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Low Impact Development (LID) and Section 404 Clean Water Act Permitting

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Abstract

The use of innovative Low Impact Development (LID) methodologies and practices is steadily gaining use on individual development projects in Virginia. LID is an approach to site design and stormwater management that seeks to maintain a site's pre-development rates and volumes of runoff. LID accomplishes this through the minimization of impervious cover, strategic placement of buildings, pavement and landscaping, and the use of small-scale distributed management features that are collectively called "Integrated Management Practices" (IMPs). This concept began in Prince George's County, Maryland in 1990, as LID began to be used as an alternative to traditional stormwater best management practices (BMPs) implemented at construction projects. Reviewing officials found that the traditional practices such as detention ponds and retention basins were not cost-effective and the results did not meet water quality goals. The U.S. Army Corps of Engineers Norfolk District Regulatory Branch has accepted and used the LID approach on several projects to minimize and/or avoid direct impacts to the aquatic environment by working with applicants to implement LID methodologies into their site design for commercial and institutional development projects. In August 2007, the Norfolk District Corps of Engineers (Corps) issued a final public notice requiring an LID design checklist as well as runoff calculations worksheets to be used in the project design of commercial and institutional developments that require a Corps permit. The Corps encourages consultants and applicants to incorporate LID methodologies into their development plans to further reduce impacts to wetlands and streams and maintain sustainably of aquatic resources. The Corps will consider LID practices in our review of specific commercial and institutional developments that involve impacts to streams and wetlands resulting from stormwater management facilities.

It is well documented that headwater streams provide valuable goods and services to the public. Very often, conventional stormwater management planning involves the placement of stormwater ponds in headwater streams. The accumulated scientific evidence indicates that there are numerous environmental consequences when headwater streams and wetlands are lost (Meyer and Wallace 2001). These consequences include changing the flow regimes of streams such as the frequency, duration and intensity from storm flows as well as reducing base flows (e.g. Dunne and Leopold 1978). When rain falls on impervious surfaces, rapid runoff is inevitable. As water spills off roofs and impermeable pavement, what water doesn't seep into the exposed ground ends up in storm drains, and that can add up quickly. According to a recent estimate by the U.S. Geological Survey, an inch of rain falling on the city of Richmond Virginia is roughly equivalent to 973 million gallons of water. Natural stream channels typically adjust to these urban runoff events by widening and deepening, causing erosion and thereby smothering aquatic life with sediment resulting in deleterious effects to the aquatic environment.

During the review of a Section 404 permit application by the Corps, some consideration must be given to assessing direct, indirect, and cumulative impacts. These impacts to streams can result from filling activities proposed in streams such as the construction of impervious surfaces and stormwater BMP ponds. The Corps regulates wetland and water impacts under two separate but harmonizing regulations. Section 404 of the Clean Water Act was established by Congress in 1972. This program was created to regulate the discharge of dredged or fill material into waters of the United States. The Rivers and Harbors Act of 1899 defined navigable waters of the United States as "those waters that are subject to the ebb and flow of the tides and/or are presently used, or have been used in the past, or maybe susceptible to use to transport interstate or foreign commerce." The Clean Water Act built on this definition and defined waters of the United States to include tributaries to navigable waters, interstate wetlands, wetlands which could affect interstate or foreign commerce, and wetlands adjacent to other waters of the United States.

The Section 404 Program is jointly administered by the U.S. Army Corps of Engineers and the Environmental Protection Agency. The Corps is responsible for the day-to-day administration and permit review and EPA provides program oversight. The fundamental rationale of the program is that no discharge of dredged or fill material should be permitted if there is a practicable alternative that would be less damaging to aquatic resources or if significant degradation would occur to the nation's waters. Permit review and issuance follows a sequencing process that encourages avoidance of impacts, followed by minimizing impacts and, finally, requiring off-setting mitigation for unavoidable impacts to the aquatic environment. This sequence is described in the guidelines at Section 404(b)(1) of the Clean Water Act.

