Low Impact Development Appendix to *Connecticut Guidelines for Soil Erosion and Sediment Control*

Partners for the Connecticut Low Impact Development and Stormwater General Permit Evaluation

Connecticut

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1 Introduction to Low Impact Development

Traditionally, stormwater has been managed using large, structural practices installed at the low end of development sites—essentially as an afterthought—on land segments left over after subdividing property. This approach, sometimes referred to as end-of-pipe management, yields the apparent advantages of centralizing control and limiting expenditure of land. Unfortunately, end-of-pipe technology has been shown to have many economic and environmental limitations such as failure to meet receiving water protection goals, high construction, operation and maintenance costs, and certain health and safety risks. In response to these deficiencies an alternative technological approach has emerged that is generally more economical and potentially provides far better environmental protection. This new approach is referred to as low impact development (LID).

In contrast to conventional centralized end-of-pipe management, LID uses site design principles and more a number of small-scale treatment practices distributed throughout a site to manage runoff volume and water quality at the source. For new development, LID uses a planning process to employ site design techniques to first optimize conservation of natural hydrologic functions to prevent runoff and erosion. If these conservation practices are insufficient to meet required stormwater goals, engineered treatment practices are used to meet soil erosion prevention objectives.

LID is still relatively new and rapidly evolving soil management technology. It was first described in 1999 in the Prince George's County, Maryland, *Low-Impact Development Design Strategies: An Integrated Design Approach*. However, today due to LID's many economic and environmental advantages over conventional end-of-pipe technology, it has been widely and rapidly adopted throughout the country. This LID design guidance has been developed using the latest information and past lessons learned to provide the most up to date design guidance.

Much of LID focuses on post-construction runoff control; however, LID includes site planning approaches as well as impact avoidance and standards that are valuable for the purposes of controlling soil erosion and sedimentation. Therefore, this is appendix primarily addresses the aspects of LID related to soil erosion and sediment control. This appendix also provides the reader with an overall context for the use of LID so that approaches described can be more readily integrated with a LID-based approach.

The remainder of this introductory section provides discussion of the advantages of LID and the basic four basic LID principles.

1.1 Advantages of LID

Typical advantages of LID's integrated approach over the conventional end-of-pipe approach include:

- <u>Reduced consumption of land for stormwater management</u> – LID practices provide opportunities to integrated controls into all aspects of a site's hardscape and landscape features. This allows multifunctional use of the entire developed site for controls allowing the most cost effective use of land. Less land is needed or consumed for end-of-pipe controls often allowing for more developable space.

- LID does not dictate particular land-use controls – Since LID is a technological approach there is no need to change conventional zoning or subdivision codes accept to allow LID's use. This means LID does not reduce development potential and with less land consumed for stormwater controls lot yields may increase.

- Reduced construction costs – Traditional stormwater management requires significant storm sewering and earthwork. LID practices apply controls as close to sources of runoff as possible. Wherever practicable, conveyances incorporate natural flow paths and swales instead of pipes. Structures installed are small, thus reducing the need for excavation and construction materials.

- Ease of maintenance – LID landscape practices require limited maintenance or no increase in maintenance beyond typical landscape care. Much of the maintenance required can be accomplished by the average landowner. Further many LID site planning, conservation, and grading techniques require no maintenance.

- Takes advantage of site hydrology – Conservation of natural resources, topography, land cover, soils, and drainage features preserve the natural hydrologic functions allowing absorption of runoff from impervious surfaces. Runoff that is absorbed recharges groundwater and stream base flow and does not need to be managed or controlled by an end-of-pipe practice. Preserving and maintaining the natural hydrology also better protects streambank stability and riparian habitat.

- More aesthetically pleasing development – Traditional stormwater management tends to incorporate the use of large, unnatural looking practices such as detention ponds. When neglected, these practices may present drowning and mosquito breeding hazards. Nonstructural and upland practices optimize use of landscape features that are more aesthetically pleasing and fit well into the natural landscape.

- Multiple benefits – LID has shown to provide multiple benefits such as reducing energy cost by using green roofs and proper location of trees for shading and water conservation by using rain water as a supplemental water supply.

- Improved profit margin – The advantages of nonstructural and upland management translate into the marketplace. The value added is significant. Several studies indicate that the cost of applying these nonstructural and upland stormwater management techniques is about half that of the traditional approach. The results of one example of such a study are summarized in *Table 1.1* below (Schuler, 2000). Properties developed using nonstructural and upland stormwater practices tend to command higher sale prices.

