95 – 100 | 45 – 80 | 10 – 30 | 5 – 10 |

201.3.3 Coarse aggregate shall consist of the best available crushed limestone or other approved material. River gravel or other material with smooth surfaces shall not be used without specific written approval of the Engineer. Coarse aggregate shall be clean, tough, sound, durable rock and shall not contain harmful quantities of foreign materials and must be satisfactory to the Engineer.

201.3.4 Coarse aggregate shall be graded approximately within the limits shown in the following table:

Percent Passing Standard Square Mesh Screens

| Aggregate | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Max Size | 2-1/2” | 2” | 1-1/2” | 1” | 3/4" | 1/2" | 3/8” | No. 4 |
| 2” | 100 | 95 – 100 | 60 – 95 | 50 – 83 | 40 – 70 | 20 – 40 | | 0 – 5 |
| 1-1/2” | | 100 | 95 – 100 | | 40 – 70 | | 10 – 30 | 0 – 5 |
| 3/4" | | | | 100 | 95 – 100 | | 40 – 75 | 0 – 5 |

201.3.5 Coarse aggregate shall conform to Standard Specifications for Concrete Aggregates, ANSI/ASTM C33, except as to graduation. The maximum size aggregate to be used in structures 6” thick and under shall be 3/4"; in structures from 6” to 10” thick, the maximum size of aggregate shall be 1-1/2”. If required, the Contractor shall furnish test certificates showing the aggregates meet the above requirements.

201.3.6 In case the concrete resulting from the mixture of the aggregates is not of a workable character or does not make the proper finished surface, the Engineer may require a different grading in order to secure the desired results, or they may allow the use of

inert admixtures to correct deficiencies, upon proper showing that such use will not materially lower the strength or increase the permeability of the concrete.

## 201.4 STEEL REINFORCEMENT

201.4.1 All reinforcing steel shall be deformed bars and shall conform to the requirements of the Standard Specifications for Deformed and Plain Billet Steel Bars for Concrete Reinforcement, ANSI/ASTM A615, for grade 40 or grade 60. All steel shall be manufactured in the United States.

201.4.2 The Engineer reserves the right to require a test of three specimens of each size of bar from each carload received. These tests shall be made by a laboratory or testing firm approved by the Engineer and the cost of such testing shall be included in the price bid for steel reinforcement.

## 201.5 STRENGTH AND PROPORTION

201.5.1 The concrete shall have a compressive strength of not less than 3500 psi, unless otherwise specified in the plans, as determined from test cylinders at 28 days, made, cured, and broken, as hereinafter specified.

201.5.2 The concrete shall be mixed in the approximate proportion of 1:2-1/2:4-1/4 and shall contain not less than six sacks of cement per cubic yard of finished concrete. With the approval of the Engineer, admixtures may be added in order to increase workability.

## 201.6 TESTING OF CONCRETE

201.6.1 During the progress of the work, a reasonable number of compression tests shall be made when and if required by the Engineer. Each test shall consist of not less than three test cylinders. At least one test shall be made for each 100 cubic yards of concrete placed. The test cylinders shall be made and stored in accordance with the Standard Method of Making and Curing Concrete Test Specimens in the Field, ANSI/ASTM C31, and shall be tested in accordance with the requirements relating to making compression tests on concrete test specimens as given in the Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens, ANSI/ASTM C39.

201.6.2 All test specimens shall be kept as near to the point of sampling as possible and yet receive the same protection from the elements as is given to the portions of the structure being built. Specimens shall be protected from injury. They shall be sent to a testing laboratory approved by the Engineer not more than seven days prior to the time of the test, and while in the laboratory shall be kept in the ordinary air at a temperature of approximately 70° F until tested.

201.6.3 The Contractor shall furnish the Engineer certified reports on these tests and shall pay all the expense of making the tests and of furnishing the concrete for preparing and testing the cylinders.

## 201.7 RESPONSIBILITY OF CONTRACTOR FOR STRENGTH

201.7.1 It is the intent of these specifications that the Contractor shall guarantee that concrete of the specified compressive strength is incorporated in the structures and that the responsibility for producing the required grades of concrete is assumed by the Contractor.

201.7.2 Should the average strengths shown by test cylinders fall below the strengths required, the Engineer will require any or all of the following changes: amount of cement, grading of aggregate, or ratio of the water to the cement used. If the tests disclose that the strength of the concrete is insufficient for the structure as built, the Engineer may condemn the part of any structure in which concrete of insufficient strength has been placed and the Contractor, at his cost, shall remove and replace such concrete with concrete meeting these specifications.

## 201.8 EXPERIMENTAL CONCRETE MIXES

201.8.1 The Contractor shall make experimental mixes prior to the placing of the concrete and at any time during the progress of the work when necessary to demonstrate that the concrete will meet these specifications. Materials for making experimental mixes shall be furnished by the Contractor and these materials shall be identical with those intended for use in the work. The cost of the materials, as well as the costs of crushing test specimens made from the experimental mix, shall be borne by the Contractor, and shall be included in the price bid for concrete.

## 201.9 MIXING

201.9.1 The concrete shall be mixed in an approved batch machine or mixer. The ingredients shall be accurately measured by weight, unless measurement by volume is permitted by the Engineer, before being placed in the mixer. Measuring boxes or other approved measuring apparatus shall be such that the proportions can be accurately determined. The quantity of water to be added, which will vary with the degree of dryness of the material and with the weather conditions, shall be accurately measured for each batch of concrete. Means shall be provided by which a measured quantity of water can be introduced at any stage of the process. The mixing shall be done in a thorough and satisfactory manner and shall continue until every particle of aggregate is completely covered with mortar. The mixing time for each batch shall not be less than one minute after the materials are in the mixer. The entire contents of the drum shall be discharged before recharging. Re-tempering of concrete, which has partly hardened, will not be permitted.

## 201.10 CONSISTENCY

201.10.1 All reinforced concrete which is required to be spaded or puddled in forms or around reinforcing steel shall be of such consistency that: all aggregate will float uniformly throughout the mass without settling or segregation; when dropped directly from the discharge chute of the mixer, it will flatten out at the center of the pile but will stand up at the edges, the pile spreading from internal expansion and not by flowing; it will flow

sluggishly when tamped or spaded; it can be readily puddled into corners and angles of forms and around reinforcing steel, it can be readily spaded to the bottom of the pour or to a depth of several feet any time within thirty minutes after placing.

201.10.2 A desirable consistency is one which results in a very slight accumulation of water at the top of a layer several feet in thickness, but not with segregation or accumulation of laitance.

201.10.3 If, through accident, intention, or error in mixing, any concrete shall, in the opinion of the Engineer, vary materially from the consistency specified, such concrete shall not be incorporated in the work but shall be discharged as waste material at a location approved by the Engineer.

201.11 PLACING CONCRETE

201.11.1 Before beginning a run of concrete, surfaces of the forms, reinforcing steel, and concrete previously placed, shall be thoroughly cleaned of hardened concrete and foreign materials. Forms shall be thoroughly wetted or oiled.

201.11.2 Concrete shall be placed in the forms immediately after mixing. It shall be deposited so that the aggregates are not separated. Dropping the concrete any considerable distance, generally in excess of 5', depositing large quantities at any point and running or working it along the forms, or any other practice tending to cause segregation of the ingredients, will not be allowed. It shall be compacted by vibration or continuous tamping, spading, or slicing. Care shall be taken to fill every part of the forms, to work the coarser aggregate back from the face, and to force the concrete under and around the reinforcement without displacing it. All concrete shall be thoroughly vibrated, except where specifically excepted in the specifications. The concrete shall be deposited in continuous horizontal layers and, whenever practicable, concrete in structures shall be deposited continuously for each monolithic section of the work. Chutes and tremies used for conveying concrete shall be mortar tight.

201.11.3 Work shall be arranged in order that each part of the work shall be poured as a unit if this is possible. Where necessary to stop pouring concrete, the work shall be brought up in level courses and against a vertical stop board.

201.11.4 The placing of concrete under water, where permitted, must be done by special approved methods.

201.12 PLACING IN COLD WEATHER

201.12.1 No concrete shall be placed without the specific permission of the Engineer when the air temperature is at or below 35° F.

201.12.2 If concreting in freezing weather is permitted by the Engineer, care shall be taken to prevent the use of any frozen material. In addition to adequate provision for protecting the concrete against chilling or freezing, the Contractor shall be required to heat the water and aggregate in order that when deposited in the forms, the concrete will have

a temperature of not less than 50° F, nor more than 90° F. The concrete shall be adequately protected in order to maintain this temperature for a minimum of 72 hours after it has been placed and a temperature above 32° F for a period of two additional days. The work shall be done entirely at the Contractor's risk.

201.12.3 No chemicals or other foreign matter shall be added to the concrete for the purpose of preventing freezing.

201.12.4 When early traffic placement on a repair is required, the following guidelines are provided as a minimum to assure required strength during cold weather. The Contractor is responsible for the protection and quality of concrete placed during all weather conditions. If circumstances occur which preclude following these guidelines, lower early strength may result in delays in opening areas to traffic as desired.

201.12.5 Ice, snow, and frost must be removed from the cut prior to placement of concrete. Concrete should not be place on frozen subgrade. Removal of frozen subgrade will be paid as unclassified excavation.

201.12.6 Fresh concrete temperatures shall be a minimum of 50° F and a maximum of 90° F at time of placement. Hot mix water and preheated aggregate may be necessary to accomplish the minimum temperature during extremely cold weather. The minimum ambient temperature at time of placement should be at least 30° F.

201.12.7 Insulated blankets should be placed immediately when average daily temperatures are below 50° F or when minimum ambient temperatures are anticipated below 40° F during the curing period and left in place until opening to traffic. Insulated blankets shall be MA KA closed cell insulated blankets or approved equal. The insulated blankets shall have a minimum R-value of two. Cost of insulated blankets shall be included in the price bid for the concrete where they are used.

201.12.8 Strict compliance with mix design slumps must be achieved to reach early strengths. "Drying out" of excessive slump mixes will not be allowed to reduce the slump.

201.12.9 All cold weather practices also apply to cementitious backfill material, except that blankets will not be required.

201.13 READY-MIXED CONCRETE

201.13.1 Ready-Mixed concrete may be used on the work, with the approval of the Engineer, when the Contractor can demonstrate that the concrete can be furnished in accordance with the specifications hereinabove and that delivery can be made at such rate as will ensure the continuity of any pour. Standard Specifications for Ready-Mix Concrete, ANSI/ASTM C94, when not in conflict with the specifications herein, shall control the furnishing of Ready-Mix concrete.

201.13.2 All mixer trucks shall be equipped with water meters. Additional water shall be added at the job site only with the specific approval of the Engineer.

## 201.14 CONSTRUCTION JOINTS

201.14.1 Construction joints shall be located as shown on the drawings and at other points as may be necessary during the construction, provided that the location and nature of additional joints shall be approved by the Engineer. In general, joints shall be located at points of minimum shear, shall be perpendicular to the principal lines of stress, and shall have suitable keys having areas of approximately 1/3 of the area of the joints.

201.14.2 In resuming work, the surface of the concrete previously placed shall be thoroughly cleaned of dirt, scum, laitance, or other soft material, and shall be roughened. The surface shall then be thoroughly washed with clean water and covered with at least 1/2" of cement mortar, after which concreting may proceed. Mortar shall be placed in a manner in order not to splatter forms and reinforcing steel.

## 201.15 FINISH OF CONCRETE SURFACES

201.15.1 All surfaces exposed to view shall be free from conspicuous lines, affects, or other irregularities caused by defects in the forms. If for any reason this requirement is not met, or if there are any conspicuous honeycombs, the Engineer may require the correction of the defects by rubbing with carborundum bricks and water until a satisfactory finish is obtained or removal at Contractors expense.

201.15.2 Immediately after removing the forms, all wires or other exposed metal shall be cut back of the concrete surface, and the depressions thus made, and all honeycombs and other defects shall be pointed with mortar and then rubbed smooth. If the Engineer deems any honeycomb or other defect to require such treatment, the defective concrete shall be cut out to a depth sufficient to expose the reinforcement and to afford a key for the concrete replacing that cut out.

## 201.16 CURING CONCRETE

201.16.1 Exposed surfaces of concrete shall be protected by approved methods from premature drying for a period of at least seven days. Curing compounds, when approved by the Engineer, shall be applied according to the manufacturer's recommendations. The Engineer may require the frequent wetting of the concrete and/or forms and the use of means to protect it from the direct rays of the sun.

## 201.17 PLACING REINFORCEMENT

201.17.1 All reinforcement, when placed, shall be free from mill scale, loose or thick rust, dirt, paint, oil, or grease, and shall present a clean surface. Bends and splices shall be accurately and neatly done and shall conform to American Concrete Institute Manual of Standard Practice for Detailing Reinforced Concrete Structures.

201.17.2 All reinforcing shall be placed in the exact position shown on the drawings and shall be held firmly in position by means of approved metal spacers and supports, by wiring to the forms, and by wiring the bars together at intersections with approved wire ties in order that the reinforcement will not be displaced during the depositing and compacting

of the concrete. The placing and fastening of reinforcement in each section of the work shall be approved by the Engineer before any concrete is deposited in the section. Care shall be taken not to disturb the reinforcement after the concrete has taken its initial set.

## 201.18 FORMS

201.18.1 Forms shall be so designed and constructed that they may be removed without injuring the concrete. The material to be used in the form for exposed surfaces shall be sized and dressed lumber or metal in which all bolt and rivet heads are countersunk. In either case, a plain, smooth surface of the desired contour must be obtained. Undressed lumber may be used for backing or other unexposed surfaces, except inside faces of conduit.

201.18.2 The forms shall be built true to line and braced in a substantial and unyielding manner. They shall be mortar-tight, and if necessary, to close cracks due to shrinkage, shall be thoroughly soaked in water or as shown in plans. Forms for re-entrant angles shall be filleted, and for corners shall be chamfered. Dimensions affecting the construction of subsequent portions of the work shall be carefully checked after the forms are erected and before any concrete is placed. The interior surfaces of the forms shall be adequately oiled with a non-staining mineral oil to insure the non-adhesion of mortar.

201.18.3 Form lumber, which is to be used a second time, shall be free from bulge or warp and shall be thoroughly cleaned. The forms shall be inspected immediately preceding the placing of concrete. Any bulging or warping shall be remedied, and all dirt, sawdust, shavings, or other debris within the forms shall be removed. No wood device of any kind used to separate forms will be permitted to remain in the finished work.

201.18.4 Temporary openings shall be placed at the bottom of the column and wall forms and at other points where necessary to facilitate cleaning and inspection immediately before depositing concrete.

## 201.19 REMOVAL OF FORMS

201.19.1 Forms shall be removed in such manner as to ensure the complete safety of the structure. No forms shall be removed except with the express approval of the Engineer. In general, this approval will be based on the following:

201.19.2 Forms on ornamental work, railings, parapets, and vertical surfaces which do not carry loads, and which will be exposed in the finished work shall be removed within 24 to 48 hours after placing, depending upon weather conditions.

201.19.3 Girder, beam, and joist sides only, column, pier, abutment, and wall forms may be removed within 24 to 48 hours after placing, depending upon weather conditions. No backfill shall be placed against walls, piers, or abutments, unless they are adequately supported or have reached the required strength.

201.19.4 Girder, beam, and joist soffit forms shall remain in place with adequate shoring underneath, and no construction load shall be supported upon, nor any shoring removed from any part of the structure under construction until that portion of the structure has attained sufficient strength to support safely its weight and the loads placed thereon.

## PART 202 – QUICK-SETTING FLOWABLE FILL

202.1 MATERIALS

202.1.1 Quick-setting flowable fill shall be a sand-cement slurry consisting of the following materials in a 1 cubic yard mixture:

| | |
|---|---|
| Type I Cement | 100 pounds |
| Sand | 2,925 pounds |
| Water | 585 pounds |
| Master Builders Pozzutec 20 | 80 ounces |
| (ASTM C494, Type C and E) | |

202.1.2 Note: Can change somewhat due to type of sand used.

202.1.3 The combination of materials above shall be mixed in a ready-mix truck to produce the sand-cement slurry mixture.

202.1.4 Submittals shall be delivered to the City of Tulsa at a date set by the Engineer. Submittals shall include the items outlined in ODOT Specification 701.03.

202.2 CONSTRUCTION METHODS

202.2.1 For each cubic yard of quick-setting flowable fill material required, the amount of the mix components in the MATERIALS section shall be used to produce the sand-cement slurry mixture. The slurry mixture shall be mixed between 70 to 100 revolutions of the ready-mix truck.

202.2.2 To minimize segregation, all flowable fill material shall be re-mixed at the project site at mixing speed in the ready-mix truck for approximately two minutes immediately prior to discharge of the sand-cement slurry mixture. Re-mixing of the flowable fill slurry shall be done under the direction of the Engineer.

202.3 TESTING

202.3.1 Special Provisions, “Flowable Fill Testing Procedures” identifies the Ohio Ready-Mixed Concrete Association (ORMCA) Standards FF1(94), and FF4(94) which shall be used in the performance of field testing.

202.3.2 The following are the testing requirements for the quick-setting flowable fill:

| | |
|---|---|
| Flow | Minimum = 4-1/2 inches |
| Compressive Strength (28 days) | Minimum = 25 pounds per square inch (psi) |
| | Maximum = 60 pounds per square inch (psi) |

202.4 GENERAL

202.4.1 The time required before placing pavement over the cured quick-setting flowable fill is a minimum of six hours and/or whenever a minimum penetration value of 400 pounds per square inch (psi) is achieved. Penetrometer readings shall be taken with a Soiltest Mortar Penetrometer, Model CT-421A, or approved equal. The upper 3” of the area of the cured flowable fill mixture to be tested shall be removed prior to taking the penetrometer readings. The test value of record shall be the average of three tests.

## PART 203 – DUCTILE IRON PIPE, DUCTILE AND CAST IRON FITTINGS, AND VALVES

203.1 PIPE AND FITTINGS

203.1.1 Where ductile iron pipe (DIP) 3 inches in diameter and larger is specified or required, it shall conform to, and be tested in accordance with, the current edition of ANSI/AWWA C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast.

203.1.2 Length of joints shall be either 18 feet or 20 feet. The minimum standard thickness class of each size pipe shall be as follows:

| Pipe Size | Thickness Class |
|---|---|
| 4-inch to 8-inch | 51 |
| 10-inch and larger | 50 |

203.1.3 For 16-inch and larger Water Ductile Iron Pipe, all bell and spigot joints shall be electrically bonded, using a #4 AWG bare copper wire of adequate length to braze, using a #15 cadweld cartridge, the copper wire to the bare metal at the bell and spigot. Cost shall be included in the unit price bid per lineal foot of Ductile Iron Pipe.

203.1.4 For 16-inch and larger Water Ductile Iron Pipe, junction box test stations shall be furnished and installed, EXCEPT, no magnesium anode banks shall be furnished or installed. Junction box test stations shall be installed in accordance with the stationing shown on the Schedule of Anode Spacing. Cost shall be included in the unit price bid per lineal foot of Ductile Iron Pipe.

203.1.5 Fittings for ductile iron pipe shall be cast or ductile iron. Cast iron and ductile iron fittings shall conform to the current edition of ANSI/AWWA C110, Ductile-Iron and Gray-Iron Fittings; or the current edition of ANSI/AWWA C153, Ductile-Iron Compact Fittings. The length of all solid sleeves (both AWWA C110 and C153) shall be the longest length listed in the AWWA C110 specification (12-inch length for 3-inch through 12-inch sleeves, 15-inch length for 14-inch through 24-inch sleeves, and 24-inch length for 30-inch through 48-inch sleeves).

203.1.6 DUCTILE IRON PIPE FOR GRAVITY SANITARY SEWER USE SHALL BE BY THE DIRECTOR OF WATER AND SEWER APPROVAL ONLY. Interior of all sanitary sewer ductile iron pipe shall be lined with 40 mils of ceramic epoxy (“Protecto 401”, or equal).

203.1.6.1 Condition of Ductile Iron Prior to Surface Preparation:

All ductile pipe and fittings shall be delivered to the application facility without asphalt, cement lining, or any other lining on the interior surface. Because removal of old linings may not be possible, the intent of this specification is that the entire interior of the ductile iron pipe and fittings shall not have been lined with any substance prior to the application of the specified lining material and no coating shall have been applied to the first 6 inches of the exterior of the spigot ends.

203.1.6.2 Lining Material:

The Standard of Quality is Protecto 401 Ceramic Epoxy. The material shall be an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. Any request for substitution must be accompanied by a successful history of lining pipe and fittings for sewer service, a test report verifying the following properties, and a certification of the test results.

A) A permeability rating of 0.00 when tested according to Method A of ASTM E 96-66, Procedure A with a test duration of 30 days.

B) The following test must be run on coupons from factory lined ductile iron pipe:

1) ASTM B117 Salt Spray (scribed panel) – Results to equal 9.0 undercutting after two years.

2) ASTM G95 Cathodic Disbondment 1.5 volts @ 77° F. Results to equal no more than 0.5 mm undercutting after 30 days.

3) Immersion Testing rated using ASTM D714-87.

a) 20% Sulfuric Acid – No effect after two years.

b) 140° F 25% Sodium Hydroxide – No effect after two years.

c) 160° F Distilled Water – No effect after two years.

d) 120° F Tap Water (scribed panel) 0.0 undercutting after two years with no effect.

C) An abrasion resistance of no more than 3 mils (.075 mm) loss after one million cycles using European Standard EN 598: 1994 Section 7.8 Abrasion Resistance.

203.1.6.3 Application:

A) Applicator

The lining shall be applied by a competent firm with a successful history of applying linings to the interior of ductile iron pipe and fittings.

B) Surface Preparation

Prior to abrasive blasting, the entire area to receive the protective compound shall be inspected for oil, grease, etc. Any areas with oil, grease, or any substance which can be removed by solvent, shall be

solvent cleaned to remove those substances. After the surface has been made free of grease, oil or other substances, all areas to receive the protective compounds shall be abrasive blasted using sand or grit abrasive media. The entire surface to be lined shall be struck with the blast media so that all rust, loose oxides, etc., are removed from the surface. Only slight stains and tightly adhering oxide maybe left on the surface. Any area where rust reappears before lining must be re-blasted.

C) Lining

After the surface preparation and within eight hours of surface preparation, the interior of the pipe shall receive 40 mils nominal dry film thickness of Protecto 401. No lining shall take place when the substrate or ambient temperature is below 40° F. The surface also must be dry and dust free. If flange pipe or fittings are included in the project, the lining shall not be used on the face of the flange.

D) Coating of Bell Sockets and Spigot Ends

Due to the tolerances involved, the gasket area and spigot end up to 6" back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum using Protecto Joint Compound. The Joint Compound shall be applied by brush to ensure coverage. Care should be taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends. Coating of the gasket seat and spigot ends shall be done after the application of the lining.

E) Number of Coats

The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The maximum or minimum time between coats shall be that time recommended by the lining material manufacturer. **To prevent delamination between coats, no material shall be used for lining which is not indefinitely re-coatable with itself without roughening of the surface.**

F) Touch-Up and Repair

Protecto Joint Compound shall be used for touch-up or repair in accordance with manufacturer's recommendations.

203.1.6.4 Inspection and Certification:

A) Inspection

1) All ductile iron pipe and fitting linings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC-PA-2 Film Thickness Rating.

2) The interior lining of all pipe barrels and fittings shall be tested for pinholes with a nondestructive 2,500-volt test. Any defect found shall be repaired prior to shipment.

3) Each pipe joint and fitting shall be marked with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.

B) Certification

The pipe or fitting manufacturer must supply a certificate attesting to the fact that the applicator met the requirements of this specification, and that the material used was a specified.

203.1.6.5 Handling:

Protecto 401 lined pipe and fittings must be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc. shall be placed inside the pipe and fittings for lifting, positioning, or laying.

## 203.2 JOINTS

203.2.1 Cast iron and ductile iron pipe and fittings shall be jointed with any of the end types as specified below unless a particular end type is specified. Fittings shall have mechanical joints, unless otherwise specified. Flanged ends shall be used only where specifically noted on the Drawings except that the valve connection end of all tapping sleeves shall be flanged.

203.2.2 Mechanical joints and push-on joints shall conform to, and be tested in accordance with, the current edition of ANSI/AWWA C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pipe and Fittings.

203.2.3 Flange joints shall conform to the current edition of ANSI/ASME B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.

203.2.4 Where ductile or cast-iron pipe is to be tapped, a split case iron or a flexible stainless-steel tapping sleeve may be used.

203.2.5 Split case iron tapping sleeves shall be of 150 psi working pressure. Sleeve body shall be cast iron conforming to AWWA C110. Sleeves shall have mechanical joints conforming to AWWA C111 on the run and a flange branch conforming to ASME B16.1, Class 125. End gaskets shall be natural rubber or neoprene material conforming to AWWA C111.

203.2.6 Flexible stainless-steel tapping sleeves shall be rated at 150 psi pressure, with flanges meeting the current edition of ANSI/AWWA C207. Steel Pipe Flanges for Waterworks Service, Sizes 4 In Through 144 In. (100 mm Through 3,600 mm) Assembly shall be NSF or UL rated. Bolts, nuts, and washers shall be stainless steel. Gaskets shall conform to AWWA C111.

203.2.7 Openings of the sizes shown on the drawings shall be furnished with steel blind flanges of proper strength to withstand working pressure of the line where no other provision is made for closing the openings. Blind flanges shall be fabricated from material as specified under AWWA C207. All bolts shall meet the current edition of ASTM A307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rods 60 000 PSI Tensile Strength, Grade A only, in accordance with AWWA C207.

203.2.8 Where restrained joints are specified or required, they shall be of a mechanical type or push-on type assembly easily removed in field once assembled without special equipment. Assemblies shall be ANSI/AWWA rated. Thrust blocks for joint restraint shall not be installed without prior approval by the Director of Water and Sewer. Set screw type retainer glands will not be permitted.

203.3 COATING, LINING, AND POLYETHYLENE WRAP

203.3.1 Cast iron and ductile iron pipe and fittings shall be bituminous coated outside and cement-mortar lined inside with seal coat in accordance with American National Standard for Cement Mortar Lining for Ductile-Iron and Gray-Iron Pipe and Fittings for Water, ANSI/AWWA C104/A21.4.

203.3.2 All ductile iron and cast-iron pipe and fittings shall be encased with polyethylene tube in accordance with AWWA C105, American National Standard for Polyethylene Encasement for Ductile Iron Piping for water and other liquids referred hereafter as polywrap. Polywrap shall be manufactured from virgin polyethylene material conforming to the following:

203.3.2.1 Raw material requirements, per ASTM D4976:

A) Group: 2 (Linear).

B) Density: 0.910 to 0.935 g/cm$^3$.

C) Dielectric strength: Volume resistivity, 1015 ohm-cm, minimum.

203.3.2.2 Physical properties of finished film:

A) Tensile strength: 3,600 psi (24.8 MPa) for an 8 mil (200-µm) minimum thickness, or 28.8 lbf/in. width (50.4 N/cm width), minimum in machine and transverse direction (ASTM D882).

B) Elongation: 700%, minimum in machine and transverse direction (ASTM D882).

C) Dielectric strength: 800 V/mil (31.8 V/µm) thickness, minimum (ASTM D149).

D) Impact resistance: 600 g, minimum (ASTM D1709 Method B).

E) Propagation tear resistance: 2,550 gf (grams force), minimum in machine and transverse direction (ASTM D1922).

203.3.2.3 Thickness: Linear low-density polyethylene film shall have a minimum thickness of 0.008” (8 mil or 200 µm).

203.3.2.4 Color: Polywrap may be supplied in its natural color, white, black, or weather-resistant black containing not less than 2% carbon black with a particle diameter of 90 nm or less. A minimum 2% of a hindered amine ultraviolet inhibitor is required for all films other than the weather-resistant black film with carbon black. Where other colors are specified for purposes of identification, the pigmentation shall not contain any regulated substances.

203.3.2.5 Tape: The polywrap shall be secured as specified below with 2” wide pressure sensitive tape not less than 10 mils thick. This flexible tape shall consist of a polyethylene or polyvinyl chloride backing with a synthetic elastomeric adhesive film comprised of butyl rubber. Tape shall remain flexible over a wide range of temperatures, with tensile strength and elongation properties in conformance with ASTM D1000.

The minimum tube size for each pipe diameter shall be per Table 1.

Table 1 Polyethylene tube and sheet sizes for push-on joint pipe*

| NOMINAL PIPE SIZES | PUSH-ON JOINT FLAT TUBE WIDTH | MECHANICAL JOINT FLAT TUBE WIDTH |
|---|---|---|
| 3 in. | 16 in. | 16 in. |
| 4 in. | 16 in. | 16 in. |
| 6 in. | 16 in. | 20 in. |
| 8 in. | 20 in. | 24 in. |
| 10 in. | 24 in. | 27 in. |
| 12 in. | 27 in. | 30 in. |
| 14 in. | 30 in. | 34 in. |
| 16 in. | 34 in. | 37 in. |
| 18 in. | 37 in. | 41 in. |
| 20 in. | 54 in. | 54 in. |
| 24 in. | 54 in. | 54 in. |
| 30 in. | 67 in. | 67 in. |
| 36 in. | 84 in. | 84 in. |
| 42 in. | 84 in. | 84 in. |
| 48 in. | 96 in. | 96 in. |
| 54 in. | 108 in. | 108 in. |
| 60 in. | 108 in. | 108 in. |

| | | |
|---|---|---|
| 64 in. | 121 in. | 121 in. |

*These wrap sizes should work with most push-on joint pipe and fitting bell sizes. Where bell or fitting circumferences are larger than the tube sizes shown, a larger tube to effectively cover these joints should be ordered.

## 203.4 GATE VALVES

203.4.1 Where gate valves are specified, they shall be resilient-wedged.

203.4.2 Resilient-wedged gate valves shall conform to and be tested in accordance with ANSI/AWWA C509. The valve shall be bubble tight from either direction at the rated design pressure of 200 psi. The valve shall have a single disc gate with synthetic rubber seat bonded or mechanically attached to the disc; non-rising stem with 2" AWWA operating nut; counterclockwise opening, "O" ring stem seals, and corrosion resistant interior coating acceptable for potable water use.

203.4.3 Where specified, flanges shall be ANSI B16.1, Class 125, cast iron. Mechanical Joint, push-on, and bell and spigot joints are allowed.

## 203.5 BALL VALVES

203.5.1 Ball valves shall conform to and be tested in accordance with the AWWA Standard for Ball Valves, ANSI/AWWA C507. Where ball valves are specified or required, they shall be double-seated with natural or synthetic rubber located in the valve body. Ball seating surfaces shall be stainless steel; designed for 150 psi working pressure; flanged end; "O" ring rotor bearing seals; constructed of high-tensile strength cast iron; counter-clockwise opening; equipped with totally enclosed manual operators, and torque limiting control device. Valves shall be tested by, and shall withstand without leak, a hydrostatic pressure of: one 250 psi on the valve body with rotor in the open position; and two 150 psi on the side of the valve with the opposite side open to atmosphere. Six copies of the test results and manufacturer's drawings shall be submitted for approval prior to delivery of the valve.

203.5.2 Valves shall be bubble tight at rated pressure with flow in either direction.

203.5.3 Where flanges are specified, they shall be ANSI B16.1, Class 125, cast iron flanges.

## 203.6 BUTTERFLY VALVES

203.6.1 Butterfly valves shall be of the tight-closing, rubber-seat type, shall have a rated pressure of 150 psig, and shall be bubble-tight at this pressure with flow in either direction. Valve opening shall be counterclockwise. The valves shall conform to and be tested in accordance with the AWWA Standard for Rubber-Seated Butterfly Valves, ANSI/AWWA C504, Class 150B. The valve body shall be of the short-body flange type, constructed of cast iron conforming to either ASTM A126, Class B, or ANSI/ASTM A48, Class 40 or ductile iron ANSI/ASTM A536, Grade 65-45-12. Flanges shall be ANSI B 16.1, Class 125, cast iron flanges. Valve Discs shall be constructed of alloy cast iron conforming to ANSI/ASTM A436, Type 1, or cast-iron conforming to ANSI/ASTM A48,

Class 40, or ductile iron ANSI/ASTM A536, Grade 65-45-12. Valve shafts shall be constructed of 18-8, Type 304 or 316 stainless steel, ANSI/ASTM A296, Grade CF8, or monel. Valve seats shall be body mounted and shall be of natural or synthetic rubber compound with mating seat surfaces of 18-8, Type 304 or 316 stainless steel, or alloy cast iron conforming to ANSI/ASTM A436, Type 1, or bronze Grade A, D, or E. Valve bearings shall be corrosion resistant and self-lubricating.

203.6.2 Interior surfaces of the valve, except seating surfaces, shall be epoxy coated in accordance with AWWA Standard for Protective Interior Coatings for Valves and Hydrants, AWWA C550. Exterior surface of the valve shall be painted with two coats of asphalt varnish conforming to Federal Specifications TT-V-51C. For non-buried service, exterior surface shall be coated with two coats of epoxy, not zinc chromate.

203.6.3 Performance, hydrostatic and leakage tests shall be conducted in strict accordance with ANSI/AWWA C 504, except that the leakage tests as outlined in Section 5.3 are to be conducted on both faces of the disc.

203.6.4 Six certified copies of the manufacturers detail drawings shall be submitted for approval prior to delivery of the valve.

203.6.5 Six certified copies of the test results, signed by a registered professional engineer, are to be furnished to the Engineer.

203.7 MANUAL OPERATORS FOR BALL VALVES AND BUTTERFLY VALVES

203.7.1 Manual Operators for Ball and Butterfly valves shall be totally enclosed, permanently lubricated, counterclockwise opening, and designed for buried or submerged service. Manual Operators shall be equipped with a 2" square AWWA operating nut with a removable handwheel complete with spinner and an open-closed indicator, suitable for one-man operation at 150 psi unbalanced across the valve. Manual Operators shall be either worm gear or traveling-nut type, and shall conform to AWWA C507 for Ball Valves or AWWA C504 for Butterfly Valves.

203.7.2 Manual Operators for Ball and Butterfly Valves 16" and larger shall be equipped with a Torque Limiting Control Device. The device shall be mounted directly on the operating nut for valves in vaults and on top of the extension shaft for buried valves. The device shall be secured to the operating nut with two setscrews. The device shall declutch at 200 lb/ft of input torque in either direction of rotation. The device shall be designed for permanent buried or submerged service. Declutch and reset shall be automatic. Repeatability shall be within 5% of original rating for a minimum of 1000 cycles. Certified proof-of-design test reports shall be furnished for the device.

203.8 AIR RELIEF VALVES

203.8.1 Where air relief valves for water applications are specified or required, the valve shall be heavy-duty combination air release and vacuum type for 150 psi working pressure. Body, cover, and baffle shall be cast iron, or nylon. All internal parts to be either highest

quality stainless steel, nylon, or bronze. Interior and exterior surfaces of cast iron valve body and cover shall be coated with epoxy.

Air Relief Valve shall be guaranteed to operate under all surge conditions. Acceptable Manufacturers for water ARV's: APCO, Crispin, ValMatic, ARI.

203.8.2 Where air relief valves for sanitary sewer force mains, are specified or required, the valve shall be heavy-duty combination air and vacuum release type for 145 psi working pressure, tested to 230 psi, size shown on plans. Body, cover, and baffle shall be 316LC stainless steel or reinforced nylon. All internal parts shall be reinforced nylon, reinforced polypropylene, or stainless steel. Valves shall have float system designed to ensure separation of sewage and sealing mechanism. Valves to have back flushing attachments for routine cleaning maintenance.

203.9 CHECK VALVES

203.9.1 Where check valves are specified or required, they shall conform to, and be tested in accordance with the AWWA Standard for Swing-Check Valves for Ordinary Water Works Service, AWWA C508. They shall be horizontally mounted, single disc, swing type with a full diameter passage providing minimum pressure loss. Valves shall be of the non-slamming type designed for the future installation of outside lever and weight. Unless otherwise specified, all check valves installed in pump or lift stations shall be equipped with position indicator. Disk shall be coated rubber and body shall be epoxy coated. Ends shall fit the pipe or fitting to which attached (push-on, mechanical, bell and spigot, or flanged).

203.10 THREE-WAY FIRE HYDRANTS

203.10.1 Where fire hydrants are specified, they shall conform to, and be tested in accordance with the AWWA Standard for Dry-Barrel Fire Hydrants, ANSI/AWWA C502. All hydrants shall have: breakable connection features and a breakable coupling on the stem immediately above the bury line which has a lower breaking point than the rest of the unit; 5-1/4" compression main valve; 6" inlet connection; standard bell or mechanical joint hub; 3' 6" bury length, or as specified on drawings; two 2-1/2" hose nozzles with National Standard threads; one 4" pumper nozzle with Tulsa Standard threads (refer to attached Standard Detail for Fire Hydrants); "O" ring seal; drain valve; left (counter-clockwise) opening; Federal yellow finish paint above ground line; and National Standard pentagon operating nut.

203.10.2 Where fire hydrant extensions are specified or required, they shall be of proper design to accommodate the make of fire hydrant installed.

203.11 FOUR-WAY FIRE HYDRANT

203.11.1 Where four-way fire hydrants are specified or required, they shall conform to, and be tested in accordance with the AWWA Standard for Dry-Barrel Fire Hydrants, ANSI/AWWA C502. All hydrants shall have: breakable connection features and a breakable coupling on the stem immediately above the bury line which has a lower

breaking point than the rest of the unit; 8” inlet connection; bell, flange, or mechanical joint inlet; 4’ 6” bury length; two 2-1/2” hose nozzles with National Standard threads; two 4” pumper nozzles with Tulsa Standard threads; "O" ring seal; drain valve; left (counter-clockwise) opening; Federal yellow finish paint above ground line; and National Standard pentagon operating nut.

203.11.2 Where fire hydrant extensions are specified or required, they shall be of the proper design to accommodate the make of fire hydrant installed.

## 203.12 BLOW-OFF HYDRANT

203.12.1 Where blow off hydrants are specified or required; they shall be constructed in accordance with Construction Standard Blow-off Hydrant.

## PART 204 – STEEL PIPE AND FITTINGS

### 204.1 GENERAL

204.1.1 Where steel pipe is specified or required, it shall conform to the AWWA Standard for Steel Water Pipe, 6” and Larger, AWWA C200. No steel less than 35,000 psi specified minimum yield strength shall be permitted. All pipe shall be hydrostatically tested in accordance with AWWA C200. Mill Test Reports shall be furnished, and the hydrostatic test pressure shown on shop fabrication drawings. AWWA Designation C200 shall govern the testing. Pipe length shall be not less than 35’ per joint, except for specials, unless otherwise noted. There shall be no more than one longitudinal or girth seam per section. Nominal pipe diameter and steel thickness shall be as specified on the drawings. The diameter shown is the required inside diameter after cement-mortar lining. All pipe shall be manufactured by an established manufacturer who has had at least five years of experience in successfully building this type of pipe. Openings for air valves, main connections, and blow-off connections shall be provided with suitable reinforcements around the opening, welded to the body of the pipe in accordance with AWWA Manual M11. Openings of the sizes shown on the drawings shall be furnished with steel blind flanges of proper strength to withstand the working pressure of the line where no other provision is made for closing the openings. Blind flanges shall be fabricated from material listed above as specified under AWWA C200. All bolts shall be carbon steel ANSI/ASTM A307, Grade A only, in accordance with ANSI/AWWA C207. For corrosion monitoring of steel pipe, junction box test stations shall be furnished and installed. Magnesium anode banks shall be furnished and installed if specified in the plans. Junction box test stations and anode banks shall be installed in accordance with the stationing as shown on the Schedule of Anode Spacing in the plans.

204.1.2 All steel pipe shall be manufactured with ends of true circular shape, free from indentations, projections, or roll marks for a distance of 8" from the end of the pipe. This shall be done by hydraulic expansion or some other method satisfactory to the Engineer. The outside circumference shall not vary by more than ±1% or as required for jointing of pipe as described in AWWA C200.

204.1.3 Where steel fittings or specials are specified or required, they shall conform to all of the steel pipe specification requirements and to the AWWA Standard for Dimensions for Steel Water Pipe Fittings AWWA C208. Where fittings and specials are fabricated from mill pipe, they shall be fabricated from pipe hydrostatically tested in accordance with AWWA C200 with mitered joints dye checked for welding flaws. Changes in line and grade shall be made by steel specials or in the joints. Joint deflection shall not exceed that as recommended by the manufacturer. Inside diameter of steel specials and fittings shall be the required inside diameter of cement-mortar lining.

204.1.4 Where field cutting of steel pipe is permitted, pipe shall be cut by sawing. The inside lining shall be removed for a minimum of 6” each side of the cut and the pipe surface shall be cleaned and brushed to bright metal. After welding, the inside lining shall be replaced in accordance with AWWA C602.

204.1.5 Steel Pipe shall be designed in accordance with AWWA M11 and AWWA C200 except as noted herein. Steel Pipe shall conform to ASTM A139 Grade B or C. The design criteria for steel pipe thickness shall be based on a minimum 150 psi working pressure plus a 100-psi allowance for water hammer except the minimum thickness of steel pipe shall be 0.25”. The minimum thickness standard in inches for each following size pipe shall be as follows:

Minimum Thickness – Inches for Grade of Steel

| Nominal Pipe Diameter | A-139 Gr. B | A-139 Gr. C |
|---|---|---|
| 6” – 36” | 0.250 | 0.250 |
| 42” | 0.281 | 0.250 |
| 48” | 0.313 | 0.281 |
| 54” | 0.375 | 0.313 |
| 60” | 0.406 | 0.344 |
| 66” | 0.438 | 0.375 |
| 72” | 0.500 | 0.406 |

Maximum depth of cover shall be 12’. Depth of cover in excess of 12’ shall require special design.

204.1.6 Hangar and support systems shall be designed in accordance with AWWA M11.

204.2 JOINTS

204.2.1 Steel Pipe and fittings shall have one of the following type joints: slip joint ends for field lap welding, single beveled ends for field butt welding, double beveled ends for field butt welding, "O" ring bell and spigot joints, or plain ends for mechanically coupled field joints. Flange ends shall be used only when noted on the drawings.

204.2.2 Welded joints shall conform to, and be tested in accordance with, the AWWA Standard for Field Welding of Steel Water Pipe Joints, AWWA C206. Slip joints for field lap welding shall be sized to provide tolerances per C200.

204.2.3 Mechanically coupled joints shall consist of Dresser Couplings, Style 38, or equal, or as specified on the drawings. The harness lugs, tie bolts, and nuts shall conform to AWWA M11 Steel Pipe Design and Installation, Par. 19.8.

204.2.4 Bell and spigot joints with rubber gasket shall conform to the AWWA Standard for Steel Water Pipe 6” and Larger, AWWA C200 and the AWWA Steel Pipe Manual, M-11. The gasket shall be a continuous "O" ring design of natural rubber or neoprene and shall be of suitable cross-section and size to assure a watertight joint. Acceptable bell and spigot joints for all steel pipe diameters and thicknesses shall be the "O" Ring-Bar Type, or the "O" Ring-Carnegie Section, or rolled groove type joint. Bell and spigot ends shall be properly sized by forcing over a sizing die or by expanding to stretch the steel beyond its elastic limit so that the difference in diameter between outside of spigot and inside of bell at normal engagement is not less than 0.03” and not more than 0.10" as measured on circumference with a diameter tape. Shop applied interior lining on the bell end of the pipe shall be held back a minimum distance of the spigot engagement

+1-1/8" for the Bar and Carnegie Type Joints. Hold back for the rolled groove joint shall be the spigot engagement +1/2". Interior lining for the spigot shall be continuous to the end. Field replacement of the interior joint linings shall be in accordance with Section 201.4. of these specification for cement-mortar linings. All "O" Ring joints shall be electrically bonded using a #4 bare copper wire, 6" length #15 cadweld cartridge brazed to bare metal at the bell and spigot or equal. Shop applied exterior coatings shall be held back in accordance with manufacturer's specifications. Field replacement of exterior coatings at the joints shall be in accordance with the AWWA C216, Heat Shrinkable Cross-Linked Polyolefin Coatings for the Exterior of Specials, Connections and Fitting, AWWA C209, Cold-Applied Tape Coatings for Special Sections, Connections, and Fittings, for Steel Water Pipelines, or AWWA C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe, 4" and Larger, Shop Applied.

204.2.5 Where steel pipe is to be tapped in the field, a split tapping saddle of 150 psi working pressure shall be used. The saddle body shall be heavy welded ANSI/ASTM A36, or ANSI/ASTM A285, Gr. C steel with flange conforming to ANSI/AWWA C207, Class D. The gasket shall be natural rubber or neoprene design in a continuous ring of suitable cross-section and sized to assure a watertight joint. The interior and exterior surfaces of the saddle body shall be shop coated with a fusion-bonded epoxy. The exterior coating or wrap on steel pipe shall be removed to bare metal beneath the entire area to be covered by the sleeve.

204.2.6 Flanged joints shall conform to the AWWA Standard for Steel Pipe flanges, AWWA C207, Class D.

## 204.3 EXTERIOR COATING

204.3.1 The exterior coating on steel pipe and fittings shall be in accordance with Tape Coating Systems for the Exterior of Water Pipelines, AWWA C214 or cement-mortar coatings in accordance with AWWA C205, Cement-Mortar Protective Lining and Coating For Steel Water Pipe, 4" and Larger, Shop Applied. Where tape coatings are used, the total thickness shall be no less than 80 mils. Where cement-mortar coating is used, the thickness shall be not less than 3/4" and reinforced with spiral-wire, wire-fabric, or ribbon mesh reinforcement in accordance with AWWA C205, Sec. 2.1. All above ground piping shall be cleaned, primed, and painted with enamel, as shown in the plans. The total dry film thickness shall be 6 mils.

204.3.2 If field welding is used, the pipe joints shall be furnished with the outside coating held back, in accordance with standard joint detailed drawings. The coating and any touch up work shall be done under the direction of the coating manufacturer, and as approved by the Engineer.

## 204.4 INTERIOR LINING

204.4.1 The interior lining shall be installed in the field in accordance with AWWA C602, Cement-Mortar Lining of Water Pipelines, 4” and Larger, In Place; or shop applied in accordance with AWWA C205, Cement Mortar Protective Lining and Coating for Steel Water Pipe, 4" and Larger, Shop Applied. The lining shall be 3/8" thick for diameters

through 36", and 1/2" thick for 42" and larger, whether shop or in place lined. Tolerances shall be in accordance with the applicable AWWA standards. Coal-tar enamel and coal tar epoxy interior linings will not be permitted.

204.4.2 Where in place cement-mortar lining is used, the contractor shall furnish all materials, labor, and equipment, prepare the interior surface, and machine place the mortar lining in the pipe. The lining at valves, specials, and bends may be hand sprayed or troweled, or hand applied as required. The lining shall be maintained in a moist condition while curing. The contractor shall be responsible for any extended curing time until acceptance by the Engineer. No additional payment shall be made for any extended curing period.

204.4.3 Where in-place mortar lining is cracked or delaminated from steel cylinder pipe, contractor shall repair broken or delaminated areas with Hilti two-part epoxy or approved equal.

## 204.5 STRUTTING AND BRACING

204.5.1 Strutting and bracing shall be provided on all specials, fittings, and straight pipe, where shop lined or coated with cement mortar, so as to limit the maximum pipe deflection to 2% of inside diameter and to maintain roundness of ±1% during transportation, handling and joining the pipe. Coated pipe shall be handled with wide belt slings or padded forks. Chains, cables, or other equipment likely to cause damage to the pipe or coating shall not be used. The strutting shall remain in place until all compacting and backfilling has been completed.

## PART 205 – CONCRETE PIPE AND FITTINGS

### 205.1 CONCRETE PIPE AND FITTINGS FOR WATER

205.1.1 Where concrete pipe and fittings are specified or required for water, it shall be designed, manufactured, and tested in accordance with the current edition of ANSI/AWWA 301, Prestressed Concrete Pressure Pipe, Steel-Cylinder Type; and the current edition of ANSI/AWWA C304, Design of Prestressed Concrete Cylinder Pipe. All prestressed concrete cylinder pipe (PCCP) shall be manufactured by an established manufacturer who has had at least three years of experience in successfully building this type of pipe. All specials and fittings shall be built to the details furnished by the manufacturer and approved by the Engineer. Each special and each length of straight pipe shall be plainly marked to indicate the head for which the pipe is designed and to indicate where the pipe will be used by reference to the layout drawings. All closure fittings shall be furnished with a 24-inch flanged access manway with a 24-inch steel blind flange. 6-inch screw type hand hole fittings will not be permitted.

205.1.2 All concrete or mortar substrates must be sweep-abrasive grit blasted to create adequate profile then made dust free. All surfaces to be lined must be free of any oil, grease, or other deleterious materials. The surface must be dry to the touch (no standing water) but can have some surface discoloration due to moisture.

205.1.3 PCCP and fittings for water lines shall be designed for the following conditions (minimum): Normal operating pressure equal to 150 psi plus 50% for surge pressure plus earth load resulting from actual backfill depth, but not less than 8 feet plus external live load equal to AASHTO HS 20 loading. The thickness of the mortar coating shall provide a minimum cover of 1 inch over the reinforcing steel.

205.1.4 Prestressed concrete cylinder pipe and fittings for water lines shall be joined according to AWWA C301 and C304, as well as the current edition of AWWA Manual M9, Concrete Pressure Pipe.

205.1.5 Where AWWA C301, PCCP is to be tapped, the tapping saddle shall be fabricated in accordance with the current edition of AWWA Manual M9 and as recommended by manufacturers of Concrete Pressure Pipe. Saddle shall provide grout gaskets and grout opening to enable filling the wall space between saddle and pipe wall with grout, to assure complete protection of the steel pipe wall. The saddle shall also provide gland assembly, including gasket and flange, to insure a tight seal.

205.1.6 Openings of the sizes shown on the drawings shall be furnished with steel blind flanges of proper strength to withstand the working pressure of the line where no other provisions are made for closing the openings. Blind flanges shall be fabricated from material as specified under AWWA C207. All bolts shall be carbon steel ASTM A307, Grade A only, in accordance with AWWA C207.

### 205.2 CONCRETE PIPE AND FITTINGS FOR STORMWATER

205.2.1 Where concrete pipe and fittings are specified or required for stormwater, except as herein modified, they shall be designed, manufactured, and tested in accordance with the current edition of ASTM C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe. Pipe shall be a minimum Class III. Pipe lengths shall be no less than 6 feet except for shorts and specials. Pipe sections connected to a manhole or structure shall be no more than 4 feet in length, as measured from the inside face of the structure to the point of flexure of the joint. Elliptical reinforcement is not allowed. At least three circumferential reinforcing bars shall be provided in each pipe bell equal in area to an equivalent length of outside cage in the pipe barrel. Concrete shall have a minimum 28-day compressive strength of 6,000 psi, and absorption not to exceed 6%. No lifting holes will be allowed on any reinforced concrete pipes or reinforced concrete boxes.

205.2.2 Testing shall be observed and reported by an independent testing laboratory approved by the Engineer. One Three-Edge Bearing Test in accordance with ASTM C497 shall be performed on a representative sample of each diameter and class of pipe to be furnished. One absorption test in accordance with ASTM C497 shall be performed for each 300 tons of pipe manufactured, not less than one test per day's production. Four concrete cylinders or core samples shall be tested for compressive strength from each day’s production, two at seven days and two at 28 days. An in-plant hydrostatic test in accordance with ASTM C361 shall be performed on each section of pipe and each pipe joint at an internal hydrostatic head of 25 feet. The joints shall be tested for a minimum period of one hour under constant pressure as specified. Each pipe unit that satisfactorily passes all hydrostatic testing shall bear the seal of the testing laboratory. This seal does not constitute acceptance of the pipe installation, which will be subjected to further testing and inspection in the field.

205.2.3 In lieu of the in-plant hydrostatic testing of each joint, the Contractor may substitute the following procedure: 1. Perform one in-plant hydrostatic test per days production, in accordance with the previously specified criteria; and 2. Perform an air test on each joint in the field after assembly, in accordance with the City of Tulsa Water and Sewer Department Standard Air Test Procedure. The Contractor shall furnish all air test equipment. Testing and test conclusions shall be verified by the Engineer. The Engineer reserves the right to require additional in-plant hydrostatic testing.

205.2.4 Reinforced concrete pipe and fittings for storm sewer shall be jointed in accordance with the current edition of ASTM C361, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe. Joints shall be concrete bell and spigot, employing a rubber gasket and cement mortar formed by a diaper. Rubber gaskets shall be either a standard O-ring gasket or a Forsheda pre-lubricated gasket, or equal. For the O-ring gasket, the spigot end shall contain a groove to confine and compress the gasket on four surfaces when the joint is in final position. The Forsheda joint shall be designed and installed in accordance with the manufacturer's recommendations.

205.2.5 REINFORCED CONCRETE PIPE AND FITTINGS ARE EXCLUDED FOR SANITARY SEWER.

## PART 206 – VITRIFIED CLAY PIPE AND FITTINGS

206.1 PIPE AND FITTINGS

206.1.1 Where vitrified clay pipe (VCP), fittings and in-line tees are specified or required, they shall conform to the current edition of ASTM C700, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated. Testing shall be in accordance with the current edition of ASTM C301, Standard Test Methods for Vitrified Clay Pipe.

206.1.2 Where vitrified clay pipe is installed, in-line tees for future connections to the sanitary sewer shall be manufactured specifically for vitrified clay pipe.

206.2 JOINTS

206.2.1 Vitrified clay pipe shall be jointed with material conforming to the current edition of ASTM C425, Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings. All jointing materials shall be used in accordance with the manufacturer's instructions and subject to the approval of the Engineer.

206.2.2 Where it is necessary to connect vitrified clay pipe to ductile iron pipe a rigid type adapter shall be used. Only the following adapters will be permitted: Dickey DPB-VC x DI, Dresser Style 39, and Rockwell Omni. Flexible couplings will not be permitted.

## PART 207 – POLYVINYL CHLORIDE (PVC) PIPE, WATER SERVICE

207.1 Where polyvinyl chloride (PVC) pipe 4 inches in diameter through 12 inches in diameter is specified or required for water service, it shall conform to and be tested in accordance with the current edition of ANSI/AWWA C900, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm), as herein modified. Polyvinyl chloride water pipe shall be restricted from use within arterial street right of way.

207.2 PVC pipe shall conform to pressure Class 200 (equivalent to Dimension Ratio 14) and shall have an outside diameter (OD) equal to the OD of equivalent size ductile iron pipe.

207.3 PVC pipe shall have integral wall-thickened bell ends and shall be jointed using one-piece elastomeric gaskets. Solvent cement jointing shall not be permitted.

207.4 Fittings for PVC pipe shall be polyethylene wrapped ductile or cast-iron conforming to Part 203 of these specifications. The use of PVC fittings shall not be permitted.

207.5 Contractor shall submit certifications from the manufacturer that PVC pipe has been manufactured in accordance with AWWA C900, and that it meets the approval of the "NSF".

207.6 Where restrained joints are required, they shall be of a mechanical type assembly easily removed in field once assembled without special equipment. Assemblies shall be ANSI/AWWA rated. Thrust blocks for joint restraint shall not be installed without prior approval by the Director of Water and Sewer. Set screw type retainer glands will not be permitted.

## PART 207A – HIGH DENSITY POLYETHYLENE (HDPE) PIPE, WATER SERVICE

207A.1 Where high density polyethylene (HDPE) pipe 4” through 63” in diameter is specified or required, it shall conform to and be tested in accordance with AWWA C906 "POLYETHYLENE (PE) PRESSURE PIPE AND FITTINGS, 4” THROUGH 63”, FOR WATER DISTRIBUTION AND TRANSMISSION" as herein modified. HDPE water pipe shall be approved by the Underwriters Laboratory Sanitation Foundation Testing Laboratory for potable water pipe. HDPE water pipe shall be restricted from use within arterial street right of way.

207A.2 Polyethylene compounds utilized in the manufacture of products furnished under this specification shall be listed in PPI TR-4, have a grade of PE47 with a minimum cell classification of PE 445574C for PE4710 materials, as defined in ASTM D3350. In conformance with AWWA C906, they shall have a PPI recommended Hydrostatic Design Basis (HDB) of 1600 psi (PE4710) at a temperature of 73.4° F (23° C). The materials shall meet the following nominal physical property requirements:

| PROPERTY | TEST METHOD* | NOMINAL VALVE |
|---|---|---|
| Material Designation | PPI/ASTM | PE4710 |
| Cell Classification | D3350 | 445574C |
| Density, Natural | D1505 | 0.947 gm/cc |
| Density, Black | D1505 | 0.956 gm/cc |
| Melt Index (190° C/2.16 kg) | D1238 | <0.15 gm/10 min |
| Flow Rate (190° C/21.6 kg) | D1238 | 8.5 gm/10 min |
| Tensile Strength @ Ultimate | D638 | 5,000 psi |
| Tensile Strength @ Yield | D638 | 3,500 psi |
| Ultimate Elongation | D638 | >800% |
| Flexural Modulus, 2% Secant | D790 | 110,000 – 160,000 psi |
| Environmental Stress Crack Resistance (ESCR) | | |
| $F_0$, Condition C | D1693 | >10,000 hrs. |
| PENT | F1473 | >500 hrs. |
| Brittleness Temperature | D746 | <-180° F |
| Hardness, Shore D | D2240 | 64 |
| Vicat Softening Temperature | D1525 | 255° F |
| Izod Impact Strength, Notched | D256 | 7 ft-lb/in |
| Modulus of Elasticity (short term) | D638 | 130,000 psi |
| Modulus of Elasticity (long term) | D638 | 32,500 psi |
| Thermal Expansion Coefficient | D696 | $8.0 \times 10^5$ in/in/°F |
| Average Molecular Weight | GPC | 330,000 |
| PPI Hydrostatic Design Basis | D2837 | 1,600 psi @ 73.4° F |
| (As listed in PPI TR-4) | | 1,000 psi @ 140° F |

*Test procedures are ASTM unless otherwise specified. (PPI = Plastics Pipe Institute, and GPC = Gel Permeation Chromatography.)

207A.3 HDPE pipe shall have a Diameter Ratio (DR) of 11, shall be Ductile Iron Pipe Size (DIPS) as indicated in the chart below, and shall be certified for conformance with NSF/ANSI Standard 61. A DR greater than 11 shall not be permitted.

| DIP/PVC Size (in) | HDPE size (in) |
|---|---|
| 6 | 8 DIPS |
| 8 | 12 DIPS |
| 10 | 12 DIPS |
| 12 | 16 DIPS |

207A.4 The Pressure Class of the PE pipe and PE fittings shall be specified on the basis of the Working Pressure Rating of the water system as defined in AWWA C906. Recurring positive pressure surges of up to 1/2 of the pipe's nominal pressure class and occasional pressure surges of up to 100% of the pipe's nominal pressure class may be

ignored due to the fatigue endurance of the polyethylene materials. For PE 4710, the net pressure capability shall be the working pressure rating (WPR) @ 73° F as follows:

| DR | WPR (psi) | WPR + Surge (psi) | Hydrotest (psi) | Nominal 60 sec. Burst (psi) |
|---|---|---|---|---|
| 11.0 | 200 | 300 | 300 | 800 |

207A.5 Polyethylene fittings, including custom fabrication, shall have the same internal pressure rating as the mating pipe. The use of derated fittings shall not be permitted. At the point of fusion, the wall thickness and outside diameter of the fitting shall be in accordance with AWWA C-906 for the same pipe size.

207A.6 All HDPE taps for water service line shall be made with a HDPE fusion tapping saddle Poly-Cam Series 415 or 575 (HDPE) or approved equal.

207A.7 Permanent identification of piping shall be provided by co-extruding multiple (minimum four) equally spaced blue color stripes into the pipe outside surface or by solid blue colored pipe shell. The identification material shall be the same material as the pipe material described herein, except for the blue color. Plain Black HDPE Pipe without color markings may not be used in the City of Tulsa Distribution System.

ASTM, AWWA, NSF and CSA standards require that markings on pipe and tubing be present at frequent intervals – generally not less than every 5’ – and that they include at least the following items of information:

A) The nominal pipe or tubing size (e.g., 1”).

B) The type of PE material from which the pipe is made (e.g., PE 4710).

C) The pipe or tubing dimension ratio or the pipe pressure rating or pressure class for 73° F water, or both.

D) The standard against which the pipe has been made and tested.

E) The manufacturer's name or trademark.

F) Production record coding the place and time of manufacture.

G) The seal or mark of the certification agency that has determined the suitability of the pipe for potable water service.

## PART 208 – POLYVINYL CHLORIDE (PVC) PIPE, SEWER SERVICE

208.1 Where polyvinyl chloride (PVC) pipe 8 inches in diameter through 15 inches in diameter, fittings and inline tees are specified or required for sewer service, it shall conform to and be tested in accordance with the current edition of ASTM D3034, Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings, for standard dimensional ratio (SDR) of 26. Minimum pipe stiffness for all sizes shall be 115 psi.

208.2 Where polyvinyl chloride (PVC) pipe 18 inches in diameter through 48 inches in diameter is specified or required for sewer service it shall conform to and be tested in accordance with ASTM F679, Polyvinyl Chloride (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings Minimum pipe stiffness shall be 115 psi.

208.3 The PVC sewer pipe shall be supplied in 12.5-foot or 20-foot laying lengths as specified.

208.4 Where it is necessary to connect PVC sewer pipe to ductile iron pipe and AWWA C110 long body solid sleeve shall be used with a special gasket for the PVC pipe. Flexible couplings will not be permitted.

208.5 Where PVC sewer pipe is being installed, the fittings for the service line and the in-line tees and risers for future service connections shall be of the same material as the mainline, manufactured and specifically designed for connection to Schedule 40 PVC service lines.

208.6 The manufacturer shall maintain quality control through regularly scheduled testing in accordance with all referenced ASTM standards. Testing for flattening and the pipe stiffness shall be performed on one test specimen for each size and class of pipe produced for the project. Manufacturers shall furnish certifications that the material was manufactured, sampled, tested, and inspected in accordance with all applicable specifications. The certifications shall indicate the manufacturer's production code from which the plant location, machine, and date of manufacture can be identified.

## PART 209 – CASTINGS

209.1 Gray iron castings shall conform to and be tested in accordance with the Standard Specification for Gray Iron Castings ASTM A48 and applicable sections of Drainage Structure Castings, AASHTO M 306, current edition. All castings, including manhole steps, lamphole covers, water meter lids, manhole frames and lids, adjustment rings and valve boxes shall be Class 35B iron.

209.1.1 Iron class shall be determined using only those guidelines outlined in ASTM A48. Tensile specimens shall be obtained using AASHTO M306 Para 9.1.4, Acceptance on the Basis of Test Bars Cust from Portions of Units Supplied to Purchaser. Where samples are too thin and cannot be obtained under ASTM M306 Para 9.1.4, specimens shall be obtained under ASTM M306 Para 9.1.3 Acceptance on the Basis of Cast-on Test Bars. Elapsed time during tensile test shall follow ASTM A48 para 14. Tensile test specimens shall fit the holders of the testing machine in a way such that the load will be axial.

209.1.2 Additionally, castings that are rated for traffic loadings within dedicated public rights-of-way or other locations subject to vehicular traffic must pass an AASHTO proof load test that can maintain a 40,000 lb. proof load for one minute, applied on a 9” x 9” contact area in the center of the casting. The load shall be applied at a constant rate requiring a minimum of 30 seconds to reach the 40,000 lb. level. Following this test, the casting shall be visually inspected for cracks or permanent deformation which will be cause for rejection. Following this, the casting shall be loaded to failure.

209.1.3 Cost for tensile and proof load testing shall be borne by manufacturer, and testing shall be performed at a testing facility acceptable to the Engineer. All tests shall be witnessed by the Engineer.

209.2 Casting dimensions shall vary by not more than ±1/16 in/ft.

209.3 All bearings surfaces shall be machined to prevent rocking and rattling.

209.4 Where sealed manholes are specified, only McGard locking system with 5/8” – 11 thread which is keyed to City of Tulsa standard lock is allowed.

209.5 Only those castings which have been approved by the Department will be permitted. Approval for each casting shall consist of approved shop drawings, plus laboratory test reports of the tensile test and load test.

209.6 City of Tulsa Engineering Services Department, on an annual basis, reserves the right to randomly select any castings for tensile and proof load testing from the foundry’s local representative’s yard. Such testing shall be at manufacturer’s expense.

## PART 210 – CONDUIT

210.1 Where conduit (also known as tunnel liner or pipe sleeve), 6” or larger, is specified or required, it shall be steel pipe, and be in accordance with AWWA C200, 3/8” wall thickness.

Conduit shall be sized according to the following:

| Carrier Pipe | | Conduit, ID |
|---|---|---|
| **Water** | **Sanitary Sewer** | |
| 6” | 6” | 18” |
| 8” | 8” | 20” |
| | 10” | 22” |
| 12” | | 24” |
| | 12” | 26” |
| | 15” | 28” |
| 16” | | 30” |
| | 16” | 32” |
| | 18” | 32” |
| 24” | 24” | 42” |
| 30” | 30” | 48” |
| 36” | 36” | 54” |
| 42” | | 60” |
| | 42” | 62” |
| | 48” | 68” |

## PART 211 – VAULT, PITS, AND MANHOLES

211.1.1 Concrete masonry units shall conform to, and be tested in accordance with the specifications for Concrete Masonry, Hollow Load Bearing Concrete Masonry Units, ANSI/ASTM C90, or Concrete Building Brick C55, Grade A.

211.1.2 Precast manholes shall conform to, and be tested in accordance with, the specifications for Precast Reinforced Concrete Manhole Sections, ANSI/ASTM C478, flat slab top type.

211.1.3 Manhole adjusting ring shall be solid cast iron that fits in the standard City of Tulsa Sanitary Sewer manhole frame and the standard manhole lid fits in the adjusting ring.

211.1.4 Adjusting rings shall conform to and be tested in accordance with the Standard Specification for Gray Iron Castings ASTM A48 and Drainage Structure Castings, AASHTO Designation: M306-89. Castings shall be Class 35-B iron and unpainted.

211.1.5 The contact surface between manhole ring and manhole frame and the contact surface between manhole ring and manhole lid shall be machined smooth to prevent rocking and rattling.

211.1.6 The 2” manhole adjusting ring where specified shall have a minimum weight of 70 pounds and the 3” manhole adjusting ring where specified shall have a minimum weight of 100 pounds.

211.1.7 Markings on all gray iron castings shall conform to AASHTO Designation M306-89. (AASHTO M306-89 states: Each casting shall be identified by the foundry showing): Name of Foundry, Country of manufacturer, ASTM Designation Number, Class by a number followed by a letter indicating the minimum tensile strength and size of test bar. (i.e. Class 35-B), Heat Number and Date. No other wording or marking of any kind other than those stated above or shown on the plan will be permitted on castings.

211.1.8 Epoxy coating shall be required for any manhole receiving or discharging sewer pipe 15 inches in diameter or greater, as described in City of Tulsa Specification Part 217.

211.1.9 Manhole Coating: This section specifies the insitu-coating of new concrete sanitary sewer manholes to provide protection against corrosion to the manhole interior. This section includes requirements for product and contractor qualifications, work, materials, and equipment required for surface preparation, repairs, and application of a monolithic solvent-free epoxy coating to specified surfaces.

211.1.10 Submittals: The following items shall be submitted to Engineer for approval:

A) Technical data sheet and material safety data sheet (MSDS) on each product used, including ASTM test results indicating the product conforms to and is suitable for its intended use per these specifications.

B) Contractor Qualifications:

1) Manufacturer certification that Contractor has been trained and approved in the handling, mixing and application of the products to be used.

2) Certification that the plural component spray equipment to be used for applying the products has been manufactured or approved by the protective coating manufacturer and Contractor's personnel have been trained and certified for proper use of the equipment.

3) Three recent references of Contractor projects of similar size and scope indicating successful application of a high-build solvent-free epoxy coating by plural component spray application in underground concrete structures.

4) Proof of any necessary federal, state, or local permits or licenses necessary for the project.

5) Design details for any additional ancillary systems and equipment to be used in site and surface preparation, application, and testing.

211.1.11 Delivery, Storage, Handling, and Site Conditions:

A) Protective coating materials are to be stored and handled according to their material safety data sheets.

B) Contractor shall conform with all local, state, and federal regulations including those set forth by OSHA, RCRA and the EPA and any other applicable authorities.

211.1.12 Warranty:

Contractor shall warrant all work against defects in materials and workmanship for a period of one year, unless otherwise noted, from the date of final acceptance of the project. Contractor shall, within a reasonable time after receipt of written notice thereof, repair defects in materials or workmanship which may develop during said one year period, and any damage to other work caused by such defects or the repairing of same, at his own expense and without cost to the Authority.

211.1.13 Existing Products:

Standard Portland cement or new concrete (not quick setting high strength cement) must be well cured prior to application of the protective coating. Minimum of 28 days cure time.

211.1.14 Manufacturer:

Raven Lining Systems, Inc., Tulsa, Oklahoma 800.324.2810, 918.584.2810, or Fax 918.582.4311, or equal.

211.1.15 Repair Materials:

Repair materials shall be used to fill voids, structurally reinforce, and/or rebuild surfaces, etc. as determined necessary by the Authority and protective coating Contractor. Repair materials must be compatible with the specified epoxy coating and shall be applied in accordance with the manufacturer's recommendations.

211.1.16 Protective Coating Material:

Raven Lining Systems' Raven 405 epoxy coating system, or equal.

| | |
|---|---|
| Product Type | Amine cured epoxy |
| Color | Light Blue |
| Solids Content (vol %) | 100 |
| Mix Ratio | 3:1 |
| Compressive Strength, psi | 18,000 |
| Tensile Strength, psi | 7,600 |
| Flexural Modulus, psi | 600,000 |
| Hardness, Type D | 88 |
| Bond Strength – Concrete | >Tensile Strength of |
| Concrete | |
| Chemical Resistance to: | |
| Sulfuric Acid, 10% | Immersion Service |
| Sodium Hydroxide, 20% | Immersion Service |
| Municipal Wastewater | Successful pass L.A. |
| County | Sanitation District Coating Evaluation |

211.1.17 Surface Preparation:

A) Contractor shall inspect all surfaces specified to receive a protective coating prior to surface preparation. Contractor shall notify Engineer of any noticeable disparity in the surfaces which may interfere with the proper preparation or application of the repair mortar and protective coating.

B) All contaminants including oils, grease, incompatible existing coatings, waxes, form release, curing compounds, efflorescence, sealers, salts, or other contaminants shall be removed.

C) All concrete or mortar that is not sound or has been damaged by chemical exposure shall be removed to a sound concrete surface or replaced.

D) Surfaces to receive protective coating shall be cleaned and abraded to produce a sound surface with adequate profile and porosity to provide a strong bond between the protective coating and the substrate. Contractor shall utilize high pressure water cleaning equipment capable of 5,000 psi at 4 gpm.

E) Infiltration shall be stopped by using a material which is compatible with the specified repair mortar and is suitable for top coating with the specified epoxy protective coating.

211.1.18 Application of Repair Materials:

A) Repair materials shall meet the specifications herein. If using approved cementitious repair materials, such shall be troweled to provide a smooth surface with an average profile equivalent to coarse sandpaper to optimally receive the protective coating. No bugholes or honeycomb surfaces should remain after the final trowel procedure of the repair mortar. The repair materials shall be permitted to cure according to manufacturer recommendations.

B) After leak repair is performed, all surfaces shall be inspected for remaining laitance prior to protective coating application. Any evidence of remaining contamination or laitance shall be removed. If repair materials are used, refer to these specifications for surface preparation. Areas to be coated must also be prepared in accordance with these specifications after receiving a cementitious repair mortar and prior to application of the epoxy coating.

211.1.19 Application of Protective Coating:

A) application procedures shall conform to the recommendations of the protective coating manufacturer, including material handling, mixing, environmental controls during application, safety, and spray equipment.

B) The protective coating material must be spray applied with protective coating manufacturer approved heated plural component spray equipment by a Certified Contractor of the protective coating manufacturer.

C) Specified surfaces shall be coated by spray application of a moisture tolerant, solvent-free, 100% solids, epoxy protective coating as further described herein. Spray application shall be to a minimum wet film thickness of 80 mils.

D) If necessary, subsequent top coating or additional coats of the protective coating should occur as soon as the basecoat becomes tack free, ideally within 12 hours but no later than the recoat window for the specified products. Additional surface preparation procedures will be required if this recoat window is exceeded.

211.1.20 Testing and Inspecting:

A) All manholes shall be vacuum tested after installation and prior to protective coating preparation and application.

B) During application a wet film thickness gage, such as those available through Paul N. Gardner Company, Inc. meeting ASTM D4414 – Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used to ensure a monolithic coating and uniform thickness during application. A log shall be submitted to Authority by Contractor that includes wet film thickness testing and protective coating material usage per manhole structure. This log is to

be kept and certified by Contractor that material usage and WFT indicates proper coverage at a minimum of 80 mils per these specifications.

C) After the protective coating has set hard to the touch it shall be inspected by Authority with high-voltage holiday detection equipment. Surface shall first be dried; an induced holiday shall then be made on to the coated concrete surface and shall serve to determine the minimum/maximum voltage to be used to test the coating for holidays at that particular area. The spark tester shall be initially set at 8,000 volts (100 volts per 1 mil of film thickness applied) but may be adjusted as necessary to detect the induced holiday (refer to NACE RPO188-99). All detected holidays shall be marked and repaired by abrading the coating surface with grit disk paper or other hand tooling method. After abrading and cleaning, additional protective coating material can be hand applied to the repair area. Large areas may require additional surface preparation and spray application to achieve minimum thickness. All touch-up/repair procedures shall follow the protective coating manufacturer's recommendations.

D) At the Engineer’s option, select structures may be subjected to adhesion testing and destructive testing for measurement of film thickness at no additional cost. Measurement of adhesion of the protective coating to the substrate can be made in accordance with ASTM D4541. Measurement of film thickness can be made from the dollies pulled during adhesion testing. Any areas detected to have inadequate adhesion shall be evaluated by the Engineer. Further tests may be performed to determine the extent of potentially deficient bonded area and repairs shall be made by Contractor in strict accordance with manufacturer's recommendations.

E) A final visual inspection shall be made by the Authority and Contractor. Any deficiencies in the finished coating shall be marked and repaired by Contractor according to the procedures set forth herein.

## PART 212 – SAND FOR CUSHION OR BACKFILL

212.1.1 Sand shall be graded from fine to coarse, free from objectionable material, and contain not more than 10% clay or loam by weight. One hundred percent shall pass a 3/4" screen, and 95% shall pass a number four screen.

## PART 213 – CRUSHED STONE FOR SURFACING, BASE COURSE, AND STABILIZATION

213.1 Crushed stone shall consist of clean, tough, durable fragments, free from an excess of soft or disintegrated particles. Sampling shall be in accordance with the Standard Method of Sampling Aggregates, ANSI/ASTM D75. Sieve analysis shall be performed in accordance with the method of Sieve Analysis, ANSI/ASTM CI36. Gradation to be used at each location will be specified by the Engineer. Crushed stone for aggregate base and surface course shall conform to the Oklahoma Department of Transportation Specifications for Highway Construction, and shall conform to the following gradations:

213.2 Percent Passing:

| Sieve Size | Type A | Type B |
|---|---|---|
| 3” | - | 100 |
| 1-1/2” | 100 | 40 – 100 |
| 3/4" | 40 – 100 | 30 – 75 |
| 3/8” | 30 – 75 | 25 – 60 |
| No. 4 | 25 – 60 | 20 – 50 |
| No. 10 | 20 – 43 | 15 – 35 |
| No. 40 | 8 – 26 | 7 – 22 |

213.2.1 Crushed stone aggregate for stabilization and bedding shall conform to the following ASTM D448 and C33 gradations:

213.2.2 Percent Passing:

| | Size # 1 | Size #467 | Size #57 | Size #67 | Size #7 |
|---|---|---|---|---|---|
| **Sieve Size** | 3 1/2” to 1-1/2” | 1-1/2” to No. 4 | 1” to No. 4 | 3/4” to No. 4 | 1/2” to No. 4 |
| 4” | 100 | - | - | - | - |
| 3-1/2” | 50 – 100 | - | - | - | - |
| 2-1/2” | 25 – 60 | - | - | - | - |
| 2” | - | 10 | - | - | - |
| 1-1/2” | 0 – 15 | 95 – 100 | 100 | - | - |
| 1” | - | - | 95 – 100 | 100 | - |
| 3/4" | 0 – 5 | 35 – 70 | - | 90 – 100 | 100 |
| 1/2" | - | - | 25 – 60 | - | 90 – 100 |
| 3/8” | - | 10 – 30 | - | 20 – 55 | 40 – 70 |
| No. 4 | - | 0 – 5 | 0 – 10 | 0 – 10 | 0 – 15 |

## PART 214 – RIPRAP

214.1 All riprap designs and installations shall comply with the more stringent requirements of the following:

A) The most current ODOT Standard Specifications which have also been adopted by the City of Tulsa.

B) The most current edition of the City of Tulsa Stormwater Management Criteria Manual.

214.2 ODOT Type IV Grouted Riprap is not allowed within the City of Tulsa unless specifically approved by the City Engineer.

## PART 215 – CORRUGATED POLYPROPYLENE PIPE AND FITTINGS FOR STORMWATER

215.1 Where corrugated polypropylene (PP) pipe 15 inches in diameter through 60 inches in diameter are specified or required for storm sewer service, it shall conform to and be tested in accordance with the current edition of ASTM F2881/F2881M, Standard Specification for 12 to 60 in. [300 to 1500 mm] Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications, and the current edition of AASHTO M330, Standard Specification for Polypropylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter. Minimum cover shall be 2 feet. Pipe sizes of less than 15 inches are not allowed in closed public or private storm sewer systems.

215.1.1 If flowable fill is to be used for backfill in lieu of ODOT Type "A" Aggregate base, a pipe anchoring system must be utilized during installation. The anchoring system must be approved by the pipe manufacturer and the Engineer prior to use.

215.2 The PP sewer pipe shall be supplied in 13-foot or 20-foot laying lengths as specified.

215.3 PP pipes shall be joined with a gasketed integral bell and spigot joint meeting the requirements of ASTM F2881, for their respective diameters. Joints shall be watertight according to the requirements of the current edition of ASTM D3212, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals. Spigots shall have gaskets meeting the requirements of the current edition of ASTM F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe. Gaskets shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. Contractor shall use a joint lubricant, as recommended by the pipe manufacturer, on the gasket and bell during joint assembly.

215.3.1 Connections shall be watertight and conform to the current edition of ASTM C923/C923M, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals; and the current edition of ASTM F2510/F2510M, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures and Corrugated Dual-and Triple-Wall Polyethylene and Polypropylene Pipes.

215.4 Fittings shall conform to ASTM F2881 for the respective diameters.

215.5 Field testing of joints as directed by the Engineer, shall be in accordance with the current edition of ASTM F2487, Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Corrugated High-Density Polyethylene and Polypropylene Pipelines, or the current edition of ASTM F1417, Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-pressure Air.

215.6 Installation shall be in accordance with the current edition of ASTM D2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications, and current City of Tulsa standards.

215.7 The manufacturer shall maintain quality control through regularly scheduled testing in accordance with all referenced ASTM standards. Certifications shall be furnished that the material was manufactured, sampled, tested, and inspected in accordance with all applicable specifications. The certifications shall indicate the manufacturer's production code, from which plant location, machine and date of manufacture can be identified.

**SECTION END**

# DIVISION III

# CONSTRUCTION SPECIFICATIONS

## PART 301 – RIGHT-OF-WAY CLEARING AND RESTORING

301.1 Work under this item shall include the removal and reconstruction or replacement of all obstructions affected by the construction of the project, including, but not limited to fences, retaining walls, patios, trash burners, signs, mailboxes, out-buildings, landscaping, etc. Any such obstructions that are not to be reconstructed are so designated on the drawings. Such shall be removed and disposed of by the contractor. All obstructions to be replaced or reconstructed shall be restored to substantially the same condition as existed prior to the construction except as otherwise noted. The Contractor shall remove and dispose of all debris, restore the grade of the surface of the earth as reasonably as may be done to the grade existing prior to construction, and upon completion of the work shall leave the site in as neat, clean, and orderly condition as nearly as it was prior to construction as may be reasonably done. Contractor shall document by photographing all concrete and asphalt driveway crossings and marking the location by street address on each photo. Photographs shall be filed with Engineering Services Department prior to commencing work. All costs of photography shall be included in Bid Item 301a, Right-of-Way clearing and restoring.

301.2 Passable surfaces across or along the construction vicinity shall be maintained at all times with gravel, steel mat or plate, or temporary bituminous surfacing material where a sidewalk, driveway, parking lot, street, or alley previously existed. Pavement damaged by the Contractor's equipment shall be replaced to original condition. Gravel surfaces shall be replaced with the same. Sodded surfaces shall be maintained in a neat and orderly fashion during construction. This shall include mowing within the Right-of-way, if directed during construction.

301.3 If an obstruction is of public ownership, the Contractor shall notify the appropriate agency, and obtain any necessary permit or license 48 hours before beginning any operations affecting the obstruction. All work shall conform to the current standards and specifications of that agency and shall be approved by the agency before completion of the project. At the Contractor's request, the Engineer will furnish information as to what licenses or permits are required.

301.4 Payment: Payment for this item shall be made at the unit price bid per square yard. The contractor shall restore all disturbed areas to a condition equal to or better than the existing improvements. Limits of disturbance shall not exceed 9’ centered on the waterline (4-1/2’ either side of the centerline). Any disturbances outside this area shall be restored at the contractor’s expense. Bores, fittings, streets, driveways, or specials shall be paid under other items of work. No additional payment shall be made for alterations of utility mains, service lines, or appurtenances, unless specifically provided for elsewhere in the Contract Documents.

## PART 302 – EXCAVATION AND BACKFILL, UNCLASSIFIED

302.1 The work under this item shall include all earth, shale, gravel, loose rock, solid rock, debris, junk, and/or other material excavated or otherwise removed in the preparation of the trench; all work in connection with the excavation, removal and subsequent handling and disposal of such material, regardless of its type, character, or condition; subgrade preparation, all sheeting, piling, shoring, bracing, and dewatering of trenches; protection of adjacent property; backfilling; sand cushion; grade base stabilization; all specified backfill consolidation; and other work necessary or required.

302.2 The trench shall be excavated so that the pipe can be laid to the alignment and grades shown on the drawings, or as directed by the Inspector. In dense or built-up areas or where unstable soils exist, the trench shall be excavated a maximum of 100’ in advance of pipe laying. In open areas or where soil conditions permit, the trench excavation may be unlimited in advance of pipe laying, as approved by the Engineer. Opening of trenches in excess of the maximum requires specific approval of the Engineer. Trenches shall be dry when the trench bottom is prepared. The trench bottom shall be shaped so that even bearing is obtained for the barrel of the pipe with the bells unsupported. The standard trench width as shown on the attached Standard Detail, shall not be exceeded at any elevation below a point 12” above the top of the pipe. If for any reason this portion of the trench exceeds the permitted width and if the Inspector shall determine that cradling or encasement then is required, said concrete cradle or encasement shall be installed. Any part of the bottom of the trench excavated more than 4” below the specified grade shall be corrected with approved material thoroughly compacted as directed by the Inspector. In the event suitable material is not available, sand shall be used. When rock is encountered and concrete cradle is required, it shall be excavated 4” below the bottom of the pipe and the trench refilled to grade with sand. When quicksand or other unstable earth is encountered, the Contractor shall excavate to sufficient depth to permit backfilling with Class “A” crushed stone in order to provide a stable base for the pipe. Trench safety shall be in accordance with applicable OSHA, State, and local regulations.

302.3 Bedding of pipe shall be as shown on the attached Standard Details. Unless otherwise shown, bedding shall be placed in the trench simultaneously on both sides of the pipe to a minimum elevation of 4” above the top of the pipe, being carefully worked and hand-tamped around the pipe in order to consolidate and assure excellent bedding. Backfill material shall not be placed in the trench covering the bedding cushion without prior approval of the Inspector. To prevent damage to the pipe, do not use compaction equipment within 18 vertical inches directly over the top of the pipe.

302.4 For large diameter (18" and above) flexible water pipe, bedding shall be in accordance with the Bedding Detail for Large Diameter Flexible Pipe. The pipe shall be bedded in soil-cement, installed over a 6” sand cushion. The bedding shall be installed to the top of the pipe for the full width of the excavated trench. The soil-cement shall consist of a mixture of sand, portland cement, and water. Each cubic yard of soil cement shall contain 1-1/2 sacks of cement and approximately 70 gallons of water. Precautions shall be taken to prevent flotation. Movable trench supports shall not extend lower than the top of the pipe.

302.5 When the type of backfill material is not indicated on the Drawings or specified, the backfill may be made with the excavated material, provided that such material, in the opinion of the Inspector is suitable for backfilling. In the event that excavated material is not suitable, sand or other approved material shall be used. From 6" above the pipe to 18" above the pipe, the trench shall be backfilled by hand or by mechanical methods approved by the Inspector. Special care shall be used in placing this portion of the backfill to avoid damaging or moving the pipe. The remainder of the trench may be backfilled by mechanical methods. Backfilling operation shall be completed within 100' or less of the finished line at all times, as directed by the Inspector.

302.6 Unless otherwise directed by the Engineer, all trenches excavated across any sidewalk, driveway, parking lot or other paved area, across any traveled portion of unpaved streets or alleys, across any proposed roadways or proposed roadway fills, and as shown on the drawings shall be bedded and backfilled with 1-1/2" Type A Aggregate Base (see 213.2), placed in 8" maximum lifts and compacted to 95% Standard Proctor Density, as measured by the Nuclear Density Method. Compaction shall be done by a vibratory hand tamper. Trenches excavated across existing street or alley paving shall be backfilled in accordance with the standard detail for Pavement Removal and Replacement. For excavations where there is more than 6' of cover over the top of the pipe and where the trench width is sufficient for use of heavy compaction equipment, an engineered fill using a suitable compactable material may be used in lieu of aggregate base, if approved in writing by the Director of Engineering Services Department. If the backfilling has been completed and the backfill material does not meet the requirements for compaction, all the material shall be removed and hauled from the job site and the trenches refilled with material as specified above. Failure of backfill shall be corrected immediately, as directed by the Engineer.

302.7 Payments: Payment for this item shall be made at the unit price bid per cubic yard. Volume will be computed as follows: standard trench width as listed in Standard Detail No. 315; length of line, as the actual horizontal measurement along the centerline of the ditch; depth of excavation as the actual depth of ditch from the original ground surface to the flow line of the pipe as shown in the construction notes. Average end-area method of computing volume will be used. No payment for excavation will be made for material excavated outside the neat lines of the standard trench width. No additional payment will be made for: sand cushion; backfilling; compaction of backfill; crushed stone used for backfill under existing and/or proposed roadways, roadway fills, streets, alleys, driveways, sidewalks, parking lots, or as shown on the Drawings; removing and replacing top soils and obstruction, tunneling of trees, storm sewers or other obstructions; blasting; bracing and shoring; dewatering; pumping and draining; grade base stabilization; removal of excess excavated material; or restoration of the site. It is mutually understood that subterranean water, quicksand, or other unstable earth may be encountered, and the Contractor has taken such into consideration in making this bid. Where such is encountered, Contractor will be required to excavate to sufficient depth to permit backfilling with crushed stone in order to provide a stable base for the pipe. Extra payment will not be made because of such additional excavation or because it is necessary to excavate wider than the standard trench width; or for crushed stone.

## PART 303 – MOBILIZATION/DEMOBILIZATION

303.1 Mobilization/Demobilization shall be bid as Each and THE AMOUNT BID SHALL NOT EXCEED 10% OF THE SUM OF ALL BID ITEM EXTENSIONS EXCLUDING MOBILIZATION/DEMOBILIZATION. This work shall consist of the performance of construction preparatory operations, including the movement of personnel and equipment to the project site and for the establishment of the Contractor's offices, buildings, and other facilities necessary to begin work on a substantial phase of the Contract. The Engineer's field office and laboratory is a separate pay item and is not included in this work.

303.2 PAYMENT

303.2.1 Payment shall be full compensation for performing the work specified and the furnishing of all materials, labor, tools, equipment, and incidentals necessary to mobilize and subsequently demobilize the construction preparatory operations.

303.2.2 Payment for this item will be made in two installments unless the first estimate submitted is also the final estimate, in which case the total will be paid. The first payment of 50% of the lump sum Contract price will be included in the pay estimate which reflects 50% completion of the work.

An additional 15% of the price bid for mobilization/demobilization may be included in the pay estimate which reflects 50% completion of the work.

303.2.3 The final 25% (35% – 50%) of the price bid for mobilization/demobilization may be included on the final pay estimate. No additional payment will be made for demobilization.

## PART 304 – CONTRACTOR CONSTRUCTION STAKING

304.1 This work shall consist of furnishing, placing, and maintaining construction layout stakes necessary for the proper prosecution and inspection of the work under the contract.

304.1.1 Contractor shall exercise care in the preservation of stakes and benchmarks and have them reset when they are damaged, lost, displaced, or removed. Contractor shall use licensed land surveyor in the State of Oklahoma and suitable equipment for the layout work required.

304.1.2 Contractor shall set all additional stakes needed, such as offset stakes, reference point stakes, slope stakes, pavement, curb line and grade stakes, stakes for bridges, sewers, roadway drainage, pipe underdrains, paved gutter, fence, culverts, or other structures – and any other horizontal or vertical controls necessary to secure a correct layout of the work. Stake centerline/control line of temporary features, such as shoo-fly detours. Contractor shall make stakes for line and grade adequate to maintain the specified tolerances for the operation being performed and satisfactorily to Engineer. Mark the station number and the distance from the centerline of construction on all grade stakes.

304.1.3 Contractor shall furnish platforms and equipment necessary for proper and safe access for checking the staking, and when significant errors occur, resurvey to satisfaction of the Engineer.

304.1.4 Contractor shall notify Engineer immediately of plan errors. Special surveys necessary to determine corrective action shall be responsibility of Engineer.

304.2 PAYMENT

304.2.1 Payment shall be by Each for Contractor Construction Staking, and shall be full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified, including profile measurements of connecting features.

304.2.2 Payment for this item of work shall be on the following schedule:

25% on the first payment estimate.
25% when 10% of the contract work is complete.
25% when 50% of the contract work is complete.
20% when 75% of the contract work is complete.
5% when all construction features have been verified as properly placed and complete.

## PART 305 – PIPE, VITRIFIED CLAY

305.1 The work under this item shall include furnishing, delivery, and placing and jointing of vitrified clay pipe (VCP) in the trench in specific conformity with the line and levels given.

305.2 The pipe shall be laid on a firm trench bottom, true to the lines and grades shown on the Drawings and/or as given in the field by the Inspector. Pipe shall be protected during handling against impact shocks and free fall. The laying of pipe in finished trenches shall be commenced at the lowest point, with the spigot ends pointing in the direction of flow. Pipe shall be laid continuously through new manholes if both inlet and outlet pipes are of the same size and in line. Upon completion of the manhole the invert shall be shaped. The ends of adjoining pipes shall butt against each other for their entire circumference in such a manner that there is no shoulder or unevenness of any kind. If Contractor uses batter boards instead of laser level, a top line shall be maintained over a span of three grade stakes when laying pipe. As each batter board is erected, the top line shall be sighted to assure the accuracy of the grade stakes and the batter boards' settings. Any errors, discrepancies, or displacement of grade stakes shall be called to the attention of the Inspector for correction.

305.3 Prior to making pipe joints, all surfaces of the portion of the pipe to be jointed shall be cleaned and dried. Jointing shall be done in strict accordance with the manufacturer's recommended procedure. Trenches shall be kept water-free during jointing and for a sufficient period thereafter to allow the joint to become fully set and completely resistant to water penetration. There shall be no realignment of the pipe after the joint is completed unless the pipe is removed and a completely new joint constructed.

305.4 Double joints of 8” pipe may be prepared and laid, provided the double joints are prepared by jointing the pipe in a vertical position using a straight edge inside the pipe to align the joint. Double joints shall not be placed in a horizontal position prior to laying unless suitably supported in racks. Double joints of pipe shall be supported at the middle joint, as well as the ends, when the pipes are lowered into the trench.

305.5 Payment: Payment for this item shall be made at the unit price bid per linear foot of the pipe specified in the Proposal and placed as shown on the Drawings. Total footage shall be the actual horizontal measurement along the centerline of the pipe. No additional payment shall be made for vertical pipe or fittings used with drop manholes.

## PART 306 – PIPE, REINFORCED CONCRETE

306.1 The work under this item shall include furnishing, delivery, placing and jointing of reinforced concrete pipe (RCP) in the trench in specific conformity with the lines and levels given.

306.2 For water and storm sewer lines, the Reinforced Concrete Pressure Pipe, Steel Cylinder Type, AWWA C300, shall govern the installation as applicable. The method of bedding shall be as shown on the attached Standard Bedding Detail. Bedding for pretensioned concrete pipe shall be in accordance with Standard Bedding Detail for Pretensioned Concrete Pressure Pipe. The Drawings show the plan and grade for the pipeline. The Contractor shall submit detailed drawings to the Engineer for approval, showing the proposed method of laying the pipe to these grades. All pipelines to be crossed shall be located by the Contractor before these drawings are prepared. The ends of the pipes to be jointed shall be cleaned immediately prior to jointing and the rubber gasket thoroughly lubricated with vegetable soap before it is placed in position on the spigot end. Extreme care shall be taken in moving the spigot end of the pipe into the bell end of previously laid pipe. If the gasket is damaged or moved out of place, the new pipe shall be removed, and a new gasket applied before rejoining. Any soap remaining on the exposed concrete surfaces inside or outside the pipe shall be completely removed. Fittings or specials included as pipe shall be blocked in accordance with the attached Standard Detail.

306.3 For storm sewers, the methods of laying pipe, foundation, and grade specified under Pipe, Vitrified Clay, shall apply. All pipe shall be installed with the mark "C-76" visible on the top of the pipe. The ends of the pipes to be jointed shall be cleaned immediately prior to joining and the rubber gasket. Extreme care shall be taken in moving the spigot end of the pipe into the bell end of previously laid pipe. If the gasket is damaged or moved out of place, the new pipe shall be removed, and a new gasket applied before rejoining.

306.4 For all lines, after the pipe has been jointed, a band at least 5-1/2” wide shall be placed around the outside of the pipe at the joint. This band shall serve as a form for placing 1:1 cement mortar grout in the external recess formed by the face of the groove and the shoulder of the tongue. If a reinforced paper joint band is used, it shall be drawn up tight around the pipe and the backfill tamped against it up to the spring line before pouring the grout. If a cloth band is used, it shall be wired around the outside of the pipe, and the grout poured before backfilling. On all pipes, the joint space remaining on the inside of the pipe shall be filled with a stiff mixture of 1:1 cement mortar which shall be troweled in place to produce a continuous, smooth, flush surface across the joint.

306.5 Payment: Payment for this item shall be made at the unit price bid per lineal foot of pipe of the type specified in the Proposal and placed as shown on the Drawings. Total footage shall be the actual horizontal measurement along the centerline of the pipe. No additional payment shall be made for vertical pipe or fittings used with drop manholes, for fittings or specials included as pipe, or for concrete blocking or interior coatings.

## PART 307 – PIPE, DUCTILE IRON

307.1 The work under this item shall include furnishing, delivery, placing, and jointing of Ductile Iron pipe in the trench in specific conformity with the lines and levels given. All Ductile Iron pipe shall be wrapped with a loose fitting, slip-on polyethylene film. The polyethylene film shall be slipped over the end of the pipe length that has been raised above the ground at the trench side. After the joint on the pipe is made up, the 1' length shall be slipped over the joint to form an over-or-under lap of the adjacent polyethylene tube at this point. The loosely fitting film shall then be neatly folded over the top of the joint and held in place with tape. The loosely fitting tube extending along the pipe shall be drawn up snugly and folded along the top and held in place by using short pieces of plastic tape at intervals not to exceed 4'. Fittings, valves, and corporation stops shall be wrapped with a section of polyethylene material split to form a flat sheet, using plastic tape to hold the material around the appurtenance. For all pipe, the American National Standard for Installation of Gray and Ductile Cast-Iron Water Mains and Appurtenances, AWWA C600 shall govern the installation as applicable. The method of bedding shall be as shown on the attached Standard Detail for Thrust Blocks and Trench Conditions, and Standard Detail for Pavement Removal and Replacements as applicable.

307.2 For water lines, all angled fittings, or specials included as pipe shall be restrained or blocked in accordance with the attached Standard Detail, the size to be determined by the Engineer.

307.3 Detectable Mylar marking tape for location of DIP water pipe shall be required. Detectable Mylar marking tape shall be 2" wide, blue in color with a continuous black lettered imprint stating, "Caution: Water Line Below". Tape shall be equal to Lineguard Tape III as manufactured by Lineguard, Inc. of Wheaton, Illinois.

307.4 Detectable Mylar tape shall be buried above DIP water lines at a depth of 10" below the surface.

307.5 Payment: Payment for this item shall be made at the unit price bid per linear foot of pipe of the type specified in the Proposal and placed as shown on the Drawings. Total footage shall be the actual horizontal measurement along the centerline of the pipe. No additional payment shall be made for vertical pipe or fittings used with drop manholes, for fittings or specials included as pipe, interior coatings, or for concrete blocking. Payment for any ductile iron pipe designated "restrained joint" shall include cost of all components necessary to restrain joints of pipe.

## PART 308 – PIPE, STEEL

308.1 The work under this item shall include furnishing, delivery, placing, and jointing of steel pipe in the trench in specific conformity with the lines and levels given. For all lines, American National Standard for Installation of Gray and Ductile Cast-Iron Water Mains and Appurtenances, AWWA C200 shall govern the installation, as applicable. The method of bedding shall be as shown on the attached Standard Bedding Detail for Steel Pipe. The Drawings show the plan and grade for the pipeline. The Contractor shall submit detailed drawings to the Engineer for approval, showing his proposed method of laying the pipe to these grades. All pipelines to be crossed shall be located before these drawings are prepared. Fittings or specials included as pipe shall be blocked in accordance with the attached Standard Detail for Thrust Blocks and Trench Conditions.

308.2 If joints are field-welded, they shall develop the full strength of the pipe. The Contractor shall file with the Engineer a description of the method of welding which he proposes to use, the name of the individual or company who will do the welding, and a statement regarding the previous experience of such individual or company in this particular line of work. Testing shall be in accordance with Section 3.3 of AWWA C206. If requested, coupons shall be cut across the field welds and tested by a testing company approved by the Engineer and at the contractor's expense. The line may be welded continuously with provisions for slack in the line, or in sections to be lowered in the trench and connected by a position weld.

308.3 If joints are to be mechanically coupled, sections up to 240' may be coupled and lowered carefully into the ditch. Electrical continuity shall be provided at all joints. Preparation for, protection of, and repair of pipe coating and lining, and coating of mechanical couplings shall conform to the applicable section of these specifications.

308.4 Field replacement of the cement-mortar interior lining shall be in accordance with the AWWA Standard for Cement-Mortar Lining of Water Pipelines, 4" and Larger, In Place, AWWA C602.

308.5 Payment: Payment for this item shall be made at the unit price bid per linear foot of pipe of the type specified in the Proposal and placed as shown on the drawings. Total footage shall be the actual horizontal measurement along the centerline of the pipe. No additional payment shall be made for vertical pipe or fittings used with drop manholes, for fittings or specials included as pipe, or for concrete blocking. Payment for any steel pipe designated "restrained joint" shall include cost of all components to restrain joints of pipe.

## PART 309A – HIGH DENSITY POLYETHYLENE (HDPE) PIPE, WATER SERVICE

309A.1 When HDPE pipe is delivered to the jobsite it shall not be exposed to sunlight for more than three weeks. HDPE pipe exposed to sunlight for more than three weeks shall be covered with an opaque protective covering. The pipe shall be left stacked and no more pipe than can be installed in one day shall be strung along the jobsite.

309A.2 Pipe and fittings shall be joined by one of the following types of thermal fusion per the Manufacturer's recommended procedures: Butt fusion, Saddle fusion or Socket Fusion. Butt fusions performed between pipe ends or pipe ends and fitting outlets shall be within the following allowable wall mismatches:

309A.2.1 Two DR difference between pipe and fitting diameters 6" and smaller.

309A.2.2 One DR difference for above a 6" and through 18".

309A.2.3 No difference for diameters above 18".

The difference in DR is determined from the following DR values: 7.3, 9, and 11.

309A.3 Polyethylene pipe and fittings may be joined together or to other materials through the use of electrofusion fittings, flange adapters with back-up rings, mechanical couplings designed for connecting polyethylene pipe and fittings to itself or to another material, or MJ adapters. The Manufacturer of the joining device shall be consulted for proper installation procedures.