When the Corps receives permit applications on a day-to-day basis for development projects that result in fill material in headwater wetlands and streams, the Corps can only permit an alternative that is the least damaging practicable alternative to aquatic resources such as headwater streams and wetlands. In the review of a Section 404 permit application involving fill in streams and wetlands, such as a commercial, industrial or residential development project, it is often difficult to assess direct and indirect impacts to headwater streams without considering the land adjacent to the stream. Imperviousness caused by land development is a major cause of channel degradation. Imperviousness, in the form of rooftops, parking lots, roads, and compacted soil prevents water from infiltrating into the soil, and limiting the ability of the soil to store water. Imperviousness interferes with the natural dissipation of surface water. The excess flow generated by precipitation falling on these impervious surfaces will cause natural stream channels to scour and erode, which in turn, is a source of non-point source pollution. In addition to increased flow, impervious surfaces decrease the base flow of channels during dry conditions. Other impacts to the aquatic environment associated with an increase in imperviousness include more frequent bankfull flooding, loss of riffle pool structure in streams, degradation of stream habitat structure and quality (large woody debris, cobble embedding, and sediment deposition) , warmer stream temperatures, greater total maximum daily loads of stormwater pollutants, higher bacteria levels, lower diversity of native fish species, and overall loss of biodiversity within the stream. In addition, research conducted in many geographical areas, concentrating on numerous different variables and employing widely different methods, has yielded a surprising similar conclusion: stream degradation occurs at relatively low levels of imperviousness (10-20%).

Booth and Rinelt (1993) reported that bank de-stabilization began after basin imperviousness about 10%. Schuler (1995) noted that these findings were supported by fisheries habitat studies.

Stormwater management is an important component of any commercial or institutional development and must be sustainability in order for the project to be viable. Conventional stormwater management traditionally requires attenuation of flood peaks and/or the treatment for stormwater pollutants such as phosphorus, nitrogen, and silt (sediment). Very often, this goal is achieved through the construction of stormwater management ponds in waters and wetlands. Conventional stormwater management ponds typically detain some of the increased volume of water caused by increased impervious surfaces and release it at a lower rate. Stormwater management facilities are primarily designed to control peak discharge rates for certain storm events. Typically, the conventional stormwater management criteria requires that the post development peak discharge for a 2- and 10- year frequency storm event be maintained at a level equal to or less than the respective 2 –and 10-year predevelopment peak discharge rates through the use of stormwater management structures that control the timing and rate runoff. The selection of the 2-year return frequency storm is based on a belief that the 1.5-to 2-year storm dictates the shape and form of natural channels (Leopold et. Al. 1964, 1968). The selection of the 10-year storm is based on consideration of possible damage due to local flooding and stream bank erosion. It is becoming increasingly recognized that this type of approach is not sustainable for protecting streams for a number of reasons. A greater volume of runoff is released for a longer duration with conventional stormwater management. In addition, the conventional approach does not address the loss of volume for groundwater recharge and maintenance of base flow to streams and wetlands during low flow periods. The stormwater management facilities associated with many conventionally designed developments thus adversely affect the aquatic environment both upstream and downstream through filling and back-flooding and changes in receiving stream hydrologic regimes. There are also substantial inspection and maintenance costs associated with conventional stormwater management associated with large stormwater ponds.

Low impact development (LID) is increasingly becoming an important component of stormwater management planning in the Commonwealth of Virginia as an sustainable alternative to be evaluated during the stormwater planning process. Some of the current driving factors for incorporation of LID are minimization and avoidance of wetland impacts and mitigation for impacts to wetlands and/or stream channels. An excellent example of the integration of LID into a stormwater master plan is the Celebrate Virginia! North project in Stafford County, Virginia. This 1,478-acre commercial development project is one of the first large-scale development projects to incorporate comprehensive LID planning and implementation. The stormwater planning phase of this project included extensive coordination between the developer (Silver Companies), the environmental consultant Williamsburg Environmental Group, Inc. (WEG), the regulatory agencies, the locality, and interested stakeholders (Friends of the Rappahannock).

LID design strategies attempt to replicate the natural environment. These design concepts now have many titles and can be called and incorporated in sustainable site design, sustainable development, or green infrastructure. Specific LID design strategies and practices attempt to minimize impervious cover, conserve natural cover, and to replicate the pre-development runoff volume and timing, and replicate the pre-development runoff rate (volume, timing, and rate).

