The *updated* Post-Construction Manual

Planning, Design, and Construction
of Low Impact Development Features and Facilities

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Workshop Objectives

- Improve the quality of applications for development project approvals
- Better use of Low Impact Development
- Timely and thoughtful integration of LID into site, landscape, and drainage design

Motivators

Regulations give you:

- A mandate
- Client support
- Acceptance of costs
- Structure
- Schedule
- Accountability

You must do your own:

- Enthusiasm
- Interest
- Energy

To achieve:

- Synergies
- Opportunities
- Elegance

Basics:
What's in the Manual

What's in the Manual

Chapters

1. About the Requirements
2. Path to Compliance
3. Preparing a Stormwater Control Plan
4. Documenting Your LID Design
5. Preparing an Operation & Maintenance Plan

Resources

VI

Post-Construction Manual with Appendices

- **A:** Source Control Checklist
- **B:** Bioretention Construction Checklist
- **C:** Stormwater Control Plan Template for Small Projects
- **D:** Stormwater Control Plan Template for Regulated Projects
- **E:** Bioretention Facility Plant Matrix

Download from Countywide Program websites

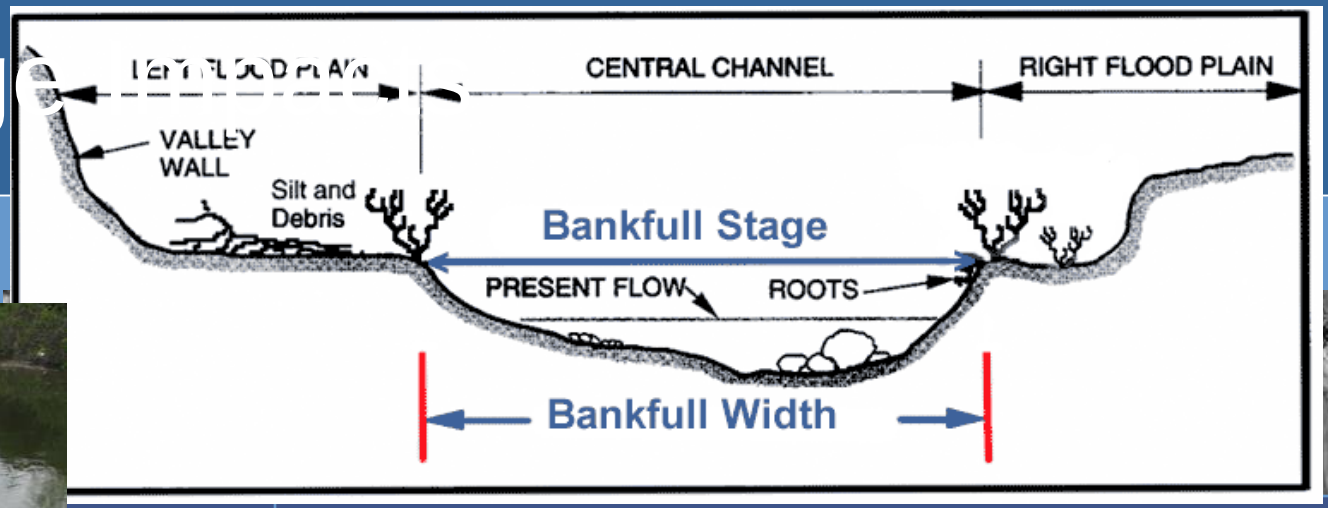
- Excel-based Calculator
- Example Stormwater Control Plans (2)
- Example Operation and Maintenance Plans (2)
- Operation and Maintenance Agreement Template
- Technical Criteria for Non-LID facilities
- Bioretention Facility Inspection Checklist

Basics:
Why Use Low Impact Development?

Conventional Urban Drainage

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

Drainage



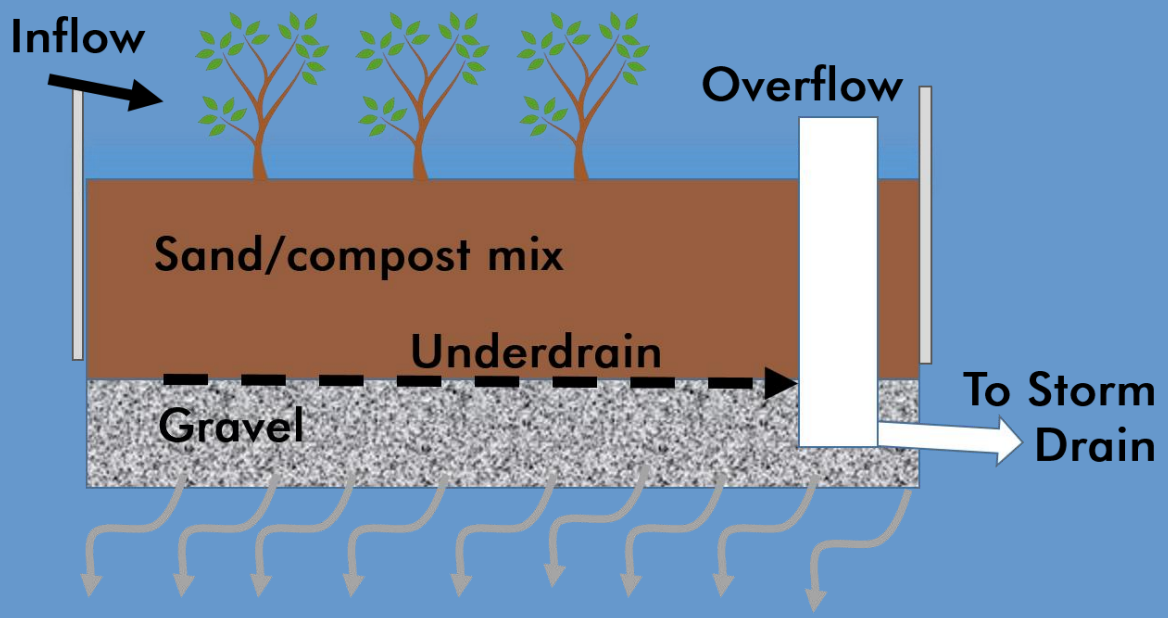
	Watershed and Stream Scale
	Flooding and scouring of stream beds
entration	Flash flows
torms	Discharge when runoff did not
rations	Stream erosion at moderate s
mes	Higher pollutant loading
Greater runoff energy	Conveys trash and gross pollu
Decreased infiltration	Lower and less frequent strea
Dry weather discharges	High pollutant concentrations

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

LID Drainage Design

- Minimize roofs and paving
- Substitute pervious paving where possible
- Disperse runoff to landscaping
- Direct runoff to bioretention facilities



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

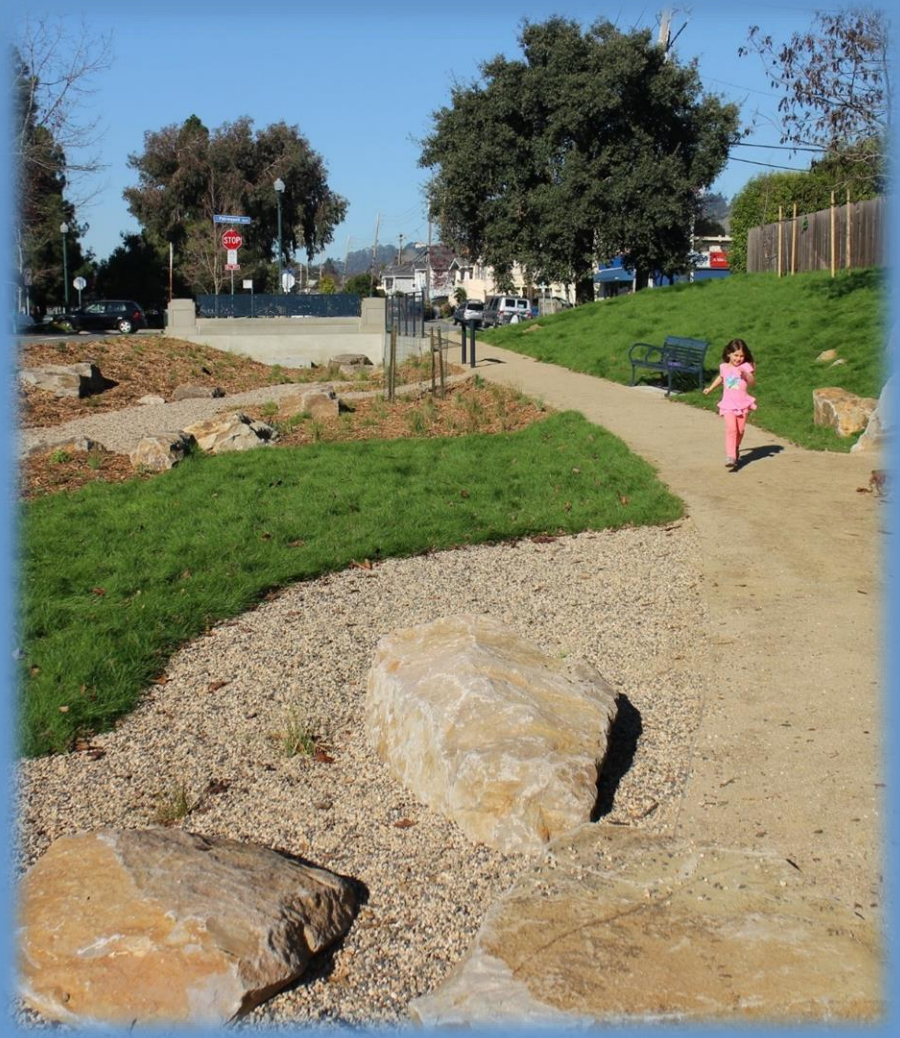
Bioretention & Urban Landscape

Resilience

Resilience


RAIN GARDEN (BIORETENTION BASIN)
The deep basin next to the park is a rain garden (bioretention basin). A rain garden acts like a giant sponge, absorbing and filtering runoff during storms. When it rains, runoff washes soot, oil, and other pollutants from our streets and yards into gutters and storm drains. The storm drains flow directly to Marsh Creek and the Delta!
In rain gardens like this one, runoff floods the surface during storms, and then seeps through a planting mix of sand and compost. Plant roots help absorb runoff and break down some pollutants. Other pollutants are safely bound up in the sand and compost mix. Filtered runoff infiltrates the ground below the rain garden, replenishing groundwater. During intense storms, excess filtered runoff seeps into a perforated pipe connected to the storm drain system.
Rain gardens also protect creeks by slowing runoff and reducing erosive flows. They prevent trash, spilled liquids, and wash waters (like from car washing) from reaching creeks during dry weather as well as during rainstorms. Rain gardens last thirty years or more with only routine maintenance of plants and landscaping—and occasional removal of trash and sediment near inlets.
Surface Runoff
Surface Runoff
Runoff From Gutters and Storm Drains
Sand and Compost Mix
Overflow Pit
Perforated Pipe
Excess Filtered Runoff Flows Through Storm Drain System
Drainage Gravel
Infiltration to Groundwater

