



ADDENDUM No. 2

Passenger Street Reconstruction CONTRACT NUMBER T-17-010-201

Item 1: Detailed Specifications Below:

Item 2: The Bid Opening Date has been extended. Separate sealed bids for furnishing all supervision, materials, labor, tools, equipment, and appliances necessary for the construction of the following described project, will be received by the City of Chattanooga at City Hall, Purchasing Department, Suite G13, located at 101 E. 11th Street, Chattanooga, TN 37402, until **2:00 p.m.**, local time, on **Tuesday, May 29, 2018**, and then at said place publicly opened and read aloud.

ITEM 1

COMMON EXCAVATION

1.01 SCOPE

Common Excavation shall consist of the removal, replacement and disposition of all materials except rock excavation to lines and grades shown on the Plans, including all construction methods and devices required to accomplish this work.

1.02 PREPARATION OF WORKSITE

(a) Preparatory to beginning of construction operations, the Contractor shall remove from the site all vegetable growth, trees, brush, stumps, roots, debris and other objectionable matter, including fences, buildings, and other structures shown on the Plans in the construction area as otherwise designated for removal. Disposal of such refuse material shall be made by the Contractor in a manner acceptable to the Engineer.

(b) Trees, brush, and other vegetable growth shall be cleared from the area. Stumps and roots shall be grubbed and removed to a depth not less than two feet below grade. All holes or cavities which extend below the subgrade elevation of the proposed work shall be filled with crushed rock or other suitable material, compacted to the same density as the surrounding material.

(c) The Contractor shall exercise special precautions for the protection and preservation of trees, mailboxes, shrubs, sod, fences, etc., situated within limits of the construction area but not directly within excavation limits. The Contractor shall be held liable for any damage his operations have inflicted on such property.

(d) Where sewers or structures are located in, near, or across stream-beds or drainage ditches, the Contractor shall be required to divert the stream or drainage and dewater the construction site as a part of this Item.

1.03 UNSUITABLE MATERIAL

(a) The determination of the suitability of material encountered below excavation limits shall be made by the Engineer after careful examination in the field.

(b) When such material has been identified as unsuitable, it shall be removed to the depth shown on Plans or as directed by Engineer and properly disposed of.

(c) Areas so excavated shall be backfilled in thin layers of crushed stone or other approved material, compacted by tamping to the density of the surrounding suitable material and to the lines and grades shown on Plans.

1.04 ROCKS AND BOULDERS

- (a) Rocks and/or boulders not classified as rock excavation shall be removed to the limits of excavation and grades shown on the Plans. The spaces created outside the excavation limits by such removal shall be backfilled with suitable material and compacted to the proper lines and grades.
- (b) The removal of such rocks and/or boulders shall be considered as earth excavation, although the Contractor may elect to remove same by drilling or blasting, in which case such operations shall comply with requirements set forth for drilling and blasting under Item 2, ROCK EXCAVATION.

1.05 DISPOSAL OF MATERIALS

- (a) All materials removed by excavation which are suitable for the purpose shall be used for backfilling pipe trenches, foundations and footings and for making embankment fills or for such other purposes as may be shown on the Plans. All materials not used for such purposes shall be considered as waste materials, and the disposal thereof shall be made by the Contractor in a manner and at locations approved by the Engineer.
- (b) Waste materials shall be spread in uniform layers and neatly leveled and shaped. Spoil banks shall be provided with sufficient and adequate openings to permit surface drainage of adjacent lands and left in a sightly condition.

1.06 SITE GRADING

Sites of all structures, roads and embankments shall be graded within the limits and to the elevations shown on the Plans. Grading operations shall be so conducted that materials shall not be removed or loosened beyond the required limits. The finished surfaces shall be left in smooth and uniform planes such as are normally obtainable from the use of hand tools. If the Contractor is able to obtain the required degree of evenness by means of mechanical equipment, he will not be required to use hand labor methods. Slopes and ditches shall be neatly trimmed and finished to slopes shown on the Plans unless otherwise approved by the Engineer.

1.07 STRUCTURAL EXCAVATION

Common excavation for structures shall not be greater in horizontal dimensions than those required between the outer surface of the structure and the walls of the adjacent excavation or of the sheeting used to protect it. The bottom of the excavation shall be true to the required shape and elevation shown on the Plans. No earth backfilling will be permitted under structures. If the Contractor excavates below elevation shown or specified, he shall fill the void made with Class B concrete at his/her own expense unless such excavation results from the provisions of paragraph 1.04.

1.08 TRENCH EXCAVATION

(a) Common excavation for pipe lines shall consist of the removal of materials necessary for the construction of water, sewer and other pipe lines and all appurtenant facilities including manholes, inlets, outlets, headwalls, collars, concrete saddles, piers, and pipe protection called for in the Plans.

Trench outline shall be scored through existing pavement for the width of pavement to be replaced before the trench excavation is started.

(b) Excavation for pipe lines shall be made to open cut, unless shown otherwise on the Plans. Trenches shall be cut true to lines and grades shown on the Plans or established by the Engineer on the ground. The banks of the trenches shall be cut in vertical, parallel planes equidistant from the pipe centerline. From an elevation twelve inches above top of the pipe to the bottom of the trench, the horizontal distance between vertical planes for different sizes of pipe shall not exceed those shown on the Plans. When sheeting is used, the width of the trench shall be considered as the distance between the inside faces of the sheeting. The bottom of the trench shall be cut carefully to required grade of the pipe except where bedding materials or cradles are shown, in which case the excavation shall extend to the bottom of the bedding or cradles as shown on the Plans. Minimum pipe cover shall be as shown on the Plans.

(c) The use of a motor-powered trenching machine will be permitted, but full responsibility for the preservation, replacement and/or repair of damage to any existing utility services and private property shall rest with the Contractor.

(d) Bell holes for bell and spigot pipe and/or mechanical joint pipe shall be excavated at proper intervals so the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes shall be large enough to permit proper installation of all joints in the pipe. Bell holes shall not be excavated more than ten joints ahead of pipe laying.

(e) Excavation for manholes, outlets, collars, saddles, piers and other pipe line structure shall conform to the requirements of paragraph 1.07, STRUCTURAL EXCAVATION.

(f) Pipe trenches shall not be excavated more than 400 feet in advance of pipe laying, and all work shall be performed to cause the least possible of inconvenience to the public. Adequate temporary bridges or crossings shall be constructed and maintained where required to permit uninterrupted vehicular and pedestrian traffic.

(g) Wherever pipe trenches are excavated below the elevation shown on the Plans, the Contractor, at his/her own expense, shall fill the void thus made with compacted, 3/4 inch or smaller, crushed stone, sand or concrete bedding materials.

(h) In cases where materials are deposited along open trenches, they shall be placed so that no damage will result to the work and to adjacent property in case of rain or other surface wash.

1.09 BORROW EXCAVATION

- (a) Where the backfill of excavated areas or the placement of embankments or other fills require specified materials not available at the site or material in excess of suitable material available from the authorized excavations, such materials shall be obtained from other sources. This may require the opening of borrow pits at points not immediately accessible to the work. In such cases, the Contractor shall make suitable arrangements with the Property Owner and shall pay all costs incidental to the borrowed material, including royalties, if any, for the use of materials. Before a borrow pit is opened, the quality and suitability of the material to be obtained therefrom shall be approved by the Engineer.
- (b) Borrow pits shall not be opened until the original surface has been cross-sectioned by the Engineer.
- (c) Borrow pits shall be excavated so that the remaining surface and slopes will conform to the applicable requirements of paragraph 1.06.
- (d) Borrow pits shall be properly cleared and grubbed in accordance with the applicable provisions of paragraph 1.02.

1.10 SHEETING, SHORING AND BRACING

- (a) The sidewalls of all excavations shall be sufficiently sheeted, shored and braced whenever necessary to prevent slides, cave-ins, settlement, or movement of the banks and to maintain the excavation clear of all obstructions. Wood or steel sheeting of approved design and type shall be used in wet, saturated or flowing ground. All sheeting, shoring and bracing shall have sufficient strength and rigidity to withstand the pressure exerted.
- (b) Excavation adjacent to existing or proposed buildings and structures or in paved streets or alleys shall be sheeted, shored or braced adequately to prevent undermining beneath or subsequent settlement of such structures or pavements. Underpinning of adjacent structures shall be done when necessary to maintain structures in safe condition. The Contractor shall be held liable for any damage resulting to such structures or pavements as a result of his/her operations.
- (c) Sheeting, shoring or bracing materials shall not be left-in-place unless otherwise shown on the Plans or ordered by the Engineer in writing. Such materials shall be removed in such manner that danger or damage will occur to new or existing structures or property. Trench sheeting shall be left-in-place until backfill has been brought to a level 12 inches above the top of the pipe. It shall then be cut off and the upper portion removed.
- (d) All holes and voids left in the work by the removal of sheeting, shoring or bracing shall be filled and thoroughly compacted.
- (e) All excavation shall be done in a manner to meet all State and Federal safety requirements.

1.11 BACKFILLING TRENCHES

- (a) The backfilling of sewer, water and other pipe line trenches shall be started immediately after the construction of same has been inspected and approved by the Engineer. Backfill material shall consist of fine, loose, earth containing optimum moisture content for thorough compaction. Material that is too dry for adequate compaction shall receive a prior admix of sufficient water to secure optimum moisture content. Material shall be free of large clods, stones, vegetable matter, debris and/or other objectionable material.
- (b) The pipe shall have a minimum of six inches of 3/8 inch crushed stone under it and be covered to a depth of at least twelve inches as shown on the drawings as a minimum for Class C bedding. Stone shall be tamped to provide a firm base and bedding for the pipe.
- (c) In traveled roadways and in sidewalk or driveway areas, backfill material shall be traffic bound stone as per Item 14, MINERAL AGGREGATE BASE, of these specifications. Fill material under haunches and around the structure shall be placed alternately in layers tamped to 6-inches on both sides of the pipe permitting thorough tamping. The fill is placed alternately to keep it at the same elevation on both sides of the structure at all times.
- (d) In all areas not affected by superimposed loads, trench backfill may be placed from the level 12 inches above the top of the pipe upward without compaction. At these places, backfill shall be neatly rounded over the trench to sufficient height to allow for settlement to grade after consolidation.
- (e) Trenches under concrete slabs and footing of structures shall be filled with dry sand or crushed stone and be tamped to 6-inch layers or filled with Class B concrete as shown on the Plans.
- (f) All backfilling shall be done in such a manner that the pipe or structure over or against which it is placed will not be disturbed or injured. Any pipe or structure injured, damaged or moved from its proper line or grade during backfilling operations shall be removed and replaced and/or repaired to the satisfaction of the Engineer and then re-backfilled.

Pavement scoring and trench backfill tamping may be done by equipment equal to Arrow Mobile Hydraulic Hammer. If the Contractor prefers to use this type equipment for trenches not over six feet in depth, the backfill may be compacted with this equipment as recommended by the manufacturer for the type of material being compacted in the backfill.

1.12 BACKFILLING AROUND STRUCTURES

Backfilling around structures shall be done by placing and tamping thinlayers of proper material for the full height to the finished grade.

1.13 FILL AND EMBANKMENTS

All fills and embankments constructed of earth material shall be consolidated to a degree of density equal to or greater than that of the material in its original state. The material shall conform to the requirements of paragraph 1.11 (a). It shall be placed in the fill or embankment in successive layers, each compacted to 6 inches are being approximately horizontal and extending to the full limit of the required cross-section, and shall be compacted or tamped as evenly and as densely as practicable by the use of suitable power tampers, rollers or hand tools over the entire surface. The process shall be repeated for each layer of material until the fill or embankment conforms to the plan lines, grades and cross-sections. The degree of compaction and moisture content required, the method of tamping and the equipment used shall be approved by the Engineer.

1.14 SLOPES

Open cut slopes shall be neatly trimmed and finished in accordance with all the requirements of paragraph 1.06.

1.15 TOPSOIL

(a) All areas to be sprigged or planted with trees, shrubs or grass as shown on the Plans shall be prepared by grading to a smooth, even surface to a level two inches (2") below the elevation of the finished grade shown on the Plans. It shall then be brought to neat and finished grade by the addition of two inches (2") of approved topsoil.

(b) Topsoil removed from the site of the work may be stockpiled and reused, or topsoil may be obtained from approved borrow areas. If obtained from borrow areas, the Contractor shall make suitable arrangements with the property owner and shall pay all costs incidental to the borrowed material including royalties.

1.16 MAINTENANCE

(a) All excavated and filled areas for structures, trenches, fills, topsoil areas, embankments and channels shall be maintained by the Contractor in good condition at all times until final acceptance by the Owner.

(b) The Contractor shall maintain trench backfill at the original ground surface by periodically adding specified backfill material as necessary or when directed by the Engineer. Such maintenance shall be continued until final acceptance of the project or until issuance of a written release by the Engineer.

(c) If trenches, embankments or backfills settle during the one-year guarantee period, Contractor shall add backfill material as required upon notification of the Owner.

(d) Trench backfill in streets and other areas where there is vehicular traffic shall be completed with six inches (6") of crushed stone as specified under Section 1.11, **BACKFILLING TRENCHES**. These trenches shall be maintained until approved for resurfacing.

1.17 DETERMINATION OF PAY QUANTITIES (IF APPLICABLE)

- (a) The volume of earth excavation for which payment will be allowed shall be expressed in cubic yards as computed from cut measurements.
- (b) Common excavation shall be computed by the average end-area method. All measurements shall be taken to the nearest 1/10 foot. Overcutting of slopes shall not be allowed for in the determination of pay quantities unless the excess materials thus produced were used as borrowed materials at the direction of the Engineer.
- (c) Common excavation for site grading, canal or channel changes, grading for access roads, and similar work where applicable and where shown on the Contract Plans, the allowable volume shall be based on cross-section measurements of the original surface and of the completed excavation.
- (d) For structural earth excavation, the allowable volume shall be based on the vertical centerline depth or on cross-section elevations from original ground level to the bottom levels of the structure elevations from horizontal dimensions but not to exceed one foot (1.0') in the clear outside the outer surface of the structure as shown on the drawings for the structural excavation payment limits. No allowance shall be made for overcutting nor for excavation below specified grade or below required elevations.
- (e) Except for trench excavation, where rock is encountered in any other type of excavation, and included in the total excavation computed, the allowable volume of rock excavation shall be deducted from the total volume of excavation allowed for payment in order to determine the net amount of earth excavation.
- (f) Trench excavation for sewers and other pipe lines and appurtenant facilities such as manholes, inlets, headwalls, collars, saddles, piers, and pipe protections or encasement shall be considered as incidental to the installation of any of the above facilities for which the trench excavation is made and shall not be included in the volume for common excavation.

1.18 PAYMENT (IF APPLICABLE)

The accepted quantities of items listed below will be paid for at the contract price per unit of measurement for each of the pay items that is listed on the Bid Schedule.

These amounts, so paid, shall cover the cost of furnishing all materials, labor, tools, plant equipment, services, and other expenses in connection with or incidental to common excavation, borrow excavation, structural excavation and sheeting left-in-place.

ITEM	DESCRIPTION	UNIT
1-1	Common Excavation	Cubic Yard
1-1a	Borrow Excavation	Cubic Yard
1-1b.1	Undercut Excavation	Cubic Yard
1-1b.2	Backfill for Undercut	Cubic Yard
1-1c	Structure Excavation	Cubic Yard
1-1d	Channel Excavation	Cubic Yard
1-1e	Sheeting Left-in-place	MBM
1-1f	Trench Cut	Cubic Yard
1-1g	Trench Backfill	Ton

END OF DOCUMENT

ITEM 3

CONCRETE

3.01 SCOPE

- (a) The work covered by this item shall consist of furnishing, erecting and removing concrete forms; furnishing, proportioning and mixing concrete ingredients; placing, curing and finishing plain and reinforced concrete masonry and all other work incidental thereto as required for the proper construction of the structures shown on the Plans or specified herein.
- (b) Steel reinforcement shall be incorporated in the concrete masonry as required on the Plans, but it shall be furnished, bent, set and placed in accordance with the provisions of Item 4 of these Specifications.

3.02 CLASSIFICATION AND DEFINITIONS

- (a) Concrete shall be either Class A or Class B, as indicated on the Plans. If the class is not otherwise indicated, the Contractor shall furnish Class A concrete.
- (b) In general, Class A concrete shall be used for reinforced concrete masonry cast-in-place in forms for piers, headwalls, tanks, walls, floors, manholes, pits and similar structures. Class B concrete shall be plain concrete and shall be used for pipe cradles, pipe protection, bedding, grade correction, anchors, collars, massive sections and similar work.
- (c) The purpose of this Specification is to obtain a dense concrete having not only the specified strength but also a mixture that will have the following characteristics: plasticity and cohesiveness to reduce the danger of honeycomb and porosity; a minimum water-cement ratio to reduce shrinkage and bleeding and for maximum water tightness and strength. The requirements herein as to aggregate grading and cement content are given as methods of obtaining the above mentioned characteristics. However, the Contractor may submit for approval other methods or modifications of the methods set forth herein for obtaining the desired results.

3.03 COMPOSITION

Concrete shall be composed of cement, fine aggregate, coarse aggregate, approved admixtures and water, so proportioned and mixed as to produce a plastic, workable mixture in accordance with all requirements under this item and suitable for the specific conditions of placement.

3.04 STRENGTH

Concrete ingredients shall be selected, proportioned and mixed in such a manner as will produce concrete which will develop the compressive strength stated below in 28 days, when tested in accordance with the producers set forth in the ASTM C 31, "Standard Method of Making and Curing Concrete Test Specimens in the Field", latest revision, and in ASTM "Standard Method of Test for Compressive Strength of Cylindrical Concrete Specimens", Serial Designation C 39, latest revision:

Class	Minimum Average 5 Consecutive Specimens	Minimum for Any One Specimen
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A	4000 pounds per sq. in.	3500 pounds per sq. in.
B	3000 pounds per sq. in.	2500 pounds per sq. in.

3.05 CEMENT

(a) Cement shall be standard Portland Cement or high-early strength Portland Cement, conforming to all of the requirements of ASTM "Standard Specifications for Portland Cement, Type I, Type II and Type III", Serial Designation C 150, latest revision. High-early Strength Portland Cement, Type III, shall be used only when specifically authorized by the Engineer. No cement of dark color shall be used.

(b) When weighed in the conventional manner, Portland Cement shall weigh not less than 94 pounds per standard sack.

(c) Unless otherwise specified as shown on the Plans, Type I, Portland Cement shall be used in all concrete.

3.06 FINE AGGREGATE

Fine aggregate shall be natural siliceous sand, consisting of hard, clean, strong, durable and uncoated particles, conforming to the requirements of ASTM "Standard Specifications for Concrete Aggregates", Serial Designation C 33, latest revision. The mortar strength developed in such test shall be 90 percent of that developed by standard Ottawa sand tested under identical conditions.

Fine aggregate shall have a fineness modulus of 2.40 minimum and 3.00 maximum. The fineness modulus shall not vary more than 0.10 plus or minus from the sample initially approved. The grading should be within the following limits of practicable:

Sieve No.	Cumulative % Retained
-----	-----
4	0 to 5
8	10 to 25
16	20 to 50
30	40 to 75
50	70 to 95
100	92 to 99

If the available sources of fine aggregate will not yield the above grading, the Engineer will approve modifications in the grading which do not adversely affect the work. However, no individual size should exceed 35 percent, and the amount passing the No. 50 sieve should be at least 15 percent.

3.07 COARSE AGGREGATE

- (a) Coarse aggregate shall consist of clean, natural, washed gravel or crushed stone suitably processed and conforming to the requirements of ASTM "Standard Specifications for Concrete Aggregate", Serial Designation C 33, latest revision.
- (b) Coarse aggregate as delivered to the mixing plant shall be graded, or individual sizes shall be so combined as to fall within the following limitations:

Percentage by Weight Passing Laboratory Sieves with Square Openings

Screen Size In Inches	2" Max. (No. 357)	1-1/2" Max. (No. 467)	1" Max. (No. 57)	3/4" Max. (No. 67)
-----	-----	-----	-----	-----
2-1/2	100	-	-	-
2	95-100	100	-	-
1-1/2	-	95-100	100	-
1	35-70	-	95-100	100
3/4	-	35-70	-	95-100
1/2	10-30	-	25-60	-
3/8	-	10-30	-	20-55
No. 4	0-5	0-5	0-10*	0-10*

* Not more than 5 percent shall pass No. 8 Sieve

- (b) Coarse aggregate which fails to pass the soundness test, as specified, shall be used only with the approval of the Engineer who may, at his/her option, order that the freezing-and-thawing tests be made.

- (d) Unless otherwise shown on the Plans or directed by the Engineer, the maximum size of aggregate shall not exceed:

1. One-fifth ($1/5$) the dimension of non-reinforced members.
2. Three-fourths ($3/4$) the clear spacing between reinforcing bars or between reinforcing bars and forms, or
3. One-third ($1/3$) the depth of non-reinforced slabs on ground.

3.08 WATER

Water used in mixing concrete shall be fresh, clean, potable water, free from injurious amounts of oil, acid, alkali, vegetable, sewage and/or organic matter. Water shall be considered as weighing 8.33 pounds per gallon.

3.09 ADMIXTURES

- (a) Except as herein specified, no curative or hardening admixtures shall be used.
- (b) An air entrainment agent capable of providing 3-6 percent air should be used.
- (c) A workable admixture of "Pozzolith", "WRDA" or "Plastiment" as manufactured by Master Builders Company, W. R. Grace and Company, and Sika Company, respectively, and approved proportions. When using "Pozzolith", "WRDA", or "Plastiment", an air entrainment agent shall be added in proper proportions to secure 3 percent-6 percent air.

3.10 STORAGE OF CONCRETE

- (a) Cement shall be shipped to the site of the mixer plant in bulk, paper or cloth bags, at the option of the Contractor. Upon arrival, it shall be stored immediately in a thoroughly dry, weather-tight and properly ventilated building with adequate provisions for the prevention of absorption of moisture. It shall be stored in a manner that will permit easy access for inspection and identification of each shipment. Storage facilities shall be provided by and at the expense of the Contractor and approved by the Engineer prior to arrival of the first shipment.
- (b) Sand and coarse aggregates shall be stored in separate stockpiles at points selected to provide maximum drainage and to prevent the inclusion of any foreign material during rehandling. Stockpiles of coarse aggregates shall be built in horizontal layers to avoid segregation and breakage. Where concrete volumes require batching or various aggregate sizes, a separate stockpile for each size shall be maintained.

3.11 SAMPLING AND TESTING CEMENT AND AGGREGATES

- (a) The Contractor shall determine the source, kind and quality of the cement and aggregates to be used in the work well in advance of the time scheduled for starting work and shall submit such information to the Engineer for approval before starting concrete operations.
- (b) The cost of testing cement and aggregates shall be borne by the Contractor. Certified test reports and certificates shall be submitted in duplicate to the Engineer and to such other agencies or persons as he may designate. Reports or certificates indicating compliance of any shipment of cement or aggregate shall be placed in the hands of the Engineer prior to use of such materials.
- (c) Where reputable cement and aggregate suppliers maintain regular recognized testing services, certified copies of such tests will be accepted by the Engineer. However, in any case of doubt as to the accuracy and/or adequacy of such tests, the Engineer may require that cement and aggregates be tested by a recognized commercial testing laboratory which has been selected by the Contractor and approved by the Engineer. The testing laboratory shall then test the cement and aggregates and prepare written reports showing the results of such tests on each shipment. The laboratory shall also certify that the materials covered by the report comply in all respects with these Specifications. In general, cement and aggregates shall be tested at the mill, but if untested shipments require sampling and testing after arrival at the site of the work, the Contractor shall be fully responsible for delays in the progress of the work due to delays in testing and reporting.
- (d) No cement or aggregate which fails to meet the requirements shall be incorporated into the work. In case of emergency, the Engineer may authorize the use of specific lots of cement which have satisfactorily passed the soundness test and the 7-day strength test only.

3.12 PROPORTIONING

- (a) Concrete materials shall be proportioned by weight to produce a workable mixture in which the water content and slump shall not exceed the maximum herein specified and the volume of cement shall not be less than herein specified.
- (b) The exact proportions of concrete ingredients within the limits herein specified shall be varied to conform to the varying quality of the ingredients. The Contractor shall provide all equipment necessary to determine positively and to control the actual amounts of all materials entering into the concrete. The proportions shall be changed whenever such changes become necessary to obtain the specified and desired workability, density, strength and uniformity. The Contractor shall not be compensated for any such changes unless they involve the use of cement in excess of the maximum specified herein.
- (c) Materials shall be measured by weight. The types of equipment and methods used for measuring material shall be subject to the approval of the Engineer.

(d) The following water-cement ratios with proper proportioning of aggregate and with approved admixture shall be used to obtain concrete meeting these specifications.

WATER-CEMENT RATIO TABLE FOR CLASS A CONCRETE

	Aggregate Size			
	2" Max.	1-1/2" Max.	1" Max.	3/4" Max.
Min. cement per CY of concrete	5.3 CF	5.8 CF	6.2 CF	6.6 CF
Max. water-cement ratio by weight	0.49	0.49	0.49	0.49
Max. water per CF of cement	5.5 Gals.	5.5 Gals.	5.5 Gals.	5.5 Gals.

WATER-CEMENT RATIO TABLE FOR CLASS B CONCRETE

	Aggregate Size			
	2" Max.	1-1/2" Max.	1" Max.	3/4" Max.
Min. cement per CY of concrete	5.0 CF	5.5 CF	5.9 CF	6.3 CF
Max. water-cement ratio by weight	0.62	0.62	0.62	0.62
Max. water per CF of cement	7.0 Gals.	7.0 Gals.	7.0 Gals.	7.0 ls.

The amount of moisture carried on the surface of the coarse aggregate and sand particles shall be included in the calculations for the water content of each mix. The amount of water and cement used shall be the minimum amount necessary to produce a plastic mixture of the specified strength and of the desired workability. In general, the slump shall be between 1-1/2 inches and 4 inches, and in no case shall it be more than 5 inches, when determined in accordance with ASTM "Standard Test Method for Slump Test of Portland Cement Concrete", Serial Designation C 143, latest revision.

The total volume of aggregate to be used in each cubic yard of concrete shall be determined by recognized standards for designing concrete mixes, utilizing the actual screen analysis of the aggregates.

Maximum size of aggregate in concrete for various portions of the work shall be designated by the Engineer based on thickness of section and clearance of reinforcement.

3.13 MIXING AND TRANSPORTING CONCRETE

(a) Concrete shall be mixed by one of three alternate methods, namely:

1. By the operation of one or more batch-type mixing plants, each with a rated capacity of 1/2 cubic yard or more, installed at the site of work
2. By the operation of a proportioning plant installed in the vicinity of the work and the use of transit mixers for mixing concrete and transporting it to the forms
3. By the use of ready-mixed concrete from a central mixing and proportioning plant.

The method selected by the contractor shall be subject to the approval of the Engineer.

(c) The mixing and proportioning plants shall be provided with adequate equipment and facilities for accurate measurement and control of the quantities of material and water used in the concrete, and for readily changing and proportions to conform to the varying conditions and requirements of the work.

(d) If ready-mixed concrete is to be used in lieu of concrete mixed on the site of the work, materials shall conform to requirements of paragraphs 3.05 through 3.09, inclusive, of these Specifications. Proportioning, mixing and transportation of concrete to the forms and the transit or truck mixers and operation of same all shall be in strict conformity with the requirements of the ASTM "Standard Specification for Ready-Mixed Concrete", Serial Designation C 94, latest revision.

(e) Stationary mixers shall be in accordance with the Concrete Mixer Standards adopted by the Mixer Manufacturer's Bureau of the Associated General Contractors of America. The mixer shall be rotated at the rate recommended by the manufacturer. The mixing time shall be as follows:

Capacity of Mixer	Time
-----	-----
1/2 cubic yard or less	1-1/4 minutes
3/4 to 1-1/2 cubic yards	1-1/2 minutes
Larger than 1-1/2 cubic yards	2 minutes

The mixing time shall be measured from the time that all cement and aggregates and most of the water are in the mixer. Excessive over-mixing, requiring additional water to preserve the required consistency, will not be permitted.

(f) Chutes may be used to convey concrete only if the concrete slides without internal motion. Vertical drops shall not be greater than 5 feet. Pumped concrete is permissible. In general, concrete shall be positioned as close as possible to its final location to prevent segregation, and this should be accomplished by using bottom dump buckets wherever possible.

(g) If transit or truck mixers are used, the concrete shall be delivered to the forms and discharged from the hauling container within a period of one hour and thirty minutes after the introduction of water to the cement and aggregates, or the cement to the water and aggregates. During hot weather when the air temperature is above 90 degrees, the delivery time limit shall be reduced to forty-five minutes. Prolonged mixing, even at agitating speed, shall be avoided where feasible by stopping the mixer and then agitating intermittently. When concrete cannot be delivered to the forms within the time limit specified, a water-reducing retarder, such as Daratard, as manufactured by Grace Construction Materials; Chemtard, as manufactured by Chem-Masters Corporation; or Pozzolith Retarder, as manufactured by Master Builders Company, may be used subject to the permission and approval of the Engineer. Such use of a water-reducing retarder will be permitted only as necessary to supplement (not to replace) other acceptable hot weather procedures. The admixtures used shall not interfere with strength development and other properties of the concrete and provided this use is carefully controlled by the concrete supplier. Before any such admixture is permitted, it shall be tested with job site materials under job conditions to determine its compatibility with the other materials and its ability under these conditions to produce the desired properties.

3.14 CONCRETE PLACEMENT

(a) Concrete shall be placed before initial set has occurred and in no event after it has contained its water content for more than one hour and thirty minutes. To prevent separation of the mix, the concrete shall be deposited in batches by use of a crane and concrete bucket. The bucket shall be unloaded reasonably close to the concrete surface and limited to a free drop of not more than five feet (5'), unless otherwise authorized by the Engineer. The concrete shall be deposited in walls by means of prefabricated rectangular tremies, constructed in short sections and spaced not more than five feet (5') apart. Placing techniques shall be followed to insure there will be no cold joints or plastic shrinkage cracking.

(b) Unless otherwise specified, all concrete shall be placed upon clean, damp surfaces, free from water, and never upon soft mud, dry absorbent earth or rock, or upon fills that have not been subjected to approved tamping to provide ultimate settlement. No concrete pour shall be started until the condition of the form or place of pouring has been approved by the Engineer.

(c) After the concrete has been deposited, it shall be distributed over the entire area within the forms in horizontal layers not more than eighteen inches (18") thick. It shall be compacted and worked into all corners and angles and around reinforcement and embedded fixtures in a manner to fill all voids, prevent honeycombing against the forms and avoid segregation of coarse aggregate. This operation shall be performed by the use of spades and internal vibrators. The operation shall be continuous, and all concrete shall be in final position before initial set has started.

(d) Vibration shall be transmitted directly to the concrete and in no case shall revolve at not less than 7000 rpm. The intensity of vibration shall be sufficient to cause settlement of the concrete into place. The vibration shall be of sufficient duration to accomplish thorough compaction. Vibration shall be supplemented by spading by hand adjacent to the forms along exposed faces in order to secure smooth, dense, even surfaces. **VIBRATORS SHALL NOT BE USED TO TRANSPORT CONCRETE WITHIN THE FORMS.** Vibrators shall be kept in motion at all times to prevent excessive vibration in one spot.

(e) At least two (2) hours shall elapse between pouring of walls or columns and placement of concrete in beams or floor system supported thereon. Brackets, haunches and fillets shall be poured with the floor system.

(f) All top surfaces not covered by forms and which are not to be covered by additional concrete or backfill shall be carried slightly above grade and struck off by board finish.

(g) Freshly placed concrete shall be protected from wash by rain, flowing water, mud deposits and other injurious conditions. Concrete shall not be allowed to dry out from the time it is placed until the expiration of curing periods.

(h) Imperfect or damaged work, or any materials damaged before final acceptance shall be replaced by the Contractor in a manner that will not impair the adequacy, stability or appearance of the structure.

(i) Hot and cold weather placing of concrete shall conform to the latest edition of American Concrete Institute Standards, ACI 605 and ACI 306.

3.15 CURING AND PROTECTING CONCRETE

(a) In addition to the "Curing and Protecting Concrete" set forth in this section of the Specifications, walls (and decks where permitted by the Engineer) shall be cured by means of a spray of "Hydrocide", "Horncrete 30D" or "Kurex 30" curing compound containing a fugitive red dye as manufactured by L. Sonneborn Sons, Inc., W. R.

Grace and Company or Chem-Masters Corp., respectively, or approved equal, with application being made in accordance with the manufacturer's instructions. Curing compound shall not be placed, used or permitted on the surfaces of construction joints.

- (a) If desired, the Contractor may cover the exposed surface of wall concrete, leaving the forms in-place and keeping the top and forms continually wet for fourteen (14) days. Construction joints shall be kept wet until the next pour is made or for fourteen (14) days.
- (b) Any method of keeping concrete surfaces damp that does not injure or discolor the visible surfaces, nor destroy the bond on surfaces to receive subsequent pours will be acceptable.
- (c) In cold weather, concrete shall be mixed and placed only when the temperature is at thirty-five (35) degrees F. or above, unless specifically authorized by the Engineer, in which event all materials shall be heated in a manner approved by the Engineer. In freezing weather, suitable means shall be provided for maintaining the concrete at a temperature of at least fifty (50) degrees F. for a period of not less than seventy-two (72) hours after placing, or until the concrete has thoroughly hardened. Salt, chemicals or other foreign materials shall not be mixed with the concrete for the purpose of preventing freezing.

3.16 FORMS

- (a) Forms shall be of wood, steel or other approved material that will give smooth unmarked finish. Unless otherwise specifically authorized, the sheeting for wood forms shall be tongue-and-groove lumber or plywood of sufficient thickness to secure desired rigidity.
- (b) Forms shall be built true and conform to lines and grades shown on the Plans and shall be cement mortar tight and sufficiently rigid to prevent displacement. Form surfaces shall be smooth and free from irregularities, dents, sags or holes. Bolts and rods used for internal ties shall be arranged so that when the forms are removed, no metal will be less than two inches (2") from any concrete surface. Forms shall be constructed so that they can be removed without hammering or prying against the concrete. Wire ties shall not be used. Through-form rods in walls shall be fitted with washers wedged to the rods as water stops. At least one side of a form shall be open above the construction joint to which a pour is about to be made.
- (c) Unlined forms shall be coated with a non-staining mineral oil that shall be applied shortly before the concrete is to be placed. Forms for unfinished surfaces may be thoroughly wetted in lieu of oiling, immediately before the placing of concrete, except that in freezing weather oil shall be used.
- (d) All salient corners of beams, slabs, columns and walls shall be provided with a one inch by one inch (1" x 1", 1.4" on the diagonal) chamfer formed by wood or metal strips.

(e) Forms shall not be removed without the approval of the Engineer. Removal shall be accomplished in a manner that will prevent injury to the concrete. In general and under average conditions, the Engineer will approve removal of forms as follows:

Slabs	14 days
Monolithic Pipe	7 days
Columns	7 days
Walls	2 days
Other Concrete	2 days

3.17 FINISH

(a) All permanently exposed surfaces shall be expected to be smooth and of uniform texture and appearance. All holes, pits or imperfections in the surface of the concrete shall be cleaned with a wire brush, thoroughly wetted and completely filled with a damp cement mortar composed of one part cement to 2 parts concrete sand. The entire surface shall be left smooth, and all lines or markings shall be smoothed over to obtain uniform appearance. In the event the Contractor fails to obtain a satisfactory appearance of the concrete in the opinion of the Engineer, the entire surface shall be thoroughly wetted down, kept wet continuously and rubbed with a No. 20 Carborundum stone until all lines, markings and surplus materials have been removed from the surface and until the surface shows a uniform smooth finish. After rubbing is completed, the concrete surface shall be washed clean with water. Rubbing may be done either by hand or with power tools.

(b) No special concrete or cement mortar topping course shall be used for slab finish unless so shown on the Plans. The base slabs shall be brought to a true and even finish by power or hand floating. Where a trowel finish is shown on the Plans, it shall be made with steel trowels in such a manner as to produce a dense, smooth, impervious surface, free from blemishes. Care shall be taken that no excess water is present when the finish is made. All permanently exposed edges shall be chamfered with 3/4 inch approved edging tool unless other treatment is indicated on the Plans. All slabs shall be finished carefully to the true surfaces shown on the Plans so no water can stand on the surface.

3.18 CONSTRUCTION JOINTS

(a) Joints, either vertical or horizontal, shall be made only at the locations indicated on the Plans unless permitted by the Engineer and then only at places designated by him/her. Water stops of type and size shall be used at locations shown on the Drawings or as directed by the Engineer.

(b) Keys shall be 1/3 the width of the walls in width and 1/16 the width of the walls in depth. All keys shall be continuous, and none shall be smaller than four inches (4") in width and two inches (2") in depth.

(c) A jet of air and water shall be applied to the surface of the horizontal construction joints to remove all laitance when the concrete has set sufficiently for the jet to expose the course aggregate without loosening same. Immediately prior to placing another lift, the surface shall be thoroughly cleaned and washed by water jet, followed by air jet, to remove standing water. The surface shall then be covered with a 1/2 inch thick layer of 1:3 cement/sand mortar evenly distributed and of the same water/cement ratio as the concrete to follow. No vertical construction joints in walls shall be used except by special permission.

3.19 EXPANSION AND CONTRACTION JOINTS AND WATER STOPS

- (a) Expansion and contraction joints and water stops shall be constructed where shown on Plans. They shall be of type and detail indicated on the Plans.
- (b) Expansion joint materials and water stops shall conform to the requirements of Item 25 of these Specifications.

3.20 WATERTIGHT STRUCTURES

It is the intention of these Specifications to provide impervious concrete. All pits below groundwater level and all structures for holding or carrying water must be watertight. A loss of not more than 1/4 inch depth in 24 hours will be permitted when water-holding structures are filled. All exposed surfaces of water-holding structures and interior surfaces of pits below groundwater level shall be free from visible damp spots or seepage before acceptance.

3.21 EMBEDDED ITEMS

- (a) Wherever steel, wrought or cast iron pipe, fittings, appurtenances and fixtures, equipment anchorage's or castings are shown for embedment in the concrete, such items must be on hand before concrete is poured. They shall be set in place accurately and firmly braced before concrete is poured around them. **NO CUTOUTS FOR FUTURE INSTALLATION OF THESE ITEMS SHALL BE PERMITTED.**
- (b) Before placing concrete, the Contractor shall see that all embedded parts are firmly and securely fastened in-place as indicated. They shall be thoroughly clean and free from any coating, rust, scale, oil or other foreign matter. The embedding of wood in concrete shall be avoided whenever possible. If wood is allowed, it shall be thoroughly wetted before the concrete is placed.

3.22 WATERPROOFING

- (a) The use of special admixtures or integral waterproofing compounds for concrete required to be watertight is not required, but may be permitted, provided the materials and methods used are approved in writing by the Engineer.
- (b) Membrane waterproofing shall be applied to all unexposed exterior surfaces of all buildings and structures where indicated on the Plans except where concrete is poured against the neat lines of rock excavation without forms.
- (c) Pitch shall conform to the requirements of ASTM, "Standard Specification for Coal-Tar Pitch for Roofing, Damp-proofing, and Waterproofing", Serial Designation D 450. Open-mesh, tar-saturated, waterproofing cotton fabric shall conform to the requirements of ASTM, "Standard Specification for Woven Cotton Fabrics Saturated with Bituminous Substances for Use in Water-proofing", Serial Designation D 173.
- (d) All surfaces on which the waterproofing is to be applied shall be firm, smooth, dry and free from loose material. The entire surface to be waterproofed shall be given a uniform priming coat of coal tar primer. Then a coat of hot pitch shall be applied to the surface and while still hot and starting at the bottom, a layer of tarred cotton fabric shall be embedded into it running horizontally. Successive coatings of hot pitch and cotton fabric shall be applied until there are five (5) coatings of pitch and four (4) layers of fabric. Each layer of fabric shall be thoroughly worked into the hot pitch to prevent wrinkles, buckles, pockets or blisters. Vertical laps shall be four (4) inches. Horizontal laps shall be $\frac{3}{4}$ the width of fabric plus $\frac{1}{2}$ inch. Not less than 150 pounds of pitch shall be used per 100 square feet of completed surface, and the pitch shall not be heated above 350 degrees F.
- (e) At salient corners, two (2) extra layers of fabric and pitch extending one foot (1') on each side of the corner shall be applied.
- (f) No waterproofing shall be applied in wet weather or when the air temperature is below 40 degrees F. unless vertical surfaces are heated and completely dried by salamanders and horizontal surfaces are heated for two hours with a two-inch (2") layer of hot sand.
- (g) Where waterproofing is punctured by drains, pipes, etc., suitable provisions shall be made to prevent getting behind the waterproofing and between it and the surface being waterproofed.
- (h) The waterproofing shall be protected by backfilling immediately after completion. Care shall be exercised not to puncture the membrane during backfill operations.

3.23 VAPOR BARRIER

Vapor barriers shall be installed under concrete slabs on ground where shown on the Drawings or as directed by the Engineer. Vapor barriers shall be constructed of .006 inch (6 Mil.) polyethylene sheets placed on a cushion of fine aggregate meeting the requirements of section 3.06. All joints in polyethylene sheets shall be lapped eighteen inches (18") and taped.

3.24 TESTING CONCRETE

(a) Before any concrete is poured, the Contractor shall prepare and submit preliminary mix designs for approval for each class of concrete specified. Tests shall be made in accordance with ASTM "Standard Method of Tests for Compressive Strength of Cylindrical Concrete Specimen", Serial Designation C 39, to determine the proper mixes of cement, sand, coarse aggregate and water-cement ratios to be used in connection with furnishing concrete for this project. Tests for the proposed mixes shall consist of making and breaking 9 standard cylinders for each mix, three (3) of which shall be broken at seven (7) days of age, three (3) more shall be broken at fourteen (14) days of age, and the last three (3) shall be broken at twenty-eight (28) days of age. The results of these tests shall be furnished to the Engineer in triplicate, and on completion of these tests, curves shall be prepared showing the strength of the concrete at the various ages. No separate payment will be made for furnishing concrete mix designs. All sampling, testing, making and breaking cylinders, etc., required for concrete mix design shall be done by the Contractor at his/her expense.

(b) During the progress of the work, slump tests and compression test cylinders shall be taken and cylinders broken in accordance with ASTM, "Standard Method of Making and Curing Concrete Test Specimens in the Field", Serial Designation C 31, latest revision, and "Standard Test Method for Slump or Portland Cement concrete", Serial Designation C 143, latest revision. Each test shall consist of four (4) test cylinders, two (2) to be broken in seven (7) days of age, two (2) to be broken at twenty-eight (28) days of age. Mixes shall be subject to laboratory control and inspection at the mixer plant, and cylinders will be taken at the place of concrete placement.

(c) The minimum number of specimens or cylinders to be taken is:

Structural pours	1 to 4 Cubic Yards	4 Cylinders
Any pours	4 to 100 Cubic Yards	4 Cylinders
Any pours	101 to 200 Cubic Yards	8 Cylinders
Any pours	201 to 300 Cubic Yards	12 Cylinders
Any pours over 300 Cubic Yards-4 Cylinders per 100 Cubic Yards		

(c) All testing and all concrete laboratory inspection, sampling and testing throughout the work shall be done by an approved independent testing laboratory and paid for by the Owner.

However, all the materials and concrete for the mix design and concrete for all test cylinders taken during the progress of the work shall be furnished by the Contractor at his expense. All other materials for testing concrete placed in the work shall be furnished by the laboratory making the concrete tests.

3.25 MEASUREMENT AND PAYMENT (IF APPLICABLE)

(a) Except for concrete sidewalks, paving and concrete for manholes, railroad and highway crossings, etc., payment for which is provided elsewhere for these items of work, payment for Class A and Class B concrete shall be made for the quantities placed at the unit prices bid per cubic yard under Item 3 in the Bid Schedule. These amounts, so paid, shall cover the cost of furnishing all labor, materials, equipment, tools, plant services and other expenses in connection with or incidental to the concrete work.

(b) The volumes of each class of concrete for which payment will be allowed shall be expressed in cubic yards as computed from the dimensions of the neat lines shown on the Plans. Where concrete masonry for which specific dimensions are not given on the Plans has been placed under the direction of the Engineer, the volume shall be determined by the Engineer from field measurements.

(c) The volumes allowed for payment shall include only the items of concrete placed in accordance with these Specifications and accepted by the Engineer. No deductions will be made for pipe or conduit runs 3 inches or less or for individual cavities or embedded pieces less than one (1) cubic foot each or for reinforcement.

END OF DOCUMENT

ITEM 4

CONCRETE REINFORCEMENT

4.01 SCOPE

The work covered by this item shall consist of furnishing, bending, placing and tying all steel reinforcement including reinforcing bars, mesh or fabric, dowels and structural steel shapes embedded in the concrete.

4.02 MATERIAL

(a) Reinforcement bars shall conform to the latest requirements of ASTM "Standard Specifications for Deformed Billet Steel Bars for Concrete Reinforcement", Serial Designation A 615. Unless otherwise shown on the Plans, all bars shall be Grade 60.

(b) Steel mesh reinforcement shall be electrically welded, cold drawn, mild steel fabric conforming to the latest requirements of ASTM "Standard Specifications for Welded Steel Wire Fabric for Concrete Reinforcement", Serial Designation A 185.

4.08 TESTS AND SHOP DRAWINGS

(a) Prior to placing any steel reinforcement, written evidence that such steel has been tested and is in conformity with these Specifications must be in the hands of the Engineer. Certified copies of mill tests may be considered evidence of compliance provided such tests as customarily made under satisfactory conditions by responsible personnel and with adequate equipment. In case of doubt, the Engineer may require additional tests by an independent testing laboratory upon mill samples or upon the finished bars as furnished.

(b) Complete detailed shop drawings, bending diagrams and schedules of the steel to be used shall be submitted by the Contractor to the Engineer for review and approval prior to fabrication of the steel. Only steel meeting specification requirements and fabricated in accordance with approved shop drawings shall be used. A minimum of six (6) copies of drawings, diagrams and schedules will be required for approval.

4.04 PLACEMENT

(a) On delivery to the site of the work, the steel reinforcement shall be carefully bundled, tagged and stored so the bars for any position in the work may be readily identified. All reinforcing steel shall be stored on timber mats or other approved material covering the ground.

(b) Before being placed in position, all steel reinforcement shall be thoroughly cleaned of oil, mill and rust scale, dirt and other coatings that would tend to destroy or reduce the bond. Where there has been a delay in depositing concrete after the reinforcement has been placed, the reinforcement shall be re-inspected and re-cleaned if necessary.

(c) Reinforcement shall be accurately positioned and tied at intersections with annealed or similar wire, No. 18 gage or heavier, or suitable approved clips. Reinforcement shall be supported by concrete or metal chairs, stays, spacers, hangers or other approved supports which shall have sufficient strength and stability to maintain the reinforcement in place throughout concreting operations.

(d) When concrete in footings or other principal structural members is in contact with the ground, reinforcement shall be protected by not less than three inches (3") of concrete. If formed concrete surfaces, after removal of the forms, are exposed to the weather, the reinforcement shall be protected by not less than two inches (2") of concrete. Unless shown otherwise on the Plans, the protective covering of concrete for reinforcement at surfaces not exposed directly to the ground or weather shall be not less than the following:

Slabs	1 inch
Floors, walkways, driveways	1-1/2 inches
Walls less than 12 inches thick	1-1/2 inches
Walls 12 inches or more in thickness	2 inches
Beams and girders-stirrup steel	1-1/2 inches
Beams and girders-main reinforcement	2 inches
Columns	2 inches

(e) The minimum distance between parallel bars shall be as shown on Plans.

(f) Unless otherwise noted on the Plans, rods shall be lapped not less than 24 diameters where splicing is necessary, and splices shall be staggered. In all cases the lapped connection shall be sufficient to transfer the full stress between bars by bond and shear and to develop the full strength of the rods. In slabs, beams and girders, no splices shall be made at point of maximum moment, and in no case shall adjacent bars be spliced at the same place.

(g) Supports and ties shall not be exposed at the face of the concrete, nor shall they discolor the surface of the finished concrete. Reinforcement which has been exposed for bonding with future work shall be protected from corrosion by heavy wrappings of burlap saturated with a bituminous material.

(h) Movement of steel reinforcement in-place during concrete operations shall be prevented. Any rods which are displaced shall be restored to proper position before they are completely covered.

4.05 MEASUREMENT AND PAYMENT (IF APPLICABLE)

(a) Except for reinforcing steel specified to be included in structures or facilities paid for per lump sum or per structure as set forth in the Bid Schedule, payment for reinforcing steel placing in connection with the work shall be made at the unit price per pound of reinforcing steel placed in accordance with the Plans or as directed by the Engineer as bid in the Bid Schedule.

(b) Determination of quantities will be made by the Engineer and shall be expressed in pounds of calculated weights as determined from Standard Bar Handbook listings. No allowance shall be made for weight of clips, ties, spacers or other fastening devices.

(c) Welded wire fabric reinforcement shall be measured in square feet of the size and gage specified. Welded wire fabric reinforcement shall be paid for at the unit price per square foot as listed in the Bid Schedule. Such payment shall include all necessary labor, materials, and appurtenances required.

END OF DOCUMENT

ITEM 5

PIPE SEWERS AND SERVICE LINES

5.01 SCOPE

(a) The work covered by this item shall consist of furnishing and laying sewer pipe, risers, service lines, and fittings as called for on the drawings and specified herein, including trench excavation and backfill.

(b) Service lines are those sewer lines from the tees in sewer system mains to the property line for all existing buildings and proposed buildings to be served by the system.

5.02 PIPE MATERIALS

(a) CLAY PIPE

Clay pipe and special fittings shall be bell and spigot, conforming to the latest requirements ASTM "Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated", Serial Designation C 700.

(b) CONCRETE PIPE

1. All concrete pipe and fittings 12 inches in diameter and larger shall be Reinforced Concrete Culvert, Storm Drain and Sewer Pipe conforming to the latest requirements of ASTM "Specification for Reinforced Concrete, Culvert, Storm Drain, and Sewer Pipe", Serial Designation C 76, except the minimum cement content of the concrete used in the manufacture of pipe 24 inches and smaller in diameter shall be 10 bags per cubic yard of concrete.

2. All pipe 12 inches in diameter and larger shall be Class IV unless otherwise called for. Wall thickness shall be in accordance with Table 4, Wall B, for sizes through 72 inches and Wall C for 78-inch and 84-inch sizes. Sizes larger than 84 inches shall be in accordance with the special design requirements of ASTM C 76. The pipe shall have bell and spigot joints or tongue & groove suitable for the use of a rubber gasket to be provided as a part of this item. Pipe shall be free from blisters, honeycomb, protruding marks on the inside of the pipe, and broken or chipped bells or spigots. On pre-bed or elliptical reinforced pipe, the pipe forms shall be constructed so that there will not be a form lap or joint in the bottom half of the pipe. On pipe with circular reinforcement, the pipe shall be laid so that any form marks on the inside of the pipe will be as close to the top of the pipe as possible.

3. Pipe shall have circumferential reinforcement as required for the particular class of pipe furnished. The bell of the joint shall contain circumferential and longitudinal

reinforcement. Reinforced concrete pipe shall be centrifugally cast or vibrated pre-bed, horizontally or vertically cast or made on a Packerhead machine and shall be furnished in lengths not more than sixteen feet (16') and not less than eight feet (8'), except where short lengths are required for construction conditions.

4. All concrete pipe less than twelve inches (12") in diameter shall be nonreinforced concrete pipe conforming to the latest ASTM "Specifications for Concrete Sewer, Storm Drain, and Culvert Pipe", Serial Designation C 14, except the minimum cement content of the concrete used in the manufacture of the pipe shall be 10 bags per cubic yard of concrete.

5. All pipe less than twelve inches (12") in diameter shall be Class 3 unless otherwise called for. The pipe shall have bell and spigot joints suitable for use with a rubber gasket to be provided as part of this item. The pipe shall be centrifugally cast or vibrated, horizontally or vertically cast or made on a Packerhead machine furnished in lengths of at least four feet (4'). Pipe shall be manufactured with machine bell pallets with a maximum slope in the bell of two degrees. The metal ring shall remain in the bell during the entire steam curing process of the pipe.

6. Each pipe shall be clearly marked as required by the standard specifications to show its class, date of manufacture, and the name or trademark of the manufacturer. Elliptical reinforced pipe shall be clearly marked top and bottom, and the minor axis clearly noted on the interior surface of the pipe.

(c) POLYVINYL CHLORIDE (PVC) PIPE

1. The pipe fittings shall be made from virgin Type I, Grade 1 Polyvinyl Chloride compounds with physical and chemical properties conforming to those defined and described in ASTM Serial Designation C 1784, "Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds."
2. The pipe shall be manufactured in accordance with the requirements of ASTM Serial Designation D 3033, "Specification Type PSP Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings" or ASTM Serial Designation D 3034, "Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings." The four-inch (4") diameter pipe for gravity sewers shall have an SDR (Standard Dimension Ratio) of 33.5. All other diameter pipe for gravity sewers shall have an SDR of 35.
3. The standard length of pipe provided under this specification shall be twenty feet (20'), with a minimum of ten feet (10'), except that all pipe used in service lines shall not exceed ten feet (10') unless otherwise approved by the Engineer.
4. Fittings shall be made in sizes and to the dimensions of standard pipe as shown above. If dimensions, structural design or materials from which they are manufactured vary from provisions of this specification, they must be approved by the Engineer.
5. Wyes, tees, bends and adapters and any other fittings required by the Engineer shall be provided. Plans for such fittings showing cross-sectional views with

dimensions shall be provided, and such plans and fittings shall be approved by the Engineer prior to their use. The materials used in the manufacture of fittings shall conform to the requirements for the pipe with which they will be used, and any variation of such requirements shall be subject to the approval of the Engineer.

6. Pipe shall be tested when requested by the Engineer, and all sizes of pipe so designated shall be tested in accordance with ASTM Serial Designation D 2412, "Test for External Loading Properties of Plastic Pipe by Parallel-Plate Loading."
7. Pipe shall be marked along the outside of the barrel in bold type and shall indicate the manufacturer's name, pipe size, PVC compound used, e.g., PVC Type 1, Grade 1, and the ASTM material specification for the PVC compound used, e.g., ASTM D 1734.
8. The type and fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions or other injurious defects. The pipe shall be as uniform as commercially practical in color, opacity, density and other physical properties.
9. The manufacturer shall provide multi-fin waterstops of a material conforming to ASTM Serial Designation C 443, "Specification for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets," acceptable to the Engineer, which shall be applied to the outside of plastic pipe when the pipe is to be enclosed in any structure where concrete or mortar is used which will prevent leakage along the outer wall of the barrel of the pipe.
10. No single piece of pipe shall be laid on any project covered by this specification unless it is found to be generally straight. Such pipe shall have a maximum ordinate as measured from the concave side of the pipe not to exceed 1/16 inch per foot of length. If the deviation from straightness exceeds this requirement, then the particular piece of pipe shall be rejected for use until it can comply with this provision.
11. PVC pipe provided under this specification shall be installed to meet the following deflection requirements:
 - a. The pipe shall have a deflection of no more than five percent (5%). Such deflection shall be computed by dividing the amount of deflection (nominal diameter minus the minimum diameter when measured) by the nominal diameter of the pipe. Sections with more than 5% deflection will be removed and replaced at the Contractor's expense.
 - b. After an initial inspection and if, in the opinion of the Engineer, the deflection may be excessive, he may order the Contractor to arrange for and take accurate measurements of the pipe at whatever intervals and at whatever locations between such adjacent manholes the Engineer deems advisable. Such measurements may be taken or ordered taken by the Engineer at any time during the maintenance period and such measurements shall be performed in a manner and by methods approved by the Engineer. The Engineer may require a go-no go type mandrel test with nine vane mandrel for deflection check.

c. All costs involved in taking measurements ordered by the Engineer following the initial inspection shall be borne by the Contractor.

(d) CAST IRON SOIL PIPE

1. Where service lines are exposed or will be covered with less than one foot of earth material over the top of the pipe, or where directed by the Engineer, cast iron pipe conforming to the requirements of "Specification for Cast Iron Soil Pipe and Fittings," Serial Designation ASTM A 74, shall be installed. Pipe shall be coal tar coated.

2. Ductile iron pipe may be substituted for cast iron soil pipe at the discretion of the Contractor.

(e) QUALITY ASSURANCE

1. Pipe and special fittings shall be furnished in sizes, types and classes at the locations shown on the plans.

2. All pipe and specials shall be inspected by an approved commercial testing laboratory prior to delivery. Each joint of pipe and each special shall be stenciled or otherwise marked with the laboratory's mark of acceptance.

3. Any pipe or specials which have been broken, cracked or otherwise damaged before or after delivery or which have failed to meet the required tests, shall be removed from the site of the work and shall not be used therein.

5.03 JOINT MATERIALS

(a) Vitrified clay pipe shall have compression type positive friction joints in accordance with the latest requirements of ASTM "Specification for Compression Joints for Vitrified Clay Pipe and Fittings," Serial Designation C 425, for Type I, II or III joints with lubricant as recommended by the manufacturer. The joint material shall be bonded to the pipe at the factory.

(b) Concrete pipe for storm and sanitary sewers shall have rubber gasket and mastic type bituminous joints.

1. Rubber gasket type joints shall conform to the applicable provisions of ASTM "Specification for Joints for Circular Concrete Sewer and Culvert Pipe Using Rubber Gaskets," Serial Designation C 443, and AWWA Standard Specifications, Serial Designation C 302, latest revisions. A groove shall be provided in the spigot end to receive the rubber gasket, and it shall be so formed that when the joint is complete, the gasket will be deformed to a near rectangular shape and confined on all four sides. All inside surfaces of the bell and outside surfaces of the spigot, on which the rubber gasket may bear during closure of the joint and at any degree of partial closure, shall be

parallel within one degree and have an angle of not more than two degrees with the longitudinal axis of the pipe. The gasket shall be capable of sealing the joint from either internal or external hydrostatic pressure.

2. Mastic type bituminous jointing compound when required shall be made from asphalt, liquefiers, mineral fillers and fibers and shall be free from moisture. The filler shall be such that it shall have position adhesion to pipe surfaces and shall be water, acid and alkali resistant. It shall be plastic and workable with a trowel and of a composition which will not result in a plastic flow of the material at temperatures up to eighty (80) degrees Fahrenheit. The bituminous jointing compound will not be required on pipe which is manufactured in the following manner:

- a. If smooth true metal rings are kept in the bell and on the spigot during the entire steam curing process of the pipe.
- b. If the pipe barrel is of minimum specified thickness to the end of the spigot.
- c. If the contact surfaces of the joint areas are smooth, free of all projections, air holes, irregularities and not patched or coated in any manner.

(c) PVC pipe joints shall be the bell and spigot type subject to the approval of the Engineer. Joints shall be sealed with a rubber O-ring gasket, and shall be of a composition and texture which is resistant to common ingredients of sewerage, industrial wastes including oils and groundwater, and which will endure permanently under the conditions likely to be imposed by this use. Installation of gasket shall be done in accordance with the pipe manufacturer's instructions using all the necessary materials, lubricants and equipment recommended by the manufacturer.

(d) Cast iron soil pipe shall have push-on joints with neoprene gaskets. Neoprene gaskets shall be in accordance with the requirements of ASTM Serial Designation C 564, "Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings."

(e) Lead joints will be permitted only where other "approved" type joints are not compatible (joining old pipe to new pipe, etc.). Lead shall be in accordance with the requirements of Federal Specification AA-L-156.

5.04 PIPE LAYING

(a) Excavation for the bottoms of the trenches and the backfill shall be prepared in three (3) classes of work, Class A, B, and C as shown on the contract drawings and to fit depths of trench, type of pipe, size of pipe, width of trench and bearing value of subgrade. The determination of the class shall be from actual width of trench, but payment therefor shall be made on class required for theoretical maximum allowable width. If Contractor increases width of trench for his convenience or due to collapse of trench walls so that a higher class of bedding is required, the increased cost of same shall be borne by the Contractor. If the bearing value of the subgrade requires special bedding methods, they

shall be as directed by the Engineer and paid for as made under his direction. Bedding shall be in accordance with the schedules and dimensions shown on the plans and shall be placed where shown on the plans or as directed by the Engineer.

(b) Before sewer pipe is placed in position in the trench, the bottom and sides of the trench shall be carefully prepared with bracing and sheeting installed where required. A Mason's line, supported at intervals not exceeding fifty feet (50'), shall be stretched tightly above ground level at a grade parallel to and directly above the axis line of the pipe. Each pipe shall be accurately placed to the exact line and grade called for on the plans by measuring down from this line to the invert of the pipe in place. The Contractor shall furnish all labor and materials necessary for erecting batter boards and establishing lines and grades therefor.

