LOW IMPACT DEVELOPMENT

GREEN INFRASTRUCTURE

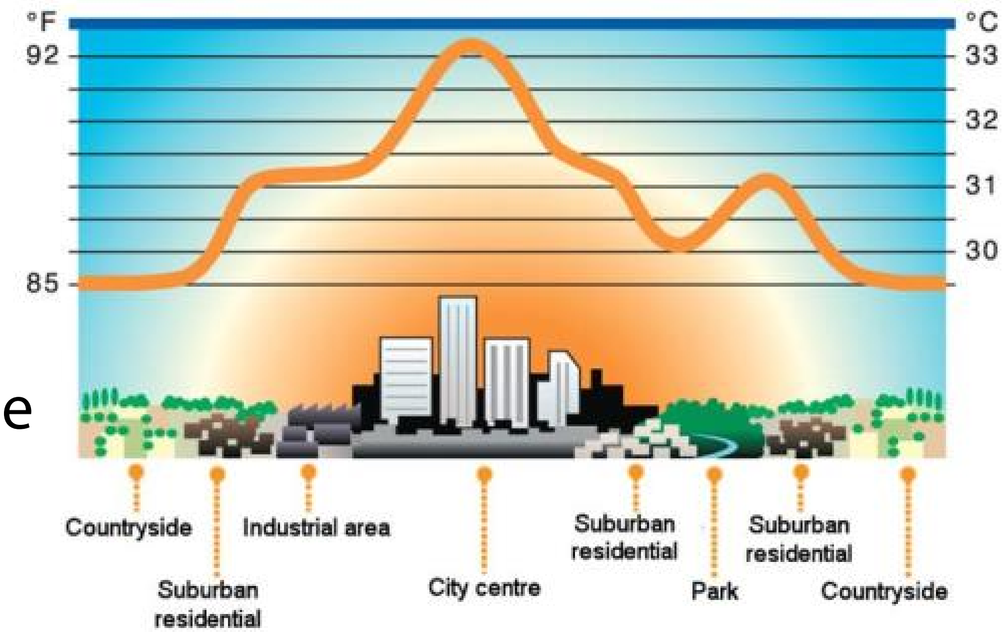
A Paradigm Shift

- Acceptance of LID is resulting in new approaches to storm water management
- It is an important tool for meeting regulatory compliance and resource protection goals.
- Municipalities have embraced LID as part of their green infrastructure goals.
- Industry is collecting evidence of LID efficacy as a result of new policies, guidelines and implemented projects.

Development Impacts and Challenges

- Flooding
- Heat-island effect
- Increased pollutant and sediment loads
- Increased costs of stormwater infrastructure
- Increased demands on existing stormwater infrastructure

Urban heat island effect



Functional Benefits of LID

- Manages stormwater close to the source
- Provides water quality benefits
- Helps meet stormwater detention requirements
- Uses natural hydrologic functions as the integrating framework
- Focuses on prevention rather than mitigation
- Emphasizes simple, nonstructural, low-tech, and low-cost methods
- Distributes small-scale practices throughout the landscape
- Relies on natural features and processes
- Creates a multifunctional landscape

Quality of Life Benefits

- Reduces flooding
- Mitigates heat-island effect
- Reduces sediment and pollutant loads
- Reduces cost of stormwater infrastructure
- Improves livability and adds value to the community
- Reduces life-cycle costs
- Prevents degradation of water quality and natural resources
- Increases lot yield
- Increases marketability/ property values
- Applicable to any scale of project

A Systems Approach

- Visible and useful
- Increases on-site developable area
- Economic value and savings

LID TOOLKIT DIAGRAM

SOURCE

ORIGIN OF MAN-MADE STORMWATER RUNOFF

- PARKING & STREETS
- HARDSCAPE AREAS
- STRUCTURE RUNOFF
- LANDSCAPE AREAS
- ALTERNATIVE SOURCES

ACTION

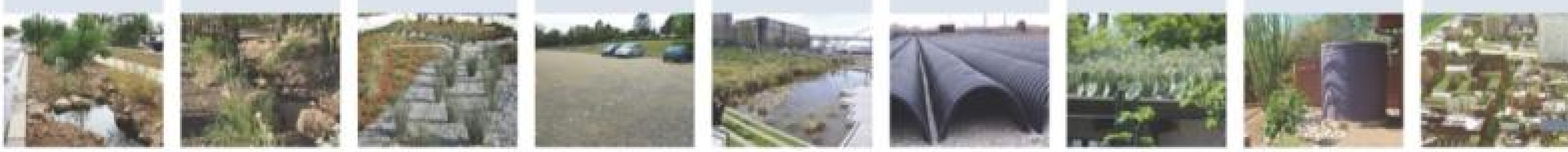
METHOD OF MANAGING STORMWATER RUNOFF

- CONVEY
- FILTER
- INFILTRATE
- EVAPO-TRANSPORATE
- STORE
- REUSE

TOOLS

MEANS TO ACCOMPLISH ACTIONS

TOOLS	GREEN STREET	VEGETATED SWALE	BIORETENTION	PERMEABLE PAVING	CONSTRUCTED WETLANDS	INFILTRATION & UNDERDRAINS	GREEN ROOF	RAINWATER HARVESTING	LANDSCAPE*
TECHNICAL VARIATIONS	Standard Curb Cut Curb Cut with Sidewing Concrete Flush Curb Grated Curb Cut Curb Cut with Sediment Capture Wheelstop Curb	Meandering or Linear Restored Wash	Vegetated Retention Basin Bioretention Cell Planter	Stabilized Aggregate Porous Asphalt Porous Concrete Structural Grids Permeable Pavers	Constructed Wetlands	Infiltration & Underdrains	Rooftop Garden Downspout Disconnection	Cisterns Above Ground Cisterns Below Ground	Tree Preservation Soil Amendment Impervious Surface Reduction Plant Selection



* Not in tookit because it is applicable to all other tools

Green street - standard Curb Cut

Functions

Benefits

Location

Curb cuts control stormwater flow from streets to LID facilities.

Description

- Curb cuts are openings created in a curb to allow stormwater from an impervious surface, such as roads, parking lots, or hardscape areas, to flow into a lower landscaped storage and infiltration area (LID facility).
- The curb cut is a useful tool for retrofitting existing development with green infrastructure practices without major reconstruction.
- Since curb cut openings are perpendicular to the flow of stormwater on the street, they will usually collect only a portion of the water flowing along the gutter. If attenuating stormwater flows along the street is the goal, place multiple curb cuts at intervals along the street.

