APPENDIX B

GEOTECHNICAL EXPLORATION AND EARTHWORK CONSTRUCTION REQUIREMENTS

Contents

SECTION B.1: GEOTECHNICAL EXPLORATIONS

B.1-1 Purpose

This section fulfills the infrastructure requirements of Kentucky Revised Statutes (KRS) 100.273 through 100.292 by determining that: (1) important in situ Subdivision soils and geologic features that will impact the functional use of public and private improvements have been identified; and (2) that soils and geologic aspects of the design and construction of public and private improvements within the Public Street Right of way or Private Street easements meet the support requirements of their intended use.

(A) All earthwork and geotechnical exploration requirements within Appendix B shall apply to areas within the Public Street Right-of-way and Private Street easements, and areas structurally supporting the Public Street Right-of-way and Private Street easements;

(B) All Geotechnical Engineering and Geotechnical Technician work and reporting required under Appendix B shall be provided by the Applicant of the proposed Subdivision. The Geotechnical Technician must be under the direction and control of the Geotechnical Engineer who has been employed by the Applicant for the proposed Subdivision. The proposed Subdivision's Geotechnical Engineer shall have substantial professional engineering discretion to determine when the Geotechnical Engineering intent of the requirements of this Appendix is being met.

(C) The Applicant shall submit all Geotechnical Engineering and Geotechnical Technician reports and testing results to staff at the appropriate submittal time, as noted in Appendix B.

B.1-2 Geotechnical Explorations Outside of Right-of-Way

(A) Prior to the approval of the preliminary plat, a geotechnical engineer shall complete a preliminary report that addresses the soil and bedrock types and any existing slope stability issues that are expected in the proposed Subdivision.

(1) The Geotechnical Engineer's preliminary report will render a preliminary engineering opinion about the suitability of those soil and bedrock types and existing slopes to provide the necessary support for the intended private property use of the Subdivision.

(2) The opinion of expected soil and bedrock types and opinion of soil support suitability can be based on the Geotechnical Engineer's local soil and bedrock knowledge, USGS maps, and a visual field reconnaissance.

(B) The requirement for preliminary and final geotechnical explorations outside of the Public Right-of-way may be further regulated by the applicable legislative body's zoning ordinance.

B.1-3 Geotechnical Explorations Within Right-of-Way

(A) Preliminary Geotechnical Exploration

(1) Prior to the approval of the preliminary plat a geotechnical engineer shall complete a preliminary geotechnical exploration report. The report will address the soil and bedrock types that are expected on the project site, and present an engineering opinion about the suitability of the soil and bedrock types (when properly prepared and constructed) to provide adequate proposed Public Street Right-of-way structural support, including the minimum required CBR (subgrade support) values for asphalt and/or concrete pavements described herein.

(2) The opinion of expected soil and bedrock types and opinion of Subgrade support suitability can be based on the Geotechnical Engineer's local soil and bedrock knowledge, USGS maps, and a visual field reconnaissance.

(3) Campbell County soil types that may require replacement or other form of remediation during Subgrade construction in order to provide the minimum required CBR values for Concrete and Asphalt pavement designs shown in Table A-1 are non-plastic silts (soils that classify ML according to the Unified Soil Classification System (USCS)) and highly plastic silts and clays (MH and CH soils) with standard Proctor maximum dry densities less than 100 pounds per cubic foot and plasticity indices greater than 30 percent.

(B) Final Geotechnical Exploration
Prior to approval of the Improvement Plans or Grading Plans a Geotechnical Engineer shall complete a final geotechnical exploration report that identifies the soil and bedrock types present on the project site covered by the Improvement Plans or Grading Plans and presents a written engineering opinion about the suitability of the soils and bedrock to provide stable Right-of-way earthwork construction, and to provide the minimum CBR values for Asphalt and Concrete pavement.

(1) This written report shall be submitted to staff and be based on the results of soil borings, test pits, field and laboratory soil testing, etc. that are sufficient for the Geotechnical Engineer to render his/her engineering opinion.

(2) If the soils are not suitable to provide the minimum CBR values, the Geotechnical Engineer shall include recommendations in the written report for subgrade improvement or alternate pavement designs.

