SECTION 31 20 00

EARTH MOVING

PART 1 – GENERAL

1.01 GENERAL PROVISIONS

A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all SECTIONS within DIVISION 1 – GENERAL REQUIREMENTS, which are hereby made a part of this section of Specifications.

1.02 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Excavation of all types.

2. Sheeting, shoring and dewatering of trenches and excavations.

3. Providing, placing, and compacting fill materials.

4. Removal, hauling, stockpiling, rehandling, and placement of materials.

5. Off-site disposal of excess or unsuitable materials.

6. Rough grading.

7. Sedimentation and Erosion Control.

1.03 SUBMITTALS AND TESTING

A. Refer to Division 1 General Requirements for submittal provisions and procedures.

1. Backfill Materials: Submit 50 pound sample for each backfill material from each proposed source including on-site materials. Submit a grain size analysis and distribution curve performed in accordance with ASTM D422 for each proposed backfill material for review by the Engineer. Additional samples and analysis shall be submitted if a change in material occurs at the borrow source.

2. Excavation and Excavation Support Plan: Submit at least 10 calendar days prior to the start of the work a detailed plan for the sequence of excavation, and methods to be used for excavation support and dewatering of excavations. Submit engineering calculation stamped by a Massachusetts Registered Professional Engineer and shop drawings for earth support systems to be used. Dewatering and groundwater control systems shall be designed to keep excavations free of water and to avoid disturbance of the subgrade.

3. Moisture-density curve indicating the maximum dry density and optimum moisture content as determined by ASTM D1557 for each proposed source of backfill.

4. Filter fabric: Submit the manufacturer's information and a one square foot representative sample of the filter fabric.

5. Obtain required permits for discharge of dewatering effluent. Submit two copies of all permits obtained at least one week prior to system installation.

6. A Soils Engineer/testing laboratory shall make such tests of materials and samples as necessary to insure materials and compaction requirements are achieved. Costs for such tests shall be borne by the University of Massachusetts, Lowell (UML). UML will procure the services of the Soils Engineer/testing laboratory; the Contractor shall coordinate the scheduling of the testing with the Soils Engineer/testing laboratory.

1.04 REFERENCE STANDARDS

A. The following standards are applicable to the work of this section to the extent referenced herein.

1. ASTM: American Society for Testing and Materials.

2. Reference is made herein to the Commonwealth of Massachusetts, Department of Transportation (MassDOT), formerly Massachusetts Highway Department (MHD) *Standard Specifications for Highways and Bridges*, latest edition, hereinafter referred to as the "Standard Specifications". All references to method of measurement, basis of payment, and payment items in the "Standard Specifications" are hereby deleted. References made to particular sections or paragraphs in the "Standard Specifications" shall include all related articles mentioned therein.

1.05 EXAMINATION OF SITE AND DOCUMENTS

A. It is hereby understood that the Contractor has carefully examined the site and all conditions affecting work under this Section. No claim for additional costs will be allowed because of a lack of knowledge of existing conditions as indicated in the Contract Documents, or obvious from observation of the site.

B. Plans, surveys, measurements and dimensions under which the work is to be performed are believed to be correct, but the Contractor shall have examined them for himself during the bidding period and formed his own conclusions as to the full requirements of the work involved.

1.06 SUBSURFACE CONDITIONS

Reference available subsurface data and reports.

1.07 EXCAVATION CLASSIFICATIONS

A. Earth Excavation or "Excavation" consists of removal of materials encountered to the subgrade elevations indicated and subsequent reuse or disposal of the materials removed. All excavation is

classified as earth excavation unless it otherwise meets the classifications provided below for unauthorized excavation, additional excavation, or rock excavation.

B. Unauthorized Excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of the Owner's Representative. Unauthorized excavation, as well as remedial work directed by the Engineer, shall be at the Contractor's expense.

1. Under footings, foundations, concrete slabs, retaining walls or other structures, fill unauthorized excavations to the proper elevations with gravel borrow. Elsewhere, backfill and compact unauthorized excavations as specified for excavations of the same class, unless otherwise directed.

