Training

Water Quality Management Plan

RIVERSIDE COUNTY
WATERSHED PROTECTION

Prepared for: Santa Ana Region Watershed Permittees

Presented By: CASC Engineering and Consulting, Inc. V[1]

Course Outline

- Watershed Background
- Regulatory Framework
- WQMP Concepts
- Developing a WQMP
- Low Impact Development
- BMP Design Examples

Watershed Background

Santa Ana Region Watershed

Characteristics – Location

- The Santa Ana Region (SAR) Watershed is bounded on the south by the Santa Margarita Watershed and on the east by the Whitewater Watershed.
- The area of the Santa Ana Watershed is approximately 2,650 square miles, covering parts of San Bernardino, Riverside, Orange and Los Angeles Counties.
- Between the Santa Ana and San Bernardino-San Jacinto barriers is an area of broken topography that includes valleys, plateaus, and minor mountain ranges.

Santa Ana Region Watershed

Characteristics – Climate

- The SAR's climate cyclicality results in high surface water flows in the spring and early summer followed by low flows during the dry season.
- Average Precipitation:
  - 10-13 inches in alluvial valleys
  - 36 inches or more in San Jacinto mountains

Santa Ana Region Watershed

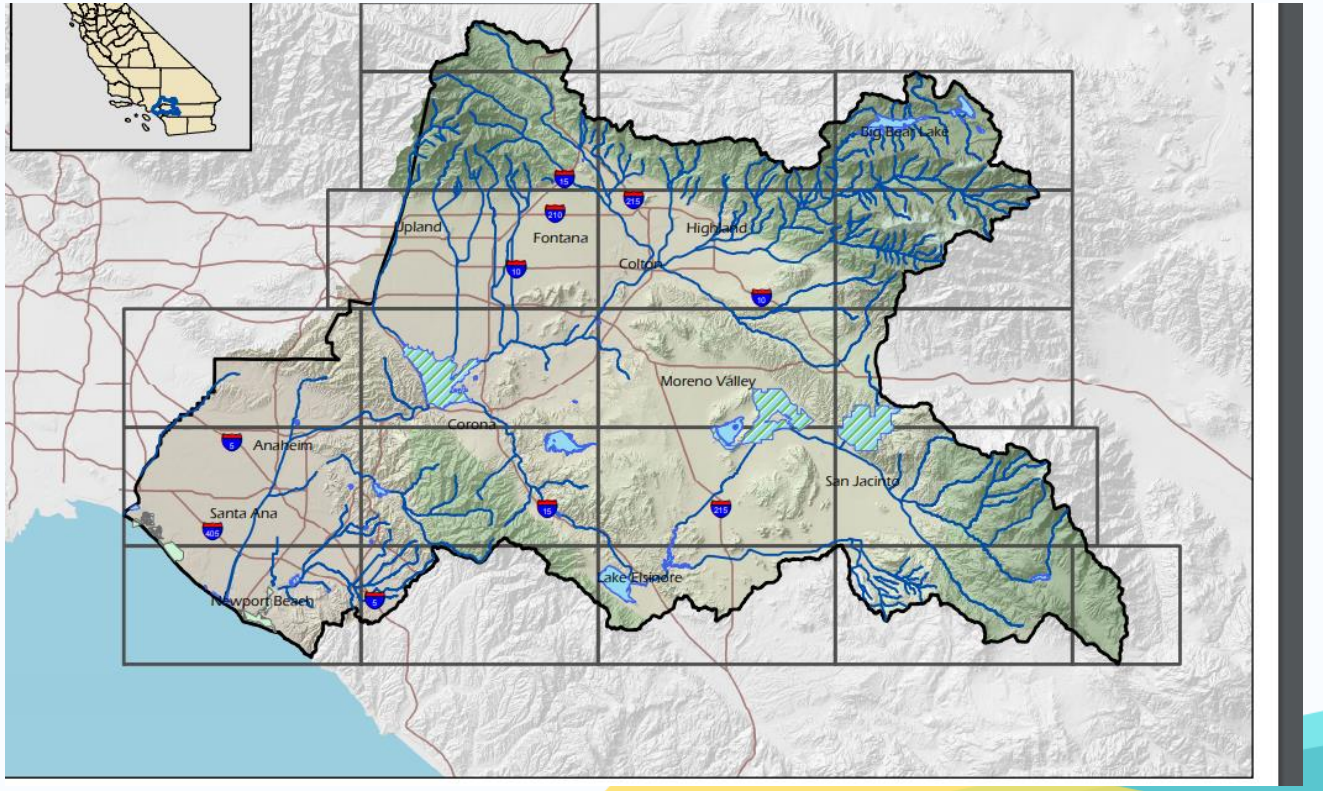
Characteristics – Soils and Topography

- Alluvial cones/fans near canyon mouths are coarse and highly porous, while deposits farther downstream tend to become finer and less porous.
- Major topographic features within the Santa Ana River Watershed include the Santa Ana, San Jacinto, and San Bernardino Mountains.
- Certain areas of the valley have very slow/non-existent infiltration rates due to the high clay content in the alluvium.
- Infiltration may not always be feasible.

Watershed Area

Interactive watershed maps of the Santa Ana region can be found here:

https://www.waterboards.ca.gov/santaana/water_issues/programs/basin_plan/basin_plan_maps.html



Santa Ana Region Watershed

Regulatory Framework

Water Quality Definitions

- Best Management Practices (BMPs) – Practices to prevent or reduce pollutant loading from discharges to receiving waters
- Low Impact Development (LID) – Land development strategies that emphasize conservation and the use of onsite natural and engineered features to more closely reflect predevelopment hydrologic conditions
- Municipal Separate Storm Sewer System (MS4) – A system for collecting and conveying stormwater only

Regulatory Framework

- Regulation of stormwater is part of the Federal Clean Water Act (CWA).
- CWA requires issuance of NPDES Phase I permits for stormwater discharges from MS4s serving populations of more than 100,000.
- Phase II permits are for Small MS4s and Non-Traditional MS4s as defined in the permit.

Regulatory Framework

- California Regional Water Quality Control Boards issue NPDES Permits.
- Region 8 Santa Ana River Regional Water Quality Control Board.
- The NPDES Permit CAS618033 (Order No. R8-2010-0033) regulates discharges from MS4s in the Santa Ana Watershed.

Permit Implementation

Principal Permittee

- Riverside County Flood Control and Water Conservation District

Co-Permittees

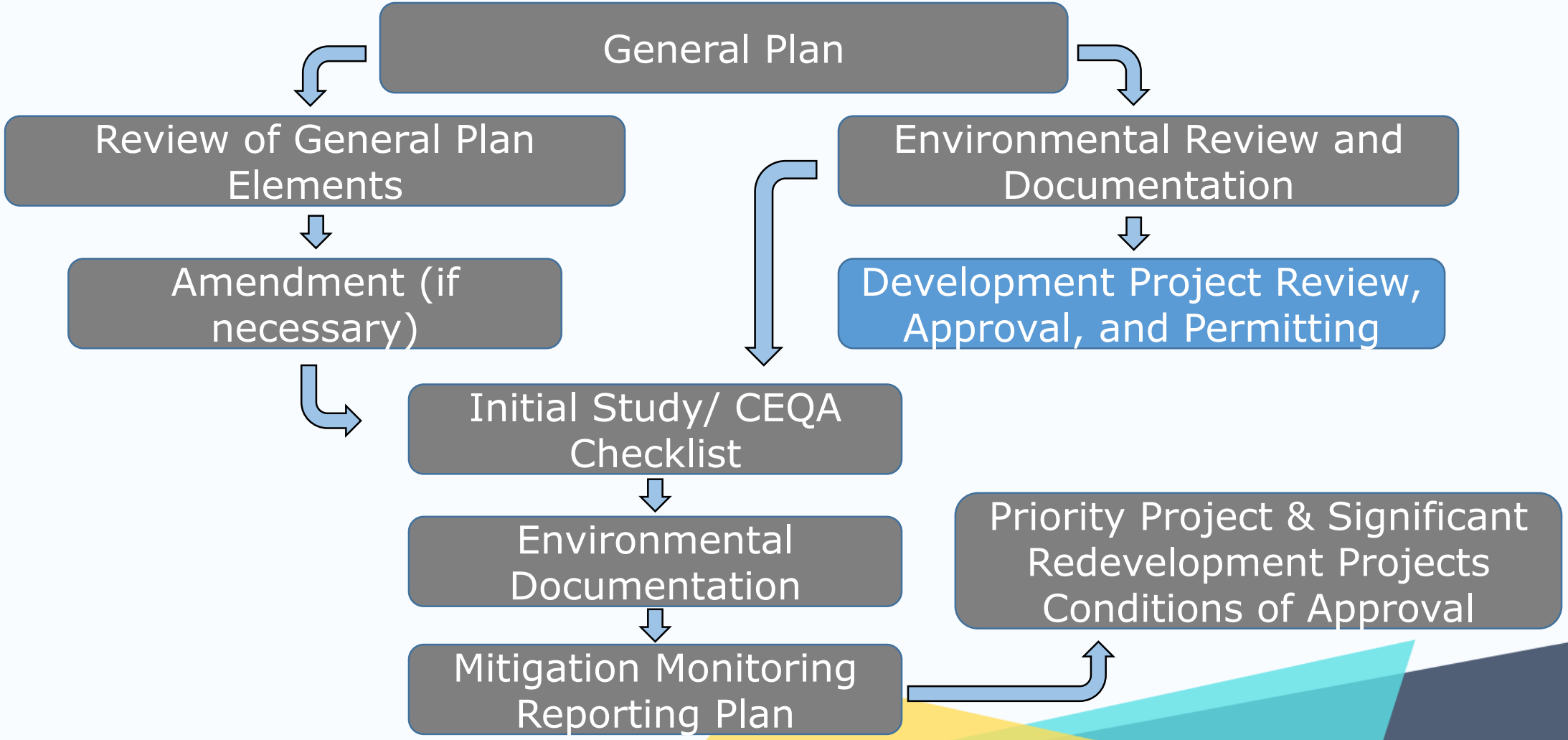
- Beaumont
- Calimesa
- Canyon Lake
- Corona
- County of Riverside *Multiple MS4 permits
- Eastvale
- Hemet
- Jurupa Valley
- Lake Elsinore
- Menifee
- Moreno Valley
- Norco
- Perris
- Riverside
- San Jacinto

Enforcement Authorization

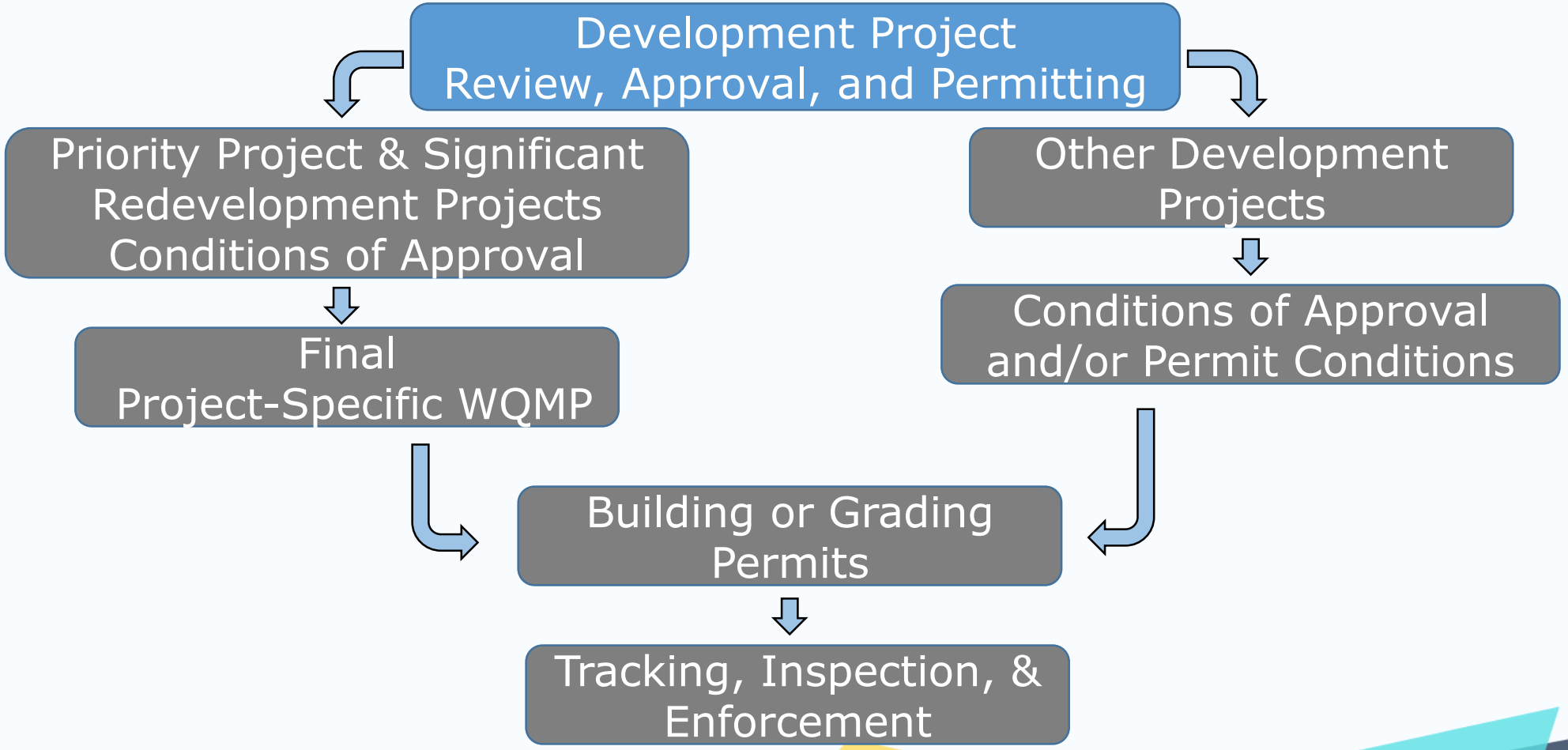
- NPDES CAS618033, Order No. R8-2010-0033, Section VIII.A:

The Permittees shall maintain adequate legal authority to control the discharge of Pollutants to the MS4 from Urban Runoff and enforce those authorities.

Planning Requirements



Planning Requirements



Quiz: Definitions

What are practices to prevent or reduce pollutant loading from discharges to receiving waters?

WQMP Concepts

What is a WQMP?

- WQMP - Water Quality Management Plan
- A WQMP is a guidance document that will help you to design your project in compliance with Santa Ana Regional Water Quality Control Board (Santa Ana Regional Board) requirements.
- A Project WQMP is a plan for addressing discharges from the post-construction use of the site.
- A WQMP is required for Priority Development Projects.

WQMP Requirements

Requirements of the 2010 SAR MS4 Permit:

- Design the site to minimize imperviousness, detain runoff, and infiltrate, reuse or evapotranspire runoff where feasible.
- Cover or control sources of stormwater Pollutants.
- Use LID to infiltrate, evapotranspire, harvest and use, or treat runoff from impervious surfaces.
- Ensure runoff does not create a Hydrologic Condition of Concern (HCOC).
- Maintain Stormwater BMPs.

