RIVERSIDE COUNTY FLOOD CONTROL and WATER CONSERVATION DISTRICT

Low Impact Development (LID) Testing & Demonstration Facility

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RIVERSIDE COUNTY FLOOD CONTROL and WATER CONSERVATION DISTRICT

1. Project Outline
2. Sampling
3. Lessons Learned
4. Results
5. Conclusions

1. Project Overview – Map

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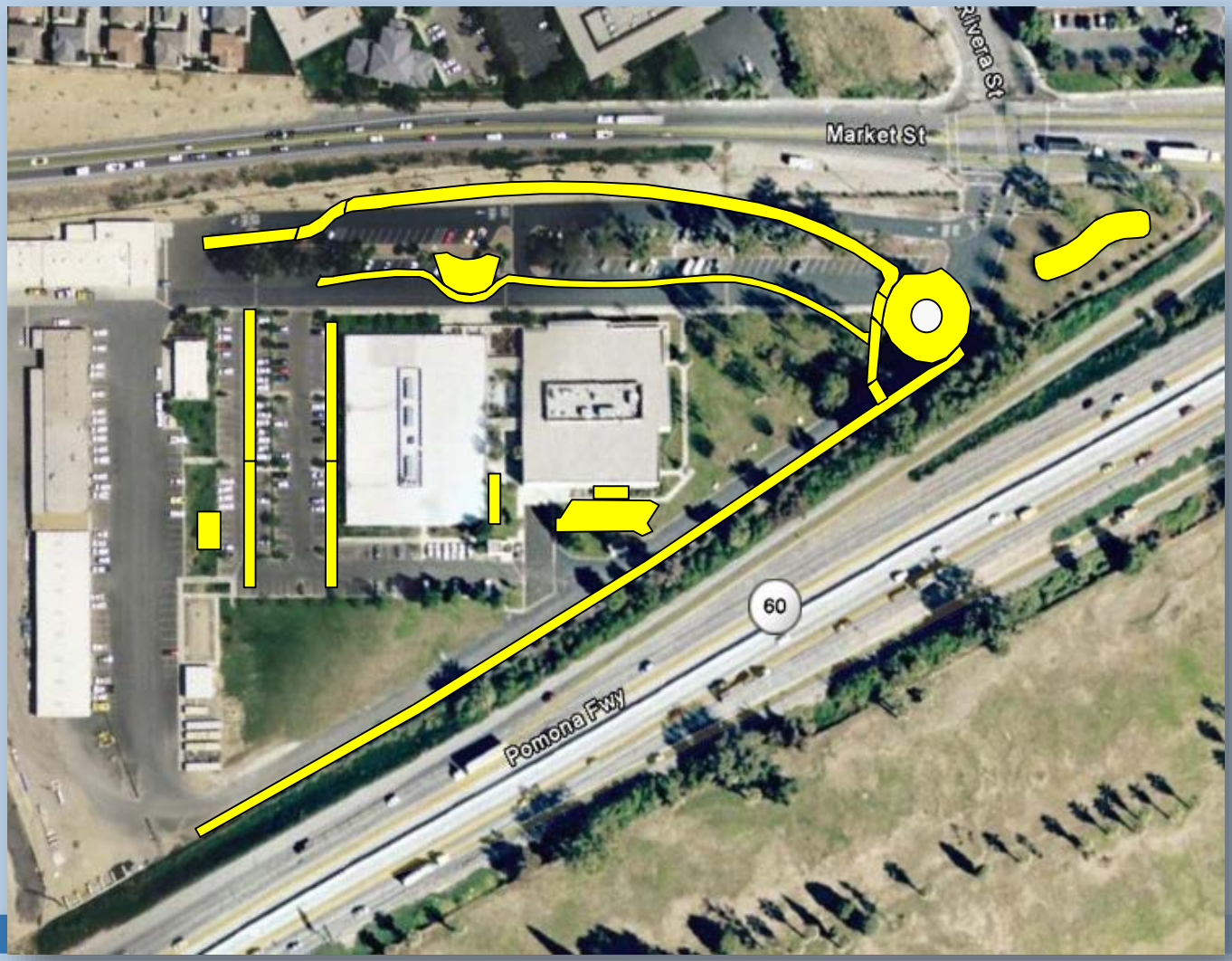


Fairham St
Riverside St
Market Street
60

1. Project Overview

- Genesis: SAWPA Prop 84 grant (~$500K)
- Total project cost = $2.5M
- Completed: 2012
- Goal:
  - Demonstrate LID and Water Conservation
  - Optimize LID for semi-arid environments
    - Simplify and standardize design
    - Resilient to real world operations
    - Maximize water quality benefits

1. Why this Project is Important

- One of oldest LID Testing Facilities in CA
- Built for monitoring and demonstration
- Designed to test and optimize worst-case (impermeable soils) LID functionality
  - Hydromodification
  - Treatment capabilities
- Will inform future LID design manuals and Permits

1. Challenges

- Retrofit site
- Rain and Mobilization
  - 11 sampling sites
- Designed to test and optimize worst-case (impermeable soils) LID functionality


