ARTICLE 9

GEOTECHNICAL GUIDELINES

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ARTICLE 9

GEOTECHNICAL GUIDELINES

SECTION 9-100 GENERAL PROCEDURES

1. A geotechnical review is required for all proposed developments and capital improvement projects. The extent of this review is directly related to the quality of the in-place materials as they relate to engineering applications. In an effort to standardize this review and to ensure all factors have been considered, the Town of Leesburg has herein formulated a systematic approach to soils and geotechnical issues.

2. The geotechnical study is to be prepared under the direction of, and sealed by, a registered professional engineer licensed in the Commonwealth of Virginia specializing in geotechnical engineering.

3. The geotechnical requirements contained herein are specifically related to the installation of public improvements required by the Town of Leesburg. Town approval of the detailed geotechnical investigation required herein does not express or imply approval by Loudoun County. All geotechnical requirements for habitable structures or retaining walls are administered by Loudoun County. Town approval of construction drawings and required geotechnical information for subdivisions and development plans does not express or imply approval of habitable structures or retaining walls which are under the jurisdiction of the Loudoun County Building Permit Process.

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SECTION 9-200 DETAILED GEOTECHNICAL EVALUATION (TYPE II)

9-210 Guidelines for Geotechnical Studies

This section sets forth minimum requirements for geotechnical field investigations and reports. Should conditions peculiar to the site of the proposal manifest a need, additional requirements may be applied at the direction of the Director.

9-220 Detailed Geotechnical Investigation

1. The scope and purpose of the detailed geotechnical investigation are comprehensive. Observations in the field should be spaced sufficiently close that site-specific recommendations can be made with confidence. Laboratory data and precise field measurements, such as ground water levels and perched water table levels, should be provided to document findings and design parameters. Maps should be provided to illustrate major conclusions. The report should address all areas impacted by the proposed construction of required public improvements, overlot cuts or fills in excess of 6 feet, and slopes exceeding 1 vertical foot in 3 horizontal feet.

2. The detailed geotechnical investigation is to be prepared under the direction of, and sealed by, a registered professional engineer licensed in the Commonwealth of Virginia with experience in geotechnical engineering.

3. All construction drawings for subdivisions or development plans shall contain a detailed geotechnical investigation as part of the submission.

9-230 Requirements for Type II Detailed Geotechnical Investigation

The detailed geotechnical investigation must respond to the construction of public improvements to support the proposed land use. Laboratory data and precise field measurements shall be provided to document findings and design parameters. The report shall address all areas impacted by the proposed construction of public improvements, overlot cuts or fills in excess of 6 feet, and slopes exceeding 1 vertical foot in 3 horizontal feet. It shall contain approximate designs, earthwork specifications, and recommendations for remedial action in problem areas. This report shall contain the following:

9-230 TOWN OF LEESBURG DESIGN & CONSTRUCTION STANDARDS

1. Background.

   A. A brief description of the terrain.

   B. A brief geological history.

   C. A description of exploration and sampling methods.

   D. A description of laboratory test procedures and results.

2. Scope of project and objectives.

3. Narrative of standard terminology.

4. Report of field investigation -- A report of the field investigation shall contain the following:

   A. A map, drawn to 1:2400 scale (one inch equals 200 feet), and others as desired, on a sheet measuring 24 inches by 36 inches shall be provided. Where the proposal covers more than one sheet, a compiled photo reduction, at 1:4800 scale (one inch equals 400 feet), of all maps shall be submitted in addition to the 1:2400 scale map. Other maps at larger scales may be used with prior approval of the Director. Maps shall show the following:

      (1) The following details located to National Map Accuracy Standards:

         a. Topography, with at least five-foot contour intervals.

         b. Planimetric detail, including swamps, marshes, ponds, wooded areas, rock outcrops, buildings, roads, fence lines, utility structures.

         c. Virginia Coordinate Grid system, with 500-foot intervals, location map, and north arrow.

      (2) Location of all test holes, borings, backhoe pits, and/or seismic tests. Test holes/pits are to be numbered and located dimensionally and are to include surface elevations.

(3) Spatial distribution of soil and/or geologic materials.

B. Cross sections of soil/geologic materials, showing stratigraphic relationships, including structure, and subsurface distribution.

C. Narratives describing geology and hydrology.

(1) General report for town utilities and public and private roads -for most development proposals, a general geologic report will be sufficient. The exceptions are land developments proposed in mountain colluvium on slopes in excess of 15 percent or in the limestone conglomerate rock outcrop belt.

a. Narrative of location, type, and hardness of bedrock encountered; presumed rippability.

b. Ground water conditions, including depth and location of water table.

(2) Detailed report -- A detailed section on geology and hydrology, evidenced by sampling data, including soil borings, soil samples (undisturbed), penetration tests and rock cores, will be required when the proposed uses include dams/impoundments, and land developments proposed in limestone, in conglomerate outcrop, or in mountain colluvium with slopes greater than 15 percent. The report shall include, but shall not be limited to:

a. Type of rock materials present, including physical, chemical, and mineralogical properties, quality of rock and description of mapping units.

b. Macro- and micro-structure of rock or geologic material, including joints and fracture patterns; faults, if present; cleavage; foliation and bedding, if applicable.

c. Geologic cross sections of the tract.

d. Water movement in both soil and geologic materials; method of recharge; dewatering effect of proposal; map showing ground water contours; transmissibility of rock; effect of regional fractures (linear fractures) on water movement; discussion of existing ground water supply; levels of water; and historic water availability; direction of ground water flow.

e. Environmental geology. Description of the area's geology to indicate the susceptibility of pollution from leachate, or surface contamination (i.e., landfills, sewage disposal facilities, or limestone conglomerate outcrop belt). Description of the potential of the area to undergo catastrophic collapse or subsidence, due to presence of slip plane, sinkholes, shock transfer or other geologic phenomena.

D. Narratives describing soils and surficial materials -- A detailed description of soils and surficial materials illustrated on the map will be required and should include the following:

(1) Description of physical properties for soils for each mapping unit or area of similar soil conditions or "strata," including silt content, clay amount, and type (shrink-swell, plasticity, bearing capacity of materials, chemical properties), particularly as these apply to revegetation, apparent stability of sidewalls in cuts.

(2) Description of surface drainage, permeability, and presence of seasonal perched water tables.

5. Recommendations/conclusions. The following are areas which should be included in the recommendations and conclusions section, as appropriate.

A. Town utilities, public and private roads, and embankment dams.

(1) Recommendations for typical pavement design, sidewalks, curb and gutter, driveways, typical design CBR values, and stabilization of subgrade.

(2) Evidence that rock strata are sound and not underlain with solution channels or recommendations that provide for correction of these conditions.

(3) Ground water elevations and recommendations for temporary dewatering procedures during construction and for permanent dewatering facilities after construction, including effects of seasonable variations.

(4) Other factors, such as alkali content, corrosiveness, underground springs, fill areas and maximum depth of frost penetration.

(5) Thickness, consistency, character, compressibility, shear value and suitability for subgrade of the various strata encountered.

(6) Recommendations for removal of perched/seasonal water tables, including underdrainage for roads.

(7) Specifications for fill materials, including gradation ASTM, AASHTO, or VTM test method and percent of maximum theoretical density and optimum moisture, site preparation and material placement, qualifications of testing personnel and testing laboratory.