C. Additional Excavation:

1. When excavation has reached required subgrade elevations, notify the Owner's Representative who will review subgrade conditions.

2. If unsuitable bearing materials are encountered at the required subgrade elevations, carry excavations deeper and replace excavated material as directed.

3. Removal of unsuitable material and its replacement as directed will be paid on the basis of contract conditions relative to changes in work or as provided for under the unit rates for this classification.

D. Rock Excavation:

1. Rock excavation in trenches includes removal and disposal of materials and obstructions encountered which cannot be excavated with a 1.0 cubic yard (heaped) capacity, 42-inch wide bucket on medium-size track-mounted hydraulic excavator equivalent to Caterpillar Model 215, rated at not less than 90HP flywheel power and 30,000 lb. drawbar pull. Trenches in excess of 10-feet in width are classified as open excavation.

2. Rock excavation in open excavations includes removal and disposal of materials and obstructions encountered which cannot be dislodged and excavated with modern track-mounted heavy-duty hydraulic excavating equipment without drilling or ripping. Rock excavation equipment is defined as Caterpillar Model No. 973 or No. 977K, or equivalent track-mounted loader, rated at not less than 170HP flywheel power and developing 40,000-lb. breakout force (measured in accordance with SAE J732C). No blasting is allowed on site.

3. Determination of rock excavation classification will be made by the Owner's Representative. Typical of materials classified as rock are boulders 3.0 cubic yards or more in volume, solid rock, rock in ledges, and rock-hard cementitious aggregate deposits. Intermittent drilling or ripping performed to increase production and not necessary to permit excavation of material encountered will be classified as earth excavation. Do not perform rock excavation work until material to be excavated has been cross-sectioned and classified by the Owner's Representative. Visual observation of the completed excavation may be made by the Owner's Representative to modify the

excavation classifications. Removal of rock excavation prior to classification by the Owner's Representative shall be considered as earth excavation unless accepted by the Owner's Representative in writing. Such excavation will be paid on the basis of contract unit rates for this classification.

4. Rock payment lines (if applicable) are limited to the following:

a. Two feet outside of concrete work for which forms are required.

b. One foot outside of the vertical walls of utility structures.

c. In pipe trenches, depth limits shall be 6 inches below the bottom of the pipe:

Depth From Ground Surface to Invert of Pipe	Pay Width (Pipe ID)	
	0-24”	Over 24”
0 to 12’	5’-0”	Pipe I.D. +3’-0”
12’ to 20’	7’-0”	Pipe I.D. +7’-0”
Over 20’	9’-0”	Pipe I.D. +7’-0”

d. Rock sloping across the width of trench shall have the top of rock established at the rock elevation over the centerline of the pipe.

1.08 EXCAVATION

A. The Contractor shall perform all excavations and of whatever materials encountered, in a manner as required to allow for placing of temporary earth support, forms, installation of pipe and other work, and to permit access for the purpose of observing the work. Excavations shall be to such widths as will give suitable space for the required work. Bottoms of trenches and excavations shall be protected from frost and shall be firm, dry and in an acceptable condition to receive the work. Work shall not be placed on frozen surfaces nor shall work be placed on wet or unstable surfaces.

B. All excavations made in open cut will be controlled by the conditions existing at that location. In no case shall earth be excavated or disturbed by machinery so near to the finished subgrade for structures and pipelines as to result in the disturbance of the earth below the subgrade. The final excavation to subgrade should be accomplished with a smooth faced bucket or by hand.

1.09 TEMPORARY EARTH SUPPORT

A. The Contractor shall furnish, place and maintain such sheeting, shoring, and bracing at locations necessary to support the sides of excavations to prevent danger to persons or damage to adjacent pavements, facilities, utilities, or structures; to prevent injurious caving or erosion or the loss of ground; and to maintain pedestrian and vehicular traffic as required by the Contract Documents, the Contractor’s sequence of construction, and as directed by the Owner’s Representative.

