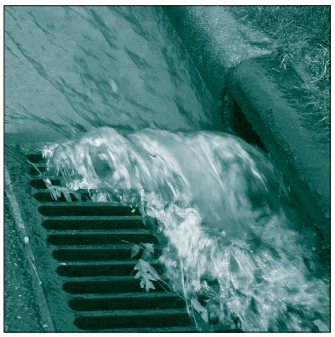
Public Works Engineering Design Manual



Town of Chapel Hill Public Works
Department Engineering Division

2023

Manager's Approval of Revisions to the Town of Chapel Hill's Public Works Engineering Design Manual

Date of Revisions: May 3, , 2023

I, Chris Blue, approve the attached recommended revisions to the Town's Public Works Engineering Design Manual

Signature: _____

Date: 5/3/2023

Endorsed By: _____ 5/12/23

Lance Norris **Date**

Public Works Director

Version 4/18/2023

TOWN OF CHAPEL HILL
Public Works Department

6850 Millhouse Road
Chapel Hill, NC 27516-8173

phone (919) 969-5100 *fax* (919) 969-2003
www.townofchapelhill.org

MEMORANDUM

To: Chris Blue, Town Manager

From: Lance Norris, Public Works Director

Date: April 21, 2023

Subject: Recommendation for Revisions to TOCH Public Works Engineering Design Manual

This Memorandum will serve as my recommendation for revisions to the Public Works Engineering Design Manual. The revised manual is attached to this memo for your review and approval.

To approve these revisions, please sign the signature page and return a copy to Public Works. All future revisions will also be submitted to you and will include a memo and signature page for your approval.

Background

The Public Works Engineering Design Manual (PWEDM) is a Town manager approved town technical document that establishes standards and processes for both public and private infrastructure improvements. Its intended users are town staff, engineers, designers, contractors and members of the public when designing or constructing public and private infrastructure projects. Examples of public infrastructure projects are road improvements, new sidewalks (public and private), public parks, Stormwater systems (public and private). The manual does not apply to buildings (interior or exterior).

The Public Works Engineering Design Manual is not a policy or regulatory document. Rather, the manual supplements Town ordinances, such as the Land Use Management Ordinance (LUMO), by providing guidance and specifications for ways to comply with ordinances and other Council-established policies.

The current manual has not been revised since 2004 due to the complexity of the approval system. In Fall 2015, Public Works/ Engineering staff began the process of revising the manual with the assistance of an engineering design consultant. The main goal of the revision was to bring the manual up to date with current engineering standards and practices and reorganize the chapters in an effective, user-friendly way. To obtain the input needed for a comprehensive update, several

meetings were held with most of the Town's departments. Input was also solicited from private engineering design firms who commonly submit development plans to the Town via email at both the beginning and end of the revision process.

To ensure participation and support from Town Advisory Boards/Commissions/Councils, all Boards were invited to a presentation of the proposed revisions to the Manual on February 7, 2017. Comments were submitted from Board Members which were analyzed and added to the proposed Manual revisions.

In 2019, five meetings were held with representatives from the Community Design Commission (CDC), Planning Commission, Stormwater, and Transportation Boards to discuss their suggestions for improving the draft manual. There was concern about the car-centric nature of Chapter 3, then titled, "Streets, Parking, and Transportation." Revision efforts stalled.

In the third quarter of FY 2023, staff from multiple departments provided revisions to better align the manual with current practices and goals. The most significant changes were to Chapter 3, now titled "Access, Mobility and Circulation." Design standards in the previous manual centered vehicular movement; the most recent revisions center pedestrians and multi-modal transportation.

This document will be submitted for review by the Town attorney's office in the summer of 2023.

To facilitate regular updates to the manual and simplify the revision approval system, staff recommended a revision to LUMO Section 5.1.3 (which governs the approval authority for making revisions to the manual) to authorize the Town Manager to approve revisions. Prior to this amendment, Council had to approve any revisions. Council adopted this amendment on June 26, 2017.

Current Revisions

The revised manual is attached. There are several new chapters, modifications to existing chapters, and several new illustrations. The existing chapters were re-arranged in an order so that as a development is designed, the chapters' subjects would follow the progression of the design.

A summary of the changes are as follows:

1) New Chapters:

    a. Chapter 1 – Definitions and Abbreviations – The original manual did not have a definition section.

    b. Chapter 2 – General Provisions (and Preference) – This replaces the introduction chapter of the previous manual. Not only has the introduction section been updated, but general information such as who can seal a plan is included here. Also, the appeals section has been moved to this chapter.

Future Revisions

Routine revisions will be scheduled once a year or as needed depending on the urgency of the revision. Staff will begin the FY24 update process by requesting feedback from the public through advisory board presentations and a feedback form on the manual webpage. The Town Attorney's office has not completed a full review of the revisions to the manual, which we anticipate several months to complete to which we can determine if there are any immediate changes required.

With the Council adopting the amendment to Section 5.1.3, the Manager is authorized to approve any revisions to the manual, as needed. The agenda item materials noted that the Manager would inform the Town Council of significant future revisions. It is up to the Manager's discretion to approved any changes immediately, request an advisory board for input before approval, request Town Council for input before approval, or any combination.

Since the current round of revisions are extensive, it is recommended that this version of the manual be the start of the revision tracking system. All future revisions would be tracked and identified in the manual for easy reference. We believe Municode would be the best tracking software to use for the manual and are in the process of obtaining a quote for this service. This is the same tracking software used for LUMO updates.

Once a revision has been approved by the Manager, a Letter to Industry will be issued and will refer to the Town's website to locate manual documents. Also, the revision will be recorded.

Next Steps to Reduce Duplication between the Manual and Other Town Documents

Coordination of manual topics with other Town regulatory documents is important to minimize duplication and to be more efficient when an update is required.

- TOCH LUMO: This manual is a compliment to the LUMO and will need to remain in-step with any revisions to the LUMO. Once the LUMO update process is near completion, a review of this manual will be performed as needed.

- TOCH Plans: The manual intentionally refers to Town Plans (Bike and Pedestrian Plan, Mobility and Connectivity Plan, etc) rather than copies material into the manual from those plans as those plans do change. This limits the need for updating the manual when a plan changes.

- State and Federal manuals and documents: There are several places in the manual that refer to partner agency documents. This was done as to limit updating the manual on information that relies on an outside party for information that may change without staff's knowledge.

Recommendation

Staff recommends approval of the attached Manual and approving next to reduce duplication and increase efficiency between the documents per the schedule as noted above.

Attachments: Town of Chapel Hill Public Works Engineering Design Manual, with Revisions
Town of Chapel Hill Public Works Engineering Design Manual, Current (old) Version

Table of Contents

Chapel Hill Public Works Engineering Design Manual

PREFACE (pages 9-11)

PURPOSE

COMPLIANCE

CHAPTER 1 - DEFINITIONS AND ABBREVIATIONS (pages 12-21)

1.0 DEFINITIONS

1.1 ABBREVIATIONS

CHAPTER 2 - GENERAL PROVISIONS (pages 22-24)

2.1 GENERAL

2.2 APPEALS

2.3 BUILDING SIGNS

2.4 ADDRESS NUMBERS

2.5 PLAN REVIEW AND PERMITTING PROCESS

CHAPTER 3 – ACCESS, MOBILITY AND CIRCULATION (pages 26-73)

3.1 GENERAL
- Vision Zero
- Universal Design
- Complete Streets

3.2 RELATIONSHIP TO TOWN PLANS

3.3 MULTIMODAL ACCESS
- Public Access Ways
- Private Access Ways Providing Required Access

3.4 CONNECTIVITY
- Extension to Boundaries

3.5 ENCROACHMENTS

Permanent Encroachment Agreements
Monument Mailbox Encroachments
Telecommunications Encroachments
Temporary Encroachment Agreements

3.6 MULTIMODAL TRANSPORATION SYSEM
Pedestrian Facilities
Sidewalks
Pedestrian Signals
Leading Intervals
Scrambles (All-Pedestrian Phase)
Accessible Pedestrian Signals (APS)
Crosswalks
Pedestrian Refuge Islands
Multi-use (Shared-Use) Paths
Multiuse Paths: Pavement Design
Multiuse Paths: Width and Clearance
Horizontal Alignment
Multiuse Paths: Grades
Multiuse Paths: Design Speed
Bicycle Facilities
Bicycle Lanes
Bicycle Parking
Transit Facilities
Federal Accessibility Mandates
Siting Transits Facilities
Required Transit Facilities & Amenities
Transit Vehicle Pull-offs
Transit Vehicle Pads
Transit Pavement Markings
Passenger Landing Pads
Transit Shelters
Bus Rapid Transit
Public Streets
Street Classifications
Street Design Standards
Pavement Structural Standards
Phased Completion of Streets
Dead End Streets
Private Streets
Passageways and Alleys
Substandard Access Ways
Intersections
Stopping Sight Distance and Sight Line Triangles at Intersections
Turn Lane Warrants
Traffic Control Devices

3.7 TRANSPORATION IMPACT STUDIES

3.8 STREET NAMES AND ADDRESSES

3.9 STREET AND CROSSWALK LIGHTING
Streetlights and Street Lighting Applicability
Street Lighting Plan Submittal Requirements
Street Lighting Guidelines
Streetlight Pole and Fixture Standards for Residential Streets
Streetlight Placement Standards for Residential Streets
STREET SIGNS
Street Signs and Markings Standards
Street Signs and Markings Applicability
Street Name Signs
Street Signs and Markings Plan Submittal Requirements
Pedestrian and Bicycle Wayfinding Sign Standards
PARKING AND LOADING
Off-Street Parking
Off-Street Parking Minimum Design Standards
Off-Street Parking: Interlocking Standard Parking Spaces
Compact Parking Spaces
Accessible Parking Spaces
Parking Pavement Standards
Parking Decks
Electric Vehicle Parking
Installation and Equipment
Location, Design, and Maintenance
On-Street Parking
Loading Space Requirements
DRIVEWAYS
Driveway Standard Dimensions
Minimum Length
Driveway Paving
Driveway Minimum Required Throat Depth (MRTD)
Driveway Grades Adjacent to Right-ofWay
Driveway Grade (Sidewalk Cross Slope), Change of Grade, and Vertical Alignment
Physical Vehicle Ground Clearance Control
THE BLUE HILL DISTRICT

CHAPTER 4 - STORMWATER MANAGEMENT (pages 74-113)

4.1 GENERAL

4.2 STORMWATER MANAGEMENT DESIGN CRITERIA
Water Quality
Volume
Flow Rate
Peak Elevation
Land Disturbance

4.3 BASIS OF STORMWATER MANAGEMENT DESIGN
Integrated Management Practices/Structural Control Measures
Drainage Areas

Hydrologic Soil Groups (HSG)
Hydrologic Methodology
Factors Considered in Determining Runoff Curve Numbers
SCS Method
SCS Method Time Concentration
Factors Affecting Time of Concentration and Travel Time
Computation of Travel Time and Time Concentration
Rational Method
Precipitation Estimates

4.4 STORMWATER DRAINAGE SYSTEM
Streets
Street Inlets
Curb and Gutter
Gutter Flow Calculations
Longitudinal Slope
Bridge Decks
Median Barriers
Open Channels
Vegetated Open Channels
Open Channel Permissible Velocity Calculations
Selecting Permanent Channel Lining
Culverts
Drainage Pipes
Outlet Protection
Subsurface Drainage
Regulatory Floodways
Reserved Storm Drainage Easement

4.5 STORMWATER CONTROL MEASURES
Stormwater Control Measures Hyperlinks

4.6 ADJUSTMENTS OR WAIVERS

4.7 STORMWATER MANAGEMENT REPORT REQUIREMENTS
Dam Embankment Construction Notes

4.8 SINGLE-FAMILY DESIGN GUIDELINES

4.9 APPLICABLE REGULATIONS

CHAPTER 5 – UTILITIES (pages 114-122)

5.1 GENERAL
Utility Providers
Location of Underground Utilities
Interrelation of Utility Lines
Private Water Lines and Sewer Lines in the Public Right-Of-Way
Water Main and Service Abandonment

Underground Utilities
Record Drawings
Trench backfill
Pavement Removal and replacement
Surface Appurtenances

5.2 SEWAGE COLLECTION SYSTEM
Flood Policy
Provision for Future Service Areas
Design and Construction Standards and Materials

5.3 WATER DISTRIBUTION SYSTEM
Provisions for Future Service Areas
Design and Construction Standards
Fire Prevention Provisions
Fire Flows
Fire Hydrants
Location of Valves
Fire Department Connections

5.4 AUTOMATIC SPRINKLER SYSTEMS
Non-Residential
Multi-family
Fraternity and Sorority Houses
Key Boxes

5.5 EASEMENTS

CHAPTER 6 - LANDSCAPING AND TREE PROTECTION (pages 123-145)

6.1 DESIGN STANDARDS
Buffer Requirements
Using Existing Vegetation
Amenity Encouragement
Parking Lot Requirements-Screening Standards
Amended Soil Volume Requirements
Parking Lot Screening
Parking Lot Shade Standards
Utility Service Requirements
Tree Placement Requirements

6.2 PLANT SELECTION STANDARDS
Standards
Prohibited Species
Suggested Species/Planting Practices

6.3 LANDSCAPE INSTALLATION AND MAINTENANCE SPECIFICATIONS
Top Soil/Amended Soil

General Pruning Requirements

6.4 TREE PROTECTION STANDARDS
Root Pruning Existing Rare and/or Specimen Trees
Cleaning and Grubbing
Construction Access within the Critical Root Zone or Rare and/or Specimen Trees

6.5 STREETSCAPE STANDARDS
Materials
Furnishings

CHAPTER 7 - SOLID WASTE MANAGEMENT (pages 146-151)

7.1 RESIDENTIAL COLLECTION
Residential Refuse Collection Note

7.2 MULTI-FAMILY/COMMERCIAL/INSTITUTIONAL REFUSE COLLECTION
Dumpster Pad Design
Dumpster Pad Screening
Overhead Clearance

7.3 RECYCLING

CHAPTER 8 – EROSION AND SEDIMENTATION CONTROL (pages 152-157)

8.1 GENERAL

8.2 MANDATORY STADRADS FOR PERMANENT GRADING

8.3 DRAINAGE REQUIREMENTS AROUND RESIDENTIAL STRUCTURES FOR S SUBDIVISIONS

CHAPTER 9 – PARKS AND RECREATION (pages 158-166)

9.1 GENERAL
Dedication of Recreation Area (Subdivisions)
Dedication of Active Recreation Space (Multi-Family Development)
Park Furniture Specifications
Benches
Litter Receptacles
Tables
Bicycle Racks
Water Fountain and Bottle Filler
Playgrounds and Play Amenities

Dog Parks

CHAPTER 10 - CONSTRUCTION AND POST CONSTRUCTION (pages 167-204)

10.1 STREET CONSTRUCTION
- Work Zone Traffic Control
- Transit Accommodations During Construction
- Groundcover within Right-of-Way
- Use of Steel Plates in Roadways During Construction
- Steel Plate Installation

10.2 STREET REPAIRS
- Applicability
- General Requirements
- Street Construction Specifications

10.3 PERMITS AND FINAL PLANS
- Zoning Compliance Permit/Final Plan Submittal Requirements
- Engineering Construction Permit Plan Submittal Requirements
- Revision to Approved Plans
- Engineering Construction Permit
- Other Permits
- Construction/Inspection Standards
- Final Approval of Construction

Preface

PURPOSE

This document (hereafter referred to as the “Manual”) is intended to establish design parameters, guidelines, best practice and standards for the preparation and submittal of infrastructure improvement plans for subdivision and other site development projects in Chapel Hill. In the event of a discrepancy, Town Code supersedes this Manual. Town of Chapel Hill staff, the Town Code and Town Council adopted plans provide the basis, goals, and performance requirements that this Manual are based on. In the event of a discrepancy, Town Code will supersede this Manual. The designer on any project should use judgment and experience to identify any additional information that may be necessary for review.

This Manual offers some options in meeting the Land Use Management Ordinance (LUMO) of the Town of Chapel Hill. The Town's land use and development policies, as embodied in the Comprehensive Plan, are necessarily discussed in such broad terms as "livability", "public safety", and "variety of housing mix". The Comprehensive Plan contains community-wide goals and objectives which emphasize the existing character of the Town and its neighborhoods. The Land Use Management Ordinance deals with the more specific concepts such as types of use, lot sizes, and parking requirements. However, even these more specific terms can be interpreted in a variety of ways, especially where a development in a specific location is being considered. This Manual has been prepared to help people involved with site development in Chapel Hill and its planning jurisdiction to understand, before they begin, what will most likely be acceptable in this jurisdiction. This Manual is intended to complement and supplement the Comprehensive Plan.

Other Town Plans that this Manual may refer to or provide content from (but not limited to):

- Bike Plan
- Mobility and Connectivity Plan
- Short Range Transit Plan
- Stormwater Master Plan
- Strategic Plan
- Pedestrian and Bicycle Wayfinding Strategy
- Complete Community’s Framework

Specific design criteria set forth in this Manual provide a ready reference of those practices and techniques acceptable to the Town. We also encourage design professionals to consider site characteristics closely in their design and to seek new and innovative practices and techniques for complying with Town development policies and regulations. Designers are encouraged to offer alternative means of compliance to the design standards contained in this Manual in the cases of challenging site characteristics, applicability of improved technology or innovative practices.

Where alternative means of compliance can be shown to conform to applicable policies and regulations, the Town may accept such alternatives in lieu of the standards contained herein. Similarly, where a particular site is characterized by a large number or extent of impediments to developing land in compliance with applicable policies and standards, or where technological changes provide for practices and techniques that better ensure compliance, the Town itself may modify or substitute additional standards for the design standards contained herein.

When there are deadlines for improvements, the Manager may allow extensions of deadlines provided these extensions: (1) will not conflict with the intent of these standards and other land development regulations, and (2) include a practical justification for an extension.

COMPLIANCE

Compliance with these standards shall be required at the time property is developed, whenever a major increase in the intensity of use is created as determined by the Town Manager, or whenever a use group change occurs as outlined in the Town of Chapel Hill Land Use Management Ordinance (LUMO).

The Town Manager may exempt modifications to existing developments from individual provisions of these standards; where, in the opinion of the Town Manager, compliance with those provisions would create a practical hardship upon the property owner and where the modification does not increase an existing non-conformity.

WHERE TO FIND THE PUBLIC WORK ENGINEERING DESIGN MANUAL AND STANDARD DETAILS

The Town Public Works Engineering Design Manual and Town Standard Details will be updated to remain current and as necessary. Both documents are available on the Public Works Engineering Design Manual and Standard Details webpage.

REVISIONS

Land Use Management Ordinance, Section 5.1.3, the Manager is authorized to approve any revisions to the manual, as needed. It is up to the Manager's discretion to approve any changes immediately, request an advisory board for input before approval, request Town Council for input before approval, or any combination.

Routine revisions will be scheduled once a year or as needed depending on the urgency of the revision. Any revisions will be officially recorded and logged, and any major revisions will include a Letter to Industry.

It is recommended that any individual using this Manual contact the Public Works / Engineering Division with suggested revisions. A revision request form will be available on the Public Works Engineering Design Manual and Standard Details webpage.

Chapter 1
Definitions & Abbreviations

1.1 DEFINITIONS

Access Easement - A permanent easement, which grants the right to the public or specified party to access and/or cross private property.

Best Management Practices – Methods implemented as a way of treating or limiting pollutants and other damaging effects of stormwater runoff to meet legislative and North Carolina Administrative Code Requirements.

Bikeway - including but not limited to bike lanes, bike paths, bike trails, multi-use paths, shared-use paths, greenways, and trails. This does not include sidewalks.

Blue Hill (Formally Ephesus/Fordham) District– A specific area of the Town designated as a focus area in the Comprehensive Plan 2020. There are special requirements for development in this area. See Section 3.13 of this Manual.

Bond - A type of surety that guarantees payment and/or performance and insures against a financial lose.

Borrow - Fill material (soil), which is required for on-site construction and is obtained from off-site locations.

Cash Bond - Performance surety in which cash is deposited with the Town and held in lieu of a performance bond until the bonded work is completed.

Certificate of Occupancy - A permit issued by the Inspections Division, setting forth that a building or structure, complies with the Building Code, its use complies with the zoning ordinance, and that the same may be used for the purposes stated therein.

Chicane – A traffic calming method that is a serpentine curve in a road, added by design rather than dictated by geography, causing a driver to reduce speed.

Choker – A traffic calming method that are curb extensions that narrow roadways to a single lane at certain points, causing a driver to reduce speed.

Complete Streets – a transportation policy and design approach that results in streets that are planned, designed, operated and maintained to enable safe, convenient, and comfortable travel and access for users of all ages and abilities regardless of their mode of transportation.

Complete Communities Strategy - assessment of capacity throughout the entire town to determine where and how to meet current and future housing needs. Included a dialogue with community leaders that identified a pilot project called Everywhere to Everywhere (E2E) Greenways that will allow trail-facing residential development.

Connectivity – it is the policy of the Town of Chapel Hill to require interconnected streets for pedestrians, bicyclists, transit and vehicular traffic. This does not apply to all streets in a new development, but it does require a reasonable level of connectivity.

Contractor/Subcontractor - Individual or firm under contract with another to perform an agreed

upon task.

Cross Drainage – Storm water drainage flow under a roadway though a culvert or across abutting parcels.

Curb Ramp - Access for pedestrian traffic at intersection of roadway, driveway or other pedestrian way. In Chapel Hill, curb ramps are required on both ends of a marked crosswalk.

Compact Parking Space – Marked parking space for compact vehicles only. These parking spaces are usually narrower than the normal parking space.

Drainage Easement - A permanent easement, which grants the right of water drainage to pass in open channels or enclosed structures, the same does not obligate the Town to maintain any storm water devices, pipes, or open channels within the easement.

Drainage Maintenance Easement - A permanent easement, which grants to the Town the right to conduct pipe maintenance repairs, alter the typical drainage channel section and/or profile in order to improve water flow, the same does not obligate the Town to maintain any storm water devices, pipes, or open channels within the easement.

Equivalent Axle Load (EAL) Pavement Schedule - A pavement schedule based on an 18-Kip Equal Axle Load.

Easement - A grant of one or more of the property rights for a specific purpose by the property owner to, or for the use by, the public, a corporation, or other entity.

Licensed Engineer - A person licensed by the North Carolina Board of Examiners for Engineers and Surveyors to practice the branch of engineering that is applicable to the design work.

Engineering Construction Permit (ECP) – Permit when work is required within the Town's right-of-way.

Erosion - The wearing-away of land surface by the action of wind, water, gravity, or any combination thereof.

Erosion and Sediment Control Plan - A set of plans prepared by or under the direction of a licensed professional engineer indicating the specific measures and sequencing to be used to control sediment and erosion on a development site during and after construction.

Exemption – a formal, documented process to free the applicant from an obligation that is typically imposed by the Town of Chapel Hill on land development applications.

Final Plat - The final map of all or a portion of a subdivision or site, showing the boundaries and location of lots, streets, easements and all other requirements of subdivision regulations.

Finished Grade - The final elevation of the ground surface after development.

Formal Street Side Parking – Parallel or angle parking which is adjacent to and contiguous with the travel way of the street and anticipated to occur on a frequent basis.

Grading - One of two (2) types of grading, rough or fine.

Ground Cover - Any natural vegetative growth, masonry, paving, riprap or other material, which renders the soil surface stable against accelerated erosion.

Hi-Visibility Crosswalks – A location indicated as an appropriate place for pedestrians to cross a street or vehicular way by marking the crossing location with high visibility crosswalk pavement markings. These crosswalks typically make use of longitudinal or "continental" or "ladder" style pavement markings, which are highly visible to approaching traffic.

Informal Street Side Parking – Parallel parking on a street where parking is anticipated to be on an occasional basis.

Inspector - The Building Inspector, Engineering Inspector, or other representative duly authorized by the Town to inspect public and private infrastructure improvements.

Land Use Management Ordinance (LUMO) – The compilation of regulations that affect land use, including the zoning, the environmental regulations, and other land use regulations.

Multimodal – all modes including, but not limited to, pedestrian, bicycle, transit and vehicular.

NC DEQ - The North Carolina Department of Environment Quality

Pedestrian Access Easement - A permanent easement dedicated to the public to facilitate pedestrian access to adjacent streets and properties.

Performance Bond - A bond for 125 percent of the estimated cost in which the surety company has an obligation to the Town for any additional cost to complete a given project due to the developer's or owner's failure to properly complete the bonded work. A Letter of Credit from a bank or savings & loan, with a branch in North Carolina, bond, certified check, or cash deposit may serve as a performance bond when bonding infrastructure improvements for the Town.

Plans - The approved plans, profiles, standard details, supplemental plans, and working drawings, which show the location, dimensions, and details of the work to be performed.

Plat - A map of a surveyed parcel of land which is intended to be, or has been, recorded in the Orange County Office of the Register of Deeds.

Preliminary Plat - A map indicating the proposed layout of a subdivision or site showing lots, streets, easements, and other requirements of subdivision regulations.

Preliminary Plans - The design phase in preparing the construction design documents. The preliminary plans include schematics and design development drawings that allows the Town

and architect/engineer to interact before the design is developed, helping to ensure a mutual understanding of the design objectives, limitations and budget.

Private Drive - A vehicular travel way, centered within an access easement, which serves more than two (2) residential lots or more than 2 principal buildings in a multi-family housing development or other non-single-family residential development. An individual entity or property owners' association shall maintain private drives. Street side parking spaces, (parallel and angle), are allowed on private drives. Parallel and angle parking spaces shall not protrude into the primary travel way.

Private Street - A vehicular travel way, permitted in developments where property owner associations exist. An individual entity or property owners' association shall maintain private streets. Private streets shall undergo the same approval process and meet the same design and construction standards as public streets. Private streets shall be approved only by Council action.

Public Street - A vehicular travel way within a dedicated and recorded public right-of-way or public easement.

Resource Conservation District: See Town Code of Ordinances, Land Use Management Ordinance, Section 3.6.3.

Sidewalk Easement - A permanent easement, which grants the right for a public sidewalk to be placed and maintained thereon.

Sight Easement - A permanent easement, which grants the Town, the right to maintain an unobstructed view across properties primarily located at street intersections, driveways and sharp horizontal curves in the roadway. (The same does not obligate the Town to maintain such).

Site Plan – A development plan required by virtue of the provisions of the LUMO as a condition for the issuance of a permit for development.

Sketch Plan - A rough sketch map of a proposed subdivision or site, showing streets, lots, and any other information of sufficient accuracy to be used for discussion by owner, developer and/or staff, of the street system and the proposed development pattern.

Slope Easement - A permanent easement, which restricts the degree of slope on property and upon which slope cannot be increased.

Stabilizing Vegetation - Any vegetation that protects the soil against erosion.

Standard Specifications – A general term referring to all provisions and requirements contained herein entitled "Roadway Design and Construction Specifications" and any subsequent addendums or revision thereto.

Stormwater Control Measure (SCM) - a permanent structural device that is designed, constructed, and maintained to remove pollutants from stormwater runoff by promoting settling or filtration or mimic the natural hydrologic cycle by promoting infiltration, evapo-transpiration, post-filtration discharge, reuse of stormwater, or a combination thereof.

Street - A vehicular travel-way, which provides a means of access and travel. The term street may include road, avenue, place, way, drive, lane, boulevard, parkway, highway, and any facility principally designed for vehicular and pedestrian traffic.

Stub-out Street - a street that is built to the property line of an adjacent property and is intended to continue into adjacent property at such time as the adjacent property is developed.

Subgrade - That portion of the roadbed prepared as a foundation for the pavement structure.

Substantially Completed - Work has progressed to the point that, in the opinion of the Public Works Director, it is sufficiently completed in accordance with the approved plans and specifications that the improved area can be utilized for its intended purposes.

Surety – A guarantee against loss or damage from one's failure to perform and a physical or financial guarantee for the fulfillment of an obligation. Performance Sureties may be in the form of Standby Letters of Credit, Performance Bonds, Certified Check, or Cash.

Licensed Surveyor - A person licensed to practice surveying in the State of North Carolina.

Temporary Construction Easement - A temporary easement, which grants the right for the Town, NCDOT or other public utility provider to encroach upon the temporary construction easement while making improvements to public infrastructure and/or public utilities.

Traffic – refers to all motor vehicles.

Traffic Calming – uses physical design and other measures to improve safety for motorists, pedestrians, and cyclists. It is a tool to combat speeding and other unsafe behaviors of drivers on residential streets. It aims to encourage safer, more responsible driving and potentially reduce traffic stress.

Traffic Impact Analysis (TIA) - an engineering study that determines potential traffic impacts of a proposed land development. TIAs are multimodal in Chapel Hill.

Transit Facility - an existing or proposed stop, station, or depot, and its associated fixtures and amenities; a bus pull-off; passenger loading or unloading zone; accessway; or other infrastructure supporting the safe and efficient provision of public transportation

Universal Design – facility design that is usable by people with all abilities and disabilities, to the greatest extent possible, without the need for adaptation or specialized facilities.

Urban Services Boundary – Adopted by the Town Council in 1986, is an area the Town eventually expects to provide with urban services like public water and sewer.

Utilities - Facilities of an agency which, provide the general public with electricity, gas, oil, water, sewage, communications, or rail transportation.

Utility Easement - A permanent easement, which grants to the Town and other public utility providers the right to install and thereafter maintain any and all utilities including, but not limited to; water lines, sewer lines, storm sewer lines, electrical power lines, communication lines, natural gas lines, and cable television systems.

Utility Easement (Private) - A permanent easement, which grants the right to install and maintain a private utility across private property. A Private Utility Easement can be granted to an individual, a utility company, a property owners association or to owners of a specified parcel of land.

Vision Zero – a strategy to eliminate all traffic fatalities and severe injuries, while increasing safe, healthy, equitable mobility for all.

Wetlands - Areas inundated or saturated by surface or ground water at a frequency and duration sufficient to support and, under normal circumstances, do support a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas as delineated by the US Army Corp of Engineers or certified professional in the field of environmental engineering as approved by the US Army Corp of Engineers.

Working Day - Monday through Friday exclusive of Town holidays.

1.2 ABBREVIATIONS

ABC	Aggregate Base Course
ADAAG	Americans with Disabilities Accessibility Guidelines
ADT	Average Daily Traffic Count
AIA	American Institute of Architects
ANSI	American National Standards Institute
APWA	American Public Works Association
ASPH	Asphalt
ASTM	American Society of Testing and Materials
AWWA	American Water Works Association
BC	Back of Curb
BC-BC	Back of Curb to Back of Curb
BRT	Bus rapid transit
BST	Bituminous Surface Treatment
CATV	Cable Television
CAP	Corrugated Aluminized Pipe
CB	Catch Basin
CFS	Cubic Feet per Second
C&G	Curb and Gutter
CI	Curb Inlet
CIP	Cast Iron Pipe
CL	Centerline
CMP	Corrugated Metal Pipe
co	Sanitary Sewer Cleanout (Drawings)
CO	Certificate of Occupancy
CONC	Concrete
CPP	Corrugated Plastic Pipe
DE	Drainage Easement
DI	Drainage Inlet
DIP	Ductile Iron Pipe
DME	Drainage Maintenance Easement
DMUE	Drainage Maintenance and Utility Easement
ECP	Engineering Construction Permit
EP	Edge of Pavement
ETJ	Extra Territorial Jurisdiction
EX	Existing

FF	Face to Face
FOC	Fiber Optic Cable
G	Gas
GV	Gas Valve
HYD	Hydrant
HDPE	High Density Polyethylene Pipe
ID	Internal Diameter
JB	Junction Box
LP	Light Pole
LOS	Level of Service
LUMO	Land Use Management Ordinance
MSL	Mean Sea Level
MUTCD	Manual on Uniform Traffic Control Devices
NACTO	National Association of City Transportation Officials
NC DEQ	North Carolina Department of Environment Quality
NC EMC	North Carolina Environmental Management Commission
NC DOT	North Carolina Department of Transportation
NEC	National Electric Code
OD	Outside Diameter
P.C.	Point of Curvature
PDE	Permanent Drainage Easement
PE	Professional Engineer
PED	Pedestal
PH	Phone
PINC	Point of Intersection
P/L	Property Line
PLA	Professional Landscape Architect
PLS	Professional Land Surveyor
PP	Power Pole
ppm	parts per million
PROP	Proposed
PROWAG	Public Rights-of-Way Accessibility Guidelines
psi	pounds per square inch
P.T.	Point of Tangency
P.V.C.	Point of Curvature on Vertical Curve
P.V.T.	Point of Tangency on Vertical Curve
PVMT	Pavement

Qmax	maximum discharge
Qmin	minimum discharge
RIRO	Right in, Right Out
R/W	Right of Way
RCP	Reinforce Concrete Pipe
SD	Storm Drain
SF	Square Feet
SS	Sanitary Sewer
STD	Standard
SCM	Stormwater Control Measure
TBC	Top Back of Curb
TC	Top of Curb
TCE	Temporary Construction Easement
TST	Temporary Sediment Trap
TWLTL	Two-way left turn lane
UDO	Unified Development Ordinance
UE	Utility Easement
VCP	Vitrified Clay Pipe
WCR	Wheelchair Ramp
WL	Water Line
WM	Water Meter

Chapter 2
General Provisions

2.1 GENERAL

For approval of street design, a North Carolina Registered Professional Engineer must seal all TIA study reports and construction plans and revisions submitted to the Engineering and Design Services Division, with the exception that the Town will accept for approval, street designs sealed by a North Carolina licensed design professional (PLS, PLA) in those circumstances allowed by North Carolina General Statutes. A digital copy in drawing file (*.dwg) format of the “Record Drawing” of the development must be submitted before final acceptance and maintenance of any streets and storm drainage systems. The digital files must be tied to the State Plane Coordinate System.

All proposed public streets shall be designed to become part of the overall street system and be identified as such on all adopted plans. All streets and roads shall align with other designated roadways for continuity in the Town's street system.

All single-family residential subdivisions shall be accessed by public streets except those wherein private streets have been approved in accordance with the provision of the Land Use Management Ordinance (LUMO).

If there are any conflicting term or requirements between this manual and the LUMO the LUMO shall govern.

The latest revisions of the *NC DOT Standard Specifications for Roads and Structures*, *NC DOT Design Manual*, *NC Stormwater Best Management Practices Manual*, *NC Erosion and Sediment Control Planning and Design Manual*, *and the Manual on Uniform Traffic Control Devices* shall apply to all roadway and storm drainage construction unless otherwise specified within this Manual.

Dedication of additional rights-of-way, easements, construction of turn lanes, roadway widening, or other improvements to existing public streets upon which the property fronts or which provide access to new developments may be required as provided for in the LUMO or the Blue Hill District. In some cases, the proposed development may be adjacent to roadways, utilities, transit routes, drainage systems, etc. in which, a large-scale infrastructure improvement project may be needed. In such cases, the Town may elect to collect a fee "In-lieu-of Infrastructure Improvements" to be used on a larger scale improvement project adjacent to the development. This process is encouraged on high volume roads where small piecemeal improvements may result in poor construction methods, impaired ride quality, and excessive inconvenience to the public.

2.2 APPEALS

Any decision of the Town Manager made in the administration of the provisions of this Manual may be appealed to the Board of Adjustment in accordance with the provisions of Article 4.10 of the LUMO Ordinance

2.3 BUILDING SIGNS

Signage is an important element which contributes to the character of Chapel Hill. The two predominant signage types which most contribute to place making in Chapel Hill are on-site signage (signs used to identify a place of business or a residential building); and wayfinding elements which are placed in the public realm to provide directional assistance or location information to pedestrians and motorists.

The quantity and quality of all signage should be considered in a comprehensive manner within a development but should also be complementary between neighborhoods.

Building identity signs are generally oriented to motorists and intended to be seen from a distance, but community character and sense of place could be enhanced with signs designed for pedestrians and bicyclists. Signs are usually located in the top half of the building, closer to the roofline. Signs should be sized for legibility, but also appropriate to the scale of surrounding buildings. They are intended to identify the name of a building or the name of a major tenant within the building. Building identity signs can also contribute to the identity of the skyline by providing visual interest when they are well-integrated into the building architecture.

2.4 ADDRESS NUMBERS

Address numbers must be a minimum of six (6) inches high and of contrasting color to their background. Reflective numbers are preferred and required on front and rear doors of strip shopping centers.

Distance from the Street:

- When the distance from the street or fire department access lane to the front or address side of the building exceeds twenty-five (25) feet, larger numbers are required,
- Twenty-six (26) feet to fifty (50) feet shall have eight (8) inch numbers,
- Fifty-one (51) to seventy-five (75) feet shall have twelve (12) inch numbers, and
- Greater than seventy-five (75) feet shall have eighteen (18) inch numbers.

Where access by private means of a private road and building cannot be viewed from the public way, a monument, pole or other sign or means shall be used to identify the structure.

2.5 PLAN REVIEW AND PERMITTING PROCESS

[Section reserved for updates

Chapter 3
Access, Mobility, and Circulation

3.1 GENERAL

Chapel Hill's multimodal transportation network, infrastructure, and facilities form the community's circulatory system, supporting safe, comfortable efficient movement of people and goods. Chapter 3 provides standards, guidance, and best practices for all aspects of the Town's transportation system and aligned with Vision Zero and Complete Streets goals and policy priorities.[1]

Vision Zero

Vision Zero is a global strategy to eliminate all traffic fatalities and severe injuries, while increasing safe, healthy, equitable mobility for all. ZERO loss of life on Chapel Hill roads is acceptable. Vision Zero recognizes that people make mistakes, and that these mistakes should not be fatal. From NC Vision Zero: Traffic safety solutions, based on data-driven strategies, must have a zero-tolerance approach to injury prevention.

In October 2021, Chapel Hill Town Council adopted the Vision Zero Resolution. Prior to the adoption of this resolution, Chapel Hill has run street safety programs under a "Road to Zero" umbrella.

All elements of the Town's transportation network shall prioritize safety for all roadway users over vehicular level of service and throughput, and the safety of vulnerable road users shall be given top priority in transportation decisions.

Chapel Hill's Vision Zero Commitment

- Eliminate traffic deaths and serious injuries by 2031.
- Vision Zero is the town-wide guiding principle for transportation, planning, the design of streets and sidewalks, the maintenance of public rights-of-way, and traffic enforcement.
- The safety of all road users shall take priority over vehicular level of service and throughput, and safety of vulnerable road users shall be given top priority in transportation decisions.

See the full Vision Zero Resolution here.

Universal Design

The Town of Chapel Hill endorses the principles of universal design and expects design professionals to incorporate universal design into travel ways, for all modes.

Complete Streets

Complete Streets provide safe, comfortable, and efficient places for everyone regardless of age, ability, or travel mode. The Town strives to achieve the appropriate balance between the needs and abilities of pedestrians, bicyclists, transit patrons, and motorists. The perspectives of transportation system users shall be incorporated into the process of planning and designing the Town's streets. This includes:

- Providing opportunities for all stakeholders to share feedback during the planning and design of existing and/or future streets.
- Assessing land use and transportation conditions, relative to established goals and objectives, to identify alternatives and tradeoffs before making decisions.
- Orient planning towards existing *and* future land use and transportation needs.
- Prioritize connecting people safely and efficiently from origin to destination.
- Design streets that are safe and comfortable for all modes of travel and appropriate based on land use context and roadway functions.

[1] *Mandated requirements for traffic control devices (signals, signs, pavement markings) are documented in the US Department of Transportation's Manual on Uniform Traffic Control Devices (MUTCD).*

All community members shall be provided opportunities to learn and share their thoughts when creating Complete Streets. This requires engaging stakeholders including, but not limited to, Town of Chapel Hill staff from the following departments: Public Works, Planning, Transit, Parks and Recreation, Police, Fire, and Sustainability); property owners abutting the street, business owners served by the street, officials from nearby schools and other institutions, and developers actively involved in property development or redevelopment.

3.2 RELATIONSHIP TO TOWN PLANS

Sidewalks, bikeways, transitways, transit infrastructure, streets, greenways, trails, and multi-use paths, shall be arranged, designed, and located in conformance with the Town's most current adopted plans (see Purpose for relevant Town Plans).

3.3 MULTIMODAL ACCESS

All development shall provide multimodal access to publicly maintained transportation facilities, as defined below:

Public Access Ways: Public access ways are sidewalks, bikeways, transitways, streets, alleys, greenways, trails, and multiuse paths located within a publicly dedicated right of way or easements and accepted for maintenance by the Town of Chapel Hill or NCDOT. Public access ways shall not be accepted for maintenance unless they meet all applicable standards.

> *Pedestrian:* Access to streets, dedicated recreation areas, or public spaces containing pedestrian ways (sidewalks or multiuse path), and/or facilities on streets where sidewalks do not exist and are not required.
>
> *Bicycle:* Access to streets, recreation areas, or public spaces containing bikeways (bike lanes, bike paths, bike trail, multiuse paths, greenways, or trails) or facilities on streets for which bikeways do not exist and are not required.
>
> *Transit*: Access to sidewalks, crosswalks, and other facilities providing easy, safe, and comfortable access to all transit stops or stations within one-quarter mile.
>
> *Vehicular:* Access to streets which are approved and in compliance with Town standards and/or currently maintained by the Town or NCDOT (State).

Private Access Ways Providing Required Access: Private access ways are sidewalks, bikeways, transitways, streets, alleys, greenways, trails, and multiuse paths located on private property. Where private access ways provide required access, they shall meet all applicable standards. Provision for their continued maintenance shall be approved by the Town Manager and recorded with the Orange County Register of Deeds in a legally valid and binding instrument which describes the properties the private access way serves. The recorded document runs with the land. The maintenance agreement shall apply to all properties which the private access ways serve. It shall contain a provision which, at any such time the private access way is no longer maintained to applicable standards, the Town of Chapel Hill, Orange County, or the State of North Carolina, as appropriate, may provide such maintenance, with the total costs of required maintenance assessed to those properties subject to the agreement.

Nothing in the above definitions of access shall be deemed to preclude the Town's authority to require improvement of substandard access ways to applicable standards. At a minimum, access ways shall have an engineered all-weather surface which will reasonably accommodate routine service vehicles and emergency vehicles.

3.4 CONNECTIVITY

The Town of Chapel Hill seeks to create an interconnected, multimodal transportation system. All proposed sidewalks, bikeways, transitways, streets, greenways, trails, and multiuse paths shall connect to existing and/or proposed sidewalks, bikeways, transitways, streets, greenways, trails, and multiuse paths to permit convenient and safe movement for all system users.

[SECTION RESERVED FOR UPDATES FOLLOWING ADOPTION OF TOCH ROADWAY CONNECTIVITY PLAN]

Extension to Boundaries

Sidewalks, bikeways, transitways, streets, greenways, trails, and multiuse paths shall extend and connect to adjacent property(ies) and/or common property lines or phase boundaries for proposed multiphase developments. Temporary turnarounds may be required at street termination points where extensions are pending to accommodate emergency vehicles.

Turnarounds or cul-de-sacs are required for street stubs longer than 150 feet.

An extension of a sidewalk, bikeway, street, greenway, trail or multiuse path beyond the site boundary may be required, where right-of-way exists, to create connectivity.

3.5 ENCROACHMENTS

Encroachments are permanent or temporary installations owned by individuals or businesses, within public rights-of-way. Approval from the Director of Public Works or their designee shall be obtained prior to placement or installation of such facilities in public rights-of-way.[2] The Director of Public Works or their designee shall determine, by his or her discretion, the necessity and type of encroachment, considering the amount of time the facilities will be in the public right-of-way and potential impacts on the public right-of-way.

Permanent Encroachment Agreements

Permanent encroachments include, but are not limited to, fences, walls, mailboxes on foundations, certain landscaping, above ground communication boxes, aerial and underground cables, ground-mounted transformers, and private irrigation systems.

A permanent encroachment agreement shall be executed when:

- Installations requiring a foundation or footing.
- Above or below grade installations that may adversely impact use and/or the Town's maintenance of the public right-of-way.

Monument Mailbox Encroachments

Monument mailboxes are those mounted on foundations and/or those serving multiple residences. The Town may approve monument mailbox encroachments, if staff review does not identify adverse impacts generated by the construction and maintenance of the monument mailbox within the public-right-of-way.

Telecommunications Encroachments

Telecommunications equipment provides services regulated under the Federal Telecommunications Act of 1996, transmitting and/or communicating between user-specified points. The Town may approve telecommunication encroachments to construct and/or maintain telecommunication equipment that is not subject to a franchise agreement if staff review does not identify adverse impacts generated by the construction and maintenance of telecommunications

[2] *In situations when the Town does not issue franchises.*

system components within the public-right-of-way. The Town may require screening for above ground installations.

To apply for a permanent encroachment, the requestor shall provide a description of the proposed encroachment, including a sketch showing the dimensions and proposed location of the encroachment, to the Town's Engineering & Design Services Division.

If approved by Town staff, the applicant must complete and submit a Permanent Encroachment Agreement, including an 8.5" x 11" exhibit illustrating the installation and location to be executed by the Town.

The fully executed Permanent Encroachment Agreement must be recorded by the Orange County Register of Deeds and a certified copy shall be sent to the Town's Engineering & Design Services Division.

Temporary Encroachment Agreements
Temporary encroachments include, but are not limited to, the short-term placement of construction management trailers, construction fencing, and maintenance activities requiring placement of equipment or materials within the public right-of-way. Temporary encroachments shall minimize adverse impacts to the use of and movement through public rights-of-way. The Public Works Department may grant a temporary encroachment to construct and maintain other facilities not included above.

To apply for a temporary encroachment, the requestor shall provide a description of the proposed encroachment, including a sketch showing the dimensions and proposed location of the encroachment, to the Town's Engineering & Design Services Division. The Town will consider approving temporary encroachments following staff review for public safety and welfare considerations.

3.6 MULTIMODAL TRANSPORTATION SYSTEM

This section describes facilities that shall be required for pedestrians, bicyclists, transit, and streets.

3.6.1 Pedestrian Facilities

Walking is a basic human right, providing freedom of movement and access to opportunities, in addition to physical, social, and emotional benefits. A busy sidewalk or crosswalk is poetry in motion. People interacting with people; shifting side to side, forward and back, and stopping on a dime. Rarely do collisions between pedestrians lead to death or injury. We have the time and flexibility of movement to react to changing conditions. If we happen to bump into another pedestrian, we will often just laugh and apologize. "Sidewalk rage" does not exist. In an ideal city, walking would be the dominant mode of travel.

Improving pedestrian mobility is one of Chapel Hill's most important policy objectives, yet many parts of the community remain hostile or inaccessible to pedestrians. The burden is always on pedestrians to remain alert and vigilant when using our transportation facilities. Luckily, Chapel Hill doesn't have to look far to find a great example of a walk-friendly community. UNC - Chapel Hill's campus provides outstanding examples of pedestrian-friendly places right in our own backyard!

To provide safer and more convenient pedestrian access, developers shall:
1. Provide direct pedestrian access to adjacent developments, neighborhoods, parks, bus

stops, sidewalks, greenways, and/or alternative pedestrian systems.
2. Investigate the feasibility of using utility easements as connecting trails.
3. Preserve existing trails unless providing superior alternatives.
4. Install pedestrian signals at intersections and pedestrian islands on roads, when warranted.
5. Provide walkways through and from parking areas to buildings, other than drive aisles.
6. Construct sidewalks along all public streets unless existing conditions dictate otherwise.
7. Clearly mark all crosswalks with paint, thermo-plastic, hi-visibility, or contrasting surface material in compliance with The Manual on Uniform Traffic Control Devices (MUTCD) (Also see North Carolina Department of Transportation's Pedestrian's Crossing Guidebook)

Right Turn on Red & Pedestrian Conflicts

Allowing right turns on red (RTOR) is the rule rather than the exception in North America, as it increases vehicle throughput at intersections. RTOR create safety issues because motorists looking left for oncoming traffic often fail to yield to pedestrians entering the intersection to their right, resulting in pedestrian-vehicle crashes. RTOR may be restricted in areas with higher rates of non-motorized activity. Because RTOR are legal unless signed otherwise, signage and enforcement and/or enforcement are required.

Town staff may approve modifications to these standards, based on site-specific conditions, neighborhood context, and existing infrastructure.

3.6.1(a) Sidewalks
All public pedestrian facilities shall, to the extent practicable, be continuous and accessible to differently abled facility users. Such facilities shall reasonably accommodate walkers, scooters, and other supplemental mobility devices. Slopes of pedestrian facilities shall not exceed 1:12 unless flat rest areas are included between steeper segments.

Intersections of pedestrian ways and motorized vehicle ways shall be at-grade or connected by ramps (ramp slopes not to exceed 1:12). Ramps and segments of pedestrian ways at intersections shall include detectable warning signals or surfaces in accordance with federal Americans with Disabilities Act (ADA) requirements (ITE).

3.6.1(b) Pedestrian Signals[3]
Conventional practice prioritizing vehicular traffic recommends using "actuated" pedestrian signals, which require the user to hit a button to activate the pedestrian interval. Because it relegates pedestrians to lower-tier roadways uses, this practice not aligned with Complete Streets best practices (ITE). A Complete Streets approach recommends "pedestrian recall" signals in areas of high pedestrian activity or walkable districts. Signals programmed for pedestrian recall do not require pedestrians to push a button to request crossing the street. Accessible pedestrian signals (APS) shall be installed ensuring compliance with ADA and MUTCD best practices. In all cases, signals shall be consistent at a district level to avoid pedestrian confusion.

3.6.1(c) Leading Intervals
Leading Pedestrian Intervals (LPI) and Leading Bicycle Intervals (LBI) give pedestrians and bicyclists a head start, making them more visible in the crosswalk or bicycle lane and alerting turning motorists to yield. LPIs have been shown to reduce pedestrian-vehicle crashes by as much as 60 percent when implemented at intersections. LPIs and LBIs do not add time to the

[3] United States Access Board Guidelines (2011)

overall signal cycle, but “borrow” time from the green time allocated to vehicles in a cycle. When LPI’s are used, they may also be paired with right turn on red restrictions. An LPI should be at least 3 seconds in duration and should be timed to allow pedestrians to cross at least one lane of traffic.

3.6.1(d) Scrambles (All-Pedestrian Phase)
Scrambles or all-way pedestrian phases can benefit pedestrians when the prevalent desire line is to cross diagonally (ITE). This happens where there is a large pedestrian generator at one corner, where two commercial streets meet, or at T-intersections. Standard crossings allow pedestrians to move simultaneously with cars in the same direction. This can create conflicts with turning vehicles. At a scramble, pedestrians are allowed to cross in all directions during a dedicated pedestrian-only phase. Scramble intersections typically include both signage, and special striping indicating this crossing pattern. Scrambles temporally separate vehicle and pedestrian movement. They can, however, increase instances of pedestrians crossing against signals as people will simply cross with traffic. Scrambles also add a signal phase to an intersection, which can increase the overall cycle time.

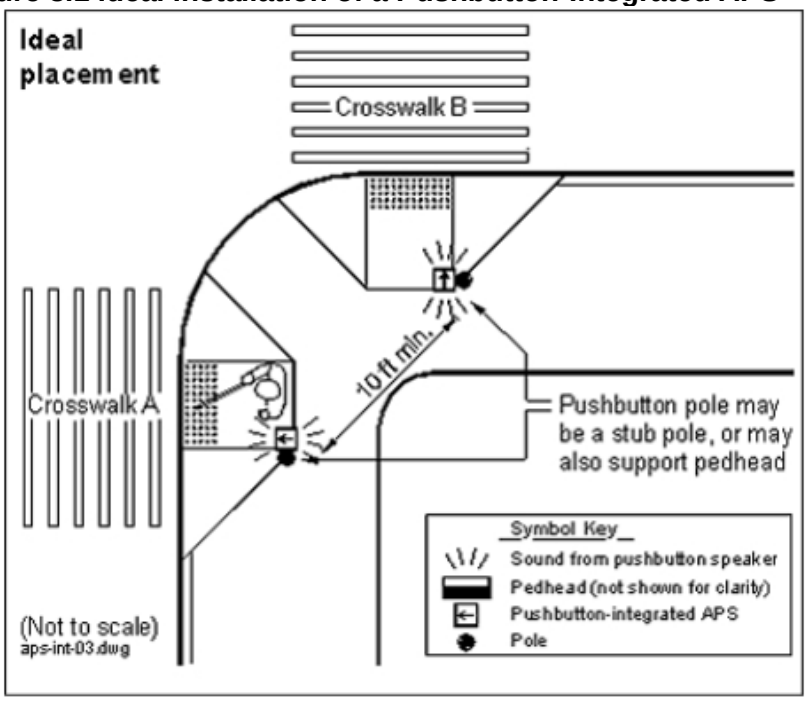
3.6.1(e) Accessible Pedestrian Signals (APS)
Accessible pedestrian signals (APS) and pushbuttons communicate “WALK” and “DON’T WALK” intervals to pedestrians using non-visual formats (i.e., audible tones and vibrotactile surfaces). APS complying with sections 4E.08 through 4E.13 and R403 (for operable parts) of the MUTCD (incorporated by reference, see R104.2) shall be installed at all signalized intersections with pedestrian amenities.