(8) Recommendations for shrink-swell clays (backfill, removal).

(9) Shoring for utility or other deep excavations.

(10) A slope stability analysis must be prepared whenever final slopes steeper than three horizontal feet to one vertical foot and greater than six feet in height are being proposed due to a site-specific condition.

B. Blasting

(1) Analysis of controlled blasting vibrations and their potential effects on structures near the proposed facility.

(2) Recommendations for monitoring programs for blasting vibrations, including location and number of observation points and frequency of sampling.

C. On-site sewage disposal (if applicable) -- Potential impacts on ground and surface water, loading rates and vegetative cover.

D. Field logs.

(1) Ground water monitoring data.

(2) Seismic data for site.

(3) "N values" (standard penetration test results) and natural moisture content ("W") from split-spoon or Shelby tube analysis.

(4) Rock core descriptions.

E. Laboratory data -- Laboratory data shall be supplied as required to support recommendations and description narrative.

(End of Section)

SECTION 9-300 STANDARD REFERENCES, METHODS, AND PROCEDURES FOR SOILS AND GEOTECHNICAL STUDIES

Publications. The following will be considered standard reference manuals and publications:

Black, C.A. (ed.), 1965. Methods of Soil Analysis: Parts I and II, Agronomy Series, American Society of Agronomy, Madison, Wisconsin.

American Society for Testing and Materials (ASTM International), (Latest Edition).

Annual Book of ASTM Standards, (Latest Edition).

NRCS Soil Survey Manual, (Latest Edition).

Virginia Department of Transportation. Virginia Test Methods Manual, (Latest Edition).

Finn, D., and Cocacza, E., 1977. Procedures Manual for Ground Water Monitoring at Solid Waste Disposal Facilities, Environmental Protection Agency Manual No. SW611.

Conrad, E.T., et al., 1981. Solid Waste Landfill Design and Operation Practices, Environmental Protection Agency, Washington, D.C.

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SECTION 9-400 STANDARD METHODS AND PROCEDURES FOR SOILS AND GEOTECHNICAL STUDIES

1. Classification and description. Classification and description of soils for geotechnical reports will be by *Standard Practice for Classification of Soils for Engineering Purposes* (Unified Classification System of Soils), (ASTM D2487) and *Standard Practice for Description and Identification of Soils (Visual Manual Proceedure),* (ASTM D2488).

   Classification and description of soils for soils reports will be by National Cooperative Soil Survey methods and procedures, (Published by NRCS).

2. The VTM manual and ASTM manual should be consulted for approved procedures for the following:

   A. Atterberg limits (ASTM D4318)
   B. Gradation (ASTM D421, D422)
   C. CBR (ASTM D1883)
   D. Compaction (ASTM D698)
   E. Consolidation tests (ASTM D2435)
   F. Permeability tests
   G. Rock drilling (ASTM D2113)

3. The publication Black, C.A. (ed.), 1965. Methods of Soil Analysis: Parts I and II, Agronomy Series, American Society of Agronomy, Madison, Wisconsin provides acceptable procedures for the following:

   A. Permeability tests
   B. Mineralogy
   C. Soil chemistry -- A1, CEC, Base saturation
   D. Particle size analysis
   E. Moisture content

4. Other procedures approved by the Director

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SECTION 9-500 IMPLEMENTATION OF RECOMMENDATIONS

9-510 Geotechnical Review

The design engineer/architect shall provide the Director with a written statement from the geotechnical engineer stating that he has reviewed the plans, as submitted, and that the plans were prepared in accordance with the recommendations of the geotechnical report.

9-520 Arbitration

Where arbitration is necessary to resolve differences of opinion in geotechnical matters, the Director may refer the proposal to the Loudoun County Department of Building and Development for review and comment, or the Director may contract with an independent geotechnical engineer for review and comment. All costs for such independent review shall be borne by the applicant.

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SECTION 9-600 GEOTECHNICAL TESTING REQUIREMENTS FOR INSTALLATION OF PUBLIC IMPROVEMENTS

9-610 Testing and Testing Laboratory Services

1. The Developer shall employ and pay for the services of an independent testing laboratory to perform testing specifically indicated herein, and may at any other time elect to have materials and equipment tested for conformity with the standards set forth herein.

2. The Contractor shall cooperate with the laboratory to facilitate the execution of its required services.

3. Employment of the laboratory shall in no way relieve the Contractor's obligations to perform the work of the contract.

4. Independent testing services shall not be required for any installation of waterline, sanitary sewer, storm drain, or road pavement where such installation is less than 500 linear feet in total length for all phases depicted on the preliminary subdivision plat or development plan.

5. Testing laboratory inspection, sampling and testing is required for, but not limited to earthwork, concrete, and paving materials.

6. The independent testing laboratory shall perform all laboratory work and on-site inspections and testing required by laws, ordinances, rules, regulations, orders or approvals of the Director.

9-611 Laboratory Duties

1. Cooperation with the Director and Contractor; provision of qualified personnel after due notice by the Director or Contractor.

2. Performance of specified inspections, sampling, and testing of materials and methods of construction.

3. Compliance with specified standards for testing procedures.

4. Ascertained compliance of materials with requirements of the standards set forth herein.

5. Prompt notification of the Director and contractor of observed irregularities or deficiencies of work or products.

6. Obtaining and handling of samples at the project site or at the source of the product to be tested.

7. Prompt submission of two copies of the written report of each test and inspection to the Director. Each report shall include:

   A. Date issued.

   B. Project title and number.

   C. Testing laboratory name, address, and telephone number.

   D. Name and signature of laboratory inspector.

   E. Date and time of sampling or inspection.

   F. Record of temperature and weather conditions.

   G. Date of test.

   H. Identification of product and specification section.

   I. Location of sample or test in the project.

   J. Type of inspection or test.

   K. Results of tests and compliance with standards.

   L. Interpretation of test results, when requested by the Director.

8. Performance of additional tests as required by the Director or the Owner.

9-612 Limitations of Authority of Testing Laboratory

The testing laboratory is not authorized to:

1. Release, revoke, alter or enlarge on requirements of standards as set forth herein.

2. Approve or accept any portion of the work.

3. Perform any duties of the contractor.

9-613 Contractor's Responsibilities/Developer's Responsibilities

1. Cooperation with laboratory personnel and provision of access to work and to operations.

2. Materials and equipment used in the performance of work under this Article are subject to inspection and testing.

3. The Director may require the contractor to provide statements or certificates from the manufacturers and fabricators that the materials and equipment provided by them are manufactured or fabricated in full accordance with the standard specifications for quality and workmanship indicated herein.

4. All costs of this testing, required statements and certificates shall be a subsidiary obligation of the Developer, and no extra charge to the Town shall be allowed for such testing and certification.

   The Contractor shall furnish incidental labor and facilities:

   A. To provide access to work to be tested.

   B. To facilitate inspections and tests.

   C. For storage and curing of test samples.

5. Notification of the laboratory and the Director sufficiently in advance of operations (48 hours minimum) to allow for laboratory assignment of personnel and scheduling of tests.

6. Meetings with the Director, Town Inspector, and testing laboratory prior to the initiation of construction, to coordinate the construction and testing schedule for the project.

9-614 Testing Procedures

1. For all roadway work or work within the public right-of-way, tests shall be in accordance with Virginia Testing Methods (VTM).

