33 40 00 – Storm Drainage

1. Introduction

   A. Duke University is divided into the main areas of the Medical Center, West Campus, Central Campus, and East Campus. The University also includes the Washington Duke Inn and Golf Course, the Sarah P. Duke Gardens, Duke Forest, and the Lemur Center.

   B. The University campus is in both the Cape Fear and Neuse River Basins. In the Cape Fear, the main braches flow to Sandy Creek and Mud Creek generally to the southwest. In the Neuse River Basin, the campus area drains to unnamed tributaries to Ellerbe Creek. No areas of the Duke Campus are within a watershed protection district for either Jordan Lake Reservoir or the Falls Lake Reservoir.

   C. Duke University is located within the City of Durham limits. A "UC Zoning" district has been established for the University. One requirement of this zoning district is that an overall campus Stormwater Impact Analysis (SIA) be developed and maintained for the University. The current SIA was submitted and approved by the City of Durham in 2004 and is currently updated for all development projects on campus.

   D. Three separate HEC-HMS models were run for the Duke University Campus SIA based on City of Durham requirements. All three HEC-HMS models use SCS unit hydrograph routing and the SCS curve number loss method. SCS model based on hydrologic soils and cover conditions and is modeled with HEC-HMS (Hydraulic Modeling System). Separate models are set up for water quantity and quality.

2. General Requirements and Process

   A. Project team's civil engineer shall schedule an initial meeting with DUES to review project utility requirements and applicable design guidelines prior to preparing and submitting plans for budgeting or outside regulatory review.

   B. Design shall comply with City of Durham Design Guidelines and Duke FMD Design Guidelines.

   C. All existing and proposed storm drain pipes, system elements and drainage barriers shall be shown on the drawings and coordinated with all other proposed utilities and improvements and proposed landscaping. All components shall be accessible for operation and maintenance and eventual replacement.

   D. Calculations or computer modeling are required for new buildings or other projects that increase impervious surface area, for sizing storm drain systems and for evaluating the impact of site development on existing drainage patterns and facilities. Profiles of storm drainage piping including HGL calculations are required for all storm piping.

   E. Storm piping shall have a minimum vertical separation of 18-inches between all utilities crossings. Vertical separation between storm and sanitary shall be 24-inches when horizontal separation is 3 feet or less.

F. Stone for rip–rap shall be clean and essentially free of rock dust and fines, and shall consist of spalls passing a 5 inch sieve, Class I. The largest pieces shall have a volume of not more than 2 cu.ft.; no more than 10 percent of the total weight of rip–rap shall exceed maximum size. All rip rap materials have to be reviewed and approved by DUES.

G. Soil separator shall be Celanese Mirafi, 104N.

3. Quality Standards

A. Materials and operations to comply with the latest edition of Codes and Standards listed:

1. AASHTO - American Association of State Highway Transportation Officials
2. ACI - American Concrete Institute
3. ACPA - American Concrete Pipe Association
4. AISI - American Iron and Steel Institute
5. ASTM - American Society for Testing and Materials
6. BIA - Brick Institute of America
7. CRSI - Concrete Reinforcing Institute
8. FEMA - Federal Emergency Management Agency
9. FS - Federal Specifications
10. HEC - Hydraulic Engineering Center
11. NCMA - National Concrete Masonry Association
12. NCSPA - National Corrugated Steel Pipe Association

4. References

A. Current SIA document: Contact Duke Utility and Engineering Services (DUES) regarding questions related to the SIA document.

B. The following City of Durham links:

1. Most current City of Durham Reference Guide for Development
2. Most current City of Durham Stormwater Performance Standard

3. Most current City of Durham Stormwater Ordinance

C. Section 31 23 00 Trenching, Backfilling and Compaction of Utilities

5. Materials

A. Reinforced Concrete Pipe shall conform to ASTM C76, Latest Class III, IV & V, AASHTO M-170-Latest. Joints shall conform to ASTM C-443-Latest. Joints shall be sealed with a plastic cement putty meeting Federal Specification SS-S-00210, such as Ram-Nek or a butyl rubber sealant.

B. High Density Polyethylene (HDPE) Corrugated Pipe: Installation of HDPE pipe shall adhere to design criteria standards. Pipe material shall meet the product specifications of ASTM F667 and shall have a smooth interior. Pipe joints shall consist of an integral bell and spigot type joint with “O” ring rubber gasket meeting ASTM F477 placed on the spigot end. At least two (2) corrugations of the spigot end must insert in the bell end. Installation shall adhere to the specification of ASTM D2321 and certified by an engineer. HDPE pipe shall only be used in non-traffic loading areas.

C. Ductile Iron pipe shall be used in areas that do not meet minimum cover requirements with other utilities. The use of DIP will be determined on a project specific basis. Pipe joints, push on type utilizing rubber ring gasket, AWWA C111 (polyvinyl wrap).

D. PVC sewer pipe: ASTM D3033, Type PSP, SDR 35; or ASTM D3034, Type PSM, SDR 35 with PVC, ASTM D3033 or D3034, solvent cement joints complying with ASTM D2855 using solvent cement complying with ASTM D2564; or elastomeric joints complying with ASTM D3212 using elastomeric seals complying with ASTM F477. PVC pipe shall only be used in non-traffic loading areas. PVC is allowed provided the pipe meets the loading criteria of the application.

6. Structure Materials

A. Clay Brick shall be solid, rough, sound clay brick conforming to ASTM C32, Grade MS. The brick shall be laid with full shove joints, filling up the joints with mortar. The thickness of the joints shall not exceed 3/8 of an inch.

