Economic Benefits of Low Impact Development (LID) Projects for Stormwater Management

Highlights from Recent Literature

"In the vast majority of cases, the US. Environmental Protection Agency (EPA) has found that implementing well-chosen LID practices saves money for developers, property owners, and communities while also protecting and restoring water quality."

Source: EPA (2007): *Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices*

Prepared by:
Ivan Ussach, Watershed Coordinator,
Millers River Watershed Council

November 2015

This paper summarizes the findings of recent studies by the United State Environmental Protection Agency (EPA) and other researchers of the economic benefits of low impact development (LID). Such studies appear to be relatively rare, especially those comparing LID and conventional development practices. The studies are divided into three sections:

1) New England case studies

2) Nationwide case studies

3) Additional studies

Key Findings from the EPA 2013 Case Study Economic Analyses:

- LID can cost less than traditional pipe and pond grey infrastructure alone.
- LID approaches result in multiple benefits.
- Economic analyses can be used to address public concerns and gain stakeholder support.

MassDEP
Funding for this project was provided by EPA's Section 319 Nonpoint Source Pollution Grant Program Administered by MassDEP

frcog
Franklin Regional Council of Governments
frcog.org

Millers River Watershed Council
millerswatershed.org

New England Case Studies

PROJECT: BOULDER HILLS - PELHAM, NH

Description: 24-unit condominium built on 14 acres of previously undeveloped land.

LID Features: Roadway, all driveways and sidewalks built of porous asphalt.

Additional Benefits: Improved water quality and runoff volume reduction; less overall site disturbance (1.3 acres) and avoidance of wetland and flood-zone areas; reported cost savings for salt for winter ice management.

Item	Conventional	LID	Difference
Site prep	$23,300	$18,000	-$5,200
Erosion Control	$75,800	$54,400	-$21,400
Drainage	$92,400	$20,100	-$72,300
Roadway	$82,000	$128,000	+$46,000
Driveways	$19,700	$30,100	+$10,400
Curbing	$6,500	$0	-$6,500
Additional	$489,000	$489,000	$0
Total SW Mgmt. Cost	$789,500	$740,300	**-$49,128 (6%)**

PROJECT: GREENLAND MEADOWS – GREENLAND, NH

Description: 56-acre retail shopping center site built in 2008 (25.6 acres impervious), with largest porous asphalt installation in northeast.

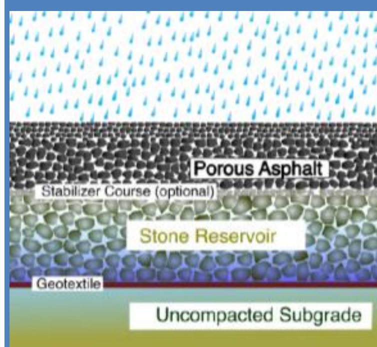
LID features: Stormwater management system includes two porous asphalt installations covering 4.5 acres along with catch basins, subsurface crushed stone reservoir, sand filter, and underground piping and catch basins.

Additional: Site adjacent to EPA-listed impaired waterway; clay soils with very low permeability; **main savings was $1,356,800 for large diameter piping.**

Item	Conventional	LID	Difference
Earthwork	$2,174,500	$2,103,500	-$71,000
Paving	$1,843,500	$2,727,500	+$884,000
SW Mgmt.	$2,751,800	$1,008,800	-$1,743,000
Total	$6,769,800	$5,839,8,00	**-$930,000 (26%)**

Porous asphalt.

Porous asphalt parking stall application.



Porous Asphalt Pavements with Stone Reservoirs. Federal Highway Administration, April 2015.

http://www.fhwa.dot.gov/pavement/asphalt/pubs/hif15009.pdf.

Source for the case studies on this page: UNH Stormwater Center, Virginia Commonwealth University, and Antioch University New England, "Forging the Links: Linking the Economic Benefits of Low Impact Development and Community Decisions," 2011

New England Case Studies (continued)

Examples of New England LID applications:

Case study source: Houle, J. and Roseen, R. et al., "Comparison of Maintenance Cost, Labor Demands, and System Performance for LID and Conventional Stormwater Management," Journal of Environmental Engineering, July 2013

PROJECT: COMPARISON OF MAINTENANCE COSTS FOR LID V. CONVENTIONAL STORMWATER MANAGEMENT

Background: Researchers from the Stormwater Center at the University of New Hampshire and colleagues "examined seven different types of stormwater control measures for the first 2–4 years of operations and studied maintenance demands in the context of personnel hours, costs, and system pollutant removal. The systems were located at a field facility designed to distribute stormwater in parallel in order to normalize watershed characteristics including pollutant loading, sizing, and rainfall. System maintenance demand was tracked for each system and included materials, labor, activities, maintenance type, and complexity."