Resilience

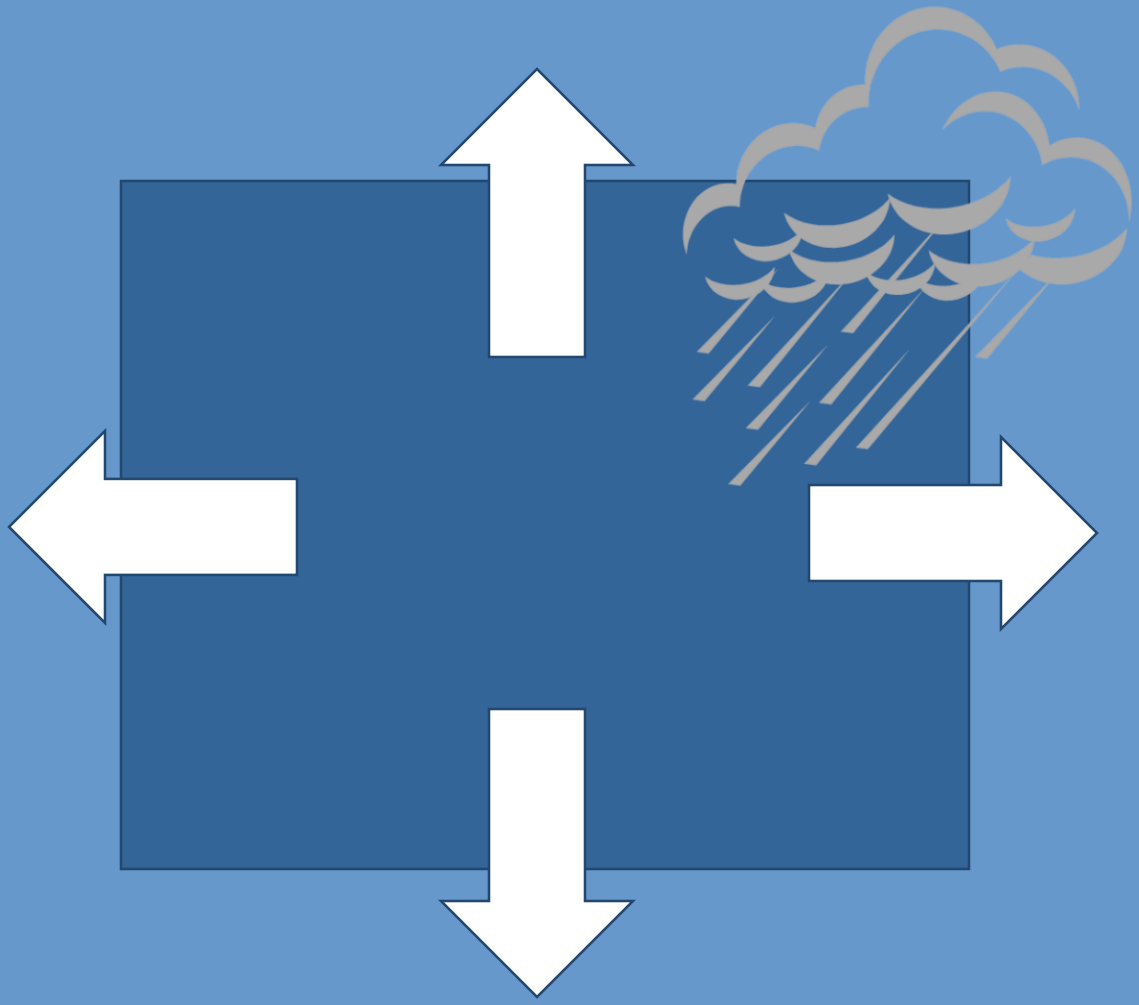


Resilience

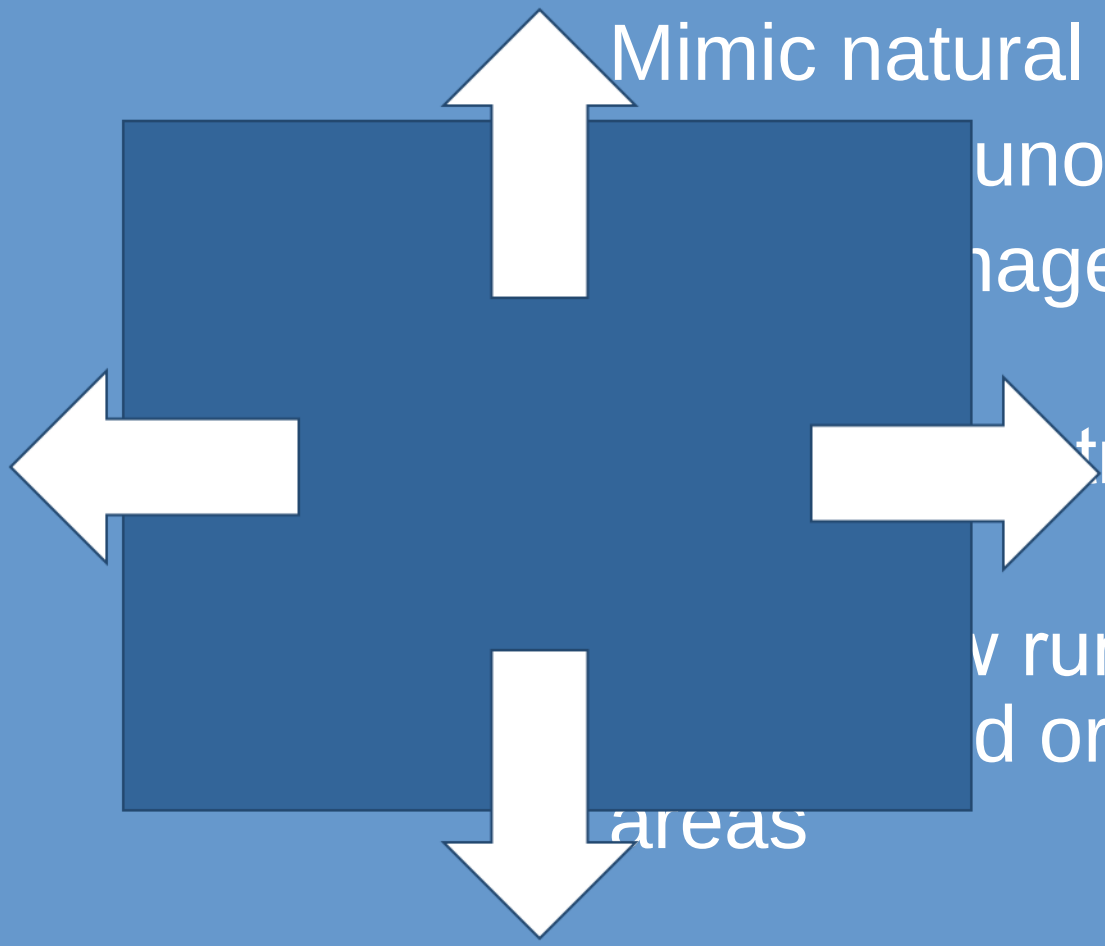
Basics: Documenting that Your LID Design Achieves Compliance

Documenting LID Site Design

LID Site Design Principles



LID Site Design Principles



Mimic natural hydrology

unoff

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v run-on from
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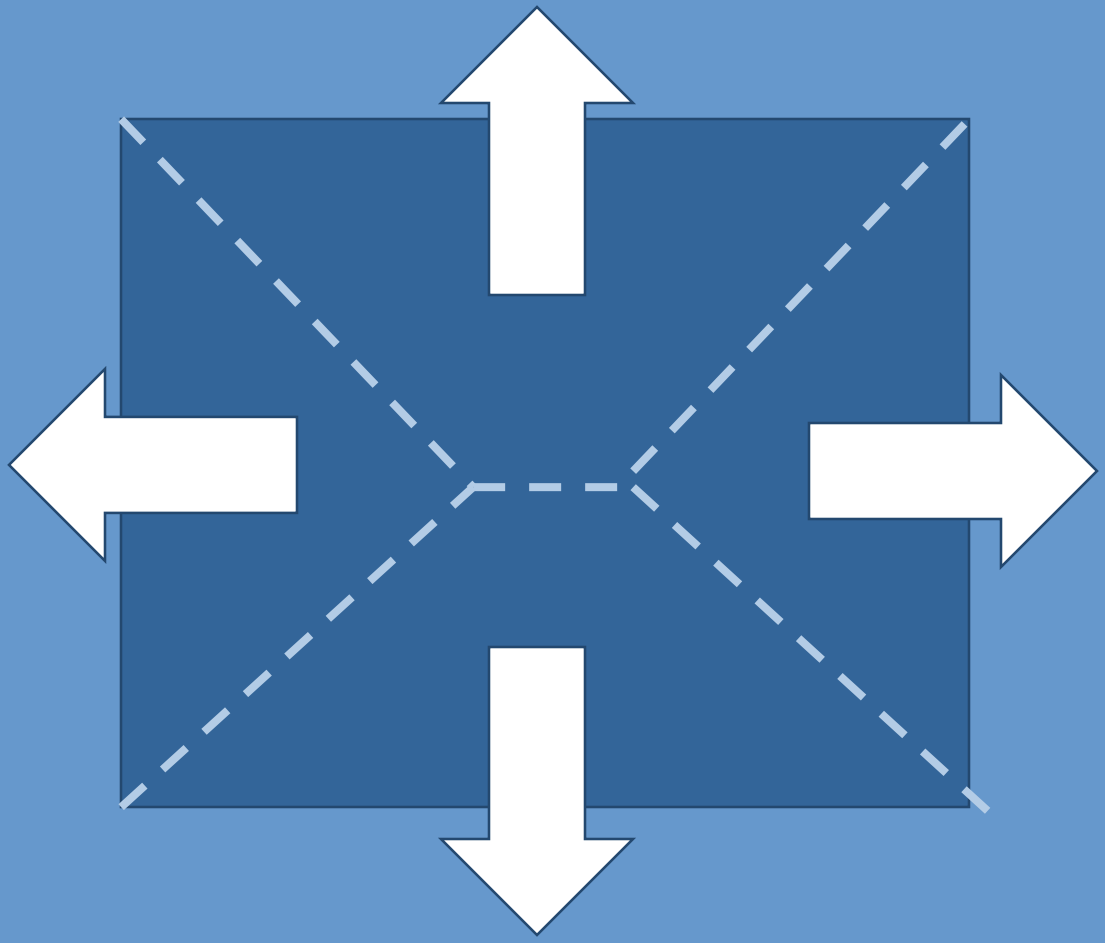
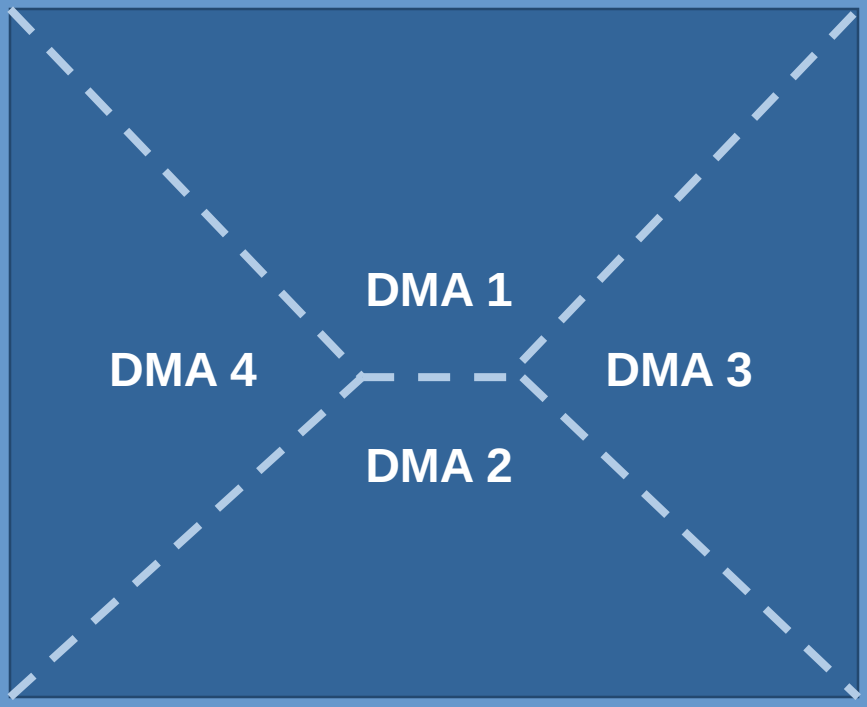
areas

