Low Impact Development – Concepts and Considerations

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Introduction

In recent years, the federal government has placed a strong emphasis on the need for proper stormwater management. The focus on stormwater was prompted, in large part, by the recognition that improperly managed stormwater represents a major source of pollution to the nation's water resources. This fact, coupled with the enormous cost resulting from flood damage, has brought the issue of stormwater management to the forefront at all levels of government.

Stormwater management issues can be viewed within the broad context of the hydrologic cycle. The hydrologic cycle is the process by which precipitation (both rain and snow) falls to the ground and either runs off to lakes, streams, and other water bodies, or infiltrates into the ground (Figure 1). This water, in turn, is returned to the atmosphere via evaporation or transpiration (directly from plants), where the cycle of condensation and precipitation is repeated. *To protect the environment, stormwater should be managed in a way that will not substantially alter the natural hydrologic regime, especially as it relates to the quantity of runoff versus infiltration.*

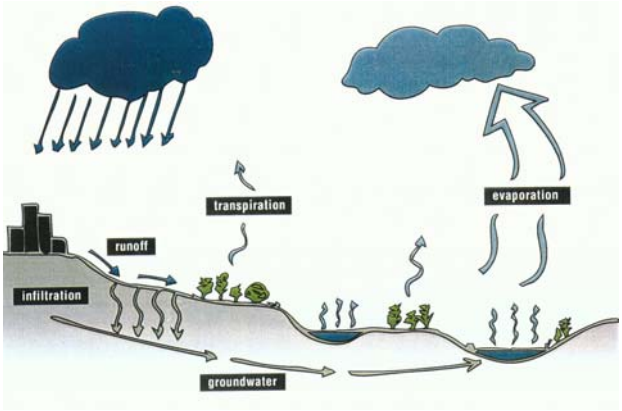

Figure 1

The Concern

As communities become more urbanized, rooftops, roadways, parking lots, and other impervious surfaces replace natural ground cover. As impervious surfaces increase, runoff increases and infiltration into the ground decreases (Figure 2).

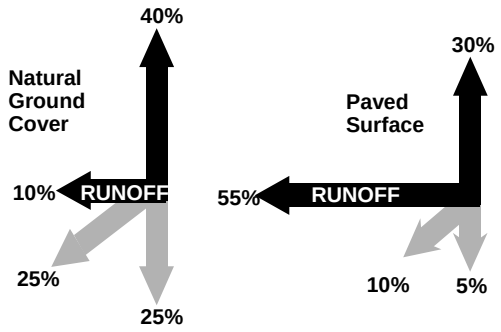

Figure 2

With the decrease in infiltration, groundwater supplies also decrease which, in turn, diminishes flow in area streams. In some instances, rivers and streams that once had stable base flows slow to a trickle during dry-weather periods due to lack of water infiltration to the water table. During rainstorms, these same streams can become a raging torrent due to the increased rate of stormwater runoff and conveyance. In these streams, the fishery cannot be sustained due to the warming of water and degraded habitat during low-flow conditions and, during high-flow conditions, stream bank erosion and flooding are common.

With an increase in imperviousness and the quantity of stormwater runoff, there is generally a concurrent increase in the quantity of pollutants transported as well. Stormwater runoff often contains high concentrations of oil and gasoline residues, nutrients, sediment, trace metals, fecal bacteria, oxygen-consuming wastes, and a variety of other contaminants. If untreated, stormwater runoff can cause siltation, nutrient enrichment, bacterial contamination, and severely degrade water resources.

Getting to the Source

While County Drain Commissioners often play a key role in stormwater management, local units of government also have an

important role to play—especially in promoting "source" controls of stormwater. *Source controls are preventative measures designed to reduce the volume of stormwater generated on-site, and eliminate initial opportunities for pollutants to enter a stormwater drainage system*. Typical source controls could include the following:

- Preservation of existing natural features that perform stormwater management functions, such as depressions, wetlands, forest land, and vegetative buffers along lakes and streams.

- Reducing impervious surface area through site planning that makes efficient use of paved and developed areas, and maximizes open space.

- Directing stormwater discharges to open grass areas, swales, and bioretention facilities (e.g., rain gardens, infiltration trenches) rather than allowing stormwater to run off impervious surfaces directly to stormwater conveyance systems.