B. In all sheeting, shoring and bracing operations, care shall be taken to prevent collapse of excavations, injury to persons or damage to adjacent structures, facilities, utilities and services. Any injuries to persons shall be the responsibility of the Contractor; and any damage to the work occurring as a result of settlement, water or earth pressure, or other causes due to inadequate bracing or other construction operations of the Contractor shall be satisfactorily repaired and made good by the Contractor, at no additional expense to the Owner.

C. Where sheeting is to be used, it shall be driven ahead of excavation operations to the extent practicable so as to avoid the loss of material from behind the sheeting; where voids occur outside of the sheeting, they shall be filled immediately with ordinary fill, thoroughly compacted.

D. The Contractor shall leave in place all sheeting and bracing at the locations and within the limits ordered by the Owner's Representative in writing. The Contractor shall cut off the sheeting at elevations as indicated on the Contract Drawings or to be determined with the approval of the Owner's Representative.

E. The Contractor shall comply with all federal, state, and local safety regulations, and requirements.

1.10 GROUNDWATER CONTROL

A. The Contractor shall provide, at his own expense, adequate pumping and drainage facilities to maintain the excavated area sufficiently dry from groundwater and/or surface runoff so as not to adversely affect construction procedures nor cause excessive disturbance of underlying natural ground. The flows of all water resulting from pumping shall be managed so as not to cause erosion, siltation of drainage systems, or damage to adjacent property.

B. Any damage resulting from the failure of the dewatering operations of the Contractor, and any damage resulting from the failure of the Contractor to maintain all the areas of work in a suitable dry condition, shall be repaired by the Contractor, as directed by the Engineer, at no additional expense to the Owner. The Contractor's pumping and dewatering operations shall be carried out in such a manner as to prevent damage to the Contract work and so that no loss of ground will result from these operations. Precautions shall be taken to protect new work from flooding during storms or from other causes. Pumping shall be continuous to protect the work and/or to maintain satisfactory progress.

C. All pipelines or structures not stable against uplift during construction or prior to completion shall be thoroughly braced or otherwise protected. Water from the trenches, excavations, and stormwater management operations shall be disposed of in such a manner as to avoid public nuisance, injury to public health or the environment, damage to public or private property, or damage to the work completed or in progress.

D. The Contractor shall control the grading in the areas surrounding all excavations so that the surface of the ground will be properly sloped to prevent water from running into the excavated area. Where required, temporary ditches shall be provided to control drainage. Upon completion of the work and when directed, all areas shall be restored by the Contractor in a satisfactory manner and as directed.

1.11 BLASTING

A. Blasting shall not be permitted without the written approval of the Owner's Representative.

1.12 PERMITS, CODES, AND SAFETY REQUIREMENTS

A. Comply with all rules, regulations, laws and ordinances of the municipality, the Commonwealth of Massachusetts, and other authorities having jurisdiction over the project site or work. All labor, materials, equipment and services necessary to make the work comply with these requirements shall be provided by the Contractor without additional cost to the Owner.

B. Comply with the provisions of the Manual for Accident Prevention in Construction of the Associated General Contractors of America, Inc., and the requirements of the Occupational Safety and Health Administration, United States Department of Labor.

C. The Contractor shall obtain and pay for all permits and licenses required to the complete work specified herein and shown on the Contract Drawings.

D. The Contractor shall not close or obstruct any street, sidewalk, or passageway without written permission from authorities having jurisdiction unless otherwise indicated on the Contract Drawings. The Contractor shall conduct his operations as to minimize interference with the use of roads, driveways, or other facilities near enough to the work to be affected by the work.

E. The Contractor shall notify "Dig Safe" at 1-888-DIG-SAFE prior to commencing any excavation work.

F. The Contractor shall provide police details when working in roadways as required by local jurisdictional authorities. The Contractor shall pay for any and all details.

1.13 PROTECTION OF EXISTING CONDITIONS

A. All work shall be executed in such a manner as to prevent any damage to existing buildings, streets, curbs, paving, service utility lines, structures and adjoining property.

B. Locate and mark underground utilities to remain in service before beginning the work. Protect all existing utilities to remain in service during operations. Do not interrupt existing utilities except when authorized in writing by authorities have jurisdiction unless otherwise indicated on the Contract Drawings.

