Training

RIVERSIDE COUNTY
WATERSHED PROTECTION

Training for WQMP

Whitewater River Watershed

Prepared for: Whitewater River Watershed Permittees
Presented By: CASC Engineering and Consulting, Inc.

What You Will Learn

- Regulatory Framework of the MS4 Permit
- Definition of Priority Projects and Categories
- Definition of Best Management Practices (BMPs)
- Water Quality Management Plan (WQMP) Concepts
- Low Impact Development (LID)
- Difference Between Site Design Concepts and LID BMPs
- How to Design two LID BMPs

Course outline

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

Watershed Background

Whitewater River Watershed

Characteristics – Climate and Rainfall

- Evapotranspiration rate 71.6 inches/year
- Average Precipitation 3.6 inches/year
- No defined rainy season
- Short intense storms
  - Typically local
  - Rarely affect entire drainage network

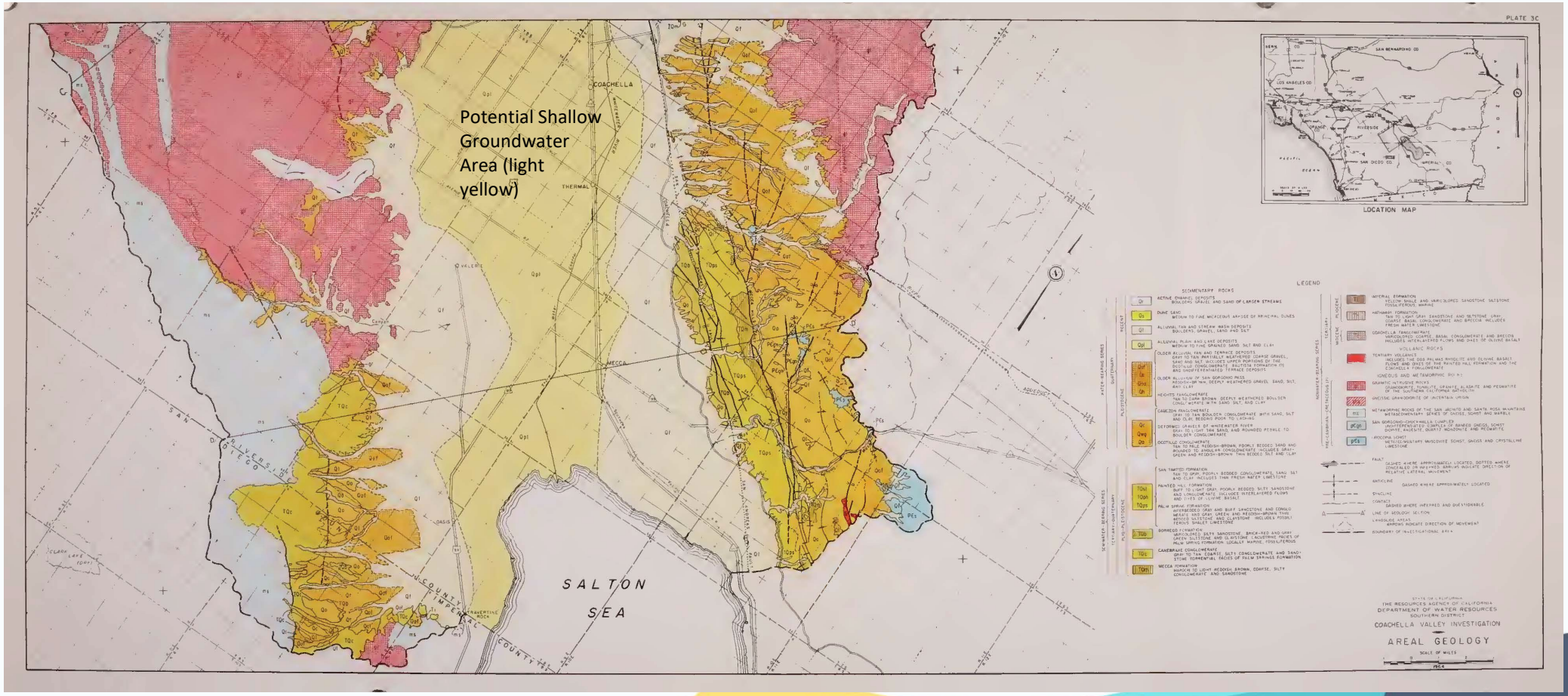
Whitewater River Watershed

Characteristics – Soils and Geology

- Predominate soil type: Carsitas and Myoma
  - Extremely pervious
- Southeast region
  - Shallow subterranean clay lens and groundwater depth

  (California Department of Water Resources, Coachella Valley Investigation, Bulletin 108, July 1964)
- Infiltration BMPs not suitable for entire watershed

Southeastern Watershed Area



Whitewater River Watershed

- Because of its unique characteristics, many permittees enacted retention requirements to mitigate flooding.
- Meeting these retention requirements meets NPDES Goals.

Regulatory Framework

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.

Regulatory Framework

- California Regional Water Quality Control Boards issue NPDES Permits.
- Region 7 Colorado River Regional Water Quality Control Board.
- The NPDES Permit CAS617002 (Order No. R7-2013-0011) regulates discharges from MS4s in the Whitewater River Watershed.

Regulatory Framework

Principal Permittees

- Riverside County
- Riverside County Flood Control and Water Conservation District

Co-Permittees

- Banning
- Cathedral City
- Coachella
- Coachella Valley Water District
- Desert Hot Springs
- Indian Wells
- Indio
- La Quinta
- Palm Desert
- Palm Springs
- Rancho Mirage

Enforcement Authorization

- NPDES CAS617002, Order No. R7-2013-0011, Section A, #63:

Permittees with land use authority authorize urbanization and land uses that may generate pollutants…therefore the Permittees can also exercise their legal authority to require implementation of BMPs to the MEP such that New Development/Redevelopment projects do not result in increases in Pollutant loads, and flows do not further degrade Receiving Waters.

Enforcement Tools and Procedures

- Land use authority allows permittees to require WQMPs and to enforce their implementation
- Whitewater River Region Stormwater Management Plan (SWMP)
- Prioritize violations
- Respond based on violation severity
- Retain records of enforcement actions
- Permittees are required to maintain an enforcement/compliance program

Illicit Connections & Illegal Discharge Detection

- Source identification
- Routine field screening
- MS4 inspections
- Quarterly dry weather IC/ID monitoring at select MS4 outfall sites

WQMP Concepts

Water Quality Lexicon

- 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

What is a WQMP?

- WQMP - Water Quality Management Plan.
- A Project WQMP is a plan for managing the quality of storm water or urban runoff that flows from a developed site after construction is completed and the facilities or structures are occupied and/or operational.
- A WQMP is required for Priority Development Projects.

Priority Development Projects

- Priority development projects (PDP) require a WQMP.
- MS4 permit lists seven categories.

Single-family hillside residence

- 10,000 square feet or more of impervious surface is created AND
  - The natural slope is 25% or more OR
  - The natural slope is 10% or more and erosive soil conditions are known

Industrial and Commercial

- Industrial and commercial developments of 100,000 square feet or more
- Examples include:
  - Recreational facilities
  - Mini-malls
  - Hotels
  - Office buildings
  - Warehouses
  - Light industrial facilities
  - Heavy industrial facilities

Automotive Repair Shops

- Based on Standard Industrial Classification Codes
  - 5013 - Motor Vehicle Supplies and New Parts
  - 7532 - Top, Body, Upholstery Repair Shops and Paint Shops
  - 7533 - Automotive Exhaust System Repair Shops
  - 7534 - Tire Retreading and Repair Shops
  - 7537 - Automotive Transmission Repair Shops
  - 7538 - General Automotive Repair Shops
  - 7539 - Automotive Repair Shops, NEC

Retail Gasoline Outlets

- Where project disturbs greater than 5,000 square feet
  - See Exhibit 6 - FAQ Q.18 of the WQMP Guidance Document for further guidance

Restaurants

- Where development disturbs greater than 5,000 square feet
  - See Exhibit 6 - FAQ Q.18 of the WQMP Guidance Document for further guidance

Home Subdivisions

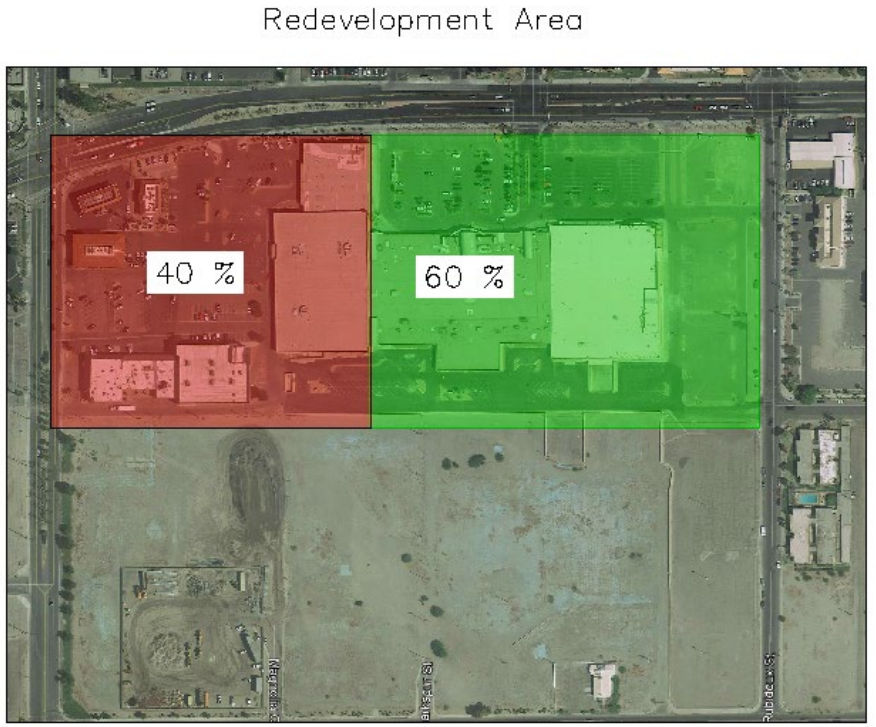
- Construction of 10 or more housing units
- Exam
  - Sin
  - Mul
  - Cor
  - Apa