Table 1.1
Cost Analysis for Convention and Alternative Development

Cost Categories	Conventional Development	Alternative Development[a]
Engineering	$79,600	$39,800
Road Construction	(20,250 linear ft.) $1,012,500	(9,750 linear ft.) $487,500
Sewer and Water	$25,200	$13,200
Other Costs	$111,730	$54,050
Total	$1,229,030	$594,550

Source: Center for Watershed Protection, 2000, *The Practice of Watershed Protection*, page 175.
Notes:
[a]Alternative development cost analysis was done for cluster development, which is similar to conservation development.

1.2 Four Basic LID Principles

A well-designed integrated stormwater system will minimize the volume of runoff generated and maximize the treatment capabilities of the landscape. A LID-based design controls runoff as close to the source as possible. A well-designed system should also be easy to maintain, not interfere with the typical use of the property, and be aesthetically pleasing. Most critical to soil erosion control, a well-designed development site will also minimize site disturbance. In considering the advantages and constraints of each site, these four fundamental concepts should remain preeminent:

1. **Minimizing site disturbance**
   Undisturbed lands possess a natural capacity to store runoff waters. Development sites may include areas that are relatively sensitive to impact from construction (e.g., erosion) or may encompass particularly rare or valuable environmental features. Protecting susceptible natural features provides the multiple benefits of preserving important resources, reducing development impact and providing capacity for prevention of erosion.

   Generally, developers should inventory and map natural features such as surface waters, vegetated wetlands and highly erodible soils, for preservation early in the site planning process. This helps to define a practicable development envelope. Preserved areas must be protected throughout construction and demarcated for conservation in land records.

2. **Working with site hydrology**
   Traditional stormwater management seeks to eliminate the nuisance and hazard of runoff by rapidly conveying it away from development—typically, via closed drainage systems such as storm sewers. This approach works efficiently to remove water from streets and sidewalks, but it expends significant capital for constructed systems that interrupt the recharge of groundwater resources. By contrast, LID techniques work to reduce stormwater generation or retain it in the upland where it can percolate naturally into the soil and replenish groundwater resources.

3. **Minimizing and disconnecting impervious surface**
   Runoff comes primarily from impervious surface, such rooftops, roadways or any smooth hard surface that prevents water from absorbing into the ground. Traditional developments tend to include superfluous impervious surface, which may minimized with thoughtful site planning. Techniques to limit impervious area include reducing road widths and lengths as well as the area of rooftops (e.g., preference for two-story over single-story buildings).

   To the extent possible, developers should promote contact between runoff and pervious land surface. Technically, this is done by increasing time of concentration—length of time required for runoff to concentrate and flow off site—and by reducing curve number.

4. **Applying small-scale controls at the source**
   Small-scale practices applied at the source—or as close as practicable—can offer significant advantages over conventional, engineered facilities such as ponds or concrete conveyances. They can decrease the use of typical engineering materials such as steel and concrete. By using materials such as native plants, soil and gravel these systems can be more easily integrated into the landscape and appear to be much more natural than engineered systems. The natural characteristics may also increase homeowner acceptance and willingness to adopt and maintain such systems. Small, distributed systems also offer a major technical advantage—one or more of the systems can fail without undermining the overall integrity of the site control strategy.

   Small-scale practices reduce safety concerns as they feature shallow basin depths and gentle side slopes. The integration of these facilities into the landscape throughout the site offers more opportunities to mimic the natural hydrologic functions and add aesthetic value. The adoption of these landscape features by the general public and individual property owners can result in significant maintenance and upkeep savings to the homeowners association, municipality or other management entity.

2 Site Planning and Design Process

The LID approach emphasizes the use of site design and planning techniques to conserve natural systems and hydrologic functions. LID is also a highly engineered design and management strategy, which integrates practices throughout a development.

The simplest and least costly LID technique is good site planning; and an important goal of LID is to mimic the predevelopment hydrology to the extent practicable. To accomplish this, LID projects require a thorough understanding of the site's soils, drainage patterns, and natural features.