2. Outside of the public right-of-way, but within public utility easements, tests will be performed in accordance with applicable ASTM or AASHTO standard methods, unless otherwise specified.

   A. The optimum moisture content and the maximum density of each type of material used for structural fill and backfill shall be determined by “Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort.” (ASTM D698 or AASHTO-99).

   B. The field moisture content of materials being compacted shall be determined by "Determination of Moisture Content of Soil in Place (AASHTO T-239)." The field density of compacted material shall be determined by "Test for Density of Soil in Place by the Sand-Cone Method", AASHTO T-191, or "Density of Soil in Place by Nuclear Methods" AASHTO T-238.

(End of Section)

SECTION 9-700 EXCAVATION, TRENCHING AND BACKFILLING FOR UTILITIES

9-710 General

9-711 Related Documents

1. Approved Construction Regulations
2. State Waterworks Regulations
3. State Sewerage Regulations
4. Virginia Erosion and Sediment Control Handbook

9-712 Description of Work

1. Trenching and backfilling for utilities.
2. Provision of suitable borrow, backfill material, and disposal of spoil.
3. Prior to beginning excavation and embankment operations in any area, all temporary erosion and sediment control measures for the area shall be in place. Phasing of site work shall conform to the approved erosion and sediment control plan. *Refer to Article 6 of this Manual.*

9-713 Quality Assurance

1. Codes and Standards. Performance of excavation work in compliance with applicable requirements set forth herein.
2. Soil Testing and Inspection Service. The Developer shall provide an independent soil testing and inspection service (the "Testing Service") for quality control testing during earthwork operations. The Contractor shall coordinate and cooperate with the work of the testing service.

3. The Developer shall furnish a guarantee that backfilled areas will not suffer ponding or settlement for a period of one year from the date of final acceptance. Fill materials and surfacing which settle shall be removed and replaced with suitable material at no cost to the Town.

4. The Contractor shall furnish a guarantee that all tests have been performed for all underground utilities.

9-714 Submittals

Tests Reports-Excavating. The following reports shall be submitted to the Director from the testing services, with a copy to contractor:

1. Subgrade. One sieve analysis and one liquid limit and plasticity index determination for cohesive soils for each 1000 lineal feet or fraction thereof.

2. Fill and Backfill Material. One sieve analysis and one liquid limit and plasticity index determination for cohesive soils for each 1000 cubic yards or fraction thereof.

3. Optimum Moisture and Maximum Dry Density. One moisture-density curve, to determine the optimum moisture content and the maximum dry density, values, shall be done for each 1000 cubic yards or fraction thereof, for each type of subgrade material.

4. Field Density Tests.

   A. Trench Subgrade.

      (1) Trenches Under Pavement. One test per 100 lineal feet or fraction thereof, of trench for each pavement.

      (2) Adjacent to Utility and Drainage Structures Abutting Pavements. One test for each structure.

B. Backfill Material.

(1) Trenches Under Pavement. One test for each lift for every 100 lineal feet or fraction thereof, of trench for each pavement. These tests shall be offset 50 feet on each subsequent lift.

(2) Trenches in Overlot Areas. One test for every 24 inches of compacted thickness or fraction thereof, for each 500 lineal feet or fraction thereof, of trench.

(3) Utility or Drainage Structures Which Abut a Pavement. One test for every 12 inches of compacted thickness or fraction thereof, for each structure.

(4) Location of tests shall be the discretion of the Director.

9-715 Site Conditions

1. The Developer's engineer shall examine the subsurface soil report and provide a preliminary analysis of the suitability of the site soils for backfill material.

2. The actual on-site testing during construction shall determine the suitability of materials and the acceptability of operations.

9-720 Materials

1. Satisfactory soil materials for backfill shall be those materials classified in ASTM 2487 as GW, GP, GM, GC, SW, SM, SC or combinations thereof, properly worked by the contractor to obtain the specified compaction, while maintaining the moisture content as specified. Soil types SP, ML, CL or combinations thereof, may be included as satisfactory material provided the liquid limit test result does not exceed 40 and plasticity does not exceed 15. The Contractor should be aware of the possible construction difficulties and the very close moisture control required in the proper field placement and compaction of these latter materials, and of any micaceous materials on site.

2. Unsatisfactory materials for fill, embankment, and backfill shall be those materials in ASTM 2487, not meeting the requirements of the satisfactory materials as defined above.

3. Pipe bedding material shall consist of well-graded sand, gravel, crushed gravel, crushed stone or crushed slag composed of hard, tough and durable particles, and shall not contain more than ten percent by weight of material passing a No. 200 mesh sieve, and no less than 95 percent by weight passing the one inch sieve, with a maximum allowable aggregate size of 1.5 inches.

4. Select granular fill shall be sound, hard, durable crushed stone and shall conform to ASTM C33, Size No. 57; Virginia Department of Transportation, Size No. 57.

5. Structural fill shall conform to the requirements set forth in Virginia Department of Transportation Road and Bridge Specifications for Select Material, Types I, II or III. Structural fill shall be used as fill and backfill as indicated on the drawings beneath appurtenant structures, and beneath paved areas, public or private.

6. Sand shall conform to ASTM Standard C33, for concrete sand.

7. Backfill materials shall be free of all organic material, trash, snow, ice, frozen soil or other objectionable materials. Soft soils, wet soils, plastic soils, expansive soils and clay soils having a natural in-place water content in excess of 30 percent, are considered unsuitable for stockpiling and/or future use as backfill.

8. Backfill shall not contain stones, stone blocks, broken concrete, masonry rubble or other similar materials larger than six inches in (largest) diameter. The backfill shall have physical properties such that it can be readily spread and compacted during filling.

9-730 Stripping and Stockpiling of Topsoil

1. Suitable topsoil encountered in excavation and/or in easement areas where pavement is to be placed shall be removed and stockpiled in locations designated or approved by the Director.

2. Topsoil shall be completely removed from an area prior to the beginning of regular excavation or embankment work and shall be kept separate from other excavated materials.

3. Topsoil stockpiles shall be temporarily seeded and provided with other temporary erosion and sediment control measures as required by the approved erosion and sediment control plan. *Refer to Article 6 of this Manual.*

9-740 Blasting

1. All blasting operations shall be conducted in full compliance with all State laws, all local ordinances of the Town and Loudoun County, under the jurisdiction of Loudoun County Fire Marshal, and with all possible care to avoid injury to persons and property. The rock shall be well covered and sufficient warning shall be given to all persons in the vicinity of the work before blasting. Care shall be taken to avoid injury to all water pipes, gas pipes or other structures and to town and private property. The contractor, in addition to observing all ordinances relating to the storage and handling of explosives, shall also conform to any further regulations which the Loudoun County Fire Marshal shall deem necessary. If track drills are used for drilling rock, water must be provided with the drill to eliminate dust.

2. It is the contractor's responsibility to use methods of blasting and excavation which will result in undamaged, finished rock surfaces and which will prevent damage to any existing structures. A satisfactory rock surface shall be a stable, safe surface, free of loose rock, and any soft or yielding material. The blasting and excavation methods should be adjusted to achieve this objective.

3. The handling, transportation, storage and use of explosives shall conform to the requirements of the Loudoun County Fire Marshal and other governmental authorities having jurisdiction and shall follow all applicable provisions as adopted by the Institute of Makers of Explosives and OSHA. The use of explosives shall be limited to labor skilled in their use; all work shall be performed under the direct supervision of licensed blasters; and all blasting shall be performed under the jurisdiction of the Loudoun County Fire Marshal.

