CHAPTER 11 – SITE DESIGN AND LOW IMPACT DEVELOPMENT

Source: City of Bend

Chapter Organization

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11.1 PURPOSE

This chapter of the Central Oregon Stormwater Manual concentrates on site design techniques for improving the quality and reducing the quantity of stormwater runoff from new developments and significant redevelopment. This chapter was developed to assist project proponents in better managing stormwater by designing features and practices that mimic the natural hydrologic cycle. The concepts discussed in this chapter are heavily referenced from the *Truckee Meadows Low Impact Development Handbook* and literature published by the *Puget Sound Action Team*.

Low Impact Development (LID) is a relatively new approach to developing land and managing stormwater runoff. LID reduces reliance on pipes, ponds, and drywells. LID techniques can help developers comply with DEQ's Underground Injection Control rule by reducing the need for drywells as the primary source of stormwater disposal. LID techniques may also help developers meet NPDES requirements for drainage to surface waters. LID represents a new set of tools to improve how we develop land and manage runoff and can reduce the need for costly permanent controls that require maintenance over the life of the project. In many cases, LID projects are less expensive to construct and maintain[1].

11.2 APPLICABILITY

Project proponents are expected to investigate LID solutions as part of their planning process. This chapter should be used during the planning and design phase of new development and redevelopment projects. It should be used as a guidance document to assist planners, design engineers, architects, and landscape professionals with the general selection, design and maintenance of LID practices. Applicants are strongly encouraged to utilize the strategies discussed in this chapter when planning and designing new projects. Using LID techniques can lower both short and long term project cost by:

- Reducing the quantity of runoff requiring treatment and flow control;
- Reducing peak flows and therefore required conveyance capacity in pipes and channels;
- Reduce long term maintenance costs; and
- Improve overall water quality which could avoid retrofit requirements in the future.

Better design techniques are further described in Appendix 11A.

[1] While economic research is preliminary or limited in scope, *The Economics of Low Impact Development: A Literature Review* by ECONorthwest, (November 2007) summarizes the findings available on the subject: http://www.econw.com/reports/ECONorthwest_Low-Impact-Development-Economics-Literature-Review.pdf

LID practices can be applied to areas of residential, commercial, industrial, and municipal development. The strategies work for both new developments and significant redevelopment projects and in both urban centers and rural communities, though the specific techniques used will vary based on individual site conditions. Detailed design guidance and application considerations for a number of LID techniques are presented in Appendix 11B.

Planning and design professionals should reference additional guidance documents and sources of information (see Appendix 11C) and are encouraged to share their design and construction experiences with the local development community.

11.3 LOW IMPACT DEVELOPMENT OVERVIEW

Typical land development involves clearing vegetation, grading, and installing roads, parking, utilities, buildings and landscaping. In the process, heavy equipment compacts soils, and the site layout often disrupts natural drainage patterns. After development, less vegetation and more impervious surfaces cause runoff to increase up to 20 to 30 times as much as undeveloped land. Detention ponds and drywells are relied upon to prevent flooding, remove pollutants, slow storm flows and recharge aquifers.

Low Impact Development (LID) is an innovative stormwater approach that was pioneered in Prince Georges County, Maryland and has been applied successfully across the country. LID goals are to mimic a site's predevelopment hydrology by using design practices and techniques that capture, filter, store, evaporate, and infiltrate runoff close to its source.

11.3.1 KEY STRATEGIES

Four key strategies of Low Impact Development are summarized below.

Design Site to Minimize Impervious Surfaces

Site designers, planners, engineers, landscape architects, and architects work together to assess and design the site to:

- Minimize impervious surfaces such as roads, parking lots, and rooftops by reducing the building or parking footprint. Eliminate as much impervious surface as possible by installing vegetated roofs or using pervious pavements.
- Locate homes, other buildings, roads and parking away from natural resource areas and soils that infiltrate well.
- Cluster houses and other buildings onsite so stormwater can follow more natural drainage patterns and so impervious infrastructure such as roads and driveways can be reduced.

Conserve and Restore Vegetation and Soils

- Retain native vegetation and trees on undeveloped sites and restore vegetation on previously cleared land. Vegetation captures, infiltrates, and evaporates runoff.

- Preserve well-draining native soil. Use compost to restore the health of soil disturbed by construction. Healthy soils store and infiltrate stormwater and produce healthy plants that require less watering.
- Use the existing topographic features of a site to slow, store and infiltrate stormwater.
- Protect and incorporate natural drainage features and patterns into site design.
- Protect areas to be used for stormwater infiltration from compaction during construction.

Manage Stormwater Close to Where the Rain Falls

- Use small-scale, integrated management practices such as bioretention, permeable pavement and vegetated roofs-rather than one large pond.
- Create a landscape that slows storm flows and increases the amount of time runoff is retained on the site. LID tries to mimic the slow movement of water typical in a native landscape.
- Integrate stormwater facilities into the site design to create an attractive landscape that protects the environment. For example, a bioretention area can be a garden that beautifies the neighborhood while managing stormwater. Swales and infiltration areas can be incorporated into community open space areas.
- Reduce reliance on traditional storm sewers, pipes, ponds, and drywells.

