Green Infrastructure Monitoring at Edison Environmental Center with Applications for Water Conservation

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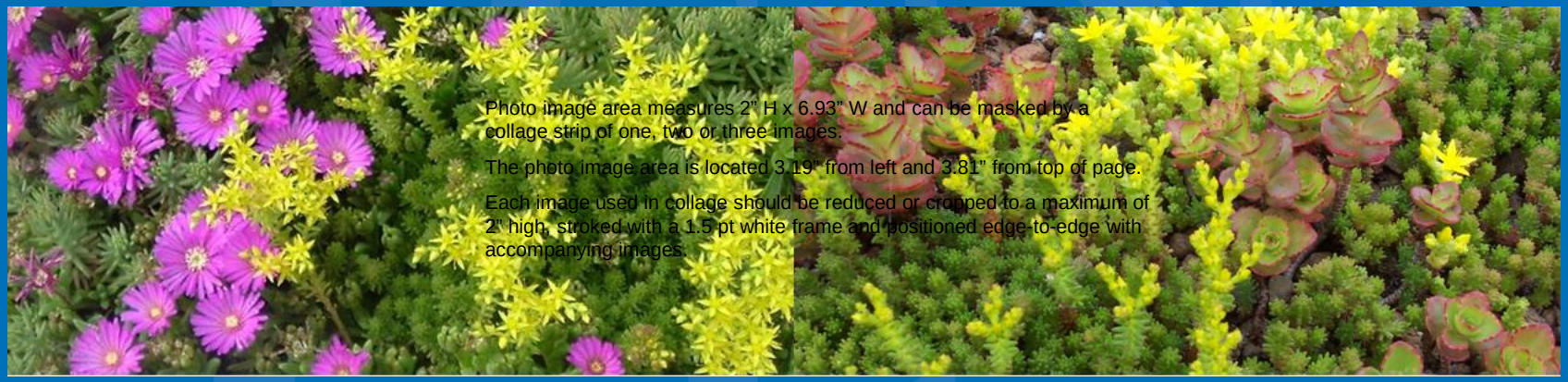

Office of Research and Development
National Risk Management Research Laboratory

EPA
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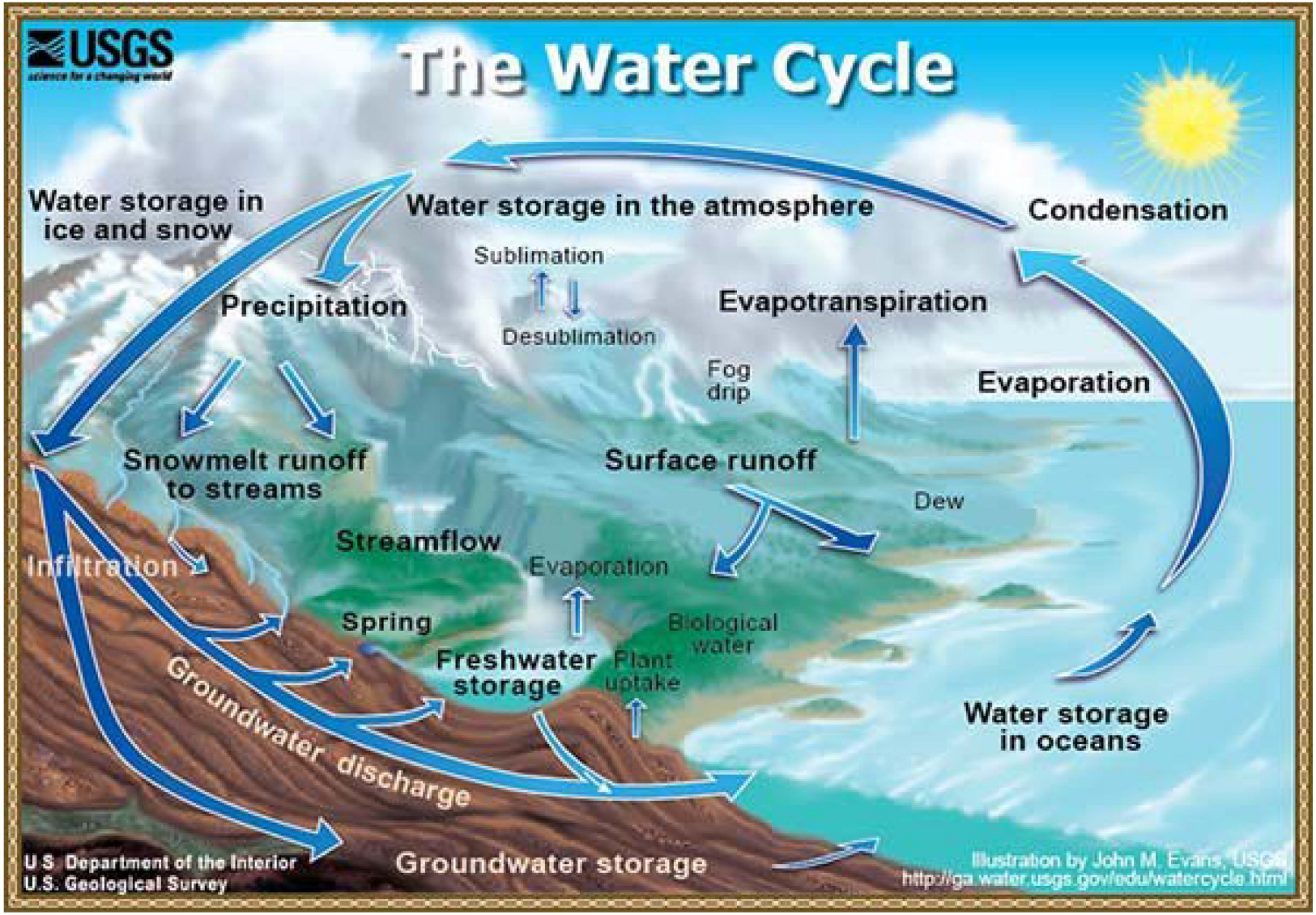
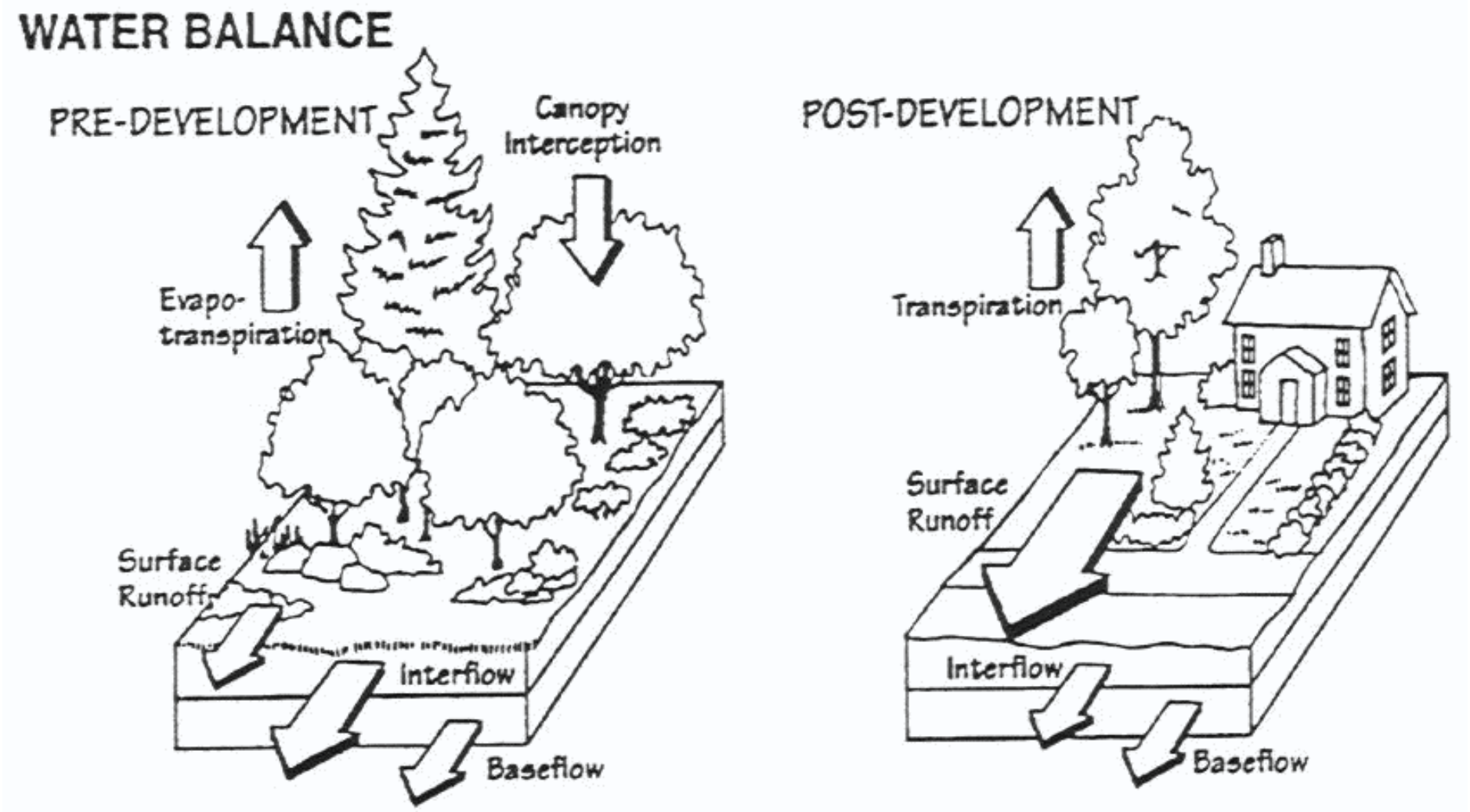


