SECTION 01810

SPECIAL PROVISIONS

PART 1 Description

1.01 SUMMARY

A. These "Special Provisions" supplement, clarify, or modify provisions of Specifications as they apply to this project.

B. Requirements of Special Provisions, General and Supplemental Conditions apply to work performed under all sections of this project.

C. Work of this contract shall include all work required to construct the entire Project as shown on the drawings and defined by the Specifications and other contract documents, unless specific exceptions are stated therein.

D. DISCREPANCY BETWEEN SPECIAL PROVISIONS, SPECIFICATIONS, AND PLANS. In the event of discrepancy between Special Provisions and other sections of the Specifications, the Special Provisions will take precedence over the Specifications, the General Conditions, and the Supplemental Conditions. The Specifications will take precedence over the Plans.

1.02 LABOR PRACTICES

EIGHT-HOUR WORK DAY

The Contractor's attention is directed to, Limitation on work hours; overtime; exceptions. a) No person shall require laborers, workmen, or mechanics to work more than eight hours in any one calendar day or forty hours in any one week upon any public works of the state, or any of its political subdivisions, except as hereafter authorized. An employee may agree to work more than eight hours per day or more than forty hours in any week provided the employee shall be paid at the rate of one and one-half times the regularly established hourly rate for all work in excess of forty hours in any one week.

1.03 CONSTRUCTION WATER

The Contractor is responsible for supplying water for construction purposes. If the Contractor wishes to use existing fire hydrants for water, he shall make the proper arrangements with the owner of the hydrant. The Contractor will be responsible for compliance with that owner's requirements as well as the payment of any fees for its use. Construction water is considered

incidental to this project and no separate payment will be made to the Contractor for this item. If the Contractor wishes to use water from a resident, he shall obtain written permission from that resident to do so.

1.04 SAFETY

In accordance with generally accepted construction practices, the Contractor will be solely and completely responsible for safety conditions at and adjacent to the job site, including the safety of all persons and property during the performance of the work. The Contractor shall comply with all federal, state, and local safety laws and regulations. This requirement shall apply continuously, and shall not be limited to normal working operations. The City Designee/Engineer's construction review of the Contractor's performance is not intended to include review of the adequacy of the Contractor's safety measures, in, on, or near the construction site. This paragraph shall be applicable to the Contractor and all of the Contractor's subcontractors.

In addition, the Contractor shall provide barriers, fences, signs, lights, etc. as necessary to control access to the site.

1.05 DISPOSAL OF WASTE MATERIALS

Excess, unsuitable, and waste materials from this project (including that from trench excavation, pavement removal, piping removal, and grading operations), shall be disposed of, offsite, by Contractor. Such disposal shall be considered incidental, and shall not be a pay item.

1.06 CODES AND STANDARDS

All materials and the completed installation shall comply with applicable standards promulgated pursuant to the State of Tennessee and City of Lakeland.

1.07 OPEN EXCAVATIONS

The Contractor shall completely backfill all excavations before stopping work for the day. No excavation (fenced or unfenced) shall be left open overnight, over a weekend, nor any period in which no work at that location is underway. The cost of reopening or re-excavation due to this provision will be borne by the Contractor.

1.08 CLEANING AND FINISHING

After completion of all work all debris and foreign material will be removed by the contractor. The project area, including staging areas, shall be clean and functional. This will

include the restoration of any disturbed landscaping in the work area.

1.09 TRAFFIC CONTROL

A traffic control plan is required for repairs in areas affecting traffic. The Contractor is responsible for furnishing a traffic control plan to the City Designee at least one week prior to the start of construction. Excavations which traverse a street shall be limited to one-half the width of the street at any one time, unless an emergency situation exists which requires the entire width of the street be excavated. The City Designee approval is required prior to traversing an entire street. The closure should not exceed forty-eight (48) hours and proper signage shall be installed detouring traffic and warning of construction.

END OF SECTION

SECTION 01551

TEMPORARY TRAFFIC CONTROLS

PART 1. Description

To establish uniform requirements for detours, signs and barricades, and traffic control plans associated with construction activities performed on or affecting City of Lakeland streets. The work in this article shall consist of furnishing, erecting, maintaining, relocating, and removing temporary traffic control devices at the locations specified on the drawings and as directed by the Engineer. All traffic control devices shall conform to the provision for construction signing as set forth in the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) latest edition.

PART 2 MATERIALS

2.01 Traffic Control Products

A. Sign Panels

1. Sign panels will be constructed of ¾" plywood conforming to plywood sign panels and barricades of the standard specification for road and bridge construction; or 6061-T6 or 5052-H38 aluminum alloy sheeting conforming to ASTM B209.

2. Wood sign panels will be backed with metal backing angles; except that backing is not required for those sign panels 48" x 60" or smaller.

3. Aluminum sign panels will be 0.125" thick and backed with metal backing angles; except that those sign panels 48" x 60" or smaller may be:

   i. 0.080" thick and backed with metal backing angles or 2 x 4 lumber; or,

   ii. Unbacked, 0.125" thick.

4. Special signs which are unique to the project, i.e., signs not shown on the plans or included in part VI of the MUTCD, and signs shown on the plans which contain a message that is unique to the project, will be furnished by the contractor, as specified on the plans, and erected by the Contractor. Posts and hardware for fixed special sign installations, and all equipment for portable special sign installations will be furnished by the contractor. Post lengths will be specified by the Engineer. Upon removal, the special sign panels, posts, hardware, and portable installation equipment will remain the property of the Contractor.

i. Special signs will be erected on fixed mountings unless portable mountings are authorized by the Engineer.

B. Barrels will be plastic conforming to the MUTCD, with 6" wide reflective stripes.

C. Temporary markings

1. Temporary reflective pavement markings will be paint, preformed tape, or raised pavement markers, and will be suitable for use on either Portland cement concrete or asphalt pavements. Minimum acceptable standards are as follows:

   i. Paint used for temporary markings will be commercially manufactured highway striping paint. The paint will be applied without dilution.

   ii. All painted stripes will be 4" wide, and will be reflectorized by dropping or spraying glass beads onto the wet paint.

   iii. The reflective beads will conform to AASHTO Specification M247, Type 1.

2. Temporary reflective pavement striping tape will be 4" wide, pressure-sensitive tape manufactured for use as pavement striping.

   i. Striping tape applied to finished pavement surfaces which will be returned to normal traffic use will be a removable type.

   ii. Striping tape applied to temporary pavement surfaces which will be obliterated may be a non-removable type.

   iii. Striping tape applied to the surface of intermediate lifts of asphalt pavement may be non-removable type, and may be let in place. If a removable type is used, it will be removed before placing the next lift.

3. Temporary retro-reflective raised pavement markers manufactured by Astro Optics of Schaumburg, Illinois, Model No. TPM, or Stimsonite Products of Niles, Illinois, Model No. 66, or an approved equal will be acceptable.

4. Temporary retro-reflective motorist guidance markers manufactured by Davidson Plastic Company of Ken, Washington, Model NO. TRPM, or TOM, or an approved equal will be acceptable.

PART 3 EXECUTION

3.01 Traffic Control Plans

A. A complete traffic control plan shall be submitted to the Engineer and the Lakeland City Engineering office at least one week prior to the start of construction.

1. Traffic will be permitted to use the street at all times, unless a detour is specifically permitted on the drawings or by the Engineer. Access to all abutting residences and properties shall be maintained to the maximum extent possible.
2. The Contractor shall construct and maintain temporary crossings, complete with flagmen, whenever necessary to expedite the work or to maintain traffic. The Contractor shall furnish not less than two flagmen at each location where loading or depositing of material requires the turning of the trucks on any highway or street and where the operation of construction equipment endangers traffic. Temporary crossings shall be of ample size to safely carry the load which comes upon them.
    i. The Contractor shall maintain the streets in a passable condition. The work shall be conducted so as to create a minimum of inconvenience to traffic.
    ii. Excavations which traverse a street shall be limited to one-half the width of the street at any one time, unless an emergency situation exists which requires that the entire width of the street be excavated. City Engineer's office approval is required prior to excavation traversing an entire street.
3. The Contractor shall furnish sufficient signs and barricades to facilitate the directing of traffic. Unless directed otherwise by the Engineer, all signs and barricades shall conform to:
    i. Within the "Manual on Uniform Traffic Control Devices (MUTCD), " latest edition.
4. The Contractor shall have a sufficient number of barricades and signs on hand prior to the start of the construction
    i. Each detour sign shall be reflectorized and shall be illuminated with two battery-powered blinkers with six-inch (6") amber lenses.
    ii. All barricades shall have blinker lights on each end.
    iii. It shall be the Contractor's responsibility to make necessary checks and inspections of all lights and barricades every day, including Sundays and holidays.
5. Temporary suspension of work does not relieve the Contractor of the responsibility outlined in the above requirements.

3.02 Permits

A. The Contractor shall obtain all necessary permits from the City Engineer's office for any closure of any street or portion thereof, as provided in the Lakeland Municipal Code. Along with the permit application, the Contractor shall provide a sketch showing traffic routing and traffic control devices to be used. The construction traffic control sketch shall be approved by the City Engineer's office before the permit is issued.

3.03 Street Closure

A. The City Engineer may permit the closing of streets to all traffic for a period of time prescribed by the office if, in the City Engineer's Opinion, it is necessary.

END OF SECTION

SECTION 02115

EROSION AND SEDIMENT CONTROL

PART 1 - Description

This work shall consist of providing erosion and sediment control during and upon completion of construction as specified herein and as shown on the Construction Drawings.

1.01 General

A. The Contractor shall provide the Engineer a copy of the Storm Water Pollution Prevention Plan (SWPPP) as submitted to the Tennessee Department of Environment and Conservation.

B. All erosion and sediment control plans shall be developed as per regulations outlined by the Tennessee Department of Environment and Conservation.

C. All erosion and sediment control plans as outlined in the SWPPP shall be installed prior to any grading and land disturbance.

D. All control measures shall be checked, and repaired as necessary, twice weekly in dry periods and within 24 hours after any rainfall of 0.5 inches (minimum). During prolonged rainfall daily checking and repairing is necessary. Maintain records of checks and repairs.

E. A specific individual who is certified by a TDEC Certification Program or its equivalent shall be designated to be responsible for erosion and sediment control.

1.02 Related Sections

Section 02230 Clearing and Grubbing

Section 02315 Excavation, Embankment and Fill

Section 02335 Roadway Earthwork

Section 02340 Geotextiles

Section 02370 Storm Drain Outfall Protection

Section 02835 Topsoil, Seeding and Lawn Restoration

PART 2 – Materials

A. The Contractor shall submit the following to the Engineer for inspection and acceptance all materials used for this Section.

B. Silt Fence Materials shall be as follows:

1. Silt Fence-See Section 02340 Geotextiles.

2. Fence Post (for fabricated units): Steel posts will be a standard "T" and "U" sections weighting not less than 1.33 pounds per lineal foot with a minimum length 42 inches.

3. Wire Fence (for fabricated units): Wire fencing shall be minimum 14-1/4 gage welded wire fabric with a maximum six inch mesh opening or as approved by the Owner.

C. Stabilized Construction Entrance Materials shall be as follows:

1. Aggregate shall be in accordance with Tennessee Department of Transportation (TDOT) #1 or #2 stone specifications (1.5 to 3.5 inch stone), washed and well graded. Refer to Tennessee Department of Environment and Conservation (TDEC) specification Riprap for aggregate size tables.

2. Geotextile fabric shall meet the requirements of Section 02340 Geotextiles.

PART 3 - Execution

3.01 Silt Fencing

A. Silt fence shall be constructed by securely fastening silt fence fabric and wire reinforcement to steel posts using wire ties. The silt fence fabric panels shall be installed loosely with adjacent panels overlapped a minimum of 12 inches. The top edge of the fabric shall be reinforced or shall have a one inch tuck.

B. Accumulated silt and debris shall be removed by the Contractor behind the face of the silt fence when the silt deposits reach approximately one half the height of the fence. Clogged or damaged silt fence fabric or wire reinforcement shall be immediately replaced at no additional expense to the Owner.

C. Refer to Silt Fence details on the construction drawing for additional details and general notes.

3.02 Erosion Control During Construction

A. The Contractor shall take sufficient precautions during construction to minimize the run-off of polluting substances such as silt, clay, wastes, fuels, oils, bitumens, and calcium chloride into the water supplies and surface waters of the State. Special precautions shall be taken in the use of construction equipment to prevent operations which promote erosion.

B. Disposal of drainage shall be in an area approved by the Owner. The Contractor shall prevent the flow or seepage of drainage back into the drainage areas. Drainage shall not be disposed of until silt and other sedimentary materials have been removed. Particular care shall be taken to prevent the discharge of unsuitable drainage to a water supply or surface water body.

C. As a minimum, the following shall apply:

1. Approved silt fencing shall be provided as points where drainage from the worksite leaves the site, to reduce the sediment content of the water.

2. Drainage leaving the site shall flow to water courses in such a manner to prevent erosion.

D. Measures for control of erosion must be adequate to assure that turbidity in receiving water will not be increased more than 10 standard turbidity units (s.t.u.) or as otherwise required by the State or other controlling body, in waters used for public water supply or fish unless limits have been established for the particular water. In surface water used for other purposes, the turbidity increases must not exceed 25 s.t.u. unless otherwise permitted.

3.03 Stabilized Construction Entrance

A. Contractor shall install stabilized construction entrances in at least one main entry point to the construction site. Additional entrances shall be stabilized depending on the project size and use of entry points to the construction sites. Construct stabilized construction entrance as per dimensions shown on the construction.

B. Geotextile Engineering fabric shall be installed prior to placement of aggregate. Fabric shall not be required for work on single family residential lot.

C. Maintenance of stabilized construction entrance shall include periodic top dressing of entrance with additional stones as conditions demand to prevent tracking or flow of sediment onto public rights of way.

END OF SECTION

SECTION 02230

CLEARING AND GRUBBING

PART 1 - Description

This work shall consist of clearing, grubbing, scalping, removal of trees and stumps, and removing and disposing of all vegetation and debris within the limits of the work as described on the drawings, except such objects that are to remain or are to be removed in accordance with other sections of these specifications.

1.01 General

A. The Engineer shall exercise control over clearing and grubbing and shall designate all trees, shrubs, plants, and other objects to be removed. This work shall also include the preservation from injury or defacement of all vegetation and objects to remain. Paint required for cut or scarred surfaces of trees or shrubs selected for retention shall be a suitable asphaltum base paint.

B. Before the Contractor removes any tree or stump which the plans state is to be removed, the Engineer shall review the plan requirements with the Owner and Contractor and appropriately mark each tree or stump which is to be removed.

C. Only such trees and stumps which have been marked for removal by the Engineer shall be removed.

D. Limitations of areas of clearing and grubbing and earthwork operations shall be in accordance with the construction drawings

PART 2 – Materials (Not Used)

PART 3 - Execution

3.01 Clearing and Grubbing

A. All surface objects, brush, roots, and other protruding obstructions, not designated to remain, and all trees and stumps marked for removal, shall be cleared and/or grubbed, including mowing, as required, except for special treatment as follows:

1. In locations to be seeded, stumps shall be removed to a minimum of 150 mm (6 inches) below ground surface.

2. In unseeded areas to be rounded at the top of backslopes, stumps shall be cut off flush with or below the surface of the final slope line.

3. Except in areas to be excavated, stump holes and other holes from which obstructions are removed, shall be backfilled with suitable material and compacted in accordance with other divisions within these specifications.

4. Materials and debris may be removed from the construction site and properly disposed of at locations off the project outside the limits of view from the right-of-way with the witten permission of the property owner on whose property the materials and debris are placed. No burning of vegetation will be allowed. The Contractor shall make all necessary arrangements with property owners for obtaining suitable disposal locations.

5. Low hanging branches and unsound or unsightly branches on trees or shrubs designated to remain shall be removed as directed. Branches of trees extending over the roadbed shall be trimmed to give a clear height of 6 m (20 feet) above the roadbed surface.

3.02 Scalping

A. The Contractor shall scalp all areas where excavation or embankment is to be made Scalping shall include the removal of material such as roots, sod, grass, residue of agricultural crops, sawdust, and decayed vegetable matter from the surface of the ground.

B. Sod and incidental topsoil removed in the scalping operation shall be salvaged and stockpiled for use as specified elsewhere. The stockpiles of scalpings shall be made in such a manner and at such locations that they will be well drained and will not impound water.

C. The depth of scalping performed under this section is not intended to include topsoil.

END OF SECTION

SECTION 02370

STORM DRAIN OUTFALL PROTECTION

PART 1 – Description

Storm drain outfall projection shall consist of furnishing and setting or placing, stones or sacked sand cement or approved materials downstream of pipes, culverts, and other drainage structures. The outfall projection shall be constructed in conformity to the lines, grades, and cross-sections, and at the locations indicated on the Plans or as directed by the Owner and in accordance with the requirements and provisions of these Specifications.

PART 2 – Materials

2.01 Material

A. Stone

1. Stone shall be sound, dense and durable, free from cracks, pyrite intrusions and other structural defects and have a density of not less than 150 pounds per solid cubic foot. When tested by the Los Angeles method, the percent of wear shall not exceed 60.

2. When the stone is subjected to five alternations of the sodium sulfate soundness test, the weighted percentage of loss shall be not more than 15 percent.

