NEW DIRECTIONS IN LOW IMPACT DEVELOPMENT: IMPLICATIONS FOR URBAN REDEVELOPMENT

Neil Weinstein, P.E., R.L.A., AICP

AUTHOR: Executive Director, The Low Impact Development Center, Inc., 5010 Sunnyside Avenue Beltsville, Maryland 20705
REFERENCE: *Proceedings of the 2005 Georgia Water Resources Conference,* held April 5-27, 2005, at the University of Georgia, Kathryn J. Hatcher, editor, Institue Ecology, The University of Georgia, Athens

---

Abstract. Low Impact Development (LID) LID offers many innovative solutions to both dry and wet weather stormwater flow management, but this approach also presents many challenges for the development of implementation and sustainable management strategies in urban areas. This paper will highlight the research and planning strategies that the Center has found in its work on integrating planning, and implementation of Low Impact Development into watershed planning, design, and construction through various federal and local grants and projects. The new objectives and opportunities for the retrofit of urban areas are requiring stormwater planners and engineers to gain a much broader understanding of the implications and opportunities of using LID in the urban environment. The paper will focus how LID can be used to accomplish both community redevelopment and water quality objectives. The Center has found that LID not only offers many advantages over conventional centralized water resource protection strategies, but also presents many new opportunities for community and economic development.

INTRODUCTION

LID was initially developed as a distributed stormwater design approaches to meet basic flood control, drainage, and water quality control requirements. The current state of the practice dictates that the basic LID approach should be expanded to include a broader range of community development and environmental issues.

Low Impact Development (LID) is a decentralized source control stormwater management strategy (PGDER, 2000). The LID site design approach can be used to address

Perhaps most powerful LID component for urban retrofit is the Integrated Management Practices (IMP) initiative. As described previously, IMPs are functional components of the built environment that have been specifically designed and integrated into site plans to address hydrologic and/or water quality project goals. IMPs can be constructed incrementally, either as a part of new construction or retrofit projects, or as large-scale capital improvement projects. They can be designed to address or incorporate one or more hydrologic, hydraulic, or water quality processes. An IMP can be designed with processes or filtering materials that can address a targeted pollutant. They are most typically designed in series as a “treatment train” where multiple pollutants are treated or hydrologic and/or hydraulic project goals are met.

IMPs can be integrated into urban sites and are quite diverse in design. Ideally, IMPs also function as aesthetic features. The placement of vegetation is a major component of IMP design and can provide benefits beyond water quality treatment and hydrologic and hydraulic control. Techniques such as tree box filters can be constructed as part of streetscape improvement programs. Bioretention Cells can be constructed by as part of job training programs, community clean up days, on a voluntary basis, and as jobs training programs. These expand the possibilities for construction as well as stakeholder and community involvement. Explicitly, integrating stormwater design into the built environment results in improved stakeholder involvement.

PLANNING METHODS

Over the last several years, the LID Center has received funding from several USEPA Office of Water, Summit Fund, and Chesapeake Bay Program grants to develop LID planning protocols and strategies for urban areas. In order to develop these protocols, the Center began with researching different approaches and strategies that have been used around the world to implement decentralized controls. Although there is a tremendous interest in using techniques that have gained widespread use in Europe, such as vegetated roofs, permeable pavements, and water conservation (recycling), there is little long-term experience in the use of “green” techniques (LID Center, 2000). One of the key challenges of using LID is the shift that planners must make to move from making the stormwater treatment the primary goal of the construction to one where the community development or aesthetics are the overriding objective and the stormwater function must be incorporated into the design of the element. For example, bioretention cells are landscaped areas where a special soil mixture, surface storage, and release structures are incorporated into the landscape area as a seamless element.

Another important shift is the recognition in much of the country is that by capturing and managing the volume of runoff from frequently occurring smaller storm events there is the opportunity to reduce a significant amount of pollutant loads. This is critical in highly developed coastal areas where water quality loads to estuarine areas are critical in habitat areas (Wright and Heaney 2001). By using minimization techniques, the volume of stormwater and required area for treatment could be reduced. This reduction in infrastructure could potentially save capital and increase the area of developable land (Thurston et al. 2003).