C. When an active utility line is exposed during construction its location and elevation shall be recorded on the Record Drawings by the Contractor and both the Engineer and the Utility Owner shall be notified in writing. Active utilities existing on the site shall be carefully protected from damage or relocated as required by the work.

D. Inactive or abandoned utilities encountered during construction operations shall be removed, plugged, capped or filled. The location of such utilities shall be recorded on the Record Drawings.

E. Provide barricades, fences, lights, signs, and all other safety devices required to protect the public against injury.

F. In case of any damage or injury caused in the performance of the work the Contractor shall, at his own expense make good such damage or injury to the satisfaction of, and without cost to, the Owner. Existing streets, sidewalks and curbs damaged during the project work shall be repaired or replaced to their condition prior to commencement of Earth Moving operations.

G. Acceptance of any of the Contractor's plans, design calculations and methods of construction by the Designer shall not relieve the Contractor of the responsibility for the adequacy of the excavation lateral support system; preventing damage to existing or new structures, utilities and streets adjacent to excavations; the safety of persons working within excavated areas and the public at large; and excavation dewatering.

1.14 DISPOSAL

A. All excess and unsuitable excavated soil shall be removed from the site and legally disposed off-site by the Contractor at no additional cost to the Owner.

1.15 EROSION CONTROL

A. Erosion control measures shall be established at the beginning of construction and maintained during the entire period of construction. On-site areas which are subject to erosion, and off-site areas which are especially vulnerable to damage from erosion and/or sedimentation, are to be identified and receive special attention.

B. The Contractor shall install and maintain sedimentation control devices during construction to prevent the movement of sediment into the underground drainage systems. Measures to prevent the movement of sediment off site shall be installed, maintained, removed, and cleaned up at no additional cost to the Owner.

C. All land-disturbing activities are to be planned and conducted to minimize the size of the area to be exposed at any one time, and the length of time of exposure.

D. Surface water runoff originating upgrade of exposed areas shall be controlled to reduce erosion and sediment loss during the period of exposure.

PART 2 – PRODUCTS

2.01 BACKFILL MATERIALS

A. Backfill materials shall conform to the following material descriptions and gradation requirements.

B. Ordinary Borrow: Ordinary borrow shall be well-graded, natural inorganic soil containing no stone greater than 6 inches maximum dimension. The materials shall be free of trash, ice, snow, tree stumps, roots and other organic and deleterious materials. It shall be free of highly plastic clays, of all materials subject to decay or other materials that will corrode piping or metals. Ordinary borrow shall have a maximum dry density of not less than 110 pounds per cubic foot. It

shall be of such a nature and character that it can be compacted to the specified densities. Topsoil shall not be considered ordinary borrow.

C. Existing available fill materials from on-site excavations may be reused as ordinary borrow if it meets the above requirements.

D. Gravel Borrow: Gravel borrow shall consist of inert material that is hard, durable stone and sand, free from loam and clay, surface coatings, and deleterious materials. Gravel borrow shall conform to the following gradation requirements (MDOT M1.03.0):

Sieve Size	Percent Finer by Weight
1/2-inch	50-85(1)
No. 4	40-75
No. 50	8-28
No. 200	0-10
(1) Maximum size of stone in gravel shall be three-inches.	

E. Crushed Stone: Crushed stone shall consist of durable crushed rock or durable crushed gravel stone, free from ice and snow, sand, clay, loam, or other deleterious or organic material. The crushed stone shall be uniformly blended and shall conform to the following requirements (MDOT M2.01.4 and MDOT M2.01.5):

Percent Passing by Weight		
Sieve Size	**3/4-inch Stone**	**1/2-inch Stone**
1-inch	100	---
3/4-inch	90-100	---
5/8-inch	---	100
1/2-inch	10-50	85-100
3/8-inch	0-20	15-45
No. 4	0-5	0-15
No. 8	---	0-5

F. Dense Graded Crushed Stone: Dense graded crushed stone shall consist of angular material derived from a stone quarry that is hard, durable and free of deleterious materials. Material shall be free from clay, loam or other plastic material. The dense-graded crushed stone shall be uniformly blended and shall conform to the following requirements (MDOT M2.01.7):