3. Stone shall conform to one of the following gradations and shall be approximately rectangular in shape:

RIP-RAP GRADATIONS
Grade B
1,200 pound maximum weight

Weight	Percent
750 lbs. to 1,200 lbs.	27%
400 lbs. to 749 lbs.	25%
200 lbs. to 399 lbs.	25%
50 lbs. to 199 lbs.	15%
10 lbs. to 49 lbs.	5%
Less than 10 lbs.	3%

Grade C
400 pound maximum weight

Weight	Percent
250 lbs. to 400 lbs.	30%
50 lbs. to 249 lbs.	20%
30 lbs. to 49 lbs.	25%
10 lbs. to 29 lbs	20%
Less than 10 lbs.	5%

Grade D
125 pound maximum weight

Weight	Percent
90 lbs. to 125 lbs.	25%
25 lbs. to 89 lbs.	50%
10 lbs. to 24 lbs.	15%
Under 10 lbs.	10%

Grade E
(upper bank)

Weight	Percent
75 lbs. to 125 lbs.	10%
25 lbs. to 74 lbs.	40-60%
5 lbs. to 24 lbs.	20-40%
Under 5 lbs.	15%

B. Filter Cloth and Fasteners.

1. The filter cloth material used as a base for rip-rap shall be pervious sheets of strong, rot proof plastic fabric meeting the following Specifications:

PHYSICAL PROPERTY	TEST METHOD	ACCEPTABLE RESULTS
Tensile Strength, wet, lbs	ASTM D-1682	200 (min)
Elongation, wet, %	ASTM D-1682	40 (min)
Coefficient of Water	Constant Head	.03 (min)
Permeability, cm/sec	ASTM D-4491	$\geq$0.80
Puncture Strength, lbs.	ASTM D-751	100 (min)
Pore Size – EOS	Corps of Engineers	40 (max)
U.S. Standard Sieve	CW-02215	

2. The filter cloth material used as a base for cellular concrete blocks shall meet the following minimum physical requirements

PHYSICAL PROPERTY	TEST METHOD	ACCEPTABLE RESULTS
Grab Tensile Strength (Unaged Geotextile)	ASTM D4632	200 Lbs. (in any principal direction)
Breaking Elongation (Unaged Geotextile)	ASTM D4632	50% max. (in any principal direction)
Burst Strength	ASTM D3786	400 psi
Puncture Strength	ASTM D4833	115 lbs.
A.O.S., U.S. Std. Sieve	ASTM D4751	See Design Manual
% Open Area	CWO-22125-86	See Design Manual
Permittivity	ASTM D4491	See Design Manual

3. The geotextile fiber shall consist of a long-chain synthetic polymer composed of at least 85 percent by weight of propylene, ethylene, ester, or amide, and shall contain stabilizers and/or inhibitors added to the base plastic, if necessary, to make the filaments resistant to deterioration due to ultraviolet and heat exposure. The edges of the geotextile shall be finished to prevent the outer fiber from pulling away from the geotextile.

4. During all periods of shipment and storage, the filter fabric shall be protected from direct sunlight, ultraviolet rays and temperatures greater than 140 degrees Fahrenheit. To the extent possible, the fabric shall be maintained wrapped in its protective covering. The geotextile shall not be exposed to sunlight, ultraviolet rays until the installation process begins.

5. Final acceptance of the filtration geotextile by the Engineer shall be dependent upon the geotextile performance when tested in accordance with ASTM D5105, Standard Test Method for Measuring the Soil-Geotextile System Clogging by the Gradient Ratio test or the Hydraulic Conductivity Ratio test. Soil characteristics such as grain size distribution and plasticity shall be determined for every 200,000 square feet of geotextile installed or for each source of borrow material used during construction. Significant differences in soil characteristics shall require further performance testing by either the Gradient Ratio or the Hydraulic Conductivity Ratio tests at the discretion of the Engineer. The locations for which the material to be tested is extracted shall be approved by the Engineer. The Contractor shall provide the site-specific soil and modified proctor curves for the site-soil, at his own expense, to the manufacturer. Also, the contractor shall be responsible for the performance of the test by a certified independent laboratory experienced in performing such test. The test shall be performed under the actual field soil conditions or as otherwise required by the Engineer.

6. At the time of installation, the filter fabric shall be rejected if it has been removed from its protective cover for over 72 hours or has defects, tears, punctures, flow deterioration, or damage incurred during manufacture, transportation or storage. With the acceptance of the Engineer, placing a filter fabric patch over the damaged

area prior to placing the mats shall repair a torn or punctured section of fabric. The patch shall be large enough to overlap a minimum of three (3) feet in all directions.

7. In the event pre-assembled panels of fabric are required, the panels of filter fabric shall be sewn together at the manufacturer or another approved location.

8. The Contractor shall furnish a certified laboratory test report from an approved testing laboratory with each shipment of materials. Laboratory test reports shall include actual numerical test data obtained on this product.

9. Pins may be any commercially available pin 6 inches in length capable of retaining a washer.

10. Washers may be any commercially available washer 2 inches in diameter and compatible with the pin.

11. The pins and washers shall be manufactured from corrosion resistant metal material.

C. High-Density Polyethylene (HDPE) Plastic Transition Matting

1. Matting shall be 4 feet by 4 feet in size and ½ inch in thickness manufactured with High Density Polyethylene. Matting shall be manufactured by ScourStop or approved equal.

2. Anchor Straps. Anchor Straps shall be provided to tie HDPE matting to soil by manufacturer.

D. Cellular Concrete Blocks

1. Materials shall be manufactured by Contech or approved equal and conform to the following applicable ASTM specifications:

Portland Cements - Specification C 150, for Portland Cement

Blended Cements - Specification C 595, for Blended Hydraulic Cements

Hydrated Lime Types - Specification C 207, for Hydrated Lime Types

Pozzolans - Specification C 618, for Fly Ash and Raw or Calcined Natural Pozzolans for use in Portland Cement Concrete.

2. Aggregates shall conform to the following ASTM specifications, except that grading requirements shall not necessarily apply:

Normal Weight - Specification C 33, for Concrete Aggregates.

3. The concrete units shall be produced by a dry cast method. The dry cast units obtain strength in a shorter duration as well as an increase in the durability and overall quality of product.

4. At the time of delivery to the work site, the units shall conform to the physical requirements prescribed in Table 2 listed below.

Compressive Strength Net Area Min. psi (mPa)		Water Absorption Max. lb/ft^3 (kg/m^3)	
Avg. of 3 units	Individual Unit	Avg. of 3 units	Individual Unit
4,000 (27.6)	3,500 (24.1)	10 (160)	12 (192)

5. When applicable, the manufacturer shall meet all requirements pertaining to a concrete unit's durability pertaining to a freeze-thaw environment.

6. Units shall be sampled and tested in accordance with ASTM D 6684-04, Standard Specification for Materials and Manufacture of Articulating Concrete Block (ACB) Revetment Systems.

7. The cellular concrete blocks, cables and fittings shall be fabricated at the manufacturer or another approved location into mats with a width of up to eight (8) feet and a length up to forty (40) feet, which is approved by the Engineer.

E. Polyester Revetment Cable and Fittings

1. Revetment cable shall be constructed of high tenacity, low elongating, and continuous filament polyester fibers. Cable shall consist of a core construction comprised of parallel fibers contained within an outer jacket or cover. The weight of the parallel core shall be between 65% to 70% of the total weight of the cable. The revetment cable shall have the following physical properties:

Nominal Cable Dia.	Approx. Ave. Strength		Weight per Length	
(in.)	(lbs)	(kN)	(lbs)/100ft	(kg/m)
1/4	3,000	13.3	2.2	0.03
5/16	7,000	31.1	4.4	0.07
3/8	10,000	44.5	5.5	0.08
1/2	15,000	66.7	9.7	0.14

2. Elongation requirements specified below are based upon stabilized new, dry cable. Stabilization refers to a process in which the cable is cycled fifty (50) times between a load corresponding to $200D^2$ and a load equal to 10%, 20% or 30% of the cable's approximate average breaking strength. Relevant elongation values are as shown in the table below. The tolerance on these values is $\pm$ 5%.

ELASTIC ELONGATION

(at Percentage of Break Strength)

10%	20%	30%
0.6	1.4	2.2

3. The revetment cable shall exhibit resistance to most concentrated acids, alkalis and solvents. Cable shall be impervious to rot, mildew and degradation associated with marine organisms. The materials used in the construction of the cable shall not be affected by continuous immersion in fresh or salt water.

4. Selection of cable and fittings shall be made in a manner that insures a safe design factor for mats being lifted from both ends, thereby forming a catenary. Consideration shall be taken for the bending of the cables around hooks or pins during lifting. Revetment cable splicing fittings shall be selected so that the resultant splice shall provide a minimum of 60% of the minimum rated cable strength. Fittings such as sleeves and stops shall be aluminum and washers shall be galvanized steel unless otherwise shown on the Contract Drawings.

F. Galvanized Steel Revetment Cable and Fittings

1. Revetment cable shall be constructed of preformed galvanized aircraft cable. The cables shall be made from individual wires and strands that have been formed during the manufacture into the shape they have in finished cable.

2. Cable shall consist of a core construction comprised of seven (7) wires wrapped within seven (7) or nineteen (19) wire strands. The revetment cable shall have the following physical properties:

Nominal Cable Dia.	Type	Approx. Ave. Strength		Weight per Length	
(in.)		(Lbs)	(kN)	(Lbs)/100ft	(kg/m)
1/8	7x7	1,700	7.5	2.8	0.04
3/16	7x7	3,700	16.4	6.2	0.09
1/4	7x7	6,100	27.1	10.6	0.16
5/16	7x19	9,800	43.6	17.3	0.26
3/8	7x19	14,400	64.1	24.3	0.36

3. The revetment cable shall exhibit resistance to mild concentrations of acids, alkalis, and solvents. Fittings such as sleeves and stops shall be aluminum, and the washers shall be galvanized steel. Furthermore, depending on material availability, the cable type (7x7 or 7x19) can be interchanged while always ensuring the required factor of safety for the cable.

4. Selection of cable and fittings shall be made in a manner that insures a safe design factor for mats being lifted from both ends, thereby forming a catenary. Consideration shall be taken for the bending of the cables around hooks or pins during lifting. Revetment cable splicing fittings shall be selected so that the resultant splice shall provide a minimum of 75% of the minimum rated cable strength.

PART 3 – Execution

3.01 Sub-grade Preparation for Stone

A. The area to be occupied by the rip-rap stabilization shall be cleared of all trees, roots, vegetation, and similar material. Immediately prior to the placement of rip-rap, the slopes or ground surface shall be trimmed in conformity to the lines and grades indicated on the Plans or as directed by the Owner and shall be thoroughly compacted by the use of hand or mechanical tamps. Unless otherwise specified herein make all fill with suitable materials excavated from site.

B. All fills in dry areas shall be compacted to a maximum density of 90 percent as determined by ASTM D 698 (Standard Proctor). On slopes, the bottom of the rip-rap shall be placed at least 2 feet below the natural ground surface, unless otherwise directed.

C. Surplus excavated material shall be removed from the site and disposed of as shown on the Plans or as directed by the Owner. Spoil material shall not be disposed of in a watercourse or on the banks of a watercourse.

3.02 Placing Filter Fabric

A. Filter Fabric for Stone Rip-Rap

1. Unless otherwise specified, filter fabric shall be placed on the prepared and compacted subgrade within the limits shown on the Plans for stone rip-rap. The filter fabric shall be laid loosely without wrinkles or creases.

2. When more than one width or length of filter fabric is necessary, the joints shall be overlapped a minimum of 24 inches.

3. Securing pins with washers shall be inserted through both strips of overlapped material and into the material beneath, until the washer bears against the fabric and secures it firmly to the base material. These securing pins shall be inserted through the overlapped fabric at no greater than 2 foot intervals along a line through the midpoint of the overlap.

4. If the fabric is torn or damaged, a patch overlapping the edges of the damaged area by 2 feet shall be sewn securely to the fabric with a continuous, monofilament, rot-proof material.

B. Filter Fabric for ACB Revetment System

1. The filtration geotextile shall be placed directly on the prepared area, in intimate contact with the subgrade, and free of folds or wrinkles. The geotextile shall not be walked on or disturbed when the result is a loss of intimate contact between the cellular concrete block and the geotextile or between the geotextile and the subgrade. The geotextile filter fabric shall be placed so that the upstream strip of fabric overlaps the downstream strip.

2. The longitudinal and transverse joints shall be overlapped at least two (3) feet. The geotextile shall extend at least one foot beyond the top and bottom revetment termination points. If cellular concrete blocks are assembled and placed as large mattresses, the top lap edge of the geotextile should not occur in the same location as a space between cellular concrete mats unless the space is concrete filled.

3.03 Placement of Rip-Rap

A. Stone Rip-Rap

1. Stone rip-rap shall be constructed upon the prepared foundation by hand placing, so that the stones shall be as close together as is practicable in order to minimize void space.

2. When rip-rap is constructed in more than one layer, it shall be so placed that it will be thoroughly tied together with the larger stones protruding from one layer into the other.

3. Each stone shall be placed so that the depth will be perpendicular to the surface upon which it is set. The length shall be placed as directed by the Owner and each main stone shall be placed so that it will be against the adjoining stones. The stones shall be placed in such a manner as to stagger all joints as far as it is possible and practicable.

4. The main stones shall be thoroughly "chinked" and filled with the smaller stones by throwing them over the surface in any manner that is practicable for the smaller stones to fill the voids. This work shall continue with the progress of the construction. Tamping of the stones will not be required if the stones have been placed in a reasonable and satisfactory manner.

5. Knapping of the stones will not be required, except stones protruding more than 4 inches above the specified grade.

3.04 Depth of Rip-Rap

A. The standard depth of stone rip-rap shall be 18 inches unless otherwise indicated or directed. The average depth for each 25 square feet of surface shall be not less than the depth indicated on the Plans or directed by the Owner, or the standard depth required in these Specifications.

B. In no case shall any part of the finished depth of stone rip-rap vary more than 3 inches above or below the specified depth.

3.05 Placement of High-Density Polyethylene (HDPE) Transition Matting

A. HDPE Matting shall not be installed over bare soil. Install HDPE matting in accordance with the dimensions shown on the plans and construction details. Optional soil covers shall be sod, turf reinforcement mats, and geotextiles. Soil covers shall extend beyond the limits of the HDPE transition matting. Install HDPE in accordance with installation instructions and with a qualified installer.

B. All transition matting shall be in contact with sod, TRM or geotextile fabric. Soil anchors shall be driven at least 18 inches deep or deeper as need to secure HDPE matting. Anchors shall be provided by manufacturer. Anchors shall be installed in a 3 by 2 by 3 pattern.

3.06 Placement of Armortec Concrete Block (ACB) Revetment System

A. The slope shall be graded to a smooth plane surface to ensure that intimate contact is achieved between the slope face and the geotextile (filter fabric), and between the geotextile and the entire bottom surface of the cellular concrete blocks. All slope deformities, roots, grade stakes, and stones which project normal to the local slope face must be re-graded or removed. No holes, "pockmarks", slope board teeth marks, footprints, or other voids greater than 1.0 inch in depth normal to the local slope face shall be permitted. No grooves or depressions greater than 0.5 inches in depth normal to the local slope face with a dimension exceeding 1.0 foot in any direction shall be permitted. Where such areas are evident, they shall be brought to grade by placing compacted homogeneous material. The slope and slope face shall be uniformly compacted, and the depth of layers, homogeneity of soil, and amount of compaction shall be as required by the Engineer.

B. Excavation and preparation for anchor trenches, flanking trenches, and toe trenches or aprons shall be done in accordance to the lines, grades and dimensions shown in the Contract Drawings. The anchor trench hinge-point at the top of the slope shall be uniformly graded so that no dips or bumps greater than 0.5 inches over or under the local grade occur. The width of the anchor trench hinge-point shall also be graded uniformly to assure intimate contact between all cellular concrete blocks and the underlying grade at the hinge-point.

C. The filtration geotextile shall be placed directly on the prepared area, in intimate contact with the subgrade, and free of folds or wrinkles. The geotextile shall not be walked on or disturbed when the result is a loss of intimate contact between the cellular concrete block and the geotextile or between the geotextile and the subgrade. The geotextile filter fabric shall be

placed so that the upstream strip of fabric overlaps the downstream strip. The longitudinal and transverse joints shall be overlapped at least two (3) feet. The geotextile shall extend at least one foot beyond the top and bottom revetment termination points. If cellular concrete blocks are assembled and placed as large mattresses, the top lap edge of the geotextile should not occur in the same location as a space between cellular concrete mats unless the space is concrete filled.

D. The cellular concrete blocks shall be placed on the filter fabric in such a manner as to produce a smooth plane surface in intimate contact with the filter fabric. No individual block within the plane of placed cellular concrete blocks shall protrude more than one-half inch or as otherwise specified by the Engineer. To ensure that the cellular concrete blocks are flush and develop intimate contact with the subgrade, the blocks shall be "seated" with a roller or other means as approved by the Engineer.

E. If assembled and placed as large mattresses, the cellular concrete mats shall be attached to a spreader bar or other approved device to aid in the lifting and placing of the mats in their proper position by the use of a crane or other approved equipment. The equipment used should have adequate capacity to place the mats without bumping, dragging, tearing or otherwise damaging the underlying fabric. The mats shall be placed side-by-side and/or end-to-end, so that the mats abut each other. Mat seams or openings between mats greater than two (2) inches shall be filled with 4000 p.s.i. non-shrink grout. Whether placed by hand or in large mattresses, distinct changes in grade that results in a discontinuous revetment surface in the direction of flow shall require a grout seam at the grade change location so as to produce a continuous surface.

