



SACRAMENTO  
STATE

# Designing and Constructing Low Impact Development Stormwater Devices at Sacramento State

---

**City of Sacramento**  
**Sacramento State Facilities Management**

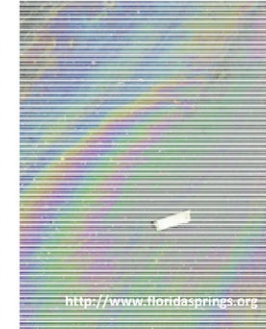
---

# Overview

- Stormwater Issues
- Managing Stormwater: LID
- Project
  - Background, collaboration, funding, benefits
  - Design goals and challenges
  - Construction
  - Operation and maintenance
  - Monitoring, education, outreach
- Site Visits

# Stormwater – Water Quality Pollutants

- Nutrients
- Pesticides
- Sediment
- Heavy Metals
- Oil and Grease
- Pathogens



# Stormwater: Pollutant Sources

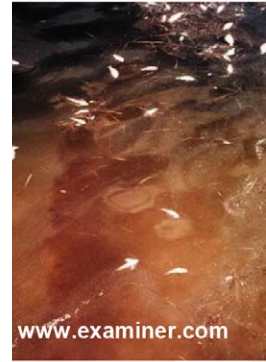
- Fertilizers
- Tree/leaf litter
- Pesticides
- Vehicles & Roads
- Industrial activities
- Stream erosion
- Construction
- Pets & wildlife
- Humans



# Stormwater: Pollutant Impacts

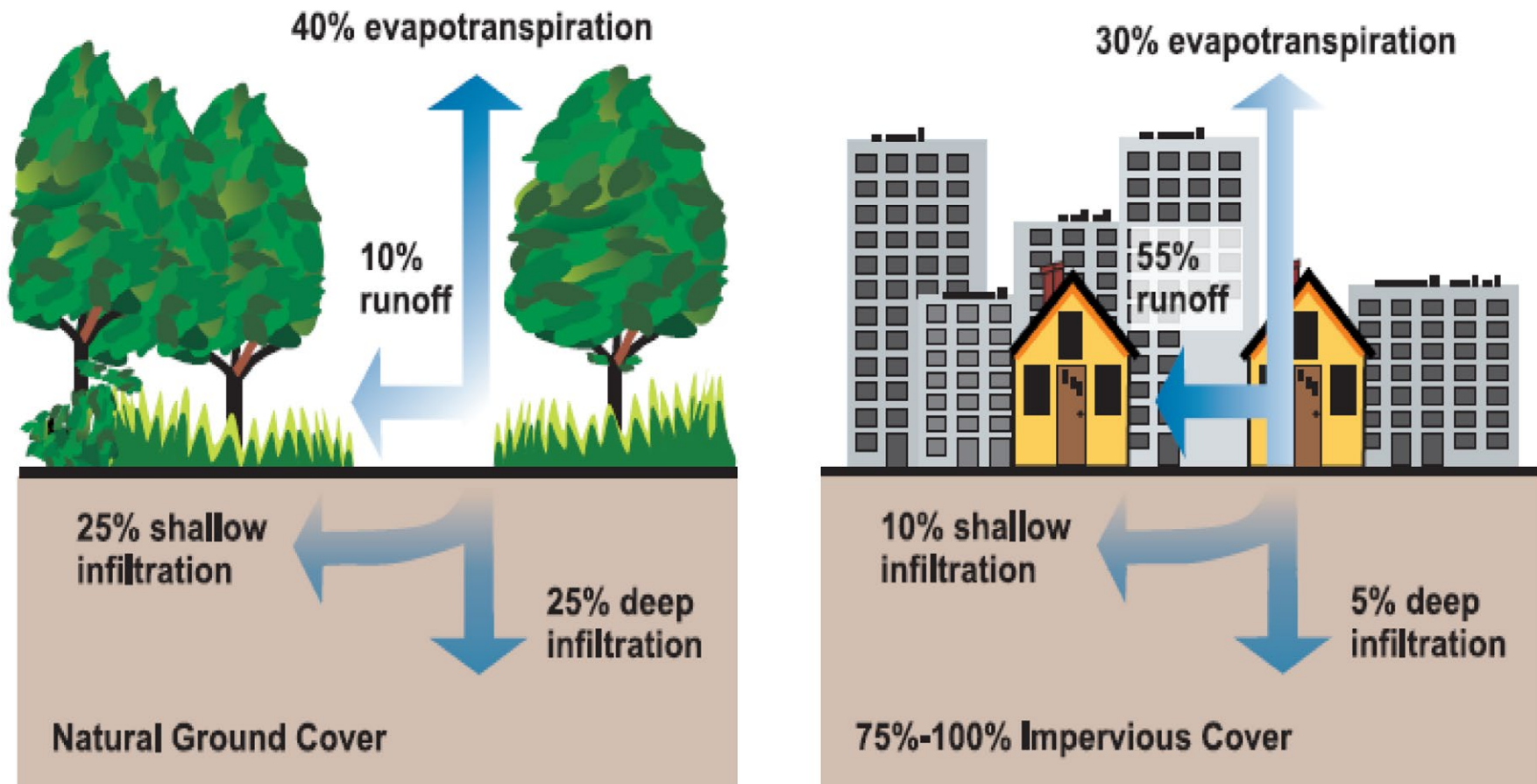
- Algae blooms
- Fish kills
- Habitat destruction
- Reservoir storage loss
- Visually Unappealing
- Odors
- Toxicity
- Beach closures

***Stormwater is one of the leading, remaining causes of water quality problems (EPA)***



# Stormwater

## A Common Theme: Urbanization



<http://www.peachcounty.net/stormwaterdepartment.cfm>

# Stormwater: Urbanization Impacts

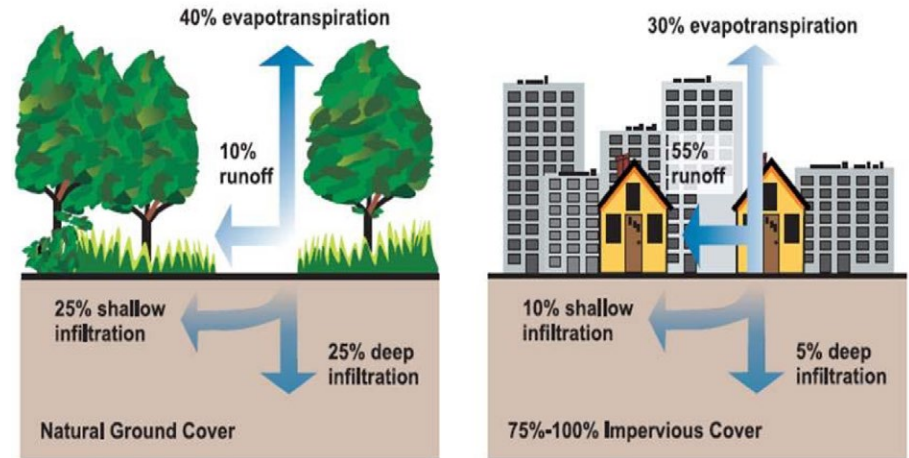
- Increased Flow and Volume Results in

- Increased Flooding
- Increased Stream Bed and Bank erosion
- Enlarged channels
- Habitat Loss and Damage
- Increased Pollutant Transport (Increase Water Quality Impacts)
  - Increased Aquatic Toxicity
  - Increased Consumer Toxicity
  - Increased Health Outbreaks
  - Increased Beach Closures
  - Degradation of Aesthetics



