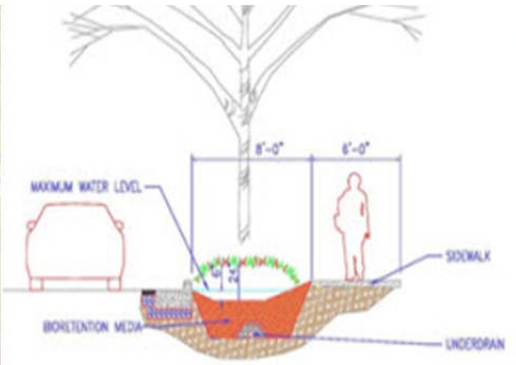
City of Cypress
Low Impact Development (LID) Guide

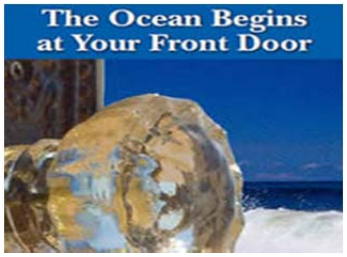


Prepared by

Department of Public Works

Department of Community Development

PROJECT Pollution PREVENTION



August 2011

When should I Prepare and submit my Project WQMP

A Preliminary Water Quality Management Plan (WQMP) is required for all new development and significant redevelopment projects. Applicants shall submit the Preliminary WQMP to the Community Development Department concurrently with the submittal of the preliminary project review application for the project.

Since the Project WQMP may affect site layout and drainage design, a Preliminary WQMP shall be prepared during the early planning stages of the project. The City of Cypress has established a preliminary WQMP initial submittal process so that all documentation is complete prior to submittal to the approving department. The Preliminary WQMP shall be approved prior to the filing of any discretionary applications for the project.

Submittal of the Preliminary WQMP shall consist of the following items:

1. Three (3) copies of Preliminary Water Quality Management Plans. The plan must include site Design Best Management Practices (BMP's) and Treatment Control BMP's). The Source Control BMP's and BMP Maintenance can be excluded from the Preliminary WQMP and can be added when the Project WQMP is submitted.

2. Three (3) copies of the following items:
    a. A Preliminary Drainage Report, including hydrology calculations, map, and calculations for sizing treatment control Best Management Practices (BMP's).
    b. A preliminary geotechnical report.

3. A preliminary plan check review deposit shall be paid at the time of plan submittal. This initial plan check review fee deposit will be used to implement the WQMP plan check review process and will be assessed accordingly. Additional fees may be incurred as the project progresses through the WQMP review process.

The initial submittal of the Project WQMP shall consist of the following:

1. Three (3) copies of the Water Quality Management Plans prepared according to an approved Preliminary WQMP.

2. Three (3) copies of the grading plan package including:
    a. The Grading Plan
    b. The Drainage Report, including the hydrology calculations, map, and hydraulic calculations for storm drain plans and sizing treatment control Best Management Practices (BMP's). The drainage study shall conform to the requirements listed in the City's Drainage Design Manual.
    c. The Geotechnical Report.

Where can I find additional information on preparing my Project WQMP?

Information packets are available upon request. Guidance documents and a template for the Model WQMP can be downloaded from the City of Cypress website at http://www.ci.cypress.ca.us/public

works/water_quality_mgt_plan.htm. Useful information about the Orange County Stormwater Program can be found at: http://www.ocwatersheds.com/StormwaterProgram.aspx.

Water Quality Management Plan (WQMP) Plan Check Fees

The City of Cypress has adopted fees to provide for review of water quality management plans. Fees are due upon submittal of the preliminary WQMP. A deposit of $500 is due at the initial submittal for a project classified as a small project. New development projects categorized as a large project shall pay a minimum $750 fee deposit for preliminary WQMP review. Any balance remaining at the conclusion of review of the preliminary WQMP will be applied to the review of the final WQMP. The applicant will be responsible for any charges incurred beyond the original deposit. If this is the case, an additional deposit may be required or invoiced to the applicant based on the hourly rates. The minimum fee represents only an estimate of plan check fees for an average type of small or large project.

All applicants are encouraged to submit their preliminary WQMP's to the City of Cypress as soon as possible to expedite the development review process. If you have any questions regarding the WQMP process, please contact the Department of Public Works at (714) 229-6694 or the Community Development Department at (714) 229-6720.

The City of Cypress has developed a brochure for use by the applicant while developing their WQMP. You may obtain a copy of this document by visiting the City's webpage at: http://www.ci.cypress .ca. us /public_works/water_quality_mgt_plan.htm.