Installation

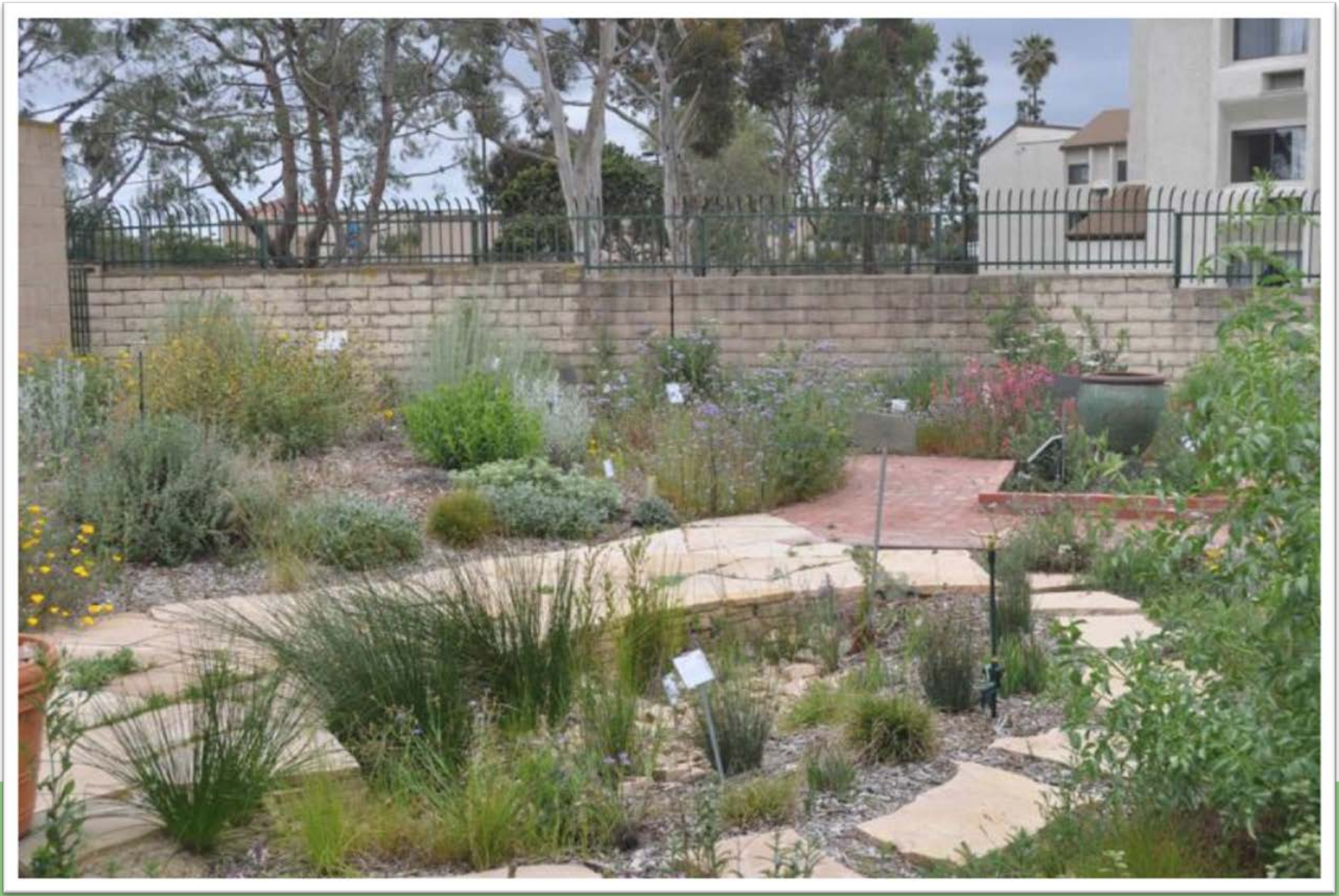
- Openings should be at least 18 inches wide, but up to 36 inches is preferred for ease of maintenance.
- Locate curb cut openings at low points and space them based upon stormwater velocity and volume, and the capacity of the area behind curb for detention, infiltration and access to overflow systems.
- The curb cut can either have vertical or angled sides. The design intent is to create a smooth transition from the paved surface to full curb height.
- Curb cuts work well with relatively shallow stormwater facilities that do not have steep side slopes that might erode.
- Set the elevation of the bottom of the curb cut to maximize flow into the landscape area.
- A drop in grade should occur between the curb cut entry point and the finish grade of the landscape area to allow for passage of sediment.
- Small amounts of hand placed rip-rap can be used on the LID facility side of the curb cut opening to reduce the potential for erosion in landscaped areas.
- Example of standard curb cut detail in Best Practice chapter, page 39.

