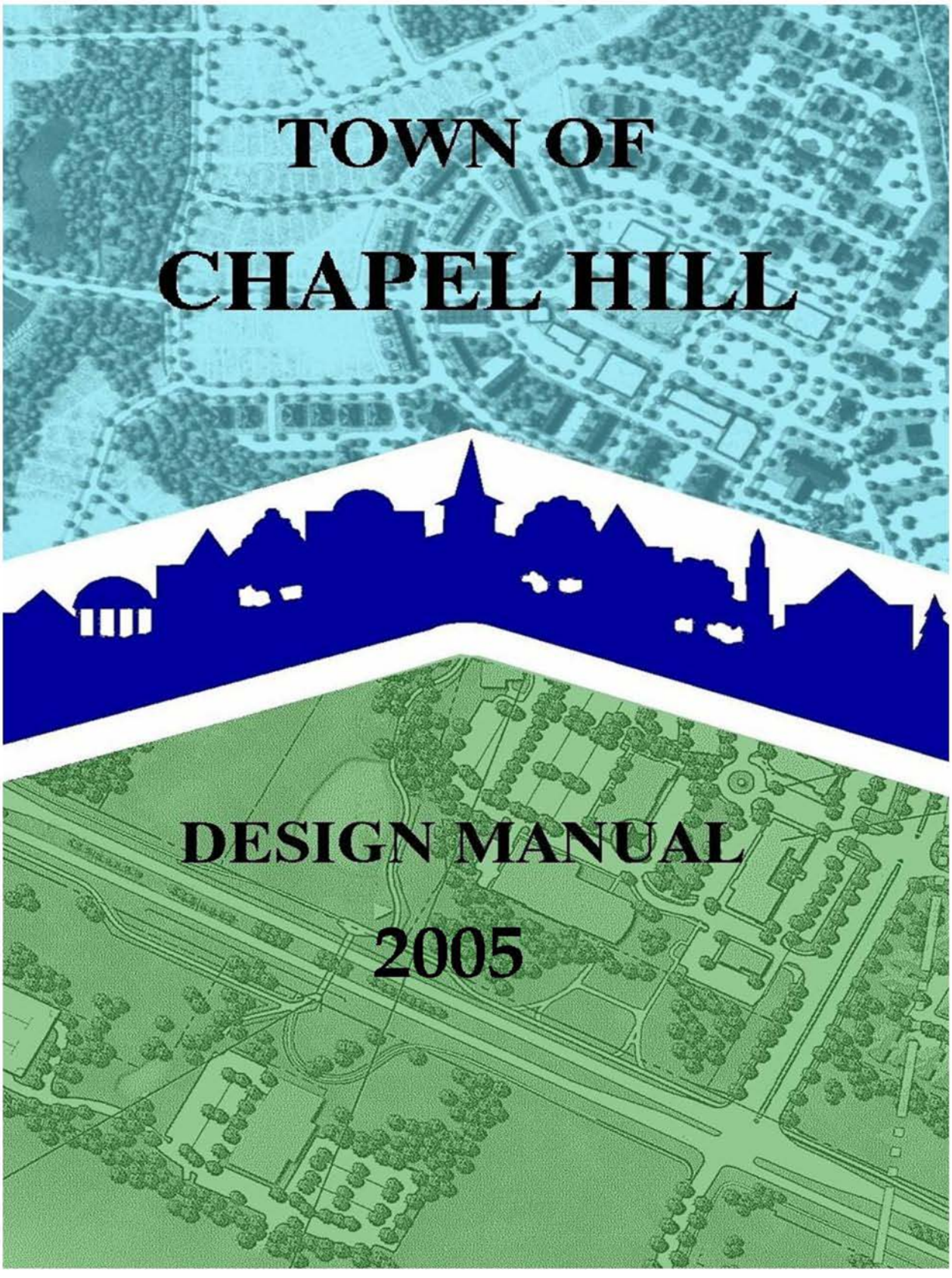

TOWN OF
CHAPEL HILL
DESIGN MANUAL
2005

Table of Contents

Design Manual
Chapel Hill, North Carolina

END

Acknowledgement:
The Town acknowledges Mr. M.C. Russell, Senior Engineering Inspector, for producing the illustrations included in this document.

SECTION - 1

INTRODUCTION

SECTION 1 INTRODUCTION

1.1 PURPOSE

These standards are meant to interpret and clarify the Land Use Management Ordinance and Design Guidelines 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 and Design Guidelines deal with the more specific concepts such as types of use, lot sizes, parking requirements and the like.

However, even these more specific terms can be interpreted in a variety of ways, especially where a specific development in a specific location is being considered. Therefore, the Town of Chapel Hill Design Manual has been prepared to help people involved with land development in Chapel Hill and its planning jurisdiction to understand, before they begin, what will most likely be acceptable in this jurisdiction. These standards are intended to complement and supplement the general Design Guidelines included in the Comprehensive Plan.

Specific design criteria set forth herein 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 better practices and techniques for complying with Town development policies and regulation. If, in response to the characteristics of a particular site, innovative practices, and/or technological changes, a designer can make a valid case for application of standards that modify or substitute for the design standards contained herein, he or she is encouraged to do so.

Where alternative standards can be shown to conform with applicable policies and regulations, the Town may accept such alternative standards 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.

These standards include 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.

1.2. 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.

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 a nonconformity.

The Design Manual and Standard Details will be updated as necessary, and the revised pages will be available from the Town of Chapel Hill Engineering Department and on the Town web site at http://www.townofchapelhill.org.

SECTION - 2

STORMWATER

MANAGEMENT

SECTION 2 STORMWATER MANAGEMENT

2.1 INTRODUCTION

Development and re-development within the Chapel Hill Planning Jurisdiction is required to manage stormwater in accordance with Article 5.4 of the Chapel Hill Land Use Management Ordinance. This section of the Design Manual provides information on the design and application of acceptable means and measures to comply with the requirements of the Ordinance.

The Ordinance requires that development and re-development activities properly manage and control stormwater runoff rate, volume, pollutants, and erosion/sedimentation as necessary to protect and safeguard the environment, property, health, safety and welfare of citizens within the Town's jurisdiction.

Low-Impact Design (LID) using integrated/best management practices is encouraged to meet the stormwater management performance criteria in the Land Use Management Ordinance. Acceptable stormwater management practices include those found in this Design Manual and in the most recent addition of the North Carolina Division of Water Quality Stormwater Best Management Practices Manual. The Town reserves the right to modify, amend or otherwise change these accepted practices as may be necessary to achieve stated stormwater management goals.

Considerations in selecting and using stormwater management means and measures for a specific development will include, but are not limited to: site applicability, public safety, spatial requirements, soil characteristics, hydrologic benefits, slope, existing land use conditions, maintenance requirements, location within the watershed, overlay districts, buffer requirements, tree protection, easements, etc. As a part of the development permit application process, conceptual methods and designs outlined in the Stormwater Management Plan and accompanying Stormwater Impact Statement (Appendix 2-G) must be submitted to the Town for comprehensive review, evaluation, optimization and approval. Revisions in the plan may be necessary to obtain Town approval.

2.2 PERFORMANCE CRITERIA

2.2.1 Total Suspended Solids - Stormwater treatment shall be designed to achieve average annual 85% Total Suspended Solids (TSS) removal and must apply to the volume of post-development runoff resulting from the first 1-inch of precipitation. Alternative treatment methods to achieve 85% average annual TSS removal may be acceptable.

2.2.2 Volume - The post-development stormwater runoff volume leaving the site shall not exceed the pre-development (existing conditions) stormwater runoff volume leaving the site for the local 2-year frequency, 24-hour duration storm event for all development, except single-family and two-family dwellings, on lots existing as of January 27, 2003 or on lots created pursuant to a Preliminary Plat that was approved by the Town Council prior to January 27, 2003. This criterion can be achieved by hydrologic abstraction, recycling, reuse, or any other accepted scientific method.

2.2.3 Rate - The post-development stormwater runoff rate leaving the site shall not exceed the pre-development (existing conditions) stormwater runoff rate leaving the site for the local 1-year, 2-year, and 25-year 24-hour storm events.

2.2.4 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.

2.3 HYDROLOGIC DESIGN

Hydrologic design includes evaluation of the impacts that development has on stormwater runoff. The evaluation involves selecting the required design storm (Table 2.1) 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, structures, and roadways.

Table 2.1 lists return periods for determining design storm and check storm discharges for different types of facilities. The check storm analysis should indicate that surcharge or overflow discharges will be conveyed in a controlled manner that will not cause a public health or safety risk.

TABLE 2.1
DESIGN and CHECK STORMS

Facility	Design Storm (SCS 24-hour duration)	Check Storm (SCS 24-hour duration)
Arterial Roadways	25 yr.	50 yr.
Collector Roadways	25 yr.	50 yr.
Local Roadway	10 yr.	25 yr.
Bridges/Box Culverts/Stream Crossings *	50 yr.	100 yr.
Detention/Retention/Infiltration Facilities**	1 yr., 2-yr. and 25-yr.	100 yr.
*For Regulatory Floodways, the Design Storm is the 100-year return period and the Resource Conservation District provisions must be met **Facilities may be designed to meet multiple stormwater management performance criteria		

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

2.3.1 Hydrologic Methodology

Hydrologic 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 are the SCS Method and the Rational Method. Other analytical tools may be approved by the Town Manager if properly substantiated. The SCS Method and Rational Method are described below. (See APPENDIX 2E, Design Manual Hydrology Technical Note.)

(a) SCS Method

For the SCS Curve Number method, peak discharge and volume calculations shall be based on a Type II precipitation distribution and total runoff depth using SCS equations, curves, and the appropriate depth-duration-frequency and intensity-duration-frequency tables provided in Appendix 2-A.

(1) Hydrologic Soil Group

Soil properties influence the relationship between rainfall and runoff by affecting the rate of infiltration. Soils have been divided into four hydrologic soil groups as noted in Table 2.2. These soil groups are used in conjunction with land use descriptions to determine runoff curve numbers.

(2) Land Use

Types of land use within a given watershed affect hydrology and runoff characteristics. Table 2.2 includes land use descriptions used to determine curve numbers.

(3) Curve Numbers

Both soil groups and land use determine applicable runoff curve numbers for use in hydrologic modeling. Table 2.2 includes runoff curve numbers for different land uses within specific soil groups.

TABLE 2.2
SCS Runoff Curve Numbers (CN)

LAND USE DESCRIPTIONS		HYDROLOGIC SOIL GROUP			
		A	B	C	D
Cultivated land:	without conservation treatment	72	81	88	91
	with conservation treatment	62	71	78	81
Pasture or range land:	poor condition	68	79	86	89
	good condition	39	61	74	80
Meadow: good condition		30	58	71	78
Wood or forest land:	thin stand, poor cover, no mulch	45	66	77	83
	good cover	25	55	70	77
Open Spaces, lawns, parks, golf courses, cemeteries					
good condition:	grass cover on 75% or more	39	61	74	80
fair condition:	grass cover on 50% to 75%	49	69	79	84
Commercial and business areas (85% impervious)		89	92	94	95
Industrial districts (72% impervious)		81	88	91	93
Residential:					
Average lot size	Average: Impervious				
1/8 acre or less	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
Paved parking lots, roofs, driveways, etc.		98	98	98	98
Streets and roads:					
paved with curbs and storm sewers		98	98	98	98
gravel		76	85	89	91
dirt		72	82	87	89

Source: USDA Soil Conservation Service Technical Release N. 55 (SCS-TR-55), "Urban Hydrology for Small Watersheds", Jan. 1971 SCS Method

Note: Other tables or methods may be used, subject to approval by the Town Engineering Department, to determine SCS Curve Numbers and/or Rational Coefficients.

The average impervious surface percentages in Table 2.2 are for typical conditions. The Chapel Hill Engineering Department may require use of adjusted curve numbers for developments which can be expected to differ significantly from the typical values shown for impervious surface area percentages. (For example, developments with limits imposed by the Water Supply Watershed Protection or other regulations may be required to use adjusted curve numbers.)

(b) Rational Method

For catchments up to and including 25 acres, the Rational Method may be used to calculate peak discharges for 1-yr, 2-yr & 25-yr storm events, unless site specific circumstances dictate that hydraulic routing and hydrograph generation are necessary.

The following procedure should be followed for Rational Method analyses:

(1) Determine the watershed size in acres (A) to the point of discharge.
(2) Calculate the time of concentration (Tc) using the equations found in Appendix 2-B.

(3) Determine the rainfall intensity (I) using the appropriate intensity-duration-frequency table found in Appendix 2-A. NOTE: For the 1-yr.storm, use 80% of the 2-year storm peak discharge, or the following equation, to calculate intensity:

I= g/(h+T) where:
I= rainfall intensity in inches per hour
G= 104 (empirically derived constant)
H= 18 (empirically derived constant)
T= rainfall duration in minutes or time of concentration in minutes

(4) Determine the composite runoff coefficient (C) using the table found in Appendix 2-C.

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

2.4 INTEGRATED MANAGEMENT PRACTICES/BEST MANAGEMENT PRACTICES (IMP/BMP'S)

Development applicants shall utilize stormwater "Integrated Management Practices and/or "Best Management Practices" (IMP/BMP's) to the extent practicable and as approved by the Town Manager. The Town encourages the use of low impact design techniques to manage stormwater runoff as close as possible to its source.

The selection and use of the IMP/BMP's for a specific development will vary depending upon a variety of factors including: site characteristics, public safety, spatial requirements, soil characteristics, hydrologic characteristics, slope, land use considerations, maintenance requirements, location within the watershed, overlay districts, buffer requirements, tree protection requirements, easements, etc.

The following structural and non-structural stormwater management practices may be used individually or in combination to meet the performance criteria established by the Town. Other stormwater management practices and facilities will be considered on a site specific basis, subject to approval by the Manager.

2.4.1 Structural IMP/BMP's:

(a) Functional Techniques

Structural IMP/BMP's are commonly used to meet stormwater runoff volume, peak discharge, and water quality performance criteria. The following information describes functional techniques typically associated with structural IMP/BMP's:

(1) Diffuse Flow - describes stormwater runoff that is conveyed in shallow unconcentrated flow at velocities that do not cause scour. Diffuse flow is typically created by uniformly and moderately sloped surfaces, often in conjunction with the installation of a level spreader device to evenly disperse concentrated runoff flows. Diffuse flow through a vegetated buffer (such as wooded areas) will often achieve significant removal of suspended solids.

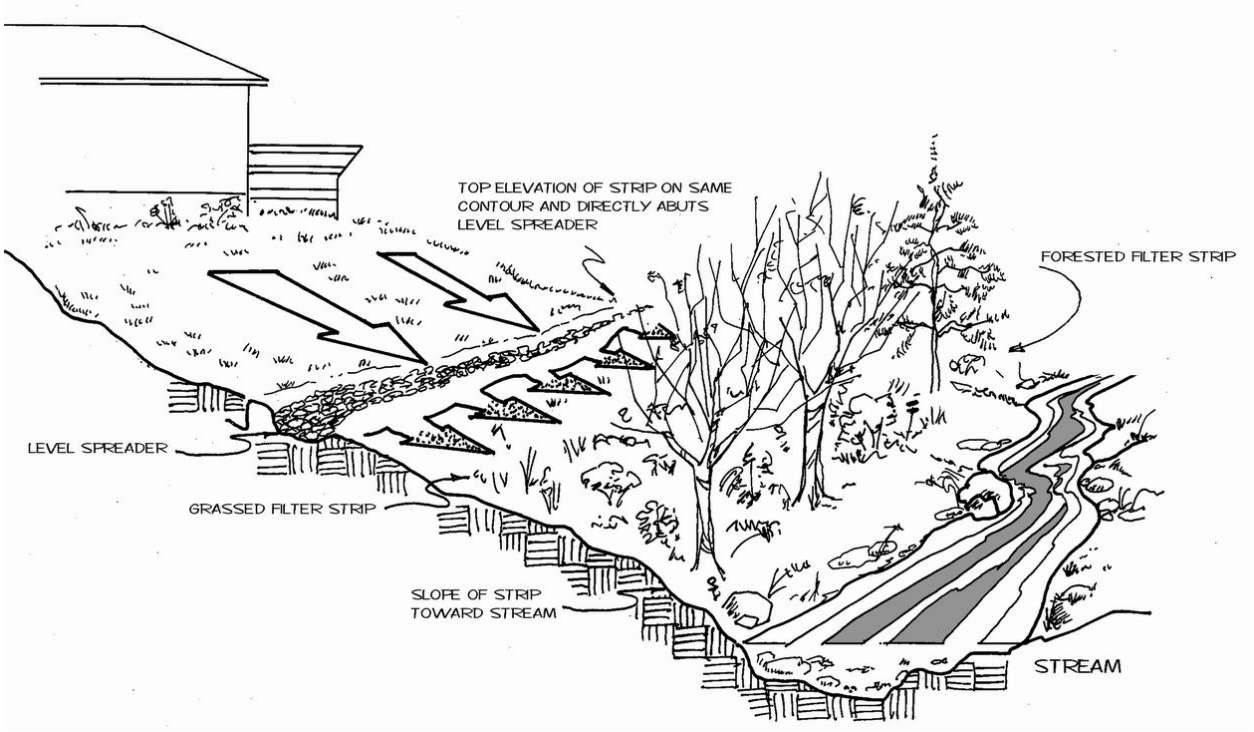


Figure 2.1: Filter Strip

(2) Infiltration - refers to the process whereby stormwater enters the soil, typically converting from surface flow (runoff) to sub-surface flow. Infiltration of stormwater may occur naturally and/or via devices that supplement and enhance the natural infiltration process.

(3) Detention - involves the temporary storage and slow release of stormwater runoff. The slow release should occur over a period of 2 to 5 days, with 3 days (72 hours) recommended. Detention facilities shall be designed to fully drain to a normally dry condition.

(4) Retention - involves both permanent and temporary storage of stormwater runoff. Retention facilities include a permanent pool with an additional area (volume) available to temporarily store stormwater runoff. The temporary storage area should be designed to slowly release its stored volume over a period of 2 to 5 days. Retention facilities shall be designed to release only the temporary storage volume, and to retain the permanent pool volume.

(5) Re-use - involves capturing stormwater runoff and using it for appropriate non-potable purposes (such as non-food crop irrigation, equipment cooling/washing, toilet flushing, etc.).

(b) Facility Types and Descriptions

(1) Diffuse flow

A. Level spreaders – Constructed devices designed to convert concentrated flow to diverse flow.

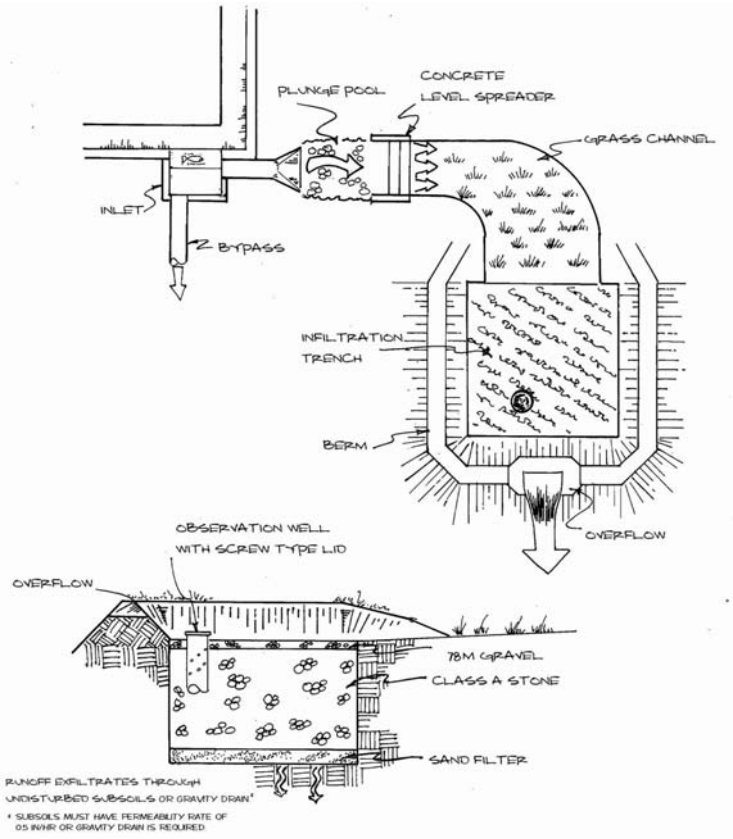
B. Uniformly graded/moderately sloped conveyances – Designed to minimize concentration of runoff flow.

C. Vegetated buffers – Natural or planted areas that will spread and reduce velocity of overland flow.

(2) Infiltration

A. Dry Wells/French Drains – Sump and/or trenches filled with high void ratio material such as uniformly graded gravel and sometimes including a perforated pipe underdrain system.

B. Swales – Shallow, low-velocity surface water conveyance, typically grassed, that allows slow-moving water to infiltrate into the surrounding soil as it is conveyed.



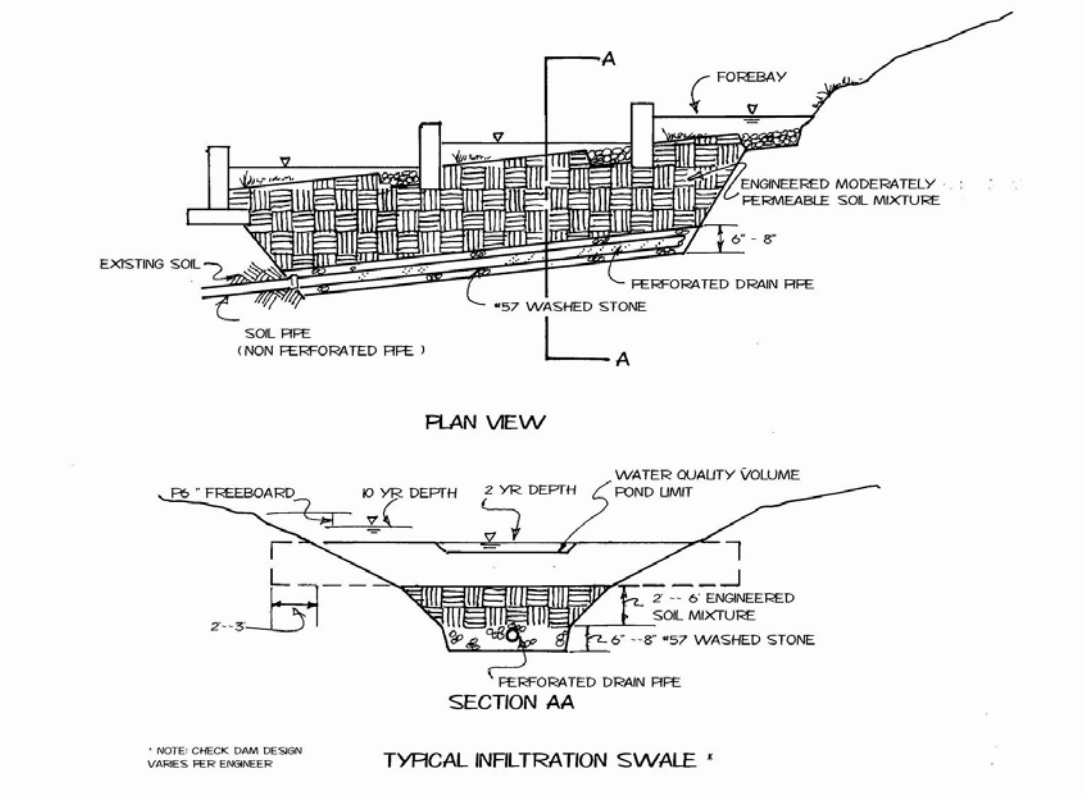


Figure 2-2.1 – A Typical Infiltration Swale

C. Bio-retention Areas/Rain Gardens – A relatively shallow, landscaped depression designed to receive and detain stormwater runoff flows, thus allowing for infiltration and removal of suspended solids/pollutants.

D. Infiltration Detention Facility - A variable depth, engineered facility typically including a forebay to intercept waterborne sediment. Release rate is controlled to facilitate water infiltration into the surrounding soils.

E. Soil Amendment - includes tilling and amending existing soil with sandy loam to increase permeability

F. Porous Pavement - Asphalt and concrete pavement specifically designed and placed with a high void ratio to create a permeable surface. Base materials are typically engineered to provide both support and storage capacity for water passing through the porous pavement. Mix designs and placement guidelines are available although the Carolina Ready-Mix Concrete Association, the U.S.D.O.T Federal Highway Administration, and the Asphalt Institute among others.

G. Green Roofs - Roof areas covered with soil material and vegetation intended to absorb rainfall and re-use it to support the rooftop vegetation

(NOTE: For Rational Method runoff coefficient (c) use 0.30; for SCS runoff Curve Number use 50.)

