

The Contra Costa Approach: Low Impact Development Facilities for NPDES Compliance

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Topics

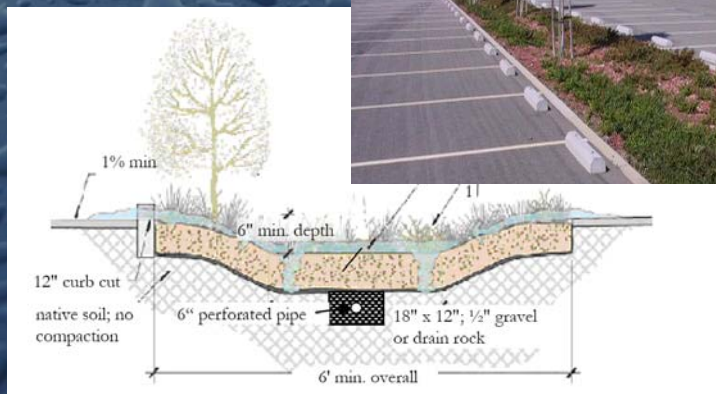
- Derivation of sizing factors
- LID Design
 - design procedure
 - design criteria
- The IMP Sizing Calculator

Low Impact Development

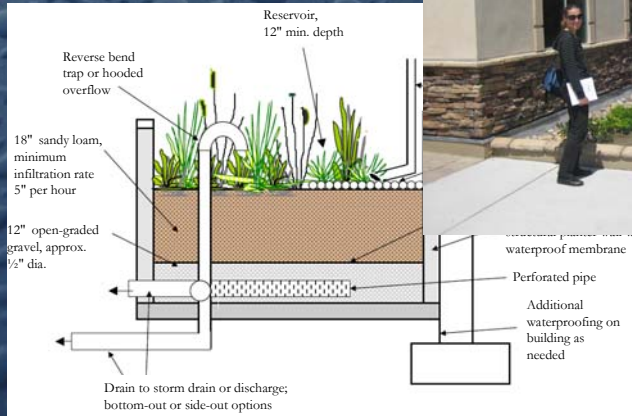
- Stormwater treatment *and* flow control
- Minimize imperviousness
- Disperse runoff
- Use Integrated Management Practices (IMPs)



