Low Impact Development Approaches Handbook

July 2009

Wherever there's water, there's **Clean Water.**

Clean Water Services

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Chapter 1: Introduction

This handbook was developed to promote and encourage Low Impact Development Approaches (LIDAs) to protect precious natural resources. It is a practical tool for those who make or influence development decisions and will be updated as codes and policies change and new techniques and best practices emerge.

The handbook is a collaborative product of the Tualatin Basin Natural Resources Coordinating Committee, which includes the land use jurisdictions within urban Washington County, and Clean Water Services, Tualatin Hills Park and Recreation District and Metro. Clean Water Services (the District) is a water resources management utility in urban areas of the Tualatin River Watershed that builds, maintains and enhances the public drainage system in partnership with Washington County and its member Cities. The District, County and Cities manage stormwater runoff to meet public needs and comply with strict water quality regulations set for the Tualatin River basin by the Oregon Department of Environmental Quality (DEQ).

The District's Design and Construction Standards (the Standards) define the requirements for development to treat and detain stormwater runoff. Stormwater is the runoff from impervious surfaces such as streets, roofs and parking lots that flows to storm drains, ditches and culverts, and then to the nearest river, stream or wetland. When it rains, stormwater runoff may pick up oil, sediment, bacteria, grease and chemicals that can pollute local waterways and the Tualatin River.

LIDAs offer more options to comply with stormwater management requirements, and complement the water quality facilities and vegetated corridors that have been established as part of the Standards. The five objectives of LIDA are to:

1. Conserve Existing Resources
2. Minimize Disturbance
3. Minimize Soil Compaction
4. Minimize Imperviousness
5. Direct Runoff from Impervious Areas onto Pervious Areas

This handbook is a supplement to the Standards and is to be used in conjunction with them and other applicable regulations.

The Handbook is for use by all public agencies within the Tualatin Basin as a reference document. There may be other standards and requirements that are jurisdiction-specific and the users are encouraged to check with the local jurisdiction for additional information.

LIDA swale

Green Roof

Porous Pavement

Vegetated Swale

Extended Dry Basin

Constructed Water Quality Wetland

Infiltration Planter

Flow-Through Planter

Vegetated Filter Strip

1.1 Why Use Low Impact Development Approaches (LIDAs)?

Typically, LIDA facilities are vegetated landscape elements such as planters, vegetated filter strips, and swales that filter and/or infiltrate stormwater. Other types of LIDAs are porous pavements and green roofs that reduce impervious area and runoff volume. LIDAs are integrated with the site landscaping to provide stormwater management, visual amenities and habitat benefits. Low impact site design may preserve trees and vegetation, and conserve water and reuse water. Site design approaches may include lot size averaging, density transfers, clustering or placement of buildings and parking areas to avoid impacts to habitat, vegetation and drainage courses.

In addition to aesthetic and habitat benefits, LIDAs may:

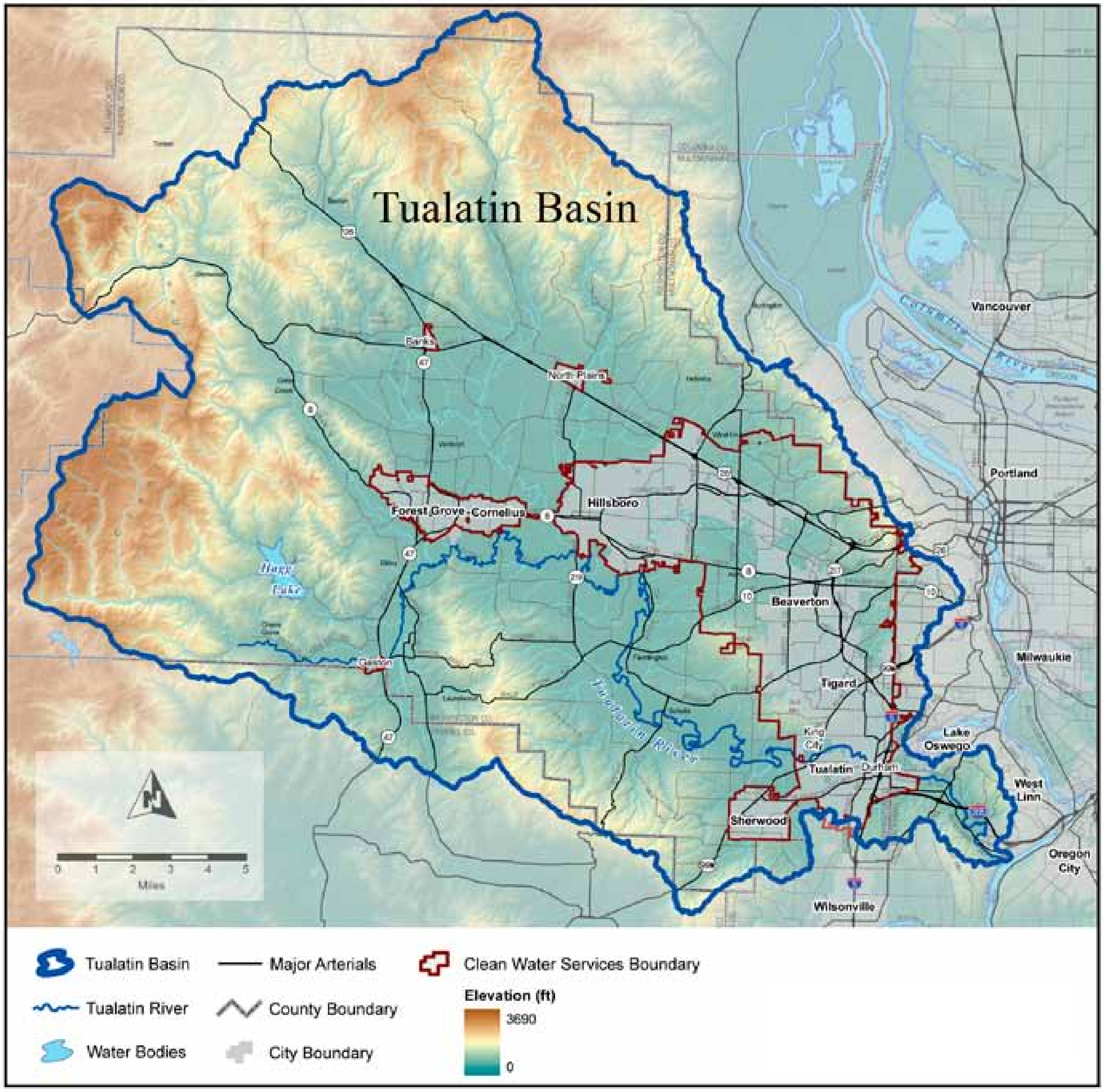
- Meet Clean Water Services' stormwater quality requirements for new development sites and redevelopment
- Reduce area needed for water quality facilities by integrating LIDAs into landscaping, buildings and pavements which may result in more buildable land
- Reduce and slow stormwater runoff for better water quality and less erosion
- Cut project costs by eliminating piping and other engineered structures
- Reduce the piping and excavation needed to manage stormwater runoff because it is conveyed and treated above ground
- Use the same areas for stormwater management and landscaping (e.g. a flow-through planter may count toward required site landscaping)
- Qualify for credits for green building, site design, etc.
- Qualify for development credits such as allowable building height increases, reduced set-backs or reduced lot sizes
- Preserve trees and significant vegetation by incorporating them into LIDA facilities or avoiding them in the site design
- Provide summer shade

None of the LIDA facilities included in this Handbook are considered to be Underground Injection Control (UIC) system. As such, no UIC regulatory requirements are noted. Check with the District or DEQ staff for additional information about UICs.

1.2 How this Handbook Relates to Other Tualatin Basin Regulations

The handbook is intended to encourage the use of LIDAs by providing guidance on their planning, design and maintenance. The District allows and encourages LIDA facilities to meet stormwater quality requirements for development. The District implements stormwater requirements in unincorporated portions of its service area and within the Cities of Banks, Durham, King City, and North Plains. In Beaverton, Cornelius, Forest Grove, Hillsboro, Sherwood, Tigard and Tualatin, the Cities' staff implement and enforce the requirements.

Map of Clean Water Services District Boundaries



This handbook is a reference for all jurisdictions within the Tualatin Basin. Users are encouraged to consult with the local jurisdiction for additional requirements and standards This handbook is a supplement and is to be used in conjunction with the Standards and other applicable regulations. LIDAs do not replace Water Quality Sensitive Areas or Vegetated Corridors.