http://ga.water.**usgs.gov/edu/watercycle.html**

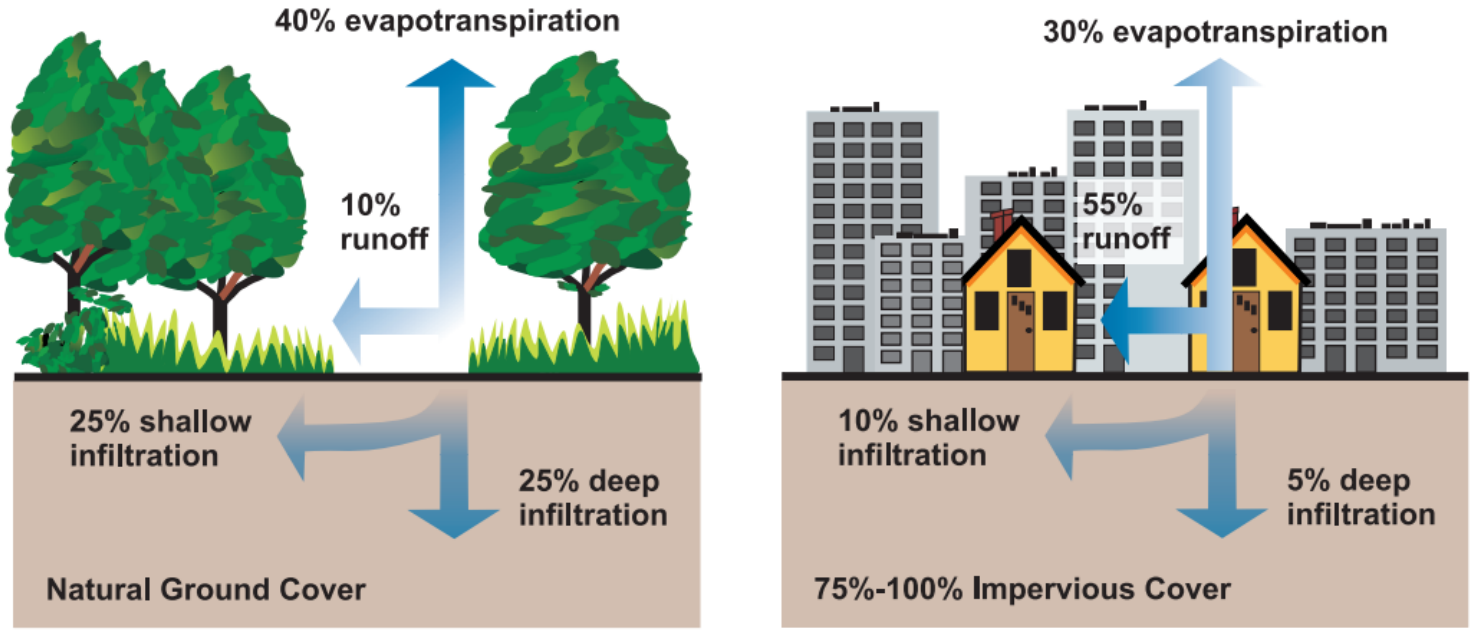
Effect of Development on Water Cycle

United States Environmental Protection Agency



EPA (2004)

Effect of Urbanization on Water Cycle



Relationship between impervious cover and surface runoff. Impervious cover in a watershed results in increased surface ruunoff. As little as 10 percent impervious cover in a watershed can result in stream degradation.

EPA 841-F-03-003
http://www.epa.gov/sites/production/files/2015-10/documents/nps_urban-facts_final.pdf

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EPA EDISON ENVIRONMENTAL CENTER (EEC) PERMEABLE PAVEMENT, RAIN GARDENS AND RAINWATER HARVESTING FOR AIR CONDITIONING DEMAND

Edison Environmental Center (EEC) former Raritan Arsenal

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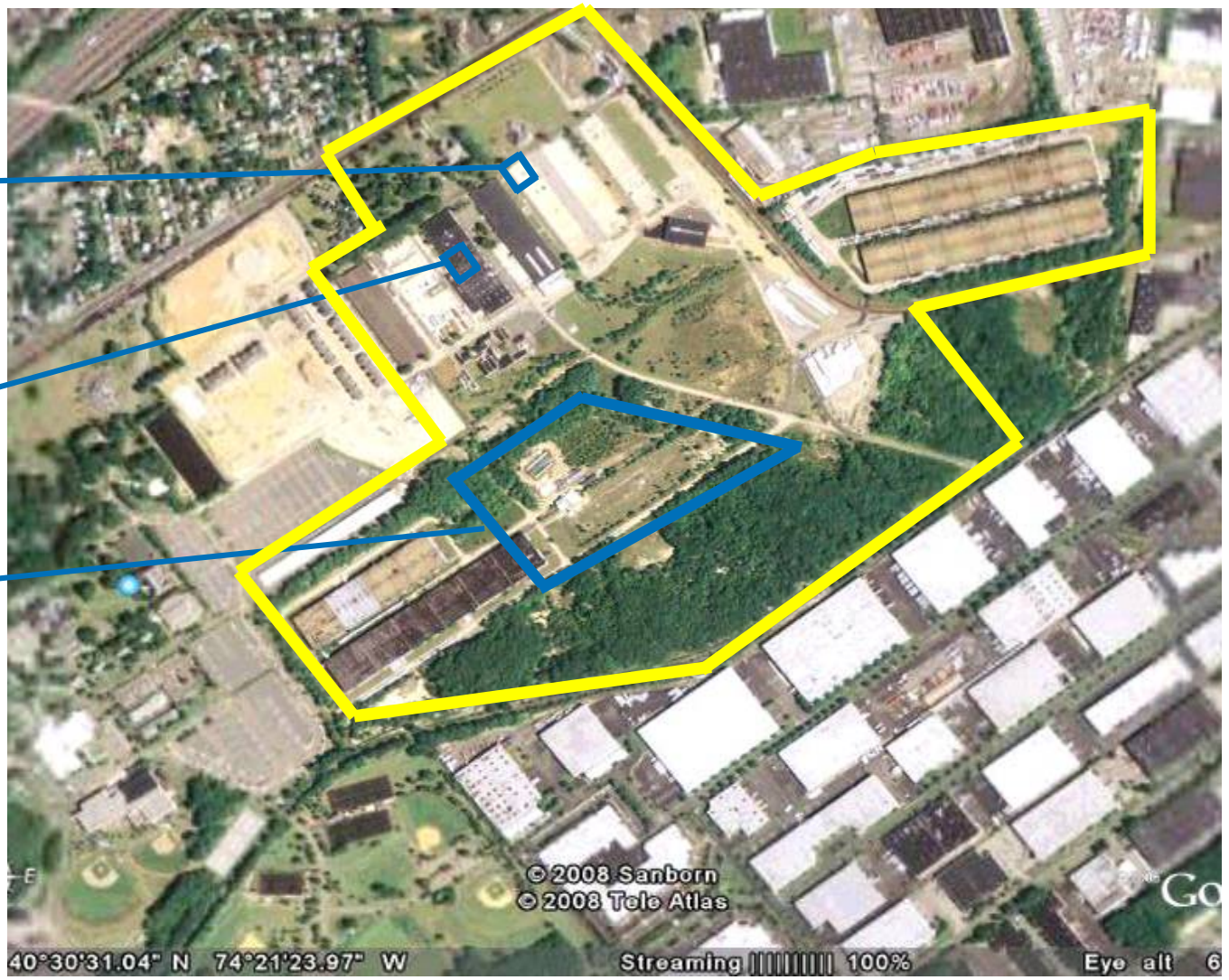
Full-scale
- porous pavement
- rain gardens