The Prototype LID Planning Process (Prototype) provides a method of assessing the project goals and site characteristics in the initial stages of design development in order to make informed decisions about the placement, magnitude, and number of LID stormwater controls. This planning method proposes a recursive, iterative methodology that can be used to design and arrange stormwater controls as efficiently as possible, in terms of space, effectiveness, and expense.

The Prototype provides guidelines for selecting site-appropriate LID stormwater controls within the framework of the project goals. The *Prototype (Figure Five)* illustrates the planning and evaluation process in five (5) steps:

Step 1. Determine watershed planning goals;
Step 2. Characterize the site and the existing urban environment;
Step 3. Evaluate the candidate LID BMPs;
Step 4. Determine the cost-effectiveness in the context of the goals and site characteristics; and
Step 5. Select suitable site-appropriate BMPs.

Step 1. Determine Watershed Planning Goals

The overall planning goals for the watershed will guide the LID retrofit strategy and influence the type and placement of BMPs chosen. There are three main categories of watershed planning goals: hydrologic, ecological, and community and economic development. Examples are given for each category.

a. Hydrologic

Hydrologic goals are related to the objectives of conventional stormwater management, but may also impact the ability of BMPs to meet ecological and community goals. This category includes addressing runoff volume, peak discharge rate, flood control, and water reuse.

b. Ecological

Ecological goals may apply at the site, downstream of the site, or both. They may involve specific criteria, such as not exceeding a specific pollutant concentration, or may be more comprehensive, such as maintaining or enhancing the site's ecological function. This includes addressing water quality, stream aquatic health, habitat creation, and antidegradation of habitat.

c. Community and Economic Development

LID techniques can also be used to address a variety of community and economic planning goals, examples of which are given below. These goals may change, or become more apparent, as the planning process proceeds and more stakeholders become involved. The planning process must be flexible enough to adapt to new concerns that arise. This includes "Green Infrastructure" or "Green City", Leadership in Energy and Environmental Design (LEED) certification, reductions in stormwater utility fees, historic preservation, and limiting construction disturbance.

Step 2. Characterize the Site

The effectiveness of LID practices in meeting planning goals may be enhanced or restricted by the site characteristics and the nature of the project. The framework or approach depends on if it is a comprehensive redevelopment of a site or a retrofit for a specific watershed planning goal. The next step is to determine the land cover (e.g. pervious, impervious), land activity (e.g. commercial, residential, industrial), and the timeframe, stability or opportunities for change of these site characteristics.

Step 3. Evaluate Candidate Practices

Once the overall regulatory, resource protection, economic, ecological goals, and site characteristics are well understood, specific LID practices can be evaluated for their suitability. LID practices must also be compatible with the land use, blend into the community fabric, and be accepted by the residents in order to become an asset of the community and to ensure long-term effectiveness. The BMPs are ranked according to these criteria and guidelines, which are offered as common examples of planning and design considerations however do not constitute an exhaustive list. The criteria for selection starts with an initial feasibility to look at utility issues and constructability. Next are the guidelines for looking the most appropriate use of the BMP. This involves matching the BMP with the appropriate land use. For example, a sand filter would not be appropriate for a low density residential use. The effectiveness of the BMP is then evaluated by modeling and conducting a cost analysis. Finally the compatibility with other BMPs, life-cycle costs, code compliance, and long-term sustainability is measured. construction on receiving waters.

Step 4. Determine Cost-Effectiveness in Context of Goals and Site Characteristics

One of the key lessons of using decentralized controls is the flexibility and the ability of several different types of BMPs to have similar stormwater management capabilities. Although the facilities may have different space requirements, aesthetics, and ancillary functions, they may be used to satisfy the management requirements. For example a vegetated roof and a bioretention system may have equivalent runoff volume capabilities. This flexibility can allow the designer to integrate equivalent controls into the landscape and site even if the land use changes.

The analysis in Step 3 may show that there is only one appropriate BMP for each portion of the site, based on the selection criteria. In some cases, two BMPs may seem to be approximately equal in suitability. For example, the capture of volume and runoff control of a rain garden system around the perimeter of a building may be equivalent to a cistern in the building.