Drainage Management Areas



Drainage Management Areas

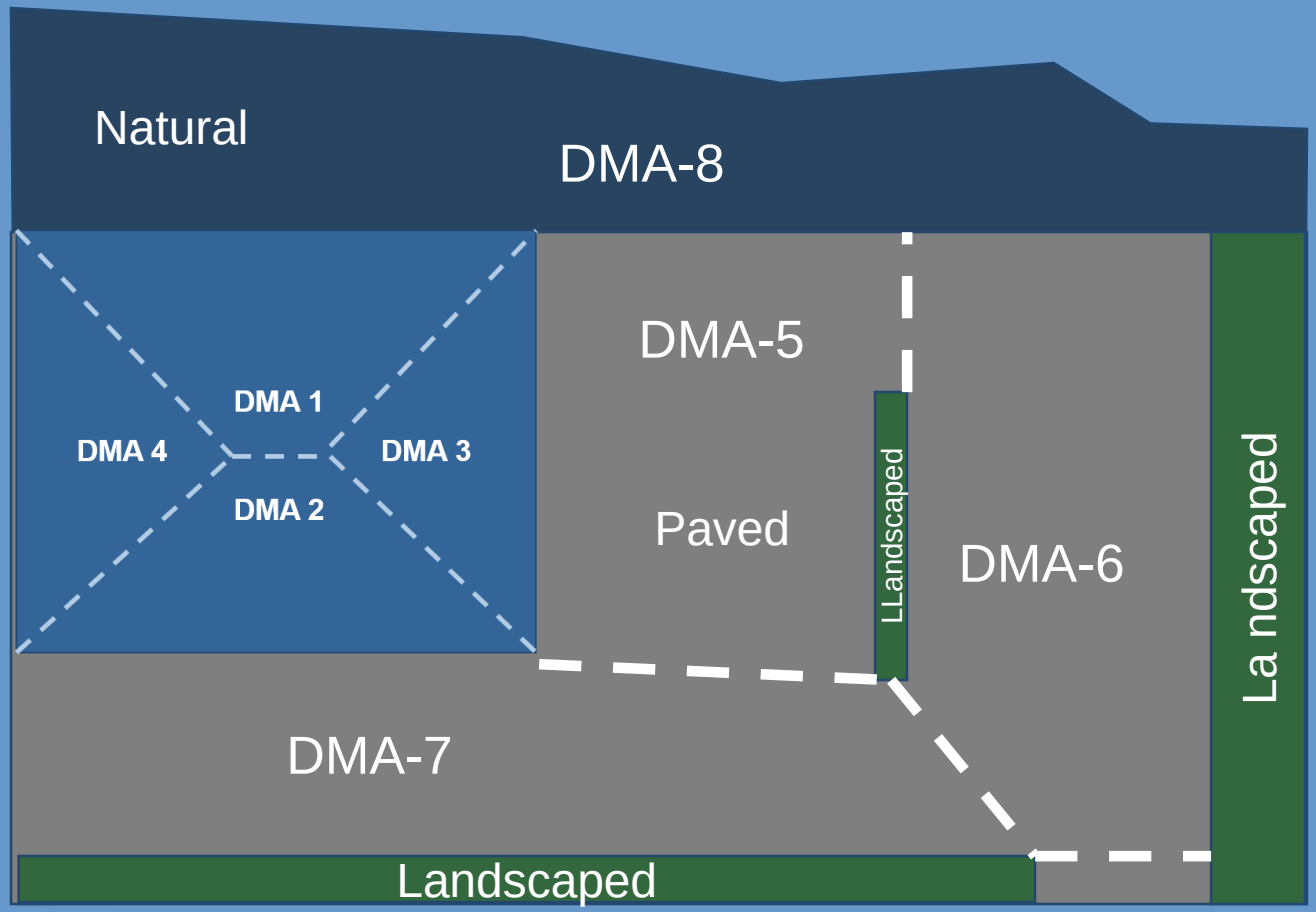
4-1



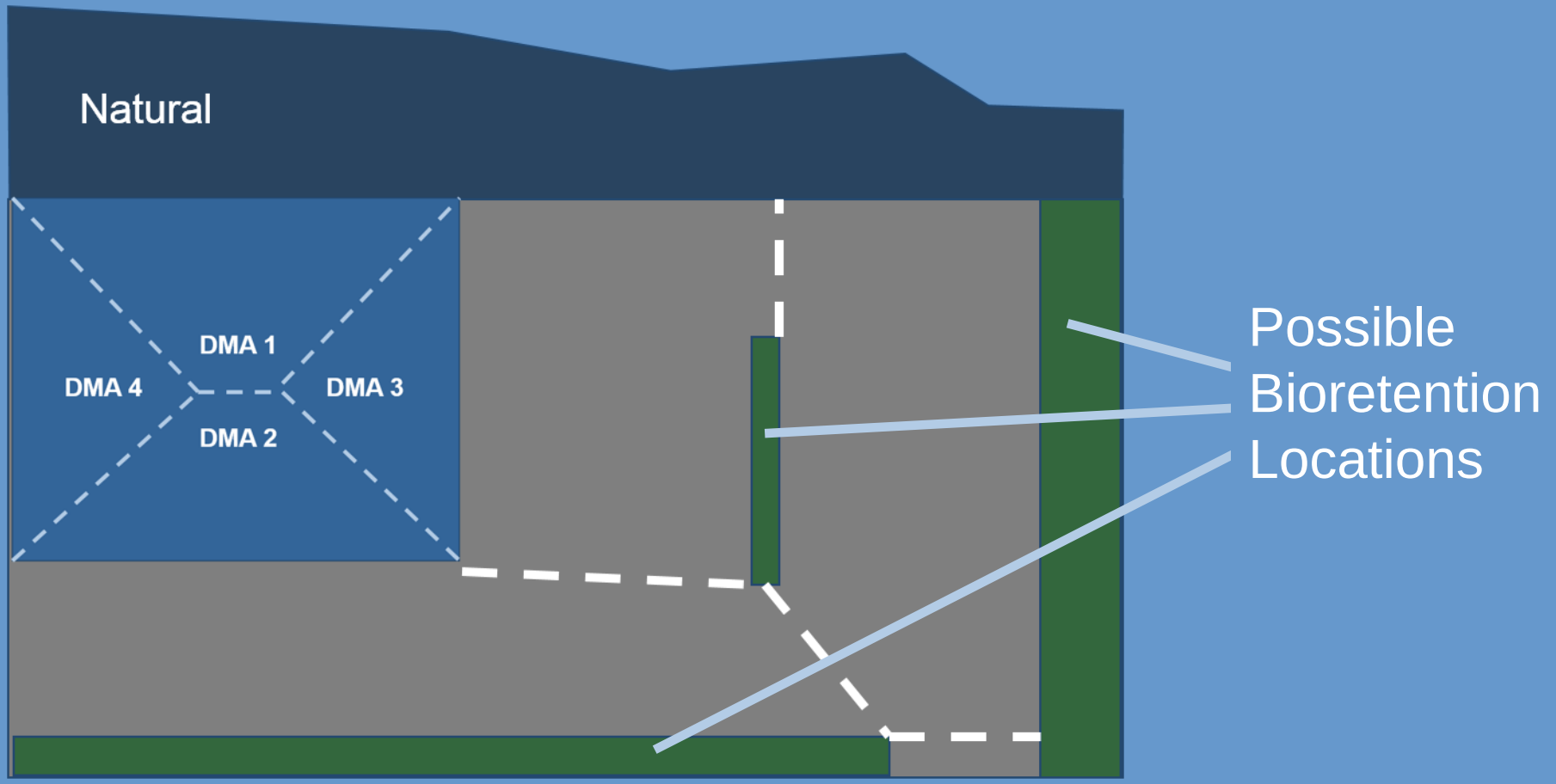
Drainage Management Areas

4-1

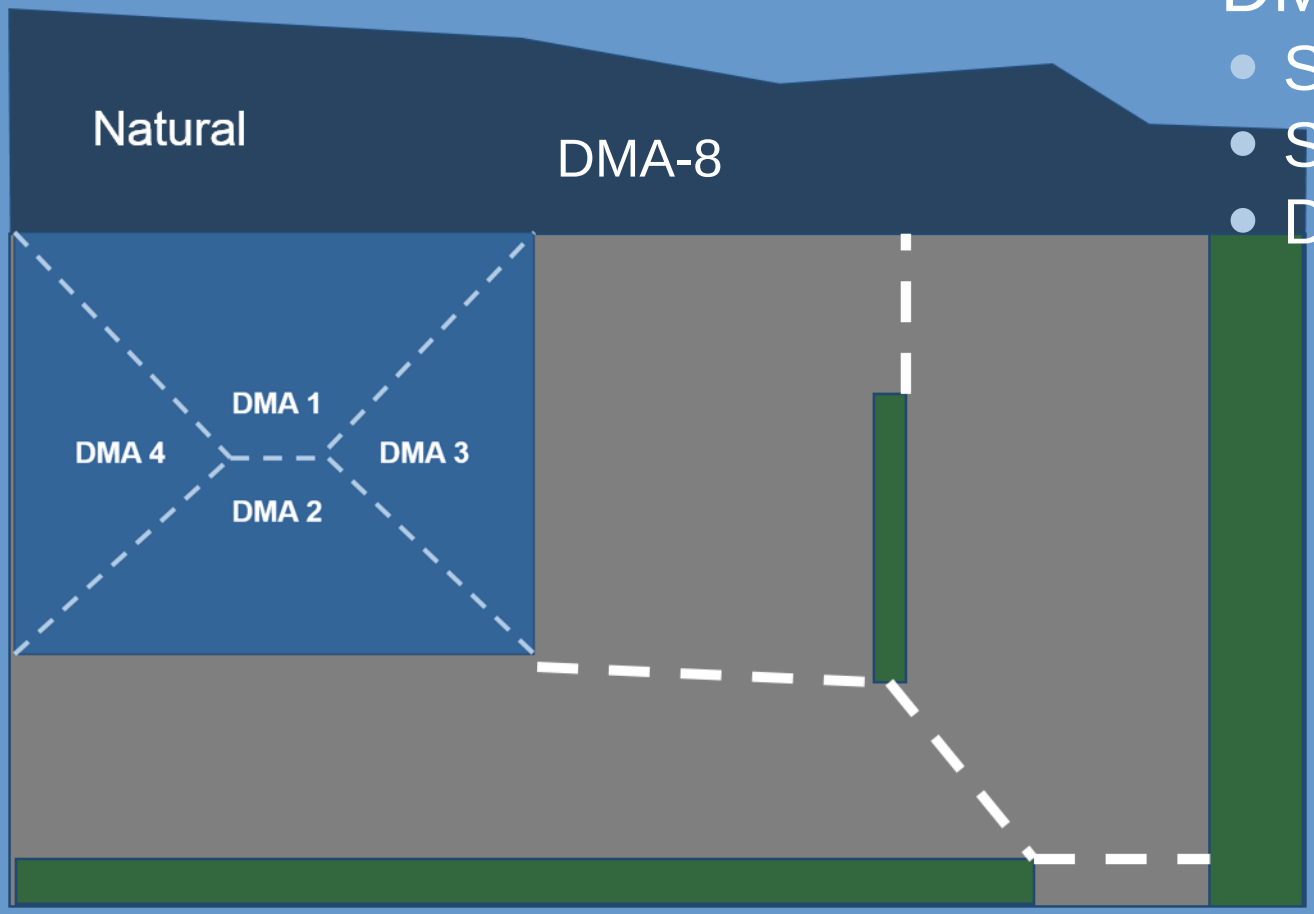
Drainage Management Areas



Drainage Management Areas



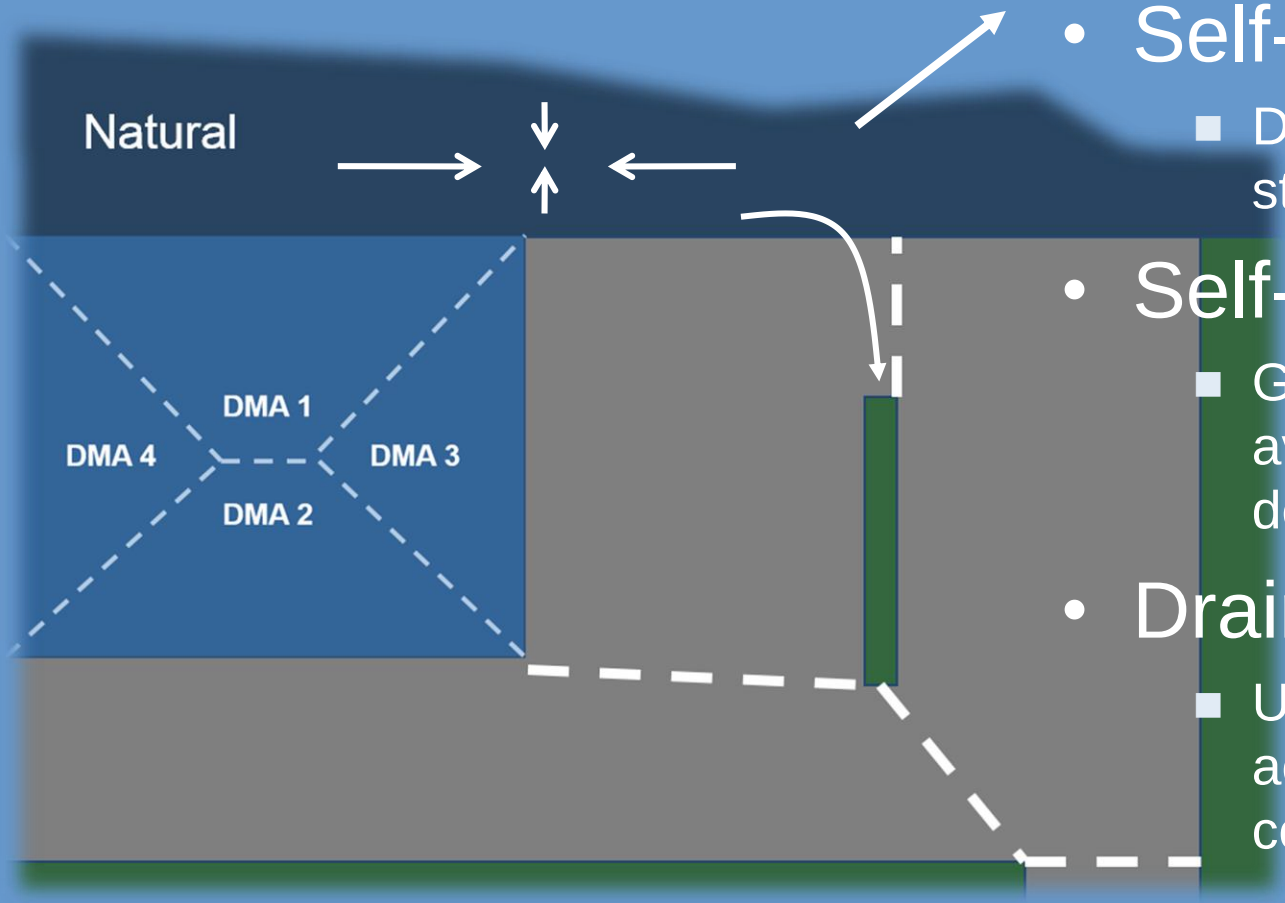
Options – Pervious DMAs



- DMA-8
  - Self-treating?
  - Self-retaining?
  - Drain to Facility?