Priority Development Projects

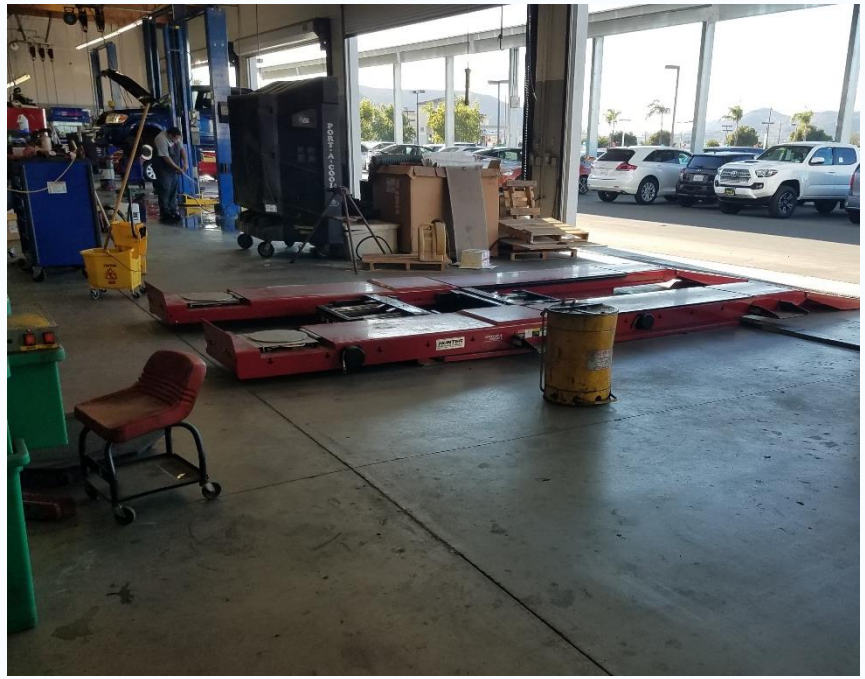
- Priority development projects (PDP) require a WQMP.
- MS4 permit lists several categories of PDPs in Table 1-1 of the SAR guidance document.

New Development Projects

- Creating 10,000 square feet or more of impervious surface including commercial and industrial projects and residential subdivisions requiring a Final Map

Automotive Repair Shops

- Based on Standard Industrial Classification Codes
  - 5013 - Motor Vehicle Supplies and New Parts
  - 5014 - Tires and Tubes
  - 5541 – Gasoline Service Stations
  - 7532 - Top, Body, Upholstery Repair Shops and Paint Shops
  - 7533 - Automotive Exhaust System Repair Shops
  - 7534 - Tire Retreading and Repair Shops
  - 7536 – Automotive Glass Replacement Shops
  - 7537 - Automotive Transmission Repair Shops
  - 7538 - General Automotive Repair Shops
  - 7539 - Automotive Repair Shops, NEC



Restaurants

- Falls under Standard Industrial Classification:
  - 5812- Eating Places
- And the project disturbs greater than 5,000 square feet (sf)

Hillside Developments

- Hillside developments disturbing 5,000 square feet or more and located on areas with known erosive soil conditions
- Natural slope is 25% or more

Environmentally Sensitive Areas

- Developments of 2,500 square feet of impervious surface or more adjacent to (within 200 feet) or discharging directly into ESAs

Parking Lots

- Parking lots of 5,000 square feet or more exposed to stormwater
- Parking lot is defined as land area or facility for the temporary parking or storage of motor vehicles

Retail Gasoline Outlets

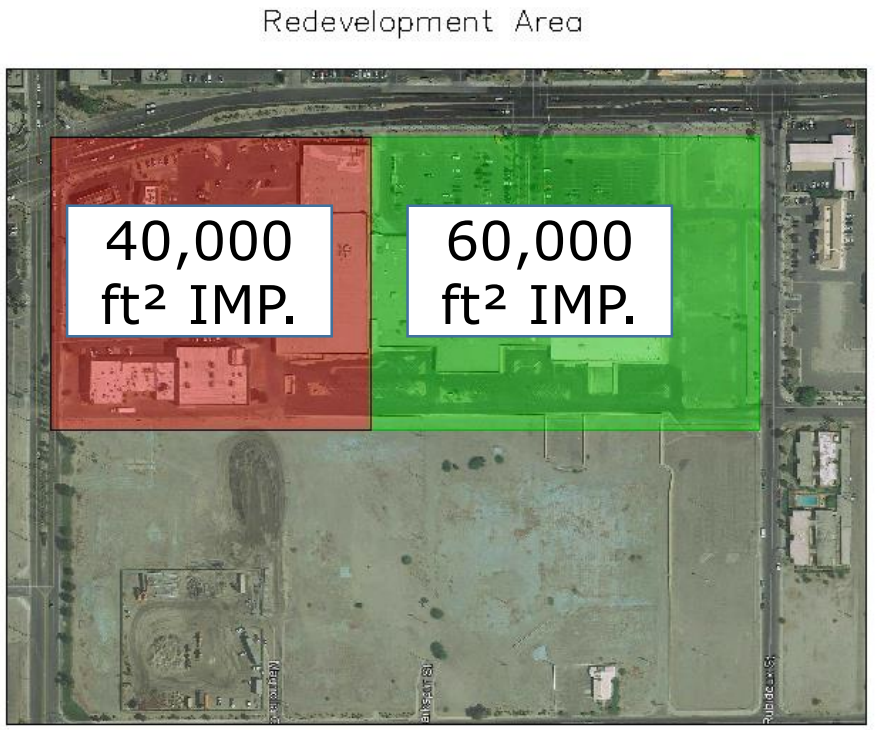
- Retail Gasoline Outlets (RGOs) that disturb 5,000 square feet or more with projected average daily traffic of 100 or more vehicles per day

Significant Redevelopment Projects

- The addition or replacement of 5,000 square feet of impervious surfaces on an already developed site
- See 50% rule

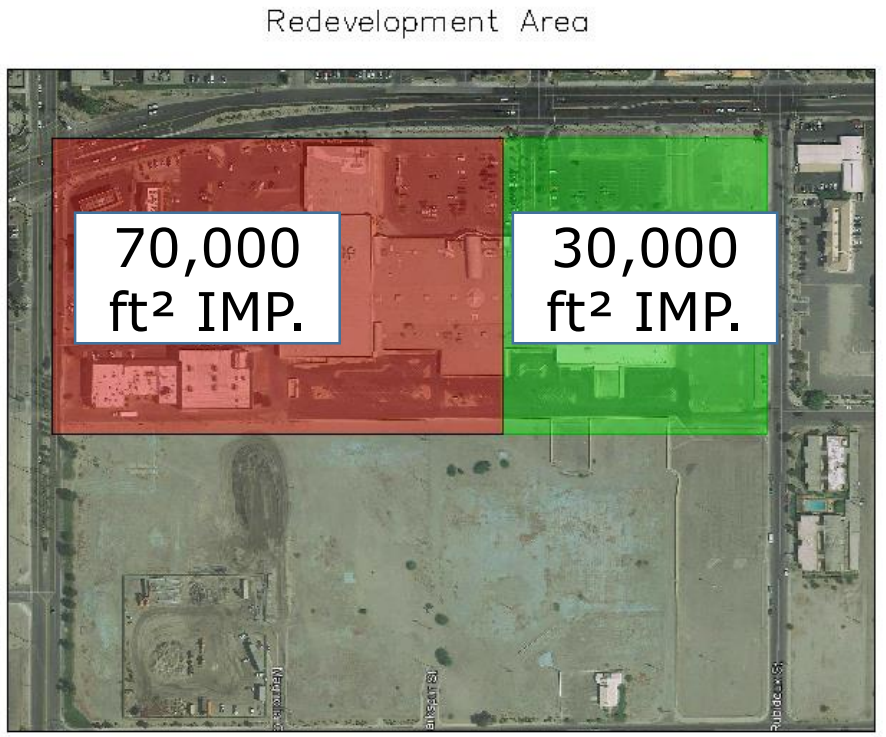
50% Rule for Redevelopment Projects

- When a Priority Redevelopment Project replaces < 50% of the impervious surfaces (red area) on an existing developed site
  - And the site was not previously subject to Priority Development Project requirements
- WQMP design standards apply ONLY to the addition or replacement (red area only)



50% Rule for Redevelopment Projects

- When a Priority Redevelopment Project replaces ≥ 50% of the impervious surfaces (red area) on an existing developed site
- Then the WQMP design standards apply to the entire development (both red & green areas)



Quiz: Does My Project Need a WQMP?

- 9,000 square foot residential development project

Quiz: Does My Project Need a WQMP?

- 190,000 square foot residential development project

Quiz: Does My Project Need a WQMP?

- 6,000 square foot parking lot

Quiz: Does My Project Need a WQMP?

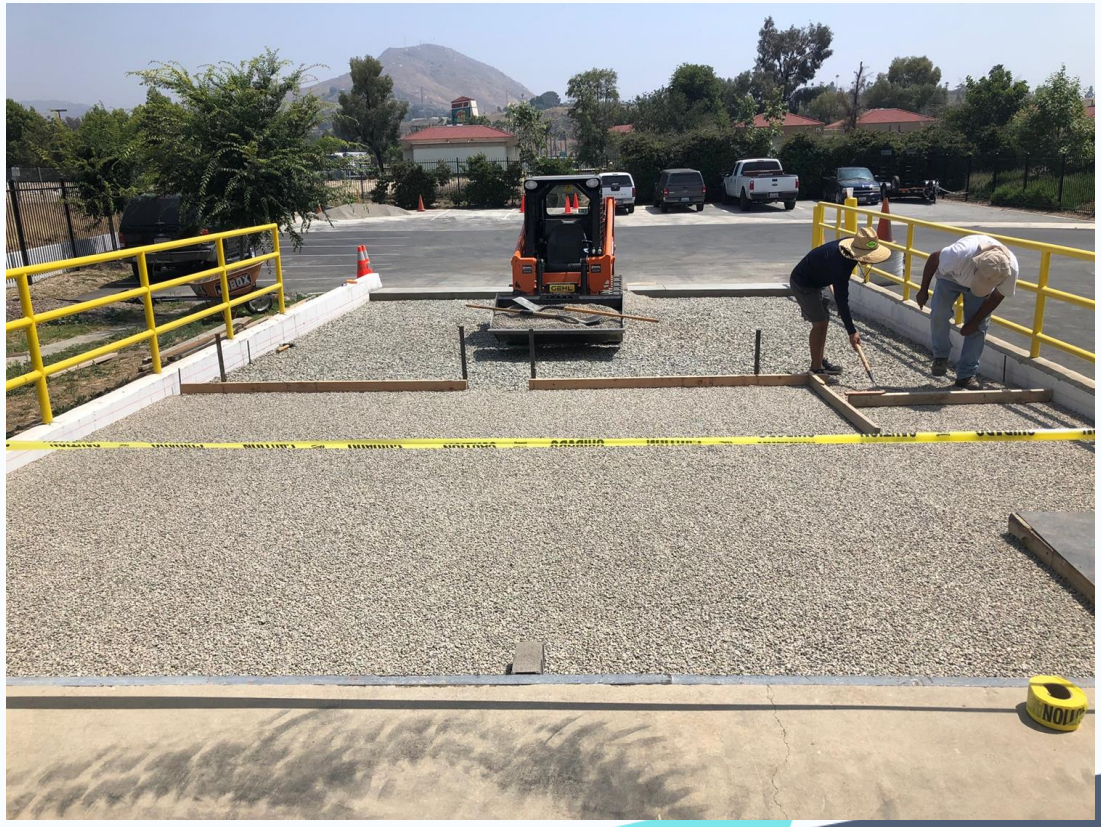
- Redevelopment project (10,500 square feet total) replacing 6,000 square feet of impervious surface

Other Development Projects

- Defined in the glossary as "Discretionary Development Projects that are not categorized as Priority Development Projects"
- Generally a project-specific WQMP is not required

Must incorporate:

- Source Control BMPs
- LID principles
- Other BMPs, which may or may not include treatment control BMPs



Public Works Projects

Public works/ Capital improvement projects falling under PDP category require a WQMP, except if they meet the following criteria (Section 1.2 of Guidance Document):

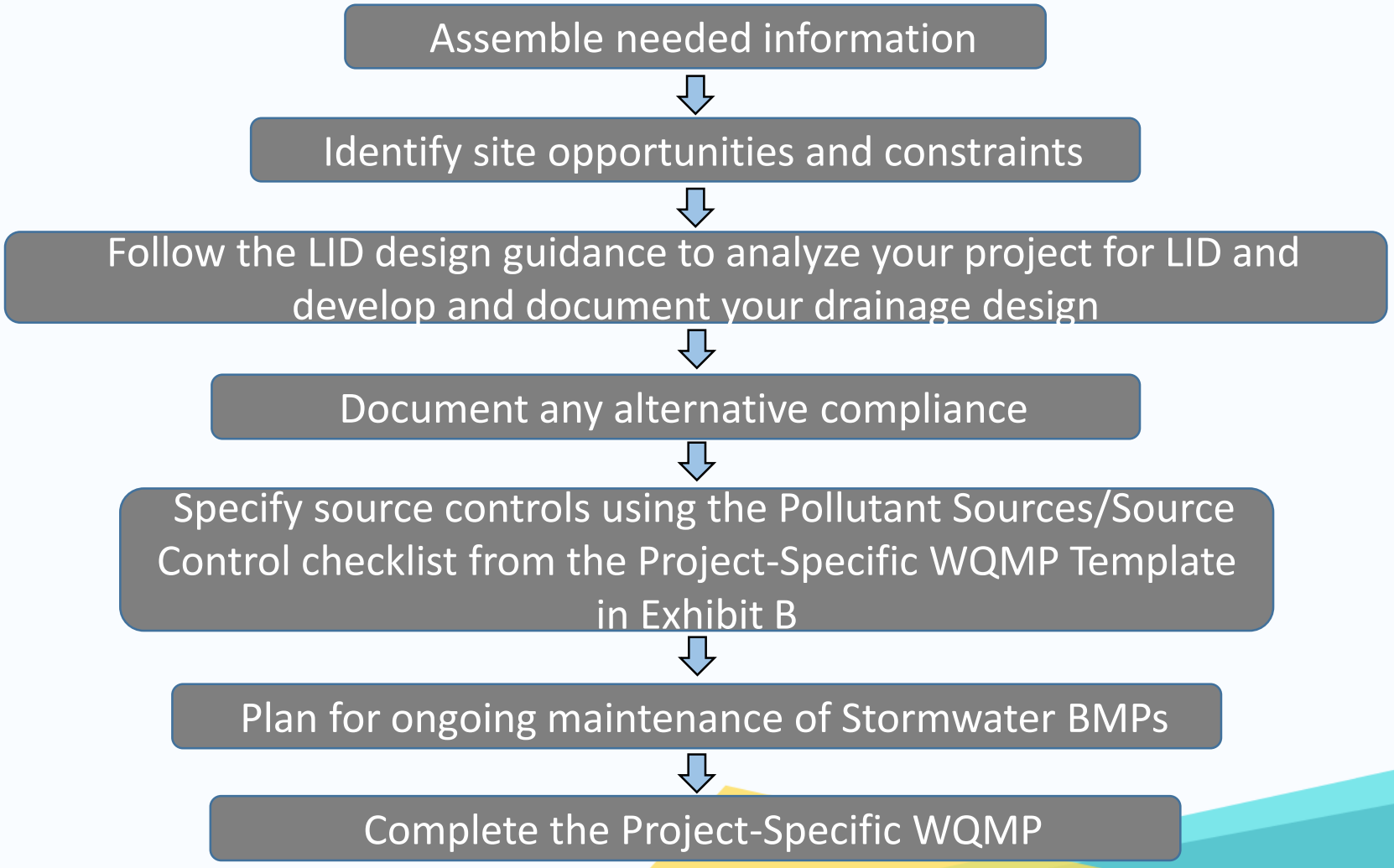
- Co-Permittee Transportation Projects
- Watershed Protection Projects
- Utility Projects
- Other Public projects