Developers should use natural features, hydrology and soils as a design element. In order to minimize the runoff potential an understanding of site drainage patterns and soils can suggest locations both for green areas and potential building sites. Integration of natural features into the site design creates a more ecologically functional site and a more aesthetically pleasing landscape that will be a vital functioning part of the ecosystem. Outlined below is the basic LID site process.

2.1 Step 1 – Define Basic Project Objectives and Goals

Identifying the project objectives not only includes identifying regulatory needs, but also ecological needs. Ecological needs include these fundamental aspects:

- Runoff volume to match predevelopment.
- Peak runoff rate to meet regulatory needs.
- Flow frequency and duration to match predevelopment.
- Water quality to meet regulatory requirements.
- Stream or wetland base flow needs.
- Recharge areas.
- Natural resource conservation requirements.

To ensure ecological needs receive appropriate attention, the developer should prioritize and rank objectives and determine the type controls required to meet objectives such as infiltration, filtration, discharge frequency, volume of discharges and groundwater recharge. Determine the feasibility for type and proper location of LID controls to best address volume, flows, discharge frequency, discharge duration and water quality.

2.2 Step 2 – Site Evaluation and Analysis

A site evaluation will facilitate design by providing details that will help to customizing LID techniques for the sites unique constraints, regulatory requirements and receiving water goals.

1. Conduct a detailed investigation of the site using available documents such as drainage maps, utilities information, soils maps, land use plans, and aerial photographs.

2. Evaluate site constraints such as available space, soil infiltration characteristics, water table, slope, drainage patterns, sunlight and shade, wind, critical habitat, circulation and underground utilities.

3. Identify protected areas, setbacks, easements, topographic features, sub drainage divides, and other site features that should be protected such as floodplains, steep slopes, and wetlands.

4. Delineate the watershed and micro-watershed areas. Take into account previously modified drainage patterns, roads, and stormwater conveyance systems.

Many other unique site features may influence the site design including historical features, view sheds, climatic factors, energy conservation, noise, watershed goals, onsite wastewater disposal and off-site flows. All of these factors help to define the building envelop and natural features to be integrated into the LID design.

2.3 Step 3 – Optimize Conservation of Natural Features at the Larger Watershed Scale

LID does not promote the use of any particular style site development such as traditional neighborhood design, conventional grid patterns, cluster development, conservation design or new urbanism. Regardless of the development style, LID techniques can always be used throughout the site. Natural features are saved to reduce impacts and allow for greater use of natural features to treat runoff. Conserving natural features not only reduces impacts but preserves habitat and natural ecological processes.

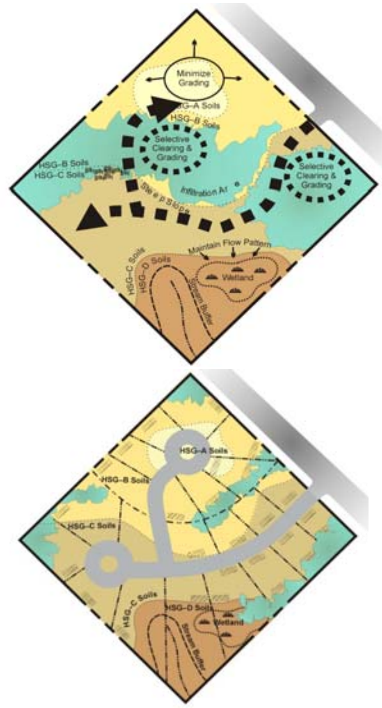

Figure 2.1 – Optimizing the use of green space.

The most successful LID design begins with understanding of the site's natural resources and how best to save these features. To the extent practicable and in accordance with current regulations, natural features (wetlands, trees/vegetation, good soils) should be conserved and integrated into the overall site plan. The conservation features should continue to be used by directing runoff to the natural features in the same manner as the predevelopment conditions. The greater use of natural features generally means reduction of clearing and grading and lower cost.