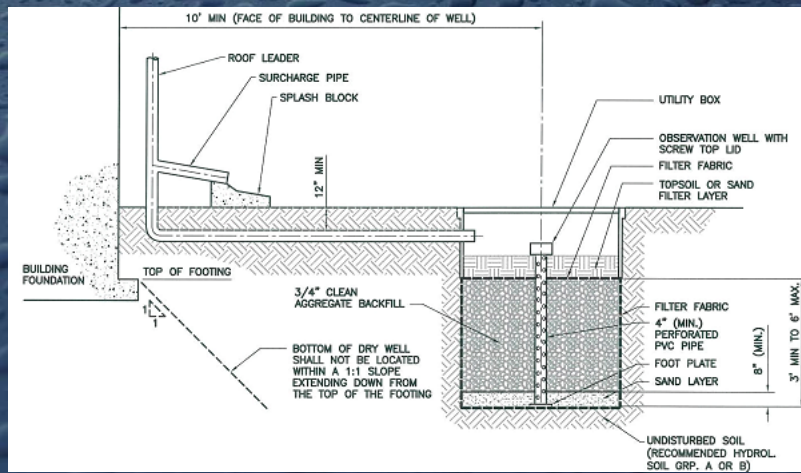
Bioretention Facility



Flow-through Planter

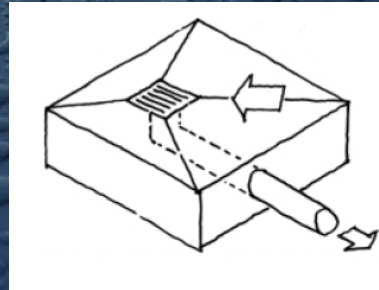


Dry Well

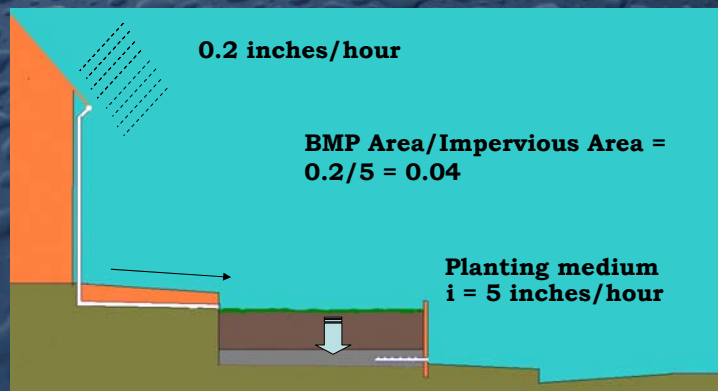


Showing Treatment Compliance

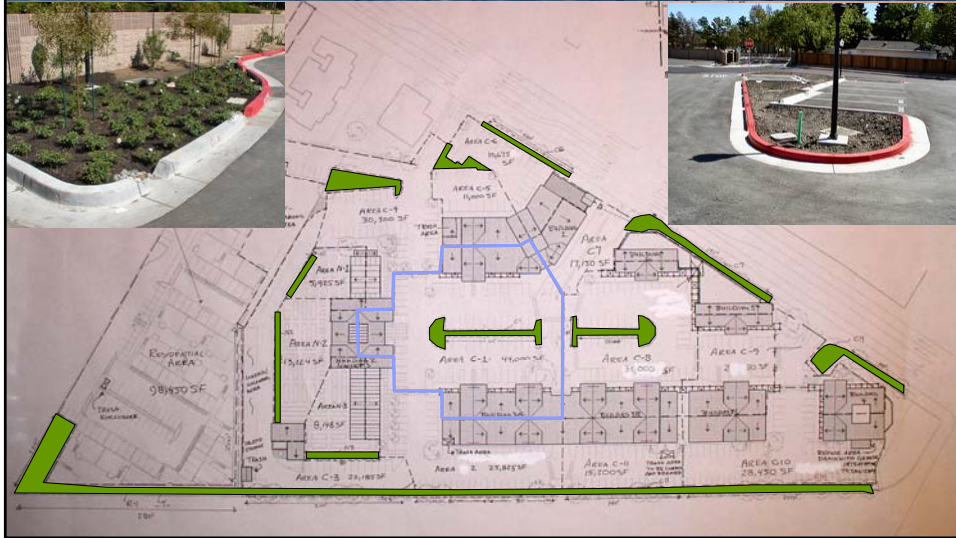
- NPDES Permit sizing criteria for treatment control:
 - “collect and convey” drainage design
 - conventional, “end of pipe” treatment
 - use of “C” factors to determine design inflow or volume



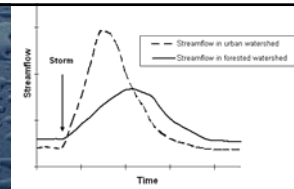
Sizing criterion for treatment



Application of sizing factor



LID for flow control



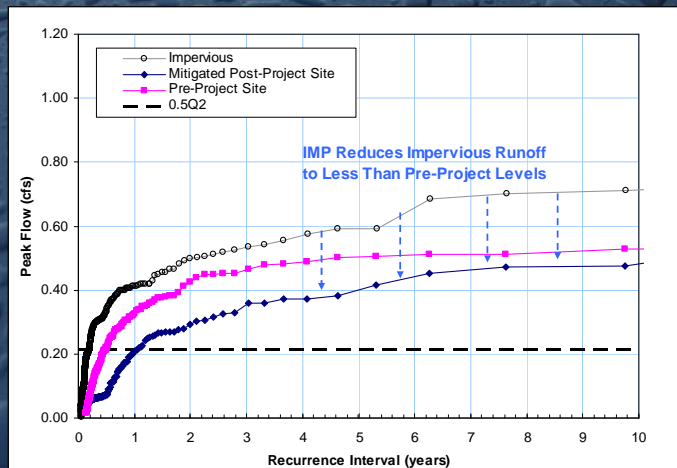
- Can LID facilities mitigate increased peaks and volumes of flows from impervious areas?
- How would we demonstrate that?
- What are the design criteria?

