Low Impact Development (LID) Practices for Storm Water Management

A cost effective way to address storm water management through site design modifications and "Best Management Practices"

Details Manufacturers Testimonials Resources CAD Details

Summary
Installation
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Benefits/Costs

PATH Attributes:

Ease of Implementation:

EASY DIFFICULT

Initial Cost: NA
Operational Cost: NA
Field Evaluations: N/A
Code Acceptance

Symbol Legend

Other technologies to reduce impact of development

Permeable Pavement

Rainwater Harvesting

Summary

Water quality concerns have intensified, and storm water management practices have come under scrutiny, as development occurs on an increasing percentage of the available land area in the United States. With more stringent design requirements, costs for traditional collection and conveyance systems have risen sharply. Organizations from community groups, to regional watershed authorities, to state and federal agencies have become involved in this issue. Subsequent changes in storm water regulations could strongly impact builders and communities as more new regulations and practices are implemented. Low Impact Development (LID) techniques can offer developers a more cost effective way to address storm water management through site design modifications and "Best Management Practices" (BMPs). These strategies allow land to be developed in an environmentally responsible manner, and create a more "Hydrologically Functional" landscape.

In 1998, a report on Stream Corridor Restoration was produced by the Federal Interagency Stream Restoration Working Group (FISRWG) documenting the impact of human activities on the stream systems forming the backbone of watersheds throughout the United States. This group represents 15 Federal agencies from the Departments of Agriculture, Commerce, Interior, Defense, Housing and Urban Development (HUD), Environmental Protection Agency (EPA), Federal Emergency Management Agency (FEMA), and Tennessee Valley Authority (TVA). The following illustration from the report shows how development affects water infiltration into soils and runoff.

Less developed land areas allow a larger portion of storm water to seep gradually into soils, remove contaminants, replenish soil moisture, and recharge groundwater aquifers. As areas become developed, a much larger percentage of rainwater hits impervious surfaces including roofs, sidewalks, parking lots, driveways, and

streets, and must be controlled through storm water management techniques. Traditional approaches have focused on collection and conveyance to prevent property damage. Local building code requirements often require developers to take an "end of pipe" approach, using gutters and piping systems to carry rainwater into ponds or detention basins. As new requirements have attempted to address water quality, erosion, flow volume, and other problems created by common conveyance methods, the cost and complexity of these engineered systems has increased.

Low Impact Development (LID) strategies strive to allow natural infiltration to occur as close as possible to the original area of rainfall. By engineering terrain, vegetation, and soil features to perform this function, costly conveyance systems can be avoided, and the landscape can retain more of its natural hydrological function. Low Impact Development practices dovetail with "green" building practices that incorporate environmental considerations into all phases of the development process. Builders can often use green building and LID to lower actual development costs. Although most effective when implemented on a community-wide basis, using LID practices on a smaller scale, i.e., on individual lots, can also have an impact.

Pollution from storm water runoff can also be a major concern, especially in urban areas. Rainwater washing across streets and sidewalks can pick up spilled oil, detergents, solvents, de-icing salt, pesticides, fertilizer, and bacteria from pet waste. Storm water drains do not typically channel water to treatment facilities, but carry runoff directly into streams, rivers, and lakes. Most surface pollutants are collected during the first one-half inch of rainfall in any "storm event". This is the period when the majority of pathogens, sediment, waste and debris are picked up by flow across lawns and roadways. Carried untreated into streams and waterways, these materials become "non-point source pollutants" which can increase algae content, reduce aquatic life, and require additional costly treatment to make the water potable for downstream water systems. LID design principles can be used as buffers to filter these pollutants before they reach aquifers. For traditional conveyance systems, specially designed catchbasins may be required to perform a "first flush" filtering function using various technologies for collection of sediment and contaminants. Some units are designed to retrofit existing storm water inlets. Manufacturers include AquaShield, Stormtreat Systems, Inc, Stormceptor, and Stormwater Management Co.

On September 21-23, 2004 the first national Low Impact Development (LID) Conference, called Putting the LID on Stormwater Management, took place in College Park, Maryland. It highlighted innovative LID techniques designed to minimize the effect of development on watersheds. Presenters of over 85 papers provided insight into a variety of Low Impact Development projects conducted nationwide.

The Future of LID

During the Conference's closing session, Future Vision of LID and Storm Water Management, a panel of experts reflected upon the current state of LID and the direction in which LID is headed. One common theme was that LID is a concept where residential developers, local public planners, engineers, citizens, and environmental groups all can support the idea of using water as a resource, reducing stream erosion, and pretreating storm water before it enterways waterways and recharges groundwater aquifers.