309A.4 Polyethylene pipe and fittings joined together through the use of a hydraulically operated heat butt fusion machine, shall utilize data recording device per ASTM F3124 – STANDARD PRACTICE FOR DATA RECORDING THE PROCEDURE USED TO PRODUCE HEAT BUTT FUSION JOINTS IN PLASTIC PIPING SYSTEMS OR FITTINGS. Each HDPE joint shall be traceable to the fusion operator and equipment. Electrofusion reports of each weld shall be appropriately identified and provided to City of Tulsa Inspector. The reports shall include, as a minimum, the fusion date, time, ambient temperature, fitting type and size, user ID, and the manufacturer of the part.

309A.5 The contractor shall be responsible for ensuring all personnel operating heat fusion equipment are qualified Heat Fusion Equipment Operators in accordance with ASTM F3190-16 – STANDARD PRACTICE FOR HEAT FUSION EQUIPMENT (HFE) OPERATOR QUALIFICATION ON POLYETHYLENE (PE) AND POLYAMIDE (PA) PIPE AND FITTINGS. All polyethylene joints shall be thermally butt fused by an HFE Operator. The HFE Operators Card shall be submitted at the Pre-Construction Conference and provided at the request of the Engineer. Certification by a distributor shall not be an acceptable substitute.

309A.6 Payment: Payment for this item shall be made at the unit price bid per linear foot of pipe of the type specified in the Proposal and placed as shown on the Drawings. Total footage shall be the actual horizontal measurement along the centerline of the pipe. No additional payment shall be made for vertical pipe or fittings or specials included as

pipe, or for concrete blocking. Payment for any HDPE pipe designated “restrained joint” shall include cost of all components to restrain joints of pipe.

## PART 310A – LOCATOR WIRE AND DETECTABLE MARKING TAPE

310A.1 A Number 8 bare copper conductor wire or Number 12 copper-clad steel (CCS) wire, 21% conductivity, for the purpose of locating **HDPE** water pipe shall be buried along the top of the pipe and connected at each end to a fire hydrant by Cadweld Brazing just above the ground.

310A.2 Detectable Mylar marking tape for location of **HDPE water pipe shall be required in areas where HDPE water pipe is buried**. Detectable Mylar marking tape shall be 2” wide, blue in color with a continuous black lettered imprint stating "Caution: Water Line Below". Tape shall be equal to Lineguard Tape III as manufactured by Lineguard, Inc. of Wheaton, Illinois.

310A.3 Detectable Mylar Tape shall be buried above **HDPE** water lines at a depth of **18”** below the surface.

310A.4 Payment for tape and wire shall be included with unit price payment for **HDPE** pipe.

## PART 311A – TAPPING OF HDPE PIPE FOR SERVICE CONNECTIONS

311A.1 Standard water service connections shall be made by using side fusion or electro fusion saddles per standard drawings. The saddles shall be provided with factory installed female threaded insert Brass Alloy C350 AWWA C 800 for standard corporation stop threads. Bushings must match the corporation stops. Direct tapping of HDPE water pipe will not be allowed.

## PART 312A – FITTINGS (HDPE)

312A.1 The work under this item shall include all of the requirements specified under the item of pipe, in that "pipe" is understood to also mean "bends, tees, crosses, sleeves, outlet assemblies and other specified fittings." All HDPE fittings shall be rated at the same pressure as the connecting pipe. Derated fittings shall not be permitted.

312A.2 PAYMENT: Payment for this item at the unit price bid per fitting, of the type specified in the Proposal, and placed as shown on the drawings. Only fittings specifically noted in the Proposal are included in this item. No additional payment shall be made for excavation, backfilling, or concrete blocking.

## PART 313 – POLYVINYL CHLORIDE (PVC) PIPE, SEWER SERVICE

313.1 The work under this item shall include furnishing, delivery, placing, and jointing PVC sewer pipe in the trench in specific conformity with the line and levels given. Installation shall be in accordance with ASTM D2321, Underground Installation of Flexible Thermoplastic Sewer Pipe, except as modified by these specifications.

313.2 Pipe shall be protected during unloading and installation against impact shocks and free fall. After unloading and before installation, pipe shall be stored on flat level ground with no rocks or other objects under the pipe. PVC pipe that appears to be faded as a result of ultraviolet aging shall not be allowed. PVC pipe exposed to sunlight for more than three weeks shall be covered with an opaque protective covering. The pipe shall be left stacked and no more pipe than can be installed in one day shall be strung along the jobsite.

313.3 The pipe shall be laid on a firm trench bottom, true to the lines and grades shown on the drawings and/or as given in the field by the Inspector. Pipe shall be protected during handling against impact shocks and free fall. The laying of pipe in finished trenches shall be commenced at the lowest point, with the spigot ends pointing in the direction of flow. Pipe shall be laid continuously through new manholes if both inlet and outlet pipes are of the same size and in line. Upon completion of the manhole, the invert shall be shaped. The ends of adjoining pipes shall butt against each other for their entire circumference in such manner that there is no shoulder of unevenness of any kind. The pipe grade shall be obtained by using laser or batter boards and a "top line". A top line shall be maintained over a span of three grade stakes when laying pipe. As each batter board is erected, the top and the batter boards settings. Any error, discrepancies, or displacement of grade stakes shall be called to the attention of the Inspector for correction.

313.4 Prior to making pipe joints, all surfaces of the portion of the pipe to be jointed shall be cleaned and dried. Jointing shall be done in strict accordance with the manufacturer's recommended procedure.

313.5 At connections to manholes or other concrete structures, where the pipe is to be grouted or cast into the wall, a tight-fitting rubber water stop gasket shall be installed around the pipe. The outer sealing surface of the pipe shall be planed smooth. The pipe section with the gasket shall be grouted or cast into the manhole wall. Only pipe with a smooth outer wall or concentric ribs shall be used for cast or grouted in place connections. Where A-Lock type gaskets are used, only smooth outer wall pipe shall be used.

313.6 Approximately 30 days after backfilling the contractor shall measure vertical ring deflection for all pipe. The deflection testing shall be performed in the presence of the Engineer or his designated representative. Maximum ring deflection of the installed pipe shall be limited to 5% of the base inside diameter. All pipe which exceeds the allowable deflection shall be replaced or corrected by the contractor at no additional cost to City. The Contractor shall provide all mandrels and necessary equipment to perform the tests. Tests must be performed without mechanical pulling devices.

Deflection shall be tested using a Go/No-Go Deflection Test Gauge conforming to the standard detail or as manufactured by Cherne Industries, Inc., or equal in accordance with the manufacturer's instructions.

313.7 Any flushing of PVC sewer lines will be performed by the City, but the Contractor will lend assistance as may be required. Any infiltration of flushing water or other leaks into the sewer shall not be acceptable, and the contractor shall immediately correct the cause of the leak in a manner acceptable to the Engineer.

313.8 All sewers shall be tested for excessive leakage above ten gallons per day per inch of pipe diameter per mile per day for any section of installed system. Where low pressure air testing of PVC pipe is specified, it shall be air tested in accordance with the City of Tulsa standard air test procedure. The air testing for all new gravity pipe alignments will be performed by the City. All pipe which exceeds the allowable leakage rate shall be replaced or corrected by the contractor at no additional cost to City.

313.9 Payment: Payment for this item shall be made at the unit price bid per linear foot of the pipe specified in the Proposal and placed as shown on the Drawings. Total footage shall be the actual horizontal measurement along the centerline of the pipe. No additional payment shall be made for vertical pipe or fittings used with drop manholes.

## PART 314 – MANHOLE

314.1 The work under this item shall include all excavation, furnishing all materials required, construction, pipe connection thereto, finishing and backfilling of new standard or drop manholes. Construction of manholes shall progress as rapidly as installation of the line permits, and as directed by the Inspector. Brick manholes are not intended for new construction and shall be allowed only as approved by Engineer.

314.2 Excavation for manholes shall be made with vertical sides and minimum dimensions permitting construction of the manhole in accordance with the attached Standard Details. Manholes are to be built to an elevation not less than that of the existing ground surface, or as shown on the drawings.

314.3 New manholes shall be constructed around existing lines without disturbance to the line. When the manhole is completed, the existing pipe shall be removed from the invert of the manhole. Care shall be taken in removing the pipe to prevent any stoppage. Immediately upon completion of the manhole, all waste mortar and debris shall be removed from the bottom and invert. When the walls are completed, a standard manhole frame and cover shall be set in place. Above the base, manhole inverts shall be carefully constructed of solid concrete to maintain proper velocities. Changes in pipe grade, alignment or size shall be made by transition sections of the invert, determined by the lower half of the inlet and outlet pipes, but not greater than that of the outlet pipe. All inverts shall be plastered, troweled, and brushed to a smooth, clean surface. Inlet and outlet pipes shall not project beyond the interior wall of the manhole and shall be free from all sharp masonry.

314.4 NOT USED

314.5 The use of concrete masonry units shall not be allowed in connection with pipes larger than 8” in diameter. If concrete masonry units 5” thick are used, the manhole shall not be located within any dedicated street or alley, or any other location subject to vehicular traffic; and shall not exceed 12’ in depth. The foregoing restrictions as to location and depth shall not apply if 8” concrete masonry units, brick, or precast manholes are used.

314.6 For brick manholes, a single rowlock course shall be turned over each pipe. Every unit shall have a full mortar joint on the bottom and sides, which shall be formed in one operation by placing sufficient mortar on the bed and forcing the unit into it. Horizontal joints shall not exceed 3/8” and vertical joints on the inside of the manhole shall not exceed 1/4" in thickness. All joints on the inside are to be rubbed full and struck as the manholes are built up. Walls shall be constructed in horizontal courses with vertical joints staggered. When the manhole top is above the proposed graded elevation, the taper shall be drawn in the manhole top to 30” I.D. at a point 1’ below said proposed elevation and the remainder constructed with brick as a 30” cylinder. The inside and outside walls of the manholes are to be plastered with 1/4" of mortar to give a smooth and regular finish.

314.6.1 Testing of Manholes shall be done in accordance with Part 109.2 of the City of Tulsa Specifications.

## 314.7 PRE-CAST MANHOLES

314.7.1 Pre-cast manholes with cast-in-place base slabs will be permitted for all standard and drop manhole installations. Cast-in-place base slab shall be placed on a minimum of 6” of compacted Class A crushed stone.

314.7.2 Pre-cast manholes with integral pre-cast floors will be permitted for standard and drop manhole installations. Pre-cast manholes of 12’ depth or greater shall have an extended base. Pre-cast floors shall be placed on a minimum of 18” of compacted Class A crushed stone.

314.7.3 A drop manhole is required when the difference in elevation between an inlet pipe’s crown and the outlet pipe’s crown is 2’ or greater. The drop leg of a manhole shall be constructed such that the crown of the drop pipe matches the crown of the outlet pipe at the manhole. The drop will not be required if the crown of the drop leg cannot be constructed to match the crown of the outlet pipe.

314.7.4 Pre-cast manholes shall conform to the specifications for Pre-Cast Reinforced Concrete Manhole Sections, ASTM C478. Joint construction shall be in accordance with the standard specification for Reinforced Concrete Pipe except that no exterior grout band is required. No more than 8” of concentric riser rings shall be used to bring the manhole to finished grade. Each concentric riser ring shall have a seal between the riser rings and between riser rings and frame per manufacturer’s recommendations. The bottom riser ring or the frame (if no riser rings used) shall be sealed to the manhole using a trowelable bitumastic joint with a nominal thickness of ½”. Alternatively, two rings of bitumastic rope or M1 adhesive may be used in lieu of trowelable bitumastic as approved by the Engineer. Inside joints shall be rubbed full and struck.

314.7.5 Cost of sealed manhole rims and lids shall be included in cost of manhole.

314.8 Payment: Payment for this item shall be made at the unit price bid per manhole of the type specified in the Proposal and placed as shown on the drawings. If the manhole depth, measured from the invert to the top of the cover, exceeds 6’, the additional depth shall be paid for at the unit price bid per vertical foot of manhole depth over 6’. No additional payment will be made for excavation, backfilling, pipe or concrete bottoms or interior coatings. Separate payment will be made for each drop manhole. No additional payment will be made for multiple drops at a manhole. Separate payment will be made at the unit price bid per vertical foot of drop manhole depth over 6’.

## PART 315 – CONNECTION – Revised 05.17.24

315.1 The work under this item shall include all excavation, furnishing all materials required, construction, finishing, and backfilling of connections to existing mains, valves, manholes, special connections, service line re-connections, plugs, or in-line tees for future connections, as indicated on the Drawings or as directed by the Inspector.

315.2 The drawing shows details of the various connections and they shall be made in accordance with the details or as directed by the Engineer. On water mains, Contractor shall make the pressure and wet connections to existing mains, as shown on the drawing, unless specifically noted otherwise.

315.3 Connections to existing manholes shall be made by cutting into the manhole at the specified grade and inserting the pipe. Pipe installation shall be done in accordance with Standard Detail No. 405 using A-LOK or Z-LOK rubber gasket, or the pipe may be grouted in place with hydrophilic waterstop formed around the pipe and the cold joint. Acceptable hydrophilic compound is ADEKA P-201 or approved equal. Joint shall be watertight. Contractor shall not break into any existing sewer unless the Inspector is present, and the work done shall be under the direction of the Inspector. Inlet and outlet pipes at the invert shall not project beyond the interior walls of the manholes. The manhole base shall be cut and reconstructed in such a manner that a proper invert section is maintained. All waste mortar, debris, and sharp edges shall be removed from the joints, bottom, and invert.

315.4 Methods of construction shall be the same for house line reconnections as for main sewers. All reconnections shall be constructed in conformance with the Plumbing Code of the City of Tulsa, unless modified herein. New pipe used shall be of the same diameter as the existing line.

315.5 Plugs shall be constructed of manhole brick and mortar, extending at least 1’ into the line plugged from the manhole. The plug shall be watertight and troweled to a smooth finish on the interior of the manhole.

315.6 In-line tee fittings shall be installed for future service connections, as shown on the plans, in accordance with the Standard Detail for in-line tees. The tee shall be capped with a screw plug of either bronze, brass or a detectable plastic, marked by a non-magnetic, mylar tape, and stapled to both sides of a nominal 2" x 4" marker, 8' long, 4' buried, and 4' exposed, directly above fitting plug. The mylar tape shall be minimum 2-1/2" width, green in color, marked "Caution, Sanitary Sewer Below," as manufactured by Terra Tape or Line Guard.

315.7 After new water mains have been tested and chlorinated, the Contractor shall excavate around the new main for the service transfer. The existing mains and new mains shall remain in service during the transfer of services. The Contractor shall tap the new main and install a new corporation stop, service clamp, bend, copper tubing or PEX, and required fittings. The new service shall be connected to the existing meter after the service has been tested for leakage. The excavated area shall be backfilled and restored to original condition. Where galvanized service lines are encountered, they

shall be replaced with copper tubing or PEX. Where long services are replaced, they shall be bored under existing pavement. Open cutting will not be permitted unless approved by the Engineer. Copper tubing shall be Type K soft annealed conforming to ASTM B88.

315.8 Payment: Payment for this item shall be made at the unit price bid for each type of connection constructed, or in-line tee for future connection, as specified on the Proposal, or as directed by the Engineer. No additional payment will be made for excavation, backfilling, furnishing and placing of concrete, flowable fill, removing and replacing of manhole steps, if necessary, or for the diversion or pumping of water or sewerage necessary to make the connection. Payment for water service transfers shall be made at the unit price bid for pipe and fittings under the appropriate connection bid item and shall include all necessary excavation, backfill, Right-of-Way clearing and restoring, sodding, seeding,materials, and labor. **Revised 08.18.25**

## PART 316 – LAMPHOLE

316.1 The work under this Item shall include all excavation, furnishing all materials required, construction, pipe connection thereto, finishing and backfilling of new lampholes. Lampholes shall be located and constructed as shown on the Drawings, or as directed by the Inspector. When the concrete lamphole frame base is completed, a standard lamphole frame is to be set in place and closed with a lamphole cover.

316.2 Payment: Payment for this item shall be made at the unit price bid per lamphole constructed as specified on the Proposal. No additional payment will be made for excavation, backfilling, or pipe.

## PART 317 – VALVE

317.1 The work under this item shall include furnishing, delivery, and installation of valves at the locations shown on the Drawings, and in accordance with the attached Standard Details. The American National Standard for Installation of Gray and Ductile Cast-Iron Water Mains and Appurtenances, AWWA C600 shall govern the installation, as applicable. If the paint is damaged, the valve shall be cleaned by wire brushing and given two coats of black asphalt paint.

317.2 Gate valves shall be set with the stems plumb. Ball valves shall be set with the handwheels horizontal. Air relief valves shall be set so that the square operating nut on the 2” valve can be operated from the top. Check valves shall be set horizontally. Construction standards for air relief and check valve vaults shall be the same as for manholes.

317.3 Fire hydrants shall be set so that the bottom of the steamer nozzle is not less than 18” nor more than 21” above the finish grade of the ground. Breakable bolts damaged in the installation shall be replaced in kind. If the Mueller hydrant is used, the oil reservoirs shall be filled before the hydrant is set. Concrete blocking shall be placed so that the drain and joints are accessible. Restraining glands may be used in lieu of concrete blocking for fire hydrants. Fire hydrant and stem extensions shall be provided and installed as necessary, in accordance with the manufacturer's recommendations.

317.4 Payment: Payment for this item shall be made at the unit price bid per valve, of the type specified on the Proposal, and placed as shown on the Drawings. If fire hydrant and stem extension are required, they shall be paid for at the unit price bid for each different length of extension used. The unit price bid for air relief and check valves shall include the valve vault. No additional payment shall be made for: excavation; backfilling; concrete blocking; the pipe length between the line and the fire hydrant, except where the pipe is shown on the Drawings in a separate profile; crushed rock for drains; air relief valve piping vaults; or restraining glands on fire hydrants in lieu of cement blocking.

Payment for any valve designated “restrained joint” shall include cost of restraining glands.

## PART 318 – VALVE BOX

318.1 The work under this item shall include furnishing, transporting, and installation of valve boxes at the locations shown on the Drawings. The American National Standard for Installation of Gray and Ductile Cast-Iron Water Mains and Appurtenances, AWWA C600, shall govern the installation, as applicable.

318.2 Valve box shall include SW services' Debris Cap or equal.

318.3 Payment: Payment for this item shall be made at the unit bid price per value box and debris cap and placed as shown on plans. Any valve box extension shall be paid under separate bid time. No additional payment shall be made.

## PART 319 – ENCASEMENT, CONCRETE

319.1 The work under this item shall include the installation of concrete encasement as shown on the Drawings or as directed by the Inspector, in accordance with the attached Standard Detail. Care shall be taken to assure that placing of encasement does not deflect the pipe from the proper grade and alignment.

319.2 Sanitary sewers shall be encased when the depth of cut from the original ground elevation to the flow line of the pipe is 4’ or less. Concrete encasement necessitated by trench widths more than the maximum as shown on the attached Standard Detail for Thrust Blocks and Trench Conditions shall be placed as directed by the Inspector.

319.3 Payment: Payment for this item shall be made at the unit price bid per cubic yard of concrete placed as encasement. All concrete encasement required because of excessive trench width shall be placed at the expense of the Contractor. No payment will be made for concrete used as fill or in excess of the theoretical quantity computation based on the attached Standard Detail for Thrust Blocks and Trench Conditions.

## PART 320 – CRADLE, CONCRETE

320.1 The work under this item shall include the installation of concrete cradle as shown on the Drawings or as directed by the Inspector, in accordance with the attached Standard Detail for Thrust Blocks and Trench Conditions. Care shall be taken to assure that placing of cradle does not deflect the pipe from the proper grade and alignment.

320.2 Payment: Payment for this item shall be made at the unit price bid per cubic yard of concrete placed as cradle. All concrete cradle required because of excessive trench width shall be placed at the expense of the Contractor. No payment will be made for concrete used as fill or in excess of the theoretical quantity computation based on the attached Standard Detail for Thrust Blocks and Trench Conditions.

## PART 321 – PIERS, REINFORCED CONCRETE

321.1 The work under this item shall include all materials, forming, construction and finishing of reinforced concrete piers, and necessary pipe anchorage. Piers shall be located and constructed as shown on the Drawings. Forms shall be made to conform to the shape of the pier and securely braced. Reinforcing steel shall be bent as detailed and securely tied in place. Bearing area for the pipe shall be made to fit the outside diameter of the pipe and shall support the pipe at the proper grade. Steel strapping and bolts shall be installed and painted with one heavy coat of coal tar or asphalt paint after bolting in place. Any honeycomb or other unevenness in the concrete shall be patched with cement mortar immediately after form removal.

321.2 Payment: Payment for this item shall be made at the unit price bid per cubic yard of concrete placed as reinforced concrete piers in accordance with the attached Standard Details, at the location shown on the Drawings, or as directed by the Engineer. No additional payment will be made for excavation, forming, bracing, dewatering, backfilling, or pipe anchorage.

## PART 322 – CONDUIT, BORED

322.1 The work under this item shall include the installation of railroad, street, or other crossings by boring utilizing steel conduit as shown on the Drawings. The conduit pipe shall be installed to the line and grades given.

322.2 Payment: Payment for this item shall be made at the unit price bid per lineal foot of steel conduit, of the size specified in the Proposal, and placed as shown on the Drawings. All carrier pipe shall be paid for under other items. No additional payment shall be made for excavation, backfilling, boring, tunneling, dewatering, bulkheads, end seals, spacers, bore pits, or vent pipes where required.

## PART 323 – STRUCTURE, SPECIAL

323.1 The work under this item shall include the furnishing of all materials and performing all work necessary to complete any special structures shown on the Drawings.

323.2 Payment: Payment for this item shall be made at the unit price bid for each structure as specified in the Proposal and constructed as shown on the Drawings. Pipe, fittings, valves, and other appurtenances will be paid for under other items. No additional payment will be made for excavation, backfill, foundations, or any particular element of construction or interior coatings.

## PART 324 – MATERIALS FURNISHED BY CONTRACTOR AND INSTALLED BY CITY

324.1 The work under this item shall include furnishing and hauling of materials to the site of work. All necessary clearing, excavation, other site preparation, backfill and restoration, shall be performed by the contractor so that the City may install the materials in place with a minimum amount of delay. The Contractor shall furnish assistance to the City in installing the materials so that they may be readily installed. The City's responsibility shall be only for the actual installation of the materials. All other work shall be performed by the Contractor.

324.2 Payment: Payment for this item shall be made at the unit price bid per material item of the type specified in the Proposal and actually installed per Drawings. Only materials specifically noted in the Proposal are included in this item. All necessary clearing, excavation, other site preparation, backfill, and restoration will be paid for under other bid items.

## PART 325 – SODDING AND SEEDING

325.1 Where the installation of water, sanitary, or storm sewer mains traverse developed areas, residential or commercial, the Contractor shall restore all damaged sod turf using same type and variety. The restoration of sod turf shall be by either Sod Replacement or Hydromulch Seeding, as directed by the Engineer. Replacement sod shall match existing sod in type and variety.

325.1.1 Only that turf in one residential block may be removed at any time. Where residential blocks are not involved, only that turf in approximately 500 linear feet of trench excavation may be removed at any time. The Contractor shall restore all turf damaged by the construction. Payment for turf restoration will be per square yard, based on the length of main installed through an area.

325.2 Sod Replacement: Remove the sod turf with approved cutting equipment. Store the turf in an area where construction operations will not damage it and apply sufficient water to preserve the root system. Replace the sod turf after the trench has been backfilled and compacted. As an alternate to this method, the Contractor may furnish and install new solid slab grass sod of the same type as that which was removed. The new sod shall be moist when excavated from the source and kept moist until planted. Sod shall consist of vegetative parts (rhizomes, stolons, and roots) with an appreciable quantity of adhering soil. Sod that becomes dry shall be discarded. Sodded areas shall be thoroughly watered after placement.

325.3 Hydromulch Seeding: Remove, store, and replace topsoil. Apply seed, fertilizer, and mulch together in homogeneously mixed slurry. Fertilizer shall be 10-20-10 and shall be applied at a rate of 10 lbs. per 1,000 sq. ft. Mulch shall be wood fiber and applied at a rate of 46 lbs. per 1,000 sq. ft. Grass seed shall be either hulled Bermuda applied at a rate of 2 lbs. per 1,000 sq. ft. or K-31 fescue applied at a rate of 8 lbs. per 1,000 sq. ft. as directed. Mulch shall be kept moist for a minimum of ten days or until seeds have germinated and rooted. Watering shall be provided as required to maintain the grass.

325.4 The Contractor shall obtain a construction meter from the Connection Control Division and pay all required fees for any watering. The Contractor shall maintain all sodded or seeded areas until acceptance of the contract.

325.5 Payment: Payment for Sod Replacement or Hydromulch Seeding will be made at the unit price bid per square yard and shall include all necessary topsoil replacement, fertilizing, watering, and maintenance. The square yard pay quantity will be measured parallel to the pipe through the area being restored.

## PART 326 – STREET WASH DOWN

326.1 The Contractor shall, at the written direction of the engineer, wash down streets to control dust and clean the streets in the area of construction. Contractor shall obtain a construction meter from the Connection Control Division of the Water and Sewer Department and shall pay all required fees for obtaining and using the meter.

326.2 Payment: Payment for street wash down shall be made at the unit price bid per linear foot of street. No payment will be made for street washing without prior written instructions from the Engineer.

## PART 327 – TRAFFIC CONTROL DEVICES

327.1 The Contractor shall furnish and install traffic control devices when construction is performed upon or adjacent to any street, alley, sidewalk, residence, public ground, or other location that is subject to pedestrian or vehicular traffic. Traffic control devices shall include safety fencing, barricades, signs, barrels, warning lights, arrow panels, flagmen, high level devices, etc.

327.2 Traffic Control Devices shall conform to the latest edition of the Manual on Uniform Traffic Control Devices.

327.3 Safety fence shall be an open mesh type, high-density plastic material, 48” in height, and colored International Safety Orange. Fence shall be supported by fence posts spaced at no more than 10’.

327.4 Payment: Payment for safety fence shall be at the unit price bid per linear foot based on the total footage used for the duration of the project. No additional payment will be made for moving the fence as the job site changes. Payment for Type I, II, and III Barricades with flashing light; warning signs with flashing lights, 16 sq. ft. and over, and below 16 sq. ft.; barrels with steady burn light; advance warning arrow panels; and high level warning devices shall be made at the unit price bid per sign day. One sign day is one traffic control device in place for one day. Flagmen shall be paid for at the unit price bid per man-day. One man-day is one man flagging for one full eight-hour period. No payment will be made for cones.

## PART 328 – BORE

328.1 Waterline installed under existing concrete or asphalt driveways shall be bored. The diameter of the bore shall be a maximum of 2” larger than the outside diameter of the pipe bell. If the carrier pipe is ductile iron, it shall be polyethylene wrapped and taped at 1’ intervals through the entire length of the bore. If the Engineer determines that boring is not possible, the driveway shall be open cut and the pavement replaced as directed by the Engineer.

328.2 Payment: Payment for crossings by boring shall be at the unit price bid per linear foot as measured from edge to edge of the driveway. All carrier pipe shall be paid for under other items. No additional payment shall be made for excavation, backfilling, boring, tunneling, dewatering or sand fill, or bore pits.

## PART 329 – PAVEMENT REMOVAL AND REPLACEMENT

329.1 Work under this item includes removal and replacement of concrete or asphalt for sidewalks, driveways, parking lots, curbs, streets, alleys, and the like. Pavement crossed at right angles shall be saw-cut, removed, and replaced as shown on the standard drawings or as directed by the Engineer for the type of pavement indicated on the proposal. Pavement crossed diagonally shall be squared by saw-cutting at right angles to the paved area. If a construction joint is within 3’ of a proposed saw line, the pavement shall be replaced to the joint as directed by the Engineer. New concrete pavement shall bridge the top of the trench by a minimum of 1’ on each side. All paving shall conform to the standards and specifications of the Tulsa Office of the City Engineer and ODOT. All street cuts shall be approved by the Office of the City Engineer and a Permit shall be obtained before work may begin.

329.2 All concrete pavement removal shall be a minimum of 3’ x 3’. Concrete shall be High Early Strength Class P5 as per ODOT Section 701A with a minimum 28-day compressive strength of 5,000 psi.

329.3 Concrete shall meet the existing concrete depth with a minimum depth of 8" for streets, 6" for commercial Driveways, 6" for residential driveways, and 4" for sidewalks. Edges of cut shall be saw-cut full depth. No traffic shall be allowed on the street replacement for 24 hours after placing of concrete. Twenty-four hours after placing of concrete, all butt joints must be sawed a minimum of 2", cleaned and sealed with joint sealer, ODOT Section 701A.08(e). If curb and gutter are removed, they shall be replaced to the standards and specifications of the typical existing curb and gutter. When one or more longitudinal construction joints are removed, the joints shall be re-established in accordance with the City of Tulsa standards for concrete pavement. When a pavement section is removed along an existing longitudinal construction joint, the pavement shall be dowelled to the adjacent pavement.

329.4 All asphalt shall be Type S4 as per ODOT Section 708. The asphalt shall be compacted to a 92% maximum density as determined by AASHTO T 209 method. Spreading and finishing of asphalt shall meet ODOT Section 411.04(I). Edges of cut shall be saw-cut full depth. Prior to placement of asphalt in cut, a tack coat shall be uniformly applied. Tack coat shall be an asphalt rubber, meeting the specifications of ASTM D1190. Optional tack coat meeting ODOT requirements. All surface edge joints of cut/overlay shall be sealed with an asphalt rubber meeting minimum specifications of ASTM D1190. Asphalt rubber shall be squeegeed into edge joints. Optional edge seal shall meet ODOT requirements. Emulsion shall be squeegeed into edge joint and blotted with dry concrete screenings. If curb and gutter are removed, they shall be replaced to the standards and specifications of the typical existing curb and gutter. Macadamized or oiled surfaces shall be replaced with asphalt.

329.5 Materials for asphalt shall meet the following ODOT requirements:

329.6 Payment: Payment for removal and replacement of concrete or asphalt pavement shall be at the unit price bid per square yard. The pay quantity of square yards will be computed using the standard pay width for the type of pavement replaced and the

length of the pavement cut along the centerline of the pipe. The pay quantity will include pavement replaced due to the proximity of a construction joint if the specified criteria is meet. For diagonal crossings, the pay quantity will include the areas replaced due to squaring. Payment for saw cut shall be at the unit price bid per linear foot. Payment for curb and gutter shall be at the unit price bid per linear foot. Payment for dowels shall be at the unit price bid per each. No payment will be made for disposal of broken pavement, temporary surfaces, excavation, preparation of subgrade, forms, or reinforcing. No payment will be made for removal or replacement of gravel. No payment will be made for the replacement of pavement damaged by the Contractor's equipment movement. No payment will be made for joint sealer, tack coats, or edge sealing.

## PART 330 – EROSION CONTROL MEASURES

330.1 The contractor is responsible to ensure that measures are taken to minimize erosion and sedimentation problems. Measures include straw bale dikes, silt fence, silt dikes, and inlet protection including but not limited to the following:

A) Place straw bale dikes in bar ditches at 500’ intervals on relatively flat grades and 200’ intervals on grades over 5%.

B) Place sediment sumps upstream of straw bales. Remove sediment on a regular basis.

C) Keep excavation and silt off streets.

D) In areas where water lines are being constructed adjacent to improved streets, measures shall be taken which will minimize siltation and excavation inlets. Precautions should be taken during heavy rains to assure that a flooding condition is not created.

E) Straw mulch can be used as an effective means of erosion control.

F) Erosion control measures shall be placed at the toe of slope of all cut and fill areas.

330.2 Straw bales shall be standard rectangular size, approximately 18" x 20" x 36", and shall be securely bound with wire. Bales shall be firmly anchored with wood or metal stakes approximately 3’ long. A sediment sump shall be placed immediately upstream of each bale. Contractor shall clean and maintain sediment sumps throughout the maintenance period.

330.3 The contractor shall furnish and install straw mulch as directed. Mulch shall be applied at a rate of 1-1/2 tons per acre. Mulch shall be securely anchored in place.

330.4 Payment: Payment for straw bales or other erosion control measures will be at the unit price bid and shall include the cost of sediment sumps and anchoring. Payment for straw mulch will be at the unit price bid per square yard and shall include the cost of anchoring.

## PART 331 – WATER TABLE CRADLE

331.1 The work under this item shall include furnishing and installing Water Table Cradle as shown on the drawings or as directed by the Engineer and in accordance with the Standard Detail for Water Table Cradle.

331.2 The trench excavation shall be completely dewatered to provide a dry and stable trench bottom. The trench shall be excavated to a minimum of 18" below the bottom of the pipe. If additional base stabilization is required crushed stone, 3-1/2" to 1-1/2" (Gradation No. 1), shall be installed on the trench bottom, prior to the installation of water table cradle. Minimum trench widths for flexible pipe installations shall be as shown in the Standard Detail No. 367.

331.3 Geotextile filter fabric shall be installed on the trench bottom and walls. Crushed stone shall be installed in the trench directly on the filter fabric to a height of 12” above the top of the pipe. The crushed stone bedding material shall be carefully worked and compacted around the pipe. The filter fabric shall be placed over the top of the crushed stone with a minimum 24" lap. All fabric joints shall be lapped a minimum of 18". Water Table Cradle shall be installed for the full excavated width of the trench.

331.4 Crushed stone for Water Table Cradle shall be Gradation No. 57, 1" to No. 4. The Geotextile Filter Fabric shall be a nonwoven, needle punch constructed fabric inert. The fabric unit weight shall be not less than 13 ounces per square yard with a Mullen Burst Strength (ASTM D3786) of not less than 600 psi.

331.5 Payment: Payment for Water Table Cradle will be made at the unit price bid per linear foot for the specified diameter of pipe. The unit price shall include the cost of all labor, equipment, and materials required. No additional payment will be made for dewatering or crushed stone required for additional base stabilization.

## PART 332 – CONDUIT, OPEN CUT

332.1 The work under this item shall include the installation of railroad, street, or other crossings by open cut utilizing conduit as shown on the Drawings. The conduit pipe shall be installed to the line and grades given and shall be installed in accordance with standard bedding detail for semi-rigid pipe.

332.2 The carrier pipe shall be installed with spacers, and end seals or bulkheads as shown in Standard No. 307.

332.3 Payment: Payment for this item shall be made at the unit price bid per lineal foot of conduit, of the size specified in the Proposal, and placed as shown on the Drawings. All carrier pipe shall be paid for under other items. No additional payment shall be made for excavation, dewatering, backfill, spacers, bulkheads, end seals, or vent pipes where required.

## PART 333 – REMOVAL, SALVAGE, ABANDONMENT OF EXISTING FACILITIES

333.1 GENERAL

Any removal, salvaging, and/or abandonment of existing facilities will be required as shown on the Drawings, and/or as described in this Section, in addition to those located in the field and identified by the Engineer. The proposed methods and materials for bulkheads, pumping, venting, cutting, plugging, filling, and blocking structures and linear assets to be abandoned shall be submitted for approval to the Engineer. Abandonment of all pipe shall be performed after accepted construction of all new mains on the Project.

333.2 MATERIALS – SPECIFIED BELOW

333.3 EXECUTION

333.3.1 Abandonment of Manholes: Manholes to be demolished in place shall have all pipes entering or exiting the structure plugged with a minimum length of 2’ of lean concrete or non-shrink grout. Manhole tops or cone section shall be removed to the top of the full barrel diameter section or to a point not less than 36” below final grade. All storm sewer and sanitary sewer castings shall remain the property of the City and shall be salvaged and delivered by the Contractor to the Sewer Operations & Maintenance Base Stockyard at 9319 East 42nd Street North. Contractor will coordinate the return of such items with the Stockyard personnel at 918-669-6130. All other debris and materials removed shall become the property of the Contractor and shall be disposed of in accordance with local regulations. The structure shall then be backfilled and compacted in accordance with Sections 333.3.5 or 333.3.6 below. Backfill material may be either clean-washed sand, cellular concrete, flowable fill, or clean, suitable excavated material approved by the Engineer. Surface restoration shall be compatible with existing surrounding surface.

333.3.2 Removal of Manholes: Manholes to be removed shall have all pipes entering or exiting the structure abandoned as described in this Section. The complete manhole, including top, or corbel (cone) section, all full barrel diameter sections and base section shall be removed. All storm sewer and sanitary sewer castings shall remain the property of the City and shall be salvaged and delivered by the Contractor to the Sewer Operations & Maintenance Base Stockyard at 9319 East 42nd Street North. Contractor will coordinate the return of such items with the Stockyard personnel at 918-669-6130. All other debris and materials removed shall become the property of the Contractor and shall be disposed of in accordance with local regulations. The excavation shall then be backfilled and compacted in accordance with Sections 333.3.5 or 333.3.6 below. Surface restoration shall be compatible with surrounding surface.

333.3.3 Cut, Plug, and Abandon Storm or Sanitary Sewer: Gravity sewer mains to be abandoned shall have the pipe entering or exiting the manhole structures cut and plugged at each end with a minimum length of 2’ of lean concrete or non-shrink grout. All sewer mains to be abandoned shall also be filled to 100% of the abandoned pipe volume. Fill material may be either cellular concrete, or flowable fill as approved by the

Engineer. Standing water, especially in low spots, must be removed prior to using cellular concrete material.

A) Contractor shall CCTV (closed circuit television inspection) all sanitary sewer mains prior to abandonment to determine location of existing service connections. Service connections shall be reconnected to proposed sanitary sewer located in immediate vicinity of the abandoned main. Engineer shall be notified immediately if there is no proposed sewer to collect the service.

333.3.4 Plug and Abandon Water or Force Mains: Pressurized mains to be abandoned shall have both ends cut and plugged with a minimum length of 2’ of lean concrete or non-shrink grout. All water or force mains to be abandoned shall also be filled to 100% of the abandoned pipe volume. Fill material may be either cellular concrete or flowable fill as approved by the Engineer. Standing water, especially in low spots, must be removed prior to using cellular concrete material. All hydrants, valves, and other fittings from abandoned water mains shall remain the property of the City and shall be salvaged and delivered by the Contractor to the South Yard at 2317 S. Jackson Avenue. Contractor will coordinate the return of such items with the South Yard personnel at 918-596-9401. All other debris and materials removed shall become the property of the Contractor and shall be disposed of in accordance with local regulations.

333.3.5 Backfilling in Areas Other Than Street Right-of-Way and Pavement Areas:

Backfill abandoned assets using acceptable materials per this Specification Section as approved by the Engineer.

Backfill in layers of 18” maximum and mechanically compact to 95% of maximum density as defined by AASHTO T 99 (Modified Proctor Test).

333.3.6 Backfilling in Street Right-of-Way and Pavement Areas:

Backfill abandoned assets under and within 2’ of all existing and proposed pavement, driveway pavement, sidewalk, and curb and gutter using only ODOT Type A aggregate base or flowable fill.

Compaction Method:

Granular backfill shall be mechanically compacted in vertical layers of 8” loose measure. Each layer shall be firmly compacted to 95% of Standard Proctor Density as determined by AASHTO T 99. Material may be compacted by tamping or by using surface vibrators in such a manner as not to disturb or injure surrounding facilities. Adequate cover over adjacent pipe or utilities shall be provided before using mobile trench compactors of the hydro-hammer or impactor type.

333.4 MEASUREMENT AND PAYMENT

Payment for all work and materials involved in abandoning sewer manholes, regardless of location, shall be included in the bid item and paid for at the unit price of EACH by inside diameter.

Payment for all work and material involved in removal of sewer manholes, in areas outside of excavated trench width required for construction of new pipe and/or manholes, shall be included in the bid item and paid for at the unit price of EACH manhole. No separate payment shall be made for removing pipe or sewer manholes when working in the same trench width required for construction of new pipe and/or manholes. Pipe and/or manholes replaced in place, along with all appurtenances, shall be included in other items of work.

Payment for cutting, plugging, and abandoning water and sewer mains shall be paid for at the unit price of LINEAR FEET by inside pipe diameter per bid item.

Measured fill volume shall be verified with material tickets and compared to calculated volume of pipe to be abandoned.

Payment for all work and materials involved in CCTV inspection of sanitary sewer mains to be abandoned shall be included in the bid item and paid for at the unit price of LINEAR FEET.

All restoration, and all other appurtenances associated with these bid items, shall be included in their respective bid item, and not paid for separately.

## PART 334 – CONSTRUCTION AS-BUILTS

334.1 This work maintaining an accurate set of as-built documents on site.

334.2 CONSTRUCTION METHODS

At the end of each day work accomplished shall be updated on the as-built plans The Contractor shall dimension from two permanent points of reference, building corners, sidewalk, or road intersections, etc., the location of the following:

A) Changes to the horizontal and vertical alignments as shown on the original Contract Plans.

B) Stations or equations that have been introduced or revised during construction.

C) Intersection and crossover details that have been modified or relocated.

D) Inlets, manholes, box culverts, and end walls that were added, relocated, revised, or deleted.

E) All sidewalk that was modified, all curb and gutter, and shoulder gutter that was added, revised, or deleted.

F) All driveways that were not shown on the original Contract Plans, or were shown but are no longer in existence, or were otherwise modified.

G) All ditch locations and grades that were adjusted during construction.

H) Changes in fencing items, including gate location.

I) Sign locations changed and pavement markings that were modified.

J) All signal details that changed during construction.

K) All bridge, approach slab, and lighting details that are different from the actual construction.

L) Benchmarks (BM) and their descriptions that were set during construction shall be added to the profile portion of the Plan Sheets.

M) All utility relocates and/or conflicts shall be reflected on the Contract Plans, complete with station/offset/elevation and/or Northing/Easting/elevation on:

1) Water: Spot elevations on the main water line relative to finished grade shall be provided at each 100’ interval and at all valves, fittings, fire hydrants (top of nut), and other appurtenant items. Spot elevations on water meter cans, vaults shall be shown with proper description (meter type, meter size, meter number, service material, service size).

2) Wastewater: Spot elevations on the main sewer line relative to finished grade shall be provided at each 100’ interval and at all rim, flowline inverts (in/out), and service connections.

3) Stormwater: Spot elevations on the main stormwater line relative to finished grade shall be provided at each 100’ interval and at all rim, flowline inverts (in/out), curb inlets, and grates.

Before the final inspection, the Contractor shall deliver to the Engineer one copy of the as-built documents to review. Delivery of this set of documents does not relieve the Contractor of the responsibility of furnishing required information that may be requested by the Engineer. The Contractor shall make corrections noted and submit final as-built documents to the Engineer for approval and acceptance. The Engineer will not certify payment requests or make final payment if as-built documents are not current or complete.

334.3 MEASUREMENT AND PAYMENT

Payment for construction as-builts in accordance with the following:

A) 20% when 25% of the contract work is completed.

B) 20% when 50% of the contract work is completed.

C) 20% when 75% of the contract work is completed.

D) 40% when the Resident Engineer verifies that all construction features have been properly as-built and redlines received from the Contractor, and the Engineer has accepted the as-built documentation.

## PART 335 – ACCEPTANCE SAMPLING/TESTING REQUIREMENTS

335.1 DESCRIPTION

Furnish Quality Control of materials and construction in accordance with the Standard Specifications, Plans and Special Provisions. This includes but is not limited to preparing and following a Quality Control Plan (See Part 335 Tables 1–7). Obtain samples and perform tests for Quality Control, provide inspection, and exercise management control to produce materials and workmanship that conforms to contract requirements. Unless otherwise noted in the plans, all pavements and bridges will be subject to requirements of any or all the Provisions which are included in this specification. City of Tulsa will provide Quality Assurance testing at their discretion.

335.2 MATERIALS

Meet materials quality requirements.

335.3 EQUIPMENT

Provide equipment at own expense, unless otherwise specified. All equipment and supplies shall conform with Standards and applicable Specifications. Certify the calibration of all equipment.

335.4 CONSTRUCTION

A) General: Provide quality of all construction covered in the project.

B) Quality Control Personnel Qualifications: All personnel directly involved in sampling and/or testing materials for either control or acceptance purposes shall be certified in the appropriate area(s) by the Oklahoma Highway Construction Materials Technician Certification Board. Manager certification for material sampling and testing is not required unless he or she is directly involved in sampling and/or testing materials.

C) Contractor's Quality Control Plan: Submit a written Quality Control Plan at least one week prior to the pre-work conference. Include the following in the plan:

1) Sources of principal materials including names of suppliers and locations.

2) Names and resumes of key Quality Control personnel.

3) Duties, responsibilities, and authorities (to suspend production, alter mixtures, etc.) granted to key Quality Control personnel.

4) Description of testing laboratories, including qualifications, key equipment, and locations.

5) Description of start-up operations, including but not limited to:

a) Review of submittal requirements and all other Contract requirements with the performance of the work.

b) Examine the work area to ascertain that all preliminary work has been completed.

c) Verify all field dimensions and advise the Engineer of any discrepancies.

6) Detailed testing schedule based on production.

7) Control, verification, and acceptance testing procedures for each specific test to include the test name, specification requiring the test, feature of work to be tested, and person responsible for each test.

8) Procedures for tracking construction deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.

a) Sampling and Testing: Perform sampling and testing according to the accepted Quality Control plan using personnel certified in appropriate areas and laboratories approved by the Engineer. Keep laboratory facilities clean and maintain all equipment in proper working condition.

b) Inspection: Provide inspection necessary to ensure compliance with applicable standards and specifications.

c) Records: Maintain complete testing and inspection records and make them accessible to the Engineer.

1. Test Results: Maintain control charts that identify the project number, contract item, test number, each test parameter, the upper and/or lower specification limit applicable to each test parameter, and the test results. Use the control charts as part of the Quality Control system to document process variability, to identify production and equipment problems, to make necessary corrections, and to identify potential pay factor adjustments.

i. Post control charts in an accessible location, keep them up to date, and make them available to the Engineer upon request. Make corrections to the process when problems are evident, including ceasing production if necessary.

2. Inspection Results: For each day of work, prepare an “Inspector’s Daily Record of Construction Operations” on an approved form. Include the following certification signed by the person with overall responsibility for the inspection system:

i. “It is hereby certified that the information contained in this record is accurate, and that all work documented herein complies with the requirements of the contract. Any exceptions to this certification are documented as a part of this record.”

3. Submit the record and certification to the Engineer within two working days of the work being performed. If the record is incomplete, in error, or otherwise misleading, a copy of the record will be returned with corrections noted. When chronic errors or omissions occur, correct the procedures by which the records are produced.

D) Use of Contractor Test Results for Acceptance Purposes: Abbreviated test procedures are allowed for Contractor use. The Quality Control Plan shall list all abbreviated test procedures, describe all deviations from standard procedures for each, and note their intended purpose. Test results from abbreviated procedures will not be used for any purpose by the City of Tulsa. It is the Engineer’s discretion to use or not use any of the Contractor’s test results for acceptance purposes.

E) Changes: Submit, in writing, all proposed changes in key Quality Control personnel, equipment or procedures from those previously approved by the Engineer. Submit written changes at least one week prior to the proposed action.

335.5 METHOD OF MEASUREMENT

Payment for Contractor’s Quality Control will be measured on a lump sum basis.

335.6 BASIS OF PAYMENT

Accepted Contractor’s Quality Control measured for payment as prescribed above will be paid for at the Contract unit price for:

CONTRACTOR’S QUALITY CONTROL.....LUMP SUM

This payment will be full compensation for furnishing all materials, facilities, equipment, labor, and incidentals to complete the work.

Subject to acceptable performance, payment for Contractor’s Quality Control will be made in accordance with the following schedule:

A) 25% on the next estimate after the Engineer’s approval of the Contractor’s Quality Control Plan and other required initial documentation.

B) 25% when 50% of the contract work is completed.

C) 25% when 75% of the contract work is completed.

D) 25% when all test results and records related to Quality Control work have been furnished to and accepted in writing by the Engineer.

As stated above, this payment is based upon acceptable performance. Payment will be reduced for unacceptable portions of the Quality Control work. Serious deficiencies in Quality Control work may result in the project being shut down.

<table>
<tr><th colspan="5">PART 335 TABLE 1<br>BITUMINOUS MIXTURES</th></tr>
<tr><th>ODOT/COT SUPPLEMENTS</th><th>MATERIAL</th><th>TYPE OF TEST(S) REQUIRED</th><th>SAMPLING POINT</th><th>MINIMUM SAMPLING/TESTING FREQUENCY</th></tr>
<tr><td rowspan="4">411, 708</td><td rowspan="2">Asphalt Concrete Pavement</td><td>Volumetric, Marshall, Rice,<br>& Air Voids</td><td>Hot Plant or Roadway</td><td>One Per Day's Production.</td></tr>
<tr><td>Oil Content (Nuclear/Ignition)</td><td>Hot Plant or Roadway</td><td>One Per 350 Tons or Fraction Thereof.<br>Minimum One Sample Per Day.</td></tr>
<tr><td rowspan="2">Cold Feed</td><td>Compaction (Core)</td><td>Roadway</td><td>One Per 300 Linear Feet for Each Lift and Lane Pass or Fraction Thereof.</td></tr>
<tr><td>Gradation</td><td>Hot Plant</td><td>When Days Production Exceeds 300 Tons:<br>One Prior to First Day of Production and<br>One Per 500 Tons Thereafter.</td></tr>
<tr><td colspan="5"><u>Remarks</u>:<br>Asphalt deficient in oil content and/or density shall be cored 50' maximum on both sides of failed section when deemed necessary by the City of Tulsa. The results of the two cores shall be averaged with the previous test results.<br>Minimum sampling and testing are required for each mix and supplier.<br>City of Tulsa reserves the right to modify sampling and testing requirements as needed to ensure quality of materials.</td></tr>
</table>

| PART 335 TABLE 2<br>CEMENTITIOUS MIXTURES | | | | |
|---|---|---|---|---|
| **ODOT/COT SUPPLEMENTS** | **MATERIAL** | **TYPE OF TEST(S) REQUIRED** | **SAMPLING POINT** | **MINIMUM SAMPLING/TESTING FREQUENCY** |
| 414, 701 | **Portland Cement Concrete (Flatwork)** | Compressive Strength | At Discharge | One Set of Six Cylinders Per 50 Cubic Yards or Fraction Thereof. |
| | | Slump, Time, & Temperature | At Discharge | One Per Set of Cylinders. |
| 509, 701 | **Portland Cement Concrete (Structures)** | Compressive Strength | At Discharge | One Set of Six Cylinders Per Type of Structure, Per 50 Cubic Yards, or Days Production. |
| | | Slump, Time, & Temperature | At Discharge | One Per Set of Cylinders. |
| 501, 701, 703 | **Controlled Low Strength Material** | Compressive Strength | At Discharge | One Set of Two Cylinders Per Shift. |
| 425, 623, 701, 733 | **Grout** | Compressive Strength | At Discharge | One Set of Four Prisms When Required by Engineer or Their Representative. |
| | | Slump, Time, & Temperature | At Discharge | One Per Set of Prisms. |
| 521, 701 733, 737 | **Mortar** | Compressive Strength | At Batch Site | One Set of Four Cylinders When Required by Engineer or Their Representative. |
| Project Plans & Specifications | **Shotcrete** | Compressive Strength | At Discharge | One Panel Per 50 Cubic Yards or One Per Mixture, Nozzleman and Shift (Whichever is Greater). |

**Remarks:**
Concrete specifications: Time is **90 minutes max** from time concrete is batched; Concrete is from **50 °F to 90 °F** [10 °C to 32 °C] during mixing, delivery, and placement.
If, in the opinion of the Engineer or his/her representative, there is sufficient cause to question the quality of the mortar or grout being utilized, random field sampling and testing may be required.
Shotcrete test panel forms should be wood or steal and a minimum of 24" x 24" x 4", generally shot in a vertical position. Minimum sampling and testing are required for each mix design and supplier.
City of Tulsa reserves the right to modify sampling and testing requirements as needed to ensure quality of materials.

| PART 335 TABLE 3<br>SOIL | | | | |
|---|---|---|---|---|
| **ODOT/COT SUPPLEMENTS** | **MATERIAL** | **TYPE OF TEST(S) REQUIRED** | **SAMPLING POINT** | **MINIMUM SAMPLING FREQUENCY** |
| 202, 613 | **Trench Backfill (including lateral trenches)** | Proctor Density, Gradation & P.I. | In-Place | One Per Soil Type. |
| | | Compaction & Moisture Content | In-Place | One Per 8" Lift for Every 100 Linear Feet, Per Pipe Run, or Day's Production. |
| 310 | **Subgrade** | Proctor Density, Gradation & P.I. | In-Place | One Per Soil Type. |
| | | Compaction & Moisture Content | In-Place | Every 100 Linear Feet or Day's Production. |
| 202, 501 | **Structure Backfill** | Proctor Density, Gradation & P.I. | In-Place | One Per Soil Type. |
| | | Compaction & Moisture Content | In-Place | One Per 8" Lift Per Structure |
| 202 | **Roadway Fill & Embankments** | Proctor Density, Gradation & P.I. | In-Place | One Per Soil Type. |
| | | Compaction & Moisture Content | In-Place | One Per 8" Lift for Every 100 Linear Feet or Day's Production. |
| 202 | **Import** | Proctor Density, Gradation & P.I. | Import Site or On-Site Stockpile | One Per Soil Type. |
| | | Compaction & Moisture Content | In-Place | One Per 8" Lift for Every 100 Linear Feet or Day's Production. |

**Remarks:**
**For Infrastructure Development Projects (IDP) only. Testing Frequencies as follows:**
Sewer & Water Services (30%) Driveways, Aprons, and ADA ramps (50%) Valley Gutters (100%)
Dry Utility, Fire Hydrant, Fire Line, and Storm Drain (100%)
Import material shall be Select Borrow in accordance with Section 202 and 705. All fill materials shall be placed at ± 2% of the optimum moisture content.
**The nuclear density gauge is to be correlated with a sand cone for every ten tests taken, or one per day, whichever is greater.**
City of Tulsa reserves the right to modify sampling and testing requirements as needed to ensure quality of materials.

| PART 335 TABLE 4<br>AGGREGATE BASE | | | | |
|---|---|---|---|---|
| **ODOT/COT SUPPLEMENTS** | **MATERIAL** | **TYPE OF TEST(S) REQUIRED** | **SAMPLING POINT** | **MINIMUM SAMPLING FREQUENCY** |
| 303, 703, 708 | **Aggregate Base (AB)** | Proctor Density | Stockpile, Windrow, Roadway | At Start of Production and as Material Changes per Supplier and/or Plant. |
| | | Compaction & Moisture Content | Roadway, Pipe Bedding, Initial Backfill | One per 100' per Lift or One per Lane Pass or Days Production. |
| | | Gradation, PI (Wet Prep) | Stockpile, Windrow, Roadway | One per Project, or One per 1000 Tons or Fraction Thereof. |
| | | Specific Gravity | Stockpile, Windrow, Roadway | At Start of Production and as Material Changes per Supplier and/or Plant. |

**Remarks:**
If asphalt millings are used for bedding, they shall meet the requirements of virgin Aggregate Base per ODOT.
Millings must meet all ASTM C33 requirements.
Millings cannot be placed until the material has been certified by ODOT/COT approved testing lab.
City of Tulsa reserves the right to modify sampling and testing requirements as needed to ensure quality of materials.

| PART 335 TABLE 5<br>REINFORCEMENT | | | | |
|---|---|---|---|---|
| **ODOT/COT SUPPLEMENTS** | **MATERIAL** | **TYPE OF TEST(S) REQUIRED** | **SAMPLING POINT** | **MINIMUM SAMPLING FREQUENCY** |
| 724 | **Steel Reinforcement** | Certificate and/or Tests | Project | One Sample for Each Size, Grade & Heat Number Per Shipment & Manufacturer. Certificate Required. |
| 517, Project Plans & Specifications | **Post-Tensioned Steel** | Certificate and/or Tests | Project | One Sample for Each Size, Grade & Heat Number Per Shipment & Manufacturer. Certificate Required. |
| 503, Project Plans & Specifications | **Pre-Stressed Steel** | Certificate and/or Tests | Project or Fabrication Plant | One Sample for Each Size, Grade & Heat Number Per Shipment & Manufacturer. Certificate Required. |

**Remarks:**
All steel and iron incorporated into Federal-Aid projects must conform to requirements of "Buy America" per 23 CFR 635.410.
City of Tulsa reserves the right to modify sampling and testing requirements as needed to ensure quality of materials.

| PART 335 TABLE 6<br>ELASTOMERIC BEARING PADS | | | | |
|---|---|---|---|---|
| **ODOT/COT SUPPLEMENTS** | **MATERIAL** | **TYPE OF TEST(S) REQUIRED** | **SAMPLING POINT** | **MINIMUM SAMPLING FREQUENCY** |
| 733.06 | **Elastomeric Bearing Pad (Grade 2)** | AASHTO M 251 | Project | Two Sample Bearing Pads Selected at Random by Engineer from every 100 Bearing Pads or Portion Thereof. Minimum of One Sample per Lot. |

**Remarks:**
Two sample bearing pads may be needed to complete the specified testing for smaller bearing pads.
Bearing pads will be selected at random by the Engineer at the project site for testing.
Bearing pads marked or otherwise presented as test bearing pads will not be tested.
Bearing pads must be made available for testing at least four weeks in advance of intended use.
Each bearing pad is to be marked in indelible ink or flexible paint. The marking shall consist of the order number, lot number, bearing identification number, and elastomer type and grade number. The marking shall be on the face that is visible after erection of the bridge.
City of Tulsa reserves the right to modify sampling and testing requirements as needed to ensure quality of materials.

## PART 335 TABLE 7A
## MINIMUM TEST SCHEDULE & FINAL REPORT

**Minimum Testing Schedule:**

A Minimum Testing Schedule is to be created and submitted to the City of Tulsa Field Engineering within ten business days of project assignment. Testing frequencies are to be calculated using an approved set of plans in conjunction with the bid tab items to create an accurate representation of the minimum testing needed for the project. Any notes, comments, special circumstances, and/or assumptions made for quantity calculations should be listed at the bottom of the page.

**Final Report Should Include the Following:**

All laboratories must submit a Final Report after the completion of each project. Laboratories will be notified by the City of Tulsa Field Engineering, via email, that the project is complete and all lab results for soils, concrete and asphalt will be attached. A CD and a hard copy of the Final Report must be delivered to the City of Tulsa Field Engineering within five business days from the date of this email.

Final Reports are to include all field and lab tests/results, daily reports, and samples taken for the entire project.

**All Final Reports must be stamped and signed by a registered professional engineer** and shall verify that all materials, sampled and tested, were found to be in compliance with the latest City of Tulsa Standards and Specifications.

Construction materials that fail to meet specification requirements, but were incorporated in the project, must be summarized in the final report with a detailed explanation listing corrective actions or justification for acceptance.

## PART 335 TABLE 7B
## INFRASTRUCTURE DEVELOPMENT PROJECTS (IDP) ONLY
## MINIMUM TEST SCHEDULE & FINAL REPORT

**Minimum Testing Schedule:**

A Minimum Testing Schedule shall be created and submitted to the City of Tulsa IPD Inspector, during the pre-construction meeting. Testing frequencies are to be calculated using an approved set of plans, in conjunction with the bid tab items, to create an accurate representation of the minimum testing needed for the project. Any notes, comments, special circumstances, and/or assumptions made for quantity calculations, should be listed at the bottom of the page.

**Final Report:**

All laboratories must submit a Final Report at the completion of each project. A spiral bound copy of the Final Report must be delivered to the City of Tulsa IDP Inspector along with final record drawings of the project.

Final Reports shall include all field and lab tests/results (including any acceptance/deficiency test results), daily reports, and samples taken for the entire project.

All Final Reports must be stamped and signed by a registered professional engineer and shall verify that all materials, sampled and tested, were found to be in compliance with the latest City of Tulsa Standards and Specifications. Construction materials that fail to meet specification requirements, but were incorporated in the project, must be summarized in the final report with a detailed explanation listing corrective actions or justification for acceptance.

## INSPECTION/TESTING SCHEDULE

| SERVICE | MINIMUM NOTICE (HOURS) | NOTES |
|---|---|---|
| Aggregate Base: | 48 | Density testing must be complete prior to string line.<br>Obtain samples for proctor/acceptance testing prior to scheduling density. |
| Aggregate Base Thickness: | 48 | Per Plans and Specifications. |
| Aggregate Base Sampling: | 48 | Material must be from a City of Tulsa approved plant. |
| Asphalt: | 48 | Contractor/Inspector must call the City of Tulsa Field Engineering for scheduling. Material must be from an ODOT approved plant. |
| Backfill: | 48 | Obtain samples for proctor/acceptance prior to scheduling density testing. |
| Concrete: | 48 | Material must be from an ODOT approved plant. |
| Coring: | 48 | Allow time to schedule and set up traffic control if required. |
| Crack Seal: | 48 | |
| Footing Inspection: | 24 | |
| Grout: | 24 | |
| Import: | 24 | Material must be approved by the City of Field Engineering prior to placement. |
| Mortar: | 24 | |
| Post Tension Pre-Pour Inspection: | 48 | |
| Post Tension Stressing Inspection: | 48 | |
| Post Tension Sampling: | 48 | |
| Reinforcing Steel (Inspection): | 48 | |
| Reinforcing Steel (Sampling): | 48 | |
| Shotcrete: | 48 | Contractor shall provide 16" x 16" x 4" sampling panel. |
| Sidewalk Slope Inspection: | 24 | |
| Slurry (CLSM): | 24 | |
| Slurry Seal: | 48 | |
| Soil Sampling: | 24 | |
| String Line: | 24 | |
| Subgrade: | 24 | Density testing must be complete prior to string line.<br>Obtain samples for proctor/acceptance testing prior to scheduling density. |
| Weld Inspection: | 48 | |

Inspection/Testing schedule time listed above has been considered in contract time. No additional time will be given.

## PART 336 – PAVEMENT AND BRIDGE DECK SMOOTHINESS – Revised 04.25.2024

These Special Provisions amend and where in conflict, supersede applicable sections of ODT's 2019 Standard Specifications for Highway Construction, English and Metric. Units of measurement are provided in the subsections in both English and Metric equivalents. the units for this provision will be those English equivalents.

These Special Provisions apply to all types of Portland cement and asphalt concrete pavements as well as bridge decks constructed as part of this contract or as specified on the plans.

336.1 DESCRIPTION

This section establishes procedures for determining acceptability as it relates to smoothness requirements of pavements and bridge decks. The equipment and testing applicable to this Section shall be provided and/or operated by the party of parties designated by the City.

336.2 MATERIALS - VACANT

336.3 EQUIPMENT

Smoothness measurement equipment to be used for control and for acceptance testing shall include either The California Profilograph or The Lightweight Profilometer as described below. Such equipment shall be certified by the Department.

**A. Profilograph**

A California type profilograph produces a smoothness profilogram (or profile trace) of the surface tested. The equipment used shall be supported on multiple wheels having no common axle. The wheels shall be arranged in a staggered pattern such that no two wheels cross the same bump simultaneously. The profile is recorded from the vertical movement of a sensing wheel attached to the frame at the midpoint and is in reference to the mean elevation of the twelve points of contact with the road surface established by the support wheels.

The strip chart recorder shall be mounted on a lightweight frame 25 feet long. The relative smoothness/roughness of the pavement or bridge deck shall be measured by recording the vertical movement of a 6-inch or a larger diameter-sensing wheel attached to the midpoint of the frame.

The recorded graphical traces of the profile (termed the "profilogram") shall be on a scale of 1-inch equals 1 inch for the vertical motion of the sensing wheel. The profilogram shall be driven by the chart drive on a scale of 1 inch of chart paper equal to 25 feet longitudinal movement of the profilograph.

**B. Lightweight Profilometer**

The profilometer equipment shall be mounted on a lightweight, motorized vehicle Such as an All-Terrain Vehicle (ATV), Golf Cart, or other approved vehicle. The vehicle profilometer equipment, and operator shall be capable of running on “green” concrete without causing damage. The profilometer equipment shall include an onboard, precision accelerometer which measures movement of the light weight and a non-contact vertical distance sensor mounted on the vehicle. The vertical distance sensor may be either infrared or laser type. The profilometer shall be capable of making all of the measurements and providing the information required in 430.04(b) of this special provision. Additionally, the profilometer shall measure the road profile in accordance with ASTM E950-98, Class I.

**C. Calibration**

The profilograph or profilometer shall be calibrated within the following limits. Horizontal measurements shall be within ±5 feet per 1,000 feet of distance tested. Vertical measurements shall be the same as those of the calibration blocks measured. a profilograph and profilometer Calibration Report shall be submitted to the Engineer each time the calibration is performed. The calibration shall be performed no more than one week prior to collection of smoothness data and repeated at the Engineer’s direction at any time during the project.

**D. Profilograph or profilometer Operator**

The City shall provide a profilograph or profilometer operator, certified by the Oklahoma Highway Construction Materials Technical Certification Board to perform All produced profilograms at no cost to the Contractor.

## 336.4 CONSTRUCTION

**A. Surface Testing**

The Contractor shall provide traffic control as necessary for all smoothness Measurements regardless of who provides and/or operates the equipment. The surface will be tested as soon as possible after completion of the work. For overlay projects when milling is not required, the surface will be tested immediately before construction and as soon as possible after completion of work in order to determine the percent reduction in the profile index. Profilometer readings or profilograph traces are to be collected from 25 feet prior to the beginning point of a project, including any exception areas, and run continuously through all bridges and changes in the pavement types to a point 25 feet beyond the ending point of a project, including any exceptions areas.

Testing shall include all mainline paving and bridge decks. Smoothness deviations occurring at construction and expansion joints will be considered in calculations of profile index and in identification of bumps.

All objects and foreign material on the surface shall be removed by the Contractor prior to testing. Protective covers, if used, shall be removed prior to testing and will be properly replaced by the Contractor after testing. Testing for smoothness shall produce a final trace; a second trace shall be made on segments on which allowable surface correction have been made.

The profilograph shall be propelled at a speed not to exceed 3 miles per hour. Data shall be gathered at lower speeds if the pavement or bridge deck is rough or Profilograms are not being produced clearly.

The profilometer shall be operated at a constant speed as recommended by the manufacturer. The sequence of position of the pavement or bridge deck to be tested will be one pass per driving lane in the wheel path farthest from the edge of a pavement or bridge deck.

Additional profiles will be taken only to define the limits of an out-of-tolerance surface variation. The evaluations shall include graphical traces of the profiles and the disks from which they were derived. The testing and evaluation will be done by a trained and certified operator and the evaluation will be so certified. the City reserves the right to verify the testing and/or evaluation. In case of differences the City ‘s results shall be considered final. If the Contractor’s results are found to be significantly in error, the City may assess the cost of the of the verification efforts.

**B. Evaluation**

**(1) Profile Index**

Unless otherwise specified in Special Provision 431-3QA, a profile index shall be calculated from the profilogram for a pavement or bridge deck on 528 feet extents or entire lengths of bridges (including approach slabs) whichever is less. The index shall be calculated using a computerized profilogram reduction system. It is understood that stations reflected by automatic profilogram interpretation systems are approximate and a further survey in the field may be required to establish bump locations. The index is calculated by summing the vertical deviations outside a 0.2- inch blanking band as indicated on the profile trace. The units of this measure (inches) will be converted into inches per mile. An extent is defined as the amount of pavement of bridge deck in a 528 feet or the entire bridge deck plus both approaches in length, whichever is less. When the quantity represented is less than a full extent in length, it will be Combined with an adjacent extent or treated as a separate extent, at the option of the Contractor.

**(2) Bumps**

Bumps will appear as high points on the profile trace and correspond to high points on the pavement or bridges deck surfaces. Unacceptable bumps are defined as those with vertical deviations in excess of 0.60 inch (without using a blanking band) in a 25-foot span.

**(3) The following will not be excluded from the smoothness requirements:**

**(a)** Shoulders

**(b)** Ramps

**(c)** Turn Lanes

**(d)** Acceleration, deceleration and climbing lanes less than 528 feet full width.

**(e)** Pavement with horizontal centerline curves curves with radii of less than 1000 feet and the super elevation transitions of such curves.

**(f)** In overlays only, areas in roadway within a 10 foot radius of existing Inlets and utility covers. (This exception does not apply to full depth pavements.)

**(g)** Short isolated pavement areas, which by normal industry practice would require handwork.

Examples include driveway blockouts, phased intersection work with variable cross slope,etc.

For the above exceptions, the profile index and adjustments calculations corrections specified in this Special Provision, will not apply. However, the requirements for mandatory correction of bumps as defined in this Special Provision and tolerances defined in subsection 401.04 of the standard Specification for Highway construction will remain in effect.

**1. Special Evacuation Requirements**

Bridge approach slabs will be evaluated in accordance with bridge deck smoothness requirements. New pavements and overlays within 50 feet of bridges or their approach slabs, 50 feet of beginning and ending stations of the Project, or 50 feet of changes from Portland index calculation. However, the requirements for mandatory correction of bumps as defined in this Special Provision and tolerances defined in subsection 401.04 of the Standard Specification for Highway Construction will remain in effect.

**C. Surface Correction**

Unless otherwise permitted by the Engineer, in writing, all new pavements (with or without prior cold milling) and bridge deck surfaces having profile indices in excess of the acceptable limits of 13.0 in/mile for all streets and 27.0 in/mile for all bridges or having individual bumps with deviations in excess of 0.60 inch in a 25 foot span shall be corrected by the Contractor at no additional cost to the City. Such corrective action shall NOT include any grinding of metal expansion joints, themselves, but may include grinding of concrete in the vicinity of the joints.

All corrective action, including the identification and correction of bumps, shall be in accordance with the requirements of the Engineer. The surfaces of ground asphalt pavements shall be fog sealed. The surfaces of corrected areas shall be retextured to be similar to that of the adjacent sections of pavement or bridge deck and shall exhibit good workmanship and be neat in appearance. Cores for thickness determinations and measurement of cover of reinforcement steel will be taken subsequently to all corrective work.

A) General: Provide quality of all construction covered in the project.

B) Quality Control Personnel Qualifications: All personnel directly involved in sampling and/or testing materials for either control or acceptance purposes shall be certified in the appropriate area(s) by the Oklahoma Highway Construction Materials Technician Certification Board. Manager certification for material sampling and testing is not required unless he or she is directly involved in sampling and/or testing materials.

C) Contractor's Quality Control Plan: Submit a written Quality Control Plan at least one week prior to the pre-work conference. Include the following in the plan:

1) Sources of principal materials including names of suppliers and locations.

2) Names and resumes of key Quality Control personnel.

3) Duties, responsibilities, and authorities (to suspend production, alter mixtures, etc.) granted to key Quality Control personnel.

4) Description of testing laboratories, including qualifications, key equipment, and locations.

5) Description of start-up operations, including but not limited to:

a) Review of submittal requirements and all other Contract requirements with the performance of the work.

b) Examine the work area to ascertain that all preliminary work has been completed.

c) Verify all field dimensions and advise the Engineer of any discrepancies.

6) Detailed testing schedule based on production.

7) Control, verification, and acceptance testing procedures for each specific test to include the test name, specification requiring the test, feature of work to be tested, and person responsible for each test.

8) Procedures for tracking construction deficiencies from identification through acceptable corrective action. These procedures will establish verification that identified deficiencies have been corrected.

a) Sampling and Testing: Perform sampling and testing according to the accepted Quality Control plan using personnel certified in appropriate areas

and laboratories approved by the Engineer. Keep laboratory facilities clean and maintain all equipment in proper working condition.

b) Inspection: Provide inspection necessary to ensure compliance with applicable standards and specifications.

c) Records: Maintain complete testing and inspection records and make them accessible to the Engineer.

1. Test Results: Maintain control charts that identify the project number, contract item, test number, each test parameter, the upper and/or lower specification limit applicable to each test parameter, and the test results. Use the control charts as part of the Quality Control system to document process variability, to identify production and equipment problems, to make necessary corrections, and to identify potential pay factor adjustments.

i. Post control charts in an accessible location, keep them up to date, and make them available to the Engineer upon request. Make corrections to the process when problems are evident, including ceasing production if necessary.

2. Inspection Results: For each day of work, prepare an “Inspector’s Daily Record of Construction Operations” on an approved form. Include the following certification signed by the person with overall responsibility for the inspection system:

i. “It is hereby certified that the information contained in this record is accurate, and that all work documented herein complies with the requirements of the contract. Any exceptions to this certification are documented as a part of this record.”

3. Submit the record and certification to the Engineer within two working days of the work being performed. If the record is incomplete, in error, or otherwise misleading, a copy of the record will be returned with corrections noted. When chronic errors or omissions occur, correct the procedures by which the records are produced.

D) Use of Contractor Test Results for Acceptance Purposes: Abbreviated test procedures are allowed for Contractor use. The Quality Control Plan shall list all abbreviated test procedures, describe all deviations from standard procedures for each, and note their intended purpose. Test results from abbreviated procedures will not be used for any purpose by the City of Tulsa. It is the Engineer’s discretion to use or not use any of the Contractor’s test results for acceptance purposes.

E) Changes: Submit, in writing, all proposed changes in key Quality Control personnel, equipment or procedures from those previously approved by the Engineer. Submit written changes at least one week prior to the proposed action.

**SECTION END**

# DIVISION IV

# SANITARY SEWER REHAB CONSTRUCTION SPECIFICATION

## PART 400 – GENERAL PROVISION

400.1 GENERAL

400.1.1 Part 400, general provisions, addresses work required for the adequate completion of the contract, specifically: Contractor's use of premises, sequence of construction, submittals, utilities, and measurement and payment.

400.1.2 Unless otherwise provided for, the order of precedence in case of conflicts or discrepancies between various parts of the contract documents subject to the ruling of the engineer shall generally, but not necessarily, follow the guidelines listed below:

A) Drawings

B) City of Tulsa Standard Construction Specifications

C) Oklahoma Department of Transportation Department Specifications

400.2 CONTRACTOR'S USE OF PREMISES

400.2.1 Confine operations at site to areas permitted by law, ordinances, permits, and the contract documents.

400.2.2 Do not load or permit any part of a structure to be subjected to any force that will endanger its structural integrity or capacity for safe use/operation.

400.2.3 Comply with and enforce City's instructions regarding signs, advertisements, fires, and smoke.

400.2.4 Assume responsibility for protection and safekeeping of products stored on premises.

400.2.5 Do not discharge smoke, dust, or other contaminants into the atmosphere, or fluids or materials into any waterway that will violate regulations of any legally constituted authority.

400.2.6 Move stored products that interfere with the operations of City or other contractors.

400.2.7 Obtain and pay for additional storage or work areas needed for operations.

400.2.8 The steps of the existing manholes cannot be guaranteed for safety; therefore, Contractor shall provide all necessary equipment to assure safe working environment inside the manhole.

400.2.9 The existing facilities will be in continuous operation during the construction period.

400.2.10 Plan and conduct construction operations to avoid disturbing existing structures, piping, equipment, and services in any manner that will interrupt or impair operations, except as approved by City's Representative.

400.2.11 Submit for approval a construction sequence and written explanation of the temporary facilities and appurtenances intended to be used in maintaining the uninterrupted operation of the existing sanitary sewer system and any other affected utilities.

400.3 SEQUENCE OF CONSTRUCTION

400.3.1 Contact property owners 48 hours in advance describing the work to be performed on private property prior to any construction or rehabilitation work on that property. City will provide guidance for notice.

400.3.2 Perform excavation work in an orderly manner so that all excavation work is completed in an area before moving to another area unless the engineer or City gives authorization.

400.3.3 Ensure that all testing has been completed and reviewed by the engineer prior to final surface restoration.

400.3.4 The Contractor shall submit a construction schedule with his first pay request. Revisions to the construction schedule will be submitted with each pay estimate if the Contractor falls more than 10% behind schedule.

400.3.5 No reimbursement will be made to Contractor for any water used to perform the work as required in the contract.

400.3.6 Notify all local residents who will be denied access to their driveways two working days prior to the closure of their access. Access may be denied only during Contractor's working hours.

400.3.7 All driveways that are open cut shall have at least a temporary riding surface provided at the end of each day at no additional cost to City.

400.3.8 All cast iron frames and covers from manhole structures that are required to be removed and not reinstalled in accordance with the manhole rehabilitation schedule shown on the drawings will remain the property of the City and shall be delivered to the City yard by the Contractor.

400.3.9 No work shall be started on highway Rights-of-Way until the utility permit covering this work has been issued by the Oklahoma Department of Transportation.

400.3.10 Keep the work sites free from accumulating waste materials and rubbish caused by Contractor's work or employees. All materials and equipment required on the site shall be kept in such a manner so as to cause a minimum of inconvenience or nuisance to the other contractors and the general public. The site shall be kept broom clean.

400.3.11 Where the Contractor's equipment is operated on any portion of a traveled surface or structures used by traffic on or adjacent to the section under construction, clean the traveled surface of all dirt and the debris at the end of each day's operations. The cost to this work shall be included in the applicable unit price bid and no additional compensation will be allowed.

400.3.12 Protect traveled surfaces and structures on or adjacent to the work in a manner satisfactory to the engineer from damage by lugs or cleats or equipment. Walking of tracked equipment directly on paved streets, driveways, curbs, or sidewalks shall not be allowed.

400.3.13 Equipment used in the performance of the work shall comply with legal loading limits established by the statutes of state and local regulations when moved over or operated on any traveled surface or structure unless permission in writing has been issued by the engineer. Before using any equipment that may exceed the legal loading, the Contractor shall secure a permit, allowing ample time for an analysis of stresses to determine whether or not the proposed loading is within safe limits. The City will not be responsible for any delay in construction operations or for any costs incurred by the Contractor as a result of compliance with the above requirements.

400.4 SUBMITTALS

400.4.1 The information provided herein supplements the information provided in the Specification Part 116.

400.4.2 For each submittal provided, the Contractor shall:

A) Review all shop drawings, project data, and samples before submitting them to the City, and certify that they comply with the contract documents per the information required by the submittal stamp (see paragraph 5 below.)

B) Verify field measurements, field construction criteria, catalog numbers, and similar data.

C) Coordinate each submittal with the requirements of the contract documents.

D) Submit shop drawings for major equipment items in one package to permit checking complete installation details.

E) In a clear space above the title block, or on the back, hand stamp the following and enter the required information:

Project Name: _____

Date: _____

Contract Drawing No.: _____

Specification Section: _____

This document has been checked for accuracy of content and for compliance with the contract documents and is hereby approved. The information contained herein has been coordinated with all involved Contractors.

Contractor: _____

Signed: _____

F) Contractor's responsibility for errors, omissions, and deviations from requirements of the contract documents in submittals is not relieved by the City representative's review.

G) Notify City's representative, in writing at time of submittal, of deviations in submittals from requirements of the contract documents.

H) Do not install materials or equipment until approved by the engineer.

400.4.3 Progress schedule: prepare a detailed progress schedule in graphic form showing proposed dates of starting and completing each major division of work, monthly completion percentages, and anticipated monthly payment requests. The schedule shall be consistent with the sequence requirements of the specifications. Submit three copies to the engineer within ten days after notice to proceed. Submit a revised schedule with each pay request.

400.4.4 The Contractor shall submit preconstruction photos, either still or video, of the area within a 20' radius of any work area and shall submit them to the engineer prior to the start of construction in any work area. Photo documentation shall not be performed more than seven days prior to the start of construction at any individual work site.

400.5 TRAFFIC CONTROL

400.5.1 Conduct the work at all times in such a manner as to insure least obstruction to vehicular and pedestrian traffic while paying particular attention to avoid inconvenience in hospital and school zones. Notify engineer at least three workdays in advance of starting any construction work that might inconvenience or endanger traffic.

400.5.2 Submit a traffic control plan to City traffic engineer and appropriate highway official three days prior to closing any road or construction on any nonresidential street. Inform police, fire, and ambulance service companies 24 hours prior to and on the day of closures.

400.5.3 When any section or portion of road is closed to traffic, provide, erect, and maintain barricades, sequencing arrow panels, red flags, detour signs, and lights at each end of the closed section, at all intersecting roads, and at all other locations shown on the

drawings, in accordance with City requirements and the Oklahoma Department of Transportation, as applicable.

400.5.4 Replace any traffic signs or posts which have been damaged or removed because of the Contractor's operations.

## 400.6 UTILITIES

400.6.1 Utilities and utility locations shown on the drawings are provided based on utility company atlases, typical placement and location, and other information provided to the engineer. Unless otherwise noted, no excavations or field locates have been performed to determine actual locations and/or elevations of utilities.

400.6.2 Notify public and private utility companies which may have overhead or underground facilities in the area at least 48 hours before construction begins. Call Oklahoma One-Call at 1-800-522-6543 for locating utilities. Make necessary arrangements for having these companies locate, protect, brace, or move their facilities as may be necessary for construction of the improvements. Costs incurred due to the moving, bracing, or protection of utilities or in satisfying the requirements of the utility companies will be considered incidental to the cost of the proposed improvement and no separate payment will be made.

400.6.3 Proceed with caution with excavation operations so that the exact location of underground utilities and structures, both known and unknown may be determined. Take all reasonable precautions against damage to the utility or structure. However, in the event of a break in an existing utility, immediately notify a responsible official from the organization operating the utility. Lend all possible assistance in restoring service and assume all costs connected with the repair of any damaged utility.

400.6.4 It is understood and agreed that the Contractor has considered in his bid all of the permanent and temporary utility appurtenances in the present or relocated positions and that no additional compensation will be allowed for any delays, inconvenience, or damage sustained by him due to any interference from the said utility appurtenances or the operation of moving them either by the utility companies or by him; or on account of any special construction methods required in executing his work due to the existence of said appurtenances either in their present or relocated positions.

## 400.7 MEASUREMENT AND PAYMENT

400.7.1 This section describes the method by which construction of this project shall be measured and paid in accordance with proposal. Only those items with a measurement and payment method described in these general provisions, in the standard construction specification, or the special provisions and included in the proposal shall be measured and paid. Any work shown on the drawings or described in the specifications but not specifically covered by the bid items in the proposal shall be included in other items of work. Any work required in the drawings, standard specifications, or special provisions for which no specific bid items is provided is considered to be ancillary and shall be considered as included in other items of work

and the measurement and payment provisions of the standard specifications shall not apply.

400.7.2 The contract price shall cover all work required by the contract documents. All costs in connections with the proper and successful completion of the work, including furnishing all materials, equipment, supplies, and appurtenances; providing all equipment and tools; and performing all necessary labor and supervision to fully complete the work, shall be included in the unit and lump sum prices bid. All work not specifically set forth as a pay item in the contract documents and on the proposal shall be considered a subsidiary obligation of Contractor and all costs in connected therewith shall be included in the contract prices.

400.7.3 Estimated quantities: quantities stipulated in the proposal or contract documents are approximate and may differ from the quantities indicated on the sanitary sewer pipeline and manhole rehabilitation schedules in the drawings and are to be used on (a) as a basis for estimating the probable cost of the work and (b) for the purpose of comparing the bids submitted for the work. The actual amounts of work done and materials furnished under unit price items may differ from the estimated quantities. The basis of payment for work and materials will be the actual amount of work done and materials furnished. 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 estimated amounts thereof.

400.7.4 Measurements and Payments:

A) Payments will be made in accordance with the general conditions for actual quantities constructed or installed in accordance with the contract documents, be they more or less than the listed quantities; said quantities being measured as specified in the standard specifications or special provisions.

B) Mobilization/demobilization shall be bid as an Each, and <u>THE AMOUNT BID SHALL NOT EXCEED TEN PERCENT (10%) OF THE SUM OF ALL BID ITEM EXTENSIONS EXCLUDING MOBILIZATION/DEMOBILIZATION</u>. This item shall include payment for Contractor mobilization and demobilization costs including bonds, insurance, move in and move out of personnel and equipment, project signs and any other costs for mobilization to and demobilization from the site. Mobilization/demobilization shall be paid for on a lump sum basis as follows:

1) 50% of the price bid for mobilization/demobilization may be included in the pay estimate which reflects 5% completion of the work.

2) An additional 25% of the price bid for mobilization/demobilization may be included in the pay estimate which reflects 50% completion of the work.

3) The final 25% of the price bid for mobilization/demobilization may be included on the final pay estimate.

C) The cost of all required photographic documentation shall be included in the lump sum bid for photo documentation and shall include all labor, equipment, and materials necessary to provide the engineer with the required photo documentation. Payment shall be made commensurate with the total percentage of the work completed.

D) The cost to protect existing structures, provide all required submittals, comply with the City's "sequence of construction," specifications, all traffic control, and utility protection/relocation are to be included in other items. No additional payment will be made.

## PART 401 – SITE PREPARATION

401.1 GENERAL

401.1.1 Clear areas necessary for performance of the work and confine operations to that area provided through easements, licenses, agreements, and Rights-of-Way. Entrance upon any lands outside of that area provided by easements, licenses, agreements, or public Rights-of-Way, shall be at the Contractor's sole liability.

401.1.2 Do not occupy any portion of the project site prior to the date established in the Notice to Proceed without prior approval of the Engineer.

401.2 MATERIALS: Not specified.

401.3 EXECUTION

401.3.1 Remove, relocate, reconstruct, or work around natural obstructions, existing facilities and improvements encountered during site preparation as herein specified. Take care while performing site preparation work adjacent to facilities intended to remain in place. Promptly repair damage to existing facilities. Dispose of waste materials in a satisfactory manner off the work site.

401.3.2 Surface Obstructions

A) Saw-cut the obstruction in straight lines or remove it to the nearest construction joint if located within 5’ of the centerline of the trench. In no case shall the joint or line of cut be less than 1’ outside the edge of the trench. Reconstruct surface obstructions removed to permit construction as specified and to the dimensions, lines, and grades of original construction. Restore damaged utilities as required by the utility company at no additional cost to the City.

B) Protect, move, or brace public and private utilities.

C) Maintain mailboxes in the manner that the Postal service requires to prevent interruption of mail delivery.

401.3.3 Site preparation includes the removal of trees, shrubs, brush, crops, and other vegetation within the limits of the easements (Rights-of-Way), or as may be provided for in licenses, permits and agreements. All efforts shall be made to retain existing landscaping. In the event that trees, shrubbery, and hedges cannot be saved, then prior approval of the Engineer must be obtained before the existing landscaping is removed.

A) Trees

1) All trees shall be saved unless removal is approved by the Engineer. Trim trees in accordance with the Engineer's instructions.

B) Shrubbery

1) Shrubbery shall be saved unless removal is approved by the Engineer. Make reasonable efforts to save all shrubbery by trimming, in accordance with acceptable pruning practices, and treating wound surfaces with a commercial pruning compound.

C) Small Plants and Flowers

1) At least 48 hours prior to the start of construction (one week if manhole is to be replaced or partially replaced), notify property owners of the proposed starting date so that the property owners can remove any small plants or flowers.

401.3.4 Fences interfering with construction, and located within public Rights-of-Way or as may be allowed for in permits or agreements, may be removed only if the opening is provided with a temporary gate which will be maintained in a closed position except to permit passage of equipment and vehicles, unless otherwise herein specified. Fences within temporary construction easements may be removed provided that temporary fencing is installed in such a manner as to serve the purpose of the fencing removed.

A) Fencing removed shall be restored to the condition existing prior to construction unless otherwise specified. The Contractor is solely liable for the straying of any animals protected or corralled or other damage caused by any fence so removed.

401.3.5 Private Sewer Facilities

A) Make every reasonable effort to protect private sewer facilities. Private sewer facilities are not shown on the Drawings. When these facilities are disturbed or damaged by the work, make necessary repairs to the facilities to maintain continuous service prior to the close of the workday at no additional cost to the City.

401.3.6 Property Pins

A) Preserve property corners, pins, and markers. In the event any property corners, pins, or markers are removed by the Contractor, such property points shall be replaced at the Contractor's expense and shall be re-set by competent surveyors properly licensed to do such work. In the event such points are section corners or Federal land corners, they shall be referenced and filed with the appropriate authority.

401.3.7 Sodded and Landscaped Areas

A) Minimize disturbance to sodded and/or landscaped thoroughfares and areas on or adjacent to improved property. Do not use such areas as storage sites for construction supplies and insofar as practicable, keep free from stockpiles or excavated materials.

401.4 SUBSURFACE OBSTRUCTION

401.4.1 Where existing utilities and service lines are encountered, notify the owner thereof at least 48 hours (not including weekends and/or holidays) in advance of performing any work in the vicinity.

401.4.2 Excavate, install pipeline, and backfill in the vicinity of such utilities in the manner required by the Engineer and, if requested, under his direct supervision. The Contractor shall be responsible for damages to a public or private utility that may occur as the result of the construction.

401.4.3 Protect, move, or brace public and private utilities as specified in Part 400.6 – Utilities.

401.4.4 Make a reasonable effort to ascertain the existence of obstructions and locate obstructions by digging in advance of machine excavation where definite information is not available as to their exact location. Where such facilities are unexpectedly encountered and damaged, notify responsible officials and other affected parties and arrange for the prompt repair and restoration of service.

401.4.5 MEASUREMENT AND PAYMENT: NO CONTRACT PRICES ARE ESTABLISHED FOR SITE PREPARATION.

## PART 402 – RESTORATION

### 402.1 GENERAL

402.1.1 Restore the project site to conditions not less than that existing prior to starting construction unless otherwise required by these specifications, Permits and/or Licenses, or shown on the Drawings.

402.1.2 Coordinate surface restoration work with the affected private property owners and the Engineer.

402.1.3 Private property over which the City has prior rights (i.e. utility easement, sewer easement) and/or has obtained Rights-of-Way, agreements, licenses and/or agreements from the property owner to allow construction of a sanitary sewer pipeline and appurtenances, shall be restored in conformance with these Contract Documents.

402.1.4 Restore Public property with strict adherence to the requirements of the public body having jurisdiction therein.

A) No restoration shall occur until testing is complete and accepted by the Engineer.

B) Complete final surface restoration within three weeks of the repair or as directed by the Engineer.

402.1.5 Reference Standards

A) Surface restoration including but not limited to pavement, driveways, sidewalks, curb and gutters, and sodding shall be in accordance with contract documents and the current edition of City of Tulsa Standard Specifications.

### 402.2 MATERIALS

402.2.1 Topsoil

A) Topsoil shall be free from large roots, sticks, weeds, brush, stones or other litter and waste products. A minimum of 5-inch plate-compacted depth of topsoil shall be used.

B) The soil texture shall be classified as loam or sandy loam according to the following criteria:

| Loam | Sand Loam |
|---|---|
| Sand (2.0 to 0.05 mm diameter) (No. 10 sieve) | 25-50% 45-85% |
| Silt (0.05 to 0.002 mm diameter) (No. 270 sieve) | 30-50% Less than 50% |
| Clay (smaller than 0.002 mm diameter) | 5-25% Less than 20% |

| | |
|---|---|
| (Hydrometer analysis) | |

C) Soil texture shall be determined by utilizing processes as prescribed in ASTM D422 using the No. 20 and No. 270 sieves and a hydrometer analysis.

402.2.2 Fertilizer

A) Fertilizer shall be a standard commercial 16-8-8, uniform in composition, free flowing and suitable for application with approved equipment, delivered to the site in bags or other convenient containers each fully labeled, conforming to applicable State laws.

402.2.3 Sod

A) Sod shall be approved nursery or field grown grass that is native to the locality of the work and shall match existing in the area of excavation. Sod shall be well rooted in soil of such consistency that it will not break, crumble, or tear during handling and placing. Sod shall be free of noxious weeds and other objectionable plants and shall not contain substances injurious to growth.

B) Grass shall be between 1-1/2” and 4” in length when the sod is cut. The sod shall be cut within 48 hours of placement in rectangular pieces not less than 12” in width and not less than 1" in soil thickness. Keep sod in a moist condition between the initiation of cutting and the completing of placing and protect against exposure to the sun, wind, freezing during transportation to the site, and during storage prior to placing.

402.2.4 Portland Cement Concrete

A) Portland Cement concrete shall have minimum compression strength of 5000 psi at 28 days and meet the requirements of Part 329 of the City of Tulsa Construction Specifications.

402.2.5 Curing Compound Commercial grade conforming to ASTM C309, Type I.

402.2.6 Reinforcing Steel: Conform to ASTM A615, Grade 40.

402.2.7 Asphalt Cement, Prime Coat and Tack Coat.

402.2.8 Asphalt Concrete

A) Asphalt for paving shall be Type B top lift and Type A base lift as per Oklahoma Department of Transportation Section 708, and Part 329 of the City of Tulsa Standard Specifications.

402.2.9 Gravel Resurfacing

402.2.10 Wearing surface on gravel surfaced streets or drives shall be replaced with 9” of compacted gravel backfill with a minimum P.I. of 4. The material shall be required to meet the sieve test of the current ASTM E11 for conformity to ASTM D448 for a Standard Aggregate Size Number 67 and a percent of wear test not to exceed 35 when tested in accordance with ASTM C131.

402.3 EXECUTION

402.4 CLEANUP

402.4.1 Upon completion of installation and backfill operations, clean and dress up the work area as follows.

A) Remove construction debris and litter from the site.

B) Remove excess excavation material from the site including material that has washed into streambeds, storm water facilities, streets, culverts, etc.

C) Remove tools, equipment, and construction materials except for designated storage areas along the pipeline route. Maintain designated storage areas in a neat appearing manner.

D) Restore surface and subsurface drainage and provide drainage wash checks necessary to prevent soils from being washed downstream.

E) Machine-grade the area in preparation of final grading, seeding, sodding, pavement replacement, etc.

F) Restore all street signs and mailboxes.

G) Maintain adequate safety signs, barricades, and lights until final restoration of work area is completed.

402.4.2 Finish Grading

A) Finish grade the area to lines and grades which existed prior to the area being disturbed, with special attention directed to proper surface drainage, and the refilling of settled excavations with earth compacted to densities required. The area shall be smoothed by raking or dragging. Flower and vegetable gardens in existence prior to this project shall have the separately stored topsoil restored unless otherwise required. Areas to be sodded or seeded shall have a minimum 5-inch depth of topsoil.

402.4.3 Sod

A) Restore grassed areas disturbed by construction with sod to match existing. Sod may be placed between the average date of the last freeze in the Spring and six weeks prior to the average date for the first freeze in the Fall according to the

Almanac or U.S. Weather Bureau for the area unless otherwise approved by the Engineer in writing. Place sod at any time during this period except when the temperature is over 90° Fahrenheit, drought conditions exist, or the sod or ground surface is frozen. Cut sod as thick as possible to aid the sod in taking root at the earliest possible date.

B) Spread fertilizer nutrients over the area at a rate of 160 pounds per acre (nutrient weight only) or as recommended by the manufacturer.

C) Place sod on the prepared surface with the edges in close contact and the alternate courses staggered. Bury exposed edges of the sod flush with the adjacent soil. In ditches, Place sod with the longer dimension perpendicular to the flow of the water in the ditch. On slopes, starting at the bottom of the slope, place sod with the longer dimension perpendicular to the slope of the ground and where the slope is 2:1 or greater, stake the sod. Sod shall be rolled after placement and joints filled between sections with scarified soil. Within eight hours after placing the sod, apply five gallons of water per square yard.

D) Provide sufficient water to prevent the sod from drying out.

E) Existing sod, which was salvaged during construction, may be reused at the Contractor's option.

F) Sod shall have taken root before acceptance Contractor shall guarantee sodding one year after acceptance by the City.

402.4.4 Tree, Bush, and Hedge Transplanting and Replacement

A) Existing trees, bushes, and hedges which cannot be tied back or trimmed to prevent damage and require removal because of the proposed construction shall be transplanted with a tree spade or replaced. Tree removal shall include removal of stump and roots 4” below grade. Transplanting shall be at the location directed by the Engineer. After digging the plants, properly store them until they can be transplanted. Replacement plants shall not be delivered until they can be planted.

B) Plant during the proper seasons. Do not plant in frozen soil or during unfavorable weather conditions. Dig tree pits of such size as to provide ample space for the entire root system, as the tree comes from the nursery, without crowding or bending the roots. The pits shall be 12” wider than the ball diameter, have vertical sides, and be 6” deeper than the thickness of the ball. Thoroughly loosen the soil in the bottom of the pit by spading to a depth of 6”. Dig holes immediately before planting. Dispose of soil earth dug from the tree pits.

C) Set trees at a depth slightly above finished grade, half-fill the hole with planting soil and thoroughly water. Loosen and fold down the upper half of the burlap, fill the hole with planting soil and thoroughly water. Fill the top 2” with well-rotted mulch.

D) After planting, prune the branches in proportion to the amount of root system lost in the transplanting operations but in such a manner as to retain the form typical of the tree. In general, remove approximately 1/3 of the branch structure. Pruning shall be done by expert workmen in such a manner as to insure healthy and symmetrical growth of new wood.

E) After planting, wrap trunks of trees planted after October 15 with special tree wrap from the crotch of the first major branches down to the ground. Tie wrapping with cotton twine to keep the wrapping in place.

F) Plant trees vertically. Trees found leaning during the guarantee period shall immediately be staked with two 2” x 3” wood stakes, 8’ long, pointed on one end. The stake shall be long enough to properly support the tree. Drive the stakes to a depth of 18” below the bottom of the tree pit. Locate the stakes on the north side and the south side of the tree, and 12” to 18” from the trunk. Do not drive stakes into the ball and burlap. Guy the trees using a figure eight hitch consisting of No. 14 gauge wire encased in a section of rubber hose.

402.4.5 Restoration of Pavement Surfaces

A) Restore (unless otherwise specified or ordered by the Engineer) permanent type pavements, sidewalks, driveways, curbs, gutters, and surface structures removed or disturbed during or as a result of construction operations to a condition which is equal in appearance and quality to the condition that existed before the work began. The surface of all improvements shall match the appearance of the existing surface.

B) Pour concrete only after inspection by the Engineer of the pouring site to verify proper forms and reinforcement. Reinforcement shall be equal in quantity and type of materials to reinforcement that existed prior to the work, or as indicated in the plans or specifications.

C) Saw-cut existing paved surfaces to provide a straight joint between the existing and new surface. Saw cutting shall be full depth and square or rectangular in shape.

D) Cure and protect all exposed concrete installed under this contract in accordance with the reference standard.

E) Allow concrete to attain a minimum seven-day strength before allowing traffic or construction equipment on the concrete.

F) Remove entire sidewalk squares. Removal of partial squares shall not be allowed.

402.5 CONCRETE SIDEWALKS

402.5.1 Concrete sidewalks shall consist of a minimum thickness of 4” of non-reinforced Portland cement concrete over 4” of compacted granular material.

402.5.2 Increase sidewalk thickness to 6” when crossing residential driveways.

402.5.3 Place 1/2" preformed bituminous expansion joints at junctions with existing work and at intervals not exceeding 50', or as directed by the Engineer.

402.5.4 Saw-cut existing sidewalks at construction joints. Patching existing sidewalk squares damaged during construction activities shall not be allowed.

402.5.5 When removing portions of a concrete sidewalk, an entire square shall be removed. Removal of a partial sidewalk square shall not be allowed.

402.5.6 At locations where sidewalks intersect with streets and sidewalk restoration is required, Contractor shall construct wheelchair ramps in accordance with the detail shown in Standards.

402.6 CONCRETE CURB AND GUTTER

402.6.1 Curb and Gutter dimensions and cross sections shall conform with existing installations.

402.6.2 Place two dowels at each junction with existing work. Dowels shall be 3/4" diameter and a minimum of 12" in length.

402.6.3 Place 1/2" preformed bituminous expansion joints at junctions with existing work and at intervals not exceeding 50', or as directed by the Engineer.

402.6.4 Place doweled expansion joints at intervals not exceeding 50', or as directed by the Engineer.

402.6.5 Saw-cut control joints at intervals not exceeding 20' and at junctions with existing traverse cracks in the pavement, or as directed by the Engineer.

402.7 CONCRETE DRIVEWAYS

402.7.1 Replace concrete driveways to the condition and thickness that existed prior to construction. Minimum thickness shall be 6".

402.8 BITUMINOUS CONCRETE DRIVEWAY

402.8.1 Replace bituminous driveways to the condition and thickness that existed prior to construction. Minimum thickness shall be 2". Construction shall be executed in accordance with Asphalt Concrete Pavement Replacement for Pipe Trenches.

402.9 TACK COAT

402.9.1 Apply a tack coat on existing asphalt concrete pavement and to each lift of new pavement that is to receive a succeeding lift in conformance with applicable requirements of Oklahoma Department of Transportation (ODOT) Section 708.

402.10 PRIME COAT

402.10.1 The prime coat shall be applied to the leveling course in accordance with applicable requirements of Oklahoma Department of Transportation Section 708 at the rate of 0.20 to 0.30-gallon per square yard of surface area. The exact amount is to be determined by the Engineer.

402.11 CONSTRUCTION OF ASPHALT CONCRETE PAVEMENT

A) Lay asphalt concrete over the base course in a single lift and the compacted depth shall be 3". The method of proportioning, mixing, transporting, laying, processing, rolling the material, and the standards of workmanship shall conform to the applicable requirements of ODOT Section 708 of the Standard Specifications.

B) The Engineer will examine the base before the paving is begun and bring any deficiencies to the Contractor's attention to be corrected before the paving is started. Roll each lift of the asphalt concrete and compact to the density specified in the referenced Standard Specification for Highway Construction. The grade, line, and cross section of the finished surface shall conform to the Drawings. Asphalt or asphalt stains which are noticeable upon surfaces of concrete or materials, which will be exposed to view, shall be promptly and completely removed.

