

Low Impact Development

*Planning, Design, and Construction
for Compliance with
MRP Provision C.3*

**Dan Cloak, Principal
Dan Cloak Environmental Consulting
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Motivations



Compliance

- Mandate
- Client support
- Acceptance of costs
- Structure
- Schedule
- Accountability

Project Quality

- Enthusiasm
- Interest
- Energy
- Synergies
- Opportunities
- Elegance

Objectives for Today

- Bring you up to date on the ongoing evolution of C.3 requirements
- Provide a refresher on LID design for C.3 compliance
- Discuss common problems and issues with project design and identify workable solutions
- Share feedback

Time	Topic
12:45	Check In
1:00	Introductions
1:10	LID Principles and Objectives
1:25	C.3 Background and Update
1:45	LID Site Design and Bioretention Design—Conceptual Level
2:30	BREAK
2:40	Issues Frequently Discussed
3:30	BREAK
3:40	Bioretention Design Details
4:15	Construction of Bioretention Facilities
4:25	Operation and Maintenance of Bioretention Facilities
4:35	Topics for Future Workshops and Wrap Up
4:45	Adjourn

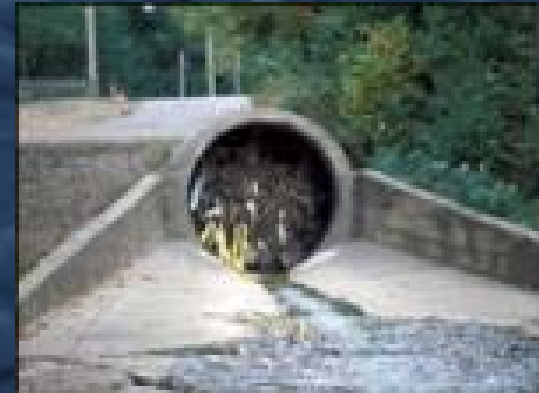


LID Planning, Design, and Construction

PRINCIPLES & OBJECTIVES

Conventional Urban Drainage

- Impervious surfaces: roofs and pavement
- Catch basins and piped drainage
- “Collect and convey” design objective



LID Design Objectives



Watershed and Stream Scale	Site scale
Reduce peak flows	Detain runoff on site
Increase time of concentration	Slow runoff from leaving site
No runoff from small storms	Infiltrate, evapotranspirate and reuse
Reduce duration of moderate flows	Let runoff seep away very slowly
Reduce runoff volume	Infiltrate and reuse where possible
Reduce runoff energy	Detain and slow flows
Increase groundwater storage and stream base flows	Facilitate infiltration
Reduce pollutants in runoff	Detain and filter runoff
Protect against spills and dumping	Disconnect drainage and filter runoff

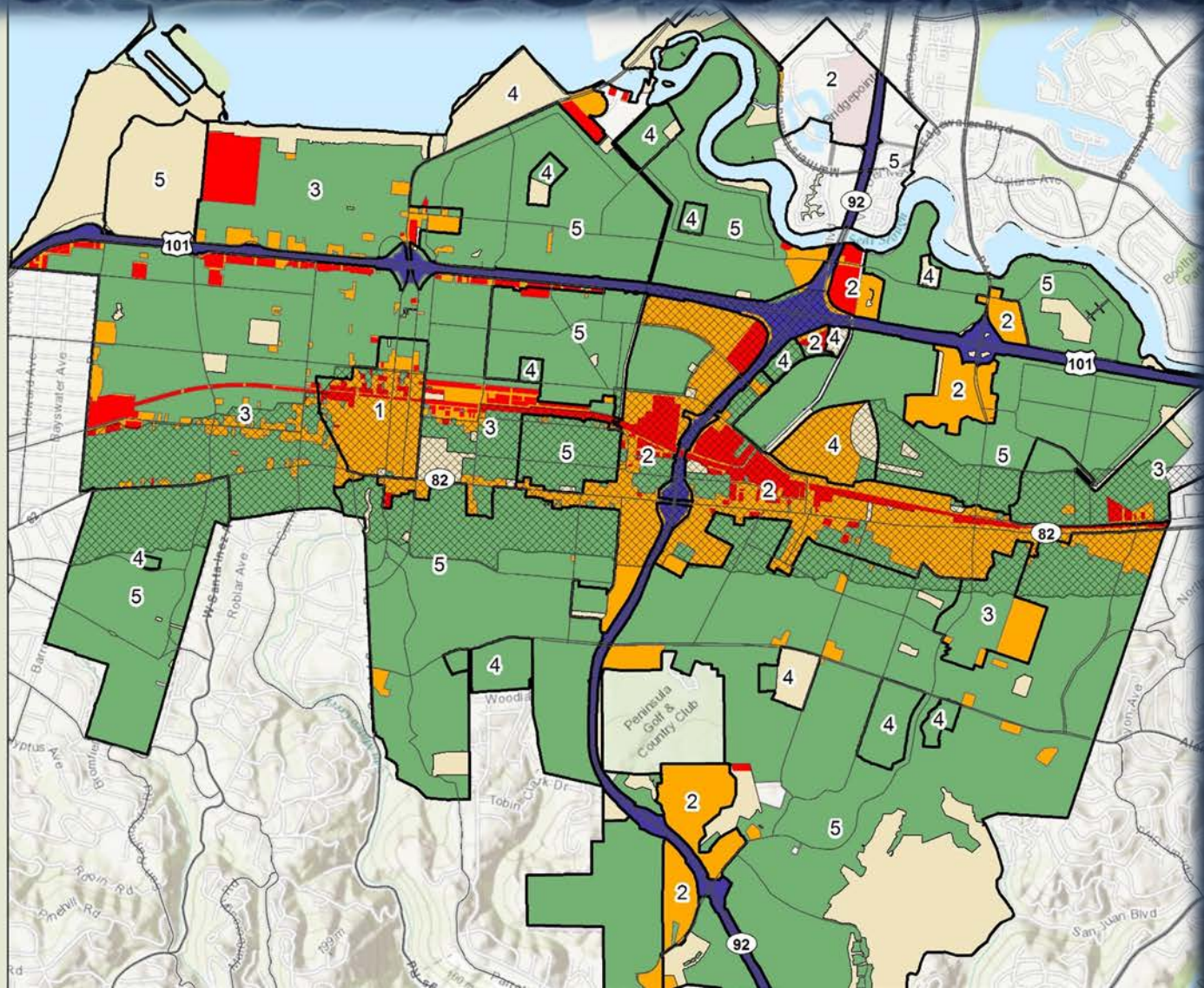
Green Infrastructure

City of San Mateo

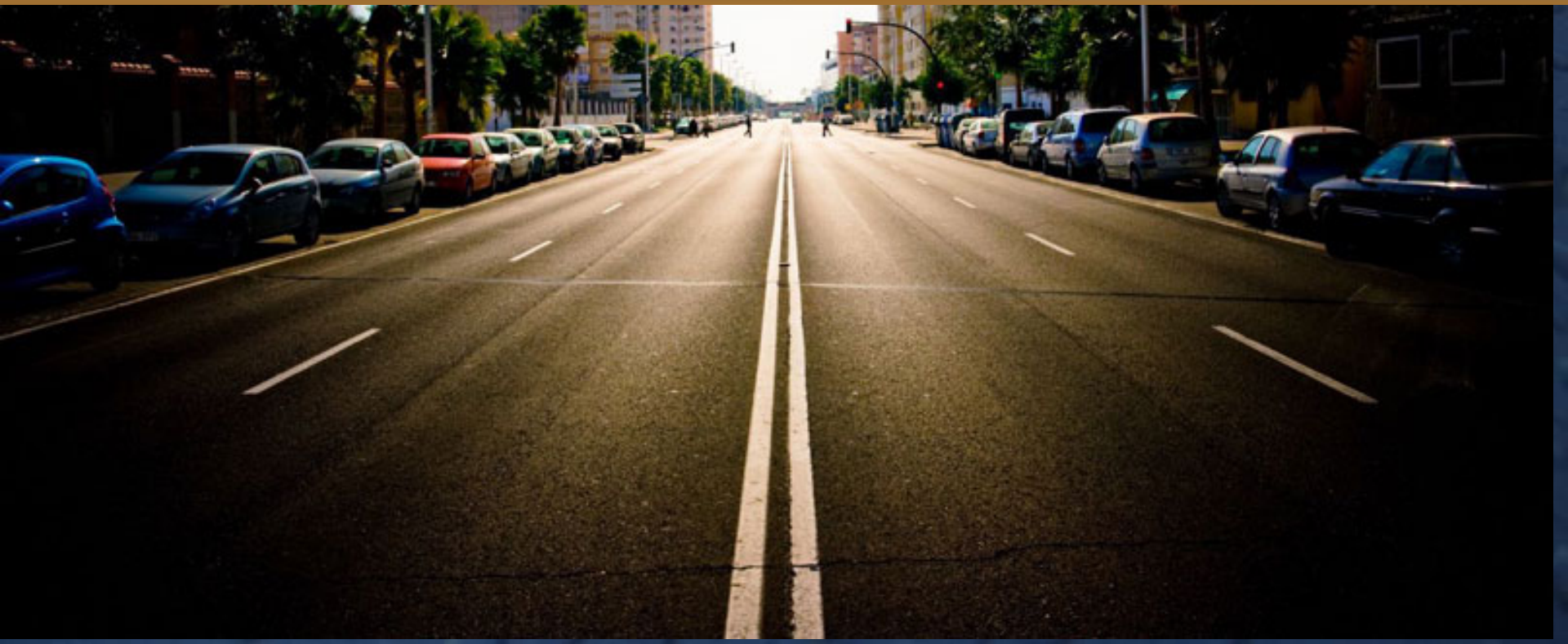
Urban Land Use Categories

-  Potential High Opportunity
-  Old Commercial/Retail
-  Old Residential/Schools/Colleges
-  Freeway
-  Open Space, Parks

-  Trash Management Areas
(1 Highest Priority, 5 Lowest Priority)
-  Planned Priority Development Area



Public ROW and Drainage



LID Planning, Design, and Construction

C.3 BACKGROUND & UPDATE

C.3 Regulatory History

- 1987** Congress adds Section 402(p) to Clean Water Act
- 1990** USEPA regulations require states to issue stormwater NPDES permits to large municipalities
- 1990** Regional Water Board issues first Bay Area stormwater NPDES permits
- 2000** State Water Resources Control Board “Bellflower decision” confirms municipalities must require new developments to treat runoff

C.3 Regulatory History

- 2003** Regional Water Board adds Provision C.3 to stormwater permit for Contra Costa municipalities
- 2005** C.3 implementation begins for projects creating or replacing an acre or more of impervious area
- 2006** Water Board adopts Contra Costa's Hydrograph Modification Management Plan and requirements take effect. C.3 threshold for treatment requirements drops from one acre to 10,000 square feet of impervious area

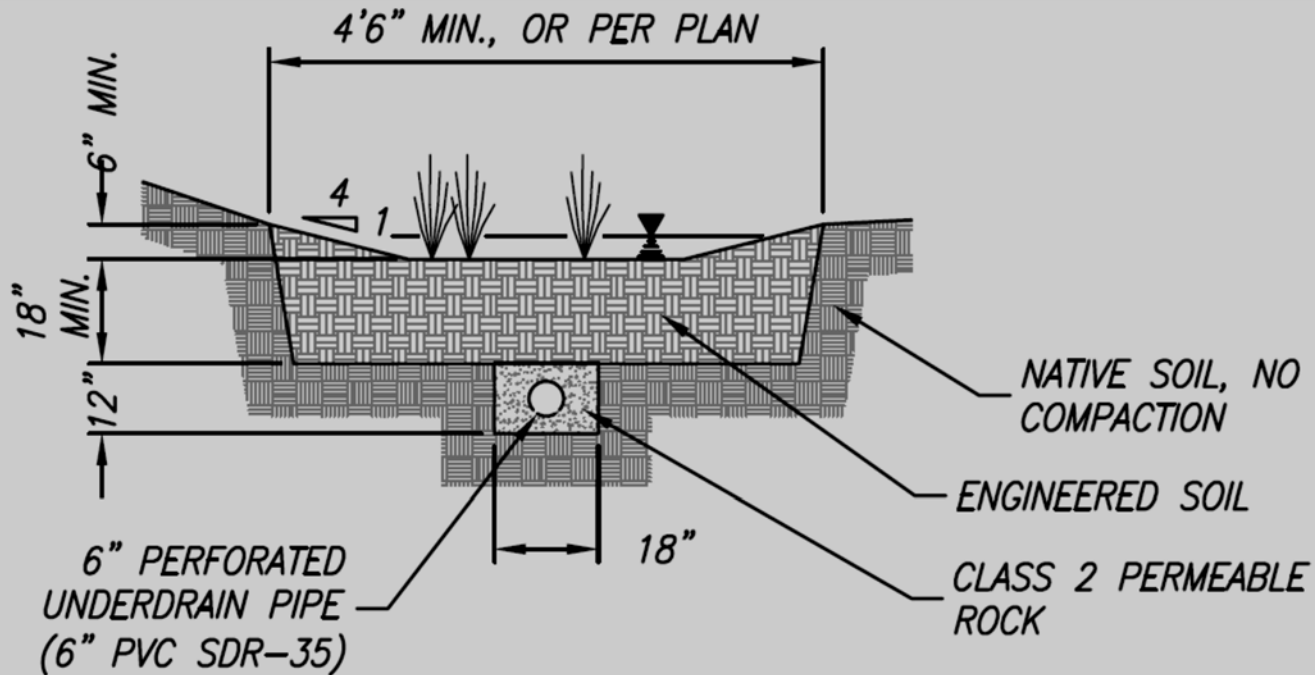
C.3 Regulatory History

- 2009** Municipal Regional Permit adopted, including LID requirements. Threshold for some land uses lowered to 5,000 SF of impervious area. Contra Costa develops current HMP sizing factors and calculator.
- 2011** MRP amended, including “Special Projects” categories. LID requirements take effect, including feasibility tests for infiltration and harvesting/reuse.
- 2013** Municipal permittees assessed implementation of feasibility tests and recommended allowing bioretention as a first choice for LID treatment.

Where Are We Now?

