OAK GROVE
MISSOURI
STRONG ROOTS. BRIGHT FUTURE.

TECHNICAL SPECIFICATIONS & DESIGN CRITERIA

FOR

UTILITY AND STREET CONSTRUCTION

April 16, 2018

CITY OF OAK GROVE, MISSOURI
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OAK GROVE PAVING
SPECIFICATION MODIFICATION TO
APWA SPECIFICATION SECTION 2200
OAK GROVE, MO - 2017

Work for the City of Oak Grove shall follow APWA Construction and Material Specification Section 2200 for paving except as modified below. The additions and/or alterations to the APWA Specification 2200 provided below shall apply to execution of the various parts of the work performed within the City.

APWA SPECIFICATIONS SECTION 2200

2201 SUBGRADE PREPARATION

Add Section 2201.4 (F) as follows:

F. For privately funded street improvements, the Engineer shall provide a geotechnical report and pavement design for approval by the City Engineer. The geotechnical report shall analyze proposed subgrade materials and if necessary make recommendations for subgrade modifications to meet the subgrade soil stability requirements for the submitted pavement design.

For publicly funded projects any subgrade modification shall be as indicated on the plans, or directed by the City Engineer.

Subgrade modification shall be in accordance with SECTION 2202 SUBGRADE STABILIZATION.

2203 AGGREGATE BASE COURSE

2203.3. Materials: Add the following sentence at the end of Section 2203.3 A.

MoDOT Type 5 aggregate may be used for untreated compacted aggregate in lieu of the material specified in this section.

2203 AGGREGATE BASE COURSE

2203.4 C. Plant Mix Bituminous Drainable Base: Delete paragraph 6. and replace with the following:

6. Handle, place and compact materials in accordance with the following.

a. Contamination of the finished base material that affects the drainage capability of the product shall not be permitted. Any areas determined to be contaminated shall be completely removed without disturbing the adjacent or underlying material and replaced at contractor's expense.

b. Rutting or other displacement of the permeable base or the underlying base will not be permitted. If displacement occurs, the material shall be completely removed without disturbing the adjacent or underlying material and shall be replaced at the contractor's expense.

c. Materials for this work will be accepted based on the requirements of Section 2205.

2205 ASPHALTIC CONCRETE SURFACE AND BASE

2205.3 Materials: Delete paragraph of 2205.3 A and replace with the following:

Asphalt cement used in the manufacture of asphalt paving mixtures shall conform to the Performance Graded (PG) system. The asphalt oil used shall be PG 64-22 for all types of AC mixes.

Add the following paragraph to the end of Section 2205.3 Materials:

E. All Asphaltic Concrete Mixes, and Tack Coat, used within the City of Oak Grove shall comply with the following:

1. Base Mixtures shall comply with APWA (Section 2205) Type 5-01 or Type 6-01. Reclaimed Asphalt Pavement (RAP), Fractionated Reclaimed Asphalt Pavement (FRAP), and/or Reclaimed Aggregate Materials (RAM) shall represent no more than 30% of the composition of all base mixtures.

2. Surface Coarse APWA (Section 2205), Type 5-01

3. Coarse Aggregate APWA (Section 2205)

4. Fine Aggregate APWA (Section 2205)

5. Asphalt Cement APWA (Section 2205)

6. Tack Coat RC70, or SS-1

2205.4 Mixing and Proportioning: Delete the first paragraph of 2205.4 C. 1. and replace with the following:

General: Except as modified herein, Recycled Asphalt Concrete (RAC) shall be equal to that produced as new material. Reclaimed Asphalt Pavement (RAP), Fractionated Reclaimed Asphalt Pavement (FRAP), and/or Reclaimed Aggregate Materials (RAM) shall represent no more than 30% of the composition of all surface and base mixtures.

2205.9 Construction: Add the following sentence to end of the fourth paragraph of Section 2205.9 A.:

A tack coat shall not be required between successive layers of base placed in the same working day.

2209 CURBING

2209.4 Construction: Delete paragraph D. and replace with the following:

D. Slip-Form Curb Machine: A slip-form curb machine shall be used to place any section of curb greater than 100 feet in length. The machine must be equipped with mechanical internal vibrators and capable of placing curb to the correct cross section, line and grade within the allowable tolerances.

Delete the first sentence of paragraph E. 2. Contraction Joints, and replace with the following:

Curbing shall have contraction joints at intervals of not more than 10 feet.

Add the following paragraph after paragraph E. 2.:

3. Expansion Joints: Expansion Joints shall be placed as indicated on Curb and Gutter Standard Details SD-41, and SD-42. Expansion joint material shall comply with ASTM D1751.

2211 SMOOTHNESS

2211.4 Construction:

Replace the first sentence of this Section with the following

Profilographing shall be performed on roadways classified as arterials, major collectors, freeways, expressways and interstates

Add the following to the end of APWA Section 2200 Paving:

SECTION 2212 INCIDENTAL PAVING ITEMS

2212.1 Street Cuts

All street cuts will have at least 10" of KCMMB 4K Concrete over street cut, or as approved by the Director of Public Works. A detailed typical section of the street cut shall be provided showing the proper street section.

Any construction performed within the City's right-of-way shall be approved by the Public Works Department before any construction activities can begin. A separate Right-of-Way Permit will be issued for any work performed within the right-of-way. The permit conditions shall be met; penalties will be given for non-compliance with these conditions. The Owner and Contractor shall be familiar with the Right-of-Way Ordinance and its contents.

2212.2 Trenching Backfill

All trenching under roadway pavement shall be backfilled with removable flowable fill, or as approved by the Director of Public Works.

2212.3 Cleaning Operations

All catch basins, manholes, inlets, outlets, and roadway surfaces shall be thoroughly cleaned of any accumulations of silt, debris, or foreign matter of any kind, and shall be free from such accumulations at the time of final inspection.

SECTION 2213 MATERIAL TESTING AND CERTIFICATIONS

When requested by the City Engineer, the Contractor shall furnish test results at the contractors' expense and from a testing laboratory approved by the City Engineer showing compliance with the plans, specifications, and all requirements of APWA Section 2200 as modified herein.

The contractor shall submit certifications for all materials used for each project to the City Engineer for approval prior to incorporating those materials into the project. Each certification shall indicate that the material is in compliance with the plans, specifications, and all requirements of APWA Section 2200 as modified herein.

At the completion of the project the contractor shall certify that the completed project is in compliance with all requirements of the plans, specification, contract documents, and all other requirements of the City of Oak Grove.

DIVISION II
CONSTRUCTION AND MATERIAL SPECIFICATIONS
SECTION 2200 PAVING

APPROVED AND ADOPTED THIS 15th DAY OF FEBRUARY, 2017

KANSAS CITY METROPOLITAN CHAPTER
OF THE AMERICAN PUBLIC WORKS ASSOCIATION

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SECTION 2201 SUBGRADE PREPARATION

2201.1 Scope

This section governs the furnishing of all labor, materials and equipment for the preparation of subgrade as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions. This section includes subgrade preparation at locations which have been previously graded in accordance with the requirements of Section 2100 "Grading and Site Preparation".

2201.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM

D 698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

2201.3 Definitions

A. Subgrade: Subgrade is defined as a well graded and compacted layer on which base and subsequent courses are placed.

B. Subgrade Preparation: Subgrade preparation is the repeated operation of fine-grading and compacting the subgrade until the specified lines, grades, and cross-section, as indicated on the Plans are obtained and the materials are compacted to the specified depth and density.

2201.4 Construction

A. General: The subgrade surface shall be brought to the specified lines, grades and cross-section by adding or removing material and compacting to the specified density. Tolerance allowed on all lines, grades and cross-sections shall be no more than 1/4 inch.

B. Compacting the Subgrade: Unless otherwise specified, the top 6 inches of subgrade for pavements shall be compacted to 95% of the standard proctor maximum density for the material used as determined by ASTM D 698 and within a tolerance of plus 3% and minus 3% of the optimum moisture content. The tolerance applies only to the top 6 inches.

C. Protection and Maintenance of Subgrade: The subgrade shall be protected from action of the elements or others. Any action (e.g. settlement or erosion) that damages the subgrade or any subgrade that has become unacceptable prior to placing the pavement thereon, shall be repaired and the specific lines, grades, cross-section, tolerance, density, and moisture content range reestablished.

D. Cleanup: Subgrade cleanup shall follow the work progressively. The Contractor shall remove from the project site all rubbish, surplus or discarded material, unsuitable material, and any equipment, tools and temporary construction items used for the preparation of the subgrade.

E. Roll Testing: Once the subgrade has been brought to the final plan elevation, but prior to approval of the

subgrade for paving, all lanes shall be roll tested in their entire length. The subgrade will not be acceptable if rutting, pumping, or deformation of the subgrade results from the roll test. This testing will be done by the contractor, and will be in addition to the applicable moisture and density testing.

Equipment for roll testing shall be a tandem dump truck (one front and two rear axles) carrying a minimum load of twenty (20) tons.

The truck shall proceed slowly along each traffic lane, allowing the Engineer to walk alongside and observe the results. Areas failing the roll test will be reworked and retested prior to approval of the subgrade for paving.

2201.5 Method of Measurement

Subgrade Preparation will generally not be listed in the Contract Documents as a separate item.

2201.6 Basis of Payment

Subgrade Preparation will generally be included in payment for other items in the Contract Documents.

SECTION 2202 SUBGRADE STABILIZATION

2202.1 Scope

This section governs the furnishing of all labor, materials and equipment for the stabilization of subgrade as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions. This work shall consist of the addition of self-cementing fly ash or lime to soil, mixing and compacting the material to the required density to develop a stabilized subgrade section. This applies to natural ground or fills and shall be constructed as specified herein and in conformity with the typical sections, lines and grades as shown on the Plans or as established by the Engineer.

2202.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM

C 25 Standard Test Methods for Chemical Analysis of Limestone, Quicklime, and Hydrated Lime
C 618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
D 698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))
D 1556 Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
D 5239 Standard Practice for Characterizing Fly Ash for Use in Soil Stabilization
D 6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

AASHTO

T 99 Standard Method of Test for Moisture-Density Relations of Soils Using a 5.5 lb. Rammer and a 12 inch Drop
M 216 Standard Specification for Lime for Soil Stabilization

2202.3 Materials

A. Fly Ash: Fly Ash shall comply with the physical requirements of ASTM D 5239, paragraph 6.4 maintaining a minimum compressive strength of 500 psi at 7 days and the chemical requirements of ASTM C 618, Table 1 for Class C fly ash, unless otherwise shown on the Plans. The source of the ash shall be selected by the Contractor and approved by the Engineer in advance of stabilization operations in order that the required laboratory tests can be completed prior to construction without delaying the work. Certification shall be provided by the supplier that the fly ash used on the project meets the above criteria. Fly ash shall be stored and handled in closed weatherproof containers until distribution. Fly ash exposed to moisture prior to mixing with soils shall be discarded.

B. Lime: Lime shall be hydrated or quicklime conforming to the requirements of AASHTO M 216. Contractor shall provide certification that the product complies. Hydrated lime shall contain not less than ninety (90) percent calcium hydroxide Ca(OH)2, and quicklime shall have a minimum available lime percentage (CaO) of 90%, as determined by ASTM C 25. Lime shall be introduced to the subgrade in a slurry form. When quicklime is used, slake it at the jobsite to manufacture hydrated lime slurry. The Contractor shall submit calculations to the Engineer that determines the amount of water needed to make a slurry with a percent solids between 20 and 40 percent. The Contractor will then determine the concentration strength of the lime slurry and the rate of application to obtain the lime percentage specified in the Contract Documents.

C. Water: Water used for mixing shall be clean and potable. For lime stabilization, it shall be added during mixing, remixing and compaction operations, and during the curing period to keep the cured material moist until covered. If water is not included in the Contract Documents as a pay item, it is subsidiary to other Contract items.

D. Soil: The subgrade soil to be stabilized shall be uniform in quality and gradation and free from rubble, rubbish, vegetation, and stones larger than 1” diameter.

2202.4 Composition

Fly ash shall be applied at a rate determined by laboratory testing using the materials from the site and the specific fly ash to be supplied unless otherwise designated by the Contract Documents. Testing shall be the responsibility of the Contractor and is subsidiary to other items. The minimum application rate shall be 15% unless testing indicates otherwise.

Lime shall be applied at a rate determined by laboratory testing using the materials from the site and the specific lime to be supplied unless otherwise designated by the Contract Documents. Testing shall be the responsibility of the Contractor and is subsidiary to other items. The minimum application rate shall be 5% (by weight) unless testing indicates otherwise.

2202.5 Thickness

The thickness of the completed, compacted soil mixture shall be 6 inches or as called out in the Plans or Special Provisions. The thickness shall not be less than the specified minimum. Check thickness and when found to be ½ inch or more out of tolerance, the contractor shall correct the area represented by the checked location at no additional cost.

2202.6 Equipment

The machinery, tools, and equipment necessary for proper execution of the work shall be on the project and approved by the Engineer prior to beginning construction operations. Utilize spreading equipment capable of producing a consistent

application rate. Blending of the soil mixture shall be accomplished by equipment with a recycling or mixing drum, positive depth control, and automatic water proportioning system that provides consistent results. Compaction shall be achieved using pneumatic or vibratory sheepsfoot or padfoot rollers capable of meeting the compaction requirements. Final surface compaction may be completed with a steel wheel or rubber-tired roller.

All machinery, tools and equipment use shall be maintained in a satisfactory and workmanlike manner.

2202.7 Construction

A. General: It is the primary purpose of this specification to secure a completed section of treated material which contains a uniform mixture with no loose or segregated areas, has a uniform density and moisture content and is well bound for its full depth. It shall be the responsibility of the Contractor to regulate the sequence of his/her work, to process a sufficient quantity of material to provide a completed section as shown on plans, to use the proper amounts of fly ash or lime, to achieve final compaction within the specified time, to maintain the work, and to rework the lifts as necessary to meet the above requirements.

B. Weather Limitations: The soil mixture shall not be mixed while the soil is frozen, the temperature is below 40°F or when conditions indicate that the atmospheric temperatures may fall below 40°F within 24 hours.

C. Preparation of Subgrade: Before other construction operations are begun, the area to be stabilized shall be cut and shaped in conformance with the lines and grades shown on the plans. All areas shall be firm and able to support, without displacement, the construction equipment and the compaction hereinafter specified. Soft or yielding subgrade shall be corrected by the Contractor using a method approved by the Engineer.

D. Moisture Control: Moisture control shall be achieved through use of a controllable water additive system capable of being regulated to the degree necessary to maintain moisture contents within the recommended range.

1. For fly ash, the required moisture content will be established by laboratory tests with the site soils and specific fly ash to be used, determined in accordance with ASTM D 698 or AASHTO T 99. Laboratory testing shall be the responsibility of the Contractor and is subsidiary to other items. Final moisture content of the mix, immediately prior to compaction shall be +/- 3 percentage points of the optimum moisture content as determined by laboratory testing unless otherwise specified in the Contract Documents. If moisture contents exceed the specified limits, additional fly ash may be incorporated to lower moisture contents to the required limits. Lowering moisture contents by aeration following addition of fly ash will not be allowed.

2. For lime, the required final moisture content of the lime-soil mix will be established by laboratory tests with the site soils and specific lime to be used, determined in accordance with ASTM D 698 or AASHTO T 99. Laboratory testing shall be the responsibility of the Contractor and is subsidiary to other items. During mixing and compaction operations, the moisture content of the mix shall be a minimum of 3 percentage points above the optimum moisture content as determined by laboratory testing, unless otherwise specified in the Contract Documents. After completion of the preliminary mixing operation and during the aging period, the surface shall be kept moist by spraying with water. Following the final mixing operation and compaction, the surface shall be kept moist by spraying with water until covered by a subsequent layer of material or sealed with a bituminous prime coat applied at a minimum rate of 0.15 gallons per square yard. Other curing methods may be submitted by the Contractor for consideration by the Engineer.

E. Application of Material

1. Fly Ash: Immediately prior to application of fly ash, the areas shall be scarified to allow for uniform distribution. The use of scarification equipment with positive depth control is required and should be performed to a depth between four inches (4") and one inch (1") less than the specified depth of treatment. The fly ash shall be spread only on that area where the placement, mixing and compaction operations can be completed within 2 hours.

   The fly ash shall be spread uniformly over the top of the subgrade – the use of a controlled application system approved by the Engineer is preferred but the Contractor may submit an alternate method of spreading for approval that provides uniform distribution at the specified rate of application. The amount of fly ash spread shall be the amount required for mixing to the specified depth which will result in the percentage determined by laboratory testing as described in section 2202.4 Composition.

   The fly ash shall be distributed in a manner that reduces the scattering of fly ash by wind to a minimum. Fly ash shall not be applied when wind conditions, in the opinion of the Engineer, are detrimental to a proper application or becomes objectionable to adjacent property owners.

   The mixing operation shall be completed within 30 minutes of the addition of water to the subgrade.

2. Lime: Immediately prior to the application of the lime, the areas shall be scarified to allow for uniform distribution. The use of scarification equipment with positive depth control is required and should be performed to a depth between four inches (4") and one inch (1") less than the specified depth of treatment.

   Lime slurry is to be applied with equipment that can regulate the amount passing through the nozzles and the speed of travel to place the specified amount on the soil with a uniform lime distribution. The concentration of the lime slurry should allow for the application of the correct quantity of lime without adding an undue amount of excess moisture. The Contractor is responsible for testing the concentration of the lime suspension a minimum of once per day or once per batch, whichever is greater.

   Application of the lime slurry should occur on the same day the slurry is produced. Continuously agitate the lime slurry once it is produced.

F. Mixing

1. Fly Ash: The full depth of the treated subgrade shall be mixed with a rotary pulvamixer which utilizes a direct hydraulic drive. Fly ash shall not be left exposed for more than 30 minutes after distribution. Water shall be added through a spray bar in the mixing drum capable of uniformly applying sufficient quantities of water to achieve the required moisture content of the soil-fly ash mixture. The system shall be capable of being regulated to maintain moisture contents within the recommended range.

   Mixing shall continue until a homogeneous, friable mixture with zero clods greater than 1-1/2" in size remain and no more than 50% of the mixture is retained on a ½" sieve.

2. Lime: The mixing process for lime includes preliminary mixing, aging, and final mixing. The preliminary mixing should occur immediately following the introduction of the lime slurry to the subgrade. The equipment used for mixing shall have positive depth control with a visual depth indicator and be capable of mixing the full specified depth of treatment to within ½" tolerance. The mixing equipment should also have a travel speed indicator and controllable water additive system. Preliminary mixing shall continue until the material is uniformly mixed, at a minimum moisture content of 3% above

optimum and with zero clods greater than 2" in size remaining. Perform a minimum of two passes over all treated areas with the mixer. Upon completion of the preliminary mixing, seal the mixture to prevent moisture loss by lightly rolling with a pneumatic or steel drum flat roller.

Aging should occur for a minimum of 24 hours and a maximum of 72 hours unless approved otherwise by the Engineer.

Following the aging period, the final mixing is performed by re-mixing the entire treated area until the mixture contains zero clods greater than 1.5" and has 95% of the mixture passing the 1" sieve and 60% of the mixture passing the No. 4 sieve. The mixture should be brought to a moisture content of a minimum of 3% above optimum for compaction.

G. Compaction

1. Fly ash: Compaction of the soil-fly ash mixture shall begin immediately after mixing of the fly ash and be completed within two hours following incorporation of fly ash. Compaction of the mixture shall continue until the entire depth of mixture is uniformly compacted to the specified density using vibratory sheepsfoot or pad foot rollers. A pneumatic rubber tire or smooth wheel steel drum roller may be used to complete the compaction of the surface. A test for both density and moisture content of the soil-fly ash mixture shall be taken for each 750 square yards of material placed with a minimum of one test per day of production. The field density of the compacted mixture shall be at least 95 percent of the maximum density established by laboratory tests using the site soils and specific fly ash to be used, determined in accordance with ASTM D 698. Laboratory testing shall be the responsibility of the Contractor and is subsidiary to other items.

   The in-place field density shall be determined in accordance with ASTM D 1556 or ASTM D 6938. When ASTM D 6938 is utilized for testing purposes, the nuclear gauge shall be calibrated within the last year. Calibration and operation of the gauge shall be in accordance with the requirements of the manufacturer. The operator of the nuclear gauge must show evidence of training and experience in the use of the instrument. The gauge shall be standardized daily in accordance with ASTM D 6938, paragraph 8.

   Final acceptance of the compaction is dependent upon passing visual roll testing. This will be observed and approved by the Engineer. All irregularities, depressions, or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing material as required and remixing and re-compacting with additional fly ash if beyond the 2 hour limit. The surface of the course shall be maintained in a smooth condition, free from undulations and ruts, until other work is placed thereon or the work is accepted.

   Should the material, due to any reason or cause, lose the required stability, density and finish before the work is accepted, it shall be reprocessed, recompacted and refinished at the sole expense of the Contractor. Reprocessing shall follow the same pattern as the initial stabilization including the addition of fly ash.

2. Lime: Compaction of the soil-lime mixture shall begin immediately after final mixing. Compaction of the mixture shall continue until the entire depth of mixture is uniformly compacted to the specified density using vibratory sheepsfoot or pad foot rollers. A pneumatic rubber tire or smooth wheel steel drum roller may be used to complete the compaction of the surface. A test for both density and moisture content of the soil-lime mixture shall be taken for each 750 square yards of material placed with a minimum of one test per day of production. The field density of the compacted mixture shall be at least 95 percent of the maximum density established by laboratory tests using the site soils and

specific lime to be used, determined in accordance with ASTM D 698. Laboratory testing shall be the responsibility of the Contractor and is subsidiary to other items.

The in-place field density shall be determined in accordance with ASTM D 1556 or ASTM D 6938. When ASTM D 6938 is utilized for testing purposes, the nuclear gauge shall be calibrated within the last year. Calibration and operation of the gauge shall be in accordance with the requirements of the manufacturer. The operator of the nuclear gauge must show evidence of training and experience in the use of the instrument. The gauge shall be standardized daily in accordance with ASTM D 6938, paragraph 8.

Final acceptance of the compaction is dependent upon passing visual roll testing. This will be observed and approved by the Engineer. All irregularities, depressions, or weak spots which develop shall be corrected immediately by scarifying the areas affected, adding or removing material as required and remixing and re-compacting.

The surface of the course shall be maintained in a smooth condition, free from undulations and ruts, until other work is placed thereon or the work is accepted.

Should the material, due to any reason or cause, lose the required stability, density and finish before the work is accepted, it shall be reprocessed, recompacted and refinished at the sole expense of the Contractor.

H. Finishing (Trimming) & Curing

1. Fly ash: After each layer or course of the fly ash treated subgrade has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections. The finished surface of the final layer shall not vary more than 3/8 inch when tested with a 10-foot straightedge applied parallel with and at right angles to the pavement centerline. Any variations in excess of this tolerance shall be corrected by the Contractor, at his/her own expense, in a manner satisfactory to the Engineer.

   After the fly ash treated course has been finished as specified herein, the surface shall be protected against rapid drying by one of the following methods for a period of not less than three days or until the pavement section is placed.

   a. Maintain in a thorough and continuously moist condition by sprinkling with water.
   b. Apply an asphalt prime coat emulsion curing seal approved by the Engineer at a rate of 0.15 gallons per square yard.
   c. Other options for maintaining moisture may be submitted in writing for approval by the Engineer.

   Restrict construction traffic from operating on the treated subgrade until it can withstand the loads without damage or deformation.

   Protect the treated subgrade from freezing throughout the protection period.

2. Lime: After each layer or course of the lime treated subgrade has been compacted, it shall be brought to the required lines and grades in accordance with the typical sections. The finished surface of the final layer shall not vary more than 3/8 inch when tested with a 10-foot straightedge applied parallel with and at right angles to the pavement centerline. Any variations in excess of this tolerance shall be corrected by the Contractor, at his/her own expense, in a manner satisfactory to the Engineer. After the lime treated course has been finished as specified herein, the surface shall be cured by one of the

following methods for a period of not less than three days and maintained until placement of the subsequent course (base or pavement) or up to seven days, whichever occurs first:

a. Maintain in a thorough and continuously moist condition by sprinkling with water.
b. Apply an asphalt prime coat emulsion curing seal approved by the Engineer at a rate of 0.15 gallons per square yard.
c. Other options for a curing seal may be submitted in writing for approval by the Engineer.

Restrict all construction traffic (except watering equipment) from operating on the treated subgrade during the curing period. Restriction may be lifted after three days if treated subgrade has gained sufficient strength to withstand the loads without damage or deformation.

Protect the subgrade from freezing throughout the curing period.

I. Maintenance: The contractor shall maintain, at his/her own expense, the entire treated subgrade in good condition from the start of work until all the work has been completed, cured, and the pavement is placed.

2202.8 Method of Measurement

The amount of completed and accepted work will be measured or determined as follows:

A. Lime: Per ton or tenth part thereof for the specified depth.

1. For bag lime, use the net weight on the bag.

2. For certified truck or rail car quantity, use the net weight of lime.

3. For hydrated lime slaked at the jobsite, use the quantity calculated in Section 2202.4, correcting for purity and inert material.

B. Fly Ash: Per ton or tenth part thereof for the specified depth.

C. Manipulation (Lime Treated Subgrade or Fly Ash Treated Subgrade): Per square yard or tenth part thereof.

D. Water: Per M Gallon (1,000 Gallons) using calibrated tanks or water meters.

1. For lime treated subgrade, measure water used for mixing, moisture control and curing but do not measure water used for slaking the lime, dust control, or excess water used due to Contractor negligence.

2. For Fly Ash treated subgrade, measure water used for mixing, moisture control and protection but do not measure water used for dust control or excess water used due to Contractor negligence.

E. Alternate curing (lime) and protection (fly ash) of subgrade: No measurement will be made if the Contractor elects to use asphalt prime coat emulsion or other alternative method for curing or protection of subgrade. These are subsidiary to other Contract Documents.

2202.9 Basis of Payment

Payment for the completed and accepted work will be made as follows when included in the Contract Documents:

A. Lime will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

B. Fly Ash will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

C. Manipulation (Lime Treated Subgrade or Fly Ash Treated Subgrade) will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

D. Water will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

SECTION 2203 AGGREGATE BASE COURSE

2203.1 Scope

This section governs the furnishing of all labor, materials and equipment for the placement of aggregate base course and underdrains, including pipe, geotextiles and granular filter material as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2203.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM

C 31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
C 33	Standard Specification for Concrete Aggregates
C 39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C 88	Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C 117	Test Method for Materials Finer than 75 µm (No. 200) Sieve in Mineral Aggregates by Washing
C 131	Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C 136	Test Method for Sieve Analysis of Fine and Coarse Aggregates
C 142	Test Method for Clay Lumps and Friable Particles in Aggregates
C 150	Standard Specification for Portland Cement
D 75	Practice for Sampling Aggregates

D 695 Test Method for Compressive Properties of Rigid Plastics
D 1621 Test Method for Compressive Properties Of Rigid Cellular Plastics
D 2419 Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
D 3034 Specification for Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings
D 3666 Specification for Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials
D 4318 Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
D 4716 Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
D 4791 Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
D 5821 Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
F 758 Standard Specification for Smooth-Wall Polyvinyl Chloride (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage

AASHTO
M 252 Corrugated Polyethylene Drainage Tubing
T 99 The Moisture-Density Relations of Soils Using a 5.5-lb. (2.5 kg) Rammer and a 12-in. (305 mm) Drop

2203.3 Materials

A. Untreated Compacted Aggregate: This base course material shall consist of crushed stone aggregate with not more than 1.0% clay lumps and friable particles in accordance with ASTM C 142, and free from vegetable or other deleterious substances. The abrasion loss shall be no more than 35% when tested in accordance with ASTM C 131. That fraction passing the 1 inch sieve and retained on the No. 4 sieve shall have a loss not greater than 18% by weighted average for magnesium sulfate method (12% maximum loss if tested using sodium sulfate method) of ASTM C 88 Soundness Test at 5 cycles. That fraction of the material passing the 1-inch sieve and retained on the No. 4 sieve shall contain less than 20% by weight of flat and elongated particles when tested in accordance with ASTM D 4791 (flat being a ratio of 1 to 3 between thickness and least width and a ratio of 1 to 3 between the least width and length). The material shall consist of angular particles with no less than 90% of particle count having two or more fractured surfaces. The gradation in percentages by weight passing square mesh sieves shall be in accordance with ASTM C 136 and as follows:

Sieve Designation (Square Opening)	Percentage by Weight Passing Sieve
1-1/4 in (31.5 mm)	100
1 in (25.0 mm)	72 – 100
3/4 in (19.0 mm)	60 – 90
3/8 in (9.5 mm)	43 – 74
No. 4 (4.75 mm)	28 – 60
No. 10 (2.00 mm)	16 – 40
No. 40 (425 um)	3 – 22
No. 200 (75 um)	0 – 15

In addition to the above limits, the difference between the "Percent Passing Square Mesh Sieve" of successive sieve sizes shall not exceed 25 percent.

That fraction of the material passing the No. 40 sieve shall have a plasticity index not to exceed 8 when tested in accordance with ASTM D 4318.

B. Drainable Base: All drainable base materials shall have a minimum coefficient of permeability of 1000 ft/day as

determined by the test method described in 2203.4.E Permeability Test Procedure.

1. Portland Cement Concrete Drainable Base: This item shall consist of an open-graded drainable base composed of mineral aggregate, Portland cement and water mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and shall conform to the lines, grades, thicknesses and typical cross sections shown on the Plans.

    a. Coarse Aggregate
        i. General: Coarse aggregate shall be 3/4 inch maximum size consisting of crushed gravel or crushed stone and shall meet the requirements of ASTM C 33 and quality requirements of 2203.3.A.
        ii. Gradation shall be ASTM C 33, Size 67.
    b. Fine Aggregate: Fine aggregate shall consist of natural sand or manufactured sand meeting the requirements of ASTM C 33.
    c. Cement: Portland cement shall conform to the requirements of ASTM C 150, Type I or Type II. Substitution of fly ash or other pozzolan for Portland cement shall be in conformance with Section 2208.
    d. Water: Water used in mixing or curing shall be clean and free of oil, salt, acid, alkali, sugar, vegetable or other substances injurious to the finished product as possible. Water known to be of potable quality may be used without testing.
    e. Admixtures: The use of any material to be added to the mixture shall be approved by the Engineer.
    f. The Contractor shall furnish vendor's certified test reports for the materials used in the project. The report shall be delivered to the Engineer as part of the mix design before permission to use the materials is granted.
    g. Proportions: The Contractor shall submit a mix design containing the quantity of each material to the Engineer including certifications of materials used. The Contractor will be responsible for preparing the drainable base mix design at no cost to the Owner. The testing laboratory preparing the mix design shall comply with Section 2203.3.B.2.e. The mix design shall include the following:

        Cement Content
        Water-Cement Ratio - Approximately 0.36
        Coarse Aggregate
        Fine Aggregate
        All Admixtures
        Coefficient of Permeability - Tested per Section 2203.4.E

    h. Compressive Strength: Proportions will be such to produce a compressive strength of 800 psi in 28 days as determined by test cylinders made in accordance with ASTM C 31 and tested in accordance with ASTM C 39. A strength of 500 psi will be required prior to any traffic being allowed on the surface.

2. Plant Mix Bituminous Drainable Base: This item shall consist of an asphalt stabilized drainable base course composed of mineral aggregate and bituminous material mixed in a central mixing plant and placed on a prepared course in accordance with the specifications and shall conform to the lines, grades, thicknesses, and typical cross sections shown on the Plans. Each course shall be constructed to the depth, typical section, or elevation required by the Plans and shall be rolled, finished, and approved before the placement of the next course. A prime coat will be used on the subbase prior to placement of the first course, and no tack coat will be used between courses.

a. Aggregate: Aggregate shall consist of crushed stone or crushed gravel and be free of organic materials.
   i. Coarse Aggregate: Coarse aggregate shall comply with Section 2303.3.A except wear may not exceed 50 % in accordance with ASTM C 131.
   ii. Aggregate shall contain at least 70% by weight of individual pieces having two fractured faces and 85% by weight having at least one fractured face as determined by ASTM D 5821.
   iii. The aggregate shall not contain more than 8%, by weight, of flat and elongated pieces, when tested in accordance with ASTM D 4791 (ratio = 5:1).
   iv. Sampling: ASTM D 75 shall be used in sampling the coarse aggregate.

b. Bituminous Material: The asphalt cement shall be in conformance with Section 2205.3.A. The type and grade of asphalt used shall be specified in the mix design but shall not be lower than a PG 64-22.

c. Preliminary Material Acceptance: Prior to delivery of materials to the job site, the Contractor shall submit certified test reports to the Engineer for the following materials:

   Coarse Aggregate - Percent of wear, soundness.

   Bituminous Material - The certification(s) shall show the appropriate ASTM test(s) for each material, the test results, and a statement that the material meets the specification requirements.

d. Job Mix Formula. (JMF): No bituminous mixture for payment shall be produced until the Engineer has approved a JMF in writing. The method of determining the proper asphalt content is to store the mix trial batches in the laboratory overnight (15-18 hrs) at 140°F. The proper asphalt content will then be selected visually.

   The asphalt content mix is selected from the batch from which a small amount of asphalt drains to the bottom of the pan and the mix still appears glossy. A heat resistant, clear glass dish may be used for better visibility of the drained asphalt. The asphalt content may be varied as necessary during construction to meet this requirement.

   The aggregate shall be of such size that the percentage composition by weight will conform to the gradation of gradations specified in Table 2, when tested in accordance with ASTM C 117 and C 136. The gradation shall be on the coarse side of the Master Band.

TABLE 2. PLANT MIX BITUMINOUS DRAINABLE BASE
MASTER GRADATION

Sieve Designation (Square Opening)	Percent by Weight Passing Sieve
1-1/2 in (37.5 mm)	100
1 in (25.4 mm)	90 – 100
3/4 in (19.0 mm)	75 – 100
1/2 in (12.5 mm)	70 – 90
3/8 in (9.5 mm)	50 – 70
No. 4 (4.75 mm)	20 – 40
No. 8 (2.36 mm)	15 – 25
No. 30 (637 um)	5 – 15
No. 200 (75 um)	0 – 3

Recommended Asphalt Cement Content 2.0% – 3.5%

The gradations in Table 2 represent the limits that shall determine the suitability of aggregate for use from the supply source.

The job mix tolerance shown in Table 3 shall be applied to the JMF to establish a job control-grading band. The resulting job control grading band must comply with the Master Gradation criteria.

TABLE 3. JOB MIX FORMULA TOLERANCES (Based on Single Test)	
Material	Tolerance Plus or Minus
Aggregate passing No. 4 (4.75 mm) sieve or larger	5.00%
Bitumen*	0.40%
Temperature*	20 degrees F

*Unless otherwise approved by the Engineer.

The aggregate gradation may be adjusted within the limits of Table 2 as directed, without adjustments in the Contract unit prices.

Should a change in sources of materials be made, a new JMF shall be established before the new material is used.

Dry aggregate gradations will be made at least twice daily. The aggregate gradation shall be tested by the Contractor in accordance with ASTM C 117 and C 136 and the results submitted to the Engineer within 24 hours.

The JMF shall be submitted in writing by the Contractor and approved by the Engineer prior to the start of paving operations. The job mix shall have been prepared no more than 12 months prior to submittal and shall include as a minimum:

Percent passing each sieve
Percent of asphalt cement
Asphalt designation and certifications
Mixing temperature
Compaction temperature
Temperature of mix when discharged from the mixer
Percent fractured faces
Percent elongated particles

The Contractor shall submit samples to the Engineer, upon request, for job mix formula verification testing.

e. Testing Laboratory: The laboratory used to develop the JMF formula shall meet the requirements of ASTM D 3666.

C. Underdrains: Underdrains shall consist of the following materials unless otherwise specified in the Plans, Standard Drawings, or Contract Documents.

1. Aggregate: Blanket underdrain aggregate and pipe underdrain aggregate shall be clean or washed

aggregate and conform to requirements of Section 2203.3.A with the following gradations:

TABLE 4. BLANKET UNDERDRAIN AGGREGATE	
Sieve Designation (Square Opening)	Percent by Weight Passing Sieve
1-1/2 in (37.5 mm)	100
1 in (25.4 mm)	90 – 100
3/4 in (19.0 mm)	60 – 90
3/8 in (9.5 mm)	-----
No. 4 (4.75 mm)	20 – 40
No. 8 (2.36 mm)	-----
No. 16 (1.2 mm)	0 – 10
No. 30 (0.6 mm)	-----
No. 50 (0.3 mm)	0 – 7
No. 100 (150 um)	0 – 2

TABLE 5. PIPE UNDERDRAIN AGGREGATE	
Sieve Designation (Square Opening)	Percent by Weight Passing Sieve
1-1/2 in (37.5 mm)	-----
1 in (25.4 mm)	-----
3/4 in (19.0 mm)	100
3/8 in (9.5 mm)	85 – 100
No. 4 (4.75 mm)	-----
No. 8 (2.36 mm)	40 – 60
No. 16 (1.2 mm)	-----
No. 30 (0.6 mm)	5 – 30
No. 50 (0.3 mm)	-----
No. 100 (150 um)	1 – 2

2. Underdrain Pipe

   a. Polyvinyl chloride pipe shall meet the requirements of ASTM F 758/D 3034.
   b. Corrugated Polyethylene Tubing may be used only outside of traffic areas and driving surfaces. The tubing shall be the heavy duty type and shall meet the requirements of AASHTO M 252. In addition, the tubing shall have a minimum pipe stiffness of 30 psi at 10% deflection.
   c. All underdrain pipes shall have a nominal minimum inside diameter of six inches unless shown otherwise on the Plans.
   d. Perforations shall be approximately circular and cleanly cut; shall have nominal diameters not less than 3/16-inch nor more than 3/8-inch; and shall be arranged in at least two rows parallel to the axis of the pipe.
   e. Fittings shall be of the same composition and have the same physical properties as the pipe and shall not restrict flow.

3. Geocomposite Edge Drain

   a. Edge drain shall consist of a plastic core completely surrounded by geotextile. The core shall provide a minimum of 10 percent open area to facilitate water entry or cross flow and shall be composed of plastic which is physically and chemically stable under a normal range of

conditions.

b. The edge drain shall have nominal dimensions of 1 to 1-1/2 inches in thickness and 12 inches in height.

c. The edge drain shall have a minimum flow capacity of 15 gallons per minute per foot of width as determined by ASTM D 4716 when tested under a confining stress of 10 psi or more at a gradient of 0.1 or less.

d. The edge drain shall have a minimum compressive strength of either 7,000 psf at a maximum deformation of 10 percent of the original thickness when tested in accordance with ASTM D 1621, or 8,000 psf at a maximum deformation of 20 percent when tested in accordance with ASTM D 695.

e. Geotextile shall have an apparent opening size (AOS) corresponding to a U.S. sieve number greater than 50 but not exceeding 100.

4. Geotextile: Geotextile for use with pipe and edge underdrains shall be a nonwoven geotextile and shall meet the requirements of Section 2605.2.C.

2203.4 Construction

A. Untreated Compacted Aggregate

1. Subgrade: Prior to placement of base course material the previously prepared subgrade surface shall be cleared of all foreign substances and restored in shape, tolerance and density as specified in Section 2201 entitled "Subgrade Preparation".

2. Material Placement: The material shall be uniformly spread in successive layers to such depth that when compacted, the base will meet the minimum thickness specified. The Contractor may construct the base in any number of layers that he chooses except that in no case shall any individual layer have a compacted thickness of more than 6 inches. Each layer shall be compacted as hereinafter specified before any succeeding layer is placed.

3. After spreading a layer of material, water in an amount sufficient to insure the desired compaction shall be added and uniformly mixed with the aggregate in a manner to prevent segregation. Excess moisture resulting in runoff shall be avoided. If for any reason, the material and subgrade become too wet to permit satisfactory work, they shall be allowed to dry to a moisture content that will permit satisfactory work.

4. The material shall meet the required specifications immediately before compaction operations are commenced. If, for any reason, segregation occurs in excess of 10% variation from the gradation required by this specification or the materials become contaminated, such segregated or contaminated materials shall be removed and replaced with suitable materials at the expense of the Contractor. The limited segregation of 10% variation will be ascertained by a sieve analysis of a minimum 100 pound sample taken from the in-place base course.

5. However, for untreated compacted aggregate base, segregated surface areas may be corrected by adding limestone screenings of such gradation and quantity as required to fill the surface voids and firmly bind the loose material in place. Screenings so used in correcting segregated surface areas will be subsidiary.

6. Shaping and compacting shall be carried on continuously until a true, even and uniform surface of proper grade and cross-section is obtained, and until the density of the complete base is at least 95%

of maximum density as determined by AASHTO T 99. The proper moisture content shall be maintained by wetting the surface as required during shaping and compacting operations. Final rolling shall be accomplished by use of a self-propelled smooth-wheeled roller.

B. Portland Cement Concrete Drainable Base

1. Spreading: The base material shall be spread to the lines and grades shown on the Plans. Any material which becomes mixed with soil or other contaminants shall be removed and replaced with fresh mixture.

2. Compaction: After spreading and/or trimming, the base material shall be uniformly compacted by making a minimum of 2 coverages with a steel wheeled roller meeting the requirements of Section 2205.8.B. The compaction process may be adjusted on the project by the Contractor with approval of the Engineer to assure uniform compaction of the drainable base material. In areas not accessible by the roller, the base material shall be compacted by mechanical hand methods. Compaction must be completed within 2 hours of the time water is introduced to the mixture.

3. If after spreading and compacting the base is not to the required lines and grade, the Contractor shall trim the base by means of an electronically controlled machine utilizing string line controls for grade. The Engineer reserves the right to direct the Contractor to suspend all operations if the Contractor produces excessive fines in the trimming process which are viewed by the Engineer to be detrimental to the permeability of the base. Appropriate corrections to the trimming process shall be made by the Contractor prior to beginning again.

4. After compaction of the drainable base, the Contractor shall protect the surface from damage and/or contamination. If the integrity of the drainable base is disturbed at any time prior to placement of the succeeding pavement course the area shall be removed and replaced with new material and compacted to conform to the original lines and grades at the Contractor's expense. Any removed material shall not be reincorporated into the drainable base or other drainage features.

5. Curing Of The Drainable Base Material: The Contractor will be required to provide a curing plan to the Engineer.

6. Temperature Limitations: The air temperature must be between 50°F and 90°F for drainable base construction. The Engineer may order operations to cease in hot windy conditions if it appears the mixture is drying out prior to achieving initial set.

7. Construction Joints: The formation of all joints shall be made in such a manner as to ensure a continuous bond between old and new sections of the course. All joints shall present the same texture and smoothness as other sections of the course.

8. All contact surfaces of previously constructed courses shall be cleaned of all dirt or other objectionable materials, and thoroughly moistened with water prior to placing the new material.

9. Thickness: The thickness of the base course may be measured by cores taken at intervals determined by the Engineer.

C. Plant Mix Bituminous Drainable Base

1. Test Section: Prior to full production, the Contractor shall prepare and place a section of drainable base according to the JMF. The amount of mixture should be 80 tons and may be placed as part of the

project. The underlying grade or pavement structure upon which the test section is to be constructed shall be the same as the remainder of the course represented by the test section. The equipment used in construction of the test section shall be the same type and weight to be used on the remainder of the course represented by the test section.

2. Two random samples of mixture may be taken at the plant and tested for aggregate gradation and asphalt content. The test section shall be considered acceptable if the gradation and asphalt content are within the limits specified in Tables 2 and 3.

3. If the initial test section should prove to be unsatisfactory to the Engineer, the necessary adjustments to the JMF, plant operation, placing procedures, and/or rolling procedures shall be made. A second test section shall then be placed. If the second test section also does not meet specification requirements, both sections shall be removed at the Contractor's expense. Additional test sections, as required, shall be constructed and evaluated for conformance to the specifications. Any additional sections that do not conform to specification requirements shall be removed at the Contractor's expense. Full production shall not begin until a satisfactory section has been constructed and accepted by the Engineer. The test sections that meet the specification requirements shall be paid for in accordance with project quantities.

4. The Contractor shall perform job mix control testing at the start of plant production and in conjunction with the calibration of the plant for the JMF. It should be recognized that the aggregates produced by the plant may not satisfy the gradation requirements or produce a mix that exactly meets the JMF. In those instances, it will be necessary to reevaluate and redesign the mix using plant-produced aggregates. Specimens should be prepared and the optimum bitumen content determined in the same manner as for the original design tests.

5. Weather Limitations: The bituminous mixture shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than 40 degrees F or the wind chill factor is less than 35 degrees F. The temperature requirements may be waived by the Engineer; however, all other requirements including compaction shall be met.

6. These materials will be placed, handled, hauled and accepted based on requirements of Section 2205.

D. Underdrains

1. General: Underdrains shall be constructed as shown on the Plans or Standard Drawings. The exact location and layout of underdrains and/or edge drains as shown on the Plans shall be subject to revision by the Engineer during construction.

2. Excavation

   a. Trenches for all lateral and longitudinal underdrains shall be excavated to the dimensions, depths and elevations shown on the Plans or Standard Drawings or as ordered by the Engineer. In case of a conflict, where the actual elevation of the strata or stratum to be intercepted is found to vary from Plan elevation, the stratigraphy shall govern in the installation of underdrains.
   b. Trench bottoms for perforated pipe underdrain and edge drain shall be in firm material (no mucky or soupy condition existing) and constructed to permit the placing of three inches (3") of aggregate underneath the pipe. If unstable material is encountered in the bottom of the trench, the trench shall be over excavated to firm material.
   c. Minimum width of trench shall be as shown in the Plans or in the specifications or the

Standard Drawings.

3. Laying Pipe

   a. All underdrain pipe shall be laid carefully to Plan line and grade.
   b. All pipe shall be laid on a minimum grade of one percent unless otherwise shown on the Plans.
   c. All dead ends of pipe underdrains shall be completely closed with a cap of the same material as the pipe.
   d. All junctions and turns shall be made with wyes, tees, and bends as supplied by the manufacturer of the pipe.
   e. Perforations shall be laid down unless otherwise indicated on the Plans.

4. Installing Edge Drain

   a. Installation shall be in accordance with manufacturer's instructions.
   b. Each length of drain shall be joined to the adjacent length prior to installation. Splices shall keep adjoining lengths in proper alignment, shall not separate during installation, shall have the same or greater compressive strength than the geocomposite drain, and shall be sealed against infiltration of backfill material.
   c. Drain shall be placed in the center of the trench and held in place with a temporary support while blanket underdrain aggregate backfill is placed.
   d. The placement of the edge drain and the first lift of backfill shall be accomplished in a single continuous operation.

5. Backfilling

   a. Backfilling the trenches of lateral and longitudinal underdrains shall not be started until approved by the Engineer.
   b. The trenches shall be backfilled to the specified elevations and in accordance with the Plans, specifications or Standard Drawings.
   c. The backfill material shall be placed in such a manner as to prevent formation of large cavities in the backfill and walls of the trench.
   d. Overbreakage due to blasting of rock in trench excavation and widening due to caving of trench walls or overbreakage at construction outcrops shall be backfilled with aggregate approved by the Engineer.

E. Permeability Test Procedure for Drainable Base

This test method is used to determine the permeability of unbound and bound aggregate base material. Bound base material will use Portland cement or asphaltic cement as a cementing agent.

1. Unbound Base and Base Bound with Portland Cement

   a. Apparatus
      i. Mold: A cylindrical metal mold with an approximate inside diameter of 6" and a minimum height of 6". The mold shall be equipped with a removable collar at least 2" in height and a removable base plate. The base plate may be used as part of the permeability test equipment. If so, the base plate must exceed the permeability of the material being tested. A #40 screen shall be placed on top of the base plate to prevent test material from being lost through the base plate during compaction and

permeability testing.

ii. Standpipe: A standpipe with the same diameter as the removable collar for the mold with a minimum height of 8.5". The standpipe shall be equipped with an overflow outlet.

iii. Rammer: A mechanically operated metal rammer equipped to control the height of drop to 12" plus or minus 1/16" above the elevation of the sample. The rammer shall be equipped to distribute the blow uniformly over the sample surface. The rammer shall have a rigid flat faced "pie shaped" foot and a nominal weight of 5.50 lbs. The "pie shaped" foot shall be a sector of 6" diameter circle and shall have an area equal to that of a 2" circular foot.

iv. Straight edge: A rigid steel straight edge with one edge beveled, at least 8" in length.

b. Sample preparation

i. Obtain a 50 lb. to 60 lb. sample, dry if necessary.

ii. Mix a sufficient amount of aggregate and cementing agent, if required, to fill the mold 1 and 1/2 times.

iii. Add the appropriate amount of water and thoroughly mix.

iv. Place the assembled mold on the rigid base and fill approximately 1/2 full of the loose moist material. Compact the layer with 25 blows of the rammer with the blows being distributed uniformly over the surface of the layer. Place three additional approximately equal layers of material in the mold and compact each layer in a similar manner (four layers total).

v. After the fourth layer has been compacted, remove the collar and trim excess material level with top of the mold.

vi. Cure Portland cement treated specimens by covering with plastic, to prevent drying for 3 days at room temperature.

vii. Unbound specimens do not need to be cured before testing.

2. Asphalt Bound Aggregates

a. Apparatus

i. Mold: A cylindrical mold with an inside diameter of approximately 6" and a minimum length of 4.5". The mold is open at each end and is equipped with a removable collar and a base plate about 0.5" thick.

ii. Specimen Mold Holder: The specimen mold holder has a semi-circular base and a flanged top to hold the specimen mold in place during the compaction process. Any equivalent hold down device that performs the same function is satisfactory.

iii. Compaction Hammer: The compaction hammer consists of a hammer having a flat circular tamping face 5.88" in diameter and appropriate extension rod with handle which acts as guide for a free falling weight. The weight shall weigh 22.5 lbs. and have a free fall of 18" plus or minus 0.1". The hammer may be operated manually or be driven with a motor.

iv. Compaction Pedestal: The compaction pedestal is a wood block approximately 12" x 12" x 18". A 12" x 12" x 1" steel plate is securely fastened to the top of the block. The pedestal is set on and securely fastened to a solid concrete slab with the vertical axis plumb and the top level.

v. Heating Equipment: Ovens or hot plates for heating aggregates, bituminous material, specimen molds, compaction hammers and other associated items required for mixing and molding. It is recommended that, when possible all heating units be thermostatically controlled to maintain the required temperature within ±5°F. Suitable shields, thick steel plates or pans of sand shall be used on the surfaces of hot plates to minimize locally overheating.

vi. Mixing Apparatus: Mechanical mixing is recommended. Any type of mechanical mixer may be used provided it will produce a well coated, homogeneous mixture of the required amount in the allowable time and further that the mixing paddle or whip does not fracture or pulverize aggregate fractions during the mixing process. The bowl employed with the mixer shall be such a nature that essentially all of the batch can be removed. More than one mixing bowl is recommended unless the mixer is equipped with a heating jacket to keep the bowl heated during the mixing process.

b. Determination of Mixing and Compacting Temperature
   i. The temperature to which the asphalt cement must be heated to produce a viscosity of 85 ± 10 SFS shall be the mixing temperature.
   ii. The temperature to which the asphalt cement must be heated to produce a viscosity of 130 ± 15 SFS shall be the compacting temperature.

c. Sample Preparation for Laboratory Prepared Mix
   i. Combine the dry individual aggregates to produce desired combined aggregate with a batch weight of approximately 8.9 lbs. This should be sufficient to produce a compacted specimen 3.75 ± 0.125 inches thick. Adjust the weight of the batch as needed to produce a compacted specimen of 3.75 ± 0.125 inches thick.
   ii. Prepare a minimum of two aggregate and asphalt specimens. The first specimen shall be mixed and thrown away. This sample is to "butter" the mixing bowl and paddle and thus reduce material loss when mixing the test specimen.
   iii. Heat the aggregate and asphalt within the limits of mixing temperature determined in Section 2203.4.E.2.b. Charge the mixing bowl with the heated aggregate and form a crater in the top. Add the required amount asphalt and mix the aggregate and asphalt until coated at least 2 minutes. Care should be taken to keep all of the sample in the mixing bowl during this process.

d. Compaction of Specimen
   i. Prior to the addition of the asphalt to the batches, thoroughly clean the specimen mold assembly and the face of the compaction hammer and heat the mold assembly and hammer to a temperature between 200°F and 350°F. Assemble the mold, base plate and collar and place a paper disc cut to size in the bottom of the mold.
   ii. Place the hot batch of aggregate-asphalt mixture in the mold, spade vigorously with a heated spatula or trowel 15 times around the perimeter and 10 times over the interior of the mold. Smooth the surface of the mix to a slightly rounded shape. The temperature of the mix prior to compaction shall be within the limits in Section 2203.4.E.2.b. Place a paper disc on top of the mix.
   iii. Place the mold assembly, including the collar, on the pedestal, fasten securely with the mold holder and apply 20 blows with the compaction hammer. Each blow must have the prescribed free fall of 18" with the axis of the compaction hammer held perpendicular to the base of the mold assembly during the compaction process. Remove the base plate and collar, and reverse and reassemble the mold. Apply the specified number of blows to the reversed specimen. After compaction remove the mold assembly from the pedestal, remove the collar and base plate and cool the specimen in the mold until the mold can be handled comfortably with bare hands. Asphalt treated samples do not need to be cured before testing, only cool to the touch.

3. Test Procedure

   a. Assemble test equipment, base plate, mold with specimen, and standpipe.
   b. Prior to conducting the test, allow a sufficient amount of water to pass through the specimen to cause all air to be expelled from the specimen. (Establish reservoir around the base with

water open to atmospheric pressure.)

c. Conduct Constant-Head Permeability test and report coefficient of permeability "k". Repeat a minimum of two additional times until two runs agree reasonably well.

d. Constant-Head Permeability:

$$k = \frac{QL}{Aht}$$

Q = quantity of water discharged (volume)
L = length of specimen
A = cross-sectional area of specimen
h = hydraulic head (height column of water above discharge)
t = elapsed time of test
k = coefficient of permeability (length/time)

Note: For very permeable material, maintain elevation of water above the sample for 3 minutes then measure Q (flow).

2203.5 Method of Measurement

A. Untreated Compacted Aggregate Base will be measured by one of the following:

1. Per square yard or tenth part thereof for the specified depth.

2. Per ton or tenth part thereof.

B. Portland Cement Concrete Drainable Base may be included in the Contract Documents as a single item or as separate items (Portland Cement and Base Aggregate) and measured by one of the following:

1. Per square yard or tenth part thereof for the specified depth.

2. Per ton or tenth part thereof.

C. Plant Mix Bituminous Drainable Base may be included in the Contract Documents as a single item or as separate items (Asphaltic Cement and Base Aggregate) and measured by one of the following:

1. Per square yard or tenth part thereof for the specified depth.

2. Per ton or tenth part thereof.

D. Pipe and Edge Underdrains will be measured per lineal foot or tenth part thereof. Pipe Underdrain and Edge Underdrain aggregate shall be subsidiary.

E. Blanket Underdrains will be measured by the actual quantities used as follows:

1. Per square yard or tenth part thereof for the specified depth.

2. Per ton or tenth part thereof.

2203.6 Basis of Payment

A. Untreated Compacted Aggregate Base will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

B. Portland Cement Concrete Drainable Base will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

C. Plant Mix Bituminous Drainable Base will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

D. Pipe and Edge Underdrains will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

E. Blanket Underdrains will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

SECTION 2204 PRIME AND TACK COAT

2204.1 Scope

This section governs the furnishing of all labor, materials and equipment for the application of liquid asphalt to a prepared pavement (concrete, asphaltic concrete), or granular base as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2204.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM
D 140 Practice for Sampling Bituminous Materials

2204.3 Materials

A. The type and grade of asphalt material to be used as prime or tack coat shall be designated by the Engineer in the Plans or in the Special Provisions. If not specified in the Plans or Special Provisions, the Contractor shall

submit proposed type and grade of asphalt material to the Engineer for approval. The liquid asphalt material to be used for surface preparation shall be as listed in the following table:

Material to be Treated	Application Usage	Type of Emulsion of Grade of Cutback	Application Rate (Gal/SY) (L/SM)	Application Temperature ^{0}F (^{0}C)	Cure Time at 70^{0}F (21^{0}C)
Existing Asphalt or Concrete Surface	Tack	RC-70	0.05-0.10 Gal/SY (0.23-0.46 L/SM)	150 – 225 (65 – 107)	1 – 6 hrs
	Tack	SS-1 SS-1h CSS-1 CSS-1h	0.05-0.15 Gal/SY (0.23-0.69 L/SM)	70 – 160 (22.5 – 42)	1 – 3 hrs
Treated Base (lime, flyash, cement)	Prime	MC-30 MC-70	0.1-0.3 Gal/SY (0.46-1.38 L/SM)	85 – 120 (29 – 49)	12 – 24 hrs
	Prime	SS-1 SS-1h CSS-1 CSS-1h	0.1-0.3 Gal/SY/in (0.46-1.38 L/SM/mm)	70 – 160 (20 – 70)	24 – 48 hrs
Untreated Aggregate Base w/ Fines	Prime	MC-30 MC-70	0.1-0.3 Gal/SY (0.46-1.38 L/SM)	85 – 120 (29 – 49)	12 – 24 hrs
Untreated Aggregate Base w/o Fines	Prime	MC-250	0.2-0.5 Gal/SY (0.92-2.30 L/SM)	85 – 120 (29 – 49)	12 – 24 hrs
Untreated Aggregate Base	Prime	SS-1 SS-1h CSS-1 CSS-1h	0.1-0.3 Gal/SY/in (0.46-1.38 L/SM/mm)	70 – 160 (20 – 70)	24 – 48 hrs
	Prime	EAP PAE, or PEP	0.1-0.3 Gal/SY (0.46-1.38 L/SM)	70 – 160 (20 – 70)	12 – 24 hrs

The asphalt material shall conform to the latest ASTM specifications for "Asphalt Cements and Liquid Asphalts." Sampling shall be in accordance with ASTM D 140.

B. Sand Cover, if used, shall be any clean granular mineral meeting the following grading requirements. When tested with laboratory sieves 100% shall pass the No. 4 (4.75 mm) sieve and not more than 2% shall pass the No. 200 (75 um) sieve. The moisture content of the sand shall not exceed 3% by weight.

C. Asphalt materials shall be approved by the Engineer prior to use in the work. The Engineer may accept a certified analysis by the material supplier laboratory when a copy of the certified analysis accompanies each shipment of asphalt to the project. The Engineer reserves the right to perform tests of the asphalt received on the job.

2204.4 Construction

A. Pressure Distributor: The distributor shall be so designed, equipped, maintained and operated that liquid

asphalt at even heat may be applied uniformly on variable widths of surface up to 15 feet at readily determined and controlled rates from 0.02 to 1.00 gallon per square yard, with uniform pressure, and with an allowable variation from any specified rate not to exceed 0.02 gallons per square yard. Distributor equipment shall include a tachometer, pressure gauges, a calibrated tank and a thermometer for measuring temperatures of tank contents. Distributors shall be equipped with a power unit for the pump, and full circulation spray bars adjustable laterally and vertically. The calibration of all distributors must be approved by the engineer, and the contractor shall furnish all equipment, material and assistance necessary if calibration is required.

B. Preparation of Existing Surface

1. For tack coats: The existing surface shall be free of dust, loose material, grease or other foreign material at the time the tack is applied. Preparation of the surface is to be performed by the contractor before the tack is applied and is subsidiary to other items in the Contract.

2. For prime coats: the surface to be primed shall be shaped to the required grade and cross section, shall be free from ruts, corrugations, segregated material or other irregularities, and shall be uniformly compacted by rolling. The surface shall be firm and slightly damp when primer is applied. Delays in priming may necessitate reprocessing or reshaping to provide a smooth compacted surface.

C. Application of Asphalt Material

1. For Tack Coats: Asphalt emulsion shall be applied uniformly with a pressure distributor at the rate specified in the Contract, or as revised by the Engineer to be within a minimum of 0.05 and a maximum of 0.15 gallons per square yard. Water may be added to the asphalt emulsion and mixed therewith in such proportion that the resulting mixture will contain no more than 50% of added water, the quantity of added water to be approved by the Engineer. The application of the resulting mixture shall be such that the original emulsion will be spread at the specified rate. The asphalt emulsion shall be heated at the time of application to a temperature in accordance with the limits provided in Sec 2204.3, or as specified in the Contract Documents. The tack shall be properly cured and the tacked surface shall be cleaned of dirt and other foreign material before the next course is placed.

   The tack coat shall be applied in such manner as to cause the least inconvenience to traffic and to permit one-way traffic without pickup or tracking of the asphalt emulsion.

2. For Prime Coats: Bituminous material shall be applied to the width of the section to be primed by means of a pressure distributor in a uniform, continuous spread. The subgrade shall be moistened before the prime is applied. The application rate shall be as specified in the Contract Documents or as approved by the Engineer between 0.1 and 0.5 gallons per square yard. The primer shall be heated at the time of application to a temperature in accordance with the limits provided in Sec 2204.3, or as specified in the Contract Documents.

   Care shall be taken that the application of bituminous material at overlap locations is not in excess of the specified quantity, per square yard. Building paper shall be placed over the end of the previous applications and the joining application shall start on the building paper. Building paper used shall be removed and satisfactorily disposed of. Pools of primer material remaining on the surface after the application shall be removed.

   When traffic is maintained, not more than one half of the width of the section shall be treated in one application and one-way traffic will be permitted on the untreated portion of the roadbed. As soon as the bituminous material has been absorbed by the surface and will not pick up, traffic shall be routed to the treated portion and the remaining width of the section will be primed.

The primer shall be properly cured, and the primed surface shall be cleaned of dirt and surplus sand before the next course is placed.

D. Application of Sand Cover: If the asphalt material is not completely cured within the maximum specified curing time, sufficient sand shall be spread over the surface with a mechanical spreader to blot up the excess asphalt. The rate of application shall be specified or approved by the Engineer. Prior to placing an asphalt paving course, all loose sand shall be swept from the primed surface.

2204.5 Method of Measurement

Asphalt Prime and Tack Coat will be measured per gallon.

2204.6 Basis of Payment

Asphalt Prime and Tack Coat will be paid for at the Contract unit bid price.

SECTION 2205 ASPHALTIC CONCRETE SURFACE AND BASE

2205.1 Scope

This section governs the furnishing of all labor, materials and equipment for the construction of asphalt concrete base and/or asphalt concrete surface as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2205.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM

C 88 Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C 117 Test Method for Materials Finer than 75- um (No. 200) Sieve in Mineral Aggregates by Washing
C 127 Test Method for Specific Gravity and Absorption of Coarse Aggregate
C 128 Test Method for Specific Gravity and Absorption of Fine Aggregate
C 131 Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C 136 Test Method for Sieve Analysis of Fine and Coarse Aggregates
C 142 Test Method for Clay Lumps and Friable Particles in Aggregates
D 75 Practice for Sampling Aggregates
D 140 Practice for Sampling Bituminous Materials
D 979 Practice for Sampling Bituminous Paving Mixtures
D 1188 Test Method for Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using Paraffin-Coated Specimens
D 2041 Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures (comparable to AASHTO T209)
D 2172 Test Methods for Quantitative Extraction of Bitumen From Bituminous Paving Mixtures
D 2726 Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous Mixtures
D 2950 Test Method for Density of Bituminous Concrete in Place by Nuclear Methods

D 3666 Specification for Minimum Requirements for Agencies Testing and Inspecting Bituminous Paving Materials
D 4552 Practice for Classifying Hot-Mix Recycling Agents
D 4791 Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
D 5444 Test Method for Mechanical Size Analysis of Extracted Aggregate
D 6307 Test Method for Asphalt Content of Hot-Mix Asphalt by Ignition Method
D 6373 Specification for Performance Graded Asphalt Binder

AASHTO
T 166 Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Using Saturated Surface-Dry Specimens
T 245 Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus
T 269 Standard Method of Test for Percent Air Voids in Compacted Dense and Open Asphalt Mixtures (ASTM Designation: D 3203/D 3203M-11)
T 283 Resistance of Compacted Bituminous Mixture to Moisture Induced Damage
T 312 Standard Method of Test for Preparing and Determining the Density of Asphalt Mixture Specimens by Means of the Superpave Gyratory Compactor

Asphalt Institute
"Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types", MS-2, latest edition

Kansas Department of Transportation
Standard Specifications for State Road and Bridge Construction, 2015 Edition

Missouri Highways and Transportation Commission
Missouri Standard Specifications for Highway Construction, 2011 Edition

National Institute of Standards and Technology
Handbook #44, "Specifications, Tolerance and other Technical Requirements for Commercial Weighing and Measuring Devices"

2205.3 Materials

No material shall be used until it has been approved by the Engineer. All costs associated with material testing, certification and the preparation of trial mixes to determine the job mix formula shall be the responsibility of the Contractor. Representative samples of all materials proposed for use under these specifications shall be submitted by the Contractor to a properly certified testing laboratory approved by the Owner, at the Contractor's expense, for testing and the preparation of trial mixes to determine the job-mix formula. Tests required by this specification for field verification of the mix shall be the responsibility of the Contractor at the Contractor's expense, unless specified otherwise. The Engineer reserves the right to perform additional testing to verify conformance with the requirements specified herein. These tests will be performed under the supervision of the Engineer without cost to the Contractor, unless specified otherwise in the Contract Documents.

A. Asphalt: Asphalt cement used in the manufacture of asphalt paving mixtures shall conform to the Performance Graded system. The PG graded material used shall conform to the provincial grade used by the local DOT or as designated by the Engineer. In the Kansas City Metropolitan area, the provincial grade is a PG64-28 but PG 64-22 is commonly used so either is deemed acceptable.

B. These general usage guidelines may not address all project conditions. APWA strongly recommends that the Engineer apply sound pavement design principles when designating mix type and selecting asphalt cement

grade based upon individual project conditions. The Federal Highway Administration makes available LTPPBIND software that will assist with asphalt grade selection for specific projects.

The asphalt cement shall conform to ASTM D 6373. Sampling shall be in accordance with ASTM D 140.

The Contractor or asphalt supplier shall submit a temperature-viscosity chart showing the recommended mix and compaction temperatures for non-modified asphalts, and shall provide the specific gravity of the asphalt.

C. Aggregate: The quality of aggregates used in Asphaltic Concrete shall conform to the following:

Coarse Aggregate (Retained on the No. 4 Sieve)
LA Abrasion (ASTM C 131) ..... 40% loss (maximum)
Soundness using Mag. Sulfate (ASTM C 88, 5 cycles) ..... 18% loss (maximum)
Soundness using Sodium Sulfate (ASTM C 88, 5 cycles)…… ..... 12% loss (maximum)
Total shale, clay, coal and lignite content (ASTM C 142) ..... 1.0% by weight (max)

Fine Aggregate (Passing the No. 4 Sieve)
Organic content ..... 1% maximum
The parent material of manufactured sand must also meet the requirements for coarse aggregate shown above.

Sampling shall be in accordance with ASTM D 75. Gradation analysis shall be in accordance with Standard Method of Test for Material Finer than No. 200 (75 um) Sieve in Mineral Aggregates by Washing, ASTM C 117 and Standard Method Test for Sieve Analysis of Fine and Coarse Aggregate, ASTM C 136. All aggregate quality tests must have been run within 12 months of the submission date of a mix design.

D. Commercial Mix: Providing a commercial mix will only be permitted when specified in the Contract Documents or approved in writing by the Engineer. Contractor shall adhere to the most current State Department of Transportation standard specifications governing commercial mix asphalt for the state the work is being performed in. Example: for Kansas, Standard Specifications for State Road and Bridge Construction, 2015 Edition, Section 611, or for Missouri, Missouri Standard Specifications For Highway Construction, 2011 Edition, Division 400.

2205.4 Mixing and Proportioning

A. Composition of the Mix: Asphaltic concrete mixtures shall consist of Mineral Aggregates and Asphalt Cement within the following limits for the type specified.

	ASPHALTIC CONCRETE-TYPE					
	1-01	2-01	3-01	4-01	5-01	6-01
Percent by Weight of Total Mixture						
Asphalt Cement	4-6	4-7	4-7	5-7.5		
Aggregate - U.S. Standard						
Square Sieve Size Total Percent Passing by Weight						
1 ½" (37.5 mm)	100	--	--	--	--	--
1" (25.0 mm)	75-100	100	--	--	100	--
¾" (19.0 mm)	60-85	80-100	100	--	95-100	100
½" (12.5 mm)	--	--	85-100	100	--	86-100
3/8" (9.0 mm)	40-65	60-80	70-90	85-100	--	75-100
No. 4 (4.75 mm)	30-50	48-65	50-70	55-75	--	--
No. 8 (2.4 mm)	19-36	35-47	37-47	39-50	28 min	28 min
No. 16 (1.2 mm)	13-26	25-36	26-36	27-38	--	--
No. 30 (0.6 mm)	--	18-30	18-30	19-30	--	--
No. 50 (0.3 mm)	--	12-22	12-22	11-23	--	--
No. 100 (150 µm	4-12	6-14	6-15	6-16	--	--
No. 200 (75 µm)	2-10	3-10	4-10	4-10	2-6	2-6

In addition to the above limits, the difference between the "Percent Passing Square Mesh Sieve" of successive sieve sizes shall not exceed 25 for types 1-01, 2-01, 3-01, and 4-01.

That fraction of material retained on the No. 4 (4.75-mm) Sieve-shall be composed of particles with not less than 75% having two or more fractured faces for asphalt types 1-01, 2-01, 3-01, and 4-01, and not more than 20% by weight of that fraction shall be composed of flat or elongated particles based on a ratio of 5:1 when tested in accordance with ASTM D 4791. For Asphalt Types 5-01 and 6-01 only, the total aggregate (coarse aggregate, fine aggregate, and the material passing the No. 200 sieve (75um) shall contain not less than 85% crushed material for intermediate course and surface course.

It shall be noted that when the gradation varies appreciably from the single point gradation used in the mix design, the test properties of the mix will be out of specification. This condition can occur even though the gradation meets the tolerances below.

The job-mix formula shall be within the limits specified above. The maximum permissible variation from the job-mix formula, within the specification limits, shall be as follows:

Permissible Gradation Variation from Mix Design Percent by Wt. of Total Mix:

U.S. Standard Sieve Size	Type 1-01, 5-01, 6-01	Type 2-01, 3-01, 4-01
No. 4 and larger	5.0	4.0
No. 8, 16, 30, 50	4.0	3.0
No. 200	2.0	1.0

Permissible Oil Content Variation from Mix Design:

Type 1-01, 5-01, 6-01 – 0.5%
Type 2-01, 3-01, 4-01 – 0.3%

B. Asphalt Mix General Usage:

	Surface	Base
Arterial	5-01, 6-01	5-01
Collector	5-01, 6-01	5-01
Local/Access	5-01	5-01
Paved Trail	2-01, 3-01, 4-01, 5-01	1-01.2-01.5-01
Recreational Surface	4-01	1-01, 2-01, 5-01
Parking Lot	2-01, 3-01, 5-01	1-01, 2-01, 5-01

Generally, mix types 1-01, 2-01, 3-01 and 4-01 are composed of local materials and are appropriate for general use other than roadways. Unless specified otherwise in the Contract, Plans or Special Provisions, only mixes 5-01 and 6-01 should be used for roadways. The Contractor may submit a written request to use mix 1-01 for pavement base or mix 3-01 for pavement surface.

Mix type 2-01 is acceptable for surfacing, but is generally more open-graded than the other surface mixes, and may not provide a tightly sealed surface.

Mix type 4-01 is very susceptible to rutting and is only recommended for non-vehicular use.

C. Asphalt Hot-Mix Recycling

1. General: Except as modified herein, Recycled Asphaltic Concrete (RAC) shall be equal to that produced as new material. Reclaimed Asphalt Pavement (RAP), Fractionated Reclaimed Asphalt Pavement (FRAP) and/or Reclaimed Aggregate Materials (RAM) shall represent no more than 30% of the composition for all surface mixtures and no more than 40% of the composition for all base mixtures. However, for base mixtures using FRAP, the composition may be no more than 50%.

   Recycled Asphaltic Concrete may contain combinations of FRAP, RAP, RAM, coarse aggregate, fine aggregate, mineral filler, asphalt cement, recycling agent, anti-stripping agent and approved additives to produce an acceptable mixture. Recycled Asphalt Shingles (RAS) are not allowed. Recycled Asphaltic Concretes shall be designated by prefacing the type with “RC,” such as “RC Type 1-01”.

2. FRAP is defined as having two or more stockpiles, where RAP is processed into coarse and fine fractions. The fine FRAP stockpile will contain only material passing the ¼ inch screen. The coarse FRAP stockpile will contain milled material retained on the ¼ inch screen and passing the ¾ inch screen. FRAP may be comprised of coarse or fine FRAP or a combination thereof. Utilize a separate cold feed bin for each stockpile of FRAP used. Do not blend coarse and fine FRAP either in the stockpile or in a cold feed bin. Add FRAP to the mix through the RAP collar. Sources and types FRAP must be recorded and submitted to the Engineer upon request. The FRAP used in production shall be similar in composition (extracted gradation and asphalt content) to the source used for design.

3. Materials Evaluation: All recycled materials shall have the following tests performed in addition to those required in Section 2205.4.D:

   a. A sieve analysis shall be performed on FRAP, RAP and/or RAM in accordance with ASTM C 117, "Standard Test Method for Material Finer than No. 200 Sieve (75 um) in Mineral Aggregates by Washing" and ASTM C 136, "Standard Method for Sieve Analysis of Fine and Coarse Aggregates" after extraction of asphalt.
   b. Asphalt content analysis shall be performed for FRAP or RAP in accordance with Method "A" of ASTM D 2172, "Standard Test Methods for Quantitative Extraction of Bitumen from Bituminous Paving Mixtures" where the FRAP or RAP content exceeds 30%. For mixtures

with FRAP or RAP contents less than 30%, asphalt content may be determined using ASTM D 6307.

c. The asphalt cement used shall be determined as follows:
   i. For FRAP or RAP contents of up to 20%, the asphalt grade shall be as specified in the mix design.
   ii. For FRAP or RAP contents from 20% up to 30%, the asphalt grade shall be decreased one temperature range. For example, a design PG 64-22 would be decreased to a PG 58-28.
   iii. For FRAP or RAP contents from 30% to 50%, the asphalt grade of the new asphalt shall be determined using the procedures outlined in MS-2, latest edition, Appendix A. This would likely result in a PG 52-34.
d. All sources of material for use in RAC must be approved by the Engineer prior to use.

4. Material Requirements

   a. New asphalt cements added to the aged asphalt shall meet the requirements of Section 2205.3.
   b. Recycling Agents, if used, shall meet the requirements of ASTM D 4552, "Standard Practice for Classifying Hot Mix Recycling Agents".
   c. The FRAP, RAP and/or RAM stockpiled at the plant site shall be maintained in stockpiles separated into surface and base. The RAP and/or RAM shall be processed such that 100% will pass the 1-1/2 inch (38 mm) sieve and 90% will pass the 1-inch (25.4 mm) sieve.
   d. The final product shall be free of foreign matter (e.g., old planer teeth, ice, wood, soil, broken sewer castings, loop detector wire, protective membranes, rubberized joint filler materials and foil turn lane markers, trash, debris, etc.).

5. Mix Design Requirements: The necessary steps for a final mix design for recycled mixtures shall be done in accordance with the Asphalt Institute's Manual MS-2 latest edition in the appendix entitled "Mix Design Using RAP". If there is a change in the RAP and/or RAM percentage from the original amount of RAP and/or RAM in the mix design, a new mix design must be submitted.

6. Asphalt Plant Requirements: All delivery tickets shall designate the type of recycled mix, (RC-Type 1-01, RC-Type 2-01, RC-Type 3-01, etc.).

D. Mix Design Criteria: Laboratory Test Specimen(s) of mixes 1-01, 2-01, 3-01 and 4-01, combined in proportions of the job-mix formula, shall be prepared and tested in accordance with AASHTO T 245 and the volumetric properties of the compacted paving mixtures as calculated by ASTM procedures using Chapter 4 of the Mix Design Methods for Asphalt Concrete and other Hot-Mix Types (MS-2), latest edition, Asphalt Institute referred hereafter as “MS-2”. The Marshall procedure shall be as specified in Chapter 5 of the MS-2.

For mixes 5-01 and 6-01, the procedures outlined in Asphalt Institute’s “Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types (MS-2)”, latest edition, must be used to prepare the asphalt samples for design and quality control testing. The gyratory values for the SuperGyratory Compactor (SGC) to be used for this purpose are $N_{initial}$ = 6, N_{design} = 50, and N_{max} = 75. At $N_{initial}$, the specific gravity of the specimen must be 90.5% or less of G_{mm}, at N_{max} the specific gravity of the specimen must be 98.0% or less of G_{mm}. The Voids in the Mineral Aggregate (VMA) shall be as specified in Chapter 5 of the MS-2.

The material for the theoretical specific gravity (G_{mm} per ASTM D 2041) and the material for the Marshall specimens and Super Gyratory Compactor specimens (pucks) shall be cured at 285+/-5ºF for four hours in a closed oven after the mix is produced in the laboratory. Also, the plant produced mixture shall be tested when the mix is four hours old when preparing a mix design but may be tested when at least two hours old for

production testing. The mixture shall be transported to the laboratory in an insulated container and then stored in a laboratory oven at 285 +/-5°F for the remainder of the curing period. This procedure shall be used when the water-absorption as determined by ASTM C 127 and ASTM C 128 of any aggregate in the mixture exceeds 1.25%. The mixture shall be compacted at 285 +/-5°F. If total mix aggregate absorption exceeds 2.0%, the laboratory may use the G_{mm} dryback option within the test method.

Test requirements and criteria for the paving mixes under these specifications shall be as follows:

Marshall Stability: 1500 lbs. (6672 N) minimum (Types 1-01, 2-01, 3-01, and 4-01)

No. of compaction blows: 50 (Types 1-01, 2-01, 3-01, and 4-01)

Flow: 0.08-0.16 inches maximum (Types 1-01, 2-01, 3-01, and 4-01)

Air Voids:	Percent
Base & Surface (Types 5-01 & 6-01)	3-5
Base & Surface (Types 1-01, 2-01, 3-01, and 4-01)	2-5

Voids filled with asphalt (VFA)	Percent
Types 5-01 & 6-01	65-75

Voids in Mineral Aggregate (VMA) for Types 5-01 & 6-01

(Nominal Max Size as defined in MS-2)	Percent (min.)
3/4" (19 mm)	13
1/2" (12.5 mm)	14
3/8" (9.5 mm)	15

The VMA for Mix Types 5-01 & 6-01 shall be the minimum value allowed. For these mixes, the asphalt content should be just to the left side of the low point on the VMA vs. Asphalt Percent curve, not to the "wet" or right (increasing) side of the curve. Nominal maximum sized as defined in MS-2 means the sieve size where the next smaller sieve size (from Table in Section 2205.4.A) retains at least 10% of the sample.

The VMA requirements shown represent values that may be higher than those obtained in the KC Metropolitan area using locally available materials. The minimum values are values recommended by the Asphalt Institute in MS-2, latest edition, for high quality asphaltic concretes, but may require the use of non-local aggregates. VMA values shown are for 4% air voids and should be used for the design of conventional roadway pavements.

During production, the air voids can be expected to vary plus or minus 1% of the design value of 4%. For Mix Types 1-01, 2-01, 3-01, and 4-01, 3% - 4% air voids may be used for design and production may be allowed to vary plus or minus 1% of the design value.

The ratio of minus 200 (75 um) material to % Effective asphalt cement (P_{eff}) based on the weight of the aggregate shall be between 0.6-1.4 for Mix Types 5-01 and 6-01.

The blend of FRAP, RAP and/or RAM and virgin aggregates or non-recycled asphalts shall be checked for resistance to stripping using AASHTO T 283 to determine if an anti-stripping agent is needed. The index of retained strength shall exceed 75% for Mix Types 1-01, 2-01, 3-01, and 4-01, and 80% for Mix Types 5-01 and 6-01.

E. Sampling and Testing of the Mixture: All Mix Types shall be sampled in accordance with ASTM D 979 and tested in accordance with AASHTO T 245, ASTM C 136, ASTM C 117, AASHTO T 312, AASHTO T 269,

AASHTO T 166, AASHTO T 283, ASTM D 2041, ASTM D 2726, ASTM D 1188, ASTM D 2950, ASTM C 127 and ASTM C 128, as specified herein. The mixtures will be tested for binder content in accordance with ASTM D 2172 or D 6307. The recovered aggregate will be sieved in accordance with ASTM D 5444.

F. Mixture Temperature Requirements: The temperature of the completed mix at the plant and at the paver shall be set by the Contractor/Producer who shall consider hauling and placing conditions, asphalt specifications as set forth in Section 2205.3, and weather limitations set forth in Section 2205.9.B. The temperature of Mix Types 5-01 and 6-01 shall not exceed 315° F at the point of discharge from the asphalt plant.

When the mix is produced in a batch-type plant, the aggregate shall be weighed accurately in the designated proportions to provide the specified batch weight. The temperature of the aggregate at the time of introduction into the mixer shall be determined by the Contractor/Producer, with a tolerance of + or - 25º F. In no case, however, shall the temperature of the mixture exceed the maximum temperature recommended by the manufacturer or supplier of the asphaltic cement (generally 350º F).

G. Control of Mixing Time: The Contractor/Producer shall control mixing time to produce asphaltic concrete that is uniformly and thoroughly coated with asphaltic cement.

H. Preparation of Asphalt Cement: The asphalt shall be heated so that it can be distributed uniformly throughout the mix. For mixing applications, the specified temperature generally will be such that the asphalt viscosity is within the range of 150-190 centistokes and shall not exceed 350º F. The material shall be sufficiently fluid to produce a complete coating on every particle of aggregate within the specified mixing time.

The Contractor/Producer shall maintain calibrated temperature monitoring equipment at the point of discharge from the asphalt plant and at the asphalt tank, and shall supply temperature records upon request.

I. Preparation and Handling of Aggregate: Coarse and fine aggregate shall be stored at the plant in such a manner that the separate sizes will not become intermixed. Cold aggregates shall be carefully fed to the plant in such proportions that surpluses and shortages in the bins will not cause breaks in the continuous operation. When loading aggregate into stockpiles, and into cars, barges, and trucks, the material shall be placed in such a manner as to prevent segregation of aggregate sizes. Stockpiles shall be built in uniform layers not exceeding 5 feet in depth.

1. Samples of coarse and fine aggregate shall be submitted to the Engineer for testing upon request. The Contractor/Producer shall be responsible for the preparation and handling of aggregates to insure that the cold-feed gradations fall within the mix design limits. Cold-feed gradation tests shall be taken as requested by the Engineer.

2. Drying: The aggregate shall be thoroughly dried and heated to provide a paving mix temperature within a tolerance of + or – 25º F of that specified by the approved mix design. The moisture content of the heated and dried aggregate shall not exceed 0.5%. The quantity of material fed through the dryer shall in all cases be held to an amount which can be thoroughly dried and heated.

J. Inspection and Control of Asphalt Mixing Plant

1. Tests: During production the plant shall have the specified tests performed by an approved laboratory. These may include: asphalt (binder) content, aggregate gradation after removal of asphalt, density, stability, % voids, VMA, VFA, theoretical specific gravity, bulk specific gravity, maximum theoretical density, maximum theoretical specific gravity, tensile strength ratio, etc. Properties of the plant produced mix shall be determined using uncompacted mix sampled behind the paver. Laboratories shall be approved if they are:

a. Accredited in accordance with ASTM D3666; and/or
b. Approved for Superpave asphalt testing by the State Highway Department in the state where the plant is located.
    i. The individual performing the test must carry a state certification for Superpave testing.
    ii. The laboratory must have an annual certification by an independent testing agency of all testing equipment used for Superpave mix designs, and must also have the Marshall hammer weight and height of drop certified by that same agency.

2. Availability of test reports: The results of the latest current test report shall be furnished to the Engineer upon request. All test reports shall be kept at the plant, and shall be made available upon request. If the mix is found to be outside of tolerance, or outside the specification limits as specified in Section 2205.4, correction shall be made. Test reports shall be furnished on the appropriate attached "Asphalt Concrete Test" form or a similar form containing equivalent information.

3. Frequency of testing for mixes 1-01 through 4-01: the tests listed in paragraph 1 shall be performed a minimum of once for every 3000 tons of asphalt production (minimum of once per day when the plant has produced at least 200 tons and at discretion of Engineer if less than 200 tons produced) except during initial startup, or whenever the production asphalt fails one of the following conditions at which time they will be tested every 1000 tons until 4 consecutive tests show compliance with the specifications:

    a. Production void content measured at the plant discharge is less than 2% or more than 5%.
    b. Extracted gradation of the production asphalt exceeds the permissible gradation variation for the mix type being produced.
    c. Asphalt cement exceeds the content variation for the mix type being produced.

4. Frequency of testing for mixes 5-01 and 6-01: the tests listed in paragraph 1 shall be performed once per day of production, or every 1000 tons, whichever is less frequent except during initial startup (if less than 200 tons produced testing is at discretion of Engineer); or whenever the production fails one of the following conditions at which time they will be tested every 500 tons, or twice per day of production, whichever is less frequent until 4 consecutive tests show compliance with the specifications:

    a. Production void content measured at the plant discharge is less than 3% or more than 5%.
    b. Extracted gradation of the production asphalt exceeds the permissible gradation variation for the mix type being produced.
    c. Production VMA measured at the plant discharge is below the design minimum VMA.
    d. Production VFA measured at the plant discharge is outside the allowable range.
    e. Production dust to binder ratio is outside the allowable range.

5. Redesign of Asphalt mixes: If four consecutive tests performed as described in paragraph 3 or 4 above show noncompliance with the specifications as enumerated in the subparagraphs of paragraph 3 or 4 above, production of that type of asphalt will immediately cease, and may not be resumed until a new mix design is submitted and approved, or the plant can demonstrate to the Engineer an ability to meet specifications. Resumption of asphalt production after a mix redesign or failure of four consecutive tests to meet specifications will be treated as an initial startup for testing purposes.