The Contractor may use the Laser Beam method of setting a line and grade for the sewer by using the Laser Beam coaxially through the center of the sewer being laid. The Laser Beam Projector is to be rigidly mounted to its support platforms, with a two-point suspension, or equivalent, assuring that all ground and equipment vibrations are kept to an absolute minimum. All equipment, including equipment necessary to control atmospheric conditions in the pipe to keep line and grade to acceptable standards of accuracy, shall be furnished by the Contractor. The Laser Beam system must be operated by competent experienced personnel who have been properly trained to operate the equipment used.

The Contractor shall stake check pegs at all manholes throughout the job. Check pegs midway between manholes and any other checkpoints deemed necessary to assure accuracy of the equipment shall be provided by the Contractor.

(c) Each piece of the pipe and special fitting shall be carefully inspected before it is placed, and no defective pipe shall be laid in the trench. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells uphill. No pipe shall be laid except in the presence of an inspector representing the Engineer. Trench bottoms found to be unsuitable for foundations after pipe laying operations have started shall be corrected and brought to exact line and grade with the approved compacted materials.

(d) Bell holes shall be of sufficient size to allow ample room for making the pipe joints properly. The bottom of the trench between bell holes shall be carefully graded so that the pipe barrel will rest on a solid foundation for its entire length as shown on the plans. Each joint shall be laid so that it will form a close concentric joint with adjoining pipe and in order to avoid sudden offsets or inequities in the flow lines.

(e) Water shall not be allowed to run or stand in the trench while pipe laying is in progress or before the joints are completely set or before the trench has been backfilled. The Contractor at no time shall open up more trench than his available pumping facilities are able to dewater. Where sewer pipelines are located in or across stream beds or drainage ditches, the Contractor shall divert the stream flow and dewater each section as the work progresses.

(f) No joints shall be made where pipe or joint materials have been soiled by earth in handling until such soiled surfaces are thoroughly cleaned by wire brushing and wiping until all traces of the earth are removed.

(g) As the work progresses, the interior of all pipe shall be kept thoroughly clean. After each line of pipe has been laid, it shall be carefully inspected, and all earth, trash, rags and other foreign matter shall be removed from the interior.

(h) Backfilling of trenches shall be started immediately after the pipe in place has been inspected and approved by the Engineer, and backfill shall be deposited and compacted as provided under Item 1, Common Excavation.

(i) Bedding for polyvinyl chloride (PVC) pipe sewers shall be in accordance with details shown on the contract drawings and to ASTM "Specification for Underground Installation of Flexible Thermoplastic Sewer Pipe," Serial Designation D 2321.

(j) Service Line Installation

1. Installation of service pipe shall conform to the appropriate requirements of main line sewers.

2. Connections to the main sewer shall be made with bends of the proper degree to make the service connection run perpendicular to the main sewer. Pipe shall be laid to a uniform line and grade. Minimum grade shall be one percent (1%).

3. The end of all service connections shall be plugged with a vitrified clay, concrete disc or PVC plug and sealed with plastic joint material. Other means of plugging shall be approved by the Engineer.

4. Crushed stone bedding and backfill material, concrete encasement and protection, etc., shall be provided as conditions required.

5. No service connections shall be covered until they have been inspected and located by the Engineer.

5.05 JOINT CONSTRUCTION

(a) Rubber Gasket Joint

1. Laying O-Ring Rubber Gasket Pipe shall be done in accordance with the pipe manufacturer's instructions, using all the necessary materials, lubricants and equipment recommended by the manufacturer.

2. Where wet conditions prevail, always use "Vreem" or a vegetable type shortening for lubrication. Never use "Flaxcap" in water.

(b) Rubber Gasket and Bituminous Joints

When required by Paragraph 5.03(b)2., joints between consecutive bell and spigot or tongue and groove pipe shall be made with a rubber gasket and compatible bituminous compound of a type recommended by the gasket manufacturer and shall be constructed as follows:

The gasket shall be fitted over the tongue or spigot of each pipe, the space behind the gasket filled with the bituminous compound on tongue and groove joints, and the pipe entered into the bell or groove and shoved home. The remainder of the joint space shall be filled with bituminous compound bevelled off with the outside of the pipe.

(c) Compression Type Joints

Compression type couplings on vitrified clay pipe shall be jointed in accordance with the pipe manufacturer's recommendations, using all the necessary materials, lubricants, adhesives and equipment as recommended by the manufacturer.

(d) Adapters approved by the Engineer shall be used wherever connections are made between pipes constructed of different sizes and types of materials.

(e) Defective joints discovered after laying shall be removed and replaced with new sections of pipe having undamaged joints. Defective pipes shall be removed and proper replacement made.

(f) All openings shall be closed with an approved type vitrified clay, concrete or PVC plug held securely in place. Dead ends of sewer lines shall be similarly stoppered.

5.06 TEES, WYES, RISERS AND PLUGGED STUBS

(a) Tee or wye branches shall be installed in the sewer lines at all places shown on the plans, specified herein or otherwise directed by the Engineer. Tee branches on pipe less than eighteen inches (18") in diameter shall be manufactured monolithically with the barrel.

(b) Riser connections, of the size and type shown on the plans, shall be installed at the locations shown on the plans or directed by the Engineer. A plastic film-marking tape five feet (5') long shall be placed twelve inches (12") over the top of each riser during backfilling to mark the location of the riser. The marking tape shall be heavy gauge polyethylene film (.004 inches thick). Tape shall be standard red color imprinted with the words "Warning - Buried Sewer Line Below." Tape shall be Allen Marking Tape No. AMT-1212 as manufactured by the Allen System, Inc., Glen Ellyn, Illinois. A second marking tape containing a metallic core which can be located with a metal detector shall be laid on top of the first marking tape. This tape shall be five feet (5') long and three inches (3") wide. Tape shall be Allen Detectotape Catalog No.ADT-1003 for buried sewer line as manufactured by the Allen System, Inc.

(c) Plugged pipe stubs for future connections to manholes and sewerage structures shall be installed where shown on the plans or directed by the Engineer. The pipe stubs shall be installed with the bell encased in the wall of the manhole and the bell of the opening flush with the outside wall of the manhole or structure.

(d) Plugged stubs and such branches of pipelines that are not to be used immediately shall be closed with clay, concrete or PVC stoppers held securely in place.

(e) Where specifically directed by the Engineer or shown on the drawings, connections to reinforced concrete pipe over eighteen inches (18") in diameter shall be made in accordance with details shown on the drawings.

5.07 CONNECTIONS

(a) If the work consists of the construction of sewer that is to replace an existing sewer, all of the existing service lines shall be kept in operation and connected to the new line.

(b) Connections shall be made to all existing sewer lines in the vicinity of the work by removing a section of the sewer from the existing line and inserting in the space a tee branch of the proper size, or by the construction of a manhole, regulator chamber or other structure as shown on the plans.

(c) Connections to existing manholes or inlets where no plugged stubs exist shall be made by cutting a hole in the wall of the existing structure, inserting a length of sewer into the hole, filling around same with concrete or mortar, and troweling the inside and outside surfaces of the joint to a neat finish. The bottom of the manhole shall be shaped to fit the invert of the sewer pipe as specified under "Manholes." PVC lines shall have water stops as shown on drawings.

(d) Connections to building services shall be made in a neat and work person-like manner. Clean out plugs shall be installed, whenever easible, by making the connection with a standard wye or tee.

5.08 EXISTING UTILITIES

(a) All existing sewers, water lines, gas lines, underground conduits, telephone lines, sidewalks, curbs, gutters, pavements, electric lines or other utilities or structures in the vicinity of the work shall be carefully protected by the Contractor from damage at all times. Here it is necessary for the proper accomplishment of the work to repair, remove and/or replace any such utility. The work shall be done under the provisions set forth in the "General Provisions." No separate payment shall be made for removing and replacing and/or repairing damaged existing sewers, water, gas, electric and telephone lines or conduits or other utilities, culverts, drains or conduits of similar existing services or structures. The removal, replacement and/or repair of these items shall be paid for in the unit price bid by the Contractor on other items or work. Similar repair and replacement of sidewalks, pavements, curbs, and gutters are provided elsewhere herein.

(b) Separation of Sewer or Water Lines and Culverts

1. Sewers shall be laid at least ten feet (10'), horizontally, from any existing or proposed water main. Should local conditions prevent a lateral separation of ten feet (10'), the sewer may be laid closer than ten feet (10') to a water main if it is laid in a separate trench, provided elevation of the top (crown) of the sewer is at least eighteen inches (18") below the bottom (invert) of the water main.

2. When sewers cross under water mains, the top of the sewer shall be at least eighteen inches (18") below the water main. If necessary, the water main shall be relocated to provide this separation or reconstructed with mechanical-joint cast iron or ductile iron pipe for a distance of ten feet (10') on each side of the sewer. One full length of water main shall be centered over the sewer so that both joints will be as far from the sewer as possible.

3. When it is possible to obtain proper horizontal and vertical separation as stipulated above, both water main and sewer main shall be constructed of mechanical-joint cast iron pipe and shall be pressure tested to assure water tightness.

4. When sewer lines cross under culverts where the sewer and the culvert are less than eighteen inches (18") apart, the sewer line shall be encased in concrete as shown on the standard drawings.

5.09 CLEANUP

After completing each section of the sewer line, the Contractor shall remove all debris and construction materials and equipment from the site of the work, grade and smooth over the surface on both sides of the line, and leave the entire right-of-way in a clean and neat condition. Unless otherwise called for on the drawings, the Contractor shall restore all disturbed areas to as close to its original condition as possible. Restoration shall include, but not be limited to, grassing, replacing shrubbery, trees, fences and other improvements which have been disturbed.

Cleanup and restoration shall be completed within sixty (60) calendar days after each section of sewer line is installed. Should the Contractor fail to do the cleanup within sixty (60) calendar days, payment made for pipe sewers and service lines for that section of the sewer not cleaned up shall be removed from the periodic estimate until the cleanup work is completed.

5.10 INSPECTION

(a) After completion of any section of sewer, the grades, joints and alignment shall be true to line and grade. Joint surfaces shall be smooth. There shall be no visual leakage, and the sewer shall be completely free from any cracks and from protruding joint materials, deposits of sand, mortar or other materials on the inside.

(b) For clay and concrete pipe, infiltration shall not exceed 300 gallons per 24 hours per mile. For PVC pipe, infiltration shall not exceed 25 gallons per 24 hours per inch of diameter per mile of sewer. For PVC force main, pipe shall be tested for leaks after laying in accordance with applicable requirements of Item 7 of the specifications for testing cast iron pipe. Contractor shall furnish all supplies, materials, labor, services, etc., needed to make infiltration or exfiltration tests including water. No separate payment will be made for equipment, supplies, material, water or services.

(c) Any leakage, including active seepage, shall be corrected by removal and replacement of pipe or joint where such leakage exists until the pipelines meet the requirements of the allowable leakage specifications.

(d) Infiltration tests shall be made when groundwater level is eighteen inches (18") or more above the top of the outside of the pipe.

(e) When normal groundwater does not stand at a level outside the pipe to enable infiltration tests to be made to the satisfaction of the Engineer, Contractor may make infiltration tests by filling the pipe or sections thereof with water to a head of not less than two feet (2') above the top of the inside of the pipe and observing the amount of water required to maintain this level.

(f) The sewers installed under the contract will be subject to television inspection by Owner and/or Engineer. It is the intent to televise sewers in which there are suspected defects. The City will furnish all equipment, materials, and labor for such inspection.

The Contractor shall provide access for the City crews and equipment for the television inspection and shall have his representative present during the inspection.

The television work shall be scheduled so as to take advantage of the time when the groundwater table is most likely to cause infiltration. Work shall be scheduled during or after rainy periods rather than after prolonged periods of dry weather. Logs and/or tapes of the inspections will be made available to the Contractor.

(g) When approved by the Engineer, "low pressure air test" shall be made in accordance with the procedures and standards listed below.

1. Clean pipe to be tested by propelling snug-fitting inflated rubber ball through the pipe with water.

2. Plug all pipe outlets with suitable test plugs. Brace each plug securely to prevent blowouts. As a safety precaution, pressurizing equipment shall include a regulator set at slightly above test pressure to avoid over-pressurizing and damaging an otherwise acceptable line. No one shall be allowed in the manhole during testing.

3. If the pipe to be tested is submerged in groundwater, insert a pipe probe by boring or jetting into the backfill material adjacent to the center of the pipe, and determine the pressure in the probe when air passes slowly through it. This is the back pressure due to groundwater submergence over the end of the probe. All gauge pressures in the test should be increased by this amount.

4. Add air slowly to the portion of the pipe installation under test until the internal air pressure is raised to 4.0 psi.

5. After an internal pressure of 4.0 psi is obtained, allow at least two minutes for air pressure to stabilize, adding only the amount of air required to maintain pressure.

6. When pressure decreases to 3.5 psi, start stopwatch. Determine the time in seconds that is required for the internal air pressure to reach 2.5 psi. Minimum permissible pressure holding times for runs of single pipe diameter and for systems of four inch (4"), six inch (6"), or eight inch (8") laterals in combination with trunk lines are indicated in the following tables in seconds.

NCPI AIR TEST TABLES

MINIMUM HOLDING TIME IN SECONDS REQUIRED

FOR PRESSURE TO DROP FROM 3 1/2 TO 2 1/2 PSI

PIPE DIAMETER														
4"	6"	8"	10"	12"	15"	18"	21"	24"	27"	30"	33"	36"	39"	

25	4	10	18	28	40	62	89	121	158	200	248	299	356	418
50	9	20	35	55	79	124	178	243	317	401	495	599	713	837
75	13	30	53	83	119	186	267	364	475	601	743	898	1020	1105
100	18	40	70	110	158	248	356	485	634	765	851	935		

125	22	50	88	138	198	309	446	595	680					
150	26	59	106	165	238	371	510							
175	31	69	123	193	277	425								
200	35	79	141	220	317									

225	40	89	158	248	340									
250	44	99	176	275										
275	48	109	194	283										
300	53	119	211											

350	62	139	227											
400	70	158												
450	79	170												
500	88													
550	97													
600	106													
650	113	170	227	283	340	425	510	595	680	765	851	935	1020	1105

NOTE: To be used when testing one diameter only.

5.11 DETERMINATION OF PAY QUANTITIES (Unit Price Contracts Only)

(a) The quantities of pipe sewers and service lines, including common excavation, for which payment will be allowed shall be expressed in linear feet for each size and type of pipe and applicable depth as shown in the Bid Schedule and shall be the horizontal length of sewer, other than cast iron or ductile iron sewers, installed complete in place as measured along the centerline of the sewer, with no deductions made for bends, increasers, tee connections or manholes. The applicable vertical depth shall be measured from the original ground surface to the invert of the sewer and shall be as shown in the Bid Schedule.

(b) The quantities of tee connections and plugged stubs for which payment will be allowed shall be the actual number of each size and type furnished and installed by the Contractor.

(c) The quantities of connecting risers for which payment will be allowed shall be expressed in linear feet of pipe and bends and shall be the vertical length of riser installed in place as measured along the centerline of the riser from the centerline elevation of the sewer line to the top of the riser connection as shown on the plans. No separate payment will be made for bends, concrete or plastic film markers used in this construction, payment therefor being included in the linear feet of riser pipe paid for in this category.

(d) The quantities of each connection installed, as directed and shown on the drawings, in reinforced concrete pipe over eighteen inches (18") in diameter for which payment will be allowed shall be the actual number each connection so made by the Contractor. The connection will be included in addition to the linear feet of pipe sewer measured.

(e) Reinforcing steel, cast iron pipe and other classes of work entering into pipeline construction shall be measured and payment made therefore under the applicable provisions set forth in other items of these specifications and the Bid Schedule.

(f) Concrete for headwalls, collars, cradles, piers, pipe protection and/or encasement shall be measured in cubic yards of concrete furnished and placed in accordance with plan dimensions and these specifications and payment for this item of work shall be made at the applicable unit price per cubic yard of the class of concrete placed as set forth in the Bid Schedule.

(g) Crushed rock, gravel or other approved bedding materials shall be measured in cubic yards of such materials furnished and placed in accordance with plan dimensions and these specifications in excess of those amounts required for Class C or Standard Bedding. No separate payment shall be made for Class C or Standard Bedding, and the cost shall be included in other items of work done under Item 5 in the Bid Schedule.

(h) No separate payment shall be made for connections to existing sewers and to manholes or inlets. The cost of this work shall be included in the unit price bid for other items of work done under Item 5.

(i) No separate payment shall be made for furnishing and installing stoppers. The cost of this item shall be included in the unit prices bid for other items of work done under Item 5 in the Bid Schedule.

(j) No separate payment shall be made for furnishing and installing adapters, bends, increasers and tees, cleanouts and other fittings and accessories in the building service lines. The cost of these shall be included in the unit prices bid for service lines under Item 5 in the Bid Schedule.

(k) No separate payment shall be made for any common, rock or borrow excavation, clearing or backfill. The cost of these items shall be included in the unit prices bid for pipe sewers under Item 5 in the Bid Schedule.

(l) In the event that inspection of the sewers by television is performed by the Contractor, the quantities for which payment of this service will be allowed shall be the horizontal length of sewer inspected, measured along the centerline of the sewer for which this service is performed, with no deduction made for manholes. No additional measurements will be allowed for tees, risers, or other sewer appurtenances between manholes. Measurement for payment shall be made on the same piece of pipe one time only. If it is necessary to televise an area more than one time for any reason, no additional allowance will be made for the second or subsequent television inspection of the same piece of pipe.

A lump sum amount shall be allowed for supplying and setting up the television equipment on the job as provided for in the Bid Schedule. Payment for this item shall be allowed one time only through the work.

5.12 PAYMENT (Unit Price Contracts Only)

(a) Payment for pipe sewers, service lines, television inspection (when required), tees, risers, plugged stubs, and connections to concrete pipe constructed under these specifications shall be made for the quantities determined in the manner specified above at the contract price per linear foot or each, as applicable, for each of the applicable pipe and special sizes and types listed in the contract pay items in the Bid Schedule.

(b) Payment for concrete and bedding materials furnished and placed under this specification shall be made for the quantities determined in the manner specified above at the contract price per cubic yard and as listed under the applicable items of the Bid Schedule as specified above.

(c) These amounts shall cover the cost of furnishing all materials, tools, labor, plant, equipment, services, and other expense in connection with common trench excavation and furnishing and installing all items of work herein specified under Item 5 and when so paid, shall constitute full compensation to the Contractor.

ITEM 6

MANHOLES

6.01 SCOPE

Work covered by this item consists of furnishing and constructing or installing manholes at the locations and in accordance with details shown on the Plans.

6.02 DESCRIPTION

Manholes shall be constructed of specified materials to the sizes, shapes and dimensions and at the locations shown on the Plans or As otherwise directed by the Engineer. The height or depth of the manhole will vary with the location, but unless shown otherwise on the Plans, shall be such that the top of the manhole frame will be at the finished grade of the pavement or ground surface, and the invert will be at the designated elevations.

6.03 DROP CONNECTION

Where the difference in the invert elevations of a sewer eighteen inches (18") in diameter or smaller and any other sewer intersecting in one manhole is two feet (2') or more, a drop manhole shall be constructed as shown on the Plans. They shall be similar in construction to the standard manhole except that a drop connection of pipe and fittings of the proper size and material shall be constructed outside the manhole and supported by Class B concrete.

6.04 MATERIAL

- (a) Concrete, cement, sand and water used in manhole construction shall conform to the applicable requirements of Item 3, Concrete, of these specifications. All concrete shall be Class A unless otherwise noted on the Plans, in the Standard Drawings, or in these Specifications. Steel reinforcement shall conform to the applicable requirements of Item 4 of these Specifications. Precast concrete manholes shall conform to ASTM C478-97.
- (b) Bricks used in manhole construction shall be medium hard or better, Grade MA bricks conforming to requirements of the latest ASTM "Specifications for Sewer Brick and Manhole Brick (Made from Clay or Shale)", Serial Designation C 32.
- (c) Manhole Frames and Covers
 - 1. Manhole frames and covers shall be cast iron conforming to the minimum requirements of ASTM, "Specifications for Gray Iron Castings", Serial Designation A 48. All castings shall be made accurately to the required dimensions, fully interchangeable, sound, smooth, clean and free from

blisters and/or other defects. Defective castings which have to be plugged or otherwise treated shall not be used. All castings shall be thoroughly cleaned and then be painted or coated with a coal tar pitch varnish. Each casting shall have its actual weight in pounds stenciled or painted on it with white paint.

2. Manhole frames and covers shall be of the size shown on the Plans and shall be the Chattanooga Standard Manhole Frame and Cover. The manhole frame shall weigh not less than 185 pounds, and the cover not less, than 165 pounds for a total of 350 pounds.
 3. Water-tight manhole frames and covers shall be Acheson Foundry & Machine Works, Inc., A-2624-71C, or approved equal, weighing 590 pounds. Covers shall be secured to the manhole frames with stainless steel stub bolts.
 4. The contact surfaces of all manhole covers and the corresponding supporting rings in the rims shall be machined to provide full perimeter contact.
 5. All sanitary sewer manhole covers shall have the word "Sewer" cast in the top in letters two inches (2") high.
 6. All storm drain manhole covers shall have the word "Drain" cast in the top in letters two inches (2") high.
- (d) Prior to delivery, all basic materials specified herein shall be tested and inspected by an approved independent commercial testing laboratory or, if approved by the Engineer, certified copies of test reports prepared by the manufacturer's testing laboratory will be acceptable. All materials which fail to conform to these Specifications shall be rejected. After delivery to the site, any materials which have been damaged in transit or are otherwise unsuitable for use in the work shall be rejected and removed from the site.
- (e) Manhole steps shall be M.S. Industries of Atlanta, Georgia, or approved equal. Manhole steps for pre-cast manholes may be plastic coated with a minimum of 1/2 inch diameter grade 60 steel.
- (f) Detailed shop drawings of manhole frames, covers, and steps shall be submitted for approval of the Engineer in accordance with provisions set forth in General Conditions.

6.05 CONSTRUCTION

- (a) Brick work to complete manholes shall be constructed using one (1) part Portland cement to two (2) parts clean sand, meeting ASTM "Standard Specification for Aggregate for Masonry", Serial Designation C 144, thoroughly mixed to workable plastic moisture. Twenty pounds of hydrated lime per sack of cement may be added. No retempered mortar shall be used. Bricks shall be laid radially with vertical mortar joints not more than three-eighths inch (3/8") thick and horizontal mortar joints not less than three-eighths inch (3/8") thick at the inside face

of the manhole. Inside joints shall be trowel-struck, flush joints to provide a smooth, clean surface. Joints shall be broken in successive layers.

- (b) Outside walls of brick shall be entirely covered with mortar to provide a smooth, clean surface.
- (c) The plastic steps shall be secured in the wall of the precast manhole sections as shown on the Plans.
- (d) The cast iron frame for the manhole cover shall be set at the required elevation and properly anchored to the masonry. Where manholes are constructed in paved areas, the top surfaces of the frame and cover shall be tilted to conform to the exact slope, crown, and grade of the existing adjacent pavement.

Manhole inverts shall be constructed with Class A concrete and shall have the same cross-sections as the inverts of the sewers they connect. Each manhole invert shall be carefully formed to match the required size and grade by gradual, even changes in sections. Changes in direction of flow through the sewer shall be made to a true curve with as large a radius as the size of the manhole will permit.

Masonry work shall be allowed to set for a period of not less than twenty-four (24) hours. Outside forms, if any, then shall be removed and backfilling and compacting around the manhole will be done in the manner provided in Item 1 of these Specifications. All loose or waste material shall be removed from the interior of the manhole. The manhole cover then shall be placed and surface in the vicinity of the work cleaned off and left in a neat, orderly condition.

After backfilling has been completed, the excavated area, if located in a street, alley, or sidewalk, shall receive a temporary surface provided under Item 1 of these Specifications.

6.06 DETERMINATION OF PAY QUANTITIES (IF APPLICABLE)

- (a) The quantities of manholes shown on the Drawings for which payment will be allowed shall be the actual number of each type, size and depth of manhole six feet (6') deep or less installed by the Contractor and accepted by the Engineer.
- (b) The depth of all manholes will be measured from the top of the manhole frame to the invert of the lowest sewer entering or leaving the manhole. Measurement of and payment for manholes six feet (6') or less in depth shall be as one manhole at the basic unit price, each, for manholes as set forth under the applicable item in the Bid Schedule.
- (c) For manholes more than six feet (6') in depth, payment will be allowed for extra depth, per linear foot, for each foot thereof over six feet (6') at the applicable unit price provided for in the Bid Schedule. Fractions of a foot of extra depth shall be accumulated until one foot (1') has been constructed for payment.

- (d) All drop manholes shall be measured and paid for as specified for standard manholes, and, in addition, extra payment will be allowed at the applicable contract unit price, each, for each drop connection, complete in place, including common excavation, pipe or specials and concrete encasement as provided for in the Bid Schedule.
- (e) All manholes with watertight covers shall be measured and paid for as specified for standard manholes, and, in addition, extra payment will be allowed at the applicable contract unit price, each, for each watertight cover as provided for in the Bid Schedule.

6.07 PAYMENT (IF APPLICABLE)

Payment for all manholes, as constructed under these Specifications shall be made for the quantities determined in the manner specified above as listed under the contract pay items in the Bid Schedule. These amounts, so paid, shall constitute full compensation to the Contractor under this item and shall cover the cost of furnishing all labor, materials, tools, plant equipment, services and other expenses in connection with the furnishing and construction of manholes complete-in-place including all excavation, backfill, masonry, all castings, reinforcing steel, inspection and tests, all as herein specified.

END OF DOCUMENT

ITEM 14

MINERAL AGGREGATE BASE

14.01 SCOPE OF WORK

This work shall consist of furnishing and placing one or more courses of aggregate, plus additives if required, on a prepared subgrade in accordance with these specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross-sections shown on the Plans or established by the Engineer.

Mineral aggregate base shall be Type A or Type B, whichever is shown on the Plans and called for in the Bid Schedule.

14.02 MATERIALS

(a) Aggregate

The mineral aggregate shall meet the requirements of Item 73.05 for Class A or Class B aggregate, depending upon whether Type A or Type B base is required in the construction. Type A Base will require the use of Class A aggregate, Grading D. Either Class A or Class B aggregate may be used for Type B Base.

When the stationary plant method for mixing is used, the aggregate will be accepted immediately following mixing or immediately prior to mixing, based on periodic samples taken from the pugmill output, or from the belt feeding the pugmill.

When two or more materials are blended on the road by means of mechanical mixers, the aggregate will be accepted after mixing and before compaction, based on samples taken from each layer of base material. Aggregate that does not require blending will be accepted at the aggregate production plant, based on samples taken from stockpiles or plant production immediately prior to delivery to the road.

(b) Calcium Chloride

Calcium chloride shall meet the requirements of Item 74.02 for Type 1 or Type 2, except that the requirements for "total alkali chlorides" and "impurities" shall not apply.

(c) Sodium Chloride

Sodium chloride shall meet the requirements of Item 74.03.

14.03 EQUIPMENT

All equipment necessary for satisfactory performance of this construction shall be on the project and approved before work will be permitted to begin. Such equipment shall include a stationary mixing plant or mechanical road mixers, whichever is applicable to the type of work to be performed, as specified under Item 14.04(b).

(a) Stationary Mixing Plant

The mixing unit shall be an approved twin-shaft pugmill capable of producing a constant, uniform mixture. The mixer shall be equipped with a suitable truck-loading hopper with gate which will prevent segregation of the material when dumped into the truck. A spray bar capable of assuring an even wetting of the aggregate shall be mounted at the entrance of or above the pug-mill. The flow of water through the spray bar shall be controlled by a meter, valve or other approved type of regulating device to maintain a uniform moisture content in the mixture. The mixing plant shall be equipped with adjustable feeders for each size material capable of regulating a constant, uniform flow of material.

(b) Mechanical Mixer (for Road Mixing)

The mechanical mixer shall be of the pugmill or rotary type capable of producing a uniform blend of all materials to the full depth of the course being placed. The mixer shall be either a self-propelled or trailer type.

14.04 CONSTRUCTION REQUIREMENTS

(a) General

1. Mineral aggregate base, Type A or Type B, shall be constructed in layers, the compacted thickness of which shall be as shown on the Plans.
2. The subgrade shall be checked and approved by the Engineer not more than five hundred feet (500') in advance of spreading any mineral aggregate. This distance may be shortened by the Engineer to as little as two hundred feet (200') between November first and April first or during periods of prolonged wet weather.
3. Mineral aggregate shall not be spread on a subgrade that is frozen or contains frost.
4. Hauling over material already placed will not be permitted until it has been spread, mixed, shaped and compacted.

(b) Mixing

1. Unless otherwise specified, Contractor shall mix the base course material, including an additive if required, on the Plans, by one of the following methods:

- a. For mineral aggregate base, Type A, the stationary plant method will be required.
- b. For mineral aggregate base, Type B, requiring the blending of two or more materials, either the stationary plant method or the road mix method (mechanical mixer) shall be used.
- c. For mineral aggregate base, Type B, requiring additive, stationary plant mixing or mechanical road mixing shall be used.
- d. For mineral aggregate base, Type B, requiring neither blending of materials nor additives, either stationary plant mixing, mechanical road mixing or mixing by motor grader on the road may be used.

2. Detailed requirements for the three types of mixing operation are as follows:

a. Stationary Plant Method

The base course material and water shall be mixed in an approved stationary mixing plant as described in Item 14.03(a). Water shall be added during the mixing operation in the amount necessary to provide a moisture content satisfactory for compacting. If combining materials is required to meet the grading requirements, the blending shall be performed as provided for in Item 73.05, prior to mixing.

b. Road Mix Method (Mechanical Mixer)

After the material for each layer of base course has been placed through an aggregate spreader or windrow-sizing device, the material shall be mixed by means of approved mechanical mixing machines as described in Item 14.03(b).

c. Road Mix Method (Motor Grader)

After material for each layer of base course has been deposited and spread uniformly, it shall be sprinkled with water in sufficient quantity to moisten all particles, but not in such quantity that segregation of sizes or softening of subgrade will occur. Immediately following the application of water, the material shall be thoroughly mixed by windrowing and spreading with motor graders until the mixture is uniform throughout.

(c) Spreading

1. Stationary Plant Mixing

After mixing, material for each layer of base shall be transported to the job site while it contains the proper moisture content, and shall be spread to the required thickness and cross-section by means of an approved mechanical spreader.

2. Road Mixing (Mechanical Mixer)

Material to be mixed by mixing method b shall be spread prior to mixing with an approved mechanical spreader. If the blending of two or more materials is to be performed on the road, each material shall be spread separately with an approved mechanical spreader capable of being adjusted to spread the materials in the proper proportions.

3. Road Mixing (Motor Grader)

a. After the aggregate and water have been thoroughly mixed, the base material shall be spread while at optimum moisture content in layers of specified thickness and cross-section by means of approved motor graders.

b. If the required compacted depth of base course exceeds six inches (6"), the base shall be constructed in two or more layers of approximate equal thickness. The maximum compacted thickness of any one layer shall not exceed six inches except when vibrating or other approved types of special compacting equipment are used, the compacted depth of a single layer of base course may be increased to eight inches upon approval of the Engineer.

c. In some cases, the plans show the base as extending for the full width of the roadbed. In other cases, the edges of the base are shown as coinciding with the inside edges of the shoulders. In the latter case, shoulder material shall be placed to a minimum width of three feet (3') prior to the spreading of each layer of base material in order to confine the base material and to permit proper compaction.

d. Any base material used for constructing detours, for maintenance of traffic, for backfilling rock cuts and capping rock fills may be spread and mixed using this method.

(d) Shaping and Compaction

1. Except where mechanical aggregate spreading equipment is used to place the base material, final shaping of each layer prior to compaction shall be accomplished by motor grader. In the event that mechanical spreading equipment fails to shape the base material properly, final shaping shall be done by motor grader or other approved means.

2. Immediately following spreading and final shaping, each successive layer shall be compacted with pneumatic-tire rollers described under Subsection 205.02 of Tennessee Department of Transportation Standard Specifications and any other types of compacting equipment, provided the required density and the required degree of uniformity and smoothness are attained. If the density requirement does not apply as provided for below, the base may be compacted with pneumatic-tire rollers meeting the requirements of Subsection 205.03 of Tennessee Department of Transportation Standard Specifications as directed by the Engineer. Compaction shall progress gradually from the edges of the base to the center, parallel with the center-line of the road, and shall continue until the base layer has been compacted to its full width. Where lifts of shoulder materials are placed to confine the base material, the initial pass of the compacting equipment shall overlap the shoulder to a width of not less than twelve inches (12").

3. Compaction of each layer shall continue until a density of not less than eighty-three percent (83%) of the solid volume has been achieved. The density determination will be based on the bulk specific gravity, AASHTO Designation T 84, "Standard Method of Test for Specific Gravity and Absorption of Fine Aggregate," and T 85, "Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate," and the dry weight of the aggregate. Unless otherwise specified, density requirements will not apply to base construction on projects that do not include the construction of a surface upon the base. The compaction of each layer shall be approved before material for the next successive layer is placed. Placing and compacting areas shall be kept separate.

4. The surface of each layer shall be so constructed that the aggregates become firmly keyed and a uniform texture produced and shall be maintained in that condition until covered by the following stage of construction or until final acceptance of the project. Any irregularities that develop shall be corrected by loosening the material at those places and adding or removing material as required.

5. Approved distributors shall be used to apply water uniformly over the base materials during compaction in sufficient quantity for proper compaction. Softening of the underlying subgrade resulting from the use of excess water is especially to be avoided.

(e) Maintenance

After construction of the base has been completed satisfactorily, it shall be maintained, under traffic if required, smooth and uniform until covered by the following stage of construction or until the project has been completed and accepted.

(f) Thickness Requirements

The thickness of the completed base shall be in reasonably close conformity to the thickness shown on the Plans. The thickness shall be measured at such frequency as established by the Engineer by means of test holes or other approved methods.

(g) Surface Requirements

The surface of the finished base shall be in reasonably close conformity to the lines, grades and cross-sections shown on the Plans or established by the Engineer and shall have a satisfactorily smooth riding quality.

14.05 COMPENSATION (IF APPLICABLE)

(a) Method of Measurement

Mineral aggregate base, unless otherwise stipulated, shall refer to Type A, Grading D mineral aggregate meeting the requirements of Item 73.05. Mineral aggregate base shall be measured by the ~~ton of 2000 pounds~~ unit(s) specified in the bid schedule.

(b) Basis of Payment

The accepted quantities of mineral aggregate base of the type specified will be paid for at the contract unit price ~~per ton for mineral aggregate~~ specified in the bid schedule.

END OF DOCUMENT

ITEM 15

CONCRETE PAVEMENT REMOVAL

15.01 SCOPE OF WORK

(a) All pavement, base course, sidewalks, driveways, curbs, gutters, etc., which are constructed of Portland Cement Concrete, designated for removal, shall be disposed of as directed.

(b) Concrete pavement, parking strip, base with or without bituminous overlay, concrete curb and gutter, sidewalks, driveways, etc., which exist within the limits of construction and are not more than one-half foot (.5') below subgrade elevation shall be removed and disposed of.

15.02 METHOD OF MEASUREMENT

Pavement areas of any kind whatsoever, as named above, shall be considered uniform in depth and shall be measured in units of square feet.

15.03 BASIS OF PAYMENT

The accepted quantities of Pavement Removal will be paid for at the contract unit price bid. Said price shall be full compensation for removing and disposing of the designated materials in accordance with the contract.

END OF DOCUMENT

ITEM 16

CEMENT CONCRETE

SIDEWALKS, DRIVEWAYS, MEDIAN PAVEMENT

16.01 SCOPE OF WORK

This work shall consist of constructing sidewalks, driveways, and median pavement, exclusive of sidewalks, driveways, and median pavement that are integrally a part of structures, of Portland Cement Concrete on a prepared subgrade, in accordance with these Specifications and in reasonably close conformity with the lines, grades, and typical cross-sections shown on the Plans or established by the Engineer. It shall, also, include removal of existing sidewalks and driveways as directed by the Engineer.

16.02 MATERIALS

Materials shall meet the requirements of:

Item 3	Concrete
Item 14	Mineral Aggregate Base
Item 25	Preformed Joint Filler

Concrete for sidewalks, driveways, and median pavement shall be Class A Concrete, unless specified otherwise on the contract drawings, meeting all the requirements prescribed in Item 3, "Concrete".

16.03 EQUIPMENT

(a) Forms

Forms shall be of wood, metal, or other suitable material and shall extend for the full depth of the concrete. All forms shall be true to line, free from warp, and of sufficient strength to resist the pressure of the concrete without springing. Curved forms of proper radius shall be used on all radial sections and shall be of a design acceptable to the Engineer. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal.

(b) Mixing, Finishing and Transportation

1. Mixers and transportation of equipment shall meet the requirements of Item 3.13.
2. Satisfactory floats, trowels, templates, straightedges, edgers, spades, and tamps shall be furnished. Compaction of subgrade shall be accomplished by any type of tamping or rolling equipment that will produce the desired results.

16.04 CONSTRUCTION REQUIREMENTS

(a) Subgrade Preparation

Subgrade preparation for sidewalks, driveways, and median pavement shall be made to the required depth and to a width that will permit the installation and bracing of the forms. The subgrade shall be shaped and compacted to a firm, even surface in reasonably close conformity with the grade and section on the Plans. All soft and yielding material shall be removed and replaced with acceptable material, which shall then be compacted as directed. The prepared subgrade shall then be brought to true line and grade with a minimum depth of two inches (2") of mineral aggregate base, unless specified otherwise on the drawings, meeting the requirements of Item 14 of these Specifications.

(b) Expansion Joints

1. Unless otherwise indicated on the Plans or directed by the Engineer, premolded expansion joint filler, three-fourths inch (3/4") in thickness, shall be placed at the locations and in line with expansion joints in the adjoining pavement, gutter or curb. When expansion joints are not required or have not been installed in the adjoining pavement or gutter, unless otherwise indicated on the Plans, a three-fourths inch (3/4") premolded expansion joint filler shall be placed at intervals of not over forty feet (40'). All premolded expansion joint filler shall be cut to full width or length of the proposed construction and shall extend to within one-half inch (1/2") of the top or finished surface. All longitudinal expansion joints shall be placed as indicated on the Plans or as directed by the Engineer. All expansion joints shall be true, even, and present a satisfactory appearance.

2. Construction joints shall be formed around all appurtenances, such as manholes, utility poles, etc., extending into and through the sidewalk or median area. Premolded expansion joint filler, one-fourth inch (1/4") thick, shall be installed in these joints. Expansion joint filler of the thickness indicated shall be installed between concrete sidewalks and any fixed structure, such as a building or bridge. One-fourth inch (1/4") thick expansion joint filler shall be installed between concrete curb and median pavement and, unless otherwise specified, between concrete curb and sidewalk. This expansion joint material shall extend for the full depth of the walk or median pavement.

(c) Limitations of Mixing

Limitations on the mixing of concrete shall be as prescribed in Item 3.13.

(d) Mixing and Placing Concrete

Concrete shall be mixed in accordance with the provisions of Item 3.14. Immediately before placing the concrete, the subgrade shall be thoroughly wetted, and the forms given a coating of light oil. Where removed and used again, the forms shall be thoroughly cleaned and oiled each time before using.

(e) Finishing

1. The concrete shall be struck-off with a transverse template resting upon the side forms. After the concrete has been struck-off to the required cross-section, it shall be finished with floats, trowels, and straightedges until the surface requirements have been obtained.

2. When the surface of the concrete is free from water and just before the concrete obtains its initial set, it shall be gone over and finished with a float and swept lightly with a broom in order to produce a sandy texture. The longitudinal surface variations shall be not more than one-fourth inch (1/4") under a twelve-foot (12') straightedge, nor more than one-eighth inch (1/8") on a five-foot (5') transverse section. The surface of the concrete shall be so finished as to drain completely at all times. The edges of the sidewalks, driveways and median pavement shall be carefully finished and rounded with an edging tool having a radius of one-half inch (1/2").

3. The surface of sidewalks shall be divided into blocks by use of a grooving tool. Grooves shall be so placed as to cause expansion joints to be placed at a groove line. The grooves shall be spaced approximately five feet (5') apart, and the blocks shall be rectangular unless otherwise ordered by the Engineer. The grooves shall be cut to a depth of not less than one-half inch (1/2") and not more than one inch (1"). The edges of the grooves shall be edged with an edging tool having a radius of one-fourth inch (1/4"). Grooves shall be placed in median pavement in line with corresponding joints in adjoining construction or as directed by the Engineer.

4. The edges of the concrete at expansion joints shall be rounded with an edging tool having a radius of one-fourth inch (1/4"). All marks caused by the edging shall be removed with a wetted brush or float. The top and ends of expansion joint material shall be cleaned of all concrete, and the expansion joint material shall be so trimmed as to be slightly below the surface of the concrete.

(f) Protection and Curing

1. Forms may be removed at any time that removal will not damage the concrete. No pressure shall be exerted upon the concrete in removing forms.

2. Curing and protection during cold weather shall be performed as provided for under Item 3.15 of these Specifications.

3. Pedestrians will not be allowed upon concrete sidewalks, driveways, or medians until seventy-two (72) hours after finishing concrete, and no vehicles or loads shall be permitted on any sidewalk, driveway, or median until the Engineer has determined that the concrete has attained sufficient strength for such loads.

4. The Contractor shall construct and place such barricades and protection devices as are necessary to keep pedestrians and other traffic off the sidewalk, driveway, or median.

5. Any sidewalk, driveway, or paved median damaged prior to final acceptance of the project shall be repaired, at the Contractor's expense, by removing concrete within groove limits and replacing it with concrete of the type and finish in the original construction.

(g) Backfilling

Immediately after removing the side forms, the spaces along the edges of sidewalk or driveway shall be filled with suitable material. This material shall be placed in layers not exceeding four inches (4") in loose thickness, and compacted until firm and stable.

(h) Final Cleanup

Final cleaning up shall be performed in accordance with the requirements of Special Conditions.

16.05 COMPENSATION (Unit Price Contracts Only)

(a) Method of Measurement

1. Concrete sidewalks and concrete driveways will be measured by the square foot, complete-in-place. The area shall be obtained by surface measurements. Where standard widths are constructed, the measurements shall not exceed the standard widths shown on the Plans, unless on written direction of the Engineer. Concrete sidewalks or each thickness, concrete driveways, and concrete median pavement will be measured separately. Concrete median pavement will be measured by the cubic yard, complete-in-place. The volume shall be obtained from the specified thickness shown on the Plans and surface measurements for width and length.

2. No measurement for payment will be made for incidental excavation, preparing the subgrade, for backfill, or expansion joint materials unless otherwise indicated on the Plans, as these are necessary parts of the construction. No additional payment shall be made for construction of handicap curb ramps located as designated by the Engineer in accordance with Tennessee state law. All mineral aggregate base used for fine grading and subgrade preparation as specified in Item 16.04 shall be included in the unit prices of the various items.

(b) Basis of Payment

The accepted quantities of concrete sidewalk of each thickness and concrete driveway will be paid for at the contract unit price per square foot for the respective items, complete-in-place. The accepted quantities of concrete median pavement will be paid for at the contract unit price per cubic yard complete-in-place.

Payment will be made as follows:

Item No.	Pay Item	Pay Unit
16A	Concrete Sidewalk (4 inches)	Square Foot
16B	Concrete Driveway (6 inches)	Square Foot
16C	Concrete Sidewalk (6 inches)	Square Foot
16M	Concrete Median Pavement	Cubic Yard

END OF DOCUMENT

ITEM 17

CEMENT CONCRETE CURB, GUTTER, OR COMBINED CURB AND GUTTER

17.01 SCOPE OF WORK

This work shall consist of curb, gutter, or combined curb and gutter constructed of Portland Cement Concrete in accordance with these Specifications, at the locations and in reasonably close conformity with the lines, grades and dimensions shown on the Plans, or established by the Engineer. It shall also include removal of existing curb and gutter as directed.

17.02 MATERIAL

(a) Materials shall meet the applicable requirements of:

- Item 3 Concrete
- Item 14 Mineral Aggregate Base
- Item 25 Preformed Joint Filler
- Item 73 Aggregate for Concrete

Concrete for curb, gutter, and combined curb and gutter shall be Class A concrete, meeting all of the requirements prescribed in Item 3, "Concrete," with the modification specified hereinafter.

(b) When the use of an approved curb machine is authorized, the following combination of materials shall be used:

Water	4.0 Gallons (Maximum)
Cement	94.0 Pounds
Coarse Aggregate-Size No. 78	260.0 Pounds
Clean Sand	245.0 Pounds

(c) Entrained air will not be required in curb concrete made with the aforementioned combination.

(d) The water and percentages of fine and coarse aggregate may be adjusted within the above limits to permit satisfactory placement.

(e) Compressive test specimens shall be made by vibratory method in accordance with AASHTO T 23, "Standard Method for Making and Curing Concrete ,Compression and Flexural Strength Test Specimens in the Field," or other approved methods.

17.03 EQUIPMENT

(a) Forms

Forms, except the templates between ten-foot (10') sections, may be either wood or metal meeting the requirements prescribed in Item 3.16. The templates shall be one-eighth inch (1/8") thick metal, of the same width as that of the curb, gutter, or combination curb and gutter, and not less than one-half inch (1/2") more in depth than the respective depth of the type curb and gutter being constructed. The templates shall have lugs, or other devices to hold them in position during placing of the concrete and shall be of such design as to permit strike-off template of the form, and shape of the gutter shall be used to shape the top surface of the gutter.

(b) Compaction Equipment

Compaction of subgrade shall be accomplished by any type of tamping or rolling equipment that will produce the desired results.

(c) Mixing and Finishing Equipment

1. Mixers shall meet the requirements of Item 3.13, except that the stipulation requiring the use of a broom and bucket will be waived.
2. Any extruding type curb machine may be used when approved by the Engineer.
3. Finishing equipment shall include satisfactory floats, trowels, edgers, spades and tamps.

17.04 SUBGRADE PREPARATION

Subgrade preparation for curb, gutter, and combined curb and gutter shall be made to the required depth, and to a width that will permit the installation and bracing of the forms. The subgrade shall be shaped and compacted to a firm, even surface, in reasonably close conformity with the grade and section shown on the Plans. All soft and yielding material shall be removed and replaced with acceptable material, which shall then be compacted as directed. The subgrade shall be finished and brought to true line and grade with a minimum two-inch (2") compacted layer of mineral aggregate base meeting the requirements of Item 14 of these Specifications.

17.05 EXPANSION JOINTS

Expansion joints shall be formed at the intervals and locations shown on the Plans, using preformed filler one-fourth inch (1/4") thick, unless otherwise specified. They shall be placed in line with corresponding expansion joints in adjoining pavement or other construction. Joint filler shall be cut to the full cross-section of the curb, gutter, or combined curb and gutter.

17.06 LIMITATIONS ON MIXING

Limitations on the mixing of concrete shall meet the requirements of Item 3.13 of these Specifications.

17.07 MIXING, PLACING, AND FINISHING CONCRETE

(a) Concrete shall be mixed in accordance with requirements of Item 3.13 of these Specifications.

(b) Immediately before placing the concrete, the subgrade shall be thoroughly wetted, and the forms given a coating of light oil. Where removed and used again, the forms shall be thoroughly cleaned and oiled each time before using. Placing concrete shall be performed as provided for under Item 3.14 of these Specifications.

(c) The concrete shall be placed immediately after mixing. The edges, sides, or faces, shall be thoroughly spaded and vibrated sufficiently to consolidate the concrete thoroughly and bring the mortar to the surface, after which the surface shall be finished smooth and even by means of a float.

(d) Concrete curb, gutter, or combined curb and gutter, shall be constructed reasonably true to line, grade and cross-section and, unless otherwise specified on the Plans, in sections having uniform lengths of ten feet (10'). The length of these sections may be reduced where necessary for closures, but no section less than six feet (6') will be permitted. The templates shall be set carefully before the placing of the concrete and allowed to remain in-place until the concrete has set sufficiently to hold its shape, but shall be removed while the forms are still in-place. The forms on the face of all curbs shall be removed as soon as the concrete will hold shape and the surface then floated with a float to a smooth and even finish. No plastering will be permitted. Unless otherwise specified, the top edges of the curb and the edge of the gutter shall be rounded to a radius of three-fourths inch (3/4"), and the edges on each side of templates and expansion joint material shall be finished with an edging tool with a radius of not over one-fourth inch (1/4"), and then all lines or marks shall be removed with a wet brush. Any exposed surface or surfaces against which some rigid type of construction is to be made shall be left smooth and uniform so as to permit free movement of the curb, gutter or combined curb and gutter.

(e) All tool marks shall be removed with a wetted brush or float, and the finished surface shall present a uniform and pleasing appearance.

(f) Extruding type curb machines may be used at the option of the Contractor and with approval of the Engineer where feasible, provided the mix meets requirements for Item 17.02.

(g) When the use of extruding type curb machines is permitted, finishing shall be performed as specified above.

(h) Weep holes or drainage openings shall be placed through curbs as indicated on the Plans or as directed by the Engineer, but when so placed, unless otherwise indicated or directed, there shall be placed at least one-half cubic foot of coarse aggregate behind each opening.

17.08 PROTECTION AND CURING

(a) Immediately after finishing the concrete, protection and curing shall be performed in accordance with the provisions of Item 3.15 of these Specifications.

(b) The Contractor shall protect the curb, gutter, and combined curb and gutter until finally accepted. Any concrete that is damaged during that period shall be repaired by removing and reconstructing each ten-foot (10') section that has been damaged. This reconstruction shall be at the Contractor's expense.

17.09 BACKFILLING

Immediately after the concrete has set sufficiently and the forms have been removed, the space back of the curb or combined curb and gutter shall be filled with suitable material. This material shall be placed in layers not exceeding four inches (4") in loose thickness, and compacted until firm and stable.

17.10 FINAL CLEANUP

Final cleaning up shall be performed in accordance with the requirements of Special Conditions.

17.11 METHOD OF MEASUREMENT (IF APPLICABLE)

(a) Concrete curb, concrete gutter, and concrete combined curb and gutter will be measured for payment by the linear foot, complete-in-place. Linear measurements will be surface measurements taken along the center of gravity of the section.

(b) No measurement for payment will be made for incidental excavation preparing the subgrade, for backfill, for expansion joint materials, unless otherwise indicated on the Plans, as these are necessary parts of the construction. No additional payment shall be made for construction of handicap curb ramps located as designated by the Engineer in accordance with State Law. All mineral aggregate base used for fine grading and subgrade preparation as specified in Item 17.04 shall be included in the unit prices of the various items.

(c) No measurement for payment will be made under this section for curb which is integral with concrete pavement or concrete base unless otherwise specified on the Plans or in the Contract.

17.12 BASIS OF PAYMENT (IF APPLICABLE)

(a) The accepted quantities of concrete curb, concrete gutter, or concrete combined curb and gutter will be paid for at the contract unit price per linear foot for the respective items.

(b) Payment will be made under:

Item No.	Pay Item	Pay Unit
17A	Type "A" Curb and Gutter	L.F.
17B	Type "B" Curb and Gutter	L.F.
17C	Type "C" Detached Curb	L.F.
17D	Type "D" Detached Curb	L.F.
17E	Type "E" Mountable Curb	L.F.
17R	Removal of Existing Curb and Gutter	L.F.
17A (ME)	Type "A" Curb and Gutter (Machine Extruded)	L.F.
17B (ME)	Type "B" Curb and Gutter (Machine Extruded)	L.F.
17C (ME)	Type "C" Detached Curb (Machine Extruded)	L.F.
17D (ME)	Type "D" Detached Curb (Machine Extruded)	L.F.
17E (ME)	Type "E" Mountable Curb (Machine Extruded)	L.F.

END OF DOCUMENT

ITEM 19

TREE AND/OR STUMP REMOVAL

19.01 SCOPE OF WORK

The work covered under this item shall consist of removing trees, stumps, shrubs, etc., from the street right-of-way. The Contractor shall use special care to protect public and private property. The Contractor shall take special care so as not to damage any utility lines in the process of cutting and removing the trees. The Contractor shall maintain proper barricades and watchpersons to detour traffic during the cutting and removal of trees.

19.02 EQUIPMENT

All equipment necessary or required in connection with this type of work must be on hand, proven to be in first class working condition, and approved by the Engineer before this work will be permitted to begin.

19.03 CUTTING TREES

Before any tree is cut down, the tree shall be completely "topped" in an accepted manner approved by the Engineer so as to protect all utilities, public and private properties. The Contractor shall be responsible for removing branches, foliage, etc., from the construction site as soon as the tree has been cut. If any curb, sidewalk, wall, street, etc., is damaged during the removal of a tree, the Contractor shall replace the damaged portions at his/her own expense as directed by the Engineer.

19.04 STUMP REMOVAL

Stumps shall be removed to a minimum depth of six inches (6") below finished grade. The stumps shall be removed by a "stump router" or any other manner as approved by the Engineer. If the portion of curb and sidewalk is in good condition at the stump and the Contractor removed the stump by other means than a "stump router" and damages the curb and sidewalk, the Contractor shall replace same at his/her own expense. If the Engineer determines that the stump cannot be removed without damaging the curb and/or sidewalk, the City will bear the cost of replacing the curb and sidewalk.

19.05 METHOD OF MEASUREMENT AND PAYMENT

(a) No separate payment shall be made for clearing and grubbing, removal of all debris from the construction site, or the installation of topsoil to finished grade.

(b) Payment will be made for the removal of trees and/or stumps for each diameter as shown in the Bid Schedule.

(c) No separate payment will be made for the removal of bushes, shrubs, or trees less than six inches (6") in diameter, nor the installation of topsoil, where their stumps were removed.

(d) Payment will be made for the removal of an existing stump as shown in the Bid Schedule at the unit price bid for each diameter. The unit price, so paid, shall cover the cost of furnishing all labor, materials, tools, services and other expense in connection with the removal of trees and/or stumps.

ITEM 21

PRIME COAT

21.01 SCOPE OF WORK

This work shall consist of an application of bituminous material, and cover material if required, on a designated base, in accordance with the requirements of these Specifications and in reasonably close conformity with the lines shown on the Plans or established by the Engineer.

21.02 MATERIALS

Materials shall meet the requirements of the following items of these Specifications:

- ITEM 67.02 CUT-BACK ASPHALT, GRADE RC-70 OR RC 250
- ITEM 67.03 EMULSIFIED ASPHALT, GRADE AE-P
- ITEM 67.05 TAR, GRADE RT-2 OR RT-3
- ITEM 73.12 AGGREGATE FOR COVER MATERIAL, SIZE 78 OR 8

When the particular type and grade of bituminous material to be used is not shown on the Plans or otherwise designated, the Contractor shall select the type and the Engineer will designate the grade. Bituminous material may be conditionally accepted at the source.

The ranges of application temperatures in degrees Fahrenheit shall be as follows:

RT-2 and RT-3 (60 -130)	RC 70 (80 -150)
RC 250 (100 -175)	AE-P (60 -140)

21.03 EQUIPMENT

All equipment necessary for the satisfactory performance of this construction shall be on hand and approved before Contractor will be permitted to begin work. The equipment shall include a power broom or other mechanical sweeping equipment, bituminous heating equipment, a pressure distributor, a water sprinkler and such other equipment and small tools as may be required to perform the work in a satisfactory manner.

21.04 LIMITATIONS

Bituminous material shall be applied only between March first and December first, and only when the air temperature in the shade, away from artificial heat, is above 60 degrees Fahrenheit. Bituminous material may be applied to a surface that is slightly damp, but never to a wet surface.

21.05 PREPARATION OF SURFACE

The surface to be primed shall be prepared in accordance with the provisions of Item 14.

When delays in the priming operation occur, the prepared surface shall be satisfactorily maintained or reworked to meet the requirements of Item 14 before the priming operation is resumed.

21.06 APPLICATION OF PRIME

All areas to be treated shall be approved by the Engineer before application of the treatment. Bituminous material shall be applied to the width of the section to be primed by means of a pressure distributor at a uniform, continuous spread. The Engineer will designate the rate of application within the extreme limits indicated on the Plans. Application temperatures shall be within the ranges specified under Item 21.02. Any areas containing an excess or deficiency of priming material shall be corrected by the addition of blotter material or bituminous material, as directed by the Engineer.

The Contractor shall protect all structures and concrete surfaces from the bituminous material during the construction.

21.07 APPLICATION OF COVER MATERIAL

All areas to be treated shall be approved by the Engineer before application of the treatment. Bituminous material shall be applied to the width of the section to be primed by means of a pressure distributor at a uniform, continuous spread. The Engineer will designate the rate of application within the extreme limits indicated on the Plans. Application temperatures shall be within the ranges specified under Item 21.02. Any areas containing an excess or deficiency of priming material shall be corrected by the addition of blotter material or bituminous material, as directed by the Engineer.

The Contractor shall protect all structures and concrete surfaces from the bituminous material during the construction.

21.08 APPLICATION OF COVER MATERIAL

If, after the bituminous material has been applied, it fails to penetrate before the time that the roadway must be used by traffic, dry cover material shall be spread at a rate established by the Engineer, between eight (8) and twelve (12) pounds per square yard, to prevent damage to the primed surface. An excess of cover material shall be avoided.

21.09 MAINTENANCE AND PROTECTION

(a) The Contractor shall maintain the prime coat and the surface intact until it has been covered by the wearing surface or until the project is completed. No succeeding stage of construction shall be placed upon the prime coat until it is properly cured.

(b) The Contractor shall clean out any spots where the prime coat may have failed due to disintegration of the underlying surface material or for any other reasons. The exposed areas so produced shall be lightly dampened, refilling with approved material and thoroughly compacted to conform with the surrounding surface, after which bituminous prime shall be applied thereto with a hand spray. If satisfactory repairs cannot be accomplished by the above method, the Contractor shall fill the depressions with approved mixtures of bituminous material and fine aggregate, and compact them to conform to the surrounding surface.

(c) Any mineral aggregate and bituminous material used for repairs will be paid for at their contract unit prices, providing the cause of repair is beyond the Contractor's control.

21.10 METHOD OF MEASUREMENT (IF APPLICABLE)

Bituminous prime coat will be measured by the number of gallons (or the number of gallons/unit(s) specified in the bid schedule) of material used in the accepted work, as determined by the Engineer, at the temperature of application.

21.11 BASIS OF PAYMENT (IF APPLICABLE)

This item will be paid for at the contract unit price per gallon (or the unit(s) per gallon specified in the bid schedule) for prime coat complete-in-place, which price shall be full compensation for all bituminous prime coat as indicated or directed and in accordance with the conditions, stipulations, provisions and requirements contained herein; for completing all incidentals thereto; and for furnishing all materials, equipment, tools, labor and incidentals required to complete the item.

END OF DOCUMENT

ITEM 22

TACK COAT

22.01 SCOPE OF WORK

This work shall consist of furnishing and applying bituminous material to a previously prepared base or surface, to provide bond for a superimposed course, in accordance with the requirements of these Specifications.

22.02 MATERIALS

- (a) Bituminous materials shall conform to the requirements of the following Items of these Specifications:

Materials

AC-20 Asphalt

When the particular type and grade of bituminous material to be used is not shown on the Plans or otherwise designated, the Contractor shall select the type and the Engineer will designate the grade. Bituminous material may be conditionally accepted at the source.

- (b) The ranges of application temperatures in degrees Fahrenheit shall be as follows:

AC-20 325° to 400°

22.03 EQUIPMENT

All equipment necessary for the satisfactory performance of this construction shall be on hand and approved before work will be permitted. The required equipment shall include a power broom, equipment for heating bituminous material, a pressure distributor meeting the requirements of Item 21.03, and such other equipment and small tools as may be required to perform the work in a satisfactory manner.

22.04 PREPARATION OF SURFACE

The designated surface shall be prepared in accordance with the applicable provisions of Item 12. The surface shall be dry at the time the tack coat is applied.

22.05 APPLICATION OF BITUMINOUS MATERIAL

- (a) Immediately after cleaning the surface, bituminous material shall be applied with the pressure distributor at a rate directed by the Engineer, but not to exceed 0.05 gallons of residual bitumen per square yard.
- (b) The surfaces of trees and structures adjacent to the areas being treated shall be protected in such a manner as to prevent their being spattered or marred.
- (c) The tacked surfaces shall be allowed to dry until it is in a proper condition to receive the surface course. Tack coat shall be applied only so far in advance of surface course placement as is necessary to obtain this proper condition of tackiness. The Contractor shall protect the tack coat from damage until the surface course is placed.

22.06 METHOD OF MEASUREMENT (IF APPLICABLE)

- (a) Bituminous tack coat will be measured by the number of gallons (or the number of gallons unit(s) specified in the bid schedule) of material used in the accepted work, as determined by the Engineer, at the temperature of application.