The requirements included in the Design and Construction Standards protect water quality, floodplains and habitat functions from the impacts of development. Water Quality Sensitive Areas, including streams and wetlands, must be protected by Vegetated Corridors. Always check the County and City planning and development standards for additional site design requirements.

LIDAs are encouraged, but in some cases might not be allowed by the local jurisdiction due to technical constraints, code restrictions or other issues. For example, a LIDA based on infiltration might not be allowed on unstable slopes, areas of high groundwater table, or soils with poor infiltration. Property owners, developers, designers and contractors must check with local permitting authorities to confirm allowed LIDAs for their projects.

LIDAs are intended to reduce and mitigate the environmental impacts of conventional development by mimicking natural hydrology instead of replacing it with imperviousness. LIDAs may meet water quality regulations and stormwater flow management goals, and may also qualify for development credits from local jurisdictions by protecting vegetation and habitat located outside of the required Vegetated Corridors.

Chapter 2: Site Planning for LIDAs

2.1 Site Analysis

The first step in using LIDAs is a thorough site analysis to learn how water moves through the site and how natural hydrologic functions could be preserved. Inventory conditions on and adjacent to the site, including topography, soils, hydrology, and vegetation. The site analysis includes site visits, topographical and vegetation/habitat surveys, review of maps and reports, and development of a site base map.

In the site analysis, the physical attributes of the development or redevelopment site should be reviewed before placing streets, parking lots and buildings to optimize stormwater management and habitat protection. Existing features should be incorporated into the site design by working with rather than against site attributes and constraints. A site layout that integrates site amenities to manage stormwater and protect habitat may reduce permitting delays.

Site analysis should follow the order depicted in Figure 1 and answer the questions below.

1. Topography

Is the site flat, steep, or moderately sloped?

The steeper the slope, the more likely soil erosion or slides could occur. Generally, slopes greater than 25% should be avoided for clearing, grading and building. Steep slopes and slide prone areas are not advisable for infiltration LIDAs. A geotechnical engineering analysis may be necessary to determine appropriate LIDAs.

2. Soils

What is the site soil type, hydrologic group, infiltration capacity, and are groundwater tables high?

Use soil maps, which are available from the Natural Resources Conservation Service (NRCS) Soil Survey for Washington County. Sizing may be adjusted for some LIDAs based on tested infiltration rates unless high groundwater is an issue.

3. Hydrology

What are the flow patterns into, on, and from the site? Where will runoff drain?

Does the site have FEMA floodplains or floodways, drainage hazard areas, or Water Quality Sensitive Areas, seeps or springs?

Working with the site's flow patterns may reduce grading and associated costs.

4. Vegetation & Habitat

Are there trees and vegetation, especially large trees (6" diameter or larger at 4 foot height) or native vegetation on the site?

Native trees and vegetation should be protected. Check local planning and development codes for habitat and tree protection requirements. Local codes also may offer incentives for protecting and avoiding trees and habitat.