Maintenance

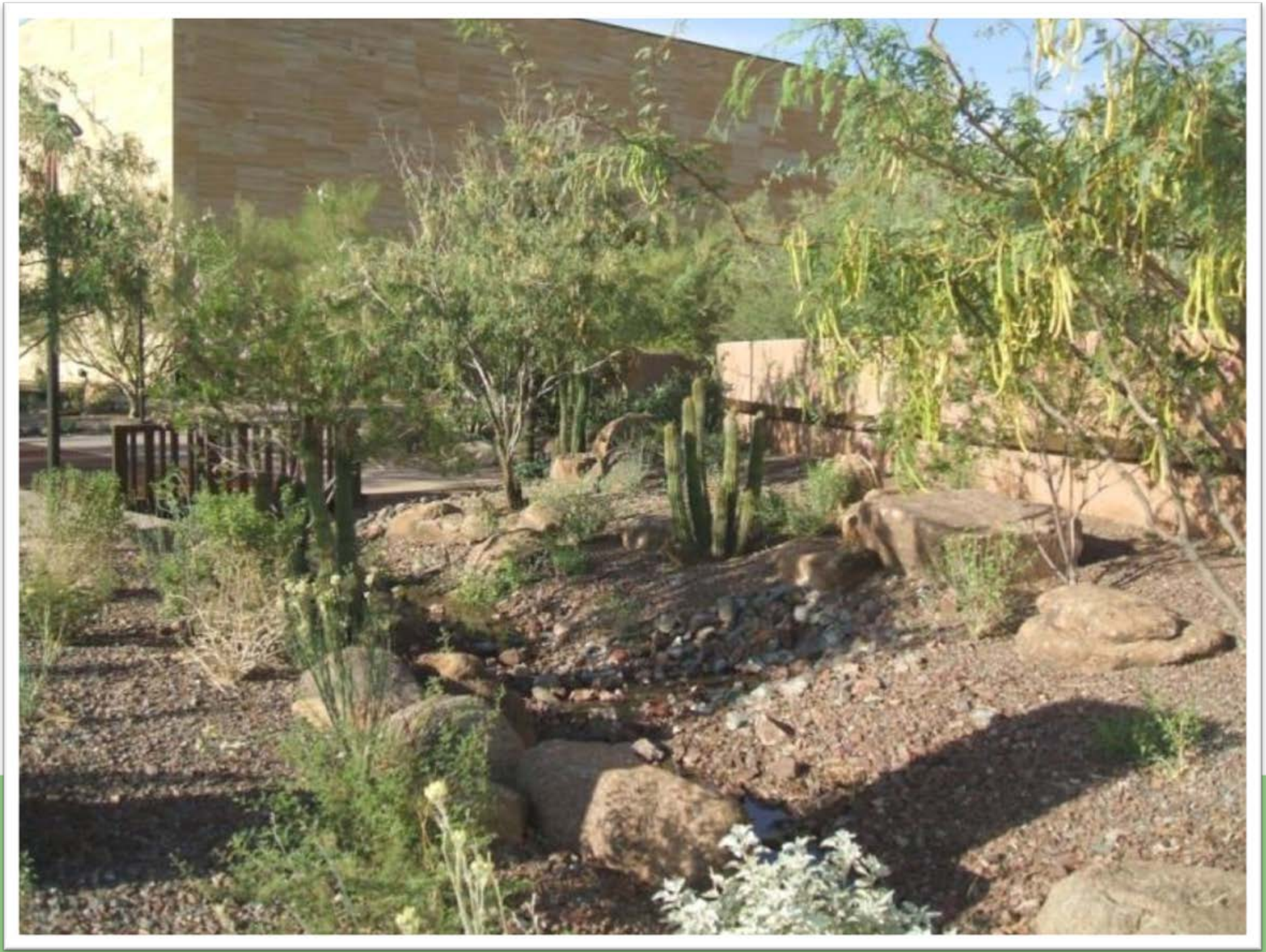
- Regularly clear curb cuts of any debris and sediment that prevents the free flow of stormwater into LID facility (1-2 times per year and after storm events).
- Periodically check rip rap areas for signs of erosion damage. Repair and reinforce as necessary (annually and after storm events).