Locating infrastructure to direct runoff to buffers, vegetative filters, existing drainage features will help to reduce runoff quantity and improve water quality. This approach reduces disturbance of the natural soils and vegetation allowing more areas for infiltration and runoff contact with the landscape. To optimize the use of green space requires an ability to lay out the site infrastructure in a way that allows saving sensitive the natural features and their functions. The basic strategy is shown in *Figure 2.2.*

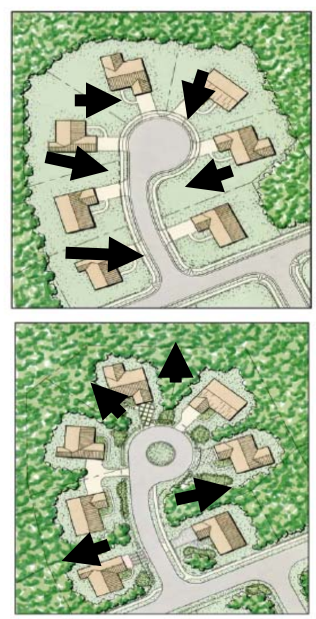
Figure 2.2 - conventional approach of draining runoff to the streets vs. a LID design using site fingerprinting.

There are many techniques that should be considered including:

- Minimizing and properly stage grading and clearing for roadways and building pads as only necessary.
- Locating, saving and utilizing pervious soils.
- Locating treatment practices in pervious hydrologic soil groups A and B.
- *Where feasible*, constructing impervious surfaces on less pervious hydrologic soils groups C and D.

- Disconnecting impervious surfaces by draining them to natural features.
- Flattening slopes where possible.
- Re-vegetating cleared and graded areas.
- Utilizing existing drainage patterns.
- Routing flow over longer distances.
- Using overland sheet flow.
- Maximizing runoff storage in natural depressions.

2.4 Step 4 – Minimize Impacts at the Lot Level

To the extent practicable, conserve trees, natural drainage patterns, pervious soils and depressions at the lot level. This often means less clearing and grading. *Figure 2.3* contrasts the conventional approach of draining runoff to the streets vs. a
LID design using site fingerprinting where runoff is directed to the natural features.

The key to preventing excessive runoff from being generated is slow down velocities by directing it toward areas where it can be absorbed. The reliance on many small measures used throughout the site will serve this purpose better than a single large control measure.

There are many lot level techniques that should be considered including:

- Avoiding installation of roof drains.
- Directing flows to vegetated areas.
- Directing flows from paved areas to stabilized vegetated areas.
- Breaking up flow directions from large paved surfaces.
- Encouraging sheet flow through vegetated areas.
- Locating impervious areas so that they drain to permeable areas.
- Maximizing overland sheet flow.
- Lengthening flow paths and increase the number of flow paths.
- Maximizing use of open swale systems.
- Increasing (or augmenting) the amount of vegetation on the site.
- Using site fingerprinting. Restricting ground disturbance to the smallest possible area.
- Reducing paving.
- Reducing compaction or disturbance of highly permeable soils.
- Avoiding removal of existing trees.
- Using on-lot tree save areas.
- Reducing the use of turf and use more natural land cover.
- Maintaining existing topography and drainage divides.
- Locating structures, roadways on Type C soils *where feasible*.[1]

[1] Because Type C and D soils tend to be poorly suited to construction, site structures on them may be ineffective from a cost-benefit standpoint or technically impractical.

Various lot level techniques are illustrated in *Figure 2.4*.

3 Design Standards for Low Impact Development Related to Soil Erosion and Sediment Control

This section discusses design standards for LID controls related to soil erosion and sediment control. It provides a general description of each control, its advantages, general use, and standards for its application.

- Complying to Limits of Clearing and Grading
- Preserving Natural Areas
- Avoiding Disturbing Long, Steep Slopes
- Minimizing Siting on Porous and Erodible Soils

3.1 Limits of Clearing and Grading

Perhaps the most potentially destructive stage in land development is the preparation of a site for building—clearing of vegetation and soil grading (Schueler, 1995). The limits of clearing and grading refer to the part of the site where development will occur. This includes all impervious areas such as roads, sidewalks, rooftops, as well as areas such as lawn and open drainage systems.

Figure 2.3 – Lot level techniques.

To minimize impacts, the area of development should be located in the least sensitive areas available. At a minimum, developers should avoid streams, floodplains, wetlands, and steep slopes (see *Section 4.3*). Where practicable, developers should also avoid soils with high infiltration rates as these will aid in reducing runoff volumes (see *Section 4.4*).