F. Anchor trenches and side trenches shall be backfilled and compacted flush with the top of the blocks. The integrity of the trench backfill must be maintained so as to ensure a surface that is flush with the top surface of the cellular concrete blocks for its entire service life. Toe trenches shall be backfilled as shown on the Contract Drawings. Backfilling and compaction of trenches shall be completed in a timely fashion. No more than 500 linear feet of placed cellular concrete blocks with non-completed anchor and/or toe trenches shall be permitted at any time.

G. The cells or openings in the cellular concrete blocks shall be backfilled and compacted immediately with suitable material to assure there are no voids and so that material extends from the filter fabric to one-inch above the surface of the cellular concrete block. Backfilling and compaction shall be completed in a timely manner so that no more than 500 feet of exposed mats exist at any time.

H. The cells or openings in the cellular concrete blocks shall be backfilled and compacted immediately with suitable material to assure there are no voids and so that material extends from the filter fabric to one-inch above the surface of the cellular concrete block. Backfilling and compaction shall be completed in a timely manner so that no more than 500 feet of exposed mats exist at any time.

END OF SECTION

SECTION 02632

STORM SEWERS AND CULVERTS

PART 1 - Description

This section covers storm sewer and culvert materials, excavation, trenching, and backfilling for storm sewers and appurtenances. Work shall consist of removal of all material of whatever description that may be encountered; removal and disposal of debris; handling and storage of materials; all necessary bracing, shoring, and protection; pumping and dewatering as necessary; all backfill preparation of subgrades; and final grading, dressing, and surface restoration cleanup of the site.

PART 2 - Materials

2.01 Submittals

Before the fabrication of the pipe and manholes is started, the contractor shall submit for review, drawings showing the pipe lengths, complete laying schedule, joint details, special sections, and other additional details, such as fittings. All pipe and manholes furnished shall be fabricated in accordance with the reviewed drawings. Manufacturer's certificates of compliance and installation recommendations shall be provided to the City prior to construction.

2.02 Materials

The materials furnished for the storm sewer pipe and culverts shall be equal to or shall exceed the following requirements.

A. Storm Sewer Pipe and Culverts

The materials furnished for the storm sewer pipe and culverts shall be equal to or shall exceed the following requirements.

1. Reinforced Concrete Pipe (RCP)

    a. All reinforced concrete pipe shall conform to the requirements of ASTM Standards for the specified diameter and strength class as follows:

        1. Circular Pipe – ASTM C76
        2. Horizontal and Vertical Elliptical Pipe – ASTM C507
        3. Arch Pipe – ASTM C506

    b. Minimum wall thickness shall be "Wall B" in referenced specifications C76 and C14 of ASTM.

    c. Strength class or classes shall be as required by the Plans or Contract Documents but in

no case shall pipe of less than strength Class III be used. Portland Cement used in manufacturing reinforced concrete pipe shall be Type II, ASTM C150.

d. Lifting holes will not be permitted in any of the pipe, except elliptical pipe and box sections.

e. Joints for the reinforced concrete pipe shall be either tongue and groove or bell and spigot. Except for special pieces, each joint shall be at least seven and one-half feet (7'6") (2.3m) in length. Unless deleted elsewhere in the specifications, joints in reinforced concrete pipe shall conform to one of the following types:

Rubber Trapped "O" Ring Gasket type – ASTM C 443
Flexible Plastic Rope Gasket type – AASHTO M 198 – Type B
Flexible Butyl Rope Gasket type – AASHTO M 198 – Type A
Portland Cement Mortar Joint type

f. Type D, Portland Cement Mortar Joint, may only be used on radial, elliptical, and arch pipe. The shape, dimensions, and tolerance of the bell and spigot or tongue and groove ends of the pipe shall be compatible with the type of joint used and shall conform to the above referenced specifications.

g. Reinforced concrete pipe shall be manufactured in a plant that is certified by the American Concrete Pipe Association.

h. In addition to the certifications and bearing test results, the contractor shall furnish the Owner with mill test reports for all cement used to manufacture proposed pipe. The owner reserves the right to sample and test any pipe after delivery and to reject all pipe represented by any sample which fails to comply with the specified requirements.

2. Polyvinyl Chloride Pipe (PVC)

a. Polyvinyl chloride pipe (PVC) shall conform to ASTM D3034, SDR 26, for four inch (4") (100mm) through fifteen inch (15") (375mm) diameter and ASTM F679 for eighteen inch (18") (450mm) through thirty six inch (36") (914 mm) diameter. The pipe shall have bell and spigot joints with an approved gasketed joint.

b. When special fittings such as wyes, tees, etc., are required, they shall be manufactured from the same material as the pipe and shall be made for use with PVC pipe. Connections to manholes and catch basins shall be made using O-ring gaskets whenever ground water is present; otherwise, catch basins and manholes may be grouted. Other suitable elastomeric boots may be used.

3. Corrugated Steel Pipe (CSP)

a. Corrugated steel pipe, band couplers, and fittings, shall be manufactured in accordance with AASHTO M-36, latest edition, as revised in these specifications. All seams shall be joined in a manner that develops the full strength of the pipe and shall not affect the shape or nominal diameter of the pipe. The wall thickness of the steel shall be specified in the Special Provisions. Corrugated Steel pipe shall not be used unless shown on the construction drawings.

b. The materials used to coat the steel sheets shall be specified in the Special Provisions and may be one or more of the following types:

   i Zinc-coated (galvanized) steel sheets for annular pipe shall be coated in accordance with AASHTO M-218.

   ii Aluminized coated (Type 2) steel sheets shall be coated by the hot dip process in accordance with AASHTO M-274, M-36, and M-274.

   iii Precoated (Polymeric) galvanized steel sheets shall be coated in accordance with AASHTO M-246 and M-245. The precoated sheets shall be Type C with a polymeric coating in a thickness of 0.010 inch (3mm) minimum on each side and edge of the sheets.

c. After the fabrication of the pipe, the manufacturer will coat the cut ends of each section of pipe with the specified coating before shipping. Exposed uncoated metal at the ends of the pipe may be reason for rejection of the pipe.

d. The CSP shall be joined together with coupling bands manufactured in accordance with AASHTO M-36. If coatings of the CSP are specified, the couplings shall be coated with the same materials. Unless otherwise specified, the couplings shall make a watertight joint.

e. All pipe shall be inspected when delivered to the job site and prior to the unloading of the pipe. Any pipe damaged during shipping and/or handling will be rejected and will not be installed. If the exterior bituminous coating is damaged during installation, the contractor shall repair the coating using approved methods and materials. If the concrete lining is damaged during installation, the contractor shall remove and replace the damaged pipe at no expense to the owner.

f. The pipe supplier shall prepare and supply the contractor with a pipe-laying schedule, and the Contractor's supervisor and superintendent and the owner's representative shall have these laying schedules available on the job site.

g. Connections for the laterals and catch basin leads may be shop fabricated or made in the field. In some instances, field connections shall be required. All field connections shall be saw cut using a saber type saw and templates made for such use. Flame cutting shall not be allowed. After field cuts have been made, the exposed metal shall be coated with the

specified coating. Coating materials shall be supplied by the pipe manufacturer. The connection shall be completed according to the manufacturer's recommendations.

h. Installation of corrugated steel pipe is considered to be a flexible conduit and, therefore, special care must be taken during the bedding and backfilling operations. Installation and backfilling operations shall be in accordance with the recommended practices set forth in the "Handbook of Steel Drainage and Highway Construction Projects", published by the American Iron and Steel Institute.

i All pipe shall be bedded with an approved granular bedding material. The pipe shall be bedded true to line and grade with uniform and continuous support from a firm base. Blocking shall not be used to bring the pipe to grade.

ii The bedding material shall be placed evenly on both sides of the pipe to a point twelve inches (12") above the top of the pipe. Special care shall be taken to insure that all voids are filled beneath the pipe haunch and that the bedding material is properly placed and compacted to provide lateral restraint. The trench sidewall shall be adequately braced, shored, or sheeted as necessary to stabilize the trench walls. The trench shall not be any wider than necessary for proper installation, and pipe jointing. The bedding material shall be placed under haunches and around the pipe alternately in 6-inch layers on both sides of the pipe to permit thorough consolidation of the bedding material. This material is placed alternately to keep it at the same elevation on both sides of the pipe at all times.

iii Extreme care shall be taken in the removal of cribbing, shoring, sheeting, etc., so as not to disturb previously constructed foundation, bedding and initial backfill. If it was necessary to place or drive sheeting or other trench protection below the top of the pipe, the sheeting, shoring, etc., shall be cut off at a point one foot (1') above the pipe and the remaining material shall be left in place. Removal of this portion could seriously jeopardize the side support necessary for "flexible conduits" and create excessive lateral soils pressures and pipe deflections.

iv Excessive concentrated loads or heavy equipment on top of or along side of the pipe shall be avoided. Maximum supporting strength in flexible conduits does not develop until the fill consolidates.

4. Corrugated PVC Drainage Pipe

a. Corrugated Polyvinyl Chloride (PVC) pipe shall conform to ASTM F794 and F949 for twelve inch (12") through thirty-six inch (36") diameter. Joints shall be an integral bell-gasketed joint. When the joint is assembled, it shall prevent misalignment of adjacent pipes and form either a soil tight joint (2psi) hydrostatic test per AASHTO Standard Specification for Highway Bridges, Section 26.4.2.4 or a watertight joint (10.8) psi test per ASTM D3212.

b. When special fittings such as wyes, tees, etc., are required, they shall be manufactured from the same material as the pipe and shall be made for use with Corrugated PVC Drainage pipe. Connections to manholes and catch basins shall be made using O-ring gaskets whenever ground water is present; otherwise, catch basins and manholes may be grouted. Other suitable elastomeric boots may be used.

5. Reinforced Concrete Box Culverts

a. Reinforced box culverts shall be precast or cast in place

b. Precast concrete box culverts shall conform to the requirements of ASTM C1433, latest revision. Concrete box culverts shall be manufactured in a plant that is certified by the American Concrete Pipe Association.

B. Manholes

1. All manholes and other precast items shall be manufactured in a plant that is certified by the National Precast Concrete Association. Manufacturer's certificates of compliance and installation recommendations shall be provided to the Engineer and City prior to construction.

a. All manholes shall be constructed with concentric precast sections without steps unless otherwise approved. Precast concrete manhole sections shall be manufactured to standards at least equal to or greater than the requirements of the standard specifications for precast reinforced concrete manhole sections, ASTM designation C478. The minimum internal diameter for storm manholes shall be forty-eight inches (48") (1.2m) unless shown otherwise. Manholes shall conform to all requirements as shown on the detail drawings. Precast manhole joints shall be made water-tight with RAM-NEK material, or approved rubber gasket at each joint. The RAM-NEK and primer must be used in accordance with the manufacturer's instructions. Rubber gaskets used for precast manhole joints shall be designed in accordance with ASTM designation C443. All lifting holes must be grouted. All Portland cement for manholes shall be Type II.

b. The concrete base shall be cast-in-place or precast concrete of the size and depth shown on the drawings. Concrete used for bases shall have a twenty-eight (28) day compressive strength of at least four thousand pounds per square inch (4,000psi) (27,600 kPa). Approved precast concrete bases will be allowed if provided with an integral groove for barrel placement. Precast concrete bases shall conform to ASTM C478. Manholes with a monolithically poured base with bottom barrel are also acceptable and preferred.

c. Precast manhole inverts shall be constructed using a secondary invert forming system designed to provide a finished invert that aligns precisely with the incoming pipelines, incorporating a finished flow depth of 0.8 to 1.0 diameter of the largest pipe. The completed precast invert shall include an alignment bench for each pipe, and provide for

uniform horizontal and vertical transition through the manhole in accordance with drawings. Provide 0.1' (30mm) minimum fall between inlet and outlet. After the installation of the pipelines into the manhole, the interior annular space around the outside of the pipe shall be sealed with grout. The acceptable tolerances for manhole inverts are one-quarter inch (1/4") (6.25mm) in any dimension and within 2 degrees for alignment. The invert forming system shall be "a-lok tru contour", or approved equal.

d. The manhole ring and cover shall be centered over the connection at the centerline of flow.

e. For manholes with depths of six feet (6') (1.8m) or less, all of the precast manhole sections shall be of the specified diameter and shall have a flat, precast concrete top.

f. For sewer manholes four (4) to six (6) feet in diameter and less than twenty (20) feet deep, precast reinforced manhole base sections shall be a minimum of 8 inches thick. For sewer manholes greater than six (6) feet in diameter or more than twenty (20) feet deep, precast reinforced concrete manhole base sections shall be a minimum of 12 inches thick. All precast manhole base sections shall be reinforced with #4 steel reinforcement bars placed 6 inches on center each way and at mid depth of the slab, unless shown otherwise on the plans.

C. Catch Basins.

1. All catch basins, inlet boxes, and other precast items shall be manufactured in a plant that is certified by the National Precast Concrete Association. Catch basins (storm inlets) shall be cast-in-place or precast concrete with dimensions as shown on the drawings or standard details.

   a. Precast concrete catch basins shall comply with all the requirements of ASTM C858 and C857. Cast-in-place concrete basins shall be constructed of materials in accordance with Section 03050, Portland Cement Concrete.

   b. The Contractor may elect to install pre-cast or cast-in-place catch basins.

D. Castings

1. Manhole frames and covers, and catch basins frames and grates shall meet the requirements of this Section unless specified otherwise in the Special Provisions or drawings.

2. Manhole frames and covers shall be heavy duty Neenah R 1643 or approved equal. Heavy-duty manhole ring and cover shall have a minimum depth of seven and half inches 1.5 inch thick cover, and an inside clearance of 24 inches in diameter.

3. Acceptable grates shall be determined by the design, hydraulic efficiency, and placement required. Additionally, grates must be suitable for use in areas where it is possible for

handicap persons and pedestrians to be present. The adoption of the Americans with Disabilities Act (ADA), the prominence of narrow-tired bicycles and concern for pedestrian safety dictates the design considerations of storm water installations.

Grate selection criteria should include a combination of capacity, and functionality for the specific location. Directional and/or vane grates are not recommended at the low points of vertical curves, and shall be used only when approved by the Engineer.

Catch basin frames and curb box shall be Neenah R-3067, D&L Supply I-3517, or equivalent. I-3516 is recommended for us in the lowpoint of vertical curves.

Grates shall be certified by the manufacturer as bicycle friendly, and the certification shall be submitted to the City prior to installation.

4. Cover and frame seat shall be machine finished to prevent any rocking of cover in its associated frame. Cover shall have the word "storm sewer" clearly cast on its surface.

   When required, self-sealing, waterproof frames and covers meeting Neenah R-1916-F, or approved equal shall be used.

5. Flared end sections for culverts shall be manufactured of the same material as the culvert. End sections shall be fitted for a trash rack on both upstream and downstream ends, or as directed by the Engineer.

E. Granular Materials

1. Granular materials furnished for foundation, bedding, encasement or other purposes as may be specified, shall consist of any material or synthetic mineral aggregate such as sand, gravel, crushed rock, crushed stone or slag, that shall be so graded as to meet the gradation requirements specified herein for each particular use.

2. Granular materials furnished for use in foundation, bedding, or encasement recommended for use in construction are:

MATERIAL USE DESIGNATION

Sieve Size	Percent Passing Foundation AASHTO M43 (No.57)	 Bedding & Encasement AASHTO M43 (No. 67)
1 inch (25mm)	95-100	100
3/4 inch (20mm)	-	90-100
½ inch	25-60	-
3/8 inch (9.5mm)	-	20-55
No. 4 (4.75mm)	0-10	0-10

No. 8 (0.075mm)	0-5	0-5

3. Other approved material for bedding and encasement shall consist of sand, sandy gravel, or fine gravel having a maximum size of three-quarter inch (3/4") (20mm), uniformly graded and a maximum plasticity of 6 as determined by AASHO T-89 and T-90. Other gradations may be used if written approved is obtained from the City.

4. Certified copies of all sieve analysis and plasticity analysis for the above materials shall be submitted to the City Engineer and approved before construction starts. Other sieve or plasticity analysis may be required during construction as directed by the City Engineer.

5. Granular materials provided for Foundation, Bedding, or Encasement use, shall be classified as to use in accordance with the following:

   a. Granular Foundation: placed below and to the midpoint of the pipe as replacement for unsuitable or unstable soils, to achieve better foundation support.

   b. Granular Bedding: placed from four inches (4") (100mm) to six inches (6")(150mm) below the pipe to the pipe midpoint, to facilitate proper shaping and achieve uniform pipe support. When foundation material is required, the granular bedding shall be of foundation material gradation.

   c. Granular Encasement: placed below an elevation one foot (1') (300mm) above the top of pipe, after pipe installation, for protection of the pipe and to assure proper filling of voids or thorough consolidation of backfill. Granular encasement shall be provided for all flexible piping.

6. Granular encasement and bedding material shall meet the gradation requirements listed in herein. Other gradations may be used if written approval is obtained from the City Engineer. Gradations should meet the requirements of ASTM 2321. Guidelines for the maximum particle size for encasement material in relation to pipe type and diameter are shown below:

Pipe Type	Nominal Diameter Inches (mm)	Maximum Particle Size Inches (mm)
PVC, Other Plastic	15" and greater	3/4 (20)
PVC, Other Plastic	Less than 15"	½ (12.5)
Concrete	6.1 - 12.0 (155 - 300)	1 (25)
Concrete	12.1 (307) and greater	1 (25)
CMP	6.1 - 12.0 (155 - 300)	1 (25)
CMP	12.1 (307) and greater	1 (25)

7. Select Backfill

Job excavated and imported select backfill material shall be free from debris, organic material, and stones larger than three inches (3") (75mm) in diameter. Contractor shall be responsible, at his expense, for separating debris, organic material and stones larger than three inches (3") (75mm) in diameter. Select material that the Engineer directs to be used shall be the same gradation as the bedding and encasement material. No asphalt chunks or concrete may be used as select backfill.