MARSHALL ASPHALTIC CONCRETE TEST (Verified Mix Design)
(Types 1-01, 2-01, 3-01, 4-01)

Description:				
APWA Type:				
LAB ID:		LOT		
Sample Date:		Belt		Tons
Sample ID:		Hot Mix		Tons
Supplier:				

Sieve Size	Belt Sample	Hot-Mix Sample*	Single Point Job-Mix Formula	Job-Mix Formula Tolerances	ASTM C 136, C 117, D 5444
1" (25 mm)					
3/4" (19 mm)					
1/2" (12.5 mm)					
3/8" (9.5 mm)					
No. 4 (4.75 mm)					
No. 8 (2.36 mm)					
No. 16 (1.18 mm)					*Uncompacted Behind Paver
No. 30 (600 um)					**total mix basis
No. 50 (300 um)					***total aggregate
No. 100 (150 um)					
No. 200 (75 um)					

EXTRACTION DATA - ASTM D6307 or D 2172	FRAP	Sample	Plant Setting	Recycled AC%
%AC**				
%AC**				

Aggregate Type	%***	Aggregate Type	%***

MARSHALL CHARACTERISTICS (ACCEPTANCE CRITERIA)			
Compaction Blows (average of 3 specimens) = 50			
	Sample*	Specifications*	
Stability, lbs (kg)		Min	AASHTO T 245
Flow, 1/100 in (mm)		Max	AASHTO T 245
% Voids		3-5	
% VFA			
Density, pcf (kg/cu.m)		-----	ASTM D 2950, D 2726, or D 1188
Max Theoretical Specific Gravity G_{mm}		-----	ASTM D 2041
Bulk Spec. Gr. of total Agg. Gsb		-----	ASTM C 127 & C 128
COMMENTS:			

LOT DENSITY SHALL BE TIED TO THE LOT AND DATE (Laboratories shall conform to ASTM D 3666)

SUPERPAVE ASPHALTIC CONCRETE TEST (Verified Mix Design)
(Types 5-01, 6-01)

Description:				
APWA Type:				
LAB ID:			TIME	TONS
Sample Date:		Belt		
Sample ID:		Hot Mix		
Supplier:				

Sieve Size	Belt Sample	FRAP/RAP Sample*	Hot-Mix Sample*	Master Grade Limits	Cal. Single Point
1" (25 mm)					
3/4" (19 mm)					
1/2" (12.5 mm)					
3/8" (9.5 mm)					
No. 4 (4.75 mm)					
No. 8 (2.36 mm)					
No. 16 (1.18 mm)					
No. 30 (600 um)					
No. 50 (300 um)					
No. 100 (150 um)					
No. 200 (75 um)					

ASTM C 136, C 117, D 5444

*Uncompacted Behind Paver
**total mix basis
***total aggregate

EXTRACTION DATA - ASTM D6307 or D 2172	FRAP	Sample	Plant Setting	Recycled AC%
%AC**				
%AC**				

Aggregate Type	%***	Aggregate Type	%***

VOLUMETRIC DATA 6" NOMINAL SIZE Gyratory Specimens			
Gyrations (avg. of 2 specimens) @ 280-290 deg F – AASHTO T312 N_{des} = 50 N_{ini} = 6 N_{max} = 75	Sample*	Specifications*	
Mix bulk specific gravity @ N_{des}, G_{mb}		---	
% Voids @ N_{des}		3.0-5.0	AASHTO T 269
% VMA @N_{des}, G_{sb} basis			
% VFA @ Ndes		9.0–11.0	=%VMA-%Voids
% G_{mm} @ Nini		85-91	AASHTO T 166
Ratio (-) 75 um (No. 200) to % Eff. Binder		0.6-1.4	
Tensile Strength Ratio, %		80 minimum	AASHTO T 283
Max Theoretical Specific Gravity G_{mm}		-----	ASTM D 2041
Max Theoretical Density, pcf		-----	
Effective Specific Gravity Agg., G_{se}		-----	
Bulk Specific Gravity of Total Agg., G_{sb}		-----	ASTM C 127 & C 128
Specific Gravity of Asphalt, G_b		-----	
COMMENTS:			

2205.5 Asphalt Mixing Plant

Plants used by the Contractor for preparation of the asphalt paving mix shall conform to the following requirements:

A. Field Testing Laboratory: The Contractor shall provide a laboratory building or room at the plant site, for the exclusive use of the Engineer for performing tests, keeping records, and making reports at such times as the Engineer is performing those actions.

   The Contractor shall also furnish necessary laboratory sieves and a powered shaker device for sieve analysis, scales, ignition oven and supplementary equipment to make aggregate sieve analysis, asphaltic concrete paving mixture analysis, and paving mixture density tests. This equipment shall be in good working condition and properly calibrated.

B. The asphalt producer shall establish a quality control plan and shall maintain records. The quality control plan required by the state highway agency is a suggested standard. Upon request by the Engineer, the quality control plan shall be submitted for review and approval.

2205.6 Transportation of Mix

The mix shall be transported to the job site in vehicles with tight metal bottoms, clean of all foreign material which may affect the mix. If a release agent is used, it must comply with State and Federal environmental regulations.

The dispatching of the vehicles shall be so scheduled that all materials delivered may be placed in daylight unless the Engineer approves artificial light. Delivery of the material to the paver shall be at a uniform rate and in an amount within the capacity of the paving and compacting equipment.

Haul trucks shall be provided with covers of sufficient size and weight to completely cover the truck bed to protect the load and to prevent cooling of the upper surface. Failure to have the load completely covered shall be sufficient cause for rejection of the entire load. The load shall remain covered until the truck is next in line to be unloaded. In no case shall a load remain uncovered for more than 10 minutes before starting to use the load. If for any reason there is a delay in completely using a load, the remaining part of the load shall be recovered until it can be used. It shall be the responsibility of the Contractor to inform all truck drivers of these provisions before starting work.

2205.7 Scales and Weighing of Vehicles

The vehicle's tare and gross weight shall be established by weighing the vehicle on a certified scale. The tare weight will be established at least twice each day. The vehicle, when establishing tare, shall be clean, bed empty, fuel tanks filled and shall have all side and back boards in place.

A. Measurement by weight: Measurement will be made by weighing each truck load on scales conforming to the requirements of Section 2205.7.B “Vehicle Scales”.

B. Vehicle Scales: Vehicle scales shall be approved by the Engineer and shall conform to the requirements specified herein. The specifications, tolerances, and other technical requirements for weighing and measuring devices as recommended by the National Conference on Weights and Measures and published in the National Institute of Standards and Technology Handbook 44, Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices, and supplements thereto or revisions thereof, shall apply to all vehicles scales used.

C. Scale acceptance shall be based on one of the following:

1. A valid certification or seal of approval by the Division of Weights and Measures from the state.

2. A certification of calibration from a commercial scale service company showing that the scale meets the requirements of these specifications. The Contractor shall furnish the certification of calibration to the Engineer.

D. Scale Calibration: Scales shall have been calibrated within the nine month period prior to any material being delivered, or at any time the Engineer has cause to question the accuracy of the scale. Scales shall meet the requirements of Accuracy Class III L as defined in Handbook 44 (above).

Verification of a vehicle scale may be required by weighing a hauling unit on another recently calibrated and certified scale.

If equipment to be weighed is of such length that all axles cannot be weighed simultaneously, a level paved surface shall be provided permitting those axles not on the scale platform to be supported by the paved surface. The approach shall be at least as wide as the platform and of sufficient length to insure the level positioning of vehicles during weight determinations. The weighing shall be performed with all brakes released. If equipment to be weighed is equipped with an air bag suspension unit on any axle, the equipment including semi-trailers or pup trailers shall be weighed on vehicle scales of sufficient size to weigh all axles of the combination simultaneously.

All costs incurred in obtaining a certification of calibration or verification shall be borne by the Contractor.

2205.8 Asphalt Paving Equipment

All asphalt paving equipment used by the Contractor shall meet the requirements of this section and shall be maintained in acceptable mechanical condition. Equipment shall be serviced and lubricated away from the paving site. Units that drip fuel, oil, grease or other fluids shall be removed from the project until such leakage is corrected.

A. Pavers and Laydown Machines: Mechanical self-powered pavers shall be capable of spreading the mix within the specified tolerances, true to the line, grade and crown indicated on the Plans.

Pavers shall be in good working condition, equipped with quick and efficient steering devices and shall be capable of traveling both forward and in reverse. They shall be equipped with hoppers and distributing screws that place the mix evenly in front of the adjustable screeds. They shall be equipped with either a vibrating screed or a tamping bar immediately preceding a static screed. There shall be sufficient auxiliary attachments for the paving machine so that it may be operated to lay the necessary width as determined in the field by the Engineer. Vibrating screed or tamp bars shall be provided for the full width of all paving operations.

The screed shall include a strike-off device which is effective on mixes at workable temperatures without tearing, shoving or gouging them, and which produces a finished surface of an even and uniform texture. The screed shall be adjustable as to the height and crown and shall be equipped with a controlled heating device for use when required. However, for irregular width paving, hydraulic extensions without tamping bars or a vibrating screed may be used only along the curb or outer edge of pavement.

1. Automatic Screed Controls: The paver shall be equipped with and use an approved system capable of automatically controlling the elevation and transverse slope of the paver screed unless otherwise directed by the Engineer. An erected stringline, traveling stringline or other approved device operating on the roadbed being paved or the surface of the previously placed lane shall be used to establish the grade reference. The grade reference device shall operate on either or both sides of the paver as

required and shall be capable of maintaining the desired transverse slope regardless of changes in the screed elevation.

2. The traveling stringline shall be constructed in such a manner that it does not vibrate or cause the sensor to make erroneous readings during the laydown operation. The length of the beam to be used shall be approved by the Engineer and shall be between 20 feet and 40 feet.

3. The use of the automatic screed control devices on asphalt pavers will not be required for paving small irregular areas, entrances, approaches, or side street connections.

4. Automatic screed control devices will be required for matching the joint with all previously laid strips, except for those areas noted above.

B. Rollers: Compaction equipment shall consist of vibratory steel wheel, static steel wheel and pneumatic-tired rollers unless otherwise directed by the Engineer. They shall be self-propelled and equipped with such controls that starting, stopping and reversing direction can be accomplished without displacing the hot asphaltic concrete pavement.

Rollers shall be equipped with adjustable scrapers to keep the wheel surfaces clean and with efficient means of keeping them wet to prevent mixes from sticking. The roller surfaces shall have no flat areas, openings or projections that will mar the surface of the pavement.

1. Steel-Wheeled Rollers: Steel-Wheeled Rollers shall be self-propelled, vibratory two-axle tandem rollers. These rollers shall develop contact pressure of 250 to 350 pounds per inch of width (vibratory mode) or 150 to 180 pounds per inch of width (static). Rollers shall be in good working condition.

2. Pneumatic-Tired Rollers: Heavy pneumatic-tired rollers shall be self-propelled and shall consist of two axles on which are mounted an odd number of pneumatic-tired wheels. The roller shall have at least nine pneumatic-tired wheels mounted in such a manner that the rear group of wheels will not follow in the tracks of the forward group, but shall be spaced to give essentially uniform coverage with each pass. Axles shall be mounted in a rigid frame provided with a loading platform or body suitable for ballast loading. Tires shall be smooth, inflated to 90 psi. Construction of the roller shall be such that each wheel is loaded to a minimum of 2,300 pounds.

3. In lieu of the above requirements, consideration will be given to use other types of equipment that are capable of producing equivalent results consistent with the requirements of the specifications. Any roller not meeting the requirements of paragraphs 1 and 2 above must be approved by the Engineer prior to use.

C. Pressure Distributor: The pressure distributor shall meet the requirements of Section 2204.4.A entitled "Pressure Distributor".

D. Hand Tools: The Contractor shall provide sufficient lutes, rakes, shovels, and other equipment as required to produce results consistent with the specifications.

2205.9 Construction

A. Preparation of the Area to be Paved: The area to be paved shall be true to line and grade, and shall have a properly prepared surface prior to the start of the paving operations. It shall be free from all loose or foreign material.

Where a base is rough or uneven, a leveling course shall be placed and properly compacted before the placing of subsequent courses.

When leveling course is not required, depressions and other irregularities shall be patched or corrected, and the work approved by the Engineer before the paving operation begins.

The area to be paved shall be primed or tacked uniformly in accordance with the provisions of Section 2204 entitled "Prime and Tack Coat".

The surfaces of curbs, gutters, vertical faces of existing pavements and all structures in actual contact with asphalt mixes shall be painted with a thin, complete coating of tack to provide a closely bonded joint.

B. Weather Limitations: When the moisture of the aggregate in the stockpile or from the dryer interferes with the quality of mix production, or with normal plant operations, the mixing and placing of hot-mix asphalt will not be permitted without the permission of the Engineer. No mixture shall be placed on wet or frozen surface.

Hot Mix asphalt paving shall not be mixed or placed when the ambient air or base temperature is below the temperatures shown in the following table, or when there is frost in the subgrade or any other time when weather conditions are unsuitable for the type of material being placed without expressed approval of the Engineer.

Paving Course	Thickness (inches)	Air Temperature (Degrees F)	Road Surface Temperature (Degrees F)
Surface	All	50	55
Base	Less than 3	40	45
Base	3 or more	30	35

All bituminous mixtures shall be delivered to the paver at a temperature sufficient to allow the material to be placed and compacted to the specified density and surface tolerance. Minimum allowable temperature for the asphalt mix to be placed into the paver is 235º F. Regardless of the temperature, final acceptance of the asphalt mat shall be based on density determined in accordance with Section 2205.9.E.

C. Spreading and Finishing: The spreading and finishing of each course shall be to the thickness, cross slope, and width indicated on the Plans or Special Provisions. The thickness of individual layers shall not exceed the following for the respective type of mixture. The suggested minimum lift thickness shall be three times the nominal maximum size of the mix. Nominal maximum is defined as the first sieve size larger than the sieve which retains at least 10% of the aggregate by weight.

Asphalt Type	Max. Compacted Lift Thickness
Type 1-01	4"
Type 2-01	4"
Type 3-01	3"
Type 4-01	2"
Type 5-01	4”
Type 6-01	3”

Spreading and finishing shall be conducted in the following manner:

1. Mechanical Pavers: The base and surface courses shall be spread and struck-off with a mechanical paving machine meeting the requirements of Section 2205.8.A entitled "Pavers and Laydown

Machines". The paving machine shall be operated so that the material does not accumulate and remain along the sides of the receiving hopper. The wings of the spreader hopper shall not be emptied (flipped) between truck loads.

a. Equipment which leaves tracks or indented areas which cannot be corrected in normal operation, or which produces other permanent blemishes or fails to produce a satisfactory surface, shall not be used.
b. The screed auger shall be operated approximately 3/4 full and the hopper conveyor shall not be allowed to run out of material during the paving operation. Sufficient trucks shall be used to continuously supply asphalt to the paver. Delays in the paving operation shall be kept to a minimum.
c. When using pavers in echelon, the second paver shall follow the edge of the material placed by the first paver. The length of each laydown pass shall be limited, depending on weather conditions, to assure a hot joint and obtain proper compaction.

2. Longitudinal joints and edges shall be constructed to true lines. Lines for the paver to follow in placing individual lanes will be established parallel to the centerline of the proposed roadway. The paver shall be positioned; and operated to follow closely the established line. Offset the longitudinal joint in successive courses by 6 to 12 inches. Longitudinal joints in the final surface layer shall be at the lane lines of the traveled way, but shall be offset to prevent lane separation pavement markings from falling on the joint. Any irregularities in alignment left by the paver shall be corrected directly behind the paver, prior to compaction. Distortion of the pavement during this operation shall be avoided. Edges against which additional pavement is to be placed shall be placed on a 30º (2:1) bevel, or as specified by the Engineer.

3. Transverse joints in succeeding courses shall be offset at least 2 feet.

4. The Contractor shall make every effort to minimize the number of passes heavy equipment makes over uncompleted roadway sections. The Contractor shall schedule and route his hauling operation to minimize hauling over a final course as much as feasible.

5. As soon as the first load of material has been spread, the texture of the unrolled surface shall be checked to determine its uniformity. Segregation of materials shall not be permitted. If segregation occurs, the spreading operation shall be immediately suspended until the cause is determined and corrected by the Contractor.

6. Any irregularities in the surface of the pavement course shall be corrected directly behind the paver. Excess material forming high spots shall be removed by a shovel or lute. Indented areas shall be filled with hot mix and smoothed. Broadcasting of material shall not be permitted.

7. Hand Spreading: In small areas where the use of mechanical finishing equipment is not practical, the mix may be spread and finished by hand. The material shall be distributed uniformly to avoid segregation of the coarse and fine aggregate. Broadcasting of material shall not be permitted. During the spreading operation, all material shall be thoroughly and uniformly distributed by lutes or rakes. Material that has formed into lumps and does not break down readily shall be removed. Following placing and before rolling, the surface shall be checked with templates and straightedges and all irregularities corrected.

D. Compaction

1. General: The Contractor is responsible for development of a compaction procedure that will obtain the

required density. A minimum of three rollers shall be used for compacting mixes on roadways (2 steel drum and 1 pneumatic tire) unless otherwise approved by the Engineer. For uses other than roadways, a minimum of two rollers shall be used unless otherwise approved by the Engineer. Rollers shall meet the requirements of Section 2205.8.B entitled "Rollers".

Immediately after spreading, each course of the pavement mixture shall be uniformly compacted by rolling. The initial or "breakdown" rolling shall be accomplished with a steel-wheeled vibratory roller and shall take place as closely behind the laydown machine as the temperature and condition of the mat will allow. The pneumatic-tired roller shall be used to knead and compact the pavement mixture following the initial rolling and preceding the final rolling. Care shall be exercised in the use of the pneumatic-tired roller to ensure that the pavement mixture is sufficiently cooled to avoid "picking up" of the mixture on the tires of the roller, and also to ensure that the pneumatic-tired rolling is completed before the mixture becomes too cool to allow satisfactory finish rolling. Final, or finish rolling, shall be done with a steel-wheeled roller in static mode. The sequence of rolling operations may be changed with the approval of the Engineer. Rolling shall be longitudinal, starting near the low or unconfined edge of the pavement, then to the other edge and finally progressing towards the center. Alternate trips of the roller shall be of slightly different lengths.

The motion of the roller shall be slow enough at all times to avoid displacement of the hot mixture (generally 3mph). Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected immediately by the use of rakes and fresh mixture when required. To prevent adhesion of the mixture to the roller, the wheels shall be kept properly moistened, but excess water will not be permitted.

The surface of the mixture after compaction shall be smooth and true to established section and grade. Any surface which is segregated, or is in any way defective, shall be removed and replaced with fresh hot mixture at the Contractor's expense, and shall be immediately compacted to conform to the surrounding area.

2. Rolling Procedure: The Contractor is responsible for determining an acceptable rolling procedure that will provide a product that is uniformly compacted to the required density and true to line and grade. There are many possible variations that may accomplish this but the general order for rolling is:

   a. Transverse joint
   b. Longitudinal joint (if in echelon)
   c. Unconfined or low side edge
   d. Other edge
   e. Middle
   f. Intermediate rolling; same procedure as breakdown rolling but pneumatic roller should stay the thickness of the lift from the free edge
   g. Finish rolling

   When paving in echelon, 2-3 inches of the first mat shall be left unrolled, and rolled when the joint between the lanes is rolled, after the 2nd mat is placed. Edges shall not be exposed more than fifteen minutes without being rolled. Particular attention shall be given to the construction of transverse and longitudinal joints in all courses.

   In laying a surface mix adjacent to any finished area, it shall be placed sufficiently high so that, when compacted, the finished surface will be true and uniform. Where the grade is slight a level will be used to insure drainage to the desired outlet.

3. Transverse joints: The Contractor shall use a method of making a transverse construction joint that provides a thorough and continuous bond with acceptable surface texture and meeting the density requirements. The surface elevation should not vary more than 3/16" in 10' when tested across the joint. If the joint has been distorted, it shall be trimmed to a line. The joint face shall be tacked before the fresh material is placed against it.

4. Longitudinal joints: When paving against existing asphalt pavement, the edge to be joined shall be tack coated. The paver screed shall be set to overlap the first mat by 1-2 inches. The elevation of the screed above the surface of the first mat should be equal to the amount of roll-down expected during compaction of the new mat. For large aggregate mixes, the coarse aggregate in the material overlapping the cold joint should be carefully removed and wasted, leaving only the finer portion of the mixture. The overlapping material should be pushed with a lute or rake onto the side of the joint where the new pavement is located prior to compaction.

   When paving against existing concrete pavement, curb and gutter or other structure, the edge to be joined shall be tack coated. The elevation of the screed above the surface of the first mat should be equal to the amount of roll-down expected during compaction of the new mat. Where drainage of stormwater will flow from the new mat onto abutting curb and gutter, add an additional ⅛" - ¼" of thickness to the new mat.

5. Breakdown Rolling: Steel wheel rollers as specified in Section 2205.8.B entitled "Rollers" shall be used for breakdown rolling. Breakdown rolling shall be performed as close behind the paver as necessary to obtain adequate density without causing undue displacement. The breakdown roller shall be operated with the drive wheel nearest the laydown machine. Exceptions may be made by the Engineer when working on steep slopes or super-elevated curves. Breakdown rolling sequencing is to be determined by the Contractor and approved by the Engineer.

6. Intermediate Rolling: Pneumatic-tired rollers as specified in Section 2205.8.B entitled "Rollers" shall be used for intermediate rolling unless otherwise approved by the Engineer. The intermediate rolling shall follow the breakdown rolling as closely as possible and while the paving mix is still of a temperature that will result in maximum density from this operation. Pneumatic-tired rolling shall be continuous after the initial rolling until all of the mix placed has been compacted to the required density. Turning of pneumatic-tired rollers on the hot paving mix which causes displacement shall not be permitted.

7. Finish Rolling: The finish rolling shall be accomplished before the material falls below a temperature of 175º F to allow for the removal of roller marks. All roller marks shall be removed by the finish rolling operation. All rolling operations shall be conducted in close sequence.

8. In places inaccessible for the operation of standard rollers as specified, compaction shall be performed by others means meeting the requirements of Section 2205.8.B entitled "Rollers." The Contractor shall ensure that the material is thoroughly compacted to the satisfaction of the Engineer. If approved by the Engineer, hand tamping, manual or mechanical, may be used in such areas, if the required density is met.

E. Density and Surface Requirements: The completed asphalt concrete paving shall have a density equal to or greater than 95% for Types 1-01 and 5-01 Asphalt Concrete Base and 96% for Types 2-01, 3-01, 4-01, 5-01, and 6-01 Asphalt Concrete Surface. Density is based on the density of laboratory specimens from plant produced mix prepared as specified in Section 2205.4.D entitled "Mix Design Criteria" and made from a sample representing the material being tested. Density testing shall conform to ASTM D 2950, ASTM D 2726, or ASTM D 1188.

If cores are used to determine density, one or more tests (one test equals three cores) will be taken for each tonnage lot and averaged to determine acceptance. The cores will be taken from random locations within the lane being paved, a minimum of 1' from any joint or edge. The Engineer will mark the locations of all cores.

All unsatisfactory work shall be repaired, replaced or corrected. The surface of the final course shall be of a uniform texture and conform to line and grade shown on the Plans. Allowable tolerance for the final surface of roadway pavement shall conform to the requirements of Section 2211 entitled "Smoothness". Tests for Plan grade conformance and surface smoothness shall be performed by the Contractor in the presence of the Engineer. Tests shall be performed at intervals as directed by the Engineer.

2205.10 Method of Measurement

Asphaltic concrete base, asphaltic concrete surface, or asphaltic concrete base and surface may be included in the Contract Documents as separate items, or as a single item, and may be measured by one of the following:

A. Per square yard or tenth part thereof for the specified depth.

B. Per ton or tenth part thereof.

C. If pavement smoothness is required in the Contract, payment shall be in accordance with Section 2211.

2205.11 Basis of Payment

Asphaltic Concrete Surface, Asphaltic Concrete Base, or Asphaltic Concrete Base and Surface whether used for paving, patching, or leveling courses will be paid for by one of the following:

A. Contract unit bid price.

B. Contract lump sum bid price.

C. Testing described in Section 2205 is subsidiary to the price bid for asphalt unless otherwise provided for in the Contract.

SECTION 2206 ASPHALT CRACK SEALING, ASPHALT CRACK FILLING, CHIP SEALING, SLURRY SEALING, AND MICRO-SURFACING

2206.1 Scope

This section governs the furnishing of all labor, materials and equipment for the performance of asphalt crack sealing, asphalt crack filling, chip sealing, slurry sealing and micro-surfacing as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2206.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM

C 88 Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C 117 Test Method for Materials Finer than 75- um (No. 200) Sieve in Mineral Aggregates by Washing
C 131 Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
C 136 Test Method for Sieve Analysis of Fine and Coarse Aggregates
C 142 Test Method for Clay Lumps and Friable Particles in AggregatesD 36 Standard Test Method for Softening Point of Bitumen (Ring-and-Ball Apparatus)
D 140 Practice for Sampling Bituminous Materials
D 242 Standard Specification for Mineral Filler For Bituminous Paving Mixtures
D 244 Standard Test Methods for Emulsified Asphalts
D 946 Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
D 977 Standard Specification for Emulsified Asphalt
D 1073 Standard Specification for Fine Aggregate for Bituminous Paving Mixtures
D 2027 Standard Specification for Cutback Asphalt (Medium-Curing Type)
D 2028 Standard Specification for Cutback Asphalt (Rapid-Curing Type)
D 2397 Standard Specification for Cationic Emulsified Asphalt
D 2419 Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
D 3381 Standard Specification for Viscosity-Graded Asphalt Cement for Use in Pavement Construction
D 3910 Standard Practices for Design, Testing, and Construction of Slurry Seal
D 5078 Standard Specification for Crack Filler, Hot-Applied, for Asphalt Concrete and Portland Cement Concrete Pavements
D 6372 Standard Practice for Design, Testing, and Construction of Micro-Surfacing
D 6690 Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements

AASHTO

T 53 Softening Point of Bitumen (Ring-and-Ball Apparatus)
T 59 Testing Emulsified Asphalts
M 208 Standard Specification for Cationic Emulsified Asphalt

ISSA Bulletin #139 “Test Method to Classify Emulsified Asphalt/Aggregate Mixture Systems by Modified Cohesion Tester Measurement of Set and Cure Characteristics”

Manual of Uniform Traffic Control Devices, latest Edition (MUTCD)

2206.3 Crack Sealing/Filling

A. Crack Sealant Application: Material used for crack sealing shall be a modified asphalt product selected to be compatible with the environment of application and found to meet the criteria of ASTM D 6690 with a modified resilience value between 30 and 60 percent, or material meeting the requirements of ASTM D 5078. Crack Sealing shall be understood to be the process of placing an asphaltic material into and/or above working cracks to prevent the intrusion of surface water and/or incompressibles into the crack. A working crack shall be understood to correspond to cracks that sustain more than 0.1 inch of movement during the course of the year.

B. Crack Filling Application: Material used for crack filling shall be a viscosity graded AC-20 asphalt product meeting the criteria of ASTM D 3381 Table 1, a penetration-graded asphalt product having a penetration number in the range of 85-100 measured in accordance with ASTM D 946, or material meeting the criteria of ASTM D 5078. Crack filling material may contain polyester or polypropylene fibers.

C. Material satisfying the criteria of a crack sealant may also be used as a crack filling material. Crack filling shall

be understood to be the process of placing an asphaltic material into non-working cracks to substantially reduce water infiltration and reinforce adjacent cracks. Crack filling materials shall not be used for sealing pavements in preparation for an overlay.

D. Equipment

1. Router: This machine shall be an impact cutter head with a minimum of 6 tungsten-carbide cutters. The router blades shall be driven with a minimum 25-hp gasoline engine.

2. Compressor: The compressor shall be a two-stage compressor rated as a minimum 40 CFM unit capable of delivering compressed air to the nozzle at a minimum pressure of 100 psi. The compressor shall be equipped with a filter trap to eliminate oil and moisture from the air line.

3. Hot-Air Lance (HCA): The hot air lance shall be capable of delivering super-heated air at an exit temperature in excess of 1500 degrees F and at a velocity in excess of 1000 ft/sec against the side walls of the crack. The hose shall be wrapped with reflective tape to keep hoses together and to protect workers in low light situations.

4. Melter/Applicator

   a. The melting pot shall consist of double-boiler type jacket and shall be equipped with a full sweep agitator that promotes proper mixing and maintains uniform heat distribution throughout the melting pot. The melting pot shall have sufficient capacity of the heat transfer oil reservoir that heat transfer oil is able to come in contact with 100 percent of the outside area of the jacket. The melting pot shall be equipped with a drain plug to permit 100% of the heat transfer oil to drain from the boiler. The heat transfer oil shall consist of ISO grade 68.
   b. The heat transfer oil shall be heated with a properly sized vapor fuel LP or diesel fuel burner. The heat shall be applied directly to the bottom of the heat transfer tank. The burner shall be lit by an electric spark igniter controlled by a sensor, which detects a lack of burn or ignition and subsequently shuts down the fuel supply. The unit must be capable of starting at ambient temperature and bringing the sealant up to the required applications temperature within the period of approximately one hour while continuously agitating and recirculating the sealant. The unit shall have the capability of independently monitoring both the transfer oil and melting pot temperatures. The unit shall be capable of heating a variety of application materials within a range of temperatures between 200 º F and 425 º F. The sealant should not be heated to a temperature in excess of that specified by the manufacturer.
   c. The agitator and material pump shall be actuated by hydraulic motors driven by a single, pressure-compensated hydraulic pump. Hydraulic fluid should only be pumped to the agitator or material pump motor on demand.
   d. The sealant shall be applied to the pavement through an application system consisting of a pressure feed hose and wand. The hose shall be specially manufactured to handle liquid asphalt products up to 450 º F at 350 psi working pressure. The hose shall not be less than 15 feet in length. The hand wand shall be constructed of steel of sufficient strength to withstand normal day-to-day operations. Material flow through the wand shall be controlled with a toggle switch. A squeegee shall be used to distribute the asphalt evenly and uniformly in the recommended configuration.
   e. All equipment shall be in good working order, as determined by the Engineer, on a day-to-day basis. The Engineer shall not be responsible for payment of labor or rental charges on days when the equipment is not in good working order.

E. Preparation

1. Crack sealing shall be limited to working, transverse and longitudinal cracks that are more than 1/8-inch in width. Cracks 1/8- to 5/8-inches in width requiring sealing shall be routed to 5/8-inches in width. Cracks 5/8- to 1-inch in width requiring sealing do not require routing but shall be thoroughly cleaned and sealed. Cracks shall be sealed using either the Standard Reservoir and Flush or Standard Recessed Band-Aid configurations. Cracks greater than 1-inch in width shall be filled with either an emulsion slurry and sand, widened and backfilled with Hot-Mix Asphalt (HMA) in compliance with Section 2205, or repaired in a manner approved by the Engineer. Cracks requiring filling do not require any routing but simply thorough cleaning. Cracks shall be filled using either the Simple Band-Aid, Simple Flush Fill, or Capped configurations.

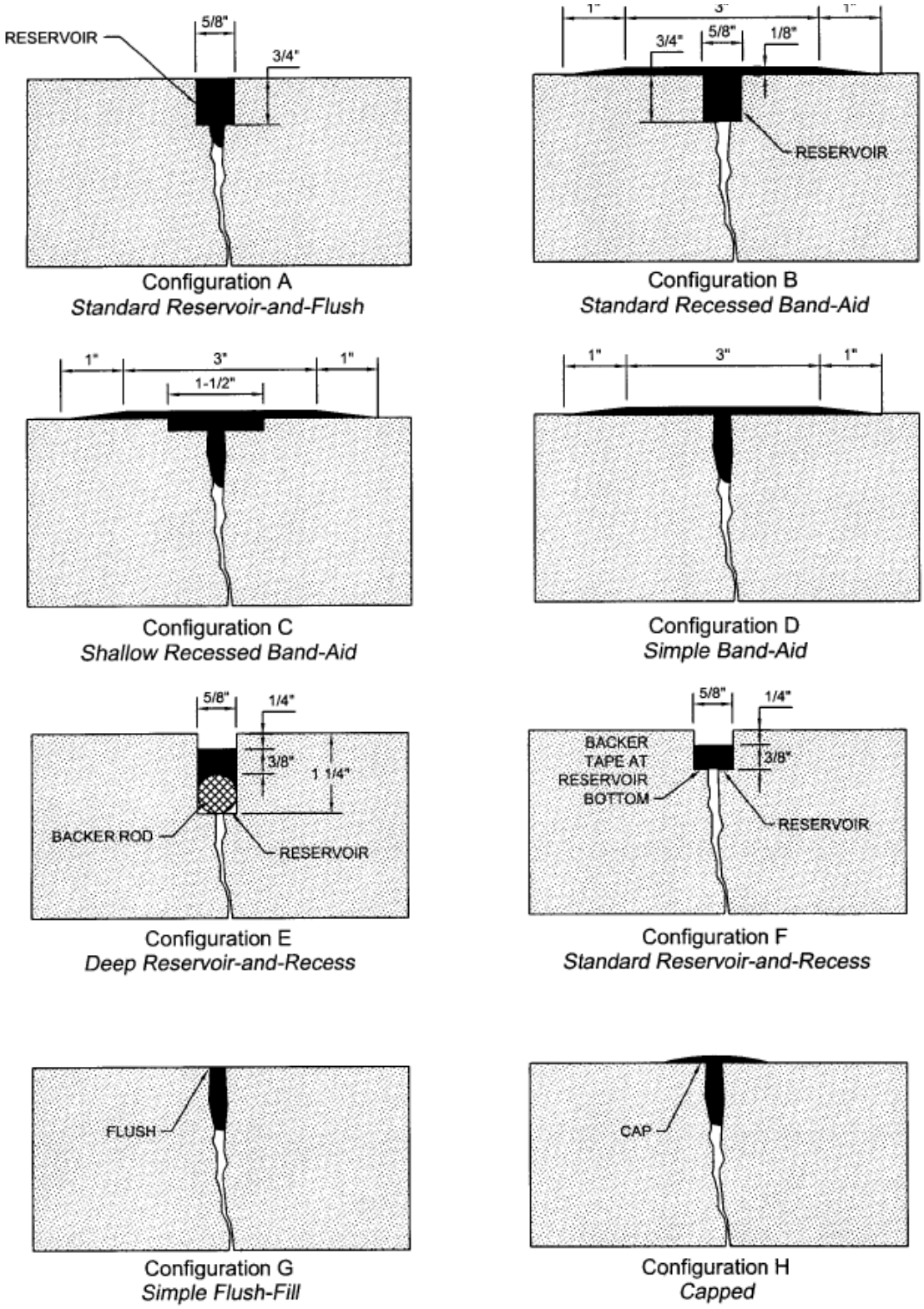
2. Cracks shall be clean and free of all deleterious materials, including any old sealant, incompressibles, and organic material. The crack shall be free of any standing water and any moisture along the sidewalls of the crack as evidenced by a darker color than the adjacent pavement. This shall be accomplished in one of three manners: wire-brushing – where the crack channels are cleaned with a mechanical wire brush followed by high-pressure compressed air; hot air blasting – where the crack channels are cleaned, heated, dried with hot compressed air (HCA) lance connected to a high pressure air compressor; or high-pressure air blasting – where the crack channels are cleaned with high-pressure compressed air. Pavement cracks to be sealed or filled shall be cleaned and dried using one of the methods described previously within 10 minutes of the application of the sealer/filler. Equipment for the two operations should be kept in a compact configuration such that not more than 50 feet separates equipment required by the two operations. Additionally, not more than 10 minutes time shall passed between the cleaning of a crack and the filling of the crack with the appropriate sealing/filling material.

F. Installation

1. Sealer/filler materials should not be applied when the pavement surface is wet or when the pavement temperature is less than 40 º F without the use of hot air blasting or the approval of the Engineer.

2. Sealant/Crack filler should be applied to fill the crack from the bottom to the top in order to prevent air bubbles from forming and creating a point of weakness in the sealant. Upon application, hot sealant/filler material should not make a hissing or popping noise indicative of moisture in the crack. Noises of this kind should indicate that additional drying of the crack is necessary in order to facilitate proper bonding of the material to the sidewalls of the crack. Application of the sealant/filler material shall be made in such a way as to completely fill the crack and provide enough excess to facilitate completion of the seal/fill consistent with the configuration selected. The use of a squeegee or applicator disk to shape the application material to conform to one of the material placement configurations shown on Figure 1 is required. Care shall be taken not to place any sealant/filler material on top of any pavement markings, manholes, or drainage castings. The Contractor shall be responsible to prevent tracking of the sealant/filler material onto the adjacent pavement surfaces to the satisfaction of the Engineer.

3. The manufacturer's technical representative shall be notified by the Contractor and shall be present during the initial installation. Prior to beginning the work, the Contractor will be required to demonstrate to the satisfaction of the Engineer and the manufacturer's representative his ability to apply the material in accordance with the manufacture's specifications. Operations and procedures which are considered by the Engineer as detrimental to the effectiveness of the material will not be permitted.



Material placement configurations for crack treatments

Figure 1

2206.4 Improved Street Chip Seal

A. Description: This work shall consist of the application of a thin, uniform layer of emulsified asphalt to the existing pavement surface in order to universally seal cracks from the intrusion of surface water. Cover aggregate shall then be uniformly distributed upon the asphalt layer and seated in place with the use of a rubber-tired roller. Any excess aggregate material shall be removed, leaving a durable wearing surface.

B. Material Requirements

1. Emulsified Asphalt

a. The asphaltic sealant material applied to the roadway surface shall consists of a rapid-setting emulsified asphalt either an anionic RS-2 meeting the criteria of ASTM D 977 or a cationic CRS-2 meeting the criteria of ASTM D 2397. These materials may be modified with rubber products in the form of liquid latex, styrene-butidane-rubber, or styrene-butidane-styrene to enhance performance of the material as approved by the Engineer. If a polymer-modified material is used, the emulsified asphalt shall meet the additional specification criteria required by the Engineer.

b. A sample of the emulsified asphalt may be taken from any of the distributors or delivery tankers on the job site. Failure of the emulsified asphalt to meet the material specification criteria at the time of application shall require the Contractor, at his own expense, to correct all unsatisfactory areas. No additional areas shall be sealed until correction has been made to the satisfaction or the Engineer.

2. Cover Aggregate – Pre-coated Chips

a. Materials: Aggregate materials shall consist of an approximately cubic and uniformly-graded, hard, durable 100 percent crushed and washed limestone, sandstone, lightweight aggregate, basalt/porphyry, granitic material, steel slag, gravel, or chat. Chat is a by-product from the production of lead and zinc from the area located in southwestern Missouri, northeastern Oklahoma, and southeastern Kansas. Lightweight aggregate shall consist of expanded shale. The application rates reported in these specifications is for the Bethany Falls Limestone in the Kansas City area. The specific gravity of this material is approximately 2.58.

b. Physical properties required of the aggregate materials:

Los Angeles Abrasion (ASTM C131)	35% loss (maximum)
Soundness using Mag. Sulfate (ASTM C 88, 5 cycles)	18% loss (maximum)
Soundness using Sodium Sulfate (ASTM C 88, 5 cycles)	12% loss (maximum)
Total Shale, clay, coal, and lignite content (ASTM C 142)	0.5% by weight (max)
Absorption	4.0% (max)

c. Gradation: Gradation of cover aggregates shall conform to the following percentages:

Sieve Size	Percent Passing
3/4” (19mm)	100
1/2” (12.5mm)	90-95
3/8” (9.5mm)	30-50
No. 4 (4.75mm)	0-5
No. 8 (2.36mm)	0

d. Pre-coating of Chips: Aggregate chips shall be uniformly heated in a dryer until surface dry. All material shall be free of moisture, dust, and lumps and shall be approved by the Engineer prior to use. The aggregate chips shall then be pre-coated with 0.9%+ 0.025% a liquid asphalt cement having a viscosity of 2000 poise, +20%. The asphaltic material and hot aggregate shall be measured separately and accurately immediately before introduction into the mixer. Mixing shall be accomplished at a temperature between 275 º F and 325 º F, sufficient to produce a thoroughly and uniformly coated aggregate. The pre-coated chips shall be stockpiled at least 3 days prior to use.

3. Weighing: Weighing of cover aggregate shall be accomplished by the Contractor on scales that he furnishes for the purpose of weighing the cover aggregate as required in Section 2205.7 entitled "Scales and Weighing of Vehicles." All loads of cover aggregate will be weighed and evidenced by approved delivery tickets showing the net weight in pounds for each load. Two copies of each ticket shall accompany the load to the work site. Upon the load being incorporated in the work, the Engineer will sign both copies and one of these copies will be returned to the Contractor.

C. Spot Patching: Areas where base failure of the roadway has occurred, or where the surface is broken out shall be repaired prior to the sealing operation. The failed sections will be marked by the Engineer, and shall be removed by sawing a neat rectangular hole into the pavement. The failed material shall be removed without damage to the adjacent pavement. Where base failures have occurred, the pavement shall be removed to the subgrade which shall be corrected to the satisfaction of the Engineer prior to patching. Unstable material shall be overexcavated and replaced with base materials meeting the requirements of Section 2203. All surfaces shall be properly primed and tacked in accordance with Section 2204.

The prepared hole shall be patched with hot-mix asphaltic patching material by placing in layers not to exceed 2 inches; each layer being thoroughly compacted before the next layer is placed. After the patching material is placed and raked to a uniform surface, it shall be thoroughly compacted by rolling with a roller meeting the requirements of Section 2205.8. The edges shall be well bonded with the old surface. The completed patch shall be in the same plane as the existing pavement.

The asphaltic concrete used for patching at the different locations shall be as directed by the Engineer and shall conform to one of the mixes as set out in Section 2205.4.

D. Sealing

1. Cleaning: After all holes and cracks have been repaired to the satisfaction of the Engineer, and immediately before sealing the Contractor shall thoroughly clean the area to be sealed with a mechanical pickup type sweeper to insure proper adhesion of the new seal coat to the existing pavement. The street shall be dry before applying the seal coat.

2. Sealing: After the street has been prepared as set forth above the Contractor shall apply the emulsified asphalt by means of an approved distributor meeting the requirements of Section 2204.4. Provisions shall be made by the Contractor to properly protect the curbs and gutters from the asphaltic spray. Emulsified asphalt shall be applied at a rate between 0.28 and 0.35 gallons per square yard. The specific rate for each job will be determined by the Engineer in the field.

Immediately after the application of the asphalt, the Contractor shall, by means of a self-propelled mechanical spreader, apply a uniform layer of cover aggregate. This material shall be spread at the rate specified by the Engineer. This rate shall be between 18 and 25 pounds per square yard of pre-coated limestone chips. The application rate shall be set to prevent bleeding of the asphaltic material

through the cover aggregate. If material is spread on any area in excess of the amount specified by the Engineer, the surplus shall be immediately removed and placed elsewhere as directed. No payment will be made to the Contractor for the picking up and redistribution of such excess. Hand spreading will be permitted only in those areas not accessible to the mechanical spreader.

Immediately after spreading the cover aggregate, the entire surface shall be rolled with multiple-wheel, pneumatic-type rollers meeting the requirements of Section 2205.8. Rolling shall be continued until a thoroughly compacted surface with a uniform aggregate coverage has been obtained, a minimum of 6 passes. The Engineer may require additional rollers if one roller cannot keep up with the operations. The first pass of the rollers over the cover aggregate shall not exceed 3 miles per hour. The rollers shall not exceed 5 miles per hour during any rolling operation.

Forty-eight hours after spreading the cover aggregate, the entire surface shall be swept with a mechanical pickup type sweeper to remove any loose or excess cover aggregate.

During the sealing operation as described above, the Contractor shall cooperate with the Engineer in arranging a program and schedule of work so traffic may be handled or routed around or through the section being sealed. Whenever possible, the street will be closed; but when this is not possible, the sealing will be done in strips while traffic is diverted to the balance of the street. No traffic will be permitted on the sealed portion of the roadway until rolling is completed. All traffic control signage shall conform to the MUTCD handbook for traffic control in work zones.

When bleeding occurs or more material is required, additional cover aggregate shall be spread as directed. As soon as the cover material has adhered to the surface, and the emulsion is thoroughly cured all excess cover aggregate shall be removed with a mechanical pickup type sweeper. This curing period is generally 48 hours, but may be adjusted by the Engineer.

2206.5 Unimproved Street Chip Seal

A. Description: This work shall consist of the application of a thin, uniform layer of liquified asphalt to the surface of the existing roadway which may either consist of an existing surface of asphaltic concrete pavement or a gravel-surfaced road. Cover aggregate shall then be distributed uniformly upon the liquified asphalt and seated in place with the use of a rubber-tired roller leaving a durable wearing surface.

B. Requirements for Liquified Asphalt Materials

Asphaltic materials used for the sealing of unimproved streets shall be liquified either by the introduction of a diluent (cutback) or by emulsification. The particular grade of cutback material for use on a particular roadway shall be determined by the Engineer. Cutback asphaltic materials shall comply with the requirements of either ASTM D 2027 or ASTM D 2028. The particular grade of emulsified asphalt material for use on a particular roadway shall be determined by the Engineer. Anionic emulsified asphaltic materials shall comply with the requirements for either a rapid or medium-setting emulsion as described in ASTM D 977 while cationic emulsified asphaltic materials shall comply with the requirements for either a medium or rapid-setting emulsion as described in ASTM D 2397.

C. Requirements for Cover Aggregate Materials

1. Aggregate materials shall consist of an approximately cubical and uniformly-sized, hard, durable 100 percent crushed and washed limestone, sandstone, lightweight aggregate, basalt/porphyry, granitic material, steel slag, gravel, or chat. Chat is a by-product from the production of lead and zinc from the area located in southwestern Missouri, northeastern Oklahoma, and southeastern Kansas. Lightweight

aggregate shall consist of expanded shale. Due to the variation in specific gravities between these materials, the application rate will need to be adjusted to reflect the change in specific gravity. The application rates reported in these specifications is for the Bethany Falls Limestone in the Kansas City area. The specific gravity of this material is approximately 2.58.

2. Physical properties required of the aggregate materials:

Los Angeles Abrasion (ASTM C 131)	35% loss (maximum)
Soundness using Mag. Sulfate (ASTM C88, 5 cycles)	18% loss (maximum)
Soundness using Sodium Sulfate (ASTM C 88, 5 cycles)	12% loss (maximum)
Total Shale, clay, coal, and lignite content (ASTM C 142)	0.5% by weight (max)
Absorption	4.0% (max)

Aggregate chips applied to cutback asphalt shall be shown to have a moisture content less than 1 percent immediately prior to application. Aggregate chips applied to emulsified asphalt shall be shown to have a moisture content of 3 percent or less immediately prior to application.

Gradation for aggregate chips used for Single sealing:

Square Sieve Size	Percent Passing
1/2" (12.5mm)	100
3/8" (9.5mm)	80-100
No. 4 (4.75 mm)	0-26
No. 10 (2.00mm)	0-2

Gradation for aggregate chips used for the first application of a Double sealing:

Square Sieve Size	Percent Passing
3/4" (19mm)	100
1/2" (12.5mm)	90 to 100
3/8" (9.5mm)	40 to 70
No. 4 (4.75mm)	0 to 15
No. 10 (2.0mm)	0-2

Gradation for aggregate chips used for the second application of a Double sealing shall conform to the gradation for a Single sealing above.

The Contractor shall furnish scales for weighing cover aggregate as required in Section 2201.7 entitled "Scales and Weighing of Vehicles". All loads of cover aggregate will be weighed as required, and evidenced by approved delivery tickets showing the net weight in pounds for each load. Two copies of each ticket shall accompany the load to the work site. In order for the load to be received and incorporated into the work, both copies will be signed by the Engineer (or inspector) and one of these copies returned to the Contractor.

D. Sealing

Sealing shall be accomplished in the same manner as described in Section 2206.3.D except as modified herein. Where a seal coat is applied to a gravel-surface roadway the surface shall be prepared in accordance with Section 2204.4. The surface shall then be primed in accordance with Section 2204.4 prior to the application of the seal coat.

The application rate of cutback asphalt shall be in the range 0.25 to 0.45 gallons per square yard as directed by the Engineer or demonstrated to result in a satisfactory seal in a test strip provided by the Contractor. Anti-Strip agent may be added to Cutback Asphalt at a rate not to exceed 1 percent of the residual asphalt volume as directed by the Engineer in order to improve adhesion of the asphalt to the moist aggregates. The cutback agent shall be thoroughly mixed and blended with the cutback asphalt. The application rate of emulsified asphalt shall be in the range of 0.28 to 0.40 gallons per square yard as approved or directed by the Engineer. The distributor used shall meet the requirements of Section 2204.4.

Limestone materials shall be spread at the rate specified by the Engineer with the range of 16 to 24 pounds per square yard.

Where double sealing is indicated on the Plans or required by the Engineer, the area shall be treated with two seal coats. The application rate of the asphaltic material for the first application shall be approximately one-half of that used for a single seal with the remainder applied during the second seal application. The application rate of the first application of cover aggregate shall be within the range specified for a single seal. The application rate of the second application shall be approximately one-half the application rate of the first layer.

2206.6 Improved Street Slurry Seal

A. Description: This work shall consist of the application of Slurry Seal Material to an existing surface. The Slurry Seal shall consist of a mixture of emulsified asphalt, mineral aggregate and potable water, properly proportioned, mixed and spread on the surface in accordance with this specification and as directed by the Engineer.

B. Material

1. Emulsified Asphalt: The emulsified asphalt shall conform to Grade SS-1h of ASTM D 977, for emulsified asphalt, or Grade CSS-1h of ASTM D 2397, for cationic emulsified asphalt. Quick-set emulsified asphalts QS-1h and CQS-1h may also be used. They shall conform to ASTM D 977 and ASTM D 2397 respectively, except that the test requirements for cement mixing and storage stability shall not apply. Refer to the International Slurry Surfacing Association (ISSA) Bulletin No. 139. The emulsified asphalt shall have not less than 60% residue after distillation when tested using ASTM D 244 and shall have a penetration of between 40 and 90 when tested using ASTM D 2397 at 77° F. Each load of emulsified asphalt delivered shall have a certificate of analysis/compliance matching the material used in the mix design.

2. Aggregate for Slurry Seal: The mineral aggregate used for this work shall be natural or manufactured crushed granite, slag, or chat which is a byproduct of the milling of lead and zinc ores and shall conform to one of the following grading requirements when tested in accordance with ASTM C 136 and ASTM C 117. All aggregate shall conform to the quality requirements of ASTM D 1073.

GRADING REQUIREMENTS FOR AGGREGATE			
Sieve Size	Amount Passing Sieves, Weight %		
	Type I	Type II	Tolerance
3/8 inch (9.5 mm)	100	100	
No. 4 (4.75 mm)	100	90 – 100	+/- 5%
No. 8 (2.36 mm)	90 – 100	65 – 90	+/- 5%
No. 16 (1.18 mm)	65 – 90	45 – 70	+/- 5%
No. 30 (600 um)	40 – 65	30 – 50	+/- 5%
No. 50 (300 um)	25 – 42	18 – 30	+/- 4%
No. 100 (150 um)	15 – 30	10 – 21	+/- 3%
No. 200 (75 um)	10 - 20	5 – 15	+/- 2%

The percent passing the No. 200 (75 um) sieve shall be determined by ASTM C 117.

3. Mineral Filler: Mineral Fillers are of two types, chemically active and chemically inactive. Both shall conform to ASTM D 242. Chemically active mineral fillers such as Portland cement, hydrated lime, and ammonium sulfate are used to improve workability, regulate the setting time, and, in some cases, to alter the aggregate gradation. Chemically inactive mineral fillers such as limestone dust, fly ash, and rock dust are used mainly to alter aggregate gradation.

4. Water: All water used shall be potable and shall be free of harmful salts or contaminates.

5. Mix Design: The Engineer shall approve all slurry seal materials and methods prior to mixing and application. The Contractor shall submit a completed and tested slurry seal mix design for the Engineer's approval. The approved test method for emulsified asphalt slurry seal shall be found in ASTM D 3910. The mix design shall be made with the same materials the Contractor will be using on the project. The percentage of each material must be shown on the mix design. Proportions of the mixture shall be as follows unless variations are approved by the Engineer:

	TYPE I	TYPE II
Aggregate for Slurry Seal	8.0 to 12.0 lbs per sq yd 3.63 to 5.44 kg/m^2 (dry basis)	13.5 to 16.5 lbs per sq yd 7.32 to 8.95 kg/m^2 (dry basis)
Emulsified Asphalt (Residual Asphalt Content)	10.0 to 16.0% by weight of dry aggregate	7.5 to 13.5% by weight of dry aggregate
Mineral Filler	1.5 to 3.0% by weight of dry aggregate	1.5 to 3.0% by weight of dry aggregate
Water	Minimum amount necessary to obtain a fluid and homogenous mixture	Minimum amount necessary to obtain a fluid and homogenous mixture

Once the proper consistency is obtained, changes in proportioning of the various components of the mixture shall be held to a minimum.

6. Application Rates: The slurry seal mixture shall be of proper consistency at all times so as to provide the application rate required by the surface condition and shall be in accordance with the following:

Type I: 8.0 to 12.0 lbs per sq yd
Type II: 13.5 to 20 lbs per sq yd

Application rates are affected by the unit weight of the aggregate, the gradation of the aggregate and

the demand of the surface to which the slurry seal is being applied.

7. Equipment: The slurry mixing machine shall be a continuous flow mixing unit and shall be capable of delivering accurately a predetermined proportion of aggregate, water and asphalt emulsion to the mixing chamber and to discharge the thoroughly mixed product on a continuous basis. The equipment shall be capable of pre-wetting the aggregate immediately prior to mixing with the emulsion. The mixing unit of the mixing chamber shall be capable of thoroughly blending all of the components together without violent mixing. The mixing machine shall be equipped with an approved fines feeder that includes an accurate metering device or method to introduce a predetermined proportion of mineral filler into the mixer. The mineral filler shall be fed at the same time and location as the aggregate. The fines feeder shall be required whenever added mineral filler is a part of the aggregate blend. The mixing machine shall be equipped with a water pressure system and fog-type spray bar, adequate for complete fogging of the surface receiving slurry treatment. Attached to the mixer machine shall be a mechanical type squeegee distributor, equipped with flexible material in contact with the surface of the pavement to prevent loss of slurry from the distributor. It shall be maintained so as to prevent loss of slurry on varying grades and crown by adjustments to insure uniform spread. There shall be a steering device and a flexible strike-off. The spreader box shall have an adjustable width. The box shall be kept clean and build-up of asphalt and aggregate on the box or in the corners shall not be permitted. Use of burlap drags or other drags shall be approved by the Engineer. Hand squeegees, shovels, and other equipment shall be provided if necessary to supplement the slurry mixing machine. Power brooms, power blowers, air compressors, and hand brooms suitable for cleaning the surface and cracks of the existing surface shall be implemented to provide a clean surface.

8. Construction Requirements

   a. Surface Preparation: Immediately prior to applying the slurry, clean the surface of all loose material, mud spots, vegetation, and other objectionable material. Any standard cleaning method used to clean pavements will be acceptable except water flushing. A pickup sweeper must be used unless otherwise approved by the Engineer. Manholes, valve boxes, drop inlets, and other service entrances shall be protected from the slurry seal by a method approved by the Engineer.
   b. Application: The surface shall be pre-wetted by fogging ahead of the slurry box unless waived by the Engineer. Water used in pre-wetting the surface shall be applied at such a rate that the entire surface is damp with no apparent flowing water in front of the slurry box. The slurry mixture shall be of the desired consistency upon deposit on the surface and no additional elements shall be added. Total time of mixing shall not exceed four (4) minutes. A sufficient amount of slurry shall be carried in all parts of the spreader at all times so that a complete coverage is obtained. Overloading of the spreader shall be avoided. No lumping, balling, or unmixed aggregate shall be permitted. No segregation of the emulsion and aggregate fines from the coarse aggregate shall be permitted. If the coarse aggregate settles to the bottom of the mix, the slurry shall be removed from the pavement. No excessive breaking of emulsion shall be allowed in the spreader box. No streaks, such as those caused by oversized aggregate will be left in the finished pavement.
   c. Hand Work: Approved squeegees shall be used to spread slurry in areas not accessible to the slurry mixer. Care should be exercised in leaving no unsightly appearance from the hand work.
   d. Curing: Treated areas shall be allowed to cure for four hours, or until such time as the Engineer permits their opening to traffic.
   e. Weather Limitation: The slurry seal shall not be applied if either the pavement or air temperature is below 60° F and falling. The mixture shall not be applied if the relative

humidity exceeds 80%.

f. Traffic Control: Suitable methods shall be used to protect the slurry from all types of traffic until sufficiently cured to accept traffic. The length of time before traffic is permitted to use the surface depends on the type of emulsified asphalt, mixture characteristics, and weather conditions.

g. Lines: Care shall be taken to insure straight lines along curb and shoulders. No runoff on these areas will be permitted. Lines at intersections will be kept straight to provide good appearance.

h. Property Owners Notification: The Contractor shall supply and place door tags on the doors of all involved property owners. The door tag language shall be approved by the Engineer.

i. Provisions for Public Convenience During Sealing Operation: The Contractor shall provide and maintain sufficient signs, barricades, warning lights, flag persons and watch persons to protect the work and public in a manner satisfactory to the Engineer. Any areas damaged prior to acceptance by the Engineer shall be repaired at the Contractor's expense. "No Parking" signs will be furnished by the Contractor. These signs shall comply with the standards established by the MUTCD with regard to size, color, working height and placement. When "No Parking" signs are posted on the streets with parking meters, the Contractor shall cover the parking meter heads with cloth or paper bags. The Contractor shall take all necessary precautions to protect the public (pedestrian and vehicular) from flying debris. The Contractor shall use warning signs and devices to warn motorists and pedestrians of work ahead.

2206.7 Improved Street Micro-Surfacing

A. Description: This work shall consist of the application of a polymer modified asphalt emulsion, mineral aggregate, mineral filler, potable water, and other additives, properly proportioned, mixed and spread on a paved surface in accordance with this specification and as directed by the Engineer.

B. Materials

1. Emulsified Asphalt: The emulsified asphalt shall be a quick wet polymer modified asphalt emulsion conforming to the requirements specified in ASTM D 2397 or AASHTO M 208 for Grade CSS-1h. The cement mixing test shall be waived for this emulsion. The polymer material shall be milled or blended into the asphalt or emulsifier solution prior to the emulsification process. The emulsified asphalt shall have not less than 62% residue after distillation when tested using ASTM D 244. The temperature for this test shall be held below 280° F. Higher temperatures may cause the polymers to break down. In addition, the emulsified asphalt shall have a penetration of between 40 and 90 when tested using ASTM D 2397 at 77° F (25° C) and shall have a minimum softening point of 135° F when tested using ASTM D 36. Each load of emulsified asphalt delivered shall have a certificate of analysis/compliance matching the material used in the mix design.

2. Aggregate for Micro-Surfacing: The aggregate shall be a manufactured crushed stone such as granite, or chat which is a by-product of the milling of lead and zinc ores. The aggregate shall be totally crushed with 100% of the parent aggregate being larger than the largest stone in the gradation to be used. The mineral aggregate used shall conform to one of the following grading requirements when tested in accordance with ASTM C 136 and ASTM C 117. All aggregate shall conform to the quality requirements of ASTM D 1073.

GRADING REQUIREMENT FOR AGGREGATE			
Sieve Size	Amount Passing Sieves, Weight %		
	Type I	Type II	Tolerance
3/8 inch (9.5 mm)	100	100	
No. 4 (4.75 mm)	90 – 100	70 – 90	+/- 5%
No. 8 (2.36 mm)	65 – 90	45 – 70	+/- 5%
No. 16 (1.18 mm)	45 – 70	28 – 50	+/- 5%
No. 30 (600 um)	30 – 50	19 – 34	+/- 5%
No. 50 (300 um)	18 – 30	12 – 25	+/- 4%
No. 100 (150 um)	10 – 21	7 – 18	+/- 3%
No. 200 (75 um)	5 - 15	5 – 15	+/- 2%

The combined aggregate prior to the addition of any chemically active mineral filler shall have a sand equivalent of not less than 65 when tested by ASTM D 2419. The aggregate shall have a weighed average loss not greater than 25% using magnesium sulfate when tested by ASTM C 88. Testing of abrasion resistance shall not exceed 30% when tested by ASTM C 131.

3. Mineral Filler: Mineral filler shall be any recognized brand of non-air entrained Portland cement or hydrated lime. The mineral filler shall be free of lumps and accepted upon visual inspections. The type and amount of mineral filler needed shall be determined by a laboratory mix design and will be considered as part of the aggregate gradation.

4. Water: All water used shall be potable and shall be free of harmful salts or contaminates.

5. Additives: Additives may be added to the emulsion mix or any of the component materials to provide the control of the quick-traffic properties. They must be included as part of the mix design and be compatible with the other components of the mix.

6. Mix Design: The Engineer shall approve all micro-surfacing materials and methods prior to mixing and application. The Contractor shall submit a completed and tested micro-surfacing mix design for the Engineer's approval. The approved test method for micro-surfacing shall be found in ASTM D 6372. The mix design shall be made with the same materials the Contractor will be using on the project. The percentage of each material must be shown on the mix design. Proportions of the mixture shall be as follows unless variations are approved by the Engineer.

	TYPE I	TYPE II
Aggregate for Micro-surfacing	10.0 to 20.0 lbs per sq yd 4.53 to 9.07 kg/m^2 (dry basis)	13.5 to 16.5 lbs per sq yd 7.32 to 8.95 kg/m^2 (dry basis)
Emulsified Asphalt (Residual Asphalt Content)	7.5 to 13.5% by weight of dry aggregate	7.5 to 13.5% by weight of dry aggregate
Polymer Based Modifier	Minimum of 3% solids based on asphalt weight content	Minimum of 3% solids based on asphalt weight content
Additive	As needed	As needed
Mineral Filler	0.0 to 3.0% by weight of dry aggregate	0.0 to 3.0% by weight of dry aggregate
Water	Minimum amount necessary to obtain a fluid and homogenous mixture	Minimum amount necessary to obtain a fluid and homogenous mixture

Once the proper consistency is obtained, changes in proportioning of the various components of the mixture shall be held to a minimum.

7. Application Rates: The Micro-Surfacing mixture shall be of proper consistency at all times so as to provide the application rate required by the surface condition and shall be in accordance with the following:

   Type II: 10.0 to 20.0 lbs per sq yd
   Type III: 15.0 to 30.0 lbs per sq yd

   Application rates are affected by the unit weight of the aggregate, the gradation of the aggregate, and the demand of the surface to which the micro-surfacing is being applied.

8. Equipment

   a. Micro-Surfacing Mixing Equipment: The micro-surfacing mixing machine shall be specifically designed and manufactured to lay micro-surfacing. The machine shall be self-propelled, continuous flow mixing unit able to accurately deliver and proportion the aggregate, emulsified asphalt, mineral filler, control setting additive, and water to a revolving multi-blade double-shafted mixer and discharge the mixed product on a continuous flow basis. The machine shall have sufficient storage capacity for aggregate, emulsified asphalt, mineral filler, control additive, and water to maintain an adequate supply to the proportioning controls. On major highway work, the machine may be required to be a self-loading machine capable of loading materials while continuing to lay micro-surfacing. The self-loading machine shall be equipped to allow the operator to have full control of the forward and reverse speed during application of the micro-surfacing material and be equipped with opposite side drivers stationed to assist in alignment. The self-loading device, opposite side drivers stations, and forward and reverse speed controls shall be original equipment manufacturer designed.
   b. Proportioning Devices: Individual volume or weight controls for proportioning each material, and used in material calibration, shall be provided and properly marked.
   c. Calibration: Each mixing unit to be used in the performance of the work shall be calibrated prior to construction. Calibration documentation shall include an individual calibration of each material at various settings, which can be related to the machine metering devices. No machine will be allowed to work on the project until a calibration has been completed. Final calibration sheets shall be provided to the Engineer for acceptance.
   d. Micro-Surfacing Spreading Equipment: The machine shall include a surfacing box with twin-

shafted paddles or spiral augers fixed in a spreader box. A flexible front seal shall be provided to insure no loss of mixture at the road surface contact point. The rear flexible seal shall act as a final strike-off and shall be adjustable in width. The spreader box and rear strike-off shall be so designed and operated that a uniform consistency is achieved to produce a free flow of material to the rear strike-off box. The box shall have suitable means provided to side-shift the box to compensate for variations of pavement geometry. A secondary strike-off shall be provided to improve the surface texture. It shall have the same leveling adjustments as the spreader box.

e. Auxiliary Equipment: Hand squeegees, shovels, traffic control equipment, and other support and safety equipment shall be provided as necessary to perform the work.

f. Cleaning Equipment: Power brooms, pickup sweepers, power blowers, air compressors, and hand brooms suitable for cleaning shall be utilized to provide a clean surface.

9. Construction Requirements

a. Surface Preparation: Immediately prior to applying the micro-surfacing, the surface shall be cleaned of all loose material, silt spots, vegetation, and objectionable material as determined by the Engineer. Any standard cleaning method used to clean pavements will be acceptable except water flushing. Manholes, valve boxes, drop inlets, and other service entrances shall be protected from the micro-surfacing by a method approved by the Engineer.

b. Application: If the pavement area to be covered is extremely oxidized and raveled or is concrete or brick, a tack coat may be required at the discretion of the Engineer. The tack coat shall conform to Section 2204 and shall be a SS or CSS grade. The tack coat shall be allowed to break sufficiently before the application of micro-surfacing. The surface shall be pre-wetted by fogging ahead of the spreader box unless waived by the Engineer. Water used in pre-wetting the surface shall be applied at such a rate that the entire surface is damp with no apparent flowing water in front of the spreader box. The micro-surfacing mixture shall be of the desired consistency upon deposit on the surface and no additional elements shall be added. A sufficient amount of material shall be carried in all parts of the spreader box at all times so that a complete coverage is obtained. Overloading of the spreader box shall be avoided. No lumping, balling, or unmixed aggregate shall be permitted. No streaks, such as those caused by oversized aggregate shall be left in the finished surface.

c. Hand Work: Areas which cannot be reached with the mixing machine shall be surfaced using approved hand squeegees to provide a complete and uniform coverage. If necessary, the area to be hand-worked shall be lightly dampened prior to mix placement. The same type of finish as applied by the spreader box shall be required.

d. Curing: Micro-surfacing shall be allowed to cure for one hour, or until the Engineer permits opening the street to traffic.

e. Weather Limitation: Micro-surfacing shall not be applied if either the pavement or air temperature is below 60° F and falling. The mixture shall not be applied if the relative humidity exceeds 80%.

f. Traffic Control: Suitable methods shall be used to protect the micro-surfacing from all types of traffic until sufficiently cured to accept traffic. The length of time before traffic is permitted to use the surface shall be determined by the Engineer.

g. Lines: Care shall be taken to insure straight lines along curb and shoulders. No runoff on these areas will be permitted. Lines at intersections will be kept straight to provide good appearance.

h. Property Owners Notification: The Contractor shall supply and place door tags on the doors of all involved property owners. The door tag language shall be approved by the Engineer.

i. Provisions for Public Convenience During Surfacing Operation: The Contractor shall provide and maintain sufficient signs, barricades, warning lights, flag persons and watch persons to

protect the work and public in a manner satisfactory to the Engineer. Any areas damaged prior to acceptance by the Engineer shall be repaired at the Contractor's expense. "No Parking" signs will be furnished by the Contractor. These signs shall comply with the standards established by the MUTCD with regard to size, color, working height and placement. When "No Parking" signs are posted on the streets with parking meters, the Contractor shall cover the parking meter heads with cloth or paper bags. The Contractor shall take all necessary precautions to protect the public (pedestrian and vehicular) from flying debris. The Contractor shall use warning signs and devices to warn motorists and pedestrians of work ahead.

2206.8 Method of Measurement

A. Asphaltic Crack Seal will be measured per pound.

B. Chip seal will be measured by one of the following:

1. Per square yard or tenth part thereof.

2. Actual quantities used:

a. Asphaltic concrete patch, per ton or tenth part thereof.
b. Bitumen (asphaltic cement or liquid asphalt) per gallon.
c. Coated cover aggregate, per ton or tenth part thereof.

C. Slurry seal will be measured per square yard or tenth part thereof.

D. Micro-surfacing will be measured per square yard or tenth part thereof.

2206.9 Basis of Payment

A. Asphaltic Crack Seal will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

B. Chip Seal will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

C. Slurry Seal will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

D. Micro-surfacing will be paid for by one of the following:

1. Contract unit bid price.

2. Contract lump sum bid price.

SECTION 2207 COLD MILLING

2207.1 Scope

This section governs the furnishing of all labor, materials and equipment for the performance of cold milling pavement surfaces as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions. This work will consist of the removal of the existing surface, loading, hauling, and stockpiling, if required, of the milled material and the cleaning of the milled surface.

2207.2 Equipment

Milling the surface of pavements shall be completed by the use of a milling machine conforming to the following:

A. Machine: The cold milling machine shall be self-propelled and able to automatically control grade and slope of the milled surface. Operate the automatic grade and slope control from a travelling stringline a minimum of 30 feet long, attached the milling machine and operating parallel to the direction of travel. Other methods of positive grade control may be used if approved by the Engineer. The machine shall have the means of milling without damaging the remaining pavement (torn, gouged, shoved, broken, etc.). The machine shall be capable of blading the cuttings into a single windrow or depositing them directly into a truck.

B. Air Pollution: The machine shall be equipped with a dust suppression system including water storage tanks and high pressure spray bars.

C. Operating Width: It is desirable that the cutting width be greater than 6 feet. In the event the cutting width is less than 6 feet, a system of electronic grade control for consecutive passes will be required.

D. Cutting Drum: The cutting drum shall be totally enclosed to prevent discharge of any loosened material on adjacent work areas.

2207.3 Construction

A. Methods of Operations for Milling

1. Utilities: Street surfaces adjacent to manholes, water valves and other utility extensions shall be completely removed to the full depth of cut specified for the street unless otherwise specified by the Engineer.

2. Material Disposal: All material from the milling operation shall be removed immediately from the surface of the pavement and properly disposed of by the Contractor at an approved disposal area.

3. Surface Conditions: The drum lacing patterns shall produce a smooth surface finish after milling, with groove depths not to exceed 1/4 inch and groove spacing not to exceed 1 inch unless otherwise approved by the Engineer.

B. Types of Cuts to be made by Milling

1. Leveling: Sufficient passes shall be made such that all irregularities or high spots are eliminated, and that 100% of the surface is milled.

2. Average Depth: Sufficient passes, or cuts, shall be made in order to remove a specified depth over the entire street section. These depths will be designated in the Plans or Special Provisions.

3. Curb Cut: Sufficient passes or cuts shall be made to remove the specified depth at the curb for a specified width. These dimensions will be designated in the Plans or Special Provisions.

4. Bridge Deck Milling: Sufficient passes, or cuts, shall be made in order to remove the material as specified on the Plans or in the Special Provisions.

C. Cleanup: All loose asphalt and debris shall be removed from the street surface and curb and gutter. Any material and debris that adheres to the curb and gutter shall be removed.

D. Opening to Traffic: If the milled area will be opened to traffic prior to surfacing, provide a smooth riding surface by either milling or placing a wedge of hot mix asphalt or other approved material of a thickness and design that will remain in place under traffic. The transition between the milled area and transverse joints shall be a minimum of 1 vertical to 24 horizontal. The transition between the milled surface and manholes, utility fixtures or other appurtenances shall be a minimum of 1 vertical to 12 horizontal. Transitions shall be removed prior to surfacing.

2207.4 Method of Measurement

Cold milling will be measured per square yard or tenth part thereof for the specified depth.

2207.5 Basis of Payment

Cold milling will be paid for by one of the following:

A. Contract unit bid price.

B. Contract lump sum bid price.

SECTION 2208 PORTLAND CEMENT CONCRETE PAVEMENT

2208.1 Scope

This section governs the furnishing of all labor, materials and equipment for the placement of Portland Cement Concrete Pavement as shown on the Plans and in accordance with the Standard Drawings, the specifications, and the Special Provisions.

2208.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM
A 615 Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
A 775 Standard Specification for Epoxy-Coated Steel Reinforcing Bars

A 1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
C 31 Standard Practice for Making and Curing Concrete Test Specimens in the Field
C 39 Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
C 143 Standard Test Method for Slump of Hydraulic-Cement Concrete
C 172 Standard Practice for Sampling Freshly Mixed Concrete
C 231 Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C 309 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
C 1064 Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete

D 1751 Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
D 1752 Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
D 2628 Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
D 2835 Standard Specification for Lubricant for Installation of Preformed Compression Seals in Concrete Pavements
D 6690 Standard Specification for Joint and Crack Sealants, Hot-Applied, for Concrete and Asphalt Pavements
D 7174 Standard Specification for Preformed Closed-Cell Polyolefin Expansion Joint Fillers for Concrete Paving and Structural Construction
E 965 Test Method for Measuring Surface Macrotexture Depth Using a Sand Volumetric Technique

AASHTO
M 148 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
M 213 Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
M 324 Joint Sealants, Hot-Poured, for Concrete and Asphalt Pavements

MCIB Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement
The current editions of the "Bulletins" and Approved Sections of the "Standard Concrete Specifications" issued by the Mid-West Concrete Industry Board, Inc. (MCIB) are made a part hereof by reference. However, when the provisions of this Specification differ from the provisions of such "Bulletins" and "Sections" the provisions of this Specification shall govern.

KCMMB Kansas City Metro Materials Board Specifications

Kansas Department of Transportation
Standard Specifications for State Road and Bridge Construction, 2015 Edition

Missouri Highways and Transportation Commission
Missouri Standard Specifications for Highway Construction, 2011 Edition

National Concrete Pavement Technology Center Guide Specifications for Concrete Overlays, September 2015, including latest revisions

2208.3 Materials

A. Concrete: Concrete shall conform to referenced specifications as called out in the Contract Documents. If no direct reference to concrete specifications is included in the Contract Documents, concrete shall meet KCMMB

specifications.

1. If KCMMB concrete is specified, an approved KCMMB concrete mix shall be required.

2. If MCIB concrete is specified, concrete shall comply with MCIB Section entitled “Concrete Pavement”.

3. If KDOT specifications are referenced for concrete, provide material in compliance with the latest version of KDOT specifications. Approval of component materials will be based on submittal of certifications from supplier. Aggregates shall meet the quality requirements specified by KDOT. Engineer reserves the right to perform testing of components to verify compliance.

4. If MoDOT specifications are referenced, provide material in compliance with the latest version of MoDOT specifications. Approval of component materials will be based on submittal of certifications from supplier. Aggregates shall meet the quality requirements specified by MoDOT. Engineer reserves the right to perform testing of components to verify compliance.

5. Proposed concrete mix designs for use on the project shall be submitted to Engineer for approval at least two (2) weeks in advance of anticipated use. Mix design shall be approved prior to use of that mix.

6. Field testing of concrete shall be performed by the Engineer at the frequency required by the referenced specification. Unless otherwise specified, the following tests shall be performed once for every 50 cuyd of concrete placed:

    a. Sampling of fresh concrete per ASTM C 172
    b. Slump per ASTM C 143
    c. Air Content per ASTM C 231
    d. Temperature per ASTM C 1064
    e. Cylinders cast per ASTM C 31 and tested per ASTM C 39. Four cylinders shall be cast with one tested at 7 days, 2 tested at 28 days and one held in reserve.

7. For concrete overlays, material and construction specifications shall be governed by the National Concrete Pavement Technology Center Guide Specifications for Concrete Overlays, September 2015, including latest revisions.

B. Reinforcement

1. Bars: Non-epoxy coated bars shall conform to ASTM A 615. Epoxy coated bars shall conform to ASTM A 775.

2. Welded Steel Wire: Welded steel wire fabric shall conform to ASTM A 1064.

3. Supporting Elements: Representative samples of supporting elements shall be submitted and approved by the Engineer prior to their use in the project.

4. Fibers: When specified in the Contract Documents, fibers shall be incorporated into the concrete at the rate recommended by the manufacturer but no less than a minimum of 3 pounds per cubic yard of concrete for macro fibers and 1 pound per cubic yard of concrete for micro fibers. Fibers shall meet the requirements of KDOT Standard Specifications for State Road and Bridge Construction, 2015 Edition, Section 1722.2. Micro fibers are used to control plastic shrinkage cracks in concrete while macro fibers control cracking in hardened concrete and are often used as a substitute for traditional crack

control steel reinforcing bars or mesh. In addition, macro fibers add toughness, and impact and fatigue resistance to hardened concrete.

C. Isolation Joint Fillers: Isolation joint fillers shall conform to ASTM D 1751, D 1752, or ASTM D 7174.

D. Joint Sealing Compounds: Joint sealing compounds shall conform to the standards for the type of sealant specified as listed in the following table:

Joint Seals and Sealants	AASHTO	ASTM
Hot-poured, Polymeric Asphalt Based	M 324	D 6690
Preformed Polychloroprene Elastomeric		D 2628
Lubricant for Installation of Preformed Seal	-----	D 2835
Preformed Expansion Joint Filler	M 213	D 1751, D 1752 or D 7174

E. Curing Membrane: All material to be used or employed in curing Portland Cement Concrete must be approved by the Engineer prior to its use. It shall be of the liquid membrane type and shall conform to ASTM C 309, Type II, Class B or AASHTO M 148, Type 2, white pigmented.

2208.4 Construction

Portland Cement Concrete Pavement shall be constructed to the configuration, and to the lines and grades shown on the Plans.

A. Grading, Subgrade Preparation and Base Course: All excavation, embankment, subgrade stabilization or aggregate base course required shall be as defined in Sections 2100 “Grading and Site Preparation”, 2201 "Subgrade Preparation", 2202 “Subgrade Stabilization”, and 2203 “Aggregate Base Course”. If areas of the subgrade are below the lines, grades and cross-sections shown on the Plans, they shall be brought to the proper line, grade and cross-section by one of the following:

1. Additional fill material placed in accordance with applicable sections.

2. Areas may be filled with additional thickness of Portland Cement Concrete Pavement.

B. Surface Preparation for Concrete Overlay: Prepare surface for concrete overlay as specified in the National Concrete Pavement Technology Center Guide Specifications for Concrete Overlays, September 2015.

C. Forms: All forms shall be in good condition, clean, and free from imperfections. Each form shall not vary more than 1/4 inch in horizontal and vertical alignment for each 10 feet of length.

1. Material & Size: Forms shall be made of metal and shall have a height equal to or greater than the prescribed edge thickness of the pavement slab. Wood forms may be substituted when approved by Engineer and if they are free from warp with sufficient strength for the intended application.

2. Strength: Forms shall be of such cross-section and strength, and so secured as to resist the pressure of the concrete when struck off, vibrated, and finished, and the impact and vibration of any equipment which they may support.

3. Installation: Forms shall be set true to line and grade, supported through their length and, joined neatly in such a manner that the joints are free from movement in any direction.

4. Preparation: Forms shall be cleaned and lubricated prior to each use and shall be so designed to permit their removal without damage to the new concrete.

D. Joints: Generally joints shall be formed at right angles to the true alignment of the pavement and to the depths and configuration specified by the appropriate standard or as modified by the Plans and specifications. For additional guidance on jointing, see American Concrete Paving Association jointing guides. All joints shall be sealed with sealant meeting the requirements of Section 2208.3.D. Unless specified otherwise on the Plans, specifications, Standard Drawings or Special Provisions, use hot-poured joint sealant.

1. Isolation Joints: Isolation joints shall be placed at all locations where shown on the Plans and Standard Drawings or as directed by the Engineer.

    a. Isolation joints shall extend the entire width of the pavement and from the subgrade to the surface of the pavement. The material will have a suitable tear strip or removable cap provided to allow for the application of the joint sealer to the required depth.
    b. Under no circumstances shall any concrete be left across the isolation joint at any point.
    c. Material: Isolation joints shall be formed by a one-piece, one inch thick preformed joint filler cut to the configuration of the correct pavement section.
    d. Stability: Isolation joints shall be secured in such a manner that they will not be disturbed during the placement, consolidation and finishing of the concrete.
    e. Dowels: If isolation joints are to be equipped with dowels they shall be of the size and type specified, and shall be firmly supported in place, by means of a dowel basket or other support method approved by the Engineer, which shall remain in place. Each dowel shall be lightly painted or greased with a product approved by the Engineer.

2. Contraction Joints: Contraction joints shall be placed where indicated and to the depth indicated by the Plans, specifications and Standard Drawings.

    a. Method: Contraction joints shall be sawed.
    b. When sawing joints, the Contractor shall begin as soon as the concrete hardens sufficiently to prevent excessive raveling along the saw cut and shall finish before conditions induce uncontrolled cracks, regardless of the time or weather. All sawed joints shall begin with a relief cut that shall be approximately 1/8 inch wide, and a minimum of 1/3 the thickness of the slab unless shown otherwise on the Plans. If the Plans indicate a joint width greater than 1/8" but with no backer rod, the Contractor may saw the initial relief cut to the full width. If a reservoir cut is specified that uses a backer rod, a second stage saw cut which widens the joints to allow the insertion of joint sealing material shall be performed. The second stage saw cut shall not be performed until the concrete is at least 48 hours old and shall be delayed longer when the sawing causes raveling of the concrete. If second stage sawing is performed prior to the completion of the curing period, the Contractor shall maintain the cure by use of materials approved by the Engineer.
    c. The Contractor shall be responsible for using suitable methods to cut joints straight and in the correct location. The Contractor shall protect joints from damage until completion of the project and shall repair damaged joints to the satisfaction of the Engineer.
    d. Where not indicated on the Plans or Standard Drawings, joint spacing for concrete overlays shall not exceed 12 times the thickness of the overlay, and shall be constructed such that the larger dimension of any panel does not exceed 125% of the smaller dimension. Joints of adjacent panels shall be aligned. Joints shall intersect pavement free edges at 90 degrees, and shall extend a minimum of 1 foot from the pavement edge. Saw joints shall be one-third the thickness of the slab, or two inches, whichever is greater.

e. For bonded concrete overlays, joints shall be located above existing joints, shall be sawed full depth plus one-half inch for overlays up to 4 inches in two stages. The first stage provides a relief cut approximately 1/8 inch wide.

f. Dowels: If contraction joints are to be equipped with dowels they shall be of the size and type specified and shall be firmly supported in place and accurately aligned parallel to the pavement line and grade with an allowable tolerance of 1/8 inch.

3. Longitudinal and Construction Joints: Longitudinal joints and construction joints shall be placed as shown on the Plans or where the Contractor's construction procedure may require them to be placed with approval of the Engineer. Longitudinal construction joints (joints between construction lanes) shall be keyed or tied joints of the dimensions shown on the Plans or Standard Drawings. Transverse construction joints of the type shown on the Plans or Standard Drawings shall be placed wherever concrete placement is suspended for more than 30 minutes. Unless shown otherwise on the Plans, do not place a construction joint within 5 feet of another transverse expansion, contraction or construction joint.

4. Center Joints: Longitudinal center joints shall be constructed using the methods specified in Section 2208.4.D.2 "Contraction Joints".

5. Tie Bars: Tie bars shall be deformed steel of the dimensions specified by the Plans or Standard Drawings. Tie bars shall be installed at the specified spacing and firmly secured so as not to be disturbed by the construction procedure. Tie bars shall not be placed mechanically or by hand into the plastic concrete during the paving operation unless approved by the Engineer. Tie bars shall not be located within one foot of an intersecting joint.

E. Placing, Finishing, Curing, and Protection: Concrete shall be furnished in quantities required for immediate use and shall be placed in accordance with the requirements of the applicable specification as stipulated in Section 2208.3.A. Prior to commencing construction, the Contractor shall furnish a concrete delivery plan which includes at a minimum the number of trucks which will be dedicated to the project, the location of the concrete plant, the route and distance from the plant to the job site, and the anticipated rate of concrete usage. It is essential that concrete be delivered in sufficient quantities to prevent stoppage of the paving operation.

1. Concrete Placement: The concrete shall be deposited on the subgrade to the required depth and width of the construction lane in successive batches and in a continuous operation without the use of intermediate forms or bulkheads. The subgrade shall be moistened prior to the placement of concrete. The concrete shall be placed as uniformly as possible in order to minimize the amount of additional spreading necessary. The concrete shall not be permitted to drop freely a distance of greater than 3 feet. While being placed, the concrete shall be vibrated and compacted with suitable tools so that the formation of voids or honeycomb pockets is prevented.

   The concrete shall be well vibrated and tamped against the forms and along all joints. Care shall be taken in the distribution of the concrete to deposit a sufficient volume along the outside form lines so that the curb section can be consolidated and finished simultaneously with the slab.

   No concrete shall be placed around manholes or other structures until they have been brought to the required grade, alignment, and cross slope.

   Concrete shall not be allowed to extrude below the forms.

   Limitations for time of placement and other items not specifically covered by this specification shall be in accordance with the most recent Standard Specifications of the State Department of Transportation

for the state the work is being performed in. The Engineer may extend placement time limitations based on field conditions and concrete consistency and workability.

2. Concrete Finishing Methods: The pavement shall be struck off and consolidated with a mechanical finishing machine. Hand finishing methods may be used for small or irregular areas. Furnish paving and finishing equipment applicable to the type of construction as follows:

    a. Slip-form Machines: Furnish slip-form machines capable of spreading, consolidating, screeding, and float finishing the freshly placed concrete in one pass to provide a dense and homogeneous pavement with minimal hand finishing.
    b. Self-Propelled Form-Riding Machines: Furnish mechanical, self-propelled spreading and finishing machines capable of consolidation and finishing the concrete with minimal hand finishing. Do not use machines that displace the fixed side forms.
    c. Manual Fixed-Form Paving Machines: Furnish spreading and finishing machines capable of consolidating and finishing the concrete with minimal hand finishing.
    d. Hand Methods: When finishing by hand methods, concrete shall be consolidated by use of vibrating units operating in the concrete. Unless the vibrating apparatus is such that the full width of concrete is consolidated in a single passage, a definite system or pattern shall be used in the operation of the vibrator so the full width of concrete in each linear foot of lane will receive adequate and uniform consolidation. The system and methods of vibrating shall be subject to approval of the Engineer. Vibrating equipment shall, under no circumstances, be used as a tool for moving concrete laterally on the grade.

3. Concrete Finishing

    a. Do not apply moisture (water, finishing aids, etc.) to the surface of the concrete pavement. The concrete should be provided with proper consistency and workability to place, strike off, consolidate, finish and texture without the addition of moisture. Only in the event of exceptional and unusual circumstances may the Engineer consider allowing a fine, fog mist to be added.
    b. Floating: All surfaces shall be consolidated and floated after strike-off and prior to final surface finish.
    c. Straightedging: Following the floating and while the concrete is still plastic, the surface shall be tested for trueness with a 10-foot straightedge placed parallel to the centerline and operated across the entire width of the pavement. The straightedge shall be advanced in successive stages not to exceed half its length and the operation repeated. Surface deviations greater than 1/8 inch shall be corrected and the straightedging repeated. Straightedging may be eliminated if the pavement smoothness is verified using a profilograph as specified in Section 2211.
    d. Edging: Before final finishing is completed and before the concrete has taken its initial set, the edges of the slab and curb shall be finished to 1/8" radius, or that shown on the Plans or Standard Drawings by the paving equipment, or with hand edging tools.
    e. Final Surface Finish
        i. Dragged Surface Treatment: For roadways with a design speed of 45 mph or less to be posted at 45 mph or less, astroturf or burlap shall be dragged longitudinally over the finished surface to produce a tight, uniform, textured surface, and the edges shall be rounded in a workmanlike manner.

            For roadways to be posted at 50 mph or more, astroturf or burlap shall be dragged longitudinally over the finished surface to produce a tight, uniform, textured surface, and the edges shall be rounded in a workmanlike manner. The texture achieved by

the astroturf or burlap drag shall be tested by the Contractor in accordance with ASTM E 965, "Test Method for Measuring Surface Macrotexture Depth Using a Sand Volumetric Technique", to ensure the texture is adequate for skid resistance. Test locations will be determined by the Engineer. The results of ASTM E 965 shall show an average texture depth of any lot, as defined below, and shall have a minimum value of 0.032 inch. Any lot showing an average of less than 0.032 inch but equal to or greater than 0.024 inch will be accepted as substantial compliance but the Contractor shall amend their operation to achieve the required 0.032 inch minimum depth. (It is not the intention of this tolerance to allow the Contractor to continuously pave with an average texture depth of less than 0.032 inch). Any lot showing an average texture depth of less than 0.024 inch shall require diamond grinding of the pavement represented by this lot to attain the necessary texture. Any *individual test* showing a texture depth of less than 0.020 inch shall require diamond grinding of the pavement represented by this lot to attain the necessary texture. Limits of any failing individual test shall be determined by running additional tests at 100 foot intervals before and after the failing test location. All testing of the surface texture shall be completed no later than the day following pavement placement.

ii. Groove Treatment: For roadways to be posted at 50 mph or more, the surface of the traveled lanes shall be grooved in a transverse direction unless specified otherwise in the Plans, Special Provisions, or Specifications. If approved by the Engineer, a suitable longitudinal grooving or a dragged surface treatment as described in Section 2208.4.E.3.e.i may be used in lieu of the transvers grooving. Surface grooving shall be done with a mechanical device such as a wire broom or comb or by hand. The broom or comb shall have a single row of spring steel tines, rectangular in cross section, 1/8 inch to 3/16 inch wide; spaced on 3/4 inch centers of sufficient length, thickness, and resilience to form grooves to a depth of a minimum of 1/8 inch and a maximum of approximately 3/16 inch in the plastic concrete. If grooves are to be installed by hand, the proposed equipment and process to be used shall be approved by the Engineer. This operation shall be done at such time and in such manner that the desired surface texture will be achieved while minimizing displacement of the larger aggregate particles and before the surface permanently sets. Where abutting pavement is to be placed, the grooving should extend as close to the edge as possible without damaging the edge. If abutting pavement is not to be placed, the 6 inch area nearest the edge or 1 foot from the face of the curb is not required to be grooved. For small or irregular areas or during equipment breakdown, grooving may be done by hand methods.