Fairham St
Riverside St
Market Street
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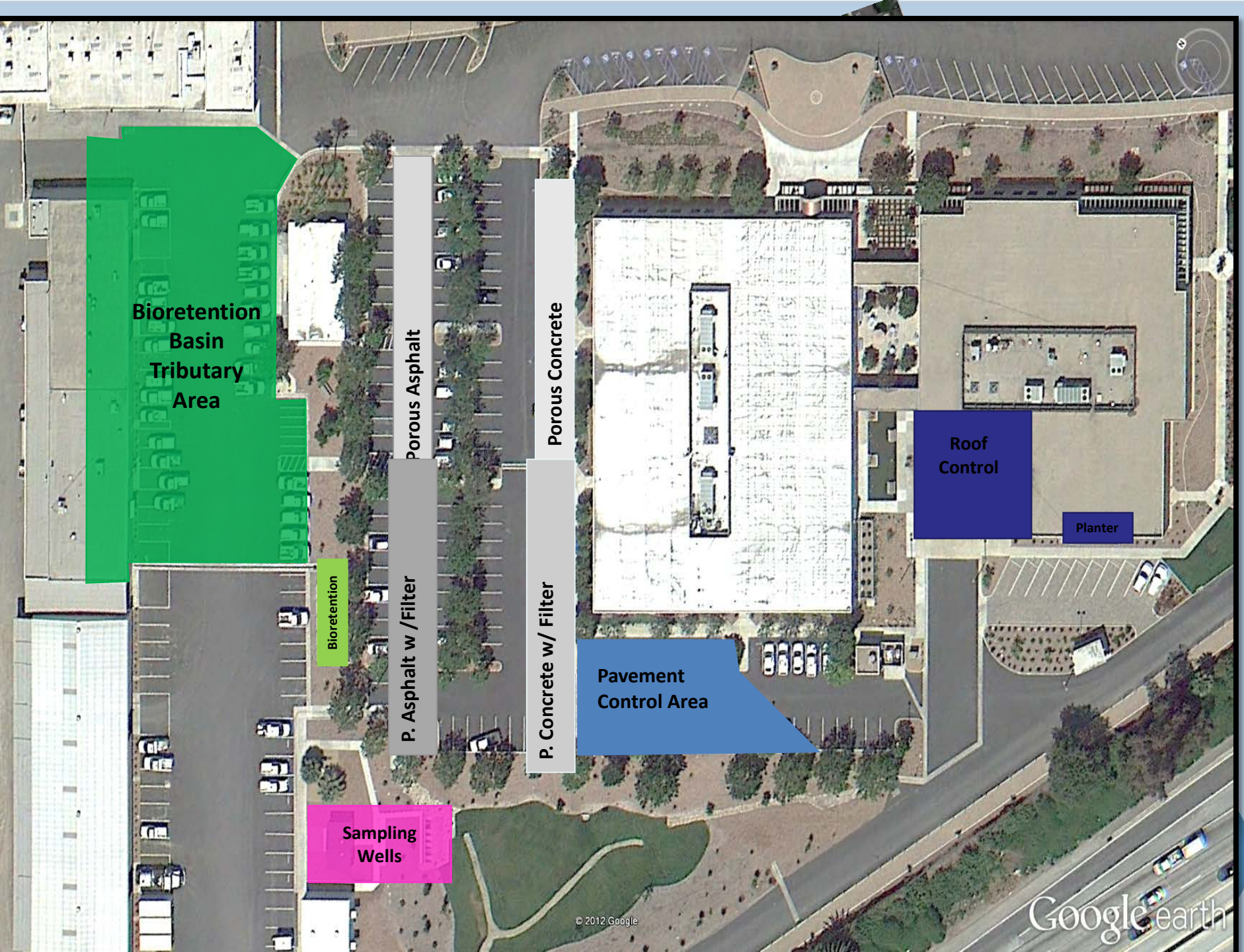