Parking Lots

- Parking potentially exposed to urban runoff <u>AND</u>
  - 5,000 square feet or more <u>OR</u>
  - 25 or more spaces
  - See FAQs #12 and #21

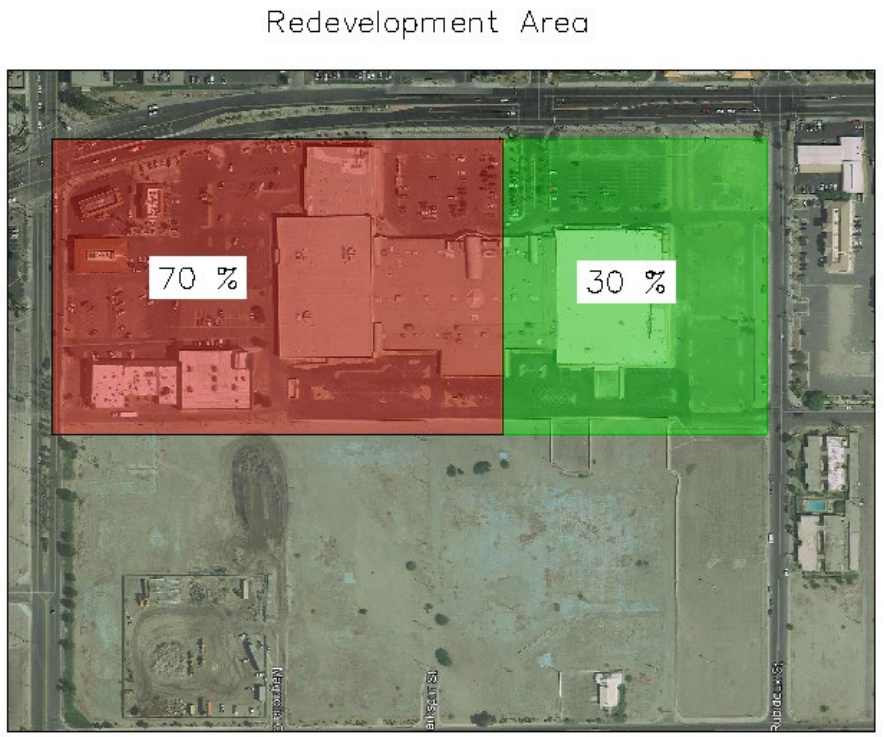
50% Rule for Redevelopment Projects

- 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)



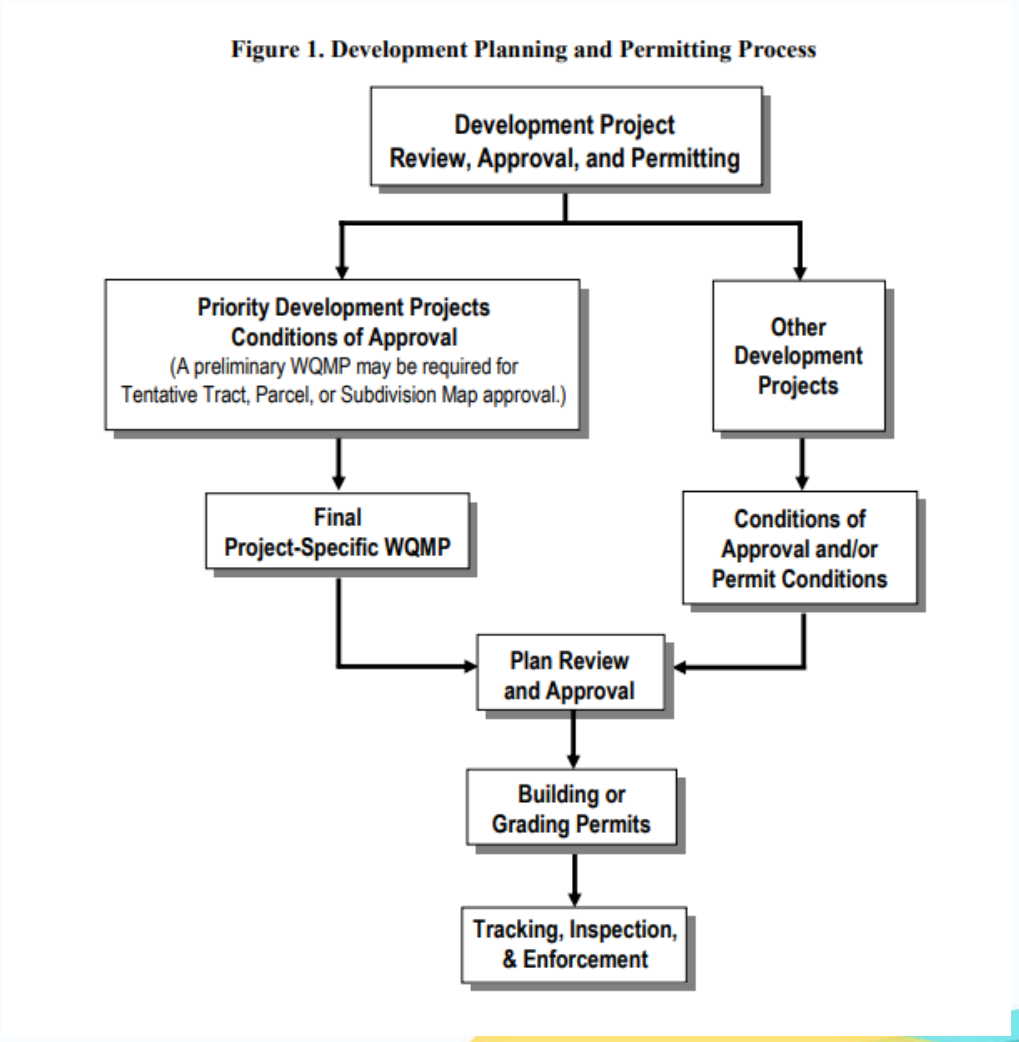
Does My Project Need a WQMP?

- 9,000 square foot residential development project
- 19,000 square foot residential development project
- 6,000 square foot parking lot
- Redevelopment project (7,500 square feet total) replacing 4,000 square feet of impervious surface

Other Development Projects

- Non-priority projects
  - Disturbed Area >= 1 acre
  - Disturbed Area < 1 acre but part of a larger common plan of development.
- Must incorporate Source Control BMPs

Planning Requirements



Project-Specific WQMP

A project-specific WQMP must:

- Be prepared and submitted during the project's review phase
- Identify potential impacts, if any, to downstream waterways caused by post-construction runoff from the project
- Identify Pollutants of Concern associated with the project
- Identify the parties responsible for long-term operation and maintenance activities of all post-construction BMPs
- Identify the funding source for post-construction BMP maintenance

What Info Will the Project-Specific WQMP Contain?