Roof runoff collection and use

UWRF
- swales
- rain gardens
- rainwater sampling
- pipelines



Permeable Pavement and Rain Garden Research and Demonstration Site

- Side by side testing of three permeable parking surfaces
- Evaluation of effect of hydraulic loading on bioinfiltration hydrologic performance
- Continuous and event-based sampling for water quantity and quality parameters

Vertical cross sections of permeable surfaces vary slightly from material to material

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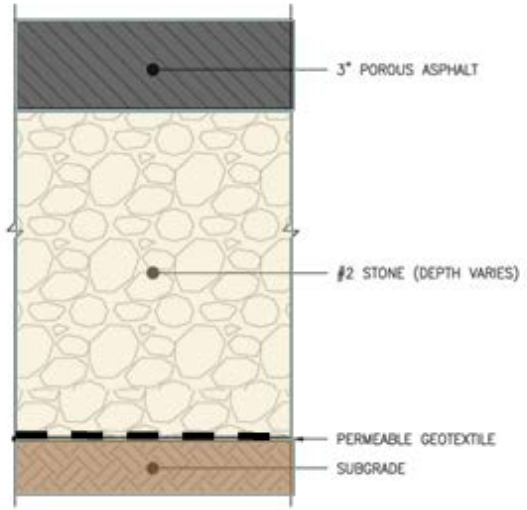
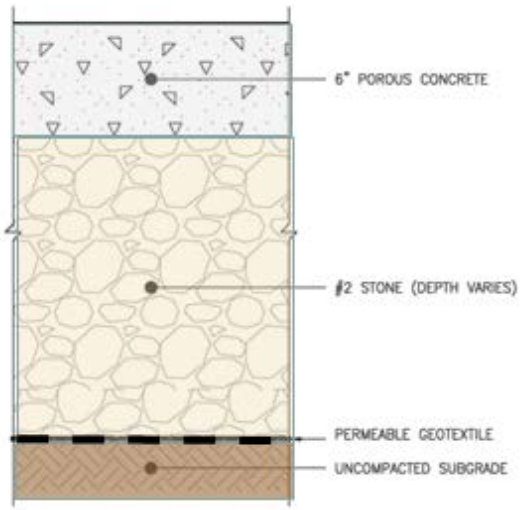
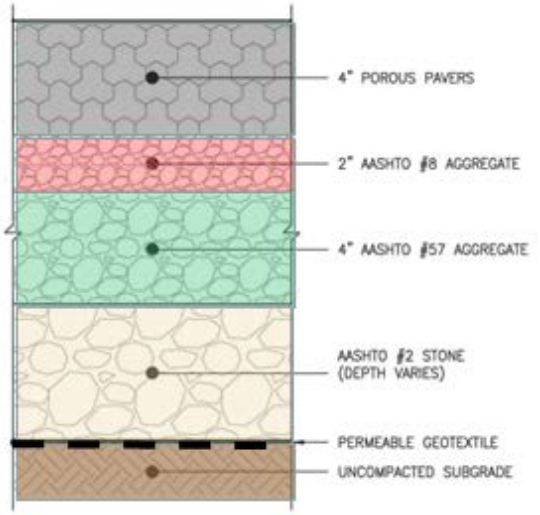
Not to scale



Porous Asphalt (PA)

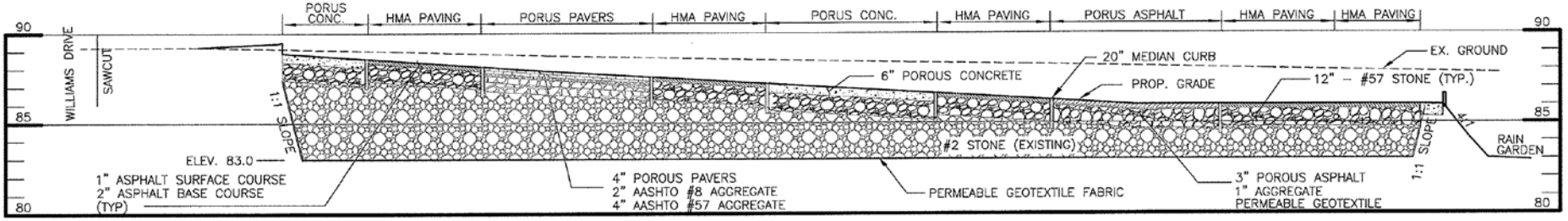


Porous Concrete (PC)



Permeable Interlocking Concrete Pavers (PICP)

*Courtesy of Morris Ritchie and Associates, 2009



SECTION A-A

SCALE: H: 1" = 20'
V: 1" = 5'

Permeable Interlocking Concrete Pavers (PICP)

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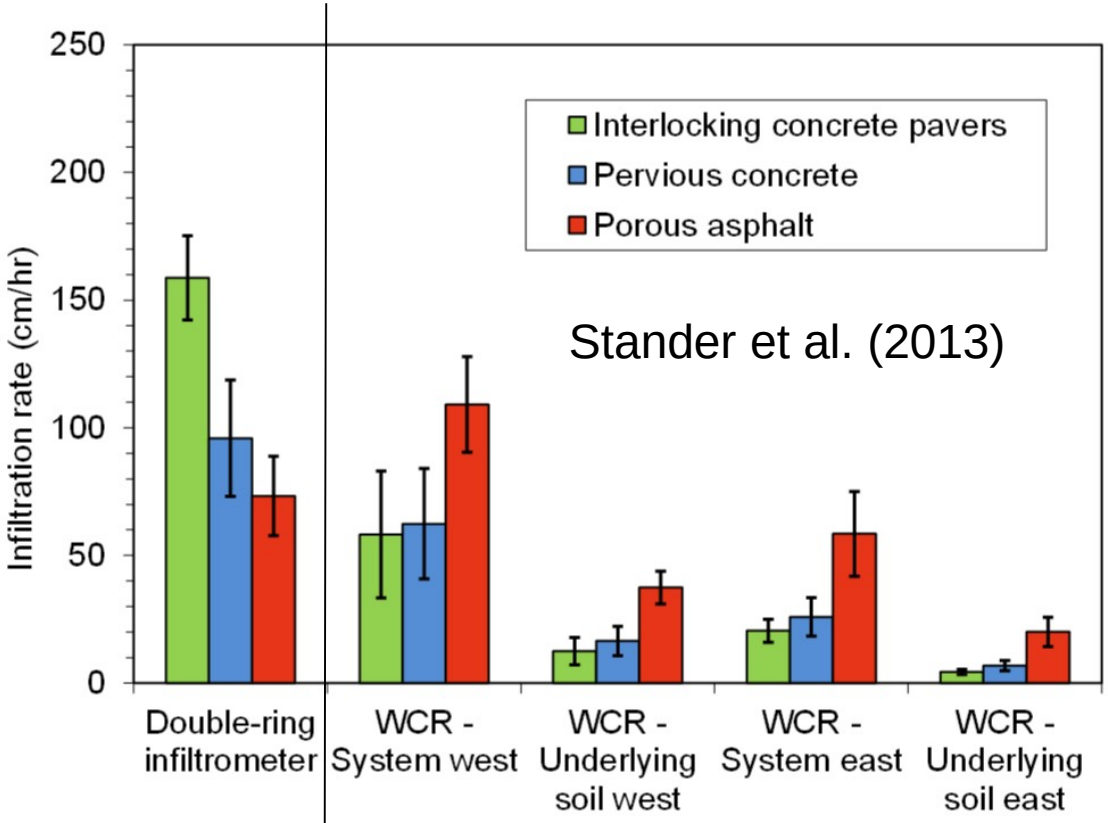
Porous Concrete (PC)

Permeable Asphalt (PA)