# Managing Stormwater Today: Low Impact Development (LID)

1. Mimic Natural Hydrology (Infiltrate)
2. Protect Receiving Waters
3. Reduce Flooding
4. Groundwater Recharge
5. Opportunities for Reuse



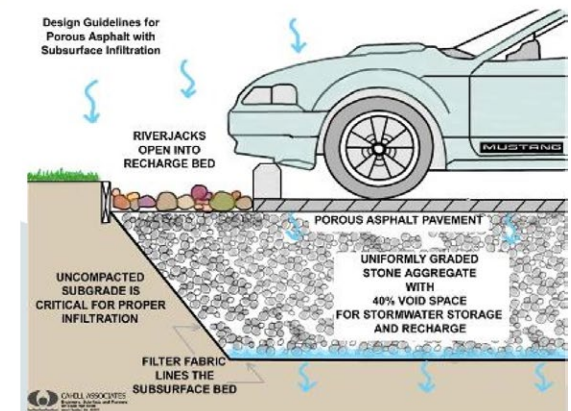
US  
EPA



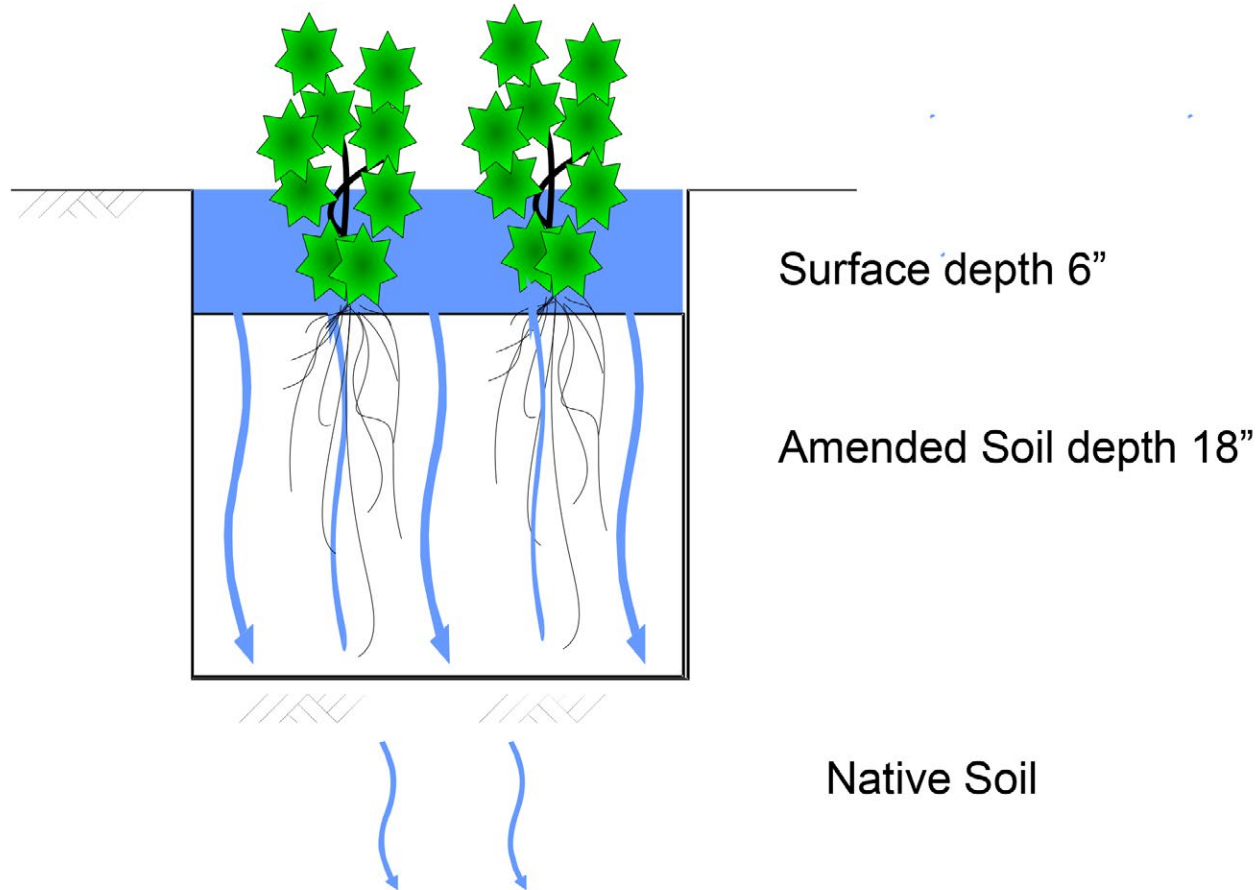
# LOW IMPACT DEVELOPMENT (LID)

## Types of Devices

- Bioretention Planters
- Rain Gardens
- Bioswales
- Porous Pavement
- Biostrips
- Road Narrowing (reduce impervious area)
- Cisterns or Rain Barrels
- Tree Box Filters
- Constructed Wetlands
- Green Roofs
- Infiltration Trenches