In this case, additional evaluation criteria can be used to decide the selection of the BMP. For this case the value of water conservation could be compared with the aesthetics and potential energy conservation of the plant material in the bioretention system. Additional selection criteria such as groundwater recharge or habitat development could also be incorporated into the ranking system.

The initial evaluation of a design strategy that only modifies the design slightly to accommodate the BMPs may show that the overall regulatory or resource protection goals may not be met. Additional controls may be required that alter the site design. This may include specialized designs for the facilities to enhance the effectiveness of the controls, a higher density of controls, additional maintenance, additional pollution prevention, or off-site controls to meet the overall watershed requirements.

Step 5. Select BMPs

Select a suite of BMPs most suitable for meeting the overall watershed requirements and provide site-specific solutions to planning goals. The suite may incorporate a single BMP, a combination of BMPs (e.g., green roofs and cisterns), or may use no BMPs depending on the watershed and natural resource protection goals. Different alternatives and scenarios, similar to a linear programming or optimization approach are employed to allow the most flexibility.

RESULTS

The following section presents the results of several studies and the implications for the planning and design process. Figure One is a schematic of a block that is being planned for redevelopment in the Anacostia Watershed in Washington, D.C. The LID design goal here is to overlay LID methods onto the existing design to demonstrate that the techniques could be integrated into the site design with minimal impact or influence on the design goal. Several scenarios and levels of integration of practices were analyzed using the Prince George's County LID Model in order to determine the effectiveness of reducing runoff volumes, peak flows, and pollutant loads. Table One shows the results of the analysis.

The results of the study show that although there are significant reductions in the loading that more extensive controls may be required to reduce the loadings to zero or minimal discharge of volume.

LID also has a place in new design approaches such as Traditional Neighborhood Design (TND). TND developments are highly dense and multi use communities that are extremely impervious and generate a tremendous amount of runoff volume on a frequent basis. The small scale nature of LID controls allows for techniques to be integrated into small spaces in the development. Figure Two is a picture of a bioretention facility integrated into residential TND courtyard.

Figure 1: LID Overlay

Table 1: Volume and Pollutant Load Results

Yearly results				
Indicator	Units	No LID	LID improvements	% reduction
Outflow	million gallons/year	3.24	2.18	33%
Sediment	tons/year	35.1	10.4	70%
BOD5-day	pounds/year	136.5	48.6	64%
Total N	pounds/year	36.3	16.2	55%
Total P	pounds/year	3.3	1.6	53%
Total Zinc	pounds/year	2.0	0.7	67%

Figure 2: TND Bioretention Cell

CONCLUSIONS

Many challenges exist for the use of integrated controls in urban environments. This includes design and planning issues as well as an understanding of the potential benefits by planners and the development review groups. As costs for technologies, such as vegetated roofs and tree box filters are reduced due to market demands and reduced construction costs, they will also gain more use in the development industry. Cities are faced with the challenge of reducing stormwater volume, peak runoff rates, and pollutant loads not only to meet regulatory requirements but as health and economic viability issues. Incentives must be provided to encourage the development community to use LID. This includes credits for density and green space. Often these issues are not coordinated between the stormwater review agencies and the planning and zoning codes and reviewers. Other economic incentives such as credits for utility fees will also help promote the use of these techniques.

REFERENCES

Heaney, J.P., Sample, D. and Wright, L. (1999). *Costs of Urban Stormwater Systems*. US EPA Report EPA/R-02/021, National Risk Management Research Laboratory, Cincinnati, OH, 113 p.
http://www.epa.gov/ORD/NRMRL/Pubs/600R02021/600R02021.htmlThurston, H.H., Szlag, D, and Lemberg, B. (2003). "Controlling Storm-Water Runoff with Tradable Allowances for Impervious Surfaces," Journal of Water Resources Planning and Management, September/October, pp. 409-418.
Weinstein, Neil. and Anne Guillette (2004) "Low Impact Development Master Plan Strategies for the Anacostia Waterfront Initiative". www.lowimpactdevelopemnt.org