- LID treatment is required
 - Runoff may be reduced or dispersed as detailed in the *Stormwater C.3 Guidebook*
 - Bioretention is LID and may be used without a feasibility test
- Bioretention facilities must meet specific design criteria
 - 12" gravel storage layer underneath entire area, with underdrain at the top
- Vault-based filters or tree-well-type biofilters may be used only on "Special Projects,"
 - Only for a portion of impervious area (table of "credits" on p. 60)
 - Document infeasibility of 100% bioretention
- Hydromodification Management requirements apply to projects with ≥ 1 acre impervious area created/replaced

Outdated

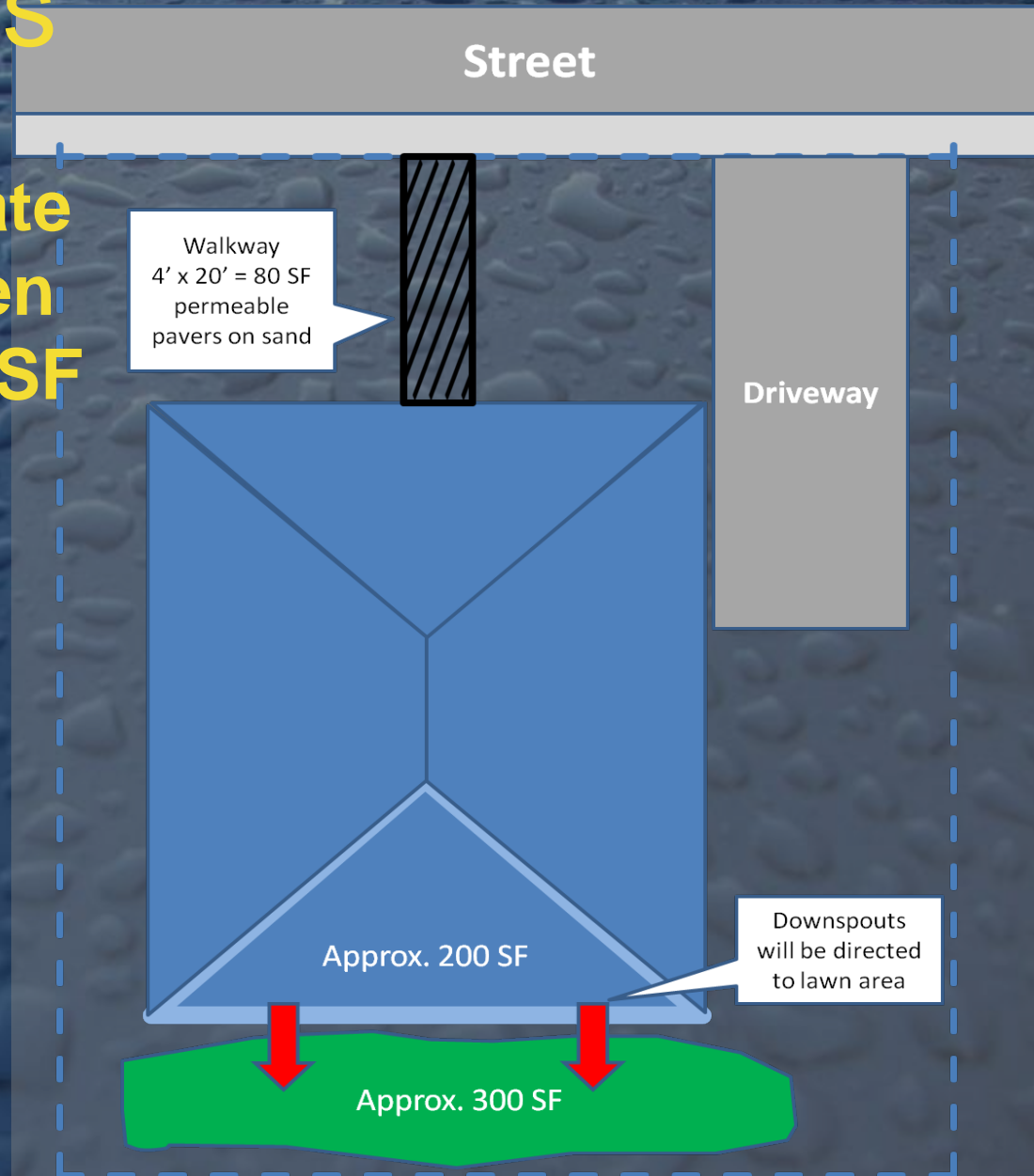


BIORETENTION FILTER

NOT TO SCALE

Small Projects

- Projects that create or replace between 2,500 and 10,000 SF of impervious surface
- Effective Dec. 1, 2012
- Use template on CCCWP website



What's Coming in MRP 2.0?

- Focus on design standards for LID
 - Bioretention
 - Pervious Pavement
- Updated hydromodification criteria
 - New sizing factors for facilities
 - Updated sizing calculator
- Focus on operation and maintenance
- Simplification and streamlining(?)

LID Planning, Design, and Construction

LID CONCEPTUAL DESIGN AND DOCUMENTATION

LID Design Process

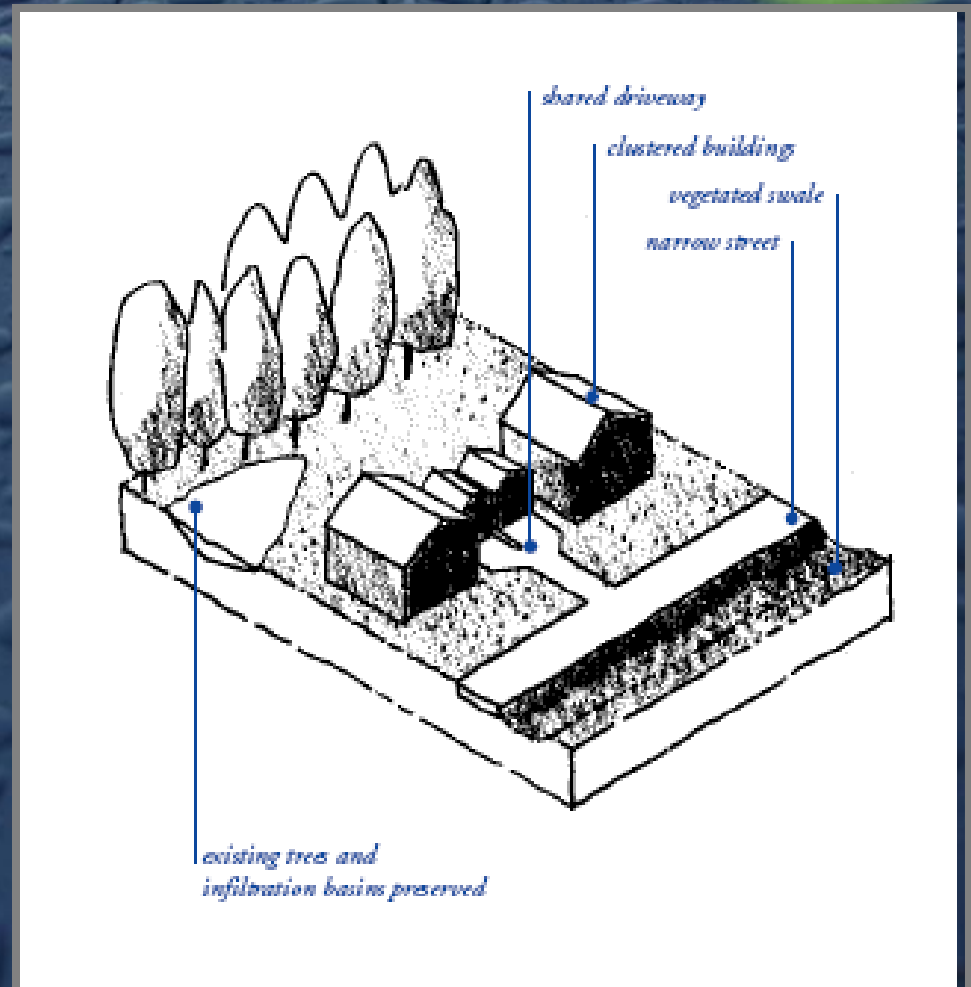


Analyze Your Project for LID

- Optimize the site layout
- Use pervious surfaces
- Disperse runoff
- Store runoff and use it later
- Drain to bioretention or other facilities to retain, treat, and control flows

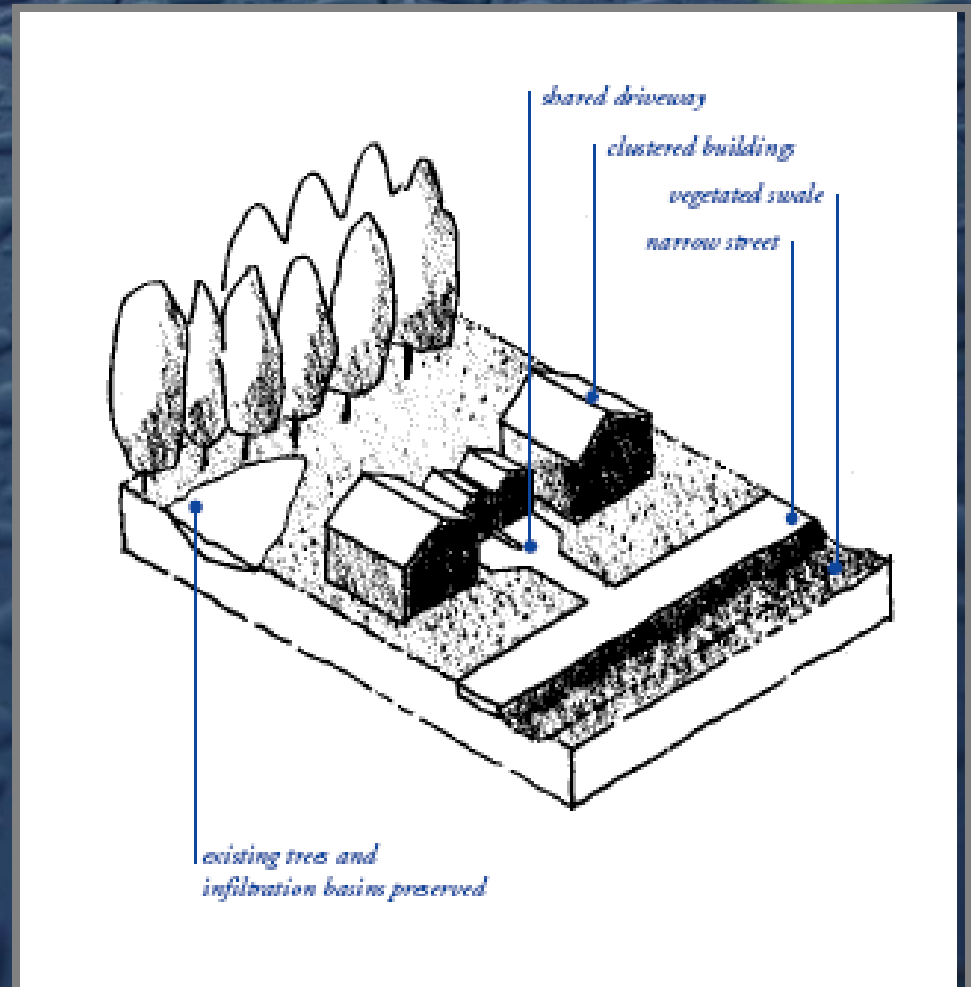
Optimize the Site Layout

- Define the development envelope
- Minimize grading
- Set back from creeks, wetlands, and riparian areas
- Preserve significant trees



Optimize the Site Layout

- Limit roofs and paving
- Preserve and use permeable soils
- Detain and retain runoff throughout the site
- Use drainage as a design element



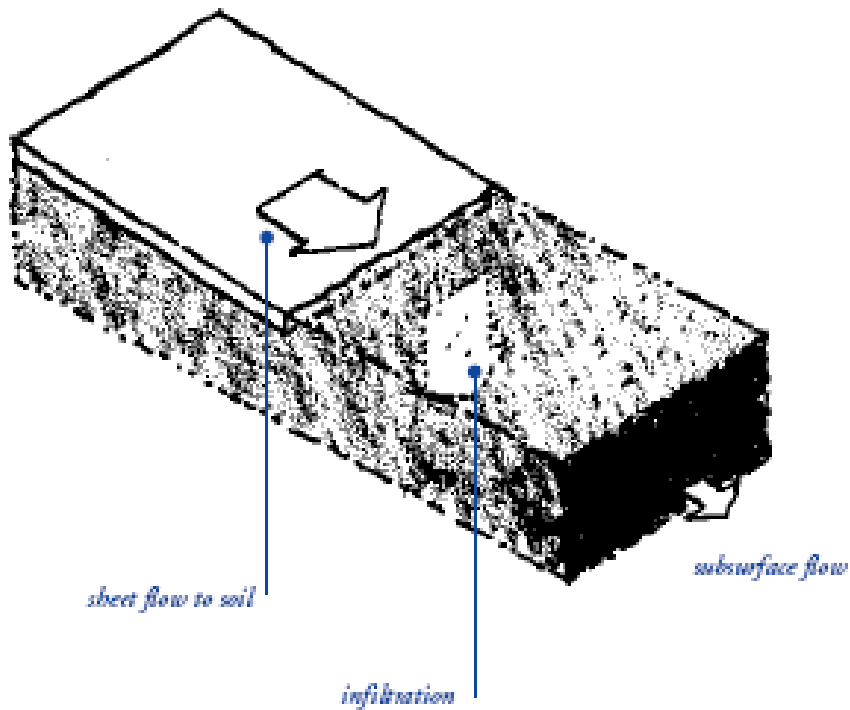
Use Pervious Surfaces

- Permeable pavements



- Green roofs

Disperse Runoff



Harvesting and Use

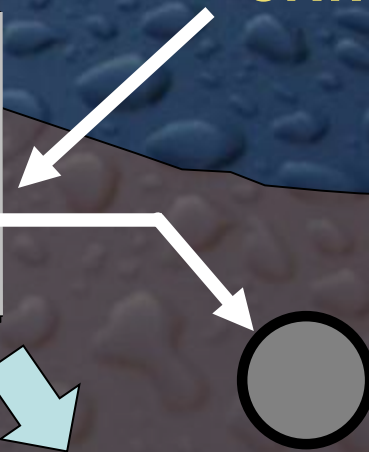


Bioretention

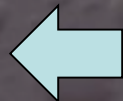
evapotranspiration



flow control
orifice



losses



infiltration

Discharge
(biotreatment)



Bioretention Advantages

- Filtration and pollutant sequestration
- Biological processing and renewal
- No mosquito problems
- Mimic natural hydrology
- Attractive landscape amenity
- Potential use as park or playground
- Low maintenance
- Easy to inspect

Category	Impervious Area	Project Characteristics	Criteria (Acres refers to total site acreage)	LID Credit	Comments
A Lot Line to Lot Line	$X \leq \frac{1}{2} \text{ Ac}$	Urban/Pedestrian design ¹ in Business/Downtown Districts ²	No density criterion	100%	Zero surface parking ³ ≥ 85% Site Coverage ⁴
B High Density	$\frac{1}{2} \text{ Ac} \leq X \leq 2 \text{ Ac}$	Urban/Pedestrian design* in Business/Downtown Districts	Floor Area Ratio (FAR) ≥ 2:1; OR for Residential (Res) projects, ≥ 50 Dwelling Units (DU)/Acre	50%	Zero surface parking ³
			FAR ≥ 3:1; OR Res ≥ 75 DU/Acre	75%	
			FAR ≥ 4:1; OR Res ≥ 100 DU/Acre	100%	
C Transit Oriented	No limit	TOD characteristics Non-auto-use project FAR ≥ 2:1 OR Res ≥ 25 DU/Ac	<i>Location Credits (count only one)</i>		
			within ¼ mi of transit hub ⁵	50%	50%+ of site w/in distance
			within ½ mi of transit hub	25%	
			within a Priority Development Area	25%	100% of site w/in PDA
			<i>Density/FAR Credits</i>		
			FAR ≥ 2:1; OR Res ≥ 30 DU/Acre	10%	
			FAR ≥ 4:1; OR Res ≥ 60 DU/Acre	20%	
			FAR ≥ 6:1; OR Res ≥ 100 DU/Acre	30%	
			<i>Minimized Parking Credits</i>		
			≤ 10% at-grade surface parking	10%	Surface parking uses LID
Zero surface parking ³	20%				