These are the three primary elements of a natural hydrograph. These goals may be achieved through the use of such options as permeable surfaces for parking areas, residential lot setbacks, minimizing of roadway widths where possible (taking into account fire and emergency vehicle access requirements), narrower sidewalks, selective clearing, flattening grades, disconnecting impervious surfaces, infiltration practices, amended soils, open, vegetated swales, and distributed versus concentrated runoff (maintaining natural runoff patterns).

Conventional Corps regulatory concerns focus primarily on the avoidance and minimization of direct impacts (i.e. fill material) to aquatic resources such as streams, wetlands and open water environments. Conventional stormwater performance criteria focus primarily on reductions in mass loading of urban pollution and flow attenuation. During the late 1990s, LID methodologies implemented on several large-scale commercial/residential development projects in the Fredericksburg, Virginia region resulted in a reduction of stream and wetland impacts by as much as 80%. An example of a typical large-scale development project would be the 960-acre planned residential development project in Stafford County, Virginia known as Embrey Mill. This project initially proposed over 35,000-linear feet of streams impacts and approximately 15-acres of wetland impacts. During the permit application review process, the applicant agreed to incorporate hybrid LID methodologies into the planning of the project. This planning greatly reduced stream and wetland impacts, primarily by revising their initial stormwater management plan. The revised selected alternative using a hybrid LID approach resulted in unavoidable impacts to 2.10-acre of wetlands and 6,901.56-linear feet of small streams. The use of a hybrid LID, pre-treatment, distributed practices and non-structural practices allowed the applicant to minimize impacts by eliminating some supplemental structural stormwater ponds that were originally incorporated into the project's approved preliminary plan, thus eliminating stream impacts associated with those facilities. More than 80% of the initially proposed impacts to streams were thus eliminated with the hybrid LID approach.

Another example of a typical large-scale development project would be the 1,126-acre planned Lee's Parke commercial/residential development project in Spotsylvania County, Virginia. Initially this project had gross impacts to wetlands and streams exceeding 20-acres. During the Corps pre-application process, the applicant was requested to explore ways to avoid and minimize those impacts and then develop a compensatory mitigation for all impacts the Corps concluded were unavoidable. As a result of the implementation of the LID worksheets developed by the Corps Fredericksburg Field Office, the applicant reduced direct and indirect impacts to the aquatic environment with the implementation of hybrid LID methodologies. This review resulted in a reduction of stream impacts from 16,679.42-linear feet to 1,927.46 linear feet (88% reduction of stream impacts) and 22-acres wetland impacts to 6.29-acres of wetland impacts (71% reduction of impacts). More than 50% of the reduction impacts resulted from distributed stormwater management practices planned in the upland, rather than stream valleys.

State-Federal LID Workshops

Due to the utility and success using LID methodologies in to reduce stream and wetland impacts and accommodating an applicant's stormwater management plans, the Corps Norfolk District sponsored several workshops around the Commonwealth of Virginia to seek comment on how LID practices should be considered in the review of development projects.

In December 2003, the Norfolk District jointly sponsored five workshops with the Virginia Department of Environmental Quality, the Chesapeake Bay Local Assistance Department, and the Virginia Department of Conservation and Recreation. The purpose of these workshops was to seek public comment on how LID practices should be considered in the review of development projects. These workshops were attended by over 375 individuals representing localities, the development community, environmental organizations, and the general public. After the workshop, a report was prepared from the workshops that outlined the comments received by the participants. The District worked with the representatives of all interests to form a workgroup to examine the issues. This workgroup produced a draft technical bulletin and draft local model ordinance and sent it to the Virginia Department of Conservation and Recreation (VDCR) in February 2005. Since 2005, VDCR has been actively working to incorporate Low Impact Development practices into the Commonwealth's new stormwater regulatory criteria, through what is referred to as the Virginia Runoff Reduction Method. The process of developing these regulations and technical criteria has involved stakeholders from various industry sectors and has seen numerous procedural hurdles and delays. VDCR anticipates that final regulations will be effective in late 2011, with the deadline for formal local adoption and implementation occurring no later than July 1, 2014.

