CHAPTER 3

PLANNING AND PLANS

SECTION I - PLANNING

Planning is the critical process by which land-disturbing activities are formulated. The planning process for activities governed by Act 599 can be broken down into the following four progressive stages:

1. preliminary site investigations
2. preliminary design
3. subsurface investigation
4. final design

For many small land-disturbing activities, steps one and two are sometimes combined but planning for major developments normally follows these four steps.

To be successful, a plan must include measures for efficient scheduling and coordination of construction activities and provisions for the maintenance of conservation practices. Stormwater management facilities should be included to reduce the impact of stormwater runoff to on-site facilities both during and after construction is completed. It is *desirable* to include stormwater retention structures. Land-disturbing activities normally will result in an increase in runoff from the site. Stormwater management structures will reduce the impact of damages on downstream facilities resulting from an increase in runoff.

Many of the Local Issuing Authorities in the State have a Stormwater Ordinance. The design professional should consult with the LIA before designing the construction plans. The Georgia Stormwater Management Manual is available for download at www.georgiastormwater.com.

PLANNING STAGES

Preliminary Site Investigation Stage. The first consideration in the preliminary site investigation stage should be the assimilation of all available resource information. This information will assist the planners in identifying critical physical features of the site which would have significant impact on erosion and sediment control. Delineation of flood-prone areas and areas which would have a high aesthetic value if protected can be identified. Sources of resource information are included in Chapter 5 of this Manual.

A conservation planning base map should be prepared utilizing all information available. The final step would be a detailed *on-site inspection*. At this time, base maps should be thoroughly checked for accuracy.

O.C.G.A. § 12-7-9, requires certification stating that the plan preparer or the designee thereof visited the site prior to creation of the plan or that such a visit was not required in accordance with rules and regulations established by the board.

GA EPD Rule 391-3-7-.10 Site Visit Required.

(1) All applications shall contain certification stating that the plan preparer or his or her designee has visited the site prior to creation of the plan.

(2) plans submitted shall contain the following certification: "I certify under penalty of law that this Plan was prepared after a site visit to the location described herein by myself or my authorized agent, under my direct supervision."

Preliminary Design Stage. In the preliminary design stage, a thorough analysis of the information assembled during the preliminary site investigation stage should be accomplished. The objective of the analysis is to determine how the proposed site can be best utilized as intended without causing undue harm to the environment. Areas particularly vulnerable to erosion and sedimentation because of existing topography, soils, vegetation or drainage should be identified. The planner is encouraged to use available soils information in his site analysis. A discussion of the use of soils information in site planning follows in this chapter.

Subsurface Investigation Stage. A subsurface investigation should be accomplished to determine the geological features and the nature and properties of the soils present on the site. A detailed on-site soils investigation will be necessary for the design of complex buildings, roadways, and other engineering structures. Facilities that will be serviced by septic tanks will require on-site testing. The stability of slopes should be determined based on soils analysis. Groundwater problems should be identified at this time. Soils subject to water flows should be analyzed for permissible velocities. Soils to be established in vegetation should be examined for pH, nutrient levels and ease of establishing vegetation. Methods of overcoming soils limitations should be explored.

Final Design Stage. Final designs should be based on detailed engineering surveys, subsurface investigations and sound conservation and engineering principles. Permanent buildings, roadways and engineering structures should be fitted to the topography and soil types. Efficient, durable and easily maintained erosion control measures should be employed. Sediment basins, barriers and traps should be designed to trap sediment which would be transported from the site. All stormwater facilities should be of adequate capacity and have the ability to withstand peak velocities. Filling or development within flood-prone areas should be avoided except those activities necessary to promote public health and welfare. If, for example, roadway crossings are made, openings must be sized to eliminate undue restriction in water flows and excessive downstream velocities. Natural vegetation and open space should be provided. Finally, rigid construction scheduling should be employed.

SOILS INFORMATION AND SITE PLANNING

An invaluable tool in planning for land disturbing activities is soils information available through USDA Natural Resources Conservation Service (NRCS). Soil scientists study, evaluate, classify and map soils in counties throughout Georgia and publish soil surveys with maps and descriptions.

Published soil surveys have been digitized and can be accessed through the Web Soil Survey. The Web Soil Survey is an interactive, internet based application that contains soil maps and associated attribute data from soil surveys produced by the National Cooperative Soil Survey. Spatial and attribute data are available on the Web Soil Survey for all Georgia counties that have a completed, correlated soil survey, which currently includes most, but not all Georgia counties. Further information about how to use the Web Soil Survey and the information it contains is in Appendix B-1 of the Manual. A status map of Georgia counties with spatial data available can be found on the Soil Data Mart, http://soildatamart.nrcs.usda.gov/Statusmap.aspx.

Soil maps and supporting data provide information about important soil properties, including the following:

Flood Hazards - Soil surveys show areas that are subject to flooding. Although this information is not a substitute for hydrologic surveys, which determine the limits of flooding on the basis of the severest flood expected once in 10, 25, 50 or 100 years, it does provide a good first approximation of the flood-prone areas.

Wetness - Soil surveys show if the soil is well drained, poorly drained, or seasonally waterlogged, and if the water table is seasonally high. The rating of the permeability of soils is also included.

Bearing Capacity - Soil surveys provide test data and estimates of the physical properties of soils that enable engineers to make sound judgments about bearing capacities for shallow foundations. Major soil layers to a depth of about 5 feet are classified in both the United and the AASHTO systems. Data is also given on grain-size distribution and expansiveness for each soil layer.

Depth to Rock - Soil surveys show locations where bedrock is at depths of less than 5 or 6 feet and describe the geologic material that underlies the soil.

Shrink-swell and Slippage - Soil properties that result in high swelling pressures, mainly the kind and amount of clay, are given in soil surveys. Soil surveys also indicate soil properties that make soils unstable and susceptible to slippage.

THE REVISED UNIVERSAL SOIL LOSS EQUATION

RUSLE1 was first released for widespread use in late 1992 as version 1.02. Improved versions of RUSLE were periodically released to cover errors and to give RUSLE increased capability. Previous versions of RUSLE were available for a fee from the Soil and Water Conservation Society (SWCS) through a Cooperative Research and Development Agreement with the Agricultural Research Service (ARS) of the United States Department of Agriculture (USDA) that gave the SWCS a copyright on RUSLE1. That agreement expired in 1996. The last version of RUSLE1 covered by that agreement was RUSLE1.05. Version 1.06c is not covered by the copyright and can be freely downloaded by anyone who wishes to use it.

NRCS is now implementing RUSLE2 in its field offices as a replacement for RUSLE1. RUSLE2 uses physically meaningful input values that are widely available in existing databases or can be easily obtained. It is believed to be the best available practical erosion prediction technology that can be easily applied at the local office level.

