

STORMWATER SITE PLANNING

1.5.1 Stormwater Management and Site Planning

1.5.1.1 Introduction

In order to most effectively address stormwater management objectives, consideration of stormwater runoff needs to be fully integrated into the site planning and design process. This involves a more comprehensive approach to site planning and a thorough understanding of the physical characteristics and resources of the site. The purpose of this section is to provide a framework for including effective and environmentally sensitive stormwater management into the site development process and to encourage a greater uniformity in stormwater management site plan preparation.

When designing the stormwater management system for a site, a number of questions need to be answered by the site planners and design engineers, including:

- How can the stormwater management system be designed to most effectively meet the stormwater management minimum standards (and any additional needs or objectives)?
- What are the opportunities for utilizing better site design practices to minimize the need for structural stormwater controls?
- What are the development site constraints that preclude the use of certain structural controls?
- What structural controls are most suitable and cost-effective for the site?

1.5.1.2 Principles of Stormwater Management Site Planning

The following principles should be kept in mind in preparing a stormwater management plan for a development site:

- 1. The site design should utilize an integrated approach to deal with stormwater quantity, quality and streambank (channel) protection requirements.**

The stormwater management infrastructure for a site should be designed to integrate drainage and water quantity control, water quality protection, and downstream channel protection. Site design should be done in unison with the design and layout of stormwater infrastructure to attain stormwater management goals. Together, the combination of better site design practices and effective infrastructure layout and design can mitigate the worst stormwater impacts of most urban developments while preserving stream integrity and aesthetic attractiveness.

- 2. Stormwater management practices should strive to utilize the natural drainage system and require as little maintenance as possible.**

Almost all sites contain natural features which can be used to help manage and mitigate runoff from development. Features on a development site might include natural drainage patterns, depressions, permeable soils, wetlands, floodplains, and undisturbed vegetated areas that can be used to reduce runoff, provide infiltration and stormwater filtering of pollutants and sediment, recycle nutrients, and maximize on-site storage of stormwater.

Site design should seek to improve the effectiveness of natural systems rather than to ignore or replace them. Further, natural systems typically require low or no maintenance, and will continue to function many years into the future.

3. Structural stormwater controls should be implemented only after all site design and nonstructural options have been exhausted.

Operationally, economically, and aesthetically, stormwater better site design and the use of natural techniques offer significant benefits over structural stormwater controls. Therefore, all opportunities for utilizing these methods should be explored before implementing structural stormwater controls such as wet ponds and sand filters.

4. Structural stormwater solutions should attempt to be multi-purpose and be aesthetically integrated into a site's design.

A structural stormwater facility need not be an afterthought or ugly nuisance on a development site. A parking lot, soccer field or city plaza can serve as a temporary storage facility for stormwater. In addition, water features such as ponds and lakes, when correctly designed and integrated into a site, can increase the aesthetic value of a development.

5. "One size does not fit all" in terms of stormwater management solutions.

Although the basic problems of stormwater runoff and the need for its management remain the same, each site, project, and watershed presents different challenges and opportunities. For instance, an infill development in a highly urbanized town center or downtown area will require a much different set of stormwater management solutions than a low-density residential subdivision in a largely undeveloped watershed. Therefore, local stormwater management needs to take into account differences between development sites, different types of development and land use, various watershed conditions and priorities, the nature of downstream lands and waters, and community desires and preferences.

1.5.2 Preparation of Stormwater Management Site Plans

1.5.2.1 Introduction

A stormwater management site plan is a comprehensive report that contains the technical information and analysis to allow a local review authority to determine whether a proposed new development or redevelopment project meets the local stormwater regulatory requirements and/or the minimum stormwater management standards contained in this Manual.

This section describes the typical contents and general procedure for preparing a stormwater management site plan. The level of detail involved in the plan will depend on the project size and the individual site and development characteristics.

The preparation of a stormwater site plan ideally follows these steps:

- (1) Pre-consultation Meeting and Joint Site Visit**
- (2) Review of Local Requirements**
- (3) Perform Site Analysis**
- (4) Prepare Stormwater Concept Plan**
- (5) Prepare Preliminary Stormwater Site Plan**
- (6) Complete Final Stormwater Site Plan**

1.5.2.2 Pre-consultation Meeting and Joint Site Visit

The most important action that can take place at the beginning of the development project is a pre-consultation meeting between the local review authority and the developer and his team to outline the stormwater management requirements and other regulations, and to assist the developer in assessing constraints, opportunities, and potential for stormwater design concepts.