LID should be more than just new storm water technologies for single

lots. LID should be about looking at water resources in a holistic, watershed-based manner, and effectively managing such resources. Such an approach involves conserving water inside and outside a house, using decentralized storm water management BMPs for single lots and larger-scale developments, and identifying the best ways to handle wastewater. The HUD publication, The Practice of Low Impact Development, provides ways to help public and private sectors meet the goal of creating a comprehensive approach to water resources management.

Low Impact Design Strategies:

The strategies fall under the two broad categories of **practices** and **site design**. The most common concepts are summarized below:

Practices:

Basic LID strategy for handling runoff is to: 1) reduce the volume of runoff and 2) decentralize flows. This is usually best accomplished by creating a series of smaller retention/detention areas that allow localized filtration rather than carrying runoff to a remote collection area. For the practices noted below, special attention should be paid to the composition of existing soils, as well as new soils or amended soils used, and underlying topography. For instance, a locale with karst topography may react differently to introduction of LID practices than a site that does not have underground channels. Common methods include:

- **Bio-retention cells** typically consist of grass buffers, sand beds, a ponding area for excess runoff storage, organic layers, planting soil and vegetation. Their purpose is to provide a storage area, away from buildings and roadways, where storm water collects and filters into the soil. Permanent ponds can be incorporated into the cell design as landscaping features. Temporary storage areas without ponds may be called detention cells. Bioretention areas have also been called rain gardens since they are typically landscaped with native plants and grasses, selected according to their moisture requirements and ability to tolerate pollutants. Annual maintenance of bioretention cells must be planned in order to replace mulching materials, remove accumulated silt, or revitalize soils as required.
- **Grass swales** function as alternatives to curb and gutter systems, usually along residential streets or highways. They use grasses or other vegetation to reduce runoff velocity and allow filtration, while high volume flows are channeled away safely. Features like plantings and checkdams may be incorporated to further reduce water velocity and encourage filtration. Walkways are either separated from roadways by swales, or relocated to other areas. In areas where salts are commonly used for winter de-icing, careful attention must be paid to selecting plant species which are salt tolerant.
- **Filter strips** can be designed as landscape features within parking lots or other areas, to collect flow from large impervious surfaces. They may direct water into vegetated detention areas or special sand filters that capture pollutants and gradually discharge water over a period of time.
- **Disconnected impervious areas** direct water flows collected from structures, driveways, or street sections, into separate localized detention cells instead of combining it in drainpipes with other runoff. Disconnecting the flow limits the velocity and overall amount of conveyed water that must be handled by end-of-pipe facilities.
- **Cistern collection systems** can be designed to store rainwater for dry-period irrigation, rather than channeling it to streams. Smaller tanks that collect residential roof drainage are often called "rain barrels" and may be installed by individual homeowners. Some collection systems are designed to be

installed directly under permeable pavement areas, allowing maximum water storage capacity while eliminating the need for gravel beds. Other innovative systems incorporate graywater collection for additional water conservation (see separate PATH Technology Inventory article on Graywater Reuse).

Site Design:

Decreasing Impervious Surfaces can be a simple strategy to avoid problems from storm water runoff and water table depletion, by reducing surfaces that prevent natural filtration. Methods may include:

- **Reducing Roadway Surfaces** can retain more permeable land area. In some cases, planners have reduced pavement needs by up to 40% by using longer, undulating roads that create more available lot frontage, instead of wide shorter streets with more intersections. Other options may include shared driveways, "flag" lots with reduced street frontage, landscaped detention islands within cul-de-sacs, or alternate designs for turn-around areas.
- **Permeable Pavement Surfaces** can be constructed from a variety of materials, including traditional asphalt and concrete, gravel or pavers. Permeable roadway or parking areas allow water to flow through, replenishing soil areas directly beneath. However, the sub-base underneath permeable pavements must be engineered to accommodate temporary water storage and filtration. In many cases, permeable surfaces can reduce or eliminate the need for traditional storm water structures. Further information is available in a separate PATH Technology Inventory article titled "Permeable Pavement."
- **Vegetative Roof Systems** create a lightweight, permeable vegetative surface on an impervious roof area. Moss, grass, herbs, wildflowers, and native plants can be used, creating an aesthetically pleasing roof landscape. The systems start with a high strength rubber membrane placed over the base roof structure. Various layers above the rubber may contain insulation, filter and drainage media, separation fabrics, lightweight growth media, vegetation, and wind erosion fabric. Some systems even incorporate rainbarrel runoff collection, pumping, and irrigation equipment. These systems are more costly than standard roofs, and have not been used on a large scale for residential development in the U.S.