8. Structural Fill Material

   Structural fill shall consist of excavated or imported material, free of organic or deleterious material and particles larger than three inches (3") (75mm) in maximum dimension. Structural fill shall be well graded from coarse gravel to fine sand with less than 10% passing the No. 200 sieve. Structural fill material shall be within +2% of optimum moisture content when placed as determined by Proctor, and shall not exhibit pumping (horizontal or vertical displacement) after completion.

9. Groundwater Barriers

   Low permeability ground water barriers may be used in areas designated by the City Engineer. Barrier material shall meet soil classification GC, SC, or CL per the Unified Soil Classification System and shall have a liquid limit less than 50. The barrier material shall be compacted to 95 percent of maximum density. Job excavated material meeting one of the above soil classifications and free from stones, organic matter and debris may be used.

10. Portland Cement Concrete shall be of the class and dimensions as shown on the Plans or as directed by the Owner. The classes of concrete for drainage facility construction are referred to as Class AS and Class C. Class AS concrete is intended principally for concrete structures designed for high strength. Class C concrete is intended principally for low strength concrete used primarily for foundation stabilization, pipe cradles and encasement and other general purposes. All Portland Cement Concrete shall meet the requirements of Division 3 of these specifications.

Part 3 - Execution.

3.01 Excavation for Pipe and Related Structures (General)

1. Complete all excavation regardless of the material encountered. If structures, utilities, or other objects are encountered that may be necessary for continued facility operation or may need preservation, immediately notify the Engineer and protect said object.

2. When cutting into existing roads, streets, alleys, or other public rights-of-way, the Contractor, shall obtain the proper licenses, cut permits, etc., from the appropriate authority.

a. Where trench excavation requires the removal of curb and gutter, concrete sidewalks, or asphaltic or concrete pavement, the pavement or concrete shall be cut in a straight line parallel to the edge of the excavation by use of a concrete saw, or similar approved equipment to obtain a straight, square, clean break. Cuts shall be located at standard joint locations, when possible.

3. When crossing existing or prospective cultivated areas, gravel streets or other developed surfaces, the Contractor shall strip the cover material to full depth of the existing surfacing. This surfacing shall be stockpiled and placed back over the trench after backfilling to the extent that it is acceptable and usable for that purpose. New material shall be provided as necessary. Topsoil shall be removed to full depth of the topsoil, or to a maximum depth of twelve inches (12") (300mm), whichever is less.

4. The disturbed area from construction shall be confined within the construction limits.

   a. The trench shall be dug only as far in advance of the pipeline as work can be reasonably completed that day. The sides of the trench shall be sloped and/or braced in accordance with the current OSHA Standards and the trench drained so that workers can work safely and efficiently. It is essential that the discharge of pumps when required, be laid to approved natural drainage channels or storm sewers

5. Pipe crossings under sidewalks or curbs may be made by tunneling only if approved by the Engineer. If the Contractor elects to remove a portion of the sidewalk or curb, he must use a concrete saw for making neat joints corresponding to existing joints, compact the backfill as specified, and pour a new concrete sidewalk or curb section in accordance with the applicable sections of these specifications.

6. During excavation, materials suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials shall be stored and retained at least two feet (2') (600mm) or more from the edge of the trench in accordance with Occupational Health and Safety Rules and Regulations for Construction. Excavated material must not be piled over nearby existing parallel trench lines unless adequate precautions are taken by the Contractor to prevent sidewall failure. Ready access to existing fire alarm boxes, fire hydrants, valves, manholes, and other appurtenances must be maintained.

   a. When making excavations, the various materials excavated shall be piled separately. All concrete and bituminous materials, any soils, which cannot be properly compacted, and all other deleterious materials shall be immediately removed from the construction site and properly disposed of in accordance with applicable laws.

   b. All excavated material shall be piled within the construction limits or in a location obtained by the Contractor and accepted by the Engineer in a manner that will not endanger the

work and that will avoid obstructing sidewalks, driveways, and fire hydrants.

7. Surface drainage of adjoining areas shall be unobstructed. Grading shall be done as may be necessary to prevent surface water from flowing into excavations, and any other water accumulating therein shall be promptly removed. Under no circumstances shall water be permitted to rise in unbackfilled trenches until after the pipe has been placed, tested, and covered with backfill. Any pipe having its alignment or grade changed as a result of a flooded trench shall be reinstalled.

    a. Gutters shall be kept clear or other satisfactory provisions made for street drainage at all times.

8. The bottom of the trenches shall be accurately graded to the line and grade shown on the drawings. Bedding material shall be added (four inches (4") (100mm) minimum) to provide uniform bearing and support for each section of pipe at every point along its length. Care must be taken to avoid over excavation. Unauthorized over-depths shall be backfilled with approved bedding material at the Contractor's expense. All bedding material added shall be moistened and compacted to the satisfaction of the City Engineer. The finished trench bedding beneath the pipe shall be prepared accurately by means of hand tools.

    a. The bottom of all excavations shall be neat and clean, containing no abrupt changes in grade except as shown and shall be free from all slough. Suitable methods shall be used to produce an excavated surface without disturbance to the underlying material by compacting soil material to at least 95% Standard Proctor, ASTM D698.

    b. If in its natural state the material at the bottom of the trench is soft and, in the opinion of the City Engineer, cannot support the pipe, a further depth and/or width shall be excavated as directed by the City Engineer and refilled with foundation material to the midpoint of the pipe. Other approved methods may be used to assure a firm foundation.

    c. Foundation material used to dewater the trench or to replace a wet material shall be considered incidental to construction.

9. Blasting the excavation to remove rock, clay, or hardpan will not proceed until the Contractor has notified the City Engineer of the necessity to do so and obtained written approval. This notification shall in no manner relieve the Contractor of the hazard and liability contingent on blasting operations. The City Engineer shall fix the hours of blasting. The Contractor at his expense shall repair any damage caused by blasting. The Contractor's methods of procedure relative to blasting shall conform to local and state laws and municipal ordinances, and the necessary permits shall be obtained.

10. The width of the trench shall be such to provide adequate working room for workers to install the pipe in the specified manner. The trench in the pipe zone and to one foot (1') (300mm) above the pipe zone shall be adequate in width to allow for proper compaction but shall in no

case be less than one and half times the outside pipe diameter plus one foot (1') (300mm).

11. Where the trench is not located near existing utilities, buildings, or other structures, and where water and other conditions permit, the Contractor may omit sheeting and bracing of the excavation. In this event, sides of the trench shall be sloped to protect the workers working within them in accordance with Occupational Health and Safety Rules and Regulations for Construction. However, the trench must stay within the construction limits.

12. The Contractor shall provide safety boxes or sheeting and bracing necessary to confine his work within the construction limits, to provide safe working conditions, to prevent damage and delay to the work, and to prevent the disturbing or settlement of adjacent road surfaces, foundations, structures, utility lines or railroad tracks. The Contractor shall be responsible for the strength and sufficiency of all sheeting and bracing.

13. Any damage to the work under this contract or to adjacent structures or property caused by settlement, water or earth pressures, slides, cave-ins, or other reasons due to failure or lack of sheeting and bracing, or improper bracing, or through negligence or fault of the Contractor in any manner, shall be repaired by the Contractor without delay and at his expense.

14. Bracing shall be so arranged as to provide ample working space, so as not to interfere with the work, and so as not to place any strain on the structures being constructed, until such structures are of sufficient strength to withstand such strain. No sheeting and bracing shall be removed until the construction has proceeded far enough to provide ample strength for its safe removal.

    a. Sheeting or bracing may be left in place in the trench at the discretion of the City Engineer. Any sheeting or bracing left in place shall be cut off approximately three feet (3') (900mm) above the top of the pipe or two feet (2') (.6m) below finish grade, whichever is lower, and the cut-off portion removed. All sheeting or bracing left in place shall be accurately located and shown on the "Record Drawings"

15. The Contractor shall be responsible for enforcing safety and maintaining safe working conditions in all trenching, shoring, and blasting operations to conform to OSHA regulations.

16. Trenching and tunneling standards near and around trees.

    a. Trenches should be routed outside the tree protection zone or critical root zone (CRZ). For trees less than 6" diameter at breast height (DBH), defined as 4.5 feet about average ground level, that are to be retained, no trenching should occur within the dripline or tree protection/critical root zone as defined by the City of Lakeland Tree Management Ordinance. For trees 6" DBH and less than 20" DBH no trenching should occur within an area equal to 1' radius for every inch of DBH or within the tree protection/critical root zone as defined by the City of Lakeland Tree Management Ordinance. For trees 20" DBH and greater, no trenching should occur within an area equal to 1.5' of radius for

every inch of DBH or within the tree protection/critical root zone as defined by the City of Lakeland Tree Management Ordinance.

b. Soil removed from the trenches should be placed on the side away from the trees and replaced as soon as possible. The width of the trench should be minimized. The use of trench walls should be considered rather than sloping sides when working around trees.

c. Trenches should be backfilled with quality or native soil when inside of a tree protection zone or critical root zone. Gravel, slurry, stone, and concrete are not appropriate fill material within a tree protection zone, unless used as bedding material.

d. If placement of utilities or other infrastructure is unavoidable within the tree protection zone or critical root zone then specific measures should be applied to minimize root damage. Tunneling is recommended as soon as roots 1 inch diameter and greater are encountered. Minimum tunnel depth should be 24 inches. Launch and recovery pits should be located outside of tree protection zones and critical root zones. If tunneling is impossible due to specific soil restrictions, the trenching should be done by hand within the tree protection zone or critical root zone. If this required trenching will sever more than 25% of the tree protection/critical root zone then the trench should be re-directed at the center of the tree with the final section dug under the base of the tree.

e. Changes to the approved construction plans or methods for trenching and tunneling must be submitted to and receive approval by the City's Representative before proceeding.

17. Dewatering, if required by site conditions, shall be provided by the Contractor. The contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface water and groundwater entering the excavations, trenches, or other parts of the work.

18. All trench excavations which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level beneath such excavations twelve inches (12") (300mm) or more below the bottom of the excavation.

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

20. The Contractor shall be responsible for the conditions 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.

21. In areas where dewatering is required, the Contractor will comply with the following requirements.

a. All discharges from dewatering systems, including well points, dewatering wells, pumps

in the bottoms of the trenches, etc. will require a permit from the Tennessee Department of Environment and Conservation (TDEC). Before starting any construction, the Contractor shall submit an application to discharge to the TDEC along with this proposed dewatering plan for review.

b. One copy of the initial application, dewatering plan, and of the permit authorizing the discharge must be provided to the City Engineering office with the application for an excavation permit. Copies of any revisions to the dewatering plan shall be immediately provided to the City Engineering office.

3.02 Disposal of Excess Material

1. Except as otherwise permitted, dispose of excess excavated materials in a legal manner.

2. When making excavations, the various materials excavated shall be piled separately. All concrete and bituminous materials, any soils which cannot be properly compacted, and all other deleterious materials shall be immediately removed from the construction site and properly disposed of in accordance with applicable laws.

3.03 Pipe and Structure Installation

1. The Contractor shall use laser beam equipment, surveying instruments, or other proven techniques to maintain accurate alignment and grade. Reasonable care shall be exercised in handling and laying the pipe and fittings. The interior of all pipe and fitting shall be kept free from dirt and foreign matter at all times, and cleaned out thoroughly before being lowered into the trench. Under no circumstances shall materials be dropped or thrown into the trench.

2. Materials shall be placed where they will not be subject to injury from vehicles or equipment. The contractor's facilities for lowering the pipe into the trench shall be such that neither the pipe nor trench will be damaged or disturbed. Pipe shall be lowered into the trench with rope slings, gin poles, dragline, or trench in such manner as to lay the pipe carefully into place and shall be lowered and laid with the bell end upgrade. Holes shall be dug under the bells so that pipe is unsupported at the pipe connection. The laying of pipe in the finished trench shall be started at the lowest point and laid upgrade. The Contractor shall clean and remove all sand, gravel, concrete, and cement grout that has entered the lines in the process of construction.

3. Any pipe which is broken, cracked, or otherwise unsuitable, as determined by the Engineer, shall be removed and replaced by the contractor at no additional cost to the owner. Any damage to pipe coatings shall be repaired with the same materials used for the original coating before laying the pipe.

4. The Contractor shall keep the pipe, manholes, catch basins, and other structures free from deposits of mud, sand, gravel, or other foreign matter, and in good working condition until the construction is completed and accepted. Upon completion of each line between manholes, a

clear and unobstructed view of the whole bore of a pipe shall be obtained between manholes by use of a light or subreflector. If such view is not apparent an air-filled rubber ball, approved by the Engineer, having a diameter one-inch (1") (25mm) less than the tile to be tested, shall be flushed through the line between manholes. Any obstruction found in any line shall be removed by the contractor without cost to the owner. Any methods used by the contractor to remove deposits of mud, sand, gravel, or other foreign matter from the line shall be approved by the Engineer. Unless specified in the Special Provisions, a leakage test will not be required. However, this does not preclude the fact that obvious and concentrated leaks (such as open joints, pinched gaskets, cracked barrels or bells, etc.) will not be allowed.

5. Pipe shall not be laid on frozen ground, or when trench conditions are unsuitable for such work.

6. The upgrade end of pipelines not terminating in a structure shall be plugged with a cap or plug approved by the Engineer.

7. Fine grading to the bottom of the barrel shall proceed ahead of the pipe laying and, should any over-excavation exceeding two inches (2") (50mm) be encountered, the material added shall be moistened (95% of Standard Proctor) and compacted to the density of the existing subgrade or foundation material shall be added at the Contractor's expense.

8. Bell holes shall be dug for the pipe bells or couplings and the materials placed along the preceding pipe laid. The pipe shall be supported for the bottom 60 degrees and throughout its length (except for the minimum distance necessary at the bell holes). Bell holes shall be adequate to make the joint, but no larger than necessary so that maximum support on undisturbed ground or pipe zone material will be provided for the pipe. The remainder of the pipe shall be surrounded to at least its midpoint by granular bedding material, compacted in maximum six inch (6") (150mm)layers to completely fill all space under and adjacent to pipe.

9. Pipe laying should proceed upgrade with the spigot ends pointed in the direction of flow. No pipe shall be laid in water or when the trench conditions are unsuitable for such work, except by written permission of the Engineer. The Contractor shall make all connections of pipe to the manholes which have previously been constructed.

10. The Contractor shall connect all existing storm inlets and sewers to the new storm sewer as shown on the drawings. These connections shall be made as the storm sewer construction progresses which will require that each section of the new sewer be fully completed and ready for operation as the construction advances.

11. Open excavation shall be satisfactorily protected at all times. At the end of each day's work, the open ends of all pipes shall be protected against the entrance of animals, children, earth, or debris, by bulkheads or stoppers. The bulkheads or stoppers shall be perforated to allow passage of water into the installed pipeline to prevent flotation of the pipeline. Any earth or other material that may find entrance into the main sewer or into any lateral sewer through any

such open end of unplugged branch must be removed at the Contractor's expense.

12. Curved alignments shall be constructed with precast, beveled end concrete radius pipe which meet the same requirements as for straight pipe. Concrete radius pipe less than or equal to 36 inch diameter shall have a minimum centerline radius of 20 feet and all radius pipe greater than 36 inch diameter and less than 72 inch diameter shall have a minimum centerline radius of 30 feet.

3.04 Installation of Manholes

1. Excavation shall be to a depth and size to provide for construction of the manhole. Concrete bases shall be poured on undisturbed ground. Precast concrete bases shall be carefully lowered onto one of the following:

   a. Six inches (6") (150mm) minimum layer of well-compacted granular material accurately laid to a smooth level surface using a straight edge and hand level.

   b. Three inches (3") (75 mm) of concrete poured on undisturbed soil.

2. Walls shall be of precast concrete as shown in the standard drawings and shall be constructed to form a complete watertight structure.

3. The Contractor shall provide a minimum of two inches (2") (50mm) and a maximum of twelve inches (12") (300mm) in two-inch (2") (50mm) layers of precast reinforced concrete adjusting rings between the cast iron frame and the manhole top section. Each ring shall be set on a full bed of mortar and shall be made watertight in accordance to Drawing 602-2. Wood will not be allowed as spacers. Adjusting rings shall conform to the size and shape of the casting frame. Frames and covers shall be set to the designated elevation in a full mortar bed.

   a. The minimum two-inch (2") (50 mm) concrete ring for grade is not needed if grade can be met with a six-inch (6") (150mm) flange on top of the cone section of the manhole.

   b. If the number of adjusting rings exceeds the maximum twelve inches (12") (300) mm), the manhole shall be reexcavated and a manhole barrel section installed.

4. Manholes shall be set as shown on drawing details. All lifting holes must be grouted in after placement.

5. When manholes are to be constructed in new streets, manhole rings shall be set to the final grade before the street-wearing course is placed. Riser rings shall not be used to make adjustments for new construction. In gravel or unpaved roads, the manhole ring shall be kept four to six inches (4"-6") (100mm-150mm) below the road surface.

6. The invert of all manholes shall be smoothly shaped so as to allow a free, uninterrupted flow of storm water. The invert forming system shall be "A-Lok Tru Contour", or approved equal. Floor troughs shall be furnished for all storm sewers entering manholes. Inverts shall be U-shaped to the 1.0 diameter point before sloping at a 1 to 12 slope to the manhole walls.