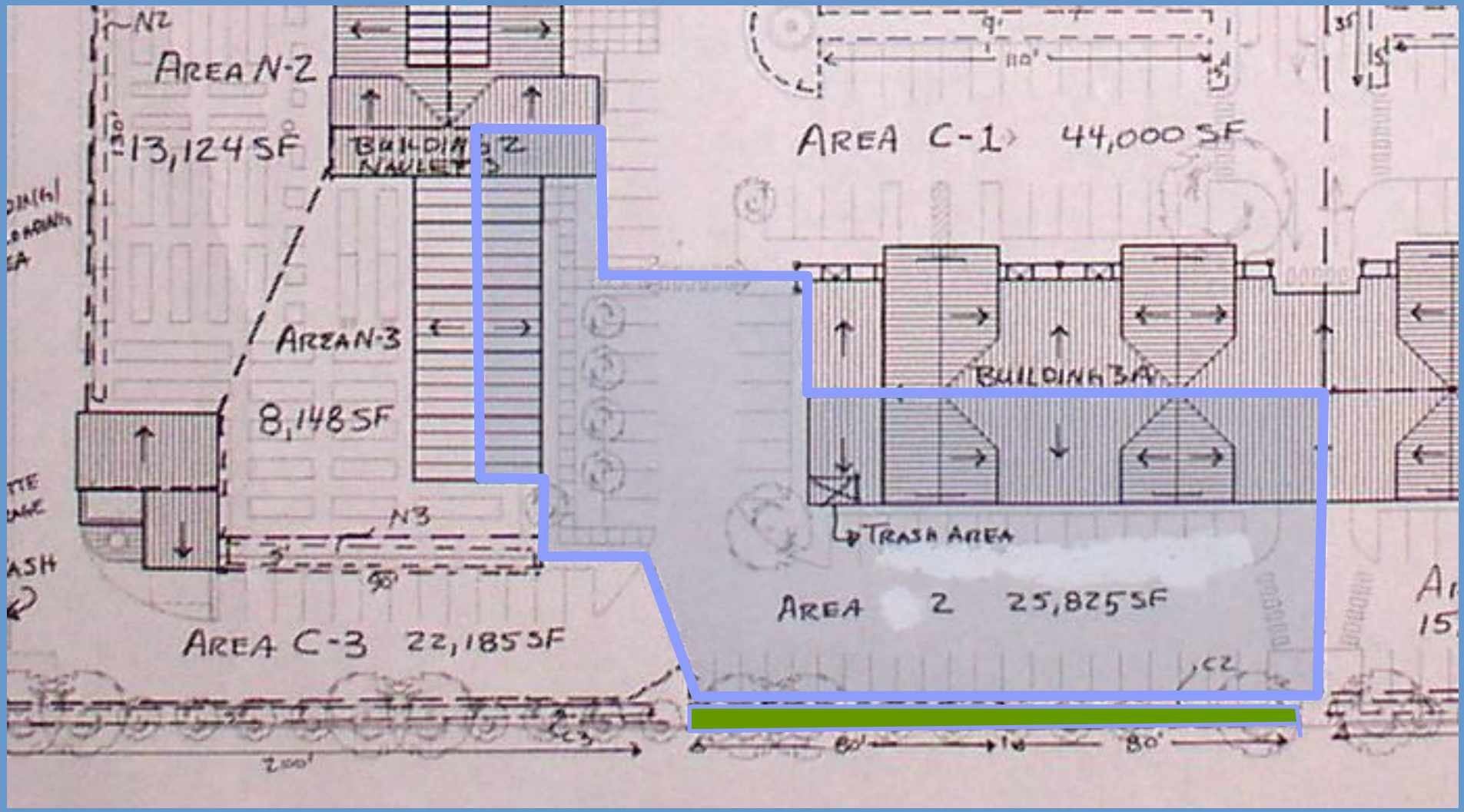
DMA 8

4-2

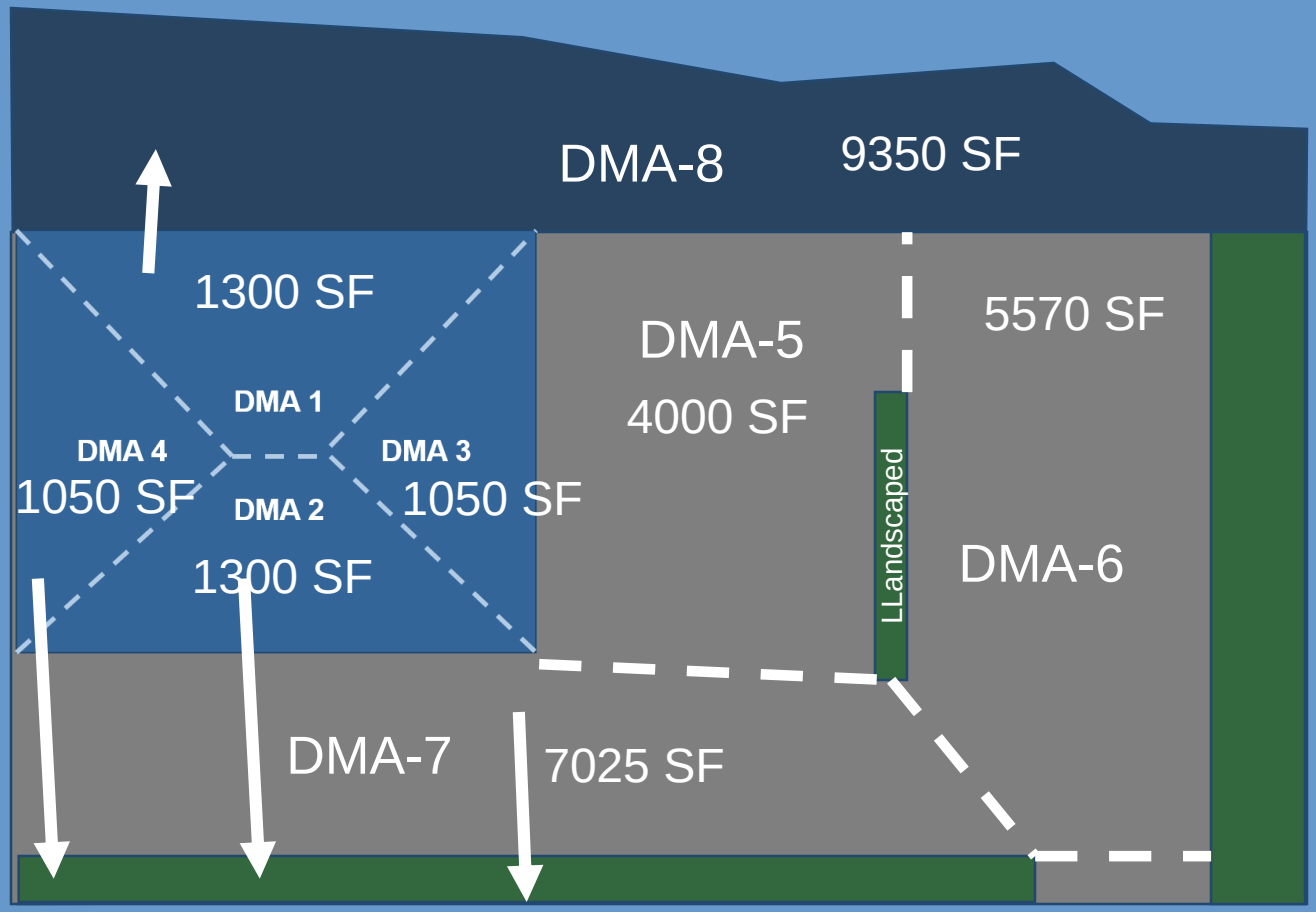


- Self-Treating
  - Drain directly to storm drain system
- Self-Retaining
  - Grade concave to average one-inch depth
- Drain to Facility
  - Use runoff factor to account for contribution

Roof and Grading Plans



Drainage Management Areas



DMA	SF
1	1300
2	1050
3	1300
4	1050
5	4000
6	5570
7	7025
8	9350
Total	**30645**

Setting Up Calculations

- Self-retaining Area

DMA Name	Square Feet
DMA-8	9350

- Area Draining to Self-retaining Area

DMA	Square Feet	Surface	Runoff Factor	Receiving DMA	Receiving DMA Area
DMA-1	1300	Roof	1.0	DMA-8	9350

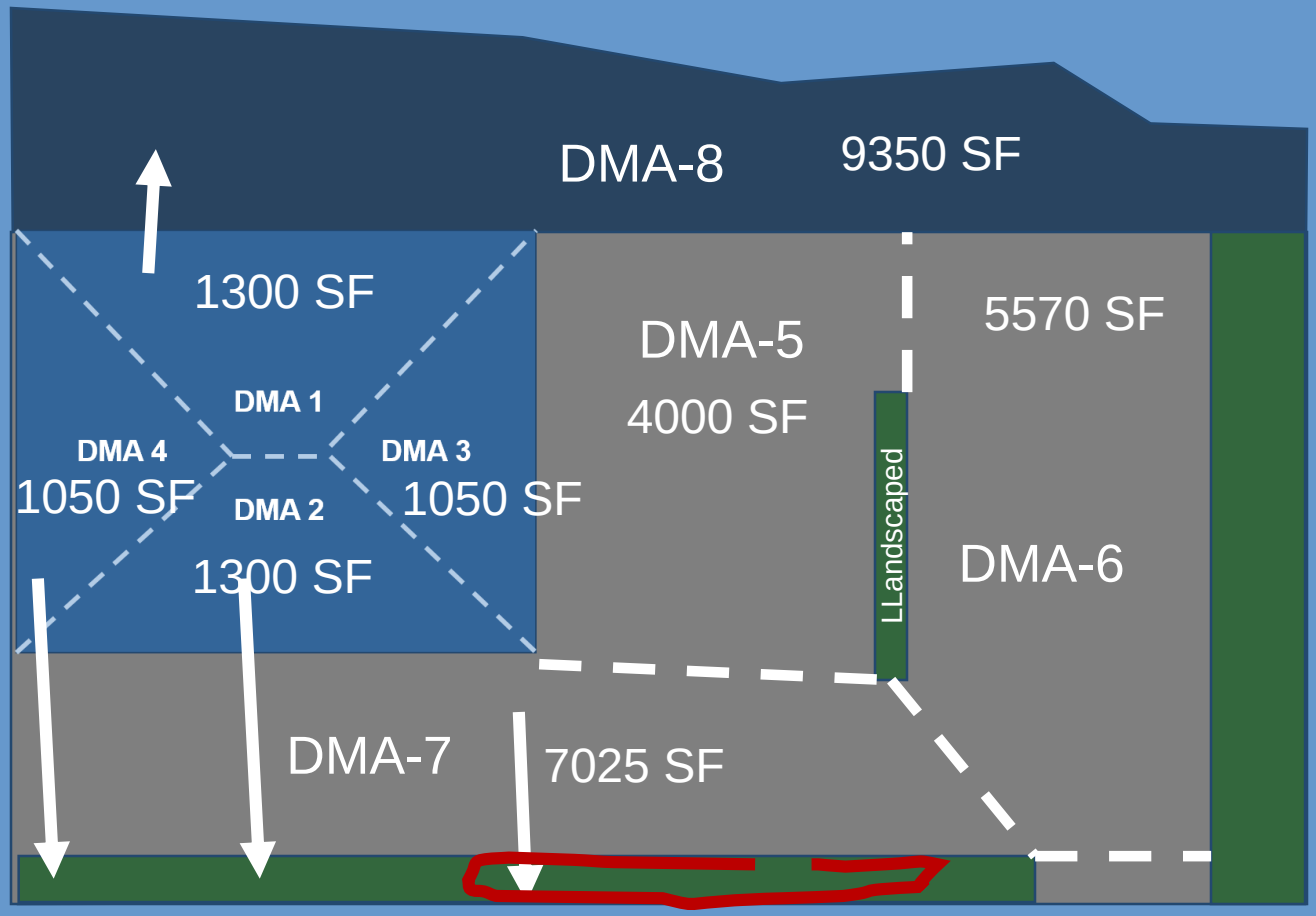
Setting Up Calculations

- Areas Draining to Facilities

DMA	Area	Surface	Runoff Factor	Area × Runoff Factor	Sizing Factor	Facility Size
DMA-2	1050	Roof	1.0	1050		
DMA-4	1300	Roof	1.0	1300		
DMA-7	7025	Paved	1.0	7025		
				9375	**0.04**	**375**

Bioretention Footprint

4-7



DMA	SF
1	1300
2	1050
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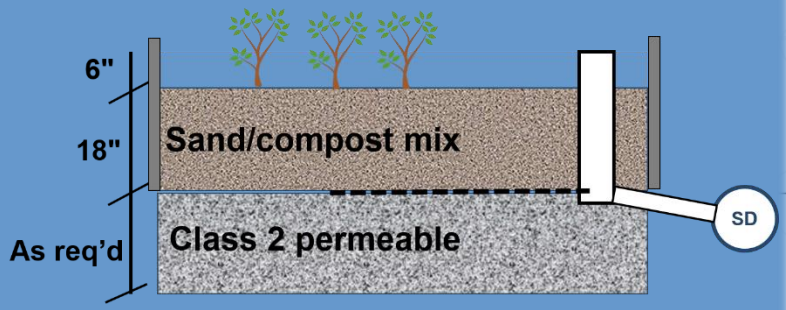
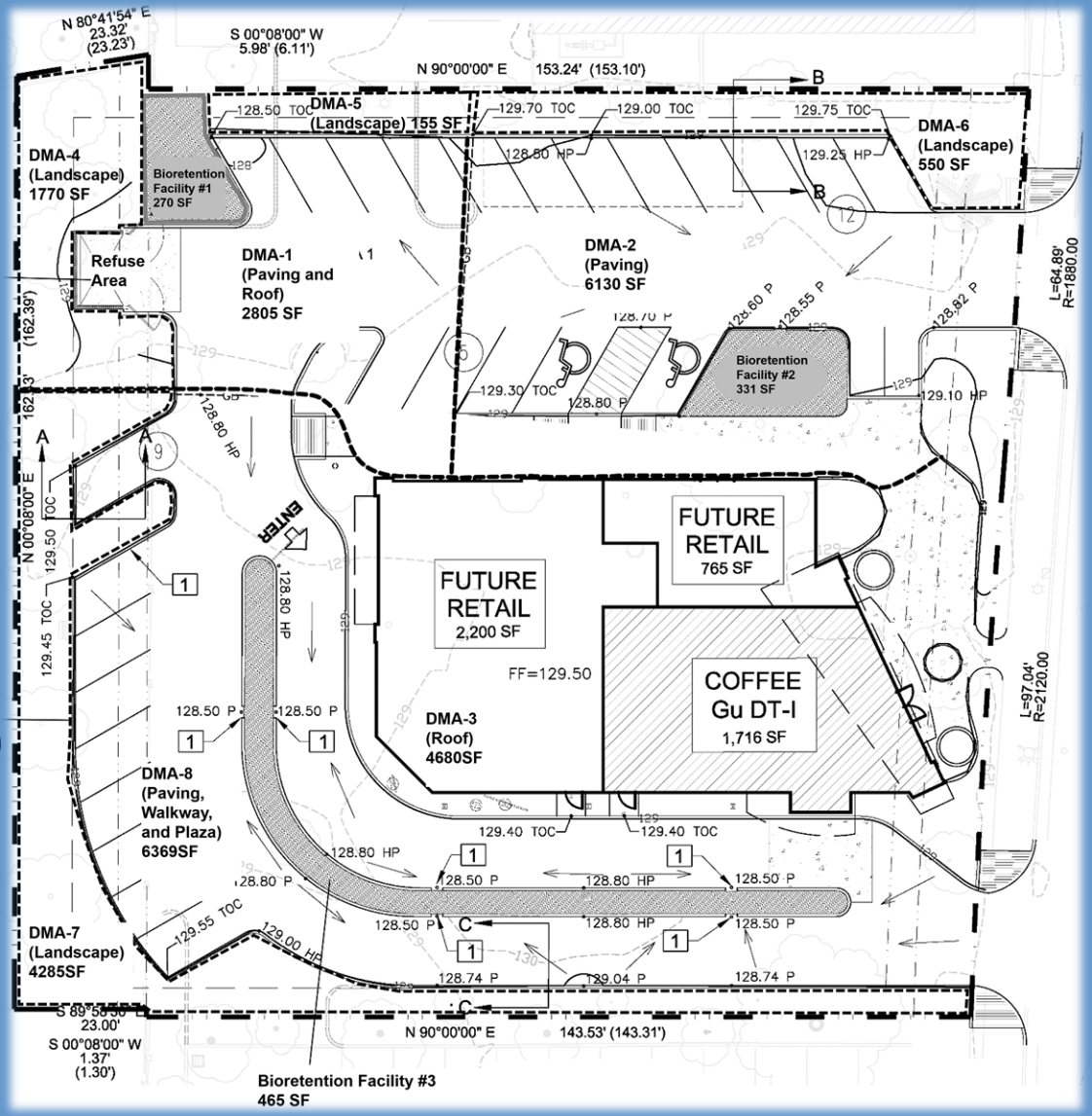
Commercial Project SCP Example