# Rain Garden Profile and Function



# Rain Gardens

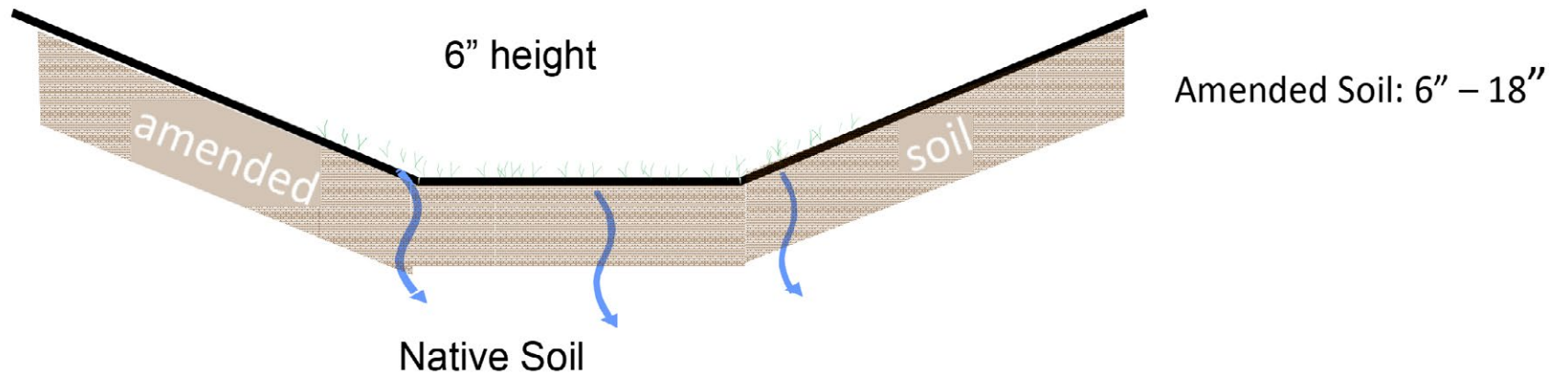


US EPA



Harford County, MD

# Bioswale - Profile



# Bioswales

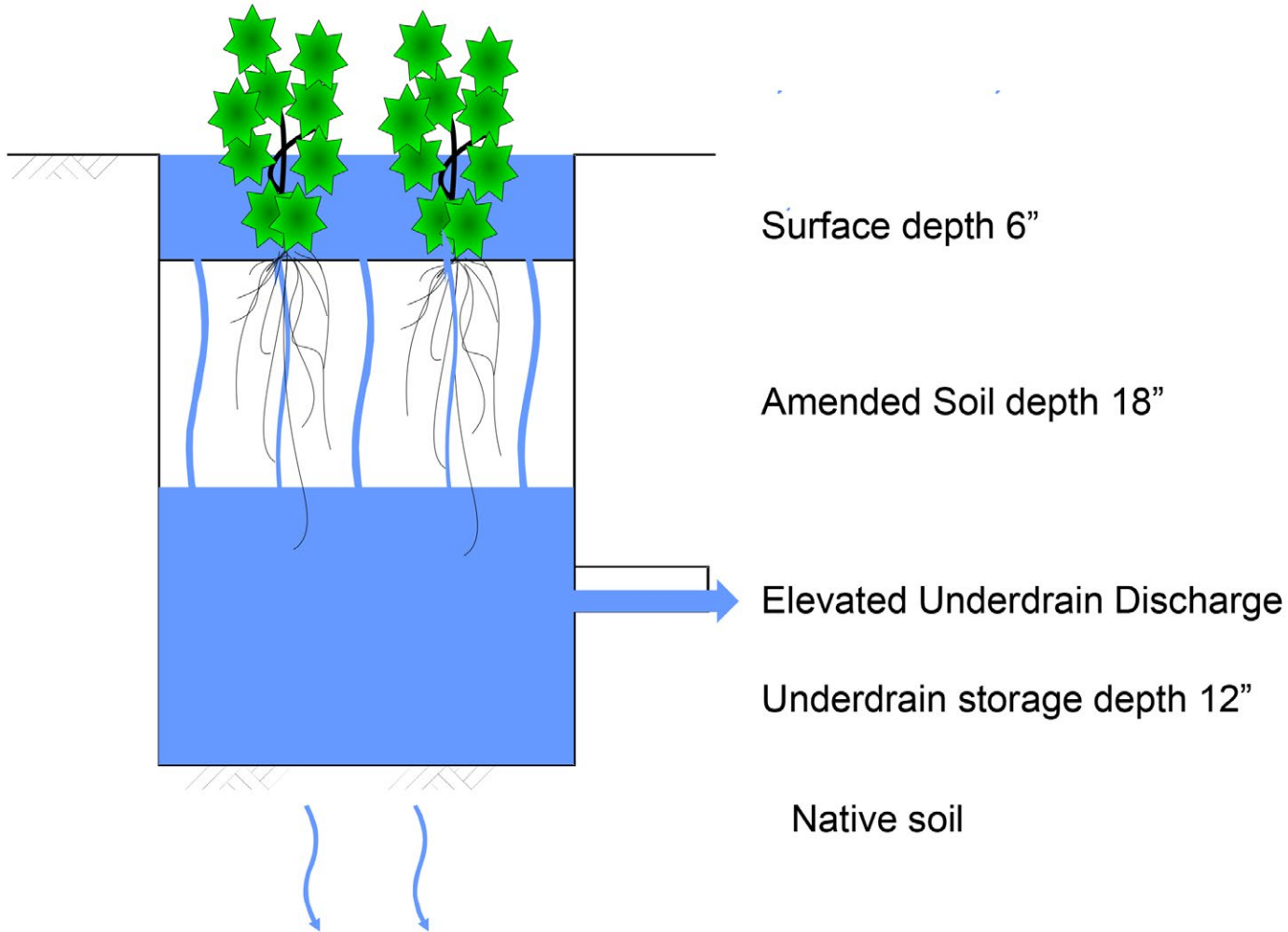


Caltrans



Lake County, IL

# Bioretention Profile and Function



# Bioretention – Parking Lots

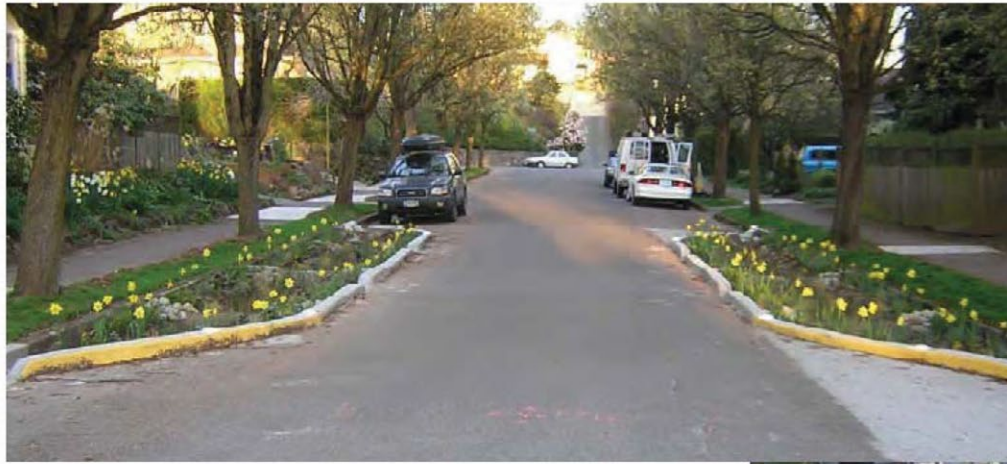


Scott Taylor, PE  
RBF Consulting



# Bioretention – Streets

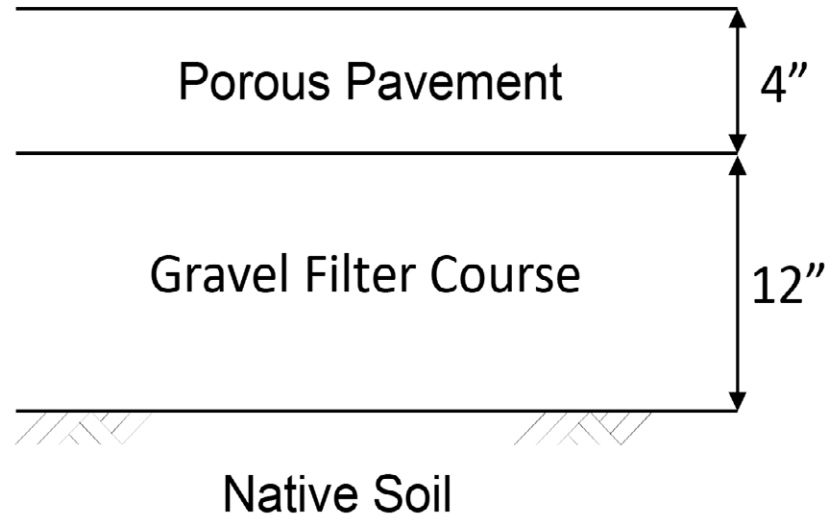
Scott Taylor, PE  
RBF Consulting



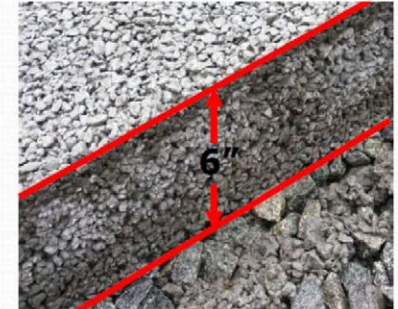


---

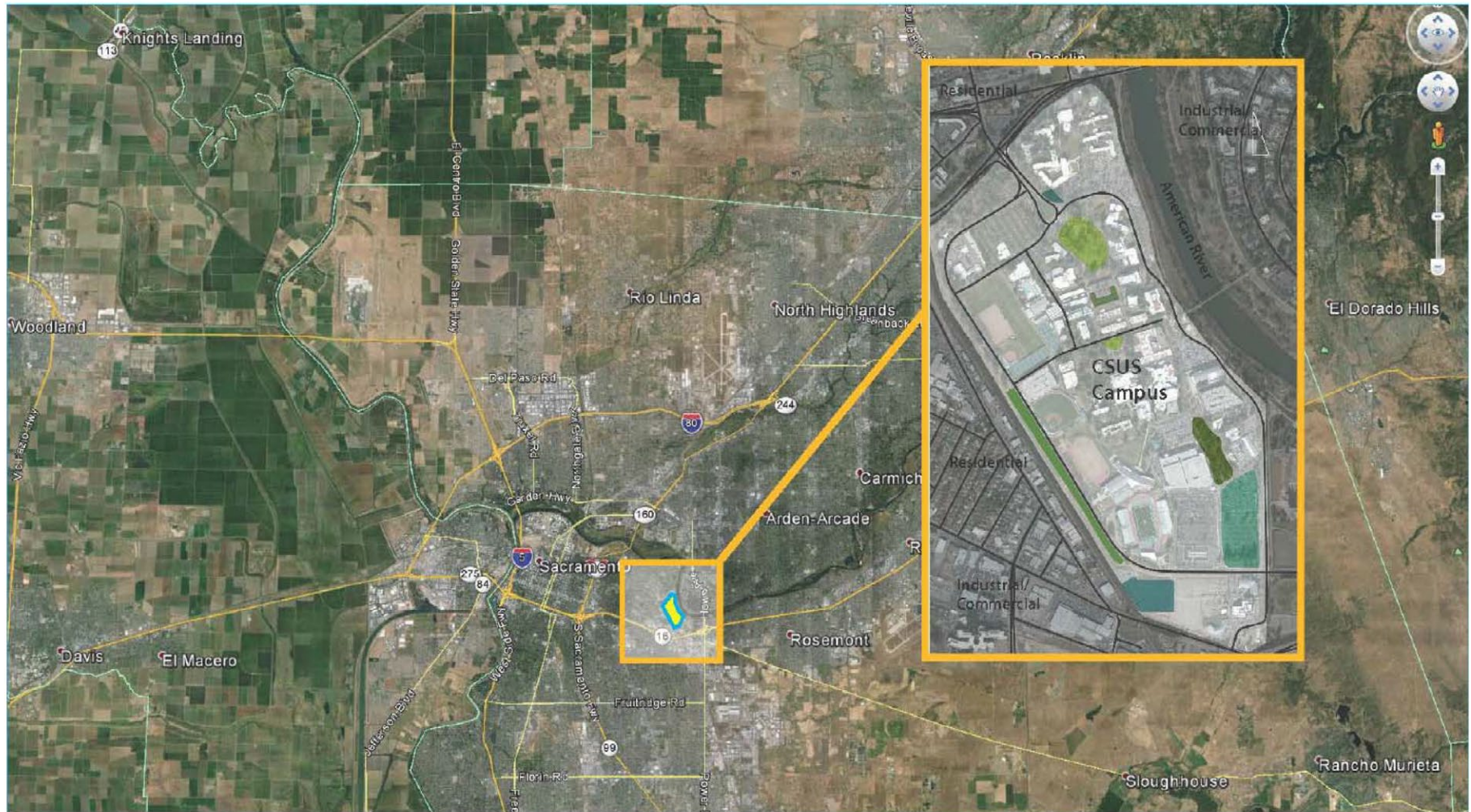
# Porous Pavement - Profile



# Porous Pavement



# LID Implementation at Sacramento



---