Advantages

- Preserves more undisturbed natural areas on a development site.
- Uses techniques to help protect natural conservation areas and other site features.
- Promotes evapotranspiration and infiltration to reduce need for treatment and peak volume control at end-of-pipe.
- Reduces generation of stormwater.
- Helps to demonstrate compliance with regulatory standards (e.g., freshwater wetlands, coastal resources, water quality, wildlife, local environmental protection, etc.) for avoidance and minimization as well as setbacks from sensitive features.
- Maintains predevelopment hydrology, natural character and aesthetic features that may increase market value.
- Promotes stable soils.
- May reduce landscaping costs.

Use

Establishing a limit of disturbance based on maximum disturbance zone radii/lengths. These maximum distances should reflect reasonable construction techniques and equipment needs together with the physical situation of the development site such as slopes or soils. Limits of disturbance may vary by type of development, size of lot or site, and by the specific development feature involved.

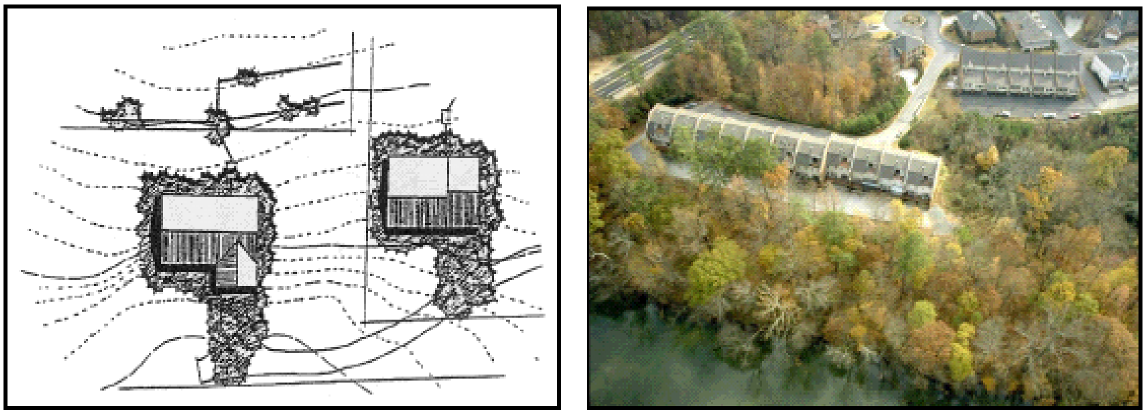

Figure 3.1 - Reduced limits of disturbance minimize water quality impacts. Source: Atlanta Regional Commission, 2001.

Standards

Generally speaking, limits of disturbance need not comprise more than:

a) Area of the building pad plus 15 feet.
b) Area of a roadbed and shoulder plus 5 feet. (This is not intended to limit lawn areas.)

3.2 Preserving Natural Areas

Natural areas include woodlands, riparian corridors, areas contiguous to wetlands and other hydrologically sensitive and naturally vegetated areas. To the extent practicable these areas should be preserved.

Natural areas can be one of the most important components within a development scheme, not only from a stormwater management perspective, but in reducing noise pollution and providing valuable wildlife habitat and scenic values. New development tends to fragment large tracts of undisturbed areas and displace plant and animal species; therefore it is essential to maintain these buffers in order to minimize impacts. Areas adjacent to waterbodies (both freshwater and coastal) are protected under state law and cannot be altered without a state agency permit.

Advantages

- Promotes evapotranspiration and infiltration to reduce need for treatment and peak volume control at end-of-pipe.
- Reduces generation of stormwater.

- Helps to demonstrate compliance with regulatory standards (e.g., freshwater wetlands, coastal resources, water quality, wildlife, local environmental protection, etc.) for avoidance and minimization as well as setbacks from sensitive features.
- Reduces safety and property-damage risks where flood hazard areas are incorporated into preservation.
- Maintains predevelopment hydrology, natural character and aesthetic features that may increase market value.
- Promotes stable soils.
- Establishes and maintains open space corridors.

Use

a) Check all federal, state and local enforceable policy to ensure proper setbacks and identification of preservation areas. Identify areas for preservation through site analysis using maps and aerial or satellite photography or by conducting a site visit.
b) Delineate areas for preservation via limits of disturbance before any clearing or construction begins and should be used to set the development envelope as well as guide site layout. Clearly mark areas for preservation on all construction and grading plans to ensure that equipment is kept out of these areas and that native vegetation is kept in an undisturbed state.
c) Protect preservation areas in perpetuity by legally enforceable deed restrictions, conservation easements and maintenance agreements.