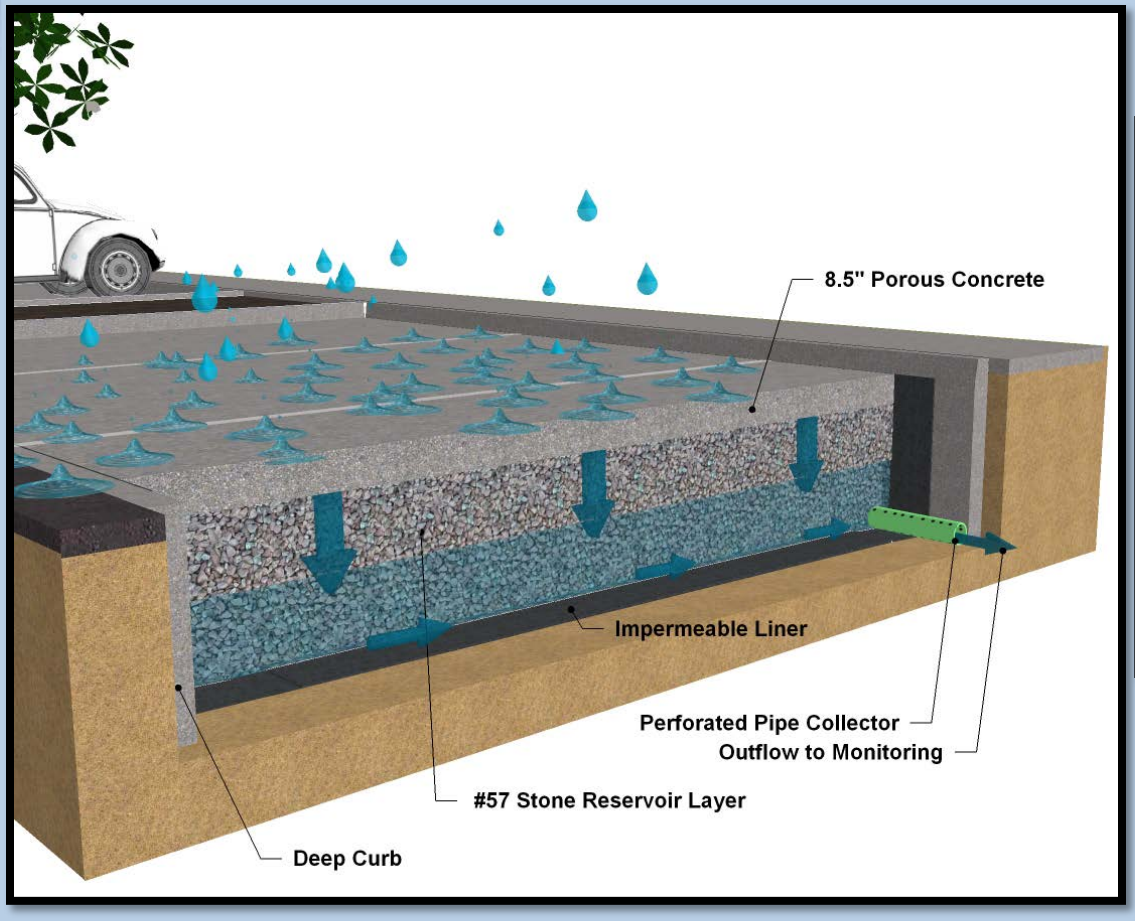
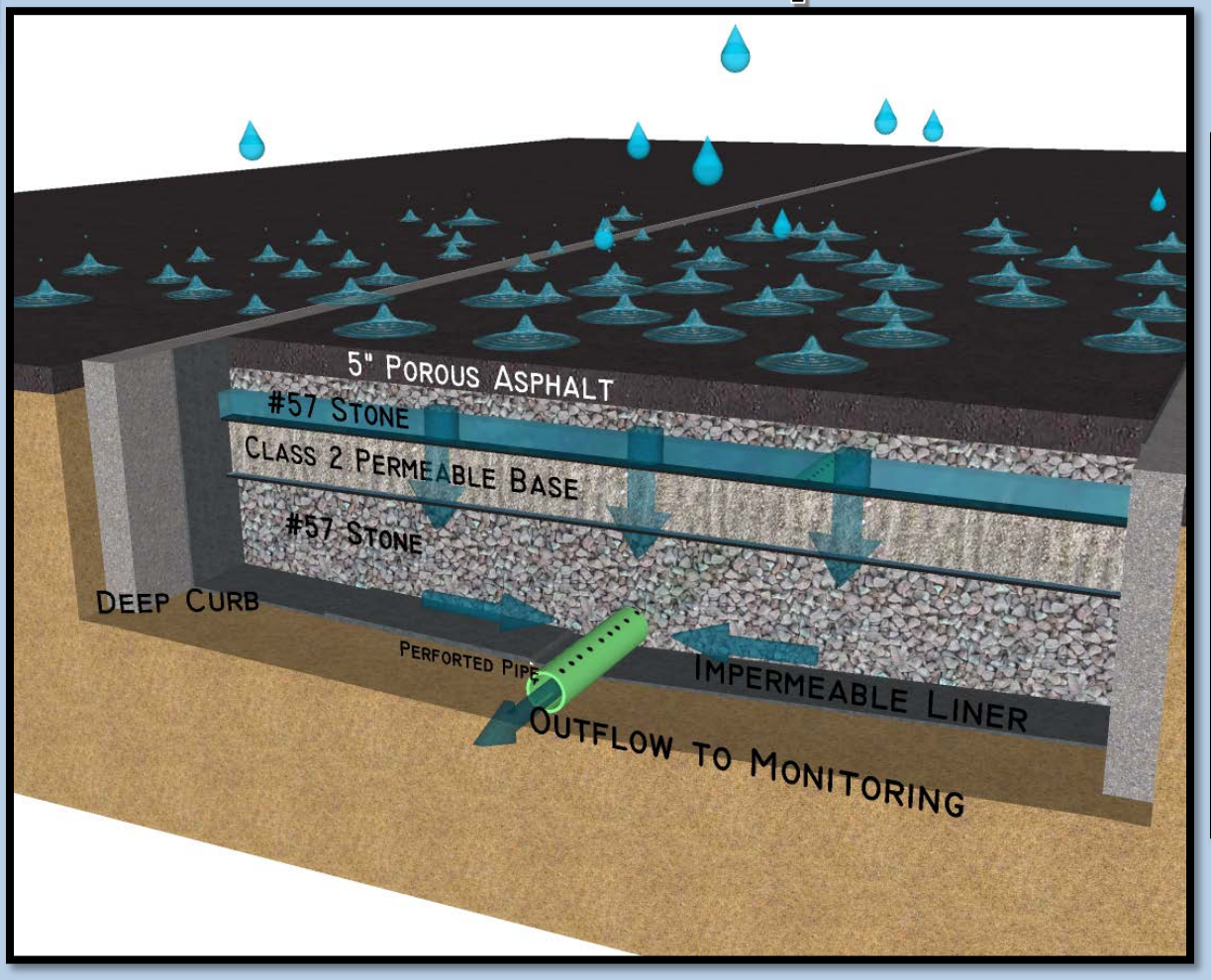
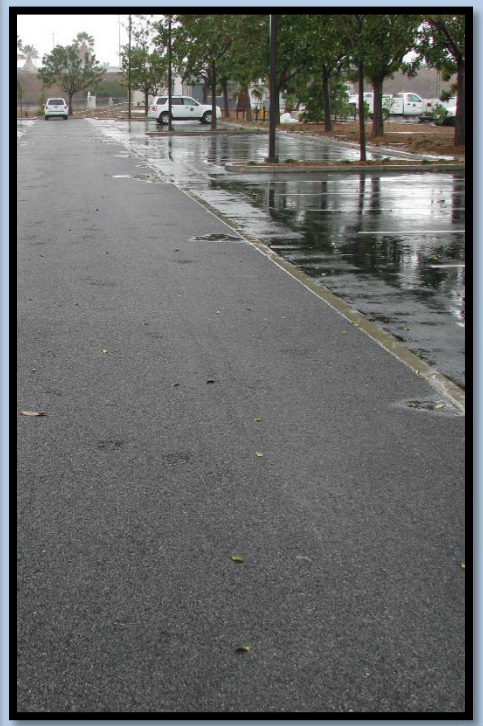