This recommended step helps to establish a constructive partnership for the entire development process. A joint site visit, if possible, can yield a conceptual outline of the stormwater management plan and strategies. By walking the site, the two parties can identify and anticipate problems, define general expectations and establish general boundaries of natural feature protection and conservation areas. A major incentive for pre-consultation is that permitting and plan approval requirements will become clear at an early stage, increasing the likelihood that the approval process will proceed faster and more smoothly.

1.5.2.3 Review of Local Requirements

The site developer should be made familiar with the local stormwater management and development requirements and design criteria that apply to the site. These requirements may include:

- The minimum standards for stormwater management included in this Manual (see Section 1.2)
- Design storm frequencies
- Conveyance design criteria
- Floodplain criteria
- Buffer/setback criteria
- Wetland provisions
- Watershed-based criteria
- Erosion and sedimentation control requirements
- Maintenance requirements
- Need for physical site evaluations (infiltration tests, geotechnical evaluations, etc.)

Much of this guidance can be obtained at the pre-consultation meeting with the local review authority and should be detailed in various local ordinances (e.g., subdivision codes, stormwater and drainage codes, etc.)

Current land use plans, comprehensive plans, zoning ordinances, road and utility plans, watershed or overlay districts, and public facility plans should all be consulted to determine the need for compliance with other local and state regulatory requirements.

Opportunities for special types of development (e.g., clustering) or special land use opportunities (e.g., conservation easements or tax incentives) should be investigated. There may also be an ability to partner with a local community for the development of greenways, or other riparian corridor or open space developments.

1.5.2.4 Perform Site Analysis and Inventory

Using approved field and mapping techniques, the site engineer should collect and review information on the existing site conditions and map the following site features:

- Topography
- Drainage patterns and basins
- Intermittent and perennial streams

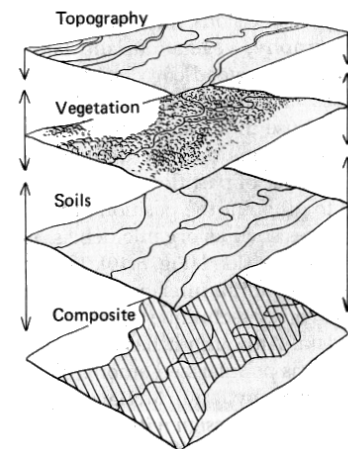
- Soils
- Ground cover and vegetation
- Existing development
- Existing stormwater facilities
- Adjacent areas

In addition, the site engineer should identify and map all previously unmapped natural features such as:

- Wetlands
- Critical habitat areas
- Boundaries of wooded areas
- Floodplain boundaries
- Steep slopes
- Required buffers
- Proposed stream crossing locations
- Other required protection areas (e.g., well setbacks)

Some of this information may be available from previously performed studies or from the previous feasibility study. For example, if a development site requires a permit under the Erosion and Sedimentation Act, most of the resource protection features will likely have been mapped as part of the land disturbance activity plan. Other recommended site information to map or obtain includes utilities information, seasonal groundwater levels, and geologic mapping.

Individual map or geographic information system (GIS) layers can be designed to facilitate an analysis of the site through what is known as map overlay, or a composite analysis. Each layer (or group of related information layers) is placed on the map in such a way as to facilitate comparison and contrast with other layers. A composite layer is often developed to show all the layers at the same time (see Figure 1.5.2-1). This composite layer can be a useful tool for defining the best buildable areas and delineating and preserving natural feature conservation areas.



**Figure 1.5.2-1
Composite Analysis**
(Source: Marsh, 1983)

1.5.2.5 Prepare Stormwater Concept Plan

Based upon the review of existing conditions and site analysis, the design engineer should develop a concept site layout plan for the project.

During the concept plan stage the site designer will perform most of the layout of the site including the preliminary stormwater management system design and layout. The stormwater concept plan allows the design engineer to propose a potential site layout and gives the developer and local review authority a “first look” at the stormwater management system for the proposed development. The stormwater concept plan should be submitted to the local plan reviewer before detailed preliminary site plans are developed.