Special Projects - Criteria

- Tree-box-type biofilters
 - 50 inches per hour surface loading rate
 - Minimum 3.5 feet depth
 - Supports a healthy tree or other vegetation
- Vault-based media filters
 - Surface loading rate of 1 gpm/ft²
 - Orifice to control flow to cartridges



Special Projects - Feasibility

- Reporting requirement to assess the feasibility of using 100% LID
- Conditions for bioretention feasibility on Special Projects:
 - Level area free of structures and utilities
 - Large enough and suitable for landscaping
 - Surface drainage or other route for runoff to reach the facility
 - Connection from underdrain with sufficient head
- Feasibility of offsite treatment
 - Project proponent owns or controls suitable site, or
 - Publicly operated mitigation program



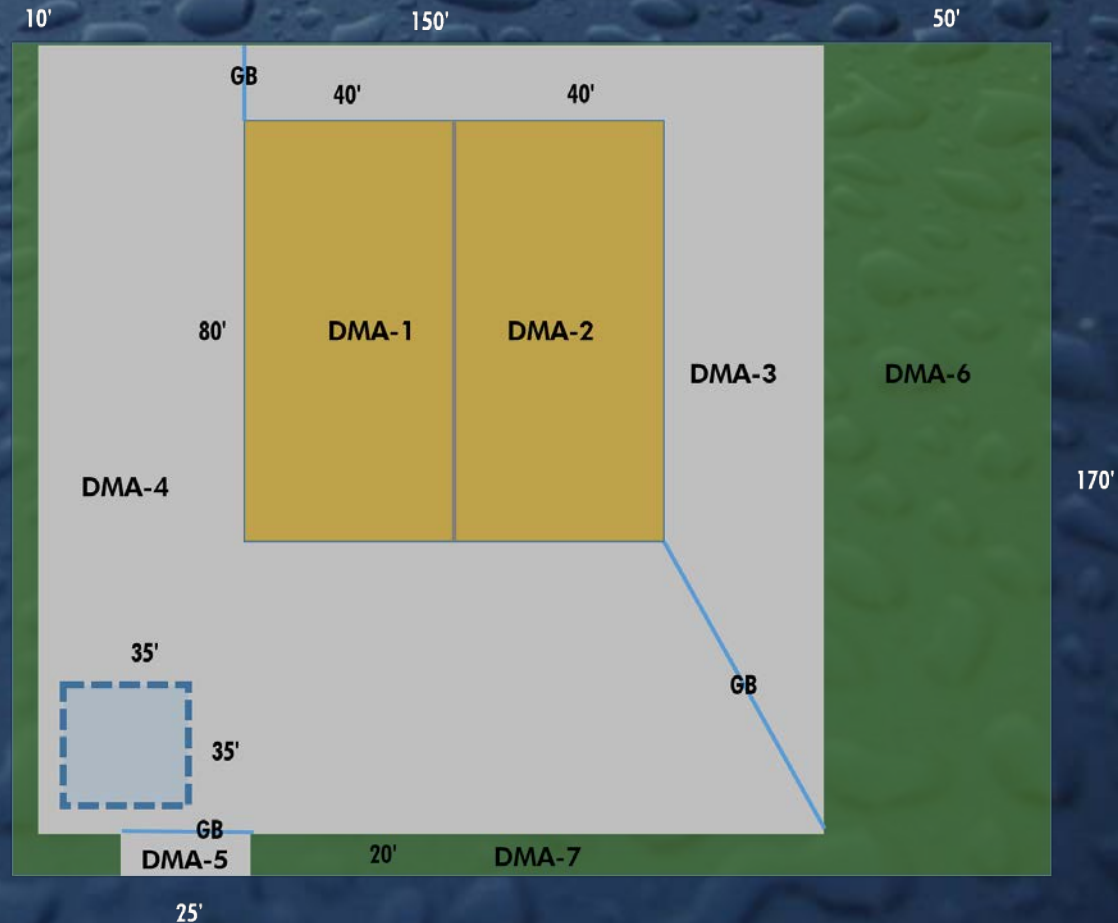
**DEVELOPING AND
DOCUMENTING A LID DESIGN**

LID Design Process



Drainage Management Areas

- Follow roof ridges and grade breaks
- Different DMA for each surface type



DMA Types

■ Pervious DMAs

- Self-treating
- Self-retaining

■ Impervious DMAs

- Drains to self-retaining
 - Max 2:1 ratio impervious:pervious
- Drains to LID facility

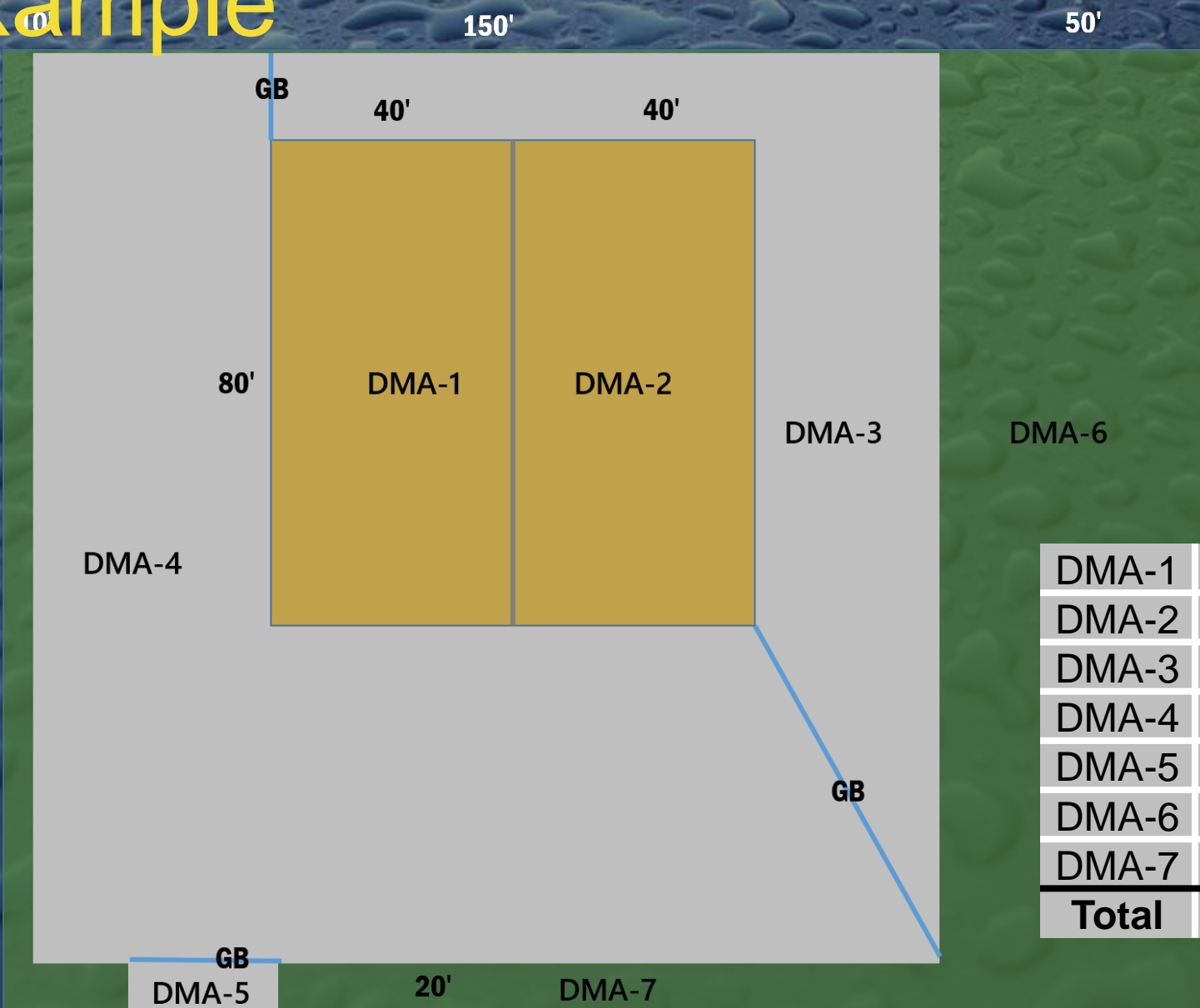
Use a curb to avoid run-on from self-treating areas



Grade self-retaining areas to drain inward. Set any area drains to pond 3"-4"



Example



DMA-1	3200
DMA-2	3200
DMA-3	3700
DMA-4	12400
DMA-5	500
DMA-6	8500
DMA-7	4200
Total	35700

Sizing

DMA Name	DMA Area (SF)	Post-project surface type	DMA Runoff factor	DMA Area × runoff factor	Facility Name		
					Facility Sizing factor	Minimum Facility Size	Proposed Facility Size
DMA-1	3200	Roof	1.0	3200	0.04	752	900
DMA-2	3200	Roof	1.0	3200			
DMA-4	12400	Paved	1.0	12400			
Total>				18800			



DMA-1	3200
DMA-2	3200
DMA-3	3700
DMA-4	12400
DMA-5	500
DMA-6	8500
DMA-7	4200
Total	35700

Sizing Calculator

Integrated Management Practice Calculator [Example Project.xml]

File Tools Help

Project Information

All the project information is required. Please fill in all of the information before editing the DMAs and IMPs.

Project Name:

Location:

APN:

Total Area: sq ft Mean Annual Precip: in

Design Goal

Treatment Plus Flow Control

Treatment Only

Drainage Management Areas (DMAs) Integrated Management Practices (IMPs) Calculation Warnings(0) Summary Report

DMA1 DMA2 DMA3 DMA4 DMA5 DMA6 DMA7 DMA8

DMA Type: IMP: NOTE: The DMA can

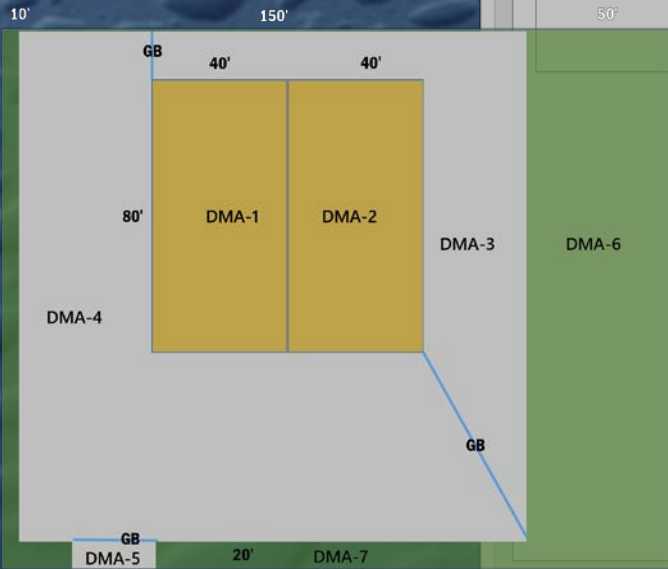
Drainage Area (sq. ft.): Drains to DMA:

NRCS Soil Group:

Post-project Surface:

Total Area (Calculated)

Drainage Management Areas	<input type="text" value="30645"/>	sq. ft.
Integrated Management Practices	<input type="text" value="3050"/>	sq. ft.
Total	<input type="text" value="33695"/>	sq. ft.





BREAK

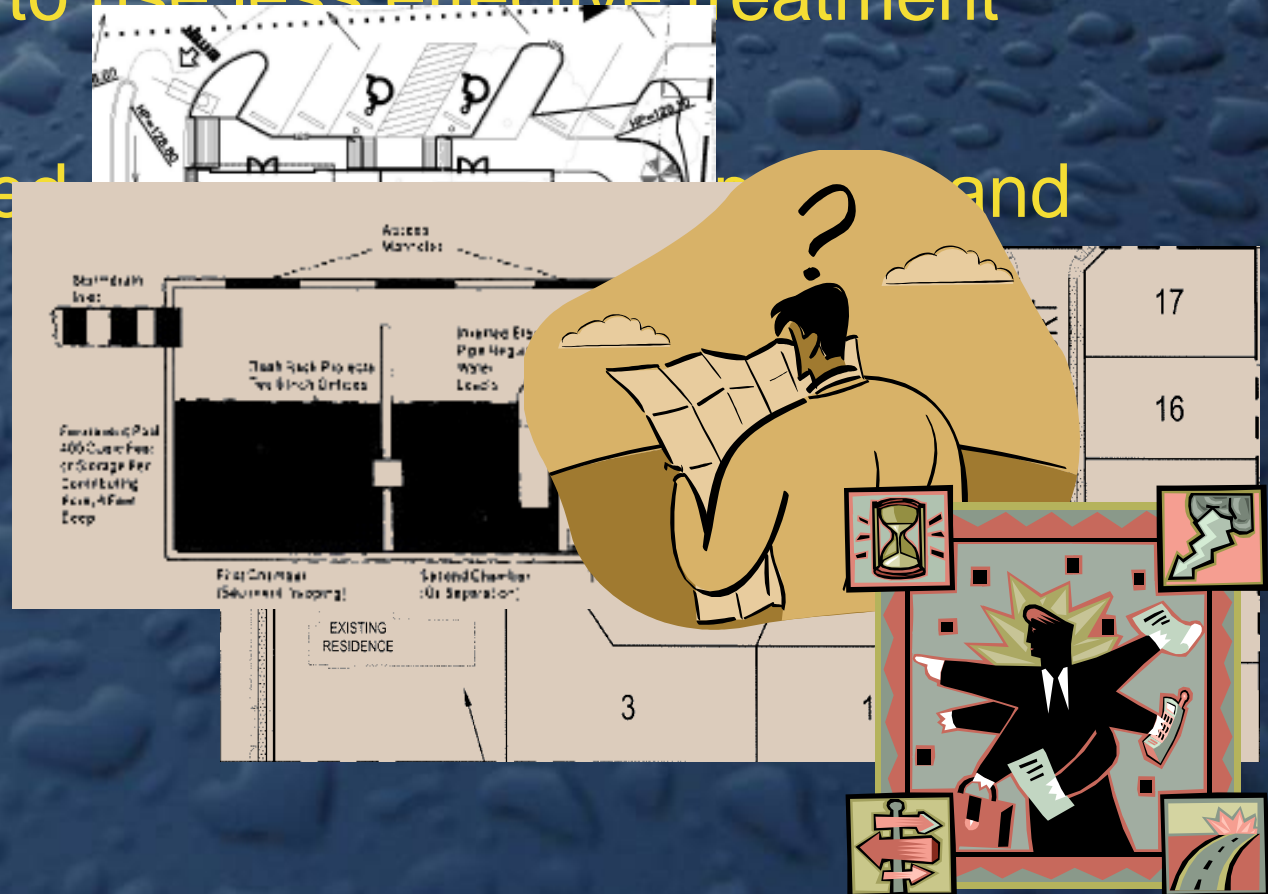


LID Planning, Design, and Construction

**ISSUES FREQUENTLY
DISCUSSED**

3 most common mistakes

1. Didn't start early enough.
2. Planned to use less effective treatment facilities.
3. Postponed start of construction and maintenance.