22.07 BASIS OF PAYMENT (IF APPLICABLE)

This item will be paid for at the contract unit price per gallon (or the unit(s) per gallons specified in the bid schedule) for "Tack Coat" complete-in-place, which price shall be full compensation for all bituminous tack coat as indicated or directed and in accordance with the conditions, stipulations, provisions, and requirements contained herein for completing all incidentals thereto and for furnishing all materials, equipment, tools, labor and incidentals required to complete this Item.

END OF DOCUMENT

ITEM 23

REMOVAL OF STRUCTURES AND OBSTRUCTIONS

23.01 DESCRIPTION

This work shall consist of the removal, wholly or in part, and satisfactory disposal of all buildings, fences, structures, old pavements, abandoned pipe lines, and any other obstructions which are not designated or permitted to remain, except for the obstructions to be removed and disposed of under other items in the Contract. It shall also include the salvaging of designated materials and backfilling the resulting trenches, holes, and pits. When the Proposal does not include pay items for Removal of Structures and Obstructions as set out in this Section, such work shall be performed, and the costs thereof shall be included in the prices bid for other items of construction.

EQUIPMENT

23.02 EQUIPMENT

All equipment necessary for the satisfactory performance of this work shall be on the project and approved before the work will be permitted to begin.

CONSTRUCTION REQUIREMENTS

23.03 GENERAL

The Contractor shall raze, remove, and dispose of all buildings and foundations, structures, fences and other obstruction, any portions of which are on the rights-of-way, except utilities, and those for which other provisions have been made for removal. All material from such work designated to become the property of the Department shall be removed without unnecessary damage, in sections or pieces which may be readily transported, and shall be stored and protected by the Contractor at specified places within the project limits, and all material not so designated will become the property of the Contractor and shall be disposed of outside the limits view from the project. If the material is disposed of on private property, the Contractor shall secure written permission from the property owner. A copy of each agreement with property owners is to be furnished by the Engineer.

The City of Chattanooga reserves the right to dispose of buildings on any tract prior to their being torn down or removed by the contractor.

Buildings and other structures, which are indicated on the Plans to be removed or disposed of by other agencies, will not be held as a charge or responsibility of the Contractor except that the Contractor waives any and all claims for interference, delay or damage due to their removal or non-removal.

Foundations of buildings and structures shall be removed to a depth of not less than one foot below natural ground, except that within construction limits, removal shall be to a depth of not less than two feet below subgrade elevation. Basement floors shall be broken up to prevent holding of water. Basements or cavities left by structure removal shall be filled to the level of the surrounding ground and within the prism of construction and below subgrade elevation shall be compacted in accordance with the provisions of Item 1, Earthwork.

23.04 REMOVAL OF BRIDGES, CULVERTS, AND OTHER DRAINAGE STRUCTURES

Bridges, culverts and other drainage structures in use by traffic shall not be removed until satisfactory arrangements have been made to accommodate traffic.

Unless otherwise specifically designated or directed, the substructure of bridges shall be razed to the adjacent ground level or natural stream bottom for such portions located in a stream, except that such portions of the substructure of a bridge located in a navigable stream shall be subject to the laws of the U. S. Government and requirements set out in the standard permit form of the applicable government agency approving the location and plans and authorizing the construction of the structure. Where such portions of existing structures lie wholly or in part within the limits for a new structure, they shall be removed as necessary to accommodate the construction of the proposed structure.

Steel bridges and wood bridges designated to become the property of the City of Chattanooga shall be carefully dismantled without unnecessary damage. All such material shall be stored in a manner as to prevent damage.

Blasting or other operations necessary for the removal of an existing structure or obstruction, which may damage new construction, shall be completed prior to placing the new work, or adequate precautions shall be taken to prevent such damage.

23.05 REMOVAL OF PIPE

Pipe designated to become the property of the City of Chattanooga shall be carefully removed and every precaution taken to avoid breaking or damaging the pipe. Pipes shall be removed, and stored when necessary, so that there will be no loss or damage. The Contractor will be required to replace sections damaged by negligence or by use of improper methods.

23.05 REMOVAL OF PAVEMENT, SIDEWALKS, CURBS, ETC., CONSTRUCTED OF PORTLAND CEMENT CONCRETE

All pavement, base course, sidewalks, curbs, and gutters, etc., constructed of portland cement concrete designated for removal shall be disposed of as directed.

Concrete pavement, parking strip, and base, all with or without bituminous overlay, concrete curb and gutter, sidewalk, driveways, etc., shall be removed and disposed of as follows:

If the items are below subgrade elevation, but by not more than two feet, they shall be removed, disposed of, and the work paid for in accordance with this Section.

If the items are more than two feet below subgrade elevation, they shall be broken into size not to exceed two feet in maximum dimension and remain in place, unless it interferes with succeeding items of construction. The cost of this work shall be included in the unit price bid for other items of construction and shall not be paid for directly.

If the items are above subgrade elevation, the removal and disposal of same shall be paid for as provided in Item 1, Earthwork.

When specified, ballast, gravel, bituminous pavement or other pavement materials shall be removed and stockpiled as in an appropriate manner. Otherwise, such materials shall be disposed of as directed.

COMPENSATION

23.07 METHOD OF MEASUREMENT (IF APPLICABLE)

When the Contract stipulates that payment will be made for removal of structures and obstructions on a lump sum basis, the pay item, Removal of Structures and Obstructions, will include all structures and obstructions encountered within the rights-of-way in accordance with the provisions of this Section. Where the Contract stipulates that payment will be made for the removal of specific items on a unit basis, measurement will be made by the unit stipulated in the Contract.

Removal of Rigid Pavements, Sidewalks, etc., to be paid for under Item 23, will be measured for payment by the square foot unless the contract stipulates that payment for removal of rigid pavements, sidewalks, etc., will be on a lump sum basis.

Where the removal of pipe is designated as a specific item, it will be measured in linear feet or lump sum basis.

23.08 BASIS OF PAYMENT (IF APPLICABLE)

The accepted quantities of Removal of Structure and Obstructions will be paid for at the contract lump sum price bid, which price shall be full compensation for removing and disposing of the obstructions in accordance with the Contract.

Specific obstruction items, including pipe removal, stipulated for removal and disposal under unit price pay items and Removal of Rigid Pavements, Sidewalks, etc., will be paid for at the contract unit price bid per unit specified in the proposal, which price shall be full compensation for removal and disposal of such items, excavation and subsequent backfill incidental to their removal. The price shall also include salvage of materials removed, their custody, preservation, storage on the rights-of-way, or disposal as provided herein.

Payment will be made only when payment for all or any part thereof is provided for in a "Pay Item."

END OF DOCUMENT

ITEM 25

JOINT MATERIALS

25.01 PREFORMED JOINT FILLERS (NON-EXTRUDING AND RESILIENT TYPES)

(a) Preformed fillers for joints shall be of the bituminous type unless otherwise specified on the Plans, and when designated, shall be punched to admit the dowels.

(1) Bituminous Type

Bituminous type preformed fillers for joints shall consist of ASTM "Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and resilient Bituminous Types)," Serial Designation D 1751

(2) Non-Bituminous Types

Non-bituminous types of preformed filler for joints shall conform to the requirements of ASTM "Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction," Serial Designation D 1752, Type I, II, or III, as specified.

(b) The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint unless otherwise specified by the Engineer. When the use of more than one piece is authorized for a joint, the abutting ends shall be fastened securely, and held accurately to shape, by stapling or other positive fastening satisfactory to the Engineer.

25.02 JOINT MORTAR

Pipe joint mortar shall consist of one part Portland Cement and two parts sand with water necessary to obtain the required consistency. Portland Cement shall conform to the requirements of Item 3.05(a), Type 1. The sand shall conform to the requirements of Item 73.02. The water shall be approved for quality by the Engineer. Mortar shall be used within thirty minutes after its preparation.

25.03 RUBBER GASKETS

The gaskets shall conform to the requirements of ASTM "Standard Specifications for Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets," Serial Designation C 443.

25.04 HEMP AND OAKUM GASKETS

Gaskets of hemp or oakum packing for joint filler shall be closely twisted, and shall be of the size and type required for pipe under construction. Gaskets shall be in one piece of sufficient length to pass around the pipe and lap.

END OF DOCUMENT

ITEM 26

BITUMINOUS PLANT MIX BINDER (HOT MIX)

26.01 SCOPE OF WORK

This work shall consist of a foundation composed of a hot mixture of aggregate and asphalt prepared in a hot bituminous mixing plant. It shall be constructed in one or more layers, on a prepared subgrade, granular subbase, or base, in accordance with these Specifications and in reasonably close conformity with the lines, grades, thicknesses and typical cross-sections shown on the Plans or as directed by the Engineer. Each course shall have a thickness after compaction of not more than four inches. This construction shall include a leveling course if specified on the Plans.

The provisions of Item 12 of these Specifications shall apply to this construction unless otherwise stipulated.

26.02 MATERIALS

- (a) The materials used in this construction shall conform to the requirements of the following Items.

ITEM 67.01 ASPHALT CEMENT
PENETRATION GRADE 60-70, OR 85-100 OR AC20

ITEM 73.06 AGGREGATE FOR MIXTURE
GRADING A, B, C1 OR C2

ITEM 73.16 INSULATION COURSE MATERIAL

- (b) The specific grade of asphalt cement to be used will be decided by the Engineer. The specific grading of aggregate to be used will be specified in the Contract or shown on the Plans. Mineral aggregate, bituminous material and plant mix will be accepted as provided for in Item 12.02.

26.03 COMPOSITION OF MIXTURES

- (a) The specified mineral aggregate and asphalt cement shall be combined in such proportions as to produce mixtures within the following master composition limits:

		Proportion of Total Mixture by Weight		

Pay Item Number	Description	Aggregate Gradation	Combined Mineral Aggregate	Asphalt Cement

26A	Binder Type "A"	A	94%-97.5%	2.5%-6%
26B	Binder Type "B"	B	94%-97.5%	2.5%-6%
26C1	Binder Type "C1"	C1	94%-97.5%	2.5%-6%
26C2	Binder Type "C2"	C2	94%-97.5%	2.5%-6%

- (b) The bituminous base and/or leveling course shall be composed of aggregate and bituminous materials. The hot plant mixes shall comply with the applicable requirements of Item 12.03.

26.04 EQUIPMENT

All equipment necessary for the satisfactory performance of this construction shall be on the project, and approved before work will be permitted to begin. The equipment shall meet the requirements of Item 12.04 through 12.17 of these Specifications.

26.05 GENERAL CONSTRUCTION REQUIREMENTS

The construction requirements shall be as prescribed in Item 12.11 through Item 12.17, Item 21.09, Item 26.06 and Item 26.07 of these Specifications.

26.06 PREPARATION OF SUBGRADE, SUBBASE, OR SURFACE

- (a) The Plans will indicate whether the plant-mixed base is to be constructed on a treated or untreated subgrade or subbase, on a granular base, or insulation course, or on an existing surface. Conditioning of existing surface, when called for on the Plans, shall be in accordance with the provisions of Item 12.10. Prime coat or tack coat, when specified on the Plans, shall be constructed in accordance with the provisions of Item 21 or Item 22, respectively.
- (b) Bituminous plant-mix base mixture shall be placed only upon a surface that is dry, and cleaned of loose particles and other undesirable materials.

26.07 THICKNESS AND SURFACE REQUIREMENTS

- (a) Thickness shall be controlled during the spreading operation by frequent measurements taken on the freshly spread mixture to establish the relationship between the uncompacted mixture and the completed course. Thickness or pounds per square yard shall be within reasonably close conformity with that specified on the Plans.
- (b) The surface of the bases shall meet the requirements specified under Item 12.18 and then tested in accordance with the provisions of that Item. The deviation of the surfaces from the testing edge of the straight-edge shall not exceed the amounts shown below for the several types of mixtures:

Grading A Mixture	1/2 Inch
Grading B Mixture	3/8 Inch
Grading C Mixture	3/8 Inch

26.08 METHOD OF MEASUREMENT (IF APPLICABLE)

- (a) "Bituminous Plant Mix Binder" -will be measured by the ~~ton of 2000 pounds~~unit(s) specified in the bid schedule, accepted and placed as indicated on the Plans and/or Specifications or as directed by the Engineer.
- (b) No allowance will be made for unacceptable materials; for material furnished or used in excess of the amount indicated on the Plans and/or Specifications or as directed by the Engineer; no allowance will be made for material used in replacing defective or condemned construction; and no allowance will be made for material wasted in handling, hauling, or otherwise.

26.09 BASIS OF PAYMENT (IF APPLICABLE)

"Bituminous plant mix binder" shall be paid for at the contract unit price ~~per ton of 2000 pounds~~specified in the bid schedule for Binder Type "A", Binder Type "B", Binder Type "C1" or Binder Type "C2", complete-in-place, which price shall be full compensation for the construction of a bituminous plant mix binder, as indicated or directed, and indicated on the Plans and/or Specifications or as directed by the Engineer, and in accordance with the conditions, stipulations, provisions, and requirements contained herein; for completing all incidentals thereto; and for furnishing all materials, equipment, tools, labor, and incidentals required to complete this Item.

END OF DOCUMENT

ITEM 27

ASPHALTIC CONCRETE SURFACE (HOT MIX)

27.01 SCOPE OF WORK

- (a) This work shall consist of an asphaltic concrete pavement composed of a mixture of coarse aggregate, fine aggregate, mineral filler if specified or required, and asphalt cement, constructed on a prepared roadbed in accordance with these Specifications and in reasonably close conformity with the lines, grades, typical cross-section and rate of application shown on the Plans, or established by the Engineer.
- (b) The provisions of Item 12 of these Specifications shall apply to his construction unless otherwise stipulated.

27.02 MATERIALS

- (a) Materials used in this construction shall meet the requirements of the following Items of these Specifications:

ITEM 14.09(b)	CHEMICAL ADDITIVE
ITEM 67.01	ASPHALT CEMENT, VISCOSITY GRADE AC-20 PENETRATION GRADE 60-70 OR 85-100
ITEM 73.11	MINERAL AGGREGATE
ITEM 73.17	MINERAL FILLER
- (b) Asphalt cement used with aggregate Gradings D and F in the preparation of asphaltic concrete surface mixtures shall be treated with an anti-stripping additive as specified in Item 74.09.

27.03 COMPOSITION OF MIXTURES

- (a) Composition of mixtures in this construction shall meet all applicable requirements of Item 12.03.
- (b) The specified mineral aggregate and asphalt cement shall be in such proportions as to produce mixtures within the following master composition ranges:

**Proportion of Total
Mixture by Weight**

Pay Item Number	Description	Aggregate Gradation	Combined Mineral Aggregate	Asphalt Cement
27D	Surface Course "D"	D	92.0%-95.0%	5.0%- 8.0%
27E	Surface Course "E"	E	92.0%-95.0%	5.0%- 8.0%
27F	Surface Course "F"	F	90.0%-93.0%	7.0%-10.0%

27.04 EQUIPMENT

The equipment used in this construction shall meet the requirements of Items 12.04 through 12.08. All equipment necessary for the satisfactory performance of this construction shall be on the project, and approved, before work will be permitted to begin.

27.05 CONSTRUCTION REQUIREMENTS

The construction requirements for this work shall be as prescribed in Item 12.09, Item 12.11, Item 12.12, Items 12.14 through 12.17, and Items 27.06 through 27.08.

27.06 PREPARING THE DESIGNATED SURFACE

Preparation of the designated surface upon which the material is to be placed shall be performed in accordance with the applicable provisions of these Specifications.

27.07 MIXING

Requirements for mixing shall be as prescribed in Item 12.13. In addition, the mixing cycle for surface course mixtures shall include a dry-mixing period of at least five seconds.

27.08 SURFACE REQUIREMENTS

The surface shall meet the requirements specified under Item 12.18, and when tested in accordance with the provisions of that Item, the deviation of the surface from the testing edge of the straightedge shall not exceed one-fourth inch (1/4").

27.09 COMPENSATION (IF APPLICABLE)

- (a) "Asphaltic Concrete Surface (Hot Mix)" will be measured by the ~~ton of 2000 pounds~~unit(s) specified in the bid schedule, accepted and placed as indicated on the Plans and/or Specifications, or as directed by the Engineer.
- (b) No allowance will be made for: unacceptable materials; for materials furnished or used in excess of the amount indicated on the Plans and/or the Specifications, or as directed by the Engineer; for material used in replacing defective or condemned construction; or for material wasted in handling, hauling, or otherwise.

BASIS OF PAYMENT (IF APPLICABLE)

"Asphaltic Concrete Surface (Hot Mix)" shall be paid for at the contract price ~~per ton of 2000 pounds~~specified in the bid schedule for Item 27D, Item 27E, or Item 27F, complete-in-place, which price shall be full compensation for the construction of an asphaltic concrete surface as indicated on the Plans or on the Specifications or as directed by the Engineer and in accordance with the conditions, stipulations, provisions, and requirements contained herein; for completing all incidentals thereto; and for furnishing all materials, equipment, tools, labor, and incidentals required to complete this Item.

END OF DOCUMENT

ITEM 33

ADJUSTING MANHOLE FRAMES AND COVERS INLETS, AND CATCH BASINS

33.01 SCOPE OF WORK

This item shall consist of reconstructing and/or adjusting manholes, inlets, or catch basins and furnishing all materials and labor necessary to bring them to the locations and grades as shown on the Plans or as designated by the Engineer. The Contractor shall be responsible for raising to grade all city manholes, whether or not visible to the naked eye. Sewer Plans showing locations of manholes shall be made available to the Contractor as construction progresses for the purpose of locating manholes which are not visible at street level.

33.02 RESETTING

All manholes, covers, inlets, and catch basins shall be reset in accordance with these Specifications when the existing manholes, inlets, or catch basins are more than one-quarter inch (1/4") over or under the grade shown on the Plans for the finished pavement or construction. They shall be accurately set to line and grade by removing the frame and cover, and raising or lowering the masonry top of the structure and resetting on a cushion of cement mortar; or, in the case of manholes, American Highway Prod's manhole risers or equal shall be used when possible. Riser heights shall be in 1/4 inch increments from 1 inch through 3 inches with turnbuckle or toggle linkage.

33.03 EXCAVATION

Excavation shall be performed wherever necessary to bring the manholes, inlets, and catch basins to grade as shown on the Plans and as designed by the Engineer.

33.04 MATERIALS

- (a) Building brick shall be number one, hard grade brick. These brick, when made from clay or shale, shall conform to AASHTO, "Standard Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)," Serial Designation M114. When made of concrete, they shall conform to ASTM "Standard Specification for Concrete Building Brick," Serial Designation C 55.
- (b) Concrete shall be Class A concrete which meets all requirements of Section 604 of the Tennessee Department of Transportation Standard Specifications.

(c) Masonry Mortar

1. Mortar shall be composed of the following mixture: one part Portland Cement, two parts sand, hydrated lime not to exceed ten percent of the cement used. Water shall be added to the mixture in such quantity as to form a stiff paste.
2. The mortar shall be hand-mixed or machine-mixed. In the preparation of hand-mixed mortar, the sand, cement and hydrated lime shall be thoroughly mixed together in a clean, tight, mortar mix until the mixture is of uniform color, after which water shall be added. Machine-mixed mortar shall be prepared in an approved mixer, and shall be mixed not less than 1 1/2 minutes.
3. Mortar shall be used within thirty minutes after mixing. Re-tempering of mortar will not be permitted.
4. Materials used shall conform to the following Specifications:

a. Portland Cement, Type I	AASHTO M 85
b. Hydrated Lime	ASTM C 6
c. Sand	Item 73.02
d. Water	Item 74.01

(d) Backfill material shall conform to the existing material in the subgrade and base course, and thoroughly tamped in place until no further displacement occurs.

(e) Adjustable manhole frames shall consist of not less than four circular segments connected by diameter adjustment screws with locking apparatus. Each segment shall contain no less than two grade-adjustment set-screws with locking apparatus. The cover seat portion of the frame shall be covered with a plastic gasket. The frame shall be capable of being adjusted to fit the existing manhole frame in such a manner that no vibration or movement of the manhole cover will occur. Adjustable frames shall be approved by the Engineer prior to placement.

33.05 CLEANING

All manholes, inlets, and catch basins shall be thoroughly cleaned of all excess mortar and accumulations of silt, clay, debris, or foreign matter of any kind and shall be free from such at the time pavement is to be laid.

33.06 MEASUREMENT (IF APPLICABLE)

The number of manholes, inlets, and catch basins paid for will be the actual number of each type ordered, reset, completed and accepted by the Engineer, except that extra payment shall be made at a price per inch for adjustment in excess of four inches.

33.07 PAYMENT (IF APPLICABLE)

The accepted number of each manhole, inlet or catch basin adjusted by not more than four inches (4") will be paid for at the respective contract unit price bid for each type. Adjustment in excess of four inches (4") shall be paid for at the contract unit price per vertical inch for "Excess Manhole Adjustment." Payment shall be payment in full for furnishing all materials, excavation, form work when necessary, backfilling, disposal of surplus materials, and for all labor, equipment, tools, and incidentals necessary to complete the work herein specified.

END OF DOCUMENT

ITEM 34
CATCH BASINS, INLETS AND
MISCELLANEOUS DRAINAGE STRUCTURES

34.01 SCOPE OF WORK

This item shall consist of catch basins, inlets, inspection holes and miscellaneous drainage structures constructed of such materials and in accordance with these Specifications at the locations and in conformity with the lines, grades and dimensions shown on the Plans or required by the Engineer. These structures shall include the furnishing and installation of such specials and connections to pipes and other structures as may be required to complete the item as shown the Plans or required by Engineer. The structures shall provide for the collection of surface water with the exception of manholes and inspection holes with closed covers which will be designated on the Plans or required by the Engineer.

34.02 BRICK

Brick shall be medium hard or better grade MA Brick, conforming to the requirements of the latest ASTM "Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)," Serial Designation C 32.

34.03 MORTAR

The mortar for brick masonry and similar work shall be composed of one part of Portland Cement and three parts mortar sand by volume. The Portland Cement shall conform to the requirements of ASTM "Standard Specification for Portland Cement," Serial Designation C 150, Type 1. The sand shall conform to the requirements of AASHTO, "Standard Specification for Aggregate for Masonry Mortar," Serial Designation M 45. The water shall be clean and free from injurious amounts of sewage, oil, acid, strong alkalies or vegetable matter.

34.04 CONCRETE

a) Plain and reinforced concrete used in structures, connection of pipes with structures, support of structures or frames, shall be Class A.

b) Precast concrete catch basins, Inlets and miscellaneous drainage structures may be precast. These precast structures shall meet the requirements set forth in ASTM 478 and ASTM C913.

34.05 FRAMES, COVERS AND GRATINGS

The castings shall conform to the following requirements:

(a) Castings shall meet the requirements of AASHTO, "Standard Specification for Gray Iron Castings," Serial Designation M 105, and shall be made in accordance with City Standard frames, grates and backs as shown on the Drawings.

(b) All castings shall be true to form and dimensions, and shall be free from inclusions of foreign material, casting faults, injurious blow holes, cracks, sponginess, and other defects rendering them unsuitable.

(c) The finished frame and cover or grate shall have the bearing surfaces machined or ground so that there will be no variation that will permit rocking or rattling, and the diameter of the cover or grate shall be such as to fit the frame without wedging.

(d) All grate castings shall be designed for supporting a uniform load of one hundred (100) pounds per square inch. The open areas of the gratings shall be as designated on Plans, and the design loading shall be as specified.

34.06 STEPS

The steps or ladder bars shall be gray or malleable cast iron, galvanized wrought iron, or galvanized steel. The bars shall be smoothly rolled and free from slivers, depressions or seams. The steps shall be the size, length, and shape as shown on the Plans. The steps which are not galvanized shall be given a coat of bituminous paint when directed.

34.07 UNCLASSIFIED EXCAVATION

(a) The Contractor shall do all excavation for structures and structure footings to the lines and grades or elevations, shown on the Plans, or as staked by the Engineer. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown. The elevations of the bottoms of footings, as shown on the Plans, shall be considered as approximate only, and the Engineer may order, in writing, such changes in dimensions or elevations of footings as may be deemed necessary to secure a satisfactory foundation.

(b) Boulders, logs, or any other objectionable material encountered in excavation shall be removed. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped, or serrated, as directed by the Engineer. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. When concrete is to rest on a surface other than rock, special care shall be taken not to disturb the bottom of the excavation, and excavation to final grade shall not be made until just before the concrete or reinforcing is to be placed.

(c) The Contractor shall do all bracing, sheathing, or shoring necessary to perform and protect the excavation and the structure; also, as required for safety or to conform to governing laws. The cost of bracing, sheathing, or shoring shall be included in the unit price bid for the structure.

(d) Unless otherwise provided, bracing, sheathing or shoring involved in the construction of this item shall be removed by the Contractor after the completion of the structure. Removal shall be effected in such a manner as not to disturb or mar finished masonry. The cost of removal shall be included in the unit price bid for the structure.

(e) After each excavation is completed, the Contractor shall notify the Engineer to that effect, and concrete and reinforcing steel shall be placed after the Engineer has approved the depth of the excavation and the character of the foundation material.

34.08 BRICK STRUCTURES

(a) Foundations

A prepared foundation shall be placed for all brick structures after the foundation excavation is completed and accepted. Unless otherwise specified, the base shall consist of Class A concrete mix. The foundation shall be built to the correct elevation, and shall be finished to insure the least possible resistance of flow.

(b) LAYING BRICK

1. All bricks shall be thoroughly clean. The bed which is to receive the brick shall be thoroughly cleaned and wetted with water before placing mortar thereon. All brick shall be laid in freshly made mortar composed of one part by volume of Portland Cement and three parts by volume of sand, with the possible addition of hydrated lime in an amount not to exceed fifteen percent (15%) by volume of the cement used. The brick shall be laid in courses using the shoved joint method to thoroughly bond them into the mortar and always with the joints completely filled with mortar. The brick shall be laid in a work person-like manner and true to the lines and grades indicated on the Plans. The arrangement of headers and stretchers shall be such as will thoroughly bond the masonry, and unless otherwise indicated, brick masonry shall be of alternate headers and stretchers with consecutive courses breaking joints. The courses shall be laid continuously with joints broken or alternating evenly with the joints in the proceeding courses. The joints shall not be less than one-fourth inch (1/4") more than one-half inch (1/2") in thickness. Face joints shall be neatly struck, using the weather joint. All joints shall be finished properly as the laying of brick progresses.

2. No spalls or batts shall be used except in shaping around irregular openings or connections or when unavoidable to finish out a course, in which case, a full brick shall be used at the corner and the bat in the interior of the course.

3. In case any brick is removed, or a joint broken during the laying, the brick shall be taken up, the mortar thoroughly cleaned from the brick, bed, joints, and the brick re-laid in fresh mortar. In hot and dry weather or when directed, the brick masonry shall be protected and kept moist for a period of at least forty-eight (48) hours after laying of the brick.
4. Brick masonry shall not be constructed in freezing weather or when bricks contain frost, except by written permission of the Engineer and subject to such conditions for protection against freezing.

34.09 CONCRETE STRUCTURES

- (a) The structures shall be constructed of concrete, built on prepared foundations, conforming to the dimensions and form indicated on the Plans. Any reinforcement required shall be of the kind, type and size, and shall be furnished, located, spaced, bent and fastened as indicated on the Plans. It shall be approved by the Engineer before the concrete is poured.
- (b) All invert channels shall be constructed and shaped accurately so as to be smooth, uniform, and cause minimum resistance to flow. The interior bottom shall be sloped downward toward the outlet.
- (c) Precast Concrete structures may be used in lieu of any poured in place concrete structure.

34.10 INLET AND OUTLET PIPES

Inlet and outlet pipes shall extend toward the walls of the structures for a sufficient distance beyond the outside surface for connections, but shall be cut off flush with the wall on the inside surface unless otherwise directed. Concrete or brick and mortar shall be constructed around the pipes so as to prevent leakage and form a neat connection.

34.11 PLACEMENT AND TREATMENT OF CASTINGS, FRAMES AND FITTINGS

- (a) All castings, frames and fittings shall be placed in the positions indicated on the Plans or as directed by the Engineer and shall be set true to line and to correct elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in-place and position before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.
- (b) When frames or fittings are to be placed upon previously constructed masonry, the bearing surface or masonry shall be brought true to line and grade and present an even bearing surface in order that the entire face or back of the unit will come in contact with the masonry, as indicated on the Plans or as directed and approved by the Engineer. All units shall set firm and secure.

(c) After the frames or fittings have been set in final position and the concrete or mortar has been allowed to harden for seven (7) days, the grates or covers shall be placed and fastened down.

34.12 INSTALLATION OF STEPS

The steps shall be installed as indicated on the Plans, or as directed by the Engineer. When the steps are to be set in concrete, they shall be placed and secured in position before the concrete is poured. When the steps are installed in brick masonry, they shall be placed as the masonry is being built. The steps shall not be disturbed or used until seven (7) days have elapsed. After this period has expired, the steps shall be cleaned and painted, unless they have been galvanized.

34.13 BACKFILLING

(a) After a structure has been completed, the area around it shall be filled with approved material, in horizontal layers not to exceed three inches (3") in loose depth, and compacted to the density specified. The fill shall be made to the elevation shown on the Plans, or as directed by the Engineer.

(b) No backfilling shall be placed against any structure until permission is given by the Engineer. In the case of concrete, such permission will not be granted until the concrete has been in place for fourteen (14) days, or until the tests made by the laboratory under the supervision of the Engineer establish that the concrete has attained sufficient strength to withstand any pressure created by the methods used and materials placed without damage or strain beyond a safe factor. Adequate provisions shall be made for thorough drainage.

(c) Fill shall be deposited all around a structure to approximately the same elevation at the same time. Special care shall be taken to prevent any wedging action against the structure, and all slopes bounding or within the area to be backfilled will be stepped or serrated to prevent wedge action.

(d) All backfill shall be compacted to the density required by Item 1.

(e) Backfill shall not be measured for direct payment. Performance of this work is not payable directly, but shall be considered as subsidiary obligation of the Contractor, covered under the contract unit price for the structure involved.

34.14 CLEANING AND RESTORATION OF SITE

(a) After the backfilling is completed, the Contractor shall dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankment, shoulder or as ordered by the Engineer.

(b) After all work is completed, the Contractor shall remove all of his/her tools from the construction site, leaving the entire site free, clear and in good condition.

(c) Performance of the work described in this section is not payable directly, but shall be considered as a subsidiary obligation of the Contractor, covered under the contract unit price for the structure.

34.15 DETERMINATION OF PAY QUANTITIES (IF APPLICABLE)

(a) The quantities of catch basins or inlets shown on the Drawings for which payment will be allowed shall be the actual number of each type, size and depth of catch basin or inlet, four feet deep or less, installed by the Contractor and accepted by the Engineer.

(b) The depth of all catch basins or inlets will be measured from the top of the frame to the invert of the lowest sewer entering or leaving the structure. Catch basins or inlets four feet or less in depth shall be measured and paid for as one catch basin or inlet at the contract unit price, each, for the catch basin or inlet as set forth under the applicable item in the Bid Schedule.

(c) For a catch basin or inlet more than four feet in depth, payment will be allowed for extra depth, per vertical foot, for each foot thereof over four feet at the applicable unit price provided for in the Bid Schedule. Fractions of a foot of extra depth shall be accumulated until one foot has been constructed for payment.

(d) All other items such as rock excavation, pipe, etc., shall be paid for under their respective items in the Bid Schedule as elsewhere provided herein.

34.16 PAYMENT (IF APPLICABLE)

Payment for all catch basins or inlets as constructed under these Specifications shall be made for the quantities determined in the manner specified above as listed under the contract pay items in the Bid Schedule. These amounts, so paid, shall constitute full compensation to the Contractor under this item and shall cover the cost of furnishing all labor, materials, tools, plant equipment, services, and other expenses in connection with the furnishing and construction of catch basins or inlets complete-in-place including all excavation, backfill, masonry, all castings, reinforcing steel, inspection and tests, all as herein specified.

END OF DOCUMENT

ITEM 35

SODDING AND/OR SEEDING

35.01 SCOPE OF WORK

(a) Sodding

1. Sodding shall consist of planting an entire area with sod.
2. Strip sodding shall consist of planting narrow strips in continuous lines.
3. Spot sodding shall be planted as indicated on the Plans.
4. Sod, strip sod, or spot sod shall be planted on areas indicated on the Plans or as directed by the Engineer and in accordance with these Specifications.

(b) Seeding

Seeding shall consist of preparing the ground area and sowing grass seed of the group specified at such locations as may be indicated on the Plans or as directed by the Engineer in conformity with the provisions and requirements set out in these Specifications, stipulated in Special Provisions, or as directed by the Engineer. Seeding shall also consist of the maintenance and final clearing up in conformity with the provisions and requirements set out in these Specifications, stipulated in Special Provisions or as directed by the Engineer. In general, all newly graded earthen areas that are not to be paved, stabilized or sodded shall be seeded, unless otherwise indicated on the Plans or as directed by the Engineer.

35.02 MATERIALS

(a) Sodding

1. Sod shall consist of a live, dense, well-rooted growth of permanent grasses, free from Johnson grass, nut grass and other obnoxious grasses, of suitable character for the purpose intended and for the soil in which it is planted. It shall be uninjured at the time of planting.
2. Sod, strip sod, or spot sod must be free of weeds, bind weeds or other matter which has a tendency to kill grass.
3. All sod for sodding shall be at least eight inches (8") wide, not less than twelve inches (12") long and have at least two and one-half inches (2 1/2"), in thickness, of dirt on its roots.

4. All sod for strip sodding shall be at least three inches (3") wide, not less than twelve inches (12") long and have at least two and one-half inches (2 1/2"), in thickness, of dirt on its roots.

5. All sod for spot sodding shall be at least three inches (3") square and have at least two and one-half inches (2 1/2"), in thickness, of dirt on its roots.

6. Ammonium nitrate shall be a standard commercial product, shall conform to the requirements for other commercial fertilizers as specified in Item 74.16 of these Specifications and shall have a minimum of thirty-three and one-half percent (33 1/2%) nitrogen.

(b) Seeding

1. Seed shall meet all requirements of Item 74.14 of these Specifications. All grass seed shall be of the previous year's crop. All seeds shall be free of illegal weed seeds; grass seeds will be rejected when they contain weed seeds in excess of one percent (1%).

2. Mulch shall meet all requirements of Item 74.18 of these Specifications. Mulch binder shall be either cut-back asphalt Grade RC-70 or RC-250 conforming to the requirements of Item 904.03 of the Tennessee Department of Transportation Specifications.

3. Topsoil shall meet all requirements of Item 36 of these Specifications.

(c) Fertilizer

Fertilizer (15-15-15) shall contain fifteen percent (15%) nitrogen, fifteen percent (15%) phosphoric acid and fifteen percent (15%) potash, and shall be a good grade commercial fertilizer. The fertilizer shall be furnished in standard containers with the name, weight and guaranteed analysis of the contents clearly marked. The containers shall insure proper protection in handling and transporting the fertilizer. All commercial fertilizer shall comply with local, state and federal fertilizer laws and with Item 74.15 of these Specifications.

(d) Agricultural Limestone

Agricultural limestone shall contain not less than eighty-five percent (85%) of calcium carbonate and magnesium carbonate combined, and shall be crushed so that at least eighty-five percent (85%) will pass the No. 10 mesh sieve.

35.03 EQUIPMENT

(a) All equipment necessary for the proper preparation of the areas and for the sowing and maintenance must be available when required, in first class working condition, and shall have been approved by the Engineer before construction is permitted to begin.

(b) The Contractor's attention is especially called to the fact that he shall provide satisfactory equipment for watering and sprinkling.

35.04 WEATHER LIMITATIONS

(a) Sodding

Sod, strip sod or spot sod shall be planted only when the soil is moist and favorable to growth. No planting shall be done between October 1st and April 1st unless weather and soil conditions are considered favorable and permission is granted by the Engineer.

(b) Seeding

1. The Contractor shall notify the Engineer at least forty-eight (48) hours in advance of the time he intends to begin sowing seed and shall not proceed with such work until permission to do so has been granted by the Engineer. Before starting seeding operations on any area, final dressing shall have been completed in accordance with the requirements of Item 36.

2. The seed group mixture shall be as specified under Item 74.14. Group A seed shall be used for seeding from February 1 to August 1, and Group B seed shall be used from August 1 to December 1, except that either Group A or B may be used during the month of August.

3. Seeding shall be performed only when the soil is in a tillable and workable condition, and no seeding shall be performed between December 1 and February 1 unless otherwise permitted.

35.05 PREPARATION AND PLANTING

(a) Sodding

1. The area to be sodded shall be constructed to the lines and grades indicated on the Plans or as directed by the Engineer, and the surface loosened to a depth of not less than three inches with a rake or other device. If necessary, it shall be sprinkled until saturated at least one inch in depth and kept moist until the sod is placed thereon. Immediately before placing the sod, the fertilizer shall be uniformly applied at the rate of eight pounds of Grade 15-15-15, or equivalent per 1,000 square feet. Agricultural limestone shall be applied at the rate of 75 pounds per 1,000 square feet.

2. The entire area shall be thoroughly covered with sod.

3. The sod shall be placed on the prepared surface with the edges in close contact and, as far as possible, in a position to break joints. Each sod laid shall be fitted in the space placed and shall be pounded into place with wooden tamps, 10 inch by 10 inch, or other satisfactory implement.

The sod shall be maintained moist from time of removal until reset but shall be placed as soon as practicable after removal from place where growing. Immediately after placing, it shall be rolled with a roller between four feet and six feet in length and weighing approximately 1,000 pounds, or hand tamped to the satisfaction of the Engineer.

4. On steep slopes, or where necessary, pinning or pegging will be required to the sod in place.

(b) Strip Sodding

Strip sod shall be laid in a continuous line, not more than 12 inches apart. Before placing these sodding strips, the furrows shall be thoroughly watered and the fertilizer applied uniformly in the furrows at the rate of 8 pounds of Grade 15-15-15, or equivalent, per 1,000 square feet. Agricultural limestone shall be applied at the rate of 75 pounds per 1,000 square feet. The sodding strips shall be reset as soon as practicable after removal from the location where growing, lightly covered with earth and thoroughly rolled with a roller between four feet and six feet in length and weighing approximately 1,000 pounds, or hand tamped. It shall then be carefully raked to the satisfaction of the Engineer in order to break up the crust of earth formed by rolling or tamping.

(c) Spot Sodding

1. The area to be spot sodded shall be constructed to the lines and grades indicated on the Plans or as directed by the Engineer. Holes shall be dug not less than four inches square and three inches deep and not more than 12 inches apart.
2. Fertilizer and lime shall be used at the rate as specified in Paragraph 35.02 (c) and 35.02 (d) above, one-half of which must be evenly distributed and placed in the holes dug for the spot sodding.
3. Before spot sodding and fertilizer have been placed, the entire area shall be thoroughly wetted until the holes hold water to 1/3 their depth.
4. After the spot sod has been placed, any openings around the sod shall be filled and the entire area thoroughly rolled and raked as set out in paragraph 35.05 (b).

(d) Seeding

The seedbed shall be prepared in the following manner and sequence:

1. Each area to be seeded shall be scarified, disced, harrowed, raked or otherwise worked until it has been loosened and pulverized to a depth of one inch and brought to the lines and grades indicated on the Plans or directed by the Engineer.

2. This operation shall be performed only when the soil is in a tillable and workable condition. Fertilizer, at the rate of not less than 10 pounds of grade 15-15-15, or equivalent, per 1,000 square feet, and agricultural limestone at a rate of not less than 75 pounds per 1,000 square feet, shall be distributed evenly over the seedbed, unless other rates are specified in the proposal or on the Plans. The limestone and fertilizer shall be lightly harrowed, raked or otherwise incorporated into the soil for a depth of approximately 1/2 inch. Fertilizer need not be incorporated in the soil as specified above when mixed with seed in water and applied with power sprayer equipment.
3. Seed of the specified group shall be sown as soon as preparation of the seedbed has been completed. It shall be sown uniformly by means of a rotary seeder, wheelbarrow seeders, hydraulic equipment or other satisfactory means and unless otherwise specified on the Plans or in the Special Provisions, at the rate of 1-1/2 pounds per unit (1,000 square feet).
4. No seeding shall be done during windy weather or when the ground surface is frozen, wet or otherwise non-tillable.

(e) Mulching

1. Immediately following the seeding operations as described above, the mulch material shall be spread evenly over the seeded areas at an approximate rate of 100 pounds per 1,000 square feet immediately following the seeding operations. This rate may be varied by the Engineer depending on the texture and condition of the mulch material and the characteristics of the area seeded. All portions of the seeded areas shall be covered with a uniform layer of mulch so that approximately 25 percent of the ground is visible.
2. The mulch shall be held in place by the use of an approved mulch binder. Cut-back asphalt or emulsified asphalt shall be applied at the approximate rate of four gallons per unit (1,000 square feet) as required to hold the mulch in-place. Mulch in medians and other areas affected by traffic shall be held in-place by applying asphalt binder at the approximate rate of 11 gallons per unit. The Contractor shall cover bridges, guardrails, signs and appurtenances if the mulch binder is applied in such a way that it would come in contact with or discolor the structures.

35.06 MAINTENANCE

(a) Sodding

1. The sod shall be watered as directed by the Engineer for a period of two weeks, after which ammonium nitrate shall be applied at the rate of 3.5 pounds per 1,000 square feet and the sod given a final watering.
2. The Contractor shall not allow any equipment or material to be placed on any planted area and shall erect suitable barricades and guards to prevent his equipment, labor or the public from traveling on or over any area planted with sod, strip sod or spot sod.

3. It shall be the obligation of the Contractor to secure a satisfactory growth of grass before final acceptance of the project.

(b) Seeding

1. All seeded areas shall be cared for properly to the Engineer's satisfaction until acceptance of the work. Such care shall include mowing the seeded areas when required by the Engineer. When mowing is required, mower blades shall be set at sufficient height to protect the vitality of the growth. Surfaces gullied or otherwise damaged following seeding shall be repaired by re-grading and re-seeding as directed.

2. All grassing which does not show satisfactory growth or a uniform stand shall be re-seeded as follows:

Reseeding shall be performed at any time when required by the Engineer during the life of the contract.

After the grass seed has started growing, any parts or areas which fail to show a uniform stand of grass for any reason whatsoever, shall be re-seeded at the Contractor's own expense, with the same combination of seed as originally used thereon, and such reseeding shall be repeated until all required areas are covered with grass.

35.07 FINAL CLEARING UP

(a) Final clearing up shall consist of completely cleaning the area of all equipment, rubbish, excess materials and unused materials caused by sodding and seeding and any other matter of materials which will mar the appearance or condition of the project and satisfactorily disposing of same.

(b) In addition, final clearing up shall be performed in accordance with the provisions and requirements set out in the General Specifications of the Contract.

(c) All pavements and structures shall be swept clean of all dirt or rubbish which may have become deposited upon them during construction.

35.08 MEASUREMENT (IF APPLICABLE)

All areas shall be obtained from surface measurements.

(a) Sodding

The area of sodding to be measured for payment shall be the number of square yards sodded in accordance with these Specifications and accepted by the Engineer.

(b) Seeding

The area of seeding to be measured for payment shall be the number of acres seeded in accordance with these Specifications and accepted by the Engineer.

35.09 PAYMENT (IF APPLICABLE)

(a) Sodding

1. No direct allowance will be made for the excavation and disposal of any material necessary for the preparation of areas to be sodded.
2. Sodding, strip sodding and spot sodding will be paid for at the contract unit price per square yard, complete-in-place, which price shall be full compensation for preparation of the area; for furnishing the required sod; for placing sod; for furnishing and placing the fertilizer, lime and ammonium nitrate; for watering or sprinkling; for disposal of excess material; for all maintenance; for re-sodding, if required; for final clearing up; for completing all incidentals thereto; and for furnishing all materials, labor, equipment, tools and incidentals required to complete the item.

(b) Seeding

1. No direct allowance will be made for the excavation and disposal of any material necessary for the preparation of areas in which seeding is to be performed.
2. Seeding, (with mulch) will be paid for at the contract unit price per acre, complete-in-place, which price shall be full compensation for preparation of the area; for furnishing the required combination of seed; for furnishing and placing the fertilizer, agriculture limestone and mulching; for watering or sprinkling; for disposal of excess material; for all maintenance; for re-sowing, if required; for final clearing up; for completing all incidentals thereto; and for furnishing all materials, equipment, tools, labor and incidentals necessary to complete the item, except topsoil which will be paid for under Item 36.

(c) Payment will be made under one or more of the following pay items as set forth in the Bid Schedule:

Item No. 35-1a	Sodding-per square yard
Item No. 35-1b	Strip Sodding-per square yard
Item No. 35-1c	Spot Sodding-per square yard
Item No. 35-2	Seeding, (with mulch)-per square yard

END OF DOCUMENT

ITEM 36

TOPSOIL

36.01 DESCRIPTION

Topsoil for planting shall consist of a rich friable soil conforming to the requirements and provisions set out in these Specifications, stipulated in special provisions, or as approved by the Engineer, and obtained from locations indicated on the Plans, stipulated in Special Provisions, or as approved by the Engineer. Topsoil shall be placed at the locations indicated on the Plans set out in the Specifications or as directed by the Engineer, and in conformity with the provisions and requirements set out in the Specifications or as required by the Engineer.

36.02 MATERIAL

Topsoil for planting shall be a rich friable loam containing a large amount of humus and shall be original surface sandy loam, topsoil of good, rich, uniform quality, free from any material such as hard clods, stiff clay, hardpan, partially disintegrated stone, pebbles larger than 1/2 inch in diameter, lime, cement, bricks, ashes, cinders, slag, concrete, bitumen or its residue, boards, sticks, chips, or other undesirable material harmful or unnecessary to plant growth. Topsoil shall be reasonably free from perennial weeds and perennial wood seeds, and shall not contain objectional plant material, toxic amounts of either acid or alkaline elements or vegetable debris undesirable or harmful to plant life. Bermuda grass roots in topsoil will not be accepted, unless otherwise approved by the Engineer.

Topsoil shall be natural topsoil without admixture of subsoil material and shall be classifiable as a loam, silt loam, clay loam, or a combination thereof. Topsoil shall contain not less than five percent nor more than 20 percent, by weight, of organic matter as determined by loss on ignition of oven-dried samples. The ignition test shall be performed on samples which have been thoroughly oven-dried to constant weight at a temperature of 221 degrees F.

Topsoil shall be secured from areas from which topsoil has not been previously removed, either by erosion or mechanical methods. Topsoil shall not be removed to a depth in excess of the depth approved by the Engineer.

The area or areas from which topsoil is secured shall possess such uniformity of soil depth, color, texture, drainage and other characteristics as to offer assurance that, when removed in commercial quantities, the product will be homogeneous in nature and will conform to the requirements of these Specifications, or as required by the Engineer.

Topsoil may be secured, if approved by the Engineer, from areas which are, or have been, in cultivation within the past five years, and which are producing or have produced fair or good yield of staple farm or truck crops without usual fertilization, or topsoil may be secured from areas supplied with good normal drainage which is arable or suitable for cultivation.

36.03 EQUIPMENT

All equipment necessary for the proper removal, transportation, protection, and maintenance of topsoil must be available when required in first class working condition and shall have been approved by the Engineer before construction will be permitted to begin.

36.04 REQUIREMENTS

Topsoil, except that reserved within excavation areas on the project, shall not be stored for use but shall be excavated and placed directly into its final position.

All areas from which topsoil is to be secured, shall be cleaned of all sticks, boards, stones, lime, cement, ashes, cinders, slag, concrete, bitumen, or its residue and any other refuse which will hinder or prevent growth.

In securing topsoil from a designated pit, or elsewhere, should strata or seams of material occur which do not come under the requirements for topsoil, such materials shall be removed from the topsoil, or, if required by the Engineer, the pit shall be abandoned.

Before placing or depositing topsoil upon any areas, all improvement within the area shall be completed, unless otherwise approved by the Engineer.

The areas or pits into which topsoil is to be placed or incorporated shall be prepared before securing topsoil for use.

The depth to which topsoil is excavated in any pit, shall be subject to the direction of and be approved by the Engineer, and if during the excavation of the pit the Engineer decides to make changes in the depth in order to secure a more satisfactory material, the Contractor shall follow such instructions as may be issued by the Engineer.

Topsoil shall be transported in vehicles which will not lose or scatter the topsoil during transportation.

Topsoil shall be placed upon or incorporated into prepared areas or pits in accordance with the provisions and requirements set out in the sections of these Specifications covering the particular type or kind of planting or seeding with which topsoil is required.

36.05 MAINTENANCE

The Contractor shall maintain topsoil, at his own expense, in connection with any seeding or planting, or otherwise, until final completion of the project. Maintenance shall consist of preserving, protecting, replacing, and such other work as may be necessary to keep the project in a satisfactory condition.

36.06 FINAL CLEARING UP

Final clearing up shall consist of completely cleaning the area of all equipment, rubbish, excess material, and unused materials which will mar the appearance of the project, and disposing of same satisfactorily.

All pavements and structures shall be swept clean of all dirt or rubbish which may have become deposited upon them during construction.

In addition, final clearing up shall be performed in accordance with the provisions and requirements set out in Item 1.15 (b) of these Specifications.

36.07 MEASUREMENT AND PAYMENT (IF APPLICABLE)

The volume of topsoil for which payment will be allowed shall be expressed in cubic yards as computed from the topsoil in-place in the finished work.

Payment for topsoil in-place as required by the Plans or Specifications or as directed by the Engineer shall be made for the quantities determined in the manner specified above at the unit price bid per cubic yard of topsoil under Item 36 of the Contract Bid Schedule.

END OF DOCUMENT

ITEM 38

CAST-IN-PLACE CONCRETE

CURB INLETS

38.01 DESCRIPTION

This item shall consist of surface drainage inlets constructed of such materials and in accordance with these Specifications at the locations shown and in conformity with the lines, grades, and dimensions shown on the Plans or required by the Engineer. These structures shall include the furnishing and installation of such specials and connections to pipes and other structures as may be required to complete the Item as shown on the Plans. The structures shall provide for the collection of surface water.

38.02 MATERIALS

(a) Concrete

These structures shall be constructed plain and reinforced concrete as specified in Items 3 and 4.

(b) Frames and Covers

Acheson frame and cover (with seal) is now A-2522-41C (formerly VM-25).

Inlet frames and covers shall be expansion cast ABS thermoplastic curb drain manhole frame and cover No. DX22-4CD by Dexol or equal.

(c) Forms

Forms shall be equal to ABS plastic forms as marketed by Improved Construction Methods, Inc., P. O. Box 685, Jacksonville, Arkansas, or P. O. Box 510, Old Hickory, Tennessee 37138.

Vertical forms, wall spacers, steps, and placing cone shall be carefully positioned and firmly clamped before placing forms.

Form marks and offsets up to one-half inch in depth will be allowed on the inside surface of the inlet. Such offset shall be troweled to a struck finish.

(d) Cover

Top cover of inlet may be precast and subsequently secured to basin by grouting as shown on the Plans.

38.03 METHOD OF MEASUREMENT (IF APPLICABLE)

(a) The quantities of curb inlets shown on the Drawing for which payment will be allowed shall be the actual number of each type size and depth inlet, 5'-0" deep or less installed and accepted.

(b) The depth of the inlet for payment purposes shall be measured from the curb edge of the top cover to the lowest pipe invert. Inlets 5'-0" or less shall be measured and paid for as one inlet at the unit price bid for each in the Bid Schedule.

(c) For inlets more than 5'-0" in depth, payment will be allowed for additional depth in units of vertical linear feet as provided in the Bid Schedule.

38.04 PAYMENT (IF APPLICABLE)

Payment for all curb inlets as constructed under these Specifications shall be made for the quantities determined in the manner specified above as listed under the contract pay items in the Bid Schedule. These amounts, so paid, shall constitute full compensation to the Contractor under this Item and shall cover the cost of furnishing all labor, materials, tools, plant equipment, services and other expenses in connection with the furnishing and construction of curb inlet complete-in-place including all excavation, backfill, masonry, all castings, reinforcing steel, inspection and tests, all as herein specified.

END OF DOCUMENT

ITEM 53

JOINT SEALANTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.02 DESCRIPTION OF WORK

A. The extent of each form and type of joint sealant is indicated on drawings and by provision of this section.

B. Sealing: Seal all joints on exterior surfaces as called for herein or as required to produce a finished watertight job.

1.03 SUBMITTALS

SEE SECTION 01300.

Product Data: Submit to the Engineer manufacturer's product specifications, handling/installation/curing instructions, and performance tested data sheets for each elastomeric product required.

1.04 JOB CONDITIONING

Weather Conditions: Do not proceed with installation of liquid sealants under unfavorable weather conditions. Install elastomeric sealants when temperature is in lower third of temperature range recommended by manufacturer for installation.

PART 2 - PRODUCTS

2.01 MATERIALS

General Sealant Requirements: Provide colors indicated or, if not otherwise indicated, as selected by Engineer from manufacturer's standard colors. Select materials for compatibility with joint surfaces and other indicated exposures, and except as otherwise indicated, select modules of elasticity and hardness or grade recommended by manufacturer for each application indicated.

2.02 SINGLE-COMPONENT SILICON RUBBER SEALANT

Except as otherwise indicated, provide manufacturer's standard, non-modified, one-part, silicone-rubber-based, air-curing, nonsag, elastomeric sealant, complying with either ASTM C 920 Type S Class 25 grade NS, or FS TT-S-001543A Class A Type Non-sag.

2.03 MISCELLANEOUS MATERIALS

A. Joint Primer/Sealer: Provide type of joint primer/sealer recommended by sealant manufacturer for joint surfaces to be primed or sealed.

B. Bond Breaker Tape: Provide polyethylene tape or other plastic tape as recommended by sealant manufacturer, to be applied to sealant-contact surfaces where bond to substrate or joint filler must be avoided for proper performance of sealant. Provide self-adhesive tape where applicable.

C. Sealant Backer Rod: Provide compressible rod stock of polyethylene foam, polyurethane foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable nonabsorptive material as recommended by sealant manufacturer for backup of and compatibility with sealant.

PART 3 - EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS

Comply with manufacturer's printed instructions except where more stringent requirements are shown or specified, and except where manufacturer's technical representative directs otherwise.

3.02 JOINT PREPARATION

A. Clean joint surfaces immediately before installation of sealant or caulking compound. Remove dirt, insecure coatings, moisture and other substrates which could interfere with seal of gasket or bond of sealant or caulking compound. Etch concrete and masonry joint surfaces as recommended by sealant manufacturer. Roughen vitreous and glazed joint surfaces as recommended by sealant manufacturer.

B. Prime or seal joint surfaces where indicated, and where recommended by sealant manufacturer. Confine primer/sealer to areas of sealant bond. Do not allow spillage or mitigation onto adjoining surfaces.

3.03 INSTALLATION

A. Set joint fill units at depth or position in joint as indicated to coordinate with other work, including installation of bond breakers, backer rods and sealants. Do not leave voids or gaps between end of joint filler units.

B. Install sealant backer rod for liquid-applied sealants, except where shown to be omitted or recommended to be omitted by sealant manufacturer for application indicated.

C. Install bond breaker tape where indicated and where required by manufacturer's recommendations to insure the liquid-applied sealants will perform as intended.

D. Employ only proven installation techniques, which will ensure that sealants are deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.

E. Install sealant to depths as shown or, if not shown, as recommended by sealant manufacturer but within the following general limitations, measured at center (thin) sections of bead.

F. For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50% of joint width, but never more than 1/2" deep nor less than 1/4" deep.

G. Spillage: Do not allow sealants or compounds to overflow from confines of joints or spill onto adjoining work, or to migrate into voids of exposed finishes. Clean adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage. Recess exposed edges of gaskets and exposed joint fillers slightly behind adjoining surface, unless otherwise shown, so that compressed units will not protrude from joints.

3.04 CURE AND PROTECTION

Cure sealants in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability. Advise Contractor of procedures required for cure and protection of joint sealants during construction period so that they will be without deterioration or damage (other than normal wear and weathering) at time of substantial completion.

END OF DOCUMENT

ITEM 67

BITUMINOUS MATERIALS

67.01-Asphalt Cement

Asphalt cement shall conform to the requirements of AASHTO MP-1 for PG 64-22. When asphalt cement PG 70-22 or PG 76-22 is specified, the asphalt cement shall conform to AASHTO MP-1. Modification of the asphalt shall be accomplished by properly blending styrene butadiene (SB), styrene butadiene styrene (SBS) or styrene butadiene rubber (SBR) to a PG 64-22 base asphalt.

In addition to the above requirements, the PG 70-22 and PG 76-22 shall meet the following:

	<u>PG 70-22</u>	<u>PG 76-22</u>
Ring & Ball Softening Point, degrees C (degrees F), minimum	53 (128)	57 (135)
Elastic Recovery by means of Ductilometer, % minimum	40	58
Screen Test	No lumps retained	

Test Procedures

Elastic Recovery by means of a Ductilometer

Condition the ductilometer and samples to be tested at the temperature prescribed for that material. Prepare the brass plate, mold, and briquet specimen in accordance with ASTM D 113, "Ductility of Bituminous Materials". Keep the specimen at the specified test temperature for 85- 90 minutes. Immediately after conditioning, place the specimen in the ductilometer and proceed to elongate the sample to 20 cm. The rate of pull shall be 5 cm/min. unless otherwise stated. After the 20 cm elongation has been reached, stop the ductilometer and hold the sample in its elongated position for 5 minutes. At this time, clip the sample approximately in half by means of scissors or other suitable cutting devices. Let the sample remain in the ductilometer in an undisturbed condition for one hour. At the end of this time period, retract the half sample specimen until the two broken ends touch. At this point note the elongation in cm.

Calculation - Calculate percent recovery by the following formula:

$$\% \text{ Recovery} = ((20 - X)/20) \times 100$$

X = observed elongation after rejoining the sample, cm

Screen Test

The procedure shall be to pour a 1000 gram sample heated to 135 degrees C (275 degrees F) through a 2.0 millimeter (No. 10) sieve. There shall be no lumps or particles retained on the sieve.

Viscometer Test

In addition to the above, a rotational viscometer, meeting ASTM D4402 requirements with a thermostatically controlled cell will be required at all hot mix asphalt mix plants using modified liquid asphalt products. A minimum of one test per day shall be run on samples taken from the contractor's storage tank or from a sampling port after the material is in-line blended if the grade of the material is being changed at the hot-mix plant. Viscosity values shall be in the range from 650-3000 cP for PG 70-22, and, 1000 to 3000 cP for PG 76-22 at 275 degrees F.

Materials Certification

A certification shall be furnished to the Engineer on each project stating that the asphalt cement furnished meets the Department's specification. A complete series of tests shall be conducted biweekly on a sample from the storage tanks and after material is added to the storage tanks.

Where blending or modification occurs after the material has left the storage tanks. A complete series of tests shall be conducted on a sample taken on the first day's production and biweekly thereafter for each grade being produced. Brookfield viscosity and DSR original tests shall be performed daily at the point of blending or modification. The DSR value $G^*/\sin \delta$ shall be ≥ 1.0 kPa at the high PG grade temperature (ie. 70 degrees C for PG 70-22).

In addition, the producer shall provide a temperature-viscosity curve with a recommended mixing temperature range. In order to develop a temperature-viscosity curve, it may be necessary to run the viscosity test at a higher temperature. This temperature would be dependent on the softening point of the modified asphalt cement.

If a SBR modifier is used, the SBR shall be pre-blended with the asphalt cement or added by means of an "in-line" motionless mixer. The "in-line" mixer shall be a Komax Model No. 30715A, Ross LPD Motionless mixer, Koch Static Mixer or other approved equal. The "in-line" motionless mixing unit shall provide a homogeneity value of 0.15 or less. The mixing unit shall be equipped with a port(s) for obtaining representative samples of the blended material in accordance with AASHTO T 40. The mixer shall be oil jacketed. The mixer shall have a minimum diameter of 13 millimeters (1/2 inch) larger than the asphalt supply line onto which it is installed. The manufacturer shall document to the Engineer that the above specifications will be obtained with the mixer furnished.

67.02-Cut-Back Asphalts. Cut-back asphalts shall conform to the requirements of AASHTO M 81 or M 82, for the type and grade specified.

67.03-Emulsified Asphalts. These specifications cover two kinds of emulsified asphalt, anionic and cationic.

The manufacturer shall furnish samples of base asphalt used in the manufacture of the asphalt emulsion, as directed by the Engineer.

All emulsified asphalts shall be homogeneous, and shall adhere firmly to the surface of the mineral aggregate. Failure of the emulsified asphalt to perform satisfactorily on the job shall be deemed cause for rejection, notwithstanding its ability to pass laboratory tests.

A. Anionic Emulsified Asphalts.

In general, anionic emulsified asphalts shall conform to all the requirements of AASHTO M 140, for the type and grade specified.