4. Curing: As soon as practical after the concrete is finished it shall be cured with an approved curing method. If a liquid curing membrane is used, it shall be white pigmented and applied in accordance to the manufacturer's directions.

   a. Method of Applying Curing Membrane: A nozzle producing a uniform fan pattern will be used on all spray equipment when applying the liquid curing membrane. The curing compound should be applied immediately after final finishing, and before the loss of all free water on the surface of the concrete. Normally one smooth, even coat shall be applied at a rate of 150 to 200 square feet per gallon, but two coats may be necessary to ensure complete coverage and effective protection. Second coats should be applied at right angles to the first.
   b. Curing Formed Surfaces: If the forms are removed from finished concrete pavement within a period of 72 hours or if a slip-form paving machine has been used, all exposed surfaces shall be cured. Curing membrane damaged by joint sawing operations shall be repaired by the Contractor as directed by the Engineer.

5. Protection: The Contractor shall, at his own expense, protect the concrete work against damage or defacement of any kind until it has been accepted by the Engineer. All vehicular traffic shall be prohibited from using the new concrete pavement until the following criteria have been met:

    a. Construction traffic: New concrete pavement may be opened to light construction traffic after a minimum of four (4) days of cure time has elapsed and the joints have been protected from the intrusion of foreign material by an approved method. The Contractor may reduce this length of time by one of these options, performed at the expense of the Contractor:
        i. Achieve a minimum compressive strength of 70% of the 28 day design strength as determined in accordance with ASTM C 39.
        ii. Achieve a minimum flexural strength of 350 psi using a third point loading method.
    b. All traffic: New concrete pavement may be opened to all traffic after a minimum of seven (7) days of cure time has elapsed and the joints have been sealed in accordance with Section 2208.4.D. The Contractor may reduce this length of time by one of these options, performed at the expense of the Contractor:
        i. Achieve a minimum compressive strength of 100% of the 28 day design strength as determined in accordance with ASTM C 39.
        ii. Achieve a minimum flexural strength of 450 psi using a third point loading method.

    Concrete pavement that is not acceptable to the Engineer because of damage or defacement shall be removed and replaced, or repaired, to the satisfaction of the Engineer, at the expense of the Contractor.

6. Pavement Smoothness: If required by the Contract Documents, pavement smoothness shall adhere to Section 2211. If not required by the Contract Documents, the Engineer shall determine areas to be checked for surface tolerance by the Contractor. The areas identified by the Engineer shall be checked with a 10 foot straightedge placed parallel to the center line at any location within a driving lane. Areas showing high spots of more than 1/4 of an inch in 10 feet shall be marked and ground down with approved grinding equipment to an elevation where the area or spot will not show surface deviations in excess of 1/8 inch when tested with a 10 foot straight edge. Grinding will be performed on the full width of the lane failing to meet the above criteria. The cost of correcting the smoothness and any other associated costs such as traffic control shall be at Contractor's expense.

7. Diamond Grinding: If required by the Contract Documents or if pavement smoothness criteria from Section 2208.4.E or Section 2211 are not achieved, the Contractor shall grind the riding surface to reduce or eliminate the irregularities.

    a. Use a self-propelled grinding machine with diamond blades mounted on a multi-blade arbor. Avoid using equipment that causes excessive ravels, aggregate fractures, or spalls. Provide uniform texture the full width of the lane.
    b. Transverse grooving will not be required.
    c. Use vacuum equipment or other continuous methods to remove grinding slurry and residue. Prevent the grinding slurry from flowing across lanes being used by traffic or into streams, lakes, ponds or other bodies of water, inlets, storm sewer or other drainage system.
    d. After corrections have been made to the riding surface, test the pavement for smoothness using the same technique used to determine smoothness originally. Furnish and operate the smoothness measurement equipment, and evaluate the results as specified in Section 2211.
    e. Perform additional grinding as required to attain the required smoothness. Correct all deviations (in excess of 1/2 inch in a length of 25 feet or ¼ inch in a length of 10 feet) within each section regardless of the profile index value.

8. Temperature Limitation: Concrete work shall be in accordance with the requirements of the state DOT specifications for the state where the work is being performed.

9. Backfill: A minimum of 24 hours shall elapse before forms are removed and 5 days shall elapse or the concrete must have attained 75% of its 28 day compressive strength before pavement is backfilled unless otherwise approved by the Engineer.

10. Backfill shall be accomplished in accordance with Sections 2100 and 2201 entitled "Grading and Site Preparation" and "Subgrade Preparation".

11. The Contractor shall be responsible for the repair of any existing street pavement damaged by the construction to the satisfaction of the Engineer.

12. Joint Sealing and Cleanup: All joints shall be sealed with an approved joint sealer meeting the requirements of Section 2208.3 applied in accordance with this section and the manufacturer's directions within 7 days of the placement of the concrete and prior to the opening of the pavement to traffic. If pavement design does not specifically require the use of joint sealant, prepare the joint as described on the Plans or in the specifications.

    The Contractor shall be responsible for the removal of excess dirt, rock, broken concrete, concrete splatters and overspray from the area of the construction.

2208.5 Integral Curb

If required by the Plans, Standard Drawings or Special Provisions, integral curbs shall be placed along the edges of all street pavement, except at such locations as the Engineer may direct.

The integral curb shall be constructed during or immediately following the finishing operation unless otherwise shown on the Plans. Special care shall be taken so that the curb construction does not lag behind the pavement construction and form a "cold joint".

Steel curb forms or integral slip-forming shall be required to form the backs of all curbs except where impractical because of small radii street returns or other special sections.

Concrete shall be consolidated with an approved vibrator.

Curbs shall be finished to the cross-section as shown on the Plans with a mule; or templates supported on the side forms and with a float not less than four feet in length, unless another method is approved by the Engineer.

The finished surface of the curb and gutter shall be checked for no more than 1/4 inch deviation by the use of a 10 foot straightedge and corrected if necessary.

Where grades are flat and while the concrete is still plastic, the flowline of the gutter should be checked by the Contractor to verify positive drainage.

Finishing, edging, curing, protection, jointing, temperature limitations and backfill shall all comply with Section 2208.4. The curb shall have a brush or broom finish.

2208.6 Repairing Defects

Any defect occurring prior to final acceptance of the project or the end of a Contract warranty period shall be repaired by removing and replacing the affected area to the nearest joint, or as directed by the Engineer. After project final acceptance or expiration of the warranty period, repair defects in conformance with the following. Do not begin corrective work until after submitting a plan and receiving the Engineer's approval for repair methods.

Defect Type	Defect Direction	Defect Location	Description	Repair Procedure	Alternate Procedure
Plastic Shrinkage Crack	Any	Anywhere	Only partially penetrates depth	Do nothing	Fill with HMWM2
Uncontrolled Crack	Transverse	Mid-slab	Full-depth	Saw and seal crack	LTR3
Uncontrolled Crack	Transverse	Crosses or ends at transverse joint	Full-depth	Saw and seal the crack; Epoxy uncracked joint	
Uncontrolled Crack	Transverse	Relatively parallel and within 5 ft of joint	Full-depth	Saw and seal the crack; Seal joint	FDR4 to replace crack and joint
Saw cut or Uncontrolled Crack	Transverse	Anywhere	Spalled	Repair spall by PDRS if crack not removed	
Uncontrolled Crack	Longitudinal	Relatively parallel and within 1 ft of joint; May cross or end at longitudinal joint	Full-depth	Saw and seal crack; Epoxy uncracked joint	Cross stitch crack
Uncontrolled Crack	Longitudinal	Relatively parallel and in wheel path 1-4.5 ft (from joint)	Full-depth, hairline or spalled	Remove and replace slab	Cross stitch crack
Uncontrolled Crack	Longitudinal	Relatively parallel and further than 4.5 ft from a long joint or edge	Full-depth	Cross-stitch crack; Seal longitudinal joint	
Saw cut or Uncontrolled Crack	Longitudinal	Anywhere	Spalled	Repair spall by PDRS if crack not removed	
Uncontrolled Crack	Diagonal	Anywhere	Full-depth	FDR4	
Uncontrolled Crack	Multiple per Slab	Anywhere	Two cracks dividing slab into 3 or more pieces	Remove and replace slab	

HMWM = High molecular weight methacrylate poured over surface and sprinkled with sand for skid resistance.
LTR = Load-transfer restoration; 3 dowel bars per wheel path grouted into slots sawed across the crack; Slots must be parallel to each other and the longitudinal joint.
FDR = full-depth repair; 10 ft long by one lane wide. Extend to nearest transverse contraction joint if 10 ft repair would leave a segment of pavement less than 10 ft long.
PDR = partial-depth repair; Saw around spall leaving 2 in between spall and 2 in deep perimeter saw. Chip concrete free, then clean and apply bonding agent to patch area. Place a separating medium along any abutting joint or crack. Fill area with patching mixture.
Cross-stitching: for longitudinal cracks only, drill ¾" holes at 35° angle, alternating from each side of joint on 30-36 inch spacing. Epoxy #5 epoxy coated deformed steel tie-bars into hole.

2208.7 Method of Measurement

Portland Cement Concrete Pavement will be measured per square yard or tenth part thereof for the specified depth.

2208.8 Basis of Payment

Portland Cement Concrete Pavement will be paid for by one of the following:

A. Contract unit bid price.

B. Contract lump sum bid price.

SECTION 2209 CURBING

2209.1 Scope

This section governs the furnishing of all labor, materials and equipment for the construction or reconstruction of curbing as shown on the Plans and in accordance with the Standard Drawings, the specifications, and the Special Provisions.

2209.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

ASTM
D 698 Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))

2209.3 Materials

All Materials shall conform to Section 2208.3. Materials submittals and testing shall conform to Section 2208.

2209.4 Construction

The curbing shall be constructed or reconstructed to the configuration and to the lines and grades shown on the Plans.

A. Removal of Existing Curbing for Reconstruction: Existing curbing shall be totally removed to the nearest contraction or expansion (isolation) joint or with the approval of the Engineer it may be sawed provided no free section is left that is less than 5 lineal feet in length, and provided the entire curbing section is sawed a minimum of 2 inches below any exposed surface, or sufficiently to prevent disturbance or damage to all adjacent structures or slabs, whichever is greater.

B. Grading and Subgrade Preparation: All excavation or embankment shall conform to Sections 2100 and 2201 entitled "Grading and Site Preparation" and "Subgrade Preparation".

   Compaction shall conform to Section 2201.4.B.

C. Forms: All forms shall be in good condition, clean, and free from imperfections. Each form shall not vary more than 1/4 inch in horizontal and vertical alignment for each 10 feet in length. Face forms will be used when feasible. Forms shall have a height equal to or greater than the height of the curb face being formed. The forms shall be set true to line and grade and shall be supported to stay in position while depositing and

consolidating the concrete. The forms shall be designed to permit their removal without damage to the concrete. The forms shall be lubricated.

D. Slip-Form Curb Machine: A slip-form curb machine may be used in lieu of forms. The machine must be equipped with mechanical internal vibrators and be capable of placing curb to the correct cross section, line and grade within the allowable tolerances.

E. Joints: The joints shall be formed at right angles to the alignment of the curbing and to the depths specified by the appropriate Standard Drawing or as shown on the Plans. Joints should be aligned with concrete pavement joints where feasible.

1. Isolation Joints: Isolation joints shall be placed at all radius points, driveways, curb inlets, or where directed by the Plans or Engineer.

    a. Material: Isolation joints shall be formed by a one piece, one inch thick preformed joint filler cut to the configuration of the correct curb section, and conforming to Section 2208.3.D.
    b. Stability: Isolation joints shall be secured in a manner so they will not be disturbed by depositing and consolidating of concrete.
    c. Edging: The edges of the joints shall be rounded with an edging tool of 1/4 inch radius.

2. Contraction Joints: Curbing shall have contraction joints at intervals of not less than 10 feet or more than 15 feet. They shall extend through the entire curb section from the top of the curb to a depth 2 inches below pavement surface.

    a. Method: Contraction joints shall be formed or sawed.
        i. When sawing joints, the contractor shall begin as soon as the concrete hardens sufficiently to prevent excessive raveling along the saw cut and shall finish before conditions induce uncontrolled cracks, regardless of the time or weather. When joint sealing backup material is specified with sawed joints, the first stage, which provides a relief cut shall be approximately 1/8 inch wide, and shall be to Plan depth. The second stage which widens the joints to allow the insertion of joint sealing backup material to Plan depth shall not be performed until the concrete is at least 48 hours old, and shall be delayed longer when the sawing causes raveling of the concrete. If second stage sawing is performed prior to the completion of the curing period, the Contractor shall maintain the cure by use of curing tapes, plastic devices, or other materials approved by the Engineer.
        ii. When forming joints, templates shall be 1/8" metal cut to the configuration of the curbing section. The templates shall be secured at the proper locations so that they will not be disturbed by the depositing of concrete. The templates shall be removed as soon as the concrete has attained its initial set and finished with a ¼ inch radius on all exposed edges.
    b. Joint Sealer: When specified, joint sealants shall conform to Section 2208.3.

F. Concrete Work: Concrete for curbing shall be placed in accordance with the requirements of Section 2208.4. Isolation and contraction joints shall be constructed as shown on the Plans, Standard Drawings, or where directed by the Engineer.

1. Concrete Placement: Concrete shall be mechanically vibrated and shall not be allowed to extrude below the forms to cause an irregular alignment of the abutting street pavement.

2. Finishing: After placing and initial strike-off the curb shall be tooled to the required radii. If the surface

of the concrete is sufficiently wet that a ridge is formed at the inside of the radius tool, finishing will cease until the excessive moisture has evaporated.

After initial set, the face forms shall be removed and the surface finished to the required dimensions. No water, dryer, or additional mortar shall be applied to the free surface of the concrete.

The finished surface of the concrete shall be broomed perpendicular to the curb with a clean broom to provide an antiskid surface.

In all cases the finished curb shall have a true surface, free from sags, twists, or warps, and shall have a uniform color and appearance.

3. Curing: As soon as practical after the concrete is finished it shall be cured with a liquid curing membrane meeting the requirements of Section 2208.4.E.4, applied according to the manufacturer's directions.

   If front and/or back forms are removed from finished curbing within a period of 72 hours of placement these surfaces shall also be cured.

   Wet burlap, cotton mat, waterproof paper, polyethylene sheeting or earth backfill is not an acceptable curing method for curbing.

4. Protection: The Contractor shall protect the concrete work against damage or defacement of any kind until it has been accepted by the Engineer. Concrete which is damaged or defaced, shall be removed and replaced, or repaired to the satisfaction of the Engineer, at the expense of the Contractor.

5. Temperature Limitations: Concrete work shall be performed in accordance with requirements of the state DOT specifications for the state where the work is being performed.

6. Backfill: Backfill shall conform to Section 2208.4.E.9. The Contractor shall be responsible for the repair of any pavement disturbed by the construction to the satisfaction of the Engineer.

7. Joint Sealing and Clean-Up: Unless otherwise specified or waived by the Engineer, an approved joint sealer shall be applied in accordance with the manufacturer's directions within 7 days of the placement of the concrete. The Contractor shall be responsible for the removal of excess dirt, rock, broken concrete, concrete splatters and overspray from the area of the construction.

8. Surface Tolerances: Curbing shall have a surface tolerance of 1/4 inch in 10 feet when checked with a ten foot straightedge.

9. Repairing Defects: Defects in the concrete shall be repaired in accordance with Section 2208.6.

2209.5 Method of Measurement

Curbing will be measured per lineal foot or tenth part thereof for the applicable type.

2209.6 Basis of Payment

Curbing will be paid for by one of the following:

A. Contract unit bid price.

B. Contract lump sum bid price.

SECTION 2210

This section has been intentionally left blank.

SECTION 2211 SMOOTHNESS

2211.1 Scope

This section governs the furnishing of all labor, materials and equipment for the determination of pavement surface smoothness, evaluation of results, and corrective actions as shown on the Plans and in accordance with the Contract Documents, Standard Drawings, the specifications and the Special Provisions.

2211.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

Kansas Department of Transportation
Standard Specifications for State Road and Bridge Construction, 2015 Edition
Kansas Test Method KT-46 from KDOT Construction Manual, latest revision

Missouri Highways and Transportation Commission
Missouri Standard Specifications for Highway Construction, 2011 Edition
MoDOT Engineering Policy Guide Section 106.3.2.59 TM-59, Determination of the International Roughness Index

2211.3 Equipment

Equipment for determination of pavement smoothness and performance of corrective actions shall be in compliance with the specifications of the Department of Transportation of the state where the work is performed; for MoDOT, Section 502.8 and for KDOT, Sections 503 and 603.

2211.4 Construction

If specified in the Contract Documents, profilographing shall be performed on roadways classified as arterials, major collectors, freeways, expressways and interstates.

A. Exceptions: Unless otherwise specified in the Contract Documents, profilographing will not be required for local roads or minor collectors. In addition, other exceptions shall be as specified in the state DOT specifications for the state the work is being performed in.

   1. Finished pavements on local roads, minor collectors and other areas exempted from profilographing shall be checked with a 10 foot straightedge placed parallel to the center line at any location within a driving lane. Areas showing high spots of more than 1/4 of an inch in 10 feet shall be marked and ground down with approved grinding equipment to an elevation where the area or spot will not show surface deviations in excess of 1/8 inch when tested with a 10 foot straight edge. Grinding will be

performed on the full width of the lane failing to meet the smoothness criteria. The cost of correcting the smoothness and associated traffic control shall be at Contractor's expense.

B. Profilographing: Profilograph testing and evaluation shall be performed in accordance with the State Department of Transportation specifications and test methods for the state where the work is being performed; for MoDOT, Section 502.8 and for KDOT, Sections 503 and 603. Within two days after the paving, furnish the Engineer with the profilogram and its evaluation.

C. Corrective Actions: Corrective actions shall be performed at the Contractor's expense and in accordance with the State Department of Transportation specifications for the state where the work is being performed; for MoDOT, Section 502.8 and for KDOT, Sections 503 and 603.

D. Final Report: The Contractor shall submit a final report to the Engineer with final profilograph results verifying compliance with the specified pavement smoothness requirements.

E. Pay Adjustments: No pay adjustments (incentive or disincentive) shall be made to the smoothness or pavement items based on the results of the profilograph testing.

2211.5 Method of Measurement

Smoothness will be measured as a lump sum unit.

2211.6 Basis of Payment

Smoothness will be paid for by Contract lump sum bid price.

END OF SECTION

OAK GROVE SANITARY SEWER
SPECIFICATION MODIFICATION
APWA SPECIFICATION SECTION 2500
OAK GROVE, MO - 2018

Work for the City of Oak Grove shall follow APWA Construction and Material Specification Section 2500 for sanitary sewers except as modified below. The following additions and/or alterations to the APWA Specification 2500 provided below shall apply to execution of the various parts of the work performed on this project.

APWA SPECIFICATIONS SECTION 2500

2502 MATERIALS

2502.2 Pipe, Fittings, Joints, Coatings and Linings

1. Modify Subsection 2502.2.D.3 to read:

Pipe shall have an integral bell and spigot joint. Wall thickness shall be SDR 26 or SDR 21 as shown on plans. The minimum wall thickness shall conform to SDR 26. Service lines shall be SDR 26 (minimum).

2. Modify Subsection 2502.2.D.5 to read:

Fittings defined as tee (T) or wye (Y) connections suitable for assembly to four (4) inch or six (6) inch building service lines shall be bell-end with a minimum wall thickness conforming to SDR 26 and shall be furnished by the pipe manufacturer. A special design is required for service connections 8 inches and larger. Saddle tees or wyes will not be permitted.

3. Delete Section 2502.2.E- Reinforced Concrete Pipe and Fittings

4. Modify Subsection 2502.2.B.6.A to read:

40 mil ceramic quartz filled amine cured novalac epoxy lining, such as Protecto 401, or approved equal, in accordance with manufacturer's specifications.

2502.3 Pipe Embedment Materials

1. Modify Subsection 2502.3.A to read:

The Class of bedding required shall be as specified in Section 2100 unless indicated otherwise in the Contract Documents, Contract Drawings, or Standard Details.

2. **Modify Subsection 2502.4.B to read:**

All Sanitary Sewer trenches under roadway pavement shall be backfilled to the subgrade elevation with Flowable Fill (CLSM). All other Sanitary Sewer trenches shall be backfilled in accordance with Section 2100 Clearing and Site Preparation.

2509 MANHOLES AND SPECIAL STRUCTURES

2509.3 Manhole Materials

1. **Modify Section 2509.3.E to read:**

Concrete shall be KCMMB 4K unless indicated otherwise in the contract documents, contract drawings or standard details

2. **Modify Section 2509.3.G to read:**

Iron Castings: Casting shall conform to the requirements of ASTM A 48, Class 35B. Castings shall be clean and without surface defects that will impair serviceability. Pricing or filling of holes or other defects will not be permitted. Parting fins and pouring gates shall be removed.

3. **Modify Section 2509.3.G.2 to read**:

No steps shall be placed in manholes.

2509.6 Manhole Installation

1. **Delete Subsection 2509.6.I Steps**

Add the following at the end of APWA Section 2500 Sanitary Sewers

SECTION 2511 MATERIAL TESTING AND CERTIFICATIONS

When requested by the City Engineer, the Contractor shall furnish test results at the contractor's expense and from a testing laboratory approved by the City Engineer showing compliance with the plans, specifications, and all requirements of APWA Section 2500 as modified herein.

The contractor shall submit certifications for all materials used for each project to the City Engineer for approval prior to incorporating those materials into the project. Each certification shall indicate that the material is in compliance with the plans, specifications, and all requirements of APWA Section 2500 as modified herein.

At the completion of the project the contractor shall certify that the completed project is in compliance with all requirements of the plans, specification, contract documents, and all other requirements of the City of Oak Grove.

DIVISION II
CONSTRUCTION AND MATERIAL SPECIFICATIONS
SECTION 2500 SANITARY SEWERS

APPROVED AND ADOPTED THIS 15th DAY OF FEBRUARY, 2017

KANSAS CITY METROPOLITAN CHAPTER
OF THE AMERICAN PUBLIC WORKS ASSOCIATION

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SECTION 2501 GENERAL

2501.1 Scope

This section governs the furnishing of all labor, materials and equipment for the complete installation of sewers and appurtenances as shown on the Plans and in accordance with the Standard Drawings, the specifications, and the Special Provisions.

2501.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

APWA

Section 2100	Grading and Site Preparation
Section 2150	Erosion and Sediment Control
Section 2200	Paving
Section 2300	Incidental Construction
Section 2400	Seeding and Sodding

ASTM

A 48	Standard Specification for Gray Iron Castings
A 139	Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)
A 153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A 184	Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
A 307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 PSI Tensile Strength
A 449	Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
A 615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
A 1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
C 32	Standard Specification for Sewer and Manhole Brick (Made From Clay or Shale)
C 33	Standard Specification for Concrete Aggregates
C 76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
C 109	Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
C 150	Standard Specification for Portland Cement
C 191	Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle
C 231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C 260	Standard Specification for Air-Entraining Admixtures for Concrete
C 270	Standard Specification for Mortar for Unit Masonry
C 361	Standard Specification for Reinforced Concrete Low-Head Pressure Pipe
C 443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
C 478	Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
C 827	Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
D 450	Standard Specification for Coal-Tar Pitch Used in Roofing, Dampproofing, and Waterproofing
D 698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3))
D 1248	Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable

D 1556 Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method
D 1784 Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
D 2167 Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
D 2235 Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
D 2240 Standard Test Method for Rubber Property—Durometer Hardness
D 2241 Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
D 2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
D 2412 Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
D 2584 Standard Test Method for Ignition Loss of Cured Reinforced Resins
D 2657 Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings
D 2661 Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings
D 2837 Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
D 3034 Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D 3139 Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
D 3212 Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
D 3262 Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe
D 3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
D 3754 Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe
D 3839 Standard Guide for Underground Installation of “Fiberglass” (Glass-Fiber Reinforced Thermosetting-Resin) Pipe
D 4101 Standard Specification for Polypropylene Injection and Extrusion Materials
D 4161 Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
D 5685 Standard Specification for Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe Fittings
D 6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
F 477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
F 628 Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe With a Cellular Core
F 679 Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
F 714 Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
F 1417 Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air
F 3125 Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions

ANSI/AWWA

C 104/A21.4 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
C 105/A21.5 American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems
C 110/A21.10 American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In.
C 111/A21.11 American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
C 115/A21.15 American National Standard for Flanged Ductile-Iron Pipe with Threaded Flanges
C 150/A21.50 American National Standard for Thickness Design of Ductile-Iron Pipe
C 151/A21.51 American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water
C 153/A21.53 American National Standard for Ductile-Iron Compact Fittings for Water Service

AWWA

C 302 Reinforced Concrete Pressure Pipe, Noncylinder Type
C 600 Installation of Ductile Iron Water Mains and Their Appurtenances
C 950 Fiberglass Pressure Pipe

ANSI

Z 60.1 American Standard for Nursery Stock

MCIB Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement
The current editions of the "Bulletins" and Approved Sections of the "Standard Concrete Specifications" issued by the Mid-West Concrete Industry Board, Inc. (MCIB) are made a part hereof by reference. However, when the provisions of this Specification differ from the provisions of such "Bulletins" and "Sections" the provisions of this Specification shall govern. Reference December 2000 Specifications if most recent version does not contain specified mix designs.

KCMMB Kansas City Metro Materials Board Specifications

2501.3 Cleanup

Cleanup shall follow the work progressively. The Contractor shall remove from the project site all rubbish, equipment, tools, surplus or discarded materials, and temporary construction items.

Streets to be opened to local traffic at the end of the day's operation shall be cleaned of dirt or mud. All equipment and material stockpiles shall be secured for safe passage of vehicles and pedestrians.

All work shall comply with Section 2150 "Erosion and Sediment Control".

SECTION 2502 MATERIALS

2502.1 Scope

This section governs the furnishing of all labor, materials and equipment that may be required to complete pipeline construction, exclusive of structures, as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

A. Requirements: Furnish pipe of materials, joint types, sizes, and strength classes indicated or specified. Higher strengths may be furnished at the Contractor's option at no additional cost to the Owner.

B. Manufacturer: The manufacturer shall be experienced in the design, manufacture and commercial supplying of the specific material.

C. Inspection and Testing: Inspection and testing shall be performed by the Manufacturer's quality control personnel in conformance with applicable standards. Testing may be witnessed by Owner, Engineer, or approved independent testing laboratory. The Contractor shall provide three (3) copies of certified test reports indicating the materials conform to the specifications.

D. Handling: The manufacturer and contractor shall use equipment and methods shall be adequate to protect the pipe, joint elements and prevent shock contact of adjacent units during moving or storage. Damaged sections that cause reasonable doubt as to their structural strength or water-tightness will be rejected. No pipe or fitting shall be delivered until the certified test reports are approved by the Engineer.

2502.2 Pipe, Fittings, Joints, Coatings and Linings

A. General: Furnish pipe and fittings of materials, joint types, sizes, strength classes, coatings and linings as indicated and specified.

B. Ductile-Iron Pipe and Fittings: Pipe and fittings shall conform to ANSI/AWWA C151/A21.51, ANSI/AWWA C110/A21.10, and ANSI/AWWA C153/A21.53 except as otherwise specified herein.

1. General: Furnish maximum pipe lengths normally produced by the manufacturer except for fittings, closures and specials.

2. Design: All ductile iron pipe shall meet the requirements of ANSI/AWWA C150/A21.50 and ANSI/AWWA C151/A21.51 and shall be of the thickness class specified herein or shown on the drawings. The minimum thickness allowed shall be Special Class 50.

3. Joints: Mechanical and push-on joints for pipe and fittings shall conform to the requirements of ANSI/AWWA C111/A21.11. Flanged joints for ductile iron pipe and fittings shall conform to the requirements of ANSI/AWWA C115/A21.15. Gaskets shall be neoprene or other synthetic rubber material. Natural rubber gaskets will not be accepted.

4. Fittings: Fittings shall be in accordance with ANSI/AWWA C110/A21.10 or ANSI/AWWA C153/A21.53 and shall have a pressure rating of not less than that specified for the pipe. Fittings used with ductile iron pipe shall be ductile iron. Fittings for pipe with mechanical joints shall have mechanical joints. Fittings for pipe with push-on joints shall have either mechanical joints or push-on joints.

5. Coatings: Pipe and fittings shall be furnished with exterior bituminous coating conforming to ANSI/AWWA C151/A21.51.

6. Linings: Pipe and fitting interior linings shall be hydrogen sulfide resistant and conform to the following:

   a. Calcium aluminate-mortar lining conforming to AWWA/ANSI C104/A21.4, a 40 mil ceramic quartz filled amine cured novalac epoxy lining, a40 mil polyethylene lining in accordance with ASTM D 1248, or be PVC (polyvinyl chloride) lined.

7. Polyethylene Encasement: Pipe and fittings shall be installed with a polyethylene tube encasement having a thickness of 0.008" (8 mils) and conforming to Section 4.1.1 of ANSI/AWWA C105/A21.5.

C. Polyvinyl chloride (PVC) Pressure Rated Plastic Pipe (SDR) and Fittings: Pipe and fittings shall conform to ASTM D 2241, except as otherwise specified herein.

1. General: Furnish maximum pipe lengths normally produced by the manufacturer, except for fittings, closures and specials. Pipe shall be used only for pressure flow systems.

2. Materials: The pipe shall be made of PVC plastic pipe having a cell classification of 12A54 B or 12A54 C as defined in ASTM D 1784.

3. Design: Pressure flow systems, i.e., force mains, shall have the wall thickness shown on the plans, with a minimum wall thickness not less than SDR 32.5 with a minimum burst pressure not less than 400 psi conforming to pipe materials designation codes PVC 1120, PVC 1220, or PVC 2120.

4. Joints: Pressure flow systems shall be joined in accordance with ASTM D 3139 with particular attention given to Section 5.3. Joints shall be push-on type only with the bell-end grooved to receive a gasket. Elastomeric seals (gaskets) shall have a basic polymer of synthetic rubber complying with ASTM F 477. Natural rubber gaskets will not be accepted.

5. Fittings: Fittings for pressure flow systems shall be ductile iron or PVC. Ductile iron fittings shall be mechanical joint conforming to Section 2503.D.3. PVC fittings shall have a minimum wall thickness conforming to SDR 32.5 and a minimum hydrostatic design stress of 400 psi conforming to pipe materials designation codes PVC 1120, PVC 1220, and PVC 2120.

D. Type PSM polyvinyl chloride (PVC) Sewer Pipe and Fittings: 4 through 15 inch diameter pipe and fittings shall conform to ASTM D 3034 and pipe having a diameter 18 inches through 27 inches shall conform to ASTM F 679 except as otherwise specified herein.

1. General: Furnish maximum pipe lengths normally produced by the manufacturer except for fittings, closures and specials.

2. Materials: The pipe shall be made of PVC plastic having a cell classification of 12454 B or 12454 C or 13364 B as defined in ASTM D 1784.

3. Design: Pipe shall have an integral bell and spigot joint. Wall thickness shall be SDR 35, SDR 26, or SDR 21 as shown on plans. If for any reason the depth of cover on SDR 35 pipe becomes greater than 15 feet, the Contractor shall immediately notify the Engineer.

4. Joints: Joint tightness shall conform to ASTM D 3212. Joints shall be push-on type only with the bell-end grooved to receive a gasket. Elastomeric seal (gasket) shall have a basic polymer of synthetic rubber conforming to ASTM F 477. Natural rubber gaskets will not be accepted.

5. Fittings: Fittings defined as tee (T) or wye (Y) connections suitable for assembly to four (4) inch or six (6) inch building service lines shall be bell-end with a minimum wall thickness conforming to SDR 35 and shall be furnished by the pipe manufacturer. A special design is required for service connections 8 inches and larger. Saddle tees or wyes will not be permitted during sewer main installation.

E. Reinforced Concrete Pipe and Fittings: Pipe and fittings shall conform to ASTM C 76 except as otherwise specified herein.

1. General: Furnish maximum lengths normally produced by the manufacturer except for fittings, closures and specials.

2. Design: Pipe shall be Class III, Class IV, or Class V, wall B as shown on Plans. Fine aggregate shall be natural sand conforming to the requirements of ASTM C 33. Reinforcement shall be circular. Modified or special designs are prohibited unless so specified in the Special Provisions.

3. Joints: Pipe and fittings shall be furnished with either spigot groove type joint with O-ring gasket or steel end joint with spigot groove and O-ring gasket conforming to ASTM C 361 and ASTM C 443. The basic polymer for O-ring gaskets shall be synthetic rubber and shall conform to AWWA C 302.

4. Fittings and Specials: Provide strength equal to design D-loads of adjacent pipe and be fabricated as one of the following types:

a. Steel cylinder segments not less than U.S. No. 16 gauge lined with three-fourths (3/4) inch concrete or mortar and reinforced concrete exterior.
b. Concrete pipe sections shall be cut while still green, reinforcing exposed and welded together at junctions and miters. Splice shall be built up to nominal wall thickness with mortar or concrete. Miters shall not exceed 30 degrees at deflection angles between segments. Minimum center line curve radius shall not be less than twice the pipe diameter.

F. Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Wastewater Pipe (8-inch diameter and larger)

1. General: This specification designates requirements for fiberglass glass-fiber reinforced thermosetting-resin pipe (RTRP) for the conveyance of wastewater. Pipe for gravity application shall conform to ASTM D 3262 for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe. Pipe for force main applications shall conform to ASTM D 3754 for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe. If ASTM D 3754 pipe is selected, its actual outside diameter shall be in accordance with AWWA C 950 Fiberglass Pressure Pipe.

2. Materials: Material used in the manufacture of the pipe, fittings and specials shall conform to the following:

a. Resin Systems: The manufacturer shall use only polyester resin system with a proven history of performance in corrosive environments found in wastewater collection systems. The historical data shall have been acquired from a composite material of similar construction and composition as the proposed product. Certification of resin compounding shall be provided by the pipe manufacturer prior to shipment to the job site. One test to verify resin compounding may be required by the Engineer. The test shall be performed by an independent testing laboratory approved by the Engineer and shall be performed upon a sample of pipe obtained from the job site. The cost of the test shall be paid for by the Contractor and shall be included with the bid price for pipe. The test shall be performed in accordance with ASTM D 2584 Standard Test Method for Ignition Loss of Cured Reinforced Resins.
b. Glass Reinforcements: The reinforcing glass fibers used to manufacture the components shall be of the highest quality commercial grade E-glass filaments with binder and sizing compatible with impregnating resins.
c. Silica Sand: Sand shall be minimum 98% silica with a maximum moisture content of 0.2%.
d. Additives: Resin additives, such as curing agents, pigments, dyes, fillers, thixotropic agents, etc., when used, shall not detrimentally effect the performance of the product.
e. Elastomeric Gaskets: Gaskets shall meet ASTM F 477 and be supplied by qualified gasket manufacturers and be suitable for the service intended.

3. Stiffness: Pipe shall conform to the requirements of AWWA M45 for the size and strength. Minimum pipe stiffness at 5-percent deflection shall be 46-psi (3.2-kg/cm2) for gravity and pressure wastewater conduit as specified for all sizes when calculated in accordance with ASTM D 2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

4. Joints: Joint tightness shall be tested in accordance with ASTM D 4161 for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals. Unless otherwise specified, the pipe shall be field connected with fiberglass sleeve couplings that utilize elastomeric sealing gaskets as the sole means to maintain joint water-tightness.

5. Fittings: Fittings shall conform to ASTM D 5685 Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe Fittings or D 3840 Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Non-pressure Applications.

G. High Density Polyethylene (HDPE)

1. General: Furnish maximum lengths normally produced by the manufacturer except for fittings, closures and specials.

2. Materials: All new pipe and fittings shall be solid wall high density polyethylene (HDPE) pipe, meeting the requirements of ASTM F 714 Polyethylene (PE) Plastic Pipe (SDR-PR) based on outside diameter, ASTM D 1248, ASTM D 3350. All HDPE pipe shall be marked with a green stripe to signify its use for sanitary sewer utilities.

   a. The pipe shall be manufactured from high density high molecular weight polyethylene resin which conforms to ASTM D 1248. The pipe produced from this resin shall have a minimum cell classification of 345434C under ASTM D 3350.
   b. The HDPE pipe shall have a wall thickness as shown on the Plans or Standard Drawings with a minimum wall thickness conforming to DR11 with a working pressure rating of 160 psi. HDPE pipe diameters shown on plans are iron pipe sizes which provide the nominal inside diameter necessary to exceed the flow capacity of cement lined ductile iron pipe.
   c. The pipe and fitting manufacturer shall certify that samples of his production pipe have undergone stress regression testing, evaluation, and validation in accordance with ASTM D 2837 and PPI TR-3. Under these procedures, the minimum hydrostatic design basis shall be certified by the pipe manufacturer to be 1600 psi at 73.4°F and 800 psi at 140°F.
   d. As approved by the Engineer, electrofusion fittings may be allowed in lieu of fittings designed for butt fusion.
   e. The HDPE pipe shall be provided to the project site in straight sections and shall not have been coiled at any time.

H. TEES, WYES, AND BUILDING SERVICE LINES

1. General: All service lines are gravity. Tees, wyes, and building service lines shall be installed as shown on the Plans and Standard Drawings or specified herein. Saddles will only be allowed with the approval of the Engineer.

2. Materials: Material used in the manufacture of the pipe, fittings and specials shall conform to the following:

   a. Acrylonitrile-Butadiene-Styrene (ABS) Service Line Pipe and Fittings
      i. Pipe and fittings shall conform to ASTM F 628 Foamed Core DWV, ASTM D 2661 DWV.
      ii. Joints: Joints shall be solvent-cemented. The cement shall conform to the requirements of ASTM D2235.
   b. Polyvinyl Chloride (PVC) Service Line Pipe and Fittings
      i. Pipe and fittings shall be made of PVC plastic pipe having a minimum cell classification of 12454 as defined in ASTM D 2241 or ASTM D 3034 for SDR26.
      ii. Joints: Joints shall be of a push-on type with a bell-end grooved to receive a synthetic rubber gasket. Solvent welded joints are not allowed. The joint shall be made in accordance with ASTM D 3212.
   c. High Density Polyethylene (HDPE) Service Line Pipe and Fittings
      i. The pipe shall be manufactured from high density high molecular weight polyethylene resin which conforms to ASTM D 1248. The pipe produced from this resin shall have a minimum cell classification of 345434C under ASTM D 3350.

ii. As approved by the Engineer, electrofusion fittings may be allowed in lieu of fittings designed for butt fusion.

d. Ductile Iron Pipe (DIP) Service Line Pipe and Fittings: Refer to paragraph 2502.2.B of this Section for requirements for DIP service line pipe and fittings.

2502.3 Pipe Embedment Materials

A. Granular Bedding Material: All materials used for granular embedment for pipe bedding shall conform to the requirements of ASTM C 33 and shall meet the graduation identified in Section 2102.4.G.:

B. Concrete for embedment and encasement:

1. Concrete shall test not less than a twenty-eight (28) day compressive strength of 3000 psi and shall otherwise conform to Section 2509.3.E.

2. Reinforcing steel when required shall be placed as shown on the Plans and shall conform to Section 2509.3.F.

2502.4 Backfill Materials

A. Granular Backfill Material: Granular backfill material shall meet the gradation requirements as outlined in Section 2102.4.

B. Flowable backfill (CLSM): Flowable backfill (CLSM) shall meet the requirements as outlined in Section 2102.2.E.

C. Select Earth Backfill Material: Select earth backfill shall be finely divided job excavated material free from debris, organic matter, rocks larger than one (1) inch and/or frozen materials.

D. Other Earth Backfill: Other backfill may be job excavated material free from debris and organic matter. No rock greater than three-inches in diameter shall be placed in any trench excavation as backfill unless approved by the Engineer.

2502.5 Tunneling, Boring and Jacking Materials

A. General: Furnish materials and necessary accessories with strengths, thicknesses, coatings, and fittings indicated, specified and/or necessary to complete the work.

B. Steel Liner Plate: Steel tunnel liner plates shall be new and with minimal oxidation. The design and shape of the liner plates shall be such that assembly can take place entirely from within the tunnel liner. Liner plates shall be capable of withstanding the ring thrust load and transmitting this from plate to plate. The minimum outside diameter shall be four (4) feet and the minimum wall thickness shall be United States Standard Gauge 12 (0.1094 inches). Sufficient sections shall be provided with one and one-half (1½) inch or larger grouting holes located near the centers so that when plates are installed there will be one line of holes on either side of the tunnel and one at the crown; the lower line of holes on each side shall not be more than eighteen (18) inches above the invert. The holes in each line shall not be more than five (5) feet apart and unless otherwise approved, shall be staggered. Bolts and nuts shall conform to ASTM A 153, A 307, F 3125 and A 449 as applicable. Steel liner plates shall have bolted joints in both longitudinal and circumferential planes. Stagger longitudinal joints in adjacent rings when assembling.

C. Steel Casings: Steel casings for bored or jacked construction shall be steel pipe conforming to ASTM A 139 with a minimum diameter as shown on the Plans.

1. Minimum wall thickness shall be in accordance with the following table:

Diameter of Casing-Inches	Nominal Wall Thickness-Inches Under Railroads	All Other Uses
16	0.312	0.188
18	0.312	0.250
20	0.375	0.250
22	0.375	0.250
24	0.406	0.281
26	0.438	0.281
28	0.469	0.312
30	0.469	0.312
32	0.500	0.312
34	0.500	0.312
36	0.500	0.344

2. Steel shall be Grade B with a minimum yield strength of 35,000 psi under railroads and Grade A on all other uses.

3. Steel pipe shall have welded joints in accordance with AWWA C 206.

D. Reinforced Concrete Pipe: Reinforced concrete pipe used as casing shall conform to ASTM C 76 except as otherwise specified under Section 2502.2.E and as specified herein.

1. Design: Provide ASTM C 76 circular pipe of the strength class required for the jacking of pipe when determined by method set forth in the latest printing of Concrete Pipe Design Manual prepared by the American Concrete Pipe Association.

2. Joints: Reinforced concrete pipe used for casing pipe shall be provided with steel end joint with a groove in the spigot end for an O-ring gasket. The O-ring gasket shall be synthetic rubber. Both joint and gasket shall otherwise conform to ASTM C 361.

3. Interior Protection: Interior protection is NOT required for reinforced concrete pipe used for casing conduit.

E. Casing Conduit Grout: Casing conduit grout shall be a pumpable grout resulting in minimum set strength of 400 psi in 28 days.

F. Sand: Sand used as fill in casing conduits shall be a clean sand and thoroughly dry. All sand fill shall conform to the requirements under Section 2509.3.E.5.

G. Pipe Supports shall conform to the following:

1. Casing Spacers: Casing spacer shall be a two-piece shell or band made from T-304 stainless steel of a minimum 14 gauge thickness. The shell/band shall have risers made of 10 gauge T-304 stainless steel and have a PVC liner. The bearing surface (skid or runner) shall be made of an ultra-high molecular weight polymer, glass reinforced polyester, or fiberglass reinforced nylon. The shell/band

shall be bolted together with T-304 stainless steel bolts. The configuration of the carrier pipe in the casing pipe shall be centered. End seals shall be made by the same manufacturer as the casing spacers and shall use stainless steel bands to hold end seals to pipes.

2. Wood Skids: Wood skids shall be provided as indicated on the Plans. The wood shall be treated with a preservative as approved by the Engineer. Cut surfaces shall be given two (2) heavy brush coats of the same preservative. If PVC pipe is used as the carrier pipe, the wood skids shall be compatible with the PVC pipe.

SECTION 2503 SITE PREPARATION

2503.1 Scope

This section governs the furnishing of all labor, materials and equipment for Site Preparation as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2503.2 General

A. See Section 2101 for Site Preparation.

SECTION 2504 EXCAVATION

2504.1 Scope

This section governs the furnishing of all labor, materials and equipment for pipeline excavation for open cut, tunneling, boring, and jacking as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2504.2 General

The terms "excavation" and "trenching" shall mean the removal and subsequent handling of all material required to perform the work.

A. All pipeline excavation work shall be accomplished under supervision of a person experienced with the materials and procedures which will provide protection to existing improvements, including utilities and the proposed pipeline.

B. The alignment, depth, and pipe subgrades of all sewer trenches shall be determined by a laser beam parallel to the sewer invert.

C. When pipe is to be installed in embankment or fill, the embankment shall be constructed in accordance with APWA section 2102.6 and shall be built up to a plane at least 18 inches above the top of the pipe prior to the excavation of the sewer trench.

D. The Contractor shall not open more trench in advance of pipe laying than is necessary. Four hundred (400) feet will be the maximum length of open trench allowed on any line under construction. All open trenches shall be adequately protected.

E. In the event hazardous wastes as defined by the Resource Conservation and Recovery Act of 1976 (PL94-580) are encountered, work shall be halted and the Engineer shall be notified. Work shall be resumed only after the Engineer notifies the Contractor. Regulation of removal, handling and disposal of hazardous wastes is the

responsibility of Federal and State agencies.

2504.3 Classification of Excavated Material

No classification of excavated materials will be made. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the contract work regardless of the type, character, composition, or condition thereof. See Section 2100 “Clearing and Site Preparation”.

2504.4 Removal of Water

The Contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface and groundwater entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

All excavations for concrete structures or trenches which extend down to or below static groundwater elevations shall be dewatered by lowering and maintaining the groundwater surface beneath such excavations a distance of not less than 12-inches below the bottom of the excavation.

Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.

The Contractor will be held responsible for the condition of any pipe or conduit which he may use for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.

2504.5 Blasting

Blasting: When blasting is permitted by the Engineer, the Contractor shall use the utmost care to protect life and property. The Contractor shall obtain any required permits from the agency having site jurisdiction and shall comply with all laws, ordinances, and the applicable safety code requirements and regulations relative to the handling, storage and use of explosives and protection of life and property, and he shall be responsible for all damage caused by his or his subcontractor's operations.

The Contractor shall provide insurance as required by the Contract Documents before performing any blasting. The governing agency shall be notified at least 24 hours before blasting operations begin.

2504.6 No Blasting Areas

No Blasting Areas: No blasting of any kind for rock excavations or any other purpose will be allowed unless noted otherwise on the Plans or permitted by the Engineer.

2504.7 Open-Cut Method (Trenching)

A. General: Excavations for pipelines shall be accomplished by the open-cut method (trenching) except as specified or approved by the Engineer. Trenching shall be with a minimum inconvenience and disturbance to the general public.

The Contractor shall sort and stockpile the excavated material so the proper material is available for backfill.

B. Trench Depths: All trenches shall be excavated to depths required for proper pipe embedment. Overdepth excavation shall be required when the subgrade is unstable. Overdepth excavations shall be backfilled with granular pipe embedment material unless otherwise directed by the Engineer.

C. Trench Walls: Undercutting of trench walls is not permitted.

D. Trench Widths

1. Minimum Widths: Minimum trench widths shall be in accordance with the Plans, Standard Drawings, and manufacturers' recommendations.

2. Maximum Widths: The allowable maximum trench widths hereinafter specified apply only to that portion of the trench below the horizontal plane parallel to and six (6) inches above the top of the pipe. The allowable maximum widths may be exceeded at manholes, bore pits, tees, and in unstable earth material. Where the maximum trench width is exceeded the Contractor shall provide the appropriate strength class of pipe embedment to provide safe support strength to the pipeline.

3. When the side clearance exceeds two and one-half (2.5) times the outside pipe diameter at either side of a flexible conduit, it shall be the Contractor's responsibility at no additional cost to the Owner to provide bedding adequate to develop the required lateral support for the pipe and/or provide a pipe of sufficient strength class to accommodate the loading conditions as approved by the Engineer.

4. Trench Slope: The trench width above a horizontal plane six (6) inches above the top of the pipe may vary and side sloping is permissible unless otherwise specified.

5. Trench Shields: When trench shields are utilized by the Contractor, said shields or any part thereof shall not extend lower than twelve (12) inches above the top of the proposed pipeline nor shall the maximum allowable trench width be exceeded.

6. Sheeting and Shoring: Except where banks are cut back on a stable slope, excavation for structures and trenches shall be properly and substantially sheeted, braced, or shored as necessary to prevent caving or sliding, to provide protection for workmen and the work, and to provide protection for existing structures and facilities. Sheeting, bracing, and shoring shall be designed and built to withstand all loads that might be caused by earth movement or pressure and shall be rigid, maintaining shape and position under all circumstances.

   Trench sheeting shall not be pulled unless pipe strength is sufficient to carry trench loads based on trench width to the back of sheeting.

   Sheeting shall not be pulled after backfilling.

   Where trench sheeting is left in place, such sheeting shall not be braced against the pipe, but shall be supported in a manner which will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed.

E. Maximum Trench Widths for Reinforced Concrete and Ductile Iron Pipe: When reinforced concrete and ductile iron pipe is utilized, the strength class and the maximum allowable trench width will be shown on the Plans.

F. Option to Trenching: Contractor may perform excavation by tunneling methods as set forth herein at no additional cost to the Owner provided prior written approval for each such location is obtained from the

Engineer.

2504.8 Tunneling, Boring and Jacking

A. General: Tunneling includes all underground horizontal excavations necessary to install the pipeline. The Contractor shall submit to the Engineer, prior to actual work, a written description of his proposed tunneling operation. It shall include the types and locations of shafts, methods to provide safe support strength for the pipeline when the shafts or bore pits exceed maximum allowable trench widths and other features that would affect the pipeline.

Tunneling shall be done with a minimum inconvenience and disturbance to the general public and abutting property owners.

B. Tunnel Cross Section: The tunnel shall be circular in cross section and of the size specified. Alternate size and shape may be submitted for consideration by the Engineer.

C. Construction

1. General: All tunnel excavation shall provide an excavation conforming to the outside diameter of the casing and/or carrier conduit. The excavation shall be to an alignment and grade which will allow the carrier conduit to be installed to proper line and grade as shown on the Plans and as established in Section 2505.4.

2. Excavation: Conduct excavation in a manner to prevent disturbing overlying and adjacent material. Perform dewatering and chemical soil stabilization or grouting if necessary, due to existing field conditions.

SECTION 2505 INSTALLATION

2505.1 Scope

This section governs the furnishing of all labor, materials and equipment for the installation of gravity and pressure pipelines and appurtenances as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2505.2 General

All pipeline installations shall conform to the following requirements:

A. Governmental Requirements: Sanitary sewer line installation shall comply with applicable State and County Health and Environment Department requirements.

B. Trench Dewatering: Contractor shall maintain a dry and stable trench, obtain necessary permits, and provide for the proper method of discharging such water from the work site at all times until pipeline installation is completed to the extent that hydrostatic pressure flotation or other adverse effects will not result in damage to the pipeline.

Proper dewatering techniques are the Contractor's responsibility. All work performed by the Contractor which is adversely affected by his failure to adequately dewater trenches will be subject to rejection by the Engineer. The Contractor shall repair and/or replace the affected pipeline without additional compensation.

C. Drainage Course Crossing Encasement: Any pipeline crossing a well-defined drainage course having less than three (3) feet of cover over the pipe shall be encased in concrete. The length of encasement shall be as shown on the Plans or if not shown as specified by the Engineer.

D. Trench Shoring and Bracing: All shoring, bracing or blocking shall be furnished and installed as necessary to preserve and maintain exposed excavation faces, to protect existing improvements, to protect the proposed pipeline and to provide for safety.

Shoring or other methods for support of trench walls is the responsibility of the Contractor and shall be accomplished by methods that will not adversely affect pipeline alignment, grade and/or structural integrity.

All bracing, sheeting and/or shoring installed below a horizontal plane six (6) inches above top of proposed pipe shall not be disturbed or removed after pipe and/or pipe embedment has been installed unless otherwise specified. The bottom skids of a trench shield shall not extend lower than twelve (12) inches above top of proposed pipe.

E. Pipe Embedments: All pipe embedment shall conform to Class B First Class Modified unless otherwise specified. Installation shall be in strict conformance with instructions for the appropriate Class being utilized.

F. All Class A concrete embedments for rigid conduits shall begin and end at a pipe joint.

G. Bedding Installation

1. The trench subgrade shall be prepared to provide a uniform and continuous pipe support between pipe bells and joints.

2. Place and densify embedment material by shovel slicing or vibrating and prepare embedment material so that the pipe will be true to line and grade after installation.

3. After each pipe has been brought to grade, aligned, and placed in final position, deposit and densify by shovel slicing sufficient bedding material under the pipe haunches and on each side of the pipe to hold the pipe in proper position during subsequent pipe jointing, bedding, and backfilling operations. Place bedding material uniformly and simultaneously on each side of the pipe to prevent lateral displacement.

4. Place pipe that is to be bedded in Class A (concrete) embedment in proper position on temporary supports consisting of wood blocks or bricks with wood wedges. When necessary, anchor or weight the pipe to prevent flotation when the concrete is placed.

5. Place concrete for Class A (concrete) embedment or encasement uniformly on each side of the pipe and deposit at approximately its final position. Do not move concrete more than five (5) feet from its point of placement.

6. If unstable subgrade conditions are encountered and it is determined by the Engineer that the bedding specified will not provide suitable support for the pipe, additional excavation to the limits determined by the Engineer will be required. This additional excavation shall be backfilled with material approved by the Engineer.

7. Pipe Embedment Designations and Descriptions

a. Class A. Embedment - Concrete Cradle. Arch or Encasement

i. All Class A embedments require a MCIB A 480-1-4-0.542 concrete mix as designated by the Mid-West Concrete Industry Board, Inc., Kansas City, Missouri, except as otherwise specified. After initial set of concrete, one (1) foot of backfill material should be placed over the conduit or concrete. The backfill above this point shall not be placed nor sheeting removed until at least forty-eight (48) hours after placement of the concrete. Time requirements may be adjusted by the Engineer to obtain structural integrity.

ii. Class A embedments for all pipe shall be installed with reinforcing steel of not be less than p= 0.4%, where p is the ratio of the area of steel to the area of concrete, or as otherwise specified. Reinforcing steel shall be uniformly spaced and have a minimum lap of sixteen (16) bar diameters.

b. Class B Embedment - The pipe shall be bedded in granular material, with a minimum thickness below the pipe as specified in Section 2104.

i. First Class: The granular material shall be placed to the horizontal center line of the pipe. The backfill from the horizontal center line to a level not less than twelve (12) inches above the top of pipe shall be carefully placed select earth backfill compacted to eighty-five percent (85%) of maximum density at an optimum moisture + /- 2% as defined in AASHTO T 99 or ASTM D 698. The select material shall be free from debris, organic matter, frozen material and rocks larger than one (1) inch. Class IV and Class V embedment materials, as defined in ASTM D 2321, shall not be used for bedding, haunching, or initial backfill of flexible pipe.

ii. First Class Modified: The backfill shall be the same as for First Class except all of the material used to a level not less than six (6) inches above the top of the pipe bell coupling shall be bedding aggregate.

iii. Class C Embedment The pipe shall be bedded in granular material with a minimum thickness beneath the pipe as specified in Section 2104.

It shall be sliced under the haunches of the pipe to a height one-sixth (1/6) of the outside diameter of the pipe. Backfill above the bedding to a point twelve (12) inches above the top of pipe, shall be carefully placed select earth backfill compacted to eighty-five percent (85%) of maximum density as defined in AASHTO T 99 or ASTM D 698.

H. Tees, Wyes and Building Service Lines: Tees, wyes, and building service lines shall be installed as shown on the Plans or specified herein.

1. Tees, wyes and saddles shall be installed at forty-five (45) degrees with pipe springline for pipe sizes 8 through 16 inch diameter. Tees, wyes and saddles shall not be installed in pipe sizes greater than or equal to eighteen (18) inch diameter.

2. Building service lines shall be installed with a straight alignment and at a uniform grade not less than two (2) percent unless otherwise specified and shall be embedded with Class B embedment. When a building service line grade exceeds twenty (20) percent, pipeline anchors shall be installed as required under Section 2505.J, with the first anchor not more than twelve (12) nor less than seven (7) feet upstream of the tee or wye.

3. The Contractor shall maintain an accurate record for submittal to the Engineer of location, size and direction of each tee, wye, saddle and/or location, size and length of each building service line. Locations shall use the pipeline stationing as shown on the PIans or the distance from the first downstream manhole. In the event such records are not kept or are lost before final acceptance of the

work, the required information shall be redetermined by the Contractor at no additional cost to the Owner.

4. Saddles will not be allowed unless approved by the Engineer.

5. Service lines shall be terminated and capped one foot on the public side of Right of Way or easement lines.

6. Tracer wire shall be installed along the top of service laterals. The wire shall have HDPE insulation, be no smaller than 12 gauge, and intended for underground applications. The tracer wire shall be green in color. Tracer wires shall terminate at the ground surface inside a tracer box. Tracer box lids shall be green in color. Tracer wire shall be grounded to a minimum one pound magnesium anode at the sewer line.

I. Gravity Sewers: All gravity sewers shall be installed to the alignment, elevation, slope, and with pipe embedment as specified and/or shown on the Plans. Maintain the following tolerances from true alignment and grade between adjacent manholes:

Alignment	6 inches
Grade	+1 inch

Joint deflection shall not exceed the maximum allowable deflection per joint according to AWWA C 600. Only one correction for alignment and/or grade shall be made between adjacent manholes.

J. Pressure Sewers (Force Main): All pressure sewers shall be installed with required pipe embedment to depths shown on the Plans (not less than 42 inches) and to a continuous slope when not shown. Approved air relief valves shall be installed at all locations shown on the Plans or where required by the Engineer.

K. The Contractor shall block and anchor the pipeline to accommodate thrust and testing forces at pipe deflections, bends, tees, and plugs in accordance with the Contract Documents. All damage caused by the Contractor's failure to provide adequate thrust supports shall be corrected by the Contractor at no additional cost to the Owner.

L. Anchors: Pipelines shall be anchored in accordance with the table below:

PIPELINE ANCHORS

Percent of Grade	Center to Center Max. Spacing (Feet)
20 – 35	36
35 – 50	24
50	16

The anchor shall be of concrete or other material approved by the Engineer. Concrete anchors shall have a minimum thickness of twelve (12) inches. The anchor shall extend not less than one (1) foot into undisturbed earth on the sides and bottom and one (1) foot above top of pipe. In incompressible material, the above dimensions may be six (6) inches each side and bottom. The anchor shall support a joint fitting.

M. Pipe Laying: All pipe shall be installed in accordance with the pipe manufacturer's recommendations, except as modified herein.

1. Pipe laying shall not proceed if the trench width as measured at the top of pipe exceeds the maximum

allowable trench width. If this occurs, the Contractor shall submit to the Engineer for approval a better bedding for the pipe or a pipe that provides safe supporting strength.

2. All pipe and fittings shall be stored and handled with care to prevent damage thereto. Do not use hooks to transport or handle pipe or fittings. Do not drop pipe or fittings.

3. Rejected pipe and fittings shall be marked and removed from the Project Site at no cost to the Owner. All pipe and fittings shall be examined for soundness and specification compliance prior to placement in the trench, and rejected pipe or fittings shall not be incorporated into the pipeline. Check the class or pipe strength to be sure proper pipe is installed.

4. Clean joint contact surfaces prior to jointing. Use lubricants, primers, or adhesives as recommended by the pipe or joint manufacturer.

5. Pipe installation shall begin at the lowest point and precede uninterrupted upgrade without gaps unless otherwise approved, in writing, by the Engineer.

6. Unless otherwise required, lay all pipe straight between manholes. Excavate bell holes for each pipe joint. When jointed, the pipe shall form a true and smooth pipeline.

7. Pipe connecting to a structure shall be supported with Class A embedment, cradle or encasement to the first joint outside the structure excavation. If flexible wall connections are used, Class B embedment may be used in lieu of concrete embedment provided the height of backfill does not result in loads exceeding the pipe's safe supporting strength.

8. All pipelines shall be plugged at the end of each day's progress. Plugs or other positive methods of sealing shall be utilized at all times to protect any existing system from entrance of storm water or other foreign matter.

9. When a sanitary sewer line crosses an existing pipeline and the clearance is less than two (2) feet, special embedment may be required.

N. Connection of Pipes of Dissimilar Materials: The connection of pipes of different materials shall be made using an approved transition coupling and shall provide a permanent and watertight connection that will withstand the hydrostatic test pressure and prevent the offset of the joint within the coupling.

2505.3 Detailed Installation Requirements

All pipes shall be installed in accordance with the following standards:

A. ASTM D 2321 ADS Solid Wall, ADS Composite Wall
ASTM D 2321 PVC Solid Wall, PVC Composite Wall

B. ANSI/AWWA C 600 Ductile Iron Pipe

C. Reinforced Concrete Pipe: Installed in accordance with American Concrete Pipe Association's "Installation Manual"

D. Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Wastewater Pipe

1. Gravity Sewer: Installed in accordance with ASTM D 3839 Standard Guide for Underground Installation of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe

2. Force Main: Installed in accordance with AWWA Manual M45, Fiberglass Pipe Design

E. High Density Polyethylene (HDPE) Joints: Assembled in accordance with ASTM D 2657 - Standard Practice for Heat Fusion Joining Polyolefin Pipe and Fittings

2505.4 Casing and Carrier Conduits

Casing and carrier conduits shall be installed at required locations by methods acceptable to the Engineer. Installation of the carrier conduit shall be completed prior to installation of the adjacent portions of the pipeline to allow for adjustments.

A. Casings Types

1. Steel Casing Pipe: Steel casing pipe is a flexible conduit and shall be designed to conform with one of the following design concepts (other methods may be submitted to the Engineer for approval).

   a. Method A: The steel casing conduit is considered a temporary construction means for the installation of the carrier conduit; therefore cathodic and corrosion protection is not required provided that the carrier and its joints are structurally designed to withstand all possible loadings (live, earth and superimposed) which would otherwise be supported by the casing conduit, and to withstand all pressures necessary to install the required grout. All exterior voids around the casing conduits shall be filled with casing conduit grout (see Section 2502.5.E). Interior void between the carrier and casing conduits shall be filled with sand conforming to Section 2509.3.E.5. Sand shall be applied under pressure to fill all of the voids without adversely affecting the carrier conduit, joints, alignment and grade.

   b. Method B: The steel casing conduit is considered a permanent installation to protect the carrier conduit and to support all loads; therefore cathodic and corrosion protection and watertight removable end seals are required for the casing conduit. Care shall be exercised to prevent the carrier conduit from floating and receiving any load transfer from the casing conduit unless it is designed for such loading. The void between casing and carrier conduits shall be treated as shown on the Plans or Standard Drawings. Cathodic and corrosion protection for method B shall be provided by two magnesium anodes, one at each end of the casing pipe, with a lead wire connected to the encasement pipe by thermite welding.

2. Reinforced Concrete Casing Pipe: Reinforced concrete casing pipe is a rigid conduit and shall be installed in accordance with recommended procedures in the latest printing of the Concrete Pipe Design Manual prepared by American Concrete Pipe Association.

B. Casing Installation: Installation of casing shall be supervised by a foreman experienced in such work. Casing shall be installed by a combination of augering and jacking. Alignment and gradient shall be such that the carrier conduit can be installed to line and grade shown on the Plans.

Welding shall be performed by a person experienced with the type of welding necessary. All welds shall conform to AWWA C 206.

C. Liner Plate Installation: Liner plates shall be assembled immediately following the excavation. Advance liner plates or casing continuously with excavation. All voids between liner and surrounding earth shall be filled with casing conduit grout forced in under pressure. As the pumping through any hole is completed, it shall be

plugged to prevent the back-flow of grout. After lining installation is complete, it shall be cleaned of all debris and all leaks sealed.

D. Carrier Conduit Installation: After completion of the installation of the casing, the carrier conduit shall be carefully pushed or pulled through the casing in a manner that will maintain proper jointing of the pipe joints and provide required gradient and alignment. Pipe skids shall be provided as indicated on the Plans. The skids shall be securely strapped to the pipe with steel strapping material at least three-quarters (3/4) inch wide.

E. Sand Fill: The annular space between lining and sewer pipe shall be filled with sand from end seal to end seal unless otherwise specified. The fill shall be placed inside the casing in a manner that will not disturb the alignment and/or grade of the sewer pipe. Sand used in casing conduits shall be as specified in Section 2509.3.E.5. Sand shall be blown into the casing so that all space is filled.

F. End Seals: Construct end seals after sewer pipe bas been installed and approved. End seals shall be manufactured end seals, concrete plugs with allowances for water flow, or brick shall be in accordance with ASTM C 32, Grade SS or SM and mortar in accordance with ASTM C 270.

G. Initial Testing: Air pressure and/or exfiltration test as required shall be successfully performed on the carrier conduit prior to filling the void between casing and carrier conduits with sand or the sealing of the ends of the casing conduit.

H. Carrier Conduit Installed Without Casing: Carrier conduits installed without casing shall be assembled at the entrance to the auger hole and carefully pushed or jacked through the opening using a method designed to prevent disturbing the assembled joints. Auger holes shall be sized to accommodate the carrier conduit with a minimum of annular space around the conduit. When finally in place, carrier conduit shall be true to the line and grade required on the Plans.

SECTION 2506 BACKFILL

2506.1 Scope

This section governs the furnishing of all labor, materials and equipment to properly backfill trenches and structures as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2506.2 General

Trench backfill shall be in accordance with Section 2102.4.I except as modified herein.

2506.3 Backfilling in Street or Alley Right of Way and Under Pavement

Backfill under areas to be paved shall be in accordance with Section 2102.4.J.

2506.4 Backfill Around Structures

A. No backfill shall be placed over or around any structure until the concrete or mortar has attained a minimum strength of 2000 psi and can sufficiently support the loads imposed by the backfill without damage.

B. The Contractor shall use utmost care to avoid any wedging action between the side of the excavation and the structure that would cause any movement of the structure. Any damage caused by premature or unbalanced

backfill or by the use of equipment on or near a structure will be the responsibility of the Contractor.

C. No rock larger than three (3) inches maximum dimension shall be placed within one (1) foot of the exterior surface of any structure.

D. Backfill around structures in street or alley Right of Way from the bottom of the structure to the bottom of the subgrade shall meet the requirements of Section 2102.4.J.

SECTION 2507 RESTORATION

2507.1 Scope

This section governs the furnishing of all labor, materials and equipment for the surface restoration of private and public properties that are disturbed by construction as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2507.2 General

The Contractor shall restore the project site to conditions equal to or better than those existing prior to entry unless otherwise specified.

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

B. Public property shall be restored to the requirements of the public body having jurisdiction.

2507.3 Clean-Up

The Contractor, upon completion of installation and backfill operations, shall prepare the area for final grading including but not limited to the following items:

A. Clean-up shall follow the backfilling operations as closely as possible.

B. Excess material shall be removed from the site including material that has washed into the stream beds, storm water facilities, streets, etc.

C. Tools, equipment and construction material shall be removed except for in designated storage areas along the pipeline route.

D. Restore surface and sub-surface drainage and provide temporary erosion control measures in accordance with Section 2150.

2507.4 Finished Grading

The Contractor shall finish grade the area to lines and grades shown on the Plans or if not shown to those that existed prior to the area being disturbed. Special attention shall be directed to assure surface drainage. The area shall be smoothed by raking or dragging.

2507.5 Seeding

Seeding shall be in accordance with Section 2400.

2507.6 Sodding

Sodding shall be in accordance with Section 2400.

2507.7 Pavement Replacement

A. General

1. Replacement of pavement shall proceed in accordance with the traffic control plans and/or approved construction schedule.

2. Prior to pavement replacement, all edges that were previously cut but have been subsequently damaged shall be recut and all adjacent undermined and heaved pavement shall be removed.

3. Removed pavement shall be replaced in conformance with the requirements of applicable portions of Section 2200 “Paving” or Section 2300 “Incidental Construction”.

4. Non-Standard Pavement: Pavement sections not conforming to Section 2200 of these specifications shall be replaced in accordance with requirements of the jurisdictional agency.

2507.8 Fences

See Section 2307.

2507.9 Walls

Retaining and architectural walls, if disturbed or damaged, shall be restored architecturally and structurally to conditions not less than that which existed prior to construction.

2507.10 Trees, Shrubs, and Bushes

Any tree, shrub, or bush as shown on the Plans as "replaced" shall be of the same species as the removed tree, shrub, or bush. Any tree, shrub, or bush species that is prohibited by local restrictions shall be substituted with a related species. Replacement planting shall conform to the guidelines ANSI-Z60.1-2004 "American Standard for Nursery Stock" specified by the American Nursery and Landscape Association.

SECTION 2508 TESTING

2508.1 Scope

This section governs the furnishing of all labor, materials and equipment for the performance of any and all acceptance tests as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2508.2 General

The Contractor shall furnish all labor, equipment, materials and reports for the required acceptance tests. All pipelines,

including building service lines, shall undergo and pass all required tests to determine soundness and workmanship. Pipelines that do not conform to the project requirements shall be repaired and/or replaced and shall be retested until the pipeline meets the project requirements. Test results shall be recorded by the Contractor and a copy shall be submitted to the Engineer. No testing of the piping system shall be performed before backfill and compaction operations have been completed.

2508.3 Alignment and Grade

Alignment, grade and visible defects shall be checked as follows:

A. Visual Internal Inspection

1. Contractor shall clean pipe of excess mortar, joint sealant and other dirt and debris prior to inspection.

2. Sewer will be inspected by flashing a light between manholes and/or by physical passage to determine the presence of any misaligned, displaced, or broken pipe and other defects.

B. Television Inspection: Sewer line installations shall be inspected by closed circuit television at the Contractor's expense.

2508.4 Infiltration - Exfiltration

Hydrostatic or air pressure tests shall be conducted on sewers before acceptance by the Owner. For sewers with a diameter less than twenty-four (24) inches, the infiltration-exfiltration shall not exceed fifty (50) gallons per day per inch of nominal diameter per mile of sewer line for any section of the system. For sewers with a diameter twenty-four (24) inches or greater, infiltration-exfiltration shall not exceed three thousand six hundred (3600) gallons per day per mile of pipe.

A. Infiltration: Where sewers are laid within the ground water table, infiltration testing shall be conducted. Where evidence of infiltration is discovered by the Engineer, the Contractor shall install weirs or other suitable flow rate measuring devices adequate to determine to the satisfaction of the Engineer that the specified infiltration limit is not exceeded for that section of gravity sewer. Where the specified infiltration limit is exceeded, the Contractor shall repair or replace the defective section of pipeline at no additional cost to the Owner. Following repair of the pipeline, the Contractor shall remeasure infiltration flow rates and make additional repairs until an acceptable infiltration flow rate is achieved.

B. Exfiltration: Exfiltration tests shall be performed by the Contractor using one or a combination of methods as set forth below. Each section of gravity pipeline between manholes and/or structures shall be tested after backfill has been completed.

1. Hydrostatic Tests for Gravity Systems

   a. Test section shall be filled not less than twelve (12) hours prior to testing. Refill test section prior to performing test.
   b. Perform at depths of water as measured above center line of pipe of not less than 2 feet nor more than 10 feet (consideration shall be given for water table above said center line). Maintain test as necessary to locate all leaks but not less than two hours.

2. Hydrostatic Tests for Pressure Systems

a. Conformance Procedure: Perform hydrostatic pressure and leakage tests. Conform to AWWA C 600 procedures as modified herein. Tests shall apply to all pressure sewers.

b. Sectionalizing: Test in segments between sectionalizing valves, between a sectionalizing valve and a test plug, or between test plugs. Contractor shall furnish and install test plugs at no additional cost to the Owner, including all anchors, braces, and other devices to withstand hydrostatic pressure on plugs. Contractor shall be responsible for any damage to public or private property caused by failure of plugs. Limit fill rate of line to available venting capacity.

c. Pressure Test: Conduct at 1.5 times maximum operating pressure determined by the following formula:

Ppt = (1.5) (.433) (OP-GE), in which

Ppt = test pressure in psi at gauge elevation

OP = operating pressure in feet as indicated for highest elevation of the hydraulic gradient on each section of the line

GE = elevation in feet at center line of gauge.

Perform pressure tests satisfactorily prior to determining leakage.

d. Leakage Test: Conduct at the maximum operating pressure as determined by the following formula:

Plt = 0.433 (OP-GE), in which

Plt = test pressure in psi at gauge elevation

OP and GE – as defined from pressure test formula (see above)

All joints shall be watertight and free from leaks

3. Air Testing of Gravity Systems

a. Contractor may perform air tests for all pipe (except concrete and fiberglass) for all sizes.

b. Furnish all facilities required including necessary piping connection, test pumping equipment, pressure gauges, bulkheads, regulator to avoid overpressurization, and all miscellaneous items required.

c. The pipe plug for introducing air to the sewer line shall be equipped with two taps. One tap will be used to introduce air into the line being tested through suitable valves and fittings, so that the input air may be regulated. The second tap will be fitted with valves and fittings to accept a pressure test gauge indicating internal pressure in the sewer pipe. Additional valve and fitting will be incorporated on the tap used to check internal pressure so that a second test gauge may be attached to the internal pressure tap. The pressure test gauge will also be used to indicate loss of air pressure due to leaks in the sewer line.

d. The pressure test gauge shall meet the following minimum specifications:

Size (diameter)	4.5 inches
Pressure Range	0 -15 psi
Figure Intervals	1 psi increments

Minor Subdivisions	0.05 psi
Pressure Tube	Bourdon Tube or diaphragm
Accuracy	± 0.25% of maximum scale reading
Dial	White coated aluminum with black lettering, 270^0 arc and mirror edge
Pipe Connection	Low male 1/2 inch N.P.T.

Calibration data will be supplied with all pressure test gauges. Certification of pressure test gauge will be required from the gauge manufacturer. This certification and calibration data will be available to the Engineer whenever air tests are performed.

Gravity sewer pipe shall be air-tested in accordance with the requirements of ASTM F 1417.

e. Plug ends of line and cap or plug all connections to withstand internal pressure. One of the plugs provided must have two taps for connecting equipment. After connecting air control equipment to the air hose, monitor air pressure so that internal pressure does not exceed 5.0 psig. After reaching 4.0 psig, throttle the air supply to maintain between 4.0 and 3.5 psig for at least two (2) minutes in order to allow equilibrium between air temperature and pipe walls. During this time, check all plugs to detect any leakage. If plugs are found to leak, bleed off air, tighten plugs, and again begin supplying air. After temperature has stabilized, the pressure is allowed to decrease to 3.5 psig. At 3.5 psig, begin timing to determine the time required for pressure to drop to 2.5 psig. If the time in seconds for the air pressure to decrease from 3.5 psig to 2.5 psig is greater than that shown in the table below, the pipe shall be presumed free of defects.

Pipe Diameter (in)	Minimum Time (min:sec)	Length for Minimum Time (ft)	Time for Longer Length (sec) L = Total Length
4	3:46	597	0.380 * L
6	5:40	398	0.854 * L
8	7:34	298	1.520 * L
10	9:26	239	2.374 * L
12	11:20	199	3.418 * L
15	14:10	159	5.342 * L
18	17:00	133	7.692 * L
21	19:50	114	10.470 * L
24	22:40	99	13.674 * L
27	25:30	88	17.306 * L
30	28:20	80	21.366 * L
33	31:10	72	25.852 * L
36	34:00	66	30.768 * L
42	39:48	57	41.883 * L
48	45:34	50	54.705 * L

If air test fails to meet above requirements, repeat test as necessary after all leaks and defects have been repaired and backfilled. Prior to acceptance, all constructed sewer lines shall satisfactorily pass the low pressure air test.

f. If the maintenance of existing flow in a pipe is necessary and air pressure testing is not possible, the Contractor shall perform closed circuit television inspection of the pipe at the

Contractor's expense.

4. In areas where ground water is known to exist, install a one-half inch diameter capped pipe nipple approximately 10" long through manhole wall on top of one of the sewer lines entering the manhole. This shall be done at the time the sewer is installed. Immediately prior to the performance of the line acceptance test, ground water level shall be determined by removing pipe cap, blowing air through pipe nipple into the ground so as to clear it, and then connecting a clear plastic tube to pipe nipple. The hose shall be held vertically and a measurement of height in feet of water shall be taken after the water stops rising in this plastic tube. The height in feet shall be divided by 2.3 to establish the pounds of pressure that will be added to all readings.

2508.5 Deflection Test

A. General: Flexible pipelines shall be tested for deflection by pulling a mandrel through the entire length thereof.

1. The mandrel (go/no-go) device shall be cylindrical in shape and constructed with nine (9) evenly spaced arms or prongs. Mandrels with fewer arms will be rejected as not sufficiently accurate. The rigid mandrel shall have an outside diameter (O.D.) equal to 95 percent of the inside diameter (I.D.) of the pipe. The inside diameter of the pipe, for the purpose of determining the outside diameter of the mandrel, shall be the average outside diameter minus two minimum wall thicknesses for O.D. controlled pipe and the average inside diameter for I.D. controlled pipe, dimensions per appropriate standard. Statistical or other "tolerance packages" shall not be considered in mandrel sizing. The dimensions of the mandrel for PVC pipe shall be as listed in the accompanying table. The "D" mandrel dimension shall carry a tolerance of ± 0.01 inch. Allowances for pipe wall thickness tolerances or ovality (from heat, shipping, poor production, etc.) shall not be deducted from the "D" dimension but shall be counted in as a part of the five (5) percent or lesser deflection allowance. Contact length (L) shall be measured between points of contact on the mandrel arm. The length shall not be less than as shown in the accompanying table.

2. The Engineer shall be responsible for approving the mandrel. Proving rings shall be used to verify this.

3. The mandrel shall be hand-pulled by the Contractor through all flexible sewer lines. Any sections of sewer not passing the mandrel test shall be uncovered and the Contractor, at no additional cost to the Owner, shall reround or replace the sewer to the satisfaction of the Engineer. These repaired sections shall be retested.

4. The testing shall be conducted after final trench backfill has been in place for a minimum of 30 days, unless approved otherwise by the Engineer.

D and L Dimensions For
9 Arm Mandrel

Nominal Diameter (L)		D		
		ASTM D3034 SDR 35	ASTM D3034 SDR 26	ASTM D2241 SDR 21
8”	8”	7.52”	7.37”	7.41”
10”	10”	9.40”	9.21”	9.24”
12”	12”	11.19”	10.96”	10.96”
15”	15”	13.70”	13.42”	N/A
18”	18”	16.76”	N/A	N/A
21”	21”	19.74”	N/A	N/A
24”	24”	22.21”	N/A	N/A
27”	27”	25.03”	N/A	N/A

5. Mandrel outside diameters for flexible pipe types not listed in the table shall be calculated as described in paragraph 2508.5.A.1 above.

6. Mandrel outside diameters for HDPE and Fiberglass Wastewater Pipe shall be calculated as described in paragraph 2508.5.A.1 above. For Fiberglass Wastewater Pipe, the outside diameter of the mandrel shall be 97% of the inside diameter of the pipe.

2508.6 Soil Density Tests

A. General: Compaction tests shall be performed as specified in Section 2102.4.I and 2102.4.J.

SECTION 2509 MANHOLES AND SPECIAL STRUCTURES

2509.1 Scope

This section governs the furnishing of all labor, materials and equipment and the performance of all work incidental to the construction of manholes, drop manholes and special sewer structures complete with covers, steps, fittings and appurtenances as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

2509.2 General

As used herein special structures refers to manholes on large sewers, special junction structures, metering stations and similar structures constructed on the pipeline.

Manholes and special structures may be constructed of pre-cast concrete sections or cast-in-place concrete, unless otherwise noted on the Plans, Standard Drawings, or Contract Documents.

2509.3 Manhole Materials

A. Mortar and plaster coating: Mortar and plaster coatings for masonry manhole units shall conform to ASTM C 270. The mix shall consist of two (2) parts portland cement to one (1) part masonry cement to six (6) parts standard plaster sand. No mortar or plaster mixed more than thirty (30) minutes shall be incorporated in the work.

B. Non-Shrink Grout: Non-shrink grout shall be in the plastic state and show no expansion after set as tested in accordance with ASTM C 827 and shall develop compressive strength not less than three thousand (3.000) pounds per square inch with a trowelable mix within twenty-four (24) hours per ASTM C 109. The placement time shall be not less than forty-five (45) minutes based on initial set per ASTM C 191.

C. Waterproofing: Waterproofing shall be a coal-tar coating and conform to ASTM D 450. Exterior surfaces shall be coated with Tnemec "46-450 Heavy Tnemecol" or approved equal. Where specified, interior surfaces (which are exposed to raw sewage and sulfide gases) shall be coated with Tnemec "46-449 Heavy Duty Black" or approved equal. The minimum dry thickness for all waterproofing shall be 14.0 mils.

D. Precast Concrete: Precast concrete manholes shall conform to ASTM C 478 with the following modifications.

1. Wall thickness shall not be less than one-twelfth (1/12) of inside diameter plus one (1) inch or five (5) inches, whichever is greater.

2. Cement, Fine Aggregate, Coarse Aggregate and Water used in the manufacture of precast manholes shall be as specified in Section 2509.3.E.

3. Developed bases shall be used where practical. The floor of developed base manholes shall have a minimum thickness of twelve (12) inches. The bottom wall section shall be embedded a minimum of five (5) inches into the cast base. The diameter of the base pad shall be eight (8) inches greater than outside diameter of the manhole.

4. Pipe openings: The first riser (barrel) section shall be provided with circular openings with continuous, circular, resilient connectors cast into the riser wall. Horseshoe-shaped boxouts, or doghouses, shall not be allowed except when approved by the Engineer. Flexible gaskets shall be used with developed base manholes. Flexible gaskets shall be Press-wedge, A-Lock, or approved equal.

5. The minimum distance from the invert of the downstream pipe to the top surface of the base shall be three (3) inches.

6. Joints between manhole sections, adjustment rings, and below the ring and cover shall be sealed with preformed bitumastic sealants, Kent-Seal, RamNet, E-Z Stick or approved equal. The minimum bead dimension shall be one inch.

7. Both the bell and spigot ends of the manhole sections shall be primed with a liquid primer that is compatible with bitumastic sealants, Kent-Seal, RamNet, E-Z Stick or approved equal.

8. Reducing sections may be used at six (6) feet or more above the invert.

9. Eccentric cone sections shall be used unless noted otherwise on the Plans.

E. Manhole and Special Concrete: Manhole and special concrete shall conform to “The Mid-West Concrete Industry Board Incorporated" (MCIB) Specifications and to the requirements therein for the MCIB Mix Number or KCMMB mix as shown on the Plans or as specified herein.

1. Standard Concrete: Standard concrete used for concrete encasements and embedments, thrust blocks, pipe anchors, pipe collars, etc. shall be MCIB Mix Number A 480-1-4-0.542, or KCMMB 3K unless otherwise specified.

2. Structural Concrete: Structural concrete used for aerial crossing piers, wetwell walls, manhole walls, bases, inverts, and flat slabs, etc. shall be MCIB Mix Number A 558-1-2-0.421 or KCMMB 4K, unless otherwise specified.

3. Concrete Materials and Admixtures

   a. For KCMMB mixes, concrete shall be an approved mix with admixtures that are approved for use in that mix design.
   b. For MCIB mixes:
      i. Air-entraining admixtures shall provide an air content within the range of 4 1/2 to 7 1/2 percent by volume as measured by the pressure method (ASTM C 231). The air entraining admixtures shall meet the requirements of ASTM C 260.
      ii. Portland Cement: Portland cement shall conform to ASTM C 150 Type I. Where high early strength is desired, Type III can be used.
      iii. Fine Aggregate: Fine aggregate shall be clean, natural sand meeting the requirements of ASTM C 33. Grading shall be within the limits as set forth by MCIB.
      iv. Coarse Aggregate: Coarse aggregate shall be limestone meeting the requirements of ASTM C 33. The sum total of all deleterious material shall not exceed the requirements of ASTM C 33.
      v. Water: Water shall be clean and free from deleterious substances. Only potable water will be acceptable without testing.

F. Reinforcement steel: Reinforcement steel shall conform to the following minimum requirements and as shown on the Plans or Standard Drawings.

1. Design: Reinforcing steel shall conform to one of the following.

   a. Welded Wire Fabric - ASTM A 1064.
   b. Reinforcing Bars - ASTM A 615, Grade 40, or Grade 60.
   c. Fabricated Steel Bar and Rod Mats - ASTM A 184, Grade 40, or Grade 60.

2. Fabricating Tolerances: Tolerances for concrete reinforcement shall conform to the following requirements.

   a. Sheared length = ± 1 inch.
   b. Stirrups, ties, and spiral = ± 2 inches.
   c. All other bends = ± 1 inch.

G. Iron Castings: Casting shall conform to the requirements of ASTM A 48, Class 30B. Castings shall be clean and without surface defects that will impair serviceability. Plugging or filling of holes or other defects will not be permitted. Parting fins and pouring gates shall be removed.

1. Rings and Covers: Rings and covers shall meet the following minimum requirements.

   a. Bearing surfaces between the ring and cover shall be machine finished or ground to assure interchangeability and a non-rocking fit in any position.
   b. Provision shall be made for opening, such as concealed pick hole(s).
   c. Bolt-down type manhole rings shall be anchored to the manhole walls with not less than four (4) three-fourths (3/4) inch diameter steel bolts embedded a minimum of four (4) inches, except where the entire ring is embedded in a concrete top slab.
   d. Rings and bolt-down covers shall be provided with machined surfaces, O-ring gaskets and

five-eighths (5/8) inch hex head brass cover bolts. Cover bolt heads shall fit flush or below the top of the cover. The O-ring rubber gasket shall be neoprene or other synthetic, sixty (60) plus or minus five (5) hardness when measured by ASTM D 2240 type Durometer.

2. Steps

a. Cast-Iron Steps are not allowed.
b. Steel core, plastic coated steps: Steel core plastic coated steps shall meet the following minimum requirements.
   i. The plastic coating shall be a copolymer polypropylene meeting ASTM D 4101.
   ii. The steel core shall be a minimum of 1/2 inch in diameter and Grade 60.
   iii. The requirements of ASTM C 478 shall be met except minimum pull-out strength shall be 1,000 pounds.

2509.4 Manhole Site Preparation

Manhole site preparation shall be governed by Section 2503.

2509.5 Manhole Excavation

A. Excavation: Excavation for manholes and special structures shall be governed by this section and Section 2504. It shall be achieved in a suitable and orderly manner providing a minimum disturbance to the general public.

B. Depth of Excavation: Depth of excavation shall be to that required for proper installation of the manhole or structure. Over-depth excavation may be required by the Engineer if the subgrade is unstable. Over-depth excavation due to unstable subgrade shall be backfilled as required by the Engineer. Over-depth excavation occurring through an oversight by the Contractor shall be backfilled as required by the Engineer at no additional cost to the Owner.

C. Side Clearances: Side clearances outside the manhole and/or structures shall be no greater than to allow for forming, connection of piping, proper application of special coatings, if required, and to permit inspection. When concrete is to be placed directly against excavated faces. excavation shall be sufficiently outside of the manhole or structure to provide not less than three (3) inches of concrete cover over the steel reinforcement.