Applicability

- The whole of an action
 - Consistent with CEQA definition
 - No piecemealing
 - Includes improvements on public ROW
- Swimming pools
- Pervious pavements
 - Must meet criteria
- Pavement reconstruction
 - Did the drainage change?

The 50% Rule

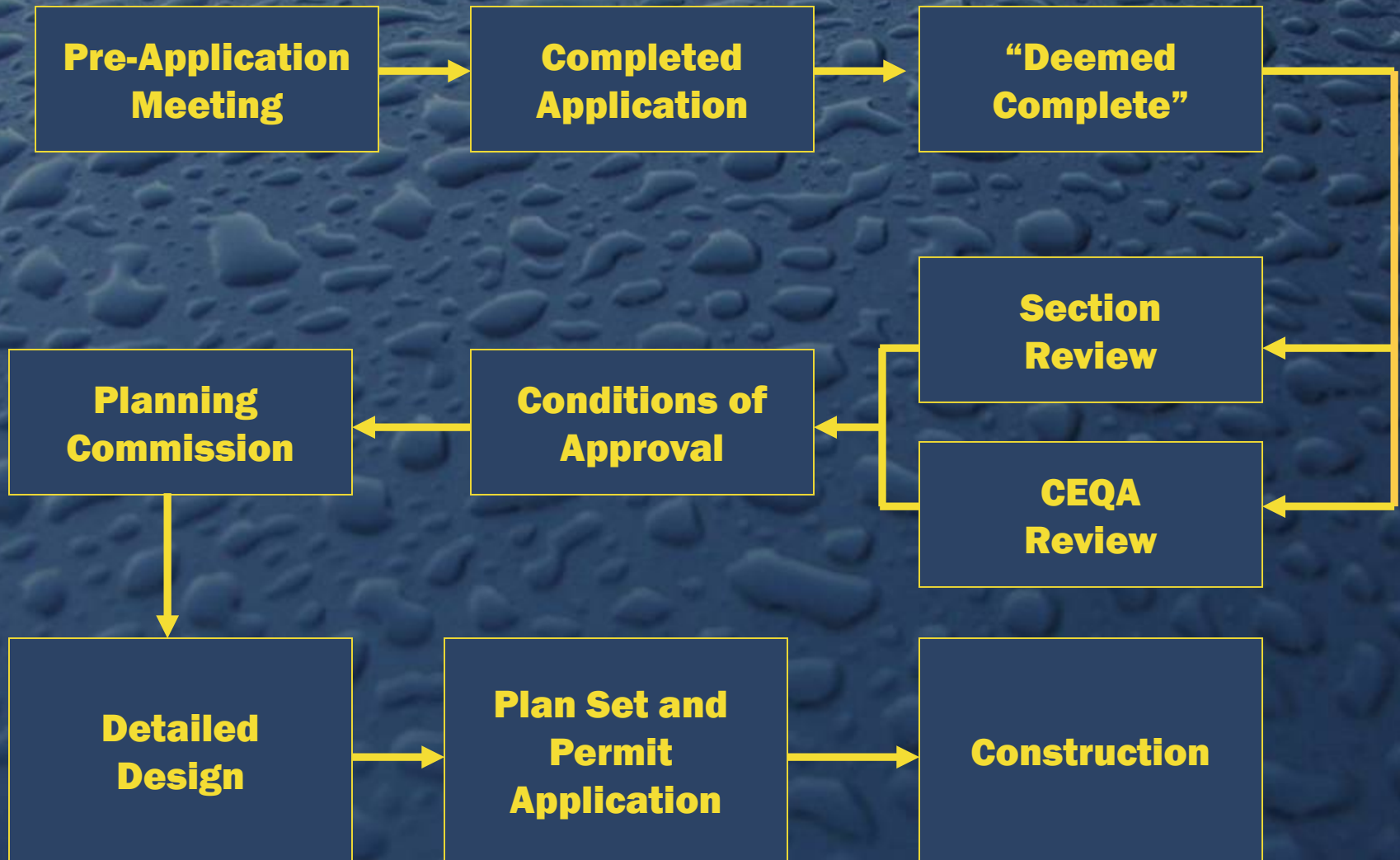


Criterion in previous permit (2003-2009): Project results in an **increase of or replacement of 50% or more** of existing development



MRP criterion: Project results in **alteration of more than 50%** of the previously existing development

Development Review Process



Level of Detail

“Plan and design your stormwater controls integrally with the site plan and landscaping for your project.”

- Drainage Management Areas
 - Grading and roof areas and slopes
- Locations/sizes of stormwater facilities
- Conceptual routing of drainage

Options for New Subdivisions

Pages
6-8

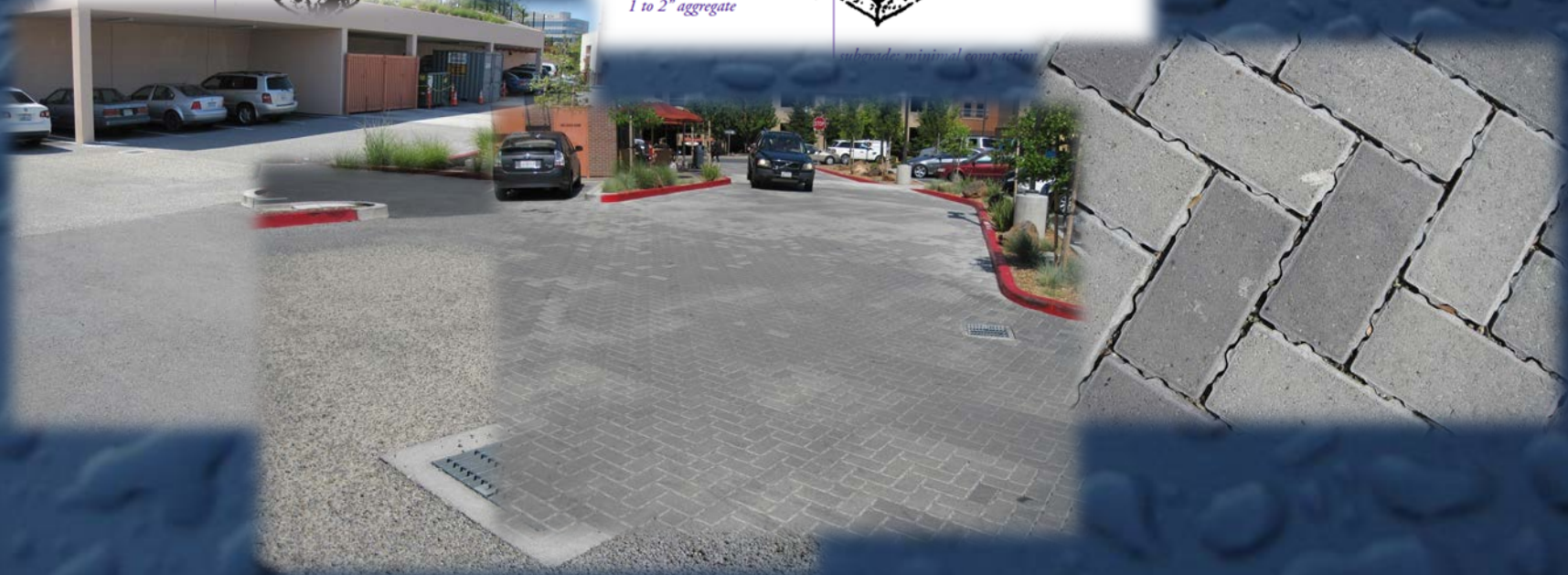
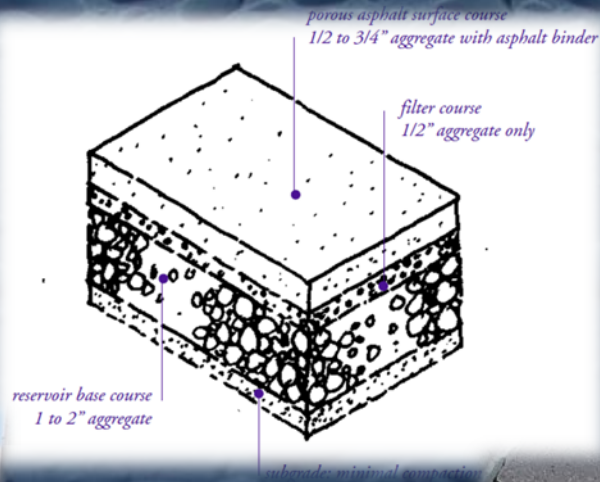
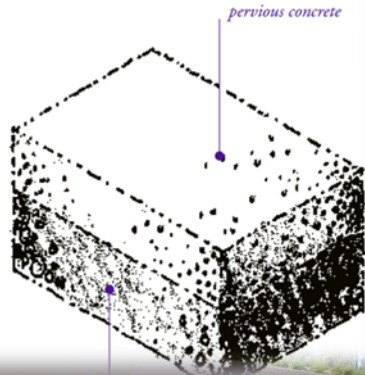
1. Total impervious area will not exceed threshold
2. Dispersal will work
3. Improvement plans showing treatment and flow-control facilities
 - Commitment to construct facilities prior to sale
4. Improvement plans showing treatment and flow-control facilities
 - Deed restriction or other legal instrument ensuring lot-by-lot implementation

Grandfathering

Requirements of previous permit apply if:

- Planning application deemed complete on or before 12/1/2011...
- ...so long as the applicant is diligently pursuing the project
 - Submittal of supplemental information
 - Plans or other required documents

Pervious Pavement



Pervious Pavement

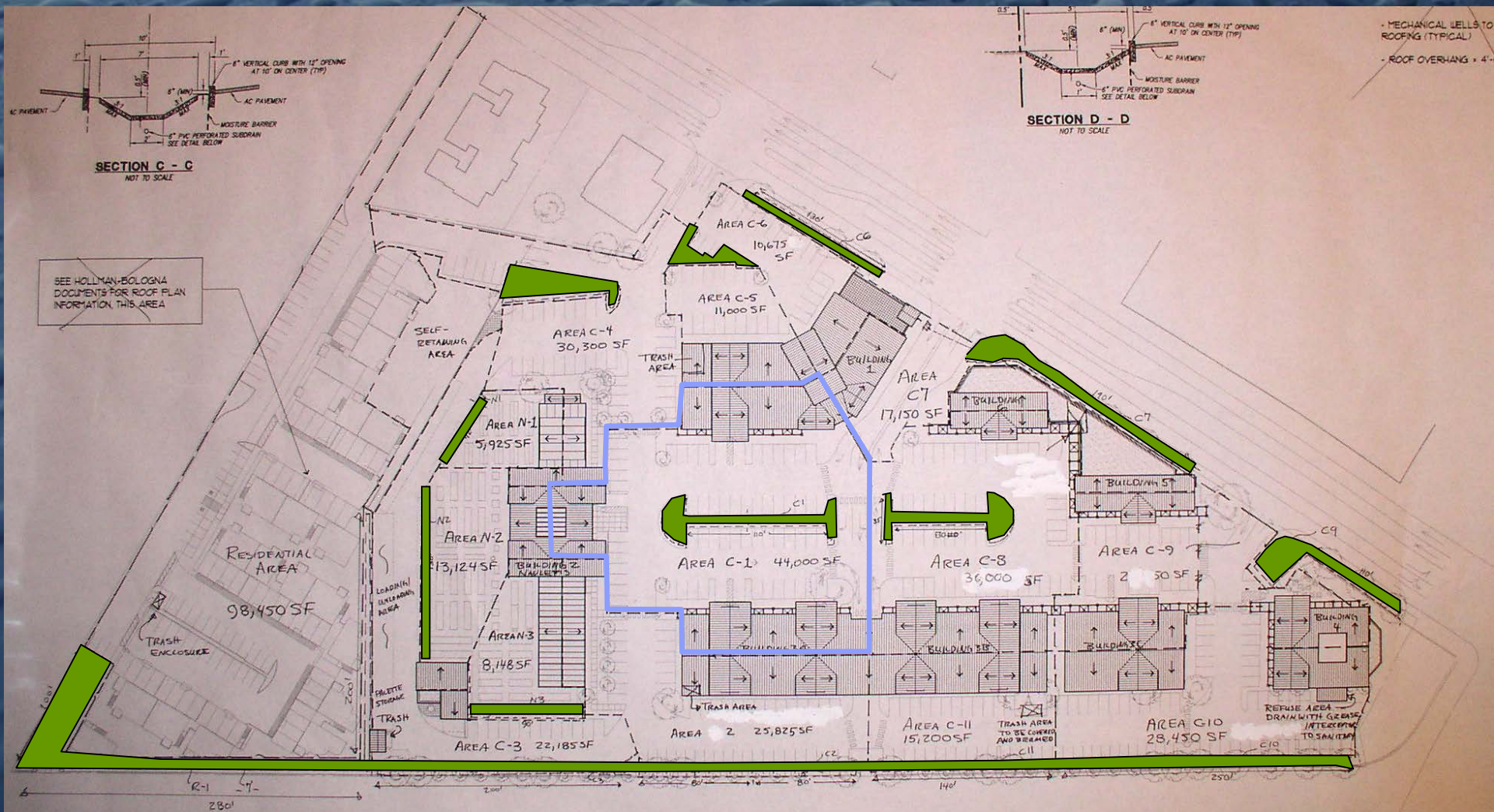
- It's for retention, not treatment
- Only suitable where:
 - Grades are flat
 - Soils will drain
 - Traffic is light
 - Current property owner wants the aesthetic effect and/or cachet
 - Future property owners will preserve it

Optimal size for bioretention?