HSPF analysis of unit-acre runoff

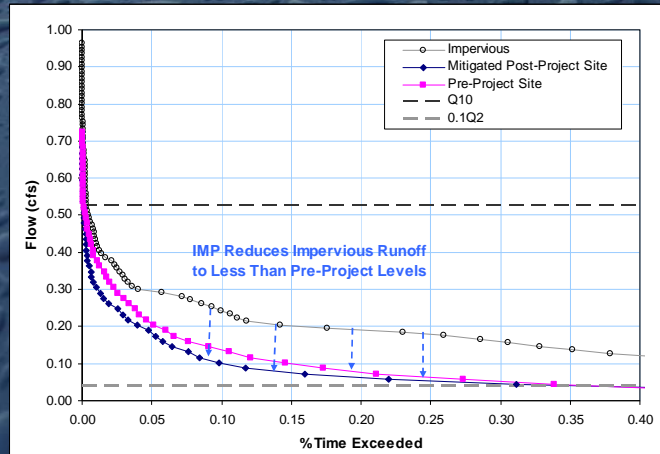
- 33 years hourly rainfall
- Pre-project condition
- 100% impervious condition
- Hydrologic soil groups A, B, C, D
- Swales, Bioretention Areas, In-ground and Flow-through Planters
 - Underdrain with flow-restrictor in C&D soils
- Dry wells, infiltration trenches and basins



Results: Control of Peak Flows



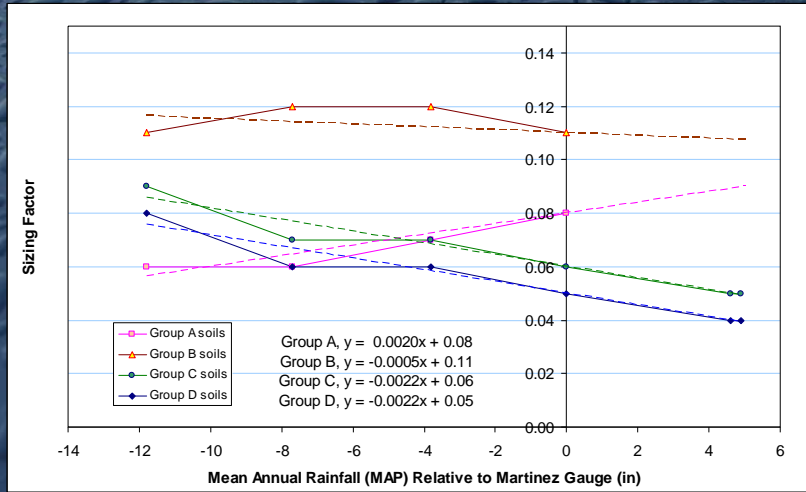
Results: Flow Duration Control



Sizing Factors for Flow Control

Treatment & Flow Control	NRCS Soil Group			
	A	B	C	D
Bioretention Facility				
A	0.07	0.11	0.06	0.05
V ₁	0.058	0.092	0.050	0.042
V ₂	N/A	N/A	0.066	0.055
Flow-through Planter				
A	N/A	N/A	0.06	0.05
V ₁	N/A	N/A	0.050	0.042
V ₂	N/A	N/A	0.066	0.055
Dry Well				
A	0.05	0.06	N/A	N/A
V	0.130	0.204	N/A	N/A
Cistern + bioretention facility				
A (bioretention facility)	0.04	0.04	0.04	0.04
V (cistern)	0.193	0.228	0.088	0.060

Adjustment to annual rainfall



LID Design Process



3 most common mistakes

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

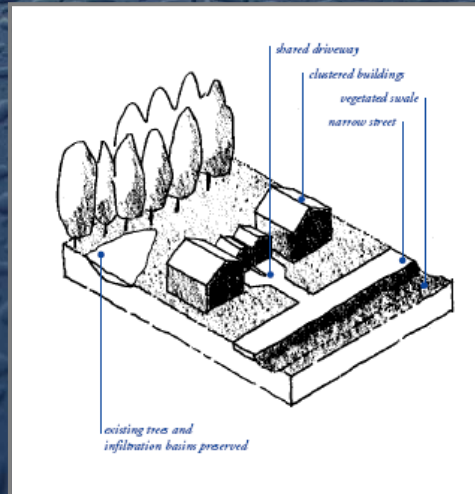


Analyze Your Project for LID

1. Optimize the site layout
2. Use pervious surfaces
3. Disperse runoff
4. Drain to Bioretention Facilities, Flow-through Planters, Dry Wells, or Cisterns with Bioretention