Provide Maintenance and Education

- Develop reliable and long-term maintenance programs with clear and enforceable guidelines.
- Educate homeowners, building owners and landscapers on the proper maintenance requirements for LID facilities.
- Involve neighborhoods in caring for their systems and protecting their natural resources.

11.3.2 HOW LID DIFFERS FROM CONVENTIONAL STORMWATER CONTROLS

Conventional development consists of impervious streets alleys, driveways, sidewalks, and structures that directly convey runoff to curb and gutter systems, storm drain inlets, and a network of underground pipes and infiltration devices. Conventional controls are designed to convey water as quickly as possible away from developed areas. Conventional development and stormwater design results in increased runoff, higher flood and system overflow potential, and often the transport of pollutants to streams, rivers, wetlands, and groundwater. Some studies have shown that the majority of pollutants are transported during small, frequent storm events, or during the “first flush” portion of peak runoff events (typically the first 0.5 inches of rain). Whether this is true in Central Oregon has not been studied, as it depends on the

soil characteristics, time between storm events, street sweeping practices, and other factors.

The goal in LID is to mimic a site's pre-developed hydrology by capturing, filtering, storing, and infiltrating runoff close to its source. Instead of conveying runoff in gutters and underground pipes and installing costly "end of pipe" facilities for treatment and disposal, LID addresses stormwater through small, cost effective landscape features located at the lot level. LID techniques are most effective when they are sized to capture and treat frequently occurring storm events (e.g. the water quality storm event as described in this manual).

11.3.3 HOW LID DIFFERS FROM SMART GROWTH AND SUSTAINABLE DEVELOPMENT

LID differs from other new urban planning techniques such as Smart Growth and Sustainable Development in that LID is primarily focused on alternative stormwater management techniques. Smart Growth focuses on managing and directing growth to minimize damage to the environment and build "livable" cities and towns. It advocates developing new areas that promote a balanced mix of land uses and a multi-modal transportation system. Smart Growth also calls for investing time and resources in central cities and older suburbs to restore community and vitality.

Sustainable Development is a term that grew out of the conservation/environmental movement of the 1970's. It looks at enhancing quality of life and preserving natural systems by understanding the interdependent relationships between the natural, social, and economic environments. Sustainable Development has been described as designing systems for the "seventh generation." While Smart Growth and Sustainable Development are important concepts to be considered in development on a regional scale, the design guidelines in this chapter focus on LID strategies for stormwater management.

11.4 LID TECHNIQUES AND STRATEGIES

There are numerous variations of LID practices that can be incorporated into development and redevelopment projects. Some common LID practices include:

Preserving Vegetation, Clustering Development, Dispersing Runoff

Protecting or replanting a significant portion of a development site's vegetation; locating development on a smaller part of the site; directing runoff to vegetated areas. In many cases, this is the most efficient and cost-effective way to manage stormwater.

Bioretention

Shallow, landscaped areas composed of soil and a variety of plants that are integrated into the overall landscaping scheme of a site. Bioretention cells are stand-alone features, while bio-retention swales are part of the conveyance system.

Soil Amendments

Compost added to soils disturbed during the construction process. Restores the health of site soils and increases the ability to infiltrate runoff.

Pervious Pavement

Allows water to infiltrate and may remove some pollutants. Includes porous concrete, porous asphalt, permeable pavers, and grid systems filled with grass or gravel.

Vegetated or "Green" Roofs

Roofs composed of a waterproof layer, root barrier, drainage layer, growth media and plants. Green roofs provide slower release of runoff, improve energy efficiency, extend roof life, and provide wildlife habitat and recreational amenities. Green roofs are becoming more common on institutional and government buildings.

Rooftop Rainwater Collection

Catchment systems or cisterns that collect rooftop runoff for irrigation, drinking water, grey water, or other purposes reduces runoff and demand on groundwater supplies. Rooftop rainwater collection is most applicable in western regions of the state, and may be less desirable in Central Oregon due to the infrequent storm events experienced in this region.

Minimal Excavation Foundations

Alternative building foundations composed of piles and a connector at or above grade. Eliminates the need for extensive excavation and reduces soil compaction.

11.4.1 SPECIFIC DESIGN GUIDANCE

Specific LID design criteria are outlined in the guidance document provided in Appendix 11B. Where design storms are required for sizing these LID techniques, the water quality design storm criteria presented in Chapter 6 and the peak storm event criteria presented in Chapter 7 should be used. Appropriate design documentation and calculations should be included in the drainage submittal as described in Chapter 3. As is the case with all stormwater management facilities, regular inspection and maintenance of LID installations is required for long term operation.

A wealth of additional LID information is available from numerous sources. Specific LID and site design resources are included in Appendix 11C. When referencing LID information it is important to choose information that is appropriate for the soil types and semi arid and cold climate in Central Oregon.