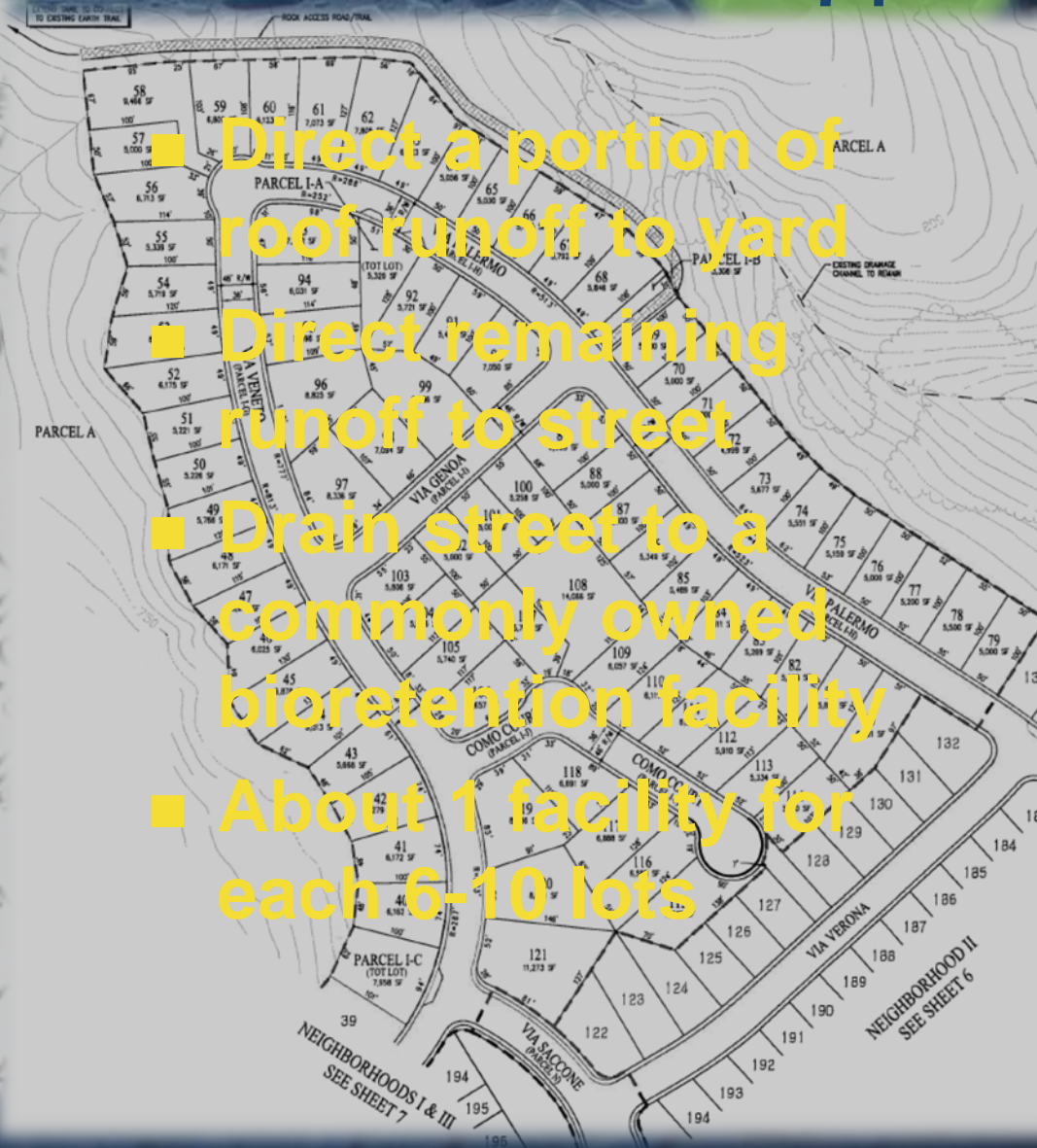
$\frac{1}{2}$ Acre

4% \updownarrow 30 ft

Best Planning for Parking Lots



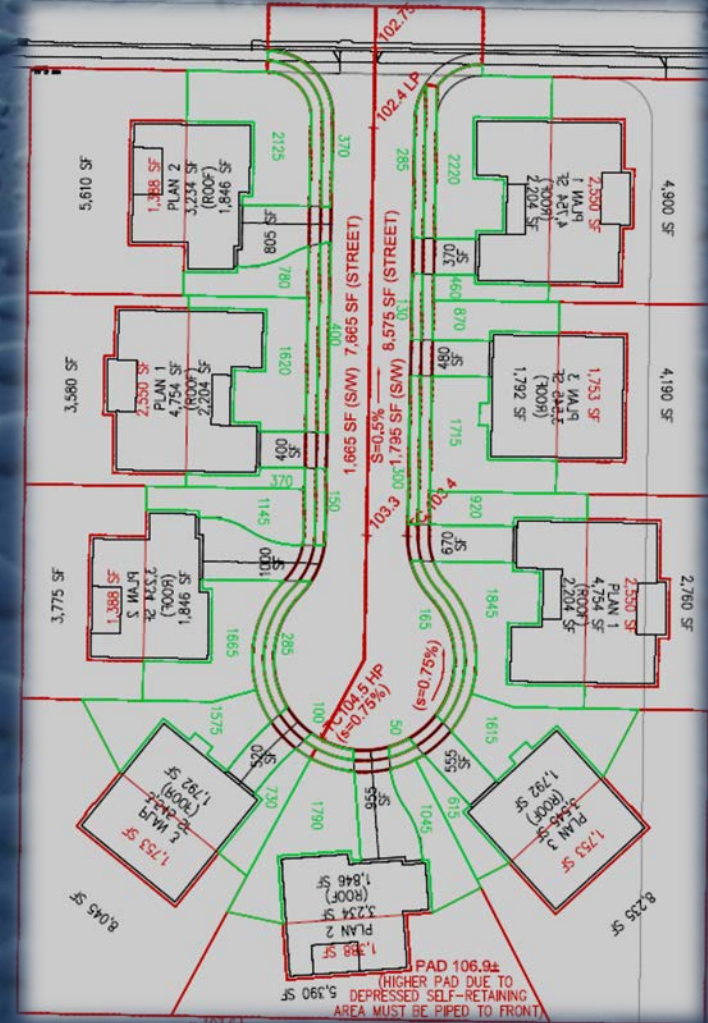
Best Planning for Subdivisions



- Direct a portion of roof runoff to yard
- Direct remaining runoff to street
- Drain street to a commonly owned bioretention facility
- About 1 facility for each 6-10 lots

Small subdivision on flat site

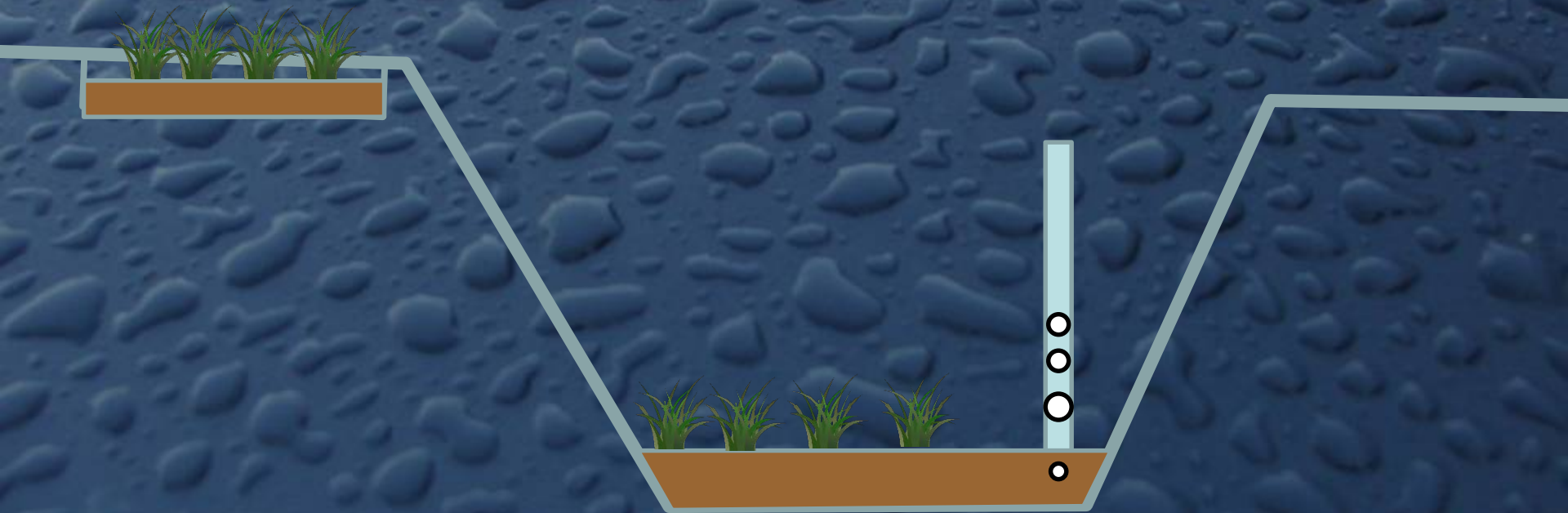
- Hydromodification management is required
- Disperse/retain as much roof drainage as possible on each lot
- No inlets – drain curb out to main street
- Regrade if necessary, and tolerate a very slight slope
- Bioretention top of soil layer is just below curb elevation—no side slopes



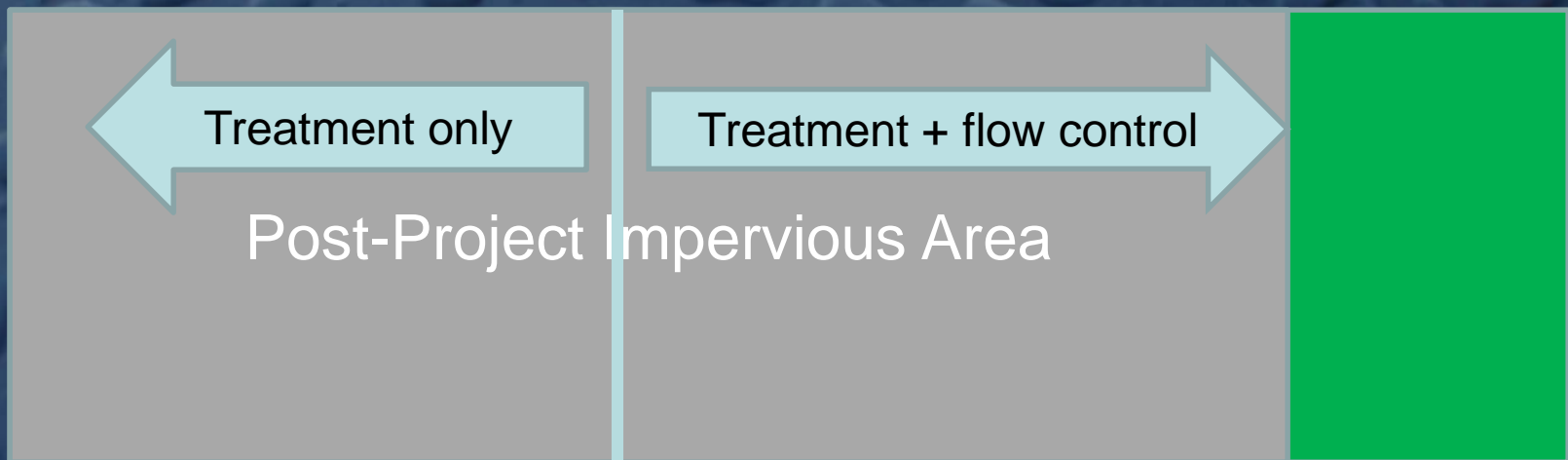
Don't create pits



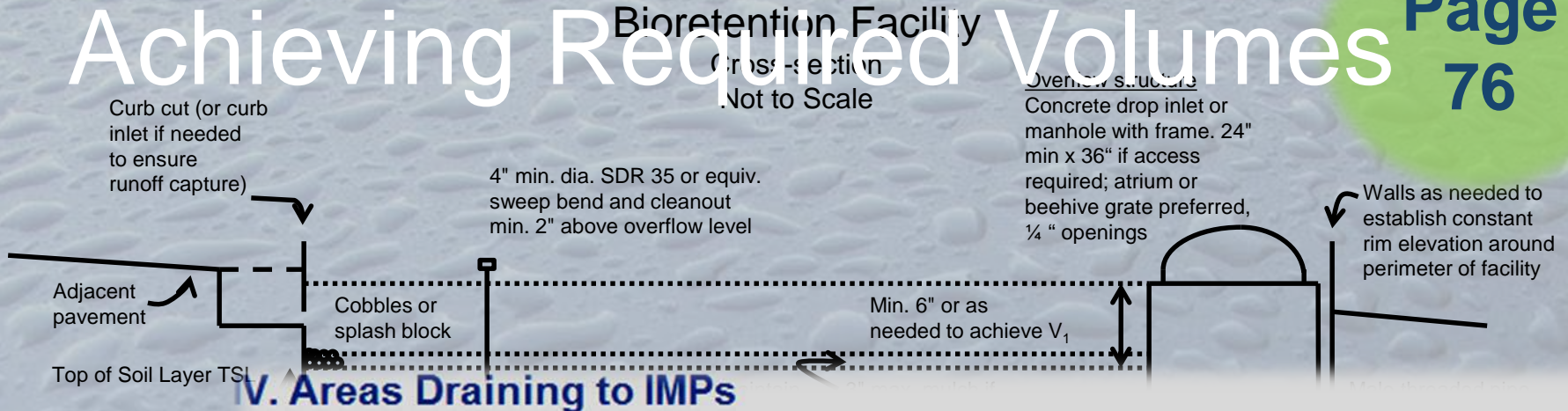
Combining with Flood Control



Flow Control & Redevelopment



Achieving Required Volumes



IV. Areas Draining to IMPs

Min. 18"

IMP Name: IMP1 (Soil Type: D)
IMP Type: Bioretention Facility
Soil Type: D

DMA Name	DMA Area (sq ft)	Post-Project Surface Type	DMA Runoff Factor	DMA Area x Runoff Factor
DMA2	1,950	Conventional Roof	1.00	1,950
DMA4	1,050	Conventional Roof	1.00	1,050
DMA7	7,025	Concrete or Asphalt	1.00	7,025
Total				10,025

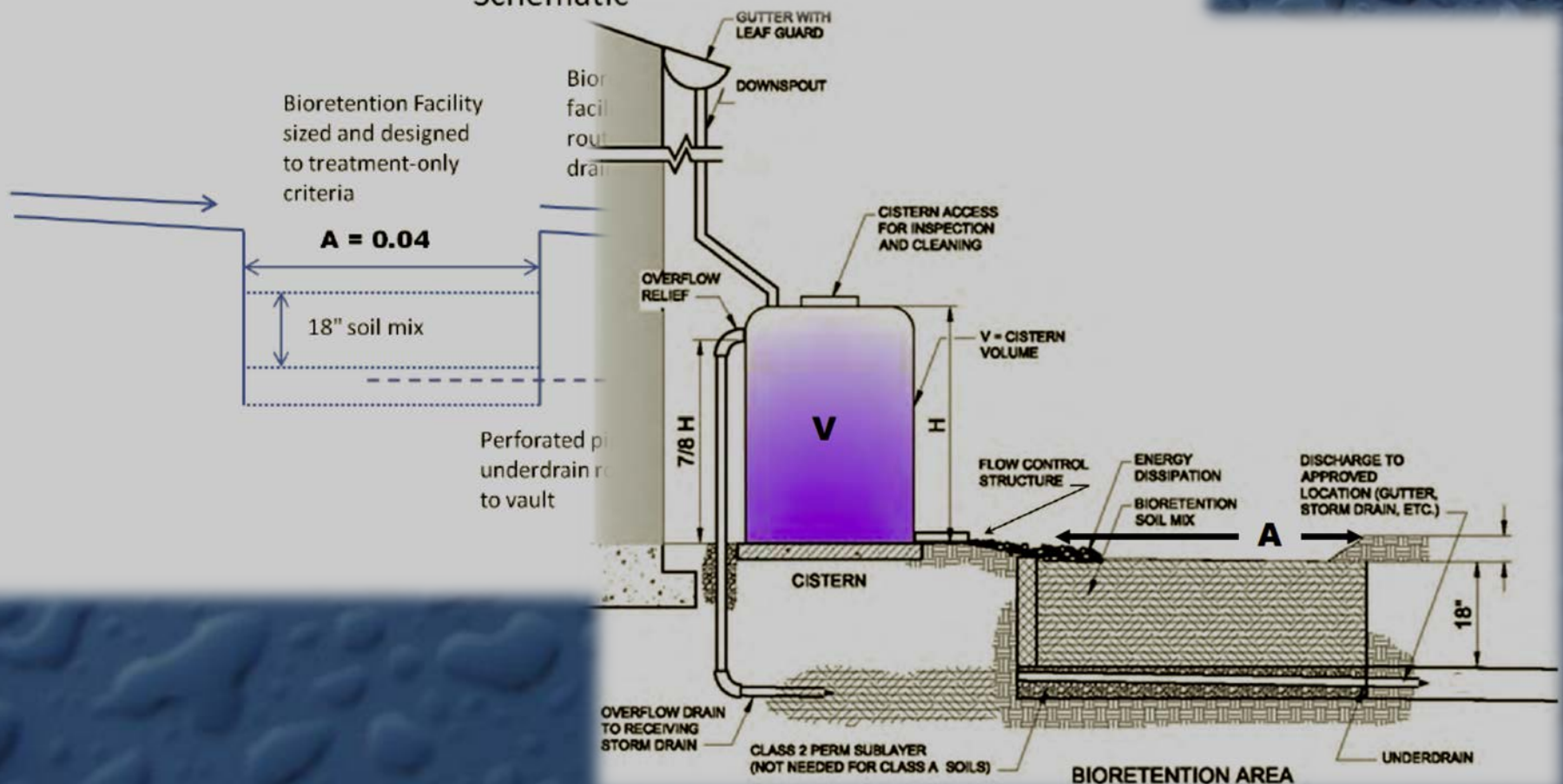
Area
Surface Volume
Subsurface Volume

IMP Sizing			
IMP Sizing Factor	Rain Adjustment Factor	Minimum Area or Volume	Proposed Area or Volume
0.050	1.009	506	506
0.042	1.009	425	425
0.055	1.009	556	557
Maximum Underdrain Flow (cfs)			0.02
Orifice Diameter (in)			0.87