Underlying Soil Infiltration Testing



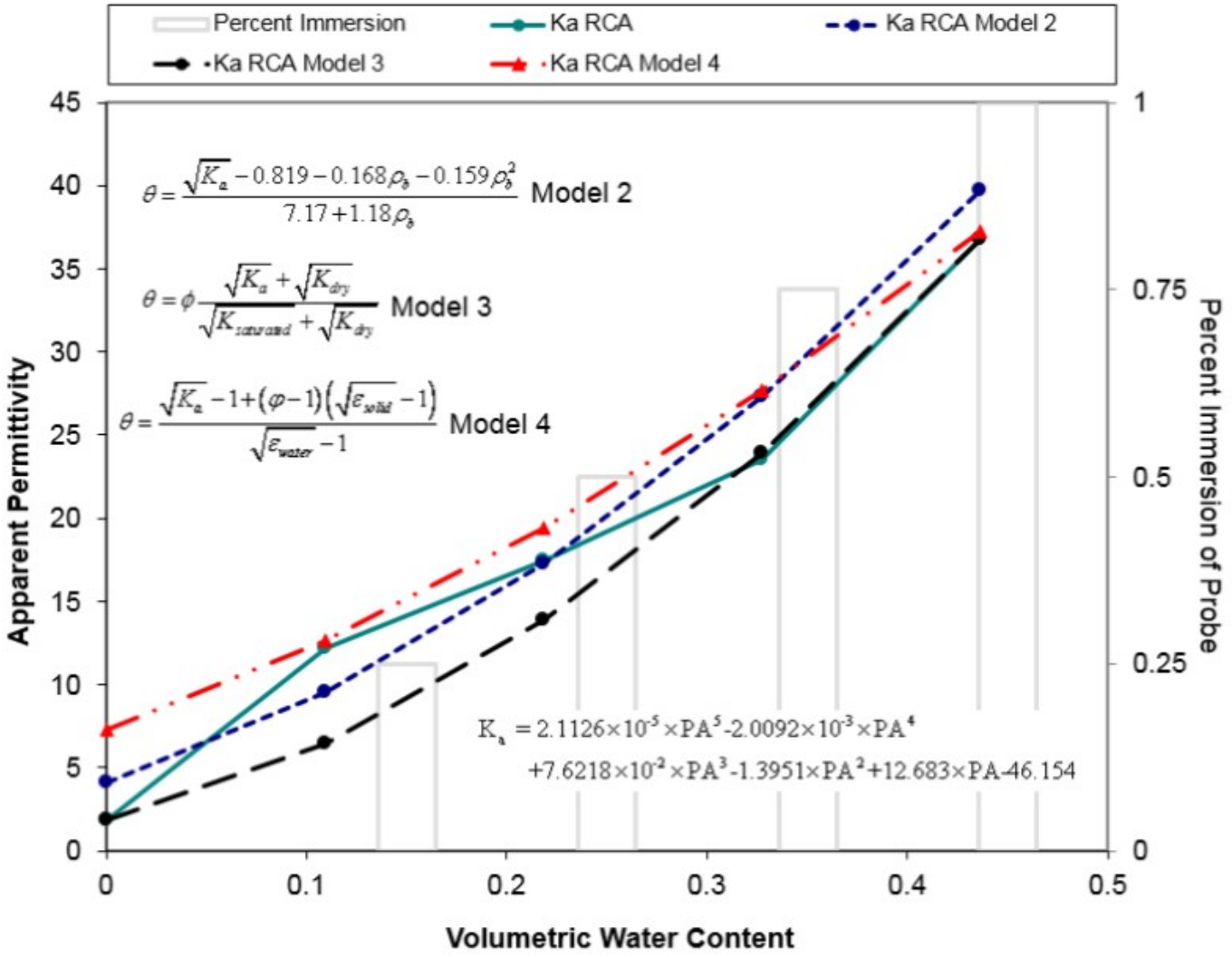
Pre-construction infiltration test

Post-construction soil moisture measurements

Water content reflectometer (WCR) installation

Calibration of water content (time domain) reflectometers in large aggregate for storage

Stander et al. (2013)



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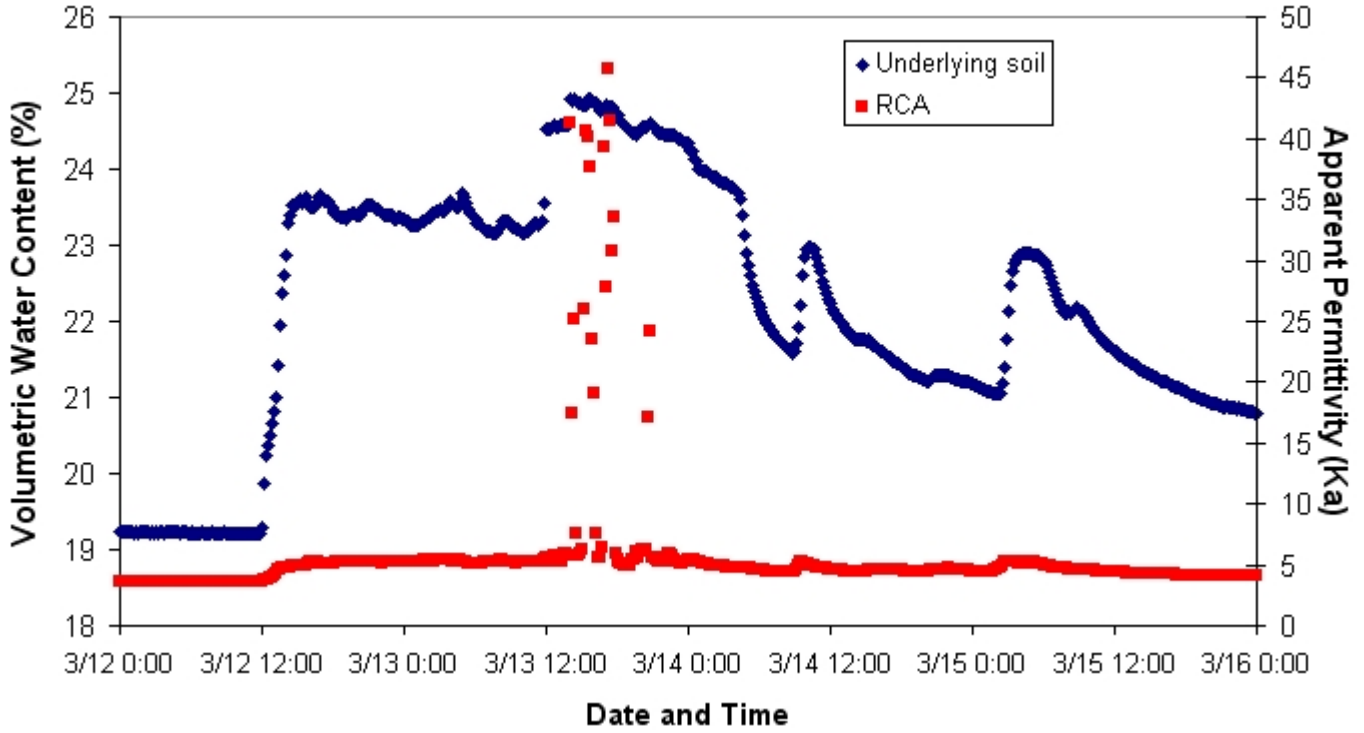
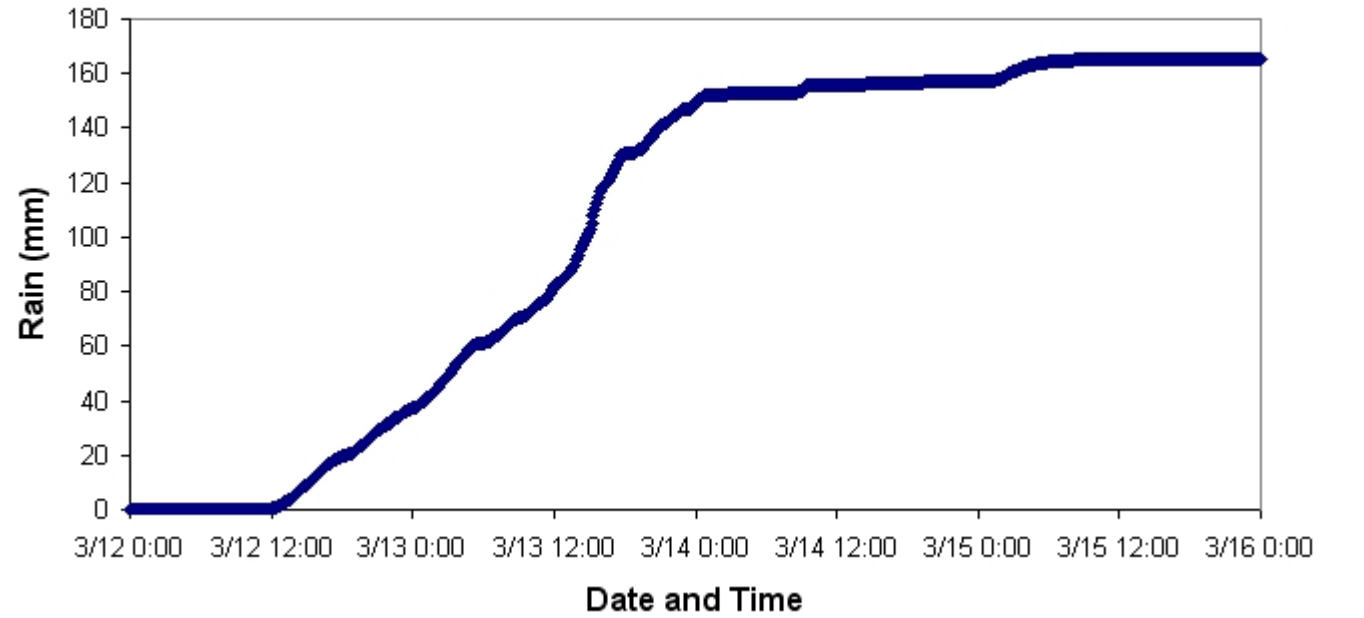
Calibration led to interpretation of data