SECTION B.2: EARTHWORK SPECIFICATIONS

B.2-1 Purpose

The purpose of this section is to establish the appropriate earthwork specifications and material testing requirements so that the Public Street Right-of-way and Private Street easements have adequate earthwork structural support and the required pavement subgrade support.

B.2-2 Earthwork Excavations

The following shall apply to earthwork excavations other than trenches or temporary excavations:

(A) All topsoil shall be stripped from proposed cut, fill and pavement areas.

(B) Excavations shall be made to approximate grade or Subgrade elevations consistent with approved plans.

(C) Final cut slopes shall not be steeper than a slope of 3.0 horizontal to 1.0 vertical unless otherwise designed by a Geotechnical Engineer, but in no case shall be steeper than 2.0 horizontal to 1.0 vertical.

(D) Any spongy, unstable, or organic material that is exposed at the finished Subgrade level must be removed to expose stiff, non-yielding, non-organic soils and the excavated material replaced with soils capable of producing the required Subgrade CBR for the pavement design being used for the project (see Section A.1: Pavement Design Method and Required Thicknesses of these regulations).

(E) When excavating at the cut/fill transition during earthwork, remove spongy or unstable material, organic matter, or other unsuitable materials that are exposed. The Contractor shall remove same to expose stiff, non-yielding, non-organic soils and shall replace with approved materials, placed and compacted in accordance with these regulations and the recommendations of the geotechnical engineer.

(F) Excavations can be backfilled with the same soils that were removed, provided they meet the requirements of Subsection B.2-3: Controlled Fill, Subsection B.2-4: Trench Backfill, Subsection B.2-5: Shallow Trench Backfill, and Subsection B.2-6: Deep Trench Backfill.

B.2-3 Controlled Fill Other than Trench Backfill

(A) Construction of controlled fills shall be observed and tested by a Geotechnical Technician. Density testing and reporting is required at a minimum frequency of one density test per 500 cubic yards.

(B) Organic or vegetative soils shall not be used in the construction of the controlled fill.

(C) Controlled fills shall be constructed of natural soils or bedrock to approximate Subgrade elevation in level lift thicknesses that are approved by the Geotechnical Engineer. All shale used in controlled fills shall be pulverized to a soil-like consistency and moisture-conditioned the same as a soil. Limestone shall be laid flat and shall be broken up and dispersed in the fill so that it does not nest or impede compaction. The incorporation of limestone floaters in the fill shall be in accordance with the recommendations of the Geotechnical Engineer.

(D) Except for the top one foot of earthwork finished grades, which is the pavement subgrade, controlled fills shall be constructed with soils that are within two percent below to three percent above their optimum moisture content and compacted to a firm, non-yielding condition and to dry densities at least 95 percent of the maximum dry density, as determined by the standard Proctor moisture-density test (ASTM D698, latest edition), or 87 percent of maximum dry density as determined by the modified Proctor moisture-density test (ASTM D1557, latest edition).

(E) Clean granular soils that do not exhibit a well-defined moisture-density curve shall be compacted to a firm, non-yielding condition and to at least 75 percent relative density as determined by the testing methods contained in ASTM D4253 and D4254, latest edition.

(F) Controlled fill slopes shall not be steeper than 3.0 horizontal to 1.0 vertical unless otherwise designed by a Geotechnical Engineer. In no case shall unreinforced fill slopes be steeper than 2.5 horizontal to 1.0 vertical.

(G) Lime stabilization in controlled fills is prohibited unless designed and approved by a Geotechnical Engineer.

(1) Prior to using lime stabilization, staff shall approve the recommended lime stabilization specifications from a Geotechnical Engineer.

(2) The Geotechnical Engineer shall be required to monitor the lime stabilization process in the field to determine that it is consistent with their recommended specifications.

(3) A letter from the Geotechnical Engineer shall be submitted to staff confirming that the lime stabilization process used in the field was consistent with their written recommendations.

(H) Heavy equipment used for compaction shall be capable of producing the required controlled fill densities without lamination.

