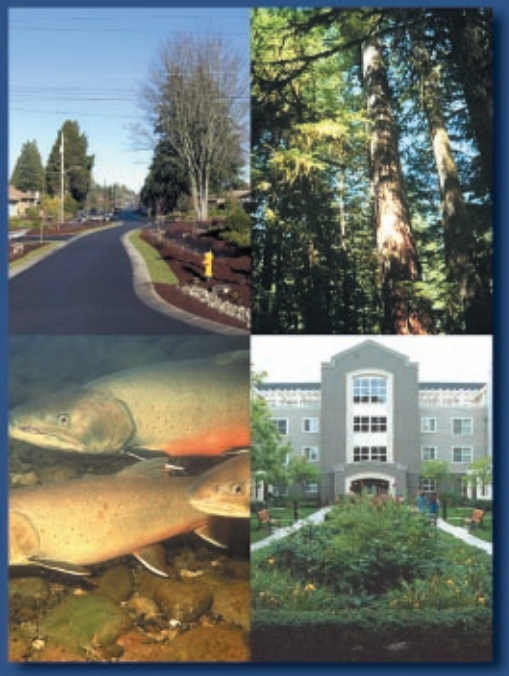
Low Impact Development

By the year 2020 another one million people will call Puget Sound their home.



How can we protect Puget Sound as we grow?

PUGET SOUND WATER QUALITY ACTION TEAM

Benefits of LID Practices...

to the Environment

- Helps maintain the natural hydrology of watersheds
- Helps maintain stream flows and wetland water levels
- Reduces impacts to streams and fish and wildlife habitat by reducing stormwater discharges
- Protects water quality by reducing sediment and other pollutant loadings to streams, rivers and bays
- Preserves trees and other native vegetation

to Developers

- Reduces the cost of stormwater drainage facilities
- Lowers costs of streets, curbs, gutters and other infrastructure
- May lower construction costs by reducing the need for mass clearing, grading and sediment controls
- May reduce stormwater utility fees due to reduced amount of impervious areas
- May allow for more lots by reducing the size of stormwater ponds

Bioretention garden in parking lot
Courtesy of Low Impact Development Center

to Local Governments and Communities

- Helps protect a community's streams, fish and wildlife, and shellfish growing areas
- Helps protect salmon listed under the Endangered Species Act
- Helps maintain drinking water supplies
- May reduce maintenance costs of stormwater facilities
- Lowers costs of streets, curbs, gutters and other infrastructure
- Increases property and community appearance and aesthetics
- May increase property resale values due to curb appeal of landscaping
- Provides new tools for cost-effective urban retrofit
- Reduces chance of contamination of sediments in bays and associated public liability
- Increases opportunities for public/private partnerships and public education

Need More Information?

For information on low impact development and the *Puget Sound Management Plan*, call the Puget Sound Water Quality Action Team at (800) 54-Sound or visit our website at: http://www.wa.gov/puget_sound/

Or try the following websites:

National Low Impact Development Center
http://www.lowimpactdevelopment.org
Stormwater Manager's Resource Center
http://www.stormwatercenter.net/
U.S. Environmental Protection Agency
http://www.epa.gov/owm/mtbfact.htm
University of Washington Center for Urban Water Resources Management
http://depts.washington.edu/cuwrm/
Washington State Department of Ecology
http://www.ecy.wa.gov/programs/wq/wqhome.html

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Low Impact Development: Protecting our Waters as We Grow

The Office of Financial Management estimates that by 2020 the Puget Sound region will grow by another one million people. Accommodating this growth, while still protecting our natural resources and maintaining our region's quality of life, will provide challenges. Traditional development and stormwater management practices cannot fully mitigate the cumulative effects of this growth on the environment. We will need new tools and techniques to protect our region's streams, salmon and other water resources. It's time to grow smarter, with less impact on our irreplaceable natural resources.

Bioretention garden at apartment building
Courtesy of City of Portland Bureau of Environmental Services

Low impact development (LID) is an ecologically friendly approach to land development and stormwater management designed to reduce impacts on watershed hydrology and aquatic resources. (Watershed hydrology is the relationship between rainfall, evaporation, groundwater infiltration and flow of surface water.) LID is based on the premise that nature knows best. Rather than collecting and conveying stormwater off-site—through pipes and other conveyance systems—native vegetation, landscaping and small-scale hydrologic controls capture, treat and infiltrate the stormwater. An LID-designed site helps protect sensitive areas, such as streams and wetlands, by preserving the natural flow patterns and the volume of runoff. Trees and other native vegetation are also protected by conservation methods to help store and retain stormwater. Specially designed landscaped gardens are then built to treat and infiltrate stormwater. Alternatives to asphalt and concrete roads, driveways and parking areas are also used to infiltrate stormwater and improve groundwater recharge. Together these measures not only help maintain site hydrology and reduce runoff, they can also reduce overall development costs, make communities more attractive, and help ensure that our drinking water supplies are replenished.