Flow Control Alternates

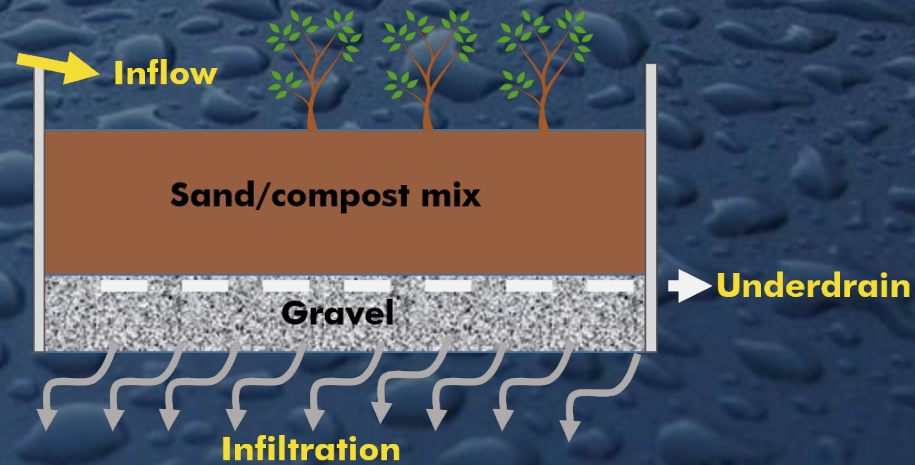
Pages
87-92

Bioretention + Vault Schematic

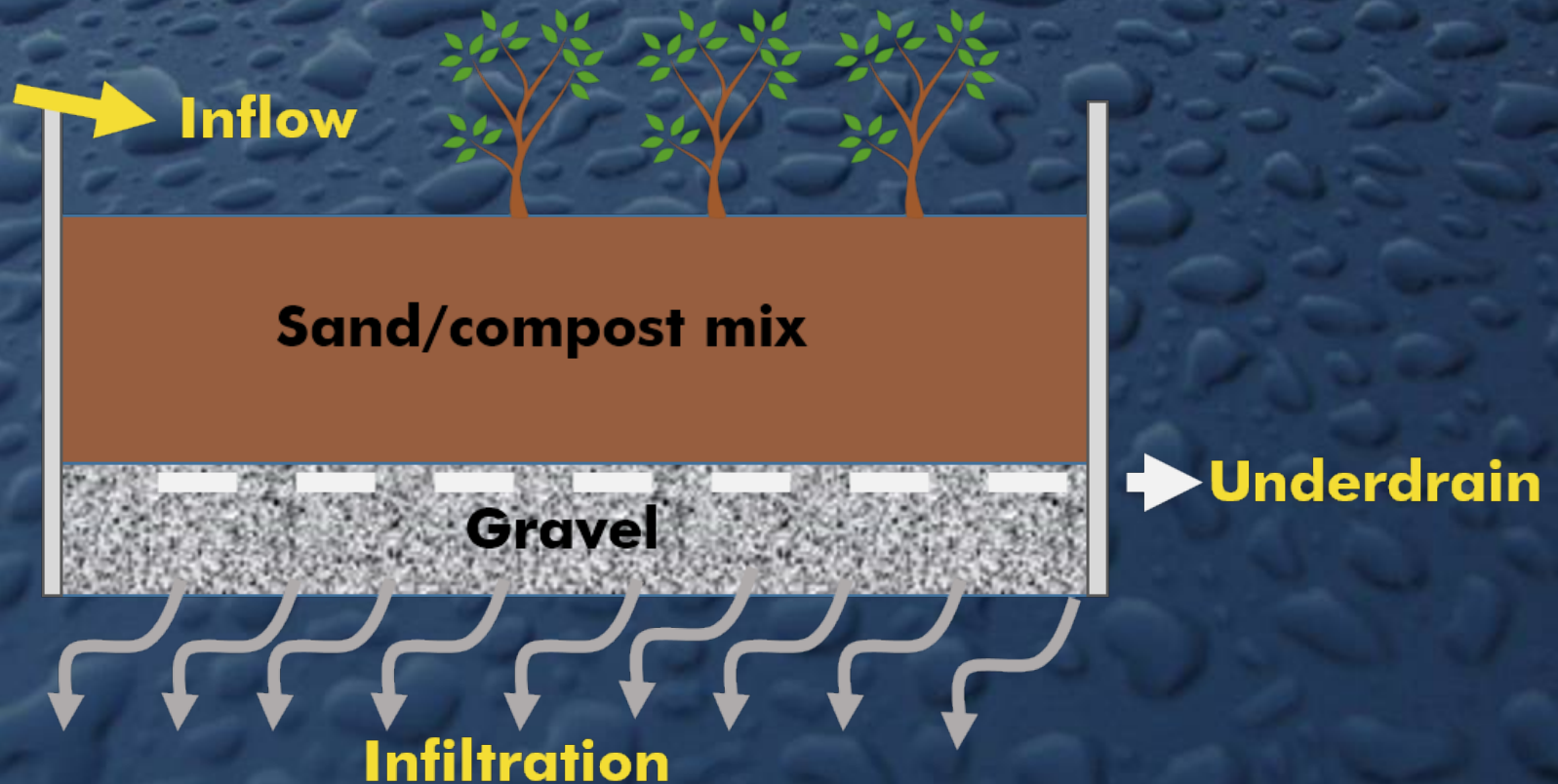


Costs and Useful Life

- Have heard \$25/SF for planning purposes
- Better to estimate components individually
- Amount of concrete work varies and could be a significant cost
- Useful life of concrete components – 30+ years?
- Sand/compost mix, gravel and piping should last at least that long
- Plus landscape maintenance