LID and Treatment Control BMP Design

LID Best Management Practices (BMP's) are required in addition to site design measures and source controls to reduce pollutants in stormwater discharges. LID BMPs are engineered devices that are designed to retain or biotreat runoff on the project site. Hydrologic Source Controls (HSC's) can be considered a hybrid between site design and LID BMPs which are designed to manage stormwater runoff similar to LID BMPs, and are designed and maintained like LID BMPs. Treatment control BMPs are required if it is not feasible to design LID BMPs for the full Design Capture Volume (DCV). Treatment control BMPs are structural, engineered devices that are designed to remove pollutants from stormwater runoff using treatment processes that do not incorporate significant biological methods. Both LID BMPs and treatment control BMPs can also partially or fully satisfy hydromodification performance criteria, depending on their design and functions.

The BMP designs described in these fact sheets and in the referenced design manuals shall constitute what are intended as LID and Treatment Control BMPs for the purpose of meeting stormwater management requirements. Other BMP types and variations on these designs may be approved at the discretion of the reviewing agency if documentation is provided demonstrating that the BMP is functionally equivalent to those described in the Technical Guidance Document (TGD) or published design standards. Water quality monitoring data may be required by local jurisdictions to validate the performance of a proposed BMP type not described in this section.

BMPs are categorized as described in Table 1 located on the following page.

This document provides an introduction to each category of BMP and provides links to fact sheets that contain recommended criteria for the design and implementation of these BMPs. Criteria specifically described in these fact sheets supercede guidance contained in referenced documents. Where criteria are not specified, the user should defer to best professional judgment based on the recommendations of the referenced guidance material or other published and generally accepted sources. When an outside source is used, the preparer must document the source in the project WQMP.

Appendixes identified on the following pages can be found in the Technical Guidance Document located on the City's website at: http://www.ci.cypress.ca.us/public_works/water_quality_mgt_plan.htm or http://www.ci.cypress.ca.us/community_develpmnt/planning.htm

Effective Site Design Elements for Low Impact Development

The following site design elements are used to frame the approach in which LID deals with stormwater. These elements are addressed via combination of Best Management Practices (BMP's).

1. **Conserve Natural Areas, soils and vegetation –** Avoid mass clearing and grading, incorporate plans to suit soil and drainage conditions, incorporate planting schemes that replicate natural sites, use vegetative plantings and bioretention techniques to neutralize soil contaminants.

2. **Minimize disturbances to natural drainage patterns –** Minimize manicured lawns and annual beds as the dominant site elements.

3. **Minimize and disconnect impervious surfaces** – Reduce impervious areas by maximizing landscaping and using pervious pavements. Reduce the amounts of "hydraulically" connected impervious areas by: incorporating porous pavements, downspouts directed towards vegetated areas, install rain barrels and cisterns below downspouts.

4. **Minimize Soil compaction** – Restrict compaction and grading to areas that will support structures as compacted soils suffer from reduced infiltration rates and limit root growth and plant survivability.

5. **Direct runoff from impervious areas to pervious areas** – Grade surface toward open space and porous pavements with infiltration capacity, infiltrate runoff a suitable distance from foundations. **Disconnect Impervious Surfaces**.

Table 1. Categories of LID BMPs and Treatment Control BMPs

HSCs[1]	Infiltration[1]	Harvest and Use	Evapotranspiration	Biotreatment[2]	Treatment Control
➢ Localized on-lot infiltration ➢ Impervious area dispersion (e.g. roof top disconnection) ➢ Street trees(canopy interception) ➢ Residential rain barrels (not actively managed) ➢ Green roofs/ brown roofs ➢ Blue roofs ➢ Impervious area reduction (permeable pavers, site design)	➢ Infiltration basins ➢ Infiltration trenches ➢ Bioretention without underdrains ➢ Bioinfiltration ➢ Drywells ➢ Permeable pavement ➢ Underground infiltration	*Storage options:* ➢ Above-ground cisterns and basins ➢ Underground detention *Potential demand:* ➢ Irrigation ➢ Toilet flushing ➢ Vehicle/ equipment washing ➢ Evaporative cooling ➢ Industrial processes ➢ Dilution water ➢ Other non-potable uses	*ET is a significant volume reduction process in:* ➢ All HSCs ➢ Surface-based infiltration BMPs ➢ Biotreatment BMPs[2]	➢ Bioretention with Underdrains ➢ Vegetated Swale ➢ Vegetated Filter Strip ➢ Wet Detention Basin ➢ Constructed Wetland ➢ Dry Extended Detention Basin ➢ Proprietary Biotreatment	➢ Sand Filters (media bed filters) ➢ Cartridge Media Filters **Pretreatment** ➢ Hydrodynamic Separators ➢ Catch Basin Inserts ➢ Biotreatment BMPs[3]

General note: Lists are not exhaustive; BMPs with similar unit processes may be approved at the discretion of local jurisdictions.