Footnote: #1

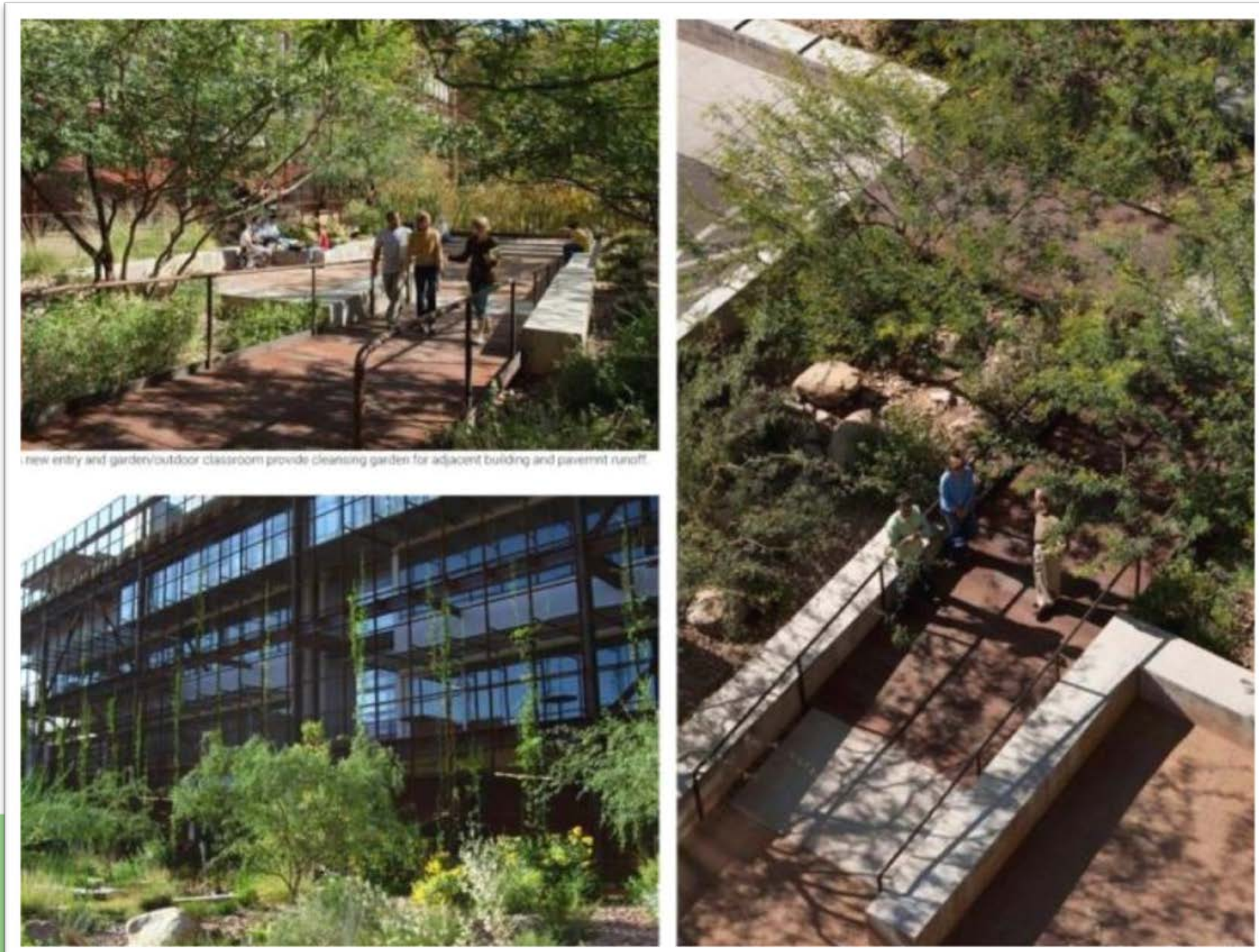
Rain Gardens



Native Vegetation



Benefit: Placemaking



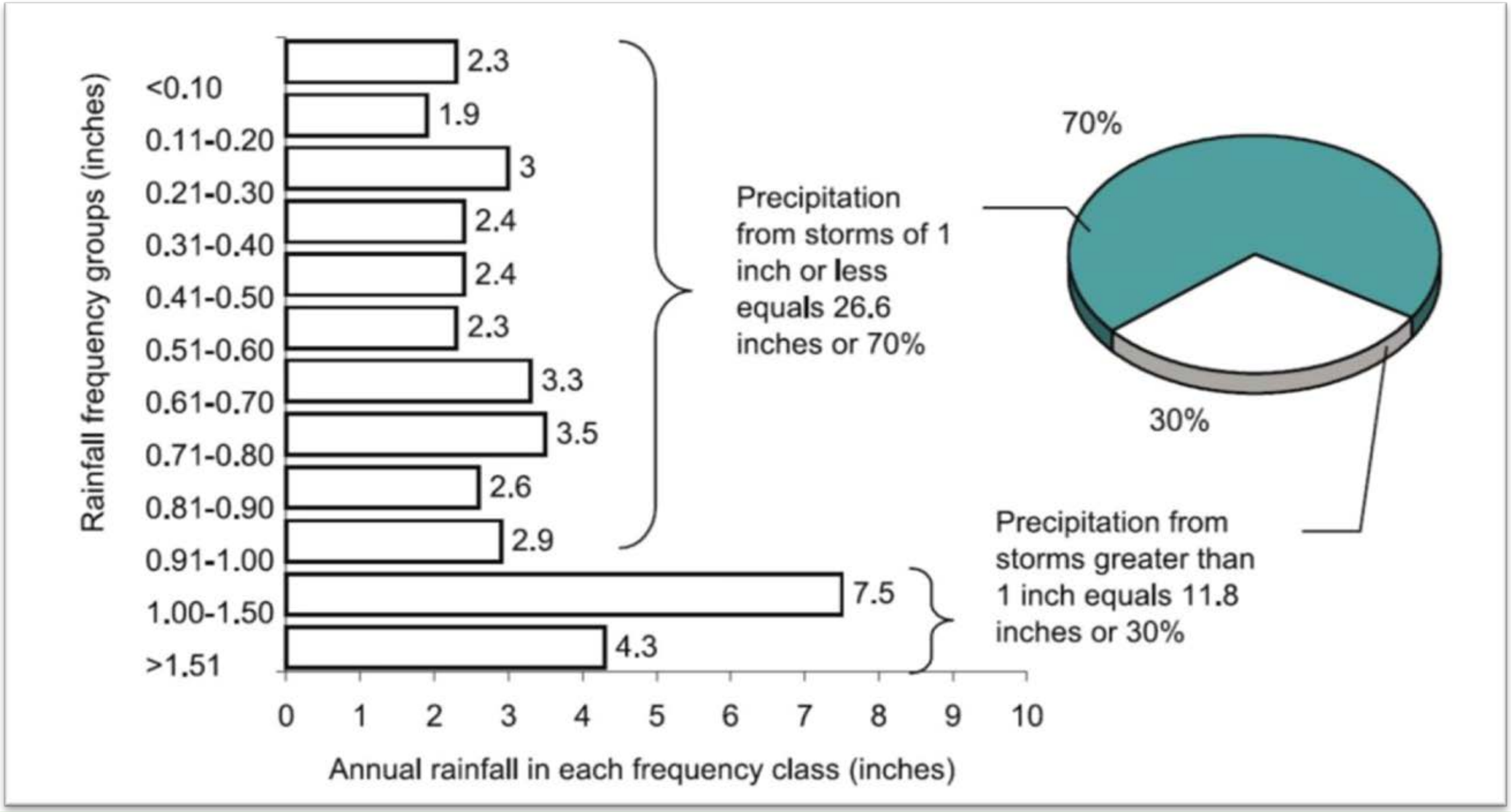
Bioswales/Bioretention Cells

Bioswale median designed by Logan Simpson and Dibble for the City of Scottsdale

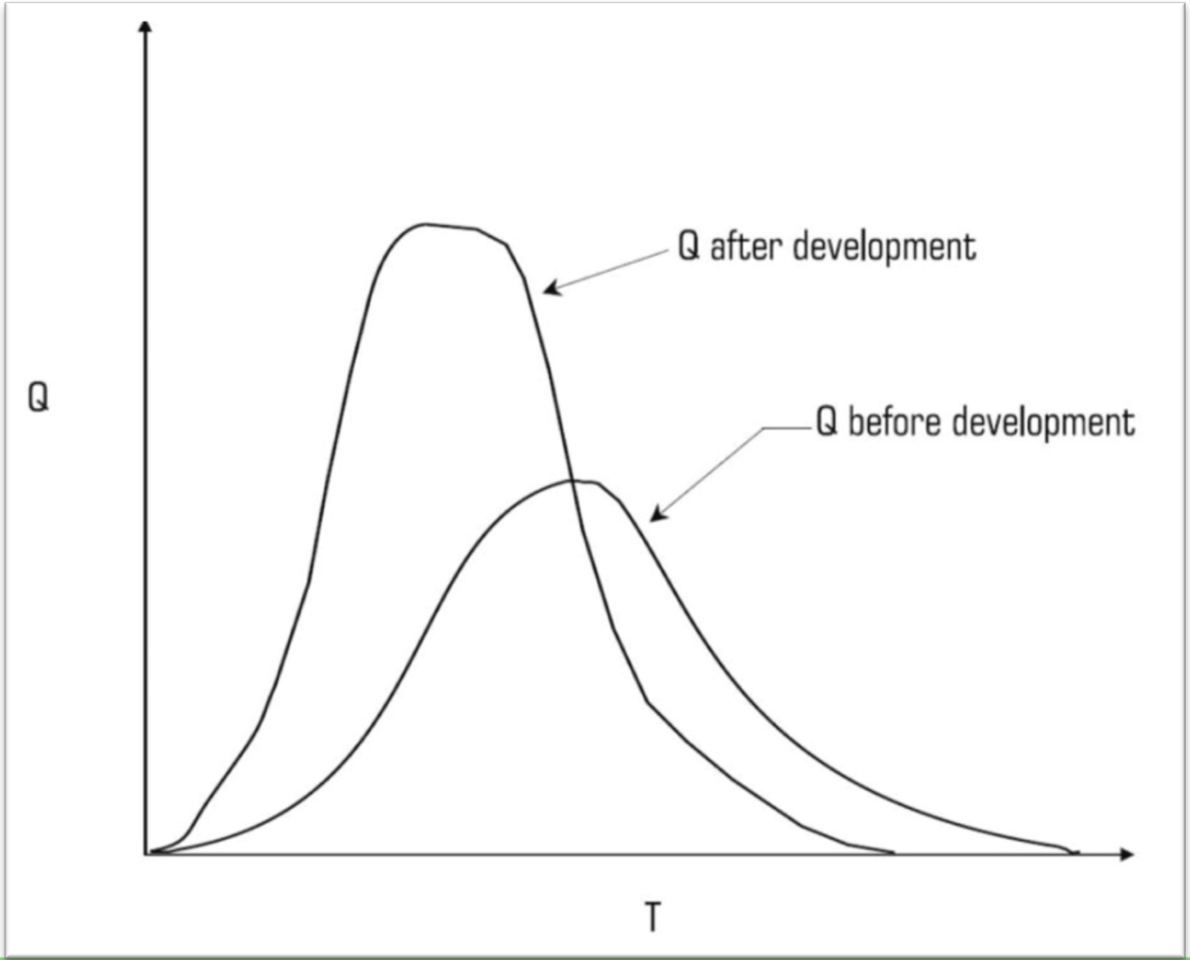
Applicability