3.05 Trench Backfilling.

A. Trench Backfilling

1. All excavation in trenches shall be backfilled to the original ground surface or to such grades as specified or as shown on the drawings. The backfill shall begin as soon as practical after the pipe has been placed and shall thereafter be carried on as rapidly as the protection of the balance of the work shall permit.

2. No pipe shall be covered before the Project Representative or the Engineer has observed and approved the pipe. If any piping or appurtenance is covered without the approval of the Engineer or Resident Project Representative, at the discretion of the Engineer, the Contractor shall be required to re-excavate to expose the covered materials. The cost of exposing those materials and then backfilling and recompacting will be at the Contractor's expense regardless of the condition of the pipe and/or the materials under question.

3. The Contractor shall completely backfill all excavations before stopping work at the end each day. Open excavations (fenced or unfenced) shall not be allowed overnight or on weekends at any site after work has stopped for the day unless approved by the City.

4. Complete cleanup shall proceed directly behind the backfilling operation to accommodate the return to normal conditions. Should the Contractor, in the City's opinion, fail to pursue diligently the backfilling and cleanup, the amount of work on which complete cleanup has not been accomplished shall be limited to one thousand lineal feet (1,000') (300m) for the entire job. The Contractor shall have sufficient equipment on the job to assure timely backfill and cleanup at all times.

B. Pipe Bedding.

1. Class A - Concrete Cradle

   Class A bedding for storm sewers and culverts shall consist of a continuous concrete cradle up to springline constructed in conformity with the details shown on the Plans or as directed by the Engineer.

2. Class B - Granular Encasement Bedding

   Class B bedding shall consist of a bed of granular material having a thickness of at least 150 mm (6 inches) below the bottom of the conduit. For conduits other than precast reinforced concrete box sections and corrugated aluminum and steel box culverts, the bedding shall extend up around the pipe for a depth of not less than 12 inches above the

top of the pipe.

3. Class C - Granular Bedding
   Class C bedding shall be constructed by bedding the drainage pipe on a bed of granular material shaped by a template to fit the lower part of the pipe exterior for at least 10 percent of its overall height (Minimum of 4 inches below the bell of the pipe). After pipe installation granular encasement material shall then be rammed and tamped in layers not over 6 inches in loose thickness around the pipe to the springline.

4. Class B bedding shall be provided for all piping unless otherwise shown on the drawings and authorized by the City Engineer.

5. Bedding material shall be placed as shown on the typical trench detail and described above. Spread bedding material to provide continuous and uniform support beneath pipe at all points between bell holes or pipe joints. Particular attention shall be given to the area from the base of the pipe or culvert to the centerline to ensure firm, uniform, and continuous support is obtained and to prevent any lateral movement upon subsequent backfilling or under service conditions. Bedding material shall be placed, prepared, and compacted simultaneously on both sides and lateral movement shall be prevented. Bedding material shall be moisture conditioned to +2% to –4% of optimum and compacted to 90% maximum density, as determined by ASTM D698. Class C bedding material shall be placed manually with shovels, and tamped in maximum 6" lifts and evenly placing the material on both sides of the pipe. Bedding material shall not exhibit pumping (horizontal or vertical displacement) after compaction. Encasement material will then be placed around and over the top of the pipe, but need not be hand placed. During conditions where flexible piping shall be buried in excess of 20 feet in depth, all bedding material shall be moisture conditioned to +2% to -4% of optimum and compacted to 95% maximum density, as determined by ASTM D698.

6. Trench Backfill above the Encasement Zone. Trench backfill above the encasement zone may consist of excavated material or select backfill material. Excavated material shall be used unless the minimum density requirements cannot be met. Select backfill material such as pit run shall be substituted for excavated material to meet compaction requirements. Backfill material shall be pushed onto the slope of the excavated trench and allowed to slide down into the trench. Backfill material shall not be permitted to free fall into the trench until at least one feet (1') (254mm) of cover is over the pipe or culvert. Moisture conditioning may be provided by water trucks or hoses. Excavated or select backfill material shall not exhibit pumping (horizontal or vertical displacement) after compaction.

7. Backfilling shall be done in lifts of uniform layers which will produce the required compaction Each lift shall be completely compacted over the full width of the excavated area. Compacting shall continue until the specified relative compaction has been attained or until no more settlement occurs. Water jetting of backfill shall not be permitted.

8. In-place densities of compacted backfill material shall be determined by the Engineer using

either ASTM standard test method D1556-82 (Sandcone) or ASTM standard test method D2922-81 (nuclear). The minimum and maximum dry density for non-cohesive materials such as clean sands and gravel shall be determined by ASTM D4253 and D4254. The maximum dry density for cohesive backfill materials, such as clays, silts, etc., shall be determined by ASTM D698.

a. Backfill above the encasement zone shall be compacted to the minimum densities and moisture conditions listed below. The densities listed below may only be modified through a geotechnical report.

Area	Cohesive
Streets, highway, alleys	95%, ±2%
Sidewalks, curbs, and driveway	95%, ±2%
Lawns and cultivated areas	90%, ±2%

9. Care of Utilities

   a. In excavating and backfilling for pipelines or structures, extreme care must be taken so as to not mar or injure any gas, telephone, sewer, water, power, or television lines. The utility owner shall be notified that the relocation is necessary and shall be given adequate time to provide for the relocation.

10. When the trench excavation for the sewer main and appurtenances is within the rights-of way of state or county highways, the backfilling of the trench, compaction of materials, subgrade preparation and surfacing shall be done in strict accordance with the requirements and specifications of the authority having jurisdiction or as required by these specifications, whichever is more stringent.

11. In all cases, the Contractor shall blade and compact the roadway after the trench has been backfilled, so that it shall be passable to traffic at all times. The Contractor shall maintain the roadway in a condition acceptable to the City at all times until final acceptance of the entire work by the City.

12. The Contractor shall also blade and maintain all detours and bypasses. All maintenance work shall be done at no additional compensation. In addition to the blading and maintenance requirements specified, the Contractor shall provide at least one tank truck with pressurized spray bars for spraying water on the streets to control the dust. Dust control shall be required as necessary on all streets after compacting and grading and on all detours and bypasses.

13. The Contractor is responsible for the complete maintenance of his work at all times. If he fails to provide proper maintenance, and safety or nuisance conditions arise, it is expressly understood that City crews may be directed by the City to provide essential maintenance, and that such work will be done at the expense of the Contractor.

14. The Contractor shall remedy at his own expense any defects that appear in the backfill following completion and during the warranty period.

C. Storm Sewers and Culverts Placed on Fill

1. Fill material placed in areas over which storm sewer or culverts will be constructed shall be select earth material from the elevation of suitable subgrade to the bottom elevation for bedding or foundation of the drainage facility.

2. Placement and Compaction. If storm sewer or culverts are constructed on filled areas, the fill material shall be placed in 6 inch loose layers and compacted to 95 percent of maximum density at plus or minus 2 percent of optimum moisture content as determined by Laboratory Standard Proctor Test (ASTM D 698) up to a point at least 2 feet above the outside top of the pipe or to the foundation of manholes, inlets, special structures, box culverts, concrete channel lining and concrete ditch paving. If compaction standards for storm sewer pipe exceed that of the adjoining fill, the width of compaction for the storm drain shall be not less than the outside diameter of pipe plus 10 feet. If compaction standards for the manhole, inlets, special structure, box culverts, concrete channel lining and concrete ditch paving exceed that of adjoining fill, the limits of compaction for the facility shall be not less than 5 feet outside of the facility base slab.

3.06 Installation of Structures.

1. Structures shall be set on a six-inch (6") (150mm) layer of foundation material when directed by the Engineer. The surface shall be accurately graded to provide uniform bearing for the structure.

2. Catch basins shall be constructed at the locations shown on the drawings and approved by the Engineer. The size and type of catch basins shall be shown on the drawings or in the Standard Details of the Specifications. Catch basin frames shall be set accurately to grade. Concrete grout shall then be placed around and beneath the frame to hold the grate securely in place.

3. Manhole castings shall be installed one-fourth inch (1/4") (6.25mm) to one-half inch (1/2") (12.5mm) below the surface of the existing pavement. Where the structure is in unpaved streets, the manhole casting shall be set to the future street elevation. The casting shall be constructed as shown in the Standard Details. The contractor shall provide a minimum of two inches (2") (50mm) and a maximum of twelve inches (12") (300mm) in two inch (2") (50mm) layers of precast reinforced concrete adjusting rings between the cast iron frame and the manhole top section. Each ring shall be set on a full bed of mortar and shall be made watertight. The bearing surface around the perimeter of the frame shall be grouted to a height within two inches (2") (50mm) from the existing street surface, and to a width of twelve inches (12") (300mm) greater than the manhole ring, and a depth of six inches (6") (150mm) below the bottom adjusting rings or one foot (1') (300MM), whichever is greater. The manhole frame

shall then be tacked and asphaltic concrete pavement shall be placed for the final two inches (2") (50mm).

3.07 Structure Backfilling.

A. Structure backfilling shall cover manholes, catch basins, junction boxes, and any other structure encountered during the course of the work. Fill around structures shall consist of trench backfill meeting the requirements of structural fill material or select backfill material. Fill material shall be spread and compacted to provide continuous and uniform support around the structure. Special attention shall be given to the compaction operation around structures to ensure uniform compaction.

B.. Do not place fill when the surface to be filled is frozen. Do not place frozen fill.

C.. Fill around concrete structures shall commence only after concrete has attained 80% of the ultimate compressive strength specified. Remove all form materials, concrete spills, and trash from around the structures before placing fill. Where backfilling on both sides or around the perimeter of a structure is required, place the backfill and compact simultaneously at the same elevation on opposite sides or around the perimeter in lifts.

D. Place fill material in eight inch (8") (200mm) maximum lifts and compact to at least 95% density for cohesive soils. The moisture content shall be +2% to –2% of optimum.

3.08 Cleanup

A. Construction cleanup and all backfill operations shall directly follow the storm sewer installation. Cleanup shall be completed to allow local traffic on the street and access to driveways, parking lots, etc.

B. During construction, all existing gutters, storm drains, runoff channels, etc., shall be kept clean of dirt, rubble, or debris which would impede the flow of storm sewer.

3.09 Quality Control

1. Light Test

    a. After the trench has been backfilled, a light test shall be made between manholes to check alignment and grade for displacement of pipe. Except for curved alignments shown on the plans, the completed pipeline shall be such that a true circle of light can be seen from one manhole to the next. If alignment or grade is other than specified and displacement of pipe is found, the Contractor shall remedy such defects at his own expense.

2. Leakage Test

a. Unless specified in the Special Provisions, a leakage test will not be required. However, this does not preclude the fact that obvious and concentrated leaks (such as open joints, pinched gaskets, cracked barrels, or bells, etc.) will not be allowed.

3. Gradation Test

   a. Bedding Material

      i One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1000 yd^3) (750m^3) placed of each material.

   b. Foundation Material

      i One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1000 yd^3) (750m^3) placed of each material.

   c. Structural Fill Material

      i One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1000 yd^3) (750m^3) placed of each material.

   d. Select Backfill Material

      i One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1000 yd^3) (750m^3) placed of each material.

   e. Encasement Backfill Material

      i One initial gradation test for each type of material plus one additional test for each one thousand cubic yards (1000 yd^3) (750m^3) placed of each material.

   f. All gradation tests shall be the responsibility of the Contractor using a certified approved testing laboratory acceptable to the Owner and Engineer. The Contractor shall be responsible for all costs associated with gradation testing.

4. Density Test

   a. Encasement Zone Material

      i One test for each five hundred lineal feet (500') (150m) pipe installed.

   b. Bedding Zone Material

      i One test for each five hundred lineal feet (500') (150m) pipe installed.

c. Trench, Select Backfill Material, and/or Structural Fill Material

i One standard proctor test ASTM D698 or one relative density test, (ASTM D4253 and D4254) for each type of material for every two foot (2') (600mm) of trench depth above the pipe zone per every three hundred lineal feet (300') (30m) pipe installed. The Engineer may elect to take one test for each one thousand cubic yards (1000yd^3) (750m^3) or a portion thereof.

d. Unless otherwise indicated in the Contract Documents, density and moisture tests shall be the responsibility of the Owner/Engineer. The Contractor shall cooperate with the Engineer or testing agency. If the initial moisture/density tests fail, the Contractor will be responsible for all costs associated with retests, until a passing moisture/density test is completed.

5. Deflection Test

a. Mandrel or deflection testing for flexible conduit shall be conducted as directed by the City Engineer. Testing shall be conducted using a mandrel with a diameter equal to 95 percent of the inside diameter of the pipe. The test shall be performed without mechanical pulling devices. The mandrel go/no-go, device shall be cylindrical in shape and constructed with either 9 or 16 evenly spaced arms or prongs. Mandrels with few arms will be rejected. Contact length of mandrel's arms shall equal or exceed nominal inside diameter of pipe to be inspected. Critical mandrel dimensions shall carry tolerance of 0.01 inch maximum. Contractor shall provide mandrel and necessary equipment for mandrel test. Mandrel shall be hand-pulled through flexible pipe lines prior to end of warranty period. Sections of pipe not passing mandrel shall be uncovered and rebedded, rerounded, or replaced to the satisfaction of the owner. Repaired section shall be retested. It is also recommended that the contractor perform a mandrel test prior to placing paving surfaces.

3.10 Final Acceptance and Record Drawings

A. "Record Drawings" shall be submitted to the City prior to preliminary acceptance of the construction project. "Record Drawings" shall include, in addition to construction drawings and details, "as built" information where it differs from construction drawings and locate information including horizontal and vertical coordinates in the datum established by the City for the Geographical Information System.

B. Final Acceptance

1. Final acceptance will not take place until preliminary acceptance is obtained and all paving and curbwalk is completed.

2. Before final acceptance of any storm sewer, the following inspections shall be made:

a. All lines clean and flushed

b. Manholes up to proper grade in a proper condition

3. All punch list items must be completed prior to final acceptance.

END OF SECTION

SECTION 02741

ASPHALTIC CONCRETE PAVEMENT

PART 1 – Description

This work shall consist of an asphaltic concrete pavement constructed in one or more layers for surface course(s) and binder course(s). The binder course may also be used as a leveling or bushing course. Binder course shall consist of a hot mixture of aggregate and asphalt prepared in a hot bituminous mixing plant. The binder course shall be constructed on a prepared subgrade, subbase, or base conforming to the lines, grades, thicknesses, and cross-sections shown on the Plans or as directed by the Engineer. The surface course shall consist of an asphaltic concrete pavement composed of a mixture of coarse aggregate, fine aggregate, mineral filler, and asphalt cement, constructed on a prepared roadbed in conformity with the lines, grades, thicknesses, and cross-sections shown on the Plans or directed by the Owner.

PART 2 – Materials And Equipment

2.01 MATERIALS

A. Asphalt Cement. Asphalt cement shall conform to the requirements of ASSHTO M 226, Table 2, for the grade specified. Unless otherwise directed, asphalt shall be Viscosity Grade AC-20, PG64-22, or PG 64-28. The type and grade of bituminous material may be changed one step by the Engineer during construction, at now change in unit price.

B. Course Aggregate. Course aggregate (aggregate retained on the No. 4 sieve) shall be crushed stone meeting the quality requirements of ASTM D 692 with the following exceptions:

1. Crushed limestone shall have a sodium sulfate soundness loss not exceeding 9 percent.
2. For Mix No. 1, material retained on the No. 4 sieve shall have a maximum of 20 percent elongated pieces (length greater than five times the average thicknesses).
3. For Mix No. 2, the aggregate shall contain no more than 5 percent soft or nondurable particles.
4. For Mix No. 3, the aggregate shall contain no more than 5 percent soft or nondurable particles.

C. Fine Aggregate. The fine aggregate shall consist of natural sand consisting of hard, clean, tough grains which will have a maximum loss of 12 percent when subjected to the sodium sulfate soundness test.

D. Composition of Mixtures

1. Asphaltic Concrete Surface, Mix No. 1, shall be laid in one course to the thickness shown on the Plans.

2. Asphaltic Concrete Binder, Mix No. 2, shall be laid in one or more courses to the thicknesses shown on the Plans. Mix No. 2 may also be used as a leveling course or bushing course.

3. Asphaltic Concrete Binder, Mix No. 3 shall be laid in one or more courses to the thickness shown on the plans.

4. The composition of the mixes shall be as follows:

	Total Percent Passing by Weight		
Sieve Size	Mix No. 1	Mix No. 2	Mix No. 3
2"	100	100	100
1-1/2"	100	100	90 - 100
3/4"	100	100	65 - 90
3/8"	76 – 96	65 - 95	----------
No. 4	51 - 76	45 - 70	30 - 55
No. 8	36 - 60	25 - 50	20 - 45
No. 30	16 - 40	12 - 30	8 - 25
No. 100	3 – 12	2 – 12	2 - 12
No. 200	2 - 8	1 - 6	1 - 6

5. The proportions of the total mixture, in percent by weight, shall be as follows:

Courses	Combined Mineral Asphalt Aggregate	Cement
Mix No. 1, Surface(Limestone)	92.0 – 96.0	4.0 – 8.0
Mix No. 2, Binder	93.0 – 97.5	2.5 – 7.0
Mix No. 3, Binder	93.0 – 97.5	2.5 – 7.0

6. It is the intent of this Section of the Specifications that the above described mixes shall conform to the following mixtures specified in the Tennessee Department of Transportation Standard Specifications for Road and Bridge construction.