RUSLE2 computes net detachment each day using a variation of the familiar RUSLE factors:

$$a = r\,k\,l\,S\,c\,p$$

Where:

a = net detachment (mass/unit area)
r = erosivity factor
k = oil erodibility factor
l = slope length factor
S = slope steepness factor
c = cover-management factor
p = supporting practices factor

The lower case symbols represent daily values. Upper case symbols used in the USLE and RUSLE1 represent annual values. Each factor, except the slope steepness factor S, in the above equation change daily and as cover-management conditions change with specific events, like soil-disturbing operations. **Although the values used for each factor are daily values, they represent long-term average conditions for that day.**

The key element in this equation is the product of rk, which produces a daily sediment production estimate for unit-plot conditions. The variables r and k have units so that the product rk has **absolute units** of mass/area. The other variables in this equation adjust the unit-plot sediment production value to reflect differences between unit-plot conditions and site-specific field conditions. The factors l,S, c, and p are **ratios** of sediment production from the given field condition to unit-plot conditions and do not have units.

RUSLE1.06c and RUSLE2 can both be freely accessed at: http://www.ars.usda.gov/Research/docs.htm?docid=5971.

Design professionals of land disturbing activities should specify that the estimated erodibility of subsurface soil be obtained during site borings, because of the natural range and variability of soil properties. Additional information about soils and their properties, use, and interpretation can be found in the Web Soil Survey, as described in Appendix B-1.

SECTION II - PLANS

Sample erosion control plans are available for review on the GSWCC website at https://gaswcc.georgia.gov/.

It should be emphasized that the methodology utilized in this example is only one of many available to the designer or planner. Many other practical combinations of erosion control measures could have been employed to effectively reduce erosion on this site.

LAND DISTURBING ACTIVITY PLAN

Any land disturbing activity which disturbs one acre or greater, is not a part of a larger common plan of development, and is not exempt from the Act as listed on page 1-3 in Chapter 1 of this Manual, must have an Erosion and Sediment Control (E&SC) Plan. Any land disturbing activity which disturbs less than one acre, and is within 200' of a perennial stream must also have an E&SC Plan.

The State of Georgia also requires most land disturbing activities disturbing one acre or greater to obtain coverage under the National Pollutant Discharge Elimination System (NPDES) Permits. There are currently three NPDES Permits for construction projects in Georgia:

1. GAR100001 For Stand Alone Projects

2. GAR100002 For Infrastructure Projects

3. GAR100003 For Common Developments

The NPDES Permits require the permittee to have an Erosion, Sedimentation and Pollution Control (ES&PC) Plan. The GSWCC and the GA EPD have compiled a plan review checklist for each of the three permits that list all the requirements for all plans to be in compliance with the Act and the NPDES Permits.

Projects that disturb less than one acre and are within 200' of a perennial stream are not exempt from the Act, but are exempt from NPDES. Items on the Stand Alone and Infrastructure checklists that do not apply when NPDES is not applicable are indicated on the checklists.

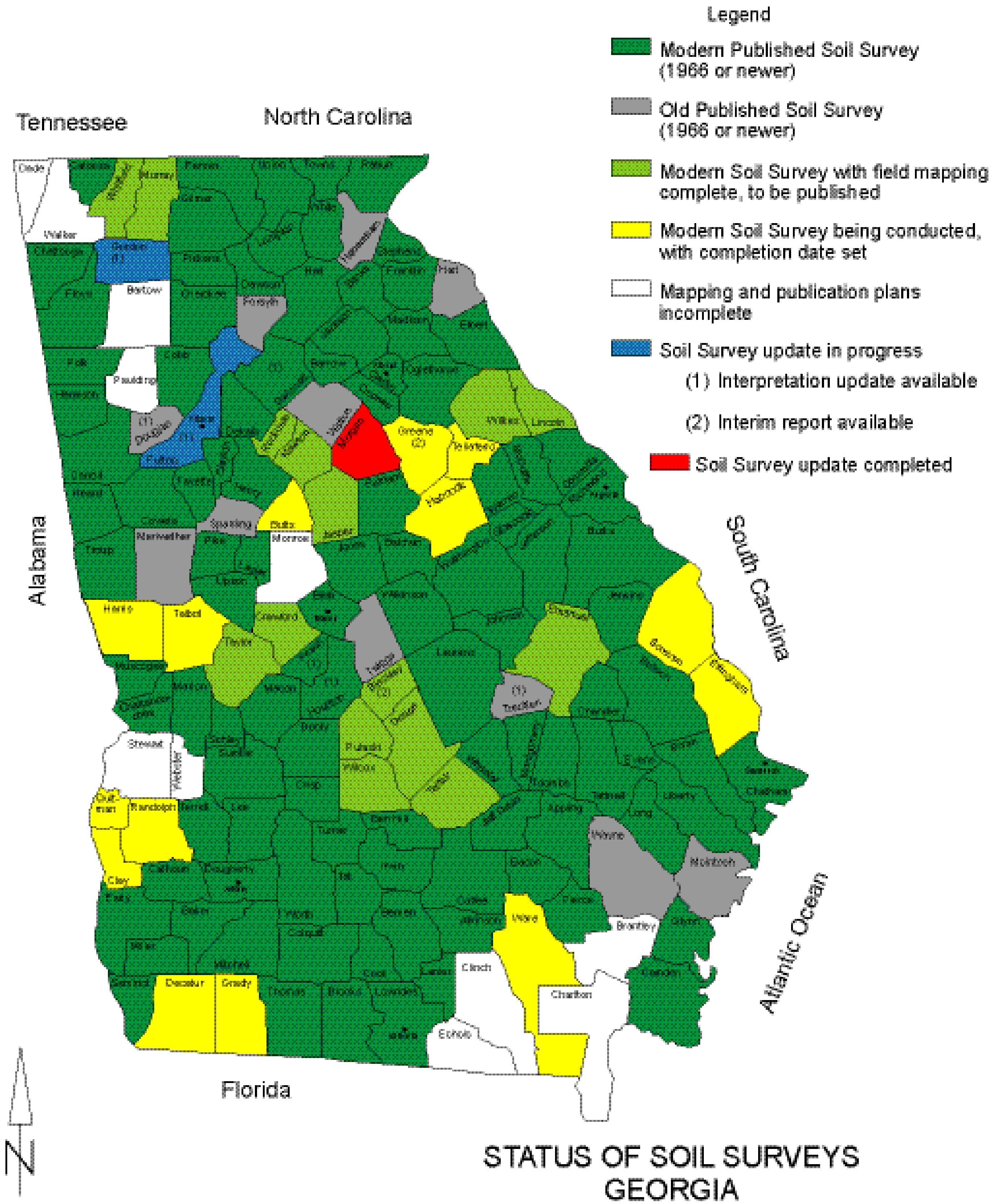
All ES&PC Plans must be prepared by a design professional licensed by the State of Georgia in the field of engineering, architecture, landscape architecture, forestry, geology, or land surveying; or a person that is a Certified Professional in Erosion and Sediment Control (CPESC) with a current certification by Certified Professional in Erosion and Sediment Control Inc*. All design professionals and plan reviewers of an ES&PC Plan must have a current Level II certification issued by the GSWCC.