LID Proposal

In July 2004, the District issued a public notice soliciting comments on a proposal to require a design checklist and runoff calculations worksheet be used in the project design of commercial and institutional developments that require a Corps Department of the Army permit. In its review of proposed commercial and institutional developments involving stormwater management facilities located in waters and/or wetlands, the Corps would first request project proponents to review alternatives to avoid such impacts. If those impacts could be avoided, the proponent would not be requested to conduct any additional LID-related analysis. However, if the proponent of a commercial or institutional development decided not to avoid all impacts to waters and/or wetlands caused by the stormwater management facilities, the Corps would request them to evaluate the practicability of incorporating LID practices to further minimize the impacts to the aquatic environment.

How Low Impact Development Practices Would Be Evaluated

The requirement to consider LID in project design acknowledges that LID is not practicable for all development sites. The Corps regulations recognize that for an alternative to be practicable it has to achieve the purpose of the project, be available to an applicant, and be feasible considering cost, logistics, and existing technology. Examples of circumstances when the use of LID practices would not be practicable, the Site Design Checklist and LID Calculations Worksheet would not need to be submitted are as follows:

- Projects that do not propose construction of stormwater management ponds in waters or wetlands (the Corps does not propose to change how we review stormwater outfalls or existing stormwater facilities.)

- Regions or project sites with soils that are prohibitive to the use of infiltration practices. This would include soil defined in county soil surveys as somewhat poorly drained to poorly drained for crops and pasture and/or the local hydric soils list. These are soils in the Hydrologic Soil Groups C and D (silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay loam, silty clay and clay).

- Regions or project sites with high water tables or Karst topography;

- Regions or project sites where opposition to the use of such practices is expressed by the governing locality; and

- For project sites where the use of distributed LID practices is incompatible with the use or development proposed, or State/local land use planning and zoning requirements.

The above clearly outlines when LID practices need to be considered. However, in cases when off-line stormwater management facilities are not practicable or LID is not considered practicable, and impacts to waters and/or wetlands will still occur, the Corps regulations require compensatory mitigation for all unavoidable impacts to waters and wetlands. In response to the Corps public notice for LID, comments were received from nine organizations with various concerns over the proposal. Over the ensuing months, a series of conference calls and meetings with various stakeholders who commented were conducted to discuss and address their concerns. After discussing the comments with the organizations expressing the concerns, a revised public notice was issued on August 10, 2006 providing the public with an opportunity to submit views on the changes we made to the proposal. Based on the public input from the August 2006 public notice, the Norfolk District issued a public notice for a Proposed Requirement Relative to Low Impact Development. Six (6) comments were received from the general public on the modified LID worksheets contained in the February 2007 Public Notice. In June 2007, the Norfolk District issued a Statement of Findings for Proposed Requirement Relative to Low Impact Development and posted the LID Site Design Checklist and LID Calculations Worksheet on its Norfolk District Homepage website.

Use of LID for Avoidance and Minimization of Impacts to Streams and Wetlands; Curve Number and Buffers

In order to determine whether a proposed project is a candidate for LID methodology under the Corps Section 404 regulatory program, consideration must be given to the project's impacts to wetlands and streams resulting from the proposed stormwater management facilities. Another important consideration is whether the use of distributed LID practices is incompatible with the use or development proposed, or is allowed under State/local land use planning and zoning requirements.

If a project is a candidate for the application of LID, a design engineer should first determine the pre-development composite curve number (CN) for the proposed development site (TR-55 peak discharge calculation). The basic concept is to design a development site as a "woods in good condition" so the initially abstracted volume of rainwater runoff can be determined. The next part of the LID process involves a series of steps included in a "Site Design Checklist" that provides the design engineer with the tools to greatly reduce stormwater quantity and quality impacts at the site. These better site design practices include avoiding and/or minimizing wetland and stream impacts, preserving natural cover on the site as much as possible, especially for areas located on hydrologic soil groups (HSG) A and B, minimizing overall impervious cover, locating infiltration practices on HSG A and B soils wherever possible, disconnecting impervious areas, increasing the travel time of water off the site (Time of Concentration), utilizing soil management/enhancement techniques to increase soil absorption, using swales for conveyance in lieu of curb and gutter wherever possible, and utilizing level-spreading of stormwater flow into natural open space unless prohibited by local or state regulations. The application of LID concepts on-site normally results in the reduction of impacts resulting from stormwater management ponds in-stream and reduction of impervious surfaces. Also, greater buffering of streams and wetlands reduces the post-development CN.