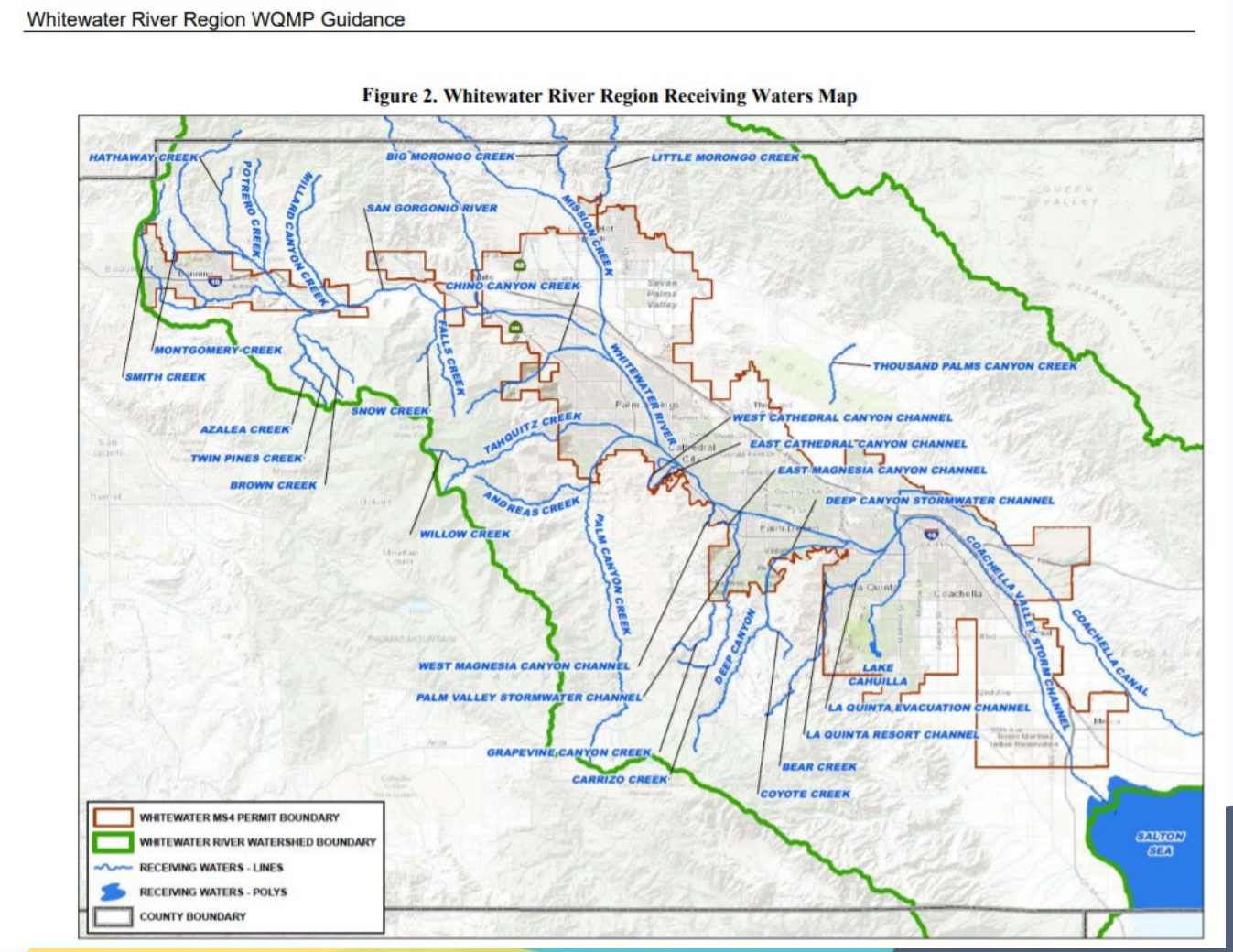
- Site Design BMP Concepts
- Source Control BMPs
- LID/Site Design BMPs
- Treatment Control BMPs
- BMP maintenance descriptions
- BMP funding description
- BMP operation responsibilities

WQMP Template

- If you project falls under the Priority Development Project category you are required to create a WQMP
- The 2014 (Revised January 2015) WQMP Template may be downloaded from:
  - http://rcflood.org/NPDES/WhitewaterWS.aspx

Receiving Waters Map

- Figure 2 in the Whitewater Guidance Document

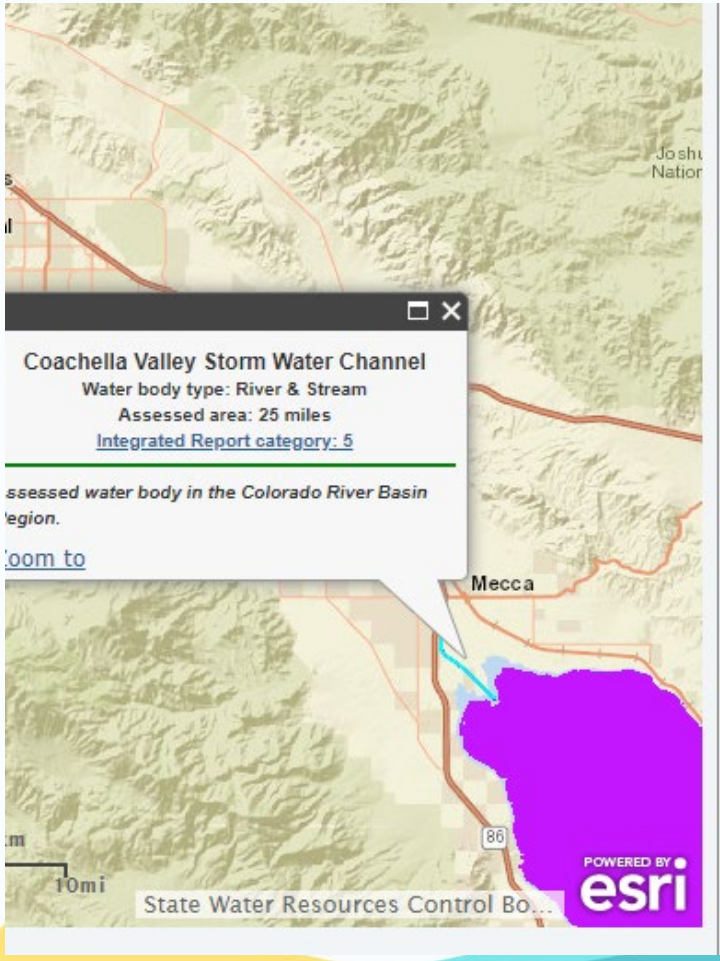


303(d) List

- 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



	Schedule / Comments
Nitrogen, ammonia (Total Ammonia)	List on 303(d) list (TMDL required list) 42942 n/a Est. TMDL completion: 2005
o,p'-DDD (Dichlorodiphenyldichloroethane)) | o,p'-DDE (Dichlorodiphenyldichloroethylene) | o,p'-DDT (Dichlorodiphenyltrichloroethane) | p,p'-DDMU	Do Not List on 303(d) list (TMDL required list) 43067 n/a
o-Dichlorobenzene	Do Not List on 303(d) list (TMDL required list) 44845 n/a
Oxychlordane | Perylene (Dibenz(de,kl)anthracene) | Phorate | Phosmet | Phosphamidon |	Do Not List on 303(d) list (TMDL required list) 43080

Pollutants of Concern

- Pollutant of Concern Summary Table
  - 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

Table 5. BMP Selection Matrix Based Upon Pollutant of Concern Removal Efficiency [1]

(Sources: Riverside County Flood Control & Water Conservation District Design Handbook for Low Impact Development Best Management Practices, dated September 2011, the Orange County Technical Guidance Document for Water Quality Management Plans, dated May 19, 2011, and the Caltrans Treatment BMP Technology Report, dated April 2010 and April 2008)

Pollutant of Concern	Landscape Swale[2, 3]	Landscape Strip[2, 3]	Biofiltration (with underdrain)[2, 3]	Extended Detention Basin[2]	Sand Filter Basin[2]	Infiltration Basin[2]	Infiltration Trench[2]	Permeable Pavement[2]	Bioretention (w/o underdrain)[2, 3]	Other BMPs Including Proprietary BMPs[4, 6]
Sediment & Turbidity	M	M	H	M	H	H	H	H	H	Varies by Product[5]
Nutrients	L/M	L/M	M	L/M	L/M	H	H	H	H	
Toxic Organic Compounds	M/H	M/H	M/H	L	L/M	H	H	H	H	
Trash & Debris	L	L	H	H	H	H	H	L	H	
Bacteria & Viruses (also: Pathogens)	L	M	H	L	M	H	H	H	H	
Oil & Grease	M	M	H	M	H	H	H	H	H	
Heavy Metals	M	M/H	M/H	L/M	M	H	H	H	H	

Abbreviations:
L: Low removal efficiency M: Medium removal efficiency H: High removal efficiency

Notes:
(1) Periodic performance assessment and updating of the guidance provided by this table may be necessary.
(2) Expected performance when designed accordance with the most current edition of the document, "Riverside County, Whitewater River Region Stormwater Quality Best Management Practice Design Handbook".
(3) Performance dependent upon design which includes implementation of thick vegetative cover. Local water conservation and/or landscaping requirements should be considered; approval is based on the discretion of the local land use authority.
(4) Includes proprietary stormwater treatment devices as listed in the CASQA Stormwater Best Management Practices Handbooks, other stormwater treatment BMPs not specifically listed in this WQMP (including proprietary filters, hydrodynamic separators, inserts, etc.), or newly developed/emerging stormwater treatment technologies.
(5) Expected performance should be based on evaluation of unit processes provided by BMP and available testing data. Approval is based on the discretion of the local land use authority.
(6) When used for primary treatment as opposed to pre-treatment, requires site-specific approval by the local land use authority.