4. If rock below grade is shattered on account of holes having been drilled too deep, excessive charges of explosives used or for any other reasons due to blasting by the contractor, and if, in the opinion of the Director, said shattered rock is unfit for foundation, the shattered rock shall be removed and the excavation refilled as required by the Director at no expense to the town.

9-741 Blasting Records and Reports

All blasting records and reports shall conform to the requirements of the Loudoun County Fire Marshal and other governmental authorities having jurisdiction.

9-750 Excavation

1. All excavation of every description and of whatever substances encountered shall be performed to the depths indicated or as otherwise specified. Test pits must be hand dug to locate existing utilities. During excavation, materials found suitable for backfilling shall be piled in an orderly manner a sufficient distance from the banks of the trench to avoid overloading and to prevent slides or cave-ins. All excavated materials not required or unsuitable for backfill shall be removed from the work area.

2. Grading shall be done as may be necessary, to prevent surface water from flowing into trenches or other excavations, and any water accumulating therein shall be removed by pumping or by other approved methods. Sheeting and shoring shall be done as may be necessary for other protection of the work and/or the safety of personnel, as determined by the Director.

9-751 Trench Excavation

1. The trench shall be excavated as recommended by the manufacturer of the pipe to be installed. Trench walls below the top of the pipe shall be sloped, or made vertical, as recommended in the manufacturer's installation manual. The trench width below the top of the pipe shall not exceed that recommended in the installation manual. Trench walls above the top of the pipe shall be sloped at a 1:1 slide slope, or:

A. Furnish, put in place, and maintain such sheeting and bracing as may be required to support the sides of excavations, to prevent any movement which could in any way diminish the width of the excavation below that necessary for proper construction, and to protect adjacent structures from undermining or other damage. If the Director is of the opinion that at any point sufficient or proper supports have not been provided, he may order additional supports put in at no expense to the Town and compliance with such order shall not relieve or release the contractor from his responsibility for the sufficiency of such supports. Care shall be taken to prevent voids outside of the sheeting, but if voids are formed, they shall be immediately filled and rammed. Where soil cannot be properly compacted to fill a void, lean concrete shall be used as backfill at no expense to the Town. Sheeting and bracing requirements are further defined in OSHA Standards, Subpart P, Part 1926, of the Code of Federal Regulations.

B. The Contractor shall construct the sheeting outside the "neat" lines of the foundation unless indicated otherwise, to the extent he deems it desirable for his method of operation. Sheeting shall be plumb and securely braced and tied in position. Sheeting and bracing shall be adequate to withstand all pressures to which the structure or trench will be subjected. Any movement or bulging which may occur shall be corrected by the contractor at no expense to the Town so as to provide the necessary clearances and dimensions.

C. Where sheeting and bracing is required to support the sides of excavations for structures, the Contractor shall engage a professional engineer, registered in the Commonwealth of Virginia, to design the sheeting and bracing. The sheeting and bracing installed shall be in conformity with the design, and certification of this shall be provided by the professional engineer.

D. All sheeting and bracing shall be carefully removed in such a manner as not to endanger the construction or other structures, utilities or property. All voids left or caused by withdrawal of sheeting shall be immediately refilled with sand by ramming with tools especially adapted to that purpose, or otherwise as may be directed.

2. Where no pipe manufacturer's installation manuals are available, design shall be performed by the developer's engineer and approved by the Director prior to installation of pipe. Design shall include using stronger pipe or special installation procedures. The cost of this design and the increased cost of pipe or installation procedures shall be at no expense to the Town.

3. If the Contractor does not provide for dewatering or erosion and sediment control properly, the Contractor shall remove the unsuitable material and replace it with concrete, compacted structural fill or other approved material at no expense to the Town, so that the condition of the subgrade meets with the approval of the Director before any work is placed thereon.

4. Bedding. The bedding surface for the pipe shall provide a firm foundation of uniform density throughout the entire length of the pipe.

   Requirements for pipe bedding with crushed stone shall be based upon the condition of the pipe foundation, the pipe material, and the anticipated loading.

   A. Pipelines constructed of ductile iron pipe, laid upon undisturbed foundation of satisfactory materials with uniform load bearing capacity do not require bedding.

   B. Pipelines constructed of PVC pipe shall have Class "B" bedding, using VDOT crushed stone #68 or #78 to the springline of the pipe.

   C. Where excavation is made in rock, boulders, or other unsuitable material, the pipe subgrade shall be built up by backfilling with a minimum of six inches of VDOT crushed stone #68 or #78 which shall be compacted to a minimum 95 percent density (Standard Proctor ASTM D698) at optimum moisture.

   D. Foundations that are unsuitable or of unsatisfactory materials shall be removed and replaced with satisfactory materials and a minimum of 6" VDOT #68 or #78 crushed stone bedding compacted to 95 percent maximum density (Standard Proctor ASTM D698) at optimum moisture.

E. The pipe shall be bedded carefully in bedding material, or in undisturbed foundation, accurately shaped and rounded to conform to the lowest one third of the outside portion of the circular pipe for the entire length of pipe. When necessary, the bedding shall be tamped. Bell holes and depressions of joints shall be only of such length, depth, and width as required for properly making the particular type joint. Bedding and foundation in all cases shall conform to the pipe manufacturer's installation manual.

5. Removal of Unyielding Material. Unyielding material, boulders, and large stones shall be removed to provide a clearance of at least six inches below and on each side of all pipe, valves and fittings for pipe 24 inches in diameter and smaller. The specified minimum clearances are the minimum clear distances which will be permitted between any part of the pipe and appurtenances being laid and any part or projection of such rock, or stone.

6. Removal of Unstable Material. Where unstable material is encountered in the bottom of the trench, such material shall be removed to the depth directed and replaced to the proper grade with select granular material. When removal of unstable material is required due to the fault of neglect of the Contractor in his performance of the work, the resulting material shall be excavated and replaced by the contractor.

7. Removal of Unsatisfactory Material. Unsatisfactory material encountered beyond the depths indicated shall be removed and replaced with satisfactory material as directed by the Director.

9-752 Excavation for Appurtenances

1. Excavation for manholes, catch basins, inlets, or similar structures shall be of sufficient size to permit the placement and removal of forms for the full length and width of structure footings and foundations. Removal of unstable material shall be as specified above. When concrete or masonry is to be placed in an excavated area, special care shall be taken not to disturb the bottom of the excavation. Excavation to the final grade level shall not be made until just before the concrete or masonry is placed.

9-753 Drainage and Dewatering

No pipe shall be laid in water or when trench conditions are unsuitable, due to inadequate drainage or dewatering.

The Contractor shall note the subsurface water level recorded and date when this level was recorded on the boring logs shown on the subsurface soil report. The water levels are only for the dates shown on the logs and it can be expected that the water table may fluctuate.

1. Drainage. Excavation, filling, and backfilling shall be performed such that the area of the site and the area immediately surrounding the site, and affecting operations at the site, will be continually and effectively drained. Perimeter and diversion ditches together with dikes and grading, shall be provided and maintained as necessary to prevent surface water from flowing into any excavation. The Contractor shall control any and all water entering the open-cut excavation or accumulating in the excavation.