Results:

- Annualized maintenance costs ranged from $2,280/ha*/year for a vegetated swale to $7,830/ha/year for a wet pond.
- In terms of mass pollutant load reductions, marginal maintenance costs ranged from $4–$8 per kilogram (kg) per year Total Suspended Solids (TSS) removed for porous asphalt, a vegetated swale, bioretention, and a subsurface gravel wetland, to $11–$21/kg/year TSS removed for a wet pond, a dry pond, and a sand filter system.
- "The results of this study indicate that generally, LID systems, compared to conventional pond systems, **do not have greater annual maintenance costs and, in most cases, have lower marginal maintenance burdens** (as measured by cost and personnel hours) and higher water quality treatment capabilities as a function of pollutant removal performance."
- "When nutrients such as nitrogen and phosphorus were considered, maintenance costs per kg per year removed ranged from reasonable to cost-prohibitive."

*A unit of area in the metric system that is equal to 10,000 square meters or 2.47 acres

Nationwide Case Studies

This section draws on two EPA studies from 2007 and 2013. The **2007 EPA report** summarized 17 case studies of developments–mostly residential subdivisions--that include LID practices. These examples were selected on the basis of "the quantity and quality of economic data, quantifiable impacts, and types of LID practices used."

Of those 17 studies, 12 studies had sufficient economic data to allow for comparison of conventional stormwater management versus LID. Savings ranged from 15 - 80%, and $3,400 - $785,000, and one project had higher costs of $737,200 (96%).

The **2013 EPA report** includes 13 detailed case studies based on one or more of various economic analyses. The 13 case studies were selected from the 45 community LID projects that EPA evaluated, and "were selected to represent various types of economic analyses and LID programs, as well as a broad geographic and demographic range." Following are selected case studies from these two reports that indicate the variety of projects and economic analyses undertaken.

PROJECT: 2ND AVENUE SEA STREET – SEATTLE, WA

__Description__: LID Redesign of entire 660 foot residential block.

__LID Features__: Bioretention, reduced impervious area, swales.

__LID cost__: $651,548 - savings of $217, 255 (25%). Narrower street width and fewer sidewalks reduced paving costs by 49%.

__Additional benefits__: Monitoring showed 99% reduction in surface runoff.

PROJECT: GAP CREEK – SHERWOOD, AK

__Description__: LID Residential subdivision (clustered).

__LID Features__: Reduced impervious area, vegetated landscaping.

__LID cost__: $3,942,100 - savings of $678,500 (15%). Developers added 17 more lots; lots sold for $3,000 more and cost $4,800 less to develop than comparable conventional lots; developer's additional profit – $2.2M.

__Additional benefits__: Open space increased from 1.5 to 23.5 acres.

Example of a subdivision that has incorporated LID elements, including a narrow roadway and a bioretention area.

Example of a subdivision plan that clusters homes in the least environmentally sensitive areas while conserving the remaining open space.

Retrofit of an existing street to include bioretention areas between the roadway and sidewalk.

Nationwide Case Studies (continued)

PROJECT: TELLABS CORP. CAMPUS – NAPERVILLE, IL

Description: 55-acre site with more than 330,000 square feet of office space, conservation design.

LID Features: Bioretention, swales.

LID cost: $2,700,650 - savings of $461,510 (15%).

Additional benefits: 6 fewer acres were disturbed.

PROJECT: SOMERSET – PRINCE GEORGES COUNTY, MD

Description: 80-acre subdivision with 200 house lots - approximately half built with LID, half conventional.

LID Features: Bioretention, swales.

LID cost: $1,671,461 - savings of $785,382 (32%).

Additional benefits: Eliminating the need for a stormwater retention pond created space for six additional lots; LID area had less runoff and lower concentrations of metals in runoff.

PROJECT: GREEN STREETS PILOT – CITY OF WEST UNION, IA

Description: Includes the renovation of six downtown blocks.

The life-cycle costs (the total capital and O&M costs for the project) of a permeable paver system in the downtown area were compared with those of traditional bituminous or Portland cement concrete pavement.

Results: While permeable pavement is initially more expensive, lower maintenance and repair costs will result in cost savings in the long run. The city would begin to realize these cost savings by year 15 of the project. Estimated cumulative savings over a 57-year period were calculated to amount to about $2.5 million.

Other benefits: Reduced flooding and improved water quality from permeable pavements, biofiltration, and rain gardens.

PROJECT: RAIN TO RECREATION PROGRAM - CITY OF LENEXA, KS

Description: Much of the city's 34-square-mile area is experiencing development pressure. The city's Rain to Recreation program includes regulatory and non-regulatory components.

Results: Substantial cost savings associated with implementing LID for multi-family, commercial, and warehouse developments in contrast to traditional stormwater management approaches using grey infrastructure.

Other benefits: Reduced flooding, improved water quality and habitat, additional recreational opportunities.