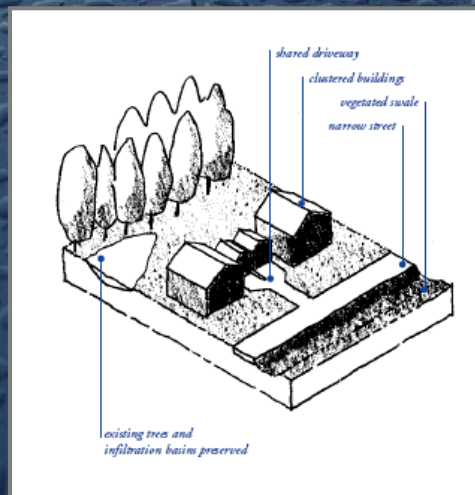
1. Optimize the Site Layout

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



1. Optimize the Site Layout

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



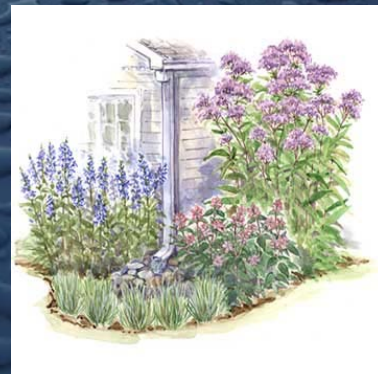
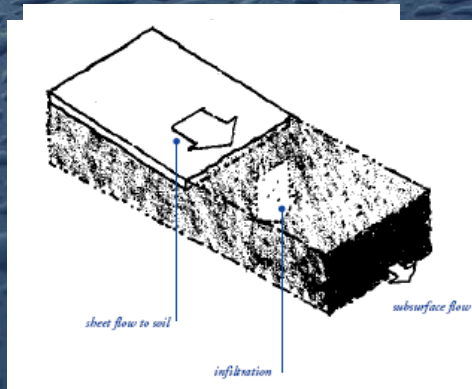
2. Use Pervious Surfaces

- Permeable pavements



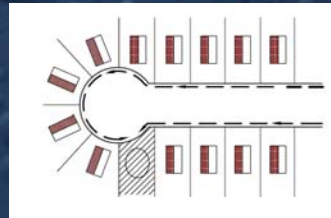
- Green roofs

3. Disperse Runoff



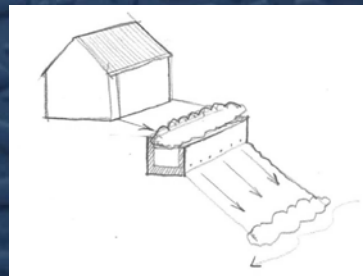
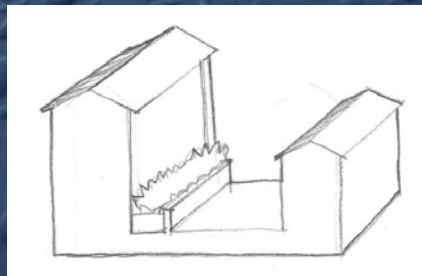
Bioretention Applications

- Think ownership and maintenance
 - Whose property will this be on?
 - Where is the drainage coming from?
 - How will both the facility and its tributary drainage area be maintained?

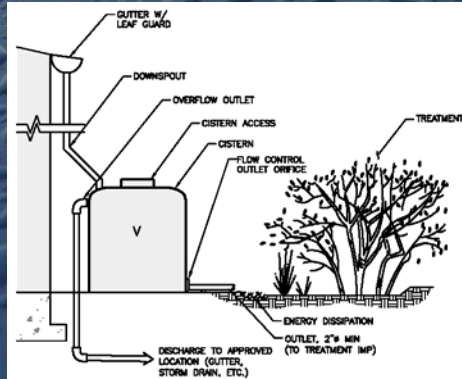


Flow-through Planter Applications

- On or adjacent to buildings
- Other areas where infiltration is not desirable



Cistern with Bioretention



- Cistern volume can be in a vault or ponded on a roof
- Bioretention area is 4% of tributary area