Why Do We Need Low Impact Development?

Land development and construction can severely alter many natural features of the landscape. Soils are compacted by construction equipment and grading. Trees and other vegetation are replaced by extensive areas of impervious surface, such as roofs and pavement. Compacted soils cannot infiltrate water as effectively and there is less vegetation to soak up, store and evaporate water. The result is that less water soaks into the ground and more runs off. Developed areas are characterized by a tremendous increase in stormwater runoff volume and rate of flow. (Figure 1 shows how groundwater infiltration decreases and surface runoff increases dramatically as a watershed is developed.) This can severely degrade fish and wildlife habitat in the streams that receive runoff from developed areas. Development also causes increases in stream temperatures and in the amount of sediment and other pollutants. Studies show that the effects of development and increased impervious surfaces have severely degraded sensitive watersheds and habitats in Puget Sound.

Traditional development approaches and many conventional stormwater management techniques are not intended to address these issues. Too many conventional land grading and storm drainage systems are designed to remove water from the site as quickly and efficiently as possible. Conventional stormwater management systems are generally designed to control only the peak runoff rate of stormwater for a few large storm events. These systems often are not designed to mitigate for the increased runoff rate and volume from frequently occurring smaller storms, which are common in our area.

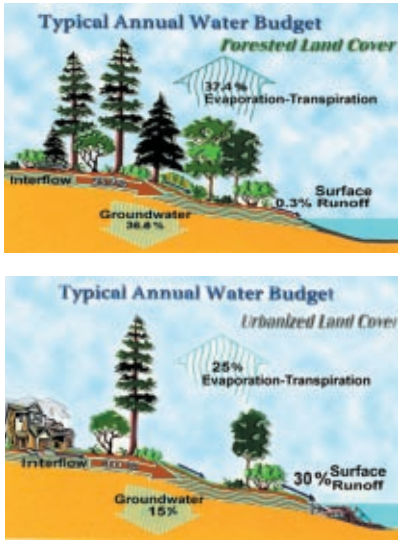


Figure 1: *Courtesy of Chris May, University of Washington*

Traditional stormwater facility
Courtesy of the City of Lacey

Low Impact Development stormwater facility
Courtesy of Low Impact Development Center

LID designs still provide for adequate conveyance of stormwater and provide additional protection for watersheds and streams by replicating, or mimicking, natural hydrologic functions. First, design strategies are used to maintain the volume and rate of runoff from the site. This helps to maintain the natural flow patterns of streams. Then small-scale controls are strategically placed throughout the site and incorporated into the landscape, open space, roads, parking, sidewalks and buildings to store, evaporate and infiltrate rainwater. This distributed approach helps to maintain watershed hydrology and the integrity of receiving waters by preserving each site's natural runoff characteristics.

In addition to protecting natural resources, many LID techniques are easier to construct and maintain than traditional stormwater facilities. This should lighten the financial burden of stormwater management on the businesses, municipalities and homeowner associations responsible for ensuring that facilities work properly and protect the environment. Because LID practices are small in scale, they can also be used in many places where land is limited or constrained by utilities.

"Studies show that the effects of development and impervious surfaces have severely degraded sensitive watersheds and habitats in Puget Sound."

Low Impact Development is...

Conservation of natural site assets

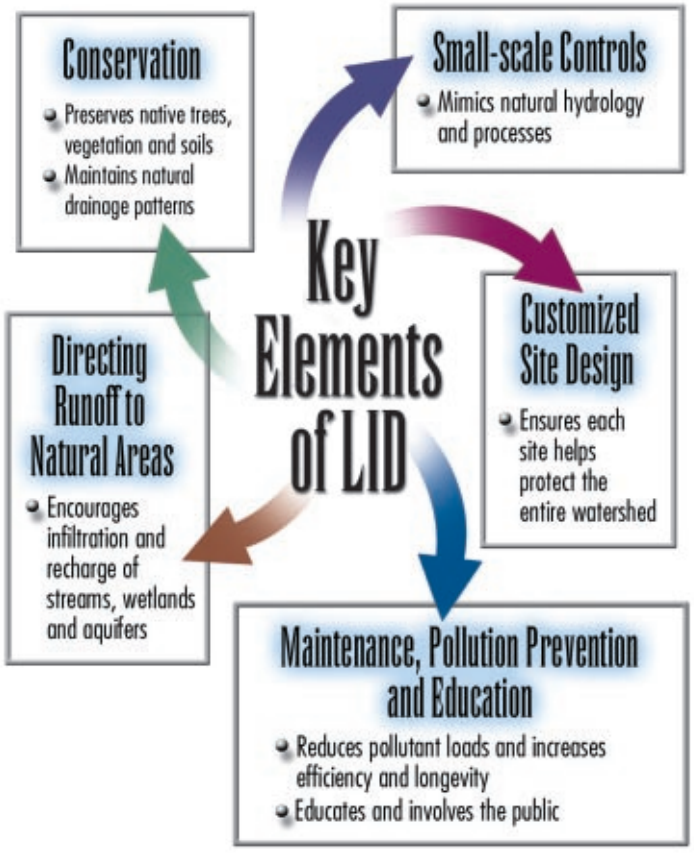
Site planning with low impact development practices begins with developing strategies to conserve the natural hydrologic assets and functions of a site. LID site conservation design techniques include directing development away from sensitive environmental areas (like streams and wetlands), preserving native vegetation and soils, maintaining existing drainage courses, and minimizing the extent of impervious areas.