# Project Background: Campus Stormwater



Drain Inlet - Campus



Storm Drain Discharges into American River

# Project Background: American River



Outfall – Guy West Bridge



Upstream Sample

Discharge Sample

---

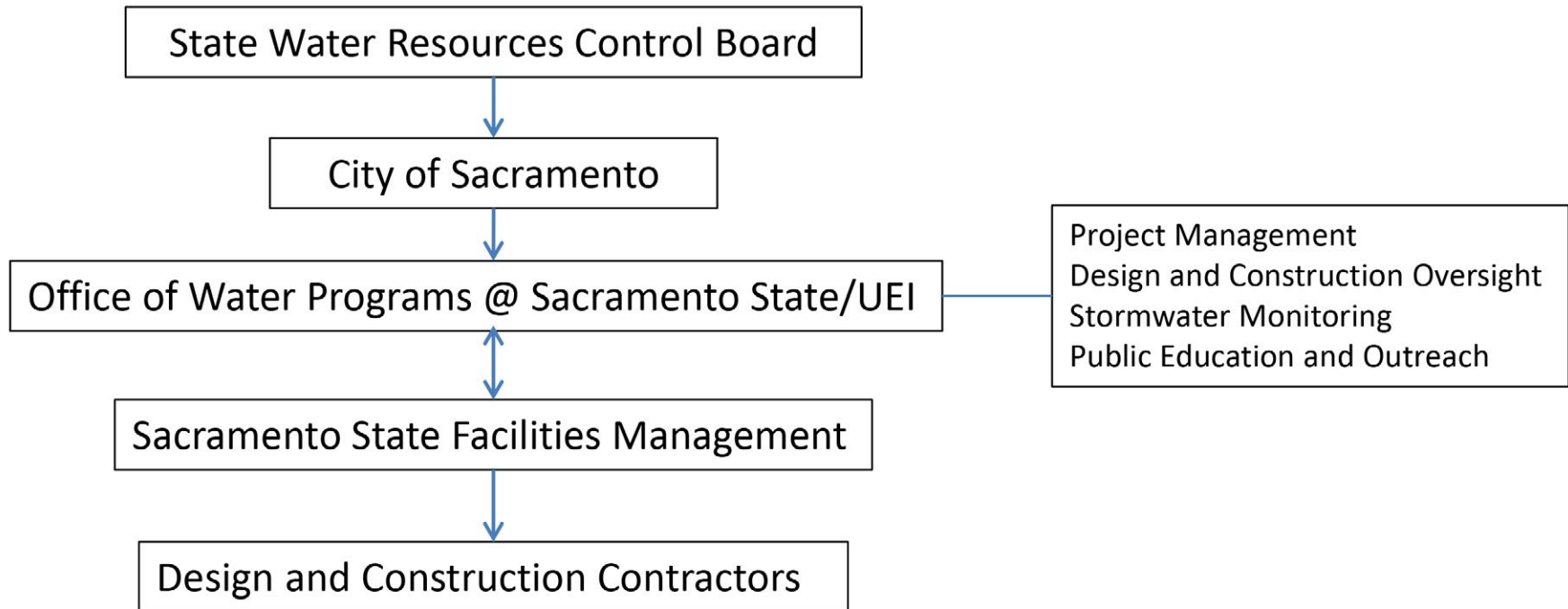
# Project Background

1. Proposition 84 – Stormwater Grant Program
2. State Water Resources Control Board
3. Objectives:
  - a) Prevent stormwater contamination of rivers, lakes, and streams.
  - b) Implement requirements of stormwater permits
  - c) Implement Low Impact Development (LID)
  - d) Monitoring and Education Outreach