LID Design Process



Document Drainage Design

1. Delineate drainage management areas (DMAs)
2. Classify DMAs and determine runoff factors
3. Tabulate DMAs
4. Lay out facilities

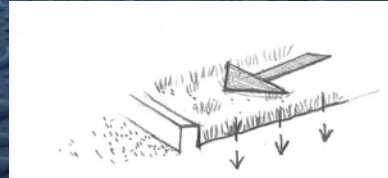
Drainage Management Areas

- Only one surface type within each area
- Many-to-one relationship between drainage areas and facilities
- Four Types of Areas
 1. Self-treating areas
 2. Self-retaining areas
 3. Areas draining to a self-retaining area
 4. Areas draining to a treatment facilities



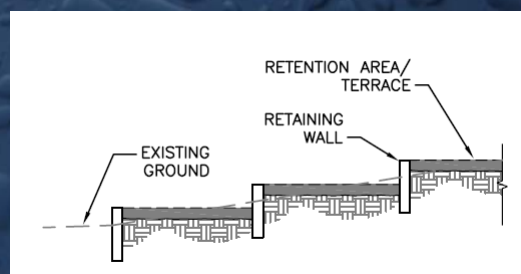
Self-treating DMAs

- Must be 100% pervious
- Must drain offsite
- Must not drain on to impervious areas
- Must not receive drainage from impervious areas
- Must not drain to treatment facilities
- No treatment or flow control required
- No further calculations required



Self-retaining DMAs

- Berm or depress grade to retain 1" rain
- Set area drain inlets above grade
- Amend soils
- Terrace mild slopes
- Have limited applicability in
 - Dense developments
 - Hillsides

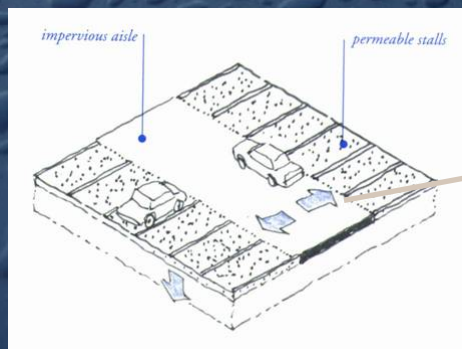
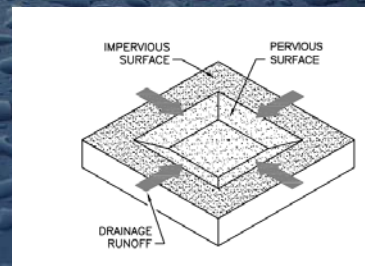


Areas draining to self-retaining areas

- Impervious areas can drain on to self-retaining areas
- Example: Roof leaders directed to lawn or landscape
- Maximum ratio is 2:1 for treatment; 1:1 for flow control
- No maintenance verification required



Areas draining to self-retaining DMAs



$$\frac{\text{Impervious}}{\text{Pervious}} \leq 1$$

Tabulating Areas

Self-Treating Areas

DMA Name	Area (SF)

Self-Retaining Areas

DMA Name	Area (SF)

Areas Draining to Self-Retaining Areas

DMA Name	Area (SF)	Post-project surface type	Runoff factor	Receiving Self-retaining DMA	Receiving DMA Area (SF)	Ratio

Areas draining to Bioretention Facilities

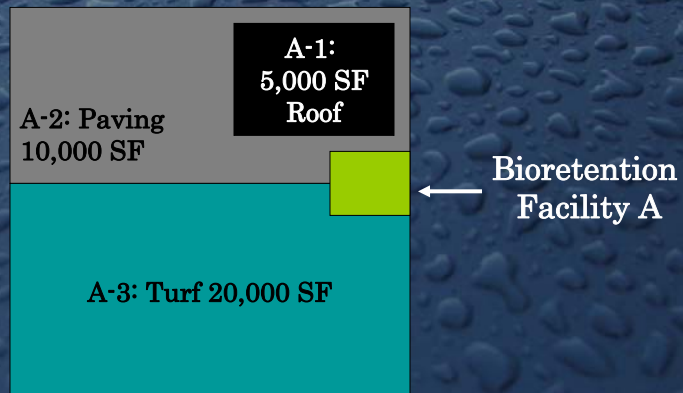
- Areas used to calculate the required size of the bioretention facility
- Where possible, drain only impervious roofs and pavement to bioretention facilities
- Delineate any pervious areas as separate Drainage Management Areas