2509.6 Manhole Installation

Manhole installation shall be governed by this Section and Section 2505. It shall be performed by the Contractor on a schedule that will provide an orderly progression of the work.

A. Bases

1. Precast developed bases shall be reinforced in accordance with ASTM C 478.

2. If preferred developed bases are not used, poured concrete bases shall be used. Developed bases shall be installed on a maximum of 4 inches of crushed rock. Depths exceeding this amount shall be filled with mass concrete.

3. Poured-in-place bases shall have a minimum thickness of eight (8) inches. When poured-in-place

bases are used, the invert shall be poured monolithically with the base. The bottom wall sections shall be embedded in the base section a minimum of three (3) inches. The bottom precast wall section shall not be set upon a previously poured base. Solid concrete blocks shall be used for supporting and leveling the wall section prior to pouring the base.

B. Inside Dimensions: The minimum horizontal clear distance in the barrel of the manholes shall not be less than four feet unless otherwise specified on the Plans.

C. Brick shall not be used for new manhole construction.

D. Precast

1. Delivery: Precast concrete components shall not be delivered to the job until representative concrete control cylinders have attained at least 80 percent of the specified minimum design strength.

2. Inspection: Precast concrete shall be inspected when delivered. Rejection of defective or cracked precast concrete components shall be in accordance with ASTM C 478.

3. Wall Thickness: Wall thickness shall conform to the requirements of Section 2509.3.D.

4. Construction: Precast sections shall be cleaned of all dirt, grass, and other deleterious matter. Seal each joint (including adjustment rings and castings) with a double bead of preformed bitumastic joint sealant sections shall be placed such that steps are aligned but without rotation or damage to sealant integrity. Lift holes shall be patched with non-shrink grout.

E. Cast-In-Place

1. Wall Thickness: Wall thickness shall conform to the dimensions as shown on the Plans or Standard Drawings.

2. Construction: Reinforcement steel shall be placed as shown on the Plans or Standard Drawings. Tie-holes shall be patched with non-shrink grout. Wall sleeves, where required, shall be installed as shown on the Plans or Standard Drawings. Water stops shall be installed at the wall and slab connection and shall be of the size, thickness and material as shown on the Plans or Standard Drawings.

3. Waterproofing: Interior protective coatings, where required, shall conform to the material specifications of Section 2509.3.C. Application shall conform to the manufacturer's recommendation.

F. Top Slabs: Thickness shall conform to the dimensions and reinforcement steel shall be placed as shown on the Plans or Standard Drawings.

G. Pipe Stubs: Stubs shall be installed at the locations, angles, elevations and of the materials as shown on the Plans or Standard Drawings. A water-tight removable stopper shall be installed in each pipe stub. Pipe stubs shall be installed so that a pipe joint will be two (2) feet or less from the outside manhole wall.

H. Inverts: Inverts shall be structural concrete and steel-troweled to produce a dense, smooth finish. The invert channel shall be "U" shaped in cross-section and extend upward one-half of the inside pipe diameter. Smooth transitions shall be formed for pipes of different sizes, elevation and bends. The invert bench shall be sloped to drain.

I. Steps: Steps shall be aligned vertically below the casting and spaced at sixteen (16) inch centers. The top step

shall be not more than one (1) foot below the top of the cone. The lowest step shall be not more than two (2) feet above the invert bench. Field drilled step holes are not permitted in precast concrete manholes.

J. Top Elevation: The finished top elevation of manhole castings shall conform to the following unless otherwise shown on the Plans or directed by the Engineer.

1. In paved or future paved areas, the top of the casting shall conform to the slope of the pavement and be 1/8 inch below the finished pavement elevation.

2. In non-pavement areas, the top of the casting shall be not more than six (6) inches above the surrounding ground or less than the sod's upper root limit. The final elevation shall be at a point where water will not pond over the manhole cover.

K. Manhole Adjustment: All new manholes will be provided with adjustment ring(s) underneath the casting as shown on Plans. The joints shall be sealed with preformed bitumastic sealant. The maximum allowable adjustment distance between the top of the cone and the bottom of the casting shall be 12 inches. If the top of an existing manhole is required to be raised to an elevation that will exceed the maximum adjustment distance or lowered more than the adjustment rings will allow, all vertical adjustments shall be made to the barrel of the manhole.

L. Castings: Castings shall be installed with the mud ring inserted inside the manhole opening and resting on a minimum of two rows of preformed bitumastic seals. Bolt-down castings shall be held in place as shown on the Plans or Standard Drawings.

2509.7 Manhole Backfilling

Manhole backfilling shall be governed by Section 2506.

2509.8 Restoration

Restoration shall be governed by Section 2507.

2509.9 Manhole Testing

A. Scope: This section governs the furnishing of all labor, materials for the required testing of manholes and structures as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions.

B. General: All manholes shall be tested for infiltration and inflow.

C. Infiltration and Inflow Testing: All manholes shall be vacuum tested in the presence of the Engineer.

1. Each manhole shall be tested after backfilling to, at least the level of the bottom adjustment ring.

2. The vacuum test shall include testing of the seal between the cast iron frame and the concrete cone, slab or top adjustment ring.

3. All pipes entering the manhole shall be plugged at least eight inches into the sewer pipe. The plug must be inflated at a location beyond the manhole/pipe gasket.

4. All plugs shall be adequately braced to prevent the plug or pipe from being dislodged and drawn into the manhole.

5. A vacuum of at least 10.5 inches of mercury shall be drawn on the manhole. Shut the valve on the vacuum line to the manhole and disconnect the vacuum line. Open the vacuum line valve and adjust the vacuum to 10 inches of mercury.

6. The pressure gage shall be liquid filled having a 3.5-inch diameter face with a reading from zero to thirty inches of mercury.

7. The time for the vacuum reading to drop from 10 inches of mercury to 9 inches of mercury must be equal to or greater than the following values for the manhole to be considered as passing the vacuum test:

Manhole Depth	Time (minutes)
10 feet or less	2
10.1 to 15 feet	2.5
15.1 to 25 feet	3

8. If a manhole fails the vacuum test the manhole shall be uncovered and the leak repaired by patching the exterior of the manhole. The manhole shall then be backfilled and re-tested.

9. The vacuum testing of manholes shall be done prior to air testing the sewer lines that enter or exit the manhole.

SECTION 2510 MEASUREMENT AND PAYMENT

2510.1 Method of Measurement

The quantities of completed work will be measured in the following units:

A. Pipe

1. Open Trenched: Measurement of various size, type and depth of pipe will be to the nearest 0.1 foot for each line between structures and made to the inside face of the connecting structure.

2. Tunneled, Bored, or Jacked: Measurement will be to the nearest 0.1 foot for the limits of tunneling, boring, or jacking as shown on the Plans.

3. Embedment or Encasement: Concrete embedment or encasement will be measured by the lineal foot of each size and type.

B. Manholes

1. Measurement will be made for the applicable type, size and depth of manhole as listed in the Contract Documents. The depth shall be determined by measuring from the top of the casting to the outlet pipe flow line to the nearest 0.1 foot where applicable.

2. Measurement will be made for the applicable type, size and depth of manhole as listed in the Contract Documents per each.

C. Seeding: Measurement will be made in accordance with Section 2400.

D. Sodding: Measurement will be made in accordance with Section 2400.

E. Pavement and Curbing: Measurement will be made in accordance with Section 2200.

F. Driveways and Sidewalks: Measurement will be made in accordance with Section 2300.

2510.2 Payment

Payment will be made at the respective unit or lump-sum price listed in the Contract Documents and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the Contract Documents, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the Contract Documents. At the Engineer's option, partial payment may be made for any lump sum item listed in the Contract Documents, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with tile approved job progress schedule.

END OF SECTION

OAK GROVE STORM SEWER
SPECIFICATION MODIFICATION TO
APWA SPECIFICATION SECTION 2600
OAK GROVE, MO - 2017

Work for the City of Oak Grove shall follow APWA Construction and Material Specification Section 2600 for storm sewers except as modified below. The additions and/or alterations to the APWA Specification 2600 provided below shall apply to execution of the various parts of the work performed on this project.

APWA SPECIFICATIONS SECTION 2600

2602 PIPE SEWER CONSTRUCTION

2602.2 Materials
Add the following to the end of Paragraph D 1.:

High density polyethylene pipe shall conform to AASHTO M294, type S (non-perforated circular cross section with corrugated outer surface and a smooth inner surface) for pipe diameters of 15 inches to 60 inches, inclusive.

Revise first sentence of 2602.2 E. Granular Bedding Material to read as follows:

The class of bedding required shall be as specified in Section 2100 unless indicated otherwise in the Contract Documents, Contract Drawings, or standard details.

Replace 2602.3 C. 1. Backfill of Trenches with the following:

1. All Storm Sewer trenches under roadway pavement shall be backfilled to the subgrade elevation with Flowable Backfill (CLSM). All other Storm Sewer trenches shall be backfilled in accordance with Section 2100 Clearing and Site Preparation.

2604 STRUCTURES

Revise 2604.2. A Concrete Mixes to read as follows:

Concrete shall be KCMMB 4K unless indicated otherwise in the Contract Documents, Contract Drawings, or standard details.

Add the following to the end of 2604.2 D. Precast Structures:

5. When installed, all gaps and openings intended to be closed, shall be sealed with grout, concrete or other approved material. If an adjustment is required for the top slab which is less than or equal to 2 inches, the adjustment shall be made with non-shrink grout as approved by the Director of Public Works. if the adjustment is greater than 2 inches, the adjustment shall be made with dowelled concrete. Dowels shall be bars embedded 6 inches into the walls. All reinforcement shall be the same size and spacing as the wall steel.

Add the following at the end of APWA Section 2600 Storm Sewers

SECTION 2607 MATERIAL TESTING AND CERTIFICATIONS

When requested by the City Engineer, the Contractor shall furnish test results at the contractors expense and from a testing laboratory approved by the City Engineer showing compliance with the plans, specifications, and all requirements of APWA Section 2600 as modified herein.

The contractor shall submit certifications for all materials used for each project to the City Engineer for approval prior to incorporating those materials into the project. Each certification shall indicate that the material is in compliance with the plans, specifications, and all requirements of APWA Section 2600 as modified herein.

At the completion of the project the contractor shall certify that the completed project is in compliance with all requirements of the plans, specification, contract documents, and all other requirements of the City of Oak Grove.

DIVISION II
CONSTRUCTION AND MATERIAL SPECIFICATIONS
SECTION 2600 STORM SEWERS

APPROVED AND ADOPTED THIS 15th DAY OF FEBRUARY, 2017

KANSAS CITY METROPOLITAN CHAPTER
OF THE AMERICAN PUBLIC WORKS ASSOCIATION

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SECTION 2601 GENERAL

2601.1 Scope

This section governs the furnishing all labor, materials, and equipment necessary for the complete installation of storm sewers and appurtenances as shown on the Plans and in accordance with the Standard Drawings, the specifications and the Special Provisions. Unless otherwise noted within these specifications, the word "sewers" shall refer to pipe sewers, box culvert sewers, or open channels.

2601.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards exist, the more stringent standard shall apply.

APWA

Section 2100	Grading and Site Preparation
Section 2150	Erosion and Sediment Control
Section 2200	Paving
Section 2300	Incidental Construction
Section 2400	Seeding and Sodding

ASTM

A 48	Standard Specification for Gray Iron Castings
A 139	Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)
A 153	Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
A 240	Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
A 615	Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
A 641	Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire
A 742	Standard Specification for Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe
A 744	Standard Specification for Castings, Iron-Chromium-Nickel, Corrosion Resistant, for Severe Service
A 745	Standard Practice for Ultrasonic Examination of Austenitic Steel Forgings
A 760	Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
A 761	Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
A 788	Standard Specification for Steel Forgings, General Requirements
A 929	Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
A 1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
C 33	Standard Specification for Concrete Aggregates
C 76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
C 88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
C 361	Standard Specification for Reinforced Concrete Low-Head Pressure Pipe
C 443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
C 478	Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
C 506	Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
C 507	Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
C 923	Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

C 990 Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
C 1628 Standard Specification for Joints for Concrete Gravity Flow Sewer Pipe, Using Rubber Gaskets
D 1683 Standard Test Method for Failure in Sewn Seams of Woven Apparel Fabrics
D 2321 Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
D 3350 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
D 3887 Standard Specification for Tolerances for Knitted Fabrics
D 5034 Standard Test Method for Breaking Strength and Elongation of Textile Fabrics (Grab Test)
F 593 Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
F 594 Standard Specification for Stainless Steel Nuts
F 2306 Standard Specification for 12 to 60 in. [300 to 1500 mm] Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications
G 152 Standard Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials

AASHTO
M 31 Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
M 36 Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drain
M 55 Standard Method of Test for Steel Welded Wire Reinforcement, Plain, for Concrete
M 196 Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
M 197 Standard Specification for Aluminum Alloy Sheet for Corrugated Aluminum Pipe
M 245 Standard Specification for Corrugated Steel Pipe, Polymer-Precoated, for Sewers and Drains
M 246 Standard Specification for Steel Sheet, Metallic-Coated and Polymer-Precoated, for Corrugated Steel Pipe
M 274 Standard Specification for Steel Sheet, Aluminum-Coated (Type 2), for Corrugated Steel Pipe
M 294 Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter

ANSI/AWWA
C 206 Field Welding of Steel Water Pipe

ACI 301 Specifications for Structural Concrete

Federal Standard 595B

MCIB Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement
The current editions of the "Bulletins" and Approved Sections of the "Standard Concrete Specifications" issued by the Mid-West Concrete Industry Board, Inc. (MCIB) are made a part hereof by reference. However, when the provisions of this Specification differ from the provisions of such "Bulletins" and "Sections" the provisions of this Specification shall govern.

KCMMB Kansas City Metro Materials Board Specifications

Kansas Department of Transportation
Standard Specifications for State Road and Bridge Construction, 2015 Edition

Missouri Highways and Transportation Commission
Missouri Standard Specifications for Highway Construction, 2011 Edition

2601.3 Cleanup

Cleanup shall follow the work progressively. The Contractor shall remove from the project site all rubbish, equipment, tools, surplus or discarded materials, and temporary construction items.

Streets to be opened to local traffic at the end of the day's operation shall be cleaned of dirt or mud. All equipment and material stockpiles shall be secured for safe passage of vehicles and pedestrians. If streets are to remain open to traffic, cleaning shall be performed at a minimum of once per day at the end of the day's work or as directed by the Engineer or Owner.

Clean-up shall be considered subsidiary to other items in the Contract Documents.

SECTION 2602 PIPE SEWER CONSTRUCTION

2602.1 Scope

This section governs the furnishing of all labor, materials and equipment for the construction of pipe storm sewers and appurtenances at the location and to the lines and grades indicated on the Plans.

2602.2 Materials

A. Reinforced Concrete Pipe

1. Pipe: Reinforced concrete pipe shall conform to the following ASTM Standards and be of the minimum strength designated herein or such higher strength as may be required by the Plans:

    a. Round Pipe: ASTM C 76, Class III (minimum), Wall B (minimum)
    b. Arch Culvert Pipe: ASTM C 506, Class A-III
    c. Elliptical Pipe: ASTM C 507, Class HE-III

    Except for fittings and closure pieces, each joint of pipe shall not be less than eight feet long for pipe diameters 48 inches or less and shall not be less than six feet long for pipe diameters larger than 48 inches.

2. Reinforcement: Circumferential reinforcement shall be full-circle type. Part-circle reinforcement will not be approved. All reinforcing shall be located and spaced as recommended by the pipe manufacturer.

3. Joints

    a. Rubber Gasket Joints: Rubber gasket joints shall conform to ASTM C 443 or ASTM C 1628-06 with the following additions and exceptions.
        i. Replace ASTM C 1628-06 5.1.1 with: Circular Cross-Section or "O-Ring" Gaskets for standard use shall meet Class A requirements. Non-Circular Cross-Section or "Profile" Gaskets for standard use shall meet Class E requirements.
        ii. Replace ASTM C 1628-06 9.4 with: The manufacturer shall conduct concurrently the hydrostatic test described in 9.2 and the structural test described in 9.3. If proven watertight under these combined conditions, hairline cracks that do not leak shall not be cause for rejection. A vacuum of the American Concrete Pipe Association, may be used in lieu of the hydrostatic test referenced above.
        iii. Joint design details shall be submitted for approval together with design data and test results verifying the adequacy of the joint design.
    b. Preformed Flexible Joint Sealant: This sealant shall be either rope form or flat tape form

conforming to ASTM C 990. Primer, if recommended by the manufacturer, shall be applied within the manufacturers' time requirements on all bell and spigot joint surfaces. Joint shall be thoroughly sealed and watertight.

B. Corrugated Metal Pipe (CMP): Pipe, coupling bands, and end section conform to the following requirements:

1. Material

a.	Aluminized Steel Type 2	AASHTO M274, ASTM A 929
b.	Polymer-Coated Steel	AASHTO M246, ASTM A 742
c.	Aluminum Alloy	AASHTO M197, ASTM B 744

2. Pipe

a. Steel (Aluminized Steel, Type 2, CSP and Spiral Rib) AASHTO M36, ASTM A 760
b. Steel (Polymer-Coated, GSP, Spiral Rib, Smooth Interior CSP) AASHTO M36, AASHTO M245, ASTM A 745
c. Aluminum (CMP, Spiral Rib) AASHTO M196, ASTM A 788

Minimum wall thickness of the pipe shall be as follows:

Circular Culvert Pipe (2-2/3" x 1/2" Corrugations)					
Under Roadways or In Street Right-of-Ways		Under Railroads		Not Under Roadways	
Diameter	Minimum Thickness	Diameter	Minimum Thickness	Diameter	Minimum Thickness
12"-21"	.064"	12"-18"	.079"	12"-30"	.064"
24"-30"	.079"	21"-24"	.109"	36"-54"	.079"
36"-54"	.109"	30"-36"	.138"	60"-84"	.109"
60"-72"	.138"	42"-84"	.168"		
84"	.168"				

Circular Culvert Pipe (3" x 1" and 5" x 1" Corrugations)			
Under Roadways or In Street Right-of-Ways		Not Under Roadways	
Diameter	Minimum Thickness	Diameter	Minimum Thickness
36" – 54"	.079"	36" – 54"	.064"
60" – 84"	.109"	60" – 84"	.079"

Circular Culvert Pipe (3/4" x 3/4" x 7-1/2" Spiral Rib)			
Under Roadways or In Street Right-of-Ways		Not Under Roadways	
Diameter	Minimum Thickness	Diameter	Minimum Thickness
12" – 24"	.064"	12" – 42"	.064"
30" – 42"	.079"	48" – 60"	.079"
48" – 66"	.109"	66" – 84"	.109"
72" – 84"	.138"		

Arch Culvert Pipe (2-2/3" x 1/2" Corrugations)			
Under Roadways or In Street Right-of-Ways		Not Under Roadways	
Equivalent Diameter	Minimum Thickness	Span*	Rise*
15"	.064"	17"	13"
18"	.064"	21"	15"
21"	.064"	24"	18"
24"	.079"	28"	20"
30"	.079"	35"	24"
36"	.109"	42"	29"
42"	.109"	49"	33"
48"	.109"	57"	38"
54"	.109"	64"	43"
60"	.138"	71"	47"

* Subject to manufacturing tolerances.

Arch Culvert Pipe (3" x 1" Corrugations)			
Equivalent Diameter	Minimum Thickness	Span*	Rise*
36"	.064"	40"	31"
42"	.064"	46"	36"
48"	.064"	53"	41"
54"	.079"	60"	46"
60"	.079"	66"	51"
66"	.079"	73"	55"
72"	.079"	81"	59"
78"	.109"	87"	63"
84"	.109"	95"	67"
90"	.109"	103"	71"

* Subject to manufacturing tolerances.

Arch Culvert Pipe (3/4" x 3/4" x 7-1/2" Spiral Rib)			
Equivalent Diameter	Minimum Thickness	Span*	Rise*
18"	.064"	20"	16"
21"	.064"	23"	19"
24"	.064"	27"	21"
30"	.079"	33"	26"
36"	.079"	40"	31"
42"	.079"	46"	36"
48"	.109"	53"	41"
54"	.109"	60"	46"
60"	.109"	66"	51"
66"	.109"	73"	55"

* Subject to manufacturing tolerances.

3. Joints: Joints shall have a gasket and may be either bell and spigot joints or made with external coupling bands. The bands shall be drawn and secured on the pipe by connecting devices as furnished by the manufacturer. Pipe ends for annular corrugation shall be identical to the rest of the pipe barrel (plain ends), or in the case of helical pipe, the pipe ends at the joint shall be reformed to an annular corrugation and flange (reformed end). Gaskets shall be furnished in accordance with the Plans and Special Provisions. Coupling bands shall be reviewed and approved by the Engineer prior to installation.

C. Structural Plate Pipe and Pipe Arches: Structural plate and galvanizing shall conform to the requirements of ASTM A 761. Bolts, nuts, and washers for reconnecting plates shall be galvanized in accordance with ASTM A 153 and meet manufacturer's recommendations.

D. High Density Polyethylene (HDPE) Pipe

1. Material: Pipe manufactured for this specification shall comply with and be certified to meet the requirements for test methods, dimensions and markings found in ASTM F 2306 and AASHTO M-294, current additions. Pipe and blow molded fittings shall be made from virgin PE compounds which conform to the requirements of cell class 435400C in the latest version of ASTM D3350.

2. Pipe Sizes: Nominal sizes for this specification include 12-60 inch diameters designated in AASHTO M294 and ASTM F 2306 as full circular cross section with an outer corrugated pipe wall and essentially smooth inner wall (waterway). Pipe corrugations shall be annular.

3. Joints: Joints shall have a gasket and may be either bell and spigot joints or made with external coupling bands. The fittings and couplings bands shall be fabricated from the same material as the pipe conforming to AASHTO M294. The coupling bands shall cover at least two full corrugations of each section of pipe and shall prevent infiltration of soil into the pipe. Gaskets shall be furnished in accordance with the Plans and Special Provisions. Coupling bands shall be reviewed and approved by the Engineer prior to installation.

4. Certification: All high-density polyethylene (HDPE) pipe used for culvert and storm sewer applications shall conform to the requirements of AASHTO M294 and ASTM F 2306, current edition. Pipe shall be provided only by manufacturers that are certified through the Plastic Pipe Institute (PPI) or National Transportation Product Evaluation Program (NTPEP) Third Party Certification program.

5. Pipe Usage: High density polyethylene pipe (HDPE) may not be used for crossroad applications of collector roadways or higher unless approved by the Engineer.

E. Granular Bedding Material: Refer to Section 2100 Clearing and Site Preparation.

F. Flowable Backfill (CLSM): Refer to Section 2100 Clearing and Site Preparation.

2602.3 Construction

A. Trench Excavation: Refer to Section 2100 Clearing and Site Preparation.

1. Unclassified Excavation: Refer to Section 2100 Clearing and Site Preparation.

2. Rock Excavation: Refer to Section 2100 Clearing and Site Preparation.

3. Earth Excavation: Refer to Section 2100 Clearing and Site Preparation.

4. De-watering: Refer to Section 2100 Clearing and Site Preparation.

5. Cribbing and Sheeting: Refer to Section 2100 Clearing and Site Preparation.

6. Unstable Foundation: Refer to Section 2100 Clearing and Site Preparation.

7. Protection of Property: The Contractor shall satisfactorily shore, support, and protect any and all structures and all pipes, sewers, drains, conduits, and other facilities, and shall be responsible for any damage resulting thereto. The Contractor shall not be entitled to any damages or extra pay on account of any postponement, interference, or delay caused by any such structures and facilities being on the line of work, whether or not they are shown on the Plans; specifically, but not limited to, damage due to delay in utility relocation.

B. Laying and Jointing

1. Handling and Protection: All pipe shall be protected during installation against shock and free fall, and be installed without cracking, chipping, breaking, bending, or damage to coating materials. Damaged pipe materials shall be replaced with new materials.

2. Grade Control: Maximum deviation from indicated alignment of any pipe after installation and backfilling shall not be greater than 0.1 foot. All pipe shall have a continuous slope free from depressions that will not drain. The Contractor shall establish such grade control devices as are necessary to maintain the above tolerances.

3. Laying: The laying of pipe in finished trenches shall commence at the lowest point, and pipe shall be installed with the bell end forward or upgrade. All pipe shall be laid with ends abutting and true to line and grade. Pipe laid shall be carefully centered to form a sewer with a uniform invert.

4. Bedding: Bedding shall be rodded, spaded, and consolidated as necessary to provide firm uniform support for the pipe, and not subject pipe to settlement or displacement.

5. Jointing: Preparatory to making filled, bonded, and watertight sealed pipe joints, all surfaces of the

portions of the pipe to be jointed shall be clean and dry. Lubricants, primers, adhesives, and other substances that are used shall be compatible with the jointing material recommended or specified.

Other than for trimming sewer pipe to be flush with the inside walls of storm sewer structures, no pipes may be trimmed unless ordered by the Engineer.

Trenches shall be kept water-free and as dry as possible during bedding, laying, and jointing, and for as long a period as required to protect the pipe joints and concrete in structures.

As soon as possible after the joint is made, sufficient bedding material shall be placed alongside each side of the pipe to offset conditions that might tend to move the pipe off line and grade.

a. Concrete Pipe
    i. Plastic Joint Sealant: Plastic joint sealant shall be applied to the tongue and spigot prior to its insertion into the bell or groove. A sufficient amount of sealant shall be used to fill the annular joint space with some excess. Wipe the outside surface of the joint with additional material to assure a complete seal.
    ii. Flexible Gaskets: Flat gaskets may be cemented to the pipe tongue or spigot. O-ring gaskets shall be recessed in a groove on the pipe tongue or spigot and confined by the bell or groove after the joint is completed. Roll-on gaskets shall be placed around the tongue or spigot and rolled into position as the joint is assembled. Flat gaskets and O-ring gaskets shall be lubricated as recommended by the manufacturer.
        a) Flat gasket: Flat flexible gaskets shall conform to ASTM C 443. If there is no recess provided for the gasket, the surface of the tongue shall be cleaned and rubber adhesive applied. Using quick-drying adhesive, gaskets may be applied ahead of the laying operation or in the plant.
        b) O-ring gasket: O-ring or roll-on flexible gaskets shall conform to ASTM C 361, Section 4.10. The entire surface of the bell that comes in contact with the rubber gasket shall be well lubricated with a soap lubricant. The entire gasket shall be greased with soap. Only the soap lubricant supplied by the pipe manufacturer shall be used. Adhesive type cements shall not be used.

b. Corrugated Metal Pipe. Corrugated metal pipe joints shall have a gasket and may be either bell and spigot joints or made with external coupling bands. The bands shall be drawn and secured on the pipe by connecting devices as furnished by the manufacturer. Pipe ends for annular corrugation shall be identical to the rest of the pipe barrel (plain ends), or in the case of helical pipe, the pipe ends at the joint shall be reformed to an annular corrugation and flange (reformed end). Gaskets shall be furnished in accordance with the Plans and Special Provisions. Coupling bands shall be reviewed and approved by the Engineer prior to installation.

c. HDPE Pipe: HDPE pipe shall be assembled, installed, and backfilled in accordance with the manufacturer's instructions. Joints shall have a gasket and may be either bell and spigot joints or made with external coupling bands. The fittings and couplings bands shall be fabricated from the same material as the pipe conforming to AASHTO M294. The coupling bands shall cover at least two full corrugations of each section of pipe and shall prevent infiltration of soil into the pipe. Gaskets shall be furnished in accordance with the Plans and Special Provisions. Coupling bands shall be reviewed and approved by the Engineer prior to installation.

    During construction of the project in areas subjected to heavy construction equipment traffic, pipe sizes 12" - 42" shall have a minimum cover of 3 feet, and pipe sizes 48"- 120" shall have a minimum cover of 4 feet.

d. Structure Connections: Pipes connected to structures shall be cut parallel with the inside face of the structure for structures having plane walls and parallel with the spring line of the pipe for structures having curved walls. Projection of the pipe beyond the inside face shall not exceed 1 inch (measured at the springline for structures having curved walls).

C. Backfill of Trenches

1. General: Refer to Section 2100 Clearing and Site Preparation.

SECTION 2603 BORING AND JACKING

2603.1 Scope

This section governs the furnishing of all labor, materials and equipment for the construction of steel casings, complete with bulkheads and sand fill, by boring and/or jacking at the locations and to the lines and grades indicated on the Plans, or where constructed at the Contractor's option, when approved, to bypass obstructions without open cutting.

2603.2 Materials

A. Steel Casing

1. Steel casing for bored or jacked construction shall conform to ASTM A 139.

2. Steel shall be grade B under railroads and grade A for all other uses.

3. Minimum wall thickness for steel casing shall be in accordance with the following table:

Diameter of Casing	Under Railroads	All Other Uses
24"	0.406"	0.281"
26"	0.438"	0.281"
28"	0.469"	0.312"
32"	0.500"	0.312"
34"	0.500"	0.312"
36"	0.500"	0.344"

4. Casing joints shall be welded by a certified welder in accordance with ANSI/AWWA C206.

B. End Seals: End seals shall be manufactured end seals, concrete plugs with allowances for water flow, or brick shall be in accordance with ASTM C 32, Grade SS or SM and mortar in accordance with ASTM C 270.

C. Sand Fill: Sand fill shall comply with ASTM C 33 or MCIB Section 4, Fine Aggregate. Moisture content of the sand shall not exceed 0.5%.

2603.3 Construction Details

A. Boring and Jacking

1. Prior to starting work, complete details of the methods and the liner material to be used shall be submitted to the Engineer for approval.

2. The maximum allowable deviation from indicated alignment and grade shall be as follows except when altered by the Plans or Special Provisions:

   a. Alignment 1.0%
   b. Grade 1.0%

B. Casing Installation

1. The steel casing shall be advanced in a continuous operation without interruption. Sections of the casing pipe shall be welded together to form a continuous conduit capable of resisting all stresses including jacking stresses. The casing in its final position shall be within alignment and grade tolerances specified in Section 2603.3.A.2. There shall be no space between the earth and the outside of the casing. Any voids which do occur shall be filled by pressure grouting.

2. Boring operations shall be performed by experienced crews using a rotary type boring machine designed especially for this purpose. Boring shall be performed in a manner to prevent disturbing the overlying and adjacent materials.

3. Jacking

   a. Jacking frame, guides, blocking, head, and reaction devices shall be arranged to apply uniform pressure about the casing circumference without damage to the casing material, and to maintain alignment within specified tolerances.
   b. Jacking reaction device shall provide adequate resistance to withstand 200 percent of the maximum jacking pressure.
   c. Provide jacks of adequate number and size for the required jacking pressure; but not less than two jacks.
   d. Maintain jacking pit and pipe installation in such condition that drainage does not accumulate. Control and disposition of surface and subsurface water at the site of jacking operations shall be the Contractor's responsibility.
   e. Excavation at the heading shall not be extended more than 1 inch outside the top and sides (upper 300-degree sector) of the casing and shall be true to grade at the invert (lower 60-degree sector).
   f. Once jacking begins, it shall proceed without interruption until installation of the entire length of the jacked casing is complete.

4. Excavation in Jacked Casings: Perform excavation within jacked casings by hand or machine methods as necessary to remove the materials encountered without disturbing the overlying material. The jacked casing shall be advanced a sufficient distance ahead of the excavation face and/or shield used as necessary to protect the workman and the work, and to prevent the uncontrolled entry of unstable materials into the casing.

5. Unstable Materials: If materials are encountered during casing installation that cannot be excavated safely or without creating voids around the exterior of the casing, the Contractor shall discontinue casing installation and stabilize such materials by dewatering, chemical soil stabilization, grouting, or other methods, and/or modify equipment and procedures as necessary to complete the casing installation.

C. Sewer Pipe Installation

1. Pipe shall be placed inside the casing to the indicated line and grade by the use of wood skids or other equivalent methods. The wood shall be pressure-treated with a preservative in accordance with ASTM D 1760. Cut surfaces shall be given 2 heavy brush coats of the same preservative. The wood skids shall be securely fastened to the sewer pipe with steel straps.

2. End seals shall be constructed after the sewer pipe is installed and approved.

3. The annular space between the casing and sewer pipe shall be filled with sand blown in so that all space is filled without disturbing the alignment and grade of the sewer pipe. Flowable Backfill (CLSM) meeting Section 2102.2.E, may be substituted in lieu of sand fill. Alternative methods may be submitted for approval by the Engineer.

SECTION 2604 STRUCTURES

2604.1 Scope

This section governs the furnishing of all labor, materials and equipment for the performance of all work necessary for construction of cast-in-place and precast concrete structures for inlets, manholes, junction boxes, box culverts, headwalls, and incidental structures.

Masonry or brick structures shall not be allowed under these Specifications.

2604.2 Materials

A. Concrete Mixes: Concrete shall be MCIB Mix Number A 558-1-2-0.421 or KCMMB 4K, unless otherwise specified.

B. Concrete Materials

1. For KCMMB mixes, concrete shall be an approved mix with admixtures that are approved for use in that mix design.

2. For MCIB mixes:

   a. Air-entraining admixtures shall provide an air content within the range of 4 1/2 to 7 1/2 percent by volume as measured by the pressure method (ASTM C 231). The air entraining admixtures shall meet the requirements of ASTM C 260.
   b. Portland Cement: Portland cement shall conform to ASTM C 150 Type I. Where high early strength is desired, Type III can be used.
   c. Fine Aggregate: Fine aggregate shall be clean, natural sand meeting the requirements of ASTM C 33. Grading shall be within the limits as set forth by MCIB.
   d. Coarse Aggregate: Coarse aggregate shall be limestone meeting the requirements of ASTM C 33. The sum total of all deleterious material shall not exceed the requirements of ASTM C 33.

3. Water: Water shall be clean and free from deleterious substances. Only potable water will be acceptable without testing.

C. Reinforcing Steel: Reinforcing bars shall conform to ASTM A 615 or AASHTO M 31, Grade 60. Welded steel wire fabric shall conform to ASTM A 1064 or AASHTO M 55.

D. Precast Concrete Structures

1. Manholes: Precast manholes shall conform to ASTM C 478.

2. End Sections for Concrete Pipe: Shall be flared end sections of the pipe manufacturer's standard design, and shall meet all applicable requirements of ASTM C 76 for Class II or higher classes of pipe.

3. Rectangular Structures: Shall conform to the inside dimension indicated on the Plans and be designed for the following loads:

   a. HS-20 live load for all structures in/or under pavement, shoulders, driveways, and other traffic areas.
   b. 2,000-lb wheel live load for curb opening inlets and junction boxes in non-traffic areas.
   c. 50 pcf equivalent fluid pressure for soil pressure on vertical walls.
   d. 120 pcf for unit weight of soil cover on top slabs.

4. Joints: Joints between concrete structures shall be filled with plastic joint compound or preformed plastic compound as stated herein.

   a. Barrel Sections: Minimum cross sectional area of preformed compound between concrete barrel sections shall be 1 inch square or 1.25 inches diameter. Minimum cross-sectional area of the preformed compound between the concrete adjustment ring and cone barrel section shall be two beads of either 1 inch square or 1.25 inches in diameter.

   b. Manhole Adjustment Rings: Rings shall be constructed of concrete, HDPE, or recycled rubber.

      If HDPE adjustment rings are used, they shall be injection molded-recycled HDPE - as manufactured by LADTECH, Inc. or approved equal. They shall be bolted to the structure top section and otherwise installed as per manufacture's recommendations.

      If recycled rubber adjustment rings are used, they shall consist of no less than 80%, by weight, recycled rubber and no less than 10% by volume shredded fiber as manufactured by GNR Technologies or approved equal. They shall be installed as per manufacturer's recommendations.

      The top and bottom of all adjustment rings shall be sealed using a mastic filler meeting the requirements of 2503.D.6 or an epoxy paste. The epoxy paste shall be a two component, moisture insensitive, containing no solvents, and capable of bonding with all materials it is to be used on, like Epoxytec Micor C.P.P or approved equal. Minimum cross-sectional area of preformed compound between concrete adjustment rings shall be two beads of either 1 inch square or 1.25 inches in diameter.

   c. Manhole Ring and Covers: Minimum cross-sectional area of preformed compound between the concrete adjustment ring and the manhole casting shall be two beads of either 1 inch square or 1.25 inches in diameter.

   d. External Manhole Chimney Frame Seal: External frame seal shall consist of a flexible rubber sleeve, interlocking adjustment extension(s), and stainless steel compression bands. The flexible rubber sleeve and extension shall be extruded or molded from a high grade rubber compound conforming to the applicable requirements of ASTM C 923 with a minimum tensile

strength of 1500 psi and minimum elongation at break of 350%. At a minimum, the compression bands shall be 16-gauge stainless steel conforming to ASTM A 240, Type 304, with a minimum width of one inch. Screws, nuts, and bolts shall be stainless steel conforming to ASTM F 593 and 594, Type 304. The compression bands shall have the capacity to tighten with enough pressure to make a watertight seal around the rubber chimney sleeve.

E. Air Entrainment: All concrete shall be air entrained. Minimum strength requirements shall be as specified in Section 2604.2.A. Concrete Mixes.

F. Manhole Castings

1. Rings and Covers: Castings shall be gray iron conforming to ASTM A 48, Class 35B. Castings of rings and covers shall be of the shape, dimension, minimum weight, and type as indicated on Plans or Standard Drawings and be free from manufacturing defects. All curb inlet castings shall have cam locks or approved equal. If requested by special order, castings shall be cleaned and painted with one coat of tar prior to delivery. Bearing surfaces between all rings and covers for installation in all areas shall be machined to provide even seating and interchangeability of like pieces.

   All manhole rings and covers placed in paved areas shall be rated for H20 traffic. Cam lock covers or similar shall not be placed in roadway pavement unless shown on the Plans or directed by the Engineer. All covers shall have provisions for opening, such as concealed pick holes.

2. Steps: All steps shall comply with Section 2509.3.G.2.b. Cast iron steps shall not be used.

G. Steel End Sections: Steel end sections shall be fabricated from aluminized base metal as specified in Section 2602, and shall be flared end sections of the metal pipe manufacturer's standard design. End sections shall be furnished with a steel toe plate. Bituminous coating is not required.

H. Toe Walls: Flared end sections for concrete and steel pipe shall be set on a concrete toe wall centered on the end of the section. Toe walls shall be 8 inches thick by 24 inches deep by the width of the end section.

2604.3 Construction

A. Concrete Structures: Concrete construction shall conform to the current ACI 301 Specifications for Structural Concrete.

1. Precast Structures: The Contractor may, at his option, construct precast concrete inlets, junction boxes, and box culverts, in lieu of the cast-in-place structures indicated on the Plans; except that all concrete base slabs for pre-cast inlets, manholes, and junction boxes may be cast-in-place. Solid concrete brick or block shall be used to block inlets and similar structures to grade during placement of base slab concrete.

   Precast concrete box culvert sections shall be installed on a 4-inch leveling course of untreated compacted aggregate conforming to Section 2200 Paving. Leveling courses shall extend 1 foot past the line of the box section, and be finished to a true plane surface to provide uniform bearing for the precast section.

   Any adjustments required for precast structures to meet field conditions shall be at the cost of the Contractor.

2. Finishing: Exposed edges of all slabs, walls, and other concrete structures shall be beveled 3/4" or edged with a 1-1/4" radial tool.

   a. Formed Surfaces: Immediately following removal of the forms, fins and irregular projections shall be removed. Form tie connections, holes, honeycomb spots, and other defects shall be chipped to ensure the voided area is exposed, and shall be chipped back to solid material. These areas shall be thoroughly cleaned, saturated with water, and painted with a grout approved by the Engineer. The repaired surfaces shall be cured in accordance with these specifications.
   b. Exposed Slabs: Finish for exposed slabs shall be wood float texture. Exposed edges shall be beveled or edged with a radial tool.

3. Form Removal: Forms shall remain in place until the concrete has attained sufficient strength to support loads imposed by backfilling, construction, and traffic. Within 24 hours of form removal, small holes and pockmarks of exposed walls shall be filled with Portland cement grout and rubbed smooth. Concrete voids and honeycombs shall be chipped open with a light hammer to expose weak areas for inspection. At the direction of the Engineer, expansive repair grout shall be used for partial reconstruction of otherwise sound structures.

   a. Walls: Forms shall remain in place for a minimum of 5 days or until the concrete reaches a minimum strength of 2000 psi.
   b. Slabs: Form shall remain in place for a minimum of 7 days or until the concrete reaches a minimum strength of 3000 psi.

4. Manhole Riser Adjustments: Manhole rings and covers shall be adjusted to match the slope and height, or grade, of pavements. In no case shall the surface pitch of the manhole ring and cover mismatch the pavement slope by more than 1/2 inch. The difference in height between the top of manhole cover and the top of precast cone shall not exceed 24 inches.

   In lieu of replacing concrete adjustment rings that are properly seated and structurally sound but have a small fracture, an external rubber chimney may be fitted to secure a watertight seal between the casting (manhole ring and cover) and the concrete cone barrel section.

B. Invert Channels: Form concrete invert channels in manholes, inlets, and junction boxes to make changes in direction of flow with smooth curves of as large a radius as permitted by the inside dimension of the structure.

   Grade changes and transitions shall be smooth and uniform, and all parts of the invert channel and adjacent floor shall slope to drain. Channel bottom shall be finished smooth without roughness or irregularity. Invert channels for precast concrete structures may be cast integrally with the structure base slabs at the Contractor's option.

C. Excavation and Backfill: Refer to Section 2100 "Clearing and Site Preparation".

SECTION 2605 OPEN CHANNELS

2605.1 Scope

This section governs the furnishing of all labor, materials and equipment for the construction of open channel lining at the location, and to the lines, grades, and dimensions indicated on the Plans. Grading shall have been previously completed in accordance with Section 2100 Grading and Site Preparation.

2605.2 Materials

A. Concrete Materials: Concrete shall be in accordance with 2604.2.B, unless otherwise specified. Reinforcing steel shall conform to ASTM A 615 or AASHTO M 31, Grade 60. Welded steel wire fabric shall conform to ASTM A 1064 or AASHTO M 55.

B. Stone: Stone for riprap, and gabion linings shall consist of quarried rock and be sound, durable, and angular in shape. No more than 10 percent shall have an elongation greater than 3:1, and no stone shall have an elongation greater than 4: 1. Material shall be free from cracks, seams, or other defects. Shale and stone with shale seams are not acceptable.

1. The minimum unit weight of the stone shall be 155 pounds per cubic foot as computed by multiplying the specific gravity times 62.4 pounds per cubic foot.

2. Not more than 10 percent of the stone shall exhibit splitting, crumbling, or spalling when subject to 5 cycles of the sodium sulfate soundness test in accordance with ASTM C 88.

3. Riprap: Riprap shall have a minimum thickness of 15 inches, or 1.5 times as thick as the larger stones, whichever is greater.

   The gradation for RipRap (Light Stone) shall be as follows:

Weight of Stone In Lbs.	Percent Passing by Weight
250	100 (minimum)
100	50 (maximum)
75	70 (maximum)
5	90 (maximum)

   The gradation for RipRap (Heavy Stone) shall be as follows:

Weight of Stone In Lbs.	Percent Passing by Weight
1,000	100 (minimum)
500	50 (maximum)
75	90 (maximum)

   The Contractor shall provide certification that the material meets the specified gradations.

4. Gabion Fill Stone: Stone shall be of the following gradations:

U.S. Standard Square Mesh Sieve	Percent Passing by Weight
10”	100
8”	85 - 100
6”	0 - 15
4”	0- 10
3”	0

   Stone shall be graded within the above limits as required to provide a unit weight in-place of 100 pounds per cubic foot or greater.

The Contractor shall provide certification that the material meets the specified gradations.

C. Filter Blanket: Filter blanket may be either of the following types at the Contractor's option:

1. Granular Filter: Granular filter material shall consist of sound, durable rock particles conforming to the following gradation:

Sieve Size	Cumulative Percent Passing By Weight
1"	100
1/2"	70 - 100
No. 4	50 - 85
No. 10	35 - 70
No. 40	20 - 50
No. 100	15 - 40

The Contractor shall provide certification that the material meets the specified gradations.

2. Filter Fabric: Filter fabric shall consist of woven or nonwoven fabric. The synthetic fiber of either the woven or nonwoven fabric shall consist of polypropylene, nylon, or polyester filaments. The percent open area shall be not less than 4 percent nor more than 10 percent. The cloth shall provide an Equivalent Opening Size (EOS) no finer than the U.S. Standard Sieve No. 100. In addition, filter fabric shall meet the following physical requirements:

a. Tensile Strength: Minimum grab tensile strength, both warpwise and fillingwise, shall be 200 pounds when tested in accordance with ASTM D 5034, using a 4-inch by 6-inch specimen and a jaw speed of 12 inches per minute.
b. Elongation: Grab elongation shall be not less than 15 percent nor more than 60 percent, both warpwise and fillingwise, when tested in accordance with ASTM D 5034.
c. Tear Strength: Minimum trapezoid tear strength shall be 100 pounds, both warpwise and fillingwise. Method of test for woven fabrics shall be in accordance with ASTM D 1117.
d. Bursting Strength: Minimum bursting strength shall be 400 psi when tested in accordance with ASTM D 3887.
e. Seam Strength: Woven fabric shall have a minimum seam-breaking strength of 180 pounds when tested in accordance with ASTM D 1683, using a jaw speed of 12 inches per minute.
f. Width: Filter fabric shall be furnished in widths of not less than 6 feet.

D. Gabion Baskets: Baskets shall be of the dimensions indicated on the drawings and be fabricated using hexagonal triple-twist wire mesh.

1. Wire: Wire shall be galvanized steel having a minimum tensile strength of 60,000 psi, and shall be zinc coated in accordance with ASTM A 641 Class 3.

2. Wire Mesh: Maximum dimension of the mesh opening shall be 4-1/2 inches or less, and the maximum area of the mesh opening shall not exceed 12 square inches. Wire shall be 0.120-inch (minimum) diameter.

3. Selvedge Wire: Selvedge wire shall be 0.1535-inch (minimum) diameter. All perimeter edges of the mesh forming the gabion shall be securely selvedged so that joints formed by tying the selvedges have a strength equal to or greater than the body of the basket.

4. Lacing and Stay Wire: Wire shall be 0.0866-inch diameter or larger. Other connection methods, such

as stainless steel clips, may be substituted with approval of the Engineer.

5. Diaphragms: Gabions shall be divided into cells not greater than 4 feet in width by wire mesh diaphragms. Diaphragms shall be factory secured to the base of the basket by continuous spiral wire.

6. PVC (Polyvinyl Chloride) Coating: Where specified in the Plans, all wire used in the fabrication of the baskets and in the wiring operations during construction shall, after zinc coating, have an extruded coating of PVC. The coating shall be gray in color ranging between series 26187 and 26293 or between series 26373 and 26375, semi-gloss, as per Federal Standard 595B. The PVC coating shall be a nominal thickness of 0.02165 inches and shall nowhere be less than 0.015 inches in thickness. The coating shall be resistant to the destructive effects of immersion in acidic, salt or polluted water, exposure to ultraviolet light, and abrasion and shall retain these characteristics after a period of not less than 3,000 hours under test in accordance with ASTM G 23.

E. Sod: Sod shall conform to the requirements of Section 2400 Seeding, Sodding and Overseeding.

F. Seed: Seeding shall conform to the requirements of Section 2400 Seeding, Sodding and Overseeding.

2605.3 Construction

A. Foundation Preparation: After completion of grading in accordance with Section 2100, the area to receive channel lining shall be trimmed and dressed to conform to the cross sections indicated on the Plans within a tolerance of plus or minus 1 inch from the theoretical slope lines and grades. All deleterious materials shall be removed from the foundation area.

B. Concrete Lining

1. Preparation: Subgrade shall be moistened by sprinkling. Forms shall be securely staked, braced, and set to line and grade. Reinforcement and tie bars shall be held in position by bar chairs, concrete brick, or other approved devices.

2. Placing and Finishing: Place, consolidate, and strike off concrete to the thickness indicated on the drawings. Concrete shall be tamped or vibrated to eliminate all voids and bring sufficient mortar to the top for finishing. Surface finish shall be a wood-float finish. Round all edges and joints with a 1/4 inch radius edging tool, except contraction joints may be sawed to a depth of 30 percent of the thickness of the concrete lining after concrete has hardened but before uncontrolled cracking occurs. Apply curing membrane as specified in Section 2000 “Paving”.

C. Filter Blanket

1. Granular Filter: Place granular filter to its full thickness in a single operation. Construction methods shall be such that the material is placed without segregation. Compaction of granular filter material is not required.

2. Filter Fabric: Place filter fabric with its long dimension horizontal and lay free of tension, stress, folds, wrinkles, or creases.

   a. Place to provide 18 inches minimum overlap at each joint and anchor to prevent dislocation during construction of overlaying material.
   b. Fabric shall not be left exposed more than two weeks prior to placement of overlaying

material. Tracked or wheeled equipment or vehicles shall not be operated on the fabric.

D. Riprap Placement: Riprap shall be placed on the prepared foundation in a manner which will provide a reasonably well-graded mass of stone with the minimum practicable percentage of voids. The entire mass of stone shall be placed so as to be in conformance with the lines, grades, and thicknesses indicated. A filter blanket of filter fabric conforming to Section 2605.2.C.2 shall be constructed under all riprap. Riprap shall be placed to full-course thickness in one operation and in such a manner as to avoid displacing the fabric. The Contractor shall place the riprap in such a way as to not tear, puncture, or shift the fabric. Riprap shall not be dropped more than 3 feet when being placed directly on the fabric. Tears or rips in the fabric shall be repaired with fabric lapped a minimum of 12 inches in all directions.

1. Placing: Placing of riprap in layers, or by dumping into chutes, or by similar methods likely to cause segregation will not be permitted.

2. Distributing: The larger stones shall be well distributed and the entire mass of stone shall conform to the specified gradation. All material shall be so placed and distributed that there will be no objectionable accumulations of either the larger or smaller sizes of stone.

3. Hand Placing: It is the intent of these specifications to produce a fairly compact riprap protection in which all sizes of material are placed in their proper proportions. Hand placing or rearranging of individual stones by mechanical equipment may be required to the extent necessary to secure the specified results.

E. Gabion Baskets

1. Assembly: Assemble each gabion unit by binding all vertical edges together with a continuous piece of connecting wire stitched around the vertical edge with coils spaced at 3 inches or less. Set empty units to line and grade and join units by stitching with connecting wire along adjoining edges. Install and securely fasten internal tie wires in each cell if necessary to retain the shape of the cell during filling operations.

2. Filling: Fill gabion cells with stone carefully by hand or machine to provide a minimum of voids and avoid bulges and distortions of the gabion. After filling, secure the lid to the sides, ends, and diaphragm by stitching with connecting wire.

3. Filter Fabric/Gabion Unit Placement: A filter blanket of filter fabric conforming to Section 2605.2.C.2 shall be constructed under all Gabion Baskets. The Contractor shall place the gabions in such a way as to avoid tearing, puncturing, or shifting the fabric. Tears or rips in the fabric shall be repaired with fabric lapped a minimum of 12 inches in all directions.

F. Sod: Sod shall be installed as specified in Section 2400 Seeding, Sodding and Overseeding, except all sod placed in drainage channels or ditches, including both the side slopes and bottom, shall be anchored in accordance with 2204.3.D.

SECTION 2606 MEASUREMENT AND PAYMENT

2606.1 Measurement

The quantities of accepted work will be measured in the following units. All measurements will be plan measure except for authorized changes.

A. Pipe: By the linear foot of each size and type. Measurement will be to the nearest 0.1 foot for each line between structures, and made to the inside face of the connecting structure. Precast or prefabricated end sections will be excluded from the pipe measurement. Excavation, bedding, and backfill shall be included in the cost per linear foot of pipe per each size and type.

B. Prefabricated or Precast End Sections: By the number of each size and type.

C. Concrete Box Culverts: By the linear foot of each size and type. Measurement will be along the center line of the culvert between the back faces of the headwalls. Headwalls will be measured separately as "Structures".

D. Structures: Inlets, manholes, headwalls, endwalls, curb inlets, field inlets, and other similar structures will be measured by the number of each size and type as listed in the Contract Documents.

E. Casings: Casings for pipe installation by boring and/or jacking methods will be measured by the linear foot of each size and type.

F. Pipe Encasement: Pipe encasement will be measured by the linear foot of each size and type.

G. Concrete Channel Lining: By the square yards of surface area. Measurement will be parallel to sloping surfaces.

H. Filter Blanket: Unless otherwise stated in the Agreement, there will be no separate measurement or payment for filter blanket. All costs for such work shall be included in the price of the related item.

I. Riprap: By the square yard of surface area per each size and depth as specified on the Plans or Standard Drawings. Measurement will be parallel to sloping surfaces. The thickness of the riprap shall conform to the plan dimension. Measurement and payment of the filter fabric shall be included in the cost per square yard of the riprap.

J. Gabion Baskets: By the cubic yard on the basis of Plan dimensions.

K. Sodding: Measurement shall be per square yard. Areas that are disturbed which lie outside the construction limits, as defined by the Plans, will not be measured for payment, but shall be restored to a condition equal to or better than that existing prior to construction. For lined (riprap or concrete) channels, sod placement and/or repairs shall be incidental to the cost of placement of the lining material.

L. Seeding: Measurement shall be per square yard. Areas that are disturbed which lie outside the construction limits, as defined by the Plans, will not be measured for payment, but shall be restored to a condition equal to or better than that existing prior to construction. For lined (riprap or concrete) channels, sod placement and/or repairs shall be incidental to the cost of placement of the lining material.

2606.2 Payment

Payment will be made at the respective unit or lump sum price listed in the Contract Documents, and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the Contract Documents, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the Contract Documents. At the Engineer's option, partial payment may be made for any item listed in the Contract Documents, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved progress schedule.

END OF SECTION

OAK GROVE WATER MAIN
SPECIFICATION MODIFICATION
APWA SPECIFICATION SECTION 2900
OAK GROVE, MO - 2018

Work for the City of Oak Grove shall follow APWA Construction and Material Specification Section 2900 for waterlines except as modified below. The following additions and/or alterations to the APWA Specification 2900 provided below shall apply to execution of the various parts of the work performed on this project.

APWA SPECIFICATIONS SECTION 2900

2902 MATERIALS

2902.3 Valves and Valve Boxes

1. Shall be modified as follows:

Delete section 2902.3.F.2 Tapping Sleeves: Iron

2902.4 Fire Hydrants

1. Subsection A.4 General. The following shall be added to the end of the subsection.

2902.4.A.4: Hydrants shall be manufactured red in color.

2. The following shall be added to the end of 2902.4 Fire Hydrants.

F. Hydrants shall be furnished with temporary black plastic caps or shall be covered with a black plastic bag until the hydrants are available for service.

G. Fire hydrant shall be Mueller “Centurion”, Waterous, “Pacer” 90 or 100 or Clow Valve “Medallion”.

H. Hydrants shall be new.

I. Hydrant collar shall be installed on the 4 ½ outlet of all new hydrants to indicate the flow in gallons per minute (GPM). The colors shall be as follows:

1.	Blue	1500 GPM or more
2.	Green	1000 – 1499 GPM
3.	Orange	500 – 999 GPM
4.	Red	Below 500 GPM

The other side of the hydrant collar shall indicate: “Out of Order”

J. A gravel pocket or dry well shall be provided. Hydrant drains shall not be connected to or located within ten feet of sanitary sewers or storm drains.

K. A clearance space of at least three feet (3 ft.) surrounding the hydrant body should be provided around every hydrant.

L. Utility poles, vaults, walls, plants, and other landscape materials should be kept outside of the hydrants clearance space.

M. In poor load-bearing soil, special construction such as support collars may be required.

3. Specification Section 2902.6 Bedding Material, Subsection A. The following shall be added to the end of this subsection.

Continuous, firm, stable, and uniform bedding shall be provided in the trench for all buried pipe. The bedding design shall insure that there is full support in the haunches of the pipe and be smooth and free of ridges, hollow, and lumps.

4. Specification Section 2902.7 Location Wire and Tape, Subsection A shall be removed and replaced with the following:

2902.7 Location Wire and Tape

1. Shall be modified as follows:

A. Installation: All non-metal pipes shall be installed with tracer wire or tape to facilitate future location of the pipe. However, tracer wire or tape is not a substitute for accurate as-built plans, GIS mapping, or individual fixture records on each extension or modification of a system.

a. All tracer wire for new utility installations shall be tested before acceptance.

b. Detectable warning tape is not a substitute for tracer wire.

B. Type: Tracer wire shall be a #12 AWG (0.0808" diameter) fully annealed, low carbon 1010 grade steel, solid copper-clad steel (CCS) conductor, insulated with a 30 mil, high-density, high molecular weight polyethylene (HDPE) insulation, and rated for direct burial use at 30 volts. CCS Conductor must be at 21% conductivity for locating purposes. Break load of 302 lbs. HDPE insulation shall be RoHS compliant and utilize virgin grade material. Insulation color shall meet the APWA color code standard for identification of buried utilities. Tracer wire shall be Copperhead® SuperFlex CCS, HDPE 30 mil insulation or city pre-approved equal and made in the USA.

2903.1 Grading and Excavation

1. Section 2903.1.H Trench Excavation. The following shall be added to the end of the subsection.

Bell holes should be excavated so that only the barrel of the pipe receives bearing from the trench bottom.

Add the following at the end of APWA Section 2900 Waterlines

SECTION 2906 MATERIAL TESTING AND CERTIFICATIONS

When requested by the City Engineer, the Contractor shall furnish test results at the contractor's expense and from a testing laboratory approved by the City Engineer showing compliance with the plans, specifications, and all requirements of APWA Section 2900 as modified herein.

The contractor shall submit certifications for all materials used for each project to the City Engineer for approval prior to incorporating those materials into the project. Each certification shall indicate that the material is in compliance with the plans, specifications, and all requirements of APWA Section 2900 as modified herein.

At the completion of the project the contractor shall certify that the completed project is in compliance with all requirements of the plans, specification, contract documents, and all other requirements of the City of Oak Grove.

DIVISION II
CONSTRUCTION AND MATERIAL SPECIFICATIONS
SECTION 2900 WATERLINES

APPROVED AND ADOPTED THIS 15th DAY OF FEBRUARY, 2017

KANSAS CITY METROPOLITAN CHAPTER
OF THE AMERICAN PUBLIC WORKS ASSOCIATION

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(Minor updates on page 5 – underlined – May 31, 2017)

SECTION 2901 GENERAL

2901.1 Scope

This section governs the furnishing of all labor, materials, and equipment necessary for the complete installation of waterlines, fittings, valves, valve boxes, fire hydrants, and other appurtenances as shown on the Plans and in accordance with the Standard Drawings, the specifications, and the Special Provisions.

2901.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

APWA

Section 2100	Grading and Site Preparation
Section 2150	Erosion and Sediment Control
Section 2200	Paving
Section 2300	Incidental Construction
Section 2400	Seeding and Sodding

ASTM

A 36	Standard Specification for Carbon Structural Steel
A 126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
A 276	Standard Specification for Stainless Steel Bars and Shapes
A 307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
A 536	Standard Specification for Ductile Iron Castings
A 564	Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
A 1011	Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
C 33	Standard Specification for Concrete Aggregates
C 150	Standard Specification for Portland Cement
C 478	Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
D 1784	Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
D 2241	Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
D 3139	Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
D 4976	Standard Specification for Polyethylene Plastics Molding and Extrusion Materials
F 477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

ANSI/AWWA

C 104/A21.4	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
C 105/A21.5	American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems
C 110/A21.10	American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In.
C 111/A21.11	American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
C 115/A21.15	American National Standard for Flanged Ductile-Iron Pipe with Threaded Flanges
C 116/A21.16	American National Standard for
C 151/A21.51	American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water

AWWA

C 207	Steel Pipe Flanges for Waterworks Service – Sizes 4 In. Through 144 In.
C 509	Resilient-Seated Gate Valves for Water Supply Service

C 515 Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
C 550 Protective Interior Coatings for Valves and Hydrants
C 600 Installation of Ductile Iron Water Mains and Their Appurtenances
C 900 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In.
C 909 Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 In. and Larger

MCIB Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement
The current editions of the "Bulletins" and Approved Sections of the "Standard Concrete Specifications" issued by the Mid-West Concrete Industry Board, Inc. (MCIB) are made a part hereof by reference. However, when the provisions of this Specification differ from the provisions of such "Bulletins" and "Sections" the provisions of this Specification shall govern. Reference December 2000 Specifications if most recent version does not contain specified mix designs.

KCMMB Kansas City Metro Materials Board Specifications

2901.3 Cleanup

Cleanup shall follow the work progressively. The Contractor shall remove from the project site all rubbish, equipment, tools, surplus or discarded materials, and temporary construction items.

Streets to be opened to local traffic at the end of the day's operation shall be cleaned of dirt or mud. All equipment and material stockpiles shall be secured for safe passage of vehicles and pedestrians.

SECTION 2902 MATERIALS

2902.1 Scope

This section governs materials for waterlines, including fittings, valves, valve boxes, fire hydrants, and appurtenances.

2902.2 Pipe and Fittings

A. Ductile-Iron

1. Pipe: Unless indicated otherwise on the construction plans, all ductile iron pipe 6-inch and larger shall be Class 50; 4-inch pipe shall be Class 51 complete with all accessories and conforming to ANSI A21.51, AWWA C151, ASTM A 536, and Grade 64-42-10.

2. Joints: Unless otherwise specified, shall be of the push-on type conforming to ANSI A21.11/AWWA C111, except gaskets shall be neoprene or synthetic rubber. Natural rubber will not be acceptable. Gaskets shall be certified as suitable for chlorinated potable water in accordance with ANSI/NSF61.

3. Restrained Joints

   a. Restrained push-on joints for ductile iron pipe and fitting shall be American "Flex-Ring" or "Fast Grip"; Clow "Super-Lock"; U.S. Pipe "TR Flex" or "Field Lok"; or Griffin "Snap-Lok".
   b. Restrained Mechanical Joints shall be EBAA Iron "Mega-Lug" or Ford Uni-Flange. "Mega-Lug" shall not be used on plain end fittings.
   c. Restrained joint fittings shall be One Bolt.

4. Fittings

   a. All ductile-iron fittings shall be complete with all accessories and shall conform to ANSI A21.10/AWWA C110, 350 psi pressure rating.
   b. Fitting joints shall be Mechanical Joint (MJ), Flange Joint (FLG), or Push-On Joint, per ANSI A21.11/AWWA C111. All MJ glands shall be ductile iron. Fittings shall be distinctly cast upon them, the pressure rating and the letters "DI" or "Ductile". FLG fittings shall be used only for above ground installations.
   c. Flanged Joints shall be provided with full-face gaskets and shall meet the requirements of ANSI A21.15/AWWA C115.

5. Appurtenances

   a. Welded – On Outlets may not be used in lieu of tees.
   b. Tapping Sleeves
      i. All material in the body, lugs, outlet, flange, bridge plate, bolts, nuts and washers shall be ASTM A 276 Type 304 or Type 316 or ASTM A 564 Type 630 stainless steel.
      ii. The body shall be a minimum of 14 gauge stainless steel and shall fit cast iron pipe classes A, B, C, and D.
      iii. The outlet shall be a minimum of 14-gauge stainless steel. The branch outlet shall be supplied with a tap and plug to permit pressure testing the sleeve prior to tapping the main.
      iv. The flange shall conform to AWWA C207 Class D with drilling in accordance with ANSI B 16.1 Class 125, and shall be indexed per MSS-SP 60 to accept tapping valve.
      v. All welding on the coupling shall be done with stainless steel rods.
      vi. Sleeve gaskets shall be full circumferential a minimum of 1/4" thick gridded with tapered lap joint ends and stainless steel bridge plates molded flush into the gasket.
      vii. The outlet flange face shall be supplied with a bonded, full-face gasket. All gaskets shall be grade 30 specially compounded rubber, synthetic rubber, or 100 percent neoprene that shall have the necessary qualities to allow outside storage, permanence, and resistance to set after installation.
      viii. All bolts, nuts and washers shall be loose; lifter bar style bolt attachments shall not be permitted. All bolts and/or nuts shall be impregnated or coated to prevent seizure. Minimum diameter shall be 5/8".
      ix. Sleeve shall be designed for a minimum working pressure of 175 psi.
      x. General: Power Seal Model 3490-AS; JMC 432; Cascade CST-Ex stainless steel extra heavy duty; Ford Model FTSS; Romac STD Band SST-III; Smith Blair Type 665.
      xi. Power Seal Model 3490MJ or approved equal may also be used.

6. Tie Rods: ASTM A 276, Type 304 or Type 316 Stainless Steel.

7. Couplings: Dresser "Style 38" or Smith-Blair "441 or 411 Flexible Coupling"; without pipe stop. Bolted compression type couplings shall be manufactured of steel or ductile iron specifically for use with ductile iron pipe.

8. Shop Coating: Pipe and fittings shall be furnished with a standard thickness exterior bituminous coating complying with ANSI/AWWA C116/A21.51. Fittings may be furnished with a fusion-bonded epoxy coating complying with ANSI/AWWA C116/A21.16.

9. Linings: All pipes and fittings shall be cement mortar lined conforming to ANSI A21.41/AWWA C 104. All buried pipe and fittings shall be coated with black asphaltic coating minimum 1 mil in thickness per ANSI A21.51/AWWA C 151. Fittings shall have distinctly cast upon them the pressure rating and letters "DI" or "DUCTILE". Any pipe or fittings above ground shall be prime coated with 6 mils DFT of Tnemec 140-1211 Epoxy Primer.

10. Bolts and Nuts

    a. Bolts: ASTM A 307, chamfered or rounded ends projecting 1/4 to 1/2 inch from surface.
    b. Nuts: ASTM A 307, hexagonal, ANSI B18.2.2.

11. Marking: Markings shall be legibly indented in the pipe or painted thereon with waterproof paint.

12. Protective Coatings

    a. Polyethylene Encasement
        i. Polyethylene encasement materials shall be in accordance with ASTM D 4976 and AWWA C105/A21.5; LLD-12 mil or KDCL-4 mil. LLD-12 mil polywrap shall be blue.

Item	LLD-12 mil	HDCL-4 mil
Tensile Strength, psi	4,400	6,300
Elongation, percent	1,000	100
Dielectric Strength, v/mil	1,900	800
Tear Resistance, gf	4,400	250
Impact Resistance, g	1,100	800

        ii. The minimum tube size for each pipe diameter shall be in accordance with AWWA C105 as follows:

Polyethylene Flat Tube Widths (inches)		
Nominal Pipe Diameter (inches)	**Push-on Bell & Spigot Joints**	**Mechanical Joints**
4	14	16
6	17	20
8	21	24
10	25	27
12	29	30
14	33	34
16	37	37
18	41	41
20	45	45
24	53	53

        iii. Adhesive tape shall be a general purpose adhesive tape1-inch wide and approximately 8 mils thick, such a Scotch Tape No. 50, Polyken No. 900, Tapecoat CT or approved equal (Duct Tape will not be allowed).

    b. Exterior Surfaces Underground (Excluding Pipe & Fittings): All metal surfaces, including each mechanical coupling, shall be thoroughly cleaned and then coated with Tnemec coal-tar epoxy "High-Build Tnemec Tar". All material and the application thereof shall conform to AWWA C203.

c. Above ground pipe and fittings shall be field coated with Tnemec Coal Tar Epoxy "High-Build Tnemec Tar".

B. Polyvinyl Chloride (PVC) 4-inch through 12-inch

1. Pipe: PVC pipe shall meet the requirements of ANSI/AWWA C900 or ANSI/AWWA C909 with cast iron pipe O.D., for PVC pipe. Materials from which the pipe is manufactured shall have been tested and approved for conveying potable water by the National Sanitation Foundation and the Underwriter's Laboratories, and shall be marked with the U.L. logo.

2. Fittings: Where fittings are required, ductile-iron fittings shall be used.

   Pipe wall thickness shall be as required to provide a minimum wall thickness with a Dimension Ratio (DR) of 18 for pressure Class 235 and a DR of 14 for pressure Class 305 as defined in ANSI/AWWA C900.

   Joints for PVC pipe shall be slip-on type with integral bell and spigot pipe, or pipe with extruded type couplings, meeting the requirements of ASTM D 3139, except flexible elastomeric gaskets meeting the requirements of ASTM F 477, shall be synthetic rubber. Natural rubber will not be acceptable.

C. Polyvinyl Chloride (PVC) 2 Inch: PVC pressure pipe shall be designed to carry potable water at pressures (including surge) up to the maximum class rating. Materials from which the pipe, couplings, and fittings are manufactured shall conform to ASTM D 1784, Type 1, Grade 1, 2,000 psi design stress. The minimum wall thickness for the pipe shall be DR 17 (Class 250) or Schedule 40 (Class 270).

All PVC pipe shall conform to the latest revisions of ASTM D 2241, Department of Commerce PS22-70 (SDR-PR) pressure rated pipe, and National Sanitation Foundation Testing Laboratories (NSF). Pipe ends shall be tapered to accept gasketed couplings. Flexible elastomeric gaskets, meeting the requirements of ASTM F 477, shall be synthetic rubber. Natural rubber will not be acceptable.

The couplings and fittings shall accommodate the pipe for which they are used. The minimum pressure ratings shall be 235 psi for couplings and 250 psi for the fittings. The insertion depth of the pipe in the coupling shall be controlled by an internal PVC mechanical stop in the coupling.

D. Fusible Polyvinyl Chloride (FPVC)

1. Pipe: FPVC shall meet the requirements of ASTM D 1784, cell classification 12454, for PVC compounds, AWWA C900, and ASTM D 2241 for standard dimensions. Materials from which the pipe is manufactured shall have been tested and approved for conveying potable water by the National Sanitation Foundation. Pipe shall be marked with nominal pipe size, dimension ratio, AWWA pressure class, AWWA standard designation number, NSF-61 mark verifying suitability for potable water service, extrusion production record code, and cell classification. Pipe shall be homogeneous throughout and be free of visible cracks, holes, foreign material, blisters, or other visible defects. FPVC pipe shall be blue in color and pressure rated at 200 psi with a dimension ratio (D.R.) of 14 as defined in AWWA C900.

   FPVC pipe shall be as manufactured under the trade name "Fusible C-900" for Underground Solutions, Inc., Poway, CA Patent No. 6,982,05, no exceptions.

2. Fittings: All fittings shall be ductile iron.

E. Prestressed Concrete Cylinder, Steel Cylinder Type

1. Pipe: All pipe shall be manufactured and designed according to the requirements of the latest editions of AWWA C301, "Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids", AWWA C304, "Design of Prestressed Concrete Cylinder Pipe", and AWWA M9, "Concrete Pressure Pipes", except as modified herein. Prestressed concrete cylinder pipe shall be embedded cylinder type for all sizes.

    a. The cylinder hoop stress at 1.5 times working pressure shall not exceed the yield strength of the steel. A minimum cylinder thickness of 10 gauge shall be furnished.
    b. Cold-rolled sheets will not be acceptable.
    c. The length of pipe with restrained joints shall be as indicated on the Plans or as specified. Restrained joints and pipe cylinders shall be designed to withstand the calculated stresses at all points along the pipe with restrained joints. The maximum longitudinal stress in pipe cylinders shall not exceed 13,500 psi at the specified working pressure; or 17,000 psi at the specified working pressure plus surge pressure, or the field test pressure, whichever is the greatest.
    d. Mortar coating thickness shall be a minimum of one-inch (1") over the prestressing wire.
    e. Cement: Cement shall be ASTM C 150, Type II. The 28-day rodded test cylinder concrete compressive strength used for the design of the pipe shall not exceed 7,000 psi. If a test cylinder compressive strength between 6,500 psi and 7,000 psi is used for design, a concrete mix design shall be submitted.
    f. Fine aggregate shall be clean natural or manufactured sand as required by ASTM C 33. No "rebound" shall be allowed in the cement mortar used for pipe.
    g. Rubber gaskets shall be synthetic rubber.

2. Joints

    a. Bell-and-Spigot
        i. Provide bell-and-spigot-type joints for all buried pipe unless otherwise specified or indicated on the Plans.
        ii. Provide joints with steel joint rings and O-ring rubber gaskets conforming to AWWA C 301.
        iii. Protect interior surface of the completed joint by grouting with Portland cement mortar.
        iv. The exterior surface of the completed joint shall be covered with a wide joint diaper (harness clamp restrained joint diaper with full width closed cell polyethylene foam lining) filled with grout.
        v. All bells and spigots shall be the deep joint type (minimum 4-1/8 inches in joint depth).
    b. Flanged
        i. Provide flanged joints for all interior and exposed exterior pipe except where otherwise specified or indicated on the Plans.
        ii. Flanges shall have a pressure rating not less than that required for pipe.
        iii. Flanges, bolts, and gaskets shall conform to AWWA C 207, Class D and shall be drilled ANSI B16.1 Class 125.
    c. Coupled
        i. Furnish couplings where indicated on the Plans or Standard Drawings.
        ii. Furnish pipe ends suitable for receiving the style of coupling indicated on the Plans or Standard Drawings.
        iii. Furnish anchored couplings where restraint is required to withstand specified operating or hydrostatic test pressure and where indicated on the Plans or Standard Drawings.

d. Special
   i. Furnish pipe with joints suitable for attaching to valves and accessories and for indicated transitions.
   ii. Joints shall be plain end, flanged, mechanical, or as otherwise indicated on the Plans or Standard Drawings.
   iii. Adapters may be furnished in lieu of pipe with special joints.
e. Restrained: Provide either clamp-type or snap-ring type rubber and steel joints acceptable to Engineer where restraint is required for joint to withstand specified operating and hydrostatic test pressure and where indicated on the Plans or Standard Drawings.

3. Closure Assemblies: Provide closure assemblies acceptable to Engineer where indicated on the Plans or Standard Drawings and as required by the sequence of construction.

4. Test Plugs

   a. Provide pressure test plugs where required to test the installation.
   b. Design test plugs to withstand hydraulic test pressure and external loading.
   c. Join test plugs to pipe with selected joint and restrain as required to maintain internal pressures with external loading applied.
   d. Provide outlets of proper size to facilitate flushing and disinfection.

5. Fittings and Specials

   a. Fabricate conforming to AWWA C301 and M9.
   b. Design to withstand internal pressure and external loading not less than that of adjoining pipe.
   c. Furnish fittings with bell-and-spigot ends where such fittings connect with concrete pipe.
   d. Furnish wall fittings with approved anchor ring where indicated on the Plans or Standard Drawings. Such fittings shall be of ductile iron or fabricated steel.
   e. Furnish all adapters, outlets, and other specials as specified or where indicated on the Plans or Standard Drawings.
   f. Furnish openings for air valve, drain, sampling, sensing, testing, and other connections with threaded bosses or flanged outlets sized and located where indicated on the Plans or Standard Drawings. Steel connections shall be lined and coated with mortar or other protective coating material if mortaring is not feasible.
   g. Provide tangent blow-off and drain assemblies where indicated on the Plans or Standard Drawings. Outlet shall be a minimum 6-inch anchored mechanical joint spigot.
   h. Short Bevel Fittings: Furnish and maintain two nominal full bevels and four nominal half bevel bends on site during pipe installation for minor alignment adjustments. Replenish as used until pipe is installed. Return unused bevels to pipe manufacturer.

6. Pipe Marking: In addition to the marking specified in paragraph "Pipe Marking", the following information shall be marked on each pipe, fitting, and special:

   a. Design pressure
   b. Laying schedule number on all fittings and specials
   c. Date of casting
   d. Length of any short pipe

2902.3 Valves and Valve Boxes

A. Gate Valves: The type, size, and location of valves shall be as shown on the Plans or Standard Drawings. Except as modified or provided herein, all gate valves in pipe lines shall be 200 psi, iron body, gate valves

with non-rising stems. Gate valves shall be resilient-seated conforming to all applicable requirements of ANSI/AWWA C509 and C515.

B. Butterfly Valves: Butterfly valves shall be used for water line valves larger than twelve (12) inches in diameter unless otherwise directed by the Engineer. Butterfly valves shall be of the rubber-seat, tight-closing type. Valve discs shall seat at 90-degree with pipe axis. Mechanical joint end valves shall be of the short body type. Packing shall be O-ring cartridge designed for permanent duty in underground service.

All butterfly valves and operators shall conform to AWWA C504 for Class 150B service. Metal mating seat surfaces shall be 18-8 stainless steel or more. Each valve shall be provided with an operator with a torque rating at least equal to the torques listed in AWWA C504, Table 1. Butterfly valves shall be epoxy coated inside and outside conforming to ANSI/AWWA C550. All exposed valve bolts and nuts shall be stainless steel.

C. Valve Ends: Valve ends shall be of the mechanical joint type, conforming to ANSI A21.11 /AWWA C111 except where flanged ends are required on the Plans.

The end flanges of flanged gate valves shall conform in dimensions and drilling to ANSI B16.1 for cast-iron flanges and flanged fittings, Class 125, unless explicitly provided otherwise on the Plans or Standard Drawings. The laying lengths of the flanged valves shall conform to the dimensions of ANSI B16.10.

D. Bonnet Thrust Plates: The bonnet shall have a removable thrust plate to permit the removal and replacement of the valve stem and "O" ring seal while the valve is in service. All bolts and nuts in the bonnet shall be stainless steel.

E. Tapping Valves: The size and location of the tapping valves shall be as shown on the Plans or Standard Drawings. The valves shall be 200 psi, ductile iron body, resilient-seated gate valves with non-rising stems conforming with all applicable requirements of ANSI /AWWA C509 and C515, except that the outlet end shall be standard mechanical joint end conforming to ANSI A21.11 /AWWA C111 and the inlet end shall have an inlet flange conforming to ANSI B16.1 for cast iron flanges, Class 125.

F. Tapping Sleeves

1. Stainless Steel: The minimum working pressure rating shall be 150 psig. The height from the flange surface to the pipe centerline shall comply with MSS SP-111. Recess dimensions are per MSS SP-60.

    a. Top Shell: The top shell shall be 18-8 Type 304 stainless steel, minimum 12 gauge thickness.
    b. Bottom Shell: The bottom shell shall be 18-8 Type 304 stainless steel, minimum 14 gauge thickness.
    c. Flange: The flange shall be 18-8 Type 304 stainless steel and shall have a 3/4-inch NPT test report.
    d. Gasket: The tapping sleeve shall have a full circumferential gasket made of synthetic rubber.

2. Iron: The minimum working pressure rating shall be 150 psig. The tapping sleeves shall comply with MSS SP-111.

    a. Tapping sleeves shall be cast iron complying with ASTM A 126, Class B or DI complying with ASTM A 536 and shall be compatible with the tapping valve.
    b. Coating shall comply with AWWA C550.

c. Cast iron tapping sleeves shall have MJ connection x flange end. The flange end shall include a recess to provide positive alignment of the tapping valve. Recess dimension are per MSS SP-60.
d. Bolts shall comply with ANSI/AWWA C111/A21.11.

G. Stem Seals and Coatings

1. All valves shall be provided with stem seals of the "O" ring type. Two "O" rings shall be used with at least one "O" ring inserted above the thrust collar. The packing plate shall be attached to the valve bonnet by not less than three (3) bolts and one "O" ring below the thrust collar.

2. All exterior surfaces of each valve shall be cleaned and painted in the shop with two (2) coats of asphalt varnish conforming to Federal Specifications TT-V-51-E. The interior surfaces of resilient-seated gate valves shall have a protective coating of fusion-bonded, nontoxic epoxy which is safe for potable water.

H. Valve Operation: All valves shall be equipped with a 2-inch square wrench nut and the direction of rotation to open the valve shall be to the left (counterclockwise) unless otherwise noted in the Special Provisions.

I. Extension Stems: When the distance from the top of the valve cover to the valve operating nut exceeds 3 feet, each buried valve shall be provided with an extension stem and operating nut shall conform to the Plans or Standard Drawings.

J. Valve Boxes, Bases, Lids and Covers

1. One-piece Valve Box and Base: One-piece valve boxes and bases shall be injection molded plastic conforming to ANSI/ASTM D 2853-70, Class 1212.

2. Two-piece Valve Box and Base

a. Valve Boxes: In paved areas, including driveways and sidewalks, valve boxes shall be 6-inch, Class 52, DIP. In non-paved areas, the Contractor may use 6-inch, Class 152, PVC pipe.
b. Valve Bases: Valves bases shall be Clay & Bailey No. 2260-4 or an approved equal. Bases are required under all valve boxes.
c. Lids and Covers: Valve lids and covers for use in pavement shall be Clay & Bailey No. 2193, 2193NS or an approved equal. Valve lids and covers for all other areas may be Clay & Bailey No. 2196, or an approved equal. Valve lids shall have "Water" cast in the lid.

2902.4 Fire Hydrants

A. General: Fire hydrants shall be dry barrel, standard compression, two-piece standpipe, break-away design conforming to AWWA C502 and shall comply with one of the two types as follows or as noted in the Special Provisions:

1. Hydrants shall have minimum design working pressure of 150 psig and test pressure of 300 psig.

2. One 4.5-inch pumper nozzle, two 2.5-inch hose nozzles, 5.25-inch minimum mechanical valve opening left and 6-inch inlet connection.

3. Two 2.5-inch hose nozzles, 5.25-inch minimum mechanical valve opening left and a 6-inch inlet

connection.

4. Hydrants should be the same type, configuration, and color as the fire hydrants in use by the Owning Authority as noted in the Plans or Special Provisions.

B. Operating Nut Dimensions: Operating stem and nozzle cap nuts shall be 1.5-inch point to flat pentagon.

C. Nozzle Threads and Caps: Hydrant nozzles shall meet NFPA standard thread requirements. All nozzle caps shall be equipped with chains attached to the hydrant. All hydrant threads shall be oil lubricated by means of an oil reservoir or grease zerk.

D. Bury Depth: The bury length of hydrant barrel shall be determined by the depth from finish grade to the invert of the connecting pipe.

E. Extension Kits

1. Extension kits shall be supplied by the hydrant manufacturer.

2. All extension shall be factory painted (baked on enamel) and shall match the color of the barrel section.

2902.5 Specials

A. General: Air release, meter, and pressure-reducing valve vaults shall be precast concrete conforming to ASTM C 478. Access lid castings shall be as shown in the Plans, Standard Drawings, or as noted in the Special Provisions.

Vaults that must be cast in place due to their special nature shall conform to the Plans, Standard Drawings, and concrete specifications in Section 2902.8.

B. Pressure Reducing Valves: Pressure reducing valves shall be designed to provide tight shutoff under conditions of no flow and shall not “hunt” under ordinary flow conditions. Pressure reducing valves shall be as noted in the Special Provisions, selected and sized as recommended by the valve manufacturer. Pressure reducing valves shall be suitable for operation under the pressure and flow conditions as shown on the Plans.

C. Combination Air Valves: Combination air-release and vacuum-relief valves shall be installed at the locations indicated on the Plans. Each valve assembly shall be installed complete with appropriate piping and valves as shown on the Plans or Standard Drawings. All piping and isolation valves shall be brass except for the air outlet from the valve which shall be brass or copper tubing.

Air releases for mains 12-inches in diameter or smaller shall have 1-inch combination air-release valves, APCO No. 143C or approved equal.

D. Blow-Off Assemblies: Blow-off assemblies shall be installed at the locations indicated on the Plans or Standard Drawings. Blow-off assemblies shall be installed with the appurtenant piping and valves as indicated on the Plans, Standard Drawings, or Special Provisions.

E. Corporation Cocks: The Contractor will furnish and install three-fourth inch (3/4") corporation cocks along the pipeline where necessary to vent the line during filling. The number and location of the corporation cocks shall be determined by the Engineer. After testing and disinfection of the line, the corporation cocks shall be removed and replaced with a tapered brass plug.

2902.6 Bedding Material

Granular Bedding Material: All materials used for granular embedment for pipe bedding shall conform to the requirements of ASTM C 33 and shall meet the graduation identified in Section 2102.4.G.

2902.7 Location Wire and Tape

Location wire or detection marking tape shall be buried above water mains.

A. Location Wire: Location wire shall be a minimum 12 gauge copper clad steel (CCS), minimum break load of 280 lbs. with blue 30 mil HDPE jacket for open trench installations or 12 gauge copper clad steel (CSS), minimum break load of 1,100 lbs. with blue 45 mil HDPE jacket for directional drilling or jack and boring installations.

B. Detection Marking Tape: Detection marking tape shall be solid aluminum foil core tape completely encased in polyethylene jacket, 5.5 mils thick minimum, and 6-inches wide.

The detection tape marking tape shall be blue in color and have "Buried Water Line Below" printed on the tape at 20- to 30-inch intervals. The detection and marking tape shall be installed directly above the centerline of the pipe and 18- to 24-inches below finish grade.

2902.8 Concrete

This specification is intended primarily for concrete thrust blocks, encasements and vaults. Concrete for all driveway, sidewalk, roadway pavement, and/or curb and gutter replacement shall conform to the requirements of Section 2301, 2302, 2200 and the appropriate authority having jurisdiction thereof.

The concrete shall be MCIB WA535-1/2-4 as designated by the Mid-West Concrete Industry Board, Inc., Kansas City, Missouri or approved KCMMB 4K mix as indicated on the Plans or Standard Drawings.

2902.9 Casing Pipe

Casing pipe shall be used where required at railroad or highway crossings. The casing pipe shall be in accordance with the Plans, Standard Drawings, or Special Provisions and meet the requirements of the railroad or highway authority with regard to type of material, wall thickness and coating of casing pipe. No casing will be installed without the approval of the involved highway or railroad authority.

A. Material: New, smooth wall, welded steel pipe fabricated from ASTM A 36 plate or ASTM A 1011 sheet with minimum yield point of 36,000 psi, conforming to AWWA C200.

B. Casing Thickness: The following table provides a listing of minimum casing diameters and thickness:

Casing Pipe Diameter (inches)	Nominal Wall Thickness (inches)	
	Under Highway	Under Railroad
12	0.188	0.282
14	0.188	0.282
16	0.188	0.282
18	0.250	0.312
20	0.281	0.344
22	0.281	0.375
24	0.281	0.406
26	0.312	0.438
28	0.312	0.469
30	0.312	0.469
32	0.344	0.500
34	0.344	0.531
36	0.344	0.531
38	0.344	0.531
40	0.375	0.563
42	0.375	0.563
44	0.375	0.563
48	0.375	0.563
50	0.406	0.625
52	0.406	0.625
54	0.406	0.625
60	0.450	0.650

C. Joints: All joints in steel pipe casings shall be field welded to conform to API 1104 or AWWA C206.

1. Clean to SSPC-SP3 and apply iron oxide field coating to all exterior joints after field welding.

2. Clean to SSPC-SP3 and apply iron oxide field coating to all interior joints on 24 inch diameter casings and larger after field welding.

D. Factory Coatings and Linings: Coat exterior and line interior of all casing pipe with iron oxide primer applied at 33 microns (1.5 mils) minimum thickness. Hold coatings and linings back from end joints to be welded at least 2 inches each side of joint.

E. Casing Spacers

1. Casing spacers shall be used to install the carrier pipe inside the encasement pipe. Casing spacers shall fasten tightly onto the carrier pipe so that when the carrier pipe is being installed the spacers will not move along the pipeline. Casing spacers shall be doubled on each end of the encasement.

2. Each casing spacer shall be capable of providing support for the carrier pipe in service at a maximum spacing of 10'. Calculations shall be provided to the Engineer by the casing spacer manufacturer showing that the casing spacer will support the service load at the recommended spacing, including a factor of safety of two (2). Casing spacers used under this specification shall meet or exceed the specifications described herein as projection-type that has a minimum of projections around the circumference totaling the number of diameter inches.