WQMP Template

- If your project falls under the Priority Development Project category, you are required to create a WQMP
- The 2016 WQMP Template may be downloaded from:
  - http://rcflood.org/npdes/SantaAnaWS.aspx

Developing a WQMP

Project-Specific WQMP Guide



Project Characteristics

Assemble Needed Information

- Know the following site characteristics:
  - Existing natural hydrologic features
  - Existing site topography
  - Zoning
  - Existing site drainage

- Area of Impervious Project Footprint (SF) = the total project area

Site Utilization

To minimize stormwater related impacts and minimize the number of Stormwater BMPs that must be used:

- Preserve existing drainage patterns
- Protect existing vegetation and sensitive areas
- Preserve natural infiltration capacity
- Minimize impervious area
- Disperse runoff to adjacent pervious areas

Pollutants of Concern

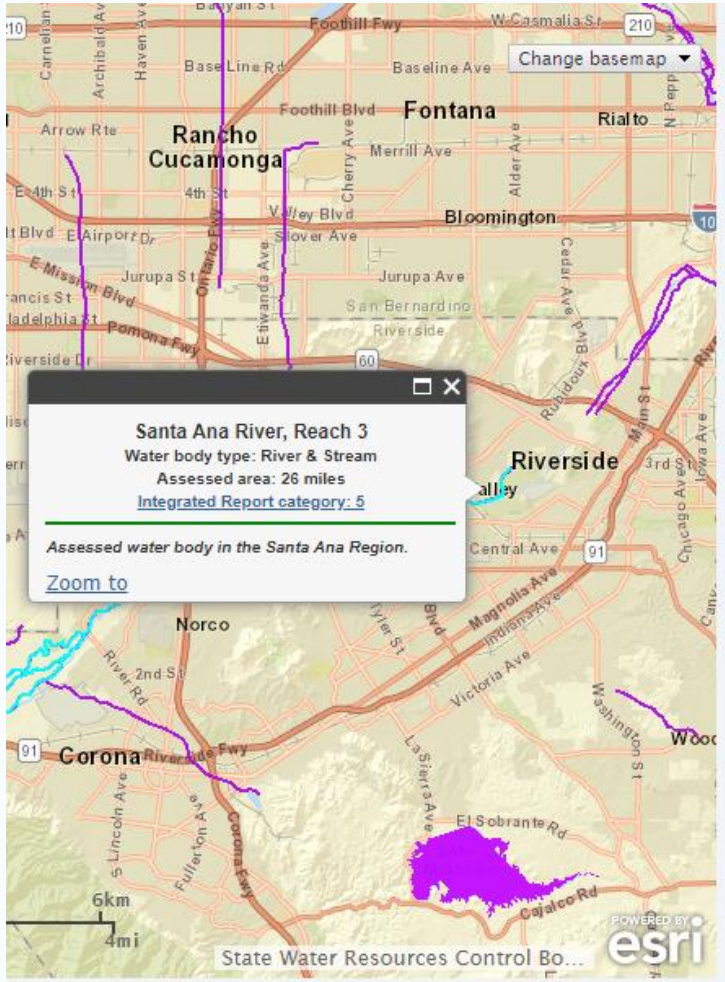
- Pollutant of Concern Summary Table (Table 3-9, SAR Guidance Document)
  - Pollutant Category
  - Potential for Project?
    - Answer 'Yes' or 'No'
  - Causing Receiving Water Impairment?
    - Answer 'Yes' or 'No'.
    - Refer to the Receiving Water Summary Table, 303(d) List of Impairments, prepared in Section II – Site Characterization
- Treatment Control BMPs provide treatment mechanisms for pollutants in runoff

Identification of Receiving Waters

- A publication by the California State Water Resources Control Board that lists waters that did not meet water quality standards established for them
- Locate project Receiving Waters in the most recent 303(d) list:
  - https://www.waterboards.ca.gov/water_issues/programs/tmdl/integrated2014_2016.shtml

303(d) List

- Note impairments for project Receiving Waters



Pollutants	Listing Decision Report Link Potential Sources Schedule *Comments*
Copper	List on 303(d) list (TMDL required list) 30191 n/a Est. TMDL completion: 2021 *The impairment is during the wet season only.*
DDE (Dichlorodiphenyldichloroethylene)	Do Not List on 303(d) list (TMDL required list) 25568 n/a
Diazinon	Do Not List on 303(d) list (TMDL required list) 25629 n/a
Iron	Do Not List on 303(d) list (TMDL required list) 25567 n/a

Design Capture Volume (DCV)

- Equivalent to the 85th Percentile, 24-hour storm event
- DCV can be calculated using:

$$DCV = \frac{D_{85} \cdot C \cdot A_{TRIB}}{12} =$$

Where:

DCV = (ft^3)

D_{85} = the Design Storm rainfall depth (from Exhibit A) (inches)

C = composite rational method runoff factor for the Drainage Management Area (unitless)

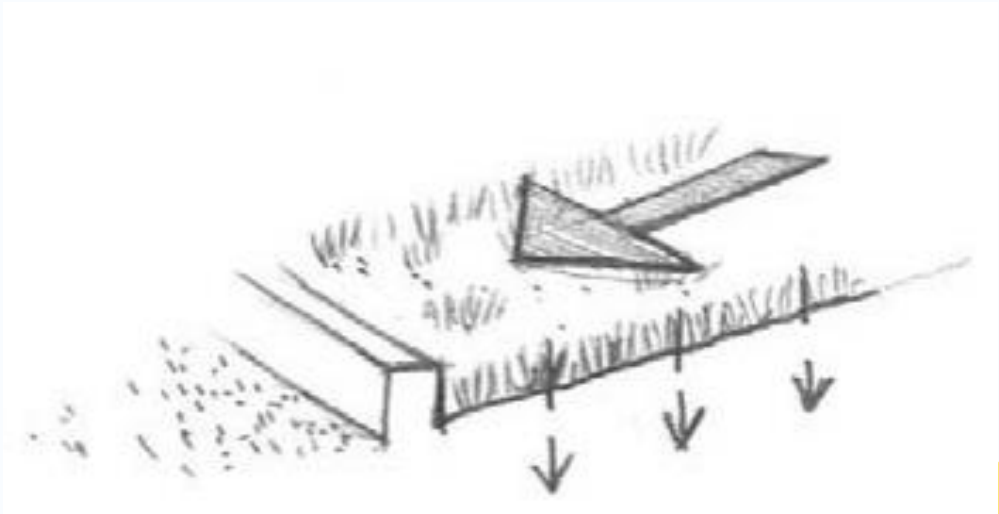
A_{TRIB} = area tributary to the BMP (ft^2)

Drainage Management Area (DMA)

- DMAs outline each LID BMP tributary area
- Establish separate DMAs for each surface type (landscaping, pervious paving, or roofs)
  - Typically these lines follow grade breaks and roof lines
- Four types of DMAs:

DMA A - Self Treating Areas

- Natural areas that do not drain to stormwater BMPs, but rather drain directly off site to the MS4
- Self-treating areas are entirely pervious and drain directly off-site or to the storm drain system

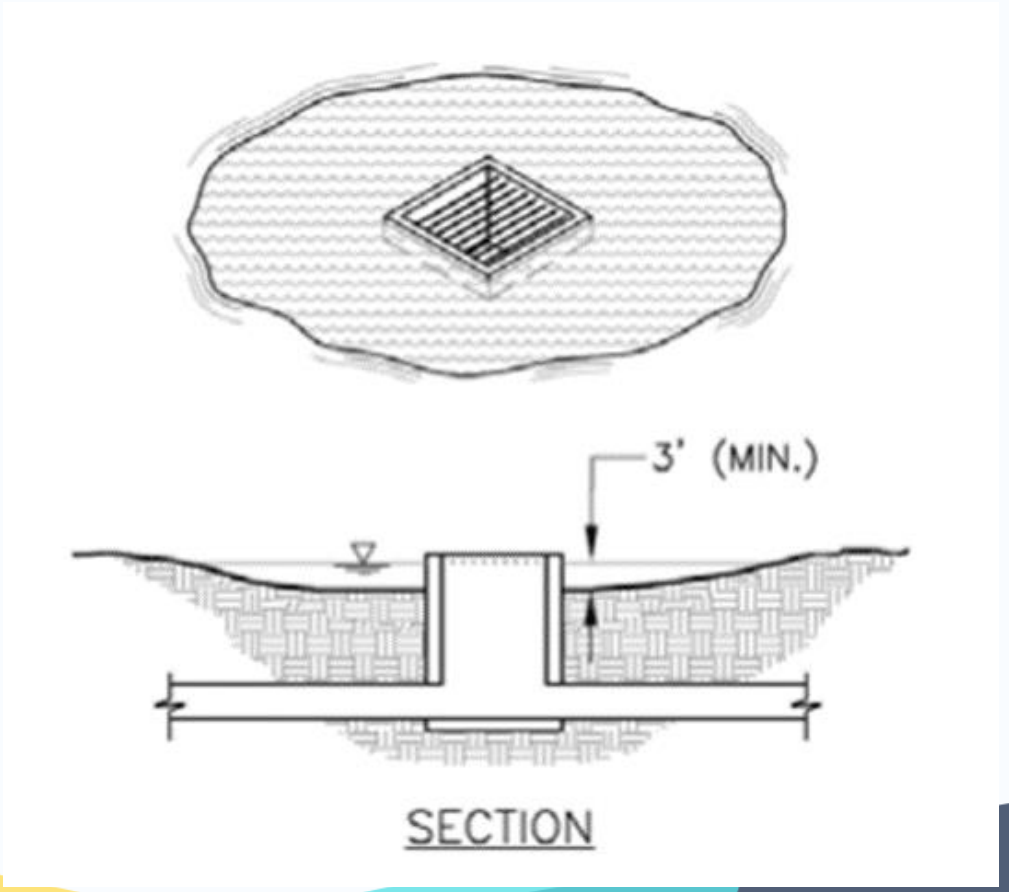


DMA B – Self Retaining Areas

- Areas designed to retain the Design Storm rainfall, without producing runoff
- Must drain within 72 hours
- Examples include:
  - Landscape areas
  - Pervious pavement
  - Ponds, fountains
  - Harvest and use areas
  - Green roofs
  - Parking islands

DMA B – Self Retaining Areas

- Berm or depress the grade to retain at least the Design Storm rainfall and set inlets of any area drains at least 3 inches above low point ponding.

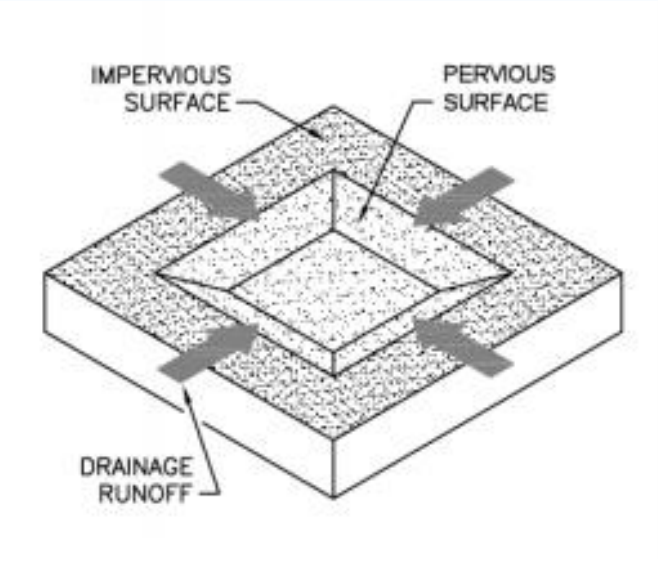


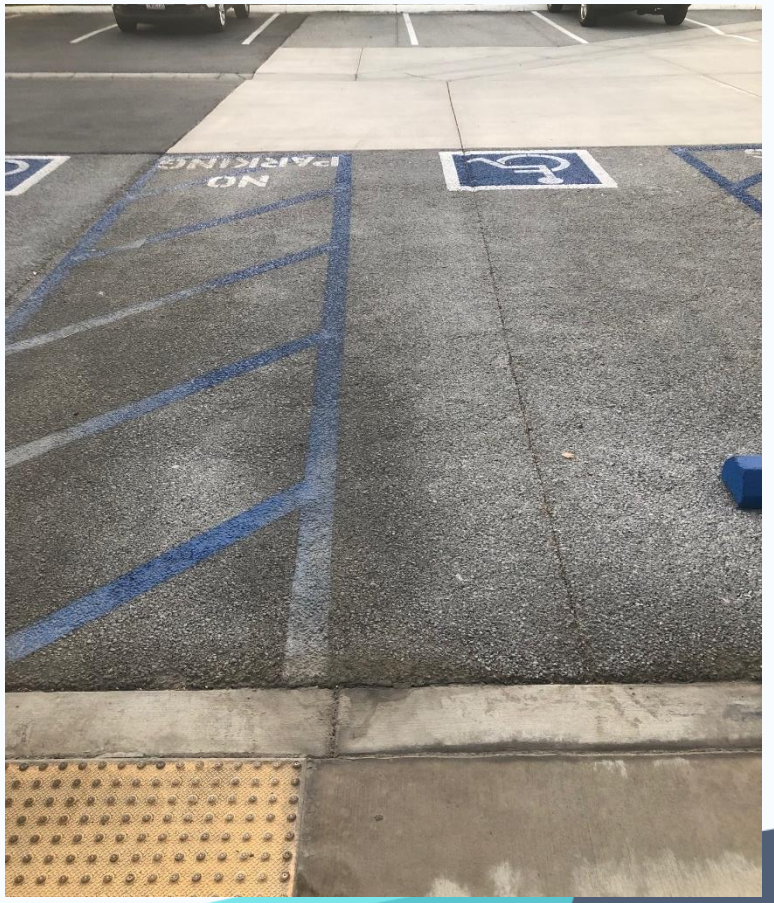
DMA C – Areas that drain to Self-Retaining Areas

- Runoff from impervious surfaces can be routed to Type "B" (self-retaining) areas
- Examples include:
  - Roof downspouts directing flows to lawn
  - Parking areas draining to landscaped areas

DMA C – Areas that drain to Self-Retaining Areas

- Must not exceed required 2:1 ratio for impervious to perviousness.