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APPENDIX 11A – BETTER SITE DESIGN STRATEGIES

The following document: *Using Site Design Techniques to meet Development Standards for Stormwater Quality* (May 2003) is published by the Bay Area Stormwater Management Agencies Association (BASMAA). This document describes how better site design and LID can reduce the water quality treatment and flow control requirements at a given development site.

INSERT BASMAA "USING SITE DESIGN TECHNIQUES TO MEET DEVELOPMENT STANDARDS FOR STORMWATER QUALITY" GUIDEBOOK

APPENDIX 11B – LOW IMPACT DEVELOPMENT DESIGN GUIDELINES

The following reference document is Chapter 3 from the *Truckee Meadows Low Impact Development Handbook* (draft August 2005, prepared by Kennedy/Jenks Consultants). This document presents BMPs for site design and low impact development including design considerations, limitations, maintenance considerations, and examples for each technique. Additional information, including the full handbook can be found through the Truckee Meadows Regional Stormwater Quality Management Program (www.TMstormwater.com). The following list summarizes the techniques included in this appendix, along with specific design elements to consider when applying the design guidance to Central Oregon.

3.0 Bioretention Systems

Bioretention areas should be sized to accommodate the water quality storm volume without accounting for any infiltration during the design storm. This creates a base storage volume available during frozen ground conditions.

Perforated underdrain systems are considered UICs and require appropriate pretreatment (see Chapter 6) as well as registration with DEQ.

3.0.0 Landscape Detention

3.0.1 Tree Box Filters

3.0.2 Storm Water Planters

3.1 Swales and Buffer Strips

Swales and buffer strips should be landscaped appropriately for the local climate. Xeriscaping practices are encouraged.

Swales may be located adjacent to, but not in natural channels. See Chapter 9 for additional information on maintaining natural drainage systems.

Perforated underdrain systems are considered UICs and require appropriate pretreatment (see Chapter 6) as well as registration with DEQ.

3.2 Porous Paving Systems

ADA requirements should be considered when designing sidewalks and trails.

3.2.0 Porous Concrete and Asphalt

3.2.1 Permeable Pavers

3.3 Rainwater Catchment Systems

3.4 Green Roofs

3.5 LID Site Design

Street widths and block lengths must meet local fire department and emergency vehicle requirements.

Use tire stops in parking lots to prevent trespass of automobiles onto the stormwater controls.

ADA requirements should be considered when designing sidewalks and trails.

3.5.0 LID Parking Lot Design

3.5.1 LID Street and Road Design

3.5.2 LID Driveway Design

3.5.3 LID Sidewalks and Bike Paths

3.6 Additional LID Strategies

3.6.0 Impervious Surface Reduction and Disconnection

3.6.1 Soil Amendments

3.6.2 Roof Rainwater Collection Systems

3.6.3 Roof Leader Disconnection

INSERT SELECTED SECTIONS FROM CHAPTER 3 OF "TRUCKEE MEADOWS LOW IMPACT DEVELOPMENT HANDBOOK"

APPENDIX 11C – ADDITIONAL RESOURCES

Additional information about site design Low Impact Development techniques can be found from the following resources:

Bay Area Stormwater Management Agencies Association – several site design guidebooks including *Start at the Source – Design Guidance Manual for Stormwater Quality Protection* and *Using Site Design Techniques to Meet Development Standards for Stormwater Quality*: http://www.basmaa.org/

Center for Neighborhood Technology – articles and resources including the Green Values Stormwater Toolbox (http://greenvalues.cnt.org) with useful stormwater calculator: www.cnt.org

Center for Watershed Protection – research and guidance documents on site planning and stormwater management including the *Stormwater BMP Design Supplement for Cold Climates*: www.cwp.org

Kansas City, MO, 10,000 Rain Gardens – Educational resource for rain garden design and implementation: www.rainkc.com

Low Impact Development Center – proper site design techniques to protect water resources: www.lowimpactdevelopment.org

Low Impact Development: Urban Design Tools – tools and techniques for low impact development: www.lid-stormwater.net

Prince George's County, Maryland – Prince George's County Maryland developed the *Low Impact Development Integrated Practices Guide* that has become the baseline for all low impact development work across the country (available from EPA's website below).

Puget Sound Action Team – widely referenced low impact development resource for the Puget Sound area: www.psat.wa.gov/Programs/LID.htm

Oregon Sea Grant Extention, Oregon Staet University – Stormwater Solutions program has a guidance document for addressing stormwater on single family residential properties. *The Oregon Rain Garden Guide – A Step-by-Step Guide to Landscaping for Clean Water and Healthy Streams* released in 2010 includes simple calculations for homeowners and lists of appropriate trees and plants for different regions of Oregon: seagrant.oregonstate.edu/sgpubs/onlinepubs.html

Truckee Meadows Regional Stormwater Quality Management Program – stormwater management agency for the City's of Reno and Sparks, Nevada and Washoe County: www.TMstormwater.com

US Environmental Protection Agency – links to EPA documents, studies comparing the economic benefits of LID, and other organization web sites: www.epa.gov/owow/nps/lid/