402.12 ASPHALT HIGHWAY REPAIR

402.12.1 Asphalt Highway Repair shall be in accordance with the Oklahoma Department of Transportation Standard Specifications for Highway Construction.

402.13 CONCRETE HIGHWAY REPAIR

402.13.1 Concrete Highway repair shall be in accordance with the Oklahoma Department of Transportation Standard Specifications for Highway Construction.

402.14 WEATHER CONDITIONS

402.14.1 Asphalt shall not be applied to wet material. Asphalt shall not be applied during rainfall, sand or dust storm, or any imminent storms that might adversely affect the construction. The Engineer will determine when surfaces and material are dry enough to proceed with construction. Asphalt concrete shall not be placed: 1) when the atmospheric temperature is lower than 40º F, 2) during heavy rainfall, or 3) when the surface upon which it is to be placed is frozen or wet. Asphalt for prime coat shall not be applied when the surface temperature is less than 50º F. Exceptions will be permitted only in special cases and only with prior written approval of the Engineer.

402.15 CONCRETE PAVEMENT

402.15.1 Pavement replacement shall be as shown on the typical section for Manhole restoration. Protect the newly placed concrete from traffic for a period of seven days

and cure by covering with burlap, sand, earth, or sawdust, which is kept continuously wet.

402.15.2 Handle and place concrete pavement in accordance with the Standard Specifications for Highway Construction of the Oklahoma Department of Transportation.

## 402.16 FENCE REMOVAL AND REPLACEMENT

402.16.1 Restore or replace existing fences that were removed or disturbed during or as a result of construction operations, to a condition equal in appearance and quality to the condition that existed before the work began.

## 402.17 MEASUREMENT AND PAYMENT

402.17.1 Sidewalk and Driveway Removal and replacement, Pavement Removal and Replacement, Gravel Resurfacing, Replacement of Curb and Gutter, Fence Removal and Replacement, and Sodding, are considered to be Restoration work items. Payment for Restoration work items will be as follows:

402.17.2 Payment for Sidewalk and Driveway Removal and Replacement, and Pavement Removal and Replacement shall be made at the unit price bid, per square yard replaced, as measured along the centerline of the sanitary sewer pipe being replaced. Sodding will be made at unit bid prices bid, per square yard, as measured along the centerline of the line being replaced. Payment will be made for open cut pipeline replacement only (except for open cut point repairs, where all surface restoration is subsidiary).

402.17.3 Gravel Resurfacing Payment shall be made at the unit price bid per linear foot, in accordance with City of Tulsa Standards, as measured along the centerline of the sanitary sewer pipe being replaced. Payment will be made for open cut pipeline replacement only (except for open cut point repairs, where all surface restoration is subsidiary).

402.17.4 Replacement of Curb and Gutter Payment shall be made at the unit price bid per linear foot of Curb and Gutter actually removed and replaced.

402.17.5 All other restoration work items discussed in this section are considered subsidiary and shall not be paid for directly.

## PART 403 – BACKFILL

403.1 GENERAL

403.1.1 This section governs all labor, equipment, materials, and testing required to properly backfill trenches and excavations around manholes and structures.

403.1.2 No granular embedment or other backfill material shall be used by the Contractor without approval by the Engineer.

403.2 MATERIALS

403.2.1 Trench Foundations Materials: 3” minus river-run or pit-run gravel, free from clay balls, roots, and organic matter; well crushed gravel or crushed rock graded with less than 8% by weight passing the 1/4" sieve. Submit samples for approval prior to delivery of the material to the site. Trench foundation material shall only be used where unsuitable soil conditions are encountered under sewers before the depth of standard embedment is reached. Where necessary, install a water table cradle as shown on the Standard Details.

403.2.2 Embedment: Embedment material shall be as shown on the Standard Details, as applicable.

403.2.3 Trench Backfill: Trench backfill will be divided into the general classification as follows:

A) Street Backfill: Street backfill material above the pipe embedment material shall be ODOT Type A aggregate base compacted to 95% Standard Proctor density per AASHTO T 99.

B) Trench Backfill: Backfill for trenches in unpaved areas shall meet the following requirements: Excavated material free from roots, organic matter, trash, debris, and other deleterious materials. Contractor may provide imported material of equivalent quality, subject to Engineer approval, if required to accomplish the work. Rocks larger than 3 inches shall not be allowed within 15 inches below finished grade and within 18 inches above the pipe crown.

403.3 DESCRIPTION

403.3.1 The Contractor shall be responsible for the furnishing of all labor, supervision, materials, equipment, and testing for the completion of backfill operations in accordance with the Contract Documents.

A) Unless otherwise specified, all sewer trenches and excavation around structures shall be backfilled to the original surface of the ground.

B) The Contractor shall be responsible for all damage or damages which might occur as a result of the settlement of trench or other backfill made by him in the fulfillment of these Contract Documents, within and during a period of one year from and after

the date of final acceptance thereof by the City, including the cost to the City of all claims of damages filed with and court actions brought against the said City for and because of such damage, and the repair to the satisfaction of the Engineer of any and each pavement, driveway, curb, slab, walk, or structure damages by such backfill settlement.

403.4 EXECUTION

403.4.1 Remove trash and debris from the excavation prior to backfilling.

403.4.2 Backfilling trenches and excavations to the original ground surface unless otherwise indicated on the Drawings.

403.4.3 Carefully place backfill materials to avoid damage to or displacement of the pipeline and other exposed utilities or structure.

403.4.4 Do not backfill with frozen material or when a blanket of snow prevents proper compaction. Backfill shall not contain waste material, trees, organic material, rubbish, or other deleterious substances.

403.4.5 The backfill material shall be placed in lifts. Each lift shall be compacted to the required density prior to the next lift being placed.

403.4.6 In gardens or flower gardens, the original topsoil shall be replaced to original elevation, location, and depth. Minimum depth shall be 12”.

403.5 BACKFILLING STREET RIGHTS-OF-WAY AND PAVEMENT AREAS

403.5.1 Backfill trenches under and within 2’ of all existing and proposed pavement, driveway pavement, sidewalk, and curb and gutter using ODOT Type A aggregate base.

403.5.2 Compaction Method

A) Granular trench backfill shall be mechanically compacted in layers of 8” loose measure. Each layer shall be firmly compacted to 95% of Standard Proctor density as determined by ASSHTO T99. Material may be compacted by tamping or by using surface vibrators in such a manner as not to disturb or injure the pipe. At least 72” of cover over sewer pipe shall be provided before using mobile trench compactors of the hydrohammer or impactor type.

403.5.3 Undermining of Paved Surfaces: Where undermining of paved surfaces has occurred, Contractor shall remove the paved surface above the undermined area prior to placing backfill.

403.6 BACKFILLING IN AREAS OTHER THAN STREET RIGHTS-OF-WAY AND PAVEMENT AREAS

403.6.1 Backfill trenches using acceptable job excavated materials or as directed by the Engineer.

403.6.2 Backfill in 12-inch maximum loose lifts and mechanically compact to 90% of maximum density as defined by AASHTO T 99 (Standard Proctor test).

403.6.3 Place a minimum of 18” of granular backfill above the top of pipe in areas where the existing surface elevation is less than 24” above the proposed top of pipe. The granular backfill shall extend 1’ from each side of the pipe and shall be placed at a 1:1 slope to bedding material or the existing ground surface.

403.7 CLAY DAMS

403.7.1 Clay dams shall be installed where shown on the plans. The dams shall be constructed in such a manner that an impervious barrier is constructed to prevent ground water from following the pipeline trench past the new construction.

403.7.2 The work will be constructed in accordance with details in these specifications.

403.8 TESTING

403.8.1 All density tests shall be performed per AASHTO standards by the City of Tulsa.

403.8.2 Tests shall be performed to meet the required density.

403.8.3 The cost of providing access to the level of trench backfill to be tested will be a cost to the Contractor, and no extra compensation will be allowed for exposing of the backfill layer to be tested.

403.8.4 Tests which indicate compaction results non-conforming to specified densities shall be re-compacted to proper density by the Contractor at no additional cost to City.

403.9 RESPONSIBILITY OF CONTRACTOR FOR BACKFILL SETTLEMENT

403.9.1 Wherever trenches or other excavations made by the Contractor in the performance of work under these Contract Documents have not been properly filled, or where settlement has occurred at any time prior to the expiration of the one year correction period, to the extent that the top of the backfill is below the original ground surface, such trenches shall be refilled and the backfilled surface compacted and smoothed to conform to the elevation of the adjacent ground surface. All sod in lawns or pavement damaged by reasons of such settlement, and the repair thereof, shall be replaced at no additional cost to City.

403.10 MEASUREMENT AND PAYMENT

403.10.1 Payment for the work in this section is considered subsidiary to other items of work and will not be paid for directly.

## PART 404 – REMOVAL, SALVAGE, AND ABANDONMENT OF EXISTING FACILITIES

See Part 333 in Division III – Construction Specifications for requirements.

## PART 405 – PIPELINE AND INSTALLATION

405.1 GENERAL

405.1.1 INTENT: The work under this item shall include furnishing, hauling, placing, and jointing of cast iron, ductile iron, vitrified clay pipe and PVC pipe in the trench in specific conformity with the lines and levels given.

405.1.2 RELATED WORK: Testing, and other general requirements for construction of pipe utilities are included in other sections of the Specifications.

405.1.3 PRESSURE PIPELINES: All fittings or specials included as pipe shall be restrained or blocked in accordance with the Standard Details and/or as determined by the Engineer. Restrained joint lengths as determined by the Engineer shall be shown in the plan and profile drawings. Where restrained joints are specified or required, they shall be of a mechanical type or push-on type assembly easily removed in field once assembled without special equipment. Assemblies shall be ANSI/AWWA rated. Thrust blocks for joint restraint shall not be installed without prior approval by the Director of Water and Sewer. Set screw type retainer glands will not be permitted.

405.2 QUALITY CONTROL

405.2.1 The Engineer shall have the right to reject pipe based upon visual defects including out-of-roundness, rough interior, discoloration, warping, or other visual defects which, in the opinion of the Engineer, affect the function or life of the pipe.

405.3 MATERIALS – DUCTILE IRON PIPE

405.3.1 Materials shall conform to Part 203 – Ductile Iron Pipe, Ductile and Cast-Iron Fittings, and Valves.

405.3.2 Sleeve couplings shall be Dresser Style 38 or equal, 7" x 3/8" designed for the specified pipe pressure class and shall have middle rings equal in thickness to that of the adjoining pipe. Couplings shall have plain gaskets, Grade 27. All fittings, bolts and related components shall be epoxy coated. Unless noted otherwise, joint harnesses shall be provided at sleeve couplings.

405.4 COATING, LINING, AND POLYETHYLENE WRAP

405.4.1 Cast iron and ductile iron pipe and fittings 12” I.D. and smaller shall be bituminous coated outside in accordance with AWWA C151, and cement-mortar lined inside with seal coat in accordance with American Standard for Cement Mortar Lining for Cast Iron Pipe and Fittings for Water, AWWA Designation C104. See section 203.1.6 for coatings associated with sanitary sewer lines 15” I.D. and larger.

405.4.2 Polyethylene tube shall be furnished with all DIP pipe and fittings per section 202.3 of City of Tulsa Standard Specifications. Polyethylene tube shall be in accordance with AWWA C105. It shall be made from virgin polyethylene resin in accordance with ASTM

Specification 31248. Thickness shall not be less than 8 mils (.008”). The material shall be chemically inert and moisture resistant to form an effective seal against penetration by water or vapor. Tensile strength shall be 1800 psi with elongation of 500%. The material shall be Polyetube, or equal, as manufactured by Polyetube Corporation, Birmingham, Alabama. Tape of polyethylene tube shall be plastic-backed adhesive tape, Polykan #900 or Scotchrap #50 or equal, 2” in width. The tube shall be of such length that a 1’ overlap is provided at each joint in pipe.

405.5 MATERIALS – PVC PIPE

405.5.1 Material shall conform to Part 208 – Polyvinyl Chloride (PVC) Pipe, Sewer Service.

405.6 EXECUTION – DUCTILE IRON PIPE

405.6.1 INSTALLATION: Installation method shall conform to Part 307.1 of the City of Tulsa Construction Specifications.

405.6.2 If a joint is to be deflected, it shall be made up in a straight line before deflecting and shall be in accordance with the manufacturer's recommendations.

405.7 GRAVITY PIPELINES

405.7.1 Joints between ductile iron pipe and other types of pipe shall be made with an AWWA C110 long body solid sleeve or another adapter as approved by the Engineer. If adapters are not available, the joint shall be made as instructed by the Engineer and encased with concrete 1’ each side of the joint.

405.7.2 The pipe shall be laid on a firm trench bottom, true to the lines and grades shown on the Plans and/or as given by the Engineer. The laying of the pipe in finished trenches shall be commenced at the lowest point, with the plain end pointing in the direction of flow. The ends of adjoining pipes shall butt against each other for their entire circumference so there is no shoulder or unevenness of any kind.

405.7.3 Pipe grade shall be obtained using laser beam, other electronic equipment, or batter boards and a "top line.” The equipment and proposed method of use shall be approved by the Engineer.

405.7.4 Clean joint contact surfaces immediately prior to jointing. Use lubricants and other materials recommended by the pipe manufacturer.

405.7.5 Backfill trenches immediately after pipe is laid in accordance with Part 403 BACKFILL and Part 402 RESTORATION.

405.8 EXECUTION – PVC SEWER PIPE

405.8.1 PVC sewer pipe shall be installed in accordance with the Standard Details and with ASTM D2321, Recommended Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe, latest edition.

405.8.2 Thirty days minimum after backfill is in place, PVC sewer pipe shall be measured for vertical ring deflection using a deflection testing mandrel in accordance with the Standard Details. The deflection testing shall be done by the Contractor in the presence of the Engineer or his designated representative. Maximum ring deflection of the installed pipe shall be limited to 5% of the average inside diameter as defined by ASTM Designation D2680. All pipe exceeding the allowable deflection shall be replaced by the Contractor at no additional cost to the Owner. Equipment used in making the measurements shall be subject to the approval of the Engineer. The Contractor will furnish the appropriate mandrel for the deflection test. Mechanical devices to pull the mandrel through the pipe will not be allowed.

405.8.3 Manhole water stop gasket and clamps assembly shall be constructed at each point where PVC sewer pipe enters/exits manhole. Fluted gasket shall be placed around pipe secured with stainless steel retainer ring. Standard o-ring coupling shall be placed around manhole water stop assembly. Engineer shall approve water stop assembly.

405.8.4 Sewer Service Laterals and Connections

A) Service shall be located and exposed before replacement operations.

B) All service laterals attached to the existing sewer shall be completely disconnected and isolated from the existing sewer before the replacement operation. (Note: Failure to do this may result in damage to laterals.)

C) Service laterals shall not be reconnected to new sewer line until installation and testing are completed. Contractor is responsible to verify each service connection to determine whether it is active or inactive. All service connections to existing buildings are to be reconnected, except where disconnection is approved by the Engineer. Service connection to a vacated lot shall not be reconnected. If more than one service is found per lot, then the Contractor shall verify that service connections are active by introducing dye into the lines at cleanouts, vents stacks or other access points as approved by the Engineer. Dye testing shall be recorded by CCTV inspection at the location in the main line where the dye appears. All addresses will be noted on log sheets for future references. Provide the address of all reconnected and disconnected services.

D) Reconnection factory tees and materials shall be as approved by the Engineer for the type of new pipe installed and lateral pipe.

405.9 MANHOLES

A) Sewer pipe entrances and exits to manholes shall be opened out to appropriate dimensions and may require that modifications be made to invert before the replacement operation if the tool and new pipe is planned to traverse the manhole without interruption during the operation.

405.10 SURFACE RESTORATION

405.10.1 Service and lateral pits, and other work areas shall be restored to condition as good as that before construction occurred. Disturbed grassed areas shall be sodded in accordance with Part 402 – RESTORATION. Pavements removed or damaged shall be replaced at Contractor's expense in accordance with these specifications.

405.11 TESTING

405.12 MEASUREMENT AND PAYMENT

405.12.1 PIPE: Payment shall be made at the unit price bid per linear foot of pipe of the size and type specified in the Bid Schedule and placed as shown on the Drawings. Total footage shall be the actual measurement along the centerline of the pipe, measured to the nearest 0.1', center of manhole to center of manhole, less 1/2 the diameter of both the upstream and downstream manholes. No additional payment shall be made for vertical pipe or fittings used with drop manholes, or fittings or specials included as pipe for concrete blocking.

405.12.2 The prices shall be payment in full for performing and completing the work and for furnishing all labor and materials necessary including excavation and removal of existing structure, pipe materials, pipe sealing materials, trench safety system, backfilling, all testing, bypass pumping and all incidental costs.

## PART 406 – PIPE REAMING

406.1 GENERAL

406.1.1 This section governs all work, materials, and testing for installation of pipe by the trenchless method of reaming existing pipes as shown on the Drawings and in conformity with these specifications. The operation shall be conducted with a directional drilling machine and a reamer that grinds and pulverizes the pipe, the excess peripheral material flushed and removed with the drilling fluids and the replacement pipe of the required size pulled into place simultaneously.

406.1.2 Description: Pipe installation shall consist of furnishing all labor, materials, and equipment for the complete installation of pipe in accordance with Contract Drawings, General Conditions, and these specifications.

406.1.3 Specification modifications: It is understood that throughout this section Specifications may be modified in accordance with the appropriate section(s) of the Contract Documents.

406.1.4 Revisions of Standards: When reference is made to a Standard Specification, i.e., ASTM, ANSI, AWWA, the Specification referred to shall be understood to mean the latest revision of said specification as amended at the time of the Notice to Bidders, except as noted on the Drawings, or in the Contract Documents.

406.1.5 Submittals: The Contractor shall provide certifications, shop drawings, or samples on all materials provided under these specifications.

406.1.6 Experience: The Contractor shall have experience installing line using the pipe reaming system, with a minimum of 10,000’ in installations, demonstrate proof of instruction by the licensor of such system, or provide on-site advisory services of the licensor until such time that the contractor’s competency to perform this work is acceptable to the owner’s representative.

406.1.7 Pipe Reaming Preparation. The following preparation work shall be performed by CONTRACTOR unless otherwise approved by Engineer.

A) Safety. CONTRACTOR shall carry out his operation in accordance with OSHA standards and recommended safety standards of the manufacturer. Particular attention is directed to safety standards and practices applicable to work performed involving scaffolding and confined spaces.

B) Bypassing Sewage. CONTRACTOR, when required, shall provide for the flow of sewage around the section or sections of pipe that are to be rehabilitated. The bypass shall be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle anticipated wet weather flow.

C) Interruption of Service. When preparing to make a connection to the existing system or other work, which will interrupt service to the utility users, CONTRACTOR shall notify the affected user at least 48 hours in advance of service interruption, stating the approximate time and duration of interruption of service. Advance notification shall not extend beyond 72 hours. CONTRACTOR shall coordinate with the authorities having jurisdiction, any necessary interruption of service and shall limit such interruption to the duration mutually agreeable to both parties.

406.1.8 Manhole Replacement. In those places where the insertion pit shaft is excavated at an existing manhole, the manhole shall be replaced with a new manhole conforming to Part 416, Complete Manhole Replacement and in accordance with the Details. Where manhole replacement is specified at locations not scheduled to be an insertion pit, The CONTRACTOR may, at the discretion of the ENGINEER, do a complete rehabilitation of the manhole in accordance with Parts 416 through 421. Costs for such work are incidental to the project and shall be the responsibility of CONTRACTOR.

406.1.9 Sealing Pipe in Manhole. The annular space between the replacement pipe and the existing sewer line shall be sealed where the sewer line enters or exits each manhole. This annular space shall be sealed for a distance of 12” to 18” inside the old sewer line with a non-shrink grout. The method of sealing shall be approved by ENGINEER.

A) Sealant should not protrude into the manhole more than 1” and shall be finished over with a quick-set, non-shrink type of cement grout. Finishing inside the manhole shall be accomplished using a quick-set cement type grout to raise the manhole trough to the invert of the replacement pipe, as required.

406.2 REFERENCE SPECIFICATIONS

406.2.1 This Specification references American Society of Testing Materials (ASTM) Standard Specifications, which are made a part hereof by such reference and shall be the latest edition and revision thereof.

406.3 MATERIALS

406.3.1 This Section governs materials required to complete pipe installation by the pipe reaming method as shown on the Drawings and/or provided for in the Contract Documents.

406.3.2 Pipe and Fittings

A) Polyvinyl Chloride (PVC) Pipe

1) PVC pipe shall be a restrained joint type such as Certa-Lok™ or Yelomine™ manufactured by CertainTeed Corporation and conform to the requirements of ASTM D2241, “Standard Specification for Polyvinyl Chloride (PVC) C-900, and manufactured from Type 1, Grade 1, 2000 psi hydrostatic design stress Polyvinyl Chloride compound and materials in accordance with ASTM D1784 Class 12454-B, or other restrained joint PVC pipe meeting these specifications

and capable of withstanding the stresses imposed on the pipe during installation.

2) Joints shall meet the requirements of ASTM D3139, “Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.”

3) O-rings shall meet the requirements of ASTM F477, “Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.”

4) The minimum wall thickness shall not be less than DR 14.

406.4 MATERIAL TESTS

406.4.1 test for compliance with this Specification shall be made according to the applicable ASTM Specification. A certificate of compliance with this Specification upon request shall be provided by CONTRACTOR for all material furnished under this Specification. In addition, CONTRACTOR may, at his own expense, witness inspection and test of the compliance with this Specification upon request shall be provided by the manufacturer for all material furnished under this Specification.

406.5 REJECTION

406.5.1 Any material may be rejected for failure to meet any of the requirements of this Specification.

406.6 SERVICE CONNECTIONS

406.6.1 After the replacement pipe has been secured, service connections shall be excavated and reconnected to the new pipe. All service connections to existing buildings are to be reconnected, except where disconnection is approved by the Engineer. Service connection to a vacated lot shall not be reconnected. If more than one service is found per lot, then the Contractor shall verify that service connections are active by introducing dye into the lines at cleanouts, vents stacks, or other access points as approved by the Engineer. Dye testing shall be recorded by CCTV inspection at the location in the main line where the dye appears. All addresses will be noted on log sheets for future references. Provide the address of all reconnected and disconnected services. The replacement pipe shall be exposed to provide adequate working space for making the new service connection. Service laterals shall be connected to the liner pipe using approved saddle connections, INSERTATEE, or equal. Service interruptions to any homes tributary to the sewer line being rehabilitated shall not exceed 36 hours. Care shall be used not to damage the pipe. If damage occurs as a result of the Contractor’s operations, the CONTRACTOR shall assume all cost associated with the repair of the pipe.

406.7 BACKFILL

406.7.1 At all points where the reamed pipe has been exposed (such as at the insertion pit or at service connection fittings), the pipe and fittings shall be backfilled and compacted

to required finished grade in accordance with Part 302 EXCAVATION AND BACKFILL, Part 402 RESTORATION, and Part 403 BACKFILL.

406.8 FINAL ACCEPTANCE

406.8.1 After installation of the replacement pipe, CONTRACTOR shall TV inspect the sewer line as specified and perform the following test on the sewer line. Deformation of the replacement pipe of 6% or more, as determined by a standard mandrel test following construction, shall be reason for rejection of the installation.

406.8.2 Testing. After installation and before any service connections are reinstated, CONTRACTOR shall run a test on the sewer line to determine if it is watertight.

406.8.3 CONTRACTOR shall furnish all necessary equipment to conduct the test. An acceptable method is a low-pressure air test, conducted as follows:

A) Pressurize the test section to 4.0 psi and hold above 3.5 psi for not less than two minutes. Add air if necessary, to keep the pressure above 3.5 psi. At the end of this two-minute stabilization period, note the pressure (must be 3.5 psi minimum) and begin the timed period. If the pressure drops 0.5 psi in less than the time given in the table below, the section of pipe shall have failed the test.

| Carrier Pipe Diameter (inches) | Minimum Elapsed Time (minutes) |
|---|---|
| 8 | 4 |
| 10 | 5 |
| 12 | 6 |

B) When the prevailing groundwater is above the sewer being tested, test pressure shall be increased 0.43 psi for each foot that the water table is above the invert of the sewer.

C) If the time for the pressure to drop 0.5 psi is 125% or less of the time given in the table, the line shall immediately be repressurized to 3.5 psi and the test repeated.

D) If building service connections have been reinstated before the air test, they shall be considered part of the pipe to which they are connected, and no adjustment of test time shall be allowed.

E) The pressure gauge used shall be supplied by CONTRACTOR and have minimum divisions of 0.10 psi and shall have an accuracy of 0.004 psi.

F) Payment for air pressure tests, including the furnishings and installing of all equipment and materials, conducting the pressure test, and making all necessary repairs shall be considered as incidental to the Contract amount.

406.9 CLEANUP

406.9.1 After the installation work has been completed and all testing acceptable, CONTRACTOR shall clean up the entire project area and return the ground cover to grade. All excess material and debris not incorporated into the permanent installation shall be disposed of by CONTRACTOR.

406.10 MEASUREMENT AND PAYMENT

406.10.1 Pipeline Reaming shall be paid for at the Contract Unit Price as follows: The unit price shall cover the entire cost of pipe, measured to the nearest 0.1', center to center of manhole, less 1/2 the diameter of both the upstream and downstream manholes.

406.10.2 Obstruction Removal shall be paid for at the bid unit price for obstruction removal.

406.10.3 Payment for service connection shall be paid for at the unit price bid for service connection.

406.10.4 The prices shall be payment in full for performing and completing the work and for furnishing all labor and materials necessary including removal of existing structure, pipe materials, surface restoration, all testing, and all incidental costs.

## PART 407 – PIPE CRUSHING

### 407.1 GENERAL

407.1.1 Pipe crushing: The pipe crushing process is defined as the reconstruction of existing sanitary sewers by the simultaneous insertion of a pipe within the bore of the existing pipe, by breaking and expanding the old pipe.

407.1.2 The pipe crushing process involves rehabilitation of deteriorated gravity sewer pipe by installing new pipe material within the enlarged bore created by using a static, hydraulic, or pneumatic hammer moling device, suitably sized to break the old pipe or by using a modified boring knife with a flared plug that crushes the existing sewer pipe. Forward progress of the mole or the knife may be aided by hydraulic equipment or other apparatus. Replacement pipe is pushed into the bore.

407.1.3 Pipe Crushing existing sanitary sewers governs all work, materials, and testing for installation of pipe by trenchless method of installing new sewer pipe as shown on the Drawings and in conformity with these specifications.

407.1.4 Rights-of-Way clearing and restoring, excavation and backfill, insertion or access pits, embedment (bedding and backfill), field quality control (testing), sealing at manhole, grouting annular space, building up, shaping and reworking the manhole inverts and benches, and pre-installation and post-installation televising of completed work shall be incidental to installation of pipe crushing.

407.1.5 Excavations used for insertion pit shall be considered as an insertion pit and not paid separately.

407.1.6 Trench safety systems, well pointing, backfill with cement-stabilized sand or bank sand, and other applicable items associated with insertion pits will not be paid separately.

407.1.7 Submit manufacturer's product data with complete information on pipeline materials, physical properties, and dimensions pertinent to this job. Furnish a certificate of compliance with specifications for materials to be supplied.

407.1.8 Prevent injury or abrasion to pipe during loading, transportation, and unloading. Do not drop pipe from cars or trucks, nor allow pipe to roll down skids without proper restraining ropes. Use suitable pads, strips, skids, or blocks for each pipe during transportation and while awaiting installation in the field.

407.1.9 Safety. CONTRACTOR shall carry out his operation in accordance with OSHA standards and recommended safety standards of the manufacturer. Particular attention is directed to safety standards and practices applicable to work performed involving scaffolding and confined spaces.

### 407.2 REFERENCE SPECIFICATIONS

407.2.1 ASTM A746 – Ductile Iron Gravity Sewer Pipe.

407.2.2 ASTM C1208 – Vitrified Clay Jacking Pipe.

407.3 MATERIALS

407.3.1 Pipe shall be Ductile Iron Gravity Service Bell-less Push Pipe Rubber Gasket Coupled Joint/Class 55 manufactured by American Ductile Iron Pipe or equal, or

407.3.2 Pipe shall be Vitrified Clay Jacking Pipe manufactured by Mission Clay Pipe Industries or equal, or

407.3.3 Pipe shall be Fastite Joint Push-Bar Pipe manufactured by American Cast Iron Pipe Company or equal.

407.4 EXECUTION

407.4.1 Locate insertion or access pits so that the total number is minimized, and footage of pipe installed in a single run is maximized. Use excavations at point repair locations for insertion pits, where possible.

407.4.2 Before excavating, check with various utility companies and determine the location of utilities in the vicinity of the work area. For damage done to utilities, the resulting repair, temporary service, and other such costs shall be borne by CONTRACTOR.

407.4.3 Perform excavation and backfill in accordance with the City of Tulsa Specifications.

407.4.4 Install and operate necessary dewatering and surface water control measures in accordance with requirements of Part 111 – Dewatering.

407.5 PIPE INSTALLATION

407.5.1 Joints: Assemble and join sections as recommended by the manufacturer.

407.5.2 Preparation: After completing insertion pit excavation, remove top of existing sanitary sewer line down to the spring line. Connect a Pipe Crushing system to the end of the pipe by use of a suitable pushing head equal to or greater than the outside diameter of pipe. Secure the pushing head to pipe and attach to Pipe Crushing system so that pipe can be satisfactorily fed and pushed through sanitary sewer main. Refer to insertion procedures given in ASTM F585.

407.5.3 Apply pushing force to pipe wall end in accordance with Table No. 1, and manufacturer’s instructions. Maximum allowable joint angular deflection shall be 3.0 degrees.

Table No. 1 GS Push Pipe – Allowable Thrust Loads

| Pipe Size (Inches) | Uniform Pipe Outside Diameter (Inches) | Nominal Pipe Wall Thickness (Inches) | Allowable Thrust Load (pounds) |
|---|---|---|---|
| 4 | 4.80 | 0.41 | 60,000 |
| 6 | 6.90 | 0.43 | 124,000 |
| 8 | 9.05 | 0.45 | 176,000 |
| 10 | 11.10 | 0.47 | 232,000 |
| 12 | 13.20 | 0.49 | 294,000 |
| 14 | 15.30 | 0.51 | 362,000 |
| 16 | 17.40 | 0.52 | 424,000 |

407.6 BYPASSING SEWAGE

407.6.1 CONTRACTOR, when required, shall provide for the flow of sewage around the section or sections of pipe that are to be rehabilitated. The bypass shall be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle anticipated wet weather flow.

407.7 INTERRUPTION OF SERVICE

407.7.1 When preparing for making connection to the existing system or other work, which will interrupt service to the utility users, CONTRACTOR shall notify the affected user at least 48 hours in advance of service interruption, stating the approximate time and duration of interruption of service. Advance notification shall not extend beyond 72 hours. CONTRACTOR shall coordinate with the authorities having jurisdiction, any necessary interruption of service and shall limit such interruption to the duration mutually agreeable to both parties.

407.8 SERVICE CONNECTIONS

407.8.1 After the replacement pipe has been secured, service connections shall be excavated and reconnected to the new pipe. All service connections to existing buildings are to be reconnected, except where disconnection is approved by the Engineer. Service connection to a vacated lot shall not be reconnected. If more than one service is found per lot, then the Contractor shall verify that service connections are active by introducing dye into the lines at cleanouts, vents stacks or other access points as approved by the Engineer. Dye testing shall be recorded by CCTV inspection at the location in the main line where the dye appears. All addresses will be noted on log sheets for future references. Provide the address of all reconnected and disconnected services. The replacement pipe shall be exposed to provide adequate working space for making the new service connection. Service laterals shall be connected to the liner pipe using approved saddle connections, INSERTATEE, or equal. Service interruptions to any homes tributary to the sewer line being rehabilitated shall not exceed 36 hours. Care shall be used not to damage the pipe. If damage occurs as a result of the Contractor's operations, the Contractor shall assume all cost associated with the repair of the pipe.

## 407.9 MANHOLE REPLACEMENT

407.9.1 In those places where the insertion pit shaft is excavated at an existing manhole, the manhole shall be replaced with a new manhole conforming to Part 416, Complete Manhole Replacement and in accordance with the Details. Where manhole replacement is specified at locations not scheduled to be an insertion pit, The CONTRACTOR may, at the discretion of the ENGINEER, do a complete rehabilitation of the manhole in accordance with Parts 416 through 421. Costs for such work are incidental to the project and shall be the responsibility of CONTRACTOR.

## 407.10 SEALING IN MANHOLE

407.10.1 Reshape and smooth the manhole invert as specified in Part 416 Complete Manhole Replacement. Use approved manhole rehabilitation material to form a smooth transition with a reshaped invert and a raised manhole bench to eliminate sharp edges of liner pipe, concrete bench, and channeled invert. Build up and smooth invert of manhole to match flow line of new liner.

407.10.2 Pipe Seals shall be repaired in accordance with Construction Specifications Part 314 Manhole.

## 407.11 BACKFILL

407.11.1 At all points where the pipe has been exposed (such as at the insertion pit or at service connection fittings), the pipe and fittings shall be encased in concrete as specified by ENGINEER to prevent deflection due to earth loading or subsidence.

407.11.2 After the encasement material is in place and accepted by Engineer, backfill shall be placed and compacted to require finished grade in accordance with Part 302 Excavation and Backfill, 402 Restoration, and 403 Backfill.

## 407.12 FINAL ACCEPTANCE

407.12.1 After installation of the replacement pipe, CONTRACTOR shall TV inspect the sewer line as specified and perform the following test on the sewer line.

407.12.2 Testing. After installation and before any service connections are reinstated, CONTRACTOR shall run a test on the sewer line to determine if it is watertight.

407.12.3 CONTRACTOR shall furnish all necessary equipment to conduct the test. An acceptable method is a low-pressure air test, conducted as follows:

A) Pressurize the test section to 4.0 psi and hold above 3.5 psi for not less than two minutes. Add air if necessary, to keep the pressure above 3.5 psi. At the end of this two-minute stabilization period, note the pressure (must be 3.5 psi minimum) and begin the timed period. If the pressure drops 0.5 psi in less than the time given in the table below, the section of pipe shall have failed the test.

| Carrier Pipe Diameter (inches) | Minimum Elapsed Time (minutes) |
|---|---|
| 8 | 4 |
| 10 | 5 |
| 12 | 6 |
| 15 | 7 |
| 18 | 8 |
| 21 | 10 |
| 24 | 13 |
| 27 | 15 |
| 30 | 18 |

B) When the prevailing groundwater is above the sewer being tested, test pressure shall be increased 0.43 psi for each foot that the water table is above the invert of the sewer.

C) If the time for the pressure to drop 0.5 psi is 125% or less of the time given in the table, the line shall immediately be repressurized to 3.5 psi and the test repeated.

D) If building service connections have been reinstated before the air test, they shall be considered part of the pipe to which they are connected, and no adjustment of test time shall be allowed.

E) The pressure gauge used shall be supplied by CONTRACTOR and have minimum divisions of 0.10 psi and shall have an accuracy of 0.004 psi.

407.12.4 Payment for air pressure tests, including the furnishings and installing of all equipment and materials, conducting the pressure test, and making all necessary repairs shall be considered as incidental to the Contract amount.

407.13 CLEANUP

407.13.1 After the installation work has been completed and all testing acceptable, CONTRACTOR shall clean up the entire project area and return the ground cover to grade. All excess material and debris not incorporated into the permanent installation shall be disposed of by CONTRACTOR.

407.13.2 Upon completion of installation work and testing, clean and restore project area affected by the Work. Restoration shall be in accordance with Part 301 – Rights of Way Cleaning and Restoring, Part 302 Excavation and Backfill, Part 402 Restoration, and Part 403 Backfill.

407.14 MEASUREMENT AND PAYMENT

407.14.1 Pipe Crushing Sanitary Sewers shall be paid for at the Contract Unit Price as follows: The unit price shall cover the entire cost of pipe, measured to the nearest 0.1', center

to center of manhole, less 1/2 the diameter of both the upstream and downstream manholes.

407.14.2 Obstruction Removal shall be paid for at the bid unit price for obstruction removal.

407.14.3 Payment for service connection shall be paid for at the unit price bid for service connection.

407.14.4 The prices shall be payment in full for performing and completing the work and for furnishing all labor and materials necessary, including removal of existing structure, pipe material, all testing, bypass pumping, and all incidental costs.

## PART 408 – PIPE BURSTING

### 408.1 GENERAL

408.1.1 Pipe bursting: Trenchless pipe enlargement consists of the enlargement of an existing pipeline without wholesale excavation of the pipeline. Excavation is normally performed only to reconnect services or to construct an insertion or retrieval pit. Trenchless pipe enlargement shall be conducted with a hydraulic pulling or pushing apparatus and a pipe expander. The pipe expander shall be pushed or pulled through the existing pipe on grade, widening the existing pipe material sufficiently to accommodate the insertion of the new pipe material (replacement pipe). The Contractor shall furnish for the Engineer's approval, a plan showing his proposed method of installation, including the design of the equipment, location of pits, direction and length of pulls, equipment support of backstop, arrangement and position of jacks, pipe guides, etc., complete in assembled position. The approval of this plan by the Engineer will not relieve the Contractor from his responsibility to obtain the specified results.

408.1.2 Rights-of-Way clearing and restoring, excavation and backfill, insertion or access pits, embedment (bedding and backfill), field quality control (testing), sealing at manhole, grouting annular space, building up, shaping and reworking the manhole inverts and benches, and pre-installation and post-installation televising of completed work shall be incidental to installation of pipe crushing.

408.1.3 Excavations used for insertion pit shall be considered as an insertion pit and not paid separately.

408.1.4 Trench safety systems, well pointing, backfill with cement-stabilized sand or bank sand, and other applicable items associated with insertion pits will not be paid separately.

408.1.5 Submit manufacturer's product data with complete information on pipeline materials, physical properties, and dimensions pertinent to this job. Furnish a certificate of compliance with specifications for materials to be supplied.

408.1.6 Prevent injury or abrasion to pipe during loading, transportation, and unloading. Do not drop pipe from cars or trucks, nor allow pipe to roll down skids without proper restraining ropes. Use suitable pads, strips, skids, or blocks for each pipe during transportation and while awaiting installation in the field.

408.1.7 Safety. Contractor shall carry out his operation in accordance with OSHA standards and recommended safety standards of the manufacturer. Particular attention is directed to safety standards and practices applicable to work performed involving scaffolding and confined spaces.

### 408.2 MATERIALS

408.2.1 Materials allowed for trenchless pipe enlargement will be polyethylene pipe or ductile iron pipe. Polyethylene pipe shall be formulated of high-density polyethylene resin

conforming to ASTM D1248, and shall meet requirements for Type III, Class B, Grade P34, Category S, and PPI rating of PE 3408, when compounded. The pipe produced from the resin shall have a minimum cell classification of 345434 D or E under ASTM D3350. Polyethylene pipe shall have a maximum SDR value of 17, a minimum working pressure of 100 psi, and an inside diameter equivalent to the existing pipe or selected pipe size.

408.2.2 Ductile iron pipe shall be American Ductile Iron GS push pipe, Fastite Joint Push-Bar, Flex-Ring Joint Pipe, or approved equal.

408.2.3 HDPE shall be stored per 409.6.2.

408.3 EXECUTION

408.3.1 Locate insertion or access pits so that the total number is minimized, and footage of pipe installed in a single run is maximized. Use excavations at point repair locations for insertion pits, where possible.

408.3.2 Before excavating, check with various utility companies and determine the location of utilities in the vicinity of the work area. For damage done to utilities, the resulting repair, temporary service, and other such costs shall be borne by Contractor.

408.3.3 Perform excavation and backfill in accordance with the City of Tulsa, Specifications.

408.3.4 Install and operate necessary dewatering and surface water control measures in accordance with requirements of Part 111 – Dewatering.

408.4 PIPE INSTALLATION

408.4.1 GENERAL: Prior to installation, the Contractor shall thoroughly clean the existing line and conduct a closed-circuit television inspection of the same. Television inspection shall be in accordance with other requirements of this specification.

408.4.2 The Contractor shall maintain sewage flow at all times. When acceptable, the Contractor will be allowed to plug the upstream line and store flows in the upstream line segments. When inadequate storage exists to make this alternative acceptable, bypass pumping shall be required. The Contractor shall submit a plan describing the methods he intends to utilize for maintaining sewage flow.

408.4.3 Suitable pit shafts, or trenches shall be excavated for the purpose of conducting the trenchless operations and for placing end joints of the pipe. Wherever end trenches are cut in the sides of the embankment or beyond it, such work shall be sheeted securely and braced in a manner to prevent earth caving. The pits or trenches excavated to facilitate the operations shall be backfilled immediately after the pipe has been installed and tested.

408.4.4 Once insertion is initiated, the Contractor shall complete the insertion without interruption.

408.4.5 The pipe shall be laid true to the lines and grades within the existing sewer as shown on the Contract Drawings. The Contractor's operations shall be conducted to prevent damage to the liner or to adjacent facilities. The City shall inspect all pipe and fittings before and after installation.

A) Where the existing main to be replaced is less than 2' deep, all utilities and services crossing the main or running parallel to it, and lying within a distance of 2' horizontal from the edge of the existing line shall be exposed prior to pipe bursting.

B) Where the existing main to be replaced is between 2' and 4' deep, all utilities and services crossing the main or running parallel to it, and lying within a distance of 2' horizontal from the edge of the existing line shall be exposed prior to pipe bursting.

408.4.6 After insertion, the liner, if polyethylene pipe, shall be allowed a minimum of 12 hours (or as otherwise recommended by the pipe manufacturer) to reach temperature equilibrium with the sewer and to stress-relieve itself. No connection shall be made to the liner during this period. The Contractor is cautioned that he must pull such additional length of pipe as is required to compensate for contraction during this period.

408.4.7 HDPE shall be installed per 409.13.2, 409.13.3, 409.13.4, and 409.13.5.

## 408.5 BYPASSING SEWAGE

408.5.1 Contractor, when required, shall provide for the flow of sewage around the section or sections of pipe that are to be rehabilitated. The bypass shall be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle anticipated wet weather flow.

## 408.6 INTERRUPTION OF SERVICE

408.6.1 When preparing for making connection to the existing system or other work, which will interrupt service to the utility users, Contractor shall notify the affected user at least 48 hours in advance of service interruption, stating the approximate time and duration of interruption of service. Advance notification shall not extend beyond 72 hours. Contractor shall coordinate with the authorities having jurisdiction, any necessary interruption of service and shall limit such interruption to the duration mutually agreeable to both parties.

## 408.7 SERVICE CONNECTIONS

408.7.1 After the replacement pipe has been secured, service connections shall be excavated and reconnected to the new pipe. All service connections to existing buildings are to be reconnected, except where disconnection is approved by the Engineer. Service connection to a vacated lot shall not be reconnected. If more than one service is found per lot, then the Contractor shall verify that service connections are active by introducing dye into the lines at cleanouts, vents stacks, or other access points as

approved by the Engineer. Dye testing shall be recorded by CCTV inspection at the location in the main line where the dye appears. All addresses will be noted on log sheets for future references. Provide the address of all reconnected and disconnected services. The replacement pipe shall be exposed to provide adequate working space for making the new service connection. Service laterals shall be connected to the liner pipe using polyethylene heat fusion saddle, strap on saddle, or INSERTATEE on polyethylene pipe; and strap on saddle, INSERTATEE, or equal on ductile iron pipe. Service interruptions to any homes tributary to the sewer line being rehabilitated shall not exceed 36 hours. Care shall be used not to damage the pipe. If damage occurs as a result of the Contractor's operations, the Contractor shall assume all cost associated with the repair of the pipe.

408.8 MANHOLE REPLACEMENT

408.8.1 In those places where the insertion pit shaft is excavated at an existing manhole, the manhole shall be replaced with a new manhole conforming to Part 416, Complete Manhole Replacement and in accordance with the Details. Where manhole replacement is specified at locations not scheduled to be an insertion pit, the Contractor may, at the discretion of the City and Engineer, do a complete rehabilitation of the manhole in accordance with Parts 416 through 420. Costs for such work are incidental to the project and shall be the responsibility of Contractor.

408.9 SEALING IN MANHOLE

408.9.1 Reshape and smooth the manhole invert as specified in Part 416. Complete Manhole Replacement. Use approved manhole rehabilitation material to form a smooth transition with a reshaped invert and a raised manhole bench to eliminate sharp edges of liner pipe, concrete bench, and channeled invert. Build up and smooth invert of manhole to match flow line of new liner.

408.9.2 Pipe Seals shall be repaired in accordance with the City of Tulsa Specifications, Part 314, Manhole.

408.10 BACKFILL

408.10.1 At all points where the pipe has been exposed (such as at the insertion pit or at service connection fittings), the pipe and fittings shall be encased in concrete as specified by Engineer to prevent deflection due to earth loading or subsidence.

408.10.2 After the encasement material is in place and accepted by Engineer, backfill shall be placed and compacted to require finished grade in accordance with Part 302 Excavation and Backfill, 402 Restoration, and 403 Backfill.

408.11 FINAL ACCEPTANCE

408.11.1 After installation of the replacement pipe, Contractor shall TV inspect the sewer line as specified and perform the following test on the sewer line.

408.11.2 Testing. After installation and before any service connections are reinstated, Contractor shall run a test on the sewer line to determine if it is watertight.

408.11.3 Contractor shall furnish all necessary equipment to conduct the test. An acceptable method is a low-pressure air test, conducted as follows:

A) Pressurize the test section to 4.0 psi and hold above 3.5 psi for not less than two minutes. Add air if necessary, to keep the pressure above 3.5 psi. At the end of this two-minute stabilization period, note the pressure (must be 3.5 psi minimum) and begin the timed period. If the pressure drops 0.5 psi in less than the time given in the table below, the section of pipe shall have failed the test.

| Carrier Pipe Diameter (Inches) | Minimum Elapsed Time (Minutes) |
|---|---|
| 8 | 4 |
| 10 | 5 |
| 12 | 6 |
| 15 | 7 |
| 18 | 8 |
| 21 | 10 |
| 24 | 13 |
| 27 | 15 |
| 30 | 18 |

B) When the prevailing groundwater is above the sewer being tested, test pressure shall be increased 0.43 psi for each foot that the water table is above the invert of the sewer.

C) If the time for the pressure to drop 0.5 psi is 125% or less of the time given in the table, the line shall immediately be repressurized to 3.5 psi and the test repeated.

D) If building service connections have been reinstated before the air test, they shall be considered part of the pipe to which they are connected, and no adjustment of test time shall be allowed.

E) The pressure gauge used shall be supplied by Contractor and have minimum divisions of 0.10 psi and shall have an accuracy of 0.0004 psi.

408.11.4 Payment for air pressure tests, including the furnishings and installing of all equipment and materials, conducting the pressure test, and making all necessary repairs shall be considered as incidental to the contract amount.

## 408.12 CLEANUP

408.12.1 After the installation work has been completed and all testing acceptable, Contractor shall clean up the entire project area and return the ground cover to grade. All excess material and debris not incorporated into the permanent installation shall be disposed of by Contractor.

408.12.2 Upon completion of installation work and testing, clean and restore project area affected by the work. Restoration shall be in accordance with Part 301 – Rights of Way Cleaning and Restoring, Part 302 Excavation and Backfill, Part 402 Restoration, and Part 403 Backfill.

## 408.13 MEASUREMENT AND PAYMENT

408.13.1 Pipe bursting Sanitary Sewers shall be paid for at the Contract Unit Price as follows: The unit price shall cover the entire cost of pipe, measured to the nearest 0.1', center to center of manhole, less 1/2 the diameter of both the upstream and downstream manholes.

408.13.2 Obstruction Removal shall be paid for at the bid unit price for obstruction removal.

408.13.3 Payment for service connection shall be paid for at the unit price bid for service connection.

408.13.4 The prices shall be payment in full for performing and completing the work and for furnishing all labor and materials necessary, including removal of existing structure, pipe material, all testing, and all incidental costs.

## PART 409 – SLIPLINING

409.1 GENERAL

409.1.1 The intent of sliplining is to rehabilitate sanitary sewer lines by the insertion of a polyethylene liner pipe into the existing sewer lines as indicated on the Drawings. When complete, the liner pipe should extend from one manhole to the next manhole in a continuous, watertight length. Sliplining is the renovation of an existing sewer line by inserting a polyethylene liner. This procedure requires an insertion pit as well as reconnection pits for re-connecting services. Sliplining shall be in accordance with ASTM F585.

409.2 REFERENCE SPECIFICATIONS

409.2.1 This Specification references American Society for Testing and Materials (ASTM) standard specifications, which are made a part hereof by such reference and shall be the latest edition and revision thereof.

409.2.2 D1248 Specification for Polyethylene Plastics Molding and Extrusion Materials

409.2.3 D1693 Test for Environmental Stress-Cracking of Ethylene Plastics

409.2.4 D2122 Determining Dimensions of Thermoplastic Pipe and Fittings

409.2.5 D2657 Practice for Heat-Jointing Polyolefin Pipe and Fittings

409.2.6 D2837 Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials

409.2.7 D3035 Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter (up to 6" IPS)

409.2.8 D3350 Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Outside Diameter (up to 6" IPS)

409.2.9 F585 Practice for Insertion of Flexible Polyethylene Pipe into Existing Sewers

409.2.10 F714 Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter (3" IPS and larger)

409.2.11 Section 702, Table 702.3 (Building Sewer Pipe) and Table 702.4 (Pipe Fittings) of the International Plumbing Code (IPC) 1997

409.3 MATERIALS

409.3.1 The following materials are approved for installation in sanitary sewer lines:

409.3.2 The sewer liner pipe and fittings shall be manufactured from a polyethylene compound, which conforms to ASTM D1248 and meets the requirements for Type II or III, Class B, Grades P23 or P 24, Category 5.

409.3.3 Pipe made from this compound must have a long-term hydrostatic strength rating of 1,250 psi or more, in accordance with ASTM D2837.

409.3.4 When the environmental stress crack resistance (ESCR) of the compound is measured in accordance with ASTM D1693, Condition C, the compound shall withstand not less than 192 hours in 100% solution of CO-630 at 100° F before reaching 20% failure point (F20).

409.3.5 Sliplining pipe interior color shall be white or very light.

409.4 LINER MATERIAL TESTS

409.4.1 Tests for compliance with this Specification shall be made according to the applicable ASTM Specification. A certificate of compliance with this Specification upon request shall be provided by the manufacturer for all material furnished under this Specification. In addition, CONTRACTOR may, at his own expense, witness inspection and test of the materials, when requested at the time of purchase.

409.5 LINER PIPE DIMENSIONS

409.5.1 The outside diameter and minimum wall thickness shall conform to dimensions listed in Table I when measured in accordance with ASTM D2122. Where construction difficulties prevent the use of these pipe sizes; other pipe sizes may be specified following Engineer's approval.

TABLE I
Max. SDR vs. Depth of Sewer Line

| Depth | For Lining Max SDR |
|---|---|
| 0' – 8' | 26.0 |
| Over 8' to 14' | 21.0 |
| Over 14' to 19' | 19.0 |
| Over 19' to 26' | 17.0 |
| Over 26' to 33' | 15.5 |

409.5.2 For line segments to be rehabilitated due to structural failure of the existing sewer pipe, minimum pipe wall thickness of the liner shall be SDR 21.

TABLE II
Sliplining Pipe Dimensions (Inches)

| Size of Sewer | OD of Liner | Nominal OD | Minimum Wall Thickness | | | |
|---|---|---|---|---|---|---|
| | | | SDR 26 | SDR 21 | SDR 17 | SDR 15.5 |
| 8 | 7.125 | 7.125” | 0.274 | 0.339 | 0.419 | 0.460 |
| 10 | 8.625 | 8” IPS | 0.332 | 0.411 | 0.507 | 0.556 |
| 12 | 10.75 | 10” IPS | 0.413 | 0.512 | 0.632 | 0.694 |
| 15 | 13.38 | 13.380” | 0.515 | 0.637 | 0.787 | 0.863 |
| 18 | 16.00 | 16” IPS | 0.615 | 0.762 | 0.941 | 1.032 |
| 21 | 18.70 | 18.700” | 0.719 | 0.890 | 1.100 | 1.206 |

409.5.3 The Standard Dimension Ratios (SDR’s) are: 26, 21, 17, and 15.5. These are referred to as SDR 26, SDR 21, SDR 17 and SDR 15.5. Standard Dimension Ratio is calculated by dividing the specified outside diameter by the minimum wall thickness. The wall thickness tolerance shall be within plus 12%.

409.6 STORAGE

409.6.1 Pipe lengths shall be stored in such a location and manner as to eliminate the possibility of scoring, gouging, or otherwise damaging the pipe. Sections of the pipe shall be assembled and joined together prior to insertion of the pipe. Assembly shall be accomplished above ground. If the liner is to be dragged when transported or inserted, then sleds, rollers or other similar devices shall be furnished and utilized by the CONTRACTOR to protect the pipe wall from damage due to cuts, gouges, or scrapes.

409.6.2 When HDPE pipe is delivered to the jobsite it shall not be exposed to sunlight for more than three (3) weeks. HDPE pipe exposed to sunlight for more than three (3) weeks shall be covered with an opaque protective covering. The pipe shall be left stacked and no more pipe than can be installed in one day shall be strung along the jobsite.

409.7 REJECTION

409.7.1 Any materials may be rejected for failure to meet any of the requirements of this Specification.

409.8 INSTALLATION: THE FOLLOWING INSTALLATION PROCEDURES SHALL BE ADHERED TO UNLESS OTHERWISE APPROVED BY CITY.

409.9 CLEANING OF SEWER LINE

409.9.1 It shall be the responsibility of CONTRACTOR to clear the line of all obstructions, solids, dropped joints, or collapsed pipe that will prevent the insertion of the liner. Protruding service connections shall be removed to allow insertion of the liner without damage or scoring of the exterior pipe surface. If inspection reveals an obstruction that is not at the location of the entry shaft, CONTRACTOR shall make an excavation to expose and remove or repair the obstruction. Such point repair shall be approved in

writing by the Engineer prior to commencement of the work and is considered a separate pay item.

409.10 TELEVISION INSPECTION

409.10.1 The CONTRACTOR shall CCTV inspect all sewer lines to be lined, utilizing a color video inspection system with data recording capabilities on Standard Transfer Media. Both a video recording and written log identifying all service connections and openings shall be furnished to the Engineer and become the property of the owner. The entire line segment between manholes shall be videoed.

409.11 BYPASSING SEWAGE

409.11.1 CONTRACTOR shall, as required, bypass the wastewater around the section or sections of line that are to be sliplined if the annular space and pulling head openings are incapable of handling the flow. The bypass shall be made by plugging an existing upstream manhole, if necessary, and pumping the sewage into a downstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle anticipated wet-weather flow.

A) At the end of each working day, a temporary tie-in shall be made between the relined section and the existing system and the bypass plug removed.

409.12 EXCAVATION

409.12.1 Where excavations for insertion of the polyethylene liner are made in a line section between two manholes, CONTRACTOR will establish the excavation points on the basis of location of the lines to be sliplined, pushing distances, and traffic conditions. The locations of the excavation points shall be such as to minimize traffic disruption. The number of excavations will be reduced by planning to insert the pipe in both directions from a single opening. Sheathing and bracing requirements will depend on depth and ground conditions and CONTRACTOR shall determine the necessity for such sheathing and bracing. The top of the existing sewer line shall be exposed to the spring line and the crown of the pipe shall be removed as necessary for insertion of the liner. Care should be taken not to disturb the bottom portion of the existing sewer line, as this will afford a stable base for the liner pipe.

409.12.2 The location of the pits shall be determined by the CONTRACTOR and submitted to the ENGINEER for approval. Insertion may be from two directions. The insertion pits shall be long enough to avoid imposing a bending radius of less than 35 times the outside diameter of the pipe liner during insertion and shall be sloped gradually from the ground surface to the top of the pipe. The width of the insertion pit(s) shall be sufficient to allow the entry of workmen. Trench supports must be positioned so as not to affect insertion. Neither winch cable nor sliplining pipe shall touch the support system.

409.13 PIPE JOINING

409.13.1 Sections of the polyethylene pipe shall be assembled and joined prior to insertion of the pipe.

409.13.2 Pipe and fittings shall be joined by one of the following types of thermal fusion per the Manufacturer's recommended procedures: Butt fusion, Saddle fusion, or Socket fusion.

409.13.3 Polyethylene pipe and fittings may be joined together or to other materials using electrofusion fittings, flange adapters with back-up rings, mechanical couplings designed for connecting polyethylene pipe and fittings to itself or to another material, or MJ adapters. The manufacturer of the joining device shall be consulted for proper installation procedures.

409.13.4 Polyethylene pipe and fittings joined together using a hydraulically operated heat butt fusion machine, shall utilize a data recording device per ASTM F3124 – STANDARD PRACTICE FOR DATA RECORDING THE PROCEDURE USED TO PRODUCE HEAT BUTT FUSION JOINTS IN PLASTIC PIPING SYSTEMS OR FITTINGS. Each HDPE joint shall be traceable to the fusion operator and equipment. Electrofusion reports of each weld shall be appropriately identified and provided to City of Tulsa Inspector. The reports shall include, as a minimum, the fusion date, time, ambient temperature, fitting type and size, user ID, and the manufacturer of the part.

409.13.5 The Contractor shall be responsible for ensuring all personnel operating heat fusion equipment are qualified Heat Fusion Equipment Operators in accordance with ASTM F3190-16 – STANDARD PRACTICE FOR HEAT FUSION EQUIPMENT (HFE) OPERATOR QUALIFICATION ON POLYETHYLENE (PE) AND POLYAMIDE (PA) PIPE AND FITTINGS. All polyethylene joints shall be thermally butt fused by an HFE Operator. The HFE Operators Card shall be submitted at the Pre-Construction Conference and provided at the request of the Engineer. Certification by a distributor shall not be an acceptable substitute.

409.13.6 Joints between pipe sections shall be smooth on the inside and internal projection beads shall not be greater than 3/16". All completed joints shall be watertight at the rated pressure for the pipe and shall have strength characteristics equal to or greater than the pipe itself. Improperly made or damaged joints shall be repaired or replaced as directed by the Engineer at the Contractor's expense. The ENGINEER shall be provided with samples of butt fused joints for testing upon request.

409.13.7 Use of a stainless-steel full encirclement clamp or the installation of a new manhole may accomplish joining of the liner, in cases where the insertion pit is not at a manhole. Minimum clamp length shall be in accordance with the following table:

| Liner Pipe O.D. (Inches) | Clamp Minimum Length (Inches) |
|---|---|
| Less than 4.0 | 7.5 |
| 4.0 thru 5.375 | 10.0 |
| 6.0 thru 8.625 | 15.0 |
| 9.0 thru 13.375 | 20.0 |
| 14.0 thru 28.0 | 30.0 |
| 29.0 thru 36.0 | 48.0 |
| Over 36.0 | 60.0 |

## 409.14 INSERTION OF THE LINER

409.14.1 Prior to inserting the polyethylene liner, the CONTRACTOR shall excavate each active sewer service tap at the locations discovered by the pre-construction TV inspection and as directed by the ENGINEER.

409.14.2 Before insertion, the pulling of a "sizing pig" through the existing sewer is required. The "pig" can be fabricated with pulling heads on each end of a piece of plastic liner approximately 8’ long, of the same diameter as the pipe to be inserted. This will prevent any difficulties with long lengths of pipe becoming stuck in insertion by insuring that offset joints and tilted sections can be cleared. The sizing pig shall be equipped with a tag line so that it can be retrieved, if necessary. The sizing pig and the liner shall be lubricated in such a manner and with such materials as recommended by the pipe manufacturer.

409.14.3 The polyethylene liner shall be inserted into the existing sewer line with a power winch and a steel cable connected to the end of the liner by use of an appropriate pulling head. A second pulling head may be attached to the other end of the liner for attachment of a tag line to pull the liner back out of the sewer line, if necessary. The winch drum capacity and winching power available and consideration of the size and condition of the sewer shall govern length of the liner pipe to be inserted at any one time.

409.14.4 During insertion, precautions shall be taken to protect the liner pipe to prevent the ragged edges of the broken sewer pipe from scoring the outside of the liner as it is being pulled into the sewer. Excessive grooving of liner will be cause for rejection as determined by ENGINEER. Caution must be taken not to stretch the polyethylene pipe beyond its elastic limit in the event of an impediment. The CONTRACTOR shall maintain on hand such equipment as might be required to withdraw the liner.

409.14.5 Once the insertion is initiated, it is desirable to continue the pull to completion without interruption.

409.14.6 After insertion, the liner shall be allowed a minimum of 25 hours (or as otherwise recommended by the pipe manufacturer) to reach temperature equilibrium with the sewer and to stress-relieve itself. No connections shall be made to the liner during this period. The CONTRACTOR is cautioned that he must pull such additional length of polyethylene pipe as is required to compensate for contraction during this period.

409.14.7 Upon completion of the lining of each section, the material previously cut out of the existing line to allow insertion of the liner shall be replaced. The entire cut section of pipe shall then be capped with lean concrete. The lean concrete shall extend 2' past each end of the cutout. The concrete shall be placed against undisturbed earth at the sides of the excavation and to a point 12" above the top of the liner. The CONTRACTOR shall take whatever precautions are necessary to protect the concrete as it cures and to prevent the polyethylene liner from rising off the existing water invert during placement of the concrete.

409.14.8 The concrete shall be placed in such manner that it will not place any undue stress on the polyethylene liner.

409.14.9 After the concrete has had at least 24 hours to set up, the CONTRACTOR shall backfill the insertion pit and restore the pit area to its original condition, including replacement of all obstructions affected by the construction of the project, including, but not limited to, fences, retaining walls, patios, signs, mailboxes, outbuildings, landscaping, sidewalks, paving, etc.

## 409.15 MANHOLE REPLACEMENT

409.15.1 In those places where the entrance shaft is excavated at an existing manhole, the manhole shall be replaced with a new manhole conforming to Part 416 COMPLETE MANHOLE REPLACEMENT of the Specifications for manhole construction and in accordance with the Drawings. Costs for such work are incidental to the project and shall be the responsibility of the CONTRACTOR. If the manhole was scheduled for replacement, it will be paid for at the unit price bid for Manhole Replacement.

409.15.2 Where a lamphole exists at the end of a line segment being sliplined, a transition coupling shall be used at the end of the polyethylene liner to connect it to standard lamphole pipe and fittings. Existing lampholes constructed of materials other than DIP or PVC shall be replaced with a new lamphole conforming to PART 417 REPLACEMENT OF CLEANOUT / LAMPHOLE AND/OR CLEANOUT / LAMPHOLE FRAME AND COVER. Prior to backfilling, the annular space adjacent to the transition coupling shall be filled with polyurethane foam, 3M Scotch-Seal 5600, or equal, for a distance of at least 6" from the transition coupling. The intent of this polyurethane foam is to seal the sewer line so that no solids or liquids enter the annular space. Costs for such work shall be paid for separately in accordance with PART 417.

## 409.16 SEALING POLYETHYLENE PIPE IN MANHOLES

409.16.1 The polyethylene pipe liner shall be pulled through all manholes except terminal manholes within the sliplining areas. After the liner has reached temperature equilibrium and stress-relieved itself, the lining shall be cut and finished, as required. The annular space between the existing sewer line and the slipliner shall be filled with expanding polyurethane foam, 3M Scotch-Seal 5600 and Oakum, or equivalent, for a distance of at least 12" along the liner and all the way around the liner, at each end of the liner pipe. This shall result in a seal between the slipliner pipe and each manhole.

The existing inlet and outlet shall be grouted as directed by the Inspector to prevent infiltration. The invert of the manhole shall be repaired and grouted to provide a smooth transition between inlet and outlet and to prevent ponding.

409.16.2 At those manholes where pipe liner size changes occur or where lateral sewers enter, the CONTRACTOR shall mate and cut the liners in such a manner as to provide a smooth transition. The CONTRACTOR shall submit his proposed methods to the ENGINEER for approval.

409.17 SERVICE CONNECTIONS

409.17.1 After the liner has been secured in the upstream manhole, service connections shall be excavated and reconnected to the new liner. A minimum relaxation period of 24 hours will be required of CONTRACTOR prior to the connection of service laterals. All service connections to existing buildings are to be reconnected, except where disconnection is approved by the Engineer. Service connection to a vacated lot shall not be reconnected. If more than one service is found per lot, then the Contractor shall verify that service connections are active by introducing dye into the lines at cleanouts, vents stacks or other access points as approved by the Engineer. Dye testing shall be recorded by CCTV inspection at the location in the main line where the dye appears. All addresses will be noted on log sheets for future references. Provide the address of all reconnected and disconnected services. A portion of the existing sewer, at the liner pipe, around each service connection shall be removed to expose the liner pipe to provide adequate working space for making the new service connection. Service laterals shall be connected to the liner pipe using polyethylene heat fusion saddles, strap-on (wrap around) saddles, INSERTATEE, or equal. Strap-on saddles shall be secured to the liner pipe using stainless steel bands. A neoprene gasket shall be inserted between the liner and the strap-on saddle.

409.17.2 The CONTRACTOR shall remove any fallen pipe, bricks, mortar, earth, or other material from the annular space. Service laterals shall be connected to the liner pipe, using polyethylene heat fusion saddles or PVC saddles.

409.17.3 If PVC saddles are used, they shall be made of Type 1, Grade 1, PVC Resin per ASTM Spec. D1784-81. The saddle shall be equipped with a stop ring to prevent the service line from protruding into the main. The wall thickness of the saddle at the line through the branch at the saddle's longest point shall be 0.250" and shall taper to 0.125" at its thinnest edge. A tolerance of +0.010" shall be acceptable. The saddle shall have a minimum skirt length of 14”. The saddle shall be of one-piece design and shall fit the exact roundness of the pipe.

409.17.4 The saddle shall have a centering ring on the outlet side of the saddle at a thickness of 0.200". The surface shall be smooth without sharp edges. The socket depth shall conform to ASTM 3033-85 and ASTM 3034-85 specification with Schedule 40 dimensions O.D. The Schedule 40 outlet hub shall be equipped with an adapter to accept cast iron soil pipe. The saddles shall be GPK solvent skirt, or equal. The saddles shall be cemented to the liner, using an expanding polyurethane foam, 3M

Scotch-Seal 5600, or equal. The saddle shall be strapped to the liner, using stainless steel bands.

409.17.5 Any saddle meeting the above referenced specifications and the requirements for materials, per table 702.3 Building Sewer Pipe and table 702.4 Pipe Fittings of the International Plumbing Code (IPC) 1997, or equal shall be acceptable.

409.17.6 The service connection riser shall be carried from the main to the existing elevation of the connection, utilizing bell and spigot cast iron soil pipe. At a location approved by the ENGINEER, a connection between the existing lateral service and the new service shall be made, utilizing a solid sleeve coupling, Rockwell Omni, OCUT sewer connector, or approved equal.

409.17.7 Prior to backfilling where the existing sewer has been broken open, the CONTRACTOR shall fill the annular space between the sliplining pipe and the existing sewer pipe with polyurethane foam, 3M Scotch-Seal 5600, or equal, for a distance of at least 6” either side of the service tap. The intent of this polyurethane foam is to seal the sewer line so that nothing can enter or exit the sewer system at the service tap, nor can fluids flow between the existing sewer pipe and the liner past the service tap.

409.17.8 All existing service laterals shall be reconnected without reducing the diameter of the service. Reconnecting a 6” service line to a 7.125” O.D. polyethylene slipline pipe shall utilize a 7.125” O.D. x 6” SDR-35 Gasketed saddle, as manufactured by GPK or equal.

409.18 BACKFILL

409.18.1 At all points where the polyethylene pipe has been exposed (such as at the insertion shafts, at the service connection fittings, or other points where the old pipe must be removed), the polyethylene pipe and fittings shall be encased in concrete as specified by ENGINEER to prevent deflection due to earth loading or subsidence.

409.18.2 After all the encasement material is in place and accepted by Engineer, backfill shall be placed and compacted to required finishing grade in accordance with Part 402 RESTORATION and 403 BACKFILL.

409.19 FINAL ACCEPTANCE

409.19.1 After installation of the liner, CONTRACTOR shall TV inspect, in color, the sewer lines as specified and perform the following test on the sewer line.

409.19.2 TESTING: After installation and before any service connections are reinstated, CONTRACTOR shall run a test on the sewer line to determine if it is watertight.

409.19.3 CONTRACTOR shall furnish all necessary equipment to conduct the test. An acceptable method is a low-pressure air test, conducted as follows:

A) Pressurize the test section to 4.0 psi and hold above 3.5 psi for not less than two minutes. Add air if necessary, to keep the pressure above 3.5 psi. At the end of

this two-minute stabilization period, note the pressure (must be 3.5 psi minimum) and begin the timed period. If the pressure drops 0.5 psi in less than the time given in the table below, the section of pipe shall have failed the test.

B) When the prevailing groundwater is above the sewer being tested, test pressure shall be increased 0.43 psi for each foot that the water table is above the invert of the sewer.

| Sewer Size (Inches) | Minimum Test Time (Minutes) |
|---|---|
| 8 | 4.00 |
| 10 | 5.00 |
| 12 | 6.00 |
| 15 | 7-1/2 |
| 18 | 9.00 |
| 21 | 10-1/2 |

C) If the time for the pressure to drop 0.5 psi is 125% or less of the time given in the table, the line shall immediately be repressurized to 3.5 psi and the test repeated.

D) If building sewers have been reinstated before the air test, they shall be considered part of the pipe to which they are connected, and no adjustment of the test time shall be allowed.

E) CONTRACTOR shall supply the pressure gauge used and have minimum divisions of 0.10 psi and shall have an accuracy of 0.004 psi.

409.19.4 PAYMENT for air pressure tests, including the furnishing and installing of all equipment and materials, conducting the pressure test, and making all necessary repairs shall be considered as subsidiary to pipeline rehabilitation.

409.20 CLEANUP

409.20.1 After the installation work has been completed and all testing acceptable, CONTRACTOR shall clean up the entire project area and return the ground cover to grade. CONTRACTOR shall dispose of all excess material and debris not incorporated into the permanent installation.

409.21 MEASUREMENT AND PAYMENT

409.21.1 Sliplining shall be paid for at the Contract Unit Prices as follows: The unit price shall cover the entire cost of sewer lining, measured to the nearest 0.1', center of manhole to center of manhole, less 1/2 the diameter of both the upstream and downstream manholes.

409.21.2 Obstruction Removal shall be paid for at the bid unit prices for obstruction removal.

409.21.3 Payment for service connections shall be paid at the unit bid price for service connection.

409.21.4 The prices shall be payment in full for performing and completing the work and for furnishing all labor and materials necessary including excavation and removal of existing structure, trench safety system, pipe lining materials, pipe sealing materials, labor, backfilling, surface restoration, sodding, pavement replacement, sidewalk and driveway replacement, curb and gutter replacement, all testing, and all incidental costs.

## PART 410 – CURED-IN-PLACE PIPE

### 410.1 DESCRIPTION

410.1.1 It is the intent of this specification to provide for the reconstruction of existing sewer lines by forming a new pipe within an existing deteriorated pipe, which has generally maintained its original shape. The Cured-In-Place Pipe (CIPP) shall provide flow capacity equal to or greater than 100% of the original pipe's flow capacity when considering age and condition. The process is defined as the reconstruction of sewer lines by installation of a thermosetting resin impregnated flexible felt fiber tube coated on one side with polyethylene or polyurethane, which is installed into the existing sewer line utilizing a water column or cool pressurized air. Curing is accomplished by circulating hot water or steam throughout the length of the inverted tube to cure the thermosetting resin into a hard, impermeable pipe with the polyethylene/polyurethane coating on the interior surface of the new pipe. The pipe shall extend the full length of the original pipe and shall provide a structurally sound, jointless, close fitting and corrosion resistant cured-in-place pipe. A Pulled-In-Place method of installation shall be allowed for pipe diameter sizes 6”, 8”, 10”, and 12” only.

### 410.2 REFERENCE SPECIFICATIONS

410.2.1 Installation and material tests of Cured-In-Place Pipe (CIPP) must meet the minimum requirements demonstrated in the following ASTM standards:

410.2.2 ASTM F1743 Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-In-Place Installation of Cured-In-Place Thermosetting Resin Pipe (CIPP)

410.2.3 ASTM F1216 Standard Practice for the Installation of Cured-In-place Pipe by Inversion Lining

410.2.4 ASTM D638 Test Method for Tensile Properties of Plastics (for pressure pipes only)

| | |
|---|---|
| Tensile Stress | 3,000 psi |

ASTM D790 Test Method of Flexural Properties of Plastics

| | |
|---|---|
| Flexural Stress | 4,500 psi |
| Flexural Modulus | 250,000 psi |

410.2.5 ASTM D-790 Test Method of Flexural Properties of Plastics

| | |
|---|---|
| Flexural Stress | 4,500 psi |
| Flexural Modulus | 250,000 psi |

410.2.6 ASTM D5813 (Cured-In-Place Thermosetting Resin Sewer Pipe)

410.2.7 ASTM D2990 (Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics)

## 410.3 SUBMITTALS

410.3.1 Product Data: Resin, Tube material, qualification testing results for laminate sample, resin enhancer, bond enhancer, certification of applicability of resin; sealant/caulking material, resin curing schedule showing time and temperature for each reach, manufacturer's recommended installation, pressures, minimum and maximum reach, and manufacturer's wet out report.

410.3.2 Design Information: Wall thickness design calculations are required for each pipe section.

410.3.3 Inspection Information: Video recordings (DVD/external drive) of pre- and post-inspections.

410.3.4 Full-length temperature sensing system to be utilized for all pipe sizes of 24" and larger.

410.3.5 Qualifications: Documentation for experience of lining manufacturer and installer.

410.3.6 Certificate: Installer Certification by the Manufacturer and a Certificate of Compliance that the tube meets all relevant specifications and ASTM Standards shall be required.

410.3.7 Public Relations: Notification Fliers or Door Hangers.

## 410.4 QUALIFICATIONS

Since sewer products are intended to have a 50-year design life, and in order to minimize the Owner's risk, only proven products with substantial successful long-term track records will be approved.

Products and Installers seeking approval must meet all the following criteria to be deemed Commercially Acceptable:

410.4.1 For a product to be considered Commercially Proven, a minimum of 1,000,000 LF of successful CIPP wastewater collection system installations shall be performed in the U.S. and documented to the satisfaction of the Owner to assure commercial viability.

410.4.2 For an Installing Company to be considered as Commercially Proven, the Installer must satisfy all insurance, financial, and bonding requirements of the Owner, and must have had at least 5 (five) years active experience in the commercial installation. In addition, the Installer must have successfully installed at least 100,000 feet of a cured-in-place product in wastewater collection systems in the U.S. for host pipe diameters equal to or larger than that which is intended for this project. Acceptable documentation of these minimum installations must be submitted to the Owner. Installer's project manager assigned to this project must

have minimum of 5 years of CIPP installation experience with the exact product and Installing Company intended for use with this bid.

410.4.3 Sewer rehabilitation products submitted for approval must provide third party test results supporting the structural performance (short-term and long-term) of the product and such data shall be satisfactory to the Owner. No product will be approved without independent third-party testing verification.

410.4.4 Both the rehabilitation manufacturing and installation processes shall operate under a quality management system which is third-party certified to ISO 9000 or other recognized organization standards. Proof of certification shall be required for approval.

410.5 MATERIALS

410.5.1 Tube – the tube should consist of one or more layers of flexible needled felt or an equivalent nonwoven or woven material capable of carrying resin, withstanding installation pressures and curing temperatures. The tube should be compatible with the resin system used. The material should be able to stretch to fit irregular pipe sections and negotiate bends. The outside layer of the tube should be plastic coated with a material that is compatible with the resin system used. The tube should be fabricated to a size that, when installed, will tightly fit the internal circumference and the length of the original conduit. Allowance should be made fo circumferential stretching during inversion.

410.5.2 Resin – The resin system shall be a corrosion resistant polyester or vinyl ester system including all required catalysts, initiators that when cured within the tube create a composite that satisfies the requirements of ASTM F1216, ASTM D5813, and ASTM F1743, the physical properties of herein, and those which are to be utilized in the submitted and approved design of the CIPP for this project. The resin shall produce a CIPP that will comply with the structural and chemical resistance requirements of this specification.

410.5.3 The minimum length shall be that deemed necessary by the Engineer to effectively span the pipelining distance of the necessary manhole section unless otherwise specified. The line lengths shall be verified in the field before impregnation of the tube with resin.

410.5.4 The outside of the tube, before installation, shall have an impermeable polyethylene or polyurethane plastic coating. This coating will form the inner layer of the finished pipe and is required for enhancement of corrosion resistance, flow, and abrasion properties. CIPP interior lines colors shall be white or a relatively light reflective color so that a clear detailed examination with closed circuit television inspection equipment may be made.

410.5.5 End Seal – A compression gasket sealing product that swells with the presence of water shall be utilized at the junction of the main and manhole. The end seal is a molded rubbed gasket that provides a full-circle compression seal to a substantial

area at the end of a mainline pipe that is rehabilitated by lining. The end seal shall be Insignia™ Hydrophilic End Seal as manufactured by LMK Technologies or engineer approved equivalent.

410.5.6 Caulking/Sealant – Sealant shall be a quick-set epoxy mortar or high viscosity epoxy with good adhesion to the line and original pipe material.

410.5.7 The Owner authorizes the use of proven materials that serve to enhance the pipe performance specified herein. Proven materials have passed independent laboratory testing, not excluding long-term (10,000 hour) structural behavior testing and have been successfully installed to repair the failing host pipes in the U.S. for at least 5 years. In addition to the aforementioned requirement, the owner may require that the contractor demonstrate that the enhancements proposed exceed the specifications herein, prior to the installation of the enhanced material systems. This section in no way shall be interpreted as authorization to deviate from the minimum standard practices set forth herein.

## 410.6 FULL-LENGTH TEMPERATURE MONITORING

410.6.1 System shall consist of a wire probe with sensors no more than ten (10) feet apart running the length of the pipe section to be lined and a computer with vendor software for monitoring in real time and recording curing data. Data output will consist of a report indicating the time and temperature at each sensor location. System shall have the ability to monitor the curing from a remote location, and this ability will be made available to the Owner and Engineer. The Owner and Engineer will be provided training in how to access the site for remote viewing and an overview of the system. Temperature monitoring systems will be the ZIA Systems, Vericure by Pipeline Renewal Technologies, or approved equal.

## 410.7 DESIGN

410.7.1 General Requirements of Cured-In-Place Pipe (CIPP) – The finished pipe must be such that when the thermosetting resin cures, the total wall thickness will be a homogenous and monolithic felt and resin composite matrix that will be chemically resistant to withstand internal exposure to domestic sewage. When cured, the CIPP shall be a tight fit liner to the host pipe.

410.7.2 The CIPP shall be designed to a minimum wall thickness based on the individual project parameters and the condition of the existing conduit. The pipe design shall have sufficient strength to support all dead loads, live loads and groundwater loads imposed.

410.7.3 The cured lining material shall conform to the minimum structural standards, as listed below.

| Linear Material Test Cured Liner | Standard | Results |
|---|---|---|
| Tensile Stress | ASTM D638 | 3,000 psi |
| Flexural Stress | ASTM D790 | 4,500 psi |
| Flexural Modulus | ASTM D790 | 400,000 psi |

Design Parameters: (unless otherwise noted in the Drawings)

| | |
|---|---|
| Design Condition: Fully deteriorated | Safety Factor = 2.0 |
| Ground water = ½ soil depth | Ovality = 2.0% |
| Long Term flexural modulus = 50% of short term (75% for enhanced materials with testing validation) | Live Load H2) = 16,000 lbs. |
| | Soil Density = 120 pcf |
| | Poisson's Ratio = 0.3 |
| Soil modulus = 700 psi for depth < 10' and 1000 psi for depth> or = to 10' | Enhancement factor K = 7 |

410.7.4 Independent material tests for compliance with this specification shall be made according to the applicable ASTM standards. Upon request, a certificate of compliance will be provided for all materials furnished under this specification.

410.7.5 The contractor shall submit his price proposal based on the appropriate length, size and existing pipe parameters designated in the Bid Item or Bid Proposal Section. The deterioration of sewers is an on-going process. Should pre-construction inspections reveal the sewers to be in substantially different conditions than those in the design considerations, the contractor shall request such changes in reconstruction liner thickness, supporting such requests with design data. The deviation, if approved, shall be reflected by Change Order.

410.7.6 The Manufacturer must have performed long-term testing for flexural creep of the resin. Such testing results are to be used to determine the long-term, time dependent flexural modulus to be utilized in the product design. A percentage of the instantaneous flexural modulus value (as measured by ASTM D790 testing) will be used in design calculations for external buckling. The percentage, or the long-term creep retention value utilized, will be verified by this testing. Retention values exceeding 50% of the short-term test results shall not be applied unless substantiated by qualified third party test data to the Owner's satisfaction. The resin and materials utilized for the contracted project shall be of equal to or better than the materials used in the long-term test with respect to to the initial flexural modulus used in the CIPP design.

410.7.7 The layers of the cured CIP shall be uniformly bonded. It shall not be possible to separate any two layers with a probe or point of a knife blade so that the layers separate cleanly or the probe or knife blade moves freely between the layers. If the layers separate during field sample testing, the CIPP shall be repaired or replaced by the Contractor at their expense.

410.8 PRE-INSTALLATION PROCEDURES

410.8.1 The following installation procedures shall be adhered to unless otherwise approved by Engineer.

410.9 SAFETY

410.9.1 CONTRACTOR shall carry out his operations in strict accordance with all OSHA and manufacturer's safety requirements. Particular attention is drawn to those safety requirements involving working with scaffolding and engineering confined spaces.

410.10 INSPECTION

410.10.1 Additional internal inspection as noted on drawings shall be conducted by CONTRACTOR prior to actual construction. Inspection shall be accomplished by means of closed-circuit color television. Supplemental normal cleaning (3 passes of jet nozzle) of the pipes to allow a clear and unobstructed view of the pipe walls will be the responsibility of CONTRACTOR and is considered as incidental to the work.

410.11 CLEANING OF SEWER LINES

410.11.1 Prior to any lining of a pipe so designated, it shall be the responsibility of CONTRACTOR to remove all internal debris out of the sewer lines in accordance with Section III, "Sewer Line Cleaning" NASSCO Specifications for Sewer Collection System Rehabilitation.

410.11.2 Sewers shall be cleaned of all debris, roots and other materials that would block proper inversion of the Cured-In-Place Pipe. Utilizing high-pressure jet cleaning equipment, several passes shall be completed to assure that all debris is removed from the pipe. If roots are present, root cutters or mechanical brushes shall be attached to the jet nozzle and sent through the line to remove all root intrusions. Heavy cleaning (beyond normal) shall either be performed by Owner or shall be paid by separate pay item.

410.11.3 Owner or Engineer shall approve cleaning prior to liner insertion.

410.12 TELEVISION INSPECTION

Sewers shall be CCTV inspected providing both a video recording and written log identifying all service connections and openings. Utilizing a color video inspection system with data recording capabilities, the entire pipe sections shall be recorded on standard transfer media to become the property of the City.

Identification and Pre-measurement of Lateral Connections. A 360-degree Pan-and-Tilt view camera shall be used to inspect the pipe traveling upstream. At each connection, the operator will stop and turn the camera lens toward the lateral thereby inspecting the first 8” to 12” of the lateral connection. If there remains a doubt as to whether or not the connection is live, additional "Dye and Flush" tests shall be performed. It will be the responsibility of the Engineer to review this process live or review the video to verify and approve which lateral connections are to be

reinstated. All lateral locations will be measured from the back wall (opposing wall) of the basis manhole, typically, the downstream manhole.

Inspection of Pipelines – Inspection of pipelines should be performed by experienced personnel trained in locating breaks, obstacles, and service connections by closed-circuit television or man entry. The interior of the pipeline should be carefully inspected to determine the location of any conditions that may prevent proper installation of the impregnated tube, such as protruding service taps, collapsed or crushed pipe, and reductions in the cross-sectional area of more than 10%. These conditions should be noted so that they can be corrected. A pre-insertion video shall be prepared by the Contractor.

## 410.13 LINE OBSTRUCTION

410.13.1 The original pipeline should be clear of obstructions such as solids, dropped joints, protruding service connections, crushed or collapsed pipe, and reductions in the cross-sectional area of more than 10% that will prevent the insertion of the resin-impregnated tube. Protruding service connections shall be removed to prevent dimpling of the finished liner unless approved by the Owner or Engineer. Maximum allowable protrusion shall be 1/2".

410.13.2 The Contractor shall perform all obstruction removals for the sewer section scheduled for relining. The repair shall be an adequate repair for insertion of the resin-impregnated tube. This shall be paid at the bid price for obstruction removal.

410.13.3 If the Contractor identifies obstructions that cannot be removed by conventional sewer cleaning equipment, then, with the Engineer's approval, an excavation shall be made to remove the obstruction.

410.13.4 If pre-insertion inspection reveals a condition such as a protruding service connection, dropped joint, or a collapse that will prevent the insertion process or will result in an unacceptable installation, and it cannot be removed by conventional sewer cleaning equipment, defined as high-pressure jetters, root cutter or grinders, then Contractor shall consult with the Engineer before proceeding with the appropriate remedy. If condition resulting in extra effort by the Contractor was not shown on the drawing or revealed to the Contractor at the time of the bid, the work shall be considered as a separate pay item by Changer Order.

## 410.14 INFILTRATION

410.14.1 Minor infiltration is a normal condition sometimes encountered during the CIPP process. It is not a “changed condition” and should not be regarded as a reason for change orders. If in the opinion of the Engineer, infiltration is significant enough to adversely affect the curing process, chemical grouting or other remedies may be required. This additional work will be paid for by the Owner as a Change Order.

## 410.15 SITE RESTORATION

410.15.1 Areas damaged or modified by the Work for his project shall be repaired or restored to a condition equal to or better than the original condition. Site restoration is incidental to the Work and shall not be regarded as a reason for change orders.

## 410.16 PUBLIC RELATIONS

410.16.1 A Public Information and Notification Program shall, as a minimum, require the Contractor to be responsible for contacting homeowners or businesses who will be affected by the construction activities and informing them of the work to be done and the estimated timing for the work. Written notice shall be delivered to each home or business two (2) weeks prior to installation. Notice shall include a local telephone number of the Contractor they can call to discuss the project, and how the homeowner or business will be affected. The written notice must be reviewed by the Owner or Engineer prior to the start of any work.

A follow-up notice shall be delivered to each home or business connected to the sanitary sewer two (2) days prior to installation. The notice shall instruct occupants to minimize water usage the day of the insertion and fill all drain traps with water to prevent potential odors.

## 410.17 BY-PASS OF FLOW AND INTERRUPTION OF SERVICE

410.17.1 Contractor, when required, shall provide for the flow of sewage around the section or sections of pipe that are to be lined. The bypass shall be made by plugging the line at an existing upstream manhole and pumping the flow into a downstream manhole or adjacent system. The pump and bypass lines shall be of adequate capacity and size to handle anticipated wet weather flow or peak flow.

410.17.2 All procedures for maintaining flows must meet the approval of the Owner or Engineer. Contractor shall submit a detailed plan of all methods of flow management, in advance of flow interruption.

## 410.18 INSTALLATION OF LINES

410.18.1 Prior to installation of the liner, the full-length temperature sensing system shall be placed and tested to ensure proper functioning. If more than two sensors in a row or more than 10% of the total sensors are malfunctioning, the entire sensor array shall be replaced and retested. Time and temperature shall be monitored in accordance with manufacturer’s recommendations.

410.18.2 Resin Impregnation of the CIPP Tube – The Contractor shall designate a location where the tube shall be impregnated or "wet out" with resin, using distribution rollers and a "single-source" vacuum system to thoroughly saturate the tube's felt fiber prior to installation in the field. The impregnated tube shall be free of pinholes, resin voids, and other defects. If the Cured-In-Place Pipe is impregnated at the manufacturing plant, it shall be delivered to the job site in a refrigerated truck and remain refrigerated prior to installation to prevent premature curing.

410.18.3 The tube should be vacuum impregnated with resin (wet out) under controlled conditions. The volume of resin used should be sufficient to fill all voids in the tube material at nominal thickness and diameter. The volume should be adjusted by adding 5% to 10% excess resin per the manufacturer's recommendation for the change in resin volume due to polymerization and to allow for any migration of resin into the cracks and joints in the original pipe.

410.18.4 Inversion of CIPP Tube – The resin impregnated tube shall be water inverted or cool air pressure-inverted through an existing manhole or other approved access point until it has fully traversed the designated line length and the inversion face breaches the destination manhole or termination point. Thermocouples shall be placed at the top and, if possible, at the bottom interface of both ends of the liner for monitoring temperature during the cure cycle. A "Pulled-In-Place" method of installation shall be allowed for pipe diameter sizes 6", 8", 10", and 12".

410.18.5 CIPP Processing (Curing and Cool Down) – the cure cycle and cool down will be dictated with consideration given to actual field conditions and shall be according to the manufacturer's recommendations. The curing temperatures shall be monitored at the heater truck's water inlet and outlet lines. The temperature readings from the truck will be compared to the thermocouples to ensure that sufficient heat is being supplied to the system to effect proper cure. Once the pipe has been cured, cool water shall be slowly introduced into the rehabilitated pipe. The water temperature shall be cooled inside of the pipe at a rate of 20° to 30° per hour until the water temperature is within 20° of the ambient temperature. The cool down process will also be affected by actual field conditions and may be modified in cases of severe conditions or below normal ground temperatures. Contractor shall not discharge cooling water to storm sewer system.

410.18.6 Termination and Sealing at Manhole Outlets – Termination of the Cured-In-Place Pipe at the manhole is completed by trimming the inverted pipe end back within approximately 6" of the outlet.

410.18.6.1 **An end seal per the materials specification shall be installed at the termination of CIPP at the manhole inlets & outlets.** All roots deposits, and debris should be removed from the pipe with hydraulically powered equipment, high velocity jet cleaners, or mechanically powered equipment as per NASSCO recommended specifications prior to installation of CIPP with end seals. Since the Insignia End Seal product may be used with a variety of rehabilitative pipe liners, the standard installation practices of each individual pipe liner method should be closely followed.

410.18.7 Hydraulic Capacity – overall, the hydraulic profile shall be maintained as large as possible. The CIPP shall have a minimum of the full flow capacity of the original pipe before rehabilitation. Calculated capacities may be derived using a commonly accepted roughness coefficient for the existing pipe material, taking into consideration its age and condition. The roughness coefficient of the CIPP shall be verified by third party test data and certified by a letter from manufacturer or raw material supplier.

## 410.19 SERVICE CONNECTIONS

410.19.1 After the liner has been cured Contractor shall reconnect the service connections. All service connections to existing buildings are to be reconnected, except where disconnection is approved by the Engineer. Service connection to a vacated lot shall not be reconnected. If more than one service is found per lot then, the Contractor shall verify that service connections are active by introducing dye into the lines at cleanouts, vent stacks or other access points as approved by the Engineer. Dye testing shall be recorded by CCTV inspection at the location in the main line where the dye appears. All addresses will be noted on log sheets for future reference. Provide the address of all reconnected and disconnected services.

410.19.2 It is the intent of the City that all service reconnections be made by external service reconnection in accordance with 410.19.4. Where there is no protruding pipe, cracks, or leaks, or where significant surface obstructions exist, service connections shall be internally reinstated as directed by Engineer in accordance with 410.19.3 or 410.19.4. Internal reinstatement of services alone will not be permitted.

410.19.3 Internal Reconnection: **Internal service reconnections without an internal tee-liner or top hat type liner shall not be allowed without prior written approval by the Owner.** Without excavation, the service connection shall be reinstated by means of a television camera and a cutting device that re-establishes the connection to not less than 90% capacity. Service connections shall be cut in with neat and smooth circumferential lines to prevent snagging of debris and/or solids. Contractor shall provide a physical demonstration, in the presence of the Engineer, to show the assurance of a watertight seal of all service connections. Service interruptions to any homes tributary to the sewer line being rehabilitated shall not exceed 24 hours. **Internal service reconnections shall require submittal to Engineer and include internal tee-liner and/or top hat type reconnection.**

410.19.4 External Reconnection: Service connections shall be reinstated by excavation and reconnecting the service with an approved saddle or engineer approved equivalent. The Contractor shall remove the appropriate amount of carrier pipe to allow the saddle to be directly connected to the outside wall of the CIPP. An epoxy, meeting the manufacturer's recommendations, shall be applied to the saddle to assure a watertight seal between the saddle and CIPP or host pipe. The saddle shall be secured with stainless steel bands. After the epoxy has set and prior to backfilling, the Contractor shall seal any open annular space between the existing sewer and new liner pipe with a non-shrink grout. The Contractor shall then completely encase the saddle and exposed pipe in concrete. Care shall be used not to damage the CIPP. If damage occurs as a result of the Contractor's operations, the Contractor shall assume all cost associated with the repair of the CIPP.

410.19.5 Connections of the saddle fitting to the existing lateral shall be made using elastomeric boots, full-encirclement clamps, or by other method as approved by the Engineer.

## 410.20 FINAL INSPECTION AND ACCEPTANCE

410.20.1 Upon completion of the installation, the rehabilitated sewer shall be CCTV inspected providing both a video recording and log identifying all service connections and openings. The entire pipe section rehabilitated shall be recorded on standard transfer media with the video becoming the property of the City.

410.20.2 CIPP samples shall be prepared and physical properties tested in accordance with ASTM F1216, Section 8.1, using either method proposed. The flexural modulus must meet or exceed the value used in design in Section D (structural requirements for the pipe size and thickness furnished in design.)

410.20.3 Leakage testing of the CIPP shall be accomplished during curing while under a positive head. CIPP products in which the pipe wall is cured while not in direct contact with the pressurizing fluid (e.g., a removable bladder) must be tested by an alternative method approved by the Engineer.

410.20.4 Visual inspection of the CIPP shall be in accordance with ASTM Fl216, Section 8.6.

410.20.5 Upon acceptance of the installation work and testing, the Contractor shall restore the project area affected by the operations to a condition at least equal to that existing prior to the work.

410.20.6 After installation of the liner, Contractor shall TV inspect the sewer line as specified herein and perform the following test on the sewer line.

410.20.7 Post-insertion video recording TV log in a format acceptable to the Engineer shall be provided to the Engineer within two (2) weeks of taping. With the exception of sag locations in existing host pipe, the pipe must be dry and clean during the televising. Camera speed shall not exceed two feet per second. Video quality shall be high.

410.20.8 No wrinkles, or other defects, will be allowed that, in the opinion of the Owner or Engineer, will impede flow.

410.20.9 Cured Pipe Physical Properties: Samples of the cured pipe should have the minimum physical properties (flexural stress, modulus of elasticity, and thickness) recommended herein.

## 410.21 MEASUREMENT AND PAYMENT

410.21.1 Cured-In-Place Pipe shall be paid for at the Contract Unit Prices as follows: The unit price shall cover the entire cost of sewer lining, measured to the nearest 0.1', center of manhole to center of manhole, and include any by-pass pumping, dye, and flush testing, and all acceptance testing.

410.21.2 Obstruction Removal shall be paid for at the set unit prices of each for obstruction removal. Where point repairs are specified, they shall be installed and paid for in accordance with Part 412 of the City of Tulsa Standard Specifications and Standard Details.

410.21.3 Payment for external service connections shall be paid at the unit bid prices for service connections. No additional payment shall be paid for internal service connections reinstatement unless a tee-liner or similar is specified and installed. Tee-liner or top-hat style internal liners shall be paid for by separate pay item different from external service reconnections.

410.21.4 Television pre-inspection shall be paid for at the unit price bid per linear foot of pipeline to be inspected. The unit price bid for Television Pre-inspection shall be payment in full for all materials, labor, and equipment necessary for televising the pipe prior to repairing or rehabilitating it. The linear feet paid shall be as measured from center of the upstream manhole to the center of the downstream manhole. Payment shall only be made once for any manhole-to-manhole pipe segment; no additional payment shall be made for multiple inspections of the same pipe segment. Payment will not be made until the pre-inspection video has been approved.

410.21.5 The cost of normal cleaning will not be paid for separately but shall be included in the Contract Unit Price of the rehabilitation or replacement being performed.

410.21.6 The cost of heavy cleaning shall be paid for at the unit price bid per linear foot of pipeline to be cleaned. The unit price bid for Heavy Cleaning shall payment in full for all materials, labor, cost of material disposal, and equipment necessary for heavy cleaning of the pipe prior to repairing or rehabilitating it.

410.21.7 The cost of post construction television inspection will not be paid for separately but shall be included in the Contract Unit Price of the rehabilitation or replacement being performed. This shall include all costs associated with the television inspection, such as viewing, record logs, and standard transfer media.

410.21.8 The prices shall be payment in full for performing and completing the work and for furnishing all labor and materials necessary including excavation and removal of existing structure, trench safety system, pipe lining materials, pipe sealing materials, labor, backfilling, surface restoration, sodding, pavement replacement, sidewalk and driveway replacement, curb and gutter replacement, all testing, and all incidental costs.

**END OF SECTION**

## PART 411 – PIPELINE PRESSURE GROUTING

411.1 SEWER LINE CLEANING

411.1.1 GENERAL. All sludge, dirt, rocks, bricks, grease, roots, and other debris shall be cleaned from each section requiring grouting by one of the following appropriate methods:

A) Light Deposits. If color television inspection reveals that only small deposits of debris are present within the segment, cleaning shall be accomplished by using high pressure water jetting equipment.

B) Heavy Deposits. If color television inspection reveals that large deposits of debris or root growth are present within the segment, cleaning shall be accomplished by using bucket machines, high pressure water jetting equipment, scrapers, augers, and root cutters.

C) Roots. Visible evidence of roots from the television inspection shall be noted by CONTRACTOR. All roots shall be mechanically and chemically removed prior to grouting. CONTRACTOR shall apply chemical root eradicator in a manner that will result in a root-free barrier around the outer perimeter of the pipe joint to be grouted. Root eradication plan shall be approved by ENGINEER.

D) All debris from the cleaning operation shall be removed at the downstream manhole and disposed of at an approved landfill or dump site.

E) Any damage to the sewer line or joints caused by cleaning equipment shall be repaired at no expense to City.

411.2 JOINT TESTING AND SEALING

411.2.1 EQUIPMENT: Testing Equipment. The basic equipment used shall consist of a color television camera, joint testing device and test monitoring equipment. The equipment shall be constructed in such a way as to provide means for introducing the test medium, under pressure, into the void area created by the expanded ends of the joint-testing device and means for continuously measuring the actual static pressure of the test medium at and within the void area only.

411.2.2 Void pressure data shall be transmitted electrically from the void to the monitoring equipment, i.e. via a TV picture of a pressure transducer located at the void. A mixing manifold packer will be required.

411.2.3 All test monitoring shall be above ground and in a location to allow for simultaneous and continuous observation of the television monitor and test monitoring equipment by ENGINEER.

411.3 MATERIALS

411.3.1 The Contractor shall be thoroughly trained and familiar with handling, mixing, and placing all material. All materials shall be used in strict accordance with manufacturer's recommendations and with the provisions of all OSHA and other safety regulations. Field conditions must be appropriate for and compatible with component mixing for the linings and sealants. All materials shall conform to and be installed according to manufacturer's recommendations and specifications. Contractor shall supply all necessary materials, including storage and transportation to the satisfaction of Engineer. Materials damaged by Contractor shall be replaced at no additional cost to the City. Existing manhole frames and covers being replaced shall become the property of City.

411.3.2 CHEMICAL GROUTING SYSTEMS: Where the pressurized injection of chemical grout is required, the material supplied shall be a urethane gel or a urethane foam (the material supplied shall be 3M Scotch-Seal 5600 (foam), or 3M Scotch-Seal 5610 (gel), without exception) with properties as follows:

411.3.3 General: Chemical sealing materials for use in manhole rehabilitation shall have the following properties and characteristics:

A) While being injected, the chemical sealant must be able to react/perform in the presence of infiltrating water.

B) The cured sealant must be capable of withstanding submergence in water without degradation.

C) The cured sealant must prevent the passage of water through the manhole defect.

D) The cured sealant must be flexible as opposed to brittle or rigid.

E) In place, the cured sealant shall be able to withstand freeze/thaw and wet/dry cycles without adversely affecting the seal.

F) The cured sealant must not be biodegradable. Additives may be used to meet this requirement, without affecting long-term strength.

G) The cured sealant shall be chemically stable and resistant to concentrations of acids, alkalis, and organics found in normal sewage.

H) Packaging of component materials must be compatible with field storage and handling requirements. Packaging must provide for worker safety and minimize spillage during handling.

I) In the event that the chemical sealant may be harmful by passing through the unbroken skin, by inhalation of dust, vapor or mist, or by swallowing, the handling and mixing shall be performed with proper equipment and by personnel thoroughly familiar with the chemicals involved and shall be in strict accordance with the manufacturer's recommendations and with the provisions of all safety regulations.

J) Mixing of component materials must be compatible with field conditions.