2. The Contractor shall at all times during construction provide and maintain proper equipment and facilities to remove all water entering excavations, and shall keep such excavations dry so as to obtain a satisfactory undisturbed subgrade foundation condition until the fills, structures or pipes to be built thereon have been completed to such extent that they will not be floated or otherwise damaged by allowing water levels to return to natural levels. Removal of water in the excavation shall be performed, exercising care so as not to wash or otherwise remove fines from the surrounding soil.

3. Dewatering. Unless otherwise specifically authorized, all excavation, filling and backfilling shall be done "in the dry". No excavation which will be influenced by ground water, shall be made to final grade until dewatering has been accomplished to the satisfaction of the Director.

    A. The Contractor shall engage a geotechnical engineer, registered in the Commonwealth of Virginia to design the dewatering system. The contractor shall submit to the Director for review, the design of the dewatering systems prior to commencing work.

B. The Contractor shall furnish, install, maintain, operate and remove a temporary dewatering system consisting of trenches, sump pits, deep wells, well points or other methods as required to lower and control the ground water level so that the structure may be constructed in the dry. The Contractor shall correct all damage resulting from inadequacy of the dewatering system or from flooding of the construction site from other causes.

C. The Contractor shall maintain the water level below the excavated area for the various phases of the work continuously and shall make such provisions as may be necessary to avoid interruptions due to weather, labor strikes, power failures, or other delays. He shall provide and have ready for immediate use at all times, diesel or gasoline powered standby pumping units to serve the system in case of failure of the normal pumping units.

4. Piping and boiling, or any form of uncontrolled seepage, in the bottom or sides of the excavation shall be prevented at all times. If for any reason a dewatering system is found to be inadequate to meet the requirements set forth herein, the Contractor shall at no expense to the Town make such additions, changes and/or replacements as necessary to provide a satisfactory dewatering system.

5. Dewatering shall at all times be conducted in such a manner as to preserve the undisturbed bearing capacity of the subgrade soils at the proposed bottom of excavation. Well or sump installations shall be constructed with proper sand filters to prevent drawing of finer grained soil from the surrounding ground.

6. Water entering the excavation from surface runoff shall be collected in shallow ditches around the perimeter of the excavation drained to sumps, and pumped from the excavation to maintain a bottom free from standing water.

7. The Contractor shall take all additional precautions to prevent uplift of any structure during construction. The Contractor shall maintain the groundwater level at or below subgrade of the structure until the concrete substructure is up high enough to prevent flooding of the structure, support is obtained at both bottom and top levels of walls and flotation is prevented.

8. Drainage water shall be disposed of through a desilting basin which will prevent the discharge of sediment into a creek or existing drains and to prevent flow or seepage back into the excavated area.

9. Flotation shall be prevented by the Contractor by maintaining a positive and continuous operation of the dewatering system. The Contractor shall be fully responsible and liable for all damages which may result from failure of this system.

10. Removal of dewatering equipment shall be accomplished after the system is no longer required; the material and equipment constituting the system, shall be removed by the Contractor.

11. The Contractor shall take all necessary precautions to preclude the accidental discharge of fuel, oil, etc. in order to prevent adverse effects on groundwater quality.

9-754 Steel Box Installation Criteria

The Contractor shall meet the following criteria when the installation method includes the use of a steel box:

1. When installing rigid pipe, any portion of the box extending below mid-diameter of the pipe shall be raised above this point prior to moving the box ahead to install the next pipe. This is to prevent the separation of installed pipe joints due to movement of the box.

2. When installing flexible pipe (PVC, DI, etc), the bottom of the box shall not extend below mid-diameter. This is to prevent loss of soil between the box and the pipe bedding which could result in excessive deflection of the installed pipe.

3. Where pipe is to be installed in fill of any type, fill shall be placed and compacted to the total depth required (rough grade elevation) and then re-excavated for pipe installation.

9-755 Borrow

Borrow shall consist of satisfactory materials obtained off-site and required for the backfill of trenches or other portions of the utility installation. Sources of borrow material shall be approved by the Director.

9-756 Structural Fill Under Closed Conduits

Fill material under closed conduits, to an elevation equivalent to the normal trench subgrade, shall consist of structural fill, select material I. Fill shall be placed in layers not exceeding six inches loose thickness for compaction by hand operated machine compactors, and eight inches loose thickness for other than hand operated machines, unless otherwise specified. Fill shall be aerated or moistened as necessary to achieve an in-place moisture content within plus or minus two percent of optimum moisture. Each layer shall be compacted to at least 95 percent maximum dry density.

9-760 Backfill

1. Backfill material shall consist of satisfactory material. Backfill shall be placed in two eight inch layers loose thickness immediately over the pipe, and each layer shall be thoroughly compacted in accordance with the criteria below. The remainder of the backfill shall then be placed in one foot layers each properly compacted in accordance with the criteria below. Backfill material shall be free of perishable material, frozen clods, sticky masses of clay, and other unsuitable matter. Rock fragments larger than one inch shall not be used in any backfill which is within two feet of the pipe.

2. Other backfill shall be placed in layers not exceeding six inches loose thickness for compaction by hand operated machine compactors, and eight inches loose thickness for other than hand operated machines, unless otherwise specified. Backfill shall be aerated or moistened as necessary to achieve an in-place moisture content within plus or minus two percent of optimum moisture. Each layer shall be compacted as follows unless otherwise specified:

Cohesionless Soils	Cohesive Soils
Soils which do not exhibit a well-defined moisture-defined moisture density relationship	Soils which exhibit a well-defined moisture density relationship
95% maximum dry density (ASTM D-698)	90% maximum dry density (ASTM D-698)

3. Cohesionless and Cohesive Materials: Cohesionless materials include materials classified Unified Soil Classification GW, GP, SW and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic.

4. Backfilling over pipes shall begin as soon as practicable after the pipe has been laid, jointed and inspected. All backfilling shall be completed expeditiously and as detailed on the plans.

   A. Trench Backfill. The trench shall be backfilled to finished grade two feet above the top of pipe prior to performing any required pressure tests. The joints and couplings shall be left uncovered during the pressure test.

   B. Replacement of Unsatisfactory Material. Unsatisfactory material removed from the limits of the trench excavation or from the pipe subgrade shall be replaced with satisfactory material placed in layers not exceeding eight inches loose thickness and compacted as specified by Section 9-760-1.

   C. Bedding and Initial Backfill. Bedding shall be of the type specified and a minimum of four inches thick below the bottom of the pipe. Total bedding layer thickness shall be sufficient to bed the lower one-third of the pipe. Initial backfill material shall be placed in two layers of a maximum of eight inches loose thickness, and compacted with approved tampers as specified by Section 9-760-1 and to a height of at least one foot above the utility pipe or conduit. The backfill shall be brought up

evenly on both sides of pipe for the full length of the pipe. Care shall be taken to ensure thorough compaction of the fill under the haunches of the pipe. Backfill material in this portion of the trench shall consist of satisfactory material at a moisture content within plus or minus two percent of optimum moisture. It shall be free from stones larger than one inch in any dimension.