NPDES Permits and Fee Schedule, Notice of Intent (NOI) for all permittees, and Notice of Termination (NOT) for all permittees can be downloaded from the EPD or the GSWCC website. Certification criteria and classes can be found on the GSWCC website.

*A CPESC certification is offered by EnviroCert International, for additional information please visit www.cpesc.org.

U.S. Department of Agriculture

Natural Resources Conservation Service



STATUS OF SOIL SURVEYS GEORGIA December 1997

Source:
Information provided by NRCS field personnel.
Natural Resources Conservation Service, Athens, GA 1997

0 25 50 75 100 miles

20 0 20 40 60 80 100 Kilometers

Scale is approximate

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Coordinating Erosion and Sediment Control With Post-Construction Stormwater Management

Introduction

It is essential to coordinate post-construction stormwater planning with the design and implementation of Erosion Sedimentation and Pollution Control (ES&PC) Plans. This chapter provides general guidance on this coordination. Post-construction stormwater management in Georgia is largely governed by:

- •The Georgia Stormwater Management Manual (Volumes 1 and 2, 2001)
- •The Georgia Coastal Stormwater Supplement (2009)

However, it is crucial for plan preparers to also check local requirements for local adaptations to post-construction stormwater requirements.

Before proceeding, it may be helpful to provide some simple definitions in order to distinguish what is meant by "erosion and sediment control" and "post-construction stormwater" in the context of this section:

EROSION & SEDIMENTATION CONTROL (ES&PC) PLANS:

The application of planning approaches and practices during the construction phase in accordance with Act 599 and the Manual for Erosion and Sediment Control in Georgia. These practices generally apply during the active construction phase of a land disturbing activity, including land clearing, filling, excavation, soil movement, construction, and other activities defined in the Act. It should be noted that construction phase plans and practices must also be coordinated with other applicable permits, such as the NPDES General Permits for Discharge from Construction Activities and, for MS4 communities, minimum measure #4.

POST-CONSTRUCTION STORMWATER:

The term post-construction stormwater is used to distinguish stormwater practices used during the active construction phase (sometimes referred to as "construction stormwater") from those that are used on a permanent basis to control runoff once construction is complete ("post-construction stormwater").

Post-construction stormwater includes site planning and structural and non-structural practices that intercept, treat, and often reduce the volume of runoff from land development sites.

Collectively, these practices are referred to as "post-construction BMPs (Best management practice)." As with construction, other permits may apply, such as MS4 minimum measure #5.

Recent trends in post-construction stormwater management that make ES&PC Plan coordination all the more important include:

•The use of better site design and green infrastructure techniques to help satisfy post-construction stormwater requirements. hese approaches involve the use of open space, vegetated areas, impervious cover disconnection, and other site planning and design techniques. For the ES&PC Plan, this can mean more "do not disturb" zones and the need to avoid disturbing and compacting soils in dispersed areas around a development site.

•The use of small-scale, distributed (low-impact development) practices that treat runoff closer to its source. Many of these practices rely on the underlying soil to infiltrate at least part of the runoff. Some may be on individual lots, within community open space, or within drainage easements. For the ES&PC Plan, this means a finer level of control for the limits of disturbance so that the performance of the ultimate post-construction practices is not compromised during the construction phase.

•More elaborate design parameters for stormwater ponds and wetlands that may begin their lives as ES&PC basins. Often, the post-construction configuration will involve pretreatment forebays, flowpath and geometry requirements, multi-stage riser structures, and other features that the designer must consider when designing the initial ES&PC basin. A detailed conversion plan is needed for the practice to succesfully meet both ES&PC and post-construction needs.

All of these trends make it essential for a higher level of coordination during site planning and implementation of ES&PC Plans in the field.

There are several key principles that apply to the coordination between ES&PC and post-construction stormwater, as outlined below:

Principle #1: Limits on the Limits of Disturbance (LOD):

The LOD on the ES&PC Plan must respect natural areas, open spaces, undisturbed vegetated areas, and the footprints of certain BMPs that are part of the post-construction stormwater plan. LODs that make sense for only the construction phase can compromise the integrity of the post-construction approach. Also, LOD boundaries may need more careful fencing, signage, and monitoring during construction.

Principle #2: Soil Structure as a Post-Construction Stormwater Tool:

Many post-construction practices rely on the underlying soil structure to allow the BMPs to function as designed. This is obviously true for practices designed to infiltrate runoff, but also applies to post-construction BMPs that have an underdrain (e.g., some bioretention, dry swale, and porous pavement designs). Care must be taken during the construction phase to avoid compacting soils in the vicinity of post-construction BMP installations.

Principle #3: Diversions:

In many cases, construction runoff can seriously compromise post-construction BMPs, even before they are installed. Sediment-laden construction runoff can damage soils intended for infiltration or filtration and can clog rock and other materials intended for use in the post-construction BMP. As such, the ES&PC Plan should include diversions to prevent construction runoff from entering certain areas associated with post-construction BMP implementation.