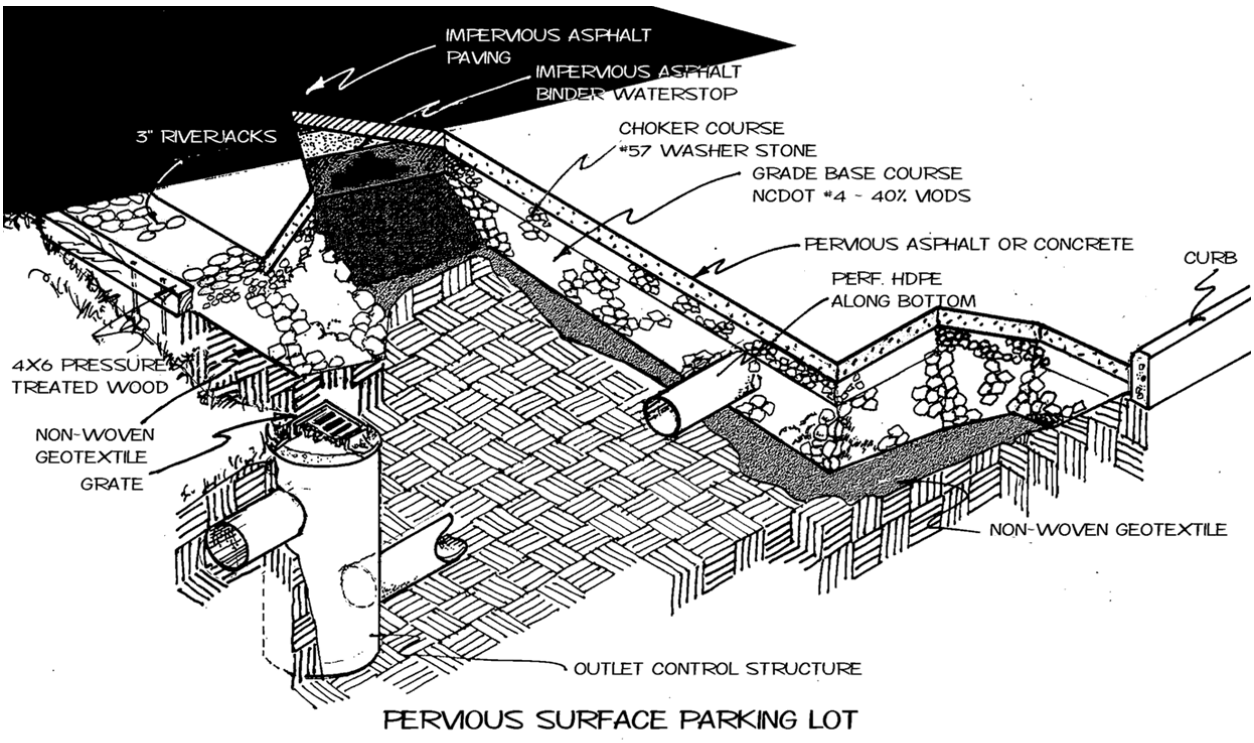


Figure 2.3

(3) Detention, Retention, and Re-use Facilities

A Detention Facilities - Include above or below ground facilities designed to collect and detain stormwater runoff, and to release the water slowly until the facility is dry (i.e. no permanent pool).

B Retention Facilities - Are above ground facilities designed with apermanent pool and additional runoff storage area (free-board above the permanent pool elevation) from which the stored volume of water can be released at a controlled rate.

C. Re-use Facilities – Are above-ground or under-ground facilities that capture and store stormwater runoff for non-potable uses such as non-food crop irrigation, equipment cooling/washing, toilet flushing, etc.

(c) Facility General Design Criteria and Illustrations

Appendix 2-D includes design information and illustrations for a variety of stormwater management control devices.

2.4.2 Non-structural IMP/BMP's

Non-structural IMP/BMP's include Low Impact Design practices that minimize alterations to the existing hydrology. These practices include minimizing the amount of land area and vegetation disturbance, minimizing impervious surface area, and eliminating direct storm sewer discharges into receiving streams.

2.5 STORMWATER IMPACT STATEMENT AND STORMWATER MANAGEMENT PLAN CRITERIA

A Stormwater Impact Statement and Stormwater Management Plan are typically required as part of Zoning Compliance Permit, Site Plan Review, Preliminary Plat, and Special Use Permit applications, in accordance with the Land Use Management Ordinance. Stormwater Impact Statement Guidelines can be found in Appendix 2-G. These guidelines provide specific information regarding preparation and submittal of Stormwater Impact Statements.

2.5.1 Application Submittal Checklist

The following information shall be submitted to the Town for review and approval prior to issuance of a:

Zoning Compliance Permit or Special Use Permit
- Stormwater Impact Statement
- Stormwater Management Plan
- Storm Drainageway Easements on plat and plan;

Certificate of Occupancy
- Engineer's Certification and as-built
- Operations & Maintenance Plan
- Recorded Deed

2.6 DRAINAGE FACILITY DESIGN

For the purposes of this section "drainage facilities" 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 and check storm as noted in Table 2-1.

2.6.1 Design Storms and Check Storms

The 10 year design storm and 25 year check storm shall be used for design of stormwater management infrastructure on Local Streets. The 25 year design storm and 50 year check storm shall be used for design of stormwater management infrastructure on Collector and Arterial Streets. All streets crossing perennial or intermittent streams must comply with the Land Use Management Ordinance regulations regarding development in the Resource Conservation District.

2.6.2 Design Standards

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

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

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

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

The maximum stormwater spread widths allowed in Table 2-3 are not exceeded for the applicable street classification.

TABLE 2.3

MAXIMUM ALLOWABLE STORMWATER SPREAD ON PAVEMENT

STREET CLASSIFICATION	MAXIMUM ALLOWABLE SPREAD
LOCAL	No curb over-topping,* flow spread must leave at least one lane free of water
COLLECTOR AND ARTERIAL	No curb over-topping*, flow spread must leave at least one lane in each direction free of water.

* Where no curbing exists, spread shall not extend outside of the public right-of-way.
(Reference: Wright-McLaughlin Engineers)

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

There is no surcharging in the drainage system for the applicable design storm. (Hydraulic grade lines or grades must be calculated to demonstrate the efficiency of the storm drain system and as a check to ensure that there is no surcharging in the system.)

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.

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.

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. Table 2-4 lists inlet coefficients (Ke) for different entrance conditions and structure types.

Refer to APPENDIX 2-F for technical information.

INLET COEFFICIENTS

Outlet Control, Full or Partly Full

Entrance head loss $H_e = K_e \frac{v^2}{2g}$

Type of Structure and Design of Entrance	Coefficient K_e
Pipe, Concrete	
Projecting from fill, socket end (groove-end)	0.2
Projecting from fill, sq. cut end	0.5
Headwall or head wall and wingwalls	
Socket end of pipe (groove-end)	0.2
Square-edge	0.5
Rounded (radius = 1/12D)	0.2
Mitered to conform to fill slope	0.7
*End-section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side or slope-tapered inlet	0.2
Pipe, or Pipe-Arch, Corrugated Metal	
Projecting from fill (no headwall)	0.9
Headwall or headwall and wingwalls square-edge	0.5
Mitered to conform to fill slope, paved or unpaved slope	0.7
*End-Section conforming to fill slope	0.5
Beveled edges, 33.7° or 45° bevels	0.2
Side or slope-tapered inlet	0.2
Box, Reinforced Concrete	
Headwall parallel to embankment (no wingwalls)	
Square-edge on 3 edges	0.5
Rounded on 3 edges to radius of 1/12 barrel dimension, or beveled edges on 3 sides	0.2
Wingwalls at 30° to 75° to barrel	
Square-edge at crown	0.4
Crown edge rounded to radius of 1/12 barrel dimension, or beveled top edge	0.2
Wingwall at 10° to 25° to barrel	
Square-edged at crown	0.5
Wingwalls parallel (extension of sides)	
Square-edged at crown	0.7
Side or slope-tapered inlet	0.2

*Note: "End Section conforming to fill slope", made of either metal or concrete, are the sections commonly available from manufacturers. From limited hydraulic tests they are equivalent in operation to a headwall in both inlet and outlet control. Some end sections, incorporating a closed taper in their design have a superior hydraulic performance.

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. (Refer to APPENDIX 2-F for further information)

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. 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.

2.6.3 Storm Drainage Pipe

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

All storm drainage pipes shall be Class III or greater reinforced concrete pipe.

The minimum pipe size is 15-inch inside diameter.

Flared-end sections may be used with pipes 36-inch or less in diameter.

End walls shall be provided for pipes with diameters larger than 36 inches unless alternative end treatments are approved by the Town Manager.

The minimum cover for drainage pipes is 2 feet unless otherwise approved by the Town Manager..

The minimum pipe grade is 2% for storm drainage pipes 36-inches or less in diameter. Flatter grades may be accepted by the Town for larger diameter pipe provided that it can be demonstrated that the design pipe grade provides for a self-cleaning velocity of 3 feet per second when the pipe is flowing half-full.

The maximum pipe length without installation of a catch basin, curb inlet or junction box is 400 feet.

2.6.4 Inlet Location and Spacing

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. (Refer to Table 2.3 Maximum Allowable Stormwater Spread.) Inlets are normally placed upstream of pedestrian crossings to intercept the gutter flow before it reaches the crosswalk. Where pavement surfaces are warped, as 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.

Runoff from areas adjacent to streets should be intercepted before reaching the pavement. This applies to water that would normally run onto the street from side streets or from cut slopes and areas along the edge of pavement. 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.

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.

2.6.5 Open Channels/Ditches

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.

2.6.6 Curb & Gutter

Standard 30 inch curb-and-gutter is required in all cases, unless an alternative is approved by the Town Manager. The minimum longitudinal grade for curb & gutter is 2%. Spot grades or profiles shall be provided in cul-de-sacs to ensure positive drainage.

2.6.7 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. See the following illustration of typical subsurface drain that may be required.

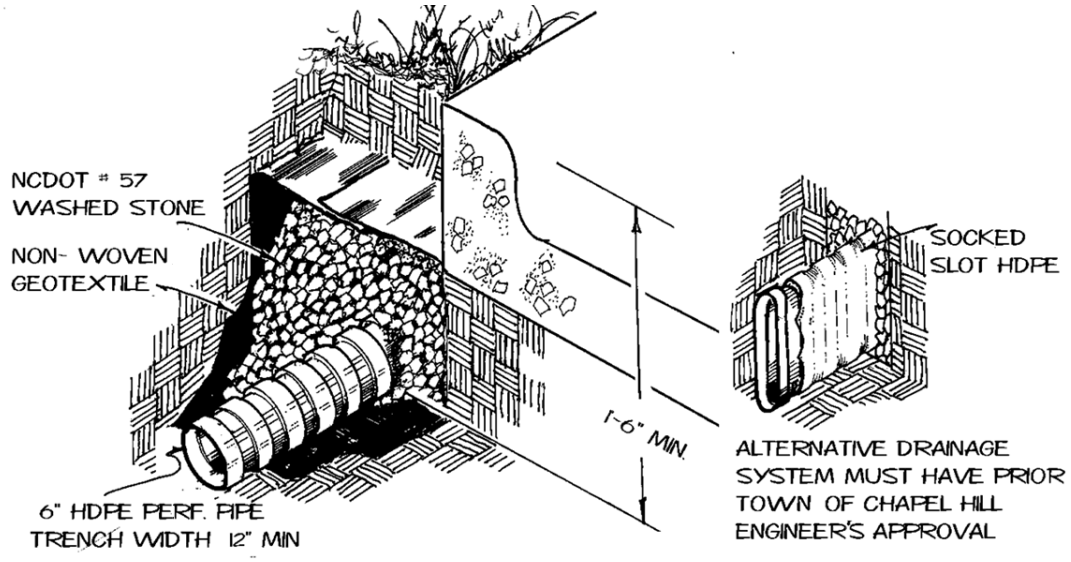


Figure 2.4

SCS Runoff Curve Number (CN) method

The SCS Runoff Curve Number (CN) method is described in detail in NEH-4 (SCS 1985). The SCS runoff equation is

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

Where

Q = runoff (in),
P = rainfall (in),
S = potential maximum retention after runoff begins (in), and
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:

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

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 2-2 into equation 2-1 gives

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

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

$$S = (1000/CN) - 10. \qquad \text{[Eq. 2-4]}$$

Figure 2-1 and table 2-1 solve equations 2-3 and 2-4 for a range of CN's and rainfall.

Factors considered in determining runoff curve numbers

The major factors that determine CN are the hydrologic soil group (HSG), cover type, treatment, hydrologic condition, and antecedent runoff condition (ARC). 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 2-A-1 is provided to aid in selecting the appropriate figure or table for determining curve numbers.

CN's in table 2-2 (a to d) represent average antecedent runoff condition for urban, cultivated agricultural, other agricultural, and arid and semiarid rangeland uses. Table 2-2 assumes impervious areas are directly connected. The following sections explain how to determine CN's and how to modify then for urban conditions.

Hydrologic soil groups

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. Appendix A defines the four groups and provides a list of most of the soils in the United States and their group classification. The soils in the area of interest may be identified from a soil survey report, which can be obtained from local SCS offices or soil and water conservation district offices.

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 type

Table 2-2 addresses most cover types, such as 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.

Treatment

Treatment is a cover type modifier to describe the management of cultivated agricultural lands. It includes mechanical practices, such as contouring and terracing, and management practices, such as crop rotations and reduced or not tillage.

Hydrologic condition

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.

Table 2-A-1 – Runoff depth for selected CN's and rainfall amounts[1]

	Runoff depth for curve number of –												
	40	45	50	55	60	65	70	75	80	85	90	95	98
Rainfall	inches												
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	.00	.00	.00	.00	.00	.00	.03	.07	.15	.27	.46	.74	.99
1.4	.00	.00	.00	.00	.00	.02	.06	.13	.24	.39	.61	.92	1.18
1.6	.00	.00	.00	.00	.01	.05	.11	.20	.34	.52	.76	1.11	1.38
1.8	.00	.00	.00	.00	.03	.09	.17	.29	.44	.65	.93	1.29	1.58
2.0	.00	.00	.00	.02	.06	.14	.24	.38	.56	.80	1.09	1.48	1.77
2.5	.00	.00	.02	.08	.17	.03	.46	.65	.89	1.18	1.53	1.96	2.27
3.0	.00	.02	.09	.19	.33	.51	.71	.95	1.25	1.59	1.98	2.45	2.77
3.5	.02	.08	.20	.35	.53	.75	1.01	1.30	1.64	2.02	2.45	2.94	3.27
4.0	.06	.18	.33	.53	.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
4.5	.14	.30	.50	.74	1.02	1.33	1.67	2.05	2.46	2.91	3.40	3.92	4.26
5.0	.24	.44	.69	.98	1.30	1.65	2.04	2.45	2.89	3.37	3.88	4.42	4.76
6.0	.50	.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	.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

[1]Interpolate the values shown to obtain runoff depths for CN's or rainfall amounts not shown.

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

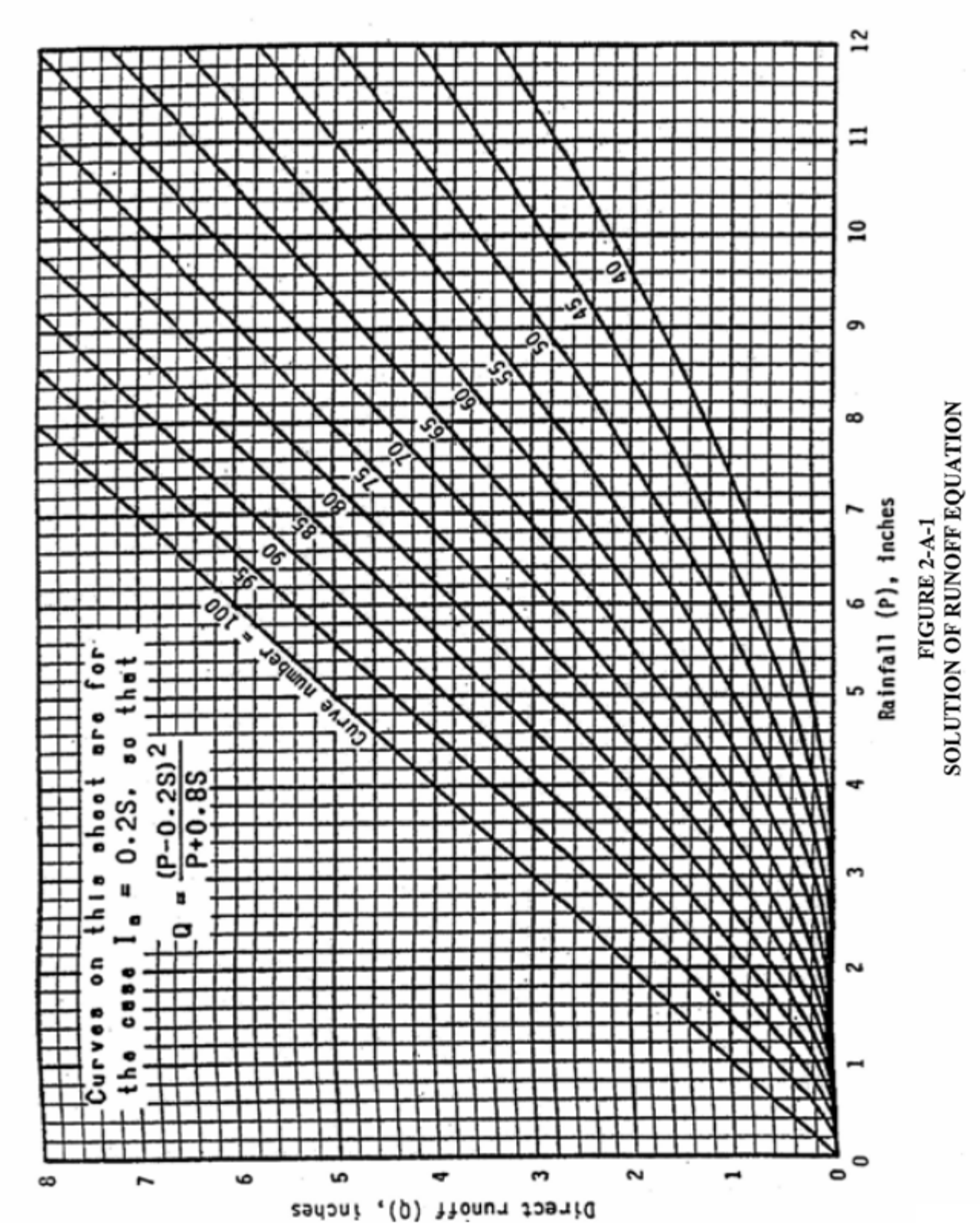
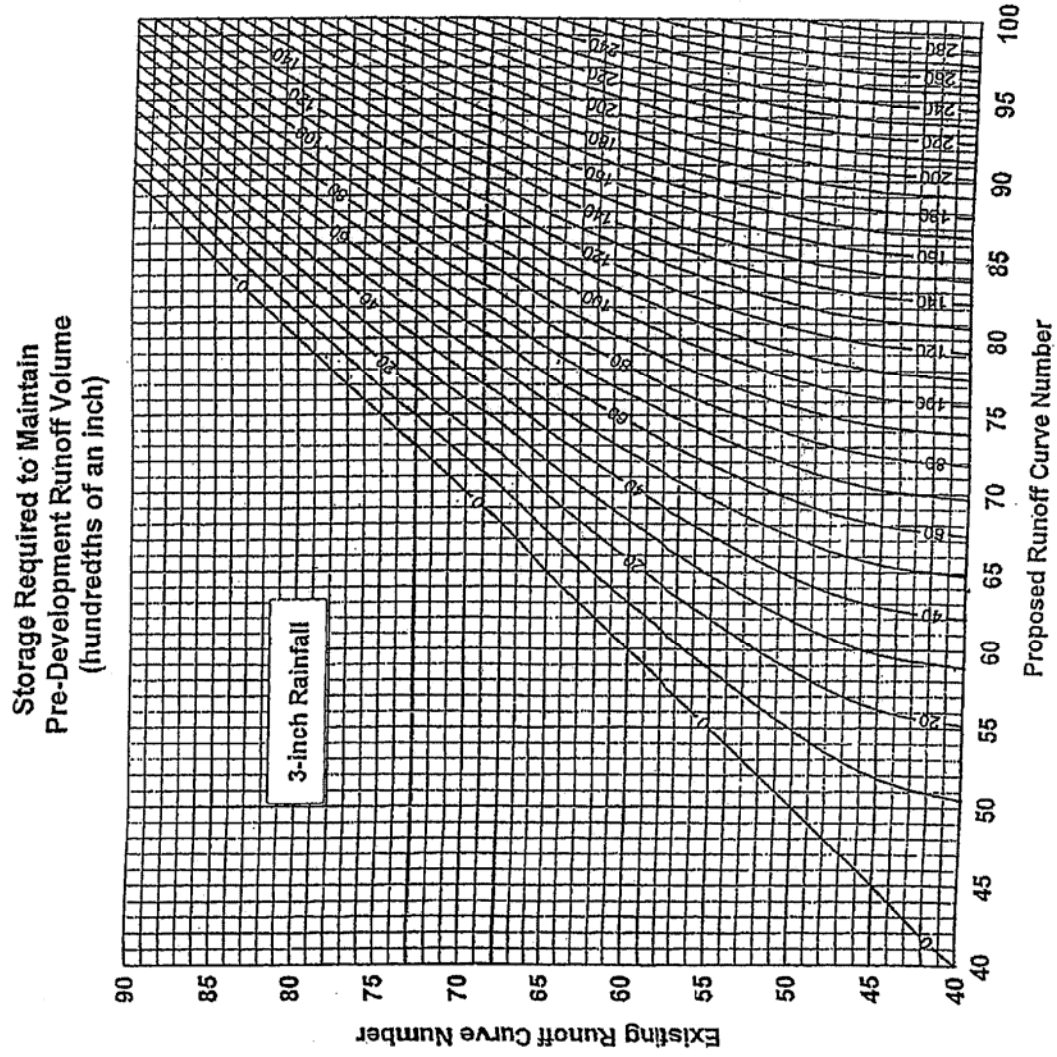


FIGURE 2-A-1
SOLUTION OF RUNOFF EQUATION

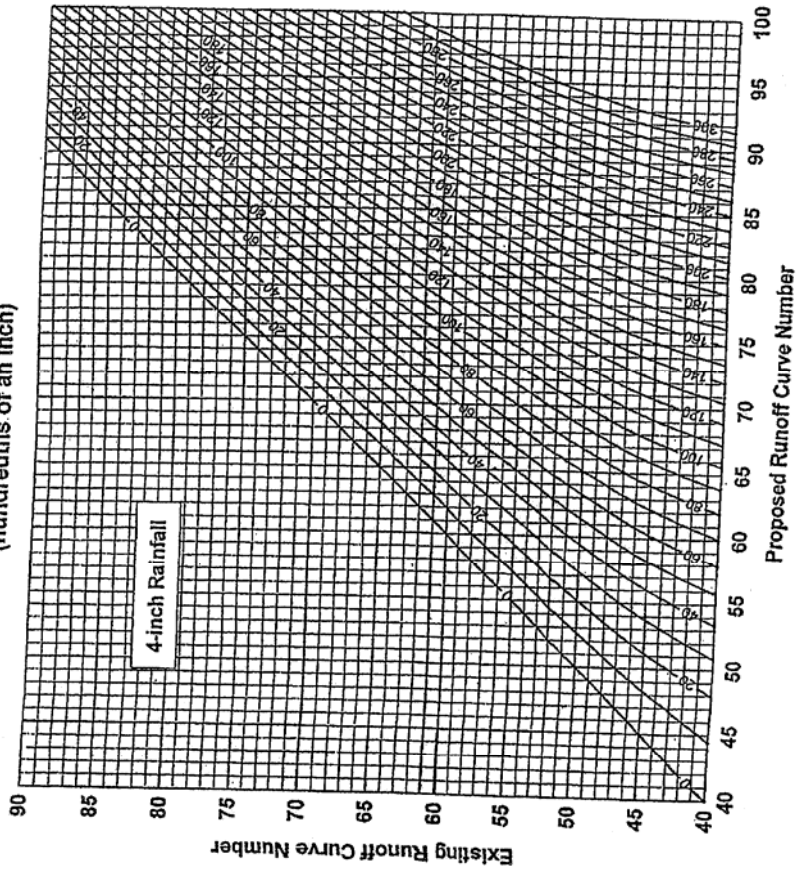
(210-VI-TR-55, Second Ed., June 1986)

FIGURE 2-A-2
SCS RUNOFF EQUATION
CURVE FOR P+3.0"



Note: 1. Interpolate P=3.6" using 3" and 4" rainfall depth curves

FIGURE 2-A-3
SCS RUNOFF EQUATION
CURVE FOR P=4.0"



Note: 1. Interpolate P=3.6" using 3" and 4" rainfall depth curves

RDU, N.C. RAINFALL FREQUENCY DATA
TABLE 2-A-2

DEPTH-DURATION-FREQUENCY TABLE						
Duration	Return Period					
	2-Year (inches)	5-Year (inches)	10-Year (inches)	25-Year (inches)	50-Year (inches)	100-Year (inches)
5 minutes	0.48	0.55	0.60	0.68	0.75	0.81
10 minutes	0.79	0.92	1.02	1.17	1.28	1.40
15 minutes	1.01	1.18	1.31	1.51	1.66	1.81
30 minutes	1.35	1.64	1.85	2.16	2.40	2.64
60 minutes	1.70	2.12	2.41	2.84	3.17	3.50
2 hours	1.91	2.40	2.74	3.23	3.61	4.00
3 hours	2.12	2.68	3.07	3.62	4.06	4.49
6 hours	2.65	3.38	3.90	4.62	5.19	5.75
12 hours	3.13	4.02	4.64	5.52	6.20	6.88
24 hours	3.60	4.65	5.38	6.41	7.21	8.00

TABLE 2-A-3

INTENSITY-DURATION FREQUENCY DATA						
Duration	Return Period					
	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	5.76	6.58	7.22	8.19	8.96	9.72
10 minutes	4.76	5.54	6.13	7.01	7.71	8.40
15 minutes	4.04	4.74	5.25	6.03	6.64	7.24
30 minutes	2.70	3.28	3.71	4.32	4.80	5.28
60 minutes	1.70	2.12	2.41	2.84	3.17	3.50
2 hours	0.95	1.20	1.37	1.62	1.81	2.00
3 hours	0.71	0.89	1.02	1.21	1.35	1.50
6 hours	0.44	0.56	0.65	0.77	0.86	0.96
12 hours	0.26	0.33	0.39	0.46	0.52	0.57
24 hours	0.15	0.19	0.22	0.27	0.30	0.33

TIME OF CONCENTRATION

Kirpich Tc Equation (For use of the Rational Method)

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.

$Tc = 0.00013\ L\ (0.77)\ S\ (0.385)$ or $Tc = \dfrac{[L^3/H]^{0.385}}{128}$

where:

Tc = Time of concentration in hours.
L = Length of the overland flow in feet.
S = Average overland slope in ft/ft.

where:

Tc = Time of concentration in minutes
L = Longest flow path in feet
H = Elevation of difference along L in feet

This equation (above left) was developed for overland flow on bare earth. For overland flow on grassy earth Tc should be multiplied by 2.0. On concrete and asphalt surface it should be multiplied by 0.4.

SCS METHOD 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 decreased 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.