In addition to the classes provided for in AASHTO M 140, a special mixing material (AE-3) or a special priming material (AEP) may be specified. These special materials shall conform to the following requirements:

Type	Special Mixing		Special Prime		Special Tack	
Grade	AE-3		AE-P		TST-1P	
Test Requirements:	Min.	Max.	Min.	Max.	Min.	Max.
Viscosity, Saybolt-Furol, 25° C (77° F), Sec.	10	50		10	75	
Viscosity, Saybolt-Furol, 50° C (122° F), Sec.	50+	& Pumpable				
Settlement, 5 days, % 24 Hours		5		5		5 1.0
Sieve Test		.10		.10		
Stone Coating (% coated)	90					
Distillation to 260° C (500° F)						
Distillate, % by weight		30		55		
Oil portion of distillate, % by vol.		6		12		
Distillation to 205°C (400°F)						
Distillate, % by weight					55	60
Tests on residue from distillation						
(a) Float Test, 60° C (140° F), Sec.	200		20			
(b) Ductility, 25° C (77° F), cm	40					
(c) Ductility, 4°C					10	35
(d) Soluble in Trichloroethylene %	97.5		97.5			
(e) Ash, by ignition, %		2				
Demulsibility (.02 Normal/35mL)						+5
Elastic recovery @ 10°C (50°F)						25+
Pen					75	150

The test requirement for settlement may be waived when the emulsified asphalt (special tack coat excepted) is used in less than five days' time; or the Engineer may require that the settlement test be run from the time the sample is received until it is used, if the elapsed time is less than five days.

The AE-3 shall be of such stability that it will remain constant and uniform while being mixed with dry or approximately dry aggregate, and shall thoroughly and uniformly coat the entire surface of each fragment while being manipulated and incorporated into the work. The emulsified asphalt after being incorporated into the work shall show no signs of re-emulsifying.

These special materials shall be tested in accordance with AASHTO T 59, with the following modification and additions:

1. Stone coating test: AASHTO T 59, except that the mixture of stone and emulsified asphalt shall be mixed vigorously for five minutes and then immediately drenched with approximately twice its own volume of tap water at room temperature.
2. Float Test: AASHTO T 50, except
 - (a) Delete Section 3.2 and substitute Section 8.7 of AASHTO T 59 for preparation of test specimen.
3. Solubility in Trichloroethylene: AASHTO T 44.

B. Cationic Emulsified Asphalts.

Cationic emulsified asphalts shall conform to the requirements of AASHTO M 208, for the type and grade specified.

In addition to the classes provided in AASHTO M 208, a special priming material may be specified which is designated CAE-P. This material shall meet the requirements listed for AE-P except as follows:

- (1) The Float Test shall be deleted.
- (2) Penetration Test (25 degrees C ,77 degrees F) shall be a minimum of 300.
- (3) The particle charge shall be positive.

When approved by the Engineer, cationic emulsions may be substituted for anionic emulsions.

C. Emulsified Asphalts for Slurry Seal.

The emulsified asphalt for a Slow-Set Emulsified Asphalt Slurry Seal shall be Type CSS-1h meeting the requirements specified herein. The emulsified asphalt for a Quick-Set Emulsified Asphalt Slurry Seal and a Quick-Traffic Emulsified Asphalt Slurry Seal shall be Type CQS-1h meeting the requirements for Type CSS-1h with the following exceptions:

Residue, %	MIN. 60
Cement mixing test, %	(waived)

Unless otherwise specified on the Plans, a Quick-Set Emulsified Asphalt Slurry Seal shall be used.

The water shall meet the requirements of Subsection 918.01 of the TDOT Standard Specifications.

The latex modifier, when specified, shall be an unvulcanized styrene-butadiene rubber in liquid latex form. The cationic latex modifier shall conform to the following requirements:

Tests	Cationic Latex Modifier
Styrene/Butadiene Ratio, %	24/76 \pm 1.5
Solids Content, %	60 Min.
ph	6.2 Max.

Kilograms per Liter (lbs. per gallon):

Wet Basis @ 25° C	0.95 (7.9) Min.
Dry Basis @ 25° C	0.55 (4.5) Min.

The manufacturer of the latex shall provide written certification of the results of the above noted tests.

Latex modified CSS-1h shall meet the requirements of AASHTO M-208 modified as follows:

Residue Requirements

Penetration @ 25° C	30 Min.
Ductility @ 25° C	150 +
@ 4° C	100 +
Softening Point, Ring and Ball, degrees C	54 +

The latex shall be combined with the asphalt emulsion at the emulsion mill to produce a homogeneous mixture.

The latex modified emulsion upon standing undisturbed for a period of 24 hours shall show no color striations, but shall be a uniform color throughout.

The latex modified asphalt emulsion shall meet the requirements of the Stretch Test which will be conducted as follows:

Pour onto a liter (quart) friction can lid or similar container, enough of the emulsion to cover the surface to a depth of 1.5 to 3 millimeters (1/16 to 1/8-inch). Immediately, while the emulsion is still brown, embed with thumb pressure several stones or chips approximately 13 millimeters (1/2- inch) in size (10 to 16 millimeters, 3/8-inch to 5/8-inch) into the binder. Put the lid, or similar container containing the emulsion and aggregate into a 38 degrees C (100 degree F) oven and allow to cure for a minimum of eight hours. After the curing period, remove the lid and allow it to cool for one hour. Upon lifting a stone or chip from the binder, the asphaltic material must adhere to the aggregate and must elongate for a minimum distance of 75 millimeters (three inches) without loss of adhesion and without breaking.

D. Emulsified Asphalts for Micro-Surface.

The latex or polymer modifier and other emulsifiers shall be milled into the asphalt cement and shall show no separation after mixing. The latex or polymer modified emulsified asphalt shall have a minimum softening point (Ring and Ball) of 57 degrees C (135 degrees F) when tested in accordance with AASHTO T 53.

The blended asphalt mixture when combined with aggregate and mineral filler shall have the following characteristics:

1. Be capable of filling up to 13 millimeters (1/2 inch) wheel ruts in one pass.
2. Be capable of field regulation of the setting time.
3. Be suitable for nighttime placement.

The latex or polymer modified emulsified asphalt shall be accepted by certification from the manufacturer.

67.04-Asphalt for Underseals. Asphalt for underseals shall conform to the requirements of AASHTO M 238.

END OF DOCUMENT

ITEM 72

ADJUSTING WATER SERVICE LINES AND MOVING EXISTING WATER METERS AND BOXES

72.01 SCOPE

(a) Wherever existing water meters interfere with the street widening and resurfacing, the water meters shall be moved to a new location as shown on the drawings or as directed by the Engineer.

(b) Wherever existing water service lines interfere with the street widening and resurfacing, the water service lines shall be adjusted and/or extended as shown on the drawings or as directed by the Engineer.

(c) The resetting of the water meters and the adjustment and/or extension of water service lines shall be done in a manner shown on the drawings and shall be in accordance with the requirements of the City of Chattanooga and the Tennessee-American Water Company, Chattanooga, Tennessee, and shall include all materials and work to provide a complete installation.

(d) At the Owner's discretion, Tennessee-American Water Company may be directed to reset water meters and water service lines if the Contractor is not deemed qualified to perform said work.

72.02 MATERIALS

(a) Existing meters, meter boxes, fittings and accessories will be reused wherever possible. Any new meter boxes required shall be 14" x 14" cast iron as approved by the water company.

(b) Copper tubing shall exceed the requirements of latest ASTM Standard Specifications, Serial Designation B88, Government Type K annealed.

(c) Broken meter boxes shall be replaced and shall meet the approval of the Engineer and water company.

72.03 JOINTS

Fittings for copper tubing shall be flared and meet the requirements of ANSI standards for Wrought Copper and Bronze Solder Joint Pressure Fittings, B16.22, latest revision.

72.04 EQUIPMENT

All equipment necessary and required for moving of existing water meters and adjusting and/or extending water service lines must be on the project, proved to be in first-class working order, and approved by the Engineer before construction will be permitted to begin.

72.05 INSTALLATION

(a) Installation of water meters shall include carefully disconnecting the meter from its existing pipe connection, resetting the meter box in the new location, and reconnecting the meter to existing piping.

(b) Where existing water meters are in the area of the proposed construction, they shall be moved to the new right-of-way line or where directed by the Engineer. Water meters are not to be installed in the sidewalk.

(c) Meter boxes shall be installed in neat and workmanlike manner. The elevation of the boxes shall be carefully adjusted so that the lid is flush with the ground surface. Soil around the meter box shall be tamped or settled in-place to eliminate settlement.

(d) Every effort will be made to keep dirt and contamination from entering the pipe system.

(e) Cost bid for adjustment and/or extension of water service lines shall include the cost of all pipe, fittings, and other appurtenances necessary to complete the work.

(f) The service line shall be installed from the water main corporation stop to the meter yoke, and it shall be placed at a sufficient depth that the work of preparing the subgrade of the street will not interfere with it.

(g) Water service lines shall be placed at the same depth as the existing service lines or a minimum of 18 inches below the top of the finished roadway, whichever is deeper.

(h) All work and materials shall be acceptable to the Tennessee-American Water Company. Work and materials not acceptable shall be redone at no additional cost to the Owner until it is acceptable.

END OF DOCUMENT

ITEM 73

AGGREGATES

73.01 FINE AGGREGATE FOR CONCRETE

Fine aggregate for Portland Cement Concrete shall conform to the requirements of AASHTO, "Standard Specification for Fine Aggregate for Portland Cement Concrete," Serial Designation M 6, with the following exceptions and added stipulations:

- (a) The option regarding alternate freeze-thaw tests for soundness will not be exercised.
- (b) The fine aggregate shall be washed in the processing operations.
- (c) Fine aggregate manufactured from limestone or dolomite shall be processed from material which has been scalped to remove quarry fines. The material from which the fine aggregate is processed shall have a percentage of wear, Los Angeles Test, of not more than forty.
- (d) The amount of deleterious substances shall not exceed the following limits:

Maximum Permissible Limits, By Weight

1. Clay Lumps	0.5%
2. Coal and Lignite	0.5%
3. Material Passing the No. 200 Sieve	3.0%
4. Other Deleterious Substances (such as Shale, Alkali, Mica, Coated Grains, Soft and Flaky Particles)	3.0%

- (e) Fine aggregate shall be well graded from coarse to fine and, when tested by means of laboratory sieves, shall conform to the following requirements:

Sieve Size	Total Percent Passing, By Weight
3/8 inch	100
No. 4	95-100
No. 16	60-90
No. 100	10-30
No. 200	0-3

73.02 FINE AGGREGATE FOR MORTAR

Mortar sand shall conform to the requirements of AASHTO, "Standard Specification for Aggregate for Masonry Mortar," Serial Designation M 45. Sand for mortar shall be uniformly graded from coarse to fine within the following limits:

Sieve Size	Total Percent Passing, By Weight
No. 8	100
No. 50	15-40
No. 100	0-10
No. 200	0-5

73.03 COARSE AGGREGATE FOR CONCRETE

Coarse aggregate for any type or class of Portland Cement shall consist of crushed stone or crushed or uncrushed gravel, unless otherwise specified.

Coarse aggregate for Portland Cement Concrete base and pavement shall be furnished in two sizes: Size No. 4 and Size No. 67, as shown in Item 73.19. The two sizes shall be manufactured, within the specified limits, so as to produce Size No. 467, Item 73.19, when combined in the proper proportions at the batching plant.

Coarse aggregate for structural concrete shall be Size No. 57, Item 73.19.

Coarse aggregate for pre-stressed and precast concrete shall be Size No. 57 or Size No. 67, Item 73.19, as may be specified or directed.

Coarse aggregate for concrete curbing placed by machine-extrusion methods shall be Size No. 7 or 78, Item 73.19.

The coarse aggregates shall otherwise conform to the requirements of AASHTO, "Interim Specification for Coarse Aggregate for Portland Cement Concrete," Serial Designation M 80, with the following exceptions and added stipulations:

(a) Deleterious Substances

The amount of deleterious substances shall not exceed the following limits:

**Maximum Percent,
By Weight**

1.	Soft or non-durable fragments (fragments which are structurally weak such as shale, soft sandstone, limonite concretions, gypsum, weathered schist or cemented gravel)	3.0
2.	Coal and lignite	1.0
3.	Clay lumps	0.25
4.	Material passing the No. 200 sieve	0.75
5.	Thin or elongated pieces (length greater than 5 times average thickness)	10.0
6.	Other local deleterious substances	1.0

The sum of the percentages of Items No. 1, 2, 3, 4, and 6 shall not exceed 5.0.

- (b) When the coarse aggregate is subjected to five alternations of the sodium sulfate soundness test, the weighted percentage of loss shall be not more than nine percent. Coarse aggregate failing to meet the requirement for soundness may be accepted, provided it can be shown by evidence satisfactory to the Engineer that concrete of comparable proportions made from the same source has been exposed to weathering under conditions similar to those occurring at the site of the structure for a period of at least ten years without appreciable disintegration.

The sum of the percentage of Items No. 1, 2, 3, 4, and 6 for soundness will not apply to (b) above.

73.04 AGGREGATE FOR PENETRATION MACADAM BASE

Aggregate for penetration macadam base shall be crushed stone or crushed slag meeting the quality requirements of AASHTO, "Standard Specification for Crushed Stone and Crushed Slag for Bituminous Concrete Surface Coarse," Serial Designation M 79, except that the sodium sulfate soundness loss shall not exceed nine percent and the percentage of wear, Los Angeles Test, shall not exceed fifty.

The gradation of the aggregate shall meet the requirements for the following sizes in Item 73.19:

Coarse	Size No. 24
Key or Choker	Size No. 6

73.05 AGGREGATE FOR MINERAL AGGREGATE BASE AND SURFACE COURSES

Aggregate for Mineral Aggregate Base and Surface Course shall be crushed stone, crushed slag, crushed or uncrushed gravel, or crushed or uncrushed chert, together with such material as manufactured sand or other fine materials naturally contained, or added thereto as needed to conform with these Specifications.

The aggregate shall be of two classes: Class A and Class B.

(a) Class A aggregate for mineral aggregate base and surface courses shall consist of hard durable particles or fragments of stone, slag, gravel, or chert, and other finely divided mineral matter. Individual materials shall meet the requirements specified below:

1. Crushed stone shall be free from silt and clay. The coarse aggregate portion of the stone shall have a percentage of wear of not more than fifty, and when subjected to five alternations of the sodium sulfate soundness test, the weighted percentage of loss shall not exceed fifteen.
2. Crushed slag shall be free of silt and clay and shall meet the quality requirements of crushed stone. It shall be reasonably uniform in density and shall have a dry-rodded weight of at least seventy pounds per cubic foot.
3. Crushed gravel and crushed chert shall be screened, and all oversize material shall be crushed and fed uniformly back over the screen. The coarse aggregate portion (retained on the No. 4 sieve) shall have a percentage of wear of not more than thirty. The portion of the material passing the No. 40 sieve shall be non-plastic or shall have a liquid limit of not more than twenty-five and a plasticity index of not more than six.

If a fine aggregate, coarse aggregate or binder, in addition to that present in the base material, is necessary in order to meet the gradation requirements, or for satisfactory bonding of the material, it shall be uniformly blended with the base coarse material at the mixing plant by a mechanical feeder to maintain a uniform flow on the belt to the mixer. Blending of materials on the stockpiles or in the pits by bulldozer, clamshell, dragline or similar equipment will not be permitted.

The composite gradation of Class A aggregate shall be the grading specified.

- (b) Class B aggregate for mineral aggregate base shall consist of crushed or uncrushed gravel, crushed or uncrushed chert, crushed stone or crushed slag, and other finely divided particles. The quality of Class B aggregate shall be the same as the quality requirements for Class A aggregate with the following exceptions:

Gravel or chert Class B aggregate shall be screened, and oversize materials may be wasted or crushed and returned over the screen and uniformly blended with the other material. The coarse aggregate portion (retained on the No. 2 sieve) shall have a percentage of wear of not more than forty. Material having a clay content greater than twelve percent, as determined by hydrometer analysis, will not be permitted. Material having a clay content not exceeding twelve percent will be acceptable, provided a plasticity index-fines product does not exceed 3 when calculated by the following formula:

$$\text{Per Cent Passing No. 40 Sieve} \times \text{P.I. of Minus 40 Material} = 100$$

If an excess of binder occurs, crushed stone, crushed slag, gravel, chert, and sand, or other approved granular materials shall be uniformly incorporated in such proportions, not to exceed twenty percent of the total mix, as the Engineer directs.

If the quantity of binder is insufficient to bond the base or surface course properly, additional binder of approved quality, in an amount not to exceed fifteen percent of the total mix, shall be uniformly incorporated as directed by the Engineer.

The use of material requiring the addition of coarse aggregate or binder in excess of the above limits will not be permitted unless otherwise specified on the Plans or in the Contract.

Blending of additional material, if required, may be performed either at the screening or mixing plant or on the road. If blending is done at the plant, mechanical feeders which will maintain a uniform flow of the materials on the conveyor belt to the mixer or screening plant shall be employed. If blending is done on the road, the two or more materials shall be spread in uniform layers and blended by means of a mechanical mixer. Blending of materials on the stockpile or in the pit by means of a bulldozer, clamshell, or similar equipment will not be permitted.

When combinations of materials for Class B aggregate for mineral aggregate base and surface courses, such as creek gravel and chert, bank gravel and chert, crushed stone and chert, or crushed slag and chert, are permitted, they will be designated on the Plans or in the Contract and the pertinent requirements of this Specification for quality, blending of materials, and gradings shall apply.

The composite gradation of Class B aggregate shall be the grading specified on the Plans or in the Contract.

**GRADING TABLE FOR CLASS A AND CLASS B AGGREGATE
FOR MINERAL AGGREGATE BASE AND SURFACE COURSES**

Sieve Size	Class A	Class B	Class C1	Class C2	Class D and E	Class F
2"	100					
1 1/2"	75-100	100				
1"			100			
3/4"	45-70	65-90	85-100	100		
1/2"					100	
3/8"	30-55		55-80	60-90	85-100	100
No. 4	20-40	30-55	35-60	40-65	55-82	85-100
No. 8	10-30	20-45			38-62	75-95
No. 30	5-20	8-25	7-22	7-25	18-42	35-70
No. 50						5-20
No. 100		1-12	1-12	1-12	3-12	5-20
No. 200	0-8	0-7			0-8	2-10

73.06 AGGREGATE FOR PLANT MIX BASE AND LEVELING COURSES (HOT MIX)

Aggregate for plant mix base and leveling courses shall consist of coarse aggregate, fine aggregate, and mineral filler when required.

Prior to the approval of the job-mix formula and at least ten working days prior to the beginning of this construction, a sample of each material to be used in the mix shall be submitted to the Engineer for laboratory tests and evaluation. If at any time the sources of materials are changed, samples of the new materials shall be submitted for laboratory tests.

(a) Coarse Aggregate

Coarse aggregate (aggregate retained on the No. 4 sieve) shall be crushed stone, crushed slag, or crushed gravel, or combinations of these materials, except as hereinafter specified. It shall conform to the quality requirements of AASHTO, "Standard Specification for Crushed Stone, Crushed Slag, and Crushed Gravel for Open-Graded Bituminous Road Mix Surface Course," Serial Designation M 63. At least fifty percent of the gravel retained on the No. 4 sieve shall have at least one fractured face. Crushed slag coarse aggregate shall contain no more than twenty percent, by weight, of glass particles.

(b) Fine Aggregate

Fine aggregate shall consist of natural sand; sand manufactured from stone, gravel, or slag; or combination thereof. It shall consist of hard, tough grains free from injurious amounts of deleterious substances, and when subjected to five cycles of the sodium sulfate soundness test, it shall have a weighted loss of not more than fifteen percent. In natural sand, the percentage of material finer than 200 mesh shall not exceed five percent.

Fine aggregate in Gradings A, B, C1 and C2 shall consist of crushed stone or crushed slag only and shall be stored separately from the coarse aggregate.

(c) The Combined Grading

The gradations of the coarse and fine fractions of aggregate shall be such that when combined in proper proportions, the resultant mixture will meet one of the following gradings, as specified.

In addition, the combination of materials for Grading B and C shall be such that when combined with the required amount of bitumen, the resultant mixture shall have a stability of not less than 1,000 pounds when tested in accordance with ASTM, "Standard Test Method for Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus," Serial Designation D 1559. The compactive effort shall be 75 blows of the hammer on each end of the specimen.

**HOT PLANT MIX BASE AND LEVELING COURSE
MIXTURE DESIGNATION
MASTER RANGE OF GRADATIONS**

Sieve Size	Total Percent Passing, By Weight			
	Grading A (Base)	Grading B (Base)	Grading C-1 (Leveling)	Grading C-2 (Leveling)
2"	100			
1 1/2"	75-100	100		
1"			100	
3/4"	45-70	65-90	85-100	100
3/8"	30-55		55-80	60-90
No. 4	20-40	30-55	35-60	40-65
No. 8	10-30	20-45		
No. 30	5-20	8-25	7-22	7-25
No. 100		1-12	1-12	1-12
No. 200	0-8	0-7		

73.07 AGGREGATE FOR ASPHALTIC CONCRETE SURFACE COURSES (HOT MIX)

Aggregate for asphaltic concrete surface courses shall consist of a combination of coarse and fine aggregate, and mineral filler when required or specified. Prior to the approval of the job-mix formula and at least ten working days prior to the beginning of this construction, a sample of each material to be used in the mix shall be submitted to the Engineer for laboratory design and determination of the optimum asphalt content. If at any time the sources of materials are changed, samples of the new materials shall be submitted for laboratory tests.

(a) Coarse Aggregate

The coarse aggregate (aggregate retained on the No. 4 sieve) shall consist of crushed stone, crushed slag, or crushed gravel. Only one kind shall be used on any project except by permission of the Engineer. The coarse aggregate shall meet the quality requirements of AASHTO, "Standard Specification for Crushed Stone, Crushed Slag and Crushed Gravel for Dense Graded Bituminous Road and Plant-Mix Surface Course," Serial Designation M 62, with the following exceptions and additions:

The sodium sulfate soundness loss shall not exceed twelve percent.

Crushed gravel shall consist of siliceous particles, processed from washed material, of which a minimum of eighty-five percent, by count, of the material retained on the No. 4 sieve shall have one or more fractured faces, fractured for the approximate average diameter or thickness of the particles. The addition of pea gravel or uncrushed particles will not be permitted.

Crushed slag coarse aggregate shall contain not more than twenty percent, by weight, of glassy particles.

(b) Fine Aggregate

The fine aggregate (passing the No. 4 sieve) shall consist of natural sand, or of sand prepared from stone, slag or combinations thereof. It shall consist of hard, tough grains free from injurious amounts of clay, loam, or other deleterious substances. The fine aggregate, when subjected to five cycles of the Sodium Sulfate Soundness Test, shall have a weighted loss of not more than 15 percent.

In addition to the above, the following requirements shall also apply.

Natural sand shall be washed, except that an unwashed filler sand may be used in an amount not to exceed fifteen percent by weight of the total fine aggregate (-4 Material).

If a filler sand is used, it shall be free of clay lumps and other deleterious substances. The natural sand shall be so graded that no more than five percent will be retained on the No. 4 sieve.

Fine aggregate consisting of natural sand, including filler sand or sand manufactured from crushed gravel, or any combination of these materials will be tested in accordance with AASHTO, "Standard Method of Test for Amount of Material Finer than 0.075 mm Sieve in Aggregate," Serial Designation T 11, and the loss on the 200 mesh sieve shall not exceed four percent by weight.

Agricultural limestone, when used as a portion of the fine aggregate, shall be manufactured from sound, durable stone and shall be crushed so that at least eighty-five percent will pass the No. 8 mesh sieve and at least fifty percent will pass the No. 30 mesh sieve.

(c) The Combined Grading

The several aggregate fractions shall be sized, graded, and combined in such proportions that the resulting composite blend will meet one of the following grading requirements, as specified, together with the stipulations pertaining to the constituents of the blend hereinafter specified.

**ASPHALTIC CONCRETE SURFACE COURSE
MIXTURE DESIGNATION
MASTER RANGE OF GRADATIONS**

Grading Sieve Size	Total Percent Passing, <u>By Weight</u>		
	<u>D</u>	<u>E</u>	<u>F</u>
3/4"	100		
5/8		100	
1/2"	95-100	95-100	
3/8"	80-98	80-98	100
No. 4	53-80	53-80	85-100
No. 8	36-60	36-60	75-95
No. 30	16-40	16-40	35-70
No. 50			20-50
No. 100	3-12	3-14	5-20
No. 200	2-8	3-10	2-10

Grading D

The mineral aggregate shall be composed of crushed gravel, crushed granite, crushed slag, natural sand, granite screenings, slag screenings, or a combination of the proper sizes of these materials. The use of carbonate rocks such as limestone and dolomite or other aggregates tending to polish under traffic will not be permitted in the coarse aggregate and will be permitted only to the extent specified herein in the fine aggregate.

When the combined mineral aggregate includes crushed gravel or natural sand, agricultural limestone in an amount of not less than ten percent nor more than twenty percent by weight of the mineral aggregate shall be used. The addition of agricultural limestone, within the range specified above, will also be required in crushed slag and crushed granite aggregate when needed to meet the specified design criteria or when directed by the Engineer.

In addition to the other requirements of these Specifications, the composition of the mineral aggregate shall be such that when combined with the required amount of bitumen, the resultant mixture will comply with the following design criteria as determined by the Marshall Method of Test Criteria.

Stability, min.	1,000 lbs.
Void Content	4-9 percent
Flow	8-16

If these values cannot be obtained with the aggregate submitted for laboratory design or if, in the opinion of the City, the quality of the mix can be improved, the addition of limestone screenings* in an amount not to exceed twenty-five (25) percent by weight of the mineral aggregate and/or the addition of mineral filler, meeting the requirements of Item 73.13, in an amount not to exceed five percent of the mineral aggregate, will be required. If the mixture still does not meet the design criteria, another source of aggregate will be necessary.

* The gradation of the limestone screenings for use in Grading "D" shall have at least 95 percent passing the No. 4 screen and not less than ten percent passing the 100 mesh sieve.

Grading E

When Grading "E" is to be used as a surface for traffic lanes, the mineral aggregate shall be composed of not less than 50 percent nor more than 55 percent crushed limestone and not more than 50 percent nor less than 45 percent natural sand, slag sand, sand manufactured from gravel, or any combination of these materials, except as herein specified.

The requested sand percentage on the job mix formula shall be in the range of 45 to 50 percent. However, if needed to meet or improve the specified design criteria, the limestone and sand percentage may be altered by the numerical value of +5 percent from the percentages shown by the Contractor on the original job mix formula request. In the event the limestone and sand percentages are altered from those shown on the original job mix formula, the Contractor shall request a new job mix formula using the aggregate percentages shown on the design.

When Grading "E" is used for surfacing of shoulders or other non-traffic lane construction, the mineral aggregate may be composed entirely or in part of limestone, but in no case shall the mineral aggregate for this construction consist of less than 50 percent.

Limestone: When this mix is used for asphalt curb construction, it shall conform to the combined gradation specified under (c) except that the requirements for material passing the 200 mesh sieve shall be 5 to 10 percent.

In addition to other requirements, the composition of the mineral aggregate shall be such that when combined with the required amount of bitumen, the mixture will comply with the Marshal Method of Test Criteria results as follows:

Stability, min.	1,000 lbs.
Void Content	4-9 percent
Flow	8-16

In the event that the above design criteria may be improved with the addition of mineral filler to the aggregate submitted to the laboratory for design, the addition of mineral filler meeting the requirements of Item 73.13 in an amount not to exceed 5 percent by weight of the mineral aggregate will be required. If mineral filler is added to a mixture, it will be considered as a part of the limestone percentage.

If the design criteria above cannot be obtained with the aggregate submitted to the laboratory for design, another source of aggregate will be necessary.

Grading F

The mineral aggregate shall be composed of not less than seventy-five percent nor more than eighty-five percent of either natural sand, slag sand, sand manufactured from siliceous material or any combination of these materials, and not less than fifteen percent more than twenty-five percent of stone screenings meeting the gradation requirements of Size No. 10, Item 73.19.

In addition to the other requirements of these Specifications, the composition of the mineral aggregate shall be such that when combined with the required amount of bitumen, the resultant mixture shall have a minimum stability of 800 pounds when tested in accordance with the Hubbard-Field Method of mix design. The method of test shall conform to AASHTO, "Standard Method of Sampling Bituminous Paving Mixtures," Serial Designation T 168, except for the following modifications:

- (1) The specimen shall be consolidated by applying a pressure of 5096 psi, which corresponds to a total load of 16,000 pounds for a specimen two inches in diameter. This pressure shall be maintained for five minutes and then released.
- (2) The test specimens, testing mold, and plunger shall be brought to the desired temperature of test by storing in a water bath for one hour with the temperature of the water maintained by (140+ 2°F.) or (60+ 1°C.) during the entire storage period.

If the minimum stability cannot be obtained, the addition of mineral filler meeting the requirements of Item 73.13 in an amount not to exceed five percent of the mineral aggregate will be permitted in order to obtain the minimum stability. If the mixture still lacks stability, another source of aggregate will be necessary. When mineral filler is added, it will be considered as part of the stone screening percentage.

73.08 AGGREGATE FOR HOT BITUMINOUS SEAL COAT (SPLIT APPLICATION)

Aggregate for hot bituminous seal coat (split application) shall consist of crushed stone, crushed slag or crushed gravel meeting the quality requirements of AASHTO, "Standard Specification for Crushed Stone, Crushed Slag and Crushed Gravel for Open-Graded Bituminous Road-Mix Surface Course Serial Designation M 63, except that the sodium sulfate soundness loss shall not exceed nine percent. Crushed slag aggregate retained on the No. 4 sieve shall contain not more than twenty percent, by weight, of glassy particles.

The amount of material finer than 200 mesh shall not exceed 1.0 percent. If all material finer than the 200 mesh sieve consists of the dust of fracture, essentially free from clay or shale, the percentage may be increased to 1.5.

At the option of the Engineer, the aggregate may be tested for bituminous film retention. When tested in accordance with AASHTO, "Standard Method of Test for Coating and Stripping of Bitumen-Aggregate Mixtures," Serial Designation T 182, the aggregate shall have a bituminous film retention in excess of ninety-five percent.

Aggregates which are tested and do not meet the film retention requirement may be approved provided a satisfactory chemical additive is used.

Aggregate used in the mat shall be Size No. 6. Aggregate used in the seal shall be Size No. 7, Item 73.19.

73.09 AGGREGATE FOR HOT BITUMINOUS SEAL COAT

Aggregate for hot bituminous seal coat shall be crushed stone, crushed gravel, or crushed slag meeting the requirements specified in Item 73.08. The gradation requirement shall be those shown for size No. 7, Item 73.19.

73.10 AGGREGATE FOR DOUBLE BITUMINOUS SURFACE TREATMENT

Aggregate for double bituminous surface treatment shall conform to the requirements of Item 73.08. Aggregate used in the mat shall be Size No. 6. Aggregate used in the seal shall be Size No. 7, Item 73.19.

73.11 AGGREGATE FOR AGGREGATE-CEMENT BASE COURSE

Aggregate for aggregate-cement base course shall consist of coarse aggregate composed of sound, tough, durable fragments of crushed stone, crushed slag, crushed or uncrushed gravel, or crushed or uncrushed chert; fine aggregate composed of natural or manufactured sand; and silt-clay or other finely divided mineral matter.

The aggregate shall be of such gradation that all will pass a 1 1/2 inch sieve, not more than seventy-five percent will pass the No. 4 sieve, and not less than five nor more than fifteen percent will pass the No. 200 sieve. The fraction passing the No. 40 sieve shall have a liquid limit not greater than thirty-five, and a plasticity index not greater than ten.

The combined total of shale, organic material, or other unwanted substances shall not exceed five percent by weight.

73.12 AGGREGATE FOR SUBGRADE INSULATION COURSE

Aggregate for Subgrade Insulation Course shall consist of sand-gravel, crushed stone, crushed or granulated slag, or combinations of these materials.

That portion of the mineral passing the No. 40 sieve shall have a liquid limit not greater than twenty-five, and a plasticity index not greater than six.

The materials shall meet the following gradation requirements:

Sieve Size	Total Percent Passing By Weight
1 1/2"	100
3/4 "	95-100
No. 8	30-100
No. 200	0-100

73.13 MINERAL FILLER

Mineral filler shall meet the requirements of AASHTO "Mineral Filler for Bituminous Paving Mixture," Serial Designation M 17.

73.14 AGGREGATE FOR UNDERDRAINS

- (a) Aggregate for under-drains shall be crushed stone, crushed slag, or washed gravel meeting the quality requirements of AASHTO, "Standard Specification for Crushed Stone, Crushed Slag, and Crushed Gravel for Open Graded Bituminous Road-Mix Surface Course," Serial Designation M 63, and the grading requirements for size 6, 7, or 8, Item 73.19.

- (b) Natural sand shall be washed and shall meet the quality requirements of AASHTO, "Standard Specification for Fine Aggregate for Bituminous Paving Mixture," Serial Designation M 29. It shall have a gradation meeting the requirements for Size 9, Item 72.19, or the gradation specified in Item 73.01 (e) except that the percent passing the No. 50 sieve shall be 0-30.

73.15 AGGREGATE FOR SAND-ASPHALT SURFACE COURSE

Aggregate for sand-asphalt surface course shall consist of natural sand and/or crushed siliceous material meeting the quality requirements of ASTM, "Standard Specification for Fine Aggregate for Bituminous Paving Mixtures," Serial Designation D 1073.

In the natural sand, the percentage of material finer than the 200 mesh shall not exceed five. The natural sand or combination of these materials shall meet the following requirements for gradation:

Sieve Size	Total Percent Passing By Weight
No. 4	100
No. 8	95-100
No. 30	50-80
No. 50	30-60
No. 100	8-65
No. 200	2-10

In addition to the above requirements, the sand-asphalt mixture shall have a minimum stability of 400 pounds when tested in accordance with AASHTO, "Standard Method of Sampling Bituminous Paving Mixtures," Serial Designation T 168. If this value cannot be obtained, the addition of mineral filler, meeting the requirements of Item 73.13 in an amount not to exceed five percent of the mineral aggregate, will be permitted in order to obtain this minimum stability. If the mixture still lacks stability, another source of aggregate will be necessary.

73.16 LIGHTWEIGHT AGGREGATES FOR STRUCTURAL CONCRETE

Lightweight aggregate for structural concrete shall conform to the requirements of ASTM, "Standard Specification for Lightweight Aggregates for Structural Concrete," Serial Designation C 330, sizes as specified.

73.17 STOCKPILING AGGREGATES

Sites for aggregate stockpiles shall be grubbed and cleaned prior to storing aggregates, and the ground shall be firm and smooth and well drained. A cover of at least three inches of aggregate shall be maintained in order to avoid the inclusion of soil or foreign material. The stockpiles shall be built in layers not exceeding four feet in height, and each layer shall be completely in place before the layer is started so as to prevent segregation. The material shall be deposited in such manner as to prevent coning, except in the case of aggregate composed essentially of material finer than the No. 4 sieve and base material.

Dumping, casting or pushing over sides of stockpiles will be prohibited, except in the case of aggregate for base material and fine aggregate materials.

Stockpiles of different types or sizes of aggregates shall be spaced far enough apart, or separated by suitable walls or partitions, to prevent the mixing of the aggregates.

When it is necessary to operate trucks or other equipment on a stockpile in the process in building the stockpiles, it shall be done in a manner approved by the Engineer. Any method of stockpiling aggregate which allows the stockpile to become contaminated with foreign matter or causes excessive degradation of the aggregate will not be permitted. Excessive degradation will be determined by sieve tests of samples taken from any portion of the stockpile over which equipment has operated, and failure of such samples to meet all grading requirements for the aggregate shall be considered cause for discontinuance of such stockpiling procedure.

73.18 TEST METHODS

In stating requirements for most materials Item 73, reference has been made to AASHTO and ASTM Standard Specification for material. Those Specifications, in turn, include reference to the respective AASHTO and ASTM methods of sampling and testing. In a few instances, however, properties of materials in Item 73 have been specified without reference to corresponding AASHTO and ASTM Standard Specifications. In such instances the following methods of sampling and testing will govern:

TEST	TEST METHOD
AASHTO T 11	Amount of Material Finer than 0.075 mm Sieve in Aggregate
AASHTO T 19	Unit Weight of Aggregate
AASHTO T 27	Sieve Analysis of Fine and Course Aggregates
AASHTO T 88	Particle Size Analysis of Soils
AASHTO T 89	Determining the Liquid Limit of Soils
AASHTO T 90	Determining the Plastic Limit and Plasticity Index of Soils
AASHTO T 96	Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine
AASHTO T 104	Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
AASHTO T 182	Coating and Stripping of Bitumen Aggregate Mixtures
See Below	Heat-Stable Additives used in Hot Bituminous Mixtures

Test Method for Heat-Stable Additives.

- (a) Place fifty grams of treated asphalt cement heated to 325° F (treated at manufacturer's recommended percent of heat-stable asphalt additive) in a clean container.
- (b) Seal the container securely and place in an oven heated to 325° F and hold at this temperature for twenty-four hours.
- (c) Remove sample from oven and after thorough stirring, use the asphalt cement for mixing with the mineral aggregate as specified in the stripping test.
- (d) The aggregate-asphalt mixture shall then be subjected to the stripping test.
- (e) This test shall be conducted as often as deemed necessary by the Engineer.

Stripping Test

Fifty grams of the mineral aggregate passing the 1/2 inch and retained on the No. 4 sieve are washed and surface dried. The selected aggregate is coated with the blend by thorough stirring of the mixture heated to 250° F. Either of the following stripping tests may be employed. (Method (b) is intended primarily for field test.)

- (a) The coated aggregate is immersed in previously boiled distilled water at 104° F. The covered beaker containing the mix is placed overnight in an oven maintained at 140° F. At the end of the heating period (approximately eighteen hours), there shall be no evidence of stripping of the asphalt as determined by visual inspection.
- (b) The coated aggregates shall be placed in boiling water and boiling continued for one minute. The water shall then be poured off the mixture and the mixture removed and placed on a paper towel. The coated aggregate shall show no signs of strippings as determined by visual inspection.

END OF DOCUMENT

ITEM 74

MISCELLANEOUS MATERIALS

74.01 WATER

Water used in mixing concrete shall be reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable matter, or other substances injurious to the finished product. Water will be tested in accordance with AASHTO, "Standard Method of Test for Quality of Water to be Used in Concrete," Serial Designation T 26. Water known to be of potable quality may be used without test. Where the source of water is relatively shallow, the intake shall be so enclosed as to exclude silt, mud, grass, or other foreign materials.

74.02 CALCIUM CHLORIDE

Calcium chloride shall conform to the requirements of AASHTO, "Standard Specification for Calcium Chloride," Serial Designation M 144, for the type specified.

74.03 SODIUM CHLORIDE

Sodium chloride shall conform to the requirements of ASTM, "Standard Specification for Sodium Chloride," Serial Designation D 632, for the type specified.

74.04 HYDRATED LIME

Hydrated lime shall conform to ASTM, "Standard Specification for Hydrated Lime for Masonry Purposes," Serial Designation C 207, Type N, except that Section 3 (b), 4, and 5 will not be applicable.

74.05 METAL CENTER STRIP

Metal center strip shall be of an approved type, shall not be lighter than sixteen gauge, and shall be painted or galvanized.

74.06 ASPHALT PLANT

Asphalt plant shall meet the requirements of AASHTO, "Standard Specification for Asphalt Plank," Serial Designation M 46, for the type specified.

74.07 PRECAST MANHOLE RISERS AND TOPS

These items shall conform to ASTM, "Standard Specification for Precast Reinforced Concrete Manhole Sections," Serial Designation C 478.

74.08 PRECAST REINFORCED CONCRETE CATTLE PASS UNITS

If these units are designed by the producer, completely detailed drawings and design computations shall be submitted to the Engineer for approval in advance of the start of manufacture. If the units are designed by the City, the applicable standard drawing sheet shall govern. Details of manufacture shall conform in all other respects to the applicable provisions of ASTM, "Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe," Serial Designation C 76. No strength tests will be required on the completed units, but the City reserves the right to conduct continuous inspection at the site of production, and to sample and test all component materials, including the concrete, for conformity of these Specifications.

74.09 CHEMICAL ADDITIVES

- (a) For Portland Cement Concrete Mixtures

These additives shall conform to the requirements of AASHTO, "Standard Specification for Chemical Admixtures for Concrete," Serial Designation M 194, covering the following five types:

Type A	Water-Reducing Admixtures
Type B	Retarding Admixtures
Type C	Accelerating Admixtures
Type D	Water-Reducing and Retarding Admixtures
Type E	Water-Reducing and Accelerating Admixtures

Before any admixture is approved for use in Portland Cement concrete mixtures under these Specifications, the manufacturer of the admixture or the Contractor shall furnish the City documentary evidence that the material proposed for use has been tested in accordance with the methods of test specified in AASHTO, "Standard Specification for Chemical Admixtures for Concrete," Serial Designation M 194, and meets the requirements of that Specification. Documentary evidence shall be the results of tests conducted by a testing laboratory inspected at regular intervals by the Cement and Concrete Reference Laboratory of the National Bureau of Standards and approved by the City. The City may from time to time require a notarized certification from the manufacturer stating that the material is identical with that originally approved and has in no way been changed or altered.

(b) Asphalt To Be Used In Hot Bituminous Mixtures

Heat-stable asphalt anti-stripping additive shall contain no ingredient harmful to the bituminous material or to the operator and shall not appreciably alter the specified characteristics of the bituminous material when added in the recommended proportions.

The manufacturer shall recommend the percentage of his compound to be used, not to exceed 1.0 percent, but in no case shall the percentage of active agent added be less than 0.5 percent by weight of the asphalt cement.

The manufacturer shall furnish the City an affidavit stating the percentage by weight of active agent in the anti-stripping additive proposed for use.

The treated asphalt cement shall show no evidence of stripping when tested in accordance with Item 73.18.

74.10 MASONRY STONE

Masonry stone shall be sound, dense and durable, free from cracks, pyrite intrusions and other structural defects. Stone which will be used with mortar shall be free from dirt, oil, or other material that might prevent good adhesion with the mortar.

When tested by the Los Angeles Test Method, the percent of wear shall not exceed sixty.

When the crushed aggregate is subjected to five alternations of the sodium sulfate soundness test, the weighted percentage of loss shall be not more than fifteen.

74.11 WATERSTOPS

Waterstops shall be of the type, shape and dimensions shown on the Plans.

(a) Metallic

Metallic waterstops shall be sheet copper conforming to the requirements of Item 908.15 of the Tennessee Department of Transportation Specifications.

(b) Nonmetallic

Nonmetallic waterstops shall be manufactured from either natural rubber, synthetic rubber, or polyvinyl-chloride (PVC) at the option of the Contractor. Waterstops shall be produced by such a process that, as supplied for use, they will be dense, homogeneous, and free from holes and other imperfections. The cross-section of the water stop shall be uniform along its length and transversely symmetrical so that the thickness at any given distance from either edge of the waterstop will be uniform.

(1) Rubber Waterstop

The waterstop shall be fabricated from a high grade thread-type compound. The basic polymer shall be natural rubber or a co-polymer of butadiene and styrene, or a blend of both. The compound shall contain not less than seventy percent by volume of the basic polymer, and the remainder shall consist of reinforcing carbon black, zinc oxide, accelerators, anti-oxidants, vulcanizing agents, and plasticizers, but shall contain no Factise.

Samples taken from the finished waterstop shall meet the following requirements when tested in accordance with the current specified ASTM method of test.

Title	<u>ASTM Method</u>	
	Requirement of Test	
Tensile Strength (Die "C")	2500 psi, min.	D 412
Ultimate Elongation (Die "C")	450 percent min.	D 412
Shore Durometer Hardness	60-70	D 2240
Specific Gravity	1.5 +/- 0.03 (Sec. 17)	D 297
Water Absorption (% by Wt.)	5 percent	D 570
Tensile Strength after accelerated aging, oxygen-pressure method	80 percent min.	D 572

(2) Polyvinyl Chloride Waterstop

This waterstop shall be extruded from an elastomeric plastic material. The material shall be a plastic compound, the basic resin of which shall be polyvinyl chloride. The compound shall contain any additional resins, plasticizers, stabilizers, or other materials needed to insure that when the material is compounded it will meet the performance requirements of this Specification. No reclaimed polyvinyl chloride shall be used.

(3) Finished Waterstop

Samples taken from the finished waterstop shall meet the following requirements when tested in accordance with the current specified ASTM method of test.

Title	<u>ASTM Method</u>	
	Requirement of Test	
Tensile Strength (Die "C")	2500 psi, min.	D 412
Ultimate Elongation (Die "C")	280 percent min.	D 412

(4) Sheet Material

Samples taken from the sheet material shall meet the following requirements when tested in accordance with the current specified ASTM method of test or the specified Civil Works Guide Specification CE 1402, "Metals, Miscellaneous Materials and Standard Articles."

Title	<u>Method</u>	
	Requirement of Test	
Tensile Strength (Die "C")	1750 psi min.	ASTM D 412
Ultimate Elongation (Die "C")	350 percent min.	ASTM D 412
Stiffness in Flexure (1/4" span)	400 psi min.	ASTM D 747
Cracking or Chipping @ -35 F	Nil	ASTM D 746
Tensile Strength (Die "C")	1500 psi min.	Accelerated
Ultimate Elongation (Die "C")	Extraction Test CE 1402	300 percent min. Accelerated
	Extraction Test CE 1402	
Change in Weight after 7 Days	0.00 to +0.25	Effect of percent Alkalies
Change in Weight After 30 Days	Test CE 1402	0.00 to +0.40 Effect of percent Alkalies
	Test CE 1402	
Change in Shore Durometer Hardness	+/- 5	Effect of Alkalies
Change in Thickness After 30 Days	Test CE 1402	+/- 1 percent Effect of Alkalies
	Test CE 1402	

For polyvinyl chloride waterstops, the supplier shall submit a certificate stating that all of the performance requirements specified for the sheet material under polyvinyl chloride waterstops have been complied with. In addition, the supplier shall submit an affidavit to the effect that the sheet sample is of the same material in all respects as that to be used in the manufacture of the finished waterstop. The supplier shall also specify the value of the specific gravity of the finished waterstop material to within plus or minus 0.02.

Waterstops shall be manufactured with an integral cross section which shall be uniform within plus or minus 1/8" in width, and the web thickness or bulb diameter within plus 1/16" and minus 1/32".

The Contractor shall furnish the City of Chattanooga at no cost to the City a certified test report from an approved laboratory covering each lot or unit of finished waterstops. These test reports shall contain the numerical laboratory test data of the required tests.

74.12 EPOXY RESIN SYSTEMS

Two-component epoxy resin systems for application to Portland Cement Concrete, bituminous concrete, and metals shall conform to the requirements of AASHTO, "Standard Specification and Recommended Practice for Epoxy Protective Coatings," Serial Designation M 200. These systems shall be supplied in one of the following types as designated;

Type A-A Polysulfide-modified system blended with mineral filler.

Type B-A Clear or light-colored amine or polyimide-cured system.

Type C-A Coal-tar modified system.

74.13 SELECT MATERIAL FOR SOIL-CEMENT BASE

Select material for soil-cement base shall be of such general character as to be classified as Group A-1 or A-2, AASHTO, "Recommended Practice for the Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes," Serial Designation M 145. The material shall be of such size that all will pass the standard 1-1/2" sieve. Samples of the select material shall be tested in the laboratory before work is started for determination of cement content and optimum moisture content.

74.14 GRASS SEED

The seed shall meet the requirements of the Tennessee Department of Agriculture and no "Below Standard" seed will be accepted.

Grass seed furnished under these Specifications shall be packed in new bags or bags that are sound and not mended.

The vendor shall notify the City before shipments are made so that arrangements can be made for inspection and testing or stock.

The vendor shall furnish the City a certified laboratory report from an accredited commercial seed laboratory or from a State seed laboratory showing the analysis of the seed to be furnished. The commercial fertilizers as specified in Item 74.15 shall have a minimum of 3-1/2% nitrogen. The report from an accredited commercial seed laboratory shall be signed by a Senior Member of the Society of Commercial Seed Technologists. At the discretion of the City, samples of seed may be taken for check against the certified laboratory report. Sampling and testing will be in accordance with the requirements of the Tennessee Department of Agriculture.

When a seed group is used, the percentages forming the group shall be as follows, unless otherwise specified:

Name	Quantity Percent by Weight
Group "A"	
Lespedeza (Common or Korean)	20%
Sericea Lespedeza	15%
Ky. 31 Fescue	40%
English Rye	15%
White Dutch Clover	5%
Weeping Love Grass	5%
Group "B"	
Ky. 31 Fescue	55%
Redtop	15%
English Rye	20%
White Dutch Clover	5%
Weeping Love Grass	5%
Group "C"	
Sericea Lespedeza	50%
Ky. 31 Fescue	30%
English Rye	15%
White Dutch Clover	5%

In mixing or forming "Groups" of seed, they shall be uniformly mixed. "Group" seed shall not be mixed until after each type seed that is used to form the "Group" has been tested and inspected separately and approved for purity and germination by the City. Seed mixed before tests and inspection are made will not be accepted.

74.15 COMMERCIAL FERTILIZER

Manufactured fertilizer shall be a standard commercial fertilizer containing the specified percentages by weight of nitrogen (N), phosphoric acid (P O) and potash (K O).

The fertilizer shall be furnished in standard containers with the name, weight and guaranteed analysis of the contents clearly marked. The containers shall insure proper protection in handling and transporting the fertilizer.

All commercial fertilizer shall comply with local, state and federal fertilizer laws.

74.16 AMMONIUM NITRATE

Ammonium nitrate shall be a standard commercial product, shall conform to the requirements for other commercial fertilizers as specified in Item 74.15 and shall have a minimum of 33-1/2 percent nitrogen.

74.17 AGRICULTURAL LIMESTONE

Agricultural limestone shall contain not less than eighty-five percent of calcium carbonate and magnesium carbonate combined, and shall be crushed so that at least eighty-five percent will pass the No. 10 mesh sieve.

74.18 MULCH MATERIAL

All mulch materials shall be air dried and reasonably free of noxious weeds and weed seed, or other materials detrimental to plant growth.

Hay shall be stalks of approved grasses, sedges or legumes seasoned before baling or loading.

Straw shall be stalks of rye, oats, wheat or other approved grain crops.

Both hay and straw shall be suitable for spreading with standard mulch blower equipment.

74.19 JUTE MESH

Jute mesh shall be of a uniform, open, plain weave of single jute yarn. The yarn shall be of loosely twisted construction and shall not vary in thickness by more than one-half of its normal diameter. Jute mesh shall be furnished in rolled strips and shall meet the following requirements.

Jute mesh shall be nontoxic to the growth of plants and germination of seeds, and shall be identified by tag. It shall have 58 wrap ends per yard, 41 weft ends per yard, and have an average weight of 0.9 pounds per square yard, with an allowable deficiency of not more than five percent.

All materials shall be new and unused, and the length shall be marked on each roll. Staples shall be machine made of No. 11 gauge new steel wire formed into a "U" shape.

74.20 LINSEED OIL PRESERVATIVE

Linseed oil preservative shall consist of fifty percent boiled linseed oil, and fifty percent petroleum spirits (mineral spirits), meeting the requirements of Item 604.28 of the Tennessee Department of Transportation Standard Specifications. The linseed oil and petroleum spirits shall be agitated and thoroughly mixed prior to application.

74.21 GROUT

Grout shall be mixed in small quantities as needed, and shall not be re-tempered or used after it has begun to set. Unless otherwise specified or directed, the grout shall consist of one part Portland Cement and three parts sand mixed with sufficient water to form a grout of proper consistency. When non-shrinking fast-setting grout is specified, it shall be formulated by the incorporation of an admixture, or a premixed grout may be used. The formulation and the admixture or the premixed grout used will be subject to the approval of the Engineer, and shall be mixed and used in accordance with the recommendations of the manufacturer. These special grouts will be classified as follows:

- Type I - Non-shrinking grout
- Type II - Non-shrinking, fast-setting grout

Portland Cement for grout shall conform to the requirements of Item 73.01. Sand for grout shall conform to the requirements of Item 73.02. Water for grout shall be approved by the Engineer.

74.22 MANHOLE STEPS

Steps used in manholes or catch basins shall be cast iron, aluminum or wrought iron, unless otherwise specified. The design of the steps shall be as shown on the Plans.

- (a) Cast iron steps shall conform to the requirements of Item 908.07 of the Tennessee Department of Transportation Standard Specifications.
- (b) Aluminum steps shall be fabricated from aluminum alloy 6060, T 60 with a minimum tensile strength of 3800 psi, a minimum yield strength of 3500 psi, and an elongation in two inches of not less than 10 percent.

74.23 RED IRON OXIDE

Red iron oxide for coloring concrete shall be a mineral product containing no organic coloring matter and shall conform to the following requirements:

Loss on ignition	4 percent, maximum
Iron Oxide, as F	80 percent, minimum
Passing 325 mesh sieve	97 percent, minimum

74.24 INOCULANTS FOR LEGUMES

Inoculants for treating legume seed shall be standard cultures of nitrogen-fixing bacteria that are adapted to the particular kind of seed to be treated. The inoculant shall be supplied in convenient containers of a size sufficient to treat the amount of seed to be planted. The label on the container shall indicate the specified legume seed to be inoculated and the date period to be used.

END OF DOCUMENT

ITEM 98

SLOPE PROTECTION AND EROSION CONTROL

98.01 SCOPE

(a) This Section shall consist of temporary control measures as shown in the plans or directed by the Engineer during the life of the Contract to control erosion and water pollution, through the use of berms, dikes, dams, sediment basins, fiber mats, netting, mulches, grasses, slope drains, temporary silt fences, and other control devices.

(b) The temporary pollution control provisions contained herein shall be coordinated with the permanent erosion control features, to assure economical, effective, and continuous erosion control throughout the construction and post-construction period.

98.02 TEMPORARY BERMS

(a) A temporary berm is constructed of compacted soil, with or without a shallow ditch, at the top of fill slopes or transverse to centerline on fills.

These berms are used temporarily at the top of newly constructed slopes to prevent excessive erosion until permanent controls are installed or slopes stabilized.

98.03 TEMPORARY SLOPE DRAINS

A temporary slope drain is a facility consisting of stone gutters, fiber mats, plastic sheets, concrete or asphalt gutters, half-round pipe, metal pipe, plastic pipe, sod or other material acceptable to the Engineer that may be used to carry water down slopes to reduce erosion.

98.04 SEDIMENT STRUCTURES

Sediment basins, ponds, and traps, are prepared storage areas constructed to trap and store sediment from erodible areas in order to protect properties and stream channels below the construction areas from excessive siltation.

98.05 CHECK DAMS

(a) Check dams are barriers composed of logs and poles, large stones or other materials placed across a natural or constructed drainway.

(b) Stone check dams shall not be utilized where the drainage area exceeds fifty (50) acres. Log and pole structures shall not be used where the drainage area exceeds five (5) acres.

98.06 TEMPORARY SEEDING AND MULCHING

Temporary seeding and mulching are measures consisting of seeding, mulching, fertilizing, and matting utilized to reduce erosion. All cut and fill slopes including waste sites and borrow pits shall be seeded when and where necessary to eliminate erosion.

98.07 BRUSH BARRIERS

(a) Brush barriers shall consist of brush, tree trimmings, shrubs, plants, and other approved refuse from the clearing and grubbing operation.

(b) Brush barriers are placed on natural ground at the bottom of fill slopes, where the most likely erodible areas are located to restrain sedimentation particles.

98.08 BALED HAY OR STRAW CHECKS

(a) Baled hay or straw erosion checks are temporary measures to control erosion and prevent siltation. Bales shall be either hay or straw containing five (5) cubic feet or more of material.

(a) Baled hay or straw checks shall be used where the existing ground slopes toward or away from the embankment along the toe of slopes, in ditches, or other areas where siltation erosion or water run-off is a problem.

98.09 TEMPORARY SILT FENCES

Silt fences are temporary measures utilizing woven wire or other approved material attached to posts with filter cloth composed of burlap, plastic filter fabric, etc., attached to the upstream side of the fence to retain the suspended silt particles in the run-off water.

98.10 EROSION CONTROL FABRIC

Mulch on slopes exceeding 3 to 1 ratio shall be held in place by the use of an approved erosion control fabric, such as Curlex 1 as manufactured by American Excelsior Company, or an approved equal.

98.11 DITCH LINING FABRIC

(a) Mat

The mat shall be of three-dimensional structures of entangled nylon filaments (0.40 mm minimum diameter) bonded at their intersections. The filaments shall be coated with polyurethane binder to increase tensile strength between the filaments and to increase abrasion resistance. The mat shall be resistant to chemical and environmental degradation. The mat shall be 10 mm in thickness and promote and maintain the integrity of the grass root system. Enkamat Type 7020 soil reinforcement matting as manufactured by the American Enka Company or an approved equal shall be used.

(b) Ground Fasteners

Ground fasteners shall be one or a combination of the following:

1. T-Staple (wire)
2. Broad wire U-staple
3. Narrow wire U-staple
4. Wood Survey stake

All staples shall be 8- to 11-gauge wire with a minimum penetration of 8 inches. The wood survey stakes will be used when high velocity and/or large volumes of water are expected to occur.

98.12 PROJECT REVIEW

Prior to the preconstruction conference, the Contractor shall meet with the Engineer and go over in detail the expected problem areas in regard to the erosion control work. Different solutions should be discussed so that the best method might be determined. It is the basic responsibility of the Contractor to develop an erosion control plan acceptable to the Engineer.

98.13 PRECONSTRUCTION CONFERENCE

At the preconstruction conference the Contractor shall submit for acceptance his schedule for accomplishment of temporary and permanent erosion control work, as are applicable for clearing and grubbing, grading, bridges and other structures at watercourse, construction, and paving. He shall also submit for acceptance his proposed method of erosion control on haul roads and borrow pits and his plan for disposal of waste materials. No work shall be started until the erosion control schedules and methods of operations have been accepted by the engineer.

98.14 CONSTRUCTION REQUIREMENTS

- (a) The Engineer has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, the surface of erodible earth material exposed by excavation, borrow and fill operations and to direct the Contractor to provide immediate permanent or temporary pollution control measures to prevent contamination of adjacent streams or other watercourses, lakes, ponds, or other water impoundment. Such work may involve the construction of temporary berms, dikes, dams, sediment basins, slope drains, and use of temporary mulches, mats, seeding or other control devices or methods as necessary to control erosion. Cut and fill slopes shall be seeded and mulched as the excavation proceeds to the extent directed by the Engineer.
- (b) The Contractor shall be required to incorporate all permanent erosion control features into project at the earliest practicable time as outlined in his accepted schedule. Temporary pollution control measures shall be used to correct conditions that develop during construction that 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.
- (c) Where erosion is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion control features can follow immediately thereafter if the project conditions permit; otherwise, erosion control measures may be required between successive construction stages. Under no conditions shall the surface area of erodible earth material exposed at one time by clearing and grubbing, exceed 750,000 square feet without approval by the Engineer.
- (d) The Engineer will limit the area of excavation, borrow, and embankment operations in progress commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent pollution control measures current in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified.
- (e) Under no conditions shall the amount of surface area or erodible earth material exposed at one time by excavation or fill within the project area exceed 750,000 square feet without prior approval by the Engineer.
- (f) The Engineer may increase or decrease the amount of surface area of erodible earth material to be exposed at one time by clearing and grubbing, excavation, borrow and fill operations as determined by his analysis of project conditions.
- (g) In the event of conflict between these requirements and pollution control laws, rules, or regulations or other Federal or State or local agencies, the more restrictive laws, rules, or regulations shall apply.

98.15 CONSTRUCTION OF STRUCTURES

(a) Temporary Berms

A temporary berm shall be constructed of compacted soil, with a minimum width of 24 inches at the top and a minimum height of 12 inches with or without a shallow ditch, constructed at the top of fill slopes or transverse to centerline on fills.

Temporary berms shall be graded so as to drain to a compacted outlet at a slope drain. The area adjacent to the temporary berm in the vicinity of the slope drain must be properly graded to enable this inlet to function efficiently and with minimum ponding in this area. All transverse berms required on the downstream side of a slope drain shall extend across the grade to the highest point at approximately a 10-degree angle with a perpendicular to centerline. The top width of these berms may be wider and the side slope flatter on transverse berms to allow equipment to pass over these berms with minimal disruptions. When practical and until final roadway elevations are approached, embankments should be constructed with a gradual slope to one side of the embankment to permit the placement of temporary berms and slope drains on only one side of the embankment.

(b) Temporary Slope Drains

Temporary slope drains shall consist of stone gutters, fiber mats, plastic sheets, concrete or asphalt gutters, half-round pipe, metal pipe, plastic pipe, flexible rubber, or other materials which can be used as temporary measures to carry water accumulating in the cuts and on the fills down the slopes prior to installation of permanent facilities or growth of adequate ground cover on the slopes.