3. Projection-type casing spacers panels, risers and fasteners shall be constructed of Stainless Steel

type 304. Casing spacer skids shall be constructed of UHMV Polyethylene. Projection-type casing spacers shall be Power Seal Model 4810 or approved equal.

F. End Seals: Power Seal Model 4810ES or approved equal.

G. Sand: Clean, natural sand in accordance with ASTM C 33.

SECTION 2903 CONSTRUCTION

2903.1 Grading and Excavation

A. General: Excavation and trenching work shall include the necessary clearing, grubbing, and preparation of the site; removal and disposal of all debris; excavation and trenching as required; the handling, storage, transportation and disposal of all excavated material; all necessary sheeting, shoring, and protection work; preparation of subgrades; pumping and dewatering as necessary or required; protection of adjacent property; and other appurtenant work.

Excavation and trenching work shall be performed in a safe and proper manner with suitable precautions being taken against all hazards.

The Contractor shall explore and expose any and all obstructions in advance of excavation so that minor changes in grade and alignment may be made.

In paralleling present water, sewer and gas mains, the Contractor shall protect all service connections and shall arrange to furnish service to the consumers with minimum interruption.

All excavated material shall be piled in a manner that will not endanger the work and that will avoid obstructing sidewalks and driveways. Gutters shall be kept clear or other satisfactory provisions made for street drainage.

B. Classification of Excavated Material: No classification of excavated materials will be made. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the contract work regardless of the type, character, composition, or condition thereof. See Section 2100 “Clearing and Site Preparation”.

C. Blasting: When blasting is permitted by the Engineer, the Contractor shall use the utmost care to protect life and property. The Contractor shall obtain any required permits from the agency having site jurisdiction and shall comply with all laws, ordinances, and the applicable safety code requirements and regulations relative to the handling, storage and use of explosives and protection of life and property, and he shall be responsible for all damage caused by his or his subcontractor's operations.

The Contractor shall provide insurance as required by the Contract Documents before performing any blasting. The governing agency shall be notified at least 24 hours before blasting operations begin.

No blasting of any kind for rock excavations or any other purpose will be allowed unless noted otherwise on the Plans or permitted by the Engineer.

D. Unauthorized Excavation: Any part of the trench excavated below grade shall be corrected with material approved by the Engineer placed and compacted by the Contractor to the satisfaction of the Engineer.

E. Removal of Water: The Contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface and groundwater entering excavations, trenches, or other parts of the work. Each

excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

All excavations for concrete structures or trenches which extend down to or below static groundwater elevations shall be dewatered by lowering and maintaining the groundwater surface beneath such excavations a distance of not less than 12-inches below the bottom of the excavation.

Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.

The Contractor will be held responsible for the condition of any pipe or conduit which he may use for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.

F. Sheeting and Shoring: Except where banks are cut back on a stable slope, excavation for structures and trenches shall be properly and substantially sheeted, braced, or shored as necessary to prevent caving or sliding, to provide protection for workmen and the work, and to provide protection for existing structures and facilities. Sheeting, bracing, and shoring shall be designed and built to withstand all loads that might be caused by earth movement or pressure and shall be rigid, maintaining shape and position under all circumstances.

Trench sheeting shall not be pulled unless pipe strength is sufficient to carry trench loads based on trench width to the back of sheeting.

Sheeting shall not be pulled after backfilling.

Where trench sheeting is left in place, such sheeting shall not be braced against the pipe, but shall be supported in a manner which will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed.

G. Stabilization: Trench bottoms shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workmen.

Trench bottoms which are otherwise solid but which become mucky on top due to construction operations shall be reinforced with one or more layers of crushed stone or gravel. Not more than 1/2-inch depth of mud or muck shall be allowed to remain on stabilized trench bottoms when the pipe bedding material is placed thereon.

H. Trench Excavation: The Contractor shall not open more trench in advance of pipe laying than is necessary to expedite the work. One block or 300 feet, whichever is the shorter, shall be the maximum length of open trench ahead of pipe laying unless by written permission of the Engineer.

Except where tunneling or boring and jacking is specified and shown on the plan by the Engineer, all trench excavations shall be open cut.

I. Alignment and Grade: The alignment and grade or elevation of the pipeline shall be as shown on the Plans.

The Contractor must maintain a constant check of the pipe alignment and trench depth and will be held responsible for any deviations therefrom.

Unless otherwise shown or indicated on the Plans or unless otherwise set forth by the Engineer, the

horizontal and vertical alignment of the water main shall be maintained to within the following tolerances of 3-inches horizontally and 42" to 48" vertical depth of cover.

J. Minimum Cover: Except where otherwise shown, trenches shall be excavated to a depth sufficient to provide a minimum depth of backfill cover over the top of the pipe as indicated above. Greater pipe cover depths may be necessary on existing pipe, conduits, drains, drainage structures, or other obstructions encountered at normal pipe grades.

Measurement of pipe cover depth shall be made vertically from the outside top of pipe to finish grade or pavement surface elevations.

K. Trench Widths

1. Minimum Widths: Minimum trench widths shall be in accordance with the Plans, Standard Drawings, and manufacturers' recommendations.

2. Maximum Widths: The allowable maximum trench widths hereinafter specified apply only to that portion of the trench below the horizontal plane parallel to and six (6) inches above the top of the pipe. The allowable maximum widths may be exceeded at manholes, bore pits, tees, and in unstable earth material. Where the maximum trench width is exceeded the Contractor shall provide the appropriate strength class of pipe embedment to provide safe support strength to the pipeline.

3. When the side clearance exceeds two and one-half (2.5) times the outside pipe diameter at either side of a flexible conduit, it shall be the Contractor's responsibility at no additional cost to the Owner to provide bedding adequate to develop the required lateral support for the pipe and/or provide a pipe of sufficient strength class to accommodate the loading conditions as approved by the Engineer.

L. Unauthorized Trench Widths: When, for any reason, the width of the lower portion of the trench as excavated at any point exceeds the maximum permitted in the foregoing tables, either pipe of adequate strength, special pipe embedment, or arch concrete encasement, as required by loading conditions and as determined by the Engineer, shall be furnished and installed by and at the Contractor's expense.

M. Trench Bottom in Earth: The trench in earth shall have a flat bottom the full width of the trench and shall be excavated to the grade to which the pipe is to be laid. The surface shall be graded to provide a uniform bearing and continuous support for each pipe at every point along its entire length.

N. Rock Exploration: Unless shown otherwise on the Plans or noted in the Special Provisions, no rock exploration has been made. On those projects where rock exploration has been made, test holes have been drilled at locations and intervals as shown on the Plans or subsurface information report to determine the approximate location and depth of rock.

Resistance to penetration was assumed to be "solid rock." This information is furnished for general-reference purposes only.

The Contractor must form his own opinion as to the character of materials which will be encountered from an inspection in the ground, from his own investigation of the test hole information, or from such other investigations as he may desire.

O. Trench Bottoms in Rock: All rock excavation shall be carried to a minimum of 6-inches below the bottom of the pipe. Granular pipe embedment material shall be used to restore the trench bottom to the desired elevation and grade and to provide a uniform bearing and continuous support for the pipe along its entire length. Care shall be exercised to prevent any portion of the pipe from coming to bear on solid rock or

boulders.

P. Mechanical Excavation: The use of mechanical equipment will not be permitted in locations where its operations would cause damage to trees, buildings, culverts, or other existing property, utilities, or structures above or below ground. In all such locations, hand-excavating methods shall be used.

Mechanical equipment used for trench excavation shall be of the type, design, and construction and shall be so operated that the rough trench excavation bottom elevation can be controlled, that uniform trench widths and vertical sidewalls are obtained at least from the bottom of the trench, and that trench alignment will be centered in the trench with adequate clearance between the pipe and sidewalls of the trench. Undercutting the trench sidewall to obtain clearance will not be permitted.

All mechanical trenching equipment, its operating conditions, and the manner of its operations, shall be subject at all times to the approval of the Engineer.

Q. Stream Crossings: Stream crossings shall be made in accordance with these specifications and as shown on the Plans.

The trench width shall be as required for proper pipe installation and the trench depth shall be as required to give minimum cover shown on the Plans or Standard Drawings. Pipe encasement, where required, shall be in accordance with the specifications and placed as indicated on the Plans or Standard Drawings.

R. Highway and Railroad Crossings: The Contractor shall make highway and railroad crossing in accordance with the specifications, the Special Provisions and as shown on the Plans.

All construction or work performed and all operations of the Contractor, his employees, or his subcontractors within the limits of highway or railroad right-of-ways shall be in conformity with all the requirements, regulations and be under the control (through the Engineer) of the authority owning or having jurisdiction over and control of the right-of-way.

The Contractor shall pay fees and obtain permits to make the crossings unless otherwise directed.

2903.2 Installation

A. General: Laying of PVC pipe, ductile-iron pipe (DIP), and HDPE pipe installation of valves, and hydrants; and embedment and backfill shall conform to the following specifications and the details as shown on the Plans or Standard Drawings.

1. Unless otherwise specified or shown on the plans, the water mains shall be laid to have a minimum cover of 42-inches, measured from the finished grade or from established street grades shown on the Plans or Standard Drawings.

2. Whenever pipe laying is stopped, the open end of the line shall be sealed with a watertight plug which will prevent trench water from entering the pipe.

3. Where the pipe is to be installed inside a casing pipe or tunnel liner, creosoted timber skids shall be strapped to each pipe before it is placed in the casing pipe or tunnel liner in accordance with the specifications and as shown on the Plans or Standard Drawings. Sand fill shall be used when shown on the Plans or Standard Drawings. The ends of each casing pipe or tunnel liner shall be closed with a dry brick wall or as shown on the Plans or Standard Drawings. The closures for each casing pipe or tunnel liner shall not be constructed until all testing of the line has been completed and accepted.

B. PVC Pipe: This specification addresses the installation of AWWA C900, C905, and C909 PVC pipe. Ductile iron fittings and valves are covered in other sections. PVC shall be installed to the minimum of AWWA C605 latest revision and per the specifications.

1. Handling: Pipe, fittings, and other accessories shall at all times be handled with care to avoid damage. Under no circumstances shall they be dropped. Pipe fittings shall be handled as specified for ductile-iron pipe. Any damaged pipe, fittings, or accessories shall be rejected.

2. Cutting Pipe: All pipes shall be cut with a saw or special cutting tool. Cutting shall be done in a neat manner without damage to the pipe. Cuts shall be smooth, straight and at right angles to the pipe axis. After cutting, the end of the pipe shall be dressed and beveled. Beveling shall be done with a specifically designed beveling tool. Hand beveling will not be allowed. When cutting pipe with couplings, mark the field cut pipe end the same distance in as the mark appeared on the original full-length pipe section.

3. Cleaning: The interior of all pipe and fittings shall be thoroughly cleaned of foreign matter before being installed and shall be kept clean until the work has been accepted.

4. Pipe Laying: PVC pipe shall be installed in strict accordance with the requirements and instructions of the pipe manufacturer. It shall be protected from lateral displacement and deflection by pipe embedment material installed as specified for pipe embedment and as shown on the Plans or Standard Drawings. No pipe shall be laid under unsuitable trench conditions. Whenever pipe laying is stopped, the open end of the line shall be sealed with a watertight plug which will prevent trench water from entering the pipe.

5. Assembly: For push on pipe, the spigot shall be inserted into the bell to the line on the spigot. The previously completed joints must be braced so the line does not become “stacked”, “over belled”, or inserted past the reference mark on the spigot. If the insertion mark is not visible after assembly, the joints shall be dissembled and done correctly.

6. Alignment: Piping shall be laid to the lines and grades as specified, as indicated on reference points, or as indicated on the Plans. The Contractor must obtain approval from the Engineer for any changes in the alignment or grade.

7. Joint Deflection: Pipelines or runs intended to be straight shall be laid straight. Deflections from a straight line using joint deflection shall not exceed the pipe manufacturer’s published axial joint deflection or 1-degree, whichever is less.

8. Bending Pipe: The Contractor will not be allowed to bend PVC pipe. The Contractor shall use the CertainTeed High Deflection Coupling if joint deflection is insufficient and an 11-1/4 bend is too large of an angle.

9. Mechanical Joints: Mechanical joints shall be carefully assembled in accordance with the manufacturer’s recommendations. If effective sealing is not obtained, the joint shall be disassembled, thoroughly cleaned, and reassembled. Kor-Blue bolts, or approved equal, shall be used for all necessary assembly. Bolts shall be uniformly tightened to the torque values listed in ANSA/AWWA C111/A21.11. Over-tightening of bolts to compensate for poor installation practice will not be permitted.

10. Push-on Joints: All joint surfaces shall be lubricated with heavy vegetable soap solution immediately before the joint is completed. Lubricant shall be stored in closed containers and shall

be kept clean. Each spigot end shall be suitably beveled to facilitate assembly.

11. Fittings: Unless directed otherwise by Engineer, Contractor shall determine the type and locations of bends required to complete the main installation. Mains shall be installed with the least number of bends practical. The Contractor will cut off the bevel of the PVC pipe before insertion into an MJ fitting.

12. Trace Wire: The Contractor shall install trace wire in the trench with the PVC pipe.

13. Thrust Restraint for PVC: Certa-lok restrained joint PVC shall be used or installed using the EBBA Iron 1900 Series restraint harness or approved equal according to the manufacturer's recommendations. Thrust restraint devices shall be provided on all pipe installed in encasement pipes and installed for street crossings.

14. Reaction Anchorage and Blocking: Where thrust restraint devices are inappropriate or when directed by the Engineer, concrete thrust blocks, thrust collars, or gravity blocks shall be used to prevent movement of the pipe caused by internal pressure.

C. Ductile-Iron Pipe (DIP)

1. Handling: Pipe, fittings and accessories shall be handled in a manner that will ensure installation in a sound, undamaged condition. Equipment, tools, and methods used in unloading, reloading, hauling, and laying pipe and fittings shall be such that the pipe, pipe coating, and fittings are not damaged. Hooks shall not be used. Under no circumstances shall pipe or accessories be dropped or dumped. Pipe and fittings on which the cement lining has been broken or loosened shall be replaced by the Contractor. Where the damaged areas are small and readily accessible, the Contractor may be permitted to repair the lining.

2. All pipe coating which has been damaged shall be repaired by the Contractor before installing the pipe.

3. Cutting Pipe: Ductile-iron pipe shall be cut with either a saw or an abrasive wheel. Cutting of existing cast-iron pipe shall be done with either a saw or abrasive wheel, or when there is a free end, with mechanical pipe cutters. The cutting of pipe with a torch will not be permitted.

4. Cutting shall be done in a neat manner without damage to the pipe, or the cement lining. Cuts shall be smooth, straight, and at right angles to the pipe axis. After cutting, the end of the pipe shall be dressed with a file to remove all roughness and sharp corners.

5. Cleaning: The interior of all pipe and fittings shall be thoroughly cleaned of foreign matter before being installed and shall be kept clean until the work has been accepted. Such surfaces shall be wire brushed, if necessary, wiped clean, and kept clean until jointing is completed.

6. Inspection: Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation. Spigot ends shall be examined with particular care since they are vulnerable to damage from handling. All defective, damaged, or unsound pipe and fittings shall be rejected and marked as such and removed from the site of the work.

7. Push-on Joints: The gasket seat in the bell shall be wiped clean after which the gasket should be placed. A thick film of lubricant should be applied to the entire inner surface of the gasket and on the spigot end of the pipe. The lubricant and the gaskets shall be as recommended and supplied by the manufacturer of the pipe being used. The lubricant shall be odorless, tasteless, nontoxic,

and suitable for use in potable water. Field-cut pipe shall be beveled by filing or by mechanical means to remove any sharp or rough edges that might otherwise damage the gasket.

8. Mechanical Joints: Mechanical joint pipe shall be used only when shown on the Plans or Standard Drawings and shall be installed in strict accordance with the manufacturer's recommendations.

9. Flanged Joints: When bolting flanged joints, care shall be taken to ensure that there is no restraint on the opposite end of the pipe or fitting which would prevent uniform gasket compression or which would cause unnecessary stress in the flanges. One flange shall be free to move in any direction while the flange blots are being tightened. Bell-and-spigot joints shall not be packed or assembled until all flanged joints affected thereby have been tightened. Bolts shall be tightened gradually and at a uniform rate so that gasket compression is uniform.

10. Restrained Joints: Restrained joints and anchoring joints shall be installed in strict accordance with the pipe manufacturer's recommendations.

11. Alignment of Bell-and-Spigot Pipe: Pipelines or runs intended to be straight shall be laid straight. Deflections from a straight line or grade shall not exceed the quantities stipulated in Tables 4 and 5 of ANSI/AWWA C600.

12. Trace Wire: The Contractor shall install trace wire in the trench with the DIP pipe.

13. Laying Pipe: Pipe shall be protected from lateral displacement by pipe embedment material installed as specified. Under no circumstances shall the pipe be laid in water, and no pipe shall be laid under unsuitable trench conditions.

D. HDPE Pipe

1. Handling: HDPE pipe and fittings shall be handled to insure installation in a sound undamaged condition. During loading, transportation and unloading, every precaution shall be taken to prevent injury to the pipe. No pipe shall be dropped from cars or trucks, or allowed to roll down slides without proper retaining ropes. During transportation each pipe shall rest on suitable pads, strips, skids, or blocks securely wedged or tied in place. Any pipe that is scratched more than 10% of the wall thickness shall not be used.

2. Laying Pipe: HDPE pipe shall not be installed when trenches or weather conditions are not suitable for such work. HDPE pipe shall be installed in a trench with engineered embedment and backfill per the Excavation and Trenching section, except the bedding material particle size shall not exceed 1/2 inch for pipe smaller than 4 inches in diameter. The bedding material may be sliced in around the pipe.

3. Fusion: Sections of polyethylene pipe should be joined into continuous lengths on the jobsite above ground. The preferred joining method shall be the butt fusion method. The butt fusion equipment used in the joining procedures should be capable of temperature requirements of 400^0 F, alignment, and an interfacial fusion pressure of 75psi. Electrofusion couplings shall be used when butt fusion equipment cannot be used. Electrofusion coupling assembly shall be completed as scribed in the attachment at the end of this section. Socket fusion, hot gas fusion, threading, solvents, and epoxies will not be used to join HDPE pipe. The operator of the butt fusion or electrofusion machine shall be trained and certified by the fusion equipment supplier to operate the fusion machine.

4. Trace Wire: The Contractor shall install trace wire in the trench with the HDPE pipe.

E. Fusible Polyvinyl Chloride Pipe (FPVC)

1. Handling (Pipe): Pipe shall be loaded, off-loaded, and otherwise handled in accordance with AWWA M23 and all pipe suppliers' guidelines shall be followed. The use of chains, wire rope, chokers, or other pipe handling implements that may scratch, nick, cut, or gouge the pipe are strictly prohibited. Any scratch or gouge greater than 10% of the wall thickness will be considered significant and may be cause for rejection. Damaged areas may be removed by cutting, limits of acceptable length of pipe shall be determined by the Owner or Engineer.

2. Handling (Fittings and Accessories): Fittings and accessories shall be handled in a manner that will ensure installation in a sound, undamaged condition. Equipment, tools, and methods used in unloading, reloading, and hauling fittings and accessories shall be such that fittings and accessories are not damaged. Fittings on which the cement lining has been broken or loosened shall be replaced by the Contractor at his sole expense. Where damaged areas are small and readily accessible, the Contractor may be permitted to repair the lining.

3. Cutting Pipe: All pipe shall be cut with facing blades specifically designed for cutting fusible polyvinyl chloride pipe.

4. Cleaning: The interior of all pipe and fittings shall be thoroughly cleaned of foreign matter before being installed and shall be kept clean until the work has been accepted.

5. Inspection: FPVC pipe shall be installed in strict accordance with the requirements and instructions of the pipe supplier for open cut, horizontal directional drilling (HDD), or pipe bursting installation methods.

6. Alignment: Waterlines or runs intended to be straight shall be laid straight. Deflections from a straight line or grade shall not exceed the pipe suppliers recommended bending radius guidelines.

7. Laying Pipe: Pipe shall be protected from lateral displacement by pipe embedment material installed as specified. Under no circumstances shall the pipe be laid in water, and no pipe shall be laid under unsuitable trench conditions.

8. Tracer Wire: The Contractor shall install trace wire in the trench with the FPVC pipe.

2903.3 Jointing

A. Push-on Joints: The gasket seat in the bell shall be wiped clean after which the gasket should be placed. A thick film of lubricant should be applied to all of the inner surface of the gasket and on the spigot end of the pipe.

The lubricant and the gaskets shall be as recommended and supplied by the manufacturer of the pipe being used. The lubricant shall be odorless, tasteless, nontoxic, and suitable for use in potable water.

Field-cut pipe shall be bevel filed to remove any sharp or rough edges which might otherwise damage the gasket.

B. Mechanical Joints: The mechanical joint shall be used only when shown on the Plans or Standard Drawings.

C. Flanged Joints: When bolting flanged joints, care shall be taken to ensure that there is no restraint on the opposite end of the pipe or fitting which would prevent uniform gasket compression or which would cause

unnecessary stress in the flanges. One flange shall be free to move in any direction while the flange bolts are being tightened. Bell-and-spigot joints shall not be packed or assembled until all flanged joints affected thereby have been tightened. Bolts shall be tightened gradually and at a uniform rate so that gasket compression is uniform.

D. Restrained Joints: Restrained joints and anchoring joints shall be installed in strict accordance with the pipe manufacturer's recommendations.

E. Fused Joints: Fusible polyvinyl chloride pipe lengths shall be assembled in the field with butt fused joint. Butt fusion shall be completed in strict accordance with the pipe suppliers' written guidelines for this procedure.

1. Butt fusion shall be performed by qualified fusion technicians as documented by the pipe supplier.

2. Fusion joints shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine. The fusion data logging and joint report shall be generated by software developed specifically for the butt-fusion of fusible polyvinyl chloride pipe. The software shall register and/or record the parameters required by the pipe supplier and these specifications. Data not logged by the data logger shall be logged manually and be included in the Fusion Technician's joint report. Joint reports shall be submitted and approved by the pipe supplier prior to installation of any fusible polyvinyl chloride pipe.

3. Only appropriately sized and outfitted machines that have been approved by the pipe supplier shall be used for the fusion process. Fusion machines must incorporate the following elements:

    a. Heat Plate: Heat plates shall be in good condition with no deep gouges or scratches. Plates shall be clean and free of any debris or contamination. Heater controls shall function properly, cord and plug shall be in good condition. The appropriately sized heat plate shall be capable of maintaining a uniform and consistent heat profile and temperature for the size of pipe being fused per the pipe suppliers' guidelines.
    b. Carriage: Carriage shall travel smoothly with no binding at less than 50 psi. Jaws shall be in good condition with proper inserts for the pipe size being fused. Insert pins shall be installed with no interference to carriage travel.
    c. General Machine: Overview of machine body shall yield no obvious defects, missing parts, or potential safety issues during fusion.
    d. Data Logging Device: An approved data logging device with the current version of the pipe suppliers' recommended and compatible software shall be used. Data logging device operations and maintenance manual shall be with the unit at all times. If fusing for extended periods of time, an independent 110V power source shall be available to extend battery life.

4. Other equipment specifically required for the fusion process shall include the following:

    a. Pipe rollers shall be used for support of pipe to either side of the machine.
    b. A weather protection canopy that allows full machine motion of the heat plate, fusion assembly and carriage shall be provided for fusion in inclement, extreme temperatures, and /or windy weather, per the pipe supplier's recommendations.
    c. An infrared (IR) pyrometer for checking pipe and heat plate temperatures.
    d. Fusion machine operations and maintenance manual shall be kept with the fusion machine at all times.

2903.4 Connection to Existing Mains

The Contractor shall furnish and install all fittings necessary to join the existing and new water mains as shown on the Plans or Standard Drawings.

The Owning Authority shall be given at least 24 hours' notice prior to turning off any water supply mains. The Contractor shall coordinate tie-ins with the Owning Authority to minimize down time.

Connections shall be made using suitable fittings from the conditions encountered. Each connection with an existing pipe shall be made at a time and under conditions which will minimize any disruption in service. Special care shall be taken to prevent contamination when dewatering, cutting into, and making connections with existing pipe. The interior of all pipe, fittings, and valves installed in such connections shall be thoroughly cleaned and swabbed with, or dipped in chlorine solution having a chorine content of 200 parts per million (ppm).

2903.5 Polyethylene Encasements

A. General: Polyethylene encasement shall be installed on ductile-iron pipe and fittings. The polyethylene shall prevent contact between the pipe, fittings, and the surround embedment.

B. Installation: The polyethylene encasement shall be installed as specified in ANSI/AWWA C105/A21.5 "Method A".

1. Method A: Polyethylene tubing shall be approximately 2-feet longer than the length of the pipe section to provide a 1-foot overlap on each adjacent pipe section. Tube ends need not be taped in place unless directed by the Engineer.

2. Repairs: Any rips, punctures, or other damages to the polyethylene shall be repaired with adhesive tape or with a short length of polyethylene tube cut open, wrapped around the pipe, and secured with adhesive tape as directed by the Engineer. Duct tape is not allowed.

2903.6 Setting Valves, Fittings and Hydrants

A. Valves and Fittings: All valves, fittings, plugs and caps shall be set and joined to the pipe in the manner heretofore specified for cleaning, laying and joining pipe, except that large valves may require special support so that the pipe will not be required to support the valve weight.

Each valve shall be inspected before installation to ensure that all foreign substances have been removed from within the valve body, and shall be opened and closed to see that all parts are in first-class working condition. Gate valves shall be set vertical in the horizontal pipeline.

Valves and pipe shall be supported in such a manner as to prevent stress in either with no deflection in the valve/pipe joint. Valve boxes and lids shall be installed at each valve and shall be supported and maintained centered and plumb over the operating nut of the valve. The valve box shaft shall not transmit shock or stress to the valve. Install valve box covers flush with the surface of the finished area or as directed by the Engineer.

All bends and tees shall be provided with thrust blocks of plain concrete, as specified. All dead ends on new mains shall be closed with plugs or caps suitably restrained to prevent blowing off under test pressure.

B. Hydrants: All new hydrant installations shall be as shown on the Plans or Standard Drawings and shall include all necessary excavation and backfill to make the installation complete.

Each hydrant shall be inspected before installation for direction of opening, nozzle size and threading, nozzle caps and chains, operating nut, and cap nut dimensions, tightness of pressure-containing bolting,

cleanliness of inlet elbow and weep hole openings, and handling damage and cracks. Defective hydrants shall be corrected or replaced.

All hydrants shall stand plumb. The weep holes of the hydrant shall be kept clear and free to drain. The areas around each hydrant and hydrant valve shall be thoroughly compacted to prevent settlement of these areas.

Hydrants shall be set to a grade that allows their proper operation. Traffic hydrants with breakaway joint must be set with the joint above the ground line. Hydrants behind curbs shall be placed with the hydrant centerline at least 24-inches from the back of curb or 4-feet from the edge of pavement when there is no curb. Hydrants shall be rotated so as to have the pumper nozzle facing the street or rotated to face any direction as required by the Engineer.

2903.7 Thrust Restraint

A. Hydrants: The back of the base elbow of each hydrant shall be braced against a sufficient area of unexcavated earth or rock with a concrete thrust block or be restrained by suitable restrained joints as shown on the Plans or Standard Drawings.

B. Fittings: All plugs, caps, tees, bends and other fittings, unless otherwise specified, shall be provided with reaction blocking or suitably restrained joints as shown on the Plans or Standard Drawings.

C. Thrust Blocks: Vertical and horizontal reaction blocking shall be concrete as specified herein. Thrust blocks shall be installed between solid ground and the fitting to be restrained. Concrete shall be located to contain the resultant thrust force and permit access to pipe and fitting joints for repairs.

D. Restrained Joints: Restrained push-on or mechanical joints, mechanical joint anchoring fittings, and mechanical joints utilizing set screw ductile-iron retainer glands may be used in lieu of concrete thrust blocking if so indicated on the Plans, Standard Drawings or as approved by the Engineer.

2903.8 Embedment and Backfilling

Embedment and backfill shall be accomplished in accordance with the laying condition as specified and as shown on the Plans or Standard Drawings.

A. Pipe Embedment: Embedment for pipe shall be in accordance with these specifications and details of the laying condition as indicated on the Plans or Standard Drawings. See Section 2100 “Clearing and Site Preparation”.

B. Trench Backfill: Backfill for the entire length of the pipeline shall be compacted full depth of the trench above the embedment. See Section 2100 “Clearing and Site Preparation”.

C. Placement and Compaction: See Section 2100 “Clearing and Site Preparation”.

2903.9 Disinfection and Testing

A. Disinfection: After installation, the entire main shall be flushed and disinfected by chlorination. Flushing shall be carried out until turbidity-free water is obtained from all points along the main at the maximum velocity, which can be developed. The flushing velocity shall be at least 2.5 feet per second. All flushing shall be done in the presence of the Engineer. The Contractor shall notify the Engineer at least 24 hours in advance of the times and places which flushing is to be done.

The Contractor shall disinfect the main or prepare the main for disinfection by the Owning Authority when so noted in the Plans, Standard Drawings, or Special Provisions.

1. Chlorination by the Contractor shall conform to AWWA C651 and be performed using a one percent (1%) chlorine solution prepared from granular calcium hypochlorite (1 pound of HTH per 8 gallons of water). Water entering the new main shall receive a dose of the chlorine solution fed at a constant rate such that the water will have not less than 60 mg/l free chlorine.

Chlorine Required to Produce 60 mg/l Concentration in 100-feet of Pipe

Pipe Diameter (Inches)	1% Chlorine Solution (Gallons)
4	0.16
6	0.36
8	0.65
10	1.02
12	1.44

2. The chlorinated water shall be retained in the main for at least 24 hours, during which time all valves and hydrants in the section treated shall be operated in order to disinfect the appurtenances.

3. At the end of the 24-hour period, the treated water in all portions of the main shall have a residual of not less than 45 mg/l free chlorine.

4. The Contractor shall dechlorinate the test water to 0 mg/L. Mains shall be flushed prior to placing in service. The flushing water shall be disposed of without damage to public or private property.

5. The contractor shall repeat disinfection procedure should initial treatment fail to yield satisfactory results of a passing Bac-T test or minimum residual at no cost to the Owner.

B. Hydrostatic Testing: The Contractor shall perform hydrostatic pressure and leakage tests in accordance with AWWA C600 procedures. Where practicable, mains shall be tested in lengths between line valves or plugs of no more than 1,000 feet in length.

Conduct test at a pressure of 150 psi measured at the highest point of the main. Duration of the test shall be not less than 2 hours. Maintain pressure throughout test +5 psi of test pressure.

Leakage test shall be conducted concurrently with the pressure test. Acceptable when leakage does not exceed that determined by the following formula:

$L = 0.0000075SD(P)^{1/2}$, in which
L = maximum allowable leakage in gallons per hour
S = length of pipe tested in feet
D = nominal internal diameter of pipe being tested in inches
P = average actual leakage test pressure in psi (pounds per square inch)

When testing against closed metal-seated valves, an additional leakage per closed valve of 0.0078 gal/hr/in of nominal valve size shall be allowed. When hydrants are in the test section, the test shall be made against the closed hydrant. All visible leaks at exposed joints and all leaks evident on the surface where joints are covered shall be repaired regardless of total leakage as shown by test. All pipes, fittings, valves and other materials found to be defective under test shall be removed and replaced at the Contractor's expense.

Lines which fail to meet test shall be repaired and retested as necessary until the test requirements are met.

2903.10 Surface Restoration

A. Seeding and Sodding: All unpaved areas cut by the line of trench or excavation or damaged during the work shall be seeded or sodded. Seeding and sodding shall conform to the requirements of Section 2400.

B. Sidewalks and Driveways: All paved sidewalk and driveway areas cut by the line of trench or excavation or damaged during the work shall be replaced. Sidewalk and driveway replacement shall conform to the requirements of Section 2301 and Section 2302.

C. Streets and Curbing: All paved street, shoulder and curbing areas cut by the line of trench or excavation or damaged during the work shall be replaced to conform to the lines and grades of the original pavement and shall be of equal quality, thickness and appearance to that removed.

Paving and curb replacement shall conform to the requirements of Section 2200.

SECTION 2904 WATER MAINS NEAR SEWERS

2904.1 Horizontal Separation

Water mains shall be laid at least 10-feet horizontally from any sewer. When local conditions prevent a lateral separation of 10-feet, a water main may be laid closer than 10-feet to a sewer, provided that the water main is laid in a separate trench, or on an undisturbed earth shelf located on one side of the sewer at such an elevation that the bottom of the water main is at least 18-inches above the top of the sewer. When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer must be reconstructed of ductile-iron pipe and should be pressure tested to assure water tightness before backfilling. The required length of sewer to be replaced will be the length necessary to achieve 10-feet horizontal separation.

2904.2 Vertical Separation

A. Whenever water mains must cross above sewers, the water main shall be laid at such an elevation that the bottom of the water main is 18-inches above the top of the sewer. A full length of water main pipe shall be centered over the sewer line to be crossed so that the joints will be equally distant from the sewer and as far away as possible. This vertical separation shall be maintained for that portion of the water main located within 10-feet, horizontally, or any sewer it crosses.

When it is impossible to obtain minimum vertical separation set forth above, the sewer must be reconstructed of ductile iron pipe and shall be pressure tested to assure water tightness before backfilling.

B. Where a water main must cross under a sewer, a vertical separation of 18-inches between the bottom of the sewer and the top of the water main shall be maintained, with adequate support, especially for the larger sized sewer lines to prevent them from settling on and breaking the water main. The sewer shall be reconstructed of ductile-iron pipe for a distance of 10-feet on either side of the crossing, and shall be pressure tested to assure water tightness before backfilling.

2904.3 Sewer Manholes and Inlets

No water pipe shall pass through, or come in contact with, any part of a sewer or a sewer manhole.

SECTION 2905 MEASUREMENT AND PAYMENTS

2905.1 Methods of Measurement

The quantities of completed work will be measured in the following units:

A. Water Main - Pipe

1. Open Trenched: Measurement of various size and types of water mains including fittings or bends, will be in linear feet, as called for in the Contract Documents and/or as shown on the Plans, based on field-measured lengths of acceptably installed pipe, as measured along the centerline thereof. Retainer glands, thrust blocks, encasement, location wire and tape, and other subsidiary items to the pipe will not be measured separately.

2. Tunneled, Bored or Jacked: Measurement will be made in linear feet for the applicable size, and type of water main, tunneled, bored or jacked as called for in the Contract Documents and/or as shown on the Plans, based on actual field-measured lengths of acceptably installed pipe within casing or tunnel liner, including sand fill, end seals and other subsidiary items.

B. Valves and Valve Boxes: Measurement will be made for the applicable size and type of valve, including valve boxes, bases, lids and covers, as determined by the quantity of valves installed.

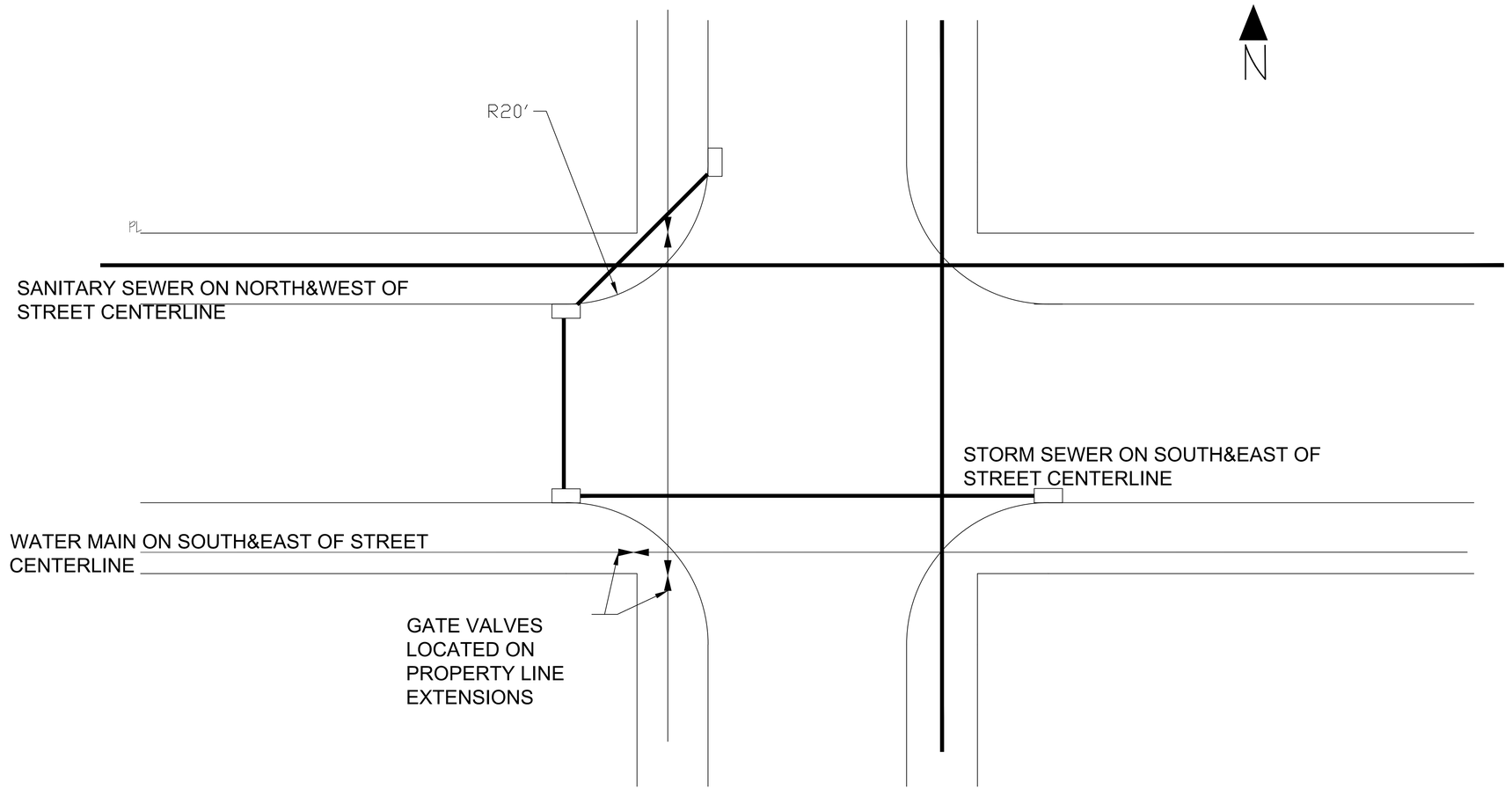
C. Fire Hydrants: Measurement will be made based on the actual number of hydrants installed as called for on the Plans or as directed by the Engineer. No measurement for payment will be made for branch piping, fittings, couplings, thrust blocks or other appurtenant items except valves and valve boxes.

D. Specials (Meter Vaults, Air Valves, Pressure-Relief Valves, etc.): Measurement for these type items will be made based on the actual number of units installed, as called for on the Plans or as directed by the Engineer.

2905.2 Basis of Payment

Payment will be made at the respective unit or lump-sum price listed in the Contract Documents and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the Contract Documents, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the Contract Documents. .At the Engineer's option, partial payment may be made for any lump sum item listed in the Contract Documents, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION



ENGINEERING
1300 BROADWAY ST.
OAK GROVE MO. 64075
(816)690-3773
FAX (816)690-8478

DRAWN	DATE
CHECKED	
APPROVED	

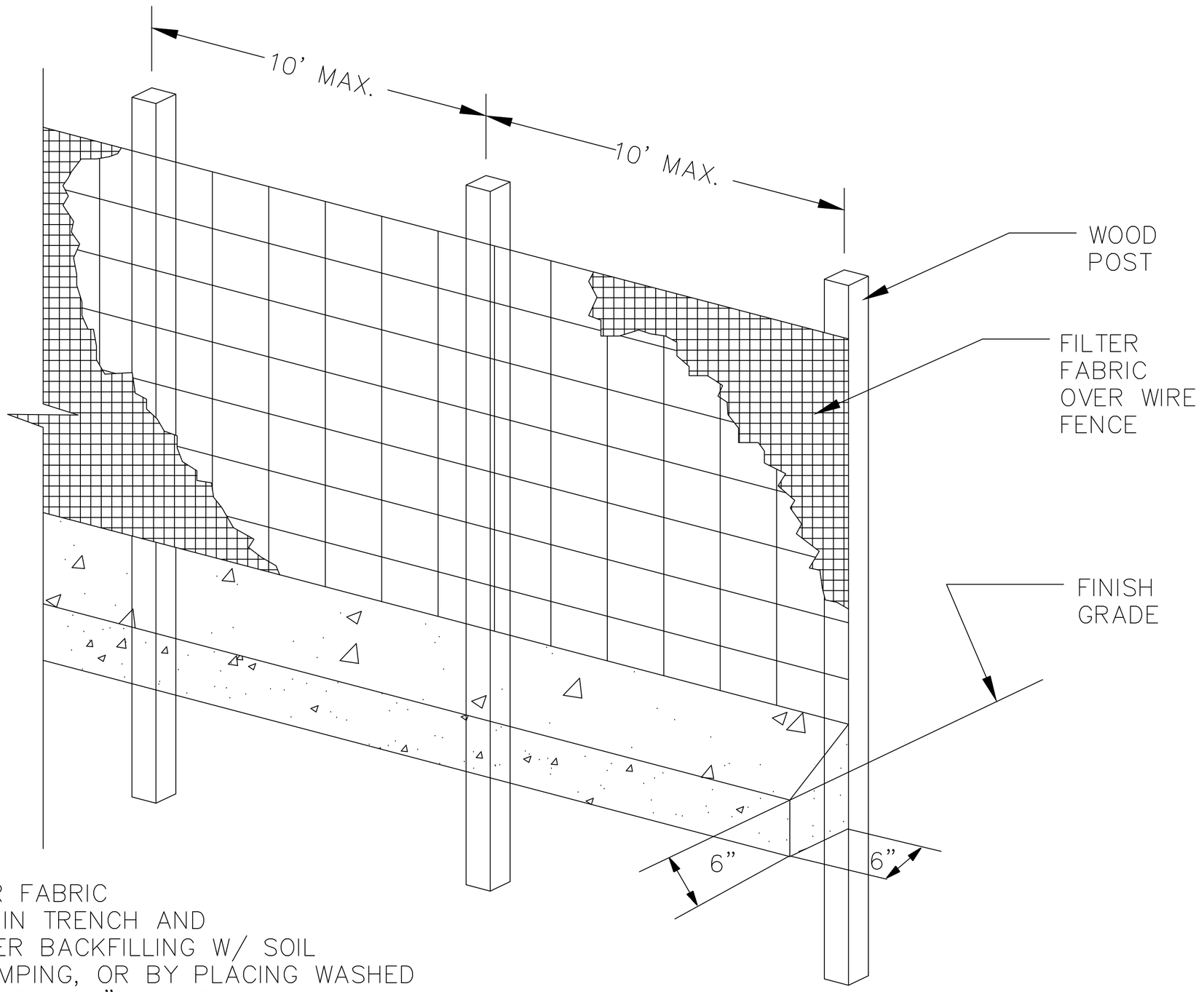
CITY OF OAK GROVE

STANDARD UTILITY LOCATIONS

SIZE	FSCM NO.	DWG NO.	REV
A		SD-1	

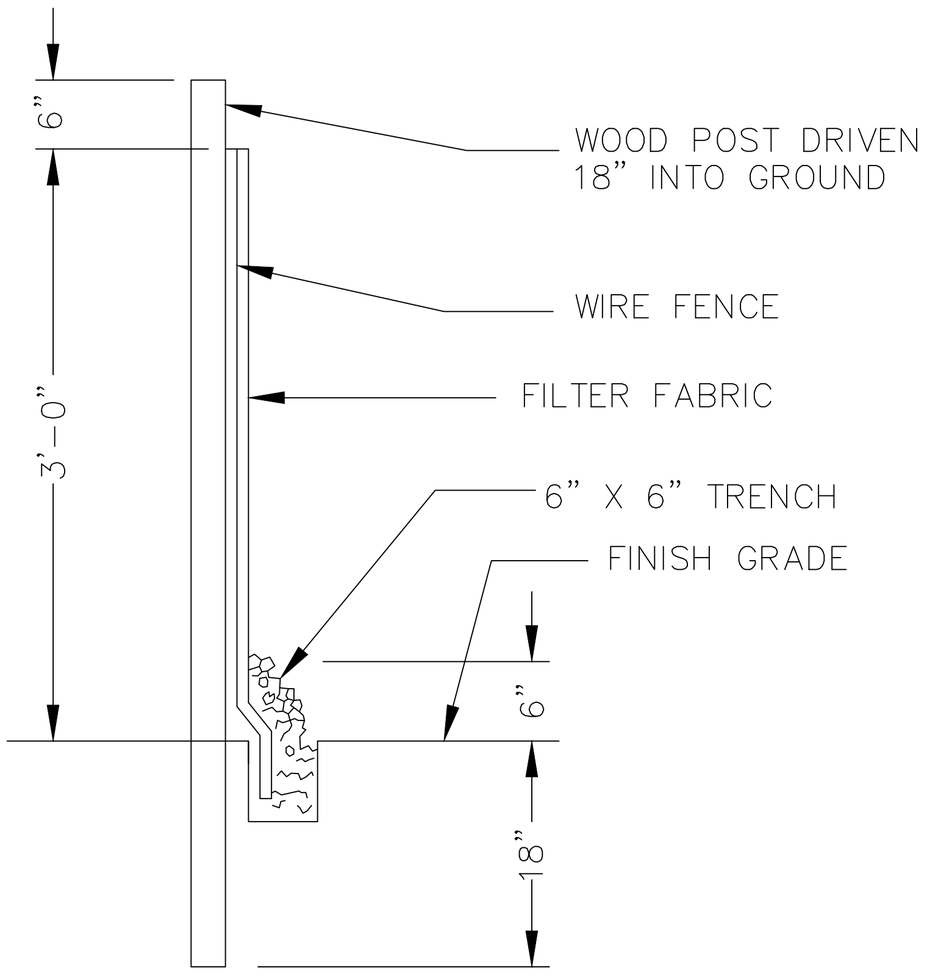
SCALE NONE

SHEET 1 OF 1



NOTE:
BOTTOM OF FILTER FABRIC MUST BE PLACED IN TRENCH AND SECURED BY EITHER BACKFILLING W/ SOIL MATERIAL AND TAMPING, OR BY PLACING WASHED STONE TO A HEIGHT OF 6" ABOVE GROUND LEVEL.

ELEVATION



NOTE:
BOTTOM OF WIRE FENCE & FILTER FABRIC ARE TO BE BURIED IN A 6" X 6" EXCAVATED TRENCH.

CROSS-SECTION

SEDIMENT FENCE

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(816)690-3773
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DRAWN	DATE
CHECKED	
APPROVED	

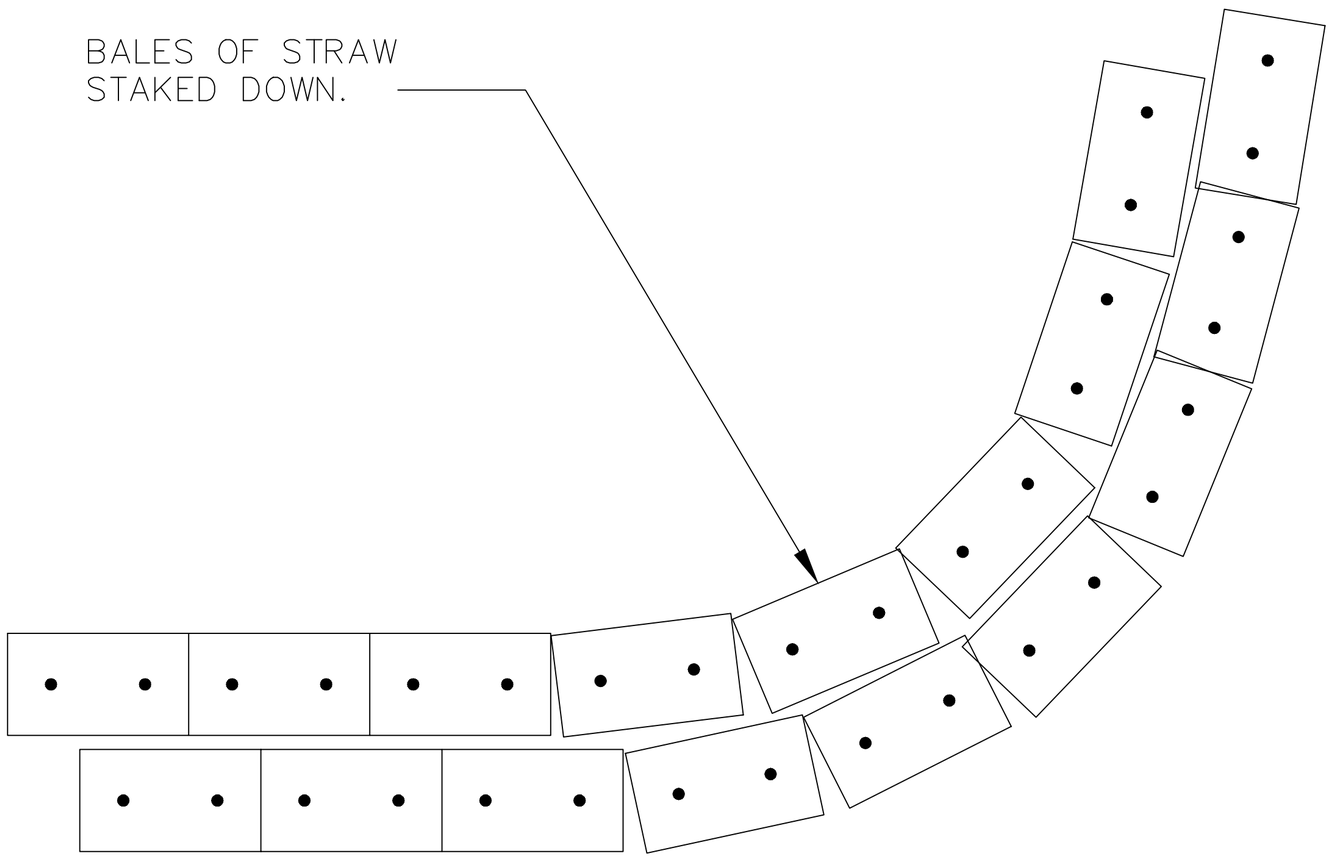
CITY OF OAK GROVE

SEDIMENT FENCE

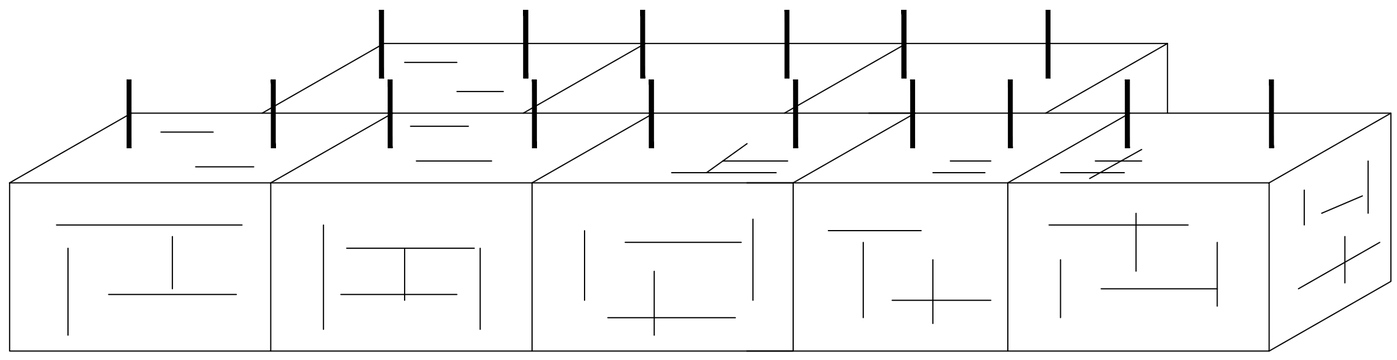
SIZE	FSCM NO.	DWG NO.	REV
A		SD-2	

SCALE NONE

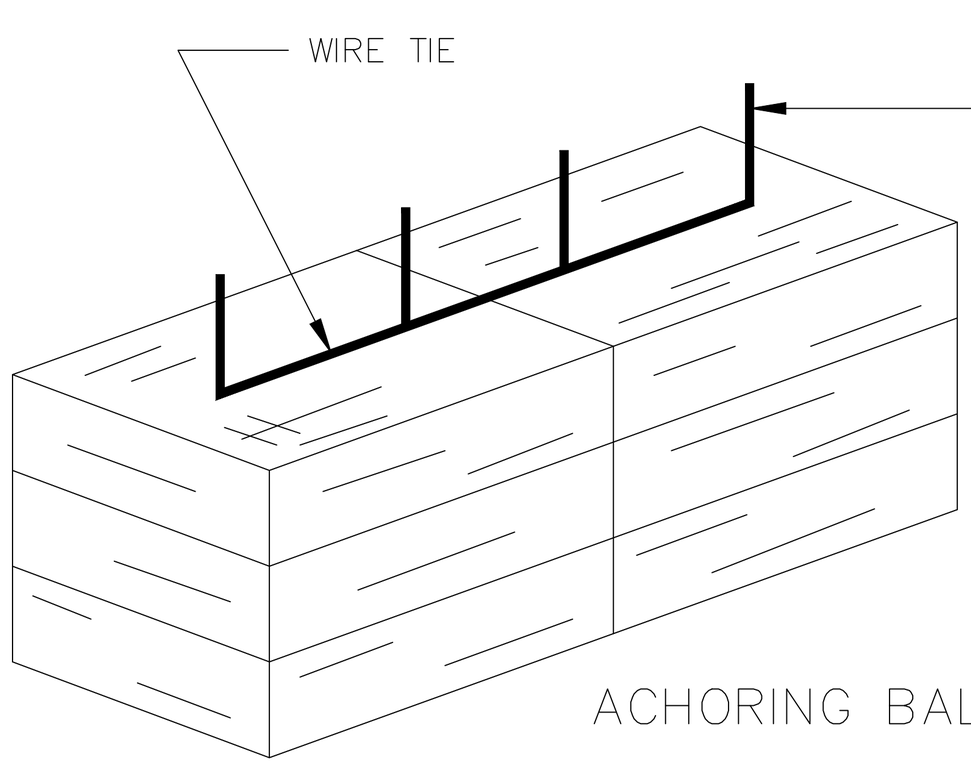
SHEET 1 OF 1



DOUBLE ROW OF BALES OF STRAW TO BE PLACED PRIOR TO THE START OF ROUGH GRADING. BALES ARE TO BE PLACED AS CLOSELY TOGETHER AS POSSIBLE IN ORDER TO PROVIDE MAXIMUM PROTECTION.



FRONT VIEW



ACHORING BALES

NOTE:
WIRE OR NYLON BOUND BALES ARE REQUIRED FOR DURABILITY.

STRAW BALE BARRIER

ENGINEERING
1300 BROADWAY ST.
OAK GROVE MO. 64075
(816)690–3773
FAX (816)690–8478

DRAWN | DATE

CHECKED

APPROVED

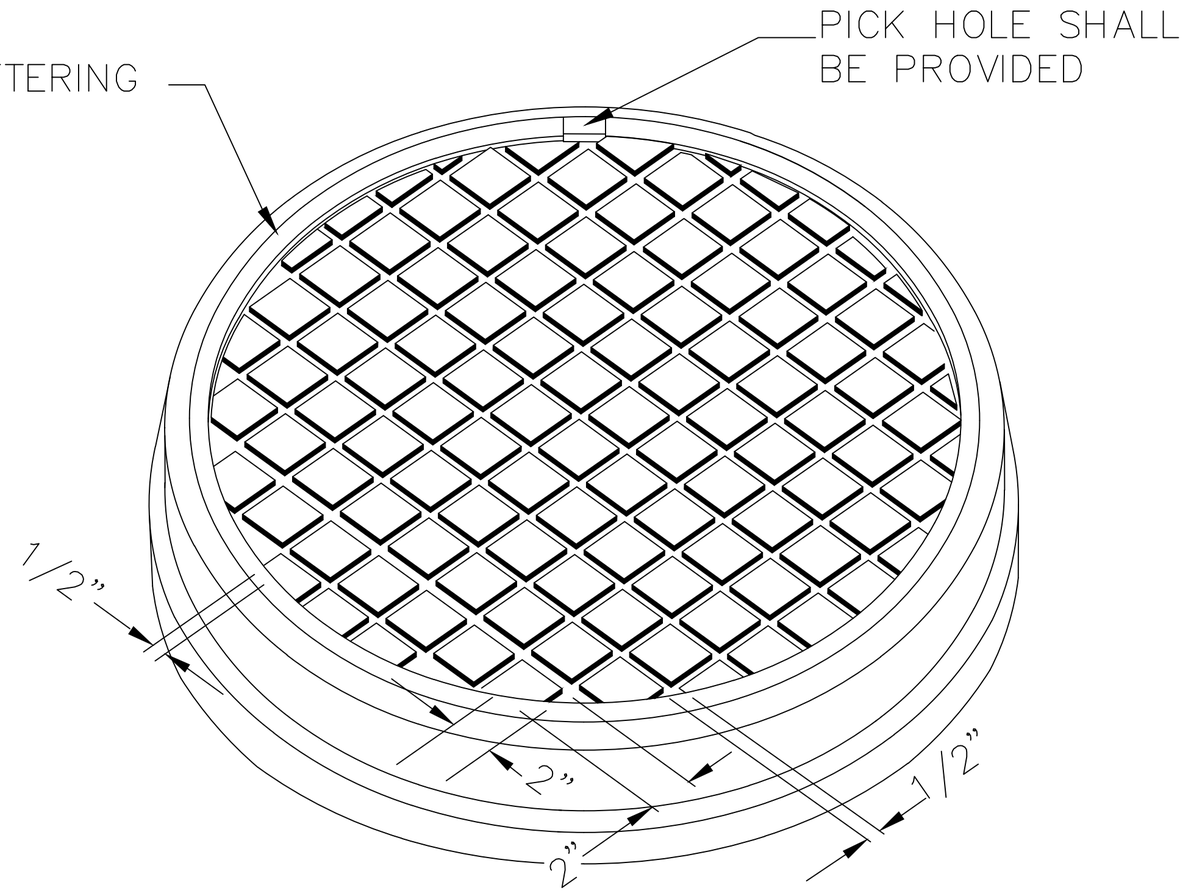
CITY OF OAK GROVE

STRAW BALE BARRIER

SIZE	FSCM NO.	DWG NO.	REV
A		SD–3	

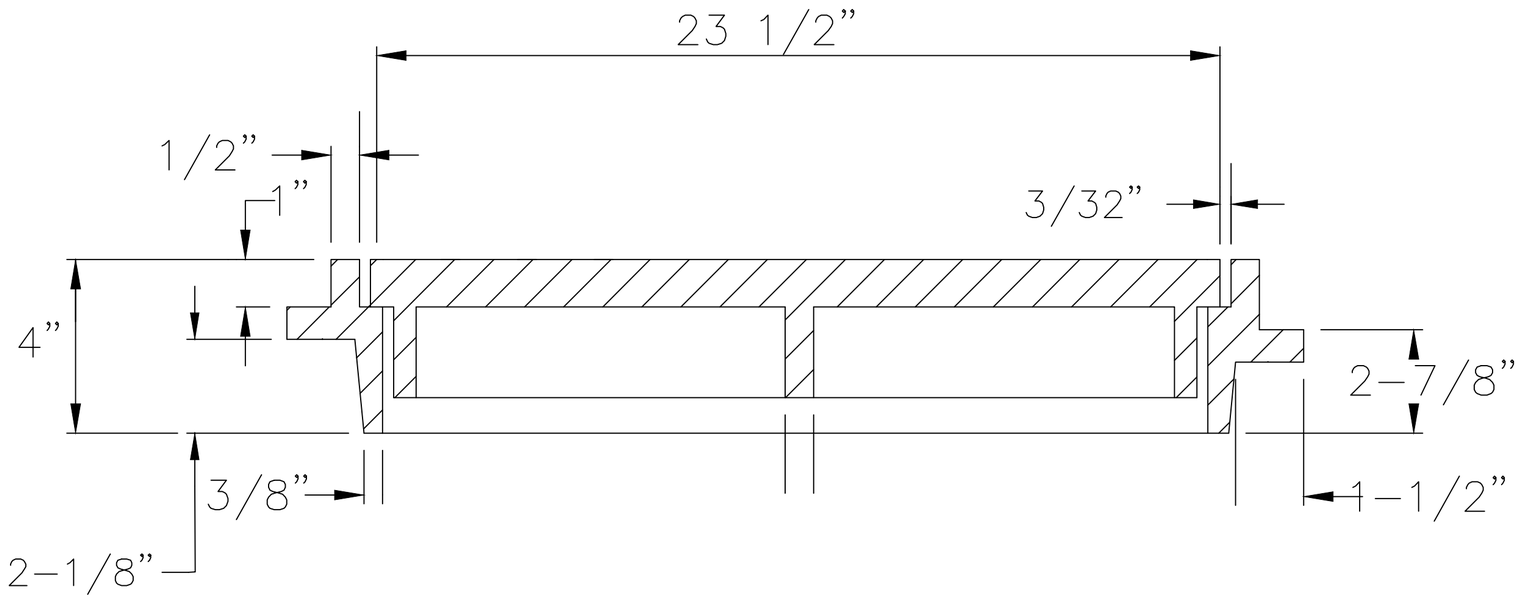
SCALE NONE

SHEET 1 OF 1



NOTE:

1. MATERIAL TO MEET SPECIFICATIONS FOR GRAY IRON CASTINGS ASTM DESIGNATION A–48, CLASS 35B AS A MINIMUM REQUIREMENT.
2. SURFACES BETWEEN RING AND COVER SHALL BE MACHINED TO PROVIDE A TRUE PLANE AROUND THE ENTIRE BEARING AREA OF THE COVER.
3. RING AND COVER SHALL BE PAINTED WITH A MINIMUM OF ONE COAT ASPHALT BASE PAINT.
4. DEETER #1332 OR CLAY&BAILY #2002



NOTE:
COVER AND RING WEIGHT SHALL MEET HS 20 TRAFFIC LOADING.

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(816)690–3773
FAX (816)690–8478

DRAWN | DATE

CHECKED

APPROVED

CITY OF OAK GROVE

MANHOLE
CURB INLET RING & COVER

SIZE	FSCM NO.	DWG NO.	REV
A		SD–4	

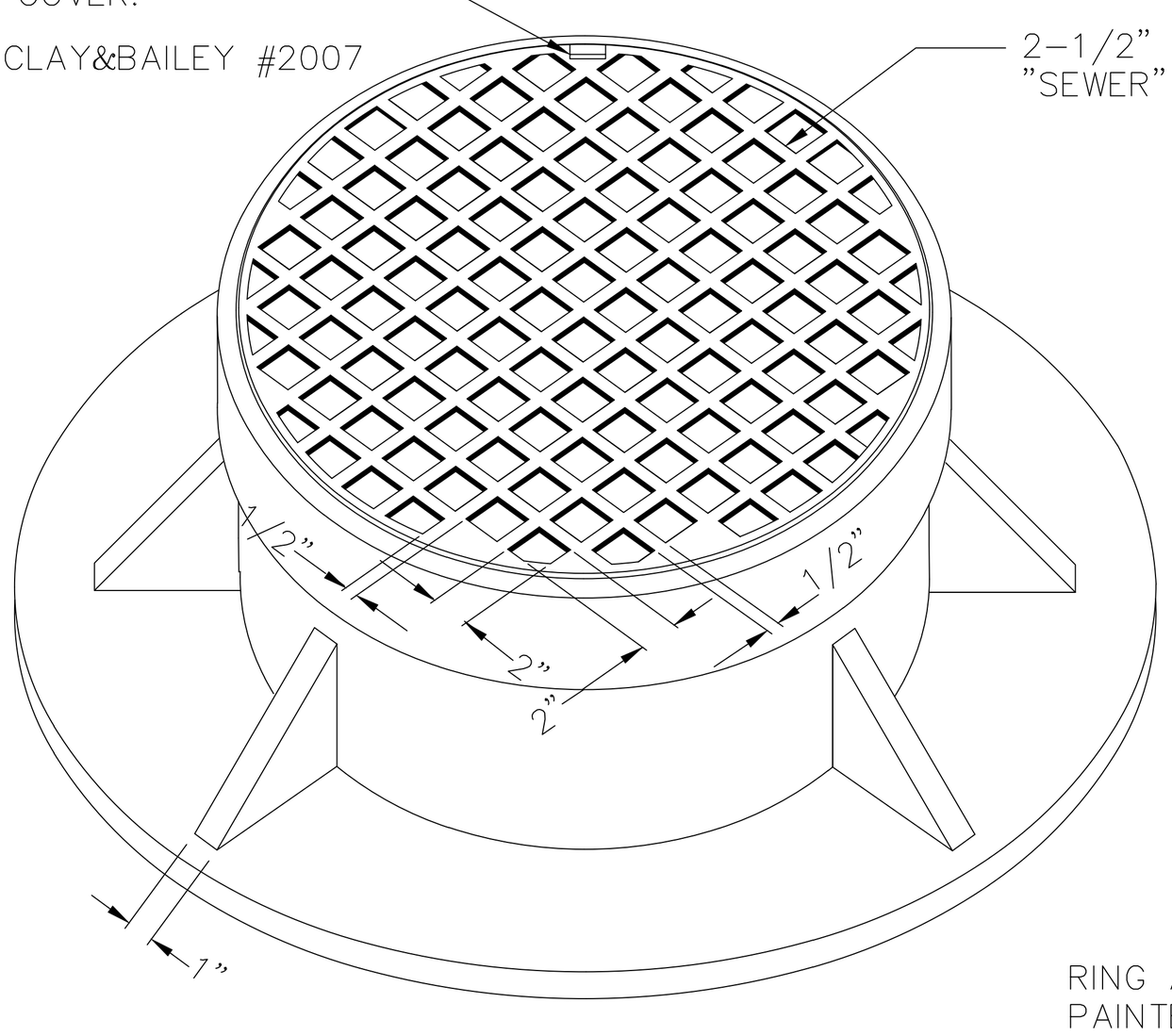
SCALE NONE

SHEET 1 OF 1

PICK HOLES SHALL BE PROVIDED IN EACH COVER.

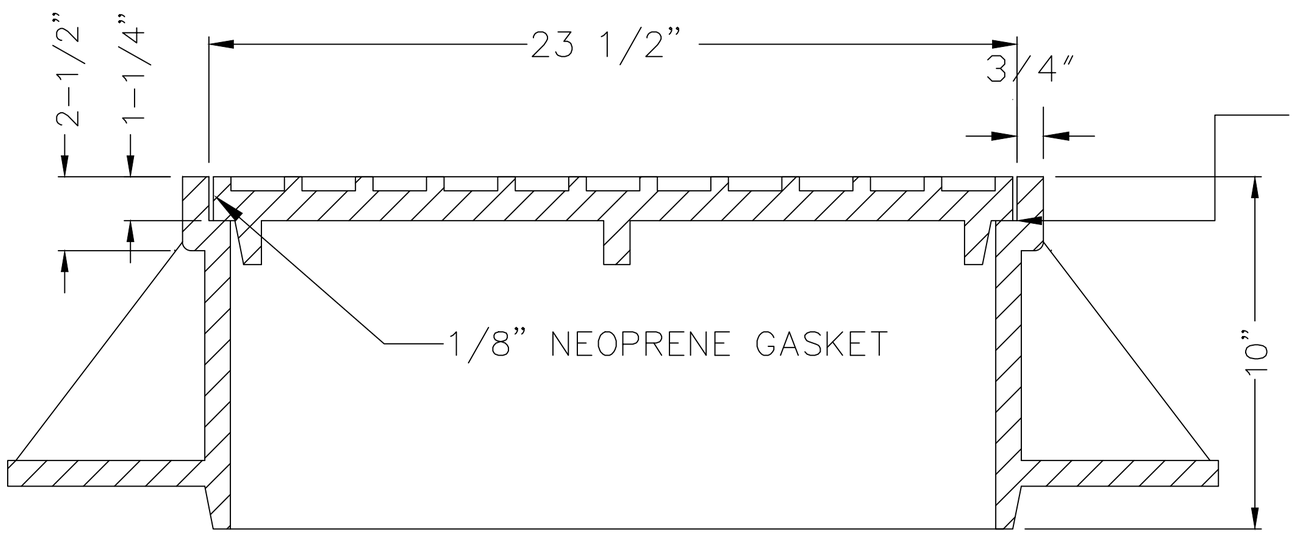
DEETER#1315 OR CLAY&BAILEY #2007

2-1/2" BLOCK LETTERING "SEWER"



MATERIAL TO MEET SPECIFICATIONS FOR GRAY IRON CASTINGS ASTM DESIGNATION A-48, CLASS 35B AS A MINIMUM REQUIREMENT.

RING AND COVER SHALL BE PAINTED WITH A MINIMUM OF ONE COAT OF ASPHALT BASE PAINT.



SURFACES BETWEEN RING AND COVER SHALL BE MACHINED TO PROVIDE A TRUE PLANE AROUND THE ENTIRE BEARING AREA OF THE COVER.

NOTE:
COVER AND RING WEIGHT SHALL MEET HS 20 TRAFFIC LOADING.

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OAK GROVE MO. 64075
(816)690-3773
FAX (816)690-8478

CITY OF OAK GROVE

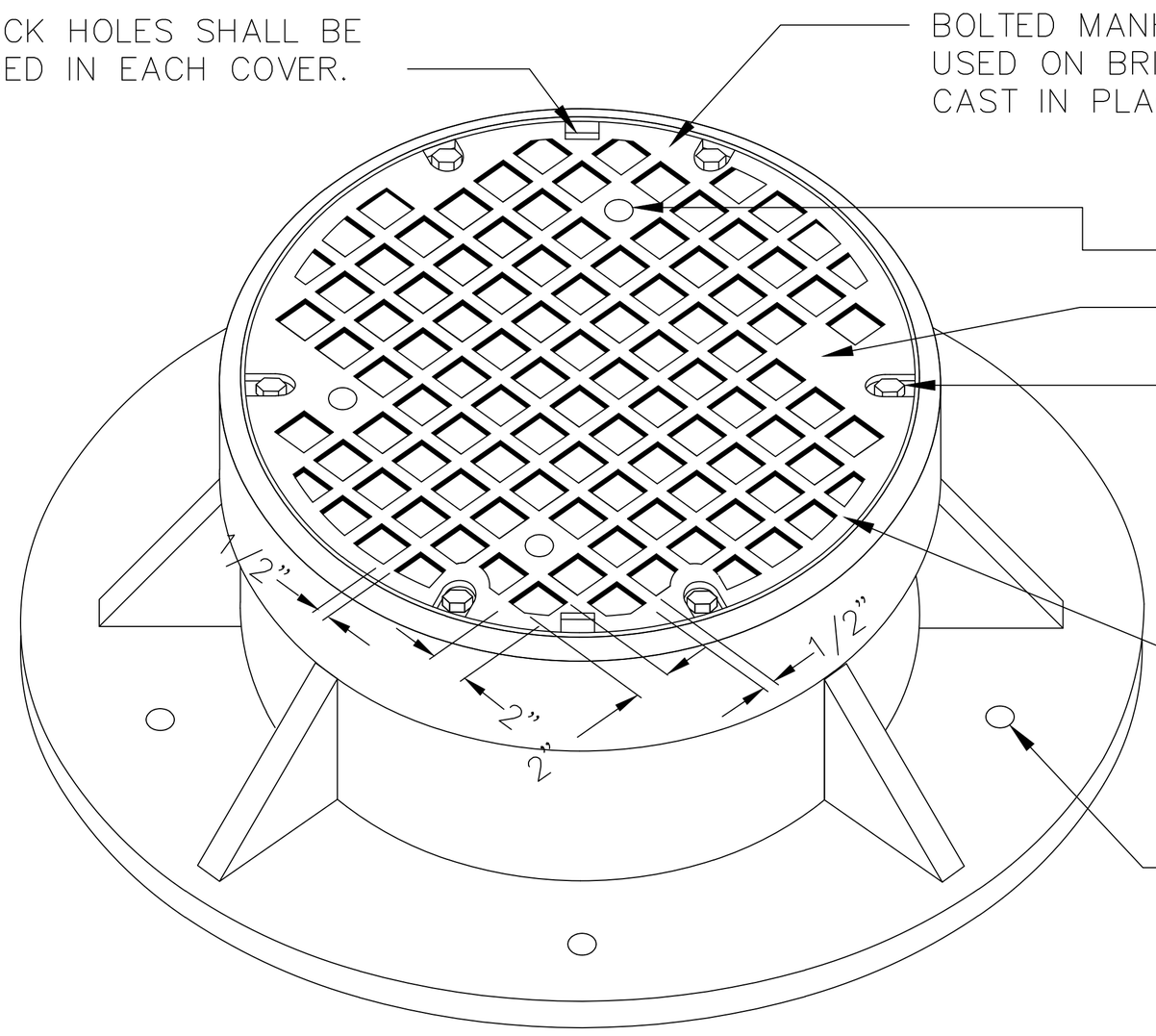
MANHOLE RING & COVER (CASTING)

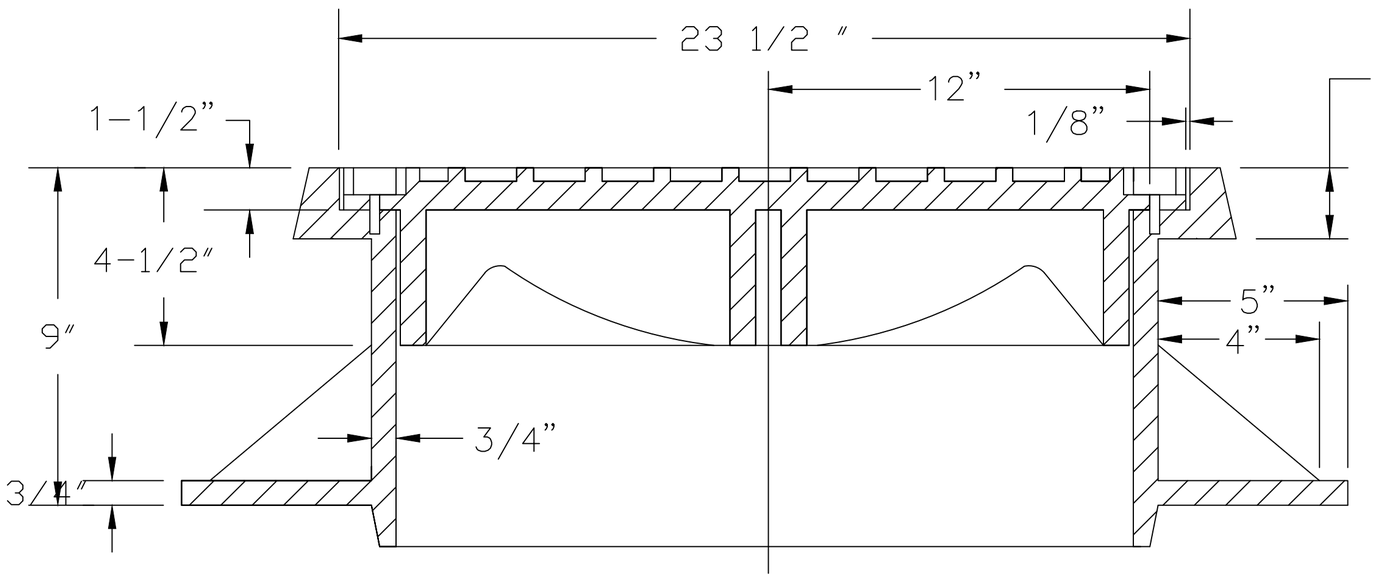
DRAWN	DATE
CHECKED	
APPROVED	

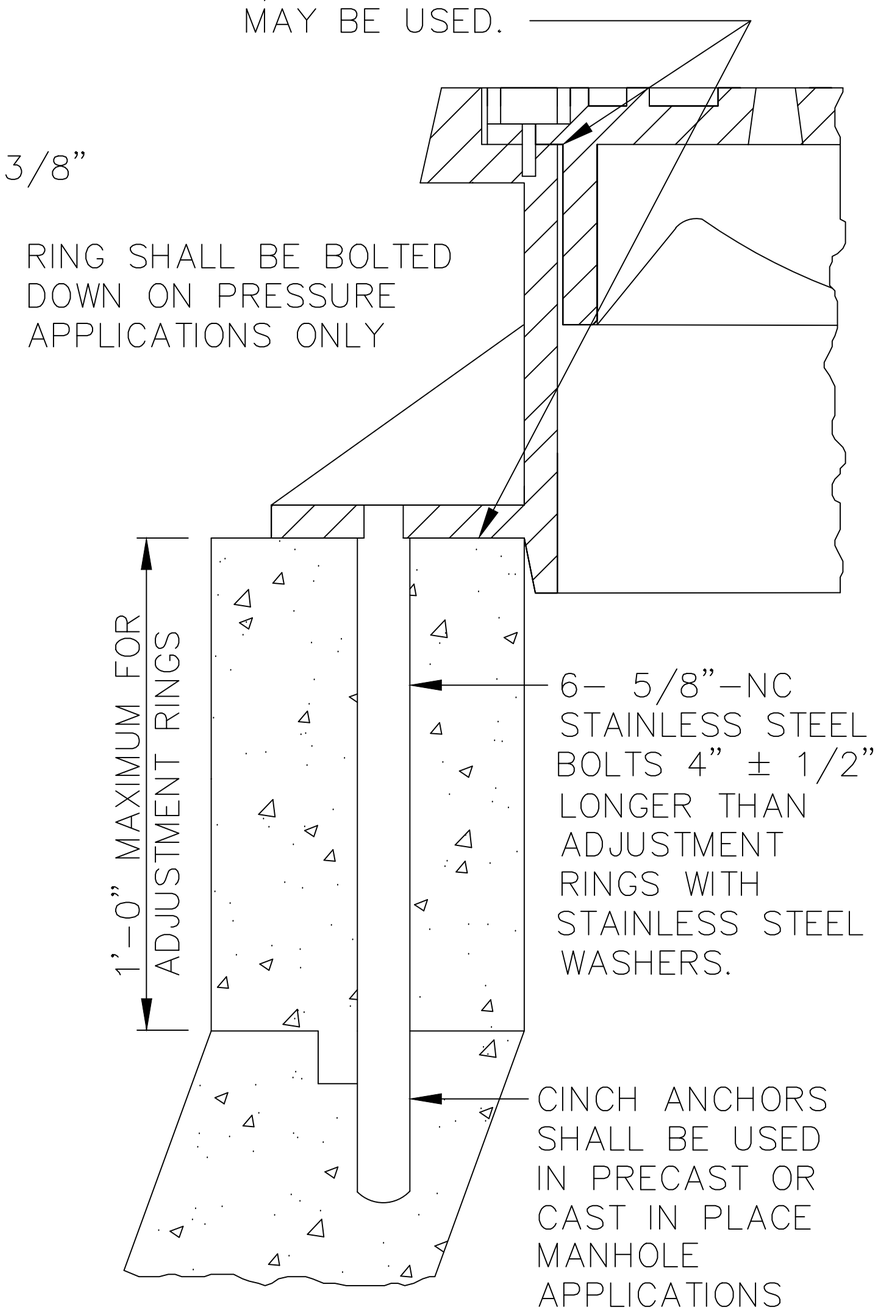
SIZE	FSCM NO.	DWG NO.	REV
A		SD-5	

SCALE NONE

SHEET 1 OF 1







NOTES:

1. VENTED COVER SHALL HAVE FOUR VENT HOLES AS INDICATED.
2. FOR PRESSURE APPLICATIONS CONSULT THE ENGINEER.
3. MATERIAL TO MEET SPECIFICATIONS FOR GREY IRON CASTINGS ASTM DESIGNATION A-48, CLASS 25 AS A MINIMUM REQUIREMENT. DESIGNATION A-48, CLASS 25 AS A
4. SURFACES BETWEEN RING AND COVER SHALL BE MACHINED TO PROVIDE A TRUE PLANE AROUND THE ENTIRE BEARING AREA OF THE COVER.
5. RING AND COVER SHALL BE PAINTED WITH AN ASPHALT BASE PAINT.
6. RING AND COVER WEIGHT SHALL MEET HS 20 TRAFFIC LOADING CLAY & BAILEY #2014, NEENAH R-1916E OR APPROVED EQUAL

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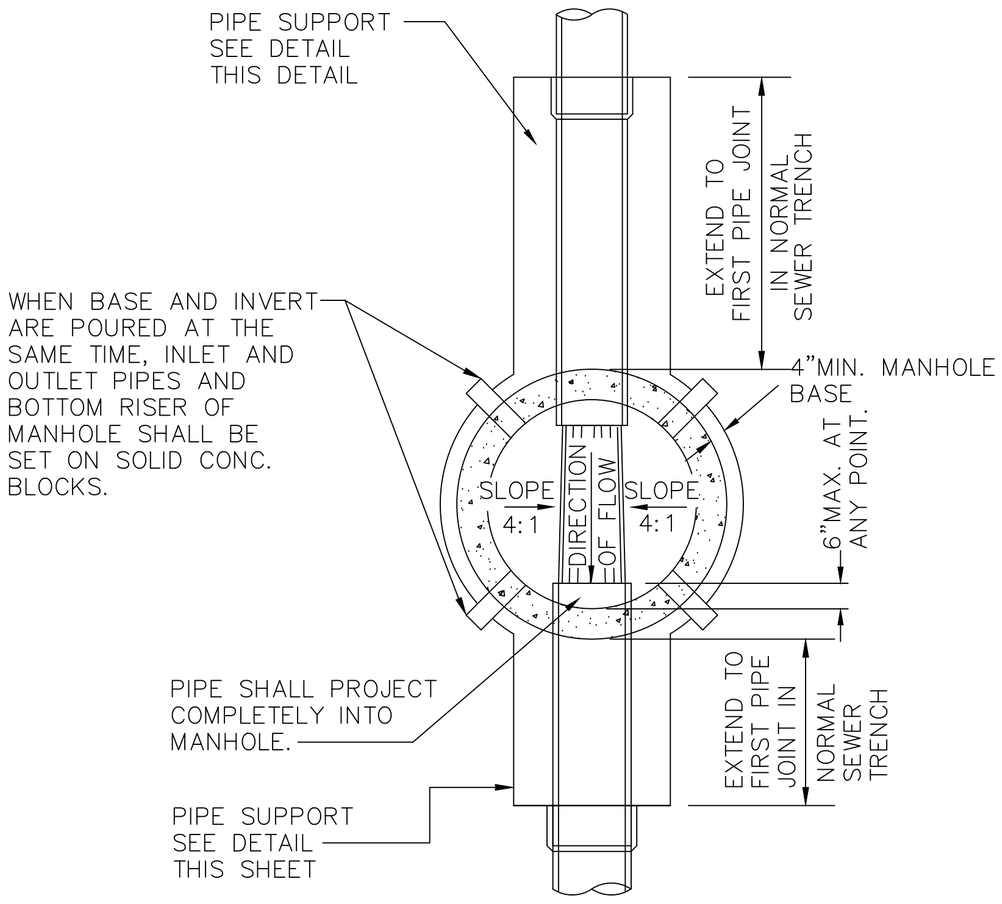
CITY OF OAK GROVE

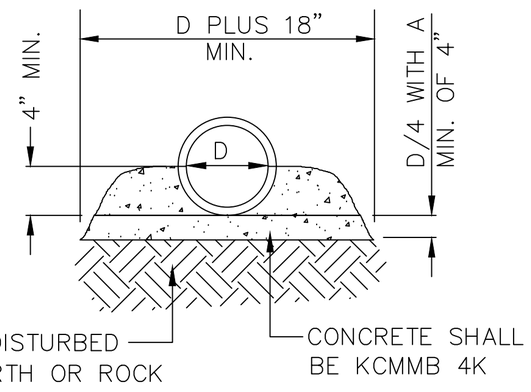
BOLTED MANHOLE RING & COVER SOLID & VENTED

SIZE	FSCM NO.	DWG NO.	REV
A		SD-6	

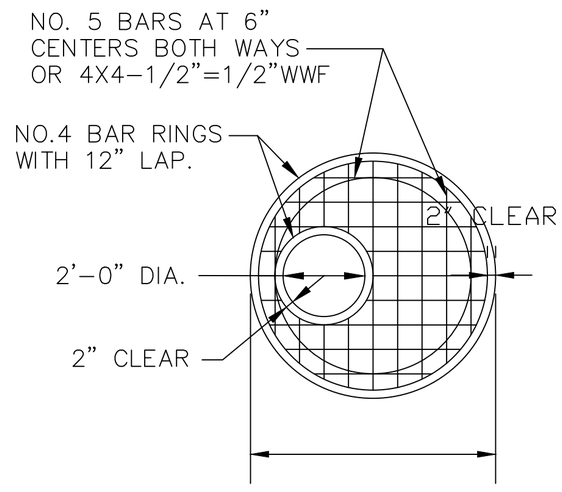
SCALE NONE

SHEET 1 OF 1

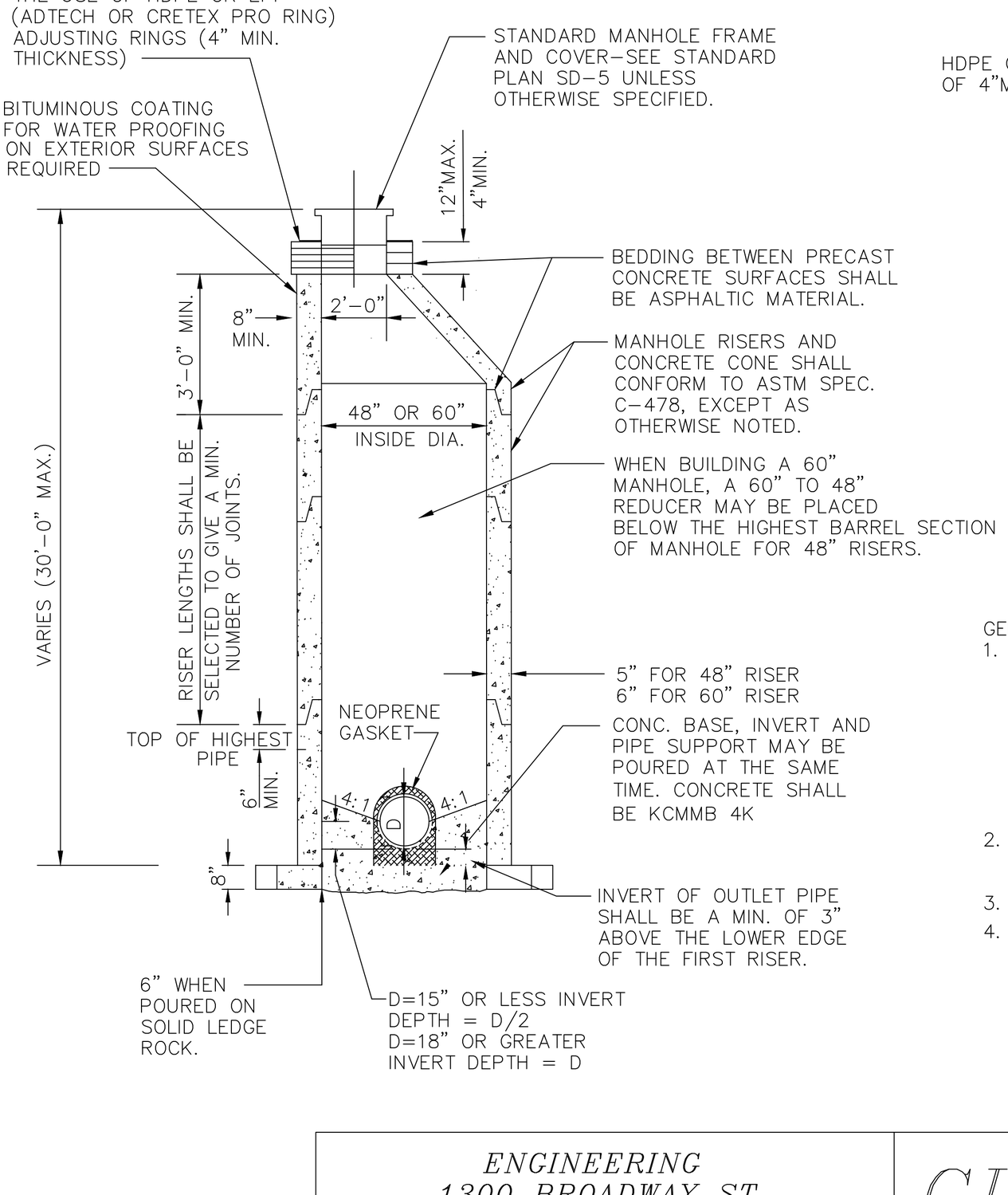


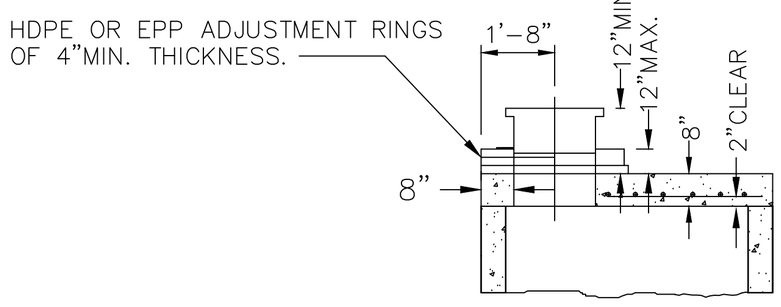


PIPE SUPPORT DETAIL



REINFORCING DETAIL
OF COVER SLAB





SLAB TOP ALTERNATE AND
SHALLOW MANHOLE DETAIL

GENERAL NOTES:

1. Clearance tolerance of pipe openings.
   The maximum allowable pipe opening on a horizontal axis shall be the outside diameter of the pipe plus 12".
   The maximum allowable pipe opening on a vertical axis shall be the outside diameter plus 8".
   The minimum clearance between the outside surface of an installed pipe and the concrete of the manhole shall be 2".
   The maximum openings allowable for the drop manhole entry in the barrel shall be the outside diameter of the pipe plus 12".
2. Installation of pipe openings.
   All required pipe openings shall be plant cast in manhole units. Field alterations of openings will be permitted only with Engineer's approval.
3. Minimum distance between any two adjacent pipes shall be 4".
4. Joint Wrap or Chimney Seal Material around each joint.