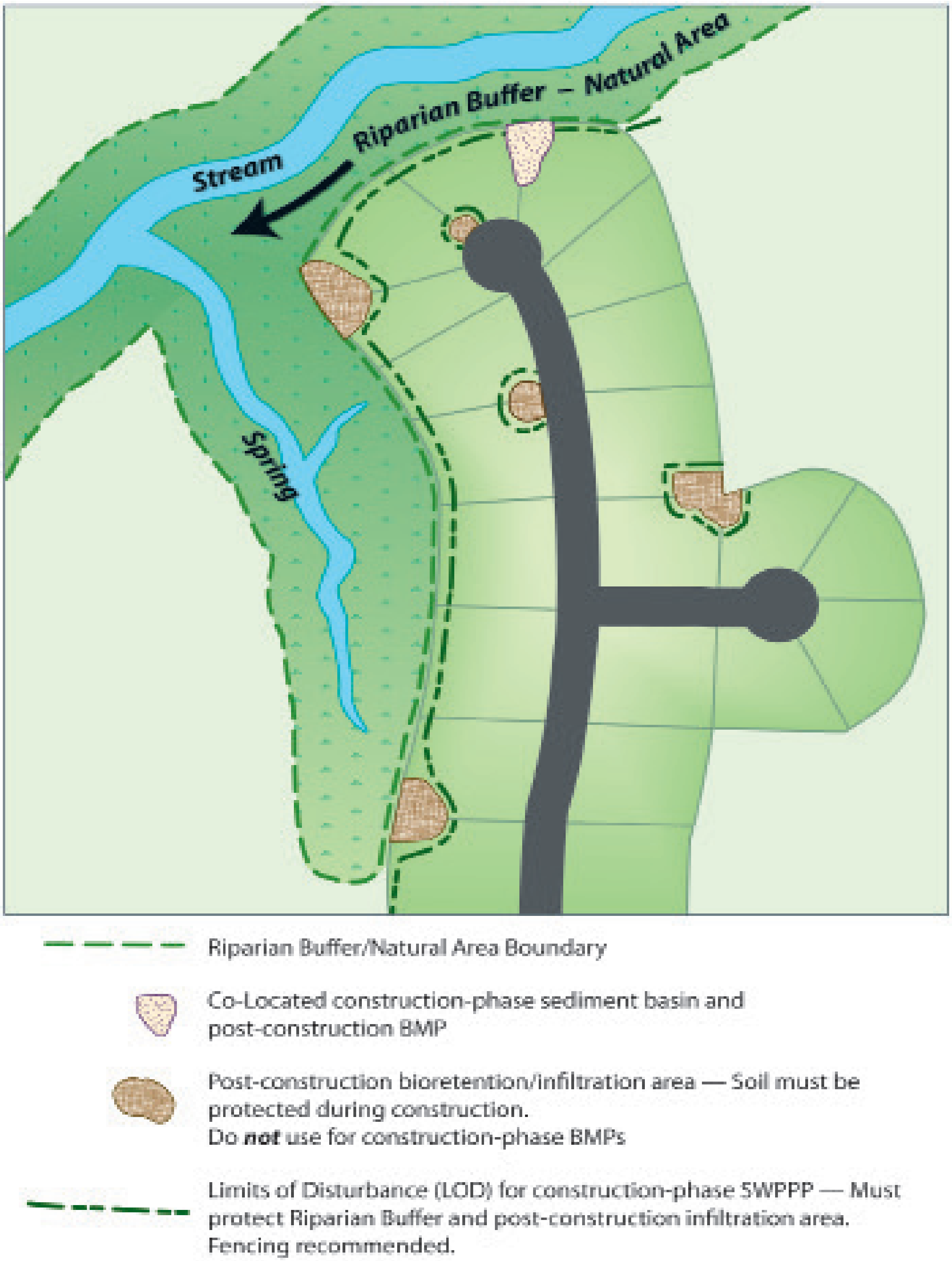
Principle #4: Conversion Details:

In many cases, ES&PC and post-construction practices can be co-located. This has advantages in terms of the efficiency of the design, and can also help the post-construction BMP because the conversion cannot take place until the erosion control function is complete (thus avoiding premature installation of the post-construction features). However, given the increasingly sophisticated nature of post-construction BMP design, a detailed conversion plan is needed as part of the ES&PC Plan to make sure that post-construction volumes, BMP geometry, riser configuration, access, and other features are adhered to. The conversion plan should also be very specific about the timing and sequencing of conversion activities with ongoing land disturbance and stabilization.

Principle #5: Communication & Coordination:

In order to coordinate erosion and sediment control with post-construction stormwater, a local program should strive to integrate activities such as plan review, site inspections, administration of performance bonds, adoption of technical standards and policies, and training and communication for the regulatory community.

Figure 1 shows several typical points of coordination between ES&PC and post-construction stormwater.



From: Managing Stormwater in Your Community, EPA Publication No.: 833-R-08-001 (CWP, 2008)

Erosion & Sediment Control
Considerations When Using Post-Construction Practices From
Georgia's Stormwater Manuals

Tables 1 and 2 provide more specific guidance on ES&PC considerations for practices and BMPs contained in both the Georgia Stormwater Management Manual (GSMM) and Georgia Coastal Stormwater Supplement (CSS):

Table 1 Provides ES&PC considerations for post-construction practices related to natural resources protection, better site design, and other site planning practices that are authorized or used to obtain post-construction credits in the GSMM and CSS.

Table 2 Lists similar considerations for structural post-construction BMPs, such as bioretention, porous pavement, vegetated swales, infiltration trenches, and stormwater ponds and wetlands.

Table 1. ES&PC Considerations for Specific Natural Resource Protection & Site Planning Practices in the GSMM & CSS

Natural Resource or Site Planning Practice	Reference to the GSMM & CSS	ES&PC Considerations
Natural Area Conservation: Protect floodplains, slopes, porous/erodible soils, aquatic resources, groundwater recharge zones	GSMM: Volume 1: Section 4.5.2 Volume 2: Sections 1.4.1 & 1.4.2 (various practices) CSS : Section 7.6.1 & 7.6.2	•Clearly identify all natural resources area boundaries on ES&PC Plans as being outside of the LOD. •Specify use of temporary construction fencing at LOD. •Diversions or other measures may be needed to divert construction runoff away from the area. •Install temporary fencing and signage at the beginning of land disturbing activities. •Monitor construction activities to ensure that heavy equipment does not enter natural resource areas.
Stream/Riparian Buffers: Protect or restore vegetated area adjacent to streams and aquatic resources	GSMM: Volume 1: Section 4.5.3 Volume 2: Section 1.4.2 (Practice #2) CSS : Section 7.6.1 & 7.6.2	•Clearly identify all stream buffer boundaries on ES&PC Plans as being outside of the LOD. •See above for other guidelines under "Natural Area Conservation."

Table 1. ES&PC Considerations for Specific Natural Resource Protection & Site Planning Practices in the GSMM & CSS (continued)		
Natural Resource or Site Planning Practice	**Reference to the GSMM & CSS**	**ES&PC Considerations**
Disconnection of post-construction Impervious Cover: direct impervious cover to downgradient pervious areas as sheet flow or overland flow filter paths	GSMM: Volume 1: Section 4.5.5 Volume 2: Section 1.4.2 (Practices #17, 20) ; Section 3.3.1 (Filter Strip) CSS : Sections 7.8.5 & 7.8.6	•Identify on ES&PC Plans all pervious areas that will receive runoff from upgradient impervious or developed areas. •Avoid compaction of pervious areas with heavy equipment during construction; use temporary fencing as necessary. •Diversions or other measures may be needed to divert construction runoff away from the pervious areas. •Make sure that all subcontractors know about the areas. •It is acknowledged that it may not be practical to prevent disturbance or compaction of ALL of these pervious receiving areas on a site (e.g., small areas on individual lots). Pervious receiving areas that ARE compacted during construction should be restored by tilling and adding compost, as per Section 7.8.1 of the CSS or similar guidance.
Grass/Vegetated Channels: direct runoff from developed areas to vegetated channels instead of storm sewer systems	GSMM: Volume 1: Section 4.5.4 Volume 2: Section 1.4.2 (Practice #18, 19) ; Section 3.3.2 (Grass Channel) CSS: Section 7.8.7	•Similar to Impervious Cover Disconnection, vegetated/grass channels and drainageways should be identified on ES&PC Plans and marked in the field to avoid disturbance and compaction. •Of course, roadside channels will be disturbed during construction; soil restoration should follow post-construction plans.
Other Better Site Design Practices that Reduce Site Grading & Disturbance: reduce limits of clearing, reduce impervious cover, more compact development design	GSMM: Volume 1: Section 4.3 Volume 2: Section 1.4 CSS : Section 7.7	•Ensure that reduced development footprint translates to ES&PC Plan by matching limits of disturbance with post-construction design and layout. •Clearly mark limits of disturbance; use temporary construction fencing as necessary.