Bioretention Basin Tributary Area
Porous Asphalt
Porous Concrete
Roof Control
Planter
Bioretention
P. Asphalt w /Filter
P. Concrete w/ Filter
Pavement Control Area
Sampling Wells
© 2012 Google
Google earth

1. Project Overview – Porous Concrete

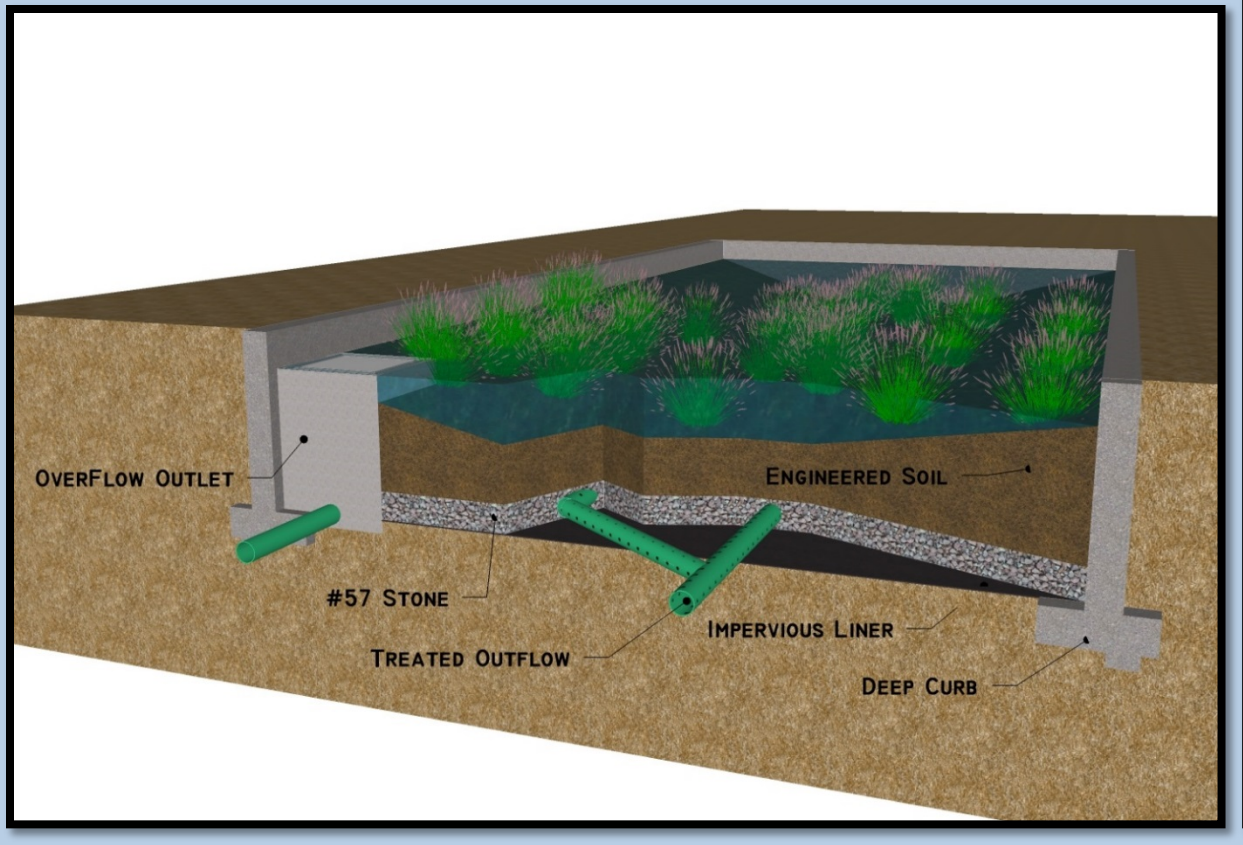


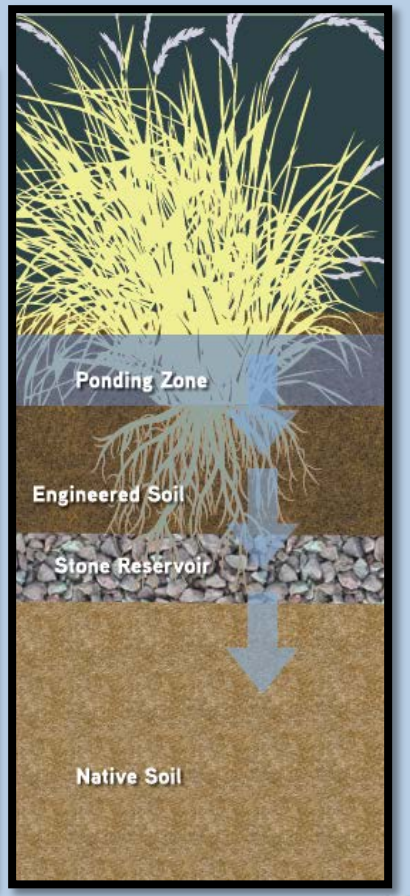
1. Project Overview – Porous Asphalt



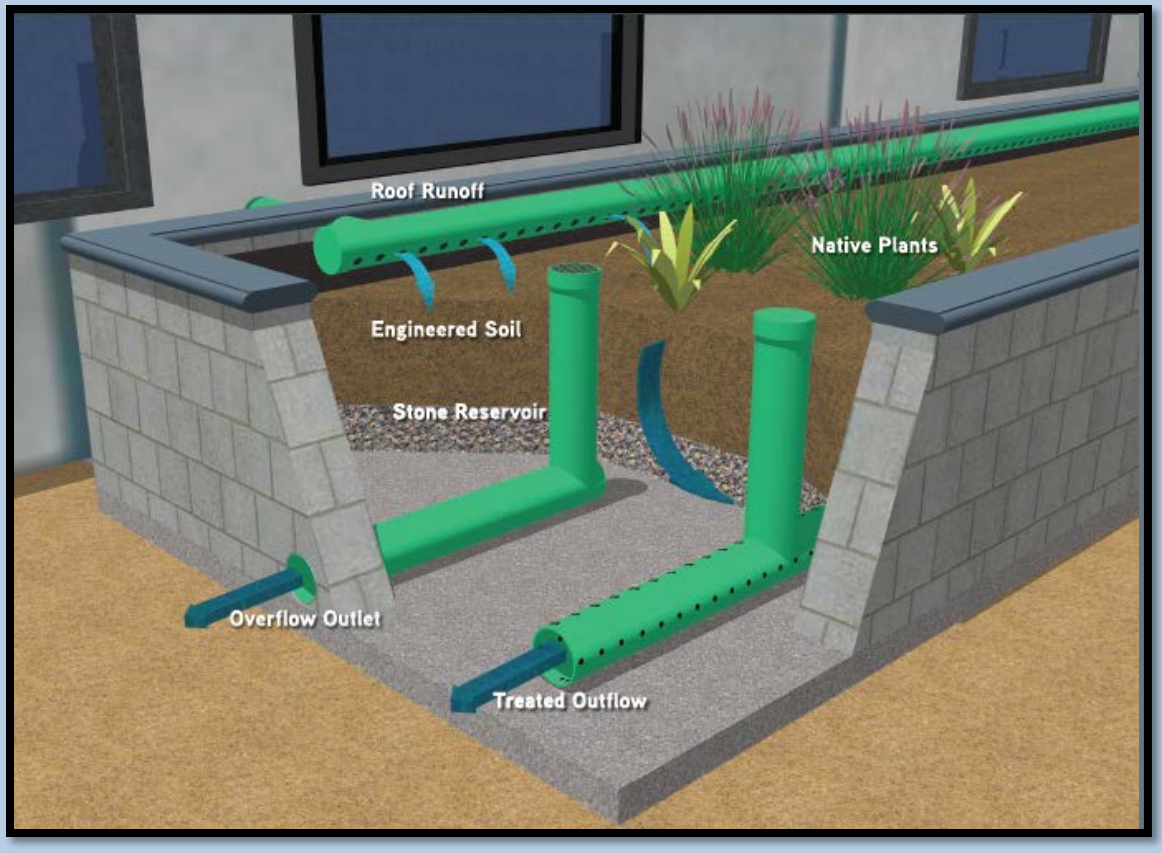


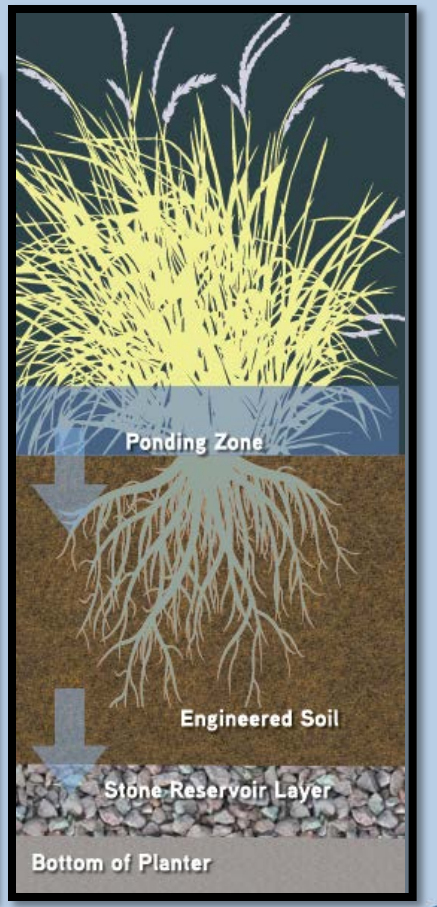
1. Project Overview – Bioretention Basin



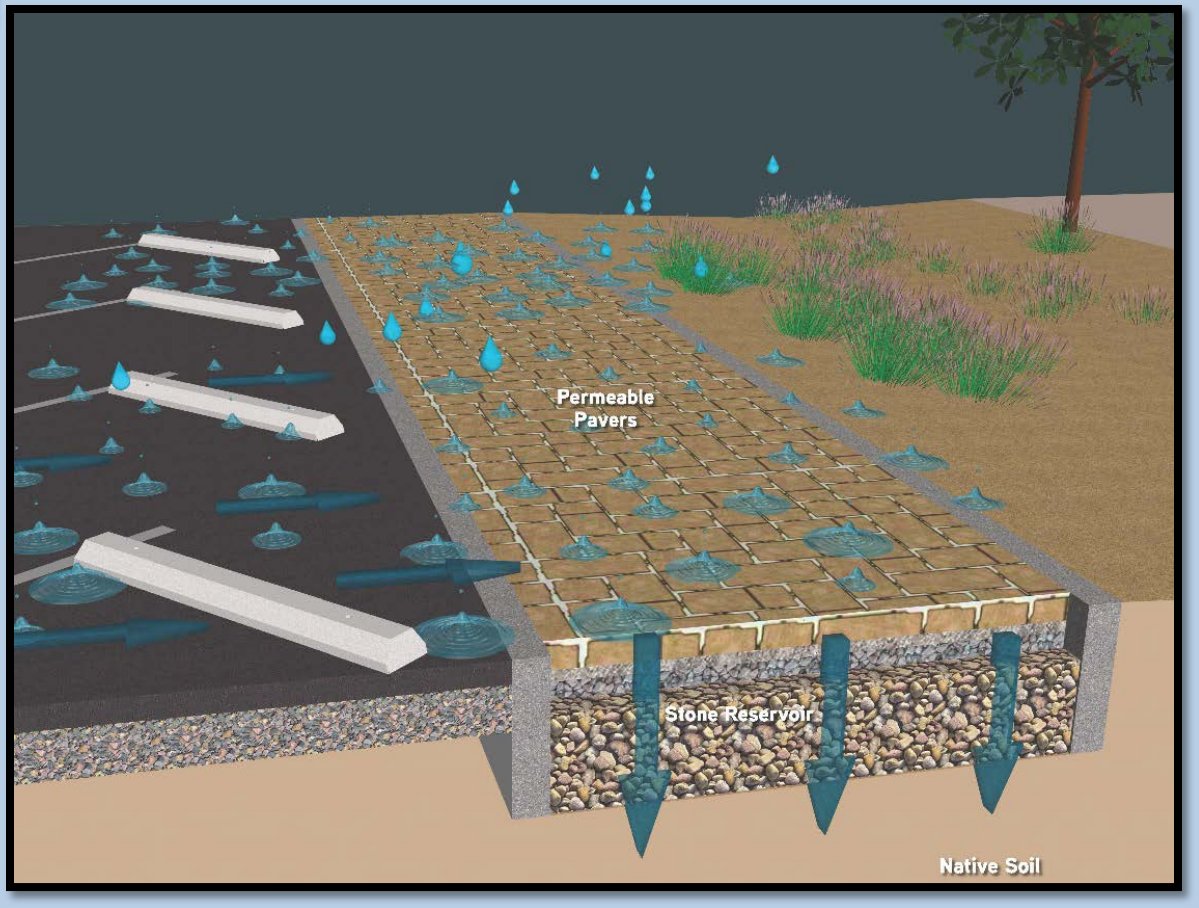


1. Project Overview – Planter Box





1. Project Overview – Porous Pavers



1. Project Overview – Awards

- 2011-2012 ASCE Civil Engineering Project Improvement Award
- 2012 ASCE Los Angeles Section Honorable Mention
- 2012 APWA Project of the Year
- 2012 Excellence in Communications Awards Special Recognition
- 2012 CSAC California State Association of Counties Challenge Award
- 2012 ASCE Region 9 Outstanding Stormwater Management Project
- 2013 Clair A. Hill Award Finalist
- 2016 NAFSMA Stormwater Management Green Infrastructure Awards for Top Overall Project

