Chapter 1

INTRODUCTION

Table of Contents

1.1 INTRODUCTION 2

1.2 LIMITATIONS 2

1.3 STORMWATER REGULATIONS 2

1.4 CHAPTER SUMMARY 3

1.5 SITE PLANNING FOR STORMWATER MANAGEMENT 4

1.5.1 INTRODUCTION TO SITE PLANNING 4

1.5.2 IDENTIFY GOALS FOR THE SITE 4

1.5.2.1 Regulatory Compliance Goals 4

1.5.2.2 Functional Goals 4

1.5.3 CONDUCT A SITE INVENTORY AND ANALYSIS 5

1.5.4 IDENTIFY AND PROTECT NATURAL FEATURES AND HYDROLOGIC FUNCTIONS 5

1.5.5 CONCEPTUAL SITE PLAN 6

1.5.6 FINAL CONCEPTUAL SITE PLAN 7

1.6 CHECKLISTS 9

1.7 DEFINITIONS 9

1.1 INTRODUCTION

This manual has been developed to assist in the design and evaluation of stormwater infrastructure within the City of Raleigh (City) and its extraterritorial jurisdiction (ETJ). It provides engineering design requirements to:

- City staff responsible for implementing the Raleigh Stormwater Management Program
- Design professionals responsible for the design of stormwater infrastructure
- Applicants involved in site planning, design and the permitting process
- Others involved in stormwater management at various levels who may find the manual useful as a technical reference to define and illustrate engineering design techniques

When accompanied by sound engineering judgment, application of the procedures and criteria presented in this manual should contribute to proper analysis and design of effective and efficient stormwater infrastructure for private and public sector projects, including but not limited to, new development, redevelopment and City projects.

This manual and its contents are fully incorporated into the City's Unified Development Ordinance (UDO) under UDO Sections 1.1.12 and 9.2.1.B, and all development activity shall be subject to these requirements.

1.2 LIMITATIONS

The manual provides a compilation of readily available literature relevant to stormwater management activities in the Raleigh area. Although it is intended to establish uniform design practices, it neither replaces the need for sound engineering judgment, nor precludes the use of information not presented. Because material presented was obtained from numerous publications and has not been duplicated in its entirety, the applicant is encouraged to obtain original or additional reference material, as appropriate. References are included at the front of the manual.

1.3 STORMWATER REGULATIONS

It is the responsibility of the applicant to be fully aware of all applicable federal and state government laws and regulations, including but not limited to:

- Federal Emergency Management Agency (FEMA) Floodplain Regulations
- Federal Clean Water Act (Section 404/401)
- North Carolina State Water Supply Watershed Regulations
- North Carolina State Riparian Buffer Regulations
- North Carolina State Dam Safety Regulations
- North Carolina State Neuse River Nutrient Control Rules

- North Carolina Department of Environmental Quality (NC DEQ) Stormwater Minimum Design Criteria (MDC)

1.4 CHAPTER SUMMARY

The discussion below provides a high-level outline of the material included in each chapter of the manual to assist in the design and evaluation of stormwater infrastructure:

- Chapter 1 provides a brief introduction to the limitations of this manual, site planning for stormwater management and additional regulations that may apply to development outside of those required by the City. Technical definitions for items mentioned throughout the manual are provided along with a list of the Stormwater Development checklists.
- Chapter 2 provides requirements regarding site development processes, including but not limited to; lot grading plans (LGPs), stormwater development analysis (SDA), designer's letter, and downstream assessments. Detailed sections for easement requirements and easement width determinations are also included.
- Chapter 3 provides requirements for hydrologic analysis related to development and stormwater management. Design criteria discussed includes, but is not limited to, hydrologic modeling parameters, acceptable hydrologic modeling programs and allowable hydrologic methodologies.
- Chapter 4 provides requirements for hydraulic analysis related to development and stormwater management. Design criteria discussed includes, but is not limited to, closed systems, inlets, acceptable pipe materials, open channels, bridges and culverts, outlets and requirements related to certifications and as-builts.
- Chapter 5 provides requirements for stormwater management design, which include rate of runoff control, water quality treatment utilizing both traditional and green stormwater infrastructure (GSI), stormwater control measures (SCMs) applicable for both small and large site developments, and requirements for certifications and as-builts.
- Chapter 6 provides requirements and design criteria for erosion and sediment control items related to land disturbance. These items include development criteria, practice standards, application requirements, construction phasing and sequencing, ground cover distinctions, single-family construction, compacted pervious areas and post-construction SCMs.
- Chapter 7 provides requirements for development related to interaction with floodplains and associated flood prone areas. Section topics include requirements regarding development within special flood hazard areas (SFHAs), permit applications, flood studies, elevation certifications, floodproofing certifications, substantial improvements, and substantial damage.
- Chapter 8 provides requirements on the stormwater utility fee credit and adjustment program available through the City. These requirements for stormwater credit include, stormwater fee credit opportunities, applying for credits, credit maintenance and enforcement, appeals and adjustments, and associated links and attachments.