1. Fiber matting and plastic sheeting shall not be used on slopes steeper than 4:1 except for short distances of 20 feet or less.
2. All temporary slope drains shall be adequately anchored to the slope to prevent disruption by the force of the water flowing in the drains. The base for temporary slope drains shall be compacted and concavely formed to channel the water or hold the slope drain in place. The inlet end shall be properly constructed to channel water into the temporary slope drain. Energy dissipaters, sediment basins, or other approved devices shall be constructed at the outlet end of the slope drains to reduce erosion downstream. An ideal dissipater would be dumped rock or a small sediment basin which would slow the water and collect sediment. All temporary slope drains shall be removed when they are no longer necessary and the site restored to match the surroundings.

(c) Sediment Structures

1. Sediment structures shall be utilized to control sediment at the foot of embankments at slope drain outlets, at the bottom and in the ditchlines atop waste sites, and in the ditchlines and/or borrow pits. Sediment structures may be used in most drainage situations to prevent excessive siltation of pipe structures. All sediment structures shall be at least twice as long as they are wide.

2. When use of temporary sediment structures is to be discontinued, all sediment accumulation shall be removed, and all excavation backfilled and properly compacted. The existing ground shall be restored to its natural or intended condition.

(d) Check Dams

1. Check dams shall be utilized to retard stream flow and catch small sediment loads. Materials utilized to construct check dams are varied and should be clearly illustrated or explained in the Contractor's erosion control plan.
2. All check dams shall be keyed into the sides and bottom of the channel a minimum depth of 2 feet. A design is not needed for check dams, but some typical designs are shown in the standard plans.
3. Stone check dams should generally not be utilized where the drainage area exceeds fifty (50) acres. Long and pole structures should generally not be used where the drainage area exceeds five (5) acres.

(e) Temporary Seeding and Mulching

Seeding and mulching shall be performed in accordance with Item 35, entitled "Sodding and/or Seeding."

(f) Brush Barriers

Brush barriers shall consist of brush, tree trimmings, shrubs, plants and other approved refuse from the clearing and grubbing operation. The brush barriers shall be constructed approximately parallel to original ground contour. The brush barrier shall be compressed to an approximate height of 3 to 5 feet and approximate width of 5 to 10 feet. The embankment shall not be supported by the construction of brush barriers.

(g) Baled Hay or Straw Erosion Checks

Hay or straw erosion checks shall be embedded in the ground 4 to 6 inches to prevent water flowing under them. The bales shall also be anchored securely to the ground by wooden stakes driven through the bales into the ground. Bales can remain in place until they rot, or be removed after they have served their purpose, as determined by the Engineer. The Contractor shall keep the checks in good condition by replacing broken or damaged bales immediately after damage occurs. Normal debris clean-out will be considered routine maintenance.

(h) Temporary Silt Fences

1. Temporary silt fences shall be placed on the natural ground, at the bottom of fill slopes, in ditches, or other areas where siltation is a problem. Silt fences are constructed of wire mesh fence with a covering of burlap or some other suitable material on the upper grade side of the fence and anchored into the soil.

2. The Contractor shall be required to maintain the silt fence in a satisfactory condition for the duration of the project or until its removal is requested by the Engineer. The silt accumulation at the fence may be left in place and seeded, removed, etc., as directed by the Engineer. The silt fence becomes the property of the Contractor whenever the fence is removed.

(i) Erosion Control Fabric

1. Fabric shall be installed immediately after seeding operations have been completed in work areas. Mulch shall not be used under the fabric.
2. Installation instructions shall be supplied by the manufacturer, and fabric shall be applied in accordance with the manufacturer's recommendation as directed by the specifier.
3. Fabric shall be unrolled and draped loosely, without stretching, so that continuous ground contact is maintained. In ditches, fabric shall be unrolled and applied parallel to the flow direction. On slopes, fabric shall be applied parallel to the slope direction unless the engineer approves an alternate application method.
4. In ditches and on slopes, each upslope and each downslope end of each piece of fabric shall be placed in a 4-inch trench, stapled on 9-inch centers, backfilled and tamped. Where one roll ends and a second roll starts, the upslope piece shall be brought over the end of the downslope roll so that there is a 12-inch overlap, placed in a 4-inch trench stapled on 9-inch centers, backfilled and tamped.
5. On slopes where two or more widths of fabric are applied, the two edges shall be overlapped according to manufacturer's installation instructions and stapled at 18 to 24-inch intervals along the exposed edge of the lap joint. The body of the fabric shall be stapled in a grid pattern with staples 3 feet maximum on center each way.
6. Where heavy concentrations of water or extremely erodible soil conditions exist, erosion checks shall be installed at intervals up to 50 feet as directed by the engineer. Erosion checks shall be a 4-inch deep trench perpendicular to the flow line across the width of the fabric. The fabric shall be stapled at 9-inch intervals along the bottom of the trench across the entire width of the fabric, backfilled and stamped.

(j) Ditch Lining Fabric

1. The ditch shall be shaped and dressed in accordance with the Specifications and Drawings at the location and grade shown on the plans or designated by the Engineer. Transverse check slots shall then be cut at the ends of the liner at 25-foot intervals along the ditch to a depth of 6 to 12 inches. Matting widths shall be as specified in the plans. Longitudinal shelves shall be cut 4 inches along the full length of the ditch for the mat edges to rest on.

2. Before the matting is placed, seeding operations shall be completed along the ditch line. Seeding operations shall conform to the requirements of Item 35, entitled, "Sodding and/or Seeding."

3. After seeding, the center strip of matting shall be rolled out starting at the upper end of the ditch. Then the side strips shall be rolled out, also starting at the upper end of the ditch, and overlapping the middle strip about 3 inches. The mat shall then be pinned down thoroughly and snugly in the transverse check slots and longitudinal shelves and at maximum intervals of 5 feet along the ditch. Where necessary, additional pins shall be used to hold the mat firmly in place, the transverse check slots and longitudinal shelves shall be covered with soil and tamped. Additional grass seed shall be applied to any disturbed areas after dressing is complete.

98.16 MAINTENANCE

(a) The temporary erosion control features should be installed by the Contractor until no longer needed or permanent erosion control methods are installed. Any materials removed shall become the property of the Contractor.

(b) In the event that temporary erosion and pollution control measures are required due to the Contractor's negligence, carelessness, or failure to install permanent controls as a part of work as scheduled, and are ordered by the Engineer, such work shall be performed by the Contractor at his own expense.

(c) Where the work to be performed is not attributed to the Contractor's negligence, carelessness, or failure to install permanent controls and falls within the specifications for a work item that has a contract price, the units of work shall be paid for at the proper contract prices.

98.17 EROSION CONTROL OUTSIDE PROJECT AREA

Temporary pollution control shall include construction work outside the project area where such work is necessary as a result of construction such as borrow pit operations, haul roads and equipment storage sites. Bid price in such cases shall include all necessary clearing and grubbing, construction incidentals, maintenance, and site restoration when no longer needed.

END OF DOCUMENT

ITEM 717

MOBILIZATION OF FORCES, SUPPLIES, AND EQUIPMENT

717.01 Description

This work shall consist of the mobilization and demobilization of the prime Contractor's and all Subcontractors' work forces, supplies, equipment, and incidentals at the project site. It shall include all Contractor and Subcontractor costs associated with obtaining performance bonds, insurance required by railroads, and other preconstruction costs incurred after award of the contract which are necessary costs to the project and are of a general nature rather than directly attributable to other pay items. All necessary preconstruction costs not attributable to a specific pay item shall be included in the contract lump sum price for Mobilization and not in any other pay item.

717.02 Method of Measurement

Mobilization will be measured by the unit for the completion of the work as described above, and payment will be made on a lump sum basis.

717.03 Basis of Payment

Partial payment for mobilization will be determined as indicated below. Upon completion of all work on the project, payment will be made of any amount bid for mobilization in excess of the total limit for partial payment.

Partial Payment Schedule

Percent of Total Contract Amount of Progress Estimate Exclusive of Mobilization	Percent of Mobilization Allowed
Not Less Than	
2%	30%*
5%	50%*
10%	80%*
25%	100%*

* % of lump sum bid price for mobilization or of the total limit for partial payment whichever is less.

Payment for mobilization will be made in accordance with the provisions set out above, which price shall be full compensation for organizing and moving all forces, supplies, equipment, and incidentals to the project site, regardless of the number of times such moves are made and also for all preconstruction costs incurred after award of the contract.

END OF DOCUMENT

SECTION 32 14 13.19

PERMEABLE INTERLOCKING CONCRETE PAVERS

[This guide specification must be edited for project-specific requirements. It should be reviewed by a qualified civil or geotechnical engineer, architect, or landscape architect familiar with the site conditions. For bracketed terms, choose the applicable item or description.]

PART 1 – GENERAL

1.01 SECTION INCLUDES

- A. Work consists of furnishing and construction of a Permeable Interlocking Concrete Pavement (PICP) System in accordance with these specifications and in reasonably close conformity with the lines, grades, design, and dimensions shown on the plans.
- B. Installation work includes:
 - 1. Verifying subgrade to the lines, grades, infiltration rate, and density and site conditions shown on the construction drawings;
 - 2. Furnishing and installing geotextile and/or membrane liner (where required), horizontal drainage piping (where required), sub-base course, base course, bedding course, edge restraint, concrete pavers and permeable joint material to the lines and grades shown on the construction drawings.

1.02 RELATED SECTIONS

- | | | |
|----|---------------------|--|
| A. | Section 31 00 00 | Earthwork |
| B. | Section 31 05 19.13 | Geotextiles for Earthwork |
| C. | Section 31 05 19.16 | Geomembranes for Earthwork |
| D. | Section 32 11 23 | Aggregate Base Courses |
| E. | Section 32 16 13 | Curbs and Gutters |
| F. | Section 32 17 00 | Paving Specialties (Bumpers, markings, snow melting) |
| G. | Section 33 46 16.19 | Pipe Underdrains |

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM C-29 Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregate
 - 2. ASTM C-33 Standard Specification for Concrete Aggregates
 - 3. ASTM C-131 Standard Test Method for Resistance to Degradation of Small-Sized Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
 - 4. ASTM C-136 Standard Test Method for Sieve Analysis of Fine and Coarse Grained Aggregates
 - 5. ASTM C-535 Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
 - 6. ASTM C-140 Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units
 - 7. ASTM C-936 Standard Specification for Solid Concrete Interlocking Paving Units
 - 8. ASTM C-979 Standard Specification for Pigments for Integrally Colored Concrete
 - 9. ASTM C-1645 Standard Test Method for Freeze-thaw and De-icing Salt Durability of Solid Interlocking Paving Units
 - 10. ASTM C-1781 Standard Test Method for Surface Infiltration Rate of Permeable Unit Pavement Systems

11. ASTM D-698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort
12. ASTM D-1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort
13. ASTM D-2488 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)
14. ASTM D-3034 Standard Specification for Type PSM Poly Vinyl Chloride (PVC) Sewer Pipe and Fittings
15. ASTM D-3350 Standard Specification for Polyethylene Plastic Pipe and Fittings Materials
16. ASTM D-4873 Standard Guide for Identification, Storage and Handling of Geosynthetic Rolls and Samples

- D. Interlocking Concrete Pavement Institute (ICPI)
1. Permeable Interlocking Concrete Pavement manual (latest edition)
 2. Permeable Design Pro software for hydrologic and structural design
 3. Tech Spec Technical Bulletins.

1.04 SUBMITTALS

[Note: For larger projects, it will be necessary for the Manufacturer to provide multiple test reports. The initial frequency shall be one set of tests for each 100,000 full sized pavers delivered to the site or at any time a change in the manufacturing process, mix design, cement, aggregate or other material occurs. If all pavers tested pass all requirements for a sequence of 400,000 pavers, then the testing frequency may be relaxed to one set of tests for 200,000 full sized pavers; however, if any pavers fail any of the required tests, then the testing frequency shall revert to the initial testing frequency.]

For larger projects, the Method Statement will need to outline a method of measuring each layer (known as cluster) of pavers by the manufacturer and in the field, and a plan for dealing with the expected growth in size of each cluster. The focus is on maintaining the specified joint width and straight joint lines for the duration of the project.]

- A. Contractor shall submit to the owner for approval, and retain for the balance of the project a minimum of [four full size samples for hand installation] [14 full size samples for mechanical installation] of each concrete paver type/size/thickness/color/finish specified. The samples shall represent the range of shape, texture and color permitted for the respective type. Color(s) will be selected by Architect/Engineer/Landscape Architect/Owner from Manufacturer's standard colors.
- B. Prior to delivery of the associated material to the site, the Contractor shall submit the following product specific documentation for approval:
 1. Aggregates
 - 1.) Sieve analysis per ASTM C-136 for sub-base, base, bedding and joint aggregate materials
 - 2.) Minimum 3 lb sample of each material for independent testing.
 - 3.) Source test results for void ratio and bulk density of the base and sub-base aggregates per ASTM C-29.
 2. Concrete Pavers:
 - 1.) Test results from an independent testing laboratory for compliance to ASTM C-936.
 - 2.) For machine installation projects, stitching details to be used during product placement as supplied by the manufacturer.
 - 3.) Warranty documentation.
 - 4.) Safety Data Sheets (SDS).
 3. Geosynthetics
 - 1.) One 18 inch x 18 inch panel of each geosynthetic (Geotextile or Membrane Liner) for inspection and testing. The sample panels shall be uniformly

rolled and shall be wrapped in plastic to protect the material from moisture and damage during shipment. Samples shall be externally tagged for easy identification. External identification shall include: name of manufacturer; product type; product grade; lot number; and physical dimensions.

2.) Safety Data Sheets (SDS).

3.) Written Method Statement that describes material staging and flow, paving direction and installation procedures, including representative reporting forms that ensure conformance to the project specifications.

1.05 QUALITY ASSURANCE

[For mechanically installed projects, there should be verification that the Contractor has the necessary equipment, and is sufficiently familiar with its operation, to properly conduct the work. The manufacturer should also provide a description of the anticipated growth in size of each cluster, and a plan for managing the growth, so as to not interfere with placement by the paving machines. Reference ICPI Technical Specification 15 for more information.]

- A. Contractor shall submit a list of five (5) previously constructed projects of similar size and magnitude prior to bid date to be qualified. Contact names, telephone numbers, and date of completion shall be listed for each project.
- B. At a minimum, the Contractor's site foreman shall hold PICP Technician Certificate from the Interlocking Concrete Pavement Institute (ICPI) contractor certification program. The site foreman is expected to be onsite for the entire installation.
- C. Contractor shall conform to all local, state/provincial licensing and bonding requirements.
- D. Contractor will hold a mandatory pre-construction meeting with Design Engineer, Owner, and affected sub-trades accessing PICP work area to review method statement and quality control plan and communicate to all parties a work flow that is most desirable to meet the construction schedule as set forth by the general contractor. Additional details of pre-construction meeting are outlined in Article 3.01.

1.06 MOCK-UPS

- A. Install a 10 ft x 10 ft paver area following the installation practices described in Article 3.02 to 3.04.
- B. This area will be used to verify: surcharge of the Bedding Course; joint sizes; lines; laying pattern(s); stitching details (for mechanical installation); color(s); and, texture of the job.
- C. To provide a proper representation of color blend, blending during installation of sample mock-up will be pulled from a minimum of 3 cubes for manual installation, and 6 cubes for mechanical installation.
- D. This area shall be the standard from which the work will be judged.
- E. Subject to approval by the Owner, the mock-up may be retained as part of the finished work. If mock-up is not retained, remove and dispose of mock-up at the completion of the project.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Comply with Manufacturer's ordering instructions and lead time requirements to avoid construction delays.
- B. Coordinate delivery and paving schedule to minimize interference with normal use of buildings adjacent to paving.
- C. Contractor shall check all materials upon delivery to assure that the proper materials have been received and are in good condition before signing off on the manufacturer's packing slip.
- D. Contractor shall protect all materials from damage or contamination due to jobsite conditions and in accordance with manufacturer's recommendations. Damaged or contaminated materials shall not be incorporated into the work.

- E. Deliver concrete pavers to the site in steel banded, plastic banded, or plastic wrapped cubes capable of transfer by fork lift or clamp lift. Unload and store concrete pavers at job site in such a manner that no damage occurs to the product.
- F. Handle and transport aggregates to avoid segregation, contamination and degradation. Keep different materials sufficiently separated as to prevent mixing. Do not dump or store one material on top of another unless it is part of the installation process. Cover material with waterproof covering to prevent exposure to rainfall or removal by wind. Secure the covering in place.
- G. Geosynthetics shall be delivered, stored and handled in accordance with ASTM D-4873.

1.08 ENVIRONMENTAL CONDITIONS

- A. Do not install during heavy rain, freezing conditions or snowfall.
- B. Do not install on frozen soil subgrade or aggregates.
- C. Do not install frozen aggregates.

1.09 MAINTENANCE MATERIALS

- A. Provide [specify area] square feet additional paver material for use by Owner for maintenance and repair.
- B. Pavers to be from the same production run as installed materials.
- C. Store paver materials in Owner designated location.

PART 2 – PRODUCTS

2.01 DEFINITIONS

[Note: for commercial applications, cast in place concrete edge restraints are recommended as they provide the greatest resistance to lateral movement. The other alternatives are listed for informational purposes only.]

- A. Base Course – within the context of this specification, a washed open graded free draining aggregate material (#57 Stone) of a designed thickness that provides both structural support over the Sub-base and water storage capacity (within the voids). It also serves as a choking material between the bedding course and sub-base.
- B. Bedding Course – within the context of this specification, a two-inch thick layer of washed open graded free draining aggregate material (#8 stone) loosely screeded smooth for bedding of the concrete pavers.
- C. Concrete Pavers – within the context of this specification, solid individual paving units manufacturing from concrete that are either specifically designed for use in permeable applications (includes joints or voids) or are laid in a pattern that creates large enough openings to provide infiltration. Concrete pavers are shipped in clusters called bundles or cubes, which consist of several layers of pavers strapped or wrapped together.
 - a. Voids – larger openings between the individual pavers that provide for infiltration.
 - b. Joints – smaller openings between the individual pavers that provide vertical and horizontal interlock between units and infiltration.
- D. Edge Restraint – within this specification, a cast in place concrete curb, building or other stationary object that prevents the lateral movement of the bedding course and concrete pavers so they do not spread and lose interlock. Other edge restraints options include plastic, steel or aluminum edging, cut stone, precast concrete and submerged concrete edge complete with mortared pavers. Use of alternative edge restrains not shown on the plans will require approval from the Engineer.
- E. Geotextile – A woven or non-woven geosynthetic fabric made from plastic filaments and/or fibers used primarily for separation between sub-base and subgrade and along side walls.

- F. Horizontal Drainage Piping – series of horizontal pipes within the sub-base that discharge to a catch basin, ditch or other receiving body beyond the extent of the paved area. Piping is typically elevated in a partial infiltration system, and at the bottom of the Sub-base in a no infiltration system.
- G. Laying Face – the working edge of the pavement where the laying of pavers is occurring.
- H. Mechanical Installation - The use of specialized machines designed specifically to lift whole layers of pavers from the bundles or pallets and place them on the prepared bedding course.
- I. Membrane Liner – impermeable liner placed at the bottom and sides of a no infiltration system, used to prevent the infiltration/discharge of water other than through the Horizontal Drainage Piping. Usually includes a cushion geotextile on top or possibly bottom for protection.
- J. Permeable Joint Material – a washed open graded free draining aggregate material (typically #8, #89 or #9 Stone) used to fill the spaces (joints and voids) between Concrete Pavers to create interlock and still maintain infiltration.
- K. Permeable Interlocking Concrete Pavement (PICP) System – a system of paving consisting of concrete pavers placed in an interlocking pattern with the joints and voids filled with permeable joint material. The bedding course, base course and sub-base courses provide structural support over the Subgrade and stores, infiltrates (into the Subgrade), and/or drains the infiltrating water.
- L. Sub-base Course – within the context of this specification, an open graded free draining aggregate material (#2 Stone) of a designed thickness that provides both structural support over the subgrade and water storage capacity within the voids.
- M. Subgrade – the soil upon which the pavement structure and shoulders are constructed.

2.02 PERMEABLE CONCRETE PAVERS

[For specific product availability, color or finish options, contact your regional Belgard representative or visit www.Belgard.com.

The pattern in which pavers are installed is very important in vehicular applications. Avoid patterns with long continuous lines; these may be subject to failure under vehicular traffic.

There are recommended minimum thicknesses, and maximum aspect ratios, of pavers used in different applications (eg: pedestrian, light vehicular, heavy vehicular). To verify what is applicable to the given project, contact your regional Belgard representative or visit our web site at www.Belgard.com.

For certain machine installation products, there are one-third/half/two third pieces within each layer that need to be removed from two adjacent layers and replaced with a single full sized piece; the purposes are to increase the interlock and to break up lines. Product quantities need to account for non-full sized pieces that will be removed and not utilized elsewhere in the project.

Efflorescence is a whitish powder-like deposit that sometimes appears on concrete products. Calcium hydroxide and other water-soluble materials form or are present during the hydration of Portland cement. Pore water becomes saturated with these materials, and diffuses to the surface of the concrete. When this water evaporates, the soluble materials remain as a whitish deposit on the concrete surface. The calcium hydroxide is converted to calcium carbonate during a reaction with carbon dioxide from the atmosphere. The calcium carbonate is difficult to remove with water. However, the efflorescence will wear off with time, and it is advisable to wait a few months before attempting to remove any efflorescence. Commercially available cleaners can be used, provided directions are carefully followed. Some cleaners contain acids that may alter the color of the pavers.]

- A. Basis-of-Design Product:

1. Belgard Aqualine Series [*Select product or products to be used*]

- A. 4-1/2" x 9" x 3-1/8" thick
- B. 9" x 9" L-Stone x 3-1/8" thick
- C. 3" x 12" x 3-1/8" thick
- D. 6" x 6" x 3-1/8" thick
- E. 6" x 12" x 3-1/8" thick
- F. 12" x 12" x 3-1/8" thick
- G. 12" x 12" L-Stone x 3-1/8" thick

2. Supplied by:

Oldcastle Architectural Location as noted below:

[Chose Belgard Location: (Head office for the given states listed below)]

KY, NC, SC, TN, South VA

Adams Products Company

P.O. Box 14489, Greensboro, NC 27415
800-446-7421 336-375-8259 Fax

CO, South ID, NV, UT, WY

Ancor Masonry Products

333 South Redwood Road, North Salt Lake, UT 84054
800-800-4004 801-936-5470 Fax

CT, DE, MA, MD, ME, NH, NJ,
NY, PA, RI, North VA, VT**Anchor Concrete Products**

1913 Atlantic Avenue, Manasquan, NJ 08736
800-682-5625 732-292-2650 Fax

ID, MT, OR, WA

Central Premix

16310 East Marietta Lane, Spokane, WA 99216
800-950-6290 509-926-8367 Fax

AL, GA, MS

Georgia Masonry Supply

1443 Battle Creek Road, Jonesboro, GA 30236
800-621-5222 770-471-2128 Fax

AR, IA, KS, MO, ND, NE, SD

Miller Materials

4201 Powell Drive, Bonner Springs, KS 66012
866-761-4552 913-667-1796 Fax

IL, IN, MI, MN, OH,
WI, WV**Northfield Block**

One Hunt Court, Mundelein, IL 60060
847-557-5008 877-222-1557 Fax

FL

Oldcastle Coastal

7167 Interpace Road, West Palm Beach, FL 33407
888-321-2354 813-783-2728 Fax

CA

Sierra Building Products

10714 Poplar Avenue, Fontana, CA 92337
866-749-3038 909-355-6444 Fax

AZ, NM

Superlite

4223 W. Highland Avenue, Phoenix, AZ 85019
833-366-7877 602-352-0101 Fax

LA, OK, TX

Texas Masonry Supply

400 Jewell Drive, Waco, TX 76712
800-792-3216 254-772-6999 Fax

3. Substitutions: No substitutions permitted.

- B. Product Requirements
 - 1. Color: [Sunset] [Rust] [Desert] [Almond] [Linen] [Suede] [Truffle] [Graphite] [Foundry]
 - 2. Finish: [Colorgard] [Texturgard]
[Note: Texturgard is a face-mix product and Colorgard is through body color product.]
- C. Concrete Pavers shall conform to the following requirements set forth in ASTM C-936:
 - 1. Measured length or width of test specimens shall not differ by more than +/- 0.063 in, while measured thickness shall not differ by more than +/- 0.125 in.
 - 2. Average compressive strength of 8,000 psi (55 MPa) with no individual unit under 7,200 psi (50 MPa) when tested in accordance with ASTM C-140.
 - 3. Average absorption of 5% with no unit greater than 7% when tested in accordance with ASTM C-140.
 - 4. Where freeze-thaw testing is required, the average mass loss of all specimens tested shall not be greater than (A) 225 g/m² when subject to 28 freeze thaw cycles, or (b) 500 g/m² when subject to 49 freeze thaw cycles. Testing shall be conducted using a 3% saline solution in accordance to ASTM C-1645.
- D. Efflorescence shall not be a cause for rejection.
- E. Pigment in Concrete Pavers shall conform to ASTM C-979.

2.03 BEDDING COURSE AND PERMEABLE JOINT MATERIAL

- A. Clean, non-plastic aggregate, free from deleterious or foreign matter, manufactured from crushed rock.
- B. Percent of angular and sub-angular particles greater than 90%. Do not use rounded river gravel.
- C. LA Abrasion <40 as per ASTM C-131.
- D. Where joints are greater than or equal to ¼ inch, use joint fill material having gradation conforming to Table 1 as tested in accordance to ASTM C-136. All aggregates shall be washed and have less than 2% passing the No. 200 (0.075 mm) sieve.
- E. Where joints are less than ¼ inch, use pre-bagged Permeable Joint Material as supplied by Belgard.

Table 1
Grading Requirements for Bedding Course and Joint Material (ASTM No. 8 Stone per ASTM C-33)

Sieve Size	Percent Passing
1/2 in. (12.5 mm)	100
3/8 in. (9.5 mm)	85 to 100
No. 4 (4.75 mm)	10 to 30
No. 8 (2.36 mm)	0 to 10
No. 16 (1.18 mm)	0 to 5
No. 200 (0.075 mm)	0 - 2

3 BASE AND SUB-BASE

- A. Clean, non-plastic aggregate, free from deleterious or foreign matter, manufactured from crushed rock.
- B. Percent of angular and sub-angular particles greater than 90%. Do not use rounded river gravel.
- C. LA Abrasion <40 as per ASTM C-535.

- D. Gradation of Base Course to conform to Table 2 as tested in accordance to ASTM C-136. Gradation of Sub-base Course to conform to Table 3 as tested in accordance to ASTM C-136. All aggregates shall have less than 2% passing the No. 200 (0.075 mm) sieve.
- E. Recycled concrete and/or recycled asphalt aggregates will not be permitted in the base or sub base layers.

Table 2
Grading Requirements for Base Course (ASTM No. 57 Stone per ASTM C-33)

Sieve Size	Percent Passing
1-½ in. (37.5 mm)	100
1 in. (25 mm)	95 to 100
1/2 in. (12.5 mm)	25 to 60
3/8 in. (9.5 mm)	0 to 10
No. 4 (4.75 mm)	0 to 5
No. 200 (0.075 mm)	0 - 2

Table 3
Grading Requirements for Sub-base Course (ASTM No. 2 Stone per ASTM C-33)

Sieve Size	Percent Passing
3 in. (75 mm)	100
2- ½ in. (63 mm)	90 to 100
2 in. (50 mm)	35 to 70
1-½ in. (37.5 mm)	0 to 15
¾ in. (19 mm)	0 to 5
No. 200 (0.075 mm)	0 - 2

2.06 EDGE RESTRAINTS

- A. Edge restraints shall be cast in place concrete curbs complying with requirements in Section 32 1313 "Concrete Paving" and to the dimensions of the municipal standards/as shown on the plans.

2.07 GEOSYNTHETICS

- A. Where required, a geosynthetic geotextile and/or membrane liner materials shall be selected by the Design Engineer based on the intended use.

2.08 HORIZONTAL DRAINAGE PIPING

- A. The horizontal drainage piping shall be perforated or slotted PVC pipe manufactured in accordance with ASTM D-3034, or corrugated HDPE pipe manufactured in accordance with ASTM D-3350 and comply with the materials and requirements of Section 33 4600.

PART 3 – EXECUTION

[Construction drawings and design calculations for the Permeable Interlocking Concrete Pavement System are typically prepared and stamped by a Professional Engineer registered in the state of the project. The engineering designs, techniques, and material evaluations should be completed in accordance with the ICPI Permeable Interlocking Concrete Pavements Design Manual (most current edition), and State/County/City Stormwater Regulations.]

Compaction of the soil subgrade may be necessary to achieve stability under vehicle load. Compaction, however, will reduce the permeability of soils. In such cases, laboratory and on-site testing for density and soil permeability should be conducted. These can help establish a

relationship between compacted density and anticipated design permeability after compaction. An experienced civil or geotechnical engineer familiar with local soil conditions should be consulted for determining project standards for the percentage of soil Proctor density and test methods for permeability. When soil compaction is required, the appropriate Proctor standard (either Standard Proctor (ASTM D-698) or Modified Proctor (ASTM D-1557) should be specified by the design consultant. Lower density standards are typically required for pedestrian areas while higher density standards are required for areas subject to vehicular traffic. Density and moisture should be checked in the field with a nuclear density gauge or other test methods for compliance to specifications]

3.01 INSPECTION

- A. Prior to commencement of any work, the Contractor shall conduct a pre-construction meeting with the Owner, Design Engineer and affected sub-trades. The pre-construction meeting should, at a minimum, verify:
 - a. The location of the mock-up, and whether it will be part of the final construction or need to be removed.
 - b. The site layout conforms to the Site Plan. In particular, the location and elevation of discharge points (if any) of the horizontal drainage pipes.
 - c. The excavation work conforms to the specified lines and elevations. Subgrade shall be trimmed to +/- 0.1ft of the specified grades as measured from the bottom edge of a 10-foot straight edge laid in any direction.
 - d. Minimum slope of subgrade shall be at least 0.5%.
 - e. The condition of the subgrade, in particular that the surface infiltration (where desired) has not been adversely impacted by the excavation work. Where compaction is desired, that the compaction densities have been met.
 - f. Locations of curbs, grade beams, utility structures, light standards, tree wells or any other protrusions as applicable to the project.
 - g. The details of the site's erosion and sediment control plan.
 - h. Panel Installation drawings for the geosynthetics, in particular the location of any protrusions through the Membrane Liner where boots are required.
- B. Although the Owner may provide soil testing and quality assurance inspection during earthwork and subgrade preparation, the Owner's quality assurance program does not relieve the Contractor of responsibility for quality control and system performance. Paver installation contractor shall obtain any quality control testing or inspection not provided by the Owner that is necessary to satisfy the Contractor's obligations under the scope of work with the condition of the Subgrade prior to commencement of the work. This work may include:
 - a. Proof rolling of the subgrade to determine presence of soft spots or localized pockets of loose, soft or other deleterious materials.
 - b. Infiltration testing to verify the subgrade has not been adversely impacted.
 - c. Compaction testing.
- C. Where deficiencies or inconsistencies are identified, the Contractor shall notify the Design Engineer in writing. The Contractor will not proceed with the work until the Design Engineer has verified that the deficiencies or inconsistencies have been corrected.
- D. Beginning of Installation means acceptance of subgrade.

3.02 INSTALLATION OF SUB BASE AND BASE COURSES

[Where required, the membrane liner is place on the prepared soil subgrade as a containment (impermeable) material. Sections are welded together, and boots are installed around all protrusions.

Where required, Geotextile is placed on the prepared soil subgrade as a separation material. Overlap is a function of CBR: 12 inches minimum for CBR of 3 and above; 24 inches minimum for CBR of 1.0 to 3.0; or, sewn for CBR less than 1.0. Please consult manufacturers' specifications and the Geotechnical Engineer.

All horizontal drain pipes must be surrounded by the #57 stone as the larger sized pieced within the #2 stone sub-base material can perforate the plastic pipe.]

- A. Keep area where pavement is to be constructed free from sediment during the entire job. Any materials contaminated with sediment shall be removed and replaced with clean material.
- B. Install membrane liner (if required) and any associated cushion geotextile in accordance with the manufacturer's recommendations. The membrane liner is applied to the bottom and sides of the excavation. Allow for enough membrane liner to exceed the final elevation of the surface. After completion of the surface, the excess liner should be cut flush with the finished grade,
- C. Install Geotextiles as required in accordance with the specifications and drawings. The Geotextile is applied to the bottom and sides of the excavation with overlapping joints a minimum of 12 inches. Overlaps to be constructed to "shingle" moisture from upstream panel to downstream panel. Allow for enough geotextile to exceed the final elevation of the surface. After completion of the surface, the excess geotextile should be cut flush with the finished grade,
- D. Install the sub-base course and base course at the thicknesses, compaction rates, surface tolerances, and elevations outlined in the specifications.
 - 1. Place and spread the first layer of sub-base without displacing or damaging the geosynthetics (if used). To prevent damage, tracked vehicles shall not be allowed directly on the geotextiles or geomembranes during the initial spreading process of the sub-base layer.
 - 2. The aggregate should be spread and compacted in uniform layers not exceeding 6 inch loose thickness. Compaction is performed using either a 10 T (10 ton) vibratory roller or a minimum 13,500 lb-f centrifugal force reversible vibratory plate compactor. For each lift, make at least two passes in the vibratory mode and at least two passes in the static mode – continue compaction until there is no visible movement in the materials.
 - 3. At the specified elevation(s), install the horizontal drain pipes in accordance with the manufacturer's recommendations. Ensure the pipes are properly sloped to provide proper drainage to the outlets. Pipes shall be surrounded by a minimum of 4 inches of base course material to prevent damage during compaction. Care must be taken not to damage horizontal drain pipes during subsequent aggregate installation.
 - 4. Final sub base surface tolerance shall be plus or minus 0.1 ft over a 10 foot straight edge laid in any direction.
 - 5. Final base surface tolerance shall be plus or minus 3/4 inch over a 10 foot straight edge laid in any direction.
 - 6. Attention will be paid to providing proper compaction near curbs, grade beams, concrete collars around utility structures, lights standards, tree wells, building edges and other protrusions as applicable to the project. In areas not accessible to large compaction equipment, compact to specified density with mechanical tampers (jumping jacks).
- E. Before commencing the placing of the bedding course, the base shall be inspected by the Owner or the Consultant

3.03 INSTALLATION OF EDGE RESTRAINTS

- A. Adequate edge restraint shall be provided along the perimeter of all paving as specified. The face of the edge restraint, where it abuts pavers, shall be vertical.
- B. All concrete edge restraints shall be constructed to dimensions and level specified and shall be supported on a compacted base not less than 6 inch thick. air-entrained and have a compressive strength and air-entrainment in accordance with the local standard or as specified. All concrete shall be in accordance with ASTM C94 requirements.

3.04 INSTALLATION OF BEDDING COURSE, PAVERS AND PERMEABLE JOINT MATERIAL

[Color variation occurs with all concrete products. This phenomenon is influenced by a variety of factors, e.g. moisture content, curing conditions, different aggregates and, most commonly, from different production runs. By installing from a minimum of three bundles simultaneously, variation in color is dispersed and blended throughout the project.]

- A. Spread the bedding course evenly over the base course and screed to a nominal 2 in. thickness. Do not use the bedding material to fill depressions in the base course surface.
- B. The Contractor shall screed the bedding course using either an approved mechanical spreader (e.g.: an asphalt paver) or by the use of screed rails and boards.
- C. Moisten and lightly compact the bedding course using a plate compactor. Surface tolerances shall be +/-3/8 inch over a 10-foot straight edge.
- D. Loose screed the bedding course.
- E. Ensure that concrete pavers are free of foreign material before installation. Concrete pavers shall be inspected for color distribution and all chipped, damaged or discolored concrete pavers shall be replaced. Initiation of concrete paver placement shall be deemed to represent acceptance of the pavers.
- F. Lay the concrete pavers in the pattern(s) as shown on the drawings. Maintain straight pattern lines. For mechanical installations, follow the stitching details submittal (reference Article 1.04) as verified during the mock-up.
- G. In order to ensure proper color blending, paving units shall be installed simultaneously from a minimum of 3 bundles for hand installations, 6 bundles for mechanical installations.
- H. Joints between the individual concrete pavers shall be maintained according to the spacer bars.
- I. Fill gaps at the edges of the paved area with cut pavers or edge units. Do not install cut pavers smaller than one-third of a whole paver along edges subject to vehicular traffic – trim two pavers to fit.
- J. Cut pavers using a masonry saw. Upon completion of cutting, the area must be swept clean of all debris to facilitate inspection and to ensure the concrete pavers are not damaged during compaction.
- K. Using a low amplitude plate compactor capable of at least 5,000 lbs. (22 kN) compaction at a frequency of 75 hz –100 hz, compact and seat the concrete pavers into the bedding course.
- L. The pavers shall be compacted to achieve consolidation of the bedding course and brought to level and profile by not less than three passes. Initial compaction should proceed as closely as possible following the installation of the paving units and prior to the acceptance of any traffic or application of permeable joint material.
- M. Any units that are structurally damaged during compaction shall be immediately removed and replaced.
- N. Apply a dressing of permeable joint material to the surface and sweep into the joints and voids. Fill joints and voids, then sweep off excess material before vibrating the material down into the joints using a plate compactor. This will require two to three passes with the compactor.
- O. Do not compact within 6 feet of the unrestrained edges of the paving units.

- P. All work to within 3 ft (1 m) of the laying face must be left fully compacted at the end of each day. Cover the laying face with plastic sheets overnight if not closed with cut and compacted pavers.
- Q. Sweep off excess aggregate when the job is complete.

3.05 Quality Assurance/Quality Control

- A. Quality Assurance - The Owner may engage inspection and testing services, including independent laboratories, to provide quality assurance and testing services during construction. This does not relieve the Contractor from securing the necessary construction quality control testing.
- B. Quality assurance should include as a minimum verification with the Design Engineer that the Contractor's quality control plan and testing are adequate. Quality assurance shall also include observation of construction for general compliance with design drawings and project specifications.
- C. Quality Control – The Contractor shall engage inspection and testing services to perform the minimum quality control testing described in the design plans and specifications. Only qualified and experienced technicians and engineers shall perform testing and inspection services.
- D. Quality control testing shall include backfill testing to verify soil types and compaction, and verification that the system is being constructed in accordance with the design plans and project specifications.

3.06 As-built Construction Tolerances

[For installation on a compacted aggregate base and soil subgrade, the specifier should be aware that the top surface of the pavers may be 1/8 to 1/4 inch above adjacent drainage inlets, concrete collars or channels after compaction. This difference is to compensate for possible minor settling.]

- A. Final inspection shall be conducted to verify conformance to the drawings after removal of excess aggregate. All pavements shall be finished to lines and levels to ensure positive drainage at all drainage outlets and channels.
- B. The final surface elevations shall not deviate more than +/- 3/8 inch under a 10 ft long straight edge.
- C. Lippage shall be no greater than 1/8 inch difference in height between adjacent pavers.
- D. Bond lines for the pavers shall be +/- 1/2 inch over a 50 foot string line.
- E. Verify the surface infiltration is at a minimum of 100 in/hour using ASTM C 1781.

3.07 Protection and Maintenance

- A. At the completion of the work, the Contractor shall provide the Owner with PICP System Inspection and Maintenance Guidelines and a sample Long-term Performance and Maintenance Agreement”.
- B. Once the work is complete, the Owner shall be responsible for protecting the work from sediment deposition and damage due to subsequent construction activity on the site.
- C. The Contractor shall return to the site after 6 months from the completion of the work and conduct an inspection of the PICP System with the Owner, Manufacturer and Contractor in accordance with the PICP System Inspection and Maintenance Guidelines. The Contractor shall provide the following remedial work, as required, as part of the original bid and with no additional compensation: fill paver joints with stones; replace broken or cracked pavers; re-level settled pavers to specified elevations; and, re-align pavers to straighten bond lines. The Owner shall be responsible for removal of debris either on the surface or within the joints, as required for the Contractor to properly conduct the necessary remedial work.

END OF SECTION

SECTION 02120
VIDEO TAPING

PART 1 – GENERAL

1.01 SCOPE

- A. The work covered by this section consists of furnishing all labor, equipment, and material required to provide a video tape record of all easement areas before construction begins in each area. One copy of the video tape(s) shall be presented to the Owner for their records.
- B. The purpose of the video tape(s) is to aid the Owner in determining the extent of construction damage to property in easement areas.

PART 2 – PRODUCTS

2.01 VIDEO TAPE

- A. The video tape shall be a standard VHS video cassette similar or equal to those produced by Sony, Fuji, or Scotchbrand.

PART 3 – EXECUTION

- A. Contractor shall use a quality video camera with sound available. The camera must have zoom capabilities, date record, and produce a clear, concise color picture of the easement area.
- B. Before construction begins, Contractor shall video record each easement by walking along the sewer alignment, recording all topographic features (i.e. trees, sheds, gardens, pools, fences, shrubs, buildings, walls, etc.) on line and also to the left and right of the centerline. The limits shall be determined by the Contractor and the Engineer as the area estimated to be disturbed by the construction.
- C. Contractor shall add sound to the video tape by denoting the line number, date and time, and stations at manholes or names and addresses or property owners.
- D. Contractor shall especially record and denote areas of existing damage prior to the construction (i.e. existing cracks in walls).

END OF SECTION

EMBANKMENT AND BACKFILLING

PART 1. GENERAL

- 1.1 This work shall consist of forming embankments, with materials from excavation or other approved sources and in conformance with the lines, grades and cross-section shown on the drawings.
- 1.2 Complete the clearing and grubbing of embankment areas.
- 1.3 Conduct all embankment operations in accordance with the requirements of the erosion control plan approved by the A/E.
- 1.4 **RELATED SECTIONS**
 - A. Item 1 – Common Excavation
 - B. Section 02260 – Finish Grading

PART 2. PRODUCTS

- 2.1 Use only acceptable materials in embankment formation. Place no frozen material, stumps, logs, roots or other perishable materials in any embankment. Place no stone or masonry fragment greater than 4 inches in any dimension within 12 inches of the finished subgrade elevation.

PART 3. EXECUTION

- 3.1 Remove topsoil from all areas to be backfilled to a depth of approximately 6 inches, or to a greater depth wherever the soils investigation report so indicates.
- 3.2 Form soil, soft shale, soft sandstone, weathered rock, bank gravel or creek gravel embankment by distributing the material in successive uniform horizontal layers no more than 12 inches thick (loose depth) to the full width of the cross-section. However, layers less than 12 inches in loose thickness will be required whenever necessary to obtain the specified density. Compact each layer as specified below. Shape the upper surface of the embankment so as to provide complete drainage of surface water at all times. The forming of ruts will not be permitted.

- 3.3 Compact all areas to the density specified below:
- A. Trail areas shall be compacted to 95 percent of the maximum density as determined by ASTM D698 (Standard Proctor).
- 3.4 During compaction, embankment material that does not have enough moisture for proper compaction, shall have water added and thoroughly mixed as necessary to obtain proper compaction. Embankment material containing an excess of moisture shall be allowed to dry before compacting; manipulating as necessary to speed drying.
- 3.5 Perform construction operations so that simultaneous rolling and placing of material in the same lane or section is prevented. To avoid uneven compaction, see that hauling equipment traverses the full width of the cross-section as much as possible. Compact each layer as necessary before depositing material for the next layer.
- 3.6 The density requirements shall be the controlling factor in compaction. Use only such equipment as will satisfy the density requirements at all times.

END OF DOCUMENT

SECTION 02220
EARTHWORK

PART 1 - GENERAL

1.01 SCOPE

- A. This specification section includes earthwork and related operations, including, but not limited to, clearing and grubbing the construction site, dewatering, excavating all classes of material encountered, pumping, draining and handling of water encountered in the excavations, handling, storage, transportation, and disposal of all excavated and unsuitable material, construction of fills and embankments, backfilling around structures and pipe, backfilling all trenches and pits, compacting, all sheeting, shoring and bracing, preparation of subgrades, surfacing and grading, and any other similar, incidental, or appurtenant earthwork operation which may be necessary to properly complete the work.
- B. The Contractor shall provide all services, labor, materials and equipment required for all earthwork and related operations necessary or convenient to the Contractor for furnishing a complete work as shown on the Drawings or specified in these Contract Documents.

1.02 GENERAL

- A. The elevations shown on the Drawings as existing are taken from the best existing data and are intended to give reasonable, accurate information about the existing elevations. They are not precise, and the Contractor should satisfy himself as to the exact quantities of excavation and fill required.
- B. Earthwork operations shall be performed in a safe and proper manner with appropriate precautions being taken against all hazards.
- C. All excavated and filled areas for structures, trenches, fills, topsoil areas, embankments and channels shall be maintained by the Contractor in good condition at all times until final acceptance by the Owner. All damage caused by erosion or other construction operations shall be repaired by the Contractor using material of the same type as the damaged material.
- D. If soil borings are available for the area of this work, they will be on file at the Owner's address where they will be made available for review. This information is made available to the Contractor for such use as he may choose to make of it in the preparation of his Bid, but the Owner gives no guarantee, either expressed or implied, that it represents a true or complete cross-section of all of the material to be encountered performing the excavation and earthwork on this project.

- E. Earthwork within the rights-of-way of the State Department of Transportation, the County Road Department, and the City shall be done in accordance with requirements and provisions of the permits issued by those agencies for the construction within their respective rights-of-way. Such requirements and provisions, where applicable, shall take precedence and supersede the provisions of these Specifications.
- F. The Contractor shall control grading in a manner to prevent water running into excavations. Obstruction of surface drainage shall be avoided and means shall be provided whereby storm water can be uninterrupted in existing gutters, other surface drains, or temporary drains. Material for backfill or for protection of excavation in public roads from surface drainage shall be neatly placed and kept shaped so as to cause the least possible interference with public travel. Free access must be provided to all fire hydrants, watergates, meters, and private drives.
- G. No classification of excavated materials will be made. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the contract work, regardless of the type, character, composition, or condition thereof.
- H. Tests for compaction and density shall be conducted by the Engineer or by an independent testing laboratory selected by him. Costs of compaction tests performed by an independent testing laboratory shall be paid for directly by the Owner and not as a part of this Contract. The Contractor shall make all necessary excavations and shall supply any samples of materials necessary for conducting compaction and density tests. The cost of all retests made necessary by the failure of materials to conform to the requirements of these Contract Documents shall be paid by the Contractor.
- I. All earthwork operations shall comply with the requirements of OSHA Construction Standards, Part 1926, Subpart P, Excavations, Trenching, and Shoring, and Subpart O, Motor Vehicles Mechanized Equipment, and Marine Operations, and shall be conducted in a manner acceptable to the Engineer.
- J. It is understood and agreed that the Contractor has made a thorough investigation of the surface and subsurface conditions of the site and any special construction problems which might arise as a result of nearby watercourses and flood plains, particularly in areas where construction activities may encounter water-bearing sands and gravels or limestone solution channels. The Contractor shall be responsible for providing all services, labor, equipment, and materials necessary or convenient to him for completing the work within the time specified in these Contract Documents.

PART 2 - EXECUTION

2.01 INITIAL SITE PREPARATION

- A. Preparatory to beginning of construction operations, the Contractor shall remove from the site all vegetative growth, trees, brush, stumps, roots, debris, and any of other objectionable matter, including fences, buildings, and other structures shown on the Drawings in the construction areas which are designated for removal or which, if left in place, would interfere with the proper performance or completion of the contemplated work, would impair its subsequent use, or would form obstructions therein.
- B. Stumps and roots shall be grubbed and removed to a depth not less than 5 feet below grade. All holes or cavities which extend below the subgrade elevation of the proposed work shall be filled with compacted layers of crushed rock or earth backfill conforming to the requirements specified here for backfill. Organic material from clearing operations shall not be incorporated in excavation backfill or embankment material.
- C. The Contractor shall exercise special precautions for the protection and preservation of trees, cultivated shrubs, sod, fences, buildings, and other structures which are located in the construction area but not within designated clearing limits as shown on the Drawings or within the limits of embankments, excavations, or proposed structures. The Contractor shall be responsible for the repair and/or replacement of any of the aforementioned items damaged by his operation or construction activities.
- D. The Contractor shall remove and dispose of all excess material resulting from clearing or site preparation operations. The Contractor shall dispose of such materials in a manner acceptable to the Engineer and at an approved location where such materials can be lawfully disposed.

2.02 DEWATERING

- A. The Contractor shall provide and maintain at all times during construction ample means and devices with which to promptly remove and properly dispose of all water from any source entering the excavations or other parts of the work. Dewatering shall be accomplished by methods which will ensure a dry excavation and preservation of the final lines and grades of the bottoms of excavations. Methods of dewatering may include sump pumps, well points, deep wells, or other suitable methods which do not damage or weaken structures, foundations, or subgrades. Shallow excavations may be dewatered using open ditches provided such ditches are kept open and free-draining at all times. The actual dewatering methods used shall be acceptable to the Engineer.

- B. Unless specifically authorized by the Engineer, no concrete or mortar shall be placed in water nor shall water be allowed to rise over newly-placed concrete or mortar for at least 24 hours after placement. No concrete structure shall be exposed to unequal hydrostatic forces until the concrete has reached its specified 28-day strength. Water shall not be allowed to rise above bedding during pipe laying operations. The Contractor shall exercise care to prevent damage to pipelines or structures resulting from flotation, undermining, or scour. Dewatering operations shall commence when ground or surface water is first encountered and shall be continuous until such times as water can safely be allowed to rise in accordance with the provisions of this section. Excavations shall be protected from the entrance of surface water to the extent possible by the use of dikes and/or covers.
- C. Standby pumping equipment shall be on the job site. A minimum of one standby unit (a minimum of one for each ten in the event well points are used) shall be available for immediate installation should any pumping unit fail. The design and installation of well points or deep wells shall be suitable for the accomplishment of the work. Drawings or diagrams on proposed well point or deep well dewatering systems shall be submitted to the Engineer for review.
- D. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with crushed rock at no cost to the Owner.
- E. The Contractor shall dispose of the water from the work in a suitable manner without damage to adjacent property. Conveyance of the water shall be such as to not interfere with traffic flow or treatment facilities operation. No water shall be drained into work built or under construction without prior consent of the Engineer. The Contractor will be held responsible for the condition of any pipe or conduit which he may use for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.
- F. Sedimentation and desilting basins shall be provided as necessary or when directed by the Engineer to prevent the entrance of excessive or injurious amounts of sand and silt from surface runoff or dewatering operations into storm drains or receiving waters. The system used for desanding or desilting the water shall be a baffled structure and shall provide not less than five minutes detention time and shall be designed to have a "flow-through" velocity not exceeding 0.2 feet per second at the anticipated peak flow. The method of desanding or desilting and the point of disposal shall be subject to the approval of the Engineer.
- G. Water shall be disposed of in such a manner as not to be a menace to the public health and in accordance with applicable Environmental Protection Agency, Corps of Engineers, and State Water Quality Control Division standards and permits, and the Storm Water Division of the Department of Public Works, City of Chattanooga, Tennessee.

2.03 SHEETING, SHORING, AND BRACING

- A. The sides of all excavations shall be sufficiently sheeted, shored, and braced as necessary to prevent slides, cave-ins, settlement or movement of the banks, to maintain the excavation clear of all obstructions, and to provide safe working conditions. Wood or steel sheeting of approved design and type shall be used in wet, saturated or flowing ground. All sheeting, shoring, and bracing shall have sufficient strength and rigidity to withstand the pressure exerted and to maintain shape and position under all circumstances.
- B. The responsibility for correctly assessing the need for sheeting and analyzing the stresses induced shall be the total responsibility of the Contractor. Since the Engineer does not dictate or determine the Contractor's sequence or limits of excavation, the Engineer assumes no responsibility for sheeting and shoring. The Contractor must employ or otherwise provide for adequate professional structural and geotechnical engineering supervision to assess the need for sheeting and shoring and design same. Results of sheeting and shoring analysis and design shall be submitted to the Engineer on request.
- C. Excavations adjacent to existing or proposed buildings and structures, or in paved streets or alleys shall be sheeted, shored, and braced adequately to prevent undermining beneath or subsequent settlement of such structures or pavements. Underpinning of adjacent structures shall be done when necessary to maintain structures in safe condition. Any damage to structures or pavements occurring through settlements, water or earth pressures, slides, caves, or other causes; due to failure or lack of sheeting or bracing, or due to improper bracing; or occurring through negligence or fault of the Contractor in any other manner shall be repaired by the Contractor at his own expense.
- D. Sheeting, shoring, or bracing materials shall not be left in place unless otherwise specified or shown on the Drawings or ordered by the Engineer in writing. Such materials shall be removed in such manner that no danger or damage will occur to new or existing structures or property, public or private, and so that cave-ins or slides will not take place. Trench sheeting shall be left in place until backfill has been brought to a level 12 inches above the top of the pipe. It shall then be cut off and the upper portion removed. Sheeting for structures shall be left in place until backfill has been brought to a level of 12 inches above the top of the bottom footing. It shall then be cut off and the upper portion removed.

- E. All holes and voids left in the work by the removal of sheeting, shoring, or bracing shall be filled and thoroughly compacted.

2.04 EXCAVATION

A. GENERAL

1. Excavation shall include the removal of all material from an area necessary for the construction of a pipeline, structure, basin, flume, or building. Excavations shall provide adequate working space and clearances for the work to be performed therein.
2. Except where otherwise shown on the Drawings, specified herein, or authorized by the Engineer, all material excavated below the bottom of concrete walls, footings, and foundations shall be replaced, by and at the expense of the Contractor, with Class B Concrete to the lines and grades shown on the Drawings.
3. Where quicksand, soft clay, spongy, swampy, or other materials unsuitable or subgrade or foundation purposes are encountered below the excavation limits, they shall be removed and disposed of to the level of suitable material. Areas so excavated shall be backfilled with Class B Concrete or with compacted layers of crushed rock, sand, or other approved material conforming to the requirements specified herein for backfill to the lines and grades shown on the Drawings.
4. Barriers shall be placed at each end of all excavations and at such places as may be necessary along excavations to warn all pedestrian and vehicular traffic of such excavations. Lights shall also be placed along excavations from sunset each day to sunrise of the next day until the excavations are backfilled. All excavations shall be barricaded in such a manner to prevent persons from falling or walking into any excavation.

B. ROCK EXCAVATION

1. Rock encountered in the process of excavation for structures shall be uncovered and stripped of all loose materials over the entire limits of excavation. Rock encountered for removal in a trench section shall be uncovered for a distance of not less than 50 feet.
2. Rock and large boulders in trenches shall be excavated over the horizontal limits of excavation and to depths as shown on the Drawings.
3. The space below grade for pipe lines shall then be backfilled to the proper grade with compacted layers of crushed rock or sand conforming to the

requirements specified herein for backfill. Where pipe sewers are constructed on concrete cradles, rock shall be excavated to the bottom of the cradle as shown on the Drawings.

4. Rock under structures shall be excavated to lines and grades shown on the Drawings. Unless specified otherwise, where rock excavation has been carried below grade, the contractor shall backfill to grade with Class B concrete at his own expense.

5. Where rock foundation is obtained at grade for over 50 percent of the area of any one structure, the portion of the foundation that is not rock shall be excavated below grade to reach a satisfactory foundation of rock. The portion below grade shall be backfilled with Class B Concrete.

6. Where rock foundation is obtained at grade for less than 50 percent of any one structure and satisfactory rock cannot be found over the remaining area by reasonable additional excavation, the rock shall be removed for a depth of 12 inches below grade and the space below grade shall be backfilled to the proper grade with compacted layers of crushed rock conforming to the requirements specified herein for backfill.

7. Drilling and blasting operations shall be conducted with due regard for the safety of persons and property in the vicinity and in strict conformity with requirements of all ordinances, laws and regulations governing blasting and the use of explosives. Rock excavation near existing pipelines or other structures shall be conducted with the utmost care to avoid damage. Injury or damage to other structures and properties shall be promptly repaired to the satisfaction of the Owner by the Contractor at his own expense.

8. Rock excavation for all structures and adjacent trenches under this Contract and any other rock excavation directed by the Engineer shall be completed before the construction of any structure is started in the vicinity.

C. BORROW EXCAVATION

1. Wherever the backfill of excavated areas or the placement of embankments or other fills requires specified material not available at the site or material in excess of suitable material available from the authorized excavations, such material shall be obtained from other sources. This may require the opening of borrow pits at points not immediately accessible from the work. In such cases the Contractor shall make suitable arrangements with the property owner and shall pay all costs incident to the borrowed material including royalties, if any, for the use of the material. Before a borrow pit is opened, the quality and suitability of the material to be obtained there from shall be approved by the Engineer.

2. Borrow pits shall be cleared, grubbed and finish graded in accordance with the requirements specified herein.

D. ROADWAY EXCAVATION

Roadway excavation shall consist of excavation for roadways and parking areas in conformity with lines, grades, cross sections, and dimensions shown on the Drawings. After shaping to line, grade, and cross section, the subgrade shall be rolled until compacted to a depth of at least 6 inches to 100 percent of the maximum density at optimum water content as determined by AASHTO T 99, Method A. This operation shall include any reshaping and wetting required to obtain proper compaction. All soft or otherwise unsuitable material shall be removed and replaced with suitable material.

E. TRENCH EXCAVATION

1. Trench excavation shall consist of the removal of materials necessary for the construction of water, sewer, and other pipelines and all appurtenant facilities including manholes, inlets, outlets, headwalls, collars, concrete saddles, piers and pipe protection called for on the Drawings.
2. Excavation for pipelines shall be made in open cut unless shown otherwise on the drawings. Trenches shall be cut true to the lines and grades shown on the Drawings or established by the Engineer on the ground. The banks of trenches shall be cut in vertical, parallel planes equidistant from the pipe centerline. From an elevation 12 inches above the top of the pipe to the bottom of the trench, the horizontal distance between vertical planes for different sizes of pipe shall not exceed those shown on the Drawings. When sheeting is used, the width of the trench shall be considered as the distance between the inside faces of the sheeting. The bottom of the trench shall be cut carefully to the required grade of the pipe except where bedding materials or cradles are shown, in which case the excavation shall extend to the bottom of the bedding or cradles as shown on the Drawings. Minimum pipe cover shall be as shown on the Drawings or specified in these Contract Documents.
3. The use of a motor-powered trenching machine will be permitted but full responsibility for the preservation, replacement, and/or repair of damage to any existing utility services and private property shall rest with the Contractor.
4. Bell holes for bell and spigot pipe and/or mechanical joint pipe shall be excavated at proper intervals so the barrel of the pipe will rest for its entire length upon the bottom of the trench. Bell holes shall be large enough to permit proper installation of all joints in the pipe. Bell holes shall not be excavated more than 10 joints ahead of pipe laying. No part of any bell or coupling shall

be in contact with the trench bottom, trench walls, or granular embedment when the pipe is jointed.

5. Excavation for manholes, outlets, collars, saddles, piers, and other pipeline structures shall conform to the additional requirements specified herein for structural excavation.

6. Pipe trenches shall not be excavated more than 400 feet in advance of pipe laying and all work shall be performed to cause the least possible inconvenience to the public. Adequate temporary bridges or crossings shall be constructed and maintained where required to permit uninterrupted vehicular and pedestrian traffic.

7. Unless otherwise specified herein or shown on the Drawings, wherever pipe trenches are excavated below the elevation shown on the Drawings, the Contractor, at his own expense, shall fill the void thus made to the proper grade with Class B Concrete or with compacted layers of crushed rock or sand conforming to the requirements specified herein for backfill.

8. In all cases where materials are deposited along open trenches they shall be placed so that no damage will result to the work and/or adjacent property in case of rain or other surface wash.

F. STRUCTURAL EXCAVATION

1. Structural excavation shall consist of the removal of all materials necessary for the construction of structures, including tanks, foundations, footings, wetwells, dry wells, box culverts, flumes, channels, buildings, and other miscellaneous structures.

2. The bottom of structural excavations shall be true to the lines and grades shown on the Drawings. Faces of excavations shall not be undercut for extended footings.

Except as provided herein for excavation of unsuitable material or rock, where the excavation is carried below the grade elevation shown on the Drawings, the Contractor shall backfill the void thus made to the proper grade with Class B concrete at his own expense.

2.05 BACKFILLING

A. MATERIALS

Materials for backfilling shall conform to the following requirements:

1. SELECT EARTH BACKFILL

Fine, sound, loose earth containing optimum moisture content for compaction to 90 percent of maximum density, free from all wood, vegetable matter, debris, and other objectionable material, and having scattered clods, stones, or broken concrete less than 2 inches in maximum dimension except that the maximum particle size shall be 3/4 inch when used with PVC, other flexible thermoplastic pipe, or extremely brittle pipe.

2. COMMON EARTH BACKFILL

Sound, loose earth containing optimum moisture content for compaction to 90 percent of maximum density, free from all wood, vegetable matter, debris, and other objectionable material, and having scattered clods, stones, or broken concrete and pavement less than 6 inches in maximum dimension. Such backfill shall be placed a minimum of one foot above top of pipe.