City of Kirkland, WA

# Project Collaboration



---

# Project Funding

Project Total - \$3.3M

A. Prop 84 - \$2.6M

B. Local Match - \$0.7M

- i. Sacramento State FM - \$500K
- ii. City of Sacramento - \$112K
- iii. Office of Water Programs – \$31K
- iv. Dry Creek Conservancy - \$30K
- v. Local LID Expertise - \$25K
- vi. County of Sacramento - \$1K



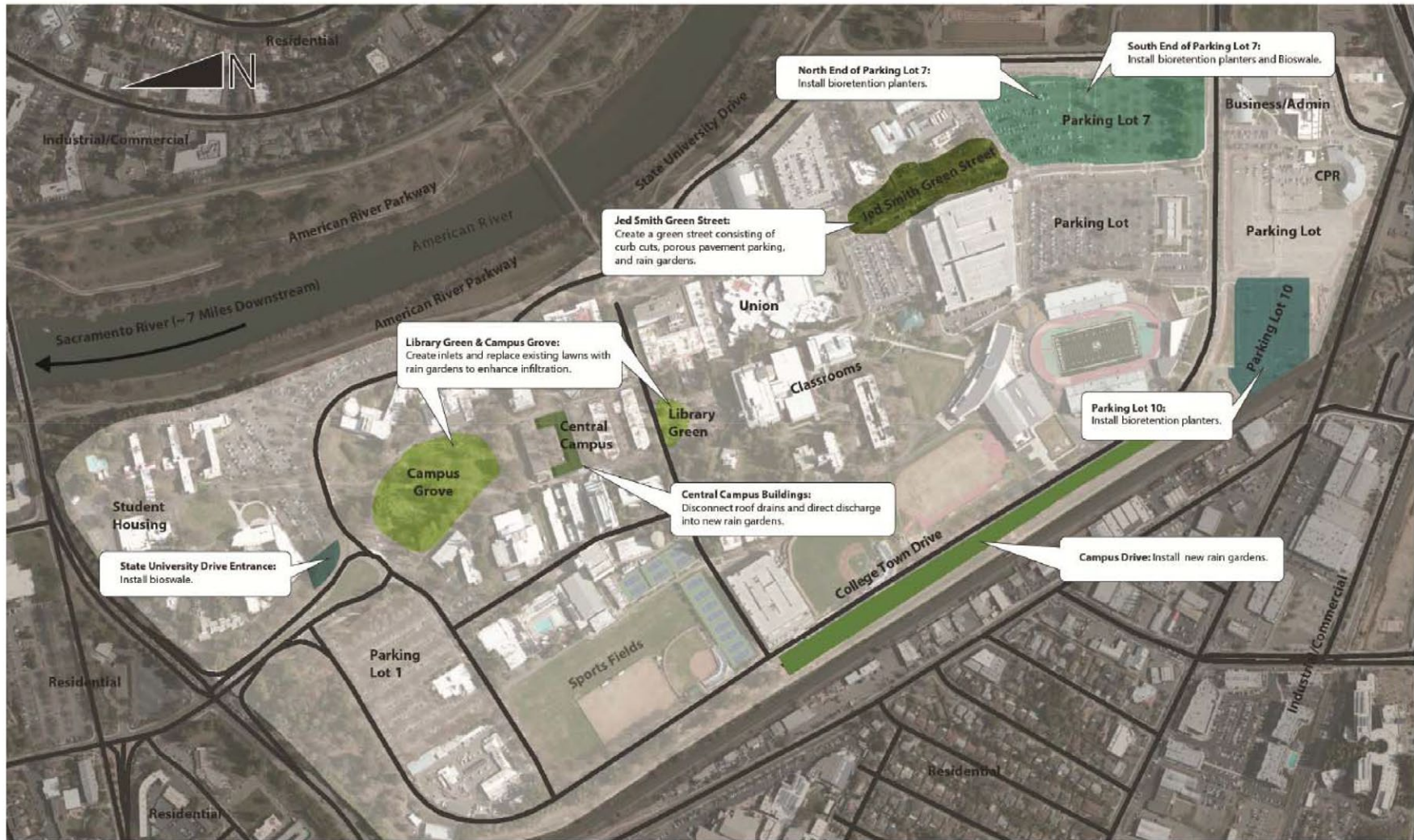
---

# Project Benefits

1. Meet Stormwater Permit Requirements
2. Faculty/Student Involvement
3. High Visibility
4. Protects the American River
5. Replenish Irrigation Wells
6. Demonstration and Training Facility for Northern CA



