Guidance to the City of Brownsville on Post-construction Stormwater Requirements to Address the Willamette Basin Bacteria TMDL

Contents

Example design standards for post-construction stormwater controls are compiled below along with examples of regulatory triggers for post-construction stormwater controls and treatment standards for stormwater generated by a proposed new development. The recommended references for post-construction stormwater control standards presented below are based on the following two selection criteria:

- Stormwater management approaches that reduce runoff and minimize the cost of engineered controls.
- Stormwater management practices that ensure compliance with the Willamette Basin TMDL for bacteria.

These examples are drawn from Oregon and other states. Additionally, I have summarized the rationale for selecting the examples of post-construction stormwater control standards that are presented below.

Rationale for the Selection of Stormwater Management Requirements

Major Shifts in Stormwater Management at State and Local Levels

The shifts in stormwater management described in this section provide a framework for stormwater management that will help the City ensure that the TMDL load allocations for bacteria and mercury are adequately addressed in new development. The framework reflected in these shifts also provides a widely used approach to reduce and infiltrate runoff locally thereby minimizing the need for engineered stormwater controls and reducing the cost of these requirements fo the developer. Stormwater design manuals that exhibit these shifts are used as examples that the City can adapt for use in regulating stormwater from new development.

According to a 2005 review by the State of Minnesota, there have been several fundamental shifts in how stormwater runoff is managed at development sites during the last decade.[1] These shifts are reflected in the statewide stormwater design manuals from the States of Wisconsin, Washington, Pennsylvania, New York, Vermont, and Maryland. The fundamental shifts in stormwater requirements noted above are as follows:

- Placing more emphasis on on-site runoff reduction using innovative site design practices or alternatively referred to as better site design and environmental site design (see discussion below);

[1] http://www.pca.state.mn.us/index.php/view-document.html?gid=8942

- Promoting/requiring greater infiltration and groundwater recharge at the site;
- Providing a unified approach to size structural stormwater controls that employs four to five defined sizing criteria for concerns such as water quality, groundwater recharge, channel protection, overbank flood control, and extreme storms;
- Requiring increased runoff volume requirements for water quality treatment and pollutant removal;
- Requiring new storage and release requirements to prevent bed and bank erosion in urban streams; and,
- Providing explicit numeric guidance to size stormwater controls.

Although not part of the above Minnesota review, other state stormwater management efforts exhibit all or some of these shifts also. For instance, the State of New Hampshire's Stormwater Manual includes low impact development controls including nonstructural controls and provides sizing criteria for structural controls that include water quality volume, water quality flow, groundwater recharge volume, channel protection as well as effective impervious cover and undisturbed cover.[2] However, as noted in the Minnesota review, the paths that each State – including the states not covered in the Minnesota review – have taken to pursue these new directions in stormwater management are often different and represent a diversity of approaches. Moreover, without statewide requirements, local jurisdictions have taken the lead in stormwater management and have developed regulatory programs for stormwater which predate the shifts noted in the review above or which emulate these shifts. The examples featured in this guidance represent the state that stormwater management has evolved to in recent years.

Low Impact Development as the Preferred Approach with Nonstructural Controls as a First Step

Given its emphasis on reducing stormwater runoff and infiltration, low impact development (LID) controls are emphasized in the examples below. LID approaches utilize both nonstructural controls (e.g., land use planning techniques, better site design) and structural controls (i.e., engineered controls).[3] LID controls help to reduce the volume of stormwater runoff generated from new development and have demonstrated effectiveness in treating a variety of stormwater pollutants particularly bacteria via stormwater filtration/bioretention. The examples below are organized such that nonstructural stormwater controls are identified as the first step in managing stormwater from new development. The rationale for this organization is that nonstructural stormwater controls reduce the volume of stormwater runoff, and this – in turn – reduces the number and size of the structural controls and, therefore, reduces the land development cost. More importantly for water quality and the Willamette Basin TMDL load allocation for bacteria, a reduction in stormwater runoff volume translates into a reduction of stormwater pollutant loading.