1.5 SITE PLANNING FOR STORMWATER MANAGEMENT

1.5.1 Introduction to Site Planning

From a stormwater perspective, effective site planning involves allowing the characteristics that define the natural condition of the site to drive decisions on site layout and function after development. Through the site planning process, the many interests and obligations of the City and the developer, or owner of the site, can all be considered simultaneously. When stormwater management is considered as a fundamental part of the site planning process from the very beginning, stormwater management goals and requirements can be accomplished in concert with the overall goals of the development.

1.5.2 Identify Goals for the Site

Site planning for stormwater management involves consideration of the many competing goals that influence how a site is developed or redeveloped. While compliance with applicable laws and regulations are always key drivers, the development goals also include a number of functional goals and may even include voluntary goals to be considered.

1.5.2.1 Regulatory Compliance Goals

Developing a comprehensive understanding of applicable regulatory stormwater requirements is an essential first step in the site planning process. Site development and redevelopment projects in the City of Raleigh are subject to a suite of federal, state, and local laws and regulations, per Section 1.3 of this manual, which may include:

- Zoning and land use regulations
- Water quantity and quality regulations (e.g., peak flow management, runoff reduction, water quality improvement)
- Regulations for setbacks, buffers, and/or easements
- Impervious surface area limitations

The location of a site within a designated watershed, jurisdiction, or near a waterbody will dictate the specific applicable regulatory requirements.

In additional to regulatory goals and requirements, there are also a number of voluntary goals that may be considered as part of the site planning process, such as:

- Participation in the Green Raleigh Review program
- Achieving compliance with nutrient loading criteria through volume matching in accordance with UDO Section 9.2.2.B.1.c

1.5.2.2 Functional Goals

When an owner seeks to develop or redevelop a site, there are typically a number of different functional goals and motivating factors to balance with regulatory compliance. For example:

- Achieving a development site that is cost effective and profitable

- Achieving a particular building density (e.g., number of units per acre)
- Attaining a specific aesthetic or compatibility with existing land uses through landscaping and site design
- Ensuring long-term sustainability of the development

Thoughtful site planning for stormwater management aims to balance these functional goals with regulatory compliance to achieve multiple objectives.

1.5.3 Conduct a Site Inventory and Analysis

After all applicable regulatory, voluntary, and functional goals have been identified for a site, the next step in the site planning process is to collect and analyze key information that drives the site design, construction and ability to meet the defined goals and objectives for the site development. The site inventory and analysis consist of an evaluation of the physical characteristics of the site and its surroundings, which typically includes:

- Identification of natural areas and features, including streams, wetlands, and buffers
- Evaluation of soil classification, topography, and vegetation
- Geotechnical investigation to evaluate drainage characteristics, hydrologic flow paths, and soil infiltration rates
- Inventory of man-made features including utilities, structures, roadways, and other impervious features

Compiling the site inventory information into a map or series of maps provides a useful tool for decision making throughout the site planning process (Perrin et al., 2009 and NCDENR, 1998).

1.5.4 Identify and Protect Natural Features and Hydrologic Functions

Preservation of existing vegetation and drainage features along with minimizing site disturbance during site development or redevelopment can have significant stormwater management benefits. Identification of these features during the site planning process helps ensure their preservation and can generate cost savings by using the existing hydrologic features and functions of a site to achieve stormwater management regulatory goals (Perrin et al., 2009 and NCDENR, 1998). Key considerations should include, at a minimum:

- Minimizing site disturbance, clearing, and grading ~~to the smallest area necessary~~ for the particular phase of development
- Preserving hydrologic soils, low areas, and densely vegetated areas, and areas of high-quality vegetation for rainfall intercept and stormwater runoff conveyance, filtration, and infiltration
- Protecting areas that provide natural hydrologic function including streams, wetlands, buffers, and floodplains

1.5.5 Conceptual Site Plan

After completion of the first three components of stormwater management site planning (identification of goals, site inventory and analysis, and identification and protection of natural features and hydrologic functions), the designer and developer should have a clear vision of the key factors influencing the development project and how they interact and drive the relevant regulatory compliance requirements and functional goals. With these considerations in mind, the site design can be initiated following the key steps below.