1 - Soil amendments are critical components of some HSCs and infiltration BMPs. Soil amendments may be used to improve infiltration capacity of low permeability soils where the limiting soil horizon lies within the depth that can be feasibly amended. Where the entire thickness of the limiting horizon cannot be amended, the use of soil amendments would increase storage volume but not increase effective infiltration rates.

2 - Biotreatment BMPs shall be designed and maintained per the criteria contained in **Appendix XII** and shall designed to achieve the maximum feasible ET and infiltration per the criteria contained in **Appendix X**I. BMPs not meeting these criteria shall be considered treatment control BMPs.

3 - Biotreatment BMPs may be used as pretreatment for other BMP categories. If biotreatment is used as pretreatment, the overflow from these facilities shall be considered biotreated.

2. Hydrologic Source Controls

HSCs can be considered to be a hybrid between site design practices and LID BMPs. HSCs are distinguished from site design BMPs in that they do not reduce the tributary area or reduce the imperviousness of a drainage area; rather they reduce the runoff volume that would result from a drainage area with a given imperviousness compared to what would result if HSCs were not used. HSCs are differentiated from LID BMPs in that they tend to be more highly integrated with site designs and tend to have less defined design and operation. For example, it may not be possible to precisely describe the storage volume and drawdown rate of a pervious area receiving drainage from downspout disconnects; however these systems can be very effective at reducing runoff.

Appendix XIV.1 provides fact sheets for several types of HSCs.

HSC-1: Localized On-Lot Infiltration
HSC-2: Impervious Area Dispersion
HSC-3: Street Trees
HSC-4: Residential Rain Barrels
HSC-5: Green Roof / Brown Roof
HSC-6: Blue Roof

Permeable pavement (INF-6) is considered to be an HSC in cases where the permeable pavement it is designed to manage only rainfall that falls directly on the pavement and a small adjacent tributary area no more than 50 percent of the size of the permeable pavement footprint.

3. Infiltration BMPs

Infiltration BMPs are LID BMPs that capture, store and infiltrate stormwater runoff. These BMPs are engineered to store a specified volume of water and have no design surface discharge (underdrain or outlet structure) until this volume is exceeded. These types of BMPs may also lose some water to ET, but are characterized by having their most dominant volume losses due to infiltration. **Appendix XIV.2** provides fact sheets for several types of infiltration BMPs.

INF-1: Infiltration INF-2: Infiltration Trench
INF-3: Bioretention with no Underdrain
INF-4: Bioinfiltration
INF-5: Drywell
INF-6: Permeable Pavement (concrete, asphalt, and pavers)
INF-7: Underground Infiltration

4. Harvest and Use BMPs

Harvest and Use (aka Rainwater Harvesting) BMPs are LID BMPs that capture and store stormwater runoff for later use. These BMPs are engineered to store a specified volume of water

and have no design surface discharge until this volume is exceeded. The utilization of captured water used should comply with codes and regulations and should not result in runoff to storm drains or receiving waters. Potential uses of captured water may include irrigation demand, indoor non-potable demand, industrial process water demand, or other demands. **Appendix XIV.3** provides fact sheets for two types of harvest and use configurations.

HU-1: Above-Ground Cisterns
HU-2: Underground Detention

5. Evapotranspiration BMPs

Evapotranspiration (ET) is a significant volume reduction process in HSCs, surface-based infiltration BMPs, and biotreatment BMPs. Because ET is not the sole process in these BMPs, specific fact sheets have not been developed for ET-based BMPs. However the criteria contained in the TGD and Appendices ensure that BMP systems will achieve the maximum feasible ET, as necessary, to demonstrate that the maximum feasible retention has been provided on-site, as summarized below:

- If a project cannot be designed to infiltrate and/or harvest and use the full DCV, the following criteria must be met before evaluating biotreatment BMPs:
    - All applicable HSCs must be considered (ET is a principal process in all HSCs)
    - The project must demonstrate that at least minimum site design practices for available open space have been met (ET is strongly a function of available ET area)

- Biotreatment BMPs, if needed to address remaining unmet volume, must be designed to achieve the maximum feasible infiltration and ET per criteria contained in **Appendix XI** and **Appendix XII.**

Therefore, HSC, Infiltration, and Biotreatment BMP fact sheets are applicable for ET as well.