After the implementation of source controls, site controls are then required to convey and treat stormwater runoff generated by development. Many source controls are best addressed during the planning stages of development. It is at this stage that opportunities exist to reduce imperviousness, minimize development site impacts, preserve natural features, and promote practices that maintain the natural hydrology.

The manner in which land is developed, along with the attendant infrastructure, begins with the developers and their design engineers and planners. While state and county permits are required for most developments, it is often the township that plays one of the most important roles in the development approval process. As such, townships can be key partners in stormwater management. In fact, townships may be best suited to encourage land development practices that address stormwater issues, especially source controls.

Low Impact Development

A method of managing stormwater that is gaining prominence and acceptance is a concept called Low Impact Development or LID. In *The Practice of Low Impact Development* (NAHB Research Center, Inc. 2003), LID is defined as an approach to land development that uses various land planning and design practices and technologies to simultaneously conserve and protect natural resource systems and reduce infrastructure costs. LID still allows land to be developed, but in a cost-effective manner that helps mitigate potential environmental impacts. Essentially, LID's promote source controls of stormwater and maintain the natural hydrological cycle by:

- Preserving open space and minimizing land disturbances;

- Protecting natural features and natural processes;

- Reexamining the use and sizing of traditional infrastructure (lots, streets, curbs, gutters, and sidewalks);

- Integrating natural site elements (wetlands, stream corridors, mature forests) into site designs; and

- Decentralizing and managing stormwater at its source.

With an LID, the development process includes a detailed site analysis that identifies natural drainage patterns and key natural features. This information is then used to help define development opportunities and constraints, and areas requiring protection. The site analysis is followed by an evaluation of alternatives to minimize development impacts. Alternatives to accomplish these objectives could include minimizing clearing and grading, reducing impervious surfaces, clustering development, limiting lot disturbance, and preserving permeable soil types. An attempt is then made to slow the conveyance of stormwater from the site by dispersing (rather than concentrating) drainage. Where feasible, natural flow paths are maintained, and vegetated swales are used to convey water (as opposed to pipes). A key element of an LID is to treat stormwater at its source, rather than conveying water to a centralized stormwater basin.

In *The Practice of Low Impact Development*, it is noted that developers who have used LID practices and technologies have indicated that one of the keys to a successful project is to invest additional time and money in the initial planning stages of development. While this idea may be unpopular because of increased up-front costs, the expenditures are often recouped in the form of reduced infrastructure costs,

rapid home sales, enhanced community marketability, and higher lot yields.

A graphic representation of a conventional development versus an LID is shown on the next page. The example is a 40-acre residential site on sandy, well-drained soils served by on-site septic systems and individual water wells. In the LID, lot sizes were reduced, roads were narrower with no curb and gutter, open swales were used to convey/infiltrate stormwater, and all roof drainage was conveyed to on-lot infiltration trenches. In comparing the two development approaches, the LID resulted in substantial reductions in effective imperviousness, storm sewer pipe and drainage structures. In addition, the LID would result in five-fold increase in open space on the development site (Table 1).

In addition, estimated costs associated with clearing, grading, and stormwater infrastructure were significantly reduced in the LID when compared to the conventional development approach (Table 2). It should be noted that these are estimates, and that the relative cost comparison between conventional development and LID should be evaluated on a site by site basis. The potential cost difference will vary dependent on site specific conditions.

Table 1
Conventional vs. Low Impact Development

	Conventional Layout	LID Layout	% Change
Impervious Surface:			
Road Area (s.f.):	93,706	97,952	
Roof Area (s.f.):	60,800	0*	
Total Area (s.f.):	154,506	97,952	-36.6%
Stormwater Management Infrastructure:			
Storm Sewer Pipe (l.f.):	3,753	1,486	-60.4%
Drainage Structures:	39	13	-66.7%
Open Space Preservation:	6.7%	32.7%	5-fold

*No roof top runoff is calculated since it is conveyed to infiltration trenches at the rear of the properties.

