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

- 12" curb cut
- Native soil; no compaction
- 6" perforated pipe 18" x 12"; ¾" gravel or drain rock
- 6" min. depth
- 1½ min.
Flow-through Planter

- Reservoir, 12" min. depth
- Reverse bend trap or hooded overflow
- 18" sandy loam, minimum infiltration rate 5" per hour
- 12" open-graded gravel, approx. ½" dia.
- Perforated pipe
- Waterproof membrane
- Additional waterproofing on building as needed
- Drain to storm drain or discharge; bottom-out or side-out options

Dry Well

- 10' min. (axt. of building to centerline of well)
- Roof loader
- Surcharge pipe
- Splash block
- Uplift filter
- Filter fabric
- Perforated PVC pipe
- Roof plate
- Sand layer
- Undisturbed soil
- Decomposed soil
- Soil grad. a & c at

- Utility box
- Obstruction well with screen top lid
- Drain line
- Bottom of dry well should not be located within 3 ft. above existing grade from the top of the footing

- 3/4" clean aggregate backfill
- Filter fabric
- 4" (min.)
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

BMP Area/Impervious Area = 0.2/5 = 0.04

Planting medium

i = 5 inches/hour
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

![Graph showing peak flows for impervious, mitigated post-project, pre-project, and 0.5Q2 conditions.](image)

IMP Reduces Impervious Runoff to Less Than Pre-Project Levels
Results: Flow Duration Control

Sizing Factors for Flow Control

<table>
<thead>
<tr>
<th>Treatment &amp; Flow Control</th>
<th>NRCS Soil Group</th>
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<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>Bioretention Facility</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>0.07</td>
</tr>
<tr>
<td>V₁</td>
<td>0.058</td>
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<tr>
<td>V₂</td>
<td>N/A</td>
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<tr>
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</table>
Adjustment to annual rainfall

Group A, $y = 0.0020x + 0.08$
Group B, $y = -0.0005x + 0.11$
Group C, $y = -0.0022x + 0.06$
Group D, $y = -0.0022x + 0.05$

LID Design Process

Analyze Project for LID
Develop and Document LID Drainage Design
Specify LID Preliminary Design Details

Coordinate with Site Design and Landscape Design
3 most common mistakes

1. Didn’t start early enough.
2. Planned to use less effective treatment facilities.
3. Postponed deciding who will operate and maintain treatment and flow-control 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

- 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
4. Direct Runoff to Facilities

- Bioretention facilities
- Flow-through planters
- Dry wells
- Cisterns

Bioretention Applications

- Think multi-purpose
  - Landscape/design element
  - Conveyance of high flows
  - Trees
  - Turf
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

1. Analyze Project for LID
2. Develop and Document LID Drainage Design
3. Specify LID Preliminary Design Details

Coordinate with Site Design and Landscape Design
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

Impervious ≤ 1
Pervious
### Tabulating Areas

#### Self-Treating Areas

<table>
<thead>
<tr>
<th>DMA Name</th>
<th>Area (SF)</th>
</tr>
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#### Self-Retaining Areas

<table>
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<tr>
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<th>Area (SF)</th>
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</table>

#### Areas Draining to Self-Retaining Areas

<table>
<thead>
<tr>
<th>DMA Name</th>
<th>Area (SF)</th>
<th>Post-project surface type</th>
<th>Runoff factor</th>
<th>Receiving Self-retaining DMA</th>
<th>Receiving DMA Area (SF)</th>
<th>Ratio</th>
</tr>
</thead>
</table>

### 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
### DMAs draining to facilities

#### Treatment-only example

<table>
<thead>
<tr>
<th>DMA Name</th>
<th>DMA Sq. Ft</th>
<th>Surface Type</th>
<th>Runoff Factor</th>
<th>Area x runoff factor</th>
<th>Sizing Factor</th>
<th>Min. Size</th>
<th>Size Planned</th>
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Facility A

### Calculating Facility Size

- **A-2:** Paving 10,000 SF
- **A-1:** Roof 5,000 SF
- **A-3:** Turf 20,000 SF

Facility A
### DMAs draining to facilities

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<tbody>
<tr>
<td>A-1</td>
<td>5000</td>
<td>Roof</td>
<td>1.0</td>
<td>5000</td>
</tr>
<tr>
<td>A-2</td>
<td>10000</td>
<td>Paved</td>
<td>1.0</td>
<td>10000</td>
</tr>
<tr>
<td>A-3</td>
<td>20000</td>
<td>Grass</td>
<td>0.1</td>
<td>2000</td>
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| Facility A | 17000 | 0.04 | 680 | 800 |

### Bioretention for Flow Control

![Diagram of bioretention cells](image)
### Bioretention Design Options

**Edge Treatments**

- **Stepped-back side slope**

**Subsurface Storage Options**

- **Using Shallow Flooding for Storage**

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Mean Annual Rainfall (MAP) Relative to Martinez Gauge (in)

Orifice Sizing for Flow Control

Locked, removable close-mesh grate, sloped installation

Discharge to an approved location
## Calculation Format with Flow Control

<table>
<thead>
<tr>
<th>DMA Name</th>
<th>DMA Area (square feet)</th>
<th>Post-project surface type</th>
<th>DMA Runoff factor</th>
<th>Soil Type</th>
<th>IMP Name</th>
<th>IMP Rain Adjustment Factor</th>
<th>Minimum Area or Volume</th>
<th>Proposed Area or Volume</th>
<th>Total IMP Area</th>
<th>V or V1</th>
<th>V2</th>
<th>Orifice Size</th>
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### LID Design Process

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3. **Specify LID Preliminary Design Details**

Coordinate with Site Design and Landscape Design
Preliminary Design Details

- Routing of drainage to the facility
- Routing of drainage from the facility to the storm drain
- Sufficient head
- Avoid large drainage areas or long conveyance runs
- Watch out for roof slopes

Tributary Area

- Drainage area includes portions of roof and of parking lot
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
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.