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 extend 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 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:

$$T_t = L/3600\ V \qquad \text{[Eq. 3-1}\}$$

Where

T_t = travel time (hr),
L = flow length (ft),
V = average velocity (ft/s), and
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:

$$T_c = T_{t1} + T_{t2} + \ldots T_{tm} \qquad \text{[Eq. 3-2)}$$

Where

Tc = time of concentration (hr) and
m = number of flow segments

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

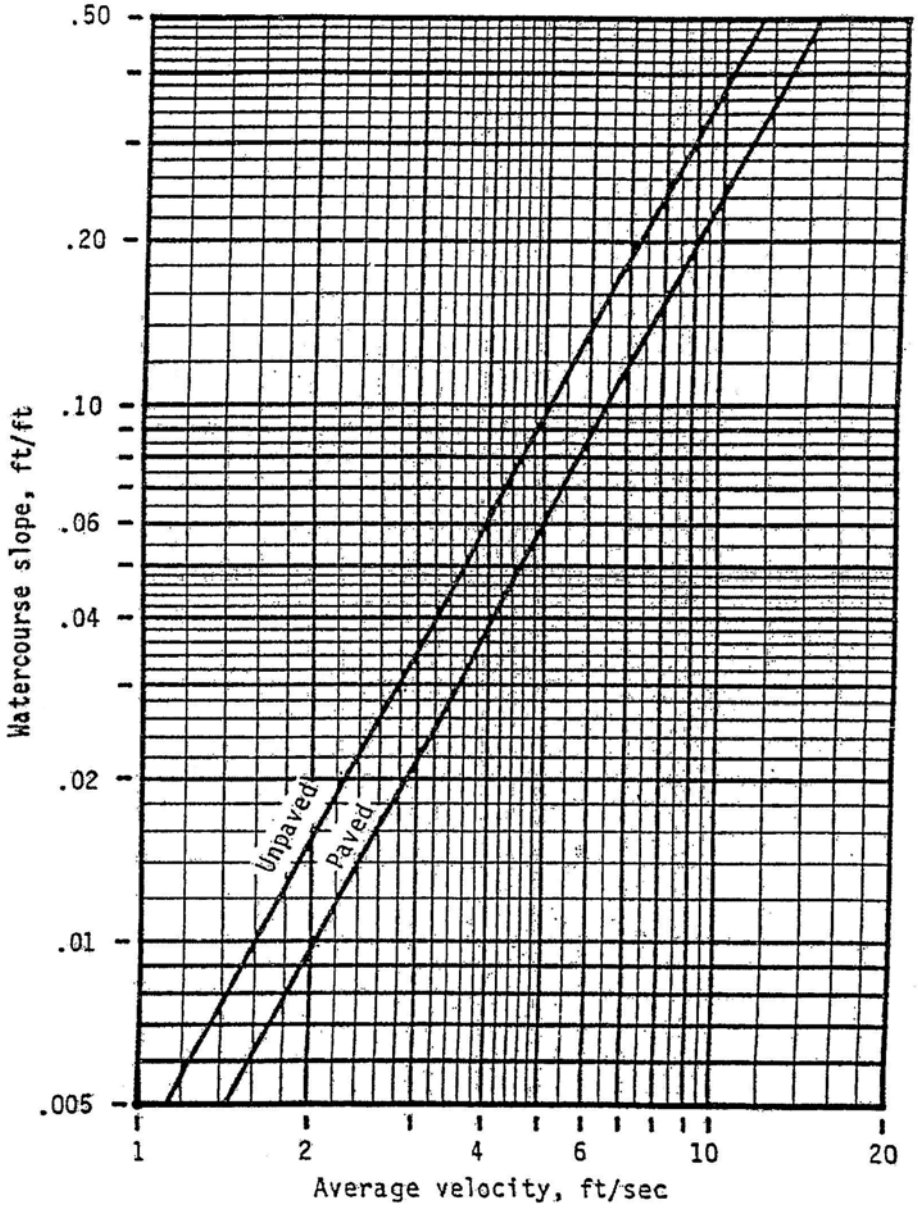


FIGURE 2-B-1
AVERAGE VELOCITIES FOR ESTIMATING TRAVEL TIME
FOR SHALLOW CONCENTRATED FLOW

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

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 or so. Table 2-B-1 gives Manning's n values for sheet flow for various surface conditions.

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

$$T_t = 0.007\ (nL)^{0.8} / (P_2)^{0.5}\ {}_s{}^{0.4} \qquad \text{[Eq.3-3]}$$

Table 2-B-1 – 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	0.40
Dense underbrush	0.80

[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.

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. Rainfall depth can be obtained from Appendix 2-A.

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 2-B-1, 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 figure 2-B-1, use equation 3-1 to estimate travel time for the shallow concentrated flow segment.

Open channels

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

$$V = 1.49\ r^{2/3}\ s^{1/2}\ /n \qquad \text{[Eq. 3-4]}$$

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 hydraulic grade line (channel slope, ft/ft, and
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 3-4, T_t for channel segment can be established using equation 3-1.

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 T_c. 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 nonpressure flow.

* The minimum T_c used in TR-55 is 0.1 hour.

* 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.

FIGURE 2-B-2

SCS METHOD FOR ESTIMATING VELOCITY

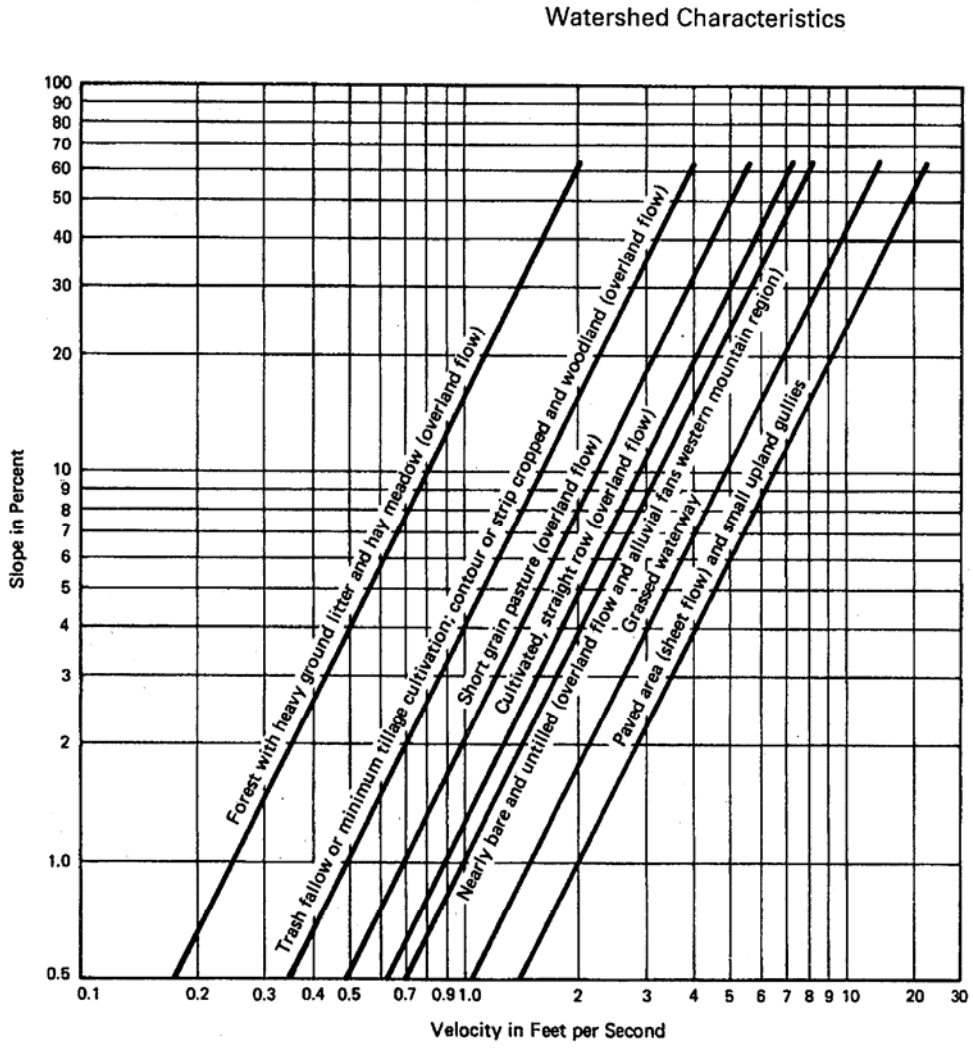


TABLE 2-C-1
Rational Runoff Coefficients

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

Note: Other tables or methods may be used, subject to approval by the Town Engineering Department, to determine SCS Curve Numbers and/or Rational Coefficients.

GENERAL DESIGN CRITERIA FOR STRUCTURAL LEVEL SPREADERS

Level spreaders are one means of providing diffuse flow through buffers or filter strips. Concentrated flow causes erosion and scour and transports pollutants to streams. Level spreaders are one method of converting concentrated flow to diffuse flow. Level spreaders may also be designed to provide for infiltration. The following general design criteria apply to level spreaders:

a. The entire system must be designed to safely pass the 10-yr. storm event without causing scour, rills, gulleys or other failure.
b. If diffuse flow is not attainable or otherwise will not cause improved conditions, other methods should be used.
c. Level spreaders shall be located in areas where land disturbances are already planned, and unless it can be shown that alternative BMP's are not practical, the removal of trees or the disturbance of soil solely for the purpose of level spreader construction is prohibited.
d. Minimum length is 15 feet.
e. The overflow lip must be level and stabilized with timber, rock, pipe or other hardened material unless the devise is designed to not overtop up to the 25-yr. storm event where a grass berm is acceptable.
f. For grass or thick ground cover buffer or filter strip, the level spreader shall be 13 feet in length for every 1 cfs and slopes less than or equal to 8%.
g. For woody vegetation buffer or filter strip, the level spreader shall be 100 feet in length for every 1 cfs and slopes less than or equal to 6%.
h. For steeper slopes, structural level spreaders shall be followed by a grass berm level spreader of the same length.
i. Manufactured level spreaders may be acceptable.
j. Reference the N.C. State University Cooperative Extension Office for further design considerations.
k. For flat areas, a Stilling Basin/Level Spreader may be used. See the Outlet Protection section for design criteria or Appendix 2-F.

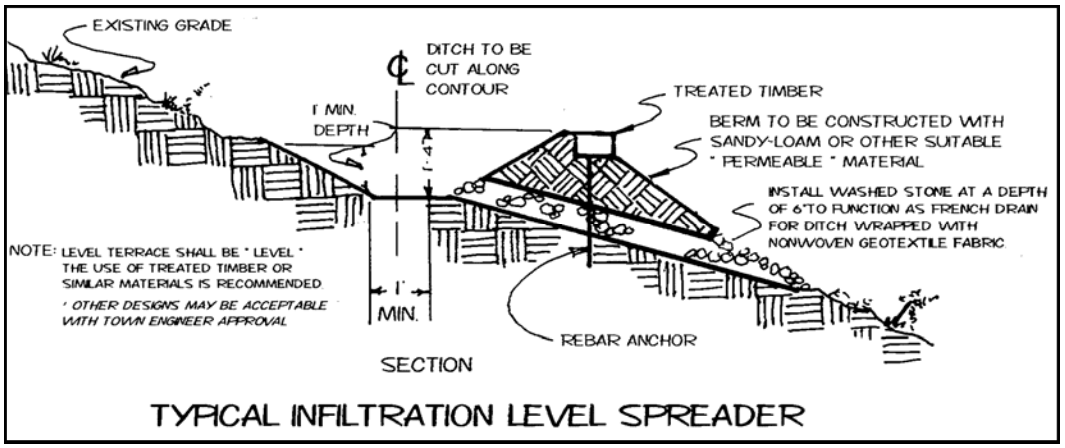


Figure 2-D-1

SAMPLE LEVEL SPREADER (WITH INFILTRATION) DESIGN FOR SINGLE-FAMILY LOT

RATIONAL RUNOFF CALCULATIONS

GROSS LOT AREA = 12,000 sq. ft. = 0.27 acres
PRE-CONSTRUCTION C = 0.20

PROPOSED IMPERVIOUS AREA = 4,000 sq. ft. = 33%
POST-CONSTRUCTION C = 0.41
TIME OF CONCENTRATION= 5 minutes
TWO-YEAR INTENSITY = 5.76 in/hr
TWENTY-FIVE YEAR INTENSITY = 8.19 in/hr

PRE-CONSTRUCTION RUNOFF:

ONE YEAR (80% OF TWO YEAR) = 0.25 cfs
TWO YEAR = 0.31 cfs
TWENTY-FIVE YEAR = 0.45 cfs

POST-CONSTRUCTION RUNOFF:

ONE YEAR (80% OF TWO YEAR) = 0.51 cfs
TWO YEAR = 0.64 cfs
TWENTY-FIVE YEAR = 0.90 cfs

RESULTS

ONE-YEAR STORM Q-POST INCREASES BY: 0.26 cfs
TWO-YEAR STORM Q-POST INCREASES BY: 0.32 cfs
TWENTY-FIVE YEAR STORM Q-POST INCREASES BY: 0.46 cfs

Assume Grass Buffer: 13 ft. in length per cfs x .64 cfs = 8.3 ft.
Therefore, use 15 feet in length level spreader
with 1 washed stone french drain.

NOTE: For infiltration level spreaders, use the following standards:

1. Berm shall be constructed with sandy loam soil
2. Use 2' wide x 6" deep washed stone french drain for every 15 feet in length of level spreader
3. Calculate length according to the two-year storm post-construction discharge. See length criteria according to buffer type.
4. Minimum length shall be 15 feet.

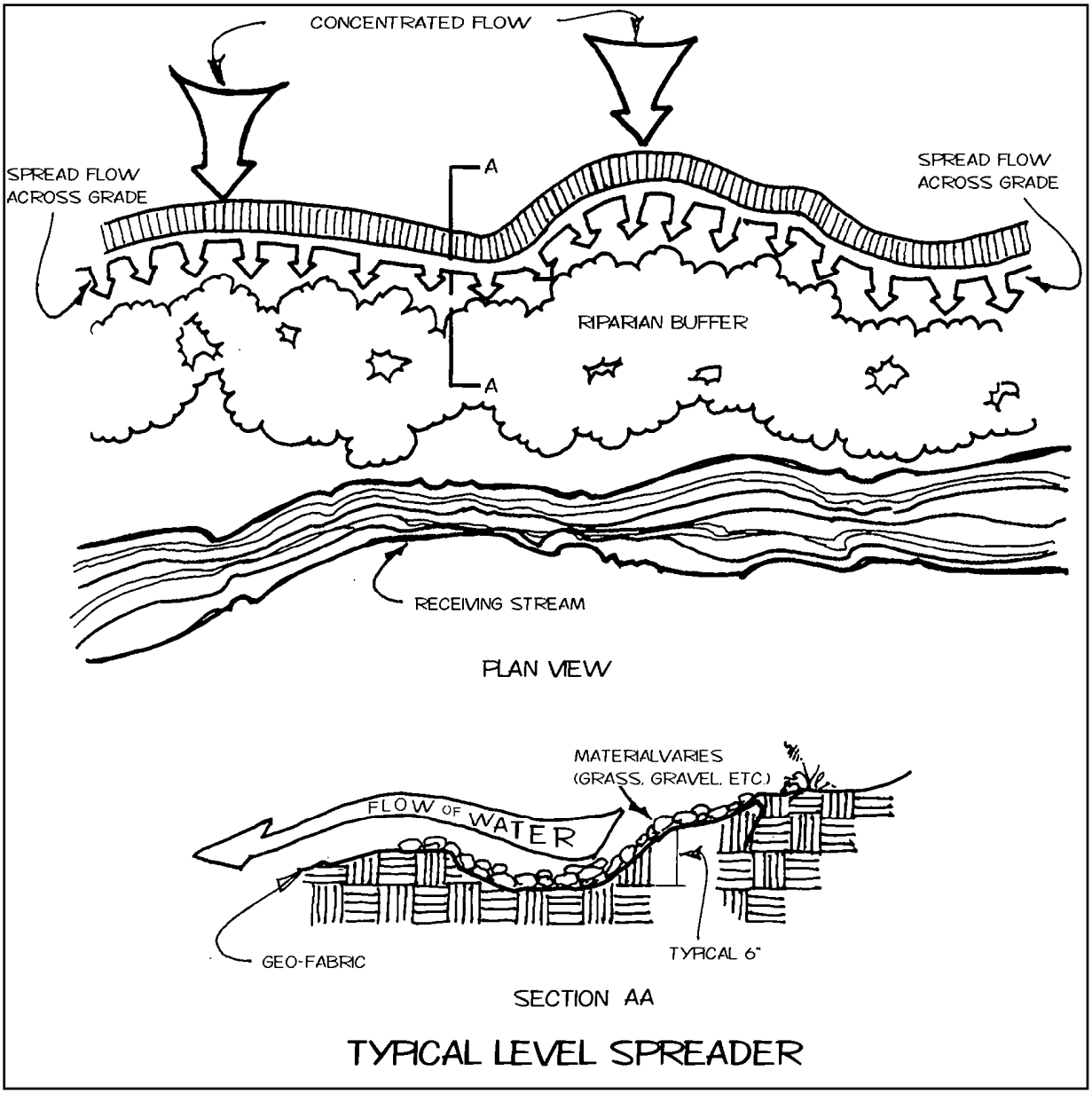

CONCENTRATED FLOW
SPREAD FLOW ACROSS GRADE
SPREAD FLOW ACROSS GRADE
A
A
RIPARIAN BUFFER
RECEIVING STREAM
PLAN VIEW
MATERIAL VARIES (GRASS, GRAVEL, ETC.)
FLOW OF WATER
GEO-FABRIC
TYPICAL 6"
SECTION AA
TYPICAL LEVEL SPREADER

Figure 2-D-2

GENERAL DESIGN CRITERIA FOR BUFFERS AND FILTER STRIPS

Filter strips are sections of vegetation designed to reduce pollutants in stormwater runoff before the runoff enters a stream or other receiving water. Filter strips are carefully designed and constructed strips of relatively flat, level land with grasses or other vegetation and some method to spread the stormwater runoff into a thin sheet.

Another type of vegetative practice is the buffer zone or buffer strip, which is a strip of vegetation that has not been disturbed during development or has been planted along a stream or other area to be protected.

Filter strips with level spreaders are not generally a sufficient means by themselves to reach the 85% TSS removal requirement, but they can be used in a series of BMPs that, when combined, will provide sufficient protection to surface waters.

Note: The following design requirements apply to buffers and filter strips:

Design Requirements

* Filter strips must be 50 feet in width (measured along the direction of flow) for filter strips up to 5% slope.
* Filter strips must be 50 feet plus 4 feet in width (measured along the direction of flow) for every 1% increase in slope up to a maximum of 15%.
* Width of filter perpendicular to flow must be 100 feet for each acre of drainage area.
* Velocity of flow must be under 2 fps for the maximum flow resulting from a 10 year storm.
* Design must include a device such as a level spreader to allow runoff to enter the filter strip as sheet flow.
* Maximum drainage areas flowing to individual filters shall be less than or equal to 5 acres.
* If the filter strip will be used during construction, the area must be stabilized within 14 days.
* A grading and vegetation plan must be prepared by a licensed professional.

The following pollutant removal credit will be given for level spreaders and filter strips that meet the previously described design criteria:

40% TSS removal – for filters strips that are primarily natural, woody vegetation
30% TSS removal – for filters strips that are planted with primarily woody vegetation
25% TSS removal – for filter strips that are planted in grass or legumes

GENERAL DESIGN CRITERIA FOR INFILTRATION DEVICES

1. Infiltration facilities receive and temporarily impound stormwater runoff and discharge (exfiltrate) it into the surrounding soil.

2. Infiltration devices are primarily used for 85% TSS removal water quality enhancement and volume management up to the two-year design storm. Infiltration practices that capture all of the 2-year, 24-hour, volume increase may utilize additional storage (if necessary) to provide sufficient reductions to the 1-year and 2-year peak discharge as required by the general performance criteria.

3. Infiltration devices shall be constructed **after** the site work is completed and stabilization measures have been implemented.

4. Infiltration devices must be protected until their contributing drainage areas have been adequately stabilized

5. Requires engineered drainage (perforated pipe system with outlet) to ensure full draw-down if underlayment soils permeability rate is less than 0.5/hour. See following Table for permeability rates.

6. Type of infiltration devise include dry well, infiltration level spreaders, bio-retention, infiltration detention basin, porous pavement, amended soils and green roofs.

7. All infiltration devices must include an observation well (standpipe cleanout) as a means to monitor the reservoir depths and drawdown capabilities as a part of the operations and maintenance of the facility.

Runoff Pretreatment

Infiltration devices shall be preceded by a pretreatment facility. Grease, oil, floatable organic materials, and settleable solids should be removed from the runoff before it enters the device. Vegetated filters (grass strip at least 20’ wide) sediment traps or forebays are just a few of the available pretreatment strategies.

Devices with surface inlets should be engineered to capture sediment from the runoff before it enters the stone reservoir. Any pretreatment facility design should be included in the design of the device, complete with maintenance and inspection requirements.

Sizing Procedure

A Darcy's Law approach is recommended for sizing infiltration devices. This will assume that the drain time of the facility is controlled by one-dimensional flow through the bottom surface.

$$Q = f\ I\ S\ A$$

where:
- Q = rate of exfiltration into soil, cfs
- f = infiltration rate of the soil in ft/hr (Assume 0.5'/hr washed stone)
- I = hydraulic gradient (assume I = 1)
- SA = bottom surface area of facility in ft^2

1. Infiltration Rate -

Over the life of an infiltration facility, the rate of infiltration into the soil, f, may gradually decrease due to clogging of the surface layer of soil. A safety factor of 2 shall be applied to the infiltration rate determined from the soil analysis. The design soil infiltration rate, f_d, therefore, is equal to one-half of the actual rate:

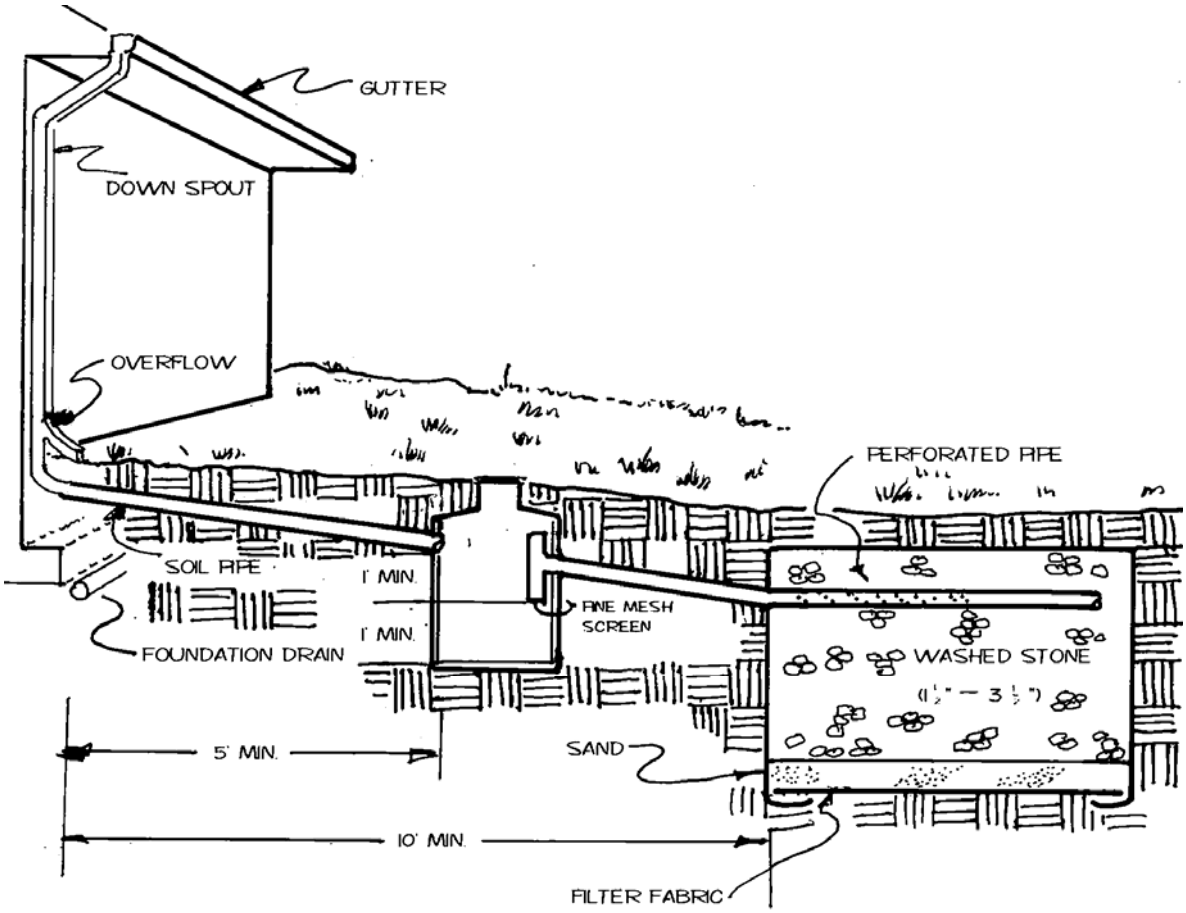
$$f_d = 0.5f$$

TABLE 2-D-1 — SOIL, DEPTH, PERMEABILITY RATES

SOIL NAME AND MAP SYMBOL	DEPTH	PERMEABILITY	SOIL NAME AND MAP SYMBOL	DEPTH	PERMEABILITY
	Inches	Inches per hour		Inches	Inches per hour
Altavista: Aa	0-6 6-50 50-80	2.0-6.0 0.6-2.0 ---	Hiwassee: HwB, HwC	0-6 6-79 79-85	0.6-2.0 0.6-2.0 ---
Appling: ApB, ApC	0-11 11-48 48-60	2.0-6.0 0.6-2.0 ---	Iredell: IrB	0-8 8-29 29-40	2.0-6.0 0.06-0.2 ---
[1]AuC: Appling part	0-11 11-48 48-60	2.0-6.0 0.6-2.0 ---	[1]IuB: Iredell part	0-8 8-29 29-40	2.0-6.0 0.06-0.2 ---
Urban land part. Cecil: CfB, CfC	0-4 4-46 46-61	2.0-6.0 0.6-2.0 ---	Urban Land part Lignum: Lg	0-6 6-36 36-48	0.6-2.0 0.06-0.6 0.2-0.6
Chewacla: Ch	0-6 6-52 52-60	0.6-2.0 0.6-2.0 ---	Louisburg: LoC, LoF	0-8 8-20 20-60	6.0-20 6.0-20 ---
Congaree: Cp	0-7 7-56 56-63	0.6-6.0 0.6-2.0 ---	Orange: Or	0-5 5-24 24-42 42-45	0.6-2.0 0.06-0.2 0.2-0.6 ---
Creedmore: CrB	0-8 8-15 15-43 43-60	2.0-6.0 0.2-0.6 <0.06 ---	Pitts: Pt. Tatum: TaD, TaE	0-5 5-34 34-60	0.6-2.0 0.6-2.0 ---
Enon: EnB, EnC	0-5 5-30 30-68	0.6-2.0 0.06-0.2 0.2-0.6	Urban land: Ur. Vance: VaB	0-9 9-37 37-60	2.0-6.0 0.06-0.2 ---
Georgeville: GeB,CeC,[1]GhC	0-7 7-59 59-65	0.6-2.0 0.6-2.0 0.6-2.0	Wedowee: WmD, WmE	0-12 12-15 15-28 28-60	2.0-6.0 0.6-2.0 0.2-0.6 ---
Goldston: GlD, ClF	0-10 10-18 18-24	2.0-6.0 2.0-6.0 2.0-6.0	White Store: WsB	0-5 5-34 34-50	0.06-2.0 <0.06 ---
Helena: HeB	0-14 14-17 17-36 36-60	2.0-6.0 0.2-0.6 0.06-0.2 ---	WtC2	0-5 5-34 34-50	0.06-0.6 <0.06 ---
Helena: [1]HhA: Helena part---	0-14 14-17 17-36 36-70	2.0-6.0 0.2-0.6 0.06-0.2 ---	[1]WwC: White Store part	0-5 5-34 34-50	0.06-0.6 <0.06 ---
Sedgefield part	0-13 13-33 33-37 37-65	2.0-6.0 0.06-0.2 0.6-2.0 ---	Urban Land part Wilkes: WxD, WxF	0-8 8-18 18-60	2.0-6.0 0.2-0.6 0.6-2.0
Herndon: HrB, HrC	0-9 9-58 58-62	0.6-2.0 0.6-2.0 0.6-6.0			

1 This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

Reference: Orange County Soil Survey, USDA



TYPICAL DRY WELL
WITH PRE-TREATMENT SUMP

Figure 2-D-3

GENERAL DESIGN CRITERIA FOR BIO-RETENTION AREAS (RAIN GARDEN)

Sizing a Bio-Retention Area

The area (size) of the rain garden should generally vary between 5 percent and 7 percent of its drainage area, depending upon the percentage of impervious surface. Size the rain garden large enough to pond runoff from the first inch of rainfall in the drainage area. To compute this, multiply 0.79 inches by the impervious surface area draining to the bio-retention area. This will yield a ponding volume for standard bio-retention areas. If the bio-retention area is also designed to meet the Town volume control criteria, the larger of the two calculated volumes controls. Note that the Town volume control criteria allows for total storage volume to include the sum of the volumes of ponding and voids in soil, pipe, and gravel reservoirs.