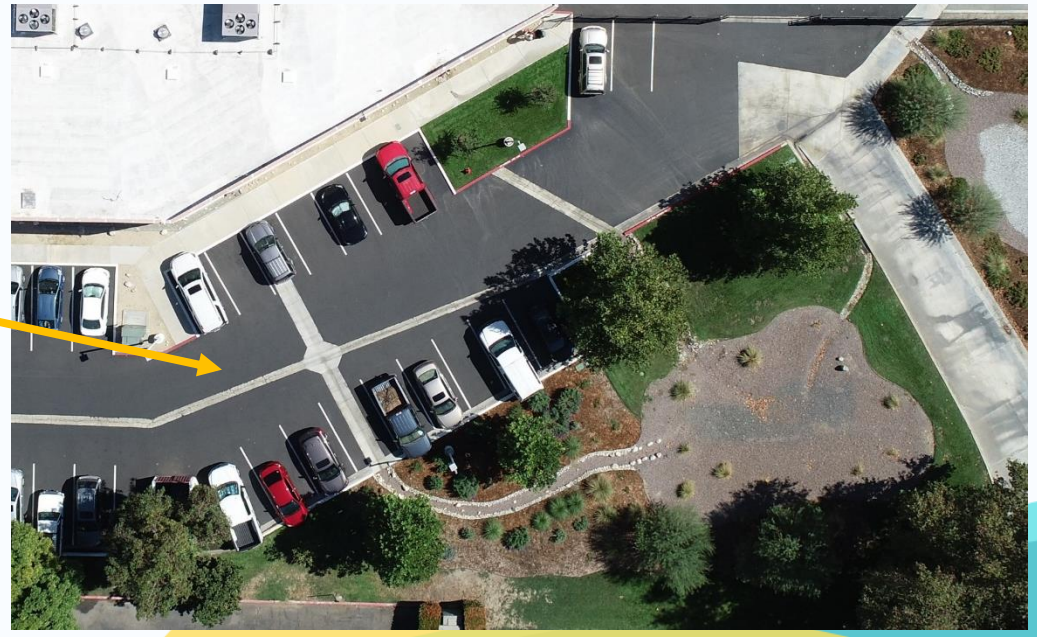




DMA D – Drains to BMPs

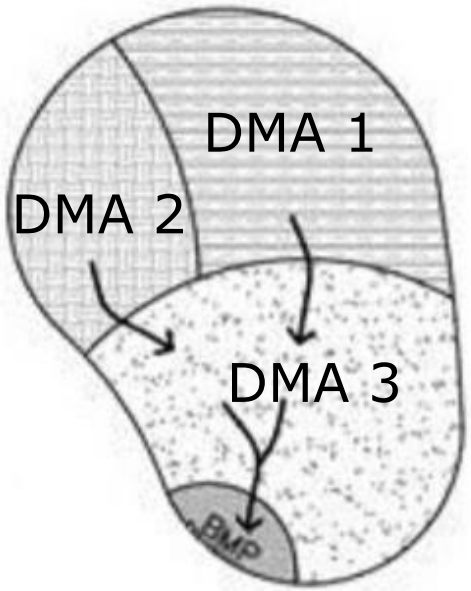
- Runoff from impervious surfaces that cannot be dealt with via non-structural preventative measures or LID Principles must be mitigated by a separate specifically designed BMP.
- Whenever possible these should consist only of completely impervious surfaces.

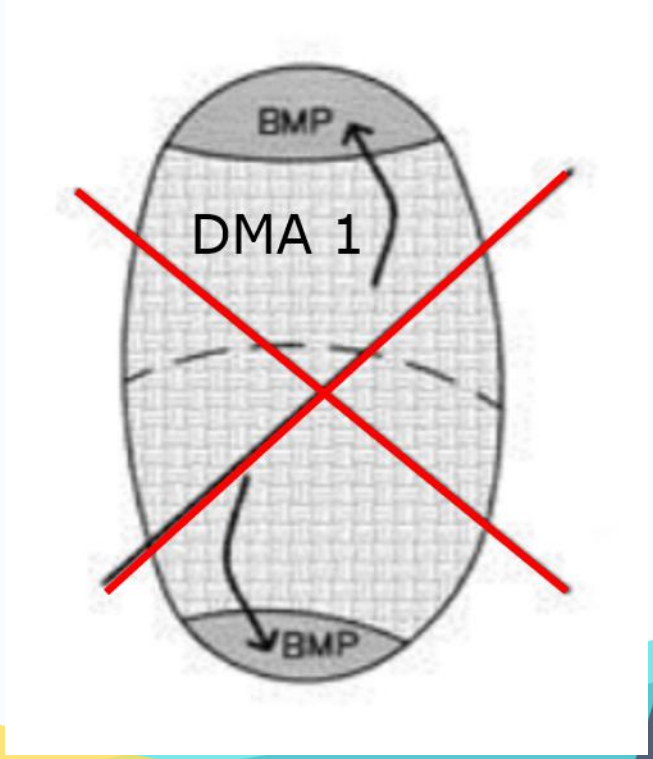
DMA D only includes the impervious areas draining to the infiltration basin



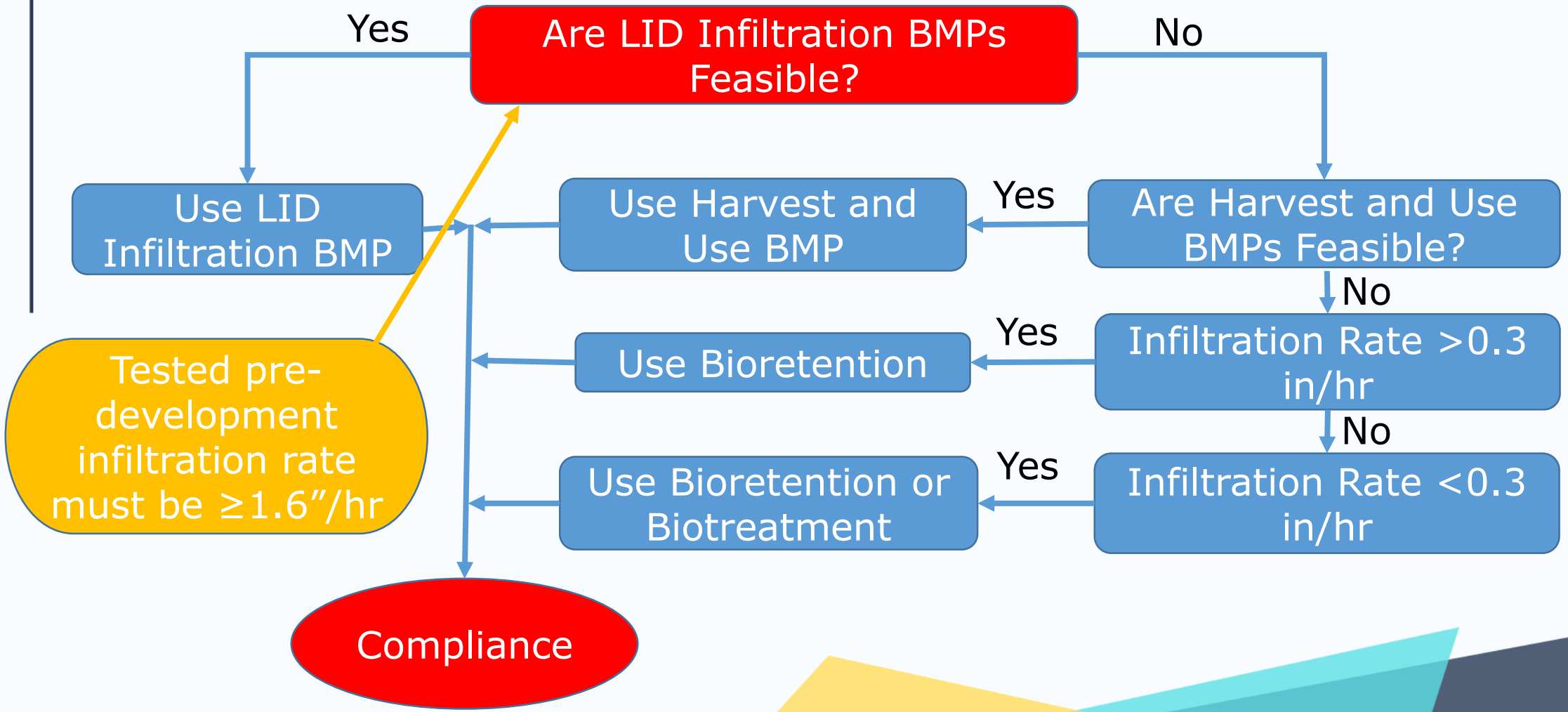
DMA D – Drains to BMPs

- More than one DMA can drain to a single LID BMP
- One DMA cannot drain to more than one LID BMP





LID BMP Hierarchy



BMP Hierarchy - Infiltration

First Tier BMP

- Can be used only where soils are highly permeable
  - Infiltration rate must be ≥1.6”/hr
- Required unless determined to be not feasible onsite
- BMPs include:
  - Infiltration basins
  - Infiltration trenches
  - Permeable pavement
  - Can also include bioretention facilities with no underdrains

Infiltration

Shallow Infiltration Basin

Infiltration Trench

BMP Hierarchy – Harvest and Use

Second Tier BMP

- Captures stormwater for reuse on the site
- If any of the anticipated demands (amount desired) exceed the applicable minimum (amount expected to receive) values then harvest and use BMPs will be required

BMP Hierarchy – Bioretention

Third Tier BMP

- Feasible on all soil types due to underdrains
- Distinguished from biotreatment BMPs, because bioretention:
  - Processes the DCV entirely
  - Maximizes both infiltration and evapotranspiration of runoff

Bioretention

Bioretention

Bioretention

BMP Hierarchy – Biotreatment

Fourth Tier BMP

- Can be used where soils are relatively impermeable
  - K_{SAT} < 0.3”/hr
- Distinguished from bioretention in that they do not process the entire DCV through a soil media
- BMPs include:
  - Extended detention basins
  - Bioswales
  - Constructed wetlands

Biotreatment

Detention Basin

Detention Basin

Alternative Compliance

- LID BMPs are expected to be feasible on all projects. However, where LID BMPs have demonstrated to be infeasible, alternative compliance may be necessary
- Other treatment control BMPs must be used to achieve the same level of compliance
- However, this does not exempt a project from first following the guidelines of the LID BMP hierarchy

Alternative Compliance

Stormwater Credits

- For certain projects LID BMPs that may be more difficult to incorporate, a credit system may be available.
- Potential project examples include:
  - Redevelopment projects
  - Brownfield redevelopment
  - Higher density development projects
  - Mixed use development
  - Transit oriented developments
  - Developments with parks
  - Regional treatment systems
  - Offsite mitigation
  - Highly urbanized areas
  - Historic developments
  - Live-work developments
  - In-fill projects

Alternative Compliance

Applying Water Quality Credits

- To determine the amount of credit a project receives, first calculate the DCV
- Use Table 3-8 to calculate percentages
- The volume credit would be calculated as:
  - Proposed DCV x sum of claimed %s (50% maximum)

TABLE 3-8. Water Quality Credits for Applicable Project Categories

Project Category	Water Quality Credit (% of DCV) [1]
Redevelopment Projects that reduce the overall impervious footprint of the project site	Percentage of site imperviousness reduced
Historic district, historic preservation area, or similar areas	10%
Brownfield redevelopment	25%
Higher density development, 7 units/acre or more	5%
Higher density development, vertical density	20%
Mixed use development, transit oriented development or live-work development	20%
In-fill development	10%

[1] Maximum total of water quality credits for a project is 50%

Hydrologic Conditions of Concern

- When projects are greater than one acre they must evaluate whether the project would cause a hydrologic condition of concern (HCOC).
- Addition of impervious surfaces increases runoff volume and peak flow.
- The 2013 MS4 Permit requires that certain development projects minimize changes to hydrology.
- Where an HCOC exists, you may need to reassess the LID design

HCOC Exemptions

Exemptions

- Disturbs less than 1 acre
- Drains to channel that conveys stormwater to engineered and stable channel
- Conveys stormwater to Controlled Release Point
- Considered a Watershed Protection Project – stormwater context
- Prado Dam beneficial uses will benefit from project
- Conveys stormwater to Natural Resistant Features or Stable Channels
- Project demonstrates that HCOC impacts are negligible or will be controlled

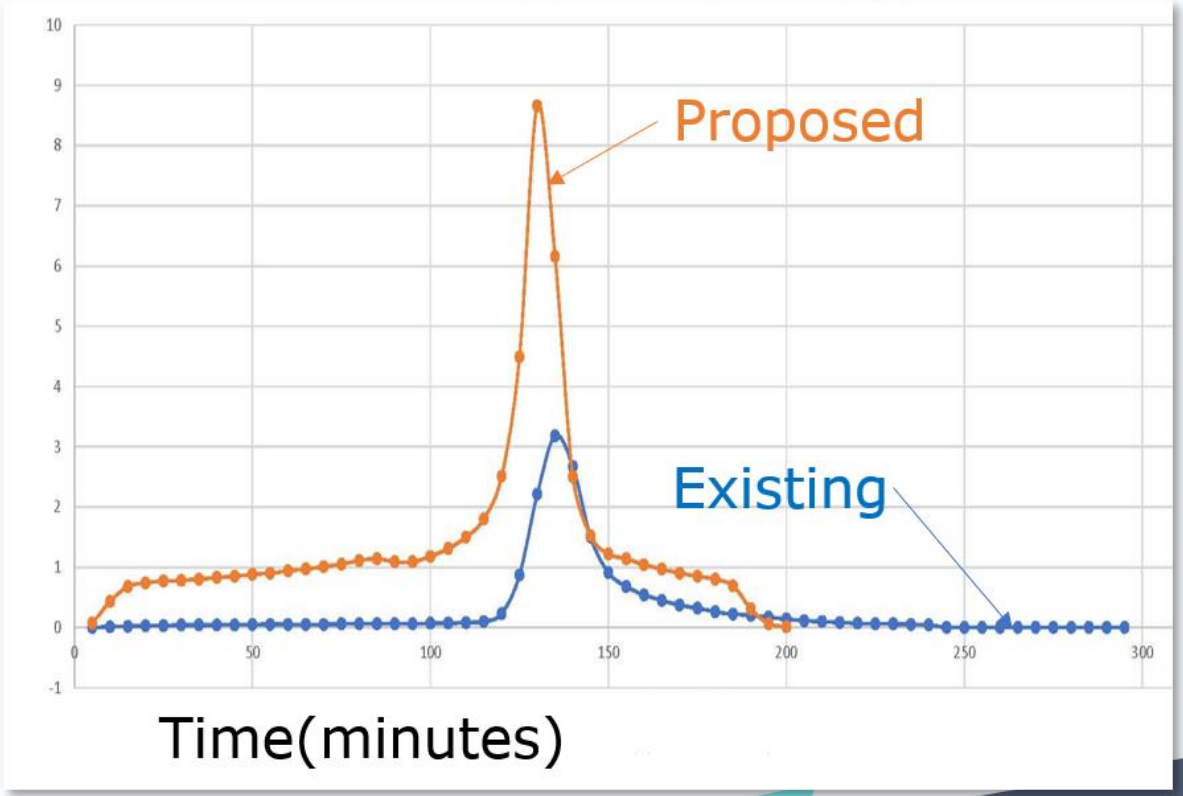
HCOC Exemptions

Exemptions

- Project is routine roadway maintenance that maintains original line and grade, hydraulic capacity, original purpose or
  - Emergency roadway maintenance activities that are required to protect public health and safety
- If volume and time of concentration of runoff is not significantly different – 5% or less is considered insignificant
- Projects must demonstrate:
  - Post-development condition TOC of 95% or more of the pre-development TOC
  - Post –development condition runoff volume of 105% or less of the pre-development runoff volume