The next step in the LID process is to determine the LID custom-made CN. Practices such as level-spreading, disconnecting of impervious areas, and open space preservation reduces the CN, and subsequent need for stormwater management ponds in-stream. For example: The development of a 1-acre commercial site has a pre-development CN of 55. The conventional CN is determined to be 68. The application of LID Custom-made CN is 63. The Lid Custom-made CN has reduced the CN from 68 to 63. The *Low-Impact Development Hydraulic Analysis* manual provides an example of the computations in Example 4.1. Since the planning for forested buffers on-site reduced the CN, a portion of the stormwater is partially handled by buffering. The critical question to ask the proponent of a project with stream or wetland impacts is how could an LID plan proposed for the site in-lieu of conventional stormwater management design result in greater avoidance and minimization of impacts and greater forested buffering on the project development site? Very often, an LID design is comparable with the proposed land-use needs of the development. Two key points to remember with an LID designed site is that the process of design should be implemented at the inception of a project's planning and design and large stormwater ponds that are traded for greater landscaping and depressional storage do not necessarily mean buildable area is reduced or lost.

The aforementioned 1,478-acre Celebrate Virginia! North project in Stafford County, Virginia is one of the first large-scale development projects to incorporate comprehensive LID planning and implementation. In 2001 during a period of discussions and negotiations between negotiations between the applicant (Silver Companies) and the regulatory agencies, the extent of LID monetary costs was addressed during the Section 404 review process. Neil Weinstein of the Center for Low Impact Development was asked to assist in facilitating these discussions. The discussion workgroup decided that several of the applicant's existing commercial development projects in the area (all using conventional stormwater management) would be evaluated for a retro-fit with LID practices. This case-study would design plans for the implementation of LID practices on these sites then these associated costs would be compared to conventional

stormwater management already in place at the sites. In all cases, by utilizing LID on the sites, the costs would not be prohibitive, thus everyone would save money.

There are numerous instances where the effective use of LID site design techniques and site fingerprinting prove environmentally sustainable and can significantly reduce the cost of providing stormwater management. Savings to the development community and localities are achieved by eliminating or minimizing the use of stormwater management ponds, reducing the use or number of pipes, inlet structures, curbs and gutters on the site, less grading and roadway paving, less parking lot grading and paving. Where LID techniques are applicable, and depending on the type of development and site constraints, stormwater and site development design construction and maintenance costs can be reduced by 25% to 30% compared to conventional approaches (Coffman, 2000). The evolution of performance-based, cost-effective stormwater management policies reflecting greater infiltration opportunities is required. The ultimate benefit of LID is an innovatively designed and healthier urban environments would be created both preserving and mimicking natural systems and in addition, protecting surrounding ecosystems.

As an example, an important overall environmental benefit achieved through the use of LID on the "Celebrate Virginia! North" planned project is the use of substantial riparian buffers preserved adjacent to the Rappahannock River. One of the most important overall environmental benefits achieved through the use of LID on the "Celebrate Virginia! North" planned project is the use of riparian buffers adjacent to the Rappahannock River. The forest buffers reduce the post-development Curve Number for the project. This helps mimic pre-development hydrology. In order to achieve permit compliance, the applicant voluntarily put over 307-acres of forested buffers in conservation on the 1.483-acre project area. The total length of forest buffer preservation added up to over 30,000 linear-feet. The buffers help maintain hydrologic function in the watershed and also maintain biological integrity of migration corridors for terrestrial and aquatic organisms.

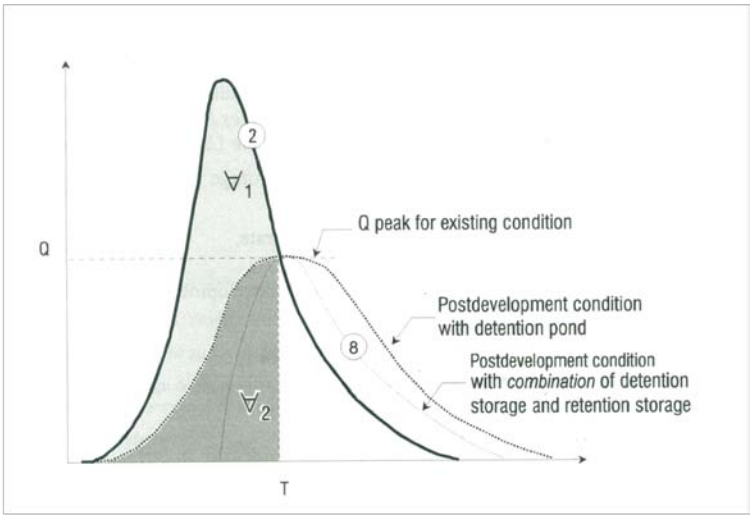

Figure 1.1: Example of Pre-development and Post-development runoff from a development site.