Measurable Goal

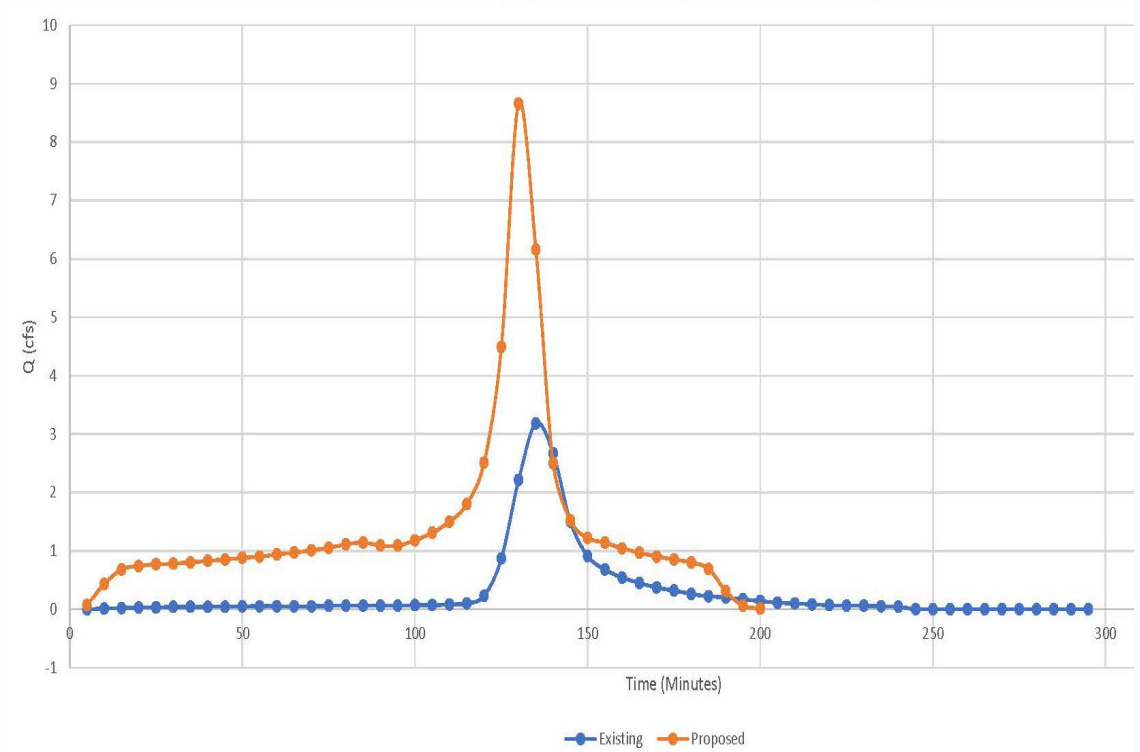
- The MS4 Permit requires the permittees to implement the per project measurable goal:
  - Address 100% of the WQMP Treatment Control BMP requirement through the implementation of Site Design/LID BMPs.

Measurable Goal Alternative

- Many Permittees have enacted ordinances that require the retention of urban runoff onsite.
- Projects which meet the local ordinance retention requirement are considered to have met the Measurable Goal.

Hydrologic Conditions of Concern

- Addition of impervious surfaces increases runoff volume and peak flow
- 2013 MS4 Permit requires that certain development projects minimize changes to hydrology



Hydrologic Conditions of Concern

- Reduce to less than pre-project condition:
  - Flow rates
  - Flow velocities
  - Flow durations
  - Flood volumes
- For these rainfall events:
  - 2-year, 24-hour storm
  - 10-year, 24-hour storm

Hydrologic Conditions of Concern

Exemptions

- Meet the Local Land Use Authority Retention Requirement
- Discharge directly to an engineered system
  - Publicly-owned, operated, and maintained
  - Storm drain or channel (MS4)
  - Meets requirements for discharge
  - Discharge would not significantly impact Receiving Waters
  - Authorized by local land use authority
- Disturb less than 1 acre

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 Record-keeping requirements

Low Impact Development

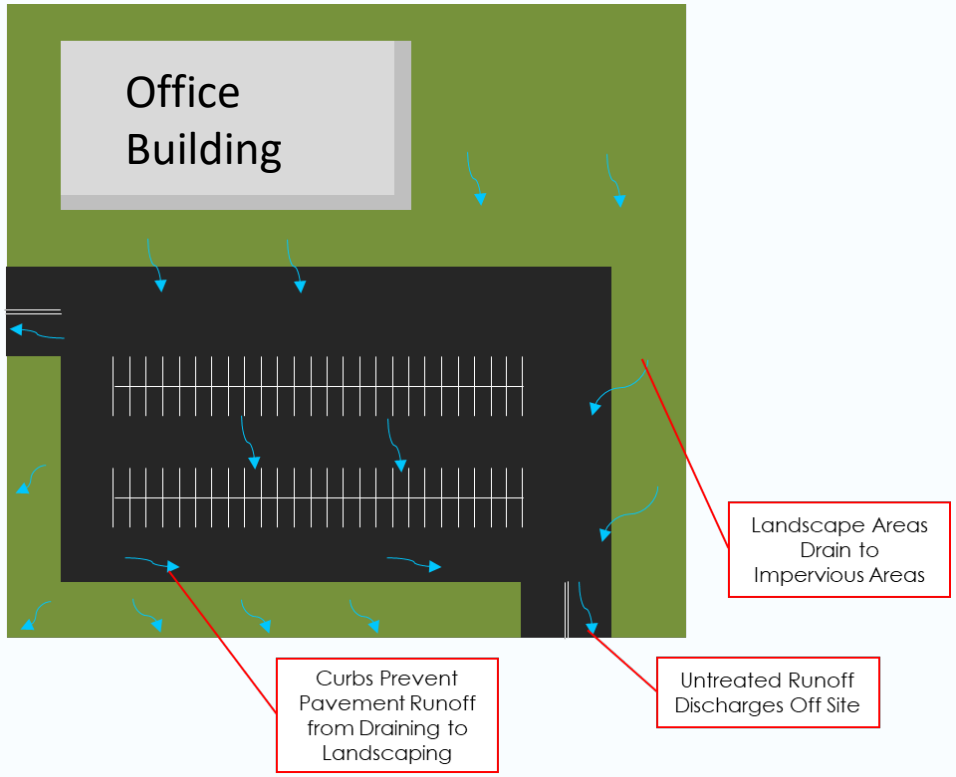
Benefits of LID

- LID – Low Impact Development
- Post-development hydrology approaches Pre development hydrology
- Reduces runoff pollutants

Comparison

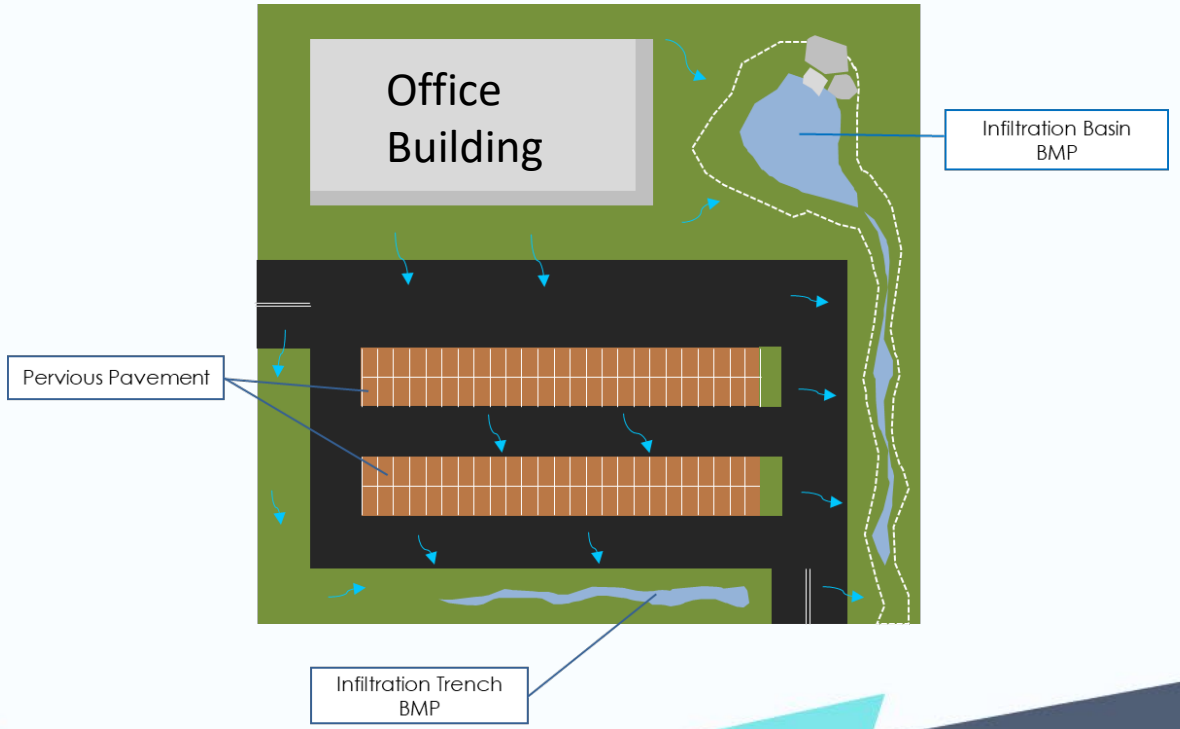
Traditional Design

Runoff directed offsite



Low Impact Design (LID)

Runoff retained onsite



Site Design/LID BMPs

- Site Design Concepts
- Source Control BMPs
- LID BMPs
- Projects which meet the local ordinance retention requirement are considered to have met the Measurable Goal