HCOC Calculations

- If a project meets HCOC requirements it must compare the 2-year, 24-hour volumes in pre- and post-development conditions
- HCOC calculations include:
  - Modified runoff curve number method
  - Short-cut synthetic unit hydrograph method on a 24-hour storm duration and a 15-minute unit time
  - Other acceptable method to the Permittee



Source Control BMPs

- Prevention of pollutants from coming into contact with rainfall and/or runoff
- Required for all Priority Development Projects
- Include as applicable
- Categorized as:
  - Structural Source Control BMPs
  - Operational Source Control BMPs

Source Control – Structural

- Structural, physical, or mechanical devices or measures that reduce the potential for pollutants to come in contact with stormwater
- Addressed through:
  - LID BMPs
  - Conventional Treatment BMPs
  - Hydromodification BMPs
  - Structural Source Control BMPs

Source Control – Operational

- Programs or activities implemented by a site operator to prevent pollution
- Regular sweeping of parking lots, and other 'housekeeping' efforts.
  - Storm drain inlet stenciling and signage
  - Landscape and irrigation system design
  - Protection of slopes and channels

Operations and Maintenance Plan

- Identify BMPs that require operations and maintenance
- Describe activities, process, waste handling
- Start up dates and frequency of O&M
- Parties responsible for O&M
- Written agreement – use local agency form
- Inspection and Recordkeeping requirements

Operations and Maintenance Plan

Resources:

- California Stormwater Quality Association (CASQA)
  - https://www.casqa.org/resources/bmp-handbooks/municipal-bmp-handbook

- Riverside County LID BMP Design Handbook
  - http://rcflood.org/downloads/NPDES/Documents/LIDManual/LID_BMP_Design_Handbook.pdf

Low Impact Development

Implementation of BMPs

- BMPs are non-structural and structural source control measures that are required to be incorporated into all new development and significant redevelopment projects.
- BMPs are essential elements for effective water pollution control.

WQMPs must include the following BMPs:

- Site Design BMP Concepts (LID Principles)
- Low Impact Development (LID) BMPs
- Source Control BMPs
- Treatment Control BMPs (Potentially)

LID Principles

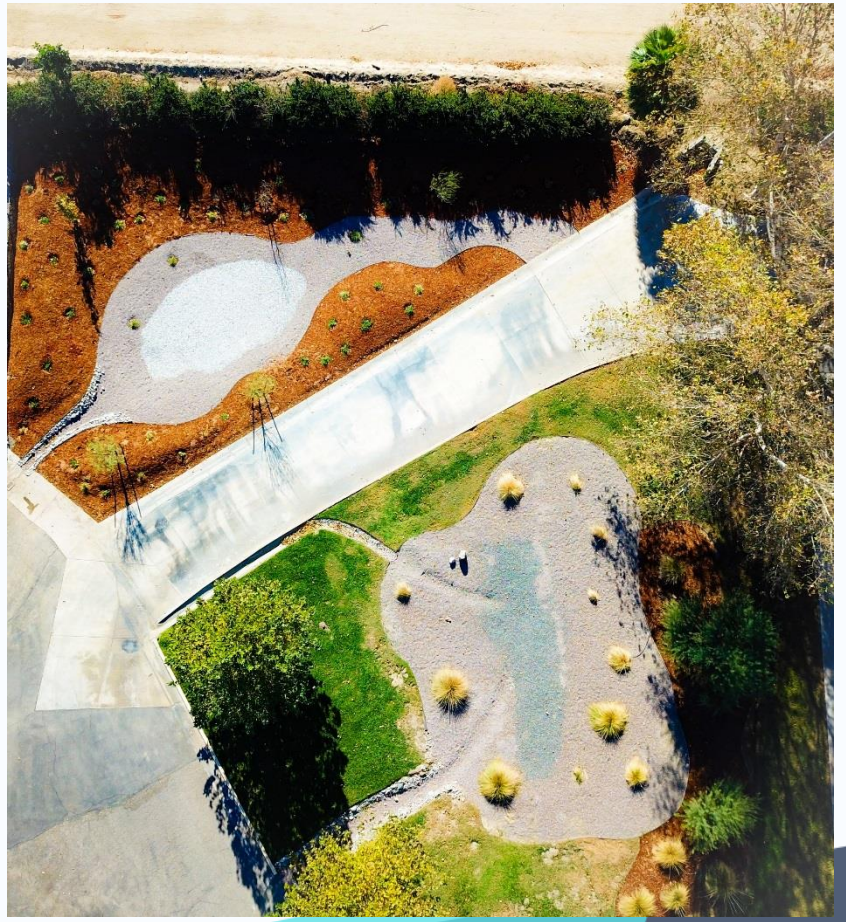
- Site design concepts that prevent or minimize the causes (or drivers) of project impacts, and help mimic the pre-development hydrologic regime.
- LID Principles should be implemented to the maximum extent practicable on all sites.

LID BMPs

- These help to mitigate otherwise unavoidable impacts; i.e. where implementation of LID Principles cannot fully address the DCV, LID BMPs must be implemented.
- Structural BMPs that primarily utilize some form of infiltration, bio-filtration, evaporation, transpiration, or a combination thereof.

Benefits of LID BMPs

- Improved water quality
- Maintenance of predevelopment runoff volume and discharge
- Groundwater recharge
- Reduced potable water demand
- Reduction in urban heat island effect
- Reduced construction and maintenance costs
- Energy cost reduction and water conservation
- Improved aesthetic value
- Educational opportunities

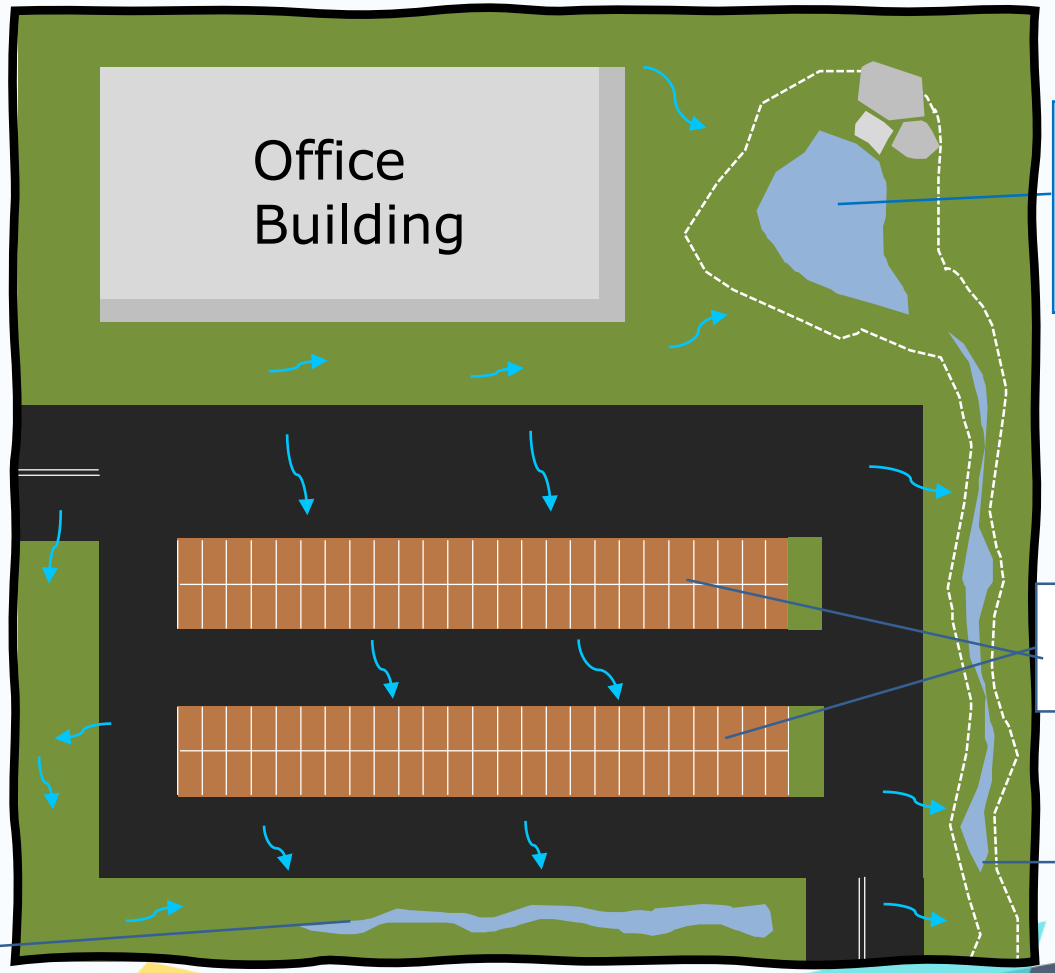


Treatment Control BMPs

- Provide treatment mechanisms for pollutants in runoff, but do not sustain significant biological processes
- Similar to LID BMPs, however they are not concerned with mimicking pre-development hydrology and generally require more maintenance

Low Impact Development

Area Treated by BMPs



Site Design Concepts

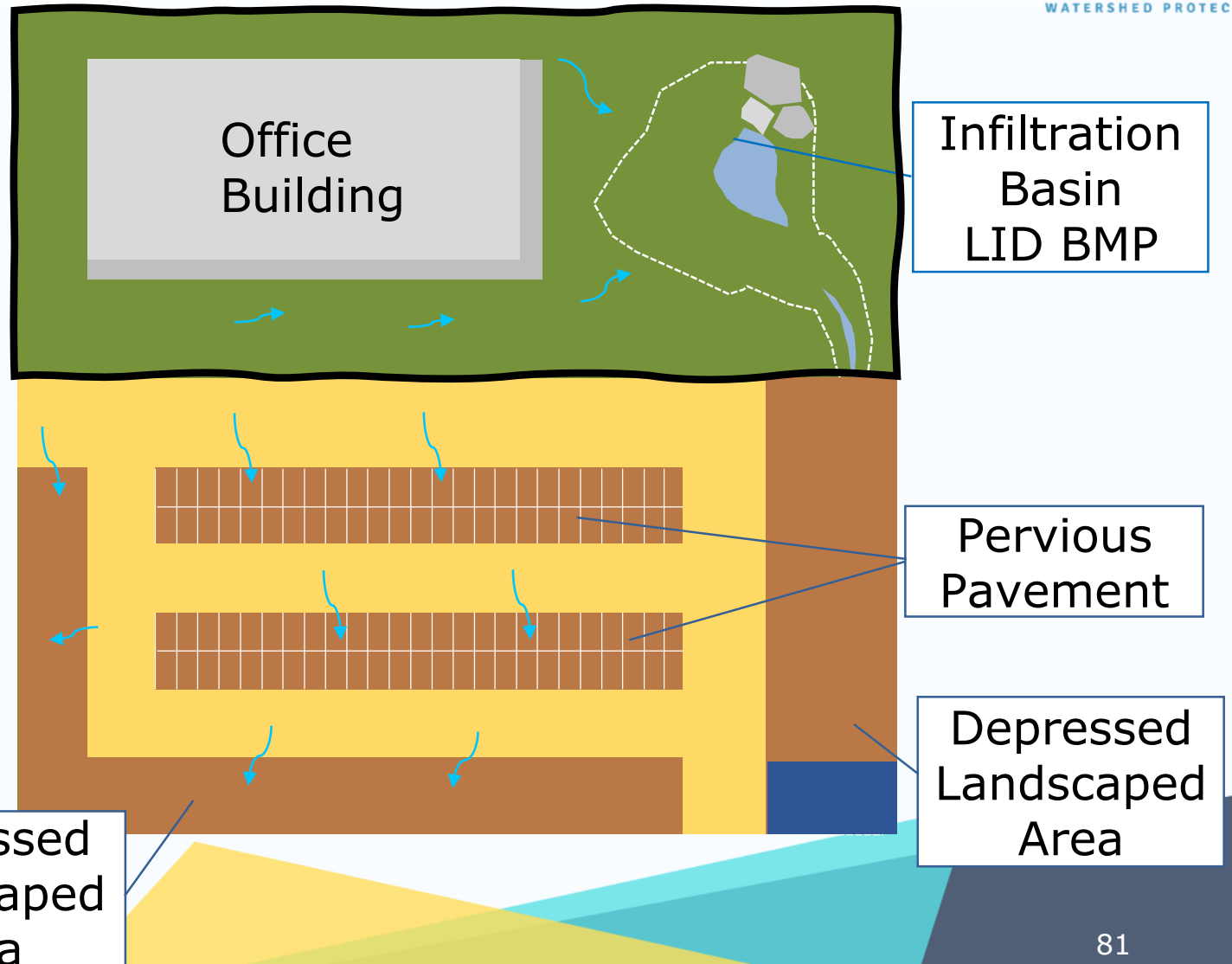
Using Site Design Concepts can reduce the size of LID BMPs