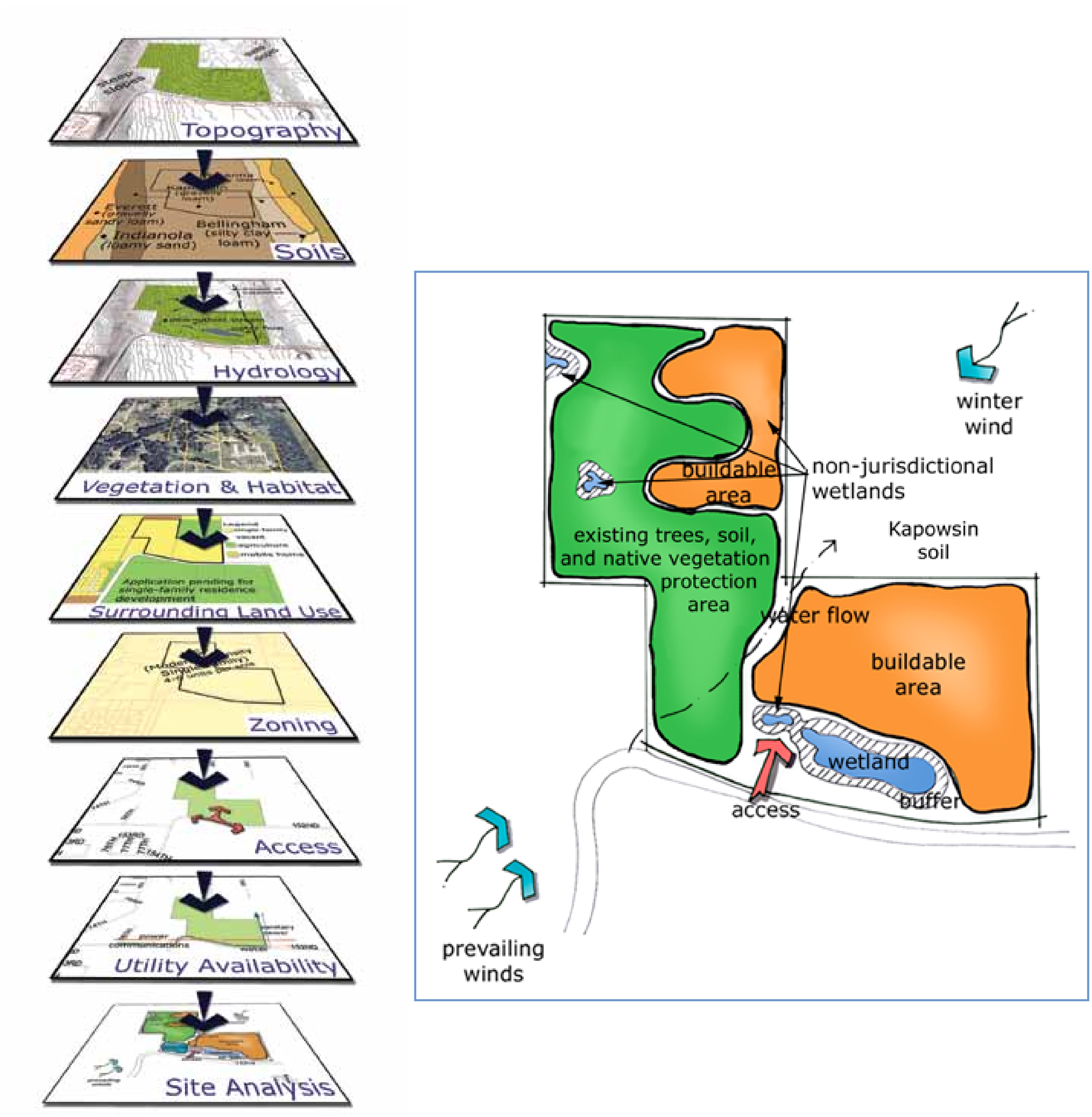


Figure 1 Site Analysis process diagram . Graphic from the LID Technical Guidance Manual for Puget Sound, courtesy of Puget Sound Partnership and AHBC, Inc..

5. Water Quality Sensitive Areas
Are there year-round or intermittent streams or channels or wetlands?
These features are protected by Corps of Engineers or Oregon Department of State Lands (DSL) environmental regulations, and the District Standards require Vegetated Corridors to protect them. Refer to National and Local Wetlands Inventory maps and consult with the District or local jurisdiction.

6. Land Use/Zoning
What type and density of development is allowed/required? Are there special or protective overlay zones? Can development be clustered or lot sizes altered?

7. Access
What are the options for auto, bike and pedestrian access, circulation and parking?

8. Utility Availability and Conflicts
What potential utility conflicts exist? Where are existing utility connections (water, sewer, storm drainage, electricity/phone/cable, etc.)? Where can new utilities be constructed with least impacts?

2.2 Site Planning

After completing the site analysis, prepare a site plan for permit submittal that addresses the five LIDA objectives listed below:

Site planning for LIDAs is based on these objectives, in order of importance:

1. Conserve Existing Resources
2. Minimize Disturbance
3. Minimize Soil Compaction
4. Minimize Imperviousness
5. Direct Runoff from Impervious Areas onto Pervious Areas

1. Conserve Existing Resources
The first and most important step in LIDA site planning is to preserve and protect existing water features and vegetated areas. Although the Standards require permanent protection of Water Quality Sensitive Areas and Vegetated Corridors, protection of other mature trees and vegetation provides habitat, prevents erosion, captures significant rainfall, provides summer shading, and reduces runoff volume and velocity which protects and enhances downstream water quality. Preservation of trees and vegetation may qualify for local incentives, and may reduce a site's ultimate impervious area and the size of required water quality or LIDA facilities.