D. Final Backfill. The remainder of the trench, except for special materials for roadways, shall be backfilled with satisfactory material. Backfill material shall be deposited and compacted as follows:

(1) Trenches in public roadways shall be excavated, backfilled and compacted in accordance with the requirements of the Virginia Department of Transportation's Road and Bridge Specifications. *Refer to Standard TS-23 in Appendix A.*

(2) For trenches in pavement areas not within the public right-of-way such as, but not limited to parking lots, common driveways, private parking courts and pipestem driveways, the following shall apply:

(a) Soil shall be compacted to not less than the percentages of maximum dry density or relative density specified by Section 9-760-1.

- Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material.

- Walkways Slabs and Steps: Compact to six inches of slab or step subgrade and each layer of backfill or fill material.

(b) Backfill shall be deposited in layers of a maximum of eight inches loose thickness and compacted.

E. Trenches in Turfed or Seeded Areas and Miscellaneous Areas.

(1) Backfill shall be deposited in layers of a maximum of 12 inches loose thickness. Backfill shall be aerated or moistened as necessary to achieve an in-place moisture content within plus or minus two percent of optimum moisture. Each layer shall be compacted as follows unless otherwise specified.

Cohesionless Soils	Cohesive Soils
Soils which do not exhibit a well-defined moisture density relationship	Soils which exhibit a well-defined moisture density relationship
90% maximum dry density (ASTM D-698)	85% maximum dry density (ASTM D-698)

(2) Cohesionless and Cohesive Materials: Cohesionless materials include materials classified Unified Soil Classification GW, GP, SW and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic.

F. Backfill for Appurtenances.

(1) After the manhole, catch basin, inlet or similar structure has been constructed and the concrete has been allowed to cure for five days, backfill shall be placed in such a manner that the structure will not be damaged by the shock of falling earth. The backfill material shall be deposited and compacted as specified for final backfill, and shall be placed in such a manner as to prevent eccentric loading and excessive stress on the structure. The top 12 inches of appurtenance subgrade and each layer of backfill or fill material must be compacted as follows unless otherwise specified.

Cohesionless Soils	Cohesive Soils
Soils which do not exhibit a well-defined moisture density relationship	Soils which exhibit a well-defined moisture density relationship
95% maximum dry density (ASTM D-698)	90% maximum dry density (ASTM D-698)

(2) Cohesionless and Cohesive Materials: Cohesionless materials include materials classified Unified Soil Classification GW, GP, SW and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are **nonplastic.**

9-761 Moisture Control in Embankment and Backfill

1. Where the subgrade or layer of soil material must be moisture conditioned before compaction, water must be uniformly applied to the surface of the subgrade or layer of soil material to prevent free water appearing on the surface during or subsequent to compaction operations.

2. For soils classified as SC, ML, CL or any combination thereof, or micaceous materials, the Contractor should be aware of the close moisture control required to achieve the proper field placement and compaction of these soil types.

3. The Contractor shall properly moisten or aerate soils as required to obtain a placement moisture content which will result in an in-place moisture of:

Soil	Moisture Content
Cohesive Soils Soils which exhibit a well-defined moisture-density relationship	Optimum ± 2 percent (See "A" below)
Cohesionless Soils Soils which do not exhibit a well-defined moisture density relationship	Very Wet (See "B" below)

A. An alternative, specific moisture content range based upon the specific soils encountered may be recommended by a geotechnical engineer subject to approval by the Director.

B. A specific moisture content range based upon the specific soils encountered shall be recommended by a geotechnical engineer subject to approval by the Director.

C. When an alternative, specific moisture content for cohesive soils is approved by the Director and for all cohesionless soils, all subgrade, embankment, and backfill materials shall be inspected for suitability and all emplacement and compaction shall be continuously inspected by a geotechnical engineer provided by the developer at no cost to the Town, licensed to practice in the Commonwealth of Virginia. Such inspection shall be continuous and documentation shall provided be provided to the Town.

D. Cohesionless and cohesive materials. Cohesionless materials include materials classified as Unified Soil Classification GW, GP, SW and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic.

4. Soil material that is too wet to permit compaction to specified density must be removed and replaced, or scarified and air dried.

5. Satisfactory soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Drying may be assisted by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

9-763 Pavement Subgrade Preparation Within Public Utility Easement

1. Public utility easements which underlie paved areas, such as but not limited to parking lots, common driveways, private parking courts and pipestem driveways shall meet the following requirements for the entire width and length of the easement which forms a pavement or sidewalk subgrade.

   A. Soft or otherwise unsatisfactory material shall be removed and replaced with satisfactory excavated material or other approved material as directed. Low areas resulting from removal of unsatisfactory material shall be brought up to required grade with satisfactory materials, and the entire subgrade shall be shaped to line, grade and cross section and compacted as specified.

   B. Subgrades which are defined as frost susceptible (Classes F1, F2, F3, and F4) by the United States Corps of Engineers criteria shall be prepared to achieve uniformity of soil conditions.

Frost Group	Kind of Soil	Percentage finer than 0.02 mm by weight	Typical soil types under Unified Soil Classification System
F1	Gravelly soils	6 to 10	GM, GW-GM, GP-GM
F2	(a) Gravelly soils	10 to 20	GM, GW-GM, GP-GM,
	(b) Sands	6 to 15	SM, SW-SM, SP-SM
F3	(a) Gravelly soils	Over 20	GM, GC
	(b) Sands, except very fine silty sands	Over 15	SM, SC
	(c) Clays, PI>12	-----	CL, CH
F4	(a) All silts	-----	ML, MH
	(b) Very fine silty sands	Over 15	SM
	(c) Clays, PI>12	-----	CL, CL-ML
	(d) Varved clays and other fine-grained, banded sediments	-----	CL, CL-ML CL and ML; CL, ML, AND SM; CL, CH, AND ML; CL, CH, ML AND SM

U.S. Army Corps of Engineers

In fill sections the least frost-susceptible soils shall be placed in the upper portion of the subgrade by temporarily stockpiling the better materials, cross-hauling and selective grading. If the upper layers of fill contain frost-susceptible soils, the completed fill section shall be subjected to the subgrade preparation procedures required for cut sections.

In cut sections, the subgrade shall be scarified and excavated to a depth prescribed by:

Depth = (2/3) x (24") - (Depth of surface course + depth of base course + depth of subbase course)

In no case shall the depth be less than 6 inches.

The excavated material to the prescribed depth shall be windrowed and bladed successively until thoroughly blended, relaid and compacted.

C. In cut areas where the Contractor is required to achieve compaction as called for above, the Contractor will undercut material which is not compactable and replace with satisfactory material. Material will be deemed not compactable if the required compaction percentage within $\pm$ 2% optimum moisture content cannot be attained. To attain specified compaction, the contractor shall use tamping rollers, vibro-tampers, smooth rollers, and sheeps-foot rollers as appropriate for the specific material being compacted.

D. In cut areas where potentially expansive clay material is encountered, the contractor shall excavate potentially expansive clay material under the direction of the "testing service" to a depth below the proposed subgrade where the proposed surcharge weight or overburden weight exceeds the potential swell pressure and replace with satisfactory material. The testing service shall provide documenting calculations to the Director prior to excavation.

9-770 Special Requirements

Special requirements for both excavation and backfilling relating to the specific utilities are as follows:

1. Water Supply. Trenches shall be a depth to provide a minimum cover of four feet from the actual finished grade to the top of the pipe.

2. Electrical Distribution System. Electrical conduit or duct line shall have a minimum cover of 24 inches from the finished grade unless otherwise indicated. Special trenching requirements for direct-burial electrical cables may be specified by the electrical utility company.