The following steps should be followed in developing the stormwater concept plan:

- (1) Use better site design approaches (see Section 1.4) as applicable to develop the site layout, including:
 - Preserving the natural feature conservation areas defined in the site analysis
 - Fitting the development to the terrain and minimizing land disturbance
 - Reducing impervious surface area through various techniques
 - Preserving and utilizing the natural drainage system wherever possible

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- (2) Calculate preliminary estimates of the unified stormwater sizing criteria requirements for water quality, channel protection, overbank flooding protection and extreme flood protection based on the concept plan site layout (Section 1.3)
 - (3) Determine the site design stormwater credits to be accounted for in the design of structural stormwater controls handling the water quality volume (Section 1.4)
 - (4) Perform screening and preliminary selection of appropriate structural stormwater controls and identification of potential siting locations (Section 3.1).

It is extremely important at this stage that stormwater design is integrated into the overall site design concept in order to best reduce the impacts of the development as well as provide for the most cost-effective and environmentally sensitive approach. Using hydrology calculations, the goal of mimicking pre-development conditions can serve a useful purpose in planning the stormwater management system.

For local review purposes, the stormwater concept plan should include the following elements:

- (1) Common address and legal description of site
- (2) Vicinity map
- (3) Existing conditions and proposed site layout mapping and plans (recommended scale of 1" = 50'), which illustrate at a minimum:
 - Existing and proposed topography (minimum of 2-foot contours recommended)
 - Perennial and intermittent streams
 - Mapping of predominant soils from USDA soil surveys
 - Boundaries of existing predominant vegetation and proposed limits of clearing and grading
 - Location and boundaries of other natural feature protection and conservation areas such as wetlands, lakes, ponds, floodplains, stream buffers and other setbacks (e.g., drinking water well setbacks, septic setbacks, etc.)
 - Location of existing and proposed roads, buildings, parking areas and other impervious surfaces
 - Existing and proposed utilities (e.g., water, sewer, gas, electric) and easements
 - Preliminary estimates of unified stormwater sizing criteria requirements
 - Identification and calculation of stormwater site design credits
 - Preliminary selection and location, size, and limits of disturbance of proposed structural stormwater controls
 - Location of existing and proposed conveyance systems such as grass channels, swales, and storm drains
 - Flow paths
 - Location of floodplain/floodway limits and relationship of site to upstream and downstream properties and drainages
 - Preliminary location and dimensions of proposed channel modifications, such as bridge or culvert crossings
- (4) Identification of preliminary waiver requests

1.5.2.6 Prepare Preliminary Stormwater Site Plan

The preliminary plan ensures that requirements and criteria are being complied with and that opportunities are being taken to minimize adverse impacts from the development.

The preliminary stormwater management site plan should consist of maps, narrative, and supporting design calculations (hydrologic and hydraulic) for the proposed stormwater management system, and should include the following sections:

(1) Existing Conditions Hydrologic Analysis

Provide an existing condition hydrologic analysis for stormwater runoff rates, volumes, and velocities, which includes:

- A topographic map of existing site conditions (minimum 2-foot contour interval recommended) with the basin boundaries indicated
- Acreage, soil types and land cover of areas for each subbasin affected by the project
- All perennial and intermittent streams and other surface water features
- All existing stormwater conveyances and structural control facilities
- Direction of flow and exits from the site
- Analysis of runoff provided by off-site areas upstream of the project site
- Methodologies, assumptions, site parameters and supporting design calculations used in analyzing the existing conditions site hydrology

(2) Post-Development Hydrologic Analysis

Provide a post-development hydrologic analysis for stormwater runoff rates, volumes, and velocities, which includes:

- A topographic map of developed site conditions (minimum 2-foot contour interval recommended) with the post-development basin boundaries indicated
- Total area of post-development impervious surfaces and other land cover areas for each subbasin affected by the project
- Unified stormwater sizing criteria runoff calculations for water quality, channel protection, overbank flooding protection and extreme flood protection for each subbasin
- Location and boundaries of proposed natural feature protection and conservation areas
- Documentation and calculations for any applicable site design credits that are being utilized
- Methodologies, assumptions, site parameters and supporting design calculations used in analyzing the existing conditions site hydrology

(3) Stormwater Management System

Provide drawings and design calculations for the proposed stormwater management system, including:

- A drawing or sketch of the stormwater management system including the location of non-structural site design features and the placement of existing and proposed structural stormwater controls. This drawing should show design water surface elevations, storage volumes available from zero to maximum head, location of inlet and outlets, location of bypass and discharge systems, and all orifice/restrictor sizes.
- Narrative describing that appropriate and effective structural stormwater controls have been selected
- Cross-section and profile drawings and design details for each of the structural stormwater controls in the system. This should include supporting calculations to show that the facility is designed according to the applicable design criteria.
- Hydrologic and hydraulic analysis of the stormwater management system for all applicable design storms (should include stage-storage or outlet rating curves, and inflow and outflow hydrographs)
- Documentation and supporting calculations to show that the stormwater management system adequately meets the unified stormwater sizing criteria
- Drawings, design calculations and elevations for all existing and proposed stormwater conveyance elements including stormwater drains, pipes, culverts, catch basins, channels, swales and areas of overland flow

(4) Downstream Analysis

Provide the assumptions and calculations from a downstream analysis (when required)

- Supporting calculations for a downstream peak flow analysis using the ten-percent rule necessary to show safe passage of post-development design flows downstream

In calculating runoff volumes and discharge rates, consideration may need to be given to any planned future upstream land use changes. Depending on the site characteristics and given design criteria, upstream lands may need to be modeled as “existing condition” or “projected buildout/future condition” when sizing and designing on-site conveyances and stormwater controls.

1.5.2.7 Complete Final Stormwater Site Plan

The final stormwater management site plan adds further detail to the preliminary plan and reflects changes that are requested or required by the local review authority. The final stormwater site plan should include all of the revised elements of the preliminary plan as well as the following items:

(1) Erosion and Sedimentation Control Plan

- Must contain all the elements specified in the Georgia Erosion and Sediment Control Act and local ordinances and regulations
- Sequence/phasing of construction and temporary stabilization measures
- Temporary structures that will be converted into permanent stormwater controls

(2) Landscaping Plan

- Arrangement of planted areas, natural areas and other landscaped features on the site plan
- Information necessary to construct the landscaping elements shown on the plan drawings
- Descriptions and standards for the methods, materials and vegetation that are to be used in the construction

(3) Operations and Maintenance Plan

- Description of maintenance tasks, responsible parties for maintenance, funding, access and safety issues

(4) Evidence of Acquisition of Applicable Local and Non-local Permits

(5) Waiver Requests

The completed final stormwater site plan should be submitted to the local review authority for final approval prior to any construction activities on the development site.

1.5.2.8 Obtain Non-Local Permits

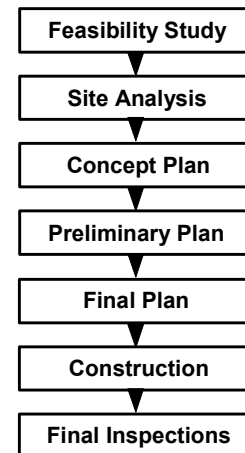
The developer should obtain any applicable non-local environmental permit such as 404 wetland permits, 401 water quality certification, or construction NPDES permits prior to or in conjunction with final plan submittal. In some cases, a non-local permitting authority may impose conditions that require the original concept plan to be changed. Developers and engineers should be aware that permit acquisition can be a long, time-consuming process.

1.5.3 Stormwater Planning in the Development Process

1.5.3.1 General Site Development Process

Figure 1.5.3-1 depicts a typical site development process from the perspective of the land developer. After an initial site visit the developer assesses the feasibility of the project. If the project is deemed workable, a survey is completed. The design team prepares a concept plan (often called a sketch plan) for consultation with the local review authority. A preliminary plan is then prepared and submitted for necessary reviews and approvals. Federal, state and local permits are applied for at various stages in the process.

After review by the local authority and possible public hearings, necessary revisions are made and a final construction plan is prepared. There may be several iterations between plan submittal and plan approval. Bonds are set and placed, contractors are hired, and construction of the project takes place. During and after construction numerous types of inspections take place. At the end of construction, there is a final inspection and a use and occupancy permit is issued for the structure itself.



**Figure 1.5.3-1
Typical Site
Development
Flowchart**

1.5.3.2 Stormwater Site Planning and Design

Stormwater site planning and design is a subset of overall site development and must fit into the overall process if it is to be successful. Table 1.5.3-1 on the next several pages shows how planning for the stormwater management system fits into the site development process from the perspective of the developer and site planner/engineer. For each step in the development process, the stormwater-related objectives are described, along with the key actions and major activities that are typically performed to meet those objectives.

Table 1.5.3-1 Stormwater Planning in the Site Development Process

Feasibility Study

Description:

A feasibility study is performed to determine the factors that may influence the decision to proceed with the site development, including the basic site characteristics, local and other governmental requirements, area information, surrounding developments, etc.

