

Appendix A-1

Construction and Materials Specifications

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SECTION 100

CONTROL OF MATERIALS

- 100.1 **Sources of Supply** - Materials shall be obtained from sources of supply, which meet the approval of the City Engineer. Inspection of materials made at principal sources of supply is solely a matter of convenience to the Contractor and producer. All materials shall meet the requirements of the specifications before being incorporated into the work. Any defective materials discovered in the process of handling or at any time during the progress of the work, even though previously accepted, will be rejected. If it is found that a source of supply does not furnish a uniform product or if for any reason the product from any source at any time proves to be unsatisfactory, the Contractor will be required to furnish approved material from other sources. The Contractor shall have no claim for any increased cost on account of such requirement.
- 100.2 **Specifications, Certifications, Samples, and Tests** - When a specification of a national standard (ASTM, AASHTO, etc.) is designated, the material may meet either the designated specifications or the latest revision thereof in effect at the time of the award of the Contract. Tests of samples of materials will be made by the City Engineer in accordance with the latest methods prescribed by the ASTM or the AASHTO. All tests not covered by the above shall be performed as specified by the Engineer. **Certifications on all materials / products must be approved before construction will be accepted for compliance or maintenance.**
- 100.3 **Storage of Materials** - Materials shall be so stored as to insure preservation of their quality and fitness for the work. The Engineer may direct that they be placed on wooden platforms or other hard, clean surfaces, and not on the ground and he may direct that they be placed under cover when weather conditions endanger the quality of the materials. Materials in storage shall be so arranged as to facilitate inspection. Lawns, grass plots, or private property shall not be used for storage purposes without written permission of the Owner or lessee.
- All aggregates and surfacing materials having a maximum size greater than one-half (1/2) inch shall be dumped in horizontal layers when placed in storage. Each layer shall not be more than three (3) feet in depth and the aggregates and surfacing materials shall be deposited in such a manner as to prevent segregation of the sizes.
- 100.4 **Defective Materials** - All materials not conforming to the requirements of the specifications shall be considered as defective, and all such materials, whether in place or not, shall be rejected and shall be removed immediately from the construction site unless otherwise permitted by the Engineer. No material which has been rejected, and or the defects of which have been subsequently corrected or removed, shall be used until written approval has been given by the Engineer.

SECTION 200 CLEARING AND GRUBBING

200.1 **Description** - Clearing and grubbing shall consist of removing, cutting and disposing of all brush, vegetation, logs, stumps, rubbish and other materials occurring within the limits of the improvement which will interfere with the excavation or which are unsuitable to be left in the roadway foundation. This shall also include the cutting, removing and disposing of all trees and stumps except those that will not interfere with the construction and not shown on the plans. The Contractor shall exercise due care in his construction operations to prevent marring or scarring of trees that are to remain. Stumps and roots in excavated or fill areas where depth of excavation or fill does not exceed three (3) feet shall be removed to a depth of eighteen (18) inches below sub-grade. In fill areas where more than three (3) feet of embankment is required, trees and stumps shall be cut off at the surface of the ground.

SECTION 201

EXCAVATION AND EMBANKMENT

- 201.1 **Description** - Excavation shall consist of removing all materials necessary for the proper construction of the work and disposing of this material in a satisfactory manner as approved or directed by the Engineer. Embankment shall be formed of suitable material taken from roadway and drainage excavation, borrow excavation and excavation for structures, and placed in successive horizontal layers distributed uniformly over the full width of the cross section. Embankment shall be made of sufficient height and width so that at the time of acceptance by the City, they will conform to the typical section shown on the plans.
- 201.2 **Classification of Excavated Materials** - In these specifications, excavating is divided into two classifications, earth and rock, which shall cover all materials encountered. The determination and classification of such excavated materials will be based on the following definitions:
- 201.2.1 Earth excavation will include all materials not otherwise classified. Decomposed or disintegrated shale which, in the opinion of the Engineer can be effectively plowed, spaded, or removed with power driven excavating equipment, as well as blacktop pavement and gravel base, will be classified as earth.
- 201.2.2 Rock excavation is defined as being sandstone, limestone, flint, granite, quartzite, or similar material, in masses measuring more than one (1) cubic yard in volume or in ledges four (4) inches or more in thickness, and which requires blasting or jack hammering for its practical and effective removal. Should rock be encountered in two (2) or more ledges, each ledge being not less than three (3) inches thick and with inter-lying strata or earth not over twelve (12) inches thick in each stratum, the entire volume from the top of the top ledge to the bottom of the bottom ledge of rock will be classified as rock.
- 201.3 **General** - After all stripping has been done, excavation of every description and of whatever substances encountered within the clearing limits of the project shall be performed to the lines and grades indicated on the drawings. All suitable excavated material shall be transported to and placed in filled areas within the limits of the work as specified and shown on the drawings. All excavated materials which are considered unsuitable by the Engineer and any surplus of excavated material which is not required for fill will be known as "waste" and shall be disposed of by the Contractor. Any additional fill material required which is not available from excavation within the project area shall be supplied by the Contractor. All such material rough to the site by the Contractor shall be subject to the approval of the Engineer. During construction, excavation and fill shall be performed in a manner and sequence that will provide drainage at all times.

201.4 **Excavation for Structures** - All structures shall be founded on undisturbed subsoil. Unauthorized excavation below the specified structure sub-grade shall be replaced with concrete.

Excavation shall be made in open cut to alignment and depth as shown on the profiles and drawings, except as otherwise indicated in the specifications drawings.

Excavation for manholes, curb inlets, junction boxes and similar structures shall be sufficient to leave at least twelve (12) inches in the clear between their outer surfaces and the embankment or timber which may be used to hold and protect the excavation. In all cases the clearance between the outer face of structures and the surrounding excavation shall be sufficient to allow the proper performance of the work including the plastering of exterior wall surfaces where required by the specifications or plans.

The Contractor shall not open more trench in advance of construction than necessary to expedite the work. Three hundred (300) feet will be the maximum length of open trench allowed.

Wherever necessary to prevent caving the excavation shall be adequately sheeted, braced and drained so that workmen may work therein safely and efficiently. Where trench bottom is in rock, the excavation limits shall allow solid rock to be exposed and cleaned of all loose material and cut to a firm surface before any foundation concrete is placed.

Whenever wet or otherwise unstable soil that is incapable of properly supporting the structures, as determined by the Engineer, is encountered such soil shall be removed to the depth required and the excavation backfilled to the proper grade with coarse sand, fine gravel, or other suitable material as may be authorized. All excavations for structures shall be kept dry and no pipe or reinforcing steel shall be installed in water and no water shall be permitted to inundate the reinforcing steel before concrete has been placed. All excavations shall be kept dewatered to the extent that water will not come in contact with any concrete within twelve (12) hours after placing. When excavations are carried below ground water elevations such excavations shall be dewatered by lowering and maintaining the ground water level at least twelve (12) inches below such excavations during all construction, including sub-grade excavation, placing of reinforcing steel or pipe, placing of concrete, plastering of masonry, and shall be maintained in a dry condition until all concrete has been placed and allowed to harden for at least twelve (12) hours as specified above.

201.5 **Excavation for Streets** - Grading shall conform to the typical sections shown on the drawings and shall be finished within a tolerance of one-half (1/2) inch of the grades indicated. Any soft and unsatisfactory material within the limits of the pavement areas shall be removed and disposed of as directed by the Engineer. Fill material required in excess of that produced by normal grading operations shall be excavated from areas indicated on the drawing or as directed by the Engineer. Excavated material not acceptable for use as fill shall be disposed of by the Contractor.

201.6 **Excavation for Storm Sewers**

201.6.1 **General** - The Contractor shall perform all excavation of every description and of whatever substances encountered to the depths indicated on the drawings or as otherwise specified. During excavation, material suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials not required or suitable for backfill shall be removed and disposed of off the site. Such grading shall be done as may be necessary to prevent surface water from flowing into trenches or other excavations, and to maintain the flow of water in natural water courses on or adjacent to the site. Any water accumulating in trenches or other excavations, shall be removed by pumping or by other approved methods as specified elsewhere. Unless otherwise indicated or authorized, excavation shall be by open cut. The use of excavation machinery will be permitted except in places where operation of same will cause damage to trees, buildings, or existing structures above or below ground, in which case hand methods shall be employed.

201.6.2 **Trench Bracing and Sheet piling** - All trenches, where necessary to prevent caving or sliding and to provide adequate protection to workmen and to the sewer or pipe line during and after construction, shall be suitably and substantially braced and sheeted. Such sheeting and bracing shall be carefully placed so as to provide complete protection to men and materials in the trench. Trench bracing shall be left in the trench permanently where such permanent bracing is required for the protection of the sewer or pipe line from excessive superimposed loads caused by the caving or sliding of trench banks either before or after backfilling.

201.6.3 **Dewatering of Trenches** - During excavation, pipe laying and jointing, or other work necessary for the installation of the storm sewers, trenches shall be kept free from water and in a workable condition. Where the trench bottom is found to be unstable or unsatisfactory because of water, and in all cases where the trench bottom falls below the ground water level by means of well points, pumps or by other means acceptable to the Engineer a sufficient amount to keep the trench free from water and the trench bottom stable at any time that work within the trench is in progress. As specified herein before the

Contractor shall take all necessary measures to prevent surface water from entering the trench and he shall further take all necessary measures to prevent the inundation or damage to any private property or structures adjacent to the site of the work.

- 201.6.4 **Trench Alignment and Grade** - The alignment, depth, and grade of all storm sewer trenches shall be maintained as shown on the drawing, and where necessary in the opinion of the Engineer shall be determined by overhead grade lines parallel to the pipe invert.
- 201.6.5 **Trench Width** - Width shall be no wider than is necessary for the proper jointing of the pipe and in no case shall exceed the outside diameter of the pipe plus eight (8) inches on either side, unless specifically authorized by the Engineer.
- 201.6.6 **Unauthorized Trench Widths** - Where trench widths as specified above, are exceeded for any reason other than by order of the Engineer, either special pipe embedment, concrete cradle, or concrete encasement, or other suitable methods shall be required as demanded by loading conditions and as ordered by the Engineer. Any additional work required, as stipulated above, as a result of unauthorized over excavation shall be performed by and at the expense of the Contractor.
- 201.6.7 **Preparation of Pipe Sub-grade** - Pipe sub-grade shall be prepared after rough trenching is complete and shall be done with hand tools immediately prior to installing pipe. The bottom of the trench shall be prepared so as to provide uniform support of the bottom quadrant of the pipe and bell holes or depression shall be hand excavated where bell and spigot pipe is used. The trench bottom shall be evenly graded as indicated on the plans and areas which are too high shall be shaved as required. Any portions of the trench bottom which are found to be too low shall be filled with suitable material, thoroughly rammed and tamped and brought to true grade.
- 201.6.8 **Replacement of Unsuitable Pipe Foundation Material** - Where, in the opinion of the Engineer, the trench bottom is found to be of a wet or otherwise unstable material or where it is impossible to provide proper bearing for the pipe, or where it is found to be impossible to carry on construction operation due to the condition of the trench bottom, the Contractor shall remove all unstable or unsuitable material to a depth of not less than four (4) inches below the elevation of the pipe sub-grade over the entire width of the trench and shall replace and backfill with a suitable finely divided material of acceptable quality and sufficiently damp for proper compaction. Such material shall be thoroughly compacted by tamping or rolling over the entire width of the trench and shall be brought to proper grade and shape and the proper elevation for the installation of the pipe as shown on the plans.

201.7 **Blasting** - Blasting for excavation shall only be performed after securing approval of the Director, proper notification of the Boone County Fire District and when proper precautions are taken for the protection of persons or property. The hours of blasting will be fixed by the Engineer. Any damage caused by blasting shall be repaired by the Contractor at his expense. The Contractor's method of procedure relative to blasting shall conform to state laws and municipal ordinances. No blasting shall be attempted within a distance of eighty (80) feet from finished work.

All excavated rock or shale which cannot be handled and compacted as earth shall be kept separate from earth and shall not be mixed with other backfill except as specified and directed.

201.8 **Excavation through Pavement** - Pavement, pavement base course, concrete walks, and concrete curbing shall be cut and removed only where shown on the plans, where specified or where directed and authorized by the Engineer. Cuts shall be no larger than necessary to provide adequate working space for installation of the pipe appurtenance or structure, except where other miscellaneous removals are required on the drawings

All cuts in pavement, walks or curbing shall be neatly sawn and shall be straight and parallel to existing construction joints. Any pavement, curbing, gutter or sidewalks, the removal of which was not required in conjunction with construction under this Contract, which is damaged due to construction operations by the Contractor shall be removed and replaced by the Contractor in first class manner, as hereinafter specified.

201.9 **Protection of Existing Utilities** - Due care must be taken not to disturb inlet covers, manhole frames, valve boxes, fire plugs, house connections or private water.

201.10 **Pavement Replacement** - All pavement, curbing, gutter, or sidewalks removed during construction of the project for any reason shall be replaced unless otherwise shown on the drawings or directed by the Engineer, the replacement construction conforming in type, quality, and dimensions to that of the portion so removed.

201.11 **Embankment**

201.11.1 **Preparation of Ground Surface for Fill** - All vegetation, such as roots, brush, heavy sod, heavy growth or grass, and all decayed vegetable matter, rubbish, and other unsuitable material within the area upon which fill is to be placed shall be stripped or otherwise removed before the fill is started. In no case will such objectionable material be allowed to remain in or under the fill area. Sloped ground surfaces steeper than one (1) vertical to four (4) horizontal on which fill is to be placed, shall be plowed, stepped (benched), or broken up in such manner that the fill material will bond with the existing surface.

201.11.2 **General** - Where filling is required to raise the sub-grade under areas to be paved or surfaced, all fill materials shall consist of earth or other approved material. All organic or other undesirable material shall be removed. All fill under paved surfaces such as streets and parking lots shall be compacted by a power roller or other approved equipment and the sub-grade brought to a reasonably true and even plain. Earth used for fill shall be placed in layers not more than eight (8) inches thick, each layer shall be uniformly spread, moistened as required, and then compacted to ninety percent (90%) of maximum density, obtained at the optimum moisture content, as determined by AASHTO Method T-99-38.

201.12 **Backfill**

201.12.1 **Street Backfill** - After completion of street, curb and gutter, and other construction below the elevation of final grades, all forms shall be removed and the excavation shall be cleaned of trash and debris. Backfill shall be free of all objectionable material and shall be placed in horizontal layers not more than nine (9) inches thick, and shall have a proper moisture content for the required degree of compaction. All parking areas, driveways, streets, and other paved areas shall be backfilled with approved material and compacted to ninety percent (90%) of maximum density obtained at the optimum moisture content.

Backfilling and grading behind curbs shall be performed to the lines and grades indicated on the drawings. The backfilled area shall provide a smooth, even transition from the existing lawn grades to the curb and shall be done so as to assure desired drainage.

When indicated on the plans and included as a bid item, the top four (4) inches of backfill behind curbs shall be topsoil, free from rocks, gravel, and any undesirable material. This material may be either topsoil available within the limits of the project or it may be topsoil furnished by the Contractor.

All driveways, paved or unpaved, which are disturbed by grading or excavation of any kind shall be graded and shaped to provide a reasonable approach, and shall upon completion of the job be left in passable condition. All driveway approaches shall be paved to the right-of-way line.

201.12.2 **Trench Backfill**

201.12.2.1 **Materials** - All materials which are to be compacted by tamping or rolling, including all tamped embedment, shall be free from sticks, large roots, or other organic matter coarser than grass roots, stones, hard lumps, and clods, and shall have a moisture content such that optimum compaction is obtained when properly tamped or rolled.

Granular material for replacement of unsuitable foundation material removed from trench bottoms shall consist of coarse sand, lime gravel, and shall be free from dust, clay, and other materials which would cause the materials to crack or cake. When tested with square mesh laboratory sieves, not less than ninety-five percent (95%) shall pass a three-eighths (3/8) inch sieve and not more than five percent (5%) shall pass a No. 10 sieve.

Fine sand which will pass a No. 4 mesh sieve shall be used for inundation purposes unless otherwise specified or authorized by the Engineer. Sand approved for use in concrete and mortar will be acceptable, although concrete quality is not required. Unwashed pit, bank, or bar sand, will be acceptable provided that the clay content does not exceed five percent (5%). A fineness modulus of less than 2.50 is preferred.

201.12.2.2 **Compaction** - All backfill under paved surfaces, streets, driveways, sidewalks, or parking areas, shall be thoroughly compacted by pneumatic tampers, or other approved methods, to the original state of consolidation of the soil encountered. Backfill shall be placed in uncompacted lifts not to exceed six (6) inches and each lift shall be thoroughly and adequately compacted. Care shall be exercised not to disturb the pipe when placing backfill. The compacted earth backfill shall be brought to an elevation of approximately six (6) inches below the finished surface grade and then surface grade or paving constructed. When authorized by the Engineer inundated sand backfill may be used in lieu of compacted earth backfill under paved surfaces.

Trenches in grassed or sodded areas shall be backfilled in lifts not to exceed twelve (12) inches and shall be compacted by suitable means to prevent undue settlement. Where authorized by the Engineer backfill may be settled by inundation. This method shall not be used where any damage to property would result from the use of water. After backfill and compaction is complete trenches shall be leveled off and grading shall be performed as is necessary to restore yards or other grassed or sodded areas to their original condition.

201.12.2.3 **Inundated Sand Backfill** - In all cases where so required by the plans or specifications the Contractor shall install inundated sand backfill. Inundated sand fill may also be used, at the option of the Contractor, in lieu of required tamping or other mechanical compaction above the

specified pipe embedment, in any location where the use of water, in the opinion of the Engineer, would cause no damage. It shall be the Contractor's responsibility to provide an adequate supply of water to insure the complete inundation of the sand to the top of the trench or structure sub-grade in one operation. Water shall be introduced into the lower one-third (1/3) of the trench and allowed to rise to the surface until inundation is completed. Trench backfill on each side of sand fill installations shall be installed and maintained at an elevation above the top of the highest point of the sand-filled area in order to adequately confine the water within the section being inundated; temporary dikes, fills, or embankments constructed from excess backfill material, shall be placed across drainage ditches and on sides of slopes where and as necessary. All such temporary dikes, fills, and embankments, shall be removed as soon as the water has drained from the sand to an elevation below the bottom of such ditches or slopes.

201.12.2.4 **Water Settlement of Earth Backfill** - Earth backfill may be compacted by the water settlement or inundation method where permitted by the specification or authorized by the Owner, and approved by the Engineer, and where water service and fire hydrants are available. Water shall be applied in a manner which will provide effective settlement of the backfill with the use of a minimum amount of water; in no case shall trenches be permitted to overflow or water be otherwise wasted. When settling earth containing considerable clays, water shall be introduced into the bottom of the trench as quickly as possible by forcing the hose vertically downward in the trench and by regulating the rate of initial application until settlement opens up a channel for the water to flow beneath the backfill so that it will cave or fall into the water from above.

201.12.3 **Structure Backfill** - Backfilling of all structures shall be permitted only after an adequate curing time, as determined by the Engineer, has lapsed.

All excavations shall be backfilled to the lines and grades shown on the drawings. In no instance shall backfill be dumped, bull-dozed, or otherwise deposited in bulk upon the newly-constructed structure. After the required curing time, the excavation shall be backfilled by depositing, entirely without shock and with careful pneumatic tamping, suitable earth, sand, or other acceptable material in lifts not to exceed six (6) inches in compacted thickness. Backfill shall be deposited at approximately the same elevation on opposite sides of the structure and shall be compacted in place to a density equal to or greater than ninety percent (90%) of maximum density as determined by the Standard AASHTO Method T-99-38. Inundated sand backfill shall not be used.

No trench backfill material containing rock, or debris from rock excavation, shall be placed in the upper eighteen (18) inches of the

excavation except with the specific permission of the Engineer. Large stones may be placed in the remainder of the trench backfill only if well separated and so arranged that no interference with backfill compaction will result.

Any deficiency in the quantity of material for backfilling the excavation, or for filling depressions caused by settlement, shall be supplied by the Contractor. All excavated material in excess of that necessary to fill the trench to the grade shown on the drawings shall be removed and disposed of by the Contractor.

- 201.12.4 **Responsibility of Contractor for Backfill Settlement** - The Contractor shall be responsible for the satisfactory compaction and maintenance thereof, of all trenches and structural excavation of any description required. If prior to the final acceptance of this project, any trenches or other excavations are found to have settled, the Contractor shall immediately rework them and restore them to the specified grades. Any sod, paving, or other surfacing damaged by settlement of trenches prior to acceptance of the work shall be replaced by and at the expense of the Contractor.

SECTION 203

CUT COMPACTION

203.1 **Description** - Cut compaction shall be performed after removal of the street excavation material to the required cross-section. A surface parallel to the pavement slope, 12 inches below the bottom of the pavement or lowest base course, shall be temporarily exposed for the full width between roadway inslopes. The exposed material, to a depth of 6 inches, shall be manipulated and compacted not less than the required density. The material above this compacted plane shall be spread in layers not exceeding 8 inches loose thickness, each layer being wetted or dried as necessary and compacted to the specified density.

203.1.1 Cut compaction shall be performed to an additional depth of 12 inches for 50 feet on each side of the intersection of the natural ground and the top of the sub-grade, then graded uniformly for 30 feet to meet the depth requirements of **Section 203.1**, and, if necessary, **Section 203.3.1.2**.

203.1.2 The existing ground for the full width between roadway slopes under embankments of less than 18 inches high shall be treated in accordance with **Section 203.1** to only such depth as to ensure having 18 inches of material of the required density and moisture below the top of the finished grade.

SECTION 205

SUB-GRADE

- 205.1 **Description** - That portion of the graded roadbed upon which surfacing is to be placed is hereby designated as the sub-grade. The sub-grade shall be constructed so that it will be uniform in density throughout its entire width and will conform to the line, grade, and cross section shown on the plans or as established by the Engineer.
- 205.2 **Finishing** - After excavation and embankment has been completed the sub-grade shall be brought to true shape and rolled with a self-propelled roller weighing not more than five (5) tons for portland cement concrete base course or pavement. For all other types of pavement, a three-wheeled roller weighing not less than seven (7) tons shall be used for rolling sub-grade. It shall then be tested with an approved template furnished by the Contractor. If the sub-grade is not to the proper elevation, material shall be added or removed as required and if material is added it shall be compacted in a manner satisfactory to the Engineer. This process shall be repeated until all irregularities are removed. Extreme care shall be taken in shaping the sub-grade, so that at no place will the completed pavement vary from the specified thickness. All soft and yielding spots shall be removed to a depth of not-to-exceed two (2) feet, and all vegetable substances or unsuitable material shall be removed, and the resulting spaces shall be refilled with approved material. All large rocks or boulders encountered shall be removed or broken off to a depth of not less than six (6) inches below the finished surface of the sub-grade, and the space shall be refilled. The sub-grade shall again be rolled until no depressions occur.
- 205.3 **Inspection** – To check compaction of sub-grade before sub-base or base is applied, a fully loaded tandem axle dump truck shall be driven over the sub-grade. If the sub-grade deflects, the sub-grade shall not pass the inspection.
- 205.4 **Restoring Sub-grade to Acceptable Condition** - If the sub-grade is disturbed in any manner after the work, described in the preceding paragraph, has been completed, it shall be brought to an acceptable condition by reshaping and rolling, or with macadam. If required by the Engineer, the Contractor shall provide planking to protect the sub-grade from disturbance.
- 205.5 **Amount of Finished Sub-grade** - There shall be at all times at least fifty (50) feet of sub-grade in the condition described in the preceding **Sections 205.2** and **205.3**, ahead of the point at which concrete is being placed.