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

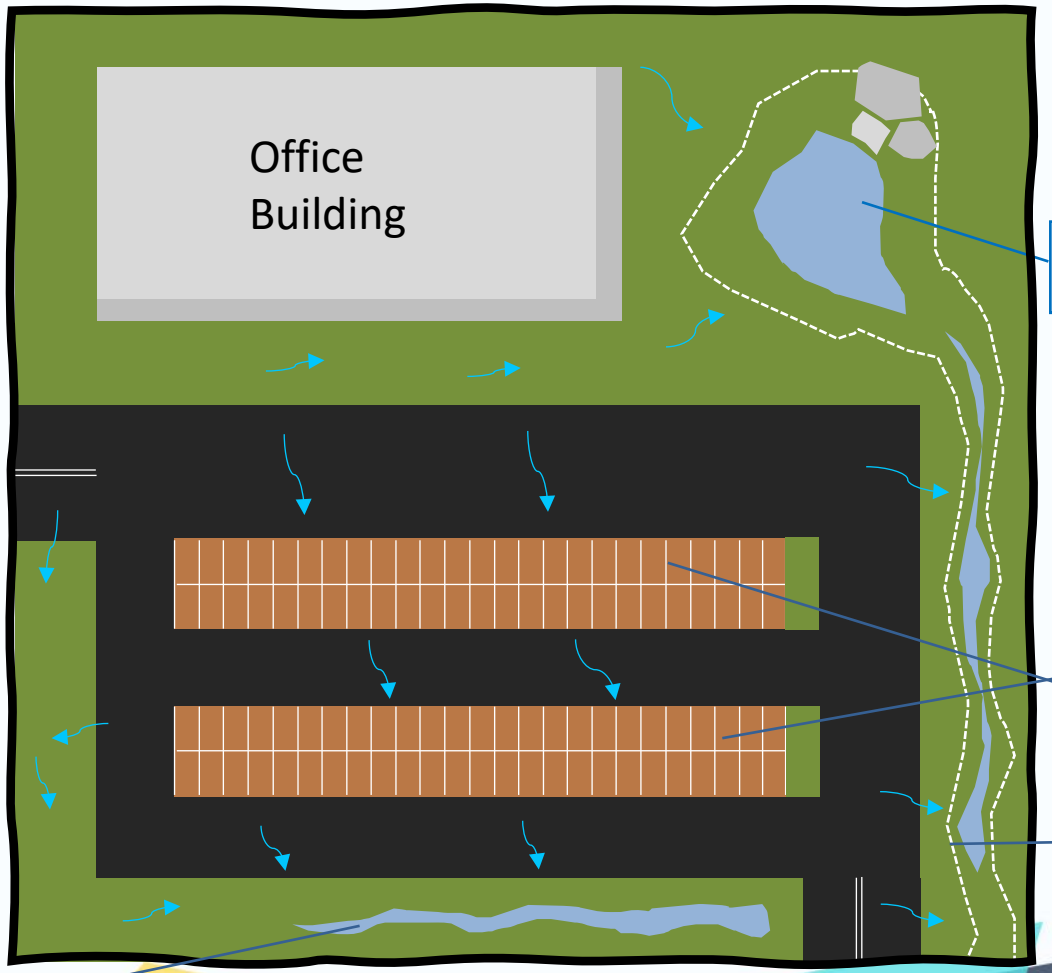
- Natural or Landscaped Area
- Drains directly offsite or to the storm drain system
- Runoff does not commingle with runoff from impervious areas

Self-Retaining Areas

- Retains design storm rainfall (0.40 inches) without producing any runoff
- 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

Low Impact Development

Area Treated by BMPs



Site Design Concepts

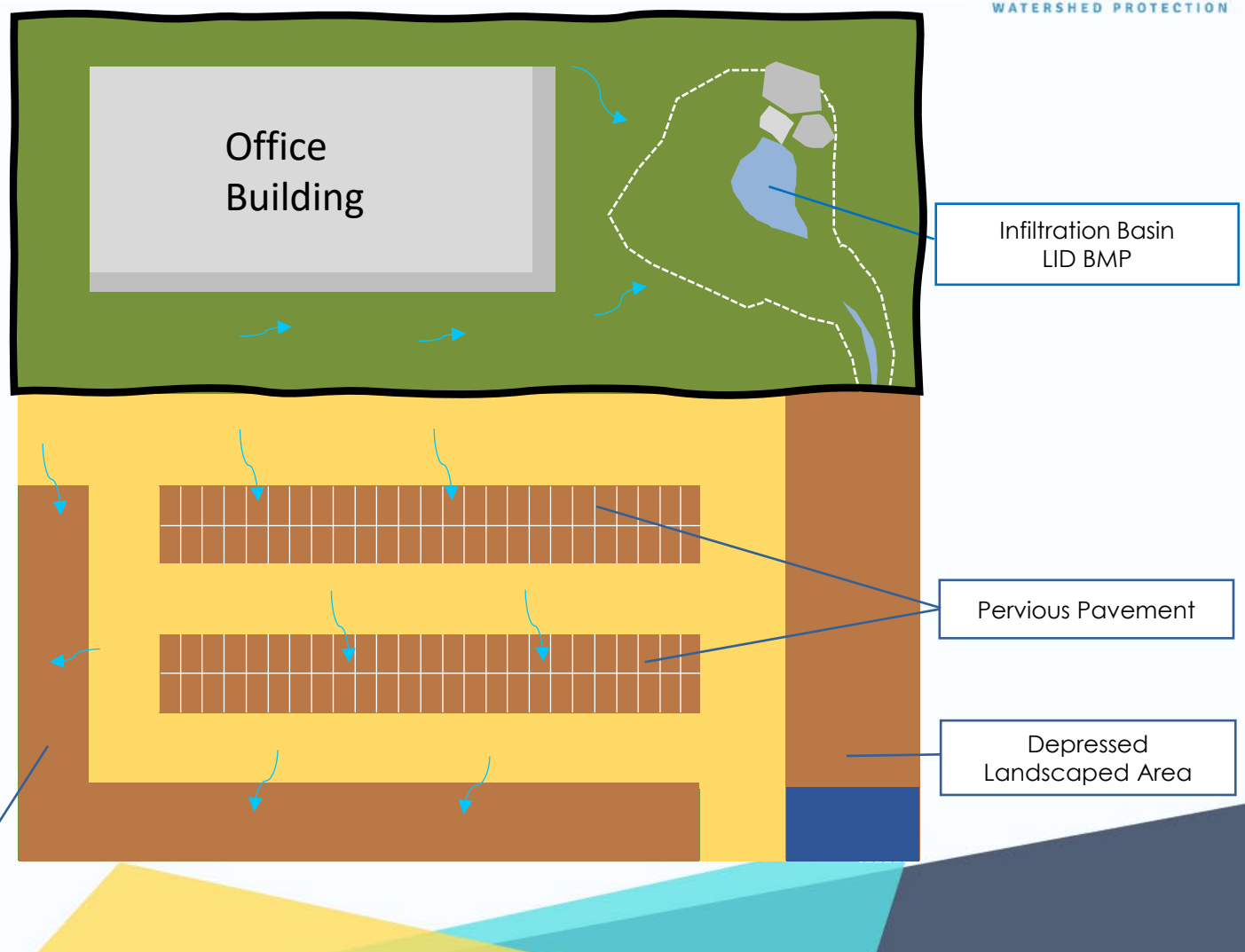
Using Site Design Concepts can reduce the size of LID BMPs

Area Treated by BMPs

Self-Treating Area

Self-Retaining Area

Area Draining to Self-Retaining Area



Source Control BMPs

- Required for all Priority Development Projects
- Include as applicable
- Non-Numeric
- Grouped as structural and non-structural

Source Control BMPs

Structural

- Education/Training
- Activity Restrictions
- Irrigation System and Landscape Maintenance
- Common Area Litter Control
- Street Sweeping
- Drainage Facility Inspection and Maintenance

Source Control BMPs

Non-Structural

- Storm drain inlet stenciling and signage
- Landscape and irrigation system design
- Protection of slopes and channels
- Proper design and maintenance of Specialized Areas
  - Fueling, Air/Water Supplies, Maintenance Bays
  - Loading Docks, Vehicle & Equipment Wash Areas
  - Outdoor Material Storage, Work, or Processing Areas
  - Trash Storage Areas

LID & Treatment Control BMPs

- Flow Based (Q_{BMP})
- Volume Based (V_{BMP})
- Details for sizing and design must comply with local land use authority

Table 7. Design Basis for LID/Site Design and Treatment Control BMPs

LID/Site Design or Treatment Control BMP	Design Basis
Landscaped Filter Strips	Q_{BMP}
Landscaped Swales	
Biofiltration (with underdrain)	V_{BMP}
Bioretention (w/o underdrain)	
Extended Detention Basin	
Sand Filter Basin	
Permeable Pavement	
Infiltration Basin	
Infiltration Trench	
Other BMPs	Q_{BMP} or V_{BMP} on case-specific basis, as approved by the local land use authority

What LID Category is This?