Stormwater-Related Objectives:

- Understand major site constraints and opportunities
- Understand local and other requirements

Key Actions:

- Initiate discussions with local review authority
- Pre-consultation between developer and plan reviewer
- Determine local stormwater management requirements

Major Activities:

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|--|---|
| • Base map development | • Joint site visit with local review authority |
| • Review of project requirements | • Collection of secondary source information |
| • Review of local development and stormwater management requirements | • Determination of other factors or constraints impacting feasibility |
| • Review of local stormwater master plans or comprehensive plans | |

Table 1.5.3-1 continued

Site Analysis

Description:

A site analysis is used to gain an understanding of the constraints and opportunities associated with the site through identification, mapping and assessment of natural features and resources. Potential conservation and resource protection areas are identified at this stage.

Stormwater-Related Objectives:

- Identify key site physical, environmental, and other significant resources
- Develop preliminary vision for stormwater management system

Key Actions:

- Site evaluation and delineation of natural feature protection areas

Major Activities:

- Mapping of natural resources: soils, vegetation, streams, topography, slope, wetlands, floodplains, aquifers
- Identification of other key cultural, historic, archaeological, or scenic features, orientation and exposure
- Identification of adjacent land uses
- Identification of adjacent transportation and utility access
- Identification of natural feature protection and conservation areas
- Mapping of easements and utilities
- Integration of all layers – map overlay
- Other constraints and opportunities

Concept Plan

Description:

A concept plan is used to provide both the developer and reviewer a preliminary look at the development and stormwater management concept. Based on the site analysis, a concept plan should take into account the constraints and resources available on the site. Several alternative “what if” concept plans can be created.

Stormwater-Related Objectives:

- Develop concept for stormwater management system
- Gain approval from developer and local review authority of concept plan

Key Actions:

- Develop site layout concept using better site design techniques where possible
- Perform initial runoff characterization based on site layout concept
- Determine necessary site design and/or structural controls needed to meet stormwater management requirements

Major Activities:

- Prepare sketches of functional land uses including conservation areas
- “What if” analysis of different design concepts
- Unified stormwater sizing criteria preliminary calculations
- Utilization of better site design concepts and crediting mechanisms in layout concept
- Preliminary selection and siting of structural stormwater controls
- Location of drainage/conveyance facilities

Table 1.5.3-1 continued

Preliminary and Final Plan

Description:

A preliminary site plan is created for local review, which includes roadways, building and parking locations, conservation areas, utilities, and stormwater management facilities. Following local approval, a final set of construction plans are developed.

Stormwater-Related Objectives:

- Prepare preliminary and final stormwater management site plan
- Secure local and non-local permits

Key Actions:

- Perform runoff characterization based on preliminary/final site plan
- Design structural stormwater controls and conveyance systems
- Perform downstream analysis

Major Activities:

- | | |
|--|--|
| • Preliminary/final site layout plan | • Design of drainage and conveyance facilities |
| • Unified stormwater sizing criteria calculations | • Development of erosion and sedimentation control plan and landscaping plan |
| • Calculation of site design credit | • Applications for needed permits and waivers |
| • Selection, siting and design of structural stormwater controls | |

Construction

Summary:

During the construction stage, the site must be inspected regularly to ensure that all elements are being built according to plan, and that all resource or conservation areas are suitably protected during construction.

Stormwater Objectives:

- Ensure that stormwater management facilities and site design practices are built as designed

Key Actions:

- Pre-construction meeting
- Inspection during construction

Major Activities:

- | | |
|---|-------------------------------------|
| • Execution of bonds | • Protection of conservation areas |
| • Inspection during key phases or key installations | • Erosion and sedimentation control |
| • Protection of structural stormwater controls | • Proper sequencing |

Table 1.5.3-1 continued

Final Inspection

Summary:

After construction, the site must be inspected to ensure that all elements are completed according to plan. Long-term maintenance agreements should be executed.

Stormwater Objectives:

- Ensure that stormwater management facilities and site design practices are built and operating as designed
- Ensure long-term maintenance of structural stormwater controls and conveyances
- Ensure long-term protection of conservation and resource protection areas

Key Actions:

- Final inspection and submission of record drawings
- Maintenance inspections

Major Activities:

- Final stabilization
- As-built survey
- Execution of maintenance agreements
- Final inspection and use permit

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