# Campus Layout



---

# Design Goals

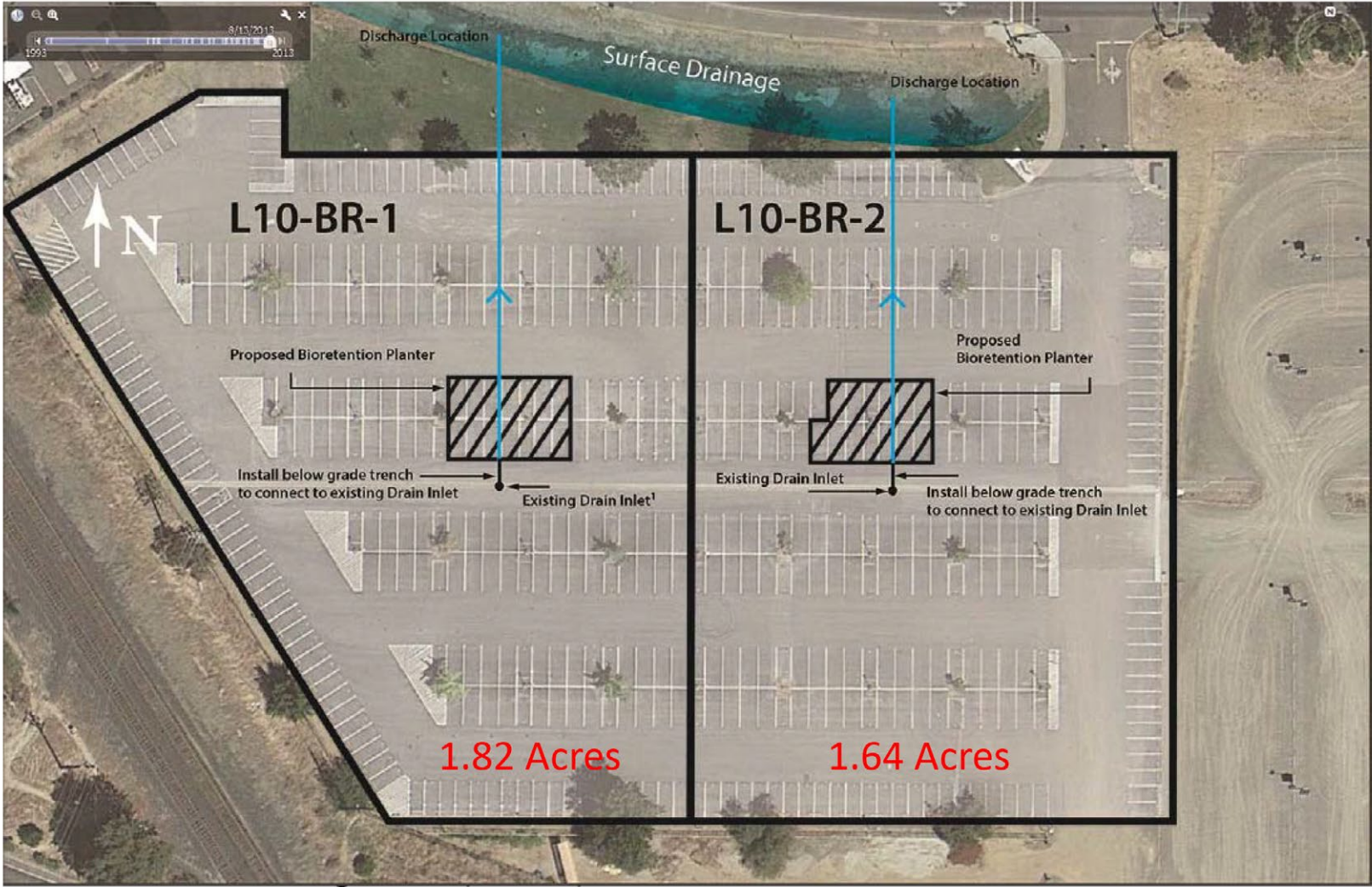
## Enhance Infiltration

- A. Silty sands over gravels
- B. No devices lined
- C. 14 acre-feet per year infiltrated or treated
- D. 13.2 acre-feet per year - infiltration alone
- E. Total Tributary Area ~ 13 acres

## Hearty Vegetation

- A. Drought- and Inundation-Tolerant
- B. Variety of Types and Combinations

# Design Goals – Large Tributary Areas



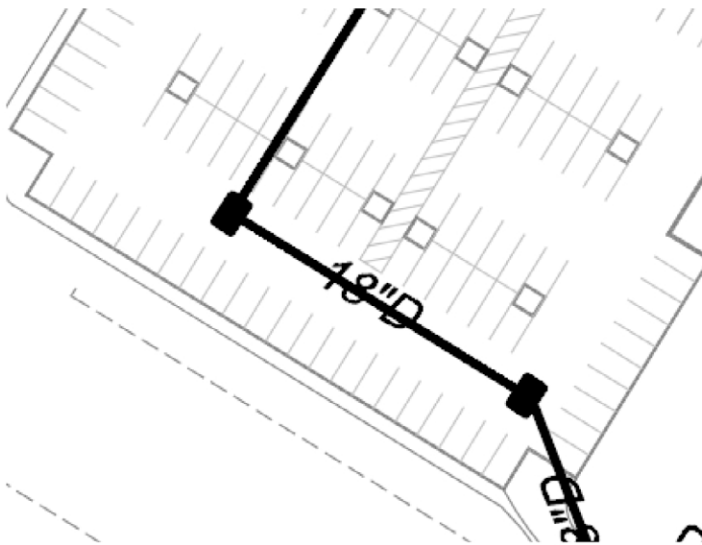
---

# Design Challenges

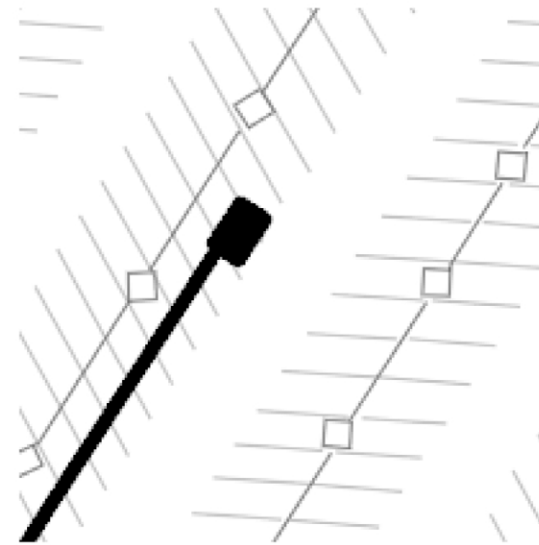
1. Proposition 84 – Stormwater Grant Program
  - a) Horizontal
  - b) Vertical
2. Negotiating the removal of parking stalls
3. Fitting into existing topography
4. Existing infrastructure
5. Interactions with buildings
6. Subsurface soil?
7. Timing
8. Compatibility with Campus Master Plan