Mix No. 1 – Section 411, Asphaltic Concrete Surface (Hot Mix), Aggregate Grading E.
Mix No. 2 – Section 307, Bituminous Plant Mix Base (Hot Mix), Aggregate Grading C.

Mix No. 3 – Section 307, Bituminous Plant Mix Base (Hot Mix), Aggregate Grading B.

7. For multiple layer construction, succeeding layers shall not be laid until the previous layer has cooled sufficiently to support the construction equipment

8. When Mix No. 1 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 80 percent crushed limestone and not more than 50 percent nor less than 20 percent natural sand. When Mix No. 1 is used for surfacing of shoulders or other non-traffic lane construction, the mineral aggregate may be composed entirely of limestone, including screening and manufactured sand, but in no case shall the mineral aggregate for this construction consist of less than 50 percent limestone. The natural sand shall be so graded that not more than 5 percent will be retained on the No. 4 sieve.

2.02 EQUIPMENT

A. All equipment necessary for the satisfactory performance of this construction shall be on the Project and approved of before work will be permitted to begin. The equipment shall meet the requirements of Specification Section 02710.

PART 3 – Execution

3.01 General

A. The general construction requirements for surface and binder courses shall be as prescribed in the applicable portions of Specification Section 02710

3.02 Preparation of Base or Existing Surface

A. The designated surface upon which asphalt concrete courses are to be placed shall meet the applicable requirements of Specification 02710 and be thoroughly cleaned of all dirt and other foreign or loose matter prior to the application of the Tack Coat or Prime Coat, as specified in TDOT Specification Sections 402 and 403.

3.03 Thickness And Surface Requirements

A. Thickness shall be controlled during the spreading operations by frequent measurements taken of freshly spread mixture to establish a relationship between the un-compacted and compacted material. This thickness shall remain in conformity with that specified on the Plans. The surface of all courses shall meet the requirements specified under Specification Section 02710 and when tested in

accordance with the provisions of Specification Section 02710 the deviation of the surfaces from the testing edge of the straightedge shall not exceed 1/4 inch for Mix No. 1 or 3/8 inch for Mix No. 2 and Mix No. 3.

3.04 Manhole Adjustments

A. Drainage and sanitary sewer manholes owned by the City shall be adjusted and set at final grade by the Contractor as necessary for compliance with the Plans. Adjustments of City owned manholes shall be as specified in Section 02530 or 02632 of these Specifications. Manholes, valve boxes, and other utility structures not owned by the City but within the right-of-way of the project shall be adjusted as necessary by the owner of such facilities. The Contractor shall be responsible for notifying other owners of any required adjustments and for the accomplishment of that work by the owner of such facilities according to the project schedule.

3.05 Traffic And Maintenance

A. The Owner will determine when the surface course has sufficient compaction and has cured sufficiently to allow construction equipment, slow moving local traffic, or normal traffic to use the completed surface.

END OF SECTION

SECTION 02770

CONCRETE CURB, CURB AND GUTTER, VALLEY GUTTERS, SIDEWALK, AND DRIVEWAYS

PART 1 - Description

The work covered by this section consists of furnishing all equipment, labor, and materials necessary for constructing concrete curb, curb and gutter, valley gutters, sidewalks, and driveways on natural or prepared subgrades and bases, completed in accordance with the following specifications and dimensions shown on the plans.

PART 2 – Materials

2.01 Materials

A. Portland Cement Concrete

1. Portland Cement Concrete shall conform to the requirements specified under Section 03050 Portland Cement Concrete

B. Reinforcing Steel and Fibers

1. Reinforcing steel for concrete reinforcement shall meet the requirements of ASTM A615, Grade 60.

2. Welded wire fabric for concrete reinforcement shall meet the requirement as ASTM A185. Mesh shall be welded plain cold-drawn steel wire fabric.

3. Reinforcing Fibers

    a. Concrete reinforcing fibers shall be polypropylene collated, fibrillated fibers designed and engineered specifically for use as secondary reinforcement for concrete, shall be three-quarter inch (3/4") (20mm) to one inch (1")(25mm) in length and be manufactured by Fibermesh Company, Forta Corporation, or approved equal.

C. Preformed Expansion Joint Material

1. Preformed joint material shall comply with the requirement of ASTM D994, ASTM D1751, or ASTM D1752.

D. Leveling Base Course

1. Base course materials, if specified, shall conform to the requirements of sand with less than 10% passing No. 200 sieve.

E. Forms

1. Concrete forms shall be wood, steel, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal.

2. Forms shall be coated with a non-staining agent that will not discolor or deface surface of concrete.

F. Curing Compound

1. Curing compound shall be poly-alpha-methyl-styrene (PAMS) meeting AASHTO 148 Class B, or engineer approved equivalent.

G. Foundation Material

1. Refer to Section 02632 for Foundation Material

H. Aggregates

1. Course and fine Aggregates shall meet the requirements of ASTM C33 Article 2. Concrete mix under this Section shall meet one and one half inch (1½") (37.5 mm) sieve size, as specified in Division 300, Section 301.

2.03 Subgrade and Base

A. Natural Subgrades.

1. Subgrade shall be cut to the grade to accommodate concrete improvement being specified. The upper eight inches (8") (200mm) of the subgrade shall be compacted to a dry density of at least 95% of maximum dry density as determined by ASTM D698 at a moisture content of ± 2% oF optimum. The finished surface of the subgrade shall be smooth, free from surface irregularities, and true to line and grade as established by grade hubs or pins.

2. Compaction tests shall be performed a minimum of every one hundred fifty feet (150') (45m) of curb walk or side walk, once for each valley gutter, and once for each driveway not part of a section of curb walk being tested. This testing requirement is only applicable for new subdivision construction.

B. Trenches crossing curbwalk, valley gutters, or other concrete paving within the City right-of- way shall be compacted the full depth of the trench and shall be compacted to a dry density of at least 95% of maximum dry density as determined by ASTM D698 at a moisture content of ± 2% oF optimum. This applies to all trenches installed for any purpose. Prepared Subgrades with

Foundation Material

1. Where spongy, organic, or otherwise unsuitable material is encountered, which, in the opinion of the Engineer is unsuitable for subgrade, such unsuitable material shall be removed to a minimum of twelve inches (12") (300mm) below the four inch (4") (100mm) thick leveling base course, and replaced with foundation material. The Engineer may direct the Contractor to excavate deeper than the specified twelve inches (12") (300mm).

2. All foundation material shall be compacted to 95% of maximum dry density, as determined by ASTM D698 at a moisture content of $\pm$ 2% of optimum. Tree roots shall be removed at least one foot (1') (300mm) laterally and twelve inches (12") (300mm) vertically below all prepared subgrades.

C. Proof Rolling

1. Subgrades shall be proof rolled after compaction testing requirements have been passed and prior to placement of the leveling base course.

2. Proof rolling shall be performed in the presence of the Engineer and a representative of the City Engineer's office.

D. Leveling Base Course.

1. Just prior to placement of concrete, the four inch (4") (100mm) thick leveling base course shall be accurately graded to conform to the grade of the forms, and sprinkled if necessary until the moisture content is at or near optimum moisture content. Optimum moisture content shall be determined by the Engineer in accordance with ASTM D698. In no case shall concrete be placed on a saturated base or if free water is standing on the base. This paragraph applies in areas where spot concrete improvements are scheduled such as short runs of new curb and gutter and in areas where valley gutters are removed and replaced and or where concrete is placed manually in lieu of machine placement.

2.04 Forms

A. When using forms, they shall be of wood or metal, straight, free from warp, and of sufficient strength when staked to resist the pressure of the concrete without springing, and the upper edge shall form a true line. Outside forms for the curbwalk shall be of a depth equal to the full depth of the sidewalk, and the inside forms shall be of the depth of the gutter and shall be so designed as to permit secure fastening to the outside form. All forms shall be cleaned thoroughly and greased or oiled before concrete is placed against them. Forms that have become worn, bent, or broken shall not be used. Forms shall be securely set true to line and grade.

B. On short radii curves, steel plates, which can be readily formed to the desired radii, shall be used. Face forms, if used, shall be preshaped to the proper radii. Care shall be exercised to insure the maintenance of the required cross-section around the entire radius.

C. The Contractor shall provide an approved metal straight edge, ten feet (10') (3m) in length for use in checking the alignment of the forms prior to placing the concrete and also to check the concrete surface during the finishing operation. Forms and the final product shall not deviate more than one-quarter inch (1/4") (6.25mm) from a straight edge ten feet (10') (250mm) in length and shall be sloped to achieve complete drainage without "bird baths."

D. Forms shall remain in place at least twelve (12) hours after concrete has been placed against them or for a longer period if so directed by the Engineer. Crowbars or other heavy tools shall not be used against green concrete in removing the forms. Forms shall be well cleaned before reoiling and reuse.

E. Screed guide templates shall be pulled prior to the concrete taking initial set. In those cases where initial set takes place prior to pulling of the templates, the joint shall be sealed with an asphaltic sealing compound approved by the Engineer.

2.05 Protection

A. Protect fresh concrete from deleterious effects of weather and from traffic until adequately cured.

B. Concrete shall not be placed on frozen subgrade or when weather is stormy, dusty, or otherwise inclement to the point that it precludes good workmanship. Air temperature shall be a minimum of 40° F (4^0C) and rising when the pour is started. Adequate measures shall be employed to protect the concrete from freezing for a period of at least seventy-two (72) hours after it is poured.

2.06 Joint Construction

A. Expansion Joints

1. All expansion joints shall be constructed straight, plumb, and shall extend through the full width and depth of the section. Expansion joint material shall be flush with the finished surface to three-quarters inch (3/4") (20 mm) below the finished surface. Edges adjacent to expansion joint material shall be tooled.

2. Expansion joints shall be constructed at the intersection with any existing curbwalk or curb and gutter, at the tangent point of curb radii, at alley returns, adjacent to inlet structures and at intermediate intervals of not more than sixty feet (60') (18m) or at such lesser spacing as may be determined by the Engineer.

B. Contraction Joints

1. Transverse weakened-plane contraction joints shall be constructed at right angles to the curb line at intervals of ten feet (10') (3.1m). Joint depth shall average at least one-fourth (1/4) of the cross- section of the concrete.

2. Contraction joints may be sawed, hand formed, or made by one-eighth inch (1/8") (3mm) thick

division plates in the formwork. Sawing shall be done early after the concrete has set to prevent the formation of uncontrolled cracking. The joints may be hand formed either by 1) using a narrow or triangular jointing tool or a thin metal blade to impress a plane of weakness into the plastic concrete; or, 2) inserting one-eighth inch (1/8") (3mm) thick steel strips into the plastic concrete temporarily. Steel strips shall be withdrawn before final finishing of the concrete.

3. After removal of templates and finishing, contraction joints shall be reopened with a mason's trowel to a depth of one-fourth (1/4) the thickness of the section, the line of cut coinciding with and extending into the joint formed by the template. The joints shall be finished with a jointer.

C. Construction Joints

1. At end of day's run, or in case of an interruption which would result in cold joint, construction joints shall be made at right angles to the longitudinal axis of the curbwalk and shall be located at the regular five foot (5') (1.5m) spacing designated for contraction joints unless otherwise specifically permitted by the Engineer. In no case shall any length of curbwalk be less than five feet (5') (1.5m) between joints.

2. Construction joints shall be formed by use of a bulkhead or divider which shall be removed before continuing with the next run. Edges of construction joints shall be edge tooled to form a recess for sealing compound.

2.07 Concrete Placement

A. Concrete shall be placed either by an approved slipform/extrusion machine, by the formed method, or by a combination of these methods. Concrete shall not be placed until base courses and forms have been checked for depth and alignment. The method used shall adequately vibrate and compact the concrete to achieve a homogeneous dense concrete free from honeycomb and pockets of segregated aggregate.

B. Machine Placement

1. The slipform/extrusion machine approved shall be so designed as to place, spread, consolidate, screed, and finish the concrete in one complete pass in such a manner that a minimum of hand finishing will be necessary to provide a dense and homogeneous concrete section.

2. The machine shall shape, vibrate, and/or extrude the concrete for the full width and depth of the concrete section being placed. It shall be operated with as nearly a continuous forward movement as possible.

3. All operations of mixing, delivery, and spreading concrete shall be so coordinated as to provide uniform progress, with stopping and starting of the machine held to a minimum.

C. Formed Method

1. Construct forms to the shape, lines, grades, and dimensions called for in the Drawings. Set wood or steel forms securely in place, true to line and grade. Forms shall be braced to prevent change of shape or movement in any direction resulting from the weight of the concrete during placement. Tops of forms shall not depart from grade line more than one-fourth inch (1/4") (6.25mm) when checked with a ten-foot (10') (3m) straightedge. Alignment of straight sections shall not vary more than one-fourth inch (1/4") (6.25mm) in ten feet (10') (3m).

2.08 Finishing

A. Finishing shall be done with a metal screed or mule designed to give proper shape to the section as detailed. Particular care shall be used to finish the gutter flow line to a true, uniform grade that will drain completely without "bird baths". The back of the curbwalk and toe of the gutter shall be edge tooled. Traffic surfaces shall be broom finished at 90° to the direction of traffic. All honeycombed areas or small defects shall be patched with 1:2 mix mortar.

B. After stripping forms, exposed concrete surfaces shall be finished smooth and even by means of a moist wood float or a moist brick.

C. Sides of concrete exposed by the removal of forms shall be protected immediately to provide continuance of curing and preventing injury to the edge and the underlying subgrade. After the forms have been removed, suitable fill material shall be placed along the edge of the walk and tamped by either hand or mechanical tampers to a density at least equal to that of the adjacent ground. The finish grade and section shall be as indicated on the drawings and to the satisfaction of the Engineer.

D. Protection And Repairs

1. Protection: Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

2. Maintain concrete with minimum moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

3. Random Cracks in Pavement Slabs on Grade: When cracks occur within 2 feet (0.61 meters) of expansion or construction joints, remove and repair,otherwise grout with epoxy adhesive grout. Use saw cuts and dowels in all cut planes.

4. Random Cracks in Curb and Gutter: When concrete cracks larger than hairline cracks appear in curb and gutter and are the width of a penny standing on edge, Engineer shall direct Contractor to remove and replace concrete curb and gutter sections. Sections to be replaced shall be a minimum of five feet in length. When cracks are hairline in width, repair with epoxy adhesive grout.

2.09 Curing

A. Concrete shall be sprayed uniformly with curing compound immediately after finishing of the surface and before the set of the concrete has taken place. Curing compound shall be applied at the manufacturer's recommended rate.

B. Curing compound shall also be applied immediately to the exposed concrete once forms have been removed.

C. See section **2.02 F** for approved curing compounds.

2.05 Jointing New and Existing Curb Sections

Where the new concrete sections will join existing concrete sections with a different cross-section, five foot (5') (1.5m) long minimum transition section shall be constructed.

2.11 Fiber Reinforced Concrete

A. Where specified or approved by the Engineer, provide polypropylene fibers added to the concrete mix to control shrinkage cracks.

B. Polyproplyene fibers shall be added at the rate of three pounds (3#) (1.4 kg) of fiber per cubic yard of concrete. Fibers shall be added to the concrete in accordance with the manufacturer's recommendations.

2.13 Cutting and Patching of Asphalt Paving.

A. When curb cuts, or other concrete structures are installed adjacent to existing asphaltic concrete paving, the asphalt paving shall be saw cut parallel to and a minimum of eighteen inches (18") (450mm) away from the edge of the concrete.

B. The excavation between the concrete and the asphalt paving shall be backfilled with a minimum of two and one-half inches (2.5 inches) of asphalt over a specified base course. Base course and asphaltic concrete paving shall comply with City of Lakeland standard specification.

C. Where the existing pavement and base course sections exceed the minimums specified above, the replacement thickness shall match the existing.

END OF SECTION

SECTION 02835
SEEDING AND LAWN RESTORATION

PART 1 - DESCRIPTION

1.01 General

The work covered in this article includes the furnishing of all materials, labor, tools and equipment for seeding and lawn restoration as described in the specifications.