States such as New Jersey, Maryland, and Delaware, for example, as well as the small Town of Warsaw, Virginia and the City of Portland and the municipalities in the Clean Water Services district require that developers consider nonstructural stormwater controls when developing a strategy for managing stormwater. Vermont's stormwater design manual is designed to integrate nonstructural controls and structural controls to foster a comprehensive stormwater management approach. As an example of the application of nonstructural stormwater control requirements in a small community, the Town of Warsaw, Virginia requires that a developer complete a checklist of nonstructural stormwater controls before considering structural stormwater controls. This information is presented in the examples below.

Bacteria Loading Best Addressed with Bioretention Controls and Controls that Reduce Runoff Volume

Although nonstructural controls play an important role in stormwater management, utilizing both nonstructural and structural controls is important for meeting the TMDL load allocation for bacteria as well as providing designers with the needed flexibility to manage stormwater given site constraints. A recent review of stormwater controls that have been entered into the International Stormwater BMP Database indicates that controls infiltrating stormwater and reducing runoff volumes are the most reliable controls for reducing the loading of

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[2] http://des.nh.gov/organization/divisions/water/stormwater/manual.htm
[3] http://www.epa.gov/npdes/pubs/region3_factsheet_lid_esd.pdf

bacteria.[4] This review indicates that the LID controls discussed above will provide a reliable control for bacteria since LID emphasizes runoff reduction and infiltration. Stormwater controls such as LID that reduce and infiltrate will be necessary for meeting the TMDL load allocation for bacteria.

Five Key Elements for Controlling Post-construction Stormwater

Based on a review of state stormwater requirements and stormwater requirements in the Portland metropolitan area, there are five key elements for an effective program for controlling stormwater from new development that addresses load allocation for bacteria in the Willamette Basin. The first element is a clear trigger for when post-construction stormwater controls are required in a new development. Once a trigger is identified, a site performance standard is needed to ensure that the volume of stormwater runoff at a site is not increased by the new development. When the site performance standard is established, a treatment standard is then needed to ensure that pollutants transported in stormwater from new impervious surfaces are removed from the stormwater before it is discharged to surface waters. Finally, to ensure that the treatment standard is achieved by the stormwater controls which are put in place to remove pollutants, sizing criteria and design specifications are needed for these structural stormwater controls. Several options for developing post-construction stormwater control requirements are presented below along with additional information on why these requirements are necessary. As noted earlier, these options were selected using the two selection criteria highlighted above and reflect the approaches for post-construction stormwater control presented above.

Post-Construction Control Triggers, Site Performance Standards & Treatment Standards

Examples of Triggers for Post-Construction Stormwater Controls

The following triggers for post-construction stormwater controls provide a clear threshold for when a proposed new development must have post-construction stormwater controls. When this threshold is triggered by a proposed development, a developer will know that a site performance standard, treatment standard, sizing criteria, and design requirements must be addressed in the design of the stormwater management system for this new development.

1. **City of Veneta's Stormwater Detention & Treatment Ordinance** – the requirement for post-construction stormwater controls are triggered if 1,000 square feet of new impervious surface are proposed.
   a. http://www.ci.veneta.or.us/pdf/ordinances/Ordinance493AdoptedJan252009.pdf
   b. **Important Note**: *A weakness in the above ordinance is that it requires a developer to maintain the "peak flows at predevelopment levels". This requirement will not protect against streambed and/or bank erosion as discussed in the cited reference.[5] Protecting against channel erosion is important to efforts targeted at minimizing sedimentation and, therefore, mercury loading. For a site performance standard that will protect stream channels, see the suggested language in Number 2 of the section on "Site performance standards to Promote Infiltration and Stormwater Volume Reduction".*

2. **EPA's MS4 Improvement Guide**
   a. *"control stormwater discharges from new development and redeveloped sites that disturb at least one acre (including projects that disturb less than one acre that are part of a larger common plan of development or sale)...must apply to both private and public development sites..."*
      i. http://www.epa.gov/npdes/pubs/ms4permit_improvement_guide.pdf
   b. Similar language can be found in the current NPDES MS4 Phase II Individual Permits in Oregon.