B. Concrete Block or brick shall be solid and conform to ASTM C139 as to design and manufacture. The block or brick shall be embedded in a mortar bed to form a 1/2 inch mortar joint.

C. Precast Concrete Manholes shall meet ASTM C478 as to design and manufacture. All manhole cones shall be the eccentric type. Joints shall be sealed with a plastic cement putty meeting Federal Specification SS-S-00210, such as Ram-Nek or a butyl rubber sealant.

D. Headwalls and Endwalls shall be constructed in accordance with NCDOT details, or precast concrete with wing walls and apron by an approved manufacturer. Installation of

precast headwalls and endwalls shall be in accordance with the manufacturer's recommendations.

E. Retention/Detention outlet structures shall be cast in-place or precast concrete.

F. Frame, Grate & Hood shall be cast iron and meet the ASTM requirements set forth in the latest edition of the NCDOT “Standard Specifications for Roads and Structures” and the dimensional requirements set forth in the latest edition of the NCDOT “Roadway Standard Drawings #840.03”. Grate shall be stamped with the NCDOT specification number as evidence of satisfying the above requirements. Frame shall be anchored to structure.

7. Installation

A. Minimum and Maximum: Minimum allowable slope shall provide flow velocities of at least 2.0 feet per second and maximum allowable slope shall provide flow velocities no greater than 10.0 feet per second during peak flow conditions.

B. Straight Alignment: All storm sewer mains shall be laid in a straight alignment between manholes.

C. Curvilinear Mains Prohibited: Curvilinear storm sewer mains shall not be allowed.

D. Pipe may enter through the corner of all structure material types except precast concrete "waffle" boxes.

E. The minimum cover for storm sewer pipe shall be 2 feet to finished subgrade under roads and 1 foot to finished grade in non-load-bearing areas.

F. Pipe shall not project into a drainage structure but shall be finished flush with the inside of the structure.

G. Catch basins between 5 and 20 feet in depth shall have minimum interior dimensions of 4 feet by 4 feet, and those over 20 feet in depth shall have minimum interior dimensions of 5 feet by 5 feet.

H. Each drainage structure shall have an invert constructed from concrete and shaped to conform with the pipe ID, and a bench with a maximum 5:1 slope. The bench shall begin at a height of one-half the pipe diameter for 12 to 24 inch pipe, one-third the pipe diameter for 30 to 48 inch pipe, and one-fourth the diameter for pipe greater than 48 inches in diameter. Precast headwalls and endwalls shall only be installed at single pipe culverts.

I. Each curb’s inlet must be installed such that the front wall is straight and aligned with the curb and gutter.

J. See section 31 23 00 Trenching, Backfilling and Compaction of Utilities for additional information.

8. Inspection

   A. Materials must be in good condition when delivered to site. Rejected materials shall be immediately removed from the job.

   B. Storm drain lines shall be clean and free from obstruction and shall be visually inspected from every structure or opening. Lines which do not exhibit a true line and grade or which have structural defects shall be corrected.

   C. All piping shall be video inspected and approved by FMD representative.

9. Summary of Water Quality Requirements

   A. Duke University is required to comply with the City of Durham Ordinance for water quality control.

   B. The analysis points for the water quality model were defined where stormwater enters the stream buffer.

   C. Water Quality is based on the proposed project boundary. Coordinate with FMD for site boundary requirements. See table 1 below for performance criteria.

   D. Effective Date for Nitrogen Control means March 9, 2001 for that portion of campus in the Neuse River Basin, and March 17, 2009 for Cape Fear Basin.

   E. Effective Date for Phosphorous Control means June 15, 2010 for that portion of campus in the Neuse River Basin and the Cape Fear Basin

   F. Duke has a water quality “credit” bank and is seeking potential water quality credits for regional treatment facilities. Consultants should coordinate with DUES Stormwater Engineer during the early phases of the project to determine potential credit availability.

10. Summary of Water Quantity Requirements

   A. Volume and peak discharge control requirements are based from the campus SIA. The SIA detention model is an SCS curve number model.

   B. The cover conditions for each sub-basin were calculated based on soil type and overlying condition. This cover condition establishes the CN number for each sub-basin. The baseline for the campus “Land Use Cover Conditions” is 1997 conditions and will not change in relation to the SIA.

   C. Each project on campus is analyzed for changes in the CN calculation. If no change to the CN is calculated, then no further analysis is required. If the CN value “flips”, then

further analysis is needed at the analysis point. Coordinate with DUES representative regarding CN analysis.

D. Analysis points are identified across campus at points where stormwater leaves campus.

E. Peak Flow Rate Detention Requirements are as follows: (Only if CN value “flips”)

1. Two and Ten Year Storms. Land disturbance that increases the peak runoff rate from either the 2-year or the 10-year storm may be required to install BMPs to address the impact. The Two and Ten year storms to be controlled to predevelopment (1997 cover conditions) flow rates. Analysis points where stormwater leave’s Duke’s property.

2. One Year Storm. Development may not increase the post-development peak runoff rate from the one-year storm over the pre-development (2009 in Cape Fear Basin and 2001 in Neuse River Basin) peak runoff rate. If the post-development peak runoff rate does increase, stormwater management facilities shall be provided such that there is no net increase. Analysis points where stormwater enters a stream section (streams defined by quad and/or soils map). Existing sub-basins may require further sub-dividing.

3. Other Design Storms. In certain circumstances (i.e. when there are existing flooding concerns, potential to flood existing structures, etc.), Development that increases the peak runoff from other design storms such as the 100-year storm may be required to install BMPs to address the impact, as determined in accordance with standards of the City’s Engineering and Stormwater Division.