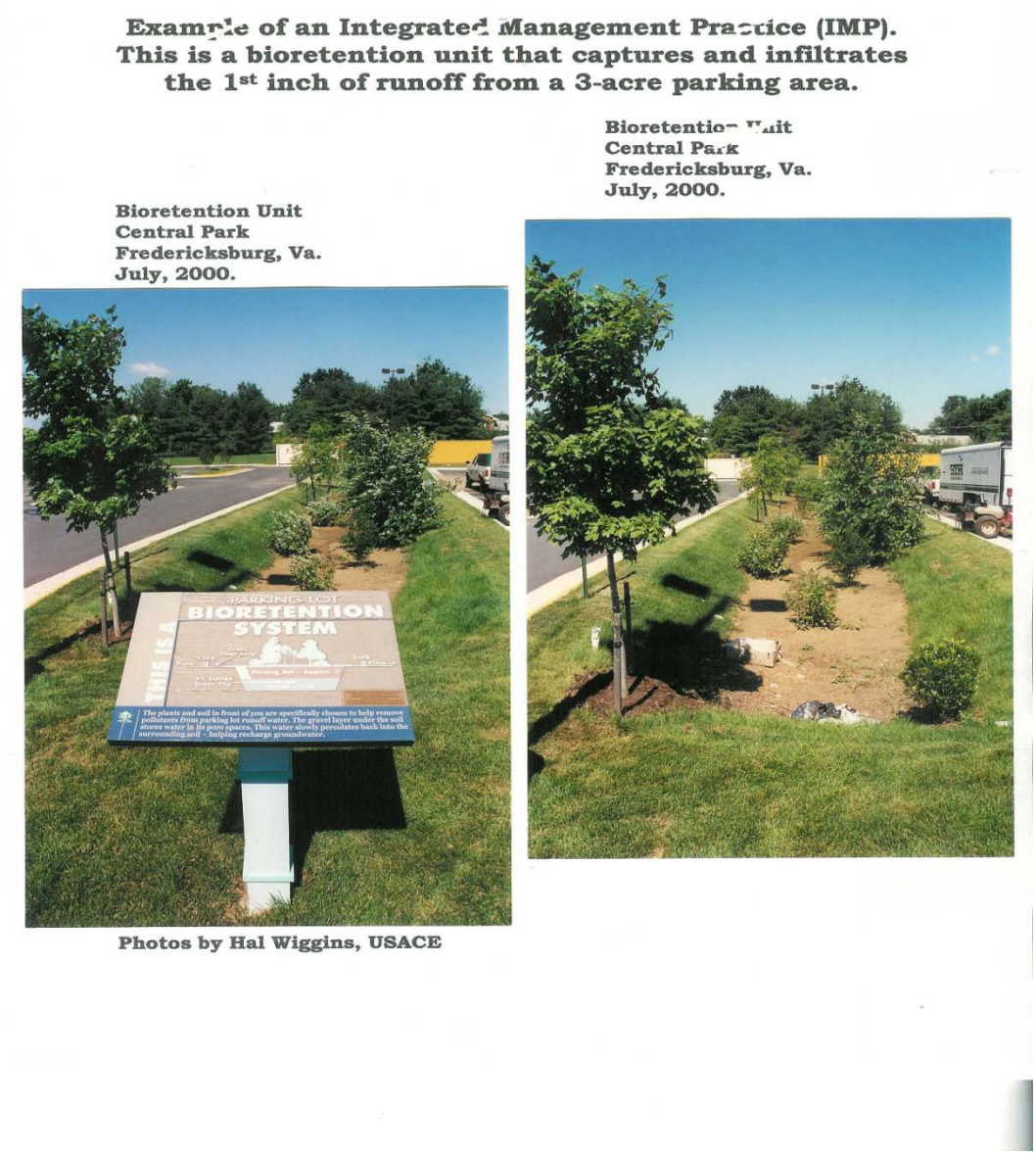

Figure 1.2: Example of bioretention adjacent to a parking lot, Central Park Commercial Development, Fredericksburg, Virginia. Photos taken by Hal Wiggins, 2000.