2. Minimize Disturbance
Protection of existing vegetation provides more water quality benefits than replanting areas that have been cleared. Undisturbed areas provide more rainfall interception, evapotranspiration and runoff rate attenuation than replanting even with soil amendments. Construction activities that compact native soils significantly reduce infiltration capacity and increase runoff. To minimize disturbances, identify areas required to be protected and other areas that will not be cleared or impacted during construction. On plan submittal drawings, identify site work zones and no-disturbance areas. And, on the site use orange construction fencing to mark work zones, access points, materials storage and areas where no disturbances will be allowed.

3. Minimize Soil Compaction
Avoid any activity that could cause soil compaction in areas designated for infiltration LIDAs. Also avoid or minimize soil compaction where other LIDAs, water quality or detention facilities, or landscaping will be placed. Truck and equipment traffic during construction compacts site soils and areas that will ultimately be landscaped. Clearing, grading and compaction by construction traffic reduces the natural absorption and infiltration capacities of the native soils. Subsequent tilling and/or addition of soil amendments such as compost can help, but will not restore the original infiltration capacity of the soils. To minimize compaction, prepare soil amendments off-site; if prepared onsite, designate an area for soil amendment preparation and use appropriate erosion prevention and sediment control methods.

4. Minimize Imperviousness
Site design layout methods that reduce impervious footprints may include: shared parking areas; clustered buildings that require less driveways and pathways; reduced parking stalls, especially in transit-served areas; adding floors to buildings or parking garages; and, reduced street width if allowed by local planning codes. In site design strive to reduce the actual footprint of buildings and paving to reduce and slow runoff from built surfaces. Green roofs and porous pavement are effectively pervious, although they are not water quality facilities, and they reduce the site impervious area and the volume of stormwater to be treated.

5. Direct Runoff from Impervious Areas onto Pervious Areas
This is the last line of defense against downstream impacts. While the first four objectives prevent runoff and pollution transport, this addresses pollutants in runoff from roofs, parking lots, streets and other impervious surfaces. Most LIDA facilities and water quality facilities fulfill this objective, including: planters, swales, vegetated filter strips, extended dry ponds and constructed water quality wetlands that serve as pervious, landscaped areas designed to receive runoff from impervious areas.

2.3 Selecting LIDAs to Match Site Conditions

LIDA facilities can be constructed on and adjacent to buildings, and integrated into site landscaping and hardscape such as parking lots and along streets. LIDA facilities can be used singly to manage rainfall and runoff from a drainage area, or constructed in a series of multiple facilities. The site analysis helps identify the types of LIDAs best suited to the site. Owners and designers may use Table 1 as a quick reference to match each LIDA with common stormwater management objectives and site constraints to select the most appropriate facilities.