SECTION 209

FINAL TRIMMING AND CLEAN UP

209.1 **Requirements** - Prior to the acceptance of the work, all shoulders, slopes, ditches if any, and sidewalk spaces shall be shaped, trimmed and made uniform, smooth and true to line, grade and cross section. All debris and rubbish resulting from the construction work or occurring within the limits of the improvement shall be disposed of before final acceptance will be made.

SECTION 210

AGGREGATE BASE MATERIAL

210.1 **Type 1 Aggregate (Rolled Stone)** - Aggregate for Type 1 base shall be essentially limestone. The crushed stone shall not contain deleterious material such as shale or disintegrated stone in excess of fifteen percent (15%). Any silt, any clay, and any deleterious material shall be uniformly distributed throughout the mass. The aggregates shall conform to the following gradation requirement:

Passing 1 inch sieve	100%
Passing 1/2 inch sieve	60-90%
Passing No. 4 sieve	40-60%
Passing No. 40 sieve	15-35%

210.2 **Type 2 Aggregate** - Aggregate for Type 2 base shall consist of crushed stone, limestone screening, sand and gravel, sand, chat, or sandstone, or combinations of these materials, with or without soil binder as may be required. The material shall conform to the following gradation requirements and in addition shall be so graded that it will readily compact to the specified density and withstand construction traffic without distortion and displacement.

If flint chat or tiff chat is used, it shall meet the requirements of this section and in addition shall have at least twenty percent (20%) passing the No. 40 sieve.

Soil binder shall consist of soil or similar fine material with such cohesive properties as to impart the desired plasticity to the finished product.

Compacted Granular Base

Passing 1 1/2 inch sieve	100%
Passing No. 40 sieve	15-50%
Passing No. 200 sieve, not more than	35%

2 1/2" Minus Compacted Granular Base

Passing 3 inch sieve	100%
Passing 2 1/2 inch sieve	90-100%
Passing 2 inch sieve	80-100%
Passing 1 inch sieve	75-90%
Passing 1/2 inch sieve	45-60%

SECTION 212

AGGREGATE BASE

212.1 **Description** - Aggregate base shall consist of a uniform mixture of properly graded materials placed on a prepared sub-grade as shown on the plans. The type of aggregate used shall be as specified on the plans.

212.2 **Materials**

212.2.1 Aggregate base materials shall conform to the following:

Type 1 Aggregate (Rolled Stone) **Section 210.1**

Type 2 Aggregate (Compacted Granular Base) &
(2 1/2" Compacted Granular Base) **Section 210.2**

212.2.2 Water shall be clean and free from acid, salt, oil and other organic matter. The use of City water is preferred.

212.3 **Equipment**

212.3.1 **Mixing Equipment** - Equipment for producing mixture shall be an approved stabilization pugmill, which will uniformly mix the water with the aggregate in such manner as to avoid undue segregation.

212.3.2 **Construction Equipment** - Equipment for this work shall consist of blade or motor patrol graders, self-powered steel wheeled rollers, self-propelled pneumatic-tired rollers, vibratory compactors, sprinklers, or any other suitable equipment required to properly complete the work.

The Contractor shall furnish all equipment, tools, machinery and other appliances, which in the opinion of the Engineer, are necessary for handling materials and performing any part of the work.

All equipment shall be subject to the approval of the Engineer before the work is started, and wherever found unsatisfactory, shall be changed and/or improved as required by the Engineer. All equipment, tools and machinery must be maintained in satisfactory working condition.

212.4 **Preparation of Mixture** - Base material, any additional material required, and water in an amount sufficient to insure the desired compaction shall be thoroughly mixed and delivered to the construction site as a combined product. Excess moisture resulting in run-off shall be avoided. The final product of base material mixed with binder shall meet the specified gradation and plasticity index (P.I.). If necessary for satisfactory work, the mixture or sub-grade or both shall be allowed to dry to a moisture content which will permit proper compacting.

212.5 Construction Procedure

- 212.5.1 **Sub-grade** - All work on any section of the sub-grade on which the base is to be constructed shall be completed prior to the placing of any base material on that section. Immediately before spreading the mixture, the sub-grade shall be sprinkled as specified by the Engineer.
- 212.5.2 **Spreading, Shaping and Compacting** - In no case will the Contractor be permitted to place the mixture or manipulate it on muddy or frozen sub-grade. Also, any mixture containing frost or frozen particles shall not be placed on the sub-grade or compacted. After the sub-grade has been properly prepared, the mixture shall be uniformly spread by blades, or other approved equipment, in successive layers of courses to such depth that, when compacted, the base will have the minimum thickness shown on the typical cross section. The Contractor may construct the base in any number of layers which he may find convenient to facilitate compacting, except that, in no case, shall any individual layer have a compacted thickness of more than four (4) inches, provided however when vibrating equipment is used, the base may be constructed in one (1) course (not exceeding six (6) inches), provided the equipment used proves capable of compacting the base in accordance with these specifications. Each layer shall be compacted as hereinafter specified before any succeeding layer is placed. Except as otherwise permitted by the Engineer, the first course placed upon the sub-grade shall be compacted and allowed to become firm before any subsequent is constructed.

If, in the opinion of the Engineer, the mixture becomes too dry to permit compaction, water shall be added during the compacting operations in such an amount as to insure proper compaction. If, for any reason, the mixture is too wet for proper compaction it shall be allowed to dry until the proper moisture content is obtained.

The mixture shall be handled in such manner as to avoid undue segregation. If segregation occurs, or, if the mixture becomes contaminated, such segregated or contaminated materials shall be removed and replaced with materials of suitable quality and gradation, except that areas of surface segregation may be corrected by spreading a quantity of limestone screening sufficient to close the voids and bind the loose material firmly in place. The screenings shall be wet and rolled so as to create a dense and uniform surface. Segregated or contaminated materials, which the Engineer orders removed, shall be removed and replaced with suitable material at the sole expense of the Contractor. The Engineer may restrict hauling over the completed or partially completed work after inclement weather, or at any time when the sub-grade is soft and there is tendency for the sub-grade material to work into the surface material. Any screenings used in correcting areas of surface segregation will be measured and paid for as part of the aggregate constituting the base course. All extra work or expense involved due to screenings being required shall be

the Contractor's obligation without extra cost to the City. Compaction shall be performed by the use of any approved equipment within the limits of these specifications, which will produce satisfactory results.

Shaping and compaction shall be carried on until a true, even, uniform base course of the proper grade, cross-section and density is obtained. Proper moisture content shall be maintained by wetting the surface as required during shaping and compacting operations. The use of excess water, resulting in run-off or in the formation of a slurry on the surface shall be avoided.

Final rolling on the top course of multiple-course construction or on single-course construction shall be accomplished by a self-propelled smooth-wheeled roller weighing not less than seven (7) tons, nor more than ten (10) tons.

Type 1 aggregate used for shoulders adjacent to portland cement concrete pavement, and Type 2 aggregate shall be compacted to not less than ninety-five percent (95%) of standard maximum density. Type 1 aggregate for use on other than shoulders adjacent to portland cement concrete pavement shall not be compacted to less than standard maximum density. Type 1 aggregate for use on other than shoulders adjacent to portland concrete pavement shall not be compacted to less than standard maximum density.

- 212.5.3 **Maintenance** - When the base is to be constructed in more than one (1) layer, the Contractor shall maintain the underlying layers by wetting or drying, blading and rolling in a manner satisfactory to the Engineer until the next layer is completed. This maintenance shall be entirely at the Contractor's expense. If a prime coat is specified in the Contract, the Contractor will be required to apply the prime coat on any completed portion of the base as soon as practicable, but he will not be permitted to prime or to construct a bituminous surface course when the moisture content of the top two (2) inches of the base is more than two-thirds (2/3) of the optimum moisture.

If the Contract includes the construction of portland cement concrete pavement, the Contractor will be required to maintain the completed base until the pavement is placed. The base shall be considered complete when it has the required density with a uniform surface of the proper grade and final template section. Lateral ditches shall be constructed through shoulders where possible to insure adequate surface drainage.

- 212.5.4 **Inspection** – To check compaction of sub-grade before sub-base or base is applied, a fully loaded tandem axle dump truck shall be driven over the sub-grade. If the sub-grade deflects, the sub-grade shall not pass the inspection.

SECTION 213

ROCK BLANKET (RIP RAP)

213.1 **Description** - This work shall consist of constructing a protecting blanket of rock or broken concrete on slopes or stream banks.

213.2 **Material** - The material for rock blanket shall be durable stone or broken concrete containing a combined total of not more than 10 percent of earth, sand, shale and non-durable rock. It is preferable that the material contain a large percentage of pieces as large as the thickness of the blanket will permit, with enough smaller pieces of various sizes to fill the larger voids.

Type 1 Rock Blanket – At least 40 percent of the mass shall be of pieces having a volume of one cubic foot or more.

Type 2 Rock Blanket – At least 60 percent of the mass shall be of pieces having a volume of one cubic foot or more.

Acceptance of quality and size of material will be made once supply tickets for such rock is received by the department.

SECTION 220

BITUMINOUS MATERIALS

Note: Streets shall be concrete except by variance of the Board of Aldermen.

- 220.1 **General - Approval of the Source of Bituminous Material** - For all bituminous construction the Contractor shall obtain from the Engineer written approval of the sources of bituminous materials. Such approval shall be obtained before any shipments are started. The Contractor shall submit written evidence to the Engineer that all bituminous materials used conform to the requirements of **Section 220.1** through **Section 220.14**.
- 220.2 **Measurement of Liquid Bituminous Material** - The Contractor shall submit to the Engineer, invoices in triplicate on all shipments of bituminous materials. The following volume correction methods, where applicable, shall be used for determining the volume of bituminous materials mentioned in these specifications.
- 220.3 **Petroleum Products** - This item includes road oil, liquid asphaltic material cutback, and penetration asphalt. Measurement of the material shall be base on the volume of sixty degrees Fahrenheit (60°F.) using the volume correction factors of ASTM D 1250-56, Table 25, for converting the material from the volume at the observed temperature to the volume at sixty degrees Fahrenheit (60°F.). The volume of uncalibrated distributors and tank trucks may be determined by weighing before and after unloading to determine the net weight of the material. The net weight shall be converted to gallons by using the unit weight in pounds per gallon at sixty degrees Fahrenheit (60°F.) designated by the Engineer.
- 220.4 **Emulsified Asphalt** - Measurement of the material shall be based on the volume at sixty degrees Fahrenheit (60°F.) using a coefficient of expansion of .0003 per degree Fahrenheit for converting the material from the volume at the observed temperature to the volume at sixty degrees Fahrenheit (60°F.).
- 220.5 **Liquid Tar Products** – Measurement of the material shall be based on the volume at sixty degrees Fahrenheit (60° F.) using the correction tables of ASTM D 633-44 for converting the material from the volume at the observed temperature to the volume at sixty degrees Fahrenheit (60° F.). In case the observed temperature exceeds the maximum given in the tables, the measurement shall then be made by considering unit volume at the observed temperature and calculating the volume at sixty degrees Fahrenheit (60° F.), by using a coefficient of expansion of .00033 per degree Fahrenheit.
- 220.6 **Proportioning and Blending Bituminous Material Constituents** – All materials shall be properly proportioned and thoroughly blended in suitable tanks prior to delivery to transportation equipment, or may be proportioned and blended by use of automatic proportioning equipment. Blending in tanks in quantities of less than eight thousand (8,000) gallons, or in tank trucks will not be permitted. All automatic proportioning blenders shall meet the approval of the Engineer and shall be equipped with precision

instruments, including electrically interlocked motors and an automatic recorder that prints the quantity of each component on the shipping ticket.

220.7 Application Temperatures for Bituminous Materials

ASPHALTIC MATERIAL	TEMPERATURE DEGREES FAHRENHEIT			
	SPRAYING		MIXING	
	MIN	MAX	MIN	MAX
X00-300 Penetration Asphalt	260	325	200	275
All other Penetration Asphalt	285	350	275	325
RC-0	65	135	50	120
RC-1	110	180	80	125
RC-2	140	210	80	150
RC-3	170	240	125	175
RC-4	180	255	150	200
RC-5	215	285	175	225
MC-0	70	140	50	120
MC-1	110	185	80	150
MC-2	140	215	100	200
MC-3	175	250	150	200
MC-4	190	265	175	225
MC-5	220	290	200	250
SC-1	110	185	80	200
SC-2	140	215	150	200
SC-3	175	250	175	250
SC-4	190	265	175	250
SC-5	220	290	200	275
EMULSIONS				
RS-1	75	130	---	---
RS-2	110	160	---	---
RS-3	100	160	100	160
SS-1	75	130	75	130
REFINED TARS				
RT-1,2	60	125	---	---
RT-3,4,5,6	80	150	80	150
RT-7,8,9	150	225	150	225
RT-10,11,12	175	250	175	250

- 220.8 **Type RC Liquid Asphaltic Materials** - The cutback asphalt shall be produced by fluxing an asphaltic base with a suitable light volatile solvent. It shall be homogenous and free from water, and shall conform to the requirements of Table I for the grade specified in the Contract.
- 220.9 **Type MC Liquid Asphaltic Materials** - The cutback asphalt shall be produced by fluxing an asphaltic base with suitable volatile solvents. It shall be homogenous and free from water, and shall conform to the requirements of Table II for the grade specified in the Contract.
- 220.10 **Type SC Liquid Asphaltic Materials** - Type SC liquid asphaltic material shall be homogenous and shall not foam when heated0...to two hundred and ten degrees Fahrenheit (210°F.). It shall conform to the requirements of Table III for the grade specified in the Contract.

TABLE I--Type RC Liquid Asphaltic Materials

Grade	Extra Light	Light	Medium	Heavy	Extra Heavy	Semi-Solid
Designation	RC-0	RC-1	RC-2	RC-3	RC-4	RC-5
(A) Flash Point F. (Tag Open Cup)						
(B) Viscosity Saybolt-FuroI, at 77° at 122° at 140° at 180°	75-150	75-150	100-200	250-500	125-250	300-600
(C) Distillation--percent by volume of total distillate to 680° F. to (1) 374° (2) 437° (3) 500° (4) 600°	15+ 55+ 75+ 90+	10+ 50+ 70+ 80+	40+ 65+ 87+	25+ 55+ 83+	8+ 40+ 80+	25+ 70+
Residue above 680° F. volume percent by diff	50+	60+	67+	73+	78+	82+
(D) Tests on residue from distillation (1) Penetration 77° F., 100g., 5 sec. (2) Ductility 77° F. (3) Percent Soluble in CCI (4) Oliensis Spot Test	80-120 100+ 99.5+ Neg.	80-120 100+ 99.5+ Neg.	80-120 100+ 99.5+ Neg.	80-120 100+ 99.5+ Neg.	80-120 100+ 99.5+ Neg.	80-120 100+ 99.5+ Neg.

TABLE II--Type MC Liquid Asphaltic Materials

Grade	Extra Light	Light	Medium	Heavy	Extra Heavy	Semi-Solid
Designation	MC-0	MC-1	MC-2	MC-3	MC-4	MC-5
(A) Flash Point (1) Tag Open Cup F. (2) Cleveland Open Cup F. (B) Viscosity Saybolt-Furol; (1) at 77° F. (2) at 122° F. (3) at 140° F. (4) at 180° F. (C) Distillation—percent by volume total distillate to 680° F. (1) to 437° F. (2) to 500° F. (3) to 600° F. (4) Residue from distillation to 680° volume percent by diff (D) Tests of residue from distillation: (1) Penetration 77° F. 100 g., 5 sec. (2) Ductility at 77° F. for residue of less than 200 penetration (cm) (3) Ductility at 60° F. for residue of 200-300 penetration (cm) (4) Percent soluble in CC1 ₄ (5) Oliensis Spot Test	100+ 75-100	100+ 75-150	150+ 100-200	150+ 250-500	150+ 125-250	150+ 300-600
	25 40-70 75-93 50+	20 25-65 70-90 60+	10 15-55 60-87 67+	5 5-40 55-85 73+	0 30 40-80 78+	0 20 20-75 82+
	150-300 100+	150-300 100+	150-300 100+	150-300 100+	150-300 100+	150-300 100+
	100+ 99.5+ Neg.	100+ 99.5 Neg.	100+ 99.5+ Neg.	100+ 99.5 Neg.	100+ 99.5+ Neg.	100+ 99.5+ Neg.

TABLE III--Type SC Liquid Asphaltic Materials

Grade	Light	Medium	Heavy	Extra Heavy
Designation	SC-1	SC-2	SC-3	SC-4
Used	Prime	Surface Treatment	Binder	Binder
1. Water, not more	0.5%	0.5%	0.5%	0.5%
2. Specific gravity 60 °F, not less than	50%	1.010	1.010	1.010
3. Asphaltic Residue of 100 penetration, not less than	100 cm.	60%	70%	78%
4. Ductility of 100 penetration residue, at 77 °F., not less than	75-125	100 cm.	100 cm.	100 cm.
5. Viscosity (Saybolt-Furol), at 122°	150 °F	125-200	200 °F	200 °F
6. Flash point (Cleveland Open Cup) not less than	11%	200 °F	9%	5%
7. Loss on heating 50 g. 5 hrs. at 325 °F., not more than	99.0	9%	99.0	99.0
8. Percent soluble in carbon tetrachloride, not less than		99.0		

220.11 Asphalt Cement (60 to 100 Penetration) - Asphalt cement shall be homogenous and free from water, and shall not, on heating, foam below the specified minimum flash point. It shall be prepared by the refining of crude petroleum by suitable methods. A solid native lake asphalt fluxed to the proper consistency with a suitable oil asphaltic flux may be permitted. Asphalt cement shall meet the following requirements:

	<u>Oil Bermudez</u>	<u>Fluxed Trinidad</u>	<u>Fluxed Asphalt</u>
Penetration, 25°C. (77°F.) 100 g, 5 seconds	60-100	60-100	60-100
Flash point (Cleveland Open Cup) (not less than)	230°C	175°C	175°C
Softening Point (Ring and Ball)	40° - 65°C	40° - 55°C	40° - 60°C
Loss on heating 50 g. for 5 hrs at 163°C. (325°F.), not more than	1.0%	3.0%	3.0%
Penetration of residue, 25°C. (77°F.), 100 g., 5 sec.in percent of original penetration, not less than	60	50	50
Total bitumen (soluble in carbon disulfide), not less than	99.5%	94.0%	65.0%
Bitumen insoluble in carbon tetrachloride, not more than	0.5%	0.5%	0.5%
Inorganic matter insoluble in carbon disulfide, not less than	—	1.5%	19.0%
Ductility at 25°C. (77°F.), not less than	100cm	40cm	40cm
Oliensis spot test	Negative	-----	-----

The penetration of the asphalt will be designated by the Engineer as one of the three following grades: 60 to 70; 70 to 85; 85 to 100. Material for any one Contract shall vary not more than 0.02 in specific gravity, nor more than ten degrees Celsius (10°C) softening point within limits specified.

220.12 Asphalt Cement (100 to150 Penetration) - Asphalt cement shall be homogenous and free from water, and shall not, on heating, foam below the specified minimum flash point. It shall be prepared by the refining of crude petroleum by suitable methods. A solid native lake asphalt fluxed to the proper consistency with a suitable oil asphalt flux may be permitted. Asphalt cement shall meet the following requirements:

	Oil Bermudez	Fluxed Trinidad	Fluxed Asphalt
Penetration, 25°C. (77°F.) 100 g, 5 seconds	100-150	100-150	100-150
Flash point (Cleveland Open Cup) (not less than)	230°C	175°C	175°C
Softening Point (Ring and Ball)	40° - 60°C	40° - 50°C	40° - 50°C
Loss on heating 50 g. for 5 hrs at 163°C. (325°F.), not more than	1.0%	3.0%	3.0%
Penetration of residue, 25°C. (77°F.), 100 g., 5 sec. in percent of original penetration, not less than	60	50	50
Total bitumen (soluble in carbon disulfide), not less than	99.5%	94.0%	65.0%
Bitumen insoluble in carbon tetrachloride, not more than	0.5%	0.5%	0.5%
Inorganic matter insoluble in carbon disulfide, not less than	—	1.5%	19.0%
Ductility at 25°C. (77°F.), not less than	100cm	40cm	40cm
Oliensis spot test	Negative	-----	-----

The penetration of the asphalt will be designated by the Engineer as one of the following grades: 100 to 120; or 120 to 150. Material for any one Contract shall vary not more than 0.02 in specific gravity, not more than ten degrees Celsius (10°C.) in softening point within the limits specified.

220.13 Asphalt Cement (150 to 300 Penetration) - Asphalt cement shall be homogenous and free from water, and shall not, on heating, foam below the specified minimum flash point. It shall be prepared by the refining of crude petroleum by suitable methods. Asphalt cement shall meet the following requirements:

Penetration, 25°C. (77°F.) 100 g, 5 seconds	150-300
Flash point (Cleveland Open Cup) (not less than)	215°C
Softening Point (Ring and Ball)	30° - 45°C
Loss on heating 50 g. for 5 hrs at 163°C. (325°F.), not more than	2.0%
Penetration of residue, 25°C. (77°F.), 100 g., 5 sec. in percent of original penetration, not less than	60
Total bitumen (soluble in carbon disulfide), not less than	99.5%
Bitumen insoluble in carbon tetrachloride, not more than	0.5%
Oliensis spot test	Negative

The penetration of the asphalt will be designated by the Engineer as one of the three (3) following grades: 150 to 200; 200 to 250; 250 to 300. Material for any one Contract shall

vary not more than 0.02 in specific gravity nor more than ten degrees Celsius (10° C.) in softening point within the limits specified.

220.14 **Emulsified Asphalt** - Emulsified asphalt shall meet the requirements prescribed in AASHTO M 140-56, for the type specified in the Contract.

SECTION 221 AGGREGATE FOR ASPHALTIC CONCRETE

221.1 **Coarse Aggregate** - All coarse aggregate shall consist of sound, durable rock, free from objectionable coatings. When the coarse aggregate is tested in accordance with AASHTO T 96-58 (c) (Los Angeles Abrasion), the percentage of wear shall not exceed fifty (50%) unless otherwise permitted by the Engineer. The percentage of deleterious substances shall not exceed the following values and the sum of percentages of all deleterious substances shall not exceed eight percent (8%).