Planning site layout and grading to natural land contours can minimize grading costs and retain a greater percentage of the land's natural hydrology. Contours which function as filtration basins can be retained or enhanced, and incorporated into the landscaping design.

- **Natural Resource Preservation and Xeriscaping** can be used to minimize the need for irrigation systems and enhance property values. Riparian, or stream bank, areas are particularly crucial to water quality, and in most areas, subject to Federal or State regulations. Preserving existing wooded areas, mature trees, and natural terrain, can give new developments a premium "mature landscape" appearance and provide residents with additional recreational amenities. Both of these features can improve marketability. Xeriscaping refers to landscaping with plants native to area climate and soil conditions. These plants thrive naturally, requiring less maintenance and irrigation than most hybrid or imported varieties. For more information, refer to the separate PATH Technology Inventory article on this subject. XeriscapeTM is a registered trademark of Denver Water, Denver, CO.
- **Clustering Homes** on slightly smaller lot areas can allow more preserved open space to be used for recreation, visual aesthetics, and wildlife habitat. Clustering can reduce infrastructure costs to the builder, since fewer feet of pipe, cable, and pavement are needed, and maintenance costs are reduced for homeowners. Builders in many areas have been able to charge a premium price for "view lots" facing undisturbed natural

vistas, or pond areas that also function as bioretention cells.

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PATH Attributes

It has been shown in side to side comparison that careful integration of LID Practices can be less espensive than actually integrating drainage and piping for retention basins, etc. This lowers costs for the developers while alowwing for environmentla performance.

Because natural filtration methods are used, run-off polution is reduced, resulting in less polution of waterways and other vegetation. In addition, the vegetation used for filtering still thrives and provides oxygen.

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Ease of Implementation

Consultation with environmental planners and engineers is critical for determining how to integrate LID practices. In some situations, they may not be practical or useful at all. However, once planned, such systems may be easier to install than their conveyance method counterparts.

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Initial Cost NA

If planned correctly, LID practices can be installed for a lower cost than other storm and water management options. Though vegetative roof systems and cisterns may be expensive initially, they can provide for energy and utility savings in the future

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Operational Cost NA

Proper maintenance and groundskeeping must be employed for the system to perform properly, but this is no more expensive than typical landscaping.

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U.S.Code Acceptance

Statutes mandating the implementation of storm water management plans include: The Clean Water Act (Wetlands, Section 404; Storm water, Section 402), the National Pollutant Discharge Elimination System (NPDES) regulations, and in some cases, State Pollutant Discharge Elimination Systems (SPDES). State, local, or subdivision codes and zoning requirements may dictate designs or systems which are sometimes not consistent with current LID strategies. Especially in largely developed areas, however, the trend is for land-use or water-basin management authorities to mandate more stringent storm water management planning and practices.

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Field Evaluations

Not Applicable

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Installation

Low Impact Development requires more precise engineering for soil characteristics, filtration rates, water tables, native vegetation, and other site features. Participation of environmental consultants and planners is critical from the earliest planning phases for residential development.

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Warranty

Not Applicable

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Benefits/Costs

Cost benefits to builders and developers utilizing LID strategies can be significant. According to the Center for Watershed Protection, traditional curbs, gutters, storm drain inlets, piping and detention basins can cost two to three times more than engineered grass swales and other techniques to handle roadway runoff. Other LID strategies can have similar impact. Choosing permeable pavement for a parking area may remove the need for a catchbasin and conveyance piping. Small distributed filtration areas on individual lots can reduce site requirements for larger detention ponds that take up valuable land area.

Not all sites can effectively utilize LID techniques. Soil permeability, slope, and water table characteristics may limit the potential for local infiltration. Urban areas and locations with existing high contaminant levels may be precluded from using LID filtration techniques.

Many existing local codes, zoning regulations, parking requirements and street standards were developed prior to the emergence of water quality and storm water management concerns, and may prohibit or inhibit implementing LID practices.

Established practices can be difficult to modify, although cost factors may help drive change. Additionally, there may be negative perceptions among homebuyers. Even though many buyers welcome naturalistic features proscribed by LID, others may prefer large flat lots with wide curbed streets. While traffic studies have not borne out the theory, some consumers perceive curbs to be a safety feature for pedestrians. Others fear that the lack of conventional storm water systems will result in basement flooding or structural damage.

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