The rain garden shall be designed to pond water 9 inches deep before exiting the basin as surface flow. The surface area required of a rain garden can be found using the following equation:

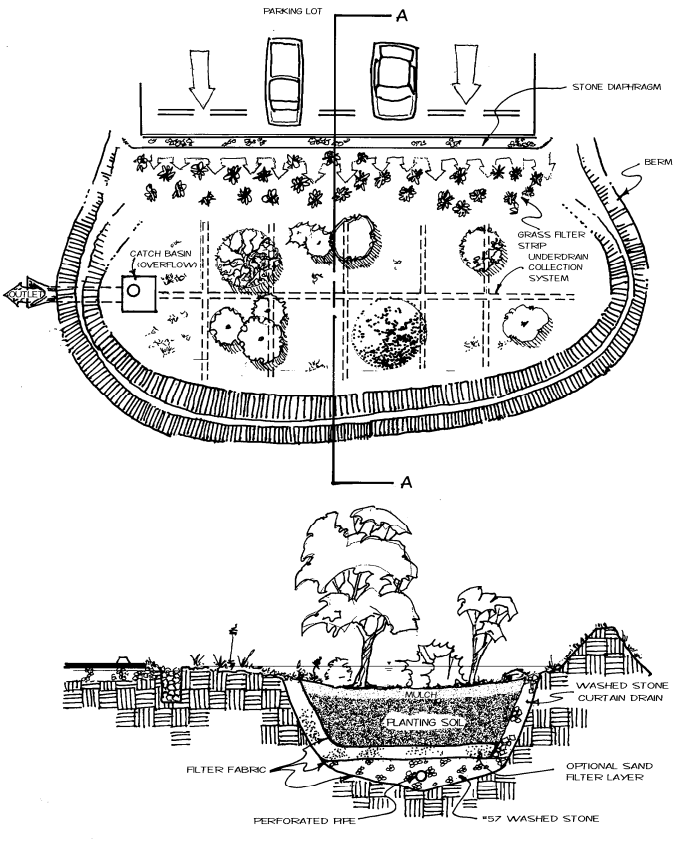
> Rain Garden surface area = Rain garden volume ponding ÷ Average depth of water (9 inches typical)

In the example given, this equation would be:

> Surface area = 130 cubic feet ÷ [(9 inches) x (1 foot/12 inches)] = 170 square feet. The shape may be designed to best fit the site. Minimum width is 15 feet.

Designing the Overflow

Design an overflow to discharge excess water out of the rain garden via a riser or yard inlet type outlet. In cases where a turf or other stable gravel cover exists, water can flow out of the rain garden on one side through a reinforced weir. Rocks or turf reinforcement mats may be used to line the outlet weir. For weir outlets, adequate drainage down slope must be present.



SECTION AA
RAIN GARDEN

Figure 2-D-4

Designing in Clay Soils

All bio-retention areas must be designed to include drainage unless the engineer wishes to design using the underlayment soil with permeability rates exceeding 0.5 inch/hour. There are three principal parts to the rain garden cross section, beginning with the bottom section:

1. The sub-surface reservoir and drainage area, which is comprised of 4 inch high density black plastic perforated pipe and #57 washed gravel.

2. The sandy loam soil zone. (2'-4' depth)

3. The vegetation zone (the visible part of the rain garden).

4. Ground cover may be double-shreaded hardwood mulch, pinestraw, or native grass. Do not use pine chips or other floatable materials.

5. Apply Darcey's Law to establish draw-down time in soil and Manning's formula for the pipe drainage system. It should completely draw-down for any design storm from 2-5 days.

Summary of design criteria parameters for rain gardens

Sandy loam Infiltration rate* And textural classification	Between 1 and 6 inches per hour for imported soil (sandy loam or loamy sand). * Constant or falling head permeability test and USDA textural classification is required for approval by Town Engineer prior to installation.
Maximum depth of water	9 inches standard. Some applications have deeper water allowances, which make plant growth difficult.
Relative size of rain garden	Varies, but typically 5 to 9 percent of contributing watershed, depending upon the amount of impervious surfaces.
Topographic feature location	Flat areas that are downstream of impervious surfaces, and adjacent to an existing storm sewer network or in an appropriate soil zone.
Existing water table	Seasonally high water table should be below the bottom of the rain garden (typically 4 to 6 feet below the surface of the rain garden).
Places to avoid placing rain gardens	Areas that flood regularly (at least yearly) for at least two weeks, hydric soils area, and areas immediately adjacent to building and road foundations.
Mulches	3 to 4 inches. Mulch should be double-shredded hardwood, not pine bark nuggets. Pine straw may be used in some cases. Native grass may be used in lieu of mulch.
Rock for gravel layer (reservoir)	Washed #57 stone. Separate gravel from fill soil and sub-grade soil with a permeable geotextile fabric.
Drainage pipes (perforated)	Design to convey approximately 10 times the maximum inflow (Q) from soil layer. High density 4" perforated black plastic pipe network with clean out at end.

Landscaping

Bio-retention areas are specifically not intended to be wetlands. They are designed so that water does not regularly saturate or inundate the garden for long periods. The vegetation must be able to withstand brief periods of inundation. Neither obligate wetland nor obligate upland vegetation is appropriate for rain gardens.

The following table lists several trees and shrubs that can be grown in bio-retention areas. Their Latin name, common name, habitat, and size are given. This table is not a complete list. Moreover, certain plants listed are primarily found in either the eastern or western portions of North Carolina. Other references include the NCDWQ BMP manual. Two published references are Manual of Woody Landscape Plants by M. Dirr and Carolina Landscape Plants by G. Halfacre.

It is very important to select trees and shrubs that do not have overly aggressive roots. Plants like willows can quickly send roots into drainage pipes. Another plant to avoid is any type of cherry tree.

Aesthetics play an important role in plant selection, especially for the homeowner. Several plants have attractive blooms. Evergreen species should also be selected to maintain color in the rain garden during the winter. Consult your nursery or landscape professional to help select material that suits your situation.

Native grasses, evergreens, deciduous trees and shrubs and herbaceous species can be planted in a rain garden.

Note:

1. It is very important that the watershed draining into the rain garden be stabilized before construction of the rain garden. The site may be used as a sediment trap during site construction and converted after site stabilization occurs and the Erosion Control Officer approves.

2. The Town Engineer must approve the sandy loam soil for permeability and texture prior to installation.

3. These facilities must be maintained according to the submitted and approved Operations and Maintenance Plan. See the NCDWQ BMP Manual to develop the required Operations and Maintenance Plan.

4. Inspect rain gardens seasonally and after substantial rainfall – particularly during the first full year. Small maintenance needs include removing trash and other unwanted debris from the garden, replacing mulch, and pulling weeds.

5. See Town Standard Detail SD-5A.

TABLE 2-D-2
Partial listing of shrubs and trees potentially used in rain garden/bio-retention areas

Latin Name	Common Name	N.C. habit	Size/form
Acer negundo	Box elder	Across N.C.	Small tree
Acer rubrum	Red maple	Across N.C.	Medium tree
Aronia arbutifolia	Red chokeberry	Across N.C.	Medium shrub
Cercis Canadensis	Redbud	Across N.C.	Large shrub
Clethra ainifolia	Sweet pepperbush	Coastal plain, piedmont	Medium shrub
Cornus sericea ssp.stolonifera	Red osier dogwood	Piedmont, mountains	Medium-small shrub
Cyrilla racemiflora	Ti-ti	Coastal plain	Large shrub (semi-evergreen)
Diospyros virginiana	Persimmon	Piedmont, mountains	Small-medium tree
Euonymus Americana	Strawberry bush	Across N.C.	Small shrub
Faxinus pennslyvanica	Green ash	Piedmont, coastal plain	Medium tree
Hypericum frondosum	St. John's wort	Piedmont, coastal plain	Ground cover/herbaceous
IIex vomitoria	Dwarf yaupon	Coastal plain	Small shrub (evergreen)
Juniperus virginiana	Grey owl red cedar	Across N.C.	Shrub (evergreen)
Magnolia virginiana	Sweetbay(magnolia)	Coastal plain, piedmont	Tall green (evergreen)
Myrica cerfera	Wax myrtle	Across N.C.	Large shrub
Pinus palustris	Longleaf pine	Coastal plain, piedmont	Tall tree (evergreen)
Pinus taeda	Lobolly pine	Piedmont, coastal plain	Medium tree (evergreen)
Quercus padogda	Cherrybark oak	Piedmont, coastal plain	Large tree
Sambucus canadensis	American elderberry	Across N.C.	Medium shrub
Scuttellaria integrifolia	Scull cap	Across N.C.	Ground cover

Note: Plant sources include the NCDENR DWQ Stormwater Manual and the NCDWQ Wetlands Restoration Program Document "Guidelines for Riparian Buffer Restoration", Jan. 2001.

GENERAL DESIGN CRITERIA FOR DETENTION, RETENTION AND RE-USE FACILITIES

1. Detention facilities shall be designed to meet one or all of the general performance criteria. They shall be designed to fully drain the design storm runoff within a period of 2 to 5 days. It is recommended that the facility fully drain within 72 hours. They may serve as an infiltration device with engineered soils and a drainage system or may be conventional utilizing existing soils. The following general design criteria apply:

    a. Must include an engineered outlet riser structure and an emergency overflow spill-way designed for the 100-yr. storm event.
    b. If design depths exceed 3 feet in any location, they must include a perimeter safety ledge with a minimum width of 10 feet and maximum depth of 3 feet.
    c. Must include sediment forebays at all points of discharge into the basin.
    d. Must include a planting plan that is appropriate for the basin hydrology and design.
    e. Must include maintenance access, Reserved Storm Drainageway Easement and Operations and Maintenance Plan.

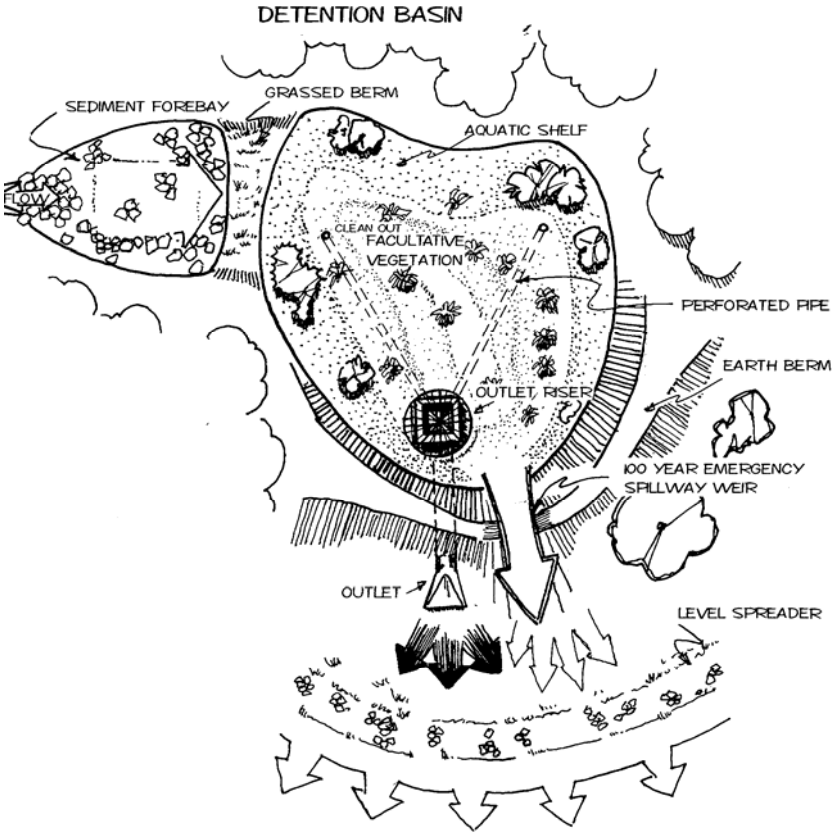
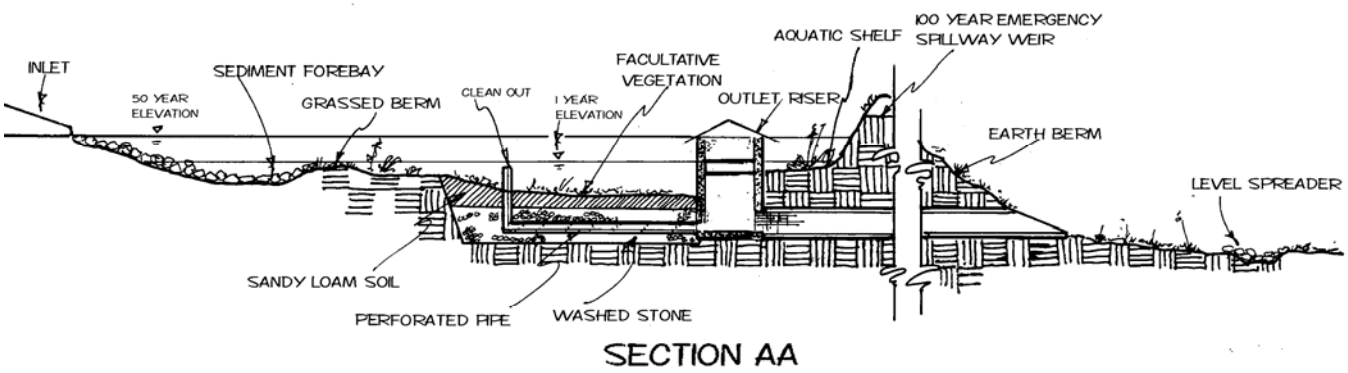


Figure 2-D-5

2. Retention facilities (permanent pool) shall be designed to meet one or all of the general performance criteria. They shall draindown to normal pool level within a period of 2 to 5 days. The following general design criteria apply:

   a. Must have a minimum depth (deepest point) of 4 feet.
   b. Must be designed to promote sufficient oxygenation via fountains, flush or other means.
   c. Must be designed to discourage mosquito larvae propagation or per acceptable practices.
   d. Must be designed to have appropriate appearance.
   e. Must include maintenance access, Reserved Storm Drainageway Easement and design.
   f. Exposed side-slopes shall be 3:1 or flatter.
   g. Retaining walls are acceptable in cases where the grades do not allow side-slopes.



SECTION AA

DETENTION BASIN SECTION

3. Re-Use facilities may be used to meet one or all of the general performance criteria. These facilities may include irrigation systems, non-potable uses in structures such as mechanical and flush water and other uses.

GENERAL DESIGN CRITERIA FOR POROUS PAVEMENT

1. Porous pavement may be used to the water quality and volume standards of the general performance criteria. The general design criteria for the porous pavement stone reservoir, drainage design and the underlaying soils are the same as for infiltration devices. Additional design is required for determining the porous pavement thickness. Pavement design is based on the underlayment soil strength, projected traffic intensities and the storage capacity of the reservoir and base.

2. A thorough examination of the site is of primary importance to the proper design and functioning of porous pavement. The following represents a general list of design elements that should be considered in any porous pavement design:

   a. Anticipated traffic intensities or average daily equivalent axle load (EAL)
   b. California Bearing Ratio (CBR) of underlayment soils
   c. Positive drainage considerations using underdrains and edge drains within the washed open-graded aggregate reservoir
   d. Geosynthetic fabric separation between stone reservoir and sub-grade soil

3. Three (3) types of porous pavement: Portand Cement Porous Pavement and Porous Asphalt Pavement (bituminous) and Permeable Pavestones

   a Portland Cement Porous Pavement may be used in parking lots, private driveways, sidewalks, patios and other acceptable structures. It may be used for light traffic paving loads only. The design criteria and material specifications **are not included** in this design manual due to the complexity. Methods of handling and placing porous concrete are different from other types of concrete. Traditional PCC testing procedures based on strength, air content and slump control are not acceptable to this type of pavement material. Only concrete providers and contractors familiar and experienced in this product are acceptable for this application. Reference the Carolina Ready Mix Concrete Association for technical specifications and other information.

   b. Porous Asphalt Pavement (bituminous) may be used in parking stalls and other acceptable structures. The design and technical notes **are not included** in this design manual. Refer to the Federal Highway Administration, NCDOT or other sources for accepted engineering standards, designs, handling, application, and practices. The asphalt mix specifications should generally include void space, aggregate type, gradation and quality, asphalt cement grade and content in the mix and mixing temperature.

c. Coring may be required. Permeable Pavestones are interlocking concrete sections that when installed, create a porous pavement surface. The material design standard should meet ASTM 936. Refer to product manufacturers installation recommendation for design details.

4. Operations and Maintenance must be carried out on all porous pavement surfaces. This includes wet vacuuming on a routine basis, and inspection of the observation wells at least quarterly to ensure that draw-down is occurring. After one year of monitoring, the observation well monitoring may be reduced to an annual basis as long as the performance is adequate. Cleaning of the surface at least quarterly is required to prevent clogging. This may be accomplished with a vacuum cleaning street sweeper followed by high pressure water washing. Otherwise, porous pavement requires maintenance similar to that of regular pavement. During snow and ice events, do not utilize sand or other aggregate material that would clog the voids. If the voids become fully clogged, the only maintenance measure is replacement.

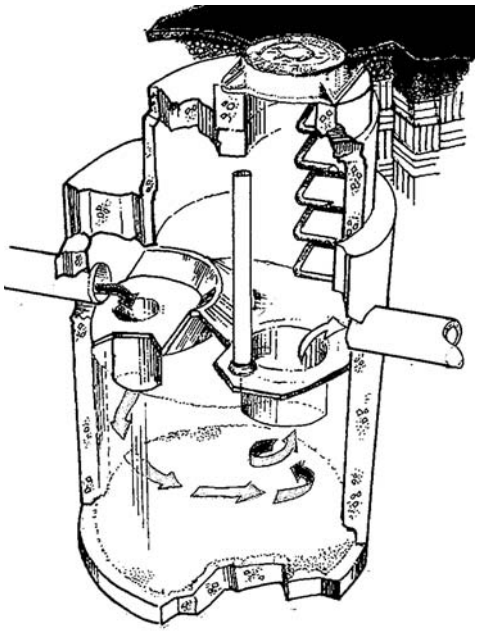
GENERAL DESIGN CRITERIA FOR MANUFACTURED PRODUCTS

1. Manufactured products may be used to meet the water quality or volume element of the general performance criteria. These products are used generally in highly urbanized areas where surface facilities are not feasible. These are flow-through structures where they perform pollutant removal in a treatment chamber, based on a design flow. When the design flow is exceeded, a by-pass coveys the flow through the structure.

2. The design flow and performance shall be based on the removal of 85% average annual total suspended solids (TSS). This may be determined with modeling using the manufactures approved software or by calculating the appropriate design discharge. Pollutant removal efficiencies are very variable, however, and highly dependant on storm frequency or size, influent pollutant concentration and type, and rainfall intensity. Additional design criteria information may become available and included in this manual.

3. There are two (2) general types of manufactured system for water quality.

   a. Hydrodynamic Structures that are based on a vortex or gravity system to remove pollutants through settling or separation of pollutants from the stormwater runoff. They either consist of chambered separation structures relaying on settling of particles or they act as vortex (swirl) systems creating tangential inflow within a cylindrical chamber. Products include but are not limited to Stormceptor, Vortechs Stormwater Treatment System, Downstream Defender, BaySaver Separation System, CrystalStream Stormwater Treatment Device, Stormwater Management Inc.Stormgate Separator, etc.)



HYDRODYNAMIC STRUCTURE
Figure 2-D-7

   b. Filtering Structures includes a filter medium to capture pollutants. They generally include a primary settling chamber to remove solids and a series of filters or cartridges to remove other pollutants such as hydrocarbons and heavy metals. Filter media is selected based on the target pollutant to remove. Products include but are not limited to Stormfilter, StormTreat System, CDS Technologies or Continuous Deflective Separation, Stormwater Management Inc. Stormfilter and Stormscreen, etc.)

4. General volume control devices include products that serve as a sub-surface reservoir in-lieu of stone. Products include Presto Geoweb, ADS perforated pipe, Invisible Structures Inc. Gravelpave, Grasspave and Rainstore, etc).

DESIGN MANUAL HYDROLOGY TECHNICAL NOTE

The section describing hydrologic methodology describes that the SCS Method, the Rational Method, HEC-1, HEC-HMS, TR-55 and other methods are acceptable for calculating peak discharge and volume.

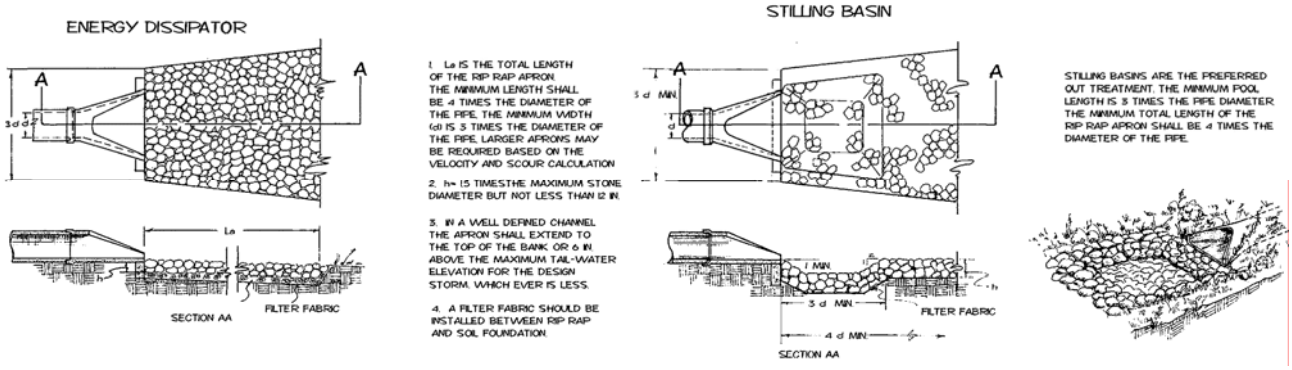
For volume calculations, the acceptable method is the SCS Curve Number Method.