- Site Design and Landscape Planning
- Bioswale
- Media Filter
- Reducing Imperviousness
- Infiltration Basin

LID BMP Design Examples

Infiltration Basin

Infiltration Basin Example

- Flat earthen basin designed to capture the design capture volume (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

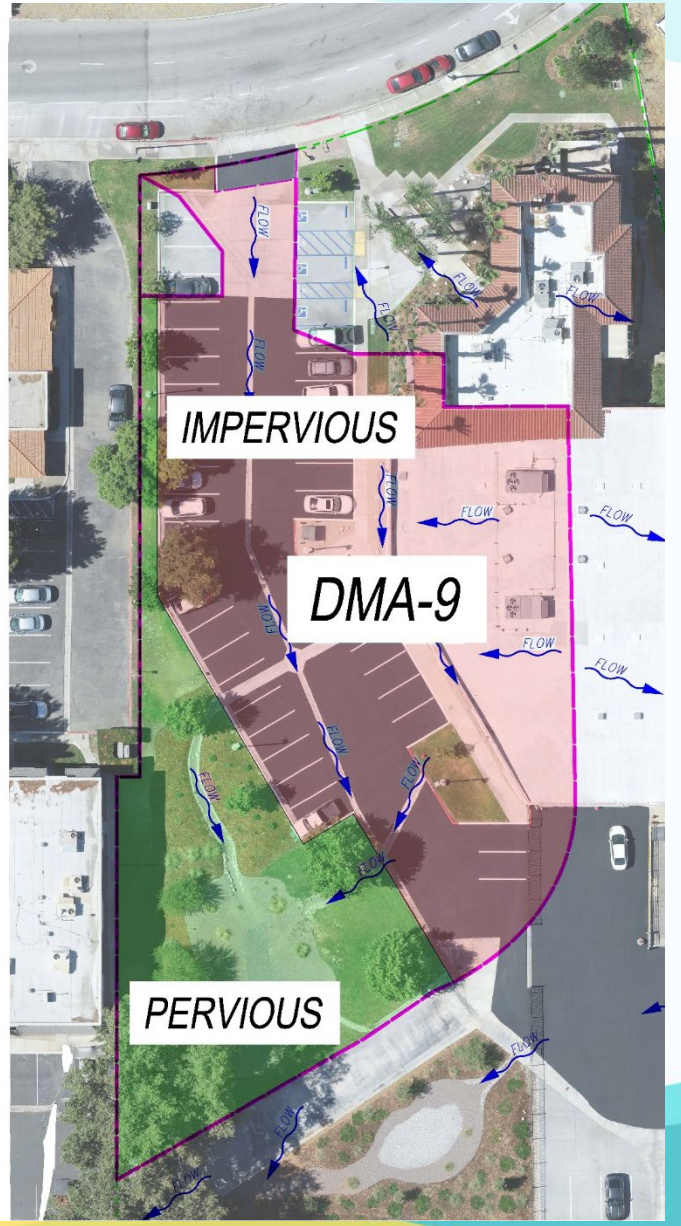
- Check Web Soil Survey
  - https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm
- Conduct Infiltration Testing per Appendix B of the Design Handbook
  - Type of Test
  - Number of Tests
- Compare results with minimums and maximums allowed for design by local agency

What Conditions are Necessary for Infiltration?

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

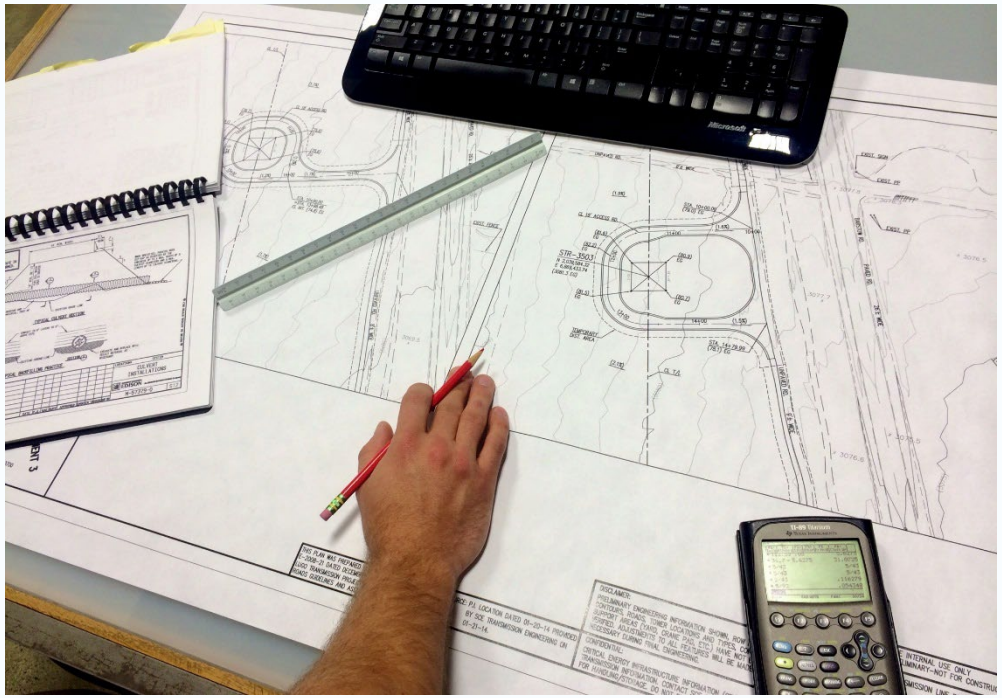
Example DMA Map

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



Design Capture Volume (V_{BMP})

Whitewater Watershed BMP Design Volume, V_{BMP} (Rev. 06-2014)		Legend:	Required Entries / Calculated Cells
Company Name	CASC Engineering & Consulting	Date	
Designed by		County/City Case No	
Company Project Number/Name	LID BMP Retrofit		
Drainage Area Number/Name	West infiltration Basin		
Enter the Area Tributary to this Feature (A_{TRIB})	A_{TRIB} = 0.541 acres		
Determine the Impervious Area Ratio			
Determine the Impervious Area within A_{TRIB} (A_{IMP})	A_{IMP} = 0.32 acres		
Calculate Impervious Area Ratio (I_f)	I_f = 0.59		
$I_f = A_{IMP}/A_{TRIB}$			
Calculate the composite Runoff Coefficient, C for the BMP Tributary Area			
Use the following equation based on the WEF/ASCE Method			
$C_{BMP} = 0.858I_f^3 - 0.78I_f^2 + 0.774I_f + 0.04$	C_{BMP} = 0.40		
Determine Design Storage Volume, V_{BMP}			
Calculate V_U, the 80% Unit Storage Volume $V_U = 0.40 \times C_{BMP}$	V_u = 0.16	(in*ac)/ac	
Calculate the design storage volume of the BMP, V_{BMP}.			
$V_{BMP}\ (ft^3) = \frac{V_U\ (in\text{-}ac/ac) \times A_T\ (ac) \times 43{,}560\ (ft^2/ac)}{12\ (in/ft)}$	V_{BMP} = 314	ft^3	
Notes:			



Infiltration Rate

- Infiltration rate must be determined from one of the approved Whitewater 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

Basin Design Depth

- 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>2.1 feet</u>

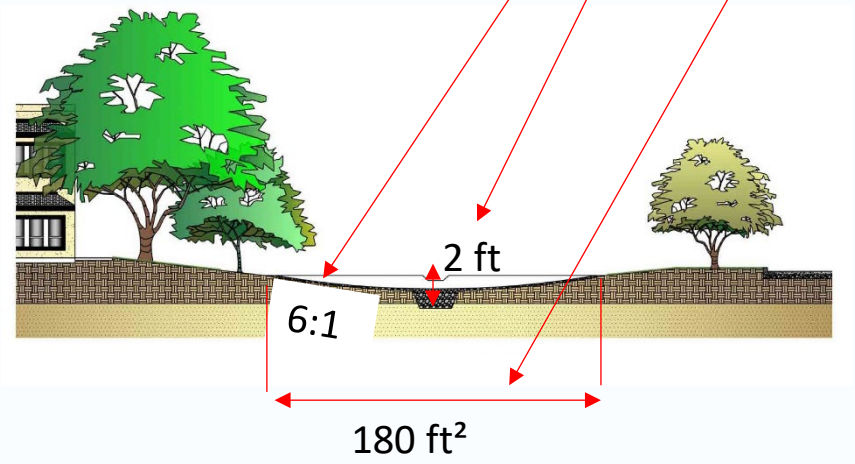
Infiltration Basin - Design Procedure (Rev. 06-2014)	BMP ID	Legend:	Required Entries / Calculated Cells
Company Name: CASC Engineering & Consulting			Date:
Designed by:			County/City Case No.:

Design Volume			
a) Tributary Drainage Area (BMP subarea)	A_{TRIB} =	0.541	acres
b) Enter V_{BMP} determined from Section 4.3 of this Handbook	V_{BMP} =	314	ft^3
Maximum Depth			
a) Infiltration rate	I =	1.6	in/hr
b) Factor of Safety (See Table 1, Appendix B: "Infiltration Testing" from this BMP Handbook)	FS =	3	
c) Calculate D_1 $D_1 = \frac{I\ (in/hr) \times 48\ hrs}{12\ (in/ft) \times FS}$	D_1 =	2.1	ft
d) Enter the depth of freeboard (at least 1 f		1	ft
e) Enter depth to historic high ground water (measured from **top** of		200	ft
f) Enter depth to top of bedrock or impermeable layer (measured from **top** of		200	ft
g) D_2 is the smaller of:			
Depth to groundwater - (10 ft + freeboard)	D_2 =	189.0	ft
Depth to impermeable layer - (5 ft +			
h) D_{MAX} is the smaller value of D_1 and D_2 but shall not exceed 5 feet	D_{MAX} =	2.1	ft