1. Use drainage and hydrology as design elements to site SCMs and maximize natural hydrologic function
2. Establish clearing and grading limits with the goal of minimizing site disturbance and protecting natural features
3. Apply design program (roads, building, parking) and site features to follow natural site contours
4. Minimize and disconnect impervious areas to minimize runoff generation and maximize infiltration
5. Site SCMs close to the source (implement distributed SCMs where feasible) to replicate pre-development site hydrology

Steps 1-5 are performed iteratively as the designer and owner or developer work together to balance the specific goals and requirements for the site. **Figures 1.5.5.1**, **1.5.5.2** and **1.5.6.1** are reproduced from the North Carolina Low Impact Development Guidebook.

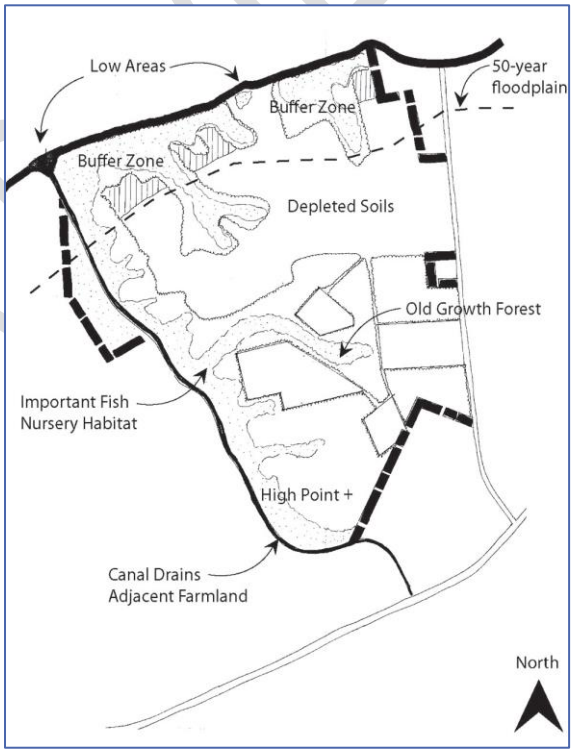

Figure 1.5.5.1 Map of Site Features

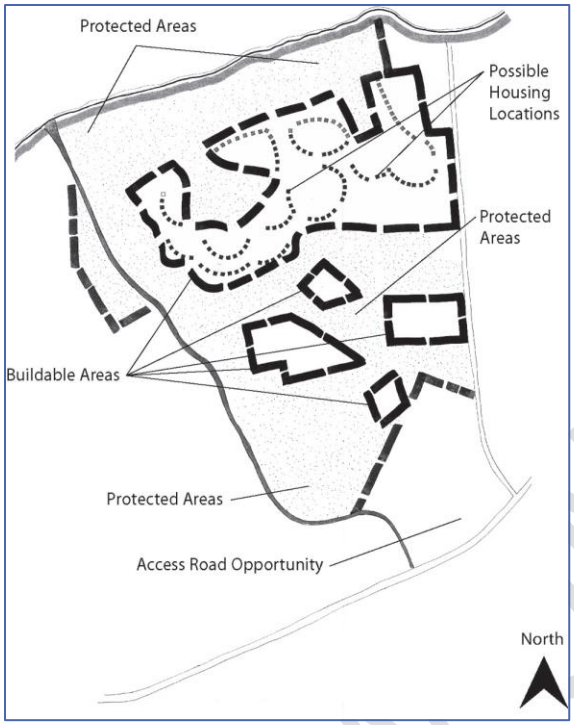

Figure 1.5.5.2 Site Analysis

1.5.6 Final Conceptual Site Plan

After completing the conceptual site plan step, the site planning process can move forward into the final stages of design. This includes sizing appropriate SCMs and stormwater conveyance systems to meet applicable design standards and regulatory compliance requirements then integrating them into the final site design in a manner that achieves the objectives set forth early on in the site planning process.

1. Size conveyance and SCMs according to applicable design standards (Chapter 5)
2. Finalize the design to achieve site-specific regulatory, voluntary, and functional goals

The remaining chapters of this manual provide additional detailed information on completing these steps.