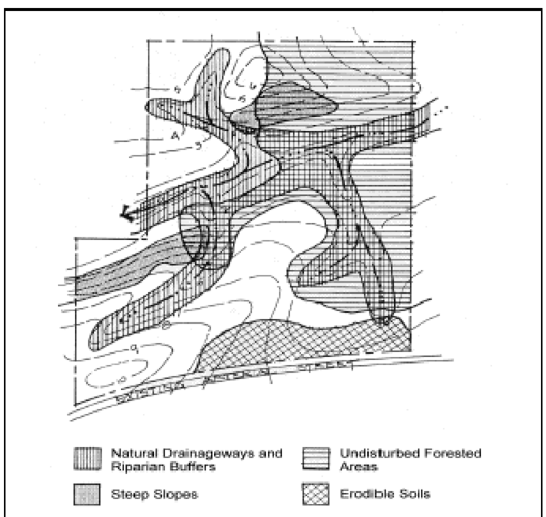

Figure 3.2 – Site map with natural areas delineated. Source: Atlanta Regional Commission, 2001.

Special Considerations

Riparian Buffers
A riparian buffer is a special type of preserved area along a watercourse where development is restricted or prohibited. Buffers protect and physically separate a watercourse from development.

Riparian buffers also provide stormwater control flood storage and habitat values. An example of a riparian buffer is shown in *Figure 3.3*. Wherever possible, riparian buffers should be sized to include the 100-year floodplain as well as steep banks and freshwater wetlands.

Figure 3.3 – Riparian buffer along the French River, in Thompson, CT. Source: Connecticut Department of Environmental Protection.

Riparian buffers consist of three zones (see *Figure 3.3*):

- The inner zone consists of the jurisdictional riverbank wetland and should have a width of no less than 100 feet from the edge of a flowing body of water less than 10 feet wide and no less than 200 feet from the edge of a flowing body of water greater than 10 feet wide. In addition to runoff protection, this zone provides bank stabilization as well as shading and protection for the stream. This zone should also include wetlands and any critical habitats, and its width should be adjusted accordingly. Permits should be sought for activities in the inner zone. Generally speaking, structural best management practices (BMPs) are not allowed in the inner zone.

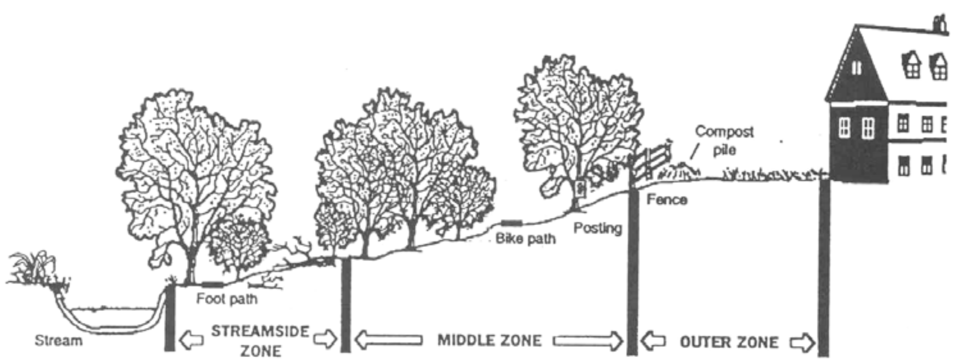

Figure 3.4 – Three-zone riparian buffer. Source: Atlanta Regional Commission, 2001.

- The middle zone provides a transition between upland development and the inner zone and should consist of managed woodland that allows for infiltration and filtration of runoff. A 25-foot width is recommended for this zone at a minimum. Forested riparian buffers should be maintained and reforestation should be encouraged where no wooded buffer exists. Proper restoration should include all layers of the forest plant community, including understory, shrubs and groundcover, not just trees.

- An outer zone allows more clearing and acts as a further setback for impervious surfaces. It also functions to prevent encroachment and filter runoff. A 25-foot width is recommended for this zone.

Ideally, all three zones of the riparian buffer should remain in their natural state. However, some maintenance is periodically necessary, such as planting to minimize concentrated flow, the removal of exotic plant species when these species are detrimental to the vegetated buffer and the removal of diseased or damaged trees.

Floodplain areas should be avoided on a development site. Ideally, the entire 100-year floodplain at full buildout should be avoided for clearing or building activities, and should be preserved in a natural undisturbed state where possible. Maps of the 100-year floodplain can typically be obtained through the local review authority.