Rain Garden Demonstration Site

This site demonstrates and allows EPA to document the capabilities of rain gardens to allow stormwater to seep, or infiltrate, into underlying soil where it will eventually recharge groundwater and nearby streams. Infiltration of stormwater in rain gardens serves to reduce stormwater runoff volumes, improve water quality through removal of stormwater contaminants, and enhance the physical and biological integrity of streams.

Research

Stormwater runoff from Building 205 and the adjacent parking lot is directed through a pipe and curb cuts into the rain garden. The rain garden has six cells of different sizes separated by walls, allowing researchers to study how size affects the ability of rain gardens to infiltrate stormwater runoff created by a wide range of storm sizes. Instruments buried in the media and underlying soil measure how quickly runoff infiltrates through the rain garden profile into the underlying soil.

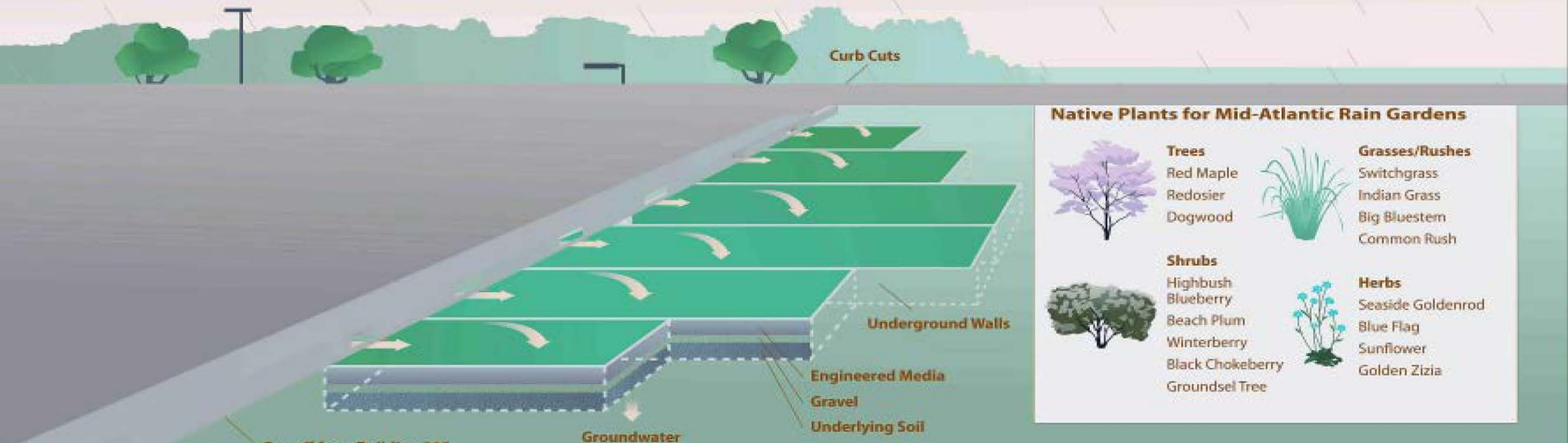
Results

The rain garden will help EPA study:

- How rain gardens mimic natural drainage processes and reduce stormwater runoff volume to the conventional storm sewer system.
- The effects of surface area on drainage properties of rain gardens.

Acknowledgements

This project is a joint research effort between EPA's Office of Administration and Resources Management, Region 2, and the Office of Research and Development.



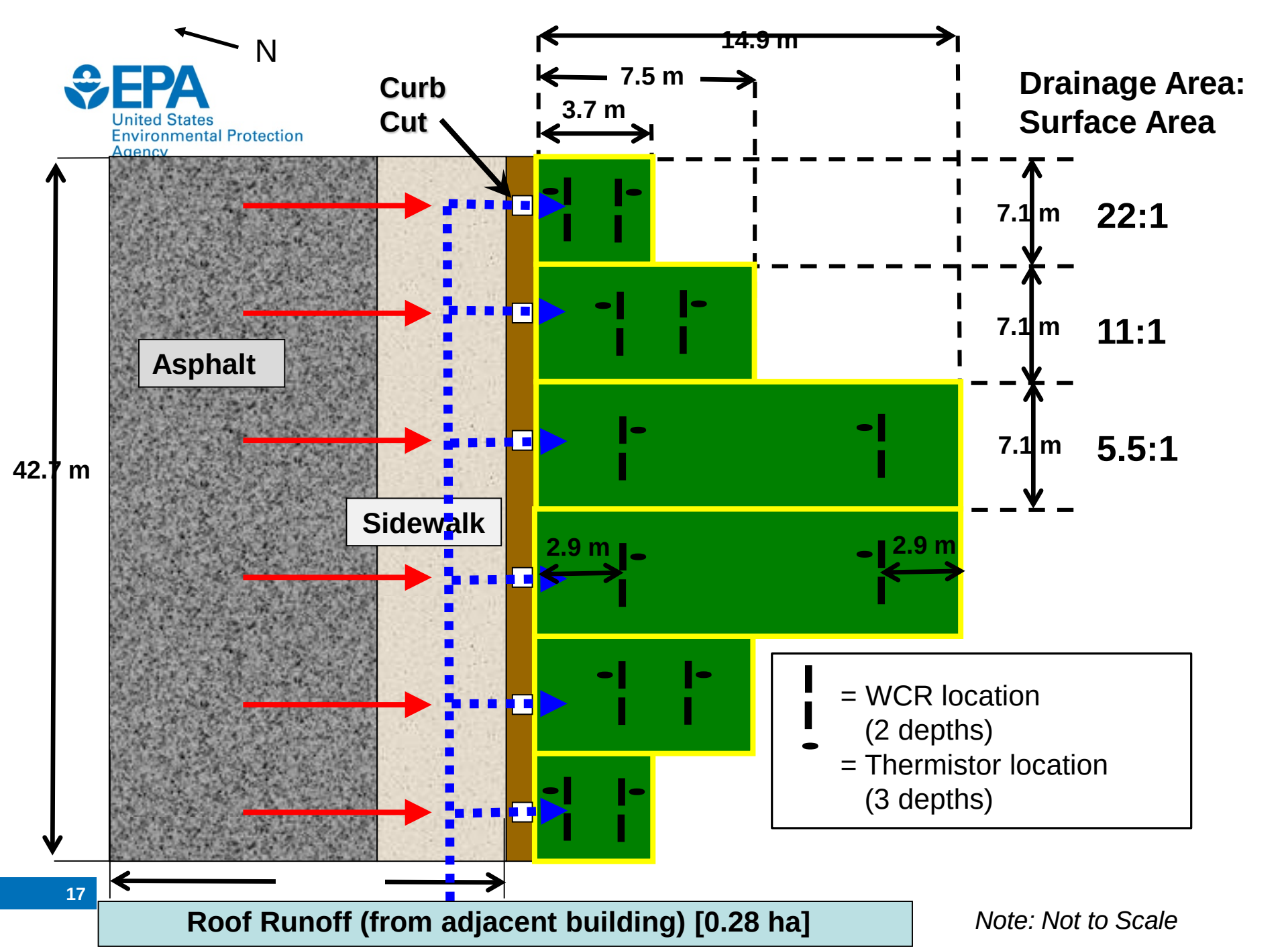
Native Plants for Mid-Atlantic Rain Gardens