3. **Minimum Impervious Surface Thresholds** - some municipalities also require post-construction stormwater controls based on the area of impervious surface created. These range from 500 square feet

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[4] http://www.udfcd.org/downloads/pdf/tech_papers/Can%20Stormwater%20BMPs%20Remove%20Bacteria.pdf
[5] http://www.nccwep.org/pdf/channel_protection.pdf

for the City of Portland to more than 5,000 square feet for some of the smaller municipalities in the Clackamas County NPDES MS4 Phase I permit. The Center for Watershed Protection recommended a minimum threshold range of 1 acre of land disturbance to as low as including all new development and redevelopment activities depending on a municipality's program resources.[6] The current draft of MS4 Permit for the Clackamas County permittees presents the list of minimum thresholds for triggering the requirement for post-construction stormwater management controls on page 10:

a. http://www.deq.state.or.us/wq/wqpermit/docs/individual/npdes/ph1ms4/clackamas/ClackamasCountyDraftPermit.pdf

Examples of Site Performance Standards to Promote Infiltration & Stormwater Volume Reduction

Site performance standards are critical for ensuring that stormwater controls employed in a new development will support a municipality's effort to adequately control bacteria loading and will comply with the Willamette Basin TMDL load allocation for bacteria referenced above. For example, if stormwater discharges from a new development are managed such that the post-development hydrology does not exceed the pre-development hydrology, the Department can assume that the new development is not increasing the volume of stormwater discharge and, presumably, the bacteria loading. Additionally, bacteria arising from the proposed new impervious surfaces of this development will be adequately treated given the treatment standard providing further assurances that the bacteria load allocation is being achieved by this treatment and other measures in the City's TMDL Plan. A treatment standard ensures that the first flush of stormwater from a rain event – containing most of the stormwater pollutants – will be captured and treated by stormwater controls before discharging to surface waters.

1. **EPA's MS4 Improvement Guide** – *"...stormwater discharges from such new development and redevelopment sites be managed such that post-development hydrology does not exceed the pre-development hydrology at the site..."*
   a. Options for criteria designed to achieve this site performance standard:
      i. Minimum storm volume to be retained on site - design, construct, and maintain stormwater management practices that manage rainfall on-site, and prevent the off-site discharge of the precipitation from the first 1-inch of rainfall from a 24-hour storm preceded by 48 hours of no measurable precipitation. Discharge volume reduction can be achieved by canopy interception, soil amendments, evaporation, rainfall harvesting, engineered infiltration, extended filtration, and/or evaportranspiration and any combination of the aforementioned practices. The first 1-inch of rainfall must be 100% managed with no discharge to surface water.
      ii. Minimum storm size to be retained on site – design, construct, and maintain stormwater management practices that manage rainfall on-site, and prevent the off-site discharge of the precipitation from all rainfall events less than or equal to the 95th percentile rainfall event. This objective must be accomplished by the use of practices that infiltrate, evaporatranspire and/or harvest and reuse of rainwater. The 95th percentile rainfall event is the event whose precipitation is greater than or equal to 95% of all storm events over a given period of record.
      iii. Recharge/runoff hydrologic analysis – design, construct, and maintain stormwater management practices that preserve the pre-development runoff conditions following construction. The post-construction rate, volume, and duration of discharges must not exceed the pre-development rates and the predevelopment hydrograph for 1, 2, 10, 25, 50, and 100 year storms must be replicated through better site design and other appropriate practices. These goals must be accomplished through the use of infiltration, evapotranspiration, and/or rainwater harvesting and reuse practices. Defensible and

[6] Benninghoff, Benjamin. *Guidelines for Determining the Post-Construction Impervious Area Minimum Threshold for the Municipal Separate Storm Sewer System (MS4) Phase I Permits.* June 3, 2009

consistent hydrological assessments and modeling method must be used and documented (see the ***Prince Georges County LID Hydrologic Analysis*** *and/or the* ***Town of Warsaw, Virginia*** *below for a hydrologic assessment that can be used to meet this site performance standard*).

iv. Additional options are provided in the matrix on page 52 of the guidance below:
   1. http://www.epa.gov/npdes/pubs/ms4permit_improvement_guide.pdf