Location
The proper functioning of pushbutton-integrated APS is based on proximity to the crosswalk location. The closer the APS is located to the departure location, the quieter it can be. In addition, the vibrotactile indication and tactile arrow are not usable when located too far back from the street. Figure 3-X illustrates installation recommendations (within five (5) feet of the crosswalk extended, within ten (10) feet of the curb, and separated by more than ten (10) feet from other ASPs on the corner, adjacent to a level landing.

Audible Signal
APS feature an audible tone indicating direction of crossing and “walk” or “don’t walk” command. The tone volume shall respond to ambient and background noise remaining audible.

Push Button Integrated APS
If installed with call buttons, APS shall feature a locator tone to help users locate the call button, a tactile arrow on the call button indicating the direction of crossing, a vibrotactile signal (i.e., vibration of the call button) during the “walk” initial, and Braille or audible navigational information (i.e., street name) (Figure 3.1)

Figure 3.1 Ideal Installation of a Pushbutton-Integrated APS



*1 Detailed guidelines and resources available in "Accessible Pedestrian Signals: A Guide to Best Practices" at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w117a.pdf*3.6.1(f) *Detectable* Pedestrian Warning Surfaces[4]

Detectable warning surfaces (complying with R305 of the MUTCD) shall be provided at the following locations:

- Curb ramps and blended transitions at pedestrian street crossings
- Pedestrian refuge islands (excepting those cut-through at street level and less than 1.8 meters (6.0 feet) in length in the direction of pedestrian travel)
- Pedestrian at-grade rail crossings not located within a street or highway
- Boarding platforms at transit stops for buses and rail vehicles where the edges of the boarding platform are not protected by screens or guards, and
- Boarding and alighting areas at sidewalk or street-level transit stops for rail vehicles where the side of the boarding and alighting areas facing the rail vehicles is not protected by screens or guards.

ACCESSIBLE WAYFINDING
Detectable warning surfaces do not provide wayfinding for pedestrians who are blind or have low vision. Wayfinding is improved by:

- Clear sidewalks free of street furniture
- Visual contrast between walking and non-walking areas (e.g., planted borders)
- Clear, detectable route edges for canes
- Direct pedestrian street crossings and curb ramps in-line with the direction of travel
- Smaller corner radii permitting short and direct pedestrian street crossings
- Orthogonal intersections facilitating navigation using parallel and perpendicular vehicle sound cues

Detectable Warning Surfaces Design Checklist

1. Dome Size: The truncated domes shall have a base diameter of 23 mm (0.9 in) minimum and 36 mm (1.4 in) maximum, a top diameter of 50 percent of the

[4] Ibid.

base diameter minimum and 65 percent of the base diameter maximum, and a height of 5 mm (0.2 in).
2. Dome Spacing: The truncated domes shall have a center-to-center spacing of 41 mm (1.6 in) minimum and 61 mm (2.4 in) maximum, and a base-to-base spacing of 17 mm (0.65 in) minimum, measured between the most adjacent domes.
3. Contrast: Detectable warning surfaces shall contrast visually with adjacent gutter, street or highway, or pedestrian access route surface, either light-on-dark or dark-on-light.
4. Size: Detectable warning surfaces shall extend 610 mm (2.0 ft) minimum in the direction of pedestrian travel. At curb ramps and blended transitions, detectable warning surfaces shall extend the full width of the ramp run (excluding any flared sides), blended transition, or turning space. At pedestrian at-grade rail crossings not located within a street or highway, detectable warnings shall extend the full width of the crossing. At boarding platforms for buses and rail vehicles, detectable warning surfaces shall extend the full length of the public use areas of the platform. At boarding and alighting areas as sidewalk or street level transit stops for rail vehicles, detectable warning surfaces shall extend the full length of the transit stop.
5. Placement: Design for detectable warnings at various intersection and ramp types are described in greater detail: Access Board's Public Rights-of-Way Accessibility Guidelines.

3.6.1(g) Crosswalks

A pedestrian crossing is the path traveled across a right of way by a pedestrian. Whether it is marked or not, a crosswalk is an extension of the sidewalk across an intersection. Ideally, crosswalks provide the most convenient, direct, and comfortable route across a street in places where people want to cross.

Street crossings are often the most challenging element of pedestrian design. Typical challenges include:
1. Misalignment of block spacing and signal spacing (blocks are natural crossing points even if signals are not present). In many states, intersections are legal crosswalks (whether marked or not) but motorists are often not aware of this law.
2. Crossings are needed at desire lines connecting trip generators, such as at transit stops, shopping centers, and building entrances.
3. Pedestrians are unlikely to walk more than 300 feet out of their way to access a marked crosswalk.
4. Resistance to adding marked crosswalks due to cost, liability, and/or maintenance concerns.

Marking crossings helps to establish visually that pedestrians will be present. Crosswalks can take many forms including:

Unmarked*:* legal crosswalks without any traffic control markings.

Marked: legal crosswalks with traffic control markings.

MUTCD guidance for low-speed streets (35 mph and under) follow FHWA's "Safety Effects of Marked versus Unmarked Crosswalks" for the treatment of marked, uncontrolled crosswalks. (Add Table) summarizes what this guidance means for crossing treatments under different conditions.

Uncontrolled: legal crosswalks without stop signs, signals, or other traffic controls.

Controlled: legal crosswalks with traffic control devices.

Crosswalks can also be a combination of those described above. For example, a crosswalk can be both unmarked and uncontrolled.

Crosswalk treatments shall be determined by considering vehicle speed, volume, and roadway configurations. Key considerations when designing crosswalks include:
Location: where the crosswalk will be situated

- Narrower streets with low volume may not need any formal crosswalks; unmarked, uncontrolled crosswalks may feel safe for all users.
- Wider, high speed, and high-volume roads may require more involved treatments to minimize conflicts between pedestrians and vehicles. These treatments may include medians, overhead signs, improved lighting, and traffic control devices.

Treatment: the type of crosswalk protections that will be installed (marked, signalized, etc.)
Design: types of striping, materials, and other visual elements.

A single missing leg at a standard four-way intersection can be highly problematic for pedestrians, as it can require crossing three approaches tripling exposure to vehicle conflicts, and if the intersection is signalized, this can greatly increase crossing times and lead to non-compliance. Crosswalks shall be striped on all legs.

- Striping crosswalks on all legs of an intersection provides a path that is more clearly visible to motorists, enhancing safety and minimizing potential conflicts and delay at intersections.
- In some cases, high turning volumes may suggest removal of a crosswalk leg. This approach could be taken in exceptional situations and for intersections where the policy is clearly to prioritize vehicle throughput.
- Another option would be the use of signal phasing that protects the crosswalk with its own phase, typically concurrent with a parallel vehicular movement. If an otherwise legal crosswalk (created by an extension of a sidewalk) is closed, such closure must be communicated to pedestrians with visual disabilities.
- Design crosswalks with the straightest and most direct path. Direct crosswalks reduce crossing time for pedestrians. Align crosswalks with sidewalks and wheelchair ramps.

At pedestrian crossings without vehicle signals, pedestrian-activated flashing yellow lights increase pedestrian visibility (ITE). Flashing yellow beacons (varying in diameter from 8-12”) and flashing yellow light emitting diodes (LED) bordering warning signs, are MUTCD-approved best practices.

Crossings that require more than enhancements need traffic control, creating marked, controlled crosswalks. MUTCD provides warrants for location of pedestrian signals (which could be pedestrian-specific, such as flashing beacons, or full signals). These factors include the following:

1. Pedestrian volumes
2. Crash history
3. School location
4. Proximity to closest traffic control (no closer than 300 feet) This standard creates several issues for pedestrian mobility and safety:
    a. Warrants are too high. TCRP Report 112: Improving Pedestrian Safety at Unsignalized Intersections, conducted a workshop with practitioners. - “The engineers who expressed concern about the MUTCD pedestrian warrant unanimously agreed that the required pedestrian volumes were too high to adequately address many pedestrian crossing issues in their jurisdiction. To address their pedestrian issues, many engineers either installed crossing

treatments that are less restrictive than traffic signals, modified the existing MUTCD pedestrian warrant, or used a supplementary engineering analysis to justify a traffic signal installation."

b. 3 Jurisdictions rigidly adhere to the 300-foot rule. The 300-foot standard applies to controlled, marked crosswalk location, but some jurisdictions interpret this to apply to all crosswalks, whether controlled or uncontrolled.
c. 4 Many cities have blocks that measure less than 300 feet. As these communities seek to add direct and frequent crossings, the 300-foot standard inhibits them from installing controlled crossings at every block. The MUTCD standard also stipulates that controlled crosswalks should not be less than 300 feet from the nearest traffic control "unless the proposed traffic control signal will not restrict the progressive movement of traffic."1 There is flexibility for engineering judgment built into the standard, but this detail is often overlooked.
d. Crashes focus on vehicles. The warrant assessing crashes only looks at vehicle crashes, without including those involving pedestrians. TCRP Report 112 describes the following useful tools and suggestions for making crosswalk placement more in line with community needs:
e. Middle ground between controlled and uncontrolled crosswalks. Communities have created installation criteria for devices that are not signals, nor are they static signs. These include in-roadway warning lights and flashing beacons.
f. Modifications to warrants. Some communities interviewed reduced the warrants based on factors such as vulnerable users, transit ridership, or type of street (i.e., wider streets are harder to cross without control). Another community used warrants that are 80% of the values included in MUTCD.
g. Incorporate roadway characteristics. Vehicle speed, width of roadway, and volumes could all be incorporated into pedestrian signal warrants.

3.6.1(h) Pedestrian Refuge Islands

A pedestrian refuge is a section of median at a crossing location that is sufficiently large (six feet or wider) for pedestrians to wait. It can stand alone or be part of a longer median. When located at an intersection, the refuge extends beyond the crosswalk to enforce slower turning speeds. Channelized right turn lane design with marked bicycle facilities. The crosswalk is cut into the median at street level, with tactile warning strips (ITE).

Benefits of Pedestrian Refuge Islands

Pedestrian refuge islands:

1. Facilitate crossing movements by providing a space for pedestrians to wait who cannot make the crossing in one phase. It is more convenient for pedestrians to cross the street in one stage (with signals timed accordingly), but some pedestrians will begin their crossing toward the end of the flashing don't walk, phase, or have mobility limitations, and will be unable to complete the crossing.
2. Median tips (extension of the refuge beyond the crosswalk) reduce left turn speeds
3. Add a friction element to the street to reduce motorist speeds
4. Provide space for landscaping or other amenities When no left turns are possible, refuge islands can take the place of the TWLTL and measure 10'–12' wide (or the width of the TWLTL). Bracket the crosswalk with the island to provide visual and physical separation of traffic. Add bollards to enhance separation.

3.6.2 Multiuse (Shared-Use) Paths

A multiuse path (MUP) is a bike/pedestrian way physically separated from motorized vehicular traffic by an open space or barrier and within the street right-of-way, an independent right-of-way,

or an easement. Multi-use paths provide recreational opportunities and serve as extensions of the transportation system. Facilities must meet accepted design criteria and best practices (i.e., most recent edition of the American Association of State Highway and Transportation Officials Guide for the Development of Bicycle Facilities Manual) and conform with the Town's adopted plans.

3.6.2(a) Multiuse Paths: Pavement Design
A hard, all-weather pavement, concrete is preferred, shall be used. A geotechnical report shall be provided by a licensed engineer with a recommendation for a pavement design suitable for bicycles and maintenance vehicles.

3.6.2(b) Multiuse Paths: Width and Clearance
The minimum paved width for bi-directional bicycle paths is fourteen (14) feet. In some cases, it may be necessary to increase the width of the path based on projected facility demand or if the path's horizontal radius is less than 95 feet (see *Horizontal Alignment*). MUPs must provide a graded shoulder of at least three (3) feet wide on both sides of the pavement for horizontal clearance and a minimum vertical clearance of at least eight (8) feet (tunnels may require more clearance).

3.6.2(c) Horizontal Alignment
The typical cross slope is two (2) percent for tangent sections. The minimum design radius of curvature shall be derived from the following list:

20 mph……...95 feet radius
25 mph…….155 feet radius
30 mph…….250 feet radius
35 mph…….390 feet radius

3.6.2(d) Multiuse Paths: Grades
Grades shall not, under normal conditions, exceed five (5) percent. If this it is not possible to comply with this standard due to terrain or other considerations, grades greater than five (5) percent for short distances may be considered by the Town on a case-by-case basis.

3.6.2(e) Multiuse Paths: Design Speed
The design speed for a bicycle path is 20 mph. When the grade exceeds 4 percent, a design speed of 30 mph is advisable

3.6.3 Bicycle Facilities
There are vastly different levels of ability among bicyclists, and different confidence levels that in fact may vary for one rider on any given day. For that reason, TOCH strives to provide different types of facilities. All cyclists want a safe environment. Most do not want to impede motorists, but often the safest place to ride is where the cyclist is visible and not crowded into a gutter on the edge of traveled way. This is an important fact to consider in the design of facilities. The TOCH has experts in bikeway and street design on staff. We encourage the user of this Manual to reach out to clarify, confirm and brainstorm as desired.

3.6.3(a) Bicycle Lanes
A bicycle lane is a portion of a street which has been designated by signs and pavement markings for the exclusive use of bicyclists. Bicycle lanes are typically one-way facilities which carry bicycle traffic in the same direction as adjacent motor vehicle traffic.

Width and Clearance

Five (5) foot width (not including gutter pan) is standard. Four (4) foot width may be approved based on site constraints. However, greater width may be required with the presence of on-street parking, narrow lanes for motorized vehicles, unsuitable curb-and-gutter conditions, or high volumes of truck traffic. See Town of Chapel Hill Bike Plan for further discussion of bike lane requirements.

Pavement Design

The surface shall be smooth with a uniform riding surface. For maintenance reasons the bicycle lane should be constructed to the same standards as the adjacent traffic lane. Curb and gutter are not to be included as width for the bike lane.

3.6.3(b) Bicycle Parking

Long-term

Indoor secured bicycle parking spaces with a locker, individually locked enclosure, or supervised area within a building providing protection for bicycles from theft, vandalism, and weather.

Short-term

Open air, stationary racks to which bicycles can be secured with locks, cables, or chains. Racks must accommodate both u-locks and cable locks. Racks supporting a bicycle by a wheel only and not the frame, such as typical “disk racks,” are damaging to wheels and are not acceptable. Table 3.1 provides general guidelines.

Location and Design

1. Parking facilities shall support bicycles in a stable position without damage to wheels, frame, or components, so the bicycle, if bumped, will not fall, or roll down.
2. Parking facilities shall be securely anchored to the lot surface so they cannot easily be removed and shall be of sufficient strength to resist vandalism and theft.
3. Parking shall be near the building’s entrance.
4. Parking facilities shall be in highly visible well-lighted areas to minimize theft and vandalism.
5. Parking facilities shall not impede pedestrian or vehicular circulation and should be harmonious with their environment both in color and design. Parking facilities should be incorporated whenever possible into building design or street furniture.
6. Each bicycle parking space shall be at least six feet long by two feet wide. Racks must not be placed close enough to a wall or other obstruction making use difficult. There must be at least 24 inches beside each parked bicycle to allow access. Adjacent bicycles may share this access. An aisle or other space shall be provided for bicycles to enter and leave the facility. This aisle shall have a width of at least six feet to the front or rear of a bicycle parked in the facility.
7. Paving is preferred, not required. Well-draining gravel is the minimum surface treatment to avoid mud and dust.
8. Bicycle parking facilities within auto parking areas shall be separated by a physical barrier such as curbs, wheel stops, poles, or other similar features to protect bicycles from damage by cars.
9. Ideally, bicycle parking shall be covered to protect bicycles from damaging sun and foul weather.

Bicycle parking spaces shall be signed appropriately.

At Transit Facilities

Transit riders who cycle to/from stops are more at ease when they can securely lock their

bicycle, expanding the catchment area for potential transit station use. Transit ridership and adjacent land uses shall guide recommendations for bike parking at transit facilities. Table 3.1 provides guidelines for bicycle parking at transit facilities.

Required parking at transit facilities may be met by providing:

- Bicycle lockers
- Bicycle racks integrated with transit stop (with permission from the Town of Chapel/Chapel Hill Transit
- Bicycle racks in the public right-of-way with approval from the Town or State, where such racks do not conflict with pedestrian use.

Table 3.1 – Bicycle Parking Spaces Required by Use

USE		Minimum Bike Parking Requirements	Short Term	Long Term
Automobile, trailer		N/A	N/A	N/A
Bank		Min 4; 2 additional spaces per every 2,500 sq. ft. of floor area	80%	20%
Business, Convenience, Restaurant		Min 4; 2 additional spaces per every 1,000 sq. ft. of floor area	80%	20%
Other convenience business		Min 4; 2 additional spaces per every 2,500 sq. ft. of floor area	80%	20%
Business, general (retail)		Under 100,000 sq. ft. floor area: Min 4; 2 additional spaces per every 2,500 sq. ft. of floor area for 1st 10,000 sq. ft.; then 1 additional space per 5,000 sq. ft; Over 100,000 sq. ft. floor area: 1 space per 10,000 sq. ft. floor area	80%	20%
Business, office-type		Min 4; 2 additional spaces per every 2,500 sq. ft. of floor area	80%	20%
Clinic		Min 4; 2 additional spaces per every 2,500 sq. ft. of floor area	20%	80%
Dwelling, single-family		N/A	N/A	N/A
Dwelling/ Duplex or multi-family	Efficiency	1 per 4 dwelling units	10%	90%
	1 bedrooms		10%	90%
	2 bedrooms		10%	90%
	3 bedrooms		10%	90%
	4 or more bedrooms		10%	90%
Fraternity or sorority		Min 4; 1 per 3 residents	10%	90%
Group Care Facility		Min 4; 1 per 4 beds	10%	90%

USE	Minimum Bike Parking Requirements	Short Term	Long Term
Hospital	Min 8; 1 per 10 beds	20%	80%
Hotel or motel	Min 8; 1 per 15 lodging units	80%	20%
Maintenance vehicles	Min 4	20%	80%
Manufacturing, light	Min 4	20%	80%
Mobile home park	N/A	N/A	N/A
Movie Theatre	Min 8; 1 per 50 seats	80%	20%
Park & ride lots	5% of total number of parking spots	N/A	N/A
Personal services	Min 4; 2 additional spaces per every 2,500 sq. ft. of floor area	80%	20%
Place of assembly	Min 8; 1 per 40 seats	20%	80%
Place of worship	Min 8; 1 per 50 seats	80%	20%
Public cultural facility	Min 8; 2 additional spaces per every 5,000 sq. ft. of floor area	80%	20%
Public use facility	Min 8; 2 additional spaces per every 4,000 sq. ft. of floor area	80%	20%
Research activities	Min 4; 2 additional spaces per every 4,000 sq. ft. of floor area	20%	80%
Residential hall	Min 4; 1 per 2 residents	90%	10%
Residential support facility	Min 4; 2 additional spaces per every 5,000 sq. ft. of floor area	10%	90%
Rooming house	Min 4; 1 per 3 lodging units	10%	90%
School, elementary	Min 8; 1 per 10 students	90%	10%
School, secondary, high	Min 8; 1 per 10 students	90%	10%
Shelter	Min 4; 1 per 10 employees	10%	90%
Tourist home	Min 4; 1 per 3 lodging units	80%	20%
Transit Stops*	Bike parking for Tier 1 transit stops	N/A	N/A

*Encouraged unless required by ordinance

3.6.4 Transit Facilities

Transit facilities shall be required for new or re-development located within one-quarter mile of a transit route or transit stop, or within one-half mile of a planned or existing bus rapid transit (BRT) route or station. Transit facilities include, but are not limited to, transit lanes, transit shelters, transit accessways and paths, lighting, pull-offs (when required), and amenities including seating, waste receptables, bike parking, and more. Town staff will determine required transit facilities and where they shall be located, based upon transit routes, street classifications, types of development, passenger volumes, and any other pertinent considerations on a case-by-case basis. Upon the recommendation of staff, Town Council may choose to adopt an ordinance accepting payments-in-lieu of public transit system improvements for new development.[5]

Best Practices

1. *Convenient and Comfortable*: Transit facilities provide shelter—either through the installation of a bus shelter or through use of existing buildings or awnings.
2. *Safe*: Facilities are well lit and provide adequate space for waiting riders to sit or stand, away from other pedestrian flow and street traffic.
3. *Visible and Easily Identifiable*: Transit facilities are located so operators can clearly see waiting passengers and are identified by the CHT brand so they are a recognizable component of the transit infrastructure. Riders feel familiar with facilities, even if the exact amenities differ somewhat from stop to stop.
4. *Provide Information on Available Services*: Higher volume transit facilities provide schedule and route information
5. *Good Pedestrian and Bicycle Access*: Transit facilities provide safe, ADA-accessible pedestrian access to the surrounding area, including well-defined and contiguous pathways to and from transit stops and crosswalks.
6. *Integrated with Surroundings*: When new developments are constructed, transit facilities are designed as part of the overall project, rather than an afterthought. When roads and/or sidewalks are reconstructed, transit facilities are developed as part of the overall design. Transit facilities blend with their surroundings.
7. *Amenities for a More Comfortable Experience*: Transit facilities include benches, lighting, shelters, and trash receptacles making waiting for the bus more comfortable.

3.6.4(a) Federal Accessibility Mandates

New or upgraded transit facilities, including transit stops and transit accessways, must meet current requirements for accessibility governed by the Americans with Disabilities Act (ADA), as well as United States Access Board guidelines known as Public Rights-of-Way Accessibility Guidelines (PROWAG) best practices (see www.access-board.gov). These include:

1. A sidewalk boarding/ alighting area with a firm, even surface (no grass), at least 5’ wide (parallel to the roadway) and 8’ deep (perpendicular to the roadway)
2. Clear zones for rear bus doors (generally 10’ wide and 4’ deep)
3. Cross slope less than 2% (perpendicular to roadway)
4. Continuous clear width of 4’ for path of travel through or around the bus stop
5. Accessible path of travel to and from transit stop and around any other amenities or street furniture
6. Landing pads and clear zones should not be obstructed by any physical features such as utility poles, sign poles, trees, newspaper machines, etc.

[5] General Assembly of North Carolina. Session Law 2006-103, House Bill 2724 An Act Amending The Charter Of The Town Of Chapel Hill To Permit The Town Council To Accept Payments In Lieu Of Transportation Infrastructure Improvements For New Development

7. Sufficient roadway length for all bus doors to be flush with curb, generally meaning that bus stops must be at least 60-120' long for a 40-foot bus pulling out of the travel lane to access the stop
8. Mechanisms for the visually impaired to access information provided (raised lettering, text-to speech, etc.)

The above requirements often mean transit facility footprints must be enlarged from existing conditions, including sidewalk widening to reduce cross slope and to accommodate accessible boarding/ alighting areas.

3.6.4(b) Siting Transit Facilities

Stop Spacing

Stop spacing refers to the distance between transit stops along a route. Stop spacing affects overall travel time and, therefore, transit demand. Tradeoffs must be weighed between stops that are closer together (resulting in shorter walking distances but more frequent stops and longer transit trips) and stops that are farther apart (resulting in longer walking distances but less frequent stops, higher speeds, more reliable bus service, and a shorter bus trip). Recommended spacing is 1,000 feet +/- between stops for local service (Table 3.2).

Closer or further spacing of stops may be appropriate based on ridership, site suitability, and land use context. For example, important transfer points and/or activity centers may support closer stop spacing while stops may be further apart in locations with less development or activity.

Table 3.2 Recommended Transit Stop Spacing (Local Service)

Minimum Stop Spacing (feet)	800
Maximum Stops per Mile	4-6

Where possible, inbound and outbound transit stops shall be paired for more efficient, convenient, and intuitive round-trip service. If a new transit stop is required less than 800 feet from an existing transit stop, Transit staff may recommend a location for a new, consolidated stop based on guidance in this Manual, ridership trends, and surrounding land use context.

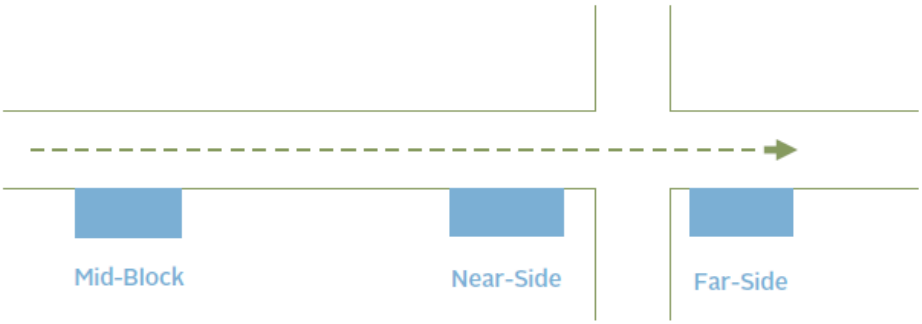
Accommodating Transfers

Transit stops for intersecting routes shall be located as close as possible, shortening distances for passengers traveling between routes at locations with heavy transfer activity.

Intersection Siting

It is important to consider the location of transit stops, relative to intersections. Siting involves weighing the needs and function of the transit system, operators, and riders when deciding between near-side, far-side, and mid-block stop siting (Figure 3.2). Generally, far-side stops are recommended where feasible, as they offer the most benefits with the fewest potential challenges. Transit staff will provide recommendations for the siting of all system stops.

Figure 3.2 Mid-block, Near Side and Far-Side Stop Siting



Mid-Block
Located between intersections; minimizes sight distance problems for vehicles and pedestrians; may experience less pedestrian congestion; requires both deceleration and acceleration lanes; requires more space for parking restrictions (Figure 3.3); may increase construction costs; increases walking distances for riders needing to cross street; only recommended under special circumstances (i.e., major destinations, high volumes, distances between intersections exceed stop spacing guidelines).

Near-Side
Located before intersection; passengers may load and unload while transit vehicle is stopped at red light or stop sign; may minimize interference where traffic is heavy on the far-side of an intersection; eliminates “double stopping” at stop-controlled locations; gaps in traffic flow accommodate transit vehicles re-entering traffic; may generate conflicts with right-turning vehicles; transit vehicles loading and unloading passengers may delay other roadway users, contributing to unsafe conditions when right-turning drivers pass, and then turn in front of, transit vehicles; transit vehicles serving near-side stops may restrict sight distances for crossing pedestrians and vehicles.

Far-Side
Located beyond intersection; allows transit vehicles to travel through intersection before loading and unloading passengers; gap generated by traffic signal accommodates transit vehicles re-entering travel lane at signal-controlled intersections; requires shorter deceleration distances; encourages pedestrians to safely cross behind transit vehicles; supports transit signal priority (TSP) treatments; takes the least amount of curb-side space; eliminates blockages in the curb-side lane on approaches to intersections providing additional right turn capacity; transit vehicles waiting to access stop may block intersections during peak travel periods or during heavy traffic; queued vehicles may restrict sight distances for crossing pedestrians and vehicles; “double stopping” stopping may delay transit operations and/or traffic flow.

Figure 3.3 Recommended Minimum Stop Length by Location

Stop Location/Type	Length	Notes
Far-Side	70'	Far-side stops located after a turn should have an additional 20' length
Near-Side	90'	
Mid-Block	110'	
In Dedicated Lane	40'	Shorter stop since bus does not need to weave in and out from travel lane
Adjacent to Protected Bicycle Lane	40'	"Floating" bus stop or bus stop "island"; bus usually stops in travel lane

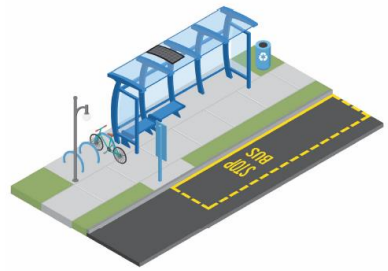
3.6.4(c) Required Transit Facilities & Amenities

Where transit facilities are required Transit staff shall assign an improvement tier between 1 and 4 (Figure 3.4).[6] Minimum transit facility improvement recommendations are based on current use (boardings) and potential demand (demographics, transfer opportunities, and land use), as described in Table 3.3; additional amenities may be voluntarily included at *any* stop based on the specific local context and community priorities.

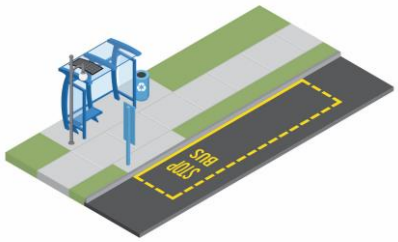
ALL transit stops, regardless of improvement tier, shall:

1. Meet ADA requirements
2. Be safely visible at night (either with ambient street or pedestrian scale lighting, or with lighting at the stop)
3. Have basic informational signage
4. Have well-maintained trash receptacles.

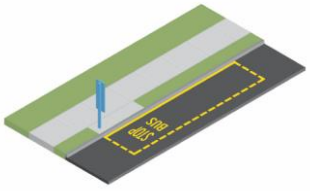
Figure 3.4 Transit Facility Improvement Tiers (from Chapel Hill Transit Bus Stop Guidelines)



Tier 1: Premium Stop



Tier 2: Major Stop



Tier 3 or 4 Moderate or Basic Stop

[6] New or re-development located within one-quarter mile of a transit route or transit stop or within one-half mile of a planned or existing bus rapid transit (BRT) route or station

Bus Stop Element	Tier 1 Premium Stop 6+ points	Tier 2 Major Stop 3-5 points	Tier 3 Moderate Stop 2 points	Tier 4 Basic Stop 0-1 points
ADA Compliant Landing Pads	✓	✓	✓	✓
Bus Stop Sign	✓	✓	✓	✓
Trash Receptacle	✓	✓	✓	✓
Lighting	✓	✓	✓	✓
Seating	✓	✓	✓	
Posted Schedules	✓	✓	✓	
Shelter	✓	✓		
Posted System Map	✓	✓		
Real-Time Arrival Display	✓			
Bicycle Rack	✓			

Note: Check marks indicate which elements are the minimum required elements for stops at each tier. Additional elements above and beyond the requirements for each tier can be included as desired and based on available resources.

TABLE 3.3 Transit improvement criteria and scoring guidelines

CRITERIA	DESCRIPTION	SCORING
Weekday Boardings	Boarding volume, or the number of daily passengers getting on the bus at a stop, determines the type and quality of appropriate amenities.	5 points: 50 or more daily boardings 4 points: 30-49 daily boardings 3 points: 20-29 daily boardings
Minority and Low-Income Population	Prioritizes facilities serving Census block groups with higher-than-average minority or low-income population.	1 point: Minority and/or low-income population is greater than the local average (based on Census block groups)
Transfers to Other Transit Services	Prioritizes facilities with local and/or regional transfers	1 point: stop is served by two or more routes and/or by other transit services (e.g., GoTriangle)
Local Activity Centers	Prioritizes facilities within or adjacent to higher intensity/ density development areas.	1 point: stop is located in/ near a designated local activity center
Proposed or Planned Development	Prioritizes facilities serving new or proposed major new developments	1 point: stop is located within ¼ mile of proposed or planned large-scale, mixed-use development
Transit Oriented Development	RESERVE FOR FUTURE USE	RESERVE FOR FUTURE USE

3.6.4(d) Transit Vehicle Pull-offs[7]

Pull-off Requirements

Pull-offs shall only be considered in locations where transit vehicles experience danger or delays when re-entering traffic. Pull-offs shall be required when street traffic speeds exceed 35 MPH **and** one or more of the following conditions exist:

- Average boardings per hour/transit vehicle exceed 20 during peak periods
- Average dwell time per transit vehicle exceeds 30 seconds during peak periods
- Multiple incidents/crashes involving transit vehicles and/or pedestrians
- Transit vehicle volumes exceed 10 during peak periods
- Reduced sight distances impact the safe stopping of transit vehicles and/or other roadway users
- Multiple boardings of riders using mobility devices at stop
- Stop must accommodate vehicle layovers
- Transit vehicles blocking side street or intersection traffic, or side street/ intersection traffic prevents transit vehicle's safe re-entry to travel lane
- Turnout length and depth already provide adequate entry and exit to/from traffic flow

Pull-off Guidelines

Where transit vehicle pull-offs are warranted (as determined by Transit staff), they shall be constructed to meet the following requirements:

1. Siting: At the far side of signalized intersections where traffic flow gaps allow safer re-entry to travel lanes.[8]
2. Width: 10' minimum; 12' preferred to reduce sideswipe accidents; where bike lanes are present and layovers must be accommodated, pull-offs should be wide enough to provide clear access for cyclists.
3. Layovers: Provide berths for multiple transit vehicles; 60' (for 40' vehicles) or 80' (for 60' vehicles) for the first position; add 80'/ 100' for each additional vehicle; add an additional 60' for pass-through buses, where required.
4. Entrance/ Exit: Deceleration/ acceleration lanes and entrance/ exit tapers required on streets where traffic speeds exceed 35 MPH.

3.6.4(e) Transit Vehicle Pads

Specifications

Transit vehicle pads are concrete (or similar materials) sections installed in the roadway at transit stops. They help reduce the asphalt distortion caused by the weight and heat of braking transit vehicles at high volume and/ or near-side stops in mixed traffic where trucks also contribute to wear.

Where required, transit vehicle pads shall be a minimum-m width of 8.5', accommodating both side wheels of the transit vehicle and shall be wider in locations where transit vehicles do not pull fully to the curb. At stops where the transit vehicle loads/unloads in a travel lane, the pad shall extend the full width of the lane. Pad length shall be determined based on the length of the stop's full bus zone (Figure 3.x4).

[7] Exceptions to these criteria may be made to eliminate safety concerns.

[8] Nearside pull-offs create conflicts with right-turning vehicles, delays when reentering travel lanes, and obstruction of pedestrian activity and traffic control devices. These should be avoided. Mid-block pull-offs should only be used if they provide safer pedestrian access to transit-oriented activity centers, subject to the general guidelines above.

3.6.4(f) Transit Pavement Markings

Guidelines

Pavement markings help reduce motorist confusion, allow for safer and more efficient use of the roadway, and facilitate accessibility. Pavement markings shall identify areas required for transit vehicles to safely enter and leave stops and load and unload passengers, preventing these areas from being blocked by moving or parked non-transit vehicles. Pavement markings shall delineate a striped, white box of sufficient size to accommodate all transit-related activities (entering, stopping, and exiting) at the stop. The words “BUS” or “BUS STOP” may also be painted on the pavement for clarity. Signage shall also be installed warning that vehicles blocking transit stops will be towed.

For transit stops in transit-only lanes, or where additional emphasis is needed to delineate stops, red or terra cotta colored pavement may be installed. Options for coloring pavement include paint, thermoplastic, methyl methacrylate, and embedded color where asphalt or concrete is mixed with a red pigment. Embedded color if preferred where possible, as it lasts longer than other methods of pavement coloring.

All pavement markings must be maintained periodically. This shall be performed when roadways are resurfaced, or other pavement markings are restriped.

3.6.4(g) Passenger Landing Pads

Paved landing pads contribute to a safe, comfortable waiting area and improve access for all transit users, especially riders requiring mobility devices.

ADA regulations require all new or upgraded transit stops to have a front landing pad meeting the following requirements:

- Firm, stable surface
- “Clear zone” of at least 10 feet long, measured parallel to the roadway, and five (5) feet wide, measured perpendicular to the curb
- Parallel to the roadway, the pad slope shall be the same as the roadway, to the maximum extent possible
- Perpendicular to the roadway, cross-slope must not exceed 1:48 (approx. 2%)
- Landing pads and clear zones shall not be obstructed by any physical features such as utility poles, sign poles, trees, newspaper machines, etc.

3.6.4(h) Transit Shelters

Transit stops are a critical component of transit service, serving as the “front door” of the system. On a round trip, a passenger typically uses different stops for boarding and alighting; poor design at any one of these stops generates significant barriers to ridership. People are more likely to use transit when stops provide a welcoming and comfortable environment. Shelters contribute to the transit customer’s experience. Well-designed stops with comfortable shelters enhance public perceptions of transit and raise awareness about the transit service, as shelters are also one of the most visible elements of the transit system (Figure 3.5).

Figure 3.5 Example of CHT Bus Stop with Concrete Passenger Landing Area and Shelter Pad (shelter is Tolar Crescent 9’ x 7’)

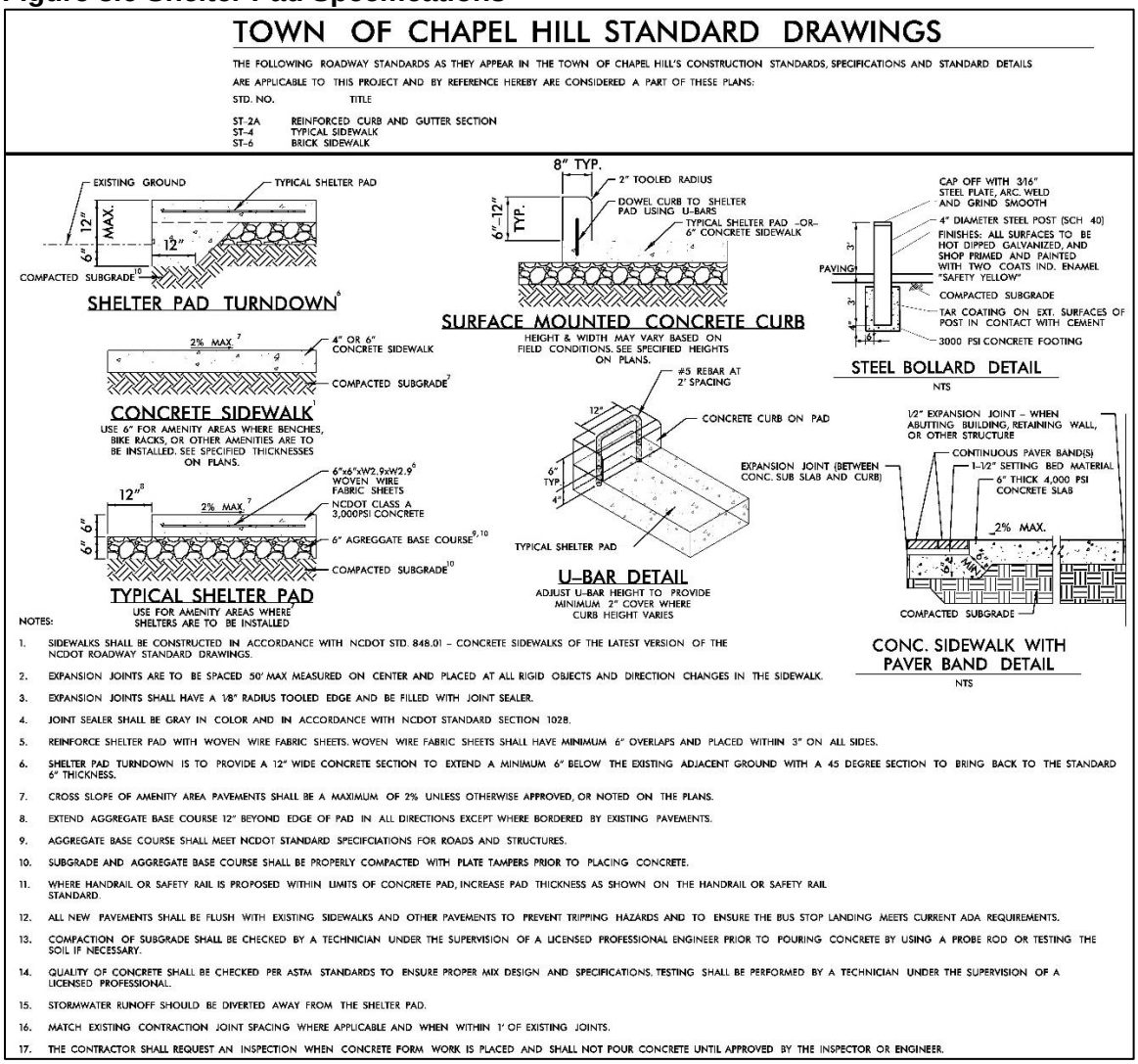
Shelter Pads

Concrete pads shall be installed to support shelters, where required (Figure 3.6). Pad sizes are based on the size of the proposed shelter (Table 3.4)

Table 3.4 Shelter and Shelter Pad Sizes

SHELTER SIZE	SHELTER PAD SIZE
Tolar Crescent 9’ x 7’	7.5’ x 12’
Tolar Crescent 13’ x 7’	7.5’ x 18’
Tolar Crescent 17’ x 7’	7.5’ x 22’

Figure 3.6 Shelter Pad Specifications



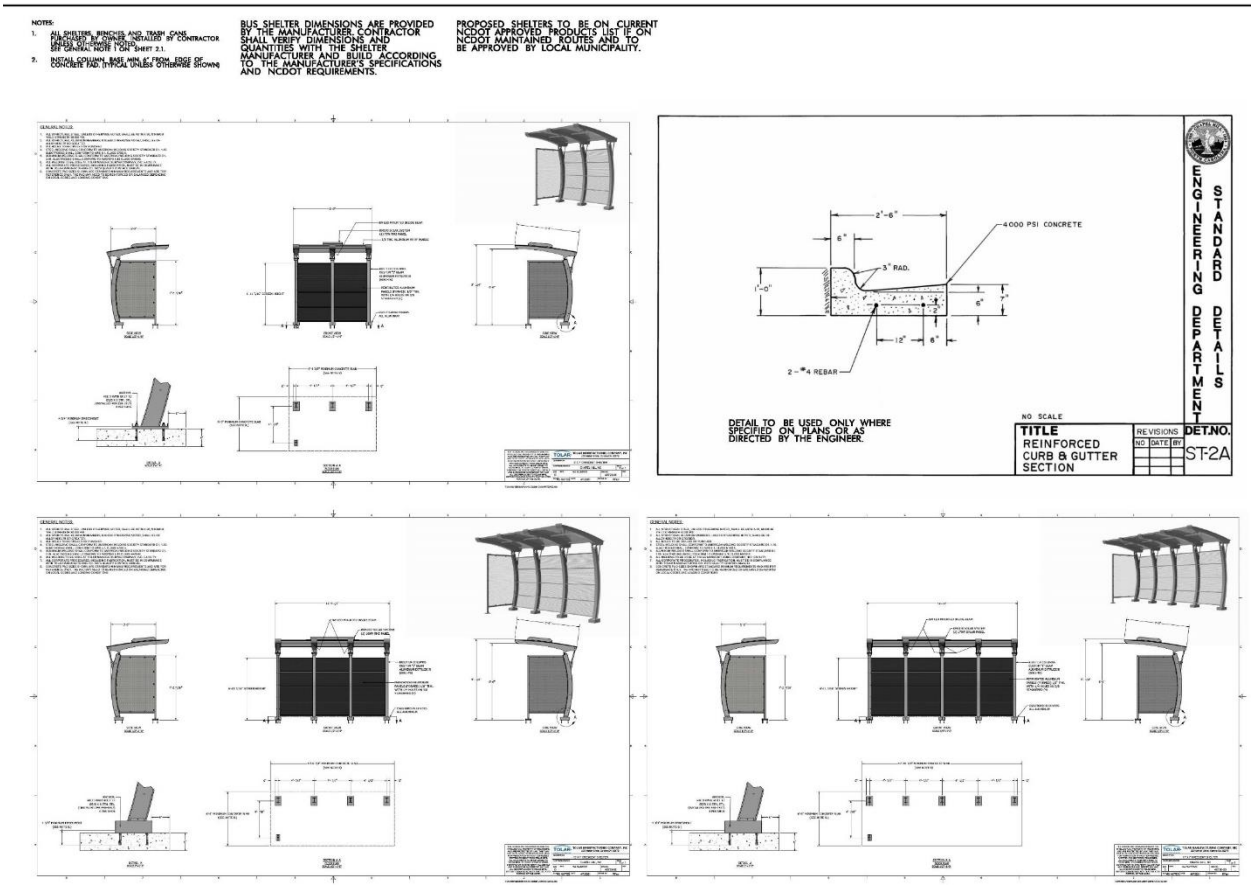
Shelter Structures

Where required, transit shelters shall have at least two walls, a roof, seating, and clear space for customers using mobility devices. Shelters shall be sited to provide a clear line of sight to approaching buses. In addition, seating within the shelter should not extend the full length, but a clear zone for wheelchairs of at least 30" x 48" must be maintained.

Shelter Sizes and Specifications

Chapel Hill Transit is currently installing Tolar Crescent shelter structures in one of three sizes (9' x 7', 13' x 7', or 17' x 7') at Tier 1 and Tier 2 transit stops. Shelter size is determined by daily boardings. Stops with 50 or more daily boardings shall install a 13' x 7' or 17' x 7' shelter (Figure 3.7)

Figure 3.7 Shelter Structure Specifications



Public Art on Shelters

Public art enhances transit stops and provides opportunities to involve the community in transit system design. Competitions and/or coordinating with local business groups and schools offer ways to involve the community. CHT has partnered with TOCH Community Arts and Culture to integrate public art into transit stops and on transit vehicles. Art can be incorporated into transit stops in many ways, including:

- Sculptural installations
- Thematic artwork that is integrated across the system
- Shelter murals or panels
- Planar installations on landing pads or shelter pads
- Functional elements (ex. artistic benches or shade fixtures)[9]

Lighting

Shelter and stop lighting enhance passenger comfort, security, and visibility. Without adequate illumination, transit accessways and stops may be dark, difficult to navigate, unsafe, or uncomfortable for waiting passengers, pedestrians, and transit operators at night or in inclement weather. Transit stops served after dark shall be illuminated at night by an overhead streetlight. In locations without overhead streetlights, mounted lights or lights within shelters shall be installed. Shadows and dark enclosures in and around transit stops shall be avoided to the extent

[9] Must meet federal ADA requirements

feasible. Where existing electrical connections are not present, or where they would be challenging or prohibitively expensive to install, freestanding solar-powered lighting fixtures are acceptable. In addition to freestanding light fixtures at or near stops, lighting can also be installed inside shelters, where feasible. Stop and shelter lighting shall be observed and maintained ensuring adequate lighting at all stops served after dark. CHT will conduct annual evening spot-audits of transit stops to ensure that lights are functional and well-maintained.

Real-time Information and Electronic Signage

Real-time information increases confidence in the transit system and helps customers feel more comfortable traveling by transit. Combined with electronic signage, it also increases awareness of available transit service and may contribute to increased ridership. Electronic signage also enhances security by displaying real time messages for emergencies, detours, or missing persons alerts and digital displays of route and arrival estimations are important for riders who do not own a smartphone. CHT provides real-time information for passengers including estimated arrival times for transit vehicles at system stops and digital signage with real-time information is installed at select transit stops.

Digital real-time arrival displays shall be installed at all Tier 1 and Tier 2 classified stops. Enhanced real-time information displays with full-color interface and information about other transit services and nearby mobility options (ex. TransitScreen multimodal information displays) shall be required for proposed developments required to submit transportation demand management (TDM) plans, if they are also required to construct a transit stop.

3.6.5 Bus Rapid Transit

Section reserved for future bus rapid transit requirements and facilities

3.6.6 Public Streets

Most motorists drive carefully and avoid pedestrians, bicyclists, and buses as best they can. Turning movements and trying to go first, before anyone else, at an intersection too often lead to crashes. Driving an appropriate speed for the conditions at the time and place is an oft-ignored requirement of the Rules of the Road. The TOCH strives to create an environment that builds in a safety cushion for people who make mistakes. One example is the townwide maximum speed limit of 35 mph (unless posted otherwise). The TOCH seeks to find the optimal balance among all modes; often this appears to be showing favor to one mode over others. The most often used balancing strategy is to add delay for motorists. This is nearly always a specific strategy to add safety for vulnerable road users. An example is the Protected Crosswalks with rapid flashing beacons that flash only when a pedestrian pushes a button on the side of the road, wanting to cross. Traffic in both directions is required to stop and allow the pedestrian to cross first. In general, motorists want to travel at a good speed with little delay and to arrive safely at their destination.

The standards in Table 3.5 are presumptive. They are intended to be valid in most cases, but it is understood public interest may be better served in certain unique situations by allowing some flexibility in the standards. New streets should be designed in a manner which balances functional and safety needs with the objective of preserving as much of the existing terrain and vegetation as is practicable and providing slow streets. The notion of limiting cut and fill within the limits of public safety has been important in developing these standards.

Street design standards represent specific interpretations of the policies embodied in the Town of Chapel Hill Land Use Management Ordinance and Design Guidelines as well as the Blue Hill

Ephesus/Fordham Form Based Code. Also note that all provisions of the North Carolina Fire Prevention Code, Appendix D must be met. Because the terrain of Chapel Hill varies from level to hilly, the standards have been written as broadly as possible.

3.6.6.(a) Street Classifications

All streets within the Town limits are classified primarily by functional and/or operational characteristics and by specific geometric criteria. Streets are classified by the Town based on technical judgment and observed function of the street. A list of existing street classifications is available from Town's Public Works Department or Department of Planning and Sustainability Department. Typical street sections are presented in the Blue Hill District section of this chapter. The list will be updated as new streets are approved by the Town. Currently, primary street classifications and their functions include:

Local

Primarily serve land-access functions; to accommodate multi-modal ingress and egress; multimodal safety and movement emphasized through traffic controls and street design.

Collector Streets

Penetrate neighborhoods, public service areas, and other districts; designed to provide both through-traffic and local-access services in relatively equal proportions, often linking the local street system to the arterial street system.

Arterial Streets

Primarily serve through-traffic; may accommodate limited access service; traffic controls and street design facilitates efficient through-traffic movement.

Design standards for functional street classifications are shown in Table 3.5.

Table 3.5 Design Standards for Streets

	Collector 11 Foot Lane			**Local 10 Foot Lane**		
	Level	Roll	Hilly	Level	Roll	Hilly
Terrain Type (% Grade)	<8	8-15	>15	<8	8-15	>15
Vertical Curve "K" Value[1] (Crest/Sag) Stop	40/ 45 14	28/ 35 9	20/ 20 7	28/ 35 9	20/ 20 7	15/ 20 5
Street Grade (%) (Max./Min.)	4/1	8/1	12/1	5/1	10/1	15/1
Min. Horizontal Street Center-line Radius (ft) *Super-elevated	300 *400	250 *350	200 *300	200 *250	150 *175	100 *100

Typical Shoulder Width for Streets Without Curb and Gutter or Sidewalk (ft.)	10	8	6	8	6	4
Minimum Street Corner Radius at Intersections	30	30	30	20	20	20
	For R/W See Typical Sections			For R/W See Typical Sections		

Notes:

- *Vertical Curve "K" Value - Used in computing the minimum length of vertical curve from the formula L=KA where: L = Length of Vertical Curve (100 ft.); K = Design Constant; A = Algebraic Difference of Connected Grades (%).*
- *Street and right-of-way widths will vary depending on specific combinations of utility requirements, sidewalks, traffic lanes, turn lanes, parking lanes, bike lanes, bus pull-offs, multimodal paths, etc. See typical street cross-section drawings for more details.*
- *All streets with centerline or one-way crowns should be designed with a 2% cross slope. This does not apply to super-elevation designs on curves.*
- *Intersecting streets should be designed to create 90° intersection angles. The minimum allowable angle of intersection is 75° under special conditions.*
- *Intersection sight distance criteria and other related information are shown in the standard details.*
- *Unless specified herein the National Association of City Transportation Officials (NACTO) guidelines and standards will apply to Town streets. A blend of AASHTO and NACTO design guidelines should be considered for State-owned roads.*

3.6.6.(b) Street Design Standards

Vertical Alignment

Streets shall be designed to provide gradual grade changes and to avoid a "roller coaster" effect. Where possible, streets shall be designed to avoid deep cuts and fills.

Horizontal Alignment

Streets shall be designed to provide long curves and to avoid sharp curves at the end(s) of straight sections or flat curves.

Minimum Street Elevations

Minimum elevations for crown of arterial street pavements shall be two (2) feet above the one hundred (100) year flood elevation as shown in the Flood Insurance Study Flood Boundary and Floodway Maps and Flood Insurance Report. Streets, bridges, and other similar transportation facilities are permitted in the Resource Conservation District only upon approval of a Special Use Permit or a Subdivision application by the Town Council or by a variance granted by the Board of Adjustment.

Guardrails and Barriers

Physical barriers (such as guardrails) shall be provided along roadway edges, if warranted due to potential roadway safety hazards such as structures, embankments, ditches, or bodies of water.[10] Guardrail shall be constructed within the right of way wherever the Town determines they are necessary.

3.6.6.(c) Pavement Structural Standards

All streets shall be paved with a minimum structure shown in Table 3.6 or Table 3.7 below or an equivalent design as approved by Town staff.

[10] Refer to NCDOT guidelines. Generally, guardrails shall be required if a fill slope is steeper than 3:1 with a fill height greater than eight feet, or as necessary adjacent to bridges and large culverts.

For all public streets, the developer will be required to submit a detailed soils report prepared by a soils engineer, licensed in North Carolina, to establish the suitability of the existing soils for roadway construction. This requirement may be waived if the Town Engineering Inspector's site investigation indicates normal compaction tests would sufficiently guarantee road base suitability.