Table 2. ES&PC Considerations for Specific Structural Post-Construction BMPs in the GSMM & CSS		
Post-Construction BMP	**Reference to the GSMM & CSS**	**ES&PC Considerations**
Bioretention, Infiltration, Porous Pavement WITHOUT an underdrain system (designed for infiltration into underyling soils)	GSMM Volume 2: Sections 3.2.3 (Bioretention), 3.2.5 (Infiltration), 3.3.7 (Porous Concrete), 3.3.8 (Modular Porous Pavement System) CSS : Sections 7.8.4 (Permeable Pavements), 7.8.9 (Rain Gardens), 7.8.11 (Dry Wells), 7.8.13 (Bioretention), 7.8.14 (Infiltration), 8.6.6 (Swales)	•Clearly show post-construction practice footprints on ES&PC Plan. Usually, these areas should be outside of the LOD (with the exception of porous pavement), unless they are used as small, temporary sediment traps as per the guidelines in Table 3. •Mark practice footprint areas in the field with temporary fencing and signage. •Monitor construction activities to ensure that heavy equipment does not enter practice footprint areas. •All contributing drainage areas (CDAs) to the practice MUST be fully stabilized and vegetated prior to installation of post-construction BMP. •In addition, runoff from the CDA can be diverted around the post-construction BMP footprint and supplemental ES&PC measures (e.g., silt fence/barriers around the perimeter of the practice) can be used to prevent erosion into the practice from the CDA or practice side slopes as they are being graded.
Bioretention, Dry Swale, Infiltration, Porous Pavement WITH an underdrain system (designed for underdrain to discharge to storm sewer)	GSMM Volume 2: Sections 3.2.3 (Bioretention), 3.2.6 (Enhanced Swales) CSS: Sections 7.8.4 (Permeable Pavements), 7.8.13 (Bioretention), 7.8.10 (Stormwater Planters), 7.8.15 (Dry Swales)	•Clearly show post-construction practice footprints on ES&PC Plan. Usually, these areas should be outside of the LOD (with the exception of porous pavement), unless they are used as small, temporary sediment traps as per the guidelines in Table 3. •If outside of the LOD, mark practice footprint areas in the field with temporary fencing and signage. •Monitor construction activities to ensure that heavy equipment does not enter practice footprint areas. •Similar to practices without underdrains, the CDA must be stabilized and supplemental ES&PC measures (e.g., silt fence/barriers around the perimeter of the practice) can be used to prevent sediment from entering the post-construction BMP.

Table 2. ES&PC Considerations for Specific Structural Post-Construction BMPs in the GSMM & CSS (Continued)		
Post-Construction BMP	**Reference to the GSMM & CSS**	**ES&PC Considerations**
Conversions from temporary ES&PC practice to post-construction BMP	GSMM Volume 2: Sections 3.2.1 (Stormwater Ponds) 3.2.2 (Stormwater Wetlands) CSS: Sections 8.6.1 (Stormwater Ponds) 8.62 (Stormwater Wetlands)	•For post-construction stormwater designs that include stormwater ponds or wetlands, it is likely that the practice will be installed initially as a temporary ES&PC basin. •ES&PC Plans should incorporate the design considerations outlined in the following section on co-locating and converting ES&PC practices to post-construction BMPs. •The timing of conversion from temporary to permanent practices depends on exposed areas and continued land disturbance in the CDA. The ES&PC Plan should have a detailed phasing plan that clearly explains this sequence.

Co-Locating & Converting ES&PC Practices to Post-Construction BMPs

Previous sections discuss the prospect of co-locating ES&PC and post-construction practices. While this cannot be done in all cases, it is an acceptable approach as long as certain guidelines are followed to ensure the integrity of the post-construction BMP. In addition, there are some notable advantages to co-locating practices, the chief one being that the post-construction conversion cannot take place until the construction-phase ES&PC function is complete. This is important because one of the chief causes of failure for post-construction BMPs is premature installation and the introduction of construction sediments into the practice. There are many bioretention, infiltration, and other practices where this has been a serious concern. See Figure 2 for examples.

The other advantage for co-location is that it is straight-forward, can be implemented easily by the contractor, and may lead to cost savings.

Given these advantages to co-location, there are circumstances where it should not be done, including:

- Post-construction BMPs that have too small of a drainage area and/or are in a location that is not conducive for an ES&PC trap.
- Post-construction BMPs where the local plan reviewer deems that construction activity will compact and damage underlying soils to an extent that performance of the post-con struction BMP will be compromised.
- Post-construction BMPs where timing and sequencing of construction phases will not allow the conversion to take place in the proper sequence so that the practice cannot fulfill its post-construction treatment objectives.
- Other situations where the local authority, plan reviewer, designer, and/or contractor believes that co-location will compromise the ES&PC and/or post-construction plan implementation.

Where co-location is a viable option, there are generally two types of practices where conversion from ES&PC to post-construction can take place:

1. Smaller-scale sediment traps (generally with drainage areas less than 3 acres) that can be converted to bioretention, dry swales, or surface sand filter BMPs. See Table 3 for specific conversion guidance.

2. Larger-scale sediment basins with larger drainage areas that can be converted to post-construction stormwater ponds or wetlands. See Table 4.

Figure 2 shows examples of ES&PC practice conversions to post-construction BMPs.

Table 3. Conversion of Smaller-Scale Sediment Traps (generally with drainage areas less than 3 acres) to Bioretention, Dry Swales, or Surface Sand Filter BMPs.