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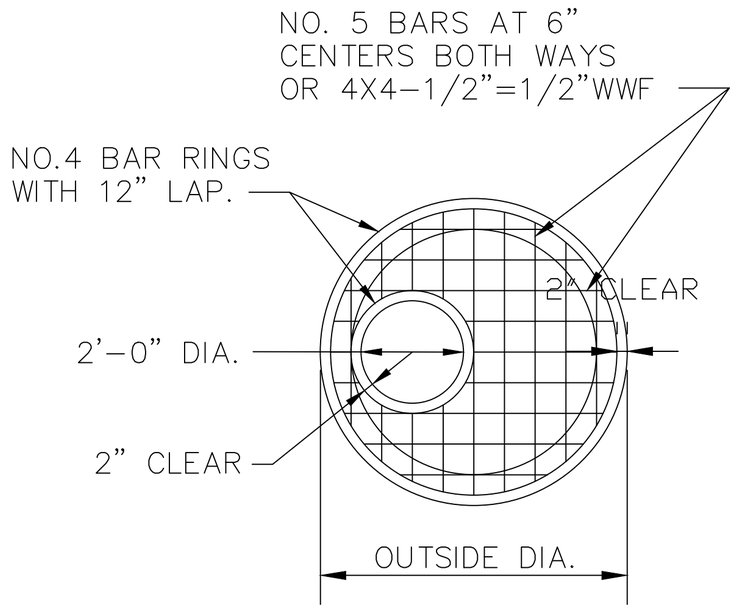
MANHOLE- PRECAST CONCRETE 4'-0" OR 5'-0" DIA

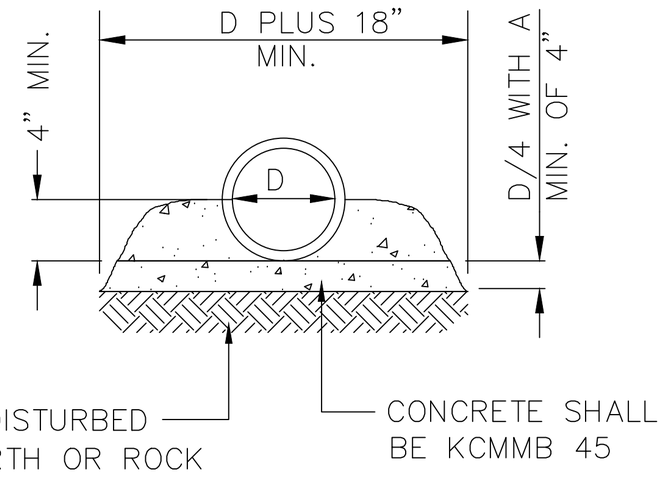
SIZE	FSCM NO.	DWG NO.	REV
A		SD-7	

SCALE NONE

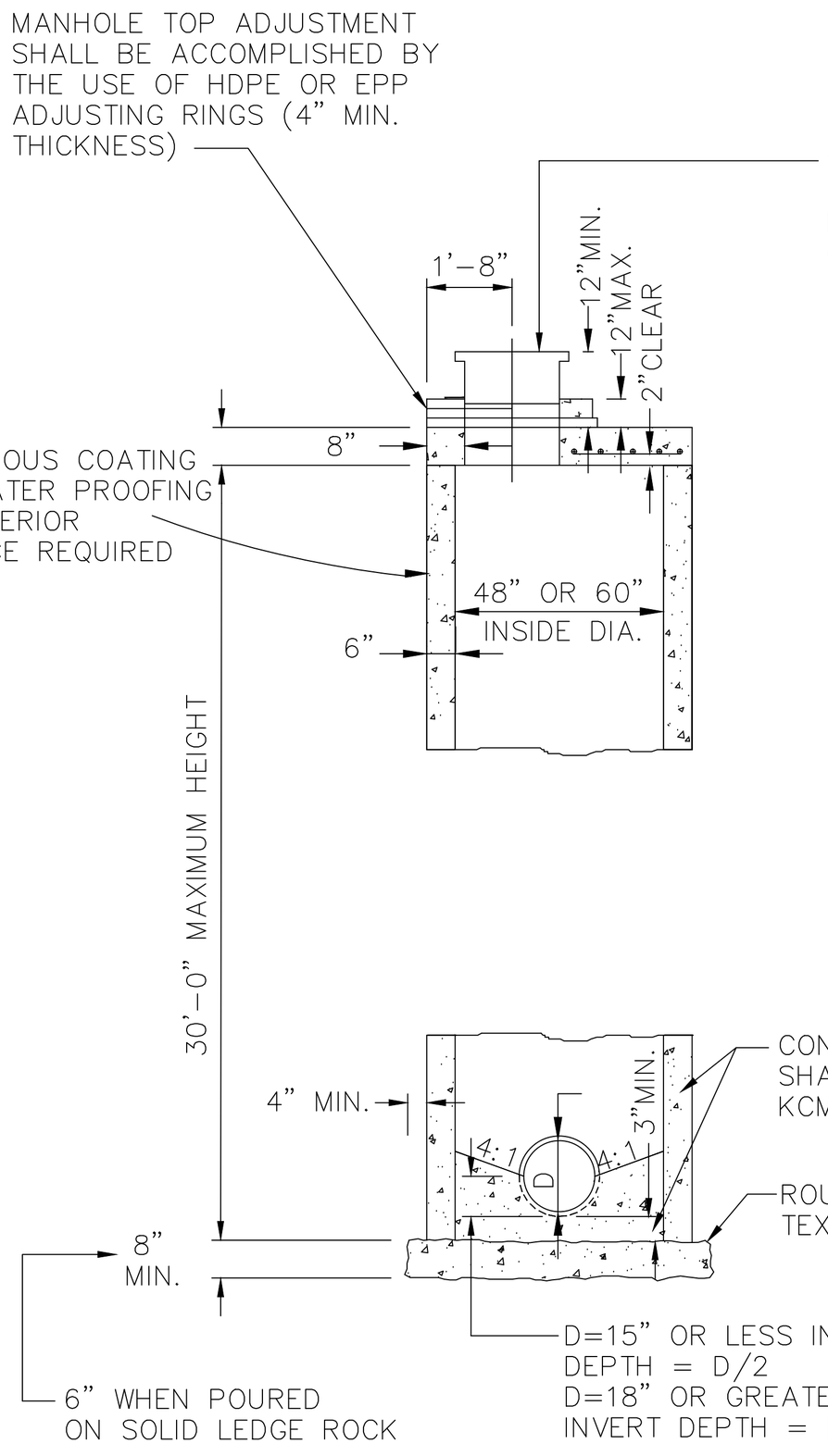
SHEET 1 OF 1



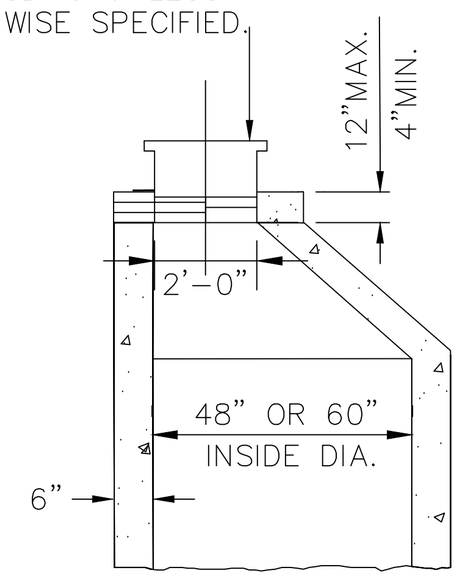
REINFORCING DETAIL OF COVER SLAB

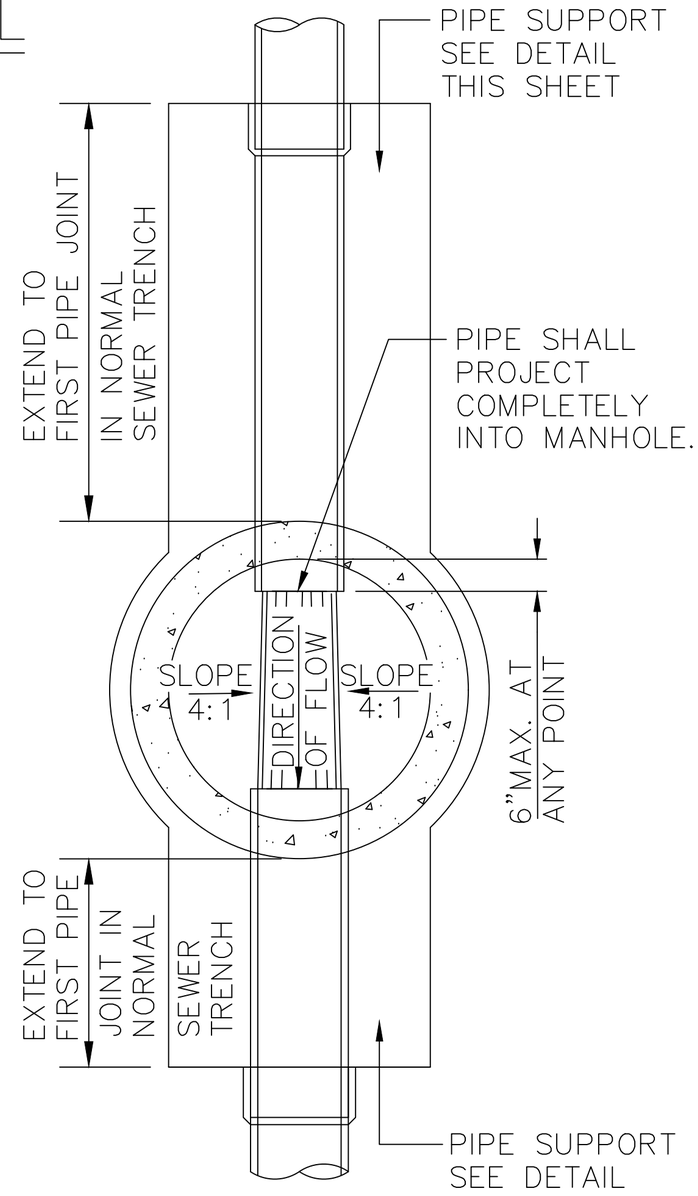


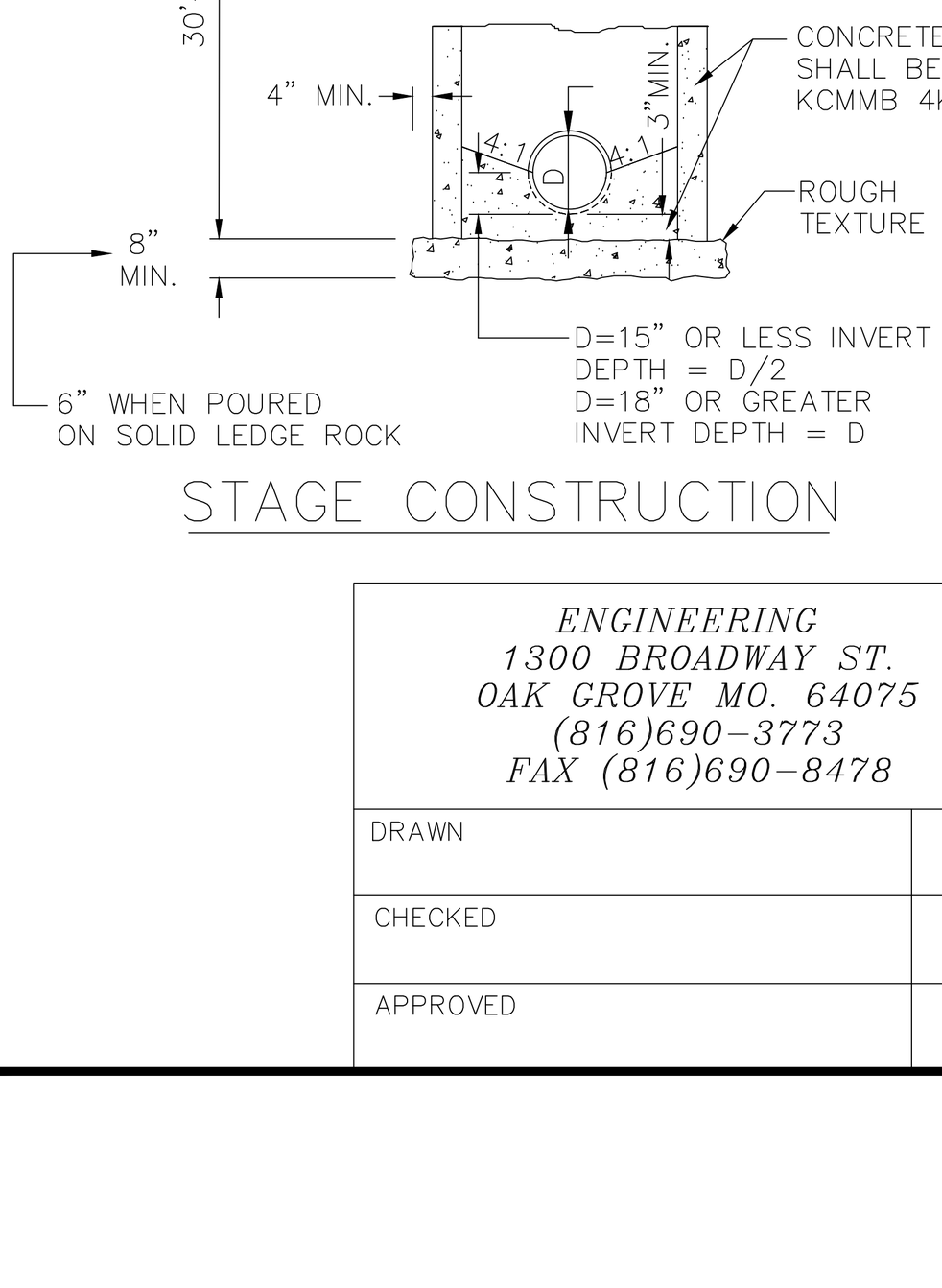
PIPE SUPPORT DETAIL



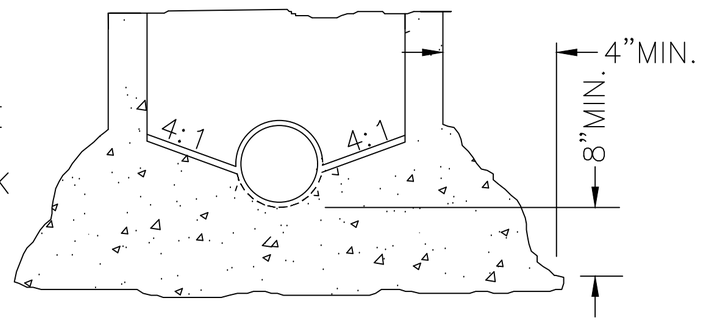
USING CONICAL SECTION







STAGE CONSTRUCTION



MONOLITHIC CONSTRUCTION

NOTE:
MINIMUM DISTANCE BETWEEN ANY TWO ADJACENT PIPES SHALL BE 4".

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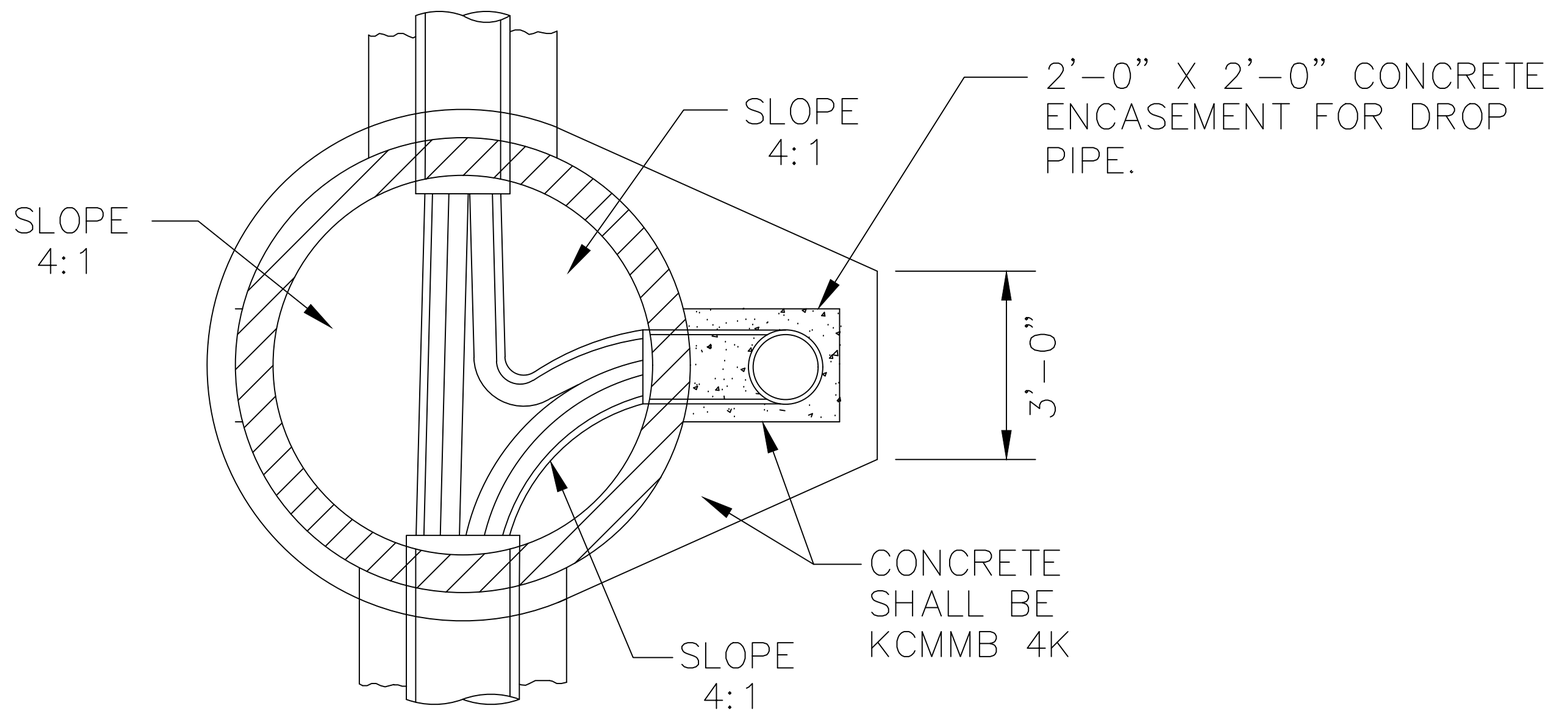
CITY OF OAK GROVE

MANHOLE– CAST IN PLACE 4'–0" OR 5'–0" DIA.

SIZE	FSCM NO.	DWG NO.	REV
A		SD–8	

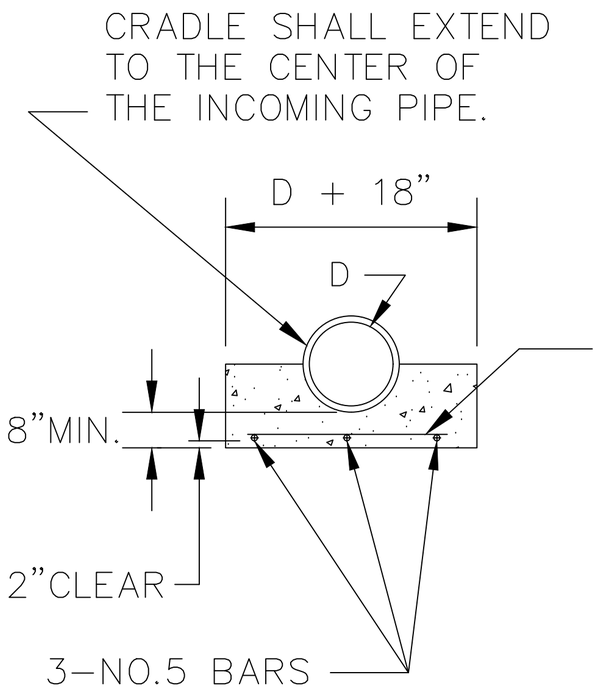
SCALE NONE

SHEET 1 OF 1

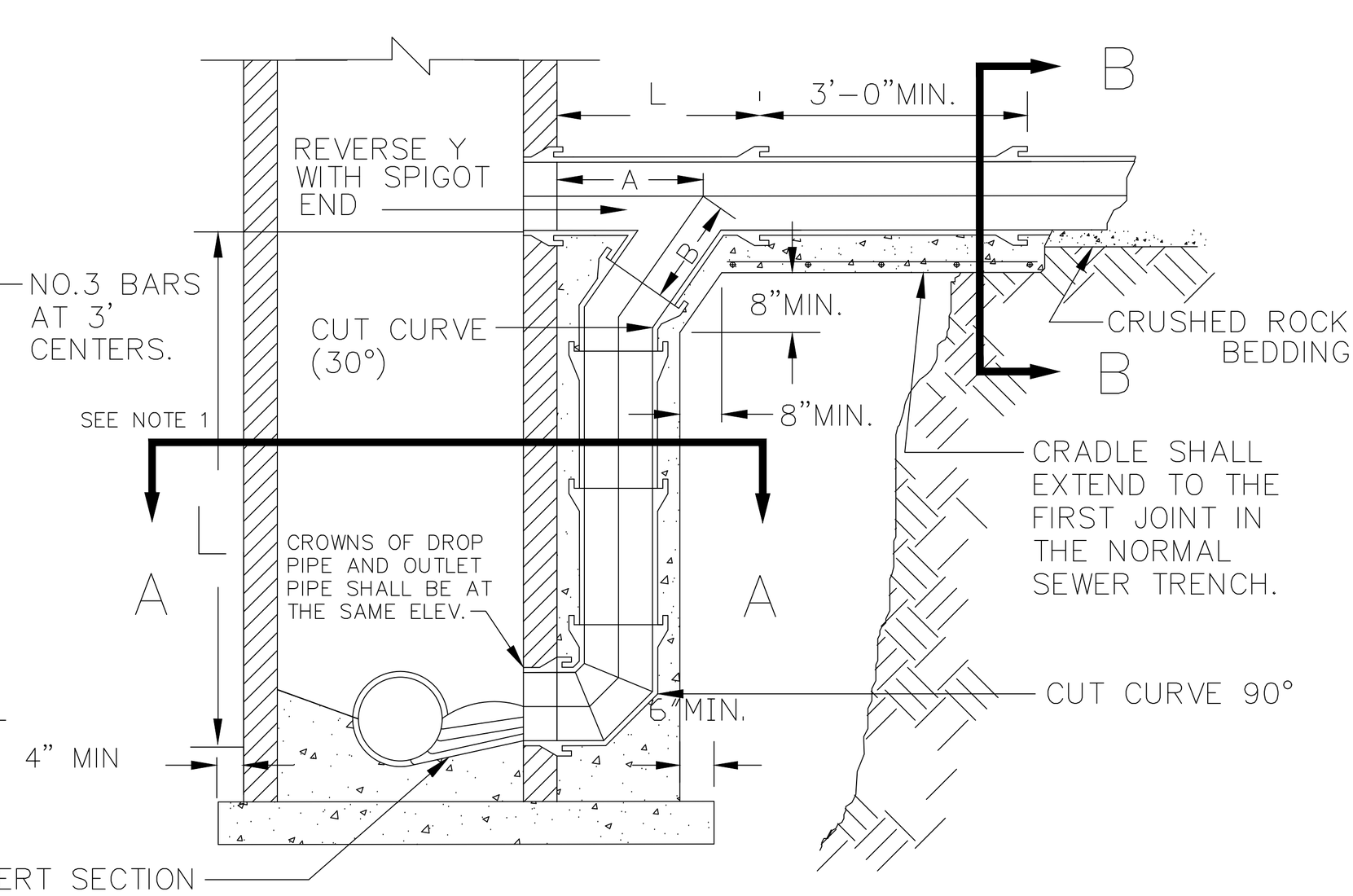


SECTION A-A

SIZE	L	A	B
8" ON 8"	3'-0"	2'-4"	1'-3"
10" ON 10"	3'-0"	2'-3"	1'-5"
12" ON 12"	3'-0"	2'-1"	1'-5"



SECTION B-B



SECTION VIEW

NOTE 1:
L > 2' DROP REQUIRES DROP MANHOLE.

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MANHOLE- OUTSIDE DROP
USE WITH ANY STANDARD MANHOLE

DRAWN	DATE
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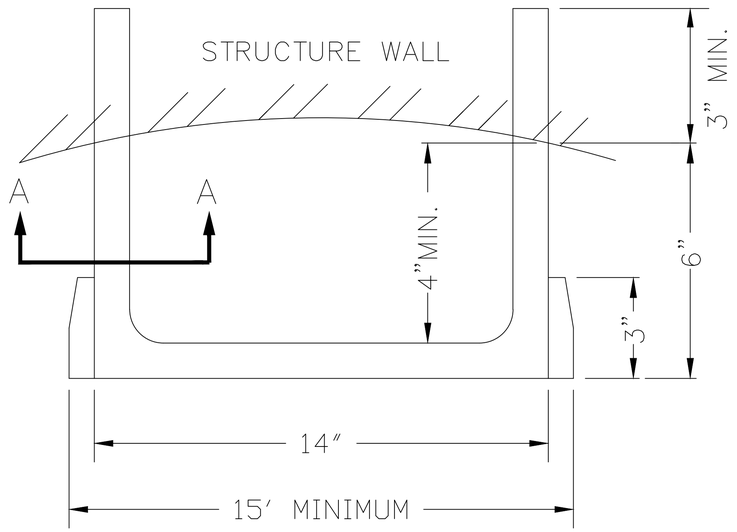
APPROVED	

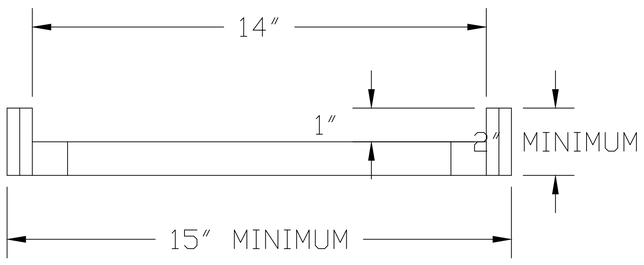
SIZE	FSCM NO.	DWG NO.	REV
A		SD-9	

SCALE NONE

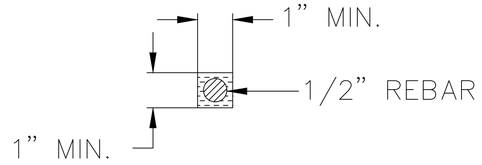
SHEET 1 OF 1



PLAN



ELEVATION



SECTION A–A

GENERAL NOTES

1. ALL STEPS MUST MEET THE FOLLOWING SPECIFICATIONS:
   GENERAL: ASTM C–478 EXCEPT THAT THE HORIZONTAL PULL OUT LOAD SHALL BE 1,000 POUNDS AND THE STEPS SHALL BE INSTALLED SO THAT THE DISTANCE FROM THE WALL OF THE RISER OR CONE, MEASURED FROM THE POINT OF EMBEDMENT TO THE OUTSIDE FACE OF THE RUNG IS 6".
   PLASTIC: COATING SHALL BE A COPOLYMER POLYPROPYLENE NESTING. ASTM D 2176C.
   STEEL REINFORCED BAR: ASTM A–615 GRADE 60 (1/2" DEFORMED STEEL REINFORCEMENT THROUGHOUT).
2. INSTALLATION METHOD MAY BE EITHER "DRIVEN IN", "CAST IN PLACE", OR "GROUTED IN". DRIVEN IN STEPS ARE NOT TO BE INSTALLED UNTIL THE CONCRETE HAS REACHED A MINIMUM COMPRESSIVE STRENGTH OF 3000 PSI. EXPANSIVE GROUT SHALL BE USED FOR GROUTED IN STEPS.
3. ALL STEPS SHALL HAVE MANUFACTURERS NAME, STEP NUMBER AND/OR MODEL NUMBER AND ASTM C–478 STAMPED IN THE PLASTIC.
4. THE RUNG OF THE STEP SHALL HAVE AN ANTI–SKID SURFACE.
5. ALL VIEWS ARE NOT TO SCALE AND ARE FOR DIMENSION PURPOSES ONLY.

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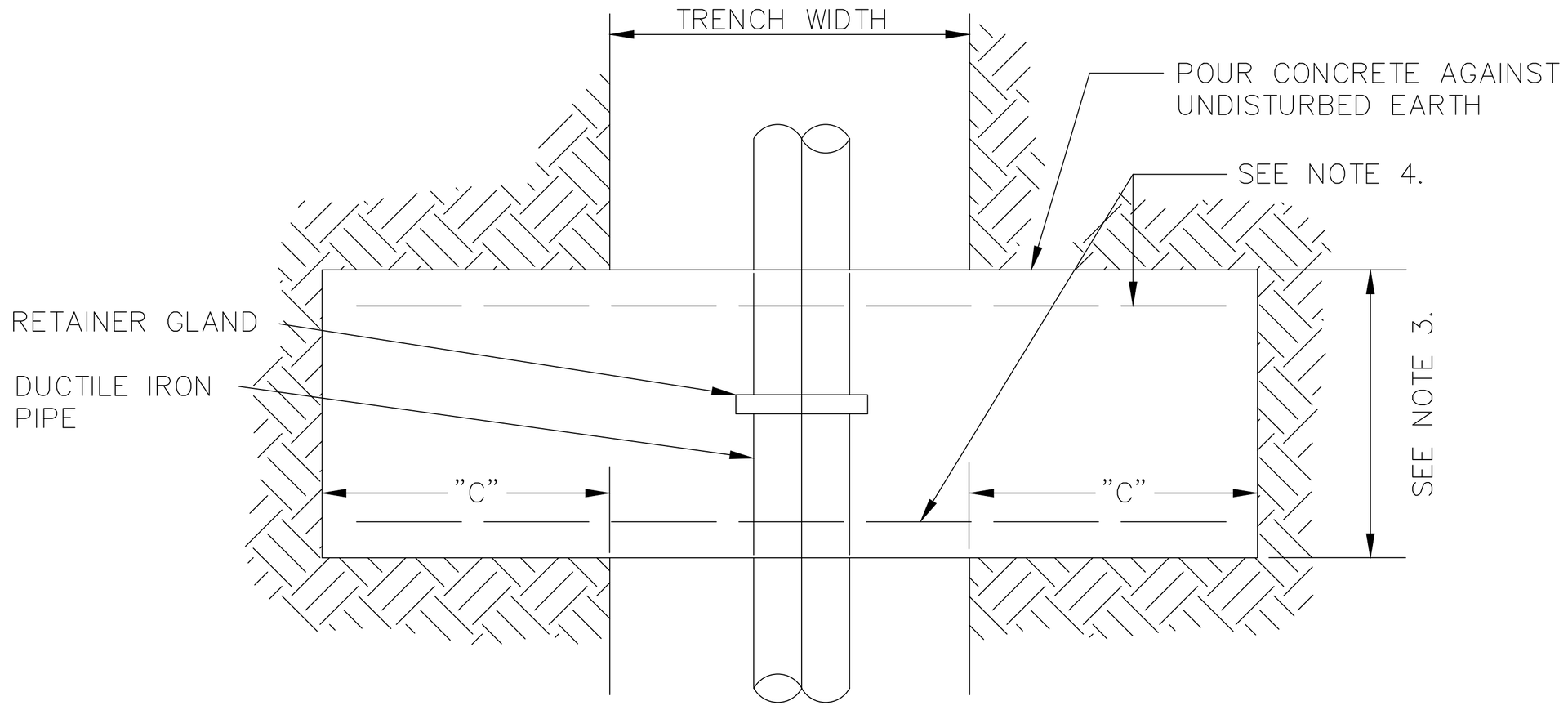
MANHOLE STEP

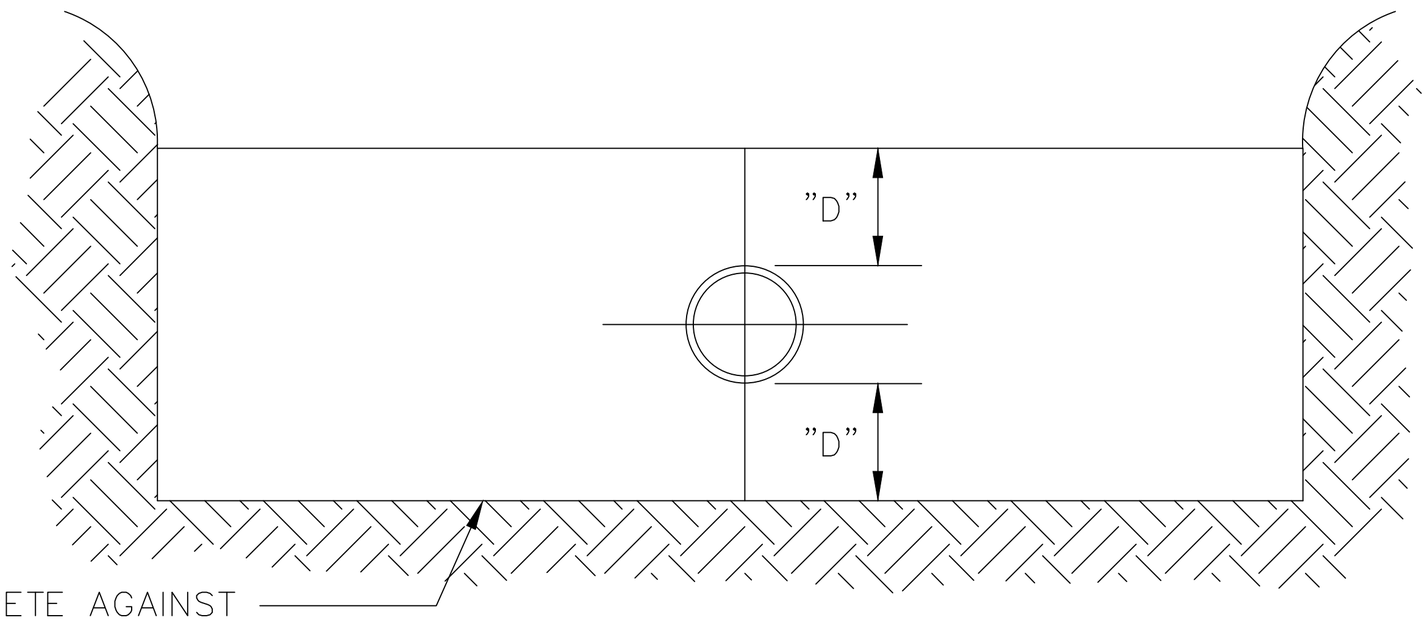
SIZE	FSCM NO.	DWG NO.	REV
A		SD–10	

SCALE NONE

SHEET 1 OF 1



PLAN



ELEVATION

PIPE SIZE	"D" MIN.	CU. FT.	"C"
2"	4"	12	24
6"	4"	18	24
8"	7"	30	24
12"	15"	61	24
16"	18"	–	30
20"	20"	–	42
24"	24"	–	48

NOTES:
1. FOR 2 THROUGH 12 INCH PIPE, STRADDLE BLOCKS ARE SIZED FOR 225 P.S.I. LINE PRESSURE INCLUDING SURGE.
2. FOR 16 THROUGH 24 INCH PIPE, STRADDLE BLOCKS ARE SIZED FOR 200 P.S.I. LINE PRESSURE INCLUDING SURGE.
3. FOR 2 THROUGH 12 INCH PIPE, 24 INCH MINIMUM OR EQUAL TO TRENCH WIDTH.
   FOR 16 THROUGH 24 INCH PIPE, 18 INCH MINIMUM OR EQUAL TO TRENCH WIDTH.
4. #5 BARS AT 12" CENTERS IN EACH DIRECTION FOR 16 THROUGH 24 INCH PIPES.

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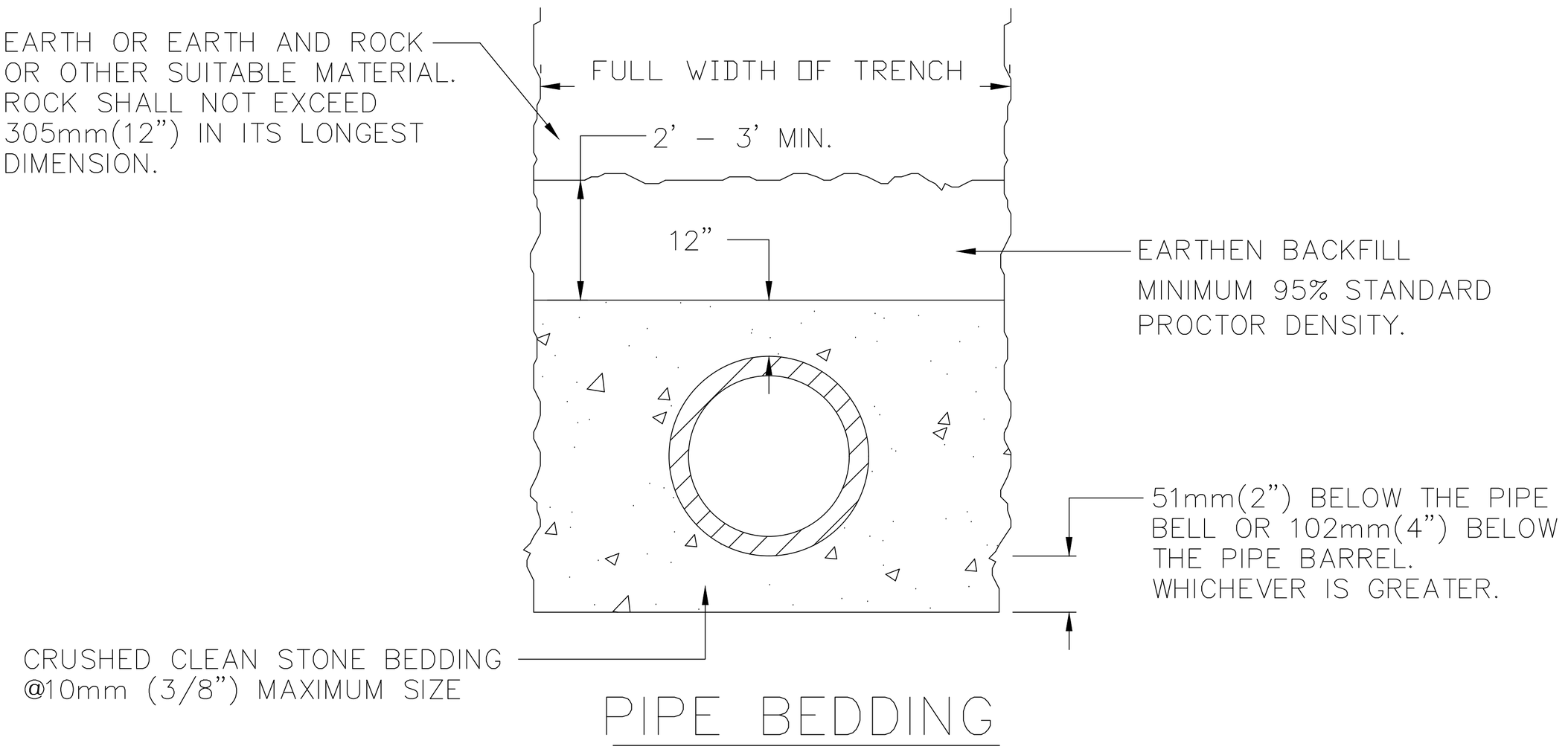
TYPICAL STRADDLE BLOCK

SIZE	FSCM NO.	DWG NO.	REV
A		SD-11	

SCALE NONE

SHEET 1 OF 1



PIPE BEDDING

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DRAWN	DATE
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APPROVED	

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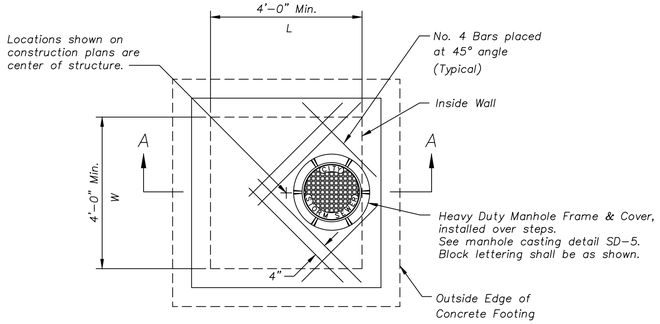
CLASS B PIPE BEDDING FOR SANITARY SEWER PIPE

SIZE	FSCM NO.	DWG NO.	REV
A		SD–12	

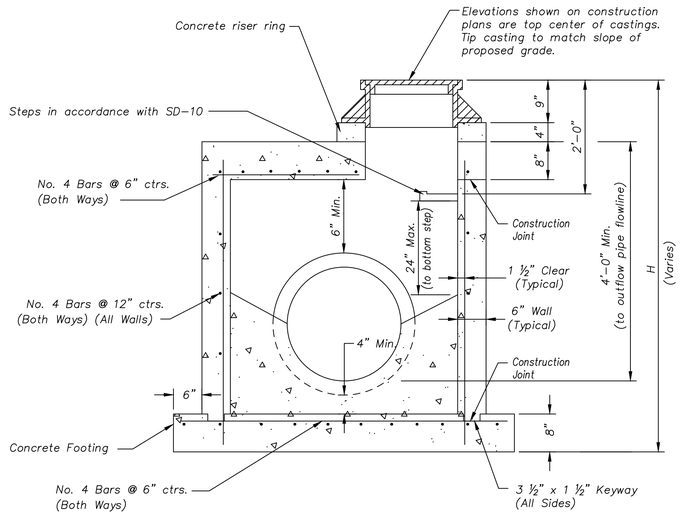
SCALE NONE

SHEET 1 OF 1



Plan

Not to Scale



Section A-A

Not to Scale

Junction Box Notes

General

1. Junction box materials and construction shall be in accordance with the City of Oak Grove Technical Specifications and Design Criteria for Utility and Street Construction.
2. All storm sewer structures shall be pre-cast or poured in place.
3. Pre-cast shop drawings shall be approved by the City Engineer prior to fabrication.
4. Do not scale these drawings for dimensions or clearances. Any questions regarding dimensions shall be brought to the attention of the City Engineer prior to construction.
5. The first dimension listed in the construction notes is the "L" dimension. The second dimension is the "W" dimension. The concrete thickness and reinforcement shown is for boxes with ("L"+"H") and ("W"+"H") less than or equal to 20. For boxes with either of these calculations greater than 20, a special design is required.
6. CMP shall be 14 gauge when pipe is less than 54", and 12 gauge when 54" or greater.
7. Pipe shall not penetrate corners of the structure.

Concrete

8. Concrete used in this work shall be KCMMB4K, as approved by the Kansas City Metropolitan Materials Board, and shall meet the requirements of the City of Oak Grove Technical Specifications and Design Criteria for Utility and Street Construction.
9. Inlet floors shall be shaped with non-reinforced concrete inverts to provide smooth flow.
10. Bevel all exposed edges with $\frac{3}{4}$" triangular molding.

Reinforcing Steel

11. Reinforcing steel shall be new billet, minimum Grade 40 as per ASTM A615, and shall be bent cold.
12. All dimensions relative to reinforcing steel are to centerline of bars. 2" clearance shall be provided throughout unless noted otherwise. Tolerance of +/- $\frac{1}{8}$" shall be permitted.
13. All lap splices not shown shall be a minimum of 40 bar diameters in length.
14. All reinforcing steel shall be supported on fabricated steel bar supports @ 3'-0" maximum spacing.
15. All dowels shall be accurately placed and securely tied in place prior to placement of bottom slab concrete. Sticking of dowels into fresh or partially hardened concrete will not be acceptable.
16. #5 Bars shall be placed diagonally 4" clear around all pipe penetrations.

Construction

17. The bottom slab shall be at least 24 hours old before placing sidewall concrete. All sidewall forms shall remain in place a minimum of 24 hours after sidewalls are poured before removal, and after removal shall be immediately treated with membrane curing compound.
18. Pipe connections to pre-cast structures shall have a minimum of 6" of concrete around the entire pipe within 2' of the outside wall of structure. A minimum of 2" – maximum of 6" clearance is required between the outside pipe wall and the edge of blackout.
19. Backfill shall be in accordance with the City of Oak Grove Technical Specifications and Design Criteria for Utility and Street Construction.

JUNCTION BOX

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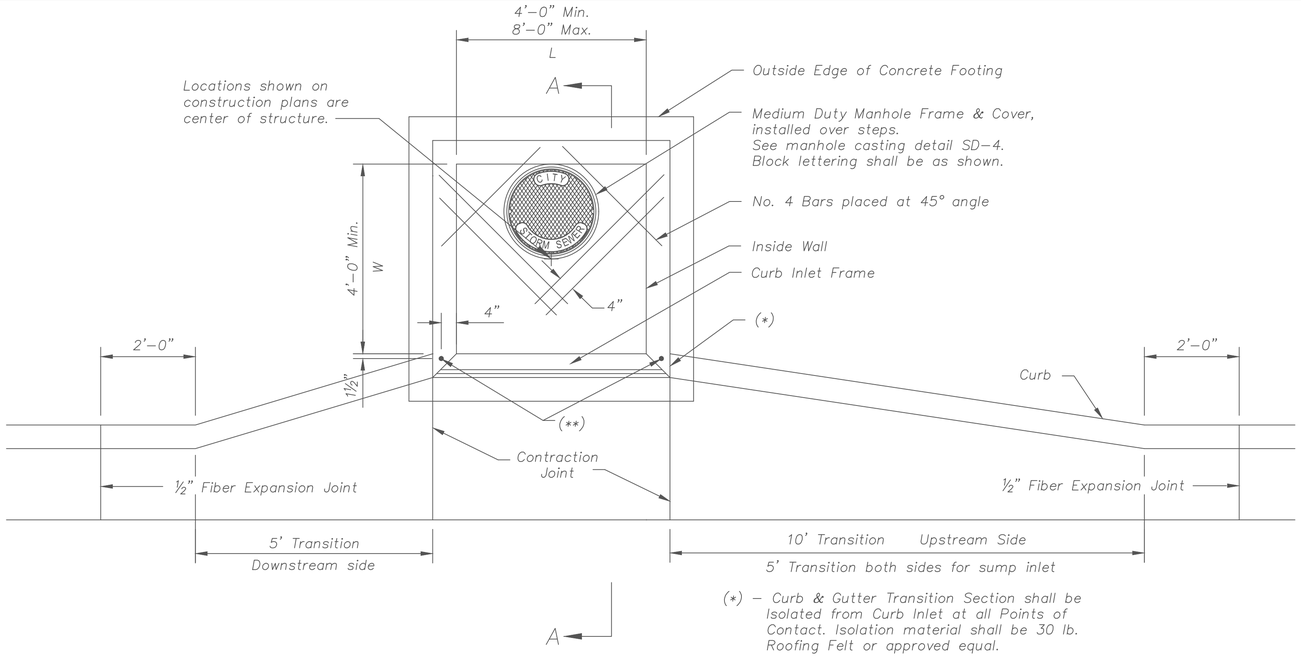
CITY OF OAK GROVE

JUNCTION BOX

SIZE	FSCM NO.	DWG NO.	REV
A		SD-13	

SCALE NONE

SHEET 1 OF 1

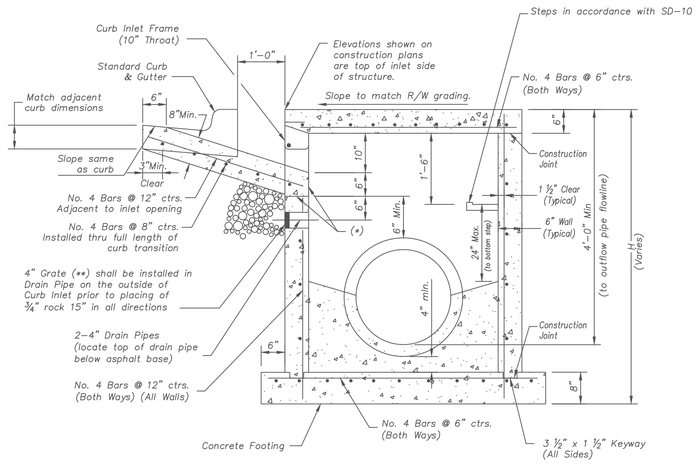


(*) – Curb & Gutter Transition Section shall be Isolated from Curb Inlet at all Points of Contact. Isolation material shall be 30 lb. Roofing Felt or approved equal.

(**) – No. 4 Vertical Bars shall be placed in Wall 1 ½" clear from finished top of slab.

Plan

Not to Scale



Section A–A

Not to Scale

(*) – Curb & Gutter Transition Section shall be Isolated from Curb Inlet at all points of contact. Isolation material shall be 30 lb. Roofing Felt or approved equal.

(**) – the material of the grate shall match the material of the pipe and shall be as follows:

a) PVC: Pipe – 4" Schedule 40 PVC meeting ASTM D–1785' Grate – 4" PVC Snap–in Drain – meets ASTM D–2665, with Stainless Steel (Type 304) Cover, mounted with two 18–8 Stainless Steel Screws; Maximum opening size ¼".

b) HDPE: Pipe – 4"HDPE meeting AASHTO M252, Type S; Grate – 4"HDPE – meets ASTM D–3350; Maximum opening size ¼".

Curb Inlet Notes

General

1. Curb inlet materials and construction shall be in accordance with the City of Oak Grove Technical Specifications and Design Criteria for Utility and Street Construction.
2. All storm sewer structures shall be pre–cast or poured in place. If pre–cast structures are used for curb inlets, the tops shall be poured in place and the wall steel shall be left exposed to a height 2" below the finish top elevation, or as directed by the City Engineer.
3. Pre–cast shop drawings shall be approved by the City Engineer prior to fabrication.
4. Do not scale these drawings for dimensions or clearances. Any questions regarding dimensions shall be brought to the attention of the City Engineer prior to construction.
5. On–grade inlets shall conform to the street grade and sump inlets shall be level.
6. The first dimension listed in the construction notes is the "L" dimension. The second dimension is the "W" dimension. The concrete thickness and reinforcement shown is for boxes with ("L"+"W") and ("W"+"W") less than or equal to 20. For boxes with either of these calculations greater than 20, a special design is required.
7. CMP shall be 14 gauge when pipe is less than 54" and 12 gauge when 54" or greater.
8. Pipe shall not penetrate corners of the structure.

Concrete

9. Concrete used in this work shall be KCMMB4K, as approved by the Kansas City Metropolitan Materials Board, and shall meet the requirements of the City of Oak Grove Technical Specifications and Design Criteria for Utility and Street Construction.
10. Inlet floors shall be shaped with non–reinforced concrete inverts to provide smooth flow.
11. Bevel all exposed edges with ¾" triangular molding.

Reinforcing Steel

12. Reinforcing steel shall be new billet, minimum Grade 40 as per ASTM A615M, and shall be bent cold.
13. All dimensions relative to reinforcing steel are to centerline of bars. 2" clearance shall be provided throughout unless noted otherwise. Tolerance of +/– ½"shall be permitted.
14. All lap splices not shown shall be a minimum of 40 bar diameters in length.
15. All reinforcing steel shall be supported on fabricated steel bar supports @ 3'–0" maximum spacing.
16. All dowels shall be accurately placed and securely tied in place prior to placement of bottom slab concrete. Sticking of dowels into fresh or partially hardened concrete will not be acceptable.
17. #5 Bars shall be placed diagonally 4" clear around all pipe penetrations

Construction

18. The bottom slab shall be at least 24 hours old before placing sidewall concrete. All sidewall forms shall remain in place a minimum of 24 hours after sidewalls are poured before removal, and after removal shall be immediately treated with membrane curing compound.
19. Pipe connections to pre–cast structures shall have a minimum of 6" of concrete around the entire pipe within 2' of the outside wall of structure. A minimum of 2" – maximum of 6" clearance is required between the outside pipe wall and the edge of blackout.
20. Backfill shall be in accordance with the City of Oak Grove Technical Specifications and Design Criteria for Utility and Street Construction.

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CURB INLET

SIZE	FSCM NO.	DWG NO.	REV
A		SD–14	

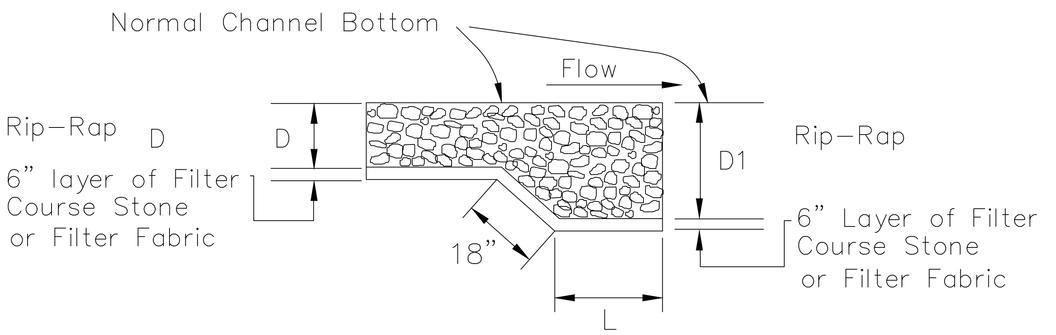
SCALE NONE

SHEET 1 OF 1

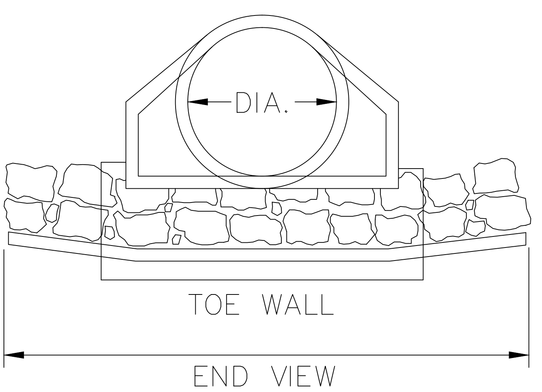
ROCK LINING FOR CULVERT OUTLETS

CULVERT SIZE. DIA INCH	MINIMUM D X W FEET	MINIMUM LENGTH FEET	END RIP-RAP L X D1 FEET	EQUIVALENT PIPE ARCH CULVERT (APPROX.)	EQUIVALENT CONC. BOX CULV. (APPROX.)
18	1.5 X 8	12	3 X 2		
24	1.5 X 8	14	3 X 2		2' X 1-1/2'
30	1.5 X 8	16	3 X 2	8-5	2' X 2'
36	1.5 X 10	18	3 X 2	8-6	3' X 2'
42	2 X 10	20	4 X 2.75	8-7	3' X 3'
48	2 X 12	20	4 X 2.75	8-8	4' X 3'
54	2 X 13.5	22	4 X 2.75	8-9	4' X 4'
60	2 X 15	26	4 X 2.75	8-10	5' X 4'
66	2 X 18	26	4 X 2.75	8-11	5' X 6'
72	2 X 20	30	4 X 2.75	8-12	5' X 8'
84	2.5 X 25	36	5 X 3.3		6' X 6'
96	2.5 X 30	40	5 X 3.3		7' X 7'
108	3 X 32	40	6 X 4		8' X 8'

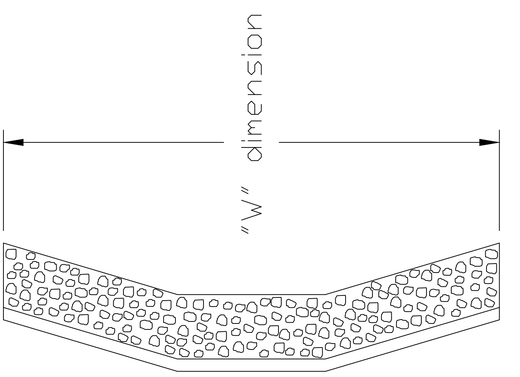
THE DIMENSIONS SHOWN IN THE TABLE CAN BE APPLIED TO BOX OR ARCH CULVERTS OF EQUIVALENT WATERWAY AREA.



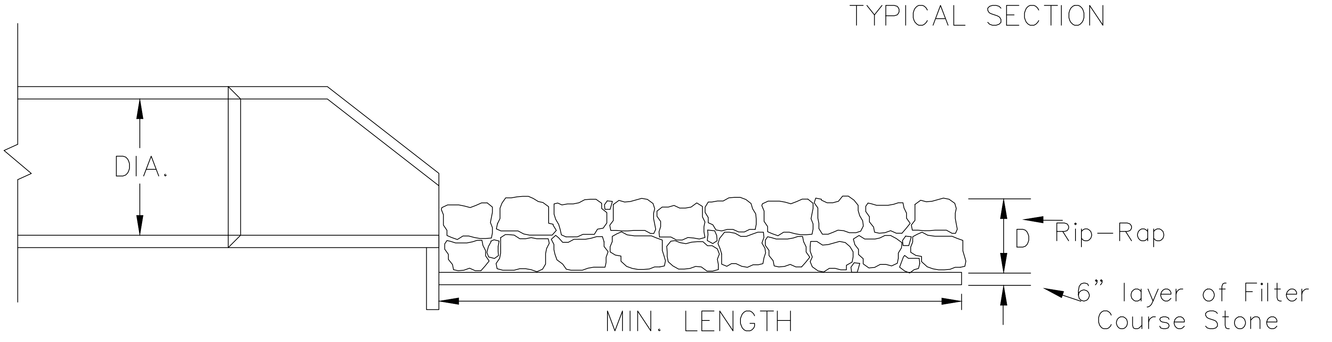
SECTION THROUGH DOWNSTREAM END OF RIP-RAP



END VIEW



TYPICAL SECTION



SIDE VIEW

NOTE:
ALL MATERIALS SHALL CONFORM TO APWA SECTION 2605.

CITY OF OAK GROVE

ROCK LINING FOR CULVERT OUTLETS & RIP RAP DITCH

SIZE A | FSCM NO. | DWG NO. SD-15 | REV

SCALE NONE | SHEET 1 OF 1

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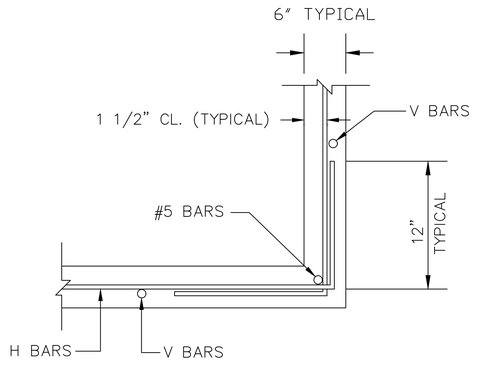
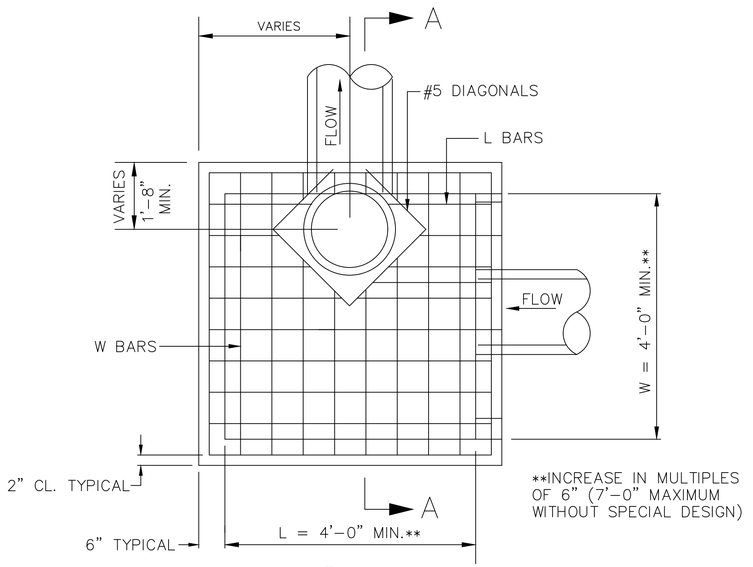
REINFORCING

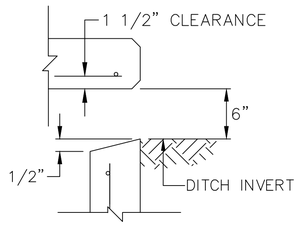
BARS	SIZE	SPACING (IN.)
H	4	12
V	4	12
L	5	6
W	5	6



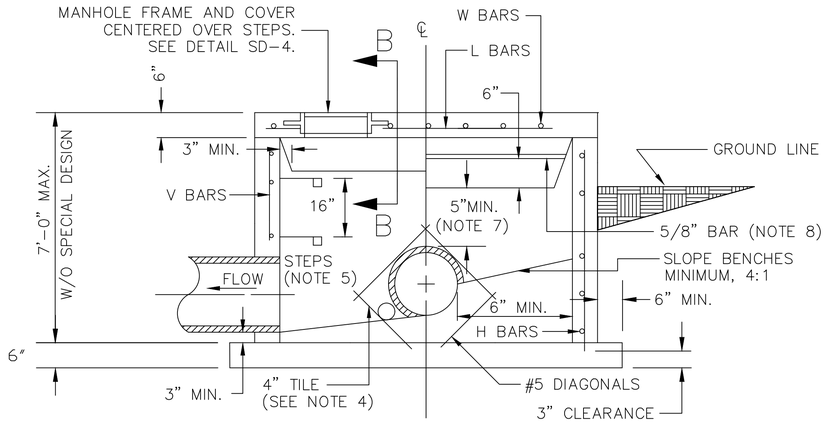
CORNER DETAIL



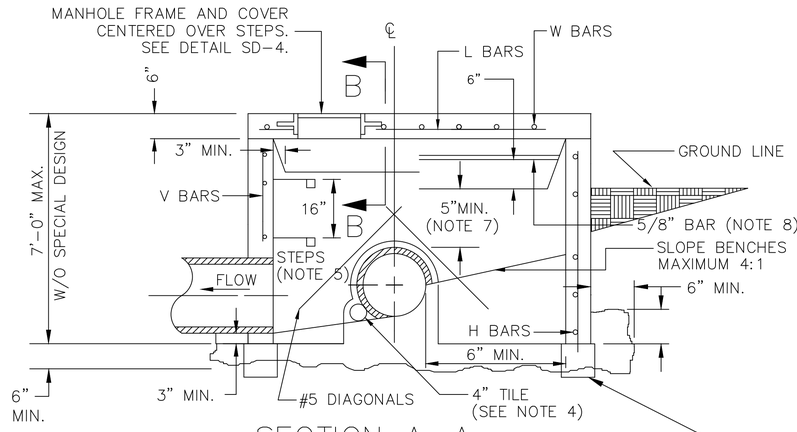
PLAN



SECTION B–B



SECTION A–A
CAST IN PLACE



SECTION A–A
PRECAST

SET ON SOLID PRECAST CONC. BLOCKS. FOUNDATION AND INVERT SHALL BE POURED MONOLITHIC, UNLESS SOIL CONDITIONS REQUIRE POURING BASE SLAB BEFORE SETTING STRUCTURE.

GENERAL NOTES:

1. Locate ring and cover over steps.
2. Concrete shall be KCMMB 4K as approved by the Kansas City Metropolitan Materials Board.
3. Use 3/4" chamfer strip on all exposed concrete corners.
4. 4" weep hole shall be located at each inlet pipe and in the front face at sump inlets. The openings shall be capped with 1/4" galvanized wire mesh on the outside of the inlet and clear the invert and base concrete.
5. Steps required @ 16" O.C. when depth from top of casting to invert exceeds 4 feet.
6. Boxouts shall not project through the corners of the structure.
7. The minimum reinforcing shall be 1 H–bar over a cast–in place pipe and 2 H–bars over a precast boxout.
8. Limit opening height to 6" with 5/8" galvanized bars extending to corner rebars.
9. Show field inlet orientation on plans plus number and size of opening.
10. O.R. = one half outside pipe diameter (O.D.).

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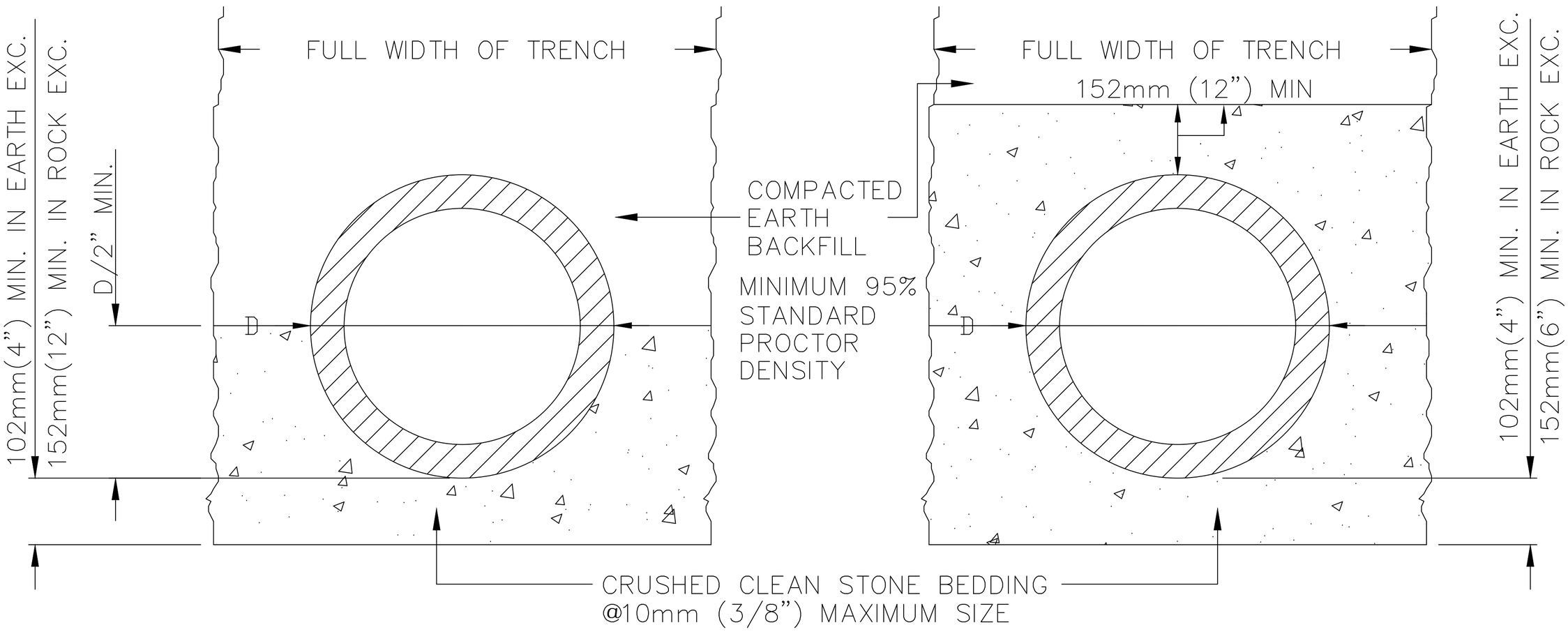
CITY OF OAK GROVE

YARD INLET

SIZE	FSCM NO.	DWG NO.	REV
A		SD–16	

SCALE NONE SHEET 1 OF 1

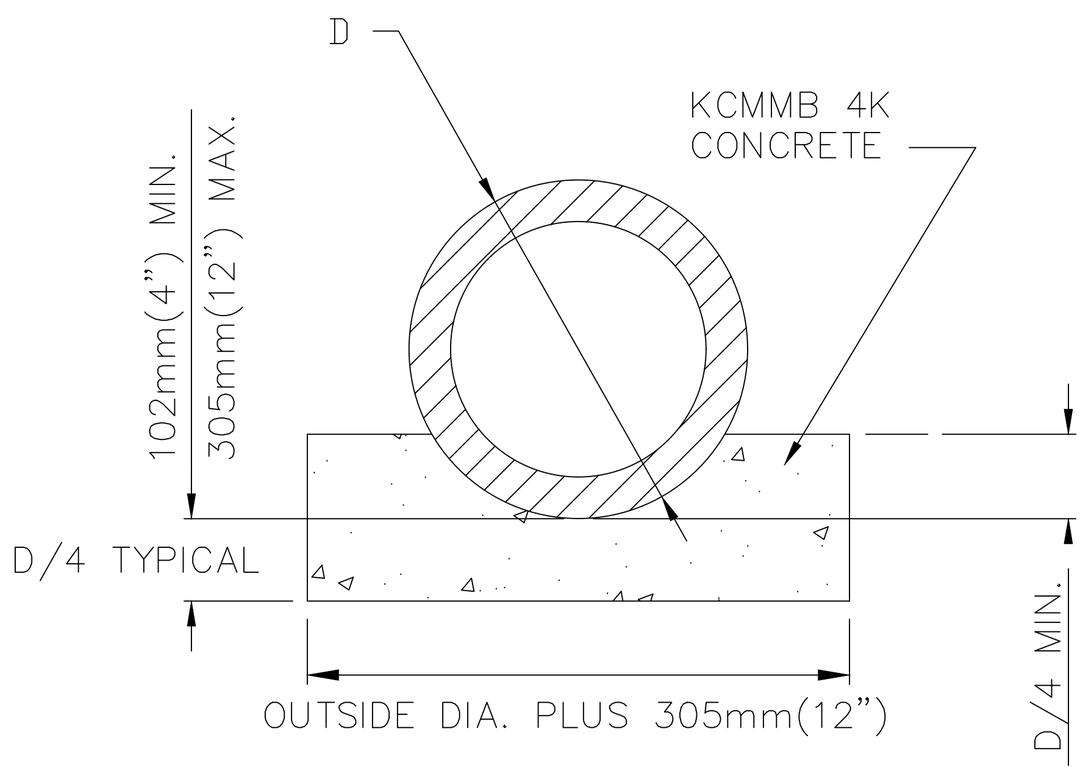


RIGID PIPE

CONCRETE CRADLE

PIPE SIZE	CU M/M	CU.YDS/FT
381mm(15")	.143	(.057)
457mm(18")	.191	(.076)
533mm(21")	.243	(.097)
610mm(24")	.301	(.120)
686mm(27")	.381	(.152)
762mm(30")	.449	(.179)
914mm(36")	.602	(.240)
1067mm(42")	.748	(.298)
1219mm(48")	.863	(.344)
1372mm(54")	.986	(.393)
1524mm(60")	1.111	(.443)

FLEXIBLE PIPE CLASS B



CONCRETE CRADLE

GENERAL NOTES:
1. STONE BEDDING REQUIRED FOR ALL SEWER PIPE WITHOUT CONCRETE CRADLE.
2. CONCRETE SHALL BE KCMMB 4K AS APPROVED BY THE KANSAS CITY METROPOLITAN MATERIALS BOARD.

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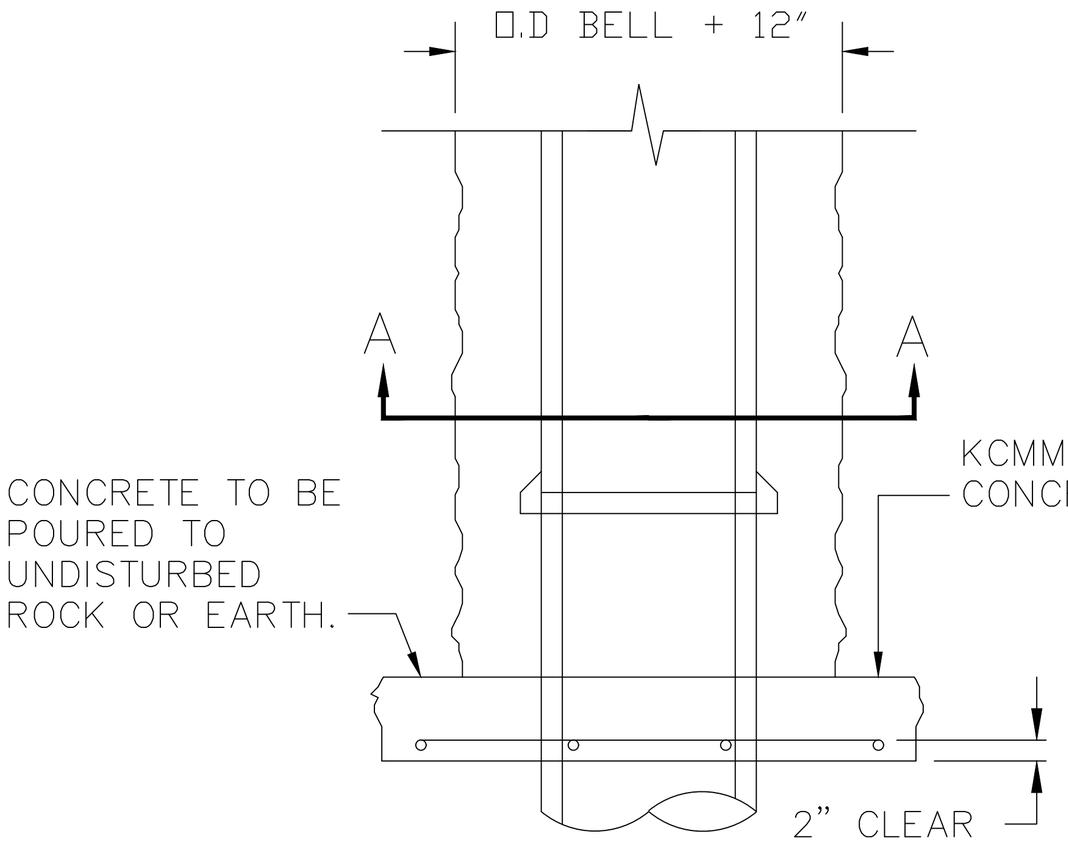
PIPE BEDDING & CRADLE FOR STORM SEWER PIPE

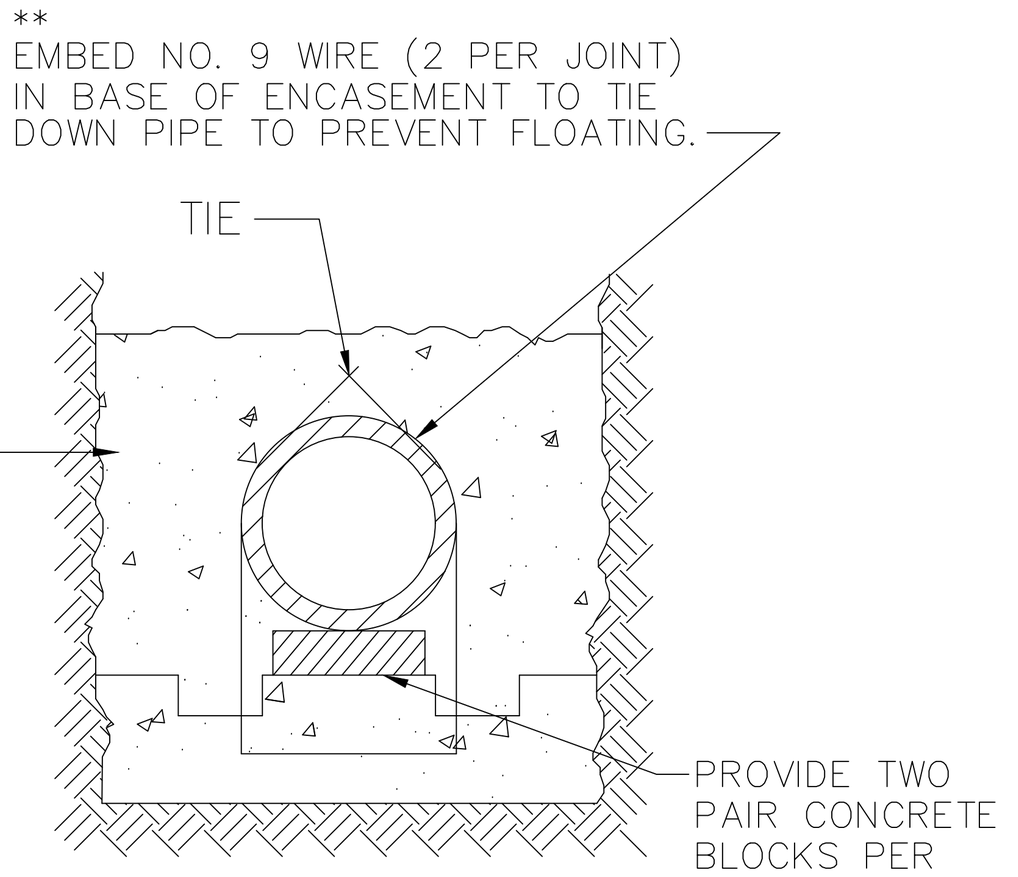
SIZE	FSCM NO.	DWG NO.	REV
A		SD-17	

SCALE NONE

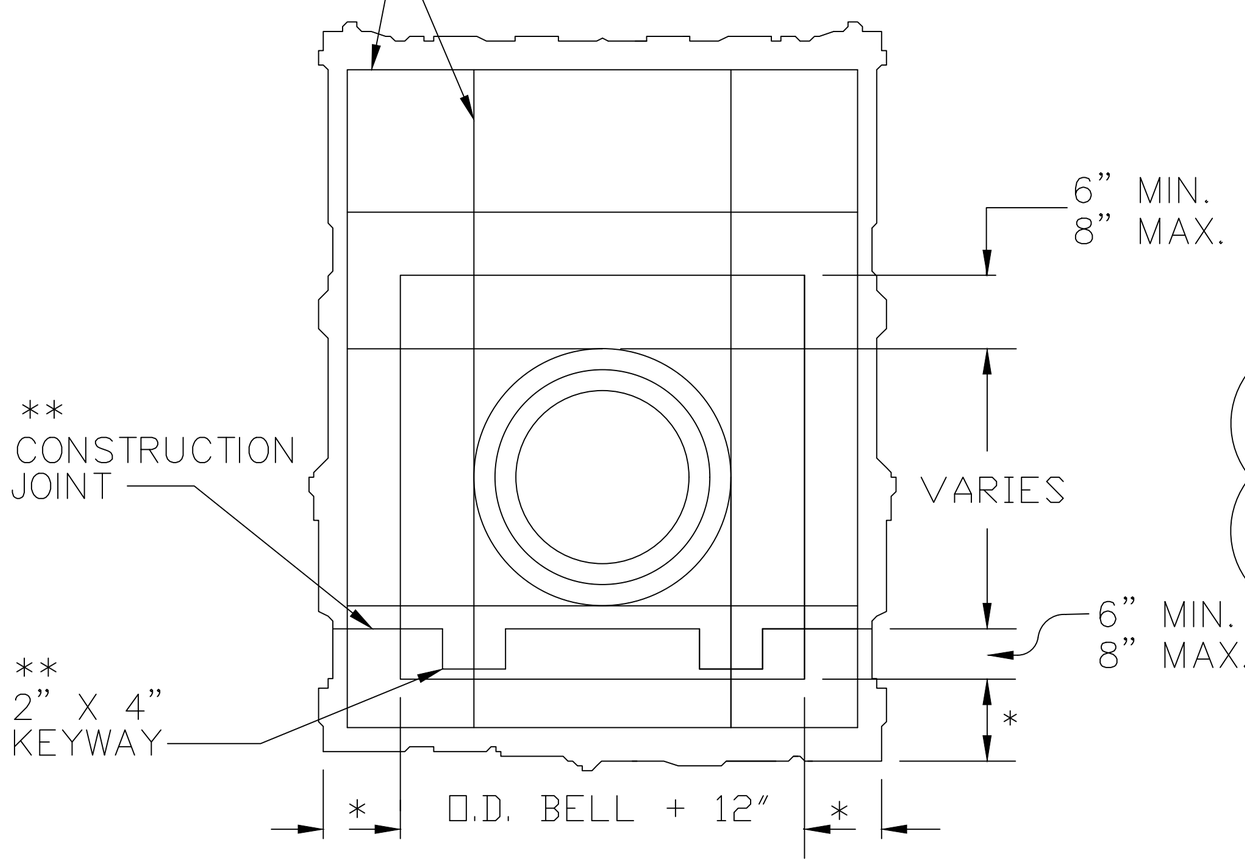
SHEET 1 OF 1



PLAN

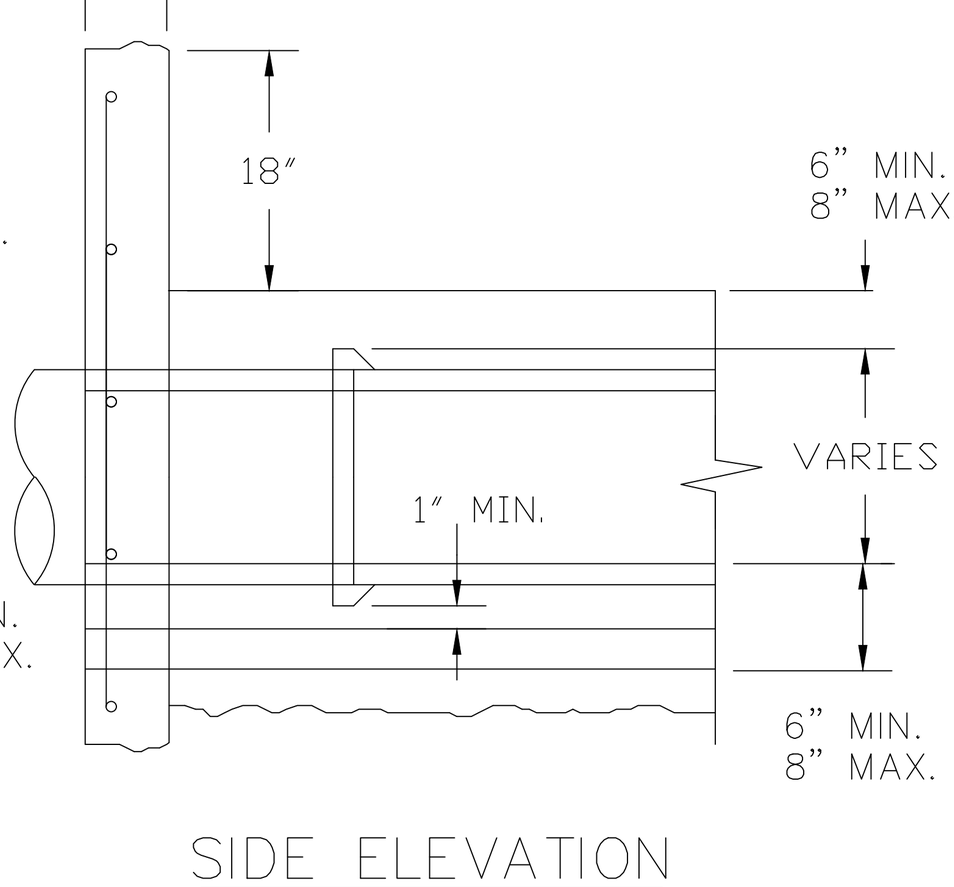


SECTION A–A



* 6" FOR TRENCH IN ROCK
12" FOR TRENCH IN EARTH

ELEVATION



SIDE ELEVATION

** APPLIES IF POUR IS NOT MADE MONOLITHICALLY.

NOTE:
ALL CONCRETE ENCASEMENT IN ROCK SHALL BE POURED AGAINST THE FACE OF ROCK ON BOTH SIDES AND BOTTOM OF TRENCH WHEN USING MONOLITHIC POUR. PIPE SHALL BE ANCHORED TO PREVENT FLOATING OR DISPLACEMENT OF THE PIPE.