Based on the results of soils investigations, previously observed conditions, and/or conditions encountered in the field; additional requirements for street construction may include increased pavement and/or base thickness, dewatering drain systems, excavation of unsuitable materials, installation of geotextile materials, and other enhancements as may be deemed necessary to assure streets will not experience premature failure.

The use of the curb and gutter section for street development has been determined to require the least amount of grading, clearing, right-of-way, and maintenance of all alternative roadway sections. Therefore, to preserve the natural environment and to minimize erosion and sedimentation, the Town will typically require the use of curb and gutter roadway section except as noted in the paragraph below.

In areas where poor subsoil drainage and periodic flooding is determined to be a problem by Town staff, or in established neighborhoods without curb and gutter streets, the developer may be required to use a roadside swale-type street construction. If curb and gutter is deleted, additional right-of-way may be required. The design of the swales shall prevent significant erosion which may occur from a ten (10) year storm rate of discharge. Shoulders on arterials shall be paved. On all other roads, shoulders shall be constructed of at least 50 percent gravel and at most 50 percent soil material.

In the event the soil report and/or site investigation indicates roadway construction requirements different from the standards described above, Town staff may require the alternative roadway construction design(s) be submitted for approval by the Public Works Department.

Table 3.6 – Pavement Design for Good to Excellent Subgrade Soils*

Functional Classification	Base Stone*	Intermediate Asphalt Course	Surface Asphalt Course
Local Street	ABC compacted to 8"	2 ½" I-19B	1" SF 9.5A
Collector/Arterial Street	ABC compacted to 10"	3" – I19	2" S 9.5B

Table 3.7 – Pavement Design for Poor to Fair Subgrade Soils*

Functional Classification	Base Stone*	Intermediate Asphalt Course	Surface Asphalt Course
Local Street	ABC compacted to 10"	2 ½" I-19B	1" SF 9.5A
Collector/Arterial Street	ABC compacted to 10"	3" I-19B	2" S 9.5B

* Soil types are as defined in the North Carolina Department of Transportation Subdivision Roads Manual

3.6.6.(d) Phased Completion of Streets

The developer shall synchronize the probable completion of houses or other building construction with the completion of utilities, fire hydrants, and streets serving those buildings. The intent is to prevent unreasonable inconvenience to the building occupants from dust, mud, or hazardous conditions and to avoid unsightly appearance along the access to these buildings.

Therefore, the developer shall complete at a minimum the base course paving of all streets within the development within one year of recording the final plat. If the developer anticipates his development will take more than one year to "build out" then he should record the final plat for only the phase expected to be completed within one year. The Town Manager may extend this deadline.

Any street failures which occur within the one-year warranty period after acceptance of the street by the Town shall be repaired by the developer.

3.6.6.(e) Dead End Streets

Maximum length shall be no greater than 750 feet or no more than thirty-five (35) dwelling units. Streets designed to be permanently dead end shall terminate in a paved circular turnaround (cul-de-sac) with a minimum radius of forty-eight (48) feet measured from the center of the turnaround to the face of the curb. Streets designed to be dead end temporarily (such as in a phased development or where a street is to be extended) can terminate in a paved circular turnaround or a paved "T" turnaround of adequate size to accommodate emergency vehicles which may use the street. Under special circumstances, a 120 foot "T" turnaround may be acceptable as a permanent improvement. Refer to the latest edition of the North Carolina Fire Prevention Code.

A separate, post mounted “Dead End” sign shall be placed at the closest intersection to the dead end. Also, temporary dead end streets expected to be extended in the future shall include a sign located at the temporary dead end stating, “This Roadway is Subject to Future Extension.”

3.6.7 Private Streets

By definition herein, a private street is a means of vehicular ingress or egress not publicly maintained and serves more than two single family lots, or as part of a privately maintained street system approved as part of a Special Use Permit or other Council approval. Sidewalks shall be required on both sides of the street. Where there are service roads, the sidewalk adjacent to the main road may be eliminated and replaced by a sidewalk adjacent to the service road on the side away from the main road.

3.6.8 Passageways and Alleys

[Section reserved for updates]

3.6.9 Substandard Access Ways

Where development impacts, abuts, or contains an existing street, bikeway, or pedestrian way providing required access which does not meet the standards described herein, improvements bringing the access way to applicable standards may be required if the development is expected to increase traffic volume and/or affect the capacity of the existing facility. This may involve off-site improvements of the access way. Partial width access ways shall be prohibited and abutting existing partial width access ways shall be completed to applicable standards.

Table 3.8 Street Standards

Main Street Classification	Sub-classification	Function	Design Speed	Lane Width	Number of Travel Lanes	Turn Lanes	Bike Lanes	Sidewalks	On-Street Parking	Intersection Spacing	Driveway Spacing	Planting Strip
Local	Local/ Subdivision Street	Local Residential	25 mph	11’ or 9’ with parking on one side	2 lanes		None	Minimum 5’ unobstructed	Allowed	100’	Varies subject to Engineering review	5’ (may request less)
Local (Public or Private)	Local/ Subdivision Street	Local Commercial	20 to 25 mph	11’	2 lanes		Shared (No striped bike lanes)	Minimum 10’ unobstructed	Minimum 8’ from face of curb	Varies subject to Engineering review	50’ subject to Engineering review	8’
Collector	Avenue	Collector	25 to 35 mph	11’	2-5 lanes		5’ with 3’ buffer at 35 mph and greater	Minimum 8’ unobstructed	Parallel, 8’ from face of curb	400’- 600’	50’ minimum between driveways	8’
Collector	Main Street	Collector	20 to 25 mph	11’	2 lanes	As warranted for multimodal safety (10’-11’ width)	5’	Minimum 10’ unobstructed	Parallel, 8’ from face of curb	Not to exceed 400’	50’ minimum between driveways	8’
Arterial	Parkway	Arterial	35 mph or more	11-12’ (11’ minimum)	4 lanes (6 lanes only by exception)	As warranted for multimodal safety (10-11')	Multiuse path; Alternative is 5’ with 3’ buffer	Minimum 6’ unobstructed or parallel, separated multiuse path	No	Minimum 1200’	600’ or subject to Engineering review	8’
Arterial	Boulevard	Arterial	25-45 mph	11-12’ (11’ minimum)	4 lanes (6 lanes only by exception)	As warranted for multimodal safety (10 – 11')	5’ with 3’ Buffer at 35 mph and greater	Minimum 6’ unobstructed; minimum 10’ with 0’ setback	Separate, parallel facility; 8’ from face of curb	1000’ or 800’ in business district	500’ minimum between driveways	8’

Note: Street Design must include safety measure for all modes of transportation.
Note: All measurements between driveways and intersections are from edge of pavement to edge of pavement.
Note: Transit Provisions will be determined by Chapel Hill Transit and as warranted by this manual.
Note: Planting Strip Width may vary if the street is in the Blue Hill District – Type A, Type B, or Type C Frontage.
Note: Street cross-section elements may vary if the street is in the Blue Hill District – Type A, Type B, or Type C Frontage. See Blue Hill section of Chapter 3.
Note: On-Street Parking is not allowed within 25 feet of any street intersection, including alleys.
Note: Sidewalks may be identified as sidepaths or multiuse paths identified in the Greenways/Mobility and Connectivity/or other Town Master Plans. These identified sidepaths must be constructed of concrete, see Town Detail PR-5.00.
Note: Driveway Access, Local Streets – No driveway connection permitted within 50 feet of a street intersection. Collector Streets – No driveway connection permitted within 100 feet of a street intersection. Residential driveway access is restricted if driveway access is available on a local street. Arterial Streets – No driveway connection permitted within 150 feet of a street intersection. Driveway connections are not allowed on an Arterial Street if access is available from a Collector or Local Street.
Note: All provision of the North Carolina Fire Prevention Code, Appendix D must be met

3.6.10 Intersections

Intersections of streets shall be designed to:

- Well-designed intersections consider the treatment of conflict points between vehicular, bicycle, and pedestrian movements.
- to coordinate the location and alignment of driveways.
- to discourage dangerous movements.
- to avoid multiple and compound merging and diverging maneuvers.
- to provide adequate and safe bicycle and pedestrian facilities.
- Daylight intersections by prohibiting on-street parking within 25 feet of the curb return. The speed limit should reflect conditions. Signs, trees, shrubs, etc. should not interfere with sight lines determined based on vehicular speed. The property owner shall dedicate sight line easements as necessary.

3.6.10(a) Stopping Sight Distance and Sight Line Triangles at Intersections
Sight line triangles at intersections should be designed to assure adequate visibility for vehicles and pedestrians using the intersection. Signs, trees, shrubs, etc. should not interfere with these sight lines. The developer shall dedicate sight line easements as necessary.

The need for sight triangles is clear in suburban contexts (where buildings are set back from the street) and along higher speed streets. In urban or transitioning contexts (buildings directly behind the sidewalk or planned to be) with speeds below 30 mph, sight triangles can be disruptive to the urban fabric because a building on a corner would need to be removed to obtain the desired sight triangle. Furthermore, in urban areas the demand for on-street parking may limit the ability to provide sight-triangles that meet AASHTO criteria. It is therefore important to understand when their use is called for, as summarized below:
Traffic Signal Control—No Sight Triangle Calculation Required
All-Way Stop Control—No Sight Triangle Calculation Required
Side-Street Stop Control (main movement not stop controlled)—Calculation Required

If the land use policy at an intersection calls for buildings to be built to the back of the sidewalk in the future (even if the current buildings are set further back), this may be considered in determining the speed design and sidewalk standards. In Figure 3.8 below, a motorist stopped on a side street looking for gaps in 30 mph main street traffic is likely to have difficulty seeing far enough along the main street due to the presence of a building. Two simple steps of reducing the vehicle speeds on the main street to 25 mph and adding a landscaped buffer between the sidewalk and the street will clear the building from the sight triangle creating a safer condition.

For suburban street design, the following table has been adopted from the American Association of State Highway and Transportation Officials (AASHTO) "A Policy on Geometric Design of Highways and Streets."

Where there are sight obstructions (such as walls, cut slopes, buildings, etc.) on the inside of curves, changes in roadway alignment shall be required to obtain adequate stopping sight distance if the sight obstructions cannot be removed.

Table 3.9 Design Intersections Sight Distance Table

Design Speed (mph)	Stopping Sight Distance (ft)	Intersection Sight Distance for Passenger Cars	
		Calculated (ft)	Design (ft)
15	80	165.4	170
20	115	220.5	225
25	155	275.6	280
30	200	330.8	335

35	250	385.9	390
Intersection sight distance shown is for a stopped passenger car to turn left onto a two-lane highway with no median and grades 3 percent or less. For further conditions, the time gap should be adjusted and the sight distance recalculated.			

3.6.10(b) Turn Lane Warrants

Right- and left-turn lanes are used to facilitate traffic flow and provide storage for vehicles queued to turn. They also create larger intersections and may add to overall signal cycle length if turning movements have dedicated phases. The Town desires to minimize the use of exclusive right-turn lanes and dual left-turn lanes.

Dedicated left turn lanes benefit motorists by removing left-turn vehicles from through traffic. Protected left turn signal phasing can facilitate turns when gaps in oncoming traffic are infrequent (ITE). Left turn lanes also widen intersection crossings. The addition of left turn signal phases can increase the overall delay at a signal for all users. Try to avoid double left turn lanes, which result in even larger intersections, and seek ways to channel traffic to other streets in the network

Additional pavement surfaces to accommodate turning movements shall be required and constructed at intersections to the standards specified below for projects not required to have a traffic impact analysis. The following table has been adopted from the American Association of State Highway and Transportation Officials (AASHTO) "A Policy on Geometric Design of Highways and Streets."

Table 3.10 - Left Turn Lane Warrants for Two-lane Roadways

Opposing Volume (veh./hr.)	*Advancing Volume (veh./hr.)*			
	5% Left Turns	*10% Left Turns*	*20% Left Turns*	*30% Left Turns*
40-mph Operating Speed				
800	330	240	180	160
600	410	305	225	200
400	510	380	275	245
200	640	470	350	305
100	720	515	390	340
50-mph Operating Speed				
800	280	210	165	135
600	350	260	195	170
400	430	320	240	210
200	550	400	300	270
100	615	445	335	295
60-mph Operating Speed				
800	230	170	125	115
600	290	210	160	140
400	365	270	200	175
200	450	330	250	215
100	505	370	275	240

Note: For operating speeds not shown, interpret between given values.

Source: City of Raleigh Design Manual

3.6.11 TRAFFIC CONTROL DEVICES

Where warranted and as necessary for motorist, bicyclist, and/or pedestrian safety; traffic signals, signs, and markings shall be provided in accordance with the standards set forth in the latest version of the Manual on Uniform Traffic Control Devices for Streets and Highways. Installation of all traffic control devices shall be approved by the Town and the North Carolina Department of Transportation where applicable. Signals may be synchronized to encourage motorists to adhere to the speed limit. This is critical during off-peak hours.

Traffic Calming Policy (2016) and Procedures

Traffic calming measures may be applicable in residential neighborhoods where speeding vehicles are the primary concerns, and periodic police enforcement is found not to have a lasting effect. Streets must typically be residential in nature for consideration under this policy. The policy is intended to promote traffic calming measures which are appropriately implemented, coordinated with the Town's key departments including Police, Fire, Engineering, and Transit, and are supported by the community. In addition to citizen requests, traffic calming projects can also be identified by Town staff, Town Advisory Boards, and/or the Town Council. There is no longer a citizen petition process requiring signatures. Town staff will make use a data-driven process and evidence-based best practice in making a recommendation to the Town Manager. The TOCH no longer installs speed tables because they violate the International Fire Code and they damage TOCH fire apparatus.

Neighborhood Slow Zones

[Section reserved for updates]

3.7 TRANSPORTATION IMPACT STUDIES

The Town of Chapel Hill considers the multimodal traffic impacts of proposed development during its review process (except for projects in the Blue Hill District, where a district-wide traffic impact assessment is in effect). A multimodal transportation impact analysis (TIA) study may be required to quantify impacts of the proposed development and to identify facility improvements needed to maintain a safe, accessible, and comfortable multimodal transportation system. The developer shall coordinate with the Town's Transportation Engineering Manager to engage a Town-selected consultant to perform all required transportation impact studies. A comprehensive transportation impact analysis (TIA) study may be required when:

1. A development proposal requests a change in zoning (including conditional zoning), or
2. Applying for a major subdivision, special use permit, or site plan review.

The requirement to prepare a comprehensive Transportation Impact Study may be waived by the Town if both the following conditions are met:

- Daily vehicle trip generation is less than 500; and
- The applicant submits a written request for a Transportation Impact Study waiver.

If the elapsed time or circumstances of the original study fall within the parameters presented in Table 3.9, the applicant shall prepare an updated or amended study documenting specific changes, and the Town Manager may waive a required comprehensive Transportation Impact Study. The Town Manager may also exercise their discretion to waive a long-term Transportation Impact Study based on the site and type of the development. For additional information refer to: Guidelines for Traffic Impact Analysis, Town of Chapel Hill, North Carolina Effective Date: October 1, 2001

TABLE 3.11

	Changes to the Original Proposed Development	
Original Report Is	Access Changed* or Trip Generation Increased by > 15%	Access Not Changed and Trip Generation Increased by < 15%
Less than 2 Years Old	Letter Amendment Required: Identify and discuss only items which changed.	Letter Documenting Change (No other reports required)
Greater than 2 Years Old or Study Prepared Prior to TIA Guidelines Approval	New Study	Letter Amendment Required: 1. New local ground counts. 2. New Trip Generation 1. New LOS Analysis 2. Meet all current requirements of this TIA Guideline

**Changed access includes proposed new access or refinement of general access locations not specifically addressed in original proposed development.*

3.8 STREET NAMES AND ADDRESSES

Names of streets shall reflect the continuity of streets (i.e., a proposed street in obvious alignment with an existing street or planned as a continuation of an existing street be given the same name as the existing street) and shall be neither wholly nor partially duplicative nor phonetically similar to the name of an existing street within the Town of Chapel Hill. For approval of new street names and addresses contact the TOCH Geographic Information Systems (GIS) Department at least two (2) weeks prior to the submittal of a final plat for recordation.

3.9 STREET AND CROSSWALK LIGHTING

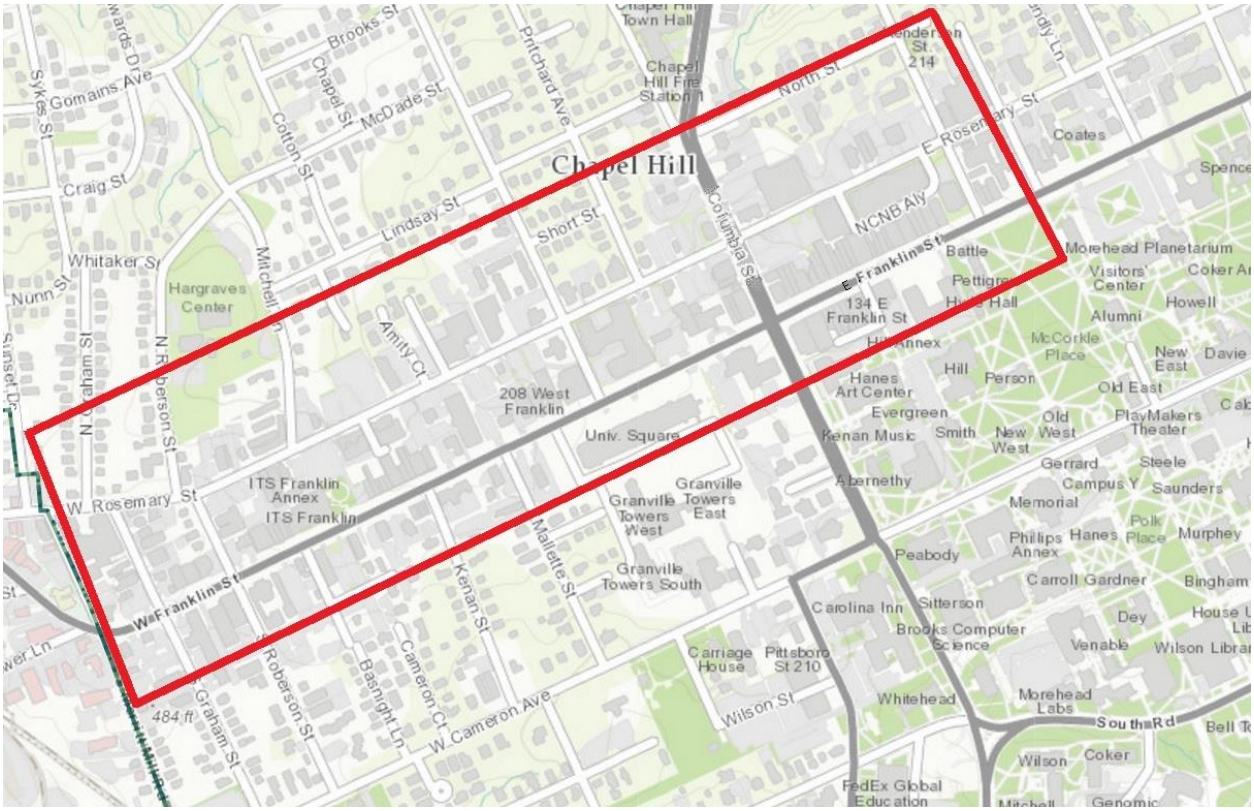
3.9.1 Streetlights and Street Lighting Applicability

A developer may be required to install or upgrade streetlights within a public right-of-way as part of the Town's design approval process. Street lighting improvements may be required when:

1. New public streets are proposed, or existing public streets are improved.
2. Significant development is proposed adjacent to a public street within the Downtown Streetscape Study Area (Figure 3.8) where a Street Lighting Master Plan has been adopted calling for the incremental replacement of existing light poles and fixtures. Refer to the Streetscapes section (Chapter 6) for lighting requirements in this area
3. When a proposed development is adjacent to inadequately lighted public streets, incremental street lighting improvements may be required.
4. Crosswalk or multiuse path safety needs enhancement.

Questions about specific sites should be directed to the Town's Transportation Engineering Manager.

Figure 3.8 Downtown Streetscape Study Area



3.9.2 Street Lighting Plan Submittal Requirements

Developers shall consult with the utility provider when proposing street lighting plans. Street lighting plans shall include the following information:

- The proposed location of streetlights, underground utility lines, and/or service conduits.[11]
- Street edge of pavement and/or curb and gutter, sidewalks, and all property lines.
- Any proposed improvements within the public right-of-way, such as benches or bus stops shall be shown.
- Description(s) and/or detail(s) of proposed light poles and fixtures. *Note*: Utility providers often require payment of a supplemental fee prior to installation of light poles and fixtures. If light poles and fixtures are within the public right-of-way, utility providers require paying the supplemental fee through the Town, as a one-time, up-front cost. Accordingly, the following note shall be included on all street lighting plans: "*The developer will be responsible for reimbursing the Town for any and all supplemental fees assessed by the utility provider prior to installation of the proposed light fixtures*." Developers should contact the utility provider directly for additional information about supplemental fees for streetlight poles and fixtures.

3.9.3 Street Lighting Guidelines

The type and placement of streetlight poles and fixtures depends on site and development context. In all areas of Town outside of the Downtown Streetscape Study Area, street lighting design and requirements are based on street classification and adjacent land uses (Figure 3.10). The Downtown Streetscape Study Area requires custom poles and fixtures providing both

[11] *If project is within the Downtown Streetscape Study Area, the Town's standard downtown conduit detail shall be used.*

pedestrian level lighting and street lighting (see Chapter 6 for specific requirements).

Because these factors vary from site to site, developers shall contact the Public Works Department when proposing street lighting in non-residential areas. In residential neighborhoods the standards for pole and fixture selection and street light placement, as described below, are consistent throughout the Town.

Street lighting on State roads shall be designed and installed in accordance with the NCDOT standards.

When installing underground electrical and telephone service, the developer shall also install, at their own expense, underground terminal facilities for street lighting along public streets according to the standards required by the Illuminating Engineering Society publication "Road Lighting." The average maintained foot-candle (fc) level for outlying and rural roads as defined in said publication shall be no less than three-tenths (0.3) and the uniformity ratio shall be no greater than sixty-four (64). The Town will not take responsibility for any street lighting system that does not meet the above standards.

Developers shall install streetlights on all:

1. Local access system roadways (residential and commercial), which will be built or improved as part of their development project (0.4 fc and 6:1 uniformity).
2. Collector system roadways (residential and commercial), which will be built or improved as part of their development project. (0.6 fc and 4:1 uniformity).
3. Minor thoroughfare system roadways, which will be built or improved as part of their development project. (0.9 fc and 4:1 uniformity). *Note*: If the roadway is built to State standards, street lighting is subject to State lighting requirements.
4. Major system roadways, which will be built or improved as part of their development project (1.2 fc and 4:1 uniformity). *Note*: If the roadway is built to State standards, street lighting is subject to State lighting requirements.
5. Secondary system roadways, which will be built or improved as part of their development project. Note: If the roadway is built to State standards, street lighting is subject to State lighting requirements.

Table 3.12 Street Classification Maintained Foot-Candle Street

Street Classifications	Maintained Foot-Candle (average)	Uniformity
Sensitive Area Streets		
• Sensitive Area Parkway	0.9	6:1
• Sensitive Area Avenue	0.6	6:1
• Sensitive Area Residential Street	0.4	6:1
Local Street		
• Neighborhood Yield	0.4	6:1
• Neighborhood Local	0.4	6:1
• Neighborhood Street (Collector)	0.6	4:1
• Multifamily Street	0.6	4:1
Mixed Use Streets		
Avenue 2-Lane Undivided	0.9	4:1
Avenue 4-Lane Divided	1.2	4:1
Avenue 6-Lane Divided	1.2	4:1
Multi-Way Boulevard, Parallel Parking	1.2	4:1
Multi-Way Boulevard, Angular Parking	1.2	4:1
Industrial and Service Streets		

(1) Industrial Street	0.6	4:1
(2) Alley, Residential	0.4	6:1
(3) Alley, Mixed Use	0.4	6:1
Accessways		
1. Primary Internal Access Drive	0.4	6:1
2. Pedestrian Passage	0.4	6:1

3.9.4 Streetlight Pole and Fixture Standards for Residential Streets

The Town's standard residential lighting fixture is a 50-, 70-, or 110-watt Light Emitting Diode (LED) mounted on a 15' black fiberglass pole. This pole and fixture combination is available from Duke Energy and requires a supplemental fee reimbursement be provided to the Town prior to installation (see Street Lighting Plan Submittal Requirements). Comparable pole and fixture combinations are available from other utility providers in areas of Town not served by Duke Energy.

LED fixtures mounted on wooden poles at a height of 25' may be acceptable in place of the Town standard fixture. This pole and fixture combination generally does not require a supplemental fee reimbursement. Other fixture and pole combinations, including taller fiberglass poles and/or ornamental fixtures, may be acceptable if the developer is responsible for reimbursement of all associated supplemental fees. Developers shall contact the Public Works Department to propose an alternative to the Town standard pole and fixture combination.

For streets with existing high-pressure sodium light fixtures, the Town's standard residential lighting fixture is a 9,500-lumen high pressure sodium "economical traditional" luminaire mounted on a 12' black fiberglass pole. This pole and fixture combination is available from Duke Energy and requires a supplemental fee reimbursement be provided to the Town prior to installation (see Street Lighting Plan Submittal Requirements). Comparable pole and fixture combinations are available from other utility providers in areas of Town not served by Duke Energy.

Alternatively, 9,500-lumen high-pressure sodium cut-off lens cobra head fixtures mounted on wooden poles at a height of 25' may be acceptable in place of the Town standard fixture. This pole and fixture combination generally does not require a supplemental fee reimbursement. Other fixture and pole combinations, including taller fiberglass poles and/or ornamental fixtures, may be acceptable if the developer is responsible for reimbursement of all associated supplemental fees. Developers shall contact the Public Works Department to propose an alternative to the Town standard pole and fixture combination.

3.9.5 Streetlight Placement Standards for Residential Streets

The following standards shall be used to determine the placement of streetlights on residential streets:

- Streetlights shall be located approximately 220 feet apart. Town staff may approve different pole separation if the foot-candle and uniformity requirements are met through an alternate design, or if separation from street trees is a consideration.
- Streetlights shall be located at all public street intersections and at the end of all cul-de-sacs and T-turnarounds.
- Where possible, all streetlights not located at an intersection shall be located on, or adjacent to, a property corner.
- Streetlights shall be located within the public right-of-way, at least three feet behind the curb or edge of pavement.
- Where sidewalks are only on one side of the street, streetlights shall be located on the same side of the street as the sidewalk. On all other streets, streetlights shall be staggered on both

sides of the street.
- On streets where streetlights are proposed adjacent to sidewalks they shall be located behind the sidewalk unless a tree lawn is provided which permits all parts of the poles to be located a minimum of three feet behind the curb.
- Light shall be cast on the sidewalk as well as the roadway.

3.10 STREET SIGNS

3.10.1 Street Signs and Markings Standards

Where warranted to ensure motorist, bicyclist, or pedestrian safety and/or to control vehicular, bicycle, and pedestrian traffic, traffic signs and markings shall be provided in accordance with the standards set forth in the most current edition of the Manual on Uniform Traffic Control Devices for Streets and Highways. All proposed street signs and markings plans shall reflect the standards for sign and marking design and placement as set forth in this manual and shall be approved by the Town Manager and, where applicable, NCDOT during the Town's design review process.

Developers may contact the Town's Public Works Department for additional information about specific design and size requirements for required street signs. Signs not meeting design and size requirements must be replaced with approved signs prior to the acceptance of any new or improved public street for Town maintenance.

3.10.2 Street Signs and Markings Applicability

A developer may be required to install or upgrade street signs and markings within a public right-of-way as part of the design review process if the proposed project includes the improvement to, or construction of, new public streets. See Town of Chapel Hill standard details.

3.10.3 Street Name Signs

Street name signs shall be provided at all street intersections as part of street construction. The location and design of street name signs shall be approved by the Town Manager in accordance with the standards set forth in the MUTCD for Street and Highways. For better visibility for pedestrians and drivers, "non-standard" large street name signs like the sign shown below shall be installed on span wires at all current and future signalized intersections.

3.10.3(a) Street Signs and Markings Plan Submittal Requirements

A Street Signs and Markings Plan shall show the type and location of all proposed street signs (stop signs, speed limit signs, etc.) and the location of all proposed street markings (centerlines, stop bars, crosswalks etc.). Plan shall include the following Town standard notes, where applicable:

- The developer shall be responsible for installing all required street signs and markings and for any necessary repairs to these signs and markings prior to the final acceptance of a new or improved public street for Town maintenance.
- Prior to the installation of any street signs or markings, the developer shall contact the Town's Public Works Department for an on-site approval of the final design and placement.
- A thermoplastic material with a minimum thickness of 125 mils shall be used for all pavement markings within the public right-of-way.

3.10.4 Pedestrian and Bicycle Wayfinding Sign Standards

Section reserved

3.11 PARKING AND LOADING

3.11.1 Off-Street Parking

Off-street parking facilities shall provide safe and convenient ingress and egress and minimize conflict points. Access points shall provide the optimum driver sight distance and least disruption to all modes of transportation on the public street system.

The number of street and driveway connections permitted to serve a single property or commercial development will be the minimum deemed necessary by the North Carolina Department of Transportation for reasonable service to the property without undue impairment of safety, mobility, and utility of the roadway. However, only one combined entrance and exit connection will be permitted where the frontage is less than 100 feet. (Policy on Street and Driveway Access to North Carolina Highways July 2003).

3.11.1(a) Off-Street Parking Minimum Design Standards

Minimum standard dimensions for parking spaces and drive aisles are shown in the lot layout schedule (Table 3.11). Parking spaces shall be identified with pavement markings and/or wheel stops.

No more than ten (10) parking spaces shall be arranged side-by-side without a landscaped parking lot island. The minimum width of landscaped parking lot islands shall be no less than ten (10) feet of pervious soil.

When angled off-street parking abuts a sidewalk, the developer shall provide additional clearance between the sidewalk and the parking space, ensuring vehicle overhangs do not decrease the useable area of the sidewalk or impede access.

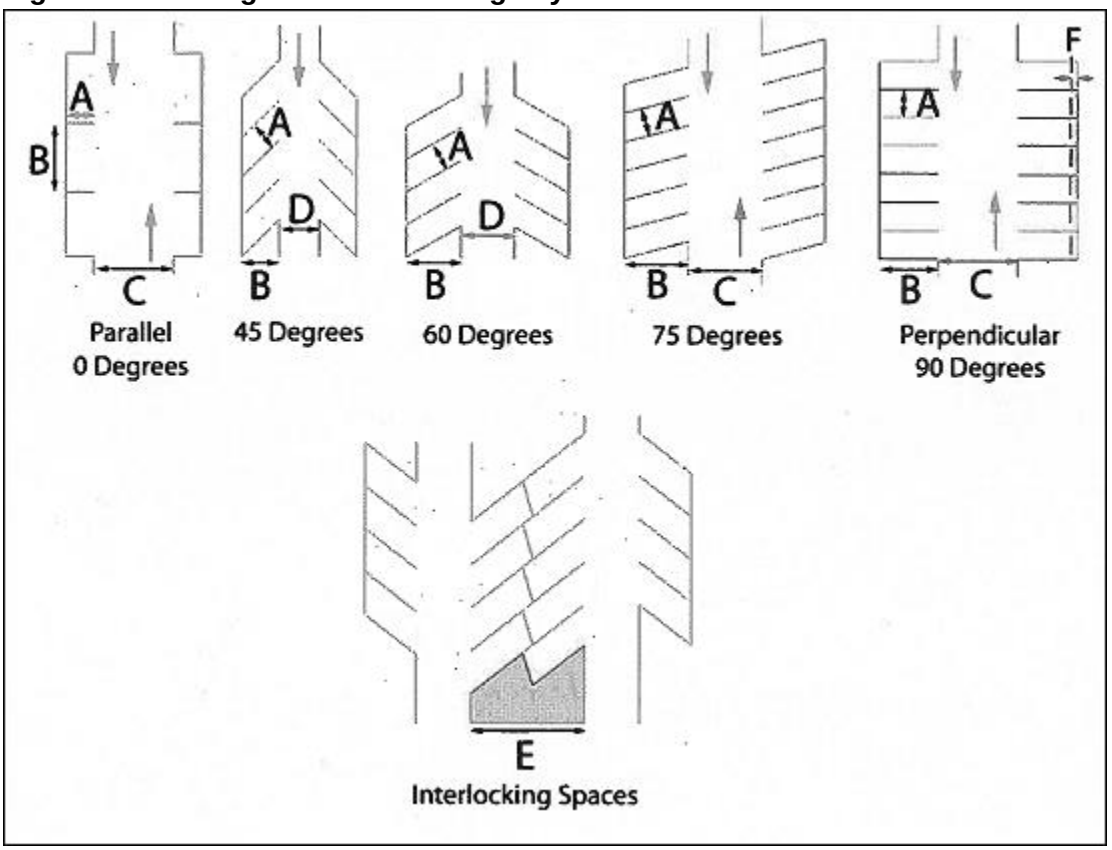
3.11.1(b) Off-Street Parking: Interlocking Standard Parking Spaces

Interlocking standard parking spaces shall comply with the minimum dimensions and layout requirements specified in Table 3.11, as generally illustrated in Figure 3.9.

Table 3.13 - Common Parking Stall Dimensions

Measurement					
	A	**B**	**C**	**D**	**E**
Parking Angle (Degrees)	**Space Width**	**Space Depth**	**Aisle Width (2-Way)**	**Aisle Width (1-Way)**	**Depth of Interlocking Spaces**
Parallel 0º	8′	22′	18′	12′	n/a
45º	8.5′	17′	18′	12′	28.25′
60º	8.5′	18′	18′	16′	32′
75º	8.5′	18.5′	22′	20′	35′
Perpendicular 90º	8.5′	18′	24′	24′	36′
Note: A one and one-half foot overhang dimension (measurement F in Figure 17.28.060.A) for parking lots using perpendicular (ninety (90) degree angle) parking spaces may be exempt from the paved area if a raised curb or bumper guards are provided, allowing a reduction of the space depth to sixteen and one-half (16 1/2) feet.					
Dimensions have been rounded to nearest inch. Design vehicle = 6'7" x 17'0".					

Figure 3.9 Parking and Maneuvering Layout



Source: Urban Land Institute and National Parking Association

3.11.1(c) Compact Parking Spaces

Compact parking spaces shall comply with the minimum dimension requirements specified in Table 3.12 and as generally illustrated in Figure 3.12. Parking areas with more than ten (10) spaces, may designate up to twenty (20) percent of spaces (exceeding the first ten (10) spaces) for compact vehicles. Compact vehicle parking spaces shall be labeled as such.

Table 3.14 Minimum Dimensions for Compact Parking Spaces

Parking Angle (Degrees)	Space Width	Space Depth
Parallel 0º	7.5′	18′
45º	7.5′	15.5′
60º	7.5′	16.25′
75º	7.5′	16.5′
Perpendicular 90º	7.5′	15.5′

3.11.2 Accessible Parking Spaces

Accessible parking spaces and access aisles shall be on hard or paved surfaces and shall be indicated by pavement markings, signage, or other appropriate means. The spaces shall be identified with above ground signs as specified in the General Statutes 20-37.6 and 136-30 and the Manual on Uniform Traffic Control Devices (MUTCD).

Standard accessible parking spaces shall have a 96-inch minimum width and an access aisle at least 60-inches wide, adjacent to the space. Van accessible parking spaces shall be at least 96-inches wide with an access aisle at least 96-inches wide. Required accessible spaces are based

on the total number of spaces in the lot (Table 3.13).

Table 3.15 Accessible Parking Space Requirements

TOTAL NUMBER OF SPACES IN LOT	MINIMUM NUMBER OF ACCESSIBLE SPACES
1 to 25	1
26 to 50	2
51 to 75	3
76 to 100	4
101 to 150	5
151 to 200	6
201 to 300	7
301 to 400	8
401 to 500	9
501 to 1,000	Two (2) percent of total spaces
1,001 and over	20 plus one (1) for every 100 spaces (or fraction thereof over 1,000)
For every six (6) or fraction of six (6) accessible parking spaces, at least one shall be a van accessible parking space. Source: 2012 North Carolina Building Code	

3.11.3 Parking Pavement Standards

Paving materials for off-street parking areas shall provide an all-weather, dust-free surface. The pavement design shall be based on traffic patterns, frequency of use, soil conditions, and stormwater drainage. Curbing may be required for stormwater control or to prevent vehicle overhang into landscaped areas or walkways. Wheel stops shall be required when other means of identifying parking spaces are not practical.

Impervious pavement is encouraged in parking areas. Refer to Chapter 4 – Stormwater Management of this Manual for additional information.

The standard pavement design for parking lot drive aisles is eight (8) inches of stone base with a two (2) inch asphalt surface course.

Heavy-duty pavement design may be required for emergency and service vehicle access lanes. The minimum standard for heavy-duty sections is ten (10) inches of stone base and three (3) inches of asphalt surface course, accommodating at least an 80,000-pound vehicle.

Alternative designs and minimum standard may be required if determined necessary by geotechnical analysis or projected traffic patterns.

3.11.4 Parking Decks

The use of structured parking facilities is encouraged to minimize the amount of land necessary to accommodate cars. The geometric requirements for parking decks are the same as surface parking requirements. A developer may provide alternative designs if they align with accepted

best practices.[12] Alternative designs are subject to the review and approval of Town staff. Modifications to parking standards may be accepted if reductions to aisle widths compensate for increases in stall widths.

3.11.5 Electric Vehicle Parking

The Town of Chapel Hill supports a transition to electric vehicles (EV). A successful transition requires convenient and cost-effective electric vehicle infrastructure including parking spaces proximate to charging stations. The following standards shall apply to EV charging stations:

3.11.5(a) Installation and Equipment

Station installation and equipment shall be consistent with the most current rules and regulations adopted by the North Carolina State Building Code.

Charging Station Equipment: Charging station outlets and connector devices shall be at least 36-inches and no more than 48-inches above the surface where mounted. Retraction devices and/or hangers keeping permanent cords and connectors off the ground and/or paved surfaces shall be required.

Charging Station Equipment Protection: Adequate equipment protection, such as wheel stops or concrete-filled steel bollards shall be used if EV parking spaces are perpendicular or at an angle to curb face and charging equipment.

3.11.5(b) Location, Design, and Maintenance

Where provided or required, parking for electric vehicle charging purposes shall meet the standards described here. “Charging” shall mean that an electric vehicle is parked at an electric vehicle charging station and connected to the charging station equipment.

Location: Single electric vehicle charging stations shall be placed at the beginning or end parking stall on a block face.

Dimensions: Minimum standard dimensions for parking spaces and drive aisles shown in the lot layout schedule (Table 3.11) shall be used where electric vehicle charging stations are required or planned.

Clearance: Charging station equipment mounted on pedestals, light posts, bollards, or other devices shall be at least 24-inches clear from the face of curb.

Maintenance: Charging station equipment shall be well-maintained and operational. A phone number or other contact information shall be provided on the charging station equipment for reporting malfunctioning or inoperable equipment.

Signage: EV parking spaces shall be posted with signage indicating the space is only for electric vehicle charging purposes. Days and hours of operation shall be posted if time limits and/or towing will be enforced (see example in Figure 3.10).

Figure 3.10 Typical Example of Electric Vehicle Sign

[12] *Refer to the National Fire Protection Association for fire design requirements for parking decks.*

3.11.6 On-Street Parking

On-street parking shall support and not conflict with the safe and orderly movement of all transportation system users. The minimum dimensions of on-street parking spaces shall account for driver sight distance, pedestrian patterns, and maneuvering area for vehicles. Time restrictions may be applied to on-street parking and posted signs or parking meters may be used for regulation and enforcement. Parking prohibitions may be warranted based on statutes, traffic capacity, or crash hazards. Statutory prohibitions apply to on-street parking near fire hydrants, crosswalks, and approaches to intersections. Please contact the Town of Chapel Hill Fire Marshall's Office for additional information concerning emergency vehicle access requirements.

Parallel and/or head-in angle parking may be permitted on low-volume, low-speed streets and in commercial areas, if sufficient curb-to-curb width is available. Head-in angle parking spaces shall comply with the minimum dimensions shown in Table 3.13. Ninety-degree (perpendicular) on-street parking is not permitted.

When angle parking abuts a sidewalk, additional clearance shall be provided between the sidewalk and the parking space, ensuring vehicle overhangs do not decrease the useable area of the sidewalk or impede access (Table 3.13)

Table 3.16 Minimum Dimensions for Head-In Angled On-Street Parking*

Angle	Stall Width	Stall Depth (perpendicular to curb)	Minimum Width of Adjacent Lane	Curb Overhang
45°	8.5-9.0'	17' 8"	11' 4"	1' 9"
50°	8.5-9.0'	18' 3"	13' 3"	1' 11"
55°	8.5-9.0'	18' 8"	13' 8"	2' 1"
60°	8.5-9.0'	19' 0"	14' 6"	2' 2"

*Source: Dimensions of Parking, 4th Edition, Urban Land Institute * Typical design vehicle dimensions: 6' 7" by 17' 0". Use 9.0' wide stall in commercial areas with moderate-to-high parking turnover. Note: Sharper angles may be approved by Town staff on a case-by-case basis.*

3.11.7 Loading Space Requirements

Off-street loading spaces shall accommodate a continuous parking maneuver by a semi-trailer truck (WB 40 design). Off-street loading spaces shall be at least 12' wide and 55' long, with a vertical clearance of at least 14' above finished grade. Town staff may consider alternative loading spaces on a case-by-case basis, if accommodating smaller trucks or restricting delivery hours.

3.12 DRIVEWAYS

Requests for new driveways on State or Town owned streets will be reviewed for safety and congestion and may be denied by the Town Manager or designee.

3.12.1 Driveway Standard Dimensions

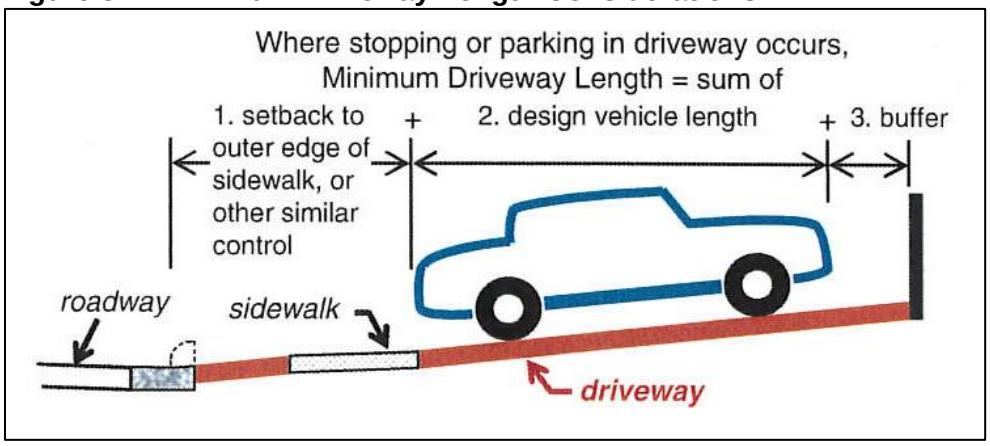
3.12.1(a) Minimum Length

Developers shall use the following to calculate the minimum driveway length (Figure 3.11):

1. Maximum length of vehicle(s) using the driveway
2. Front buffer dimension, based on vehicle design (passenger cars – 2', bus or large truck – 3', add additional space for vehicles with outward opening front or rear gates.
3. Rear clearance (the distance from the edge of the driveway to the far edge of the sidewalk; allow a minimum of 2' if no sidewalk exists)

Sum these values to determine the minimum driveway length.

Figure 3.11 Minimum Driveway Length Considerations



Source: National Cooperative Highway Research Program (NCHRP) - Report 659

3.12.2 Driveway Paving

Paving the connection between a gravel or dirt driveway and the public right-of-way stabilizes the driveway surface "platform" where the traveled way is entered and exited and minimizes or eliminates the deposition of dirt, gravel, and mud onto the public right-of-way. Factors affect the extent to which debris from such a private driveway are deposited on the traveled way include:

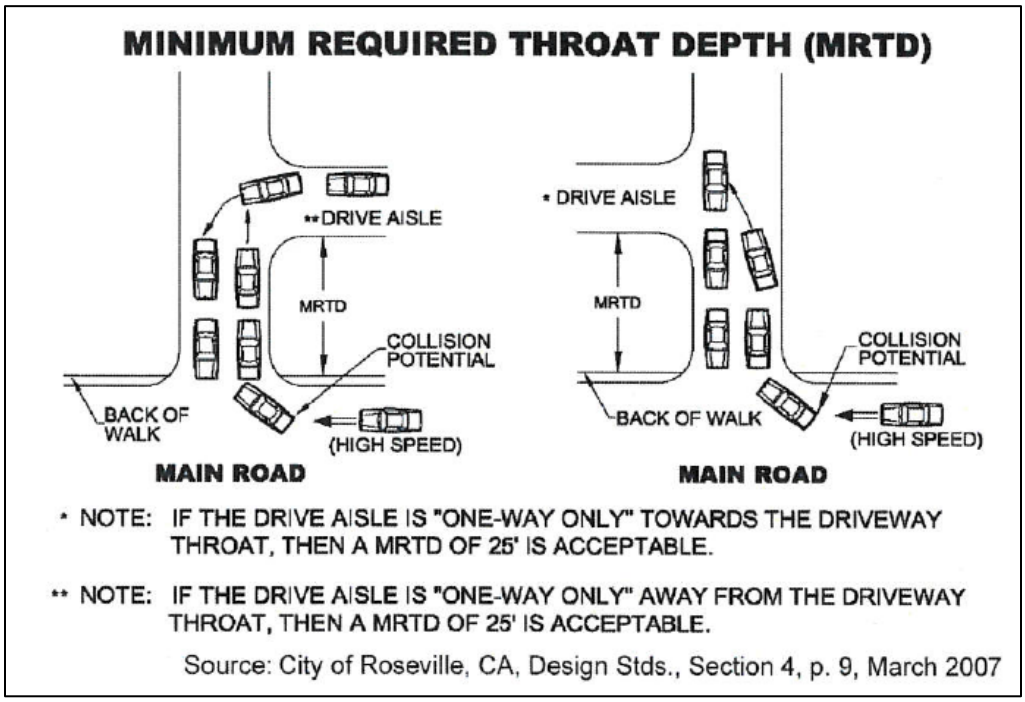
- The distance from the traveled way edge to the beginning of the gravel or dirt surface;
- The grade of the driveway;
- Surface drainage patterns, combined with the amount of precipitation; and
- The volumes and types of traffic using the driveway.

The minimum length of driveway pacing shall be 10’ or extending to the right-of-way line, whichever is less. Greater lengths may be required by Town staff.

3.12.3 Driveway Minimum Required Throat Depth (MRTD)

The distance between internal drive aisles and the street can affect traffic operation and safety. To protect the storage and operational needs of the driveway/street intersection, a protected driveway stem of a sufficient link may be required. The designer should provide 50-foot minimum vehicle storage length (minimum required throat depth, Figure 3.12) for driveway intersections with the street. Alternate distances may be used if dictated by sight conditions.

Figure 3.12 Minimum Required Throat Depth (MRTD)



3.12.4 Driveway Grades Adjacent to Right-of-Way

Maximum allowable grade, by itself, is not a sufficient control. What matters is the difference between successive grades, or the change of grade. The change of grade may create the crests and sags which cause the underside of a vehicle to drag.

Table 3.17 - Steepest Allowed Driveway Grades Adjacent to Right-of-Way

	Commercial	Residential
Grade: maximum from road allowed	10%	15%

3.12.5 Driveway Grade (Sidewalk Cross Slope), Change of Grade, and Vertical Alignment

Three types of control for the design of the driveway profile are physical, operational, and drainage:

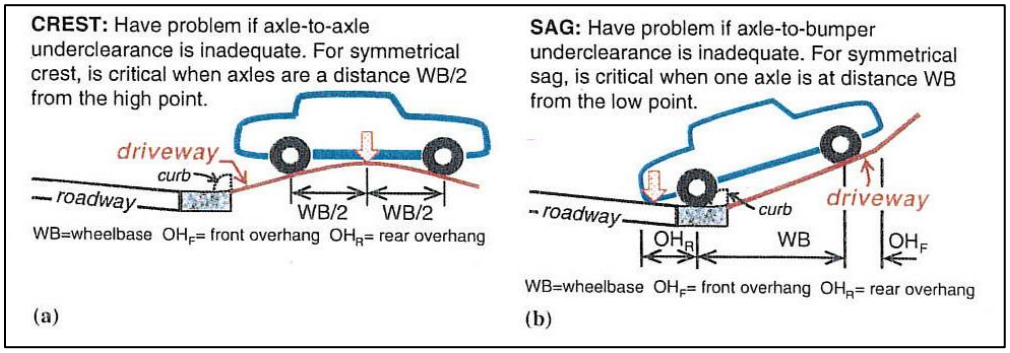
Physical controls: Maintaining enough clearance so the underside of a vehicle does not drag on the roadway or driveway surface. This control is necessary for all driveways, even ones connecting to an alley. Due to the changes in vertical profile grade often found at driveway entrances, these locations are more vulnerable to hang ups when the undercarriage of the vehicle meets or drags against the pavement surface.

Operational controls: dictate vertical alignment for the driveway allowing a convenient and safe entry with minimal conflicts. To achieve this, grade changes must not be too abrupt. This is especially important on driveways which intersect higher volume or higher speed roadways. Operational problems may arise from certain combinations of vertical profiles and vehicles. One problem is vehicle occupant discomfort due to poor vertical alignment such as bumps, steep grades, and abrupt changes in grade. In extreme cases, there may be restricted sight distance

which adversely affects safety. In addition, excessive differences in speed between through vehicles and vehicles turning into or out of the driveway from a vertical profile can also increase vehicles' exposure to crashes.
Drainage controls: require profiles mitigating undesirable flow patterns. It may be unacceptable for street runoff to flow into the driveway opening and onto private property, and for stormwater run-off to flow from a driveway into the street.

3.12.5(a) Physical Vehicle Ground Clearance Control
As Figure 3.13 shows, the underside of a vehicle entering or exiting a driveway can drag on either a crest or a sag alignment with an abrupt change of grade. Any excessive grade change between the cross slope of the roadway and the driveway grade, between the driveway grade and an intersecting sidewalk, or between successive driveway grades can cause a vehicle to drag. Vehicles with low ground clearance and a long wheelbase or overhang can even become lodged (also referred to as "hung up" or "high-centered") on alignments with sharp grade changes. At best, hang-ups result in some vehicular delay and minor damage to the undercarriage of the vehicle and to the pavement surface. At worst, a crash can occur.

Figure 3.13 Physical Vehicle Ground Clearance Control



Source: NCHRP

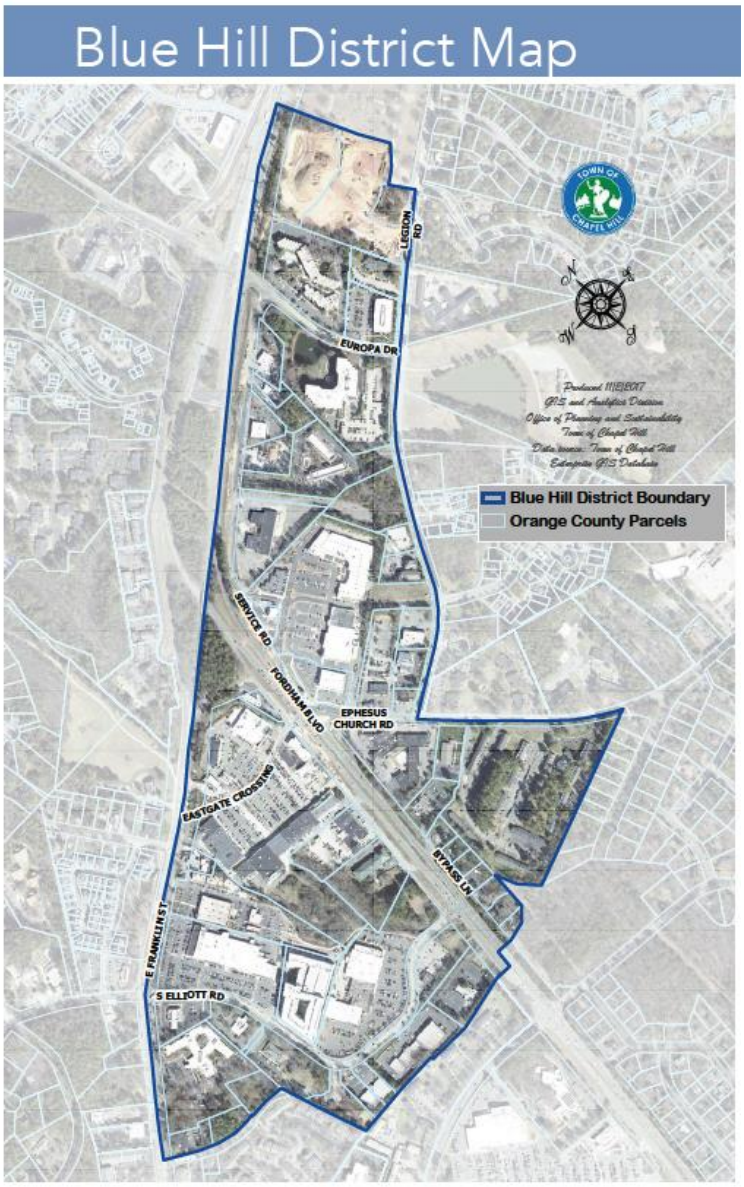
Table 3.18 Minimum Length of Crest Vertical Curve to Accommodate Low-Clearance Vehicle at Driveway Intersection with Street

Algebraic Difference (%)	Curve Length	
	Feet	Meters
1	4	1.2
2	8	2.4
3	12	3.7
4	16	4.9
5	20	6.1
6	24	7.3
7	28	8.5
8	32	9.8
9	35	10.7
10	39	11.9

3.13 THE BLUE HILL DISTRICT
The Blue Hill District is emerging as a vibrant part of Chapel Hill based on a vision for redevelopment that is set forth in the area's Form-Based Code. The code establishes basic

requirements for development as a series of prescriptive standards to be administered by Town staff. It also provides for a design review process, using design guidelines, for a specific set of topics, in which the Town's Community Design Commission (CDC) participates. These design guidelines are published, therefore, as provided in the code. The intent is to facilitate interpretation of the code by staff and review of the specified topics by the CDC. To access the Blue Hill District Design Guidelines, please go to:
https://www.townofchapelhill.org/government/departments-services/chapel-hill-2020/future-focus-areas/the-blue-hill-district/form-based-code

Figure 3.14 Blue Hill District



Chapter 4
Stormwater Management

4.1 GENERAL

Development and redevelopment within the Town's municipal boundaries and its Extraterritorial Jurisdiction (ETJ) are required to manage stormwater in accordance with Section 5.4 of the Chapel Hill Land Use Management Ordinance (LUMO).