Topic	Conversion Guidance
Drainage Areas	Drainage areas should be limited by the appropriate post-construction BMP design specifications, even if construction phase drainage areas could be larger. This means that sites may have to be divided into smaller drainage areas with use of multiple ES&PC traps and other ES&PC measures.
Grading to Blend Into Topography	Some temporary ES&PC practices are graded onto slopes, have steep embankments or side slopes, and otherwise don't blend into the surrounding topography. These types of practices are not good candidates to convert to post-construction BMPs, unless regrading is part of the conversion plan. A sounder approach is to design the temporary ES&PC practice so that this type of regrading is not necessary, which may include changing the footprint, grading, slopes, and other features of the ES&PC practice.
Stabilizing the Drainage Area	Make sure the contributing drainage area (CDA) is stabilized prior to conversion. This is a good thing about using ES&PC traps, since they cannot be taken out until their erosion control function is complete. Therefore, the tendency to prematurely install post-construction practices is lessened. The conversion can proceed when site inspectors indicate that the CDA is properly stabilized. In addition to CDA stabilization, other supplemental ES&PC measures may be warranted, such as diverting flow around the practice during the conversion process and using silt fence or matting/sod on side slopes of the practice.
Remove Construction Sediments	All construction sediments should be removed as the first step in the conversion process. This may also involve dewatering the ES&PC practice using an approved dewatering and sediment capture method (e.g., dirt bags, sediment traps).
Excavate Below the ES&PC Practice Bottom Elevation	The bottom of the post-construction practice should be at least one foot lower than the temporary ES&PC bottom elevation. This is so that the bottom of the post-construction BMP will be in undisturbed soils that are not impacted by construction activities. During excavation to the post-construction design elevation, scarify or rip the underlying soil to promote infiltration.
Installing Underdrains	If the post-construction practice design has an underdrain, decide when to install the underdrain. Usually this will be done as part of the conversion (after the construction phase). However, if the underdrain goes through an impounding structure or berm that will stay in place with the post-construction BMP, it may be best to install the underdrain with the initial ES&PC practice, cover it with heavy gage plastic, and then fill on top to reach the desired bottom elevation of the ES&PC practice. This will prevent having to breach the impounding structure or berm to install an underdrain system during the conversion process. At the time of conversion, the overlying soil and plastic can be removed, exposing the underdrain system, at which point the desired soil or filter layers can be placed on top of the underdrain.

Table 3. Conversion of Smaller-Scale Sediment Traps (generally with drainage areas less than 3 acres) to Bioretention, Dry Swales, or Surface Sand Filter BMPs. (continued)	
Topic	**Conversion Guidance**
Proceed to Install Post-Construction BMP	Install the practice as per the approved post-construction plans. Some minor grading or adjustments to the footprint may be needed to meet the post-construction design.
Be Aware of Easement and Post-Construction Practice Location	If the post-construction BMP is supposed to be located within a drainage easement or in another specific location (e.g., common area in a subdivision), it is very important to make sure that the final practice is within the specified area in order to avoid costly relocation of the practice.

Table 4. Conversion of Larger Scale ES&PC Sediment Basins to Post-Construction Stormwater Ponds and Wetlands	
Topic	**Conversion Guidance**
Timing/Sequencing	Generally, ES&PC basins cannot be converted to a post-construction configuration until the contributing drainage area (CDA) is fully developed and stabilized. However, phasing plans can incorporate additional upgradient ES&PC practices if certain portions of the CDA will be disturbed subsequent to the conversion. This is likely the case with multi-phase development projects, commercial subdivisions, etc.
Sediment Removal	Construction sediment will have to be removed from the basin before conversion to a post-construction BMP. Additional grading may be needed to meet the design standards for the post-construction configuration.
Volume & Design Elevations	Sizing rules are different for ES&PC basins and post-construction BMPs. The ES&PC basin may be larger or smaller than the post-construction practice, so additional grading is likely needed for the conversion. A common problem with conversions is that not all of the construction sediment is removed so that the post-construction elevations are incorrect. Contractors should always check design elevations for the post-construction BMP.
Pond Geometry	Compared to an ES&PC basin, a post-construction practice may have a longer flow path (3:1 recommended), multiple cells, larger surface area, shallower side slopes (e.g., 3:1), deeper or shallower pool depths, safety benches around permanent pools, and other design features. The ES&PC basin should at least consider the overall footprint and general depth of the post-construction pond so that major grading can be avoided in the conversion process.
Pre-Treatment	Most post-construction ponds will incorporate one or more forebays for pretreatment. The forebays can be constructed as part of the ES&PC basin, but it may be preferable to install them as part of the conversion to avoid the cost of cleaning them out, repairing or replacing rock spillways, etc. In either case, the footprint of the forebay should be incorporated into the ES&PC basin footprint.

Table 4. Conversion of Larger Scale ES&PC Sediment Basins to Post-Construction Stormwater Ponds and Wetlands (continued)	
Topic	**Conversion Guidance**
Risers & Spillways	The post-construction practice design will adhere to certain safety features and riser designs (likely multi-stage risers to address water quality, channel protection, and flood protection). The designer should consider constructing the post-construction design as part of the ES&PC basin, and then modifying it for the construction phase. For instance, risers can be perforated during construction, and then the perforations plugged as part of the conversion. Certain orifices will likely need to be temporarily plugged during construction. In addition, the spillway and freeboard requirements may be different for the post-construction pond, and relevant design elevations should be used for the temporary ES&PC basin, unless this is specifically addressed otherwise in the conversion plan.
Dewatering Drains	Certain post-construction pond or wetland designs may call for dewatering drains so that pools can be drained to remove sediment or for maintenance. With regard to constructability, it may be best to install drains with the original ES&PC basin, and make sure they do not get clogged during construction.
Rock Weirs, Spillways, Outlet Protection	Rock features may be part of the ES&PC and/or post-construction practice. However, it is likely that they will get filled with sediment during construction, so will have to be replaced or rebuilt as part of the conversion.
Maintenance Access	While temporary ES&PC basins only need to be accessed during the construction phase, post-construction ponds require permanent maintenance access, so this should be planned for during construction.
Landscaping	Most post-construction ponds will have a landscaping plan. Obviously, the landscaping should be installed during the conversion, and not during the active construction phase.

Figure 2. Typical ES&PC to Post-Construction Conversions as well as Common Pitfall

Conversion of a small-scale sediment trap to bioretention. The photos shows adding an underdrain system.

Conversion of a sediment basin to a bioretention area. The original riser acts as the overflow structure for the bioretention practice.

Post-construction conversion called for the creation of sediment forebay in this larger scale pond.

A major issue with conversions is timing. Premature installation of the post-construction practice can result in damage from construction sediments.

Conclusion

Increasingly, it is important to coordinate ES&PC planning and implementation with post-construction stormwater plans. A coordinated plan will help both phases (construction and post-construction) to proceed in a logical, well thought-out way that avoids costly redesigns and work delays.

The principles of adjusting the limits of disturbance, protecting soil structure associated with post-construction BMPs, diverting construction runoff around important post-construction areas, developing detailed conversion plans for ES&PC to post-construction BMPs, and coordination and communication among plan reviewers, design professionals, inspectors, and contractors, will help achieve this integration of ES&PC and post-construction stormwater.

Low Impact Development (LID)

What is low impact development (LID)?