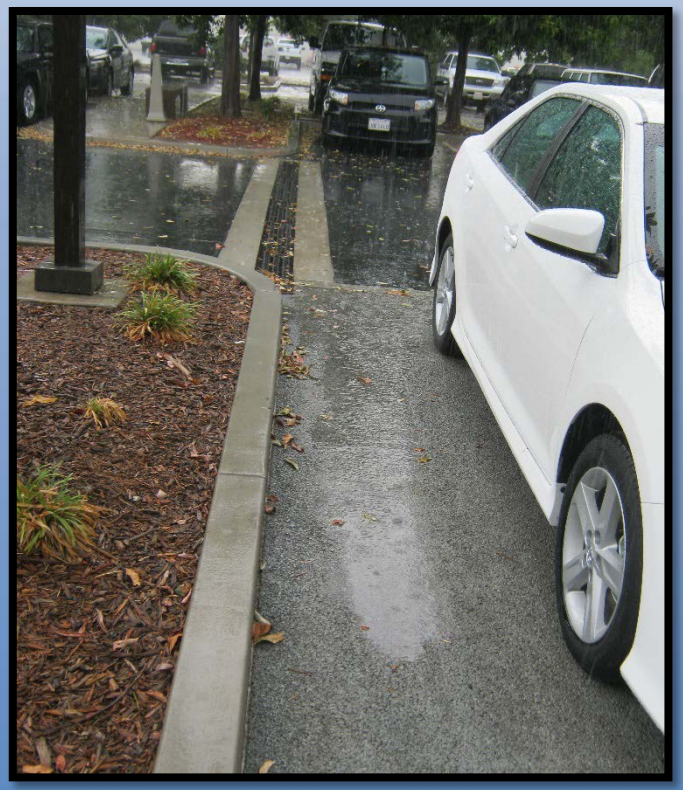
2. Sampling – Storm Events

Storm Events Sampled:

- 3/17/2012
- 4/26/2012
- 1/25/2013
- 2/28/2014
- 12/2/2014
- 12/22/2015
- 1/19/2017

~5 additional storms gave us a false start

2. Sampling – Storm Events



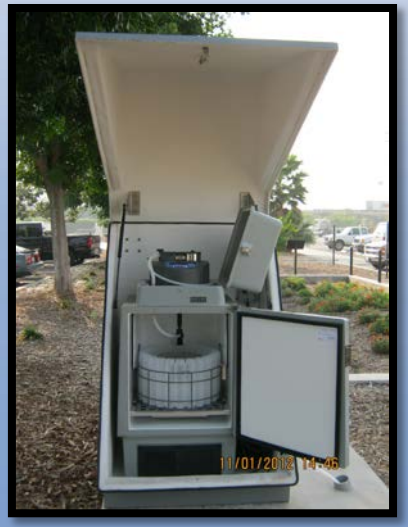
Representative Event:

Between 0.27" in 6 hours and 0.81" in 18 hours, when possible

Not all storms were sampled- Hard to predict rainfall and mobilize equipment

2. Sampling – Equipment

YSI multi-parameter sondes



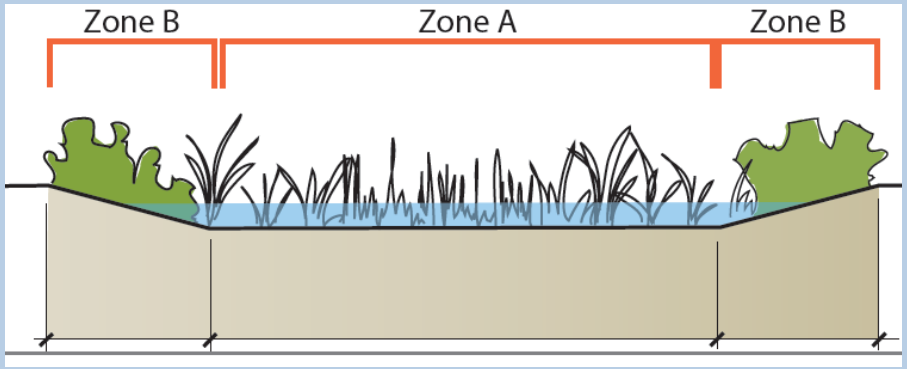
ISCO Refrigerated Auto-sampler

Thel-Mar Weirs

3. Lessons Learned – Design

- Clean vs washed aggregate
- Plant selection
- Plant placement
  - Inundation zones

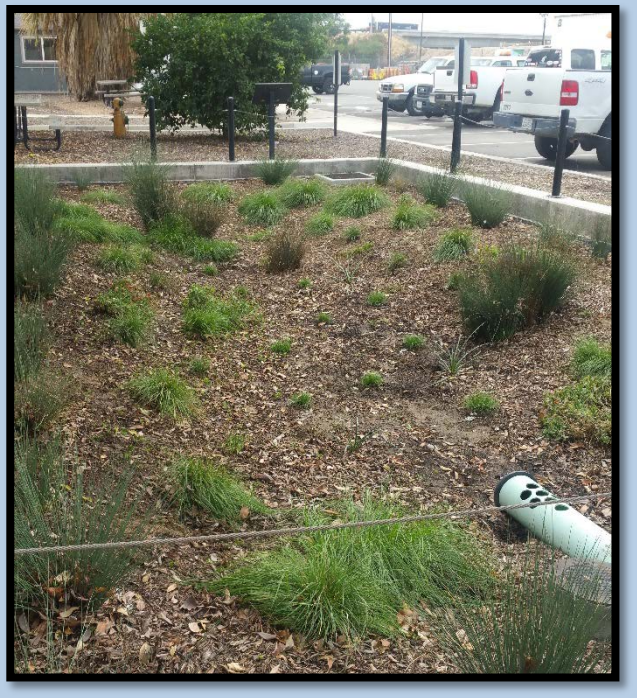
"Washed" number 57 stone



3. Lessons Learned – Maintenance

Bioretention Basin

- Native grasses planted February 2017
- Animal burrowing causing water to short circuit