Area Treated by BMPs

Self-Treating Area

Self-Retaining Area

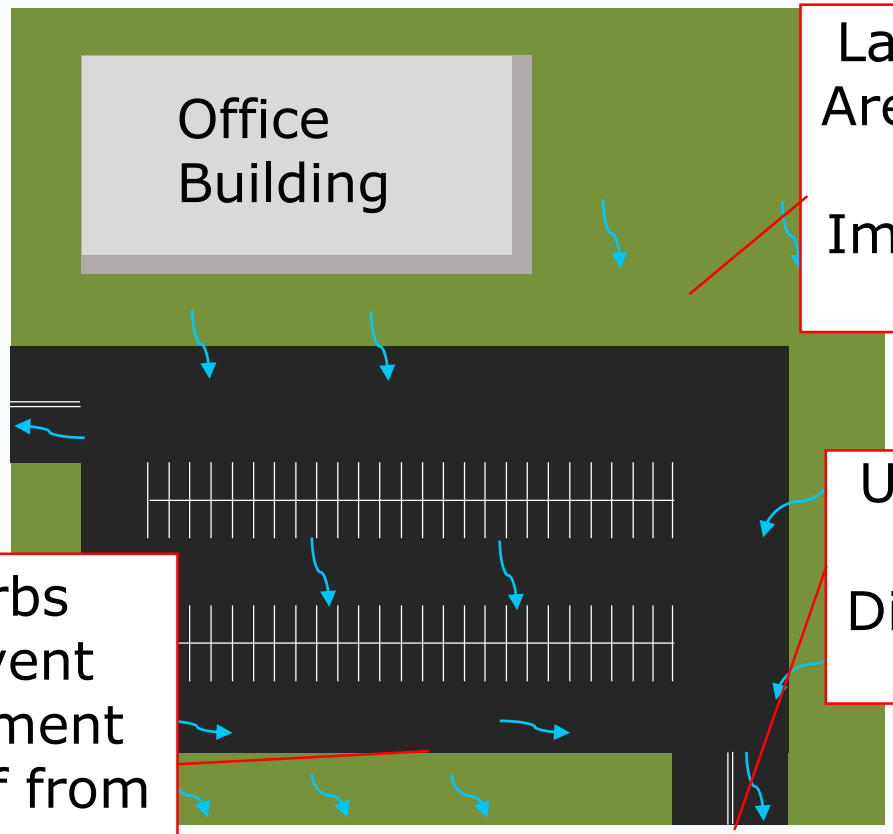
Area Draining to Self-Retaining Area



Comparison

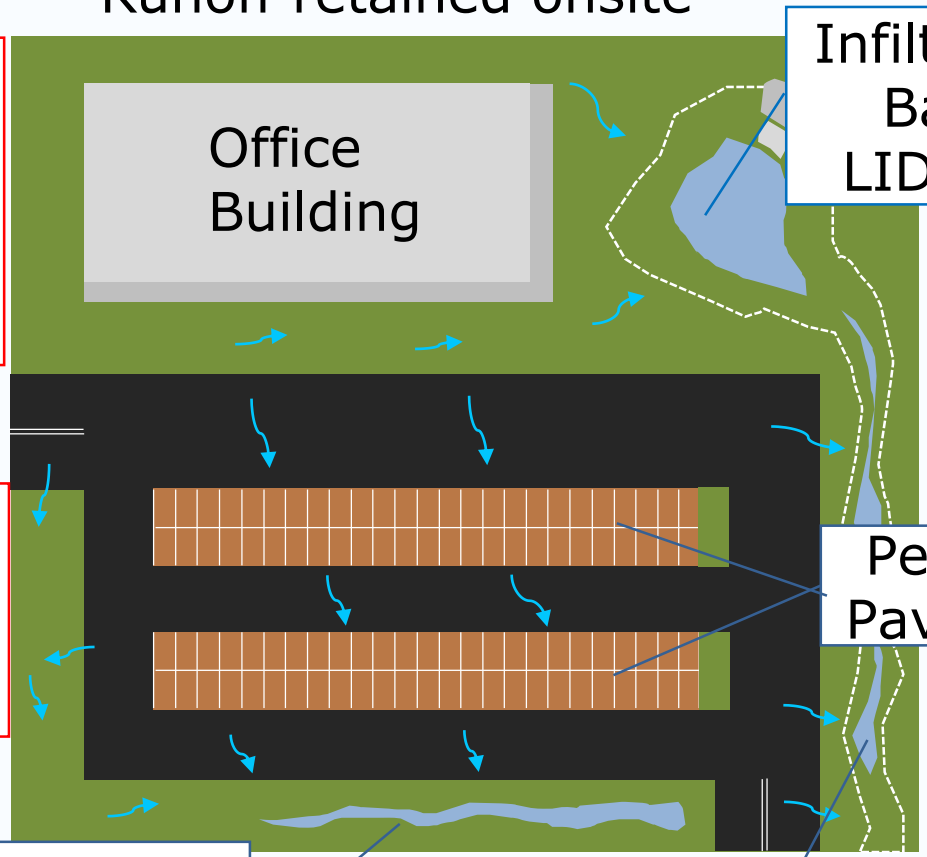
Traditional Design

Runoff directed offsite



Low Impact Design (LID)

Runoff retained onsite



Site Design Concepts

- Reduce imperviousness
- Conserve natural resources and areas
- Maintain and use natural drainage courses
- Provide runoff storage areas (self-retaining areas)
- Incorporate self-treating areas
- ↑ Site Design Concept Areas ⇨ BMP Tributary Area ↓

Self-Treating Areas

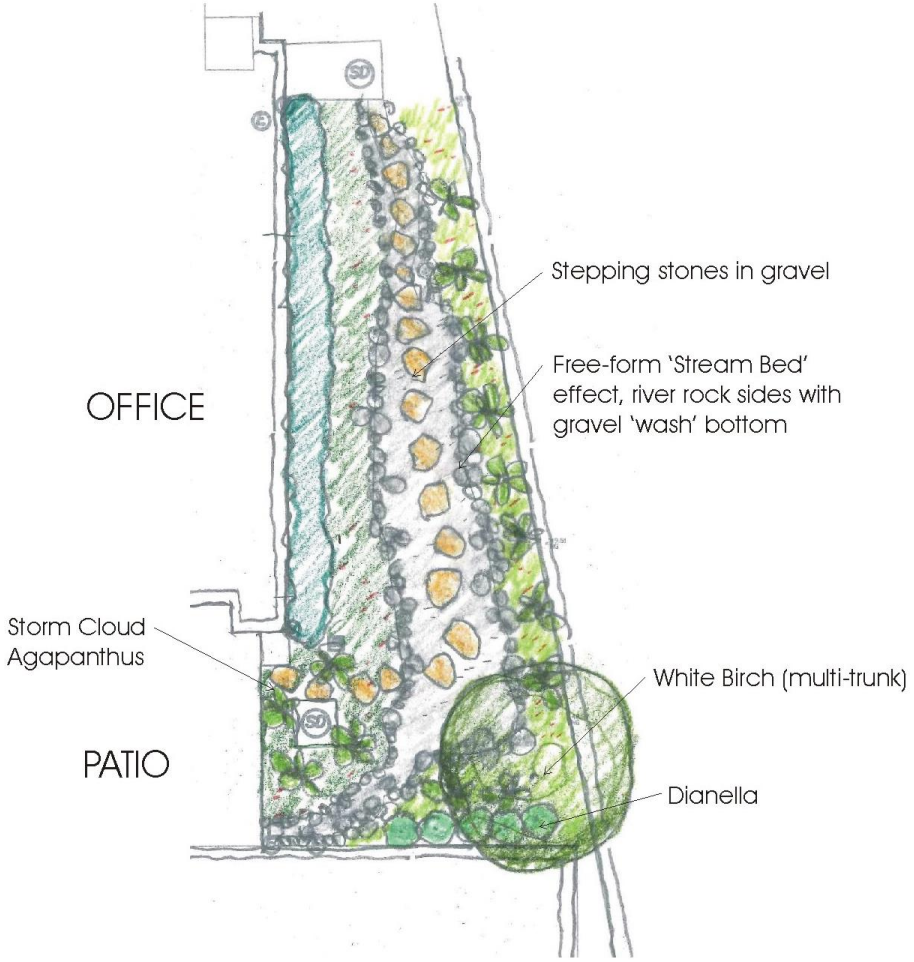
- Natural or Landscaped Area
- Drains directly offsite or to the storm drain system
- Runoff does not commingle with runoff from impervious areas

Self-Retaining Areas

- Must retain at least the design storm rainfall and set inlets of any drain at least 3 inches above low ponding point
- Can accept runoff from impervious areas
- If sized correctly, both the self-treating area and tributary impervious area can be subtracted from the area draining to BMPs

Quiz: What LID Category is This?

- Site design and landscape planning



Quiz: What LID Category is This?

- Bioswale

Quiz: What LID Category is This?

- Media Filter

Quiz: What LID Category is This?

- Reducing Imperviousness

Quiz: What LID Category is This?

- Infiltration Basin

LID BMP Design Examples

Infiltration Basin

Infiltration Basin Example

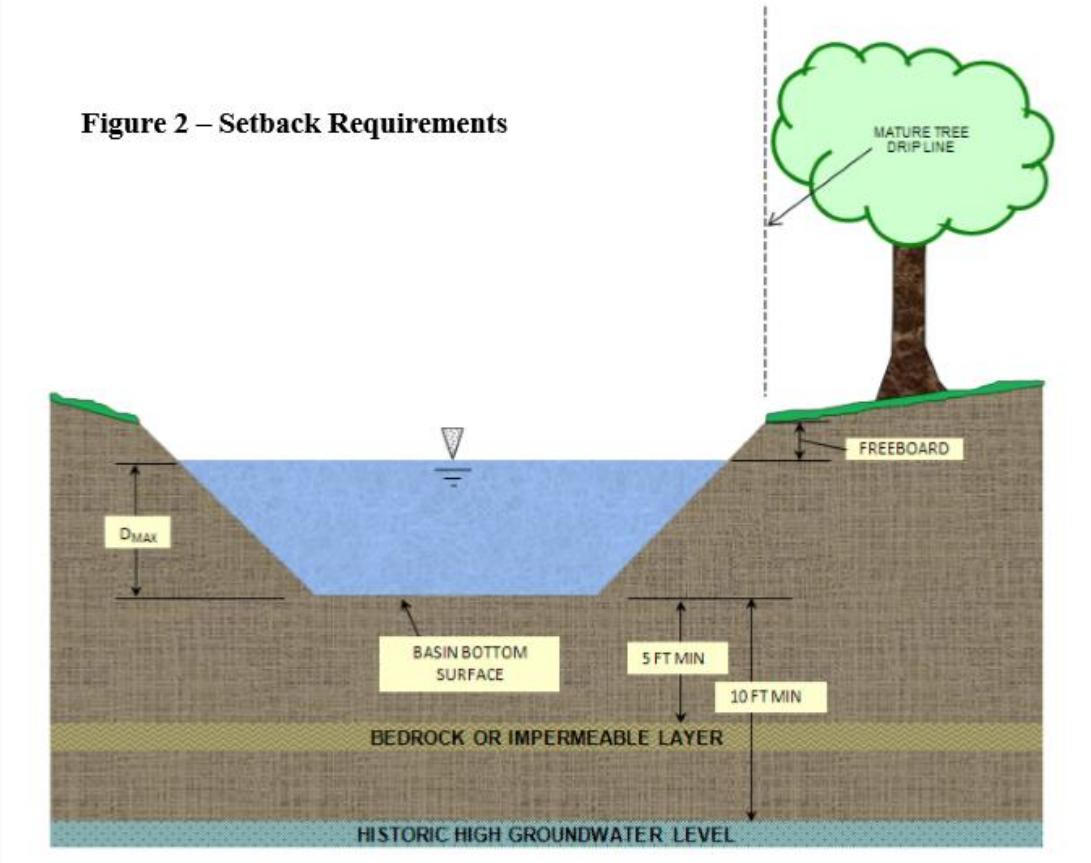
- Flat earthen basin designed to capture the design capture volume (DCV or V_{BMP})
- Stormwater infiltrates through the bottom of the basin and into underlying soil
- Flows exceeding V_{BMP} must discharge to a downstream conveyance system

Infiltration Feasibility

- Check Web Soil Survey
  - https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
- Conduct Infiltration Testing per Appendix B of the Design Handbook
  - Type of Test
  - Number of Tests
- Compare results with minimums and maximums allowed for design by local agency

Infiltration Basin Setbacks

- Infiltration basins typically must be set back:
  - 10 feet from the historic high groundwater
  - 5 feet from bedrock or impermeable surface layer
  - From all existing mature tree drip lines
  - 100 feet horizontally from well, tanks or springs

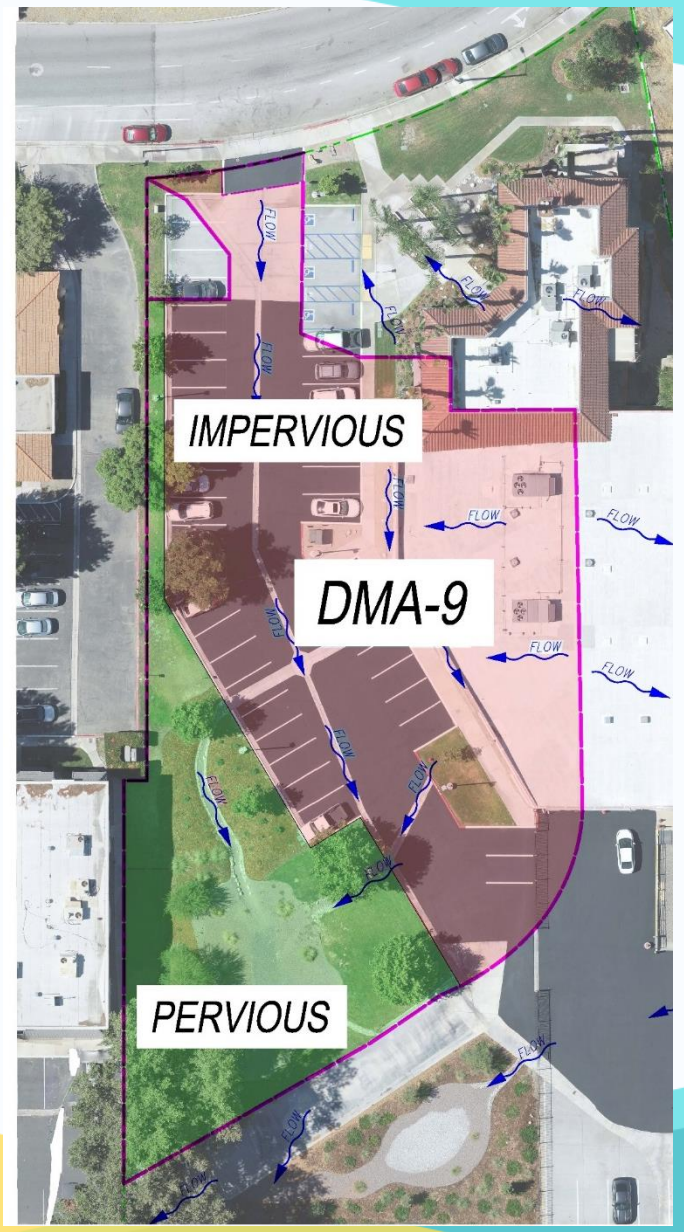


What Conditions are Necessary for Infiltration?

- Permeable soils
- Divert flows to BMP
- Don’t compact the soils

Example DMA Map

- Focus on DMA-9
  - Total Area = 0.541 acres
  - Impervious Area = 0.32 acres



Infiltration Basin Design Procedure

Download Infiltration Basin Design Worksheet
http://rcflood.org/NPDES/LIDBMP.aspx

1. Find the Design Volume, VBMP
   a) Enter the Tributary Area, AT
   b) Enter the Design Volume, VBMP, determined from Section 2. 1 of this Handbook.