2. **Town of Warsaw, Virginia Better Site Design Checklist and LID Calculations Worksheet** – this checklist and worksheet were designed for the specific needs of this small community and developed to meet the primary goal noted below in (c) of this example (see Prince Georges County's *LID Design Strategies* and *LID Hydrologic Analysis*). In particular, these materials were designed to meet the developer's need for clear guidance and the town's need for clear review criteria as noted in the following:
   a. http://www.chesapeakenemo.net/communitystory.cfm?story=9&level2=Financial&level3=Money%20for%20Planning&level3url=money
      i.
   b. The *Site Design Checklist and LID Calculations Worksheet* can be accessed on the following webpage:
      i. http://www.riverfriends.org/Publications/LowImpactDevelopment/tabid/86/Default.aspx
      ii. For technical references used to develop this checklist and worksheet, see the Prince Georges County references noted below.
   c. **Prince Georges County LID Design Strategies & Hydrologic Analysis** – "*The primary goal of Low Impact Development methods is to mimic the predevelopment site hydrology by using site design techniques that store, infiltrate, evaporate, and detain runoff. Use of these techniques helps to reduce off-site runoff and ensure adequate groundwater recharge. Since every aspect of site development affects the hydrologic response of the site, LID control techniques focus mainly on site hydrology.*" This site performance standard is achieved by using the following technical references:
      i. *Low Impact Development Design Strategies*
         1. http://www.epa.gov/owow/NPS/lidnatl.pdf
      ii. *Low Impact Development Hydrologic Analysis*
         1. http://www.epa.gov/owow/NPS/lid_hydr.pdf

Examples of Stormwater Treatment Standards (Volume of Stormwater Treated)

The treatment standard ensures that a substantial portion of the stormwater generated from the impervious surfaces of a new development will be captured by required structural stormwater controls, and pollutants such as bacteria will be removed by these controls before discharging the runoff to surface waters. The example treatment standards provided below will reduce the pollutant loads in the stormwater carried in the first flush of a storm event. A small percentage of these storm events may exceed the capacity of the proposed stormwater control, but these controls should treat most of the pollutants including bacteria carried by the first flush.

1. **Clackamas County Co-permittees Draft NPDES MS4 Phase I Permit** - "*…capture and treat 80% of the annual average runoff volume, based on a documented local or regional rainfall frequency and intensity…*" This treatment standard would apply to the following municipalities:
   a. Gladstone, Happy Valley, Johnson City, Lake Oswego, Milwaukie, Oregon City, Rivergrove, West Linn, and Wilsonville
2. **New Hampshire Stormwater Manual Design Criteria for Water Quality Treatment** – "*The Water Quality Volume (WQV) is the amount of stormwater runoff from a rainfall event that should be captured and treated to remove the majority of stormwater pollutants on an average annual basis. The recommended*

WQV is the volume of runoff associated with the first 1-inch of rainfall, which is equivalent to capturing and treating the runoff from the 90th percentile of all rainfall.

  a. See page 7 of Volume 2, Chapter 2 (Design Criteria) of the Manual for an equation for calculating the volume of stormwater to be treated and the rational for this design criteria:
     i. http://des.nh.gov/organization/divisions/water/stormwater/manual.htm

First Step - Non-Structural Control Requirements for Stormwater Management

Nonstructural controls should be the first step in developing a stormwater management approach for a new development since these may eliminate or reduce the number and/or size of structural stormwater controls. Moreover, since they minimize the need for conventional, structural stormwater infrastructure such as stormwater conveyance pipe and detention ponds, nonstructural controls can lower land development costs, and this should reduce the housing costs for homebuyers.

Nonstructural controls refer to approaches such as lot size averaging, cluster development, transfer of development rights, on-site density transfers, minimizing soil compaction, riparian buffers, vegetation standards, reducing street widths, reducing the width of sidewalks, shortening driveway lengths, allowing pervious pavement, and allowing alternatives to curbs and gutters. These approaches are often referred to as better site design, environmental site design, conservation site design, or innovative site design. These approaches may require that flexibility be built into land use development standards. Others nonstructural controls such as transfer of development rights may require legislative authority from the City council.