The LUMO requires development and redevelopment activities to manage and control stormwater runoff rate, volume, pollutants, and erosion/sedimentation in order to protect and safeguard the environment, property, and safety of residents within the Town's jurisdiction. Low Impact Design (LID) measures are highly encouraged to meet the stormwater management performance criteria in the LUMO; the goal is to maintain a site's predevelopment (or improve redevelopment) hydrologic conditions utilizing ecologically-based management techniques that infiltrate, filter, store and evapotranspirate stormwater on-site. For examples of LID measures, see the most recent addition of the North Carolina Department of Environmental Quality *Stormwater Best Management Practices Manual*.

This section of the Design Manual provides information about the design and acceptable techniques and controls to comply with the requirements of the LUMO. Acceptable stormwater management practices include those found in this Design Manual and in the most recent addition of the North Carolina Department of Environmental Quality *Stormwater Best Management Practices Manual*. The Town reserves the right to modify, amend, restrict, or otherwise change these accepted practices as may be necessary to achieve stated stormwater management goals. Any modifications or restrictions shall be noted in this chapter.

Applicant Requirements
As part of the permit application process, the applicant is required to submit the methodology and accompanying calculations for the design solutions proposed within the stormwater management plan. Calculations shall be provided for all proposed stormwater infrastructure including, but not limited to, culverts, piped storm drainage systems, inlets, ditches, open channels, IMPs /SCMs outlet protection, etc.—and shall be sealed and signed by a registered design professional.

4.2 STORMWATER MANAGEMENT DESIGN CRITERIA

The stormwater management design criteria are contained in Subsection 5.4.6 of the Town's LUMO. A summary of these requirements is below.

WATER QUALITY: Stormwater treatment must achieve **85% Total Suspended Solids** (TSS) average annual removal. This removal rate is applied to the post-development runoff from the first one-inch (1") of precipitation.

> **STAFF NOTE**: The 85% TSS treatment requirement can be achieved by meeting the Minimum Design Criteria (MDC) for Primary SCMs in the NCDEQ Stormwater Design Manual.

VOLUME: The post-development runoff volume shall not exceed the pre-development runoff volume for the local 2-year, 24-hour storm.

STAFF NOTE: The post development runoff volume requirement may be met by retaining the increased volume of stormwater runoff for a minimum of 2 days, but no longer than 5 days.

FLOW RATE: Post-development peak discharge flow rate cannot exceed pre-development peak discharge flow rate for the 1-year, 2-year, and 25-year, 24-hour storms from the site.

STAFF NOTE: Post-development peak discharge flow rate must be evaluated for each property boundary discharge point as well as for the overall site.

PEAK ELEVATION: 100-year, 24-hour storm peak elevation of post-development runoff shall not exceed the top dam embankment for retention and detention systems.

LAND DISTURBANCE: Disturbance of any stream channel shall be prohibited unless explicitly authorized by issuance of a Zoning Compliance Permit after demonstration of the necessity for the disturbance. If stream channel disturbance is authorized, it shall be minimized to the extent practicable.

STAFF NOTE: The implementation of the Jordan Lake Rules in Section 5.19 of the LUMO are currently delayed. However, for future nutrient accounting purposes, the Jordan Lake Accounting Tool output is required with the Stormwater Management Plan.

4.3 BASIS OF STORMWATER MANAGEMENT DESIGN

Hydrologic design includes evaluating the impacts that development has on stormwater runoff. The evaluation involves selecting the required design storm and using accepted hydrologic methodology to design storm drainage infrastructure, stream crossings, detention/retention facilities, etc. as necessary to meet applicable requirements and the performance standards of the Town's Land Use Management Ordinance. Designers must evaluate the impacts of proposed stormwater management practices both on-site and on adjacent properties, downstream, structures, and roadways.

Integrated Management Practices/Structural Control Measures

LUMO Subsection 5.4.7 requires applicants to use Integrated Management Practices/Structural Control Measures. "Integrated Management Practices" is a term that generally refers to the Structural Control Measures (SCM) used for stormwater management in a Low Impact Design (LID) project.

The stormwater goals of LID are to maintain groundwater recharge and quality; reduce stormwater pollutant loadings; protect stream channels; and prevent increased flooding. This can be accomplished by providing multi-functional stormwater controls that are decentralized and disconnected to the extent practicable.

Some examples of structural LID measures are bio-retention basins, infiltration structures, filter strips, permeable pavement, and green roofs.

Non-structural LID measures include site fingerprinting; minimizing the area of land disturbance; reducing impervious area; maintaining natural riparian buffers and vegetation; and prohibiting direct connections of site drainage to streams.

Drainage Areas

The corresponding pre-development drainage areas must be delineated and field verified to ensure that the entire contributory area has been properly identified and that any off-site runoff has been accounted for.

The pre- and post-development drainage area maps must clearly delineate the areas that are being directed to each analysis point/SCM, and identify the corresponding areas, runoff values and time of concentration (T_c) flow paths and flow types (sheet, shallow concentrated, channel, etc., unless the post-developed T_c is assumed to be 5 minutes).

The corresponding runoff rate must be calculated assuming off-site properties are fully developed at each discharge point (that point at which runoff leaves the tract of land or enters a stream buffer).

Hydrologic Soil Groups (HSG)

Infiltration rates of soils vary widely and are affected by subsurface permeability as well as surface intake rates. Soils are classified into four HSG's (A, B, C, and D) according to their minimum infiltration rate, which is obtained for bare soil after prolonged wetting. The soils in the area of interest may be identified from a soil survey report, which can be obtained from local SCS offices, local soil and water conservation district office, the USDA NRCS Web Soil Survey or another reputable source. A copy of the soils report for the entire drainage should be included within the submittal. SCMs reliant upon infiltration rates for functionality will require that the underlying soils are tested (confirmation of hydraulic conductivity, K_{sat}) and a geotechnical/soils report submitted.

Most urban areas are only partially covered by impervious surfaces: the soil remains an important factor in runoff estimates. Urbanization has a greater effect on runoff in watersheds with soils having high infiltration rates (sands and gravels) than in watersheds predominantly of silts and clays, which generally have low infiltration rates. Any disturbance of a soil profile can significantly change its infiltration characteristics. With urbanization, native soil profiles may be mixed or removed or fill material from other areas may be introduced.

Cover types include vegetation, bare soil, and impervious surfaces. There are a number of methods for determining cover type. The most common are field reconnaissance, aerial photographs, and land use maps.

Hydrologic condition indicates the effects of cover type and treatment on infiltration and runoff and is generally estimated from density of plant and residue cover on sample areas. *Good* hydrologic condition indicates that the soil usually has a low runoff potential for that specific hydrologic soil group. Cover type, and treatment. Some factors to consider in estimating the effect of cover on infiltration and runoff are (a) canopy or density of lawns, crops or other vegetative areas; (b) amount of year-round cover; (c) amount of grass or close-seeded legumes in rotations; (d) percent of residue cover; and (e) degree of surface roughness.

Hydrologic Methodology

Hydrologic (quantity) methodology includes estimating peak runoff rates, volumes and time distributions (discharge per unit of time) as a result of precipitation. The most commonly recognized methods for determining the relationship between rainfall and runoff is the SCS Method and the Rational Method. Other analytical tools may be approved by the Town's Stormwater Management Division if properly substantiated.

The Rational Method for determining peak runoff rates of discharge is appropriate only for drainage areas that do not exceed 10 acres. The SCS Method should be utilized to determine peak runoff rates for drainage areas that exceed 10 acres. The corresponding C, CN, and hydrologic soil groups for soil types must utilize the information provided within the current edition of the *NCDEQ Stormwater Design Manual*, published by the North Carolina Department of Environmental Quality. The Stormwater Management Division may require use of adjusted curve numbers for developments which can be expected to differ significantly from the typical values shown for the impervious area percentages.

SCS Method

The SCS method requires basic data similar to the Rational Method. The SCS Method approach, however, is more sophisticated in that it also considers the time distribution of the rainfall, the initial rainfall losses to interception and depression storage, and an infiltration rate that decreases during the course of a storm. Details of the methodology can be found in the *USDA NRCS Urban Hydrology for Small Watersheds*.

Peak discharge and volume calculations shall be based on a Type-II precipitation distribution. Total runoff depth using SCS equations, curves, and the appropriate depth-duration-frequency and intensity-duration-frequency values, which are provided in Table 4.5 and Table 4.6, respectively.

Hydrology: A branch of science that determines the amount of water (water quantity or discharge) that will run off as a result of precipitation. The hydrology will be affected by the amount, frequency, and duration of the precipitation, the land cover, soils, the watershed shape and slope, and amount of storage available in the watershed.

Hydraulics: A branch of science that studies the practical applications of water in motion. Combines the watershed hydrology with cross section data to estimate the depth and area of water.

The SCS runoff equation is:

$$Q = \frac{(P-I_a)^2}{(P-I_a)+S} \qquad \text{[Eq. 4-1]}$$

Where: *Q = runoff (in)*
P = rainfall (in)
S = potential maximum retention after runoff begins (in)
I_a = initial abstraction (in)

Initial abstraction (I_a) is all losses before runoff begins. It includes water retained in surface depressions, water intercepted by vegetation, evaporation, and infiltration. I_a is highly variable but generally is correlated with soil and cover parameters. Through studies of many small agricultural watersheds, I_a was found to be approximated by the following empirical equation:

$$I_a = 0.2S \qquad \text{[Eq. 4-2]}$$

By removing I_a as an independent parameter, this approximation allows use of a combination of *S* and *P* to produce a unique runoff amount. Substituting equation 4-2 into equation 4-1 gives:

$$Q = \frac{(P-0.2S)^2}{(P+0.8S)} \qquad \text{[Eq. 4-3]}$$

S is related to the soil and cover conditions of the watershed through the CN. CN has a range of 0 to 100, and *S* is related to CN by:

$$S = \frac{1000}{CN} - 10 \qquad \text{[Eq. 4-4]}$$

Figure 4.1 - Solution of the SCS Runoff Equation

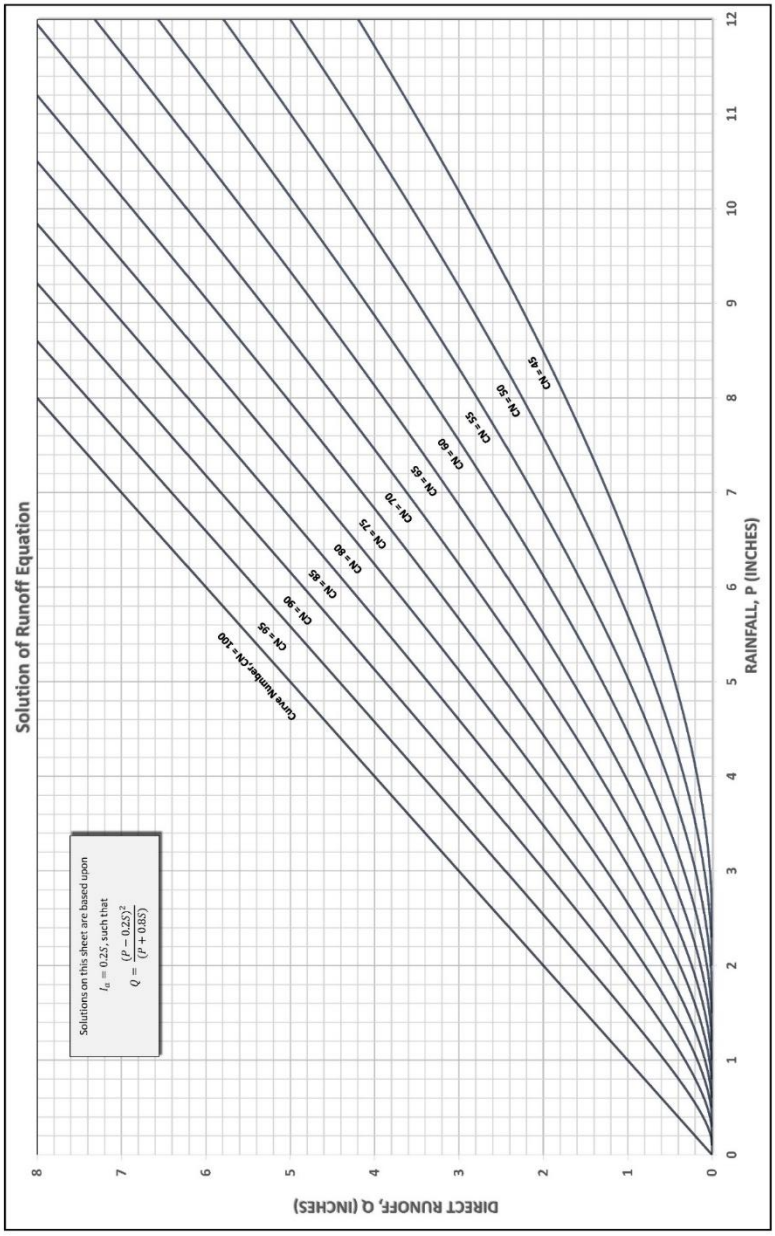


Figure 4.2 – SCS Runoff Equation Curve for P=3”

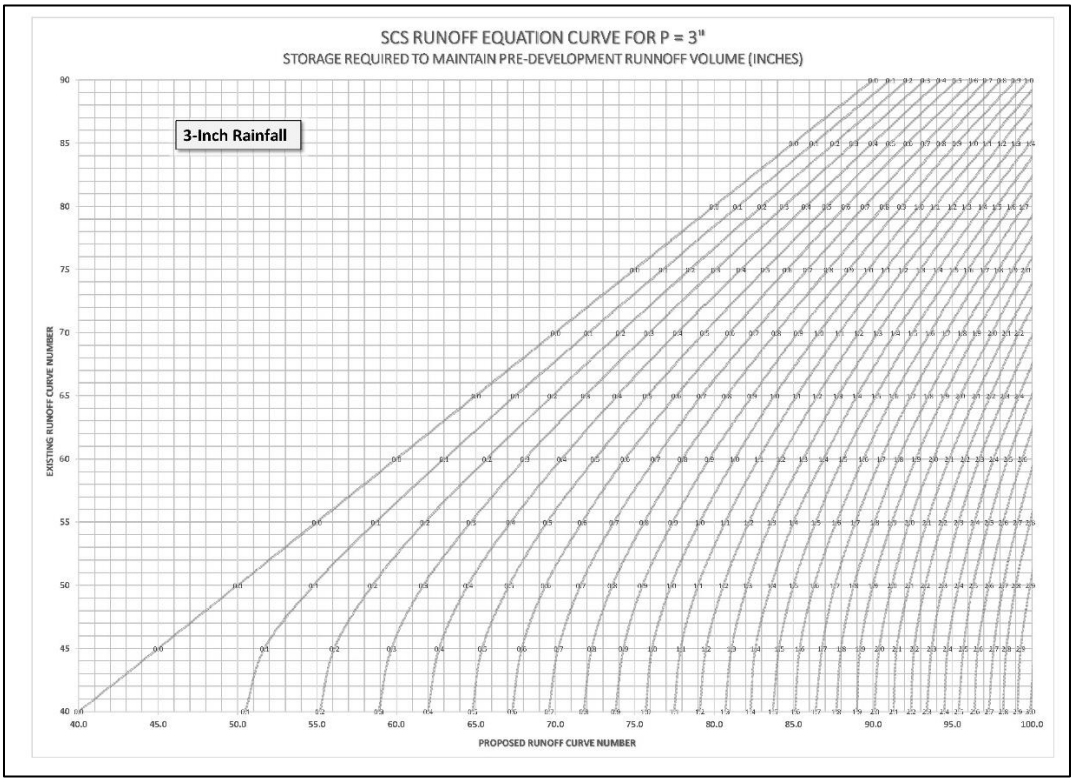


Figure 4.3 – SCS Runoff Equation Curve for P=4”

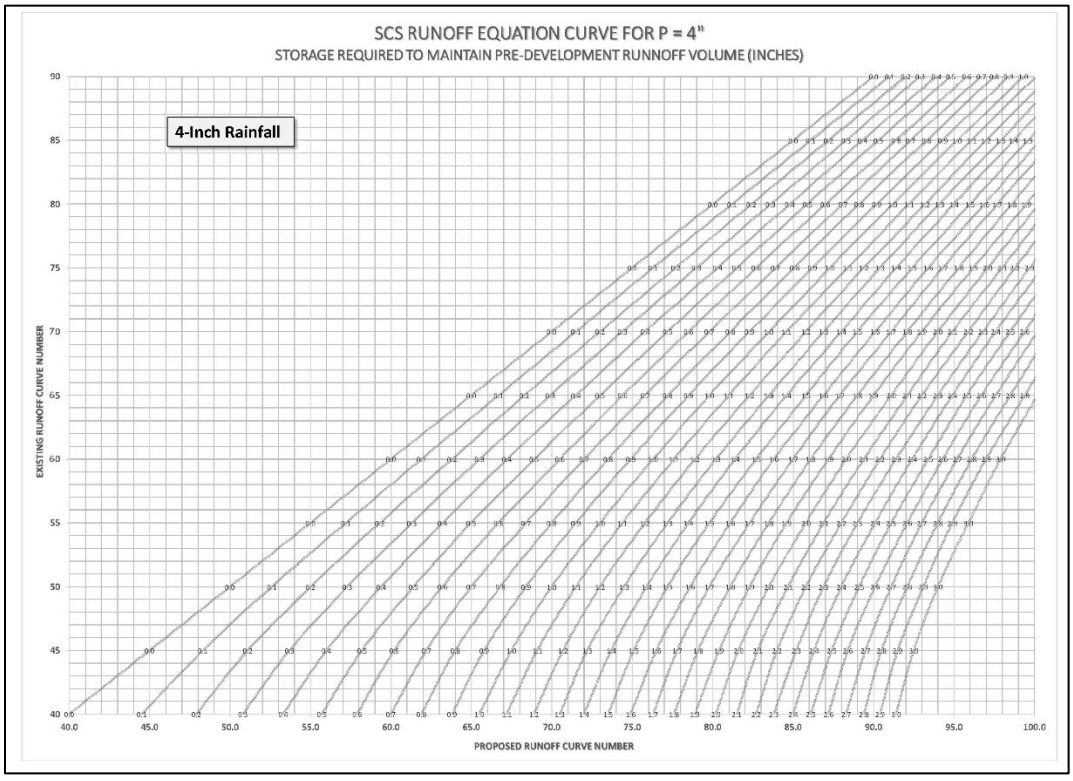


Table 4.1 – Runoff Depths

Rainfall	Runoff depth (inches) for curve number of—												
	40	45	50	55	60	65	70	75	80	85	90	95	98
1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56	0.79
1.2	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.07	0.15	0.27	0.46	0.74	0.99
1.4	0.00	0.00	0.00	0.00	0.00	0.02	0.06	0.13	0.24	0.39	0.61	0.92	1.18
1.6	0.00	0.00	0.00	0.00	0.01	0.05	0.11	0.20	0.34	0.52	0.76	1.11	1.38
1.8	0.00	0.00	0.00	0.00	0.03	0.09	0.17	0.29	0.44	0.65	0.93	1.29	1.58
2.0	0.00	0.00	0.00	0.02	0.06	0.14	0.24	0.38	0.56	0.80	1.09	1.48	1.77
2.5	0.00	0.00	0.02	0.08	0.17	0.30	0.46	0.65	0.89	1.18	1.53	1.96	2.27
3.0	0.00	0.02	0.09	0.19	0.33	0.51	0.71	0.96	1.25	1.59	1.98	2.45	2.77
3.5	0.02	0.08	0.20	0.35	0.53	0.75	1.01	1.30	1.64	2.02	2.45	2.94	3.27
4.0	0.06	0.18	0.33	0.53	0.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
4.5	0.14	0.30	0.50	0.74	1.02	1.33	1.67	2.05	2.46	2.91	3.40	3.92	4.26
5.0	0.24	0.44	0.69	0.98	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.42	4.76
6.0	0.50	0.80	1.14	1.52	1.92	2.35	2.81	3.28	3.78	4.30	4.85	5.41	5.76
7.0	0.84	1.24	1.68	2.12	2.60	3.10	3.62	4.15	4.69	5.25	5.82	6.41	6.76
8.0	1.25	1.74	2.25	2.78	3.33	3.89	4.46	5.04	5.63	6.21	6.81	7.40	7.76
9.0	1.71	2.29	2.88	3.49	4.10	4.72	5.33	5.95	6.57	7.18	7.79	8.40	8.76
10.0	2.23	2.89	3.56	4.23	4.90	5.56	6.22	6.88	7.52	8.16	8.78	9.40	9.76
11.0	2.78	3.52	4.26	5.00	5.72	6.43	7.13	7.81	8.48	9.13	9.77	10.39	10.76
12.0	3.38	4.19	5.00	5.79	6.56	7.32	8.05	8.76	9.45	10.11	10.76	11.39	11.76
13.0	4.00	4.89	5.76	6.61	7.42	8.21	8.98	9.71	10.42	11.10	11.76	12.39	12.76
14.0	4.65	5.62	6.55	7.44	8.30	9.12	9.91	10.67	11.39	12.08	12.75	13.39	13.76
15.0	5.33	6.36	7.35	8.29	9.19	10.04	10.85	11.63	12.37	13.07	13.74	14.39	14.76

**Note: Interpolate the values shown to obtain runoff depths for CN's or rainfall amounts not shown.*

Factors considered in determining runoff curve numbers

The major factors that determine Curve Numbers (CN) are the hydrologic soil group (HSG), cover type, treatment, hydrologic condition, and antecedent runoff condition. Another factor considered is whether impervious areas outlet directly to the drainage system (connected) or whether the flow spreads over pervious areas before entering the drainage system (unconnected). Table 4.2 is provided to aid in selecting the appropriate figure or table for determining curve numbers.

Table 4.2 - Runoff Curve Numbers

Cover description		Curve numbers for hydrologic soil group			
Cover type and hydrologic condition	Average percent impervious area [2]	A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) [3]:					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) [4]		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas (pervious areas only, no vegetation) [5]		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

[1] Average runoff condition, and $I_a = 0.2S$.

[2] The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.

[3] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[4] Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.

[5] Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Time of Concentration

Travel time (T_t) is the time it takes water to travel from one location to another in a watershed. T_t is a component of time of concentration (T_c) which is the time for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. T_c is computed by summing all the travel times for consecutive components of the drainage conveyance system.

T_c influences the shape and peak of the runoff hydrograph. Urbanization usually decreases T_c, thereby increasing the peak discharge. But Tc can be increased as a result of (a) ponding behind small or inadequate drainage systems, including storm drain inlets and road culverts, or (b) reduction of land slope through grading.

> The Land Use management Ordinance (LUMO) states that for the 1-, 2- and 25-year peak discharges, the **24-hour duration** event must be considered. This statement was assuming that the method to generate the peak discharges was the **SCS Method**, not the Rational Method.

Factors affecting time of concentration and travel time

Surface roughness – One of the most significant effects of urban development on flow velocity is less retardance to flow. That is, undeveloped areas with very slow and shallow overland flow through vegetation become modified by urban development; the flow is then delivered to streets, gutters, and storm sewers that transport runoff downstream more rapidly. Travel time through the watershed is generally decreased.

Channel shape and flow patterns – In small non-urban watersheds, much of the travel time results from overland flow in upstream areas. Typically, urbanization reduces overland flow lengths by conveying storm runoff into a channel as soon as possible. Since channel designs have efficient hydraulic characteristics, runoff flow velocity increases and travel time decreases.

Slope – Slopes may be increased or decreased by urbanization, depending on the extent of site grading or the extent to which storm sewers and street ditches are used in the design of the water management system. Slope will tend to increase when channels are straightened and decrease when overland flow is directed through storm sewers, street gutters, and diversions.

Computation of travel time(s) and time of concentration

Water moves through a watershed as sheet flow, shallow concentration flow, open channel flow, or some combination of these. The type that occurs is a function of the conveyance system and is best determined by field inspection.

Travel time (T_t) is the ratio of flow length to flow velocity:

$$T_t = \frac{L}{3600V} \qquad \text{[Eq. 4-5]}$$

Where:
T_t = travel time (hr)
L = flow length (ft)
V = average velocity (ft/s)
3600 = conversation factor from seconds to hours

Time of concentration (T_c) is the sum of T_t values for the various consecutive flow segments:

$$T_c = T_{t1} + T_{t2} + \ldots T_{tm} \quad \text{[Eq. 4-6]}$$

Where: T_c = *time of concentration (hr)*
m = *number of flow segments*

Time of concentration estimates for the SCS method shall utilize the segmental T_c approach as outlined in Worksheet 3: Time of Concentration or travel time, from the publication *USDA NRCS Urban Hydrology for Small Watersheds*, United States Department of Agriculture (USDA), with the following parameters:

Sheet Flow

Sheet flow is flow over plane surfaces. It usually occurs in the headwater of streams. With sheet flow, the friction value (Manning's n) is an effective roughness coefficient that includes the effect of raindrop impact; drag over the plane surface; obstacles such as litter, crop ridges, and rocks: and erosion and transportation of sediment. These n values are for very shallow flow depths of about 0.1 foot. Table 4.3 gives Manning's n values for sheet flow for various surface conditions. Pre-development wooded areas must be assumed to be woods, dense underbrush; n = 0.80, unless can be proven otherwise.

For flow length, use the following:

Pre-development: Minimum of 100 feet, Maximum of 300 feet.

Post-development: No more than 50 feet unless it can be shown that the sheet flow depth is 0.10 foot or less.

For sheet flow of less than 300 feet, use Manning's kinematic solution (Overton and Meadows 1976) to compute T_t:

$$T_t = \frac{0.007(nL)^{0.8}}{(P_2)^{0.5} s^{0.4}} \quad \text{[Eq. 4-7]}$$

Where: T_t = *travel time (hr.)*
n = Manning's roughness coefficient
L = flow length (ft.)
P_2 = *2 year, 24-hour rainfall (in), and*
s = slope of hydraulic grade line (land slope, ft/ft).

This simplified form of the Manning's kinematic solution is based on the following: (1) shallow steady uniform flow, (2) constant intensity of rainfall excess (than part of a rain available for runoff), (3) rainfall duration of 24 hours, and (4) minor effect of infiltration on travel time.

Table 4.3 - Roughness coefficients (Manning's n) for sheet flow

Surface Description	n[1]
Smooth surfaces (concrete, asphalt, gravel or bare soil)	0.011
Fallow (no residue)	0.05
Cultivated soils	
Residue cover ≤ 20%	0.06
Residue cover > 20%	0.17
Grass	
Short grass prairie	0.15
Dense grasses[2]	0.24
Bermudagrass	0.41
Range (natural)	0.13
Woods[3]	
Light underbrush	0.4
Dense underbrush	0.8

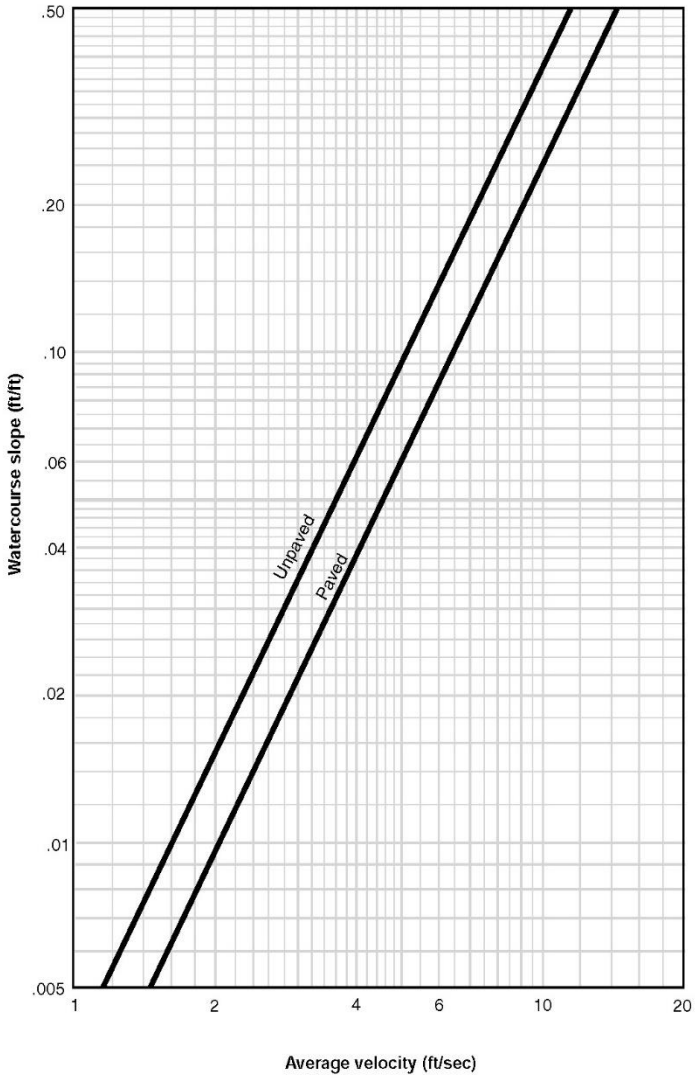
1 - The n values are a composite of information compiled by Engman (1986).
2 - Includes species such as weeping lovegrass, bluegrass, buffalo grass, blue grama grass, and native grass mixtures.
3 - When selecting n, consider cover to a height of about 0.1 ft. This is the only part of the plant cover that will obstruct sheet flow.

Shallow concentrated flow

After a maximum of 300 feet, sheet flow usually becomes shallow concentrated flow. The average velocity for this flow can be determined from *Figure 4.4 – Average Velocities for Estimating Travel Time for Shallow Concentrated Flow*, in which average velocity is a function of watercourse slope and type of channel. Tillage can affect the direction of shallow flow. Flow may not always be directly down the watershed slope if tillage runs across the slope.

After determining average velocity in, use equation 4-5 to estimate travel time for the shallow concentrated flow segment.

Figure 4.4
Average Velocities for Estimating Travel Time for Shallow Concentrated Flow



(210-VI-TR-55, Second Ed., June 1986)

Channelized Flow

Open channels are assumed to begin where surveyed cross section information has been obtained, where channels are visible on aerial photographs, or where blue lines (indicating streams) appear on United States Geological Survey (USGS) quadrangle sheets. Manning's equation or water surface profile information can be used to estimate average flow velocity. Average flow velocity is usually determined for bank-full elevation.
Manning's equation is:

$$V = \frac{1.49}{n}(R^{2/3})(S^{1/2}) \qquad \text{[Eq. 4-8]}$$

Where: V = average velocity (ft/s)
r = hydraulic radius (ft) and is equal to a/P_w
a = cross sectional flow area (ft^2)
P_w = wetted perimeter (ft)
s = slope of the HGL (channel slope, ft/ft)
n = Manning's roughness coefficient for open channel flow

Manning's n values for open channel flow can be obtained from standard textbooks such as Chow (1950) or Linsley et al. (1982). After average velocity is computed using equation 4-8, Tt for channel segment can be established using equation 4-5.

Reservoirs or lakes

Sometimes it is necessary to estimate the velocity of flow through a reservoir or lake at the outlet of a watershed. This travel time is normally very small and can be assumed as zero.
Limitations

Manning's kinematic solution should not be used for sheet flow longer than 300 feet. Equation 3-3 was developed for use with the four standard rainfall intensity-duration relationships.

In watersheds and storm sewers, carefully identify the appropriate hydraulic flow path to estimate Tc. Storm sewers generally handle only a small portion of a large event. The rest of the peak flow travels by streets, lawns, and so on, to the outlet. Consult a standard hydraulics textbook to determine average velocity in pipes for either pressure or non-pressure flow.

A culvert or bridge can act as a reservoir outlet if there is significant storage behind it. The procedures in TR-55 can be used to determine the peak flow upstream of the culvert. Detailed storage routing procedures should be used to determine the outflow through the culvert.

Rational Method

For catchments up to and including 10 acres, the Rational Method may be used to calculate peak discharges for storm events, unless site specific circumstances dictate that hydraulic routing and hydrograph generation are necessary such as multiple drainage basins routed to a common point of analysis within the project area.

The following procedure should be followed for Rational Method analyses:

(1) Determine the watershed size in acres (ac) to the point of

The **Rational Method** considers time of concentration for the selection of the storm duration and the rainfall intensity. It cannot be used with a prescribed duration of 24 hours. The result will be inaccurate and much less peak discharge generation for both pre and post-development conditions will result, which will lead to poor design practices. Most storm events in small catchments cause a peak discharge in a much less timeframe than 24-hours, such as **5 minutes**.

Kirpich's equation (1940) was developed for small, agricultural watersheds. It was derived by examining the required time for the stream to rise from low to maximum stage during a storm. The time of concentration was then assumed equal to that time. This equation (left) was developed for overland flow on bare earth; T_c for flows over other surfaces must be adjusted accordingly.

discharge.

(2) Time of Concentration (Tc) estimates shall utilize the Kirpich Equation, below.

$$T_C = \frac{(L^3/H)^{0.385}}{128} \quad \text{[Eq. 4-9]}$$

Where: *T_c = Time of concentration, in minutes*
L = Longest flow path, in feet
H = Elevation of difference along L, in feet

NOTE: *The following adjustments for T_c must be made.*
For well-defined natural channels use T_c x 1
For overland flow on grassy surfaces use T_c x 2
For overland flow on paved surfaces use T_c x 0.4
For concrete channels use T_c x 0.2

(3) Determine the rainfall intensity (I) using the appropriate intensity-duration frequency table found in (provided in Table 4-6).

NOTE: For the 1-year.storm, use 80% of the 2-year storm peak discharge, or the following equation, to calculate intensity:

$$i = \frac{g}{(h+T)} \quad \text{[Eq. 4-10]}$$

Where: i = Rainfall intensity (in/hr)
T = Time of duration (min)
G = 104 (empirically derived constant)
h = 18 (empirically derived constant)

(4) Determine the composite runoff coefficient (*C_{comp}*) using Eq. 4-11 and Table 4.4, below.

$$C_{comp} = \frac{\Sigma(C_{Individual\ Area})(A_{Individual\ Area})}{A_{Total\ Area}} \quad \text{[Eq. 4-11]}$$

Table 4.4 - Rational Runoff Coefficients

Description	C	Source
Roof, inclined	0.96	Malcom, 2003
Street, driveway, sidewalk, parking lot	0.96	Malcom, 2003
Gravel	0.90	T.O.C.H.
Commercial, generalized	0.90	Malcom, 2003
Apartments, schools, churches	0.84	Malcom, 2003
Residences, 10 dwellings/acre	0.80	T.O.C.H.
Residences, 6 dwellings/acre	0.60	T.O.C.H.
Residences, 4 dwellings/acre	0.74	Malcom, 2003
Residences, 2 dwellings/acre	0.70	Malcom, 2003
Unimproved cleared area	0.50	T.O.C.H.
Lawn, dense soil, steep >7%	0.60	Malcom, 2003
Lawn, dense soil, avg 2-7%	0.50	T.O.C.H.
Lawn, dense soil, flat 2%	0.20	T.O.C.H.
Lawn, sandy ≥ 2%	0.15	Chow, 1964
Lawn, sandy, flat <2%	0.10	Chow, 1964
Wooded, deep ground litter	0.40	Malcom, 2003
Wooded, sparse ground litter	0.40	T.O.C.H.
Porous Asphalt	0.30	T.O.C.H.
Park, cemetery	0.50	T.O.C.H.
Playground	0.60	Malcom, 2003

(5) Apply the Rational Equation for the applicable pre/post-development condition and storm frequency.

$$Q = CiA \qquad \text{[Eq. 4-12]}$$

Where:
Q = Peak flow in cubic feet per second (cfs)
C = Runoff coefficient to reflect the ratio of rainfall to surface runoff
i = Rainfall intensity in inches per hour (in/hr)
A = Drainage area in acres (ac)

Precipitation Estimates

The analysis shall utilize point precipitation frequency estimates from the most recent version of NOAA Atlas 14 for North Carolina. Since 2004, this has been NOAA Atlas 14 Volume 2. This volume will be replaced by NOAA Atlas 14 Volume 13 upon completion. The station to be used for NOAA Atlas 14 precipitation data is CHAPEL HILL 2 W (31-1677).

The analysis shall use the upper end of the 90% confidence interval. For example, this would be 3.16 inches for the 1-year, 24-hour storm from Table 4.5. For the same storm event from Table 4.6, this would be 0.132 in/hr.

Table 4.5 - Depth-Duration Frequency Data

Duration	Average Recurrence Interval						
	1-Year (inches)	2-Year (inches)	5-Year (inches)	10-Year (inches)	25-Year (inches)	50-Year (inches)	100-Year (inches)
5 minutes	0.411 (0.376-0.449)	0.484 (0.444-0.530)	0.558 (0.511-0.609)	0.615 (0.563-0.672)	0.676 (0.615-0.736)	0.718 (0.651-0.782)	0.756 (0.682-0.824)
10 minutes	0.657 (0.601-0.718)	0.774 (0.710-0.847)	0.893 (0.818-0.976)	0.984 (0.900-1.07)	1.08 (0.980-1.17)	1.14 (1.04-1.25)	1.20 (1.08-1.31)
15 minutes	0.821 (0.751-0.897)	0.973 (0.893-1.07)	1.13 (1.03-1.23)	1.25 (1.14-1.36)	1.37 (1.24-1.49)	1.45 (1.31-1.58)	1.52 (1.37-1.66)
30 minutes	1.13 (1.03-1.23)	1.35 (1.23-1.47)	1.61 (1.47-1.75)	1.80 (1.65-1.97)	2.02 (1.84-2.20)	2.18 (1.98-2.38)	2.33 (2.10-2.53)
60 minutes	1.40 (1.28-1.53)	1.69 (1.55-1.85)	2.06 (1.89-2.25)	2.35 (2.15-2.56)	2.69 (2.45-2.93)	2.95 (2.68-3.22)	3.20 (2.89-3.49)
2 hours	1.68 (1.53-1.84)	2.03 (1.85-2.22)	2.49 (2.28-2.74)	2.87 (2.61-3.14)	3.33 (3.01-3.64)	3.70 (3.33-4.05)	4.05 (3.62-4.43)
3 hours	1.79 (1.64-1.96)	2.16 (1.98-2.37)	2.66 (2.44-2.92)	3.08 (2.81-3.37)	3.61 (3.27-3.94)	4.04 (3.64-4.41)	4.46 (3.99-4.87)
6 hours	2.15 (1.98-2.35)	2.59 (2.38-2.83)	3.20 (2.94-3.50)	3.71 (3.40-4.05)	4.37 (3.97-4.76)	4.92 (4.44-5.35)	5.47 (4.89-5.94)
12 hours	2.54 (2.34-2.77)	3.06 (2.82-3.34)	3.80 (3.49-4.15)	4.44 (4.06-4.83)	5.28 (4.79-5.73)	5.99 (5.39-6.48)	6.71 (5.98-7.25)
24 hours	2.96 (2.78-3.16)	3.58 (3.36-3.82)	4.47 (4.19-4.77)	5.17 (4.83-5.52)	6.11 (5.70-6.54)	6.86 (6.38-7.34)	7.62 (7.07-8.17)

Source: NOAA Atlas 14, Volume 2, Version 3 - CHAPEL HILL 2 W (31-1677) station

Table 4.6 - Intensity-Duration Frequency Data

Duration	Average Recurrence Interval						
	1-Year (in/hr)	2-Year (in/hr)	5-Year (in/hr)	10-Year (in/hr)	25-Year (in/hr)	50-Year (in/hr)	100-Year (in/hr)
5 minutes	4.93 (4.51-5.39)	5.81 (5.33-6.36)	6.70 (6.13-7.31)	7.38 (6.76-8.06)	8.11 (7.38-8.83)	8.62 (7.81-9.38)	9.07 (8.18-9.89)
10 minutes	3.94 (3.61-4.31)	4.64 (4.26-5.08)	5.36 (4.91-5.86)	5.90 (5.40-6.44)	6.46 (5.88-7.04)	6.86 (6.22-7.48)	7.21 (6.50-7.85)
15 minutes	3.28 (3.00-3.59)	3.89 (3.57-4.26)	4.52 (4.14-4.94)	4.98 (4.55-5.43)	5.46 (4.97-5.95)	5.79 (5.25-6.31)	6.07 (5.48-6.62)
30 minutes	2.25 (2.06-2.46)	2.69 (2.47-2.94)	3.21 (2.94-3.51)	3.61 (3.30-3.94)	4.04 (3.68-4.41)	4.36 (3.95-4.75)	4.65 (4.19-5.07)
60 minutes	1.40 (1.28-1.53)	1.69 (1.55-1.85)	2.06 (1.89-2.25)	2.35 (2.15-2.56)	2.69 (2.45-2.93)	2.95 (2.68-3.22)	3.20 (2.89-3.49)
2 hours	0.838 (0.766-0.922)	1.01 (0.926-1.11)	1.25 (1.14-1.37)	1.43 (1.30-1.57)	1.66 (1.50-1.82)	1.85 (1.66-2.02)	2.03 (1.81-2.22)
3 hours	0.595 (0.545-0.653)	0.719 (0.660-0.789)	0.887 (0.812-0.973)	1.03 (0.937-1.12)	1.20 (1.09-1.31)	1.34 (1.21-1.47)	1.48 (1.33-1.62)
6 hours	0.359 (0.330-0.392)	0.433 (0.398-0.473)	0.534 (0.491-0.584)	0.620 (0.567-0.676)	0.730 (0.663-0.795)	0.821 (0.741-0.894)	0.913 (0.817-0.992)
12 hours	0.211 (0.194-0.230)	0.254 (0.234-0.277)	0.316 (0.290-0.344)	0.368 (0.337-0.401)	0.438 (0.398-0.475)	0.497 (0.448-0.537)	0.557 (0.497-0.601)
24 hours	0.123 (0.116-0.132)	0.149 (0.140-0.159)	0.186 (0.175-0.199)	0.215 (0.201-0.230)	0.255 (0.237-0.272)	0.286 (0.266-0.306)	0.318 (0.294-0.340)

Source: NOAA Atlas 14, Volume 2, Version 3 - CHAPEL HILL 2 W (31-1677) station

4.4 STORMWATER DRAINAGE SYSTEM

For the purposes of this section “storm drainage systems” include engineered infrastructure designed to safely and effectively receive, convey, and discharge stormwater runoff within Town’s planning jurisdiction. Drainage facilities must be designed to control/convey stormwater runoff resulting from all storm events up to and including the design storm as noted in Table 4.7.

Streets

The stormwater management and storm drainage infrastructure shall be designed such that:

(1) Streets will not be flooded as a result of stormwater runoff from the applicable design storm.

(2) Backwater will not exceed the boundaries of storm drainage easements or rights-of-way.

(3) Structures and/or property located outside of drainage easements or regulatory floodplains will not be flooded.

(4) When checking spread requirements at sag points (0% slope) check spread upstream of sags (at the 0.5% slope point) to verify spread is not exceeded. Additional flanking inlets upstream may need to be added to keep spread criteria from being exceeded at these points.

(5) Ponding at yard inlets outside the roadway shall be limited to a maximum of one foot above a grated inlet for the 10-year storm.

(6) No concentrated runoff flowing over Town sidewalks.

(7) Roadside ditches, when allowed, shall be a minimum of 18 inches deep and shall provide the capacity designed for a 10-year storm. For subdivision streets ditch flow for the 25-year storm shall not encroach onto the pavement. For thoroughfare streets ditch flow for the 50-year storm shall not encroach onto the pavement. Exceptions due to grading constraints may be granted by the Town on a case-by-case basis. See "Open Channels" subsections for more information.

(8) For subdivision streets the driveway and culvert shall be designed such that the flow from a 25-year storm shall not encroach onto the roadway pavement. For thoroughfare streets the driveway and culvert shall be designed such that the flow from a 50-year storm shall not encroach onto the roadway pavement.

Table 4-7 lists return periods for determining design storm discharges for different types of street facilities. The analysis should demonstrate that the surcharge or overflow discharge will be conveyed in a controlled manner and will not cause a public health or safety risk.

Table 4.7 - Design Storms for Streets

Facility*	**Design storm** (NRCS 24-hour duration)
Arterial Roadways	25 yr.
Collector Roadways	25 yr.
Local Roadway	10 yr.

*In Regulatory Floodways, the Design Storm is the 100-year, 24-hour return period; 2 feet of freeboard should also be provided for the 100-year, 24-hour storm. The Resource Conservation District provisions must be met also.

Check the 25-year, 24-hour and 50-year, 24-hour for local roadways and collector/arterial roadways, respectively.

Bridge/box culvert for stream crossings shall be designed to pass the 100-year, 24-hour storm event.

Note: Where conflicts exist between applicable State and Town design storm requirements, the more restrictive of the two shall govern.

Note: See Chapter 3 of this Manual for Roadway Classifications.

The maximum stormwater spread widths allowed in Table 4-8 are not exceeded for the applicable street classification.

Table 4.8 - Maximum Allowable Stormwater Spread on Pavement

Street classification	Maximum allowable spread
Local	No curb over-topping, *flow spread must leave at least one dry 10-ft travel lane.
Collector and arterial	No curb over-topping, *flow spread must leave at least one dry 10-ft travel lane *in each direction*.

* Where no curbing exists, spread shall not extend outside of the public right-of-way.

(Reference: Wright-McLaughlin Engineers)

Street Inlets

(1) Street inlet spacing shall utilize a design storm intensity of 4 inches per hour. Gutter spread widths shall not exceed ½ the width of a travel lane, with an absolute maximum of 8 feet. In areas of heavy pedestrian traffic or alleys, the maximum allowable spread may be decreased by the Stormwater Management Division.

(2) Inlet bypass shall be limited to less than 0.10-cubic feet per second (cfs) into an intersection**.** Inlets on a continuous grade should be spaced to limit the spread of stormwater onto the pavement. The spacing of inlets is based on the allowable spread and the inlet capacity. The flow bypassing an inlet must be included in the flow arriving at the next inlet.

(3) Inlets should be placed at intersections and all low points in the gutter grade to prevent gutter flow from crossing traffic and pedestrian lanes of the intersecting road.

(4) Inlet capacity calculations shall assume a 50% clogging factor for inlets located in a sump condition.

(5) A minimum of two inlets- double inlet) should be placed in the sag of vertical curves. The additional inlets provide extra capacity and a safety factor against potential street flooding if the inlets become clogged due to deposition of sediment and debris. This also reduces the flow arriving at the low point and thereby help reduce ponding which could flood the road.

(6) Inlet types shall be selected from the Town of Chapel Hill Standard inlet type or equivalent North Carolina State Department of Transportation standards on NCDOT Streets. Inlets shall be located or spaced in such a manner that the design curb flow does not exceed the spread limitations.

(7) Inlets on a continuous grade should be spaced to limit the spread of stormwater onto the pavement. The spacing of inlets is based on the allowable spread and the inlet capacity. The flow bypassing an inlet must be included in the flow arriving at the next inlet.

(8) Inlets are normally placed upstream of pedestrian crossings to intercept the gutter flow before it reaches the crosswalk. Where pavement surfaces are warped at cross streets, ramps, or transitions between super elevated and normal sections, gutter flow should be diverted into the storm drainage system to prevent water flow across the roadway. Where a curbed roadway crosses a bridge, gutter flow should be intercepted before it reaches the bridge.

Curb & Gutter

1) Standard 30-inch curb-and-gutter is required in all cases, unless an alternative is approved by the Town Manager.

2) The typical minimum longitudinal grade for curb & gutter is 2%.

3) Spot grades or profiles shall be provided in cul-de-sacs to ensure positive drainage.

Gutter Flow Calculations

The following form of Manning's equation should be used to evaluate gutter flow hydraulics:

$$Q = \left[\frac{0.56}{n}\right] ST^{\frac{5}{3}} SL^{\frac{1}{2}} T^{\frac{8}{3}} \qquad \text{[Eq. 4-13]}$$

Where: *Q = Gutter flow rate (ft^3/sec)*
n = Manning's roughness coefficient
ST = Pavement/roadway cross-slope (ft/ft)
SL = Longitudinal slope (ft/ft), Generally, this is equivalent to the roadway centerline profile.
T = Width of flow or spread (ft)
Note: Manning's n value for concrete curb and gutter is 0.016.

In tabular format, report the following:

a. Inlet # – Assigned number (or label) of drainage structure.
b. Drainage Area – Area contributing runoff to the inlet (acres).
c. Surface 'Q' Sub, Q_{sub} – Flow (in cfs) from inlet sub-basin
d. Inlet flow capacity, $Q_{inlet\ cap}$ – Flow (in cfs) capacity of the inlet
e. Bypass flow, Q_{bypass} – Flow (in cfs) that is bypassed around the inlet
f. Total gutter flow, Q*total* – All gutter flow (in cfs) at inlet

$$Q_{sub} = CiA \qquad \text{[Eq. 4-12]}$$

Where: *Q = Peak flow in cubic feet per second (cfs)*
C = Runoff coefficient to reflect the ratio of rainfall to surface runoff
i = Rainfall intensity in inches per hour (in/hr) = 4.0 in/hr
A = Drainage Area in acres (ac)

$$Q_{inlet\ cap} = KD^{5/3}$$ [Eq. 4-15]

Where: $Q_{inlet\ cap}$ *= Inlet Capacity (cfs)*
K = Coefficient is used to determine the inlet capacity of a catch basin grate on grade.
D = ST x T, depth of flow at curb (ft)

ST = Pavement cross slope (ft/ft)
T = Width of flow or spread (ft) (refer to Table 4.8)

Example:

For a "normal crown" street, ST = 3/8" per 1' = 0.0313 ft/ft.

The maximum spread, T, is 10'. D = 0.0313 ft/ft x 10' = 0.313'

$$Q_{bypass} = Q_{sub} - Q_{inlet\ cap}$$ [Eq. 4-16]

Note/list the bypass destination

$$Q_{total} = Q_{sub} + \sum Q_{bypass}$$ [Eq. 4-14]

Note: Computer software for gutter flow analysis is acceptable. The computer printout should contain the same information as described above *(Inlet #, Drainage Area,* $Q_{sub,}$ Q_{bypass}, $Q_{inelt\ cap}$ *and* Q_{total}*,).*

Longitudinal Slope

A minimum longitudinal gradient is more important for a curbed pavement, since it is susceptible to stormwater spread. Flat gradients on uncurbed pavements can lead to a spread problem if vegetation is allowed to build up along the pavement edge.

Curb and gutter grades that are equal to pavement slopes shall not fall below 0.5 percent. Minimum grades can be maintained in very flat terrain by use of a sawtooth profile. For long vertical curves, cross slope may be varied slightly to achieve 0.5 percent minimum gutter grade.

Bridge Decks

Drainage of bridge decks is similar to other curbed roadway sections. Because of the difficulties in providing and maintaining adequate deck drainage systems, gutter flow from roadways should be intercepted before it reaches a bridge. In many cases, deck drainage must be carried several spans to the bridge end for disposal. Zero gradients and sag vertical curves should be avoided on bridges. The minimum desirable longitudinal slope for bridge deck drainage should be 1 percent. When bridges are placed at a vertical curve and the longitudinal slope is less than 1 percent, the gutter spread should be checked to ensure a safe, reasonable design. Scuppers are the recommended method of deck drainage because they can reduce the problems of transporting a relatively large concentration of runoff in an area of generally limited right-of-way.