Deleterious Rock	8.0%
Shale	1.0%
Other Foreign Material	0.5%

221.1.1 Gravel aggregate shall be washed sufficiently to remove any objectionable coating.

221.1.2 The above requirements apply to each size or fraction of aggregate produced.

221.1.3 Pile-run chat, defined as tailings from mills in which metallic minerals are recovered, will not be approved for use in asphaltic concrete unless the chat has been conditioned to meet a specified gradation. A tolerance of seven percent (7%) plus or minus, on each sieve fraction will be permitted provided the aggregate complies with other provisions of this specification.

221.1.4 Coarse aggregate for Type "B" and Type "C" asphaltic concrete mixtures shall be furnished and stockpiled in two (2) or more separate sizes or fractions. One fraction shall consist of material retained in the one-half (1/2) inch sieve, and the other fraction shall consist of material passing the one-half (1/2) inch sieve. A tolerance not to exceed fifteen percent (15%) may be permitted on the one-half (1/2) inch sieve for each fraction. The gradation of coarse aggregate shall be such that the combinations of coarse aggregate fractions, when combined with the fine aggregate, will meet the gradation requirements for the type of asphaltic concrete specified. The various coarse aggregate fractions shall comply with the following requirements:

PERCENTAGE BY WEIGHT		
<u>Maximum Size of Fraction</u>	No. 10 Sieve	No. 200 Sieve
2		2.0%
1		2.0%
$\frac{3}{4}$	8.0%	
$\frac{3}{8}$	10.0%	

221.2 Fine Aggregate

221.2.1 Fine aggregate for asphaltic concrete shall be a fine, granular material naturally produced by the disintegration of rock of a siliceous nature. Fine aggregate shall be free from cemented or conglomerated lumps and shall not have any coating or injurious material. The percentage of deleterious substances shall not exceed the following values:

Clay lumps and shale	1.0%
Coal and lignite	0.25%
Other deleterious substances	0.1%

221.2.2. Fine aggregate delivered to the coal bin shall be furnished in one fraction. In case two (2) or more fractions of fine aggregate are delivered to the job site, they shall be uniformly blended to form a single material, and the gradation of the blended fine aggregate shall comply with the following gradation limits. The blending shall be done a sufficient distance from the coal feed bins so that the blended stockpile of fine aggregate shall be moved at least once before being fed into the coal bin.

Total Passing 3/8 inch sieve	100%
Passing 3/8 inch and retained on No. 4	0-8%
Passing No. 4 and retained on No. 10	0-12%
Passing No. 10 and retained on No. 40	20-50%
Passing No. 40 and retained on No. 80	25-55%
Passing No. 80 and retained on No. 200	12-35%
Passing No. 200, not more than	4-0%

221.3. **Mineral Filler** - Filler shall consist of stone dust, portland cement, or other artificially or naturally powdered mineral dust approved by the Engineer. It shall be free from foreign or other objectionable material, and shall meet the following gradation requirements:

Passing No. 30 sieve	100%
Passing No. 200 sieve	75-100%
Passing 325 sieve, not less than	30%

SECTION 222 ASPHALTIC CONCRETE PAVEMENT

222.1. **Description** - Asphaltic concrete pavement shall consist of a mixture of mineral aggregate and asphalt cement prepared in a stationary plant and placed in one or more courses on a prepared base or underlying course in conformity with the line, grade, and section shown on the plans.

222.2. **Materials** - All materials shall conform to the following sections of these specifications:

Type	Section
Asphalt (60 to 100 Penetration)	220.11
Coarse Aggregate	221.1
Fine Aggregate	221.2
Mineral Filler	221.3

Asphaltic concrete mixture shall consist of mineral aggregates and asphalt cement combined in such proportions that the composition by weight of the finished mix shall be within the following range for the type specified:

TYPE B

	Min	Max
Passing 1 inch sieve	100%	--
Passing 1 inch sieve, retained on 3/4 inch sieve	0%	20%
Passing 3/4 inch sieve, retained on 1/2 inch sieve	10%	40%
Passing 1/2 inch sieve, retained on No. 4 sieve	10%	40%
Passing No. 4 sieve, retained on No. 10 sieve	5%	18%
Passing No. 10 sieve, retained on No. 40 sieve	5%	18%
Passing No. 40 sieve, retained on No. 80 sieve	3%	20%
Passing No. 80 sieve, retained on No. 200 sieve	2%	15%
Passing No. 200 sieve	2% 8%	
Asphalt Cement	3.5% 6%	

TYPE C

	Min	Max
Passing 1/2 inch sieve	100%	---
Passing 1/2 inch sieve, retained on 3/8 sieve	0%	25%
Passing 3/8 inch sieve, retained on No.4 sieve	20%	45%
Passing No. 4 sieve, retained on No. 10 sieve	7%	20%
Passing No. 10 sieve, retained on No. 40 sieve	7%	20%
Passing No. 40 sieve, retained on No. 80 sieve	5%	20%
Passing No. 80 sieve, retained on No. 200 sieve	5%	18%
Passing No. 200 sieve	4%	10%
Asphalt Cement	4%	7%

The Engineer may require at the time the job mixture is approved, that not less than 30 percent (30%) of material designated as fine aggregate be incorporated in the mixture. At

least thirty (30) days prior to preparing any of the mixture on the project, the Contractor shall obtain, in the presence of the Engineer or his authorized representative, samples of asphalt and mineral aggregates for tests and shall submit in writing the mixing formula which he proposes to use. The mixing formula shall include the type and sources of all materials, the gradations of the aggregates, the relative quantity of each ingredient and shall state a definite percentage for each sieve fraction of aggregate and for asphalt cement. The samples of materials shall be within the limit of size designated by the Engineer and shall be submitted by the Contractor and at the expense of the Contractor to a reputable testing laboratory, which shall design a mix formula meeting these specifications, a copy of which shall be sent to the Engineer.

No mixtures shall be accepted for use on the project until an approved job mixing formula is approved by the Engineer. In producing mixtures for the project the plant shall be so operated that no intentional deviations from the job mixing formula shall be made except as specifically authorized by the Engineer. In any case the maximum variations from the approved formula shall not be greater than the following requirements and shall be within specifications limits.

Retained on 1/2 inch sieve	5%
Passing 1/2 inch sieve, retained on No. 10 sieve	5%
Passing No. 10 sieve, retained on No. 200 sieve	3%
Passing No. 200 sieve	1%
Asphaltic Cement	0.5%

In addition to these maximum permissible variations from the approved formula, not more than thirty percent (30%) variation will be permitted on the individual sieve fractions between the forty to eighty (40-80) mesh sieve and the eighty to two hundred (80-200) mesh sieve.

The Engineer may make adjustments in the mix formula submitted by the Contractor in order that seventy to eighty percent (70-80%) of the voids in the mineral aggregate shall be filled with asphalt.

In mixtures containing rounded or uncrushed aggregate, it may be necessary for a portion of the aggregate to be a highly angular or crushed material in order to comply with the stability and other requirements. If difficulty is experienced with the aggregate combinations submitted, the Engineer may designate the amount of angular or crushed material necessary after laboratory investigations are made of the combinations proposed by the Contractor.

If the mixing formula submitted for approval or a previously approved mixing formula results in mixtures which are unsatisfactory in the opinion of the Engineer, due to surface texture, workability, segregation tendencies, or for any other reason, the Engineer shall have the right to make any changes within the limits of the specifications which he deems advisable and establish a new mixing formula.

222.3 Construction Procedure

- 222.3.1 **Transportation of Mixture** – The prepared mixture shall be transported from the paving plant to the work in tight vehicles previously cleaned of all foreign materials. The inside of truck beds shall be lubricated with a thin oil to prevent mixture from adhering to the bed, but an excess of lubricant will not be permitted. Each load shall be covered with canvas or other suitable material of sufficient size to protect it from the weather. No loads shall be sent out so late in the day that spreading and compacting of the mixture cannot be completed during daylight.
- 222.3.2 **Application of Primer** - The prime coat, when specified, shall be applied as set forth in **Section 223**.
- 222.3.3 **Spreading of the Mixture** - The base course, primed surface, or preceding course shall be cleaned of all dirt, packed soil, or any other foreign material prior to spreading the asphalt mixture. Asphaltic concrete shall not be placed on any portion of an aggregate base when the moisture content of the top two (2) inches of the base is more than two-thirds (2/3) of the optimum moisture.

The mixture, when delivered to the spreading and finishing machine shall have a temperature of not less than two hundred degrees Fahrenheit (200°F.) and be within twenty-five degrees Fahrenheit (25°F.) of that designated by the Engineer. It shall spread only when the prepared grade or preceding course is dry. Bituminous material shall not be mixed or placed when the atmospheric temperature is below forty degrees Fahrenheit (40°F.) or when there is frost in the subgrade, or any other time when weather conditions are unsuitable for the type of material being placed.

The thickness and width of each course shall conform to the typical section in the Contract. The Contractor may construct each course in any number of layers he chooses but no individual layer shall have a compacted thickness greater than three (3) inches for Type B material and four (4) inches for Type C material.

For pavements having a width of sixteen (16) to twenty-four (24) feet, inclusive, the asphaltic concrete pavement shall be laid in lanes approximately one-half (1/2) the full width of the completed pavement and the full width

completed as soon as practicable. Unless otherwise permitted, a single lane of any course shall not be constructed to a length, which cannot be completed to full width of the pavement in one day's operation. For pavement greater than twenty-four (24) feet in width, single lane width constructed shall be limited to one day's production and completion to full width shall be accomplished as soon as practicable.

Except as otherwise permitted herein, the mixture shall be spread by means of an approved mechanical spreading and finishing machine of a type that will uniformly spread the mixture to obtain the required compacted thickness designated in the Contract. No segregation will be permitted in handling the mixture at the plant, from the truck, or during spreading operations on the roadway. The spreading and finishing machine shall spread the mixture and strike it off so that the surface is smooth and true to cross section, free from all irregularities, and of uniform density throughout. All courses shall be feathered out, by hand raking if necessary, in transitioning, the depth of the surface to meet present grades at end of projects to provide a uniform smooth riding surface free of irregularities

When the asphaltic concrete construction consists of more than a single course, each course shall be compacted as specified and allowed to cool throughout to the atmospheric temperature before the next course is placed. The Contractor shall keep traffic off the asphaltic concrete until it has cooled for a sufficient period of time to prevent flushing of the asphalt to the surface, marking or distorting the surface, or breaking down the edges. Normally, this time will vary from two (2) to four (4) hours, depending on the atmospheric and temperature conditions. The final course shall be laid in the same sequence over the entire project as the previously constructed courses unless otherwise approved by the Engineer.

222.3.4 **Wedge Course** - Since one of the primary objectives of this construction is to obtain the smoothest possible riding surface, the existing roadbed surface will be studied by the Engineer to determine the location's thickness of wedge courses. This procedure may result in wedging operations over small areas, and rigid control of placement thickness will be required to insure desired feather-edging at high points and ends of wedge areas. Wedge course, consisting of a layer of asphaltic concrete of variable thickness used to eliminate irregularities in the existing base, shall be spread uniformly to the desired profile grade and cross section. The use of an approved finishing machine will be required on all work. Type C mixture shall be used for all wedge course.

Compaction of asphaltic mixtures shall consist of initial or break-down rolling, intermediate rolling, and final or finish rolling. Except for projects

involving small quantities of mixture, initial rolling shall be performed with three (3) wheel rollers or two (2) wheel tandem rollers weighing from eight (8) to twelve (12) tons. Intermediate rolling shall be done with oscillating type pneumatic-tire rollers if required by the Engineer; otherwise it shall be done with either two (2) or three (3) wheel tandem rollers. Final rolling shall be done with either two (2) or three (3) wheel tandem rollers weighing not less than ten (10) tons. Rollers shall be operated at a speed of not more than three (3) miles per hour and in a manner that will avoid shoving, cracking or displacing the mixture during the compacting period. The Contractor shall furnish a sufficient number of rollers to compact and finish satisfactorily the amount of mixture being placed.

The mixture shall be rolled when it is at the proper temperature to receive the roller and when rolling does not cause undue displacement or shoving. This proper temperature varies with the atmospheric condition and type of mixture. Initial compaction shall be done when the mixture has cooled just sufficiently to receive the roller. Intermediate and final compaction shall be done while the mixture is warm and malleable enough to respond to the kneading action of the roller. Rolling shall begin at the sides and progress gradually to the center of each land. Rollers shall move parallel to the center line of the roadway and uniformly lap each preceding track. Alternate trips of the roller shall be terminated in steps to prevent the formation of surface irregularities. The alternate stops shall be spaced in such a manner that any excess water will drain quickly. Lateral or diagonal rolling may be permitted to remove high spots, provided the rolling is done in such a manner and at such a time that shoving or cracking will not result. To prevent adhesion of the mixture, steel roller wheels shall be properly moistened, but an excess of water will not be permitted.

All mixtures shall be thoroughly compacted, and rolling shall be continued until no further compaction is being obtained. Except as otherwise specified, all compacted mixtures shall have a density not less than ninety-eight percent (98%) of that obtained by the laboratory compaction of an identical mixture.

Along curbs, headers, manholes and similar structures and at all places not accessible to the roller, thorough compaction must be secured by means of hot tampers and at all contacts of this character the joints between these structures must effectively sealed.

The compacted course shall be free of surface irregularities and shall conform to the grade and dimensions shown on the plans. Weak areas resulting from excess quantities of asphalt, segregation of aggregate or asphalt, areas which become loose or broken, mixed with dirt, or are in any way defective, shall be removed and replaced with fresh hot mixture, compacted to conform with the surrounding area, at the Contractor 's expense.

222.3.5 **Joints** - Longitudinal and transverse joints shall be made in a careful manner. Well bonded and sealed joints are required. Joints between old and new pavements, or between successive day's work shall be carefully made in such a manner as to insure thorough and continuous bond between the old and new surfaces. Hot soothers or tampers shall be carefully employed in such a manner as to heat up the old pavement sufficiently (without burning it) to insure a proper bond. Before placing mixture against them, all contact surfaces of dry longitudinal joints, curbs, gutters, headers, manholes, etc., shall be painted with a thin uniform coating of primer. In making the joint along any adjoining edge such as a curb, gutter, or an adjacent paving and after the hot mixture is placed by the finishing machine, just enough of the hot material shall be carried back to fill any space left open. The joint shall be properly "set-up" with the back of rake at proper height and level to receive the maximum compression under rolling. The work of "setting-up" this joint shall be performed always by competent workmen who are capable of making a correct, clean, and neat joint.

222.3.6 **Testing Pavement** - The finished courses shall have the thickness shown on the plans and shall be free from waves or irregularities and shall not vary from a ten (10) foot straight-edge, applied parallel to the center line, by more than one-half (1/2) inch on the first or intermediate courses and not more than one-eighth (1/8) inch on the surface course.

SECTION 223 PREPARATION OF BASE AND APPLICATION OF PRIMER

223.1 **Description** - Preparation of base and application of primer shall consist of applying a primer to a prepared base. The type and grade of prime material to be used will be specified in the Contract.

223.2 **Materials** - All materials shall conform to the following sections of these specifications:

Item	Section
Type RC Liquid Asphaltic Materials	220.8
Type MC Liquid Asphaltic Materials	220.9
Asphalt (60 to 100 Penetration)	220.11
Emulsified Asphalt	220.14

The quantity of asphalt in emulsified asphalts may be reduced to thirty-five percent (35%) when directed by the Engineer. Material meeting the requirements of **Section 220.8** and **Section 220.11** shall be diluted with naphtha in a manner approved by the Engineer.

223.3 **Equipment** - The equipment required on this work shall consist of a pressure distributor meeting the requirements specified below and other approved equipment including a five (5) ton roller. The pressure distributor shall be designed and equipped with pressure gauges to enable the operator to control the flow and to distribute the primer under a uniform pressure of not less than twenty-five (25) pounds per square inch. The distributor shall be equipped with proper adjustments to insure uniform application of primer in the amount specified over the area of the surface designated. Adjustable length, spray bars shall be operated a proper distance above the ground to insure a fifty percent (50%) lap of the sprays from adjacent jets. A thermometer well and an accurate thermometer shall be located on the distributor so that it is readily accessible at all times. The calibration of all distributors will be approved by the Engineer and the Contractor shall furnish all equipment, materials, and assistance necessary if calibration is required.

223.4 **Construction Procedure** - Preparation of Base.

223.4.1 **Absorbent Surface** - When the base consists of bound aggregate, loose gravel, or stone, the existing surface shall be prepared by wetting, if necessary, and blading and rolling unless otherwise specified. These operations shall continue until a smooth, uniform and compact surface is obtained, and shall be performed just prior to applying the primer. The surface shall be slightly damp and firm when primer is applied, no direct payment will be made for furnishing or applying any required water.

223.4.2 **Non-absorbent Surface** - When the base is of concrete, brick, or other non-absorbent surface, the surface of the base shall be cleaned of all dust, loose material, grease or other foreign material, and shall be maintained in this condition until the primer is applied. Any fat bituminous surface mixture or

bituminous joint material will be removed by others without cost to the Contractor before the primer is applied. If sixty to one hundred (60-100) Penetration Asphalt is permitted as an alternate for RC-0 for primer on non-absorbent type of surface, the penetration asphalt shall be cut back by the addition of naphtha to produce a final product that is the approximate equivalent of RC-O. The naphtha used shall have an initial boiling point of not less than one hundred eighty degrees Fahrenheit (180°F.) and an end point not greater than three hundred fifty degrees Fahrenheit (350°F.). The prepared and primed base shall meet the requirements of the specification relating to such work at the time it is covered, regardless of when the primer is applied. The surface of the base shall be dry when the primer is applied, except in the case of emulsion primer.

The primer shall be applied at a rate as specified in the Contract, or as revised by the Engineer within the following limits:

Type of Surface	Rate(gallons per square yard)	
	Minimum	Maximum
Absorbent	0.2	0.5
Non-absorbent	0.02	0.1

The primer shall be heated at the time of application to a temperature designated by the Engineer in accordance with the limits provided in Section 220.7, Application Temperatures of Bituminous Materials. Pools of primer material remaining on the surface after the application shall be removed. The primer shall be properly cured and the primed surface shall be cleaned of all dirt and surplus sand, before the next course is placed.

Unless otherwise permitted, whenever it is necessary to carry traffic over the roadway during priming operations, the prime coat for absorbent surfaces shall be applied in lanes approximately one-half (1/2) the width of the base at a time and shall be permitted to cure before application is made to the remaining one-half (1/2) width. The prime coat for non-absorbent surfaces may be applied full width, provided the primed surface including entrances and side streets is blotted with sand in such quantity as directed by the Engineer before it is opened to traffic.

Primer shall be applied only when the atmospheric temperature is above fifty degrees Fahrenheit (50°F.), and when ground and other conditions are favorable. Unless sand or some other blotting material is specified, the Contractor shall prevent traffic from using the primed surface until it is cured.

It shall be the Contractor 's responsibility to maintain or restore the completed primed surface in such a manner that a smooth, uniform surface will be available for the next course.

223.5 **Method of Measurement** - Measurement of bituminous material to the nearest ten (10) gallons will be made as specified in **Section 220.2**, Measurement of Liquid Bituminous Materials.

Measure of material for sanding primer will be made to the nearest ton, weighed in the vehicle at such location as may be directed by the Engineer.

SECTION 225 PLANT MIX BITUMINOUS BASE COURSE

225.1 **Description** - This work shall consist of aggregate, filler if needed, and asphalt binder mixed in a stationary bituminous mixing plant in such proportions that the resulting mixture meets the grading requirements of the job-mix formula. The mixture shall be placed, spread and compacted in conformity with the lines, grades, thicknesses and typical cross sections shown on the plans or established by the engineer.

225.2 **Material** - All material shall as follows:

225.2.1 **Coarse Aggregate** - All coarse aggregate shall consist of sound, durable rock, free from cemented lumps or objectionable coatings. When tested in accordance with AASHTO T 96, the percentage of wear shall not exceed 50. The percentage of deleterious substances shall not exceed the following values and the sum of percentages of all deleterious substances shall not exceed 8.0 percent.

Item	Percent by Weight (Mass)
Deleterious Rock	8.0
Shale	1.0
Other Foreign Material	0.5

The requirements of this section apply to each size or fraction of aggregate produced.

At least 60 percent of the particles retained on a No. 4 sieve, for use in bituminous mixtures shall have two or more mechanically induced faces.

If a density requirement is specified for asphaltic concrete, the total quantity of chert in each size or fraction of produced crushed stone aggregate, including that permitted as deleterious, shall not vary more than 10 percentage points from the quantity present in the aggregates used in the approved laboratory job mixtures.

Crushed stone shall be obtained from rock of uniform quality. Rock tested from individual ledges for preliminary source approval shall meet the following criteria. Los Angeles Abrasion, AASHTO T 96, percent loss, max 50 Absorption, AASHTO 85, percent, max 4.0.

225.2.2 **Fine Aggregate** - Fine aggregate for asphaltic concrete shall be a fine, granular material naturally produced by the disintegration of rock of a siliceous nature and/or manufactured by the mechanical reduction of sound durable rock with a percentage of wear not exceeding 50 when tested in accordance with AASHTO T 96. With written approval of the engineer and compliance with this specification, chat sand produced from flint chat in the Joplin area, dolomite chat as produced in the southeast lead belt area or fines

manufactured from igneous rock and chert gravel or wet bottom boiler slag may be used as fine aggregate for asphaltic concrete. Fine aggregate shall be free from cemented or conglomerated lumps and shall not have any coating or injurious material. The fraction passing a No. 40 sieve shall be non-plastic. The percentage of deleterious substances shall not exceed the following values:

Item	Percent by Weight (Mass)
Clay lumps and shale	1.0
Total lightweight (low mass density) particles, including coal and lignite	0.5
Other deleterious substances	0.1

Lightweight (Low mass density) sand particles are not considered deleterious lightweight (low mass density) particles. The total lightweight (low mass density) particles requirement shall not apply to wet bottom boiler slag, angular chert sand or manufactured sand.

Natural aggregate delivered to the cold bin shall be furnished in one fraction and shall meet the following gradation requirements. If the material is produced by use of two or more fractions, they shall be thoroughly blended at the site of original mixing to form a single material of uniform gradation. Further, if the blending is performed at the job site, it shall be done a sufficient distance from the cold feed bins so that the blended stockpile of fine aggregate will be moved at least once before being fed into the cold bin.

Sieve Size Percent

Passing by Weight (Mass)

3/8 inch	100
No. 200	0-6

Fine aggregate manufactured by the mechanical reduction of sound durable rock shall be delivered to the cold feed in one fraction, separate from any natural fine aggregate and shall meet the following gradation requirements.