In this process, the Final Conceptual Site Plan will be submitted to the City as the Preliminary Development Plan.

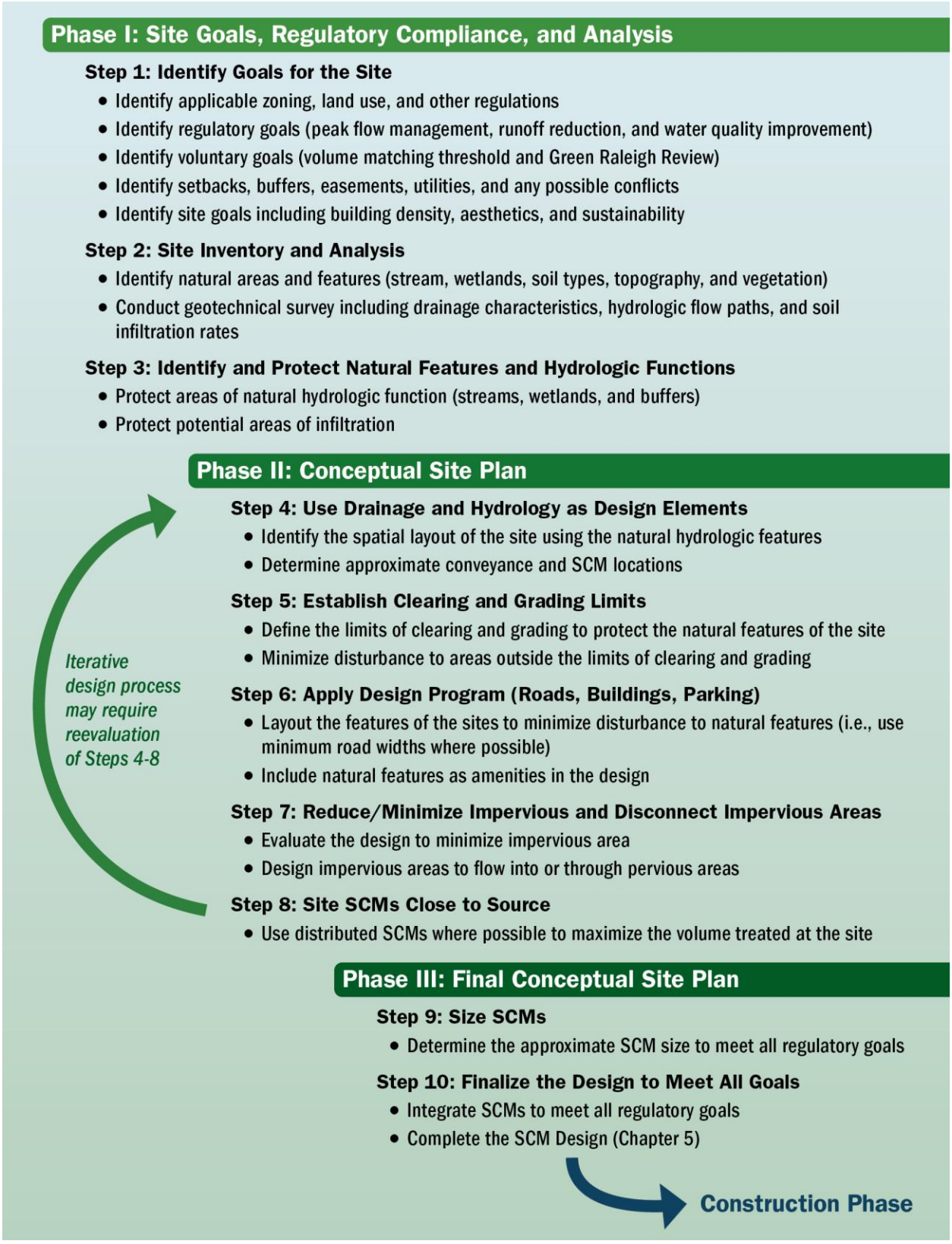

Figure 1.5.6.1 Key Elements of Stormwater Management Site Planning

1.6 CHECKLISTS

Each stormwater development project is unique in nature; therefore, it is imperative for applicants to select the appropriate checklist(s) below for their project. Project requirements are stated throughout the manual. Checklists are provided as an additional resource for ensuring compliance, but their use is not a substitution for thorough review and adherence to all applicable manual and UDO requirements. Checklists are living documents that may be updated over time at the City's sole discretion; therefore, the most recent versions shall be downloaded by applicants from the City's website.