Example Use of E.12 Calculator

Provision E.12 Sizing Calculator

See the instructions and the BASMAA Post-Construction Manual

Step 1: Enter Total Site Area	**Step 2:** List names of all DMAs and square footage of each	**Step 3:** If DMA is "Self-Treating" or "Self-Retaining," copy square footage to appropriate column		**Step 4:** If the DMA is "Drains to Self Retaining" or "Drains to Bioretention" enter runoff factor from Table 4-1		**Step 6:** For "Drains to Self-Retaining" DMAs, enter the name of receiving DMA	**Step 5:** Slide (move) number from this column to correct column (F or H-Q)			
Total Site Area:	27800									
DMA Names	**Square Feet**	**Self-Treating**	**Self-Retaining**	**Runoff Factor**	**Drains to Self-Retaining**	**Name of Receiving DMA**	**Facility 1**	**Facility 2**	**Facility 3**	**Facili**
DMA-1	2805			1			2805			
DMA-2	6130			1				6130		
DMA-3	4680			1					4680	
DMA-4	1770			1			1770			
DMA-5	155			0.1			15.5			
DMA-6	550			0.1			55			
DMA-7	4275			0.1					427.5	
DMA-8	6369			1					6369	
DMA-9										
DMA-10										
DMA-11										
DMA-12										
DMA-13										
DMA-14										
DMA-15										
DMA-16										
DMA-17										
DMA-18										
DMA-19										
DMA-20										
Total DMAs	26734	0	0		0		4646	6130	11477	
						Sizing Factor	**0.04**	**0.04**	**0.04**	
						Minimum Size	186	245	459	
Total Facilities	1066	**Step 7:** Enter Facilty Footprints				**Footprint on Exhibit**	270	331	465	
DMAs + Facilities	27800						OK	OK	OK	O
	OK	**Step 8:** Iterate sizes of facility footprints and DMAs until all footprints are at least the minimum **AND** DMAs								
		Step 9: Check to make sure Areas Draining to each Receiving Self-Retaining Area do not exceed maximum 2								
		Step 10: Check results on this spreadsheet are consistent with what is shown on the SCP Exhibit.								

Topic 1: Provision E.12 Applicability and Requirements

E.12 Applicability at a Glance

1-2

Project Type	Impervious Area	Requirements	Submittal
Single-Family	SF ≥ 2,500	At Least One Site Design Measure	Follow Small Projects template
Small	2,500 ≤ SF ≤ 5,000		
Regulated	SF ≥ 5,000	Site Design + Bioretention	Follow manual and use template
Roads	SF ≥ 5,000*	Case-by-case	

What to count toward threshold

1-1

- Count:
  - New impervious surface that is built on footprint of existing impervious surface
- Do not count:
  - Interior remodels
  - Routine maintenance or repair (including re-roofing)
  - Pavement resurfacing
  - Raised decks or surfaces that drain to sanitary

Hydromodification Management

1-1

- Standard for Phase II municipalities is in Provision E.12.f.
  - Post-project runoff shall not exceed the estimated pre-project flow rate for the 2-year, 24-hour storm.
- A modeling study shows a bioretention facility designed according to the Manual criteria will meet this hydrologic standard.

C

Topic 2:
E.12 Compliance for Small Projects

Using the Template

Small Projects Template

C

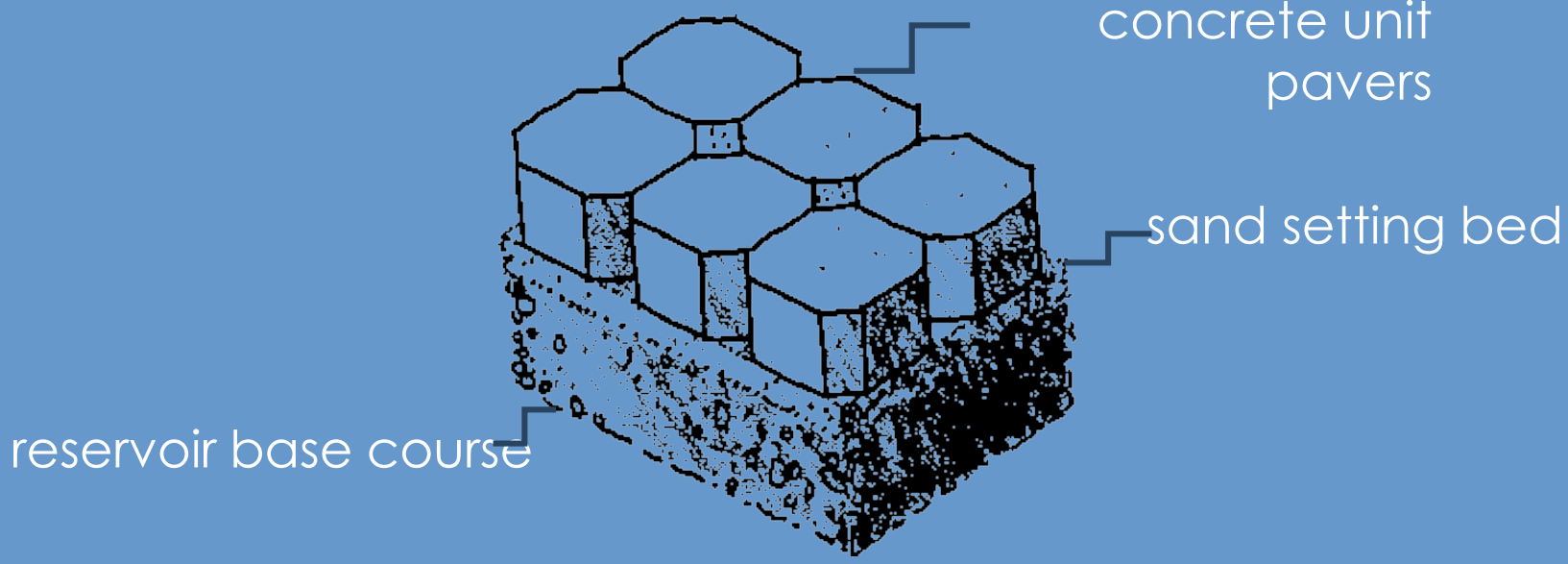
1. Complete Project Data Form
2. Delineate impervious areas and locations of runoff reduction measures
    - Disperse runoff to vegetated area
    - Pervious pavement
    - Cisterns or Rain Barrels
    - Bioretention Facility or Planter Box
3. Complete and submit your plan

Small Projects Options

- Option 1: Disperse runoff from roofs or pavement to vegetated areas
  - Direct downspout to landscaping or
  - Sheet flow from pavement to landscaping
  - Maximum 2 SF impervious to 1 SF pervious
  - Reasonable expectation an inch of rainfall will produce no runoff

Small Projects Options

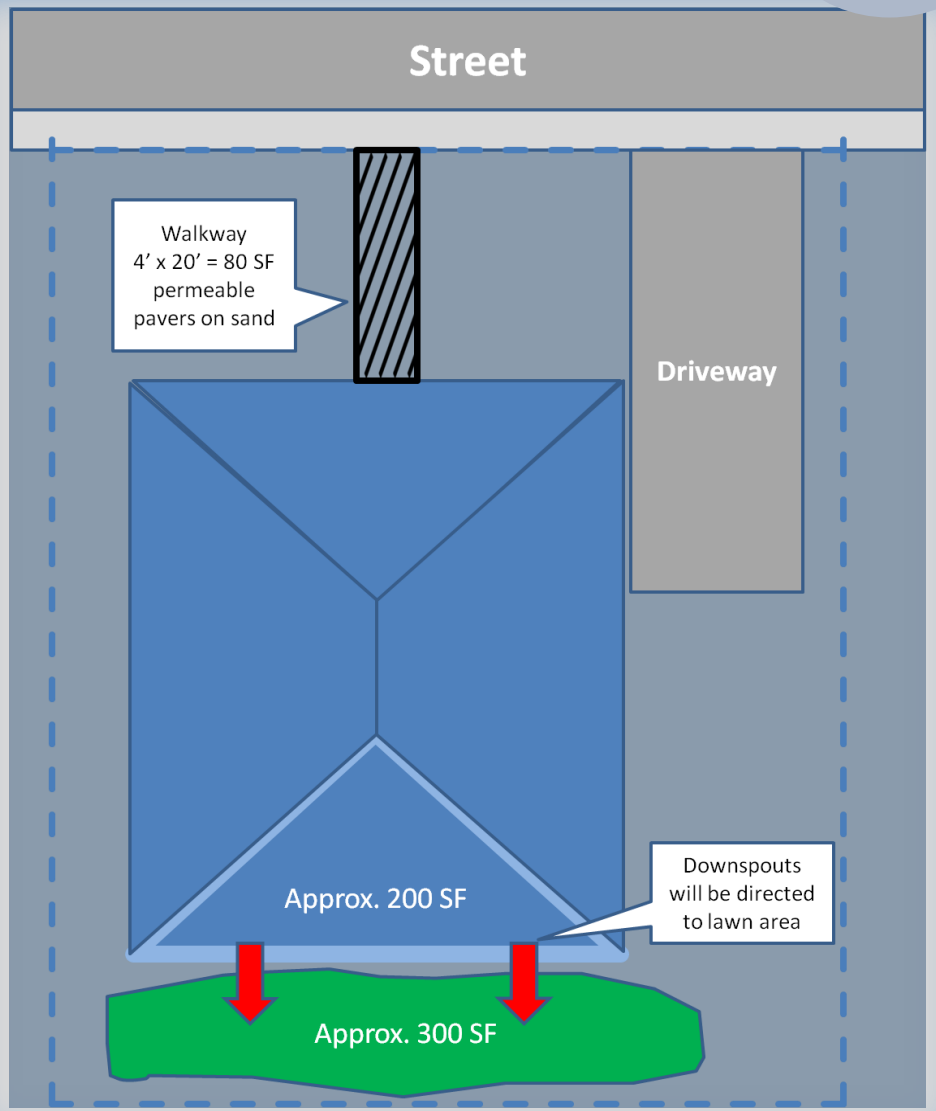
- Option 2: Use pervious pavement
  - Meet design criteria (same as for Regulated Projects)
  - Path or walkway