Sieve Size	Percent Passing by Weight (Mass)
3/8 inch	100
No. 4	85-100
No. 200	0-8

225.2.3 **Mineral Filler** - Mineral filler shall consist of limestone dust, portland cement or other suitable mineral matter. Mineral filler shall be thoroughly dry and free of lumps consisting of aggregations of fine particles. When tested in accordance with AASHTO T 37 the mineral filler shall conform to the following gradation requirements:

Sieve Size	Percent Passing by Weight (Mass)
No. 30	100
No. 50	95-100
No. 100	90-100
No. 200	0-100

225.2.4 **Hydrated Lime** - Hydrated lime shall be thoroughly dry and free of lumps. It shall comply with AASHTO M 303, Type I or II, except the gradation shall be determined in accordance with AASHTO T 37.

225.3 **Gradation** - The gradation of coarse aggregate shall be such that the total aggregate meets the gradation requirements specified in this section prior to being fed into the cold aggregate feeders.

225.4 **Screenings** - When screenings are used, they shall be considered coarse aggregate consisting of tough, durable particles of approved quality, and shall be free from dirt or other objectionable material. The fraction passing a No. 40 sieve shall be non-plastic.

225.5 **Composition of Mixtures** - The bituminous base shall be composed of a mixture of crushed limestone or dolomite, except as hereinafter permitted, filler if needed, and asphalt binder. The total aggregate prior to mixing with asphalt binder shall meet the following gradation requirements:

Sieve Size	Percent Passing by Weight (Mass)
1 inch	100
1/2 inch	60-90
No. 4	35-65
No. 8	25-50
No. 30	5-12

At the option of the contractor, fine aggregate may be incorporated into the mixture. The total quantity of such fine aggregate shall not exceed 30 percent by weight (mass) of the combined aggregate and shall be added at the plant by means of a separate cold aggregate feeder.

225.6 **Composition** - The composition of the mixture shall be as directed by the engineer and shall conform to the following limits by weight (mass):

<u>Item</u>	<u>Percent</u>
Total Mineral Aggregate	94-97
Asphalt Binder	3-6

225.7 No job- mix formula will be approved when it fails to fall within the limits specified in **Sections 225.5** and **225.6**. The full tolerances shall be applied as specified in **Section 225.10** for asphalt binder and not less than 1/2 the tolerances shall be applied as specified in **Section 225.10** for material passing the No. 8 sieve and the material passing the No. 200 sieve. The job- mix formula approved for the mixture shall be in effect until modified in writing by the engineer. When unsatisfactory results or other conditions make it necessary, or should a source of material be changed, a new job- mix formula may be required.

225.8 The engineer will make such changes in the proportions of asphalt binder and aggregates as considered necessary. The proposed mixture will be compacted and tested in the laboratory in accordance with AASHTO T 167 or AASHTO T 245, at the option of the engineer and modified as follows. The test method used shall be modified by aging the mixture for two hours, at the specified compaction temperature range of the asphalt binder, just prior to compaction of the specimens. The mixture of mineral aggregate and asphalt binder shall result in a bituminous mixture, which will be durable and retain satisfactory cohesion and stability in the presence of moisture.

225.9 Moisture susceptibility may be tested in accordance with AASHTO T 283 or AASHTO T 165, at the option of the engineer. A minimum retained strength of 70 percent shall be obtained when tested for moisture susceptibility. If requested by the contractor, hydrated lime may be added to increase retained strength to a passing level.

225.10 **Gradation Control** - In producing mixtures for the project, the plant shall be so operated that no intentional deviations from the job-mix formula are made. Mixtures as produced shall be subject to the following tolerances and controls:

225.10.1 The total aggregate gradation shall be within the master range specified in **Section 225.5**.

225.10.2 The maximum variations from the approved job- mix formula shall be within the following tolerances:

Passing No. 8 sieve ± 5.0 percentage points

Passing No. 200 sieve ± 2.0 percentage points

225.10.3 The quantity of asphalt binder introduced into the mixer shall be that quantity specified in the job-mix formula. No change may be made in the quantity of

asphalt binder specified in the job- mix formula without written approval of the engineer. The quantity of asphalt binder determined by calculation or tests on the final mixture shall not vary more than 0.5 percentage point from the job- mix formula.

225.11 The gradations of the total aggregate will be determined from samples taken from the hot bins on batch- type plants or continuous mixing plants or from the composite cold feed belt on drum mix plants. Batch-type or continuous mixing plants shall have a screening unit, which separates the usable heated aggregate into at least two sizes. One of the aggregate bin sizes produced by the screening unit shall contain not more than 10 percent by weight (mass) retained on the No. 4 sieve.

225.12 **Commercial Mixture** - If specified in the contract that an approved commercial mixture may be used, the contractor shall, at least seven days prior to the desired time of use, furnish a statement setting out the source and characteristics of the mixture proposed to be furnished. The statement shall include: (1) the types and sources of aggregates, percentage range of each and range of combined gradation; (2) the percent and grade of asphalt binder; and (3) the mixing time and range of mixture temperature. The plant shall be designed and operated to produce a uniform, thoroughly mixed material free from segregation. A field laboratory will not be required. If the proposed mixture and plant are approved by the engineer, the component material and the mixture delivered will be accepted or rejected by visual inspection. The supplier shall furnish with the first truck load of each day's production, a certification in triplicate that the material and mixture delivered are in conformance with the approved mixture. Upon completion of the work, a plant certification in triplicate shall be furnished by the supplier for the total quantity delivered. The mixture shall be placed in accordance with the requirements specified in **Sections 225.15** through **225.20** and shall be compacted as specified in **Section 225.19**.

Construction Requirements

225.13 **Weather Limitations** - Bituminous mixtures shall not be placed (1) when either the air temperature or the temperature of the surface on which the mixture is to be placed is below 40 F, (2) on any wet or frozen surface, or (3) when weather conditions prevent the proper handling or finishing of the mixture.

225.14 **Sub-grade Preparation** - The sub-grade upon which the bituminous mixture is to be placed shall be prepared in accordance with **Section 205**.

225.15 **Spreading** - The base course, primed surface or preceding course or layer shall be cleaned of all dirt, packed soil or any other foreign matter prior to spreading the bituminous mixture. When delivered to the roadbed, the mixture shall be at a temperature which will permit proper placement and compaction. The mixture shall be spread with an approved spreading and finishing machine in the number of layers and in the quantity required to obtain the compacted thickness and cross section shown on the plans. When placing multiple layers with varying thicknesses, the thicker layer shall be placed first.

The compacted thickness of a single layer shall be between 3 and 4 inches, except as follows:

- 225.15.1 For spot- leveling and leveling course work, the layer thickness may be less.
- 225.15.2 For base widening, the material may be placed in two layers, provided no individual layer has a compacted thickness greater than 7 inches.
- 225.16 The mixture shall be spread without tearing the surface and struck off so that the surface is smooth and true to cross section, free from all irregularities, and of uniform density throughout. Care shall be used in handling the mixture to avoid segregation. Areas of segregated mixture shall be removed and replaced with suitable mixture. The outside edges of the base shall be constructed to an angle of approximately 45 degrees with the surface of the roadbed. The outside edge alignment shall be uniform and any irregularities shall be corrected by adding or removing mixture before compacting.
- 225.17 **Leveling Course** - If required by the contract, a leveling course consisting of a layer of variable thickness shall be spread to the desired grade and cross section to eliminate irregularities in the existing surface. Spot- leveling operations over small areas, with feather-edging at high points and ends of spot areas, may be required prior to placing the leveling course. Rigid control of the placement thickness of the leveling course will be required. The use of an approved finishing machine will be required on the spot- leveling and the leveling course, except that the spreading of the spot- leveling with a blade grader will be permitted if results indicate the mixture is practically free from segregation.
- 225.18 **Joints** - Longitudinal and transverse joints shall be carefully made and well bonded. The minimum density of all traveled way pavement within 6 inches of a longitudinal joint, including the pavement on the traveled way side of the shoulder joint, shall not be less than 2.0 percent below the specified density. Once an established procedure has been demonstrated to provide the required density for longitudinal joints, at the engineer's discretion, the procedure may be used in lieu of density tests provided no changes in the material, typical location or temperatures are made. Pay adjustments due to longitudinal joint density shall apply to the full width of the traveled way pavement and shall be in addition to any other pay adjustments. Transverse joints shall be formed by cutting back on the previous run so as to expose the full depth of the layer. When a transverse vertical edge is to be left and opened to traffic, a temporary depth transition shall be built as approved by the engineer. The longitudinal joints in one layer shall offset those in the layer immediately below by approximately 6 inches.
- 225.19 **Compaction** - Rolling shall begin as soon after spreading the mixture as it will bear the weight (mass) of the roller without undue displacement. All rollers shall be in satisfactory condition capable of reversing without backlash, and steel wheel rollers shall be equipped with scrapers. Rollers shall have a system for moistening each roll or wheel. A trench roller shall be used on depressed areas inaccessible to regular width equipment. The compacted mixture shall have a density of not less than 95 percent of that obtained by the laboratory compaction of a specimen made in the proportions of the approved mixture.

225.20 Surface Tolerance - The finished layers shall be substantially free from waves or irregularities and shall be true to the established crown and grade. At transverse construction joints the surface of all layers shall not vary from a 10-foot straightedge, applied parallel to the center line, by more than 1/4 inch, except that the entire surface of the final layer of plant mix bituminous base mixture shall not vary from the 10-foot straightedge by more than 1/8 inch if this layer is used as the final riding surface course. Areas exceeding this tolerance shall be re-rolled, replaced or otherwise corrected in a manner satisfactory to the engineer.

The surface of the mixture after compacting shall be smooth and true to the established crown and grade. Any mixture showing an excess of bituminous material or that becomes loose and broken, mixed with dirt, or is in any way defective shall be removed and replaced with satisfactory mixture, which shall be immediately compacted to conform with the surrounding area.

225.21 During construction, the engineer will make as many tests as are necessary to ensure that the course is being constructed of proper thickness, composition and density.

SECTION 230

PORTLAND CEMENT CONCRETE

230.1. **Description** - Portland cement concrete shall consist of a mixture of portland cement, fine aggregate, coarse aggregate, and water combined in the proportions specified for the various classes of concrete. Admixtures for the purpose of entraining air, retarding or accelerating the set, tinting and other purposes may be added as specifically required or permitted.

230.2. **Materials**

230.2.1 Portland cement shall conform to the requirements of ASTM Specifications C 150 and C 175, Type 1 or Type 1-A cement shall be used for all concrete work unless otherwise specified by the Engineer. The Contractor shall submit evidence to the Engineer that the portland cement conforms to ASTM Specifications C 150 and C 175.

If Type 1 is selected it shall be used with an air entraining admixture added at the plant to produce three to six percent (3% - 6%) air in the concrete. If Type 1-A cement is selected it also shall produce from three to six percent (3% - 6%) air in the concrete.

230.2.2 Concrete air entraining admixtures shall conform to the requirements of ASTM Specifications C 260 and C 233 as last revised except as permitted by the Engineer. In order to obtain approval for the use of any air entraining agent, the Contractor shall submit to the Engineer evidence that the agent conforms to the requirements of ASTM C 260 and C 233 as last revised.

230.2.3 Fine aggregate shall consist of clean natural sand of hard, sharp, durable and uncoated, grains. The amount of deleterious substances shall not exceed the following limits:

Item	Percent by weight
Clay lumps	0.25
Coal and lignite	0.25
Material passing No. 200 sieve	3.00
Other deleterious substances	0.10

All fine aggregate shall be from injurious amounts of organic impurities.

The gradation of the fine aggregate shall conform to the following sieve analysis when tested by the Standard U.S. Sieve Analysis:

Sieve Size	Percent Passing
3/8	100%
4	95-100%
20	40-70%
50	5-20%
100	0-5%

230.2.4 Coarse aggregate shall consist of either gravel or crushed stone of sound, durable, and uncoated particles. Gravel shall be washed clean. The coarse aggregate shall meet the purity and soundness requirements of the Missouri Department of Transportation.

Crushed stone shall be of uniform quality. The percentage of wear shall not exceed fifty (50%) when tested in accordance with AASHTO Specification T-96-58 (c) (Los Angeles Abrasion Test).

Gravel shall be washed when tested in accordance with AASHTO T-96-58 (c) (Los Angeles abrasion test). The percentage of wear shall not exceed forty-five (45%).

The percentage of deleterious substances shall not exceed the following values. The sum of percentages of all deleterious substances, exclusive of Items 5 and 6, shall not exceed six percent (6%).

Item	Percent by Weight
Deleterious rock	5%
Shale	1%
Chert in limestone	4%
Other foreign material	0.5%
Material passing No. 200 sieve	2.0%
Thin or elongated pieces	5.0%

The gradation shall conform to the following limits based on the standard sieve sizes:

Size Sieve	Percentage Passing
1 1/2 inch	100%
1 inch	95-100%
1/2 inch	25-60%
No. 4	0-8%
No. 10	0-3%

230.2.5 The water used for mixing and curing concrete shall be clean and free from acid, salt, oil, and other organic matter harmful to the concrete. The use of potable water is required.

230.2.6 Calcium chloride shall conform to AASHTO Specifications M144-57. Calcium chloride shall be sampled and tested in accordance with ASTM Specifications D 345-48.

230.3 **Mix Design** - The proportions of the various ingredients for portland cement concrete shall be as specified by the Engineer within applicable limits of the specifications for the class of concrete designated by the Contract. The mix set by the Engineer will be based upon the materials intended for the use in the work, and if sources of supply are changed, the mix may be revised.

230.4 **Class of Concrete**

230.4.1 **Class A** concrete shall contain six (6) sacks of cement to the cubic yard (one sack of cement - ninety-four (94) pounds). The water content shall not exceed six (6.0) U.S. gallons per sack of cement including the surface moisture in the aggregate.

230.4.2 **Class AA** concrete shall contain seven (7) sacks of cement to the cubic yard. The water content shall not exceed six (6.0) U.S. gallons per sack of cement.

230.4.3 **Class B** concrete shall contain five (5) sacks of cement to the cubic yard. The cement water content shall not exceed six and a half (6.5) gallons per sack of cement.

230.5. **Mixing** - The concrete may be mixed on the site as in case of a paving machine mixed, at a central mixing plant, or mixed in transit. In all cases the concrete shall be agitated and mixed until there is a uniform distribution of the materials and shall be discharged completely before the mixer is recharged.

230.5.1 In the case of ready-mix concrete, the concrete shall be discharged within sixty (60) minutes and the time required between start and completion of discharge shall not exceed fifteen (15) minutes. If the length of time is greater than sixty (60) minutes, the load of concrete shall be rejected at the expense of the Contractor. The ready-mix concrete shall be mixed and

delivered in accordance with the requirements set forth in standard specification for ready-mix concrete ASTM C 94.

230.5.2 Ready-mix concrete shall be produced by a plant which has been approved by the Missouri Department of Transportation and the Engineer.

230.6 **Inspection and Tests.**

230.6.1 All materials shall be subject to inspection by the Engineer at all times.

230.6.2 The strength of the concrete shall be tested by either the standard compression test as designated by ASTM Specification C 39-49 or the concrete flexure test as designated by ASTM Specification C 78.

The City or its representative may take samples of the concrete delivered to the job for making concrete tests and the testing of the specimens will be done at the City's expense.

Slump tests may be made by the City in accordance with ASTM Specifications C 143. Slumps shall not exceed the maximum designated for the class and use of the concrete.

All equipment and tools which are used for material handling and performing all parts of the work must meet the approval of the Engineer. The equipment must be kept in full and good working order.

SECTION 231 PORTLAND CEMENT CONCRETE PAVEMENT

231.1 **Work Included** - This work shall consist of the construction of portland cement concrete placed with or without reinforcement on a prepared sub-grade. The type and dimensions of the pavement will be indicated by the typical section on the construction plans.

231.2 **Materials** - Concrete used in the construction of portland cement concrete pavement shall be **Class "A"** concrete, unless specified otherwise, and all materials, proportioning, air-entrainment, mixing, and transporting for portland cement concrete shall be in accordance with **Section 230**, Portland Cement Concrete.

Reinforcing steel shall conform to **Section 238**, Reinforcement for Portland Cement Concrete.

231.3 The sub-grade shall be graded, compacted and rolled to insure maximum density to the exact cross section and elevations and shall be tested with an approved template before concreting. High areas shall be reduced to grade and low areas raised to grade with approved material compacted in place, as directed.

The sub-grade shall be moistened in advance of concreting but shall not be muddy or excessively wet.

231.4 Forms shall be of steel or of wood two (2) inches thick, dressed on the top and inside. Built up, battered, bent, twisted, broken or dirty forms shall not be used. Flexible forms may be used for curves of radii less than one hundred (100) feet. Forms shall be cleaned and oiled before use and shall be securely staked and braced and have rigid, tight connections at joints. Face forms are required when forming integral curbs.

231.5 The concrete shall be placed with a minimum of rehandling to avoid segregation. No concrete that has partially hardened or has been contaminated by foreign material shall be deposited on the work, nor shall re-tempered concrete be used. All concrete shall be thoroughly compacted by spading or vibrating to eliminate the voids. Care shall be exercised particularly at and about form and joints to avoid formation of voids or honeycombs and to prevent damage to joint installations.

231.6 Expansion and contraction joints may be sawed or premoulded and shall be installed as indicated, at right angles to the grade and length of the street unless shown otherwise on the plans. Sawed grooves shall have a depth of at least one-fourth (1/4) the thickness of the concrete and shall be filled with a bituminous joint sealing material.

231.6.1 **Premoulded Expansion Joints** - Three-fourths (3/4) inch premoulded bituminous filler shall be installed as noted on the plans, and at all connections with existing concrete structures. Expansion joint materials shall be cut to the full depth of the pavement and integral curb cross section. The top of the expansion joint shall be scraped free of mortar.

- 231.6.2 **Premoulded Contraction Joints** - Contraction joints of one-eighth (1/8) inch pressed fiber material shall be installed at intervals of not more than twenty (20) feet.
- 231.6.3 **Longitudinal Joints** - Dimensions of the key are indicated on the plans.
- 231.6.4 **Construction Joints** - Construction joints shall be located at the regular location of a contraction joint or not less than ten (10) feet from any other joint. Butt type joints shall have dowels on two (2) foot centers extending at least six (6) inches into and out of the concrete.
- 231.6.5 Transverse contraction joints of pre-moulded pressed fiber material, dimensions of which are shown on the drawings, shall be installed at intervals of not more than twenty (20) feet.
- 231.6.6 Dowel bars shall be used to transfer load across all expansion joints or in other locations as shown on the plans. The diameter and length of bars shall be as shown on the plans. Dowel bars shall be smooth round rail or billet steel bars placed as shown on the drawings, and shall be held in position exactly parallel to the surface and center line of the slab by a metal device that shall be left in the pavement. The use of stone, brick or other bulk material for supporting dowels or sleeves will not be permitted. One-half (1/2) of each bar shall be coated with basic lead sulphate, blue lead or red lead paint and with a heavy oil (not grease) to prevent bond. The painted and oiled end of the bar shall also be furnished with an approved paper or metal sleeve so designed as to provide a three-fourths (3/4) inch space at that end of the bar.
- 231.6.7 **Sawed Joints** - Sawed joints shall be provided at a maximum of twelve (12) foot for a six (6) inch slab and fifteen (15) foot for a seven (7) inch slab using a special concrete saw which has one or more circular blades at least one-eighth (1/8) inch thick. These may be reinforced abrasive blades or steel blades inlaid with diamonds (or other types that meet with the approval of the Engineer). In either case the blades shall be cooled and lubricated abundantly with cold water. The joints must be cut early, before shrinkage stresses have caused the formation of early cracks.
- 231.6.8 **Joint Filler** - After the pavement has been properly cured, all open joints including expansion joints, construction joints, and longitudinal joints, shall be cleaned, primed with a light grade of cut-back asphalt, and poured full of an approved hot poured joint sealing compound. The joint sealing compound shall be heated and applied in strict accordance with instructions of the manufacturer. Joints must be clean and dry before seal is poured and sealing compound shall be poured so that the joint is filled to the level of the adjacent concrete surfaces.

- 231.7 The paving machine must be checked and inspected by the Engineer before work begins. The paving machine may at no time be operated on the finished concrete or on the base, which is to be paved, unless permission is granted by the Engineer.
- 231.8 The temperature of the concrete shall be between sixty and ninety degrees Fahrenheit (60° - 90° F.) when placed in the forms.
- 231.9 **Cold Weather Construction** - All cold weather concrete construction is derived from ACI Manual of Concrete Practice. All policies will be strictly adhered to. Specific questions will be referenced through ACI.
- 231.9.1 **Definition** - Cold weather is defined as a period when, for more than 3 consecutive days, the following conditions exist: (1) the average daily air temperature is less than 40° F and (2) the air temperature is not greater than 50° F for more than one-half of any 24-hr period.
- 231.9.2 **Sub-grade Temperature** - Under no circumstances may the concrete be placed on a frozen sub-grade. Concrete injured by frost action shall be removed and replaced at the Contractor's own expense. Temperature will be ascertained on site by infrared thermometer.
- 231.9.3 **Ambient Temperature** - Under no circumstances may concrete be placed when the ambient air temperature is 32° F and below. Temperature will be ascertained on site by infrared thermometer.
- 231.9.4 **Placement Temperature** - The temperature of the concrete shall be between sixty and ninety degrees Fahrenheit (60° - 90° F.) when placed in the forms.
- 231.9.5 **Concrete Temperature** - The minimum temperature of concrete immediately after placement shall be as specified in Column 2 of Table A of this section.

TABLE A		
1	2	3
<i>Least dimension of section, inches</i>	<i>Minimum temperature of concrete as placed and maintained during the protection period</i>	<i>Maximum gradual decrease in surface temperature during any 24 hour after end of protection</i>
<i>Less than 12 in.</i>	55	50
<i>12 in. to less than 36 in.</i>	50	40
<i>36 in to 72 in.</i>	45	30
<i>Greater than 72 in.</i>	40	20

231.9.6 **Protection Temperature** - The minimum temperature of concrete during the protection period shall be as shown in Column 2, Table A of this section.

231.9.7 Concreting shall be discontinued when the temperature falls below 40° F unless the aggregates or the water are heated to produce the temperatures in **Section 231.8** above. However, the Engineer may require that no concrete be poured when in his opinion the concrete might become damaged from freezing due to subsequent falling of the temperature.

231.9.7.1 Mixing water shall be heated to a maximum of 150° F.

231.9.7.2 Aggregates shall be heated until free of all ice and frost.

231.9.7.3 All covering and heating equipment shall be on hand and approved by the Engineer before any concrete is placed.

231.9.7.4 The use of an accelerator such as calcium chloride, Type III (meeting ASTM C 150) or 100 lb/yd³ of additional cement shall be used only with the consent of the Engineer.

231.9.8 **Protection of Concrete against freezing** - Cure and protect concrete against damage from freezing for a minimum period of 3 days, unless otherwise specified. Maintain the surface temperature of the concrete during that period in accordance with Column 2, Table A of this section. Protection will be performed by applying blankets or plastic with straw in sufficient depth to maintain the temperatures set forth in Column 2, Table A of this section. Such protection shall be continued for a minimum period of (3) days unless directed otherwise by the Engineer. Temperatures will be monitored and measured via High/Low, or infrared thermometers throughout (3) day duration by Public Works staff.