Table 2
Estimated Construction Cost Comparison

	Conventional Layout	LID Layout
Grading	$255,400	$188,600
Clearing	10,000	2,000
Roads	281,010	195,900
Storm Sewer Pipe	174,510	55,730
Drainage Structures	78,000	26,000
SWM Ponds	17,000	---------
Bioretention/Micro	--------	12,600
Total	**$815,920**	**$480,830**
Unit Cost	**$21,470**	**$12,330**
Lot Yield	**38**	**39**


TYPICAL RESIDENTIAL LOT
• 38 LOTS
• 30,000 S.F. AVERAGE LOT SIZE
• INDIVIDUAL ON-SITE SEPTIC SYSTEMS
• ROOF & DRIVEWAY RUN-OFF IS PIPED TO DETENTION POND
STORMWATER MANAGEMENT SYSTEM
• MOST HARD SURFACE RUN-OFF IS PIPED TO A SINGLE DETENTION FACILITY
DETENTION BASIN
OPEN SPACE IS LIMITED TO REGULATED WETLAND AREA TOTALING 6.7% OF THE SITE
MOST EXISTING STREAMBANK VEGETATION HELD IN PRIVATE OWNERSHIP
SITE TOPOGRAPHY IS CHANGED TO PROVIDE BUILDABLE LOTS
TYPICAL ROADWAY DEVELOPMENT
• 24' WIDE WITH BITUMINOUS CURB
• 66' WIDE ROW
• ROADWAY, ROOF & DRIVEWAY RUN-OFF IS PIPED TO DETENTION POND VIA DRAINAGE STRUCTURES IN ROAD
SECTION ROAD
CONVENTIONAL PLAN
LOW IMPACT DEVELOPMENT PLANNING
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INFILTRATION TRENCH FOR ROOF RUN-OFF
ROADSIDE DRAINAGE SWALES
NATURE TRAIL
TYPICAL RESIDENTIAL LOT
• 39 LOTS
• 20,000 S.F. AVERAGE LOT SIZE
• INDIVIDUAL ON-SITE SEPTIC SYSTEM
• ROOF RUN-OFF IS CONVEYED TO ON-LOT INFILTRATION TRENCH
STORMWATER MANAGEMENT SYSTEM
• MOST HARD SURFACE RUN-OFF IS CONVEYED TO A SERIES OF SMALL FILTRATION/DETENTION PONDS AND INTO THE WETLANDS
• DRAINAGE INFRASTRUCTURE AND PIPING ARE GREATLY REDUCED
• ROOF RUN-OFF IS INFILTRATED
OPEN SPACE SYSTEM
• SENSITIVE SLOPE/VEGETATION AND WETLAND AREAS ARE PRESERVED AS OPEN SPACE TOTALING 32.7% OF SITE
• OPEN SPACE AREAS ARE CONNECTED FOR NATURE TRAIL DEVELOPMENT
• OPEN SPACE SYSTEM HAS POTENTIAL FOR OFF-SITE LINKAGES
TYPICAL ROADWAY DEVELOPMENT
• 22' WIDE WITHOUT CURB
• 60' WIDE ROW
• ROADWAY AND SOME DRIVEWAY RUN-OFF IS DIRECTED TO WETLAND AND EXISTING DAINAGE COURSES VIA ROADSIDE SWALES AND SMALL FILTRATION/DETENTION PONDS
SECTION ROAD
LOW IMPACT DEVELOPMENT PLAN
LOW IMPACT DEVELOPMENT PLANNING
ProgressiveAE
LSL

Practical Considerations

A key element in a typical LID is to provide for the infiltration of stormwater at or near its source. This approach may not be feasible in areas with a high water table or soils with poor infiltration capacities such as clays. To avoid the potential for failure of infiltration facilities, care must be taken to ensure the facilities are properly designed, constructed, and maintained. Drainage easements may be appropriate to help ensure proper maintenance over the long term.

Infiltration of stormwater in residential developments generally does not pose a pollution problem. However, in the case of industrial, commercial, and concentrated parking facilities, pretreatment of stormwater may be required to prevent groundwater contamination.

The LID approach embodies many of the design principles required to mitigate stormwater impacts and can help communities comply with federal National Pollution Discharge Elimination System (NPDES) Phase 2 stormwater mandates. If site conditions are suitable, LID should be considered as an alternative to conventional development approaches. A properly designed LID can be a win-win for the developer, the home buyer, the community, and the environment.

For more information visit:

www.lowimpactdevelopment.org
www.epa.gov/owow/nps/urban.html
www.raingardens.org