However, the use of scuppers should be evaluated for site-specific concerns. Scuppers should not be located over embankments, slope protection, navigation channels, driving lanes, or railroad tracks. Runoff collected and transported to the end of the bridge should generally be collected by inlets and down drains. For situations where traffic under the bridge or environmental concerns prevents the use of scuppers, grated bridge drains should be used.

Median Barriers

Weep holes are often used to prevent ponding of water against median barriers (especially on superelevated curves). In order to minimize flow across traveled lanes, it is preferable to collect the water into a subsurface system connected to the main storm drain system.

Open Channels

For open channels, the erosion potential of the soil shall be evaluated for the 10-year storm event. Channels and ditches shall be designed to carry the design flow at non-erosive velocities, and contain the design storm within the banks.

Surface flow and channel velocities shall not exceed 4 feet per second for the applicable design storm.

Appropriate measures shall be taken to protect the soil and/or reduce velocities to prevent erosion. The channel protection required to prevent erosion is determined by computing the velocity in the channel at the design discharge and comparing that velocity with the permissible value for the type of channel lining used.

Calculations indicating design velocities shall be provided along with typical channel cross-sections. The non-erosive velocities shall be based on the permanent cover and temporary lining proposed as per Table 8.05a in the North Carolina Erosion and Sediment Control Planning and Design Manual published by NCDEQ. The minimum slope for open channel systems (ditches, swales) shall be 2%.

1. For maintenance and stability reasons, the maximum side-slope for open channels is 3:1.
2. Riprap will not be allowed for stabilization within the street right-of-way (except as outlet protection on culverts).

Super elevation of the water surface at horizontal curves shall be accounted for by increased freeboard.

A minimum freeboard of 6” must be provided in the 10-year design storm.

Transition from closed systems to channel sections (or between transitioning channel sections) shall be smooth and gradual, with a minimum of 5:1 taper.

In addition to the design of roadside ditches, a design shall be provided for driveway culverts for each individual lot on the plan. The use of a small driveway culvert, 15-inches minimum diameter, in conjunction with overtopping of the driveway itself will be allowed as further described in the Culverts paragraph below. Sizes for all driveway culverts shall be shown in tabular form on the plans, and each culvert shall be designed for the highest ditch flow applicable for the lot.

Vegetated Open Channels

Vegetation is the most desirable lining for an artificial channel. It stabilizes the channel body, consolidates the soil mass of the bed, inhibits erosion on the channel surface, and controls the movement of soil particles along the channel bottom. Conditions under which vegetation may not be acceptable; however, include but are not limited to:

5. Flow conditions in excess of the maximum shear stress for bare soils
6. Standing or continuous flowing water
7. Lack of regular maintenance necessary to prevent domination by taller vegetation
8. Lack of nutrients and inadequate topsoil
9. Excessive shade
10. Excessive velocities

Proper seeding, mulching, and soil preparation are required during construction to ensure establishment of a healthy stand of grass. Soil testing may be performed and the results evaluated by an agronomist to determine soil treatment requirements for pH, nitrogen, phosphorus, potassium, and other factors. In many cases, temporary erosion control measures are required to provide time for the seeding to establish a viable vegetative lining.

Under continuous base flow conditions when a vegetative lining alone would be appropriate, a small concrete pilot channel could be used to convey the continuous low flows. Vegetation could then be maintained for conveying larger flows.

Open Channel Permissible Velocity Calculations

The permissible velocity procedure uses two equations to calculate flow:

Manning's equation,

$$V = \frac{1.49}{n}(R^{2/3})(S^{1/2}) \qquad \text{[Eq. 4-8]}$$

Where: V = average velocity (ft/s)
r = hydraulic radius (ft) and is equal to a/P_w
a = cross sectional flow area (ft^2)
P_w = wetted perimeter (ft)
s = slope of the HGL (channel slope, ft/ft)
n = Manning's roughness coefficient for open channel flow

And the continuity equation,

$$Q = AV \qquad \text{[Eq. 4-17]}$$

Where: Q = flow in the channel (cfs)
A = cross-sectional area of flow within the channel (ft^2)
V = average velocity in the channel (ft/sec)

Manning's equation and the continuity equation are used together to determine channel capacity and flow velocity.

Selecting Permanent Channel Lining

The design of concrete and similar rigid linings is generally not restricted by flow velocities. However, vegetative and flexible channel linings do have maximum permissible flow velocities beyond which they are susceptible to erosion. The designer should select the type of liner that best fits site conditions. Before an acceptable vegetation liner is established, permissible velocity is determined by the choice of temporary liner. Permissible velocities for riprap linings are higher than for a vegetation liner and are dependent upon on the stone size.

Recommended Manning's n values for natural channels are given in Table 4.9 and recommended Manning's n values for artificial channels are given in Table 4.10.

Table 4.9 - Recommended Manning's n Values for Natural Channels

Type of channel and description	Minimum	Normal	Maximum
Minor Streams (top width at flood stage < 100 ft)			
a. Streams on plain			
1. Clean, straight, full stage, no rifts or deep pools	0.025	0.03	0.033
2. Same as above, but more stones and weeds	0.03	0.035	0.04
3. Clean, winding, some pools and shoals	0.033	0.04	0.045
4. Same as above, but some weeds and stones	0.035	0.045	0.05
5. Same as above, lower stages, more ineffective slopes and sections	0.04	0.048	0.055
6. Same as 4, but more stones	0.045	0.05	0.06
7. Sluggish reaches, weedy deep pools	0.05	0.07	0.08
8. Very weedy reaches, deep pools, or floodways with heavy stand of timber and underbrush	0.075	0.1	0.15
b. Mountain streams, no vegetation in channel, banks usually steep, trees and brush along banks submerged at high stages			
1. Bottom: gravels, cobbles and few boulders	0.03	0.04	0.05
2. Bottom: cobbles with large boulders	0.04	0.05	0.07
Flood Plains			
a. Pasture, no brush			
1. Short grass	0.025	0.03	0.035
2. High grass	0.03	0.035	0.05
b. Cultivated areas			
1. No crop	0.02	0.03	0.04
2. Mature row crop	0.025	0.035	0.045
3. Mature field crop	0.03	0.04	0.05
c. Brush			
1. Scattered brush, heavy weeds	0.035	0.05	0.07
2. Light brush and trees, in winter	0.035	0.05	0.06
3. Light brush and trees, in summer	0.04	0.06	0.08
4. Medium to dense brush, in winter	0.045	0.07	0.11
5. Medium to dense brush, in summer	0.07	0.1	0.16
d. Trees			
1. Dense willows, summer, straight	0.11	0.15	0.2
2. Cleared land with tree stumps, no sprouts	0.03	0.04	0.05
3. Same as above, but with heavy growth of sprouts	0.05	0.06	0.08

4. Heavy stand of timber, a few down trees, little undergrowth, flood stage below branches	0.08	0.1	0.12
5. Same as above, but with flood stage reaching branches	0.1	0.12	0.16

Abridged from Chow, V.T., ed. 1959, Open-Channel Hydraulics

Table 4.10 - Recommended Manning's n Values for Artificial Channels

Rip rap	*n (depth of flow ≥ 2')*
Class B stone	0.037
Class 1 rip rap	0.040
Class 2 rip rap	0.045

Note: See Table 4.11 for temporary lining materials such as straw matting. If using values other than ones listed above or in Table 4.9, please provide documentation

Table 4.11 - Recommended Manning's n Values for Temporary Lining Materials

Lining Type	0.0' - 0.5'	0.5' - 2.0'	> 2'
Jute Net	0.28	0.022	0.019
Straw/Curled Wood Mat	0.066	0.035	0.028

For maintenance and stability reasons, the maximum side-slope for open channels is 3:1. The channel protection required to prevent erosion is determined by computing the velocity in the channel at the design discharge and comparing that velocity with the permissible value for the type of channel lining used.

Culverts

1. For culverts, the 25-year storm shall be used unless otherwise required by Town staff. Culverts shall be sized in accordance with the Energy Equation and applicable nomographs to carry the design flow and to provide a velocity of at least 2 feet per second during the 2-year storm. The minimum slope for culverts shall be 1% unless the existing stream channel is flatter. In no case should pipe slopes be less than 0.5%.

2. Culvert design on Town maintained roads shall provide 1 foot of freeboard from the edge of road surface during the:

    1. 10-year, 24-hour storm event for all driveways, alleys, local streets, and main streets.

    2. 25-year, 24-hour storm event for all other streets.

3. Culverts on State maintained roads, or roads the Town has identified as potentially being turned over to the State's system, shall meet NCDOT standards.

4. Stream crossings requiring greater than a 36-inch culvert will necessitate a back water study of the 100-year storm.

5. Determining the hydraulic efficiency of a culvert requires calculation of three energy losses: inlet losses (resulting from the shape and alignment of the entrance to a culvert), outlet losses (resulting from the change in cross-sectional area at the outlet of a culvert), and friction losses (resulting from resistance to flow within a culvert). Culvert design may require the calculation of the hydraulic grade line to ensure surcharge protection.

    1. The **inlet control analysis** evaluates the capacity of a culvert at its entrance considering the depth of headwater, type of inlet, and the entrance shape. The headwater depth is the vertical distance from the culvert invert at the entrance to the headwater pool surface. The roughness, length and outlet conditions of the culvert are not factors in an inlet control analysis. Inlet control calculations shall be provided for all culverts and demonstrate a headwater over depth (HW/D) ratio less than or equal to 1.0 preferred, with an absolute maximum of 1.2.

    2. The **outlet control analysis** evaluates the capacity of a culvert considering all hydraulic factors upstream from the outlet. These hydraulic factors include the culvert shape, length, slope, and roughness, and the depth of water at the culvert outlet. Friction losses are part of the outlet control analysis. The downstream hydraulic gradient at the outlet end of the culvert shall be the “known” water surface elevation (based on downstream backwater elevation) or the crown of the pipe, whichever is greater. Outlet control calculations shall be provided for all culverts and demonstrate a headwater over depth (HW/D) ratio less than or equal to 1.0 preferred, with an absolute maximum of 1.2.

6. Culvert End Treatments are intended to provide protection against excessive scour at inlets and outlets. End treatments typically include flared end sections and/or headwalls.

7. There should be no more than two pipe culverts per crossing. Installation shall include box culverts or elliptical pipe, of no more than two barrels, if requiring greater than double pipe culverts.

Drainage Pipes

After the tentative locations of inlets, drain pipes, and outfalls with tailwaters have been determined and the inlets have been sized, the next logical step is the computation for the rate of discharge to be carried by each drain pipe and the determination of the size and gradient of pipe required to convey this discharge. This is done by proceeding in steps from upstream of a line to downstream to the point at which the line connects with other lines or the outfall, whichever is applicable. The discharge for a run is calculated, the drain pipe serving that discharge is sized, and the process is repeated for the next run downstream. It should be recognized that the rate of discharge to be carried by any particular section of drain pipe is not necessarily the sum of the inlet design discharge rates of all inlets above that section of pipe, but as a general rule is somewhat less than this total. It is useful to understand that the time of concentration is most influential and as the time of concentration grows larger, the proper rainfall intensity to be used in the design grows smaller.

For ordinary conditions, drain pipes should be sized on the assumption that they will flow full or practically full under the design discharge but will not be placed under pressure head. The Manning's equation is recommended for capacity calculations.

The following criteria apply to storm drainage pipes under public streets, within public rights-of-way, and/or within public drainage easements.

1. For enclosed pipe system sizing, the Hydraulic Grade Line (HGL) shall not exceed the crown of pipe elevation for the 10-year storm event and shall not exceed the top of structures (or gutter line elevation, as appropriate) for the 25-year storm event.

2. Where the HGL cannot be fully contained within the pipe due to physical or engineering constraints, the Town may allow pipe meeting ASTM C443/AASHTO M198 (Joints for Concrete Pipe and Manholes using Rubber Gaskets) to be used for the affected line segments.

3. All drainage pipes to be maintained by the Town shall be Class III or greater reinforced concrete pipe. The minimum inside pipe diameter shall be 15 inches. Pipe joints shall be sealed.

4. Flared-end sections may be used with pipes ≤ 36 inches in diameter. The flared end section shall be installed with appropriate curtain wall. Flared end sections may not be installed on multiple pipe culverts. End walls shall be provided for single pipes with diameters > 36 inches and on multiple pipe culverts unless alternative end treatments are approved by the Town.

5. The maximum pipe velocity shall not exceed 20 feet per second, or 10 feet per second in corrugated metal pipe.

6. The maximum discharge velocity at a pipe outlet is 10 fps.

7. Energy dissipaters shall be installed at all discharge points and shall be properly sized to ensure that stormwater is released at a non-erosive velocity. A fabric barrier shall be installed between dissipation pads and the natural ground.

8. The minimum pipe slope shall be 0.5% and maximum acceptable slope shall be 10%. Storm drainage pipes shall be sized in accordance with the Manning Equation and applicable nomographs to carry the design flow and to provide a velocity of no less than 2 feet per second when the pipe is flowing half-full.

9. The maximum pipe length without installation of a structure providing maintenance access is 400 feet (catch basin, curb inlet, junction box, etc.). Pipe shall be installed to provide a true line and grade between structures. Structures shall be installed at each deflection of

line and/or grade.

10. The minimum cover for drainage pipes is 2 feet unless otherwise approved by the Town Manager. Pipes shall maintain a minimum of 2 feet of cover from top of pipe to bottom of pavement structure within a roadway, or finished grade when not within a load bearing area.

11. Each drainage structure shall have an invert constructed from concrete and shaped to conform to the pipe inside diameter, and a bench with a maximum 5:1 slope. The bench shall begin at a height of one-half the pipe diameter for pipes with a diameter or 12 to 24 inches, one-third the pipe diameter for pipes with a diameter of 30 to 48 inches, and one-fourth the diameter for pipe with a diameter greater than 48 inches.

12. Sanitary sewer mains shall have a minimum vertical separation of 24 inches between storm pipes when the horizontal separation is 3 feet or less. Where sanitary and storm sewers cross with a vertical separation of less than 24 inches, the entire leg of sanitary sewer shall be made of standard ductile iron pipe with joints rated for water main service and the void space between the pipe crossing shall be backfilled with 3000-psi concrete or quick setting, minimum 500-psi, non-excavatable flowable fill that meets or exceeds NCDOT specifications.

    The classifications all streams, creeks, and/or waterbodies within 100’ of sanitary sewers shall be documented and it shall also be documented that the sanitary sewer separation is in accordance with 15A NCAC 2T .0305 (f) and (g).

    Sanitary sewers located adjacent to streams shall be located outside of the streambed and sufficiently removed therefrom to provide for future possible stream widening and to prevent pollution by siltation during construction.

13. Prohibited Illicit Connections shall include, but are not limited to:
    1. Any connection conveying discharges of sanitary sewerage, process wastewater, dumpster runoff, cooling or boiler water
    2. Area (floor) drains serving interior covered spaces (such as parking decks or garages)
    3. Sump pits serving related to hydraulic or mechanical equipment (elevators)

Outlet Protection

1) The outlet protection should be designed in accordance with the North Carolina Erosion and Sedimentation Control Planning and Design Manual or other approved methods by the Town of Chapel Hill. The engineer should submit calculations with drawings for approval.

2) Outlet Protection must be provided as necessary to dissipate energy and to create diffuse flow at the outlet ends of conveyance structures. Outlet protection measures include installation of rock-reinforced aprons, stilling basins, level spreaders, or other approved methods.

3) Evaluation of flow conditions, scour potential, and channel erosion should be included in standard design analyses. The initial protection against channel erosion should be sufficient to minimize the impacts of a single storm event. Stilling basin and level spreader installations are preferred means of energy dissipation.

4) The use of local rock is preferred in lieu of quarried riprap for the construction of energy dissipating rock aprons and stilling basins. This Design Manual provides the minimum dimensions for rock aprons and stilling basins at storm drainage outlets. However, existing conditions at the outlet and scour potential may dictate the installation of outlet protect measures in excess of the minimum requirements.

Subsurface Drainage

The installation of subsurface drainage measures may be required to protect against inundation of subgrade materials when landscaped and/or irrigated areas are constructed adjacent to streets or sidewalks.

Regulatory Floodways

For areas prone to flooding, the 100-year, 24-hour storm shall be used for design purposes.

Reserved Storm Drainage Easement

- The standard utility easement width is thirty feet (30') wide. Easements for more than one utility typically are increased ten feet in width for each additional underground utility to provide for adequate separation between utility lines.

- All engineered stormwater facilities intended for management of peak discharges, volume, or water quality treatment shall be located within easements entitled: "RESERVED STORM DRAINAGEWAY EASEMENT" and shall be indicated on the Stormwater Management Plan.

- Unless specifically designated as being "Public", these easements and the facilities/functions they serve are considered by the Town to be private, and the Town assumes no responsibility for necessary inspection, operation, and/or maintenance duties. These easements shall be maintained by homeowner or property owner associations, or in the absence thereof, the individual property owner. Private drainage easements should be located in open space to the maximum extent practicable.

- The minimum building setback on all stormwater easements shall be 2 feet. Excessively deep storm sewers shall have an additional building setback from the easement:
    - 5 feet for pipes between 10 feet and 15 feet in depth (measured from the ground surface to the pipe invert)
    - 10 feet for pipes deeper than 15 feet

- Encroachments into any drainage easement, except those expressly permitted, shall be prohibited. In no instance shall the load plane of a building or structure come within 5 feet of the outside edge of a storm pipe.

- When a yard swale or private pipe drains two or more upstream properties or conveys a 10-year storm event peak flow rate of 2 cfs or greater, a storm drainage easement of ≥ 20' shall be provided.

- All drainage easements shall be drivable and constructed of a solid surface where they intersect a roadway.

- Variable width easements are allowed for roof leaders and small yard drainage systems. The maintenance of these systems is expected to be done by digging by hand, so a smaller width easement is allowed.

- The maximum longitudinal slope permitted is 5:1 (horizontal: vertical).

- The maximum cross slope permitted is 10:1 (horizontal: vertical).

4.5 STORMWATER CONTROL MEASURES

All design submittals shall be sealed by a professional engineer licensed in the State of North Carolina. Stormwater design summaries and checklists are included in Appendix A. While not required, the checklists are very helpful to the reviewer and may expedite the review.

Orifice provided for water quality or 2-year volume drawdown shall not be smaller than one inch diameter. The stormwater reviewer may waive the drawdown requirement if the one inch cannot meet the 2-5 day requirement.

Stormwater Control Measures Hyperlink

NCDEQ Stormwater Design Manual

4.6 ADJUSTMENTS OR WAIVERS

Information requirements may be adjusted or waived by the Town Manager for a particular development application upon written request of the applicant, provided that at least one of the following circumstances can be demonstrated:

- Alternative measures for on-site and/or off-site management of stormwater have been proposed, and these measures are approved by the Town Manager and comply with local ordinance(s).

2. It is otherwise demonstrated that the proposed development will not produce any significant change to the existing pre-application hydrology.

STORMWATER MANAGEMENT REPORT REQUIREMENTS

Pursuant to the Town of Chapel Hill Land Use Management Ordinance Section 5.4, Stormwater Management, all applications for developments or subdivisions and any building (some single-family or two-family dwellings resulting in less than or equal to 20,000 square feet of land disturbance may not be subject to these requirements) within the Town of Chapel Hill Planning Jurisdiction must include a Stormwater Management Report. As authorized by the Chapel Hill Land Use Management Ordinance, affirmative exemption to all or part of the requirements of the Stormwater Management Report may be granted by the Town.

Stormwater Management Report requirements include:

a. Written narrative describing:
   1. Existing & proposed conditions
   2. Pertinent onsite and offsite drainage conditions
   3. Anticipated stormwater impacts
   4. Design criteria
   5. Discussion of structural and non-structural SCMs and strategies chosen to mitigate development impacts that will be part of the stormwater management plan
   6. Soils information (classification, infiltration rates, seepage control, percent compaction of dam embankment, depths to groundwater and bedrock) certified by NCPE with geotechnical expertise for ZCP and as-built submission

b. Summary tables of the peak discharge flow rates (1, 2, and 25-year storms) for pre-development; post-development without stormwater management; and post-development with stormwater management, for *each* sub-basin/POA *and* the project site as a whole.

Summary of Peak Discharge Flowrates, Q *(cfs)*

Point of Analysis (POA) / Basin ID:_____

Design Storm	Pre-development (cfs)	Post-development			
		w/out Mitigation (cfs)	w/Mitigation (cfs)	Δ(PRE)-(POST w/Mitigation) (cfs)	Δ(PRE)-(POST w/Mitigation) (%)
1-year, 24-hour					
2-year, 24-hour					
25-year, 24-hour					

Summary Runoff Volumes (ft^3)

Point of Analysis (POA) or Basin ID	2-year, 24-hour Storm			WQV (P = 1"), Post-dev (ft^3)	SCM Storage (ft^3)
	Pre-dev (ft^3)	Post-dev (ft^3)	Δ(PRE)-(POST) (ft^3)		
(indicate each POA or Basin ID and add rows as necessary)					
∑					

c. Summary table of the volume management results (WQV and 2-year storms) for pre-development; post-development without stormwater management; and post development with stormwater management, for all sub-basins/POAs and the project site as a whole.

d. Hydrology calculations, to include:

   1. Pre-development and post-development drainage maps clearly labeled and showing delineated drainage sub-basins; connectivity of conveyance system and stormwater structures; and POAs. Flow paths in each sub-basin must be indicated (may be included in plan set). Drainage area maps must be to scale; scale shall be no smaller than 1-inch = 100-feet

   2. Summary table of land uses and areas (in square feet) within each drainage basin, curve numbers/runoff coefficients for each land use, Basin ID, and source of values used

   3. Time of concentration (T_c) calculations

   4. Peak discharge calculations, with results documented in a summary table (See b. above)

   5. Volume management calculations, with results documented in a summary table (See c. above)

e. Hydraulic calculations, to include:

   1. Water quality volume calculations for providing 85% TSS removal for post-development stormwater runoff

   2. SCM sizing calculations, including stage-storage-discharge information

   3. Routings and hydrographs for each sub-basin point of analysis

   4. Pipe sizing calculations, pipe schedule and Hydraulic/Energy Grade Line (HGL/EGL) study (for all storm drainage pipe systems; the study shall include profiles with labeled inverts, slopes, proposed finished grade and hydraulic grade line for 10-year, 24-hour and 25-year, 24-hour storm events)

   5. Channel sizing calculations

   6. Outlet dissipater sizing calculations

HGL/EGL Study must include all portions of private storm sewer collection system(s) to the outlet structure(s) or connection(s) to public (ToCH or NCDOT) storm sewer infrastructure.

Final plans will need to detail the types and frequency of inspection and maintenance operations (major and minor), equipment necessary to perform maintenance activities, access to the stormwater control facility, disposal methods for uncontaminated and contaminated materials, and information regarding the facility owner(s) and party or parties responsible for facility operation and maintenance. The Town will require a maintenance plan and may require that a perpetual maintenance bond be posted.

f. Nutrient Loading Calculations – Completed output from Jordan/Falls Stormwater Load Accounting Tool printed on 11x17 paper.

g. Draft Inspections, Operations, and Maintenance Plan for each stormwater management structure.

STAFF NOTE: When responding to review comments, the applicant should provide a response to each comment and indicate where the changes have been made. Plan revisions should be highlighted graphically, e.g., clouds, boxes, etc. An example of the preferred layout of the Stormwater Submittal is outlined above.

Stormwater submittal requirements	Required for preliminary submittal	Required for final submittal
a. Written narrative describing:	x	x
1. Existing & proposed conditions	x	x
2. Pertinent onsite and offsite drainage conditions	x	x
3. Anticipated stormwater impacts	x	x
4. Design criteria	x	x
5. Discussion of structural and non-structural SCMs and strategies chosen to mitigate development impacts that will be part of the stormwater management plan.	x	x
6. Soils information (classification, infiltration rates, depths to groundwater and bedrock)	x	x
b. Summary tables of the peak discharge flow rates for the 1, 2, and 25-year, 24-hour storms for *each* sub-basin/POA *and* the project site as a whole.	x	x
1. Pre-development	x	x
2. Post-development without stormwater management	x	x
3. Post-development with stormwater management		x
4. Change in predevelopment to post-development with stormwater management		x
c. Summary table of runoff volumes (WQV and 2-year storms) for all sub-basins/POA and the project site as a whole.	x	x
1. 2-yr, 24-hr, Predevelopment	x	x
2. 2-yr, 24-hr, Post-development	x	x
3. 2-yr, 24-hr, change in predevelopment to post-development	x	x
4. WQV	x	x
5. SCM Storage		x
d. Hydrology calculations, to include:	x	x
1. Predevelopment and post-development drainage maps to scale; scale shall be no smaller than 1-inch = 100-feet.	x	x
A. Clearly labeled with delineated drainage sub-basins	x	x
B. Showing Points of analysis (POAs)	x	x
C. Showing connectivity of conveyance system and stormwater structures		x
D. Showing flow paths in each sub-basin (may be included in plan set)		x
2. Summary table of land uses and areas (in square feet) within each drainage basin, curve numbers/runoff coefficients for each land use, Basin ID, and source of values used.		x
3. Time of concentration (T_c) calculations		x
4. Peak discharge calculations, with results documented in a summary table (See b. above).		x
5. Volume management calculations, with results documented in a summary table (See c. above).		x
e. Hydraulic calculations, to include:	x	x
1. Water quality volume calculations for providing 85% TSS removal for post-development stormwater runoff	x	x
2. BMP sizing calculations	x	x
A. Including surface area / sizing requirements	x	x
B. Including stage-storage-discharge information		x
3. Routings and hydrographs for each sub-basin point of analysis		x
4. Pipe sizing calculations, pipe schedule and Hydraulic/Energy Grade Line (HGL/EGL) study (for all storm drainage pipe systems; the study shall include profiles with labeled inverts, slopes, proposed finished grade and hydraulic grade line for 10-year, 24-hour and 25-yr, 24-hour storm events)		x
5. Channel sizing calculations		x
6. Outlet dissipator sizing calculations		x
f. Nutrient Loading Calculations - Completed Jordan Lake Stormwater Load Accounting Tool, if required, printed on 11x17 paper.		x
g. Draft Inspections, Operations, and Maintenance Plan for each stormwater management structure.		x

DAM EMBANKMENT CONSTRUCTION NOTES

- Placement of any fill material must be conducted under the observation of a qualified licensed geotechnical engineer and upon completion of the earthwork activities, the town of chapel hill stormwater management office must be provided with a final grading report that includes the corresponding compaction test results and certifies the type of fill material and its proper placement with as-built.
- All fill material to be used for the dam embankment shall be taken from borrow areas approved by the on-site geotechnical engineer. Fill material shall be constructed of clean structural soil, free of roots, stumps, woods, stones greater than 2'' and other objectional material. Controlled fill, as specified by the geotechnical engineer, in the embankment fill shall be placed in 6" loose layers (3" loose layers within 3' on either side of the principal pipe to a depth of 2" over the pipe) compact to at least 98% standard proctor maximum dry density. All compaction is to be determined by AASTHO method T-99 (standard proctor)
- The geotechnical engineer shall observe and certify all aspects of the construction of the embankment (i.e., preparation of foundation, installation of the cut-off trench, installation of principal spillway pipe, installation of internal drainage, installation of compacted fill, etc.). The frequency of observation and testing must be sufficient for the geotechnical engineer to state in his/her opinion, that the specific items observed and tested were installed in accordance with the approved construction drawings and specifications.
- Colored digital photographs showing the dam foundation areas, the riser, the principal spillway pipe, the concrete cradle, the seepage diaphragm, relief drains, etc., as those items were being prepared and installed (electronic format: .jpg) shall be provided to town stormwater management division with the as-built.
- A natural liner (i.e. clay) shall be installed over the entire pond floor below the permanent pool to reduce the infiltration rate of the bottom of the pond to less than 0.1 in/hr.

4.8 SINGLE-FAMILY DESIGN GUIDELINES

A Professional Engineer's Certification and Stormwater Management Plan are required for all Zoning Compliance Permit/Building Permit Applications for single or two-family development involving more than 20,000 square feet of land disturbance. The Stormwater Management Plan shall indicate the Stormwater control measures (SCMs) necessary to manage peak discharge rate, to provide 85% total suspended solids (TSS) removal and, if applicable, to provide volume management.

All design submittals shall be sealed by a professional engineer licensed in the State of North Carolina. The Stormwater Management Plan shall include all applicable stormwater impact calculations. Erosion control measures and a Stormwater Operations and Maintenance Plan are required for all development disturbing more than 20,000 square feet of land area. Prior to issuance of a Certificate of Occupancy (CO), a P.E. Certification must be submitted certifying that the stormwater management measures were installed as shown on the approved Stormwater Management Plan, and the agreed upon stormwater easement(s) and covenant(s) must be recorded with the appropriate County Register of Deeds.

Consider the site conditions when planning the project:

- Maintain natural drainage patterns as much as possible
- Minimize the amount of land disturbance
- Minimize the impervious area footprint
- Runoff must be discharged in a non-erosive and diffused manner
- Energy dissipaters are required at all outlets
- No drainage outlets are permitted in setbacks or riparian buffers

Figure 4.5 - CONCRETE SPLASH BLOCK DETAIL

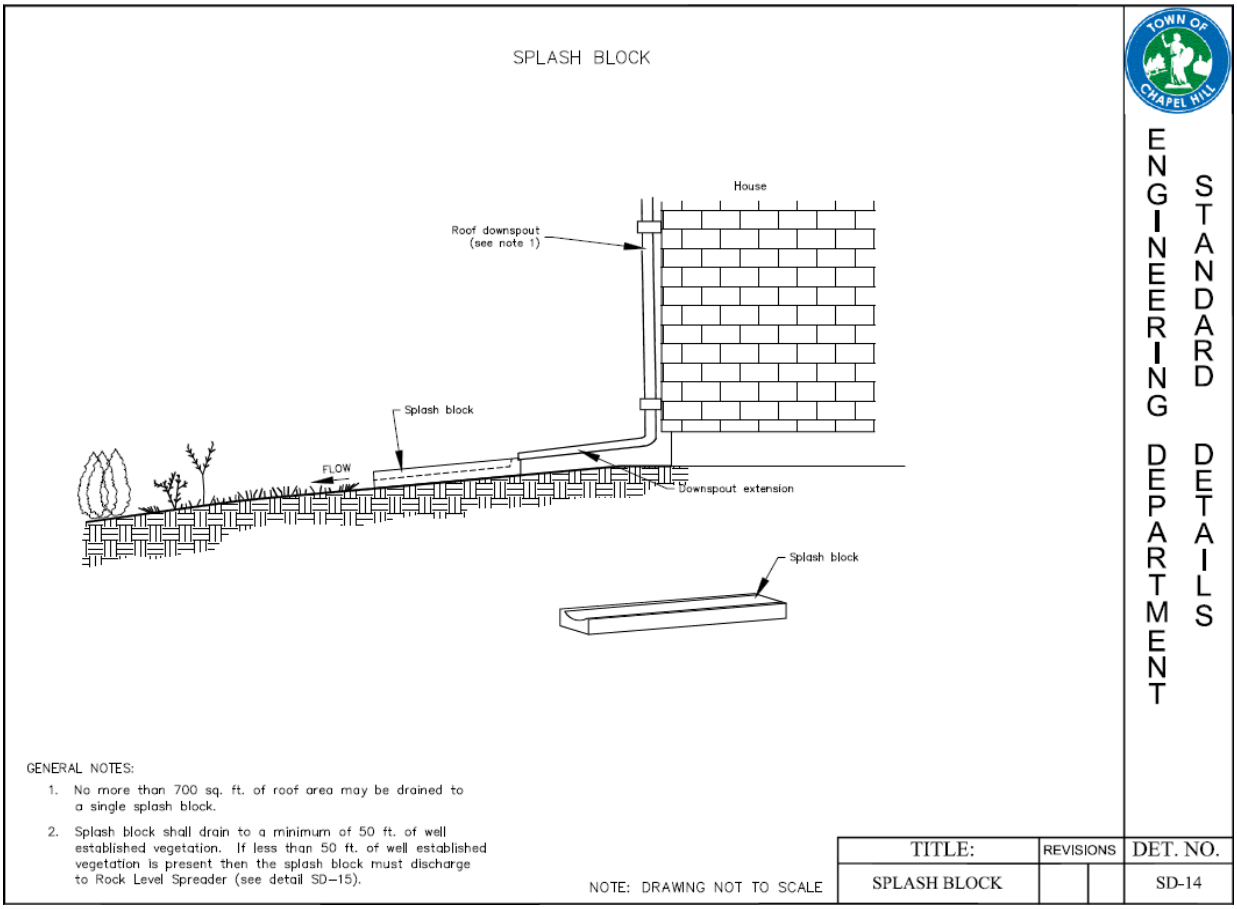


Figure 4.6 – Decorative Residential Splash Block / Energy Dissipater Examples

4.9 APPLICABLE REGULATIONS

- Stormwater Management - §5.4 Land Use Management Ordinance. Requires projects to address water quality, volume and rate. Requires projects to address water quality, volume and rate.
- Steep Slopes - §5.3.2 Land Use Management Ordinance. Steep slope restrictions and requirements.
- Jordan Riparian Buffers - §5.18 Land Use Management Ordinance. Regulates activities in and adjacent to the Jordan riparian buffer, which is the first 50 feet measured landward from the top of bank, each side.
- Jordan Stormwater Management - §5.19 Land Use Management Ordinance. Adds nutrient (nitrogen and phosphorus) reductions in addition to the Town's stormwater management requirements.
- Flood Damage Prevention Ordinance - Chapter 5, Article IV Town Code of Ordinances. Any modifications to the floodway or floodplain will require modeling.
- Soil Erosion and Sediment Control – Chapter 5, Article V Town Code of Ordinances. Requires erosion and sediment control permit for land disturbance of 20,000 sq. ft. or more, from Orange County Erosion Control. The Town requires a bond.
- Resource Conservation District - §3.6.3 Land Use Management Ordinance. Town's stream buffer regulation.

Watershed Protection District - §3.6.4 Land Use Management Ordinance. Limits impervious area to 50% and 70% of net land area for single-family and non-single-family residential development, respectively.

Chapter 5
Utilities

5.1 GENERAL

Utility Providers

The public water and sanitary sewer systems within the Town of Chapel Hill and its Extraterritorial Jurisdictional (ETJ) are owned and operated by Orange Water & Sewer Authority (OWASA). Before beginning utility planning or design work the engineer should consult with the Town to determine ownership of the utilities in the project area. For utilities owned and operated by others within the Town and its ETJ, consult with that particular owner's' engineering department for plan requirements or submittal procedures.

Information on water and sewer design standards and permitting for OWASA owned utilities can be found in the OWASA's Standard Specifications, latest edition. The Design Engineer should refer to OWASA's Technical Specifications and Detail Drawings, Water Line and Sanitary Sewer Line Construction, latest edition, for all material specifications and detail drawings.

Location of Underground Utilities

Before commencing any excavations in any highways, streets, public spaces, or in an easement, the State of North Carolina Underground Damage Prevention Act Article 8, § 87-102 requires notification of each utility owner having underground utilities located in the proposed area to be excavated, either orally or in writing, not less than two nor more than ten working days prior to starting, of the intent to excavate. If planning on digging, excavating, demolishing, or moving the earth in any way that could damage underground utility facilities, call the North Carolina One-Call Center toll-free number (811) 72 hours before work commences.

Interrelation of Utility Lines

The installation and location of any utility line shall be integrated with that of all other utility lines in the vicinity so as to avoid cross-connections, minimize trenching and tunneling, and keep incompatible systems separate. Notwithstanding, sufficient preparation shall be provided as soon as possible to minimize digging that would result in customer service interruption and to minimize adverse operating environments for other utilities.

Private Water Lines and Sewer Lines in the Public Right-Of-Way

Private water lines and sewer lines are not permitted to extend into the right-of-way beyond the intersection of the property corner or within the public right-of-way across the street frontage of another parcel. Service lines should not cross adjacent private properties. Perpendicular (or nearest perpendicular) crossings of public right-of-way are allowed. Note that OWASA does install these service connection does not maintain these service connections.

Water Main and Service Abandonment

Contractors abandoning water services shall remove the entire service stub. A plan shall be provided to the Town identifying the location of the abandoned line. All remaining portions of the service stub shall be removed from the main to the right of way line and shall be disposed of properly. Water main abandonment within the public street must be performed in accordance with a plan approved by the Public Works Department and OWASA. Service and main abandonment requires an inspection by the Public Works Department. The abandoned pipe shall be filled with flowable fill and shall be abandoned as shown in OWASA Standard Detail 512.05, or as described in OWASA's standards & specifications and according the North Carolina Department of Transportation standards

Underground Utilities
Where underground utility lines are to be provided beneath street roadways, sidewalks, or other paved access ways, all such lines shall be consolidated, where practical, in a contiguous area so as to optimize excavation for installation consistent with good operations and maintenance. Where underground utility lines are to be located within a street right-of-way, sewer lateral lines shall be provided from the trunk lines to the right-of-way line for all lots and/or development sites along the street, and shall be installed concurrent with the installation of the trunk line to minimize cutting and repairing of street sub-surfaces, base courses and paving. Sanitary sewer laterals shall have cleanouts at the edge of the right-of-way. Lateral lines shall be installed as close to a 90-degree angle to the trunk line as possible and should not cross into or along the street frontage of abutting lots.

The minimum required horizontal separation between water, sanitary sewer and stormwater drainage pipes installed in a common easement is ten feet

Record Drawings
Prior to a Certificate of Occupancy, Record Drawings shall be provided for all development for which a Zoning Compliance Permit or Engineering Construction Permit was required. In addition to providing the depth of the installation and horizontal location the Record Drawings shall call out the type of utility, size, and materials used for the installation.

Trench Backfill
Backfilling open cuts: The contractor shall backfill any trench made with approved soil that is free of organic material and does not contain more than five (5) per cent clay content (number 200 sieve). Backfill material at a moisture content range within two (2) per cent of optimum, per ASTM D-648.

Compaction tests shall be provided for all utility main line, and service lateral installations and removals, unless affirmatively exempted by the Town's Engineering Inspector. All backfill shall be compacted in six-inch lifts measured from the pipe foundation. Backfill for roadway shall be compacted to at least 98% of maximum soil density per ASTM D698 (Standard Proctor). Laboratory determination of maximum soil density will follow the procedure of AASHTO T99-86. Field determination of the density of the soil in place shall follow the procedure of AASHTO T191-86 or T204-86. The result of any one test may be a minimum of 95% of maximum density, but the average of any three tests in an area shall be 98% of maximum density. All tests shall be conducted at the direction of the Town Inspector, and the cost of such tests will be borne by the contractor.

Where trench compaction using standard procedures is impractical, or if time constraints so dictate, the Town will require the use of flow able fill material.

Pavement Removal and Replacement
All pavements to be removed shall be cut along straight lines with the appropriate saw cut machine. The removal and replacement of the pavement shall conform to the information shown in the pavement repair information provided in this manual. (See pavement repair requirements in Chapter 10).

- All cuts of Town streets must be patched the same day with a temporary or permanent patch. (Steel plating is allowed with special permission of the Public Works Department.) After work has been completed, all temporary patches shall be replaced with permanent ones. All work from patching shall be

cleaned up at the same time as patching.

- The Town shall require the contractor to perform density tests as needed to determine subgrade compaction.
- Pavement cuts shall be confined to a maximum trench width as shown in the Town Standard Details.
- Asphalt compaction shall be done with a gasoline or diesel powered smooth drum roller.

Surface Appurtenances

Surface appurtenances such as pump stations, backflow preventers, transformer boxes, pedestal-mounted thermal boxes, and meter cabinets shall be located so as to minimize safety hazards, visual impact, and noise effects.

5.2 SEWAGE COLLECTION SYSTEM

Within the Urban Services Boundary a system of sanitary sewers, together with all necessary pumping station and appurtenances, shall be provided to serve all parcels of the subdivision or principal building of the development. The system shall be designed to accommodate all reasonably anticipated future construction and occupancies. The collection system shall convey the sewage in sewers of adequate capacity to an approved treatment facility. For development outside of the Urban Services Boundary, approval of a septic or private sewer collection system by the County Health Department shall be required.

Flood Policy

In flood prone areas, the manholes must be watertight and vented to three feet above the 100-year flood elevation Pump stations must be approved by OWASA and constructed above the 100-year flood elevation as determined by the current FEMA Flood Insurance Rate Map (FIRM).

Provisions for Future Service Areas

Where adjacent property is in the same drainage basin as the property being developed, lines shall be designed to accommodate development of other properties in the same drainage basin. Easements or other right-of-ways should be consistent with the potential needs for future extensions as well as the project under consideration.

Design and Construction Standards and Materials

The sewage collection system shall conform to all requirements and minimum standards of OWASA and of the applicable County and State regulatory agencies, unless more stringent standards are provided herein. Ductile iron pipe must be used for taps to the public sewer and must extend to the property line. Clean-outs must be located at the right-of-way line.

5.3 WATER DISTRIBUTION SYSTEM

A water distribution system, providing potable water from an approved treatment facility, shall be provided to serve all parcels of the subdivision or principal buildings of the development. The pipes shall be sized to provide fire protection and an adequate supply of domestic water for all reasonably anticipated construction and occupancies. For development outside of the Urban Services Boundary, approval of a well (including a community well) by the County Health Department shall be required.

Provisions for Future Service Areas
Developers may be required to install additional linear footage of water mains and/or of larger size to provide for water service to property outside the project under consideration. Easements and rights of ways should be provided for lines installed by the developer and provisions shall be available for extensions to other adjacent properties.

Design and Construction Standards
The water distribution system shall conform to all requirements and minimum standards of OWASA and of the applicable State and County regulatory agencies, unless more stringent standards are established herein.

All pipe shall be Ductile Iron. If a developer deviates from this type of pipe it must be approved by the Town Manager after consultation with OWASA.

Fire Prevention Provisions

Fire Flow
The piping for fire protection shall provide a minimum residual pressure of at least 20 psi when the following gallons per minute of fire flow is withdrawn from any hydrant. The fire flow calculation area shall be the total floor area of all floor levels within the exterior walls, and under the horizontal projections of the roof of a building, except as modified by the most recent edition of the North Carolina Fire Code. The Fire Chief and Fire Marshal are authorized to increase or decrease the fire flow requirements where conditions indicate.

- One and Two Family Dwellings (less than 3,600 SF) = 1000 gpm for one hour. For dwellings greater than 3,600 SF shall not be less than that specified in Table 5.1 on the following page. A reduction in required fire flow of 50 percent may be allowed by the Fire Marshal, if the building is equipped with an approved automatic sprinkler system.

- For buildings other than one and two family dwellings: The minimum fire flow and flow duration shall be as specified in Table 5.1. A reduction in required fire flow of up to 75 percent, as approved, may be allowed by the Fire Marshal when the building is equipped with an approved automatic sprinkler system. For additional information, consult the North Carolina Fire Code, latest edition.

Prior to issuance of a Zoning Compliance Permit, a fire flow report shall be submitted to the Town Manager for approval. The report must call out the gallons per minute that would be available at the applicable hydrant(s), state if the available fire flow will comply with the Town's standards and be sealed by an engineer registered in North Carolina. A typical report would include an OWASA flow test that was conducted less than a year prior to submission of the report with supporting calculations.

If the required flows cannot be obtained from the existing OWASA systems, it is the developer's responsibility to make improvements to the system, with OWASA approval, as necessary to comply with Town fire flow requirements. If improvements to the OWASA system are not practical additional fire protection practices may be used.

Table 5.1 - Minimum Required Fire-Flow and Flow Duration for Buildings

FIRE-FLOW CALCULATION AREA (square feet)					Fire-flow (gallons per minute)[b]	Flow duration (hours)
Type IA and IB[a]	Type IIA and IIIA[a]	Type IV and V-A[a]	Type IIB and IIIB[a]	Type V-B[a]		
0-22,700	0-12,700	0-8,200	0-5,900	0-3,600	1,500	2
22,701-30,200	12,701-17,000	8,201-10,900	5,901-7,900	3,601-4,800	1,750	
30,201-38,700	17,001-21,800	10,901-12,900	7,901-9,800	4,801-6,200	2,000	
38,701-48,300	21,801-24,200	12,901-17,400	9,801-12,600	6,201-7,700	2,250	
48,301-59,000	24,201-33,200	17,401-21,300	12,601-15,400	7,701-9,400	2,500	
59,001-70,900	33,201-39,700	21,301-25,500	15,401-18,400	9,401-11,300	2,750	
70,901-83,700	39,701-47,100	25,501-30,100	18,401-21,800	11,301-13,400	3,000	3
83,701-97,700	47,101-54,900	30,101-35,200	21,801-25,900	13,401-15,600	3,250	
97,701-112,700	54,901-63,400	35,201-40,600	25,901-29,300	15,601-18,000	3,500	
112,701-128,700	63,401-72,400	40,601-46,400	29,301-33,500	18,001-20,600	3,750	
128,701-145,900	72,401-82,100	46,401-52,500	33,501-37,900	20,601-23,300	4,000	4
145,901-164,200	82,101-92,400	52,501-59,100	37,901-42,700	23,301-26,300	4,250	
164,201-183,400	92,401-103,100	59,101-66,000	42,701-47,700	26,301-29,300	4,500	
183,401-203,700	103,101-114,600	66,001-73,300	47,701-53,000	29,301-32,600	4,750	
203,701-225,200	114,601-126,700	73,301-81,100	53,001-58,600	32,601-36,000	5,000	
225,201-247,700	126,701-139,400	81,101-89,200	58,601-65,400	36,001-39,600	5,250	
247,701-271,200	139,401-152,600	89,201-97,700	65,401-70,600	39,601-43,400	5,500	
271,201-295,900	152,601-166,500	97,701-106,500	70,601-77,000	43,401-47,400	5,750	
295,901-Greater	166,501-Greater	106,501-115,800	77,001-83,700	47,401-51,500	6,000	
-	-	115,801-125,500	83,701-90,600	51,501-55,700	6,250	
-	-	125,501-135,500	90,601-97,900	55,701-60,200	6,500	
-	-	135,501-145,800	97,901-106,800	60,201-64,800	6,750	
-	-	145,801-156,700	106,801-113,200	64,801-69,600	7,000	
-	-	156,701-167,900	113,201-121,300	69,601-74,600	7,250	
-	-	167,901-179,400	121,301-129,600	74,601-79,800	7,500	

-	-	179,401-191,400	129,601-138,300	79,801-85,100	7,750	
-	-	191,401-Greater	138,301-Greater	85,101-Greater	8,000	

Source: Table B105.1 Minimum Required Fire-Flow and Flow Duration for Buildings, NC Appendix B, 2012 NC Fire Code

For SI: 1 foot=0.0929 m^2, 1 gallon per minute = 3.785 L/m, 1 pound per square inch = 6.895kPa.
a. Types of construction are based on the International Building Code.
b. Measured at 20 psi residual pressure.

Fire Hydrants
Fire hydrants shall be placed on lines eight (8") inches or larger in diameter unless approved otherwise by the Town Manager and OWASA. Hydrants shall also be spaced so that the farthest portion of all principal buildings, divisions thereof or dwelling units therein, and all building areas of site plans and parcels are within 400 feet (as a fire hose would normally be deployed) of a hydrant; and if applicable on the same side of an arterial street. This distance may be increased from 400 feet to 500 feet for sprinkled structures.

Fire hydrants shall be located on loop main line systems with two (2) sources of flow when reasonably possible as determined by the Town Manager after consultation with OWASA.

Subject to approval by the Fire Marshal a fire hydrant may be served from a 6-inch water main if the fire flow requirements are met, the 6-inch line does not exceed 400 feet in length, and if this section of the main waterline is not part of a continuous looped waterline system. Typically, a 6-inch waterline is only allowed to serve a cul-de-sac, or dead end street.

Fire hydrants shall be located such that all points on streets and access roads adjacent to a building are within the distances listed. Existing fire hydrants on public streets are allowed to be considered as available. Existing fire hydrants on adjacent properties shall not be considered as available unless fire apparatus access roads extend between properties and easements are established to prevent obstruction of such roads. If protection of fire hydrants by bollards are needed they shall be installed subject to review by the Fire Marshal and OWASA.

Location of Valves
Valves shall be installed as required by OWASA.

Fire Department Connections
If protection of fire department connections by guard posts or bollards are needed they shall be installed, subject to review by the Fire Marshal and OWASA. Fire department connections must be located within 100 feet of a fire hydrant.

5.4 AUTOMATIC SPRINKLER SYSTEMS

Non-Residential - An automatic fire sprinkler-system meeting the requirements of National Fire Protection Association (NFPA) Standard 13 is required to be installed in non-residential construction, as follows. In new non-residential structures if:

- The building has more than 6,000 square feet of floor area, or
- 20 percent or more of the total floor area is more than 200 feet of travel distance from the nearest access point for a fire truck, or
- The building exceeds two stories or 24 feet in height from the height of average grade of the lot to the windows on the topmost occupied floor.

In addition, all fire department connections shall be located on the fire access side of each building, and activation of the sprinkler system shall activate both a local building alarm and an alarm at a twenty-four (24) hour certified and licensed alarm monitoring service.

Upon the occupancy of any new, renovated or expanded structure subject to this Section, no person shall shut off or disable such automatic fire sprinkler system and no owner or resident of such building shall fail to prevent the shutting off or disabling of such a system. Provided, however, that a sprinkler system may be shut off in order to perform maintenance work on the system during the time that qualified maintenance personnel are on the premises performing necessary maintenance work. Such maintenance work shall only be conducted after notice to and approval by the Town Fire Department.

Multi-Family

An automatic fire sprinkler system meeting the requirements of NFPA Standard 13 or 13R is required to be installed in new multi-family construction, renovations and additions, as follows. In all new multi-family residential structures of three or more attached housing units if:

- The building has more than 6,000 square feet of floor area, or
- 20 percent or more of the total floor area is more than 200 feet of travel distance from the nearest access point for a fire truck, or
- The building exceeds two stories of 24 feet in height from the average grade of the lot to the windows on the topmost occupied floor.

Activation of the sprinkler system shall activate both a local building alarm and an alarm at a twenty-four (24) hour certified and licensed alarm monitoring service.
Upon the occupancy of any new, renovated or expanded structure subject to this Section, no person shall shut off or disable such automatic fire sprinkler system and no owner or resident of such building shall fail to prevent the shutting off or disabling of such a system. Provided, however, that a sprinkler system may be shut off in order to perform maintenance work on the system during the time that qualified maintenance personnel are on the premises performing necessary maintenance work. Such maintenance work shall only be conducted after notice to and approval by the Town Fire Department.

Fraternity and Sorority Houses

An automatic fire sprinkler system meeting the requirements of NFPA Standard #13 or #13R is required to be installed in each fraternity and sorority house in accord with the compliance deadlines in the Town's Land Use Management Ordinance.

In addition, all fire department connections shall be located on the street side of each building, and activation of the sprinkler system shall activate both a local building alarm and an alarm at a twenty-four (24) hour certified and licensed alarm monitoring service.

Key Boxes

Key boxes shall be required on any building that has a fire alarm system, a fire sprinkler system, an elevator, or special locking arrangements. The key box shall be of an approved type as required from the Chapel Hill Fire Department. The size of the key box will be determined by the number of keys necessary to mitigate any emergency situation based on the building and its occupancy. An approved lock shall be installed on gates or similar barriers when required by the fire code official. Keys shall be changed out immediately if the locks are changed or rekeyed.

5.5 EASEMENTS

Public utilities are installed in either dedicated easements or public right-of-ways. The standard utility easement width is thirty feet wide. Easements for more than one utility typically are increased ten feet in width for each additional underground utility to provide for adequate separation between utility lines.

- The contractor or utility company should make a reasonable effort to avoid damage to landscaping and vegetation within and/or adjacent to easements. The Town will not be liable for plants, trees, and other vegetation damaged as a result of work associated with use of utility easements.
- When utilities are located in the public right-of-way it is desirable for the utilities to be located at the outer edge of the right-of-way. Utility poles should be located as near the right-of-way lines as practical. Utilities crossing under streets should be bored and jacked when practical.
- Utilities crossing under NCDOT streets are subject to the NCDOT's policy for utility installations.

Chapter 6
Landscaping and Tree Protection

6.1 DESIGN STANDARDS

Buffer Requirements

Table 6.1 shows the minimum dimensions and planting requirements for buffers as established in Section 5.6 of the Town of Chapel Hill's Land Use Management Ordinance (https://library.municode.com/nc/chapel_hill/codes/code_of_ordinances?nodeId=CO_APXALAUSMA_ART5DEDEST_5.6LASCBU). Allowing greater than minimum buffer widths can provide more design flexibility.