Table 1: LIDA Selection for Site Conditions

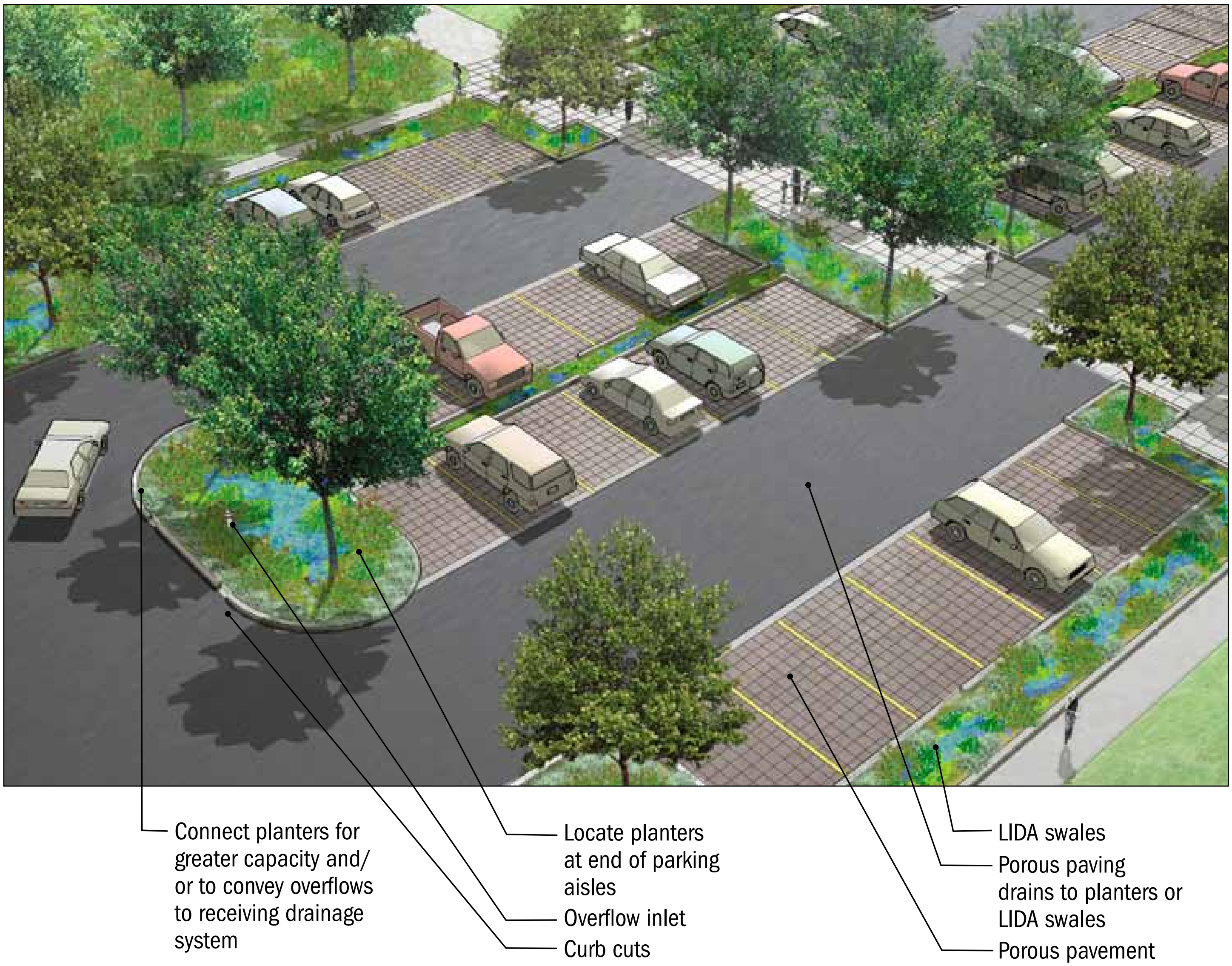
	Green Roof	Porous Pavement	Flow-through Planter	Infiltration Planter/ Rain Garden	Vegetated Filter Strip	LIDA Swale
Reduce imperviousness	✓	✓				
Infiltrate		✓		✓	✓	✓
Detention/ flow control		✓		✓		
Provide Habitat			✓	✓	✓	✓
Near Vegetated Corridor			✓	✓	✓	✓
Private property	✓	✓	✓	✓	✓	✓
Private street		✓	✓	✓	✓	✓
Public Street/ROW*			✓		✓	✓
On or next to building	✓		✓			
Parking lot		✓	✓	✓	✓	✓
Landscaped area			✓	✓	✓	✓
Steep slope	✓		✓			
Soils with low infiltration rate	✓	✓	✓		✓	✓
High GW table	✓		✓		✓	✓
Contaminated soils	✓		✓			

* Check with local juristiction about use in ROW

Figures 2, 3 and 4 illustrate how various LIDAs can be integrated into development sites, landscaping and street designs.