Sieve Size	Percent Passing By Weight
2-inch	100
1½-inch	70-100
¾ -inch	50-85
No. 4	30-55
No. 50	8-24
No. 200	3-10

G. Sand: Sand shall consist of clean inert, hard, durable grains of quartz or other hard durable rock, free from clay, organics, surface coatings or other deleterious material. Sand shall conform to the following gradation (MDOT M1.04.0):

Sieve Size	Percent Passing by Weight
1/2-inch	100
3/8-inch	85-100
No. 4	60-100
No. 16	35-80
No. 50	10-55
No. 100	2-10

H. Filter Fabric: Filter Fabric used, as a drainage medium shall consist of a non-woven fabric made from polypropylene or polyethylene filaments or yarns. The fabric shall be inert to organic chemicals commonly encountered in the soil. The fabric shall conform to the following recommended property tests:

Property	Unit	Test Method	Minimum Value
Weight	oz/sy	ASTM D-3776-84	4.5
Grab Strength	lbs	ASTM D-4632-86	120
Grab Elongation	percent	ASTM D-4632-86	55
Trapezoid Tear Strength	lbs	ASTM D-4533-85	50
Mullen Burst Strength	psi	ASTM D-3786-80	210
Puncture Strength	lbs	ASTM D-4833-88	70
Apparent Opening Size (AOS)	U.S. std. Size Sieve	ASTM D-4751-87	70

a. Edges of filter fabric shall overlap a minimum of one foot.

I. Control Density Fill - Flowable Fill: Controlled Density Fill (CDF) material is flowable, self consolidating, rigid setting, low density material that can substitute for compacted gravel in backfills, fills, and structural fills. Excavatable Type 2E shall be used to backfill trenches as detailed on the Contract Drawings. It shall be a mixture of Portland cement, fly ash (if very flowable), sand, and water designed to provide strengths within the range specified.

1. Excavatable mixes, Type 2E, shall be hand tool excavatable.

2. CDF is to be batched at a ready mix plant and is to be used at a high or very high slump of approximately 10 to 12 inches. It shall be flowable, require no vibration and after it has been placed can be excavatable by hand tools and/or small machines.

   The ingredients shall comply with the following:
   Portland Cement ….. …….ASSHTO M 85.
   Fly Ash …… …….AASHTO M 295. Class F
   Sand …….M4.02.02 (Standard Specifications)
   Air Entraining Admixtures…….M4.02.05 (Standard Specifications)

   In lieu of the slump test, a 6 inch long, 3 inch diameter tube may be filled to the top and then slowly raised. The diameter of the resulting “pancake” may be measured and the range of the diameter shall be 9 to 14 inches. High air may be used instead of fly ash with an adjustment in sand content.

3. Type 2E controlled density must meet the requirements set forth in the table below:

CONTROLLED DENSITY FILL	TYPE 2E
Compressive Strength @ 28 days	30 to 80 psi*
Compressive Strength @ 90 days	100 psi maximum*
Slump	10 -12 inches

*May be changed by the Engineer to fit particular job requirements.

2.02 EROSION CONTROL

A. Straw bales shall be of wire or nylon bound bales of straw.

B. Siltation fence shall consist of the following elements:

1. Fabric for siltation fence shall be a minimum width of 3 feet and conforming to the following criteria:

MINIMUM ACCEPTABLE

Fabric Properties	Value	Test Method
Grab Tensile Strength (lbs)	124	ASTM D 4632
Elongation of Failure (%)	15	ASTM D 4632
Mullen Burst Strength (PSI)	300	ASTM D 3786
Puncture Strength (1bs)	65	ASTM D 4833
Flow Rate (gal/min/sf)	10	ASTM D 4491
Apparent Opening Size (sieve)	30	ASTM D 4751
Ultraviolet Radiation (% strength retained)	70	ASTM D 4355

2. Use only commercially available fabric that is certified in writing by the manufacturer for the purpose intended.

3. Acceptable fabric materials include "Mirafi Envirofence" by TC Mirafi, "Style 2130" by Amoco Fabrics Co., and "FX-55" by Carthage Mills, or approved equal by the Engineer.