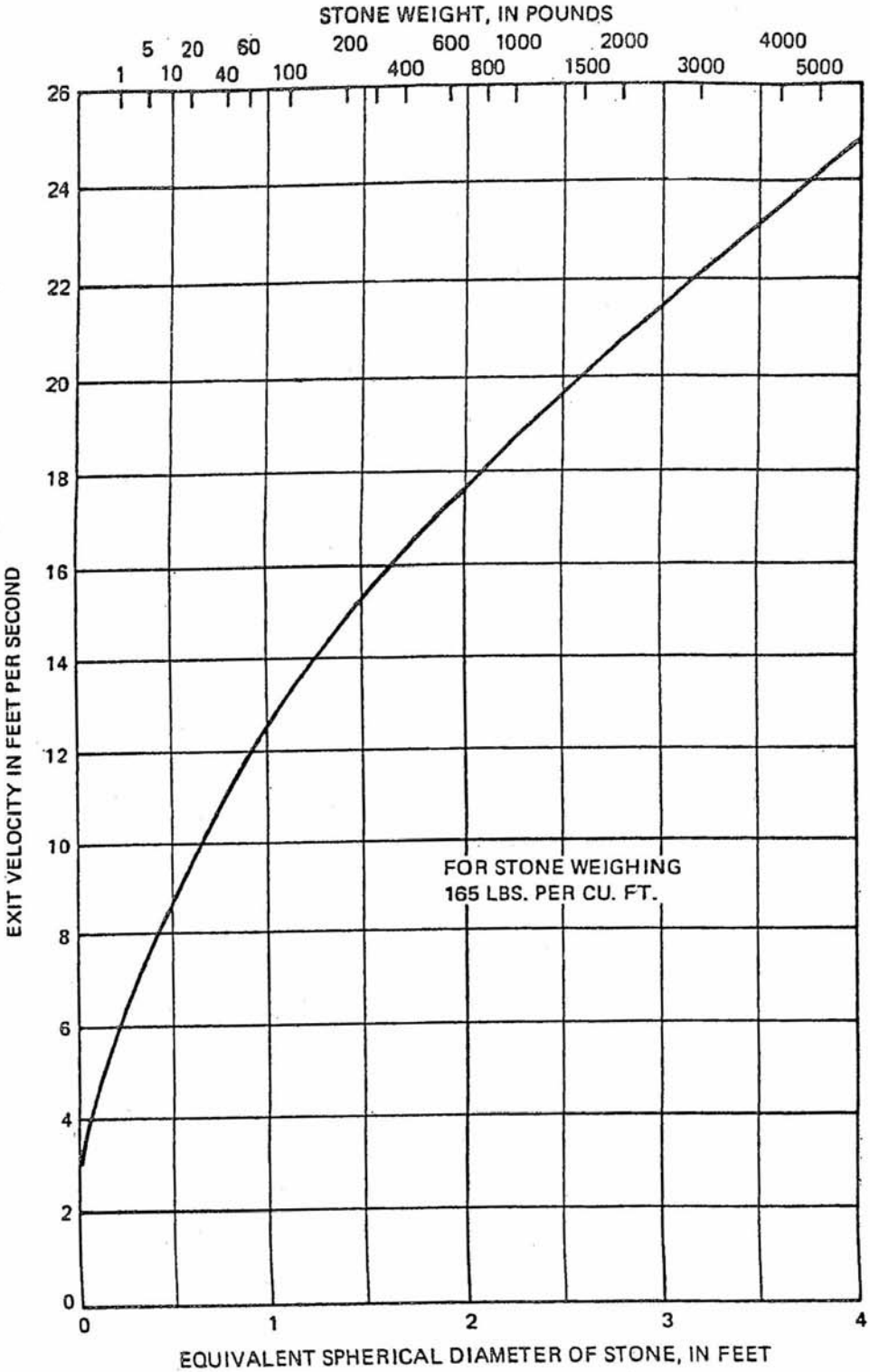
For peak discharge calculations, either the generation of hydrographs (Type II) or the Rational Method is acceptable for smaller catchments. We are suggesting that the Rational Method be used for catchments up to 25 acres in size, unless routing the discharge through engineered facilities is required or deemed necessary thereby generating a hydrograph.

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.

The Land Use Management Ordinance 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.

The Rational Method is a proven and reliable method to predict discharges in small catchments. It is quick and easy to use and review. Used correctly, it is a good tool for the development community and the Town. Therefore, the Town should continue to accept the Rational Method, however it must be used in accordance with acceptable engineering practices. This will require that the time of concentration be calculated and used for the storm duration consideration, not necessarily the 24-hour duration. Most storm events in small catchments cause a peak discharge in a much less time-frame than 24-hours, such as 5 or 10 minutes.





RIPRAP SIZE FOR USE DOWNSTREAM OF ENERGY DISSIPATORS

Source: U.S.D.O.T.

Town of Chapel Hill

Stormwater Impact Statement and Stormwater Management Plan Guidelines
(Revised March 14, 2003)
(Revised August 22, 2003)

I. INTRODUCTION

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 5,000 square feet of land disturbance may not be subject to these requirements) within the Town of Chapel Hill Planning Jurisdiction must include a Stormwater Impact Statement and a Stormwater Management Plan. As authorized by the Chapel Hill Land Use Management Ordinance, affirmative exemption to all or part of the requirements of the Stormwater Impact Statement may be granted by the Town Manager.

II. STORMWATER IMPACT STATEMENT (THE FOLLOWING INFORMATION SHALL BE PROVIDED, UNLESS OTHERWISE NOTED, FOR ALL DEVELOPMENT OTHER THAN SINGLE-FAMILY OR TWO-FAMILY DWELLINGS INVOLVING LESS THAN OR EQUAL TO 5,000 SF OF LAND DISTURBANCE.)

II-A. SITE ANALYSIS AND NARRATIVE

A pre-application discussion with the Town Stormwater Management Engineer is encouraged to determine the limits of study and to define study elements required. Elements of the analysis should include, but are not limited to:

1. Land use, density, impervious surface area, and phasing;
2. Location, topography, on-site and off-site drainage conditions;
3. Upstream and/or downstream volumes, discharges and velocities;
4. Backwater impacts, effects on existing upstream and/or downstream drainage conveyance facilties;
5. Ability of natural drainage channel to convey additional volume, discharges and velocities;
6. Potential mitigation measures; and
7. Delineation of the Resource Conservation District (RCD) for perennial and intermittent streams as determined by the Town, jurisdictional wetlands, soil series, and regulatory FEMA Special Flood Hazard Areas.

Note: If it is believed that an intermittent or perennial stream may be on or within 150 feet of the property to be developed, the applicant should submit a request for a stream determination to be performed by Town staff.

II-B. RELEASE RATE MANAGEMENT

Accepted engineering practices will be required for determining both pre-development and post -development stormwater peak discharge data. Hydrographs may be required on a site-specific basis.

The peak discharge rate for the post-development conditions shall be no greater than the peak discharge rate for the pre-development conditions for the local 1-year, 24-hour duration, 2-year, 24-hour duration and the 25-year, 24-hour duration return period storms. Acceptable methodologies for computing peak flow rates include: the Rational Method, HEC-1 or HEC-HMS methods, USDA TR-55, or other methods subject to approval by the Town Stormwater Management Engineer.

Depending on the development site location, size/area and the condition of the existing conveyance system and associated lands, the Manager may waive or change the peak discharge rate criteria in part or in whole if, based on an approved Stormwater Impact Statement, it is demonstrated that detention would intensify existing peak discharges or might otherwise create problems on abutting and/or downstream properties.

II-C. VOLUME MANAGEMENT (Not applicable for single-family and two-family lots existing prior to January 27, 2003)

Using USDA Soil Conservations Service Curve Number (CN) method for total run-off volume (or other approved method) the increase in volume from pre-development conditions to post-development conditions for the 2-year/24-hour storm, (where P=3.6") shall be managed on-site using infiltration, re-use or other approved BMP/IMP methods.

II-D. WATER QUALITY MANAGEMENT

The applicant shall utilize stormwater Integrated Management Practices (IMP's) and/or Best Management Practices (BMP's), as approved by the Manager, to treat stormwater runoff from all disturbed, built-upon, and impervious areas associated with the development. The IMP/ BMP shall be minimally designed to remove 85% average annual total suspended solids (TSS) from post-development stormwater runoff. The IMP/BMP may also be used to provide for volume management and release rate management as approved by the Manager. Further information regarding the IMP/BMP practices will be made available in the Town Design Manual.

Submit proposal(s) for IMP's/BMP's to the Town Stormwater Management Engineer for review. The assumed TSS removal efficiencies for properly designed IMP's/BMP's are as follows:

Retention Basins	85%
Sand Filters	85%
Bioretention Areas	85%
Grassed Swales (100 linear ft. per drained acre)	35%

Detention Basins	50%
Filter Strips	25-40%
Infiltration Devices	85%
Level Spreaders & Buffers (50' minimum length)	40%
Manufactured Products	(Varies)

Single devices may be used or devices may be used in combination to achieve the required pollutant removal of 85% average annual TSS. As experience grows in the use and effectiveness of the devices and methods, other IMP's/BMP's and/or other specifications may be considered for use in Chapel Hill. The NCDWQ and the Town of Chapel Hill will continue to review and modify both design and removal efficiencies as appropriate.

II-E. NUTRIENT LOADING CALCULATIONS (Not applicable for development involving less than 1 acre of land disturbance)

Nutrient loading calculations shall be included with the Stormwater Impact Statement. Yearly loads are calculated by multiplying the area of each land use by the appropriate loading coefficient as provided in Table 2-G-1. Required calculations shall include the pollutant loading of total nitrogen and total phosphorus. Treating stormwater for nutrient loads is not currently required by the Town.

TABLE 2-G-1

Chapel Hill Pollutant Loading Coefficients (lbs/acre/yr)*

LAND USE TYPE	TOTAL N	TOTAL P
Low Density Residential (< 12% impervious or < 1 unit/acre)	5.2	0.7
Moderate/High Density Residential (> 12% impervious or > 1 unit/acre)	7.4	1.2
Office/Institutional	8.8	1.6
Commercial	13.2	1.6
Industrial	11.2	1.4
Undeveloped/Forest/Open	0.6	0.08
Pasture	2.6	0.5

*Values calibrated for the Town of Chapel Hill and based on data from Hartigan (1983), CDM (1989), Haith (1992), and Schueler (1987).

In order to perform these loading calculations, the land use types and relative acreage must first be determined. For example, a proposed development contains 100 residential half acre lots (moderate density). A 20 acre commercial district is also planned. The remaining tracts (15 acres) will remain undeveloped open space. The total nitrogen loading calculations for this proposed development would be as follows:

Moderate Residential	- 100 lots x ½ acre	50 acres
	- 50 acres x 7.4 lbs/acre/yr	370 lbs/yr
Commercial	- 20 acres x 13.2lbs/acre/yr	264 lbs/yr
Undeveloped	- 15 acres x 0.6 lbs/acre/yr	9 lbs/yr
Total Nitrogen Load		**643 lb/yr**

II-F. MAINTENANCE AND OPERATIONS PLAN

The Stormwater Impact Statement shall include a Maintenance and Operations Plan. This plan shall 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.

III. STORMWATER MANAGEMENT PLAN (SEE SECTION IV FOR FURTHER INSTRUCTIONS REGARDING SINGLE-FAMILY OR TWO-FAMILY DWELLINGS)

A *preliminary* Stormwater Management Plan shall be submitted with the Stormwater Impact Statement detailing site location, existing and proposed stormdrainage system(s), stormwater detention structure(s), BMP's/IMP's, grading, landscaping, erosion control features, and Resource Conservation District location(s). The plan must present the existing and proposed conditions and features at a scale and quality suitable to include all impacted areas (on-site and off-site). For certain applications, a pre-application discussion with the Town Stormwater Management Engineer is suggested to discuss alternatives. A *final* Stormwater Management Plan shall be submitted prior to issuance of a Zoning Compliance Permit.

III-A. EROSION AND SEDIMENT MANAGEMENT

Any development causing the disturbance of more than 5000 sf of land area requires erosion and sedimentation control measures. For disturbance greater than 20,000 sf of land area, an Erosion Control Permit is required by Orange County. For development causing one (1) acre or more of land disturbance, the applicant must also submit an erosion control performance guarantee or bond with the Town. Contact the Engineering Department for the required dollar value of this guarantee

A general description of the proposed erosion and sediment control measures shall be indicated on the Stormwater Management Plan. If applicable, a phasing schedule for construction and/or

removal of proposed control devices will also be required to ensure adequate protection for all phases of the development. Inspection and approval of the installed devices by the Town or Orange County is required.

III-B. RESERVED STORM DRAINAGEWAY EASEMENT

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.

IV. STORMWATER MANAGEMENT PLAN FOR SINGLE-FAMILY OR TWO-FAMILY DWELLINGS)

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 5,000 square feet of land disturbance. The Stormwater Management Plan shall indicate the Best Management Practices (BMP's) and or Integrated Management Practices (IMP's) 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 in lieu of a separate Stormwater Impact Statement. Erosion control measures and a Stormwater Operations and Maintenance Plan are required for all development disturbing more than 5,000 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.

V. BEST MANAGEMENT PRACTICES AND INTEGRATED MANAGEMENT PRACTICES

If applicable, where the post-development peak discharge rate or volume of runoff exceeds the pre-development rate or volume and to achieve average annual 85% total suspended solids removal, BMP/IMP's will be required. These practices may include structural or non-structural measures. Structural measures may include, but are not limited to, level-spreaders, curb cuts or diffuse flow, grassed swales, wet or dry detention basins, wet retention basins, extended dry detention basins, bioretention areas, pervious pavement and other infiltration practices. Non-structural measures may include, but are not limited to, utilizing natural buffers, limiting impervious surfaces and limiting disturbed areas. Low impact design options are encouraged.

VI. 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:

(a) 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).

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

If you have any questions regarding these Guidelines, contact the Town Stormwater Management Engineer.

REFERENCES

CDM. 1989. Watershed Management Study: Lake Michie and Little River Reservoir Studies.

Field, Richard, M.L. O'Shea and K. K. Chin. 1993. Integrated Stormwater Management. Lewis Publishers. Boca Raton, FL.

Haith, D.A., et al. 1992. Generalized Watershed Loading Functions: User's Manual. NY.

Hartigan, J.P., et al. 1983. Calibration of NPS Model Loading Factors. Journal of Environmental Engineering Division. 109: no. 6 pp. 1259-1272.

Schueler, Thomas R. 1987. Controlling Urban Runoff: A Practice Manual for Planning and Designing Urban BMPs. Metropolitan Washington Council of Governments, Washington, DC.

Stormwater Best Management Practices 1999. North Carolina Department of Environment and Natural Resources, Division of Water Quality, Water Quality Section.

Urbonas, Ben, and P. Stahre. 1993. Stormwater Best Management Practices and Detention. Prentice Hall. Englewood Cliffs, NJ.

SECTION - 3

LANDSCAPING

AND

TREE PROTECTION

SECTION 3 LANDSCAPING AND TREE PROTECTION

3.1 DESIGN STANDARDS

3.1.1 Buffer Requirements

The following chart indicates the minimum width and planting requirements for each buffer type established in Section 5.6 of the Land Use Management Ordinance. The arrangement of plants within each buffer should be integral to the design concept of the project as a whole, as well as responsive to the landscapes of adjacent properties. The room required for plants to develop their natural form, especially large trees, should also be considered when determining plant spacing. Allowing greater than minimum buffer widths can therefore provide more design flexibility. The buffer locations shown in the chart refer to whether the buffer area is adjacent to a street (external) or adjacent to some other property line (internal). When developing external buffers, large trees may be planted within the public right-of-way if they are consistent with adjacent street tree plantings and are acceptable to the Town and the North Carolina Department of Transportation, if applicable.

Plants per 100 Linear Feet

Buffer Type	Minimum Width	Location	Large Trees	Small Trees	Shrubs
"A"	15	External	2	4	6
		Internal	2	4	6
"B"	15	External	6	8	15
	10	Internal	4	7	12
"C"	20	External	5	10	36
		Internal	4	8	30
"D"	30	External	6	12	40
		Internal	5	10	30
"E"	100	External	10	15	70

Examples of appropriate varieties of large and small trees and shrubs can be found in the Plant Selection Standards. When selecting shrub species, a minimum of 50% of the total number of required shrubs should be evergreen.

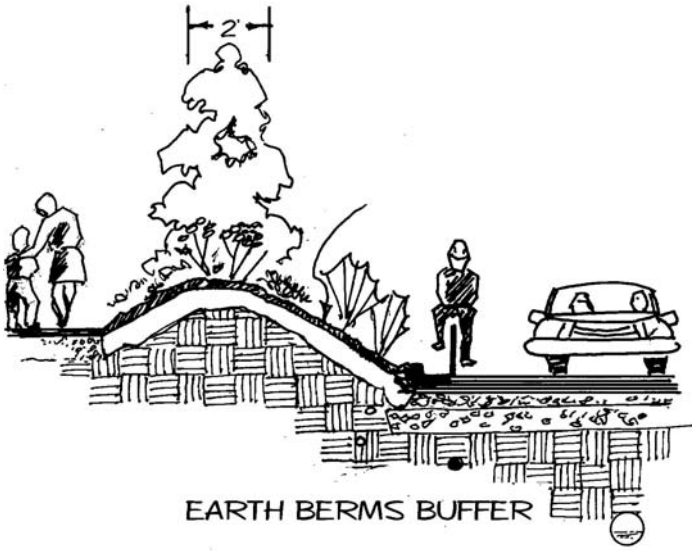
When it is acceptable to the Town, existing vegetation can be used to satisfy some or all of the required buffer plantings. In these cases, the existing vegetation shall be in good health and be protected during the development process. In most locations where existing vegetation is retained, supplemental plantings of evergreen shrubs along buffer edges will still be needed in order to meet the planting requirements noted above.

The location of existing or proposed utility easements should be taken into account when determining the location of proposed buffers. Consistent with Section 5.6.3 of the Land Use Management Ordinance, required buffers cannot overlap utility easements other than in locations where the easements cross these buffers. In these locations and where easements exist that may conflict with other landscaping standards, applicants should contact the affected utility provider to determine what types of plantings, typically limited to shrubs and small trees, are permitted within the easement areas.

3.1.2 Parking Lot Requirements

(a) Screening Standards:

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 2 years of planting when vegetation is included to meet the screening standards**.** There should be no gaps in the screen greater than 6' wide.



(b) Screening Materials:

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 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 materials used for screening in lieu of fences or walls shall be evergreen and have a minimum height of 2' when planted for 3’ tall screening, and 3’ when planted for 6’ tall screening.

Earth berms used for screening should have a minimum crown width of 2', maximum slopes of 3:1, and be covered with approved vegetation to provide a screen of the required height.

(c) Parking Lot Shading Standards:

In addition to the screening requirements, all parking lots are required to be landscaped and should provide vegetation to achieve at least 35% shading at maturity. One large tree per 2,000 sf of paved surface planted within 10' of the parking lot edge will satisfy this requirement if the plants are spaced appropriately. Typically, no parking space should be farther than 50' from the trunk of a large tree, or farther than 75' from 2 large trees.

When it is acceptable to the Town, existing vegetation can be used to satisfy some or all of the required interior plantings. In these cases, the existing vegetation should be in good health and be protected during the development process. Trees and shrubs required for interior plantings can be planted within buffer zones where parking lots abut these buffers.

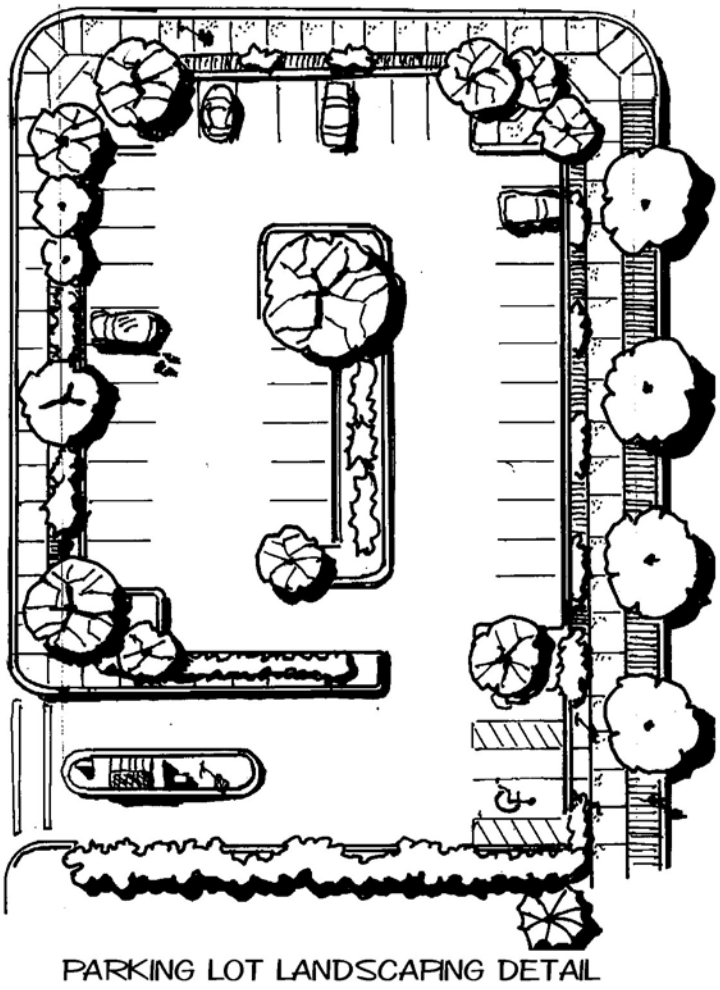


Figure 3.2

(d) Landscaped Island and Median Requirements

Landscaped islands in parking lots, and medians separating lanes of traffic on public streets and on internal drives, should be a minimum of 4' in width measured from the back of curb.

If large trees are to be planted in landscape islands or medians, these islands or medians should be a minimum of 10' in width measured from the back of curb, and include a minimum of 200 sf of soil surface area per large tree.

All landscaped islands and medians shall receive a minimum of 6" of topsoil over finished subgrade**,** and shall be graded to provide adequate drainage .Subsurface drainage is recommended for all landscaped islands and medians. In some specific situations, where site conditions merit, automatic irrigation systems may also be recommended. In these situations, the use of water conserving irrigation systems is encouraged.

(e) Loading Area Requirements

All loading areas shall have a minimum width of 12' and be screened from public rights-of-way and all adjacent properties.

All standards applicable to screening parking lots are required of loading area screening, except that the screening height shall be a minimum of 6' above existing grade for both right-of-way and residential screening..

(f) Utility Service Area 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.

(g) Tree Placement Requirements

When designing projects in the downtown area, developers should refer to the Town's Downtown Streetscape Master Plan for information about planter design and planting standards along downtown streets. For additional information developers should contact the Town's Public Works Department. In all areas it is important to be certain that the placement of plantings does not interfere with site visibility at intersections. For additional information about sight distance triangles, developers should refer to the Town's Standard Details. In general the following tree placement standards apply:

(1) Large Trees - All trees reaching a mature height of thirty five (35) feet or more should be planted a minimum of:

3-1/2 feet from back of curb, edge of street pavement and driveways (allow for any proposed future widening);

3-1/2 feet from sidewalks and other paved pedestrian surfaces except where urban conditions would prohibit any planting;

10 feet from all buildings;

15 feet from street lights, utility poles and above-ground utility wires;

10 feet from all underground utilities; and

10 feet from utility vaults and ground level utility structures.

(2) Small Trees - All trees reaching a mature height of less than 35 feet should be planted a minimum of:

3 ½ feet from back of curb, edge of street pavement and driveways (allow for any proposed future widening);

2 ½ feet from sidewalks and other paved pedestrian surfaces except where urban conditions would prohibit any planting;

5 feet from all buildings;

10 feet from street lights and utility poles;

5 feet from all underground utilities; and

5 feet from utility vaults and ground level utility structures (10 feet from door side).

3.2 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. Accordingly, the Town provides here a list of plants that are known to be invasive in the Chapel Hill area and are thereby prohibited from being used on Town-regulate planting projects. Following this list is a list of plants species that are discouraged due to their potential to become invasive and a third list of native plant species that 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 that they are providing a diverse mix of species that will perform well on a specific project site. For additional information about local plant adaptability landscape designers can contact the North Carolina Botanical Garden and the J.C. Raulston Arboretum.

Consistent with these Town landscaping objectives, landscape designers are discouraged from planting large numbers of a single species in any given project and from utilizing plant varieties, such as red-tip photinia and leyland cypress, that are prone to insect and disease problems in the Chapel Hill area. For additional information about susceptible plant species, landscape designers can contact the North Carolina County Extension Service.

3.2.1 Prohibited Invasive Exotic Species

The following list includes exotic species that may be available in the nursery trade and are known to be invasive in the Chapel Hill area. Plants on this list cannot be specified for use on landscaping plans for development applications requiring planting plan approval by the Town staff. The use of the listed plants is also strongly discouraged in non-regulated landscaping projects within the Town.

(a) Trees:

Scientific Name(s)	Common Name(s)	Remarks
Ailanthus altissima	Tree of Heaven	
Albizia julibrissin	Mimosa	
Morus alba	White Mulberry	
Paulownia tomentosa	Princess Tree	

(b) Shrubs and Vines:

Scientific Name(s)	Common Name(s)	Remarks
Celastrus orbiculatus	Oriental Bittersweet Vine	
Eleagnus angustifolia, E. pungens, E. umbellate	Russian Olive, Silverleaf	
Ipomoea purpurea, I. Tricolor	Common Morningglory	Reseeding annual
Ligustrum lucidum	Waxleaf Privet	
Ligustrum sinense	Chinese Privet	Includes variegated type
Ligustrum vulgare	Common Privet	
Lonicera japonica	Japanese Honeysuckle	
Lonicera maackii, L. morrowii, L. tatarica	Bush Honeysuckle	
Rosa multiflora	Multiflora Rose	
Wisteria floribunda	Japanese Wisteria	
Wisteria sinensis	Chinese Wisteria	

(c) Groundcovers and Grasses:

Scientific Name(s)	Common Name(s)	Remarks
Fallopia cuspidatum, Polygonum cuspidatum	Japanese Knotweed	
Lythrum salicaria,	Purple Loosestrife	
Polygonum perfoliatum, P. sachalinense	Giant Knotweed	

3.2.2Restricted Species

This following list includes exotic species that may be available in the nursery trade and have the potential to be invasive in the Chapel Hill area. This list includes plants that vary in their likelihood to become invasive. Some plants, such as chinaberry and norway maple have not yet become established as invasive species in the Chapel Hill area but are known to be invasive elsewhere in the Southeast. A number of other plants, including the bamboos and periwinkles spread vegetatively but are unlikely to self-sow and therefore can be specified for applications, such as in planters, where their spread can be carefully controlled. Several other plants, including english ivy, and chinese silvergrass are shown on the list but include dwarf, sterile or non-vigorous varieties that likely pose only a minimal risk of becoming invasive.