Small Projects

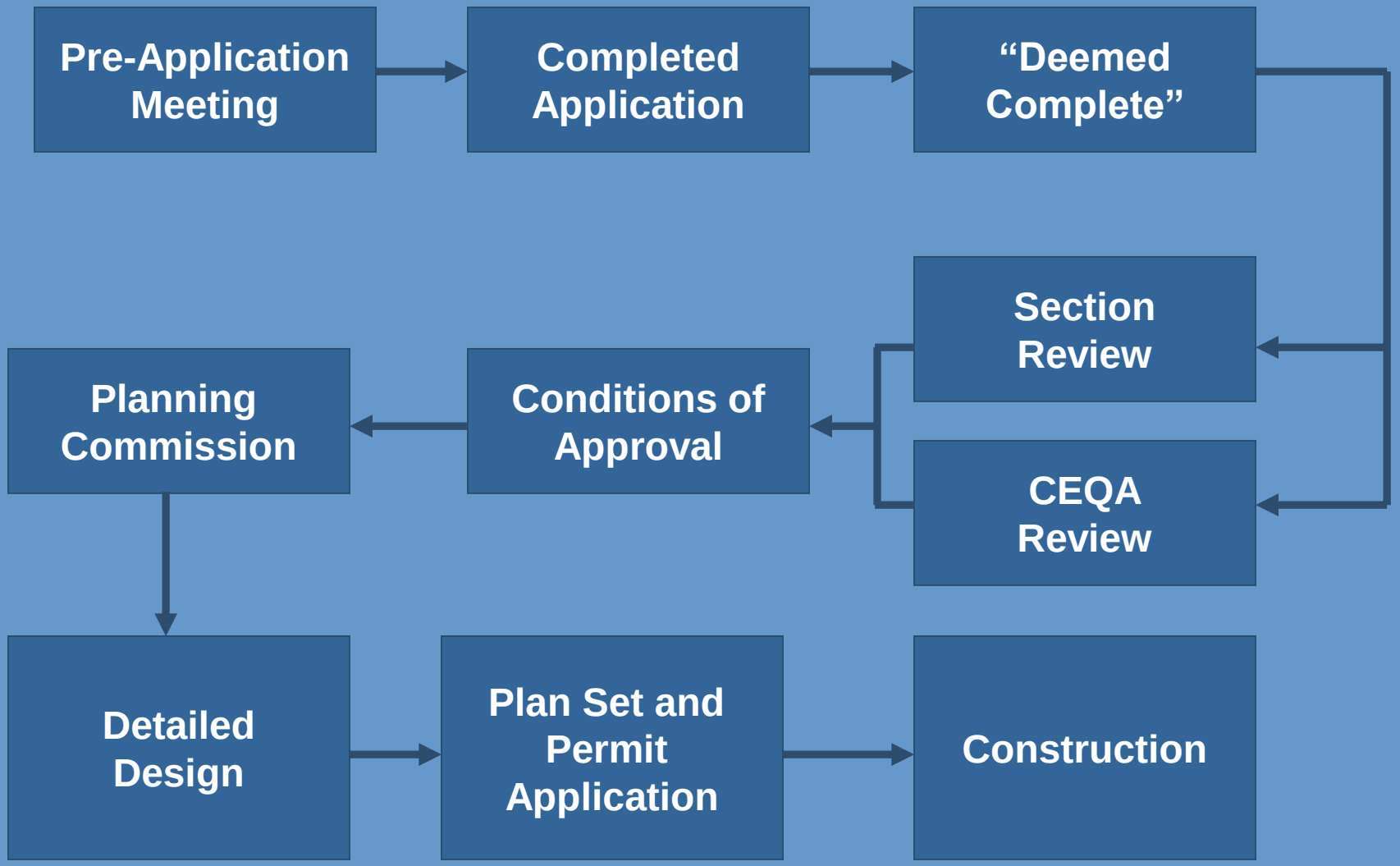
C

- Simple sketch is all that's required
- Delineate areas and show approximate square footage



Topic 3: LID and the Development Review Process

Development Process



Conditions/Mitigation Measures

- Disperse runoff from impervious roofs and pavement to adjacent pervious areas where feasible.
- Include bioretention facilities to detain, retain, and treat runoff from remaining roofs and pavement.
- Put bioretention facilities in high-visibility, well-trafficked, common accessible areas and integrate them with site landscaping.

Submittal for Entitlements

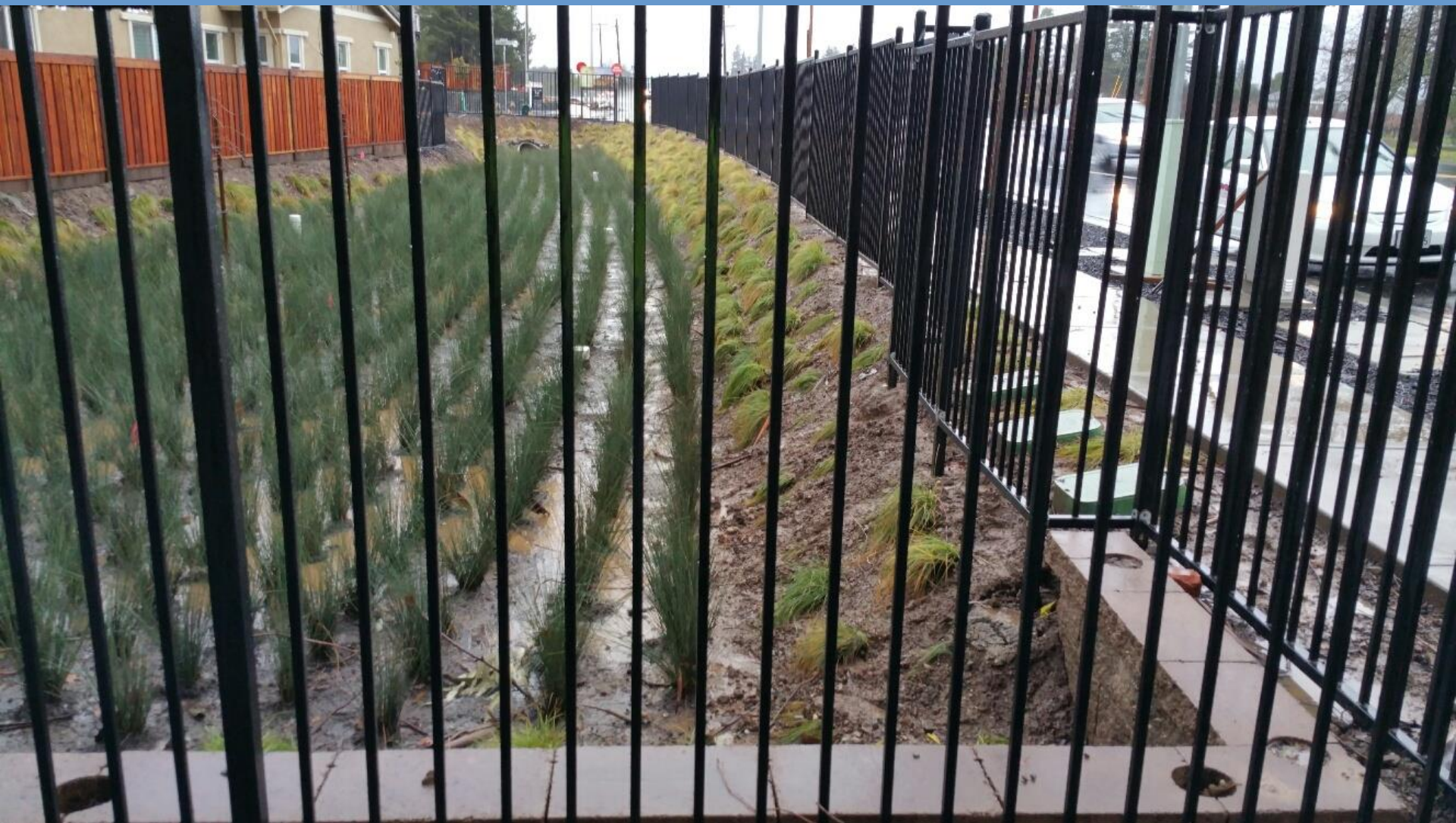
- Show LID features and facilities on:
  - Site Plan
  - Landscape Plan
  - Preliminary Grading and Drainage Plan

Bioretention Facilities Locations

- High-visibility, well-trafficked places
- Common, accessible areas
- Dispersed throughout the site
- Drain only impervious roofs and pavement
- Use surface drainage; keep runs short
- Make facilities flat and level
- Make top of soil elevation high as possible

Don’t create pits

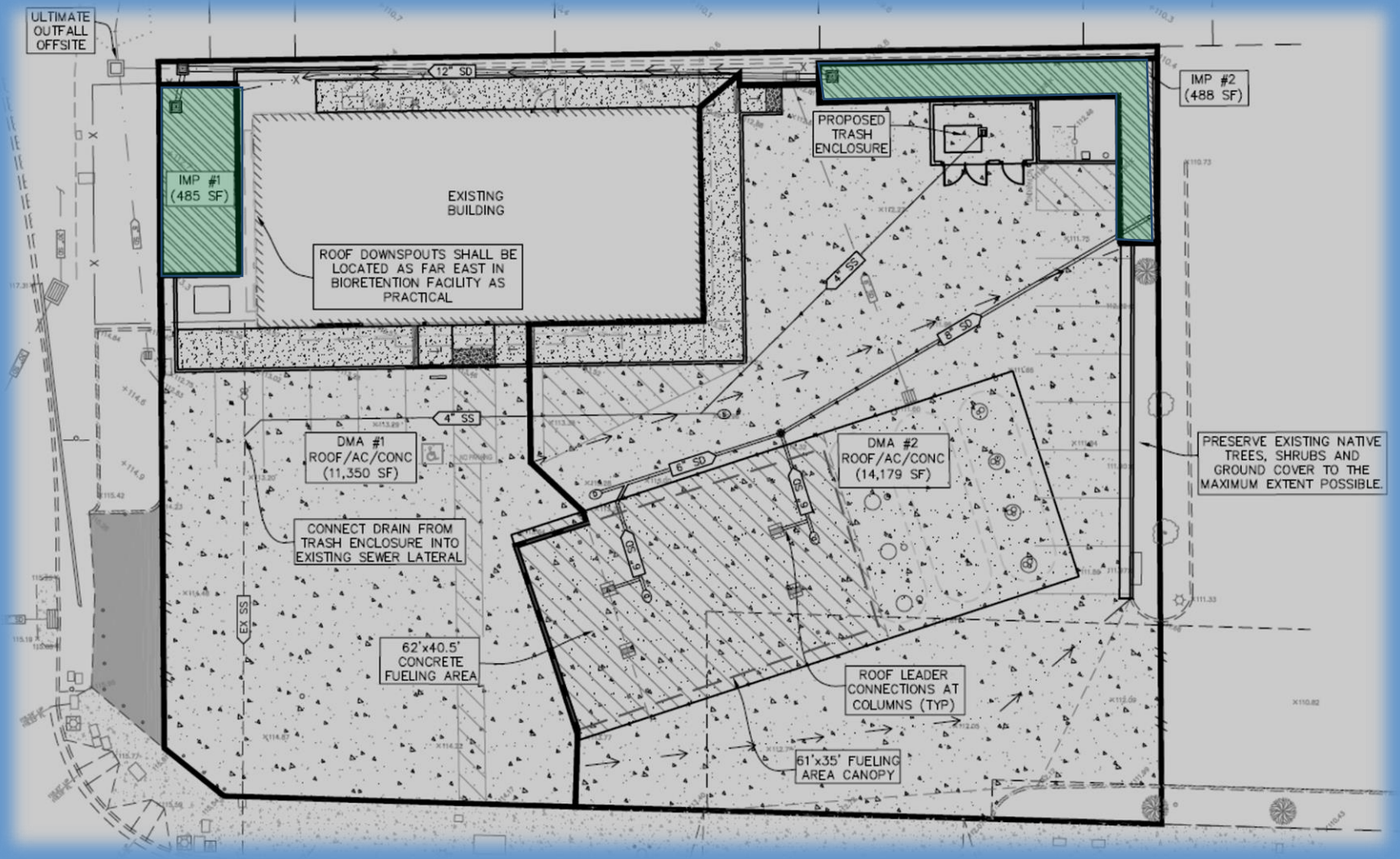
Don’t create pits



Optimal size for bioretention?

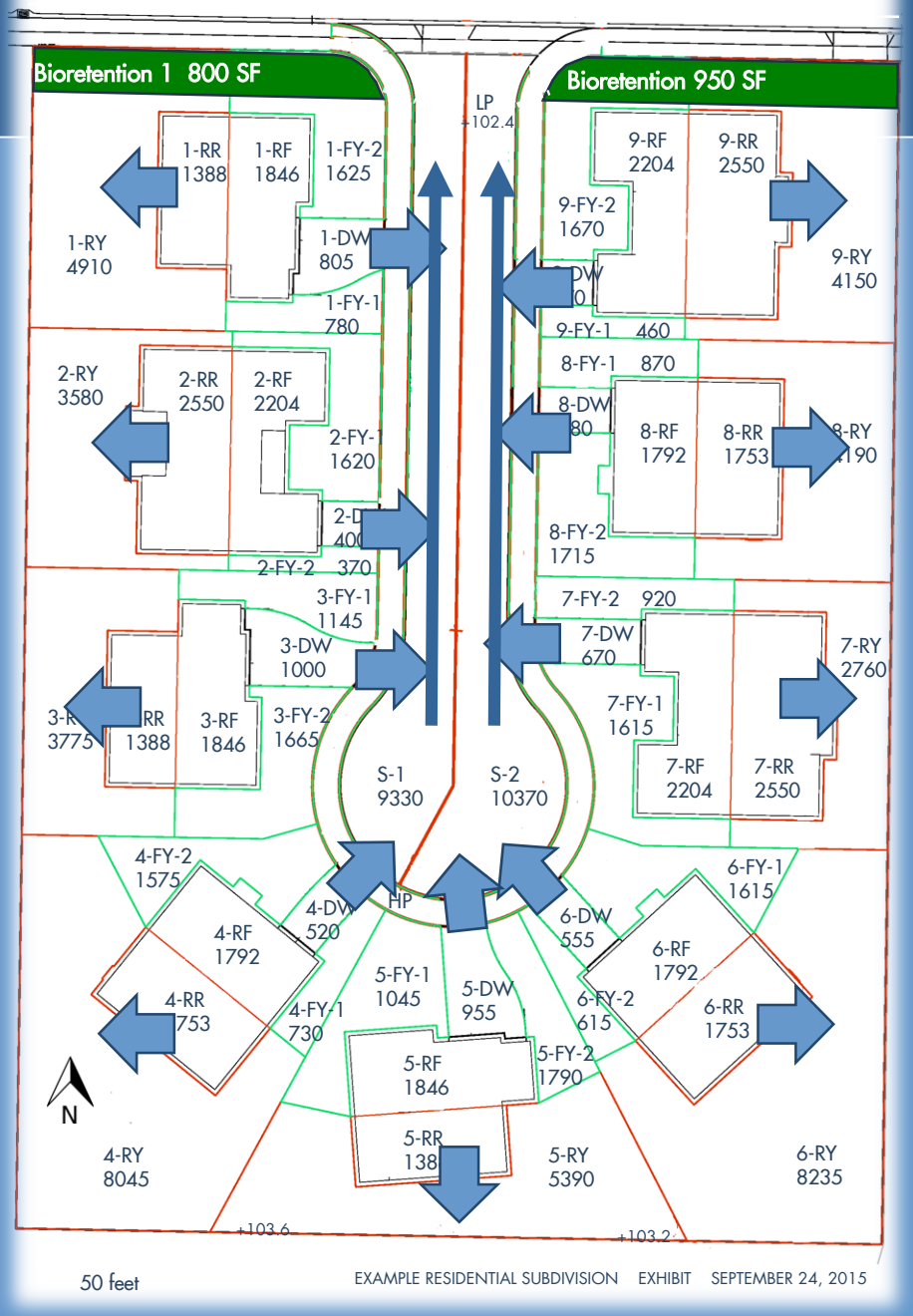
Small Shopping Center

Gas Station/Mini-Mart



Subdivisions 3-5

- Drain a portion of each roof to yard
- Drain driveways to street
- Drain street to bioretention facilities on commonly owned parcels