3. SAND

Natural or imported sand conforming to ASTM D1073.

4. CRUSHED ROCK

Crushed rock conforming to Class A aggregate as specified in Section 903.05 and Section 903.22, Size 7 of the Tennessee Department of Transportation Standard Specifications for Road and Bridge Construction.

5. CLASS B CONCRETE

Class B concrete as specified in the Section entitled "Cast-In-Place Concrete" of these Specifications.

B. GENERAL

1. Unless otherwise specified herein, earth backfill shall be compacted to not less than 90 percent of the maximum density at optimum water content as determined by AASHTO T-99, Method A. Crushed stone and sand shall be compacted or consolidated to not less than 83 percent of the solid volume density as determined from the bulk specific gravity by AASHTO T-84 AND T-85 and the dry weight of the aggregate.

2. Material that is too dry for adequate compaction shall receive a prior admix of sufficient water to secure optimum moisture content. Material having excessive water content shall not be placed at any time.
3. Unless otherwise specified herein backfill material required to be compacted shall be placed in horizontal layers not to exceed 6 inches in thickness (before compaction) and compacted in place by ramming, tamping, or rolling. Compaction shall be accomplished by power driven tools and machinery wherever possible. Compaction and consolidation of sand and crushed rock backfill shall be accomplished using vibrating equipment in a manner acceptable to the Engineer.

C. BACKFILLING TRENCHES

1. The backfilling of sewer, water, and other pipeline trenches shall be started immediately after the construction of same has been inspected and approved by the Engineer. Select backfill or bedding material if specified shall be placed in the trench under and on each side of the pipe in 6-inch layers for the full width of the trench and thoroughly and uniformly compacted by ramming and/or tamping to a minimum of 90% of the maximum density determined as specified herein. Select earth backfilling shall start above the class of pipe bedding as specified or shown the Drawings. Sufficient select earth backfill shall be placed around the pipe and compacted to provide a cover of not less than 12 inches over the top of the pipe. Mechanical compactors or tampers shall not be used within 12 inches of pipe. Compaction in this area shall be accomplished by hand methods. Sand or specified crushed stone bedding material shall be substituted for select earth backfill when the pipe is bituminous coated steel pipe or wrapped steel pipe or when crushed stone trench backfill is required. Backfilling shall proceed simultaneously on both sides of the pipe to prevent lateral displacement.
2. Caution shall be used during backfill operations for PVC or other flexible thermoplastic pipe (non-pressure or sewer pipe) to prevent pipe deformation. PVC or other flexible thermoplastic pipe (sewer pipe) shall not be subjected to roller or wheel loads until a minimum of 36 inches of backfill has been placed over the top of the pipe and a hydrohammer shall NOT be used until a minimum depth of 48 inches backfill has been placed over the top of the pipe.
3. Backfilling of PVC pressure pipe or other flexible thermoplastic pipe (water pipe) shall be as described in Paragraph 1 above.
4. In streets, alleys, across sidewalks and driveways, paved areas, and at any other places subject to vehicular traffic

or other superimposed loads, crushed rock backfill shall be placed and compacted in 6-inch layers from the level of 12 inches above the top of the pipe upward for the full depth of the trench, except for the top 48 inches of backfill, which shall be compacted pugmill mix. Crushed rock shall be clean, uniform-sized stone placed in lifts of 6 inches maximum and compacted by use of a hydrohammer or approved vibratory compactor for the full depth of the trench, except for the top 48 inches of crushed rock backfill, which shall be compacted pugmill mix.

5. Trenches under concrete slabs and footings of structures shall be completely backfilled with compacted sand or crushed rock or filled with Class B concrete as shown on the Drawings.

6. In all other areas not affected by superimposed loads, common earth backfill may be placed from a level of 12 inches above the top of pipe upward for the full depth of the trench without compaction. At these places, backfill shall be neatly rounded over the trench to sufficient height to allow for settlement to grade after consolidation. In no event, however, will storm water be allowed to pond due to the backfilled trench.

7. All backfilling shall be done in such a manner that the pipe or structure over or against which it is being placed will not be disturbed or injured. Any pipe or structure injured, damaged, or moved from its proper line or grade during backfilling operations shall be removed and repaired to the satisfaction of the Engineer and then rebackfilled.

D. BACKFILLING AROUND STRUCTURES

1. Backfilling around structures shall consist of common earth backfill placed in 6-inch layers and compacted by tamping to a minimum of 90% of the maximum density determined as specified herein for the full depth of the excavation from the bottom to the finished grade. No backfill shall be placed against concrete structures until the concrete has reached its specified 28-day compressive strength. Where practical, compaction of structural backfill shall be accomplished by power-driven tamping equipment.

2. Where crushed rock mats under slabs and foundations are called for on the Drawings, the Contractor shall excavate below grade to the depth of the crushed rock mat as shown on the Drawings and shall install a compacted crushed rock bed. This shall be finished to a true line or plane and even with the subgrade of

the concrete foundations, piers, footings or slabs. Before placing any crushed rock, all loose earth or debris shall be removed. This crushed rock mat shall extend 12 inches beyond all slabs and foundations or to edges of sheet piling.

3. Crushed rock mats, 12 inches or less in thickness shall be constructed of compacted layers of crushed rock conforming to Section 903.22, Size Number 67 (3/4-inch to No. 4), of the Tennessee Department of Transportation, Standard Specifications for Road and Bridge Construction.

4. Crushed rock mats of thickness greater than 12 inches shall have the top 12 inches constructed of compacted layers of crushed rock as specified above. That portion below the top 12 inches shall be constructed of compacted layers of crushed rock conforming to Section 903.05, Class A, with a modified gradation of 6 inches to dust as received from the crusher.

5. Unless otherwise shown on the Drawings, the use of earth backfill to support footings, foundations, and structures shall not be permitted.

2.06 FILLS AND EMBANKMENTS

A. Fills and embankments shall consist of all earth fills except backfills in trenches or around structures. Unless special material is specified or shown on the Drawings, material for fills and embankments shall consist of excavated material from structures or of a mixture of such excavated materials and materials borrowed from other sources by the Contractor. All material used for fills and embankments shall be free from wood, vegetable matter, debris, soft or spongy earth or clay, large rock, or other objectionable material and shall be acceptable to the Engineer.

B. Material shall be placed in the fill or embankment in successive layers 6 inches or less in thickness before compaction, each layer being approximately horizontal and extending to the full limit of the required cross section and shall be compacted at optimum water content over the entire surface to not less than 95% of the maximum density as determined by AASHTO T-99, Method A. The process shall be repeated for each layer of material until the fill or embankment conforms to the plan lines, grades, and cross-sections. The degree of compaction and moisture content required, the method of tamping, and the equipment used shall be approved by the Engineer.

C. The area over which the fill or embankment is to be constructed shall first be cleared of all vegetation, debris, and other objectionable material and, if the ground is in a loose, uncompacted condition, it shall be compacted to a maximum density determined as specified herein.

D. No material shall be placed beyond the sloping lines of embankment unless so ordered by the Engineer. Material allowed to be placed beyond the lines of embankment shown on the Drawings will be compacted as required above unless otherwise authorized by the Engineer.

E. Material for embankments or roadway fills shall be placed in 6-inch maximum lifts and shall be compacted by rolling with power rollers weighing not less than 10 tons, with sheeps foot rollers, with vibrating rollers, or with pneumatic tire rollers, as required to accomplish the work. While and as each layer is deposited, water shall be applied in sufficient amount to ensure optimum moisture to secure the compaction specified.

F. The use of truck, carryalls, scrapers, tractors, or other heavy hauling equipment shall not be considered as rolling in lieu of rollers, but the traffic of such hauling equipment shall be distributed over the fill in such a manner as to make the use of the compaction afforded thereby as an addition to compaction by the use of rollers.

G. Wherever a trench passes through a fill or embankment, the fill or embankment material shall be placed and compacted to an elevation 12 inches above the top of the pipe before the excavation of the trench begins.

H. On subgrades for all roadbeds, the density for the top 6 inches of the finished subgrade shall be equal to not less than 100% of the maximum density as determined by AASHTO T-99, Method A. When field tests show failure to meet the density requirement, the subgrade shall be loosened by disking, harrowing or other approved methods to a depth of not less than 6 inches, then reshaped and recompacted as indicated in this paragraph.

2.07 DISPOSAL OF WASTE AND UNSUITABLE MATERIALS

A. All materials removed by excavation, which are suitable for the purpose, shall be used to the extent possible for backfilling pipe trenches, foundation, and footings and for making embankment fills or for such other purposes as may be shown on the Drawings. All materials not used for such purposes shall be considered as waste materials and the disposal thereof shall be made by the Contractor in a manner and at locations subject to the approval of the Engineer.

B. Waste materials shall be spread in uniform layers and neatly leveled and shaped. Spoil banks shall be provided with sufficient and adequate openings to permit surface drainage of adjacent lands.

C. Unsuitable materials, consisting of wood, vegetable matter, debris, soft or spongy clay, peat, and other objectionable material so designated by the Engineer shall be removed from the work site and disposed of by the Contractor in a

manner and at a location approved by the Engineer.

D. No unsuitable or waste material shall be dumped on private property unless written permission is furnished by the Owner of the property and unless a dumping permit is issued from the local jurisdiction.

2.08 FINAL GRADING

A. After other earthwork operations have been completed, the sites of all structures, roads, and embankments shall be graded within the limits and to the elevations shown on the Drawings. Grading operations shall be so conducted that materials shall not be removed or loosened beyond the required limits. The finished surfaces shall be left in smooth and uniform planes such as are normally obtainable from the use of hand tools. If the Contractor is able to obtain the required degree of evenness by means of mechanical equipment he will not be required to use hand labor methods. Slopes and ditches shall be neatly trimmed and finished to slopes shown on the Drawings unless otherwise approved by the Engineer.

B. Unless otherwise specified or shown on the Drawings, all finished ground surfaces shall be graded and dressed to present a surface varying not more than plus or minus 0.10 foot as regards local humps or depressions and shall be acceptable to the Engineer.

2.09 TOPSOIL

A. All areas to be sprigged or planted with trees, shrubs, or grass as shown on the plans shall be prepared by grading to a smooth, even surface to a level 4 inches or other specified depth below the elevation of the finished grade shown on the Drawings. It shall then be brought to a neat and finished grade by the addition of 4 inches or other specified depth of approved topsoil as specified or directed in Section 02485.

B. Topsoil removed from the construction area may be stockpiled and reused or topsoil may be obtained from approved borrow areas. If obtained from borrow areas, the Contractor shall make suitable arrangements with the property owner and shall pay all costs incident to the borrowed material including royalties.

2.10 SETTLEMENT

A. The Contractor shall be responsible for all settlement of backfill, fills, and embankments which may occur within one (1) year after final acceptance of the work by the Owner.

B. The Contractor shall make, or cause to be made, all repairs or replacement made necessary by settlement within 30 days after receipt of written notice from the Engineer or Owner.

2.11 PREVENTION OF BLASTING DAMAGE

A. GENERAL

The Contractor shall be responsible for all property damage and personal injury caused by blasting for excavation work on this project. This includes events in which flying debris, air blast, or ground vibrations cause personal injury or property damage.

B. PREVENTING DAMAGE BY FLY-ROCK

A qualified Explosive Engineer and experienced Powder Foreman shall be available to direct and supervise the design of the blasting work. This shall consist of selecting the correct burden, spacing and stemming dimensions for the explosives used and the rock being blasted. This includes, but is not limited to, controlling water in the blast hole and using the proper stemming. The objective is to select the optimum blast dimensions which ensure that just enough explosive is available to break the rock, and that there is no excess explosive to propel the rock fragments beyond safe limits.

Blasting mats and/or backfill materials shall be used for each "shot" to help confine the limits of fly-rock in populated areas.

Traffic and access to blasting areas shall be closed off and blasting signals audible for 2,000 feet shall be sounded in time for all workers and nearby residents to get under cover. Also, residents immediately adjacent to a blast should be notified personally before any blast occurs.

C. PREVENTING DAMAGE BY AIR BLAST

Design measures shall be taken to reduce or control air blast to levels below which actual damage will not occur. Microphones to which a metering device is attached to record over pressure levels shall be used to monitor air results of all blasts. These records shall be filed and maintained throughout the construction of the project.

The use of detonating cord on the surface shall be avoided.

The use of sufficient burden, spacing and stemming to prevent the premature release of explosive gases shall be required for all blasting in closely populated areas.

The specific gravity of stemming material shall always be equal to or greater than that of the rock, and its length equal to 0.7 of the burden. The shape of the stemming material shall be coarse and angular.

There should be no top priming of any holes.

Decking shall be used to bridge limestone cavities or other weak areas in any hole.

In closely populated areas, all blast shall be designed to limit the peak particle velocity to less than two (2) inches per second.

D. PREVENTING DAMAGE BY GROUND VIBRATIONS

The Explosive Engineer and Powder Foreman shall design each "shot" to obtain the desired fragmentation without providing extra explosives which could be used to produce ground vibrations. In closely populated areas where old residential or auxiliary structures in poor condition exists, the two (2) inches per second peak particle velocity limit shall be lowered. Monitoring of these structures with seismographs shall be required and the data filed and maintained for the duration of the project.

Delay intervals such as millisecond caps or millisecond connectors shall be used to reduce the vibration effects of large blasts to the range of smaller charges at reduced peak particle velocity.

Tight confined shots that require increased powder charges shall not be attempted.

Excessive sub-drilling shall not be permitted.

In decking charges where small weights of powder are used, the inert material between decks shall be one (1) to two (2) feet thick.

The use of sensitive explosives such as straight dynamite shall not be permitted.

In drilling blast holes with cavities, the driller shall measure the depth and size of each cavity encountered. This log shall be used by the Powder Foreman in loading the explosive in the rock parts and filling with the stemming material in cavity parts.

Delay pattern shall be designed to provide maximum amount of free faces which reduces the amount of energy-transfer in ground vibrations.

Where potential settlement of a structure is involved, a pre-split line shall be required to help reduce the peak particle velocity beneath the structure to be protected.

FINISH GRADING

PART 1. GENERAL

- 1.1 The work called for by this section shall include, but not necessarily be limited to, finish grading and the spreading and shaping of topsoil to the finished contour elevations indicated by the drawings.
- 1.2 Refer to other sections for work related to that specified under this heading. Coordinate this work with that specified by other sections for timely execution.

PART 2. PRODUCTS

- 2.1 Topsoil: Use stripped topsoil that has been stockpiled as specified elsewhere. If the quantity of topsoil on the job is inadequate, furnish enough additional topsoil. Topsoil furnished shall be natural, fertile, friable soil possessing characteristics of representative productive soils in the vicinity. It shall be obtained from naturally well-drained areas. It shall not be excessively acid or alkaline nor contain toxic substances that may be harmful to plant growth. Topsoil shall be without admixture of subsoil and shall be cleaned and reasonably free from clay lumps, stones, stumps, roots, or similar substances 2 inches or more in diameter, debris, or other objects that are a hindrance to planting operations. Such material shall be subject to testing.

PART 3. EXECUTION

- 3.1 Do not begin work until the earth is dry enough to be tillable.
- 3.2 Inspect sub-grades to see that they generally conform to the standards called for elsewhere in these specifications, particularly with regard to the approximate depths required for the work. After work is completed, inspect it to ensure that all finish grading complies with design requirements.
- 3.3 Place finished grade stakes wherever necessary to bring the work accurately to the elevations required by the drawings.

- 3.4 Finish grade all areas outside the building line to the depths required for the work as follows:
- A. Grade uniformly with rounded surfaces at the tops and bottom of abrupt changes of planes.
 - 1. Hand grade steep slopes and areas that are inaccessible for machine work.
 - 2. Protect grades areas from undue erosion, and repair and re-grade areas where erosion does occur.
 - 3. Refill areas where noticeable settlement has occurred.
 - 4. Finish grade areas that are to receive topsoil up to 4 inches below the finished contour elevations called for by the drawings or, over rock, to 12 inches below these elevations.
 - B. Place topsoil uniformly over disturbed areas that do not receive other work as follows:
 - 1. Obtain approval of the finish grading from the A/E before starting to place topsoil.
 - 2. Scarify sub-grade to a depth of 3 inches.
 - 3. Place the topsoil to a depth of 4 inches when lightly rolled or, on rock, to a depth of 12 inches.
 - 4. Level the topsoil so that it slopes uniformly and has no water pockets.
 - 5. Carefully rake the topsoil by hand to remove all clods, roots, sticks, stones over 1 inch in diameter, and other foreign materials from the surface.
 - C. Dispose of excess excavated materials and debris away from the site.

END OF DOCUMENT

SECTION 02452
TRAFFIC SIGNS AND PAVEMENT MARKINGS

PART 1 GENERAL

1.1 STANDARD SPECIFICATIONS, TRAFFIC SIGNS

The Tennessee Department of Transportation (TDOT) Standard Specifications for Roads and Bridge Construction. March 1, 1995, Section 713, "Highway Signing," and Section 916, "Highway Signing Material," shall apply and are hereby amended as follows.

- A. Amend Section 713.04, "Construction Methods and Requirements," (b) – Post Supports for Ground Mounted Signs, by adding, "All ground mounted sign post shall be 2-pound-per-foot U-post painted with Jones/Blair two-part Pole Green, Item No. 4550. Acrylithane.C catalyst Item No. 99931 shall be used.
- B. Delete Section 713-06, "Method of Measurement."
- C. Delete Section 713-07, "Basis of Payment."

1.2 DRAWINGS, TRAFFIC SIGNS

The applicable Tennessee Department of Transportation Standard Details are listed below.

RD-A-1	12-18-99	STANDARD ABBREVIATIONS
T-S-10	05-27-03	STANDARD MOUNTING DETAILS FLAT SHEET SIGNS ALUMINUM – STEEL DESIGN
T-S-16	05-27-01	GROUND MOUNTED SIGN AND DETAILS
T-S-19	07-29-91	STANDARD MEMBERS BENDAWAY SIGN SUPPORTS STEEL DESIGN
T-S-20	05-27-01	SIGN DETAIL

1.3 STANDARD SPECIFICATIONS, PAVEMENT MARKINGS

The Tennessee Department of Transportation Standard Specifications for Roads and Bridge Construction. March 1, 1995, Section 716, "Pavement Markings," shall apply.

1.4 DRAWINGS, PAVEMENT MARKINGS

The applicable Tennessee Department of Transportation Standard Details are listed below.

RD-A-1	12-18-99	STANDARD ABBREVIATIONS
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T-M-1	04-15-04	DETAILS OF PAVEMENT MARKINGS FOR CONVENTIONAL ROADS AND MARKINGS ABBREVIATIONS
T-M-2	04-15-04	DETAILS OF PAVEMENT MARKINGS FOR CONVENTIONAL ROADS
T-M-3	09-19-91	MARKING STANDARDS FOR TRAFFIC ISLANDS, MEDIANS & PAVED SHOULDERS ON CONVENTIONAL ROADS
T-M-4	05-27-01	STANDARD INTERSECTION PAVEMENT MARKINGS

END OF DOCUMENT

SECTION 02485
SEEDING AND MULCHING

PART 1 - GENERAL

1.01 SCOPE

- A. The Work covered by this Section consists of furnishing all labor, equipment, and material required to place topsoil, seed, commercial fertilizer, agricultural limestone, and mulch material, including seedbed preparation, harrowing, compacting, and other placement operations on graded earthen areas as described herein and/or shown on the Drawings. In general, seeding operations shall be conducted on all newly graded earthen areas not covered by structures, pavement, or sidewalks; all cleared or grubbed areas which are to remain as finish grade surfaces; and on all existing turf areas which are disturbed by construction operations and which are to remain as finish grade surfaces. Areas disturbed by borrow activities shall also be seeded according to these Specifications.
- B. The Work shall include temporary seeding operations to stabilize earthen surfaces during construction or inclement weather and to minimize stream siltation and erosion.

1.02 QUALITY ASSURANCE

- A. Prior to seeding operations, the CONTRACTOR shall furnish to the ENGINEER labels or certified laboratory reports from an accredited commercial seed laboratory or a state seed laboratory showing the analysis and germination of the seed to be furnished. Acceptance of the seed test reports shall not relieve the CONTRACTOR of any responsibility or liability for furnishing seed meeting the requirements of this section.
- B. Prior to topsoil operations, the Contractor shall obtain representative samples and furnish soil test certificates including textural, pH, and organic ignition analysis from the State University Agricultural Extension Service or other certified testing laboratory.
- C. All existing lawns encountered shall be replaced with topsoil and seeding of the same type and quality as that existing prior to construction and shall be restored to original condition or better.

PART 2 - PRODUCTS

2.01 TOPSOIL

- A. The CONTRACTOR shall place a minimum of 4 inches of topsoil over all graded earthen areas and over any other areas to be seeded. Sources of topsoil shall be approved by the ENGINEER prior to disturbance.

- B. Topsoil shall be a friable loam containing a large amount of humus and shall be original surface soil of good, rich, uniform quality, free from any material such as hard clods, stiff clay, hardpan, partially disintegrated stone, pebbles larger than 1/2 inch in diameter, lime, cement, bricks, ashes, cinders, slag, concrete, bitumen or its residue, boards, sticks, chips, or other undesirable material harmful or unnecessary to plant growth. Topsoil shall be reasonably free from perennial weeds and perennial weed seeds, and shall not contain objectionable plant material, toxic amounts of either acid or alkaline elements or vegetable debris undesirable or harmful to plant life.
- C. Topsoil shall be natural topsoil without admixture of subsoil material, and shall be classifiable as loam, silt loam, clay loam, sandy loam, or a combination thereof. The pH shall range from 5.5 to 7.0. Topsoil shall contain not less than 5 percent nor more than 20 percent, by weight, of organic matter as determined by loss on ignition of oven-dried samples to 65 degrees C. The ignition test shall be performed on samples which have been thoroughly oven-dried to constant weight at a temperature of 221 degrees F.

2.02 SEED

- A. Seed shall be delivered in new bags or bags that are sound and labeled in accordance with the U.S. Department of Agriculture Federal Seed Act.
- B. All seed shall be from the last crop available at time of purchase and shall not be moldy, wet, or otherwise damaged in transit or storage.
- C. Seed shall bear the growers analysis testing to 98% for purity and 90% for germination. At the discretion of the ENGINEER, samples of seed may be taken for check against the growers analysis.
- D. Species, rate of seeding, fertilization, and other requirements are shown in the Seeding Requirements Table.

2.03 FERTILIZER AND LIMING MATERIALS

- A. Fertilizer and liming materials shall comply with applicable state, local, and federal laws concerned with their production and use.
- B. Commercial fertilizer shall be a ready mixed material and shall be equivalent to the grade or grades specified in the Seeding Requirements Table. Container bags shall have the name and address of the manufacturer, the brand name, net weight, and chemical composition.

Seeding Requirements Table

<u>Area</u>	<u>Sowing Season</u>	<u>Species</u>	<u>Seed</u>	<u>Fertilizer</u>	<u>Limestone</u>
Flat to rolling Terrain with slopes less than 3:1	3/1-6/1	Kentucky 31			

- C. Agricultural limestone shall be a pulverized limestone having a calcium carbonate content on not less than 85% by weight. Agricultural limestone shall be crushed so that at least 85% of the material will pass a No. 10 mesh screen and 50% will pass a No. 40 mesh screen.

2.04 MULCH MATERIAL

- A. All mulch materials shall be air dried and reasonably free of noxious weeds and weed seeds or other materials detrimental to plant growth.
- B. Mulch shall be composed of wood cellulose fiber, straw, or stalks, as specified herein. Mulch shall be suitable for spreading with standard mulch blowing equipment.
- C. Wood-cellulose fiber mulch shall be as manufactured by Weyer-Hauser Company, Conway Corporation, or equal.
- D. Straw mulch shall be partially decomposed stalks of wheat, rye, oats, or other approved grain crops.
- E. Stalks shall be the partially decomposed, shredded residue of corn, cane, sorghum, or other approved standing field crops.

2.05 MULCH BINDER

- A. Mulch on slopes exceeding 3 to 1 ratio shall be held in place by the use of an approved mulch binder. The mulch binder shall be non-toxic to plant life and shall be acceptable to the ENGINEER.
- B. Emulsified asphalt binder shall be Grade SS-1, ASTM D 977. Cut-back asphalt binder shall be Grade RC 70 or RC 250.

2.06 INNOCULANTS FOR LEGUMES

All leguminous seed shall be inoculated prior to seeding with a standard culture of nitrogen-fixing bacteria that is adapted to the particular seed involved.

2.07 WATER

Water shall be clean, clear water free from any objectionable or harmful chemical qualities or organisms and shall be furnished by the CONTRACTOR.

PART 3 - EXECUTION

3.01 SECURING AND PLACING TOPSOIL

- A. Topsoil shall be secured from areas from which topsoil has not been previously removed, either by erosion or mechanical methods. Topsoil shall not be removed to a depth in excess of the depth approved by the ENGINEER.
- B. The area or areas from which topsoil is secured shall possess such uniformity of soil depth, color, texture, drainage, and other characteristics as to offer assurance that, when removed the product will be homogeneous in nature and will conform to the requirements of these Specifications.
- C. All areas from which topsoil is to be secured, shall be cleaned of all sticks, boards, stones, lime, cement, ashes, cinders, slag, concrete, bitumen, or its residue, and any other refuse which will hinder or prevent growth.
- D. In securing topsoil from a designated pit or elsewhere, should strata or seams of material occur which do not come under the requirements for topsoil, such material shall be removed from the topsoil, or if required by the ENGINEER, the pit shall be abandoned.
- E. Before placing or depositing topsoil upon any areas, all improvement within the area shall be completed, unless otherwise approved by the ENGINEER.

3.02 SEEDBED PREPARATION

- A. Before fertilizing and seeding, the topsoil surfaces shall be trimmed and worked to true line free from unsightly variation, bumps, ridges and depressions, and all detrimental materials, roots, and stones larger than 1 inch in any dimension shall be removed from the soil.
- B. Not earlier than 24 hours before the seed is to be sown, the soil surface to be seeded shall be thoroughly cultivated to a depth of not less than 2 inches with a weighted disc, tiller, pulvimixer, or other equipment, until the surface is smooth and in a condition acceptable to the ENGINEER.
- C. If the prepared surface becomes eroded as a result of rain or for any other reason, or becomes crusted before the seed is sown, the surface shall again be placed in a condition suitable for seeding.
- D. Ground preparation operations shall be performed only when the ground is in a tillable and workable condition.

3.03 FERTILIZATION AND LIMING

- A. Following seedbed preparation, fertilizer shall be applied to all areas to be seeded so as to achieve the application rates shown in the Seeding Requirements Table. Copies of all weight tickets shall be furnished to the ENGINEER.
- B. Fertilizer shall be spread evenly over the seedbed and shall be lightly harrowed, raked, or otherwise incorporated into the soil for a depth of 1/2 inch.
- C. Fertilizer need not be incorporated in the soil as specified above when mixed with seed in water and applied with power sprayer equipment. The seed shall not remain in water containing fertilizer for more than 30 minutes when a hydraulic seeder is used.
- D. Agricultural limestone shall be thoroughly mixed into the soil according to the rates in the Seeding Requirements Table. The specified rate of application of limestone may be reduced by the ENGINEER if pH tests indicate this to be desirable. It is the responsibility of the CONTRACTOR to obtain such tests and submit the results to the ENGINEER for adjustment in rates.
- E. It is the responsibility of the Contractor to make one application of maintenance fertilizer according to the recommendations listed in the Seeding Requirements Table.

3.04 SEEDING

- A. Seed of the specified group shall be sown as soon as preparation of the seedbed has been completed. No seed shall be sown during high winds, nor until the surface is suitable for working and is in a proper condition. Seeding shall be performed during the dates shown in the Seeding Requirements Table unless otherwise approved by the ENGINEER. Seed mixtures may be sown together provided they are kept in a thoroughly mixed condition during the seeding operation. Copies of all weight tickets shall be furnished to the ENGINEER.
- B. Seeds shall be uniformly sown by any approved mechanical method to suite the slope and size of the areas to be seeded, preferably with a broadcast type seeder, windmill hand seeder, or approved mechanical power drawn seed drills. Hydro-seeding and hydro-mulching may be used on steep embankments, provided full coverage is obtained. Care shall be taken to adjust the seeder for seedings at the proper rate before seeding operations are started and to maintain their adjustment during seeding. Seed in hoppers shall be agitated to prevent segregation of the various seeds in a seeding mixture.
- C. Immediately after sowing, the seeds shall be covered and compacted to a depth of 1/8 to 3/8 inch by a cultipacker or suitable roller.
- D. Leguminous seeds shall be inoculated prior to seeding with an approved and compatible nitrogen-fixing inoculated in accordance with the manufacturer's mixing instructions.

3.05 MULCHING

- A. All seeded areas shall be uniformly mulched in a continuous blanket immediately after seeding. The mulch shall be applied so as to permit some sunlight to penetrate and the air to circulate and at the same time shade the ground, reduce erosion, and conserve soil moisture. Approximately 25 percent of the ground shall be visible through the mulch blanket.
- B. One of the following mulches shall be spread evenly over the seeded areas at the following application rates:
 - 1. Wood Cellulose Fiber 1,400 lbs./acre
 - 2. Straw 4,000 lbs./acre
 - 3. Stalks 4,000 lbs./acre

These rates may be adjusted at the discretion of the ENGINEER at no additional cost to the OWNER, depending on the texture and condition of the mulch material and the characteristics of the seeded area.

- C. Mulch on slopes greater than 3 to 1 ratio shall be held in place by the use of an approved mulch binder. Binder shall be thoroughly mixed and applied with the mulch. Emulsified asphalt or cutback asphalt shall be applied at the approximate rate of 5 gallons per 1,000 square feet as required to hold the mulch in place.
- D. The CONTRACTOR shall cover structures, poles, fence, and appurtenances if the mulch binder is applied in such a way that it would come in contact with or discolor the structures.
- E. Mulch and binder shall be applied by suitable blowing equipment at closely controlled application rates.

3.06 WATERING

- A. CONTRACTOR shall be responsible for maintaining the proper moisture content of the soil to insure adequate plant growth until a satisfactory stand is obtained. If necessary, watering shall be performed to maintain an adequate water content in the soil.
- B. Watering shall be accomplished by hoses, tank trucks, sprinklers in such a way to prevent erosion, excessive runoff, and overwatered spots.

3.07 MAINTENANCE

- A. Upon completion of seeding operations, the CONTRACTOR shall clear the area of all equipment, debris, and excess material and the premises shall be left in a neat and orderly condition.
- B. The CONTRACTOR shall maintain all seeded areas without additional payment

until final acceptance of the work by the Owner. Seeding work shall be repeated on defective areas until a satisfactory uniform stand is accomplished. Damage resulting from erosion, gullies, washouts, or other causes shall be repaired by filling with topsoil, compacting, and repeating the seeding work at contractor's expense.

SECTION 02753

SEWER FLOW CONTROL

PART 1 - GENERAL

1.01 SCOPE OF WORK

- A. This covers the sewer flow control procedures of plugging, blocking, and by-pass pumping. The Contractor shall provide all material, equipment, labor and services necessary to perform the work in accordance with the items of this section.

1.02 RELATED WORK

- A. Preparatory cleaning of sewers as specified in Section 02751.
- B. Television Inspection as specified in Section 02752.

1.03 GENERAL

- A. When sewer line flows at the manhole section being replaced are sufficient to cause a washing of the bedding or backfill material into the line then the flows shall be reduced by one of the following methods: manual operation of pumping stations; plugging/blocking of the flows; or by pumping/bypassing of the flows, as specified by the Engineer or his Representative.
- B. Sewer flows shall not exceed five (5) percent of the pipe diameter for the respective line sizes as measured in the manhole when performing television inspection.
- C. Plugging, blocking, or bypassing of the sewer flow shall be considered incidental to the work and shall not be considered for payment.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.01 PLUGGING AND BLOCKING

- A. A sewer line plug shall be inserted into the line at a manhole upstream for the section being inspected. The plug shall be so designed that all or any portion of the sewage flows can be released. During the inspection portion of the operation, flows shall be shut off or reduced to within the maximum flow limits specified in 1.03 B. After the work tasks have been completed, flows shall be restored to normal.

3.02 PLUGGING AND BYPASSING

- A. When pumping/bypassing is required, the Contractor shall supply the necessary pumps, conduits and other equipment to divert the flow of sewage around the manhole section in which work is to be performed. The bypass system shall be of sufficient capacity to handle existing flows plus additional flow that may occur during periods of a rain storm. The Contractor will be responsible for furnishing the necessary labor and supervision to set up and operate the pumping and bypassing system. A "setup" consists of the necessary pumps, conduits, and other equipment to divert the flow of sewage around a manhole section, from the start to finish of work performed in the manhole section.

3.03 FLOW CONTROL PRECAUTIONS

- A. Whenever flows in a sewer line are blocked, plugged or bypassed, sufficient precautions must be taken to protect the sewer lines from damage that might be inflicted by excessive sewer surcharging. Further, precautions must be taken to ensure that sewer flow control operations do not cause flooding or damage to public or private property being served by the sewers involved. Damage to said properties shall be the sole responsibility of the Contractor.

END OF DOCUMENT

SECTION 2810

LANDSCAPING

PART 1 - GENERAL

1.01 REQUIREMENT, CODES

- A. All applicable portions of the site work and general conditions, specifications and requirements are to be considered as included with this section.
- B. The following are minimum requirements and shall govern except that all local, state and/or federal codes and ordinances shall govern when their requirements are in excess hereof.
- C. The landscaping shall be installed by a licensed Landscape Contractor.

1.02 SCOPE

- A. Provide all labor, materials, equipment and services necessary and incidental to the completion of all landscaping where shown or indicated on the drawings and specified herein.
- B. Work included consists of, but is not limited to, the following:

LAWN INSTALLATION:

Fertilizer and lime application.
Final soil preparation.
Seeding of new lawn areas.
Placement of slope ground cover.
Mulch application.
Maintenance of seeded areas.
Replanting of unsatisfactory or damaged turf.

PLANT MATERIAL INSTALLATION:

Furnishing, delivering, and unloading of plant materials at site.

Preparation of planting pits and beds and related excavation, backfilling, and disposal of surplus and unsuitable excavated material.

Planting of trees, including fertilizing, mulching, and if necessary pruning, guying and/or staking.

Guarantee and replacement of plant material.

Maintenance of lawns and trees, as specified in Section 2820, Landscape Maintenance.

1.03 OTHER DOCUMENTS INCLUDED OR RELATED TO THIS CONTRACT

- A. Annual Maintenance Manual - Section 2820
- B. Landscape Plan and Details - Sheets C-1 through C-13.

1.04 SUBMITTALS

- A. CERTIFICATION OF QUALIFICATION: Prior to bid acceptance, submit certification of insulator's experience identifying a minimum of four (4) projects to the Owner's representative. Include the following information for each project: Owner, Landscape Architect, project location, type and size of contract.
- B. WORK SCHEDULE:
 - 1. Submit a proposed work schedule to City of Chattanooga's Construction Representative at least 30 days prior to start of work under this Section. After approval, no modification shall be made to this schedule without written authorization by City of Chattanooga's Construction Representative.
 - 2. All landscape work must be completed by _____, 2001.
 - 3. Complete erosion control and turf establishment must be completed by _____, 2001.
 - 4. The Landscape Contractor shall carefully correlate his work with that of other site Contractors.

1.05 INSPECTION OF CONDITIONS

- A. EXAMINATION OF SITE: This subcontractor will have examined the site personally to ascertain the state thereof and to understand the complexities of the work. This subcontractor will be held to have satisfied himself as to the condition of the premises, the actual elevation, existing obstructions, areas of work, and other conditions that would affect the completion of the work.
 - 1. The bidder must acknowledge that he has examined the site, plans and specifications, and the submission of a quotation shall be considered evidence that examinations have been made.
 - 2. The bidder shall verify availability of stockpiled topsoil prior to submittal to bid.
 - 3. The Contractor shall verify the accuracy of all finish grades within the work area.

- B. FIELD CONDITIONS: The Contractor shall verify drawing dimensions with actual field conditions and inspect related work and adjacent surfaces. The Contractor shall report to the City of Chattanooga's Construction Representative all conditions which prevent proper execution of this work.
- C. The exact location of all existing utilities, structures, and underground utilities, which may not be indicated on the drawings, shall be determined by the Contractor, and he shall conduct his work so as to prevent interruption of service or damage to them. The Contractor shall protect existing structures and utility services and be responsible for their replacement if damaged by him. Any required removal, repair, or replacement of this work caused by unsuitable conditions shall be done at no additional cost to the City of Chattanooga or Owner.

1.06 PRECONSTRUCTION CONFERENCE

Schedule a preconstruction conference with City of Chattanooga's Construction Representative at least 7 days before beginning work under this Section. The purpose of this conference is to review any questions Contractor may have regarding the work, administrative procedures during construction and project work schedule.

1.07 SUBSTITUTIONS

- A. Specific reference to manufacturers' name and products specified in this Section are used as standards, but this implies no right to substitute other material or method without written approval of the City of Chattanooga's Construction Representative.
- B. Installation of any approved substitution is Contractor's responsibility. Any changes required for installation of any approved substitution must be made to the satisfaction of the City of Chattanooga's Construction Representative and without additional cost to the City of Chattanooga.

1.08 WARRANTY

- A. All Plant material, lawns, and related work and material shall be warranted for a period of not less than one year from the date of acceptance of the landscape installation. See Section 3.07, completion and acceptance.
- B. All replacement stock shall be subject to the same warranty requirements as the original stock. Any damage due to replacement operations shall be repaired by the Landscape Contractor at no expense to the City of Chattanooga or Owner.

1. During the last month of the Guarantee Period, the City of Chattanooga's Construction Representative will inspect the planting to determine the number and type of plants to be replaced. A count and description of the dead plants shall be made and submitted to the Contractor in writing. The Contractor shall replace these during the first thirty (30) days of the next earliest planting season.

2. Plants which have lost over 33 percent (33%) of their branches shall be considered dead and shall be replaced. When replacements have been made and installed in compliance with these specifications, the requirements for planting under this contract shall be considered fulfilled.

3. All replacements under the guarantee shall be plants of the same kind, size, and quality as specified in the Plant List. They shall be furnished, planted, and mulched as specified herein.

1.09 FINAL ACCEPTANCE

Work under this Section will be accepted by the City of Chattanooga's Construction Representative upon satisfactory completion of all work. Upon Final Acceptance, and after one year maintenance period, City of Chattanooga will assume responsibility for the maintenance of the work. Said assumption does not relieve Contractor of obligations under Warranty.

1.10 APPROVAL

Wherever the terms "approve," "approval," "approved" are used in the Specification, they mean approval of the City of Chattanooga's Construction Representative, in writing.

PART 2 - PRODUCTS

2.01 STANDARDS

Comply with the provisions of the latest editions of the following specifications and standards, except as otherwise shown or specified herein.

- A. AMERICAN STANDARD FOR NURSERY STOCK, 1986 Edition, American Association of nurserymen (ANSI.1-1986)
- B. PLANT HARDINESS ZONE MAP, 1965 Edition, Miscellaneous Publication No. 814 Agricultural Research Service, U. S. Department of Agriculture.
- C. U.S.D.A. TRIANGULAR SOIL TEXTURE CHART, Bureau of Plant Industries, Soils and Agricultural Engineering, U. S. Department of Agriculture.

2.02 TOPSOIL

- A. Topsoil shall be fertile, natural topsoil, typical of the locality, obtained from well-drained areas. Stockpiled topsoil may be used. It shall be without admixture of subsoil or slag and shall be free of stones, lumps, sticks, plants or their roots, toxic substance or other extraneous matter that would be harmful to plant growth or would interfere with future maintenance. Topsoil pH range shall be 5.3 to 6.0.

- B. If the supply of stockpiled topsoil is insufficient, the Landscape Contractor shall supply additional topsoil to meet all landscaping needs.
- C. **SOIL TESTING:** The Contractor shall be responsible for having topsoil tested. Topsoil shall be tested by the local county extension office. The Contractor shall furnish one (1) copy of the soil analysis and recommended amendments prepared (to meet the desired pH, nutritional and organic levels determined to be adequate for the area) by the county extension agent, to the City of Chattanooga's Construction Representative's satisfaction prior to application of any amendments or fertilizer.

2.03 SOIL CONDITIONERS AND AMENDMENTS

- A. Agricultural limestone shall contain not less than 95 percent calcium carbonate equivalent and shall be ground to such a fineness that at least 98 percent will pass a 20-mesh sieve and at least 50 percent will pass a 100-mesh sieve. Other liming material shall have a minimum calcium carbonate equivalent of 80 percent and shall be crushed to such a fineness that 98 percent will pass a 20-mesh sieve and at least 50 percent will pass a 100-mesh sieve.
- B. Aluminum sulfate shall be horticultural grade.
- C. Peat shall be a natural product of sphagnum moss peat (peat moss), derived from a freshwater site conforming to ASTM D2607 except as otherwise specified. Peat shall be shredded and granulated to pass a 1/2 inch mesh screen and conditioned in storage piles for at least 6 months after excavation. Peat shall be measured in a dry condition, containing not more than 35% moisture by weight.
- D. Sand shall be clean and free of toxic materials.
- E. Vermiculite shall be horticultural grade and free of any toxic materials.
- F. Manure shall be well-rotted, unbleached stable or cattle manure not less than 8 months or more than 2 years old, containing not more than 25 percent by volume of straw, sawdust, or other bedding materials, and containing no chemicals or ingredients harmful to plants. The manure shall be heat treated to kill weed seeds.
- G. Rotted sawdust shall have 7.5 pounds of nitrogen added uniformly to each cubic yard and shall be free of chips, stones, sticks, soil, and toxic substances.
- H. Gypsum shall be 90 percent pure, free of any toxic materials, and at least 95 percent by weight shall pass a 4-mesh sieve.
- I. Other amendments as recommended by the county extension agent.

2.04 SEED

- A. Seed shall be the best blend of certified lawn grass and/or ground cover. Plant seeds common to the site location. Provide fresh, clean, new-crop seed complying with established tolerances for germination and purity in accordance with the U. S. Department of Agriculture Rules and Regulations under the latest edition of the Federal Seed Act. Seed shall be mixed by the dealer and shall be delivered to the site in sealed containers which shall bear the dealer's guaranteed analysis. Seed mixture and seeding rate shall be specified on the drawings and on the following table:

	Purity/Germination	MIN%	WT %	RATE/AC
1.	WARM SEASON, TEMPORARY BLEND (See Plan For applicability)			
	Tall Fescue Grass (Festuca Arundinacea)	98%/85%	100%	40 lbs./ac.
	Annual Ryegrass (Lolium Multiflorum)	98%/85%	100%	15 lbs./ac.
2.	WARM SEASON, PERMANENT BLEND (See plan for applicability)			
	Bermuda Grass "Tifton 419" (Cynodon Dactylon "Tifton 419")	98%/85%	100%	40 lbs./ac.
3.	STEEP BANK GROUND COVER BLEND (See plan for applicability)			
	Tall Fescue Grass (Festuca Arundinacea)	98%/85%	100%	40 lbs./ac.
	Sericea Lespedeza (Lespedeza Cuneta Var. Sericia)	98%/85%	100%	70 lbs./ac.

2.05 FERTILIZER

- A. All fertilizers shall be complete formula fertilizers and shall conform to the applicable State Fertilizer Laws. All fertilizers shall be uniform in composition, free-flowing and suitable for application with approved equipment. Fertilizers shall be delivered to the site in the manufacturer's original unopened containers, fully labeled according to the applicable State Fertilizer Laws and shall bear the name, trade name, trademark, and warranty of the producer.
- B. PLANT STOCK: Fertilizer shall be "Agriform" slow release fertilizer tablets.

- C. LAWN AREAS: Shall be high phosphorus starter fertilizer. Fertilizer formula and application rate shall be as recommended by the County Extension Agent based on soil test results.

2.06 PLANTING MIXTURE

Planting mixture shall consist of a uniform mixture of the following materials in respective proportions: three parts topsoil, one part peat moss, and one part manure. The mixture must be thoroughly ground up and mixed so that there is no visible segregation of material.

2.07 HERBICIDES

- A. Herbicides must comply with all applicable State and Federal Laws and be registered with the U. S. Environmental Protection Agency.

1. HERBICIDE CONTROL SHALL BE:

- a. Pre-emergence application of "Treflan 5% Granules" or equivalent, applied according to manufacturer's recommendations and incorporated into soil as specified.
- b. Post-emergency application of "Roundup" or equivalent, applied as specified by manufacturer. Spray with extreme care to avoid contact with landscape plants and lawns to remain.

- 2.08 Water shall not contain elements toxic to plant life. It shall be obtained from on-site water source.

2.09 TREE PROTECTANTS

- A. Trees shall not be staked.

2.10 MULCHES

- A. MULCHES FOR PLANT STOCK: Shredded hardwood bark mulch common to the locality shall be specified. Bark shall be of a relative uniform particle size with a median size of one and one-half inches (1-1/2") and shall be free of sticks, stones, leaves and any other debris.

- B. MULCHES FOR LAWN AREAS:

1. SEEDED AREAS 3:1 OR LESS: shall be clean, dry, weed-free straw suitable for placing with mulch blower equipment or by hand.

2. SEEDED AREAS OVER 3:1: Hay or straw as specified above with binder and wood cellulose fiber.

a. MULCH BINDER: RMB Plus by Reinco Mulch Binder Corporation (800) 526-7687, applied per manufacturer's specifications.

b. WOOD CELLULOSE: Wood cellulose fiber for use with hydraulic application of grass and seed and fertilizer shall consist of commercially prepared natural wood cellulose fiber or wood pulp processed to contain no growth or germination-inhibiting factors and dyed any appropriate color to facilitate visual metering of the application. On an air-dry weight basis, the wood cellulose fiber shall contain a maximum of 12 percent moisture, plus or minus 3 percent at the time of manufacture. The pH range shall be from 3.5 to 5.0. The wood cellulose fiber shall be manufactured so that the fibers disperse readily and uniformly as a homogeneous slurry, so that when hydraulically sprayed on the ground, the material will form blotter like cover impregnated uniformly with grass seed, and so that moisture and rainfall will absorb and percolate the underlying soil.

2.11 TREE ROOT CONTROL SYSTEMS

A. TYPAR BIOBARRIER

DowElanco, 9002 Purdue Road, Indianapolis, Indiana, 46268-1189, Phone 1-800-352-6776.

Typar biobarrier is a multi-year root control system, consisting of herbicidal time release nodules permanently attached to a permeable geotextile fabric, which will inhibit plant root encroachment.

B. DEEP ROOT

Deep Root Corporation, 15040 Golder West Circle, Westminster, California, 92683, Phone 1-714-898-0563.

Deep Root products are a multi-year root control system, consisting of a rigid plastic barrier which will direct the growth of root systems down, away from surface rooting.

C. Any substitution must be approved in writing and must be equal to the above mentioned products.

Refer to Section 1.07, Substitutions.

2.12 PLANT STOCK

A. The Contractor shall notify the City of Chattanooga's Construction Representative of the source of his materials and the inspection certificates required for their transportation to the job site, prior to tagging plant materials.

B. Plant sources are subject to approval by the City of Chattanooga's Construction Representative.

- C. Plant Material shall be first quality stock and shall conform to the code of standards set forth in the current edition of the American Standards for Nursery Stock sponsored by the American Association for Nurserymen, Inc.
- D. Species and variety as specified on the drawings and delivered to the site shall be certified true to their genus, species and variety as specified on the drawings and as defined within the current edition of International Code of Nomenclature for Cultivated Plants, issued by the International Union of Biological Sciences.
- E. Planting stock shall be well branched and well formed, sound, vigorous, healthy, free from disease, sun-scale, windburn, abrasion, and harmful insects or insect eggs, and shall have healthy, normal unbroken root systems. Deciduous trees and shrubs shall be symmetrically developed, or uniform habit of growth, with straight trunks or stems, and free from objectionable disfigurements. All trees shall be branched as street trees.
- F. Plant materials shall be provided in the quantity, size and species as shown and/or scheduled under this contract. All stock shall be balled and burlapped or container grown stock. Bareroot stock of any kind is unacceptable.
- G. Plant material shall be nursery grown in accordance with good horticultural practices and shall have been grown for at least two years in the same plant hardiness climate zone as the planting site, under climatic conditions similar to those in the locality of the project. Plant materials shall be typical of their species and variety and shall have been grown under proper cultivation with appropriate wide spacing of the plants to produce healthy, balanced and sturdily developed branches and densely foliated plants.
- H. Plant materials shall be freshly dug and vigorous plants. No heel-in plants or plants from cold storage will be accepted.
- I. Plants shall conform to measurements as shown on the drawings and/or specified in schedules except that plants larger than specified may be used if approved by the City of Chattanooga's Construction Representative prior to planting. Use of such plants shall not increase the contract price. If larger plants are approved, the root ball and planting pits shall be increased in proportion to the size of the plant.
- J. All plant material measurements, i.e., caliper, height, branching, level, number of canes, ball sizes, etc., shall be in strict accordance with the latest edition of the American Standard for Nursery Stock. Minimum acceptable sizes are:

Trees 2 – ½” to 3”

- K. Plant materials shall be measured when branches are in their normal position. Height and spread dimensions, when specified, refer to the main body of the plant and not from branch tip to branch tip.

- L. Trees shall be labeled with a durable waterproof label and weather-resistant ink. Labels shall state the correct plant name and size as specified in the plant list of required plants. Labels shall be securely attached to plants and shall be legible for 60 days after delivery to the planting site. Wire identification tags shall not be used.
- M. Caliper measurements shall be taken at a point on the trunk, six inches (6") above natural ground for trees up to and including four inch (4") caliper size material and at a point twelve inches (12") above the natural ground line for larger trees.
- N. Where a range of sizes is specified in the schedule, no plant shall be less than the minimum size, and not less than 50 percent of the plants shall be as large as the average size specified.
- O. All plants shall be free from disease, insect infestations, defects and physical damage that would prevent the plant from thriving with the desired quality, appearance and growth characteristics.
- P. All plant materials shall be matched specimens from a single block source.
- Q. Plants shall not be pruned before delivery. Trees which have a damaged or crooked leader, or multiple leaders, unless specifically requested, will be rejected. Damaged trees such as trees with abrasions of the bark, sun-scald, disfiguring knots, or cuts of limbs over 1/4 inch which have not completely callused, will be rejected.
- R. No change in quality, quantity, species, variety, or sex of plants from those specified will be permitted without the written approval of the City of Chattanooga's Construction Representative. The Contractor may suggest alternative available plants which conform to the requirements of the contract as to size, type, and function. In no case shall the price for the substitution exceed the bid price of those replaced.

PART 3 - EXECUTION

3.01 GENERAL

- A. Prior to beginning the work of this section, verify that site grading and preparation have been properly completed. At this point, rough grades should be 6" below the finish grade levels for all landscape and turf areas.
- C. The Landscape Contractor shall proceed with the installation work as soon portion of the site becomes available.
- C. UNDERGROUND OBSTRUCTIONS TO PLANTING: If underground utilities, construction or solid rock ledges are encountered, other locations for planting may be selected by the City of Chattanooga's Construction Representative. Damage to utility lines shall be repaired at the Contractor's expense at no additional cost to the City of Chattanooga or Owner.

- D. PROTECTION OF EXISTING VEGETATION: If lawns have been established prior to planting operations, the surrounding turf shall be covered in a manner that will protect turf areas before excavations begin.
- E. MATERIALS STORAGE AND CLEANUP: The Contractor shall keep the premises free from rubbish and all debris at all times and shall arrange his material storage so as not to interfere with the operation of the project. All unused materials, rubbish, and debris shall be removed from the site.

3.02 APPLICATION OF TOPSOIL

- A. The Landscape Contractor shall place a six-inch (6") compacted layer of topsoil over all areas to be established in turf, shrubs or groundcover, except planter islands as specified below. The topsoil layer shall bring all landscape areas to finish grade.
- B. PREPARATION OF PLANTER ISLANDS
 - 1. The Landscape Contractor is to remove 36" of sub-grade from all planter islands and backfill with topsoil.
 - 2. Planter islands shall be bermed to a high point of six inches (6") above adjacent curb, or higher as necessary to ensure positive drainage (a minimum of 2% slope). (See Detail Sheet).
- C. Prior to topsoil placement, areas to receive topsoil shall be cleared of all debris. Clearing shall consist of the satisfactory removal and disposal of brush and rubbish occurring within all lawn and planting areas. Any collected debris shall be removed from the site.
- D. Topsoil shall be tested and evaluated by the local county extension office. See Item 2.02, Paragraph C of this section.
- E. Fertilizer and soil amendments as recommended shall be thoroughly tilled in before placing into planter areas. To assure that soil, organic matter and fertilizer are properly blended, several passes with the tiller in opposite directions shall be made.
- F. After soil amendments have been thoroughly tilled in to soil, all areas are to be rolled with a hand roller weighing not more than 100 pounds per foot of width. (Compact at 85% Standard Proctor). During the rolling, all depressions caused by settlement of rolling shall be filled with additional topsoil and the surface shall be re-graded and rolled until presenting a smooth and even finish to the required finish grade.
- G. Finish grading shall be done just prior to seeding or sodding. The entire area shall be carefully raked to a smooth surface free of all clods, roots or stones 1/2" or larger.
- H. Final grades shall drain and conform to finish grades and contours indicated on site drawings. Grades shall not vary more than one-tenth of a foot from true surface grade when tested with a 12 foot straight edge.

- I. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface moisture to dry before planting lawns. Do not create a muddy soil condition.

3.03 SEEDING

- A. Topsoil, fertilizer, lime and seed shall be applied to all areas to be seeded as specified herein and in accordance with standard horticultural practices.
- B. Any undulations or irregularities in the surface resulting from fertilizing, liming, tilling, or other causes shall be smoothed prior to application of seed. The final grade shall be reasonably firm but friable.
- C. CLEANUP: Prior to seed application, the surface shall be raked of all trash, debris and stones larger than 1 inch in diameter, and of all roots, brush, wire, grade stakes and other objects that would interfere with planting or maintenance operations.
- D. SEEDING DATES: The normal seasonal dates for permanent seeding shall be May 1 to September 1 and from the time the soil is workable in the Spring to May 1. Seeding of a specified grass variety at times other than the normal seasonal dates must be approved by the City of Chattanooga's Construction Representative. Seeding shall not be done during windy weather or when the ground is excessively wet, frozen or otherwise un-tillable.
- E. Seeding may be applied with a mechanical hand seeder or by hydroseeding as specified below:
 - a. SEEDING: Seed shall be spread in two (2) successive sowings with the second perpendicular to the first. The rate of each sowing shall be one-half of the total seed rate specified. Immediately after seeding, all areas shall be lightly rolled. If, due to slope conditions, rolling cannot be done, seed shall be raked unto top ¼" of soil. Mulch as specified below shall be applied immediately after seed has been sown.
 - b. MULCHING: All seeded areas shall be mulched immediately after seeding. Mulch may be either dry straw or wood cellulose fiber. Straw shall be applied at a rate of 100 pounds per 1,000 square feet. Straw shall be stabilized with specified mulch binders. Mulch binder shall be applied per manufacturer's specifications.
- F. All areas which do not show a satisfactory catch of grass shall be reseeded at intervals of 21 days until a dense lawn of permanent grasses, free from any bare spots, areas of washout or erosion damage has been established.
- G. WATERING: Seeded areas shall be watered daily to ensure good germination. Once seeds have germinated, irrigation may be decreased, but the seedlings must never be allowed to dry out completely. Frequent watering should be continued for approximately three (3) weeks after germination or until grass has become sufficiently established to warrant watering on an "as needed" basis.

- H. Seeded areas shall be maintained by the Landscape Contractor for the specified maintenance period (a minimum of one year) or longer if necessary to establish a dense cover as specified above (Paragraph F). See Section 2820 for complete maintenance requirements.
- I. The Contractor shall be responsible for repair of damage to turf areas until all work is accepted.

3.04 PLANTING OF TREES

- A. All planting shall be performed by personnel familiar with the accepted procedure of planting and under the constant supervision of a qualified planting foreman.
- B. All planting is to be done as shown on drawings or as specified herein and in strict accordance with standard horticultural practices.
- C. The Contractor shall label for shipment and planting operations all trees and shrubs in each group of a similar species. Plant materials labels shall be durable, legible labels stating the correct plant name (botanical and common name from the contract documents) and size in weather resistant ink or embossed by a process capable of remaining readable at least two years. They shall be labels which can be tied securely to all plants in a manner that normal growth will not be restricted.
- D. No material shall be dug or transported after the leaf buds are open unless special conditions exist which may warrant a variance, subject to approval by the City of Chattanooga's Construction Representative.
- E. Trees may be planted in accordance with the time schedule outlined in these specifications, and in keeping with good horticultural practice.
- F. No digging or planting operations shall be conducted when the soil or plants are excessively wet, muddy, or in a frozen condition.
- G. When considered advisable and in keeping with proper horticultural procedures, the Contractor may request in writing permission to plant and transplant out of season. The City of Chattanooga's Construction Representative shall take under advisement the needs and requirements of the City of Chattanooga, weather factors, planting conditions and other factors to alter the planting seasons. Holes may be dug prior to these planting seasons as approved by the City of Chattanooga's Construction Representative.
- H. Location of trees shall be staked in the ground by the Contractor and approved by the City of Chattanooga's Construction Representative prior to beginning and planting work. The Contractor may accompany the City of Chattanooga's Construction Representative to review and approve all plant staking. Adjustments in locations and outlines shall be made as directed by the City of Chattanooga's Construction Representative.

I. OBSTRUCTIONS:

1. The Contractor may secure from the utility companies at his own expense all information and assistance needed and copies of layout drawings to identify the location of all utilities, electrical conduits, steam conduits, water lines, irrigation lines, sewer and gas lines, etc. Care shall be taken when excavating plant pits and placing stakes and anchors in the proximity of such utilities to avoid damaging them and to adjust the planting in harmony with work performed by other tradesmen.

2. In the event obstructions are encountered, the Contractor shall at once notify the City of Chattanooga's Construction Representative so that arrangements may be made to change locations of such planting. The Contractor shall assume the responsibility of repairing all utilities damaged in the performance of his work.

3. In the event that rock, tree stumps or underground construction work or other obstructions are encountered in any plant pit excavation work to be done under this contract, alternate locations shall be approved by the City of Chattanooga's Construction Representative. Where locations cannot be changed, the obstructions shall be removed to a depth of not less than 3 feet below grade and no less than 24 inches from the edges of the plant pit.

J. Existing plants remaining on the site (as shown on the plans), shall be protected from soil compaction and other damages during the planting operations. Care will be taken by the Contractor to work in and from open areas to avoid contact with the existing trees and root feeding areas. The Contractor is responsible to repair all damages and in the case of extreme damages shall replace the plant with a specimen nursery grown plant as similar in size as possible to the destroyed plant. Compaction of soils caused by planting operations within root feeding areas will be loosened.

K. EXCAVATION OF PLANTING PITS:

1. Planting pits shall be excavated to produce vertical sides and flat bottoms. Scarify side walls to alleviate glazing and loosen any hard subsoil in the bottom of pit.

2. Dispose of subsoil (off-site) removed from planting excavations. Do not mix with planting soil or use as backfill.

3. If plant pits are prepared and backfilled with the planting mixture to grade prior to planting, their location shall be marked and recorded on the plans and marked clearly on the site so that when planting proceeds they can easily be located.

2. The Contractor shall not leave any hole unattended when an unsafe condition exists without proper protection, signals, barriers, etc., or when in any manner it presents a hazard to pedestrians or vehicles on the site.

3. Planting pits may be dug with a motorized augur provided the sides and bottom of the pits are cut at least 2 inches larger with a hand spade. This cutting shall be deep enough and of a method to assure natural subsurface water circulation after planting.

6. Mechanical "Tree Spade" transplanting equipment may be used to dig and install plants. Provisions shall be made to assure natural subsurface water circulation and surface water circulation and surface water absorption, the sides of the plant pits shall be cut at least 2 inches deep at 4 to 6 inch intervals with a hand spade to pierce the compacted wall surface of the tree pit.

L. DRAINAGE TESTING/DRAINAGE CHANNEL REQUIREMENTS:

Prior to planting, all pits selected for testing shall be tested in the following manner:

1. All material removed from the drainage channel shall be discarded.
4. When backfilling planting pits with planting mixture, care must be taken to keep the consistency of the soil mix and the same throughout the planting pit and drainage channel.

Note: Refer to vertical drain notes on the plans.