ENCOURAGED	DISCOURAGED
Plantings that are integrated with the design concept	Prescriptive/Static planting designs
Plantings that respond to the landscape, topography and site context.	Repeated 100' planting layouts
Providing enough room for plants to develop their natural form, especially large trees	

Plant material must be planted within the required buffer width to count towards buffer requirements. "External" buffers are those next to a street and "Internal" buffers are those next to another property line. For example, large trees may be planted within the public rights-of-way if they are consistent with adjacent street tree plantings and are acceptable to the Town and NCDOT (when applicable).

You can find examples of appropriate varieties of trees and shrubs in the Plant Selection Standards. A minimum of 50% of the total number of required shrubs should be a combination of native, drought tolerant and evergreen material.

Table 6.1

BUFFER TYPE	MIN. WIDTH (FT.)	LOCATION	CANOPY	UNDERSTORY	SHRUBS
A	15'	External	2	4	6
	15'	***Internal***	***2***	***4***	***6***
B	15'	External	6	8	15
	10'	***Internal***	***4***	***7***	***12***
C	20'	External	5	10	36
	20'	***Internal***	***4***	***8***	***30***
D	30'	External	6	12	40
	30'	***Internal***	***5***	***10***	***30***
E	100'	External	10	15	70

Note-Where buffer width has been allowed to be reduced by ruling of a modified buffer from Town Council, the landscape architect should take care to consider the crowding of the required plant material in a reduced footprint. The number of plants per linear feet may be reduced by increasing the caliper of the proposed tree size, so that the total caliper of all proposed trees remains the same.

Using Existing Vegetation

The Town encourages using existing vegetation to satisfy some or all of the ordinance required buffer plantings. To qualify, the existing vegetation shall be in good health. Plant material must also be surveyed and mapped.

Note-In most locations where existing vegetation is retained, supplemental plantings along buffer edges will still be needed to meet the planting requirements noted above.

Required buffers cannot overlap utility easements other than in locations where the easements cross these buffers (Section 5.6.3 of the Land Use Management Ordinance). Where easements may conflict with other landscaping materials, applicants should contact the affected utility provider to determine what types of plantings, typically limited to shrubs and understory trees are permitted within the easement areas.

Amenity Encouragement

The Town encourages integrating amenities in buffers to create more dynamic spaces. Amenities should be programmed to fit the design vocabulary of the proposed and surrounding uses. Sensitivity should be exercised to promote similar activities between the proposed and surrounding uses. Staff may approve such amenities.

- Fences
- Lighting
- Bollards
- Paths
- Active Recreational Activities
- Passive Recreational Activities
- Physical Fitness Activities
- Public Art
- Walls
- Stormwater Features

Note-The provided list is not meant to be exhaustive and other amenities not listed above may be proposed for review by the Planning Department. Approved amenities may replace up to 75% of understory trees and shrubs. Canopy trees shall be planted to provide scale and shading with the remaining plant material planted to enhance the proposed buffer design.

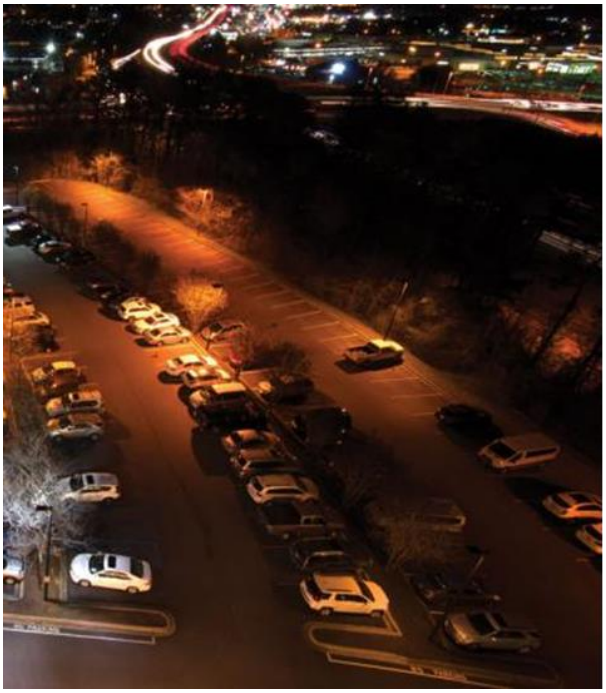
Parking Lot Requirements-Screening Standards

All parking lots shall be screened from public rights-of-way and adjacent residential zoned properties. The Planning Department will determine minimum screening heights during the design review process with the Applicant. Screening may include landscaping, lighting, trellis and green screen with associated landscaping. Applicants shall provide justification as to how proposed designs satisfy the most recent Crime Prevention Through Environmental Design (CPTED), specifically for vegetation height and spread requirements (**Figure 6.2**). For vegetation, minimum heights should be reached within two (2) years of planting to meet the screening standards.

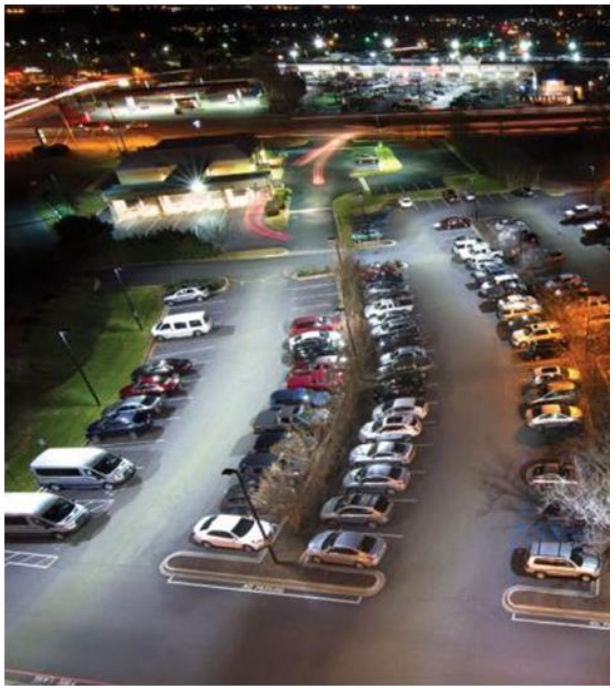
Figure 6.2

Before

After



Before



After

Amended Soil Volume Requirements

Amended soils consistent with landscape and nurseryman national standards should be provided for all urban condition plantings. Amended soils should be compacted 80% backfill with soil taken out of planting hole or 50% clean existing soil, 25% topsoil and 25% organic matter.

Table 6.3 indicates the minimum volume dimensions required for each material type. These standards are in alignment with landscape and nurseryman national standards. On streets

where trees are planted a 3’ wide tree planting strip shall be required. The design of this strip can either be provided in the form of a grass verge or an urban grate design. A continuous soil panel is suggested for additional tree success as noted (**Figure 6.4/6.5**).

Table 6.3

MATERIAL TYPE	SOIL VOLUME REQUIREMENT	MIN. DIMENSION
Canopy Tree	*2,000* cu.ft.	3'-0"
Understory Tree	*1,000* cu.ft.	3'-0"

Figure 6.4

Cross Section Drawing of Continuous Soil Panel

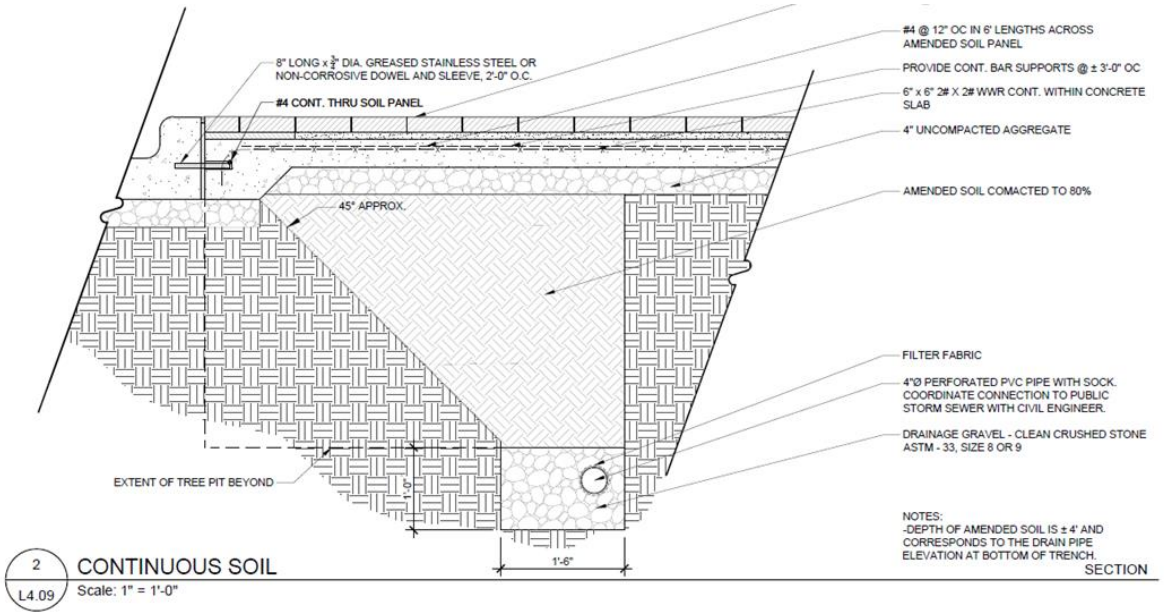
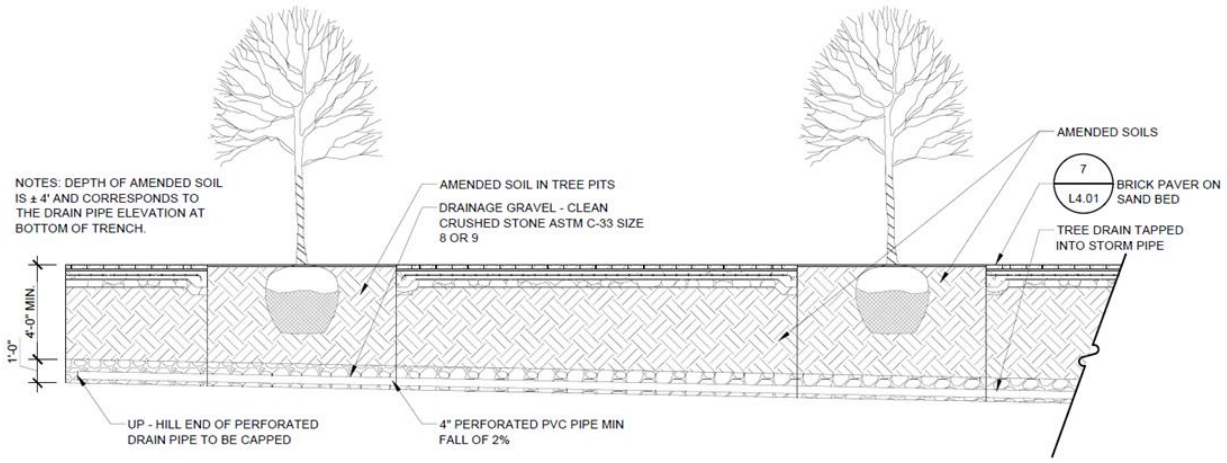


Figure 6.5

Longitudinal Cross Section Drawing of Continuous Soil Panel



Parking Lot Screening

All parking lots shall be screened from public rights-of-way and adjacent properties zoned residential. The minimum height of the screening should be 3' above the existing grade of the parking lot edge for right-of-way screening and 6' above the existing grade for residential screening. These minimum heights should be reached within two (2) years of planting when vegetation is included to meet the screening standards. There should be no gaps in the screen greater than 3’ wide.

Fences or walls used for screening should be built of materials compatible with the principal building or existing adjacent fences or walls. A minimum of 25% of the surface area of all fences and walls should be screened by plant materials within two (2) years. Whether plantings alone or a combination of plantings and fences or walls are used for screening, the screen should be of a density to occupy 75% of a vertical plane of the required height for the peripheral length of the parking lot. Plant material used for screening in lieu of fences or walls shall be evergreen, have a minimum heights of 2’ at planting and related to CPTED (http://cptedsecurity.com/cpted_design_guidelines.htm) design parameters.

Parking lot and property berms and associated crowns and slopes should be designed to fit contextually with the site with no prescribed heights, widths or slope requirements (**Figure 6.6**). However, at a minimum a berm should be 15-18” tall. The constraints of the site should be considered, and land use should also be a considered as a means of design context for design aesthetic.

Figure 6.6

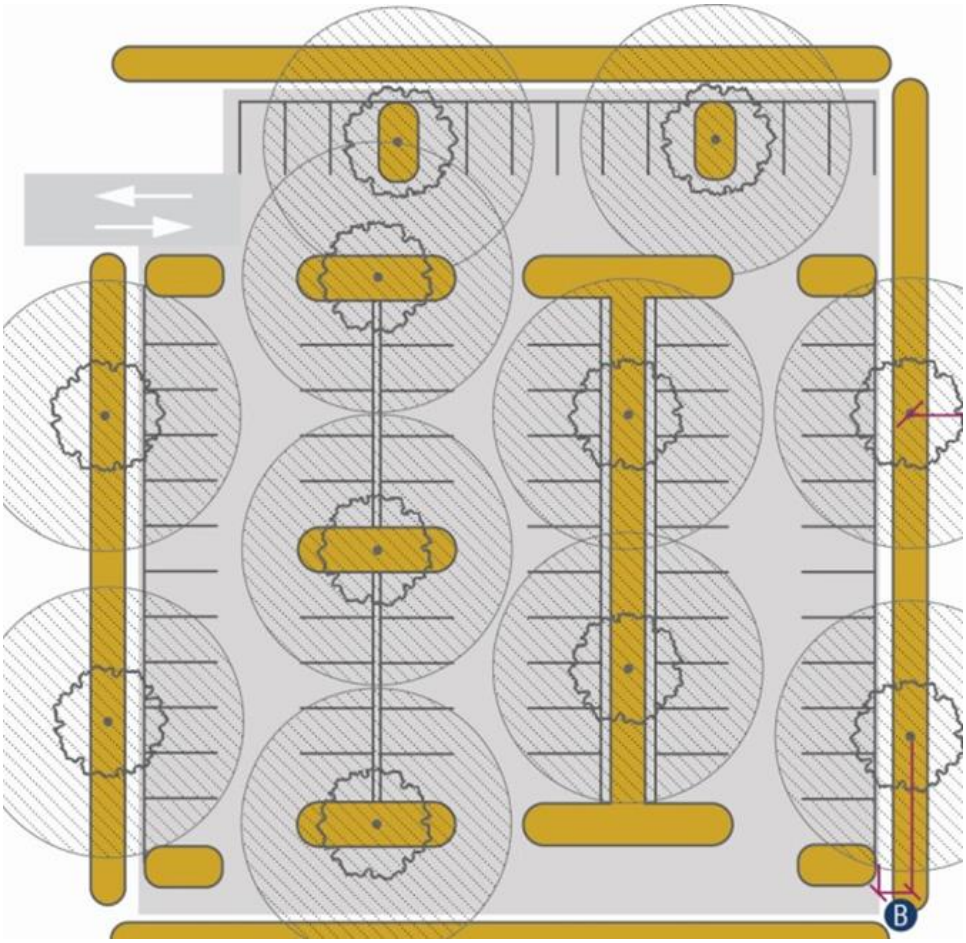
Site Confined Berm (Steep slope w/ min. width)

Sprawling Berm (Shallow/Steep slope w/ max. width)

Parking Lot Shade Standards

One large canopy tree per 2,000SF of paved surface area planted within 10’ of the parking lot edge will satisfy this requirement if the plants are spaced appropriately. No parking space should be farther than 50’ from the trunk centerline of a canopy tree, or farther than 75’ from 2 canopy trees (**Figure 6.7**).

Figure 6.7



If canopy trees are to be planted in landscape islands or medians, these spaces should be a minimum or 8’ wide as measured from back of curb. Amended soil volume requirements should meet **Figure 6.3** above.

All loading areas shall be screened from public rights-of-way and all adjacent properties. All standards, applicable to screening parking lots are required for loading area screening except the screen height requirements shall be a minimum of 6’ above grade for both rights-of-way and residential screening.

Utility Service Requirements

All utility service areas should be screened from public rights-of-way and all adjacent properties. To avoid conflicts with utility services, applicants should review proposed plantings with affected utility providers prior to including such plantings on proposed planting plans.

All standards applicable to screening parking lots are required of utility service areas, and the screening height should be equal to or greater than the structure to be screened.

Screening should be located to provide adequate access and workspace for the utility structure and the installation of plants with thorns or pointed leaves should be avoided adjacent to the service area.

Tree Placement Requirements

When designing projects in downtown, applicants should refer to the Town's Downtown Street Master Plan for information about planter design and planning standards. For additional information applicants can contact the Town's Public Works Department or the Downtown Special Projects Manager. In all areas, it is important to be certain the placement of plantings does not interfere with the site visibility at intersections or disrupt site distance triangles. For additional information about site distance triangles, applicants should refer to the Town's Standard Details. In general, the following tree placement standards will apply:

Table 6.8

CANOPY TREE-All trees reaching a mature height of 35' or more should be planted a min. of:
4' from back of curb, edge of street pavement and driveways (allow for any proposed future widenings)
4' from sidewalks and other paved pedestrian surfaces expect where urban conditions may prohibit planting or require a reduction in offset.
10' from all buildings.
15' from street lights, utility poles and above-ground utility wires.
15' from fire department connections and fire hydrants.

Table 6.9

UNDERSTORY TREE-All trees reaching a mature height of 35' should be planted a min. of:

	3' from back of curb, edge of street pavement and driveways (allow for any proposed future widenings)
	3' from sidewalks and other paved pedestrian surfaces expect where urban conditions may prohibit planting or require a reduction in offset.
	5' from all buildings.
	10' from streetlights, utility poles and above-ground utility wires.
	10' from fire department connections and fire hydrants.

Plant Selection Standards

The Town encourages the use of diverse plantings of native and well adapted non-native species in all landscaping projects. Because some species of plants have the potential to become invasive, however, there is a need for all landscape designers to carefully consider the risk of unintentional environmental damage when specifying exotic plant materials on planting plans. Invasive plants are prohibited from use on Town-regulated planting projects. Native plant species which are specifically encouraged as substitutions for more commonly planted non-native species.

In addition to the information provided in the following lists of plants, landscape designers are encouraged to research their plant selections carefully to assure they are providing a diverse mix of species which will perform well. Additional plant resources for North Carolina include the NC Botanical Garden (https://ncbg.unc.edu/plants/plant-sales/) and JC Raulston Arboretum (https://jcra.ncsu.edu//).

Consistent with these Town landscape objectives, landscape designers are discouraged from planting large numbers of single species in any given project and from using plant species which are prone to insect and disease problems. For additional information about susceptible plant species, landscape designers can contact the NC Cooperative Extension Service (https://gardening.ces.ncsu.edu/gardening-plants/).

Prohibited Species

Please refer to the Invasive Plant Atlas of the US (https://www.invasiveplantatlas.org/distribution.cfm) for a list of invasive-exotic plants which cannot be specified for use on landscape plans for development applications requiring planting plan approval by Town Staff. The use of the listed plants is strongly discouraged in non-regulated landscaping projects within the Town. The Invasive Plant Atlas of the United States is a collaborative project between the National Park Service, the University of Georgia Center for Invasive Species and Ecosystem Health, the Invasive Plant Atlas of New England and the Lady

Bird Johnson Wildflower Center. The purpose of the Atlas is to assist users with identification, early detection, prevention, and management of invasive plants. Species are added to the list periodically.

Suggested Species/Planting Practices

Please use the following list as suggestions for plant material. This list is not meant to be exhaustive, only noting certain genus that are successful in the central part of North Carolina.

Native Genus

Trees-Amelanchier, Halesia, Ilex, Magnolia, Nyssa and Prunus.

Shrubs-Hydrangea, Ilex, Itea and Myrica.

Vines-Bigonia, Gelsemium and Lonicera.

Ground Covers-Andropogon, Coreopsis and Rudbeckia.

Xeriscape Genus

Shrubs-Abelia, Aucuba and Cotoneaster

Ornamental Grasses-Muhlenbergia and Pennisetum

Ground Covers-Festuca, Liriope and Ophiopogon

Landscape Installation and Maintenance Specifications (Minimum)

MATERIAL	HEIGHT (MIN. FT.)	CALIPER (MIN. INCH)	SPREAD/SIZE
CANOPY TREES	14-16'	3-3.5"	
Notes-B&B, Full Specimen w/ strong central leader, uniform branching w/ full uniform crown.			
UNDERSTORY TREES	8-10'	1.5-2"	

Notes-B&B, Single-stem full specimen w/ strong central leader, uniform branching w/ full uniform crown. Multi-stem should be 3-5 canes (no more, no less)			
SHRUBS	18-24"		18-24"
Notes-Uniform crown, full form, healthy and well established/rooted in container, displaying vigorous growth (plugs will not be accepted).			
GROUNDCOVERS			1 QT.
Notes-Full, healthy specimen, well established/rooted in container & displaying vigorous growth (plugs will not be accepted)			
ORNAMENTAL GRASSES			#3 CONT.
Notes-Full, healthy specimen, well established/rooted in container & displaying vigorous growth (plugs will not be accepted			

1. All materials shall be in accordance with industry standard for grading plant material (the American Standard for Nursery Stock)
2. Maintenance of all trees and landscape materials shall adhere to accepted industry standards set forth by the Landscape Contractors Association, American Society of Landscape Architects, the International Society of Arboriculture and the American National Standards Institute.
3. Tree Maintenance Agreements will be required for trees in public rights-of-way.
4. Mixture of plant species are important to reduce monoculture impacts including disease and environmental stresses.

Top Soil/Amended Soil

All topsoil used for finished grading and planter applications should be the sites original topsoil or should be tested by NC Dept. of Ag. And Consumer Services (http://www.ncagr.gov/) to determine the soil's suitability for landscape use.

All topsoil/amended soils should contain a minimum 2% organic matter, range in pH from 5.0-7.0 and be free of herbicide and pesticide residues prior to the addition of amendments.

All topsoil/amended soil should be amended as determined by soil testing results and should be loose and friable at the time of planting.

Amended soils, should be compacted 80% and backfilled with soil taken out of planting hole, or 50% clean existing soil, 25% top soil and 25% organic material.

Maintenance of all trees and landscape materials shall adhere to accepted industry standards set forth by the Landscape Contractors Association, American Society of Landscape Architects, the International Society of Arboriculture and the American National Standards Institute.

- Backfill for Planting Pits/Amended Soils-Soil dug from the planting pit should be used for backfilling in order to avoid creating soil interfaces at the edge of the planting pit. The backfill may be amended to contain a maximum of 10% added organic matter. The backfill should be loose and friable at the time of planting.
- Non-Natural 'Green' Material-Artificial turf and other non-natural green materials will be considered for use on a case-by-case basis by the Planning Department.
- Mulch-All mulch is required to be double or triple shredded, aged hardwood mulch. Installation of 3-4" depth is required. Earth tone colors are encouraged with vibrant colors being prohibited. Mulch color is subject to review by the Planning Department.
- Soil Preparation (Tillage & Topsoil)-Existing compacted topsoils which are to receive plants, seed and/or subsoils which are to be overlaid with topsoil should be tilled to a minimum depth of 8", avoiding contact with critical root zones of adjacent existing trees. All areas to be planted with turf, shrubs or trees should receive a minimum of 6" of top soil over finished subgrade, avoiding the critical root zones of adjacent existing trees.
- Planting Requirements (Planting Seasons)-Trees and shrubs should be planted prior to May 15 and after September 15. Delayed plantings of required buffers and/or other landscaping can be accommodated with the acceptance of a letter of credit submitted to and approved by the Town Planning Department.

1 *Weather Conditions-Digging and planting operations should be performed only when the soil temperature at each planting area and of all backfill materials is above 32ºF.*

1. *Handling Plant Materials-Shade and water should be provided to all delivered material during dry weather and B&B materials should be heeled0in with root balls covered in mulch if they are to remain unplanted for over 24hrs.*

2. *For temporary plantings including all B&B material, dig hole minimum 24" deep and wide to receive root ball. Surround with wood chips or approved shredded mulch, cover entire ball (do not cover crown). Water in material thoroughly, continue to water 2x per week until planting.*
3. *Excavating Planting Pits-All planting pits should be excavated to a depth equal to or slightly less than the height of the planting ball. The sides of the planting pits should be loosened and roughened to facilitate the movement of roots into the surrounding soil.*
4. *Setting B&B Container Plants-Planting height should be determined by the soil drainage characteristics of the planting site while allowing for some settling after planting. All plant material greater than three feet in height should be set plumb regardless of the slope of finished grade. Groundcover plants smaller than 3 feet in height may be set perpendicular to finished grade on sloping sites.*
5. *For container grown plants, carefully remove the container and cut any container-bound circling roots. For balled-and-burlap plants, cut burlap away from the top half of the root ball. For plants in wire baskets, set plant in planting pit; then cut and remove wire from the top half of the root ball*
6. *Place and tamp backfill around root ball in six-to-eight inch layers up to the level of the finished grade. Avoid bruising or breaking roots when tamping the soil. Remove all protective wrapping from trunks and branches and thoroughly settle plantings with water.*
7. *Place a minimum of three inches of mulch over plant ball and pit area, taking care to keep material a minimum of two inches from the trunk of tree.*
8. *Staking-Support should be provided only for trees greater than 8 feet in height planted in exposed locations. Trees should be secured using vertical stakes driven into the ground outside the planting pit with constraining lines made of webbing, hose-protected wire or other material which will not abrade or become embedded in the trunk. Slack should be provided in each constraining line to allow for some trunk movement. All supports should be removed after one year unless tree has a flexible leader such as an evergreen affected by windy conditions.*

General Pruning Requirements

Pruning should consist of the removal of dead, dying, diseased, conflicting, obstructing and weak branches and selective thinning to lessen wind resistance and improve the appearance of trees and shrubs. All cuts should be made without leaving a protruding stub and without cutting into the branch collar or the branch bark ridge. Clean cuts should be made at all times.

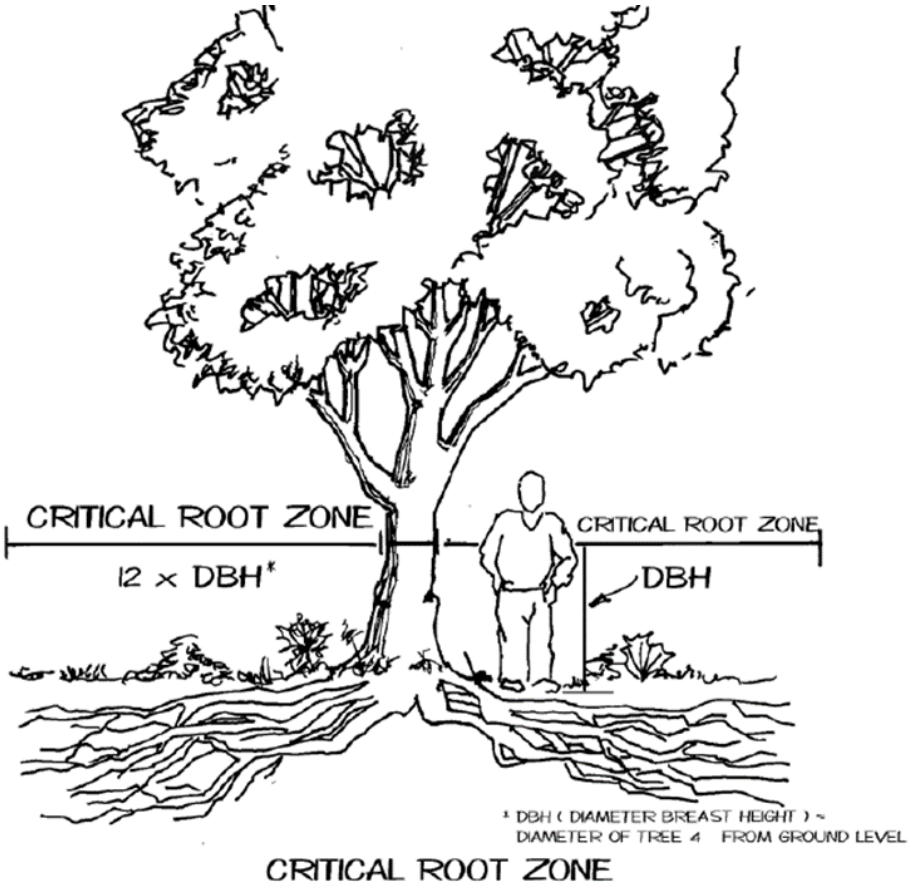
Tree limbs too heavy to handle by hand should be precut above the final cut to prevent splitting or peeling of the bark. Where necessary to prevent tree or property damage, branches should be lowered to the ground with ropes or equipment.

Treatment of cuts and wounds with tree wound dressing is discouraged except for cosmetic purposes in highly visible areas. If such treatment is made, materials non-toxic to the cambium layer must be used and care should be taken to treat only the exposed wood with a thin coat of dressing. Climbing spurs should not be used unless the tree is dead or is to be removed.

Tree Protection Ordinance Requirements

All development activities on non-exempt sites which involve disturbance to trees, or to the soil within the critical root zone of any tree, should conform to the provisions of a Landscape Protection Plan submitted to the Town for approval.

Figure 6.10



A Landscape Protection Plan should be prepared to Section 5.7.3 of the Land Use Management Ordinance showing existing and proposed site conditions and areas to be protected during construction.

Existing conditions to be shown on the plan include areas of significant tree stands and other notable landscape elements of the development site, as well as the critical root zone of all rare and specimen trees which will be impacted by construction. Significant tree stands are defined in Section 5.7 of the Town's Land Use Management ordinance and generally include all wooded areas greater than 5,000sf in size with a continuous mature canopy, where over fifty (50%) percent of the canopy is provided by hardwoods with a DBH of 24" or greater. Rare and specimen trees are defined in Sec. 5.7.6

(https://library.municode.com/nc/chapel_hill/codes/code_of_ordinances?nodeId=CO_APXALAUSMA_ART5DEDEST_5.7TRPR) of the Town's Land Use Management Ordinance and generally include all hardwood trees with a DBH greater than twelve (12") inches and all pine trees with a DBH of eighteen (18") inches or more. Certain native species such as a Dogwood, Redbud, Beech and Holly are included at 6" DBH.

The critical root zone (see **Figure 6.10**)of a tree is defined as a circular area centered on the trunk of the tree, the radius of which is twelve (12") times the diameter (DBH) of the tree at 4'-6" above grade. The critical root zone is also equal to one (1') foot of radius for every inch of trunk diameter.

The Landscape Protection Plan should also be on the proposed grading plan, should identify the construction limit line and should indicate where tree protection fencing will be installed. In addition, the following standard notes and a detail of the proposed tree protection fencing should be included as part of the Landscape Protection Plan.

1. A pre-con conference will be held with the Town's Urban Forester in the Planning Department prior to beginning any site work.
2. Any tree roots exposed by construction will be severed cleanly with an appropriate, properly sharpened pruning tool.
3. The soil within the critical root zones of existing trees will not be driven on or otherwise disturbed during the installation of landscape.
4. Two (2) site supervisors must be trained by the Planning Staff on tree protection fencing and must be onsite at any time land disturbance or tree work is being done. Please contact the Town's Urban Forester to schedule this review.

To properly protect and ensure the health of existing trees to remain, protective fencing should be installed to protect no less than 75% of a tree's critical root zone. When erecting fencing near trees not individually identified on the Landscape Protection Plan, the fencing location should be shifted, where possible, or a tree removed if its critical root zone is not adequately protected. All land disturbing activity, storage of equipment, building material, soil and other debris should be kept within the area of development activity and outside of the tree protection fencing.

The Town's standard for tree protection fencing is orange (see **Figure 6.11**), woven plastic mesh or fabric with a height of four (4') feet installed on metal t-posts set a maximum of ten (10') feet apart as shown in the following typical detail.

Figure 6.11

Orange Mesh Tree Protection Fencing

In some situations, where silt fence is required to be installed along the construction limit lines, the silt fence is considered to function in lieu of the standard tree protection fencing; and therefore, the standard tree protection fencing is not required. Because silt fence installation required cutting tree roots, it should be located outside critical root zones of protected trees.

Root Pruning Existing Rare and/or Specimen Trees

Root pruning is recommended prior to construction if digging, trenching or grading operation are to occur within the critical root zone of a rare of specimen tree. Root pruning is especially beneficial when undertaken during a tree's dormant season. If root pruning is indicated on the Landscape Protection Plan, it should be done with a properly sharpened root pruning or pavement cutting machine, or by trenching with appropriate equipment and cleanly severing all large roots, while taking care not to compromise any remaining roots.

Cleaning and Grubbing

Trees and brush should be removed only in the areas indicated on the Landscape Protection Plan avoiding damage to limbs, trunks and roots of the remaining vegetation. If tree protection fencing is damaged during the clearing operation, staging or construction it should be repaired prior to the continuation of work. If trees fall inside areas shown as being protected on the Landscape Protection Plan they should be removed without the use of heavy equipment.

Construction Access within the Critical Root Zone or Rare and/or Specimen Trees

In limited situations where no permanent changes are proposed within areas of the critical root zones of rare and specimen trees but where these areas may be needed to access construction, a specialized root protection method may be required. This method involves the installation of logging mats over a bed of mulch to evenly distribute the weight of vehicles and equipment over the access route where it overlaps critical root zones. Where access through tree protection areas is proposed, protective measures should be clearly designated on the Landscape Protection Plan.

Streetscape Standards

Projects located within the boundaries shown below in Figure 6.7 are subject to sidewalk, landscape and lighting standards contained in the 2009 Downtown Streetscape and Lighting Master Plan (https://www.townofchapelhill.org/government/departments-services/town-manager/downtown-investments/downtown-work-plan/downtown-streetscape-improvements).

Figure 6.12

Figure 6.13

Figure 6.14

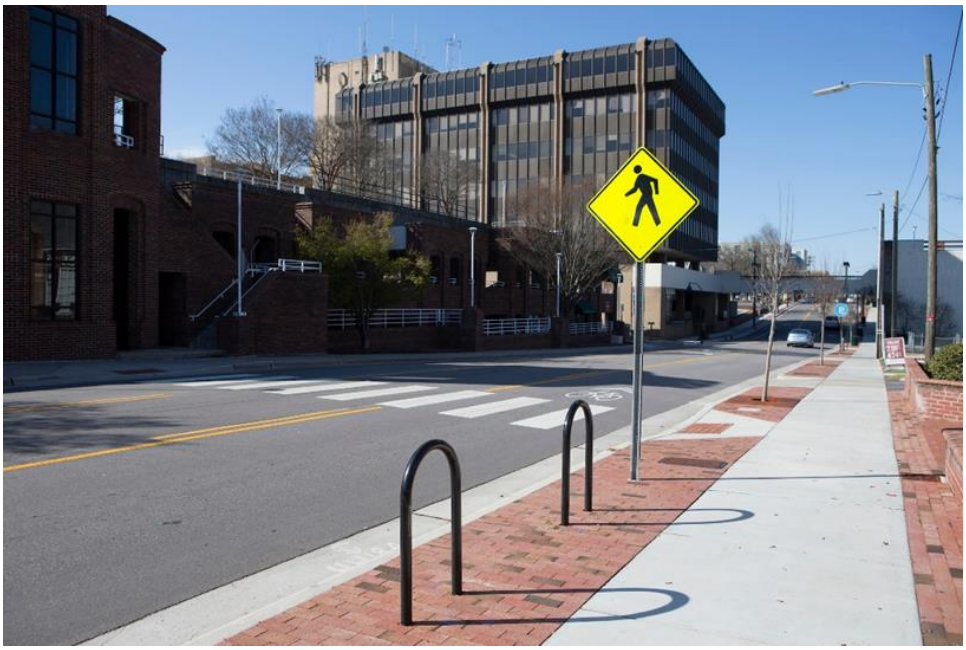


Figure 6.15

Materials

Furnishings and lighting standards are specified in the following sections. Any substitutions must be submitted in advance in writing accompanied by a sample for approval by the Town.

- **Brick-All brick shall be (see Figure 6.13/6.15):**
    - Pinehall Pathway F/R Modular Paver
    - 2 1/4" x 3 5/8" x 7 5/8"

- **Manufacturer:**
    - Pine Hall Brick Company, 634 Lindsey Bridge Road, Madison NC, 27025

- **Domed brick for handicap ramps:**

  - Adam Products domed red brick or equivalent (to be approved by Town Staff) red brick paver with truncated domes to meet current standards of the Americans with Disabilities Act (ADA).

- **Tree Pits and Grates:**

  - Structural soil for tree pits shall be 70% Stalite expanded slate (PermaTill), 30% sandy loam installed a minimum of eighteen (18") inches deep for the width of the brick amenity strip or as approved by the Town. Tree pit drains and roof drains extended into the

Structural soil for tree pits shall be 70% Stalite expanded slate (PermaTill), 30% sandy loam installed a minimum of eighteen (18") inches deep for the width of the brick amenity strip or as approved by the Town. Tree pit drains and roof drains extended into the public rights-of-way shall be tilled into the subsurface SW conveyances or catch basins. If no subsurface drainage system exist, curb openings for tree pit or roof drains shall be Neenah Foundry Company, R-3262-3, www.nfco.com or equivalent to be approved by Town Staff.

Adequate growth space b/w the tree trunk and first inner ring of the tree grate shall be provided to allow the tree to grow properly. The opening in the center of the tree grate through which the tree growth should be at least eighteen (18") inches in diameter at installation and provide 4-6" of clearance from the tree trunk. The tree should be centered within the tree grate opening.

If large-area grates are not available or cannot be used, the required permeable surface area may be provided by using multiple tree grates which are at least four (4') wide or by providing natural permeable materials, such as landscaping pavers, over the planting pit surface. Any non-standard tree grate frame installation shall have adequate support and be approved by the Town's Planning Staff Urban Forester.

- Tree grates are to be pedestrian safe with slot openings ¼" in width or less or compliant with **current ADA standards. Tree grates shall be:**
  - 4' x 6' rectangles (Model #R-8815-1), Metropolitan series made by Neenah Foundry.
  - 5' x 5' squares (Model #8855), Sunray series by East Jordan Iron Works (www.etjo.com).
  - 6' x 6' squares (Model #8856), Sunray series by East Jordan Iron Works.
- **No light wells (exemptions can be considered by Town Staff).**
  - Cast iron, not painted. Removable center ring, where available.

Furnishings

The palette of streetscape furnishings was developed for durability and simplicity.

Bike Racks shall be Sunshine U-Lock Corp. http://www.sunshineu-lok.com, Model "Simple-Lock" Single Loop inverted "U" Bike rack, Black, in-ground installation (not surface mounted).

- Trash Receptacles shall be Victor Stanley Ironsites, Series S-424, 36gal. capacity (includes liner), with standard lip, Victor Stanley green.
- Sidewalk recycling container shall be Nex-Terra, Single, 38gal. capacity, side load, Saturn shaped opening, Slant top, green with white lettering & chasing and recycling symbols.
- Combination Streetlight Pedestrian Light (Ordered through Duke Energy).
- Style "C", 25' cast aluminum fluted pole with decorative base on Rosemary Street and Side Streets.
- Union Metal Octaflute steel tapered pole on a Denver style base on Franklin Street color RAL 6012, Dark Green.
- 150wall green LED Roadway Luminaire fixture on Davit arm and at 15' mounting height at 75watt LED 'Bell' fixture on Davit arm.

Pedestrian Lights (Ordered through Duke Energy)

- Style "C", 15' cast aluminum fluted pole with decorative base on Rosemary Street.
  - Union Metal Octaflute steel tapered pole on a Denver style based on Franklin Street.
  - Color, RAL 6012 (Dark Green).
  - 15' mounting height a 75watt LED 'Bell' fixture on Davit arm.

Chapter 7

Solid Waste Management

7.1 RESIDENTIAL COLLECTION

Residential refuse collection is provided by the Town of Chapel Hill Public Works Department for occupants of dwellings with five (5) units or less. In order to provide this service the owner or occupant of the residence is required to use roll-out containers available from the Town's Public Works Department. A maximum of two (2) containers will be collected from each residential unit and must be placed at the curb on collection days. Residents who cannot bring their trash containers to the curb for health reasons can contact the Public Works Department and apply for an exemption, allowing them to receive side or rear yard collection services for trash collection only.

In newly proposed residential developments all streets are required to be built to Town standards to assure refuse collection vehicles will have adequate access. Developers should refer to the Town of Chapel Hill Engineering Standard Details for vertical and horizontal curves, pavement sections, street widths and the dimensions of cul-de-sacs and T-turnarounds for this information.

Residential Refuse Collection Note:

- Certain refuse (paint, medical waste, etc.) cannot be collected from standard refuse receptacles. Residents are advised to contact the Town of Chapel Hill Public Works Department for additional information about refuse requiring special handling and refuse, yard trimmings, leaf, and white good collection schedules.

- Refuse, recycling, and yard trimming containers along with loose yard trimming piles may not be stored in the public street right-of-way and but be stored out of sight from the street or screened.

Containers and loose piles shall be brought to the public street or a street built to Town standards and placed behind the curb or edge of pavement for servicing on the collection day by 6:00 am and removed by 7:00 pm on the day of collection. Containers and loose piles shall not block sidewalks.

7.2 MULTI-FAMILY/COMMERCIAL/INSTITUTIONAL REFUSE COLLECTION

Multi-family development includes all sites zoned for multi-family use with apartment buildings, townhouses or condominiums with six (6) or more units. This includes complexes or groups of buildings which may individually have less than six (6) units but are located on a single zoning lot or have either shared driveways or common parking areas. Commercial and institutional development includes all sites zoned for commercial or institutional use which are not used for residential development.

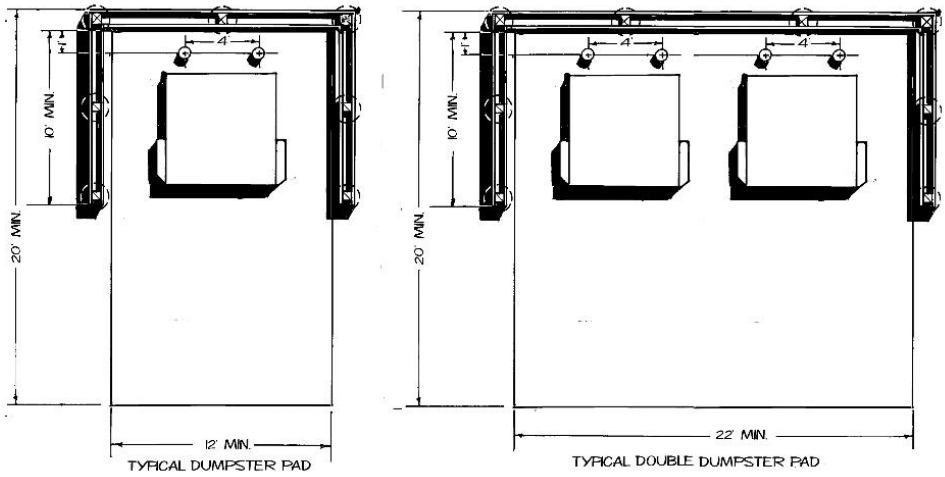
For some other commercial and institutional developments, it may be possible to share the use of an existing or proposed dumpster pad on an adjacent property. In these cases, a joint use agreement between the affected property owners will need to be developed, submitted to the Town Attorney for approval and recorded in the appropriate county Registrar of Deeds Office. In addition to this, the proposed site plan may need to include an accessible location for a possible future dumpster. This may also be required in other situations where an on-site dumpster pad, although not initially needed to service the anticipated quantity of refuse, may be required in the future.

- Roll-cart service (regardless whether the provider is public or private) is prohibited for commercial and institutional entities with greater than five thousand square feet (5,000 sf) of floor area.

  - For non-residential locations approved for roll-cart service, no more than six roll-carts will be serviced by the Town once per week.
- A minimum of one 8-yard dumpster per 25 units must be provided, unless otherwise approved by the Town.
- Within large multi-family/commercial/institutional developments the use of roll-off compactors may be preferable to the use of multiple refuse dumpsters.
- In order to receive collection of food wastes, including preparation waste, extra portions, or plate scrapings, the owner or occupant of any food/beverage business is required to provide space for food waste collection container(s). This material is generally collected from roll cart type containers.
- The Town will not collect dumpsters on casters or stacked dumpsters.

Dumpster Pad Design

Figure 7.1



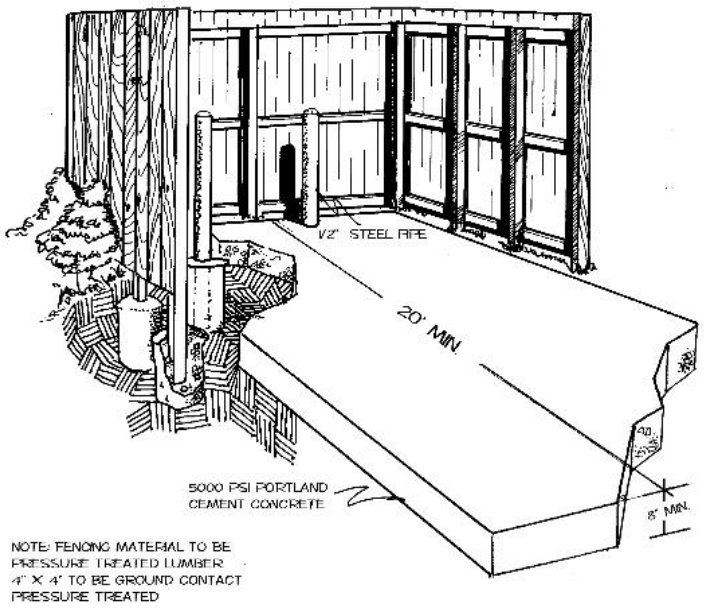
- Dumpster pads should be constructed of concrete with a minimum compressive strength of 3500 psi (5000 psi recommended).
- For a typical single dumpster, the pad should be 12’ wide and 20’ deep.
- For two dumpsters, the pad should be 22’ wide and 20’ deep for side-by-side layout. Other layouts must be requested to the Public Works Department for consideration.
- The pad apron should be a minimum of eight (8) inches thick.
- Two concrete filled 6” I.D. steel pipe bollards should be installed 4’ apart and 1’ from the rear edge of the pad behind each dumpster to protect the adjacent screening materials. These bollards should be set in concrete footings a minimum of 2’ in depth.

Dumpster Pad Screening

- All dumpsters are required to be screened on three sides. Typically this includes screening the full width of the rear of the pad and 10’ along either side.
- If gates are proposed to screen the front of the dumpster(s) they should be installed with retainers to keep the gates in the open position during servicing and the use of this hardware should be noted on the development plans.
- All gates should be dimensioned to provide a minimum clear width of 12’ to service each dumpster.

- Town staff is not responsible for unlocking, opening, or closing gates for collection service.
- Additionally, if the box is enclosed with gates it is recommended that pedestrian user access be provided in addition to the service gates.
- Screening can consist of stone, block, brick, wood or a combination of these materials. The screen should be designed and landscaped so it is consistent with the Town's Landscaping Standards.
- The screen should be a minimum of 7' in height and should be located directly adjacent to the dumpster pad.
- In some cases, the use of plantings alone to screen the dumpster may be acceptable if they are planted at a size which will permit them to reach the required minimum height within one growing season.
- The most common type of screening used is a wooden privacy fence.

Figure 7.2



STANDARD DUMPSTER PAD WITH FENCING

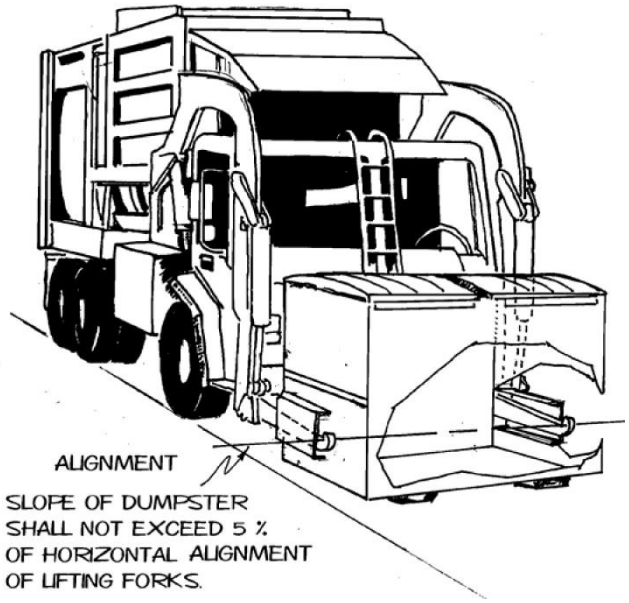
Dumpster Placement and Access

The essential element in locating a dumpster is the ability of the refuse collection vehicle to safely and efficiently service the container. The Town's front loading refuse collection vehicles are 33' in length and have an inside turning radius 36.5 feet. In the design of developments where driveways and/or parking lot drive aisles will be used to access dumpsters, a turning radii template should be used to assure that access can be provided without unnecessary backing maneuvers.

Where refuse collection vehicles will need to turn around to exit a development site, the site plan should be designed so backing movements do not exceed 100' in length. In these cases the turnaround area should be dimensioned using a turning radii template of the appropriate scale. In all cases, the proposed site plan should be designed so refuse collection vehicles do not need to back on or off of any public street or over any public sidewalk.

Where dumpsters are proposed to be placed at an angle to the centerline of the driveway or drive aisle the angle should not exceed 30 degrees. On sloped sites, the vehicle approach to the dumpster should be at the same slope as the dumpster pad and should not exceed 5 percent – see Figure 7.3, below.

Figure 7.3



In newly proposed multi-family, commercial and institutional developments all driveways and drive aisles are required to be built to Town standards. Drive aisles proposed to be used for refuse collection vehicle access shall be constructed with a minimum section of 10-inch stone base and 3-inch asphalt surface. Developers should refer to the Town of Chapel Hill Engineering Standard Details for driveway cut specifications, vertical curve requirements and pavement sections.

Overhead Clearance

- Electrical service drop connectors and other overhead utility wires are required by the National Electric Safety Code to allow 18 feet clearance over all public streets and over private driveways subject to truck traffic.
- If a dumpster pad is proposed to be located in an area which requires the refuse collection vehicle to drive under wires, the development plans should indicate the wires will meet this standard.
- In addition, if refuse collection vehicles must drive below awnings, canopies or other structures to access a dumpster, these structures should also be a minimum of 14’6” in height.
- In the immediate vicinity of the dumpster pad the minimum height clearance is 24’.
- Overhead clearance is required for refuse collection vehicle directly above the container.

Figure 7.4

Multi-family/Commercial/Institutional Refuse Collection Note

- Certain refuse (yard trimmings, white goods/bulky items, paint, corrugated cardboard, medical waste, etc.) will not be collected from standard dumpsters.
- Owners/occupants of developments receiving dumpster collection service are advised to contact the Town of Chapel Hill Public Works Department for additional information about refuse requiring special handling and refuse collection schedules.

7.3 RECYCLING

Recycling services within the Town of Chapel Hill are provided by Orange County through the county Solid Waste Management Department pursuant to their recycling program policies and guidelines. For further information including design standards and development guidelines contact the Solid Waste Management Department at 919-968-2788 or visit their webpage at the following link: http://www.orangecountync.gov/recycling.

Recyclable Corrugated Cardboard Note: Since November 1, 1995, Town of Chapel Hill ordinance prohibit the disposal of recyclable corrugated cardboard from any business, institution, multifamily or construction activity into any bulk waste refuse container. Dumpsters found to contain recyclable, corrugated cardboard may be refused service, and/or assessed a monetary penalty. This material must be recycled. Private contractors are available locally for cardboard recycling containers and collection services. Some businesses may use public recycling dropoff sites for corrugated cardboard recycling, depending on quantity produced.

Chapter 8

Erosion and Sediment Control

8.1 GENERAL

All projects which disturb more than 20,000 SF within the Town of Chapel Hill and its Extraterritorial Jurisdiction (ETJ) must have an approved Erosion and Sedimentation Control Plan and Permit from NC DEMLR or Orange County Planning and Inspections. Residential single family homes, and projects that disturb less than 20,000 SF, are still required to provide erosion control measures. At a minimum these measures should include a construction entrance and silt fencing along downhill slopes of the site.

Information on erosion and sedimentation control design standards and permitting can be found in the NC DEQ's *Erosion and Sedimentation Control Planning and Design Manual*, latest edition. Permitting requirements for Orange County can be found at: http://www.orangecountync.gov/departments/planning_and_inspections/erosion_control.php.

The following is a summary to assist applicants in proper submittal of an erosion control plan to Orange County within the Town of Chapel Hill.

Reference the Orange County website http://www.orangecountync.gov/departments/planning_and_inspections/erosion_control.phpfor application links and guidance on proper submittal of an erosion control application and plan.

CAUTION: Any timbering, demolition, clearing, grading, or land-disturbing activity associated with land development before the erosion & sedimentation control plan is approved constitutes a violation, making the responsible party not only subject to civil penalties but the erosion & sedimentation control plan review and land disturbance permit subject to double fees. The enforcement of these penalties is discretionary and to a great extent depends on the circumstances surrounding the violation, including intent and the history of the parties involved.