(1) Cohesive soils shall be compacted with kneading type compaction equipment.

(2) Cohesionless soils shall be compacted with smooth face vibratory equipment.

B.2-4 Trench Backfill

The following general information shall apply to all trench backfill:

(A) Trench backfill is defined as the backfill material used to refill the trench excavation above the initial utility conduit bedding and cover that is a part of underground utility installation.

(B) Natural non-organic soils, bedrock, approved aggregates, and Controlled Low Strength Material shall be used to backfill utility trenches as defined herein.

(C) Backfill shall not be flushed with water to obtain compaction.

(D) A Geotechnical Technician shall observe, test and report on the trench backfill compaction at least once per day when said trench backfill operations are occurring.

B.2-5 Shallow Trench Backfill

The following shall apply to shallow trench backfill:

(A) Shallow trenches are defined as the utility trenches where the backfill material (the material above the granular utility conduit bedding and cover material) is less than three feet deep to finish earthwork grade.

(B) Shallow trench backfill under the pavement and within a 1 horizontal to 1 vertical projection downward from the bottom edge of curb shall be dense graded aggregate (DGA), No. 57 crushed limestone (only when connected to a Drainage structure) or controlled low strength material (CLSM) as set out in Appendix C: Details C.2 and C.3. Aggregates shall be compacted as shown in the above noted details.

(C) Shallow trench backfill within the Right of Way but outside of the pavement and beyond a 1.0 horizontal to 1.0 vertical projection downward from the bottom edge of curb shall be natural, nonorganic soil or bedrock (no pieces of limestone thicker than six inches or more than 12 inches long/wide or specified aggregates as set in Appendix C: Details C.2 and C.3.

(1) All shale shall be pulverized to a soil-like consistency and moisture-conditioned as a soil.

(2) All limestone shall be laid flat, broken up, and dispersed so it does not nest or impede compaction.

(3) All backfill shall be moisture-conditioned to within two percent below to three percent above the optimum moisture content for compaction, shall be placed in layers of 8 to 10 inches in thickness, and each lift shall be thoroughly compacted to densities not less than 90 percent of the standard Proctor maximum dry density, or 82 percent of the modified Proctor maximum dry density for that soil.

(4) Backfill method shall be either a sheepsfoot roller attachment on a track mounted excavator or a self-propelled kneading-type compactor operating longitudinally in the trench excavation.

B.2-6 Deep Trench Backfill

The following shall apply to deep trench backfill:

(A) Deep trench backfill is defined as any trench with backfill deeper than shallow trench backfill.

(B) Deep trench backfill shall consist of natural non-organic soil or bedrock (no pieces of limestone thicker than six inches or more than 12 inches long/wide) or specified aggregates as set out in Appendix C: Details C.2 and C.3.

(1) All shale shall be pulverized to a soil-like consistency and moisture-conditioned as a soil.

(2) All limestone shall be laid flat, broken up and dispersed so that it does not nest or impede compaction.

(3) All backfill shall be moisture-conditioned to within two percent below to three percent above the optimum moisture content for compaction.

(4) Backfill lifts shall be 10 inches thick or less (unless otherwise specified by the Geotechnical Engineer), and compacted to not less than 95 percent of the standard Proctor maximum dry density for that soil.

(5) Backfill method shall be either a sheepsfoot roller attachment on a track mounted excavator or a self-propelled kneading-type compactor operating longitudinally in the trench excavation.

(C) Where depths of trenches are more than four feet and worker safety is at risk, the technician shall observe the compaction process in layers with an appropriate type of compaction equipment and document observations until worker safety is assured when compaction testing, as required, is resumed.

B.2-7 Street Pavement Subgrade

(A) Subgrade Preparation During Excavation
Subgrade is defined as the top one foot of the soils under the pavement. The pavement Subgrade must provide adequate support for the pavement structure as defined in these regulations.

(1) During earthwork and initial pavement subgrade preparation, the Geotechnical Engineer or Geotechnical Technician shall evaluate in situ pavement subgrade materials on the site and develop an opinion about their suitability to provide the minimum CBR values when compacted to the required densities at the specified moisture contents.