Exceptions to Bioretention

3-6

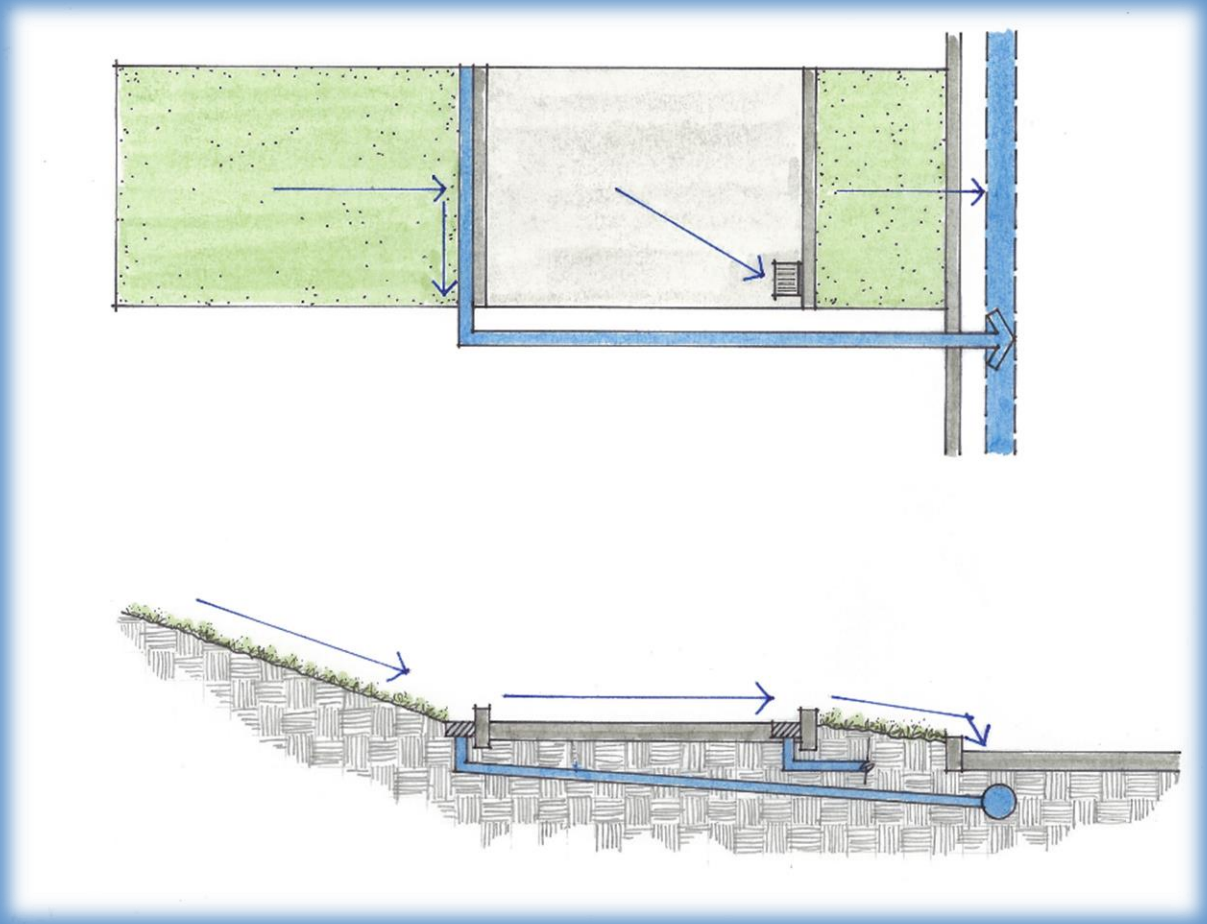
- An acre or less of impervious area
  - Designated pedestrian oriented district
  - 85% of project site covered by structures
- Facilities receiving runoff only from pre-project impervious areas
- Historic sites, structures, or landscapes

Topic 4. Self-Treating and Self-Retaining Areas

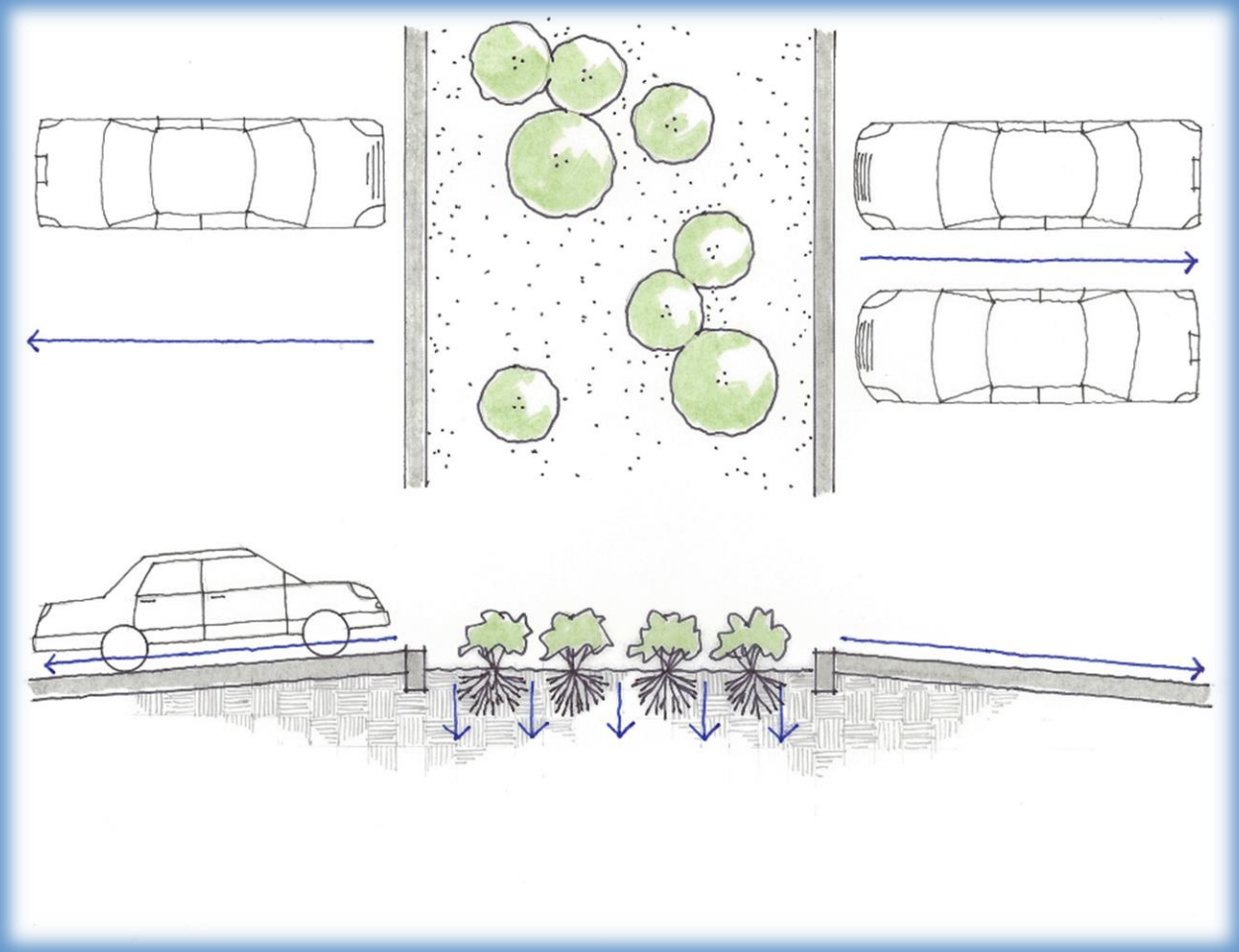
Self-Treating and Self-Retaining

- Essential to LID design
- Track and quantify runoff reduction
- Steps:
  - Delineate Drainage Management Areas
  - Classify DMAs
    1. Self-treating areas
    2. Self-retaining areas
    3. Areas draining to self-retaining areas
    4. Areas that drain to IMPs