Guidance/Background Information on Nonstructural Stormwater Control Techniques

1. **Delaware's Conservation Design for Stormwater Management**
   a. http://www.dnrec.state.de.us/DNREC2000/Divisions/Soil/Stormwater/New/Delaware_CD_Manual.pdf

2. **Chapter 4 of Minnesota's Stormwater Manual (Better Site Design/Low Impact Development)**
   a. http://www.pca.state.mn.us/index.php/view-document.html?gid=8937

3. **Virginia's Better Site Design Information Brochure**
   a. http://www.dcr.virginia.gov/chesapeake_bay_local_assistance/documents/bsd_brochure.pdf

Examples of Nonstructural Stormwater Control Requirements

1. **Town of Warsaw, Virginia Better Site Design Checklist** – for more background information on this checklist and worksheet, see Number 3 in the section "*Examples of Site Performance Standards to Promote Infiltration and Reduce Stormwater Volume*".
   d. The *Site Design Checklist* must be completed before a developer can consider structural stormwater controls. The checklist is also designed to help town staff or their consulting engineer review a stormwater management plan for a development. This checklist can be accessed on the following webpage:
      i. http://www.riverfriends.org/Publications/LowImpactDevelopment/tabid/86/Default.aspx
   b. **Important Note** – these requirements are based on **Prince Georges County's *LID Design Strategies*** and ***LID Hydrologic Analysis*** discussed above.

2. **Chapter 2 (see Section 2.1 - Site Planning) of Portland's Stormwater Manual**
   a. http://www.portlandonline.com/bes/index.cfm?c=47952

3. **Chapter 2 (see Site Planning for LIDAs) of Clean Water Services' Low Impact Development Approach Handbook** – see page 6:
   a. http://www.cleanwaterservices.org/Content/Documents/Permit/LIDA%20Handbook.pdf

4. **Maryland's Environmental Site Design Process & Computations** – requires that environmental site design be used to the maximum extent practicable (MEP) to control stormwater from new and redevelopment. The new criteria for ESD are based on the runoff curve number (RCN) hydrology method developed by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS).
   a. http://mde.maryland.gov/programs/Water/StormwaterManagementProgram/Documents/www.mde.state.md.us/assets/document/ESD%20Process%20Computations%20Review.pdf

Examples of Site Evaluation Tools for Developers

The following site evaluation tools will provide the developer with an opportunity to evaluate several alternative approaches to managing stormwater for a proposed development in an effort to select an approach that achieves the site performance/treatment standards and the developer's goals in the most cost effective manner.

1. **Site Evaluation Tool (SET)** - the model was developed to assess the effects of development, including sediment and nutrient loading, on a site scale. The tool allows definition of pre- and post-treated land use, allowing for multiple drainage areas and various combinations of practices. Structural and nonstructural practices can be represented, giving the user a suite of options for evaluation. Thirteen participating governments were interested in a tool that could be used for local stormwater programs and created SET.
   a. http://www.unrba.org/set/index.shtml

2. **OSU Extension Service Stormwater Management & Decision Support Process (SWAMP)** – SWAMP is an open source, web-based tool designed to assist local governments and developers in streamlining adoption of low impact practices. SWAMP provides the following tools and information: geographical data land cover, soils, precipitation, and slope; stormwater runoff reduction tool; vegetated infiltration calculator, and fact sheets for LID controls such as rain gardens, stormwater planters, green roof, porous pavements, swales, and vegetated filter strips.
   a. http://extension.oregonstate.edu/stormwater/swamp

3. **Delaware Urban Runoff Management Model (DURMM)** - the Delaware Department of Natural Resources (DNREC) created DURMM to provide a more rigorous hydrological design tool for Green Technology BMPs. Green Technology BMPs are designed to "intercept runoff from rooftops, parking lots and roads as close as possible to its source, and direct it into vegetative recharge/filtration facilities incorporated into the overall site design and runoff conveyance system." They include conservation site design, impervious area disconnection, conveyance of runoff through swales and biofiltration swales, filtration through filter strips, terraces, bioretention facilities, and recharge through infiltration facilities.
   a. www.swc.dnrec.delaware.gov/Pages/SedimentStormwater.aspx

Examples of Ordinance Providing the Authority for Land Management Techniques Supportive of Better Site Design

The following example ordinances present land management techniques that provide greater flexibility or provide compensation for site designs that protect landscape features which can be used for nonstructural stormwater controls for new developments.