(2) Any soils identified as unsuitable to prove the minimum CBR values will be removed from the subgrade and replaced with suitable soils, or otherwise improved as recommended by the Geotechnical Engineer.

(B) Final Subgrade Preparations and Testing

(1) At the time of final Subgrade preparation, density testing and proofrolling before paving, the Subgrade shall be within two percent of its optimum moisture content and compacted to a firm, non-yielding condition and to dry densities at least 98 percent of the maximum dry density, determined by the standard Proctor moisture-density test (ASTM D698, latest edition) or 89 percent of the maximum dry density as determined by the modified Proctor moisture-density test (ASTM D1557, latest edition). Cohesive Subgrade material shall be properly knit together and free of loose, dry, crumbly, baked or crusted soil material.

(2) The Subgrade shall consist of cohesive soils, clean #57 crushed limestone, crushed stone base, or Controlled Low Strength Material (CLSM). Any aggregate material used to replace part of the cohesive Subgrade soil must be drained, so that no standing water can collect and be held in the aggregate Subgrade.

(3) Clean granular soils that do not exhibit a well-defined moisture-density curve shall be compacted to a firm, non-yielding condition and to at least 80 percent relative density as determined by the testing methods contained in ASTM D4253 and D4254, latest edition.

(4) The Subgrade shall be shaped to plan elevation and cross-section and checked by the Staff inspector for conformity with the cross section shown on the approved Improvement Drawings immediately prior to placing the pavement. Pavement shall not be placed on any part of the Subgrade which does not conform to the cross section shown on the approved Improvement Drawings.

(C) Final Subgrade Proofrolling

(1) Subgrade Proofrolling is the final test to be performed immediately prior to beginning the paving operations.

(2) Prior to the placement of pavement materials and after confirming proper density and moisture content of the Subgrade soils, all Street Subgrades shall be proofrolled to test the stability and uniformity of Subgrade materials.

(3) Subgrade Proofrolling shall be performed with a dual axle dump truck fully loaded with clayey soils or aggregate.

(4) Subgrade Proofrolling shall be performed at walking speed with at least two passes made in each drive lane direction with the outside wheel generally traveling along the inside line of the future Curb during one pass, and the wheel-paths offset one-half of the truck width during the second pass to maximize subgrade coverage. Extra proofroll passes shall be made at the discretion of the Staff inspector.

a) Where proofrolling indicates areas of soft or unsuitable Subgrade soils or areas of non-uniform Subgrade stability, the area shall be delineated and repaired.

b) Areas of soft or unsuitable Subgrade soils or areas of non-uniform Subgrade stability shall be identified by observing Pumping and/or Rutting. Pumping is defined as movement or deflection of the Subgrade soil that extends beyond the limits of the direct wheel load. Unless accompanied by Rutting (which is common), the pumping Subgrade soil may rebound back to its original position after the wheel load passes. Pumping failures are typically caused by Subgrade soils with higher than optimum moisture content located within a zone up to several feet below the Subgrade surface. Rutting is defined as imprints or depressions in the Subgrade caused by direct wheel loads. Rutting failures are typically caused by inadequate compaction of near surface soils.

c) Rutting in excess of one inch in depth shall be deemed a Subgrade failure requiring Subgrade repair.

d) Pumping or deflection of less than one inch is acceptable so long as the Subgrade soil rebounds back to its original position after the wheel load

passes. Pumping or deflection greater than one inch or areas of permanent deflections shall be deemed a Subgrade failure requiring Subgrade repair.

e) For larger areas of subgrade proofroll failure, the alternative pavement design procedures in Subsection A.1-2(B) can be implemented by the Applicant.

(5) Subgrade repairs shall be performed by scarifying, aerating and recompacting the Subgrade soils. As an alternative, the failed Subgrade soils can be removed and replaced with properly compacted soils capable of producing the required CBR value.

(6) In all cases, repaired areas shall be retested for compaction and proofrolled again before proceeding with the placement of pavement materials. Rutting can typically be repaired by scarifying, aerating, and recompacting, while areas of pumping will more likely require a more significant repair with depth often including the removal and replacement of unsuitable Subgrade materials.