Basin Design Bottom Surface Area

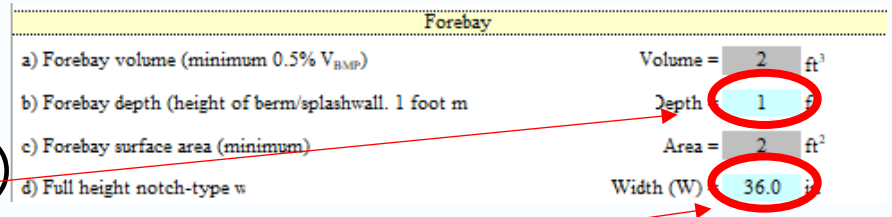
- Choose the basin side slopes (no steeper than 4:1)
  - 6:1
- Choose basin depth
  - 2 feet
- A minimum bottom surface area of the basin at 157 feet² is calculated
- Choose design surface area of the basin
  - 180 feet²

Basin Geometry		
a) Basin side slopes (no steeper than 4:1)	z = 6	:1
b) Proposed basin depth (excluding	d_B = 2	ft
c) Minimum bottom surface area of basin ($A_S = V_{BMP}/d_B$)	A_S = 157	ft²
d) Proposed Design Surface	A_S = 180	ft²



Basin Design 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 $feet^3$
- Forebay surface area is then calculated to be 2 $feet^2$



Infiltration Basin Final Design

Infiltration Basin - Design Procedure (Rev. 06-2014)	BMP ID	Legend:	Required Entries / Calculated Cells
Company Name: CASC Engineering & Consulting			Date:
Designed by:			County/City Case No.:

Design Volume			
a) Tributary Drainage Area (BMP subarea)	A_{TRIB} =	0.541	acres
b) Enter V_{BMP} determined from Section 4.3 of this Handbook	V_{BMP} =	314	ft^3
Maximum Depth			
a) Infiltration rate	I =	1.6	in/hr
b) Factor of Safety (See Table 1, Appendix B: "Infiltration Testing" from this BMP Handbook)	FS =	3	
c) Calculate D_1 $D_1 = \frac{I\ (in/hr) \times 48\ hrs}{12\ (in/ft) \times FS}$	D_1 =	2.1	ft
d) Enter the depth of freeboard (at least 1 f		1	ft
e) Enter depth to historic high ground water (measured from **top** of		200	ft
f) Enter depth to top of bedrock or impermeable layer (measured from **top** of		200	ft
g) D_2 is the smaller of:			
Depth to groundwater - (10 ft + freeboard)	D_2 =	189.0	ft
Depth to impermeable layer - (5 ft +			
h) D_{MAX} is the smaller value of D_1 and D_2 but shall not exceed 5 feet	D_{MAX} =	2.1	ft
Basin Geometry			
a) Basin side slopes (no steeper than 4:1)	z =	6	:1
b) Proposed basin depth (excluding	d_B =	2	ft
c) Minimum bottom surface area of basin ($A_S = V_{BMP}/d_B$)	A_S =	157	ft^2
d) Proposed Design Surface	A_D =	180	ft^2
Forebay			
a) Forebay volume (minimum 0.5% V_{BMP})	Volume =	2	ft^3
b) Forebay depth (height of berm/splashwall. 1 foot m	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
■ Factors responsible for clogging should be repaired immediately. ■ Weed once monthly during the first two growing seasons.	Post construction
■ Stabilize eroded banks. ■ Repair undercut and eroded areas at inflow and outflow structures. ■ Maintain access to the basin for regular maintenance activities. ■ Mow as appropriate for vegetative cover species. ■ Monitor health of vegetation and replace as necessary. ■ Control mosquitoes as necessary. ■ Remove litter and debris from infiltration basin area as required.	Standard maintenance (as needed)
■ Mow and remove grass clippings, litter, and debris. ■ Trim vegetation at the beginning and end of the wet season to prevent establishment of woody vegetation and for aesthetic and vector reasons. ■ Replant eroded or barren spots to prevent erosion and accumulation of sediment.	Semi-annual
■ Scrape bottom and remove sediment when accumulated sediment reduces original infiltration rate by 25-50%. Restore original cross-section and infiltration rate. Properly dispose of sediment. ■ Seed or sod to restore ground cover. ■ Disc or otherwise aerate bottom. ■ Dethatch basin bottom.	3-5 year maintenance

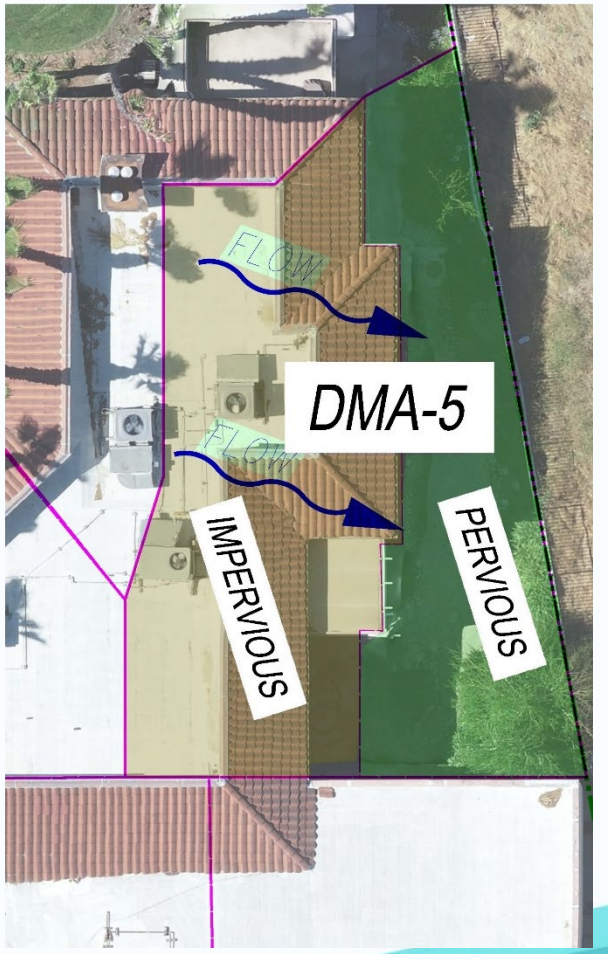
Infiltration Trench

Infiltration Trench Example

- Shallow excavated area that is filled with rock material to create a subsurface reservoir layer.
- The trench is sized to store the V_{BMP} in the void space between the rocks.
- Stormwater infiltrates through the bottom of the trench and into the surrounding soil.

Example DMA Map

- Focus on DMA-5
  - Total Area = 0.07 acres
  - Impervious Area = 0.04 acres



Design Capture Volume (V_{BMP})

Whitewater Watershed

BMP Design Volume, V_{BMP} (Rev. 06-2014)

Legend: Required Entries / Calculated Cells

Company Name	CASC Engineering & Consulting	Date	
Designed by		County/City Case No	
Company Project Number/Name	LID BMP Retrofit		
Drainage Area Number/Name	East Infiltration Trench		

Enter the Area Tributary to this Feature (A_{TRIB}) — A_{TRIB} = 0.07 acres

Determine the Impervious Area Ratio

Determine the Impervious Area within A_{TRIB} (A_{IMP}) — A_{IMP} = 0.04 acres

Calculate Impervious Area Ratio (I_f) — I_f = 0.57

$I_f = A_{IMP}/A_{TRIB}$

Calculate the composite Runoff Coefficient, C for the BMP Tributary Area

Use the following equation based on the WEF/ASCE Method

$C_{BMP} = 0.858I_f^3 - 0.78I_f^2 + 0.774I_f + 0.04$ — C_{BMP} = 0.39

Determine Design Storage Volume, V_{BMP}

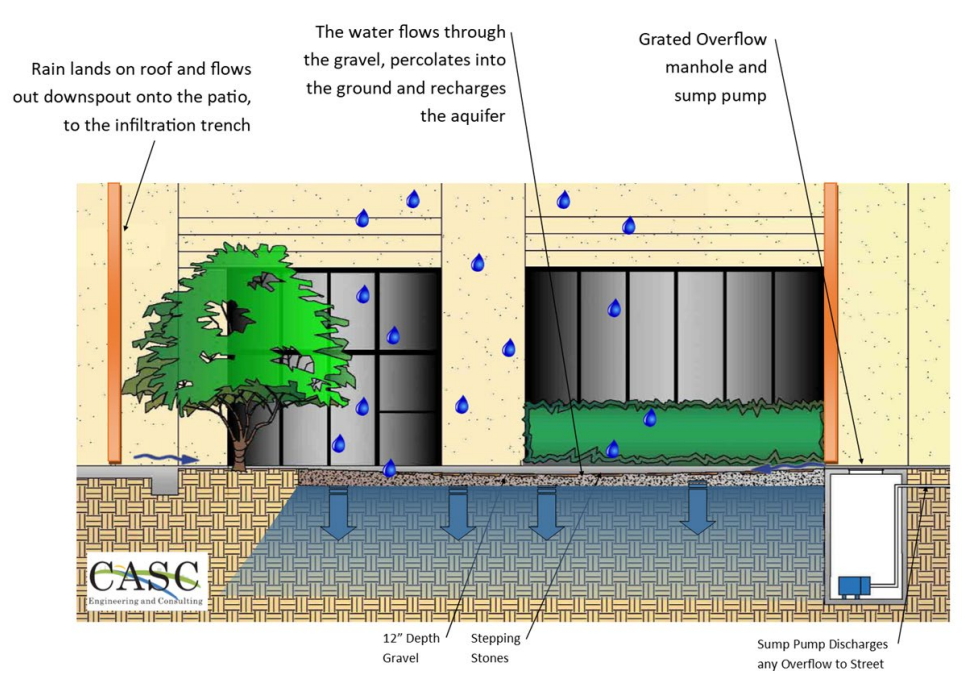
Calculate V_U, the 80% Unit Storage Volume $V_U = 0.40 \times C_{BMP}$ — V_u = 0.16 (in*ac)/ac

