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400 GENERAL

400.01 General Requirements

1. Three categories of testing and reports are required for all Public Improvements and projects requiring right-of-way grading and paving; Geotechnical Report, Final Pavement Design (refer to Section 500, Street Improvements) Report, and extra testing (e.g., imported fill).
 - a. Geotechnical Report - This report evaluates the characteristics of the soils and the general issues of groundwater, soil stability, and swell consolidation potential (refer to Section 405 for Groundwater Report). A geotechnical report is required for street and related improvements within the right-of-way, public easements, or slope easements. This report is required as part of the preliminary plat submittal.
 - b. Final Pavement Design Report - This report is required for all projects with roadway improvements, right-of-way grading and paving. The soil investigation associated with this report will occur after overlot grading is completed. This report must be submitted and approved prior to any concrete or paving installation (refer to Section 500 Street Improvements).
 - c. Extra Testing - If fill material is required for the project, this material shall also be tested before placement and must be approved by the Town Engineer.
2. Supervision by Engineer - All sampling and testing of soils shall be performed under the direct supervision of the Professional Engineer who stamps and signs the report.

401 SOIL TESTING FOR GEOTECHNICAL REPORT

401.01 Timing of Soil Borings

1. Initial Borings - Any information from initial soil borings must be summarized in the geotechnical report. The entire site shall be sampled for initial testing to obtain a preliminary overall geologic "picture" of the site.
2. Structures - Soil borings for design of structures shall be taken prior to the design of the structure.
3. Imported Fill for Right-of-Way Grading - All fill material shall be tested by a qualified soils testing company hired by the Contractor and approved by the Town of Frederick prior to its use on the project. The material should meet minimum requirements and be equal to or better than existing conditions. No material shall be imported which has a liquid limit greater than 40 and plasticity index greater than 20 unless otherwise approved by the Town Engineer.

401.02 Frequency of Testing



1. A minimum of two borings shall be provided for each project. The number of borings should be dependent on project size and the geotechnical engineer's recommendations. The Town Engineer may require more frequent testing.
2. Testing frequency for structures shall satisfy AASHTO Bridge Design requirements and CDOT Materials Testing requirements.

401.03 Location and Depths of Samples

1. Samples shall be taken as close as possible or within the limits of the roadways and/or slopes and extend to a minimum depth of 10-feet below finished grade.
2. Borings shall extend deeper if needed to determine if bedrock or high groundwater levels are design concerns. (Minimum depth to bedrock shall be 3-feet below the finished pavement surface.)
3. The Geotechnical Engineer shall use industry standard care in determining the number of samples that are needed to characterize soils.
4. Samples for structures shall be as close as possible or within the proposed footing of the structure and shall be taken to a minimum depth of 10-feet below the footing elevation. Additional depth may be required for piers or piles.

402 SOIL GROUPING

402.01 General

To simplify subgrade support testing, soil samples may be combined to form soil groups consistent with the AASHTO classification, group index, and location for the area investigated with written approval from the Town Engineer. Groupings shall not mix samples with different AASHTO classifications. (For example, soils with swell potential greater than 2% may not be grouped).

402.02 Composite Samples

1. Composite samples may be obtained by mixing portions of each sample within a soil group to provide a uniform sample of the soil group only with the written approval of the Town Engineer. Composite samples remolded in the laboratory shall not be used for swell/consolidation testing.
2. A minimum of one soluble sulfate test shall be run on each composite sample.

403 TESTING

403.01 Required Tests



The tests marked with an “X” in the table below are required for the subgrade soils investigations or final pavement design testing. Refer to Section 500 Street Improvements for Final Pavement Design.

Table 400-1 - Required Tests		
Test	Geotechnical	Final Pavement
	Report	Design Report
Visual	X	X
Liquid Limit	X	X
Plastic Limit	X	X
Moisture	X	X
Percent Passing No. 200	X	X
Gradation (Granular Soils)	X	X
AASHTO Classification	X	X
Subgrade Support		
R-Value		X
Swell Evaluation (Preliminary Considerations)	Indicator: Low/Moderate/High For Moderate or High, Run Swell Tests	Mitigation and Detailed Analysis
Percentage of Soluble	X	X
Standard Penetration Test	X	X
Groundwater Level	X	X
Bedrock Level	X	X

403.02 Classification Testing

Soils shall be classified visually and tested to determine engineering properties. Sand and gravel samples shall be analyzed for gradation where needed to comply with classification requirements.