LID includes a variety of practices that mimic or preserve natural drainage processes to manage stormwater. LID practices typically retain rain water and encourage it to soak into the ground rather than allowing it to run off into ditches and storm drains where it would otherwise contribute to flooding and pollution problems (see www.epa.gov/nps/lid).

Excerpt from US EPA Low Impact Development (LID) a Literature Review

Introduction

Low impact development (LID) is a relatively new concept in stormwater management. LID techniques were pioneered by Prince George's County, Maryland, in the early 1990's, and several projects have been implemented within the state. Some LID principles are now being applied in other parts of the country, however, the use of LID is infrequent and opportunities are often not investigated.

LID is a site design strategy with a goal of maintaining or replicating the pre-development hydrologic regime through the use of design techniques to create a functionally equivalent hydrologic landscape. Hydrologic functions of storage, infiltration, and ground water recharge, as well as the volume and frequency of discharges, are maintained through the use of integrated and distributed micro-scale stormwater retention and detention areas, reduction of impervious surfaces, and the lengthening of flow paths and runoff time (Coffman, 2000). Other strategies include the preservation/protection of environmentally sensitive site features such as riparian buffers, wetlands, steep slopes, valuable (mature) trees, flood plains, woodlands and highly permeable soils.

LID principles are based on controlling stormwater at the source by the use of micro-scale controls that are distributed throughout the site. This is unlike conventional approaches that typically convey and manage runoff in large facilities located at the base of drainage areas. These multifunctional site designs incorporate alternative stormwater management practices such as functional landscape that act as stormwater facilities, flatter grades, depression storage and open drainage swales. This system of controls can reduce or eliminate the need for a centralized Best Management Practice (BMP) facility for the control of stormwater runoff. Although traditional stormwater control measures have been documented to effectively remove pollutants, the natural hydrology is still negatively affected (inadequate base flow, thermal fluxes or flashy hydrology), which can have detrimental effects on ecosystems, even when water quality is not compromised (Coffman, 2000). LID practices offer an additional benefit in that they can be integrated into the infrastructure and are more cost effective and aesthetically pleasing than traditional, structural stormwater conveyance systems.

Conventional stormwater conveyance systems are designed to collect, convey and discharge runoff as efficiently as possible. The intent is to create a highly efficient drainage system, which will prevent on lot flooding, promote good drainage and quickly convey runoff to a BMP or stream. This runoff control system decreases groundwater recharge, increases runoff volume and changes the timing, frequency and rate of discharge. These changes can cause flooding, water quality degradation, stream erosion and the need to construct end of pipe BMPs. Discharge rates using traditional BMPs may be set only to match the predevelopment peak rate for a specific design year. This approach only controls the rate of runoff allowing significant increases in runoff volume, frequency and duration of runoff from the predevelopment conditions and

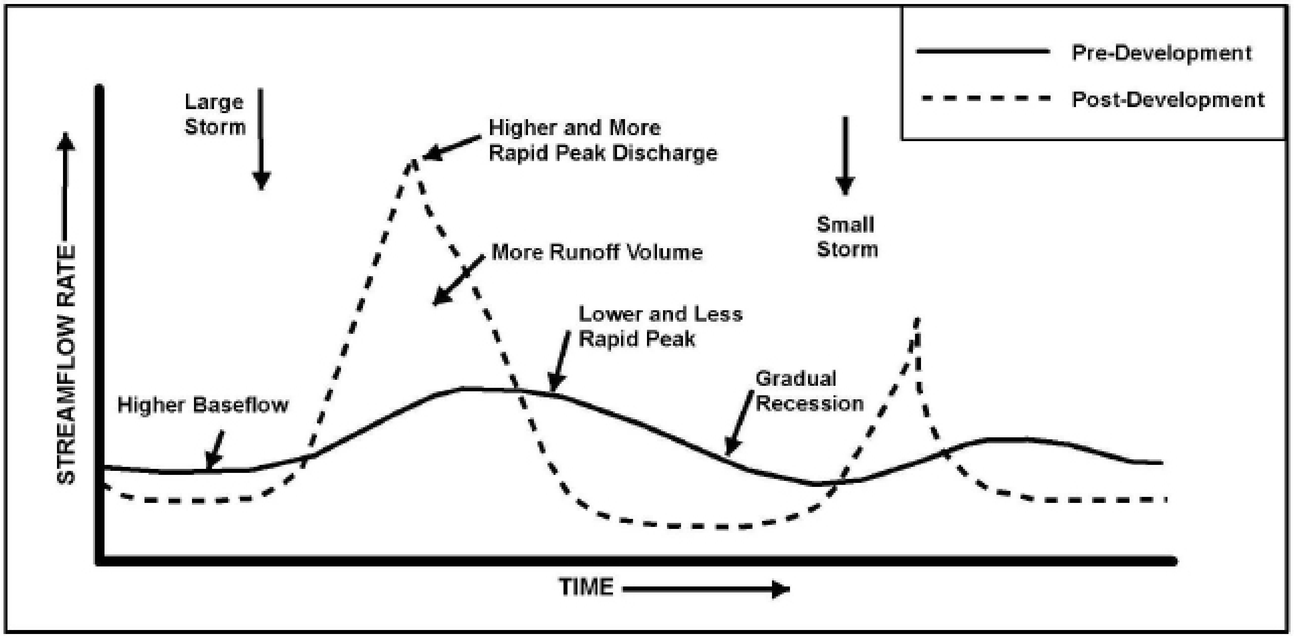


Figure 1: Changes in Stormwater Hydrology as a Result of Urbanization, Schueler, 1992

provides the mechanisms for further degradation of receiving waters (Figure 1).

LID has often been compared to other innovative practices, such as Conservation Design, which uses similar approaches in reducing the impacts of development, such as reduction of impervious surfaces and conservation of natural features. Although the goals of Conservation Design protect natural flow paths and existing vegetative features, stormwater is not treated directly at the source. Conservation Design protects large areas adjacent to the development site and stormwater is directed to these common areas.

Although this approach protects trees and does reduce runoff, there is still potentially a significant amount of connected impervious area and centralized stormwater facilities that may contribute to stream degradation through stormwater volume, frequency and thermal impacts. Therefore, the hydrologic and hydraulic impacts of this approach on receiving waters may still be significant, although the volume and flows will be less than without the conservation design. The stormwater control measures used in Conservation Design are off-site and therefore not the individual property owner's responsibility. However, maintenance is generally provided by the homeowners association and financed through association fees.