231.10 **Placing and Finishing Concrete**

231.10.1. Concrete shall be placed in successive batches over the entire width between side forms. Care shall be taken in discharging concrete to avoid segregation. Concrete shall be thoroughly vibrated along the forms or sides and along expansion longitudinal joints by means of a small approved hand-type

mechanical vibrator. Care shall be taken that the vibrator does not penetrate the sub-grade or dislodge or remove the joints.

- 231.10.2. The concrete shall be brought to the proper section by means of a mechanical finishing machine, a vibrating screen or by an approved type of strike-off board. If a strike-off board is used, it shall be constructed of a material that will not warp, shrink or sag and shall weigh not less than ten (10) pounds per lineal foot. The strike-off board shall be used as a tamping template, if other equipment is not provided for this purpose, with an up and down motion while being propelled forward manually. Any of the above devices, if used, shall be adjusted to the exact crown of the pavement.

The surface shall be checked with a straight edge not less than ten (10) feet in length, mounted on long handles and any low spots filled in and high spots removed. All disturbed places shall be refloated. The pavement shall not vary more than one-fourth (1/4) inch from a ten (10) foot straight edge laid parallel to the center line.

The final finishing operation may be accomplished by any one of the following methods. If the Contractor has elected to use either the mechanical brooming or the burlap drag method and the results are not satisfactory, the Engineer may require that the hand brooming method be used.

- 231.10.2.1 **Hand Brooming** - After surface irregularities have been removed, the surface of the concrete shall be given a broom finish. Approved steel or fiber brooms of not less than eighteen (18) inches wide, shall be drawn across the surface from the center line towards each side, with the broom held perpendicular to the surface, one stroke of the broom per width of broom, slightly overlapping adjacent strokes. The corrugations resulting from the broom operation shall be uniform in appearance and not more than one-sixteenth (1/16) inch in depth. Brooming shall be completed before the concrete is in such condition that it will be torn or unduly roughened and before the concrete has obtained its initial set.

- 231.10.2.2 **Mechanical Brooming** - A machine capable of producing a finished surface similar to that required for hand brooming may be used for the final finishing of the pavement surface.

- 231.10.2.3 **Burlap Drag** - A seamless strip of damp burlap or cotton fabric which will produce a uniform surface of gritty texture by dragging the fabric along the full width of pavement may be used for the final finishing of the pavement surface. The fabric drag shall be at least two (2) feet longer than the width of the pavement being finished and shall be dragged in a

longitudinal direction. The fabric shall be cleaned or replaced as often as necessary to obtain the required surface texture.

The Contractor will be held responsible for the correct alignment, grade and contour specified. Any spots higher than one-fourth (1/4) inch in ten (10) feet, for concrete pavement shall be ground to the required surface by the Contractor at his own expense.

All exposed edges of the concrete at joints, other than sawed joints, and back of curb shall be finished with an edging tool of one-fourth (1/4) inch radius.

- 231.11 **Integral Curb** - Integral curb shall be constructed at each side of the pavement conforming to the dimensions and design as shown on plans and shall be constructed of the same concrete as the pavement.

The curb shall be placed immediately after all pavement finishing operations but before the concrete has taken its initial set. The time elapsing between placing the pavement and placing the curb shall not be more than forty-five (45) minutes. A thorough bond shall be obtained between the pavement and curb; if necessary the pavement shall be roughened by a trowel or wire brush. After the concrete has been placed in the curb form, it shall be spudded or tamped to insure sufficient density to prevent honeycomb. When the concrete has sufficiently set, the face forms shall be removed and the curb finished to proper alignment, grade and cross section by troweling and floating with properly shaped tools. No plastering with grout will be permitted. The final finish shall be made by brushing transversely from bottom to top.

All transverse joints in the pavement shall be matched evenly and through the curb and shall conform to the shape of the curb.

- 231.12 **Curing** - After the concrete has been finally finished and the water has left the surface, the exposed surface shall be sprayed with a transparent membrane solution (Hunts Process Curing Compound, Cure Crete or approved equal). The curing material shall be applied in strict accordance with the manufacturer's recommendations and as directed by the Engineer. If rain falls on the newly coated pavement before the film has dried sufficiently to resist damage, or if the film is damaged in any other way, the Contractor will be required to apply additional curing material to the affected portions. Application shall be by a pressure spray at a uniform rate not to exceed two hundred (200) square feet of surface per gallon of spray. If hair checking develops before the membrane can be applied, the concrete shall be initially cured with wet burlap before the membrane is applied. After the side forms are removed the sides shall be sprayed with the curing compound.

Other methods of curing may be used if pre-approved by the Public Works Department. Request for use of an alternate method must be received by the Public Works Department

in writing no later than five (5) working days before plan of use and must be supported with the specifications of such method.

- 231.13 **Backfilling Slab Edges and Curbs** - Slab edges and the back side of integral curbs shall be banked with earth as soon as the forms are removed and the required finishing operations completed. Before the pavement is opened to traffic or the work accepted, the area outside the slab edge or back of the curb shall be backfilled with selected earth approved by the Engineer, thoroughly compacted in layers not exceeding six (6) inches in depth and neatly graded off flush with the slab or top of the curb or as shown on the plans.
- 231.14 **Opening to Traffic** - The concrete pavement may not be opened to traffic until seven (7) full days have passed since the concrete was placed unless otherwise directed by the Engineer.
- 231.15 **Protection from Traffic** - As soon as the placing of concrete begins, the Contractor shall provide means for completely protecting the pavement from any and all damage or marring of the surface. Barricades, lights and signals shall be provided as needed. At all places where it is necessary to maintain public or private crossing over the pavement the Contractor shall at his own expense provide and maintain bridges or other devices that will prevent the damage or marring of the concrete.
- 231.16 **Inspection and Testing** - Inspection and testing shall be performed in accordance with **Section 230.6**. Concrete for pavement shall have a slump of two (2) to four (4) inches when using ready-mix concrete and one (1) to three (3) inches when using a concrete paving machine. Concrete used for paving shall have a minimum average compressive strength of 4000 psi at twenty-eight (28) days and a minimum average flexural strength of 550 psi.

SECTION 232 CONCRETE CURB AND GUTTER

- 232.1 **Description** - Concrete curb and gutter shall consist of portland cement concrete, placed with or without reinforcement on a prepared sub-grade. The type and dimensions shall be as shown on the construction plans.
- 232.2 **Materials** - Concrete used in the construction of curb and gutter shall be **Class "A"** concrete, unless otherwise specified; and all materials, proportioning, air-entraining, mixing, and transporting for portland cement concrete shall be in accordance with **Section 230**, Portland Cement Concrete. Reinforcing steel shall conform to **Section 238**, Reinforcement for Portland Cement Concrete.
- 232.3 **Sub-grade** - The sub-grade shall be graded, compacted and rolled to insure maximum density to the exact cross section and elevations shown on the plans. The sub-grade shall be moistened in advance of depositing concrete, but shall not be muddy or excessively wet.
- 232.4 **Forms** - The forms for this work shall be metal or wood of full depth of the concrete, straight, free from warp and of sufficient rigidity to prevent distortion due to the pressure of the concrete and other loads incidental to the construction operations. The forms shall be substantial and unyielding and shall be so designed that the finished concrete will conform to the proper dimensions and contours. Forms shall be set and maintained true to the line designated until the concrete is sufficiently hardened. Forms shall be thoroughly cleaned, greased or soaped before concrete is placed. Forms shall be joined neatly and tightly for a distance of at least one hundred (100) feet in advance of the point of placing concrete.
- 232.5 **Mixing, Handling and Placing, Finishing and Curing Concrete** - The mixing, handling and placing, finishing and curing of concrete for curb and gutter shall be in accordance with the appropriate requirements as designated under **Section 231**, Portland Cement Concrete Pavement, unless otherwise specifically designated.
Concrete curb and gutter shall be constructed in sections having a uniform length of ten (10) feet maximum. The length of a single section may be reduced to a minimum of four (4) feet where necessary for closure. Expansion joints shall be provided at intervals of ninety (90) feet. All joints in concrete curb and gutter shall receive joint filler in accordance with **Section 231.6.8** of these specifications. The face and top of the curb and gutter shall be floated smooth and the edges shall be rounded as shown in typical section.
- 232.6 **Backfill**. - After the concrete has set sufficiently, as determined by the Engineer, the spaces back of curbs shall be back-filled to the required elevation with suitable material which shall be compacted in layers of not more than six (6) inches until firm and solid.
- 232.7 **Inspection and Tests** - Inspection and testing shall be performed in accordance with the requirements of **Section 230.6**, Concrete for Concrete Curb and Gutter, shall have a slump of two (2) to four (4) inches.

SECTION 234

CONCRETE SIDEWALKS

- 234.1 **Description** - Concrete sidewalks shall be constructed to the line, grade and dimensions shown on the plans or as established by the Engineer. Unless otherwise specifically designated, concrete sidewalks shall have a width of four (4) feet and a depth of four (4) inches, except that at driveways or other points designated on the plans, the depth shall be increased to six (6) inches.
- 234.2 **Concrete** - Concrete used in the construction of sidewalks shall be **Class "A"** concrete as specified in **Section 230**, Portland Cement Concrete, with the additional requirement that the amount of chert in crushed limestone aggregate shall not exceed two percent (2%) by weight. All materials, proportioning, air-entraining, mixing, and transporting for concrete shall be in accordance with **Section 230**.
- 234.3 **Construction**
- 234.3.1 **Sub-grade** - Concrete sidewalks shall be constructed on a prepared smooth sub-grade of uniform density. Large boulders and ledge rock found in the sub-grade shall be removed to a minimum depth of six (6) inches below the finished sub-grade elevation and the space shall be backfilled with suitable material which shall be thoroughly compacted by rolling or tamping. The Contractor shall furnish a template and shall thoroughly check the sub-grade prior to depositing concrete.
- 234.3.2 **Forms** - The forms shall be of either metal or wood and shall be straight, free from warp, of sufficient strength to resist springing during construction, and of a height equal to the full depth of the sidewalk to be constructed. Wood forms shall have a minimum thickness of two (2) inches. Metal forms shall be of a type approved by the Engineer. Flexible or curved forms of proper radius shall be furnished on curves. The forms shall be thoroughly cleaned, well oiled, securely staked, braced, and held to the required line and grade before any concrete is deposited.
- 234.4 **Depositing Concrete** - The concrete shall be deposited between the forms on moistened sub-grade and shall be struck off and compacted to the required thickness. Concrete may be compacted by internal vibrating equipment, spading, rodding or tamping or as directed by the Engineer.
- 234.5 **Joints** - Dummy joints, spaced approximately at five (5) feet intervals, shall be provided for the full width (and length for wider sidewalks) to a depth of one (1) to two (2) inches. The joint may be made by a suitable tooling device or by tamping tapered metal or wooden strips into the plastic concrete, which strips shall be removed after the concrete has partially set. As an alternate method, the dummy joint may be made by sawing the concrete after initial set and before shrinkage cracks occur.

Premoulded expansion joint material, one-half (1/2) inch thick, shall be installed in the sidewalk for its full depth wherever it meets another sidewalk, driveway, building, curb, lighting standard, fireplug, or other rigid object. Expansion joints shall be placed on all four (4) sides of the square formed by the intersection of two (2) sidewalks. When the sidewalk fills the space between the curb and a building or wall, an expansion joint shall be placed between the sidewalk and the curb and between the sidewalk and the building or wall.

- 234.6 **Finishing** - After the concrete has been brought true to line and grade it shall be finished to a medium rough finish by use of a stiff broom or other approved method to produce an even, gritty texture. All edges shall be rounded with an edging tool to one-fourth (1/4) inch radius.
- 234.7 **Curing** - Immediately after finishing, the sidewalk shall be cured in the same manner as required under **Section 231.12**.
- 234.8 **Cold Weather Concreting** - Temperature of the concrete and cold weather construction requirements shall be the same as specified in **Sections 231.8** and **231.9**.
- 234.9 **Backfilling** - After the concrete has sufficiently set, the form shall be removed and the space on each side of the walk shall be backfilled. The earth shall be compacted and graded in a manner satisfactory to the Engineer.
- 234.10 **Inspection and tests** - Inspection and testing if required, shall be performed in accordance with the requirements of **Section 230.6**. Concrete for concrete sidewalks shall have a slump of two (2) to four (4) inches.

SECTION 236 PATCHING PORTLAND CEMENT CONCRETE PAVEMENT

236.1 **Description** - Where noted on the plans, or as directed by the Engineer, the Contractor will be required to patch the existing portland cement pavement.

236.2 **Construction** - After all pavement in the patch area has been removed as required, the sub-grade shall be excavated to provide an under-cut approximately two (2) inches wide and two (2) inches deep. Should the sub-grade be unstable, such undesirable material as may be encountered shall be excavated to a minimum depth of twelve (12) inches below the top of the finished concrete patch. The sub-grade shall then be constructed to proper elevation by filling with approved aggregate material and compacted until all sub-grade weakness has been corrected.

The area shall then be paved with **Class "AA"** portland cement concrete as specified in **Section 230**, Portland Cement Concrete. All appropriate provisions of **Sections 230** and **231** shall apply, except for the following items:

236.2.1 Hand finishing will be permitted.

236.2.2 Transparent membrane curing solution will not be permitted if the pavement is to be resurfaced.

Unless otherwise noted on the plans, material excavated from sub-grade shall be disposed of away from the project at locations, which are the sole responsibility of the Contractor.

SECTION 237

CONCRETE DRIVEWAY PAVEMENT

237.1 **Description** - Where called for on the plans, or as directed by the Engineer, non-reinforced concrete driveway pavement shall be constructed to the line, grade and dimensions shown on plans.

237.2 Concrete used in the construction of driveway pavement shall be **Class "A"** concrete, and all materials, proportioning, air entrainment, mixing, and transporting for the concrete shall be in accordance with **Section 230**, Portland Cement Concrete.

The mixing, handling and placing, finishing and curing of concrete for driveways shall be in accordance with the appropriate requirements of **Section 231**, Portland Cement Concrete Pavement.

SECTION 238 REINFORCEMENT FOR PORTLAND CEMENT CONCRETE

238.1 **Description** - This item shall include billet-steel bars, rail-steel bars, axle-steel bars, cold-drawn steel wire, fabricated steel bars or rod mats and welded steel wire fabric for concrete reinforcement. Also minimum requirements for the deformations of deformed steel bars for concrete reinforcement.

238.2 **Materials** - All materials shall conform to the requirements of the American Society for Testing Materials as hereinafter designated. Only one grade of steel will be allowed on any one Contract, unless otherwise noted on the plans or in the special provisions.

238.3 **Protection of Material** - Steel reinforcement shall be protected at all times from injury. When placed in the work, it shall be free from dirt, detrimental scale, paint, oil or other foreign substance. However, when steel has on its surface detrimental rust, loose scale and dust which is easily removable, it may be cleaned by a satisfactory method, if approved by the Engineer.

238.4 **Fabrication** - Bent bar reinforcement shall be cold bent to the shapes shown on the plans, and unless otherwise provided on the plans or by authorization, bends shall be made in accordance with the following requirements:

Bar reinforcement shall be shipped in standard bundles, tagged and marked in accordance with the *Code of Standard Practice of the Concrete Reinforcement Steel Institute*.

238.5 **Bar Reinforcement** - Bar reinforcement shall conform to the requirements of the ASTM Specifications Designation A 15-58T for billet-steel bars or ASTM Designation A 16-59T for rail steel bars, or the latest revision thereof.

All bars shall be of the deformed type conforming to ASTM Designation A 305-56T or the latest revision thereof, unless otherwise specified.

The use of twisted bars is not permitted. Steel for all bars shall be made by the open hearth process, unless otherwise called for in the special provisions of the plans.

238.6 **Wire and Wire Mesh** - Wire shall conform to ASTM Designation A 82-58T for cold-drawn steel wire for concrete reinforcement, or the latest revision thereof.

Wire mesh, when used as reinforcement in concrete, shall conform to ASTM Designation A 185-58T Welded Steel Wire Fabric, or the latest revision thereof. The type of mesh shall be approved by the Engineer.

238.7 **Bar Mat Reinforcement** - Bar mat reinforcement for concrete shall conform to ASTM Designation A 184-37 the specification for fabricated steel bar or rod mats, or the latest revision thereof.

238.8 **Placing and Fastening** - All steel reinforcement shall be accurately placed in the position shown on the plans and firmly held during the placing and setting of concrete. When placed in the work, it shall be free from dirt, detrimental rust, loose scale, paint, oil or other foreign material. Bars shall be tied at all intersections except where spacing is less than one (1) foot in each direction when alternate intersections shall be tied.

Distances from the forms shall be maintained by means of stays, blocks, ties, hangers, or other approved supports. Blocks for holding reinforcement from contact with the forms shall be precast mortar blocks of approved shape in dimensions or approved metal chairs. Metal chairs which are in contact with the exterior surface of the concrete shall be galvanized. Layers of bars shall be separated by precast mortar blocks or by other equally suitable devices. The use of pebbles, pieces of broken stone or brick, metal pipe and wooden blocks shall not be permitted. The minimum spacing center to center of parallel bars shall be two and a half (2 1/2) times the diameter of round or three (3) times the side dimension of square bars, but in no case shall the clear distance between the bars be less than one and a half (1 1/2) times the maximum size of the coarse aggregate. Reinforcement in any number shall be placed and then inspected and approved by the Engineer before the placing of concrete begins. Concrete placed in violation of this provision may be rejected and removal required.

If fabric reinforcement is shipped in rolls, it shall be straightened into flat sheets before being placed.

238.9 **Splicing** - All reinforcement shall be furnished in the full lengths indicated on the plans. Splicing of bars, except where shown on the plans, will not be permitted without the written approval of the Engineer. Splices shall be staggered as far as possible.

Unless otherwise shown on the plans, bars in the bottom of beams and girders, and in wall, columns and haunches shall be lapped twenty (20) diameters and bars near the top of beams and girders having more than twelve (12) inches of concrete under the bars shall be lapped thirty-five (35) diameters, to make the splice. In lapped splices, the bars shall be placed in contact and wired together in such a manner as to maintain a clearance of not less than the minimum clear distance to other bars and the minimum distance to the surface of the concrete, as specified above under Placing and Fastening. Welding of reinforcement steel shall be done only if detailed on the plans or if authorized by the Engineer in writing. Welding shall conform to the current specification for Welded Highway and Railway Bridges of the American Welding Society.

238.10 **Lapping** - Sheets of mesh or bar mat reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The edge lap shall not be less than one (1) mesh in width.

238.11 **Substitutions** - Substitution of different size bars will be permitted only with specific authorization by the Engineer. If steel is substituted, it shall have an area equivalent to the design area, or larger.

The weight of plain bars or bar mat, or of deformed bars, which do not comply with ASTM A 305-56T will be computed from the theoretical weight of plain round or square bars of the same nominal size as shown in the following table:										
Size	1/4"	3/8"	1/2"	5/8"	3/4"	7/8"	1"	1-1/8"	1-1/4"	1-1/2"
Weight in Round Pounds	0.167	0.376	0.668	1.043	1.502	2.044	2.670			
Per Square Foot			0.850				3.400	4.303	5.313	7.650

The weight of bars which comply with ASTM A 305-56T will be calculated as follows:										
Bar	No. 3	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9	No. 10	No. 11	
Weight Pounds Per Lineal Foot	.376	0.668	1.043	1.502	2.044	2.670	3.400	4.303	5.313	

The weight of reinforcement used in railings when they are paid for on a lineal foot basis, shall not be included. The weight of reinforcement in precast piles and other items where the reinforcement is included in the Contract price for the item shall not be included.

When laps are made for splices, other than those shown on the plans, for the convenience of the Contractor, the extra steel shall not be included.

SECTION 250

CONCRETE STRUCTURES

250.1 **Description** - Concrete structures shall include drainage structures such as reinforced concrete boxes, culverts, junction boxes, curb inlets, manholes, catch basins, paved channels, etc., also retaining walls and any special concrete structures.

250.2 **Materials** - Portland cement shall conform to the requirements of **Section 230.2.1** of these specifications. Concrete air entraining admixtures shall conform to the requirements of **Section 230.2.2** of these specifications. Fine aggregate shall conform to the requirements of **Section 230.2.3** of these specifications. Coarse aggregate shall conform to the quality requirements of **Section 230.2.4** of these specifications and gradation conforming to the following table for the various uses listed below:

Table Gradations of Coarse Aggregates			
Maximum Size Sieve	1-1/2"	1"	3/4"
Percent of Passing			
Size	Column I	Column II	Column III
2"	100		
1-1/2"	95-100	100	
1"		95-100	100
3/4"	35-70		90-100
1/2"		25-60	
3/8"	10-30		20-55
No. 4	0-5	0-10	0-10
No. 8		0-5	0-5

250.3 **Uses**

250.3.1 All general structural construction, including walls, slabs, beams, etc., which are either four (4) inches or more thick in the smallest dimension and not reinforced, or five (5) inches or more thick in the smallest dimension and reinforced with at least two (2) inch space between steel and forms: Column II.

250.3.2 Exceptionally heavy slabs, structural members and footings may meet (at the option of the concrete producer and with the approval of the Engineer): Column I.

250.3.3 Very thin or heavily reinforced sections not having the minimum dimensions or steel clearances of paragraph (a) but not floor toppings thinner than two and a half (2-1/2) inches: Column III.

250.4 Uniformity

The following limits of variation in gradation of coarse aggregate at the time of batching into the mixer shall be met:

250.4.1 The fineness modulus for coarse aggregate to be used in any given mix design shall not vary more than plus or minus 0.20 from the fineness modulus of the gradation on which the mix was designed. For the purposes of this specification, the fineness modulus shall be the sum of the percentages by weight retained on the following standard sieve series: 1 1/2", 3/4", 3/8", No. 4, No. 8, No. 16, No. 30, No. 50 and No. 100. Aggregates from more than one supplier must be used separately with different mix designs unless they are sufficiently similar to fall within the limits of this section.

250.4.2 The variation in percentage between any two successive sieves shall be limited to two percent (2%) or one-tenth (1/10) of the percentage of the same size material contained in the gradation on which the mix was designed, whichever is larger.

Water shall conform to the requirements of **Section 230.2.5** of these specifications.

250.5 Sampling and Testing - Sampling and testing of concrete and materials, if required, shall be made under the direction of the Engineer, who shall have access to all places where concrete materials are stored, proportioned, mixed or placed. A recognized testing laboratory, selected by the Contractor and approved by the Engineer, shall be employed by the Contractor to test cement and aggregates proposed for inclusion in the work, to design the concrete mix, and to test all concrete cylinders. The Contractor shall furnish the laboratory with adequate samples of aggregates and cement to permit required testing.