K) Residual sealing materials must be easily removable from the bench of manhole to prevent reduction or blockage of the sewer flow.

L) No grouting operations shall be performed at temperatures below 40° F or where the temperature of the groundwater is below 40° F.

411.3.4 Urethane Gel: Urethane gel shall have the following properties and characteristics:

A) One-part urethane prepolymer thoroughly mixed with between five and ten parts water by weight. The recommended mix ratio is one-part urethane prepolymer to eight parts of water (11% prepolymer).

B) A liquid prepolymer having a solids content by weight of 77% to 83%, specific gravity of 1.04 (8.65 pounds per gallon), and flash point of 200° F.

C) A liquid prepolymer having a viscosity of 600 to 1,200 centipoise at 70, that can be pumped through 500’ of 1/2" hose with a 1,000-psi head at a one-ounce per second flow rate.

D) The water used to react the prepolymer should be in the pH range of 6.5 to 8.0.

E) A cure time of 80 seconds at 40° F, 55 seconds at 60° F, and 30 seconds at 80° F when one-part prepolymer is reacted with eight parts of water only. Higher water ratios give longer cure times.

F) A cure time that can be reduced to ten seconds for water temperatures of 40° F to 80° F when one-part prepolymer is reacted with eight parts water containing gel control agent.

G) A relative rapid viscosity increase of the prepolymer/water mix. Viscosity increases from about 10 to 60 centipoise in the first minute for 1:8 prepolymer/water ratio at 50° F.

H) A reaction (curing) which produces a chemically stable, non-biodegradable, tough, flexible gel.

I) The ability to increase mix viscosity, density, gel strength and resistance to shrinkage by using additives in the water component of the grout.

J) The ability to accept suspended additives such as 2,6-dichlorobenzonitrile root control.

K) Contain a minimum of 15% shrink control agent supplied by the same manufacturer.

411.3.5 Urethane Foam: Urethane foam shall have the following properties and characteristics:

A) Approximately one-part of urethane prepolymer thoroughly mixed with one-part water by weight (50% prepolymer).

B) A liquid prepolymer having a solids content by weight of 82% to 88%, specific gravity of 1.1 (9-15 pounds per gallon), and flash point of 200° F.

C) A liquid prepolymer having a viscosity of 30 to 500 centipoise at 72° F that can be pumped through 500’ of 1/2" hose with a 500-psi head at a one-ounce/second flow rate.

D) A cure time of 15 minutes at 40° F, 8.2 minutes at 70° F, and 4.6 minutes at 100° F when the prepolymer is reacted with water only.

E) A cure time of 5.5 minutes at 40° F, 3.5 minutes at 70° F, and 2.6 minutes at 100° F when the prepolymer is reacted with water containing 0.4% accelerator.

F) During injection, foaming, expansion, and viscosity increase takes place.

G) Physical properties of the cured foam of approximately 14 pounds per cubic foot density, 80 to 90 psi tensile strength, and 700% to 800% elongation when a mixture of 50% prepolymer and 50% water undergoes a confined expansion to five times its initial liquid volume.

H) The ability to accept suspended additives such as 2,6-dichlorobenzonitrile for root control.

411.4 EXECUTION

411.4.1 Test Medium. Air only is acceptable.

411.4.2 Test Procedure. Each sewer pipe joint which is not visibly leaking shall be individually tested at a pressure equal to 0.5 psi per vertical foot of pipe depth (not exceeding a test pressure of 6 psi and not less than 3.5 psi) in accordance with the following procedures:

A) The testing device shall be positioned within the line in such a manner as to straddle the pipe joint to be tested.

B) The testing device ends (end elements, sleeves) shall be expanded so as to isolate the joint from the remainder of the line and create a void area between the testing device and the pipe joint. The ends of the testing device shall be expanded against the pipe with sufficient pressure to contain a minimum of 6 psi within the void without leakage past the expanded ends.

C) The test medium shall then be introduced into the void area until a pressure equal to or greater than the required test pressure is observed with the void pressure monitoring equipment. If the required test pressure cannot be developed, the joint

will have failed the test and shall be sealed as specified in Part 411.4.3 "Joint Sealing Procedure".

D) After the void pressure is observed to be equal to or greater than the required test pressure, the air flow shall be stopped. If the void pressure decreases by more than 2 psi within 15 seconds, the joint will have failed the test and shall be sealed as specified in Part 411.4.3 "Joint Sealing Procedure".

411.4.3 Joint Sealing Procedure. Joint sealing shall be accomplished by injecting chemical grout into or through faulty joints by a system of pumps, hoses, and sealing packers. The packer shall be a hollow type packer to allow for flow of wastewater during the sealing operation. The packer shall be positioned over the faulty joint by means of a measuring device and the closed-circuit television camera in the line. The procedure used by CONTRACTOR for positioning the packer shall be accurate to avoid overpulling the packer and thus not effectively sealing the intended joint. The packer ends shall be expanded using controlled pressure. The expanded ends shall seal against the inside periphery of the pipe so as to form a void area at the faulty joint thereby isolating from the remainder of the pipeline. Sealant materials shall be pumped through the hose system at controlled pressures which are in excess of groundwater pressures. The pumping unit, metering equipment, and the packer device shall be designed so that proportions and quantities of materials can be regulated in accordance with the type and size of the leak being sealed. Pumps, fittings, and hoses shall be designed to transport a high viscosity material and shall be capable of supplying an uninterrupted and continuous flow of the sealing material at rates between 0.25 and 10 gallons per minutes at a minimum pressure of 60 psi, for a continuous period of up to ten minutes.

411.5 JOINT SEALING VERIFICATION

411.5.1 TESTING. Upon completing the sealing of pipeline joint, all loose and residual sealing material shall be removed from the interior of the pipe. The sealed joints shall be left "flush" with the existing surface. All joints sealed shall then be tested as described in Part 411.4.2 "Test Procedure" and those joints which fail to meet the specified test criteria shall be resealed and retested until the test criteria can be met in order to receive payment.

411.5.2 TELEVISION INSPECTION OF GROUTING. CONTRACTOR shall furnish a video color recorder to record the entire grouting operation. The video shall be available for review by ENGINEER at all times. At the completion of line grouting operations, all videos shall become the property of City.

411.5.3 RECORDS: CONTRACTOR shall supply to ENGINEER complete records of all lines grouted. There records shall include, but not be limited to, the following: joint testing, joint sealing quantity of grout used at each joint, the number of injections required to seal each joint, and TV videos with audio and visual accounts of the testing and sealing operation on each joint. The date, line segment, footage, and pressure tests accurate to 0.1 psig shall be indicated in digital format on the screen.

## 411.6 MEASUREMENT AND PAYMENT

411.6.1 Pipeline Pressure Grouting shall be paid for at the Contract Unit Prices as follows: The unit price shall cover the entire cost of sewer pipeline grouting, measured to the nearest 0.1', center of manhole to center of manhole, less 1/2 the diameter of both the upstream and downstream manholes.

411.6.2 The prices shall be payment in full for performing and completing the work and for furnishing all labor and materials necessary including excavation and removal of existing structure, trench safety system, pipe grouting materials, labor, backfilling, surface restoration, all testing, labor and all incidental costs.

## PART 412 – POINT REPAIRS

412.1 GENERAL

412.1.1 INTENT: Point repairs are work required to repair defective sections of existing sewer lines. Repair work may be required at joints, service connections, and to short segments of damaged pipe by removal and replacement of sections of pipe. All work to expose and correct the defects, and the materials and methods used shall conform to the applicable specifications, including excavation and backfill, surface restoration, pipe installation, and sewer flow control. A point repair is considered to be 10’ in length. Repair footage required greater than 10’ is considered extra length.

412.1.2 TELEVISION INSPECTION: CONTRACTOR shall clean and inspect each line immediately prior to reconstruction utilizing a pan and tilt camera capable of verifying active or inactive service connections and the overall structural condition of the pipeline. All roots, debris, and protruding service connections shall be removed prior to reconstruction. Inspection shall include the complete length of the line from manhole to manhole. The exact location of the point repairs will be determined by internal television inspection prior to excavation. The Standard Transfer Media will have a digital footage display on the screen and shall be reviewed by ENGINEER prior to excavation to determine the extent of the repair as indicated on the Drawings.

412.1.3 NOTIFICATION: CONTRACTOR shall notify ENGINEER not less than 48 hours in advance of the time he plans to begin repair work at a particular location with the Project.

412.2 MATERIALS

412.2.1 PIPE AND FITTINGS: All pipeline point repair materials shall be like-kind, in accordance with Parts 305, 306, 307, and 313.

412.2.2 BACKFILL: Backfill, including pipe bedding, shall be placed and compacted as specified in Part 302.

412.2.3 RIGID FITTINGS: Pipeline point repairs shall be connected to solid existing pipe with rigid fittings with stainless steel fittings, clamps and bands, Dresser fittings or approved equal.

412.3 PROCEDURE

412.3.1 Excavate repair pit and uncover the sewer line a minimum of 12” clearance all around the damaged section.

412.3.2 Remove defective pipe or fittings to the nearest joint or by cutting perpendicular to the pipe axis to leave a plain end.

412.3.3 Prepare a replacement section of like pipe material, or as otherwise approved by ENGINEER, to within 1/4" of required replacement pipe length.

412.3.4 Connect replacement section to existing pipe with appropriate size rigid coupling.

412.3.5 All service connections within the repair area shall be tested by CONTRACTOR to determine if they are active or inactive. Only active services shall be reconnected to the sewer system. Inactive services shall be plugged with hydraulic cement or non-shrink grout. Any liability associated with the plugging of active services shall be the CONTRACTOR'S sole responsibility.

412.3.6 Service connections shall be reinstated with an approved saddle. The saddle shall be secured with stainless steel bands. The connection to the existing lateral shall be made with using a solid sleeve coupling, Rockwell Omni, OCUT sewer connector, or approved equal. Where a service lateral reconnection cannot be made because of the poor condition of the existing service lateral pipe, the ENGINEER must be notified. Additional work may then be authorized.

412.3.7 Point repairs shall be visually inspected and measured by ENGINEER prior to backfilling.

412.3.8 Surface Restoration: Service and lateral pits, and other work areas shall be restored to condition as good as that before construction occurred. Disturbed grasses shall be sodded in accordance with Part 402 Restoration. Pavements removed or damaged shall be replaced. Concrete embankment shall be replaced or installed at locations indicated in the Drawings and in accordance with these specifications.

412.4 TESTING

412.4.1 PROCEDURE: Sanitary sewer lines with point repairs shall be tested to determine the adequacy of each repair by televising the repaired area and 10’ beyond each end of the repair. Video media of the repaired section shall be provided for ENGINEER and shall become property of City.

412.4.2 Visual observations, by ENGINEER, may be made where repairs can be observed by lamping the sewer line from the closest manhole, instead of television inspection. If the repair is found to be unsatisfactory by ENGINEER, CONTRACTOR shall repair the defect at no additional cost.

412.4.3 TESTING CRITERIA: A repair will be considered unsatisfactory if any one of the following are observed:

A) Pipe joint not seated properly.

B) Improperly connected lateral or service connection.

C) Cracked or broken pipe.

412.5 MEASUREMENT AND PAYMENT

412.5.1 Pipeline Point Repairs shall be paid for at the Contract Unit Prices as follows: The unit price shall cover the entire cost of a 10’ sewer repair.

412.5.2 Additional length of repair required will be paid for at the unit price bid for additional horizontal feet of repair, paid to the nearest 0.1’.

412.5.3 The prices shall be payment in full for performing and completing the work and for furnishing all labor and materials necessary including excavation and removal of existing structure, trench safety system, pipe repair materials, connectors, pipe sealing materials, labor, backfilling, surface restoration, testing, and all incidental costs.

412.5.4 Service reconnections within the point repair area shall be included with the unit price bid for point repairs.

## PART 413 – CONCRETE EMBANKMENT

413.1 GENERAL

413.1.1 This work shall consist of the construction of riprap composed of approved stone, grouted stone, or reinforced concrete, in accordance with these specifications and as shown on the Drawings or as established by the Engineer.

413.2 MATERIALS

413.2.1 Reinforced Concrete riprap shall be Class A concrete. Stone riprap shall be in accordance with Part 214 of the City Specifications.

413.3 EXECUTION

413.3.1 Excavation. The area upon which the riprap is to be placed shall be excavated to the required grades and lines and the surface shall be smoothed and compacted. Sheeting shall be used for forming the toe wall for concrete riprap, if necessary, in order for the concrete to be placed in the dry.

413.3.2 Reinforced Concrete Riprap.

A) Reinforced concrete riprap shall be of Class A concrete. Sufficient temporary headers and strike-offs shall be used to construct the riprap to the dimensions and grades indicated and to obtain a smooth, even surface. The surface shall be finished with a wooden float and lightly broomed to obtain a more desirable finish.

B) Reinforcement shall be placed as indicated on the Drawings. Unless otherwise noted on the Drawings, the reinforcement shall extend through construction joints.

C) Contraction joints shall be spaced as indicated on the Drawings and shall be constructed by inserting a metal plate in the fresh concrete or by cutting the fresh concrete with a trowel or other suitable tool. The indentations shall extend to the reinforcement and be perpendicular to the surface of the riprap. Guide plates shall be used in making the indentations to insure straight joints.

D) Curing for Concrete Riprap. The curing of concrete riprap shall begin immediately after finishing, and curing shall continue for at least seven days.

E) Curing shall be accomplished and maintained so that moisture is always present at the concrete surface and shall be an integral part of the concreting operations.

F) Concrete surfaces shall be covered with wet burlap, moisture proofed burlap, liquid membrane-forming compound, white polyethylene sheeting or other approved impermeable material immediately after the finishing of the concrete has been complete and at such time that marring of the concrete will not occur. If any curing material becomes perforated or torn, it shall be immediately repaired or discarded

and replaced with acceptable material. The Contractor shall furnish a work bridge for application of curing materials.

G) If rain falls on the newly coated concrete before the film has dried sufficiently to resist damage, or if the film is damaged in any other manner, a new coat of the membrane shall be applied to the affected portion equal in curing value to the original application.

H) Spraying equipment shall be capable of supplying a constant and uniform pressure to provide uniform and adequate distribution of the curing membrane at the rates required. The curing membrane shall be continuously agitated during application.

I) When concrete is being placed and the ambient air temperature may be expected to drop below 40º F. during the curing period, the contractor shall provide suitable measures such as straw, additional burlap, or other suitable blanketing materials and/or housing and artificial heat to maintain the concrete temperature between 40º F and 90º F as measured on the surface of the concrete. The surface of the concrete shall be kept moist by the use of an approved moisture barrier such as wet burlap or polyethylene sheeting. The moisture barrier shall be maintained in intimate contact with the concrete during the entire seven-day curing period. After the completion of the required seven-day curing period, the Contractor shall remove the curing and protection in such a manner that rapid cooling of the concrete will be prevented.

413.3.3 Stone Riprap

A) The stones for riprap shall be laid on edge with the bedding plane at right angles to the slope with the ends and sides abutting. The larger spaces between stones shall be filled with spalls of suitable size and all spalls shall be rammed thoroughly in place. The entire surface shall be rammed and compacted to obtain a tight surface. The finished surface shall present an even surface conforming to the lines, grades, and sections given.

B) When grouted stone riprap is indicated, the spaces between stones of grouted riprap shall be filled with grout consisting of one-part Portland cement and three parts of fine aggregate with sufficient water to form a plastic mix. The grout shall be poured and broomed into the spaces until they are completely filled.

C) The grout shall be cured in the manner provided above for concrete riprap.

413.4 MEASUREMENT AND PAYMENT

413.4.1 This work shall be measured by the square yard of riprap complete in place as measured along the finished surface. The amount of completed and accepted work, measured as provided above, shall be paid for at the Contract unit price per square yard for riprap of the type designated complete in place, which prices shall be full compensation for furnishing, transporting, delivering and placing all materials, for all

excavation, and for all labor, equipment, tools, and incidentals necessary to complete the work.

## PART 414 – CLAY DAM

414.1 EXECUTION

414.1.1 Clay Dam construction shall be performed in accordance with the Wastewater Clay Dam construction detail at the locations indicated on the Drawings. Clay Dams shall be keyed into undisturbed soil to make an impervious barrier to reduce groundwater percolation through the pipeline trench. Construction material shall consist of compacted bentonite clay or quickset flowable fill.

414.1.2 Clay Dam construction shall include performing and completing the work and furnishing all labor and materials necessary including excavation and removal of existing structure and materials, trench safety system, clay dam materials, forming, placing and finishing, labor, backfilling, surface restoration, all testing, labor and all incidental costs.

414.2 MEASUREMENT AND PAYMENT

414.2.1 Payment for Clay Dam construction shall be included with other construction and shall not be paid for separately.

414.2.2 The prices shall be payment in full for performing and completing the work and for furnishing all labor and materials necessary including excavation and removal of existing structure and materials, trench safety system, clay dam materials, labor, backfilling, surface restoration, all testing, and all incidental costs.

## PART 415 – CONSTRUCTION TELEVISION INSPECTION OF SANITARY SEWER

415.1 GENERAL

415.1.1 PRE-CONSTRUCTION TELEVISION INSPECTION shall include an internal television inspection of the pipeline prior to performing pipe reaming (406), pipe crushing (407), pipe bursting (408), sliplining (409), Cured-In-Place Pipe (CIPP) (410), pipeline pressure grouting (411), and point repairs (412).

415.1.2 POST CONSTRUCTION TELEVISION INSPECTION covers the furnishing of all necessary materials and equipment to perform television inspection of all sanitary sewer lines and point repairs installed under this contract. Television inspection is considered as a part of the final inspection. A satisfactory inspection is required before the project is considered complete.

415.2 MATERIALS

415.2.1 Standard format video recording equipment and standard transfer media are required for video recordings. The video camera used for the inspection shall be specifically designed and constructed for such inspection and shall provide a color picture. Lighting for the camera shall be suitable to allow a clear picture of the entire periphery of the pipe acceptable to the Engineer. The camera shall be operative in 100% humidity conditions and shall have a minimum of 600-line resolution.

415.2.2 Recording equipment shall be equipped with data recorder capable of the following:

A) Date and time

B) Footage

C) Project name, Contract number, Contractor, and inspection firm

D) Location and manhole number

415.3 EXECUTION

415.3.1 The Contractor shall obtain the services of a qualified independent company to perform the television inspection.

415.3.2 The Contractor shall provide traffic control during inspection operation to maintain public traffic and safety of all personnel.

415.3.3 The Contractor shall clean and clear all obstructions, roots, debris, sand, and gravel from the sewer to be inspected.

415.3.4 Satisfactory precautions shall be taken to protect the sewer lines from damage that might be inflicted by the improper use of inspection equipment. Any damage done

during inspection shall be repaired by the Contractor. There shall be no additional payment for these repairs.

415.3.5 Internal Television Inspection

A) The inspection shall be done one sewer section at a time. The section being inspected shall be isolated from the remainder of the sewer in a manner approved by the Engineer. Any defects found shall be repaired by the Contractor and then re-inspected. There shall be no additional compensation allowed for such repair or re-inspection.

B) The camera shall be moved through the line in either direction at a uniformly slow rate, stopping at all defects to allow adequate evaluation by the Engineer. In addition, the camera shall be stopped at each service connection.

C) Cost for excavation to retrieve inspection equipment shall be the responsibility of the Contractor. The City shall not be liable for any costs relative to retrieving inspection equipment from the sewer system.

D) Sanitary sewer mains must be laced with enough water to fill all low points. The television inspection must be done immediately following the lacing of the main with no water flow. Sanitary sewage may be used to propel the camera if the main is live. However, flow may be restricted in a manner approved by the Engineer when necessary to provide a clear image of the sewer being inspected.

E) Telephones, portable radios, CB, walkie talkies, or other electronic means of voice communication must be set up where voice or manual communication is not feasible.

F) Pre-construction television inspection shall include verification of active service connections by introducing dye into the lines at cleanouts, vent stacks or other access points as allowed by the private property owner. Dye testing shall be recorded by CCTV inspection at the location in the main line where the dye appears. All addresses will be noted on log sheets for future references. Post construction television inspection shall identify the address of each service reconnected.

415.3.6 Viewing

A) The television inspection company shall provide facilities for the purpose of viewing the monitor while the inspection is in progress.

B) The Engineer shall witness the television inspection.

415.3.7 Record Logs

A) The video of each sewer segment shall note on the standard transfer media the project name and number, the beginning manhole number, the ending manhole

number, the time, and date of inspection. Footage for camera location in the sewer line shall be displayed continuously during the inspections.

B) The original unaltered video recordings will be reviewed by the Engineer for focus, lighting, clarity of view, and technical quality. The inspection company shall maintain sharp focus, proper lighting, and clear, distortion-free viewing during the camera operations. Failure to maintain these conditions can result in rejection of the video by the Engineer. Any sewer line whose video is not acceptable to the Engineer shall be re-televised at no expense to the City.

C) Defects shall be described and quantified on the videos by the company doing the inspection. Measurement for location of defects in sewer mains shall be at the ground level by means of a metering device. Marking on cable of the like which requires interpolation for depth of manhole will not be allowed. Measurement meters shall be accurate to 0.2'. Measurements shall be taken from the center of the manhole and displayed on the video.

D) A typewritten report shall be provided with the video. Each run sheet shall identify the segment being televised, and the location of each service or defect with its appropriate clock position.

E) Each month, the Contractor shall provide to the City the original video and logs of each section of sewer line televised.

## 415.4 MEASUREMENT AND PAYMENT

415.4.1 Television pre-inspection shall be paid for at the unit price bid per linear foot of pipeline to be inspected. The unit price bid for television pre-inspection shall be payment in full for all materials, labor, and equipment necessary for televising the pipe prior to repairing or rehabilitating it. The linear feet paid shall be as measured from the center of the upstream manhole to the center of the downstream manhole. Payment shall only be made once for any manhole-to-manhole pipe segment; no additional payment shall be made for multiple inspections of the same pipe segment. Payment will not be made until the pre-inspection video has been approved.

415.4.2 Obstruction Removal shall be paid for at the bid unit price for obstruction removal.

415.4.3 The cost of post construction television inspection will not be paid for separately but shall be included in the Contract Unit Price of the rehabilitation or replacement being performed. This shall include all costs associated with internal television inspection, such as viewing, record logs, and standard transfer media.

## PART 416 – COMPLETE MANHOLE REPLACEMENT

416.1 SCOPE

416.1.1 Work covered in this section consists of complete manhole replacement. Testing, cleanup, and materials requirements are also included.

416.1.2 The Contractor shall be responsible for the furnishing of all labor, supervision, materials, and equipment required to complete all rehabilitation and replacement work and testing in accordance with the Contract Documents. This includes any follow-up rehabilitation work required of the CONTRACTOR by the ENGINEER.

416.2 MATERIALS

416.2.1 The Contractor shall be thoroughly trained and familiar with handling, mixing, and placing all material. All materials shall be used in strict accordance with manufacturer's recommendations and with the provisions of all OSHA and other safety regulations. Field conditions must be appropriate for and compatible with component mixing for the linings and sealants. All materials shall conform to and be installed according to manufacturer's recommendations and specifications and shall conform to City Standard Specifications unless herein modified. Contractor shall supply all necessary materials, including storage and transportation to the satisfaction of Engineer. Materials damaged by Contractor shall be replaced at no additional cost to the City. Existing manhole frames and covers being replaced shall become the property of City. Contractor shall dispose of existing castings at a site indicated by Sewer Operations and Maintenance.

416.2.2 Precast concrete manholes will be allowed for complete manhole replacements.

416.2.3 Frames and covers shall be as specified in Part 418 – Replacement of Manhole Frame and Cover, Frame Seal, Chimney, and Grade Adjustment.

416.2.4 Exterior surfaces of manhole sections shall be coated only when specified. Coating shall be two mop coats of coal tar epoxy paint, Koppers "Bitumastic Super Service Black", Tnemec "46-450 Heavy Tnemecol", or approved equal. Dry film thickness shall be a minimum of 14.0 mils per coat. Recoating shall be done in accordance with manufacturer's recommendations. Interior coatings shall be required in accordance with Part 211.1.8.

416.2.5 Grout shall be non-shrink in the plastic state and show no expansion after set as tested in accordance with ASTM C827 and shall develop compressive strength not less than 3,000 psi with a trowelable mix within 24 hours per ASTM C109. The placement time shall be not less than 45 minutes based on initial set per ASTM C191. Test results shall be furnished by the manufacturer and submitted to the ENGINEER.

416.2.6 Opening for each connecting pipe shall be circular with a compression type flexible rubber gasket cast integrally into the manhole wall. Flexible gaskets shall be manufactured in accordance with rubber joint specification ASTM C443 and shall meet

the performance and test requirements of ASTM C425 for compression joints. Pipe seals to the new manhole structure shall be A-Lok, Presswedge, or approved equal.

## 416.3 REPLACE COMPLETE MANHOLE

416.3.1 Complete manhole replacement shall be done in accordance with the Drawings and as shown in the Standard Specifications. Any structurally unsound manholes observed by Contractor shall be replaced as directed by ENGINEER.

416.3.2 The existing manhole structure designated for complete replacement shall be completely removed before installation of the new precast manhole structure. Contractor shall dispose of all debris and prevent any debris from entering the existing sewer lines.

416.3.3 Manhole diameters shall be 4’ I.D. for 8” to 12” pipe; 5’ I.D. for 15” to 21” pipe; and 6’ I.D. for 24” to 36” pipe. For pipes larger than 36” diameter, a special manhole is required.

416.3.4 All new manholes shall have 30” frame and covers in accordance with the Standard Details

416.3.5 Install frames and covers in accordance with Part 418 – Replacement of Manhole Frame and Cover, Frame Seal, Chimney, and Grade Adjustment. Precast manhole sections shall be sealed and wrapped in accordance with construction details.

416.3.6 Any damage done to existing sanitary pipe during excavation or replacement shall be replaced by Contractor at no additional cost.

416.3.7 Contractor shall maintain wastewater flow at all times. Contractor shall submit a plan for maintaining wastewater flow to the ENGINEER prior to beginning work.

416.3.8 Form inverts with mortar material and steel-trowel to produce a dense, smooth finish and shape to form a channel that approximates the lower half of the inside diameter of the pipe. The channel shall extend to 3/4 the diameter of the pipe. Bench shall be shaped to drop approximately 2” from wall to invert.

416.3.9 Any incoming pipes which are 2’ or more above the outgoing invert elevation shall be equipped with outside drop connections.

416.3.10 Complete manhole replacement shall also include replacement of frame and cover, bench and invert, frame seal, grade adjustment and five linear feet of pipe at each connection to the manhole. Pipe shall be like kind unless otherwise ordered by the ENGINEER. Additional footage of pipe, if required, will be paid for at a per foot price as shown in the bidding documents.

416.3.11 Service lines encountered shall be connected to the main sewer outside the manhole using an integral tee connection.

416.3.12 A concrete collar shall be constructed on each manhole constructed or repaired in pavement in accordance with the Drawings. Concrete collars shall not be constructed in unpaved areas. Concrete collars constructed in asphalt streets shall be constructed to finish grade with concrete. No additional payment will be made for concrete collars as the concrete collar is considered subsidiary to other items of work.

416.3.13 The exterior surface of all chimneys, frame adjustments and pre-cast manhole sections joints shall be thoroughly cleaned with a wire brush and then waterproofed with a minimum 3/8" coat of trowelable bitumastic joint sealant (Easystik, Tnemec Series 265 Elasto-Shield TG, or approved equal) up to and including the bottom flange of the frame. The entire frame and grade adjustment shall then be wrapped with six mil plastic to protect against damage from backfill.

416.3.14 Complete manhole replacement includes performing and completing the work and for furnishing all labor and materials necessary including excavation and removal of existing structure, trench safety system, replacement of frame and cover, installing new adjustment rings, manhole walls, manhole steps, corbel and/or flattops, bench/invert and base for complete manholes, pipe replacement required at each pipe entering the manhole, backfilling, surface restoration, and all testing.

416.4 MEASUREMENT AND PAYMENT

416.4.1 Complete manhole replacement shall be paid for at the Contract Unit Prices as follows:

A) A unit price to cover the construction of one standard manhole of the diameter and type indicated; 0’ to 6’ in depth.

B) A unit price which shall cover the entire cost of each additional foot of vertical manhole depth in excess of 6’, measured to the nearest 0.1’.

416.4.2 The prices shall be payment in full for performing and completing the work and for furnishing all labor and materials necessary including excavation and removal of existing structure, trench safety system, replacement of frame and cover, installing new adjustment rings, manhole walls, corbel and/or flattops, bench/invert and base for complete manholes, five linear feet of pipe replacement at each pipe entering the manhole including rigid connection, backfilling, surface restoration all interior and exterior coatings, and all testing.

416.4.3 Additional pipe required for Manhole Replacement may be required when the 5’ length of pipe included in the Manhole replacement is inadequate to reach to sound pipe. If additional pipe is required, restoration bid items will be paid for, including Sodding, Pavement Replacement, Sidewalk and Driveway Replacement and Curb and Gutter Replacement at the unit price per bid item.

## PART 417 – REPLACEMENT OF CLEANOUT / LAMPHOLE AND/OR CLEANOUT / LAMPHOLE FRAME AND COVER

417.1 GENERAL

407.1.1 Description: This section describes replacement of existing lamphole frame/cover, the sealing of cleanout frames and the complete cleanout/lamphole replacement. At the Engineer's direction, cleanouts/lampholes where location permits, and the work area is not restricted may be replaced and paid for with a manhole in accordance with Part 416 – COMPLETE MANHOLE REPLACEMENT.

417.2 MATERIALS

417.2.1 The replacement cover shall form a water-resistant seal between the frame and lamphole cover surface. The cover shall have a concealed pick bar, and a machined bearing surface between cover and frame.

417.2.2 A typical standard lamphole frame/cover design shall conform to the City of Tulsa Standard Detail 360.

417.2.3 Covers shall set flush with the rim of the frame and shall have no larger than a 1/8" gap between the frame and lid.

417.2.4 Bearing surfaces shall be machine finished.

417.2.5 Portland Cement Concrete shall be specified in Part 402 – RESTORATION.

417.2.6 The joint between frame ring and chimney and between the frame ring and PVC shall be sealed with trowelable bitumastic joint sealer material. The bitumastic joint sealer shall meet or exceed Federal Specifications SS-S-210A. The trowelable sealer shall be as manufactured by Easystik, or approved equal, and applied in strict accordance with the manufacturer's specifications and recommendations. The material shall be able to withstand hydrogen sulfide and other corrosive gases found in sewers.

417.2.7 Cleanout/lamphole riser section shall be constructed using DIP or PVC pipe as directed by the Engineer.

417.2.8 Backfill shall be in accordance with Part 403 – BACKFILL.

417.3 EXECUTION

417.3.1 The Contractor shall be responsible for supplying the required material for the replacement of the frame and/or covers, and sealing of frame including the unloading, temporary storage, and transporting of the materials.

417.3.2 To replace frame and cover only, the work consists of removal of existing lamphole frame and base, and replacement with a new frame, cover, and concrete base, in

accordance with the detail and specification. Excavation will be required for replacement or extension of pipe.

417.3.3 Frames shall be sealed to the base with bitumastic joint sealer. Base and frames shall be free of dirt, stones, debris, and voids to ensure a watertight seal. Wire brush frame and exposed base to remove dirt and loose debris. Coat exposed base surface with an approved bonding agent, Weld-Crete as manufactured by Larsen Products Company or approved equal, followed with an application of a quick-setting hydraulic cement to provide a smooth working surface as thin as possible. Place the flexible bitumastic joint material, minimum 1/2" thick, in two concentric rings along the inside and outside edge of the joint.

417.3.4 Lamphole rims in parkways, lawns, and other improved lands shall be at an elevation not more than 1” nor less than 1/2" above the surrounding ground. Backfill shall provide a uniform slope from the top of casting for not less than 3’ each direction to existing finish grade of the ground. The grade of all surfaces shall be checked for proper slope and grade by string lining the entire area regraded near the manhole.

417.3.5 Lamphole riser stacks which may be damaged during removal of the existing lamphole, shall be replaced at the Contractor's expense by using a like material and jointing to existing undamaged pipe using a rubber coupling with stainless steel bands.

417.3.6 Cleanout/lamphole diameters shall be 8”.

417.3.7 Backfill shall be in accordance with Part 403 – BACKFILL.

417.3.8 Restoration shall be in accordance with Part 402 – RESTORATION.

417.3.9 Replacement shall include replacement of riser pipe, replacement of frame and cover, backfill and concrete, restoration and all other appurtenances related to the replacement.

417.3.10 Trench Safety shall be in accordance with applicable OSHA, State, and local regulations.

417.4 MEASUREMENT AND PAYMENT

417.4.1 To replace cleanout/lamphole cover and frame only, payment shall be based on the Contract Unit Price per each cleanout/lamphole frame and cover replacement. Payment will provide complete compensation for locating lamphole; excavation; removal and replacement of lamphole casting; concrete embedment (base); placing and compaction of backfill and restoration of surface features.

417.4.2 Cleanout/lamphole replacement shall be paid at the Contract Unit Price to cover the construction of one standard cleanout/lamphole for all depth. Unit price shall include all items necessary for complete replacement of cleanout/lamphole to include, but not be limited to, frame and cover replacement, concrete, riser pipe, concrete embedment

(base), placing and compaction of backfill and restoration of surface features, and all labor and materials required for complete replacement.

## PART 418 – REPLACEMENT OF MANHOLE FRAME AND COVER, FRAME SEAL, CHIMNEY, AND GRADE ADJUSTMENT

### 418.1 SCOPE

418.1.1 Work covered in this section consists of replacement of manhole frame, cover, frame seal, chimney, and grade adjustment in accordance with this Section and with City of Tulsa Standard Detail 402. Testing, cleanup, and materials requirements are also included.

418.1.2 The Contractor shall be responsible for the furnishing of all labor, supervision, materials, and equipment required to complete all rehabilitation and replacement work and testing in accordance with the Contract Documents. This includes any follow-up rehabilitation work required of the Contractor by the ENGINEER.

### 418.2 MATERIALS

418.2.1 The Contractor shall be thoroughly trained and familiar with handling, mixing, and placing all material. All materials shall be used in strict accordance with manufacturer's recommendations and with the provisions of all OSHA and other safety regulations. Field conditions must be appropriate for and compatible with component mixing for the linings and sealants. All materials shall conform to and be installed according to manufacturer's recommendations and specifications. Contractor shall supply all necessary materials, including storage and transportation to the satisfaction of Engineer. Materials damaged by Contractor shall be replaced at no additional cost to the City. Existing manhole frames and covers being replaced shall become the property of City. Contractor shall dispose of existing castings at a site indicated by the Sewer Operations and Maintenance.

418.2.2 Frame Sealing Materials

A) The joint between frame ring and chimney and between the frame ring and top row of brick shall be sealed with trowelable bitumastic elastic material. The bitumastic joint sealer shall meet or exceed Federal Specifications SS-S-210A. The trowelable sealer shall be as manufactured by Easystik, or approved equal, and applied in strict accordance with the manufacturer's specifications and recommendations. The material shall be able to withstand hydrogen sulfide and other corrosive gases found in sewers.

B) Alternatively, for frame to manhole or riser ring to manhole, two rings of bitumastic rope of M1 adhesive may be used in lieu of trowelable bitumastic as approved by the Engineer.

C) Applied sealing material may not be permitted in certain applications where field conditions restrict its use as directed by the ENGINEER.

### 418.3 FRAME

418.3.1 Frame material shall be cast iron conforming to ASTM A48, Class 35B, or better. The frame shall exhibit a tensile strength of not less than 35,000 psi.

418.3.2 Frames for existing 4’ I.D. Sanitary manholes, new 4’ I.D. and larger Sanitary Manholes, or lampholes shall conform to Standard Details 352, 353, 354 or 360, as applicable, and Part 209 – Castings.

418.3.3 Bearing surfaces between the ring and cover shall be machine finished or ground to assure non-rocking fit in any position, and interchangeability.

418.3.4 Frames shall be certified by the manufacturer to meet AASHTO M 306-89 requirements.

418.4 COVER

418.4.1 The replacement cover shall form a water-resistant seal between the frame and manhole cover surface. The cover shall have pick bars or pick slots and a machined bearing surface on the bottom and side of the casting. The cover material shall be cast iron conforming to ASTM A48, Class 35B or better, for Gray Iron. The cover shall exhibit a tensile strength of not less than 35,000 psi.

418.4.2 A typical manhole cover design shall conform to Standard Details 353 and 354.

418.4.3 Covers shall set flush with the rim of the frame and shall have no larger than a 1/8” gap between the frame and cover.

418.4.4 Covers shall be certified by the manufacturer to meet AASHTO M 306-89 requirements.

418.5 CHIMNEY RISER RINGS

418.5 Precast concrete chimney riser rings shall be a minimum of 4” thick, shall conform to ASTM C478, and shall be one piece. For sloping surface grades tapered chimney rings may be used to permit the manhole frame and cover to conform to the sloping surface. No chimney ring will be allowed if the ring has a crack of more than 0.01” as measured by an appropriate gauge or measuring device. Concrete chimney riser rings shall not be used unless approved by the ENGINEER.

418.5.2 Plastic riser rings shall be manufactured by Cretex or approved equal.

418.6 WATERPROOFING MEMBRANE

418.6.1 A cold-applied seamless, elastomeric membrane shall be used for all partial and complete manhole rehabilitation. HLM 5000, as manufactured by Sonnenborn Building Products, shall be applied to the exterior of the exposed structure.

418.6.2 The membrane shall be a single component moisture curing bitumen modified polyurethane that is formulated for hand application by trowel to vertical surface. It shall comply with ASTM C836-84.

418.7 MATERIALS TESTING

418.7.1 Testing shall be the responsibility of the Contractor. Tests for compliance with this Specification shall be made as specified herein and in accordance with the applicable Specification. A Certificate of Compliance with this Specification along with a report of each test, shall be furnished by the Contractor for all material furnished under this specification. The Contractor shall inform the Engineer as to when, where, and by whom, testing will be conducted, at least one week prior to testing. The Engineer may, at its own expense, witness testing of the materials.

418.8 EXECUTION

418.8.1 Replacement of Cover/Frame/Frame Seal

418.8.2 Excavation and Pavement Replacement in Paved Areas:

A) The removal of the manhole frame and cover shall be accomplished by making a circular cut in the pavement as shown in the Drawings.

B) Material in the exposed area shall be excavated toward the casting to a depth of approximately 6” below the bottom of the frame. Excavated material shall be disposed of by Contractor.

C) Specified sub-base materials shall be tamped in place to the minimum specified density as shown on the Drawings to form the sub-base for the pavement.

D) Contractor shall, at no additional cost to the City, replace any portion of the existing manhole that is damaged during replacement of covers and frames.

E) A concrete collar shall be constructed on each manhole constructed or repaired in pavement in accordance with the Drawings. Concrete collars shall not be constructed in unpaved areas. Concrete collars constructed in asphalt streets shall be constructed to finish grade with concrete. No additional payment will be made for concrete collars as the concrete collar is considered subsidiary to other items of work.

F) At the City's option, all castings removed from the work and not reused shall remain the property of the City. Contractor shall stockpile castings at a location designated by the City. If the City elects not to retain ownership of the unused castings, the Contractor shall be responsible for their proper disposal. Disposal of other removed materials is also the Contractor's responsibility.

G) The surfacing used to cover the exposed area shall conform to the existing pavement as specified in the Standard Specifications.

H) Pavement replacement not performed to the satisfaction of the ENGINEER shall be replaced by Contractor at no additional cost to City.

418.8.3 Excavation for Replacement in Unpaved Areas:

A) No unnecessary excavation of materials from around the manhole shall be done.

B) Backfill shall be replaced and compacted to prevent subsequent settlement and to restore the site to a condition equal to or better than that found. Backfill shall not cover the manhole.

C) If surface obstructions are present that prevent access to the manhole, the obstructions shall be removed and reinstalled after completion of the work. Cost for this additional work is considered subsidiary to other items of work and will not be paid for directly.

418.8.4 Removal, Replacement, and Sealing of Manhole Frames:

A) Replacement of chimney adjustment rings, and/or brick and mortar broken during excavation shall be at Contractor's expense. Damaged adjustments shall be replaced with plastic adjustment rings.

B) The manhole frame shall be removed from the manhole and the condition of the grade adjustment rings shall be observed. Any damages shall be brought to the ENGINEER'S attention.

C) All surfaces between the frame, chimney and corbel shall be free of dirt and debris. Joint sealing material shall be troweled concentrically on the grade to frame joint. If deterioration of the grade adjustments or chimney is observed, Contractor shall notify ENGINEER prior to replacement of the manhole frame, and partial chimney replacement may be required.

D) Contractor shall, at no additional cost to the City, replace any portion of the existing manhole that is damaged during replacement of covers and frames.

E) In paved areas frames shall be installed to the slope and finish elevation of the paved surface. The top of the frame shall be even with or 1/8" below the finished elevation. Allowances for the compression of the joint sealer material shall be made to assure a proper final grade elevation.

F) Manhole frames in non-paved areas shall be installed at not more than 2" nor less than 1" above the surrounding surface. Site restoration shall provide a uniform slope away from the top of the manhole frame for a distance of not less than 3' in any direction.

G) Manholes in drainage courses shall be at the elevation which existed prior to rehabilitation or as directed by ENGINEER.

H) A concrete collar shall be constructed on each manhole constructed or repaired in pavement in accordance with the Drawings. Concrete collars shall not be constructed in unpaved areas. Concrete collars constructed in asphalt streets shall be constructed to finish grade with concrete. No additional payment will be made for concrete collars as the concrete collar is considered subsidiary to other items of work.

## 418.9 REPLACEMENT OF CHIMNEY / GRADE ADJUSTMENT / FRAME SEALING

418.9.1 Excavation shall be to a minimum depth of 6” below the repair depth.

418.9.2 Chimneys being replaced shall use plastic riser rings as described in Section 418.5.2.

418.9.3 Contractor shall replace that portion of the defective manhole chimney up to a maximum depth of 24” below the bottom of the frame. If the chimney is deeper than 24”, Contractor shall notify the Engineer prior to performing any work on the manhole. In those instances, the Contractor may be required to perform a Partial Manhole Replacement to include removal and replacement of the existing corbel or manhole barrel and either:

A) Replacement with a new manhole wall section and precast flattop section, or
B) Replacement with a new manhole wall section, corbel, frame, and cover.

418.9.4 A bonding agent, Weld-Crete as manufactured by Larsen Products Company or approved equal, shall be applied to the top surface of the existing manhole after the defective portion of the manhole has been removed. Hydraulic cement mortar shall be used to bring the surface to grade and provide a smooth surface for the joint sealing material and additional chimney riser rings. Thickness of hydraulic cement shall not exceed 3”. Hydraulic cement shall be allowed to set a minimum of one hour prior to placement of joint sealing material and adjustment rings. Set time may be adjusted in accordance with the manufacturer’s recommendations. The bonding agent and the cement mortar shall not be applied when the temperature is below manufacturer's recommendations.

418.9.5 All surfaces between the frame, chimney, and corbel shall be free of dirt and debris. Joint sealing material shall be placed at the edge of each chimney to frame joint, and top of corbel section.

418.9.6 Contractor shall, at no additional cost to City, replace any portion of the existing manhole that is damaged during chimney and frame sealing.

418.9.7 Grade adjustments exceeding 12”, but less than 24”, must be braced during backfilling operations. When the required grade adjustment exceeds 24”, ENGINEER shall be notified prior to placement of new adjustment rings to determine if additional work is necessary.

418.9.8 The exterior surface of all chimneys and frame adjustments shall be thoroughly cleaned with a wire brush and then waterproofed with a minimum 1/2" coat of trowelable bitumastic joint sealant up to and including the bottom flange of the frame. The entire frame and grade adjustment shall then be wrapped with six mil plastic to protect against damage from backfill.

## 418.10 PARTIAL MANHOLE REPLACEMENT (TYPE F)

418.10.1 Overview: Partial manhole replacement shall be performed when required by the plans or as directed by the Engineer. Partial manhole replacement will be utilized when frame and cover replacements, chimney replacements, or grade adjustments cannot be performed within the allowable requirements of the City of Tulsa Specifications with regard to maximum height of the chimney section. Partial manhole replacement shall normally be required when a proposed grade adjustment would result in a chimney height of greater than 24”. (See condition “A” in Standard No. 401.) Unless required by the plans, Partial Manhole Replacement shall not be performed unless directed by the Engineer.

418.10.2 Determination of need: Contractor shall bring to the Engineer’s attention any manhole which, if adjusted to grade, would have a chimney height greater than 24”. The Contractor and Engineer shall jointly inspect the manhole and reach agreement as to the work to be performed on the manhole. Should the Engineer require it, a partial manhole replacement shall be performed.

418.10.3 Execution: Partial manhole replacement shall consist of the removal of the existing manhole components necessary to expose the top barrel section of the manhole wall, to include the frame and cover, adjusting rings, and corbel; and replacement with additional manhole wall sections, corbel, adjusting rings, frame and cover as are necessary to achieve the proper manhole top elevation with a chimney height of less than 24”.

418.10.4 The Contractor shall excavate the exterior of the manhole to an elevation 1’ below the corbel/wall joint and shall remove the frame and cover, adjusting rings, corbel, and any portions of the wall which must be removed for the performance of the work. The exterior and top of the existing manhole wall shall be thoroughly cleaned of any dirt and debris; and any voids, joints, or irregularities shall be grouted.

418.10.5 The Contractor shall measure the diameter of the old manhole wall. In those instances where the old wall section is a precast section designed to utilize an O-ring gasket, and the new precast wall section or corbel will mate and seal over the old section, the installation will be completed in a manner consistent with the requirements for new construction (See Standard No. 358 and Section 314.7 of the Standard Specifications).

418.10.6 In those instances where the new and old wall sections have incompatible diameters, the Contractor shall complete the installation of the new wall/corbel section in accordance with Standard No. 401A. The Contractor shall utilize a new wall section or corbel with a diameter larger than the existing wall section. The Contractor shall saw cut the bottom edge of the new wall section or corbel to produce a flat, smooth surface.

Around the existing wall section, the Contractor shall pour a concrete collar upon which to set the new wall section or corbel. The top surface of the concrete collar and the bottom surface of the new wall section or corbel shall be prepared with hydrophilic paste and waterstop and the new wall section or corbel shall be placed upon the concrete collar. The exterior gap between the collar and new wall section or corbel shall be sealed with a non-shrink grout.

418.10.7 Prior to pouring of the concrete collar, a strip of hydrophilic paste shall be placed on the existing manhole wall to seal all joints, depressions, cavities, and irregularities in the surface. This shall be followed by placing a hydrophilic waterstop on the paste. The Cast-In-Place concrete collar shall be allowed to cure for 48 hours prior to installation of the new wall section or corbel. One strip of hydrophilic waterstop shall be placed on the new wall section or corbel prior to its installation on the concrete collar. Hydrophilic paste shall be ADEKA P101, or equal. Hydrophilic waterstop shall be ADEKA KBA-1510FP, or equal.

418.10.8 All new or old surfaces shall be primed with Weldcrete as manufactured by Larsen Products Company, or equal, prior to placement of concrete.

418.10.9 The exterior surfaces of all exposed existing wall sections, concrete collar, and new wall section, corbels, and adjusting rings shall be thoroughly cleaned with a wire brush and then waterproofed with a minimum ½" coat of troweleable bitumastic joint sealant up to and including the bottom flange of the frame and then wrapped with a six mil sheet of plastic to protect against damage from backfill.

418.11 MEASUREMENT AND PAYMENT

418.11.1 Each item listed under this specification shall be measured and paid for at the unit price bid per manhole, regardless of size, for each manhole replaced or rehabilitated.

418.11.2 Measurement of Repair Types:

A) Replacement of manhole cover and frame and frame seal in accordance with Part 418.9.1 (Type A Repair) shall be paid for at the Contract Unit Price.

B) Replacement of manhole frame seal in accordance with Part 418.9.4 (Type B Repair) shall be paid for at the Contract Unit Price.

C) Replacement of manhole cover, frame, frame seal and chimney in accordance with Part 418.9.1 and 418.10 (Type C Repair) shall be paid for at the Contract Unit Price.

D) Replacement of manhole frame seal and chimney in accordance with Part 418.10 (Type D Repair) shall be paid for at the Contract Unit Price.

E) Payment for manhole grade adjustment shall be included in bid items for Repair Types A, B, C, D, or F in accordance with Part 418 of the Construction specification. No separate payment shall be made for manhole grade adjustment.

F) Partial Manhole Replacement in accordance with Part 418.11 (Type F) shall be paid for at the unit price bid for each of the following items:

1) Type Ft: Precast Flattop Section: The unit price bid for each precast flattop section shall be payment in full for performing and completing all work and furnishing labor, supervision, materials, equipment necessary to remove and dispose of the existing ring and cover, and install a new precast flattop section, complete with frame and cover upon an existing or new manhole wall section. No additional payment will be made for materials or installation or the new frame and cover. Additional payment will be made for a concrete collar (Type Fl) and also for the vertical footage or precast wall section (Type Fw) needed to achieve the proper finished to elevation.

2) Type Fc: Precast Corbel Section: The unit price bid for each precast corbel shall be payment in full for performing and completing all the work, and furnishing labor, supervision, materials, equipment necessary to remove the existing frame and cover, corbel, or manhole wall section and replace it with a precast corbel of the required height; install adjusting rings, frame and cover; and all additional materials, equipment and labor needed for a complete restoration of the manhole. No additional payment shall be made for modifying portions of the existing manhole or the end section of the precast corbel to affect a watertight seal between the old and new manhole components or for adjusting rings, frame, and cover. Additional payment will be made for a concrete collar (Type Fl). Additional payment will also be made for a precast wall section (Type Fw), if needed.

3) Type Fw: Precast Manhole Wall Section: The unit price bid for each vertical foot of precast manhole wall shall be payment in full for performing and completing all the work and furnishing labor, supervision, materials, equipment necessary to remove the existing corbel or section of manhole wall, and install each foot of new precast wall section up to the height required for the proposed installation. Payment for Precast Manhole Wall Section will be in addition to payment for a Precast Corbel Section if a new corbel is needed, or a new Precast Flattop Section if a new precast flattop section is needed. Additional payment will be made for a concrete Collar (Type Fl).

4) Type Fl: Cast-In-Place Concrete Collar: The unit price bid for each Cast-In-Place Concrete Collar shall be payment in full for performing and completing all the work, furnishing labor, supervision, materials, and equipment necessary to form and pour the concrete collar and install hydrophilic paste and waterstop, in preparation for installation of a Precast Corbel or Precast Wall Section, Cast-In-Place Concrete Collar shall only be paid for once for each manhole in which a Cast-In-Place Concrete Collar is installed.

418.11.3 The prices shall be payment in full for performing and completing the work and for furnishing all labor and materials necessary including excavation and removal of existing structure, replacement of frame and cover, chimney, frame sealing, grade adjustment, backfilling, surface restoration, and all testing. No payment shall be made

until the manhole and its adjacent area have been restored and the manhole and its appurtenances have satisfactorily passed testing.

## PART 419 – PATCHING, REPAIRS, AND PLUGGING LIFT HOLES

### 419.1 SCOPE

419.1.1 Work covered in this section consists of rehabilitation of bench and invert, patching holes in the manhole, and plugging precast lift holes. Testing, cleanup, and materials requirements are also included. Steps shall not be removed from manholes requiring rehabilitation unless the steps are deemed unsound by the ENGINEER.

419.1.2 The Contractor shall be responsible for the furnishing of all labor, supervision, materials, and equipment required to complete all rehabilitation and replacement work and testing in accordance with the Contract Documents. This includes any follow-up rehabilitation work required of the Contractor by the ENGINEER.

### 419.2 MATERIALS

419.2.1 The Contractor shall be thoroughly trained and familiar with handling, mixing, and placing all material. All materials shall be used in strict accordance with manufacturer's recommendations and with the provisions of all OSHA and other safety regulations. Field conditions must be appropriate for and compatible with component mixing for the linings and sealants. All materials shall conform to and be installed according to manufacturer's recommendations and specifications. Contractor shall supply all necessary materials, including storage and transportation to the satisfaction of Engineer. Materials damaged by Contractor shall be replaced at no additional cost to the City. Existing manhole frames and covers being replaced shall become the property of City.

### 419.3 HYDRAULIC CEMENT

419.3.1 Hydraulic cement shall be used for repairing, filling, patching, and plugging various holes in manhole chimney, corbel, walls, bench, and invert. Hydraulic cement shall be durable, quick setting, high early strength hydraulic cement such as Pennygrout or Octocrete supplied by IPA or approved equal. Wall coating material may also be applied to the bench.

### 419.4 BENCH AND INVERT REHABILITATION (TYPE Gh)

419.4.1 Existing deteriorated bench and invert areas shall be removed to sound material. Care shall be taken to avoid damaging other parts of the manhole. Loose and broken brick and mortar shall be removed from the manhole to eliminate the possibility of pieces entering the sewer lines.

419.4.2 After removal of the existing deteriorated bench and invert areas, new bench and invert shall be formed in accordance with the Drawings. Bonding agent, Weld-Crete as manufactured by Larsen Products Company or approved equal, shall be applied to existing surfaces in accordance with manufacturer's recommendations. Octocrete or approved equal shall be placed in such a manner that it is consolidated, fills existing voids, and creates a smooth, dense, steel troweled surface in accordance with the

Drawings. Wastewater flow shall be maintained by methods which prevent contact with new bench and invert for 6-8 hours after concrete placement. If 6-8 hours set time is not possible, a fast setting, high early strength concrete shall be used with provisions for flow control until concrete has initially set. The bench and invert shall be finished in such a manner as to have a smooth surface and form a continuous monolithic conduit with the sewer pipe entering and leaving the manhole. The bench and invert shall form a watertight seal with the manhole walls, base and pipe seal and shall be cleaned of all debris or foreign matter.

419.4.3 Contractor shall, at no additional cost to City, replace any portion of the existing manhole which is damaged during bench and invert rehabilitation.

419.5 PLUG LIFT HOLES/PATCH HOLES (TYPE Go/TYPE Gr)

419.5.1 The lift hole or hole to be patched shall be cleaned and all loose debris removed. Holes shall have all unsolid material removed with hammer and chisel. Holes and voids shall be filled, and the patch consolidated to leave the repair location leak resistant. The surface shall be troweled to a smooth finish even with surrounding surfaces.

419.6 MEASUREMENT AND PAYMENT

419.6.1 Plug Lift Hole (Type Go): Lift Hole Plugging shall be paid at the unit price bid per manhole, regardless of the size of the manhole.

419.6.2 Patch Hole (Type Gr): Hole Patching shall be paid for at the unit price bid per manhole, regardless of the size or number of holes to be patched.

419.6.3 Bench and Invert Rehabilitation (Type Gh): Bench and Invert Rehabilitation shall be paid for at the unit price bid per manhole, regardless of the size, diameter, or material of the manhole or connected line segments.

## PART 420 – MANHOLE STEP REMOVAL AND REPLACEMENT

420.1 SCOPE

420.1.1 Work covered in this section consists of removing steps in the manhole, patching holes, and replacing steps when specified. Testing, cleanup, and materials requirements are also included.

420.1.2 The Contractor shall be responsible for the furnishing of all labor, supervision, materials, and equipment required to complete all rehabilitation and replacement work and testing in accordance with the Contract Documents. This includes any follow-up rehabilitation work required of the Contractor by the ENGINEER.

420.2 MATERIALS

420.2.1 The Contractor shall be thoroughly trained and familiar with handling, mixing, and placing all material. All materials shall be used in strict accordance with manufacturer's recommendations and with the provisions of all OSHA and other safety regulations. Field conditions must be appropriate for and compatible with component mixing for the linings and sealants. All materials shall conform to and be installed according to manufacturer's recommendations and specifications. Contractor shall supply all necessary materials, including storage and transportation to the satisfaction of Engineer. Materials damaged by Contractor shall be replaced at no additional cost to the City.

420.3 HYDRAULIC CEMENT

420.3.1 Hydraulic cement shall be used for repairing, filling, patching, and plugging various holes in manhole chimney, corbel, walls, bench, and invert. Hydraulic cement shall be durable, quick setting, high early strength hydraulic cement such as Pennygrout or Octocrete supplied by IPA or approved equal.

420.4 MANHOLE STEP REMOVAL AND STEP INSTALLATION

420.4.1 Existing deteriorated steps shall be removed and surrounding loose or deteriorated structure removed to sound material. Care shall be taken to avoid damaging other parts of the manhole. Loose and broken brick and mortar shall be removed from the manhole to eliminate the possibility of pieces entering the sewer lines.

420.4.2 After removal of the existing deteriorated steps and surrounding areas, holes shall be patched in accordance with the Drawings and Part 418 – Patching, Repairs, and Plugging Lift Holes.

420.4.3 Contractor shall, at no additional cost to City, replace any portion of the existing manhole, which is damaged during step removal, patching, or step installation.

420.4.4 When specified in the Drawings and Contract Documents, install replacement steps in accordance with manufacturer's recommendations.

## 420.5 MEASUREMENT AND PAYMENT

420.5.1 Step removal and, when specified, replacement, shall be paid for at the Contract Unit prices bid for Step Removal and Replacement (Type I Repair) per each step removed, regardless of size of manhole.

420.5.2 The prices shall be payment in full for performing and completing the work and for furnishing all labor and materials necessary including equipment, flow diversion, excavation, backfilling, pipe restoration or utility restorations, manhole cleaning, debris removal, step removal, hole preparation, patching and hole plugging, step installation (when specified), manhole surface restoration, and all testing per manhole for all steps removed.

420.5.3 The replacement of Manhole Steps bid item is only for manholes being rehabilitated. In manholes being rehabilitated, step condition shall be reviewed by the Engineer and Contractor and steps replaced if deemed necessary. Payment will be by the number of steps installed.

## PART 421 – INTERIOR MANHOLE REHABILITATION – CORBEL (CONE) AND WALL REHABILITATION, BENCH AND INVERT, AND PIPE SEAL REHABILITATION

421.1 SCOPE

421.1.1 Work covered in this section consists of rehabilitation of manhole corbel or cone and walls, bench and invert, and pressure grouting and coating pipe seals including the lower 18" of the manhole, and pressure grouting precast joints. This Bid Item includes all interior manhole repairs below the chimney. Testing, cleanup, and materials requirements are also included.

421.1.2 The Contractor shall be responsible for the furnishing of all labor, supervision, materials, and equipment, including manhole cleaning, patching, repairs required to stop active leaks, corbel, wall, bench and invert, and pipe seal coating and grouting, and surface restoration, required to complete all rehabilitation and replacement work, and testing in accordance with the Contract Documents. This includes any follow-up rehabilitation work required of the Contractor by the ENGINEER.

421.2 MATERIALS

421.2.1 The Contractor shall be thoroughly trained and familiar with handling, mixing, and placing all material. All materials shall be used in strict accordance with manufacturer's recommendations and with the provisions of all OSHA and other safety regulations. Field conditions must be appropriate for and compatible with component mixing for the linings and sealants. All materials shall conform to and be installed according to manufacturer's recommendations and specifications. Contractor shall supply all necessary materials, including storage and transportation to the satisfaction of Engineer. Materials damaged by Contractor shall be replaced at no additional cost to the City. Existing manhole frames and covers being replaced shall become the property of City. Contractor shall dispose of existing castings at a site indicated by the Sewer Operations and Maintenance.

A) INTERIOR COATING: This Specification will describe minimum requirements for a one-component, rheoplastic, fiber or polypropylene-reinforced, shrinkage compensated mortar lining system for manhole wall and corbel (cone) rehabilitation. Coating materials for use in manhole rehabilitation shall conform to Strong Systems, Inc. MS-2A; Master Builders, Inc. Emaco S88C; Standard Cement Materials, Reliner MSP; Permacast MS 10,000; or Quadex QM-1s Restore; wall coating material may also be used for the bench and invert rehabilitation repair.

B) Design Mix. Design mix shall be a preblended mixture of cements, chemically active aggregates, glass fibers and other additives specifically selected for special properties. No material (other than water) shall be used with or added to the approved design mix without prior approval or recommendation from the ENGINEER.

C) Water Supply. All water used in the mixture shall be clean and potable.

D) Certification. The Contractor must furnish certification to the ENGINEER that the coating system materials proposed for the project meet or exceed all of the minimum requirements as specified herein.

E) Density. Density of the material at placement of the coating system shall not be less than 95 lbs./cubic feet.

F) Working Time. Approximate working time of the material after initial application shall be 30 minutes.

G) Compressive Strength. Compressive strength shall conform to ASTM C495 and C109 and shall meet or exceed a minimum 28-day break of 4,000 psi.

H) Flexural Strength. Flexural strength shall conform to ASTM C348 and shall meet or exceed a minimum 28-day break of 1,200 psi.

I) Slant Shear Bond Strength. Slant shear bond strength shall conform to ASTM 882 modified and shall meet or exceed a minimum 28-day break of 2,400 psi.

J) Freeze-Thaw. Freeze/thaw testing shall conform to ASTM C666 and shall show no visible damage after 100 cycles.

K) Permeability. Permeability of the formulation shall conform to ASTM T277 and shall be less than or equal to 450 Coulombs.

L) Manholes scheduled for Interior Manhole Coating shall have a minimum 1” coating thickness for depths up to 12’ measured from the lowest flowline elevation to the rim. For depths greater than 12’, an additional 1/2" thickness shall be added to the manhole below the 12’ depth. For example, a 15’ deep manhole scheduled for Interior Manhole Coating would have the bottom 3’ coated with a minimum coating thickness of 1-1/2” and the top 12’ would have a minimum coating thickness of 1”. The additional material thickness shall be considered subsidiary to the bid item Interior Manhole Coating and will not be paid for directly.

## 421.3 CHEMICAL GROUTING SYSTEMS

421.3.1 Where the pressurized injection of chemical grout behind the manhole walls and joints is required, the material supplied shall be a urethane gel with properties as follows:

A) While being injected, the chemical sealant must be able to react/perform in the presence of infiltrating water.

B) The cured sealant must be capable of withstanding submergence in water without degradation.

C) The cured sealant must prevent the passage of water through the manhole defect.

D) The cured sealant must be flexible as opposed to brittle or rigid.

E) In place, the cured sealant shall be able to withstand freeze/thaw and wet/dry cycles without adversely affecting the seal.

F) The cured sealant must not be biodegradable. Additives may be used to meet this requirement, without affecting long-term strength.

G) The cured sealant shall be chemically stable and resistant to concentrations of acids, alkalis, and organics found in normal sewage.

H) Packaging of component materials must be compatible with field storage and handling requirements. Packaging must provide for worker safety and minimize spillage during handling.

I) In the event that the chemical sealant may be harmful by passing through the unbroken skin, by inhalation of dust, vapor or mist, or by swallowing, the handling and mixing shall be performed with proper equipment and by personnel thoroughly familiar with the chemicals involved and shall be in strict accordance with the manufacturer's recommendations and with the provisions of all safety regulations.

J) Mixing of component materials must be compatible with field conditions.

K) Residual sealing materials must be easily removable from the bench of manhole to prevent reduction or blockage of the sewer flow.

L) Urethane gel grout shall be utilized for the entire manhole.

M) No grouting operations shall be performed at temperatures below 40° F or where the temperature of the groundwater is below 40° F.

421.4 URETHANE GEL: URETHANE GEL SHALL HAVE THE FOLLOWING PROPERTIES AND CHARACTERISTICS:

421.4.1 One-part urethane prepolymer thoroughly mixed with between five and ten parts water by weight. The recommended mix ratio is one-part urethane prepolymer to eight parts of water (11% prepolymer).

421.4.2 A liquid prepolymer having a solids content by weight of 77% to 83%, specific gravity of 1.04 (8.65 pounds per gallon), and flash point of 200° F.

421.4.3 A liquid prepolymer having a viscosity of 600 to 1,200 centipoise at 70° F, that can be pumped through 500’ of 1/2" hose with a 1,000-psi head at a one-ounce per second flow rate.

421.4.4 The water used to react the prepolymer should be in the pH range of 6.5 to 8.0.

421.4.5 A cure time of 80 seconds at 40° F, 55 seconds at 60° F, and 30 seconds at 80° F, when one-part prepolymer is reacted with eight parts of water only. Higher water ratios give longer cure times.

421.4.6 A cure time that can be reduced to ten seconds for water temperatures of 40° F to 80° F when one-part prepolymer is reacted with eight parts water containing gel control agent.

421.4.7 A relative rapid viscosity increase of the prepolymer/water mix. Viscosity increases from about 10 to 60 centipoise in the first minute for 1:8 prepolymer/water ratio at 50° F.

421.4.8 A reaction (curing) which produces a chemically stable, non-biodegradable, tough, flexible gel.

421.4.9 The ability to increase mix viscosity, density, gel strength, and resistance to shrinkage by using additives in the water component of the grout.

421.4.10 The ability to accept suspended additives such as 2,6-dichlorobenzonitrile root control.

421.4.11 Contain a minimum of 15% shrink control agent supplied by the same manufacturer.

421.5 MATERIALS DELIVERY AND STORAGE

421.5.1 The Contractor shall provide adequate facilities for storage of raw materials and for preparation of the materials for installation. They shall conform to the manufacturer's recommendations and all applicable codes, regulations, and safety requirements. These facilities shall be approved by the ENGINEER prior to initiation of manhole rehabilitation or replacement and shall be provided by the Contractor at no additional cost. Materials stored will not be paid for.

421.6 MATERIALS TESTING

421.6.1 Testing shall be the responsibility of the Contractor. Tests for compliance with this Specification shall be made as specified herein and in accordance with the applicable Specification. A Certificate of Compliance with this Specification along with a report of each test, shall be furnished by the Contractor for all material furnished under this Specification. The Contractor shall inform the ENGINEER as to when, where and by whom, testing will be conducted, at least one week prior to testing. The ENGINEER may, at its own expense, witness testing of the materials.

421.7 WALL REHABILITATION (TYPE Gg)

421.7.1 General. Corbel and wall rehabilitation shall be performed by the installation of approved coatings. The type of rehabilitation system to be utilized for each manhole shall be identified in the Drawings.

421.7.2 Manholes that are scheduled to interior manhole coating, and that are above grade with manhole components exposed shall have the exposed exterior corbel and wall of the manhole coated using approved coating materials and in accordance with manufacturer's recommendations and specifications for exterior application.

Prior to performing the work, the Contractor and Engineer will jointly inspect the manhole exterior and agree upon the scope and extent of exterior coating required. Exterior coating shall be performed on:

A) Manholes with exposed brick or block.

B) Brick or block manholes with a cracked or otherwise damaged exterior mortar coating.

C) Other manholes, as required by the Engineer. Exterior coating of precast or Cast-In-Place concrete manholes in good condition shall not normally be required. Based on the condition of the manhole exterior, the Engineer may require that only portions of the manhole exterior be coated.

Materials utilized for coating the exteriors of manholes shall conform to the requirements of Part 421.2.1.

421.7.3 Installation of a coating system shall entail the preparation of the manhole interior, application of the liner, and testing.

421.7.4 Interior Coatings. It is the intent of this section to govern all aspects of internal rehabilitation of manhole corbels, walls, bench and invert, and pipe seals using a high-strength, waterproofing, coating system. Manhole defects shall be repaired where shown or specified, or as directed by ENGINEER. Repair of manhole defects shall be accomplished by the methods specified herein. All manufacturer's recommendations shall be strictly followed for the entire rehabilitation procedure, including cleaning and possible surface preparation of the interior of the manhole, storing, and preparing the products and sealing the manholes. The work consists of spray and/or trowel applying an interior coating mix to the corbel, walls, benches and inverts, and pipe seals of manholes, resulting in a monolithic liner of a minimum 1" thickness for depths up 12'. For depths greater than 12', an additional 1/2" thickness shall be added to the manhole below the 12' depth. The applicator, approved and trained by the coating manufacturer, shall furnish all labor, equipment, and materials for applying the system over brick, tile, precast concrete, or concrete block manholes.

A) Preparation:

1) Place bench covers over invert before prepping manhole. Contractor shall prevent all construction materials from entering sewer pipelines.

2) All foreign materials shall be removed from the manhole walls and bench using high pressure water spray (minimum 3,500 psi). Loose and protruding brick, mortar and concrete shall be removed using a mason's hammer and chisel

and/or scrapers. Voids shall be filled with Octocrete as manufactured by IPA, Strong-Seal QSR as manufactured by Strong Systems, Inc., or approved equal, at least one hour prior to spray application of the coating system.

3) Active leaks shall be stopped using products specifically for that purpose. Ipanex-R as manufactured by IPA, or approved equal, mixed in accordance with manufacturers recommendations. If necessary, water shall be channeled to the bottom of the manhole structure through one or more weep holes and allowed to weep during the coating process. Once the walls of the manhole have been rehabilitated, weep holes shall be plugged with Ipanex-R or approved equal.

4) After all preparation has been completed, Contractor shall remove all loose material.

B) Mixing: Contractor shall follow published recommendations of the manufacturer for mixing of all products.

C) Spraying:

1) Prior to spraying, the surface shall be damp without noticeable free water droplets or running water. If required by the manufacturer, bond-coat slurry will be applied to the surface prior to application of the formulation. Material shall be spray applied to a minimum 1” uniform thickness to ensure that all voids and crevices are filled, and a smooth surface remains after troweling. The troweling shall compact material into voids and crevices and "set" the bond on the manhole surface (brick, tile, block, or concrete). Wall/Corbel coating shall not go above top of corbel.

2) After the coating application to all vertical surfaces has been completed, the temporary bench covers shall be removed and the bench reconstructed with the coating mix from walls to the invert in such a manner so as to produce a bench having a gradual slope from the walls to the invert with the wall/bench joint interface built up and rounded to a uniform radius the entire circumference of the manhole. The thickness of the bench shall be no less than 3/4" at the invert and shall increase in the direction of the wall so as to provide the required minimum slope as shown on the Drawings.

3) No application shall be made when ambient temperatures are less than manufacturer's recommendations and when freezing is expected within 24 hours unless specific recommendations are made by the manufacturer. If ambient temperatures are in excess of 90° F, precautions shall be taken to keep mixing water below 85° F, using ice if necessary.

4) The final application shall have a minimum of four hours cure time before being subjected to active flow.

A) A minimum of two test cylinders shall be taken from each day's work with the date, location and job recorded on each. The cylinders shall be sent to a certified

concrete testing laboratory, where a 28-day compression test will be made and recorded. Cost of testing shall be the responsibility of the Contractor.

B) Packaging of component materials must be compatible with field storage and handling requirements. Packaging must provide for worker safety and minimize spillage during handling.

C) Residual filler and formulations must be easily removable from the sanitary sewer line and manhole trough to prevent blockage of flow and minimize the amount of solids that enter the waste stream.

421.8 MANHOLE GROUTING

421.8.1 PRESSURE GROUTING: All manholes listed for interior rehabilitation shall have pipe seals pressure grouted and coated. Pressure grouting shall be done in accordance with the Drawings. Any structurally unsound manholes observed by Contractor shall be replaced as directed by ENGINEER.

421.8.2 The existing manhole structure designated for pressure grouting for pipe seals or for precast joints shall be thoroughly cleaned prior to grouting. Contractor shall dispose of all debris and prevent any debris from entering the existing sewer lines.

421.8.3 Grade adjustments, frame and cover replacements, chimney repairs, frame seals and other repairs shall be performed prior to pressure grouting. Pressure grouting shall be done prior to interior coating. All roots exposed in the manhole shall be removed.

421.8.4 Grouting of the manhole may include precast wall joints, pipe seals, and/or bench and invert. Areas and specific manholes requiring grouting shall be specified in the Schedule in the Drawings.

421.9 PIPE SEAL COATING AND PRESSURE GROUTING (TYPE Gk)

421.9.1 Injection holes shall be drilled in accordance with the Drawings. After removal of the grouting probe, activated oakum rope shall be used to fill the injection hole. Pipe seal pressure grouting will include the entire lower 18" of the manhole. Injection hole shall be patched with waterproof, quick setting mortar and covered with a moisture resistant two-part epoxy adhesive coating. Any pipe damaged by Contractor while drilling the injection hole shall be replaced at no expense to City.

421.9.2 Contractor shall, at no additional cost to City, replace any portion of the existing manhole or pipe, which is damaged during pipe sealing.

421.9.3 The deteriorated area of the pipe seal shall be removed to sound material. Care shall be taken to avoid damaging other parts of the manhole structure. Loose and broken brick, mortar, concrete, and pipe shall be removed from the manhole.

421.9.4 Bonding agent, Weld-Crete as manufactured by Larsen Products Company or approved equal, shall be applied to existing surfaces in accordance with manufacturer's recommendation.

421.9.5 Contractor shall place Octocrete, as manufactured by IPA, or approved equal to the area. Octocrete shall be placed in such a manner that it is consolidated, fills existing voids, and creates a smooth, dense surface in accordance with the Drawings.

421.9.6 Wastewater flow shall be maintained by methods which prevent contact with new pipe seal for 6-8 hours after Octocrete placement.

421.9.7 The pipe seal shall form a water-tight seal with the manhole wall, bench, trough, and pipe. The manhole and pipes shall be cleaned of all debris and foreign matter.

421.9.8 All manholes scheduled for Corbel and Wall Rehabilitation, interior coating, shall have pipe seals and the lower 18” of the manhole drilled and grouted. The lower 18” is measured from the lowest flowline elevation up 18”. Drilling and grouting the lower 18” shall include at least two rows of drill and grout holes. Grouting the pipe seals and the lower 18” is subsidiary to Interior Manhole Coating and will not be paid for directly.

421.9.9 Additional grouting above the bottom 18” is not expected to be needed. Contractor is responsible to stop all active inflow and infiltration leaks in the manhole prior to placing the interior coating. Work and materials required to stop leaks in the manhole are considered subsidiary to Interior Manhole Coating and will not be paid for directly.

421.9.10 Drop manholes scheduled for Interior Manhole Coating shall have the pipe seals of all grade lines and drop lines grouted in addition to the bottom 18” of the manhole. All incoming and outgoing pipe seals shall be grouted, regardless of the height above the flowline of the manhole.

421.10 SEAL PRECAST JOINTS – PRESSURE GROUTING (TYPE Gp)

421.10.1 General: Prior to pressure grouting of manholes specified in the Drawings, all unsealed step holes, missing pipe seals and unsealed lift holes shall be repaired. A quick-setting cement and bricks, when necessary, shall be used to fill these defects. After the setting of the hydraulic cement, the repair shall be covered with a moisture resistant two-part epoxy adhesive coating such as Aquatapoxy as manufactured by American Chemical Corp. or approved equal.

421.10.2 Grout Material Utilization

A) Corbel and Frame, Wall, Pipe Seal, Bench and Invert: Urethane grout or other approved chemical pressure grout shall be utilized for the entire manhole.

B) No grouting operations shall be performed at temperatures below manufacturer's recommendations or where the temperature of the groundwater is below manufacturer's recommendations.

421.10.3 Corbel and Wall Grouting

A) Surface Preparation: Prior to pressure grouting of manhole corbel, entire surface area shall be coated with a layer of dry polymer mortar in accordance with the manufacturer's recommendations. Dry polymer mortar shall not be applied to the wall portion of the manhole unless grout migration back into the manhole is observed during the grouting operation. No drilling or pressure grouting shall be done until the dry polymer mortar has been allowed to dry for a period of 24 hours. The dry polymer mortar shall extend to a point 12” below the corbel to wall joint. The dry polymer mortar shall be Octocrete as manufactured by IPA Systems, Inc., or approved equal.

B) Corbel Drilling: A minimum of four injection holes shall be drilled at 90° angles from each other at the same plane of elevation. Additional rows shall be separated by a distance of 18”, and the holes shall be staggered with the holes in the rows above and below in accordance with the Drawings. After removal of the grouting probe, activated oakum rope shall be used to fill the injection holes. Injection holes shall be patched with a waterproof quick setting mortar.

C) Wall Drilling: A minimum of four injection holes shall be drilled at 90° angles from each other at the same plane of elevation. Additional rows shall be separated by a distance of 24”, and the holes shall be staggered with the holes in the rows above and below in accordance with the Drawings. After removal of the grouting probe, activated oakum rope shall be used to fill the injection holes. Injection holes shall be patched with a waterproof quick-setting mortar.

421.11 PRECAST JOINT SEALING

421.11.1 Pressure Grout: A minimum of four injection holes shall be drilled at 90° angles from each other at the same plane of elevation approximately 6" above the precast section joint. An additional row of holes shall be drilled 6" below the joint staggered by 45° as shown in the plans. After removal of the grouting probe, activated oakum rope shall be used to fill the injection holes. Injection holes shall be patched with a waterproof, quick-setting hydraulic cement.

421.12 MEASUREMENT AND PAYMENT

421.12.1 Wall Rehabilitation (Type Gg):

A) Wall Rehabilitation shall be paid for at the unit price bid per square foot of manhole corbel or wall area rehabilitated. Corbel or wall area rehabilitated shall be measured as the interior and/or exterior surface area actually coated, measured to the nearest 0.1 square foot.

B) In manholes where Wall Rehabilitation is performed, Bench and Invert Rehabilitation, Pipe Seal Coating and Pressure Grouting, Lift Hole Plugging, Pre-cast Joint Sealing, and Hole Patching shall be paid for separately at the unit price bid for each individual item.

421.12.2 Bench and Invert Rehabilitation (Type Gh): Bench and Invert Rehabilitation shall be paid for at the unit price bid per manhole, regardless of the size of the manhole or the number, diameter, or material, of the line segments connecting the manholes.

421.12.3 Pipe Seal Coating and Pressure Grouting (Type Gk): Pipe Seal Coating and Pressure Grouting shall be paid for at the unit price bid per manhole, regardless of the size of the manhole or the number, diameter, or material of the line segments entering the manholes.

421.12.4 Lift Hole Plugging (Type Go): Lift Hole Plugging shall be paid for at the unit price bid per manhole, regardless of the size of the manhole or the number of lift holes to be plugged.

421.12.5 Pre-cast Joint Sealing (Type Gp): Pre-cast Joint Sealing shall be paid for at the unit price bid per manhole, regardless of the size of the manhole of the number of joints sealed.

421.12.6 Hole Patching (Type Gr): Hole Patching shall be paid for at the unit price bid per manhole, regardless of the size or number of the holes to be patched.

421.12.7 Epoxy Coating (Type Gs):

A) Epoxy coating shall be paid for at a unit price bid per square foot of manhole corbel or wall area rehabilitated. Wall area rehabilitated shall be measured as the interior surface area actually coated, measured to the nearest 0.1 square foot.

B) In manholes where Epoxy coating is performed, Bench and Invert Rehabilitation, Pipe Seal Coating and Pressure Grouting, Lift Hole Plugging, Pre-cast Joint Sealing, and Hole Patching shall be paid for separately at the unit price bid for each individual item.

## PART 422 – MANHOLE TESTING OF NEW AND REHABILITATED MANHOLES

### 422.1 GENERAL

#### 422.1.1 Scope

A) This section describes manhole testing to effectively confirm the water-tight integrity of new manholes and existing manholes following infiltration related repairs and inflow related repairs.

#### 422.1.2 Description

A) Infiltration may be observed in manhole defects at manhole walls, pipe seals or bench/trough areas. Infiltration related repairs are intended to eliminate leakage of groundwater into manholes.

B) Inflow may be observed in manhole defects at manhole frames, covers, frame seals, grade adjustments, grade adjustment seals, corbels, or walls. Inflow related repairs are intended to eliminate sources of surface water entry that become active during rainfall events.

#### 422.1.3 Testing, Observations, and Guarantee Periods

A) The testing required shall be performed by the Contractor at locations designated by the Engineer and documented to the satisfaction of the Engineer.

B) Any new or rehabilitated manholes that are observed to be leaking by the Engineer during periods of high groundwater or during inflow conditions shall be subject to additional repairs. The Contractor shall be responsible for all additional repairs required on unsatisfactory manholes during the guarantee period.

### 422.2 MATERIALS

#### 422.2.1 Not specified.

### 422.3 EXECUTION

#### 422.3.1 Infiltration Testing

A) All of rehabilitated manholes and all of new manholes shall be observed (tested) by the Contractor in the presence of the Engineer for sources of infiltration. Observations will be made during high groundwater conditions, wherever possible.

B) 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. The lines entering the manhole shall be temporally plugged with the plugs braced to prevent them from being drawn into the manhole. The plugs shall be installed in the lines beyond drop-connections, gas sealing

connections, etc. The test head shall be placed inside the frame at the top of the manhole (so that the manhole frame seal is tested) and inflated in accordance with the manufacturer's recommendations. A vacuum of 10” of mercury shall be drawn, and the vacuum pump will be turned off. With the valve closed, the level of vacuum shall be read after the required test time. If the drop in the level is less than 1” of mercury (final vacuum greater than 9” of mercury), the manhole will have passed the vacuum test. After a successful test, the temporary plugs will be removed. The required test time is determined from Table I.

Table I
MINIMUM TIME REQUIRED FOR A VACUUM DROP
OF 1” Hg (10” Hg – 9” Hg) (MIN:SEC)

| HEIGHT OF M.H. (DEPTH IN FT.) | 48” M.H. | 60” M.H. | 72” M.H. |
|---|---|---|---|
| 4 | 10.0 sec. | 13.0 sec. | 16.0 sec. |
| 8 | 20.0 sec. | 26.0 sec. | 32.0 sec. |
| 12 | 30.0 sec. | 39.0 sec. | 48.0 sec. |
| 16 | 40.0 sec. | 52.0 sec. | 64.0 sec. |
| 20 | 50.0 sec. | 65.0 sec. | 80.0 sec. |
| 24 | 60.0 sec. | 78.0 sec. | 96.0 sec. |
| ** | T = 5.0 sec. | T = 6.5 sec. | T = 8.0 sec. |

**For all Manholes over 24’ in depth, add the "T" seconds as shown for each respective diameter for each 2’ of additional depth of manhole to the time shown for that 24’ depth. [Example: A 30’ deep, 48” Manhole Total Test Time would be 75.0 seconds. 60.0+ 3(5.0) = 75.0 seconds] (Values listed above are extrapolated from ASTM C924-85).

C) Manhole vacuum levels observed to drop greater than 1” of mercury (Final vacuum less than 9” of mercury) will have failed the test and will require additional rehabilitation. The Contractor shall make the necessary repairs to the already completed rehabilitation work at no additional compensation. If the failure of the vacuum test is determined to be due to preexisting conditions not on the manhole rehabilitation schedule for that manhole, this additional work may be authorized by the Engineer. After completion of the additional rehabilitation the manhole shall then be retested as described above until a successful test is made.

D) If it is determined by the Engineer that additional rehabilitation work items need to be completed on a manhole that has failed the vacuum test, these may be authorized. After the additional work is completed, the manhole will be retested.

422.3.2 Inflow Testing

A) All of rehabilitated manholes and all of new manholes shall be dyed water tested unless the manhole has successfully passed the vacuum test. Manholes shall be dyed water tested in the presence of the Engineer. The dye test shall consist of applying a concentrated dye solution around the manhole frame. Dyed water shall be applied for at least ten minutes.

B) Manholes observed to be actively leaking greater than one drip per five seconds will have failed the test and will not be acceptable. Manholes failing the test will require additional rehabilitation by the Contractor at no additional compensation.

## 422.4 MEASUREMENT AND PAYMENT

422.4.1 The cost of manhole testing will not be paid for separately but shall be included in the Contract Unit Price of the rehabilitation or replacement being performed.

## PART 423 – OBSTRUCTION REMOVAL

423.1 GENERAL

423.1.1 INTENT: Obstruction removals are excavations to clear obstructions such as solids, dropped joints, crushed or collapsed pipe, and reductions in the cross-sectional area of more than 20% that will prevent pre-construction television inspection and associated pipeline rehabilitation.

423.1.2 TELEVISION INSPECTION: Obstructions indicated on the Drawings are based on previously performed television inspections. The exact location of the obstruction removal will be determined by internal television inspection prior to excavation. The television video will have a digital footage display on the screen and shall be reviewed by ENGINEER prior to excavation to determine the extent of the repair as indicated on the Drawings.

423.1.3 NOTIFICATION: CONTRACTOR shall notify ENGINEER not less than 48 hours in advance of the time he plans to begin work at a particular location with the Project.

423.2 MATERIALS

423.2.1 BACKFILL: Backfill, including pipe bedding, shall be placed and compacted as specified in Part 403.

423.3 PROCEDURE

423.3.1 The Contractor shall identify all obstructions for the sewer section scheduled for rehabilitation.

423.3.2 If the Contractor identifies obstructions that cannot be removed by conventional sewer cleaning equipment, then, with the Engineer's approval, an excavation shall be made to remove the obstruction. The repair shall be an adequate repair for insertion of required equipment or material. This shall be paid at the bid price for obstruction removal.

423.3.3 Surface Restoration: Service and lateral pits, and other work areas shall be restored to condition as good as that before construction occurred. Disturbed grasses shall be sodded in accordance with Part 402 – Restoration. Pavements removed or damaged shall be replaced. Concrete embankment shall be replaced or installed at locations indicated in the Drawings and in accordance with these specifications.

423.4 MEASUREMENT AND PAYMENT

423.4.1 Obstruction Removal shall be paid for at the Contract Unit Price for each obstruction removal actually performed.

423.4.2 Protruding Service connection removal and replacement shall be paid for at the Contract Unit Price for Service Connection.

423.4.3 The prices shall be payment in full for performing and completing the work and for furnishing all labor and materials necessary including excavation and removal of existing structure, trench safety system, pipe repair materials, connectors, pipe sealing materials, labor, backfilling, surface restoration, testing, and all incidental costs.

## PART 424 – CURED-IN-PLACE SECTIONAL AND SPOT REPAIR

### 424.1 GENERAL

424.1.1 It is the intent of this specification to provide for the reconstruction of a particular section of sewer pipe without excavation. The reconstruction will be accomplished using a non-woven fabric tube of particular length and a thermoset resin with physical and chemical properties appropriate for the application. The tube is impregnated with the resin and then placed inside or over a protective launching device with a translucent bladder and then winched into the existing sewer. The inflation bladder, when expanded, will conform to the host conduit. When the launching device is properly positioned, the end is opened, and the resin-saturated tube is moved into place. Once the tube/resin composite is cured, the inflation bladder and the launching device are removed.

424.1.2 Reference Standards

A) Installation and material tests of Cured-In-Place sectional and spot repair must meet the minimum requirements demonstrated in the following standards:

| | |
|---|---|
| ASTM F1216 | Standard Practice for the Installation of Cured-In-Place Pipe by Inversion Lining |
| ASTM F1743 | Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pull-In-Place Installation of Cured-In-Place Thermosetting Resin Pipe (CIPP) |
| ASTM D790 | Test Method of Flexural Properties of Plastics: Flexural Strength 4,500 psi (minimum) and Flexural Modulus 250,000 psi (minimum) |
| NASSCO | Specifications for Sewer Collection System Rehabilitation |

### 424.2 MATERIALS

424.2.1 Tube

A) The tube shall consist of one or more layers of flexible needled felt or an equivalent nonwoven material capable of carrying resin, withstanding installation pressures and curing temperatures. The tube shall be compatible with the resin system used. The tube shall be capable of conforming to offset joints, bells, and disfigured pipe sections. The tube shall be fabricated to a size that, when installed, will tightly fit the internal circumference of the original conduit. Allowance shall be made for circumferential stretching during inversion.

424.2.2 Resin

A) A general purpose, unsaturated, styrene-based, thermoset resin and catalyst system or an epoxy resin and hardener that is compatible with the inversion process shall be used. The resin must be able to cure in the presence of water and the initiation temperature for cure shall be less than 180º F (82.2º C).

B) Resin – The resin used shall be high-grade corrosion resistant isophthalic polyester, vinyl ester, or epoxy, specifically designed for the Cured-In-Place sectional and pipe repair being installed.

C) The minimum length shall be that deemed necessary by the ENGINEER to effectively span the entire pipeline defect being corrected to sound pipe beyond either end of the defect, unless otherwise specified. The required minimum lengths shall be verified in the field before impregnation of the tube with resin.

## 424.3 EXECUTION

### 424.3.1 Pre-Installation Procedures

A) Safety

1) CONTRACTOR shall carry out his operations in strict accordance with all OSHA and manufacturer's safety requirements. Particular attention is drawn to those safety requirements involving working with scaffolding and engineering confined spaces.

B) Cleaning and Inspection

1) CONTRACTOR shall clean and inspect each line immediately prior to reconstruction utilizing a pan and tilt camera capable of verifying active or inactive service connections and the overall structural condition of the pipeline. All roots, debris, and protruding service connections shall be removed prior to reconstruction. Inspection shall include the complete length of the line from manhole to manhole.

2) Prior to installing Cured-In-Place sectional and point repairs, the CONTRACTOR shall verify that service connections are active by introducing dye into the lines at cleanouts, vent stacks or other access points as approved by the Engineer. Dye testing shall be recorded by CCTV inspection at the location in the main line where the dye appears. All addresses will be noted on log sheets for future reference. The CCTV camera shall be equipped with a rotating head and shall be pivoted to provide a view into each service line.

C) Line Obstructions and Point Repairs

1) The original pipeline shall be clear of obstructions such as solids, dropped joints, protruding service connections, crushed or collapsed pipe, and reductions in the cross-sectional area of more than 20%. Protruding service connections shall be removed to prevent dimpling of the finished liner. Maximum allowable protrusion shall be 1/2". If inspection reveals an obstruction that cannot be removed by conventional sewer cleaning equipment, then a point repair excavation shall be made per Part 411.

2) If, during pre-television inspection, the CONTRACTOR identifies dropped joints, line sags, or sections requiring repairs not scheduled, he shall notify the ENGINEER. The ENGINEER will determine whether such defects require correction by Cured-In-Place sectional and spot repair and/or by point repair excavation. The CONTRACTOR shall not perform such additional repairs without prior approval from the ENGINEER.

D) By-Pass of Flow and Interruption of Service

1) The lines scheduled for Cured-In-Place sectional and spot repair shall have all flows bypassed around them when determined necessary by the Engineer to ensure adequate conveyance of flow during repair. The pumping system shall be sized for normal to peak flow conditions. The upstream manhole shall be monitored at all times and an emergency deflate system shall be incorporated so that plugs may be removed at any time without requiring confined space entry.

2) When preparing for making connection to the existing system or other work, which will interrupt service to the utility users, CONTRACTOR shall notify the affected user at least 48 hours in advance of service interruption, stating the approximate time and duration of interruption of service. Advance notification shall not extend beyond 72 hours.

3) Public advisory services will be required to notify all parties whose service laterals will be out of commission and to advise against water usage until the mainline is back in service.

424.3.2 Installation of Lines

A) The tube shall be inspected for tears or frayed sections. Tubes failing the inspection shall be immediately removed from the job site and replaced with suitable sections at no additional cost to City. Tubes passing the inspection shall be impregnated with the thermoset resin.

B) No uncontrolled pouring of resin will be allowed during tube saturation. All resin shall be contained. CONTRACTOR shall ensure that no public or private property is exposed to contamination by liquid resin components or compounds.

C) The saturated tube, with inflation bladder where required by the installation process, shall be pulled into the host pipe in accordance with the manufacturer's standard specifications. The pull shall be complete when the tube is properly aligned with the section of the host pipe being reconstructed. Any loss of resin required for development of proper wall thickness and curing of the repair or any loss of resin into the collection system creating an obstruction will not be permitted. Any resin lost during the insertion process shall be caught and removed from the system at the next downstream manhole. No contamination or dilution of the resin by exposure to dirt, debris, or water during the pull will be permitted.

D) When required, the tube shall be inverted out of the launching device by controlled air or water pressure. The tube shall be held tightly in place against the wall of the host pipe by the applied pressure until the cure is complete. The resin and tube shall be completely protected during the curing. No contamination or dilution of the tube/resin composite by exposure to dirt, debris, or water during curing will be permitted.

E) When the curing process is completed, the pressure shall be released and the inflation bladder and launching device shall be removed from the host pipe with the winch. No barriers, coatings, or any material other than the cured tube/resin composite shall be left in the host pipe. Any materials other than the cured tube/resin composite used in the installation shall be removed from the pipe by the CONTRACTOR.

424.3.3 Service Connections

A) After the tube/resin composite has been cured, CONTRACTOR shall reconnect the existing active service connections. Service connections shall be reinstated by one of two methods. In general, service connections shall be reinstated internally in accordance with Part 423.3.b. Where service connections are found to be protruding or otherwise defective (i.e., end of service connection is broken away or irregular such that the full circumference of the service line would not contact with the Cured-In-Place Pipe) reinstatement shall be an external service reconnection in accordance with Part 423.3.c.

B) Internal Reconnection: Without excavation, the service connection shall be reinstated by means of a television camera and a cutting device that re-establishes the connection to not less than 90% capacity. Service connections shall be cut in with neat and smooth circumferential lines to prevent snagging of debris and/or solids. CONTRACTOR shall provide a physical demonstration, in the presence of the Engineer, to show the assurance of a watertight seal of all service connections.

C) External Reconnection: Service connections shall be reinstated by excavation and reconnecting the service with an approved saddle. The CONTRACTOR shall remove the appropriate amount of carrier pipe to allow the saddle to be directly connected to the outside wall of the CIPP. An epoxy, meeting the manufacturer's recommendations, shall be applied to the saddle to assure a water-tight seal between the saddle and CIPP. The saddle shall be secured with stainless steel bands. After the epoxy has set and prior to backfilling, the CONTRACTOR shall seal any open annular space between the existing sewer and new liner pipe with a non-shrink grout. The service connection riser shall be carried from the main to the existing elevation of the connection, utilizing bell and spigot cast iron soil pipe. At a location approved by the ENGINEER, a connection between the existing lateral service and the new service shall be made, utilizing a solid sleeve coupling, Rockwell Omni, OCUT sewer connector, or approved equal. The CONTRACTOR shall then completely encase the saddle and exposed pipe in concrete. Care shall be used not to damage the CIPP. If damage occurs as a result of the

CONTRACTOR'S operations, the CONTRACTOR shall assume all cost associated with the repair of the CIPP.

D) It is the intent for service connections to be re-opened by internal reconnection where a watertight seal can be made. Where service connections are identified by TV inspection as defective, they shall be re-opened by external reconnection.

E) Service interruptions to any home tributary to the sewer line being rehabilitated shall not exceed 24 hours.

F) If external service connections are identified, the Engineer shall determine if a point repair should be made by the remove and replace method.

424.3.4 Final Inspection

A) Upon completion of the installation, the rehabilitated sewer shall be CCTV inspected providing both a video recording and log identifying all service connections and openings, in accordance with Part 415 – Construction of Television Inspection of Sanitary Sewers.

B) Visual inspection of the sectional and spot repair shall be in accordance with ASTM F1216, Section 8.6.

C) Upon acceptance of the installation work and testing, the CONTRACTOR shall restore the project area affected by the operations to a condition at least equal to that existing prior to the work.

424.4 MEASUREMENT AND PAYMENT

424.4.1 Cured-In-Place Sectional and Spot Repair shall be paid for at the applicable Contract Unit Price as follows: The unit price shall cover the entire cost of Cured-In-Place sectional and spot repair for a 6' length.

424.4.2 Additional length of Cured-In-Place sectional and spot repair in excess of 6' shall be paid for at the applicable Contract Unit Price measured to the nearest 1'.

424.4.3 The prices shall be payment in full for performing and completing the work and for furnishing all labor and materials necessary including excavation and removal of existing structure, trench safety system, pipe repair materials, connectors, pipe sealing materials, labor, backfilling, surface restoration, testing and all incidental costs.

424.4.4 Service reconnections within the point repair area shall be included with the unit price bid for the point repair.

424.4.5 Pre-installation television inspection and cleaning shall be paid for by bid unit price per foot of sewer line inspected. All post-television inspection shall be included in price of repair in accordance with Part 415.

## PART 425 – SEALED MANHOLE FRAME AND COVER

425.1 GENERAL

425.1.1 The Contractor shall install a sealed frame and cover when performing manhole repair Types A (manhole frame, cover and frame seal) and C (manhole frame, cover, frame seal, and chimney) within the City of Tulsa regulatory flood plain boundary, as shown on the plans, or when directed by the Engineer.

425.1.2 Manhole frame and cover repairs shall adhere to City of Tulsa Construction Specifications Part 418 – Replacement of Manhole Frame and Cover, Frame Seal, Chimney Seal, and Grade Adjustment; except where specified otherwise by this Part.

425.2 DEFINITIONS

425.2.1 Sealed frame and cover shall be defined as a frame and cover as described in City of Tulsa Standard Detail Nos. 352,353, or 354, as applicable, with the incorporation of a sealing gasket, bolts, and bolting pads.

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425.2.2 Sealed Lamphole Frame and Cover shall be defined as a lamphole frame that among its attributes includes a minimum circular opening of 8.5” in diameter to conform to the City of Tulsa Standard Detail No. 360 (Standard Detail for Lampholes). In addition to the requirements of the referenced detail, the frame and cover shall incorporate a sealing gasket, bolts, and bolting pads.

425.3 MATERIALS

425.3.1 Sealed Frame and Cover shall be “Deeter 1265 – Bolted and Sealed” or “Deeter 1296 – Bolted and Sealed”, as applicable, with Tulsa emblem or equal.

425.3.2 Sealed Lamphole Frame and Cover shall be “Deeter 1828-B – Bolted and Sealed.”

425.3.3 Bolt threading for sealed manhole frame and cover shall be 5/8” at 11 threads per inch, unless specified otherwise by the Engineer. Bolts shall utilize the McGard locking system keyed to the City of Tulsa standard lock.

425.3.4 All other materials shall be in accordance with City of Tulsa Construction Specification Part 418 – Replacement of Manhole Frame and Cover, Frame Seal, Chimney Seal, and Grade Adjustment.

425.4 EXECUTION

425.4.1 Sealed Lamphole Frame and Cover

A) Installation of a Sealed Frame and Cover shall result in a watertight installation conforming to the requirements of Special Detail No. 2.

B) Contractor shall apply hydrophilic paste to ensure filling of any voids or pits on the pipe surface and to ensure adhesion of the hydrophilic waterstop to the pipe prior to placement of the concrete collar. Paste and waterstop shall be placed immediately prior to pouring of the concrete collar and kept from contact with water. Avoid premature wetting of the paste or waterstop in order to avoid premature swelling of the paste or waterstop. Paste or waterstop which begin to swell prior to placement of the concrete shall be removed and replaced prior to placement of the concrete collar. Follow all manufacturer's requirements for hydrophilic paste and hydrophilic waterstop.

C) Concrete collar shall be placed and finished to a smooth, level surface. Troweleable bitumastic shall be placed in a layer 3/16" over the collar prior to placement of the frame and cover.

425.5 MEASUREMENT AND PAYMENT

425.5.1 Payment for the installation of a Sealed Frame and Cover, and payment for a Sealed Lamphole Frame and Cover shall be in addition to the prices bid for Type A, Type C repair, Type F repair, Manhole Replacement, Lamphole Replacement, or Lamphole Frame and Cover, for each Sealed Frame and Cover, and for each Sealed Lamphole Frame and Cover installed.

425.5.2 The price bid for a sealed Frame and Cover shall be payment in full for performing and completing all additional work and for furnishing all additional labor and materials necessary above and beyond the cost of a Type A or Type C repair.

425.5.3 The price bid for a Sealed Lamphole Frame and Cover shall be payment in full for performing and completing all additional work and for furnishing all additional labor and materials necessary above and beyond the cost of a Lamphole Frame and Cover, or a Lamphole Replacement.

425.5.4 No payment shall be made until the manhole and its adjacent area have been restored and the manhole and its appurtenances have satisfactorily passed testing.

**SECTION END**

## DIVISION V

## WATER METER SPECIFICATIONS

APPROVED METER AND BACK FLOW PREVENTER MANUFACTURERS

| Size | Type | Manufacturer | Application |
|---|---|---|---|
| 5/8” x 3/4" | Displacement | Neptune | Domestic or irrigation water or Limited area fire sprinkler* by Connection Control *As approved |
| 3/4" | Displacement | Neptune | All<br>Domestic or irrigation water or Limited area fire sprinkler* by Connection Control *As approved |
| 1” | Displacement | Neptune | All<br>Domestic or irrigation water or Limited area fire sprinkler* by Connection Control *As approved |
| 1-1/2” | Displacement | Neptune | Domestic or irrigation water or Limited area fire sprinkler*<br>*As approved by Connection Control |
| 2” & 3” | Compound | Neptune | Domestic or irrigation water or Limited area fire sprinkler*<br>*As approved by Connection Control |
| 2” & 3” | Turbine | Neptune | Domestic* or irrigation water or Limited area fire sprinkler*<br>*As approved by Connection Control |
| 4”, 6”, & 8” | Compound | Neptune | Domestic or irrigation water or Limited area fire sprinkler*<br>*As approved by Connection Control |
| 4”, 6”, 8”, & 10” | Fire Flow | Neptune | Combo domestic/fire protection as approved by Connection Control. |
| 4”, 6”, 8”, & 10” | Fire Service Turbine | Neptune | Combo domestic/fire protection as approved by Connection Control. |
| 4”, 6”, 8”, & 10” | Turbine | Neptune | Domestic or irrigation water or limited area fire sprinkler where particularly approved by Connections Control. |

| SIZE | BACKFLOW PREVENTERS | MANUFACTURERS | REQUIREMENTS |
|---|---|---|---|
| All Sizes | Double Check Assembly | Ames, Conbraco, Febco, Hersey, Watts, Wilkins | USE ONLY APPROVED WATER METER IN ASSEMBLY |
| All Sizes | Double Check Detector | Ames, Conbraco, Febco, Hersey, Watts, Wilkins | USE ONLY APPROVED WATER METER IN ASSEMBLY |
| All Sizes | Reducer Pressure | Ames, Conbraco, Febco, Hersey, Watts, Wilkins | USE ONLY APPROVED WATER METER IN ASSEMBLY |
| All Sizes | Reducer Pressure Detector | Ames, Conbraco, Febco, Hersey, Watts, Wilkins | USE ONLY APPROVED WATER METER IN ASSEMBLY |

**Part 500 – Definitions**

500.1 Absolute True Encoder Register – A meter register designed either to electronically determine the position of the odometer wheels or otherwise electronically capture the register reading. The register must be designed to reliably provide an accurate reading, or an error signal in the event of a malfunction, with no manual adjustment when it is connected to an interrogation device. The register must be capable of internally storing or sensing the reading so that it can be accurately read with a remote interrogator without relying on an external device to count periodic signals.