- Small rain events (typically 1 inch or less)
- Not meant for flood control

How Much Rain Comes in 1-Inch Events?



The Runoff Challenge

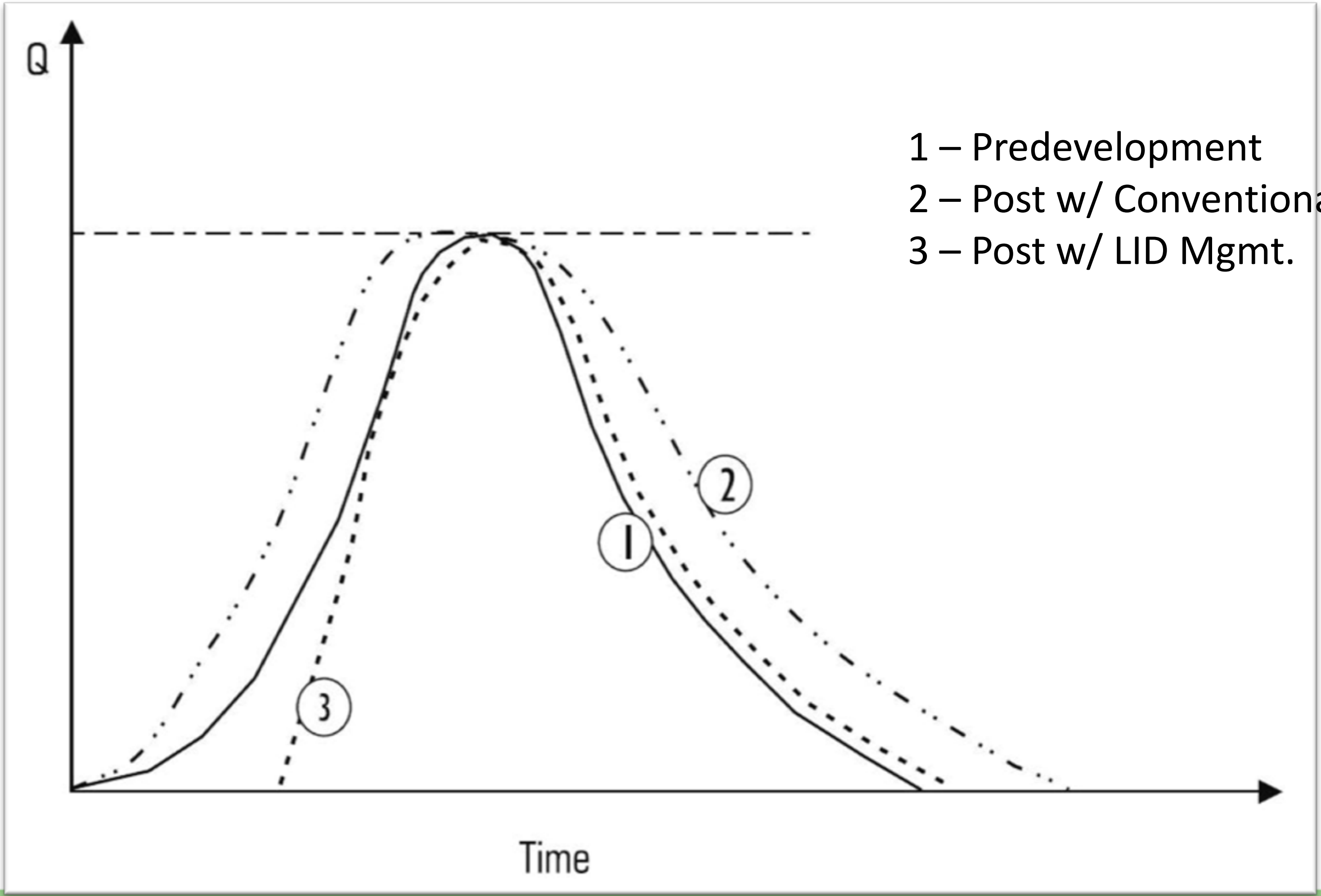


Tools for Reducing Peak and Total Flows

Table 2.1. Low-Impact Development Techniques and Hydrologic Design and Analysis Components