4. **Smart Codes: Model Land-Development Regulations (Marya Morris, General Editor) (American Planning Association)** – contains model ordinance for transfer of development rights (TDRs), on-site density transfers, cluster development, and lot size averaging.

5. **Examples of On-site Density Transfers and TDRs in the Pacific Northwest**
   a. http://www.mrsc.org/subjects/planning/FlexEnviron.aspx#onsite (on-site density transfer)
   b. http://www.oregon.gov/LCD/tdr_pilot_program.shtml (transfer of development credits)
      i. http://www.farmlandinfo.org/documents/37001/TDR_04-2008.pdf (TDR to protect farmland)

4. **New Hampshire's Innovative Planning Techniques – Handbook for Sustainable Development** –
   a. http://des.nh.gov/organization/divisions/water/wmb/repp/documents/ilupt_front_cover.pdf
   b. Section in this handbook on ***lot size averaging*** can be accessed in the following link:
      i. http://des.nh.gov/organization/divisions/water/wmb/repp/documents/ilupt_chpt_1.2.pdf

Examples of Tools for Assessing Codes and Ordinances for Opportunities or Barriers for Better Site Design

The following tool can be used to evaluate whether a municipalities current ordinance provides the needed flexibility to support a developer's effort to use better site design to manage stormwater from a new development. More specifically, this tool will help a planning department identify development standards that have a significant influence on stormwater management or identify gaps in current code/development standards that – if present – would provide the developer the needed flexibility for better site design.

1. **Center for Watershed Protection's (CWP) Code and Ordinance Worksheet** – this worksheet walks users through the process of evaluating how their community's code measures up to 22 better site design principles. The worksheet is geared specifically toward water quality, but provides a good overall assessment of the environmental friendliness of local codes and ordinances.
   a. http://www.scdhec.gov/environment/baq/docs/ModelOrdinances/CodesandOrdinancesWorksheet.pdf
   b. The work sheet is from the **CWP's Better Site Design Handbook** – Better Site Design: A Handbook for Changing Development Rules in Your Community (Center for Watershed Protection, 1998). Covering everything from basic engineering principles to actual vs. perceived barriers to implementing better site designs, the handbook outlines 22 guidelines for better developments and provides detailed rationale for each principle. Better Site Design also examines current practices in local communities, details the economic and environmental benefits of better site designs, and presents case studies from across the country.
      i. http://www.cwp.org/documents/cat_view/77-better-site-design-publications.html
2. **Massachusetts LID – Do Your Codes Allow It (A checklist for Regulatory Review)** – Low Impact Development strategies can reduce the "environmental footprint" of new housing and businesses. However, outdated local codes and standards may prohibit the use of LID techniques or may discourage developers by requiring special permits or variances. Simple modifications to local codes can encourage builders and property owners to apply low impact techniques, while also ensuring high quality development, adequate access, and public safety. Some communities may also wish to enact a stormwater/LID ordinance, but a comprehensive review of local codes should happen before drafting ordinance; the emphasis of both efforts should be on creating a predictable, streamlined process that reduces the permitting cost for developers.
   a. http://mapc.org/sites/default/files/LID_Local_Codes_Checklist.pdf
3. **EPA's Water Quality Scorecard** (EPA 231B09001) – was developed to help local governments identify opportunities to remove barriers and revise and create codes, ordinances, and incentives to better protect water quality. It guides municipal staff through a review of relevant local codes and ordinances