3. Lessons Learned – Maintenance

Porous Pavement

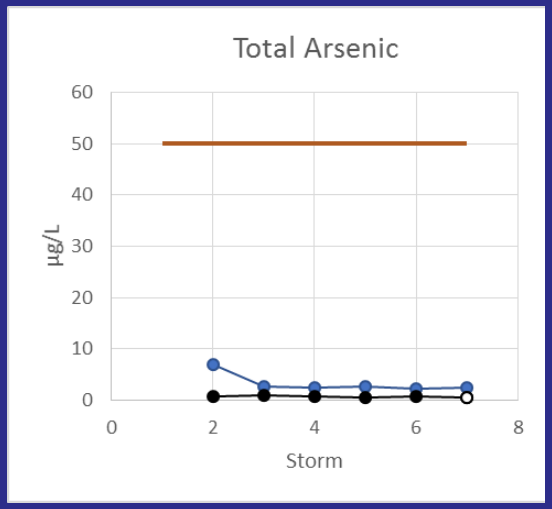
- Difficult finding local vacuum sweeper
- Original void fill for pavers no longer available
- Some pavement clogged
  - Cores of pavement indicate clogging is only at surface

4. Results – Water Quality

The 32 constituents sampled fall into 3 categories relating to Water Quality Objectives (WQOs)

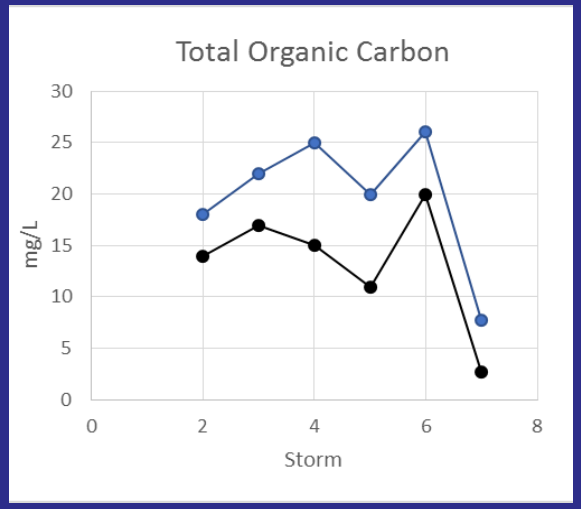
609 Planter Box Effluent | 610 Planter Box Control | Nondetects | WQO (Santa Margarita Basin Plan)

Below WQOs

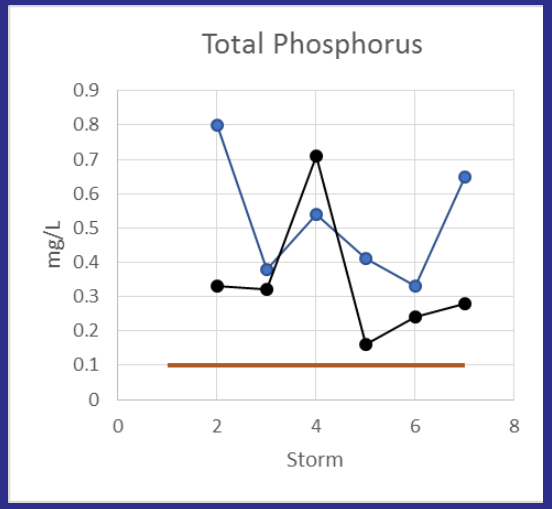


Santa Ana Basin Plan
Santa Margarita Basin Plan
California Toxics Rule

Undetermined WQOs



Above WQOs



Santa Ana Basin Plan
Santa Margarita Basin Plan
California Toxics Rule

4. Results – Water Quality

Below WQOs

Santa Ana Basin Plan
- Hardness
- Total Dissolved Solids
- Total Suspended Solids

Santa Margarita Basin Plan
- Dissolved Chromium
- Dissolved Iron
- Dissolved Manganese
- Total Arsenic
- Total Cadmium
- Total Chromium
- Total Copper
- Total Lead
- Total Zinc

California Toxics Rule
- Dissolved Arsenic
- Dissolved Zinc

Undetermined WQOs

- Dissolved Cadmium
- Dissolved Copper
- Dissolved Lead
- Dissolved Nickel
- Dissolved Organic Carbon
- Ammonia
- Nitrite
- TKN
- Oil & Grease
- Ortho Phosphorus
- Total Nickel
- Total Organic Carbon