Considering these issues, the listed plants should not be specified for use on landscaping plans prepared for development applications requiring planting plan approval by the Town staff unless the variety specified or the method of installation is carefully researched. The use of the listed plants is also discouraged in non-regulated landscaping projects within the Town.

(a) Trees:

Scientific Name(s)	Common Name(s)	Remarks
Acer platanoides	Norway Maple	
Broussonetia papyrifera	Paper Mulberry	
Melia azadarach	Chinaberry	
Populus alba	White poplar	
Quercus acutissima	Sawtooth Oak	
Ulmus pumila	Siberian Elm	

(b) Shrubs and Vines:

Scientific Name(s)	Common Name(s)	Remarks
Akebia quinata	Fiveleaf Akebia	
Ampelopsis brevipendunulata	Porcelain Berry Vine	
Berberis thunbergii	Japanese Barberry	Dwarf forms may be acceptable
Clematis paniculatus, C. terniflora	Sweet Autumn Clematis	
Euonymus alata	Burning Bush	Dwarf forms may be acceptable
Euonymus fortunei	Wintercreeper	Dwarf forms may be acceptable
Hedera helix	English Ivy	Dwarf forms may be acceptable
Rhamnus alnus, R. cathartica	Buckthorn	
Spiraea japonica	Japanese spiraea	Some varieties may be acceptable
Viburnum dilatatum	Linden Arrowwood	

(c) Groundcovers and Grasses:

Scientific Name(s)	Common Name(s)	Remarks
Arundinaria sp.	Golden Grove Bamboo	Contained use may be acceptable
Arundo donax	Giant Reed	
Coronilla varia	Crownvetch	
Iris psuedoacorus	Yellow Flag	
Lysimachia nummularia	Creeping Jenny	Variegated forms may be acceptable
Miscanthus sinensis	Chinese Silvergrass	Some varieties may be acceptable
Phalaris arundinacea	Reed canarygrass	
Phyllostachys aurea, P. nigra	Golden Bamboo, Black Bamboo	Contained use may be acceptable
Sasa palmata, S. pygmaea	Dwarf bamboo	Contained use may be acceptable
Vinca major	Bigleaf Periwinkle	Contained use may be acceptable
Vinca minor	Common Periwinkle	Contained use and variegated forms may be acceptable

3.2.3 Recommended Native Species

This list includes species native to the Southeastern United States that are generally available in the nursery trade and are known to perform well in typical landscape installations in the Chapel Hill area. Plants on this list are underutilized in area landscapes and are recommended for inclusion in regulated and non-regulated landscape projects within the Town.

(a) Trees:

Scientific Name(s)	Common Name(s)	Remarks
Aesculus pavia	Red Buckeye	
Amelanchier laevis	Serviceberry	Several varieties available
Chionanthus virginicus	Fringe Tree	
Halesia Carolina	Carolina Silverbell	
Ilex opaca	American Holly	Several varieties available
Ilex vomitoria	Yaupon Holly	Several varieties available
Magnolia virginiana	Sweet Bay Magnolia	
Nyssa sylvatica	Black Gum	
Prunus caroliniana	Cherry Laurel	
Quercus pagodifolia.	Cherrybark Oak	Very tolerant of heavy soils
Quercus laurifolia	Laurel Oak	
Taxodium distichum	Bald Cypress	Very tolerant of heavy soils

(b) Shrubs and Vines:

Scientific Name(s)	Common Name(s)	Remarks
Bignonia capreolata	Crossvine	
Callicarpa Americana	American Beautyberry	
Calycanthus floridus	Sweetshrub, Sweet Betsy	
Gelsemium sempervirens	Carolina Jasmine	
Hydrangea quercifolia	Oakleaf Hydrangea	
Ilex glabra	Inkberry Holly	Several varieties available
Ilex verticillata	Winterberry Holly	Several varieties available
Illicium floridanum	Florida Anise	Several varieties available
Itea virginica	Virginia Willow	
Leucothoe fontanesiana	Drooping leucothoe	
Lonicera sempervirens	Coral Honeysuckle	
Myrica cerifera "nana"	Dwarf Waxmyrtle	

(c) Groundcovers and Grasses:

Scientific Name(s)	Common Name(s)	Remarks
Andropogon gerardii	Big Bluestem	
Coreopsis spp.	Tickseed	
Echinacea purpurea	Purple Coneflower	
Monarda didyma	Bee Balm	
Panicum virgatum	Switchgrass	
Rudbeckia spp.	Black-eye Susan	

3.3 LANDSCAPE INSTALLATION AND MAINTENANCE SPECIFICATIONS

3.3.1 Materials Requirements

(a) Plant Materials:

The American Standard for Nursery Stock published by the American Society of Nurserymen should be used for determining caliper, heights, widths and ball sizes, for all plants.

Plant material should be free of any diseases, funguses or insect infestations.

Town standard minimum planting sizes are listed below. Larger sizes may be required, however, for specific landscape applications including parking lot screening**.**

Ground Cover:	2" pots
Shrubs:	18" in height
Small Trees:	5' in height
Large Trees:	2" caliper
Street Trees:	12' in height, limbed up to a minimum of 7’ in areas of pedestrian traffic.

(b) Topsoil Mix:

All topsoil mixes used for finish grading and planter applications should be the site's original topsoil or should be tested by N.C. Department of Agriculture to determine their suitability for landscape use.

All topsoil mixes should contain a minimum 2% organic matter; range in pH from 4.5 5.0 - 7.0; and be free of herbicide and pesticide residues prior to the addition of amendments.

All topsoil mixes should be amended as recommended by soil test results, and be loose and friable at the time of planting.

(c) Backfill for Planting Pits:

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.

(d) Mulch:

Mulch should consist of pine bark, leaf mold or well-aged wood chips or a combination of these three components. On sloped sites where pine bark may float, well-aged wood chips should be used.

3.3.2 Soil Preparation

(a) Tilling of Areas to be Landscaped:

Existing compacted topsoils that are to receive plants or seed and subsoils that are to be overlaid with topsoil should be tilled to a minimum depth of 6".

(b) Placing Topsoil in Areas to be Landscaped:

All areas that are to be planted with turf, shrubs or trees should receive a minimum of 6" of topsoil over finished subgrade.

Within the critical root zones of rare and specimen trees, no remaining soil should be disturbed and, provided that no change in grade occurs at the tree's trunk, no more than 6" of topsoil should be placed over the critical root zone.

3.3.3 Planting Requirements

(a) 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.

(b) 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 32 degrees F.

Following a period of precipitation, planting operations should resume only when the full depth of the planting pits has satisfactorily drained.

(c) Handling Plant Materials:

Shade and water should be provided to all delivered material during dry weather and B&B materials should be mulched if they are to remain unplanted for over 24 hours.

(d) 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

(e) Setting Balled-and-Burlapped and Container Plants:

The top of the plant root ball should be set so that it will be level with the finished grade after settlement. Generally, large plants should be installed from 3" – 4" above grade to allow for

settlement. All plant material greater than 3 feet in height should be set plumb regardless of the slope of finished grade. Plants smaller than 3 feet in height may be set perpendicular to finished grade on sloping sites.

For container grown plants, carefully remove the container and cut any container-bound circling roots. For balled-and-burlapped plants, cut burlap away from the top of the root ball. For plants in wire baskets, set plant in planting pit; then cut and remove wire that will remain exposed after backfilling along with the burlap from the top of the root ball.

Place and tamp backfill around root ball in 6-to 8-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. Place a minimum of 3 inches of mulch over plant ball and pit area, taking care to keep material a minimum of 2 inches from the trunk of tree.

(f) Staking Trees:

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 that will not abrade or become embedded in trunk. Slack should be provided in each constraining line to allow for some trunk movement and all supports should be removed after one year unless tree is excessively weak.

3.3.4 General Pruning Requirements

Pruning should consist of the removal of dead, dying, diseased, interfering, obstructing and weak branches and selective thinning to lessen wind resistance and improve the appearance of trees and shrubs.

All cuts should be made close to the trunk or parent limb 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.

Trees 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.

3.4 TREE PROTECTION STANDARDS

3.4.1 Tree Protection Ordinance Requirements

All development activities on non-exempt sites that 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.

(a) Landscape Protection Plan:

A Landscape Protection Plan should be prepared showing existing 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 zones of all rare and specimen trees that will be affected by construction. Significant trees stands are defined in Section 5.7.7 of the Town's Land Use Management Ordinance and generally include all wooded areas greater than 1000 square feet in size with a continuous canopy exceeding thirty (30) feet in height where over fifty (50) percent of trees with a diameter at breast height (DBH) over six (6) inches are hardwoods. Rare and specimen trees are defined in Section 5.7.6 of the Town's Land Use Management Ordinance and generally include all trees with a DBH greater than eighteen (18) inches.

The critical root zone of a tree is defined as: A circular area, the radius of which is twelve (12) times the diameter of the tree at breast height, measured from the trunk of the tree.

The Landscape Protection Plan should also be overlaid on the proposed grading plan, should identify the construction limit line, and should indicate where tree protection fencing will be located. In addition, the following standard notes and a detail of the proposed tree protection fencing should be included on all plans.

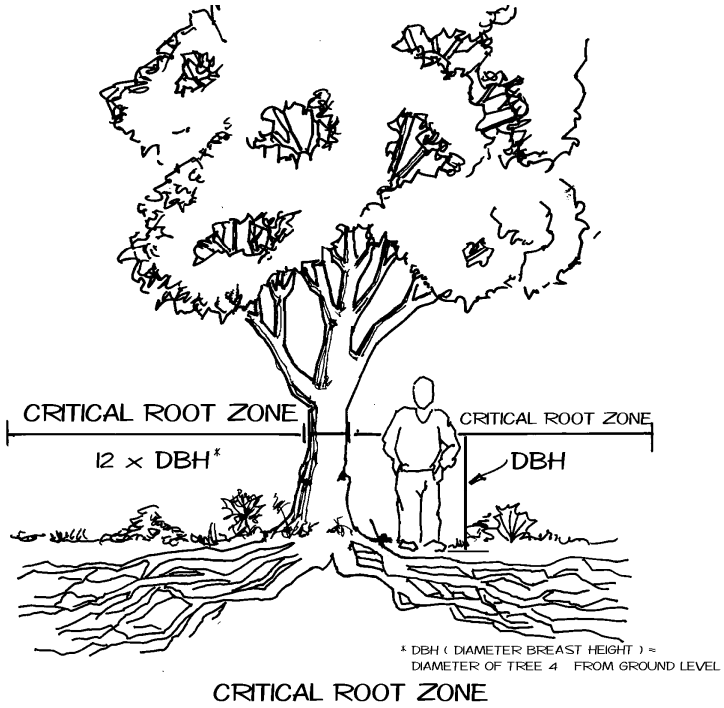


Figure 3.3

(b) Town Standard Tree Protection Notes:

(1) A pre-construction conference will be held with the Town's Urban Forester prior to beginning site work.

(2) Any tree roots exposed by construction will be severed cleanly with an appropriate 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 landscaping.

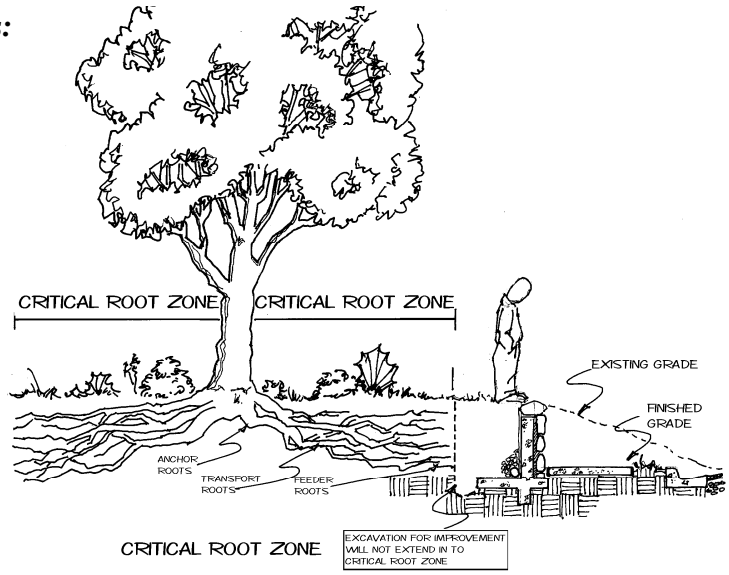


Figure 3.4

4) A Landscape Protection Supervisor who is registered with the Town of Chapel Hill will be present on site at all times when the following activities are taking place: clearing, grubbing, excavation, grading, trenching, moving of soil, installation and removal of tree protection fencing, and the delivery transporting and placement of construction materials and equipment.

(On development applications for non-residential and multi-family construction the following additional note should also be included on the plans.)

(c) Tree Protection Fencing:

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 that are 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 protective fencing.

The Town's standard for tree protection fencing is orange woven plastic or fabric with a height of four (4) feet installed on metal posts set a maximum of ten (10) feet apart as shown in the following typical detail.

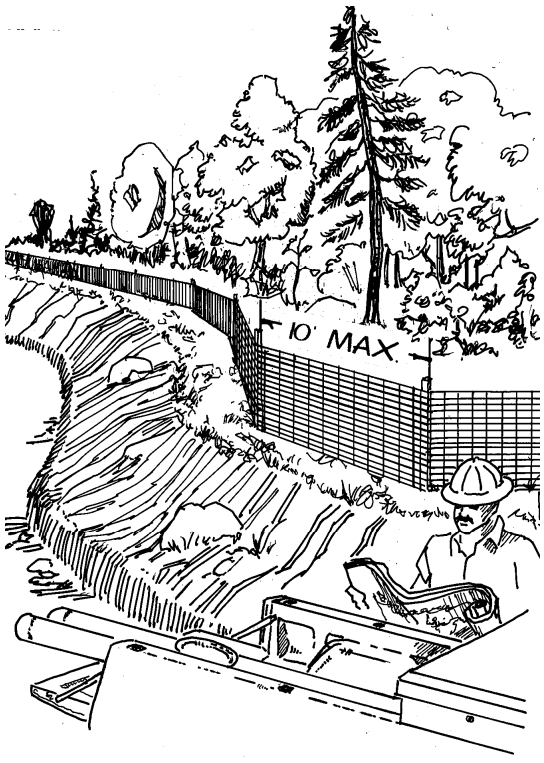


Figure 3.5

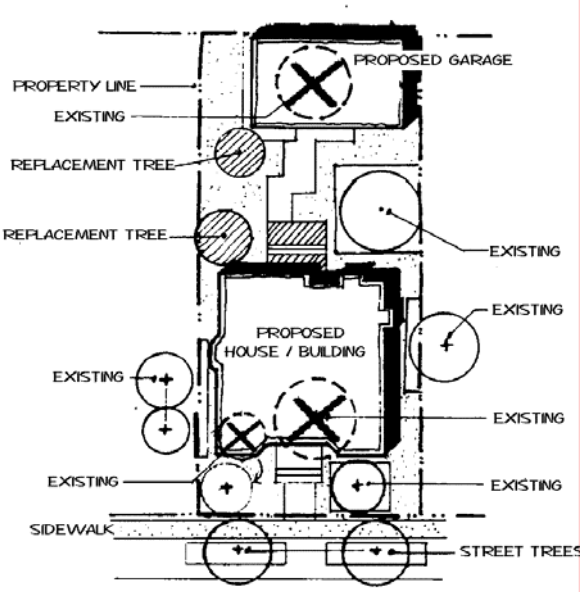
In some situations, where silt fence is required to be installed along the construction limit lines, the silt fence is considered to function in lieu of the standard tree protection fencing and therefore the standard tree protection fencing is not required. In other limited situations, where construction impact is anticipated to be minimal, a continuous line of survey flagging may be acceptable to delineate the construction limit lines. Developers should contact the Public Works Department if there are questions about when these tree protection fence alternatives can be utilized.

(d) Site Work Guidelines:

1) Root Pruning Existing Rare and Specimen Trees:

Root pruning is recommended prior to construction if digging, trenching or grading operations are to occur within the critical root zone of a rare or 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 root pruning or pavement cutting machine, or by trenching with a ditch-witch and cleanly severing all large roots.



SINGLE FAMILY HOME TREE LOCATION

(2) Clearing and Grubbing:

Trees and brush should be removed only in the areas indicated on the Landscape Protection Plan in such a manner that avoids damage to the limbs, trunks and roots of the remaining vegetation.

If tree protection fencing is damaged during the clearing operation, 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.

(3) Construction Access within the Critical Root Zone of Rare and 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, and areas where this is proposed should be clearly designated on Landscape Protection Plans. Several different types of logging mats area available and can be utilized depending upon the type of equipment that will be utilizing the proposed access way. Developers can contact the Town's Public Works Department for additional information about recommended logging mats.

SECTION - 4

ACCESS

AND

CIRCULATION

SECTION 4 ACCESS AND CIRCULATION

4.1 REQUIRED ACCESS

All development must provide access to publicly maintained vehicular, bicycle, and pedestrian facilities, as defined below:

Vehicular Access - access to a street that is approved by the Town as being in compliance with Town standards and/or is currently maintained by the Town or the State of North Carolina.

Bicycle Access - access to a street or recreation area/space containing a bikeway (bike lanes, bike paths, or bike trail) or abutment on a street for which bikeways are not required. (Such streets are presumed to be adequate for combined vehicular/bicycle traffic.)

Pedestrian Access - access to a street or publicly dedicated recreation area/space containing a pedestrian way (sidewalks or pedestrian trail), or abutment on a street for which sidewalks are not required. (Such streets and/or shoulder areas are presumed to be adequate for pedestrian traffic.)

Nothing in the above definition 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 that will reasonably accommodate routine service vehicles and emergency vehicles.

4.2 GENERAL STANDARDS

4.2.1 Relationship to Town Plans - Streets, including associated bikeways, sidewalks, trails, and transit amenities, shall be arranged, designed, and located in conformance with the Land Use Plan, Thoroughfare Plan, Street Classification Plan, Bikeways Plan, Sidewalk Plan, Entranceways Plan, and Transit Plan.

4.2.2 Relationship to Surrounding Access Ways - Streets, including associated bikeways, sidewalks, trails, and transit amenities, shall be appropriately related to and coordinated with surrounding existing and proposed roadways, bikeways, pedestrian ways and transportation patterns. Roadways, bikeways, and pedestrian ways shall connect where necessary to permit the convenient and safe movement of traffic. While street connections are encouraged, connections to local streets should be designed to minimize their use by through traffic.

To provide convenient access for pedestrians each new development should:

1. Provide walkways with direct access to adjacent developments, neighborhoods, parks, bus stops and street sidewalks or an alternative pedestrian system.

2. Investigate the possibility of using utility easements as connecting trails.

3. Preserve existing trails unless a superior alternative is provided.

4. Install pedestrian signals at major intersections and pedestrian islands on roads wider than four lanes, when warranted.

5. Provide walkways from parking areas to buildings, other than the parking lot itself.

6. Submit written plan clearly identifying the party responsible for ongoing maintenance of pedestrian facilites.

7. Construct walkways along all public streets unless environmental conditions dictate otherwise.

8. All crosswalks should be clearly marked with paint, thermo-plastic or contrasting surface material in compliance with The Manual On Uniform Traffic Control Devices.

9. Provide bicycle access to adjacent greenways.

If the scale of new improvements is small in relation to the amount of surrounding existing improvements, new improvements should be designed to blend with existing improvements wherever possible unless existing improvements are inadequate.

4.2.3 Appropriate Speed - Local streets should be designed to discourage excessive vehicular speeds. Traffic calming techniques are encouraged where warranted by conditions. Such traffic calming measures may include, but are not limited to, curved and/or narrow streets, offsets at intersections, traffic islands, chokers, raised crosswalks, speed humps, traffic circles, chicanes, etc. Standards for traffic calming means and measures are included as a supplement to the Town's adopted Policy for Neighborhood Traffic Management. Additional information can also be found in the Standard Details.

4.2.4 Vertical Alignment - Streets should be designed to provide gradual grade changes and to avoid a "roller-coaster" effect. Where possible streets should be designed to avoid deep cuts and fills.

4.2.5 Horizontal Alignment - Streets should be designed to provide long curves and to avoid sharp curves at the end(s) of straight sections or flat curves. Compound curves and "S" curves are to be avoided.

4.2.6 Barriers - Physical barriers (such as guardrails) should be provided along roadway edges and in medians where warranted due to potential roadway safety hazards such as structures, embankments, ditches, or bodies of water. Guardrail shall be constructed within the right-of-way wherever the Town Manager determines that guardrails are necessary for public safety.

Reflectorized barriers shall be installed at the end of pavement on all streets which are temporarily dead ended or where "T" turnarounds are constructed.

4.2.7 Intersections - Intersections of streets should be designed to minimize the number of potential conflicts among vehicular movements; to give preference to the heaviest and fastest traffic flows; to coordinate the location and alignment of driveways; to discourage dangerous vehicular movements; to avoid multiple and compound merging and diverging maneuvers; and to provide adequate sight distances.

4.2.8 Sight Line Triangles at Intersections - Sight line triangles at intersections should be designed to assure adequate visibility for vehicles and pedestrian using the intersection. Signs, trees, shrubs, etc. should not interfere with these sight lines. The property owner shall dedicate sight line easements as necessary.

4.2.9 Dead-End Streets - Street designed to be permanently dead-end shall terminate in a paved circular turnaround (cul-de-sac) with a minimum radius of forty feet measured from the center of the turnaround to the back 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 vehicles expected to use the street. Under special circumstances, a "T" turnaround may be acceptable as a permanent improvement.

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".

4.3 STRUCTURAL STANDARDS

All streets shall be paved with a minimum of an eight-inch (8") (compacted thickness) crushed rock base and a minimum of a three-inch (3") (compacted thickness) asphaltic concrete surface, or equivalent design as approved by the Town Manager.

Streets to be constructed in areas designated as "Type II" on the map at the end of this section will require a ten-inch (10") (compacted thickness) crushed rock base unless otherwise approved by the Town Manager.

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 that 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 the Town Manager, 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 be such that no significant erosion will 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% gravel and at most 50% soil material.

4.3.1 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 also 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 believes that for certain reasons 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 that occur within the one year warranty period after acceptance of the street by the Town shall be repaired by the developer.

4.4 TRAFFIC CONTROL DEVICES

Where warranted and as necessary for motorist, bicyclist, and/or pedestrian traffic control; 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 Manager and the North Carolina Department of Transportation where applicable.

4.5 EXTENSION AND COMPLETION OF ACCESS WAYS

4.5.1 Extension to Boundaries - Streets, bikeways, and pedestrian ways to be extended onto adjacent property or into subsequent approved phase(s) of a single development shall be constructed to the common property line or phase boundary. Where necessary to facilitate traffic flow or accommodate emergency vehicles, a temporary turnaround may be required at the end of a street pending its extension. Extension beyond the boundaries may be required, where right-of-way exists, to create connectivity.

4.5.2 Improvement of Substandard Access Ways - Where a development impacts, abuts or contains an existing street, bikeway, or pedestrian way that provides required access but does not meet the standards contained herein, improvement of such 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 improvement of the access way off-site. Partial width access ways shall be prohibited and abutting existing partial width access ways shall be completed to applicable standards.

4.6 PUBLIC AND PRIVATE ACCESS WAYS

4.6.1 Public Access Ways - Public access ways are streets, bikeways, and pedestrian ways located within publicly dedicated rights-of-way or easements and accepted for maintenance by the Town of Chapel Hill or the State of North Carolina. Public access ways shall not be accepted for maintenance unless they meet all applicable standards.

4.6.2 Private Access Ways Providing Required Access - Private access ways are streets, bikeways, and pedestrian ways other than the above. 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 County Register of Deeds in a legally valid and binding instrument that describes the properties which the private access way serves and which runs with the land. The maintenance agreement shall apply to all properties which the private access ways serve. It shall contain a provision that at any such time that the private access way is no longer maintained to applicable standards, the Town of Chapel Hill, the 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.

4.7. NAMES, IDENTIFICATION AND ADDRESSES FOR PUBLIC AND PRIVATE STREETS

4.7.1 Street Names - Names of streets shall reflect the continuity of streets (i.e., that a proposed street obviously in alignment with an existing street or planned as a continuation of a existing street be given the same name as the existing street) and shall be neither wholly or partially duplicative nor phonetically similar to the name of an existing street within Chapel Hill Township.

4.7.2 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 as in accord with the standards set forth in the Manual on Uniform Traffic Control Devices for Street and Highways.

4.7.3 Street Addresses - Street addresses are assigned to properties by the Town Manager.

4.8 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.

4.9 GUARDRAILS & BARRIERS

Guardrail shall be constructed within the right-of-way wherever the Town Manager determines that guardrails are necessary. Generally, guardrails will 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.

Reflectorized barriers shall be installed at the end of pavement on all streets or drives which are temporarily dead ended or when a "T" turnaround is installed. The type(s) of barrier(s) required will be determined by the Town Manager.

4.10 TRANSIT AMENITIES

Transit amenities including shelters, benches, walkways, pulloffs, etc. will be required for areas to be served by the transit system.

The appropriate Town party (Council, Planning Board, Manager) will determine which amenities will be required and where they will be located, based upon transit routes, street classifications, types of development, passenger volumes, and any other pertinent considerations on a case-by-case basis. However, bus pull-offs should be provided at bus stops on Collector and Arterial streets with only two travel lanes unless traffic volumes or site conditions indicate that a pull-off is not warranted, as determined by the Town Manager.

4.11 BICYCLE PARKING

(a.) Classification of bicycle parking

(1.) Class I bicycle parking means a locker, individually locked enclosure, or supervised area within a building providing protection for bicycles therein from theft, vandalism and weather.

(2.) Class II is a stationary rack to which a bicycle can be secured with the user supplying both lock and cable or chain. Racks must be easily usable with both U-locks and cable locks. Example is inverted 'U' rack. Racks that support a bicycle primarily by a wheel only and not the frame, such as typical "disk racks," are damaging to wheels and are not acceptable.