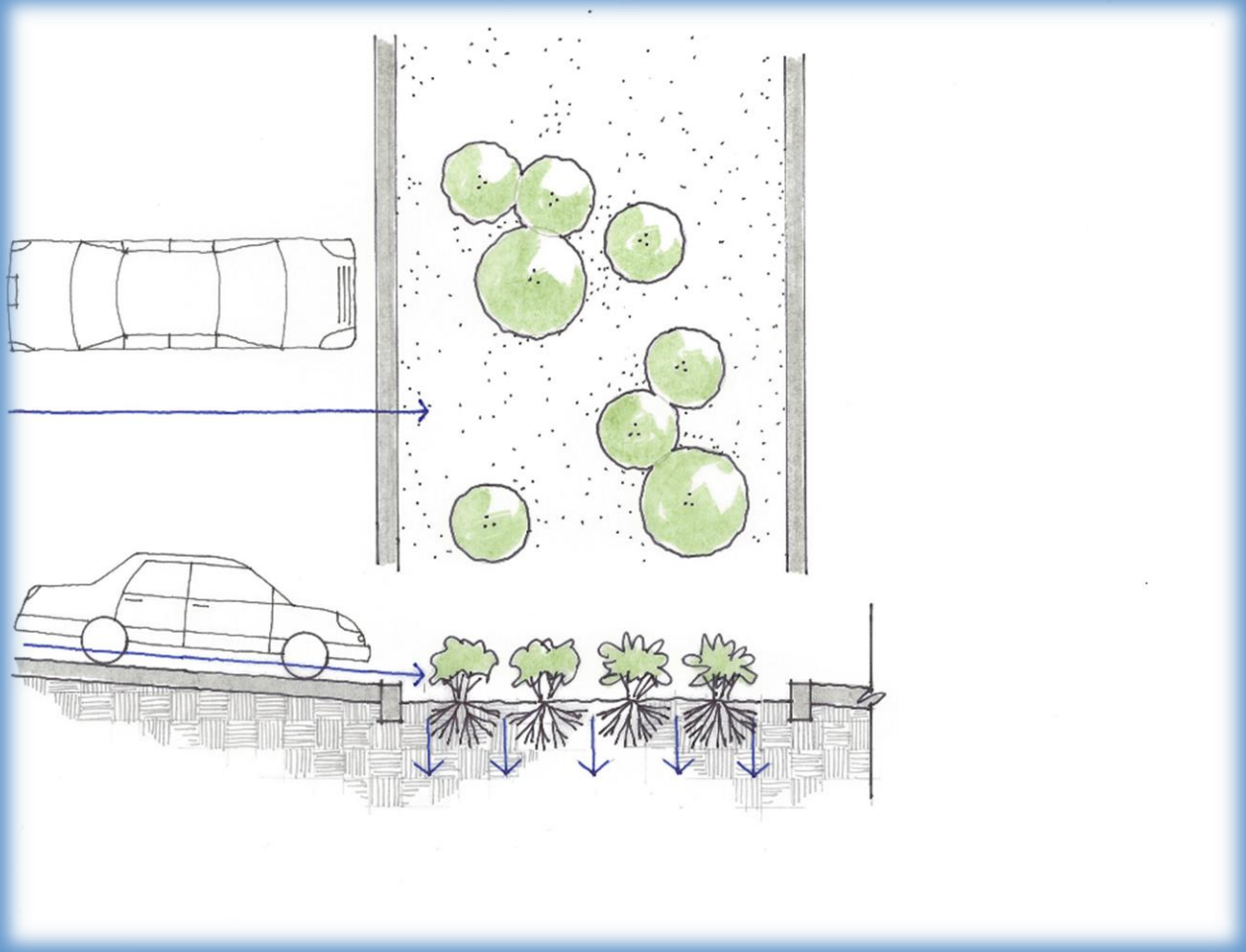
Self-treating Areas



Self-retaining Areas



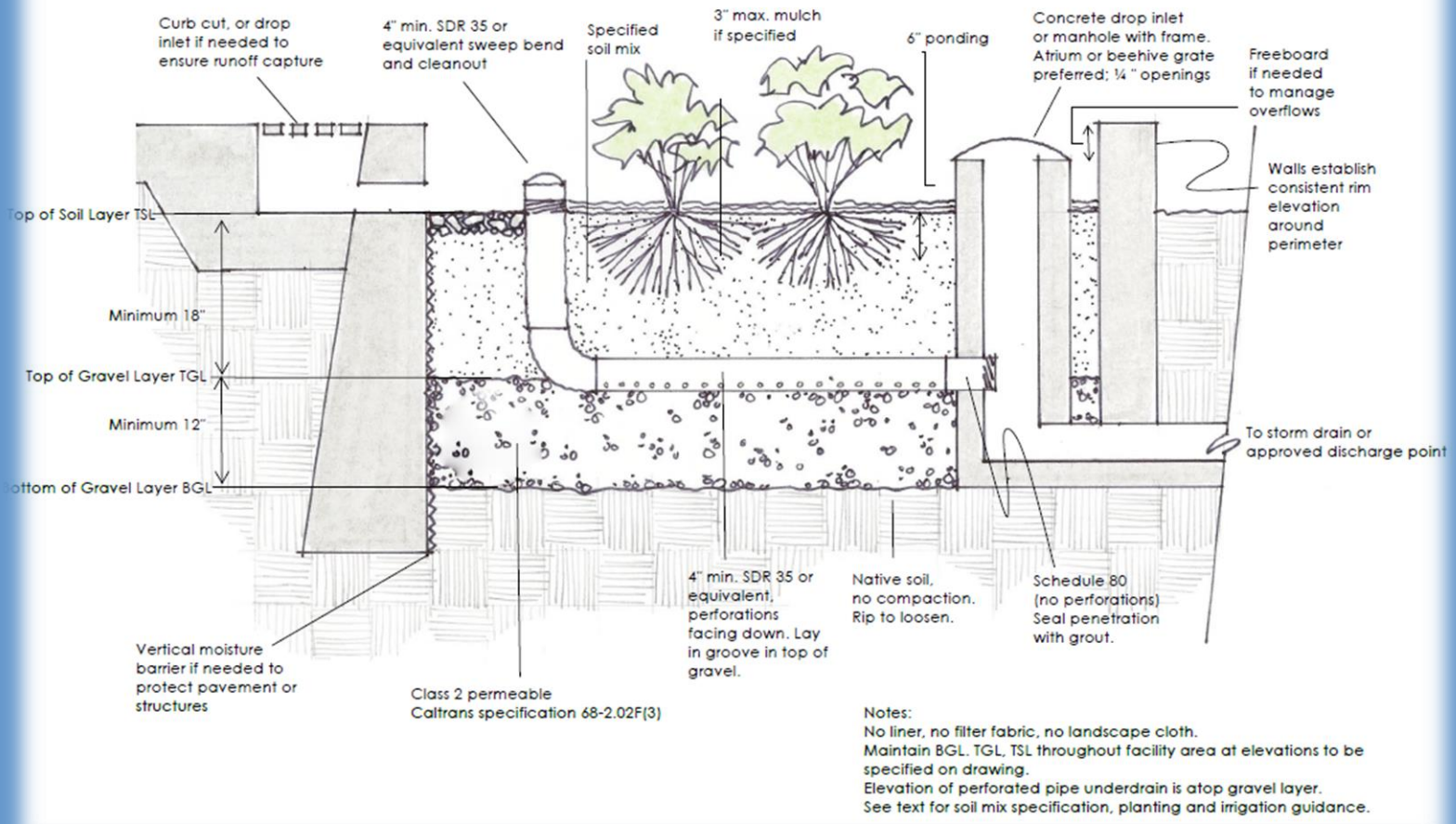
Areas draining to self-retaining



Topic 5. Bioretention Design Criteria

Bioretention Design Criteria

Figure 4-5. Bioretention Facility
Cross-section
Not to Scale

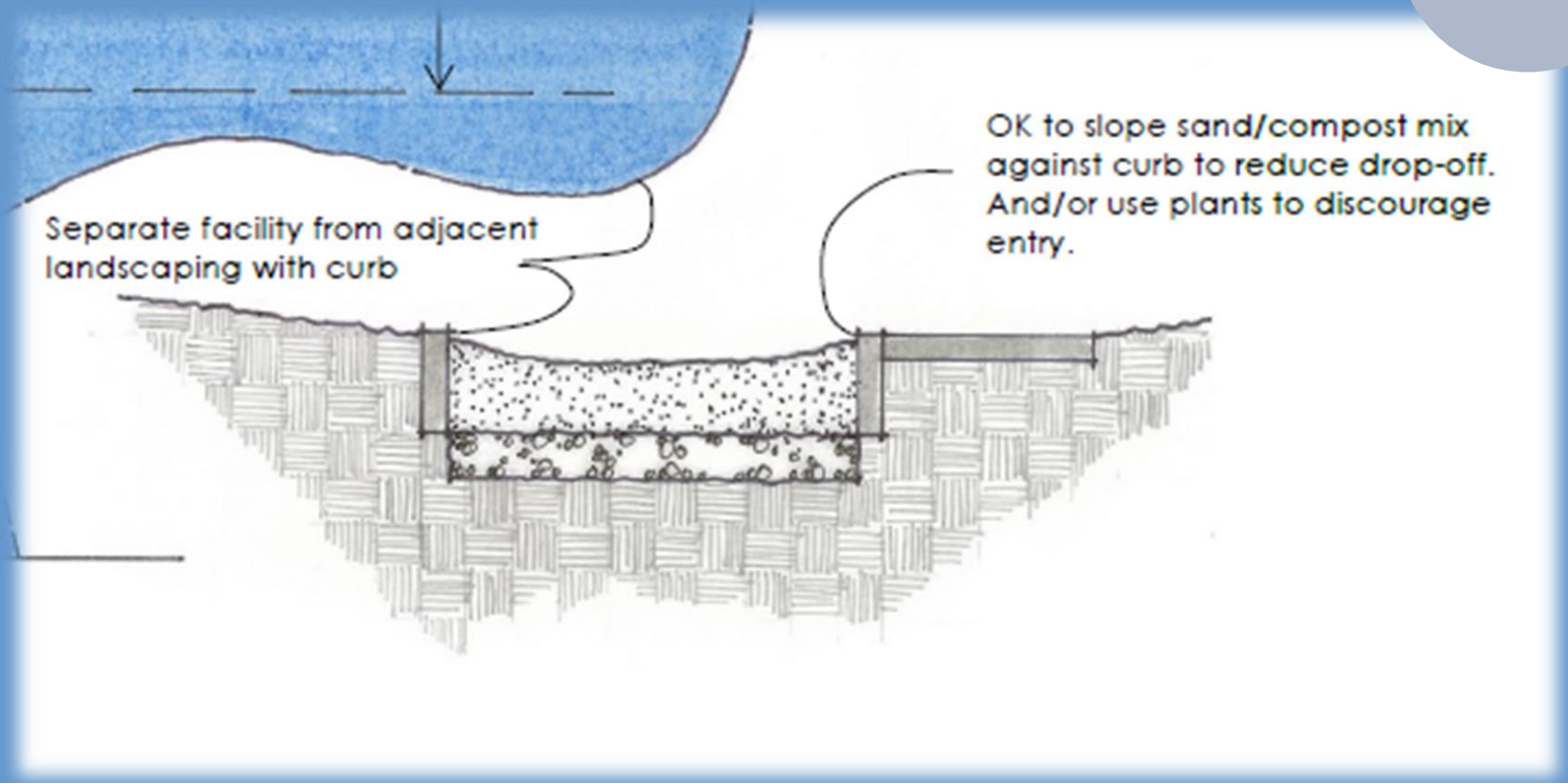


Notes:
No liner, no filter fabric, no landscape cloth.
Maintain BGL. TGL, TSL throughout facility area at elevations to be specified on drawing.
Elevation of perforated pipe underdrain is atop gravel layer.
See text for soil mix specification, planting and irrigation guidance.

Edge Treatments

4-7

4-11



Make This Happen

4-6

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

Flat, Flat, Flat

4-6

Gravel and Underdrain

4-7

- 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

Flat, Flat, Flat

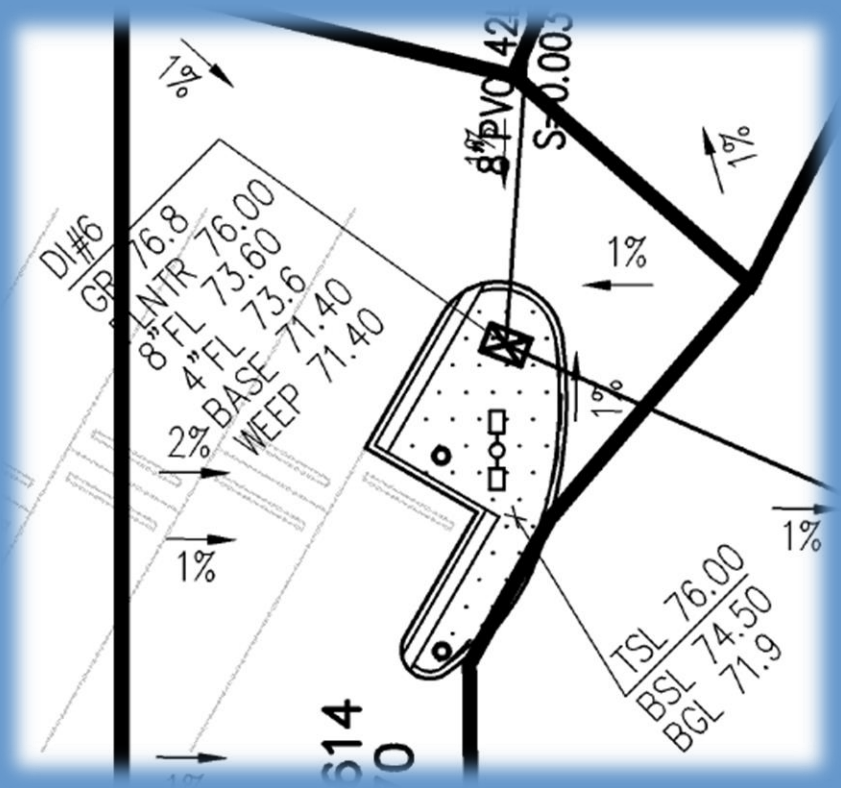
Planting Medium

4-8

- 60-70% **Washed** 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

Call out elevations

- Outlet structure
  - Overflow grate
  - Underdrain connection
- Soil layers
  - Top of soil layer
  - Bottom of soil layer
  - Bottom of gravel layer



Foundations and Pavement

Plants that work

F

Plant Categories	
Grasses and Grass-like Plants	Grass refer to those species that are monocotyledonous plants with slender-leaved herbage.
Herbaceous Perennials and Groundcovers	Herbaceous refers to those species with soft upper growth rather than woody growth. Some species will die back to the roots at the end of the growing season and grow again at the start of the next season. This list only includes those that are perennial, i.e. live for several years.
Shrubs	Shrub is a horticultural distinction that refers to those species of woody plants which are distinguished from trees by their multiple stems and lower height. A large number of plants can be either shrubs or trees, depending on the growing conditions they experience.
Small Tree	Small trees refers to those species of woody plants with one main trunk and a distinct and elevated head with a maximum size of 25' tall and wide.
Tree	Tree refers to those species of woody plants with one main trunk and a rather distinct and elevated head with a size greater than 25' tall or wide.
Water Preference	
Water Preference-Low/Moderate/High	We have provided recommendations for irrigation. All plants should be watered with more frequency during the first two years after planting. After this establishment period, Low water use plants will only need supplemental irrigation at the hottest and driest sites. Plants with Moderate irrigation needs will be best with occasional supplemental water (once per week to once per month) and plants with High irrigation needs will be best with more frequent watering especially during periods of drought in the cooler seasons.
Water Preference-Summer Irrigation	Plants with a check in this column will not withstand a long period of summer drought without irrigation. Plants with an 'ok' in this column are tolerant of, but do not require, frequent summer irrigation. Plants with nothing in this column may not tolerate summer irrigation after establishment.
Stress Tolerance	
Tolerates Heat	A check in the heat column indicates that the plant will tolerate hot sites. It should not be confused with a plants preference for sun. Absence of the check indicates it should only be used in areas close to the Bay or other cool sites.
Tolerates Coast	The coast column indicates plants that perform well within 1,000 feet of the ocean or bay. Most of these plants tolerate some amount of salt air, fog, and wind.
Tolerates Wind	A check in the wind column means that the plant will tolerate winds of ten miles per hour or more.
Zone 1	Plants that tolerate Zone 1 are common riparian, wetland and bog plants capable of surviving in

Avoid design conflicts

- Elevations consistent with grading and architectural plans
- Facilities do not interfere with parking or pedestrian circulation
- Utilities are located elsewhere

Topic 6. Bioretention Construction

Construction Checklist

B

- 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

Topic 7. Bioretention Operation and Maintenance

Key O&M Requirements

- Composted mulch
- No fertilizer
  - See instructions for using compost tea
- Weed manually
  - Listed “natural” herbicides for invasions
- No synthetic pesticides
  - Beneficial nematodes or listed natural pesticides

Typical maintenance plan

- Inspect weekly for trash and remove
- Weed monthly
- Check drainage and inspect facilities before the rainy season
- Inspect after each significant rainfall
- Annual vegetation cut-back and maintenance

Wrap Up