Maintenance and Monitoring of LID Practices

The Corps generally does not require LID worksheets for single family residential development or the construction of integrated management practices (IMPs) such as raingardens on individual lots. These requirements could be in opposition to local land-use policies. The monitoring for compliance of these facilities on-lot could be problematic as the homeowners may not have maintenance agreements with local governments. The Corps does evaluate the direct and indirect effects of stormwater management related to large-scale developments on a case-by-case basis that are proposed in waters of the United States. The LID worksheets were developed to

assist in the analyses of these types of projects. Maintenance requirements and inspection frequencies for larger residential, commercial and industrial projects are outlined in Commonwealth of Virginia's 2001 Stormwater Management Regulations (4VAC3-20). The responsibility of the required maintenance rests with the permittee for the life of the permit unless a transfer to another party is approved by the Norfolk District, Corps of Engineers. Permits are transferable in whole or in part. (USACE, Norfolk)

Determining the LID Runoff Curve Number
(LID Hydrologic Analysis, pg 22-25)

I. Calculate pre-development Curve Number (CN) and Time of Concentration (Tc) using TR-55 or other suitable method. The 1-year, 24-hour storm may be used in this calculation.

CN_{pre} = _____
Tc_{pre} = _____ *minutes*

b. For comparison purposes, calculate a composite curve number for the *developed site*, using the conventional TR-55 approach. For sites with less than 30% imperviousness area, calculate a composite curve number for the site, following the approach in Section 4.3 (paragraph 22-24) of LID Hydrologic Analysis"

$CN_{conventional}$ - _____

c. Calculate a composite custom LID curve number for the site, following the approach in Section 4.3 (pages 22-24) of "LID Hydrologic Analysis*". *This is much more detailed than the conventional Tr-55 approach.* This approach factors in the use of higher permeability soils for infiltration and the use of "disconnectedness" (impervious cover flowing to pervious cover). Use an R factor of "1" for bioretention practices.

$CN_{conventional}$ = _____ *(from above)*
CN_{LID} = _____

Reduction in CN achieved with site design = _____ *($CN_{conventional}$ - CN_{LID})*

d. Calculate the post-development Time of Concentration (Tc). To increase the Tc to the predevelopment Tc or greater, utilize the practices described in "LID Design Strategies"*, such as flattening grades, lengthening flow paths, etc to increase the Tc to the predevelopment time.

Tc_{pre} - _____
Tc_{LID} - _____ (the Tc after maximizing practices to lengthen flow travel time)

NOTE: For the LID approach to function effectively, the Tc_{pre} should be less than or equal to equal to the Tc_{LID}. If Tc_{LID} is lower, **STOP here** and incorporate practices to increase it.
See "LID Design Strategies" for details.

Figure 1.3: Excerpt from Section B: LID Calculations Worksheet.

Conclusion

In an ever changing world of wetland regulations and environmental standards, we strive for innovative and better technology. The implementation of low impact development practices are a great tool in the toolbox that can be used to mitigate the loss of headwater streams associated with large-scale development projects. The LID approach implemented on development projects such as Celebrate Virginia! North, Embrey Mill, and Lee's Parke and others in the Central