M. SETTING AND BACKFILLING:

1. Planting pit shall be filled with water and allowed to drain before backfilling.
2. Balled and burlapped and container-grown plants shall be handled and moved only the ball or container. Plants shall be set plumb and held in position until sufficient soil has been placed around roots or ball. Plants shall be set in relation to surrounding grade so that they are even with the depth as which they were grown in the nursery, collecting fields, or container.
5. All plants shall be planted in soil mixture as specified and backfilled in 6 inch layers to eliminate voids and air pockets. When planting pit is approximately two-thirds full, fertilize as specified below, and thoroughly water again before placing remainder of backfill. Soils which are in a frozen or muddy condition shall not be used for backfilling plant pits.
4. Balled and stock shall be backfilled with planting soil mixture to approximately half the depth of the ball and then tamped and watered. Burlap and tying materials shall be carefully removed or opened and folded back from top one-third of root ball. The remainder of backfill or planting soil mixture shall be tamped and watered.
5. Container-grown stock shall be removed from containers without damaging plant or root system. Planting shall be completed as specified for balled or burlapped plants.

6. A root ball cracked or broken before or during planting operations shall be cause for rejection of the plant material.
7. Fertilizer as specified herein shall be added at the time of backfilling. Delay addition of fertilizer if planting mixture will not be used within two (2) days.

N. PLANT TABLET INSTALLATION:

1. The rate of application of planting tablets shall be according to the manufacturer's instructions and as follows:
 - a. For balled and burlapped plant material use two 21-gram tablets per each 1/2 inch caliper.
2. Placement of the planting tablets shall be as follows:

Position the ball in the plant pit. Place the recommended number of tablets evenly around the perimeter of, and adjacent to, the root ball at a depth which is in the upper one-third of the settled backfill around the root area and in accordance with planting details.
3. Plant tablets shall be placed only during the Spring growing season.

O. MULCHING AND WEED REMOVAL:

1. See Section 2: "Products" for the type of mulch to be used.
2. Mulch shall be applied after plants have been watered, backfilled, and allowed to settle, and shall be installed within 48 hours after planting.
3. Mulch for planting beds shall be installed to a minimum depth of four inches (4") in all areas specified on the drawings.
8. Mulch shall be kept out of the crowns of shrubs and off buildings, sidewalks, light standards, and other structures.
5. The top of all areas of mulch shall be 1" below the top of adjacent curb, walk or edge of pavement.
6. The mulched bed outline shall be continuous and cut vertically. Vegetation within bed outline shall be removed a minimum of 1 inch in depth to prevent re-growth. Planting beds shall be mulched as detailed on the drawings. The basin shall be maintained, as specified, within the plant beds.

7. Prior to the installation of mulch, all areas to be covered shall be weed free and shall be treated with a pre-emergent herbicide. Herbicide shall be used only on bedding plants which spread by rhizomes. DO NOT treat beds which contain surface rooting plants. The pre-emergent herbicide shall be evenly applied to the surface of all plant beds AFTER the mulch has been applied and firmed in place. All weeds and grasses existing within the beds and saucers shall be removed, after which the soil and mulch shall be smoothed and firmed in place. The pre-emergent shall be applied in accordance with the manufacturer's recommendation. The planting bed shall then be thoroughly watered.

P. PRUNING:

1. Plant materials shall be pruned following planting operations to remove broken or damaged branches and roots.
2. Pruning shall be performed by experienced plantsmen by using clean and sharp tools, after the plants have been inspected by the City of Chattanooga's Construction Representative.
3. Damaged or pruned tree leaders and otherwise excessively damaged and improperly pruned plants shall be cause for rejection.

3.05 ADJUST AND CLEAN

- A. Constant care should be exercised by the Contractor to maintain a safe and clean condition of the site for safe movement of pedestrians and vehicles. The ground shall be cleared of all debris and superfluous materials and all equipment shall be entirely removed from the public traffic-ways when not being used to the satisfaction of the City of Chattanooga's Construction Representative.
- B. At the completion of the work in an area or areas, or when work is stopped for a period of time due to weather conditions, etc., the work areas shall be cleaned of all superfluous soils, materials and equipment, in order to maintain a neat, clean and safe condition, to the satisfaction of the City of Chattanooga's Construction Representative.
- C. The Contractor shall be responsible for the repair of any damage to lawns, paved areas, roads, walks, curbs, or underground utilities which may result from his work. Such repairs shall be made swiftly in a thorough and workmanlike manner, with minimum inconvenience and at no cost to the City of Chattanooga.
- D. LAWN AREA: Where lawn areas have been damaged, the damaged lawn areas, ruts and/or depressions shall be cultivated, filled with topsoil and settled to proper grades, and replanted to the satisfaction of the City of Chattanooga's Construction Representative.

3.06 COMPLETION AND ACCEPTANCE

- A. The completion of the contract will be accepted and Notice of Completion recorded only when the entire contract is completed to the satisfaction of the City of Chattanooga's Construction Representative.
- B. Work under this section will be accepted by the City of Chattanooga's Construction Representative upon satisfactory completion of all work including "punch list" items.
- C. Acceptance of plant material by the City of Chattanooga's Construction Representative shall be for general conformance to the specifications, including size and character, and shall not relieve the Contractor of responsibility for full conformance to the contract documents including maintenance.
- D. The Contractor shall replace, without cost to the City of Chattanooga, and as soon as weather conditions permit within the next 30 days or within the first month of the next earliest planting season, whichever occurs first, all plants and all plants not in a vigorous thriving condition, as determined by the City of Chattanooga's Construction representative. The plants shall be free of dead or dying branches and branch tips, and shall bear foliage of normal density, size and color. Replacements shall closely match adjacent specimens of the same species. Replacements shall be subject to all requirements stated in this specification.
- E. Upon completion of repairs and replacements by the Contractor, the City of Chattanooga's Construction Representative shall certify as to the completion for the initial acceptance of the project and recommendation for beginning the Guarantee Period.

END OF DOCUMENT

SECTION 03110

CONCRETE FORMWORK

PART 1 - GENERAL

1.01 SCOPE

This Specification section prescribes materials and methods to be used in fabricating, erecting, and removing forms for cast-in-place concrete. The CONTRACTOR shall furnish all form design, forms, shoring, ties, form coating, and materials and all labor, equipment, and other items necessary or convenient to the CONTRACTOR for the fabrication, erection, and removal of formwork.

1.02 GENERAL

- A. Forms shall be fabricated, erected, and removed as specified herein and shall be of a type, size, shape, quality and strength to produce hardened concrete having the shape, lines and dimensions indicated on the drawings. The forms shall be true to line and grade in accordance with the tolerances as specified in "Cast-In-Place Concrete" and shall be mortar tight and sufficiently rigid to resist deflection during concrete placement. The surfaces of forms shall be smooth and free from irregularities, dents, sags, and holes that would deface the finished surfaces.
- B. The responsibility for correctly assessing and analyzing the erection stresses induced upon the structure, its elements and supporting foundations during construction will be the total obligation of the CONTRACTOR. Since the ENGINEER does not dictate or determine the CONTRACTOR'S sequence of operations of construction, the ENGINEER cannot determine erection stresses and therefore assumes no responsibility or obligation to do so. The CONTRACTOR must employ or otherwise provide for adequate professional structural engineering supervision to determine erection stresses and notify the ENGINEER of the results of the study.
- C. The responsibility for adequate formwork design for construction of cast-in-place, reinforced concrete will be the total obligation of the CONTRACTOR. The CONTRACTOR shall employ competent professional engineering services to design formwork and supervise the erection of all formwork needed for the job.
- D. Except as modified herein, form design, fabrication, and erection shall conform to the requirements of ACI 347 and ACI 318 and shall be acceptable to the ENGINEER. Design criteria for plywood shall conform to APA Form V345.
- E. Formwork shall comply with the requirements of ANSI A10.9 and OSHA Construction Standards, Part 1926, "Subpart Q, Concrete, Concrete Forms, and Shoring."

1.03 SUBMITTALS

- A. When requested by the ENGINEER, the CONTRACTOR shall submit to the ENGINEER for review shop drawings and design calculations for formwork the CONTRACTOR intends to use in constructing the work. The CONTRACTOR shall furnish said shop drawings and design calculations at no additional cost to the OWNER.
- B. Prior to beginning concreting operations, the CONTRACTOR shall submit to the ENGINEER for approval engineering data and manufacturer's literature on all form ties, spreaders, bar supports, form coatings, and prefabricated steel forms intended for use in the work.

1.04 STORAGE

All form materials and accessories shall be stored above ground on framework or blocking and shall be covered with a suitable waterproof of covering providing adequate air circulation and ventilation.

PART 2 - PRODUCTS

2.01 FORMS

- A. Forms for surfaces which will be exposed to view when construction is completed shall be prefabricated plywood panel forms, job-built plywood forms, or forms that are lined with plywood or fiberboard.
- B. Plywood or lined forms will not be required for surfaces which are normally submerged or not ordinarily exposed to view, such as the insides of manholes or wetwells. Other types of forms, such as steel or unlined wooden forms, may be used for surfaces which are not restricted to plywood or lined forms, and may be used as backing for form linings. Forms are required above all extended footings.
- C. Forms for cast-in-place concrete shall conform with the following requirement:

- | | |
|------------------------------|--|
| 1. Prefabricated Steel Forms | Simplex "Industrial Steel Frame Forms", Symons "Steel Ply", Universal "Uniform", or equal. |
| 2. Plywood | Product Standard PSI, waterproof resin-bonded, exterior type Douglas Fir. |
| a. Normal | Face adjacent to concrete Grade B or better |
| b. Architectural | Face adjacent to concrete Grade B or better with plastic overlay. |

PART 3 - EXECUTION

3.01 FABRICATION AND ERECTION

- A. Forms shall be substantial and sufficiently tight to prevent leakage of mortar. Forms shall be braced or tied to maintain the desired position, shape, and alignment during and after concrete placement. Walers, studs, internal ties, and other form supports shall be sized and spaced so that proper working stresses are not exceeded. Joints in forms shall be bolted tightly and shall bear on solid construction. Forms shall be constructed so they can be removed without hammering, wedging, or prying against the concrete. Form ties in exposed surfaces shall be uniformly spaced and aligned in horizontal and vertical rows. The forms shall produce finished surfaces that are free from off-sets, ridges, waves, and concave or convex areas.
- B. Forms to be reused shall be thoroughly cleaned and repaired. Split, frayed, delaminated, or otherwise damaged forms shall not be used.
- C. All form panels shall be placed in a neat, symmetrical pattern with horizontal joints level and continuous. The CONTRACTOR shall place special attention on mating forms to previously placed walls so as to minimize steps or rough transitions. Form panels shall be of the largest practical size to minimize joints and to improve rigidity.
- D. Beams and slabs supported by concrete columns shall be formed so the column forms may be removed without disturbing the supports for the beams or slabs.
- E. Wherever the top of a wall will be exposed to weathering, the forms on at least one side shall not extend above the top of the wall and shall be brought to true line and grade. At other locations forms for concrete which is to be finished to a specified elevation, slope, or contour, shall be brought to a true line and grade, or a wooden guide strip shall be provided at the proper location on the forms so that the top surface can be finished with a screed or template. At horizontal construction joints in walls the forms on one side shall not extend more than 2 feet above the joints.
- F. Temporary openings shall be provided at the bottom of column and wall forms and at other points where necessary to facilitate cleaning and inspection prior to concrete placement.
- G. Unless shown otherwise on the Drawings, all salient corners and edges of beams, columns, walls, slabs, and curbs shall be provided with a 3/4 inch by 3/4 inch chamfer formed by a wood or metal chamfer strip.
- H. Forms for exposed surfaces and all steel forms shall be coated with nonstaining form release agent which shall be applied just prior to placement of steel reinforcement. After coating, any surplus form release coating on the form surface shall be removed. Wood forms for unexposed surfaces may be thoroughly wetted with water in lieu of coating immediately before concrete placement, except in freezing weather form release coating shall be used.

- I. Should misalignment of forms or screeds, excessive deflection of forms, or displacement of reinforcement occur during concrete placement, immediate corrective measure shall be taken to insure acceptable lines and surface to required dimensions and cross sections.
- J. If any forms bulge or show excessive deflection, in the opinion of the ENGINEER, the concrete shall be removed and the forms rebuilt and strengthened.

3.02 FORM REMOVAL

- A. Forms shall not be removed or disturbed until the concrete has attained sufficient strength to safely support all dead and live loads. Shoring beneath beams or slabs shall be left in place and reinforced as necessary to carry any construction equipment or materials placed thereon.
- B. No forms shall be removed without the approval of the ENGINEER. In general and under normal conditions, the ENGINEER will approve removal of forms after the following time has elapsed:

ITEM	TIME AFTER PLACEMENT
Elevated Slabs and Beams	14 days
Columns	7 days
Walls	3 days
Other Concrete	2 days

- C. When ambient air temperatures during the curing period fall below 45 degrees F., form removal will take place based on job-cured test cylinder strength only.
- D. Care shall be taken in form removal to avoid surface gouging, corner or edge breakage, or other damage to the concrete. Immediately after form removal, any damaged or imperfect work shall be repaired as specified in "Cast-In-Place Concrete" of these Specifications.

SECTION 03240

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 SCOPE

This specification section describes steel reinforcement to be furnished and installed in cast-in-place concrete. The CONTRACTOR shall furnish all steel reinforcement, supports, and materials and all labor equipment, and other items necessary or convenient to the CONTRACTOR for the proper installation of the reinforcement.

1.02 GENERAL

- A. Steel reinforcement shall be designed, detailed, fabricated and placed in conformance with all applicable requirements of ACI 315, ACI 318, and CRSI Manual of Standard Practice.
- B. No concrete shall be placed until all steel reinforcement to be covered has been inspected in place and approved by the ENGINEER.

1.03 SUBMITTALS

- A. Prior to placing any steel reinforcement, the CONTRACTOR shall submit to the Engineer written evidence that the steel reinforcement has been tested and is in conformance with the material and mechanical requirements specified herein. Certified copies of mill tests may be considered evidence of compliance provided such tests are regularly conducted by the reinforcement supplier by experienced, competent personnel using adequate testing equipment. In case of doubt as to the adequacy or accuracy of the mill tests, the Engineer may require the Contractor to furnish, at no additional cost to the OWNER, test results from an independent testing laboratory acceptable to the ENGINEER on mill samples or delivered steel reinforcement. Mill or laboratory test results for verifying compliance with this specification section shall be provided for each 15 tons of steel reinforcement shipped. Results of laboratory or mill tests submitted to the ENGINEER shall be of tests conducted not earlier than 90 days prior to delivery.
- B. The cost of all sampling and testing of steel reinforcement necessary to furnish satisfactory evidence of compliance shall be borne by the CONTRACTOR and no separate payment will be made.
- C. Prior to fabrication and bending of steel reinforcement, the CONTRACTOR shall submit to the ENGINEER for review and approval complete shop drawings, bending diagrams, and schedules of all steel reinforcement to be incorporated in the work.
- D. The reinforcement shop drawings and bending diagrams shall show all dimensions, details, notes, location, size, length, and each bar mark, together

accessories and other materials belonging to the reinforcement for the concrete. Schedules shall show all information and be of the same general form as those on the Drawings. Concrete walls shall be detailed in elevation.

PART 2 - PRODUCTS

2.01 MATERIALS

A. REINFORCING BARS

Reinforcing bars shall be deformed billet-steel bars conforming to ASTM A 615. All bars #4 and larger shall be Grade 60. All bars #3 and smaller shall be Grade 40. All bars shall be shop fabricated and bent cold. Bars shall be free from defects and kinks and from bends not indicated on the Drawings or approved bending diagrams.

B. MESH REINFORCEMENT

Mesh reinforcement shall be electrically-welded, cold-drawn, mild-steel, plain wire fabric conforming to ASTM A 185. Wire shall be cold-drawn steel conforming to ASTM A 82.

C. SUPPORT CHAIRS

Reinforcement supports shall conform to Product Standard PS7 and CRSI Manual of Standard Practice, Class D or E.

Reinforcement support chairs shall be stainless steel or shall be plastic-tipped when used in walls and elevated slabs. Support chairs used in slabs on grade shall be stainless steel or shall be hot-dip galvanized after fabrication or plastic-tipped in such a manner as to provide a minimum 1-1/2 inches of protection from the subgrade. Nails shall not be used to support reinforcement.

D. TIE WIRE

Tie wire shall conform to Federal Specification QQ-W-461 and shall be of black annealed steel, 16-gauge minimum.

PART 3 - EXECUTION

3.01 DELIVERY AND STORAGE

- A. Reinforcement shall be delivered to the job site carefully bundled and tagged for identification. Reinforcement shall be stored at least 12 inches above ground on timber mats or other supports acceptable to the ENGINEER. Contact between reinforcement and the ground shall not be permitted during storage. Reinforcement shall be supported so as not to bend or deflect excessively under its own weight.

3.02 SURFACE PREPARATION

Before placement, all reinforcement shall be thoroughly cleaned of oil, dirt, mill scale, rust scale, and other coatings that would tend to destroy or reduce bond. A thin coating of orange rust resulting from short exposure will not be considered objectionable; but any reinforcement having heavy rust scale or thick rust coating shall be thoroughly cleaned to the satisfaction of the ENGINEER or shall be ejected and removed from the job site. When there is a considerable delay between placement of reinforcement and placement of concrete, the reinforcement shall be reinspected prior to placement of concrete and recleaned if necessary.

3.03 PLACEMENT

- A. Reinforcement shall be accurately positioned and tied at intersections with annealed wire or suitable clips approved by the ENGINEER. Reinforcement shall be supported by concrete or metal chairs, stays, spacers, hangers, or other supports acceptable to the ENGINEER.
- B. Reinforcing bars shall be fastened with wire ties at a minimum of three places per bar. Bars shall be tied at every intersection around the periphery of slabs. Wall steel shall be tied at every fourth intersection as a minimum.
- C. Reinforcement supports shall have sufficient strength and stability to maintain the reinforcement in place throughout placement and concreting operations. Supports and ties shall not be exposed at the face of the concrete nor shall they discolor the surface of the finished concrete.
- D. Movement of steel reinforcement in place during concreting operations shall be prevented. Any reinforcement which is displaced shall be accurately repositioned in the proper place before being completely covered.
- E. Dowels for successive work shall be securely fastened in correct position before placing concrete. The sticking of dowels after placing concrete shall not be permitted.
- F. Reinforcement which has been exposed for bonding with future work shall be protected from corrosion by heavy wrappings of burlap saturated with a bituminous material.
- G. No bar partially embedded in concrete shall be field-bent unless approved by the ENGINEER.

3.04 MINIMUM COVER AND CLEARANCE

The minimum concrete cover for the protection of embedded steel reinforcement shall be as follows:

A. Surfaces cast against crushed rock, sand, or earth:

All bar sizes	3 inches
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B. Surfaces exposed directly to water, backfill, or weather after form removal:

All bar sizes	2 inches
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C. Surfaces not exposed directly to water, backfill, or weather after form removal:

- | | | |
|----|----------------------------|--------------|
| 1. | Elevated Slabs | 1 inch |
| 2. | Floors, Walkways, Pavement | 1-1/2 inches |
| 3. | Walls | |
| | Less than 12 inches thick | 1-1/2 inches |
| | 12 inches or thicker | 2 inches |
| 4. | Beams | |
| | Stirrups | 1-1/2 inches |
| | Principal Reinforcement | 2 inches |

The minimum clearance between adjacent parallel bars shall not be less than the nominal diameter of the bars, not less than 1.5 times the maximum course aggregate size, and not less than 1 inch in beams, 1-1/2 inches in columns, and 2 inches in other locations.

3.05 TOLERANCES

A. Allowable tolerances for fabricating steel reinforcement shall be as follows:

ITEM	MAXIMUM TOLERANCE	
Sheared Length of Bars	+1"	-1"
Depth of Truss Bars	+0.0"	-1/2"
Outside Dimensions of Stirrups, ties, and Spirals	+1/2"	-1/2"
Location of Bends	+1"	-1"

B. Allowable tolerances for placing steel reinforcement shall be as follows:

ITEM	MAXIMUM TOLERANCE
Concrete Cover from Outside of Bar to Finished Surface	+1/4" -0.0"
Lateral Spacing of Bars in Plane of Reinforcement in Beams and Joists	+1/4" -0.0"
Lateral Spacing of Bars in Plane of Reinforcement in Slabs and Walls	+1" -1"
Spacing of Stirrups, Ties, and Spirals along Longitudinal Axis of Member	+1/2" -1/4"
Height of Bottom Bars in Slabs, Beams, and Joists	+1/4" -1/4"
Height of Top Bars in Slabs, Beams, and Joists	
Depth 8" and less	+1/4" -1/4"
Depth 9-24"	+1/2" -1/2"
Depth 25" and greater	+1" -1"

3.06 SPLICES

- A. Splices in reinforcement shall conform to the requirements of AC1-318, Chapter 7, Details of Reinforcement. Unless otherwise shown on the Drawings, all bars shall be lapped a minimum of 36 bar diameters where splicing is necessary and splices shall be staggered. Except where indicated on the Drawings, welding or tack welding of reinforcement shall not be permitted. Lapped connections shall be sufficient to transfer the full stress between the bars by bond and shear and to develop the full strength of the bars. In slabs and beams no splices shall be made at points of maximum positive or negative moment, and in no case shall adjacent bars be spliced at the same place.
- B. Although tolerances are allowed in the lateral spacing of parallel bars in the plane of reinforcement layers and in the spacing of stirrups, ties, and spirals along the longitudinal axis of a member, in no case shall the number of bars per layer of reinforcement provided in walls and slabs be less than the lateral dimension on the wall or slab in the plane of the reinforcement layer divided by the specified spacing, nor shall the number of stirrups, ties, or spirals provided along the longitudinal axis of a member in a given segment be less than the length of the segment divided by the specified spacing.

- C. Welded wire fabric reinforcement shall be lapped a minimum of 6 inches at joints and shall be wired securely. Mesh shall extend to within 2 inches of sides and ends of slabs. Lapped ends of welded wire fabric shall be offset to prevent continuous laps. Splices shall not be made midway between supporting beams or directly over beams of continuous structures.

****END OF SECTION****

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SECTION 03310

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SCOPE

This specification section covers all materials, equipment, and methods to be used by the CONTRACTOR in mixing, placing, testing, finishing, and curing cast-in-place concrete. The CONTRACTOR shall furnish all cement, aggregate, water, admixtures, and other materials and all labor, equipment, and supplies necessary or convenient to him for completing the work described in these Contract documents.

Cast-in-place concrete reinforcement and form work shall be as specified in the sections entitled "Cast-In-Place Concrete Reinforcement" and "Concrete Formwork" respectively of these Specifications.

1.02 CLASSIFICATION OF CONCRETE

Concrete shall be either Class A or Class B, as indicated on the Drawings or specified in these Specifications. If the class is not otherwise specified, the CONTRACTOR shall furnish Class A concrete.

In general Class A concrete shall be used for reinforced concrete cast-in-place in forms for slabs, footings, foundations, manholes, and similar reinforced concrete structures coming under the scope of ACI 318. Class B concrete shall be plain concrete and shall be used for pipe cradles, pipe and conduit encasement, bedding, grade correction, anchors, collars, thrust blocks, massive sections, and other non-reinforced concrete.

1.03 GENERAL REQUIREMENTS

All cast-in-place concrete shall be accurately formed and properly placed and finished as shown on the Drawings and specified herein.

The materials, aggregate grading, cement content, and placement methods specified herein are intended to provide a concrete that satisfies the minimum strength requirements, exhibits sufficient plasticity and cohesiveness to facilitate placement and reduce honeycombing and porosity, and incorporate a minimum water-to-cement ratio to minimize bleeding and shrinkage and to provide maximum water tightness. However, the CONTRACTOR may submit to the ENGINEER for review and approval alternate material requirements and placement techniques for achieving the desired results.

All Class A cast-in-place concrete shall be designed in accordance with the applicable requirements of ACI 318, latest edition.

SECTION 03310

CAST-IN-PLACE CONCRETE

1.04 PRELIMINARY MIX DESIGN

Before starting any concreting operations, the CONTRACTOR shall submit to the ENGINEER for approval a preliminary mix design for each class of concrete and for each size and gradation of aggregate and each consistency within a given class of concrete intended for use in the work. The preliminary mix design submittals shall contain the following information for each: (including those items listed in the latest ASTM designations, if different from those specified)

A. FINE AGGREGATE (Sample per ASTM D 75)

1. Source and type
2. Sieve analysis per ASTM C 136
3. Magnesium sulfate soundness per ASTM C 88
4. Deleterious substance per ASTM C 117, C 123, and C 142
5. Saturated surface dry weight per cubic yard of concrete
6. Bulk specific gravity per ASTM 127
7. Fineness modulus as defined in ASTM C 125

B. COARSE AGGREGATE (Sampled per ASTM D 75)

1. Source and type
2. Sieve analysis per ASTM C 136
3. Abrasion loss per ASTM C 535
4. Magnesium sulfate soundness per ASTM C 88
5. Deleterious substances per ASTM C 117, C 123, AND C 142
6. Saturated surface dry weight per cubic yard of concrete
7. Bulk specific gravity per ASTM 128

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CAST-IN-PLACE CONCRETE

C. CEMENT (Sampled per ASTM C 183)

1. Manufacturer, type, and ASTM designation
2. Sacks per cubic yard of concrete
3. Total gallons of water per sack (cu.ft.) of cement
4. Compressive strength at 7 days per ASTM C 109
5. Chemical analysis per ASTM C 114

D. SLUMP per ASTM C 143

E. AIR CONTENT per ASTM C 231

F. UNIT WEIGHT per ASTM C 138

G. TIME TO INITIAL SET at 70 Degrees F. per ASTM C 403

H. COMPRESSIVE STRENGTH at 7, 14, and 28 days ages per ASTM C 192, and C 39. A total of 9 standard test cylinders shall be prepared and cured in the laboratory for each preliminary mix design, three of which shall be tested each at 7-, 14-, and 28-day ages.

I. ADMIXTURES

1. Manufacturer, type, and ASTM designation
2. Dosage and point of introduction into the mix.

A preliminary mix design shall not be considered acceptable if the concrete resulting from that mix design does not produce an average 28-day compressive strength at least 1,200 psi higher than that required, unless a standard deviation for compressive strength testing has been established for the concrete supplier using the methods described in ACI 214. If a standard deviation has been established, the strength used as a basis for selecting concrete proportions shall exceed the required 28-day strength by the amounts given in ACI 318, Section 4.2.2.1, based on the appropriate value of the standard deviation. If a standard deviation is utilized, the CONTRACTOR or concrete supplier shall furnish written evidence to the ENGINEER that the standard deviation has been determined in accordance with the methods described in ACI 214. A written statement from an independent testing laboratory may be considered satisfactory evidence of compliance.

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CAST-IN-PLACE CONCRETE

Tests for compressive strength and all sampling and testing of aggregate and cement shall be conducted in accordance with the specified ASTM standards by an independent testing laboratory acceptable to the ENGINEER. Alternately, when approved by the ENGINEER, testing of cement and aggregate may be conducted at the point of manufacture by reputable cement and aggregate suppliers who regularly provide such testing services by experienced, competent personnel.

Tests for slump, air content, unit weight, and time to initial set may be conducted by the concrete supplier, providing such tests are performed in accordance with the specified ASTM standards by experienced, competent personnel using proper equipment.

The CONTRACTOR shall submit with each preliminary mix design four (4) copies of certified laboratory or mill test reports on all aggregate and cement incorporated in the preliminary mix design and four (4) copies of certified laboratory test reports on the compressive strength of the resulting concrete. Test reports on aggregate and cement shall contain written evidence that clearly indicates that all cement and aggregate covered by the test reports conform in all respects to the applicable material requirements of this specification section.

Approval of the preliminary mix designs shall in no way be interpreted to relieve the CONTRACTOR of any responsibilities, duties, or obligations for providing concrete conform in to the requirements of this specification section.

If, during the course of concreting operations, the CONTRACTOR desires to use an alternate mix design differing from the approved mix design in order to obtain a desired workability, density, strength, or uniformity, he shall submit to the ENGINEER for approval the information specified herein on the proposed alternate mix design prior to its use.

If, based on the result of laboratory or field tests conducted during concreting operations, concrete prepared according to an approved mix design fails to satisfy the requirements of this specification section, the ENGINEER shall have the right to require that the CONTRACTOR develop and submit in the manner specified an alternate mix design that will provide concrete conforming to the requirements of this section. The need for a change in mix design will be based on the ENGINEER'S statistical analysis and interpretation of laboratory and field tests conducted during concreting operations. Statistical methods and interpretation of test results will be as described in ACI 214, and ACI 318, latest edition.

Any increased material costs resulting from changes in mix designs during construction shall be paid for by the CONTRACTOR and no separate payment will be made.

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CAST-IN-PLACE CONCRETE

The cost of all materials, labor, equipment and all sampling and testing services required for the preliminary mix designs or for alternate mix designs during construction shall be paid for by the CONTRACTOR and no separate payment will be made.

1.05 QUALITY CONTROL DURING CONSTRUCTION

A. CERTIFICATION OF MATERIAL COMPLIANCE

During concreting operations, the CONTRACTOR shall furnish the ENGINEER written evidence that clearly indicates that the cement and aggregate used in each batch of concrete delivered to or mixed at the job site conforms in all respects to the applicable material requirements of this specification section. Satisfactory certified mill test reports from the cement or aggregate supplier may be considered as evidence of compliance provided that such testing is performed in accordance with the specified ASTM standards by experienced, competent personnel on a regular basis. In case of doubt as to the adequacy or accuracy of mill tests, the ENGINEER may require that the CONTRACTOR furnish, at no additional cost to the OWNER, test reports on the cement and aggregate from an independent testing laboratory acceptable to the ENGINEER. Certified reports or certificates indicating compliance of cement and aggregate shall be submitted to the ENGINEER before such materials are incorporated into the work. The CONTRACTOR shall be responsible for any delays in the progress of the work due to delays in testing and reporting.

Certified reports submitted to the ENGINEER for laboratory or mill tests on cement and aggregate shall be based on tests conducted not earlier than 90 days prior to incorporation of these materials into the work.

The cost of all sampling and testing of cement and aggregate necessary to furnish satisfactory evidence of compliance shall be borne by the CONTRACTOR and no separate payment will be made.

B. FIELD SAMPLING AND TESTING

During concreting operations, the ENGINEER will periodically require additional field inspection, sampling, and testing of cement, aggregate, and/or concrete by an independent testing laboratory in order to determine if the requirements of this specification section are being satisfied.

Field sampling and testing of cement, aggregate, and concrete will be performed according to the following latest ASTM Standards at a frequency determined by the ENGINEER.

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1. AGGREGATE

- a. Sampling ASTM D 75
- b. Testing Any test specified in ASTM C 33

2. CEMENT

- a. Sampling ASTM C 183
- b. Testing Any test specified in ASTM C 150

3. CONCRETE

- a. Sampling ASTM C 172
- b. Slump Test ASTM C 143
- c. Air Content Test ASTM C 231
- d. Making and Curing
 Test Cylinders ASTM C 31
- e. Compression
 Strength Tests ASTM C 39

Compressive strength testing will consist of making, curing, and testing cylinders of concrete. A total of four test cylinders will be prepared from each sample of concrete to be tested. Two test cylinders will be broken at an age of 7 days, two test cylinders will be broken at an age of 28 days. The minimum number of samples and test cylinders to be taken is as follows:

Concrete Class	Total Size of Pour	Number of Samples	Number of Cylinders
Class A	1-4 cu. yds.	1	4
Class A or B	4-100 cu. yds.	1	4
Class A or B	101-200 cu. yds.	2	8
Class A or B	201-300 cu. yds.	3	12
Class A or B	Over-300 cu. yds.	1/100 cu.yd.	4/100 cu.yd.

Test cylinders will normally be laboratory-cured. However, the ENGINEER may require tests on field-cured specimens to check the adequacy of curing operations.

A slump test and an air content test will be performed on each sample of concrete tested for compressive strength.

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Cement and aggregate will be subject to inspection, sampling, and field testing at the batching plant. Concrete will be subject to inspection, sampling, and field testing at the place of concrete placement. All field sampling, field testing, making and curing of field test cylinders, and laboratory testing performed during concreting operations for the purpose of determining if the requirements of this specification section are being satisfied shall be conducted by an independent testing laboratory selected by the OWNER and paid for directly by the OWNER and not as a part of this Contract.

The CONTRACTOR shall furnish the testing laboratory representative satisfactory samples of cement, aggregate, and concrete for inspection and testing purposes. The CONTRACTOR shall furnish any barrows, shovels, mixing boards, shaded area for preparing test cylinders, and similar equipment required by the testing laboratory representative for securing samples, making test cylinders, and conducting field tests.

No materials or concrete which fail to conform to the requirements of this specification section shall be incorporated into the work.

1.06 SHOP DRAWINGS AND ENGINEERING DATA

Complete ENGINEERING and product data shall be submitted to the ENGINEER on all admixtures, curing compounds, hardeners, sealers, and waterstops in accordance with the requirements of the section entitled "Submittals" of these Specifications.

1.07 GUARANTEE

Provide a guarantee against defective or deficient workmanship and materials in accordance with the requirements of the section entitled "Guarantees and Warranties" of these Specifications.

PART 2 - PRODUCTS

2.01 GENERAL

Concrete shall be composed of Portland Cement, fine aggregate, coarse aggregate, admixtures as specified herein, and water, so proportioned and mixed as to produce a plastic, workable mixture meeting the requirements of this specification section.

Materials and concrete not conforming to the requirements specified herein shall not be incorporated in the work.

SECTION 03310

CAST-IN-PLACE CONCRETE

2.02 MATERIALS

A. CEMENT

All cement used in cast-in-place concrete shall be Portland Cement conforming to the requirements of ASTM C 150, and, unless otherwise approved by the ENGINEER, shall be Type 1. No cement of dark color shall be used. No re-sacked, lumpy or partially set cement shall be used. Each sack of cement shall contain not less than 94 pounds (net) of cement, and each sack of cement shall be deemed to have a volume of 1 cubic foot; and each 94 pounds, if weighed or measured in bulk, shall be deemed to have a volume of 1 cubic foot.

B. FINE AGGREGATE

Fine aggregate shall be natural siliceous river sand, consisting of hard, clean, sharp, strong, durable and uncoated particles, conforming to the requirements of ASTM C 33. The mortar strength developed in such test shall be 90 percent of that developed by standard Ottawa sand tested under identical conditions.

Fine aggregate shall be graded in conformance with the requirements of ASTM C 33, except that it shall have a fineness modulus of 2.40 minimum and 3.00 maximum and the material passing the No. 200 sieve shall not exceed 3.0 percent by weight of the total sample. Coal and lignite shall not exceed 0.5 percent by weight of the total sample for all concrete. The fineness modulus of fine aggregate incorporated in the work shall not vary more than 0.10 plus or minus from the fineness modulus of the fine aggregate in the appropriate preliminary mix design approved by the ENGINEER.

If the locally available sources of fine aggregate will not yield the required grading, the ENGINEER may approve alternate gradations if such deviations do not adversely affect the work. However, the amount retained on any individual sieve size shall not exceed 35 percent of the sample and the amount passing the No. 50 sieve shall not be less than 15 percent of the sample.

C. COARSE AGGREGATE

Coarse aggregate shall consist of clean, natural, washed gravel or crushed stone suitably processed and conforming to the requirements of ASTM C 33, Class Designation 3S.

Coarse aggregate as delivered to the mixing plant shall be graded, or individual sizes shall be so combined as to fall within the grading requirements corresponding to the following grading size numbers, as contained in Table 2 of ASTM C 33:

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Maximum Aggregate Sizes, Inches	Grading Size No.
3/4	67
1	57
1-1/2	467
2	357

The maximum size of aggregate shall be no larger than one-fifth of the narrowest dimension between sides of forms within which concrete is to be cast nor larger than three-fourths of the minimum clear spacing between reinforcing bars, or between bars and forms. Coarse aggregate shall be limited to 3/4 inch maximum size for pumped concrete.

D. WATER

Water used in mixing concrete shall be fresh, clean, potable water free from injurious amounts of oil, acid, alkali, vegetable, sewage, and/or organic matter. Water shall be considered as weighing 8.33 pounds per gallon.

E. ADMIXTURES

All concrete shall contain an air entraining admixture conforming to ASTM C 260 in order to provide an entrained air content of 5 + 1 percent by volume. Air entraining admixtures shall be W. R. Grace "Darex AEA", Master Builders "MB-VR", Protex "AES", Sika "AEA", or equal.

All concrete shall contain a chloride-free, water reducing admixture or plasticizer conforming to ASTM C 494, Type A. Water reducing admixtures shall be W. R. Grace "WRDA-HC", Sika "Plastocrete", Gifford-Hill "PSI Normal", Master Builders "Pozzoloth Normal", Chem-Masters "WR-77", or equal.

Accelerators and retarders may be used under adverse placement conditions when authorized in writing by the ENGINEER. Accelerators shall be calcium chloride conforming to ASTM D 98, dispensed as a solution. Calcium chloride content shall not exceed 1 percent of the cement content by weight. Retarders shall be chloride-free water reducing and retarding admixtures conforming to ASTM C 494, Type D. Retarders shall be W. R. Grace "Daratard-HC", Sika "Plastiment", Protex "Protard", Gifford-Hill "PSI Retarder", Master Builders "Pozzoloth Retarder", or equal.

The admixture content, batching method, and time of introduction into the mix shall be in strict accordance with the manufacturer's recommendations.

SECTION 03310

CAST-IN-PLACE CONCRETE

2.03 MEMBRANE CURING COMPOUND

Membrane curing compound shall have a 100 percent resin base and shall be of the colorless type with a fugitive dye added conforming to ASTM C 309, Type I, Class B. The membrane curing compound shall contain sufficient dye to produce a definite, distinguishing color. Curing compound shall be compatible with liquid hardeners and epoxy sealers.

Membrane curing compound shall be Protex "LR-151", Sonneborn "Hydrocide-309", W. R. Grace "Horncrete 30D", Chem-Masters "Kurex 3", or equal.

2.04 POLYETHYLENE FILM

Polyethylene film shall conform to Product Standard PS 17 and, unless otherwise specified or shown on the Drawings, shall have a thickness of 6 mils.

2.05 EPOXY BONDING AGENT

Epoxy bonding agents shall be specially formulated to bond fresh concrete to existing concrete. Epoxy bonding agents shall be two-component polysulfide or polyamide epoxies containing 100 percent solids. Epoxy bonding agents shall be insensitive to moisture during cure. When cured at a temperature of 63 Degrees F., neat epoxy bonding agent shall have a one-day compressive strength of not less than 5,000 psi and a 28-day compressive strength of not less than 12,000 psi, when tested in accordance with ASTM D 695, and shall have a 28-day tensile strength of not less than 3,500 psi, when tested in accordance with ASTM D 638.

2.06 WATERSTOPS

Waterstops shall be manufactured of PVC and shall be of the ribbed type with center bulb. Waterstops shall have a nominal width of 6 inches and shall be as manufactured by W. R. Meadows, Vulcan Metal Products; W. R. Grace; or equal. Waterstops placed in concrete shall be continuous. Lapped joints shall not be permitted.

2.07 CHEMICAL HARDENER

Unless otherwise specified, all interior concrete floors of shops, garages, and vehicle service areas shall be treated with a liquid hardener composed of magnesium and zinc fluorosilicates combined with an anionic surfactant for improved wetting penetration. Liquid hardener shall be colorless, nontoxic, nonflammable, and compatible with and providing good adhesion for subsequent toppings and/or coatings. Liquid hardener shall be suitable for use on new or old concrete floors and shall comply with Corps of Engineer Specification 204. Liquid hardener shall be Sonneborn "Lapidolith", Protex "Lithoplate", L & M "Fluo Hard", or equal.

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CAST-IN-PLACE CONCRETE

2.08 EPOXY FLOOR SEALER

Epoxy floor sealer shall be a two-component, 100 percent solids, epoxy coating that provides a smooth, tough, flexible, wear abrasion, and chemical resistant surface. Epoxy floor sealer shall be applied only where shown on the Drawings. Sealer shall be U.S.D.A. approved for use in food processing plants. Unless otherwise specified, sealer shall be colored gray. Epoxy sealer shall be Chem-Masters "Durakote", Sonneborn "Sonoplex", L&M "Dynaflor", or equal.

2.09 VAPOR BARRIER

Unless otherwise specified, all interior concrete slabs on grade in buildings shall be furnished with an FHA approved vapor barrier under the concrete slab. Vapor barrier shall be constructed of a multi-ply lamination of polyethylene film and glass scrim reinforced paper to form a moisture, scuff, and puncture resistant membrane. Moisture permeance shall not exceed 0.10 perms in accordance with ASTM E96, Procedure A. Vapor barrier shall be St. Regis Paper Company "Moistop", Glas-Kraft "Plybar", or equal.

2.10 STRENGTH

Concrete ingredients shall be selected, proportioned, and mixed in such a manner as will produce a watertight durable concrete that will develop the following minimum compressive strengths at an age of 28 days when sampled, cured, and tested in accordance with the procedures specified in ASTM C 31 and C 39:

Class of Concrete	AGE	Average of Three Consecutive Specimens	Minimum Any One Specimen
A	28 days	4,000 psi	3,500 psi
B	28 days	2,500 psi	2,000 psi

Should the average compressive strength of three consecutive specimens or the compressive strength of any single specimen fall below the minimum strengths specified above, the ENGINEER shall have the right to order a change in the mix design for the remaining portion of the work. The ENGINEER shall also have the right to order additional curing of the affected concrete followed by cores taken in accordance with ASTM C 42 and ACI 318, all at the expense of the CONTRACTOR. If the additional curing does not bring the average compressive strength of three cores taken in the affected area to at least the minimum strength specified, the ENGINEER may require that the CONTRACTOR strengthen the structure by means of additional concrete and steel or he may require that the CONTRACTOR replace the affected portions. The cost of all such changes in mix designs and any modifications to or replacement of deficient concrete shall be borne by the CONTRACTOR at no additional cost to the OWNER.

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CAST-IN-PLACE CONCRETE

2.11 CONSISTENCY

Concrete shall be of such consistency and composition that it can be worked readily into the corners and angles of the forms and around the reinforcement without excessive spading and without permitting the materials to segregate or free water to collect on the surface. When dropped from the discharge chute, the concrete mass should flatten out at the center and spread out slowly at the edges.

The proportions shall be adjusted to secure the lowest water-cement ratio which is consistent with good workability, a plastic cohesive mixture, and one which is within the following slump range as determined in accordance with ASTM C143:

CONCRETE USE	SLUMP IN INCHES
Walls	2-1/2 - 4
Floors and Slab	2 - 3
Beams	2 - 3
Blocks and Footings	2 - 4

Concrete having a slump greater than one inch over the specified maximum shall be rejected.

In pumped concrete the maximum slump of the concrete at the suction of the pump may be increased above the maximum specified slump by the amount of slump loss in the pumping system up to a maximum of one inch. The amount of slump loss shall be the difference between slump tests made at both ends of pumping system, and shall be limited to a total loss of one inch. If tests indicate a loss greater than one inch, the CONTRACTOR shall take corrective measures acceptable to the ENGINEER.

For thin sections and construction with limited clearance between reinforcing steel and when placement conditions preclude the use of vibrators, the ENGINEER may authorize the use of concrete having a slump of 5 inches.

PART 3 - EXECUTION

3.01 STORAGE OF MATERIALS

Cement shall be shipped to the site of the mixer plant in bulk or in paper or cloth bags, at the option of the CONTRACTOR. Upon arrival it shall be stored immediately in a thoroughly dry, weather-tight and properly ventilated building or enclosure with adequate provisions for the prevention of absorption of moisture. It shall be stored in a manner that will permit easy access for inspection and identification of each shipment. If cement is to be stored at the job site, storage facilities shall be provided by and at the expense of the CONTRACTOR and approved by the ENGINEER prior to arrival of the first shipment. Cement which has become caked or lumpy shall not be used.

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Sand and coarse aggregates shall be stored in separate stockpiles at points selected to provide maximum drainage and to prevent the inclusion of an foreign material during rehandling. Stockpiles of coarse aggregates shall be built in horizontal layers to avoid segregation and breakage. Where concrete volumes require batching of various aggregate sizes, a separate stockpile for each size shall be maintained. The bottom 6 inches of aggregate piles shall not be used.

3.02 PROPORTIONING

Concrete materials shall be accurately proportioned and mixed to produce a homogeneous and workable mixture having the consistency and minimum compressive strength specified herein.

Concrete materials shall be proportioned by weight. The types of equipment and methods used for measuring ingredients shall be acceptable to the ENGINEER.

The amount of water and cement used shall be the minimum amount necessary to produce a concrete mixture of the required strength and consistency, but in no case shall the water-to-cement ratio exceed that specified herein nor shall the cement content be less than that specified herein.

Compressive strength may not necessarily be the most critical factor in proportioning concrete mixes since other factors, such as durability and watertightness, may impose lower water-cement ratios than are required to meet strength requirements. In such cases compressive strength will, of necessity, be in excess of that specified.

Minimum cement contents and maximum water-to-cement ratios shall be as follows:

Factor	Class of Concrete	Maximum Aggregate Size			
		2"	1-1/2"	1"	3/4"
Minimum Cement Factor Sacks/cu. yd.	A	5.3	5.8	6.2	6.6
	B	5.0	5.5	5.9	6.3
Maximum Water-to-Cement Ratio, lb./lb.	A	0.49	0.49	0.49	0.49
	B	0.62	0.62	0.62	0.62
Maximum Water-to-Cement Ratio, Gal./Sack	A	5.5	5.5	5.5	5.5
	B	7.0	7.0	7.0	7.0

The water content of the mix shall be based on the total amount of water in the mixture, including any free water in the aggregate or adhering to the surface of the aggregate, but not including water absorbed by the aggregate.

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The total volume of aggregate to be used in each cubic yard of concrete shall be determined by recognized standards for designing concrete mixes, utilizing the actual screen analysis of the aggregates.

The proportion of fine and coarse aggregate shall be such that the ratio of the coarse to the fine based on weight shall not be less than 1.0 nor more than 2.0, nor shall the amount of coarse material be such as to produce harshness in placing or honeycombing in the structure.

3.03 MIXING CONCRETE

The mixing equipment used by the CONTRACTOR shall be capable of combining the aggregates, cement, admixtures, and water within the time specified into a thoroughly mixed and uniform mass.

Concrete shall be mixed by one of the three following methods: (1) by the operation of one or more batch-type mixing plants, each with a rated capacity of 1/2 cubic yard or more, installed at the site of the work; (2) by the operation of a proportioning plant installed in the vicinity of the work and the use of transit mixers for mixing concrete and transporting it to the forms; or (3) by the use of ready-mixed concrete from a central mixing and proportioning plant. The method selected by the CONTRACTOR shall be subject to the approval of the ENGINEER.

The mixing and proportioning plants shall be provided with adequate equipment and facilities for accurate measurement and control of the quantities of material and water used in the concrete and for readily changing the proportions to conform to the varying conditions and requirements of the work.

A. STATIONARY MIXED CONCRETE

Stationary mixing shall be done in a batch mixer of approved type which will ensure a uniform distribution of the materials throughout the mass. The equipment at the mixing plant shall be so constructed that all materials including the water entering the drum can be accurately proportioned and be under control. The cement and aggregate shall be proportioned by weight. No volumetric batch shall be allowed. The mixer shall be equipped with an automatic timing device made to lock the discharge level before aggregate and cement enter the drum, and to release such level only after the specified mixing time has elapsed. Stationary mixers shall be in accordance with the "Concrete Mixer Standards" adopted by the Mixer Manufacturer's of the Associated General CONTRACTORS of America and shall bear a plate giving the manufacturer's rated capacity of the mixer.

The entire batch shall be discharged before recharging. The volume of the mixed material per batch shall not exceed the manufacturer's rated capacity of the mixer. Mixing of each batch shall continue for the period indicated herein, during which time the drum shall rotate at a peripheral speed as recommended by the manufacturer.

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The mixing time shall be as follows:

Capacity of Mixer	Mixing Time in Minutes
1/2 cubic yards	1-1/4
3/4 to 1 1/2 cubic yards	1-1/2
Larger than 1-1/2 cubic yards	2

The mixing time shall be measured from the time that all cement and aggregates and most of the water are in the mixer. Excessive over mixing, requiring additional water to preserve the required consistency will not be permitted. All of the mixing water shall be introduced before one-fourth of the total mixing time has elapsed.

B. TRANSIT MIXED CONCRETE

The type, capacity, and manner of operation of the mixing and transporting equipment for transit ready-mixed concrete shall conform to the current "Standards for Operation of Truck Mixers and Agitators of the National Ready-Mixed Concrete Association," the "Truck Mixer and Agitator Standards of the Truck Mixer Manufacturers Bureau," and ASTM C94. Transit mix concrete trucks shall be equipped with an automatic device for recording the number of revolutions of the drum during the mixing period. Each mixer and agitator shall have attached thereto in a prominent place, a metal plate or plates, installed by the manufacturer, on which is plainly marked the capacity of the drum in terms of the volume of mixed concrete and the speed of rotation for the agitating and mixing speeds of the mixing drum or blades. Each mixer shall have identification number painted on the truck in such a location that it can be easily read from the batching platform.

The total volume of materials introduced into the mixer shall not exceed the manufacturer's guaranteed mixing capacity. If the concrete so mixed does not meet the uniformity requirements of this subsection, the amount of materials charged into the mixer shall be reduced. The drum of the mixer shall be completely emptied of any previously mixed load. The proper proportions of aggregate, cement, and water for each load of concrete shall be placed in the mixer and shall be mixed therein for not less than 70 nor more than 100 revolutions of the drum or blades at the speed designated by the manufacturer of the equipment as the mixing speed. Additional revolutions of the drum shall be at the speed designated by the manufacturer of the equipment as the agitating speed; however, immediately prior to discharging the concrete, the drum shall be revolved at the mixing speed for a minimum of three minutes. The revolving of the drum shall be continuous until the concrete is completely emptied from the drum.

When Class A concrete is being placed, all wash water shall be emptied from the mixer before any portion of the succeeding load is placed therein. For Class B concrete the mixer shall be empty or may carry no more than 10 gallons of water in the drum.

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Water added at the point of discharge shall only take place with the approval and in the presence of the ENGINEER. Water so added shall be mixed into the load for a minimum mixing time of three minutes. Water shall not be added to the load during the transit.

The total elapsed time between the addition of water to the cement and aggregate or the addition of cement to the water and aggregate and the placement of the concrete in the forms shall not exceed 90 minutes. During hot weather or conditions contributing to quick setting, the total elapsed time permitted may be reduced at the direction of the ENGINEER to 45 minutes. When the concrete cannot be delivered to the forms within the time period specified, a water-reducing and retarding admixture may be used subject to the approval of the ENGINEER. Such use of a water reducing retarder will be permitted only as necessary to supplement (not to replace) other acceptable hot weather procedures. The retarding admixture used shall not interfere with strength development and other properties of the concrete and its use shall be carefully controlled by the concrete supplier. Before any such admixture is permitted, it shall be tested with job site materials under job conditions to determine its compatibility with the other materials and its ability under these conditions to produce the desired properties.

Addition of water at the job site to offset evaporation of mixing water shall be done with the ENGINEER'S approval and in his presence using water in the form of a cement paste having the same water-to-cement ratio as the batch in the transit mixer. Following addition of the cement paste, the mixer drum or blades shall be rotated a minimum of 70 revolutions. Addition of water during transit to offset evaporation losses shall not be permitted.

Prolonged mixing, even at agitating speed, shall be avoided where feasible by stopping the mixer and then agitating intermittently.

A legible certified weigh master's certificate shall be prepared for each load of ready-mixed concrete. A legible copy of the certified weigh master's certificate shall be submitted to the ENGINEER by the truck operator at the time of delivery. The weigh master's certificate shall contain the following information:

1. Name of Vendor
2. Name of CONTRACTOR
3. Number of cubic yards in the load
4. Actual weights of cement and of each size of aggregate in the load
5. Amount of water added at the plant
6. Amount of free water in the aggregate

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7. Brand and type of cement
8. Brand and amount of admixture
9. Time and date of batching

When mix proportions have been approved for a project and are identified by a mix number, the ENGINEER may waive the foregoing and accept a legible certified weigh master's certificate which shall contain the following information:

1. Name of Vendor
2. Name of CONTRACTOR
3. Number of cubic yards in the load
4. Mix designation number
5. Amount of water added at the plant (including free water in aggregate)
6. Time and date of batching.

Space shall be provided on the certificate so that amount of water and cement added on the job may be indicated.

3.04 CONVEYING CONCRETE

Concrete shall be conveyed from the mixer to the place of final deposit by methods which will prevent separation or loss of the materials. Equipment for chuting, pumping, and pneumatically conveying concrete shall be of such size and design as to insure a practically continuous flow of concrete at the delivery end without separation of the materials.

If the concrete is to be transported more than fifty feet in carts or buggies, they shall be equipped with pneumatic tires. Concrete delivered to the carts, buggies or conveyors from spouts, troughs, or mixer trucks shall not have a free fall of more than three feet. Separation or loss of ingredients shall be prevented while transporting the concrete. Delivery carts, buggies, conveyor trucks or barrows shall be kept on temporary runways built over the floor system; runway supports shall not bear upon reinforcing steel or fresh concrete.

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3.05 PLACING CONCRETE

A. GENERAL

Prior to placing concrete, the CONTRACTOR shall ensure that all reinforcement is securely and properly fastened in position and protected against displacement, that all items to be embedded in the concrete are in place and securely anchored in position, that all forms have been thoroughly coated or wetted, that all form ties at construction joints have been retightened, that concrete surfaces to be covered have had all free water, form coating, loose concrete, and debris removed, and that all conveyances, buggies, and barrows are clean and wetted.

The CONTRACTOR shall inform the ENGINEER at least 24 hours in advance of the times and places at which he intends to place concrete. The ENGINEER will make a final inspection of forms, reinforcing steel, screeds, construction joints, openings, anchors, pipe sleeves, conduit, and inserts. No concrete pour shall be started until the condition of the forms and place of pouring has been inspected and approved by the ENGINEER.

Concrete shall not be placed when the sun, wind, heat or humidity prevents proper placement and consolidation.

No water or cement shall be added to the mix without the ENGINEER'S approval or in his absence. No partially hardened concrete shall be deposited.

B. PLACING CONCRETE

Unless otherwise specified, all concrete shall be placed upon clean, damp surfaces, free from water, and never upon soft mud, dry absorbent earth or rock, or upon fills that have not been subjected to approved tamping to provide ultimate settlement.

Groundwater shall be kept below subgrade until the concrete has set. When subgrade is dry earth, it shall be thoroughly dampened with water to ensure that no moisture will be absorbed from fresh concrete.

Where concrete is placed against gravel or crushed rock which does not contain at least 25 percent of the material passing a No. 4 sieve or where shown on the Drawings or directed by the ENGINEER, surfaces against which concrete is cast shall be covered with polyethylene film to protect the concrete from loss of water.

Joints in the film shall be lapped at least 12 inches and taped. The polyethylene film shall be protected against puncture from the underlying crushed rock by a cushion of natural or imported sand meeting the requirements of ASTM D 1073 placed on top of the crushed rock. Where concrete is placed against rock, all loose pieces of rock shall be removed and the exposed surface cleaned with a high pressure hose.

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Place vapor barrier under designated interior concrete slabs on grade. Sheeting shall extend the full area of the slab and shall be turned up or down to footings as indicated. Lap all seams at least 12 inches and seal per manufacturer's instructions. Install reinforcement with care so as not to puncture vapor barrier. Tape all cuts, tears, punctures, and pipe penetrations before pouring concrete.

To prevent segregation of the mix, concrete shall be deposited in its final position in batches without being moved laterally in the forms more than 5 feet. A crane and a bottom dump concrete bucket shall be used wherever possible. Unless authorized by the ENGINEER, no concrete shall be dropped freely into place from a height of greater than 5 feet. Concrete shall be deposited in walls by means of prefabricated, rectangular tremies, constructed in short sections and spaced laterally not over 5 feet apart. Special care shall be observed to avoid slopping concrete over forms when placing.

The limits of each concrete pour shall be predetermined by the CONTRACTOR and shall be acceptable to the ENGINEER. All concrete within such limits shall be placed in one continuous operation.

After the concrete has been deposited, it shall be distributed over the entire area within the forms in approximately horizontal layers of not more than 18 inches in depth and shall be brought up evenly in all parts of the form. Each layer of concrete shall be plastic when covered with the following layer and the forms shall be filled at a rate of vertical rise of not less than 2 feet per hour nor more than 6 feet per hour.

Should a layer of concrete reach its initial set before the next lift can be placed or should more than 60 minutes elapse between placement of successive concrete lifts, the CONTRACTOR shall cease placement of concrete until the surface of the previous lift is prepared in accordance with the procedures specified in Part 3.08, Construction Joints, of this specification section. Workmen shall not walk on concrete during placing or finishing with any earth or foreign matter on footgear. Hand spreading shall be done with forks and shovels, not rakes.

Concrete shall be placed and compacted in wall or column forms before any reinforcing steel is placed in the structural system to be supported by such walls or columns. The portion of any wall or column placed monolithically with a floor or roof slab shall not exceed 6 feet of vertical height. Concrete in walls or columns shall set at least two hours before concrete is placed in the structural systems to be supported by such walls or columns. Brackets, haunches and fillets shall be poured monolithic with the floor or roof slab system.

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C. COMPACTION

During and immediately after placement, concrete shall be thoroughly compacted and worked into all corners and angles and around reinforcement and embedded fixtures in a manner to fill all voids, prevent honeycombing against the forms and avoid segregation of coarse aggregate. This operation shall be performed by the use of spades or forks and internal vibrators.

Vibration shall be transmitted directly to the concrete and in no case shall it be transmitted through the forms. Vibrator driving mechanisms shall revolve at not less than 7,000 rpm. The vibration shall be sufficiently intense to cause the concrete to flow and settle readily into place and to visibly affect the concrete over a radius of at least 18 inches. Vibration shall be supplemented by manual forking or spading adjacent to the forms on exposed faces in order to secure smooth, dense surfaces. Special care shall be taken to ensure consolidation around reinforcement, pipes and other shapes built into the work. Vibrators shall be kept in motion at all times to prevent excessive vibration in one spot. The operation shall be continuous and all concrete shall be in final position before initial set has started.

In addition to the vibrators in actual use while concrete is being placed, the CONTRACTOR shall have on hand at least one operable vibrator as a spare in case of equipment failure. No concrete shall be placed until all vibrating equipment, including spares, is at the placement site.

Concrete shall be thoroughly compacted prior to top finishing. All laitance, debris, and surplus water shall be removed from concrete surfaces at tops of forms by screeding, scraping, or other effective means. Wherever the top of a wall will be exposed to weathering, the forms shall be overfilled and after the concrete has been compacted, the excess shall be screeded off.

D. PLACEMENT SEQUENCE

Unless otherwise indicated on the Drawings or directed by the ENGINEER, the following placement sequence shall be followed to reduce the effect of shrinkage in producing cracking:

1. BOTTOM SLAB

A center section (as outlined by the construction joints shown on the Drawings) shall be placed first. Not less than 72 hours after the center section has been placed, the Contractor may proceed with the placement of an adjoining section. Sections shall be placed alternately, first on one side and then on the other side of previously placed sections. Pours shall be scheduled so that two adjacent sides of each section are free, except at closures.

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2. WALLS

Walls shall be divided into sections by the construction joints shown on the Drawings. A section near the center of each wall shall be placed first. Sections shall be placed alternately, first on one side and then on the other side of the previously placed section. Pours shall be schedule so that one end of each section is free, except at corner closures.

3. FOOTINGS

Footings, except for wall footings, shall be poured in one operation with no joints.

E. REQUIREMENTS DUE TO ADVERSE WEATHER CONDITIONS

No concrete shall be placed during rain. No concrete shall be placed if rain is forecast unless there is sufficient time to complete the placement and finishing. All concrete placed prior to rain shall be protected by whatever means necessary to prevent damage to finish or water entering the mix. Protection equipment and materials shall be on hand prior to placement operations. Freshly placed concrete shall be protected from scour by flowing water and from mud deposits or other injurious conditions.

Except as modified herein, cold weather concreting shall comply with ACI 306. The temperature of concrete at the time of placing shall be not less than shown in the following table for the corresponding ambient outdoor air temperature (in shade) existing at the time of placement:

Ambient Outdoor Air Temperature	Minimum Concrete Temperature
Below 35 Degrees F.	70 Degrees F.
Between 35 Degrees F. and 45 Degrees F.	60 Degrees F.
Above 45 Degrees F.	45 Degrees F.

Placing of concrete when the ambient air temperature at the time of placement is 45 Degrees F. or less shall be done only when specifically authorized by the ENGINEER using concrete heated in a manner acceptable to the ENGINEER. If the use of heated concrete is authorized, the temperature of the concrete at the time of placement shall not exceed 80 Degrees F.

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Adequate means shall be provided for maintaining the temperature of the air surrounding the concrete at 70 ° F for three days, or 50 ° F for five days, or for as long as is necessary to ensure proper curing of the concrete. Rapid cooling of the concrete shall be prevented. Housing or covering or other protection used in connection with heating shall remain in place and intact at least 24 hours after the artificial heat is discontinued. The use of calcium chloride or other chemicals to prevent freezing shall not be permitted.