MAXIMUM CONCRETE QUANTITIES FOR ENCASEMENT

PIPE SIZE	CU.YDS/LIN.FT.	PIPE SIZE	CU.YDS./LIN.FT.
8"	.1173	15"	.2063
10"	.1397	18"	.2533
12"	.1647	21"	.3056

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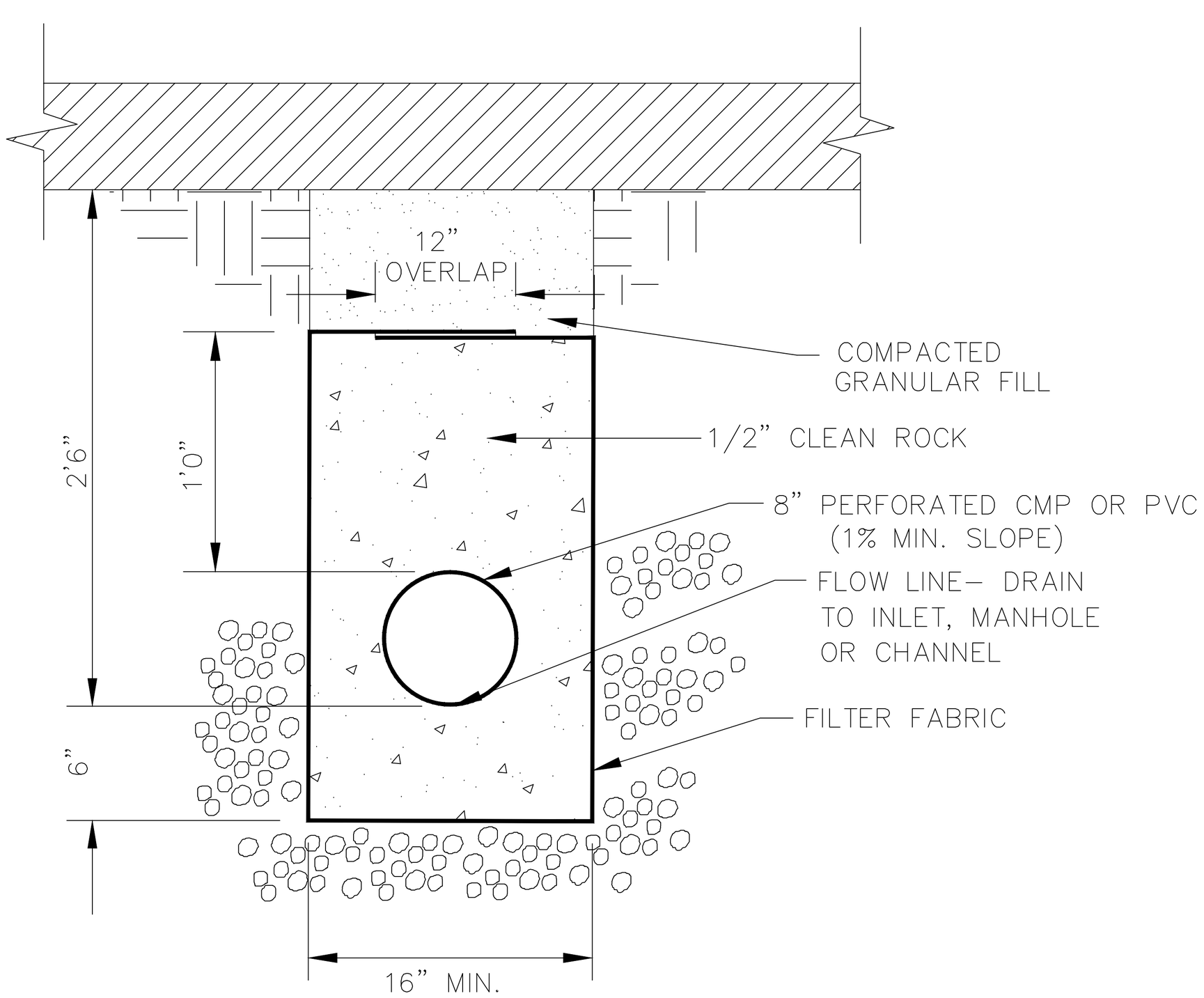
PIPE ENCASEMENT AND COLLAR

SIZE	FSCM NO.	DWG NO.	REV
A		SD–18	

SCALE NONE | SHEET 1 OF 1



UNDERDRAIN DETAIL

SHOWN UNDER PAVEMENT

NOTE:

1. GRANULAR FILL TO BE CRUSHED STONE OR PEA GRAVEL WITH NO LESS THAN 95% PASSING 1/2" AND NOT LESS THAN 95% TO BE RETAINED ON A #4 SIEVE. FILL TO PLACED IN NOT MORE THAN 6" LAYERS AND COMPACTED.

2. FILTER FABRIC TO MEET AASHTO DESIGNATION M 288–90 CLASS A.

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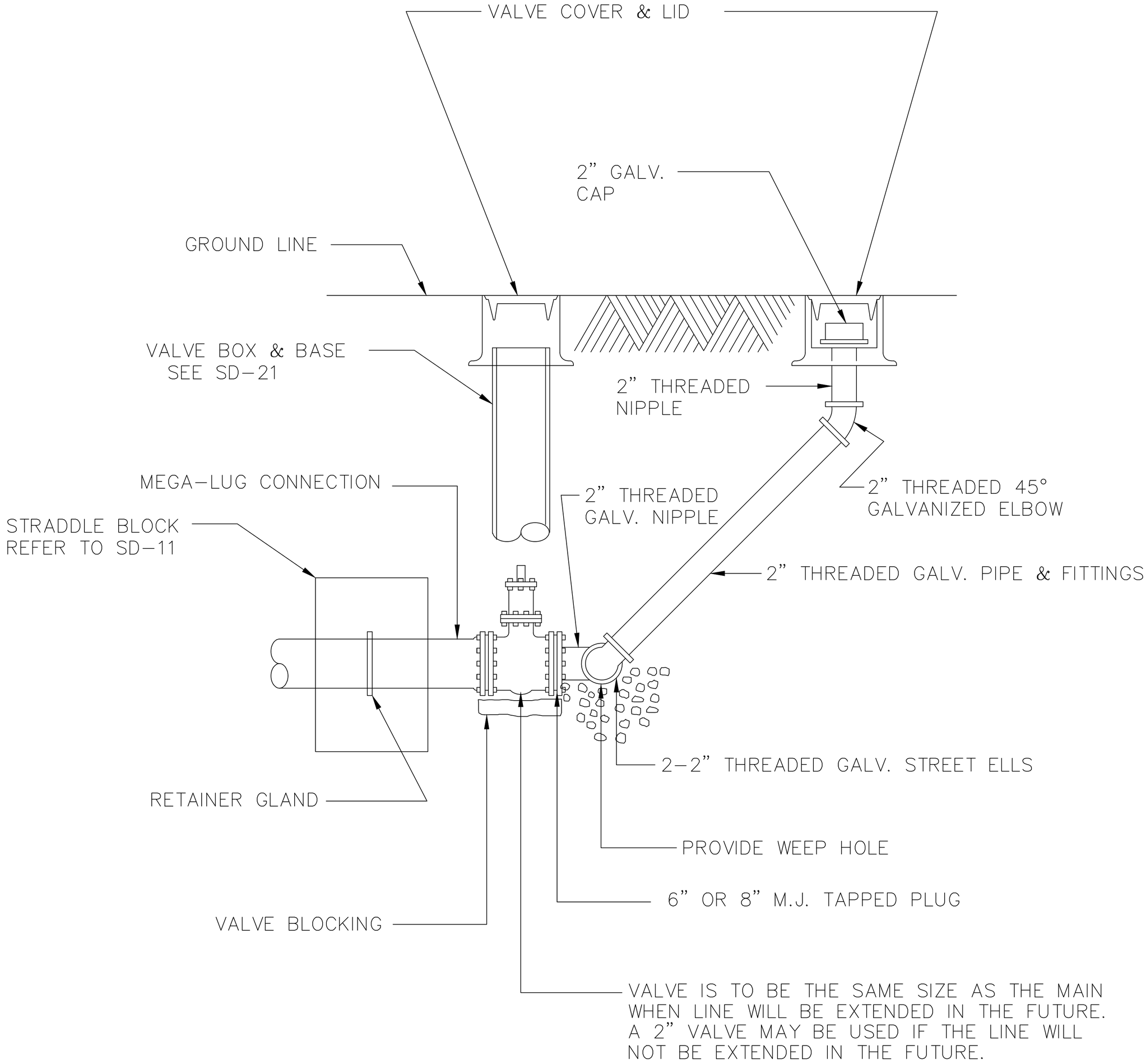
UNDERDRAIN DETAIL

SIZE	FSCM NO.	DWG NO.	REV
A		SD–19	

SCALE NONE

SHEET 1 OF 1



NOTES:
1. VALVE BOX TO BE METALIC ADJUSTABLE TYPE.
2. DRAINAGE SHOULD BE PROVIDED BY HOLE IN STREET ELL.
3. USE APPROVED RESTRAINING DEVICE.
4. ALL PIPES 6 INCHES OR ABOVE SHALL BE DUCTILE IRON CLASS 50.
   ALL 4 INCH PIPES SHALL BE DUCTILE IRON CLASS 51.

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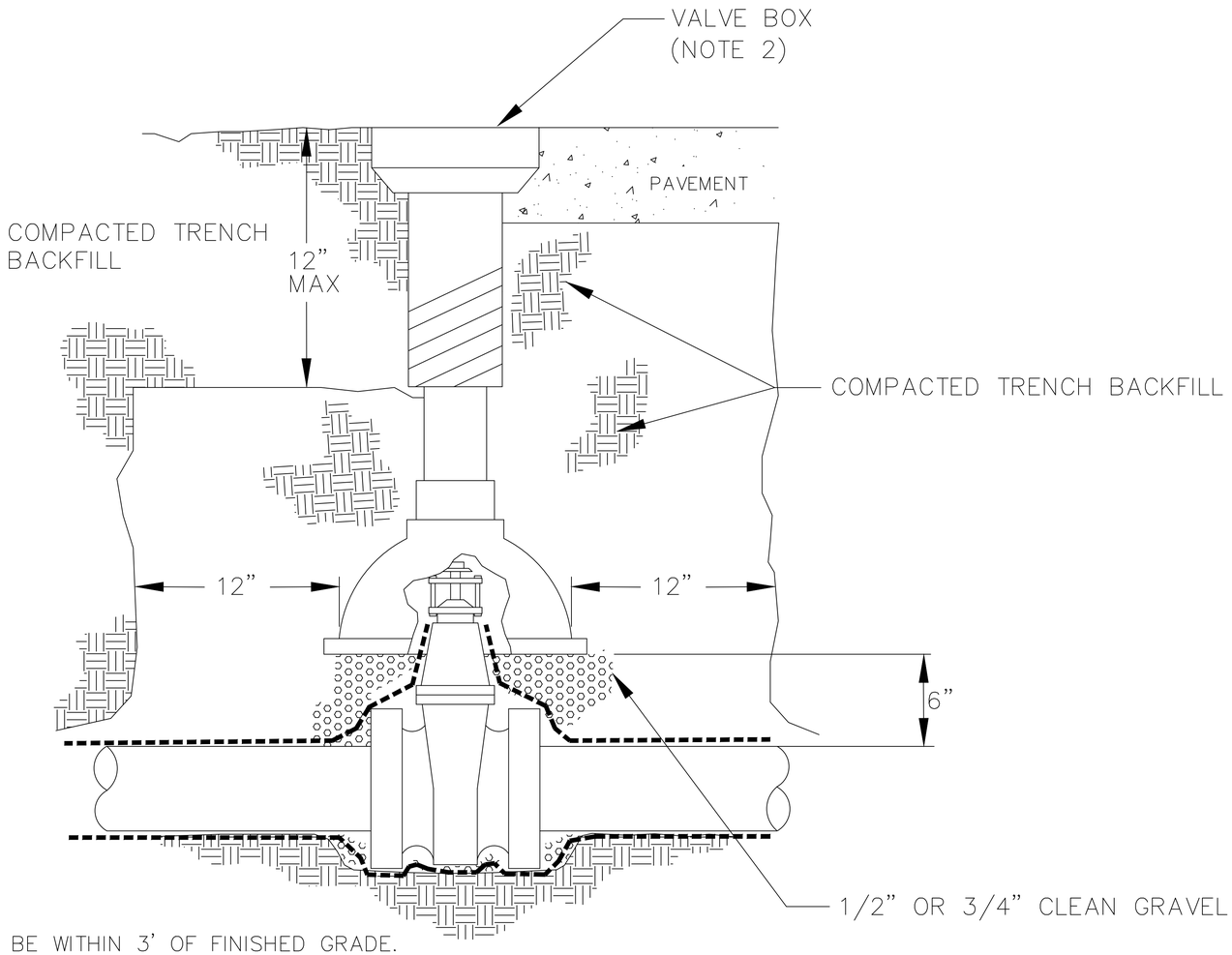
TYPICAL BLOWOFF ASSEMBLY

SIZE	FSCM NO.	DWG NO.	REV
A		SD-20	

SCALE NONE

SHEET 1 OF 1



NOTE: VALVE NUT TO BE WITHIN 3' OF FINISHED GRADE.

NOTES:

1. VALVE NUT TO BE WITHIN 3' OF FINISHED GRADE.
2. VALVE BOX SHALL BE 6" C900 w/ A CLAY & BAILEY 2195 OR APPROVED EQUAL.

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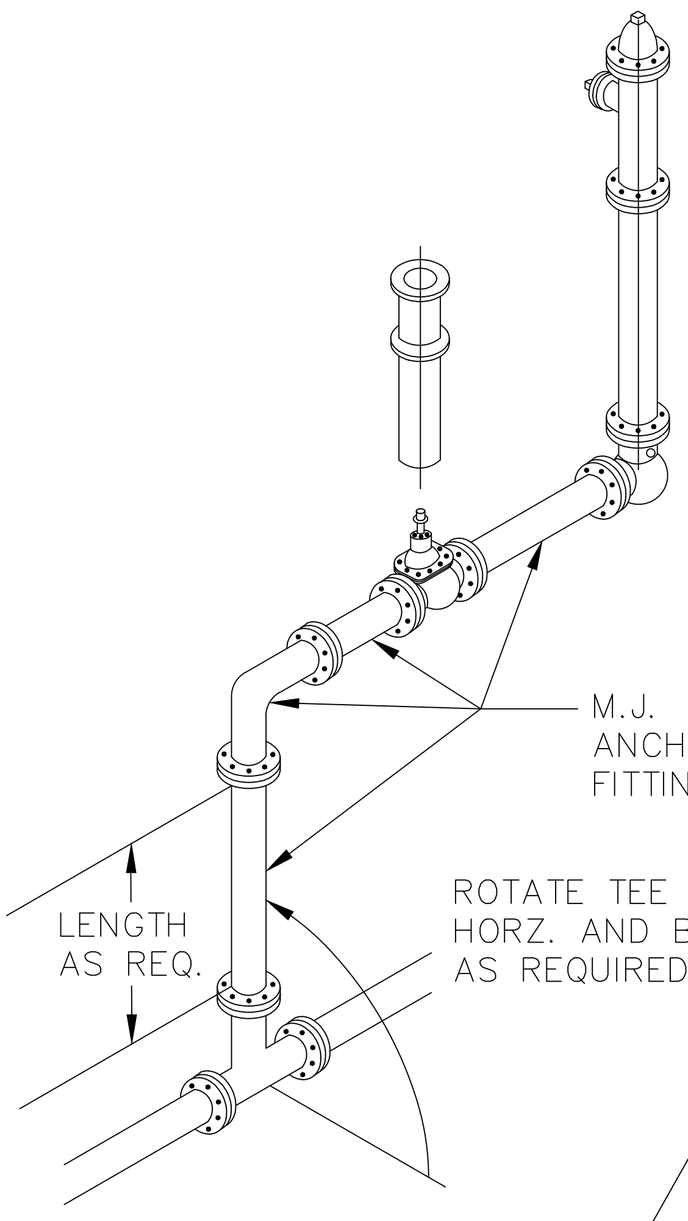
WATER VALVE BOX

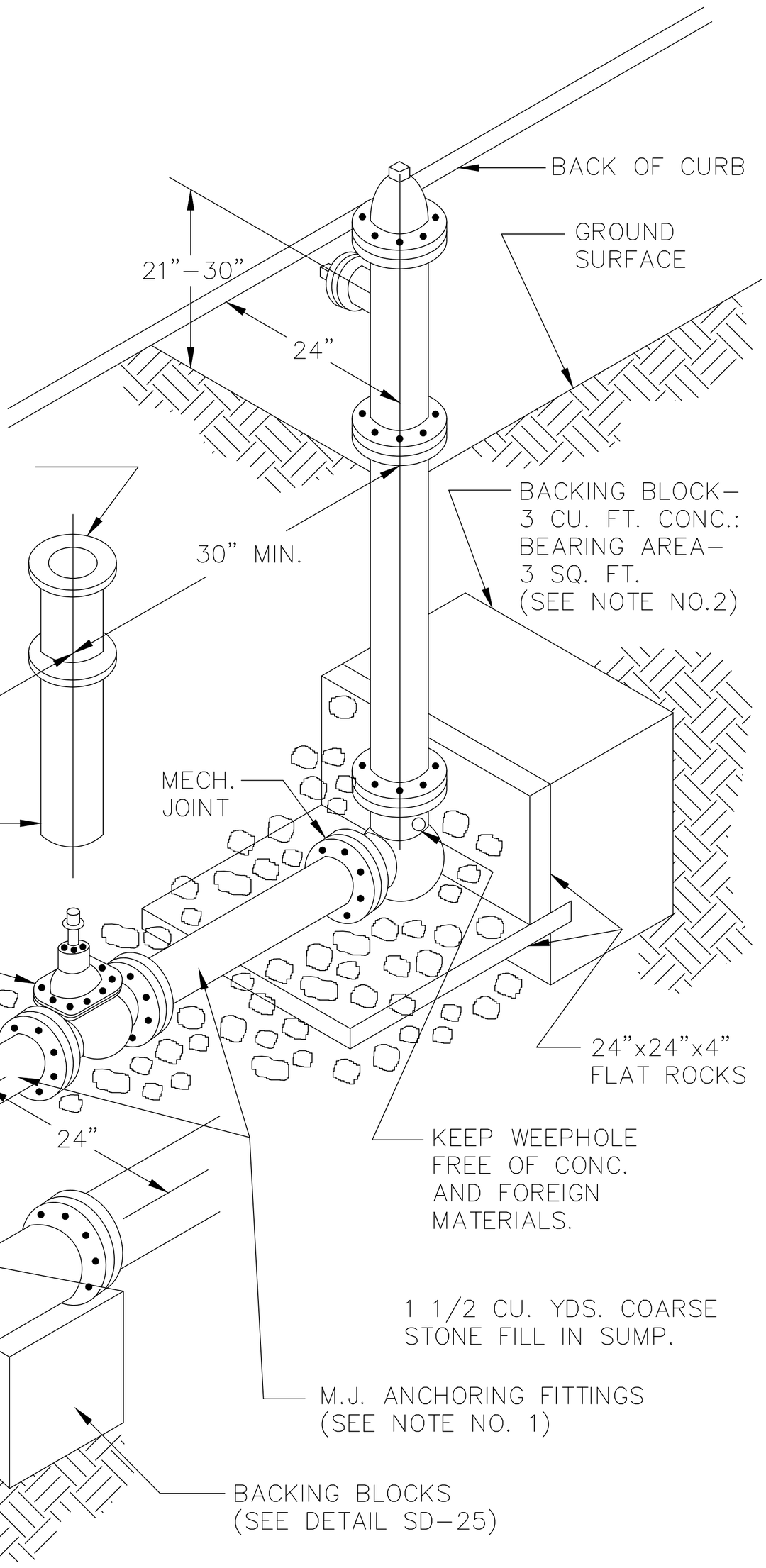
SIZE	FSCM NO.	DWG NO.	REV
A		SD-21	

SCALE NONE

SHEET 1 OF 1



USE "S" BEND FOR
SMALL DEVIATION



NOTES:
1. ALL FIRE HYDRANTS SHALL BE INSTALLED USING EITHER RETAINER GASKETS OR ANCHORING FITTINGS.
2. BACKING BLOCKS ARE REQUIRED WHEN CONNECTING TO P.V.C. MAINS.
3. SEE SD–21.
4. SEE APWA SECTION 2902.4 FOR FIRE HYDRANT REQUIREMENTS. HYDRANT TO BE PAINTED RED.
5. ALL PIPES 6 INCHES OR ABOVE SHALL BE DUCTILE IRON CLASS 50.
   ALL 4 INCH PIPES SHALL BE DUCTILE IRON CLASS 51.
6. WHEN INSTALLING HYDRANTS ON PVC MAIN, THE HYDRANT LEAD PIPE SHOULD BE OF THE SAME MATERIAL AS THE SUPPLY MAIN, AND A CONCRETE COLLAR SHALL BE INSTALLED AROUND THE HYDRANT LOWER BARREL.

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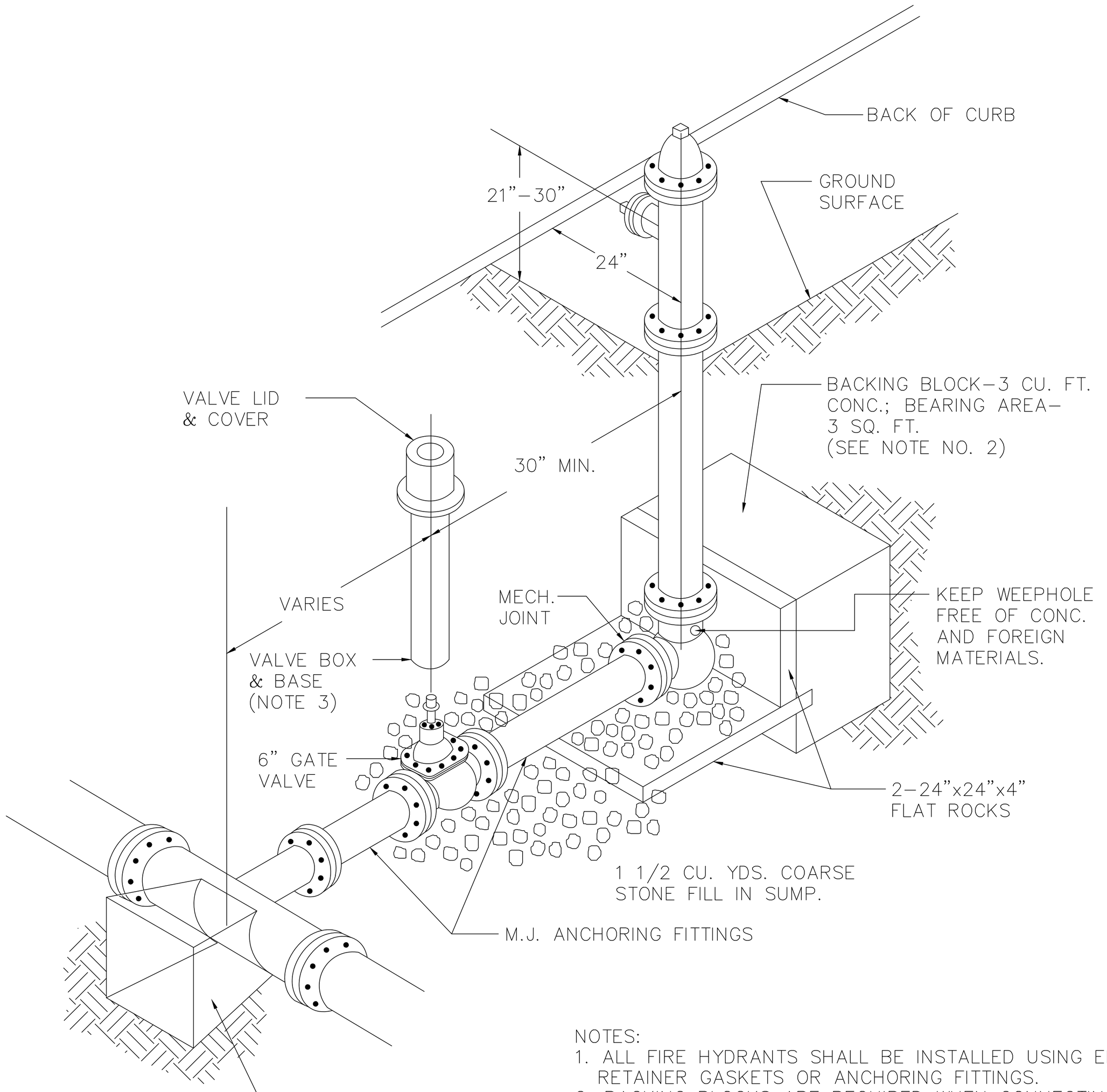
CITY OF OAK GROVE

TYPICAL HYDRANT INSTALLATION WITH 90° BEND (TYPE "A")

SIZE	FSCM NO.	DWG NO.	REV
A		SD–22	

SCALE NONE

SHEET 1 OF 1



NOTES:

1. ALL FIRE HYDRANTS SHALL BE INSTALLED USING EITHER RETAINER GASKETS OR ANCHORING FITTINGS.
2. BACKING BLOCKS ARE REQUIRED WHEN CONNECTING TO P.V.C. MAINS.
3. SEE SD–21.
4. SEE APWA SECTION 2902.4 FOR FIRE HYDRANT REQUIREMENTS. HYDRANT TO BE PAINTED RED.
5. ALL PIPES 6 IN. OR ABOVE SHALL BE DUCTILE IRON CLASS 50.
   ALL 4 IN. PIPES SHALL BE DUCTILE IRON CLASS 51.
6. WHEN INSTALLING HYDRANTS ON PVC MAIN, THE HYDRANT LEAD PIPE SHOULD BE OF THE SAME MATERIAL AS THE SUPPLY MAIN, AND A CONCRETE COLLAR SHALL BE INSTALLED AROUND THE HYDRANT LOWER BARREL.

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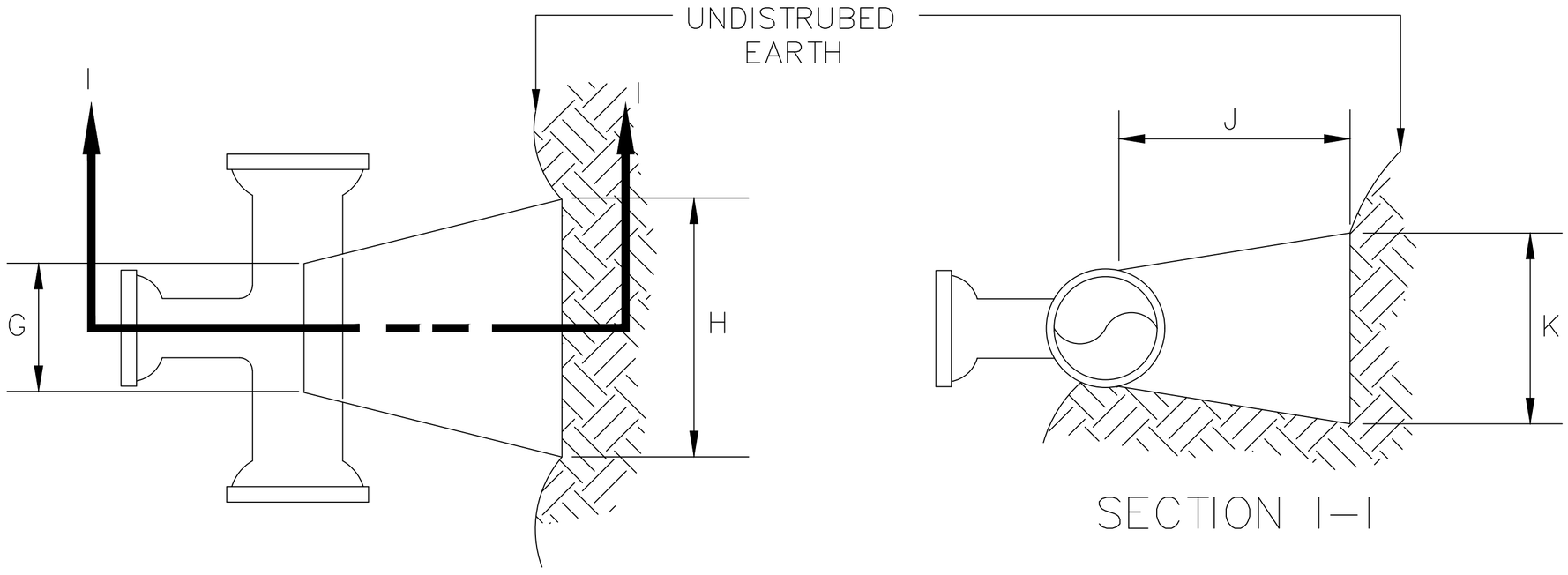
TYPICAL HYDRANT INSTALLATION (TYPE "B" SETTING)

SIZE	FSCM NO.	DWG NO.	REV
A		SD–23	

SCALE NONE

SHEET 1 OF 1



SECTION I–I

NOTES:
1. WHEN USING A PLUG OR TEE WITH A BRANCH SIZE NOT COVERED IN THESE CHARTS, A BACKING BLOCK FOR THE NEXT LARGER PLUG OR BRANCH SHALL BE USED.
2. BACKING BLOCKS FOR PIPING SIZES UP THROUGH 12–INCH ARE BASED ON WORKING PRESSURE OF 225 P.S.I. INCLUDING SURGE.
3. BACKING BLOCKS FOR PIPING SIZES 16–INCH THROUGH 24–INCH ARE BASED ON A WORKING PRESSURE OF 200 P.S.I. INCLUDING SURGE.

BRANCH SIZE	G	H	J	K
6”	8”	30”	24”	18”
8”	8”	40”	24”	24”
12”	12”	54”	30”	40”
16”	12”	65”	36”	50”
20”	16”	85”	40”	60”
24”	18”	102”	54”	72”

CUBIC FEET OF CONCRETE REQUIRED								
PLUG		TEE						
		RUN	BRANCH					
SIZE	CU. FT.		6	8	12	16	20	24
6	5	6	5	–	–	–	–	–
8	8	8	5	8	–	–	–	–
12	21	12	5	8	21	–	–	–
16	37	16	5	8	21	37	–	–
20	64	20	5	8	21	37	64	–
24	123	24	5	8	21	37	64	123

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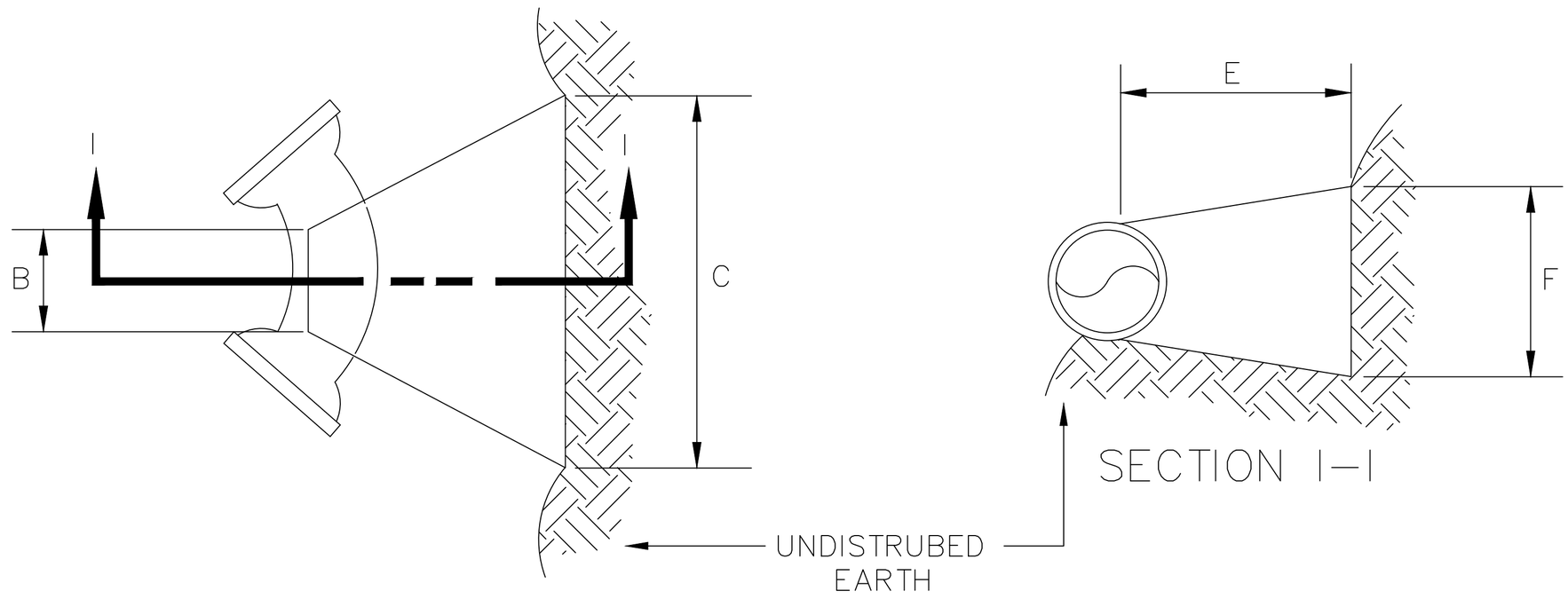
TYPICAL BACKING BLOCKS FOR TEES AND PLUGS

SIZE	FSCM NO.	DWG NO.	REV
A		SD–24	

SCALE NONE

SHEET 1 OF 1



NOTES:

1. WHEN USING A BEND WITH A DIAMETER NOT COVERED IN THESE CHARTS, A BACKING BLOCK FOR THE NEXT LARGER DIAMETER PIPE WITH THE SAME DEGREE OF BEND SHALL BE USED.
2. BACKING BLOCKS FOR PIPING SIZES UP THROUGH 12–INCH ARE BASED ON WORKING PRESSURE OF 225 P.S.I. INCLUDING SURGE.
3. BACKING BLOCKS FOR PIPING SIZES 16–INCH THROUGH 24–INCH ARE BASED ON A WORKING PRESSURE OF 200 P.S.I. INCLUDING SURGE.

BENDS	B	C	D	E	F
6" 11 1/4 & 22 1/2 °	8"	12"	8"	24"	9"
6" 45°	8"	17"	8"	24"	12"
6" 90°	8"	27"	8"	24"	14"
8" 11 1/4 & 22 1/2 °	8"	16"	10"	24"	12"
8" 45°	8"	23"	10"	24"	16"
8" 90°	8"	34"	10"	24"	20"
12" 11 1/4 & 22 1/2 °	8"	26"	12"	24"	16"
12" 45°	8"	34"	12"	24"	24"
12" 90°	8"	50"	12"	24"	30"
16" 11 1/4 °	8"	20"	16"	24"	16"
16" 22 1/2 °	8"	32"	16"	24"	20"
16" 45°	8"	42"	16"	30"	30"
16" 90°	8"	58"	16"	36"	40"
20" 11 1/4 °	12"	24"	20"	24"	20"
20" 22 1/2°	12"	42"	20"	30"	24"
20" 45°	12"	54"	20"	36"	36"
20" 90°	12"	75"	20"	42"	48"
24" 11 1/4 °	12"	30"	24"	24"	24"
24" 22 1/2°	12"	44"	24"	30"	33"
24" 45°	12"	59"	24"	42"	48"
24" 90°	12"	87"	24"	54"	60"

CUBIC FEET OF CONCRETE REQUIRED				
BEND	11 1/4 °	22 1/2°	45°	90°
6"	1.4	1.4	2.9	3.3
8"	2.1	2.1	3.3	5.5
12"	3.8	3.8	6.5	11.3
16"	3.8	5.6	12.4	25.9
20"	5.4	11.2	23.2	47.2
24"	7.4	15.5	38.4	86.6

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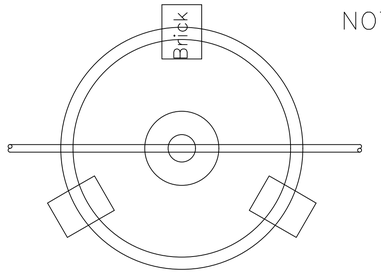
TYPICAL BACKING BLOCKS FOR BENDS

SIZE A | FSCM NO. | DWG NO. SD–25 | REV

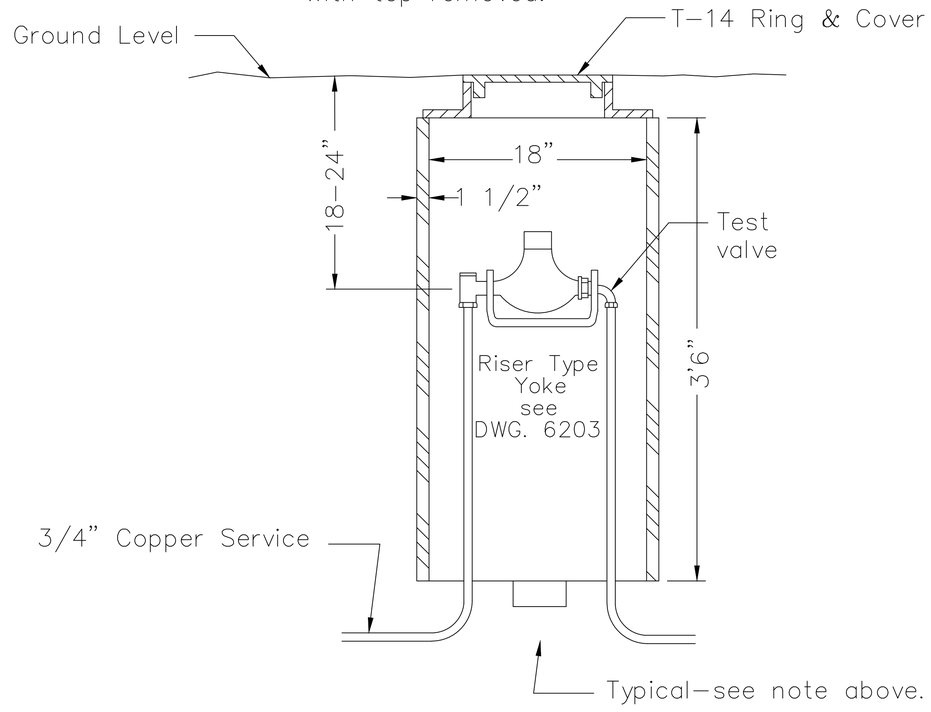
SCALE NONE

SHEET 1 OF 1

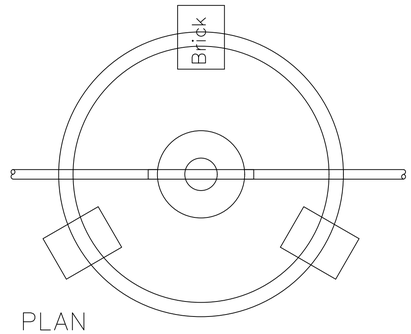
NOTE: 3 full brick equally spaced.
Tile to be set plumb.
Not for installation in driveway.
Tile may be supported from
and/or secured to foundation.



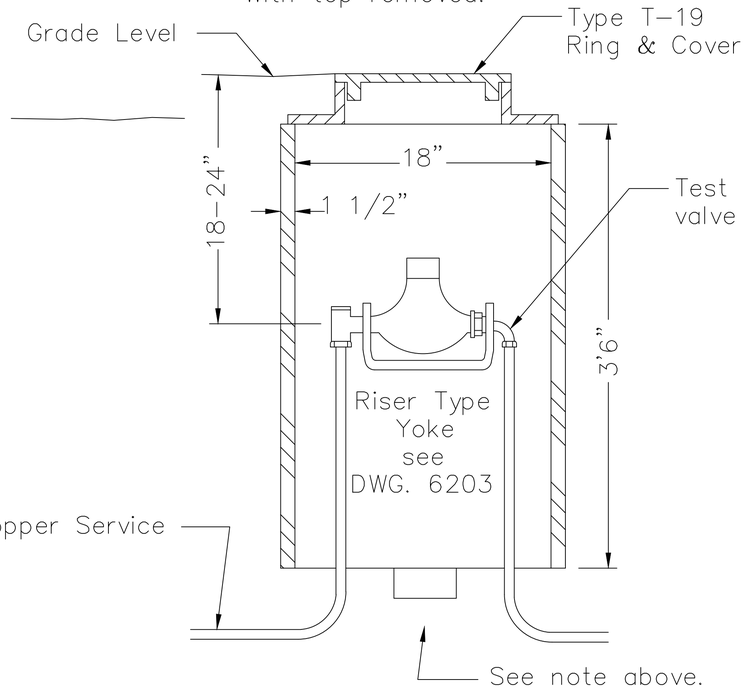
PLAN
With top removed.



SECTION



PLAN
With top removed.



SECTION

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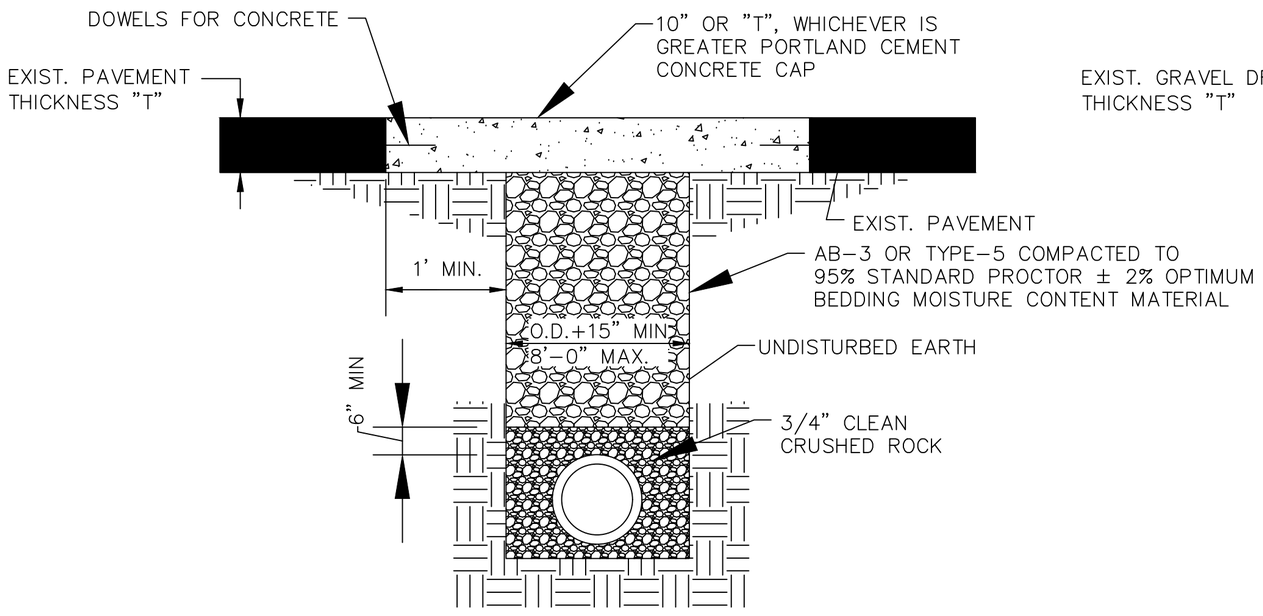
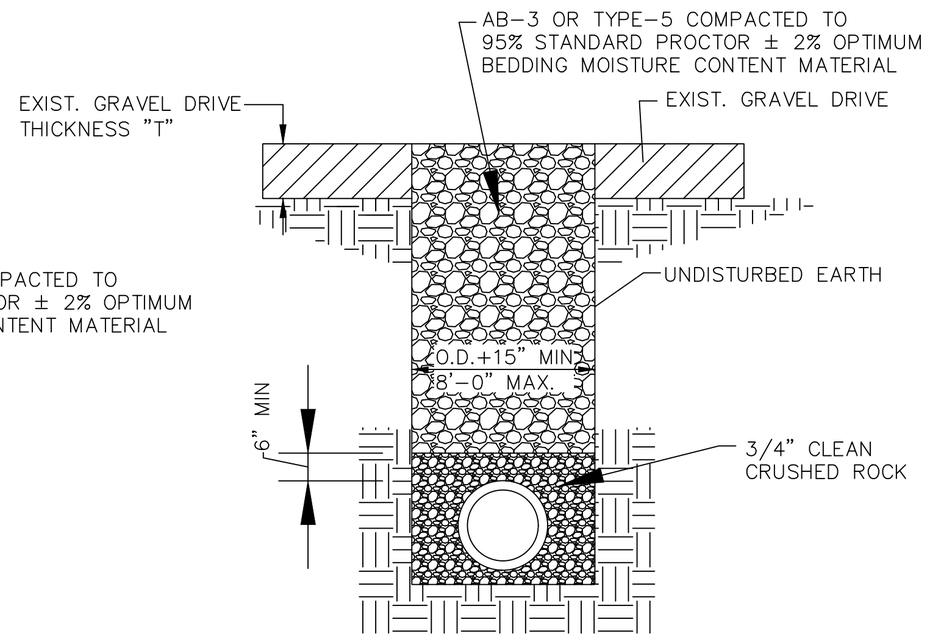
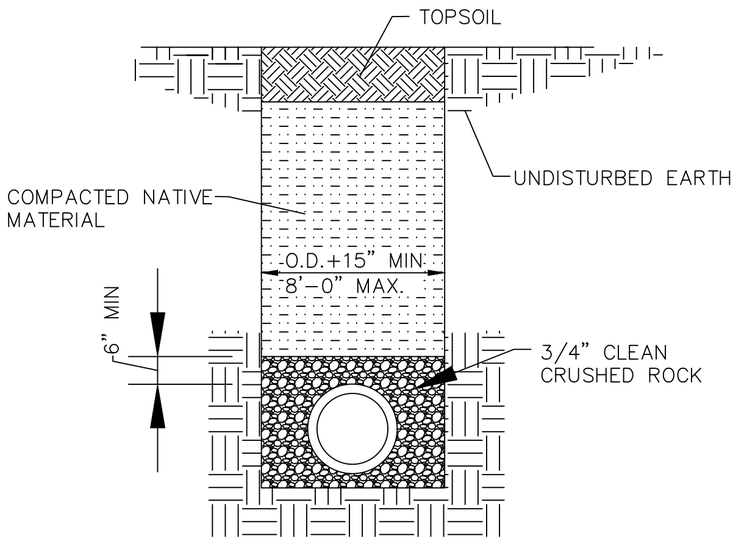
DRAWN / DATE	Detail of Tile Box for 3/8", 3/4" & 1" Meter Settings
CHECKED	SIZE A · FSCM NO. · DWG NO. SD–26 · REV
APPROVED	SCALE · SHEET OF



TRENCH UNDER PAVEMENT DETAIL
SCALE: NOT TO SCALE



TRENCH UNDER GRAVEL DRIVE & SHOULDER DETAIL
SCALE: NOT TO SCALE



TRENCH UNDER GRASSY AREAS DETAIL
SCALE: NOT TO SCALE

TRENCH UNDER PAVEMENT NOTES:

1. NEW SURFACING SHALL BE INSTALLED FLUSH WITH SURROUNDING SURFACE AND SHALL MATCH THE SLOPE AND CONTOURS OF THE SURROUNDING PAVEMENT.
2. DRIVEWAY PAVEMENT SHALL BE REMOVED TWELVE (12) INCHES BEYOND THE DISTURBED AREA. IF EXCAVATION IS WITHIN THREE (3) FEET OF AN EXIST. JOINT OR CUT, THE SURFACE SHALL BE EXTENDED TO THE JOINT.
3. EXIST. PAVING TO BE SAW CUT.
4. ROCK BACKFILL SHALL BE AB-3 OR TYPE-5. BACKFILL SHALL BE COMPACTED TO 95% STANDARD PROCTOR ± 2% OPTIMUM MOISTURE CONTENT.

TRENCH UNDER GRAVEL DRIVE/SHOULDER NOTES:

1. NEW SURFACING SHALL BE INSTALLED FLUSH WITH SURROUNDING SURFACE AND SHALL MATCH THE SLOPE AND CONTOURS OF THE SURROUNDING PAVEMENT.
2. ROCK BACKFILL SHALL BE AB-3 OR TYPE-5. BACKFILL SHALL BE COMPACTED TO 95% STANDARD PROCTOR ± 2% OPTIMUM MOISTURE CONTENT.
3. IN GRASS SHOULDER AREAS, 12" OF TOPSOIL SHALL BE PLACED.

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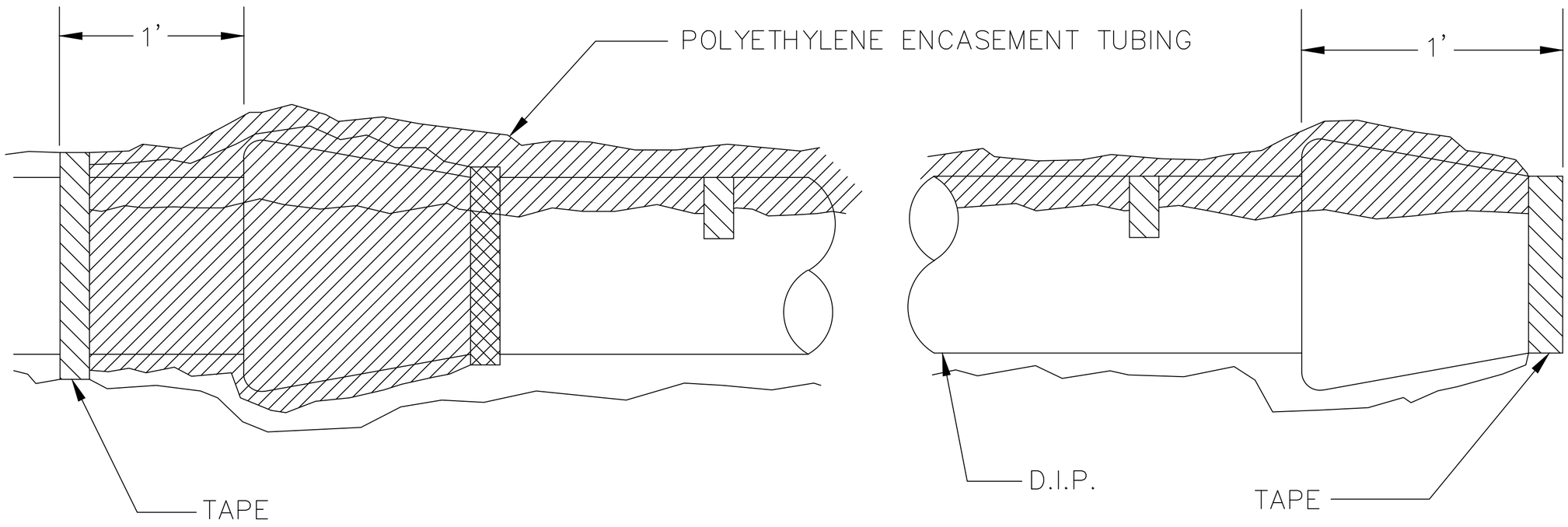
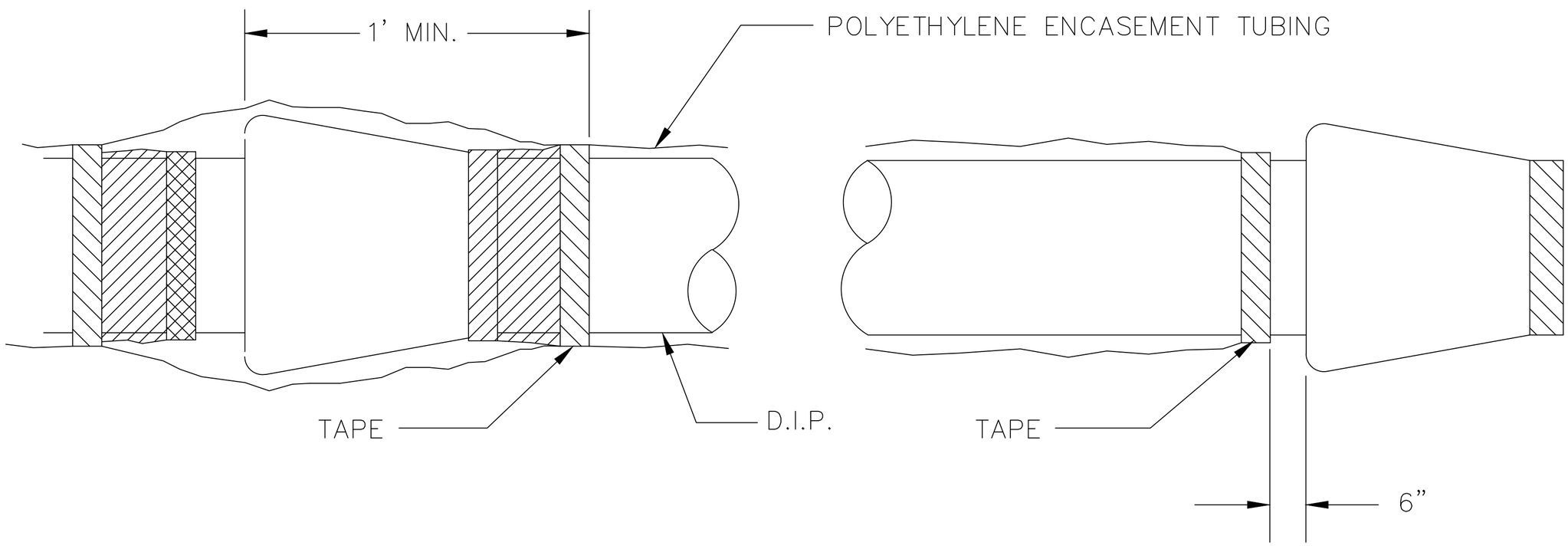
EMBEDMENTS FOR WATER MAINS

SIZE	FSCM NO.	DWG NO.	REV
A		SD-27	

SCALE NONE | SHEET 1 OF 1



METHOD A



METHOD B

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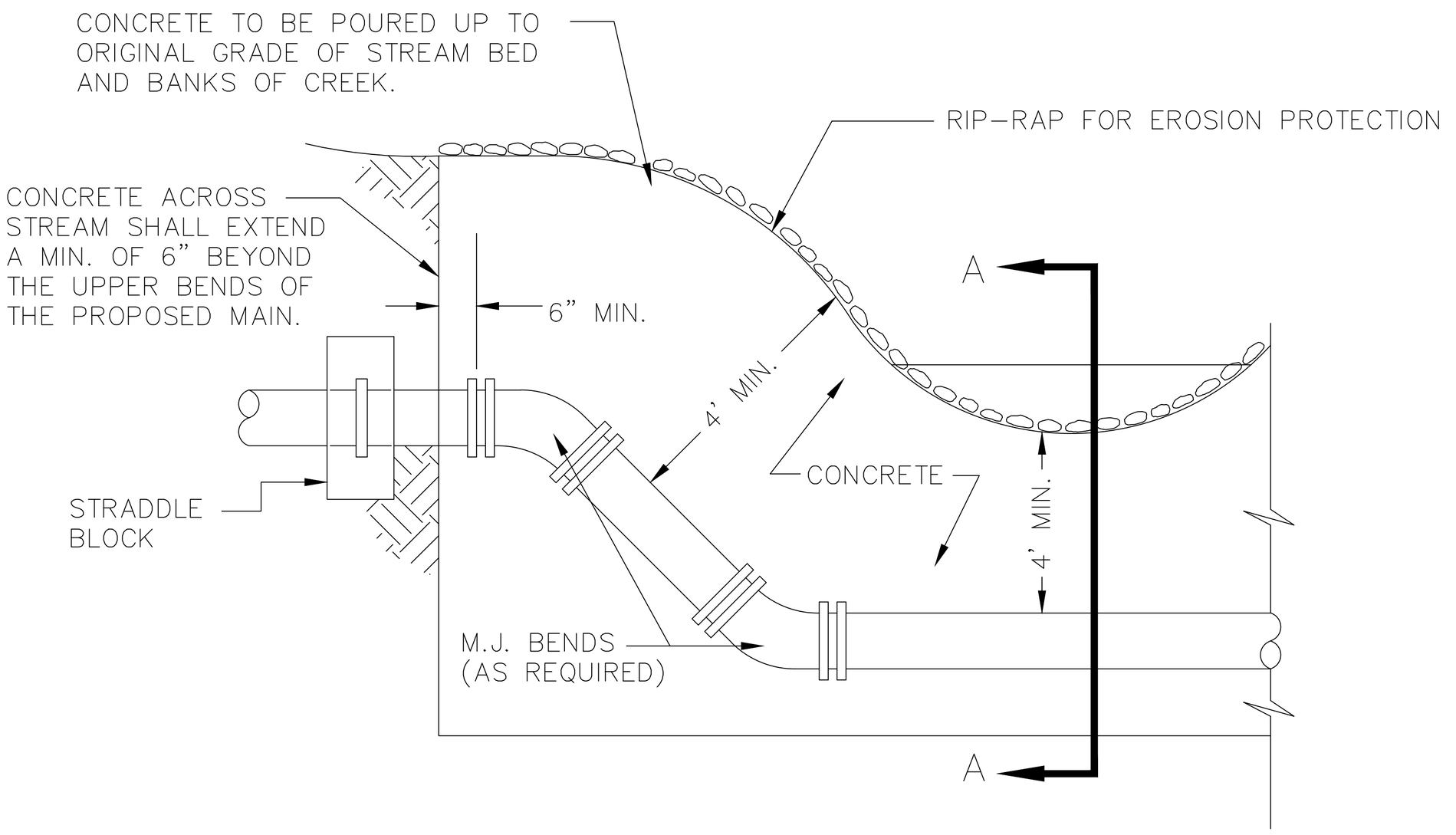
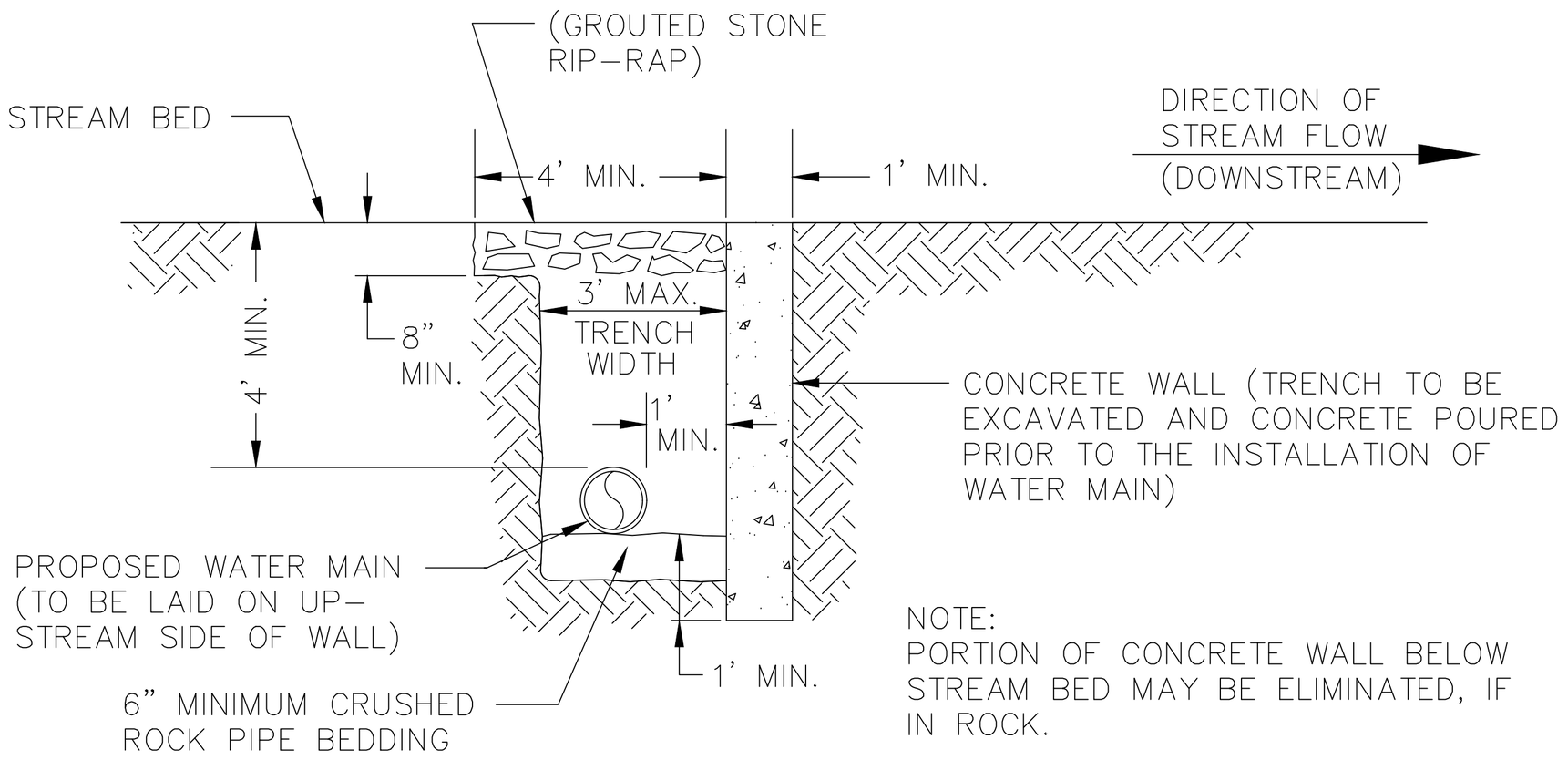
POLYETHYLENE ENCASEMENT FOR DUCTILE IRON PIPE

SIZE	FSCM NO.	DWG NO.	REV
A		SD-28	

SCALE NONE

SHEET 1 OF 1





SECTION A-A

NOTES:
1. JOINTS SHALL BE RESTRAINED THROUGHOUT WITH RETAINER GLANDS. RUNS CONSISTING OF MORE THAN ONE LENGTH OF PIPE SHALL BE RESTRAINED BY USING SOLID SLEEVES AND RETAINER GLANDS.
2. STONE RIP-RAP ON UPSTREAM SIDE OF WALL SHALL EXTEND ACROSS STREAM BED AND BANKS TO THE END OF THE WALL.
3. ALL PIPES 6 INCHES OR ABOVE SHALL BE DUCTILE IRON CLASS 50. ALL 4 INCH PIPES SHALL BE DUCTILE IRON CLASS 52.

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TYPICAL STREAM CROSSING 12" MAINS AND SMALLER

SIZE	FSCM NO.	DWG NO.	REV
A		SD-29	

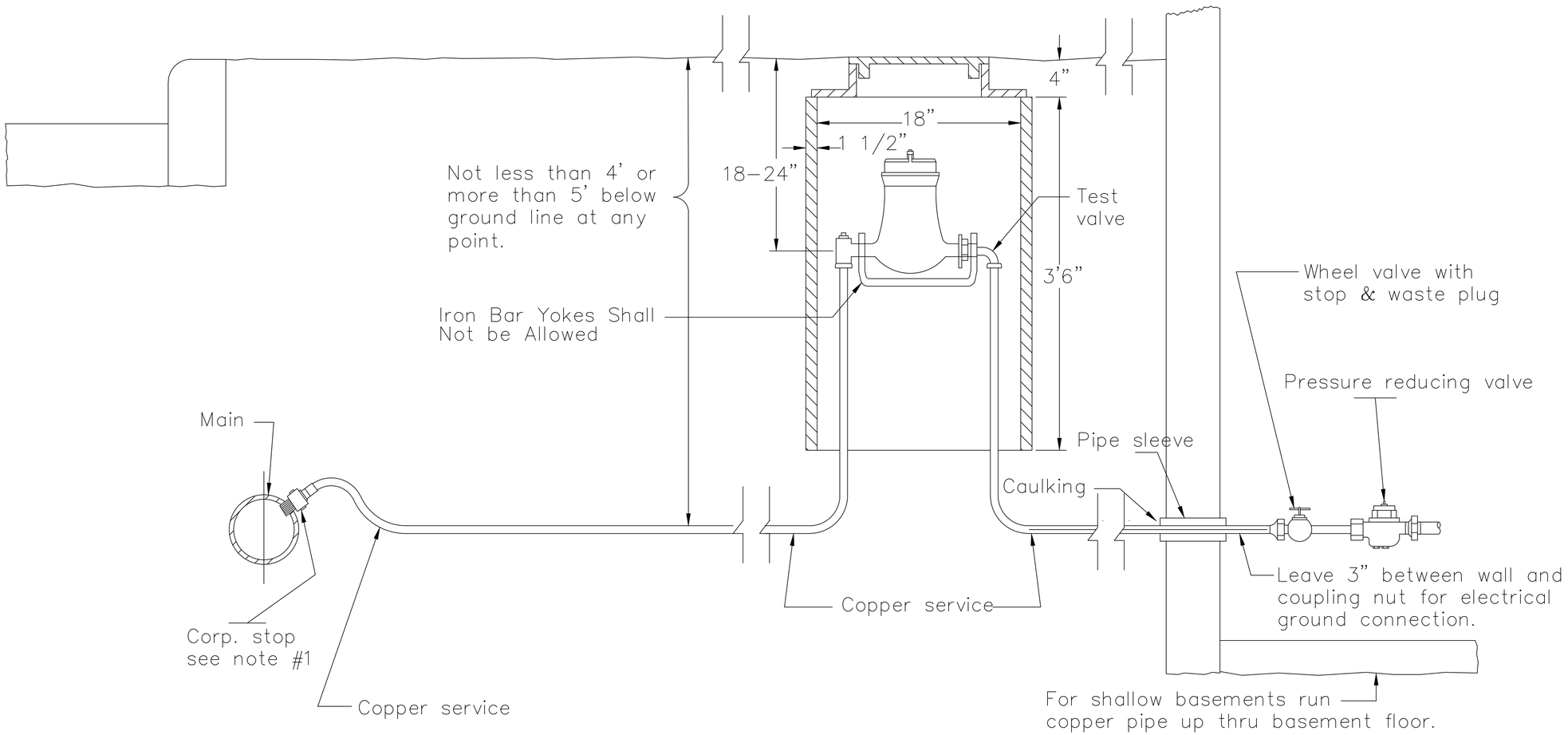
SCALE NONE

SHEET 1 OF 1

NOTES:

1. Corp stops installed by Water Dept.
2. All service piping to be copper type K.

SERVICE LINE REQUIREMENTS			
Service Size See Note #3	Corp. Size See Note #1	Curb Stop Size See Note #2	Meter Size
3/4"	3/4"	3/4"	5/8" or 3/4"
1"	1"	1"	1"



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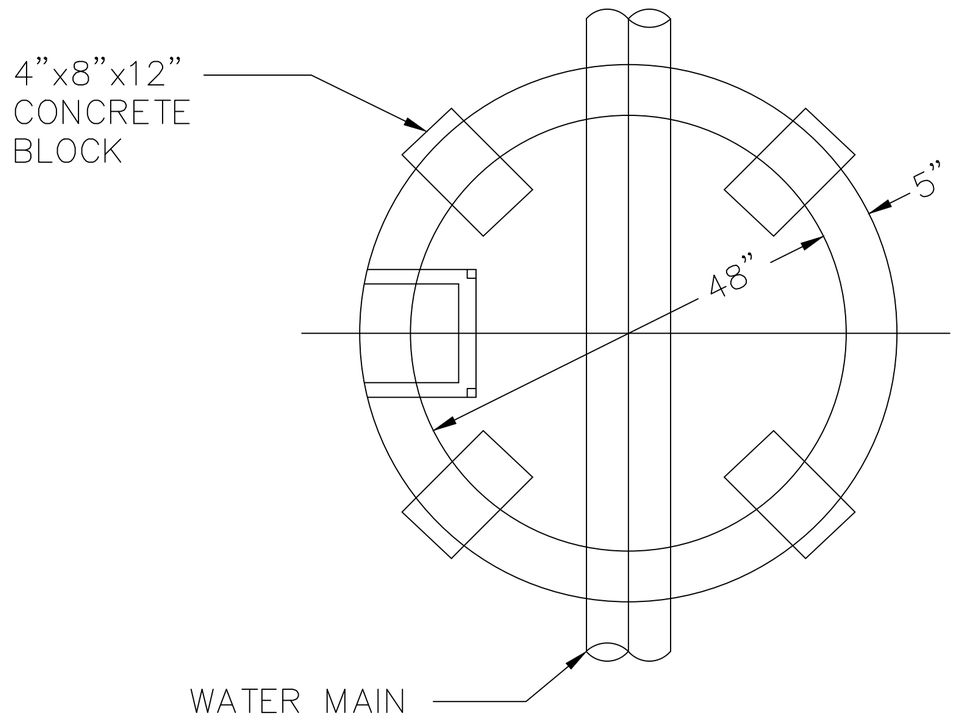
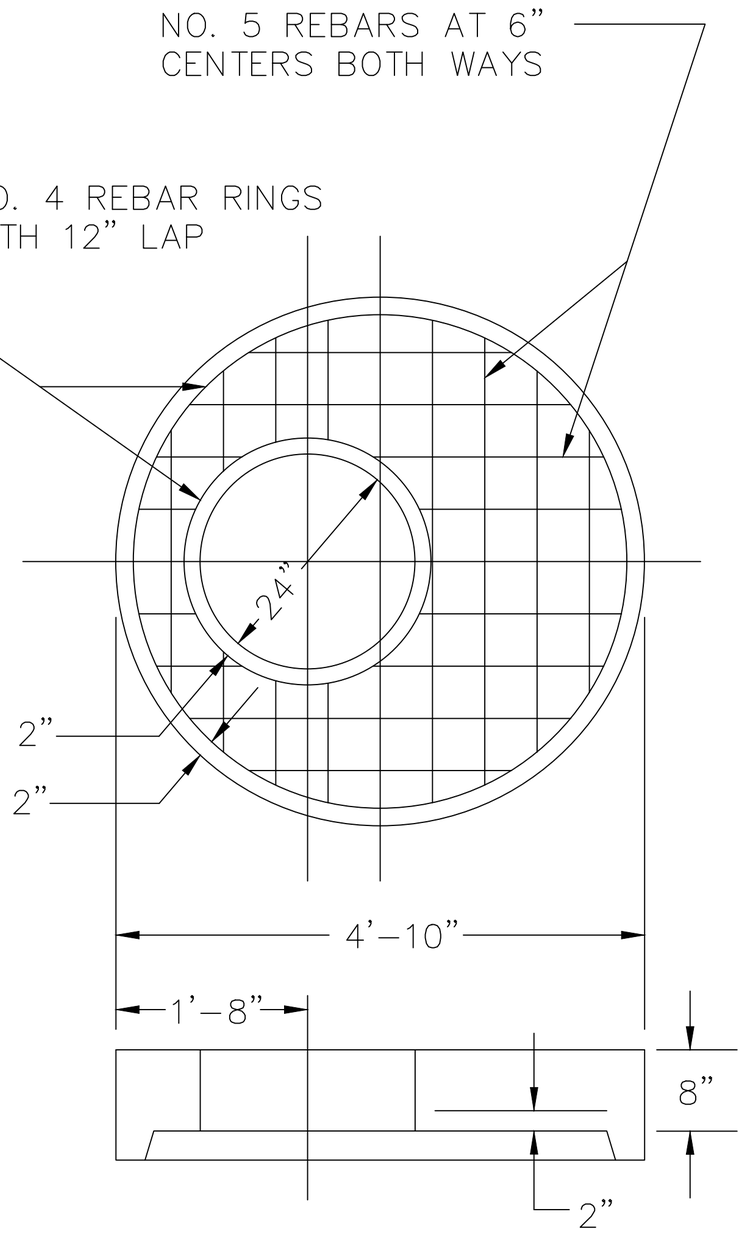
Outside Installation for 3/4" & 1" Services

SIZE	FSCM NO.	DWG NO.	REV
A		SD–30	

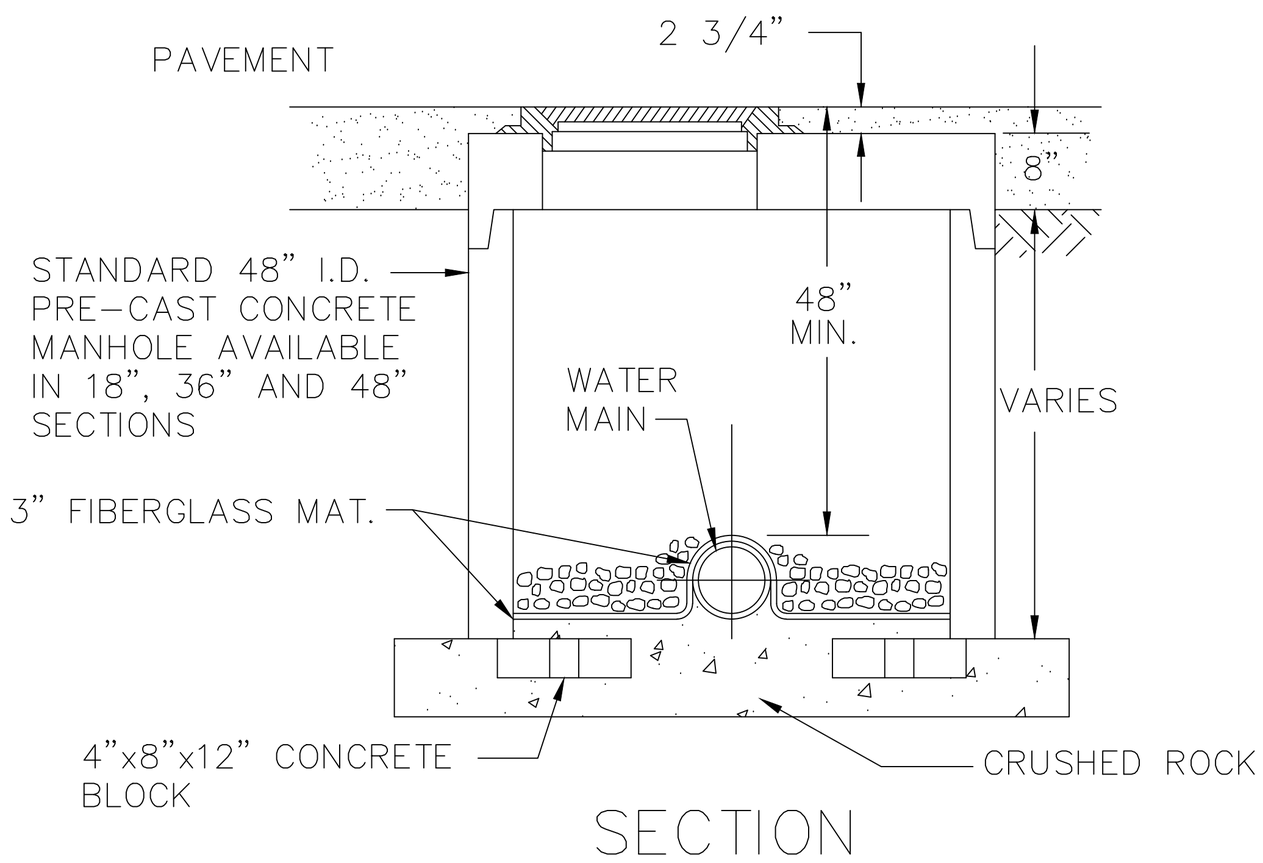
SCALE | SHEET OF



PLAN



DETAIL
ROOF SLAB



SECTION

NOTES:
1. VAULT SHALL BE STANDARD 48" I.D. PRECAST CONCRETE MANHOLE USING A MINIMUM RISER OF 48 INCHES. ADDITIONAL RISERS MAY BE USED, IF NEEDED, TO ADJUST DEPTH OF MANHOLE.
2. RINGS AND LIDS:
   SEE SD-5

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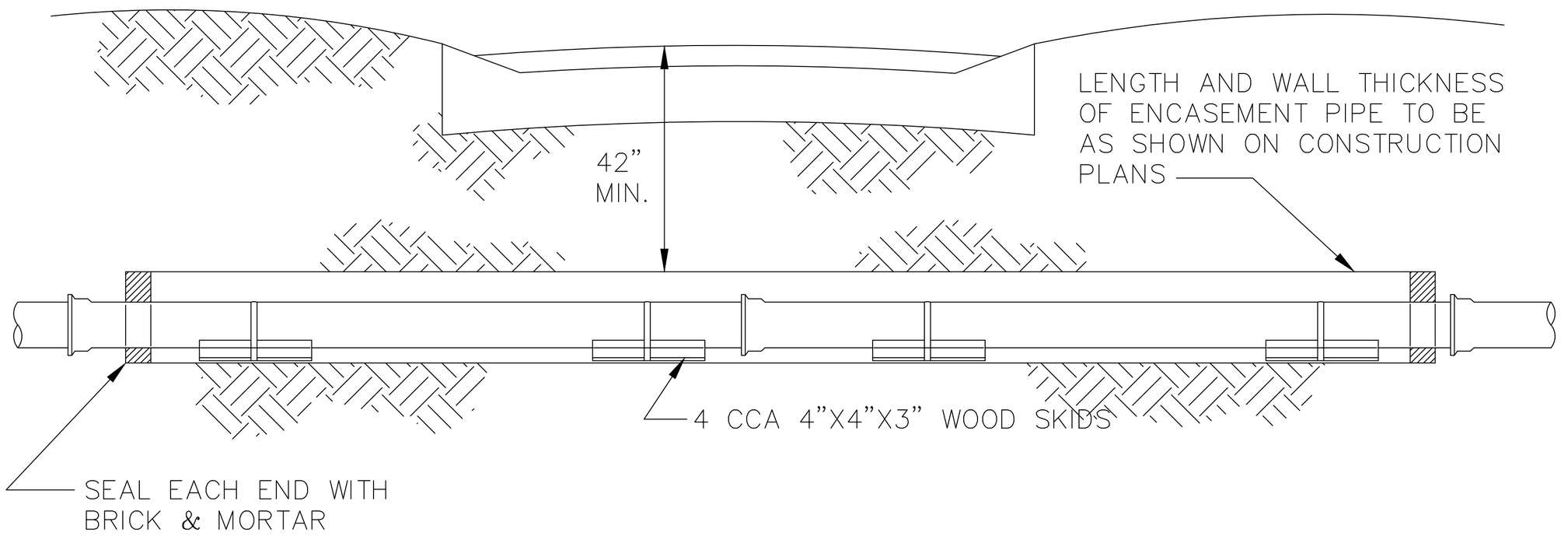
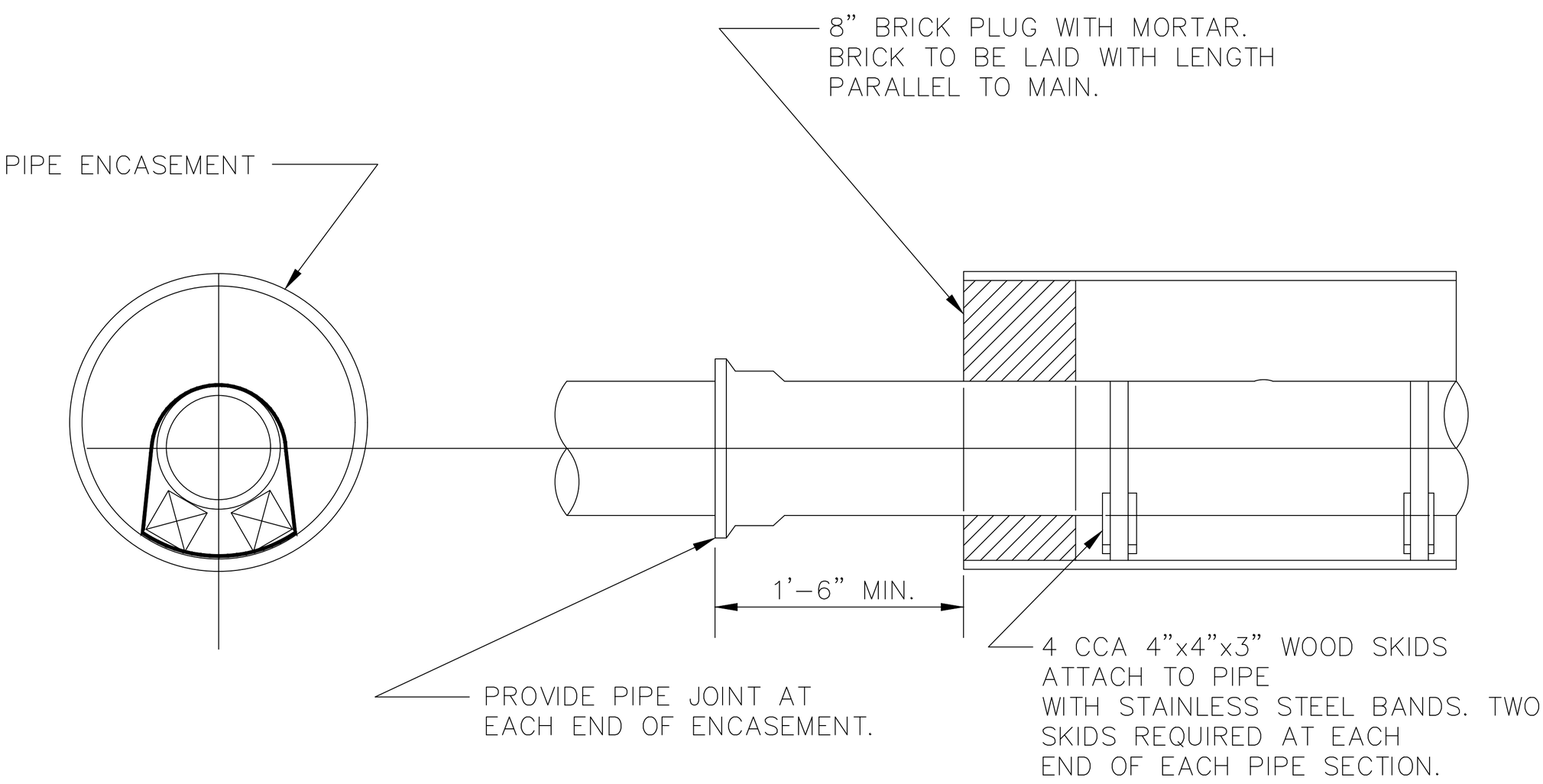
TYPICAL PRE-CAST CONCRETE VAULT

SIZE	FSCM NO.	DWG NO.	REV
A		SD-31	

SCALE NONE

SHEET 1 OF 1





CROSS SECTION

SECTION

NOTES:
1. DETAILS SHOWN ARE SIMILAR FOR STEEL & CONCRETE PIPE ENCASEMENT.
2. POLYETHYLENE ENCASEMENT SHALL BE INSTALLED ON ALL DUCTILE IRON PIPE AND FITTINGS INCLUDING DUCTILE IRON PIPE WHICH IS IN ENCASE-MENT PIPE.

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TYPICAL ENCASEMENT UNDER ROADWAYS

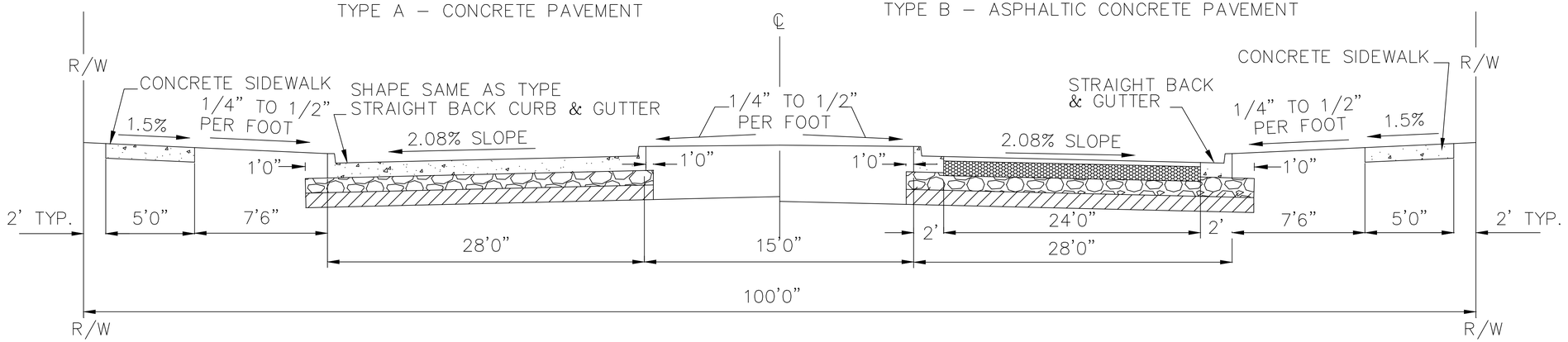
SIZE	FSCM NO.	DWG NO.	REV
A		SD-32	

SCALE NONE

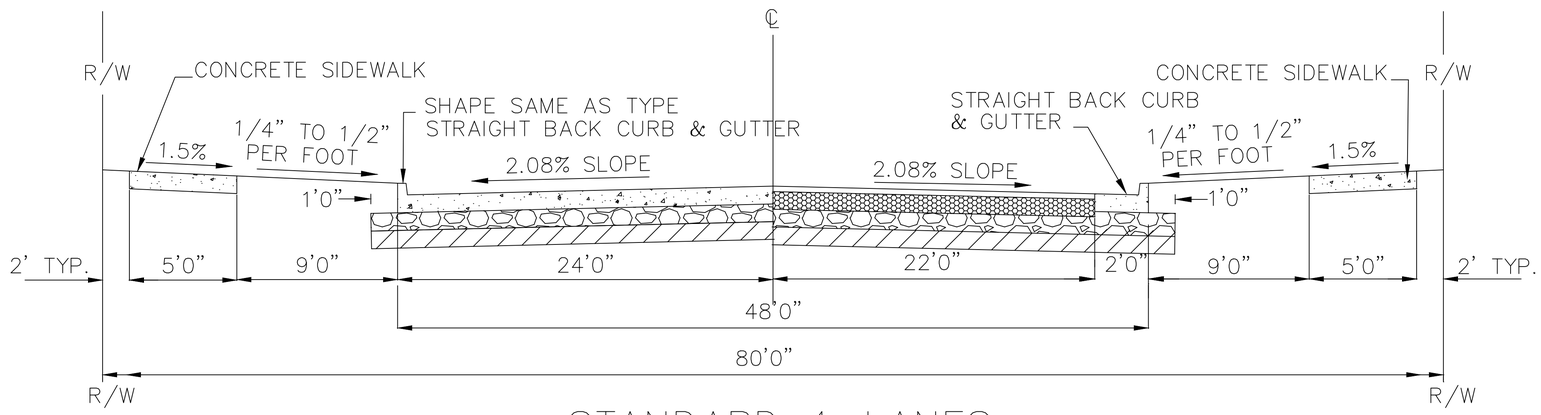
SHEET 1 OF 1

TYPE A – CONCRETE PAVEMENT

TYPE B – ASPHALTIC CONCRETE PAVEMENT



DUAL LANE 4–LANE



STANDARD 4–LANES

TYPE A – CONCRETE PAVEMENT
(Minimum Thickness)

- 9" PORTLAND CEMENT CONCRETE PAVEMENT
- 6" MODOT TYPE 5 AGGREGATE
- 6" COMPACTED SUBGRADE 95% OF STANDARD MAXIMUM DENSITY

TYPE B – ASPHALTIC CONCRETE PAVEMENT
(Minimum Thickness)

- 2" TYPE 6–01 ASPHALTIC CONCRETE SURFACE COURSE
- 8" TYPE 5–01 ASPHALTIC CONCRETE BASE COURSE
- 6" MODOT TYPE 5 AGGREGATE
- 6" COMPACTED SUBGRADE 95% OF STANDARD MAXIMUM DENSITY

NOTE:

1. MATERIAL THICKNESS SHOWN IS THE REQUIRED MINIMUM THICKNESS. ACTUAL THICKNESS TO BE DETERMINED BY A SUBMITTED PAVEMENT DESIGN, SUBJECT TO APPROVAL OF CITY ENGINEER.
2. PORTLAND CEMENT CONCRETE PAVEMENT SHALL BE NRDJ, AND MATERIAL SHALL BE KCMMB 4K IN ACCORDANCE WITH THE KANSAS CITY METROPOLITAN MATERIALS BOARD.
3. ALL ASPHALTIC CONCRETE JOINTS IN NEW CONSTRUCTION SHALL BE SEALED WITH HOT POUR JOINT SEALANT AS DIRECTED BY THE CITY ENGINEER.