- **Confirm that the project is in the Town of Chapel Hill jurisdiction**. If so, the corresponding stormwater plan, if required, will be administered by the Town of Chapel Hill stormwater program staff. Tree protection will also be overseen by Chapel Hill staff.
- **Determine if an erosion control plan is required for the project**. First determine the area of land disturbance associated with the project. NOTE: Do not include land disturbance for wells and/or on-site sewage disposal systems.
- The next step is to **refer to the land disturbance thresholds for erosion control** in the Orange County Watershed Matrix (reference the Orange County Erosion Control web page**). If exceeded, an erosion control plan must be submitted for review, approval and subsequent issuance of a land disturbance permit.**
- The level of design needed for your erosion control plan will depend on specific project conditions. There is no statutory requirement that erosion and sedimentation control plans can be designed by a registered Professional Engineer (PE) or any other licensed/certified person; however, persons with these licenses and/or certifications are often qualified to prepare erosion and sedimentation control plans. In addition, these plans can become quite complex and involve design elements that do classify as "engineering" work; therefore, requiring they be designed by a qualified PE.

- Erosion & sedimentation control plans (sketches) for land disturbance projects of less than an acre, in general, need to illustrate the following:
    - Base plan can be a to-scale printout from the Orange County GIS.
    - Delineation and annotation of the various components of the project (i.e. structures, driveway, etc.).
    - A designated temporary gravel construction entrance. This is normally where your driveway is going be constructed. The main concern is to ensure no off-site tracking of sediment, mud, etc.
    - Silt fencing with silt fence outlets downhill of all land disturbance (Refer to Detail 6.62 Sediment Fence from NC DEMLR DEQ Erosion and Sediment Control Planning & Design Manual). The main emphasis is to ensure the bottom of the sediment fencing is secured below grade and the fencing locations cover the area downhill of the planned disturbance.
- **Bona Fide Farm Projects**. Please supply Orange County with an Orange County Bona Fide Farm Exemption Affidavit Pursuant to N.C.G.S. 153-340(b), along with a current farm number, if that has been issued and is being utilized for farm status. The affidavit is available from the County Attorney and is also linked on the Orange County Erosion Control web page. Bona fide farm status may exempt portions of the site development associated with farm uses. The applicant is encouraged to schedule a pre-application meeting or at least a telephone consultation to discuss specific details of the required submittal. NOTE: THIS AFFIDAVIT IS YET TO BE ADAPTED FOR EROSION & SEDIMENTATION CONTROL AND APPROVED BY THE COUNTY ATTORNEY. THE LANGUAGE ABOVE UNDER 6 IS SUGGESTED TEXT AND PROCESS
- Provide surface water identification (SWID) for any properties containing "questionable" or **potentially jurisdictional (intermittent or perennial**) **streams.** This would be streams shown on a USGS map as blue line streams in which the property owner only observes water flowing during storms. Surface water identification (SWID) is a service for which Orange County staff members are trained and certified; however, it should be noted that USACE reserves the right to confirm Orange County SWID's for permitting stream crossings. The existence of a "jurisdictional stream" on your property affects development potential, imposes constraints and additional permitting/time lines. Riparian stream buffers must be maintained, if a stream is jurisdictional, and any impacts must be minimized and sometimes mitigated.
- **Stream crossings** are regulated on a site specific basis and may require additional (404/401) permitting by the U.S. Army Corps of Engineers (USACE) and the North Carolina Department of Environmental Quality (NCDEQ). A land disturbance permit cannot be issued until copies of the USACE 404 Permit and NCDEQ 401 Water Quality Certification are provided to Orange County Erosion Control.
- Orange County offers free **pre-application meetings** and highly recommends this process, especially for those who have not permitted land disturbance in Orange County previously.
- **Erosion and sedimentation control plans are submitted directly to Orange County** and can be processed concurrently with your site plan application to the Town of Chapel Hill.
- Upon receipt of your complete erosion and sedimentation control plan application package by Orange County, **Orange County staff will notify Chapel Hill by e-mail that your application has been received and is under review.** It is highly

recommended that a copy of the transmittal to Orange County and one set of the erosion and sedimentation control plans be submitted along with your stormwater management plan submittal to the Town of Chapel Hill, as reference, to assist with their stormwater management review and approval.

- **Stormwater management plans are to be submitted directly to the Town of Chapel Hill. One copy of these plans should be submitted to Orange County, as reference, to assist with complete erosion and sedimentation control review.**
- **Upon approval** of your erosion and sedimentation control plan(s), Orange County will e-mail the approval package to the engineer of work, the applicant, and stakeholders at the Town of Chapel Hill.

Lessons Learned

a) A pre-application meeting can save time and effort for both the applicant and reviewer. A sketch plan or concept plan with an estimate of disturbed acreage in hand will help this meeting be as productive as possible.
b) Do not harvest trees within Chapel Hill's jurisdiction, prior to obtaining a land disturbance permit.
c) Temporary top-down dewatering sediment basin and permanent stormwater control measure (SCM/BMP) can often be co-located.
d) Pay close attention to a logical and constructible sequence of construction (i.e. don't specify installation of sand filters or bio-retention basins before a site is stabilized).
e) The Applicant shall provide a copy of the approved plan and permit to the Town before final approval of construction drawings.

Directories of Licensed/Certified Individuals

The following are provided as references:
NC Board of Examiners for Engineers & Surveyors: http://www.ncbels.org/
NC Board of Licensed Soil Scientists: http://www.ncblss.org/
Certified Professionals in Erosion and Sediment Control: http://www.cpesc.org/

8.2 MANDATORY STANDARDS FOR PERMANENT GRADING

Soils in the Chapel Hill area tend to be fairly erodible due to steeper slopes and less soil cohesion. Erosion is increased when vegetation is removed from the land's surface or when the surface is disturbed by digging or movement of heavy equipment. In a steep area, even a small amount of land disturbance can lead to the formation of deep gullies unless steps are taken to cover and stabilize the soil. Each sediment basin or trap shall have a minimum volume of 3,600 cubic feet per acre of disturbed area and a minimum surface area of 435 square feet per cfs of Q25 (25-year storm) peak inflow.

- Proposed street right-of-way shall be graded to their full width for ditch and type of street and a minimum of eight feet behind the curb for curb and gutter sections.
- Fill embankments shall be constructed in accordance with section 235 of the North Carolina Department of Transportation Standard Specifications for Roads and Structures and placed in successive lifts not to exceed more than six inches in depth for the full width of the cross-section, including the width of the slope area.
- No stumps, trees, brush, rubbish or other unsuitable materials or substances shall be placed in the right-of-way.

- Each successive six-inch layer shall be thoroughly compacted by the sheep's-foot tamping roller, 10-ton power roller, pneumatic-tired roller, or other methods approved by the Town Engineer.
- Embankments over and around all pipe culverts shall be of select material, placed and thoroughly tamped and compacted as directed by the Public Works/Engineering Division representative.

  All final graded slopes shall comply with these standards.
  - No cut or fill greater than ten (10) vertical feet shall be made which creates a slope steeper than three to (3:1) unless approval is granted during plan review by the Public Works/Engineering Division.
  - No cut or fill less than ten (10) vertical feet shall be made which creates a slope steeper than two to (2:1) unless approval is granted during plan review by the Public Works/Engineering Division.
  - The angle for graded slopes and fills shall be no greater than the angle which can be retained by vegetative cover or other adequate erosion control devices or structures.
  - The angle for graded slopes and fills must be demonstrated to be stable. Stable is the condition where the soil remains in its original configuration, with or without mechanical constraints. Mechanically stabilized slopes, including but not limited to riprap, cribs, timber or masonry retaining walls, shall not exceed ten (10) feet in height without intervening terraces ten (10) feet in width with a maximum slope of three to one (3:1).
  - With prior approval of the Public Works/Engineering Division, the ten (10) foot height limit for mechanically stabilized slopes may be increased for:
    - Wing walls with earth retaining devices.
    - Wing walls allowing subgrade access and other earth retaining devices required for the structural support of buildings, bridges, dams, culverts, or similar structures.
    - Stormwater channels. (Mechanical stabilization is required for engineering stormwater channels).

8.3 DRAINAGE REQUIREMENTS AROUND RESIDENTIAL STRUCTURES FOR SUBDIVISIONS

L) A detailed grading plan for residential development shall be submitted with construction plans for the storm drainage system (with the exception of residential developments with over 20,000 SF lots and ribbon paved streets).

M) The detailed grading plan shall include, among other things, consideration of and provisions for adequate drainage of surface water between, around and away from residential living units.

N) Finish grading in the vicinity of the building foundation shall result in a minimum slope away from the building of six (6) inches in 10 feet and be in compliance with the most current requirements of the North Carolina Building Code.

O) Shallow, grassed drainage swales provided to transport surface water drainage between, around and away from the residential building shall have a minimum slope of one (1) percent.

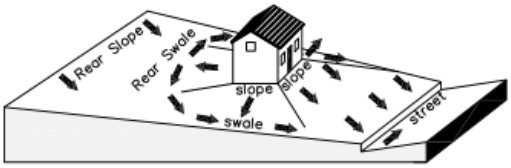
P) If drainage swales having a minimum slope of one (1) percent are not feasible, then a pipe system shall be installed of sufficient design capacity to carry the runoff.

Q) All storm drainage intended to transport storm water runoff between, around and away from residential structures shall have a hydraulic design capacity sufficient to carry a 10-

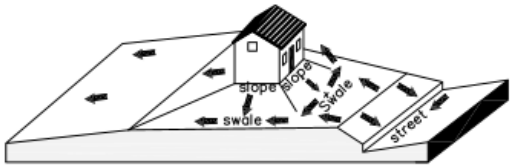
year storm event. See Figure 8.1 below.

Figure 8.1
Schematic Design for Grading for Drainage around a Building

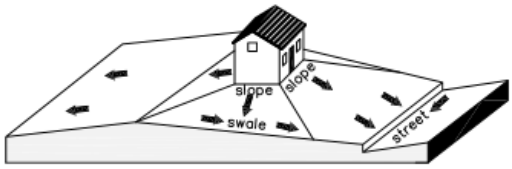
a) Lot Grading: Drainage Directed Toward Front of Dwelling



b) Lot Grading: Drainage Directed Toward Rear of Dwelling



c) Lot Grading: Drainage Directed Toward Front and Rear of Dwelling



Note: Figure copied from "Land Development Handbook", Second Edition.

Chapter 9
Parks and Recreation

9.1 GENERAL

The Town of Chapel Hill is nationally regarded for its quality of life. In addition to its parks, open green spaces, and a myriad of indoor and outdoor recreational facilities, the Chapel Hill Parks & Recreation Department offers recreational programs and cultural activities for all ages and social backgrounds. Public parks and recreation are the gateways to a healthier, more livable community.

Everyone needs the opportunity for self-enrichment, adventure, fellowship and quiet reflection. At Chapel Hill Parks and Recreation Department, we understand these needs and are dedicated to providing cultural, natural and recreational opportunities in a safe and inviting environment.

The Town adopted its most recent Comprehensive Parks Plan (2013 – 2022) on May 29, 2013. This Comprehensive Parks Plan will help ensure that the Town Council, Parks and Recreation Department, and citizen leaders have a road map to guide decision-making and actions as the community grows and becomes more urban. It provided a ten-year vision (2013-2022) for the Department. This guide was carefully crafted by staff, the public, volunteers, and with the help of outside experts to ensure that future generations will have adequate parks, greenways/trails, and open space.

Dedication of Recreation Area (Subdivisions)
Minimum requirements for land to be dedicated as Recreation Area in the case of subdivisions must meet all minimum requirements listed in the Town's LUMO, Chapter 5.5 Recreation, and in the following Town and Construction Standards for Park Facilities (Design Standards).

a) Provision or dedication of Recreation Area is not required for a minor subdivision.
b) The purpose of Recreation Area is to provide either:
a) Active recreation on site which will provide real and meaningful recreational experiences for the residents of the development.
b) A suitable parcel of land which could be converted to active recreational use in the future, if the residents of the development so desire.
c) In some cases the preservation of greenway corridors or exceptional natural areas.
c) In general, Recreation Areas shall be located outside of the Resource Conservation District. Exceptions may be made for areas which protect high quality natural areas or greenway corridors.
d) Recreation Area is often not developed during the initial development of the subdivision. However, the land dedicated must have the character, shape and location suitable for use as a playground, playfield, or for other active recreation purposes including greenway pedestrian and non-motorized vehicle easements. Recreation areas shall be located on

land which is relatively flat and dry and is otherwise capable of accommodating active recreation uses. Exceptions to the "flat and dry" requirement may include:

- Sites abutting or including areas designated as future greenways. In most cases the Town Council will require easements to be provided which will allow the Town the authority to build and maintain trails and public use of the greenway area.
- Important natural areas which would be best protected within a Recreation Area. This exception is not intended as a method of allowing developers to build on flat and dry areas while offering less desirable sites as Recreation Areas. Sites qualifying for this exception must have true merit as high quality natural areas.

e) Recreation Areas and Recreation Spaces shall be conveniently accessible to all residents of the subdivision and, other than greenway pedestrian and non-motorized vehicle easements shall have at least fifty (50) feet of frontage on at least one public street within the subdivision.

f) In most cases land provided for Recreation Areas shall be in the form of a single parcel. In rare cases the Town Council may determine two (2) or more parcels are more suitable to the needs of a particular subdivision. In such cases the Town Council may require such parcels be connected in some manner to promote pedestrian and bicycle connectivity.

g) In most cases the developer of small subdivisions will be asked to provide 100% of their required Recreation Area as a payment in lieu since the dedication of very small Recreation Areas in general will not provide meaningful opportunities for recreation. As a general guideline, developments which have required Recreation Areas of less than 2,000 square feet will be asked to provide 100% of the requirement as a payment in lieu.

Dedication of Active Recreation Space (Multi-Family Development)

Minimum requirements for land to be dedicated as Recreation Space in the case of multi Family developments must meet all minimum requirements listed in the Town's LUMO, Chapter 5.5 Recreation, and in the following Town and Construction Standards for Park Facilities (Design Standards).

a) The purpose of Recreation Space is to provide either:

d) Active recreation on site which would provide real and meaningful recreational experiences for the residents of the development.

e) In some cases the preservation of greenway corridors or exceptional natural areas.

b) In general, Recreation Space shall be located outside of the resource conservation district. Exceptions may be made for areas protecting high quality natural areas or greenway corridors.

c) Recreation Space must be developed during the initial development of the subdivision.

d) Recreation Space must be located on land suitable for the active recreation use proposed for the development.

e) Recreation Space shall be conveniently accessible to all residents of the development.

f) Recreation Space may be in the form of a single active recreation amenity or multiple sites and amenities depending on the nature and size of the development.

g) The Town Council may allow up to thirty (30) percent of the recreation space to consist of passive recreation elements if they are located adjacent to and support the more active recreation elements. For example, some picnic facilities, seating, and lawn games could be counted if they are adjacent to a children's play area and support the mission of the play area.

h) The Town Council may waive suitability requirements in order to preserve greenway corridors or important natural areas.

i) Multifamily developments will be asked to provide a minimum of 25 percent of their required Recreation Area as a payment in lieu. These funds will be used to make capital level improvements to public recreation amenities which will serve the area of

development. The requirement may be higher than 25 percent if the development does not have the land required to provide meaningful recreation amenities which will truly serve the recreational needs of the residents. The Town has enabling legislation for this requirement.

j) All active recreation space amenities must adhere to requirements of the Americans with Disabilities Act.

k) Recreation space shall be improved with recreation facilities designed for active play. All recreation space improvements must be built or installed using standards generally accepted for each type of amenity. Examples of acceptable active play facilities include:

a) Playgrounds utilizing commercial grade play equipment and adhering to the U.S. Consumer Product Safety Commission's ("CPSC" or "Commission") Public Playground Safety Handbook for play equipment and fall surfaces. Refer to national safety standards.
b) Ballfields and athletic fields designed and built for active recreation. Such fields must be properly graded and have appropriate turf, goals, sub-drainage, benches, and other amenities commonly required for the intended sport. Unimproved open grass areas are not considered to be athletic fields.
c) Basketball courts installed with regulation goals and in hard surface court areas large enough to sustain regulation play. Half courts are acceptable. Basketball goals installed in a street or parking lot are not acceptable.
d) Splash pads, Swimming pools and bathhouses. – refer to County standards created by the state
e) Tennis, elevated bocce, and pickle ball courts.
f) Community gardens appropriately designed and constructed with at least five (5) percent of the garden area consisting of raised beds for handicap users, a source of water throughout the garden area, storage area for tools, deer protection fencing, handicap accessibility, and access for maintenance. Community gardens will only be acceptable under the following conditions:

a) Dwelling units have no yards or yard areas too small to garden in a reasonable manner.
b) The garden area is reasonably centrally located.
c) The garden area has reasonable access for all residents.

g) Clubhouses intended to be owned by a homeowners' association and operated for the recreation needs of the community. If the building is shared by a sales or management office, the space used for those activities will not count toward Recreation Space requirements.
h) Exercise rooms within an apartment, condominium, or other such building intended to be used by the residents for recreation purposes.
i) Ponds improved to support fish, stocked with fish, and improved to allow fishing access by persons with disabilities. If the ponds are required for stormwater or other purposes, only those features directly related to fishing may be counted.
j) Roof top running tracks or other active facilities are permitted. However, any such roof top facilities must have significant separation from HVAC units. The developer must show the recreation facility would not be negatively impacted from heat and noise generated by such units.
k) Paved greenway trails which are designated as future greenways on the town's comprehensive plan, greenway project conceptual plans adopted by the council, greenway project master plans adopted by the council, or greenway trails which would offer significant pedestrian and bicycle interconnectivity. Standalone paved trails that do not directly connect into the Town's greenway system or make significant direct connections to important destinations must be at 2,500 linear feet or longer. Greenways

along creeks must be built with concrete and must be able to support maintenance and emergency vehicles.

l) Unpaved trails of a length which provides a meaningful recreation experience. Generally three thousand (3,000) linear feet or longer. Exceptions can be made for shorter trails that connect directly into an existing trail system or a trail system shown in a Town plan.

L) Dog parks intended for the residents and built with commercial grade fencing, double gate entry, waste disposal systems, water source, shade and seating. Dog parks will be acceptable for developments of at least 100 dwelling units.

M) Examples of facilities which will not be considered as acceptable as Active Recreation Space:

- Open lawn areas.
- Large expanses of unimproved space between or around active recreation elements.
- Picnic tables and picnic facilities.
- Seating areas.
- Areas dedicated to lawn games such as badminton, croquet, lawn darts, horseshoes, etc.
- Areas dedicated to table top board games.
- Gardens not improved for active gardening by the community.
- Orchards.
- Sidewalks, stairwells, parking lots, stormwater detention areas, and other facilities required for development of the project.



Recreation Area Furnishings

The palette of recreation area furnishings was developed to create a sense of place by providing specific standards for furniture and amenities for all types of parks, recreation trails/greenways development, and redevelopment in Chapel Hill, NC.

Park Bench shall be Fall Creek Series (https://www.sitescapesononine.com/fallcreek) Arch Back Bench 4’ or 6’ DuraCoat Finish (Silver) in-ground drop-in anchor installation

Litter Receptacle shall be New Castle Series (https://www.sitescapeonline.com/newcastle) Side Opening Litter Receptacle 36 Gallon DuraCoat Finish (Silver) in-ground drop-in anchor concrete slab installation

Litter Recycling Receptacle shall be New Castle Series (https://www.sitescapeonline.com/newcastle) Side Opening Recycling Receptacle 36 Gallon DuraCoat Finish (Silver) in-ground drop-in anchor concrete slab installation

Picnic Table shall be Streetsites Series (https://www.victorstanley.com) Steel Strap Table 6' or 8' Bench Length DuraCoat Finish (Silver or Sterling) in ground drop-in anchor concrete slab installation

Table and Chairs shall be City View Series (https://www.sitescapesonline.com/cityview) Solid Table with Three or Four Seats DuraCoat Finish (Silver) in ground drop-in anchor concrete slab installation

Bicycle Rack shall be Cycle Sentry Five or Three Loop (https://victorstanley.com) Metal Tubing DuraCoat Finish (Silver or Sterling) in ground drop-in anchor concrete slab installation

Water Fountain shall be an Elkay or Equal Outdoor Barrier Free Bi-Level Fountain with Bottle Filler and Pet Water Bowl Dura Coat Finish (Silver or Sterling) in ground drop-in anchor concrete slab installation

Playgrounds and Play Amenities
The following are minimum requirements for playground equipment, specifications and installation at the goal of this section is to require high-quality play equipment that will provide a fun, safe experience for users with low maintenance issues and costs by the ultimate owners and operators.

The following are minimum requirements for playground equipment, specifications and installation at all park, Recreation Area, and Recreation Space sites.

1) General

a) All playgrounds and swings must be of commercial quality; no exceptions will be made.

b) Acceptable playground manufacturer fastening types:
   a) Clamp type fastening system for components to main structure.
   b) Direct-bolt type fastening system for components to main structure.

c) All play areas must have an accessible path of travel (rubberized resilient poured-in-place surfacing or tiles).

d) Equipment and components to be IPEMA certified.

e) Equipment manufacturer to comply with ISO 9001 and ISO 14001.

f) Equipment manufacturer to provide installation manual and playground layout at completion of project: hard copy and digital file.

g) Equipment and fall surfacing must comply with current Standards and Guidelines as listed:
   - CPSC Handbook for Public Playground Safety, Pub. No. 325.
   - ASTM F 1487 Standard, Consumer Safety Performance Specification for Playground Equipment for Public Use.
   - ASTM F 2223 Standard, ASTM Standards on Playground Surfacing.
   - ASTM F 2373 Standard, Performance Specifications for Public Use Play Equipment for Children 6 months through 23 months.
   - ASTM 1292 Standard Specification for Impact Attenuation of Fall Surfacing Materials.
   - Accessibility Guidelines for Play Areas as described in ADAAG.

- *ANSI Standards:* Z535.1 Safety Color Code, Z535.4 Products Safety-Signs and Labels.
- *Federal Standards:* 16 CFR Part 1303, 16 CFR 1500 – Including Sections 1500.48 and 1500.49, 16 CFR Section 1501, 36 CFR Part 1191.
- *UL Standards:* UL 969 Standard for Safety: Marking and Labeling Systems
- *CSA Standards*: CAN/CSA-Z614 Children's Play Spaces and Equipment.

h) Equipment installation shall be performed by a Certified Playground Safety Inspector in good standing. Contractor shall be National Playground Safety Institute (NPSI) - Certified.

i) Equipment to have safety use (fall) zone as required by ASTM F-1487 Standards.

2) Definitions

a) Standards and Guidelines: applicable standards and guidelines will include but not be limited to most current editions of: ASTM F-1487; ASTM F-2223; ASTM 2373; CPSC Pub. No. 325; USATBCB Guide to ADA Accessibility guidelines for play areas. (Will be referred to ASTM and CPSC as applicable.) put link to ASTM website

b) Composite Play Structures: According to ASTM F 1487, this means "two or more play structures attached or functionally linked," creating one integral unit with more than one play activity.

c) Critical Height: According to CPSC No. 325, this means "the fall height below which a life-threatening head injury would not be expected to occur."

d) Fall Height: According to ASTM F 1487, this means "the vertical distance between a designated play surface and the protective surfacing beneath it." The fall height of playground equipment should not exceed the Critical Height of the protective surfacing beneath it as set forth by play activity or specified critical fall height, whichever is more restrictive.

e) IPEMA: International Play Equipment Manufacturers Association.

f) Play Structure: According to ASTM F 1487, this is "a free-standing structure with one or more components and their supporting members."

g) Protective Surfacing: According to ASTM F 1487, this means "impact-attenuating materials to be used within the use zone of any playground equipment" for playground surface systems. See Specification below.

h) Use Zone: According to ASTM F 1487, this is "the area beneath and immediately adjacent to a play structure which is designated for unrestricted circulation around the equipment and on whose surface it is predicted a user would land when falling from or exiting the equipment."

3) Required Certificates

a) Product Certificates: Signed by manufacturers of playground equipment certifying products furnished comply with all requirements set forth in specifications and/or construction drawings.

b) Installer Certificates: Manufacturers Certification and NPSI Certification.

c) Manufacturer Certificates: IPEMA Certification of playground equipment and components.

4) Quality Assurance

a) Equipment installation to be performed by National Playground Safety Institute Certification (NPSI) - Certified Playground Safety Inspector, in good standing.

b) All hardware, equipment, and components must be IPEMA certified and compliant with all specifications as set forth herewith.

c) Manufacturer Qualifications: A firm whose playground equipment, components, and hardware have been certified by IPEMA's "3rd Party Certification" service.

d) Provide only playground equipment and play structure components bearing the IPEMA Certification Seal.

e) Standards and Guidelines: Provide playground equipment complying with or exceeding requirements in the following:

1) ASTM F 1487: To include warning labels, manufacturers identification
2) CPSC No. 325, "Handbook for Public Playground Safety."

5) Playground Fall Surfacing

a) Engineered Wood Fiber shall comply with most current versions of ASTM-1292 and ASTM-F 1951 and F 2075.

b) Playground Safety Tiles shall comply with most current versions of ASTM F1292, CPSC Handbook and ADAAG Standards.

c) Resilient Poured-in-Place Rubber Surfacing must be in compliance with latest ASTM F1292, F1487, F2479, CPSC Handbook and ADAAG Standards

Dog Parks

1) General

a) Dog parks are to be designed to assure the safety and comfort of dogs, owners, and nearby residents.

b) In general dog parks should be between 1-2 acres in size; although smaller dog parks may be permissible in some cases.

c) Dog parks should be on flat terrain and if graded, to a general slope of less than 2.5%.

d) Dog parks must have a water source for months between April and November.

e) Dog parks should be ADA accessible.

f) In general dog parks should be split into two sections. One section should be for only smaller dogs' 25 lbs. or smaller. The second area can be for any size dog.

g) Site dog parks out of swales, steep slopes, streams and beaches.

h) Provide vegetated buffers of prescribed widths between dog parks and waterways, swales, storm drain inlets, gulley's and steep slopes.

i) Add pooper scooper stations with free sanitary "pick-up" bags and proper receptacles.

2) Fencing

a) All fencing must be at least 5 feet high.

b) Chain link fencing posts must be installed with at least 40 weight pipe.

c) All chain link fence fabric must be vinyl coated with a minimum 9 gauge core and 8 gauge finish fuse bonding. All fabric needs to be "Knuckle-Knuckle" for safety reasons. "Extruded" fabric is not permitted.

d) Entry areas should have a double gate system to prevent dogs from escaping.

e) All fence fabric and gates should be installed without gaps in order to prevent dogs from escaping. Gaps can be no more than 2 inches.

Chapter 10
Construction and Post Construction

10.1 STREET CONSTRUCTION

Work Zone Traffic Control

The developer is responsible for notifying the Public Works/Traffic Engineering Division, Transit, Emergency Medical Services, Police and Fire Departments, and residents of the area prior to implementation of work zone traffic control for a public street. Street closings are not allowed unless approved by the Town Manager. Lane closings are allowed only from 9:00 am to 4:00 pm on weekdays with the approval from the Town Public Works/Traffic Engineering Department. Work in the public right-of-way other than between 9:00 am and 4:00 pm weekdays is subject to approval by the Town Manager.

All work zone traffic control devices and procedures shall conform to the requirements of the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD), and the current edition of the North Carolina Department of Transportation (NCDOT) Supplement to the MUTCD for Streets and Highways, the NCDOT Roadway Drawings and the current edition of the NCDOT Standard Specifications for Roads and Structures.

Transit Accommodations During Construction

The developer is responsible for notifying Transit when permanent or temporary transit accommodations are required (i.e., street or sidewalk improvements; street closures; construction impacting access to transit facilities). Existing, temporary, and/or relocated transit stops shall be shown on documents and site plans for all projects. The developer must work with Transit to identify alternate stops and needed improvements and Transit must review and approve proposed temporary stops and permanent transit improvements. Transit must be notified in writing at least 30 days prior to the start of construction work impacting existing or temporary transit stops, so adequate notice can be provided to customers.

Temporary bus stops shall be as safe, convenient, and fully accessible as permanent stops, where they are required. The developer is responsible for maintaining access to existing and/or temporary transit stops throughout project construction unless detours are reviewed and approved by Transit and included in project documents. All accessways must meet federal ADA requirements. If a project causes a temporary stop to be in an area without sidewalks, the developer is responsible for providing and maintaining a temporary accessway and platform (made of wood, or other appropriate materials) ensuring safe access for individuals using mobility devices who require the deployment of the transit vehicle's ramp.

The developer shall accommodate temporary signage identifying transit facilities impacted by construction, including wayfinding signage in locations where stops have been temporarily or permanently moved or discontinued. Signs shall be posted in high visibility locations, allowing them to be seen from a distance. Signage shall be consistent with CHT branding and color. Information about temporarily or permanently impacted transit stops shall be posted at least two weeks prior to the changes going into effect and until construction is completed and regular transit facilities are restored or constructed. Temporary signage will be removed by Transit staff at the end of construction.

Groundcover within Right-Of-Way

All disturbed areas within the right-of-way, including medians, shall have groundcover established in accordance with Town specifications. Groundcover shall be installed in all rights-of-way at a time determined by the Town Manager, providing however, it shall be installed and established prior to the release of the improvement bond.

Soil tests shall be submitted to the North Carolina Department of Agriculture by the contractor for all seeding, lime, and fertilizer requirements, unless this requirement is waived by the Town Manager. The contractor shall lime and fertilize according to the test results. A native grass seed mixture is acceptable, with 22% Big Bluestem, 6% Little Bluestem, 8% Indiangrass, 33% Switchgrass, 6% Eastern Gama, 3% Sand Dropseed, 6% Canada Wildrye, 11% Virginia Wildrye, 6% Sand Bluestem. Planting type and rates shall be per North Carolina Department of Transportation standard specifications.

All groundcover shall be maintained in accordance with North Carolina Department of Transportation specifications and shall be kept at a height no greater than six (6) inches (except on embankments) until the roadway has been accepted by the Town Manager and the performance bond has been released.

Use of Steel Plates in Roadways during Construction

Subject to written approval from Engineering, when backfill operations of an excavation in the traveled way, whether transverse or longitudinal, cannot be properly completed within a work day, steel plate-bridging will be required to preserve unobstructed traffic flow in Town streets and roadways. In such instances the following applies:

Steel Plates Requirements

- Steel plates must be able to withstand H-20 traffic loading without any movement.
- Steel plates shall be fabricated to meet ASTM A36 steel requirements,
- When two or more plates are used, the plate shall be tack-welded together at each corner to reduce or eliminate vertical movement. Alternative methods to accomplish this, such as metal connectors, will be considered for approval on a case-by-case basis.
- Steel plates shall be installed to resist bending, vibrations, etc., under traffic loads and shall be anchored securely to prevent movement. If these conditions are not met, the applicant will be required to backfill and pave the excavation daily, or use alternative methods such as “Plate Locks” which are designed to secure the plates with minimum noise and vibration.
- All steel plates shall be property marked with the utility and contractor name, after-hours contact phone number in the event the plates need to be secured.
- All steel plates within the right-of-way, whether used in or out of the traveled way, shall be without deformation. The plate surface must not deviate more than ¼ inch when measured with a 10-foot straight edge along the length of the plate.
- It is the responsibility of the permittee to perform and document daily inspections of all active plate(s) or unattended plate(s) location(s), and where necessary take appropriate measures to protect the public safety until work is completed. This documentation shall be available to the Town inspector upon request. No un-plated excavation shall be left unattended overnight.
- In the event the improper installation of steel plates presents a nuisance or a public safety problem, the permittee shall respond to all excavation restoration requests by the Town immediately upon notification.
- Steel plates must extend a minimum of 12-inches beyond the edges of the excavation.
- Before steel plates are installed, the excavation shall be adequately shored to support the bridging and traffic loads.
- Temporary paving with a cold asphalt mix should be used to feather the edges of the plate to form a wedged taper to cover the edges of the steel plate. Other alternative methods to accomplish this will be considered for approval.
- Wedges or other non-asphaltic devices shall be used for leveling as required to eliminate rocking of

the plates. Compacted temporary asphalt shall be used to fill all gaps between the plates and existing pavement surfaces.

- The use of steel plate in state maintained streets is subject to approval and inspection by the North Carolina Department of Transportation.

Steel Plate Installation:

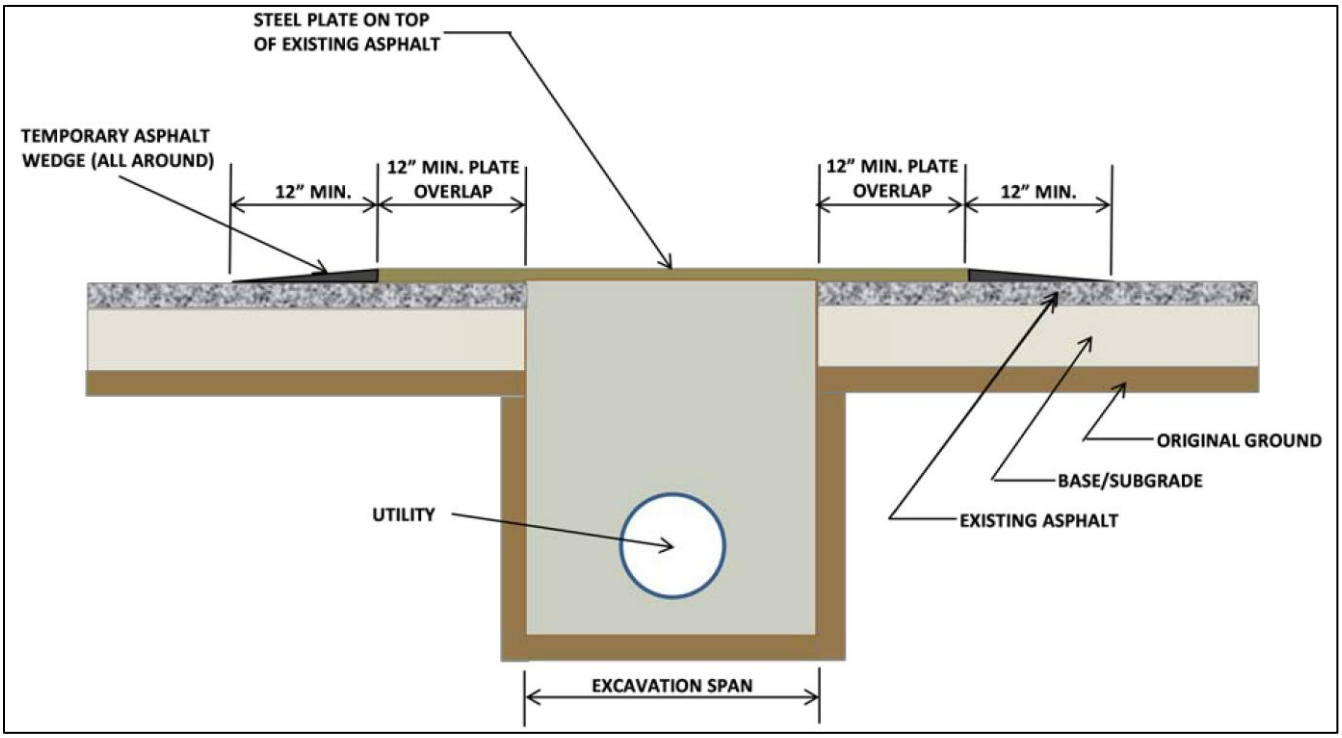
Steel plate placement on traverse and longitudinal excavations shall be in accordance with the following:

Steel Plate Installation	Street/Road Type	Posted Speed Limit	Steel Plate Thickness
TYPE 1	Urban/Residential	35 MPH or Less	1-inch minimum
TYPE 2	Arterial/Collector	Greater than 35 MPH	1-1/4-inch minimum

Type 1 Installation

Type 1 installation shown in Figure 10.1, shall be used in areas where backfilling operations of an excavation in the traveled way, whether traverse or longitudinal cannot be properly completed within the same day, and the posted speed limit is 35 MPH or less. The steel plate shall be anchored securely to prevent movement. Temporary paving with a cold asphalt mix, or approved equal, should also be used to feather the edges of the plate to form a wedged taper to cover the edges of the steel plate.

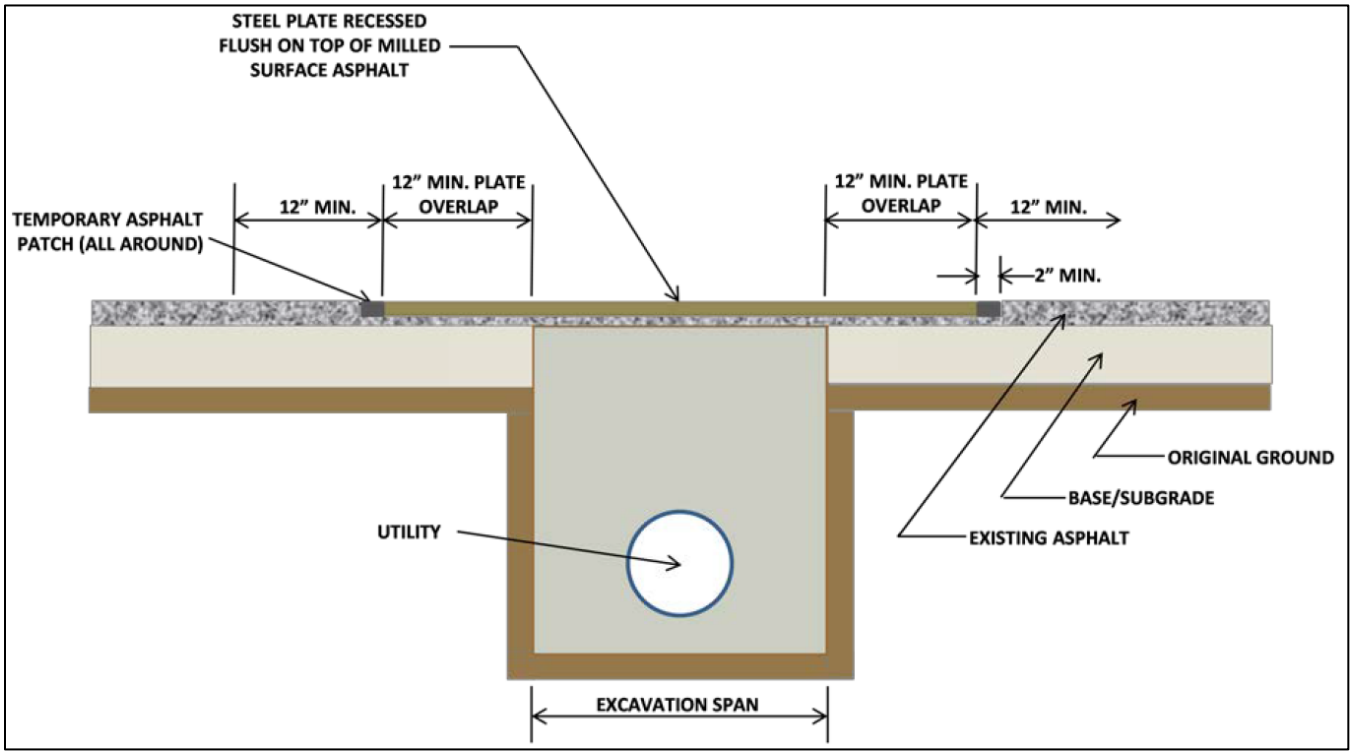
Figure 10.1 Type 1 Installation Detail



Type 2 Installation

Type 2 installation shown in Figure 10.2, shall be used in areas where backfilling operations of an excavation in the traveled way, whether traverse or longitudinal cannot be properly completed within the same day and the posted speed limit is greater than 35 MPH. The steel plate for Type 2 installations shall be recessed by milling into the existing asphalt to set flush with the surface of the existing asphalt. The pavement shall be cut and cold planed to a depth equal to the thickness of the plate and to a width and length equal to the dimensions of the plate. Full depth cutting of the asphalt section of excavation is not allowed. The steel plate shall be anchored securely to prevent movement. The gap between the edge of the plate and the adjacent existing asphalt pavement must be filled with temporary asphalt patch (cold mix). Wedges or other non-asphaltic devices shall be used for leveling as required to eliminate rocking of the plates. Compacted temporary asphalt shall be used to fill all gaps between the plates and existing pavement surfaces.

Figure 10.2 - Type 2 Installation Detail



10.2 STREET REPAIRS

Applicability

These standards apply to anyone cutting and excavating the Town of Chapel Hill streets, regardless of the reason for the cut and excavation. The standards apply to private and public utilities and contractors as well as the Town of Chapel Hill. These standards are not intended to supersede more substantial repair or resurfacing requirements on projects where specified repairs are shown on approved construction drawings or otherwise directed by Public Works.

General Requirements

Street cuts cause damage which reduce the level of service of the street on which they are made. In general, the repair standard will be what is termed a "T-patch", which includes flow compatible fill and a minimum bench (or key) of 12 inches beyond the edges of the excavation. This 12-inch bench will define the width of the required surface repair (if applicable) measured parallel to the travel direction of the street. The length of the surface repair (if applicable) measured perpendicular to the street will be at a minimum the full width of a travel lane (from curb or edge of pavement to the crown or edge of travel lane). If the edge of the excavation crosses or is less than 2 feet from the crown or edge of travel lane, the surface repair must extend to the full width of the street or edge of the next travel lane. The cost of all repairs shall be borne by the party cutting the streets.

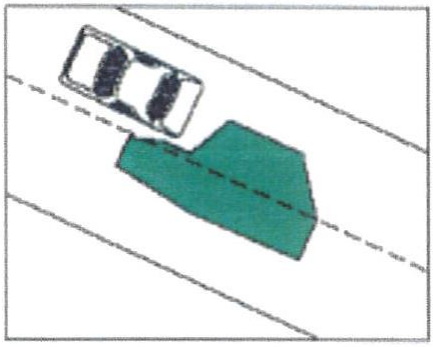
The full resurfacing area requirements specified herein shall apply to the Town streets with Institute for Transportation Research and Education (ITRE) pavement condition ratings (PCI) of 50 or higher. The full-depth structural repair is required on all Town streets.

Resurfacing requirements could possibly be reduced or increased, at the Town Public Works Department's discretion, in situations where extenuating circumstances exist such as pending resurfacing or road widening projects, safety and traffic flow issues, speed humps, adjacent pavement features or the condition of adjacent pavement.

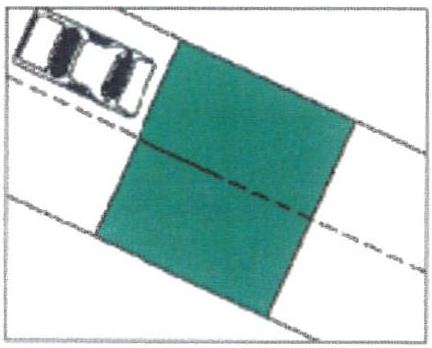
The examples on the following pages (adopted from Nashville, TN and Durham, NC) of utility cut repair details show repair methods not acceptable and the corresponding acceptable method.

Example 1: Existing pavements should be removed to clean, straight lines parallel and perpendicular to the flow of traffic. Do not construct patches with angled sides and irregular shapes. All repairs should be full lane width.

Not Acceptable

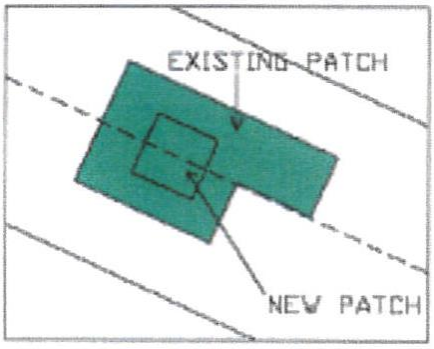


Acceptable

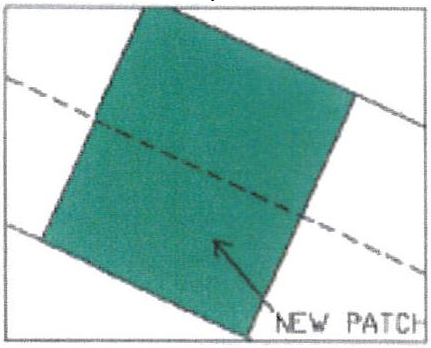


Example 2: Avoid patches within existing patches. If this cannot be avoided, make the boundaries of the patches coincide. All repairs should be full lane width.

Not Acceptable

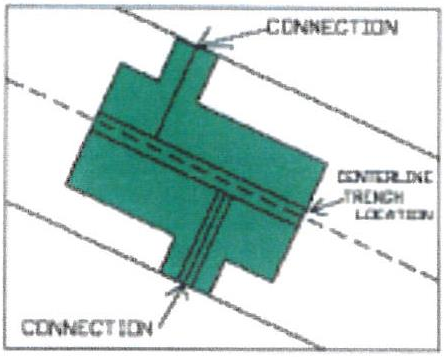


Acceptable

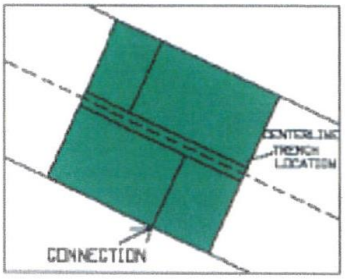


Example 3: For patches in asphalt, a tack coat shall be applied to all edges of the existing asphalt before placing the new pavement. After placing the new asphalt, all seams (joints) between the new and existing pavements shall be sealed with an asphalt tack coat or rubberized crack seal material. Avoid frequent changes in width of patches. For future maintenance, this simplifies removal of adjacent pavement failures.

Not Acceptable



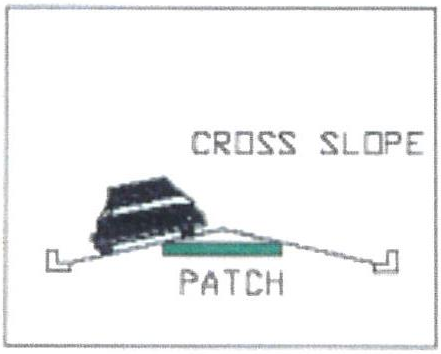
Acceptable



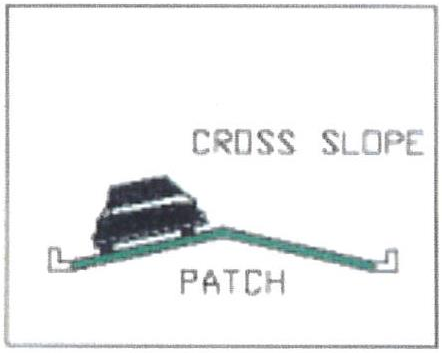
NOTE – TRENCH AND CONNECTOR LOCATIONS ARE CONCEPTUAL ONLY. SEE DETAILED CROSSECTION AND PROFILE SHEETS FOR CONSTRUCTION PROCEDURES AND WIDTHS.

Example 4: Patches should have a smooth longitudinal grade consistent with the existing roadway. Patches should also have a cross slope or cross section consistent with the design of the existing roadway.

Not Acceptable

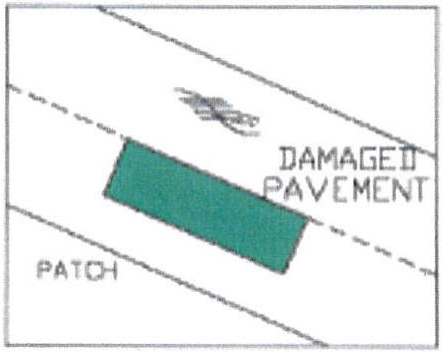


Acceptable

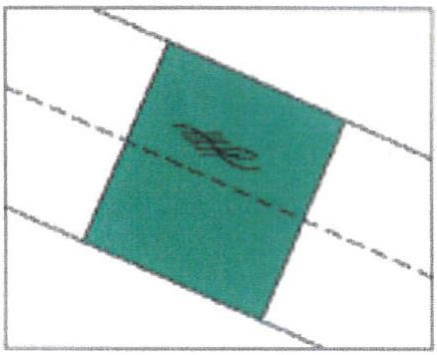


Example 5: When the proposed excavation falls within ten feet of a section of pavement damaged during the utility repair, the failed area shall be removed to sound pavement and patched. Scarring, gouging, or other damaged pavement adjacent to a patch shall be removed and the pavement repaired to the satisfaction of the engineering and public works divisions.

Not Acceptable

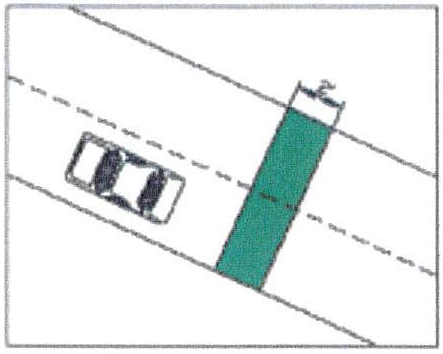


Acceptable

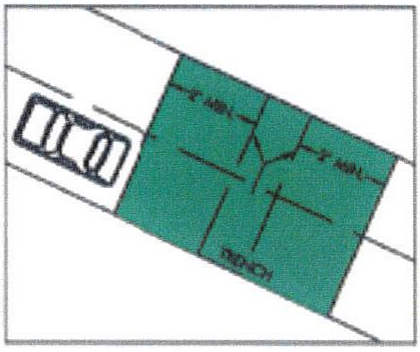


Example 6: Transverse patches on arterial and collector streets shall be overlaid across the entire street width for a distance of two (2) feet minimum on all sides of the trench using T-Patch.

Not Acceptable

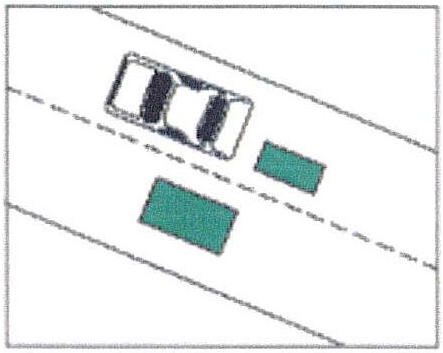


Acceptable

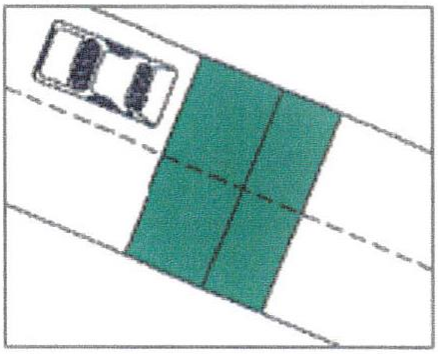


Example 7: Do not allow the edges of patches to fall in existing wheel paths. The edges of patches parallel to the direction of traffic shall be limited to the boundaries of lanes or to the centerline of travel lanes.

Not Acceptable

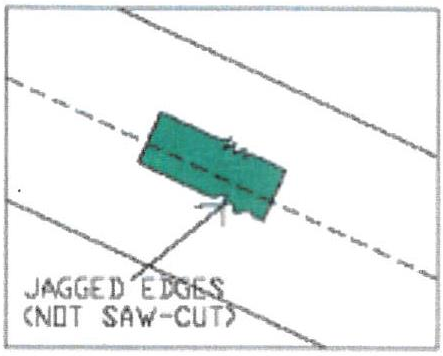


Acceptable

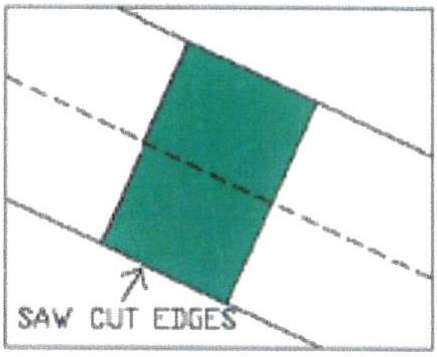


Example 8: Asphalt and concrete pavements should be removed by saw cutting or grinding. Avoid breaking away the edges of the existing pavement or damaging the remaining pavement with heavy construction equipment.

Not Acceptable

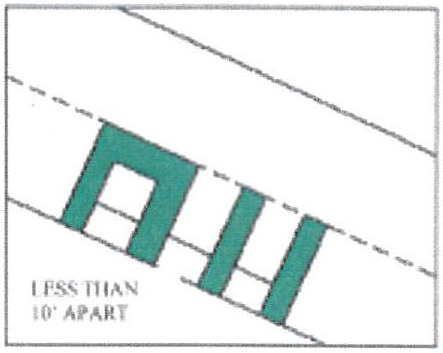


Acceptable

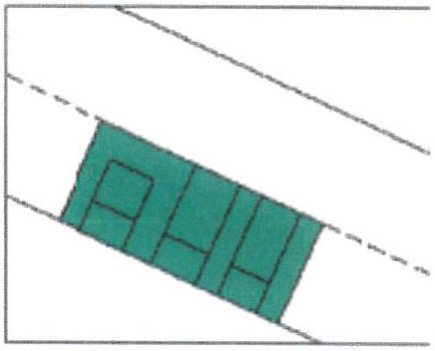


Example 9: In the case of a series of patches or patches for service lines off a main trench, repair the pavement over the patches by grinding and overlay when the spacing between the patches is less than 10 feet.