PART 2 - MATERIALS

2.01 Materials

A. Type A – Native Seed

1. Priority should be given to native species in any mixture due to the level of damage that non-native species are currently exhibiting within the City as noted by the Natural Resources Inventory. Suggested native seed mixes are shown below but can be modified to include a variety of native warm season grasses and native forbs. Suggested native warm season grasses include:
    (a) Big bluestem (*Andropogon gerardii*)
    (b) Little bluestem (*Schizachyrium scoparium*)
    (c) Indiangrass (*Sorghastrum nutans*)
    (d) Broomsedge bluestem (*Andropogon virginicus*)
    (e) Sideoats grama (*Bouteloua curtipendula*)
    (f) Switchgrass (*Panicum virgatum*)
    (g) Eastern gamagrass (*Tripsacum dactyloides*)

2. Any native warm season grass mixture should contain no more than 30% of one species. Native forbs may be included in the seed mixture including but not limited to:
    (a) partridge pea (*Chamaecrista fasciculata*)
    (b) Illinois bundleflower (*Desmanthus illinoensis*)
    (c) roundhead lespedeza (*Lespedeza capitata*)
    (d) perennial sunflowers *(Helianthus salicifolius)*
    (e) purple prairieclover *(Dalea purpurea var. purpurea)*
    (f) purple coneflower *(Echinacea purpurea)*
    (g) Tennessee Coneflower *(Echinacea tennesseensis)*
    (h) black-eyed susan *(Rudbeckia hirta)*
    (i) blazing star *(Liatris spicata / Liatris squarrulosa)*
    (j) lance-leaved coreopsis *(Coreopsis lanceolata)*
    (k) joe pyeweed *(Eupatorium purpureum var. purpureum)*
    (l) evening primrose *(Oenothera biennis)*

(m)New England aster *(Symphyotrichum novae-angliae)*
(n) Indian blanket *(Gaillardia pulchella var. pulchella)*

Suggested Type A Seed Mixes With Planting Dates

Native Grass Mixture	Little Bluestem Indian Grass Side Oats Grama Big Bluestem Switchgrass (native) (*Panicum virgatum*)	April 1 – June 30
Southeast Native Mixture	Indiangrass Little Bluestem Switchgrass Big Bluestem Lovegrass (Native only)	March 1 – June 15
Songbird Native Grass /Wildflower Mixture (Useful near conservation easements or natural areas for establishment of wildlife habitat)	Side Oats Grama Little Bluestem Indian Blanket Lance-leaved Coreopsis Purple Coneflower Goldenrod Joe Pyeweed Evening Primrose New England Aster Black-Eyed Susan	April 1 – June 15 August 15 – October 15
Wetland Mixture	Red Top (Native only) Virginia Wild Rye Fox Sedge Woolgrass Soft Rush Lurid Sedge Joe Pyeweed	March 15 – June 15 August 15 – October 15
Native Rough Mixture (Fescue mix may not be appropriate in all locations due to invasive nature)	Hard Fescue Little Bluestem Chewings Fescue Blue Fescue	March 15 - June 1 August 15 – Octobe

3. Some of the above mixtures may not be appropriate near natural areas due to the inclusion of non-natives and plants that are invasive by nature. Mowing should only be done in late October and late February to early March. Other forms of maintenance (that closely resemble natural disturbance) may be needed to exclude undesirables and to further promote the growth and spread of the native grasses.

4. Type A seed mix should be sown at approximate rates of 4-8 pounds pure live seed (PLS) per acre. Seed purity should be no less than 50% PLS.

B. Type B – Lawn Seed

1. Bermuda, Zoysia, and Fescue shall be used in areas where frequent mowing occurs. An established mowing schedule shall be in place in order to prevent species from becoming invasive.

C. Grass seed mixtures under brand names may be acceptable if they approach the above specifications and if accepted by the City Engineer. All seed types 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 furnish the Engineer 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.

D. Tackifiers

1. Tackifiers shall be a synthetic polyacrylamide tackifier. The tackifier shall water soluble and anionic in nature. Cationic tackifiers shall not be permitted. Organic tackifiers such as starch based compounds may be substituted upon approval of the engineer.

E. Mulch

1. Hay or straw mulch materials shall be air dried and reasonable free of noxious weeds and weed seeds or other materials detrimental to plant growth. Hay shall be stalks of approved grasses, sedges or legumes seasoned before bailing 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.

2. Wood fiber mulch shall be in accordance with Section 02925.

PART 3 - EXECUTION

3.01 Restoration of Lawn and Grassed Areas.

A. Any sod which is disturbed during the project or its appurtenances shall be replaced with similar sod including necessary topsoil, by the Contractor.

1. Top soil shall be replaced to a thickness equal to that removed up to a maximum of six inches (6") (150mm). No sod or seed shall be laid on less than four inches (4") (100mm) of topsoil. Topsoil shall be light friable loam containing a liberal amount of humus and shall be free from heavy clay, coarse sand, stones, plants, roots, sticks, and other foreign materials.

2. Sod shall be rolled within 24 hours after its placement with a roller that leaves the sod smooth and the joints properly closed. The new sod shall be trimmed neatly to match old sod, curbs, and walks. In all sod areas, the Contractor shall be responsible for ensuring adequate moisture until the new sod has properly established itself.

B. In other areas, the Contractor shall reseed as specified in the City's Standard Specifications.

1. In general, Type A seeding shall be used in undeveloped areas having a "native" grass vegetation. After the disturbed area has been backfilled as specified, the Contractor shall place four inches (4") inches (100mm) of topsoil over the disturbed area, prior to Type A, seeding. The area to be seeded shall be made smooth and uniform and shall conform with the finished grade. Type B seeding shall be used in developed areas where the disturbed vegetation would not be classified as sod. For temporary seeding of disturbed areas, Type A seed shall be used.

2. The seedbed, if not loose, shall be loosened to a depth of from 1 to 2 inches (25-50mm) below finished grade. Seeds and fertilizers can be sown with standard agricultural drills, or other approved methods. Grass seeds may be sown broadcast or with a special seeder attachment on agricultural drills, but shall not be covered with more than ½-inch (12mm) of soil, whether drilled or raked in. If not covered by the drill, all uncovered seed shall, immediately after sowing, be slightly raked or harrowed to cover the seed. No seed shall be broadcast during high wind.

3. Seeding shall be done in accordance with the manufacturers recommendation and approved of by the City Engineer. During other periods, the time of sowing shall be determined by the Engineer, whose decisions will be based on the moisture content of the soil and weather conditions.

3.02 Fertilization, Mulching and Tackifier

A. Fertilizer shall be applied in accordance to the soils analysis recommendation. Cellulose hydromulch shall be applied according to manufacturer's recommendation.

3.03 Warranty

A. Weed control in planted areas shall be the responsibility of the Contractor. Watering schedules of City-owned property shall be the responsibility of the Contractor during the warranty period.

END OF SECTION

SECTION 03050

PORTLAND CEMENT CONCRETE

Part 1- Description.

The work covered in this section includes the classification, materials, proportioning of materials, equipment, mixing requirements, and testing for Portland Cement Concrete to be used for curbs, curb and gutter, and sidewalks, streets, bridges, and miscellaneous structures.

Part 2 - Materials

2.01. Classes of Portland Cement Concrete. Portland cement concrete used for construction of the various items specified elsewhere in these Specifications shall be classified by usage as follows:

A. Class A.
Class A concrete shall be used as specified for such items as directed by the Engineer and other uses as noted in the Special Provisions.

B. Class AS.
Class AS concrete shall be used for storm and sanitary structures, concrete curb, curb and gutter, valley gutters, sidewalks, ditch paving, and similar structures unless otherwise noted in the Special Provisions.

C. Class B.
Class B concrete shall be used for roadway base, soil cement, and pavement.

D. Class C.
Class C concrete shall be used as specified for such items as concrete cradles, encasements, embankment slope paving at bridge abutments, and other low strength applications.

E. Class P.
Class P concrete shall be used for cast-in-place box culverts and precast and precast-prestressed concrete structures or structural members. High-early-strength concrete shall be as specified in Specification Section 03050 Paragraph 6.05.

2.02 Materials.

A. Portland Cement.
1. Type I or Type I-SM cement shall be used unless otherwise specified. Different types of cement shall not be mixed. Portland Cement shall conform to all requirements of the "Standard Specifications for Portland Cement," AASHTO M 85. M. Specification C150 for Class Type I, except that for high early strength concrete, Type III cement may be used.

B. Fine Aggregate.

1. Fine aggregate for concrete shall consist of sand and shall conform to the following ASSHTO M6 with the following exceptions.

   i. General Composition. Concrete sand shall be composed of clean (washed), hard, durable, uncoated grains, free from injurious amounts of clay, dust, soft flaky particles, loam, shale, alkali, organic matter, or other deleterious matter. Fine aggregate shall not contain appreciable materials which have unsatisfactory expansive properties when combined with Portland Cement and water.

   ii. Sieve Analysis. Fine aggregate shall be graded within the following limits:

	% Passing by Weight	
Sieve	Min.	Max.
3/8" (9.5mm)	100	---
No. 4 (4.75mm)	95	100
No. 8 (2.36mm)	80	100
No. 16 (1.18mm)	50	90
No. 50 (330um)	5-30	
No. 100 (150um)	0	10
No. 200 (75um)	0	3

   Deleterious Substances. The fine aggregate shall not contain more than the following maximum amounts of deleterious substances:

	Max. % of Weight
Clay lumps.	0.5
Coal, lignite, or shale.	0.5
Material passing the No. 200 Sieve.	3.0
Other deleterious substances such as Shale, alkali, mica, coated/grains soft and flaky particles.	3.0

   If the fine aggregate is manufactured from limestone or dolomite and if the material finer that the No. 200 sieve consists of dust of fracture, essentially free from clay or shale, this limit may be increased from 3% to 5%

   iv. Organic Impurities. Fine aggregate subjected to the colorimetric test as per ASTM C40 for organic impurities and producing a color darker than the standard shall be rejected unless it passes the mortar strength test as specified herein, Organic Impurities ASTM C40.

C. Coarse Aggregate. Coarse aggregate for concrete shall consist of crushed stone or gravel or crushed or uncrushed gravel and shall conform to the following requirements:

1. Coarse aggregate for Class A, Class B, or Class C concrete shall be furnished in two sizes: Size No. 4 and Size No. 67 as shown hereinafter in the attached Table Coarse

Aggregate Gradation Table.

2. The two sizes shall be manufactured, within the specified limits, to produce Size No. 467 when combined in the proper proportions at the batching plant. If the supplier provides a proper stockpile to prevent segregation, then a combined Size No. 467 can be used in lieu of blending Size No. 4 and Size No. 67.

3. Coarse aggregate for Class AS concrete shall be Size No. 57. Only limestone coarse aggregate will be used for Class AS concrete; gravel coarse aggregate will not be permitted.

4. Coarse aggregate for Class P concrete shall be size No. 57 or Size No. 67 as may be specified or directed. Only limestone coarse aggregate shall be used for Class P concrete; gravel coarse aggregate will not be permitted.

5. Coarse aggregate for concrete curbing placed by machine extrusion methods shall be Size No. 57or Size No. 67.

6. The coarse aggregates shall otherwise conform to the requirements of AASHTO M 80 and ASTM C 33 with the following exceptions and stipulations:

a. Deleterious Substances. The coarse aggregate shall not contain more than the following maximum amounts of deleterious substances:

	Max. % of Weight
Clay lumps	0.25
Material passing No. 200 sieve	1.0
Coal or Lignite	1.0
Other deleterious substances such as friable, thin, elongated, or laminated pieces	10.00
Other Local deleterious substances	1.00
Soft or nondurable fragments (fragments which Are structurally weak such as shale, soft Sandstone, limonite concretions, gypsum, Weathered schist, or cemented gravel.	3.0

7. The sum of the above, excepting thin or elongated pieces, shall not exceed 5% by weight.

8. Soundness. When subjected to 5 cycles of the soundness test, as set forth in ASTM C88, the loss in weight of coarse aggregate weighted in accordance with the grading of a sample complying with the grading requirements specified, shall not exceed nine (9) percent for sodium sulfate.

9. Abrasion. The coarse aggregate shall not have an abrasive loss greater than 40% as determined by AASHTO T96.

10. In the case of crushed aggregate, if all the material finer than the 200 mesh sieve consists of the dust of fracture essentially free of clay or shale, Item 4, Maximum Per Cent by Weight, may be increased to 1.5.

COARSE AGGREGATE GRADATION TABLE
Amounts Finer than Each Lab. Sieve (Sq. Opening), %By Weight

SIZE NO.	2"	1-1/2"	1"	¾"	½"	3/8"	NO. 4	NO. 8
4	100	90-100	20-55	0-15	-----	0-5	----	----
467	100	95-100	-------	35-70	-----	10-30	0-5	----
57	-----	100	95-100	----	25-60	----	0-10	0-5
67	----	----	100	90--100	----	20-55	0-10	0-5

D. Water for Concrete. The water shall be clean and free from objectionable amounts of oil, acid, alkali, organic matter, or other deleterious materials and shall not be used until the source of supply has been approved. If at any time the water from an approved source becomes of unsatisfactory quality or insufficient quantity, the Contractor will be required to provide satisfactory water from another source. Water of questionable quality shall be subject to the acceptance criteria of Table I, as specified in ASHTO T26.

E. Air-Entraining Admixture. The Contractor shall use a regular Portland Cement with the addition of an air-entraining admixture meeting requirements of AASHTO M 154. Air-entraining admixtures to be used in air-entrained concrete shall be Darex AEA, Neutralized Vinsol Resin, and Protex, or any other air-entraining agent meeting the approval of the Engineer. Air-entraining admixtures shall contain no chlorides. The air-entraining characteristics of the admixture, in suitable proportions in combination with Portland Cement, fine aggregate and water, within the limits of the proportion specified, shall be such that the resulting concrete will have a satisfactory workability, and the total air content shall be as provided below in the following table.

Nominal Max Size of Coarse Aggregate	Total Air Content Percentage by Volume Concrete
3/8 inch	6 to 10
½ inch	5 to 9
¾ inch	4 to 8
1 inch	3 ½ to 6 ½
1 ½ inch	3 to 6
2 inch	2 ½ to 5 ½
3inch	1 ½ to 4 ½

F. Chemical Admixtures. Chemical admixtures shall conform to ASTM C494, except TYPE C accelerating admixtures shall contain no chlorides, shall be non-toxic after thirty (30) days, and shall be compatible with air-entraining admixtures. The amount of admixture added to the concrete shall be in accordance with the manufacturer's recommendations.

G. Pozzolan Admixture. Pozzolan admixture shall conform to the requirements of ASTM C311 and ASTM C618-85 (including Table IA) for either Class C or Class F. Class C fly ash may be used as a replacement for Portland cement if approved in writing by the Owner. The maximum amount of cement being replaced by fly ash shall not exceed 15 percent. When a specific air content has been required and fly ash is being used, the air content shall be tested on each truck load of concrete at the batch plant and the tested value shall be indicated on the ticket.

H. Fiber-Reinforced Concrete shall conform to ASTM C1116 material requirements and classifications. Concrete containing fibers (steel, glass fibers, or synthetic fibers) shall conform to the manufacturers addition rate and shall be included in the mix design approved by the Engineer. Glass Fiber and synthetic fiber reinforced concrete shall not be used to replace structural reinforcement, and shall be added at the batch plant.

PART 3 – Execution

3.01 Sampling and Testing and Storage of Materials.

A. Cement. Cement may be accepted on the basis of mill tests and the manufacturer's certification of compliance with the specifications, provided the cement is the product of a mill with a record for production of high quality cement. Certificates of compliance shall be furnished the Engineer by the Contractor, for each lot of cement furnished prior to use of cement in the work. This requirement is applicable to cement for job- mixed, ready-mixed, or transit-mixed concrete. Cement proposed for use where no certificate of compliance is furnished, or where, in the opinion of the Engineer, the cement furnished under certificate of compliance may have become damaged in transit or deteriorated because of age or improper storage, will be sampled at the mixing site and tested for conformance to the specifications.

1. Cement will be approved for use if it satisfactorily passes the fineness, soundness, and time of set test requirements specified, provided the general run of materials has been satisfactorily meeting the 28-day strength requirements. Any approved cement failing to pass the 28-day strength requirements, if unused, shall be rejected. If, in the judgement of the Engineer, it is considered necessary, other lots of shipments from the same mill may be held for the results of tests before being used.

2. If cement is supplied from a new source or from a source of unknown quality, it may be held for the results of strength test before being approved.

B. Fine and Coarse Aggregate. At least two (2) weeks in advance of the beginning of concrete work the Contractor shall submit to an approved materials testing laboratory approximately five hundred pound (500#) (225kg) samples of each concrete aggregate proposed for use unless otherwise waived by the Engineer in writing. All tests which are necessary to determine the

compliance of the concrete materials with these specifications shall be performed on these samples. These samples shall also be used by the laboratory as the basis for a concrete mix design. The results of all tests and the concrete mix design shall be submitted to and approved by the City Engineer prior to the start of any concrete work. Standards shall conform to the latest applicable codes. The sampling and testing shall conform to the following standard procedures:

C. Cement. The Contractor shall provide adequate protection for the cement against dampness. No cement shall be used that has become caked or lumpy. Accepted cement which has been held in storage more than 90 days after shipment from the mill shall be retested, and if failing to meet the requirements specified herein shall be rejected.

1. Accepted cement which has been stored in approved sealed bins at the mill for not more than six (6) months may be used without further testing unless a retest is specifically requested by the Engineer.

D. Aggregate. Aggregates shall be handled and stored in separate piles at the site in such manner as to avoid a separation of the coarse and fine particles and contamination by foreign materials. Sites for stockpiles shall be prepared and maintained in such a manner as to prevent the mixing of deleterious materials with the aggregate. The Contractor shall deposit material in stockpiles at the batching plant site until the moisture content becomes uniform. Stockpiles shall be built in layers not to exceed three feet (3') (1m) in height, and each layer shall be completed before beginning the next one.

1. Coning or building up stockpiles by depositing the materials in one place will not be permitted. The storing of aggregates in stockpiles, or otherwise, upon the subgrade or shoulders will not be permitted.

3.02 Concrete Mixture Requirements.

A. The concrete shall meet the following requirements as outlined in the Concrete Classification Table attached to the end of this Section.

1. If it is found impossible to produce concrete having the required air content with the materials and mixing procedures that are being used, the Contractor shall make such changes in the materials or mixing procedures, or both, as may be necessary to insure full compliance with the requirements of air content in the concrete.

2. The total weight of aggregates per sack of cement and the relative proportions of coarse and fine aggregate shall be determined by yield tests made during the progress of the work. The Engineer may, at his discretion, adjust the laboratory mix design to obtain the proper yield, and consistency of concrete.

3. The Contractor shall receive written permission from the Engineer prior to adding Pozzolan admixture to Portland Cement Concrete.

4. Any combination of aggregates which requires the use of more than six and one-half gallons (6.5g) (25*l*) of water per sack of cement to produce a workable mixture, with the brand of cement used will be considered as being unsatisfactory, and all such combinations of aggregate will be rejected.