3. A minimum of one lane of traffic must be maintained at all times where a utility trench crosses an existing road, driveway or parking lot. Traffic control and flagmen must be provided to maintain orderly traffic flow.

4. Before commencing excavation in areas so designated on the plans, the Contractor shall dig test pits as directed by the engineer to determine sizes and types of pipe and other underground utilities. Test pits shall be excavated sufficiently in advance of trench construction such that reasonable changes in line and grade can be made where the location of existing utilities and structures varies from that shown on the plans. The contractor shall adjust pipeline profile as required at connections to existing mains, subject to the approval of the Director. Sufficient trench shall be excavated to ensure that no unforeseen obstructions exist before commencing pipe installation. Work resulting from failure to take such precautions shall be performed at no cost to the Town.

5. Where subgrade or completed compacted areas are disturbed by subsequent construction operations, adverse weather or failure to maintain adequate drainage, the surface must be scarified, reshaped and compacted to required density prior to further construction.

6. The Contractor shall take measures for allaying dust. Measures shall be as described in the Virginia Road and Bridge Specifications.

7. The Contractor shall be responsible for the stability of all embankments made under the contract until final acceptance of the work, and shall replace any portions which have become displaced due to carelessness or negligence on his part or due to damage resulting from natural causes.

9-800 TOWN OF LEESBURG DESIGN & CONSTRUCTION STANDARDS

9-800 Excavation and Earthwork for Embankment Dams

9-810 Embankment Dams

The following sections shall apply to all embankment dams utilized for stormwater management ponds (wet or dry) and permanent improvements constructed within the Town of Leesburg.

9-815 Related Documents

1. Approved Construction Drawings.

2. Virginia Department of Transportation.

   A. Road and Bridge Standards

   B. Road and Bridge Specifications

   C. Drainage Manual.

3. Virginia Erosion and Sediment Control Handbook.

9-820 Quality Assurance

1. Codes and Standards. Excavation and earthwork shall be performed in compliance with applicable requirements.

2. Soil Testing and Inspection Service. The Developer as set forth herein, shall provide an independent soil testing and inspection service (the "Testing Service" for quality control testing) during earthwork operations. The Contractor shall coordinate and cooperate with the work of the Testing Service.

3. The Developer shall furnish a guarantee that embankment areas will not suffer excessive settlement for a period of one year from the date of final acceptance. Fill materials which settle shall be removed and replaced with suitable material at no cost to the Town.

4. The Contractor shall furnish a guarantee that all tests have been performed for underground utilities before backfilling.

9-825 Submittals

Test Reports-Excavating. The following reports shall be submitted directly to the Director from the testing service, with a copy to the Contractor:

1. Subgrade. One sieve analysis and one liquid limit and plasticity index determination for cohesive soils for each 100 lineal feet of embankment or fraction thereof.

2. Fill and Backfill Material. One sieve analysis and one liquid limit and plasticity index determination for cohesive soils for each 100 cubic yards or fraction thereof.

3. Optimum Moisture and Maximum Density. One moisture-density curve to determine the optimum moisture content and the maximum density values shall be provided for each 100 cubic yards or fraction thereof, for each type of embankment.

4. Field Density Tests.

   A. Core Trench Subgrade. One test for every 100 linear foot or fraction thereof, of trench.

   B. Fill Material.

      (1) Embankment. One test for each lift per 100 lineal feet or fraction thereof, of embankment. Tests offset 50 feet for each lift.
      (2) Utility or Drainage Structures which Abut a Pavement. One test for every 12 inches of compacted thickness or fraction thereof, for each structure.

   C. Location of tests shall be the discretion of the Director.

9-830 Site Conditions

The Developer's engineer shall examine the subsurface soil report and provide a preliminary analysis of the suitability of the site soils for embankment material. However, the actual on-site testing during construction shall determine the suitability of materials and the acceptability of operations.

9-835 Site Preparation

1. Areas designated for borrow areas, embankment and structural works shall be cleared, grubbed and stripped of topsoil. All trees, vegetation and other objectionable material shall be removed. Channel banks and sharp breaks shall be sloped to no steeper than two horizontal feet to one vertical foot.

2. In order to facilitate clean-out and restoration, the area (measured at the top of the pipe spillway) will be cleared of all trees.

3. All cleared and grubbed material shall be disposed of outside and below the limits of the dam and reservoir as indicated on the approved plans. A sufficient quantity of topsoil shall be stockpiled in a suitable location for use on the embankment and other designated areas.

9-840 Earth Fill

1. Material. The fill material shall be taken from approved borrow areas. It shall be clean mineral soil free of roots, woody vegetation, oversized stones, rocks or other objectionable material. Relatively porous materials such as sand or gravel (Unified Soil Classes GW, GP, SW & SP) shall not be placed in the embankment.

2. The allowance for settlement shall be 5.0% of the final design dam height including the required free board.

   A. The fill height along the full length of the embankment shall be increased at least 5% above the design elevation and "camber" of the side slopes (as defined in USBR publication Earthdams (6.20(d)) shall be provided. The design and placement top of embankment elevations and camber shall be shown on the construction drawings.

   B. If settlement during the one year maintenance period brings the dam height below design elevation, the developer shall provide remedial construction, at no cost to the town, to bring the dam to design elevation and shall at that time, again provide the 5% settlement allowance.

3. All embankment materials shall be inspected for suitability and all emplacement of embankment shall be inspected by a geotechnical engineer licensed

to practice in the Commonwealth of Virginia provided by the developer at no cost to the town. Such inspection shall be continuous and documentation shall be provided to the Town.

4. Placement. Prior to placement of fill material, the subgrade shall be proof rolled and yielding material shall be replaced with satisfactory material. Areas on which fill is to be placed shall be scarified prior to placement of fill. Fill materials shall be placed in eight-inch maximum thickness (before compaction) layers which are to be continuous over the entire length of the fill. The most porous borrow material shall be placed in the downstream portions of the embankment.

5. Compaction. The movement of the hauling and spreading equipment over the fill shall be controlled so that the entire surface of each lift shall be traversed by not less than one tread track of the equipment or compaction shall otherwise be achieved by a minimum of four complete passes of a sheeps-foot, rubber tired or vibratory roller. Fill material shall contain sufficient moisture such that the required degree of compaction is obtained with the equipment used. Each layer of fill shall be compacted as necessary to obtain the minimum required density specified, and is to be certified by the testing laboratory service.

6. Soil must be compacted to not less than the following percentages of maximum dry density for soils which exhibit a well-defined moisture density relationship determined in accordance with ASTM D-698; and not less than the following percentages of relative density, determined in accordance with ASTM D-2049, for soils which will not exhibit a well-defined moisture to density relationship.

    A. The top 12 inches of subgrade and each layer of backfill or fill material shall be compacted to:

Cohesionless Soils	Cohesive Soils
Soils which do not exhibit a well-defined moisture-density relationship	Soils which exhibit a well-defined moisture-density relationship.
95% maximum density (ASTM D-698)	90% maximum dry density (ASTM D-698)

B. Cohesionless and Cohesive Materials: Cohesionless materials include materials classified Unified Soil Classification GW, GP, SW and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic.