- Designer's Letter Submittal Checklist
- Downstream Assessment Submittal Checklist
- Erosion and Sediment Control (E&SC) Plan Submittal Checklist
- Flood Study Submittal Checklist
- Green Stormwater Infrastructure (GSI) Submittal Checklist
- Operations and Maintenance (O&M) Manual Submittal Checklist
- Overall Large Site Development Submittal Checklist
- Overall Small Site Development Submittal Checklist
- Stormwater Control Measure (SCM) As-Built Submittal Checklist
- Stormwater Control Measure (SCM) Design Submittal Checklists (unique to each type)
- Stormwater Conveyance As-Built Submittal Checklist
- Stormwater Development Analysis (SDA) Submittal Checklist
- Typical Lot Grading Plan (LGP) Submittal Checklist

1.7 DEFINITIONS

Antecedent Moisture
Soil moisture conditions of the watershed at the beginning of a storm. These conditions affect the volume of runoff generated by a particular storm event.

Applicant
The Owner or Owner's Representative submitting required materials to the City for review and potential approval.

Built Area
The sum of horizontal areas of materials, that are existing or placed at the ground surface, and have impervious surfaces, as defined in UDO Section 12.2, ~~that are greater than 0% impervious and include, but are not limited to, permeable and semi-permeable pavements and pavers, green roofs, and living roofs.~~

Bypass Discharge
Diverted flow around a system.

City Standards
Requirements for design, construction and maintenance of stormwater infrastructure. These standards include the City Stormwater Management Design Manual, City Code, UDO and all City standard details and specifications.

Combination Inlet
A drainage inlet composed of a curb-opening, as well as a grate.

Common Plan of Development
A single development plan, regardless of ownership of the parcels, governing a site where multiple separate and distinct development activities may occur at different times and on different schedules. Information that may be used to determine a "common plan of development" includes, but is not limited to, plats, blueprints, marketing plans, contracts, building permits, public notices or hearings, zoning requests and infrastructure development plans.

Conveyance Design Storm
The 10-year, 24-hour stormwater management goal for rate reduction and detention design requirements for SCMs.

Critical Depth
The depth at which water flows over a weir when the energy of flow is at a minimum. For a given discharge and cross-section geometry, there is only one critical depth.

Crown
The highest point inside a pipe at any given cross section.

Culvert
A structure that conveys any flow collected in an open-ended pipe and can be utilized as a cross-drain.

Depression Storage
The natural depressions within a watershed that store runoff. Generally, after the depression storage is filled, runoff will commence.

Designer's Letter
Submittal required by the City in lieu of an SDA, under certain conditions, and at the sole discretion of the City. See *Chapter 2 – Site Development Requirements* for more information.

Erosion Protection Design Storm
The 1-year, 24-hour stormwater management goal for rate reduction and detention design requirements for SCMs.

Freeboard
An additional depth (added to the top of a basin, pond, ditch, dam or roadway embankment, etc.) regarded as a safety factor, above the peak design storm water surface elevation.

Frequency
The average time interval between equal magnitude storm events. For example, a 25-year storm event has the probability of being equaled or exceeded once every 25 years, or a 4% chance of being equaled or exceeded in any given year.

Flood Mitigation Design Storm
The 100-year, 24-hour stormwater management goal for rate reduction and detention design requirements for SCMs to ensure no flooding or impoundment of water against homes or other habitable structures.

Green Stormwater Infrastructure (GSI)
Any number of practices that, when used individually or collectively, contribute to managing, treating, and reducing stormwater runoff from a development or a redevelopment site, as closely as possible to the runoff's original source by preserving natural landscape features (such as vegetation, soils, hydrology, and natural processes) and/or by mimicking natural processes through installation and maintenance of structurally engineered devices (such as bioretention cells, bioswales, permeable paving/pavers, green roofs, stormwater street trees, and cisterns). In addition to contributing to stormwater management, GSI practices can enhance site aesthetics, improve air quality, reduce urban heat island impacts, provide shading, create wildlife habitat, reduce energy consumption, reduce infrastructure costs, and increase property values.

Green Stormwater Infrastructure (GSI) Volume
The 90th percentile stormwater management goal for GSI design requirements.