5. Concrete shall be uniformly plastic, cohesive, and workable. Workable concrete is defined as concrete which can be placed without honeycomb and without voids in the surface. Workability shall be obtained without producing a condition such that free water appears on the surface when finished. The consistency of the mixture shall be that required for the specified conditions and methods of placement; however, the previously determined maximum water cement ratio shall not be exceeded.

3.03 Proportioning of Materials.

All materials shall be separately and accurately measured by weight, and each batch shall be uniform. The coarse and fine aggregates shall be weighed separately. A sack of cement shall weigh ninety-four pounds (94#) (43kg). When bulk cement is used, ninety-four pounds (94#) (43kg) shall be considered as one sack. The Contractor shall furnish and use approved weighing devices, which, in operation, will give the exact quantity of materials required for the class of concrete. When the cement is in contact with the aggregate, it shall not remain more than forty-five (45) minutes before being deposited into the mixer.

3.04 Measurement of Aggregate.

A. Where sack cement is used, the quantities of aggregate for each batch shall be exactly sufficient for one or more sacks of cement. No batch requiring a fraction of a sack of cement will be permitted. All measurements shall be by weight, upon approved weighing scales and shall be such as will insure separate and uniform proportions. Scales shall be of either beam or springless dial types, and shall be suitable for supporting the hopper or hoppers. They shall be set accurately in substantial mountings which will insure a permanent spacing of the knife edges under all conditions of loading and use. They shall be so designed and maintained that they will at all times be accurate to within one-half (1/2) of one (1) percent throughout the entire weight range. Clearance shall be provided between the scale parts and the hopper or the bin structure to prevent displacement of the scale parts due to vibrations, accumulations, or any other cause. The value of the minimum gradations on any scale shall not be greater than five pounds (5#) (2.3kg). The weighing beam or dial shall be so placed that it will be in full view of the operator during the operation of the gate which delivers the material to the hopper. Scales shall be protected from air currents that may affect the accuracy of weighing.

B. Separate hoppers shall be provided for weighing fine and coarse aggregate. They shall be of suitable size and tight enough to hold the aggregate without leakage, and shall be supported entirely upon the scales. Suitable provisions shall be made for removal of overload from the hopper by the operator while he operates the bin gates.

C. The Contractor shall provide a sufficient number of fifty-pound (50#) (23kg) standard test weights for calibrating the weighing equipment.

D. The volume of concrete mixed per batch shall not exceed the manufacturer's guaranteed capacity of the mixer.

E. When the aggregates are delivered to the mixer in trucks, each batch shall be in a separate compartment of the capacity required by the Engineer. Suitable covers shall be provided for the batch compartments of the trucks to protect the cement from the wind. All trucks, truck bodies, bulkheads, and compartments used in proportioning and transporting to the mixer of concrete materials shall be so designed and operated to insure the charging of the mixer, batch by batch, with the proper amounts of each material without overspillage, intermixing of batches or wastage. Any units which, in the opinion of the Engineer, do not operate satisfactorily, shall be removed from the work until properly rebuilt and corrected.

3.05 Mixing Concrete.

A. Consistency. The quantity of water to be used shall be determined by the Engineer and shall not be varied without his consent. The Contractor shall furnish and use with the mixer an approved adjustable, water measuring device which will prevent excess water flowing into the mixer, in order that the consistency may be under positive control and that all batches may be of the same consistency.

1. In general, the minimum amount of water shall be used which will produce the required workability. The mortar shall cling to the coarse aggregate and shall show no free water when removed from the mixer.

B. Mixer. The mixing machine used shall be of an approved type known as a batch mixer, and of a design having a suitable device attached for automatically measuring the proper amount of water accurate to one percent (1%) and for automatically timing each batch of concrete so that all materials will be mixed together for the minimum time required. Such device shall be easily regulated and controlled to meet the variable conditions encountered. If the time device becomes broken or fails to operate, the Contractor will be permitted to continue the balance of the day without the timing device while the same is being repaired, provided that each batch of concrete is mixed two (2) minutes.

1. The normal mixing time for each batch shall be one (1) minute, and the measuring of this period shall begin after all the materials are in the drum. During this mixing period, the drum shall revolve at the speed for which the mixer is designed, but shall make not less than fourteen (14) nor more than twenty (20) revolutions per minute.

2. No materials for a batch of concrete shall be placed in the drum of the mixer until all of the previous batch has been discharged therefrom. The discharge of water into the drum shall commence with the flow of the aggregates, but shall not be started before the entrance into the drum of part of the aggregates. The discharge of all of the mixing water for any batch shall be completed within ten (10) seconds after all of the aggregates are in the drum. The inside of the drum shall be kept free from hardened concrete.

3. The use of mixers having a chute delivery will not be permitted except by permission of

the Engineer. In all such cases the arrangement of chutes, baffle plates, etc., shall be such as will insure the placing of fresh concrete without segregation.

4. Ready-mixed concrete from a central mixing plant delivered at the work ready for use, will be permitted, provided the mixture is transported to the job site in an agitating truck having the concrete contained in a revolving drum and provided there is no segregation of the mixture at the point of placing. Ready-mixed concrete from a central batching plant and mixed in transit will be permitted; however, the mixing and transporting equipment will be subject to the special approval of the Engineer. Any ready-mixed concrete shall comply with all of the requirements of these specifications.

5. The time elapsing from the time the water is added to the mix until the concrete is deposited in place at the site of the Work shall not exceed 30 minutes when hauled in non-agitating trucks, not 60 minutes when hauled in truck mixers or truck agitators. In addition, the total revolutions at mixing speed shall not be less than 70 nor more than 100. When truck mixers are used on hauls in excess of 1 hour, the cement shall be added at the site of the work. The concrete must be of workable consistency when placed. No mixer which has a capacity of less than a two-sack batch shall be used.

   i. Hand mixing will not be permitted except with the permission of the Engineer and then only in very small quantities or in case of an emergency.

6. Retempering concrete by adding water or by other means will not be oermitted; however, a portion of the mixing water may be withheld from transit mixers and added at the work site provided the delivery ticket indicates the amount withheld. The batch shall be mixed for 30 revolutions at mixing speed after adding the water. Water cannot be added to a partial load of concrete mix. Concrete that is not within the specified slump limits at time of placement shall not be used.

7. In using air-entraining admixtures, the mixer shall be equipped with a suitable automatic dispensing device which will proportion the air entraining admixture accurately to each batch of concrete. The device shall be calibrated and adjusted to deliver to each batch of concrete the quantity of admixture required to produce the specified air content in the concrete.

8. The manufacturer of the concrete shall furnish to the purchaser with each batch of concrete before unloading at the site, a delivery ticket. The purchaser shall provide the Engineer with one (1) copy of each delivery ticket.

3.06 Forms.

A. Forms shall be made of wood or metal. Forms shall be provided with adequate devices for secure setting so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. The top and face of forms shall be cleaned and oiled prior to the placing of concrete.

3.07 Placing Concrete.

A. The concrete shall be unloaded into an approved spreading device, or deposited on the base, and spread in such a manner as to prevent segregation of the materials. As deposited, the mixture shall be placed where it will require as little rehandling as possible. No concrete shall be placed on frozen grade.

B. Necessary hand spreading shall be done with shovels or other approved tools. Workmen shall not be allowed to walk in the freshly mixed concrete with boots or shoes coated in earthen or other foreign substances.

C. Concrete shall be thoroughly consolidated against and along the faces of all forms and along the full length and on both sides of all joint assemblies, by means of vibrators inserted in the concrete. Vibrators shall not be permitted to come in contact with a joint assembly, the grade, or a side form. In no case shall the vibrator be operated longer than 5 seconds in any one location.

3.08 Protection.

A. It shall be the responsibility of the Contractor to protect from damage all freshly poured concrete regardless of the location or type of structure for a minimum period of seven (7) days or for such longer period as the Engineer may direct. Any concrete which is damaged shall be repaired to the satisfaction of the Engineer prior to acceptance of the completed work.

3.09 Quality Control Testing.

A. The Owner or Consultant will employ a testing laboratory to perform test and submit test reports. Test reports will be reported in writing to Consultant, Owner, and Contractor as soon as possible upon completion of tests.

1. Compressive Strength Tests. Concrete test cylinders will be made by a qualified technician from a certified material testing laboratory.

2. The cylinders shall be made and tested in accordance with ASTM C39.

2. Tests may be required for each day's run or according to the following schedule:

Total Cubic Yards of Concrete Placed (m^3)	Minimum Number of Tests* (3 cylinders each)
	One for 7 days, two at 28 days
0 – 100(0-75)	One for each 50 cu. Yds. ($38m^3$)
100 – 1000 (75 -750)	One for each 125 cu. Yds. ($100m^3$)
1000 – 2000 (750 – 1500)	One for each 175 cu. Yds. ($125\ m^3$)
2000 and Over (1500)	One for each 250 cu. Yds. ($200\ m^3$)

*One test per pour minimum.

iii. Results of all tests shall be furnished to the Engineer as soon as they are available.

2. Slump. Slump test shall be conducted in accordance with ASTM C172. A test shall be performed for each day's pour of each type of concrete and for each set of compressive strength test.

2. Air Content. Air content shall be tested in accordance with ASTM C143 or ASTM C231. Air content test shall be performed for each set of compressive strength tests of each type of air-entrained concrete.

CONCRETE CLASSIFICATION TABLE

Class of Concrete	Min. 28 day Compressive Strength (psi)	Slump in Inches	Min Cement–Sacks//CY (3)		Min Cement–#//CY (3)		Net Water Max. Gal/CY (3)		Net Water Max-#/CY (3)	
			Gravel Course Aggregate	Limestone Course Aggregate	Gravel Course Aggregate	Limestone Course Aggregate	Gravel Course Aggregate	Limestone Course Aggregate	Gravel Course Aggregate	Limestone Course Aggregate
A	3000	3-5	6.0	5.5	564	517	36	33	300	275
AS	4000	3-5	(2)	6.2	(2)	583	(2)	37.2	(2)	310
B	3500(1)	1-2.5	6.2	5.8	583	545	34.1	31.9	284	266
C	2500	2-4	5.0	4.5	470	423	34	30.6	283	255
P	5000	1-3	(2)	7.0	(2)	658	(2)	35	(2)	292

Notes:

(1) Minimum compressive strength at 14 days. Minimum flexural strength at 14 days of 550 psi per AASHTO T 22
(2) Gravel Coarse Aggregate not permitted.
(3) Tabulated valves are for Type I cement conforming to the requirement of AASHTO M 85 only.

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 - Description

The work covered in this section includes: reinforcing steel bars, wire fabric, and rod mats for cast-in-place concrete; support chairs, bolsters, bar supports, and spacers for supporting reinforcement; and fiber reinforced concrete.

PART 2 – Materials

2.01 Submittals

A. Manufacturer's Certificate: Submit mill test certificates of supplied concrete reinforcement, indicating physical and chemical analysis.

B. Welder's certification.

C. Shop Drawings.

1. Indicate sizes, spacings, locations, and quantities of reinforcing steel, wire fabric, bending and cutting schedules, splicing, stirrup spacing, supporting, and spacing devices.

2. When required, prepare Shop Drawings by an engineer who complies with Tennessee licensing law having jurisdiction and acceptable to agency having jurisdiction.

D. Fiber Reinforced Concrete

1. Submit one (1) copy of manufacturer's printed product data indicating proposed fibrous concrete reinforcement materials. Printed data should state the application rate of fibers to be added to each cubic yard of each type of concrete.

2. Submit one (1) copy of a manufacturer's printed batching and mixing instructions.

3. Submit one (1) copy of a certificate prepared by the concrete supplier and/or material testing laboratory providing information on the application rate of fibers for the type or mix design of concrete. Each certificate shall be accompanied by one (1) copy of each batch delivery ticket indicating amount of fibrous concrete reinforcement material added to each batch of concrete.

2.02 Materials

A. Concrete Reinforcement Materials

1. Reinforcing Steel: Reinforcement shall be in accordance with ASTM A 615 deformed bars, grade, and type as indicated, either uncoated or as indicated on the drawings or other specifications. When no grade is indicated, use 60 ksi (414 MPa) yield grade steel. Use ASTM A 706 steel if welding is indicated or specified.

2. Welded Steel Wire Fabric: In accordance with ASTM A185 plain type; in flat sheets or coiled rolls either uncoated or as indicated.

3. Stirrup Steel: In accordance with ASTM A 82.

4. Plain Dowel Bars for Expansion Joints: In accordance with ASTM A 615, 60 ksi (414 MPa) yield grade steel.

    a. Epoxy coated in roadway pavements.

    b. Provide metal dowel can at one end of dowel to permit longitudinal movement of dowel within concrete section. Design caps with 1 end closed.

    c. Provide for movement equal to joint width plus 1/2 inch (12.5 mm).

    d. For load transfer bars, paint with 1 coat of paint conforming to AASHTO M 254 and coat 1/2 with grease.

B. Fibrous Concrete Reinforcement Material

1. 100 percent virgin polypropylene fibrillated fibers containing no reprocessed olefin materials and specifically manufactured to an optimum gradation for use as concrete secondary reinforcement. Volume per cubic yard shall equal a minimum of 3 to 5 pounds per cubic yard of concrete.

2. Fiber reinforced concrete shall be Fibermesh 650 as manufactured by Propex Concrete Systems, 6025 Lee Highway, Chattanooga, TN 37422 or equal. The type of fiber to be specified shall be outlined in the construction drawings or as directed by the Engineer. If the specifications or drawings do not specify the type of fiber reinforcing, then Fibermesh 650 or equal shall be provided.

3. Fibrous concrete reinforcement materials provided in this Section shall produce concrete conforming to the requirements for each type and class of concrete required, as indicated on the drawings or specifications where the concrete is tested in accordance with ASTM C-94 and ASTM C1116 Type 1114.1.3 and ASTM C-116 (Ref: ASTM C-1018) Performance Level I5 outlined in Section 21 Note 17.

C. Accessory Materials

1. Tie Wire: Minimum 16 gage steel wire shall be plain, cold drawn and shall comply with ASTM A 82.

2. Supports for reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement in place:

   a. Use wire bar type supports complying with CRSI recommendations unless otherwise indicated. Do not use wood, brick, and other unacceptable materials.

   b. For slabs on grade, use supports with sand plates or horizontal runners where base material will not support chair legs.

   c. For exposed-to-view concrete surfaces, where legs of supports are in contact with forms, provide supports with either hot-dip galvanized for plastic protected legs.

D. Fabrication

1. Fabricate reinforcement in accordance with ACI 315, providing for the concrete cover.

2. Locate reinforcing splices not indicated on drawings at points of minimum stress. Indicate location of splices on Shop Drawings.

3. Weld reinforcing bars in accordance With AWS D1.4.

4. Unacceptable materials: Reinforcement with any of the following defects will not be permitted in the Work:

   a. Bar lengths, depths, and bends exceeding specified fabrication tolerances.

   b. Bends or kinks not indicated on Drawings or final Shop Drawings.

   c. Bars with reduced cross-section due to excessive rusting or other cause.

PART 3 - Execution

3.01 Product Handling

A. Deliver reinforcement to the job site bundled, tagged, and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings shown on placement diagrams.

B. Storage: Take all means necessary to protect reinforcement materials before, during, and after installation and to protect the installed work of other trades. Store all reinforcement materials in a manner to prevent excessive rusting and fouling with grease, dirt, and other bond-breaking coatings. Take all necessary precautions to maintain identification after bundles are broken. In the event of damage or errors, immediately make all repairs or replacements necessary and at no additional cost to the OWNER.

3.02 Placing

A. All reinforcement to be free of loose mill scale, loose or thick rust, dirt, paint, oil or grease.

B. Place all reinforcement in the exact position indicated. With tie wire, tie bars together at all intersections.

C. Maintain the distance from vertical forms and between layers of reinforcement by means of prefabricated chairs, ties, hangers, or other approved devices. Placing and fastening of reinforcement in each section of the Work must be approved before concrete is placed.

D. Overlap sheets of metal mesh one square plus 6 inches (150 mm) to maintain a uniform strength. Securely fasten at the ends, edges, and supports to maintain clearances.

3.03 Splicing

A. Furnish all reinforcement in the full lengths indicated unless otherwise permitted. Splicing of bars, except where indicated is not permitted without written approval. Stagger splices where possible.

B. Unless indicated otherwise, overlap reinforcing bars a minimum of 30 diameters to make the splice. In lapped splices, place the bars and wire to maintain the minimum distance for clear spacing to the surface of the concrete.

C. Do not use lap splices on bars greater in diameter than No. 11 (35) unless approved.

D. Weld reinforcing steel only if indicated or if authorized in writing. Weld in conformance to AWS D1.4.

E. Do not bend reinforcement after embedding in hardened concrete.

F. Do not permit reinforcement or other embedded metal items bonded to the concrete, to extend continuously through any expansion joint, except dowels in floors bonded on only one side of joints.

3.04 Placing Embedded Items

A. Place all sleeves, inserts, anchors, and embedded items prior to concrete placement. Temporarily fill voids in embedded items to prevent entry of concrete.

B. Give all trades whose work is related to the concrete Section ample notice and opportunity to introduce or finish embedded items before concrete placement.

3.05 Fiber Reinforced Concrete

A. Add fibrous concrete reinforcement to concrete materials at the time concrete is batched in amounts in accord with approved submittals for each type of concrete required.

B. Mix batched concrete in strict accord with fibrous concrete reinforcement manufacturer's instructions and recommendations for uniform and complete dispersion.

END OF SECTION