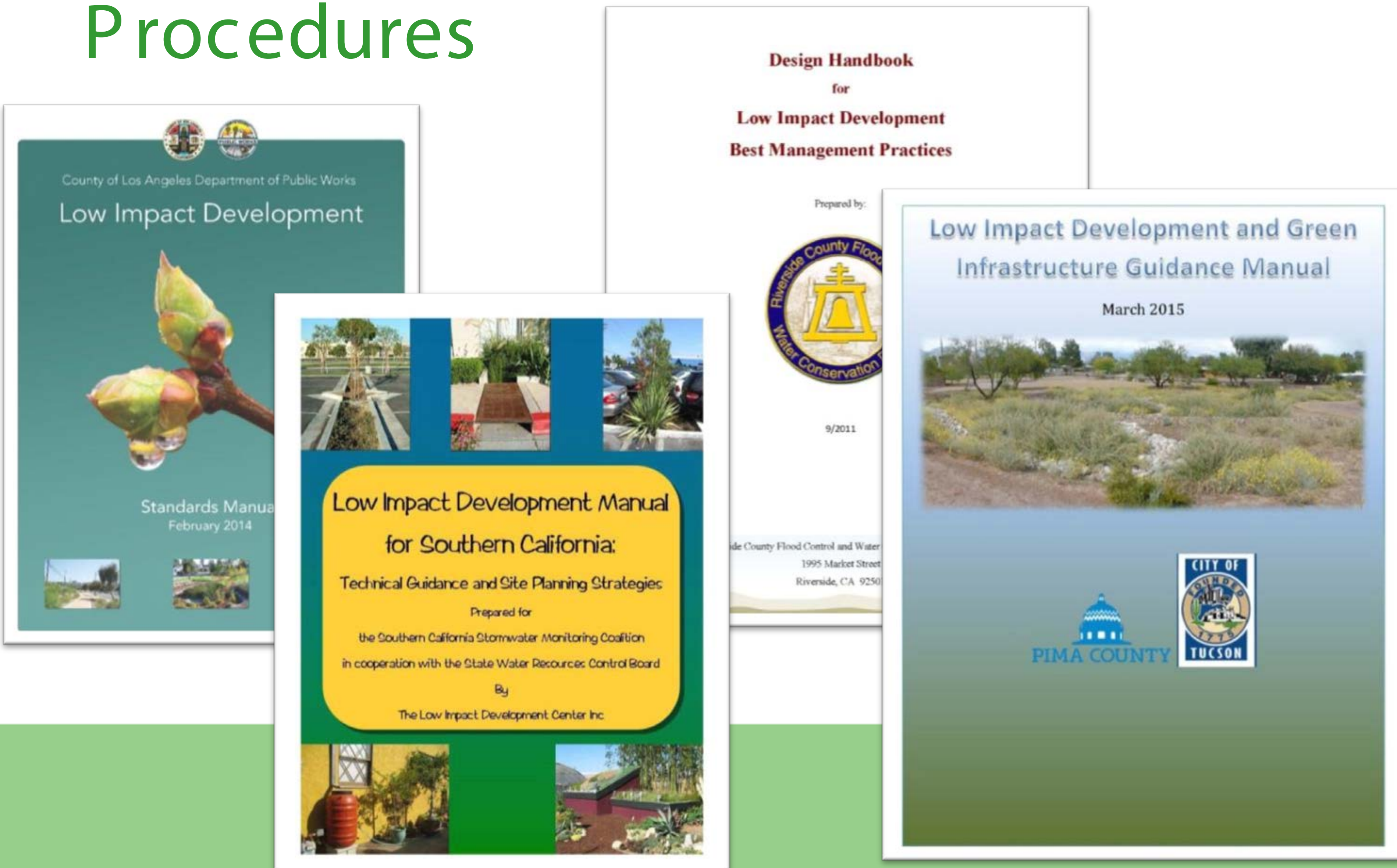
	Low-Impact Development Technique															
Low-Impact Hydrologic Design and Analysis Components	Flatten slope	Increase flow path	Increase sheet flow	Increase roughness	Minimize disturbance	Flatten slopes on swales	Infiltration swales	Vegetative filter strips	Constricted Pipes	Disconnected impervious areas	Reduce curb and gutter	Rain barrels	Rooftop storage	Bioretention	Revegetation	Vegetation preservation
Lower Postdevelopment CN					✓		✓	✓		✓	✓			✓	✓	✓
Increase Tc	✓	✓	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
Retention							✓	✓				✓	✓	✓	✓	✓
Detention						✓			✓			✓	✓			