The tests listed below shall be performed by the laboratory with certified test results submitted to the Engineer for his approval. Materials to be tested and testing shall be according to the following:

250.5.1 Cement shall be sampled and tested according to ASTM C 150 and C 175.

250.5.2 Coarse and fine aggregates shall be sampled and tested as follows:

Sampling	ASTM D 75
Gradation	ASTM C 136 and C 117
Impurities	ASTM C 40 (Sand), C 123, C 142 and AASHTO-T10
Soundness	ASTM C 88, if required

250.5.3 The determination of slump of concrete shall conform to ASTM C 143.

250.5.4 Concrete test cylinders shall be cast and tested in accordance with ASTM C 31 and C 39. The Contractor shall make three (3) job cylinders for each day's pour, or as directed by the Engineer. All cylinders shall be cured under the same

conditions as job concrete. Job cylinders shall be identified at the time cast as to which pour is represented.

The Contractor shall ship or deliver two (2) cylinders to the laboratory on the fourth day, one of which is to be tested on the seventh day, the other to be laboratory cured and tested on the twenty-eighth day. One (1) cylinder shall be shipped on the twenty-fourth day and tested on the twenty-eighth day.

The Contractor shall furnish the City three (3) copies of test reports for concrete test cylinders. Unsatisfactory tests of job cylinders shall make the concrete concerned subject to rejection, with consequent removal and replacement by the Contractor at his expense.

250.6 **Classes of Concrete** - Concrete shall be divided into various grades to be used in the respective places shown on the plans, called for in the specifications, or ordered by the Engineer. The classes of concrete mixtures are referred to as Class C, Class D, Class E and Class F.

250.6.1 **Class C** – Class C concrete is intended principally for precast concrete slabs and shall conform to Mix Number A600-3/4-2, or A600-1-2.

250.6.2 **Class D** - Class D concrete is intended principally for reinforced concrete structures designed for high strength and water tightness, and shall be used for columns, walls, beams, slabs, and in general, wherever form-work, other than simple forms, is required and shall conform to Mix Number A550-3/4-4, or A550-1-4.

250.6.3 **Class E** - Class E concrete is intended principally for reinforced concrete structures, designed for high strength and water tightness and shall be used for bottoms of structures and, in general, where concrete is deposited directly on the bottom or slopes of excavations and where simple forms only are required and shall conform to Mix Number A550-3/4-2 or A500-1-2.

250.6.4 **Class F** - Class F concrete is intended principally for low strength concrete, plain or reinforced, used for soil stabilization, pipe cradle, filling, and other similar purposes. For large volumes, as between the underside of structures and the surface of rock, boulders, or fragments or rock excavated during construction may be embedded in the concrete to provide added bulk. Care should be taken in placing boulders or rock fragments, so that there will be no voids in the concrete. This concrete shall conform to Mix Number A450-4-4 or A450-1-4.

250.6.5 **Mix Design** - Mix numbers in paragraphs above refer to the mix numbers in the Mix Design Tables shown on the following pages.

250.7 **Cold Weather Requirements** - No concrete shall be placed on iced or frozen subgrade or when temperature is below thirty-two degrees Fahrenheit (32° F.). Concreting shall not be continued when the air temperature is below forty degrees Fahrenheit (40° F.) unless the following conditions are attained:

250.7.1 Mixing water shall be heated to a maximum of one hundred fifty degrees Fahrenheit (150° F.).

250.7.2 Aggregates shall be heated until free of all ice and frost.

250.7.3 The concrete temperature after mixing shall be between fifty degrees Fahrenheit (50° F.) and seventy degrees Fahrenheit (70° F.) if the air temperature is twenty degrees Fahrenheit (20° F.) to forty-five degrees Fahrenheit (45° F.).

250.7.4 After the concrete is placed, it shall be covered, protected, and heated so as to maintain a maximum of seventy degrees Fahrenheit (70° F.) air temperature for the first twenty-four (24) hours and fifty degrees Fahrenheit (50° F.) air temperature for the next six (6) days.

250.7.5 Moist conditions shall be maintained during the heating period.

250.7.6 All covering, heating equipment, etc., shall be on hand and approved by the Engineer before any concrete is placed.

250.7.7 Admixtures, such as calcium chloride, shall be used only with the approval of the Engineer.

250.8 **Hot Weather Requirements.** No exposed concrete is to be placed in air temperatures above one hundred degrees Fahrenheit (100° F.). Cover, protect and cool work as required to maintain the temperature of the concrete below one hundred degrees Fahrenheit (100° F.). The concrete temperature, after mixing shall not be greater than eighty-five degrees Fahrenheit (85° F.). Spray and/or shade aggregate piles and cool mixing water is required.

MIX DESIGN TABLES

Mix Number	Max. Stone Size	Max. Total Water #'s	W/C Weight Ratio	Gallons Per Sack	28-Day Design Strength psi	28-Day Av. Test Strength psi
450 POUNDS OF CEMENT PER CUBIC YARD (4.78 SACKS) - AIR-ENTRAINED CONCRETE						
4" Slump						
A-450-1 1/2-4	1 1/2"	260	.578	6.52	2750	3150
A450-1-4	1"	260	.578	6.52	2750	3150
A450-3/4-4	3/4"	270	.600	6.77	2600	2950
A450-1/2-4	1/2"	290	.644	7.27	2300	2650
500 POUNDS OF CEMENT PER CUBIC YARD (5.32 SACKS) - AIR-ENTRAINED CONCRETE						
2" Slump						
A500-1 1/2-2	1 1/2"	235	.470	5.30	3550	4100
A500-1-2	1"	235	.470	5.30	3550	4100
A500-3/4-2	3/4"	245	.490	5.53	3400	3900
A500-1/2-2	1/2"	265	.530	5.98	3100	3550
550 POUNDS OF CEMENT PER CUBIC YARD (5.85 SACKS) - AIR-ENTRAINED CONCRETE						
2" Slump						
A550-1 1/2-2	1 1/2"	235	.427	4.82	3950	4500
A550-1-2	1"	235	.427	4.82	3950	4500
A550-3/4-2	3/4"	245	.445	5.02	3800	4350
A550-1/2-2	1/2"	265	.482	5.44	3450	4000
4" Slump						
A550-1 1/2-4	1 1/2"	260	.473	5.34	3550	4050
A550-1-4	1"	260	.473	5.34	3550	4050
A550-3/4-4	3/4"	270	.491	5.54	3400	3900
A550-1/2-4	1/2"	290	.527	5.95	3100	3600

MIX DESIGN TABLES (continued)

600 POUNDS OF CEMENT PER CUBIC YARD (6.38 SACKS) - AIR-ENTRAINED CONCRETE						
Mix Number	Max. Stone Size	Max. Total Water #'s	W/C Weight Ratio	Gallons Per Sack	28-Day Design Strength psi	28-Day Av. Test Strength psi
2" Slump						
A600-1 1/2-2	1 1/2"	235	.392	4.42	4250	4900
A600-1-2	1"	235	.392	4.42	4250	4900
A600-3/4-2	3/4"	245	.408	4.60	4100	4700
A550-1/2-2	1/2"	265	.442	4.99	3800	4350

Required Air Content in the Air Entrained Concrete at the Time of Discharge from the Mixer at the Job Site

Maximum Aggregate Size

Percent Limits of Entrained Air

1 1/2"	6% plus or minus 1 1/2%
1"	6% plus or minus 1 1/2%
3/4"	6% plus or minus 1 1/2%
1/2"	7% plus or minus 1 1/2%

Slump shown indicates the slump to be expected at time of discharge from the mixer at the job site plus or minus one (1) inch, i.e. a four (4) inch slump indicates a range between three (3) and five (5).

The above strength tables are based on Type 1 portland cement meeting the requirements of ASTM Standard Specifications C 150. For Type 2 portland cement, multiply the 28-day strength values by the factor 0.90. For ninety (90)-day strength values of Type 2 portland cement, multiply the 28-day design or average strength values by the factor 1.00.

The "28-Day Average Test Strength" values are 115% of the "28-Day Design Strength" values.

NOTES PERTAINING TO THE MIX DESIGN TABLES

1. **The "28-Day Average Test Strength"** - The average strength of all 28-day test cylinders for the designated mix shall not fall below the figure shown in the table.

2. **The "28-Day Design Strength"** - Each 28-day strength test shall consist of the average strength of a set of at least two (2) laboratory cured (ASTM C 192) cylinders broken at 28 days. In any cylinder test set if any one (1) cylinder has a test strength of less than seventy-five percent (75%) of the higher strength cylinder in the set (or in the case of more than two (2) cylinders per set less than seventy-five percent (75%) of the average of the other cylinders in the set) then this low strength cylinder shall be rejected in determining the average strength of the set. The average strength of any five (5) consecutive sets shall not fall below the strengths in this column. No set of tests shall have an average strength of less than eighty percent (80%) of the design strength indicated by the table. Should any test fall below eighty percent (80%) of the design strength it may be disregarded if the Architect-Engineer's investigation shows that the low strength is the result of improper testing procedures.
3. **Proportions** - Sand Factor. In each mix design the percentage of fine aggregate in the total aggregate shall be the optimum ratio for good workability. The supplier shall adjust proportions of fine and coarse aggregates to obtain optimum workability provided the specified water-cement ratio is maintained.
4. **Water-Cement Ratio** - In each mix design the water content has been stated realistically for the size of aggregate and slump specified. In the event more water is used in any mix design than stated in the strength tables, additional cement shall be added to maintain the stated water-cement ratio.
5. **Total Pounds of Water** – The total pounds of water per cubic yard of concrete include allowance for all surface moisture on the aggregates.
6. **Verification of Designs** - If the project specification so requires, samples of materials proposed for use in concrete shall be submitted to a designated testing laboratory employed by the Owner to demonstrate through strength tests from trial batches, that when proportioned in accordance with the *Mix Design Tables*, the materials will, in fact, produce concrete of the class and strength required. Verification tests to be deemed satisfactory shall be at least equal to the "28-Day Average Test Strength" for the mix specified. If verification tests fall below this limit, either the material samples shall be changed and resubmitted or a revised design shall be employed.
7. **Producer's Duty** - The frequent measurement of moisture content in aggregates and the correction of quantities of ingredient for variations in moisture content and quality control of ingredients delivered to the plant, together with mix adjustments to compensate for observed variations of gradations, shall be the responsibility of the concrete producer.
8. **Use of Concrete Admixtures** – The use of concrete admixtures which involves an adjustment of the cement factor, as given in the Mix Design Tables for "28-Day Design Strength" as specified, shall require approval by the Engineer.

Reinforcing steel shall conform to the requirements of **Section 238** of these specifications

250.9 Construction

250.9.1 **Forms for Concrete Structures** - Forms shall conform to the shape, lines and dimensions of members called for on plans, and shall be sufficiently rigid and tight to prevent leakage of mortar. They shall be properly braced or tied together to maintain their position and shape when concrete is tamped or vibrated. Forms may be constructed of:

250.9.1.1 Lumber, No. 2 or better, with a minimum thickness of one (1) inch, and containing no holes or loose knots. Ship lap may be used where so specified on the plans. Form liners shall be one-fourth (1/4) inch plywood or approved fiber board on one (1) inch solid backing.

250.9.1.2 Plywood forming material may be used if three-fourths (3/4) inch plywood forms have studs on sixteen (16) inch centers or five-eighths (5/8) inch plywood forms have studs on twelve (12) inch centers.

250.9.1.3 Steel forms may be used if of a reputable manufacturer and in first class order, free from dents, etc.

All exposed corners and edges shall be provided with three-fourths (3/4) inch chamfer. Cleanouts shall be provided as required to remove sawdust and debris. All contact surfaces shall be oiled sparingly.

Wall form ties shall be steel of the breakback type with one and a half (1 1/2) inch breakback and with a cone the full depth and not larger than one (1) inch diameter. For other forms use pencil rods and cut back inside the concrete.

The Engineer's approval of forms shall be required before any concrete is placed.

250.9.2 **Placing Reinforcing Steel** - All reinforcing shall be free from scale, rust or coatings which will reduce the bond on the concrete. Bars shall be accurately bent and placed as indicated on the shop drawings and securely supported and tied with #16 annealed iron tie wire at all intersections to prevent movement during the placement of concrete. Where shown on the plans, certain bar intersections shall be welded. The Contractor may, at his option, weld all intersections and splices.

Lap and tie or spot weld the reinforcing steel together at splices. Splices shall be staggered as shown on the plans.

Reinforcing steel shall be placed for minimum concrete coverage as follows:

250.9.2.1 Three (3) inch for bottom steel in footings and slabs poured on sub-grade

250.9.2.2 Two (2) inch from surface to be exposed to water or earth backfill

250.9.2.3 One and a half (1 1/2) inch for walls, beams and columns above ground

250.9.2.4 One (1) inch from top of slabs

Consult the plans for any exception to the above.

The Engineer's approval is required at the completion of placing reinforcing steel prior to the placing of any concrete.

250.9.3 Placing Concrete - Prior to placing concrete, all water shall be removed from excavations; no concrete shall be placed under water; sub-grade for slabs less than twelve (12) inches thick shall be dampened. All debris shall be removed from the forms.

Wall concrete shall be placed continuously in horizontal layers of eighteen (18) inch lifts. Placing locations shall not be more than ten (10) feet apart. Tremies are required when the concrete has to be dropped farther than five (5) feet. Surface water shall be drained off and mixing water shall be reduced as required in the top layers of deep pours.

The working face of the concrete shall be kept plastic and "alive." High frequency vibrators shall be used at all times, supplementing as required with hand tamping, slicing, etc. Avoid vibrator contact against finished face forms of reinforcing steel adjacent to partially set concrete. Avoid over-vibrating.

Concrete shall be protected against rain or immersion under water for at least twelve (12) hours.

250.9.4 Construction Joints - Construction joints shall be made only at points shown or noted on the Plans, except when otherwise approved by the Engineer. Vertical construction joints in the reinforced concrete boxes shall be spaced at a maximum of thirty (30) feet on center. Reinforcing shall be carried continuously through all construction joints. Construction joints shall be formed straight and true with finished edges.

Where a joint is to be made, the surface of the concrete shall be thoroughly cleaned and all laitance removed. The joint shall be thoroughly wetted and slushed with a coat of cement grout immediately before placing of new concrete. Grout shall be mixed using a ratio of one (1) to two and a half (2 1/2) parts of cement to sand.

250.9.5 Removing Forms - Remove forms only after concrete has safe and sufficient strength and only with approval of the Engineer.

250.9.6 Concrete Finish - Immediately after the removal of forms, the Engineer will examine the exposed concrete. Any concrete not conforming to the lines and grades shown on the Plans, or which shows poor joints, voids, stone pockets, honeycomb and otherwise defective areas shall be considered as not conforming with these specifications, and shall be replaced by the Contractor at his expense, except in cases where the Engineer approves patching the defective parts of the structures. Permission to patch any defective parts of the structure shall not waive the Engineer's right to require the replacement of defective parts if the patching does not, in his opinion, satisfactorily restore the quality and appearance of these defective parts.

Specific concrete finishes required will be as follows:

250.9.6.1 Top of drainage structure to slab: sand float.

250.9.6.2 Inside of drainage structure top slab and walls: form-finish with rough spots as well as honeycombing removed; ties to be broken and tie holes grouted.

250.9.6.3 Drainage structure floor slab: sand float.

250.9.6.4 Outside of structure wall: ties to be broken and tie holes grouted with honeycombing removed.

250.9.6.5 Exposed structural concrete surfaces: hand rubbed to a smooth finish with a carborundum brick until form prints are removed.

250.9.7 Curing of Concrete - Curing of concrete shall be maintained continuously for seven (7) days after placing the concrete. Concrete temperature is to be maintained between fifty degrees Fahrenheit (50°F.) and one hundred degrees Fahrenheit (100°F.). Moisture is to be retained in the concrete by the following means:

250.9.7.1 Walls and Structures

250.9.7.1.1 Cover with tarps and leave form on seven (7) days, or

250.9.7.1.2 Cover with cotton batts continuously wet seven (7) days, or

250.9.7.1.3 Spray approved membrane, one (1) gallon to two hundred (200) square feet for unfinished surfaces only.

250.9.7.2 **Slabs**

Pond, or wet cotton batts, or two (2) inch wet sand blanket, or curing paper with sealed edges. Apply immediately after finishing.

250.9.8 **Welding** - All welding shall be shielded arc, fusion welding, made in conformity with the requirements of the "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings" of the A.I.S.C. and the "Code for Arc and Gas Welding in Building Construction" of the American Welding Society, as amended to date. Methods employed and technique shall be subject to the approval of the Engineer.

250.9.9 **Maintenance of Storm Sewers During Construction** - All storm sewers, drain lines, and appurtenances installed under this Contract must be kept reasonably clean during construction. The Contractor shall at all times maintain the storm sewers and appurtenances so as to prevent obstructing surface water.

SECTION 260

STORM SEWERS

260.1 **Description** - Storm sewer construction shall consist of complete installation of sewers and appurtenances in accordance with the standards, drawings, general conditions, and detail specifications. Unless indicated otherwise in these specifications, the word "Sewer" shall refer to pipe sewers, box culvert sewers, or paved channels.

260.2 **Standards** - Whenever any reference is made to ASCE, ASTM, AASHTO, AWWA, and ASA Standard Specifications, the specification referred to shall be understood to mean the latest revision of said specifications or standards as amended to date of letting of Contract.

260.3 **Materials**

260.3.1 **Concrete** - Concrete used in the construction of concrete storm sewers and drainage structures and appurtenances shall conform to Section 250. Concrete Structures.

260.3.2 **Non-Reinforced Concrete Pipe** - All non-reinforced concrete pipe shall conform to ASTM Designation C 14-59. This specification covers non-reinforced concrete pipe intended to be used for the conveyance of sewage and storm sewers. For joints see Section 3 of these specifications.

260.3.3 **Reinforced Concrete Pipe** - All reinforced concrete pipe shall conform to ASTM Designation C 76-62T. This specification covers reinforced concrete pipe of twelve (12) to one hundred eight (108) inches and is intended for use in conveyance of storm water and for the construction of culverts.

260.3.4 **Corrugated Metal Pipe (CMP)** – All CMP shall be fabricated with circumferential corrugations and have riveted lap joint construction (annular riveted) except when the pipe ends within a structure (inlets, junction box, etc), then and only then will spiral (helical) pipe be allowed. Spiral (helical) pipe shall meet the same specifications as the annular riveted. All pipe and connecting bands shall conform to the requirements of the following tables.

Corrugated metal culvert pipe requirements shall conform to the following specifications unless otherwise specified by the plans and specifications or by the Engineer.

MATERIAL	SPECIFICATION (AASHTO)
Roadway pipes - Zinc Coated and Polymeric Coated Sheets and Coils	M36, M245, M218 & M246
Driveway & Stormwater pipes - Zinc Coated Sheets and Coils	M36 & M218

***** Aluminum Coated Sheets and Coils are not permitted.**

Minimum Gauge Specifications for Corrugated Metal Pipe

CIRCULAR CULVERT PIPE

PIPE DIAMETER	2 2/3 X 1/2 CORR GUAGE	MINIMUM COVER	3 X 1 CORR GUAGE	MINIMUM COVER			
12"	16	12"	[REDACTED]	[REDACTED]			
15"							
18"							
21"							
24"							
30"					14		
36"							
42"	12		14		12"		
48"							
54"							
60"	10					12	24"
66"							
72"							
78"		[REDACTED]					
84"							
90"	12						
96"							
102"							
108"							
114"							
120"							

ARCHED CULVERT PIPE

PIPE ARCH SPAN & RISE	2 2/3 X 1/2 CORR GUAGE	MINIMUM COVER	3 X 1 CORR GUAGE	MINIMUM COVER
17" X 13"	16	12"	[REDACTED]	[REDACTED]
21" X 15"				
24" X 18"				
28" X 20"				
35" X 24"	14			
42" X 29"				
49" X 53"	12			
57" X 38"				
64" X 43"				
60" X 46"		[REDACTED]	14	12"
66" X 51"				
73" X 55"	12			
81" X 59"				
87" X 63"				
95" X 67"				
103" X 71"				
112" X 75"				
117" X 79"				
128" X 83"				
137" X 87"	10		24"	
142" X 91"				

Whenever corrugated metal culverts are installed on Railroad Property which is occupied by tracks or which may be occupied by tracks at any time in the future, then it shall conform to the A.E.E.A. "Specifications for Corrugated Metal Culverts."

Diameter of Pipe

Minumum Guage of Metal

12" TO 18"	14
20" TO 24"	12
26" TO 36"	10
38" TO 60"	08

Pipes larger than 60" require special consideration and special specifications.

Corrugated metal storm sewer pipe shall be handled in such a manner that it is not chipped, dented or bent. If in handling the culvert the base metal is exposed in any way then it shall be rejected or repaired to the satisfaction of the Engineer.

260.3.5 **High Density Polyethylene (HDPE) Pipe** - HDPE pipe shall only be used when the pipe ends within a structure (inlets, junction box, etc). Pipe installation must meet the manufacturer recommendations and specifications. There are a wide range of HDPE pipe products on the market. The City Engineer must approve specifications of HDPE pipe to be used.

260.3.6 **Encasement Pipe** - When circular corrugated iron lineal plat or structural plate pipes or tunnels are installed on railroad property which is occupied by tracks or by tracks at any time in the future, then it shall conform to A.R.E.A. "Specifications for Corrugated, Structural, Plate Culverts and Arches." The minimum gage of the metal shall be as follows:

<u>Neutral Axis Diameter</u>	<u>Minimum Gage</u>
48"	8
60"	8
62"	7
72"	7
74"	5
84"	5

260.4 **Joints for Concrete Pipe**

260.4.1. Flexible Compression Joints. Flexible compression joints may be made with rubber gasket, rubber "O" rings which shall conform with ASTM Destination C 443-59T.

260.4.2. Cement Mortar Joints may be made by thoroughly filling the joint, inside and outside, around the circumference of the pipe, with cement mortar. The mortar to be used shall consist of one (1) part of cement to three (3) parts of fine aggregate for cement mortar.

260.5 **Sewer Construction**

260.5.1 **Excavation and Backfill** - All excavation for structures, trench excavation, and backfilling for storm sewer construction and all related work shall be performed in accordance with **Section 201** of the specifications.

260.5.2 **Pipe Bedding** - For proper bedding, refer to the load tables recommended by the American Concrete Pipe Association or other material manufacturers. The type of bedding to be required shall be designated on submitted plans.

Should any excess material be removed from the ditch bottom, the space shall be filled with the approved material and thoroughly tamped, with a pneumatic tamper to the satisfaction of the Engineer, or replaced with a six (6) inch thick layer of approved granular material on top of other approved compacted materials.

Regardless of the method used to transfer the line and grade from the stakes to the sewer, each pipe shall be checked for line and grade using a method approved by the Engineer.

260.5.3 Laying the Pipe - All pipe shall be protected during handling against shock and free fall.

The laying of pipe in finished trenches shall be commenced at the lowest point and installed with the bell end forward or upgrade. All pipe shall be laid with ends abutting and true to line and grade. They shall be carefully centered so that when laid they will form a sewer with a uniform invert.