Above WQOs

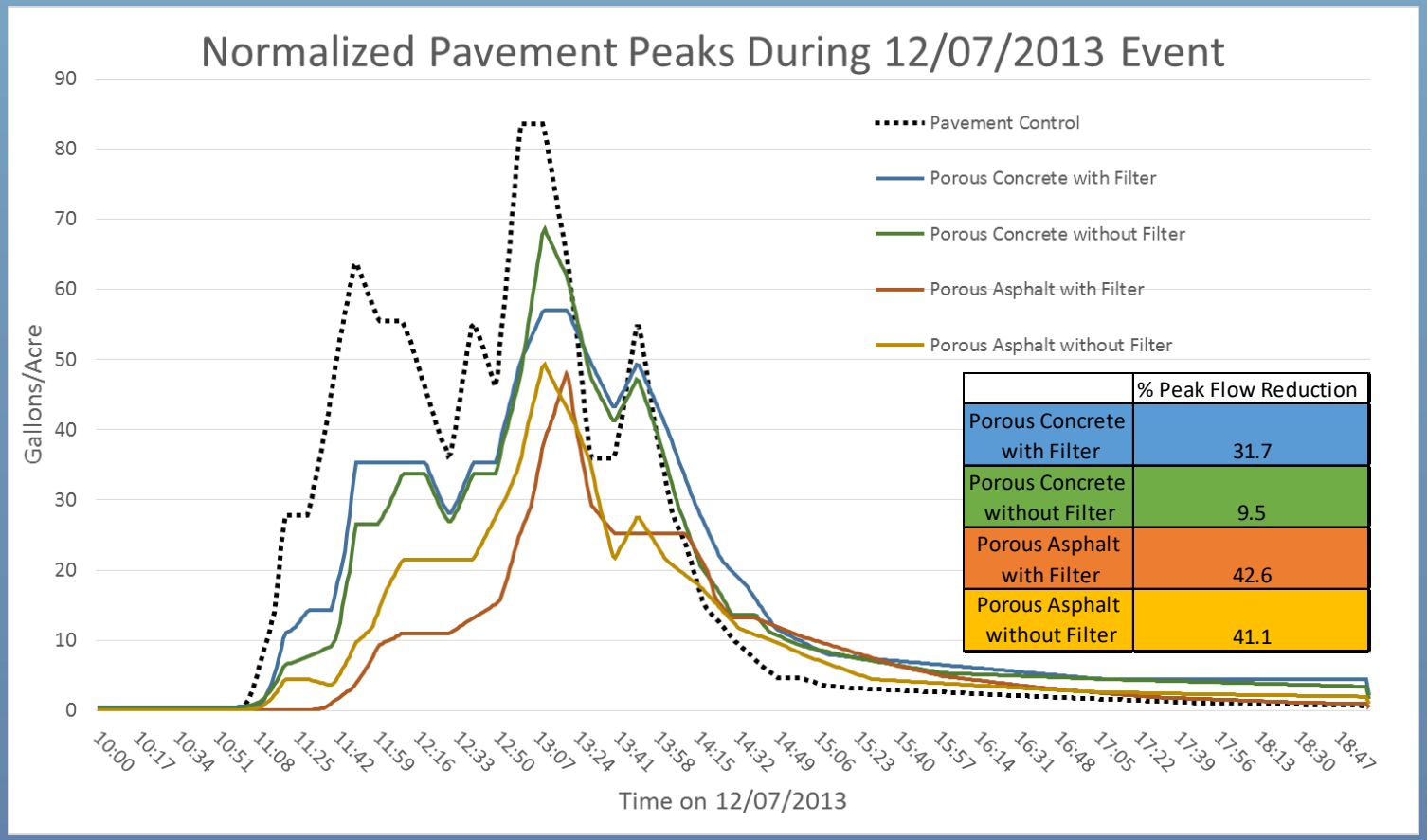
Santa Ana Basin Plan
- E. coli*

Santa Margarita Basin Plan
- Total Iron
- Total Manganese
- Nitrate
- Total Phosphorus

*Our sampling wells are great habitats for animals!

4. Results – Hydromod Benefits

Results indicate that porous pavement reduces peak flow and increases lag time

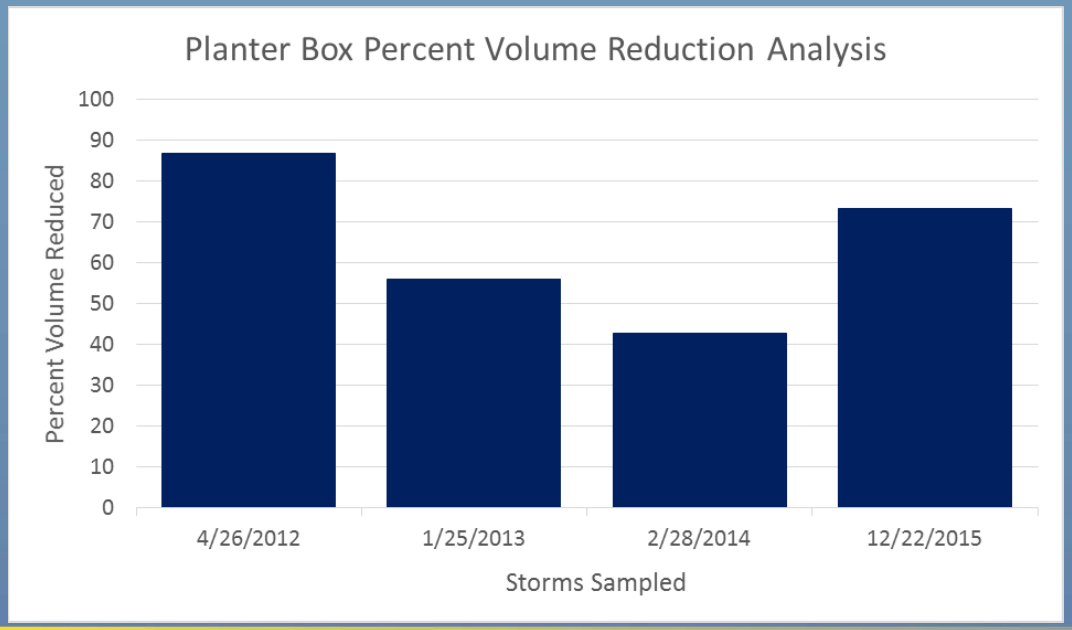


	% Peak Flow Reduction
Porous Concrete with Filter	31.7
Porous Concrete without Filter	9.5
Porous Asphalt with Filter	42.6
Porous Asphalt without Filter	41.1

4. Results – SMC CLEAN Planter Box

SMC CLEAN: Stormwater Monitoring Coalition
California LID Evaluation & Analysis Network

Results indicate that the planter box reduces volume during storms



Storm Events	% Volume Reduction
4/26/2012	86.8
1/25/2013	55.8
2/28/2014	42.6
12/22/2015	73.1
Average	64.6

4. Results – Planter Box Percent Load Reductions

Load = Concentration x Volume

Total Zinc	86
Dissolved Zinc	89
Total Arsenic	-126
Solids, Total Dissolved (TDS)	-124
Dissolved Arsenic	-122
Nitrogen, Nitrate (as N)	-75
Dissolved Nickel	-5
Total Nickel	-2
Total Iron	17
Total Chromium	21
Dissolved Organic Carbon	26
Phosphorus, ortho (as P)	27
Phosphorus (Total)	28
Organic Carbon, total (TOC)	29
Dissolved Copper	34
Total Copper	36
Total Lead	45
Nitrogen, Total Kjedahl	56

Dissolved Cadmium
Dissolved Chromium
Dissolved Iron
Dissolved Lead
Dissolved Manganese
E. Coli
Hardness as CaCO3
Nitrogen, Ammonia (as N)
Oil & Grease
Solids, Total Suspended (TSS)
Total Cadmium
Total Manganese

Insignificant reductions are most likely because our concentrations are already so low

- "*Determining Urban Storm Water BMP Effectiveness"* Eric Strecker, ASCE, 2001

Nondetects
Significant Decrease in Load
Insignificant Change*
Significant Increase in Load BUT Below WQOs
Significant Increase in Load & Above WQOs

*Insignificant if % load reduction < 70%

- "*A Review of Applicability and Effectiveness of Low Impact Development/Green Infrastructure Practices in Arid/Semi-Arid United States"* Yan Jiang et al, EPA, 2015

5. Conclusion

1. One of oldest purpose-built LID monitoring facilities
2. Focused on collecting worst case performance data
3. Need to continue collecting and analyzing data in order to make conclusions regarding LID effectiveness and design
4. Soil based BMPs retain significant runoff
5. Porous pavements with subsurface storage can assist with hydromod mitigation