500.2 Enhanced Absolute True Encoder Register– The Electronic Absolute Encoder Register is a custom integrated circuit design that digitally encodes the rotation of the measuring chamber. The register provides an eight-digit remote meter reading, and value-added features including leak detection, tamper detection, no flow detection, and backflow indication. Leak detection provided by monitoring a 24-hour period in 15-minute intervals. Tamper detection provided by reverse flow indication and number of days of zero flow over the previous 35 days. In addition, the register provides a visual read as well as a visual read out on rate of flow. Enhanced Absolute True Encoder shall carry ten-year warranty and shall be battery less. Enhanced Absolute True Encoder shall be Neptune R900i, or equal.

500.3 Radio Frequency Meter Interface Unit (MIU) – The MIU and Enhanced Absolute True Encoder register shall be an integrated package with no external wires to be installed or special programming. MIU unit shall interrogate the Enhanced Absolute True Encoder register(s) thru a cable lead and transmit the meter reading and other information to a data collection device via an RF interface. The MIU shall be attached to the underside of the cast iron meter can lid thru the industry standard 1-3/4” hole in the pit lid with no degradation of transmission range. Range shall not be affected by

flooded pit. Antenna shall be metallic and polymer material to withstand traffic and shall have dual seal connection to MIU housing. MIU shall be protected from static discharge without loss of data per IEC 801-2, issue 2. MIU shall be waterproof. MIU shall be configured to accommodate a minimum of two Enhanced Absolute True Encoders. The MIU is a one-way communication device that transmits a signal every 15 seconds using frequency hopping spread spectrum technology. The unit shall operate within the 910-920 unlicensed RF bandwidth. The unit shall be a Neptune R900i or MIU shall be Neptune R900 Pit Radio MIU or equal.

500.4 Meter Register Assembly – The system component that converts a meter reading into an electronic signal. This component consists of a meter register and true encoder assembly, assembled as either a single unit or as separate units, to be mounted on the meter.

500.5 Signal Transmission Assembly – System component consisting of electronic wires (or cable) and connectors, which transmit the electronic signal from a meter-register assembly to a remote receptacle.

500.6 Remote Pit Receptacle – The system component at a remote location from the meter, which receives the probe or a portable visual-display unit or a portable data-acquisition unit.

500.7 Probe – The system component that connects a remote receptacle with a portable data-acquisition unit or portable visual-display unit.

500.8 Portable data-acquisition unit (PDAU) – The system component that semi-automatically obtains and records on electronic data-storage unit, the significant meter registration and the customer identification number when its probe is connected to a remote receptacle.

500.9 Portable visual-display unit (PVDU) – The system component that provides a visual display of the significant meter registration when its probe is connected to a remote receptacle.

## PART 501 – DISPLACEMENT WATER METERS – 5/8” x 3/4", 1”, & 1-1/2”

501.1 WATER DISPLACEMENT METERS

501.2 GENERAL

501.2.1 Displacement water meters shall conform to current standard specifications of the AWWA C700, latest edition, “Cold Water Meters – Displacement Type.”

501.2.2 All meters and components shall be manufactured in the territorial boundaries of the United States.

501.2.3 The overall length of the 1-1/2” meters shall be 13”. Overall length of 5/8” x 3/4” and 3/4” meters shall be 7-1/2” in length. Overall length of 1” meters shall be 10-3/4” in length.

501.2.4 The meter size and pressure shall conform to Table 1, “Characteristics of Displacement Type Meters”, of AWWA C700.

501.2.5 All meters must be guaranteed to operate under a working pressure of 150 psi without leakage or damage to any part.

501.3 CASE

501.3.1 The main case of the meter shall be cast waterworks bronze, with a cast iron bottom to allow breakage in the event of freezing so as not to distort the main housing. The “frost proof” cast iron bottom shall be attached to the bronze housing by four (300 Series) stainless steel bolts or cast bronze bolts and the internal water separated from the cast iron bottom by means of suitable polymer or rubber liner.

501.3.2 The serial number of the meter shall be imprinted permanently on the raised portion of the main case over the outlet spud or on the raised portion of the main case over the outlet flange. Non-encoder registers of 1-1/2” and smaller meters shall have covers.

501.3.3 Castings shall not be repaired in any manner.

501.4 MEASURING CHAMBER

501.4.1 The measuring chamber shall be cast bronze or suitable synthetic polymer and be guaranteed to measure accurately for 15 years. Nutating disc or oscillating piston type will be acceptable. Disc or piston shall be made of the highest grade vulcanized hard rubber or synthetic polymer and fitted accurately into the measuring chamber. Discs shall be equipped with a thrust bearing. The disc shall be flat and one-piece construction. The number of disc nutations shall comply with the AWWA C700 latest edition.

501.4.2 Measuring chambers shall be field repairable/replaceable without recalibration using change gears.

501.5 REGISTER

501.5.1 Registers will be magnetic driven straight reading in U.S. gallons and hermetically sealed with heat-treated glass. The date of manufacture and the size of the meter the register is compatible with shall be placed on the face of the register. The integrated Enhanced True Encoder register shall have the associated MIU number on the face of the register as well as the size and manufacture date.

501.5.2 All gearing shall be enclosed in the sealed register unit. All 1-1/2" meters shall have identical change gears.

501.5.3 The sealed register unit shall be warranted for 25 years to be free from defects and fogging.

501.5.4 The registration indicated on the meter dial shall not be less than 98.5% nor more than 101.5% while being tested within normal test flow limits as specified in Table 1 "Characteristics of Displacement Type Meters", of AWWA C700. Meters shall register not less than 95% and not more than 101% at the minimum test rate flow as specified in Table 1 "Characteristics of Displacement Type Meters" of AWWA C700.

501.6 SCREEN

501.6.1 A rigid screen of non-corrosive material shall be installed inside the meter case. The screen shall fit snugly, shall be easily removable, and shall have an effective straining area at least double that of the main case outlet.

501.7 LOCAL REMOTE READOUT

501.7.1 Each meter shall be capable of accepting the Enhanced Absolute True Encoder register with the value-added package of leak detection, tamper detection, no flow and reverse flow data. Any enhanced absolute true encoder registers shall not require outside electrical power.

501.7.2 Manufacturers must demonstrate that they have at least five consecutive years of successful experience in the manufacture and sale of a reliable absolute true encoder register.

501.7.3 Remote pit receptacles shall automatically query the encoder register to obtain a numeric reading. Manufacturers shall demonstrate that a reading obtained from a remote pit receptacle or AMR device will match the reading on the encoder register.

501.7.4 When available from an approved meter manufacturer, remote pit receptacles or AMR devices shall read in 1,000-gallon increments.

501.8 WARRANTY AND CERTIFICATES OF TESTING

501.8.1 The company guarantees that all meters will perform to AWWA new meter accuracy standards for a period of one year from date of installation and to meet AWWA repaired meter standards for ten years, and the meter register shall be guaranteed for 25 years to perform accurately and free from fogging. The manufacturer shall replace at his own expense all meters rejected for failure to comply with this standard. Each meter shall be furnished with certificates of testing indicating conformance with AWWA meter accuracy for new meters.

501.9 CONNECTIONS

501.9.1 The connections for 1-1/2” meter shall be bronze, flanged, oval type, faced and drilled, conforming to Class 125, ANSI B16.24.

501.9.2 5/8” x 3/4”, 3/4”, and 1” meters shall have threaded connections.

501.10 EXCHANGE PROGRAM

501.10.1 Each bidder will indicate the unit price for the new meters including an allowance per unit for an equal number of meters from the City of Tulsa for a trade-in. Successful bidders shall furnish shipping crates and shall pick up trade-in meters.

501.10.2 Each bidder shall furnish a bid for testing up to 25% of the trade-in meters.

501.11 REPAIR PARTS

501.11.1 Successful bidders shall furnish a complete repair parts list and price list for each type meter including prices for future register exchange and chamber exchange. Price shall be net prices of parts Free on Board (FOB) destination for the duration of the contract.

501.12 METER LITERATURE AND HEAD LOSS DELIVERY CURVES

501.12.1 Each bidder shall include with his proposal, two complete copies of descriptive material, loss of head and delivery curves for each item for which a bid is placed. No bids shall be considered unless the above information is furnished with bids.

501.13 COMPANION FLANGES (OPTIONAL)

501.13.1 Where specified, the meters shall be furnished with waterworks bronze companion flanges, gaskets, bolts, and nuts.

501.14 CONFLICTS

501.14.1 Where conflicts arise, the City interpretation shall prevail.

## PART 502 – COMPOUND TYPE WATER METERS – 2”, 3”, 4”, 6”, & 8”

502.1 COMPOUND WATER METERS

502.2 GENERAL

502.2.1 Where 2” through 8” compound water meters are specified or required, they shall conform to AWWA C702, “Cold Water Meters – Compound Type”, Latest Edition. Meters shall be designed to operate at a minimum working pressure of 150 psig without leakage or damage to any part.

502.2.2 The compound meter shall contain two measuring chambers, one for low flow and one for high flow, with flow through the chambers controlled by a swing, lifting action, or spring-loaded valve.

502.3 SIZE, CAPACITY, AND DIMENSIONS

502.3.1 The compound meter size and pressure shall conform to Table 1, “Operating Characteristics”, of AWWA C702. The overall dimensions from flange to flange of the meter shall not exceed those shown in Table 2, “Meter Dimensions”, of AWWA C702.

502.4 CASE

502.4.1 All meters shall have an outer case with separate, removable measuring chambers. Castings shall not be repaired in any manner. The case shall be bronze.

502.4.2 The size, model, and flow direction shall be cast on the outer case.

502.4.3 All interior parts shall be removable for repair without disturbing the pipeline connections.

502.4.4 The serial number of the meter shall be imprinted permanently on the top of the outlet flange.

502.5 FLANGED CONNECTIONS

502.5.1 All 2” compound meters shall be bronze flanged, oval type, faced and drilled, conforming to Class 125, ANSI B16.24.

502.5.2 The 3” through 6” compound meters shall be bronze flanged, round type, faced and drilled, conforming to Class 125, ANSI B16.24.

502.6 REGISTER

502.6.1 Registers shall be magnetically driven, hermetically sealed, and straight reading in U.S. gallons with heat-treated glass. The date of manufacture and the size of the meter the register is compatible with shall be placed on the face of the register. The integrated Enhanced True Encoder register shall have the associated MIU on the face of the

register as well as the size and manufacture date. The register(s) furnished shall be the same register(s) that was on the meter when it was tested for accuracy.

502.6.2 Register capacity and indication shall meet the requirements of Table 5 “Maximum Indication on Test Circle and Minimum Register Capacity” of the AWWA C702. A large center sweep test hand register shall be provided.

502.6.3 The accuracy of the meter shall not be less than 97% nor more than 103% of the water actually passed through the meter at any rate of flow specified in Table 1, “Operating Characteristics” of the AWWA C702. The test water shall be at a temperature less than 80° F. The accuracy at changeover flow, due to operation of the automatic valve mechanism, shall not be less than 97% and not more than 103%, and shall meet the requirements of Table 3 “Changeover Flow Rates” of AWWA C702.

502.6.4 Copper or stainless steel seal wires with lead seal shall be furnished and installed by manufacturer (supplier) to seal the register.

502.7 MEASURING CHAMBER, TURBINE BEARINGS

502.7.1 The measuring chamber shall be bronze or synthetic polymer and shall be easily removable from the main case.

502.7.2 The turbine bearings or bushings shall be made of vulcanized hard rubber, or synthetic polymer material, and shall be replaceable.

502.7.3 The high flow metering mechanism shall be driven by a rotor or propeller mounted on a horizontal shaft. No vertical shaft mounted rotor or torrent wheel measuring chambers shall be allowed.

502.8 MAGNETIC OR DIRECT COUPLINGS

502.8.1 Magnetic or direct drive register couplings with stuffing boxes may be used when the intermediate gear trains are located in the water compartment. Only magnetic register couplings shall be used when the intermediate gear trains are located in the register compartments.

502.9 STRAINER

502.9.1 The strainer shall be flanged and shall have an effective straining area at least double the meter case inlet area. The body shall be ductile or cast iron or bronze, and the strainer screen shall be bronze or stainless steel. The strainer shall be designed for a minimum working pressure of 150 psig.

502.9.2 The total laying length of the meter and strainer shall be as follows:

| Meter and Strainer | |
|---|---|
| Meter Size, Inches | Max. Laying Length, Inches |
| 2 | 24 |
| 3 | 24 |
| 4 | 33 |
| 6 | 33 |

502.10 LOCAL REMOTE READOUT

502.10.1 2” meters shall be capable of accepting an enhanced absolute true encoder register operable with no outside electrical power.

502.10.2 3” and larger meters shall be furnished with an enhanced absolute true encoder register operable with no outside electrical power.

502.10.3 Manufacturers must demonstrate that they have at least five consecutive years of successful experience in the manufacture and sale of a reliable absolute true encoder register.

502.10.4 Remote pit receptacles shall automatically query the encoder register to obtain a numeric reading. Manufacturers shall demonstrate that a reading obtained from a remote pit receptacle or AMR device will match the reading on the encoder register.

502.10.5 When available from an approved meter manufacturer, remote pit receptacles or AMR devices shall read in 1,000-gallon increments.

502.11 AFFIDAVIT OF COMPLIANCE

502.11.1 An Affidavit of Compliance and Certificate of Testing shall be furnished to the City of Tulsa with each meter to ensure that the meter conforms to these specifications.

502.12 COMPANION FLANGES (OPTIONAL)

502.12.1 Where specified, the meter shall be furnished with waterworks bronze companion flanges, gaskets, bolts, and nuts.

502.13 REPAIR PARTS

502.13.1 Successful bidders shall furnish a complete repair parts list and price list for each type meter including prices for future register exchange and chamber exchange. Price shall be net prices of parts FOB destination for the duration of the contract.

502.14 WARRANTY

502.14.1 The manufacturer guarantees that all meters will perform to AWWA new meter accuracy standards for a period of one year from date of installation. The manufacturer shall replace at its own expense all meters rejected for failure to comply with this

standard. Each meter shall be furnished with certificate of testing indicating conformance with AWWA meter accuracy for new meters.

502.15 EXCHANGE PROGRAM

502.15.1 Each bidder shall indicate the unit price for the new meters. Successful bidders shall furnish shipping crates and shall pick up trade-in meters.

502.15.2 Each bidder shall furnish a bid for testing up to 25% of the trade-in meters.

502.16 METER LITERATURE AND HEAD LOSS DELIVERY CURVES

502.16.1 Each bidder shall include with their proposal, two complete copies of descriptive material, loss of head, and delivery curves for each item for which a bid is placed. No bids shall be considered unless the above information is furnished with bids.

502.17 CONFLICTS

502.17.1 Where conflicts arise, the City interpretation shall prevail.

## PART 503 – TURBINE WATER METERS – IRRIGATION AND SPECIAL SERVICES – 2” & 3”

503.1 TURBINE WATER METERS

503.2 GENERAL

503.2.1 Where 2” and 3” turbine meters are specified or required, they shall conform to AWWA C701, “Cold Water Meters, Turbine Type, for Customer Service”, Latest Edition. They shall be designed to operate at a minimum working pressure of 150 psig without leakage or damage to any part.

503.3 SIZE CAPACITY AND DIMENSIONS

503.3.1 The meter size, nominal capacity ratings, and pressure loss shall conform to Table 1, “Operating Characteristics”, of AWWA C701. The overall dimensions from flange to flange of the meter shall not exceed those shown in Table 2, “Meter Dimensions for Class 1 and Class II Turbine-Type Meters”, of the AWWA C701.

503.4 CASE

503.4.1 All meters shall have a bronze outer case with a separate, removable measuring chamber, in which the turbine operates. Castings shall not be repaired in any manner.

503.4.2 All interior parts shall be removable for repair without disturbing the pipeline connections.

503.4.3 The size, model, and flow direction shall be cast on the outer case.

503.4.4 The serial number of the meter shall be imprinted permanently on the top of the outlet flange.

503.4.5 An adjustment vane for positive and negative calibration of meter accuracy shall be incorporated into the meter main case or measuring chamber cover.

503.5 FLANGED CONNECTIONS

503.5.1 All 3” turbine meters shall be bronze flanged, round type, faced and drilled, conforming to Class 125, ANSI B16.24.

503.5.2 All 2” turbine meters shall be bronze flanged, oval type, faced and drilled, conforming to Class 125, ANSI B16.24.

503.6 REGISTER

503.6.1 The register shall be magnetically driven, hermetically sealed, and straight reading in U.S. gallons with heat-treated glass. The date of manufacture and the size of the meter the register is compatible with shall be placed on the face of register. The integrated Enhanced True Encoder register shall have the associated MIU number on the face of

the register as well as the size and manufacture. The register(s) furnished shall be the same register(s) that was on the meter when it was tested for accuracy.

503.6.2 The register capacity and indication shall meet the requirements of Table 4 “Maximum Indication on Initial Dial and Maximum Register Capacity” of AWWA C701. A large center sweep test hand register shall be provided.

503.6.3 The accuracy of the meter shall not be less than 98% nor more than 102% of the water actually passed through the meter at any rate of flow specified in Table 1 “Operating Characteristics” of the AWWA C701. The test water shall be at a temperature less than 80° F.

503.6.4 Register cover shall be made of bronze with the name of the manufacturer cast on the lid in raised letters. The serial number shall be imprinted permanently on the cover. Register cover not required for encoder registers.

503.6.5 Copper or stainless steel seal wires with lead seal shall be furnished and installed by manufacturer (supplier) to secure the register.

503.7 MEASURING CHAMBER, TURBINE BEARING

503.7.1 The measuring chamber shall be bronze or synthetic polymer and shall be easily removable from the main case.

503.7.2 The turbine bearings or bushings shall be made of vulcanized, hard rubber, synthetic polymer, or ceramic material, and shall be replaceable.

503.8 STRAINER

503.8.1 The strainer shall be flanged and shall have effective straining area at least double the meter case inlet area. The body shall be ductile or cast iron or bronze, and the strainer screen shall be bronze or stainless steel. The strainer shall be designed to operate at a minimum working pressure of 150 psi.

503.8.2 The total laying length of the meter and strainer shall be as follows:

| Meter and Strainer | |
|---|---|
| Meter Size, Inches | Max. Laying Length, Inches |
| 2 | 20 |
| 3 | 19 |

503.9 LOCAL REMOTE READOUT

503.9.1 Each 2” meter shall be capable of accepting an absolute true encoder register operable with no outside electrical power.

503.9.2 Each 3” meter shall have an absolute true encoder register operable with no outside electrical power.

503.9.3 Manufacturers must demonstrate that they have at least five consecutive years of successful experience in the manufacture and sale of a reliable absolute true encoder register.

503.9.4 Remote pit receptacles and AMR devices shall automatically query the encoder register to obtain a numeric reading. Manufacturers shall demonstrate that a reading obtained from a remote pit receptacle or AMR device will match the reading on the encoder register.

503.9.5 When available from an approved meter manufacturer, remote receptacles or AMR devices shall read in 1,000-gallon increments.

503.10 AFFIDAVIT OF COMPLIANCE

503.10.1 An Affidavit of Compliance and Certificate of Testing shall be furnished to the City of Tulsa with each meter to ensure that the meter conforms to these specifications.

503.11 COMPANION FLANGES (OPTIONAL)

503.11.1 Where specified, the meter shall be furnished with waterworks bronze companion flanges, gaskets, bolts, and nuts.

503.12 REPAIR PARTS

503.12.1 Successful bidders shall furnish a complete repair parts list and price list for each type meter including prices for future register exchange and chamber exchange. Price shall be net price of parts FOB destination for the duration of the contract.

503.13 WARRANTY

503.13.1 The company guarantees that all meters will perform to AWWA new meter accuracy standards for a period of one year from date of installation. The manufacturer shall replace at its own expense all meters rejected for failure to comply with this standard. Each meter shall be furnished with certificates of testing indicating conformance with AWWA meter accuracy for new meters.

503.14 METER LITERATURE AND HEAD LOSS DELIVERY CURVES

503.14.1 Each bidder shall include with his proposal, two complete copies of descriptive material, loss of head and delivery curves for each item for which a bid is placed. No bids shall be considered unless the above information is furnished with bids.

503.15 CONFLICTS

503.15.1 Where conflicts arise, the City interpretation shall prevail.

## PART 504 – TURBINE METERS – FIRE SERVICE – 4”, 6”, 8”, & 10”

504.1 FIRE SERVICE TURBINE METERS

504.2 GENERAL

504.2.1 Where fire service meters are specified or required, they shall conform to AWWA C703, “Cold Water Meters, Fire Service Type”, Latest Edition. They shall be designed to operate at a minimum working pressure of 150 psig without leakage or damage to any part.

504.2.2 The meter shall be a high velocity turbine type with strainer and shall conform to the National Fire Protection Association (NFPA) requirements and shall be approved by the Underwriters Laboratory (UL) for fire service.

504.3 SIZE, CAPACITY, AND DIMENSIONS

504.3.1 The meter size and nominal capacity ratings and pressure loss shall conform to Table 1 “Operating Characteristics” of AWWA C703. The overall dimensions from flange to flange of the meter shall not exceed those shown in Table 2 “Meter Dimensions” of AWWA C703.

504.4 CASE

504.4.1 All meters shall have an outer case with a separate, removable measuring chamber, in which the turbine operates. Castings shall not be repaired in any manner. The case shall be bronze or cast iron.

504.4.2 The size, model, and flow direction shall be cast on the outer case.

504.4.3 All interior parts shall be removable for repair without disturbing the pipeline connections.

504.4.4 The serial number of the meter shall be imprinted permanently on the top of the outlet flange.

504.5 FLANGED CONNECTIONS

504.5.1 The fire service turbine meter shall be bronze flanged, round type, faced and drilled, conforming to Class 125, ANSI B16.24.

504.6 REGISTER

504.6.1 The registers shall be magnetically driven, hermetically sealed, and straight reading the U.S. gallons. The date of manufacture and the size of the meter the register is compatible with shall be placed on the face of the register. The integrated Enhanced True Encoder register shall have the associated MIU number on the face of the register

as well as the size and manufacture date. The register furnished shall be the same register that was on the meter when it was tested for accuracy.

504.6.2 The register capacity and indication shall meet the requirements of Table 4 “Register Characteristics” of the AWWA C703. A large center sweep test hand register shall be provided, if available.

504.6.3 The accuracy of the meter shall not be less than 98% nor more than 102% of the water actually passed through the meter at any rate of flow specified in Table 1 “Operating Characteristics” of AWWA C703. The test water shall be at a temperature less than 80° F.

504.6.4 Register cover shall be made of bronze with the name of the manufacturer cast on the lid in raised letters. The serial number shall be imprinted permanently on the cover. Register covers not required on encoder equipped registers.

504.6.5 Copper or stainless steel seal wires with lead seal shall be furnished and installed by manufacturer (supplier) to seal the register.

504.7 MEASURING CHAMBER, TURBINE BEARING

504.7.1 The measuring chamber shall be bronze or synthetic polymer and shall be easily removable from the main case.

504.7.2 The turbine bearings or bushings shall be made of vulcanized, hard rubber, synthetic polymer, or ceramic material, and shall be replaceable.

504.7.3 An adjustment vane for positive and negative calibration of meter accuracy shall be incorporated into the meter main case or measuring chamber cover.

504.8 STRAINER

504.8.1 The strainer shall be flanged and shall have effective straining area at least quadruple the meter case inlet area. The body shall be ductile or cast iron or bronze, and the strainer screen shall be bronze or stainless steel. The strainer shall be designed to operate at a minimum working pressure of 150 psi.

504.8.2 The total laying length of the meter and strainer shall be as follows:

| Meter and Strainer | |
|---|---|
| Meter Size, Inches | Max. Laying Length, Inches |
| 4 | 35-1/16” |
| 6 | 44-7/8” |
| 8 | 51-5/16” |
| 10 | 59-3/4” to 61-3/4” |

504.9 LOCAL REMOTE READOUT

504.9.1 Each meter shall be furnished with an absolute true encoder register operable with no outside electrical power.

504.9.2 Manufacturers must demonstrate that they have at least five consecutive years of successful experience in the manufacture and sale of a reliable absolute true encoder register.

504.9.3 Remote pit receptacles and AMR devices shall automatically query the encoder register to obtain a numeric reading. Manufacturers shall demonstrate that a reading obtained from a remote pit receptacle or AMR device will match the reading on the encoder register.

504.9.4 When available from an approved meter manufacturer, remote pit receptacles or AMR devices shall read in 1,000-gallon increments.

504.10 AFFIDAVIT OF COMPLIANCE

504.10.1 An Affidavit of Compliance and Certificate of Testing shall be furnished to the City of Tulsa with each meter to ensure that the meter conforms to these specifications.

504.11 COMPANION FLANGES (OPTIONAL)

504.11.1 Where specified, the meter shall be furnished with waterworks bronze companion flanges, gaskets, bolts, and nuts.

504.12 REPAIR PARTS

504.12.1 Successful bidders shall furnish a complete repair parts list and price list for each type meter including prices for future register exchange and chamber exchange. Price shall be net price of parts FOB destination for the duration of the contract.

504.13 WARRANTY

504.13.1 The company guarantees that all meters will perform to AWWA new meter accuracy standards for a period of one year from date of installation. The manufacturer shall replace at its own expense all meters rejected for failure to comply with this standard. Each meter shall be furnished with certificates of testing indicating conformance with AWWA meter accuracy for new meters.

504.14 METER LITERATURE AND HEAD LOSS DELIVERY CURVES

504.14.1 Each bidder shall include with his proposal, two complete copies of descriptive material, loss of head and delivery curves for each item for which a bid is placed. No bids shall be considered unless the above information is furnished with bids.

504.15 CONFLICTS

504.15.1 Where conflicts arise, the City interpretation shall prevail.

## PART 505 – FIRE FLOW METERS – 4”, 6”, 8”, & 10”

505.1 FIRE FLOW METERS

505.2 GENERAL

505.2.1 fire flow meters shall have a compound meter bypass, or they shall be a Neptune Protectus II Turbine meter with a displacement meter bypass, the high flow metering mechanism for compound bypass meters shall be driven by a rotor or propeller mounted on a horizontal shaft. No vertical shaft mounted rotor or torrent wheel measuring chambers shall be allowed. The meter shall conform to AWWA C703 “Cold Water Meters, Fire Service Type”; AWWA C702, “Cold Water Meters Compound Type”; or AWWA C701, “Cold Water Meters, Turbine Type.”

505.2.2 Meters shall be designed to operate at a minimum working pressure of 150 psig without leakage or damage to any part.

505.2.3 The meter shall conform to the National Fire Protection Association (NFPA) requirements and shall be approved by the Underwriters Laboratory (UL) for fire service.

505.3 SIZE, CAPACITY, AND DIMENSIONS

505.3.1 The meter size, nominal capacity ratings and pressure loss shall conform to Table 1 “Operating Characteristics” of AWWA C702.

505.4 CASE

505.4.1 The main line meter and automatic valve case shall be made of galvanized cast iron or bronze. The bypass type of meter shall have a bronze case.

505.4.2 The flow direction shall be cast on the outer case.

505.4.3 All interior parts shall be removable for repair without disturbing the pipeline connections.

505.5 FLANGED CONNECTIONS

505.5.1 The meter flanges shall be integral with the case, round type, faced and drilled, and conform to Class 125, ANSI B16.1.

505.6 REGISTERS

505.6.1 Registers shall be magnetically driven, straight reading, hermetically sealed, and shall read in U.S. gallons. The date of manufacture and the size of the meter the register is compatible with shall be placed on the face of the register. The integrated Enhanced True Encoder register shall have the associated MIU number on the face of the register

as well as the size and manufacture date. The register furnished shall be the same register that was on the meter when it was tested for accuracy.

505.6.2 The register capacity and indication shall meet the requirements of Table 1 “Operating Characteristics” of the AWWA C703.

505.6.3 The accuracy of the meter shall not be less than 97% or more than 103% of the water actually passed through the meter at any rate of flow specified in Table 1 “Operating Characteristics” of the AWWA C703. The test water shall be at a temperature less than 80° F.

505.6.4 Register cover shall be made of bronze with the name of the manufacturer cast on the lid in raised letters. The serial number shall be imprinted permanently on the cover. Register cover not required on encoder-equipped registers.

505.6.5 Copper or stainless steel wires with lead seal shall be furnished and installed by manufacturer (supplier) to seal the register.

505.7 MEASURING CHAMBER, TURBINE BEARINGS

505.7.1 The measuring chamber shall be bronze or synthetic polymer and shall be easily removable from the main case.

505.7.2 The turbine bearings or bushings shall be made of vulcanized, hard rubber, synthetic polymer, or ceramic material, and shall be replaceable.

505.7.3 100% of the flow through the meter must pass through the metering chambers. No proportional metering chambers shall be allowed.

505.8 STRAINER

505.8.1 The strainer shall be flanged and shall have effective straining area at least quadruple the meter case inlet area. The body shall be ductile or cast iron or bronze, and the strainer screen shall be bronze or stainless steel. The strainer shall be designed to operate at a minimum working pressure of 150 psi.

505.9 LOCAL REMOTE READOUT

505.9.1 Each meter shall be furnished with an integrated Enhanced True Encoder register operable with no outside electrical power.

505.9.2 Manufacturers must demonstrate that they have at least five consecutive years of successful experience in the manufacture and sale of a reliable absolute true encoder register.

505.9.3 Remote pit receptacles and AMR devices shall automatically query the encoder register to obtain a numeric reading. Manufacturers shall demonstrate that a reading

obtained from a remote pit receptacle or AMR device will match the reading on the encoder register.

505.9.4 When available from an approved meter manufacturer, remote pit receptacles or AMR devices shall read in 1,000-gallon increments.

505.10 AFFIDAVIT OF COMPLIANCE

505.10.1 An Affidavit of Compliance and Certificate of Testing shall be furnished to the City of Tulsa with each meter to ensure that the meter conforms to these specifications.

505.11 COMPANION FLANGES (OPTIONAL)

505.11.1 Where specified, the meter shall be furnished with waterworks bronze companion flanges, gaskets, bolts, and nuts.

505.12 REPAIR PARTS

505.12.1 Successful bidders shall furnish a complete repair parts list and price list for each type meter including prices for future register exchange and chamber exchange. Price shall be net price of parts FOB destination for the duration of the contract.

505.13 WARRANTY

505.13.1 The company guarantees that all meters will perform to AWWA new meter accuracy standards for a period of one year from date of installation. The manufacturer shall replace at its own expense all meters rejected for failure to comply with this standard. Each meter shall be furnished with certificates of testing indicating conformance with AWWA meter accuracy for new meters.

505.14 METER LITERATURE AND HEAD LOSS DELIVERY CURVES

505.14.1 Each bidder shall include with his proposal, two complete copies of descriptive material, loss of head and delivery curves for each item for which a bid is placed. No bids shall be considered unless the above information is furnished with bids.

505.15 CONFLICTS

505.15.1 Where conflicts arise, the City interpretation shall prevail.

## PART 506 – DOUBLE CHECK DETECTOR ASSEMBLY – 4”, 6”, 8”, & 10”

506.1 DOUBLE CHECK DETECTOR ASSEMBLY

506.2 GENERAL

506.2.1 Where specified or required for fire service lines, a Double Check Detector Assembly Backflow Preventor shall be installed in accordance with the City of Tulsa Plumbing Code.

506.2.2 The assembly shall consist of a double check valve, resilient seated gate valves, and a parallel bypass meter assembly. Design working pressure shall be a minimum of 150 psi.

506.2.3 The assembly shall be tested by a City of Tulsa, approved Back Flow Assembly Tester before it will be accepted.

506.2.4 The check valves in the main line and bypass shall remain closed until there is a demand for water. Flow rates up to approximately three gallons per minute shall be directed through the metered bypass. Higher flow rates shall open the mainline check valves causing flow to occur through the mainline and the bypass.

506.3 REFERENCE STANDARDS AND APPROVALS

506.3.1 The double check detector assembly shall meet or exceed the following standards:

506.3.2 Manual of Cross-Connection Control, Foundation for Cross-Connection Control and Hydraulic Research, University of Southern California (USC-FCCC & HR).

506.3.3 American Society of Sanitary Engineering (ASSE Standard Number 1048.)

506.3.4 American Water Works Association (AWWA) Standard Number C510, Double Check Valve Backflow Prevention Assembly (mainline assembly only).

506.3.5 The double check detector assembly shall be tested and approved as follows:

A) USC-FCCC & HR Approved

B) Factory Mutual (FM) Approved

C) Underwriters Laboratories (UL) Classified

506.4 MAIN LINE DOUBLE CHECK ASSEMBLY

506.4.1 The main line unit shall consist of two independently acting spring-loaded check valves, located between two resilient seated gate valves, and four properly placed resilient seated test cocks.

506.4.2 The main line body and cover shall be constructed of cast iron, ductile iron, or stainless steel. All iron bodies and parts shall be coated with a polymerized coating conforming to AWWA C550.

506.4.3 All internal metal parts of the check valves shall be bronze or stainless steel. Check valves shall be serviceable in-line.

506.4.4 The shutoff valves shall be resilient seated gate valves conforming to AWWA C509, outside screw and yoke (OS&Y). Main line end connections shall be flanged, 125 lb. ANSI B16.1.

506.5 BYPASS METER ASSEMBLY

506.5.1 The bypass assembly shall consist of two independently acting spring-loaded check valves, two shutoff valves, displacement water meter, and four properly placed resilient seated test cocks.

506.5.2 The bypass assembly piping and valve bodies shall be constructed of bronze. All internal metal parts shall be bronze or stainless steel.

506.5.3 The bypass meter shall be a City of Tulsa approved displacement meter furnished with an integrated Enhanced True Encoder register operable with no outside electrical power. The meter shall be furnished with a certificate of testing indicating conformance with AWWA meter accuracy for new meters.

506.5.4 Remote pit receptacles and AMR devices shall automatically query the encoder register to obtain a numeric reading. Manufacturers shall demonstrate that a reading obtained from a remote pit receptacle or AMR device will match the reading on the encoder register.

506.5.5 When available from an approved meter manufacturer, remote interrogators or AMR devices shall read in 1,000-gallon increments.

506.6 AFFIDAVIT OF COMPLIANCE

506.6.1 An affidavit of Compliance and Certificate of Testing shall be furnished to the City of Tulsa with each double check detector assembly to ensure that it conforms to these specifications.

506.7 SHIPPING

506.7.1 Each double check detector assembly shall be fully assembled, placed on pallets, and crated for shipping.

506.7.2 Meters shall be FOB destination.

**SECTION END**

# DIVISION VI

# TRAFFIC SPECIFICATIONS – MATERIALS

## PART 601 – PULL BOXES

601.1 DESCRIPTION

601.1.1 This work shall consist of furnishing materials and installing the pull boxes in accordance with these specifications and in reasonably close conformity with the location and dimensions shown on the Plans or established by the Traffic Engineer.

601.2 MATERIALS

601.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Operations Approved Products List.

601.2.2 General:

A) The pull box ring and cover shall be constructed of polymer concrete consisting of sand and aggregate bound together with a polymer resin. Internal reinforcement shall be fiberglass in the form of woven fabric or chopped strand or mat. The box and cover shall be gray in color.

B) All pull boxes shall come without mouse holes

C) All pull boxes with cracked, chipped, or broken lid, lips, or sidewalls shall be replaced at the contractor's expense.

D) Pull box covers shall be inscribed with the label "TRAFFIC SIGNALS" or "HIGHWAY LIGHTING" as appropriate.

601.2.3 Testing Requirements: Pull boxes shall meet or exceed the current material and performance requirements as outlined in the latest version of ANSI/SCTE 77 *Specification for Underground Enclosure Integrity* (Tier 15).

601.2.4 Ground Rod: A 5/8" x 8' minimum copper clad ground rod shall be installed in each pull box and shall be included in the price bid for the pull box. A minimum length of 8ft of the ground rod shall be embedded into and in direct contact with soil. Increase the overall length of the ground rod as needed. Ground rods shall have manufacturer's certification stamps visible, or have the stamp inspected prior to installation, showing the diameter and overall length of the rod. Ground rods shall not be cut or modified.

601.2.5 Concrete Apron: A concrete apron shall be installed around each pull box not located in the sidewalk or other paved area. The concrete shall be Class "A" concrete with a minimum thickness of 6", with a light broom finish. The cost of this concrete apron shall be included in the price bid for the pull box.

601.2.6 Gravel: Gravel in bottom of pull box shall meet the quality requirements specified in ODOT Section 701 or of ASTM C330, #67 for lightweight aggregate. Compact Dirt Fill shall meet the quality requirements specified in ODOT.

601.2.7 All pull boxes that need access cuts shall be saw cut by approved means (example Quickie saw, Sawzall; no hammer cuts allowed).

601.3 CONSTRUCTION METHODS

601.3.1 General: Provide underground enclosures as shown on the plans. Obtain the Traffic Engineer's approval to revise enclosure locations to fit field conditions or facilitate conduit system installation.

601.3.2 Installation:

A) Install underground enclosures on a bed of gravel as shown in the City of Tulsa Standard Drawing 601.

B) After the conduit ends are plugged, pour 6” of 3/4" washed gravel into the hole and set the pull box on the gravel to the proper elevation and pour additional 6" of gravel around the outside and inside of the pull box.

C) After cable and wire have been installed no gravel shall be added unless traffic or other personal are present. Push pennies or duct seal must be used to seal conduits before gravel is added.

D) When installing pull boxes in sidewalks or other surfaced areas, make the tops of the pull boxes flush with the finished surface.

E) When installing pull boxes in unpaved areas, make the tops of the pull boxes flush with the top of the ground or no greater than 1” above the ground. Provide all pull boxes not installed in surfaced areas with concrete aprons.

F) Pull boxes shall be installed without bolts in the cover.

G) Inside compartment of installed pull box shall be free of mud, concrete, and any material blown out of conduits or trash.

601.3.3 Location:

A) Pull box locations shall be located outside of wheelchair ramps and wheel drag path.

B) Pull boxes shall be set on a parallel or perpendicular line with the N-S-E-W axis of the intersection.

C) The maximum distance of a conduit run between pull boxes is 180’.

601.4 METHOD OF MEASUREMENT

601.4.1 The pull boxes of the size and type specified will be measured by each unit installed. Each pull box unit shall include cover, ground rod, concrete apron, gravel, excavation, and backfilling, necessary to construct and install pull boxes as shown on the Plans.

601.5 BASIS OF PAYMENT

601.5.1 Accepted pull boxes, measured as provided above, will be paid for at the contract unit price as follows:

A) Pull Box Size I ..... EACH

B) Pull Box Size II ..... EACH

C) Pull Box Size III ..... EACH

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals required to complete the work as specified.

## PART 602 – ELECTRICAL CONDUIT

602.1 DESCRIPTION

602.1.1 This work shall consist of furnishing and installing all the electrical conduit, fittings, expansion devices, and miscellaneous hardware necessary to complete the electrical conduit system in accordance with these specifications and the plans, and the latest adopted edition of the National Electric Code (NEC). The location of the conduit, as shown on the plans, is diagrammatic and may be subject to adjustment as the Traffic Engineer may direct in order to conform to existing field conditions.

602.2 MATERIALS

602.2.1 General:

A) Ensure all conduits and fittings are liquid tight. Ensure outlet boxes, fittings, entrance caps, and other accessories comply with current industry standards and are compatible with the conduit material used.

B) Ream conduit ends to remove burrs and rough edges. Make cuts square so ends will butt together for the full circumference. All conduit ends shall be bushed.

C) Provide factory conduit bends in accordance with the latest edition of the NEC, or bend conduit without crimping or flattening using the longest centerline radius for each installation, not less than six times the conduit inside diameter.

602.2.2 Rigid Metal Conduit (RMC):

A) Provide a UL rated rigid galvanized steel conduit that meet the requirements shown on the plans. All exposed conduit shall be rigid galvanized steel.

B) Galvanized conduit ends shall be threaded, reamed to remove rough edges, and bushings shall be installed prior to installing any wires.

C) The City will not allow slip joints or running threads for coupling conduit. If standard couplings are not practical, use threaded-union couplings to couple metal conduit, as approved by the Traffic Engineer. Pop rivets, sheet metal screws, or any other unapproved method shall not be used to connect any conduit. Tighten couplings until the ends come together; do not leave threads exposed.

D) If damage to galvanized conduit exposes bare metal, re-galvanize, metalize, or paint with zinc dust-oxide paint at no additional cost to the City.

602.2.3 Liquid Tight Flexible Metal Conduit (LFMC):

A) Provide LFMC electrical conduit in accordance with UL-360.

B) LFMC ends shall be reamed inside and outside to remove rough edges and bushings shall be installed prior to installing any wires.

C) All couplers and connectors shall be approved and listed for use with LFMC.

602.2.4 Rigid Polyvinyl Chloride Conduit (PVC):

A) Provide polyvinyl chloride (PVC) schedule 40 electrical conduit in accordance with UL-651. For solvent cement to join conduit refer to ASTM 2564.

B) PVC conduit ends shall be reamed to remove rough edges and bushings shall be installed prior to installing any wires.

C) Connections shall be solvent weld type. Connection point shall be properly cleaned as required by the adhesive manufacturer's directions.

D) All PVC conduit attached to HDPE conduit shall be attached by means of E-LOC, or approved equal, coupling suited for this purpose. Normal primer and PVC cement shall be used. Payment for E-LOC coupling shall be included in the cost of HDPE conduit.

E) All fittings shall be of the same schedule as the conduit run.

602.2.5 High Density Polyethylene Conduit (HDPE):

A) Provide High-density polyethylene (HDPE) conduit in accordance with the requirements of NEMA TC7. HDPE conduit shall be smooth wall coilable duct meeting the requirements of ASTM D1248 Type III Class C, Grade P33, Category 5, Schedule 40, unless otherwise specified in the Plans.

B) All PVC conduit attached to HDPE conduit shall be attached by means of E-LOC, or approved equal, coupling suited for this purpose. Normal primer and PVC cement shall be used. Payment for E-LOC coupling shall be included in the cost of HDPE conduit.

602.2.6 Outlet Boxes, Fittings, and Entrance Caps

A) Outlet boxes, fittings, and entrance caps shall comply with current industry standards and be compatible with the conduit material used.

B) Fittings and cement used with PVC and/or HDPE conduit shall be compatible with conduit material.

602.2.7 Acceptance: Conduit may be accepted on the project without testing provided it is visually inspected and all pieces are clearly labeled with the UL label or a type D certification is furnished by the manufacturer.

602.3 CONSTRUCTION METHODS

602.3.1 General: The contractor shall obtain the necessary permits for electrical inspection on all signal and lighting work. Electrical inspections shall include all electrical equipment, enclosures, devices, cables, conductors, and raceways as defined by the NEC. High or low voltage shall be installed, maintained, connected, or removed by a State of Oklahoma licensed Electrical contractor. All work shall meet the requirements of the NEC. City of Tulsa shall reserve the right to define workman like manner. Proof of license shall be carried on person at all times and be available to City of Tulsa personnel upon request per Title 158 – Construction Industries Board Chapter – 40 Subchapter 11-2(a)(9). Contractor shall contact City of Tulsa Traffic Operations to obtain the address needed to obtain the permit.

602.3.2 Location:

A) All conduits shall be installed to fit the existing field conditions. However, if major relocations are necessary that may affect the overall design of the electrical system, the contractor shall receive approval of the Traffic Engineer prior to making the relocations.

B) Conduit runs shall not terminate in corner wheel drag paths.

C) The maximum distance of a conduit run between pull boxes is 180’.

D) Termination of multiple conduit runs shall be installed vertically and clustered toward the center of the pull box. Conduit runs within a pull box shall not cross one another.

602.3.3 Installation:

A) Install conduit in accordance with the NEC. Install direct runs with no less than the minimum size shown on the plans. The use of a larger conduit for the entire length of the run will be allowed, at no additional cost to the City.

B) If conduit is installed on top of slab surface, it shall be anchored or staked every 8’ to prevent rising (floating) during island forming. Conduits shall be installed 1’ from one edge of the island if not centered in island. See Standard Drawing 602 for details.

C) No long radius 90° or 45° bends will be allowed unless specified in the plans.

D) There shall be no more than three 90° bends or 270° total of all the bends in a single run of conduit.

E) All conduits shall have a green #12 THHN electrical conductor installed to be used as a pull wire (wire to be paid for separately).

F) Complete all potentially damaging work before installing conductors or cables in the conduit system.

G) All conductors or cables in a damaged conduit shall be replaced to the next joint of undamaged conduit at contractor's expense. No exceptions shall be made.

H) All 90-degree bends in conduit shall be galvanized rigid steel conduit.

I) All conduit stub ups above concrete foundations and in pull boxes shall be PVC, unless approved otherwise by the Traffic Engineer. Galvanized conduit stub ups, if approved by the Traffic Engineer, shall be properly bonded and grounded via a #4 bare copper wire connected to 5/8” x 8’ minimum copper clad ground rod. A minimum length of 8ft of the ground rod shall be embedded into and in direct contact with soil. Increase the overall length of the ground rod as needed. Ground rods shall have manufacturer’s certification stamps visible, or have the stamp inspected prior to installation, showing the diameter and overall length of the rod. Ground rods shall not be cut or modified.

602.3.4 Termination of Conduit:

A) Termination in Signal Pole or Pedestal Base: Stub base conduits 4" to 6" above finished base for mast arm bases and 2" for pedestal bases. All conduit ends shall be reamed and bushed.

B) Termination in Pull Box: Extend conduit entering pull box sides no more than 2” inside the box wall and slope the conduit toward the top of the box. Conduit entering through the bottom of a pull box shall extend 9” to 12” below the lid and shall be located near the center of the box. All conduit ends shall be reamed and bushed.

C) Connection to Existing Conduit: If incorporating existing underground conduit into a new system, clean with compressed air until clean air is exhausted from the conduit. This shall be an inspected process by traffic inspector.

D) For Future Use: Cap conduit ends not terminating in a junction box or electrical enclosure.

E) General: Cap all conduit ends with standard pipe caps until wiring starts. After removing the caps, install conduit bushings on the threaded ends.

602.3.5 Pushed or Bored Conduit:

A) Bored conduit shall be continuous (no joints) HDPE schedule 40 and shall be extended 2’ from the back of curb or edge of pavement on both ends. "No thread" couplings shall not be used under pavement.

B) Place the conduit under pavement by approved pushing or boring methods. Do not disturb the pavement without permission from the Traffic Engineer. Keep pushing or boring pits at least 2’ clear of the edge of any type of surface area whenever possible.

C) Excessive use of water, such that the pavement might be undermined or the subgrade softened, will not be permitted. If pits are to be left overnight, cover them with substantial planking and mark them in a manner approved by the Traffic Engineer.

D) Unless otherwise shown on the plans, install bored conduit or pushed conduits a minimum depth of 30” below top of ground line.

E) Restoration and repair of right-of-way damage by boring operations shall be included in the price for boring.

F) Damaged bored HDPE conduit shall be re-bored at the contractor's expense; no under pavement repairs shall be made.

602.3.6 Trenched Conduit and Backfilling:

A) Conduit installed in a trench shall be of the type and size specified on the Plans.

B) Excavate trenches deep enough to provide for 30” minimum cover over the conduit, unless otherwise specified. Do not use cinders, broken concrete, or other hard or abrasive materials in backfilling. Also, clear the trench of such materials before the conduit is placed.

C) Excavate immediately before installing conduit, placing the material in a position where there is the least damage and obstruction to vehicular and pedestrian traffic and the least interference with the surface drainage. Be careful not to excavate the trenches wider than necessary for the proper installation of the electrical conduits or cables.

D) Dispose of all surplus excavated material in a manner approved by the Traffic Engineer.

E) When rock is encountered during trenching and the required trench depth cannot be attained the trench depth or location may be altered at the discretion of the Traffic Engineer. The minimum trench depth shall meet NEC minimum requirements.

F) Reconstruct all disturbed surfaced areas, base materials, and sodded areas using replacement materials of equal or better quantity; this is to be done at the expense of the Contractor and to the satisfaction of the Traffic Engineer.

G) Whenever a part of an existing concrete sidewalk or driveway is broken or damaged, remove the entire square or slab unless otherwise specified by the Traffic Engineer, and reconstruct the concrete as specified above.

H) If trenched conduit must cross under existing guardrail it should be between posts and as close to perpendicular to the rail as feasible.

I) Backfill all trenches with acceptable material as soon as possible after installation of conduit; deposit the backfill material in the trench in layers not to exceed 6” in depth and compact to 95% density of the surrounding earth. The first layer shall be free of rocks and debris and compacted, and each successive layer shall be free of rock and debris and compacted before the next layer is placed.

J) Unless otherwise directed by the Traffic Engineer, all trenches excavated across any sidewalk, driveway, parking lot or other paved area, across any traveled portion of unpaved streets or alleys, across any proposed roadways or proposed roadway fills, and as shown on the drawings shall be bedded and backfilled with 1-1/2” Type A Aggregate Base, placed in 8” maximum lifts and compacted to 95% Standard Proctor Density, as measured by the Nuclear Density Method. Compaction shall be done by a vibratory hand tamper. Trenches excavated across existing street or alley paving shall be backfilled in accordance with the City of Tulsa Standard Detail for Pavement Removal and Replacement.

K) Utility marking tape shall be installed 6” below finished grade and conduit shall be blown clear of water and debris after backfilling. Utility marking tape shall be a minimum of 4 mil thickness, 6" wide polyethylene tape; color shall be in accordance with AWPA uniform color code. Tape used to mark underground electrical cable shall be safety red color with printed legend "caution electrical cable buried below" The cost of the tape shall be included in the cost of trenching.

602.3.7 Exposed Conduit:

A) Refer to ODOT Standard Drawing T-302 Typical Conduit Construction Details for exposed conduit installation for installation details.

B) When conduit is to be installed on the surface of structures, poles, or other exposed locations, use rigid metal-type unless otherwise specified.

C) Run surface-mounted conduit straight and true, so that it's horizontal or vertical on the surface of the structure or pole. Support it at intervals of not more than 5’, unless otherwise specified, using galvanized malleable iron conduit clamps and bolts with expansion shield anchor devices approved by the Traffic Engineer.

D) Lag or machine bolt shields and percussion driven anchors in concrete or masonry will not be accepted.

E) When conduit installed on a concrete structure crosses an expansion joint in the structure, install an expansion device of the type and size shown on ODOT Standard Drawing T-302.

F) Use only Approved Products List approved supporting devices for conduit that is attached to structural steel members.

G) Where exposed rigid conduit installed on bridges or other structures transition to an underground trenched installation, only threaded fittings will be permissible until run

of conduit has fully turned horizontal in the trench, no PVC to rigid adaptors or fittings. No thread couplings or connectors shall be used.

602.3.8 Testing:

A) After clearing and backfilling the conduit blow in each conduit run a 1/8" 1,000 lb. test polypropylene string the full length of the conduit. The City Traffic Inspector shall be present during blow in.

B) The polypropylene string shall be blown in with the appropriately sized conduit position, I.E. 2" conduit use 2" piston, 3" conduit use 3" piston, etc.

C) Blowing the string shall be in the direction away from the controller cabinet. This is an inspection point required by Traffic Operations.

D) After clearing and installing string, conduit ends shall be capped with PVC cap or sealed bushings to prevent entry of debris. Duct tape is not an approved method of capping. If capping is removed before cable is installed, contractor shall reprove conduit with inspector present.

E) For conduit not accepted contractor shall replace conduit to the next joint and have the new conduit inspected and wired pulled before it will be accepted.

602.4 METHOD OF MEASUREMENT

Electrical conduit of the size and type specified will be measured by the linear foot along a horizontal plane of the centerline of the installed conduit from end to end, and shall include all fittings, outlets, entrance caps, pull wires, conduits, expansion devices, and other miscellaneous hardware necessary to complete the conduit system. Each size and type of conduit shall constitute a separate pay items, unless otherwise provided. Unless otherwise provided, trenching and backfilling and boring will not be measured for payment.

602.5 BASIS OF PAYMENT

Accepted quantities of electrical conduit, measured as provided above, will be paid for at the contract unit price as follows:

A) 2" PVC Sch 40 Conduit (Trenched)..... LINEAR FOOT

B) 3" PVC Sch 40 Conduit (Trenched)..... LINEAR FOOT

C) 2" HDPE Sch 40 Conduit (Directional Bore)..... LINEAR FOOT

D) 2 – 3" HDPE Sch 40 Conduit (Directional Bore)..... LINEAR FOOT

E) 3" HDPE Sch 40 Conduit (Directional Bore)..... LINEAR FOOT

F) 2 – 3" PVC Sch 40 Conduit (Trenched)..... LINEAR FOOT

G) 1-1/2" Galv. Steel Electrical Conduit (Exposed)..... LINEAR FOOT

H) 2" Galv. Steel Electrical Conduit (Exposed)..... LINEAR FOOT

I) 3" Galv. Steel Electrical Conduit (Exposed)..... LINEAR FOOT

J) 1" PVC Sch 40 Conduit (Trenched)..... LINEAR FOOT

K) 1" HDPE Sch 40 Conduit (Directional Bore)..... LINEAR FOOT

L) 1-1/2" PVC Sch 40 Conduit (Trenched)..... LINEAR FOOT

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals to complete the work as specified.

## PART 603 – SIGNAL POLE FOOTINGS

603.1 DESCRIPTION

603.1.1 This work shall consist of furnishing materials and installing concrete footings for traffic control devices in accordance with these specifications and in reasonably close conformity with the locations and dimensions shown on the Plans or established by the Traffic Engineer.

603.2 MATERIALS

603.2.1 Materials used shall meet the requirements specified in the following City of Tulsa Standards and Specifications, ODOT Standards and Specifications, Section 700-Materials and AASHTO Specifications:

| | |
|---|---|
| Portland Cement Concrete, Class A | ODOT 701 |
| Reinforcing Steel | ODOT 723 |
| Electrical Conduit | COT 602 |
| Anchor Bolts and Nuts | AASHTO M 183 |
| Galvanizing (Bolts, Nuts, & Washers) | AASHTO M 232 |

603.3 CONSTRUCTION METHODS

603.3.1 Footings: Construct concrete footings in accordance with ODOT Section 509 so that they rest on firm ground with the top of the footing level, to minimize the amount of shimming required later. Construct the footings in locations as shown on the Plans and to the grade established by the Traffic Engineer. If an obstruction prevents the construction of a footing at the planned location, construct it at a location approved by the Traffic Engineer prior to drilling. Construction methods or materials designed to extend the length of the base to meet height requirements shall not be accepted. The H-frame and template shall be left in place a minimum of eight hours. Once the H-frame and template are removed the concrete shall be finished with a stone. Footings shall be circular in shape ±1/4” maximum tolerance. Any footing that is not circular will not be accepted, and shall be replaced at the contractor’s expense.

603.3.2 Anchor Bolts: Use anchor bolts of the size and quantity specified in City of Tulsa Standards 603 and 617 a~~nd 618~~. Locate them accurately and securely in the footing by means of a template. Anchor bolts shall be square or centered as called for in the design and plumb. Anchor bolts shall be placed into the concrete base per the design shown in City of Tulsa Standard Drawing 603. Construction methods and hardware designed to extend the manufactured length of the anchor bolts shall not be accepted.

Anchor bolts shall extend out of the base to ensure that the anchor extends the full depth of the base nuts.

NOTE: Do not weld on any portion on the body of the anchor bolt.

603.3.3 Conduits: When conduit must be installed as part of the footing, it shall be of the quantity, size and type shown on the Plans. The conduit required in the footing will be paid for in the cost of other materials in the footing. Conduits installed in poured signal bases shall be plumb ±5 degrees maximum tolerance, and centered ±1/2" maximum tolerance in the base pour. Conduit height above the finished base shall be 4" to 6" for a mast arm pole base and 2" for a pedestal pole base. Stub-outs for pedestal footings shall be 2" conduit.

603.3.4 Ground Rod: Copper clad ground rod is required (Copperweld or approved equal); it shall be of size shown in the Plans. Ground rods installed in poured signal bases shall be plumb in the base pour and far enough away from the conduit that a grounding connector can be installed. A minimum length of 8ft of the ground rod shall be embedded into and in direct contact with soil. Increase the overall length of the ground rod as needed. Ground rods shall have manufacturer's certification stamps visible, or have the stamp inspected prior to installation, showing the diameter and overall length of the rod. Ground rods shall not be cut or modified. Ground rod height above the finished base shall be 4" to 6" for mast arm signal pole bases and 2" for pedestal signal pole bases.

603.3.5 Poles, Posts, or Breakaway Bases:

A) Do not erect poles, posts, or breakaway bases until the foundation reaches 100% of the required 28-day compressive strength and has set at least 72 hours unless they are required to be set directly into the footing. After the footing has been completed, restore the surrounding area to an acceptable appearance.

B) All mast arms installed shall be aligned as shown on the plans or installed parallel or perpendicular to the axis of the intersection. If the mast arm is more than 2° out of alignment due to the placement of the anchors in the base, the base shall be replaced at the contractor's expense.

603.3.6 Bases poured in sidewalk shall have the bottom of the chamfered edge flush with the top of sidewalk grade. Bases poured outside of sidewalks shall not extend any further than ~~4"~~ 5" ±1 ½" above the finished grade of the surrounding area. Bases below finished grade shall not be accepted.

603.3.7 The Traffic Engineer shall inspect the ground rods, conduit, reinforcing steel and proper alignment of anchor bolts for proper placement and approve the installation prior to pouring concrete. At the Traffic Engineer's discretion, concrete testing may be required for pole bases.

603.4 METHOD OF MEASUREMENT

Reinforced concrete footings of various sizes and shapes will be measured by the each. The footing unit shall include concrete, reinforcing steel, anchor bolts, nuts, washers, ground rod, conduit, all labor, tools, equipment, excavation, backfilling, and incidental work necessary to construct the footing as shown on the Plans.

603.5 BASIS OF PAYMENT

Accepted reinforced concrete footings, measured as provided above, will be paid for at the contract unit price as follows:

A) Signal Footing ..... EACH

Such payment shall be full compensation for finishing all materials, equipment, labor, and incidentals to complete the work as specified.

## PART 604 – LOOP DETECTORS

604.1 DESCRIPTION

604.1.1 This work consists of providing and installing a solid-state inductive vehicle loop detector, loops, and lead in wire in accordance with these specifications, the latest NEMA TS-1 or TS-2 Specifications, and as shown on the Plans.

604.2 MATERIALS

604.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Operations Approved Products List.

604.2.2 Detector Loop Wire: The detector loop wire that is embedded in the pavement for the detector loop shall be a single conductor, rated for heavy traffic applications with a nominal outer diameter of .240". Insulation and outer jacket shall be orange in color.

604.2.3 Loop Lead-in Cable: The loop lead in cable shall be two-conductor #16 AWG with a double jacket made of cross link polyethylene and shall include water block gel and moisture resistant binder tape. The conductors shall be twisted eight times per foot and the conductor insulation colors shall be black and white. The inner and outer jacked color shall be orange.

604.2.4 Shelf Mounted Detector: Provide a self-contained, self-tuning, solid state digital detector that automatically compensates for temperature variations and environmental conditions as described in the 2019 ODOT Specification 828.02 (B).

604.2.5 Card Rack Detector Unit: Provide two channel-self tuning, solid state, digital card rack detector units as described in the 2019 ODOT Specification 828.02 (C).

604.2.6 Card Rack Assembly: Provide a card rack, cross wired for two or four channel operations as described in the 2019 ODOT Specification 828.02 (D).

604.2.7 Power Supply: Provide a 24 V (DC) power supply as described in the 2019 ODOT Specification 828.02 (E).

604.2.8 Conduit: Conduit shall be paid for separately and shall meet the requirements of City of Tulsa Specification Drawing 602.

604.2.9 Vehicle Loop Wire Sealant:

A) This section shall govern for furnishing and installing loop wire sealant for use in the installation of vehicle detector loop in asphaltic and concrete pavement as shown on Plans. The sealant shall be a one-part polyurethane material and shall be suitable for use in both asphaltic and concrete pavement. The sealant shall be designed to enable traffic to pass over the filled slot immediately after application without tracking or stringing. The sealant shall not shrink in volume during or after its curing process.

B) The sealant shall have a minimum shelf life to 12 months. The sealant shall have certain physical properties in its uncured and cured states. They are as follows:

1) Uncured (wet) Sealant: The physical properties of the uncured (wet) sealant are as follows:

| Property | Requirement | Standard |
|---|---|---|
| Weight | 717.87 lbs./cy +/-1.0 lb. (1210 kg/cu.m+/-0.45 kg) | ASTM E201 |
| Total Solids by Weight | 75-86% | ASTM D1353<br>18 Hours at 200° F |
| Viscosity | 0.00073-0.0123 psi-s | Brookfield RVF<br>No 6 Spindle at 20 RPM,<br>77° F 50% Rel. Hum. |
| Curing Time | Touch: 24 Hour Max<br>Complete: 36 Hours Max<br>4 mil film, 77°, 50% Rel. Hum. | ASTM D1640 |

2) Cured Sealant: The physical properties of the cured sealant are as follows:

| Property | Requirement | Standard |
|---|---|---|
| Hardness (Indentation) | 65 – 85 | ASTM D2240 Model 1700, 25C<br>50% Relative Humidity. |
| Tensile Strength | 125 psi Minimum | ASTMD412<br>Die C Pulled at 20 IPM |
| Elongation | 200% Minimum | ASTM D412<br>Die C Pulled at 20 IPM |
| Adhesion (Peel Strength) | 15 lb./in width | ASTM D903<br>Canvas to Concrete |
| Application Temp Range | +41° F to 131° F | |
| Service Temp. Range | -40° F to 150° F | |

3) Resistance: The cured sealant shall have the following chemical resistances:

| | | |
|---|---|---|
| Deicing | No Effect | ASTM D471* |
| Gasoline | Slight Swell | ASTM D471* |
| Hydraulic Brake Fluid | No Effect | ASTM D471* |
| Motor Oil | No Effect | ASTM D471* |
| Sodium Chloride (5%) | No Effect | ASTM D471* |
| *The ASTM Test shall be conducted at 70° F to 77° F for a period of 22 hours. | | |

604.3 CONSTRUCTION METHODS

604.3.1 Location: Locate the loop detection system as shown on the plans. Mark the exact location on the roadway with chalk string, spray paint or some suitable and legible marking device that can withstand weather and traffic until such time as the locations have been approved by the Traffic Engineer.

604.3.2 Saw Cuts:

A) Disable old loops when cutting new loops, the existing cuts shall be properly sealed using approved sealant over a long period of time.

B) Contractor will saw the induction loop slot, including corner cuts, to the exact depth as shown on City of Tulsa Traffic Standard Drawing 604. All loop corners shall be cut as shown in the saw cut corner diagram shown on City of Tulsa Traffic Standard Drawing 604.

C) Saw cut shall be made with a blade that is a maximum of 3/8” in width. The minimum width cut shall be 5/16”.

D) Saw cuts that pass-through changes in surfaces (example, asphalt to concrete) or expansion joints shall be drilled with a minimum of 1-1/2” bit and excess loop wire installed to allow loop to move with road surfaces.

E) Clean and dry the slot with compressed air to remove all water and debris before loop wire is installed.

F) Use a blunt wood instrument for placing the wire into the slot so that the insulation is not damaged in any way.

G) The loop detector saw cut shall be sealed with loop wire sealant filled to the top of each saw cut.

604.3.3 Loop Detector Wire Installation:

A) Wind all non-quadrupole loops in a clockwise direction as shown in City of Tulsa Traffic Standard Drawing 604 with four wraps.

B) The beginning end of the loop winding shall be marked with a colored tie wrap, inside the pull box. If there are multiple loops terminating in the pull box, the loop nearest the pull box shall have a red tie wrap on the "beginning end" of the winding, the second loop from the pull box shall have an orange tie wrap, the third loop shall be marked with a green tie wrap and the fourth loop shall have a blue tie wrap.

C) All loop wire shall be one continuous length to the pull box where it shall be connected to the lead-in cable.

D) After the loop has been completed, the two wires extending into the pull box shall be twisted together with five turns per foot. These wires shall extend into the pull box a minimum of 6', with 6" of wire exposed from the ducting.

604.3.4 Connection to Lead-In Wire:

A) Drill or pour in place 1" conduit (to be paid for separately) for each loop detector spaced 2" apart for loop wire. Backfill the conduit with asphaltic joint sealer. See City of Tulsa Standard Drawing 602 for installation details.

B) Place the loop detector lead-in cables in conduit from each loop detector pull box to the traffic signal controller. At each loop detector pull box, splice the loop wire to the loop detector lead-in cable with a waterproof, self-insulating connection using soldered connections and epoxy, or gel cast splice kits as shown on City of Tulsa Standard Drawing 604B.

C) All connections that are made from loop wire to the lead-in cable shall be made only in the pull box. No pull box lid, lips, or sidewalls shall be saw cut to gain access to an existing loop pull box.

D) All loops shall be left disconnected in the pull box for inspection. After inspection, solder the connection with a 60/40 alloy, resin core solder. Take care while soldering not to damage the insulation of the wire and cable.

E) Lead-in cable shall be a continuous run without any splices

F) Lead-in cable shall be installed with a minimum of 4' of slack cable per pull box and 8' of slack at the controller. No damaged or skinned cable will be accepted.

G) When the connection has been completed, place a watertight connector sealing packet over it. After carefully placing the loop wire in the slot and checking the circuitry, seal the slot with a sealer that meets the requirements of this specification.

604.3.5 Color Coding in the Cabinet:

A) Each cable shall be color coded at the cabinet with colored marking tape placed on the end of the jacket at the point where the installation is stripped. This color code designates the cable origin as it relates to the direction of traffic.

1) North Bound Left Turn Loop = Red/White

2) North Bound Through Loop = Red

3) South Bound Left Turn Loop = Orange/White

4) South Bound Through Loop = Orange

5) East Bound Left Turn Loop = Green/White

6) East Bound Through Loop = Green

7) West Bound Left Turn Loop = Blue/White

8) West Bound Through Loop = Blue

604.3.6 Sealant: Unless otherwise shown on the Plans, the Contractor shall apply the sealant using his own equipment. The City reserves the right to perform any or all of the tests described in this specification to ensure compliance. Failure of a sample will require that the loops be removed and replace with new sealant meeting this specification.

604.4 METHOD OF MEASUREMENT

604.4.1 Loop Detector Wire: The loop detector wire will be measured by each loop installed and connected to the loop detector. All items necessary to connect the loop wire to the lead in wire; including all connectors, splices, curb cuts and any incidentals necessary shall be included in the loop detector.

604.4.2 Lead-In Wire: Lead-in wire will be measured by the foot from the splice to the loop wire to the loop detector in the cabinet.

604.4.3 Shelf Mounted Detector Unit: Shelf Mounted Detector Unit shall be paid for by each and shall include all connections and a card rack assembly if necessary.

604.5 BASIS OF PAYMENT

The accepted vehicle loop detector unit and loop detector wire, measured as provided above, will be paid for at the contract unit price as follows:

A) 6’ x 6’ Loop Detector ..... EACH

B) 6’ x 30’ Loop Detector ..... EACH

C) 6’ x 50’ Quadrupole Loop Detector ..... EACH

D) Loop Lead-In Wire ..... LINEAR FOOT

E) Shelf Mounted Detector Unit ..... EACH

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

## PART 606 – PRE-EMPTION AND SIGNAL PRIORITY SYSTEMS

606.1 DESCRIPTION

606.1.1 This item consists of furnishing materials and installing emergency pre-emption and low-level priority systems for traffic signal systems as shown on the Plans.

606.2 MATERIALS

606.2.1 General: The priority control system shall interface with the traffic controller to give emergency vehicles approaching the intersection a green with all other indications being red. The system shall be capable of two priority levels and green sensing. The low-level priority system shall be capable of both green extension and red truncation. It shall log the last 1,000 events with time date stamp. All equipment must be plainly marked as to the manufacturer of the equipment to provide clear identification as to the manufacturer's model and serial number of each unit. NEMA certification, test reports shall be provided upon request by the Traffic Engineer. All equipment in the system shall meet NEMA environmental standards.

606.2.2 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List.

606.2.3 Compatibility: If an alternate brand is requested for consideration, the priority control system shall be completely compatible with the existing system currently being used by the City. It shall include full compatibility of preempt codes and provision of on-card history of 1,000 events.

606.2.4 Cable: Cable shall be GTT #739 or approved equal. All cable shall be color coded per City of Tulsa Specification and Standard 611 direction color tape chart.

606.2.5 Detectors: The manufacturer or manufacturer's representatives shall provide assistance to the contractor or agency installing the equipment as to the best location for the detector placement at each intersection involved in the project. Detector locations shall be approved by the Traffic Engineer. If infrared detectors are used, single detectors shall be provided for each direction of travel at a minimum. Mounting brackets for the detector heads shall be an ASTRO Mini-Brac AB-0163-42-SS or approved equal. All hardware shall be stainless steel.

606.2.6 Emitters: Emitter shall be selectable to transmit up to 9999 vehicle codes.

606.2.7 Phase Selectors: The phase selector shall be a four-channel card capable of interfacing with GPS and infrared emitters with an auxiliary interface panel, adapter cable, and any other equipment necessary to make it operational in the signal cabinet provided at the intersection. The card supplied shall provide for database upload to a laptop computer using the City of Tulsa Traffic Operations Division's existing software.

606.3 CONSTRUCTION METHODS

606.3.1 The pre-emption and signal priority system shall be installed as per manufacturers' recommendations.

606.3.2 No splices shall be allowed in the cable. The cable run from the detector head to the cabinet shall be continuous.

606.4 METHOD OF MEASUREMENT

606.4.1 The cable will be measured by the linear foot installed and connected from the detector to the phase selector. The detector will be measured by the unit, complete in place, including wiring and all hardware. The emitter will be measured by the unit, delivered to the Traffic Operations Division. The phase selector will be measured by the unit, complete in place and operational, including programming.

606.4.2 Contractor installing the pre-emption and signal priority system shall perform a field operation test using a vehicle emitter inspected and approved by the Traffic Engineer prior to conducting the test. Each individual detector shall be tested with City of Tulsa Traffic Operations personnel present to ensure the system and programming are fully functional.

606.5 BASIS OF PAYMENT

The accepted pre-emption and signal priority cable, detectors, emitters, and phase selectors, measured as provided above, will be paid for at the contract unit price as follows:

A) Pre-Emption Cable ..... LINEAR FOOT

B) Infrared Pre-Emption Detector ..... EACH

C) GPS Pre-Emption Detector ..... EACH

D) Infrared Pre-Emption Emitter ..... EACH

E) Pre-Emption Phase Selector ..... EACH

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

## PART 607 – POWER SUPPLIES

607.1 GENERAL

607.1.1 This work shall consist of furnishing materials and installing power supply systems of the various types in accordance with these specifications and in reasonably close conformity with the locations and dimensions shown on the Plans or established by the Traffic Engineer.

607.2 MATERIALS

607.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Operations Approved Products List.

607.2.2 General:

A) Materials used shall meet the requirements specified in the following sections, subsections of ODOT Specifications, and external references.

| Wood Poles | American National Standards Institute 05.1 |
|---|---|
| Electrical Conduit and Fitting | COT Section 602 |
| Portland Cement Concrete, Class A | ODOT Section 701 |
| Reinforcing Steel | ODOT Section 723 |
| Conductors | COT Section 611 |

B) Control equipment shall conform to NEMA Specifications, as applicable.

607.2.3 Conductors:

A) Conductors shall conform to City of Tulsa Specification 611.

B) All conductors shall be copper and properly sized for the load.

C) Number 8 THHN stranded black, white, and Green or UF cable of the same size with ground shall be used to supply power from the power sources to the controller.

D) The primary wiring shall be provided by the local utility company.

607.2.4 Conduit:

A) All conduit, conduit fittings, and electrical work shall conform to the NEC and City of Tulsa Specification and Standard Drawing 602.

B) All conduit clamps shall be galvanized malleable iron and installed according to the NEC.

607.2.5 Circuit Breakers:

A) When a traffic signal system without luminaries is installed a single circuit breaker shall be furnished. When the signal system includes luminaries, two circuit breakers shall be furnished: one for each system.

B) The enclosure for the circuit breaker shall be a NEMA 3R rain tight enclosure; GE compatible 4 circuit 125 amp, installed according to the NEC, metal boxes only.

C) The breakers shall be sized for the load requirements.

607.2.6 Service Poles: Service poles shall be treated full length in accordance with American Wood Preservers Association Specifications, to be at least 7.5 lbs. per cubic foot retention of creosote or .38 pentachlorophenol measured by the empty cell process. Wood poles shall comply with the latest revisions of ANSI Standard 05.1.

607.2.7 All miscellaneous pole line hardware required to complete the installation as planned shall be standard material manufactured for pole line construction. All metal parts shall be hot-dipped galvanized or other non-corrosive metals and shall be in accordance with the power company requirements.

607.2.8 Concrete: Concrete construction shall be in accordance with ODOT Section 509. Reinforcing steel construction shall be in accordance with ODOT Section 511.

607.3 CONSTRUCTION METHODS

General: The construction of power supplies shall be in accordance with NIST Handbook 81 Safety Rules for the Installation and Maintenance of Electric Supply and Communication Lines. When in conflict, these specifications shall supersede. Contact local "excavator alert" organizations prior to trenching or boring operations.

Coordination with American Electric Power (AEP): The contractor shall install the required metering equipment furnished by the local utility company. The service shall be single wire 110 volt and the contractor shall jumper the breaker box accordingly and wire meter can per local utility company requirements. The contractor shall coordinate with the power company to get the connection at the proper time. Contractor shall cooperate with AEP in locating, installing, and connecting all power supplies. Traffic Engineer must also approve locations before installing.

607.3.1 Electrical Inspections and Permitting: The contractor shall obtain the necessary permits for electrical inspection on all signal and lighting work. Electrical inspections shall include all electrical equipment, enclosures, devices, cables, conductors, and raceways as defined by the NEC. High or low voltage shall be installed, maintained, connected, or removed by a State of Oklahoma licensed Electrical contractor. All work shall meet the requirements of the NEC. City of Tulsa shall reserve the right to define workman like manner. Proof of license shall be carried on person at all times and be available to City of Tulsa personnel upon request per Title 158 – Construction Industries Board Chapter – 40 Subchapter 11-2(a)(9). Contractor shall contact City of Tulsa Traffic operations to obtain the address needed to obtain the permit.

607.3.2 Voltage Requirements:

A) All 110-volt electrical connections excluding luminaire connections in the controller cabinet shall be field lug style.

B) The contractor is required to supply a minimum of 110 volts to the signal cabinet under full load of the intersection.

C) The voltage for the permanent or temporary service pole(s) shall be as shown on the Plans.

607.3.3 Pedestal Service:

A) The equipment, construction and installation of the pedestal and service shall be subject to the approval of the City of Tulsa Electrical Inspector and AEP.

B) Traffic Operations Personal shall approve the conduits placement on bases before the pour.

C) The conduit shall be plumbed in two different directions. No offset nipples shall be used.

D) The pedestal service shall be installed on a F1 concrete base, using pad-mount bracket (CHPADEXT or approved equal) and 4-1/2" x 5" stainless steel wedge anchors. See City of Tulsa Standard Drawing 607B.

E) Primary service shall be furnished underground to a service pedestal. The installation shall include two ground rods, meter can, insulators, cables, conduit, service disconnect, weather head, service bracket, circuit breakers, pull box, wires, and all other items necessary to complete the work.

F) Ground Rod: (2) 5/8” x 8’ minimum copper clad ground rods shall be installed for electrical services and shall be included in the price bid for the electrical service. A minimum length of 8ft of the ground rods shall be embedded into and in direct contact with soil. Increase the overall length of the ground rods as needed. Ground rods shall have manufacturer’s certification stamps visible, or have the stamp inspected prior to installation, showing the diameter and overall length of the rods. Ground rods shall not be cut or modified.

607.3.4 Overhead Service to Service Pole:

A) The service pole shall be installed as close to the right-of-way as possible. Location shall be approved by the traffic engineer prior to construction.

B) Primary service shall be furnished to a service pole. The installation shall include two ground rods, meter can, insulators, cables, conduit, service disconnect,

weather head, service bracket, circuit breakers, pull box, wire, and all other items necessary to complete the work.

C) The equipment, construction and installation of the service pole and service shall be subject to the approval of the City of Tulsa Electrical Inspector and AEP. The cost of materials and installation of the service pole, as described above, including any permits or charges for the connection shall be included in the price bid for the service.

D) If the service pole is to be located more than 75’ from the Utility Company's pole a down guy may be required. Contact AEP for their requirements.

E) Ground Rod: (2) 5/8” x 8’ minimum copper clad ground rods shall be installed for electrical services and shall be included in the price bid for the electrical service. A minimum length of 8ft of the ground rods shall be embedded into and in direct contact with soil. Increase the overall length of the ground rods as needed. Ground rods shall have manufacturer’s certification stamps visible, or have the stamp inspected prior to installation, showing the diameter and overall length of the rods. Ground rods shall not be cut or modified.

607.3.5 Overhead Service to Signal Standard:

A) Where electrical service is planned to be mounted on a signal standard the meter and disconnect shall be located on the non-traffic side of the pole and the push buttons shall be installed on a separate pole and base.

B) Weather head shall be mounted above the point of attachment of service drop conductors.

C) Service drop conductors shall have minimum clearance of 18' above final grade and must be mounted above all cable TV and fiber optic lines.

D) Drip loops shall be formed on the individual conductors to prevent the entrance of moisture.

E) Conduits shall be strapped to the pole at intervals not to exceed 4'-0".

607.4 METHOD OF MEASUREMENT

Power Supplies of the various types will be measured by each unit installed, including any permits or charges for the connection shall be included in the price bid for the service as shown on City of Tulsa Standard Drawing 607A or B depending on what type of service is installed.

607.5 BASIS OF PAYMENT

607.5.1 The accepted power supply items, measured as provided above, will be paid for at the contract unit price as follows:

A) Pedestal Service Installation ..... EACH

B) Service to Signal Standard ..... EACH

C) Portland Cement Concrete, Class A ..... SEE SECTION 701

D) Overhead Service to Service Pole ..... EACH

Such payment shall be full compensation for furnishing all material, equipment, labor, and incidentals required to complete the work as specified.

## PART 608 – TRAFFIC SIGNS

608.1 GENERAL

608.1.1 This work shall consist of furnishing materials and installing traffic signs in accordance with these specifications and in reasonably close conformity with the location and dimensions shown on the Standards, Plans, or established by the Engineer.

608.1.2 Signs shall be designed in accordance with the 11th Edition of the Manual on Uniform Traffic Control Devices (MUTCD), December 2023 with revisions.

608.1.3 Street name sign proofs shall be submitted to the Traffic Engineer for review and approval prior to fabrication.

608.2 MATERIALS

608.2.1 General: Signs shall be composed of aluminum metal sheeting overlaid with cut-out film and a reflective sheeting material. Mounting shall be with posts, hardware and brackets as specified.

608.2.2 Sheet Aluminum: Provide 0.080-ga sheet aluminum signs in accordance with ASTM B209, alloy 6061-T6 or alloy 5052-H38 with mill finish. Use the dimensions, filleted corners, and hole, filleted corners, and hole sizes and locations as shown on the sign standards, with the following exceptions: All holes shall be 3/8” diameter, and all corner radiuses shall be 1 1/2". Ensure panels are flat and straight within commercial tolerances. Treat sheet aluminum signs with a chromate type chemical conversion coating in accordance with ASTM B449, Class II.

608.2.3 Reflective Sheeting:

A) Post-Mounted Signs: Sheeting shall be High Intensity Prismatic meeting ASTM D4956 Type III / IV (3M 3930 or approved equal).

B) Mast-Arm Mounted Signs: Sheeting shall be Diamond Grade meeting ASTM D4956 Type XI (3M DG3 or approved equal).

C) All sheeting shall have a Class I adhesive backing.

608.2.4 Overlay: Electronic cuttable sign film designed for use with electronic sign plotters (3M ElectroCut Series 1170 Film or approved equal).

608.2.5 Mounting Hardware: Bolts, nuts, washers, brackets, and all other hardware needed for mounting shall be suitable for long-term outdoor use:

A) Bolts: 5/16” x 3”, hex head

B) Nuts: Flanged, self-locking, size as needed

C) Washers: 3/4" O.D., maximum

D) Brackets: For mast-arm mounting, use a prefabricated mounting system (Pelco Structural Astro-Bracket® or approved equal). See City of Tulsa Standard Drawing 616.

608.2.6 Posts: Signposts shall be perforated square tube (Telespar® or approved equal). Signs shall be composed of new hot-rolled carbon sheet steel, structural quality, ASTM A1101. Provide a finish that is in-line, hot-dip galvanized zinc coating in accordance with AASHTO M 120, followed by a chromate conversion coating, and a clear organic exterior coating. Provide posts with 1/2" (± 1/16”) diameter holes spaced 1” on center along the center of each of the four sides.

608.3 CONSTRUCTION METHODS

608.3.1 General: Construction methods shall involve fabrication and mounting of the sign to the appropriate type mount.

608.4 METHOD OF MEASUREMENT

608.4.1 Signs of the size and type specified will be measured by the square foot of area of the vertical front face with no deduction for rounded corners or bolt holes.

608.4.2 Posts of the size specified will be measured by the linear foot between the ends of the installed post.

608.5 BASIS OF PAYMENT

608.5.1 Accepted signs, measured as provided above, will be paid for at the contract unit price as follows:

608.5.2 Signs:

Ground Sign ..... SQUARE FOOT
Overhead Sign ..... SQUARE FOOT

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals required to complete the work as specified.

608.5.3 Posts:

1-1/2” Signpost ..... LINEAR FOOT
1-3/4” Signpost ..... LINEAR FOOT
2” Signpost ..... LINEAR FOOT

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals required to complete the work as specified.

## PART 610 – TRAFFIC SIGNAL CONTROLLER CABINET ASSEMBLY

### 610.1 GENERAL REQUIREMENTS

610.1.1 Description: This specification describes the minimum acceptable requirements for a fully actuated traffic controller assembly with the options specified on the Plans. The controller cabinet assembly shall include the ground rod, conduit with bushings, aluminum base, base anchor bolts, caulking, cabinet, a solid state fully-actuated controller unit, switch packs, flasher, conflict monitor, detectors, all auxiliary equipment required to control the system and pertinent documentation. The controller assembly shall meet the latest, applicable requirements of Caltrans Transportation Electrical Equipment Specifications and Standards unless otherwise directed in these specifications or in the project plans.

610.1.2 Serial Numbers: Each individual piece of equipment including the cabinet unit shall have a unique serial number that is permanently and neatly displayed on the unit. A printed list of all serial numbers for the equipment provided for the controller cabinet assembly shall be provided by the contractor or supplier.

### 610.2 MATERIAL REQUIREMENTS

610.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List.

610.2.2 332 Cabinets: The 332 controller cabinets shall be base mount. The location and orientation of the cabinet shall be approved by the Traffic Engineer prior to installation. 332 Cabinet shall meet the Caltrans Specification with noted exceptions:

A) The Control Cabinet shall come with a Hesco/RLS HE1750 TEES AC Suppressor or approved equal. This unit carries the full intersection load; the Suppressor shall have a 30 amp circuit breaker between the HE1750 TEES and the public utility service to provide the ability to disconnect the Control Cabinet from the power source; mount near the HE1750 TEES for access.

B) The Control Cabinet shall come with three Pedestrian Isolator Model 242 cards or approved equal.

C) The controller in control cabinet shall have communications to Centracs.

D) Six Position Output File – The Output file shall have MOV’s. The Odd Phase Reds and Ped Walks and Don’t Walks shall have snubbers attached to the switch packs output to prevent going to flash for an odd phase Red, Walk or Don’t Walk out. The Snubbers shall be “General Electric” GE 42L1151 capacitor, or approved equal, rated at 1.5 microfarads at ±5% tolerance and 850 VDC rated and high current or equivalent.

E) The outside of cabinet exterior shall be anodized aluminum or gray powder coat.

F) The interior shall be powder coated white.

G) The Control Cabinet shall not have a Police panel.

H) The Control Cabinet shall come with 18 switch packs.

I) The Control Cabinet shall come with 8 flash transfer relays.

J) The Control Cabinet shall come with 4 flashers.

K) The Control Cabinet shall come with auxiliary output file for six overlaps.

L) The Control Cabinet shall come with an 18” high adapter base for mounting.

M) The Control Cabinet shall come with a 206L power supply.

N) The Control Cabinet shall come with a flip-down drawer mounted directly on the front door, at a height of no higher than 5’ above the concrete pad. A 9” x 14” heavy duty, all-weather, heat resistant, protective, transparent sleeve with a zipper shall be included to protect the field charts and timing card. Note, all 332 controller cabinets are mounted on an 18” base.

O) The Control Cabinet guard shall not be more than 36” above the pad to ensure that the door of a UPS mounted on the cabinet will open properly.

P) The Control Cabinet shall come with a duplex outlet with GFCI protection mounted to front power supply. A GFCI protection duplex outlet shall also be provided on the back, in addition to the duplex outlet that powers the controller.

Q) Yellow / Red or all Red may be programmed through the use of Flash Plugs. Both red and yellow flash plugs shall be provided.

R) Cabinet shall have two LED Cabinet Light Fixtures mounted in top of the cabinet, one at the front and the other at the rear, and also two LED cabinet light fixtures minimum, mounted on the vertical rails at the terminal side of the cabinet. The mounting hardware shall not penetrate the exterior of the cabinet shell. The light fixtures shall not interfere with access to any cabinet component or terminal blocks. The light fixtures power shall be switched “ON” when any cabinet door is opened.

S) Cabinet shall come with two Thermostatic Control 100 CFM Fans and 12 x 16 Air Intake in one door with one filter.

T) Operating voltage ranges shall be between 90V and 135V.

U) The input terminal blocks shall be mounted at the rear rack and will require SRA 6-LCB Surrestors or approved equal

V) Type 332 Test Switch – The Control Cabinet shall have all input detection device outputs pass through a 3-position switch to allow for isolation of device output to controller. The 3-position switch shall have (a) “Momentary”, down position, (b) “On”, up position, (c) “Off”, center position. The switch shall be placed in the mount with the top terminal as number 1. With the switch toggle in the “UP” position, this will be “On”.

1) The input file switches shall be set up in the following manner:

a) Switch 1 terminal 3 to I6-W,

b) Switch 2 terminal 3 to I7-F,

c) Switch 3 terminal 3 to I3-W,

d) Switch 4 terminal 3 to I2-F,

e) Switch 5 terminal 3 to I7-W,

f) Switch 6 terminal 3 to I6-F,

g) Switch 7 terminal 3 to I2-W,

h) Switch 8 terminal 3 to I3-F,

i) Switch 9 terminal 3 to I12-F,

j) Switch 10 terminal 3 to I12-W,

k) Switch 11 terminal 3 to I13-F,

l) Switch 12 terminal 3 to I13-W.

2) This allows for manipulating the output of all the input devices. The Input switches shall be mounted at the top of rack above the controller for easy access while being able to view the controller display.

3) Switches:

a) The switches shall be wired as follows: The center terminal of the switch shall be wired to the C1 cable, Switch 1 terminal 2 to C1-45, Switch 2 terminal 2 toC1-65, Switch 3 terminal 2 to C1-76, Switch 4 terminal 2 to C1-39, Switch 5 terminal 2 to C1-78, Switch 6 terminal 2 to C1-41, Switch 7 terminal 2 to C1-43, Switch 8 terminal 2 to C1-63, Switch 9 terminal 2 to C1-67, Switch 10 terminal 2 to C1-69, Switch 11 terminal 2 to C1-68, Switch 12 terminal 2 to C1-70.

b) The switch terminal number 1 for momentary operation shall be wired to Logic Ground on all 12 switches.

c) The wire bundle shall be long enough to allow for maintenance of the switch panel for switch replacement if necessary. There must be a terminal block on the back side for manipulation of C-1 controller inputs. Terminal block shall contain one additional terminal connector for Logic Ground to be tapped.

W) Cabinet Base, Pad, and Apron:

1) All hardware shall be stainless steel.

2) Controller cabinet adapter base to concrete pad hardware shall consist of:

a) Quantity four of 3/4” x 5-1/2" Stainless Steel Wedge Anchors,

b) Quantity four of 2-1/2” O.D. x 1-1/16” Stainless Steel Flat Washers,

c) Quantity four of 1-7/8” O.D. x 3/4” Stainless Steel Flat Washers,

d) Quantity four of 3/4” Stainless Steel Lock Washers,

e) Quantity four of 3/4” Stainless Steel Hex Nuts.

3) Controller cabinet adapter base shall be secured to controller cabinet using the hardware provided by the signal cabinet manufacturer with the base.

X) Cabinet Door Lock: The controller cabinet doors shall be equipped with a CL-TC1 Gen 2 Cyberlock cylinder and either A15481RS CCL Traffic Cabinet Lock RH, or A15481LS CCL Traffic Cabinet Lock LH. The contractor will be required to purchase a Cyberkey Blue 3, or they can use one that has been previously purchased. The cyberkey shall be programmed by the Traffic Signal Maintenance Supervisor at the Traffic Operations facility located at 4015 N Harvard Ave, Tulsa, OK for the specific individual projects.

610.2.3 336S Cabinets: The 336S controller cabinets shall be base mount. The location and orientation of the cabinet shall be approved by the Traffic Engineer prior to installation. 336S Cabinet shall meet the Caltrans Specification with noted exceptions:

A) The 336S cabinet shall come with a 337 rack.

B) The Control Cabinet shall come with a Hesco/RLS HE1750 TEES AC Suppressor or approved equal. This unit carries the full intersection load; the Suppressor shall have a 30 amp circuit breaker between the HE1750 TEES and the public utility service to provide the ability to disconnect the Control Cabinet from the power source; mount near the HE1750 TEES for access.

C) The Control Cabinet shall come with three Pedestrian Isolator Model 242 cards.

D) The input terminal block shall be mounted on the rear of rack and will require SRA 6-LCB Surrestors or approved equal.

E) Six Position Output File – The Output file shall have MOV's. The Odd Phase Reds and Ped Walks and Don't Walks shall have snubbers attached to the switch pack output to prevent going to flash for a Red, Walk or Don't Walk out. The Snubbers shall be "General Electric" GE 42L1151 capacitor, or approved equal, rated at 1.5 microfarads at plus or minus 5% tolerance and 850 VDC rated and high current or equivalent.

F) Cabinet shall be anodized aluminum or gray powder coat on the outside.

G) Interior of Cabinet shall be powder coated white.

H) Cabinet shall not have a Police Panel.

I) The Control Cabinet shall come with six switch packs.

J) The Control Cabinet shall come with six Flash Transfer Relays.

K) The Control Cabinet shall come with two Flashers.

L) Cabinet shall come with an 18" high adaptor base for 336S.

M) One power distribution assembly.

N) The Control Cabinet shall come with a pull-out drawer mounted directly below the Controller. Top drawer shall be 29.5" above bottom of Cabinet.

O) The Control Cabinet shall come with a duplex outlet with GFCI protection.

P) Yellow / Red or all Red may be programmed through the use of Flash Plugs. Both red and yellow flash plugs shall be provided.

Q) Cabinet shall have two LED Cabinet Light Fixtures mounted in top of the cabinet, one at the front and the other at the rear. The mounting hardware shall not penetrate the exterior of the cabinet shell. The light fixtures shall not interfere with access to any cabinet component or terminal blocks. The light fixtures power shall be switched "ON" when any cabinet door is opened.

R) Cabinet shall come with Thermostatic Control 100 CFM Fan and 6 x 16 Air Intake in each Door with two filters.

S) Operating voltage ranges shall be between 90V and 135V.

T) TYPE 336S Test Switch – The Control Cabinet shall have all input detection device outputs pass through a 3-position switch to allow for isolation of device output to controller. The 3-position switch shall have: (a) “Momentary”, down position, (b) “On”, up position, (c) “Off”, center position. The switch shall be placed in the mount with the top terminal as Number 1 this will be the “On” position. The Input switches shall be mounted at the top of rack above the controller for easy access while being able to view the controller display and allows for manipulating the output of all the input devices. The wire bundle shall be long enough to allow for maintenance of the switch panel for switch replacement if necessary.

U) Wiring:

1) All cable and wiring shall meet the requirements of City of Tulsa Specification 611.

2) The Input file switches shall be set up in the following manner:

a) Switch terminal 1 shall be wired to Logic Ground on all six switches.

3) The switch terminal 2 shall be wired in the following manner:

a) Switch 1 terminal 2 to I1-S,

b) Switch 2 terminal 2 to I2-S,

c) Switch 3 terminal 2 to I3-S,

d) Switch 4 terminal 2 to I4-S,

e) Switch 5 terminal 2 to I9-S,

f) Switch 6 terminal 2 to I10-S.

4) The switch terminal 3 shall be wired in the following manner:

a) Switch 1 terminal 3 to I1-F,

b) Switch 2 terminal 3 to I2-F,

c) Switch 3 terminal 3 to I3-F,

d) Switch 4 terminal 3 to I4-F,

e) Switch 5 terminal 3 to I10-F,

f) Switch 6 terminal 3 to I10-W.

V) Cabinet Base, Pad, and Apron:

1) All hardware shall be stainless steel.

2) Controller cabinet adapter base to concrete pad hardware shall consist of:

   a) Quantity four of 3/4” x 5-1/2" Stainless Steel Wedge Anchors,

   b) Quantity four of 2-1/2” O.D. x 1-1/16” Stainless Steel Flat Washers,

   c) Quantity four of 1-7/8” O.D. x 3/4” Stainless Steel Flat Washers,

   d) Quantity four of 3/4” Stainless Steel Lock Washers,

   e) Quantity four of 3/4” Stainless Steel Hex Nuts.

3) Controller cabinet adapter base shall be secured to controller cabinet using the hardware provided by the signal cabinet manufacturer with the base.

W) Cabinet Door Lock: The controller cabinet doors shall be equipped with a CL-TC1 Gen 2 Cyberlock cylinder and either A15481RS CCL Traffic Cabinet Lock RH, or A15481LS CCL Traffic Cabinet Lock LH. The contractor will be required to purchase a Cyberkey Blue 3, or they can use one that has been previously purchased. The cyberkey shall be programmed by the Traffic Signal Maintenance Supervisor at the Traffic Operations facility located at 4015 N Harvard Ave, Tulsa, OK for the specific individual projects.

610.2.4 Controller Units shall be Econolite ATC Cobalt Controllers and shall meet the Caltrans Specification with noted exceptions:

A) The Econolite ATC Cobalt controller shall come with the latest EOS version of the software, or approved equivalent, that is capable of interfacing with the central software in use by the City of Tulsa.

610.2.5 Conflict Monitors and Auxiliary Equipment. Conflict Monitor and Auxiliary Equipment shall meet the Caltrans Specification. Cabinet shall be wired for an EDI 2018 E-Clip with extended features or approved equal. Printed Circuit board shall have sockets for the Integrated Circuits.

610.2.6 Cables and Wiring in Signal Cabinets. All cable and wiring shall meet the requirements of City of Tulsa Specification 611.

610.2.7 Modifications: Any requests to modify the requirements for the equipment listed in this specification must be submitted in writing to the Traffic Engineer. Modifications to the models listed, new models not listed and other equipment or technologies not discussed in this specification will be approved on a case by case basis for each project, unless the equipment is added to the Approved Products List.

610.3 CONSTRUCTION METHODS

610.3.1 Cabinets:

A) General Cabling Requirements (see Standard Drawing 610C for more information on these wiring requirements).

1) Cable jacket shall extend no more than 1/2" above the bottom of the auxiliary file.

2) Drill 1/4" holes in the bottom of the cabinet lip and the bottom of the rack support and secure cables with cable ties.

3) Within 1” of end of the wire insulation individual wires shall be color coded per corner tape chart. (See City of Tulsa Standard 611)

4) Only one neutral conductor shall be terminated per AC- buss connection point.

5) A minimum of 8” of insulated conductors shall be exposed for termination. The UF ground must be insulated from the cabinet rack.

6) Conductors shall be stripped, twisted, and insulated with the appropriately sized wire nut.

7) Bundle all wires or cables with tie wraps and clip off the excess tie (example locations are shown on Standard Drawing 610C).

8) Follow the following procedure for installing all tape on jackets: Begin tape installation on jacket, tape forward 1/2" past end of jacket then reverse direction and tape 1-1/4” of cable jacket reverse and end where it started.

9) All individual, conductor wiring shall follow the same uniform path. If conductors are cut short, no splices shall be allowed, re-stripping of extra cable is required.

10) All cable jackets shall extend a minimum of 1” above the bottom of the cabinet rack.

11) Cable fastened to the rack shall not hinder the lowering of the back panels.

B) Specific Cabling Requirements:

1) 20#14 IMSA 20-1 signal cable shall be stacked and color coded per corner tape chart. (See City of Tulsa Standard 611)

2) A 2” I.D. wire loop shall be installed in #8 Blk AC+ and the #8 Wht AC- and the #8 Green Ground power wires.

3) 7#14 IMSA 20-1 push button cables shall be stacked and color coded per corner tape chart (See City of Tulsa Standard 611). Spare wires shall be secured with tie wraps to cable jacket and not cut off.

4) 5 – UF 2#12 with ground street light cables shall be stacked and secured to rack with tie wraps, a minimum of 6" of cable. Jacket shall extend above the bottom of the rack. Cable shall be taped yellow then also taped and color coded per corner tape chart. (See City of Tulsa Standard 611)

5) Green #12 pull wires shall be bow tied and stored next to the conduit they originate from.

6) Install jumper to tie Ped isolator returns together.

7) Cabinet install shall include 12' of 20#14, 7#14, PWR, and street light cable, do not cut extra off.

8) All cabling for vehicle heads, pedestrian heads and push buttons shall be a solid conductor wire. And all connections in cabinets shall be connected with Cat #Ideal 87.002 MD#LA-6A Alscu lug.

C) Spares: 20#14 cable spares shall be left full length and run straight up the right side of the output file and secured with cable ties. Cable spares shall be secured every 6" with tie wraps. Cable spares and cables shall be color coded per corner tape chart. (See City of Tulsa Standard 611). Spare wires in cables shall not be wrapped around cable jackets, they shall be left full length and stored neatly, and marked with proper corner coding tape.

D) All cable shall be neatly sorted and organized in a workman like manner before cabinet wiring begins, like cables shall occupy the same path to their termination point. The cables and conductors shall be arranged so that the base conduits shall be, visibly and physically, readily accessible. Excellent craftsmanship is required to complete cabinet wiring, City of Tulsa reserves the right to define Excellent Craftsmanship, examples will be provided upon request.

E) Cabinet and base shall be fully cleaned and vacuumed upon completion of wiring cabinet.

610.3.2 Cabinet Base, Concrete Pad, and Concrete Apron:

A) The concrete portions of the cabinet base, the concrete pad, the cabinet guard and the apron shall be paid for separately from the traffic signal controller assembly and shall meet the requirements of City of Tulsa Specification 612 for Cabinet Bases, Aprons, and Guards. All other parts of the cabinet base shall be provided for as required in this specification.

B) Traffic Operations shall inspect for proper placement and alignment of the controller cabinet adapter base, concrete pad, ground rod, and conduit prior to pouring of the concrete.

C) 3” conduits and ground rod in cabinet base shall not exceed 3” in height.

D) Conduit in cabinet base shall be bushed on the ends. The bushed edge of all conduits shall be stubbed up level.

E) Ground rod shall be 5/8” x 8’ minimum copper clad. A minimum length of 8ft of the ground rod shall be embedded into and in direct contact with soil. Increase the overall length of the ground rod as needed. Ground rods shall have manufacturer’s certification stamps visible, or have the stamp inspected prior to installation, showing the diameter and overall length of the rod. Ground rods shall not be cut or modified.