Calculating Design Capture Volume (V_{BMP})

A. Delineate Drainage Management Areas (DMAs)
   - DMA 1 = 23,566 SF

B. Compile list of DMAs draining to the BMP using the VBMP calculation worksheet (http://rcflood.org/NPDES/LIDBMP.aspx)

C. Determine the effective impervious fraction (I_f)
   - We will use 0.59

D. Calculate a DMA runoff factor (C) using:
   $C=0.858*I_f^3-0.78*I_f^2+0.774*I_f+0.04$

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor
1	*23566*	*Mixed Surface Types*	*0.59*	*0.40*	*9458.4*

Calculating Design Capture Volume (V_{BMP})

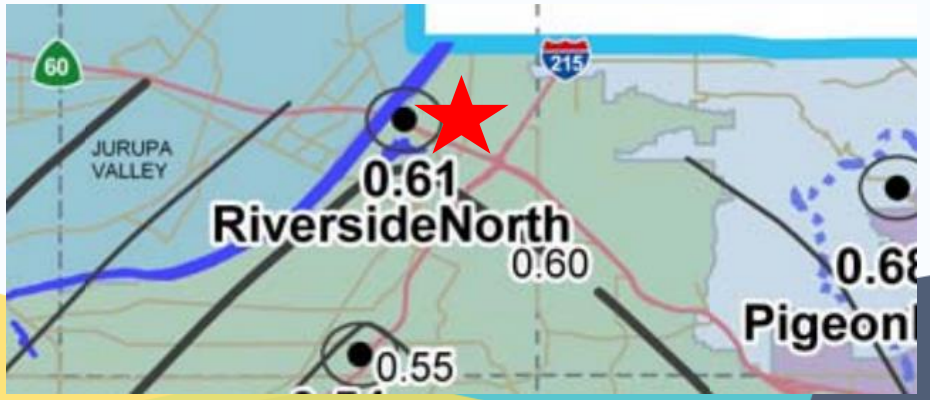
E. Multiply the area of each DMA by the runoff factor, and add up the sums if applicable

F. Determine the Design Storm Depth (D85) from the Isohyetal Map for the 85th Percentile 24 Hour Storm Event
   - We will use 0.61

G. Determine the Design Capture Volume:

   $V_{BMP}(ft^3)$ = (DMA Areas x Runoff Factor) x (V_{BMP}) / 12 (in/ft)
   - We will use 481 ft³

Design Volume			
a) Tributary area (BMP subarea)	A_T =	0.541	acres
b) Enter V_{BMP} determined from Section 2.1 of this Handbook	V_{BMP}=	481	ft^3



Infiltration Basin Design Procedure

RIVERSIDE COUNTY
WATERSHED PROTECTION

2. Determine the Max Depth

- Infiltration rate must be determined from one of the approved Santa Ana Region methods
- Geotech Report will usually give the infiltration rate & Factor of Safety
- We will use the Double Ring Infiltrometer Test
  - Infiltration rate (I) = 1.6 in./hr.
- Factor of Safety (F.S.) can also be determined from Table 1
  - F.S. = 3

Table 1 - Infiltration Testing Requirements

Infiltration BMP	Testing Options	Ring Infiltrometer Tests[1]	Percolation Test[2]	Test Pits or Boring Logs[3]	Final Report[4]	Hydrology Manual[5]	Factor of Safety
Infiltration Trench	Option 1▶	2 tests min. with at least 1 per trench	not used	1 boring or test pit per trench	Required	not used	FS = 3
	Option 2▶	not used	4 tests min. with at least two per trench	1 boring or test pit per trench	Required	not used	FS = 3
	Option 3[7]▶	not used	not used	1 boring or test pit per trench	Required	not used	FS = 6
	Option 4▶	not used	not used	1 boring or test pit per site	not used	only	FS = 10
Infiltration Basin	Option 1▶	2 tests min. with at least 1 per basin[6]	not used	1 boring or test pit per basin	Required	not used	FS = 3
	Option 2▶	not used	4 tests min. with at least 2 per basin[6]	1 boring or test pit per trench	Required	not used	FS = 3
	Option 3[7]▶	not used	not used	1 boring or test pit per basin	Required	not used	FS = 6
	Option 4▶	not used	not used	1 boring or test pit per site	not used	only	FS = 10
Permeable Pavement	Option 1▶	2 tests min. with at least 1 every 10,000 ft^2	not used	1 boring or test pit every 10,000 ft^2	Required	not used	FS = 3
	Option 2▶	not used	4 tests min. with at least 2 every 10,000 ft^2	1 boring or test pit every 10,000 ft^2	Required	not used	FS = 3

Infiltration Basin Design Procedure

- The groundwater table and bedrock height is usually given in the Geotech Report
  - Groundwater table & bedrock = 200 feet
  - Freeboard = 1 foot
- D1 & D2 are then calculated
- D_{MAX} is the smaller value of D1 & D2
  - Max depth is <u>3.2 feet</u>

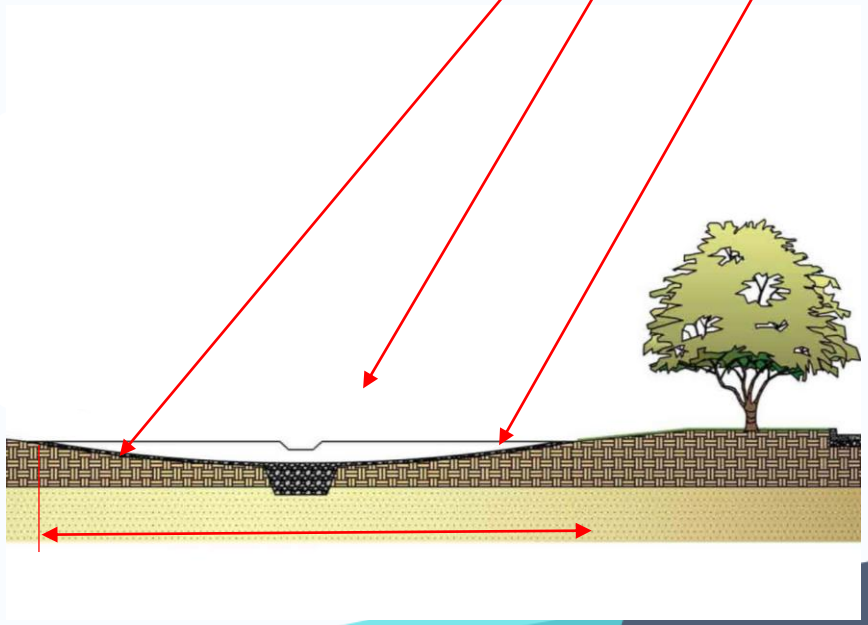
a) Tributary area (BMP subarea)	A_T =	0.541	acres
b) Enter V_{BMP} determined from Section 2.1 of this Handbook	V_{BMP}=	481	ft^3
Maximum Depth			
a) Infiltration rate	I =	1.6	in/hr
b) Factor of Safety (See Table 1, Appendix A: "Infiltration Testing" from this BMP Handbook)	FS =	3	
c) Calculate D_1 $D_1 = \frac{I\ (in/hr) \times 72\ hrs}{12\ (in/ft) \times FS}$	D_1 =	3.2	ft
d) Enter the depth of freeboard (at least 1 ft)		1	ft
e) Enter depth to historic high ground water (measured from **top** of basin)		200	ft
f) Enter depth to top of bedrock or impermeable layer (measured from **top** of basin)		200	ft
g) D_2 is the smaller of: Depth to groundwater - (10 ft + freeboard) and Depth to impermeable layer - (5 ft + freeboard)	D_2 =	189.0	ft
h) D_{MAX} is the smaller value of D_1 and D_2 but shall not exceed 5 feet	D_{MAX} =	3.2	ft

Infiltration Basin Design Procedure

3. Basin Geometry – Find bottom surface area

- Choose the basin side slopes (no steeper than 4:1)
  - 6:1
- Choose basin depth
  - 2.5 feet
- A minimum bottom surface area of the basin at <u>192 feet²</u> is calculated
- Choose design surface area of the basin
  - 200 feet²

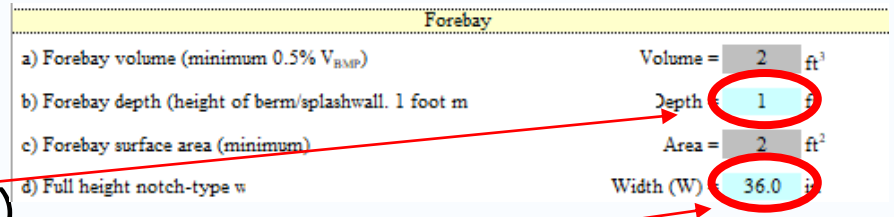
Basin Geometry		
a) Basin side slopes (no steeper than 4:1)	z = 6	:1
b) Proposed basin depth (excluding	d_B = 2.5	ft
c) Minimum bottom surface area of basin ($A_S = V_{BMP}/d_B$)	A_S = 192	ft^2
Area	A = 200	ft^2



Infiltration Basin Design Procedure

4. Calculate the Forebay

- Forebay - a pool and settling point constructed at the incoming discharge points before a BMP.
- Minimum forebay volume is equal to 0.5%V_{BMP}
- Determine height of forebay (1 foot minimum)
  - 1 foot is used
- Choose full height notch-type weir
  - 36 inches is used
- Forebay volume is then calculated to be 2 feet³
- Forebay surface area is then calculated to be 2 feet²



Infiltration Basin Final Design

Infiltration Basin - Design Procedure (Rev. 03-2012)	BMP ID	Legend:	Required Entries / Calculated Cells
Company Name:			Date:
Designed by:			County/City Case No.:
Design Volume			
a) Tributary area (BMP subarea)		A_T = 0.541	acres
b) Enter V_{BMP} determined from Section 2.1 of this Handbook		V_{BMP} = 481	ft^3
Maximum Depth			
a) Infiltration rate		I = 1.6	in/hr
b) Factor of Safety (See Table 1, Appendix A: "Infiltration Testing" from this BMP Handbook)		FS = 3	
c) Calculate D_1 $D_1 = \frac{I\ (in/hr) \times 72\ hrs}{12\ (in/ft) \times FS}$		D_1 = 3.2	ft
d) Enter the depth of freeboard (at least 1 ft)		1	ft
e) Enter depth to historic high ground water (measured from **top** of basin)		200	ft
f) Enter depth to top of bedrock or impermeable layer (measured from **top** of basin)		200	ft
g) D_2 is the smaller of: Depth to groundwater - (10 ft + freeboard) and Depth to impermeable layer - (5 ft + freeboard)		D_2 = 189.0	ft
h) D_{MAX} is the smaller value of D_1 and D_2 but shall not exceed 5 feet		D_{MAX} = 3.2	ft
Basin Geometry			
a) Basin side slopes (no steeper than 4:1)		z = 6	:1
b) Proposed basin depth (excluding		d_B = 2.5	ft
c) Minimum bottom surface area of basin ($A_S = V_{BMP}/d_B$)		A_S = 192	ft^2
d) Proposed Design Surface		A_D = 200	ft^2
Forebay			
a) Forebay volume (minimum 0.5% V_{BMP})		Volume = 2	ft^3
b) Forebay depth (height of berm/splashwall. 1 foot mir		Depth = 1	ft
c) Forebay surface area (minimum)		Area = 2	ft^2
d) Full height notch-type w		Width (W) = 36.0	in

Infiltration Basin Typical Maintenance Schedule

Maintenance Activities	Suggested Frequency

• Maintain vegetation as needed. Use of fertilizers, pesticides and herbicides should be strenuously avoided to ensure they don't contribute to water pollution. If appropriate native plant selections and other IPM methods are used, such products shouldn't be needed. If such projects are used,
  • Products shall be applied in accordance with their labeling, especially in relation to application to water, and in areas subjected to flooding.
  • Fertilizers should not be applied within 15 days before, after, or during the rainy season.
	Ongoing including just before annual storm seasons and following rainfall events

Infiltration Basin Typical Maintenance Schedule Cont.

Maintenance Activities	Suggested Frequency
• Remove debris and litter from the entire basin to minimize clogging and improve aesthetics. • Check for obvious problems and repair as needed. Address odor, insects, and overgrowth issues associated with stagnant or standing water in the basin bottom. There should be no long-term ponding water. • Check for erosion and sediment laden areas in the basin. Repair as needed. Clean forebay if needed. • Re-vegetate side slopes where needed.	**Ongoing** including just before annual storm seasons and following rainfall events

Infiltration Basin Typical Maintenance Schedule Cont.

Maintenance Activities	Suggested Frequency
• Inspect hydraulic and structural facilities. Examine the inlet for blockage, the embankment and spillway integrity, as well as damage to any structural element. • Check for erosion, slumping and overgrowth. Repair as needed. • Check basin depth for sediment build up and reduced total capacity. Scrape bottom as needed and remove sediment. Restore to original cross-section and infiltration rate. Replant basin vegetation.	**Annually**. If possible, schedule these inspections within 72 hours after a significant rainfall

Infiltration Basin Typical Maintenance Schedule Cont.

Maintenance Activities	Suggested Frequency
• Verify the basin bottom is allowing acceptable infiltration. Use a disc or other method to aerate basin bottom only if there is actual significant loss of infiltrative capacity, rather than on a routine basis. • No water should be present 48 hours after an event. No long-term standing water should be present at all. No algae formation should be visible. Correct problem as needed.	**Annually**. If possible, schedule these inspections within 72 hours after a significant rainfall

Bioretention Facility

Bioretention Facility Example

- Shallow, vegetated basins underlain by an engineered soil media
- When the infiltration rate of the underlying soil is exceeded, fully biotreated flows are discharged via underdrains
- Bioretention facilities work best when designed in a relatively level area

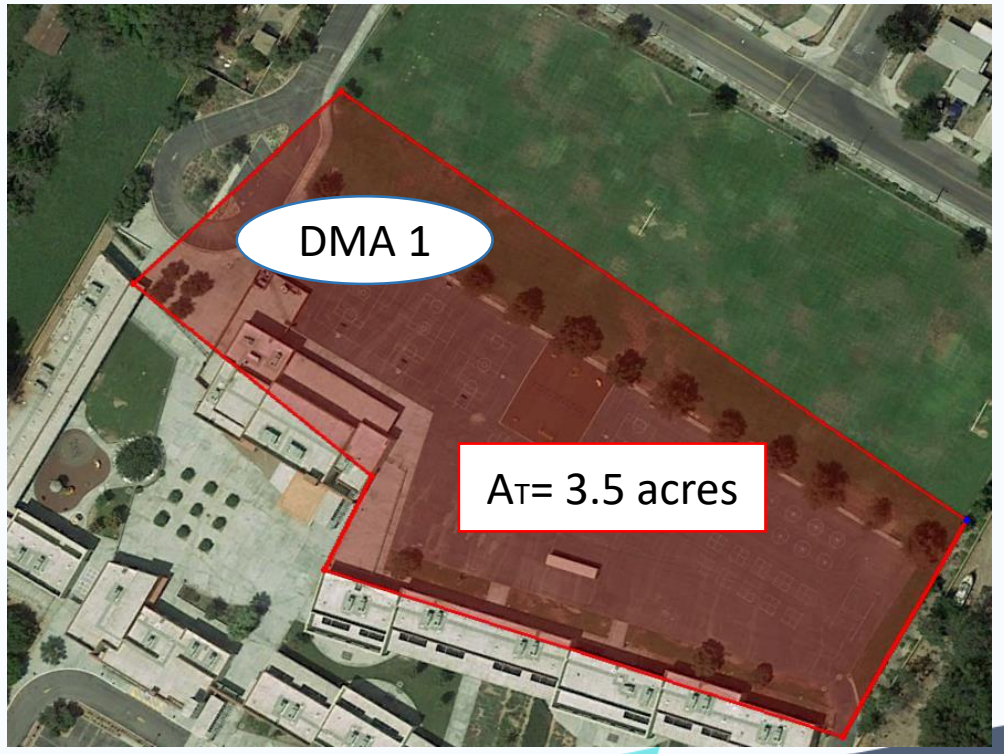
Bioretention Facility Standards

- Recommended cross section necessary includes:
  - Vegetated area
  - 18” minimum depth of engineered soil media
  - 12” minimum gravel layer depth with 6” perforated pipes
- Engineered soil media: 85% Mineral component, 15% Organic component
- Mature vegetative cover: 70% minimum
- Curb cut flow lines must be at or above V_{BMP} water surface level
- Side slopes shall be 4:1 minimum
- An overflow route is needed
- Ponding depth of 6” maximum (measured from top of mulch)