Standards

General

a) No disturbance shall occur to preservation areas during project construction.

b) Preserved areas shall be protected by limits of disturbance clearly shown on all construction drawings and clearly marked on site.

c) Preservation areas shall be located within an acceptable conservation easement instrument that ensures perpetual protection of the proposed area. The easement must clearly specify how the natural area vegetation shall be managed and boundaries will be marked. [Note: managed turf (e.g., playgrounds, regularly maintained open areas) is not an acceptable form of vegetation management.]

d) Preservation areas shall have a minimum contiguous area of 10,000 square feet or in the case of stream buffers must maintain a 50-foot set back from the jurisdictional wetland edge along the entire length of stream through the property of concern. Areas of smaller size may be incorporated for disconnection of impervious surface, but will be considered as open space in good condition.

e) Level spreaders or other dispersion devices shall be incorporated, where practicable, to ensure sheet flow. See *Figure 3.5*, which depicts a level spreader. (Please note that the level spreader shown here is for dispersion of low flows only.

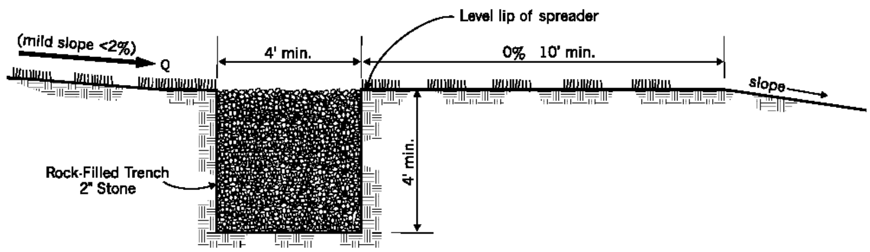

Figure 3.5 – Rock trench level spreader for low flows. Source: Prince George's County, Maryland, 2000.

f) Bypass mechanisms for higher flow events shall be included to prevent erosion or damage to a buffer or undisturbed natural area.

g) The incorporation of constructed berms around natural depressions and below undisturbed vegetated areas shall be considered to provide for additional runoff storage and infiltration. Proper use of berms is discussed in the section entitled vegetated filter strips.

h) Where no berms are provided in Hydrologic Soil Group (HSG) type A and B soils, buffers may be used to attenuate and treat flows up to the water quality volume (i.e., volume equal to one inch over the impervious surface) in the following ratios:

Table 3.1
Ratio of Forested Buffer to Impervious Surface Required to Attenuate Runoff for Precipitation between 0.5 and 1.0 Inches[a, b]

	HSG Soil Type			
Runoff (inches)	**A**	**B**	**C**	**D**
1.0	1:3	2:1	N/A	N/A
0.9	1:4	1:1	N/A	N/A
0.8	1:6	2:3	N/A	N/A
0.7	1:9	2:5	N/A	N/A
0.6	1:15	1:4	1:1	N/A
0.5	1:25	1:8	1:2	N/A

Notes:

[a]Buffer size calculations based on TR-55. Calculations for precipitation depths less than 0.5 inches are not included as the empirical equations of TR-55 become less accurate for storms less than 0.5 inches.

[b]Standards for buffer width, area and length of contributing flow path, etc. must be met regardless of soil's capacity to attenuate flow.

i) Land cover in buffers will be assumed to be woods in good condition (i.e., Curve number (CN) equal to 32 in type A soil and 55 in type B soil). Type C and D may not be used for this purpose as woods on these soil types cannot abstract the depth of rainfall associated with one inch of runoff from the impervious surface.

j) Runoff must enter the buffer as overland sheet flow. The average contributing slope should be no less than 1% and no more 3%. Maximum average slope may be increased to 5% if a flow spreader is installed across the entire contributing length followed by a flat (i.e., 0% slope) 10-foot shelf across the length.

Streambank Areas

a) The minimum undisturbed buffer width shall be at least the wetland jurisdictional setback plus 50 feet (e.g., 150 feet for streams less than 10 feet wide).

b) The maximum length of area contributing runoff should be no more than 150 feet for pervious surfaces and 75 feet for impervious surfaces. The minimum contributing length should be no less than 20 feet.

Maintenance

Except for routine debris removal, buffers shall remain in a natural and unmanaged condition.