F) The joint between the controller cabinet and the adapter base and the joint between the adapter base and the concrete pad shall be caulked with Dow Corning 795 Silicone Building Sealant with Limestone Color or approved equal. It shall have a minimum of a 1/4" bead or, if it is more than a 1/4" bead, it shall be worked with a caulking tool.

G) Aluminum bases shall not be modified in any way except drilling of anchor bolt holes.

H) The concrete controller base shall be installed level and plumb with the controller cabinet adapter base and the cabinet door shall open and close without lifting or forcing the door.

I) The cabinet shall be free of dust and debris prior to acceptance.

J) The cabinet and cabinet guard shall be oriented and positioned to leave adequate space to access the cabinet and have good visibility of the signal.

K) The space between the energized terminal block and the cabinet guard and/or any other grounded part shall be a minimum of 36”. The cabinet door shall be capable of opening at least 90 degrees and shall be a minimum width of 30”.

610.3.3 Cabinet Inspections:

A) Signal cabinets shall be set up and wired by the manufacturer or contractor to meet or exceed these specifications and Traffic Operations Division Standard Practices then delivered by the contractor to the City of Tulsa Traffic Operations Division prior to installation for inspection and approval of all equipment and cabinet wiring.

B) If deficiencies are found, the Traffic Engineer or designee shall inform the contractor and provide a list of the deficiencies that must be corrected prior to approval.

C) The cabinet will be picked up from the Traffic Operations Division by the contractor to correct the deficiencies, and then the cabinet shall be delivered by the contractor to the Traffic Operations Division again for re-inspection and approval after the corrections are made.

D) The contractor will be responsible for picking up the cabinet from the Traffic Operations Division for final installation in the field after it is approved.

E) Traffic Signal Controller Cabinet Assemblies must meet the requirements of this specification and of the Standard Practices for Cabinet Preparation and Installation. Contact the Traffic Operations Division for a copy of the written Traffic Operations Division Standard Practices for Cabinet Preparation and Installation.

## 610.4 METHOD OF MEASUREMENT

610.4.1 Each traffic signal controller cabinet assembly shall include the installation of the ground rod, conduit with bushing, cabinet base, cabinet, detectors, surge suppressor, traffic signal controller unit with auxiliary equipment, and any other appurtenances necessary to make the signal cabinet operational in the field. The signal cabinet controller assembly will be measured by the unit, operational and complete in place.

## 610.5 BASIS OF PAYMENT

Traffic signal controller cabinet assemblies, measured as provided above, will be paid for at the contract unit price as follows:

A) Traffic Signal Controller Cabinet Assembly ..... EACH

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals necessary to complete the work as specified. Specifics of which controller cabinet and which signal controller units shall be supplied will be detailed in the project plans or prior to ordering.

## PART 611 – ELECTRICAL CONDUCTORS TRAFFIC SIGNAL

611.1 DESCRIPTION

611.1.1 This item consists of furnishing materials and installing electrical conductors for traffic signal systems as shown on the Plans.

611.2 MATERIALS

611.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Operations Approved Products List.

611.2.2 Traffic and signal electrical cable shall comply with the requirements of the International Municipal Signal Association (IMSA) Specification Number 20-1. Traffic and signal electrical cable shall be measured using the American Wire Gage (AWG) system, solid core with the exceptions of Number 8 and larger diameters.

611.2.3 Cable used for the downtown traffic signal communications interconnect system shall be industrial grade, shielded 24 AWG gel filled, twisted-pair cable, rated for outdoor use with either 6-pairs, 12-pairs, or 24-pairs, unless otherwise specified in the project plans. Ethernet cable used for wireless signal communications shall be industrial grade shielded CAT 6, rated for outdoor use, unless otherwise specified in the project plans. Shielding shall be riser rated, polyolefin insulation shield bonded to an oil resistant and sun resistant PVC jacket.

611.3 CONSTRUCTION METHODS

611.3.1 General:

A) The installation of all electrical cables and conductors must conform to the National Electric Code. This code represents the minimum required standard. City of Tulsa or Plan requirements may exceed those of the code.

B) The contractor shall obtain the necessary permits for electrical inspection on all signal and lighting work. Electrical inspections shall include all electrical equipment, enclosures, devices, cables, conductors, and raceways as defined by the NEC. High or low voltage shall be installed, maintained, connected, or removed by a State of Oklahoma licensed Electrical contractor. All work shall meet the requirements of the NEC. City of Tulsa shall reserve the right to define workman like manner. Proof of license shall be carried on person at all times and be available to City of Tulsa personnel upon request per Title 158 – Construction Industries Board Chapter – 40 Subchapter 11-2(a)(9). Contractor shall contact City of Tulsa Traffic operations to obtain the address needed to obtain the permit.

C) Avoid damaging the conductor and the insulation during installation. Replace damaged conductors at no additional cost to the City.

D) Complete the conduit system before installing the conductors. Provide slack in each conductor at the pole bases, pull boxes, and cabinets.

611.3.2 Installation:

A) Install traffic signal electrical conductor from the heads on each traffic signal pole to the traffic signal controller. Place the electrical cable from the traffic signal pole to the controller in conduit. Furnish electrical cable and at least one spare as shown on the Plans.

B) Complete the conduit system before installing the conductors. Provide slack in each conductor at the pole bases, pull-boxes, and cabinets, as approved by the Traffic Engineer.

C) Cable shall be installed to limit sun exposure.

611.3.3 Splices:

A) The City will only allow splices in the traffic signal conductors at the pole bases, terminal block, or controller cabinet. Any splices shall be above ground in the signal standard base, no splices will be allowed in the pull-box.

B) Cables coming from signal heads shall be continuous (without splices) to the base connection.

C) All cable runs from pole bases to controller shall be continuous with a minimum of 4' slack of cable per pull-box and 12’ of extra cable at the controller.

D) Cable jacket shall not be removed more than 6” at signal head connection and 6” at base splices.

E) Vehicle and pedestrian neutrals shall remain separate.

611.3.4 Bonding: There shall be #6 green THHN stranded copper connected to the bonding point of each traffic signal standard or pedestal and the service disconnect ground buss. See City of Tulsa Specification and Standard Drawing 618 for more information.

611.3.5 Color Coding and Wire Wrapping:

A) Each conductor shall be color coded with colored marking tape placed on the end of the jacket at the point where the installation is stripped. This color code designates the corner of cable origin or direction of traffic. For all signal and pedestal poles:

1) North East corner = Red

2) South West corner = Orange

3) South East corner = Green

4) North West corner = Blue

5) Luminaire = Yellow

6) Island or Interconnect (Special) = Purple

B) Each conductor shall be wrapped with white or gray tape at the base of the traffic signal standard as shown in City of Tulsa Standard 611 and stated below:

a) Far End Signal Head = 3 wraps

b) Center Signal Head = 2 wraps

c) Far Right (Curb End) Signal Head = 1 wrap

d) North bound and South bound pedestrian push buttons = 1 wrap

e) North bound and South bound pedestrian signal heads = 1 wrap

f) East bound and West bound pedestrian push buttons = 2 wraps

g) East bound and West bound pedestrian signal heads = 2 wraps

h) For Downtown Signals:

a) East/West Vehicle Head = 2 wraps

b) East/West Pedestrian Head = 2 wraps

c) North/South Vehicle Head = 1 wrap

d) North/South Pedestrian Heads = 1 wrap

C) All electrical connections shall be made in standard base by twisting wires and using appropriately sized wire nuts. All splices shall be placed with wire nuts in an upright vertical position. This splice shall extend 3’ ±6” out of the hand hole. Strip the outside sheathing back 6" and each conductor 1". All splices shall be taped up before stuffing into base (the wire nuts shall remain un-taped).

611.3.6 Luminaires: All luminaire electrical conductors from the controller to each traffic signal pole shall be separate runs of 2/c #12 UF with ground. Conductor ran between luminaire arm and pole base fuse holder shall be identified with yellow tape. Leave 26” of 2 conductor #14 in base.

611.3.7 Communications: Extreme caution shall be used when working with communications cable to prevent bending or crimping the cable.

611.4 METHOD OF MEASUREMENT

611.4.1 The electrical conductors will be measured by the foot for each of the various types specified and installed, and shall include all connectors, splices, and incidentals necessary to complete the traffic signal system as provided on the Plans.

611.5 BASIS OF PAYMENT

The accepted electrical conductors, measured as provided above, will be paid for at the contracted unit price as follows:

A) 4#14 Traffic Signal Electrical Cable ..... LINEAR FOOT

B) 5#14 Traffic Signal Electrical Cable ..... LINEAR FOOT

C) 20#14 Traffic Signal Electrical Cable ..... LINEAR FOOT

D) White #10 THHN Electrical Conductor ..... LINEAR FOOT

E) White #12 THHN Electrical Conductor ..... LINEAR FOOT

F) Green #12 THHN Electrical Conductor ..... LINEAR FOOT

G) 2#12 UF Electrical Conductor with Ground ..... LINEAR FOOT

H) 7#14 Traffic Signal Electrical Cable ..... LINEAR FOOT

I) 10#14 Traffic Signal Electrical Cable ..... LINEAR FOOT

J) 22 AWG Filled BJFA, BJFC, PE-39, 6-Pair ..... LINEAR FOOT

K) 24 AWG Filled BJFA, BJFC, PE-39, 6-Pair ..... LINEAR FOOT

L) 2 #14 Shielded Electrical Conductor ..... LINEAR FOOT

M) Green #6 THHN Electrical Conductor ..... LINEAR FOOT

N) 24 AWG Filled, BJFA, BJFC, PE-39, 6-Pair ..... LINEAR FOOT

O) 24 AWG Filled, BJFA, BJFC, PE-39, 12-Pair ..... LINEAR FOOT

P) 24 AWG Filled, BJFA, BJFC, PE-39, 24-Pair ..... LINEAR FOOT

Q) CAT 6 Ethernet Cable ..... LINEAR FOOT

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

## PART 612 – CABINET BASES, APRONS, AND GUARDS

612.1 GENERAL

612.1.1 This work consists of furnishing materials and installing the concrete pad, the cabinet guard, the concrete portions of the cabinet base, and the apron for a traffic controller cabinet in accordance with these specifications and in reasonably close conformity with the location and dimensions shown on the Plans or established by the Traffic Engineer.

612.2 MATERIALS

612.2.1 All concrete to be Class “A” with light broom finish.

612.2.2 The cabinet guard shall be constructed using 4” Schedule 80 steel tubing.

612.2.3 The cabinet guard footings shall be fully encased in Class “A” concrete.

612.2.4 The completed cabinet guard shall be painted with two coats of “Bronze” Rustoleum exterior paint or approved equal. Concrete splatter or over-pour shall be removed from the guard prior to painting.

612.3 CONSTRUCTION METHODS

612.3.1 Shop drawings shall be submitted prior to installation of cabinet guard if cabinet guard does not meet the standard dimensions exactly.

612.3.2 The Control Cabinet guard shall not be more than 36” above the pad to ensure that the door of a UPS mounted on the cabinet will open properly.

612.3.3 Prior to painting, the upright tubing shall be filled with concrete and the ¼” steel caps shall be welded into place.

612.3.4 The tolerance of the cabinet guard shall be 1/4” measured from the diagonal. Horizontal numbers shall be plumb and level. The guard shall be centered on the controller cabinet base. The cabinet guard shall not be more than 36” above the top of the concrete pad to ensure that the door of a UPS mounted on the cabinet will open properly.

612.3.5 The location of the cabinet base, apron, controller cabinet, and guard shall be approved by the Traffic Engineer prior to installation. Traffic Engineer shall inspect for proper placement and alignment of the controller cabinet adapter base, concrete pad, ground rod, and conduit prior to pouring of the concrete.

612.3.6 Any backfill under or around the concrete pad and apron shall be filled in 6” layers and tamped to 95% density of the surrounding earth.

612.3.7 Apron slope shall be a minimum of 1” per foot from the concrete pad. The apron must be configured so that it maintains negative slope on all four sides to keep water draining

away from the cabinet base. If the standard design does not accommodate this a special design must be provided in the plans for the concrete pad, apron, and guard.

612.3.8 All concrete pads and aprons shall be vibrated from top to bottom.

612.3.9 Screed board shall be used on all poured aprons and pads before finish is applied.

612.3.10 If Sonotube concrete forms, or approved equal, are used to pour the cabinet base or foundation, it shall not extend into the concrete pad.

612.3.11 Concrete over pour around or in between materials used to seal or support conduits shall be removed from stubbed up conduits and ground rod above the finished grade of concrete base.

612.3.12 The controller cabinet and base shall be covered during the pouring of the concrete to prevent splatter.

612.3.13 The joint between the controller cabinet and the adapter base and the joint between the adapter base and the concrete pad shall be caulked with Dow Corning 795 Silicone Building Sealant with Limestone Color or approved equal. It shall have a minimum of a 1/4" bead or, if it is more than a 1/4" bead, it shall be worked with a caulking tool.

612.3.14 The concrete controller base shall be installed level and plumb with the controller cabinet adapter base and the cabinet door shall open and close without lifting or forcing the door.

612.4 METHOD OF MEASUREMENT

612.4.1 The cabinet guard of the size and type specified will be measured by the Each unit installed, which includes all items shown in Standard Drawing 612 – CABINET GUARD DETAIL.

612.5 BASIS OF PAYMENT

Accepted cabinet guards, measured as provided above will be paid for at the contract unit price as follows:

A) Cabinet Base, Apron, and Guard ..... EACH

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

## PART 613 – PEDESTRIAN PUSH BUTTON

613.1 GENERAL

613.1.1 The work shall consist of furnishing materials and installing pedestrian push buttons and signs on traffic signal installations in accordance with these specifications and as shown on the Plans.

613.2 MATERIALS

613.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List.

613.2.2 Pedestrian Signal (APS) Push Buttons shall meet the requirements of the latest edition of the Public Right-Of-Way Accessibility Guidelines (PROWAG), ADA, and the 11th Edition of the Manual on Uniform Traffic Control Devices (MUTCD) and shall meet the following requirements:

A) They shall be vibrotactile and shall have the capability of both speech-walk messages and rapid ticks.

B) They shall include an MUTCD compliant R10-3 series sign with a yellow housing and internal speakers, LED confirmation light, and adjustable raised tactile arrows.

C) They shall include the central control unit (CCU) and voice IC chip per intersection (diamond interchanges are counted as two intersections for the purpose of pedestrian push button equipment).

D) If audible push button equipment is mounted within 10’ of another pushbutton, they shall be factory programmed with a speech message in accordance with MUTCD section 4K.03 paragraphs 18 and 20, including the names of the street; otherwise they shall be programmed for a rapid tick. Messages shall be capable of being reprogrammed.

E) Audible pedestrian push buttons shall be programmable via internet or other software over an Ethernet connection or on-site in the controller cabinet via a laptop or configurator unit.

613.2.3 Non-Audible Pedestrian Push Buttons: Non-audible pedestrian push buttons shall meet the requirements of the latest Manual on Uniform Traffic Control Devices (MUTCD) and shall meet the following requirements:

A) They shall be vibrotactile.

B) They shall include an MUTCD compliant R10-3 series sign with a yellow housing, LED confirmation light, and adjustable raised tactile arrows.

613.2.4 Push Button Cables and Wiring: All cable and wiring shall meet the requirements of City of Tulsa Specification 611.

613.3 CONSTRUCTION METHODS

613.3.1 Install pedestrian push buttons in accordance with the latest edition of PROWAG, ADA and the MUTCD.

613.3.2 Construct the pedestrian push button so that it is tamper proof. Design it to prevent an electrical shock under any weather conditions.

613.3.3 Attach the pedestrian push button and sign to a traffic signal pole, push button pole or pedestal pole as shown on the Plans. Align the arrows parallel to the crosswalks that the push buttons are to serve.

613.3.4 Audible pedestrian push buttons shall be delivered with the signal cabinet to the City of Tulsa Traffic Operations Division prior to installation for inspection and approval.

613.3.5 The location and mounting height of pedestrian push buttons shall be approved by the Traffic Engineer prior to installation.

613.3.6 Non-audible push buttons shall be drilled and secured with pop rivets, 1/4" x 1-1/4” long with a 1/2" wide head.

613.3.7 Audible push buttons shall be installed according to manufacturer’s instructions.

613.3.8 Push buttons shall not be installed until the finished grade of the sidewalk is installed.

613.4 METHOD OF MEASUREMENT

613.4.1 The pedestrian push button will be measured by the unit operationally complete in place, connected, including signs and all software and hardware.

613.5 BASIS OF PAYMENT

The accepted pedestal poles and pedestrian push buttons, measured as provided above, will be paid for at the contract unit price as follows:

A) Non-Audible Pedestrian Push Buttons Station and Sign ..... EACH

B) Audible Pedestrian Push Buttons Station and Sign ..... EACH

C) Audible Pedestrian Push Buttons Configuration/Programming Device ..... EACH

D) Audible Pedestrian Push Buttons Control Card/Unit ..... EACH

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

## PART 614 – LED TRAFFIC SIGNAL HEADS AND PEDESTRIAN SIGNAL HEADS

614.1 GENERAL

614.1.1 This item shall consist of providing and installing Light Emitting Diode (LED) traffic signal heads and LED pedestrian signal heads on various types of supports at locations shown on the Plans and in conformance with these specifications and the Institute of Transportation Engineers (ITE) Standard Specifications.

614.2 MATERIALS

614.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List.

614.2.2 General: The traffic signal heads and all component parts shall be in compliance with the requirements contained in this specification and the standards contained in the publication No. ST-017, *Equipment and Material Standards of the Institute of Transportation Engineers*.

614.2.3 Housing:

A) Traffic signal head housing shall be fabricated from a one-piece engineering plastic equal in strength and performance to polycarbonate resin material with LED Indications.

B) All Acrylonitrile-Butadiene-Styrene (ABS) sheet material shall be UV stabilized.

C) The sides, top and bottom of each head section shall be integrally molded.

D) The traffic signal head shall consist of the number of sections and the lens configuration(s) specified in the Plans. The heads shall be designed for vertical installation.

E) The sections shall be designed so that they can be locked in position in increments not exceeding 5° of rotation. The individual sections shall be fastened together by means of bolts extending through each section and shall be positively locked when the bolts are tightened down. When assembled, together with doors, LEDs, and mounting attachments the housing shall be completely dust and moisture proof.

F) The top and bottom of each section shall be provided with an opening to accommodate standard 1-1/2" pipe brackets. Any open end of an assembled traffic signal head shall be plugged with a pinnacle cap and gasket. Any other unused openings shall be made watertight by a method approved by the Traffic Engineer.

G) All bolts, nuts, washers, and other hardware used for securing the signal head sections shall be completely rust proof.

H) Traffic Signal Backplates shall be aluminum with a durable factory applied non-reflective black finish (powder coated, baked enamel, or other finish as approved by the traffic engineer.) Backplates shall be a minimum thickness of 0.05” and shall have louvers. At the front side of the backplate a 2” wide strip of fluorescent yellow retro-reflective tape shall be installed at the perimeter. The retro-reflective tape shall be Type XI.

I) All 5-section heads top and bottom backplate butt joints shall have a minimum of two screw and clip nuts per joint, a minimum of one is required for 3-section heads and 4-section heads.

J) All 5-section cluster signal backplates must be reinforced with a minimum of a 5/8" flange on all sides.

K) Each traffic signal vehicle section shall have four appropriately sized stainless-steel washers and fasteners.

L) Traffic signal heads and visors shall have the appropriate color completely impregnated in the resin material. The exterior shall be Federal Yellow in color and the interior surface of all visors shall have a flat black finish.

614.2.4 Traffic Signal Doors:

A) Each signal lens shall be mounted in a door fabricated of the same material as the housing. The doors shall be suitably hinged and shall be latched with a latch bolt of the adjustable pressure type. Hinges shall be located to the left side for 3-section signal heads and 4-section signal heads, and toward the outside edges for a 5-section signal head. The outer face of the door shall have at least four tapped holes equally spaced around the lens opening to receive the screws, which hold the visor in place.

B) Each door shall be provided with a visor approximately 12” in length. Traffic signal head visors shall be the tunnel type. All visors shall be fabricated of the same material as the head sections.

C) Neoprene or superior material shall be provided for gasketing between the body of the housing and the doors, to exclude dust and moisture.

614.2.5 Pedestrian Signal Heads:

A) Pedestrian signal heads shall be Single-Section with LED indications.

B) Single-Section design shall be provided with a band type mounting bracket for each signal head. The pole half of the assembly shall not weigh more than 44 ounces and shall be designed to adapt to a wide range of pole configurations (4” minimum diameter).

C) The mounting hardware shall be a two piece, cast aluminum alloy assembly. The two separate casting shall be joined in the final assembly by the use of stainless-steel spring pins. The spring pins shall be factory installed into the hinge ears which shall be integrally cast into the pole half of the assembly. Final mating of the two halves shall be accomplished by inserting the spring pins into the drilled hinge ears of the head half of the assembly (loose fit).

D) Band type mounting shall be provided by integrally casting two recessed slots near the top and bottom of the pole half of the assembly. The corners of this slot shall be relieved to prevent damage to the band strapping material. Approximate dimensions of each slot shall be 7/8” wide and 1/8” deep thus adequately retaining 3/4" strapping material.

E) Lenses shall be rectangular with a nominal size of 16”, as specified in the Plans. Lens design shall conform to the provisions of the latest edition of the standard "Pedestrian Traffic Control Signal Indications" from ITE publication ST-17 and the Manual on Uniform Traffic Control Devices.

F) Single-Section pedestrian heads shall be equipped with egg crate visors.

G) Pedestrian signal heads shall conform to the applicable requirements contained herein for traffic signal heads.

H) The pedestrian traffic control signal indications shall use the international symbols.

I) The pedestrian signal indications furnished shall include countdown timers.

J) Pedestrian signal heads and visors shall be flat black.

614.2.6 LED Units:

A) Provide LED lamps in accordance with the most recent version of the ITE standard "*Vehicle Traffic Control Signal Heads*" (VTCSH) and "*Pedestrian Traffic Control Signal Indications*" (PTCSI). Unless otherwise shown on the plans.

B) Lenses shall be of hard coated and UV stabilized polycarbonate design to provide color and light output as specified in Section 8.04 and Figure 1 of the VTCSH standard. Lenses shall be securely mounted in the door with weatherproof gaskets and rust proof clips.

C) The LED signals shall not be the screw-in type.

D) The LED signal shall be marked "TOP" to designate the proper orientation of the LED unit in the traffic signal housing manufacturer part number, and date code shall be visible on the rear of the assembly.

E) The colors of the LED traffic modules shall conform to the chromaticity requirements of Section 8.04 and Figure 1 of the VTCSH standard.

F) Traffic and pedestrian signal indications shall fail catastrophically. Pixelated LED indications shall not be accepted.

G) The LEDs shall operate over the voltage range of 92 VAC to 125 VAC.

H) The variation in line voltage shall not cause the light to vary more than 30%

I) Arrow lenses shall conform to Section 9.00 of ITE publication ST-017. Lenses shall be of hard coated and UV stabilized polycarbonate with the arrow mask inserted in the lens.

J) The LED unit shall utilize the same mounting hardware used to secure an incandescent lens and gasket assembly and only require a screwdriver compete the mounting.

614.2.7 Wiring:

A) The leads on the LED signal module shall be 36” long made of 20 AWG 600-volt Opticom or approved cable able to withstand temperatures of at 75° C. Use UV rated cable ties to secure excess wire and cable.

B) The leads shall be strain relieved and have fully insulated quick disconnect female (spade) couplers.

C) Each LED Unit shall be provided with two color coded wires. These wires shall be a minimum of 18-gauge copper. The color coding shall be as follows:

1) Brown – Green or Green Arrow

2) White – Common (Grounded side of power)

3) Red – Red, Red Arrow

4) Yellow – Yellow or Yellow Left or Right Arrow

5) Green – Green, Green Arrow

6) Blue – Walk

7) Orange – Don't Walk

D) The leads shall be securely fastened to the LED module and connected to a terminal block by means of solderless wire connectors. The leads shall be long enough to reach the terminal block in each of the head sections.

E) A terminal block shall be positioned in the appropriate section of the signal head and shall have a screw terminal for each wire from the LED module and separate

terminal for each field wire. See City of Tulsa Standard Drawing 615 for more details. The terminal blocks shall be mounted vertically or horizontally.

614.3 CONSTRUCTION METHODS

A) Make each signal head weathertight.

B) A signal head may consist of one or more signal sections of the adjustable, LED type, with multiple signal section rigidly and securely fastened together.

C) Each signal section shall be a self-contained assembly consisting of an LED unit with housing, housing door, visor and backplate unless otherwise specified on the Plans.

D) Supply signal heads with all brackets and fittings necessary for proper mounting on the type signal support designated on the Plans and make them capable of being positively positioned to control the movement of one direction of traffic.

614.4 METHOD OF MEASUREMENT

The traffic signal heads and lamps will be measured by the unit, complete in place, including wiring and all hardware. The backplates and visors will be included in this pay item.

614.5 BASIS OF PAYMENT

The accepted traffic signal and pedestrian heads with backplates, visors and LEDs, and all materials, labor, equipment, and incidentals necessary to complete the work as specified will be paid for at the contract unit price as follows:

A) LED 3-Section Traffic Signal Head (#25)..... EACH

B) LED 3-Section Traffic Signal Head (#33)..... EACH

C) LED 3-Section Traffic Signal Head (#36)..... EACH

D) LED 3-Section Traffic Signal Head (#36) (Louvered)..... EACH

E) LED 3-Section Traffic Signal Head (#37)..... EACH

F) LED 3-Section Traffic Signal Head (#54L)..... EACH

G) LED 3-Section Traffic Signal Head (#54L) (Louvered)..... EACH

H) LED 3-Section Traffic Signal Head (#54R)..... EACH

I) LED 3-Section Traffic Signal Head (#54R) (Louvered)..... EACH

J) LED 3-Section Traffic Signal Head (#64R)..... EACH

K) LED 3-Section Traffic Signal Head (#64L)..... EACH

L) LED 4-Section Traffic Signal Head (S-13L)..... EACH

M) LED 4-Section Traffic Signal Head (S-13L) (Louvered)..... EACH

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

## PART 615 – BASE COVERS

615.1 DESCRIPTION

615.1.1 This work consists of furnishing materials and installing base covers around traffic signal poles at the locations shown on the Plans or established by the Traffic Engineer to prevent damage to the wiring at the base of signal poles due to vandalism, protection from the elements and wildlife and other hazards.

615.2 MATERIALS

615.2.1 General: Base Covers shall be a full base cover that covers the underside of the traffic signal pole as well as the anchor bolts and nuts. It shall be designed for easy removal and shall be manufactured specifically to fit the existing or planned signal poles on which they are to be installed. Base covers shall be either aluminum or galvanized steel. All hardware shall be stainless steel.

615.2.2 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List.

615.3 CONSTRUCTION METHODS

615.3.1 Base covers shall be installed per manufacturer's specifications and shall be installed such that they are flush to the ground and firmly in-place on the pole and do not rotate or wobble.

615.4 METHOD OF MEASUREMENT

615.4.1 The base covers will be measured by the unit installed complete in place, including all hardware and any incidental items necessary for secure installation.

615.5 BASIS OF PAYMENT

The installation of base covers, measured as provided above, will be paid for at the contract unit prices as follows:

A) Base Covers ..... EACH

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals required to complete the work as specified.

## PART 616 – MAST ARM BRACKETS

### 616.1 DESCRIPTION

This item consists of furnishing materials and installing mast arm brackets for signs, signal heads, and any other signal equipment, as necessary. Details and information on mast arm brackets are provided in City of Tulsa Standard Drawing 616.

### 616.2 BASIS OF PAYMENT

All materials, labor, equipment, and incidentals necessary for providing and installing mast arm brackets shall be paid for as part of the cost of the signs, signal heads, or other signal equipment.

## PART 617 – SIGNAL POLES AND MAST ARMS

617.1 GENERAL

617.1.1 This work shall consist of furnishing materials and installing poles, mast arms, luminaire arms, push button poles and pedestal poles for traffic signals in accordance with these specifications and in reasonably close conformity with the locations and dimensions shown on the Plans or established by the Traffic Engineer.

617.2 MATERIALS

617.2.1 General: Mast arm and pole assemblies, with the exception of pedestal poles, shall be multi-sided, tapered steel monotube traffic signal mast arms and poles. Pedestal poles may be without taper. All material and workmanship for these products must be United States origin.

617.2.2 Standards: Materials shall meet the requirements specified in AASHTO Standard Specifications for Structural Supports of Highway Signs 2009, Luminaries and Traffic Signals and ODOT Section 700. Mast arms and poles shall be designed for a minimum of 90 MPH wind velocity and Fatigue Category II with galloping not considered. The following ASTM Standards shall also be met:

A) Shaft: ASTM A570-50.

B) Base and Flange Plates: ASTM A36.

C) All Other Bolts: ASTM A325 (Thread per UNC Series).

D) Pole Top Plate: ASTM A36.

617.2.3 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List.

617.2.4 Signal Poles: Unless otherwise specified, furnish each pole with a reinforced handhold and weatherproof cover. Signal poles shall not have a terminal block in the handhole. Anchor bases may be either cast or structural plate.

617.2.5 Signal Mast Arms: Signal mast arms over 50’-0” shall be two sections slipped together after galvanizing and held in place with one 5/8” diameter pin bolt. The arm is to be shipped assembled. Mast arms shall be of the length shown on the Plans. Signal mast arm poles shall be designed to support signals and/or signs of the weight and area as indicated on the plans.

617.2.6 Signal Pole Anchor Bolts: Anchor bolts shall meet manufacturer’s specifications and shall be installed square to roadway centered in the base, with a 6” hook, two hex nuts (A-563-GR-A), two flat washers (F436), and one lock washer, or approved equals. Bolts for mast arm bases shall be ASTM A325 (thread per UNC series). The holes in the base plates shall be oversized holes (diameter of anchor bolt plus 5/16”) to allow

for future raking of the signal pole for oversized loads. Raking is defined as loosening the nuts on the anchor bolts at the base plate of the signal pole so the signal pole may be pushed or pulled to a maximum of 3 degrees out of plumb.

617.2.7 Pedestal Poles: All pedestal poles and push button poles shall have a stabilizing collar. Pins shall be installed.

617.2.8 Pedestal Pole Anchor Bolts: Anchor bolts for pedestal pole bases shall be stainless steel wedge anchor bolts or approved equal and shall include the following hardware:

A) Quantity four of 3/4" x 8-1/2" stainless steel wedge anchors,

B) Quantity four of 2-1/2" O.D. x 1-1/16” stainless steel flat washers,

C) Quantity four of 1-7/8” O.D. x 3/4" stainless steel flat washers,

D) Quantity four of 3/4" stainless steel lock washers, and

E) Quantity four of 3/4" stainless steel hex nuts.

617.2.9 Luminaire Arms: Luminaire arms shall support the weight of a 75 lb. luminaire with a projected area of 3.3 square feet and provide a smooth raceway for the wiring and each shall come with a slip-fitter tenon.

617.2.10 Finish: Each assembly shall be galvanized to ASTM A123. The top portion of the anchor bolts shall be galvanized to ASTM A153. All threaded fasteners shall be galvanized to ASTM A153.

617.2.11 Welds: All welding must be performed at the manufacturer’s place of business by AWS Certified welders. All welds shall conform to the latest AWS D1.1 requirements.

617.2.12 Pole and Mast Arm Identification Markings: All mast arms shall be permanently marked with the length of the arm on the flange plate. Poles are to be permanently marked with the arm length range on the top side of the base plate. All parts (top, end, caps, hand hole covers and attachment hardware), with the exception of the anchor bolts, are to be packed on a per pole basis and identified for the mast arm assembly that corresponds with the parts. All sections shall be color coded per the marking legend shown in City of Tulsa Standards Drawings 617 and 618 in the following locations:

A) Bottom of the base plate.

B) Bottom of the arm flange plate.

C) Bottom of the luminaire flange plate.

D) Inside of the luminaire extension.

E) Inside of the arm extension.

617.2.13 Inspection: All materials shall be inspected by an authorized agent of the City of Tulsa Traffic Operations Division to ensure compliance with the specifications.

## 617.3 CONSTRUCTION METHODS

617.3.1 The manufacturer shall submit shop and design drawings, and calculations in accordance with ODOT Subsection 105.02.

617.3.2 Mast arms may be mounted to the pole prior to erection of the pole. Care shall be taken not to damage the pole, mast arm, luminaire arm, or finish during erection. If the finish is damaged, repair it at no additional cost and in a manner approved by the Traffic Engineer.

617.3.3 All unused, drilled holes in the poles or mast arms shall be resealed by non-ferrous rain-tight materials and methods as approved by the Traffic Engineer.

617.3.4 Level anchor base poles with double nuts leveling.

617.3.5 Install all fasteners in accordance with the manufacturer's specifications.

617.3.6 Cast all structural casting in permanent molds.

617.3.7 The nominal mounting height of the luminaries or traffic signal shall be as indicated in City of Tulsa Standards and Specifications or as shown on the Plans. Luminaires shall be installed at the end of the luminaire arm. 110 volts shall be supplied on a separate circuit from the cabinet to the standard base and identified with yellow tape. A 5-amp fuse shall be installed in the signal base. The Contractor shall provide the LED luminaire(s) and related equipment (LED Fixture(s), 120V photocell, inline fuse holder, and 5-amp ktk fuse).

617.3.8 Make sure poles are straight and centered on the longitudinal axis. Install a removable pole cap on each signal pole (except pedestal signal poles where slip fitters are used).

617.3.9 Provide all metallic poles with a bonding connection inside the base of the signal pole and ground them as shown on the Plans.

617.3.10 Traffic signal poles shall be grounded to a ground rod located in the foundation. No. 4 AWG stranded copper wire shall be installed from the ground rod to the pole grounding lug.

617.3.11 The Traffic Engineer shall inspect the pole rake and mast arm installation after all equipment has been installed on the mast arm before final approval.

## 617.4 METHOD OF MEASUREMENT

617.4.1 Poles and mast arms, push button poles, pedestal poles, and post top poles of various types, sizes, and lengths will be measured by each unit installed.

## 617.5 BASIS OF PAYMENT

The accepted poles and mast arms, measured as provided above, will be paid for at the contract unit price as follows:

A) Modular Traffic Signal Mast Arm Poles with Luminaire Extension ..... EACH

B) Modular Traffic Signal Mast Arm Poles without Luminaire Extension ..... EACH

C) Six Foot Pedestrian Push Button Pole ..... EACH

D) Ten Foot Pedestal Pole ..... EACH

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as shown on the Plans and these specifications.

## PART 618 – BONDING

618.1 GENERAL

618.1.1 This pay item shall consist of furnishing all conductors, split bolts, miscellaneous hardware and connections necessary to bond the traffic signal standards and/or pedestals from the bonding point and the service disconnect buss as shown in City of Tulsa Standard Drawing 619, Bonding Detail.

618.2 MATERIALS

618.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List.

618.2.2 Bonding Wire: Use a #6 THHN stranded wire as the bond wire. See City of Tulsa Specification 611 Conductors for more details.

618.2.3 Split Bolts and Hardware: Split bolt standard connections shall be copper, and UL rated for the right size multiple conductors. No zinc coated hardware allowed. Use stainless steel hardware to fasten split bolts to poles.

618.3 CONSTRUCTION METHODS

618.3.1 There shall be #6 green THHN stranded copper connected to the bonding point of each traffic signal standard or pedestal and the service disconnect ground buss (see City of Tulsa Standard Drawing 607)

618.3.2 If the bonding connection is inadequate standard or base shall be drilled away from traffic.

618.3.3 Service #8 green THHN shall be isolated with connection at service ground and cabinet suppressor (check this matches the service standard/specifications).

618.3.4 There shall be no connection made to the ground rod in the traffic signal cabinet. It is for test purposes only.

618.3.5 Bonding wires do not go to grounding rods in pedestals, standards, or pull boxes.

618.3.6 All bonding wires shall be installed oriented to the corner of the service, not the control cabinet.

618.3.7 All bonding wire connections shall be made above finished grade, no splices allowed in pull boxes.

618.3.8 All bonding wire shall be wrench tight.

618.4 BASIS OF PAYMENT

All materials, labor, equipment, and incidentals necessary to complete the work as specified herein for bonding shall be paid for as part of the cost of the wiring, per City of Tulsa Specification 611.

## PART 619 – TEMPORARY SIGNALS

619.1 GENERAL

619.1.1 This work consists of furnishing material and installing a temporary traffic signal when an existing signal must be taken out of service.

619.2 MATERIALS

619.2.1 Existing poles and mast arms may be used as part of the temporary signal, span wires may be attached to existing poles, or wooden poles may be provided with span wire equipment.

619.3 CONSTRUCTION METHODS

619.3.1 Temporary signals should be installed in reasonably close conformity with the location and dimensions shown on the Plans or established by the Traffic Engineer.

619.4 METHOD OF MEASUREMENT

619.4.1 Temp Signal Span: This item includes all equipment and installation necessary for a temporary signal across one leg of an intersection using overhead signal cable from one standard or temporary wooden pole to another standard or temporary wooden pole. This includes all equipment and installation necessary for a temporary signal across one leg of an intersection including, but not limited to, a guy span, cable, signal heads, and any hardware or incidental items needed to connect the span and cables and make it operational. This item does not include payment for standards, poles, cabinet, or service.

619.4.2 Temp Signal Pole: This item includes temporary wooden poles and hardware as necessary to install a temporary signal.

619.4.3 Temp Signal Cabinet: This item includes all equipment and installation necessary for a traffic signal control cabinet with controller needed to operate a temporary traffic signal when the existing cabinet cannot be utilized. The temporary cabinet is the property and responsibility of the Contractor and will be retained by contractor after job completion.

619.4.4 Temporary Signal Service: This item includes any necessary meters or service connections to provide electrical service to the temporary signals. All electrical service connections must meet the applicable requirements of the NEC, PSO, and City of Tulsa Electrical Requirements as detailed in City of Tulsa Specification 607 unless otherwise authorized by the City Traffic Engineer.

619.5 BASIS OF PAYMENT

Temporary signal items, installed and operational in place, measured as provided above, will be paid for at the contract unit price as follows:

A) Temp Signal Span ..... PER EACH

B) Temp Signal Pole ..... PER EACH

C) Temp Signal Cabinet ..... PER EACH

D) Temp Signal Service ..... PER EACH

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

## PART 620 – VIDEO DETECTION SYSTEM

620.1 GENERAL

620.1.1 This work consists of furnishing materials and installing a video detection system in accordance with these specifications. For the purposes of video detection systems, signals at interchanges are considered separate intersections at each end of the interchange.

620.2 MATERIALS

620.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List.

620.2.2 The video detection system provided shall be fully compatible with existing City of Tulsa video equipment and cabinets and shall include built-in Ethernet communications capability for remote monitoring and setup of the system as well as the capability to zoom and focus the image both in the cabinet and remotely at an off-site location.

620.2.3 The video detection shall be wired in the controller cabinet and shall be installed according to manufacturer's specifications. Video detection systems shall come with Video Filter/ Power Panel for video detection. When required, each video camera shall have a separate appropriately sized circuit breaker for camera power. The video filters shall be “EDCO” Video Filter CX06-BNCY, CX06-M or an approved equal will also be accepted. Each video camera shall have a separate appropriately sized circuit breaker for camera power. Manufacturer specific video detection system requirements shall be detailed on the Approved Products List.

620.2.4 Video cable shall meet the requirements of City of Tulsa Specification 611.

620.2.5 Video cards shall be provided for each intersection. The number of cards to be provided may vary by system and shall be designated on the Approved Products List.

620.2.6 If video detection is to be installed in a NEMA style cabinet, it shall be PEAK video track IQ, Autoscope, or approved equal with two 4-channel video cards supplied per intersection.

620.2.7 Where a controller cabinet is not already wired to accept video detection a rack and any other equipment necessary for installation of the video detection shall be provided as part of the video detection system.

620.3 CONSTRUCTION METHODS

620.3.1 Video detection assembly shall be installed per manufacturers’ recommendation.

620.3.2 The minimum mounting height for video cameras shall be 25’ above the roadway surface.

620.3.3 A 6” x 6” junction box shall be provided on the mast arm near the video camera mount. Junction boxes shall either be powder coated metal or UL F1 rated NEMA 3 gray polycarbonate.

620.3.4 The Traffic Engineer shall approve all camera locations and elevations prior to installation.

620.3.5 The Traffic Engineer shall approve the video image of each camera prior to acceptance of the signal by the City.

620.3.6 For signals currently in operation, video cameras shall be put into operation a maximum of two weeks after installation.

620.3.7 For new signals or signals out of operation, video detection shall be operational when the signal is put into operation.

620.3.8 During construction, the contractor shall set up and adjust the detection zones to accommodate shifts in traffic due to work zone traffic control adjustments. Once construction is complete on the project and the permanent pavement markings are in place, the contractor shall realign the video detection zones to their permanent configuration as directed by the Traffic Engineer.

620.4 METHOD OF MEASUREMENT

620.4.1 The video detection system shall include the installation of video detection per intersection, including but not limited to one or more cameras per approach as indicated by the plans or as directed by the Traffic Engineer, set-up and installation equipment, pole extension, mounts, brackets, cable, wire, hardware, monitor, keyboard, video cards, and any other appurtenances necessary to make the vehicular detection operational.

620.5 BASIS OF PAYMENT

The accepted video detection system, measured as provided above, will be paid for at the contract unit price as follows:

A) Video Detection System ..... EACH

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

## PART 621 – HIGHWAY, STREET, AND PEDESTRIAN LIGHTING

621.1 GENERAL

621.1.1 This work consists of providing and installing electrical conductors, poles, luminaires, high-mast poles, and high-mast lowering devices for street, trail, pedestrian, and highway lighting systems.

621.2 MATERIALS

621.2.1 Approved Products List: All materials shall be new, unused, and undamaged. All materials provided for highway lighting shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List (APL). All poles, ballasts and lights on City streets must also be types that American Electric Power (AEP) / Public Service Company of Oklahoma (PSO) will maintain.

621.2.2 Electrical Conductors for Lighting: Provide Materials in accordance with ODOT Section 738.02 and City of Tulsa Standard Specification 611. For wiring inside of the poles, wire shall be #12 Copper THWN Black and #12 Copper THWN White. For wiring between the poles, wiring shall be #4 Aluminum XHHW Black and #4 Aluminum XHHW White. Ground wires shall be either #12 Copper THWN Solid Green, #4 Aluminum Stranded XHHW Green, or solid bare copper wire sized in accordance with the National Electric Code (NEC). Other configurations of wiring may be used only with approval of the Traffic Engineer.

621.2.3 Conduit and Underground Infrastructure:

A) Junction boxes for 1” plastic coated rigid metallic conduit shall be as follows: two-gang, feed-thru, deep, three-threaded hubs, with cover.

B) Liquid tight metallic conduits shall not be stainless steel or aluminum.

621.2.4 Lighting Controllers:

A) 480 Volt Services: The magnetic controller for 480 Volt services shall be in a cast aluminum rain tight enclosure as shown on City of Tulsa Standard Drawing 621A and be composed of:

1) 480/120 Volt potential transformer.

2) Magnetic relay having a 120-volt operating coil and normally open 480-volt DPST contacts rated as shown in City of Tulsa Standard Drawing 621A.

3) Three-pole polarized twist lock photoelectric control.

4) Fuse clips for two renewable link type fuses.

5) All control wire shall be copper #12 AWG. All power conductors shall be aluminum #4 XHHW.

6) Terminals suitable for #12 AWG standard copper conductors. Terminals shall be labeled.

7) Line, load, and neutral terminals shall be #4 XHHW aluminum conductors.

8) Line and load lightning arrestors shall be externally mounted.

9) Circuitry in the controller shall be according to the wiring diagram shown on City of Tulsa Standard Drawing 621A.

10) The enclosure shall be a hinged door with two door fasteners and locking capabilities and a mounting bracket for attachment to the pole with two 5/8" diameter lag screws.

11) Enclosure shall be 24” x 24” x 10”.

12) Photoelectric Control shall be either an Intermatic LC4536C or approved equal.

13) The "Auto Manual" test switch shall be a 3-wire, 2-pole, 20-amp outdoor circuit breaker in either a NEMA 3R or 4 enclosure with provisions for padlocking.

14) Lighting arrestor shall be a 1-pole, 600 or 650-volt rated with 3/4" NPT pipe nipple with lock nut and brushing washer and 1'-6" long leads.

15) The disconnect switch shall be a fusible 60-amp, 3-pole, 600-volt, in a NEMA 3R enclosure with provisions for padlocking the switch handle and door. The switch shall be provided with the appropriately sized fuse to fit the load and shall be equipped with the appropriate conduit hubs. 600-volt services shall require a second disconnect above the meter that is unfused.

B) 240 Volts: If the secondary voltage is 120 or 120/240 the controller shall be the same as the above described unit except the potential transformer may be eliminated and the model number changed accordingly.

621.2.5 Poles:

A) Galvanized steel poles: Provide materials in accordance with ODOT 806.02.

B) Wood poles: Provide wood poles in accordance with ANSI 05.1.

C) High mast poles: Provide Materials in accordance with ODOT Section 812.02.

D) High mast lowering devices: Provide materials in accordance with ODOT Section 813.02. All high mast lowering devices shall be top latching.

E) Break away base: Provide Materials in accordance with ODOT 807.02.

621.2.6 Anti-theft Devices:

A) All handhold covers and lighting pole transformer base doors shall be the Pelco Copper Safe System, or approved equal, and shall come with all associated hardware and locking kits needed for installation and proper use of the system, sized to fit the pole where it is to be installed.

B) Anti-theft cabling devices shall be the Pelco Copper Safe Retainer System, or approved equal, and shall come with all associated hardware needed for installation and proper use of the system.

621.2.7 Luminaires:

A) Roadway Luminaire – Provide Materials in accordance with ODOT 809.02.

B) Underpass Luminaire – Provide Materials in accordance with ODOT 809.02.

C) High Mast Lighting – Provide Materials in accordance with ODOT 809.02.

D) Post Top Lighting – Provide Materials in accordance with ODOT 809.02.

621.2.8 LED Luminaires:

A) LED replacement fixtures shall replace the entire fixture. Retrofit kits shall not be accepted.

B) All specified equipment shall be purchased new directly from an authorized distributor/reseller or manufacturer of luminaires product.

C) All referenced national standards, including but not limited to IES, ANSI, ASTM, IESNA, FTC, and NEMA are to be the most current versions and shall be superseded by updated versions as they become available.

D) LED luminaires shall meet the following requirements:

1) Luminaires shall include a housing, ballast, reflector, refractor, and lamp of the type and lumen rating as indicated on the materials request.

2) LED luminaires shall come with a seven-pin receptacle and shall be designed to have a photocell for each fixture instead of only at the lighting controller.

3) Luminaire shall meet foot candle and uniformity values as outlined in ANSI/IENSA RP-8-14, American National Standard Practice for Roadway Lighting, or the most current version.

4) Where LED fixtures are to be installed on existing poles luminaires shall meet the design parameters as close as possible utilizing the existing spacing.

5) LED luminaires shall have a minimum luminaire efficacy of 100 lumens per watt.

6) Luminaire shall be rated for operation in -40° C to 40° C ambient temperature.

7) Transmissive optical components shall be applied in accordance with OEM design guidelines to ensure suitability for the environment (e.g., electromagnetic, thermal, mechanical, chemical).

8) Luminaire shall be designed for ease of component replacement and end-of-life disassembly.

9) Electrical components shall come with disconnect connectors for ease of installation and maintenance.

10) Nominal luminaire input wattage shall account for nominal applied voltage and any reduction in driver efficiency due to sub-optimal driver loading.

11) Luminaire shall accept the voltage or voltage range specified at 50/60 Hz and shall operate normally for input voltage fluctuations of ±10%.

12) All internal components shall be assembled and pre-wired using modular electrical connections.

13) The following shall be in accordance with corresponding sections of ANSI C136.37.

    a) Terminal blocks for incoming AC lines (electrical mains wires)

    b) Photocontrol receptacle (when applicable)

    c) Latching and hinging

    d) Mounting provisions

    e) Ingress protection

14) Luminaire shall have an external label per ANSI Cl 36.15 and an internal label per ANSI C136.22.

15) Fixture must have an IESNA luminaire classification not to exceed TM-15: B2 U2 G3.

E) LED housings shall meet the following requirements:

1) The housing shall be cast aluminum and shall be rust resistant and powder coated.

2) Driver shall be mounted internally and field replaceable.

3) All screws shall be stainless steel.

4) All components that require regular maintenance will require captive screws.

5) Painted or furnished luminaire surfaces shall achieve a scribe creepage rating of eight per ASTM D1654 after 5,000 hours exposure to salt fog chamber per ASTM B117.

6) Meets minimum vibration withstand and capability as outlined in ANSI C136.31, 3G rated.

F) Optical requirements for LEDs shall be as follows:

1) The lens shall be clear, tempered, shock resistant glass. The optical system shall be sealed to protect against water and dirt with an IP66 Enclosure rating. The optic life should last as long as the other fixture components.

2) Optic Assembly shall be rotatable to provide alignment of asymmetric distributions to the roadway.

G) Color attributes and color shift for LEDs shall be as follows:

1) Color Rendering Index (CRI) shall be no less than 70.

2) Nominal Correlated Color Temperature (CCT) shall be 4,100 K +/- 300 K.

H) LED drivers shall meet the following requirements:

1) The minimum power factor of the power supply shall be .90 or greater at full input power and across specified voltage range.

2) Electronic driver has an expected life of 100,000 hours at 25° C, L83.

3) LED light engines are rated >100,000 hours at 25° C ambient temperature.

4) Driver meets maximum harmonics distortion (THD) of 20% and is RoHS compliant.

5) Provide a three-stage terminal block for ease of installation.

I) Photocontrol receptacles and control interfaces for LEDs shall be as follows:

1) Photocontrol provided must be specifically designed for use with LED fixtures.

2) Luminaire designation(s) indicated "ANSI C136.41, 7-pin" shall be fully prewired and shall incorporate an ANSI C136.41 compliant receptacle. If a dimmable LED driver is specified, its 0-10V or DALI control wires shall be connected to the receptacle pads as specified in ANSI C136.41; connection of the two remaining pads shall be by Supplier, as directed by Owner.

3) Provide a long-life solid-state locking-style photocontrol with a minimum 20-year rated life.

J) Interference and power quality for LEDs shall be as follows:

1) Luminaire shall comply with FCC 47 CFR Part 15 interference criteria for Class A digital devices.

2) Luminaire shall comply with Section 5.2.5 (luminaires rated for outdoor use) interference criteria of ANSI C82.77 at full input power and across specified voltage range.

K) Thermal management for LEDs shall be as follows:

1) Luminaire shall start and operate in ambient temperature range specified.

2) Maximum rated case temperature of driver and other internal components shall not be exceeded when luminaire is operated in ambient temperature range specified.

3) The thermal management system shall facilitate hose-down cleaning and be resistant to debris buildup.

4) No liquids or moving parts shall be accepted.

L) Electrical safety and immunity requirements for LEDs shall be as follows:

1) Luminaire shall be listed for wet locations.

2) A surge device shall be included and shall be designed to meet ANSI/IEEE C62.41, Category C, with a high exposure level.

3) Luminaire shall meet the performance requirements specified in ANSI C136.2 for dielectric withstand, using the DC test level and configuration and electrical immunity, using the combination wave test level – Basic (6kV / 3kA).

4) Manufacturer shall indicate on submittal form whether failure of the electrical immunity system can possibly result in disconnect of power to luminaire.

621.2.9 Concrete Footings for Lighting Poles: Provide materials, including concrete, steel, and anchor bolts in accordance with ODOT Section 700, “materials”, and the latest edition

of the AASHTO Standard Specifications for Structural Supports of Highway Signs, Luminaires, and Traffic Signals. Footings shall be constructed in accordance with ODOT detail sheet No. T-304, design number GMF1-2, with the exception that all conduit ends shall be reamed and bushings shall be installed prior to installing any wires. All concrete footings shall be cast-in-place. Pre-cast concrete footings will not be accepted.

621.2.10 Electrical Services: Electric Service shall be provided in accordance with City of Tulsa Specification and Standard Drawing 607A and B and current AEP requirements. All electrical services shall be bonded to #4 bare copper wire connected to (2) – 5/8" copper clad ground rods, spaced 6' apart, and each ground rod shall extend a minimum of 8' into the soil. Ground rods shall have manufacturer's certification stamps visible, or have the stamp inspected prior to installation, showing the diameter and overall length of the rod. Ground rods shall not be cut or modified.

A) Disconnect switches shall be as follows: 60-Amp, 600-Volt, 3-Pole, NEMA 3R.

B) Channel Strut shall be as follows: Galvanized, half-slot, 1-5/8" x 10' sections.

C) Band Straps shall be stainless steel with the following dimensions: 3/4" wide x 3/10" thick.

D) Band Strap Clips shall be stainless steel.

E) Grounding clamps shall be acorn style. Ground rods shall be copper clad with the following dimensions: 8' long minimum and 5/8" diameter.

621.2.11 Padlocks:

A) Padlocks shall be secured with a specialized key to better secure the lighting controllers. Contact the Traffic Operations Division for specific details on the size and type of padlock typically used and for approval of any other equivalent systems.

B) Padlocks shall be considered incidental to the cost of the lighting controller or service.

621.2.12 Tests and Acceptability of Materials:

A) Submittals for materials and parts not included in the Approved Products List shall be provided as set forth in this specification. Any substitutions or changes must be approved by the Traffic Engineer prior to acceptance of the products or services.

B) To have LED luminaires considered for addition to the Approved Products List or for consideration as an approved equal on a project, provide five copies of the following materials schedule and proposed equipment including catalog cuts, diagrams, drawings and the following:

1) LM-79 luminaire photometric report(s) shall be produced by the test laboratory. The test laboratory must hold National Voluntary Laboratory Accreditation Program (NVLAP) accreditation for the IES LM-79 test procedure.

2) Complete luminaire catalog number.

3) Goniophotometry – Backlight-Uplift-Glare (BUG) ratings shall be for initial (worse-case) values, i.e., Light Loss Factor (LLF) – 1.0.

4) Lumen Depreciation in accordance with the most current version of IES LM-80 and IES TM-21.

5) Computer generated point by point photometric analysis of maintained light levels per ANSI/IES RP-8. Calculations shall be for maintained values, i.e. Light Loss Factor (LLS) < 1.0, where LLF=LLD x LDD x LATF and Lamp Lumen Depreciation (LLD) based on the TM-21 data and 50,000 hours of operation, with the following requirements:

   a) Luminaire Dirt Depreciation (LDD) = 0.90,

   b) Luminaire Ambient Temperature Factor (LAT F) = 0.96, and

   c) Listing and labeling by applicable testing bodies as determined by the U.S. Occupational Safety and Health Administration (OSHA) as a Nationally Recognized Testing Laboratory (NRTL) which includes: CSA (Canadian Standards Association), ETL (Edison Testing Laboratory), and UL (Underwriters Laboratory).

6) Documentation supporting any U.S. origin claims for the product, in accordance with FTC guidance.

7) Summary of reliability testing performed for LED driver(s).

8) Safety certification and file number indicating compliance with UL 1598.

9) Written product warranty.

C) In addition, for LED products, before approval and purchase, the City may request luminaire samples identical to product configurations submitted for inspection. The City may request IES LM-79 testing of luminaire samples to verify performance is within manufacturer-reported tolerances. Vendors must electrically test fully assembled luminaires before shipment from factory and provide documentation to the City prior to acceptance of the product. After installation, the City may perform IES LM-50 (field measurements) to verify performance requirements, giving consideration to manufacturing tolerances and measurement uncertainties as outlined in IES LM-61 and NEMA LSD 63.

621.2.13 Warranties:

A) Materials shall come with either a one-year warranty or a standard manufacturer's warranty, whichever is longer.

B) LED products shall come with a minimum five-year warranty covering maintained integrity and functionality of the following:

1) Luminaire housing, wiring, and connections.

2) LED Light source(s) – Negligible light output from more than 10% of the LED packages constitutes luminaire failure.

3) LED Driver(s).

621.3 CONSTRUCTION METHODS

621.3.1 Electrical Conductors: Follow construction methods as outlined in ODOT Specification 811.04 Electrical Conductors for Highway Lighting with the following exceptions:

A) City of Tulsa will require the use of a grounding conductor as specified in the National Electrical Code. See City of Tulsa Standard Drawing 621B for installation details.

B) In addition to the internal fuse located within each light pole base as directed in ODOT Specification 810.04 D install fuse holders and fuses in line with the light wiring, in series with the 240V or 480V feed. The length of the circuit shall be divided into three lengths: the fuse located closer to the controller shall be a 30-amp fuse. The second fuse installed shall be a 20-amp fuse and the fuse located furthest away from the controller shall be a 10-amp fuse. See City of Tulsa Standard Drawing 621 for fuse locations. In line fuses shall be included in the cost of the Conductor.

621.3.2 Lighting Controllers:

A) Provide control equipment in accordance with NEMA 3R or 4 and UL Specifications.

B) All connections shall be of either bolted type or compression type.

C) Conduits shall be strapped to the pole at intervals not to exceed 4'-0".

D) See plan sheets for service pole locations, number of controllers required, and contact ratings.

E) 6ft tall chain link fence, a gate, razor wire, and 6” thick concrete housekeeping pads shall be installed around lighting controllers and service poles. Price for all these items shall be included in the cost of the lighting controllers.

621.3.3 Poles:

A) Galvanized steel poles: Follow construction methods outlined in ODOT 806.04.

B) Wood poles: Follow construction methods outlined in ODOT 810.04.

C) High mast poles: Follow construction methods outlined in ODOT 812.04.

D) High mast lowering devices: Follow construction methods outlined in ODOT 813.04. All high mast lowing devices shall be top latching.

E) Break away base: Follow construction methods outlined in ODOT 807.04.

F) Concrete Footings for Light Poles: Construct lighting pole foundations in accordance with ODOT 804.04.

G) Concrete housekeeping pads shall be installed at all light pole footings. These housekeeping pads shall be 4” thick minimum and extend a minimum of 2ft all around the light poles. Price for housekeeping pads shall be included in the cost of the light pole footing.

621.3.4 Luminaires:

A) Roadway luminaire: Follow construction methods outlined in ODOT 809.04.

B) Underpass luminaire: Follow construction methods outlined in ODOT 809.04.

C) High mast lighting: Follow construction methods outlined in ODOT 809.04.

D) Post top lighting: Follow construction methods outlined in ODOT 809.04.

E) LED Luminaires: Install in accordance with Manufacturer’s recommendations.

621.4 METHOD OF MEASUREMENT

621.4.1 Electrical Conductors: The electric conductors will be measured by the foot for each of the various types specified and installed, and shall include all in line fuses, connectors, splices, and incidentals necessary to power the lighting system as provided in the plans.

621.4.2 Lighting Poles and Bases: Poles and bases shall be paid for by each.

621.4.3 Lighting Controllers: The Lighting Controllers shall be paid for by each fully installed. Such payment shall be full compensation for furnishing all material, equipment, labor, and incidentals required to complete the work as specified.

621.4.4 Luminaires: Luminaires shall be paid for as each complete fixture installed.

621.4.5 Concrete Footings: Foundations for lighting poles shall be in accordance with ODOT 804.

621.5 BASIS OF PAYMENT

The accepted lighting items, measured as provided above, will be paid for at the contract unit price as follows:

A) 1/C #12 Copper THWN Electrical Conductor, Black ..... LINEAR FOOT

B) 1/C #12 Copper THWN Electrical Conductor, White ..... LINEAR FOOT

C) 1/C #12 Copper THWN Electrical Conductor, Green ..... LINEAR FOOT

D) 1/C #4 Aluminum XHHW Electrical Conductor, Black ..... LINEAR FOOT

E) 1/C #4 Aluminum XHHW Electrical Conductor, White ..... LINEAR FOOT

F) 1/C #4 Aluminum XHHW Electrical Conductor, Green ..... LINEAR FOOT

G) 1/C #4 Copper Stranded Bare Wire ..... LINEAR FOOT

H) Lighting, Galvanized Pole and Mast Arm ..... EACH

I) Lighting, Decorative Pole ..... EACH

J) Lighting, 35’ Wood Pole ..... EACH

K) Lighting, High Mast Pole ..... EACH

L) High Mast Lowering Device, Top Latching ..... EACH

M) Breakaway Transformer Base ..... EACH

N) Anti-Theft Breakaway Transformer Base Door ..... EACH

O) Anti-Theft Cable Retainer System for Breakaway Transformer Bases ..... EACH

P) Lighting Controller, 240V ..... EACH

Q) Lighting Controller, 480V ..... EACH

R) Highway Luminaire, 250W HPS Mongoose Fixture ..... EACH

S) Highway Luminaire, 400W HPS Mongoose Fixture ..... EACH

T) Highway Luminaire, 200W HPS Cobra Head Fixture ..... EACH

U) Highway Luminaire, 400W HPS Cobra Head Fixture ..... EACH

V) Highway Luminaire, LED 250W HPS Equivalent Fixture ..... EACH

W) Highway Luminaire, LED 400W HPS Equivalent Fixture ..... EACH

X) Highway Luminaire, LED 200W HPS Equivalent Fixture ..... EACH

Y) Highway Luminaire, LED 400W HPS Equivalent Fixture ..... EACH

Z) Underpass Luminaire, 100W HPS ..... EACH

AA) Underpass Luminaire, LED 100W HPS Equivalent ..... EACH

BB) Highmast Luminaire, 1,000W MH ..... EACH

CC) Highmast Luminaire, 12-LED 1,000W MH Equivalent Fixture ..... EACH

Such payment shall be full compensation for furnishing all material, equipment, labor, and incidentals required to complete the work as specified.

## PART 622 – WIRELESS TRAFFIC SIGNAL COMMUNICATIONS SYSTEM

622.1 DESCRIPTION

622.1.1 This work consists of furnishing materials and installing wireless traffic signal communications equipment per intersection.

622.2 MATERIALS

622.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List.

622.2.2 Communications equipment provided shall include the following per intersection:

A) One Ethernet switch with rack power supply: Unit shall be a managed Ethernet switch hardened to NEMA TS/2 Specifications. Temperature range shall be -34° C to 74° C. Unit shall have at least 8 ethernet ports (6+2 modular is acceptable) 10/100/1000Base(T)X.

B) One Access Point Module: Access point module shall be at a minimum point to multipoint wireless 5.7 Gigahertz devices. Unit shall have AES encryption and have Cambium software. Unit shall have PMP450i access points or better. Unit shall be compatible with existing Cambium cnMaestro management software. Unit shall come with two universal mounts and power supplies with power cords.

C) One Subscriber Module: Unit shall be part of a point to multi-point wireless system and shall include at a minimum a 5.7 Gigahertz radio. Unit shall have AES encryption and have Cambium software. Unit shall have PMP450i access points or better. Unit shall come with two universal mounts and power supplies with power cords.

D) Two antennas, 5Ghz PTP450i end, integrated high gain antennas.

E) CAT 6 cable, rated for outdoor use, from the controller cabinet to the wireless equipment. All cable and wiring shall meet the requirements of City of Tulsa Specification 611.

F) Two surge suppression modules for wireless access point and subscriber module, (one for each).

G) If fiber is used for communications, it shall be coordinated with the City of Tulsa IT Department and Traffic Operations.

622.3 CONSTRUCTION METHODS

622.3.1 The Traffic Engineer shall locate all communications equipment prior to installation.

622.3.2 The City of Tulsa Traffic Operations Division shall install the communications equipment.

622.3.3 The Contractor shall pull CAT 6 cable from the controller to the signal pole where the communications shall be mounted.

622.3.4 Excess cable shall be stored in the handhole of the signal pole and in pull boxes.

622.3.5 Extreme cautions shall be used when working with the CAT 6 cable to prevent bending or crimping the cable.

622.4 METHOD OF MEASUREMENT

622.4.1 Wireless traffic signal communications equipment will be measured per intersection installed complete in place, including all hardware and any incidental items necessary for installation.

622.5 BASIS OF PAYMENT

The installation of a wireless traffic signal communications system, measured as provided above, will be paid for at the contract unit prices as follows:

A) Wireless Traffic Signal Communication System.....EACH

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals required to complete the work as specified.

## PART 623 – BATTERY BACKUP

623.1 DESCRIPTION

623.1.1 The equipment furnished under this specification shall be the latest production models conforming to the latest Standard Specifications of the Oklahoma Department of Transportation (ODOT) and the City of Tulsa. The below listed Specifications are the desired minimum. Bidder's equipment should equal or exceed these specifications. Deviations may be accepted only as approved by the Traffic Engineer.

623.2 MATERIALS

623.2.1 Approved Products List: All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List (APL).

623.2.2 Standards and Testing:

A) The equipment shall conform to the requirements of the National Electrical Manufacturers Association (N.E.M.A.). Any equipment manufacturer shall supply certification showing that the particular model of equipment intended to be furnished has been tested and approved by a qualified independent testing laboratory per requirements specified in the N.E.M.A. Standard. A qualified independent testing laboratory is defined as a laboratory which clearly shows that it is capable of performing the test in accordance with the N.E.M.A. The manufacturer shall supply qualification statements and/or other documentation that indicates that the laboratory is professionally recognized, reputable in nature, and equipped with or has access to all necessary testing apparatus to supply a certified letter with delivery of the equipment (identified by location and serial number) indicating that the particular equipment furnished is identical to the equipment that was tested and approved and that all "components and parts" used in assembling the equipment are equal or superior in quality to the ones used in the testing of the equipment.

B) The battery backup system shall have manufacturer's certificates (if needed), warranty of service, instruction books, service manuals, a list of generic part numbers for service personnel, and complete installation instructions.

623.2.3 General: The system shall provide a 120 VAC 60 Hz pure sine wave. The system shall provide power for normal signal operation, flash operation, railroad preemption and normal/flash combination modes. The system shall be designed for outdoor applications and meet the environmental requirements as is standard in the traffic industry. It shall be compatible to N.E.M.A TS1 & TS2, 170, 332, 332S, 336, and 336S controllers and cabinets. The system shall include all necessary cables, wiring harnesses, battery cables, and all components for proper operation.

623.2.4 Equipment Requirements:

A) Output Power: 1,100 Watts (W) Minimum

B) Active Output Power: 350 W Minimum

C) Output/Input Voltage: 120 VAC 60 Hz

D) Output Waveform: Pure Sine Wave, <3% THD

E) Input Current: 30 Amps Maximum

F) Input Voltage Variation: 85-150 VAC

G) Typical Efficiency: >95%

H) Max. Charge Current: 30A

I) Operating Temperatures: -37° C to 74° C

J) Typical Transfer Time: <33 milliseconds (ms)

K) Audible Noise at 1M: <55 dba

L) Lightning/Surge Protection: Must pass ANSI/IEEE C.62.41/C.62.45 Cat A&B

M) Other Unit Protection: Automatic electronic short circuit/overload shutdown, Automatic over-temperature shutdown, Voltage adjustment due to input voltage variation (for brownout protection)

N) Other Unit Features: L.E.D. Indicator for Online, On Battery, Low Battery Overload and Fault, or alpha numeric L.C.D.

O) Other Unit Features: RS-232 Computer Interface Port and Ethernet Port

P) Typical Battery Recharge Time: 90% in four hours

623.2.5 Warranty: A minimum of 36 months on all battery backup system components shall be provided when using Zinc Blue2. A minimum of 10 years on all battery backup system components shall be provided when using Super Capacitor Battery Modules. The warranty period shall begin within 30 days prior to completion of the project, after all punch-list items have been completed. The contractor shall purchase an extended warranty from the manufacturer as necessary.

623.2.6 Battery Backup System: Shall be one of the following as determined by the Traffic Engineer.

A) The Battery Backup System shall be an Econolite Zinc Blue2 or approved equal. Battery backup system shall be certified to operate in temperature range of -34° F to 165° F. Numbers of batteries and amp-hour rating shall be sufficient to operate the battery backup system in full signal operation at 350 watts for a minimum of four hours. Batteries shall be provided with appropriate interconnect wiring and

corrosion resistant mounting trays and brackets for the cabinet into which they will be installed. Battery charging system shall be regulated, and temperature compensated. Battery backup system shall be warranted for full replacement for three full years.

B) The Battery Backup System shall be an Econolite ZX2000-48 Super Capacitor Battery Modules and DBLMXU-48 Series Double Conversion UPS or approved equal. Battery backup system shall be certified to operate in temperature range of -34° F to 165° F. The battery backup system shall be sufficient to operate the traffic signal in full signal operation at 350 watts for a minimum of four hours. Modules shall be provided with appropriate interconnect wiring and corrosion resistant mounting trays and brackets for the cabinet into which they will be installed. The charging system shall be regulated, and temperature compensated. Battery backup system shall be warranted for full replacement for ten full years.

623.2.7 Supplemental Battery Cabinet: Mountable to side of controller cabinet, 0.125” thick aluminum type 5052-H32, natural aluminum finish, sturdy, aluminum shelves, lockable cover/door. Battery cabinet shall not exceed 46.5” H x 20.5” W x 10.5” D and shall house all units associated with the battery backup. The supplemental battery cabinet shall only be allowed in specific locations as determined by the Traffic Engineer. In most locations the battery backup system will be required to fit within the controller cabinet without using a supplemental battery cabinet.

623.3 CONSTRUCTION METHODS

623.3.1 The Traffic Engineer shall identify the location for installation of battery backup system prior to installation.

623.3.2 The supplemental battery backup cabinet shall be installed such that the door will open fully. If cabinet guard modifications are necessary, they shall be included as part of the battery backup installation.

623.3.3 When the battery backup system is placed inside the controller cabinet, the cabinet shall be a 332 stretch cabinet or larger.

623.4 METHOD OF MEASUREMENT

623.4.1 Battery backup equipment will be measured per intersection installed complete in place, including all hardware, software, and any incidental items necessary for installation.

623.5 BASIS OF PAYMENT

The installation of battery backup equipment, measured as provided above, will be paid for at the contract unit prices as follows:

A) Battery Backup System ..... EACH

B) Battery Cabinet ..... EACH

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals required to complete the work as specified.

## PART 624 – REMOVE AND RESET EXISTING TRAFFIC SIGNAL CONTROLLER ASSEMBLY

624.1 DESCRIPTION

624.1.1 This work consists of removing an existing traffic signal controller assembly, removal of the existing concrete pad, conduit and apron, construction of a new concrete pad, conduit, and apron, and reinstallation of the existing controller in the new location.

624.2 MATERIALS

624.2.1 All materials and labor shall meet the requirements of City of Tulsa Standards and Specifications for signal construction, cabinet guards and for traffic signal controller assemblies.

624.3 CONSTRUCTION METHODS

624.3.1 The Traffic Engineer shall approve the new cabinet location prior to installation.

624.3.2 All materials, equipment, and labor necessary to make the electrical connections to the existing controller cabinet shall be included.

624.4 METHOD OF MEASUREMENT

624.4.1 Removal and resetting of existing traffic signal controller assemblies will be measured per intersection installed complete in place, including all hardware and any incidental items necessary for installation.

624.5 BASIS OF PAYMENT

The removal and resetting of existing traffic signal controller assemblies, measured as provided above, will be paid for at the contract unit prices as follows:

A) Remove and Reset Existing Traffic Signal Controller Assembly ..... Each

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals required to complete the work as specified.

## PART 625 – REMOVAL OF TRAFFIC ITEMS

625.1 DESCRIPTION

625.1.1 This work consists of removing all items relating to traffic signals, street signs, and highway lighting items. This work shall meet the requirements of Section 805 of the ODOT Standard Specifications.

625.2 MATERIALS

625.2.1 This work shall include, but not be limited to, the removal of the following types of traffic items:

A) Traffic signal items including multi-sided, galvanized traffic signal poles, signal heads, pedestrian signal heads, pedestrian push buttons, backplates, controller cabinet assemblies, cabinet guards, pull box lids, mast arm signs, astro-brackets, span wire equipment, pull boxes, conduit, wire, and all other traffic signal equipment.

B) Street sign items including all ground-mounted street signs, street sign poles or other mounting hardware, sign toppers, sign assemblies with flashers, and sign flasher controllers.

C) Highway lighting items including poles, luminaires, high mast towers, lighting controllers, and undamaged pull box lids.

625.5.2 Footings, pull boxes, conduit, wire, green arm poles and all other signal poles, other than multi-sided poles, removed are to become the property of the Contractor unless otherwise specified by the Traffic Engineer. All other items that are in good condition prior to removal shall be returned in good condition to the Traffic Operations Division. Contact the Traffic Operations Division to schedule delivery appointments so the appropriate City staff may be on hand to verify the delivery.

625.2.3 Any traffic items not included in this specification for removal shall be handled and removed as determined by the Traffic Engineer.

625.3 CONSTRUCTION METHODS

625.3.1 All signal pole and sign footings shall be removed a minimum of 2ft below the ground level or as directed by the Traffic Engineer.

625.4 METHOD OF MEASUREMENT

625.4.1 This shall include all labor and incidental items necessary for complete removal of all items relating to traffic signals, street signs, and highway lighting items as detailed in ODOT Section 805 and in this specification. Separate payment shall not be made per item listed, but instead payment for this item shall include removal of all traffic related equipment per intersection or per block for items between intersections, both for items

specifically listed herein and for any other traffic related items found that are not specifically covered by this specification. An intersection is defined as extending to the beginning of a turn lane or 150ft, whichever is greater, unless otherwise designated in project plans.

625.5 BASIS OF PAYMENT

The removal of traffic equipment, measured as provided above, will be paid for at the contract unit prices as follows:

A) Removal of Traffic Items per Intersection ..... EACH
B) Removal of Traffic Items per Block ..... EACH

Such payment shall be full compensation for furnishing all materials, equipment, labor, and incidentals required to complete the work as specified. If a separate pay item for this work is not required by the Contract, the City of Tulsa will consider the cost to be included in the contract unit price for other relevant items of work.

## PART 626 – TRAFFIC SIGNAL CONSTRUCTION AND OPERATION

626.1 GENERAL

626.1.1 This specification covers all work performed on traffic signals in the City of Tulsa. Section 626.2 outlines the requirements when no signal work is anticipated and there is not an approved Traffic Signal Contractor on the project. Section 626.3 outlines the requirements when signal work is anticipated so the project has an approved Traffic Signal Contractor or Subcontractor. The remainder of this specification covers all requirements for Contractors performing traffic signal construction, maintenance, or operations work.

626.2 SIGNAL OPERATION WHERE NO SIGNAL WORK IS ANTICIPATED

626.2.1 On projects that are not anticipated to impact the signals where construction activities will occur near existing signalized infrastructure, the Contractor shall use all due caution to avoid damage to the traffic signal infrastructure.

626.2.2 If a Contractor believes that damage is unavoidable, they should halt that operation and contact the City of Tulsa prior to damaging the infrastructure. The Traffic Engineer, or designee, will determine if other measures need to be taken to avoid the damage or if additional work is necessary on the project for the work to progress.

626.2.3 An approved Traffic Signal Contractor or Subcontractor shall perform all of the work necessary for the signal operations and performing necessary repairs according to Specification 628 Signal and Lighting Project Contractor Experience Requirements.

626.2.4 In the case that the Contractor's operations or work damages any part of the signal infrastructure, the Contractor shall be responsible for any repairs necessary. Any repairs necessary shall be performed by the Contractor at his sole expense.

626.2.5 If the damage to the traffic signal renders any part of it inoperable, the Contractor shall immediately notify the City of Tulsa Traffic Operations Division. The Contractor shall be responsible for any interruptions to the signal operation due to the Contractor's operations and shall perform all work to restore the signal to normal operation at his sole expense (this is solely intended to bring the signal to the same state of operation as it was in prior to the damage), per Section 626.4 Signal Repair and Maintenance Response Times.

626.2.6 The City Traffic Engineer, or designee, shall work with the Contractor to assess the damage, to determine what needs to be done to make the intersection safe for traffic (including vehicles and pedestrians), and to determine what repairs shall be necessary.

626.3 SIGNAL OPERATION WHERE SIGNAL WORK IS ANTICIPATED

626.3.1 For projects that are anticipated to modify or replace existing infrastructure and new signals after they are put into operation prior to acceptance by the Traffic Engineer, the Contractor shall be expected to maintain the signal in a proper working condition during

construction as directed by the Traffic Engineer. Traffic signal heads shall either be turned away from approaching traffic or shall be covered with approved traffic signal bags in a manor approved by the Traffic Engineer while signal is out of operation. Plastic garbage bags, duct tape, gunny sacks and similar methods will not be accepted.

626.3.2 An approved Traffic Signal Contractor or Subcontractor shall perform all of the work and maintenance according to Specification 628 Signal and Lighting Project Contractor Experience Requirements.

626.3.3 Beginning of Contractor's Maintenance Responsibility: The Traffic Signal Contractor shall be responsible for traffic signal maintenance from the date established for work to begin in the Notice to Proceed. The Traffic Signal Contractor MUST notify the Traffic Engineer in writing at least 24-hours prior to starting any traffic signal work at an intersection. At that point, they will be added to the list referenced above and they will assume maintenance of the traffic signal. The Traffic Signal Contractor will also sign a form indicating that they are assuming maintenance for the Traffic Signal during construction per the requirements of this procedure.

626.3.4 Ending of Contractor's Maintenance Responsibility: The Traffic Signal Contractor shall be responsible for traffic signal maintenance until all traffic signal work has been inspected and approved, including completion and approval of all inspections punch-list items. When the traffic signal work is fully accepted and approved by the Traffic Engineer or Designee, the project will be removed from the list referenced above and the City of Tulsa will resume maintenance of the traffic signal.

626.3.5 Communication and Notification: All maintenance and operations requests received while the signal is the Contractor's responsibility (as described above), shall be forwarded to the Contractor for response.

For signal outages or other immediate safety concerns, City of Tulsa Staff shall notify the Traffic Signal Contractor as soon as a trouble report is received at an intersection. Other calls shall be routed to the Contractor as soon as possible.

In order to facilitate this process, good communication must occur between the Traffic Signal Contractor and the Traffic Engineer or Designee. The Contractor shall provide a contact number that will be answered 24/7 during construction projects.

The City of Tulsa shall maintain a list of all construction projects that this procedure applies to, along with the Traffic Signal Contractor's name and information. This information shall be available to necessary Traffic Operations staff and to the Water Dispatch group in order to route calls to the proper entities. Calls shall be handled as follows:

A) Daytime Calls: Traffic Dispatch or the Traffic Signal Inspector shall notify the Traffic Signal Contractor at the number provided whenever a call is received that is the Traffic Signal Contractor's responsibility.

B) After-Hours Calls: All after-hours trouble calls are routed through Water Dispatch, which is staffed 24/7. Water Dispatch shall contact the Traffic Signal Contractor when any trouble is reported at an intersection under their responsibility. If the Traffic Operations Trouble Truck receives a call for one of these projects, they will notify the Traffic Signal Contractor.

C) Logging: All calls received and all calls to the Traffic Signal Contractor shall be logged. The times discussed in the Response Times Section of this specification shall begin from the time that the Traffic Signal Contractor is notified.

626.3.6 Maintenance Responsibilities: Maintenance Responsibilities of the Contractor shall include the following:

A) Contractor shall maintain a sufficient stock of materials to be able to respond to and perform emergency repairs to the signal in order to keep it operational.

B) Contractor shall have on staff a Traffic Signal Field Technician, Level Il IMSA Certification, with a minimum of five years of troubleshooting experience, who can assist with emergency repairs and operational problems as needed.

C) Traffic Signal Contractors shall also be responsible for implementing and maintaining construction signal timing upon request of the City or general Contractor. The City of Tulsa may modify any signal timing at the sole discretion of the City Traffic Engineer.

626.4 SIGNAL REPAIR AND MAINTENANCE RESPONSE TIMES

626.4.1 As soon as the Contractor is notified that a signal is out of operation, the Contractor must take the following actions within the specified time frames:

A) Deploy all-way stop signs within one hour of notification.

B) Diagnose and perform simple emergency repairs within two hours of notification. If the repairs are more extensive, then the Contractor must contact the Traffic Engineer or designee before the end of this two-hour period.

C) Have the signal operational within 24 hours. A signal shall not be out of operation for more than a 24-hour period without approval of the Traffic Engineer.

D) If repairs cannot be made within 24 hours and an extension is not approved by the Traffic Engineer, temporary signals acceptable to the Traffic Engineer shall be installed per Specification 619 Temporary Signals.

626.5 SIGNAL CONSTRUCTION, OPERATIONS, AND MAINTENANCE REQUIREMENTS FOR ALL PROJECTS

626.5.1 Signal Cabinet Access: Unless the traffic signal is being maintained by the Contractor during construction as described in Section 626.2 of this Specification, the Contractor

shall request prior authorization at least 24 hours in advance before performing any work on a City of Tulsa signal cabinet. Once the work is completed, the City Traffic Engineer, or designee, must approve the work before the Contractor leaves the project.

626.5.2 Signal Modifications for Lane Closures: The Contractor shall notify the City of Tulsa Traffic Operations Division at least 24 hours prior to opening or closing lanes that will require enabling or disabling of a signal indication for the closure. The Contractor shall install all required traffic controls and signs including mast-arm mounted signs. All turn restrictions at signalized intersections must have appropriate mast arm mounted signs and conflicting signs must be temporarily removed or bagged with approved materials. No closures or openings requiring changes to the signal phases will be permitted on weekends. Changes to signals for weekend-only closures must be set up on Friday and removed on Monday during normal City of Tulsa business hours. Regardless of whether work is anticipated on the traffic signal or infrastructure, authorized Traffic Signal Contractors, per City of Tulsa 628 as noted above, shall be responsible for enabling and disabling signal phases, to accommodate closures during construction according to the approved Work Zone Traffic Control Plan, or as directed by the City. Pay items shall be included in the plans for this work.

626.5.3 Signal Heads Out of Operation: Traffic signal heads shall either be turned away from approaching traffic or shall be covered with approved traffic signal bags in a manner approved by the Traffic Engineer while signal is out of operation. Plastic garbage bags, duct tape, gunny sacks and similar methods will not be accepted.

626.5.4 Returning Signals Back to Operation: Signals that are out of operation shall not be put into operation on Mondays, Fridays, or holidays to allow troubleshooting during normal City of Tulsa business hours. Signals shall not be put into operation during rush hour traffic.

626.5.5 Concrete Work: At the Traffic Engineer's discretion, applicable concrete testing may be required for any concrete used in the construction of traffic items.

626.5.6 As-Built Drawings: Whenever modifications are made to a signal, the Contractor shall provide as-built drawings after the construction and installation is completed. If plans were available, the Contractor shall clearly note any and all deviations from plans by marking up a clean set of plans identified as "As-Built Plans". The notes, sketches, or attached drawings used to document the deviations shall show all necessary detail and dimensions to thoroughly and accurately depict the changes. The "As-Built Plans" must be submitted and approved by the Traffic Engineer before final acceptance of the project.

626.5.7 Permitting and Inspection: The contractor shall obtain the necessary permits for electrical inspection on all signal, flasher signs, and lighting work. Electrical inspections shall include all electrical equipment, enclosures, devices, cables, conductors, and raceways as defined by the NEC. High or low voltage shall be installed, maintained, connected, or removed by a State of Oklahoma licensed Electrical contractor. All work shall meet the requirements of the NEC. City of Tulsa shall reserve the right to define workman like manner. Proof of license shall be carried on person at all times and be

available to City of Tulsa personnel upon request per Title 158 – Construction Industries Board Chapter – 40 Subchapter 11-2(a)(9).

Contact the City of Tulsa Traffic Operations Division for the address to use on the permit. Requestor shall provide a location map showing the location of the signal or lighting controllers for which addressing is being requested (CAD files are preferred if available). Allow for a minimum of two weeks for this information to be provided.

626.5.8 Standards and Workmanship: The City will require excellent workmanship and precise compliance with the details provided in the plans, if available, as well as with the City of Tulsa Standards and Specifications. Requirements of the NEC, IMSA, and MUTCD that conflict with City of Tulsa Standards shall supersede at the discretion of the Traffic Engineer. Unacceptable work will be removed and redone at the contractor's expense. ODOT Standards are acceptable in matters where the City of Tulsa Standards are silent.

626.5.9 Utilities: Utilities shown in the plans are intended for information purposes only and are not to be construed as the extent or exact location and depth of utilities that may be encountered during the course of construction. The contractor shall field verify the presence, type, size, location, and depth of all existing utilities in the project area prior to construction.

The contractor shall be responsible for any damage he may inflict to the existing underground utilities within the project area as a result of his digging, trenching, boring, etc. The contractor shall meet the requirements of City of Tulsa Specification 105 and shall notify the Notification Center of Oklahoma One-Call System, Inc. of any excavation or demolition prior to the commencement of such work.

Depth of existing utilities shall be verified by the contractor prior to construction.

626.5.10 Traffic Signal Plans: Symbols and legends are diagrammatic only and locations shall be adjusted for existing field conditions, but no major alterations or relocations will be made without first consulting with the Traffic Engineer.

626.5.11 Waste Materials and Debris: All broken concrete, waste material and debris shall become the property of the contractor and shall be removed from the limits of the project and disposed of in a manner approved by the Traffic Engineer. No payment will be made for the disposal of this material.

## 626.6 ACCEPTANCE OF WORK

626.6.1 When all work has been completed by the Contractor and approved by the City of Tulsa Traffic Operations Division, the City of Tulsa shall provide a letter of acceptance to the Contractor. The Traffic Operations Division shall resume regular maintenance of the signal from the Contractor as of the date of acceptance specified in the letter.

## 626.7 METHOD OF MEASUREMENT

626.7.1 Traffic Signal Maintenance: This item includes all equipment and labor necessary to maintain and operate the signalized intersections during construction as described in Section 626.3, Signal Operation Where Signal Work Is Anticipated, of this specification. Materials shall be paid through other pay items included in the plans, as appropriate. As approved by the Traffic Engineer, except for materials that are considered incidental to the work being performed, if no pay item for the needed material is included in the plans, the Contractor shall notify the City of Tulsa so that appropriate materials may be supplied to the Contractor for repairs and maintenance. Payment shall be made per hour spent in maintenance work during construction. Depth of existing utilities shall be verified by the contractor prior to construction.

For repair work, if a pay item is included in the plans for a material and that pay item includes labor, then no separate payment shall be made for signal maintenance for that particular item. If materials are supplied by the City, then this pay item shall also cover the labor needed to install the materials and to complete the necessary repairs.

Contractors shall keep a log of all hours spent in maintenance work, including sufficient detail on what labor and materials were required, and shall submit those along with their pay estimates for approval and to document their hourly work.

626.7.2 Temporary Signals: Any temporary signals necessary during construction shall be paid for per Specification 619 Temporary Signals, unless otherwise noted in this specification or as required by the Traffic Engineer.

626.7.3 Signal Modifications for Lane Closures: This pay item shall be used to accommodate closures required by the approved work zone traffic control plan. The following work is included as a part of this pay item:

A) Modifications to the traffic signals to accommodate lane closures including bagging traffic signal heads, installation of temporary mast arm mounted signs, and signal cabinet work including minor signal timing modifications.

B) Any incidental materials or labor required to accomplish the lane closures.

C) Any work or equipment required to reopen the lane at the end of the lane closure.

Payment for this shall be made per signalized intersection.

626.7.4 All other labor and materials required as part of this specification shall be considered incidental to the work performed and no separate pay item shall be made for those items.

626.8 BASIS OF PAYMENT

626.8.1 Traffic Signal Maintenance and Signal Modifications for Lane Closures, as described in this specification, measured as provided above, shall be paid for at the contract unit price as follows:

A) Traffic Signal Maintenance ..... PER HOUR

B) Signal Modifications for Land Closures, Per Signalized Intersection .. PER EACH

## PART 627 – PRE-QUALIFICATION FOR TRAFFIC OPERATIONS MATERIALS

627.1 APPROVED PRODUCTS LIST

627.1.1 Approved Products List: The City of Tulsa Traffic Operations Division maintains the City of Tulsa Traffic Engineering's Approved Products List of all materials conforming to the requirements of this specification. Materials appearing on the Approved Products List require no further testing, unless deemed necessary by Traffic Engineer. Equipment, material, and hardware not pre-approved when required will not be allowed for use on the project except as provided for in these specifications.

627.1.2 Bidders' and Suppliers' Requirements:

A) To be accepted on bids, materials must have approved product codes or designations and be from pre-qualified producers.

B) The supplier's facilities must be of sufficient size and staffing that all warranty repairs to the cabinet assembly can be made on a timely basis. The interpretation of 'timely return of equipment' is no more than 18 calendar days from the date of receipt by the supplier to the return receipt of the equipment at the specified location. This requirement may be met by field service. Failure to meet these requirements may result in rejection of future bids.

C) Each item delivered shall be individually packed in its own shipping container. When loose Styrofoam is used for packing the item, the item shall be sealed in a plastic bag to prevent direct contact with the Styrofoam. Each item delivered for testing shall be complete, including manuals, and ready for testing. All static sensitive materials shall be sealed in anti-static enclosures.

627.1.3 Procedure: Prospective producers interested in submitting their product for evaluation must submit a written request to the City of Tulsa Traffic Operations Division. Forms will be provided by the Traffic Engineer for submitting requests.

627.1.4 Material Requirements:

A) Controller Cabinet Assemblies:

1) Sample: Submit one signal controller assembly with the pre-qualification request. All materials submitted for pre-qualification tests will be at no cost to the City of Tulsa and must be new and unused.

2) Documentation: Provide a complete list of parts and quantities supplied along with any model numbers, serial numbers, or other identifying information.

a) Provide each cabinet with the following documentation:

1. Three complete, accurate, and fully legible diagrams and one schematic for every electronic device (This must include but not be limited to cabinet

wiring, back panel, detector panel, power panel, PE panel, flasher circuit, switch packs, card rack power supply, bus interface unit, and power supply diagrams).

2. Complete parts list including names of vendors for parts not identified by universal part numbers.

b) Provide each controller unit with the following documentation:

1. One service manual per unit that includes description of controller unit, description of its operation, and basic maintenance and troubleshooting information.

2. Two complete, accurate, and readable schematic diagrams for all circuitry in the controller unit (one set of these diagrams may be included in the service manual).

3. Complete parts list including names of vendors for parts not identified by universal part numbers (this may be included in the service manual).

4. Pictorial-of-components layout for each circuit board or individual component identification permanently printed on each circuit board. (Regardless of which of the above is provided, each electronic component on the board must be clearly identified or labeled. This may be included in the service manual).

c) Bidders must be prepared to furnish manufacturer's certifications obtained from the producer, supplier, or an approved independent testing laboratory that it meets standards defined in this section for the complete cabinet assembly from an independent laboratory. A manufacturer's certification shall be a certified statement that the material actually shipped to the project was manufactured by production processes that are periodically and routinely inspected to assure conformance to specification requirements. When requested by the Traffic Engineer, provide additional certifications from independent testing laboratories and sufficient data to verify item meets applicable specifications. Ensure additional certification states the testing laboratory is independent of the material manufacturer and neither the laboratory nor the manufacturer has a vested interest in the other.

d) Identify all proprietary parts in Contractor-furnished material. The Traffic Engineer reserves the right to reject material that uses proprietary components not commercially available through electronic supply houses.

3) Sampling and Testing:

a) Signal controller cabinet assemblies must meet or exceed all applicable Standards and Specifications of the National Electrical Manufacturers Association (NEMA), Caltrans Transportation Electrical Equipment

Specifications, Oklahoma Manual on Uniform Traffic Control Devices (MUTCD), National Electric Code (NEC), Institute of Transportation Engineers (ITE) and the City of Tulsa Standards and Specifications. In addition to testing of pre-shipment samples, complete testing of signal controller assemblies may be required at any time before acceptance.

b) Burn-in each controller cabinet assembly for a period of 48 hours at a temperature of 140° F or for a period of 96 hours at a temperature of 73.4° C. A certification must be included with or attached to each controller cabinet indicating the dates of the burn-in period, number of hours, burn-in temperature, and results.

c) The Traffic Engineer may test any controller cabinet assembly under load in a shop environment for a period of at least 120 hours. During this time, the entire controller cabinet assembly will be inspected for compliance with the specifications.

d) The Traffic Engineer may then require the results of testing as detailed in the Caltrans Transportation Electrical Equipment Specifications, Chapter 1 – Section 8 on Electrical, Environmental, and Testing Requirements.

e) Testing will be performed in the normal operating (i.e., non-flashing) range of 95-135 VAC. All traffic signal cabinet assembly components must operate normally at 95 VAC, just as the unit would operate at 120 VAC.

f) Provide Traffic Operations Division with closed-loop software, hardware, and cables needed to monitor controller operations during testing.

B) All Other Materials:

1) Sample: Submit one material sample with the pre-qualification request. All materials submitted for pre-qualification tests will be at no cost to the City of Tulsa and must be new and unused.

2) Documentation: Provide a complete list of parts and quantities supplied along with any model numbers, serial numbers, or other identifying information. Provide any manufacturer's documentation available on the product.

3) Sampling and Testing: All materials must meet or exceed all applicable Standards and Specifications of the National Electrical Manufacturers Association (NEMA), Caltrans Transportation Electrical Equipment Specifications, Oklahoma Manual on Uniform Traffic Control Devices (MUTCD), National Electric Code (NEC), Institute of Transportation Engineers (ITE) and the City of Tulsa Standards and Specifications. In addition to testing of pre-shipment samples, complete testing of submitted materials may be required at any time before acceptance. Length of testing necessary shall depend on the equipment and shall be determined by the Traffic Engineer, standard evaluation times shall be documented on the Approved Products List.

627.1.5 Warranty: All equipment on the Approved Products List must have no less than 95% of the manufacturer's standard warranty remaining on the date that the contractor submits equipment invoices for payment. The Traffic Operations Division will not accept any equipment with less than 95% of its warranty remaining.

627.1.6 The cabinet assembly including all contents must be fully warranted for parts and labor for a minimum of five years from the date of acceptance. Software and firmware updates must be included as part of the warranty.

627.1.7 Other material warranties will be evaluated based on the materials as part of the approval process and will be listed on the Approved Products List, as necessary.

627.1.8 Evaluation: Material evaluation falls into two categories: Equal or New. When a request for material evaluation is received by the Traffic Engineer, the information will be reviewed to determine if it is an Equal Product or a New Product. Traffic Engineer will notify prospective bidders and suppliers after completion of the material evaluation.

A) Equal Product: Equal Products are similar to materials that are currently used by the Traffic Operations Division and are covered by existing Specifications and Standards. For Equal Products, the manufacturer or supplier must provide certification(s) and/or test results from an independent testing laboratory addressing all existing Specifications and Standards.

B) New Product: New Products are materials that are not addressed by current City of Tulsa Specifications and Standards. New Products must follow the procedures outlined in this specification for approval. For any New Products that are not covered by this specification, the Traffic Engineer will review the request and determine what testing is appropriate and reasonable to determine if the material is acceptable for use in the City of Tulsa.

C) Qualification: If approved for use by the Traffic Operations Division, the material will be added to the Approved Products List as Approved. If material is listed on the Approved Products List as Approved, no additional submittals are required for that product.

If a product is approved conditionally, the material will be added to the Approved Products List as Under Evaluation and the conditions for approved use will be noted. If a material is listed on the Approved Products List as Under Evaluation, then submittals must still be provided to show that the product use falls within the restrictions stated.

Date of acceptance will be the date that Traffic Operations Division adds it to the Approved Products List as Approved or Under Evaluation.

The materials supplied from the Approved Products List must be identical to the approved materials. Submit any deviations from the approved materials for evaluation and approval before any material is fabricated or ordered.

Deviations from the approved material after shipment of any parts of the order will be cause for rejection and nonpayment of the remainder of the order. Excessive delays or noncompliance by the vendor at any point in the approval process may be cause for cancellation and nonpayment.

D) Failure: Products not qualified under this specification will be listed on the Approved Products List as Rejected and those materials may not be furnished for Traffic Operations Division projects. A manufacturer or supplier must show evidence of correction of all deficiencies before reconsideration for qualification.

If any of the assemblies fail any of the tests, the supplier will be permitted to make one complete repair of the order on a timely basis, which will be determined by the Traffic Engineer, and the testing may be redone once before it is given Rejected status.

Minor discrepancies noted in sampling and test of this item received must be corrected within 30 days of written notice of the discrepancies or as stated in the notice. Major discrepancies that in the opinion of the Traffic Engineer will substantially delay receipt and acceptance of the item will be cause for cancellation of the purchase order. Any discrepancies found in partial shipments must be corrected before the delivery of subsequent shipments.

Unsatisfactory performance of a material or supplier, at any time, will result in a rejection of a product and removal from the Approved Products List.

627.2 PROJECT AND EQUIPMENT SUBMITTAL REQUIREMENTS

627.2.1 Materials on the Approved Products List: No additional submittals are required if it is listed as Approved. Materials listed as Under Evaluation must provide material specifications showing that they adhere to the conditions listed in the Approved Products List.

627.2.2 Materials not on the Approved Products List: Furnish three copies of the equipment list including three copies of catalog cuts. Identify proposed material on catalog cuts by a reproducible means (highlighter pen does not transfer to copies). Ensure materials lists contain material description, brand name manufacturer’s address and telephone number, stock number, size, identifying trademark or symbol and other appropriate ratings. New products must follow this specification.

627.2.3 Approval: Approval will be given in writing. Contractor or supplier shall not fabricate or order material until receipt of the Traffic Engineer’s approval.

## PART 628 – SIGNAL AND LIGHTING PROJECT CONTRACTOR EXPERIENCE REQUIREMENTS

628.1.1 Pre-Qualification: Only contractors that have been pre-qualified by the Traffic Engineer or designee will be allowed to work on any Traffic Signals in the City of Tulsa.

628.1.2 Contractor Requirements: Bidders shall be experienced Contractors that have demonstrated their capabilities in executing projects that are similar in technical requirements and dollar values. In the City of Tulsa, for all work relating to the installation, maintenance, or removal of traffic signals, electrical conduit, sign flashers, or street and highway lighting, qualified Contractors or Subcontractors must be able to perform the work in conformance with the following requirements:

A) For all work relating to the installation, maintenance, or removal of traffic signals, electrical conduit, sign flashers, or street and highway lighting, qualified Contractors or Subcontractors must be able to perform the work in conformance with all applicable City, State, and Federal regulations including City of Tulsa Standards and Specifications, the Project plans, the Manual on Uniform Traffic Control Devices (MUTCD), and the National Electric Code (NEC). Contractors or Subcontractors shall also have at least one employee on-site at all times with applicable International Municipal Signal Association (IMSA) certifications including, but not limited to, Level I and Level II in Traffic Signals.

B) The Contractor shall obtain the necessary permits for electrical inspection on all signal, conduit, sign flasher and lighting work. Electrical inspections shall include all electrical equipment, enclosures, devices, cables, conductors, and raceways as defined by the NEC. High or low voltage shall be installed, maintained, connected, or removed by a State of Oklahoma licensed Electrical contractor. Proof of license shall be carried on person at all times and be available to City of Tulsa personnel upon request per Title 158 – Construction Industries Board Chapter – 40 Subchapter 11-2(a)(9). All work shall meet the requirements of the NEC. City of Tulsa shall reserve the right to define workman like manner.

C) The Contractor shall provide a maintenance bond that covers all of the work and materials listed in this specification for one year after the project is accepted by the City.

D) By bidding, the Contractor is agreeing that they are capable of meeting the requirements of Part 626 of these Specifications for Traffic Signal Operation and Construction.

628.1.3 Documentation: In order to ensure that the Project work is performed by qualified and experienced Contractors, bidders must submit a qualification statement attached to their bid consisting of the following for the Contractor or Subcontractor who will be performing the signal, sign flasher, or lighting work:

A) List of projects completed within the past four years that are similar in scope and dollar value to this project. The Contractor must have successfully completed at least five projects within this time period.

B) For each submitted project in Item A provide the following information:

1) Company owner's name and telephone number,

2) If applicable, the name and telephone number of any Licensed Electrical Contractors who worked on the project,

3) The location of the project,

4) The beginning and completion dates of the project,

5) The contract amount,

6) A brief description of the project work including applicable information on the type of signal, sign or lighting equipment installed, i.e. what type of signal controller, cabinet, detection, preemption system, communications equipment, lighting controllers, signal flashers, etc.

C) Provide a list of all Sub-Contractors (if applicable) that will be utilized on the project and their experience as detailed in Items A and B above.

D) The name and phone number of the Licensed Electrical Contractor to work on the project.

E) The name and phone number of the Traffic Signal Field Tech on call to perform repairs as necessary for the project.

628.1.4 Changes: After the bid is accepted, if the Contractor needs to change any item already approved through the above process, the Contractor must submit those changes along with the revised documentation as listed above in items A-D to the Traffic Engineer for approval at least five business days prior to commencing work on any of the work items referenced in this specification.

## PART 629 – SIGNS ASSEMBLIES WITH FLASHING BEACONS

### 629.1 GENERAL

629.1.1 This work shall consist of furnishing materials and installing poles, signs, controllers, confirmation lights and all other equipment for all types of sign assemblies with flashing beacons, including school zone flashing signs, in accordance with these Specifications and in reasonably close conformity with the locations and dimensions shown on the Plans or established by the Traffic Engineer. Standard sign assemblies with flashing beacons are intended for 24/7 operations. School sign assemblies with flashing beacons are intended for intermittent operation during school hours only.