Each piece of pipe shall be checked for vertical and horizontal alignment immediately after being laid.

Preparatory to making pipe joints, all surfaces of the portions of the pipe to be jointed, or of the factory made jointing materials, shall be clean and dry. Lubricants, primer, adhesives, etc., shall be used as recommended by the pipe or joint manufacturer's specifications.

260.6 Manholes and Junction Chambers

260.6.1 Precast Manholes - Precast manholes shall be constructed as shown in the standard drawings, as specified herein and as directed by the Engineer.

260.6.2 Manhole Base and Invert - The manhole base and invert shall be constructed of **Class E** concrete as specified under **Section 250** of these specifications. All bases and inverts shall be poured individually in one continuous pour for each, unless otherwise specified and particular care taken to make channels smooth and perfect. All manhole inverts and bases shall conform to the applicable manhole standards.

Precast manhole bases may be used with precast manholes provided the design of the base has been approved.

260.6.3 Manhole Rings and Covers - The rings and covers of all manholes shall be set at the elevation shown on the drawings and solidly built into place and grouted with cement mortar. Any brick work that might be used shall be placed so that it will be water tight.

260.7 **Catch Basins and Inlets**

260.7.1 **Precast** - Precast catch basins shall be constructed in accordance with the standards or approved equal. Concrete for precast concrete basins shall conform to the applicable sections of these specifications for **Class D** concrete.

260.7.2 **Reinforced** - Reinforced concrete catch basins and inlets shall conform to the standard drawings and the applicable sections of these specifications for **Class D** and **Class E** concrete. Concrete cover over steel reinforcement shall be not less than one (1) inch for covers and one and one-half (1 1/2) inches for walls and floors. All exposed concrete shall have smooth steel trowel or brushed finish. Interiors of structures shall have the forms removed and surface voids filled.

260.8 **Reinforced Concrete Box Culverts**

260.8.1 **General** - Reinforced concrete box culverts shall be constructed in strict accordance with this section and **Section 250** of these specifications.

260.8.2 **Composition of Concrete** - To determine the actual mixed proportions of cement, aggregates and water proposed for use on the project, the Contractor shall furnish all the information required by the testing laboratory retained by the Engineer. The testing laboratory will proportion a concrete mix based upon the requirements of these specifications and will determine the compressive breaking strength of these specimens at seven (7) days and will determine that the mix is in strict compliance with the specifications.

260.9 **Paved Ditches and Rip-Rapping** - Paving concrete for paved ditches shall conform to **Class E** concrete specifications herein described and shall correspond with the standard drawings or approved equal.

Rip-rapping shall consist of rock or concrete and shall be approved by the Engineer prior to placement.

260.10 **Headwalls, Wingwalls and Endwalls** - Design of these structures shall conform to the standards attached or to the approved details as submitted by the Engineer. Concrete shall conform with **Class E** concrete as outlined under **Section 250** of these specifications.

260.11 **Railroad Crossings** - Wherever a railroad crossing is being constructed beneath or at grade the necessary permit for the construction will have been previously secured by the Contractor. It shall also be the responsibility of the Contractor to contact the railroad company prior to beginning of such crossings, and to proceed with the construction as directed by the railroad company.

All railroad crossings shall be made at right angles to the railroad tracks wherever possible, and shall be laid by jacking or tunneling.

260.12 **Traffic** - Provision shall be made for taking care of traffic in accordance with the Manual on Uniform Traffic Control Devices (MUTCD).

260.13 **Existing Utilities** - The Contractor shall contact Missouri One Call for location of existing utilities.

260.14 **Replacement of Pavement** - All pavement, surfacing, driveways, curb, walks, buildings, utility poles, guy wires, and other surface structures affected by construction operations in connection with the performance of the Contract, together with all sod and shrubs in yards, parks, and parking, shall be maintained and if removed, or otherwise damaged, shall be restored to the original condition thereof, as determined and approved by the Engineer, unless otherwise specified on the plans.

The Contractor shall be responsible for, including any damage caused by settlement of backfill placed beneath pavements, street, road, and driveway surfacing, and drainage and other structures, and beneath sod in yards, parkings, and parks, which may occur at any time prior to, and during a period of one (1) year from and after the date of final acceptance of the work covered by the Contract; during such period the Contractor shall at his own cost and expense refill all excavations where backfill damage to structures, pavements, surfacing, and sod caused by such settlement, to the satisfaction of the City. Should the Contractor fail to repair settlement which may occur as described above within thirty (30) days after being given notice thereof, the Owner shall have the right to repair such settlement and charge the cost of such repairs to the Contractor.

The Contractor will be held responsible for all damage to roads, highways, shoulders, ditches, embankments, bridges, culverts and other property, caused by him or any of his Subcontractors in hauling or otherwise transporting materials to and from the several sites of the work, regardless of the location of such damage. The Contractor shall make arrangements relative to the payment for, or repair or replacement of, such damage or damaged surfaces or structures which are satisfactory and acceptable to the Owners or Owner of such damaged surfaces or structures, or to their legally responsible officers, agents or other representatives, at the Contractor's own cost and expense.

SECTION 270

FERTILIZING

270.1 **Description** - This work shall consist of the application of lime and commercial fertilizer and soil preparation for seeding and sodding on areas shown on the plans or designated by the engineer.

270.2 **Material.**

270.2.1 Material used for soil neutralization, unless otherwise specified, shall be a pelletized bagged lime, or an agricultural lime with not less than 90 percent passing the No. 8 sieve and containing not less than 65 percent calcium carbonate equivalent.

270.2.2 The rate of application of lime shall be a minimum of 2,200 lbs/acre for agricultural lime or 1,100 lbs/acre for pelletized lime. Except as otherwise provided in this specification, the quantity of material required to provide the specified pounds of effective neutralizing material per acre shall be determined from the producer or distributor's certification of analysis furnished by the Director of the Missouri Agriculture Experiment Station, Columbia, Missouri in accordance with the Missouri Agricultural Liming Materials Act.

270.2.2.1 When agricultural lime is to be furnished from a source that has not been tested and certified in accordance with the Missouri Agricultural Liming Materials Act, the contractor shall notify the engineer at least 30 days prior to application of agricultural lime to permit sampling, testing and determination of the required rate of application. The engineer will determine the effective neutralizing material per ton of liming material by the following formula:

$$E.N.M. = \% C.C.E. \times \text{Fineness Factor} \times 800$$
 where: E.N.M. is the Effective Neutralizing Material per ton. % C.C.E. is the percent Calcium Carbonate Equivalent as determined by Association of Official Analytical Chemists (AOAC) methods of analysis. Fineness Factor = $(\% \text{ passing No. 8 sieve and retained on the No. 40} \times 0.25) + (\% \text{ passing No. 40 sieve and retained on the No. 60} \times 0.60) + (\% \text{ passing No.60})$. Gradation will be determined in accordance with AOAC wet sieving methods. The 800 is a constant representing the theoretical maximum quantity of calcium in one ton of lime.

270.2.2.2 If agricultural lime is furnished as a commercially bagged product, pelletized or otherwise, with a guaranteed product analysis shown on the bag listing the elemental properties and gradation, the E.N.M. shall be calculated in accordance with **Section 270.2.2.1**. Material may be accepted on the basis of bag label analysis.

270.2.3 Fertilizer shall be a standard commercial product that will supply a minimum of 145 pounds of total nitrogen (N), 435 pounds of available phosphoric acid (P 2 0 5) and 270 pounds of soluble potash (K 2 0) per acre. Material may be accepted on the basis of bag label analysis or supplier's certification and shall comply with all applicable Missouri fertilizer laws.

270.3 **Equipment** - Lime and commercial fertilizer shall be applied by mechanical equipment designed for this purpose.

270.4 **Construction Requirements**

270.4.1 The area to be limed and fertilized will be the area specified within the limits of construction; shall have a uniform surface free from rills, washes and depressions; and shall conform to the finished grade and cross section as shown on the plans. The soil shall be thoroughly broken up, worked, tilled and loosened to a minimum depth of 2 inches. The seedbed or sodbed shall be prepared by loosening the existing soil on the slope, rather than by the addition of loose soil.

270.4.2 Lime and fertilizer shall be applied evenly at the rates specified in this section and only when the soil is in a tillable condition. After application, the lime and fertilizer shall be mixed into the soil by disking, harrowing or raking to a minimum depth of 2 inches, unless applied hydraulically on slopes steeper than 2:1 (1:2) in accordance with **Section 275.3.2.1**.

270.4.3 Lime and fertilizer shall be applied separately, but may be incorporated into the soil in one operation.

270.4.4 Lime and fertilizer shall be applied not more than 48 hours before the seed is sown unless otherwise authorized by the engineer.

SECTION 272

MULCHING

272.1 **Description** - This work shall consist of the application of a mulch. All seeded areas shall be mulched.

272.2 **Material**

272.2.1 **Type 1 Mulch (Vegetative)** - The vegetative mulch shall be prairie hay or straw from oats, rye, wheat or barley. Prairie hay shall consist of any combination of any of the following plants: Big Bluestem, Little Bluestem, Indiangrass, Sideoats Grama and native wildflowers. The mulch shall be free of prohibited weed seed as stated in the Missouri Seed Law and shall be relatively free of all other noxious and undesirable seed. The mulch shall be clean and bright, relatively free of foreign material and be dry enough to spread properly. If the above specifications cannot be met practicably, hay of the following plants may, with the engineer's approval, be substituted: Smooth Brome, Timothy, Orchard Grass, Reed Canary Grass, Tall Fescue, Redtop, Kentucky Bluegrass, Alfalfa and Birdsfoot Trefoil.

272.2.2 **Type 2 Mulch (Vegetative with Asphalt Emulsion)** - The asphalt emulsion shall be SS-1, SS-1h, CSS-1 or CSS-1h conforming to the requirements of AASHTO M 140 or AASHTO M 208. The vegetative mulch shall be as specified in **Section 272.2.1**.

272.2.3 **Type 3 Mulch (Vegetative with an Overspray)** - The vegetative mulch shall be as specified in **Section 272.2.1**. The overspray material may be virgin wood cellulose fibers or recycled slick paper as herein specified. It shall not contain any germination or growth inhibiting substances. The overspray shall be green in color after application and shall have the property to be evenly dispersed and suspended when agitated in water. When sprayed uniformly over vegetative mulch, the mulch fibers shall form an absorbent cover, allowing percolation of water to the underlying soil. The mulch shall be packaged in moisture resistant bags with the net weight (mass) of the packaged material plainly shown on each bag. The mulch fibers shall not be water soluble.

272.2.3.1 **Virgin Wood Cellulose** - Virgin wood cellulose fibers shall be produced by either the ground or cooked fiber process and shall have the following properties: Moisture Content, percent by weight (mass), max 15 Organic Matter-Wood Fiber, percent by weight (mass), min 80 pH 4.3-8.5

272.2.3.2 **Recycled Slick Paper Mulch** - Recycled slick paper mulch shall be produced from printers slick paper containing wood cellulose and kaolin clay. Recycled newsprint or cardboard will not be allowed. The material shall be free of other material or fillers and shall have the

following properties: Moisture Content, percent by weight (mass), max 8
pH 4.5-6.5

272.2.3.3 The contractor shall furnish a manufacturer's certification in triplicate certifying that the overspray mulch materials complies with these specifications. The engineer may sample and test these materials prior to approval and use. Acceptance will be based upon a satisfactory certification and results of any test deemed necessary by the engineer.

272.2.4 **Type 4 Mulch (Embedded)** - The vegetative mulch shall be as specified in **Section 272.2.1**. The mulch shall be embedded by a disk type roller having flat serrated disks spaced not more than 10 inches apart and cleaning scrapers shall be provided.

272.3 Construction Requirements

272.3.1 **Type 1 Mulch (Vegetative)** – Type 1 Mulch shall be applied at the rate of 2 1/2 tons per acre.

272.3.2 **Type 2 Mulch (Vegetative with Asphalt Emulsion)** – Type 2 Mulch shall be applied by mechanical mulch spreaders equipped to eject, by means of a constant air stream, controlled quantities of the vegetative mulch and emulsified asphalt in a uniform pattern over the specified area. The mulching machine shall be so designed that the asphalt will be injected at the proper rate directly into the air stream carrying the straw, resulting in a uniform spotty tacking of the vegetative mulch with asphalt. The vegetative mulch shall be applied at the rate of 2 1/2 tons per acre. The application rate for the asphalt emulsion shall be 100 gallons per ton of straw.

272.3.3 **Type 3 Mulch (Vegetative with an Overspray)** – Type 3 Mulch shall be hydraulically applied over the vegetative mulch as a separate operation. Recycled slick paper shall be applied at the rate of 750 pounds per acre. Virgin wood cellulose fibers with 90 percent or more organic matter shall be applied at the rate of 750 pounds per acre and that with 80 to 89 percent inclusive shall be applied at a rate calculated as follows:

$$\text{Rate lb/acre} = 100 \times 750 \text{ lb/acre} \times \text{Actual Percent Organic Matter}$$

The overspray material shall be mixed with water in a manner to provide a homogeneous slurry. Equipment for mixing and applying the slurry shall be capable of applying it uniformly over the entire vegetative mulched area. The slurry mixture shall be agitated during application to keep the ingredients thoroughly mixed.

272.3.4 **Type 4 Mulch (Embedded)** – Type 4 Mulch shall be applied at the rate of 2 1/2 tons per acre. The mulch roller shall be operated approximately parallel to the

roadbed grade. The mulch shall be embedded in the soil a sufficient depth to prevent the loss of mulch by wind or water erosion. Excelsior blanket may be used in lieu of Type 4 Mulch at the option of the contractor.

272.3.5 All mulch shall be distributed evenly over the area to be mulched within 24 hours following the seeding operation. Following the mulching operation, precautions shall be taken to prohibit foot or vehicular traffic over the mulched area. Any mulch which is displaced shall be replaced at once, but only after the work preceding the mulching which may have been damaged as a result of the displacement has been acceptably repaired.

SECTION 275

SEEDING

275.1 **Description** - This work shall consist of preparing, liming and fertilizing a seedbed, and the furnishing and sowing of seed. All disturbed areas shall be seeded except: (1) sodded areas, (2) surfaced areas, (3) solid rock and (4) slopes consisting primarily of broken rock.

275.2 **Material**

275.2.1 Seed shall comply with the requirements of the Missouri Seed Law. Commercially available seed will be permitted, however, the percentages for purity and germination as certified by the supplier shall be subject to the approval of the engineer. The contractor shall supply the supplier's certifications to the engineer. Seed may be accepted on the basis of bag labels. If seed is accepted on the basis of bag labels, the contractor shall retain the bag labels and shall write a letter to the engineer stating the amount and type of seed. Unless otherwise specified, the seed mixture and rate of application shall be as specified below:

All Seasons	Mixture %
Kentucky Bluegrass	20% @ 90 lbs/per acre
Perennial Rye Grass	40% @ 310 lbs/per acre
Tall Fescue (No K31)	20% @ 325 lbs/per acre
Red Fescue	20% @ 175 lbs/per acre

SECTION 276

EROSION AND SEDIMENT CONTROL

276.1 **Description** - This work shall consist of furnishing, installing, maintaining and removing temporary pollution, erosion and sediment control measures; furnishing and placing permanent erosion control features; or a combination of both as shown on the plans or as designated by the engineer.

276.1.1 The contractor shall exercise effective management practices throughout the life of the project to control pollution. Pollutants such as chemicals, fuels, lubricants, bitumen, raw sewage or other harmful material shall not be discharged on or from the project. Temporary pollution control measures, such as storage and handling of petroleum products and other pollutants, shall be coordinated with temporary and permanent erosion control features that ensure economical, effective and continuous erosion and pollution control. This work shall also apply to work within easements designated by the Engineer.

276.2 **Material** - All material shall conform to the following details as follows:

Item	Section
Fertilizer and Lime	270
Straw for Bales	272
Mulching	272
Seed	275
Geotextile Fabric	285

276.3 **Construction Requirements** - The contractor shall provide immediate permanent or temporary pollution control measures to prevent contamination of adjacent streams or other bodies of water. Such work may involve the construction of temporary berms, dikes, dams, sediment basins, slope drains, and use of temporary mulches, seeding or other control devices or methods as necessary to control erosion and pollution.

276.3.1 The contractor shall incorporate all permanent erosion and pollution control features into the project at the earliest practicable time. Temporary measures shall be used to correct conditions that develop during construction which were not foreseen during the design stage; that are needed prior to installation of permanent pollution control features; or that are needed temporarily to control erosion that develops during normal construction practices, but are not associated with permanent control features on the project.

276.3.2 Clearing and grubbing operations shall be scheduled and performed so grading operations and erosion control features will follow immediately thereafter. The surface area of erodible earth material exposed at one time by clearing and grubbing, excavating fill or borrow shall not exceed 435,000 square feet within any individual drainage area without installation of erosion controls for that

drainage area. The total erodible surface area exposed at one time for the entire project shall not exceed 750,000 square feet without documented approval by the engineer.

- 276.3.3 The engineer will limit the additional amount of erodible surface areas exposed by clearing and grubbing, excavation, borrow and fill operations with the amount of fill area in which the finished grading, mulching, seeding and other such permanent erosion control measures are completed and properly maintained. Should seasonal limitations make such operations unrealistic, temporary erosion control measures shall be taken immediately.
- 276.3.4 Unless otherwise provided or approved in writing by the engineer, construction operations in streams or other bodies of water shall be restricted to those areas, which must be entered for the construction of temporary or permanent structures. Streams or other bodies of water shall be promptly cleared of all falsework, piling, debris or other obstructions placed therein or caused by construction operations.
- 276.3.5 Frequent fording of streams or other bodies of water with construction equipment will not be permitted. Temporary bridges or other structures shall be used wherever an appreciable number of streams or other bodies of water crossings are necessary. Unless otherwise approved in writing by the engineer, mechanized equipment shall not be operated in streams or other bodies of water except as may be required to construct channel changes and temporary or permanent structures. If a Corps of Engineer Section 404 or Department of Natural Resources Section 401 permit is applicable for a project, the permit requirements and conditions shall prevail.
- 276.3.6 The location of all local material pits, other than commercially operated sources, and all excess material sites shall be subject to the approval of the engineer. Erosion from construction operations and pollution control measures shall not cause water pollution.
- 276.3.7 In the event of conflict between these requirements and the pollution control laws, rules or regulations of other federal, state or local agencies, the more restrictive laws, rules or regulations shall apply.
- 276.3.8 Unless otherwise specified by the engineer, all temporary erosion control measures shall be removed by the contractor after permanent erosion control measures are established.

SECTION 277

TEMPORARY BERMS

277.1 **Description** - This work shall consist of constructing temporary berms of compacted soil at the top of fill slopes or transverse to the centerline of fills.

277.2 **Material** - Temporary berms shall consist of graded material from within the project limits, or any other suitable material approved by the engineer.

277.3 **Construction Requirements** - Temporary berms shall be constructed to the approximate dimensions as shown on the plans.

277.3.1 **Type A Berms** - Type A berms shall be machine compacted with a minimum of one pass over the entire width of the berm.

277.3.2 **Type B Berms** - Type B berms shall be machine compacted with a minimum of three passes over the entire width of the berm. Material removed from Type B berms shall be incorporated in the embankment when possible. The contractor shall dispose any excess or unsuitable material to a location as directed by the engineer.

277.3.3 **Type A and Type B Berms** - Temporary berms shall drain to a compacted outlet at a slope drain. On transverse berms, the top width of the berms may be wider and the side slopes flatter to allow equipment to pass over these berms with a minimal disruption.

277.3.4 **Type C Berms** - Type C berms shall be constructed of rock base material meeting the requirements of **Section 277.4** or other material as approved by the engineer. A straw layer or an equivalent erosion control blanket shall be placed on the upslope side of the Type C berm. The straw layer shall be placed in such a manner that the final compacted thickness is 2 inches. The material for the straw layer shall be Type 1 mulch meeting **Section 272**. The straw layer or equivalent erosion control blanket shall be removed and replaced as determined by the engineer.

277.4 Rock Base Material

277.4.1 The material source for rock base shall meet the approval of the engineer. Geologic conditions may vary from available subsurface information. Approval by the engineer of a source for the inherent stoned does not constitute approval of the final rock base product. Additional mechanical processing beyond excavation such as, but not limited to, scalping, size reduction, washing, etc., of the material may be necessary to comply with this specification.

277.4.2 Material for rock base shall be durable stone or broken concrete containing a combined total of not more than 10 percent of earth, sand, shale and non-durable

rock. Material from geologic filled sink deposits or stone indicating evidence of solution activity shall not be used.

277.4.3 The material shall be as large as can be conveniently handled within the limits of this specification. No particle dimension shall exceed 18 inches. There shall be at least some material with particle dimensions exceeding 12 inches. The material shall be uniformly graded from coarse to fine.

277.4.3 Broken sound concrete pavement may be used provided the ratio of the longest dimension measurement to thickness does not exceed 2:1 and provided there is no excessive exterior steel mesh that would affect compaction. Concentrated forms of bituminous pavement (milled, crushed or chunked) shall not be used. Small, thin amounts adhering to broken concrete pavement will be allowed.

277.4.4 Acceptance of quality and size of material may be made by visual inspection at the job site.

SECTION 278

TEMPORARY SLOPE DRAINS

- 278.1 **Description** - This work shall consist of constructing temporary slope drains to carry water down slopes and reduce erosion. The method selected shall be approved by the engineer prior to construction.
- 278.2 **Construction Requirements** - The contractor shall provide temporary, impermeable slope drains to carry water or water with suspended solids down fill slopes until permanent erosion control measures are established. The contractor shall provide temporary slope drains on fill slopes at approximately 500 foot intervals or as directed by the engineer. All temporary slope drains shall be adequately anchored to the slope to prevent disruption of flow. Inlet ends shall be properly constructed to channel water into the temporary slope drain. Outlet ends shall have some means of dissipating the energy of the water to reduce erosion downstream. The contractor shall restore the site to the satisfaction of the engineer.

SECTION 279

TEMPORARY DITCH CHECKS

279.1 **Description** - This work shall consist of constructing and maintaining temporary ditch checks, removing sediment deposits from these ditch checks and disposing of the sediment at a location approved by the engineer.

279.2 Construction Requirements

279.2.1 **Type I Ditch Checks** - Type I ditch checks shall be constructed of straw bales, silt fence or an approved alternative erosion control measure. Type I ditch checks shall not be used where drainage areas exceed 3 acres or ditch slopes exceed 10 percent. Type II ditch checks may be substituted for Type I ditch checks.

279.2.1.1 **Straw Bale Ditch Checks** - Straw bale ditch checks shall be constructed according to the plans and specifications.

279.2.1.2 **Silt Fence Ditch Checks** - Silt fence ditch checks shall be constructed according to the plans and specifications.

279.2.1.3 **Alternative Ditch Checks** - Approved alternative ditch checks shall be installed and maintained according to the manufacturer's recommendations.