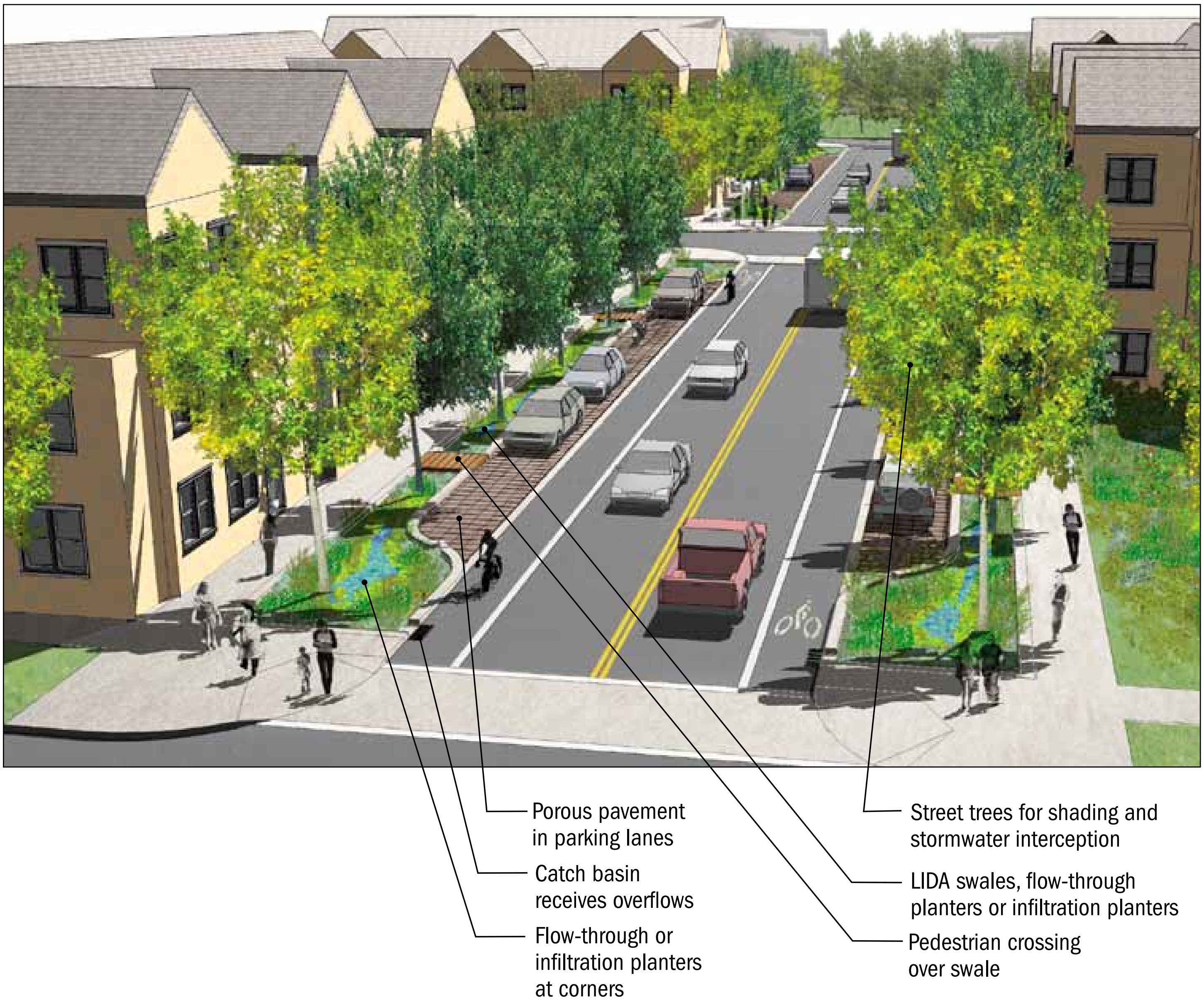
LIDAs in Parking Areas

Figure 2



LIDAs for Streets

Figure 3



LIDAs for Buildings and Adjacent Areas

Figure 4

Flow-through planters (next to building) as needed for non-green roof areas

Infiltration planter (minimum 10' setback from building) or flow-through planter

Stormwater art (sculptural downspout)

Green roof

Disconnected downspout and splash basin

Infiltration or flow-through planters for street, parking areas or sidewalk runoff

Chapter 3: LIDA Design Process

3.1 Design Basis

Primary goals of LIDA site design are to reduce the volume of stormwater runoff and to treat pollutant loads where they are generated using appropriate site planning and by directing stormwater to small-scale systems throughout the site. LIDAs integrated into landscaping and the site design may reduce the size of or eliminate stormwater ponds in separate land tracts, and may reduce underground piping, curbs, and gutters.

The District requires stormwater treatment for nearly all development and other activities that create new impervious surfaces or increase the amount of stormwater runoff or pollution leaving the site. Refer to the Standards for specific requirements and how to calculate the impervious area requiring LIDA or water quality facilities.

Stormwater treatment to remove pollutants is required in the Tualatin River Basin by the Oregon Department of Environmental Quality to comply with the Clean Water Act. The District's Total Maximum Daily Load (TMDL) and National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit require new development and redevelopment to reduce pollution from stormwater runoff. This is achieved by constructing water quality facilities to remove pollution, or by using LIDAs to reduce runoff and pollutants.