Directing runoff through natural areas

Natural wooded areas are extremely effective groundwater recharge areas. Once conservation design and minimization techniques have been applied, an LID plan identifies or creates opportunities to retain as much runoff as possible on site and allow it to slowly infiltrate back into the ground. These practices include gently sloping impermeable surfaces to direct runoff onto vegetated areas with porous soils. Adding crushed stone and organic material near and directly on these areas also increases infiltration, recharge and storage.

Small-scale and distributed controls

To mimic the way natural areas store, infiltrate and release water, LID uses small-scale controls that are distributed throughout the site. This not only allows for a redundant system with less opportunity for failure, but can also provide a "treatment-train" approach where there are multiple opportunities to filter pollutants.



Customized site design

LID requires the designer to examine each site for its role in the hydrologic function of the watershed. Since land within a watershed is developed incrementally, rather than all at once, this helps protect the integrity of surface waters within a watershed as development occurs. This approach requires the designer to incorporate any available watershed or basin planning information into site design and design strategies to ensure that the effects of the site don't compromise the integrity of the watershed.

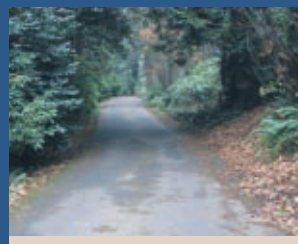
Maintenance, pollution prevention and education

In contrast to traditional stormwater facilities (such as ponds), many LID practices require only a minimum of maintenance. Bioretention cells may only require occasional mulching or fertilizing, and permeable pavements may only need to be swept periodically. Pollution prevention techniques that reduce the amount of fertilizers, pesticides, dirt and other chemicals that enter LID practices help reduce maintenance needs, in-crease efficiency and protect receiving waters. LID design approaches require that property owners and site managers be provided with brochures, videotapes or other educational materials on how to properly handle and apply chemicals and reduce pollutants. This can en-hance a community's water quality education and involvement program.

Common Low Impact Development Practices

There are potentially unlimited opportunities to integrate LID into a site design. Here are some of the more common practices.

Disconnectivity: The practice of directing runoff from impervious areas, such as roofs and roads, onto landscaped and vegetated areas reduces the volume of runoff, encourages groundwater recharge and reduces the temperature of runoff.



Narrow road where runoff is directed to vegetation
Courtesy of Curtis Hinman

Bioretention: Specialized landscaped areas used to filter and store runoff and promote groundwater recharge through infiltration. These areas are constructed with a specialized soil and plant mix that is attractive and has low maintenance requirements.

Permeable Pavements: Pavement blocks, porous concrete, or porous asphalt that lets water flow to an underground gravel area where water can be slowly released to the soil.

Open Swales: Grassy or vegetated areas, often at the edges of parking lots that receive runoff, promote infiltration and help treat pollutants.

Permeable pavement improves infiltration

Vegetated (Green) Rooftops: A combination of specialized planting media and vegetation that helps filter pollutants, store runoff and reduce energy consumption.

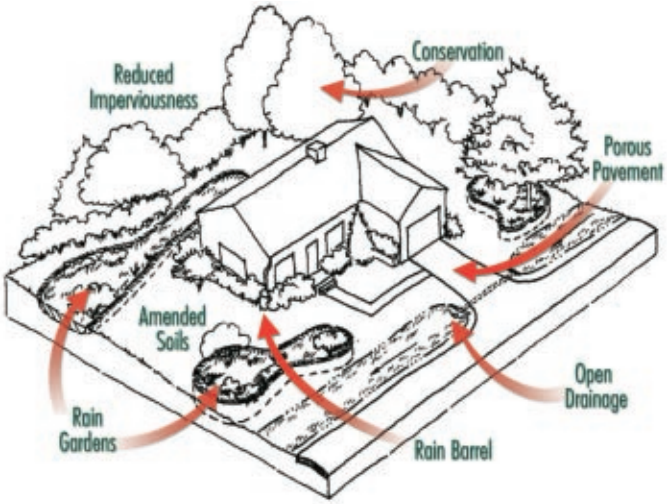
Tree Filter Boxes: Container bioretention areas that use soil and crushed stone to store and slow down runoff and filter out pollutants.