3.3 Avoid Disturbing Long, Steep Slopes

Disturbance of long, steep slopes tends to cause soil erosion. Studies show that soil erosion is significantly increased on slopes of 15% or greater. In addition, the geometry of steep slopes means that greater surface areas are disturbed to locate facilities on them compared to flatter slopes as demonstrated in *Figure 3.5*.

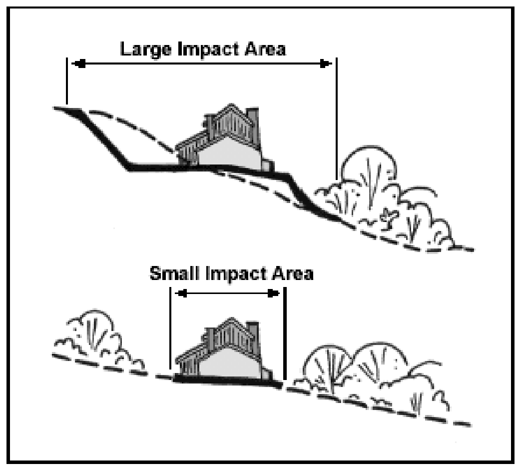

Figure 3.6 – Building on flatter slopes reduces the impact of development. Source: Atlanta Regional Commission, 2001.

Advantages

- Prevents soil erosion and sedimentation.
- Stabilizes hillsides and soils.
- Reduces the need for cut-and-fill and grading and may substantially reduce cost of development.

Standards

a) Avoid development on steep slope areas. As a general rule do not exceed the following values:

Grade	Slope Length
0% - 7%	300 feet
7% - 15%	150 feet
over 15%	75 feet

(Prince George's County, 2000)

b) On slopes greater than 25% (Georgia, 2000), no development, regarding, or stripping of vegetation should be considered unless the disturbance is for roadway crossings or utility construction. Erosion hazard risk increases as follows:

Grade	Erosion Risk
0% - 7%	Low
7% - 15%	Moderate
over 15%	High

(Prince George's County, 2000)

c) Avoid unnecessary grading on all slopes, as should the flattening of hills and ridges.

d) After cutting out soils, avoid inverting the soil horizons while filling.

3.4 Minimize Siting on Porous and Erodible Soils

This technique discusses appropriate standards for managing development in areas of erodible and porous soils.

Advantages

- Areas with highly permeable soils can be used as nonstructural stormwater infiltration zones.
- Avoiding highly erodible or unstable soils can prevent erosion and sedimentation problems and water quality degradation.
- Infiltration of stormwater into the soil reduces both the volume and peak discharge of runoff as well as groundwater recharge.
- Infiltration provides for water quality treatment.

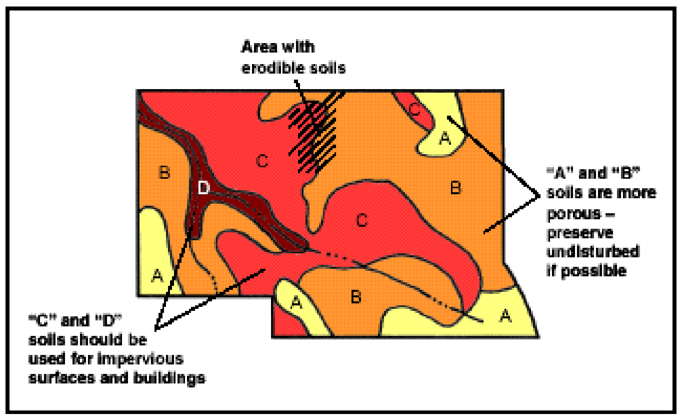

Figure 3.6 – Site plans depicting hydrologic soil groups1

Use

a) Use soil surveys to determine site soil types.
b) Delineate hydrologic soil types on concept site plans to guide site layout and the placement of buildings and impervious surfaces (see *Figure 3.6*).

Standards

a) Whenever possible, leave areas of porous or highly erodible soils (hydrologic soil group A and B soils such as sandy and silty soils) as undisturbed conservation areas (see Preserve Natural Areas for more information on conservation areas).

b) Conversely, locate buildings and other impervious surfaces on those portions of the site with the *least* permeable soils. Gravel soils tend to be the least erodible. Also as clay and organic matter increase erodibility tends to decrease.

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