Pollutant Retention and Buildup





BREAK

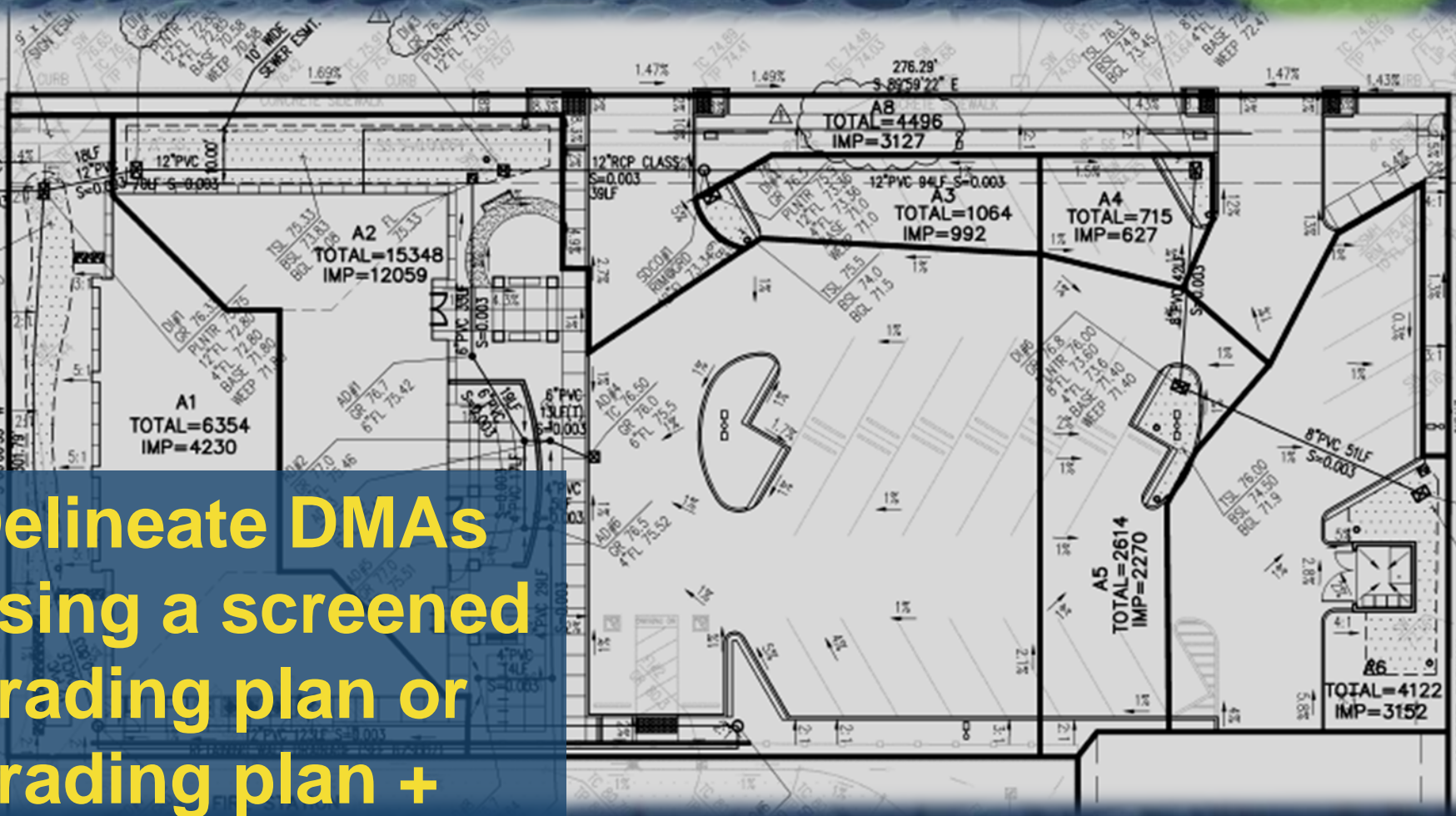


LID Planning, Design, and Construction

**BIORETENTION
DESIGN DETAILS**

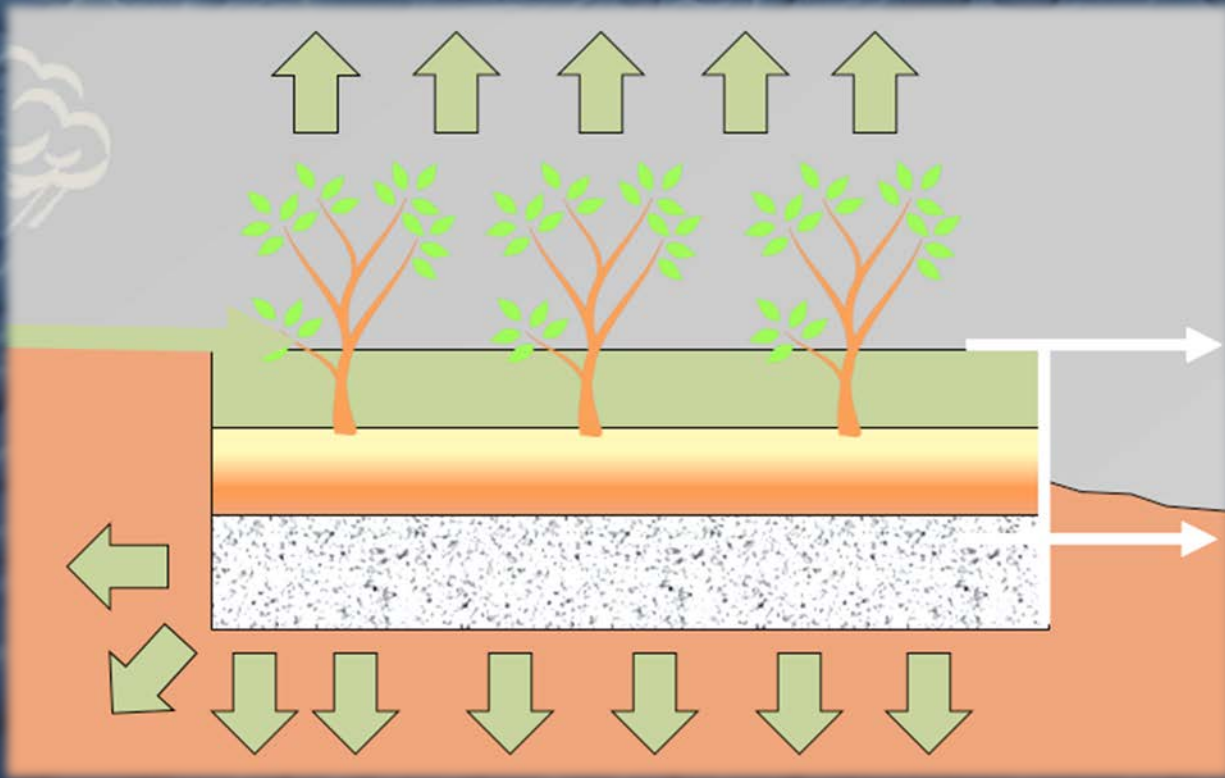
DMAs are as intended

**Delineate DMAs
using a screened
grading plan or
grading plan +
roof plan.**

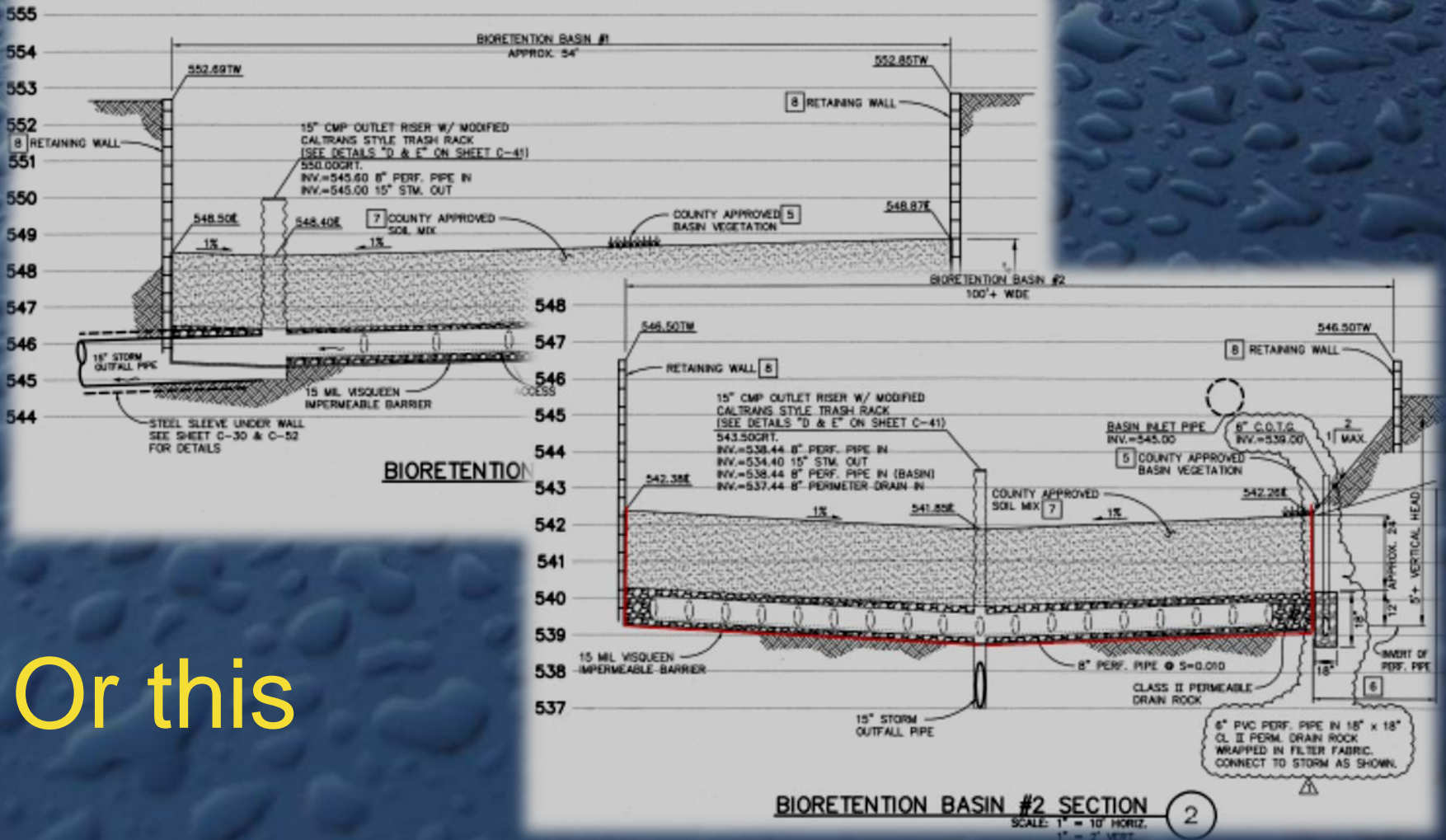


Make This Happen

- Bioretention facilities are level so they “fill up like a bathtub.”



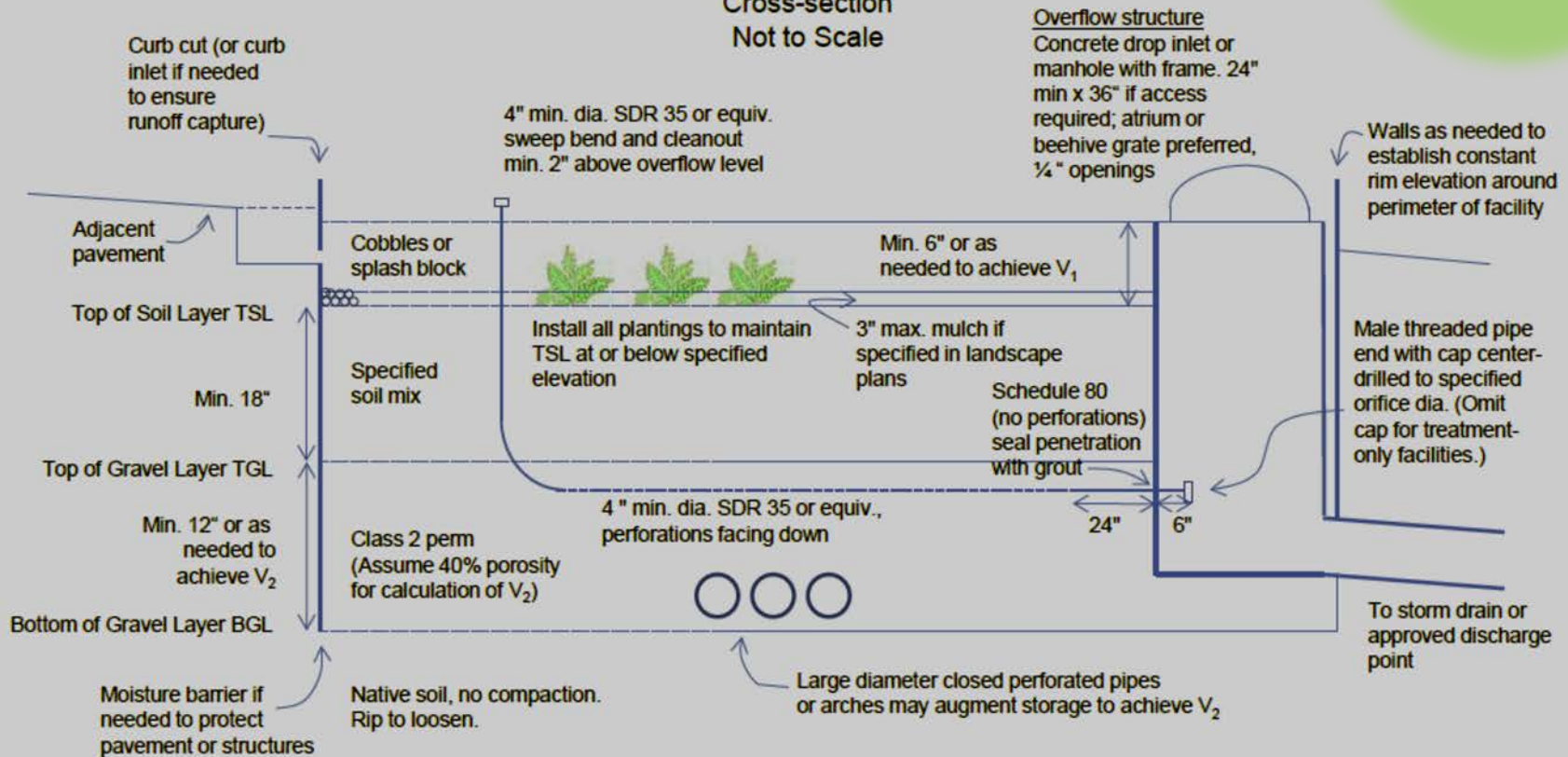
Not this



Or this

Bioretention Facility

Cross-section
Not to Scale



Notes:

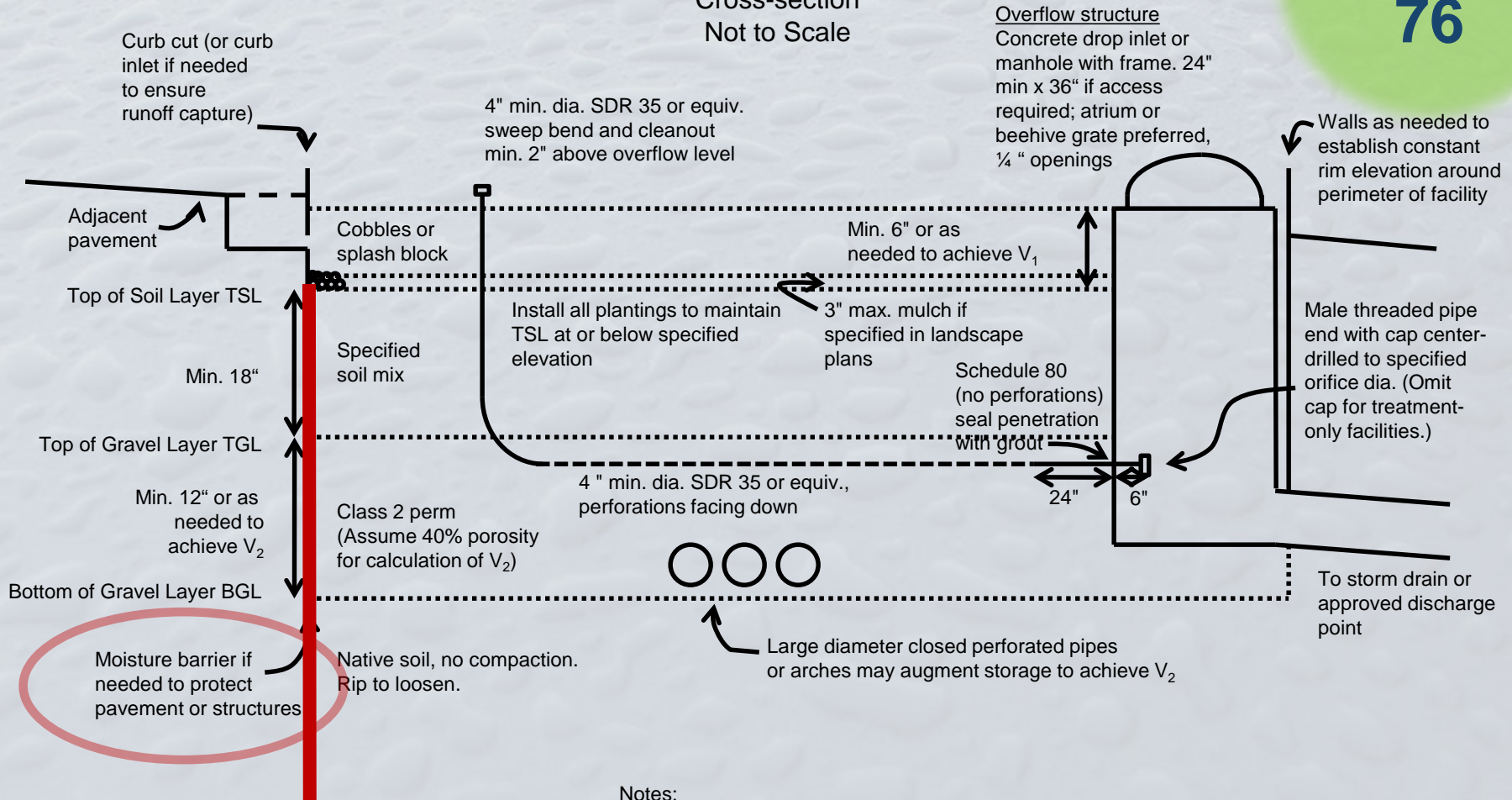
- No liner, no filter fabric, no landscape cloth.
- Maintain BGL, TGL, TSL throughout facility area at elevations to be specified in plan.
- Class 2 perm layer may extend below and underneath drop inlet.
- Elevation of perforated pipe underdrain is near top of gravel layer, except when zero infiltration is expected.
- See Appendix B for soil mix specification, planting and irrigation guidance.
- See Chapter 4 for factors and equations used to calculate V_1 , V_2 and orifice diameter.

Foundations and Pavement



Bioretention Facility

Cross-section
Not to Scale



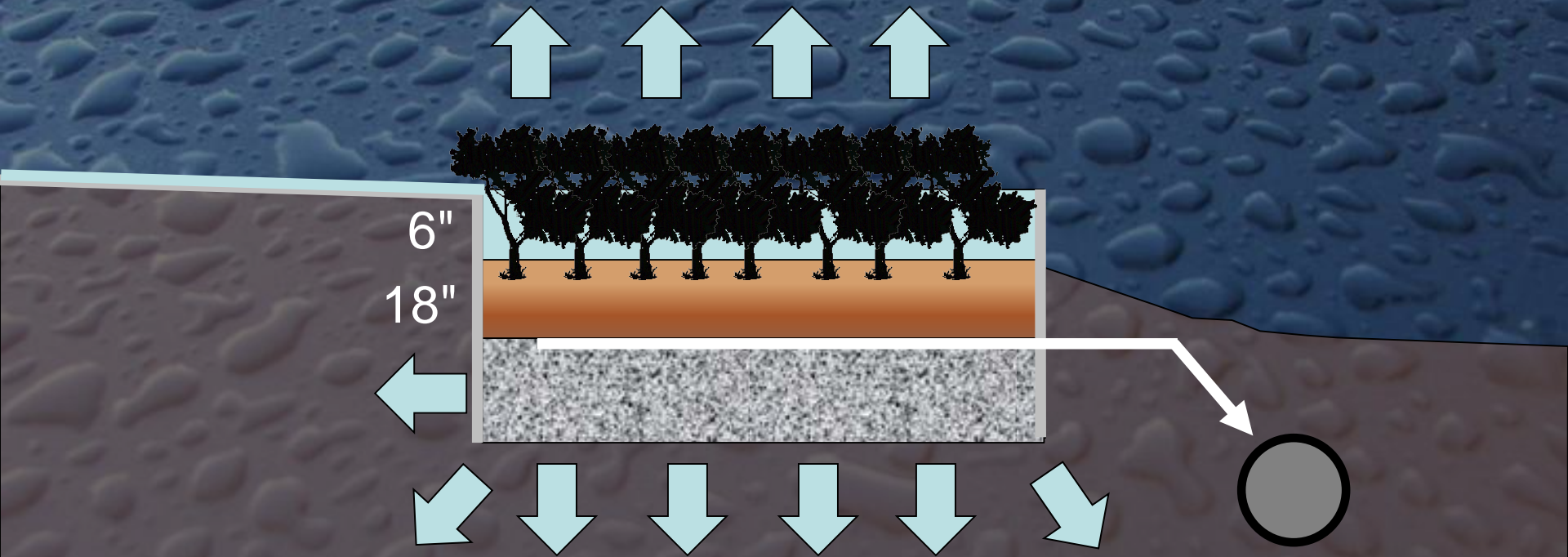
Notes:

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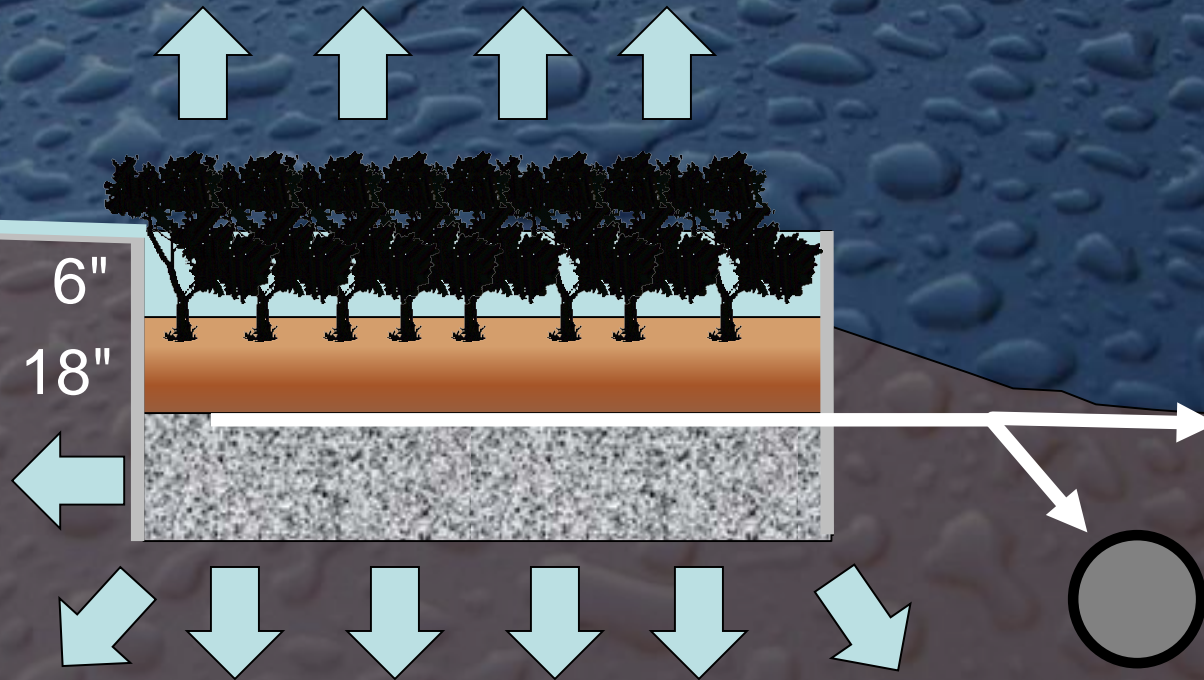
Geotechnically Difficult Sites



High Groundwater



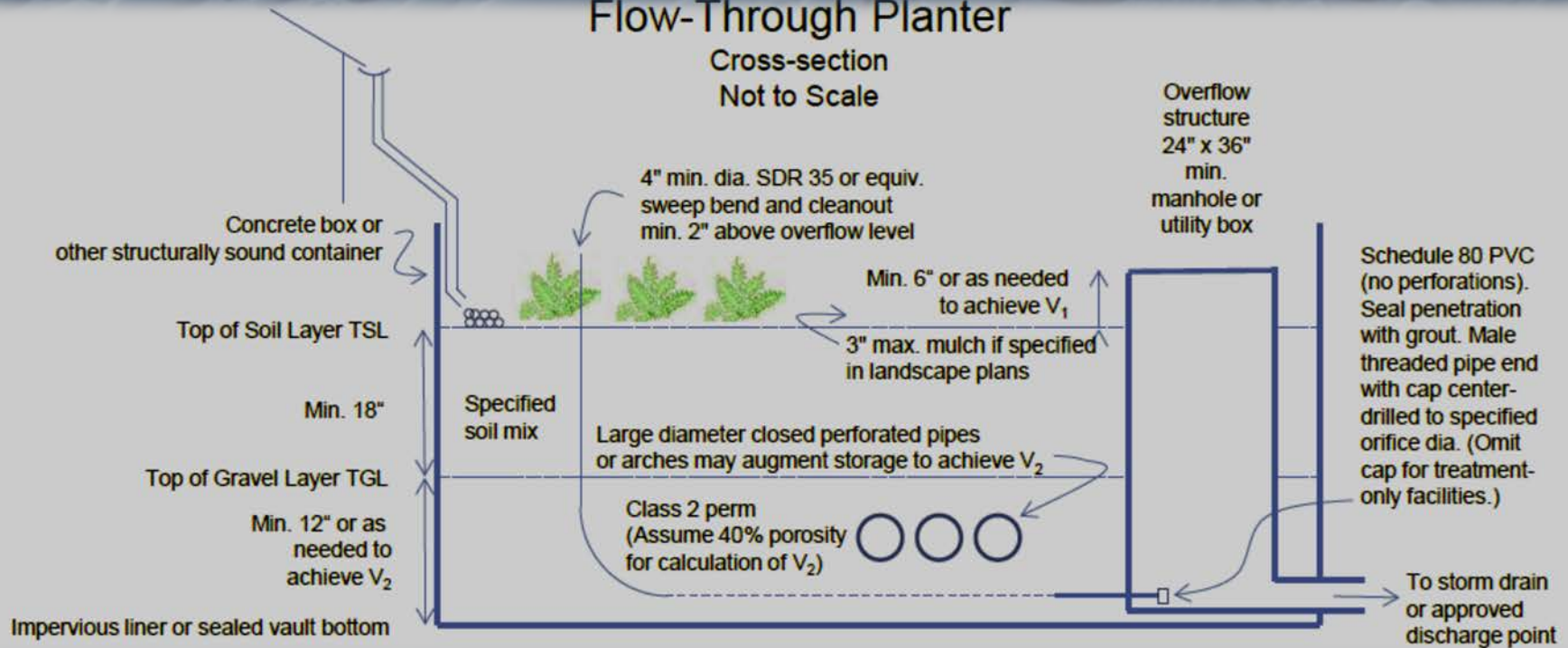
No Storm Drain



- Where soil or groundwater is polluted
- On plazas or other structures

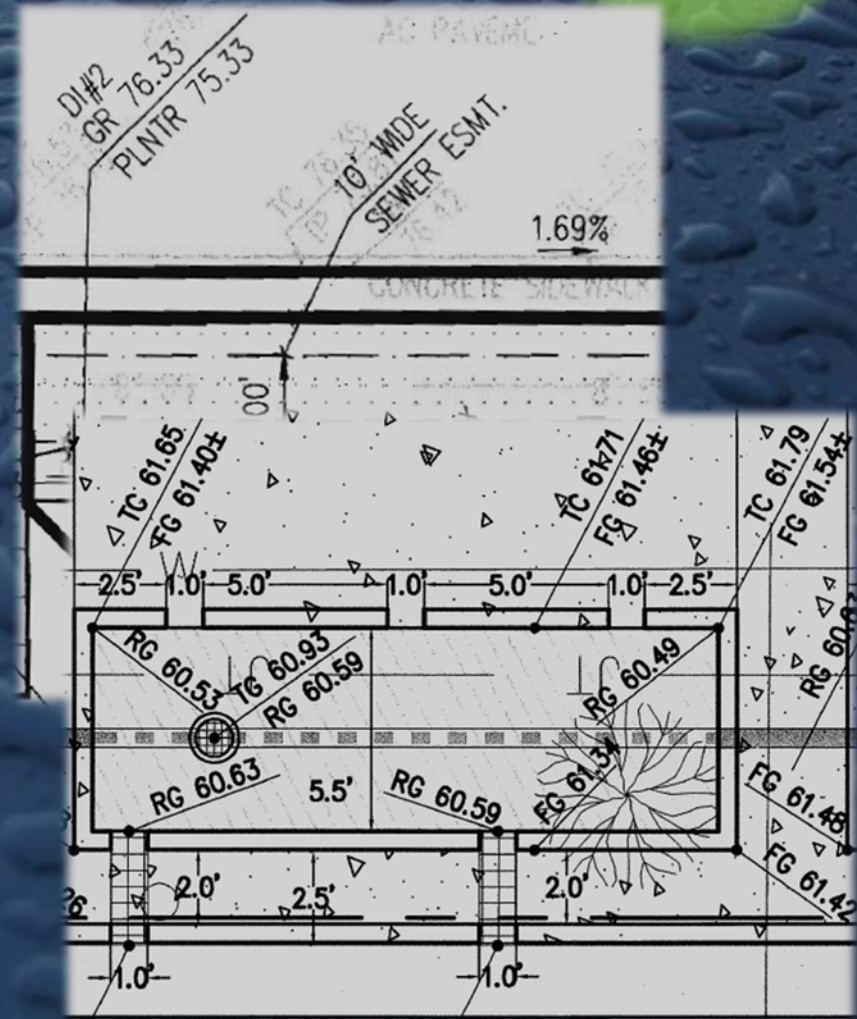
Flow-Through Planter

Cross-section
Not to Scale



Call out elevations

- Outlet structure
 - Top of overflow grate
 - Underdrain connection
- Inlet
 - Flow line at inlet
 - Top of curb
 - Top of adjacent paving
- Soil layers
 - Top of soil layer
 - Bottom of gravel layer
 - Bottom of soil layer



Outlets

ity

Overflow structure
24" min x 36" min.
concrete drop inlet
or manhole with
frame and atrium
or beehive grate.
¼" openings

Overflow
elevation

r as
to achieve V_1

mulch if
in landscape

Schedule 80
(no perforations)
seal penetration
with grout

24" 6"

To storm drain or
approved discharge



Bioretention Edges



Fill mix against
drop-off. And/or use
scourage entry

6" min. or as required to achieve V_1

Soil mix

Gravel layer

Gravel and Underdrain

- Class 2 permeable
 - Caltrans spec 68-2.02(F)(3)
- No filter fabric
- Underdrain
 - Discharge elevation at top of gravel layer
 - PVC SDR 35 or equivalent; holes facing down
 - Solid pipe for 2' closest to outlet structure
 - Cleanout



Planting Soil

Apx.
B

- 60-70% Sand
 - ASTM C33 for fine aggregate
- 30-40% Compost
 - Certified through US Composting Council Seal of Testing Assurance Program
- Install in 8"-12" lifts
- Do not compact
- Do not overfill
- Leave room for mulch



Soils, Planting, Irrigation

Apx. B

- Select plants for fast-draining soils
- Select for facility location
- Avoid problem conditions
 - Overly dense plantings
 - Aggressive roots
 - Invasive weeds
 - Need for irrigation or fertilization

Plants that work

Apx. B

Plant Recommendations for Bioretention Facilities and Planter Boxes

Grasses and Grass-like Plants

Scientific name Common name	Light Preference			Size (feet)		Watering				Tolerates				CA Native	Other Notes
	Sun	Part	Shade	Ht.	Width	L	M	H	Summer	Heat	Coast	Flood	Wind		
<i>Bromus carinatus</i> California brome	✓			2	1	✓			ok	✓		✓	✓	✓	
<i>Bouteloua gracilis</i> blue grama	✓			1.5	1	✓				✓		✓	✓		Tolerates no sun irrigated remote
<i>Carex densa</i> dense sedge	✓			1	1		✓	✓	✓	✓		✓		✓	
<i>Carex obnupta</i> slough sedge	✓			2	1		✓	✓	✓	✓	✓	✓	✓	✓	
<i>Carex praegracilis</i> clustered field sedge	✓	✓		1.5	1.5		✓	✓	✓	✓	✓	✓	✓	✓	
<i>Carex subfusca</i> rusty sedge	✓	✓		1	1		✓		ok	✓	✓	✓	✓	✓	Great for swale
<i>Carex divulsa</i> Berkeley sedge		✓	✓	1	1		✓		ok		✓	✓	✓	✓	AKA <i>Carex tumida</i> coast.
<i>Deschampsia cespitosa</i> tufted hairgrass	✓			2	1		✓		ok			✓	✓	✓	Can look weed
<i>Distichlis spicata</i> salt grass	✓			0.3	3		✓	✓	✓	✓	✓	✓	✓	✓	Looks like berm traffic, for soils
<i>Eleocharis palustris</i> creeping spikerush	✓			1	1		✓	✓	ok	✓	✓	✓	✓	✓	
<i>Elymus glaucus</i> blue wildrye	✓			1.5	2		✓	✓	ok	✓	✓	✓	✓	✓	good for grazing looking lawn
<i>Festuca californica</i> California fescue	✓	✓	✓	2	2	✓			ok	✓	✓		✓	✓	

Landscaping—O&M issues

- Avoid filling in or regrading
- No fertilizer
 - Compost tea once per year if needed
- No pesticides
- Clean up as needed and annually
- Add mulch if needed annually
 - Compost mulch (aged mulch) recommended

Avoid design conflicts

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- Elevations consistent with grading and architectural plans
- Facilities do not interfere with parking or pedestrian circulation
- Utilities are located elsewhere
- Protection of adjacent paving and structures has been considered



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CONSTRUCTION OF BIORETENTION FACILITIES

Construction Checklist

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- Layout
- Excavation
- Overflow or Surface Connection
- Underground connection (underdrain)
- Drain rock/subdrain
- Soil Mix
- Irrigation
- Planting
- Final

Construction

- Yes, inspections are needed
- Special inspections (or inspectors) may be appropriate
- Edit construction checklist and deliver to general contractor at pre-construction meeting
- Make sure landscape contractor gets the message(s)
 - Elevations
 - Additions of material
 - Fertilizers

2-Year Warranty

- Extension of standard 1-year warranty for landscaping
- Allows identification and correction of problems during rainy season

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**BIORETENTION FACILITIES
OPERATION & MAINTENANCE**

Current Approach to Verification

**Table C.3.h. – Operation and Maintenance of Stormwater Treatment Systems
City of Eden Annual Report FY 2008-09**

Facility/Site Inspected and Responsible Party for Maintenance	Date of Inspection	Type of Inspection (annual, follow-up, etc.)	Type of Treatment System or HM Control Inspected	Inspection Findings or Results	Enforcement Action Taken (Warning, NOV, administrative citation, etc.)	Comments
ABC Company 123 Alphabet Road San Jose	12/06/08	annual	offsite bioretention unit	proper operation	none	Unit is operating properly and is well maintained.
DEF site 234 Blossom Drive Santa Clara	12/17/08	annual	onsite media filter	ineffective filter media	verbal warning	Media filter is clogged and needs to be replaced.
	12/19/08	follow-up	onsite media filter	proper operation	none	New media filter in place and unit is operating properly.
	1/19/09	follow-up	onsite media filter	proper operation	none	Unit is operating properly.
GHI Hotel 1001 Grand Blvd 227 Touring Parkway	12/21/08	annual	onsite swales	proper operation	notice of violation	Bioretention unit #2 is badly eroded because of flow channelization. Stormwater is flowing over the eroded areas, bypassing treatment and running off into parking area.
			onsite bioretention unit #1	proper operation		
			onsite bioretention unit #2	eroded areas due to flow channelization		
	12/27/08	follow-up	onsite bioretention unit #2	proper operation	none	Entire bioretention unit #2 has been replanted and re-graded. Raining heavily but no overflow observed.
Rolling Hills Estates Homeowners?	01/17/09	annual	onsite pond	sediment and debris accumulation	notice of violation	Pond needs sediment removal and check dam needs debris removal.

Bioretention O&M

- Inspect inlets, outlets, and side slopes
- Soils percolate
- Check dams and flow spreaders
- Healthy vegetation
- **Removal or alteration**

Bioretention—No O&M



Possible new approach to O&M



Possible new approach to O&M

- Identify and delineate facilities
 - Increase awareness
 - Prevent alteration
- Track locations and status
 - Confirm ongoing operation and effectiveness of individual facilities
 - Track rollout of LID across watersheds
- Engage property owners and users

The background of the slide is a close-up photograph of numerous water droplets of various sizes scattered across a dark blue, slightly textured surface. The lighting creates highlights on the top of each droplet, giving them a three-dimensional appearance. The overall color palette is monochromatic, ranging from deep navy blue to a slightly lighter, almost blackish-blue.

LID Planning, Design, and Construction

DISCUSSION