6. Biotreatment BMPs

Biotreatment BMPs are a broad class of LID BMPs that reduce stormwater volume to the maximum extent practicable, treat stormwater using a suite of treatment mechanisms characteristic of biologically active systems, and discharge water to the downstream storm drain system or directly to receiving waters. Treatment mechanisms include media filtration (though biologically-active media), vegetative filtration (straining, sedimentation, interception, and stabilization of particles resulting from shallow flow through vegetation), general sorption processes (i.e., absorption, adsorption, ion-exchange, precipitation, surface complexation), biologically-mediated transformations, and other processes to address both suspended and dissolved constituents. Biotreatment BMPs include both flow-based and volume-based BMPs.

Conceptual criteria for biotreatment BMP selection, design, and maintenance can be found in **Appendix XII**. These criteria are generally applicable to the design of biotreatment BMPs in Orange County and BMP-specific guidance is provided in the following fact sheets.

Note: Note: Biotreatment BMPs shall be designed to provide the maximum feasible infiltration and ET based on criteria contained in **Appendix XII**.

Appendix XIVI.4 provides fact sheets for several types of biotreatment BMPs.

BIO-1: Bioretention with Underdrains
BIO-2: Vegetated Swale
BIO-3: Vegetated Filter Strip
BIO-4: Wet Detention Basin
BIO-5: Constructed Wetland
BIO-6: Dry Extended Detention Basin
BIO-7: Proprietary Biotreatment

7. **BMP Performance Summaries**

Table 4.2 provides ratings of relative performance or LID BMPs and Treatment Control BMPs, respectively, to support the **BMP selection criteria** described in **Section 2.4.2.5** of the Technical Guidance Document.

This table is based on literature and recent analysis of BMP performance monitoring data. The performance ratings in this table are based on observed effluent quality, observed differences between influent and effluent quality (magnitude and significance), and assumed unit operations and processes (UOPs) provided by each BMP. In order for a BMP to achieve the level of performance anticipated by this table, the BMP must:

- Be designed to contemporary design standards based on the criteria contained in the BMP Fact Sheets (**Appendix XIV**), the guidance manuals referenced from these fact sheets, and **Appendix XII** (Conceptual Biotreatment Design, Operation and Maintenance Criteria).
- Include the assumed UOPs listed in this table. BMPs not found on this list may be acceptable on the basis of the UOPs they provide.

Table 4.2 - Relative Treatment Performance Ratings of Biotreatment BMPs

Unit Operations and Process	Assumed Principal Unit Operations and Processes Provided	Suspended solids / sediment/ turbidity	Nitrogen compounds	Phosphorus	Heavy metals	Microbial / viral pathogens	Oils and grease	Dissolved toxic organic compounds	Trash and debris
Bioretention system	• Particulate Settling • Size Exclusion • Inert Media Filtration • Sorption/Ion Exchange • Microbial Competition/Predation • Biological Uptake • Volume loss (via infiltration, ET)	**H**	**L**	**L**	**H**	**M**	**H**	**M**	**H**
Bioretention system with internal water storage zone and nutrient sensitive media design	Bioretention UOPs, plus: • Microbially Mediated Transformations (if designed with internal water storage zone)	**H**	**M**	**M**	**H**	**M**	**H**	**M**	**H**
Dry extended detention basin	• Particulate Settling • Size Exclusion • Floatable Capture • Vegetative Filtration (with low-flow channel) • Volume loss (via infiltration, ET)	**M**	**L**	**M**	**M**	**L**	**M**	**L**	**H**
Dry extended detention basin with vegetated sand filter outlet structure	Dry extended detention basin UOPs, plus: • Inert Media Filtration	**H**	**L**	**M**	**M**	**M**	**M**	**L**	**H**
Vegetated Swale	• Vegetative Filtration • Sorption/Ion Exchange • Volume loss (via infiltration, ET)	**M**	**L**	**L**	**M**	**L**	**M**	**M**	**M**
Vegetated Filter Strip	• Vegetative Filtration • Sorption/Ion Exchange • Volume loss (via infiltration, ET)	**M**	**L**	**L**	**M**	**L**	**M**	**M**	**L**