Nationwide Case Studies (continued)

PROJECT: CAPITOL REGION WATERSHED DISTRICT (CRWD) - MN

Description: The CRWD is almost completely developed—42% covered by impervious surfaces. Water quality is impaired and there is localized flooding. In addition, aging sewer infrastructure has caused drainage problems and sewer overflows to Lake Como.

Results: A new storm sewer for conveying untreated, frequent flood-waters to Lake Como was estimated to cost $2.5 million compared to $2.0 million to implement LID infiltration practices.

Other benefits: The 18 stormwater BMPs provide high stormwater volume-reduction and pollutant-removal efficiencies, and improved the quality of an economically important, nutrient-impaired recreational lake. The city of St. Paul now uses a similar design for under-the-street infiltration trenches for street reconstruction projects.

Capitol Region Watershed District educational factsheet on underground infiltration trenches.

http://www.capitolregionwd.org/

PROJECT: ECOROOF PROGRAM – CITY OF PORTLAND, OR

Description: The Ecoroof program is one of several sustainable storm-water management systems used to treat 10 billion gallons of annual stormwater runoff.

Results: For *the public*, ecoroof construction provides both an immediate and a long-term benefit; the net present benefit is $101,660 at year 5 and $191,421 at year 40. For *building owners*, benefits do not exceed costs until year 20 - when conventional roofs need replace-ment. Over the 40-year life of an ecoroof, the net present benefit to private stakeholders is more than $400,000.

Other benefits: Numerous benefits were identified (including reduced operation and maintenance costs, carbon reduction, improved air quality). Some were quantified and/or monetized as part of a full benefit-cost analysis that showed a public economic benefit.

Green roof examples.

Additional Studies

Several other studies from the literature documenting various kinds of economic benefits from LID projects are briefly summarized below.

(1) In **Frederick County, Maryland**, several cost-saving benefits were realized by redesigning a conventional subdivision with LID designs. These included eliminating two stormwater ponds, which reduced infrastructure cost by roughly $200,000; increasing the number of buildable lots from 68 to 70, which added roughly $90,000 in value; and allowing the site design to preserve around 50% of the site in undisturbed wooded condition, which reduced clearing and grubbing costs by $160,000 (Clar, 2003).

(2) An infill site in **northern Virginia** saved over 50% in infrastructure costs by minimizing impervious surfaces, protecting sensitive areas, treating stormwater at the source, and reducing setback requirements. (CWP et al, 2001).

(3) In the Village Homes LID development in **Davis, California**, natural vegetation and reduced pavement area helped lower home cooling expenses and energy bills by 33-50% as compared to surrounding neighborhoods (MacMullan, 2007).

(4) In **Dane County, Wisconsin**, permit fees for development are calculated according to the amount of impervious area in a site, providing developers with an incentive to use LID to reduce permitting fees. (UNH Stormwater Center, 2011)

(5) An analysis of 184 lots in **South Kingstown, Rhode Island** found that conservation subdivisions were more profitable than conventional subdivisions. Lots in the conservation subdivisions cost an average of $7,000 less to produce. Those lots had a 50% decrease in selling time, and were valued at from 12 to 16% higher than lots in conventional subdivisions (Mohamed, 2006).

Street trees can reduce cooling costs for neighboring buildings.

Top and bottom:
LID stormwater features in two subdivisions.

Below: A residential development with mature vegetation maintained.

References

Clar, M. "Case Study: Pembrook Woods LID Development Residential Subdivision," Ecosite, Inc., 2003

Center for Watershed Protection (CWP) and VA Department of Conservation, "The Economic Benefits of Protecting Virginia's Streams, Lakes and Wetlands and the Economic Benefits of Better Site Design in Virginia," 2001

City of Portland, "Summary of Cost Benefit Evaluation of Ecoroofs Report," November 2008

Houle, J. and Roseen, R. et al., Comparison of Maintenance Cost, Labor Demands, and System Performance for LID and Conventional Stormwater Management," Journal of Environmental Engineering, July 2013

MacMullan, E., "Using Incentives to Promote Green Infrastructure," 2009 Stormwater Summit, Oregon ACWA

MacMullan, E., "Economics of LID," EcoNorthwest, Eugene, OR., 2007

Mohamed, R. , "Economics of Conservation Subdivisions," Urban Affairs Review, 41 # 3, 2006

Roseen, R. and Janeski, T. et. al., "Economic and Adaptation Benefits of Low Impact Development," Conference Proceedings, 2011 Low Impact Development Symposium, Philadelphia, PA

UNH Stormwater Center, Virginia Commonwealth University, and Antioch University New England, "Forging the Links: Linking the Economic Benefits of Low Impact Development and Community Decisions," 2011

USEPA, "Reducing Stormwater Costs through Low Impact Development (LID) Strategies and Practices," 2007

USEPA, Case Studies Analyzing the Economic Benefits of Low Impact Development and Green Infrastructure Programs, EPA 841-R-13-004, August 2013