Not Acceptable

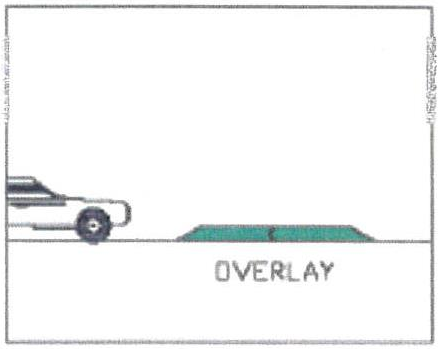


Acceptable

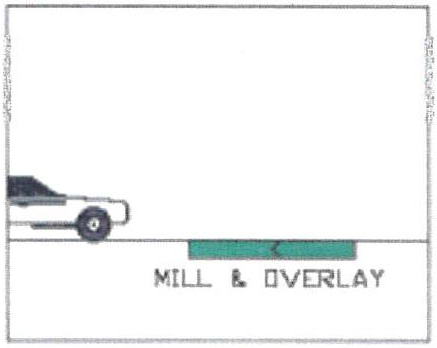


Example 10: Completed street repairs should have a ride ability at least as good as, if not better than, the pavement prior to the repairs. A driver may be able to see a street repair, but in the case of a quality repair, should not be able to "feel" it in normal driving. A patch should provide a smooth ride with transitions on and off the repair and all joints should be located outside the wheel path. Overlays should be placed by first removing the existing pavement to the desired depth by grinding or milling, and then placing the pavement flush with the adjacent surfaces. Overlays with feathered edges are not acceptable.

Not Acceptable

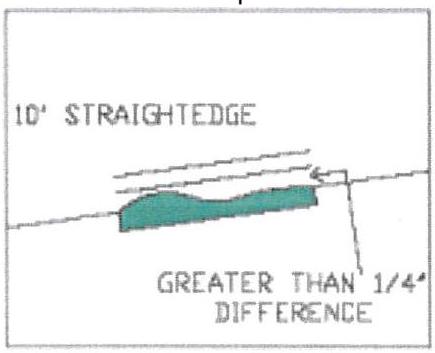


Acceptable

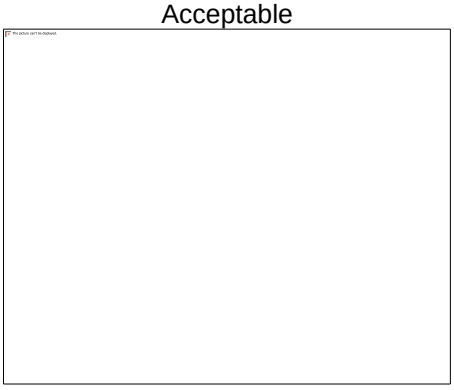


Example 11: Surface tolerances for street repairs should meet the standard for new construction. The finished surface of the street repair should be tested with a ten (10) foot straightedge parallel to the centerline or perpendicular across joints. Variations measured from the testing face of the straightedge to the surface of the street repair should not exceed on-quarter (1/4) inch.

Not Acceptable



Acceptable



Street Construction Specifications
Unless stated otherwise in this manual all work in the Town and NC DOT right-of-way must follow NC DOT standard drawings and specifications.

10.3 PERMITS AND FINAL PLANS

STEP #1: Get your plans approved

ZONING COMPLIANCE/FINAL PLAN SUBMITTAL

The initial step for approval of Final Plans is to submit a Final Plan Application to the Permit Center in the Town of Chapel Hill Planning and Sustainability Department, 405 Martin Luther King, Jr Boulevard, Chapel Hill, NC 27514.

The link to the application web page is provided below, along with a comprehensive list of submittal requirements. Please note that some of the listed submittal requirements may not be applicable to every project. However, it is the responsibility of the applicant to ensure that all required submittals are provided with the initial application. An incomplete submittal will not be accepted. The applicant is advised to contact the Permit Center prior to filing the application.

The Final Plan Application for Zoning Compliance (ZCP) can be found on the TOCH Planning Department webpage.

ZONING COMPLIANCE PERMIT/FINAL PLAN SUBMITTAL REQUIREMENTS

The applicant shall submit all requirements and sections of the Final Plan Application. These are the minimum requirements for any submittal in order for the applicant to receive a complete review. In general, the minimum plans and design information required will include stormwater impact statement, cover sheet with area map, existing conditions plan, detailed site plan, roadway design plan, traffic plans, street light plan/streetscape plan, stormwater management plan, landscape protection plan, steep slope plan, grading and erosion control plan, planting plan, streetscape plan, phasing plan, solid waste plan, fire protection & utility plan, and transportation management plan. The minimum requirements for each plan are listed on the application.

Project Information:

Development Name:		Phase:
Owner:	Phone:	Email:
Contact Person:	Phone:	Email:

General Requirements

___1. Cover letter
___2. Attach Planning approvals for rezoning, subdivision, special use, etc. to the plans.
___3. Appropriate checklist completed and attached

General Information Required on All Plans

___1. Development Name
___2. Owner(s) Name(s) & Contact Information
___3. Preparer Name & Contact Information

___4. Graphic Scale, Date & North Arrow
___5. Property Boundaries w/ Bearings & Distances
___6. Adjoining Property Owners w/ Tax Pin Numbers & Zoning Information
___7. Adjoining Roadways w/ Right-of-Way Dimensions and Transit Facilities (Existing, Proposed, and/or Temporary)
___8. Current Zoning (and Proposed Zoning if applicable)
___9. Total Site Acreage
___10. Existing Easements & Building Setback Limits shown
___11. Proposed Easements, ROW, Common Areas, Areas Dedicated to Public Use
___12. Building Footprints w/ Square Footages & Finished Floor Elevations
___13. Limits of 100 Year Floodplain where applicable
___14. Location of Existing Structures

Cover Sheet/Area Map

a. Include Project Name, Project fact information, PIN, Design team
b. Area Map including:

    a. Project name, applicant, contact information, location, PIN, & legend
    b. Dedicated open space, parks, greenways
    c. Overlay Districts, if applicable
    d. Property lines, zoning district boundaries, land uses, project names of site and surrounding properties, significant buildings, corporate limit lines

___15. Existing roads (public & private), rights-of-way, sidewalks, driveways, vehicular parking areas, bicycle parking, handicapped parking, street names, and transit facilities (existing, proposed, and/or temporary)

    e. Phasing Plan if required

Existing Conditions Plan

a. Slopes, soils, environmental constraints, existing vegetation, and any existing land features
b. Location of all existing structures and uses
c. Existing property line and right-of-way lines
d. Existing utilities & easements including location & sizes of water, sewer, electrical, & drainage lines
e. Nearest fire hydrants
f. Nearest transit facilities
g. Existing topography at minimum 2-foot intervals and finished grade
h. Natural drainage features & water bodies, floodways, floodplain, RCD, Jordan Buffers & Watershed boundaries

Detailed Site Plan

a. Existing and proposed building locations
b. Description & analysis of adjacent land uses, roads, topography, soils, drainage patterns, environmental constraints, features, existing vegetation, vistas (on & off-site)
c. Location, arrangement, & dimension of vehicular parking, width of aisles and bays, angle of parking, number of spaces, handicapped parking, bicycle parking. Typical

pavement sections & surface type
d. Location of existing and proposed fire hydrants
e. Location and dimension of all vehicle entrances, exits, and drives
f. Dimensioned street cross-sections and rights-of-way widths
g. Pavement and curb & gutter construction details
h. Dimensioned sidewalk and tree lawn cross-sections
i. Required Transit Facilities (Existing, Proposed, and/or Temporary)
j. Required buffers (or proposed alternate buffers)
k. Required recreation area/space calculations (including written statement of recreation plans and payment-in-lieu formula and amount)
l. Refuse collection facilities (existing and proposed) or shared dumpster agreement
m. Construction parking, staging, storage area, and construction trailer location

Roadway Design Plan

a. Horizontal alignment with curve data (if applicable)
b. Vertical alignment (profile, curve length, grades, k-values, PVI stations)
c. Typical street cross-section
d. Cut and fill limits on topography
e. Intersection curb radii
f. Driveway locations and widths
g. Sight distance triangles at intersections
h. Geotechnical analysis (if applicable)
i. Right-of-way widths
j. Easements
k. Drainage facilities (materials used, slopes, invert elevations, HGL, spread/intercepted flow, pipe & channel size calculations for 10 and 25-year storm, pertinent off-site drainage features
l. Work zone traffic control plan
m. Pavement removals/demolitions

Traffic Plan

i. Traffic Calming Plan – detailed construction designs of devices proposed & associated sign & marking plan
ii. Traffic Sign, Street Name Sign, and Pavement Marking Plan – in accordance with Manual on Uniform Traffic Control Devices. Street name signs in accordance with Town of Chapel Hill standards
iii. Traffic Signal Plan – in accordance with Manual on Uniform Traffic Control Devices and NCDOT traffic signal design standards (prepared by licensed professional engineer)

Street Lighting Plan/Streetscape Plan

a. In accordance with Town of Chapel Hill and Duke Energy standards; sealed by professional engineer
b. Proposed location of streetlights and underground utility lines and/or conduit lines to be installed

c. Description and/or detail of proposed light poles, fixture, watts, lumens, and spacing
d. Other improvements, such as benches or transit facilities, if proposed within public right-of-way
e. If Downtown Streetscape area, utilize standard downtown conduit detail
f. Location of street edge of pavement and/or curb and gutter, sidewalk, & property lines

Stormwater Management Plan

a. Topography (2-foot contours)
b. Existing drainage conditions
c. RCD and Jordan Riparian Buffer delineation and boundary (perennial & intermittent streams, note ephemeral streams on site)
d. Proposed drainage and stormwater conditions
e. Drainage conveyance system (piping)
f. Roof drains
g. Easements
h. BMP plans, dimensions, details, and cross-sections
i. Planting and stabilization plans and specifications

Landscape Protection Plan

a. Rare, specimen, and significant tree survey within 50 feet of construction area
b. Rare and specimen tree critical root zones
c. Rare and specimen trees proposed to be removed
d. Certified arborist tree evaluation, if applicable
e. Significant tree stand survey
f. Clearing limit line
g. Proposed tree protection /silt fence location
h. Pre-construction/demolition conference note
i. Detailed tree protection fencing
j. Landscape protection supervisor note
k. Existing and proposed tree canopy calculations, if applicable

Steep Slopes Plan

1. Classify and quantify slopes 0-10%, 10-15%, 15-25% and 25% and greater
2. Show and quantify areas of disturbance in each slope category
3. Provide/show specialized site design and construction techniques

Grading and Erosion Control Plan

5. Topography (2-foot contours)
6. Cut and Fill Lines
7. Cross-sections (Streets)
8. Detailed Drawings of infrastructure (BMPs, curb inlets, infiltration systems, erosion control, etc.)
9. Limits of Disturbance
10. Pertinent off-site drainage features
11. Existing and proposed impervious surface tallies

12. Ground cover
13. Spot elevations when necessary
14. Size calculations

Planting Plan

1. Dimensioned and labeled perimeter buffers
2. Landscape buffer and parking lot planting plan (including planting strip between parking and building, entryway planning)
3. Off-site buffer easement, if applicable
4. Detailed buffer planting plan
5. Detailed parking lot shading/screening plan
6. Detailed composite plant list with installation sizes
7. Landscape installation details and maintenance plan

Streetscape Plan

1. Public right-of-way existing conditions plan
2. Streetscape demolition plan
3. Streetscape proposed improvement plan
4. Streetscape proposed utility plan and details
5. Streetscape proposed pavement/sidewalk details
6. Streetscape proposed furnishing details
7. Streetscape proposed lighting details

Solid Waste Plan

- Solid Waste Management Plan approval by Orange County
- Existing and proposed dumpster pads
- Proposed dumpster pad layout design
- Proposed dumpster pad construction section
- Proposed dumpster pad protective bollard and screening fence details
- Proposed heavy duty pavement locations and pavement construction detail
- Existing pavement damage waiver note
- Refuse facility lighting plan

Fire Protection and Utility Plan

- Fire Flow Report: for a fire hydrant within 400 feet of each building, provide the calculated gallons per minute when residual pressure is 20 pounds per square inch. The calculations should be sealed by a licensed Professional Engineer in NC and accompanied by a water supply flow test conducted within one year of the submittal (see Utilities Chapter of Town of Chapel Hill Engineering Design Manual for required gallons per minute)
- Indicate location and size of water, sewer, electric, cable, telephone, gas and fire safety apparatus

Transportation Management Plan

A Transportation Management Plan (TMP), for the development process, shall be approved by the Town Manager prior to issuance of Zoning Compliance Permit. This plan shall be updated annually and approved by the Town Manager. The following steps may be required.

1. Installation of a shower for use by any building employees utilizing alternative transportation
2. Designated spaces will be provided for car poolers as well as alternative fuel vehicles.
3. Designation of a Transportation Management Plan (TMP) Coordinator – name, title, email, phone, and address to be provided
   1. Regularly communicate and promote alternate modes of transportation, year-round, to all those employed in the building, including onsite availability of local and regional transit schedules.

   2. Attend the annual Go Chapel Hill TMP Conference to receive updates and training regarding TMP information distribution and application.

   3. Submit to the Town of Chapel Hill Planning an Occupancy Survey due 90 days after issuance of the final Certificate of Occupancy.

   4. Submit to the Town of Chapel Hill Planning Department and Chapel Hill Transit an updated annual Transportation Management Plan Report.

   5. Conduct Employee and Resident surveys during survey years. Employee surveys will be distributed to each employee working in the building and then returned to the Town of Chapel Hill Planning Department and Chapel Hill Transit by specified deadline.

   6. Will take steps to gradually attain the goals of the Go Chapel Hill TMP Program.

   7. Conduct annual survey of employees for any increased demand for additional bicycle parking and installation of those facilities on an as-needed basis, if determined to be appropriate by Town staff.

Stormwater Requirements

<u>Stormwater Management Report Requirements</u>

Pursuant to the Town of Chapel Hill Land Use Management Ordinance Section 5.4, Stormwater Management, all applications for developments or subdivisions and any building (some single-family or two-family dwellings resulting in less than or equal to 20,000 square feet of land disturbance may not be subject to these requirements) within the Town of Chapel Hill Planning Jurisdiction must include a Stormwater Management Report. As authorized by the Chapel Hill Land Use Management Ordinance, affirmative exemption to all or part of the requirements of the Stormwater Management Report may be granted by the Town.

___1. Written narrative describing

___1. Existing & proposed conditions

___2. Pertinent onsite and offsite drainage conditions

___3. Anticipated stormwater impacts

___4. Design criteria

___1. Discussion of structural and non-structural SCMs and strategies chosen to mitigate development impacts that will be part of the stormwater management plan

___2. Soils information (classification, infiltration rates, depths to groundwater and bedrock)

___2. Summary tables of the peak discharge flow rates (1, 2, and 25-year storms) for pre-development; post-development without stormwater management; and post-development with stormwater management, for *each* sub-basin/POA *and* the project site as a whole.

___3. Summary table of the volume management results (WQV and 2-year storms) for pre-development; post-development without stormwater management; and post development with stormwater management, for all sub-basins/POAs and the project site as a whole.

___4. Hydrology calculations, to include:

___1. Pre-development and post-development drainage maps clearly labeled and showing delineated drainage sub-basins; connectivity of conveyance system and stormwater structures; and POAs. Flow paths in each sub-basin must be indicated (may be included in plan set). Location of jurisdictional wetlands, streams and regulatory FEMA Special Flood Hazard Areas. Drainage area maps must be to scale; scale shall be no smaller than 1-inch = 100-feet. Maps must include 2-foot contours, at minimum.

___2. Summary table of land uses and areas (in square feet) within each drainage basin, curve numbers/runoff coefficients for each land use, Basin ID, and source of values used.

___3. Time of concentration (T_c) calculations

___4. Peak discharge calculations, with results documented in a summary table (See b. above).

___5. Volume management calculations, with results documented in a summary table (See c. above).

___5. Hydraulic calculations, to include:

___1. Water quality volume calculations for providing 85% TSS removal for post-development stormwater runoff

___2. BMP sizing calculations, including stage-storage-discharge information

___3. Routings and hydrographs for each sub-basin point of analysis

___4. Pipe sizing calculations, pipe schedule and Hydraulic/Energy Grade Line (HGL/EGL) study (for all storm drainage pipe systems; the study shall include profiles with labeled inverts, slopes, proposed finished grade and hydraulic grade line for 10-year, 24-hour and 25-year, 24-hour storm events)

___5. Backwater elevations and effects on existing drainage conveyance facilities.

___6. Channel sizing calculations

___7. Outlet dissipater sizing calculations

___6. Nutrient Loading Calculations – Completed output from Jordan/Falls Stormwater Load Accounting Tool printed on 11x17 paper.

___7. Draft Inspections, Operations, and Maintenance Plan for each stormwater management structure.

ENGINEERING CONSTRUCTION PERMIT PLAN SUBMITTAL

An Engineering Construction Permit (ECP) is issued by the Engineering & Design Division for the installation of all non-franchised public infrastructure in existing or proposed public rights-of-way, and required stormwater management devices. Although it is typically issued in conjunction with a Zoning Compliance Permit, the applicant must have an ECP prior to beginning any work in the public right-of-way.

ENGINEERING CONSTRUCTION PERMIT PLAN DRAWING SUBMISSION REQUIREMENTS

The following list should be used by the applicant before any engineering design submittal so that applicants are aware of the minimum requirements. The checklists in this section are intended as a guide and may not be inclusive of all the required information. The Engineering Roadway Plan Checklist is a submittal requirement.

All plans that are submitted directly to the Town of Chapel Hill, Public Works/Engineering & Design Services Division shall be accompanied by a cover letter (or transmittal note) stating:

___1. Project Name
___2. Contact Person, Phone Number, Email Address
___3. Reason for Plan Submittal
___4. Planning Approvals, if applicable (Rezoning, Subdivision, Special Use, etc.)
___5. Appropriate Engineering Checklist(s)
___6. Engineering Review Fee (See Fee Schedule)

Note:

___1. All plan submittals must be stamped and sealed by the engineer and marked “For Construction” or “Preliminary”.

___2. Failure to identify the project and the reason it is being submitted may cause delay in the review process.

For first time submittal of construction drawings that require Engineering's review for public infrastructure, submit a minimum of three (3) complete bound sets of prints and one (1) electronic PDF file. The plans are submitted to the Senior Engineering Coordinator in the Engineering & Design Services Division of the Public Works Department, 6850 Millhouse Road, Chapel Hill, NC.

*Submit drawings separately to the Orange Water & Sewer Authority if requiring a water and/or sewer plan review.

All drawings must have the following stamp of approval on each sheet.

Town of Chapel Hill

All Construction Methods and Materials shall be In accordance with the Town of Chapel Hill, Orange Water & Sewer Authority (OWASA), end NCDOT Standards and Specifications. In the event of a conflict between standards, the more stringent shall govern unless a waiver la issued by the Town Engineer and/or Authority Having Jurisdiction (AHJ). Utility installations and other Public Facilities, Including streets, sidewalks, stormwater, and handicap ramps, have been approved by the Town of Chapel Hill and shall be so installed unless a change is authorized by prior written approval. Public Water/Sanitary Sewer, Stormwater, and Utility Easements shall be recorded prior to final acceptance and/or issuance of a Certificate of Occupancy by the Town.

The Town of Chapel Hill may require redesign and/or reconstruction of work shown on the approved plans, subsequent to such approval, if it becomes evident that the design is inadequate to meet actual field conditions and/or is based on incomplete, insufficient, inaccurate, or misleading data portrayed on the approved plans. The Town of Chapel Hill accepts no responsibility for costs involved in such redesign end/or reconstruction.

Engineering Date:

Roadway Plans Check List

Coordination with approved site plan

___1. Verify Site plan hasn't changed
___2. Functional criteria for each street listed matches approved site plan
___3. Intersections match approved site plan
___4. Driveways match approved site plan
___5. Bike/Ped accommodations match approved site plan
___6. Traffic Management plans match approved site plan
___7. Transit facilities match approved site plan

Functional Criteria for every proposed street or connecting street

___1. Street classification
___2. Proposed speed limit
___3. Typical Cross-section

Horizontal Design

___1. Alignment shown and labeled on plan view
___2. Curve Data on plans
___3. Pavement width identified
___4. Tapers
___5. Guardrail (if applicable)
___6. Islands/Medians (with detailed drawing)

Vertical Design

___1. Roadway profile with centerline, and back of curb elevations for cul-de-sacs
___2. Vertical curve data on plans, with K values
___3. Grades
___4. Drainage pipe profiles shown

Storm Drainage

___1. Calculations with HGLs provided
___2. Table on plans
___3. All pipes and structures shown and labeled on plan & profile
___4. Drainage areas identified on plan view
___5. Gutter spread
___6. Ditch cross-sections

Utilities

___1. OWASA approval for water/sewer (prior to final plan approval)
___2. Water/sewer in approved cross-sectional corridor
___3. Utilities in approved cross-sectional corridor
___4. Minimum cover
___5. Street lights

Cross-Sections at 50 feet Stations

___1. Pavement width, depth and type
___2. Superelevation or normal crown
___3. Drainage ways
___4. Furniture/plant zone
___5. Bike/Ped accommodations
___6. Transit facilities
___7. ROW & Easements shown
___8. Utility corridors identified
___9. Cut/fill slopes

ROW & Easements

___1. ROW
___2. Utility Easements
___3. PDE
___4. Sight distance triangles
___5. Setbacks
___6. Buffers

Bridges and culverts

___1. Sealed Shop Drawings

Intersections

___1. Stop control
___2. Storage lengths
___3. Curb radii
___4. Pedestrian treatments
___5. Sight distance

Driveways

___1. Type
___2. Location
___3. Spacing
___4. Vertical profile or typical
___5. Width

Bike/Ped

___1. Sidewalks
___2. Pedestrian crossing
___3. Greenways

Transit

___1. Existing, proposed, and/or temporary transit facilities
___2. Access to transit facilities (sidewalks, paths)

Parking

___1. On street-marked
___2. On street-unmarked
___3. Private Lot
___4. Private drives

Details

___1. Standard & Non-standard items

Traffic Control

___1. Signage
___2. Markings

Other

___1. Fire Hydrant locations
___2. Submittal of Fire Flow Calculations to Permit Center
___3. Submittal of Work Zone Traffic Control to Traffic Division

Once approved by all agencies involved, five (5) paper copies, two (2) digital copies (PDF and DWG) of approved drawings with "For Construction" stamped on the plans and all appropriate signatures must be submitted to the Senior Engineering Coordinator with Engineering and Design Services Division. Prints are logged in, reviewed, stamped "Approved for Construction", signed, and distributed as follows:

- One (1) paper copy on file in the Engineering Division
- One (1) paper copy for the Engineering Inspector
  One (1) paper copy for the Stormwater Division
  One (1) paper copy for the Stormwater Engineer
- One (1) paper copy will be returned to the submitting Engineer

The applicant should submit additional copies if needed for their own use.

Revisions to Approved Plans

- Any revisions (including any revised phasing) made to previously approved construction plans must be re-submitted through the review process for approval. However, proposed Field Changes for projects under construction may be submitted directly to the Senior Engineer and Senior Engineering Coordinator for expedited review.
- All revisions must be "hi-lighted" on all copies each time they are submitted.

STEP #2A: Get Your Permit to Construct

ENGINEERING CONSTRUCTION PERMIT

Copies of permit applications are available in Appendix A, or on-line at: http://www.townofchapelhill.org/home/showdocument?id=3166

TO GET AN ENGINEERING CONSTRUCTION PERMIT (ECP)

- Provide an itemized cost estimate with quantities and unit prices for all work in the public right-of-way, in addition to any town maintained trails, sidewalks, paths and other amenities outside of the right-of-way. If the improvements exceed $10,000 a surety bond, bank or saving and loan letter-of-credit, or cash must be provided to the Town. The bond amount will be 125 percent of the estimated cost.
- A Sediment and Erosion Control Bond is required for any land disturbance activity of one acre or more. The Bond amount is calculated at a pro rata rate of $5,000 per disturbed acre.
- The aforementioned bonds, when applicable, will be submitted along with the Engineering Construction Permit (ECP) for approval. The ECP requires a copy of the applicant's State Contractor's License for work exceeding $50,000, and a Certificate of Liability Insurance with the Town named as a certificate holder, in the amount of $1,000,000.
- Schedule a pre-construction conference with Town staff prior to any land disturbing activity.

In addition to the approved drawings the applicant must complete the Engineering Construction Permit with the required fees. The Contractor must provide the following:

1. Itemized Cost Estimate
2. Performance Bond (converted to Warranty Bond at completion)
3. S & E Bond
4. Copy of Contractor's License
5. Proof of Insurance
6. Pay the Permit Fee
7. Schedule Preconstruction Conference

After items 1 through 6 have been completed the contractor shall schedule a preconstruction conference with the Public Works/Engineering Division.

- During the construction process the contractor will ensure that Town required Engineering inspections are accommodated.
- Upon completion of the public infrastructure improvements, a Final Inspection will be scheduled with the Engineering Inspector and the Stormwater Engineer.
- Upon satisfactory completion of the Final Inspection Punch-List, the developer/owner will provide the Town sealed as-built construction plans for the project, a Stormwater Maintenance Bond and Maintenance Manual as required, and a Public Improvements Warranty Bond in the amount of 25 percent of the original public improvements cost estimate, but not to exceed $50,000.
- If the project is located within the Town limits all public improvements will be accepted for maintenance by letter from the Public Works Department. Projects within the ETJ will receive a Letter of Completion.

Information on appropriate Building Permits can be found on the Planning and Inspection website. http://www.townofchapelhill.org/town-hall/departments-services/planning-and-sustainability/permits-and-inspections.

STEP #2B: Check to Ensure you have Permits from other Agencies

OTHER PERMITS

It is usually necessary to obtain permits/approvals from other entities prior to construction. It is the applicant's responsibility to obtain approvals from other Town departments and outside agencies.

General

New construction with in the Town or its ETJ may require the developer to obtain several different permits. Below is a list of permits that may be required along with the appropriate contacts and their contact information. If you are not sure if a permit is needed please contact the Public Works Department for assistance.

NCDOT Driveway Permit

Copies of the NC DOT driveway permit can be obtained on line at: http://www.ncdot.org at the district NC DOT offices in Graham, North Carolina.

For Orange County: NC DOT Division 7, District 1
Counties-Alamance, Orange
PO Box 766
127 East Crescent Square Dr.
Graham, NC 27253

Town of Chapel Hill Driveway Permit

All new and modified driveways accessing Town or NC DOT streets and road right-of-way are required to obtain driveway permits prior to installation. Any change of use on a property also requires approval of a driveway permit. For driveways onto NCDOT right-of-way, Public Works/Engineering Division must first sign the driveway permit before forwarding to NCDOT.

With the exception of single family residential driveways onto Town right-of-way, the driveway permit is approved as part of the Engineering plan approval process and no additional form is required. Standards for residential driveways can be found in Chapter 3.

For single family residential driveways, a copy of the Town's Driveway Permit Application is at Appendix A, or http://www.townofchapelhill.org/home/showdocument?id=3164

Contact: Town of Chapel Hill:
Public Works/Engineering Division
6850 Millhouse Road
Chapel Hill, NC 27516
919-969-5100

Encroachments in the Town Maintained Public Right-of-Way

An encroachment is an installation that is owned by an individual(s) or business entity within the street right-of-way. Generally, an encroachment agreement is required for all installations when

a foundation or footing is necessary for the encroachment, any installation above or below grade that may inhibit the public use of the available space in the right-of-way or create potential maintenance difficulties for the Town. Some examples of encroachments are fences, walls, mail box on a foundation, significant landscaping, above ground communication boxes, aerial and underground cable, and private irrigation systems.

The Town Manager or Public Works Director may approve temporary encroachments after staff review to ensure the public's safety and welfare. To apply for an encroachment the requestor must contact the Engineering Division and provide a description of the proposed encroachment, plus a sketch showing the dimensions with the proposed location. If approved, the applicant must fill out the Encroachment Agreement and attach an 8 1\2 inch by 11 inch exhibit showing the installation and location. (See Appendix A for sample agreement) After all signatures the applicant is asked to record the agreement at the Register of Deeds and send a copy of the recorded document to the Engineering Division.

Contact: Town of Chapel Hill
Public Works**/**Engineering Division
6850 Millhouse Road
Chapel Hill, NC 27516
919-969-5100

Encroachment in NCDOT Maintained Public Right-of-way

A three party NC DOT encroachment agreement is required when any developer, contractor, utility company or other government agency proposes work of any nature, other than routine maintenance, in NC DOT's Right-Of-Way. Copies of the three party encroachment agreements are available on the NC DOT web site at: http://www.ncdot.gov .

Contact: NC DOT Division 7, District 1
Counties-Alamance, Orange
PO Box 766
127 East Crescent Square Dr.
Graham, NC 27253

Jordan Buffer Authorization

A stormwater/watershed permit is required for all development and redevelopment, unless exempt by the stormwater and watershed ordinances. The permit is intended to provide a mechanism for the review, approval, and inspection of the approach to be used for the management and control of stormwater for the development or redevelopment site consistent with the requirements of the stormwater and watershed ordinances, whether the approach consists of structural BMPs or other techniques such as low-impact or low-density design. A copy of the town's permit application is available on the Town's web site, or at:

Contact: Town of Chapel Hill
Stormwater Administrator

6850 Millhouse Road
Chapel Hill, NC 27516
919-969-5100

Stream Crossings or Wetlands Disturbance

Any development or redevelopment activity that proposes to cross or disturb any length of stream or disturb more than 0.1 (one-tenth) of an acre of wetlands may require a notification or a permit obtained though the U.S. Army Corps of Engineers, and the NC DEQ Division of Water Resources (DWR) 401 permitting unit. Stream determinations in the Town of Chapel Hill are made by the town's Stormwater Administrator. For more information on these permit requirements contact the Town's Stormwater Administrator.

Contact: Town of Chapel Hill
Stormwater Administrator
6850 Millhouse Road
Chapel Hill, NC 27516
919-969-5100

Water and Sewer Permits

Any development or redevelopment that requires a new or upgraded connection to public or private water and sewer systems will require a water and/or sewer permit. These permits are obtained through Orange County Water and Sewer Authority (OWASA). The requirements for submission including the required project fact sheet can be found at: https://www.owasa.org/development-project-documents-and-forms.

Contact: OWASA
Plans Review Coordinator
400 Jones Ferry Road
Carrboro, NC 27510
919-968-4421

Sediment and Erosion Control

All projects which disturb more than 20,000 SF within the Town of Chapel Hill and its Extraterritorial Jurisdictional (ETJ), including areas of Durham County within the Town limits, must have an approved Erosion and Sedimentation Control Permit from either Orange County or NC DEQ. Information on Orange County, including required forms and checklist can be found at: http://www.orangecountync.gov/departments/planning_and_inspections/erosion_control.php. Copies of the required forms and checklist can be found at: http://portal.ncdenr.org/web/lr/forms, or by contracting the Orange County or NC DEMLR

Contact: Orange County
Planning and Inspections
West Campus Office Building
131 West Margaret Lane
Hillsborough, NC 27278
919-245-257

Contact: NC DEQ Raleigh Regional Office
3800 Barrett Drive
Raleigh, NC 27609
919-791-4200

Building Permits

The Inspections Division, as a part of the Office of Planning and Sustainability, manages the inspections and permits. The main responsibilities of the Division include:

- Enforcement of the NC State Building Codes, Chapel Hill Code of Ordinances, Minimum Housing Code, and the Land Use Management Ordinance.
- Resolution associated complaints, public requests for assistance, issuing sign installation permits, inspecting day care facilities, and inspecting business occupancies.

Additional information on obtaining a building permit can be found on the Inspections Division's web site: http://www.townofchapelhill.org/town-hall/departments-services/planning-and-sustainability/permits-and-inspections.

For more information about online permitting services, please visit the Town's Online Permitting Services webpage. http://www.townofchapelhill.org/town-hall/departments-services/planning-and-sustainability/permits-and-inspections/online-permitting-services.

Contact: Town of Chapel Hill
Planning and Inspections
First Floor, Town Hall
405 Martin Luther King Jr. Blvd.
Chapel Hill, NC 27514
919-968-2718

Tree Work Permits

Section 5.7 of the LUMO requires a Tree Work Permit for any tree removal within the Town Limits. An example of a Tree Removal Request can be found on the Town's web site. The following information at a minimum must be provided:

- Property Owner
- Tree Location
- Tree Description
- Reason for Removal
- Removal Method
- Maps, aerial imagery, and pictures are also helpful.

Tree removals shall be carried out in a manner that minimizes damage to existing vegetation that is to be retained. Tree protection fencing shall be installed along the adjacent property line within the limits of work and inspected prior to the start of any activity authorized by the Tree Work Permit. As per the written permit request, no heavy equipment is allowed over/on critical root zones of rare and specimen trees to remain (see Section 5.7 of the Land Use Management Ordinance).

The stump and root mat shall remain in place to minimize damage to roots of adjacent trees to remain. The stump may be cut flush and/or ground.

Work shall be contained on the subject property, including disposal of debris and wood chips. No access to adjacent property is authorized by this permit and is subject to permission of the adjacent property owner.

Contact: Town of Chapel Hill
Public Works/Engineering Division
6850 Millhouse Road
Chapel Hill, NC 27516
919-969-5100

All properties except single/two family residential require a Tree Work Permit. Submit site plan with the location of the tree(s) and the reason for removal in writing with signature of the property owner. If the tree removal is tied to a landscape requirement replacement of the tree may be required. Please flag the tree(s) for review in the field.

Step #3 – Build Your Project

CONSTRUCTION/INSPECTION STANDARDS

General

- Failure to adhere to these preliminary requirements as well as the requirements contained in this section titled CONSTRUCTION/INSPECTION STANDARDS would constitute justification for an immediate issuance of a "Stop Work Order" from Engineering.
- Refer to the Stormwater Chapter of this manual for inspections on Stormwater BMPs.

Coordinating Site Construction with Town Engineering

1. It should be restated that any construction activity authorized by construction plan approval cannot take place until all of the regulatory approvals required by law, but not necessarily limited to the Town of Chapel Hill, Orange County, North Carolina Department of Transportation, North Carolina Department of Environment and Natural Resources, and US Army Corps of Engineers, are received. Copies of all the required corresponding approvals must be provided to the Town.
2. No change can be made to the construction plans or in the field unless the Town of Chapel Hill Public Works/Engineering Department is notified, and reviews and approves the change prior to initiating construction.
3. A pre-construction meeting must be scheduled with the Town's engineering inspectors prior to the start of construction to ensure that the scope of work and the corresponding method of construction and testing are acceptable and noting when site inspections are required to be conducted by Town staff. At a minimum, engineering inspections must be scheduled and coordinated during the following construction stages:
    a. Verification of tree protection fence
    b. Temporary traffic control (including transit facilities)
    c. Placement of fill
    d. Road subgrade
    e. Curb and gutter alignment

f. Curb and gutter installation
g. Road paving
h. Sidewalk forms (includes driveway aprons)
i. Sidewalks and driveway aprons
j. Retaining walls
k. Drainage pipes and other structures before backfilling
l. Stormwater management facilities
m. Street name signs
n. Traffic control signs and pavement markings

4. The Certificate of Occupancy shall not be issued until all on-site and off-site improvements in the applicable phase are constructed and accepted by the approving authority. Please be advised that to attain a final Certificate of Occupancy from the Town of Chapel Hill all Town Departments performing inspections must sign-off to release the project.

General Construction Requirements

- Each phase of the work will be satisfactorily completed as shown on the "Approved" plans before the next phase will be allowed to begin, except those items of work that may be performed concurrently, or as consistent with the approved phasing plan.

- All construction tolerances and materials will conform to NC DOT standard drawings and specifications or as may be included in this manual.

- Should construction be discontinued during the winter, the entire project will be re-evaluated in the spring. All necessary corrections to prior work will be made at that time and the project can proceed to the next phase.

- For privately maintained infrastructure: Following the completion of all work items, the developer and/or their engineer will inspect privately owned infrastructure for compliance with the construction drawings and provide the appropriate certifications.

- For publicly maintained infrastructure: After the developer and/or their engineer have inspected the development and verified that any needed corrections have been made, the Public Works/Engineering Division shall be contacted to schedule the applicable inspection. If the project is not accepted, the Public Works/Engineering Division will provide the developer or their representative with a checklist of corrections (punch list).

- For public infrastructure, once a final inspection has been conducted and the work approved, the developer will be required to provide a one (1) year warranty bond on all roadway and storm drainage improvements. The bond amount shall be 25 percent of the cost of construction but not greater than $50,000 The Developer and/or Engineer shall submit “As-Builts” and “Final Plat” both in hard copy (1) and electronically (one disc).

Construction Procedures for Town Inspected Projects

Beginning Construction:

- Hold a preconstruction meeting with the Town’s Engineering and Public Works Department after final plans have been approved, and prior to the start of construction.

- An erosion control permit must be obtained from the Orange County prior to any land

disturbing activities over one 20,000 sf in size. Erosion Control and DWQ permits must be obtained as site conditions necessitate.

- Contractors shall have "Approved" plans on the job site while any work is being performed.

- Any work done without proper inspection will be subject to being uncovered or removed as required to fully verify compliance with the "Approved" plans, specifications, and proper construction practices.

Construction Sequence:

- The Public Works/Engineering Division has the responsibility to control to determine the acceptability of construction operations relative to recognized standards and specifications. Unless specifically approved by the Public Works/Engineering Division, the construction sequence should follow Table 10.1 below. The Town's Inspector will check items listed under Town's Inspector as the work progresses. An inspection is **REQUIRED** under items listed under the Inspection required column before the next step of construction can proceed.

TALBLE 10.1 Construction Sequence Guideline for Town Maintained Construction

#	Inspection Activity	Official Inspector	Inspection Required
1	Conduct Preconstruction Conference	X	
2	Obtain all Permits, Encroachment, Erosion, etc.	X	
3	Have an approved final set of plans	X	
4	Stake the clearing limits		
5	Stake and install all of the erosion control devices possible prior to grubbing	X	
6	Clear and grub the site	X	
7	Stake and install the remaining erosion control devices	X	
8	Slope stake		
9	Rough grade within R/W and utility easements	X	X
10	Temp. seeding and mulching shall be performed as needed to meet the erosion control permit requirements	X	
11	Density testing as needed	X	
12	Stake and install the storm drainage and sewer mains and services. All services to be outside of the sidewalk limits	X	X
13	Install erosion control devices around storm drain structures	X	
14	Stake and install all water mains and services. All services to be outside of the sidewalk limits		
15	Stake and install the utility conduits lines		
16	Density testing as needed on trench lines, specifically within R/W	X	
17	Sub-grade fine grading	X	
18	Sub-grade, proof roll and density testing as needed	X	X
19	First lift of ABC placement	X	

20	Staking and placement of C & G	X	X
21	Backfill of C & G	X	
22	Completion of ABC placement, fine grading and setting up of the ABC	X	
23	Proof roll and grade check of ABC, density testing as needed	X	X
24	Placement of Intermediate course asphalt	X	X
25	Shoulder and utility easements to be close to final grade +/- 0.1	X	
26	Install utility lines within the utility easements	X	
27	Street light installation	X	
28	Grade and place sidewalks	X	X
29	Finish dressing up shoulders and utility easements	X	
30	Placement of surface course asphalt	X	X
31	Core samples collected on Roadway	X	
32	Installation of pavement markings if required	X	
33	Final seeding of R/W and utility easements	X	
34	Final Inspection conducted and certifications submitted	X	X

Notification for Inspections:

- It is the responsibility of the contractor to notify the Public Works/Engineering Division **before each work phase begins**. Failure to notify the Public Works/Engineering Division for an inspection may result in the need to uncover completed work. The Town reserves the right to deny final acceptance of streets and storm drainage systems where developers failed to construct as per the standards in this manual and/or fail to make repairs as directed by the Inspector. Notification should be made two (2) days in advance.

- For an inspection, call the Public Works/Engineering Services Division to schedule an inspection.

- For Stormwater BMP inspections refer to Chapter 4 of this Manual.

Schedule of Inspections

Required Inspections:

Rough Grade Inspections - Periodic rough grade inspections will be conducted by the Inspector. The developer/owner shall immediately notify the Public Works/Engineering Division upon discovery of unsuitable soils such as, alluvial material, gumbo, underground springs, old fill material such as stumps, trees, top soil, trash, etc.

Storm Drainage Inspections - Periodic storm drainage installation inspections will be conducted by the Inspector to insure approved materials are being used and the installation conforms to the standards found in this manual and the NCDOT Standard Specifications. The developer/owner shall notify the Public Works/Engineering Division before storm drainage work is scheduled to begin.

Subgrade Proof Roll - Forty-eight (48) hours prior to base placement, the subgrade shall be proof rolled by a loaded tandem dump or larger dump truck with certified weight ticket

provided by the developer/owner under inspection of the Public Works/Engineering Division. The developer/owner shall notify the Public Works/Engineering Division before the proof roll to set up an appointment with the Inspector. If rain occurs between the proof roll and prior to base placement, another proof roll may be required. It is the responsibility of developer/owner to make corrections to the subgrade when sections of the roadway fail the proof roll test.

Curb & Gutter Placement Inspection - Periodic curb and gutter placement inspections will be conducted by the Inspector to ensure approved materials are being used and the installation conforms to the standards found in this manual and the NCDOT Standard Specifications. The developer/owner shall notify the Public Works/Engineering Division before curb and gutter placement is scheduled to begin. No concrete will be placed until the forms and subgrade have been approved by the Inspector.

Roadway ABC Stone Base Proof Roll - The ABC stone base will be proof rolled by a loaded tandem or larger truck with certified weight ticket provided by the developer/owner under inspection of the Public Works/Engineering Division. The developer/owner shall notify the Public Works/Engineering Division before the proof roll to set up an appointment with the Inspector. It is the responsibility of developer/owner to make corrections to the ABC stone base and/or subgrade when sections of the roadway fail the proof roll test.

Plant Mix Asphalt Placement and Density Inspections - Periodic asphalt placement inspections will be conducted by the Inspector to ensure approved materials are being used and the installation conforms to the standards found in this manual and the NCDOT Standard Specifications. The developer/owner shall notify the Public Works/Engineering Division before asphalt placement is scheduled to begin. The Inspector may require another ABC proof roll if it has been longer than 72-hours since the last proof roll, significant rainfall event, or base has been damaged.

Sidewalk Placement Inspections - Periodic sidewalk placement inspections will be conducted by the Inspector to ensure approved materials are being used and the installation conforms to the standards found in this manual and the NCDOT Standard Specifications. The developer/owner shall notify the Public Works/Engineering Division before sidewalk placement is scheduled to begin. No concrete will be placed until the forms and subgrade have been approved by the Inspector. Refer to Appendix 1 & 2 for additional information.

Final Inspection - Prior to roadway maintenance acceptance by the Town of Chapel Hill a final inspection must be conducted. All “As-Built” requirements and punch list items must be completed, and a one (1) year warranty must be provided by the developer/owner for all improvements in the public right-of-way and public easements.

Order of Construction

The Public Works/Engineering Division has the responsibility to determine the acceptability of construction relative to recognized standards and specifications. The developer or their engineer, would be expected to follow the construction sequence should follow Table 10.2:

TABLE 10.2 Construction Sequence for Privately Maintained & Inspected Streets

#	Inspection Activity	Developers Inspector	Inspection Report Filed	P.E. Certification Required***
1	Conduct Preconstruction Conference			
2	Obtain all Permits, Encroachment, Erosion, etc.			
3	Have an approved final set of plans			
4	Stake the clearing limits	X	X	
5	Stake and install all of the erosion control devices possible prior to grubbing	X	X	
6	Clear and grub the site	X	X	
7	Stake and install the remaining erosion control devices	X	X	
8	Slope stake	X	X	
9	Rough grade within R/W and utility easements	X	X	
	Interim Certifications			**X**
10	Temp. seeding and mulching shall be performed as needed to meet the erosion control permit requirements	X	X	
11	Density testing as needed	X	X	
12	Stake and install the storm drainage and sewer mains and services. All services to be outside of the sidewalk limits	X	X	
13	Install erosion control devices around storm drain structures	X	X	
14	Stake and install all water mains and services. All services to be outside of the sidewalk limits	X	X	
15	Stake and install the utility conduits lines	X	X	
16	Density testing as needed on trench lines, specifically within R/W	X	X	
	Interim Certifications			**X**
17	Sub-grade fine grading	X	X	
18	Sub-grade, proof roll and density testing as needed	X	X	
19	First lift of ABC placement	X	X	
20	Staking and placement of C & G	X	X	
21	Backfill of C & G	X	X	
	Interim Certifications			**X**
22	Completion of ABC placement, fine grading and setting up of the ABC	X	X	
23	Proof roll and grade check of ABC, density testing as needed	X	X	
	Interim Certifications			**X**
24	Placement of Intermediate course asphalt	X	X	

25	Shoulder and utility easements to be close to final grade +/- 0.1	X	X	
26	Install utility lines within the utility easements *	X	X	
27	Street light installation	X	X	
28	Grade and place sidewalks	X	X	
29	Finish dressing up shoulders and utility easements	X	X	
30	Placement of surface course asphalt	X	X	
31	Core samples collected on Roadway	X	X	
32	Installation of pavement markings if required	X	X	
	Interim Certifications			**X**
33	Final seeding of R/W and utility easements	X	X	
34	Final Inspection conducted and certifications submitted **	X	X	
	Certification of Completed Project			**X**

* Utility locations and utility installations will be under the inspection of the appropriate utility company. All ditches will be proof rolled prior to base placement.
** Backfill, seeding and mulching, adjustments, cleanup, etc. shall be complete prior to final acceptance.
*** An example certification is in Appendix A.

Purpose - To ensure that new construction inspected by others (consultants, testing laboratories, etc.) meet the Town of Chapel Hill standards before it is accepted as complete.

Requirements - All new construction inspected by others (consultants, testing laboratories, etc.) which is to be accepted as complete must be certified by a registered Professional Engineer.

Expectations - When work which is to be accepted into the town system is following inspections, testing and certifications are expected of the engineer:

Permits

- Verify that all Federal, State and Local permits have been acquired.
- A copy of any Corp of Engineers and Division of Water Quality permits (including any approved modifications) must be submitted with the final certification package.
- A "Verification of Compliance with Environmental Regulations" form must be submitted with the final package (if form hasn't already been submitted during plan approval).

Alignment

- Field verify that vertical and horizontal alignment of all aspects of construction are in reasonable close conformance to the approved plans and to the Town Standards and Specifications.
- Verify that new construction is centered in the platted right of way or utility easement.
- Verify that all materials meet Town Specifications and are installed at the proper elevation.

Grading and Proof Rolling

a. Verify subgrade elevation + or - 0.1 foot.
b. Verify shoulder width and slope.
c. Verify ditch locations and depth.
d. Prepare the trench for stone base placement, which should be the approved pavement width + 3 feet.

e. Compact the top 8 inches of the subgrade to a density of 100%.
f. Perform a proof roll of the full width of the compacted subgrade with a fully loaded dump truck with a total gross weight of at least 40,000 Ibs or equivalent.
g. All failures must be repaired and rechecked to complete the proof roll.
h. A copy of the proof roll report must be submitted with the final package.
i. Aggregate Base Course Placement for Roadways
j. Place ABC base material at the required depth with a spreader to avoid segregation and to avoid contaminating the material with earth from the edge of the trench.
k. Add water if necessary to achieve the proper moisture content of the material prior to compaction.
l. Uniformly compact the material to the required compacted thickness at a density of 100%.
m. Verify the top width of the compacted ABC base material to be the approved plan pavement width + 6 inches on each side.
n. Verify the approved plan thickness and correct density of the ABC base material prior to placement of any asphalt surface material.

Asphalt Surface Material Placement

- Submit a Job Mix Formula Sheet for all asphalt mixes prior to the anticipated placement of the material.
- All asphalt, used in the work, must come from an NCDOT approved asphalt plant.
- A QMS Certified Plant Technician must be present at the plant during the production of the material.
- A QMS Certified Roadway Technician must be present on site during all placement of hot mix asphalt.
- The approved plan thickness and density for each layer must be verified by an approved testing method performed by the Certified Technician.
- A copy of the Roadway Technician's Report, the completed Job Mix Formula Sheet and the Certification of Pavement Conformance must be submitted with the final package.
- A copy of all thickness and density testing reports must be submitted with the final package.

Roadway Shoulder Construction and Seeding and Mulching

- The shoulders should be constructed in accordance with the approved typical section as soon after the placement of the final surface layer of asphalt as practical using caution not to damage the asphalt.
- Seeding & mulching of shoulders, ditches and back slopes, utility easements and other disturbed areas must be completed within 15 days of completing the construction.
- All required erosion control measures must remain in place until an adequate stand of vegetation is established.

Guardrail Placement

- Guardrail will be placed when warranted and in accordance with the approved plans & NCDOT certified materials.

Sign Placement

- Stop signs at intersections and signing for round-a-bouts will be placed on each road in accordance with the Manual on Uniform Traffic Control Devices and the approved plans.

- A final inspection letter will not be issued until all required signs are properly installed to the appropriate standard.
- All design and construction details not covered above or in the approved plans, should be found in the most current "NCDOT Subdivision Roads - Minimum Construction Standards" or the most current "NCDOT Standard Specifications for Roads and Structures" manuals.

STEP #4: FINAL APPROVAL OF CONSTRUCTION

A. Upon completion of the public infrastructure improvements a Final Inspection will be scheduled with the Engineering Inspector and the Stormwater Engineer.

B. Upon satisfactory completion of the Final Inspection punch-list the developer/owner will provide the Town sealed as-built construction plans for the project, a Stormwater Maintenance Bond and Maintenance Manual when required, and a public improvements Warranty Bond in the amount of 25 percent of the original public improvements cost estimate, but not to exceed $50,000.

C. If the project is located within Town Limits all public improvements will be accepted for maintenance by letter from the Public Works Department. Projects only within the ETJ will receive a Letter of Completion.

As-Built Drawings

- After the water, sewer, storm drainage and roadway improvements have been constructed, and prior to final acceptance, an "As-Built Drawings" must be submitted.
- A “Record Drawing” shall be marked as such and the Town staff will inspect the job site to verify accuracy of the "As-Built Drawings". If errors are found, the drawing must be corrected and re-submitted.
- Once the Public Works/Engineering Division has verified the “As-Built” to be accurate, the Submitting Engineer must submit the following:
  - One (1) set of signed “As-Built Drawings”
  - Two (2) digital copies of “As-Built” (one DWG format and one PDF format) and two (2) digital copies of the Final Plat (one DWG format and one PDF format).
  - Note: Project must be submitted on one disk or flash drive. Use a DVD or CD as needed.

Public Works/Engineering Division As-Built Submittal Checklist

1. The following section provides a list, which should be used by the applicant before any engineering design submittal so that applicants are aware of the minimum requirements in order to receive a complete review.
2. The checklists in this section are intended as a guide and may not be inclusive of all the required information.
3. The As-Built review checklist is a submittal requirement.

Project Information

Development Name		Phase:
Owner:	Phone:	Email:
Contact Person:	Phone:	Email:

General Requirements

___1. Cover letter
___2. Appropriate checklists completed and attached
___3. All required construction inspection documentation as defined in Chapter 10

Submit all As-Built drawings to Engineering Services & Design, and Planning & Sustainability (if applicable) for Acceptance of Public Improvements. As-Builts should meet ALL items listed for detailed design as well as all utility owner requirements from the appropriate water and sewer service provider listed below:

- Upon the acceptable completion of all punch list items the Town the Owner/Developer will receive an initial acceptance letter from Engineering.
- This acceptance begins a warranty for materials and workmanship for not less than one year from the date of acceptance. The warranty period shall continue until all construction activities (i.e., phased project) are completed or no longer impact the area(s) under warranty. The maintenance guarantee will be to the Town from the Owner/Developer.
- The performance guarantee shall be replaced with a maintenance guarantee in an amount of $50,000 or 25 percent of the cost of the improvements, whichever is less.
- During the warranty period, the Town assumes ownership of the public facilities and will perform routine maintenance; however, until a letter of final acceptance has been issued, all defects in materials and/or workmanship are the responsibility of the Owner/Developer.
- No more than 30 days prior to expiration of the warranty period, the Owner/Developer in writing must request a final inspection from the Engineering Division so a letter of final acceptance or a punch list letter can be provided.
- Upon the acceptable completion of all punch list items, the Owner/Developer will receive a letter of final acceptance from the Engineering Division and the corresponding warranty bond will be released.
- The Town will begin total maintenance as of the date of the final acceptance letter.

Orange Water and Sewer Authority (OWASA) Standards:
https://www.owasa.org/Data/Sites/1/media/whatWeDo/spec/2015-version-owasa_standards_and_specs.pdf