Table 4.2 - Relative Treatment Performance Ratings of Biotreatment BMPs

Unit Operations and Process	Assumed Principal Unit Operations and Processes Provided	Suspended solids / sediment/ turbidity	Nitrogen compounds	Phosphorus	Heavy metals	Microbial / viral pathogens	Oils and grease	Dissolved toxic organic compounds	Trash and debris
Wet detention basins and constructed stormwater wetlands	• Particulate Settling • Size Exclusion • Floatable Capture • Sorption/Ion Exchange • Microbially Mediated Transformations • Microbial Competition/Predation • Biological Uptake • Solar Irradiation • Volume loss (via infiltration, ET)	**H**	**M**	**M**	**M**	**M**	**H**	**M**	**H**
Proprietary Biotreatment and Treatment Control	• Varies by product.	Expected performance should be based on evaluation of unit processes provided by BMP and available testing data. Testing data should be evaluated based primarily on the effluent quality achieved by the BMP and the ability of the BMP to provide statistically significant removal under average conditions. Percent removal alone should not be used to evaluate the performance of proprietary BMPs (See Wright Water Engineers and Geosyntec Consultants, 2007). The basis for determining the rating of proposed proprietary BMPs must be documented in the Project WQMP. Approval is based on the discretion of the reviewing agency. Product-specific rankings may be published in the Technical Guidance Document at a later date.							

Sources

Strecker, E.W ., W.C Huber, J.P. Heaney, D. Bodine, J.J. Sansalone, M.M. Quigley, D. Pankani, M. Leisenring, and P. Thayumanavan, "Critical assessment of Stormwater Treatment and Control Selection Issues." Water Environment Research Federation, Report No. 02-SW-1. ISBN 1-84339-741-2. 290pp

International Stormwater Best Management Practices (BMP) Database Pollutant Category Summary: Bacteria. **http://www.bmpdatabase.org/Docs/BMP%20Database%20Bacteria%20Paper%20Dec%202010.pdf**

International Stormwater Best Management Practices (BMP) Database Pollutant Category Summary: Nutrients. **http://www.bmpdatabase.org/Docs/BMP%20Database%20Nutrients%20Paper%20December%202010%20Final.pdf**

International Stormwater Best Management Practices (BMP) Database Pollutant Category Summary: Sediment (Pre-publication).

Overview of Performance by BMP Category and Common Pollutant Type, International Stormwater Best Management Practices (BMP) Database [1998-2008] **http://www.bmpdatabase.org/Docs/Performance%20Summary%20Cut%20Sheet%20June%202008.pdf**

Oil and grease, Organics, and Trash and Debris based on review of unit operations and processes; comprehensive dataset not generally available.
BMP must include design elements to address pollutants of concern.

Wright Water Engineers and Geosyntec Consultants, 2007. *Frequently Asked Questions Fact Sheet for the International Stormwater BMP Database: Why does the International Stormwater BMP Database Project omit percent removal as a measure of BMP performance?* (as posted on www.bmpdatabase.org)]

Table 3 - Pollutants Address by Unit Operations and Processes

Unit Operations and Process	Suspended solids / sediment	Particulate-bound pollutants	Dissolved Fraction			Microbial / viral pathogens	Oils and grease	Toxic organic compounds	Trash and debris
			Nitrogen compounds	Phosphorus	Heavy metals				
Volume Loss (via Infiltration and ET)	X	X	X	X	X	X	X	X	
Particulate Settling (Density separation)	X	X							X
Size exclusion (trash racks, outlet structures. Media filtration)	X	X							X
Floatable Capture (Density separation -outlet structures designed to remove floatables)							X		X
Vegetative Filtration	X	X					X		X
Inert Media Filtration	X	X			X[1]	X	X		X
Sorption/Ion Exchange within media or soils				X	X		X	X	
Microbially Mediated Transformation (oxidation, reduction, or facultative processes)			X	X	X		X	X	
Microbial Competition/ Predation						X			
Biological Uptake			X	X	X	X	X	X	
Solar Irradiation						X		X	

1 – Inert media filters (i.e. sand) in fact have shown the ability to remove dissolved constituents either after they have been "seasoned" (i.e. organics have built up in the media) or they contain specialized inorganic media (e.g., iron coated sand) which can result in dissolved metals removals.

Principal Source

Strecker, E.W ., W.C Huber, J.P. Heaney, D. Bodine, J.J. Sansalone, M.M. Quigley, D. Pankani, M. Leisenring, and P. Thayumanavan, "Critical assessment of Stormwater Treatment and Control Selection Issues." Water Environment Research Federation, Report No. 02-SW-1. ISBN 1-84339-741-2. 290pp