# Design Challenges

- Fitting into the existing drainage system
  - Horizontal



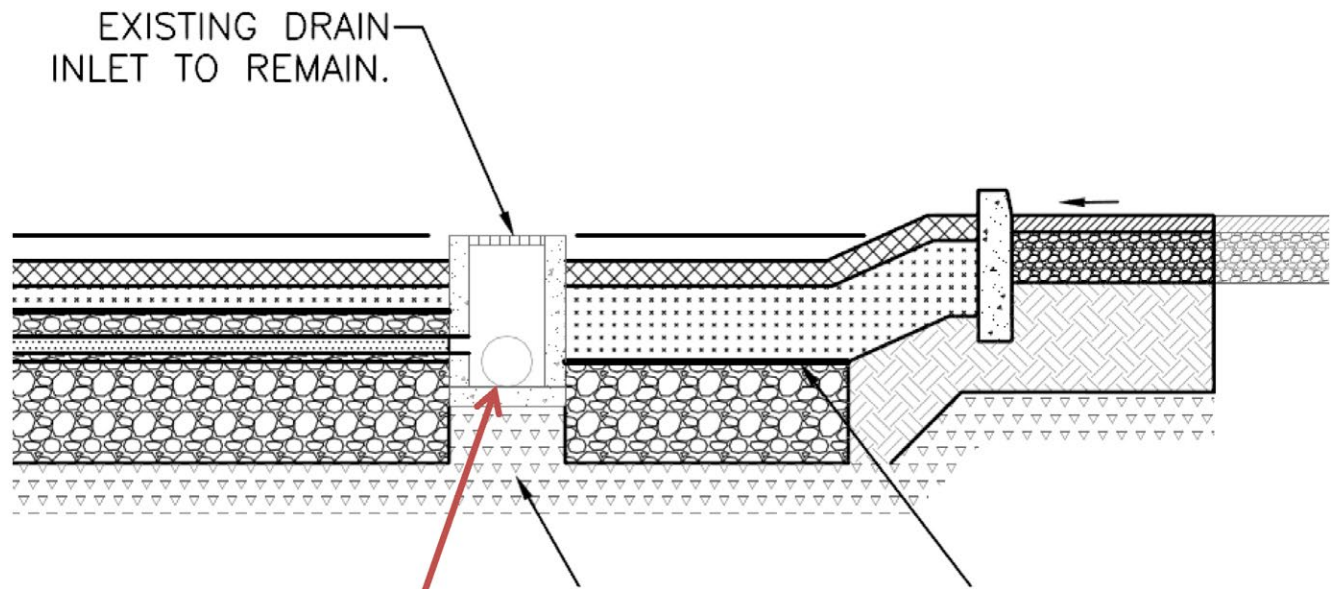
Drain in traveled way



Drain conveniently located

# Design Challenges

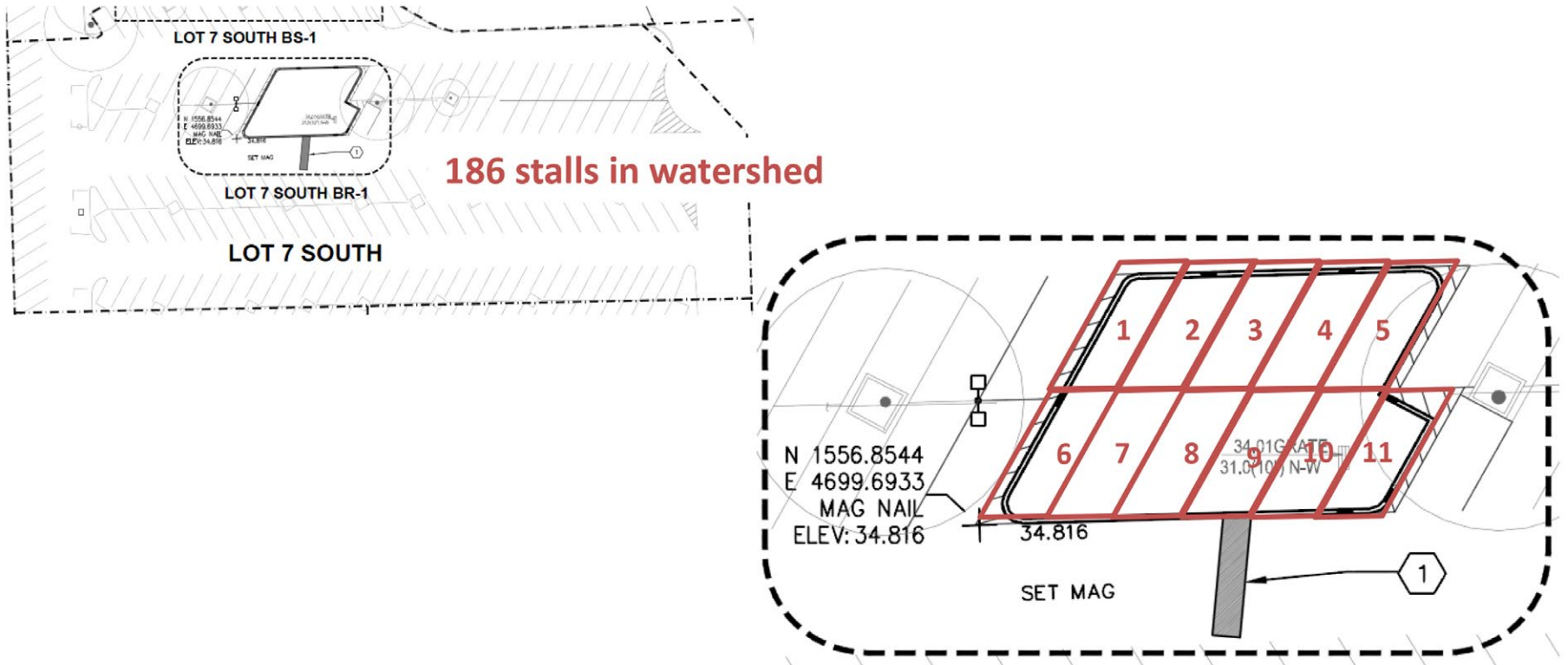
- Fitting into the existing drainage system
  - Vertical



Existing pipe invert to be maintained  
(can limit depth of bioretention media)

# Design Challenges

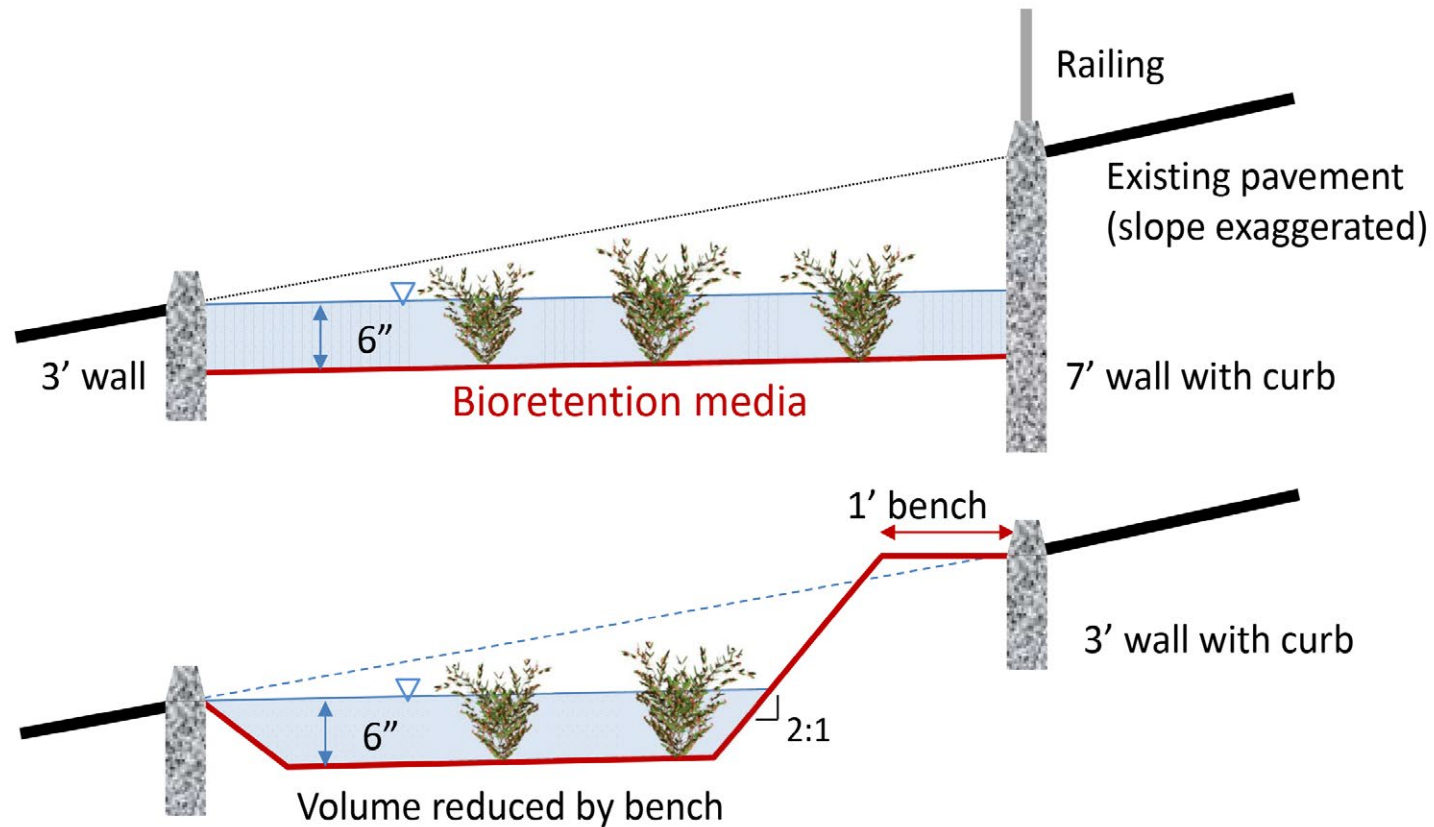
- Negotiating the removal of parking stalls