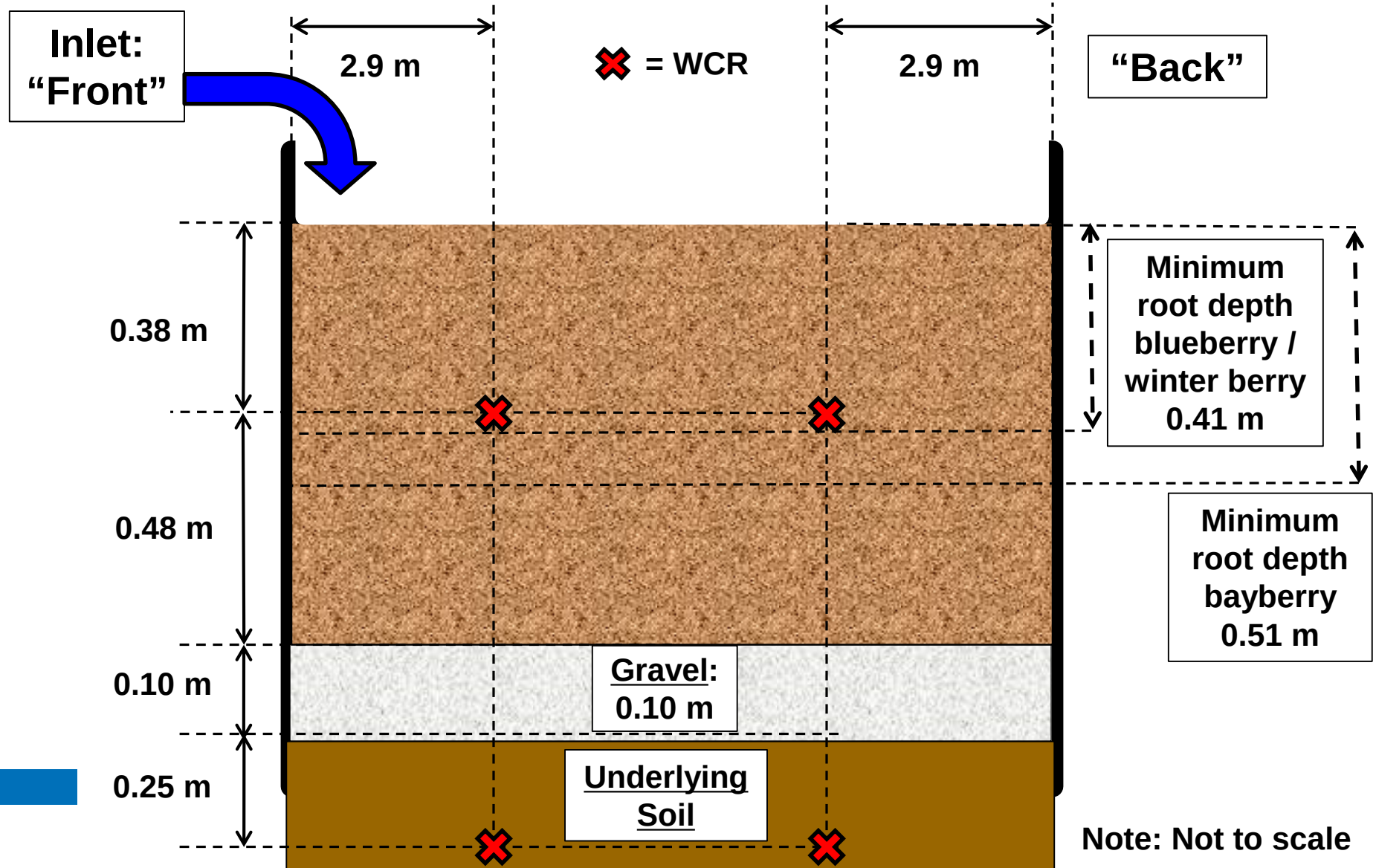
Trees
Red Maple
Redosier
Dogwood

Grasses/Rushes
Switchgrass
Indian Grass
Big Bluestem
Common Rush

Shrubs
Highbush Blueberry
Beach Plum
Winterberry
Black Chokeberry
Groundsel Tree

Herbs
Seaside Goldenrod
Blue Flag
Sunflower
Golden Zizia


N
EPA
United States
Environmental Protection
Agency
Curb
Cut
14.9 m
7.5 m
3.7 m
Drainage Area:
Surface Area
7.1 m
22:1
7.1 m
11:1
7.1 m
5.5:1
42.7 m
Asphalt
Sidewalk
2.9 m
2.9 m
= WCR location
(2 depths)
= Thermistor location
(3 depths)
Roof Runoff (from adjacent building) [0.28 ha]
Note: Not to Scale

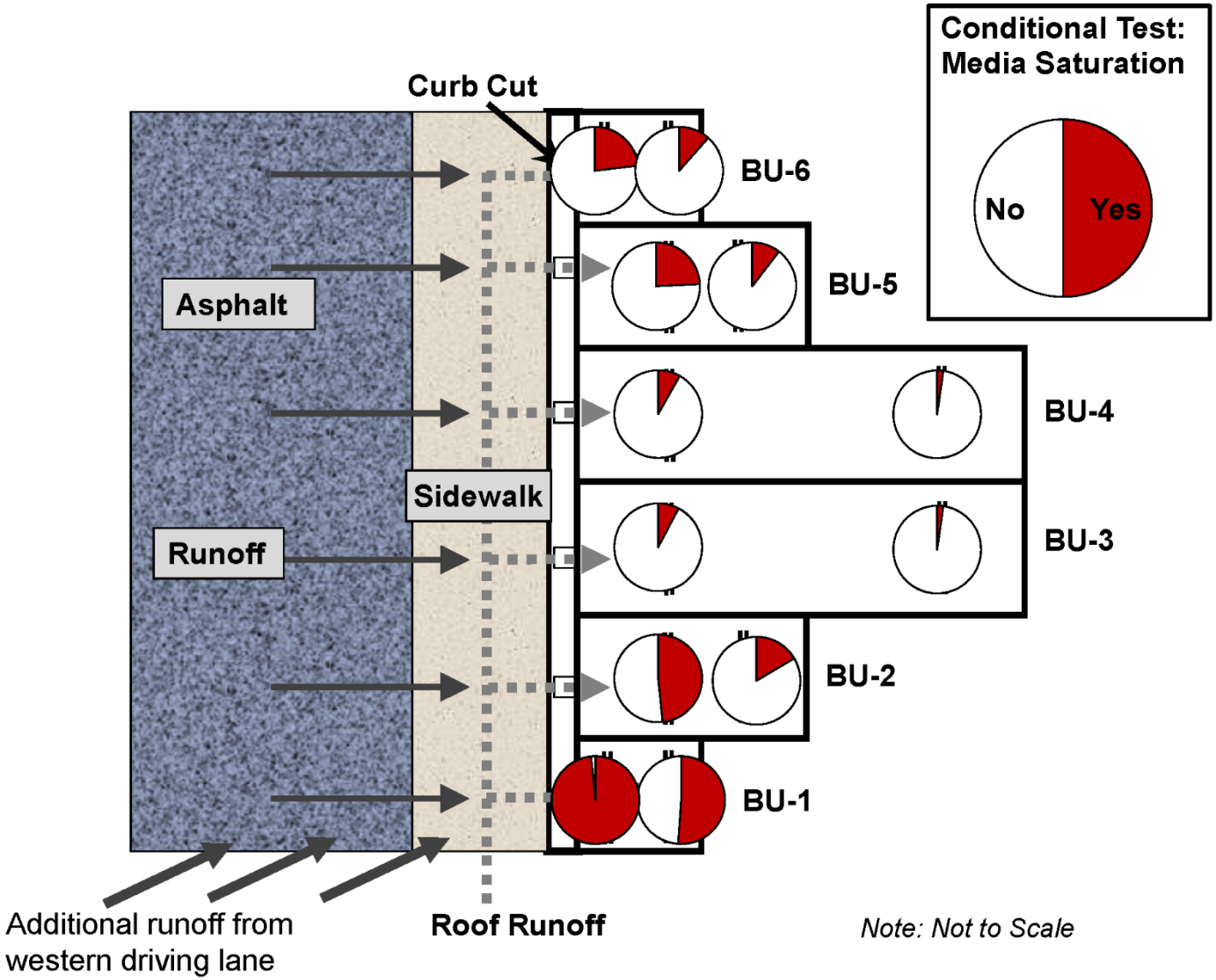

Inlet:
"Front"
2.9 m
= WCR
2.9 m
"Back"
0.38 m
0.48 m
0.10 m
0.25 m
Minimum root depth blueberry / winter berry 0.41 m
Minimum root depth bayberry 0.51 m
Gravel: 0.10 m
Underlying Soil
Note: Not to scale