across multiple municipal departments to ensure that these codes work together to support a green infrastructure approach. The two main goals of this tool are to: (1) help communities protect water quality by identifying ways to reduce the amount of stormwater flows in a community and (2) educate stakeholders on the wide range of policies and regulations that have water quality implications. The scorecard is intended for municipalities of various sizes in rural, suburban, and urban settings, including those that have combined sewers, municipal separate storm sewers, or limited or no existing stormwater infrastructure. It can help municipal staff, stormwater managers, planners, and other stakeholders better understand where a municipality's land development regulations and other ordinances may present barriers or opportunities to implementing a comprehensive water quality protection approach. The scorecard provides policy options, resources, and case studies to help communities develop a comprehensive water quality program.
   a. http://www.epa.gov/smartgrowth/pdf/2009_1208_wq_scorecard.pdf
4. **County of San Diego Low Impact Development Handbook (Stormwater Management Strategies)** – the LID Handbook is designed to assist public and private land developers with the selection of various design features. LID planning techniques include: minimizing paved areas, minimizing soil compaction, preservation of natural open space including trees and natural drainage channels, clustering of development on compacted soils, and locating open space areas to absorb overflows.
   a. http://www.sdcounty.ca.gov/dplu/docs/LID-Handbook.pdf
   b. This handbook provides information that could be used to develop an assessment and or policy options including:
      i. Site planning practices (conserve natural areas, minimize and disconnect impervious services, minimize soil compaction, drain runoff from impervious surfaces to pervious areas)
      ii. LID site design examples
      iii. LID road design standards for public and private roads, curb-cuts, rural swale systems)
      iv. LID parking lot design
      v. LID driveway, sidewalk, and bike path design
      vi. LID building design
      vii. LID landscaping design

Miscellaneous Guidance on Nonstructural Controls

A guidance on street design standards is presented below as an example of a nonstructural stormwater control that can assist a developer in minimizing the need for structural stormwater controls. Since street design standards influence the amount of impervious surface that is created by a new development and, therefore, the volume of stormwater runoff from a new development, adjustments in these can:

- greatly reduce the volume of stormwater that must be treated and controlled by the developer,
- lower the land development costs for the developer by reducing the developer's investment in public infrastructure and, consequently, lower the housing costs for the homebuyer; and,
- reduce the size of the new public infrastructure and, therefore, the maintenance burden that small communities assume when they acquire roads and stormwater systems from a new development.

The following Oregon guidance identifies opportunities for adjusting street widths:

1. **Oregon DLCD's Neighborhood Street Design Standards – an Oregon Guide to Reducing Street Widths**
   a. http://www.oregon.gov/LCD/docs/publications/neighstreet.pdf?ga=t

Second Step - Design Specifications for Stormwater Structural Controls

As noted above, the selection of structural stormwater controls should be the second step in the selection of controls for stormwater management in a new development. Since structural stormwater controls tend to be more costly, the developer and the designer should first investigate and identify nonstructural controls that can be employed to help meet the site performance and treatment standards discussed above before taking the second step of selecting structural controls. Nonstructural controls alone may not achieve the site performance standard; however, the use of these nonstructural controls in stormwater management will reduce the number and size of the structural stormwater controls needed to meet the site performance and treatment standards discussed above. This, in turn, will reduce the cost of stormwater management.

Below are examples of sizing criteria and design manuals that the City can adopt for its post-construction stormwater control program. The recommended references below provide direction to designers on how to size stormwater structural controls for water quality treatment, stream channel protection, overbank flood control, and for controlling runoff from extreme storm events, for example. In addition to sizing criteria, the stormwater manuals below provide detailed guidance for designing selected stormwater controls that each state or municipality has identified and approved as the most effective controls for new development. The sizing criteria and the design guidance in these manuals provide reasonable assurance that the structural controls proposed for a new development will achieve their intended functions in terms of pollutant removal and channel protection, for example.

This assurance is important for TMDL compliance since the load allocation for bacteria requires a 65% reduction in bacteria loading. The addition of new impervious surfaces that are inadequately controlled and treated due to poor design and installation will increase bacteria loading from a municipality rather than, at minimum, maintain the current bacteria loading from municipal runoff (i.e., no new loading from new development). When structural controls are designed following the guidance in the stormwater manuals noted below, the Department can presume that the proposed controls will achieve the site performance standards and treatment standards discussed and presented above and will not increase bacteria loading.