### 629.2 MATERIALS

629.2.1 General. Provide regulatory or warning sign assemblies that consist of a sheet aluminum sign with the message, traffic signal heads, signpost, foundation, wiring, and conduit as shown on the Plans or as directed by the Traffic Engineer.

All flashing beacon sign assemblies shall include the following items: aluminum pedestal pole, octagonal pedestal pole base, pole and base collar assembly for the octagonal base, signal housings and visors, two yellow ball LED indications, controller cabinet, sign as directed by the Traffic Engineer, sign mounting brackets and hardware, wiring, bonding and all other appurtenances to make the sign flasher assembly stable and functional in-place.

Power shall be supplied either via electrical service or solar panels.
All hardware shall be stainless steel. All fittings shall be aluminum with no coating.

629.2.2 Solar Powered Flashers. Solar powered flashers shall also include mounting hardware, battery, 55 Watt solar module (including solar panels, 1/2" Carflex electrical tubing or approved equal to protect panel wiring, and 1/2" Carflex threaded connection or approved equal) with top of pole mounting, and cabinet mounting bracket.

629.2.3 Electrical Service Powered Flashers. Services for electrically powered flashing signs shall be installed and paid for per City of Tulsa Specification 607.

629.2.4 School Flashers. School zone flashers shall include school controller cabinet either AC powered or solar powered as specified by the Traffic Engineer, with a cellular programmable time switch, antenna, and confirmation light assembly.

629.2.5 Standards. Materials shall meet the requirements specified in AASHTO Standard Specifications for Structural Supports of Highway Signs 2009 – Luminaries and Traffic Signals, ODOT Specifications – Section 836, and City of Tulsa Standards and Specifications.

629.2.6 Approved Products List. All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List (APL).

629.2.7 Flashing Beacon Sign Pole. Sign poles shall be 4” in diameter (4-1/2” O.D.), 13’ tall, schedule 40 spun aluminum with 8 NPT taper (Pelco 5100-13 with Pelican ID or approved equal) with no coatings and an aluminum dome type pole cap (Pelco PB-5402 or approved equal). For signs taller than 48”, a pole longer than 13’ may be allowed with the approval of the Traffic Engineer.

629.2.8 Flashing Beacon Sign Pole Base. The base for the sign pole shall be an aluminum octagonal pedestal pole base assembly (Pelco PB-5349-GL or approved equal) with an aluminum pole and base collar assembly for an octagonal base (Pelco PB-5326 or approved equal).

629.2.9 Flashing Beacon Sign Pole Anchor Bolts. Anchor bolts for flashing beacon sign pole bases shall be stainless steel wedge anchor bolts or approved equal and shall include the following hardware:

A) Quantity 4 of 3/4" x 8 1/2" stainless steel wedge anchors,

B) Quantity 4 of 2 1/2" O.D. x 1 1/16” stainless steel flat washers,

C) Quantity 4 of 1 7/8” O.D. x 3/4" stainless steel flat washers,

D) Quantity 4 of 3/4" stainless steel lock washers, and

E) Quantity 4 of 3/4" stainless steel hex nuts.

629.2.10 Flashing Beacon Sign Pole Footing. Pole footings shall be a standard F-1 pedestal footing furnished and installed in accordance with City of Tulsa Specification 603.

629.2.11 Flashing Beacon Sign Pole Conduit. A 2” conduit shall be installed in the footing for electrical service powered flashing beacon signs. A City of Tulsa Pull Box Size I meeting the requirements of City of Tulsa Specification 601 shall be installed within 10’ of the footing for electrical service powered flashing beacon signs.

629.2.12 Flashing Beacon Sign Pole Bonding. There shall be #6 green THHN stranded copper connected to the bonding point of the aluminum base of each flashing beacon sign pole and the service disconnect ground buss. Bonding wire shall be connected using LA-6A Ideal Part #87-002 aluminum lug and 1/4" X 20 stainless steel bolt and nut or approved equal.

629.2.13 629.2.13 Signs. Provide signs in accordance with City of Tulsa Specification 608. Signs shall be attached to the pole using at least two stainless steel U-bolt clamps (Pelco SH-0209-SS or approved equal). Signs shall meet requirements of the Manual on Uniform Traffic Control Devices (MUTCD). School signs shall be 24” X 48” in size and, unless otherwise directed by the Traffic Engineer, shall read as follows: SCHOOL SPEED LIMIT 25 WHEN FLASHING. All other signs will be installed as directed by the Traffic Engineer.

629.2.14 U-Bolt Clamp Mounting Hardware. Hardware for mounting the sign and controller cabinet shall be stainless steel and shall include the following per sign or cabinet:

A) Quantity 2 of 5/16" x 1 1/2" stainless steel flat washers,

B) Quantity 2 of 5/16" stainless steel lock washers,

C) Quantity 2 of 5/16” stainless steel hex nuts.

629.2.15 Wiring. All wire shall meet the requirements of City of Tulsa Specification 611 for Electrical Conductors for Traffic Signals.

629.2.16 Flashing Beacons. Flashing beacon assemblies shall consist of two polycarbonate signal heads with amber LED indications mounted in an over sign and under sign configuration. For flashing beacon signs powered by an electrical service connect, use two 120-volt AC amber LED indications. For flashing beacon signs powered by solar panels, use two 12-volt DC amber LED indications.

Heads shall be wired so they will bounce flash using 4#14 Traffic Signal Electrical Cable as specified in City of Tulsa Standard 629 between the signal heads and the cabinet. A 2#14 shielded electrical conductor shall be used between the two amber LED indications and run through a shoe.

Flashing beacons shall be mounted using a gusseted tube (Pelco AB-0300-18 inch or approved equal), two-way upper arm assembly (Pelco AB-0296-SS or approved equal), two-way lower arm assembly (Pelco AB-0297-SS or approved equal), and neoprene gaskets (Pelco SE-0354 or approved equal) as shown in City of Tulsa Standard Drawing 629.

The flashing beacon assembly shall be mounted to the pole using a 62” cable mount clamp kit (Pelco Astro-Brac Stellar Series Clamp Kit, AS-3009-62-SS, or approved equal).

The signal housing, visor, and 12” amber LED indications shall meet the requirements of City of Tulsa Specification 614 except that they shall be considered part of the assembly and shall not be paid for separately.

629.2.17 Confirmation Light Assembly. Confirmation light assemblies shall be LED with stainless steel, clear globe, on-way hub assembly and 29” band mount (Pelco SM-0286-CL-29-SS or approved equal). A 2#14 shielded electrical cable shall be used for the confirmation light.

629.2.18 School Controller Cabinet. Cabinet shall be an RTC Model #502608-T model or approved equal. The cabinet shall use NEMA flasher and transfer relay. Cabinet dimensions shall be 15” high, 15” wide and 12” deep. The cabinet shall not be pre-drilled for conduit connection. The cabinet shall come with an RTC AP22 programmable time switch with Guardian Board and cellular modem, or approved equal, with the latest software and hardware.

If a solar powered flashing beacon assembly is being used along with a school zone controller cabinet, then the cabinet shall be an RTC Model #502598SW cabinet or approved equal. The cabinet shall contain one DCF2, two circuit 12-volt DC battery. Cabinet dimensions shall be 17" high, 18" wide and 14" deep. The cabinet shall come with an RTC AP22 cellular programmable time switch with Guardian Board, or approved equal, with the latest software and hardware.

If cabinet is mounted on the flashing beacon sign pole, cabinet shall be mounted using two stainless steel U-bolt clamps (Pelco SH-0209-SS or approved equal) or using two stainless steel 4" mounting kits (Pelco SE-1100-SS or approved equal). If U-bolt clamps are used, the connection from the base of the cabinet to the pole shall consist of one 1-1/2" case nipple, one 1-1/2" aluminum L.B. gasket and cover, one 1-1/2" X 2" aluminum all thread nipple (Pelco SE-0309-2 or approved equal) and one stainless steel 1-way hub assembly for a 4-1/2" O.D. pole (Pelco SE-3093-SS or approved equal).

If cabinet is mounted to wooden service pole, cabinet shall be mounted using stainless steel banding. Conduit shall be 1-1/2" galvanized steel electrical conduit as specified in City of Tulsa Specification 602 and shall be strapped to the pole using 2-hole straps. From the cabinet to the disconnect, 1" Sealtight, or approved equal, shall be used.

Cabinet door shall lock with a 3-point locking system, similar to the 3-point locking system used on a McCain 332 traffic signal cabinet.

629.2.19 Flasher Controller Cabinet. If a school controller cabinet is not used, flasher controller cabinet assembly shall be the same as for the school controller cabinet but shall not include a time clock.

629.2.20 School Controller Cellular Programmable Time Switch. Programmable time switch shall be fully compatible with existing school flasher hardware used by the City of Tulsa, as outlined in this specification (RTC AP22 programmable time switch with Guardian Board and cellular modem, or approved equal, with the latest software and hardware). In addition, the system shall meet the following requirements:

A) 10-year prepaid cellular service plan,

B) Monitoring software must be included at no additional charge,

C) Software may be cloud-based and have the ability to define secure logins with variable access levels for users,

D) Software must have the ability to schedule a full calendar year,

E) Software must include real time monitoring of the voltage/battery status, beacon status, clock drift, and loss of communications,

F) Front-panel status indication (Including time of day and schedule),

G) Programmable directly from the front panel with no extra hardware, laptop or programming devices,

H) Easily retrofitted into existing cabinets as described in this specification without modifications,

I) Must be able to remotely program and monitor, schedule and give manual commands,

J) All hardware including modem, mounting brackets, antennas, and other incidentals shall be included,

K) Licensing shall include a minimum of 250 school flashers.

629.2.21 School Controller Antenna. Antennas shall be installed according to City of Tulsa Standard 629 unless otherwise specified by the Traffic Engineer.

Antennas shall include any cabling, mounting equipment, or other appurtenances to make them operational. All cabling shall be secured with UV rated tie wraps.

629.2.22 Inspection. All materials shall be inspected by an authorized agent of the City of Tulsa Traffic Operations Division (TOD) to ensure compliance with the specifications.

629.3 CONSTRUCTION METHODS

629.3.1 All hardware and fittings shall be installed wrench tight.

629.3.2 Controller cabinets for electrical service powered flashers shall be mounted to the wooden service pole. If a pedestal service is being used, the controller cabinet may be mounted on the flashing beacon pole.

629.3.3 Poles shall be installed plumb in two perpendicular directions. The pole must be wrench tight before the collar is installed. Pins must be installed.

629.3.4 Flashing beacons and signs shall be aimed and leveled properly to insure maximum visibility prior to acceptance of the sign assembly.

629.3.5 Excess cable must be tied down using UV rated tie wraps.

629.3.6 All unused, drilled holes in the poles shall be resealed by non-ferrous rain-tight materials and methods as approved by the Traffic Engineer.

629.3.7 All holes in the top of the signal heads shall be permanently sealed with aluminum, stainless or nylon hardware or approved equal. No silicone shall be allowed.

629.3.8 Antenna for cellular programmable time switch shall be mounted per manufacturer's instructions. For antennas installed on the pole cap, a 7/8" hole shall be drilled into the

pole cap and filed smooth for antenna installation. For antennas installed on a wooden service pole, the antenna riser shall be strapped to the pole using 3/4" straps and 3/4" EMT.

629.3.9 Antenna for cellular programmable time switch shall be mounted to the top end of the solar panel frame with self-tapping screws if solar flashing beacon is used. For antennas installed on a solar panel, drill a 7/8” hole for a 1/2" case nipple and locknut to prevent coaxial cable from chafing. Coaxial cable for the antenna shall be installed to limit exposure to sunlight.

629.3.10 Antennas shall be installed plumb.

629.3.11 A 1-3/8” hole for cable access for the confirmation light assembly shall be drilled through the pole and filed smooth, located 26” from the top of the pole as shown on City of Tulsa Standard 629.

629.3.12 A 1-3/8” hole shall be drilled for cable access for the controller cabinet and filed smooth as shown on City of Tulsa Standard 629.

629.3.13 For solar powered flashing beacon sign assemblies, no splices shall be allowed between the panel junction box and the control cabinet.

629.4 METHOD OF MEASUREMENT

629.4.1 Sign assemblies with flashing beacons will be measured by each assembled unit installed.

629.5 BASIS OF PAYMENT

The accepted sign assemblies with flashing beacons, measured as provided above, will be paid for at the contract unit price as follows:

A) Sign Assembly with Flashing Beacon, Electric ..... EACH

B) Sign Assembly with Flashing Beacon, Solar ..... EACH

C) School Sign Assembly with Flashing Beacon, Electric ..... EACH

D) School Sign Assembly with Flashing Beacon, Solar ..... EACH

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as shown on the Plans and these Specifications.

## PART 630 – RECTANGULAR RAPID FLASHING BEACONS

630.1 GENERAL

630.1.1 This work shall consist of furnishing and installing solar powered rectangular rapid flashing beacons (RRFB) at the locations indicated on the plans or where directed by the Traffic Engineer.

630.2 MATERIALS

630.2.1 Approved Products List. All materials provided shall be supplied per the approved materials listed on the City of Tulsa Traffic Operations Approved Products List (APL) or by approved submittals.

630.2.2 Each RRFB should meet the specifications of Interim Approval for Optional Use of Pedestrian Actuated Rectangular Rapid Flashing Beacons at Uncontrolled Marked Crosswalks (IA-21) (FHWA) and Interpretation Letter 4(09)-5(I) – RRFB.

630.2.3 Use with W11-2 (FYG) sign for crosswalks, S1-1 (FYG) sign for school crosswalks and W11-15 (FYG) sign for shared use paths or other locations where bikes are permitted to cross. All diamond shaped signs shall be 30” x 30” for single lane roads and 36” x 36” for multi-lane roads and shall meet the requirements of City of Tulsa Specification 608 for Traffic Signs.

630.2.4 Each RRFB full assembly shall be a complete assembly, consisting of supporting structure (pole, all mounting brackets for all components of the assembly, and foundation), indications, signage, and electrical components (wiring, solid-state circuit boards, solar panels, etc.).

630.2.5 The supporting structure of the RRFB shall consist of a 2” minimum perforated square-tube post, meeting the requirements of the latest version of the City of Tulsa Specification 608 for Traffic Signs. If the manufacturer recommends that the sign be placed into a concrete or other footing, and/or a larger pole, then that shall also be included as a part of the full assembly. Posts shall not be attached to the top of concrete slabs by bracketed anchor assemblies.

630.2.6 Each RRFB shall be powered by solar panels.

630.2.7 Each RRFB to be supplied with all required hardware to install assembly. Hardware for mounting the sign to the pole shall meet the requirements of City of Tulsa Specification 608 for Traffic Signs.

630.2.8 Single Sided RRFB Full Assemblies shall typically only be used at one-way streets or divided streets. All other RRFB Full Assemblies shall be double sided, unless directed otherwise by the Traffic Engineer.

630.3 CONSTRUCTION METHODS

630.3.1 Each RRFB shall be activated by a push button unless otherwise specified. Supplemental RRFB signs used in coordination with other push button activated RRFBs at a crosswalk may not have push buttons, as determined by the Traffic Engineer. All RRFB assemblies including supplemental RRFB assemblies for a crosswalk shall actuate at the same time when a push button is pushed.

630.3.2 The push buttons shall be PROWAG, ADA and MUTCD compliant and shall meet the applicable requirements of City of Tulsa Specification 613 for Pedestrian Push Buttons.

630.3.3 The push buttons shall be Accessible Pedestrian Signals (APS) push buttons to allow for both factory and manually programmed speech-walk messages. If an APS system is utilized, the standard verbal message will be “Warning Lights are Flashing”. This message shall be repeated twice.

630.3.4 Construct the pedestrian push button so that it is tamper proof. Design it to prevent an electrical shock under any weather conditions.

630.3.5 RRFB’s that have pedestrian push buttons shall also have an R10-25 sign, PUSH BUTTON TO TURN ON WARNING LIGHTS / AWAIT GAP IN TRAFFIC.

630.4 METHOD OF MEASUREMENT

630.4.1 For the pay items that require installation, the Contractor shall provide all installation services, equipment, and materials as necessary to install a fully operational RRFB assembly in the locations indicated by the plans or as directed by the Traffic Engineer. This is to include all set-up and installation equipment, pole mounts, brackets, hardware, and any other appurtenances necessary to make the RRFB operational.

630.5 BASIS OF PAYMENT

The accepted RRFB system, measured as provided above, will be paid for at the contract unit prices as follows:

A) Single Sided RRFB with APBS, Installed ..... EACH

B) Single Sided RRFB with APBS, Materials Only ..... EACH

C) Single Sided RRFB without Push Buttons, Installed ..... EACH

D) Single Sided RRFB without Push Buttons, Materials Only ..... EACH

E) Double Sided RRFB with APBS, Installed ..... EACH

F) Double Sided RRFB with APBS, Materials Only ..... EACH

G) Double Sided RRFB without Push Buttons, Installed ..... EACH

H) Double Sided RRFB without Push Buttons, Materials Only ..... EACH

Such payment shall be full compensation for furnishing materials, labor, equipment, and incidentals necessary to complete the work as specified.

**SECTION END**

# 701 Special Requirements, New Equipment Purchases

## 701.1 Design and Construction Features

### 801.701.1 Scope

The following special requirements are to be incorporated into specifications for purchase of new equipment by contractors, engineering consultants, or the City of Tulsa. In case of conflict between the "Special Requirements, New Equipment Purchases", and the purchase order, unless specifically stated by the order as an exception, the vendor shall obtain a written determination from the City of Tulsa Division Engineer before proceeding with the work affected.

### 701.1.1 Pumps – Horizontal, Vertical, Submersible

1. All hardware including bolts, studs, washers, nuts, nameplate / fasteners, grease caps or plugs, drain plugs or fittings, etc. shall be of plated steel minimum. Hardware for wastewater service shall be of 316 stainless-steel constructions.316 stainless steel fasteners specified will include nickel-based anti-seize and shall be applied to threaded fasteners during factory assembly and all piping installation applications.
2. Bolts and studs shall fully engage nuts and shall have a minimum of three threads visible beyond nut. All wastewater fasteners shall not be painted. Refer to 801.1.2 section 1 for required fastener type.
3. All through-bolt flanges shall be full-faced on back side or shall be back spot-faced.
4. Horizontal and vertical pumps in wastewater service with 8 inch and larger nozzles shall have a minimum 5-inch diameter hand hole clean-out ports with closure flange to allow access to the suction and discharge areas of the impeller. If impractical to locate the hand hole clean-out ports on the pump nozzles, the ports shall be added to the suction and discharge piping. (This requirement is referenced in "Piping" section 801.1.27.1.)
5. Horizontal and vertical pump nozzles (both suction and discharge) shall each have minimum 0.50-inch NPT (National Pipe Thread) connections for air relief, and minimum 0.75 inch NPT connections for pressure measurements. If this is not standard for the pump manufacturer, the taps are to be incorporated into the adjacent suction and discharge piping. (This requirement is referenced in "Piping" section 801.1.27.2.)
6. An air relief valve shall be fitted at high point(s). The ARV shall be supplied either by the pump manufacturer or by the engineering contractor. (N/A to submersible pumps.) (This requirement is referenced in "Piping" section 801.1.27.2.)
7. Bearing housings containing oil shall be vented to the atmosphere through a desiccant breather to prevent ingestion of dirt and moisture. (N/A to submersible pumps.)
8. Equipment and accessories shall be designed and constructed for continuous operation.
9. Pumps which spare each other shall be identical.

10. Pumps that have stable head/capacity curves which continuously rise to shutoff are preferred for all applications and required when parallel operation is specified by purchaser.
11. NPSHA and NPSHR (Net Positive Suction Head Available and Net Positive Suction Head Required) margin shall be a minimum of 3 feet at rated capacity and speed, or the margin recommended by Hydraulic Institute, whichever is greater.
12. Suction specific speed (NSS) greater than the Hydraulic Institute allowable of 8,500 shall require specific approval by the City of Tulsa Water and Sewer Division Engineer.
13. For sewage applications, pumps to be non-clog design, and must allow passage of spheres of the diameter specified by the City of Tulsa Water and Sewer Division Engineer.
14. For all solids-handling applications, the pump speed is not to exceed 1800 RPM per the Hydraulic Institute.
15. Impellers shall be keyed to the shaft to prevent harmful effects of any possible reverse rotation. A locking ring or threaded nut shall fix the impeller's axial position to the shaft and withstand maximum hydraulic thrust loads.
16. All pump casings shall be unpainted when hydrostatically tested with water at 1.5 times the maximum casing design pressure. The hydrostatic tests shall be considered satisfactory when no leaks are observed for a minimum of 10 minutes.
17. Pipe strain shall be minimized during installation of piping and rotating equipment per vendor's IOM and Standard Maintenance Guideline AM-SMG-803, "Pipe Strain Allowed on Rotating Equipment." (N/A to submersible pumps.)
18. Vibration of pumps, compressors, motors, etc. shall not exceed the values given in Tables 1 and 2 below as measured on the bearing housing(s). The maximum allowable vibration levels under any circumstance are per "ANSI/Hydraulic Institute Vibration Limits" per Tables 1 and 2 below. The "Preferred Vibration Limits" are to be aimed for with all applications. Note: ANSI/Hydraulic Institute 9.6.4-2016 specifies vibration limits in "RMS" values. The "RMS" values have been converted to "Inches / Sec. Peak" values which are 1.414 X the "Inches / Sec. RMS" values in the referenced ANSI/HI spec. A field vibration certificate shall be supplied by the installation contractor after commissioning. (N/A to submersible pumps.)
19. Overhead cranes shall be installed to provide lifts directly over the pump CG (center of gravity) and motor CG. Not applicable for supply of equipment for existing installations.
20. Peripheral piping of steel or stainless-steel construction shall have wall thicknesses sized per "Piping" section 801.1.27.3 and 4. This is not a requirement for the supply of replacement pumps.
21. When required by the City of Tulsa Plant Engineer, high bearing temperature sensors and alarms on pump bearings are specified. (N/A to submersible pumps.)
22. When required by the City of Tulsa Plant Engineer, vibration sensors and alarms on pump bearings are specified.

### Table 1 – Maximum Acceptable Field Vibration Levels of Rotating Equipment Not in Solids-Handling Service

| Driver Size, HP | ANSI / Hydraulic Institute Vibration Limits, Inches / Sec. Peak | Preferred Vibration Limits, Inches / Sec. Peak |
|---|---|---|
| Less than 33 (25 kW) | 0.21 | 0.07 |
| Above 33 (25 kW) and below 268 (200 kW) | 0.21 | 0.11 |
| Greater than 268 (200 kW) | 0.27 | 0.18 |

### Table 2 – Maximum Acceptable Field Vibration Levels of Rotating Equipment In Solids-Handling Service

| Driver Size, HP | ANSI / Hydraulic Institute Vibration Limits, Inches / Sec. Peak | Preferred Vibration Limits, Inches / Sec. Peak |
|---|---|---|
| Less than 33 (25 kW) | 0.35 | 0.17 |
| Above 33 (25 kW) and below 100 (75 kW) | 0.40 | 0.20 |
| 100 (75 kW) and above | 0.44 | 0.22 |

### 701.1.2 Pumps – Horizontal

1. Stainless steel shims are to be placed under the motor feet and in bearing housings, when necessary, with allowance to specific needs for shim sizes and shall be applied for alignment purposes which is determined by the alignment technician if needed. Plastic shims are not allowed.
2. Alignment positioning screws shall be provided for all horizontal motors 25 HP and larger, to facilitate longitudinal and transverse horizontal adjustments. The ends of screws that contact motor feet shall be rounded convex. The lugs holding these positioning screws shall be attached to the baseplate so that they do not interfere with the installation or removal of the motor, or the placement of shims.
3. Casing drains shall be valved and plugged on the valve outlet.
4. Pumps shall not be doweled to the baseplate but shall be provided with dowel holes pre-drilled in the casing feet and supports only. (Drilling of the dowel holes in the baseplate may be done in the field after alignment.) Dowel pins shall be of the pullout design and shall be supplied by the manufacturer.

### 701.1.3 Pumps – Vertical

1. Vertical pump shaft or shaft sleeve maximum runout measured immediately above the mechanical seal or stuffing box when pump is turned by hand shall be 0.002-inch TIR

(Total Indicator Reading) for pumps operating above 1400 RPM, and 0.004-inch maximum TIR for pumps operating below 1400 RPM.

2. Vertical suspended can pumps shall be furnished with a separate mounting plate for bolting and grouting to the foundation. The top of the mounting plate shall be flat within 0.002 inch of the surface plane and level to within 0.002 inch per foot of width or diameter. The foundation shall be designed so that the pump can is directly attached to the separate mounting plate and is removable without damaging the grout below the mounting plate. The foundation bolts shall not be used to secure the flanged joint under pressure.
3. Vertical pumps shall operate in continuous hydraulic down-thrust over the pump's full operating range.
4. When vertical pump shafts of more than one piece are approved by the City of Tulsa Water and Sewer Division Engineer, the joints shall be secured against reverse rotation by utilizing a ring and key joint connection(s).
5. All vertical pumps with mechanical seals shall have a vent connection on the stuffing box or flush piping located to ensure that fluid is present at the seal faces before start-up.
6. Vertical pumps and vertical in-line pumps shall have spacer couplings connecting the pump and motor shafts. The distance between shaft ends (DBSE) and length of spacer coupling manufactured shall allow removal of the mechanical seal without removal of the motor.
7. Vertical pumps and vertical in-line pumps shall be provided with a close-clearance register fit on the mating flanges of the motor and pump, or jacking screws provided.

### 701.1.4 Pumps – Submersible

1. Lifting devices (ring, chain, cable, eye, etc.) shall be of stainless-steel construction.
2. The power cable shall be supplied 6 feet longer than what is required by the manufacturer.
3. For solids applications, the vertical discharge piping shall be sized to maintain at least 4 feet / second flow velocity.

### 701.1.5 Installation and Commissioning of Pumps

1. A pump to motor shaft alignment certificate shall be supplied by the installation contractor. (N/A to submersible pumps.)
2. Confirm the numbering of the pump to be inspected matches sign off documentation.
3. Written and documented certificate provided by the contractor ensuring that pipe strain, soft foot, alignment, and runout are all within the acceptable range as stated in AM SMG 803.
4. Run the motor on no-load (decoupled from the pump) for a time which should achieve operating temperature. Vibration, thermal imaging scans, amperage and voltage values shall be recorded and documented and qualified and supplied by the contractor and needs to meet OEM specifications.
5. Run pump with flooded suction for a minimum period of seventy-two hours of operations before signing off and accepting ownership by operations, maintenance, and engineering.
6. The lines going to the pump inlet should be flushed with demineralized water while being disconnected from the pump.
7. The strainer on the inlet should be cleaned if applicable and accessible.

8. Recommended oil should be used to flush the pump and drained.
9. Recommended oil should be filled in the pump and the level should be confirmed satisfactory.
10. Suction lines are then connected to the pump.
11. The suction lines are to be bled off to prevent air pockets from getting through to the pump.
12. Pump should be coupled with motor in preparation for load run.
13. The discharge valve should be fully closed (Centrifugal pumps only) to check for maximum pump pressure/head.
14. Upon startup of pump, the system should be checked for leaks, abnormal sound, vibration and bearing temperature and be documented and certified by the contractor and OEM.
15. The flow should be checked (upon certification from the measuring instrument and gauge calibration has been checked and calibrated) by the contractor and pump OEM.
16. Confirm power consumption of the pump is in line with equipment data sheet and efficiencies are documented by the contractor and pump OEM.
17. Ensure OEM documentation is correct, and all manuals (digital and physical) are supplied by contractor 4 weeks before the project is completed.
18. Should all parameters fall within range, the pump needs to be signed off by engineering, operations, and maintenance before being put in operation.

### 701.1.6 Mechanical Seals

1. Unless otherwise specified, mechanical seals shall be furnished with all pumps. The mechanical seal and seal support system shall be designed to ensure fluid film stability, to minimize the effect of erosion of the component parts, and to ensure that process dilution is minimized.
2. For vertical, horizontal, and submersible pumps, the mechanical seal face materials are specified per Table 3. For seal flush plans refer to Table 4.
3. All mechanical seal metallic seal components shall be constructed of stainless steel. For water service, all flush and circulation tubing and/or piping shall be constructed of PEX or copper (painted on OD) tubing. For wastewater service, all flush and circulation tubing and/or piping shall be constructed of 3/16 stainless-steel tubing. PEX tubing deteriorates in sunlight and shall be used for indoor applications only. All steel and stainless-steel piping shall have wall thickness per "Piping" section 801.1.27.3 and 4.
4. Elastomers shall be constructed of Aflas. Elastomers are not to fret the shaft sleeve OD.
5. Seal glands shall bolt to the pump seal chamber with four equally spaced stainless-steel fasteners. The mechanical seal shall not be mounted to a standard packing cross-section stuffing box. The seal chamber shall be specially constructed to optimize the mechanical seal environment. The radial clearance of the mechanical seal ID to the sleeve OD shall have a minimum of 0.187-inch radial clearance. The cross section around the outside diameter of the mechanical seal components shall optimally be a minimum of 1.00-inch radial clearance.
6. A throttle bushing of a non-sparking material shall be provided in the mechanical seal gland to minimize leakage in case of complete seal failure.
7. For applications other than AESSEAL (or equal) double seals and Plan 53A, each pump to be provided with a pressure switch that will send a signal to shut down the electric motor in event of no external flush water going to the mechanical seal faces.

8. For applications other than AESSEAL (or equal) double seals and Plan 53A, to always maintain flush water inside the seal, a solenoid-activated flow switch shall be located downstream of the pump mechanical seal. The energizing of the electric motor activates the solenoid. A flow indicator (paddlewheel, etc.) shall be installed on this line near the solenoid-activated flow switch.
9. Water service mechanical seals shall be single or split cartridge design and shall be equivalent to ANSI standard single cartridge seals, Chesterton 42, AESSEAL CURC, or equal.
10. Sewage service mechanical seals shall be equivalent to ANSI standard dual cartridge mechanical seals, AESSEAL CDSA, or equal. The inboard seal faces shall operate on a clean barrier water fluid, pressurized to a minimum of 15 PSI greater than the maximum process pressure in the pump seal chamber. The inboard seal face shall be pressure balanced to the barrier fluid with approximately a 30 / 70 (process / barrier) pressure.

11. The mechanical seal face drive mechanism should be metal against metal for durability. The seal environment shall be protected by a close clearance between the back plate and the rotating shaft on the process side of the seal. The optimal diametrical clearance shall be 0.125 inch, and this closed frame plate configuration shall be designed for the purpose of reducing the velocity of the process slurry in the seal housing. The double mechanical seal shall reduce heat by thermosiphon flow through the seal support system and connecting piping. Alternatively, the double mechanical seal can be equipped with a pumping ring to maintain circulation through the seal and Plan 53A system.
12. The API Plan 53A seal support system shall be AESSEAL SSE25 Water Management System or equal. Vessel capacity shall be 6.6 gallons (25 liters). The vessel shall be constructed of 304 SS and designed to ASME VIII, Div. 1. The Vessel shall be designed to 145 psig MAWP and shall be hydro tested to 218 psig for a minimum of 10 minutes.

The bottom of the vessel shall be located 1-2 feet above the centerline of the mechanical seal. The connecting tubing shall have extra-large radius, sweeping bends. The exit from the seal (BO = Barrier Out) shall enter the upper of the two vessel barrier fluid connections. The lower of the two vessel barrier fluid connections shall connect to the seal (BI = Barrier In) connection. A drain shall be fitted to the lowest portion of the vessel with a valve and a plug to allow periodic (possibly quarterly) purging of accumulated contaminates (a few ounces of water.) A stainless-steel non-return valve and a stainless-steel flow indicator shall be provided. A brass water supply regulator and a brass pressure gauge shall be provided. A stainless-steel pressure switch shall be supplied to alarm on falling pressure. The water quality shall be filtered to 1 micron. A pre-filter of 5 microns can be, but is not required, fitted upstream of the 1-micron filter. The in-line filter shall be constructed of stainless steel, brass, or a UV-stabilized material, and be rated to 120 psig MAWP minimum. The filter is preferred, but not required, to be fitted with a flush valve. The inter-connecting tubing and tube fittings shall be stainless steel material. The barrier fluid shall be potable city water. If city water is not available, plant effluent

water (PEW) can be used but with great caution as it will quickly plug filters, greatly degrade the seal life, and should be avoided.

13. For each dual pressurized mechanical seal, the manufacturer shall provide a computerized report detailing the operating conditions for each application to include Shaft diameter, RPM, process pressure, barrier fluid pressure, ambient temperature, designed for dry running and hard-face combinations. The report to state the heat removal capability of the system in HP and/or kW. The maximum temperature of seal water as it returns to the seal should not exceed 158 deg. F (70 deg. C), and the report should show the expected steady state temperature for the system. The City of Tulsa Plant Engineer to verify applicability considering a possible cost adder for additional submittals.

14. Plan 53A seal support system (where applicable) shall include a unique serial number referenced to a pressure test certificate. The City of Tulsa Water and Sewer Division Engineer to verify applicability considering possible cost adders and additional submittals.
15. Each mechanical seal shall be individually serialized with a unique reference number, and that detail to be permanently electrochemically etched on the seal gland. The City of Tulsa Plant Engineer to verify applicability considering a possible cost adder for additional submittals.
16. Each double mechanical seal to be statically air tested to API 682 pressure test parameters. The City of Tulsa Water and Sewer Division Engineer to verify applicability considering a possible cost adder for additional submittals.
17. Documentation and Certifications – Vendor shall supply: Mechanical Seal GA certified drawing and Seal Support System certified drawing. Installation instructions shall be included with each seal in the shipping box. Installation instructions for system installation shall be provided separately prior to the construction phase and detail mounting position relative to the pump seal. The City of Tulsa Division Engineer to verify applicability considering a possible cost adder and additional submittals.

**Table 3 – Mechanical Seal Face Materials**

| Type of Pump | Water Service | Sewage Service PH <5 | Sewage Service PH >5 |
|---|---|---|---|
| Horizontal | SiC vs. Carbon | SiC vs. SiC | TC vs. TC |
| Vertical | SiC vs. Carbon | SiC vs. SiC | TC vs. TC |
| Submersible | SiC vs. Carbon | TC vs. TC | TC vs. TC |

**Table 4 – Mechanical Seal Flush Plans per API 682**

| Type of Pump | Water Service | Sewage Service PH <5 | Sewage Service PH >5 |
|---|---|---|---|
| Horizontal | 11/32 | 53A (32 Not Allowed) | 53A (32 Not Allowed) |
| | | | |
| Vertical | 13/32 | 53A (32 Not Allowed) | 53A (32 Not Allowed) |
| Submersible | N/A | N/A | N/A |

### 701.1.7 Motors – Low and Medium Voltage

1. All hardware including frame bolts, conduit box bolting, nameplate fasteners, grease caps or plugs, fan clamp and bolt, drain plugs or fittings, etc. shall be of plated steel minimum. Hardware for wastewater service shall be offered with an option of stainless-steel construction. If stainless steel hardware is specified, nickel-based anti-seize to be applied to threaded fasteners during assembly.
2. Motor thrust bearings for vertical pumps shall be designed to carry the maximum thrust loads that may develop while starting, stopping, or operating at any capacity.
3. Bearing housings containing oil shall be vented to the atmosphere through a desiccant breather to prevent ingestion of dirt and moisture. (N/A to submersible pumps / motors.)
4. Equipment and accessories to be designed and constructed for continuous operation.
5. For pumps rated less than or equal to 250 BHP, motors shall be sized for end of curve BHP for rated impeller and specific gravity without including the motor service factor above 1.0. Where it appears, this will lead to unnecessary oversizing of the motor, vendor shall submit an alternate quotation for the City of Tulsa Water and Sewer Division Engineer's approval.
6. Insulation Class F 155 deg. C (311 deg. F) is required. Temperature rise of 105 – 115 deg. C (221 – 239 deg. F) is required.
7. Noise level shall not exceed 85 dB A sound pressure level (SPL) generated by the motor at a three-foot distance from the motor in any direction.
8. Space heaters shall be 110V, 60 Hz, and supplied for 25 HP and larger motors when approved by the City of Tulsa Plant Engineer and specified on the data sheet. Space heaters shall be arranged to provide optimum uniform heating of the stator windings.
9. When required by the City of Tulsa water and Sewer Division Engineer, the Premium Efficiency motor design is specified. (The US Dept. of Energy recommends P/E for motors 500 HP and under that operate more than 2,000 hours per year. Payback is approximately 3-5 years.)
10. When required by the City of Tulsa Plant Engineer, high bearing temperature sensors and alarms on motor bearings are specified.
11. When required by the City of Tulsa Water and Sewer Division Engineer, vibration sensors and alarms on motor bearings are specified.
12. Electric motors in variable speed applications require special engineering considerations. These motors shall be purchased as part of a packaged system including the motor and the VFD controller. The City of Tulsa Plant Engineer and the drive system supplier should be included in discussions regarding the application and specifications and requirements. The electric motor shall be compatible with the variable frequency drive. The motor shall be inverter duty rated, have insulated bearings, and a grounding ring and brush. If any of these requirements are cost-prohibitive, vendor shall also submit an alternate quote.
13. Motors shall be designed, constructed, and rated for the NEMA area classification.

### 701.1.8 Gear Boxes

1. (No criteria presented.)

### 701.1.9 Blowers, Fans

1. (No criteria presented.)

### 701.1.10 Valves – Air Relief, Ball, Butterfly, Check, Plug, Gate

1. Ball valves shall be constructed of stainless-steel material.
2. Check valves shall have a visible outward arm to identify "open" and "closed" operation.
3. All valves that utilize electrical motor operators shall be fitted with mechanical stops on the stem (or other mechanical device) to prevent mechanical damage to valve while opening or closing.

### 701.1.11 Electrical Cable, Fiber Optic Cable

1. Individual conductor electrical cable shall be XHHW rated for 90 deg. C (194 deg. F.)
2. Three conductor electrical power cables shall be oil resistant, water resistant and high heat resistant Type XHHW.

### 701.1.12 Variable Frequency Drives 60-400 HP

1. VFD's shall be provided with internal bypasses, electrical input and output filters, internal heat sinks, internal cooling fan(s), and reusable air filters.
2. VFD's for wastewater service shall have filters impregnated with KMNO4 (potassium manganate – obtain and read the MSDS) to exclude H2S.
3. When required by the City of Tulsa Water and Sewer Division Engineer, the VFD is to be oversized at 125% of the motor HP to extend service life. Doing such addresses temperature issues due to the possibility of the VFD being in un-conditioned spaces, dirty filters on cooling fans, etc.
4. Applications of 100 HP and greater to be 18 pulse design to reduce harmonics.

### 701.1.13 Variable Frequency Drives 401 HP and Larger

1. VFD's shall be provided with internal bypasses, electrical input and output filters, internal heat sinks, internal cooling fan(s), and reusable air filters.
2. VFD's for wastewater service shall have filters impregnated with KMNO4 (potassium manganate – obtain and read the MSDS) to exclude H2S.
3. When required by the City of Tulsa Plant Engineer, the VFD is to be oversized at 125% of the motor HP to extend service life. Doing such addresses temperature issues due to the possibility of the VFD being in un-conditioned spaces, dirty filters on cooling fans, etc.
4. Applications of 100 HP and greater to be 18 pulse design to reduce harmonics.
5. VFD's are required and specified by the City of Tulsa Water and Sewer department shall be housed in humidity and climate-controlled buildings or shall be housed and cooled (air conditioned) in a NEMA 4 cabinet to prevent VFD thermal breakdown.

### 701.1.14 Low Voltage Switchgear and MCC'S

1. All applicable requirements of the latest edition of the National Electrical Code shall be

met. All switchgear and MCC shall include ultrasound and thermal imaging ports for Predictive Maintenance practices.
2. Color coding is per latest edition of IEEE.
3. Infrared windows and power monitoring capability are to be supplied.

### 701.1.15 Low Voltage Circuit Breakers

1. All applicable requirements of the latest edition of the National Electrical Code shall be met.
2. Integrated surge suppression shall be provided.

### 701.1.16 Motor Starters

1. All applicable requirements of the National Electrical Code shall be met.
2. NEMA design is preferred over IEC design because NEMA design allows more start/stop cycles and is more robust in design.
3. For critical assets only, a spare set of heaters to be included with the order – two sets of heaters total per motor starter. The City of Tulsa Water and Sewer Division Engineer to determine criticality.

### 701.1.17 Lighting

1. Unless otherwise specified, all lighting shall be designed and rated for the NEMA area classification.

2. LED lighting is required.

### 701.1.18 Programmable Logic Controllers

1. Rockwell Allen-Bradley ControlLogix systems using the L72 or better processor and provided with a fully functional licensed copy of the same version of Rockwell Studio 5000 software used by the contractor to program the system using ladder logic.
2. Or the CTI 2500-C200 based systems or CTI 2500C-C200 Compact-based systems can be provided. There is no requirement to provide programming software for the two CTI options because the City of Tulsa maintains an existing site license for all CTI PLC processors.

### 701.1.19 Control Panel Instruments

1. (No criteria presented.)

### 701.1.20 Level Measurement Instruments

1. (No criteria presented.)

### 701.1.21 Flow Measurement Instruments

1. Flow measurement devices shall have a local display provided and wired for a remote display.

### 701.1.22 Pressure / Vacuum Measurement Instruments

1. Pressure and vacuum gauges shall be liquid filled. When required by the City of Tulsa Plant Engineer, the gauges shall have isolators of the diaphragm seal design to exclude

debris from the gauge function.

2. Piping of steel or stainless-steel construction from the gauge-to-line or gauge-to-vessel shall have wall thickness sized per "Piping" section 801.1.27.3 and 4.
3. Pressure transducers shall have a local display provided and wired for a remote display.

### 701.1.23 Uninterruptable Power Supplies (UPS)

1. The UPS shall be designed and nameplated for 20% more capacity than required.
2. Air conditioning shall be provided if the UPS is in a cabinet that could reach an internal temperature over 104 deg. F (40 deg. C) were A/C not provided.
3. If A/C is provided for wastewater service and Lift Stations, the condenser coils shall be coated with Blygold or equal to prevent corrosion.
4. Continuous duty rating for Raw Water control panels for I/C engines and electric starters.

### 701.1.24 Analytical Meters (PH, Dissolved Oxygen, etc.)

1. Hach, HF Scientific analytical meters for PH, dissolved oxygen etc. shall be used in all related applications.

### 701.1.25 Gas Detectors, Wall-Mount

1. Gas detectors shall have a local display provided and wired for a remote display.

2. A visual (red, amber for warning and green lights) and audible alarm (bull horn, etc.) shall be mounted outside of the area monitored.

### 701.1.26 Piping

1. Refer to paragraph 801.1.2.4 for hand hole clean-out ports as required. For small diameter nozzles on equipment, hand hole clean-out ports will need to be incorporated into the adjacent suction and discharge piping.
2. Refer to paragraph 801.1.2.5 and 801.1.2.6 for pipe tap connections as required. Piping adjacent to equipment nozzles may require pipe taps also.
3. Piping of steel construction shall be Schedule 80 for 2-inch NPS and smaller and shall be Schedule 80 for 1.75 inch and 2.00 inch NPS (National Pipe Size). This paragraph is referenced in 801.1.2.20, 801.1.6.3, and 801.1.23.2.
4. Piping of stainless-steel material shall be Schedule 40S minimum for all sizes. This paragraph is referenced in 801.1.2.20, 801.1.6.3, and 801.1.23.2.
5. P-traps for floor drains that are inaccessible and are under concrete floors of sewage lift stations shall not be utilized because they clog easily and cannot readily be cleaned out.
6. Schedule 40 PVC piping shall be the minimum required thickness for standard projects. All chemical piping applications shall be in schedule 80 PVC piping. Spears shall be the preferred manufacturer with no alternative for PVC fittings for serviceability.
7. All schedule 80 and schedule 40 PVC for plumbing parts including unions installed for operable monitoring devices, regulators, valves, or equipment shall have standard NPT threaded (not metric) unions and fittings of the preferred brand Spears as a standard installed on the inlet and outlet of device piping and any additional threaded pipe or nipples needed for serviceability.
8. All schedule threaded 80 and schedule 40 valves shall have standard NPT threads, (not metric). If metric equipment is selected, adapters shall be installed to convert to standard

NPT to allow for serviceability. Standardization requirements will be Spears as a preferred manufacturer with no alternative.

### 701.1.27 Preparation for Shipment

1. Spare parts that are subject to corrosion (steel, cast iron, etc.) shall be individually prepared for long term storage in an unheated warehouse. Solvent washable preservative coatings shall be applied, and additional wrapping using waxed cloth, plastic shrink wrap, wood crating, or equal shall be used to protect the preservative coating. Each part shall be individually tagged external to any preservation materials.
2. Preparation of the pumps, gear boxes, fans, motors, electrical components, etc. for shipment shall be made including all exterior surfaces subject to atmospheric corrosion (with exception of machined surfaces) shall be given a coat of the manufacturer's standard paint (unless specified otherwise.) All external machined surfaces shall be coated with suitable rust preventative.
3. All threaded openings shall be plugged with pipe plugs of a material comparable to that of the casing. In no case shall nonmetallic plugs (such as plastic) be used. Exposed shafts and shaft couplings shall be wrapped with waterproof moldable wax cloth or vapor phase inhibitor paper or equal.
4. Each piece of equipment shall be properly identified as required by the purchase order with a metal tag showing the City of Tulsa Equipment ID.
5. One copy of the vendor's standard installation instructions shall be packed and shipped with the equipment.
6. Storage of pumps, electrical motors, electrical components, etc. shall follow the manufacturers' guidelines. Space heaters, if provided in electrical motors, are normally energized during storage at site regardless of if motor is stored inside or outside.

### 701.1.28 OEM Literature and Warranty logs, Tagging and Equipment Documentation

1. Ensure OEM and Warranty and contractor documentation and contacts are correct, and all manuals (digital and physical) are supplied by contractor 4 weeks prior to acceptance of equipment, which allows maintenance and operations to enact new Preventive and Predictive maintenance practices and asset information to be entered into the CMMS (Lucity) system.

2. All equipment documentation (which includes the OEM and general contractor warranty start and end dates), project information, tag information, equipment description, purchase and commissioning date, equipment initial and final test readings, supplier and phone number per The City of Tulsa's Water and Sewer Asset Management protocol. Startup inspection reports, OEM manuals and in-service dates are due 4 weeks prior to acceptance of equipment. All information shall be included in the Water and Sewers Asset Management spreadsheet, which will be supplied at no additional cost and is part of the contractual agreement for all new equipment purchased. All warranty logs shall be provided by the general contractor which applies to the actual purchase date and the date of commissioning.

3. Warranties for all new equipment whether purchased by the general contractor for a project or by the City of Tulsa Water and Dewer Department requires an extended warranty or applicable

extension applied for the first year of operation, even if it includes additional costs and the warranty will be covered by the OEM in the first year with no alternate exceptions.

### 701.1.29 Failure Modes, Troubleshooting Flow Diagrams and Equipment Machine Blueprints

1. OEM manufacturer shall be required to provide known and common failure modes, troubleshooting flow diagrams, designated format, and equipment design blueprints in either an excel or alternative format designated by The City of Tulsa Water and Sewer Department. All mentioned documentation shall be provided 4 weeks prior to the end of the project by the OEM to the general contractor and provided to the City of Tulsa Water and Sewer Department in accordance with Water and Sewer Asset Management protocols.

Note: The City of Tulsa Water and Sewer Division Engineer's input is needed regarding the following 22 paragraphs: AM-SMG-801.1.1, AM-SMG-801.1.2.12, 13, 21, and 22, AM-SMG-801.1.4.4, AM-SMG-
801.1.6.12, 13, 14, 15, and 16, AM-SMG-801.1.7.5, 8, 9, 10, 11, and 12, AM-SMG-801.1.12.3, AM-SMG-801.1.13.3 and 5, AM-SMG-801.1.16.3, and AM-SMG-801.1.23.1., SMG 801.1.29, SMG 801.1.30

# 702 Preferred Manufacturers, New Equipment Purchases

## 702.1 Types of Equipment and Preferred Manufacturers

### 702.1.1 Scope

The following list of preferred manufacturers is to be incorporated into specifications for purchase of new equipment by a Contractor or an Engineering Consultant or the City of Tulsa. If there should be any conflict between this Guideline and the City of Tulsa Purchasing Ordinance #6-4 or its Revisions, the Ordinance #6-4 or its Revisions shall take precedence. This Guideline includes a list of manufacturers that is not comprehensive, and it is not required that manufacturers be chosen specifically from this list. The manufacturers listed in this Guideline are preferred due to past performance, ability, parts availability, matching of site equipment, support, total cost of ownership, etc. Full and open competition is to be encouraged on all purchases and sales.

In order to reduce any possible conflicts, and to eliminate any omissions of manufacturers during the bid request / review stages, the City of Tulsa Engineering Department and/or the Using Department shall provide all technical specs, Standard Maintenance Guidelines, a listing of any suggested potential bidders, and any supporting documents to the Contractor or Engineering Consultant or the City of Tulsa Purchaser before a purchase requisition is submitted by any of these parties. Manufacturers (or their rep's or their distributors, etc.) are invited to bid, whether they are or are not currently on this list. Therefore, all parties shall agree on the specific manufacturers selected for the new equipment before award.

### 702.1.2 Pumps – Horizontal

1. Manufacturers preferred are Flowserve (including Ingersoll-Dresser), RuhrPumpen, Flygt, AC-Flygt, Fairbanks-Morse, Vaughan, Yeomans/Grundfos, Peerless, Patterson.

### 702.1.3 Pumps – Vertical

1. Manufacturers preferred are Flowserve (including Ingersoll-Dresser), RuhrPumpen, Flygt, AC-Flygt, Fairbanks-Morse, Vaughan, Yeomans/Grundfos, Peerless, Patterson.

### 702.1.4 Pumps – Submersible

1. Manufacturers preferred are Vaughan, Flyght, Fairbanks-Morse, Hayward Gordon, Yeomans/Grundfos.

### 702.1.5

1. Sump pumps; Manufacturers preferred are: Barnes, Goulds, Dayton, Zoeller, Little Giant, Homa.
2. Grinder pumps; Manufacturers preferred are: Environment One Model 2010-74.

3. Chopper pumps; Manufacturers preferred are: Vaughan, (or equal).
4. Progressive Cavity pumps; Manufacturers preferred are: Seepex, Moyno.
5. Peristaltic pumps; Manufacturers preferred are: Watson / Marlow.
6. Metering pumps; Manufacturers preferred are: Wallace and Tiernan, Watson-Marlow, Milton Roy.

### 702.1.6 Mixers

1. Manufacturers preferred are: Mixtec, Flyght, Philadelphia, Jensen, Plenty

### 702.1.7 Mechanical Seals

1. Manufacturers preferred are AES, Chesterton, Flowserve, John Crane.

### 702.1.8 Motors – Low and Medium Voltage

1. Manufacturers preferred are US, Baldor, GE, Siemens.

### 702.1.9 Gear Boxes

1. Manufacturers preferred are Dodge and Lufkin.

### 702.1.10 Blowers, Fans

1. Manufacturers preferred are New York Blowers, Continental Blowers and Fans.

### 702.1.11 Valves – Air Relief, Ball, Butterfly, Check, Plug, Gate

1. Air relief, ball, butterfly, check (refer to para. 802.1.11.3 below), gate valves; Manufacturers preferred are: per City of Tulsa "Division II Material Specifications Approved Fittings Manufacturers." Web site path: City of Tulsa (external web site) / Development – Business / Engineering Services / Government Departments – Engineering Services / Specifications, Checklists, and Details.
2. Plug valves are not included in Div. II spec referenced in no. 1 above; Manufacturers preferred are per City of Tulsa Div. II spec manufacturers of gate valves, (or equal).
3. Check Valves, in addition to Div. II spec referenced in no. 1 above of Section 802.1.10; Manufacturers preferred are: due for ease of maintenance is AVK, (or equal), unless the City of Tulsa Engineering states otherwise per application.

### 702.1.12 Electrical Cable, Fiber Optic Cable

1. For electrical cable, Manufacturers preferred are: Beldon, Southwire.
2. For fiber optic cable, Manufacturers preferred are: (no criteria presented).

### 702.1.13 Variable Frequency Drives

1. Manufacturers preferred are:

A. Raw Water prefers Rockwell Allen-Bradley, ABB.
B. ABJ WTP prefers Rockwell Allen-Bradley, ABB.
C. Mohawk WTP prefers Rockwell Allen-Bradley, ABB.

D. Water Operations prefers Dan Foss (less than or equal to 300 HP).
E. NS WWTP prefers Schneider Electric (Square D), Rockwell Allen-Bradley, Eaton.
F. LBC WWTP prefers Schneider Electric (Square D), Rockwell Allen-Bradley, Eaton.
G. SS WWTP prefers Rockwell Allen-Bradley, Schneider Electric (Square D).
H. HC WWTP prefers Rockwell Allen-Bradley, Schneider Electric (Square D).

### 702.1.14 Low Voltage Switchgear and MCC'S

1. Manufacturers preferred are Schneider Electric (Square D), GE, Eaton, Siemens

### 702.1.15 Low Voltage Circuit Breakers

1. Manufacturers preferred are: Schneider Electric (Square D), GE, Eaton, Siemens.

### 702.1.16 Motor Starters

1. Manufacturers preferred are: Schneider Electric (Square D), GE, Eaton, Siemens

### 702.1.17 Lighting

1. Manufacturers preferred are: Cooper, Dialight

### 702.1.18 Control Systems

1. Manufacturers preferred are Rockwell Allen-Bradley, Control Logix, Siemens, Control Systems Inc. (CTI)

### 702.1.19 Programmable Logic Controllers

1. Manufacturers preferred are: Rockwell Allen-Bradley Control Logix using L72 or better processor with fully functional licensed version of Rockwell RSLogix 5000 using ladder logic, or Control Technologies Inc. CTI 2500-C200 based systems or CTI 2500C-C200 Compact based systems (The City of Tulsa already maintains CTI programming software).

### 702.1.20 Control Panel Instruments

1. Manufacturers preferred are: Rockwell Allen-Bradley, APC by Schneider Electric (Square D).

### 702.1.21 Level Measurement Instruments

1. Ultrasonic instruments; Manufacturers preferred are: Endress+Hauser, Siemens.

### 702.1.22 Flow Measurement Instruments

1. Ultrasonic instruments: Manufacturers preferred are Siemens.
2. Magnetic instruments: Manufacturers preferred are Krone.

### 702.1.23 Pressure / Vacuum Measurement Instruments

1. Pressure or vacuum gauges; Manufacturers preferred are Ashcroft.
2. Differential pressure gauges: Manufacturers preferred are Siemens.

### 702.1.24 Uninterruptable Power Supplies (UPS)

1. Manufacturers preferred are APC by Schneider Electric (Square D).

### 702.1.25 Analytical Meters (PH, Dissolved Oxygen, etc.)

1. Manufacturers preferred are: Hach, Fisher Scientific.

### 702.1.26 Gas Detectors, Wall-Mount

1. Manufacturers preferred are: Scott Safety, Capitol Controls, Siemens, MSA, Honeywell, Drager.

### 702.1.27 Actuators

1. Manufacturers preferred are: Limitorque, Rotork.

# 703 Pipe Strain Allowed on Rotating and Static Equipment

## 703.1 Practical Guidelines to Minimize Pipe Strain on Rotating and Static Equipment

### 703.1.1 Scope

Pipe strain imposed on the suction and discharge nozzles of pumps, blowers, compressors, etc. causes shaft wear, seal and bearing failures, case breakage, etc. Static equipment is also susceptible to imposed strain. This Guideline is written to apply to both rotating and static equipment (some portions of Guideline N/A to static equipment.) This guideline shall be incorporated into specifications for purchase of new equipment by contractors, engineering consultants, or the City of Tulsa. In case of conflict between this guideline and the purchase order, unless specifically stated as an exception in the PO, the vendor shall obtain a written ruling from the City of Tulsa Plant Engineer before proceeding with the work affected. API 686 "Recommended Practice for Machinery Installation and Installation Design" is referenced for allowable values of field measurements. This guideline is applicable to rotating and static equipment connected to external piping, etc., but is not applicable to electric motors or submersible pumps. Before performing any work, Lock-Out, Tag-Out (LOTO) all sources of energy including electrical power, suction and discharge valves, etc., and drain liquid from equipment / lines, etc.

## 703.2 Check for Pipe Strain During Removal of an Installed Pump, Blower, Compressor, and Static Equipment

### 703.2.1 Check Motor to Pump Shaft Alignment

1. With pump and motor, or right-angle gear and engine uncoupled, check alignment of shafts with a laser alignment tool. Alternatively, use dial indicators. Record in Table 1.

### 703.2.2 Dial Indicator Placement Prior to Pump / Piping Maintenance

1. Place magnetic bases of two dial indicators on motor frame and/or baseplate. Place dial indicator needles perpendicular to pump shaft in the vertical and horizontal positions.

### 703.2.3 Remove Suction and Discharge Piping Stud-Bolts / Measure Pipe Strain

1. Remove stud-bolts and gasket on pump suction and discharge flanges to adjacent piping flanges. Pump anchor bolts to remain tightened.
2. Check movement of dial indicator needles. Record in Table 1.
3. Measure distance between pump flanges and connected piping flanges. Allowable limits per Table 3, measured at flange outside diameter. Check bolt hole misalignment, and flange face separation within gasket spacing +/- 0.06 inch. Record values in Table 1.

### 703.2.4 Check Motor to Pump Shaft Alignment

1. With pump and motor, or right-angle gear and engine uncoupled, check alignment of shafts with a laser alignment tool. Alternatively, use dial indicators. Record in Table 1.

## 703.3 Correcting Pipe Strain / Strain Measurements

### 703.3.1 Correct Pipe Strain if Required for Rotating and Static Equipment

1. If pipe strain is present as determined from all readings taken and recorded, the strain must be corrected. Methods for achieving piping alignment include shimming supports, adjusting spring hanger tie-rod turnbuckles, retorquing flanges, installing piping support spacers, installing an expansion bellows in the piping line, field machining mating flange faces (portable rig), selectively heating one side of the pipe (piping disconnected from pump), ring heating (piping attached to pump w/ an insulating gasket), cutting and rewelding, or completely refabricating the piping. The methods vary for each installation. Consult with the City of Tulsa Plant Engineer and Maintenance Supervisor for allowable method(s). Verify all machined flanges are plane to within 0.002 inch. Record in Table 2.

## 703.4 Install Pump in New or Existing Installation

### 703.4.1 Dial Indicator Placement Prior to Pump / Piping Maintenance

1. Place magnetic bases of two dial indicators on motor frame and/or baseplate. Place dial indicator needles perpendicular to pump shaft in the vertical and horizontal positions.

### 703.4.2 Strain Measurements, Tighten Suction and Discharge Piping Stud-Bolts

1. Measure distance between pump flanges and connected piping flanges. Allowable limits per Table 3, measured at flange outside diameter. Check bolt hole misalignment, and flange face separation within gasket spacing +/- 0.06 inch. Record values in Table 2.
2. Install new gaskets on pump flanges. Lube all fasteners w/ anti-seize. Tighten all stud-bolts on pump flanges. In a crisscross fashion, tighten stud-bolts snug to 10% of final torque, then to 30%, then to 100%. Refer to Table 4 for final stud-bolt torque. Record actual final stud-bolt torques in Table 2.
3. Check for any movement of dial indicator needles against pump shaft. If either vertical or horizontal dial indicator registers more than 0.002 inch allowable at end of reassembly process, this indicates excessive pipe strain that must be corrected. Record in Table 2.

### 703.4.3 Check Motor to Pump Shaft Alignment

1. With pump and motor, or right-angle gear and engine uncoupled, check alignment of shafts with a laser alignment tool. Alternatively, use dial indicators. When correcting any misalignment, shim under motor feet only. Record in Table 2.

### 703.4.5 If Pipe Strain is Present for Rotating and Static Equipment

1. In case pipe strain is present, correct to within allowable limits. Repeat applicable portions of section 803.4.

### 703.4.6 Dowel Pump to Baseplate

1. After all steps are completed, if required dowel the pump to the baseplate according to the manufacturer's recommendations. Dowels shall be a pullout design.

**Table 1 Removal of Rotating and Static Equipment – Actual Vs. Allowable Strain Measurements. – Contractor or City of Tulsa Personnel to Provide Data to Site Maintenance Supervisor Including Equipment No., Date, Name(s) of Person(s) that Recorded Data. Data to be Entered Into Lucity for the Equipment No.**

| Parameter | Description | Actual Strain Measurement | Allowable Strain Measurement |
|---|---|---|---|
| Motor to Pump Shaft Alignment | Parallel / Angular | / | Laser "Green" or 0.002 Inch by Dial Indicators |
| Pump Shaft Movement Relative to Motor | Vertical / Horizontal | / | 0.002 Inch |
| Flange Face Outside Diameters Out of Parallel / Strain Measurement | Suction / Discharge. | / | Table 3 |
| Bolt Hole Misalignment | Suction / Discharge | / | 0.062 Inch |
| Flange Face Separation | Suction / Discharge | / | Within Gasket Spacing +/- 0.06 Inch |
| Motor to Pump Shaft Alignment | Parallel / Angular | / | Laser "Green" or 0.002 Inch by Dial Indicators |

**Table 2 Installation of Rotating and Static Equipment – Actual Vs. Allowable Strain Measurements. – Contractor or City of Tulsa Personnel to Provide Data to Site Maintenance Supervisor Including Equipment No., Date, Name(s) of Person(s) that Recorded Data. Data to be Entered into Lucity for the Equipment No.**

| Parameter | Description | Actual Strain Measurement | Allowable Strain Measurement |
|---|---|---|---|
| Flange Faces Plane | All Rotating Equipment and Connected Piping | / | 0.002 Inch |
| Flange Face Outside Diameters Out of Parallel / Strain Measurement | Suction / Discharge | / | Table 3 |
| Bolt Hole Misalignment | Suction / Discharge | / | 0.062 Inch |
| Flange Face Separation | Suction / Discharge | / | Within Gasket Spacing +/- 0.06 Inch |
| Stud-Bolt Torque | Suction / Discharge | / | Table 4 |
| Pump Shaft Movement Relative to Motor | Parallel / Angular | / | 0.002 Inch |
| Motor to Pump Shaft Alignment | Parallel / Angular | / | Laser "Green" or 0.002 Inch by Dial Indicators |

**Table 3 Allowable Out-of-Parallel / Strain of Flange Faces for Rotating and Static Equip.**

| Class 125/150/250/300 Flange Size (Inches) | Out-of-Parallel, Flange Faces (Inches) | Preferred Out-of-Parallel, Flange Faces (Inches) |
|---|---|---|
| 0.25 / 0.50 / 0.75 / 1 | 0.005 | 0.005 |
| 1.25 / 1.50 | 0.005 | 0.005 |
| 2 | 0.006 | 0.005 |
| 2.5 | 0.007 | 0.005 |
| 3 / 3.5 | 0.008 | 0.005 |
| 4 | 0.009 | 0.005 |
| 5 | 0.010 | 0.005 |
| 6 | 0.011 | 0.005 |
| 8 | 0.014 | 0.010 |
| 10 | 0.016 | 0.010 |
| 12 | 0.019 | 0.010 |
| 14 | 0.021 | 0.010 |
| 16 | 0.024 | 0.010 |
| 18 | 0.025 | 0.010 |
| 20 | 0.028 | 0.015 |
| 24 | 0.032 | 0.015 |
| 30 | 0.039 | 0.015 |
| 36 | 0.046 | 0.015 |
| 42 | 0.053 | 0.015 |
| 48 | 0.060 | 0.015 |

Measure gap between flanges at flange OD's. Column 2 values are per API 686 and shall not be exceeded. Column 3 values are common practice, tighter than API 686, and should be aimed for, but not required.

**Table 4 Stud-Bolt Torque Recommended for Rotating and Static Equipment**

| Stud-Bolt Diameter (Inches) | Torque, ASTM A307, and SAE GR. 2 (ft.-lbs.) | Torque, ASTM A193 B7, and SAE GR. 5 (ft.-lbs.) |
|---|---|---|
| 0.500 | 35 | 75 |
| 0.625 | 70 | 150 |
| 0.750 | 120 | 270 |
| 0.875 | 170 | 450 |
| 1.000 | 250 | 650 |
| 1.125 | 350 | 900 |
| 1.250 | 500 | 1400 |
| 1.500 | 870 | 2300 |

Check IOM for specific torques. Torque values based on stud-bolts, nuts, and nut-bearing surface contacting flange coated w/ anti-seize, etc. (Note: Newton-meters X 0.74 = ft.–lbs.)

# DIVISION VIII

# STREETSCAPE SPECIFICATIONS

## PART 800 – DECORATIVE LIGHTING

800.1 GENERAL

800.1.1 Summary:

A) This Section includes specific requirements for lighting and control for street and sidewalk lights to be installed in the City of Tulsa.

B) Section Includes:

1) Exterior Lighting Poles for support of luminaires, poles, and accessories.

2) Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.

3) Luminaire supports.

4) Lighting control equipment.

5) Standard details are provided primarily to illustrate style and appearance of light fixtures. Performance of the lights is detailed in the specification in regard to lumen output, light color temperature, efficacy and testing requirements. All lights and poles provided shall be identical (within noted tolerances) in appearance to fixtures and poles specified in the standard details. Before approval for purchase, current test data as specified in this document is to be provided to the City of Tulsa, produced by an independent, UL Certified test lab.

C) Related Documents and Requirements:

1) Drawings and general provisions of the Contract, including General, Supplementary Conditions and City of Tulsa Special Conditions, apply to this Section.

2) City of Tulsa standard details.

800.1.2 Definitions:

A) The following terms are used within the text of this Section:

1) BUG: Backlight, Uplight, and Glare.

2) CCT: Correlated Color Temperature.

3) CRI: Color Rendering Index.

4) EPA: Equivalent Projected Area. This is important to verify wind loads if a new light is submitted.

5) Fixture: See “Luminaire”.

6) IPP: International Protection or Ingress Protection Rating.

7) Lumen: Measured output of lamp and luminaire, or both.

8) Luminaire: Complete lighting unit, including lamp, reflector, and housing.

9) Pole: Luminaire-supporting structure.

10) LED Module: LED assembly including circuit board, LEDs, and electronic components that plug into the fixture and produce light.

11) IES: Illumination Engineering Society.

12) NRTL: National Recognized Testing Laboratory.

13) NIST: National Institute of Standards and Technology.

14) PMMA: Poly (methyl methacrylate).

15) IESNA: Illuminating Engineering Society of North America.

16) ISTMT: In-situ Temperature Measurement Testing.

17) UL: Underwriters Laboratories.

B) The following items are included in the decorative lighting specifications and all equipment referenced is to be in compliance with this document.

1) All light fixtures, light poles, and pole bases associated with street lighting including those on street right-of ways and sidewalks.

2) All underground conduit and wire or above ground electrical service for powering lights and receptacles associated with the light poles.

3) All lighting controllers, contactors, photocells, and other components associated with the referenced lighting equipment.

4) Electrical Service provided by AEP-PSO for powering street lighting and associated receptacles.

800.1.3 Action Submittals:

A) Product Data (Poles): For each pole, accessory, and luminaire-supporting device, arranged as indicated.

1) Include data on construction details, profiles, EPA, materials, dimensions, weight, rated design load, and ultimate strength of individual components.

2) Include finishes for lighting poles and luminaire-supporting devices.

3) Anchor bolts.

B) Project Data (Luminaires): For each type of luminaire.

1) Arrange in order of luminaire designation.

2) Include data on features, accessories, and finishes. Include data on performance specification items identified in this document.

3) Include physical description and dimensions of luminaire.

4) For LEDs, include life, output (lumens, CCT, and CRI), and energy-efficiency data.

5) Before approval for purchase, provide for review IES LM-79, LM80 and TM21 test results. Data to be provided from an independent UL Certified laboratory.

6) Provide means of attaching luminaires to supports and indication that the attachment is suitable for components involved and is consistent with detail drawings.

800.1.4 Closeout Submittals:

Operation and Maintenance Data:

A) For luminaires include an operation and maintenance manual.

800.1.5 Maintenance Material Submittals:

A) Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1) Poles: Furnish one spare pole to owner for every twenty poles installed. Furnish at least one pole of each type.

2) LED Modules: One for every ten of each type and rating installed. Furnish at least one of each type.

3) Lens Covers and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.

4) Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

5) Internal House Side Shield for acorn style luminaires: Furnish one spare house shield to owner for every five luminaires installed. Furnish at least one of each type.

800.1.6 Quality Assurance:

A) Luminaire Photometric Data Testing Laboratory Qualifications:

1) Provided by an independent UL Certified testing agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 for Energy Efficient Lighting Products and complying with applicable IES testing standards.

B) Provide luminaires from a single manufacturer for each luminaire type.

C) Each luminaire type shall be binned within a four-step MacAdam Ellipse to ensure color consistency among luminaires or use other processes to ensure light color is as specified by CCT and CRI values.

D) Installer Qualifications: An authorized representative who is a licensed electrician and is trained and approved by manufacturer is to be responsible for construction of the lighting system.

E) Manufacturer Qualifications:

1) Supplier of poles and LED fixtures must have documentation that they have been in the business of manufacturing poles and LED fixtures for at least five years.

2) It shall be the duty of the Director to investigate and examine the qualifications of all manufacturers of poles and LED fixtures, and consider the following:

a) Financial responsibility: An audited or reviewed financial statement from a Certified Public Accountant indicating a current asset-to-debt ratio of not less than 1.5 shall be provided upon request from the City. The City also reserves the right to request any additional documentation of the manufacturer's financial resources and condition.

b) The character, quality and availability of the manufacturer's products and experienced personnel.

c) The performance record of the manufacturer's products on other contracts for public or private improvements.

d) The nature and extent of commitments involving the manufacturer's equipment and personnel.

e) Reputation for reliability and integrity.

f) Recommendation of other entities concerning the use of manufacturer's products and services.

g) Any other facts which would materially affect the ability of the manufacturer to properly, adequately, expeditiously, and satisfactorily provide poles and LED fixtures and fulfill all warranty requirements, as necessary.

800.1.7 Delivery, Storage, and Handling:

A) Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping. Retain factory-applied pole wrappings on poles until right before pole installation.

B) Store poles on decay-resistant skids at least 12" above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C) Retain factory-applied pole wrappings on metal poles until right before pole installation. Handle poles with web fabric straps.

800.1.8 Warranty:

A) Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in performance, materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period.

1) Warranty Period for Luminaires: Seven years from date of Substantial Completion.

2) Warranty Period for Metal Corrosion: Seven years from date of Substantial Completion.

3) Warranty Period for Color Retention: Seven years from date of Substantial Completion.

4) Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within seven years from date of Substantial Completion.

5) Warranty Period for Entire System: Seven years from date of Substantial Completion.

B) Warranty to include all parts and labor as required to bring failed products back into compliance with the lighting system as originally specified.

C) Contractor to identify a local source for providing the warranty repair work. If necessary, to expedite repairs the owner may furnish spare parts to the warranty provider, with the understanding these parts shall be replaced at the earliest date possible.

D) City of Tulsa and the vendor are required to examine parts and mutually agree to when to declare damage to any fixture is the result of an electrical surge or lightning strike or other act not covered by the warranty.

800.2 MATERIALS

800.2.1 Lighting Poles Types:

A) Foundation Design per latest AASHTO Standards for Structural Supports.

B) Structural Characteristics: Comply with AASHTO LTS-4-M.

1) Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated below.

a) Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.

b) Basic wind speed for calculating wind load for poles is 90 mph.

C) Basis of design-Acorn Pole: Subject to compliance with requirements, provide the following:

1) Tapered fiberglass composite core fluted pole.

2) Nominal Height: 12’.

a) Wall thickness: 0.125”.

b) Base: 20” diameter.

3) Anchor bolts: Per manufacturer standards and City of Tulsa Standard 804.

4) Finish and Color: Powder Coated Black.

5) Accessories:

a) Duplex Receptacle GFCI type, 120V AC, 15A in a weatherproof assembly. Comply with requirements in Section on “Wiring Devices”. Mount as indicated on Detail.

b) See City of Tulsa Standard 800.

c) Banner Arms: Manufacturer’s standard to match pole type. Two 30” banners per pole.

D) Basis of Design Product: “Blue Dome” Pole. Subject to compliance with requirements, provide the following:

1) Pole:

a) Aluminum or steel.

b) Nominal Height: 25.5’.

c) Base: 16.5” diameter.

2) Anchor Bolts: Per manufacturer’s standards and City of Tulsa Standard 804.

3) Finish & Color: Powder Coated, black.

4) Accessories:

a) Duplex Receptacle GFCI type, 120V AC, 15A in a weatherproof assembly. Comply with requirements in Section on “Wiring Devices”. Mount as indicated on Detail.

b) See City of Tulsa Standard 801.

c) Banner Arms: Manufacturer’s standard to match pole type. Two 30” banners per pole.

E) Basis of Design – “Ball Field” Pole (Existing Poles in Brady and Greenwood Districts)

1) Pole:

a) Aluminum or steel.

b) Nominal Height: 18’ for 4” pole and 25’ for 5” pole.

c) Base: 18’ pole has 16” base, 25’ pole has 18” diameter base.

2) Anchor Bolts: Per manufacturer’s standards and City of Tulsa Standard 804.

3) Finish & Color: Powder Coated, black.

4) Accessories:

a) Duplex Receptacle GFCI type, 120V AC, 15A in a weatherproof assembly. Comply with requirements in Section on “Wiring Devices”. Mount as indicated on Detail.

b) See City of Tulsa Standard 802.

c) Banner Arms: Manufacturer’s standard to match pole type. Two 30” banners per pole.

800.2.2 Performance Requirements (Luminaires):

A) Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an independent UL certified testing agency, and marked for intended location and application.

B) NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

800.2.3 Luminaire Types:

A) Basis of Design-Acorn Light: Subject to compliance with requirements. Provide the following:

1) Luminaire:

a) Diameter: 17.00”, ±1”.

b) Height: 39.5”, ±1”.

c) Lamp: LED modules.

2) Optical System: IES Type V distribution, IP66 rated.

a) Flat lens, optical grade PMMA acrylic refractor or,

b) Clear, tempered, shock-resistant glass or,

c) Prismatic globe, or

d) Approved equal.

3) Voltage: 120V to 277V.

4) Mounting & Configuration: Pole top mount.

5) Finish & Color: Powder Coated Black.

6) Lumens: Minimum 7600.

7) EPA: 2.17.

8) Luminaire Efficacy Rating (LM/W): Minimum 96.

9) BUG rating: B3-U3-G2

10) CRI = 70

11) CCT = 4,000K

12) System (LED + Driver) Rated Life: Minimum 100,000 hours.

13) Accessories:

a) Duplex receptacle GFCI type, 120V AC, 15A in weatherproof assembly. Comply with requirements in section on “Wiring Devices”. Mount as indicated on detail.

b) Provide fixture with “Dark Sky” compatible top shield to prevent spill light going upward.

c) Fixture to have factory provided “house shields” that can be installed in the globe to prevent light from spilling into adjacent residences or businesses, where this creates a problem.

d) See City of Tulsa Standard No. 800.

B) Basis of Design Product: Blue Dome Light Fixture. Subject to compliance with requirements, provide the following, or equal:

1) Luminaire:

a) Diameter: 27.5”, ±1”.

b) Height: 23.25”, ±1”.

c) Lamp: LED modules

2) Optical System: IES Type III distribution, IP66 rated.

a) Flat lens, optical grade PMMA acrylic refractor, or

b) Clear, tempered, shock-resistant glass.

3) Voltage: 120V – 277V.

4) Finish & Color: Powder Coated, black.

5) Lumens: Minimum 9600.

6) Luminaire Efficacy Rating (LM/W): Minimum 96.

7) BUG rating: B3-U0-G2.

8) CRI = 70.

9) CCT = 4,000K.

10) System (LED + Driver) Rated Life: Minimum 100,000 hours.

C) Basis of Design Product: Ball Field Style Light Fixture.

1) Luminaire:

a) Diameter: ±1”.

1. 18” on 18’ pole.

2. 26” on 25’ pole.

b) Height: ±1”.

1. 13” on 18’ pole.

2. 19” on 25’ pole.

c) Lamp: LED modules.

2) Optical System: IES Type III distribution, IP66 rated.

a) Flat lens, optical grade PMMA acrylic refractor, or

b) Clear, tempered, shock-resistant glass.

3) Voltage: 120V – 277V.

4) Finish & Color: Powder Coated, black.

5) Lumens: Minimum 7200 on 18’ pole and minimum 9200 on 25’ pole.

6) Luminaire Efficacy Rating (LM/W): Minimum 96.

7) BUG rating: B3-U0-G2.

8) CRI = 80.

9) CCT = 4,000K.

10) System (LED + Driver) Rated Life: Minimum 100,000 hours.

800.2.4 Special LED Lighting Requirements:

A) The following requirements are made on all proposed LED light Fixtures:

1) Fixtures must be comprised of modular components that are field replaceable, including glass lenses (where applicable), LED drivers and LED modules.

2) Power supply shall have a minimum power factor of .90 and a total harmonic distortion (THD) of 20% or less at full input power and voltage. Line transient protection shall be 20 kv or greater for both common mode and differential mode, per IEEE C.6241-2-2002 Class A operation. Power supply shall meet consumer emissions limits as described in FCC 47 CFR Part 15/18. TVSS shall have visible indication of failure and shall be field replaceable. The power supply shall have a Class A sound rating per ANSI Standard C63.4.

3) Luminaire to operate at temperature limits and have heat sinks and passive thermal management hardware that does not require fans or liquids. Thermal management systems to limit current when excessive temperatures are sensed. Thermal management system shall maintain LED temperature equivalent to the manufacturers rated specifications.

800.2.5 Infrastructure Standards:

A) Conduit:

1) All buried conduit to be schedule 40 PVC. Wall thickness to be per ASME Standards B36.10M and B36.19M. All exposed conduit to be Rigid Galvanized Steel.

2) Conduit for AEP-PSO service feeders to lighting controllers to be minimum 3" PVC or HDPE.

3) Where boring is required, use minimum 3" HDPE.

B) Wire:

1) Wire to be installed in conduit for lighting.

2) Wire to be sized for ampacity of connected lighting and derated per NEC for multiple circuits, and voltage drop.

3) Minimum wire size is #12 for lighting and grounding circuits.

C) Pull Boxes:

1) Street Lighting pull boxes to be concrete or Prescolite (combination of plastic and fiberglass) or approved equal flush mounted boxes with lids.

2) Pull box lids to be permanently engraved with "LIGHTING".

D) Pole Bases:

1) All light fixtures shall be installed on cast-in-place concrete pole bases, as shown on the standard Standards 804 and 805.

2) Where special conditions are encountered, modified pole details shall be provided.

3) All pole bases to have an 8' copper clad ground rod installed adjacent to them and be bonded to the support steel using minimum #6 stranded wire. Connection is to be made via Cadweld.

4) Concrete testing of material for pole bases is to be per the latest ODOT Specifications.

800.2.6 Mounting Hardware:

A) Exterior hardware shall be stainless steel.

B) General Finish Requirements:

1) Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2) Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

800.3 EXECUTION

800.3.1 Examination:

A) Examine areas and conditions, with Installer present, for compliance with pole manufacturer requirements for installation tolerances and other conditions affecting performance of the Work.

B) Examine poles, luminaire-mounting devices, and pole accessories before installation. Components that are scratched, dented, marred, wet, moisture damaged, or visibly damaged are considered defective.

C) Examine rough-in for foundation and conduit to verify actual locations of installation.

D) Examine rough-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

E) Proceed with installation only after unsatisfactory conditions have been corrected.

F) Check architectural finishes and verify that luminaires are provided with proper trim, finishes, supports, and miscellaneous accessories regardless of catalog numbers prefixes or suffixes shown in fixture schedule.

G) Verify all circuits in the lighting controller are permanently labeled and a circuit description is included in the panel lid. Confirm timer settings are correct.

800.3.2 Pole Installation:

A) Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B) Orient access door away from curb.

C) Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings.

1) Fire Hydrants and Storm Drainage Piping: 60”.

2) Water, Gas, Electric, Communication, and Sewer Lines: 5’.

3) Trees: 15’ from tree trunk.

4) From back of curb: 1’6”.

D) Concrete Pole Foundations:

1) Cast in place, with anchor bolts to match pole base flange. Structural steel complying with ASTM A36/A36M and hot-dip galvanized according to ASTM A123/A123M and with top plate and mounting bolts to match pole-base flange and strength required to support pole, luminaire, and accessories. Concrete, reinforcement, and formwork as specified in latest ODOT specification.

2) Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements as specified in latest ODOT specification.

E) Foundation-Mounted Poles: Mount poles with leveling nuts and tighten top nuts to torque level recommended by pole manufacturer.

1) Grout void between pole base and foundation. Use non-shrink or expanding concrete grout firmly packed to fill space.

2) Install base covers unless otherwise indicated.

3) Use a short piece of 1/2" diameter PVC pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

F) The City of Tulsa field inspector shall inspect pole bases before they are poured.

G) Raise and set poles using web fabric slings (not chain or cable).

H) Where pole receptacles are used, verify proper function of receptacles with a portable receptacle tester.

800.3.3 Luminaire Installation:

A) Comply with NEC.

B) Use fastening methods and materials as approved by manufacturer.

C) Supports:

1) Sized and rated for luminaire weight.

2) Able to maintain luminaire position after cleaning and re-lamping.

3) Support luminaires without causing deflection of finished surface.

4) Luminaire-mounting devices shall be capable of supporting a horizontal force of 100% of luminaire weight and a vertical force of 400% of luminaire weight.

D) Install luminaires level, plumb, and square with finished grade unless otherwise indicated.

E) Coordinate layout and installation of luminaires with other construction.

F) Verify proper operation of all luminaires and repair/replace any non-working material.

G) Adjust luminaires that require field adjustment or aiming.

800.3.4 Corrosive Prevention:

A) Aluminum: do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B) Steel Conduit: Comply with City of Tulsa Electric Code. In concrete foundations, wrap conduit with 0.010" thick, pipe-wrapping plastic tape applied with a 50% overlap.

800.3.5 Grounding:

A) Ground metal poles and support structures according to City of Tulsa Electric Code.

1) Install grounding electrode for each pole unless otherwise indicated.

2) Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

B) Ground nonmetal poles and support structures according to the City of Tulsa Electric Code on "Grounding and Bonding for Electrical Systems".

1) Install grounding electrode for each pole.

2) Install grounding conductor and conductor protector.

3) Ground metallic components of pole accessories and foundations.

800.3.6 Field Quality Control:

A) Inspect each installed fixture for damage. Replace damaged fixtures and components with new.

B) Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

C) Verify operation of photoelectric controls.

D) Illumination Tests:

1) Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s).

a) IESNA LM-50 – “Photometric Measurements of Roadway Lighting Installations”.

b) IESNA LM-64 – “Photometric Measurements of Parking Areas”.

c) IESNA LM-72 – “Directional Positioning of Photometric Data”.

800.4 PAYMENT

800.4.1 Method of Measurement:

The City of Tulsa Inspector and the Project Architect or Engineer will review Pay Applications submitted by the Contractor and shall approve payment based on the quantity of lights that are properly and completely installed according to the drawings including footings, poles, fixtures and touch-up.

800.4.2 Basis of Payment:

Payment will be made for each site furnishing pay item at the contract unit price per specified pay unit:

| PAY ITEM | PAY UNIT |
|---|---|
| STREETLIGHT | EACH |

800.5 Design Criteria:

800.5.1 In order to facilitate a uniform look for the City of Tulsa the following standards are to be met in regard to street lighting:

A) Lighting Requirements:

1) For LED lights, contractor must submit the following test information performed by a UL certified lab:

a) LM-79 Fixture Test: This test is documentation of the fixture performed in a lab. Minimum acceptable efficacy for the fixture is to be 96 lumens/watt.

b) Manufacturer to provide an ISTMT Thermal measurement test showing operation of the fixture in question under temperature, while current and light output are monitored. A test temperature of 25° C is required. This is a test of the submitted fixture under temperature, with documented performance values.

c) Independent 24-hour 40° C thermal testing shall be performed. Thermal measurements shall not exceed LED and power supply rated maximum values.

2) Provide TM-21 data: TM-21 is the IES-recommended method for projecting lumen degradation of an LED package, array or module based on data collected according to LM-80.

3) Lighting Correlated Color Temperature shall be 4,000 K nominal. Independent UL testing to confirm lighting color temperature of the selected fixture.

4) Minimum foot-candle illumination of 1.0 on sidewalk areas with a maximum average to minimum ratio of 3:1. Refer to IESNA standards or AASHTO Roadway Lighting Design Guide for other applications.

B) Lighting Controller and Light Pole Circuiting:

1) Contractor to feed lighting controller below grade, from AEP-PSO power pedestal or service pole.

2) Power conduit for AEP-PSO service feed to be minimum of 3” diameter.

3) No power for traffic control or other loads shall be fed from the lighting controller or associated conduits, with the exception of irrigation power and pole receptacles.

4) Provide controller per Standard No. 803. Feed only decorative lights and receptacles for the controller.

5) Traffic control equipment and AEP-PSO provided lights are not to be fed from lighting controller.

6) Receptacles on poles to be switched on with decorative lights.

7) Lighting controller is to be in a stand-alone NEMA 4X hinged stainless steel box. Box dimensions are to be approximately 30” W x 40” H x 24” D and to be mounted on a 4’ x 4’ x 0.5’ thick concrete base with conduits entering from the bottom. Box to be bolted to concrete foundation with four 3/4" stainless steel bolts, length as required with 4” embedment. Use Hilti HIT-RE 500-SD epoxy or approved equal. Seal joint between cabinet and concrete pad with Dow Corning 795 Silicone Building Sealant with Limestone color or approved equal.

8) Lighting controller to have AEP-PSO approved meter installed on it. Meter is to be a minimum of 18” above grade.

9) Contractor to obtain permit and circuit for decorative street lighting in the name of the responsible party. Decorative lights and associated receptacles shall be metered.

10) Coordinate with AEP-PSO for electrical service for controller. Minimum service size is 240/120V 60A, single phase. Where needed, three phase panels are allowed. Size actual controller for connected load plus 20% additional load.

11) Astronomic timer must have at least 48 hours of internal backup to keep programmed times in the event of power loss.

12) Confirm exact location of lighting controller with owner before final installation.

13) All pole or fixture receptacles are to be GFCI rated in-use receptacles and be 120V single phase.

14) When pole mounted receptacles are used, the pole circuits and the receptacle circuits should match the same groupings.

15) All lights should have the same operating voltage.

C) Performance Requirements (Poles):

1) Structural Characteristics: Comply with AASHTO LTS-6-M.

2) Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied according to AASHTO LTS-6-M.

3) Ice Load: Load of 3 lbs./sq. ft. (145 Pa), applied according to AASHTO LTS-6-M for applicable areas on the Ice Load Map.

4) Minimum Design Life: 25 years.

## PART 810 – BRICK UNIT PAVERS

### 810.1 GENERAL

#### 810.1.1 Summary:

A) Section Includes:

1) Brick pavers set in sand or mortar setting beds.

2) Cast-in-place concrete edge restraints.

B) Related Sections:

1) Section: ODOT 303 – Aggregate Base

2) Section: ODOT 325 – Separator Fabric for Bases

#### 810.1.2 References:

American Society of Testing Materials (ASTM):

A) C902 Standard Specification for Pedestrian and Light Traffic Paving Brick.

B) C1272 Standard Specification for Heavy Vehicular Paving Brick.

C) C136 Method for Sieve Analysis for Fine and Coarse Aggregate.

D) C67 Method of Sampling and Testing Brick and Structural Clay Tile.

E) C33 Specification for Concrete Aggregates.

F) C144-89 Standard Specification for Aggregate for Masonry Mortar.

#### 810.1.3 Submittals:

A) Product Data and Specifications from Manufacturers:

1) Brick Paver.

2) Bedding Sand.

3) Polymeric Joint Sand.

4) Masonry Adhesive.

B) Adhesion and Compatibility Test Reports: From latex-additive manufacturer for mortar and grout containing latex additives.

C) Sand Equivalency test results according to AASHTO T 176.

D) Sieve Analyses: For aggregate setting-bed materials, according to ASTM C136.

E) Samples for Initial Selection for the following:

1) Each type of unit paver indicated.

2) Polymeric Joint Sand.

F) Samples for Verification:

1) Full-size units of each type of unit paver indicated on drawings. Six units each.

810.1.4 Quality Assurance:

A) Installer Experience: Installation shall be by an installer with at least two years of experience and who has installed at least 200,000 sq. ft. of sand set pavers in commercial projects.

B) Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

C) Mockups: Construct mockups of full-size sections of brick paver pavement to demonstrate typical joints, surface finish, texture, color, and standard of workmanship. Include 2 sq. ft. of brick on mortar.

1) Build mockups to be 6’ x 6’ in a location as directed by Owner’s Representative.

a) Mockups shall include all joint types, including joints with caulk.

b) Provide one mockup for each type of paving pattern indicated on the plans.

c) Contractor shall provide up to two mockups for each type of paving as base bid for the project.

2) Notify Owner’s Representative seven days in advance of dates and times when mockups will be constructed.

3) Obtain Owner’s Representative's approval of mockups before starting construction.

4) Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed pavement.

5) Demolish and remove approved mockups from the site when directed by Owner's Representative.

6) Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

D) Preinstallation Conference: Conduct conference at Project site.

810.1.5 Delivery, Storage, and Handling

A) Deliver, store, and handle all paving materials in accordance with the manufacturer's recommendations.

B) Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

C) Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

D) Store aggregates where grading and other required characteristics can be maintained, and contamination avoided.

E) Store liquids in tightly closed containers protected from freezing.

810.1.6 Project Conditions:

A) Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B) Weather Limitations for Mortar and Grout:

1) Cold-Weather Requirements: Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

2) Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100° F and higher.

810.2 PRODUCTS

810.2.1 Brick Pavers:

A) Manufacturer: Below or approved equal.

1) The Belden Brick Company, Crestline Brick Pavers
PO Box 20910
Canton, OH 77401-0910
330.451.2013

2) Endicott Clay Products Co.
PO Box 17
Fairbury, NE 68352
402.729.3323

3) Pine Hall Brick
2701 Shorefair Drive
Winston-Salem, NC 27105
800.334.8689

4) Glen-Gery Brick, Extruded (repressed chamfer)
PO Box 7001
Wyomissing, PA 19610
610.374.4011

B) Brick Pavers: Light-traffic paving brick; ASTM C902-09 Class SX Type I, Application PS. With a Minimum Coefficient of Friction at 0.70. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.

C) Efflorescence: Brick shall be rated "not effloresced" when tested according to ASTM C67.

810.2.2 Aggregate Base Materials:

A) Graded Aggregate for Base: Oklahoma Department of Transportation, Type “A” aggregate base according to Section 703.01 Aggregate for Aggregate Base, Oklahoma Department of Transportation Standard Specifications for Highway Construction, with the following exceptions:

1) 8% maximum passing the No. 200 sieve.

B) Sand for Setting Bed: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33 for fine aggregate with the following exceptions:

1) 1% maximum passing the No. 200 sieve.

2) Sand equivalent of not less than 25.

C) Polymeric Sand for Joints: Fine, sharp, washed, natural sand per ASTM C144 mixed with Ethylene-vinyl acetate or acrylic additive in dry, redispersible form; prepackaged. Equal to:

1) Manufacturer: Techniseal.

2) Product: Techniseal HP.

3) Color: Granite Gray.

4) 1% maximum passing the No. 200 sieve.

D) Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

810.2.3 Mortar Setting-Bed Materials:

A) Portland Cement: ASTM C150, Type I or Type II.

B) Hydrated Lime: ASTM C207, Type S.

C) Sand: ASTM C144.

D) Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed Portland cement and aggregate mortar bed, and not containing a retarder.

1) See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers. Retain one of first two subparagraphs and list of manufacturers below. See Division 1 Section "Product Requirements".

2) Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a) Custom Building Products.

b) Laticrete International, Inc.

c) MAPEI Corporation.

E) Water: Potable.

1) Polymer Type: Ethylene-vinyl acetate or acrylic additive in dry, redispersible form; prepackaged with other dry ingredients.

810.2.4 Mortar and Ground Mixes:

A) General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimum performance characteristics. Discard mortars and grout if they have reached their initial set before being used.

B) Mortar-Bed Bond Coat: Mix neat cement and latex additive to a creamy consistency.

C) Portland Cement-Lime Setting-Bed Mortar: Type M complying with ASTM C270, Proportion Specification.

D) Latex-Modified, Portland Cement Setting-Bed Mortar: Proportion and mix Portland cement, sand, and latex additive for setting bed to comply with written instructions of latex-additive manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive pavers.

E) Latex-Modified, Portland Cement Bond Coat: Proportion and mix Portland cement, aggregate, and liquid latex for bond coat to comply with written instructions of liquid-latex manufacturer.

F) Masonry Adhesives: Concrete or Masonry Adhesives: Moisture Cure Urethane Glue for use with masonry and concrete.

1) `HP-Pro' by Techniseal, or

2) Approved equal.

810.2.5 Edge Restraints:

A) Where not otherwise retained, provide edge restraints installed around the perimeter of all interlocking concrete paving unit areas as follows:

1) Custom concrete edge restraint as shown in the details.

2) 1/4" x 4" steel edging as manufactured by Joseph T. Ryerson & Son, Inc, Chicago, Illinois or Collier Metal Specialties, Inc., Garland Texas, or

3) Approved equal.

810.2.6 Geotextiles:

A) Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50%; complying with AASHTO M 288 and the following, measured per test methods referenced:

1) Survivability: Class 2; AASHTO M 288.

2) Grab Tensile Strength: 247 lbf (1100 N); ASTM D4632.

3) Sewn Seam Strength: 222 lbf (990 N); ASTM D4632.

4) Tear Strength: 90 lbf (400 N); ASTM D4533.

5) Puncture Strength: 90 lbf (400 N); ASTM D4833.

6) Apparent Opening Size: 300 to 600 µm; ASTM D4751.

7) Permittivity: 0.02 per second, minimum; ASTM D4491.

8) UV Stability: 50% after 500 hours' exposure; ASTM D4355.

## 810.3 EXECUTION

### 810.3.1 Examination:

A) Acceptance of Site and Verification of Conditions:

1) All units shall be sound and free of defects that would interfere with the proper placing of unit or impair the strength or permanence of the construction.

2) Minor cracks incidental to the usual methods of manufacture, or chipping resulting from customary methods of handling in shipment and delivery, shall not be deemed grounds for rejection.

3) Contractor shall inspect, accept, and certify in writing to the paver installation contractor that site conditions meet specifications for the following items prior to installation of interlocking concrete pavers.

a) Verify that subgrade preparation, compacted density and elevations conform to specified requirements.

b) Verify that geotextiles, if applicable, have been placed according to drawings and specifications.

c) Verify that aggregate or concrete base materials, thickness, compacted density, surface tolerances and elevations conform to specified requirements.

d) Higher density or compaction to ASTM D1557 may be necessary for areas subject to continual vehicular traffic. Stabilization of the subgrade and/or base material may be necessary with weak or saturated subgrade soils.

e) Provide written density test results for soil subgrade, and aggregate base materials to the CITY.

f) Verify location, type, and elevations of edge restraints, concrete collars around utility structures, and drainage inlets.

4) Do not proceed with installation of bedding sand and pavers until sub-grade soil and base conditions are corrected by the Contractor.

B) Where pavers are to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations, including areas where waterproofing system is turned up or flashed against vertical surfaces.

810.3.2 Preparation:

A) Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

B) Verify base is dry, certified by Contractor as meeting material, installation, and grade specifications.

C) Verify that base and geotextile is ready to support sand, edge restraints, pavers, and imposed loads.

D) Edge Restraint Preparation:

1) Install edge restraints per the drawings and manufacturer's recommendations at the indicated elevations.

2) Mount directly to finished base. Do not install on bedding sand.

3) The minimum distance from the outside edge of the base to the spikes shall be equal to the thickness of the base.

E) Proof-roll prepared subgrade according to requirements of ODOT subgrade method B to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive base course for unit pavers.

810.3.3 Installation, General:

A) Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

B) Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C) Cut clay pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer or split cuts will be rejected.

D) Handle protective-coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

E) Joint Pattern:

1) As indicated on drawings for pedestrian applications.

F) Joint filler before setting pavers. Sealant materials and installation are specified in Division 7 Section "Joint Sealants".

G) Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

1) Install job-built concrete edge restraints or bands indicated on the drawings.

2) Where pavers set in mortar bed are indicated as edge restraints for pavers set in aggregate setting bed, install pavers set in mortar and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.

810.3.4 Aggregate Setting-Bed Applications:

A) Compact soil subgrade uniformly to at least 95% of ASTM D698 laboratory density.

B) Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

C) Place aggregate base, compact by tamping with plate vibrator, and screed to depth indicated.

D) Place aggregate base, compact to 98% of ASTM D1557 (modified proctor) maximum laboratory density, and screed to depth indicated.

E) Place sand setting bed and screed to a thickness of 1”, taking care that moisture content remains constant and density is loose and uniform until pavers are set and compacted.

F) Treat setting bed with herbicide to inhibit growth of grass and weeds.

G) Set pavers with a minimum joint width of 1/16” and a maximum of 1/8” being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Cut and arrange pavers so no pavers are smaller than 1/3 paver, and no joints are greater than 1/8”. Exceptions will be made where pavers abut utility lids and curb radius. Fill gaps between units that exceed 3/8” insert dimension with pieces cut to fit from full-size unit pavers.

H) Set pavers with a minimum joint width of 1/16” and a maximum of 1/8” being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 3/8” insert dimension with pieces cut to fit from full-size unit pavers.

1) When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

I) Compaction of Pavers: Vibrate pavers only under Manufacturer’s Approval or recommended written installation instructions, into sand setting bed with a low-amplitude plate vibrator capable of a 3,500-lbf to 5,000-lbf (16-kN to 22-kN) compaction force at 80 to 90 Hz. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.

1) Place plywood protection plating over brick pavers prior to vibrating pavers into place. Operate compaction device on plywood to seat pavers.

2) Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36” (900 mm) of uncompacted pavers adjacent to temporary edges.

3) Before ending each day's work, compact installed concrete pavers except for 36” (900 mm) width of uncompacted pavers adjacent to temporary edges (laying faces).

4) As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36” of laying face.

5) Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover setting bed on which pavers have not been placed with non-staining plastic sheets to protect them from rain.

J) Polymeric Joint Sand: Spread dry joint sand and fill joints immediately after vibrating pavers into leveling course. Protect pavers with plywood and vibrate pavers to force

sand into joints. Repeat process as necessary to completely fill the joints and remove the excess sand.

1) Placement and hydration of polymeric joint sand shall be performed in accordance with the joint sand manufacturer's written instructions.

K) Do not allow traffic on installed pavers until sand has been swept and vibrated into joints and joint sand has cured.

L) Repeat joint-filling process as may be required for joints that are not completely filled.

810.3.5 Mortar Setting-Bed Applications:

A) Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.

B) Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Limit area of bond coat to avoid its drying out before placing setting bed. Do not exceed 1/16" thickness for bond coat.

C) Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

D) Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.

E) Wet brick pavers before laying if the initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested according to ASTM C67. Allow units to absorb water so they are damp but not wet at time of laying.

F) Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16" thick bond coat to mortar bed or to back of each paver with a flat trowel.

1) Joints are to match dry set pavers on sand setting bed and joints are to receive polymeric joint sand.

G) Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.

810.3.6 Masonry Adhesive:

A) Prepare surface and apply glue per the manufactures written instructions.

810.3.7 Field Quality Control:

A) Tolerances: do not exceed 1/16” unit-to-unit offset from flush (lippage) or 1/8” in 24” and 1/4" in 10’ from level, or indicated slope, for finished surface of paving.

B) Pavers installed in heavy vehicular areas:

1) Pavement surface shall be set 1/8” to 1/4" (3 to 6 mm) above drainage gratings.

2) Pavement surface shall be set 1/8” above concrete edge restraints.

810.3.8 Maintenance for Refilling Joint Sand and Paver Settlement:

A) Refilling of Joints: One month after initial installation of pavers and at completion of project contractor shall sweep additional sand into the joints as needed and as directed by Engineer.

B) Paver Settlement: One month after initial installation of pavers and at completion of project contractor shall check surface of pavers for settlement and re-set pavers as needed and as directed by Engineer.

810.3.9 Repairing and Cleaning:

A) Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B) Cleaning: Remove excess joint sand from exposed paver surfaces; wash and scrub clean.

810.3.10 Protection:

After work in this section is complete, the Contractor shall be responsible for protecting work from damage due to subsequent construction activity on the site.

810.4 PAYMENT

810.4.1 Method of Measurement:

The City of Tulsa Inspector and the Project Architect or Engineer will review Pay Applications submitted by the Contractor and shall approve payment based on the quantity of brick unit pavers that are properly and completely installed including aggregate base materials, mortar setting bed materials, mortar and grout mixes, masonry adhesives, edge restraints and geotextiles.