DMA's draining to facilities

Treatment-only example

<i>DMA Name</i>	<i>DMA Sq. Ft</i>	<i>Surface Type</i>	<i>Runoff Factor</i>	<i>Area x runoff factor</i>			
					<i>Sizing Factor</i>	<i>Min. Size</i>	<i>Size Planned</i>
Facility A----->							

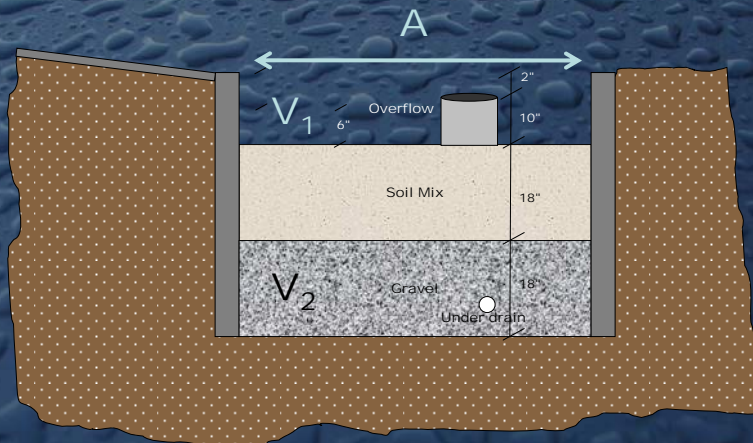
Calculating Facility Size



DMA's draining to facilities

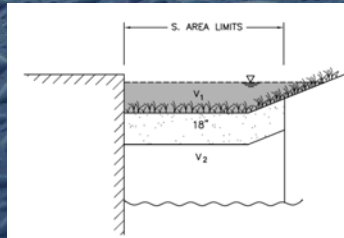
<i>DMA Name</i>	<i>DMA Sq. Ft</i>	<i>Surface Type</i>	<i>Runoff Factor</i>	<i>Area x runoff factor</i>				
A-1	5000	Roof	1.0	5000				
A-2	10000	Paved	1.0	10000				
A-3	20000	Grass	0.1	2000	<i>Sizing Factor</i>	<i>Min. Size</i>	<i>Size Planned</i>	
Facility A----->					17000	0.04	680	800