Examples of Stormwater Structural Controls Sizing Criteria and Design Manuals

1. **Minnesota's Issue Paper on Sizing Criteria for Stormwater Controls** – provides a review of various approaches to size stormwater structural controls for groundwater recharge, water quality, channel protection, overbank flood control, and extreme flood control.
   a. http://www.pca.state.mn.us/index.php/view-document.html?gid=8942

2. Various state and local government manuals provide sizing criteria for structural controls. For a listing of state manuals and Oregon local government manuals, refer the hyperlinks below:

   a. Below are examples of Oregon local government sizing criteria and stormwater design manuals. The sizing criteria used by Clean Water Surfaces and the City of Eugene was adapted from the approach used by the City of Portland:
      i. **City Portland's Stormwater Manual (see Chapter 2, Section 2.2, Sizing Methodologies)**
         1. http://www.portlandonline.com/bes/index.cfm?c=47952
      ii. **Clean Water Services' Low Impact Development Approach Handbook (see Chapter 3, LIDA Design Process for sizing criteria) and Design and Construction Standards** - according to this handbook, most LID facilities can be designed using the sizing criteria presented in this chapter:
         1. http://www.cleanwaterservices.org/Content/Documents/Permit/LIDA%20Handbook.pdf

2. This Handbook is used in conjunction with the design and construction standards presented in the following manual – see Section 4.07 for LIDA design standards:
    a. http://www.cleanwaterservices.org/PermitCenter/DesignAndConstruction/default.aspx

iii. **City of Eugene's SIM Form 2008 and Manual** – the SIM Form is a spreadsheet used to design stormwater control facilities in accordance with the City's sizing requirements that could be modified/adapted for use in another municipality:
1. http://www.eugene-or.gov/portal/server.pt/gateway/PTARGS_0_2_266493_0_0_18/2008-Form-SIM.pdf
2. Chapter 2 of Eugene's Stormwater Management Manual provides background information on how the SIM Form is used:
    a. http://www.eugene-or.gov/portal/server.pt/gateway/PTARGS_0_0_12093_689_1795_43/http%3B/ceppcontent.eugene1.net%3B7087/publishedcontent/publish/pw/stormwater/docs/ch2_stormmgmtfacdesign.pdf
3. Eugene's Stormwater Management Manual:
    a. http://www.eugene-or.gov/portal/server.pt?open=514&objID=1795&parentname=CommunityPage&parentid=2&mode=2&in_hi_userid=2&cached=true

b. State Stormwater Design Manuals:
    i. http://yosemite.epa.gov/R10/WATER.NSF/0/17090627a929f2a488256bdc007d8dee?OpenDocument

Example Criteria for Reviewing a Stormwater Plan

An example of plan review criteria for stormwater plans is presented below. Providing clear criteria helps the developer comply with all the necessary post-construction stormwater control requirements and, thereby, avoid delays associated with plan approval. Clear review criteria ensures that plan reviewers know what to look for in a stormwater plan to determine a developer's compliance with post-construction stormwater control requirements. This ensures that plan reviews are consistent and objective and avoids delays associated with unnecessary requests which unnecessarily increase costs for the developer.

1. **Town of Warsaw, Virginia Better Site Design Checklist and LID Calculations Worksheet** – for more background information on this checklist and worksheet, see Number 3 in the section *"Examples of Site Performance Standards to Promote Infiltration and Reduce Stormwater Volume"*.
    a. The *Site Design Checklist* must be completed before a developer can consider structural stormwater controls. The checklist is also designed to help town staff or their consulting engineer to review a stormwater management plan for a development. This checklist can be accessed on the following webpage:
        i. http://www.riverfriends.org/Publications/LowImpactDevelopment/tabid/86/Default.aspx
    b. **Important Note** – these requirements are based on **Prince Georges County's *LID Design Strategies*** and ***LID Hydrologic Analysis***

Guidance for Designing LID Controls that Don't Trigger State UIC Requirements

The hyperlink below provides you access to the Oregon State University Extension Service's Fact Sheets on LID controls for porous pavement, rain gardens, stormwater planters, and swales. These fact sheets provide guidance on how to avoid triggering state underground injection control (UIC) requirements when using LID structural controls to manage stormwater. The fact sheets below have been jointly reviewed by the Department's stormwater and UIC programs and provide clear triggers for UIC requirements so that a designer of a LID structural control can avoid triggering state UIC requirements unnecessarily. In some circumstances, UIC controls are a viable option for managing stormwater; however, to protect groundwater sources from contamination from the pollutants in stormwater, UIC devices must comply with state requirements designed to protect sources of drinking water and comply with the federal Safe Drinking Water Act.

- http://extension.oregonstate.edu/stormwater/lid-fact-sheets