4. Silt fence posts: Posts may be wood or metal. Wood post shall be a minimum 1¼ inch by 1¼ inch by 5 feet long hardwood stakes commonly used to support siltation fabric. Metal posts shall be a minimum of 1 inch wide and 5 feet long. Posts shall be spaced at a maximum distance of 8 feet on center.

5. Provide suitable heavy nylon cord for securing abutting silt fence posts.

C. Silt-Sac, Hydro-FloGard + Plus Catch basin Insert, Ultra-DrainGuard Insert, or approved equal, shall be used in catch basins to trap sediments and debris.

PART 3 – EXECUTION

3.01 GENERAL REQUIREMENTS

A. The Contract Drawings indicate the proposed finish alignment, elevation, and grade of the work. Establish the line and grade in close conformity with the Contract Drawings. The Owner's Representative, however, may make minor adjustments in the field as necessary due to conditions encountered.

B. The Contractor is responsible for establishing construction phasing, means, and methods and interim grading and temporary conditions required to attain the finish product required by the Contract Documents. The Contractor is responsible for all construction, protection, movement, and maintenance of stockpiles. Establish and maintain suitable benchmarks and grade control to accurately perform the work.

C. All excavation shall be performed in the dry. Excavation and dewatering shall be accomplished by methods, which preserve the undisturbed state of the subgrade soils.

D. No excavation will be permitted below a line drawn downwards at 2 horizontal to 1 vertical from the underside of the closest edge of any in-place footing or utility at a higher elevation without providing adequate sheeting and bracing to prevent movement of the in-place footing or utility.

E. When excavations have reached the prescribed depths, the condition of the bottom of the trench or hole shall be inspected by the Owner's Representative. After inspection the Contractor will receive approval to proceed if conditions meet project requirements.

F. No excavation shall be deposited or stockpiled at any time to endanger portions of new or existing structures, either by direct pressure or indirectly by overloading banks contiguous to the operation. Material, if stockpiled, shall be stored so as not to interfere with the established sequence of the construction. If there is not sufficient area available for stockpiling within the limits of the project, the Contractor will be required to furnish his own area for stockpiling.

G. When the plans require excavation in areas in close proximity to existing buildings, roads, structures and utilities it shall be the responsibility of the Contractor at his expense to use satisfactory means and methods to protect and maintain the stability of such roads, and structures located immediately adjacent to but outside the limits of excavations.

H. Temporary ditches shall be made as needed to drain off surface water to avoid damaged to areas of cut or fill. Such ditches shall be maintained as required for efficient operations, at no additional cost to the Owner.

I. Provide shoring, sheeting, and/or bracing at excavations, as required, to assure complete safety against collapse of earth at the side of excavations. Provide shoring of public utility lines where exposed in the excavations in accordance with rules and regulations of the local authorities, as no additional cost to the Owner.

3.02 FILLING AND BACKFILLING

A. Subgrade Preparation: The subgrade shall be shaped to line, grade, and cross-section, and be thoroughly compacted in accordance with the requirements of paragraph 3.03. This operation shall include any required reshaping and wetting to obtain proper compaction. All soft or otherwise unsuitable material shall be removed and replaced with suitable material from excavation or borrow. The resulting area, and all other low sections, holes, or depressions shall be brought to the required grade with accepted material and the entire subgrade shaped to line, grade and cross-section and thoroughly compacted.

1. Before surface or base materials are spread, the subgrade shall be shaped to an accurate and true surface conforming to the line and grades indicated on the Contract Drawings. All surface irregularities shall be filled with suitable material or removed and such areas recompacted until the surface is properly shaped and properly compacted. A tolerance of 3/8-inch in paved areas and 1/2-inch in non-paved areas above or below the finished subgrade elevation will be allowed provided that this dimension above or below grade is not maintained for a distance longer than 50-feet and that the required crown is maintained in the subgrade. Any portion, which is not accessible to a roller, shall be thoroughly compacted by other mechanical or manual methods.