Benefits and Limitations

The use of LID practices offers both economical and environmental benefits. LID measures result in less disturbance of the development area, conservation of natural features and can be less cost intensive than traditional stormwater control mechanisms. Cost savings for control mechanisms are not only for construction, but also for long-term maintenance and life cycle cost considerations. For example, an alternative LID stormwater control design for a new 270 unit apartment complex in Aberdeen, NC will save the developer approximately 72% or $175,000 of the stormwater construction costs. On this project, almost all of the subsurface collection systems associated with curb and gutter projects have been eliminated. Strategically located bioretention areas, compact weir outfalls, depressions, grass channels, wetland swales and specially designed storm water basins are some of the LID techniques used. These design features allow for longer flow paths, reduce the amount of polluted runoff and filter pollutants from stormwater runoff (Blue Land, Water and Infrastructure, 2000).

Today many states are facing the issue of urban sprawl, a form of development that consumes green space, promotes auto dependency and widens urban fringes, which puts pressure on environmentally sensitive areas. "Smart growth" strategies are designed to reconfigure development in a more eco-efficient and community oriented style. LID addresses many of the environmental practices that are essential to smart growth strategies including the conservation of open green space. LID does not address the subject of availability of public transportation.

LID provides many opportunities to retrofit existing highly urbanized areas with pollution controls, as well as address environmental issues in newly developed areas. LID techniques such as rooftop retention, permeable pavements, bioretention and disconnecting rooftop rain gutter spouts are valuable tools that can be used in urban areas. For example, stormwater flows can easily be directed into rain barrels, cisterns or across vegetated areas in high-density urban areas. Further opportunities exist to implement bioretention systems in parking lots with little or no reduction in parking space. The use of vegetated rooftops and permeable pavements are 2 ways to reduce impervious surfaces in highly urbanized areas.

LID techniques can be applied to a range of lot sizes. The use of LID, however, may necessitate the use of structural BMPs in conjunction with LID techniques in order to achieve watershed objectives. The appropriateness of LID practices is dependent on site conditions, and is not based strictly on spatial limitations. Evaluation of soil permeability, slope and water table depth must be considered in order to effectively use LID practices. Another obstacle is that many communities have development rules that may restrict innovative practices that would reduce impervious cover. These “rules” refer to a mix of subdivision codes, zoning regulations, parking and street standards and other local ordinances that determine how development happens (Center for Watershed Protection, 1998). These rules are responsible for wide streets, expansive parking lots and large-lot subdivisions that reduce open space and natural features. These obstacles are often difficult to overcome.

Additionally, community perception of LID may prevent its implementation. Many homeowners want large-lots and wide streets and view reduction of these features as undesirable and even unsafe. Furthermore, many people believe that without conventional controls, such as curbs and gutters and end of pipe BMPs, they will be required to contend with basement flooding and subsurface structural damage.

Low Impact Development Practices

LID measures provide a means to address both pollutant removal and the protection of pre-development hydrological functions. Some basic LID principles include conservation of natural features, minimization of impervious surfaces, hydraulic disconnects, disbursement of runoff and phytoremediation. LID practices such as bioretention facilities or rain gardens, grass swales and channels, vegetated rooftops, rain barrels, cisterns, vegetated filter strips and permeable pavements perform both runoff volume reduction and pollutant filtering functions.

Bioretention

Bioretention systems are designed based on soil types, site conditions and land uses. A bioretention area can be composed of a mix of functional components with each performing different functions in the removal of pollutants and attenuation of stormwater runoff.

Grass Swales

Grass swales or channels are adaptable to a variety of site conditions, are flexible in design and layout, and are relatively inexpensive (USDOT, 1996). Generally open channel systems are most appropriate for smaller drainage areas with mildly sloping topography (Center for Watershed Protection, 1998). Their application is primarily along residential streets and highways. They function as a mechanism to reduce runoff velocity and as filtration/infiltration devices. Sedimentation is the primary pollutant removal mechanism, with additional secondary mechanisms of infiltration and absorption. In general grass channels are most effective when the flow depth is minimized and detention time is maximized. The stability of the channel or overland flow is dependant on the erodibility of the soils in which the channel is constructed (USDOT, 1996). Decreasing the slope or providing dense cover will aid in both stability and pollutant removal effectiveness.

Vegetated Roof Covers

Vegetative roof covers or green roofs are an effective means of reducing urban stormwater runoff by reducing the percentage of impervious surfaces in urban areas. They are especially effective in older urban areas with chronic Combined Sewer Overflow (CSO) problems, due to the high level of imperviousness. The green roof is a multilayered constructed material consisting of a vegetative layer, media, a geotextile layer and a synthetic drain layer. Vegetated roof covers in urban areas offer a variety of benefits, such as extending the life of roofs, reducing energy costs and conserving valuable land that would otherwise be required for stormwater runoff controls. Green roofs have been used extensively in Europe to accomplish these objectives. Many opportunities are available to apply this LID measure in older U.S. cities with stormwater infrastructures that have reached their capacities.

Permeable Pavements

The use of permeable pavements is an effective means of reducing the percent of imperviousness in a drainage basin. More than thirty different studies have documented that stream, lake and wetland quality is reduced sharply when impervious cover in an upstream watershed is greater than 10%.

Porous pavements are best suited for low traffic areas, such as parking lots and sidewalks. The most successful installations of alternative pavements are found in coastal areas with sandy soils and flatter slopes (Center for Watershed Protection, 1998).

Permeable pavements allow stormwater to infiltrate into underlying soils promoting pollutant treatment and recharge, as opposed to producing large volumes of rainfall runoff requiring conveyance and treatment. Costs for paving blocks and stones range from $2 to $4, whereas asphalt costs $0.50 to $1 (Center for Watershed Protection, 1998).

Other LID Strategies

Another strategy to minimize the impacts of development is the implementation of rain gutter disconnects. This practice involves redirecting rooftop runoff conveyed in rain gutters out of storm sewers, and into grass swales, bioretention systems and other functional landscape devices. Redirecting runoff from rooftops into functional landscape areas can significantly reduce runoff flow to surface waters and reduce the number of CSO events in urban areas. As long as the stormwater is transported well away from foundations, concerns of structural damage and basement flooding can be alleviated. As an alternative to redirection of stormwater to functional landscape, rain gutter flows can be directed into rain barrels or cisterns for later use in irrigating lawns and gardens. Disconnections of rain gutters can effectively be implemented on existing properties with little change to present site designs.

For the complete literature review visit:http://water.epa.gov/polwaste/green/lidlit.cfm

Links for additional information:

Center for Watershed Protection -http://www.cwp.org/

City of Atlanta - http://www.atlantawatershed.org/greeninfrastructure/

City of Roswell - http://www.roswellgov.com/index.aspx?NID=1586

Georgia Department of Natural Resources - Coastal Resources Division
http://coastalgadnr.org/cm/green/guide
http://coastalgadnr.org/cm/green/demo

Georgia Institute of Technology, Office of Environmental Stewardship
http://www.stewardship.gatech.edu/stormwater.php

US Environmental Protection Agency - http://water.epa.gov/polwaste/green/