WCR monitoring locations media saturation

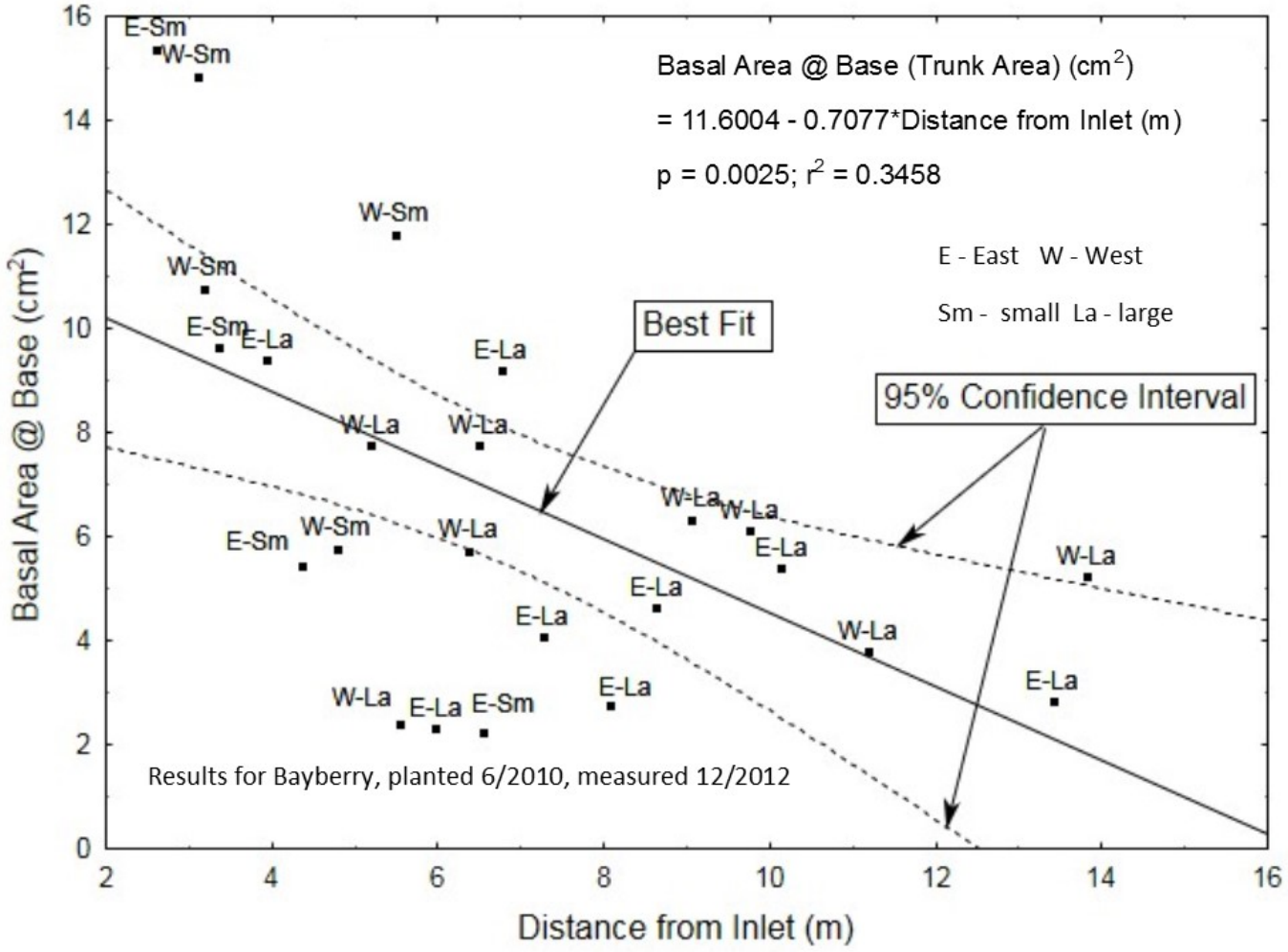
91 events analyzed with complete data from all WCR locations.

Period: 2010-2012 growing seasons (April to October)

When saturation not frequent, the change in soil moisture was attributed to direct rainfall.