Specialized Inlets: Storm drain inlets that prevent the inflow of trash and debris or can store and detain stormwater to change the timing of runoff into the storm drain system.

Vegetated rooftop stores and treats runoff
Courtesy of City of Portland Bureau of Environmental Services

Soil Amendments: Sand and organic materials, such as mulch, are added to the soil to increase the infiltration characteristics of soil and filter pollutants.

Where to Begin...Steps for Local Governments and Developers



Any successful design approach requires a thoughtful and organized process. Local government staff and developers must work together to create an LID development so that natural resources are protected and local codes, ordinances and development requirements are met. The developer, designer and builder must use a process that helps them understand site constraints and characteristics, develop the hydrologically functional design approach, and then prepare construction plans for the local approval process. Listed below is a representative LID site analysis and design process.

Residential neighborhood where runoff is directed to an open swale for treatment and infiltration
Courtesy of Low Impact Development Center

1. **Identify Applicable Zoning, Land Use and Other Local Regulations.** Identify any waivers, modifications or special processes that may be needed to gain approval (e.g., subdivision, grading, drainage).

2. **Define Development Envelope.** Delineate any buffers, setbacks, overlay zones or resource protection areas where development is discouraged or prohibited.

3. **Use Drainage/Hydrology as a Design Element.** Match the development to the natural landscape to minimize land disturbance. Maintain drainage patterns and restrict development and disturbance in valuable hydrologic areas such as woods or other established native vegetation and highly permeable soils. Avoid change in land cover runoff characteristics.

4. **Reduce/Minimize Total Site Impervious Areas.** Impervious areas, such as roofs, roads and sidewalks, increase the volume and rate of runoff, convey pollutants and raise water temperature. Look for opportunities to decrease road width and length and use alternative permeable surfaces. Cluster buildings and other developed areas.

5. **Integrate Controls with Site Plan Layout.** Determine the preliminary amount (area or percentage of the site) that will be required to achieve the hydrologic objective. Develop standard design templates and practices that will be employed on each lot. Determine the best location, type and size of practice required for each lot.

6. **Minimize Directly Connected Impervious Areas.** Divert flows from impervious areas to vegetation and limit the size and length of drainage from impervious areas.

7. **Modify/Increase Drainage Flow Paths.** Modify the grading design by flattening slopes and swales and encouraging sheet flow. Use detention devices such as smaller culverts and rainwater collection to further maintain the natural runoff rate within the watershed.

8. **Compare Pre- and Post-Development Hydrology.** Review the design to determine the effectiveness of LID practices in meeting stormwater management requirements, using the flow frequency and flow duration curves predicted by a hydrology model such as in the Department of Ecology's Stormwater Manual for Western Washington. The size of stormwater ponds may be significantly reduced by following these steps.

9. **Complete LID Site Plan.** Complete final construction design drawings and specifications, including erosion and sediment controls, pollution prevention and any maintenance or education requirements.

Facts and Figures...

▶ A cost comparison for a 21-acre single-family subdivision in Prince George's County, Maryland, showed that the development costs for an LID subdivision design were almost 30 percent less than a conventional approach.

▶ As part of their street reconstruction programs for residential neighborhoods, Seattle and Maplewood, Minnesota, are installing narrower streets and replacing curb and gutter road sections with open swales and bioretention swales.

Redesigned street using LID techniques
Courtesy of Seattle Public Utilities

▶ The Model Home Lawn Project in Woodbury, Minnesota, demonstrated that the addition of compost and aeration of lawn areas for new residential construction during final grading conserves 20-30 percent of home water use.

▶ A study in Ontario, Canada, showed that grass swales along roadways outperformed a conventional system in reducing metals, suspended solids and nutrients. Lead and copper releases were almost 90 percent lower with the grass swales.

▶ A program to disconnect downspouts and footing drains in Birmingham, Michigan, helped significantly reduce the number of combined sewer overflows in the city. The cost per home was less than $200 and was completed by city maintenance crews.

▶ A long-term monitoring study of a 12-acre parking lot at the Florida Aquarium showed that LID practices, including bioretention swales, permeable pavement and street sweeping, produced dramatic reductions in metals, nutrients and suspended solids. Phosphorus was reduced almost 45 percent.