9-845 Core Trench

1. Where specified, a core trench shall be excavated along or parallel to the centerline of the embankment as shown on the plans. The bottom width of the trench shall be governed by the equipment used for excavation, with the minimum width being four feet. The depth shall be at least four feet or as shown on the plans. The side slopes of the trench shall be one horizontal foot to one vertical foot.

2. The backfill material for the core trench shall be the most impervious material available and shall be compacted with equipment or rollers to assure maximum dry density and minimum permeability. The trench shall extend up both abutments to the riser crest elevation. The trench shall be dewatered during the backfilling and compacting operations.

9-850 Backfill For Outlet Structures and Outfalls

1. Backfill material shall be of the type and quality conforming to that specified for the adjoining fill material. The fill shall be placed in horizontal layers not to exceed four inches in thickness and compacted by hand tampers or

other compaction equipment. The material must completely fill all spaces under and adjacent to the pipe. At no time during the backfilling operation shall driven equipment be allowed to operate closer than four feet, measured horizontally, to any part of a structure. Under no circumstances shall the Contractor drive equipment over any part of a concrete structure or pipe unless there is a compacted fill of 24 inches or greater over the structure or pipe.

2. The top 12 inches of subgrade and each layer of backfill or fill material shall be compacted to 95 percent maximum density or 90 percent relative density.

9-855 Moisture Control in Embankment and Backfill

1. Where the subgrade or layer of soil material must be moisture conditioned before compaction, water must be uniformly applied to the surface of the subgrade or

layer of soil material to prevent free water appearing on the surface during or subsequent to compaction operations.

2. For soils classified as SC, ML, CL or any combination thereof, or micaceous materials, the Contractor should be aware of the close moisture control required to achieve the proper field placement and compaction of these soil types.

3. The Contractor shall properly moisten or aerate soils as required to obtain a placement moisture content which will result in an in-place moisture of:

Soil	Moisture Content
Cohesive Soils	
Soils which exhibit a well-defined moisture density relationship	Optimum ± 2 percent (See "A" below)
Cohesionless Soils	
Soils which do not exhibit a well-defined moisture density relationship	Very Wet (See "B" below)

A. An alternative specific moisture content range based upon the specific soils encountered may be recommended by a geotechnical engineer subject to approval by the Director.

B. A specific moisture content range based upon the specific soils encountered shall be recommended by a geotechnical engineer subject to approval by the Director.

C. When an alternative, specific moisture content for cohesive soils is approved by the Director and for all cohesionless soils, all subgrade and backfill materials shall be inspected for suitability and all emplacement and compaction shall be continuously inspected by a geotechnical engineer provided by the developer at no cost to the Town, licensed to practice in the Commonwealth of Virginia. Such inspection shall be continuous and documentation shall provided be provided to the Town.

D. Cohesionless and Cohesive Materials: Cohesionless materials include materials classified Unified Soil Classification GW, GP, SW and SP. Cohesive materials include materials classified as GC, SC, ML, CL, MH and CH. Materials classified as GM and SM will be identified as cohesionless only when the fines are nonplastic.

4. Soil material that is too wet to permit compaction to specified density must be removed and replaced, or scarified and air dried.

5. Satisfactory soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Drying may be assisted by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

9-860 Outlet Structures and Outfalls

1. Base. The riser shall have a base attached with a watertight connection and shall have sufficient weight to prevent flotation of the riser. Two approved bases for risers ten feet or less in height are a concrete base 18 inches thick, with the riser embedded six inches in the base and a 1/4-inch (minimum thickness) steel plate attached to the riser by a continuous weld around the circumference of the riser to form a watertight connection. The plate shall have 2.5 feet of stone, gravel, or tamped earth placed on it to prevent flotation. In either case, each side of the square base shall be twice the riser diameter. For risers greater than ten feet high, computations shall be made to check flotation. The minimum factor of safety shall be 1.25 (downward forces = 1.25 x upward forces).

2. Anti-seep collars. Anti-seep collars shall be installed around the pipe conduit within the normal saturation zone to increase the seepage length at least ten percent when any of the following conditions exist:

   A. The settled height of dam exceeds ten feet, or;

   B. The embankment material has a low silt-clay content (Unified Soil Classes SM or GM) and the pipe diameter is ten inches or greater.

   The phreatic line may be approximated with a line drawn downward on a 4:1 slope from the intersection of the normal pool (corresponding to the top of the riser and the upstream face of the embankment).

   The seepage length is the length of the flow path of a particle of water along the conduit from the riser to the point of intersection between the approximate phreatic line and the invert of the pipe conduit. When anti-seep collars are used, the equation for revised seepage length is:

$$L_s + 2nV \geq 1.1\, L_s \quad \text{or} \quad n \geq \frac{.05L_s}{V}$$

   Where: L_s = Saturated length is length, in feet, of pipe between the riser and the intersection of the phreatic line and the pipe invert.
   N = number of anti-seep collars.
   V = vertical projection of collar from pipe, in feet.

   The anti-seep collar and its connection to the pipe shall be watertight. The maximum spacing, in feet, between collars shall be 14 times the minimum projection of the collar measured perpendicular to the pipe. The anti-seep collar shall be located below the phreatic line in the embankment and should be equally spaced. They shall not be located closer than two feet to a pipe joint. There shall be sufficient distance between collars to allow space for the hauling and compacting equipment.

3. Reinforced Concrete Pipe Outfalls

   A. Materials - Reinforced concrete pipe shall have a rubber gasket joint and shall equal or exceed ASTM Specification C-361. Approved equivalents are AWWA Specification C-300, 301, and 302.

B. Bedding - All reinforced concrete pipe conduits shall be laid in a concrete bedding for their entire length. This bedding shall consist of high slump concrete placed under the pipe and up the sides of the pipe at least ten percent of its diameter with a minimum thickness of three inches.

C. Laying pipe - Bell and spigot pipe shall be placed with the bell end upstream. Joints shall be made in accordance with recommendations of the manufacturer of the material. After the joints are sealed on the entire line, the bedding shall be placed so that all spaces under the pipe are filled. Care shall be exercised to prevent any deviation from the original line and grade of the pipe.

D. Backfilling shall conform to structural backfill. Refer to this Article.

E. Other details (anti-seep collars, valves, etc.) shall be as shown on the plans.

9-865 Emergency Spillway

The emergency spillway shall not be installed in fill. Elevations, design width, entrance and exit channel slopes shall be constructed as shown on the approved construction plans.

9-870 Stabilization

All borrow areas shall be graded to provide proper drainage and left in a sightly condition. All exposed surfaces of the embankment, spillway, spoil and borrow areas, and berms shall be stabilized by seeding, liming, fertilizing and mulching (if required) in accordance with the vegetative treatment specifications.

9-875 Erosion and Sediment Control

Construction operations will be performed in such a manner that erosion will be controlled and water and air pollution minimized. State and local laws concerning pollution abatement will be followed. Construction plans shall detail erosion and sediment control measures to be employed during the construction process.

9-880 Riprap

Riprap, if required for proper sediment and erosion control, shall be placed in conformance with the applicable requirements of Virginia Department of Transportation's Road and Bridge Specifications and the Drainage Manual. Large stones shall be placed at the bottom of the slope. Spaces between stones shall be filled with spalls of suitable size to construct a solid, stable slope, free from large voids and defects which might not protect the earth slopes against erosion.

A filter blanket shall be designed and approved as part of the riprap installation.

(End of Section)

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