The water quality storm runoff rate volume calculations for sizing water quality facilities are presented in Chapter 4 of the Design and Construction Standards. To determine the size of LIDA facilities, owners and designers may use the LIDA Sizing Form in Section 3.2. This form is based on the water quality design storm and typical soil conditions. [Retrofit project sizing: For retrofit projects where there has been no stormwater treatment, the sizing requirements must be determined by District and City staff. Do not rely solely on the sizing methods in this manual.]

LIDA facilities are intended as stormwater quality facilities. However, onsite stormwater quantity detention may be incorporated into LIDA facility design in some cases if required. Porous pavement and infiltration planters/rain gardens may be adapted to provide detention storage. Porous pavement may be constructed with vaults or gravel/rock storage galleries to detain excess runoff. Infiltration planters or rain gardens may reduce stormwater runoff volume to meet all or part of a site's detention requirements if there is adequate native soil infiltration (greater than 2 inches per hour). Also, extended dry basins and constructed water quality wetlands (refer to the Water Quality Facilities section of the Design and Construction Standards) may be designed with additional capacity to provide both detention and water quality treatment. **When detention and treatment functions are to be combined, the analysis and design calculations must be done by a professional engineer.**

See the fact sheets in Chapter 4 for specific design criteria, photos and sketches of various LIDA facilities.

3.2 Design Steps for LIDA Facilities

For most development sites, LIDA facilities may be designed using District sizing factors. Complete stormwater plan submittal requirements are detailed in the Design and Construction Standards, and local planning and permitting departments may have additional requirements. For sites less than one acre, the impervious area requiring treatment may be reduced if LIDAs are used. This manual includes a LIDA Sizing Form to assist in sizing. The following steps describe the sizing process.

STEP 1: Determine impervious area requiring treatment

- Refer to Chapter 4 of the Design and Construction Standards for instructions to calculate the impervious area requiring water quality treatment for new development and redevelopment sites.

STEP 2: Deduct impervious area LIDA credits

- Deduct the site areas designed with porous pavement or green roofs from the impervious area calculated in Step 1.
- Check with the local jurisdiction about any additional credits (i.e. rainwater harvesting, tree protection, etc.)

STEP 3: Size LIDA facilities for remaining impervious area

- Use the LIDA Sizing Form to determine the size of LIDA facilities required to treat stormwater runoff from the remaining impervious area.
- Sizing factors for infiltration based LIDAs assume an existing site soil infiltration rate of less than 2 inches per hour. Fact sheets for these facilities (in Chapter 4) provide information about soil infiltration testing that may be performed if the designer believes site soils have greater infiltration capacity and wants to produce information to support a smaller sizing factor.
- If more than one LIDA facility is used on the development site, each facility must be sized for the amount of impervious area draining into it.

STEP 4: If needed, design water quality facilities for large impervious areas or remaining untreated impervious area

- The sizing factors noted in this Handbook shall not be used for LIDA facilities treating runoff from more than 15,000 square feet of impervious area.
- For large development sites and impervious areas, a large water quality facility (vegetated swale, extended dry basin or constructed water quality wetland) or proprietary facility may be appropriate.

Clean Water Services LIDA Sizing Form

Project Title:	
Project Location:	
Contact Name/Title/Company:	
Phone/e-mail:	

STEP 1: Determine Impervious Area Requiring Treatment

Total Site Area (acres):

Total Existing Impervious Area (sq.ft.):

Proposed New Impervious Area (sq.ft.):

Impervious Area Requiring Treatment (sq.ft.)
(Refer to Design & Construction Standards Chapter 4 for instructions to calculate this area, which will be less than or equal to the new plus existing site impervious area.)

STEP 2: Deduct Impervious Area LIDA Credits

Porous Pavement (sq. ft.):

Green Roof (sq. ft.):

Other Credits as approved (sq. ft.):

Total Credits (sq. ft.):

Remaining Impervious area (sq. ft.)
(Total from Step 1 – Total Credits):

STEP 3: Size LIDA Facilities for Remaining Impervious Area

	IA: Impervious area treated (sq.ft.)	SF, Sizing Factor	LIDA facility size (sq.ft.) (IA x SF)
Infiltration Planters/Rain Garden		0.06	
Flow-through Planter		0.06	
LIDA Swale		0.06	
Vegetated Filter Strip		0.06	

Total Impervious Area treated (sq.ft.)

(*Must equal total from Step 2 or additional LIDA facilities or Water Quality Facilities must be added.)