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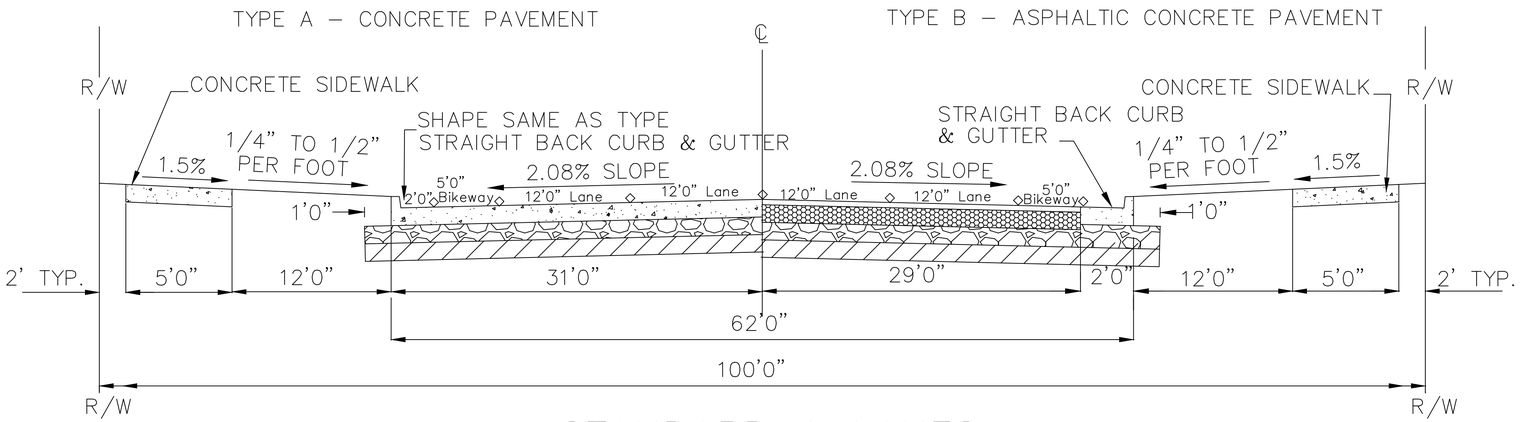
CITY OF OAK GROVE

SECONDARY ARTERIAL STREETS

SIZE	FSCM NO.	DWG NO.	REV
A		SD–33	

SCALE NONE

SHEET 1 OF 1



STANDARD 4–LANES

TYPE A – CONCRETE PAVEMENT
(Minimum Thickness)

- PORTLAND CEMENT CONCRETE PAVEMENT
- 6" MODOT TYPE 5 AGGREGATE
- 6" COMPACTED SUBGRADE 95% OF STANDARD MAXIMUM DENSITY

TYPE B – ASPHALTIC CONCRETE PAVEMENT
(Minimum Thickness)

- 2" TYPE 6–01 ASPHALTIC CONCRETE SURFACE COURSE
- 8" TYPE 5–01 ASPHALTIC CONCRETE BASE COURSE
- 6" MODOT TYPE 5 AGGREGATE
- 6"COMPACTED SUBGRADE 95% OF STANDARD MAXIMUM DENSITY

NOTE:

1. MATERIAL THICKNESS SHOWN IS THE REQUIRED MINIMUM THICKNESS. ACTUAL THICKNESS TO BE DETERMINED BY A SUBMITTED PAVEMENT DESIGN, SUBJECT TO APPROVAL OF CITY ENGINEER.
2. PORTLAND CEMENT CONCRETE PAVEMENT SHALL BE NRDJ, AND MATERIAL SHALL BE KCMMB 4K IN ACCORDANCE WITH THE KANSAS CITY METROPOLITAN MATERIALS BOARD.
3. ALL ASPHALTIC CONCRETE JOINTS IN NEW CONSTRUCTION SHALL BE SEALED WITH HOT POUR JOINT SEALANT AS DIRECTED BY THE CITY ENGINEER.

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CITY OF OAK GROVE

SECONDARY
ARTERIAL STREETS & BIKEWAY

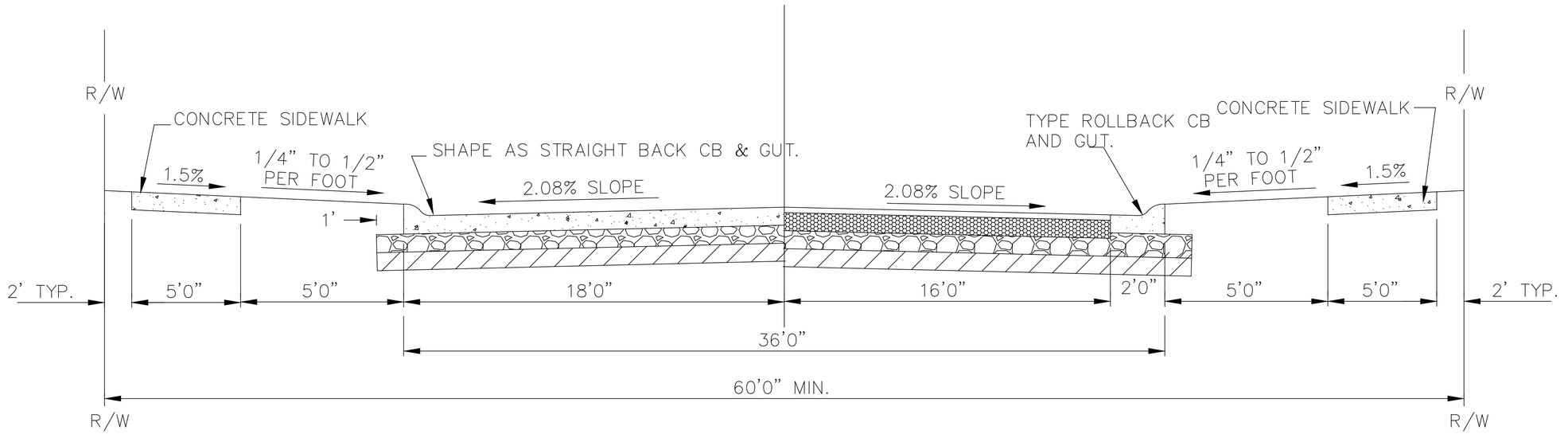
SIZE	FSCM NO.	DWG NO.	REV
A		SD–34	

SCALE NONE

SHEET 1 OF 1

TYPE A – CONCRETE PAVEMENT

TYPE B – ASPHALTIC CONCRETE PAVEMENT



TYPE A – CONCRETE PAVEMENT
(Minimum Thickness)

- 8" PORTLAND CEMENT CONCRETE PAVEMENT
- 6" MODOT TYPE 5 AGGREGATE
- 6" COMPACTED SUBGRADE 95% OF STANDARD MAXIMUM DENSITY

TYPE B – ASPHALTIC CONCRETE PAVEMENT
(Minimum Thickness)

- 2" TYPE 6–01 ASPHALTIC CONCRETE SURFACE COURSE
- 7" TYPE 5–01 ASPHALTIC CONCRETE BASE COURSE
- 6" MODOT TYPE 5 AGGREGATE
- 6" COMPACTED SUBGRADE 95% OF STANDARD MAXIMUM DENSITY

NOTE:

1. MATERIAL THICKNESS SHOWN IS THE REQUIRED MINIMUM THICKNESS. ACTUAL THICKNESS TO BE DETERMINED BY A SUBMITTED PAVEMENT DESIGN, SUBJECT TO APPROVAL OF CITY ENGINEER.
2. PORTLAND CEMENT CONCRETE PAVEMENT SHALL BE NRDJ, AND MATERIAL SHALL BE KCMMB 4K IN ACCORDANCE WITH THE KANSAS CITY METROPOLITAN MATERIALS BOARD.
3. ALL ASPHALTIC CONCRETE JOINTS IN NEW CONSTRUCTION SHALL BE SEALED WITH HOT POUR JOINT SEALANT AS DIRECTED BY THE CITY ENGINEER.

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APPROVED	

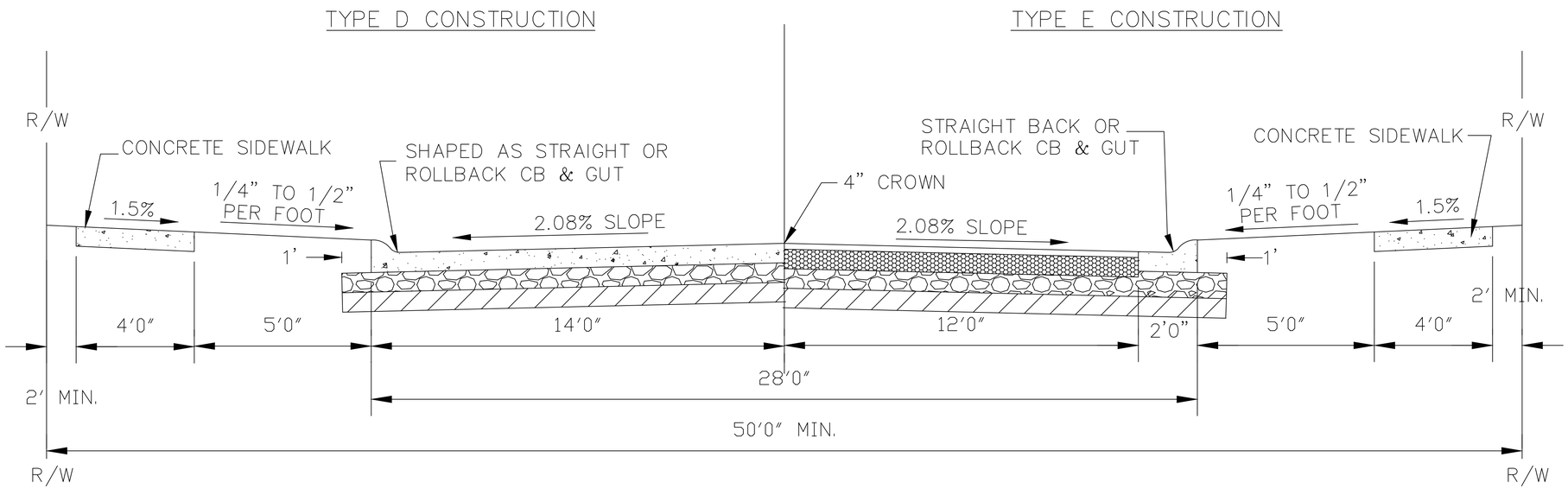
CITY OF OAK GROVE

COLLECTOR DETAIL

SIZE	FSCM NO.	DWG NO.	REV
A		SD–35	

SCALE NONE

SHEET 1 OF 1



TYPE D CONSTRUCTION
(Minimum Thickness)

- 8" PORTLAND CEMENT CONCRETE PAVEMENT
- 6" MODOT TYPE 5 AGGREGATE
- 6" COMPACTED SUBGRADE 95% OF STANDARD MAXIMUM DENSITY

TYPE E CONSTRUCTION
(Minimum Thickness)

- 2" TYPE 6-01 ASPHALTIC CONCRETE SURFACE COURSE
- 6" TYPE 5-01 ASPHALTIC CONCRETE BASE COURSE
- 6" MODOT TYPE 5 AGGREGATE
- 6" COMPACTED SUBGRADE 95% OF STANDARD MAXIMUM DENSITY

NOTE:

1. MATERIAL THICKNESS SHOWN IS THE REQUIRED MINIMUM THICKNESS. ACTUAL THICKNESS TO BE DETERMINED BY A SUBMITTED PAVEMENT DESIGN, SUBJECT TO APPROVAL OF CITY ENGINEER.
2. PORTLAND CEMENT CONCRETE PAVEMENT SHALL BE NRDJ, AND MATERIAL SHALL BE KCMMB 4K IN ACCORDANCE WITH THE KANSAS CITY METROPOLITAN MATERIALS BOARD.
3. ALL ASPHALTIC CONCRETE JOINTS IN NEW CONSTRUCTION SHALL BE SEALED WITH HOT POUR JOINT SEALANT AS DIRECTED BY THE CITY ENGINEER.

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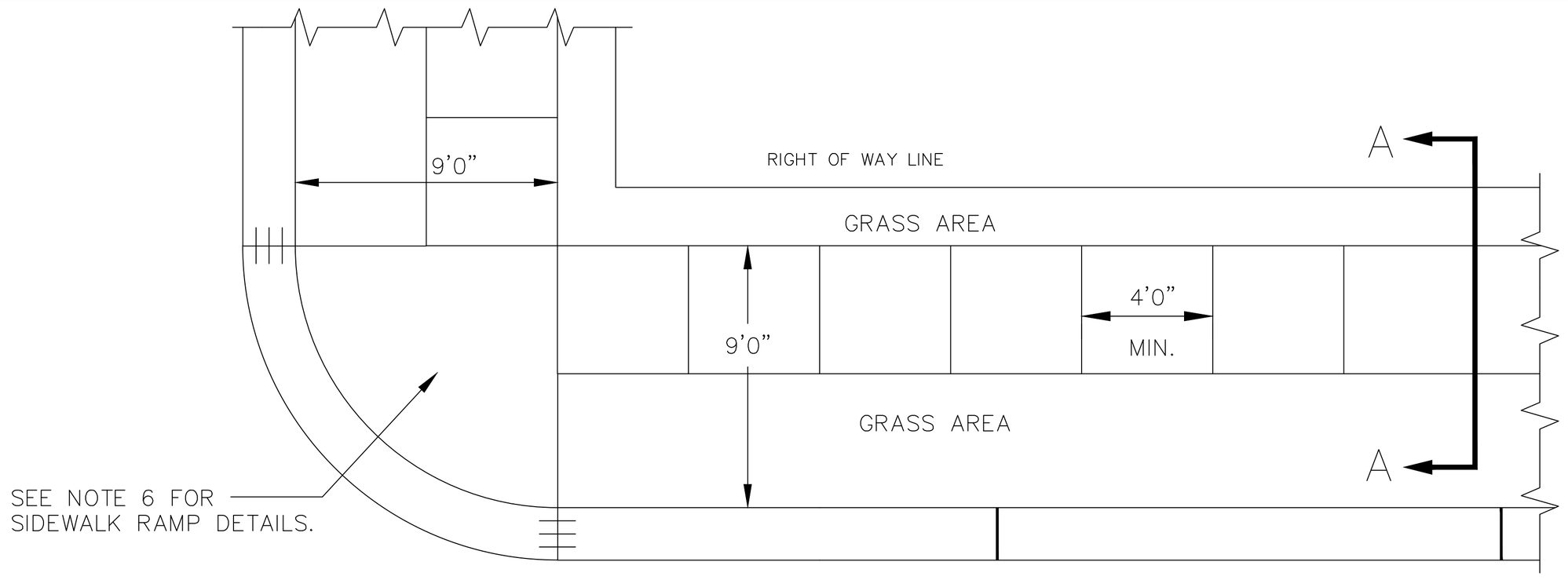
CITY OF OAK GROVE

RESIDENTIAL STREET

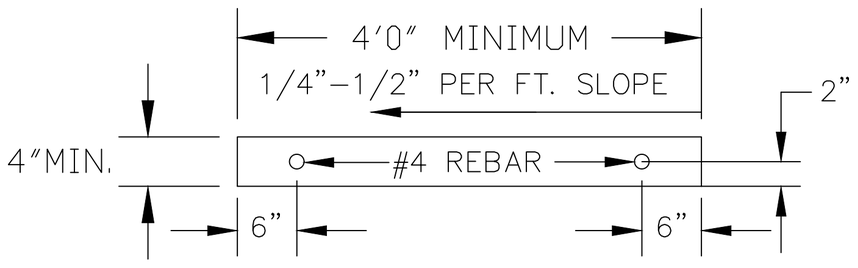
SIZE	FSCM NO.	DWG NO.	REV
A		SD-36	

SCALE NONE

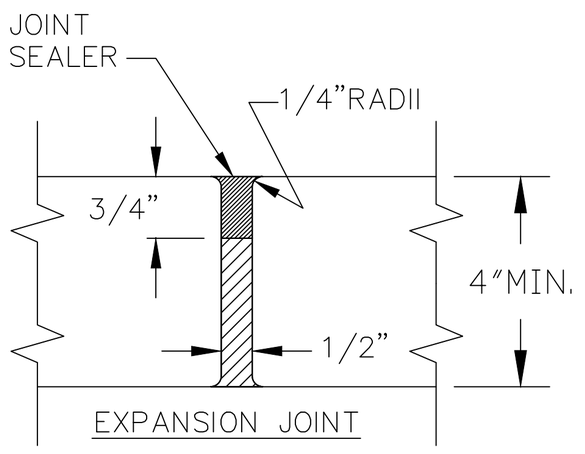
SHEET 1 OF 1

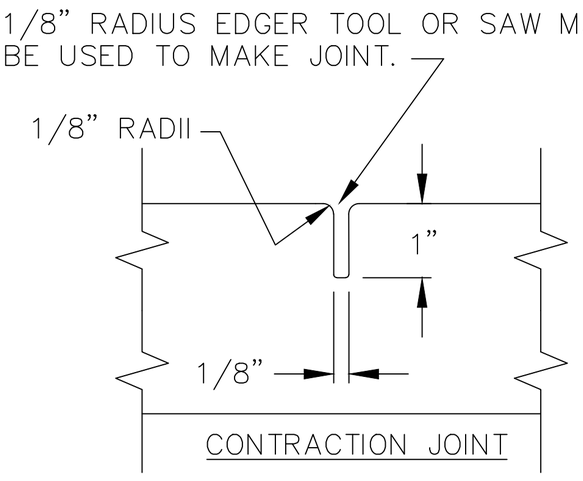


PLAN VIEW

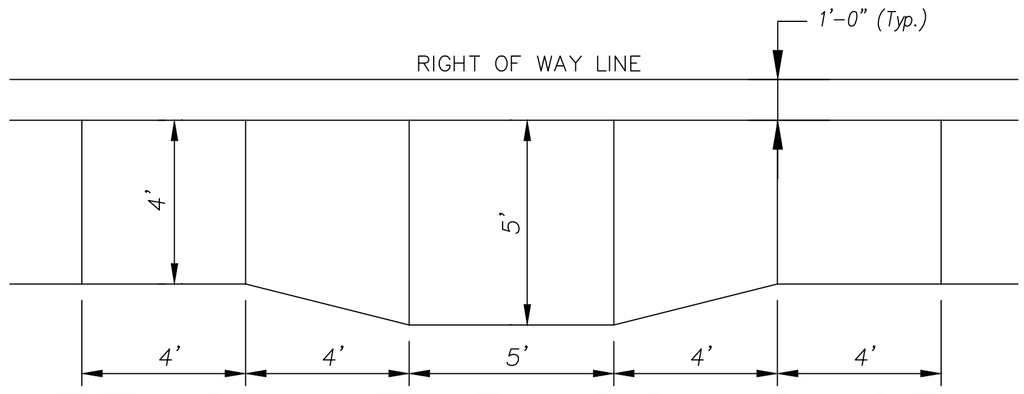


SECTION A-A





JOINT DETAIL



WHEELCHAIR PASSING SPACE

WHEELCHAIR PASSING SPACE TO BE CONSTRUCTED WHERE LENGTH OF 4' WIDE SIDEWALK EXCEEDS 200'.

NOTE:

1. COMPACT TOP 6" OF SIDEWALK SUBGRADE TO 90% OF STANDARD MAXIMUM DENSITY WHERE DISTURBED OR EQUIVALENT TO DENSITY OF THE IMMEDIATELY SURROUNDING UNDISTURBED SOIL.
2. MATERIAL FOR SEALING EXPANSION & CONTRACTION JOINTS SHALL BE ANY MATERIAL MEETING ASTM SPECS. FOR JOINT SEALING COMPOUNDS. D-1850 AND D-1190.
3. EXPANSION JOINTS SHALL BE PLACED AT RADIAL POINTS AND WHERE SIDEWALK ABUTS CONCRETE CURBS, DRIVEWAYS AND SIMILAR STRUCTURES.
4. THE SIDEWALK SURFACE SHALL BE JOINTED INTO SQUARE PANELS BY CONTRACTION JOINTS, THE LENGTH OF THESE PANELS SHALL BE EQUAL TO THE WIDTH OF THE SIDEWALK.
5. CONCRETE SHALL CONFORM TO THE REQUIREMENTS OF KCMMB 4K IN ACCORDANCE WITH THE KANSAS CITY METROPOLITAN MATERIALS BOARD.
6. SIDEWALK RAMP CONSTRUCTION SEE DETAIL SD-40a, SD-40b, OR SD-40c.
7. ALL RIGHT OF WAY SHALL BE GRADED TO 2% SLOPE. (R/W TO TOP OF CURB)
8. ALL SIDEWALK AND SIDEWALK RAMP DESIGN, MATERIALS, AND CONSTRUCTION SHALL BE IN COMPLIANCE WITH CURRENT ADA AND PROWAG REQUIREMENTS.

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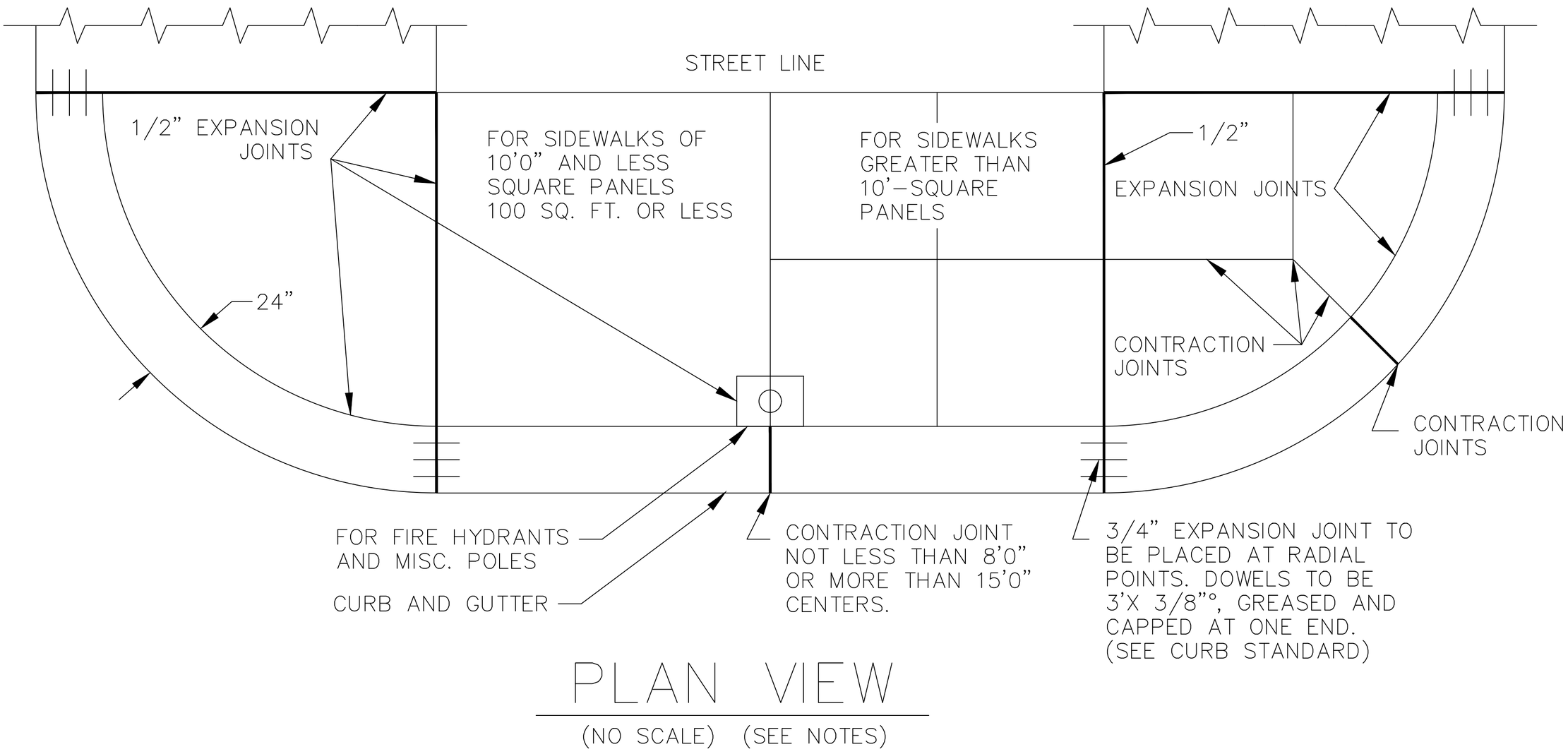
SIDEWALK - RESIDENTIAL

SIZE	FSCM NO.	DWG NO.	REV
A		SD-37	

SCALE NONE

SHEET 1 OF 1



PLAN VIEW

(NO SCALE) (SEE NOTES)

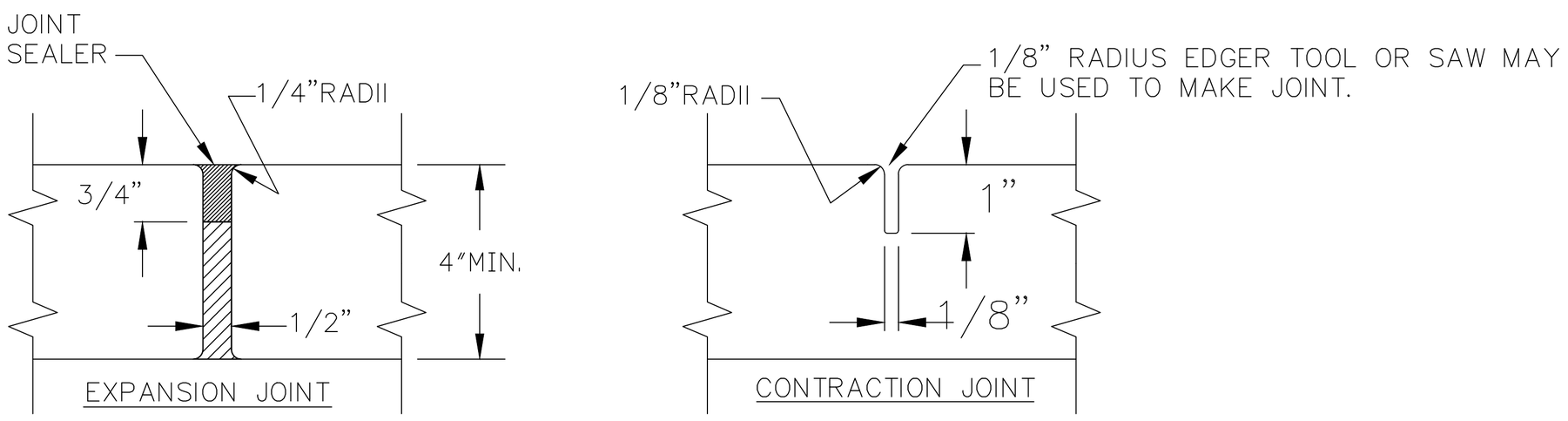
EXPANSION JOINTS:

PLACED AT INTERVALS WITH NOT MORE THAN 300' CENTERS.

CONTRACTION JOINTS:

THE SIDEWALK SURFACE SHALL BE JOINTED INTO SQUARE PANELS BY CONTRACTION JOINTS. THE LENGTH OF THESE PANELS SHALL BE EQUAL TO THE WIDTH OF THE SIDEWALK UP TO 10 FEET. WHERE SIDEWALK EXCEEDS 10 FEET IN WIDTH, A LONGITUDINAL CONTRACTION JOINT SHALL BE CONSTRUCTED IN THE CENTER OF THE WALK, AND THE LENGTH OF PANELS SHALL BE EQUAL TO 1/2 THE TOTAL WIDTH OF WALK.

JOINTS FOR MONOLITHIC CURBS SHALL MATCH THE CONTRACTION JOINTS IN THE PAVEMENT.



JOINT DETAIL

(NO SCALE) (SEE NOTE 2)

NOTE:

1. FOR ALL COMMERCIAL SIDEWALKS, USE KCMMB 4K IN ACCORDANCE WITH THE KANSAS CITY METROPOLITAN MATERIALS BOARD.
2. MATERIAL FOR SEALING EXPANSION AND CONTRACTION JOINTS SHALL BE ANY MATERIAL MEETING ASTM SPECS. FOR JOINT SEALING COMPOUNDS, D-1850 AND D-1190.
3. SIDEWALK RAMPS SHALL BE CONSTRUCTED WHERE REQUIRED.
4. ALL SIDEWALK AND SIDEWALK RAMP DESIGN, MATERIALS, AND CONSTRUCTION SHALL BE IN COMPLIANCE WITH CURRENT ADA AND PROWAG REQUIREMENTS.

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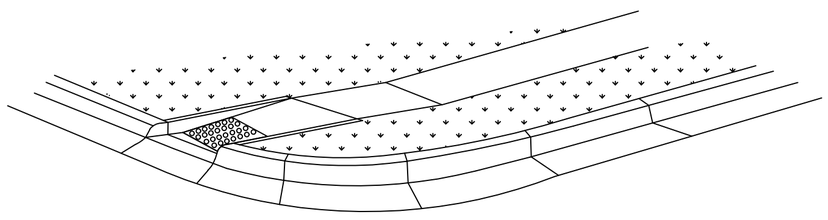
SIDEWALKS - COMMERCIAL

SIZE	FSCM NO.	DWG NO.	REV
A		SD-38	

SCALE NONE

SHEET 1 OF 1

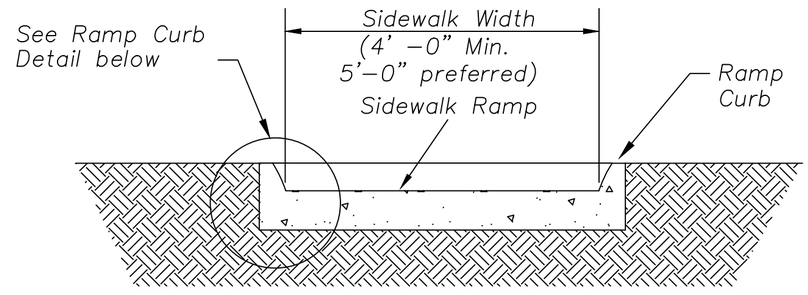


3–D View Type A
Sidewalk Ramp

Not to Scale

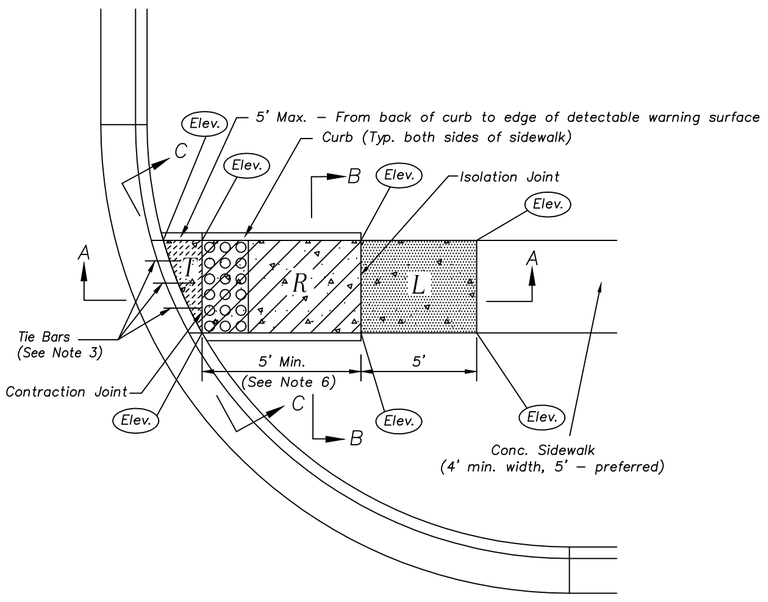
SIDEWALK RAMP NOTES:

1. SIDEWALK RAMP LOCATION DETERMINED FROM THE INTERSECTION OF THE EXTENSION OF BACK OF SIDEWALK AND BACK OF CURB & GUTTER.
2. PLAN DRAWINGS SHALL INCLUDE A TABLE OF ELEVATIONS FOR ALL POINTS LABELLED AS (Elev.) .
3. KEY ALL CONSTRUCTION JOINTS OR USE TIE BARS #4 EPOXY COATED @ 12" O.C.
4. LONGITUDINAL JOINT SPACING TO MATCH WIDTH OF SIDEWALK.
5. ISOLATION JOINTS SHALL BE PLACED WHERE WALK ABUTS DRIVEWAYS AND SIMILAR STRUCTURES, AND 250' CENTERS MAX.
6. SIDEWALK RAMP SHALL BE LENGTHENED TO PROVIDE ADA COMPLIANCE SLOPE BUT SHALL NOT EXCEED 15'.
7. ADA MAXIMUM RAMP SLOPE = 1"/FT.
   ADA MAXIMUM CROSS SLOPE = 2%.
8. DETECTABLE WARNINGS TO COMPLY WITH ADA REQUIREMENTS.
9. LANDING FOR TYPE C RAMP ALONG THE ENTIRE CURB RETURN IS PREFERRED, BUT MAY BE SHORTENED TO MINIMUM ADA COMPLIANT DIMENSION.
10. ALL SIDEWALK AND SIDEWALK RAMP DESIGN, MATERIALS, AND CONSTRUCTION SHALL BE IN COMPLIANCE WITH CURRENT ADA AND PROWAG REQUIREMENTS.
11. DETECTABLE WARNING SURFACE MATERIAL SHALL BE APPROVED BY THE CITY ENGINEER PRIOR TO INSTALLATION.



Section B–B
Type A & B Sidewalk Ramp

Scale: ½"=1'–0"

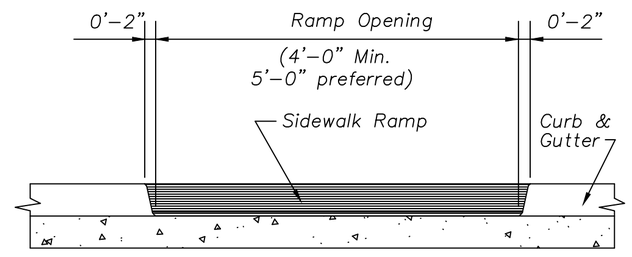


Type A Sidewalk Ramp

Scale: ¼"=1'–0"

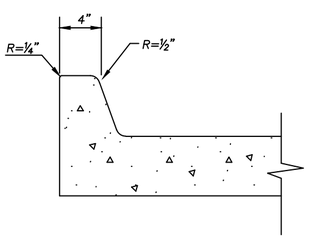
LEGEND:

- R — RAMP
- L — LANDING
- 2' WIDE DETECTABLE WARNING
- T — TRANSITION



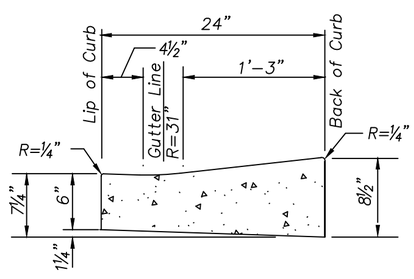
Section C–C
Type A & B Sidewalk Ramp

Scale: ½"=1'–0"



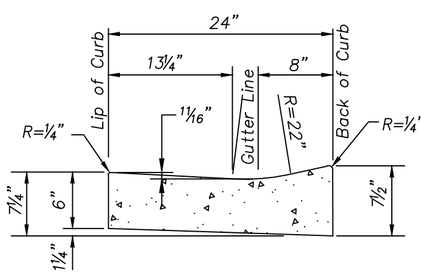
Ramp Curb Detail

Not to Scale



Use With Roll Back
Curb and Gutter

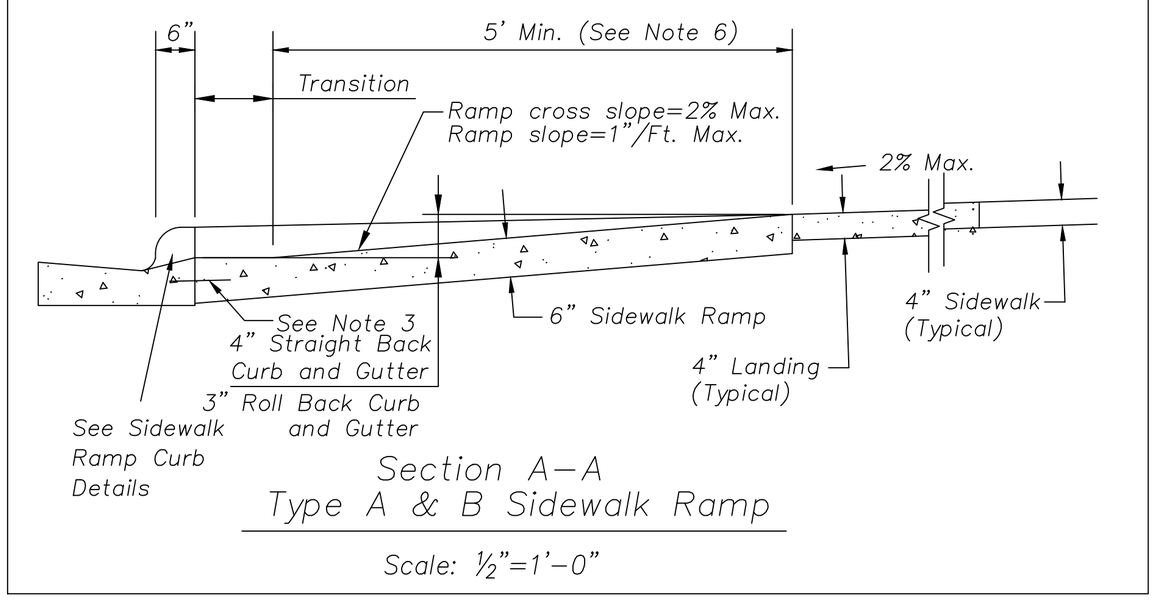
Scale: 1"=1'–0"



Use With Straight Back
Curb and Gutter

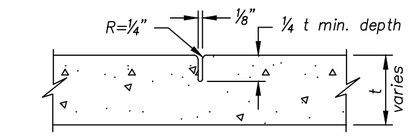
Scale: 1"=1'–0"

Street Curb Detail at Ramp

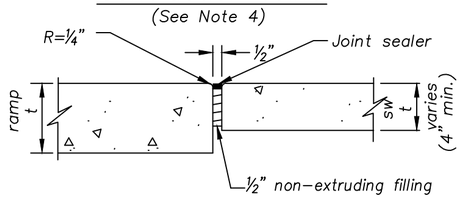


Section A–A
Type A & B Sidewalk Ramp

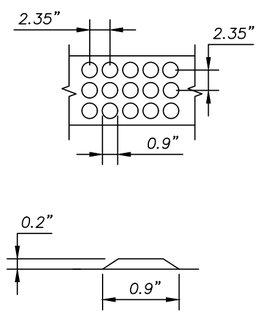
Scale: ½"=1'–0"



Contraction Joint
(See Note 4)



Isolation Joint
(See Note 5)



Detectable Warning
Dome Spacing and Section

Not to Scale

ENGINEERING
1300 BROADWAY ST.
OAK GROVE MO. 64075
(816)690–3773
FAX (816)690–8478

DRAWN	DATE
CHECKED	
APPROVED	

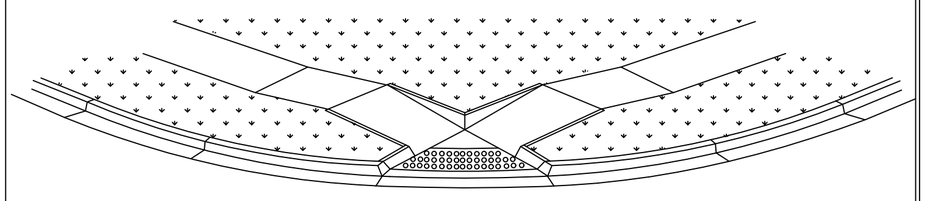
CITY OF OAK GROVE

TYPE A SIDEWALK RAMP

SIZE	FSCM NO.	DWG NO.	REV
A		SD–39a	

SCALE NONE

SHEET 1 OF 1

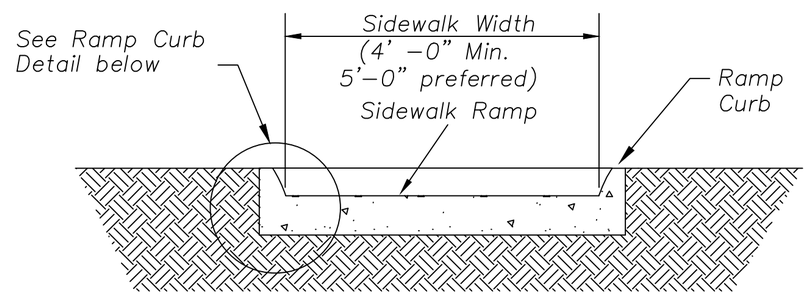


3–D View Type B
Sidewalk Ramp

Not to Scale

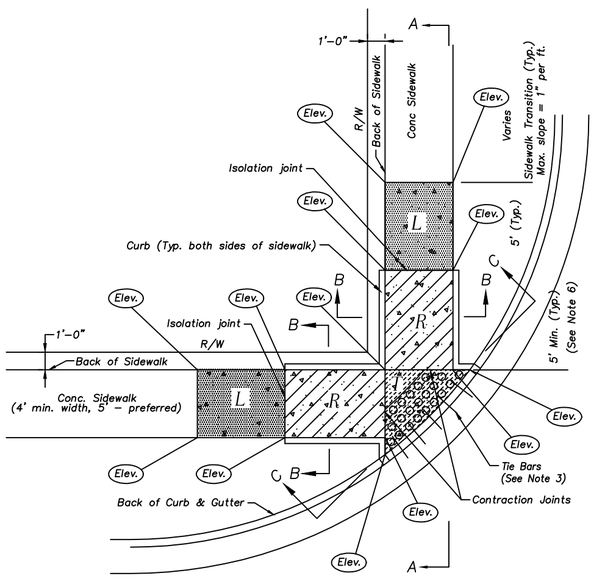
SIDEWALK RAMP NOTES:

1. SIDEWALK RAMP LOCATION DETERMINED FROM THE INTERSECTION OF THE EXTENSION OF BACK OF SIDEWALK AND BACK OF CURB & GUTTER.
2. PLAN DRAWINGS SHALL INCLUDE A TABLE OF ELEVATIONS FOR ALL POINTS LABELLED AS (Elev.) .
3. KEY ALL CONSTRUCTION JOINTS OR USE TIE BARS #4 EPOXY COATED @ 12" O.C.
4. LONGITUDINAL JOINT SPACING TO MATCH WIDTH OF SIDEWALK.
5. ISOLATION JOINTS SHALL BE PLACED WHERE WALK ABUTS DRIVEWAYS AND SIMILAR STRUCTURES, AND 250' CENTERS MAX.
6. SIDEWALK RAMP SHALL BE LENGTHENED TO PROVIDE ADA COMPLIANCE SLOPE BUT SHALL NOT EXCEED 15'.
7. ADA MAXIMUM RAMP SLOPE = 1"/FT.
   ADA MAXIMUM CROSS SLOPE = 2%.
8. DETECTABLE WARNINGS TO COMPLY WITH ADA REQUIREMENTS.
9. LANDING FOR TYPE C RAMP ALONG THE ENTIRE CURB RETURN IS PREFERRED, BUT MAY BE SHORTENED TO MINIMUM ADA COMPLIANT DIMENSION.
10. ALL SIDEWALK AND SIDEWALK RAMP DESIGN, MATERIALS, AND CONSTRUCTION SHALL BE IN COMPLIANCE WITH CURRENT ADA AND PROWAG REQUIREMENTS.
11. DETECTABLE WARNING SURFACE MATERIAL SHALL BE APPROVED BY THE CITY ENGINEER PRIOR TO INSTALLATION.



Section B–B
Type A & B Sidewalk Ramp

Scale: ½"=1'–0"

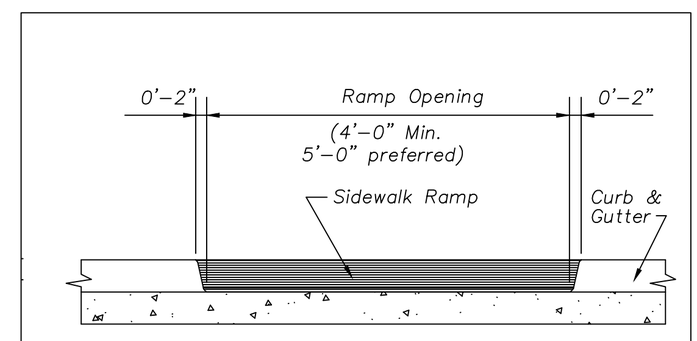


Type B Sidewalk Ramp

Scale: ¼"=1'–0"

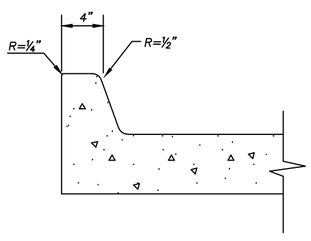
LEGEND:

- R — RAMP
- L — LANDING
- 2' WIDE DETECTABLE WARNING
- T — TRANSITION



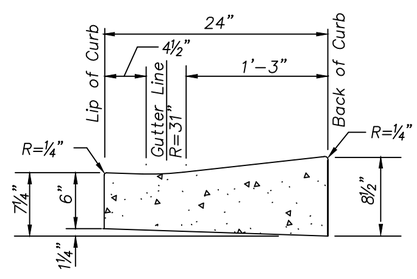
Section C–C
Type A & B Sidewalk Ramp

Scale: ½"=1'–0"



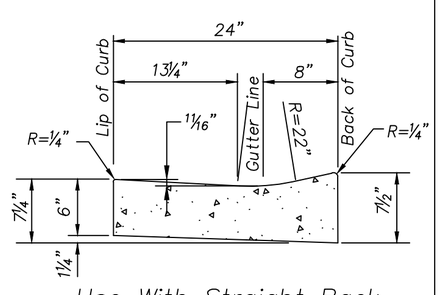
Ramp Curb Detail

Not to Scale



Use With Roll Back
Curb and Gutter

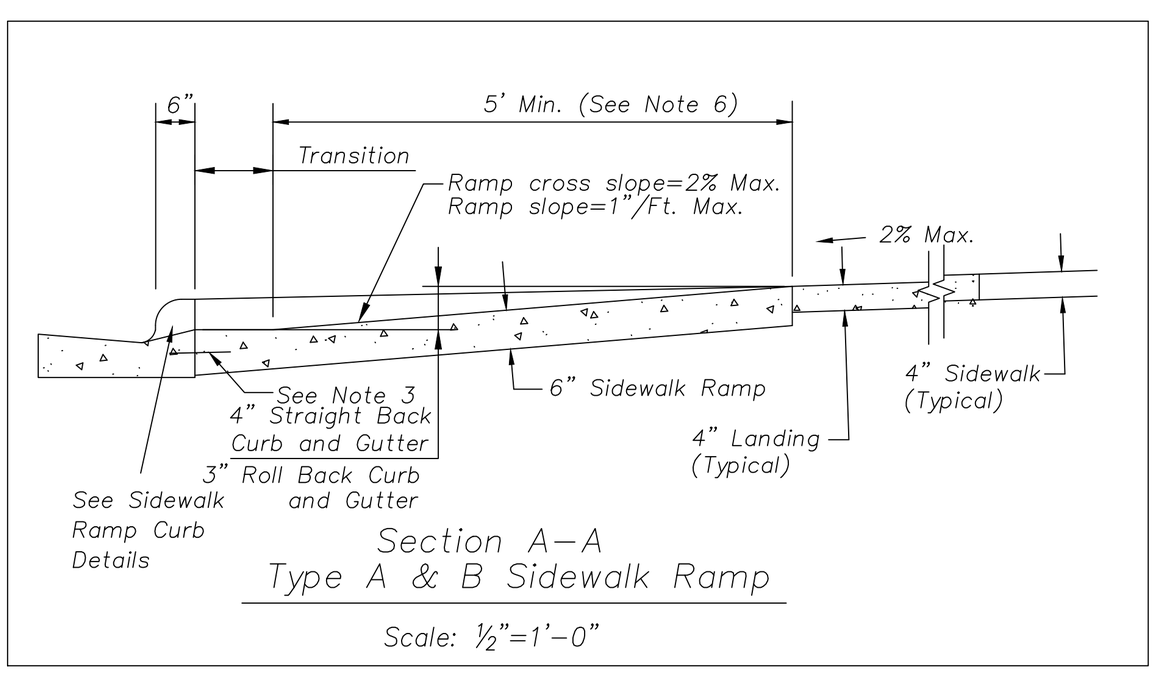
Scale: 1"=1'–0"



Use With Straight Back
Curb and Gutter

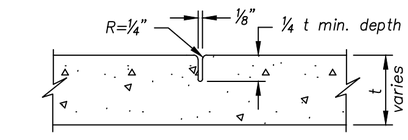
Scale: 1"=1'–0"

Street Curb Detail at Ramp

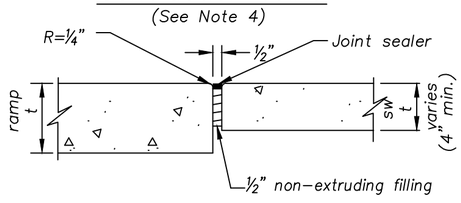


Section A–A
Type A & B Sidewalk Ramp

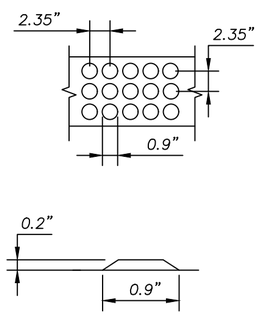
Scale: ½"=1'–0"



Contraction Joint
(See Note 4)



Isolation Joint
(See Note 5)



Detectable Warning
Dome Spacing and Section

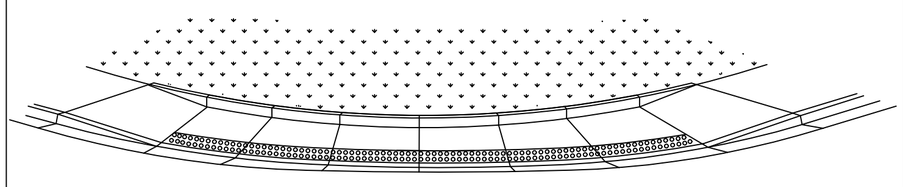
Not to Scale

ENGINEERING
1300 BROADWAY ST.
OAK GROVE MO. 64075
(816)690–3773
FAX (816)690–8478

CITY OF OAK GROVE

TYPE B SIDEWALK RAMP

DRAWN	DATE	SIZE	FSCM NO.	DWG NO.	REV
CHECKED		A		SD–39b	
APPROVED		SCALE NONE		SHEET 1 OF 1	



3–D View Type C
Sidewalk Ramp

Not to Scale

SIDEWALK RAMP NOTES:

1. SIDEWALK RAMP LOCATION DETERMINED FROM THE INTERSECTION OF THE EXTENSION OF BACK OF SIDEWALK AND BACK OF CURB & GUTTER.
2. PLAN DRAWINGS SHALL INCLUDE A TABLE OF ELEVATIONS FOR ALL POINTS LABELLED AS (Elev.) .
3. KEY ALL CONSTRUCTION JOINTS OR USE TIE BARS #4 EPOXY COATED @ 12" O.C.
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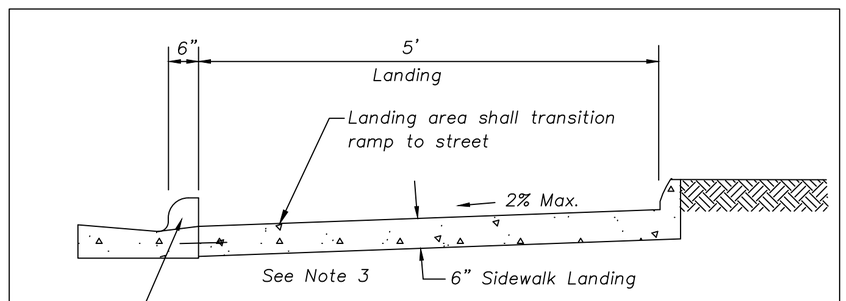
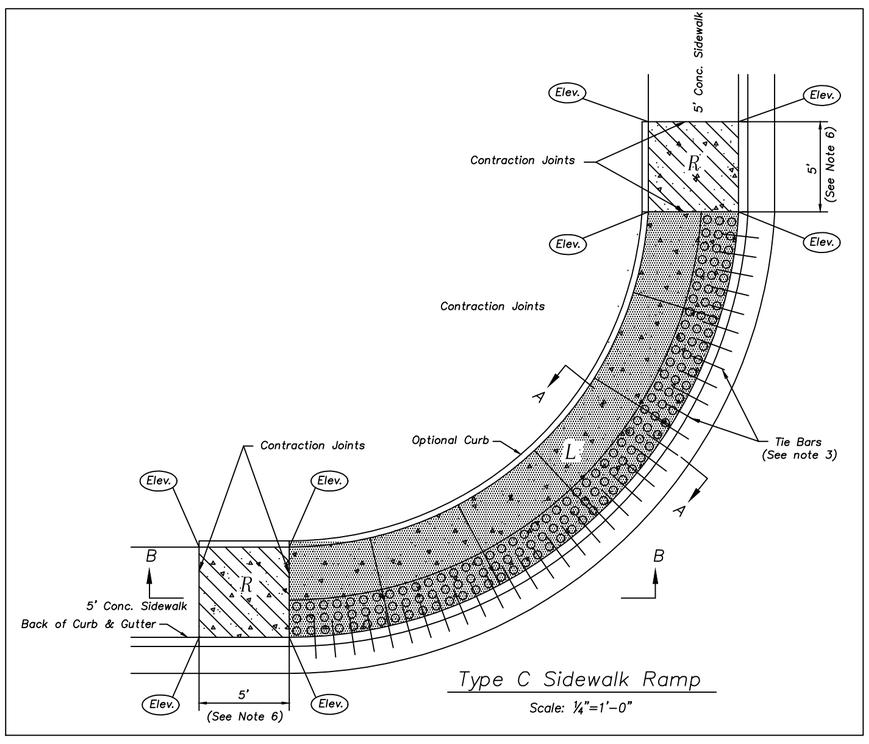


Section A–A
Type C Sidewalk Ramp

Scale: ½"=1'–0"

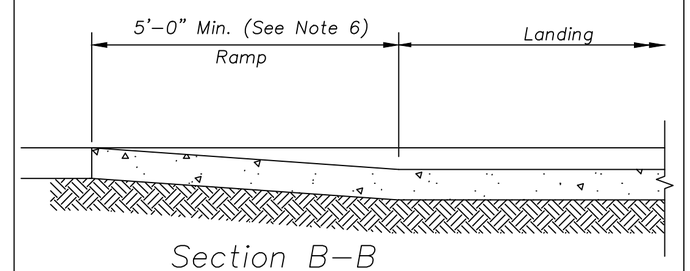


Type C Sidewalk Ramp

Scale: ¼"=1'–0"

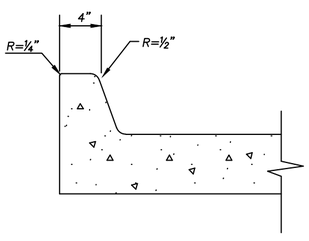
LEGEND:

- R — RAMP
- L — LANDING
- 2' WIDE DETECTABLE WARNING
- T — TRANSITION



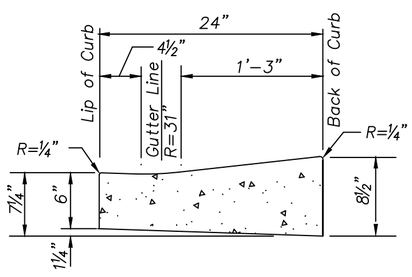
Section B–B
Type C Sidewalk Ramp

Scale: ½"=1'–0"



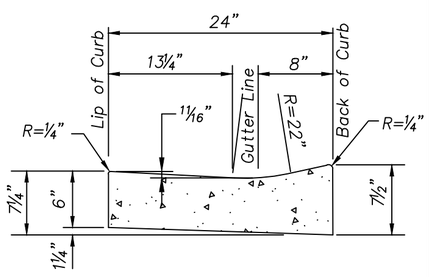
Ramp Curb Detail

Not to Scale



Use With Roll Back
Curb and Gutter

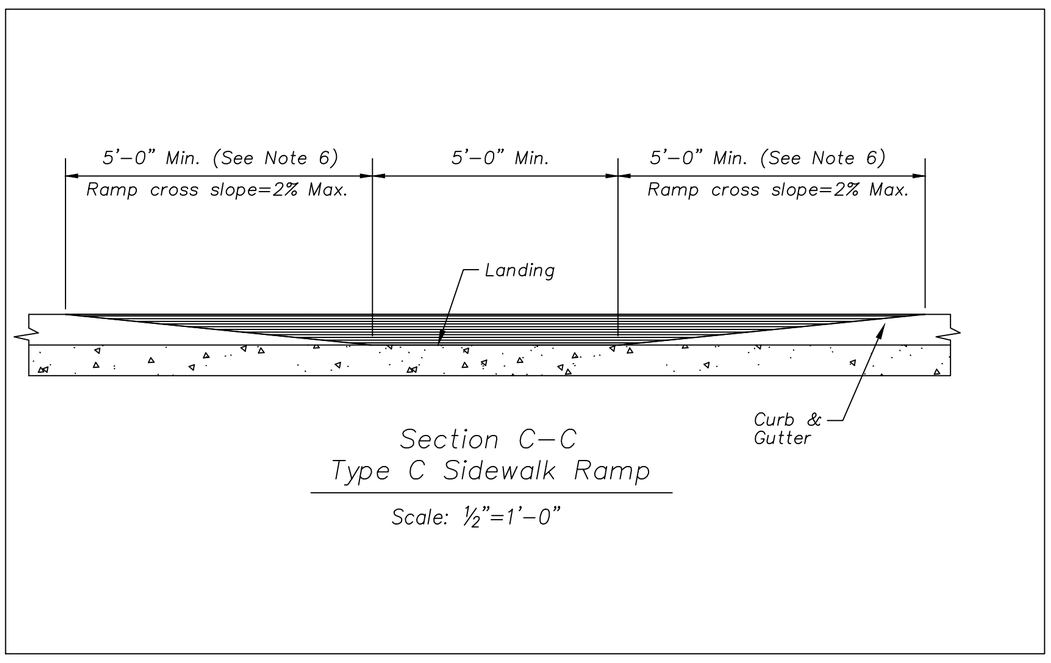
Scale: 1"=1'–0"



Use With Straight Back
Curb and Gutter

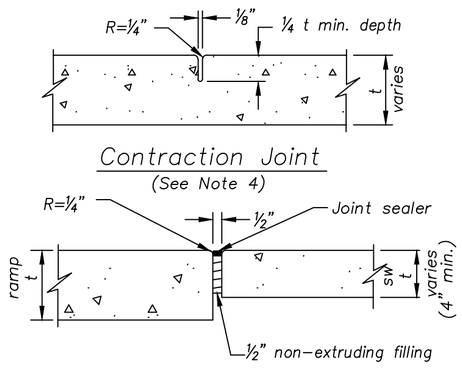
Scale: 1"=1'–0"

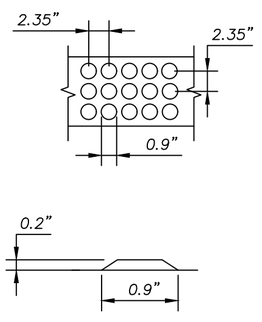
Street Curb Detail at Ramp



Section C–C
Type C Sidewalk Ramp

Scale: ½"=1'–0"





Detectable Warning
Dome Spacing and Section

Not to Scale

ENGINEERING
1300 BROADWAY ST.
OAK GROVE MO. 64075
(816)690–3773
FAX (816)690–8478

DRAWN	DATE
CHECKED	
APPROVED	

CITY OF OAK GROVE

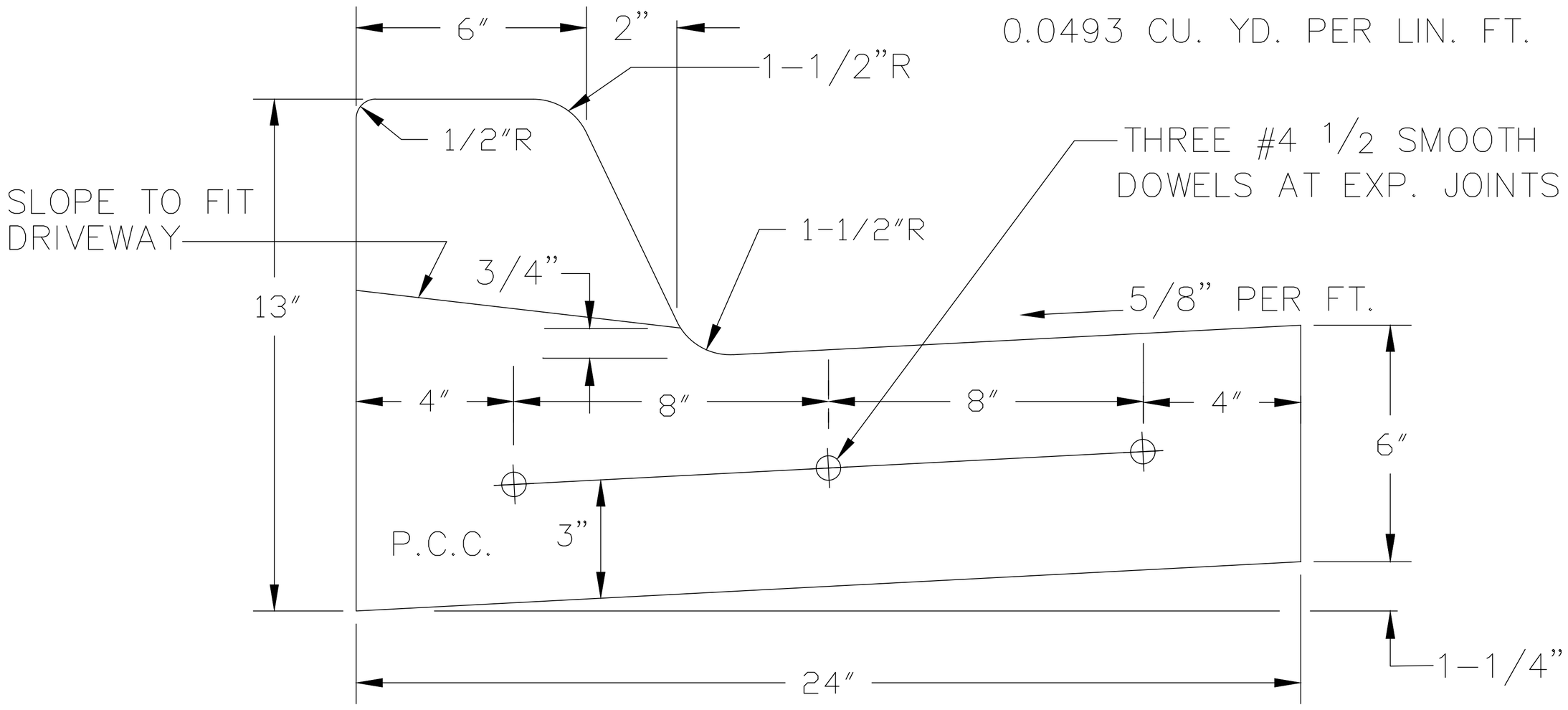
TYPE A SIDEWALK RAMP

SIZE	FSCM NO.	DWG NO.	REV
A		SD–39c	

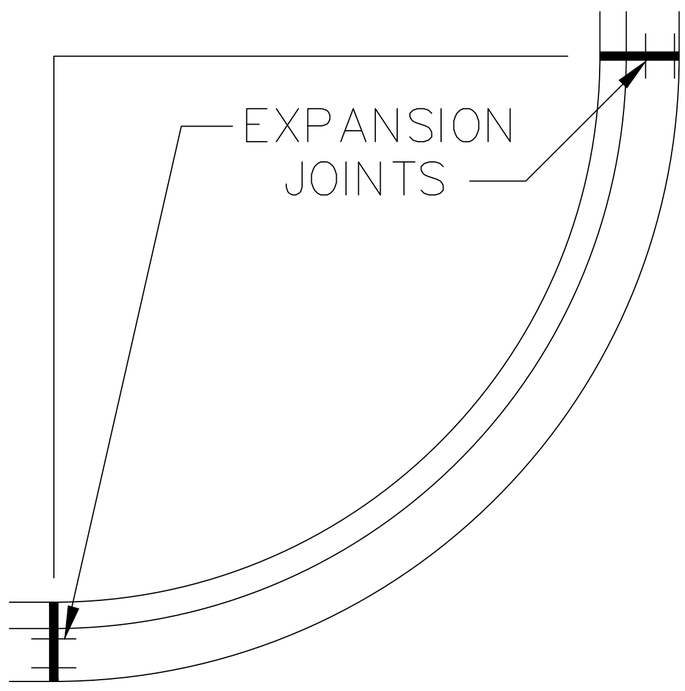
SCALE NONE

SHEET 1 OF 1

0.0493 CU. YD. PER LIN. FT.



CROSS SECTION



PLAN VIEW

OF EXPANSION JOINTS LOCATIONS

NOTES:

1. 3/4" explansion joints with THREE 2' dowels to be placed at radius points and at intermediate points not to exceed 300 feet. These dowels shall be greased and capped on one end with expansion tubes.
2. 1-1/2" deep contraction joints shall be installed at approximately 10' intervals. These joints shall pass through the entire curb section.
3. Fix dowels with bar chairs or equal.
4. All concrete for curb and gutter shall be KCMMB 4K in accordance with the Kansas City Metropolitan Materials Board.

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DRAWN	DATE
CHECKED	
APPROVED	

CITY OF OAK GROVE

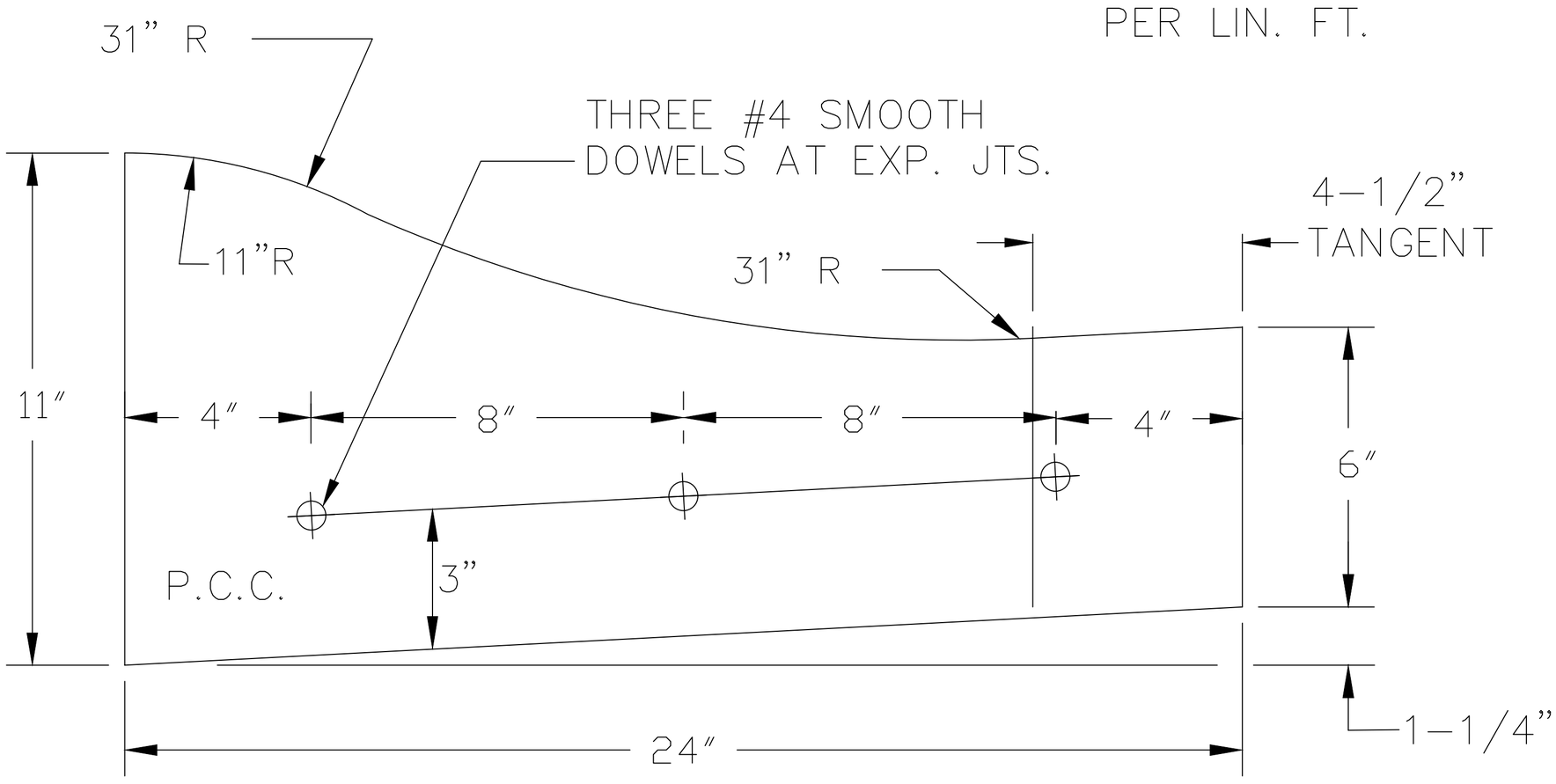
STRAIGHT BACK CURB & GUTTER

SIZE	FSCM NO.	DWG NO.	REV
A		SD-40	

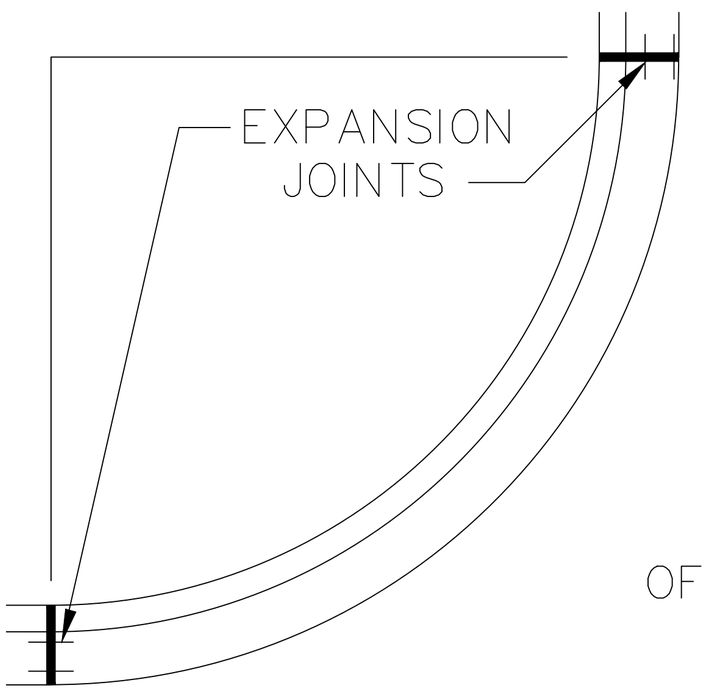
SCALE NONE

SHEET 1 OF 1

0.0462 CU. YD.
PER LIN. FT.



CROSS SECTION



PLAN VIEW

OF EXPANSION JOINTS LOCATIONS

NOTES:

1. 3/4" explansion joints with THREE 2' dowels to be placed at radius points and at intermediate points not to exceed 300 feet. These dowels shall be greased and capped on one end with expansion tubes.
2. 1-1/2" deep contraction joints shall be installed at approximately 10' intervals. These joints shall pass through the entire curb section.
3. Fix dowels with bar chairs or equal.
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ENGINEERING
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OAK GROVE MO. 64075
(816)690-3773
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DRAWN	DATE
CHECKED	
APPROVED	

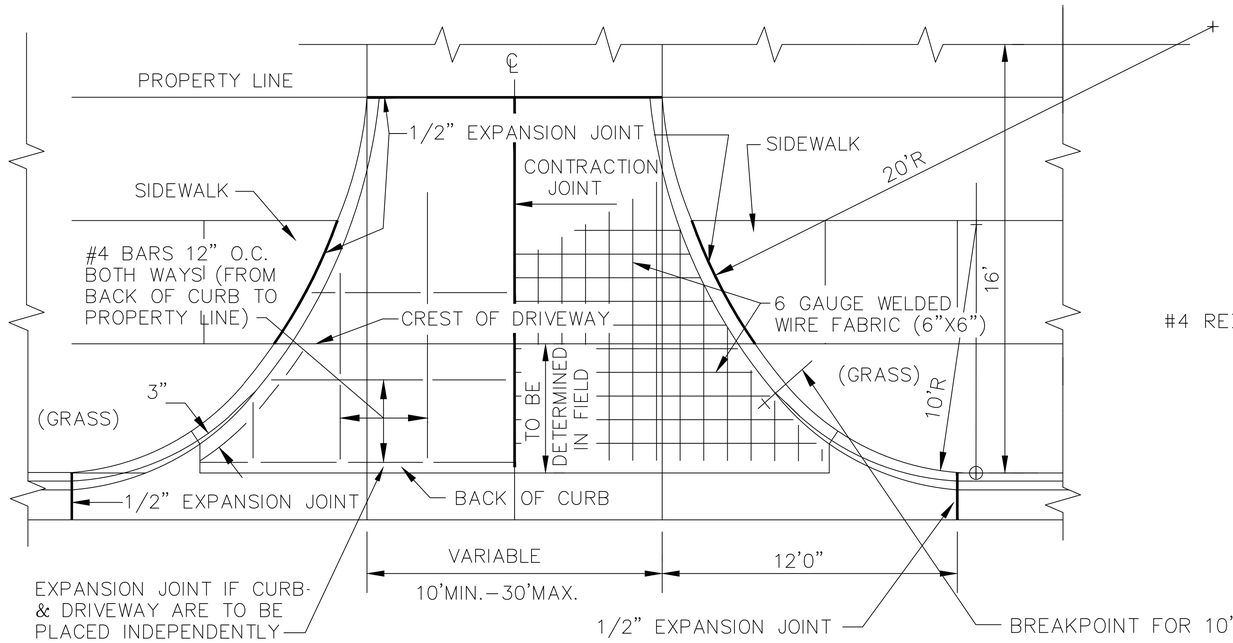
CITY OF OAK GROVE

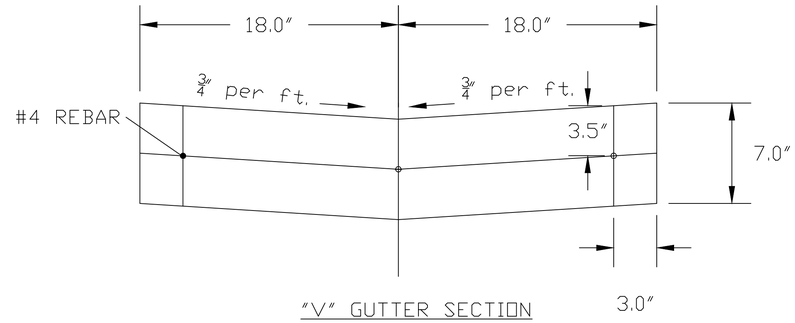
ROLL BACK
CURB & GUTTER

SIZE	FSCM NO.	DWG NO.	REV
A		SD-41	

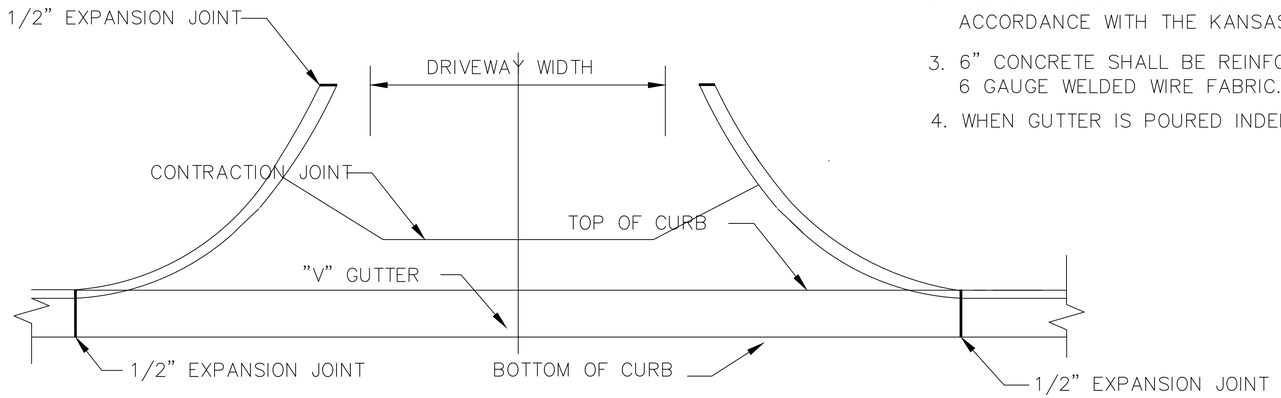
SCALE NONE

SHEET 1 OF 1





"V" GUTTER SECTION



NOTE:

1. CONSTRUCT CONTRACTION JOINT 1" DEEP IN ℄ OF DRIVE.
2. ALL CONCRETE FOR DRIVEWAY CONSTRUCTION SHALL BE KCMMB 4K IN ACCORDANCE WITH THE KANSAS CITY METROPOLITAN MATERIALS BOARD.
3. 6" CONCRETE SHALL BE REINFORCED WITH #4 BARS 12" O.C. BOTH WAYS, OR WITH 6 GAUGE WELDED WIRE FABRIC. 8" CONCRETE SHALL BE NON-REINFORCED.
4. WHEN GUTTER IS POURED INDEPENDENT OF DRIVE USE EXPANSION JOINT.

ENGINEERING
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OAK GROVE MO. 64075
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DRAWN	DATE
CHECKED	
DESIGN	

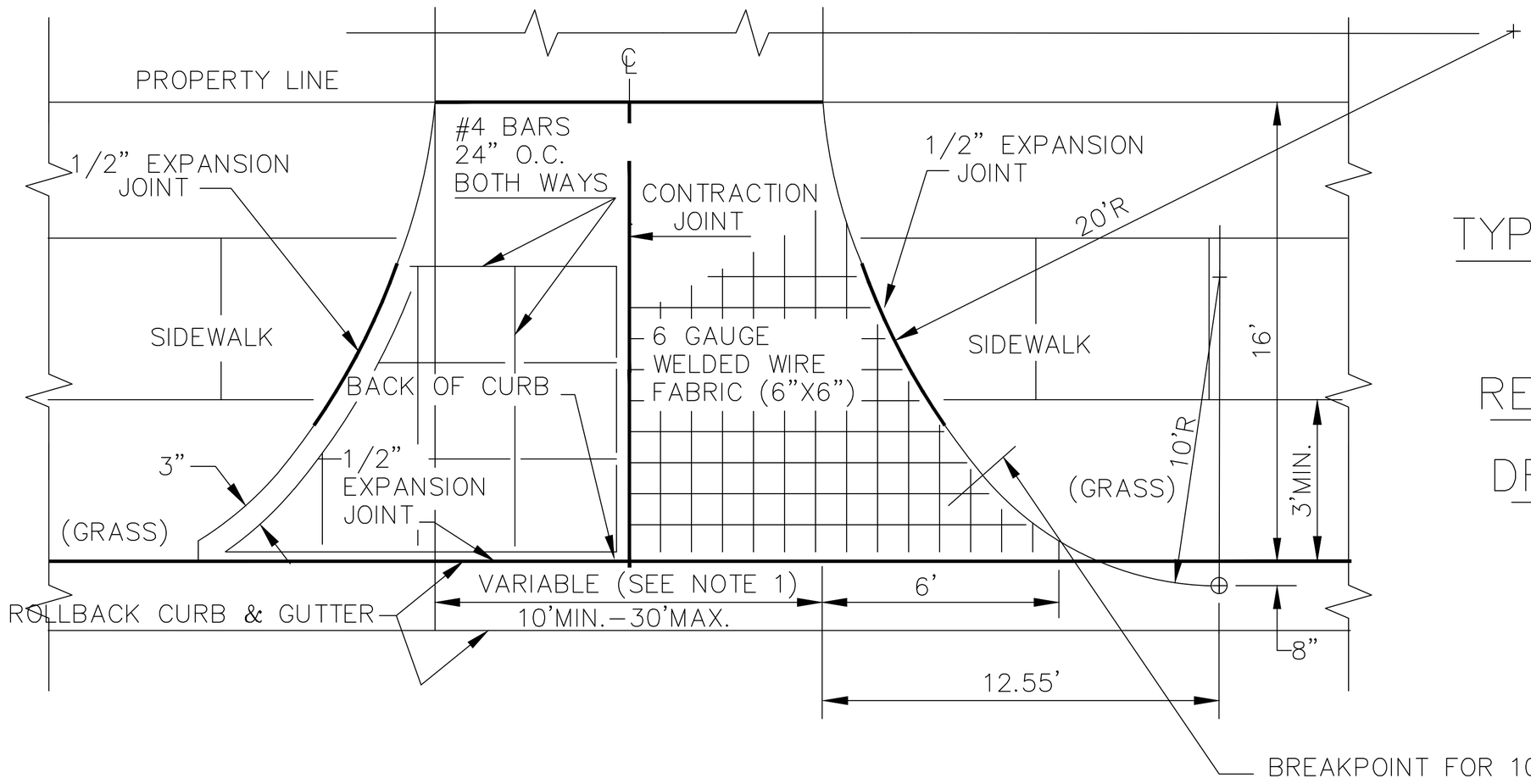
CITY OF OAK GROVE

DRIVEWAYS (CONCRETE) COMMERCIAL & STRAIGHT BACK RESIDENTAL

SIZE	FSCM NO.	DWG NO.	REV
		SD-42	

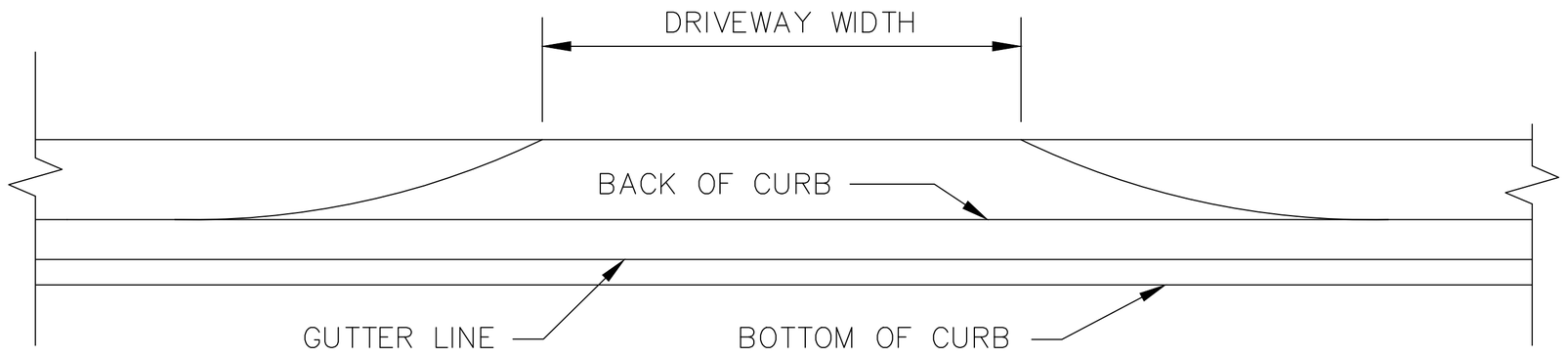
SCALE NONE

SHEET 1 OF 1

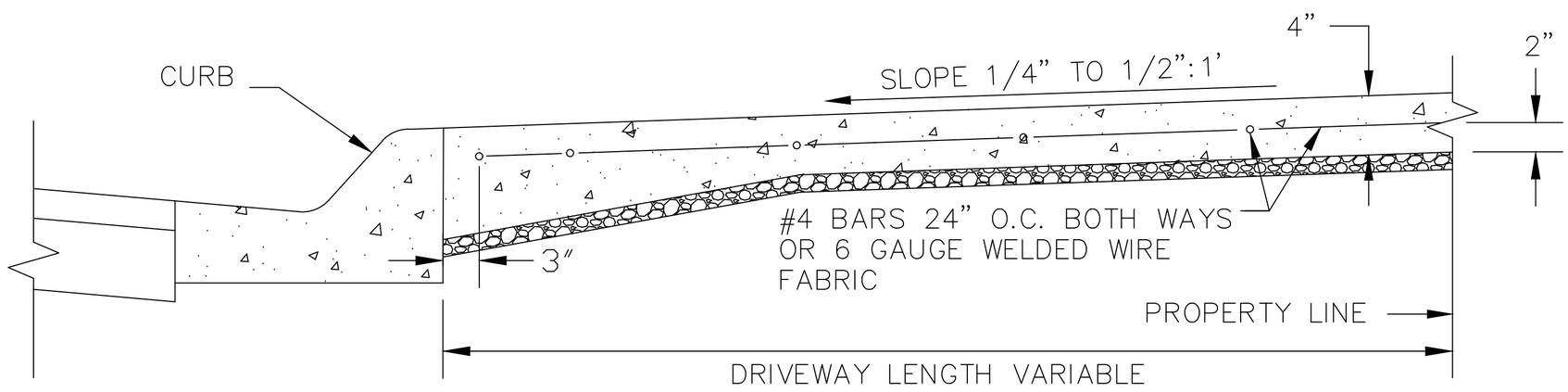


TYPICAL PLAN OF RESIDENTIAL DRIVEWAY

(NO SCALE)

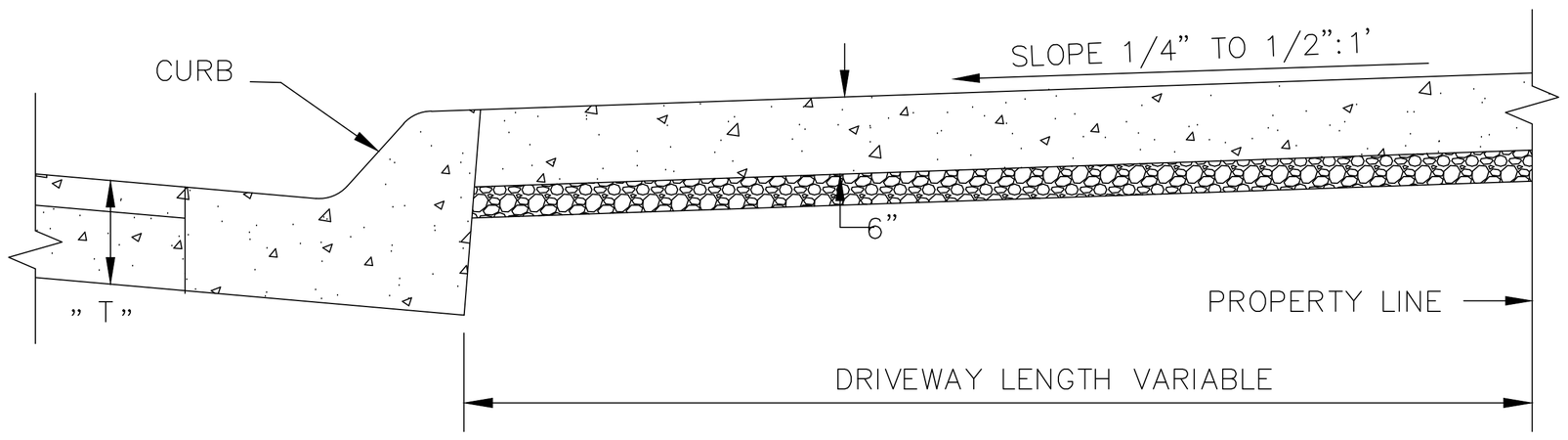


ELEVATION



SECTION ROLLBACK

(4"THICK, REINFORCED)



SECTION ROLLBACK

(6" THICK, NON-REINFORCED)

NOTE:

1. USE MCIB MIX NO. A558-1-2 OR MCIB MIX NO. A618-1-4 (BOTH MECHANICALLY VIBRATED).
2. 4" OF 1/2"-3/4" CLEAN CRUSHED ROCK AS BASE MATERIAL.
3. ALL CONCRETE FOR DRIVEWAY CONSTRUCTION SHALL BE KCMMB 4K IN ACCORDANCE WITH THE KANSAS CITY METROPOLITAN MATERIALS BOARD.

ENGINEERING
1300 BROADWAY ST.
OAK GROVE MO. 64075
(816)690-3773
FAX (816)690-8478

DRAWN | DATE

CHECKED

APPROVED

CITY OF OAK GROVE

DRIVEWAYS-RESIDENTIAL (FOR ROLLBACK CURB ONLY)

SIZE	FSCM NO.	DWG NO.	REV
A		SD-43	

SCALE NONE

SHEET 1 OF 1