2. All fills shall be placed in horizontal layers. Fill shall not be placed following the natural contours of the ground. Fill shall be placed starting in the lowest areas working up to finish grades in horizontal layers in the manner specified herein. Each layer of fill shall be benched into the existing slope in order to avoid the formation of a shear plane.

B. Backfill Material: Unless otherwise specified or directed, material used for filling and backfilling shall meet the material requirements specified herein. In general, the material used for backfilling utility trench excavations shall be material removed from the excavations provided that the reuse of these materials result in the required trench compaction and meets the requirements specified for ordinary borrow. All backfill placed within the building limits shall be gravel borrow unless otherwise specified. In areas where the bottom of the excavation is in fine sand and silt, and is below the groundwater table, the first lift of backfill shall be 12-inches of 3/4-inch maximum crushed stone to provide a working mat and drainage layer. Place backfill to a maximum loose lift thickness of 12-inches. Maintain backfill material with a uniform moisture content, with no visible wet or dry streaking, between plus two percent and minus three percent of optimum moisture content. The final filled soil mass shall be as uniform as possible in lift thickness, moisture content, and effort required to compact soil mass.

C. Trench Backfill:

1. After the utility pipe installation has been inspected and approved, trenches shall be backfilled as soon as practicable with specified material. All trench backfilling shall be done with special care.

2. Backfill material for pipe bedding shall be deposited in the trench, uniformly on both sides of the pipe, for the entire width of the trench to 12 inches above the top of the pipe. The backfill material shall be placed by hand shovels, in layers not more than 8-inches thick in loose depth, and each layer shall be thoroughly and evenly compacted by

tamping on each side of the pipe to provide uniform support around the pipe, free from voids.

3. The balance of the trench backfill shall be accomplished with control density fill. All trench backfilling shall be done with special care and must be carefully placed so as not to disturb the work.

4. Any trenches or excavations improperly backfilled or where settlement occurs shall be reopened, to the depth required for proper compaction, then refilled and compacted with the surface restored to the required grade and condition, at no additional expense to the Owner.

5. During filling and backfilling operations, pipelines will be checked by the Owner's Representative to determine whether any displacement of the pipe has occurred. If the observation of the pipelines shows poor alignment, displaced pipe or any other defects they shall be remedied in a manner satisfactory to the Owner's Representative at no additional cost to the Owner.

D. Backfilling Against Structures:

1. Backfilling against masonry or concrete shall not be done until permitted by the Owner's Representative. The Contractor shall not place backfill against or on structures until they have attained sufficient strength to support the loads (including construction loads) to which they will be subjected, without distortion, cracking or other damage. As soon as practicable after the structures are structurally adequate and other necessary work has been satisfactorily completed and approved, special leakage tests of the structures shall be made by the Contractor, as required by the Owner's Representative. After the satisfactory completion of leakage tests and the satisfactory completion of any other required work in connection with the structures, the backfilling around the structures shall proceed using suitable and approved excavation material. The best of the backfill material shall be used for backfilling within 2-feet of the structure. Just prior to placing backfill, the areas shall be cleaned of all excess construction material and debris and the bottom of excavations shall be in a thoroughly compacted condition.

2. Symmetrical backfill loading shall be maintained. Special care shall be taken to prevent any wedging action or eccentric loading upon or against the structures. During backfilling operations, care shall be exercised that the equipment used will not overload the structures in passing over and compacting these fills. Except as otherwise specified or directed, backfill shall be placed in layers not more than 12-inches in loose depth and each layer of backfill shall be compacted thoroughly and evenly using approved types of mechanical equipment. Each pass of the equipment shall cover the entire area of each layer of backfill.

3. In compacting and other operations, the Contractor shall conduct his operations in a manner to prevent damage to structures due to passage of heavy equipment over, or adjacent to, structures, and any damage thereto shall be made good by the Contractor at no additional expense to the Owner.