403.03 Subgrade Support Testing

1. Individual subgrade or composite samples shall be tested for subgrade support value. The geotechnical report shall clearly state whether or not the subgrade soil is capable of supporting the proposed construction and design traffic loads. Recommendation for subgrade stabilization, if required, shall also be provided. The final pavement report shall contain specific mitigation. Refer to Section 500, Street Improvements, for requirements.
2. The following table shows minimum allowable subgrade R values based on the minimum ESAL amounts shown in Section 510. All subgrade upon which street or other paving will be placed shall be shown by a geotechnical engineer to have at least the minimum R values shown below. If the subgrade does not meet the minimum R



values shown below, then subgrade stabilization, as directed by the geotechnical engineer and approved by the Town Engineer, shall be required.

<i>Classification</i>	<i>Industrial</i>	<i>Commercial</i>	<i>Multi-Family</i>	<i>Single-Family</i>
Arterial	23	21	18	18
4-Lane Collector	18	18	18	18
2-Lane Collector	15	15	10	10
Low Density Rural	8	—	—	—
Local Street	12	10	8	7
Fire Lane	10	10	8	—
Parking, Cars Only	6	6	6	6
Parking, All Others	12	12	6	6

403.04 Right-of-Way Fill Material Testing

1. All imported fill material shall be evaluated for swell and R-value and approved by the Town Engineer prior to use in the right-of-way.
2. All imported fill shall have an R-value and plasticity index equal to or better than the subgrade material within the right-of-way.
3. Imported fill shall not have a liquid limit greater than 40 and plasticity index greater than 20 or a high to very high swell potential.

404 GEOTECHNICAL REPORT

404.01 Basic Report Requirements

A geotechnical report shall be submitted with the preliminary plat. The report shall show results from all required testing in Table 400-1. The report shall also include a description of site characteristics, e.g., topography, drainage features, etc.

404.02 Detailed Report Requirement

In addition to the basic report requirements, each soils report shall include the following Items (refer to Section 500, Street Improvements, for pavement design report requirements).

List of Required Items

- a. Site location and description
- b. Laboratory test reports with evaluations (classification tests)
 - i. Visual classification
 - ii. Liquid limit - AASHTO T89 or ASTM D4318



- iii. Plastic limit - AASHTO T90 or ASTM D4318
 - iv. In-situ moisture content
 - v. Percent passing No. 200 sieve - AASHTO T11 or ASTM C117-90
 - vi. Gradation of granular (sand & gravel) materials - AASHTO T27, ASTM D422 or ASTM C136
 - vii. AASHTO classification and group index - AASHTO M145 h. Standard Penetrations Test
 - viii. Swell Evaluation
- c. Boring logs
 - d. Soil and groundwater conditions. The expected seasonal elevation variation shall be summarized.
 - e. Depth to bedrock. To indicate shallow bedrock. Include mitigation requirements if bedrock is within 3-feet of subgrade.
 - f. Percentage of soluble sulfates.
 - g. Recommendations and discussions
 - h. Mitigation plans
 - i. Additional tests. These may be required for trench backfill evaluation, fill evaluation, etc.
 - j. Elevation of groundwater encountered in each boring
 - k. Engineer seal and signature. Required by a qualified geotechnical engineer.

405 SUBSURFACE WATER INVESTIGATION

405.01 When a Subsurface Water Investigation is Required

1. If groundwater is encountered within 10-feet of the original ground surface, a subsurface water investigation report shall be submitted for approval by the Town Engineer. This report is required to ensure mitigation of high groundwater effects upon public improvements within the right-of-way. This information may be a separate report or may be included in the geotechnical report.
2. This report requirement may be waived if the Applicant and Designer certify that the street subgrade elevations will be a minimum of 3-feet above the “maximum” predicted (seasonal highest) water table. This certification shall be written, stamped and signed by a Professional Engineer and submitted to the Town of Frederick.