Gutter
A depression along the edge of the roadway, attached to the inside part of the curb, used to convey stormwater runoff, typically directing it to a curb opening inlet.

Hydraulic Grade Line (HGL)
In open-channel flow, the HGL is equal to the water surface elevation in the channel or partially full pipe. In pressure flow (full-pipe flow), the HGL denotes the level water will rise to if unconstrained.

Hydrograph
A graph of runoff over time for a given storm and watershed.

Impervious Area
Any surface, which because of its material composition or compacted nature, impedes or prevents natural infiltration of stormwater into the soil. Impervious surfaces include, but are not limited to, roofs, roof extensions, patios, balconies, decks, streets, parking areas, driveways and sidewalks, as well as any concrete, stone, brick, asphalt or compacted gravel surfaces. Refer to impervious surface in UDO Section 12.2 for complete definition.

Infiltration
A complex process of allowing runoff to penetrate the ground surface and flow through the upper soil surface.

Initial Abstractions
All losses (water retained in surface depressions, intercepted by vegetation, evaporated and/or infiltrated) before surface water runoff commences.

Invert
The lowest point inside of a pipe or of a channel.

Lag Time
The time from the centroid of the excess rainfall to the peak of the runoff hydrograph.

Large Site Development
Developments that are subject to active stormwater control measures (stormwater runoff controls and nitrogen reduction requirements) under UDO Section 9.2.2. These are lots or developments which do not meet the criteria listed for exemption to active stormwater control measures per UDO Section 9.2.2.A.

Limits of Disturbance (LOD)
The area proposed to be disturbed due to improvements. Limits of land disturbance shall provide an adequate work area and include an additional 20-foot offset or extend to the property line to allow for construction activities, which include staging, access, mobilization, and storage.

Lot Grading Plan (LGP)
Submittal required from the applicant of a property proposed for development to ensure proper drainage of an individual lot. See *Chapter 2 – Site Development Requirements* for more information.

May
A permissive condition. No requirement is intended.

Must
A mandatory condition. When certain requirements are described with the "must" stipulation, it is mandatory that they be met.

Peak Discharge
The maximum rate of flow for water passing a given point during or after a rainfall event. Also referred to as peak flow.

Person
Any individual, partnership, firm, association, joint venture, public or private corporation, trust, estate, commission, board, public or private institution, utility, cooperative, interstate body or other legal entity.

Post-Development
The condition of a property following any development activity. For upstream areas, this refers to complete build-out conditions, as determined from zoning and the City's Comprehensive Plan.

Pre-Development
The condition of a property before development occurs (e.g. forested, open space, etc.).

Runoff
The excess water available after initial abstractions have been satisfied.

Shall
A mandatory condition. When certain requirements are described with the "shall" stipulation, it is mandatory that they be met.

Should
An advisory condition. Considered to be recommended but not mandatory.

Small Site Development
Lots identified in the City's Unified Development Ordinance (UDO) under UDO Section 9.2.2.A.1 and 9.2.2.A.2. The intent of the small site development definition is to identify grandfathered and subdivided lots, along with use standards, that are granted an exemption from active stormwater controls.

Spread
The width of flow measured perpendicularly from the roadway pavement edge or the face of curb towards the center of the roadway.

Stage
The elevation of the water surface above a given elevation datum.

Stormwater Development Analysis (SDA)
Submittal required by the City if drainage patterns are proposed to be changed, if impervious area is proposed to be increased, if any existing system is replaced or supplemented or if any new system is proposed. See *Chapter 2 – Site Development Requirements* for more information.

Time of Concentration
The time required for water to flow from the most hydraulically remote point of the watershed to the location being analyzed. Thus, the time of concentration is the maximum time for water to travel through the watershed, which is not always the maximum distance from the outlet to any point in the watershed.

Unified Development Ordinance (UDO)
City document that contains most local regulations concerning the use and development of land and buildings, including zoning, subdivision, stormwater, and natural resource conservation.

Unit Hydrograph
A depiction of runoff resulting from a rainfall event that has a specific temporal and spatial distribution and lasts for a specific duration. The ordinates of the unit hydrograph are such that the volume of direct runoff represented by the area under the hydrograph is equal to one inch of runoff from the drainage area.

Water Quality Volume
Runoff from the first one inch of rainfall (also known as the First Flush) which is a stormwater management goal for many stormwater control measure (SCM) design requirements.

Will

A mandatory condition. When certain requirements are described with the “will” stipulation, it is mandatory that they be met.