The following table provides general guideline:

TABLE 4.1

LAND USE	NUMBER OF SPACES	CLASSIFICATION
Industrial and Office	10% of auto spaces	80% Class I/20% Class II
Commercial/Retail	10% of auto spaces	20% Class I/80% Class II
Multi-Family Residential	1 space per unit, plus 10% of auto spaces	90% Class I (Garages or secure accessible indoor areas count) 10% Class II
Recreation	25% of auto spaces	10% Class I/90% Class II
School	1 space per 3 students, plus 1 space per 10 faculty/staff	90% Class II 10% Class I
Park and Ride Lot/ Transit Center	10% of auto spaces	80% Class I/20% Class II

(b.) Location and design of bicycle parking areas.

(1.) Parking facilities shall support bicycles in a stable position without damage to wheels, frame or other components, and so that a 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 should be located in close proximity to the building's entrance.

(4.) Parking facilities should be located in highly visible well-lighted areas to minimize theft and vandalism.

(5.) Bicycle 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 accommodate a bicycle at least six feet long by two feet wide. Racks must not be placed close enough to a wall or other obstruction so as to make use difficult. There must be at least 24 inches beside each parked bicycle that slows 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 reatment in order 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 should be under cover to protect bicycles from damaging sun and foul weather."

In addition to the above parking requirements, commercial developments should provide shower and locker facilities. (Please refer to SECTION 10, DESIGN MANUAL SUPPLEMENT.)

4.12 STREET CLASSIFICATIONS AND GEOMETRIC STANDARDS

Street classifications and geometric design standards are outlined in Appendix 4-A. Information regarding existing streets and their classifications is available in the Chapel Hill Engineering Department.

All streets within the Town limits are classified primarily by functional and/or operational characteristics, rather than by specific geometric criteria.

The street design standards represent specific interpretations of the general intentions embodied in the Town of Chapel Hill Land Use Management Ordinance and Design Guidelines. Because the terrain of Chapel Hill varies from level to hilly, the standards have been written as broadly as possible. The notion of limiting cut and fill within the limits of public safety has been important in developing these standards.

The conscientious designer may occasionally find that street design in specific areas could be better accomplished in a manner which does not coincide with every standard in Appendix 4A at the end of this section. In such cases, the Town Manager will consider justification that strict adherence to all standards would create significantly undesirable conditions and/or that deviation from the standards would produce a significantly better improvement. Similarly, the Town Manager may not allow the use of a standard if public safety considerations dictate otherwise under specific conditions.

The standards in Appendix 4A are presumptive. They are intended to be valid in most cases, but it is understood that the public good may be better served in certain unique situations by allowing some flexibility in the standards. New streets should be designed in a manner that balances functional and safety needs with the objective of preserving as much of the existing terrain and vegetation as is practicable.

4.13 BICYCLE PATHS

A bicycle path is a bikeway 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. Bicycle paths provide recreational opportunities and serve as extensions of the transportation system. The designer must use accepted design criteria to provide a safe bicycle facility.

Width and Clearance – The minimum paved width for all two directional bicycle paths is ten (10') feet. In some cases it may be necessary to increase the width of the path due to a significant number of pedestrians using the path; or when the path is designed with a horizontal radius less than 95 feet. For horizontal clearance purposes, a minimum of three foot wide graded shoulder must be provided on both sides of the pavement. The minimum vertical clearance should be eight feet. However, a greater clearance may be needed for tunnels.

Grades – Grades greater than 5% are undesirable. If, due to the terrain or other considerations, the installation of a 5% or flatter grade is shown to be impractical, then a steeper grade may be used for short distances if approved by the Town Manager.

Design Speed – The typical design speed for a bicycle path is 20 mph. When the grade exceeds 4%, a design speed of 30 mph is advisable.

Horizontal Alignment – The typical cross slope is 2% 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

Pavement Design – A hard, all-weather pavement 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.

4.14 BICYCLE LANE

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

Width and Clearance – The minimum width for a designated bicycle lane is four feet. 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.

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.

4.15 WORK ZONE TRAFFIC CONTROL

The developer is responsible for notifying the Engineering Department, Emergency Medical Services, Police and Fire Departments, and residents of the area prior to implementation of work zone traffic control. 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 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.

4.16 DISABILITY ACCESS

All public pedestrian facilities shall, to the extent practicable, be continuous and accessible to physically disabled users. Such facilities should be designed to reasonably accommodate users with physical disabilities that require the use of walkers, wheelchairs, scooters, or other such supplemental mobility devices. Pedestrian facilities shall be designed such that they do not include slopes in excess of 1:12 unless flat rest areas are included between steeper segments.

Intersections between motorized vehicle ways and pedestrian ways shall be at grade or connected by means of a ramp with a slope no steeper than 1:12. Ramps and segments of pedestrian ways at intersections shall include detectable warnings in accordance with the requirements of the Americans with Disabilities Act.

See Section 5 of this manual for information on Parking Requirements.

4.17 SOILS REPORT

The developer may be required to submit a detailed soils report prepared by a soils testing company 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 that normal compaction tests would sufficiently guarantee road base suitability.

In the event that the soil report and/or site investigation indicates roadway construction requirements different from the standards described herein, the Town Manager may require that alternative roadway construction design(s) be submitted for approval by the Chapel Hill Engineering Department.

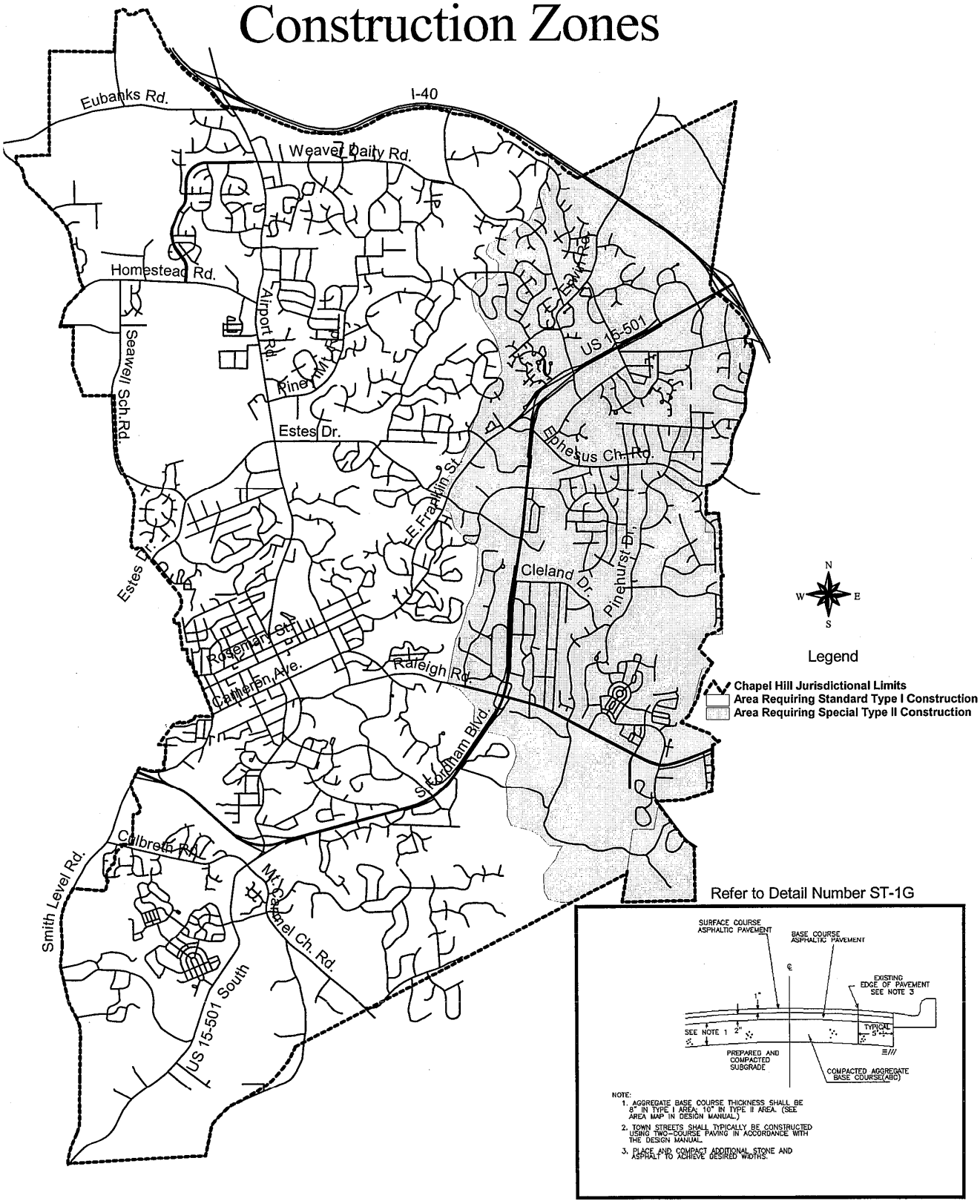
4.18 GROUNDCOVER WITHIN RIGHTS-OF-WAY

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, that 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. Tall Fescue Kentucky 31 is acceptable, with 99% minimum purity and 85% minimum germination. Application rate shall be 225 pounds of fescue grass seed per acre unless site conditions dictate a different rate.

All groundcover shall be maintained in accordance with Town 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 improvement bond has been released.

Typical Street Construction Zones



Refer to Detail Number ST-1G

STREET CLASSIFICATIONS AND STANDARDS

STREET CLASSIFICATIONS

Streets in Chapel Hill are classified by their functional relationship to through-traffic service and land-access service. The three street classifications are:

1. Arterial - Arterial streets function primarily to serve through-traffic movement. Limited land-access service may be accommodated, but traffic controls and street design are intended to provide efficient through-traffic movement.

2. Collector - Collector streets penetrate neighborhoods, public service areas, and districts. They are intended to provide both through-traffic and land-access services in relatively equal proportions, often linking the local street system to the arterial street system.

3. Local - Local streets primarily serve land-access functions. They are intended to accommodate land parcel ingress and egress. Through-traffic movement is difficult and discouraged by traffic controls and street design.

The relationship between functional street classifications is a continuous one, without specific clear-cut boundaries. Streets are classified by the Town Traffic Engineer based on technical judgment and observed function of the street. A list of existing Arterial and Collector Streets is available from the Town Engineering Department. The list will be updated as new Collector and Arterial Streets are approved by the Town.

The construction of new private streets to serve new development is not allowed. By definition herein, a private street is a means of vehicular ingress or egress that is not publicly maintained and serves more than two single family lots.

TABLE 4-A-1
STREET STANDARDS

	Arterial	Collector	Local
Design Volume (ADT)	7,500-40,000	1,000-7,500	<1,000
Design Speed	35 - 45 mph	25-35 mph	25 mph
Overall Length	Unlimited	≤ 2 miles typical	≤ 1 mile typical
Number of Travel Lanes[1]	4 typical	2 typical	2 typical
Turn Lanes	Right/Left at intersections and major driveways. (11' Width, Min.)	As warranted by turning traffic volume and/or safety criteria. (10' Width, Min.)	As warranted by turning traffic volume and/or safety criteria. (10' width, min.)
Bike Lanes[2]	May be required on a site specific basis in accordance with Town policy.	May be required on a site specific basis in accordance with Town policy.	May be required on a site specific basis in accordance with Town policy.
Transit Provisions[5]	Bus turnout and shelter, where warranted for separation from through traffic and volume of loading passengers.	Bus shelter where warranted for volume of loading passengers.	Bus shelter where warranted for volume of loading passengers.
Sidewalks	Both sides of street (typically). (5' width, min.)	Both sides of street (typically). (5' width, min.)	One side of street. (Additional pedestrian facilities may be required on a site-specific basis.)
On-street Parking	Not permitted (typically)	One side (typically). Controlled adjacent to street and driveway intersections.	One side (typically). Controlled adjacent to street and driveway intersections.
Intersection Spacing[3]	1000' minimum.	400' minimum.	200' minimum.
Driveway Spacing[4]	750' min. between driveways. 250' minimum between driveway and street intersections.	100' minimum between driveways and between driveway and street intersections.	50' minimum between driveways and between driveway and street intersections.
Access Control	Residential and non-residential: No access if alternative is possible to street of lower classification. (Maximum 2 driveways per lot.)	Residential and non-residential: No access if alternative is possible to street of lower classification. (Maximum 2 driveways per lot.	Residential: Permitted. Non-residential: No access if alternative is possible to street of higher classification.

Notes:

1. The number of travel lanes necessary for each street classification may vary depending on traffic volumes.

2. Off-street bicycle facilities may be provided in lieu of on-street bike lanes if approved by the Town Manager. Extra width paving in the outer travel lanes may be considered to function as an unstriped bike lane. Combination sidewalk-bike paths may be considered.

3. Intersection spacing is measured along centerline of street between the centerlines of intersecting streets.

4. Driveway spacing is measured between closest edges of driveway connections and intersecting roadways. Additional spacing may be required by Town Manager under special conditions.

5. Refer to the Standard Details for further information regarding bus turnouts and shelters.

Sidewalks may be omitted on one side of new streets where that side clearly cannot be developed and where there are no existing or anticipated uses that would generate pedestrian trips.

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.

For rural roads likely to serve development, a shoulder of at least 4 feet in width, preferably 8 feet on primary highways, should be provided. Surface material should provide a stable, walking surface.

TABLE 4-A-2
GEOMETRIC DESIGN STANDARDS FOR STREETS AND INTERSECTIONS

	Arterial			Collector			Local		
	Level	Roll	Hilly	Level	Roll	Hilly	Level	Roll	Hilly
Terrain Type (% Grade)	<8	8-15	>15	<8	8-15	>15	<8	8-15	>15
Vertical Curve "K" Value[1] (Crest/Sag)	55/ 55	45/ 45	40/ 40	40/ 45	28/ 35	20/ 20	28/ 35	20/ 20	15/ 20
Street Grade (%) (Max./Min.)	4/1	6/1	8/1	4/1	8/1	12/1	5/1	10/1	15/1
Min. Horizontal Street Center-line Radius (ft) *Super-elevated	500 *NA	425 *NA	350 *NA	300 *400	250 *350	200 *300	200 *250	150 *175	100 *100
Typical Shoulder Width for Streets Without Curb and Gutter or Sidewalk (ft.)	12	10	8	10	8	6	8	6	4
Minimum Street Corner Radius at Intersections (ft.)	40	40	30	30	30	30	20	20	20
Minimum Street and Right-of-Way Widths[2]	(See Typical Section Detail Drawings)			(See Typical Section Detail Drawings)			(See Typical Section Detail Drawings)		

TABLE 4-A-2 REFERENCE NOTES:

1. 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 (%).

2. 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, etc. See typical street cross-section drawings for more details.

3. All streets with centerline or one-way crowns should be designed with a 2% cross slope. This does not apply to superelevation designs on curves.

4. Intersecting streets should be designed to create 90° intersection angles. The minimum allowable angle of intersection is 75° under special conditions.

5. Intersection sight distance criteria and other related information are shown in the standard details.

6. Unless specified herein the American Association of State Highway and Transportation Officials (AASHTO) guidelines and standards will apply where appropriate.

SECTION - 5

PARKING AND LOADING

SECTION 5 PARKING AND LOADING

5.1 OFF-STREET PARKING

The designer must design off-street parking facilities to provide safe, convenient ingress and egress for vehicular traffic and to minimize conflict with pedestrian movements. Access points should be located to provide the optimum driver sight distance and least disruption to traffic on the public street system. Driveway spacing requirements are provided in the Appendix 4-A in the Access and Circulation Section of this Manual.

When angle parking abuts a sidewalk it will be necessary for the designer to provide additional clearance between the sidewalk and the parking space to ensure vehicle overhangs would not decease the useable area of the sidewalk to adversely affect the pedestrian and handicap accessible routes.

(See Section 4.11 for bicycle parking requirements)

5.1.1 Geometric Design

A lot layout schedule is provided in the Town of Chapel Hill Standard Details. The lot layout schedule specifies the minimum standard dimensions for parking spaces and drive aisles. All parking spaces should be identified with pavement markings and/or wheel stops. Because of the difficulty of controlling the use of parking spaces, the designer is encouraged to use standard or larger size spaces. If site conditions dictate the necessity of compact spaces, the percentage of compact spaces shall not exceed 20% of the total number of spaces.

Typically, no more than 10 parking spaces should be arranged side by side without the provision of a landscaped island. The island shall be of sufficient shape and width to provide for landscaping. The minimum width for a landscaped parking lot island is 10 feet of pervious soil.

5.1.2 Pavement Standards

The minimum standard pavement design for parking lot drive aisles shall be 8 inches of stone base with a 2 inch asphalt surface course. A heavy-duty pavement section will be required in locations determined to be necessary for service vehicle access. The minimum heavy-duty section shall be 10 inches of stone base and 3 inches of asphalt surface course. An alternative design may be required if geotechnical information or projected traffic patterns dictate a different design. The pavement design for parking space areas must 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 as wheel stops to prevent vehicle overhang into landscaped areas or walkways. Wheel stops are required when other means for identifying parking spaces are not practical.

5.1.3 Parking Decks

The use of structured parking facilities is encouraged to minimize the amount of land necessary to accommodate cars. Generally, the geometric requirements for parking decks are the same as for surface parking. However, the designer may provide an alternative design based on accepted practices and subject to the approval of the Town Manager.

5.1.4 Accessible Parking Spaces for the Handicapped

Parking spaces and access aisles for the handicapped shall be on hard or paved surfaces and shall be indicated by pavement markings or other suitable 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.

Standard handicapped accessible parking spaces shall have a 96 inch minimum width and an access aisle adjacent to the space with a minimum width of 60 inches. Van accessible parking spaces shall have a 96 inch minimum width and an access aisle 96 inches wide.

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 percent (2%) of total
1,001 and over	20 plus 1 for each 100 over 1,000

Source: North Carolina Building Code

5.2 ON-STREET PARKING

The designer must design on-street parking to provide safe and orderly traffic flow on the street. The primary use of the street is the movement of vehicles. On-street parking is considered a secondary use of street space, as are other uses, such as truck loading zones

Parking prohibitions can be warranted on the basis of statues, traffic capacity, or accident hazard. Statutory prohibitions also apply to on-street parking spaces near fire hydrants, crosswalks, and approaches to intersections.

Parallel and/or angle parking is allowed on Town streets. However, 90-degree (perpendicular) on-street parking is not permitted. Time restrictions may be posted for on-street parking by means of signs or parking meters to regulate the use of parking spaces.

Dimensioning of on-street parking spaces shall take into account driver sight distance, pedestrian patterns and maneuvering area for vehicles. For more information please contact the Town of Chapel Hill Engineering Department.

5.3 LOADING SPACE REQUIREMENT

Off-street loading spaces shall be designed so that a semi-trailer truck (WB 40 design) can use the space by means of one continuous parking maneuver. The off-street loading space shall have a minimum width of 12 feet, a minimum length of 55 feet, and a vertical clearance of 14 feet above the finished grade.

SECTION - 6

STREET LIGHTS

SIGNS AND MARKINGS

SECTION 6 STREET LIGHTS, SIGNS AND MARKINGS

6.1 STREET LIGHTING APPLICABILITY

A developer may be required to install or upgrade street lights within a public right-of-way as part of the Town's design approval process. The two situations in which these street lighting improvements are typically required are:

6.1.1 - When new public streets are proposed or existing public streets are improved.

6.1.2 - When significant development is proposed adjacent to a public street within the Downtown Streetscape Study Area where a Street Lighting Master Plan has been adopted that calls for the incremental replacement of existing light poles and fixtures.

Less commonly, where development is proposed adjacent to inadequately lighted public streets, incremental street lighting improvements may also be required. If there are questions about a specific site the developer can contact the Town's Public Works Department.

6.2 STREET LIGHTING PLAN SUBMITTAL REQUIREMENTS

Developers should consult with the appropriate utility provider in the development of proposed street lighting plans. Typically a street lighting plan will include the following information:

6.2.1 - The proposed location of street lights and the underground utility lines and or conduits that will be installed to service them. If work is proposed within the Downtown Streetscape Study Area, the developer should utilize the standard downtown conduit detail included in the Town's Standard Details.

6.2.2 - The location of street edge of pavement and/or curb and gutter, sidewalks and all property lines in the area where street lighting is proposed. If other improvements, such as benches or bus stops, are proposed within the public right-of-way, these should also be shown on the plan.

6.2.3 - A description and/or detail of the proposed light pole and fixture.

Most commonly selected street light poles and fixtures require that a supplemental fee be paid to the utility provider prior to installation. Where these poles and fixtures are placed within the public right-of-way, utility providers require that this supplemental fee be paid through the Town as a one-time up front cost. Accordingly, the following note is required to 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.

For information about the relative supplemental fees assessed for different types of street light poles and fixtures, developers should contact the utility provider directly.

6.3 STREET LIGHTING GUIDELINES

The type of street light pole and fixture selected and the recommended placement of the poles and fixtures will depend on a number of site specific variables. In the Downtown Streetscape Study Area several different custom poles and fixtures that provide pedestrian level lighting as well as street lighting are recommended. Developers can contact the Public Works Department for information about the specific lighting requirements included in the Street Lighting Master Plan for this area.

In other areas within the Town, street lighting design is based on street classification and on the uses of adjacent properties. Because these factors vary from site to site, developers should 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.

6.4. STREET LIGHT POLE AND FIXTURE STANDARDS FOR RESIDENTIAL STREETS

The Town's standard residential lighting fixture is a 9,500 lumen high pressure sodium "economical traditional" luminaire mounted on a 12' black fiberglass. This pole and fixture combination is available from Duke Power Company and requires that a supplemental fee reimbursement be provided to the Town prior to installation. Comparable pole and fixture combinations are available from other utility providers in areas of Town not served by Duke Power Company.

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 as long as the developer is responsible for reimbursement of all associated supplemental fees. Developers should contact the Public Works Department if an alternative to the Town standard pole and fixture combination is proposed.

6.5 STREET LIGHT PLACEMENT STANDARDS FOR RESIDENTIAL STREETS

The following standards should be used to determine the placement of street lights on residential streets:

6.5.1 - Street lights should be located approximately 220 feet apart.

6.5.2 - Street lights should be located at all public street intersections and at the end of all cul-de-sacs and T-turnarounds.

6.5.3 - Where possible, all street lights that are not located at an intersection should be located on or adjacent to a property corner

6.5.4 - Street lights should be located within the public right-of-way a minimum of 3' behind the curb or edge of pavement

6.5.5 - On streets with sidewalks on only one side, street lights should be located on the same side of the street as the sidewalk. On all other streets, street lights should be staggered on both sides of the street.

6.5.6 - On streets where street lights are proposed adjacent to sidewalks they should be located behind the sidewalk unless a tree lawn is provided that permits all parts of the poles to be located a minimum of 3' behind the curb.

6.6 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.

6.7 STREET SIGNS AND MARKINGS PLAN SUBMITTAL REQIREMENTS

A street signs and markings plan should 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.). This plan should also include the following Town standard notes, where applicable:

6.7.1 - Prior to the installation of any street signs or markings, the developer will contact the Town's Public Works Department for an on-site approval of the final design and placement.

6.7.2 - All pavement markings within the public right-of-way will be installed using a thermoplastic material with a minimum thickness of 125 mils.

6.7.3 - The developer will be responsible for installation of all required street signs and markings and for any repairs to these signs and markings that are necessary prior to the final acceptance of a new or improved public street for Town maintenance.

6.8 STREET SIGNS AND MARKINGS STANDARDS

Where warranted by the need to ensure motorist, bicyclist or pedestrian safety and/or to control vehicular, bicycle and pedestrian traffic; traffic signs and markings should 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 should reflect the standards for sign and marking design and placement as set forth in this manual and should be approved by the Town Manager and, where applicable, NCDOT during the Town's design review process.

Developers can contact the Town's Public Works Department for additional information about the specific design and size requirements for required street signs. Signs that do not meet these design and size requirements will require replacement with approved signs prior to the acceptance of any new or improved public street for Town maintenance.

All pavement markings within the public right-of-way should be installed using a thermoplastic material with a minimum thickness of 125 mils. Pavement markings that do not meet this standard will require replacement with approved markings prior to the acceptance of any new or improved public street for Town maintenance.

SECTION - 7

UTILITIES AND EASEMENTS

SECTION 7 UTILITIES AND EASEMENTS

7.1 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. Not withstanding, sufficient preparation shall be provided as possible to minimize digging that would result in customer service interruption and to minimize adverse operating environments for other utilities.

7.2 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, 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 subsurfaces, base courses and paving. 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 desirable horizontal separation between water, sanitary sewer and stormwater drainage pipes installed in a common easement is ten feet.

Prior to a Certificate of Occupancy as-built 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 as-built drawing shall call out the type of utility, size, and materials used for the installation.

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

7.3 SURFACE APPURTENANCES

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

7.4 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 conduct the sewage in sewers of adequate capacity to an approved treatment facility. For

development outside of the Urban Services Boundary, approval of the lot by the County Health Department shall be required.

7.4.1 - 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.

7.4.2 - 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

7.5 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.

7.5.1 - 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.

7.5.2 - 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.

Materials that are used by OWASA for piping are ductile and C-900 PVC. If a developer deviates from this type of pipe it must be approved by the Town Manager after consultation with OWASA.

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:

Single Family = 750 - 1000 gpm;
Multifamily = 1500 - 2500 gpm;
Commercial = 2500 - 12,000 gpm;

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.

7.5.3 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. They 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 plan and parcels are within five hundred feet (as a fire hose would normally be deployed) of a hydrant and, if applicable, on the same side of an arterial street as the site. 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.

7.5.4 Location of Valves - All intersections of lines shall be adequately valved as determined by the Town Manager in consultation with OWASA.

7.6 AUTOMATIC SPRINKLER SYSTEMS

7.6.1 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.

(a) In new non-residential structures if:

(1) the building has more than 6,000 square feet of floor area, or

(2) 20% 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

(3) the building exceeds two stories or 24 feet in height from the height from the average grade of the lot to the windows on the topmost occupied floor.

In addition, all 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 a supervisory 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.