Bioretention for Flow Control

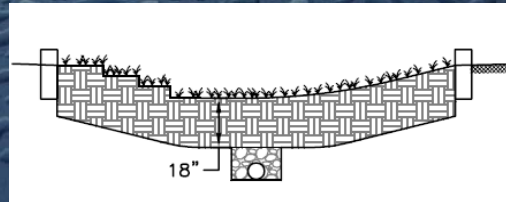


Bioretention Design Options

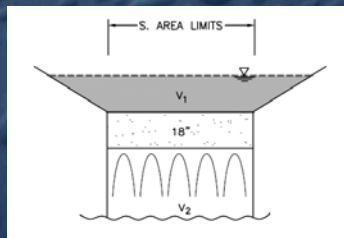
Edge Treatments



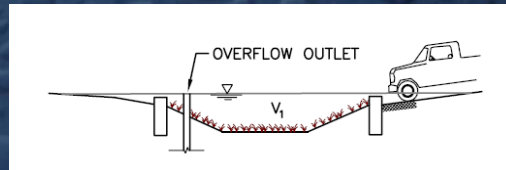
Stepped-back side slope



Subsurface Storage Options



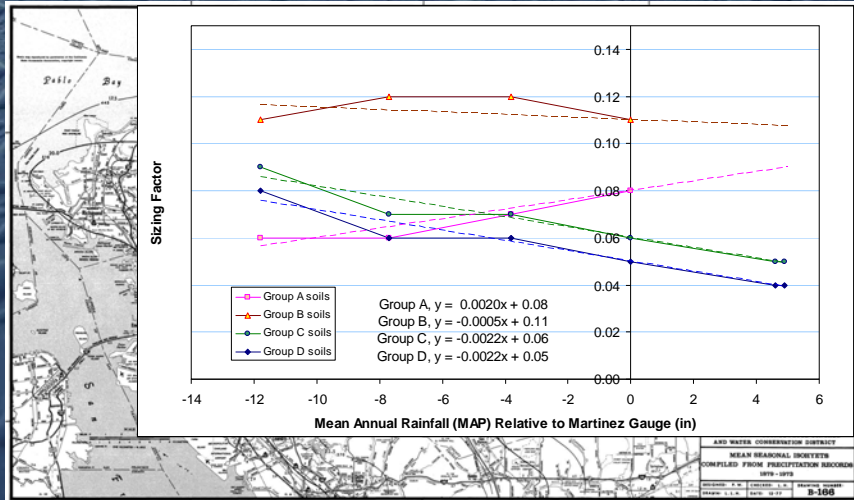
Using Shallow Flooding for Storage



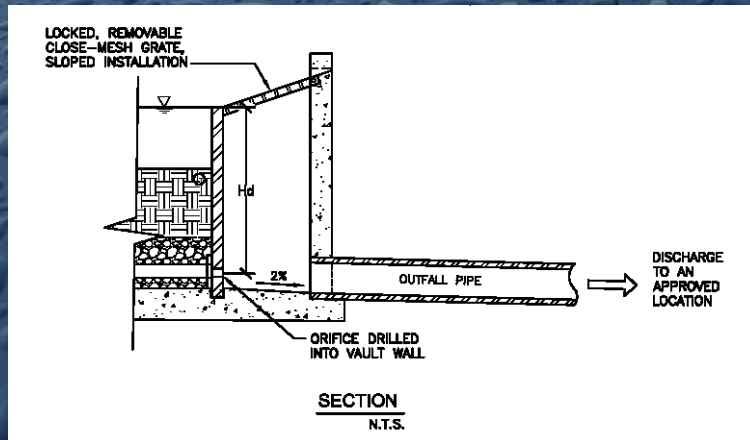
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Adjustment for Rainfall



Orifice Sizing for Flow Control



Calculation Format with Flow Control

DMA Name	DMA Area (square feet)	Post-project surface type	DMA Runoff factor	DMA Area x runoff factor	Soil Type:		IMP Name	
					IMP Sizing factor	Rain Adjustment Factor	Minimum Area or Volume	Proposed Area or Volume
Total								IMP Area
								V or V1
								V2
								Orifice Size:

LID Design Process

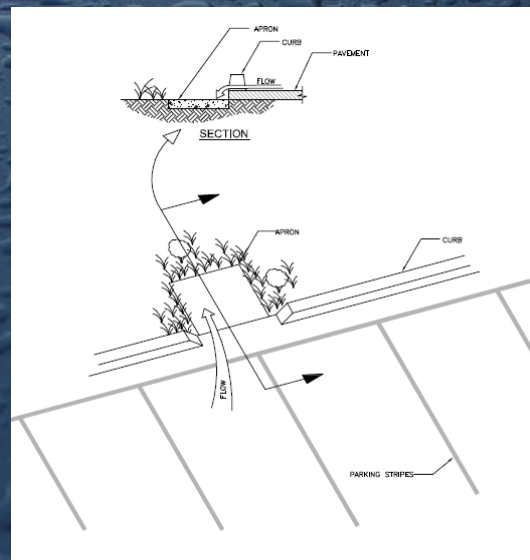


Ensuring flow to the facility

- Runoff may enter by sheet flow or be piped.
- Roof leaders can be piped directly or spill across pavement



Inlet Design



Distribute flow evenly



Distribute flow evenly



Surface reservoir must fill



Surface reservoir must fill



Surface reservoir must fill



Surface reservoir must fill



Summary

- The *Guidebook* design procedure and design criteria are paramount.
- Design and construction of site drainage and facilities is key to performance.
- All calculations can be done manually and should be checked manually.
- The IMP Sizing Calculator is useful for performing iterative calculations and exploring design scenarios