Virginia region focused on the conservation of wetlands and streams, stream buffers, and the restoration and maintenance of hydrologic functions within a largely developed watershed. This paper has put forth a variety of sustainable infiltration practices are designed and incorporated into the planning for each large-scale development projects within their watersheds. These include maintaining 25% or greater open space with emphasis on planting and preserving native trees, using biofiltration systems, level-spreaders, vegetated swales and sandfilters, and also using extended detention ponds with sediment forebays. Low impact development can be implemented by determining the initial abstracted volume of stormwater for the pre-development scenario (the amount of water held by the soil and depressional features in the watershed before runoff starts) and by calculating the area weighted CN for the watershed's pre-development condition. The goal is to reduce the curve number of the post-development scenario to the pre-development curve number, or as close as possible, using any of a diverse array of "LID" techniques. This is the key to replicating pre-development hydrology. This can be accomplished by conserving trees and open space, minimizing impervious cover, lengthening the "Time of Concentration" by creating slower, circuitous, rougher flow routes, and using distributed, "Integrated Management Practices" throughout the landscape, which allows the landscape features to detain, slow, and infiltrate water. The TR-55 methodology is an effective tool to model the reduction in curve numbers using LID practices distributed across the landscape. For example, a biofilter can be modeled for 6" or more of detention or infiltration. Management of both runoff volume and peak runoff rate is included in the LID design. The LID approach is to manage runoff at the source rather than at the end of a pipe. Maintaining the hydrologic regime of the pre-development condition may require both structural and non-structural techniques to compensate for the hydrologic alterations caused by the development. The use of LID to mitigate stream loss is appropriate in a case-by-case review, and the associated costs and practicality of LID should be considered in the project review. The Site Design Checklist and LID Calculations Worksheet developed by the Corps assists land planners, environmental consultants and design engineers with the tools to accomplish this goal. The Commonwealth of Virginia's final stormwater regulations anticipated in late 2011, with the deadline for formal local adoption and implementation occurring no later than July 1, 2014 could allow for greater flexibility and stormwater credit for the implementation of LID.

Definitions

Site Fingerprinting: Development approach that places development away from environmentally sensitive areas (wetlands, steep slopes, etc.), future open spaces, tree save areas, future restoration areas, and temporary and permanent vegetative forest buffer zones. Ground disturbance is confined to areas where structures, roads, and rights-of-way will exist after construction is complete.

Time of Concentration (Tc): The time for runoff to travel from the hydraulically most distant point of the development site to the watershed outlet of study point (i.e. receiving stream).

Integrated Management Practices (IMPs): An LID practice or combination of practices that are the most effective and practicable means (including technological, economic, and institutional considerations) of controlling the predevelopment site hydrology. IMP strategies help replicate

the pre-development surface and sub-surface hydrologic regime is through the combination of design principles and practices. These design principles incorporate structural and non-structural stormwater practices into a site design, and will each have either a direct or indirect effect on the measurable hydrologic characteristics of the site.

Hydrological Soil Groups (HSG): Soil groups which are classified according to their drainage potential. Group A soils absorb a lot of water and are deep, well-drained, and composed of sand or gravel. Conversely, Group D soils do not absorb as much water and have a high run-off potential, and have a layer of high clay content near the surface or are shallow soils over bedrock or other material which does not absorb water.

Curve Number (CN): The curve number (CN), also called the runoff curve number is an empirical parameter used in hydrology for predicting direct runoff or infiltration from rainfall excess. The curve number method was developed by the USDA and was formerly known as "SCS runoff curve number." The CN is based on an area's hydrologic soil group, land use, treatment and hydrologic condition. CN has a range from 30 to 100; the lower numbers indicate low runoff potential while larger numbers are for increasing runoff potential.

LID "Hybrid" Design: A hybrid LID design employs both LID and conventional BMPs or detention practices (e.g., centralized BMPs) to meet stormwater requirements. Such a design might conserve specific natural features and provide open space to the greatest extent possible, while detention measures or centralized BMP's are also implemented to provide peak rate or quantity control beyond the site-specific capabilities of the LID strategy. Another example of a hybrid design is one that incorporates LID for both the attenuation and infiltration of small storm events, and centralized BMPs to provide storage for larger storm events. (Control of runoff from larger storm events may be necessary to protect downstream manmade or natural conveyance systems in accordance with MS-19, or other watershed specific criteria.)

Detention: The collection of runoff in a ponding area, depression, or storage chamber followed by its gradual release through an outlet into a receiving water body. Detention is one way to reduce a site's peak runoff rate to its pre-development peak rate for the storm event of a given magnitude, but is not an effective way to reduce the runoff volume.

Retention: The collection of runoff in a ponding area or receptacle where it is kept until it soaks into the ground through infiltration. Retention reduces the volume of runoff from a site and can also be effective in reducing the peak runoff rate if the retention volume is sufficiently large.

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