Except as modified herein, hot weather concreting shall comply with the requirements of ACI 305. Hot weather precautions shall be taken whenever the maximum ambient outdoor air temperature (in shade) during the day exceeds 85 Degrees F. When rapid mixing water evaporation in transit causes the concrete to be delivered in an unworkable condition, initial correction may be made at the job site, provided that water added is in the form of cement paste having the same water to cement ratio as the batch in the truck, and provided that the drum or mixer blades be operated at mixing speed for at least 70 revolutions after the paste addition. Once need for water has been observed, subsequent additions shall be at the batching plant until the need has passed. Correction shall consist of a simultaneous and proportionate increase of water and cement, up to 10 percent of the stated quantity of each material in the batch. Such increases in cement shall not constitute grounds for an increase in the Contract Price.

The temperature of concrete at the time of placement shall not exceed 85 ° F.

During hot weather, extra caution shall be taken to prevent rapid evaporation of water. Forms shall be kept cool by frequent wettings. Flat work shall be protected from drying winds, direct sun, and high temperatures whenever conditions of temperature and humidity are such as to cause plastic shrinkage cracking.

In order to prevent plastic shrinkage cracking due to rapid evaporation of moisture, no concrete shall be placed when the rate of evaporation, determined by using Figure 2.1.4 in ACI 305, equals or exceeds 0.2 pound per square foot per hour.

3.06 FINISHING

A. FINISHING FORMED SURFACES

All permanently exposed surfaces shall be expected to be smooth and of uniform texture and appearance. Surfaces to be rubbed shall include all submerged concrete surfaces that can be seen when water is drained. Rubbing may be omitted for minor blemishes on buried surfaces or on exposed surfaces that cannot normally be seen, such as inside covered tanks. Final determination for which surfaces are to be rubbed is to be the decision of the ENGINEER. All holes, pits or imperfections in the surface of the concrete shall be cleaned with a wire brush, thoroughly wetted and completely filled with damp cement mortar composed of 1 part Portland Cement to 2 parts fine aggregate. The entire surface shall be left smooth and all lines or markings shall be smoothed over to obtain uniform appearance. In the event the CONTRACTOR fails to obtain a satisfactory appearance of the concrete in the opinion of the ENGINEER, the entire surface shall be thoroughly wetted down, kept wet continuously and rubbed with a

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No. 20 Carborundum stone until all lines, markings and surplus materials have been removed from the surface and until the surface shows a uniform smooth finish. After rubbing is completed, the concrete surface shall be washed clean with water. Rubbing may be done either by hand or with power tools.

B. FINISHING UNFORMED SURFACES

No surface treatment will be required for buried or permanently submerged concrete not forming an integral part of a structure except that required to obtain the surface elevations or contours and surfaces free of laitance. The unformed surfaces of all other concrete shall be screeded and given an initial float finish followed by additional floating followed by troweling where required. Care shall be taken that no excess water is present when the finish is made. No special concrete or cement mortar topping course shall be used unless so shown on the Drawing.

1. SCREEDING

All slabs shall be screeded to an even surface by the use of a straight edge and screeding strips accurately and securely set to the proper level. Screeds shall be such type and so arranged so as not to interfere with the top bar reinforcement.

Screeding shall provide a concrete surface conforming to the proper elevation and contour with all aggregates completely embedded in mortar. All screeded surfaces shall be free of surface irregularities with a height or depth in excess of 1/4 inch as measured from a 10-foot straight edge.

2. FLOATING

Screeded surfaces shall be given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance with no unnecessary working of the surface.

Initial floating shall be followed by a second floating at the time of initial set. The second floating shall produce a finish of uniform texture and color. Unless additional finishing is specifically required, the completed finish for unformed surfaces shall be the float finish produced by the second floating.

Floating shall be performed with hand floats or suitable mechanical compactor floats.

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3. BROOMING

Surfaces of equipment bases and curbs and sidewalks shall be given a light broom finish providing a nonslip surface. Brooming shall be done after the second floating and for traffic areas shall be at right angles to the normal traffic direction.

4. TROWELING

Surfaces to be covered with resilient floor coverings and other surfaces designated on the Drawings to be troweled shall be steel trowel finished. Trowel finishing will not be required for floors which are normally submerged. Troweling shall be performed after the second floating when the surface has hardened sufficiently to prevent an excess of fines being drawn to the surface. Troweling shall produce a dense, smooth, uniform surface free from blemishes and trowel marks.

5. EDGING

All permanently exposed edges of unformed surfaces shall be chamfered with a 3/4 inch approved edging tool unless other edge treatment is indicated on the Drawings.

3.07 CURING

All concrete shall be protected from loss of moisture by curing for at least 14 days following placement. Curing operations shall take place immediately after concrete finishing is complete or forms are removed. Breaking of form ties or otherwise breaking the seal between the concrete surface and the form shall be considered form removal.

Curing shall be accomplished by water curing, membrane curing, film curing, or any other curing method acceptable to the ENGINEER which does not injure or discolor exposed surfaces nor destroy the bond on surfaces to receive subsequent concrete pours or protective coatings.

A. WATER CURING

Concrete surfaces being water-cured shall be kept constantly and visibly wet for a period of not less than 14 days. Water saturation of concrete surfaces shall begin as quickly as possible after the initial set of the concrete. The rate of water application shall be regulated to provide complete surface saturation with a minimum of runoff.

Slabs poured on grade and decks may be water-cured by ponding or by covering with wet burlap sacks, sand, or sawdust and keeping this covering continually and visibly wet during this period. Standard canvas seep hose placed in parallel runs on 8-foot centers is recommended for ponding.

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Walls may be cured by leaving the forms tied in place and keeping the forms and all exposed surfaces of the concrete continually and visibly wet for the duration of the curing period.

B. MEMBRANE CURING

Membrane-curing compound may be used in lieu of water curing on Class B concrete and on concrete which will not be covered later with mortar, liquid hardener, or additional concrete. Except as modified herein, membrane-curing compounds shall be applied in strict accordance with the manufacturer's recommendations. Membrane-curing compounds shall conform to the requirements of Part 2.04, Membrane Curing Compound, of this specification section.

Membrane-curing compound shall be spray applied in two separate coats, each having a surface coverage of not more than 300 square feet per gallon.

Unformed surfaces shall be covered with curing compound within 30 minutes after final finishing. If forms are removed before the end of the specified curing period, curing compound shall be immediately applied to the formed surface before they dry out.

Curing compound shall be suitably protected against abrasion during the curing period. Whenever the membrane will be subject to damage from traffic or other cause, it shall be protected after drying for 24 hours by a layer of sand or fine earth not less than one inch thick or by other means acceptable to the ENGINEER.

Compound applied improperly or compound applied without sufficient dye to produce a distinguishing color shall be reapplied to the satisfaction of the ENGINEER.

C. FILM CURING

Film curing with polyethylene sheeting may be used in lieu of water curing on concrete which will be covered later with mortar or additional concrete or will otherwise be covered or hidden from view.

Film curing shall begin as quickly as possible after initial set of the concrete. Polyethylene sheeting shall completely cover the surfaces. Sheeting shall overlap the edges sufficiently for proper sealing and anchorage. Joints between sheets shall be overlapped a minimum of 12 inches and sealed. All tears, holes and other damage shall be promptly repaired. Covering shall be anchored continuously at edges and shall be anchored on the surface as necessary to prevent billowing.

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3.08 CONSTRUCTION JOINTS

Construction joints shall be made only at locations indicated on the Drawings or specified herein. Construction joints shall not be made at other locations without the concurrence of the ENGINEER. No vertical construction joints shall be used in walls unless specifically approved by the ENGINEER. The work shall be laid out and conducted so as to minimize the number of construction joints.

All construction joints shall be keyed. Keys shall be continuous and shall have a width equal to 1/3 of the thickness of the wall and a depth equal to 1/6 of the thickness of the wall. Unless indicated otherwise on the Drawings no keys smaller than 3 inches in width and 1-1/2 inches in depth shall be used.

Waterstops of the type specified shall be installed where indicated on the Drawings and in all construction joints in concrete walls and slabs having one face exposed in a dry pit or room and having the other face in contact with backfill, sub grade, groundwater, or other liquid.

A jet of air and water shall be applied to the surface of horizontal construction joints to remove all laitance when the concrete has set sufficiently for the jet to expose the coarse aggregate without loosening same. Immediately prior to placing another lift, the surface shall be thoroughly cleaned and washed by water jet followed by air jet to remove standing water. The surface of the concrete shall then be covered by a uniform, evenly distributed layer of cement-sand mortar to a thickness of 1 inch. The cement-sand mortar shall be composed of a mixture of 1.3 parts by volume Portland Cement and 1 part by volume fine aggregate and shall have a water-to-cement ratio equal to that of the concrete to follow.

3.09 EXPANSION JOINTS

Expansion joints shall be provided as shown on the Drawings. Details of the expansion joints and materials of construction shall be as shown on the Drawings and specified in these Contract Documents. If not shown on the Drawings, expansion joints shall consist of full-depth, preformed, 1/2-inch asphalt plank material conforming to ASTM D 994.

3.10 BONDING NEW CONCRETE TO EXISTING CONCRETE

Where new concrete is to be cast against and permanently bonded to an existing concrete surface, the existing concrete shall be chipped or cut back from the surface a minimum distance of 1-1/2 inches or as necessary to expose sound concrete, remove loose or weathered concrete and provide a roughened surface for bonding to the new concrete. Edges shall be cut square and feathered edges will not be permitted. All loose material remaining after chipping or cutting operations shall be removed by sandblasting and/or stiff wire brushing.

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Where chipping back of existing concrete is not possible and where approved by the ENGINEER, the surface of existing concrete may be prepared by sandblasting or acid etching. If sandblasting or etching is used, the surface of the existing concrete shall be bare, clean, dry, and structurally sound. All grease, oil, wax, or other residue shall be removed by scraping followed by washing with a nonionic detergent or a suitable solvent compatible with the epoxy bonding agent to be used. Animal fats may be removed by scrubbing with a 10 percent solution of caustic soda to saponify them.

After all loose material, grease, etc., have been removed, the surface of the existing concrete shall be etched by either sandblasting or scrubbing with a 10-20 percent solution of hydrochloric acid in water applied at a rate of 1 quart per square yard followed by a thorough rinsing with clean water. The surface shall then be allowed to dry completely before application of the epoxy bonding agent. Goggles, rubber boots, and rubber gloves shall be worn by workmen when applying caustic soda or acids.

When the surface is dry and just prior to placing the new concrete, an epoxy bonding agent shall be applied to the surface of the existing concrete with a whitewash brush or stiff broom. The epoxy bonding agent shall be spread evenly over the surface to be bonded, avoiding skips and holidays, to wet film thickness of 40 to 60 mils. The new concrete shall be placed as soon as the epoxy bonding agent becomes tacky. In the event that the epoxy bonding agent is allowed to dry before placement of the new concrete, the surface shall be recoated with epoxy.

The epoxy bonding agent shall comply with the material requirements of Part 2.06, Epoxy Bonding Agents, of this specification section and shall be applied in strict conformance to the manufacturer's recommendations. Adequate safety precautions shall be taken during the handling and use of the epoxy bonding agent.

3.11 EMBEDDED ITEMS

Wherever steel, wrought or cast iron piping, fittings, valves, collars, sleeves, structural steel, electrical conduits, appurtenances and fixtures, equipment, anchorages or castings are shown for embedment in the concrete, such items must be on hand before concrete is poured. They shall be set in place accurately and firmly braced before concrete is poured around them. No cutouts for future installation of these items shall be permitted.

Before placing concrete, the CONTRACTOR shall see that all embedded parts are accurately positioned and firmly and securely fastened in place. They shall be thoroughly clean and free from any coating, rust, scale, oil or other foreign matter. The embedding of wood in concrete shall be avoided whenever possible. If wood is to be embedded, it shall be thoroughly wetted before the concrete is placed. After placement, surfaces not in contact with concrete shall be cleaned of concrete spatter and other foreign substances.

Conduit shall be installed between the reinforcing steel in walls or slabs which have reinforcement in both faces. In slabs which have only a single layer of reinforcing steel, conduit shall be placed under the reinforcement.

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Unless installed in pipe sleeves, anchor bolts shall have sufficient threads to permit a nut and washer to be installed on the concrete side of the form or template. A second nut and washer shall be installed on the other side of the form or template and the two nuts shall be adjusted so that the bolt will be held rigidly in proper position.

The CONTRACTOR shall be responsible for coordinating all work and ensuring that all embedded items or openings to be built into the concrete are placed in the forms before concrete is placed. The contractor shall be responsible for conferring with his subcontractors and suppliers regarding their requirements for embedments and openings.

Forms, sleeves, and inserts shall be set, and concrete shall be cast to the lines and grades indicated on the Drawings and as detailed in these Contract Documents. The maximum deviation from true line and grade shall not exceed the tolerance listed below. Deviation in alignment of slabs or wall shall not exceed a rate of 1/8 inch in 10 feet within the tolerances specified.

ITEM	MAXIMUM TOLERANCE
Sleeves and inserts	+1/8" -1/8"
Project ends of anchor bolts	+1/4" -0.0"
Anchor bolt setting	+1/16" -1/16"
Concrete forms	+1/8" -1/8"

All slabs shall be carefully finished true to grade such that the surface is free draining and contains no depressions which can hold or collect water.

Regardless of the tolerances listed herein, it shall be the responsibility of the CONTRACTOR to limit deviations in line and grade to tolerance which will permit proper installation and operation of mechanical equipment and piping.

3.12 WATER TIGHTNESS

It is the intention of this specification section to provide impervious concrete. All pits below groundwater level and all structures for holding or carrying water shall be watertight. A loss of not more than 1/4 inch depth in 24 hours will be permitted when water-holding structures are filled. All exposed surfaces of water-holding structures and interior surfaces of pits below groundwater level shall be free from visible damp spots or seepage before acceptance. Repeated tests and repairs may be required by the ENGINEER to obtain watertight structures. All structure shall be drained at the completion of tests unless otherwise directed by the ENGINEER. The cost and expense of all testing for water tightness and of providing a watertight structure shall be borne by the CONTRACTOR. Methods of repair shall be acceptable to the ENGINEER.

The use of special admixtures or integral waterproofing compounds in concrete required to be watertight is not required but may be permitted, provided the materials and methods are approved in writing by the ENGINEER.

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3.13 CONCRETE EMBEDMENT AND ENCASEMENT OF PIPE

Concrete for embedment and encasement shall be installed where and as indicated on the Drawings and at such locations where installation conditions require such pipe reinforcement because of unforeseen conditions encountered in the work, as determined by the ENGINEER.

Embedment and encasement of pipe shall be preceded by the following preliminary steps:

- A. All loose material shall be removed from the trench prior to placing concrete. All concrete shall have a continuous contact with undisturbed soil on sides and bottom of trench.
- B. A base course of concrete shall be accurately screeded to such grade and elevation that the pipe will be at specified grade when pipe bells are supported on, and in contact with, the top surface of such base course.
- C. Each length of pipe shall be rigidly held in alignment and anchored, to prevent flotation, in a manner acceptable to the ENGINEER.

3.14 PILE DRIVING AND CONCRETE WORK

The Contractor shall not drive foundation piling which may damage freshly placed or existing concrete structures. Minimum distance between concrete less than seven days old and pile driving operations shall be 100 feet. Any damage made to concrete structures from pile driving operations shall be repaired by the Contractor at his expense.

3.15 DEFECTIVE WORK AND METHODS OF REPAIR

All defective or damaged work shall be removed and replaced or repaired as directed by the ENGINEER. Any work which has not been constructed in accordance with these Contract Documents shall be considered defective. No defective or damaged work shall be patched, repaired or covered without prior inspection and approval of the ENGINEER.

Defects in formed concrete surfaces shall be repaired within 24 hours of placement, to the satisfaction of the ENGINEER, and defective concrete shall be replaced within 48 hours after the adjacent forms have been removed. All concrete which is honeycombed or otherwise defective shall be cut out and removed to sound concrete, with edges square cut to avoid feathering.

Except as modified herein, concrete repair work shall conform to Chapter 9 of ACI 301 and shall be performed in a manner that will not interfere with thorough curing of surrounding concrete. All repair work shall be adequately cured.

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Where authorized by the ENGINEER, repair may be accomplished by patching conducted as specified herein. However, permission to patch shall not waive the ENGINEER's right to have the defective work completely removed if the patch or repairs do not, in the ENGINEER's opinion, satisfactorily restore the quality and appearance of the work. Patching shall be conducted as follows:

- A. Chip away defective areas at least 1-1/2 inches deep perpendicular to the surface, wet the area and 6 inches around it to prevent absorption of water from patching mortar, and brush a sand-cement grout consisting of one part fine aggregate to one part Portland Cement into the surface, following with patching mortar.
- B. Patching mortar shall be no richer than one part Portland Cement to three parts fine aggregate using white Portland Cement to replace a portion of the gray cement as determined by a trial patch and shall contain only the minimum mixing water required for placing. Re-temper the mortar if necessary without the addition of water by allowing it to stand for one hour during which time it shall be mixed with a trowel to prevent setting.
- C. Mortar shall be compacted into place and screeded to leave the patch higher than the surrounding surface, then left undisturbed for one or two hours to permit initial shrinkage before being finally finished to match the adjoining surface. Cure patch in accordance with the requirements of Part 3.07, Curing, of this specification section.

3.16 LOADS APPLIED TO NEW CONCRETE

Loads including, but not limited to, earth loads, loads exerted from bracing or shoring, wind loads, hydrostatic or hydraulic loads, equipment or vehicle loads, or loads exerted by stacked materials, shall not be permitted until the concrete has reached its specified 28-day strength.

Concrete which has cracked due to overloading, loading before required strength has developed, or otherwise damaged shall be repaired or replaced as determined by the ENGINEER.

END OF SECTION

SECTION 15064-B

POLYVINYL CHLORIDE (PVC) SEWER AND SERVICE PIPE

PART 1 - GENERAL

1.01 SCOPE

The work covered by this section includes furnishing all labor, equipment, and materials required to install and test polyvinyl chloride (PVC) pipe, including accessories, as shown on the Drawings and/or specified herein.

1.02 QUALITY ASSURANCE

- A. The Contractor, at the Engineer's request, shall furnish a certificate from the manufacturer of the pipe and fittings that the manufacturer is fully competent and capable of manufacturing PVC sewer pipe, fittings, and accessories of uniform texture and strength that will fully comply with these Specifications and have so manufactured this class of pipe in sufficient quantities to be certain that it will meet all normal field conditions of usage. The manufacturer must have adequate equipment and quality control facilities to be sure that each extrusion of pipe is uniform in texture, dimensions, and strength.
- B. Pipe shall be tested when requested by the Engineer and all pipe so designated shall be tested in accordance with ASTM D 2412 "Standard Method of Test for External Loading Properties of Plastic Pipe by Parallel Plate Loading."
- C. Each length of pipe and each fitting shall have the following data clearly marked on each piece:
 - 1. Manufacturer's name
 - 2. Pipe size
 - 3. PVC compound used
 - 4. ASTM material specification for the PVC compound used

1.03 SHOP DRAWINGS AND ENGINEERING DATA

Complete shop drawings and engineering data shall be submitted to the Engineer in accordance with the requirements of the section entitled "Submittals" of these Specifications.

1.04 STORAGE AND PROTECTION

- A. PVC piping and accessories shall be stored and protected in accordance with the requirements of the section entitled "Storage and Protection" of these Specifications.

- B. PVC pipe and fittings shall be stored under black plastic cover.
- C. All pipe and accessories shall be stored above ground and fully supported so as not to bend or deflect excessively under its own weight.

1.05 GUARANTEE

The Contractor shall provide a guarantee against defective equipment and workmanship in accordance with the requirements of the section entitled "Guarantees and Warranties" of these Specifications.

PART 2 - PRODUCTS

2.01 PVC PIPE AND FITTINGS

- A. The pipe and fittings shall be homogeneous throughout and free from visible cracks, holes, foreign inclusions, or other injurious defects. The pipe shall be as uniform as commercially practical in color, opacity, density, and other physical properties.
- B. The manufacturer shall provide waterstops, acceptable to the Engineer, which shall be applied to the outside of the plastic pipe when the pipe is to be enclosed in any structure where concrete or mortar is used which will prevent leakage along the outer wall of the barrel of the pipe.
- C. No single piece of pipe shall be laid on any project covered by this Specification unless it is found to be generally straight. Such pipe shall have a maximum ordinate as measured from the concave side of the pipe not to exceed 1/16 inch per foot of length. If the deviation exceeds this requirement, then the particular piece of pipe shall be rejected from use until it can comply with this provision.
- D. Wyes, tees, bends, adapters, and any other fittings required or directed by the Engineer shall be provided. Engineering data for such fittings showing cross-sectional views with dimensions shall be provided and such data and fittings shall be approved by the Engineer prior to their use. The materials used in the manufacture of fittings shall conform to the requirements for the pipe with which they shall be used and any variation of such requirements shall be subject to the approval of the Engineer. Fittings shall have wall thicknesses equal to or greater than that of the pipe to which they are joined.

2.02 PIPE

- A. The 4-inch through 15-inch PVC pipe and accessories shall be manufactured in accordance with the requirements of either ASTM D3034, Type PSM (SDR 35 or less) or ASTM F789, Type PS-46 POLY (Vinyl Chloride) (PVC) Plastic Gravity Flow Sewer Pipe and Fittings. The 18-inch through 36-inch PVC pipe and accessories shall be manufactured in accordance with the requirements of ASTM F679, Poly (Vinyl Chloride) (PVC) Large Diameter Plastic Gravity Sewer Pipe and Fittings.

- B. The standard length of PVC pipe under this Specification shall be 20 feet with a minimum of 10 feet, except that all pipe used in service lines shall not exceed 10 feet in length unless otherwise approved by the Engineer.

2.03 JOINTS

- A. PVC pipe joints shall be the bell and spigot type subject to the approval of the Engineer.
- B. The pipe joint shall meet ASTM D-3212-81 for joints for drain and sewer pipes using flexible elastomeric seals, and the seals shall meet ASTM F-477 for elastomeric seals. All gaskets shall be factory installed and positively retained by means of a steel, polypropylene, or PVC ring.

Factory-installed glued gaskets will be acceptable; however, field-installed gaskets will not be acceptable for ASTM D-3034, ASTM F789, or ASTM F-679 PVC pipe. Pipe manufactured according to ASTM F949 is permitted to have a field-installed gasket.

PART 3 - EXECUTION

3.01 PIPE LAYING

- A. Before sewer pipe is placed in position in the trench, the bottom and sides of the trench shall be carefully prepared and bracing and sheeting installed where required. A mason's line, supported at intervals not exceeding 50 feet, shall be stretched tightly above ground level at a grade parallel to and directly above the axis line of the pipe. Each pipe shall be accurately placed to the exact line and grade called for on the Drawings by measuring down from this line to the invert of the pipe in place. The Contractor shall furnish all labor and materials necessary for erecting batter boards and establishing lines and grades therefor.
- B. The Contractor may use the laser beam method of setting a line and grade for the sewer by using the laser beam coaxially through the center of the sewer being laid. The laser beam projector is to be rigidly mounted to its support platforms, with a two-point suspension, or equivalent, assuring that all ground and equipment vibrations are kept to an absolute minimum. All equipment including equipment necessary to control atmospheric conditions in the pipe to keep line and grade to acceptable standards of accuracy shall be furnished by the Contractor. The laser beam system must be operated by competent experienced men who have been properly trained to operate the equipment used.
- C. The Contractor shall stake check pegs at all manholes throughout the job. Check pegs midway between manholes and any other check points deemed necessary to assure accuracy of the equipment shall be provided by the Contractor.
- D. The Contractor shall stake check pegs at all manholes throughout the job. Check pegs midway between manholes and any other check points deemed necessary to assure accuracy of the equipment shall be provided by the Contractor.

- E. Each piece of pipe and special fitting shall be carefully inspected before it is placed and no defective pipe shall be laid in the trench. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells uphill. No pipe shall be laid except in the presence of an inspector representing the Engineer. Trench bottoms found to be unsuitable for foundations after pipe laying operations have started shall be corrected and brought to exact line and grade with approved compacted materials.
- F. Bell holes shall be of sufficient size to allow ample room for making the pipe joints properly. Bell holes shall not be cut out more than ten joints ahead of pipe laying. The bottom of the trench between bell holes shall be carefully graded so that the pipe barrel will rest on a solid foundation for its entire length as shown on the Drawings. Each joint shall be laid so that it will form a close concentric joint with adjoining pipe in order to avoid sudden offsets or inequalities in the flow line.
- G. Water shall not be allowed to run or stand in the trench while pipe laying is in progress or before the joints are completely set or before the trench has been backfilled. The Contractor at no time shall open up more trench than his available pumping facilities are able to dewater. Where sewer pipelines are located in or across stream beds or drainage ditches, the Contractor shall divert the stream flow and dewater each section as the work progresses.
- H. No joints shall be made where pipe or joint material have been soiled by earth in handling until such soiled surfaces are thoroughly cleaned by wire brushing and wiping until all traces of the earth are removed.
- I. As the work progresses, the interior of all pipe shall be kept thoroughly clean. After each line of pipe has been laid, it shall be carefully inspected and all earth, trash, rags, and other foreign matter removed from the interior. A filled bag or other approved type of follower shall be pulled through the line immediately after each joint is made in order to remove any debris which may be left on the inside of the pipe.
- J. Backfilling of trenches shall be started immediately after the pipe in place has been inspected and approved by the Engineer and backfill shall be deposited and compacted as provided under the section entitled "Earthwork" of these Specifications.
- K. Installation of service pipe shall conform to the appropriate requirements of main line sewers.
- L. Connections of service lines to the main sewer shall be made with bends of the proper degree to make the service run perpendicular to the main sewer. Pipe shall be laid to a uniform line and grade. Minimum grade shall be 1 percent.
- M. Connections of service lines to the main sewer shall be made with bends of the proper degree to make the service run perpendicular to the main sewer. Pipe shall be laid to a uniform line and grade. Minimum grade shall be 1 percent.
- N. The end of all service connections shall be plugged with a PVC plug and sealed with plastic joint material.

- O. Crushed stone bedding and backfill material, concrete encasement and protection, etc., for service line installation shall be provided as conditions require and as directed by the Engineer.
- P. No service connections shall be covered until they have been inspected and located by the Engineer.

3.02 INSTALLATION OF TEES, RISERS, AND PLUGGED STUBS

- A. Tee branches shall be installed in the sewer lines at all places shown on the Drawings, specified herein or otherwise directed by the Engineer. Tee branches on pipe less than 12 inches in diameter shall be cast or extruded and manufactured monolithic with the barrel.
- B. Riser connections of the size and type shown on the Drawings shall be installed at the locations shown on the Drawings or directed by the Engineer. A plastic film marking tape 5-feet long shall be placed 12 inches over the top of each riser during backfilling to mark the location of the riser. The marking tape shall be heavy gauge polyethylene film (.004-inch thick). Tape shall be standard red color imprinted with the words "Warning-Buried Sewer Line Below." Tape shall be Allen Marking Tape No. AMT-1212 as manufactured by the Allen System Inc., Glen Ellyn, Illinois, or equal. A second marking tape containing a metallic core which can be located with a metal detector shall be laid on top of the first marking tape. This tape shall be 5 feet long and 3 inches wide. Tape shall be Allen Detectotape Catalogue No. ADT-1003 for buried sewer line as manufactured by the Allen System Inc., or equal.
- C. Plugged pipe stubs for future connections to manholes and sewerage structures shall be installed where shown on the Drawings or directed by the Engineer. The pipe stubs shall be installed with the bell encased in the wall of the manhole and the bell opening flush with the outside wall of the manhole or structure. Stubouts shall be the type manufactured by McCullough Industries or an approved equal.
- D. Plugged stubs and such branches of pipelines that are not to be used immediately shall be closed with PVC stoppers held securely in place.
- E. Where specifically directed by the Engineer or shown on the Drawings, connections to reinforced concrete pipe over 18 inches in diameter shall be made in accordance with details shown on the Drawings.

3.03 CONNECTIONS

- A. If the work consists of the construction of a sewer that is to replace an existing sewer, all of the existing service lines shall be kept in operation and connected to the new line.
- B. Connections shall be made to all existing sewer lines in the vicinity of the work by removing a section of the sewer from the existing line and inserting in the space a tee branch of proper size, or by the construction of a manhole, regulator chamber or other structure as shown on the Drawings.

- C. Connections to existing manholes or inlets where no plugged stubs exist shall be made by cutting a hole in the wall of the existing structure, installing a Kor-N-Seal rubber boot, inserting a length of sewer pipe into the hole, filling around same with concrete or mortar and troweling the inside and outside surfaces of the joint to a neat finish. The bottom of the manhole shall be shaped to fit the invert of the sewer pipe as specified under the section entitled "Manholes" of these Specifications.
- D. Connections to building services shall be made in a neat and workmanlike manner. Cleanout plugs shall be installed, wherever feasible, by making the connections with a standard wye or tee.

3.04 EXISTING UTILITIES

- A. All existing sewers, water lines, gas lines, underground conduits, telephone lines, sidewalks, curbs, gutters, pavements, electric lines, or other utilities or structures in the vicinity of the work shall be carefully protected by the Contractor from damage at all times. Where it is necessary for the proper accomplishment of the work to repair, remove and/or replace any such utility, the work shall be done under the provisions set forth in the "General Conditions." No Separate payment shall be made for removing and replacing and/or repairing damaged existing sewers; water, gas, electric, telephone lines or conduits; or other utilities, culverts, drains, or conduits or similar existing services or structures. Similar repair and replacement of sidewalks, curbs, gutters, and pavements are provided elsewhere in these Specifications.
- B. Sewers to be installed parallel to any existing or proposed water main shall be laid at least 10 feet, horizontally, from the water main. If conditions prevent the 10-foot separation, the sewer may be constructed closer to a water main if it is laid in a separate trench and if the bottom of the water main at least 18 inches above the top of the sewer.
- C. When sewers cross under water mains, the top of the sewer shall be at least 18 inches below the bottom of the water main. If necessary, the water main shall be relocated to provide this separation or reconstructed with mechanical-joint ductile iron pipe for a distance of 10 feet on each side of the sewer. One full length of water main shall be centered over the sewer so that both joints will be as far from the sewer as possible.
- D. When it is impossible to obtain proper horizontal and vertical separation as stipulated above, both water main and sewer shall be constructed of mechanical-joint ductile iron pipe and shall be pressure tested to assure water tightness.
- E. When sewer lines cross under culverts where the sewer and the culvert are less than 18 inches apart, the sewer line shall be encased in concrete as shown on the Standard Drawings.

3.05 INSPECTION AND TESTING

- A. The grade, joints, and alignment shall be true to line and grade after completion of any section of sewer. Joint surfaces shall be smooth. There shall be no visual leakage and the sewer shall be completely free from any cracks and from protruding joint materials, deposits of sand, mortar, or other materials on the inside.
- B. One hundred percent of all PVC pipe 8 inches in diameter and greater shall be deflection tested. The maximum allowable deflection for PVC pipe is 5 percent. After the PVC pipe has been installed and backfilled, the Contractor shall check the deflection by pulling a rigid ball or an Engineer approved 9-arm mandrel sized at 95 percent of the actual inside diameter of the pipe used through the pipe. Deflection tests shall not be conducted before the elapse of 30 days after backfilling. Any pipe not passing the mandrel shall be replaced and rechecked.
- C. Infiltration shall not exceed 25 gallons per 24 hours per inch of diameter per mile of sewer. Contractor shall furnish all supplies, materials, labor, service, etc., needed to make infiltration or exfiltration tests including water. No separate payment will be made for equipment, supplies, material, water, or services.
- D. Any leakage, including active seepage, shall be corrected by removal and replacement of pipe or joint where such leakage exists until the pipelines meet the requirements of the allowable leakage specifications.
- E. The sewers installed under this contract will be subject to television inspection in accordance with Section 02752 of these specifications.
- F. The Contractor shall provide access for the Owner's crews and equipment for the television inspection and shall have his representative present during inspection.
- G. The television work shall be scheduled so as to take advantage of the time when the groundwater table is most likely to cause infiltration. Work shall be scheduled during or after rainy periods rather than after prolonged periods of dry weather. Logs and/or tapes of the inspections will be made available to the Contractor.
- H. All sewer pipe shall be tested using low pressure air testing in accordance with the procedures and standards listed below.
 - 1. Clean pipe to be tested by propelling a snug-fitting inflated rubber ball through pipe with water.
 - 2. Plug all pipe outlets with suitable test plugs. Brace each plug securely to prevent blowouts. As a safety precaution, pressurizing equipment shall include a regulator set at slightly above test pressure to avoid overpressurizing and damaging an otherwise acceptable line. No one shall be allowed in the manhole during testing.

3. Add air slowly to the portion to the pipe installation under test until the internal air pressure is raised to 4.0 psig greater than the average back pressure of any groundwater above the pipe (0.43 psi per foot of groundwater above the pipe invert), but not greater than 9.0 psig.
4. After an internal pressure of 4.0 psig is obtained, allow at least two minutes for air temperature to stabilize, adding only the amount of air required to maintain pressure.
5. When pressure decreased to 3.5 psig, start stopwatch. Determine the time in seconds that is required for the internal air pressure to reach 3.0 psig. Minimum permissible holding times for runs of single pipe diameter are indicated in the table in seconds. No separate allowance shall be given for laterals.

SPECIFICATION TIME REQUIRED FOR 0.5 PSIG PRESSURE DROP
FOR SIZE AND LENGTH OF PIPE INDICATED

		Length Time														
		Min.	for	for	Specification Time for Length(L) Shown(min:sec)											
Pipe	Time	Min.	Longer													
Dia. (min.: (in.)	Time (sec.)	(ft.)	(sec.)	100 ft.	150 ft.	200 ft.	250 ft.	300 ft.	350 ft.	400 ft.	450 ft.					
8	3:47	298		3:47	3:47	3:47	3:47	3:48	4:26							
10	4:43	239		4:43	4:43	4:43	4:57	5:56	6:55							
12	5:40	199		5:40	5:40	5:42	7:08	8:33	9:58							
15	7:05	159		7:05	7:05	8:54	11:08	13:21	15:35							
18	8:30	133		8:30	9:37	12:49	16:01	19:14	22:26	25:38						
21	9:55	114		9:55	13:05	17:27	21:49	26:11	30:32	34:54						
24	11:20	99	6.837xL	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17					
27	12:45	88	8.653xL	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54					
30	14:10	80	10.683xL	17:48	26:43	35:37	44:31	53:25	62:19	71:13	80:07					
33	15:35	72	12.926xL	21:33	32:19	43:56	53:52	64:38	75:24	86:10	96:57					
36	17:00	66	15.384xL	25:39	38:28	51:17	64:06	76:55	89:44	102:34	115:23					

3.06 CLEANUP

After completing each section of the sewer line, the Contractor shall remove all debris and construction materials and equipment from the site of the work, grade and smooth over the surface on both sides of the line and leave the entire right-of-way in a clean and neat conditions. Unless otherwise called for on the Drawings, the Contractor shall restore all disturbed areas to as close to its original condition as possible. Restoration shall include but not be limited to grassing, replacing shrubbery, trees, fences and other improvements which have been disturbed.

Cleanup and restoration shall be complete within 60 calendar days after each section of sewer line is installed. Should the Contractor fail to do the cleanup within 60 calendar days, payment made for pipe sewers and service lines for that section of the sewer not cleaned up shall be removed from the periodic estimate until the cleanup work is completed.

END OF DOCUMENT

15064-B-9

15064-B-10

SECTION 15562 POINT REPAIRS OF SEWERS

1.1 SCOPE

- A. *The work covered* in this section shall include furnishing all labor, equipment, and materials required to complete the point repairs determined to be necessary. All point repairs shall be completed in strict accordance with this section of the Specifications.
- B. *The existing flow* in the line segment being replaced shall be controlled whenever necessary during replacement.

1.2 DESCRIPTION

- A. *The term "point repair"* shall refer to construction required to correct a severe problem at a specified location in a sewer line which cannot be corrected by internal sewer line grouting. Point repairs will be line replacements from 3 to 12 linear feet performed at locations previously identified during internal sewer inspections. The length of pipe to be replaced at each point is representative only and may not reflect the actual extent of work required. If additional length is required to be replaced beyond that described, based on field observations, the Contractor, at the Engineer's instruction, may be directed to replace additional sections of pipe such that an appropriate connection to sound pipe is possible. No change in contract price shall be deemed justified due to a change in the length of pipe, 12 linear feet or less, for each point repair line item. Payment for additional replacement over 12 linear feet shall be at the unit prices bid.

1.3 MAIN LINE POINT REPAIRS

- A. *Locate all existing underground utilities* before beginning excavation for main line and service connection repairs from the manhole of reference.
- B. *Where a point repair is to be made underneath existing pavement or concrete*, the surface to be excavated shall be saw cut in straight lines.
- C. *Where point repair is to be made in an easement*, any fences or other interferences shall be removed. Contractor is responsible for replacement of such interferences in the same or better condition than found.
- D. *Exercise reasonable care* during the initial excavation of the defective pipe so as not to disturb existing pipe that is still acceptable. After the defective pipe has been exposed, as much additional pipe shall be uncovered as is necessary to allow space for workmen and the installation of the new pipe. The defective pipe shall be saw cut out in such a way that the ends are straight and smooth and free of chips or cracks so that a smooth plain-end spigot exists at both ends to receive replacement section. The defective pipe shall be removed from the trench and the former bedding material of that pipe excavated to 6

inches below the pipe grade. The bottom of the trench shall then be filled with 6 inches of 1/2 to 3/4-inch crushed stone.

- E. *No pipe shall be laid* except in the presence of the Resident Project Representative (RPR) representing the Owner and the Engineer.
- F. *Before sewer pipe is placed in position* in the trench, carefully prepare the bottom and sides of the trench and install any necessary bracing and sheeting required.
- G. *On sewer lines where more than 6 feet of existing line is replaced* with new pipe, a mason's line or wire shall be tightly stretched above ground level, parallel to and directly above the axis of the pipe to be installed. This line to be supported at intervals not exceeding 50 feet on sewers being laid on a 2 percent or more grade and not exceeding 25 feet on grades less than 2 percent. The exact line and grade for each section of pipe shall be determined by measuring down this line to the invert of the pipe in place. Each replacement pipe section shall be accurately placed to the exact same line and grade as the existing sewer line. Furnish all labor and materials necessary for erecting batter boards.
- H. *Sewer lines where more than 12 feet of existing line is replaced* with new pipe, shall meet the specification requirements of this section and Sections 15062 and 15064.
- I. *Lasers* may be used after the type and procedures are approved by the Engineer. When lasers are used, reference points for both line and grade will be set at each manhole. Where grades are 0.6 percent or less, the elevation of the beam shall be checked each 50 feet by using an offset point or Engineer's level.
- J. *While pipe laying is in progress*, do not allow water to run in the trench sufficient to cause a washing of the bedding or backfill material into the line. Do not open up at any time more trench than available pumping facilities are able to dewater.
- K. *Trench bottoms* found to be unsuitable for foundations after pipe laying operations have started shall be corrected and brought to exact line and grade as required.
- L. *Carefully inspect* each piece of pipe and special fitting before it is placed, and no defective pipe shall be laid in the trench. Pipe laying shall proceed upgrade, starting at the lower end of the grade and with the bells upgrade. When pipe laying is not in progress, the ends of the pipe shall be kept tightly closed with an approved temporary plug.
- M. *Bell holes* shall be of sufficient size to allow ample room for properly making the pipe joints. Bell holes shall be cut out not more than two joints ahead of the pipe laying. The bottom of the trench between bell holes shall be carefully graded so that each pipe barrel will rest on a solid foundation for its entire length. Each pipe joint shall be laid to form a close concentric joint with adjoining pipe and so as to avoid sudden off-sets or inequalities in the flow line.
- N. *Wherever dissimilar pipe materials are joined*, the replacement pipe shall be cut to a length one inch less than the overall length of the section being replaced. The pipe shall then be placed in the trench and the compression couplings installed. After installation, the work

shall be checked to ensure that the replacement pipe is vertically and horizontally aligned with the existing pipe and that the compression couplings are tight and evenly fitted.

- O. *If the point repair work occurs in an area of construction adjacent to or that is part of a service line connection, the existing service line(s) shall be connected to the new line, using new tees, wyes, and other fittings, as required. Service lines shall be replaced from the tee or tap up to sound pipe. If necessary, due to poor pipe conditions, and at the direction of the Engineer, service line shall be replaced to the property line. Payment for service line replacement will be based on linear feet as bid. Service lines cut and temporarily plugged for the purpose of point repairs or sewer line replacement shall be reconnected and placed back into service the same day. Maintain existing sewage flow from the service connections during construction.*
- P. *Any sound portion of the main sewer pipe or service line broken by Contractor's negligence or carelessness shall be replaced at the Contractor's expense.*

1.4 CROSSING WATER LINES AND STORM SEWERS

- A. *Where sewers cross storm sewers and below water lines with an 18-inch clearance or greater separation, backfill with crushed stone between the sewer main and storm sewer or water main crossing.*
- B. *Where sewers cross storm sewers with less than an 18-inch separation, the sewer pipe shall be encased with 3,000 psi concrete for a distance of 5 feet each side of the crossing.*
- C. *Where sewers cross below water lines with less than an 18-inch separation, the sewer pipe shall be encased with 3,000 psi concrete for a distance of 10 feet each side of the crossing.*
- D. *Where sewers cross above water lines, both the sewer main and water main shall be ductile iron pipe with joints that are equivalent to water main standards, placed such that the joints are centered for a distance of 10 feet on each side of the point of crossing.*

1.5 CONNECTIONS

- A. *Replacing connections to existing manholes or inlets by removing all connecting pipe and existing mortar, inserting a length of sewer pipe into the hole, sliding pipe gasket onto the pipe such that the gasket will be centered within the manhole wall, filling around same with grout, Hydraulic Cement for Manholes, and troweling the inside and outside surfaces of the joint to a neat finish. As specified elsewhere, the bottom of the manholes shall be shaped or reshaped as necessary to fit the invert of the sewer pipe.*

1.6 PIPE PROTECTION

- A. *Pipe sewers with less than 3-1/2 feet of cover where subject to traffic loads and 2-1/2 feet of cover at any other location when completed shall be ductile iron pipe or will be provided with concrete protection as shown on the plans. Such pipe protection, when not shown on the plans, will be placed in accordance with the typical section shown.*

1.7 EXISTING UTILITIES

- A. *Carefully protect from damage* at all times all existing sewers, water lines, gas lines, sidewalks, curbs, gutters, pavements, electric lines, or other utilities or structures in the vicinity of the work. Where it is necessary to repair, remove, and/or replace any such utility or structure for the accomplishment of the work, the work shall be done under the provisions set forth in the General and Special Conditions of these Specifications. Any such work shall be considered incidental to the construction of sewers and no additional payment will be allowed for the work.

1.8 FIELD JUDGMENT

- A. *The Engineer and/or his duly authorized representative may make a field judgment* at any time during a repair which shall govern over the repair until such time that the Specifications will again prevail.

1.9 CLEANUP

- A. *After completing each section of the sewer line repair*, remove all debris, construction materials, and equipment from the site of the work; grade and smooth over the surface of both sides of the line; reseed and/or repave as required; and leave the entire right-of-way in a clean, neat, and serviceable condition.

1.10 MEASUREMENT AND PAYMENT

- A. Measurement shall be along the center line of the pipe from beginning of repair to end as specified by work order or as directed by the engineer. All sections under 12 feet in length shall be measured as each and all additional length beyond the initial 12 feet shall be measured by the linear foot. Measurement of tees shall be measured by each used of different sizes. Service lines shall be measured by the linear foot beyond the main trench.
- B. Payment for point repairs shall be at the unit price bid for the first 12 feet of each point repair complete in place excluding service tees and service lines. Service tees shall be paid for at the unit price bid for each tee of different size used. Service lines will be paid at the unit price bid for the different sizes per linear foot complete in place.

END OF SECTION

SECTION 16111

CONDUIT

PART 1 - GENERAL

1.01 SCOPE

- A. The work covered by this section includes furnishing all labor, equipment, and materials required to install electrical conduit and fittings as specified herein and/or shown on the Drawings.
- B. The Contractor's attention is called to the fact that all conduits and conduit fittings are not necessarily shown completely on the Drawings, which are more or less schematic. However, the Contractor shall furnish and install all conduit and conduit fittings indicated or required for the proper connection and operation of all equipment and services requiring such conduit.

1.02 SHOP DRAWINGS AND ENGINEERING DATA

Shop drawings and engineering data shall be submitted in accordance with the requirements of the section entitled "Submittals" of these Specifications.

1.03 STORAGE AND PROTECTION

Store and protect conduit and fittings in accordance with the manufacturer's recommendations and the requirements of the section entitled "General Equipment Stipulations" of these Specifications. Conduit shall be stored aboveground and adequately supported.

1.04 GUARANTEE

Provide a guarantee against defective equipment and workmanship in accordance with the requirements of the section entitled "Guarantees and Warranties" of these Specifications.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Unless otherwise shown or specified, all conduits shall be rigid metal or intermediate metal conduit.
- B. Where specifically indicated on the Drawings, rigid nonmetallic conduit may be used for encased buried power and motor control wiring. Under no circumstances will rigid nonmetallic conduit be used for instrumentation and low-level signal wiring.

- C. Conduits carrying instrumentation wiring and conduits carrying low voltage (less than 600 volts) power and control wiring may be run in the same trench if all conduits are rigid metal or intermediate metal.
- D. Conduit terminations at electrical equipment such as electric motors and heaters shall be made using liquid-tight, flexible metal conduit.
- E. Buried, nonencased rigid metal conduit run along the outside walls of concrete or masonry structures shall be plastic-coated.
- F. Damaged, dented, flattened, or kinked conduit shall not be used.

2.02 RIGID METAL CONDUIT

Rigid metal conduit shall be heavy wall, mild steel conduit conforming to ANSI C80.1 and Federal Specification WW-C-581, hot dip galvanized both inside and out. All conduits shall bear the approved stamp of the Underwriters Laboratories and shall be as manufactured by Republic Steel, General Electric, General Cable, or equal.

2.03 INTERMEDIATE METAL CONDUIT

Intermediate metal conduit shall be intermediate wall, high strength steel conduit conforming to Federal Specification WW-C-581E, hot-dip galvanized both inside and out. Intermediate metal conduit shall bear the approved stamp of the Underwriters Laboratories and shall be approved by the National Electrical Code as a direct substitute for rigid metal conduit in all uses and occupancies, including hazardous locations.

2.04 RIGID NONMETALLIC CONDUIT

- A. Rigid nonmetallic conduit for voltages 600 volts and less shall be SCH 40 heavy wall polyvinyl chloride (PVC) electrical conduit rated for 90EC conductors and conforming to NEMA TC-2, Type EPC-40-PVC. It shall be listed by Underwriters Laboratories in conformance with the National Electrical Code. Conduit fittings, elbows, and joint cement shall be produced by the same manufacturer as the conduit. Conduits shall be as manufactured by Carlon, Borg-Warner, or equal.
- B. Rigid nonmetallic conduit for voltages higher than 600 volts shall be polyvinyl chloride (PVC) power duct rated for 90EC conductors and conforming to NEMA TC-6, Type DB. Conduit fittings, elbows, and joint cement shall be produced by the same manufacturer as the conduit. Conduit shall be as manufactured by Carlon, Olin, or equal.

2.05 PLASTIC-COATED RIGID METAL CONDUIT

- A. Rigid metal conduit prior to application of plastic coating shall conform to Part 2.02, Rigid Metal Conduit, of this section.

- B. Plastic coating shall be polyvinyl chloride (PVC) bonded to the metal a uniform thickness of 40 mils the full length of the conduit except the threads. The bond between the metal and PVC coating shall be equal or greater than the tensile strength of the PVC coating.
- C. A coupling shall be furnished loose with each length of conduit and shall have a PVC sleeve extending one pipe diameter or 2 inches, whichever is least, beyond the end of the coupling. Elbows shall have the same thickness of PVC coating as on the conduit. All threaded conduit and elbow ends shall have plastic thread protectors.
- D. The rigid steel galvanized PVC coated conduit and fittings shall be KorKap as manufactured by Plastic Applicators, Houston, Texas; Plasti-Bond as manufactured by Pittsburgh Std. Div. of Robroy Industries, Verone, Pa.; or equal.

2.06 LIQUID-TIGHT FLEXIBLE METAL CONDUIT

Flexible conduit shall have an oil-resistant, liquid-tight jacket in combination with flexible metal reinforcing tubing and shall be designed for use with waterproof fittings. An integral ground wire shall be included. Flexible conduit shall be American Brass Sealtite Type UA as manufactured by Electric-Flex Company; Flexible Metallic Conduit as manufactured by Ideal Industries, Inc.; or equal. Only Underwriter's Laboratories approved fittings shall be used.

2.07 CONDUIT FITTINGS AND BUSHINGS

- A. Wherever conduits terminate in sheet steel boxes, double bonding type locknuts and bushings shall be used except when terminating in cast hubs. All bushings shall be insulated metallic type, equal to O. Z. Electrical Manufacturing Company, Type B; T & B Company, 1200 Series; Appleton Electric Company, Type BU-I; or equal.
- B. Where conduits terminate in steel or cast NEMA 4 enclosures with no factory-installed threaded hubs, a threaded hub shall be installed equal to Myers Electric Products, Inc., Type ST or STG; Appleton Electric Company, Type HUB; Crouse-Hinds, Type HUB; or equal.
- C. All conduits terminating at motor control centers shall be suitably grounded to the motor control center ground bus using grounded type insulated bushings equal to O. Z. Electrical Manufacturing Company, BLB or IGB; Appleton, Type BIB; Thomas and Betts, 3800 Series; or equal.
- D. Conduit expansion fittings shall be O. Z. Electrical Manufacturing Company, Type EX with Bonding Jumper, Type XJ; Appleton, Type SJ with Type XJB4 Bonding Jumpers; Crouse-Hinds, Type XJ with GC100 Bonding Jumper; or equal.

2.08 CONDUIT BOXES

Exposed conduit boxes and pulling elbows shall be of die-cast, copper-free aluminum with threaded body and removable neoprene-gasketed cover. Conduit boxes shall conform to Federal Specification W-C-586a and shall be Crouse-Hinds "Condulet," Appleton "Unilet Form 85," or equal.

PART 3 - EXECUTION

3.01 GENERAL

- A. Minimum size conduit shall be 3/4 inch aboveground and 1 inch below ground except where noted otherwise, and no conduit shall have more than 40 percent of its internal area occupied by conductors.
- B. During construction all installed conduits shall be temporarily plugged, capped, or otherwise protected from the entrance of dust, trash, moisture, etc., and any conduits which may become clogged shall be replaced. No conductor shall be pulled in until all work that might cause damage to the conduit or conductors has been completed.
- C. Conduit connections to sheet metal enclosures shall be securely fastened by double lock nuts inside and outside and shall have grounding bushings.
- D. Conduit straps or brackets secured to concrete, brick, or masonry shall be by means of expansion bolts, toggle bolts, or approved drill anchors. No wood plugs will be permitted.
- E. Conduits supported from building walls shall be installed with at least 1/4-inch clearance from the wall using pipe spacers equal to Appleton Electric Company, T & B Company, Steel City, or equal. Clamp back to prevent the accumulation of dirt and moisture behind the conduit.
- F. Unless otherwise shown or specified, exposed rigid conduit shall be installed parallel or at right angles to structural members, surfaces, and building walls.
- G. Two or more conduits in the same general routing shall be parallel with symmetrical bends.
- H. Conduits shall be at least 12 inches from high temperature piping, ducts, and flues.
- I. Conduit installed horizontally shall allow headroom of at least 7 feet, except where it may be installed along structures, piping, equipment, or in other areas where headroom cannot be maintained because of other considerations.
- J. Wherever necessary and where shown on the Drawings, conduit boxes and pulling elbows shall be inserted in the lines. Gaskets shall be used to ensure a dust and watertight installation on all conduit boxes and fittings.
- K. All bends and turns in conduits shall have a bend radius of not less than six (6) times the internal diameter of the conduit. Bends shall be made using an approved bender to provide smooth bends with no kinks, dents, or flattening.
- L. All conduit shall be run concealed wherever practical. Unless otherwise shown or required, conduit 2 inches and larger shall be run exposed.

- M. All concealed conduit shall be placed in walls, floors, ceilings, or slabs at the proper time in accordance with the progress of meeting schedules and shall not delay the structural work unnecessarily. Conduits embedded in concrete shall be blocked and braced in place by use of adequate conduit separators to prevent displacement during pouring of the concrete. Where conduit interferes with structural steel, steel reinforcement, or in the opinion of the Engineer occupies too much space in the slab, the conduits shall be rearranged or installed exposed as directed by the Engineer or required. No additional payment will be made for such rearrangement of conduit whether or not additional conduit or fittings might be required.
- N. Conduit wall seals with water stops shall be installed in outside walls below grade for all incoming or outgoing underground conduit emerging directly into the building area. The conduit wall seals shall have a pressure ring and sealing grommet to ensure a watertight installation.
- O. Conduit expansion fittings and ground bonding jumpers shall be installed on all conduits passing through building expansion joints to provide movement in the conduit system.
- P. Where groups of conduits terminate together or pass through floors, provide template to hold conduits in proper relation to each other and to building.
- Q. Conduits shall be plugged or capped with plastic caps during construction to protect threads and prevent entrance of dirt and water.
- R. Conduits shall be adequately supported at intervals as required by the National Electrical Code. One to two exposed conduits running parallel to each other may be supported by strap anchors, or one-hole clamps (walls only). Exposed conduits larger than 2 inches or groups of more than two conduits run parallel shall be supported by means of minimum 12 gauge, slotted steel channels fitted with two-piece, bolted pipe clamps. All conduit supports, clamps, straps and brackets shall be heavily hot dip galvanized for corrosion resistance.
- S. Runs of conduit shall not contain more than four 90-degree bends (360 degree total) between conduit boxes panelboards, or terminations. In general and to the extent practical length of conduit runs between conduit boxes or similar means of access shall not exceed 100 feet.
- T. Exposed service entrance conduits and main feeder conduits shall be identified using stenciled letters at intervals not to exceed 20 feet. Size of letters shall be equal to one-half the diameter of the conduit or 2 inches, whichever is less.

3.02 INSTALLATION OF RIGID METAL AND INTERMEDIATE METAL CONDUIT

- A. Terminations and connections of rigid and intermediate metal conduit shall be threaded. Conduits shall be reamed free of burrs and terminated with insulated metallic conduit bushings.
- B. Conduit threads shall be coated with a petroleum base corrosion-inhibitor with low electrical contact resistance before assembly equal to Burndy Engineering Company, Inc., Penetrax "A" or equal screw thread lubricant (zinc-petroleum or zinc-chromate compounds are permissible).
- C. All conduits shall be suitably grounded to the plant ground grid using grounded type insulated bushings, O. Z. Electrical Manufacturing Company, Type BLG or IGB; T & B Company; Appleton Electric Company, or equal.
- D. Conduit across structural joints where structural movement is allowed shall have bonded, weathertight expansion and deflection fitting the same size as the conduit.
- E. Support spacing for conduits 1 inch and smaller shall not exceed 6 feet, and conduits 1-1/4 inches and larger shall not exceed 10 feet. Supports shall be cadmium-plated steel or galvanized iron. Conduits 1-1/2 inch and smaller may be supported by one-hole conduit straps and 2 inch and larger shall be supported by two-hole conduit straps. Conduit racks shall be as manufactured by Unistrut, Kindorf, or equal.
- F. Conduit joints shall be made up tight using a pipe wrench. Channel lock pliers will not be permitted, and unions shall be used as necessary to aid in the installation. Conduits shall be cut square and the ends reamed smooth after threading to prevent injury to conductors. Conduit joints in concrete or exposed to weather or damp locations shall be drawn up tight and coated with insulating paint before casting in concrete or painting exposed conduit system.

3.03 INSTALLATION OF RIGID NONMETALLIC CONDUIT

- A. Field bending of polyvinyl chloride conduit shall be made with appropriate equipment. No torches or flame-type devices shall be used.
- B. When joints are to be made with polyvinyl chloride conduit, the conduit shall be cut with a fine-tooth saw and deburred. Conduit ends shall be wiped clean of dust, dirt, and shavings and shall be dry. A solvent cement shall be applied to bond the joint. The joint should be watertight.
- C. Polyvinyl chloride conduit shall be installed in accordance with the manufacturers' specifications and recommendations.

3.04 INSTALLATION OF LIQUID-TIGHT FLEXIBLE METAL CONDUIT

- A. Terminations at motors shall be made with flexible liquid-tight metal conduit from conduit stub to terminal box; flexible connection shall be made as short as possible. Flexible conduit shall be Type UA, black. Underwriter's Laboratories approved flexible liquid-tight conduit connectors shall be as manufactured by Thomas and Betts Company, Appleton Electric Company, or equal.
- B. Uncoated flexible metal conduit may be used for short connections between junction boxes and lighting fixtures or speakers installed in suspended ceiling systems. Flexible metal conduit shall be connected using Underwriters Laboratories approved grounding connectors.

3.05 INSTALLATION OF PLASTIC-COATED RIGID METAL CONDUIT

- A. Conduits shall be installed per manufacturer's recommendations.
- B. Joints shall be drawn up tight using a strap wrench. Touch up any damage to the polyvinyl chloride coating with a liquid polyvinyl chloride patching compound.
- C. Support spacings and spacers shall conform to Part 3.02 of this section.

3.06 INSTALLATION OF UNDERGROUND CONDUIT

- A. All underground conduits shall be concrete-encased unless otherwise noted on the Drawings or directed by the Engineer. No conduit shall be concealed or encased until the Engineer has inspected the conduit for proper installation and accurate placement.
- B. The Contractor shall be responsible for all excavating, draining, trenches forming of duct assembly and protective concrete envelope, backfilling, and removal of excess earth.
- C. Underground conduit shall be installed with a minimum 3-inch per 100-foot downward slope for drainage. Drains shall be provided at all low points.
- D. Bends and turns shall be made using long sweeps. Ninety-degree bends will be used only where required and shall be kept at a minimum.
- E. Where rigid nonmetallic conduits emerge from underground, an adapter from rigid nonmetallic conduit to rigid metal conduit shall be installed and all exposed conduit shall be rigid metal conduit.
- F. All rigid metal conduit risers shall be protected with two coats of a Bitumastic compound before concrete is poured from a point 12 inches below grade to a point not less than 6 inches above grade or surface of concrete. All stub-ups shall extend upward with one length of rigid metal conduit until after concrete is poured to assure vertical alignment.
- G. Conduits shall be backfilled with crushed stone (pug 33P, Type A, Grade D).

- H. All underground conduit runs for voltages less than 600 volts shall be at least 24 inches below grade and shall have a minimum conduit separation of 3 inches.
- I. All underground conduit runs for voltages over 600 volts shall be at least 36 inches below grade and shall have a minimum conduit separation of 6 inches. Conduit shall have a minimum 6-inch concrete cover on all sides.
- J. All underground conduit runs shall be rodded and a mandrel drawn through followed by a swab to clean out any obstructions which may cause cable abrasions. The mandrel shall be 12 inches in length and the diameter 1/2 inch less than the inside diameter of the conduit.
- K. All underground conduit runs shall be marked by a strip of permanently-colored red polyethylene tape, 0.004 inch thick and 6 inches wide, buried above the conduit and 6 inches below finished grade.
- L. Unless otherwise shown, at least 20 percent spare conduits, but not fewer than one, of each size required shall be provided with water-proof plugs at stub-ups and shall be furnished with No. 8 aluminum pulling wire.

END OF DOCUMENT

Excavate and Prepare Subgrade

Do not compact or subject pervious pavement locations to excessive construction equipment traffic during construction. Protect areas from vehicle traffic during construction with construction fence, silt fence, or compost sock.

Initial excavation of infiltration beds can be performed during rough site grading. When performing initial excavation, do not grade bottom beyond 2 feet above the final bed bottom elevation. Complete final excavation only after all disturbed areas in the drainage area have been stabilized, or after the bed is adequately protected from receiving sediment-laden water (i.e., with erosion and sediment control measures around the BMP).

Remove fine materials and/or surface ponding in the grading bottom, caused by erosion, with light equipment and scarify the underlying soils to a minimum depth of 6 inches with a York rake or equivalent by light tractor.

Bring subgrade of infiltration bed to line, grade, and elevations indicated. Fill and lightly regrade any areas damaged by erosion, ponding, or traffic compaction. All infiltration beds should be level grade on the bottom.

Halt excavation and notify engineer immediately if evidence of sinkhole activity or unanticipated bedrock or groundwater conditions are encountered, or other site conditions that may affect infiltration bed design or performance become evident.