The Result

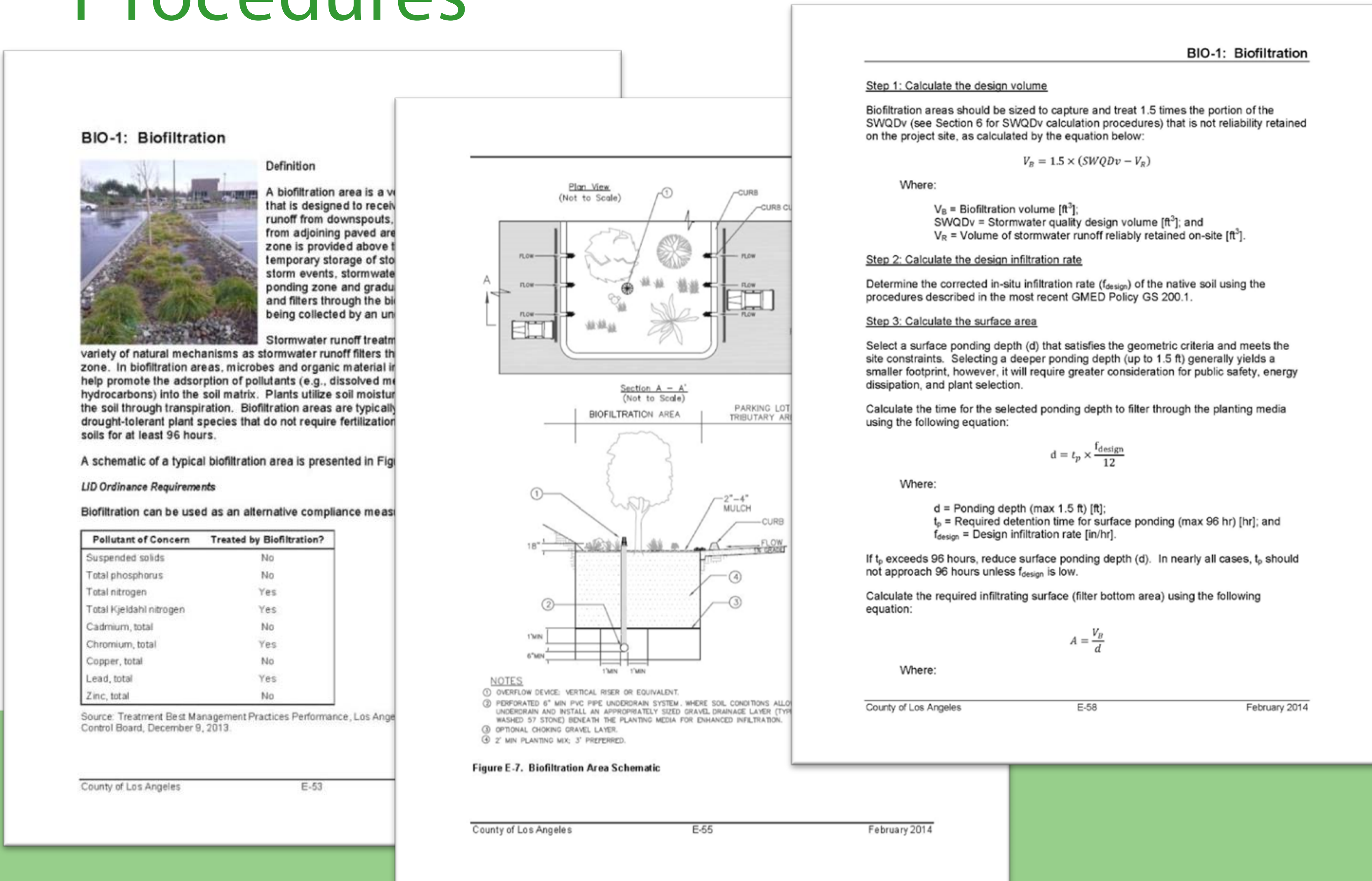


1 – Predevelopment
2 – Post w/ Conventional Mgmt.
3 – Post w/ LID Mgmt.

The Next Steps – Design Procedures



The Next Step – Design Procedures



BIO-1: Biofiltration

Definition

A biofiltration area is a v
that is designed to recei
runoff from downspouts,
from adjoining paved are
zone is provided above t
temporary storage of sto
storm events, stormwate
ponding zone and gradu
and filters through the bi
being collected by an un

Stormwater runoff treatm
variety of natural mechanisms as stormwater runoff filters th
zone. In biofiltration areas, microbes and organic material i
help promote the adsorption of pollutants (e.g., dissolved m
hydrocarbons) into the soil matrix. Plants utilize soil moistu
the soil through transpiration. Biofiltration areas are typicall
drought-tolerant plant species that do not require fertilization
soils for at least 96 hours.

A schematic of a typical biofiltration area is presented in Fig

LID Ordinance Requirements

Biofiltration can be used as an alternative compliance meas

Pollutant of Concern	Treated by Biofiltration?
Suspended solids	No
Total phosphorus	No
Total nitrogen	Yes
Total Kjeldahl nitrogen	Yes
Cadmium, total	No
Chromium, total	Yes
Copper, total	No
Lead, total	Yes
Zinc, total	No

Source: Treatment Best Management Practices Performance, Los Ange
Control Board, December 9, 2013.

County of Los Angeles E-53

NOTES
① OVERFLOW DEVICE: VERTICAL RISER OR EQUIVALENT.
② PERFORATED 6" MIN PVC PIPE UNDERDRAIN SYSTEM. WHERE SOIL CONDITIONS ALLO UNDERDRAIN AND INSTALL AN APPROPRIATELY SIZED GRAVEL DRAINAGE LAYER (TYP WASHED 57 STONE) BENEATH THE PLANTING MEDIA FOR ENHANCED INFILTRATION.
③ OPTIONAL CHOKING GRAVEL LAYER.
④ 2' MIN PLANTING MIX; 3' PREFERRED.

Figure E-7. Biofiltration Area Schematic

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BIO-1: Biofiltration

Step 1: Calculate the design volume

Biofiltration areas should be sized to capture and treat 1.5 times the portion of the SWQDv (see Section 6 for SWQDv calculation procedures) that is not reliability retained on the project site, as calculated by the equation below:

$$V_B = 1.5 \times (SWQDv - V_R)$$

Where:

V_B = Biofiltration volume [ft^3];
SWQDv = Stormwater quality design volume [ft^3]; and
V_R = Volume of stormwater runoff reliably retained on-site [ft^3].

Step 2: Calculate the design infiltration rate

Determine the corrected in-situ infiltration rate (f_{design}) of the native soil using the procedures described in the most recent GMED Policy GS 200.1.

Step 3: Calculate the surface area

Select a surface ponding depth (d) that satisfies the geometric criteria and meets the site constraints. Selecting a deeper ponding depth (up to 1.5 ft) generally yields a smaller footprint, however, it will require greater consideration for public safety, energy dissipation, and plant selection.

Calculate the time for the selected ponding depth to filter through the planting media using the following equation:

$$d = t_p \times \frac{f_{design}}{12}$$

Where:

d = Ponding depth (max 1.5 ft) [ft];
t_p = Required detention time for surface ponding (max 96 hr) [hr]; and
f_{design} = Design infiltration rate [in/hr].

If t_p exceeds 96 hours, reduce surface ponding depth (d). In nearly all cases, t_p should not approach 96 hours unless f_{design} is low.

Calculate the required infiltrating surface (filter bottom area) using the following equation:

$$A = \frac{V_B}{d}$$

Where:

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The Next Steps – Ordinances, Etc.

COVENANT AND AGREEMENT
REGARDING THE MAINTENANCE OF LOW IMPACT DEVELOPMENT (LID) &
NATIONAL POLLUTANTS DISCHARGE ELIMINATION SYSTEM (NPDES) BMPs

The undersigned, ______________________________ ("Owner"), hereby certifies that it owns the real property described as follows ("Subject Property"), located in the County of Los Angeles, State of California:

LEGAL DESCRIPTION

ASSESSOR'S ID #__________

ADDRESS: __________

____

Owner is aware of the requiremen
and National Pollutant Discharge Elin
installed on the Subject Property:

- ☐ Porous pavement
- ☐ Cistern/rain barrel
- ☐ Infiltration trench/pit
- ☐ Bioretention or biofiltration
- ☐ Rain garden/planter box
- ☐ Disconnect impervious surfa
- ☐ Dry Well

COVENANT FOR MAINTENANCE OF WATER QUALITY (WQ) DEVICES

I (we) ______________________________, hereby certify that I (we) am (are) the legal owner(s) of Tract # _____, and as such owners for the mutual benefit of future purchasers, their heirs, successors, and assigns, do hereby fix the following protective conditions to which their property, or portions thereof, shall be held, sold and/or conveyed.

That owner(s) shall maintain the WQ system shown on attached Exhibit A map and on Grading Plan GPC # ___________, on file in the office of the Director of Public Works, in a good and functional condition at least once a year and retain proof of the inspection. The owner(s) shall perform this responsibility, unless the County discharges this obligation through a subsequently recorded written instrument.