Bioretention Design Procedure

Download Bioretention worksheet http://rcflood.org/NPDES/LIDBMP.aspx

1. Enter the area tributary, A_T
   - A_T = 3.5 acres
2. Enter the Design Volume, V_{BMP}
   - Calculated based on capturing volume of runoff generated from an 85th percentile, 24-hour storm



Calculating Design Capture Volume (V_{BMP})

A. Delineate Drainage Management Areas (DMAs)
   - DMA 1 = 159,190 SF

B. Compile list of DMAs draining to the BMP using the VBMP calculation worksheet (http://rcflood.org/NPDES/LIDBMP.aspx)

C. Determine the effective impervious fraction (I_f)
   - Assume 0.7 for this example.

D. The worksheet calculates the DMA runoff factor (C):

$$C=0.858*I_f^3-0.78*I_f^2+0.774*I_f+0.04$$

DMA Type/ID	DMA Area (square feet)	Post-Project Surface Type	Effective Imperivous Fraction, I_f	DMA Runoff Factor	DMA Areas x Runoff Factor
1	*159190*	*Mixed Surface Types*	*0.7*	*0.49*	*78623*

Calculating Design Capture Volume (V_{BMP})

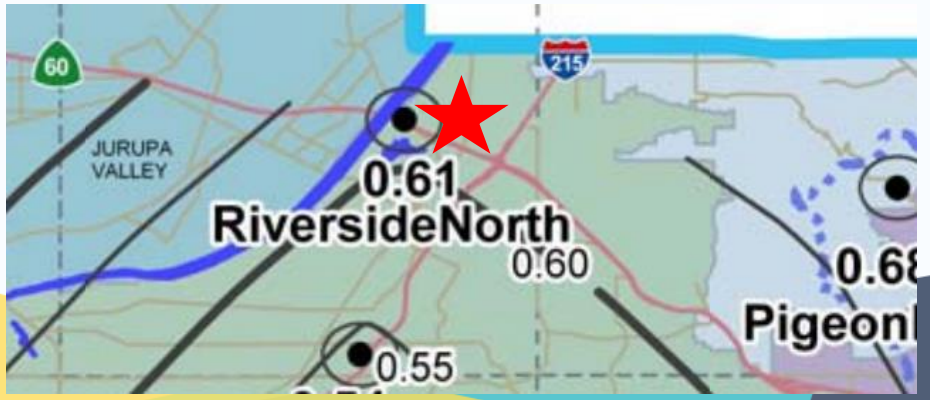
E. Multiply the area of each DMA by the runoff factor, and add up the sums if applicable

F. Determine the Design Storm Depth (D85) from the Isohyetal Map for the 85th Percentile 24 Hour Storm Event
   - We will use 0.61

G. Determine the Design Capture Volume:

   $V_{BMP}(ft^3)$ = (DMA Areas x Runoff Factor) x (V_{BMP}) / 12 (in/ft)
   - We will use 3,827.7 ft³

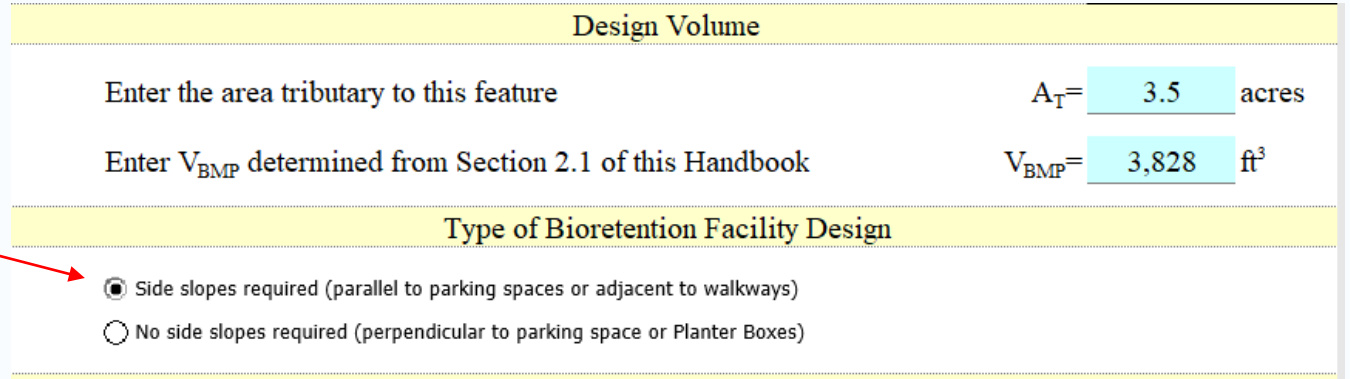
Design Volume			
Enter the area tributary to this feature	A_T=	3.5	acres
Enter V_{BMP} determined from Section 2.1 of this Handbook	V_{BMP}=	3,828	ft^3



Bioretention Design Procedure

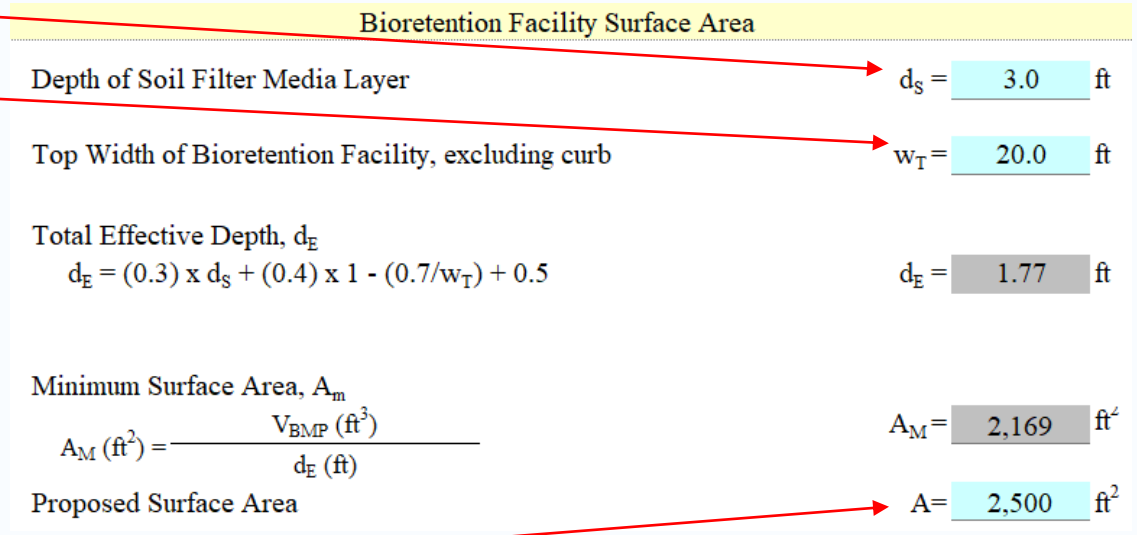
- Input A_T and V_{BMP} achieved from the previous steps

3. Select type of design
   - Standard (includes side slopes)
   - Modified (BMP is perpendicular to parking spaces or in planter box)



Bioretention Design Procedure

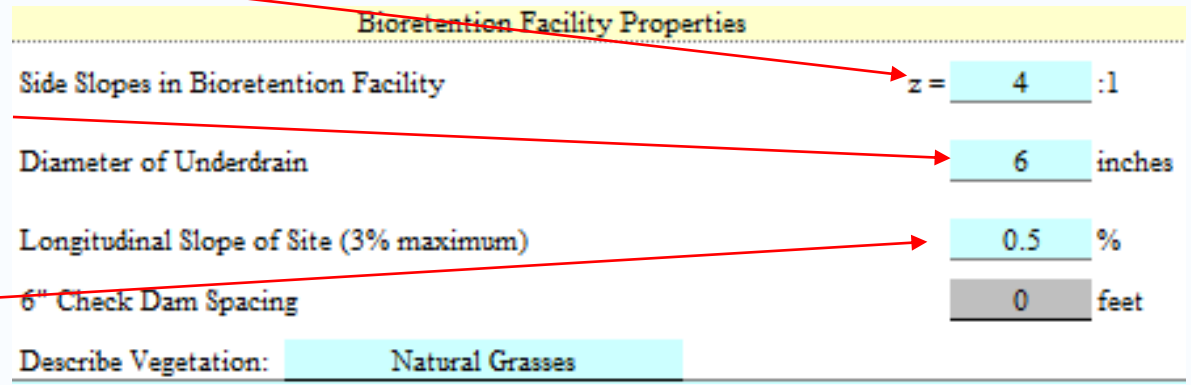
4. Enter depth of engineered soil media (d_S).
5. Enter top width of Bioretention Facility.
6. Worksheet calculates Total Effective Depth, d_E.
7. Worksheet calculates Minimum surface area (A_M).
8. Enter proposed bottom surface area. This area does not include the side slopes.



Bioretention Facility Surface Area			
Depth of Soil Filter Media Layer	d_S =	3.0	ft
Top Width of Bioretention Facility, excluding curb	w_T =	20.0	ft
Total Effective Depth, d_E $d_E = (0.3) \times d_S + (0.4) \times 1 - (0.7/w_T) + 0.5$	d_E =	1.77	ft
Minimum Surface Area, A_m $A_M\ (ft^2) = \frac{V_{BMP}\ (ft^3)}{d_E\ (ft)}$	A_M =	2,169	ft^2
Proposed Surface Area	A=	2,500	ft^2

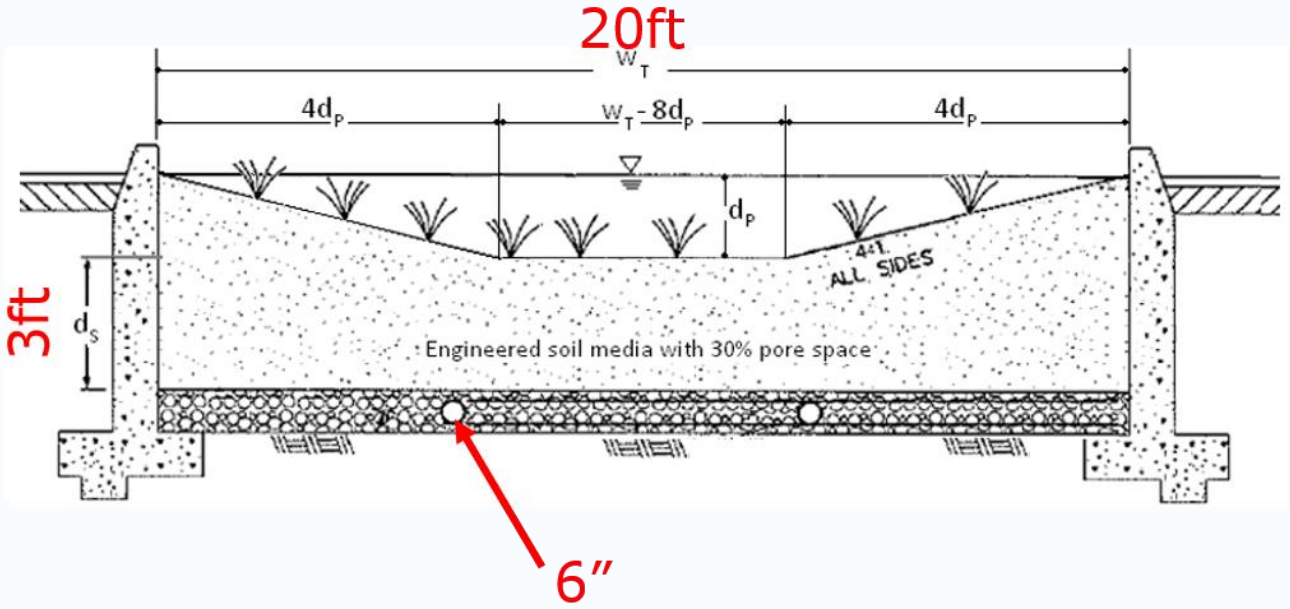
Bioretention Design Procedure

7. Verify side slopes are no steeper than 4:1.
8. Provide diameter of perforated underdrain (6 inch minimum).
9. Provide the slope of the site (3% maximum).
10. Worksheet provides check dam spacing if necessary.
11. Describe the vegetation used.



Bioretention Facility Properties			
Side Slopes in Bioretention Facility	z =	4	:1
Diameter of Underdrain		6	inches
Longitudinal Slope of Site (3% maximum)		0.5	%
6" Check Dam Spacing		0	feet
Describe Vegetation:	Natural Grasses		

Bioretention Final Design



Bioretention Facility - Design Procedure	BMP ID	Legend:	Required Entries / Calculated Cells
Company Name:			Date:
Designed by:			County/City Case No.:

Design Volume

Enter the area tributary to this feature	A_T=	3.5 acres
Enter V_{BMP} determined from Section 2.1 of this Handbook	V_{BMP}=	3,828 ft³

Type of Bioretention Facility Design

- (●) Side slopes required (parallel to parking spaces or adjacent to walkways)
- ( ) No side slopes required (perpendicular to parking space or Planter Boxes)

Bioretention Facility Surface Area

Depth of Soil Filter Media Layer	d_S =	3.0 ft
Top Width of Bioretention Facility, excluding curb	w_T =	20.0 ft
Total Effective Depth, d_E $d_E = (0.3) \times d_S + (0.4) \times 1 - (0.7/w_T) + 0.5$	d_E =	1.77 ft
Minimum Surface Area, A_m $A_M\,(ft^2) = \frac{V_{BMP}\,(ft^3)}{d_E\,(ft)}$	A_M =	2,169 ft²
Proposed Surface Area	A=	2,500 ft²

Bioretention Facility Properties

Side Slopes in Bioretention Facility	z =	4 :1
Diameter of Underdrain		6 inches
Longitudinal Slope of Site (3% maximum)		0.5 %
6" Check Dam Spacing		0 feet
Describe Vegetation:	Natural Grasses	

Bioretention Facility Typical Maintenance Schedule

Maintenance Activities	Suggested Frequency
• Keep adjacent landscape areas maintained. Remove clippings from landscape maintenance activities. • Remove trash & debris • Replace damaged grass and/or plants • Replace surface mulch layer as needed to maintain a 2-3 inch soil cover.	Ongoing
• Inspect areas for ponding	After storm events
• Inspect/ clean inlets and outlets	Annually

You Have Successfully Completed the SAR WQMP Training

- Questions may be asked via:
  - Contacting your NPDES Coordinator
  - Contacting Charlene Warren at RCFC & WCD
    - cwarren@rivco.org
  - Contacting the CASC presenter
    - mgentile@cascinc.com