279.2.2 **Type II Ditch Checks** - Approved alternate Type II ditch checks may be used. Type II ditch checks shall not be used where drainage areas exceed 50 acres or ditch slopes exceed 10 percent.

279.2.2.1 **Rock Ditch Checks** - Rock ditch checks shall be constructed according to the plans and specifications with clean rock. A minimum of 50% of the rock shall have a diameter of 6 inches or greater with a maximum size of 9 inches. Silt fence or an equivalent filter fabric shall be placed beneath the rock ditch check as shown on the plans.

279.2.2.2 **Sand Bag Ditch Checks** - The sand bag ditch check shall be constructed as shown on the plans. Sand or rock for sand bags shall be a uniform granulation with a maximum aggregate size of 2 inches, shall be clean to allow percolation of water through the sand bag and meet the approval of the engineer. Sand bags shall be of tightly woven burlap or other material that is sufficiently durable to remain intact for the time intended. Sand bags shall be filled approximately $\frac{3}{4}$ full, shall weigh approximately 55 pounds and shall be securely closed. Sand bags shall be placed in the ditches at locations shown on the plans or as directed by the engineer. The sand bags shall be laid in horizontal courses, and successive courses shall break joints with preceding ones. The sacks shall be packed against each other and tamped to provide a uniform surface.

279.2.3 If the engineer determines a Type I or II ditch check is not suitable due to site conditions, a combination of ditch checks and erosion control blankets or rock blankets shall be designed to effectively reduce flow velocities.

279.3 **Maintenance** - The contractor shall replace ditch checks at the request of the engineer. Periodic sediment removal shall include removal and disposal of sediment to a location where it will not erode into construction areas, streams or other bodies of water. The contractor shall inspect the ditch checks for sediment accumulation after each storm event and shall remove the sediment when deposits reach approximately one-half the original height of the ditch check.

SECTION 280

SEDIMENT BASINS

- 280.1 **Description** - This work shall consist of constructing sediment basins as shown on the plans or as determined by the engineer to detain sediment. This work shall also include disposal of excavated material, sediment and basin removal and site restoration.
- 280.2 **Construction Requirements** - The area where a sediment basin is to be constructed shall be cleared of vegetation to enable sediment removal. The sediment basin shall be an excavated or dammed storage area with defined side slopes. Inlet and outlet areas shall be lined with rock riprap.
- 280.2.1 The inlet of a sediment basin shall be constructed with a wide cross-section and a minimum grade to prevent turbulence and to allow deposition of soil particles. When the depth of sediment reaches 1/3 the original depth of the structure in any part of the pool, all accumulation shall be removed.
- 280.2.2 The contractor shall dispose of accumulated sediment and excavated material removed during the construction of the sediment basin in locations where it will not erode into the construction areas, streams or other bodies of water.
- 280.2.3 Sediment basins shall remain in service until all disturbed areas draining into the structure have been satisfactorily stabilized. When use of a temporary sediment basin is to be discontinued, the contractor shall remove any sediment, backfill, and properly compact all excavations and restore the existing ground to its natural or intended condition.

SECTION 281 TEMPORARY SEEDING AND MULCHING

281.1 **Description** - This work shall consist of furnishing and applying fertilizer, seed, Type 1 mulch or other acceptable cover authorized by the engineer. This work shall produce a quick ground cover to reduce erosion in disturbed areas expected to be redisturbed at a later date. Finish grading of areas will not be required. Hydraulic seeding and fertilizing in accordance with **Section 275** will be allowed.

281.2 **Construction Requirements** - Seeding and mulching shall be a continuous operation on all cut and fill slopes, excess material sites and borrow pits during the construction process. All disturbed areas shall be seeded and mulched as necessary to eliminate erosion.

281.2.1 The contractor shall provide permanent seeding and mulching as shown on the plans following temporary seeding.

281.2.2 Temporary seeding mixtures of oats, cereal rye or wheat shall be applied at a rate of 100 pounds per acre. Temporary seeding mixtures of oats shall be applied only during the months of December through May.

281.2.3 Temporary mulch placed over temporary seed mixtures shall be applied in accordance with **Section 272.2.1**.

281.2.4 Fertilizer shall be applied at a rate of 40 pounds nitrogen (N) per acre.

281.2.5 Lime will not be required for temporary seeding.

281.3 **Construction Requirements**

281.3.1 The contractor shall install temporary silt fence as shown on the plans and at other locations directed by the engineer. Fence construction shall be adequate to handle the stress from hydraulic and sediment loading. Fabric at the bottom of the fence shall be buried a minimum of 6 inches to prevent flow under the barrier. The trench shall be backfilled and the soil compacted over the fabric. Fabric splices with a minimum 6-inch overlay shall be located only at a support post. Any installation method acceptable to the engineer will be allowed as long as the effectiveness and intent of the silt fence is achieved. All geotextile construction shall be in accordance with **Section 286**.

281.3.2 Post spacing shall not exceed 5 feet. Posts shall be driven a sufficient depth into the ground or placed on closer spacing as necessary to ensure adequate resistance to applied loads.

281.3.3 The silt fence shall be fastened securely to the upslope side of the post. When wire support fence is used, the wire shall extend into the trench a minimum of 2 inches.

281.3.4 The contractor shall maintain the integrity of silt fences as long as they are necessary to contain sediment runoff. The contractor shall inspect all silt fences immediately after each rainfall and at least daily during prolonged rainfalls. Any deficiencies shall be immediately corrected by the contractor. In addition, the contractor shall make a daily review of the silt fences in areas where construction activities have changed the natural contour and drainage runoff to ensure the silt fences are properly located for effectiveness. Where deficiencies exist, additional silt fences shall be installed as approved or directed by the engineer.

281.3.5 The contractor shall remove and dispose of sediment when accumulations reach approximately one-half the fence height, or sooner when directed by the engineer. If required by heavy sediment loading, a second silt fence shall be installed as directed by the engineer.

281.3.6 The silt fence shall remain in place until removal is directed by the engineer. Upon removal, the contractor shall remove and dispose of any excess silt accumulations, grade and dress the area to the satisfaction of the engineer, and establish vegetation on all bare areas in accordance with the contract requirements. The fence material shall remain the property of the contractor and may be used at other locations, provided the material continues to meet the requirements of this specification, is sound and not weakened by exposure to the elements.

SECTION 282

STRAW BALES

282.1 **Description** - This work shall consist of furnishing, installing, maintaining and disposing of bales of straw or other approved foliage used as a means of controlling sheet flow erosion, as shown on the plans or designated by the engineer.

282.2 **Material** - Bales shall be Type 1 mulch in accordance with **Section 272**.

282.3 Construction Requirements

282.3.1 The contractor shall place bales at the bottom of embankment slopes or on the lower side of cleared areas to divert runoff and to detain sediment from sheet flow. When used to divert runoff or detain sediment, the bales shall be adequately anchored to withstand the applied load.

SECTION 283

TEMPORARY SILT FENCE

283.1 **Description** - This work shall consist of furnishing, installing, maintaining, removing and disposing a wire-supported or self-supported geotextile silt fence designed to remove suspended particles from sheet flow passing through the fence and prevent sediment from polluting nearby streams or other bodies of water. The quantities of temporary silt fence shown on the plans may be increased or decreased at the direction of the engineer. At the engineer's discretion, the location may be modified to fit field conditions. Such variations in quantity will not be considered as alterations in the details of construction or a change in the character of the work.

283.2 **Material** - Geotextile Type 2 material shall conform to **Section 285**.

283.2.1 **Posts** - Wood, steel or synthetic posts may be used. Posts shall be of sufficient length, not less than 4 feet, to ensure adequate embedment while fully supporting the silt fence and shall have sufficient strength to resist damage during installation and support applied loads while in service.

283.2.2 **Support Fence** - All geotextile silt fence shall be supported either externally by wire or other approved mesh to a height of at least 24 inches or by a suitable designed-in support system capable of keeping the material erect. Either method shall be strong enough to withstand applied loads.

283.2.3 **Prefabricated Fence** - Prefabricated fence systems may be used provided they meet all of the above material requirements.

283.3 **Construction Requirements**

283.3.1 The contractor shall install temporary silt fence as shown on the plans and at other locations directed by the engineer. Fence construction shall be adequate to handle the stress from hydraulic and sediment loading. Fabric at the bottom of the fence shall be buried a minimum of 6 inches to prevent flow under the barrier. The trench shall be backfilled and the soil compacted over the fabric. Fabric splices with a minimum 6-inch overlay shall be located only at a support post. Any installation method acceptable to the engineer will be allowed as long as the effectiveness and intent of the silt fence is achieved. All geotextile construction shall be in accordance with **Section 286**.

283.3.2 Post spacing shall not exceed 5 feet. Posts shall be driven a sufficient depth into the ground or placed on closer spacing as necessary to ensure adequate resistance to applied loads.

283.3.3 The silt fence shall be fastened securely to the upslope side of the post. When wire support fence is used, the wire shall extend into the trench a minimum of 2 inches.

- 283.3.4 The contractor shall maintain the integrity of silt fences as long as they are necessary to contain sediment runoff. The contractor shall inspect all silt fences immediately after each rainfall and at least daily during prolonged rainfalls. Any deficiencies shall be immediately corrected by the contractor. In addition, the contractor shall make a daily review of the silt fences in areas where construction activities have changed the natural contour and drainage runoff to ensure the silt fences are properly located for effectiveness. Where deficiencies exist, additional silt fences shall be installed as approved or directed by the engineer.
- 283.3.5 The contractor shall remove and dispose of sediment when accumulations reach approximately one-half the fence height, or sooner when directed by the engineer. If required by heavy sediment loading, a second silt fence shall be installed as directed by the engineer.
- 283.3.6 The silt fence shall remain in place until removal is directed by the engineer. Upon removal, the contractor shall remove and dispose of any excess silt accumulations, grade and dress the area to the satisfaction of the engineer, and establish vegetation on all bare areas in accordance with the contract requirements. The fence material shall remain the property of the contractor and may be used at other locations, provided the material continues to meet the requirements of this specification, is sound and not weakened by exposure to the elements.

SECTION 284

TEMPORARY PIPE

- 284.1 **Description** - This work shall consist of installing temporary pipe of any material acceptable to the engineer, utilized to carry water under temporary roadways, silt fences, berms or other locations determined by the engineer and to prevent the contractor's equipment from coming in direct contact with water when crossing an active stream or other bodies of water or intermittent streams created during heavy rainfalls.
- 284.2 **Construction Requirements** - Installation of temporary pipe shall be in accordance with the specifications for permanent pipe and shall prevent water from causing erosion around the pipe. All backfill material for pipes shall be placed in 6-inch lifts and mechanically compacted. Compaction tests will not be required.

SECTION 285

GEOTEXTILE FABRIC

285.1 **Scope** - This specification covers geotextile for use in subsurface drainage, sediment control, erosion control or as a permeable separator.

285.2 **Material** - Geotextiles shall meet the physical and chemical requirements of AASHTO M 288 for the specified application except as modified herein.

285.2.1 General

285.2.1.1 No specific permeability values are required.

285.2.1.2 The U. S. Standard sieve number corresponding to the apparent opening size (AOS) shall not exceed 100 for geotextile used in contact with any soil with more than 50 percent passing the No. 200 sieve nor shall the AOS exceed 70 when used between any two dissimilar granular material, less than 50 percent passing the No. 200 sieve, or when used to control movement of fines from a granular backfill through structural joints or into a drain pipe.

285.2.1.3 During shipment and storage, geotextiles shall be protected from direct sunlight, ultra-violet rays, temperatures greater than 140 F, mud, dust and debris.

285.2.2 **Type 1, Subsurface Drainage** - Type 1 geotextile is intended for use in subsurface drainage as a filter to protect drainage media from clogging with fines from adjacent soil. Typical applications include lining of drainage trenches and wrapping drain pipes.

285.2.2.1 The minimum permittivity shall be 1.3 sec⁻¹.

285.2.2.2 The material may be either AASHTO Class A or Class B unless otherwise specified.

285.2.2.3 When material is furnished in the form of a knitted or woven sock to be stretched to fit snugly around perforated pipe, the grab strength requirements for AASHTO Class B applications may be reduced by 33 percent provided the minimum elongation is greater than 50 percent.

285.2.3 **Type 2, Sediment Control** - Type 2 geotextile is intended for use in supported or non-supported sediment control fencing.

285.2.4 **Type 3, Erosion Control** - Type 3 geotextile is intended for uses such as erosion control of slopes and channels when placed under rock blanket, rock ditch liner, etc.

285.2.4.1 The minimum permittivity shall be 1.0 sec -1 .

285.2.4.2 The material may be either AASHTO Class A or Class B unless otherwise specified.

285.2.5 Type 4, Separation - Type 4 geotextile is intended for use as a separation material to prevent mixing of dissimilar material and to control migration of backfill material through joints in structural elements. Typical applications include use between soil and select granular backfills behind retaining structures, box culvert joint wraps, placement behind mechanically stabilized earth wall facing panels, cover for drainage blankets and soil/rock fill separation in slide repairs.

285.2.5.1 The minimum permittivity shall be 1.0 sec -1 .

285.2.5.2 The material may be either high or medium survivability level unless otherwise specified.

285.3 Certification and Acceptance

285.3.1 The contractor shall furnish a manufacturer's certification to the engineer, for each lot of material furnished stating the name of the manufacturer, the chemical composition of the filaments or yarns and certifying that the material supplied conform to all requirements specified. The certification shall include or have attached typical results of tests from specific lots for all specified requirements.

285.3.2 Acceptance of the material will be based on the manufacturer's certification and upon the results of such tests as may be performed by the engineer.

SECTION 286

GEOTEXTILE CONSTRUCTION

286.1 **Description** - This work consists of installation of geotextile for use in subsurface drainage, in erosion control, as a permeable separator or as otherwise specified.

286.2 **Material** - All material shall conform to **Section 285**.

286.3 Construction Requirements

286.3.1 Areas on which geotextile is to be placed shall be reasonably smooth and free from mounds, windrows, debris or projections. Geotextile shall be placed in a manner to minimize wrinkles or creases in the material. When used for erosion control or to separate soil and granular material, geotextile shall be placed loose to the contour of the ground so as to be free to adjust to minor indentations and protrusions as rock or fill is placed against or over the material but secured sufficiently to preclude sliding or displacement during fill placement and under traffic. Geotextile shall be secured in place as necessary to perform the work with steel pins or by other suitable means.

286.3.2 Lengths and widths of geotextile shall be chosen to minimize the required number of overlaps or seams. Adjacent rolls or strips of geotextiles shall either be sewn in accordance with recommendations of the manufacturer to meet seam strength requirements of AASHTO M 288, or overlapped.

286.3.2.1 Overlaps shall be sufficient to prevent openings in the geotextile coverage as a consequence of subsequent filling operations and shall meet the following minimum requirements: 18" overlap on slopes 3:1 or flatter; 24" on slopes steeper than 3:1; 36" if placed underwater or on soft, yielding ground which, in the opinion of the engineer, ruts excessively under construction traffic; 12" when used to cover structural joints or drain pipes; and equal to the trench width, when used to line drainage trenches unless otherwise shown on the plans.

286.3.2.2 Strips installed horizontally on slopes shall be overlapped upslope over downslope. Strips placed transverse to channel slopes shall be overlapped in the direction of flow. If a preformed "sock" is not used to cover pipe embedded in sand, the pipe shall be wrapped one and one-half times, tied or otherwise secured at intervals as required to maintain the integrity of the overlap and laid in the trench with the exposed lap end oriented toward the bottom of the trench.

286.3.2.3 Fill placement and spreading on geotextile shall not be performed against the direction of geotextile overlap.

286.3.3 Traffic shall not operate directly on uncovered geotextile. Sudden stops, starts and turning motions shall be kept to a minimum unless at least two lifts of overfill

are in place. Unless otherwise specified, the initial lift of overfill shall not be less than 8 inches, loose measurement, in thickness or twice the maximum particle size, whichever is greater.

286.3.4 Damaged or punctured geotextile shall be replaced or patched to the satisfaction of the engineer. Patches may be sewn or overlapped. Unsewn patch overlaps beyond the area of damage shall exceed roll overlap requirements of this section by at least 12 inches.

286.3.5 Type 3 (Erosion Control) geotextile shall be protected from damage due to the placement of large rock by limiting the height of drop of the material to no greater than three feet. In addition, if a Class B geotextile is used, either a cushioning layer of sand shall be placed on top of the geotextile or a zero drop height shall be utilized to place the rock. Regardless of the required placement technique, the contractor shall demonstrate that the placement technique will prevent damage to the geotextile. Placement of material shall begin at the toe and proceed up the slope.

286.3.6 When placed behind wall panels or facing elements, geotextile shall be installed and secured in a manner proposed by the contractor and approved by the engineer such that migration of fines is controlled while allowing free drainage.

286.3.7 Drainage trenches to be lined with Type 1 (Subsurface Drainage) geotextile shall be prepared with smooth sides and bottoms. The geotextile shall be placed to conform loosely to the shape of the trench and laid back on either side of the trench to allow for placement of aggregate backfill and pipe. Backfill compaction shall be done in a manner to prevent damage to the geotextile. After compaction, the geotextile shall be lapped over the completed installation trench width or as shown on the plans.

286.3.8 The U. S. Standard sieve number corresponding to the apparent opening size (AOS) shall not exceed 100 for geotextile used in contact with any soil with more than 50 percent passing the No. 200 sieve, nor shall it exceed 70 when used between any two dissimilar granular material, less than 50 percent passing the No. 200 sieve, or to control movement of fines from a granular backfill through structural joints or into a drain pipe.

286.3.9 During shipment and storage, geotextiles shall be protected from direct sunlight, ultra-violet rays, temperatures greater than 140 F, mud, dust and debris.

SECTION 287

EROSION CONTROL BLANKET

287.1 **Description** - This work shall consist of furnishing and placing erosion control blankets at locations shown on the plans or as designated by the engineer.

287.2 **Material**

287.2.1 **Blanket** - Blanket shall consist of North American Green SC150 or equal approved by the Engineer

287.2.2 **Material Composition**

Top Net	Heavyweight UV stabilized polypropylene 3 lbs/1000 sq ft approximate weight
Straw/Coconut	70% straw at 0.35 lbs/sq yd
Matrix	30% coconut at 0.15 lbs/sq yd
Bottom Net	Lightweight photodegradable polypropylene 1.64 lbs/1000 sq ft approximate weight
Thread	Degradable

287.2.3 **Roll Specifications**

Width	6.67 ft
Length	108.00 ft
Weight	40.00 lbs ± 10%
Area	80.00 yds ²
Stitch Spacing	1.50 inches

287.3 **Installation** - Blankets shall be installed as per the manufacturer's instructions and shall use materials specified by the manufacturer and approved by the Engineer.

SECTION 288

STREET SIGNS AND POSTS

- 288.1 **Description** - This specification contains materials required for Street ID / Name Signs installation in the City of Ashland.
- 288.2 **Regulatory Signs** – Warrants and Placement shall be made consistent with the Boone County Traffic Manual, July 2002, or the “Manual on Uniform Traffic Control Devices – Millennium Edition” (MUTCD).
- 288.3 **Street ID / Name Signs** – Placement shall be consistent with **Section 2.8** of the Boone County Traffic Manual, July 2002.
- 288.4 **Street ID / Name Sign Mounting** – All Street Name Signs shall be mounted on Uni-Strut type posts with two (2) one (1) sided sign blanks mounted on opposite sides of the post. At least two (2) spacers shall be used per two (2) blanks. The signs must be riveted to the post.
- 288.5 **Street ID / Name Sign Blanks** – Blanks shall be 0.135” thick X 10” or 13” Green Fiberglass FRP.
- 288.6 **Lettering** - Street ID / Name signs shall have reflective white lettering, engineering grade, on a green background.
- 288.6.1 Street name signs for all private roads shall have non-reflective black lettering on a reflective white background. An informational placard stating “Private Road” shall have non-reflective black lettering on a reflective white background. **See Appendix B-1, Drawing 540.00.**
- 288.6.2 All numbers and letters shall conform to current industry standards for highway applications and also to specifications in the most current Manual for Uniform Traffic Control Devices (MUTCD). For local roads with a speed limit of 60 miles per hour or less, street name signs shall have six (6”) inch white reflective upper case- **See Appendix B-1, Drawing 540.00.**
- 288.6.3 For local roads with a speed limit of 60 miles per hour or greater, street name signs shall have nine (9”) inch white reflective upper case-letters, set three quarter (3/4”) inches above the bottom of the sign. **See Appendix B-1, Drawing 540.00.**
- 288.6.4 Any supplementary lettering that indicates the type of street, such as Street, Lane, Circle, Drive or Road, shall have a minimum height of three (3”) inches and shall be abbreviated as ST, LN, CIR, DR and RD. The street coordinates and directional letters (i.e. 2000 NE, 2000 SE, NW, etc.) shall be two (2”) inches in height and shall be three quarter (3/4”) inches above the top of the road name and a half (1/2”) inch from the top of the sign. The street coordinates

and directional letters shall be in the upper right hand corner or upper left and right corners if there are two (2) sets of street coordinates.

288.6.5 There is to be a minimum of five (5") inches and a maximum of six (6") inches between each word on multiple word roadway names.

288.7 **Sign Post Materials**

288.7.1 **U-Channel Post Material and Finish** - Steel U-Channel Posts shall conform to the standard specification for hot rolled carbon steel, structural quality, ASTM designation A570, Grade 50. Yield strength after cold-forming shall be 60,000 psi. minimum. Finish shall be a baked green enamel paint.

288.7.2 **Uni-Strut Post Shape** - The cross section of the post shall be square tube formed of 12 gauge steel material, carefully rolled to size and shall be welded directly in the corner by high frequency resistance welding and externally scarfed to agree with corner radii.

288.7.3 **Uni-Strut Telespar Post and 2-Piece Break-Away Material and Finish** - Post size shall be 1 3/4" x 1 3/4" square and anchor shall be 2" x 2" square x 3' in length. The post and break-away shall be manufactured from hot-dipped galvanized steel conforming to ASTM designation A653, Grade 50, Class 1. The corner weld shall be zinc coated after scarfing operations. The steel shall also be coated with a chromate conversion coating and a clear organic polymer topcoat. Both the interior and the exterior of the post and anchor shall be galvanized.

288.7.4 **U-Channel and Uni-Strut Telespar Post / 2-Piece Break-Away Hole Spacing** - Posts shall be manufactured with perforated holes 7/16 + or - 1/64 inches in diameter on 1-inch centers on all four (4) sides (one side on u-channel) down the entire length of the post. Holes shall be on centerline of each side in true alignment and opposite each other directly and diagonally.

288.7.5 **Length Tolerance** - The length of each post shall have a permissible length tolerance of 1/4" + / -.

288.7.6 **Telescoping Properties** - The finished post and anchor shall be straight and have a smooth, uniform finish. It shall be possible to telescope all consecutive sizes of square tubes freely and for not less than 10 feet of their length without the necessity of matching any particular face to any other face. All holes and ends shall be free from burrs and ends shall be cut square.