7.6.2 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:

(a) In all new multi-family residential structures of three or more attached housing units if:

(1) the building has more than 6,000 square feet of floor area, or

(2) 20% 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

(3) the building exceeds two stories or 24 feet in height from the average grade of the lot to the windows on the topmost occupied floor.

In addition, all 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 a supervisory 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.

7.6.3 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 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 a supervisory alarm at a twenty-four (24) hour certified and licensed alarm monitoring service.

7.7 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.

SECTION - 8

SOLID WASTE

MANAGEMENT

SECTION 8 SOLID WASTE MANAGEMENT

8.1 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 68 gallon roll-out containers available from the Town's Public Works Department. Alternatively, standard commercially available metal or plastic containers can be used if they have tight fitting lids and do not exceed 32 gallons in size. A maximum of two containers will be collected from each residential unit and must be placed at the curb on collection days. Residents who cannot bring their containers to the curb for health or age reasons can contact the Public Works Department and apply for an exemption, allowing them to receive side or rear yard collection services.

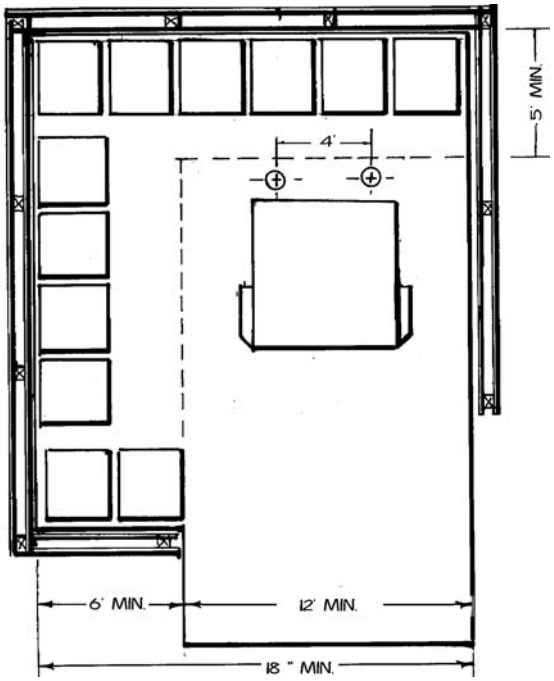
In newly proposed residential developments all streets are required to be built to Town standards to assure that refuse collection vehicles will have adequate access. Developers should refer to the Town of Chapel Hill Engineering Department's Standard Details for vertical and horizontal curves, pavement sections, street widths and the dimensions of cul-de-sacs and T-turnarounds for this information.

8.1.1 Residential Refuse Collection Note:

Certain refuse (yard waste, 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 waste, leaf and white good collection schedules.

8.2 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 that may individually have less than six (6) units but which 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 that 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.

On large multi-family/commercial/institutional developments the use of roll-off compactors may be preferable to the use of multiple refuse dumpsters. Developers can contact the Public Works Department for additional information about roll-off compactor capacity, collection, and site design issues.

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 barrel-type containers from 5-55 gallons in size.

8.2.1 Recyclable Corrugated Cardboard Note:

Since November 1, 1995, Town of Chapel Hill ordinance and Orange Regional Landfill policy prohibit the disposal of recyclable corrugated cardboard from any business, institution, multi-family 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 drop-off sites for corrugated cardboard recycling, depending on quantity produced. Non-recyclable corrugated cardboard, such as that which has been contaminated with food, grease, oil, paint, or wax, and/or non-corrugated cardboard, like that used to construct single-layer cereal box-type

8.2.2 Dumpster Pad Design

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 (see diagram 1). For two dumpsters the pad should be 22’ wide and 20’ deep (see diagram 2). The pad apron should be a minimum of 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 (see diagram 3).

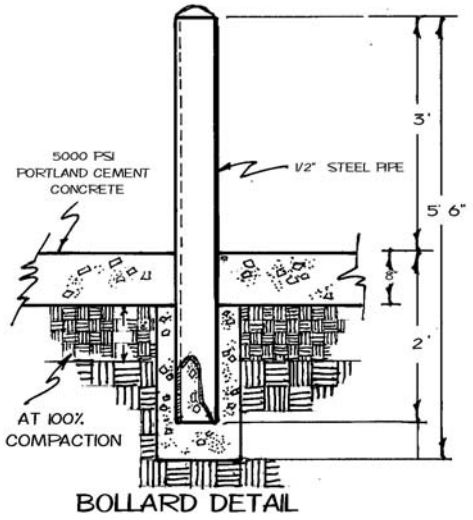


Diagram 3.

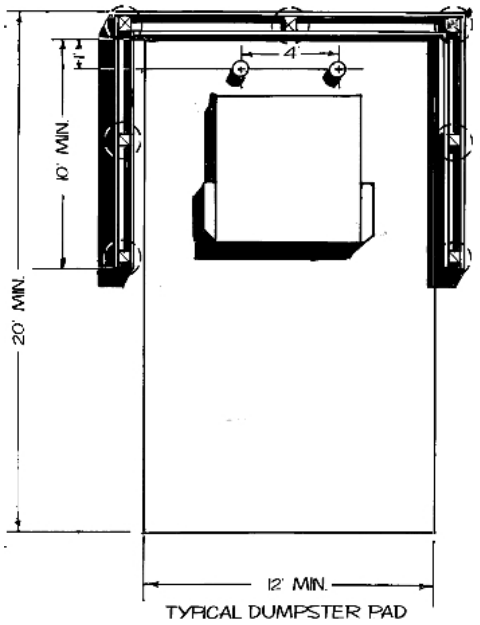


Figure 8-1

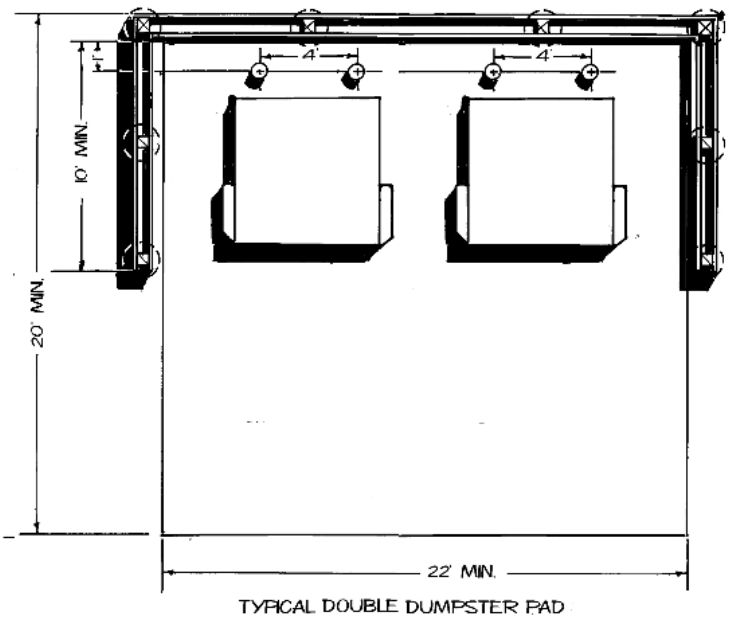


Figure 8-2

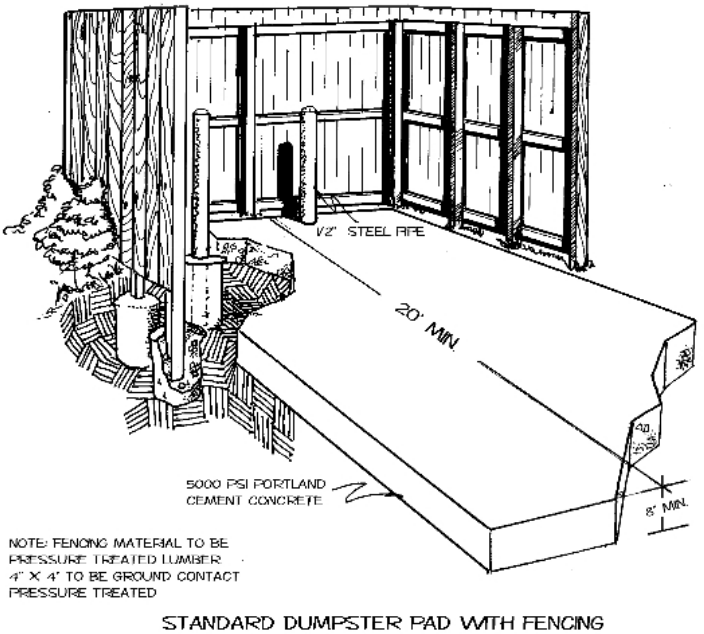


Figure 8-5

8.2.3 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.

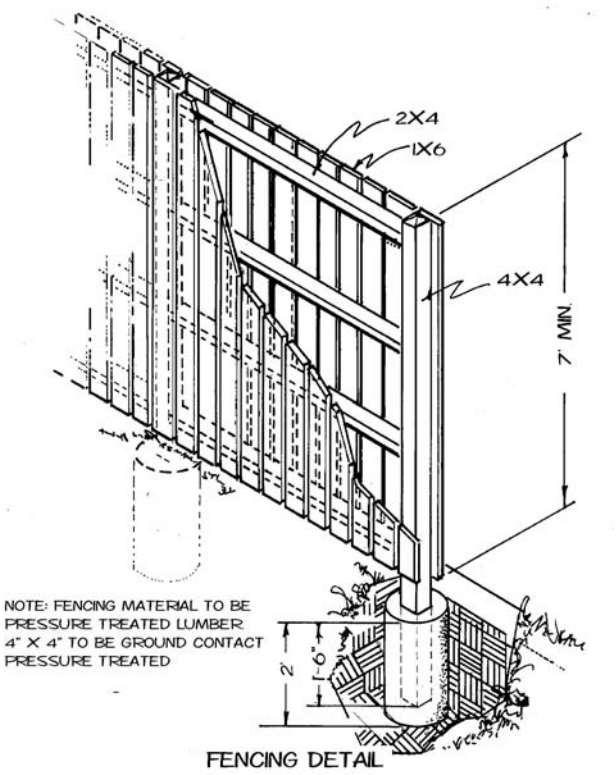


Figure 8-4

Screening can consist of stone, block, brick, wood or a combination of these materials. The screen should be designed and landscaped so that 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 dumpser may be acceptable if they are planted at a size that 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.

8.2.4 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 (see diagram 5).

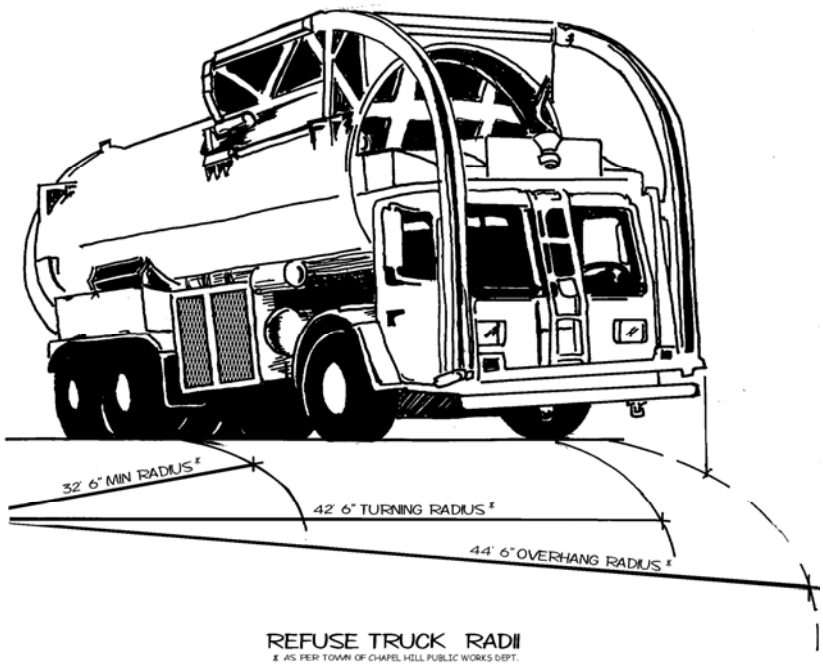
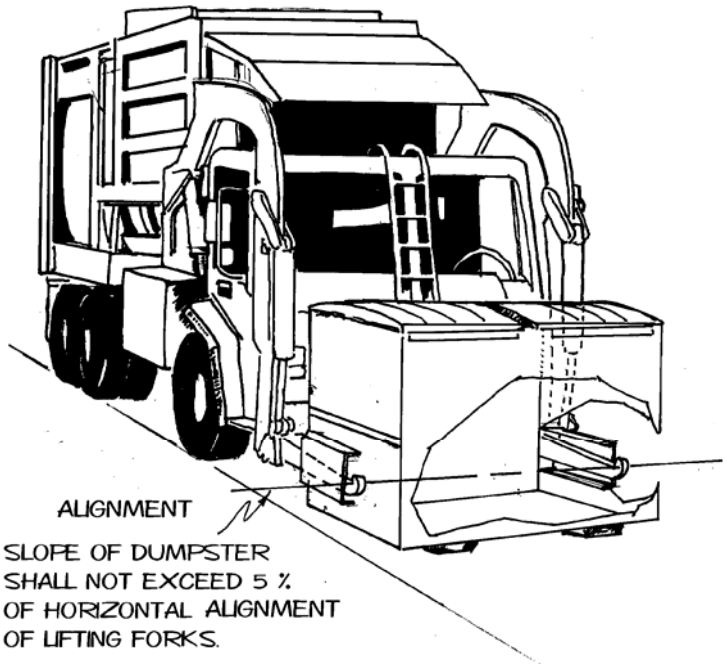


Figure 8-6

Where refuse collection vehicles will need to turn around to exit a development site, the site plan should be designed so that backing movements do not exceed 100' in length. In these cases the turn around area should be dimensioned using a turning radii template of the appropriate scale. In all cases, the proposed site plan should be designed so that refuse collection vehicles do not need to back onto or off of any public street or over any public sidewalk.

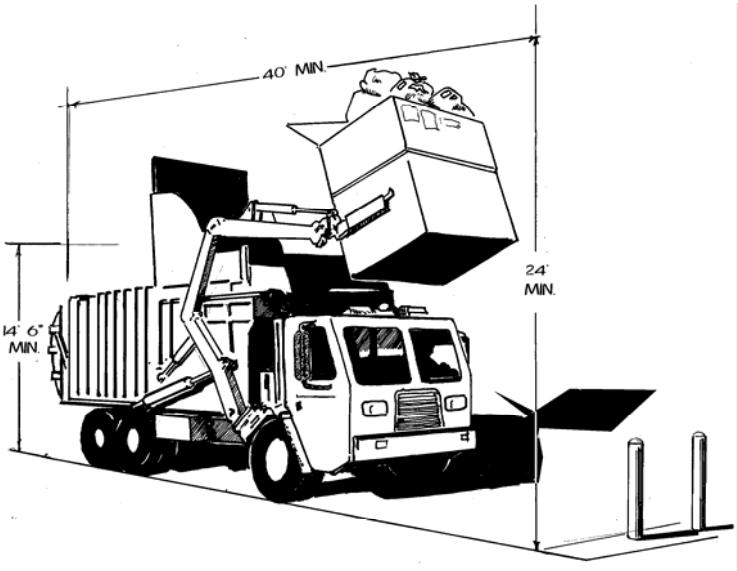


Where dumpsters are proposed to be placed at an angle to the centerline of the driveway or drive aisle this angle should not exceed 30 degrees. On sloped sites, the vehicle approach to the dumpster should be at the same slope as the dumpster pad and should not exceed 5% (see figure 8-7).

In newly proposed multi-family, commercial and institutional development 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 inches stone base and 3 inches of asphalt surface course. Developers should refer to the Town of Chapel Hill Engineering Department's Standard Details for driveway cut specifications, vertical curve requirements and pavement sections.

8.2.5 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 that requires the refuse collection vehicle to drive under wires, the development plans should indicate that 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



REFUSE TRUCK OVERHEAD CLEARANCE

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 required for refuse collection vehicle directly above the container.

Multi-family/Commercial/Institutional Refuse Collection Note: Certain refuse (yard waste, 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.

8.3 RESIDENTIAL RECYCLING

Residential recyclables collection is provided by the Orange County Solid Waste Department for occupants of dwellings with five (5) units or less.

8.3.1 Residential Recycling Note:

Contact the Orange County Solid Waste Department for a current list of approved materials, for information on collection schedules, and to obtain an approved recycling container.

8.4 MULTI-FAMILY RECYCLING

Multi-family development includes all sites zoned for multi-family use with apartment buildings, townhomes or condominiums with six (6) or more units. This includes complexes or groups of buildings which are located on a single zoning lot or have shared driveways or common parking areas. The Orange County Solid Waste Department provides recyclables collection at all sites that meet the County's standards for service area design and access.

8.4.1 Service Area Design

For developments of six (6) or more units, a combination refuse dumpster and recyclables rollcart area is recommended (see diagrams 9 and 10). Note the pad dimensions needed to provide rollcart storage and access around the dumpster(s) in these sample layouts. Recycling rollcart sites are typically grouped in multiples of 7-9 rollcarts, arranged in any configuration allowing access to the front of each cart and providing one site per increment of 50-100 dwelling units, depending on occupancy.

8.4.2 Service Area Access

In order to provide recyclables collection all service areas must be accessible to recyclables collection vehicles. These vehicles are comparable in size to refuse dumpster collection vehicles and the access standards described in the multi-family/commercial/institutional refuse collection section of this manual for driveway and drive aisle design also apply here.

Figure 8-7

In addition to providing accessible service areas, the developer of any new multi-family development should contact the Orange County Solid Waste Department to complete a Solid Waste Management Plan addressing construction waste management, the use of materials with recycled content during construction, and space planning for storage and collection of refuse and recyclables.

8.5.1 COMMERCIAL/INSTITUTIONAL RECYCLING

Commercial/institutional development includes all sites zoned for commercial or institutional use that are not used for residential development. A Solid Waste Management Plan is required to be submitted to and approved by the Orange County Solid Waste Department to determine what types of recyclable materials will be generated by all newly proposed commercial or institutional development.

In order to receive glass and metal container recycling collection service the owner or occupant of any food/beverage service business is required to provide space for County standard roll-carts compatible with semi-automated collection vehicles. For some small food/beverage service businesses, typically less than 1,000 square feet of serving floor area, roll -carts for glass and metal container recycling may not be required dependent upon the collection needs as determined by a Solid Waste Management Plan.

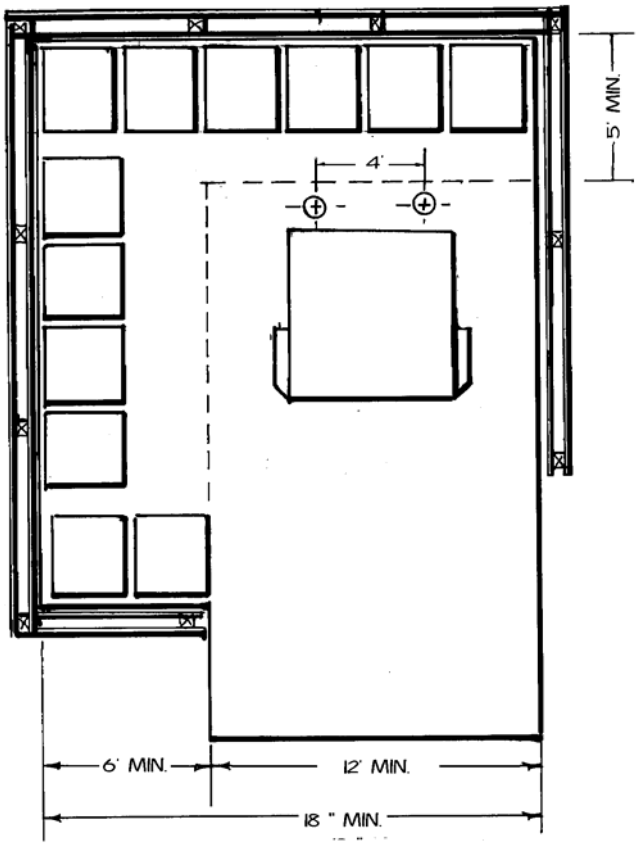


Figure 8-9

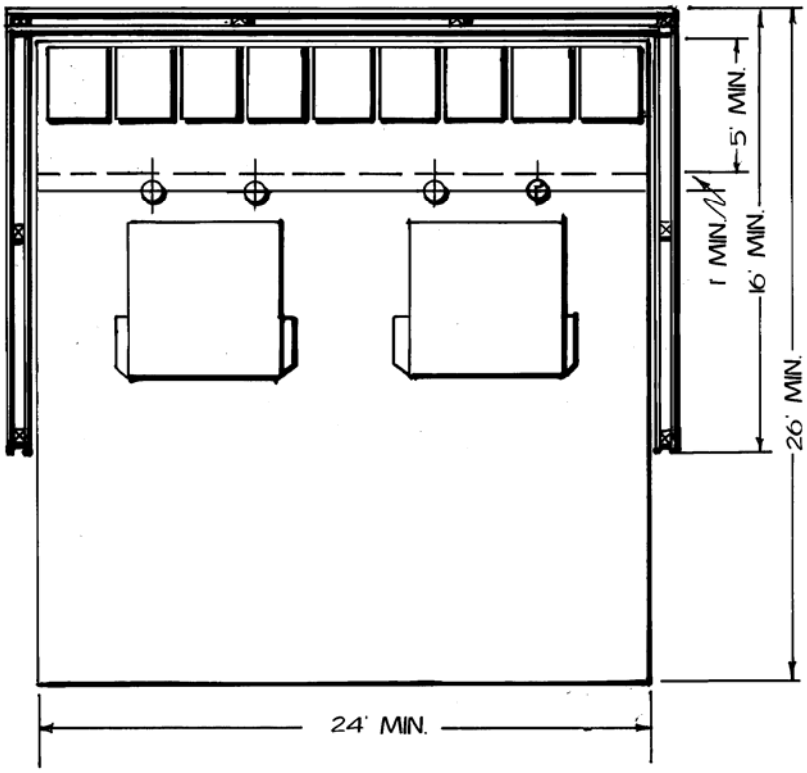
8.5.2 Service Area Design

Design requirements for dumpster pads for cardboard-only dumpsters are identical to the requirements for refuse dumpsters. For food/beverage service businesses utilizing roll-carts for glass and metal container recycling a combination refuse dumpster and roll-cart area is recommended (see previous diagrams 8 and 9).

(a) Service Area Access

In order to provide recyclables collection all service areas must be accessible to recyclables collection vehicles. These vehicles are comparable in size to refuse dumpster collection vehicles and the access standards described in the multi-family/commercial/institutional refuse collection section of this manual for driveway and drive aisle design also apply here.

In addition to providing accessible service areas, the developer of any new commercial/institutional development should contact the County's Solid Waste Department to complete a Solid Waste Management Plan addressing construction waste management and the use of materials with recycled content during construction, and space planning for storage and collection of refuse and recyclables. This plan will also need to address the storage and management of all regulated and potentially regulated wastes.



TYPICAL DOUBLE WITH ROLLOUT CARTS

Figure 8-10

* Note: Pad width is 2' wider than standard double dumpster pad to allow rollcart access.

SECTION - 9

APPEALS

SECTION 9 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 accord with the provisions of Article 4.10 of the Land Use Management Ordinance.

SECTION - 10

DESIGN MANUAL

SUPPLEMENT

DESIGN MANUAL SUPPLEMENT

A RESOLUTION AMENDING THE TOWN'S DESIGN MANUAL AS RECOMMENDED BY THE BICYCLE AND PEDESTRIAN ADVISORY BOARD (2000-10-11/ R-7b)

WHEREAS, the Chapel Hill Bicycle and Pedestrian Advisory Board has recommended a set of standards for new development that address bicycle and pedestrian access, numbers of bicycle parking spaces that should be required, type of bicycle parking spaces that should be provided, and standards for location and design of bicycle parking areas; and

WHEREAS, the Chapel Hill Town Council has considered this recommendation, and concludes that it would be desirable to have additional sections on bicycle and pedestrian issues added to the Town's Design Manual;

NOW, THEREFORE, BE IT RESOLVED that the Council directs the Town Manager to revise the Town's Design Manual to include all recommendations of the Bicycle and Pedestrian Advisory Board, as contained in Attachments A and B of a memorandum to the Town Council from the Board dated June 26, 2000.

This the 11th day of October, 2000.

The following are the recommendations of the Town Bicycle and Pedestrian Advisory Board referred to in the above resolution:

"In order to provide pleasant and convenient access for pedestrians, each new development should:

1. Provide walkways with direct access to adjacent developments, neighborhoods, parks, bus stops and street sidewalks or an alternative pedestrian system.
2. Investigate the possibility of using utility easements as connecting trails.
3. Not destroy or hinder pre-existing trails unless a superior alternative is provided.
4. Provide pedestrian signals at major intersections and pedestrian islands on roads wider than four lanes.
5. Provide walkways from parking areas to buildings, other than the parking lot itself.
6. Provide a written plan clearly identifying the party responsible for ongoing maintenance of pedestrian facilities.
7. Provide walkways along all public streets unless environmental conditions dictate otherwise. All crosswalks should be clearly marked with paint or contrasting surface material.

Each new develop should:

1. Provide access to adjacent greenways.
2. Provide bicycle parking spaces in the amount of 10% of the automobile parking spaces that are provided.
3. Provide shower and locker facilities, if a commercial development.

Bicycle parking areas should be located and designed as follows:

1. Parking facilities shall support bicycles in a stable position without damage to wheels, frame or other components, and so that a 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 should be located in close proximity to the building's entrance.
4. Parking facilities should be located in highly visible well-lighted areas to minimize theft and vandalism.
5. Bicycle 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 accommodate a bicycle at least six feet long by two feet wide. Racks must not be placed close enough to a wall or other obstruction so as to make use difficult. There must be at least 24 inches beside each parked bicycle that slows 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 in order to avoid mud and dust.
8. Bicycle parking facilities within auto parking areas shall be separated by a physical barrier such as curbs, wheel spots, poles or other similar features to protect bicycles from damage by cars.
9. Ideally, bicycle parking should be under cover to protect bicycles from damaging sun and foul weather."

NOTES

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