E. After backfilling trenches and excavations, the Contractor shall maintain the surfaces of backfill areas in good condition so as to present a smooth surface at all times level with adjacent surfaces. Any subsequent settling over backfilled areas shall be repaired by the Contractor immediately, and such maintenance shall be provided by the Contractor for the life of this Contract, at no additional expense to the Owner.

F. The completed and approved subgrades upon which topsoil is to be placed, or pavements are to be installed, shall not be disturbed by traffic of other operations and shall be maintained in a satisfactory condition until the base and finished courses are placed. The storage or stockpiling of materials on finished subgrade will not be permitted.

G. Uniformly shape the surfaces of all areas to be graded, to the lines and grades indicated on the Contract Drawings, and as directed, including excavated and filled sections, embankments and adjacent transition areas, and all areas disturbed as a result of the Contractor's operations. The finished surfaces shall be reasonably smooth, compacted and free from surface irregularities.

H. The Contractor is responsible to provide the finish grades as shown on the Contract Drawings. The Contractor shall provide temporary erosion control throughout the construction period to maintain all constructed lawns, and to protect all existing drains, catch basins, swales, from any debris or soil entering from excavation, backfill, or erosion. Contractor shall take whatever precautions are necessary to accomplish this temporary erosion control such as haybales, silt fence, erosion control fabric, or pumping, at no additional cost to the Owner.

I. Steel plates shall be installed over the trench after placement of the controlled density fill as a temporary means of protecting the trench until the controlled density fill has cured for at least 24 hours. Steel plates shall be pinned to the existing pavment surface in at least one location on all sides. A wedge of temporary hot mix asphalt shall be placed around the entire circumference of the plate if it will be exposed to traffic.

3.03 COMPACTION

A. Compaction Requirements: The degree of compaction is expressed as a percentage of the maximum dry density of the material at optimum moisture content as determined by ASTM Test D1557, Method C. The compaction requirements are as follows:

Area	ASTM Density Degree of Compaction
Below footings	95%
Below slabs	95%
Pavement base course	95%
Pavement subgrade	95%
General fill below pavement subbase	95%
Trench backfill - below pavements - below landscaped areas - below structures	95% 92% 95%
All other areas	90%

B. Moisture Control:

1. Fill that is too wet for proper compaction shall be disced, harrowed, or otherwise dried to a proper moisture content to allow compaction to the required density. If fill cannot be dried within 24 hours of placement, it shall be removed and replaced with drier fill.

2. Fill that is too dry for proper compaction shall receive water uniformly applied over the surface of the loose layer. Sufficient water shall be added to allow compaction to the required density.

C. Unfavorable Conditions:

1. In no case shall fill be placed over material that is frozen. No fill material shall be placed, spread or rolled during unfavorable weather conditions. When work is interrupted by heavy rains, fill operations shall not be resumed until the moisture content and the density of the previously placed fill are as specified.

2. In freezing weather, a layer of fill shall not be left in an uncompacted state at the close of the day's operations. Prior to terminating work for the day, the final layer of compacted fill shall be rolled with a smooth wheeled roller to eliminate ridges of soil left by compaction equipment.

D. Compaction Control:

1. In-place density tests shall be made in accordance with ASTM D1556, D2922, or D2167 as the work progresses, to determine the degree of compaction being attained by the Contractor. Any corrective work required as a result of such tests, such as additional compaction, or a decrease in the thickness of layers, shall be performed by the Contractor

at no additional expense to the Owner. In-place density testing shall be made by UML's geotechnical testing laboratory.

2. In-place density tests shall be performed at a minimum according to the following:

   a. A minimum of one per trench.

   b. One test per lift for each parking lot and sidewalk subgrade area.

E. Erosion control

1. The work of the Section consists of all sedimentation and erosion control related items as indicated on the Contract Drawings and/or specified herein and includes but is not limited to the following:

   a. Hay bale and silt fence barriers.
   b. Temporary covers for drainage structures.
   c. Temporary protective soil coverings.

2. The Contractor shall install all measures needed to control sediment and erosion as required by the Contractor and Sub-contractor's construction methods and operations, the weather conditions, and as directed by the Engineer.

END OF SECTION 312000