(D) Final Subgrade Inspection Testing and Reporting Requirements

(1) Both the Staff inspector and the Geotechnical Technician have final Subgrade review, testing, and reporting responsibilities.

(2) The Geotechnical Engineer shall provide soil testing to develop an opinion of adequate bearing characteristics of the final Subgrade soils. Those tests will include, but are not limited to, moisture content testing, density testing, and verification of soil types being adequate to produce the required CBR values for the pavement. Moisture content testing, density testing, and verification of soil types being adequate to produce the required CBR values for the pavement shall be performed by the Geotechnical Engineer at intervals no less than one test per 100 lineal feet of Street for Streets of 500 lineal feet or less, or one test per 200 lineal feet for Streets over 500 lineal feet.

(3) The Geotechnical Technician and the Staff Inspector shall review the proofrolling described in Subsection B.2-7(C): Final Subgrade Proofrolling and determine whether the Subgrade passes the proofroll.

(4) Paving operations shall only be permitted to begin after passing inspection results are achieved from Subsection B.2-7: Street Pavement Subgrade, Subsection B.2-7(C): Final Subgrade Proofrolling, and Clause B.2-7(D)(2). Inspection reports referenced in Clause B.2-7(D)(1) and Clause B.2-7(D)(2) shall be placed in the Staff project file and Staff shall make their inspection records available to the Developer.

(5) Street paving shall occur within 30 hours after passing inspection results are achieved from Clause B.2-7(D)(1) and Clause B.2-7(D)(2). A ¼ inch rain event or sub-freezing temperature occurrence between a passing proofroll and Street paving shall void the proofroll and geotechnical testing and shall require re-evaluation.

(6) For concrete pavements, small pours of up to one hundred square yards to complete intersections, cul-de-sacs, etc. do not require subgrade re-proofrolling

after initially passing a proofroll as part of a large subgrade preparations and testing. Moisture conditioning and rerolling may be required.

B.2-8 Controlled Low Strength Material

(A) CLSM may be used in place of compacted clayey soils to uniformly backfill utility trenches, manholes, etc.

(B) CLSM shall not be used in place of clean, free-draining #57 crushed limestone specified for and intended as Drainage backfill around catch basins and manholes or in trench drains, such as between catch basin pairs.

(C) CLSM shall be transported by mixing truck to ensure proper suspension when placed. Constant agitation is required.

(D) Flotation of pipes should be avoided by backfilling in 8 to 12 inch lifts until fluid head subsides.

(E) Adequate separation from aluminum pipe, such as a bituminous coating, is required.

(F) CLSM shall extend from the top of compacted bedding or other backfill to bottom of pavement structure.

(1) CLSM placement shall begin no greater than six inches above the top of the pipe.

(G) CLSM shall have a minimum excavatable strength of 20 pounds per square inch at three days and 30 pounds per square inch at 28 days. CLSM shall have a maximum excavatable strength of 100 pounds per square inch at 28 days for potential future excavatability.

B.2-9 Construction Equipment on Paved Surfaces

Only rubber tired or rubber tracked equipment shall be used on paved surfaces.

B.2-10 Work Adjacent to Plastic Concrete

Grading operations adjacent to Concrete Curb are prohibited for a minimum of 24 hours after Concrete placement has been completed.

B.2-11 Final Geotechnical Reporting

After the completion of all earthwork covered under this Appendix, for each Subdivision section that is constructed and is to be recorded, the Geotechnical Engineer shall complete a final written report for that Subdivision section. The report will include the following:

(1) All relevant construction inspection results; and

(2) A statement from the project Geotechnical Engineer that, to the best of his/her knowledge and belief, all earthwork operations within the Public Street Right-of-

way, Private Street easements and areas structurally supporting the Public Street Right-of-way and Private Street easements were performed in general conformance with the requirements of this Appendix and the recommendations for the areas within the Public Street Right-of-way, Private Street easements and areas structurally supporting the Public Street Right-of-way and Private Street easements contained in the associated geotechnical exploration report.