The undersigned also covenants and agrees for himself, his heirs, successors, and assigns, to indemnify, defend, and save harmless the County, its agents, officers and employees from and against any and all liability, expenses, including defense costs and legal fees, and claims for damages of any nature whatsoever, including, but not limited to, bodily injury, death, personal injury, or property damage arising from or connected with the construction or maintenance of said work.

The Next Steps – Standards

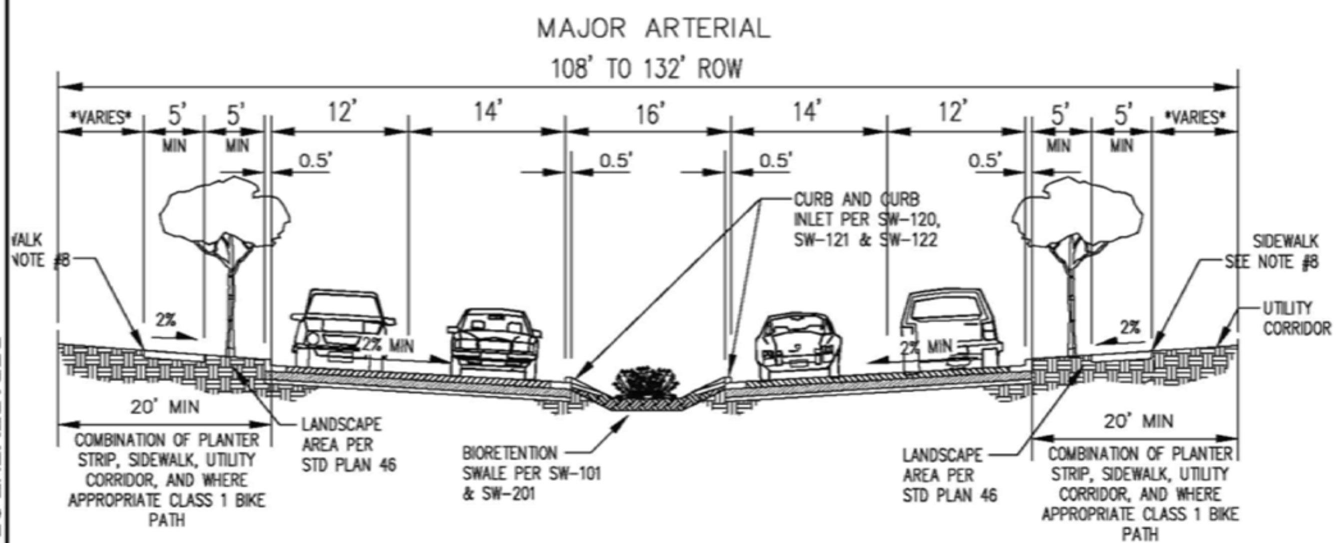
DEPARTMENT OF PUBLIC WORKS
CITY OF GONZALES

TITLE:
SECTION: MAJOR ARTERIAL

DESIGNED BY: STAFF
DRAWN BY: STAFF
CHECKED BY: STAFF

APPROVED:
CITY ENGINEER: ______ DATE:

STANDARD PLAN
01A



DESIGNER INFORMATION

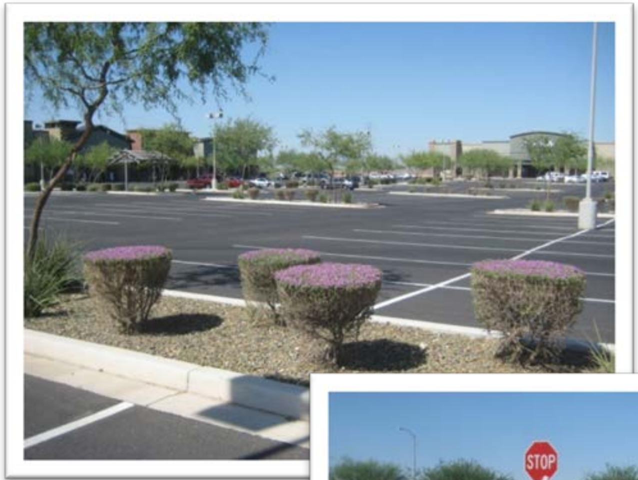
1. ADAPT PLAN VIEW EXAMPLE TO YOUR ENGINEERED DESIGN.
2. PROVIDE BEGINNING AND ENDING STATIONS FOR EACH FACILITY. PROVIDE STATIONS AND/OR DIMENSIONS AND ELEVATIONS AT EACH INLET, OUTLET CHECK DAM, PLANTER CORNER, AND SIDEWALK NOTCH.
3. LONGITUDINAL SLOPE OF PLANTER MATCHES STREET.
4. SIDEWALK ELEVATIONS MUST BE SET ABOVE CHECK DAM AND INLET/OUTLET ELEVATIONS TO ALLOW OVERFLOW TO DRAIN TO STREET BEFORE SIDEWALK.
5. A MINIMUM 4 FOOT WIDE INTERIOR PLANTER IS REQUIRED FOR STREET TREES. MAXIMIZE PLANTER WIDTH.
6. EXISTING UTILITY LINES MUST BE SLEEVED OR RELOCATED. PROPOSED UTILITY LINES TO BE LOCATED OUT OF FACILITY.
7. AREA AND DEPTH OF FACILITY ARE BASED ON ENGINEERING CALCULATIONS AND RIGHT-OF-WAY CONSTRAINTS.
8. OPTIONAL: PERVIOUS SURFACING PER SW-151.

RELATED DETAILS AND RESOURCES

9. REFER TO DETAIL SW-100 OR SW-200 FOR STORMWATER PLANTER. FOR MINIMUM AREA SEE SALINAS SWDS SECTION 4.0 (DATED 2013). CHECK DAM DETAILS SW-130 AND SW-131.
10. PLANTER WALL DETAIL SW-110 OR SW-111.
11. INLET DETAILS SW-120, SW-121, AND SW-122.
12. SPECIAL REQUIREMENTS FOR WATER LINES, METERS, AND FIRE HYDRANTS DETAIL SW-142.
13. STORMWATER PLANTER PLANTING LIST DETAILS SW-160 & SW-161.
14. STORMWATER FACILITY CONSTRUCTION AND BSM REQUIREMENTS SEE CITY OF SALINAS SWDS APPENDIX D (DATED 2013).

What About Maintenance?

Maintenance requires a different approach and the involvement of maintenance staff in the design of LID features.



Traditional

Appropriate

The Making of the LID Toolkit