Calculate the design storage volume of the BMP, V_{BMP}.

$$V_{BMP}\ (ft^3) = \frac{V_U\ (in\text{-}ac/ac) \times A_T\ (ac) \times 43{,}560\ (ft^2/ac)}{12\ (in/ft)}$$

V_{BMP} = 41 ft^3

Notes:



Infiltration Rate

- Infiltration rate must be determined from one of the approved Whitewater Region methods.
- Geotech Report will usually give the infiltration fate & Factor of Safety.
- The same numbers from the previous example will be used
  - Infiltration rate (I) = 1.6 in./hr.
  - 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

Trench Design Depth

- The groundwater table and bedrock height is usually given in the Geotech Report
  - Groundwater table & bedrock = 200 feet
- D1 & D2 are then calculated
- D_{MAX} is the smaller value of D1 & D2
  - Max depth is <u>5.3 feet</u>

Infiltration Trench - Design Procedure (Rev. 06-2014)	BMP ID	Legend:	Required Entries / Calculated Cells
Company Name:	CASC Engineering & Consulting	Date:	
Designed by:		County/City Case No.:	

Design Volume

Enter the area tributary to this feature, Max = 10 acres	A_{TRIB} =	0	acres
Enter V_{BMP} determined from Section 4.3 of this Handbook	V_{BMP} =	41	ft^3

Calculate Maximum Depth of the Reservoir Layer

Enter Infiltration rate	I =	1.6	in/hr
Enter Factor of Safety, FS (unitless)	FS =	3	
Obtain from Table 1, Appendix B: "Infiltration Testing" of this BMP Handbook	n =	40	%
Calculate D_1. $D_1 = \frac{I\ (in/hr) \times 48\ hrs}{12\ (in/ft) \times (n/100) \times FS}$	D_1 =	5.33	ft
Enter depth to historic high groundwater mark (measured from finished grade)		200	ft
Enter depth to top of bedrock or impermeable layer (measured from finished grade)		200	ft
D_2 is the smaller of: Depth to groundwater - 11 ft; & Depth to impermeable layer - 6 ft	D_2 =	189.0	ft
D_{MAX} is the smaller value of D_1 and D_2, must be less than or equal to 8 feet.	D_{MAX} =	5.3	ft

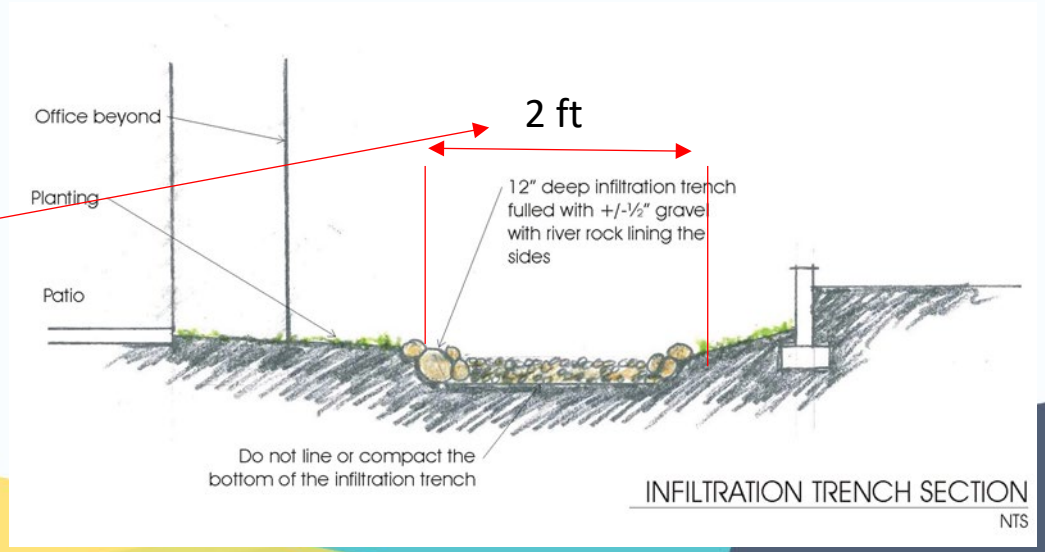
Trench Design Minimum Width

- Choose proposed reservoir layer depth
  - 1 foot was used
- Determine proposed design surface area
  - 602 feet² was used
- Minimum width of trench is calculated to be <u>2 feet</u>

Trench Sizing

Enter proposed reservoir layer depth D_R, must be $\leq D_{MAX}$	D_R = 1.00	ft
Calculate the design depth of water, d_W		
Design $d_W = (D_R) \times (n/100)$	Design d_W = 0.40	ft
Minimum Surface Area, A_S $A_S = \frac{V_{BMP}}{d_W}$	A_S = 103	ft^2
Proposed Design Surface Area	A_D = 602	ft^2
Minimum Width = D_R + 1 foot pea gravel	2.00	ft
Sediment Control Provided? (Use pulldown)	Yes	
Geotechnical report attached? (Use pulldown)	Yes	

If the trench has been designed correctly, there should be no error messages on the spreadsheet.



Infiltration Trench Final Design

Infiltration Trench - Design Procedure (Rev. 06-2014)	BMP ID	Legend:	Required Entries / Calculated Cells
Company Name:	CASC Engineering & Consulting	Date:	
Designed by:		County/City Case No.:	

Design Volume

Enter the area tributary to this feature, Max = 10 acres	A_{TRIB} =	0	acres
Enter V_{BMP} determined from Section 4.3 of this Handbook	V_{BMP} =	41	ft^3

Calculate Maximum Depth of the Reservoir Layer

Enter Infiltration rate	I =	1.6	in/hr
Enter Factor of Safety, FS (unitless)	FS =	3	
Obtain from Table 1, Appendix B: "Infiltration Testing" of this BMP Handbook	n =	40	%
Calculate D_1. $D_1 = \frac{I\ (in/hr) \times 48\ hrs}{12\ (in/ft) \times (n/100) \times FS}$	D_1 =	5.33	ft
Enter depth to historic high groundwater mark (measured from finished grade)		200	ft
Enter depth to top of bedrock or impermeable layer (measured from finished grade)		200	ft
D_2 is the smaller of: Depth to groundwater - 11 ft; & Depth to impermeable layer - 6 ft	D_2 =	189.0	ft
D_{MAX} is the smaller value of D_1 and D_2, must be less than or equal to 8 feet.	D_{MAX} =	5.3	ft

Trench Sizing

Enter proposed reservoir layer depth D_R, must be ≤ D_{MAX}	D_R =	1.00	ft
Calculate the design depth of water, d_W Design $d_W = (D_R) \times (n/100)$	Design d_W =	0.40	ft
Minimum Surface Area, A_S $A_S = \frac{V_{BMP}}{d_W}$	A_S =	103	ft^2
Proposed Design Surface Area	A_D =	602	ft^2
Minimum Width = D_R + 1 foot pea gravel		2.00	ft
Sediment Control Provided? (Use pulldown)		Yes	
Geotechnical report attached? (Use pulldown)		Yes	

If the trench has been designed correctly, there should be no error messages on the spreadsheet.

Infiltration Trench Typical Maintenance Schedule

Maintenance Activities	Suggested Frequency
■ Repair undercut and eroded areas at inflow and outflow structures. ■ Remove sediment, debris, and oil/grease from pretreatment devices and overflow structures.	Standard maintenance (as needed)
■ Remove trash, debris, grass clippings, trees, and other large vegetation from the trench perimeter and dispose of properly. ■ Mow and trim vegetation to prevent establishment of woody vegetation, and for aesthetic and vector reasons.	Semi-annual, more often as needed
■ Clean out sediment traps, forebays, inlet/outlet structures, overflow spillway, and trenches if necessary. ■ Remove grass clippings, leaves, and accumulated sediment from the surface of the trench. Replace first layer of aggregate and filter fabric if clogging appears only to be at the surface. ■ Clean trench when loss of infiltrative capacity is observed. If drawdown time is observed to have increased significantly over the design drawdown time, removal of sediment may be necessary. This is an expensive maintenance activity and the need for it can be minimized through prevention of upstream erosion.	Annual
■ If bypass capability is available, it may be possible to regain the infiltration rate in the short term by providing an extended dry period. ■ Seed or sod to restore ground cover.	5-year maintenance
■ Total rehabilitation of the trench should be conducted to maintain storage capacity within 2/3 of the design treatment volume and 72-hour exfiltration rate limit. ■ Trench walls should be excavated to expose clean soil. ■ All of the stone aggregate and filter fabric or media must be removed. Accumulated sediment should be stripped from the trench bottom. At this point the bottom may be scarified or tilled to help induce infiltration. New fabric and clean stone aggregate should be refilled.	Upon failure

YOU HAVE SUCESSFULLY COMPLETED THE WWR 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