810.4.2 Basis of Payment:

Payment will be made for each square foot of installed brick unit pavers at the contract unit price per specified pay unit:

| PAY ITEM | PAY UNIT |
| --- | --- |
| BRICK UNIT PAVERS | PER SQUARE FOOT |

## PART 811 – INTERLOCKING CONCRETE PAVERS

### 811.1 GENERAL

#### 811.1.1 Summary:

A) Section Includes:

1) Interlocking Concrete Paver Units (manually installed).

2) Bedding and Joint Sand.

3) Edge Restraints.

B) Related Sections:

1) Section: ODOT 303 – Aggregate Base

2) Section: ODOT 325 – Separator Fabric for Bases

#### 811.1.2 References:

A) American Society for Testing and Materials (ASTM):

1) ASTM C33, Standard Specification for Concrete Aggregates.

2) ASTM C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.

3) ASTM C140, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.

4) ASTM C144, Standard Specification for Aggregate for Masonry Mortar.

5) ASTM C936, Standard Specification for Solid Concrete Interlocking Paving Units.

6) ASTM C979, Pigments for Integrally Colored Concrete.

7) ASTM D698, Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,000 ft-lbf/ft$^3$).

8) ASTM D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft$^3$).

9) ASTM D2940, Specification for Graded Aggregate Material for Bases or Sub-bases for Highways or Airports.

811.1.3 Submittals:

A) Manufacturer's drawings and details: Indicate perimeter conditions, relationship to adjoining materials and assemblies, expansion and control joints, concrete paver layout, patterns, color arrangement, installation and setting details.

B) Sieve analysis per ASTM C136 for grading of bedding and joint sand.

C) Concrete pavers:

1) Four representative full-size samples of each paver type, thickness, color, finish that indicates the range of color variation and texture expected in the finished installation. Color(s) selected by Owner and approved by the City of Tulsa from manufacturer's available colors.

2) Accepted samples become the standard of acceptance for the work.

3) Test results from an independent testing laboratory for compliance of paving unit requirements to ASTM C936.

4) Manufacturer's certification of concrete pavers by ICPI as having met applicable ASTM standards.

5) Manufacturer's catalog product data, installation instructions, and material safety data sheets for the safe handling of the specified materials and products.

D) Paver Installation Contractor:

1) A copy of Contractor's current certificate from the Interlocking Concrete Pavement Institute Level I Concrete Paver Installer Certification program.

2) Job references from projects of a similar size and complexity. Provide Owner/Client/General Contractor names and phone numbers.

811.1.4 Quality Assurance:

A) Paving Contractor Qualifications:

1) Utilize an installer with at least one year of experience having successfully completed concrete paver installation similar in design, material, and extent indicated on this project.

2) Utilize an installer holding a current certificate from the Interlocking Concrete Pavement Institute Concrete Paver Installer Certification program and shall be fully aware and follow their recommendations and specifications.

B) Manufacturer: Company specializing in the manufacture of concrete interlocking pavers for a minimum of three years.

C) Installation Contractor shall conform to all local, state/provincial licensing and bonding requirements.

D) Contractor shall be certified by the Interlocking Concrete Pavement Institute and shall be fully aware and follow their recommendations and specifications.

E) Regulatory Requirements and Approvals: As required by the City of Tulsa for work within the Right of Way.

F) Mockups:

1) Install a 6’ x 6’ paver area.

2) Use this area to determine surcharge of the bedding sand layer, joint sizes, lines, laying pattern(s), color(s), and texture of the job.

3) Evaluate the need for protective pads when compacting paving units with architectural finishes.

4) This area will be used as the standard by which the work will be judged.

5) Subject to acceptance by owner, mockup may be retained as part of finished work.

6) If mockup is not retained, remove, and properly dispose of mockup.

811.1.5 Delivery, Storage, and Handling:

A) General: Comply with Division

1) Product Requirement Section.

B) Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers packaging with identification labels intact.

1) Coordinate delivery and paving schedule to minimize interference with normal use of buildings adjacent to paving.

2) Deliver concrete pavers to the site in steel banded, plastic banded, or plastic wrapped packaging capable of transfer by forklift or clamp lift.

3) Unload pavers at job site in such a manner that no damage occurs to the product.

C) Storage and Protection: Store materials protected such that they are kept free from mud, dirt, and other foreign materials. Store concrete paver cleaners and sealers per manufacturer's instructions.

811.1.6 Project/Site Conditions:

A) Environmental Requirements:

1) Do not install sand or pavers during heavy rain or snowfall.

2) Do not install sand and pavers over frozen base materials.

3) Do not install frozen sand or saturated sand.

4) Do not install concrete pavers on frozen or saturated sand.

811.2 PRODUCTS

811.2.1 Interlocking Concrete Pavers:

A) Manufacturer:

1) Concrete pavers shall be equal to those supplied by Pavestone Company,

a) D/FW, TX: 817.481.5802

b) Houston, TX: 281.391.7283

c) Kansas City, MO: 816.524.7283

d) San Antonio/Austin, TX: 512.558.7283

e) Dallas Service Center: 972.404.0400

f) Cape Girardeau, MO: 573.264.1500 or

2) Hanover Prest-Paving Company
240 Bender Road
Hanover, PA 17331
800.426.4212, or

3) Belgard Pavers from Bonner Springs, Kansas.

B) Interlocking Concrete Paver Units, including the following:

1) Paver Type: Equal to Holland Stone

a) Material Standard: Comply with material standards set forth in ASTM C936.

b) Color and finish: As selected by the Owner and approved by the City of Tulsa.

c) Color Pigment Material Standard: Comply with ASTM C979.

d) Size in Pedestrian Areas: Nominal 3.875” x 7.875” x 2.36” (60 mm) thick, or as approved by the City of Tulsa.

e) Size in Vehicular Areas: 3.875” x 7.875” x 3.16” (80 mm) thick, or as approved by the City of Tulsa. For driveway and access use only – not for street use.

f) Average Compressive Strength: 8,000 psi with no individual unit under 7,200 psi.

g) Average Water Absorption (ASTM C140): 5% with no unit greater than 7%.

h) Freeze/Thaw Resistance (ASTM C67): Resistant to 50 freeze-thaw cycles with no greater than 1% loss of material.

i) Minimum average cube compressive strength of 7,250 psi for laboratory cured specimens or 5,800 psi for unconditioned field samples.

j) Resistance to 28 freeze-thaw cycles while immersed in a 3% saline solution with no greater mass lost than 225 g/$m^2$ of surface area after 28 years, or 500 g/$m^2$ after 49 cycles.

811.2.2 Aggregate Base Materials:

A) Provide bedding and joint sand as follows:

1) Clean, non-plastic, free from deleterious or foreign matter, symmetrically shaped, natural, or manufactured from crushed rock.

2) Do not use stone dust.

3) Do not use limestone screenings or sand for the bedding that does not conform to the grading requirements of ASTM C33.

4) Do not use mason sand, or sand conforming to ASTM C144 for the bedding sand.

5) Where concrete pavers are subject to vehicular traffic, utilize sands that are as hard as practically available.

6) Sieve according to ASTM C136.

7) Bedding Sand Material Requirements: Conform to the grading requirements of ASTM C33 with modifications as shown in Table 1.

8) Joint Sand Material Requirements: Conform to the grading requirements of ASTM C144 as shown with modifications in Table 2 or meet the requirements for bedding sand in Table 1.

Table 1
Grading Requirements for Bedding Sand

| ASTM C33 | | CSA A23.1 FA1 | |
|---|---|---|---|
| Sieve Size | Percent Passing | Sieve Size | Percent Passing |
| 3/8” (9.5 mm) | 100 | 10 mm | 100 |
| No. 4 (4.75 mm) | 95 to 100 | 5 mm | 95 to 100 |
| No. 8 (2.36 mm) | 80 to 100 | 2.5 mm | 80 to 100 |
| No. 16 (1.18 mm) | 50 to 85 | 1.24 mm | 50 to 90 |
| No. 30 (0.600 mm) | 25 to 60 | 0.630 mm | 25 to 65 |
| No. 50 (0.300 mm) | 10 to 30 | 0.315 mm | 10 to 35 |
| No. 100 (0.150 mm) | 2 to 10 | 0.160 mm | 2 to 10 |
| No. 200 (0.075 mm) | 1 | 0.075 mm | 1 |

B) Polymeric Sand for Joints: Fine, sharp, washed, natural sand per ASTM C144 mixed with Ethylene-vinyl acetate or acrylic additive in dry, redispersible form; prepackaged. Equal to:

1) Manufacturer: Techniseal.

2) Product: Techniseal HP.

3) Color: Granite Gray.

4) 1% maximum passing the No. 200 sieve.

Table 2
Grading Requirements for Joint Sand

| | ASTM C144 Natural Sand | ASTM C144 Sand | CSA A179 Manufactured Sand | CSA A179 Sand |
|---|---|---|---|---|
| Sieve Size | Percent Passing | Percent Passing | Percent Passing | Percent Passing |
| No. 4 (4.75 mm) | 100 | 100 | 5 mm | 100 |
| No. 8 (2.36 mm) | 95 to 100 | 95 to 100 | 2.5 mm | 90 to 100 |
| No. 16 (1.18 mm) | 70 to 100 | 70 to 100 | 1.25 mm | 85 to 100 |
| No. 30 (0.600 mm) | 40 to 75 | 40 to 100 | 0.630 mm | 65 to 95 |
| No. 50 (0.300 mm) | 10 to 35 | 20 to 40 | 0.315 mm | 15 to 80 |
| No. 100 (0.150 mm) | 2 to 15 | 10 to 25 | 0.160 mm | 0 to 35 |

| | | | | |
|---|---|---|---|---|
| No. 200 (0.075 mm) | 0 to 1 | 0 to 10 | 0.075 mm | 0 to 1 |

811.2.3 Edge Restraints:

A) Where not otherwise retained, provide edge restraints installed around the perimeter of all interlocking concrete paving unit areas as follows:

1) Custom concrete edge restraint as shown in the details.

2) 1/4" x 4" steel edging as manufactured by:
Joseph T. Ryerson & Son, Inc.
Chicago, Illinois
or
Collier Metal Specialties, Inc.
Garland Texas.

3) Other if approved by the City of Tulsa.

811.2.4 Geotextiles:

A) Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50%; complying with AASHTO M 288 and the following, measured per test methods referenced:

1) Survivability: Class 2; AASHTO M 288.

2) Grab Tensile Strength: 247 lbf; ASTM D4632.

3) Sewn Seam Strength: 222 lbf; ASTM D4632.

4) Tear Strength: 90 lbf; ASTM D4533.

5) Puncture Strength: 90 lbf; ASTM D4833.

6) Apparent Opening Size: 300 to 600 µm; ASTM D4751.

7) Permittivity: 0.02 per second, minimum; ASTM D4491.

8) UV Stability: 50% after 500 hours' exposure; ASTM D4355.

811.3 EXECUTION

811.3.1 Examination:

A) Acceptance of Site and Verification of Conditions:

1) All units shall be sound and free of defects that would interfere with the proper placing of unit or impair the strength or permanence of the construction.

2) Minor cracks incidental to the usual methods of manufacture, or chipping resulting from customary methods of handling in shipment and delivery, shall not be deemed grounds for rejection.

3) Contractor shall inspect, accept, and certify in writing to the paver installation contractor that site conditions meet specifications for the following items prior to installation of interlocking concrete pavers.

   a) Verify that subgrade preparation, compacted density and elevations conform to specified requirements.

   b) Verify that geotextiles, if applicable, have been placed according to drawings and specifications.

   c) Verify that aggregate or concrete base materials, thickness, compacted density, surface tolerances and elevations conform to specified requirements.

   d) Higher density or compaction to ASTM D1557 may be necessary for areas subject to continual vehicular traffic. Stabilization of the subgrade and/or base material may be necessary with weak or saturated subgrade soils.

   e) Provide written density test results for soil subgrade, and aggregate base materials to the CITY.

   f) Verify location, type, and elevations of edge restraints, concrete collars around utility structures, and drainage inlets.

4) Where pavers are to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations, including areas where waterproofing system is turned up or flashed against vertical surfaces.

811.3.2 Preparation:

A) Verify base is dry, certified by Contractor as meeting material, installation, and grade specifications.

B) Verify that base and geotextile is ready to support sand, edge restraints and pavers, and imposed loads.

C) Edge Restraint Preparation:

1) Install edge restraints per the drawings and manufacturer's recommendations at the indicated elevations.

2) Mount directly to finished base. Do not install on bedding sand.

3) The minimum distance from the outside edge of the base to the spikes shall be equal to the thickness of the base.

811.3.3 Installation:

A) Spread bedding sand evenly over the base course and screed rails, using the rails to produce a nominal 1” (25 mm) thickness, allowing for specified variation in the base surface.

1) Do not disturb screeded sand.

2) Screeded area shall not substantially exceed that which is covered by pavers in one day.

3) Do not use bedding sand to fill depressions in the base surface.

B) Ensure that pavers are free of foreign materials before installation.

C) Lay pavers in pattern(s) shown on drawings. Make horizontal adjustments to laid pavers as required.

D) Provide joints between pavers 1/16” (2 mm) wide.

E) Joint (bond) lines shall not deviate more than ±1/2" (12 mm) over 50’ (15 m) from string lines.

F) Fill gaps at the edges of the paved area with cut pavers or edge units. Cut and arrange pavers so no pavers are smaller than 1/3 paver, and no joints are greater than 1/8”. Exceptions will be made where pavers abut utility lids and curb radius.

G) Cut pavers to be placed along the edge with a masonry saw.

H) Adjust bond pattern at pavement edges such that cutting of edge pavers is minimized. All cut pavers exposed to vehicular tires shall be no smaller than one-third of a whole paver.

I) Keep skid steer and forklift equipment off newly laid pavers that have not received initial compaction and joint sand.

J) Use a low-amplitude plate compactor capable of at least minimum of 3,000 lbf for 60 mm pavers, and 5,000 lbf for 80 mm pavers, at a frequency of 75 to 100 hHz to

vibrate the pavers into the sand. Remove any cracked or damaged pavers and replace with new units.

K) Simultaneously spread, sweep, and compact dry joint sand into joints continuously until full. This will require at least four to six passes with a plate compactor. Do not compact within 3’ (900 mm) of unrestrained edges of paving units.

L) All work within 3’ (900 mm) of the laying face must be left fully compacted with sand-filled joints at the end of each day or compacted upon acceptance of the work. Cover the laying face or any incomplete areas with plastic sheets overnight if not closed with cut and compacted pavers with joint sand to prevent exposed bedding sand from becoming saturated from rainfall.

M) Remove excess sand from surface when installation is complete.

N) Allow excess joint sand to remain on surface to protect pavers from damage from other trades. Remove excess sand when directed by Architect.

O) Surface shall be broom clean after removal of excess joint sand.

P) Re-sanding of the paver joints as necessary shall be accomplished by the Contractor for a period of 90 days after completion of the work.

811.3.4 Field Quality Control:

A) The final surface tolerance from grade elevations shall not deviate more than ±3/8” (10 mm) over 10’ (3 m). Use a straightedge, flexible straightedge or transit depending on surface slope and contours.

B) Check final surface elevations for conformance to drawings.

C) The surface elevation of pavers shall be 1/8” to 3/8” (3 to 10 mm) above adjacent drainage inlets, concrete collars, or channels.

D) Lippage: No greater than 1/8” (3 mm) difference in height between adjacent pavers.

811.3.5 Repairing and Cleaning:

A) Remove and replace pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B) Clean concrete pavers in accordance with the manufacturer's written recommendations.

811.3.6 Protection:

A) After work in this section is complete, the General Contractor shall be responsible for protecting work from damage due to subsequent construction activity on the site.

## 811.4 PAYMENT

811.4.1 Method of Measurement:

The City of Tulsa Inspector and the Project Architect or Engineer will review Pay Applications submitted by the Contractor and shall approve payment based on the quantity of concrete pavers that are properly and completely installed including aggregate base materials, edge restraints and geotextiles.

811.4.2 Basis of Payment

Payment will be made for each square foot of installed brick unit pavers at the contract unit price per specified pay unit:

| PAY ITEM | PAY UNIT |
|---|---|
| CONCRETE PAVERS | PER SQUARE FOOT |

## PART 812 – STAMPED CONCRETE FINISHING

812.1 GENERAL

812.1.1 Summary:

A) Section Includes:

1) Integrally colored and color-hardened Portland cement concrete paving with imprinted pattern and stain/sealer treatments.

B) Related Documents:

1) Section 7 9000 – Joint Sealants: Sealant for joints.

812.1.2 References:

A) American Concrete Institute (ACI)

1) ACI 305R – Hot Weather Concreting.

2) ACI 306R – Cold Weather Concreting.

3) ACI 308 – Standard Practice for Curing Concrete.

4) ACI 309 – Standard Practice for Consolidation of Concrete.

5) ACI 347 – Guide to Formwork for Concrete.

6) ACI 503 – Standard Specification for Bonding Plastic Concrete to Hardened Concrete with a Multi-Component Epoxy Adhesive.

B) American Society for Testing and Materials (ASTM)

1) ASTM C33 – Standard Specifications for Concrete Aggregates.

2) ASTM C150 – Standard Specifications for Portland Cement.

3) ASTM C260 – Standard Specifications for Air-Entraining Admixtures for Concrete.

4) ASTM C309 – Standard Specifications for Liquid Membrane Forming Compounds for Curing Concrete.

5) ASTM C494 – Standard Specifications for Chemical Admixtures for Concrete.

812.1.3 Submittals:

A) Product Data: Manufacturer's data sheets on each product to be used, including:

1) Preparation instructions and recommendations.

2) Storage and handling requirements and recommendations.

3) Installation methods.

B) Testing:

1) Submit proposed mix design for each class of concrete for review prior to commencement of work.

2) Testing firm will take cylinders and perform slump and air entrainment tests in accordance with ACI 301.

3) Four concrete test cylinders will be taken for each class of concrete placed each day.

4) One slump test will be taken for each set of test cylinders taken.

812.1.4 Quality Assurance:

A) Installer Qualifications:

1) The Installer shall provide a qualified foreman or supervisor who has a minimum of three years of experience with imprinted and textured concrete, and who has successfully completed at least five imprinted concrete installations of high quality and similar in scope to that required.

2) The concrete is cast in place, on the job site, by trained and experienced workmen who shall be employed by a firm that is a licensed and certified Imprint Licensed Contractor by a reputable national colored concrete company.

3) Perform work in accordance with ACI 301, 302, 303.

4) Obtain materials from same source throughout.

5) Conform to applicable codes and regulations for paving work performed within the public right of way.

B) Ready-Mixed Supplier Qualifications:

1) Supplier of ready-mixed concrete products shall comply with ASTM C94 requirements for production facilities and equipment. Supplier shall be certified

according to NCRMA's "Certification of Ready Mixed Concrete Production Facilities Quality Control Manuals".

C) Testing Agency Qualifications:

1) An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 to conduct the testing indicated, as documented according to ASTM E548.

D) Mockup:

1) Provide field samples of surface colors textures and patterns specified for architect approval prior to beginning work, 48" x 48" in size illustrating paving finishes.

a) Finish areas designated by Architect.

b) Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect

c) Finish mockup area as required to produce acceptable work.

812.1.5 Delivery, Storage, and Handling:

A) Store products in manufacturer's unopened packaging until ready for installation.

B) Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

812.1.6 Project Conditions:

A) Do not place pavement when base surface or ambient temperature is less than 40° F (4° C) or if base surface is wet or frozen.

B) Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

812.1.7 Warranty:

A) All materials equal to that manufactured by The Bomanite Company and warranted to be of uniform quality within manufacturing tolerances.

812.2 PRODUCTS

812.2.1 Manufacturers:

A) Acceptable Manufacturers:

1) The Bomanite Company
8789 Auburn Folsom Rd #108
Granite Bay, CA 95746
Tel: 303.369.1115
Fax: 303.291.0282
Email: info@bomanite.com
Web: www.bomanite.com

2) Patterned Concrete Industries, Ltd.
800.252.4619
www.patternedconcrete.com

812.2.2 System:

A) Supporting Structure:

1) Mix Design:

a) Mix and deliver concrete in accordance with ASTM C94, Alternate 2. Refer to Drawings for concrete strength requirements.

b) Use accelerating admixtures containing no calcium chloride in cold weather only when approved by testing laboratory. Use of admixtures will not relax cold weather placement requirements.

c) Use set retarding admixtures during hot weather only when approved by testing laboratory.

d) Add air entraining agent to concrete mix for concrete work exposed to exterior, in amounts of 4% to 7% of total concrete volume or as otherwise recommended by testing laboratory.

e) Add coloring admixture where scheduled in quantities recommended by coloring admixture manufacturer to achieve selected color.

f) Maintain water cement ratio to produce a minimum of 3” to maximum of 5” slump.

g) Use of calcium chloride is strictly prohibited.

2) Subgrade:

a) Refer to drawings for scope of subgrade preparation.

B) Color:

1) Integral Color: to be selected from Manufacturer’s standard color chart.

a) Integral Coloring Admixture: Integral Color, synthetic oxide pigment, meeting ASTM C979 and C494.

1. Type A cement dispersing/water reducing.

2. Type D set retarding/water reducing.

3. Color to be equal to Interstar Ready Mix Color Chart – Egyptian Red (two bags)

2) Color Hardener:

a) Bomanite Color Hardener: The concrete shall be colored with Color Hardener. Color to be selected from Manufacturer's standard color chart.

C) Tools Selection:

1) Imprinting Tools:

a) Mat type imprinting tools for texturing freshly placed concrete, in pattern/texture as selected by Architect or as scheduled.

b) Imprinting tools for specialty projects shall become property of the City of Tulsa after the project.

2) Bomanite Patterns:

a) Herringbone Brick 4" x 8" pavers.

3) Textures and Patterns:

a) Designs as scheduled. Refer to Drawings. Up to two patterns to be selected.

D) Release Agent Selection:

1) Powdered Release Agent. Up to two colors to be selected.

a) PermaPro Gunsmoke Release Agent or equal.

b) Liquid Release Agent. Clear color.

c) Bomanite Liquid Release or equal.

E) Secondary Antique or Coloration:

1) Topical Stain:

a) Colors to be selected from Manufacturer's standard color chart.

b) Equal to Bomanite Topical Stain.

2) Chemical Stain:

a) Colors to be selected from Manufacturer's standard color chart.

b) Equal to Bomanite Chemical Stain.

F) Cure Agent:

1) Membrane Color Cure:

a) Color(s) as scheduled. Refer to Drawings.

1. Curing Compound: Meeting ASTM C309, water-based emulsion.

2. Silicate Cure & Densifier:

i. The concrete shall receive a cure treatment of Bomanite Con Shield or equal.

G) Sealing and Finish Coatings:

1) Equal to Color Wax by The Bomanite Company.

2) HydroLock by The Bomanite Company or equal.

3) VOC II by The Bomanite Company or equal.

812.2.3 Related Materials

A) Cement:

1) ASTM C150, Type 1, Portland cement, gray color.

B) Fine and Coarse Aggregates:

1) ASTM C33.

C) Water:

1) Clean and not detrimental to concrete.

D) Form Material:

1) Conform to ACI 301. If using metal, material shall be free from deformities. If using wood, use construction grade lumber, sound and free of warp, minimum 2” (51 mm) nominal thickness, except where short radii of curves require thinner forms.

E) Contraction Joint Devices:

1) Galvanized sheet metal, keyed profile.

F) Tie Wire:

1) Annealed steel, minimum 16 gage size.

G) Dowels:

1) ASTM A615, Grade 40, plain steel, uncoated finish.

H) Form Release Agent:

1) As acceptable to concrete colorant manufacturer, non-staining, dissipative type.

I) Vapor Retarding Membrane:

1) 10 mil (.2540 mm) reinforced polyethylene.

J) Air-Entraining Admixture:

1) ASTM C206. Air Entrained Concrete shall be used wherever concrete is exposed to the freezing weather. Proportions of entrained air, as determined by ASTM C233, and C260, shall be as follows:

a) Aggregate: 3/8” maximum size aggregate 6% to 8% entrained air.

b) Aggregate: 3/4" maximum size aggregate 5% to 7% entrained air.

K) Joint Fillers:

1) Asphaltic Joint Filler:

a) Asphalt impregnated fiberboard, ASTM D1751, 1/2" (12 mm) thick.

2) Non-Asphaltic Joint Fillers:

a) ASTM D1752, Type I

L) Sealants:

1) Two-part polyurethane sealants, of grade as required to suit application, meeting ASTM C920, in manufacturer's custom colors.

a) Urethane, SL grade, as specified in Section 7 9000.

b) Urethane, SL-TB grade as specified in Section 7 9000.

M) Bonding Agent:

1) ASTM C1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene rubber.

N) Epoxy-Bonding Adhesive:

1) ASTM C881, two component epoxy resin, capable of humid curing and bonding to damp surface, of class and grade to suit requirements if required, and as follows: Types I and II, non-load bearing, for bonding hardened of freshly mixed concrete to hardened concrete.

812.3 EXECUTION

812.3.1 Inspection:

A) Verify compacted subgrade is ready to support paving and imposed loads, free of frost, smooth and properly compacted.

B) Verify gradients and elevations of base are correct, and proper drainage has been provided so water does not stand in the area to receive paving.

C) Beginning of installation means acceptance of existing conditions.

812.3.2 Preparation:

A) If vapor retarding membrane is not used, moisten base to minimize absorption of water from fresh concrete.

B) Notify Architect and testing laboratory, minimum 24 hours prior to commencement of concreting operations.

812.3.3 Forming:

A) Construct and remove forms in accordance with ACI 347.

B) Place and secure forms to correct location, dimension, and profile. Adequately brace to withstand loads applied during concrete placement.

C) Assemble formwork to permit easy stripping and dismantling without damaging concrete.

D) Place joint fillers vertical in position, in straight lines. Secure to formwork during concrete placement.

812.3.4 Inserts and Accessories:

A) Make provisions for installation of inserts, accessories, anchors, and sleeves.

B) Place vapor retarder continuously over subgrade. Overlap joints a minimum of 12" (305 mm) and seal with a joint tape of same permeance as sheeting material.

812.3.5 Joints:

A) Intentional stoppage of concrete placing shall be at planned location of either an expansion joint or contraction joint.

B) When stoppage occurs at an expansion joint, install joint assembly with a bulkhead of sufficient section drilled to accommodate required dowels. Provide expansion joints at maximum 50' (15 m) on center each way (OCEW) at pedestrian paving. Align joints with stamped concrete pattern.

C) When stoppage occurs at a contraction joint, install sheet metal joint assembly of sufficient section to prevent deflection, shaped to concrete section.

D) Stoppage at Unintentional Location:

1) Immediately upon unintended stoppage of concrete placing, place available concrete to a line and install bulkhead perpendicular to surface of pavement and at required elevation. Place and finish concrete to this bulkhead. Remove and dispose of concrete remaining on subgrade ahead of bulkhead.

2) When placing of concrete is resumed before concrete has set to extent that concrete will stand on removal of bulkhead, new concrete shall be rodded with the first; otherwise, carefully preserve joint face.

3) Provide a joint seal space at edges created by a construction joint of this type shall have a joint seal space as detailed on Drawings.

E) Provide sawed contraction joints in pedestrian paving spaced 10' OCEW spacing. Align joints with stamped concrete pattern.

1) Saw joints after completion of finishing operations as soon as concrete has hardened to extent necessary to prevent revealing of joint or damage to adjacent concrete surfaces.

2) Saw joints same day that concrete is placed except that sawing of joints in concrete placed late in day may be delayed until morning of following day.

3) In any event, saw joints within 18 hours after placing concrete. Use a power-driven concrete saw made especially for sawing concrete and maintain in good operating condition.

4) Saw cut shall be to a depth equal to 1/4 of slab thickness, minimum 1" (25 mm) depth.

5) Align joints in vehicular paving with joints in adjacent pedestrian paving.

6) Cut joints through curbs at right angles to back of curb.

F) Place joint filler between paving components and building or other appurtenances.

G) Provide scored joints in sidewalks and plazas to a depth of 1/4 the slab thickness, and at intervals as indicated, but in no case spaced greater than width of walk.

812.3.6 Placing Concrete:

A) Place concrete in accordance with ACI 301, 302, and 304. Deposit concrete so that specified slab thickness will be obtained after vibrating and finishing operations. Minimize handling to prevent segregation. Consolidate concrete by suitable means to prevent formation of voids or honeycombs. Exercise care to prevent disturbance of forms and damage to vapor retarder. Place concrete to lines and levels shown, properly sloped to drain as designed.

1) Hot Weather Placement: ACI 305.

2) Cold Weather Placement: ACI 306.

3) Ensure inserts, embedded parts, and formed joints are not disturbed during concrete placement.

4) Place concrete continuously between predetermined construction joints. Do not break or interrupt successive pours such that cold joints occur.

B) After consolidating and screeding, float concrete to gradients indicated. Use a straight edge to level and test surface in longitudinal direction to required grade. Finish edges to provide a smooth dense surface with 1/8" (3 mm) radius.

C) Apply Color Hardener prior to application of pattern. Apply at rate recommended by manufacturer, evenly to the surface of the fresh concrete by the dry-shake method. Applied in two or more shakes, floated after each shake, and troweled only after the final floating.

D) While concrete is still in its plastic state, apply the tool/texture pattern to the surface of the concrete. Properly tamp tools into the surface to achieve the required texture, with uniformity of pattern and depth of stamping. Utilize bond breaker to keep tools from sticking to fresh concrete.

1) Release material shall be applied to the troweled surface prior to imprinting.

E) Place curing compound on exposed concrete surfaces immediately after finishing.

F) Apply in accordance with manufacturer's instructions.

G) Apply secondary stain treatment per approved mock-up or as scheduled to achieve design.

H) Apply finish sealer per approved mock-up or as specified to achieve design required.

812.3.7 Field Quality Control:

A) Maintain records of placed concrete items. Record date, location of pour, quantity, air temperature, and test samples taken.

812.3.8 Protection:

A) Immediately after placement, protect concrete from premature drying, excessive hot or cold temperatures, and mechanical injury.

812.3.9 Method of Measurement:

Stamped Concrete Paving. The quantity to be measured for under this item shall be for each logo installed at the location and of the type shown on the Plans or in the Proposal, completed and accepted, measured in place.

812.3.10 Basis of Payment:

Accepted quantities of stamped concrete paving, measured as provided above, will be paid for at the contract unit price INSTALLED:

STAMPED CONCRETE ROUTE 66 LOGO (16" x 16")..... EACH

STAMPED CONCRETE PAVING (DECORATIVE BAND)..... SQUARE FOOT

STAMPED CONCRETE PAVING.....SQUARE YARD

Payment shall be full compensation for furnishing ALL materials, equipment, labor, excavation, and incidentals to complete the work as specified including concrete footing construction.

## PART 820 – STREETSCAPE AMENITIES

820.1 GENERAL

820.1.1 Summary:

A) Section includes:

1) Fabricate and install benches, trash receptacles, bollards, bike racks, tree wells, and parking lot screens in accordance with the requirements set forth in this section.

B) Additional work included in this section:

1) Field measuring for weld plates, sleeves and insert locations.

2) Field measuring.

3) Anchors or inserts and footings.

4) Touch-up of powder coated materials.

820.1.2 References:

A) American Concrete Institute (ACI)

1) ACI 347 Recommended Practice for Concrete Formwork.

B) American Society for Testing and Materials (ASTM)

1) A53 Pipe, Steel, Black and Hot Dipped, Zinc Coated Welded and Seamless.

2) A123 Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products.

3) A269 Specification for Seamless and Welded Austenitic Stainless-Steel Tubing for General Service.

4) A312 Specification for Seamless and Welded Austenitic Stainless-Steel Pipe.

C) Powder Coating Properties (ASTM)

1) D523-89: 80-90 Gloss at 60°.

2) D3363-92a: Pencil hardness 2H.

3) D2794-93: Dir / Rev Impact, Gardner, Up to 160 in./lbs.

4) D522-93a: Flexibility, Mandrel, 1/4” diameter no fracture.

D) Americans With Disabilities Act Accessibility Guidelines (ADAAG), and Public Right of Ways Accessibility Guidelines (PROWAG)

E) Green Globes System

F) International Code Council (ICC)

1) International Building Code (IBC).

2) International Residential Code (IRC).

G) National Association of Architectural Metal Manufacturers (NAAMM) and National Ornamental and Miscellaneous Metals Association (NOMMA)

1) Metal Finishes Manual

H) National Association of Home Builders (NAHB)

1) Model Green Home Building Guidelines.

I) Institute of Building Sciences

1) Metric Guide for Federal Construction.

2) U.S. Green Building Council.

3) The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™.

820.1.3 Quality Assurance:

A) Fabricator Qualifications:

1) A firm experienced in manufacturing site furnishings similar to those required for this project and with a record of successful in-service performance.

2) Furnish references listing projects of similar size and scope.

B) Installer Qualifications:

1) An experienced installer who has completed installation of bicycle parking racks, trash receptacles, and benches, similar in material, design, and extent to that indicated for this project and whose work has resulted in construction with a record of successful in-service performance.

C) Source Limitations:

1) Obtain each color, finish, shape, and type of furnishing from a single source with resources to provide components of consistent quality in appearance and physical properties.

D) Product Options:

1) Drawings indicate general size, shape, and dimensional requirements of furnishings, but are not intended to limit specific site furnishings to one manufacturer unless specifically stated. Submitted products should meet the general design intent and appearance of the detailed product.

E) Regulatory Requirements:

1) Components and installation are to be in accordance with state and local code authorities.

F) Certifications:

1) Furnish certification that all components and fittings are furnished by the same manufacturer or approved by the primary component manufacturer.

820.1.4 Submittals:

A) Submit shop drawings and product data that:

1) Show sections and plans of site, dimensions, and assembly of components.

2) Show all field connections.

3) Provide setting diagrams for installation of anchors, location of pockets, and weld plates for attachment of rails to structure.

4) Indicate all required field measurements.

5) Submit six sets of hard copies, and one digital copy of PDF and CAD files for approval.

B) Indicate component details, materials, finishes, connection and joining methods, and the relationship to adjoining work.

C) Submit manufacturer’s installation instructions.

D) Submit recommended methods for repairing damage to the powder coat, or other finishes of the site furnishings.

E) Substitutions:

1) Any changes in specified material must meet requirements of the General Conditions "or equal" clause.

2) Changes in architectural details to fabricator's standard procedures will be allowed when appearance and strength are not affected.

F) State any alternatives that affect the work and/or bid price of this section, such as a change in material or a change to contractor's standard details.

820.1.5 Delivery, Storage, and Handling

A) Deliver materials to the job site in good condition and properly protected against damage to finished surfaces.

B) Storage on site:

1) Store material in a location and in a manner to avoid damage. Stacking shall be done in a way, which will prevent bending.

2) Store material in a clean, dry location away from uncured concrete and masonry. Cover with waterproof paper, tarpaulin, or polyethylene sheeting in a manner that will permit circulation of air inside the covering.

3) Keep handling on site to a minimum. Exercise particular care to avoid damage to finishes of material.

820.1.6 Examination of Conditions:

A) Contractor should visit the site and be fully aware of the location and orientation of all site furnishings. Unless otherwise stated in the drawings, benches and trash receptacles may be mounted directly on existing concrete sidewalks. Below grade footings should be poured to allow the proposed paving to be placed with the correct finished grade, and at the proper thickness.

820.1.7 Warranty:

A) Furnishings are to carry a minimum one-year manufacturer’s limited warranty against defects in materials and workmanship. The one-year warranty shall be extended to cover the time period one-year from the date of final acceptance of the project.

820.2 PRODUCTS

820.2.1 Acceptable Manufacturers:

A) Bike Rack and components shall be equal to those manufactured or supplied by:

1) Inverted U Bike Parking Rack:
   SiteScapes, Inc.
   P.O. Box 22326
   Lincoln, NE 68542
   888.331.9464
   www.sitescapeonline.com

2) Dumor Bike Rack Model 83:
   ACS Playground Adventures
   8501 Mantle Avenue
   Oklahoma City, OK 73132
   405.721.3506
   www.acsplay.com

3) 'U' Bike Rack:
   Madrax, a division of Graber Manufacturing, Inc.
   1080 Uniek Drive
   Waunakee, WI 53597
   608.849.1080
   www.madrax.com

4) Loop Bikerail Kit Embedded:
   The Wagner Companies
   P.O. Box 423
   Butler, WI 53007
   Tel: 888.243.6914
   Fax: 414.214.0550
   www.wagnercompanies.com
   info@mailwagner.com

B) Benches shall be equal to those manufactured or supplied by:

1) Dumor Bench Model 119:
   ACS Playground Adventures
   8501 Mantle Avenue
   Oklahoma City, OK 73132
   405.721.3506
   www.acsplay.com

2) Plaza Series, Model PL-5 Bench with Center Frame:
   FairWeather Site Furnishings
   1540 Leader International Drive
   Port Orchard, WA 98367
   800.323.1798

3) Victor Stanley CBF-12 Bench:
Victor Stanley
P.O. Drawer 330
Dunkirk, MD 20754
800.368.2573
www.victorstanley.com

C) Trash Receptacle shall be equal to those manufactured or supplied by:

1) Dumor Trash Receptacle Model 119:
ACS Playground Adventures
8501 Mantle Avenue
Oklahoma City, OK 73132
405.721.3506
www.acsplay.com

2) Litter Receptacle S-42:
Victor Stanley
P.O. Drawer 330
Dunkirk, MD 20754
800.368.2573
www.victorstanley.com

3) Model URT-FBS-36-F-P-LD-LF:
Creative Pipe, Inc.
P.O. Box 2458
Rancho Mirage, CA 92270-1087
800.644.8467
www.creativepipe.com

D) Bollards shall be equal to those manufactured or supplied by:

1) Model B4-5 Bench with Center Frame:
FairWeather Site Furnishings
1540 Leader International Drive
Port Orchard, WA 98367
800.323.1798

2) Model matching details provided:
Creative Pipe, Inc.
P.O. Box 2458
Rancho Mirage, CA 92270-1087
800.644.8467
www.creativepipe.com

E) Tree Grates with Expandable Tree Openings shall be equal to those manufactured or supplied by:

1) Model 8655 Tree Grate Set:
East Jordan Ironworks
270 Redwing Road
Ardmore, OK 73401
580.389.5010
customersupport@ejco.com

2) Model 6018/20-1:
Ironsmith
41701 Corporate Way #3
Palm Desert, CA 92260
800.338.4766
www.ironsmith.cc

3) Metropolitan Collection Tree Grate R-8707:
Neenah Foundry
2121 Brooks Avenue
Neenah, WI 54956
800.558.5075
www.nfco.com

820.2.2 Materials and Finishes:

A) Steel:

1) Pipe: ASTM A53.

2) All steel to be powder coated in the factory.

3) Colors of all site furnishings to be approved in writing by the City of Tulsa prior to placing order.

B) Stainless Steel: Type 304

1) Pipe: ASTM A269 and A312.

820.2.3 Site Furnishings

A) Material shall conform to and be finished in accordance with 2.2.

B) Bicycle Rack:

1) Fabricate from powder coated steel 2" (2.375" OD).

2) Capacity: Two bicycles.

3) Mount: Embedded.

4) Color: As approved by the City of Tulsa.

C) Benches, Trash Receptacles, and Bollards:

1) Fabricate from powder-coated steel.

2) Cast elements on benches to be either wrought iron or aluminum.

3) Color: As approved by the City of Tulsa.

820.2.4 Fasteners:

A) All mechanical fasteners used in the assembly shall be manufactured from stainless steel.

B) Cement: Hydraulic, ASTM C595, factory prepared with accelerator.

820.2.5 Fabrication:

A) Cut material square and remove burrs from all exposed edges, with no chamfer.

B) Make exposed joints butt tight and flush.

C) For posts set in concrete, furnish matching sleeves or inserts not less than 5” long.

D) Verify dimensions on site prior to shop fabrication.

820.2.6 Protective Coatings:

A) Following fabrication, site furnishings should be cleaned and treated with a corrosion preventative under-coating.

B) All furnishings are to be coated with a TGIC exterior rated powder in the color approved by the Architect and the City of Tulsa. All parts should be finished to an average of 8 to 10 mil thickness and fully cured to the manufacturer’s specifications.

820.3 EXECUTION

820.3.1 Examination:

A) Coordinate installation of footings and attachment bolts with the installation of paving.

B) Supply items to be cast in concrete or embedded in masonry.

820.3.2 Installation:

A) Install in accordance with shop drawings and manufacturer's instructions at locations indicated on the drawings.

B) Erect work square and level, and free from distortion or defects detrimental to appearance or performance.

C) Expansion joints shall be provided as needed to allow for thermal expansion or contraction.

820.3.3 Repair and Cleaning:

A) As installation is completed, wash thoroughly using clean water and soap, rinse with clean water.

B) Do not use acid solution, steel wool, or other harsh abrasives.

C) If stain remains after washing, remove finish and restore in accordance with *NAAMM/NOMMA Metal Finishes Manual*.

D) Remove stained or otherwise defective work and replace with material that meets specification requirements.

E) Repair damaged finish as directed by City of Tulsa.

F) Replace defective or damaged components as directed by City of Tulsa.

820.3.4 Protection:

A) After work of this section is complete, contractor shall be responsible for protecting site furnishings from damage from subsequent construction activity on the site.

820.3.5 Method of Measurement:

The City of Tulsa Inspector and the Project Architect or Engineer will review Pay Applications submitted by the Contractor and shall approve payment based on the quantity of site furnishings that are properly and completely installed including footings, attachment and touch-up.

820.4.2 Basis of Payment:

Payment will be made for each site furnishing pay item at the contract unit price per specified pay unit:

| PAY ITEM | PAY UNIT |
|---|---|
| BIKE RACK | EACH |
| BENCH | EACH |

| | |
|---|---|
| TRASH RECEPTACLE | EACH |
| TREE GRATES | EACH |
| PARKING LOT SCREENING FENCE | PER LINEAL FOOT |

## PART 830 – STRUCTURAL SOIL

### 830.1 GENERAL

#### 830.1.1 Summary:

A) The work of this section consists of all Structural Soil work and related items as indicated on the drawings or as specified herein and includes, but is not limited to, the following:

1) CU-Soil™ is a proprietary material patented by Cornell University (US Patent #5,849,069) and marketed under the registered trademark, CU-Structural Soil®. Only licensed companies are authorized to produce this material, meeting the specifications described in this text. For a list of licensed CU-Soil™ producers, call AMEREQ, INC. at 800.832.8788.

#### 830.1.2 Related Work:

A) Section 831 – Trees, Shrubs, and Ground Cover

B) Section 840 – Underground Sprinkler System

#### 830.1.3 Quality Assurance:

A) Qualifications of installing contractor: The work of this section should be performed by a contracting firm which has a minimum of five years of experience. Proof of this experience shall be submitted as per paragraph, SAMPLES and SUBMITTALS, of this section.

#### 830.1.4 Submittals:

A) At least 30 days prior to ordering materials, the installing contractor shall submit to the Engineer representative samples, certificates, manufacturer's literature, and test results for materials specified below. No materials shall be ordered until the required samples, certificates, manufacturer's literature, producer's current license and test results have been reviewed and approved by the Engineer. The Engineer reserves the right to reject any material that does not meet CU-Structural Soil® specifications. Delivered materials shall closely match the approved samples.

B) Submit soil test analysis reports for sample of clay loam from an independent soil-testing laboratory. The testing laboratory for particle size and chemical analysis may include a public agricultural extension service agency.

1) Submit a mechanical analysis of the clay loam sample and particle size analysis including the following gradient of mineral content:

| USDA Designation | Size in mm |
|---|---|
| Gravel | +2 mm |

| | |
|---|---|
| Sand | 0.05 – 2 mm |
| Silt | 0.002 – 0.05 mm |
| Clay | minus 0.002 mm |

C) Sieve analysis shall be performed and compared to USDA Soil Classification System.

D) Sieve analysis shall be done by a combined hydrometer and wet sieving using sodium hexametaphosphate as a dispersant in compliance with ASTM D422 after destruction of organic matter by hydrogen peroxide.

E) Submit a chemical analysis, performed in accordance with current AOAC Standards, including the following:

1) pH and buffer pH.

2) Percent organic matter as determined by the loss of ignition of oven dried samples. Test samples shall be oven dried to a constant weight at a temperature of 230° F, ±9°.

3) Analysis for nutrient levels by parts per million.

4) Soluble salt by electrical conductivity of a 1:2 soil/water sample measured in Millimho per cm.

5) Cation Exchange Capacity (CEC).

6) Carbon/Nitrogen Ratio.

F) At the Engineer's discretion, the sample of CU-Structural Soil® may be tested for the following:

1) Compaction in accordance with ASTM D698/AASHTO T 99 without removing oversize aggregate.

2) California Bearing Ratio in accordance with ASTM D1883 soaked CBR shall equal or exceed a value of 50.

3) Measured dry-weight percentage of stone in the mixture.

4) The approved CU-Structural Soil® sample shall be the standard.

5) Any deviation from the specified crushed stone and clay loam specifications shall be approved by Amereq, Inc.

830.1.5 Delivery, Storage, and Handling:

A) Delivered CU-Structural Soil® shall be at or near optimum compaction moisture content as determined by AASHTO T 99 (ASTM D698) and should not be placed in frozen, wet, or muddy sites.

B) Always protect CU-Structural Soil® from exposure to excess water and from erosion. Do not store CU-Soil™ unprotected. Do not allow excess water to enter site prior to compaction. If water is introduced into the CU-Soil™ after grading, allow water to drain to optimum compaction moisture content.

C) CU-Structural Soil® shall be amended to produce a consist pH within the range of 6.0 to 7.0.

830.1.6 Examination of Conditions:

A) All areas to receive CU-Structural Soil® shall be inspected by the installing contractor before starting work and all defects such as incorrect grading, compaction, and inadequate drainage shall be reported to the Engineer prior to beginning this work.

830.2 PRODUCTS

830.2.1 Materials:

A) CU-STRUCTURAL SOIL®

1) A uniformly blended urban tree mixture of crushed stone, clay loam and Gelscape® Hydrogel Tackifier, as produced by an Amereq-licensed company, mixed in the following proportion:

| Material | Unit of Weight |
|---|---|
| Specified crushed stone | 100 units dry weight |
| Specified clay loam | 20 – 25 units (to achieve minimum CBR of 50) |
| Gelscape® Hydrogel Tackifier | 0.035 units dry weight moisture |
| ASTM D698/AASHTO T 99 | Optimum moisture |

830.3 EXECUTION

830.3.1 Mixing and Quality Control Testing:

A) All CU-Structural Soil® mixing shall be performed at the licensed producer's yard using appropriate soil measuring, mixing, and shredding equipment of sufficient capacity and capability to assure proper quality control and consistent mix ratios. No mixing of CU-Structural Soil® at the project site shall be permitted.

B) Maintain adequate moisture content during the mixing process. Soils and mix components shall easily shred and break down without clumping. Soil clods shall easily break down into a fine crumbly texture. Soils shall not be overly wet or dry.

The licensed producer shall measure and monitor the amount of soil moisture at the mixing site periodically during the mixing process.

C) Raw materials shall be mixed off-site, only at the licensed producer's facility, on a flat asphalt or concrete paved surface to avoid soil contamination.

D) Should the independent laboratory test results of the clay loam reveal a need to amend it, to meet specifications, the amending materials should be added to the clay loam following the rates and recommendations provided by Amereq, Inc.

830.3.2 Underground Utilities and Subsurface Conditions:

A) The installing contractor shall notify the Engineer of any subsurface conditions which will affect the contractor's ability to install the CU-Structural Soil®.

B) The installing contractor shall locate and confirm the location of all underground utility lines and structures prior to the start of any excavation.

C) The installing contractor shall repair any underground utilities or foundations damaged during the progress of this work.

830.3.3 Preparation:

A) Do not proceed with the installation of the CU-Structural Soil® material until all walls, curb footings and utility work in the area have been installed. For site elements dependent on CU-Structural Soil® for foundation support, postpone installation of such elements until immediately after the installation of CU-Structural Soil®.

B) Install subsurface drain lines as shown on the plan drawings prior to installation of CU-Structural Soil® material.

C) Excavate and compact the proposed subgrade to depths, slopes and widths as shown on the drawings. Maintain all required angles of repose of the adjacent materials as shown on the drawings. Do not over excavate compacted subgrades of adjacent pavement or structures.

D) Confirm that the subgrade is at the proper elevation and compacted as required. Subgrade elevations shall slope parallel to the finished grade and/or toward the subsurface drain lines as shown on the drawings.

E) Clear the excavation of all construction debris, trash, rubble, and any foreign material. In the event that fuels, oils, concrete washout silts, or other material harmful to plants have been spilled into the subgrade material, excavate the soil sufficiently to remove the harmful material. Fill any over excavation with approved fill and compact to the required subgrade compaction.

F) Do not proceed with the installation of CU-Structural Soil® until all utility work in the area has been installed. All subsurface drainage systems shall be operational prior to installation of CU-Structural Soil®.

G) Protect adjacent walls, walks and utilities from damage. Use 1/2" plywood and/or plastic sheeting as directed to cover existing concrete, metal and masonry work and other items as directed during the progress of the work.

1) Clean up all trash and any soil or dirt spilled on any paved surface at the end of each working day.

2) Any damage to the paving or architectural work caused by the installing contractor shall be repaired, as directed by the Engineer.

H) Maintain all silt and sediment control devices required by applicable regulations. Provide adequate methods to assure that trucks and other equipment do not track soil from the site onto adjacent property and the public right of way.

830.3.4 Water:

A) The installing contractor shall be responsible to furnish his own supply of water (if needed) free of impurities, to the site.

830.3.5 Installation:

A) Install CU-Structural Soil® in 6" lifts and compact each lift.

B) Compact all materials to at least 95% Proctor Density from a standard compaction curve AASHTO T 99 (ASTM D698). No compaction shall occur when moisture content exceeds maximum as listed herein. Delay compaction if moisture content exceeds maximum allowable and protect CU-Structural Soil® during delays in compaction with plastic or plywood as directed by the Engineer.

C) Bring CU-Structural Soil® to finished grades as shown on the drawings. Immediately protect the CU-Structural Soil® from contamination by toxic materials, trash, debris, water containing cement, clay, silt or materials that will alter the particle size distribution of the mix with plastic or plywood as directed by the Engineer.

D) The Engineer may periodically check the material being delivered, prior to installation for color and texture consistency with the approved sample provided by the installing contractor as part of the submittal for CU-Structural Soil®. If the Engineer determines that the delivered CU-Soil™ varies significantly from the approved samples, the Engineer shall contact the licensed producer.

E) Engineer shall ensure that the delivered structural soil was produced by the approved CU-Soil™ licensee by inspecting weight tickets showing source of material.

F) CU-Soil™ should not be stockpiled long-term. Any CU-Soil™ not installed immediately should be protected by a tarp or other waterproof covering.

830.3.6 Fine Grading:

A) After the initial placement and rough grading of the CU-Structural Soil® but prior to the start of fine grading, the installing contractor shall request review of the rough grading by the Engineer. The installing contractor shall set sufficient grade stakes for checking the finished grades.

B) Adjust the finish grades to meet field conditions as directed.

1) Provide smooth transitions between slopes of different gradients and direction. Fill all dips with CU-Soil™ and remove any bumps in the overall plane of the slope.

a) The tolerance for dips and bumps in CU-Structural Soil® areas shall be a 3” deviation from the plane in 10’. All fine grading shall be inspected and approved by the Engineer prior to the installation of other items to be placed on the CU-Structural Soil®.

830.3.7 Acceptance Standards:

A) The Engineer will inspect the work upon the request of the installing contractor. Request for inspection shall be received by the Engineer at least ten days before the anticipated date of inspection.

830.3.8 Clean-Up:

A) Upon completion of the CU-Structural Soil® installation operations, clean areas within the contract limits. Remove all excess fills, soils and mix stockpiles and legally dispose of all waste materials, trash, and debris. Remove all tools and equipment and provide a clean, clear site. Sweep (do not wash) all paving and other exposed surfaces of dirt and mud until the paving has been installed over the CU-Structural Soil® material. Do no washing until finished materials covering CU-Structural Soil® material are in place.

830.4 PAYMENT

830.4.1 Method of Measurement:

The Engineer will review Pay Applications submitted by the Contractor and shall approve payment based on the quantity of structural soil that is properly and completely installed according to the drawings, including placing, and compacting.

830.4.2 Basis of Payment:

Payment will be made for each Cubic Yard of installed Structural Soil at the contract unit price per specified pay unit:

| PAY ITEM | PAY UNIT |
|---|---|
| STRUCTURAL SOIL | PER CUBIC YARD |

## PART 831 – TREES, SHRUBS, AND GROUND COVER

831.1 GENERAL

831.1.1 Summary:

A) Trees, shrubs, vines, and ground cover as applicable.

B) Topsoil backfill.

C) Staking and guying.

D) Maintenance service.

831.1.2 Related Work:

A) 832 – Sodding.

B) 833 – Landscape Maintenance.

C) 840 – Underground Sprinkler System.

831.1.3 References:

A) Standardized Plant Names, 1942 edition, American Joint Committee on Horticulture Nomenclature.

B) American Standard for Nursery Stock (ANSI Z60), latest edition, American Association of Nurserymen.

C) FS O-F-241 – Fertilizer, Mixed, Commercial.

831.1.4 Quality Assurance:

A) Contractor to locate all utilities and be responsible for all damage to utilities resulting from demolition and planting operations.

B) Perform work with personnel experienced in the work required of this Section under direction of a skilled foreman.

C) Submit sources of plant materials. All materials to have name tags attached. Submit invoice with plant names noted if required.

D) Contractor shall locate all materials and be responsible for conformance with requirements of this Section. All plants not meeting requirements to be rejected.

E) All trees are to be reviewed by Engineer prior to planting.

1) Trees will be reviewed at local growing or nursery site by Engineer or his appointed representative and approved before delivering to the site. Contractor shall schedule review of plant material in such a manner that no single review period will exceed one working day with a maximum of two review periods. Contractor shall be responsible for notification and coordination with all parties prior to scheduling review sessions.

2) Prior to review by Engineer, Contractor shall have pre-selected all trees and identified each with a "locking" tree tag. Additional tree tags will be provided by Contractor for changes at time of visit. Tree tags will have permanent, non-reproducible identifying notation unique to this project.

F) Submit analysis of topsoil to be imported for backfill. Test performed by accredited soils laboratory.

831.1.5 Delivery, Storage, and Handling:

A) Move B&B plant materials with solid balls wrapped in burlap. Plants to be lifted only by ball or container.

B) Deliver plant materials immediately prior to placement. Keep plant materials not immediately installed moist and protect from freezing by covering ball or container with mulch. Any plants not planted within two days of delivery are to be heeled-in in a vertical position, root balls fully encompassed by mulch and a temporary watering system installed.

C) Reject plants when ball or container of earth surrounding roots has been cracked, broken, or frozen preparatory to or during process of planting.

831.1.6 Warranty:

A) Warrant all plants to be living, healthy specimens for a period of one year commencing upon Final Acceptance by City. Warranty period shall terminate only if plants have been in full leaf for 30 days at end of warranty period. Termination of warranty period shall be extended as necessary to comply. All materials to be in vigorous condition at end of warranty period.

B) Immediately remove dead plants and plants not in a vigorous condition and replace as soon as weather conditions permit. Each replacement shall be covered with a one-year warranty commencing at time of planting.

C) Replacements: Match with adjacent plants of the same species in size and form.

831.1.7 Maintenance Service:

A) Begin maintenance of plant materials immediately after planting and continue until Final Acceptance by City.

B) Maintenance shall include measures necessary to establish and maintain plants in a vigorous and healthy growing condition. Include the following:

1) Cultivation and weeding of plant beds and tree pits. When herbicides are used for weed control, apply in accordance with manufacturer's instructions. Remedy damage resulting from use of herbicides.

2) Watering sufficient to maintain optimum moisture level.

3) Pruning, including removal of dead or broken branches.

4) Disease and insect control.

5) Maintaining plants in an upright, plumb position, and repair of settling.

6) Maintenance of wrappings, guys, turnbuckles, and stakes. Adjust turnbuckles or otherwise keep guy wires tight. Repair or replace accessories when required.

C) Contractor to be responsible for pruning or removing trees that become an obstruction to safe traffic flows or the open view of traffic signalization.

831.2 PRODUCTS

831.2.1 Materials:

A) Trees, Shrubs, Vines, and Ground Cover: Species and size identified in plant list. Plant materials shall be true to name, in good health, free of disease and insects, excellent in form and in complete conformance with ANSI Z60. All materials to be nursery grown.

B) Topsoil: Friable loam, typical of cultivated topsoil locally, containing at least 2% of decayed organic matter (humus) secured from a well-drained, arable site, reasonably free of subsoil, stones, earth clods, sticks, roots, or other objectionable extraneous matter or debris, and containing no toxic materials. Topsoil to have acidity range of 6.0 to 7.0.

C) Mulch: Shredded cedar, cypress, or hardwood; dyed brown in color. Submit type and source for approval.

D) Fertilizer: Osmocote 18-6-12 or approved equal.

E) Compost: "Back to Earth Composted Cotton Burrs", premium compost, course screened, as manufactured by Soil Mender Products, LP, www.soilmender.com.

"Hu-More Plant and Soil Builder" manufactured by Humalfa, Inc., P.O. Box 878, Shattuck, OK 73858, 580.938.2514, or approved equal.

F) Peat Moss: Sphagnum peat moss.

G) Metal Edging: 3/16" x 4" steel landscape edging with steel stakes as manufactured by Col-Met, 3333 Miller Park South, Garland, Texas 75042, 972.494.3900, www.colmet.com, or approved equal.

831.2.2 Accessories:

A) Wrapping Materials: Heavy paper manufactured for tree wrapping purpose.

B) Stakes: Green Metal Fence posts (three per tree) – 6' height.

C) Hardware (cables, wire, eye bolts, and turnbuckles): Noncorrosive; of sufficient strength to withstand wind pressure.

D) Tie straps: Soft polypropylene material equal to ArborTie, by Deep Root Partners, L.P., 31 Langston St., Suite 4, San Francisco, CA, 94103, 1.800.277.7668, or approved equal.

831.3 EXECUTION

831.3.1 Preparation:

A) Locate trees so they do not obstruct safe traffic flow, or the open view of traffic signalization.

B) Verify topsoil is ready to receive the work of this Section. All areas to be planted with shrub or ground cover masses to have minimum 12" depth of topsoil.

C) Remove all weeds and grasses from planting beds. Bermuda grass, if present, to be exterminated by approved means or all soil removed to 6" depth and replaced with topsoil free of Bermuda grass.

D) Stake tree locations and place shrubs, vines, and ground covers for review and final orientation by Owner's Representative prior to installation.

E) Outline bed edges for approval.

F) Prepare topsoil for shrub and ground cover beds, after removing any vegetation with approved procedure by tilling 2" layer (165 CF per 1,000 sq. ft.) of compost into the upper 6" of soil.

831.3.2 Installation:

A) Excavate for plant materials. Tree pits shall be as indicated in the details. Slope cut edge to 6” depth and bottom of pit to depth required to accommodate tree root ball. Shrub pits shall be 12” greater in diameter than root ball. Topsoil or structural soil from excavation may be retained for backfill if it is friable and free of rock and clods greater than 2” in diameter. Remove all subsoil, rock, and debris from site.

B) Set trees and other plant materials with top of root ball 2” below adjacent paving, after settlement.

C) Remove containers from container-grown stock. Set plants in center of pits and backfill with topsoil in 6” layers. Pull away ropes, wires, etc. from the top of the ball.

D) Remove any soil from the top of the root ball to the level of the root flare.

E) Final 6” layer of backfill around trees to consist of 1:1 mixture of compost and topsoil.

F) Thoroughly water soil when the hole is half-full and again when full.

G) Apply 1/2 lb. fertilizer evenly over cultivated area around each tree and 1 lb. per 100 sq. ft. to shrub and ground cover plantings.

H) Evenly spread a 3” layer of mulch over tree pits and planting beds.

I) Prune trees and shrubs after planting to remove dead and broken branches.

J) 8’ diameter circular area around trees to be mulched and free of vegetation. For trees 2” and greater in caliper, area to be 8’ in diameter. For trees less than 2” caliper, area to be 6’ in diameter. Circle to be centered on tree and true in form.

K) Wrap trunks of all trees of the Acer and Gleditsia genus.

L) After planting trees, form a 3’ diameter ridge of topsoil around edge of excavation to retain water.

831.3.3 Plant Support:

A) Brace plants upright in position by staking and guying as detailed. Guys to be secured to tree with loops as detailed.

831.3.4 Finishing:

A) Install pavers or tree grates as indicated on the plans and details.

B) Provide edge restraint to maintain the position of the pavers.

C) Install mulch or gravel as indicated on details.

831.4 PAYMENT

831.4.1 Method of Measurement:

The Engineer will review Pay Applications submitted by the Contractor and shall approve payment based on the quantity of trees and shrubs that is properly and completely installed according to the drawings, including planting, backfilling, and finishing.

831.4.2 Payment will be made for each Tree, and each Shrub at the contract unit price per specified pay unit:

| PAY ITEM | PAY UNIT |
|---|---|
| TREE | PER EACH |
| SHRUB | PER EACH |

## PART 832 – SODDING

832.1 GENERAL

832.1.1 Summary:

A) Preparation of planting surface.

B) Fertilizing.

C) Sod installation.

D) Maintenance service.

832.1.2 Related Work:

A) 831 – Trees, Shrubs, and Ground Cover.

B) 833 – Landscape Maintenance.

C) 840 – Underground Sprinkler System.

832.1.3 References:

A) Standardized Plant Names, 1942 Edition, American Joint Committee on Horticulture Nomenclature.

B) ASPA (American Sod Producers Association) – Guideline Specifications to Sodding.

C) FSO-F-241 – Fertilizers, Mixed, Commercial.

832.1.4 Definitions:

A) Weeds: Includes Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lamb's Quarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nut Grass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel and Brome Grass.

832.1.5 Quality Assurance:

A) Sod Producer: Company specializing in sod production and harvesting with a minimum of five years of experience.

B) Sod: Root development that will support its own weight, without tearing, when suspended vertically by holding the upper two corners.

C) Submit sod certification for grass species and location of sod source.

832.1.6 Regulatory Requirements:

A) Comply with regulatory agencies for fertilizer and herbicide composition.

832.1.7 Tests:

A) Provide soils tests and recommendations for areas to be sodded. Obtain from approved testing agency. Such tests shall be a composite of random samples. Test areas exhibiting different soil types separately. Provide separate tests for each 10,000 sq. ft. of sodded area.

832.1.8 Maintenance Data:

A) Submit recommended maintenance procedures to be followed by City/Owner.

B) Include maintenance instructions, cutting method and maximum grass height, types, application frequency, and recommended coverage of fertilizer.

832.1.9 Delivery, Storage, and Handling:

A) Deliver sod on pallets. Protect exposed roots from dehydration.

B) Do not deliver more sod than can be laid within eight hours for Fescue Sod, or 24 hours for Bermuda Sod.

832.1.10 Coordination:

A) Coordinate the work of this Section with installation of underground sprinkler system and plant material as applicable.

832.1.11 Maintenance Service:

A) Maintain sodded areas immediately after placement until grass is well established, has achieved complete coverage, and exhibits a vigorous growing condition or until Final Acceptance by the City whichever is longer. Maintenance period shall include minimum of two mowings.

832.2 PRODUCTS:

832.2.1 Materials:

A) Sod: Cultivated grass sod, type indicated on Drawings, with strong fibrous root system, free of stones, burned or bare spots, and weeds.

B) Fertilizer: Type recommended for grass; of proportions necessary to eliminate any deficiencies of topsoil as indicated in soils test or otherwise approved.

C) Soil Amendments: Lime, Sulphur, or other material recommended by soil test.

D) Water: Clean, fresh, and free of substances or matter which could inhibit vigorous growth of grass.

832.2.2 Accessories:

A) None

832.2.3 Harvesting:

A) Machine cut sod and load on pallets in accordance with ASPA guidelines.

B) Cut sod with minimum 1/2" and maximum 1” topsoil base.

832.3 EXECUTION

832.3.1 Inspection:

A) Verify that prepared soil base is ready to receive the work of this Section.

B) Beginning of installation means acceptance of existing site conditions.

832.3.2 Preparation:

A) Finish grade areas to be sodded so that the surface is smooth and is approximately 1” below adjoining sidewalks and other paved surfaces.

B) Remove all weeds and grasses from areas to be sodded. If Bermuda grass is present in areas to receive Fescue sod, to be exterminated by approved means or all soil removed to 6” depth and replaced with topsoil free of Bermuda grass.

C) Planting surface shall be made friable by approved method of scarification. Prepared surface shall be floated smooth and free of bumps and depressions. Remove stones and foreign matter over 2” in diameter from top 2” of sod bed. Plant immediately, thereafter, provided the bed has remained in a friable condition and has not become muddy or hard. If it has become hard, till to a friable condition again.

D) Apply fertilizer per soil tests recommendation. Apply fertilizer prior to installation of sod. For fescue sod apply 6-24-24 fertilizer at a rate of 5 lbs. per 1,000 sq. ft. and Milorganite or approved equal at a rate of 5 lbs. per 1,000 sq. ft. Fertilizer application to be done before laying sod.

E) Apply fertilizer no more than 48 hours before laying sod.

F) Lightly water to aid the dissipation of fertilizer.

G) Prior to laying sod, incorporate soil amendments such as lime and Sulphur at rates recommended by soils tests to a 4” depth.

H) Fescue sod should be laid only when the temperature is below 90° and is expected to remain less than 90° for the following 12 hours.

I) Fescue sod to be laid only when the wind is less than 10 mph.

832.3.3 Laying Sod:

A) Moisten prepared surface immediately prior to laying sod.

B) Remove plastic netting from sod.

C) Lay sod immediately on delivery to site within 24 hours for Bermuda grass or eight hours for Fescue after harvesting to prevent deterioration.

D) Lay sod tight with no open joints visible and no overlapping; stagger end joints 12” minimum. Do not stretch or overlap sod pieces.

E) Finished sodding to be smooth and free of bumps and depression. Surface to be flush with adjoining grass areas if any. Place top elevation of sod approximately 1/2" below adjoining edging, paving, and curbs. Grade planting surface as necessary to accomplish above.

F) On slopes 4” per foot and steeper, lay sod perpendicular to slope and secure every row with wooden pegs at maximum 2’ on center. Drive pegs flush with soil portion of sod.

G) Water sodded areas deeply immediately after installation.

H) After sod and soil have dried sufficiently, roll sodded areas to ensure good bond between sod and soil and to remove minor depressions and irregularities.

832.3.4 Warranty:

A) Sodded areas to be vigorously growing at time of final acceptance or if installation occurs during dormancy warranty to extend through first month of following growing season. At conclusion of initial warranty period replace dead or unhealthy sod.

B) For a period of one year commencing upon the Date of Substantial Completion, re-sod or reseed bare areas until complete coverage is achieved. Repairs to be completed as specified in the Maintenance requirements below.

832.3.5 Maintenance:

A) Maintain sod until Final Acceptance by the City, or for additional time period as indicated in the Pay Quantity items for the project.

B) Mow grass at regular intervals to maintain at a maximum height of 3” for Fescue and 2-1/2” for Bermuda grass. Do not cut more than 1/3 of grass blade at any one mowing.

C) Neatly trim edges and hand clip where necessary.

D) Immediately remove clippings after mowing and trimming.

E) Water sufficiently to ensure establishment and maintain vigorous appearance. For a period of one week following Fescue sod installation, each area shall be watered four times daily with spray mist.

F) Roll and/or topdress surface as needed to remove minor depressions or irregularities.

G) Control growth of weeds. Apply herbicides in accordance with manufacturer's instructions. Remedy damage resulting from improper use of herbicides.

H) Immediately replace sod in areas which show deterioration or bare spots. Any areas that have had topsoil washed away shall be filled to match specified grade with topsoil before re-sodding.

I) Protect sodded areas with warning signs during maintenance period.

J) Apply approved fertilizer at rate to provide 1-1/2 lbs. of actual Nitrogen per 1,000 sq. ft. every 25 days during growing season.

K) For the purpose of establishing an acceptable standard, no bare areas will be permitted.

832.4 PAYMENT

832.4.1 Method of Measurement:

The Engineer will review Pay Applications submitted by the Contractor and shall approve payment based on the square foot quantity of each type of solid sod that is properly and completely installed according to the drawings, including placing and maintaining.

832.4.2 Basis of Payment:

Payment will be made for each Tree and each Shrub at the contract unit price per specified pay unit:

| PAY ITEM | PAY UNIT |
|---|---|
| BERMUDA SOD | PER SQUARE FOOT |
| FESCUE SOD | PER SQUARE FOOT |

## PART 833 – LANDSCAPE MAINTENANCE

### 833.1 GENERAL

#### 833.1.1 Summary:

A) Work includes furnishing of necessary labor, tools, equipment, materials, supplies, and miscellaneous items required for accomplishing landscape maintenance as specified.

B) Certain items of work included but not necessarily limited to the following are:

1) Mowing, watering, edging, trimming, weed control, fertilization, trash and debris removal, and repair of lawn areas.

2) Pruning and fertilization and watering of trees and shrubs.

3) Mulching, weed control, cultivation and trash removal from shrub, groundcover, and tree beds and saucers.

C) For Seasonal Color planting areas, includes furnishing all labor, materials, services, and equipment to plant and maintain seasonal color beds as herein specified except as follows:

1) 1” depth layer of compost to be incorporated into upper 6” of soil profile by tilling. To be performed once annually in between spring and fall plantings.

2) At end of each season, upon approval by owner or representative, spent or dead plants to be removed.

3) Fertilize beds at time of spring planting at rate of 1 lb. of Nitrogen per 100 sq. ft. of bed.

#### 833.1.2 Related Work:

A) Section 831 – Trees, Shrubs, and Ground Cover.

B) Section 832 – Sodding.

C) Section 840 – Underground Sprinkler System.

#### 833.1.3 Quality Assurance:

A) All maintenance operations shall be accomplished as required to maintain standards as herein specified. Frequencies indicated herein are general guidelines and are not intended to restrict accomplishment of work as dictated by existing conditions or contractual agreements.

B) Maintenance operations shall not be performed when existing weather or ground conditions would adversely affect quality of work or result in damage to grounds.

C) Contractor shall protect all existing facilities and plant material and repair or replace any damage due to landscape maintenance operations.

D) It is the Contractor's responsibility to report in writing to the Owner any and all conditions that may exist or occur which detract from the appearance of the landscaping and is beyond the scope of this contract.

E) Clean up shall occur during and after all maintenance operations and debris shall be disposed of legally off-site.

833.1.4 Submittals:

A) Submit type and manufacturer's data for fertilizer.

833.2 PRODUCTS

833.2.1 Material:

A) Fertilizer: Shall be a commercial fertilizer furnished in standard factory sealed containers conforming to specified analysis. The term analysis shall mean the percentages of "total nitrogen", "available phosphoric acid", and "soluble potash".

B) Water: Shall be furnished by the Contractor and transported to the site, or via irrigation system or hydrants on site, and paid for by Contractor. Contractor shall furnish all other equipment necessary for use of water.

833.3 EXECUTION

833.3.1 Lawn Areas:

A) Mowing: To be accomplished as growth rate indicates, approximately four times a month; during the growing season, approximately April 1 – November 1. Thirty times per year total.

1) Mow at a height of 2" to 2-1/2". Not more than 1" of the leaf blade shall be removed at one mowing unless otherwise directed by the Owner.

2) Remove visible buildup of grass clippings from lawn areas after each mowing.

3) After each mowing, promptly remove grass clippings from sidewalks, streets, driveways, and gutters. Clippings shall not be allowed to remain on such areas overnight.

4) Surface of mowed grass to be even without ridges of irregularities.

5) A mowing cycle shall be completed within two days.

6) In the event of drought conditions which necessitate water curtailment, height of mowing shall be raised to 3" and frequency decreased as approved by the Owner's Representative.

B) Watering: During the growing season, adjust for amount of rainfall to provide approximately 1-1/2" – 2" of moisture every ten days.

1) Newly planted lawn areas should be watered as necessary to keep the upper 2" of soil moist.

2) During lawn dormancy watering shall be accomplished once a month.

C) Fertilization: Fertilization requirements will be as follows for lawn areas:

1) All lawns 1 lb. of actual Nitrogen per 1,000 sq. ft. four to six weeks after planting and thereafter 1 lb. of Nitrogen/1,000 sq. ft. per every six weeks. Test all turf areas for requirements at second growing season.

D) Edging: All lawns shall be edged where areas meet curbs, sidewalks, or other non-lawn surfaces.

1) Shall be accomplished every other mowing, except cut of Site Entries and Ring Road which will be accomplished every fourth mowing.

2) All resulting debris to be removed and disposed of by contractor. No grass clippings or trimmings will be allowed to remain overnight.

E) Trimming: All grass around trees, shrubs, building, benches, light poles, stairs, mow strips, pavement inserts, etc., that is not cut by mowing shall be trimmed to height of adjacent mowed area.

F) Trash Removal: All trash and litter shall be removed from lawn areas prior to each mowing.

G) Pest, Insect, and Disease Control: Apply proper chemicals by certified personnel to control pests, insects, and diseases and to maintain lawns and planting in a healthy condition. Application should be performed at a time that public and tenants will not be in contact or have any real or imagined harm done to them by application and apply only during times of favorable weather.

H) Repair:

1) Repair erosion by top-dressing with topsoil and re-vegetation.

2) Maintenance shall include all temporary protection barriers and signs, as necessary.

3) Dethatching to occur once per year.

833.3.2 Trees, Shrubs, and Groundcovers:

A) Watering: Normally, trees and shrubs will not require water in addition to that provided for lawns as hereinbefore specified. Should lawn water be suspended, trees, shrubs and groundcover will be deeply watered as frequently as possible to approach rates set for lawn irrigation.

B) Weeding and Cultivation:

1) Area around all trees within saucer rim as per planting details should be cultivated and freed of all grass and weed growth. Saucer rim shall be maintained around the cultivated area to hold water. During the growing season, weeds and grass should be removed each time lawn is mowed.

2) Shrub beds and groundcovers should be kept weed-free by weeding to occur each lawn mowing. Weeds may be chemically removed and/or controlled.

C) Fertilization: Apply evenly within saucer rim. Time of application to be April or May.

1) Trees 2-1/2" caliper and greater: 1 lb.

2) Trees less than 2-1/2" caliper: 1/2 lb.

3) Shrubs: 1 lb./1,000 sq. ft. of bed area.

D) Pruning:

1) Trees: Prune as necessary to remove broken or dead branches and maintain natural character in accordance with acceptable horticultural standards. Pruning should be accomplished at least once a year.

2) Shrubs:

a) Remove broken or dead branches and prune (not shear) as necessary to maintain natural form. Pruning should be accomplished at least once a year.

b) Shearing will be permitted for the following species: Buxus, Euonymus Alatus and Kiautschovicus, and Taxus media “Hicksii”. Encourage growth to ultimate height of 4’ to 5' for Euonymus and Taxus, and 18" for Buxus, by shearing lightly during the first few growing seasons.

3) Cleanup: Remove all debris created by pruning as work proceeds.

E) Trash Removal: All litter and trash in shrub beds and groundcover areas shall be removed each time lawn is mowed.

F) Re-mulching: Shrub beds and groundcover areas shall be mulched as necessary to maintain a 2" mulch depth. This item shall be performed at least every six months if replenishment is necessary.

833.3.3 Seasonal Color:

A) Beds for seasonal color to be maintained as herein specified. Plantings shall be changed twice per year, with the material, and at the times specified herein.

833.3.4 Irrigation System:

A) Maintain irrigation materials and equipment per manufacturer's current recommendations for maximum efficiency.

B) Set, adjust, and clean heads to maintain proper moisture content of soil.

833.3.5 Roads, Walks, and Parking:

A) Clean trash, glass, leaves, and dirt from all planting beds and surrounding areas.

833.4 PAYMENT

833.4.1 Method of Measurement:

A) Payment for maintenance of plant material and sod prior to Final Acceptance by the City shall be included in the unit price bid for the installation of plant material or sod.

B) When an additional maintenance period is required by the bid documents, the Engineer will review Pay Applications submitted by the Contractor and shall approve payment based on the Number of Months that additional maintenance is required and is properly and completely performed.

833.4.2 Basis of Payment:

Payment will be made for each Tree and each Shrub at the contract unit price per specified pay unit:

| PAY ITEM | PAY UNIT |
|---|---|
| LANDSCAPE MAINTENANCE | PER MONTH |

## PART 840 – UNDERGROUND SPRINKLER SYSTEM

### 840.1 GENERAL

#### 840.1.1 Summary:

A) Furnishing of materials and installation of a complete automatic sprinkler system providing uniform moisture coverage. The work shall include all materials, equipment and labor required to complete the project as outlined in the project drawings, documents, and this specification.

B) Install sleeves for irrigation pipe and wires. Coordinate work with City of Tulsa.

C) Supply and install one 1" water meter and one 1" reduced pressure backflow preventer meeting City of Tulsa Ordinances and Specifications.

D) Excavation and Backfill.

E) Installation of irrigation lines (pressurized), automatic control valves, valve boxes, control and common wiring, lateral lines, sprinkler heads, automatic controller(s) and electrical supply to controller, and backflow preventer as shown on the project drawings and irrigation plan.

F) Tests including system pressure and performance test.

#### 840.1.2 Related Work:

A) Section 830 – Structural Soil.

B) Section 831 – Trees, Shrubs, and Ground Cover.

#### 840.1.3 References:

A) ANSI/ASTM D2564 – Solvent Cements for Polyvinyl Chloride) (PVC) Plastic Pipe and Fittings.

B) ASTM D2241 – Polyvinyl Chloride) (PVC) Plastic Pipe (SDR-PR).

C) ASTM – American Society of Testing Materials.

D) AWWA – American Water Works Association.

E) NSF – National Sanitary Foundation.

F) NEC – National Electric Code.

#### 840.1.4 System Description:

A) Electric solenoid controlled underground irrigation system consisting of PVC plastic pipe and fittings, with fixed spray pop-up heads in a multi-station electric control system, programmed as approved by Engineer.

840.1.5 Submittals:

A) For planting within the right-of-way, an automatic irrigation system must be provided for plant maintenance unless otherwise approved by the City of Tulsa. The irrigation system may be designed and sealed by a licensed professional authorized to do business in the state of Oklahoma, as a part of the Construction Documentation submittal, or an irrigation design may be submitted as a design/build drawing by the contractor. As part of the Construction Documentation set, the irrigation design be reviewed only for general compliance with the standards set forth in this document, and related details. If a design/build drawing is provided through the submittal process, the design professional will review and approve the drawing. The licensed professional will attest by approving the plan, that to the best of their ability and knowledge, the system is designed to provide complete coverage with minimal overspray. No construction on the irrigation system will be allowed until plans are approved.

B) The design shall include the piping layout, location and coverage of sprinkler heads, plant and landscaping features, site structures, list of fittings to be used, and control system and wiring diagrams and data, and shall note water pressure at the project site.

C) Upon award of contract, Contractor shall provide the following:

1) Three copies of manufacturer's product data for each type of sprinkler head, swing joint assemblies, electric control valves, automatic and manual drain valves, isolation valves, air relief valves, pressure regulators, valve boxes, pipe, fittings including tapping tees and saddles, control wire, waterproof wire connectors, backflow preventer, booster pump, irrigation controllers, rain sensors, freeze sensors, and moisture sensors proposed for use.

2) Provide one of each sprinkler head of each type to be used on the project, one electric control valve, one waterproof wire connector, sample of common and control wire, and one of each type of valve box. Accepted samples will be returned to Contractor for use in project.

D) Determine and submit to Engineer in writing the static water pressure at meter and/or other designated points of connection at least two weeks prior to beginning of installation.

E) Upon project completion and final review of system by City of Tulsa, Contractor shall provide the following:

1) Provide record or “as-built” drawings of completed facilities as installed. Drawings shall be provided to City of Tulsa in:

   a) Electronic form (CAD),

   b) In a reproducible form of mylar or vellum and,

   c) Three copies of the as-built drawing in blueline or blackline form. As-built drawing shall show the measured distance from easily identified, fixed locations to isolation valves, electric control valves, manual drain valves, and wire splices. Two dimensions from fixed point per location are required.

2) Three binders containing manufacturer’s installation, operational and maintenance instructions as well as a parts breakdown and catalog for each piece of equipment installed on the project. As a minimum the binders shall include information for the irrigation controller, booster pump, backflow preventer, pressure regulators, isolation valves, electric control valves, drain valves, air relief valves, all spray and rotary sprinkler heads, and rain, freeze, and moisture sensors.

3) A plastic laminated (sealed) reduced drawing of the irrigation system indicating the areas or zones of the irrigation system controlled by each electric control valve. For clarity, drawing may be divided into two sections and shown on both sides of the laminated sheet. Reduced drawing shall be placed on the inside of the controller door. Drawing shall be approved for clarity by City of Tulsa prior to acceptance of system.

F) Upon project completion and prior to the certificate of occupancy and/or Final Acceptance, the design professional noted in paragraph 1.5 A., shall review the system and submit a written certification that the automatic irrigation system was installed per the plan, and provides full coverage of the landscaped area with minimal overspray.

840.1.6 Operation and Maintenance Instruction and Demonstration:

A) Provide a schedule indicating length of time each electric control valve is required to be open to provide determined amount of water.

B) Provide a recommended schedule for station run times and frequency of watering for the first two weeks, the first two months, and the first twelve months (including all seasonal change requirements) after completion of the installation.

C) Instruct City of Tulsa's personnel in operation and maintenance of system, including adjusting of sprinkler heads.

840.1.7 Extra Stock:

A) Provide the following extra stock items:

1) Two sprinkler heads of each type and size.

2) Two valve keys for manual valves.

3) Two keys for valve boxes or markers.

4) Two adjustment tools for each type sprinkler head and any tool required to remove or disassemble each type head.

5) Two couplers keys for each size of quick coupling valve with brass hose swivels.

6) Two replacement diaphragms and solenoids for each size and type of valve installed on the project.

840.1.8 Warranty:

A) Entire sprinkler system will be unconditionally guaranteed against defects in material and workmanship, including repair of settling of backfilled areas below grade and adjusting heads to proper level for a period of one year from final acceptance.

B) Minor adjustments, any defective electrical controls, valves, sprinkler heads or other working parts will be repaired or replaced without cost to the City of Tulsa for a period of one year from the date of acceptance.

C) Damage by others during the one year of guarantee period will be City of Tulsa's responsibility.

D) Warrant sprinkler system to have 100% uniform moisture coverage of areas shown to be irrigated.

840.1.9 System Service:

A) Inspect system at two and four weeks after Date of Final Acceptance and make necessary adjustments. Drain System in fall following installation and turn on system the following spring, providing complete system inspection and adjustment.

840.2 PRODUCTS

840.2.1 Materials – General

A) The specific materials to be used shall be as designated on the project drawings and this specification. All materials to be incorporated in this work shall be new and of the best quality, meeting the requirements for such materials and for the purpose intended. Since the irrigation lines on the contract drawings are essentially

diagrammatical, the Contractor shall be responsible for computing and supplying the required pipe, fittings, control wires, and electrical accessories according to the contract documents.

B) Acceptable Manufacturers:

1) Weather-matic.

2) Rain Bird.

3) Hunter.

4) Toro.

5) Approved equal.

840.2.2 Pipe and Fitting Materials:

A) Pressurized Main Line Pipe:

1) All 2" and smaller main line pipe shall meet the latest requirements of ASTM D1785 Standard Specification for Schedule 40 Polyvinyl Chloride) PVC pipe with size as shown on the project drawings.

2) All main line pipe to be installed in curved sleeves shall be copper, Type L Soft, and shall be the size shown on the project drawings. All transition fittings to PVC shall be copper sweat socket with threaded MIPT or FIPT connections to the PVC main line pipe.

B) Lateral Pipe:

1) All lateral pipe, downstream of the control valves, shall be have solvent weld joints and shall meet the latest requirements of ASTM D2241 Standard Specification for Polyvinyl Chloride) (PVC) Plastic Pipe with standard dimension ratio (SDR) of 21 and a Pressure Rating (PR) of 200 psi.

C) Sleeving Pipe:

1) The contractor is responsible for the location and placement of all sleeves on the project whether shown on the drawings or not. Sleeves under sidewalks and concrete other than City of Tulsa streets shall be PVC SCH 40 for straight sections and shall be HD Polyethylene for curved sections. Sleeves shall be sized two times the nominal diameter of the largest pipe passing through the sleeve. Minimum sleeve size shall be 2”. Sleeves shall be installed at a minimum cover depth of 20” from finish grade. Coordinate horizontal and vertical elevations with utilities and footings. A separate minimum 2” diameter sleeve shall be provided for the control wires to pass through at each crossing.

All sleeves passing under City of Tulsa streets shall be steel or ductile iron pipe and shall meet the requirements of the governing departments of the City of Tulsa.

D) Fittings:

1) Main Line Fittings (2" and smaller): All pressurized main line fittings at all points of direction change such as 22.5, 45, tees or 90° turns shall be solvent weld with a minimum of Schedule 40 dimensions and shall meet the requirements of ASTM D2466-78. Schedule 40 fittings shall be Spears Manufacturing or approved equal.

   Main Line Installation of Electric Control Valves and Quick Coupling Valves (2" and smaller) onto the main line shall be PVC Schedule 80 solvent welded or threaded fittings and shall meet ASTM D2467 and ASTM D2464, respectively. PVC Schedule 80 fittings and nipples shall be used on all fittings required between the mainline tap and the electric control valve as well as the threaded connection between the electric control valve and the lateral piping. Schedule 80 fittings shall be Spears Manufacturing or approved equal. Contractor shall use manufacturer's recommended sealing compounds and/or Teflon tape according to manufacturer's recommended practice for the specific application.

2) Lateral Line Fittings: Solvent welded fittings shall be Schedule 40 dimensions and wall thickness and shall meet the requirements of ASTM D2466 and shall be used on all piping downstream of electric control valves.

E) Solvent Cement: ANSI/ASTM D2564 for PVC pipe and fittings.

F) All 1/2" inlet spray heads and 3/4" inlet rotary heads shall be connected to the irrigation piping utilizing 1/2" thick walled polyethylene tubing (Rain Bird Model SPX-100 or approved equal) and appropriate insert fittings (Rain Bird Models SBE-050, SBE-075, SBA-050, SBA-075, or approved equal). Sufficient lengths of flexible pipe shall be used to form a sweeping arc to ensure that spray heads are supported properly and allow for vertical adjustment and movement during service.

G) All 1" inlet quick coupling valves shall be installed on prefabricated, manufactured swing joint assembly rated for 315 psi with pre-lubricated buttress threads and O-ring seals equal to Spears Manufacturing Co. Series 5807-01012 or approved equal.

H) Swing Joints: Prefabricated, schedule 80 PVC, equal to Spears. Use for ground level pop-up impact driven heads, gear-driven rotary heads, hydrant, and quick-coupler valves.

I) Drip Irrigation: Pipe and fittings equal to Rain Bird 1/2” Pressure Compensating Emitter Tubing, or Netafin U.S.A. A Drip Operation Indicator Kit equal to #17500 as supplied by Rain Bird or approved equal shall be installed at each drip irrigation

zone or each tree well (where portions of the drip zone is separated from others with solid line).

840.2.3 Sprinkler Heads and Nozzles:

A) Sizes and types required to provide complete, even coverage with minimum overspray as noted on the drawings.

B) Shrub/Ground Cover Beds: 12" Pop-up – Rain Bird 1812-PRS with pressure regulator incorporated into stem with necessary 1800-EXT extensions or approved equal.

840.2.4 Valves:

A) The irrigation system control valves shall be contamination resistant, glass filled high strength nylon body and bonnet, electrical solenoid operated, normally closed, diaphragm globe valves. The valve shall have a 200 psi CWP rating. The valve shall be activated by a 24 V.A.C. solenoid. Flow control stem shall be non-rising. The valve cover shall be secured to the body with stainless steel threaded studs and nuts. Bleeding of water during manual operations shall be either internal or external. Valves shall be as manufactured by Weathermatic, Inc. Model Series 11,000 or approved equal with size as shown.

B) Irrigation drip zone control valve to be specifically designed commercial applications with medium flow requirements and incorporating a pressure-regulating filter.

C) Gate valves (isolation shut off valves): 2" and smaller – shall be bronze, threaded, screw-in bonnet with non-rising stem rated for a 125 psi WSP and 200 psi non-shock WOG. The valve shall be of domestic manufacture, shall meet Federal Specifications MSS SP-80 equal to Hammond Model IB645.

D) Isolation valves for the electric control valves shall be of the ball type, plastic construction, threaded ends, and have a maximum pressure rating of 235 psi at 73° F. The valves shall be equal to Spears Model 2131-0XX size the same as the control valve.

E) Automatic drain valves: King Technology, Inc. Model 22, 1/2" inlet or approved equal.

F) Quick coupling valves: Equal to Weathermatic V100RL-NP with “Non-Potable” purple rubber cover and locking cover. Contractor shall supply two model 44K keys with bronze hose swivel adapters, Buckner model 45002 or approved equal. Quick coupling valve shall be prevented from rotation with Leemco Model LS-120 valve stabilizer or approved equal.

G) Backflow Preventer: Reduced pressure device equal to Wilkens Model 975XL meeting the requirements of the City of Tulsa for irrigation system use. The

backflow preventer shall be installed using Type L copper pipe and shall incorporate two unions for ease of construction. The contractor shall provide freeze protection for the backflow preventer and piping by using thermostatically controlled "heat tape". The backflow preventer shall be placed in a protective cabinet along with the controller.

H) Backflow Preventer and Controller Protective Cabinet: The backflow preventer and controller shall be installed in an aluminum cabinet. The protective cabinet shall be installed on a concrete base or sidewalk as indicated on Standard Detail 840 – 842. The contractor is responsible for supplying a connection of 120 Volt power to the cabinet for the controller and backflow preventer. Source of 120 Volt power to be from new project circuitry. Submit proposed connection to engineer for approval.

840.2.5 Water Meter:

A) New, 1" as provided by the City of Tulsa (One Required).

840.2.6 Controller:

A) Electronic, compatible with valves, multi-station, programmable, in U.L. approved rainproof housing. The controller shall be installed inside the cabinet at the specified location according to the manufacture's recommendations. The contractor is responsible for supply and connection of 120 Volt power to the controller. Source of 120 Volt power to be from new project circuitry. Submit proposed connection to engineer for approval. The controller shall be as manufactured by Rain Bird Sprinkler Mfg. Corp., Glendora, California Model ESP-12LX+ or approved equal.

840.2.7 Valve Boxes and Markers:

A) For automatic control valves: Equal to Carson Industries Inc. model 1419E-13 with 1419E extensions as required.

B) For quick coupling valves and isolation gate and ball valves: Equal to Carson Industries Inc. model 910-12 with 8" corrugated plastic pipe for extension.

C) For main line isolation valves: Carson Industries, Inc. model 910-12 with 8" I.D. corrugated polyethylene pipe, as manufactured by Advanced Drainage Systems, Inc. (ADS) or approved equal, cut to length as required.

D) For 24 Volt (low voltage) electrical splices: Carson Industries, Inc. model 910-12 with 8" I.D. corrugated polyethylene pipe, as manufactured by Advanced Drainage Systems, Inc. (ADS) or approved equal, cut to length as required.

840.2.8 Wiring:

A) Wire: All control wiring to be used for connecting the remote-control valves to the controller shall be 14 gauge and all common wiring shall be 14 gauge. The wire shall be Type UF, 600 Volt, single or stranded solid copper wire with PVC insulation and shall bear UL approval for direct underground burial feeder cable.

B) Splicing Materials: All electrical connections shall be waterproof so that there is no chance for leakage of water and corrosion build-up in the joint. The type of connection to be used shall be 3M DBY direct bury splice kits, King Silicon-Filled Safety Connectors or approved equal.

840.2.9 Environmental Condition Sensors:

A) Rain Sensor – Equal to Mini-Clik II manufactured by Mini-Clik, Inc.

B) Freeze Sensor – Equal to Freeze-Clik manufactured by Mini-Clik, Inc.

840.3 EXECUTION

840.3.1 Preparation:

A) Contractor shall call and notify the local utility location center before any excavation to request the exact location of all utility lines. Contractor is responsible for the protection of all utility lines located on the site.

B) Design system to provide coverage of turf and planting beds on separate zones. Route piping to avoid plants and structures. All planting beds with sun exposure shall be zoned separately from shaded planting bed areas. All planting beds with shrubs and perennial plantings shall be zoned separately from beds with annual or seasonal planting. Turf rotor heads to be zoned separately from turf spray heads.

C) Head locations and pipe routing are diagrammatic only and shall be adjusted during installation to compensate for prevailing winds, gradient, and landscaping to ensure proper coverage with minimal overthrow.

D) Review layout requirements with other affected work. Location of heads to be coordinated with planting bed and lawn edges. Verify location and installation of sleeves (under paving and other improvements) to accommodate system.

E) Contractor shall ensure that his equipment, materials, tools, excavations, backfills, any obstruction, and in general, the job site, are properly barricaded, posted, and lighted to prevent unnecessary risk to the public, municipal, or construction employees that may encounter the job site.

F) Protect landscaping and other features remaining as final work.

840.3.2 Irrigation Design:

A) Spray heads shall be spaced no further than for "Head to Head" coverage based on the sprinkler head performance published by the head manufacturer. Rotary heads (3/4" inlet) shall be spaced no further than 85% of the published radius for the design pressure.

B) Valves shall be sized according to the flow through the valve as follows:

1) 3-18 GPM – 1" Valve.

2) 28-54 GPM – 11/2" Valve

3) 55-80 GPM – 2" Valve

C) All components of the irrigation system are to be designed and specified to maintain the design pressure and performance at the sprinkler heads with a fluctuation of static water pressure of ±10%.

D) Pressurized main line pipe shall have maximum velocity of 5’ per second.

E) Lateral line pipe shall have maximum water velocity of 5’ per second.

F) The maximum pressure differential between the sprinkler head nearest the control valve and the sprinkler head furthest from the control valve shall not exceed 10% of the pressure at the control valve.

G) Review layout requirements with other affected work. Location of heads to be coordinated with planting bed and lawn edges. Verify location and installation of sleeves (under paving and other improvements) to accommodate system.

H) Protect landscaping and other features remaining as final work.

840.3.3 Trenching:

A) Trenches for pipe shall be excavated to a sufficient width and depth to permit proper handling and installation of the pipe and fittings. All manifold, main lines, and lateral lines shall be installed at a minimum cover depth of 18”. The minimum cover specifications shall govern regardless of variations in ground surface profile. Trenches shall be graded and sloped to lowest drain points.

B) All water, sewer, drainage, electrical, and all other utility lines shall be protected where encountered in trenching and, where cut or damaged by Contractor, shall be repaired at the expense of the Contractor and to the satisfaction of the City of Tulsa.

C) Concrete and asphalt crossings shall be sleeved prior to their installation. No cutting of existing sidewalks or roadways shall be permitted.

840.3.4 Installation:

A) Contractor is responsible for the placement and installation of all sleeves whether shown on the drawings or not. Install sleeves under paving and other improvements prior to construction. Install where required to accommodate piping at proper depth to prevent damage by other construction activities and to provide specified burial depth for irrigation pipe. Location of sleeves to be recorded and marked.

B) Arrange and coordinate installation of water meter. Cost paid by Contractor.

C) Install backflow preventer inside the cabinet at the specified location as approved by the City of Tulsa.

D) Install pipe, valves, controls, and sprinklers in accordance with manufacturer's instructions. Connect to water and electrical service. All work to be accomplished in accordance with applicable codes.

E) Provide for thermal movement due to expansion and contraction of the pipe.

F) Solvent weld pipe and fitting connections shall be made according to ASTM D2855-83 Standard Practice for making solvent-cemented joints with Polyvinyl Chloride (PVC) pipe and fittings. Special care shall be taken to:

   1) Cut pipe square, remove burrs and chamfer 2” pipe and larger.

   2) Apply uniform coating on all parts with lighter coats on sockets.

   3) Avoid pockets of cement left in joints.

   4) Use small cans to maintain cement's original viscosity.

   5) Make joints immediately and hold to prevent pipe from pushing out.

G) After piping is installed, before sprinkler heads are installed and backfilling commences, open valves and flush system with full head of water.

H) Set valve box covers level at finish grade. Rectangular valve boxes to be placed parallel to nearby curbs and walks or other improvements. Valves and valve boxes shall be installed where shown or directed and shall be set plumb. Valve boxes shall be centered on the valves. Where feasible, valves shall be located outside the area of natural walkways or paths and shall be placed in groundcover areas where possible. Earth fill shall be carefully tamped around each valve box. Valve boxes should be supported or blocked such that any surface loads on the valve boxes will not be transmitted below to the pipe or valves. Washed gravel sumps shall be provided below all valve boxes to permit drainage of water away from valves. Minimum depth of gravel sump is 8”.

I) Install at least two automatic drain valves per zone at all low points sections of lateral piping (lines downstream from valves) to ensure complete drainage of system when not in use.

J) All sprinklers shall be installed on flexible connections or swing joints as specified in Section 2.2 "Pipe and Fitting Materials" and shall be set plumb and level with the final grade.

K) Install control wiring. Place the excess wire in a 10” expansion coil at each valve to which controls are connected and at 100’ intervals. Control wiring may be installed in the same trenches with the irrigation piping. Wiring shall be bundled and taped with electrical tape at 10’ intervals the entire length of each run. Wiring shall be installed on the north or east side of the pipes. Wire shall not be taut in the trench and expansion loops shall be provided to prevent the wire from being tensioned by backfilling or other subsequent construction. The side of the trench in which the wires are located shall be free of stones and other hard material which might injure the wire insulation. Backfill material placed against the wires shall be select material especially free from stones or other material with might injure the insulation.

L) A minimum of 24" of wire for an expansion loop shall be allowed at each valve for contraction of wire or tightening of wire due to back-filling of trenches or possible valve service or replacement.

M) Splices outside of valve locations are not desirable and are discouraged. However, should splices be necessary, all splices shall be made in a minimum 10" round valve box. All connections at the electric control valves and splice points shall be water-proofed with the system specified in Section 2.8 “Wiring”.

N) All trenches shall be carefully backfilled with the excavated materials approved for backfilling, consisting of earth, loam, sandy clay, sand, soft shale, or other approved materials, free from large clods of earth or stone. Rock, broken concrete or pavement, and large boulders shall not be used as backfill material. The backfill shall be thoroughly compacted and evened off with the adjacent soil level. Selected fill dirt or sand shall be used if soil conditions are as discussed above. The fill dirt or sand shall be used in filling 4” above the pipe. The remainder of the backfill shall contain no lumps or rocks larger than 1”. The top 6” of backfill shall be free of rocks or gravel particles over 1/2” in diameter, subsoil, or trash. Open trenches or partially backfilled trenches shall be kept to a minimum and effort shall be made to completely backfill that trench opened each day. The Contractor will be responsible for restoration of all settlement for a period of one year from acceptance.

O) The irrigation controller shall be mounted level and plumb at the specified location shown on the contract drawings according to manufacturer's recommendations. Electrical conduit PVC sweep ells shall be used for the entering and exiting of the 24 Volt control wires into the conduit entering the controller. Controllers shall be connected to the appropriate valves as indicated on the contract drawings.

Electrical power supply to the controller shall be installed according to local electrical codes and shall be provided by Contractor.

P) Rain and freeze sensors shall be installed according to manufacturer's recommendations and shall be installed at locations approved by the design professional.

Q) Clean area and remove all debris and excess materials from site.

840.3.5 Tests:

A) Static Pressure Test:

1) The entire main line system shall be constructed to successfully withstand, when completed, a full static pressure or 125 psi (whichever is greater) for a period of six hours with no resulting flow or pressure loss.

2) The testing for leakage shall be conducted with the observation of the City of Tulsa and all pipe, joints, and appurtenances will be inspected while the system is under test pressure and leaks corrected as directed. The testing shall extend over a period of up to six hours to allow for a complete inspection.

B) Performance Test

1) Upon completion of the irrigation system including all pressure tests, Contractor shall perform a 48-hour performance test of the complete system to ensure that all components are functioning properly. Contractor shall keep a technically qualified person and necessary crew on the job site during this period of testing.

2) The Contractor shall balance and adjust the various components of the system so that overall operation of the system is most efficient. This includes adjustments to pressure regulators, part-circle sprinkler heads, and individual station adjustments on the controllers.

3) Repair grades and re-dress mulch in planted areas disturbed by final testing and adjustment.

840.4 PAYMENT

840.4.1 Basis of Payment:

Underground Sprinkler System will be paid for at the contract unit price by lump sum for the system, or as indicated on the Contract Documents and approved by the City of Tulsa.

SPECIAL – IRRIGATION LUMP SUM (or as otherwise indicated on Contract Documents)

Such payment shall be full compensation for all equipment, tools, labor, and incidentals necessary to complete the work as specified.

**END OF SECTION**