3. This report is not required for temporary dewatering activity needed to facilitate construction of buried utilities. However, all applicable state requirements must be followed.

405.02 Report Requirements

The subsurface water investigation report shall include the following information.

- a. Site location and description. Include locations of any irrigation ditches, streams, ponds, lakes, and wetlands.
- b. Elevation of water table, direction of flow, flow rates, groundwater barriers, and seasonal high water level.
- c. Potential sources of groundwater. Include proximity to all water sources.
- d. Water rights associated with ponds, ditches, seeps, etc...
- e. Other relevant subsurface information such as water ownership (water rights), groundwater quality (contamination or other undesirable characteristics)
- f. Potential future groundwater conditions
- g. Subsurface drainage recommendations, including its effects on all conditions, including sensitive habitat.
- h. Cone of influence.
- i. Control measures and designs:
 - i. Subsurface Drains. If subsurface drains are recommended, the drains must have a gravity discharge without any possibility of back flow or blockage of the outlet. Any subsurface drain system shall be owned and maintained by the Developer or the Developer's assigned successor(s). These drains may discharge into the Town's storm drainage system, including inlets or detention ponds, upon approval of the Town Engineer. Anticipated impacts to the groundwater table on adjacent properties must be quantified.
 - ii. Drain Lines. The drain lines may be installed in the sanitary sewer trench, at an elevation of one sewer diameter lower than the sanitary sewer line.
 - iii. Drain Line Separation from Sewer. The drain line shall be marked to specifically distinguish the drain from the sanitary sewer line.
 - iv. Pipe. The drain line shall be an approved pipe material, for long-term (100-years minimum) design life, with appropriate cleanouts.



v. Drain Outlet. The outlet of the drain into an inlet structure or detention pond shall be designed to prevent any possibility of backflow and blockage of the drain line.

j. Professional Engineer's seal and signature.

406 SOIL PROBLEM MITIGATION

Mitigation plans for soil problems revealed by the soils investigation shall be submitted to the Town Engineer.

406.01 Mitigation Plans and Approval

1. All substandard soils found in the investigation (e.g., expansion, shallow bedrock, heave, soil instability, subsidence, etc.) shall be addressed in the mitigation plans. All mitigation procedures must be approved by the Town Engineer prior to their implementation.
2. Moisture treatment alone may not be sufficient. If soil problem mitigation is made, the soil treatment shall extend to the back of curb, or to the back of walk for attached or monolithic walks. For detached walks, separate mitigation procedures may be required.
3. Approval of Chemical Treatment. Mitigation procedures that alter existing soil conditions (such as lime, fly ash, or cement treatment) shall follow an approved mix design process. Additional testing is required to appropriately apply chemicals to soil and effectively mitigate existing soil conditions. Procedures and testing must be approved in writing by the Town Engineer.

406.02 Mitigation for Swell

If the average swell is 2% or greater, the pavement design report must provide mitigation measures. The mitigation measures shall reduce destructive swell potential under the public improvements, including landscaping, to an acceptable level of less than 2%. The swell test report shall specify sample conditions, surcharge pressures, and other key testing factors.

406.03 Mitigation of Unstable Subgrade

Possible measures for mitigation may include the following:

1. Over-excavation and replacement with suitable non-expansive or low-expansive material to a depth sufficient to mitigate expansion is a common mitigation method.
2. Chemical treatment to eliminate unstable characteristics of the soil is another common mitigation method, such as cement or flyash.
3. Condition with moisture and compact to an appropriate level of compaction for the unstable condition, including stability requirements.



4. Other procedures may be proposed for review and approval by the Town Engineer. The chosen method must work for the full life expectancy of the improvements.

407.00 REFERENCES

Standards Referenced in Section 400	
Standard	Title
ASTM C117	Standard Test Method for Material Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136	Standard Test Method for Sieve Analysis of Soils
ASTM D422	Standard Test Method for Particle Size Analysis of Soils
AASHTO T11	Material Finer than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing
AASHTO T27	Sieve Analysis of Fine and Coarse Aggregates
AASHTO T90	Determining the Plastic Limit and Plasticity Index of Soils, Single User Digital Publication
AASHTO M145	Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes, Single Use Digital Publication