# Design Challenges

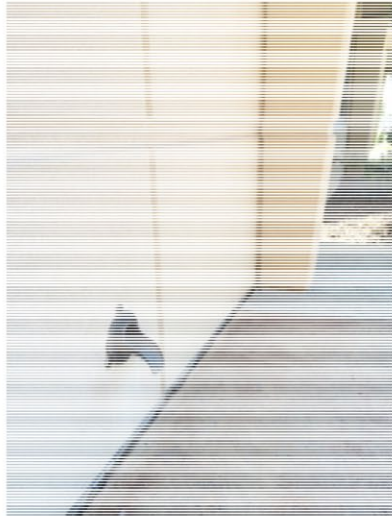
- Fitting into existing topography
  - Steep slopes don't accommodate large bioretention cells



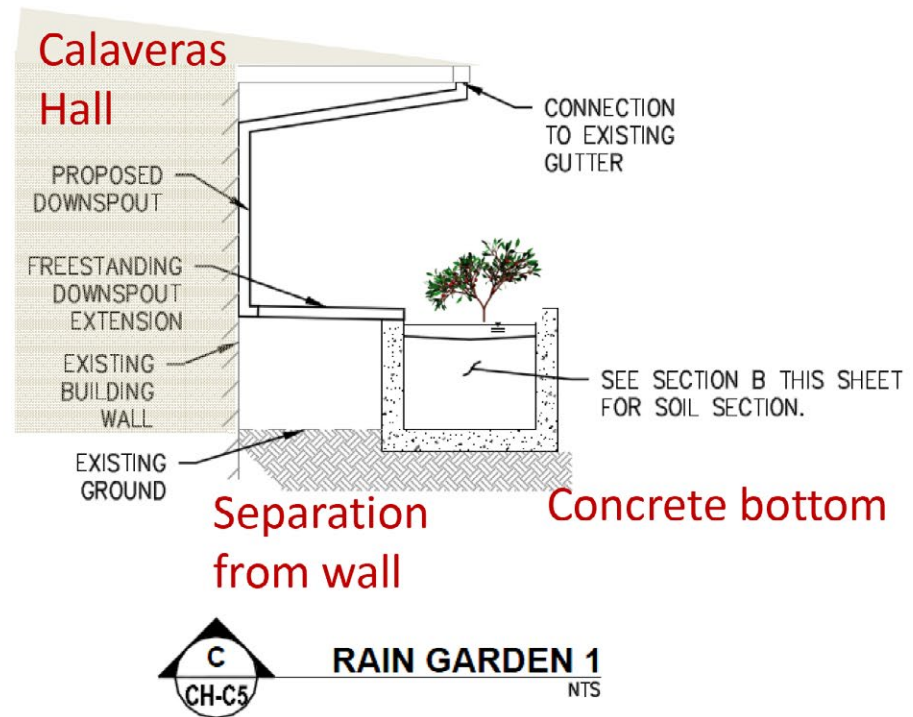


# Design Challenges

- Interactions with buildings
  - Avoid saturating soils around foundations
  - Tapping into building drainage systems
    - May require architect or mechanical engineer
    - Some inaccessible



This one is OK but what if the pipe is inside the building?



---

# Design Challenges

- **Subsurface soil**
  - Will it infiltrate?
  - How has it been affected by previous construction?
- **Timing**
  - Summer Construction Window

# Design Challenges

- Compatibility with campus master plan



# Construction Status

- Lot 7, Lot 10, College Town Drive
  - Construction complete
  - Contractor returning mid-October to replace plants



---

# Construction Status

- **Jed Smith Drive**
  - Construction complete
  - Planting and landscaping currently underway



---

# Construction Status

- **Library Green, Campus Grove, & Calaveras Hall**
  - Rain garden infrastructure complete
  - Planting and landscaping currently underway
  - Public access installations resuming soon





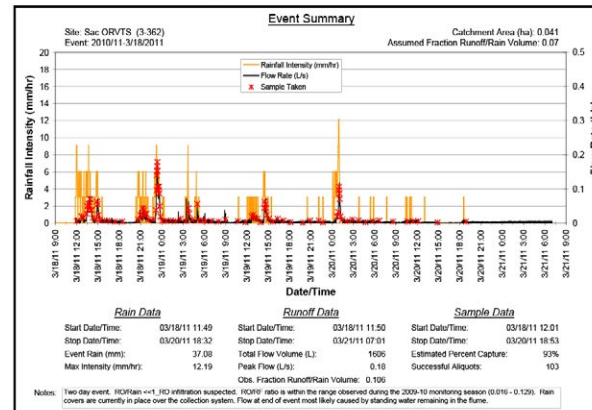
# Construction Challenges

- Unanticipated utilities and tree roots
  - Reduced footprints
  - Changed geometry
  - Broken irrigation lines flooded excavations
  - Parking pass dispenser shut down
- Specified plants not available
- Keep heavy equipment off excavations
- Unknown vehicular access points
- Extremely hot weather
- Improper planting techniques



# Monitoring

- Performance Monitoring
  - Flows (pressure heads)
  - Water Quality
    - TSS, TDS, turbidity
    - Chlorpyrifos & Diazinon
    - Copper, Lead, & Zinc
- Evaluation & Reporting
  - Up to 90% reductions



# Education and Outreach

1. Signage, Website, Tours (Mobile App)
2. Brochures
3. Conferences and Papers
4. LID Conference
5. Campus Presentations
6. Public Affairs



Kitsap Conservation District



Green Side Up



# Operation and Maintenance

1. Weed, Litter, and Debris Removal (As needed)
2. Infiltration Inspections (Runoff Infiltrating?) (Twice a year during storms)
3. Low or no Infiltration? Remove and Replace Topsoil (~ 5 to 10 years)
4. Use integrated pest management (IPM) techniques to minimize use of fertilizers, pesticides and herbicides. (As needed)
5. Inspect (~ 2 times per year – including once at end of wet season) for erosion and sediment buildup. Correct problems as needed.



Kevin Perry  
Urban Rain Design

---

# Project Timeline

Spring 2015: Complete Design

Summer and Fall 2015: Construction

2015/2016: Post-Construction Monitoring

January 2017: Final Report

2016 – 2036: O&M

---

# Project Funded by SWRCB

Funding for this project has been provided in full or in part through an agreement with the State Water Resources Control Board. The contents of this document do not necessarily reflect the views and policies of the State Water Resources Control Board, nor does mention of trade names or commercial products constitute endorsement or recommendation for us.



*[Maureen.Kerner@owp.csus.edu](mailto:Maureen.Kerner@owp.csus.edu)*

*[www.owp.csus.edu](http://www.owp.csus.edu)*