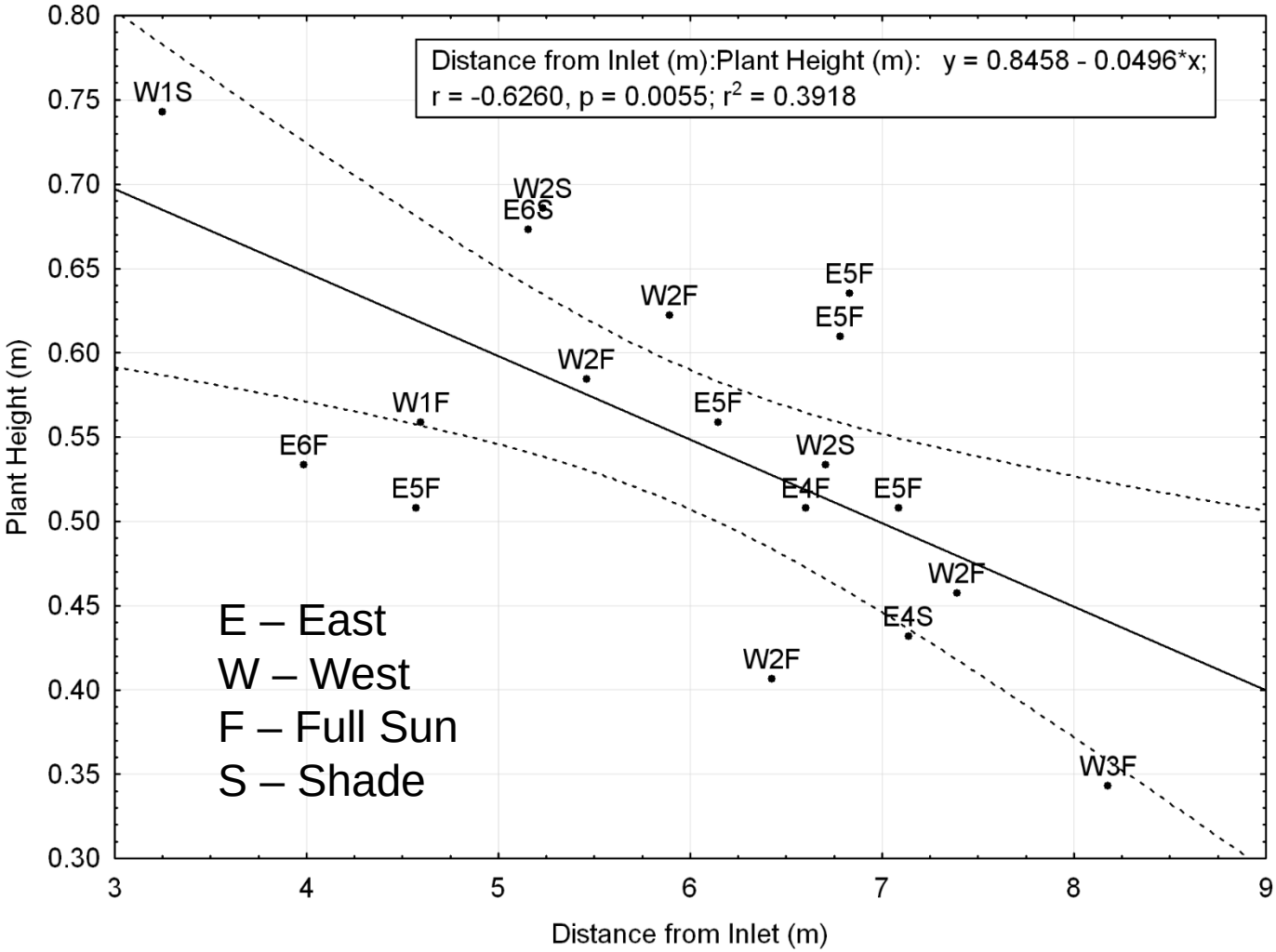


Bayberry growth closer to inlet and in smaller rain gardens better than large



Winterberry height closer to inlet and in smaller rain gardens better than large

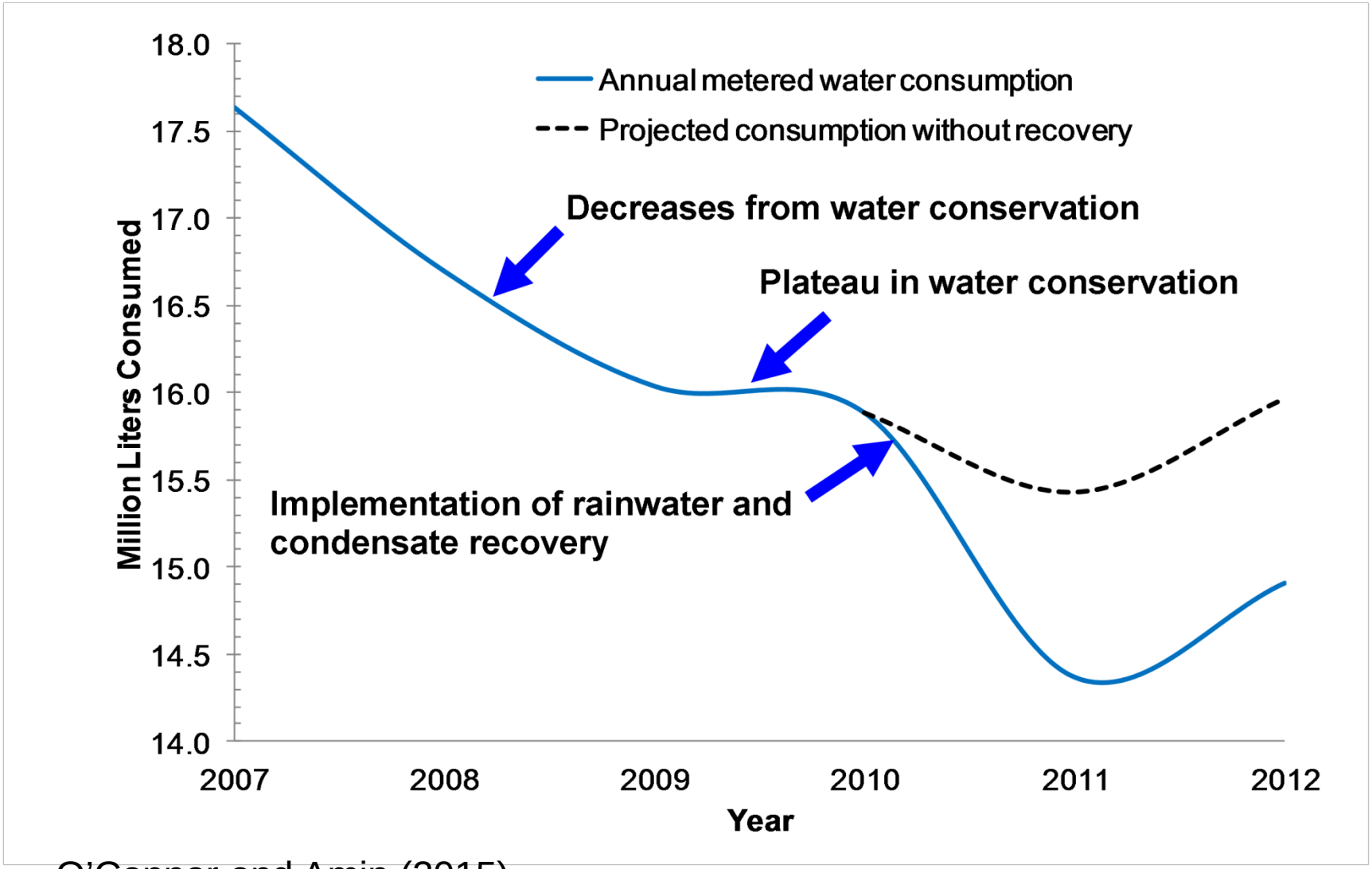
Also effect of shading



Rainwater Harvesting at EEC

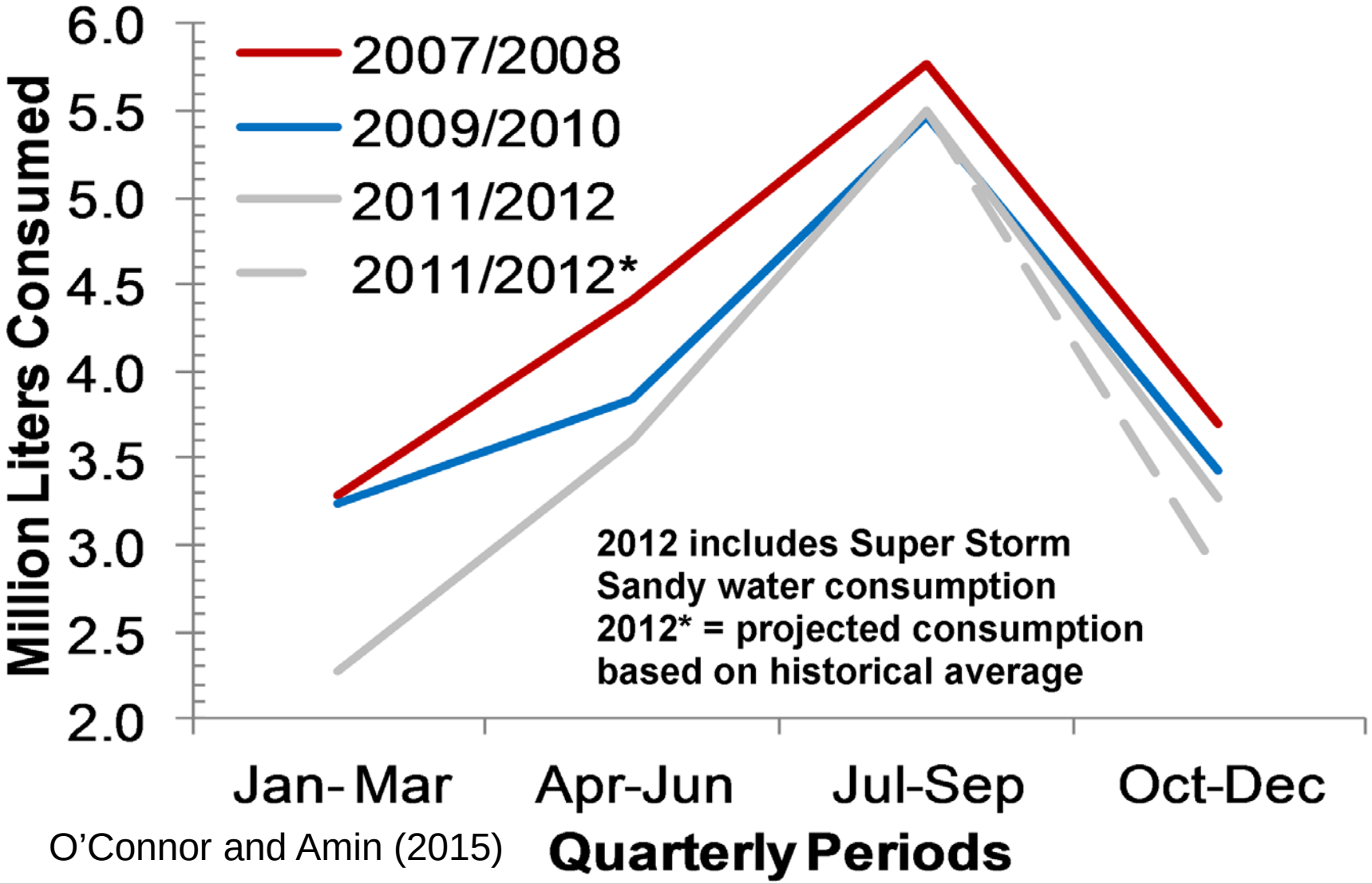
- Laboratory cooling tower is largest consumer of water at EEC
- Peak demand exceeds 4,000 gallons per day
- Rainwater from three 1,500 gallon tanks now supplements demand

EEC Annual Water Consumption



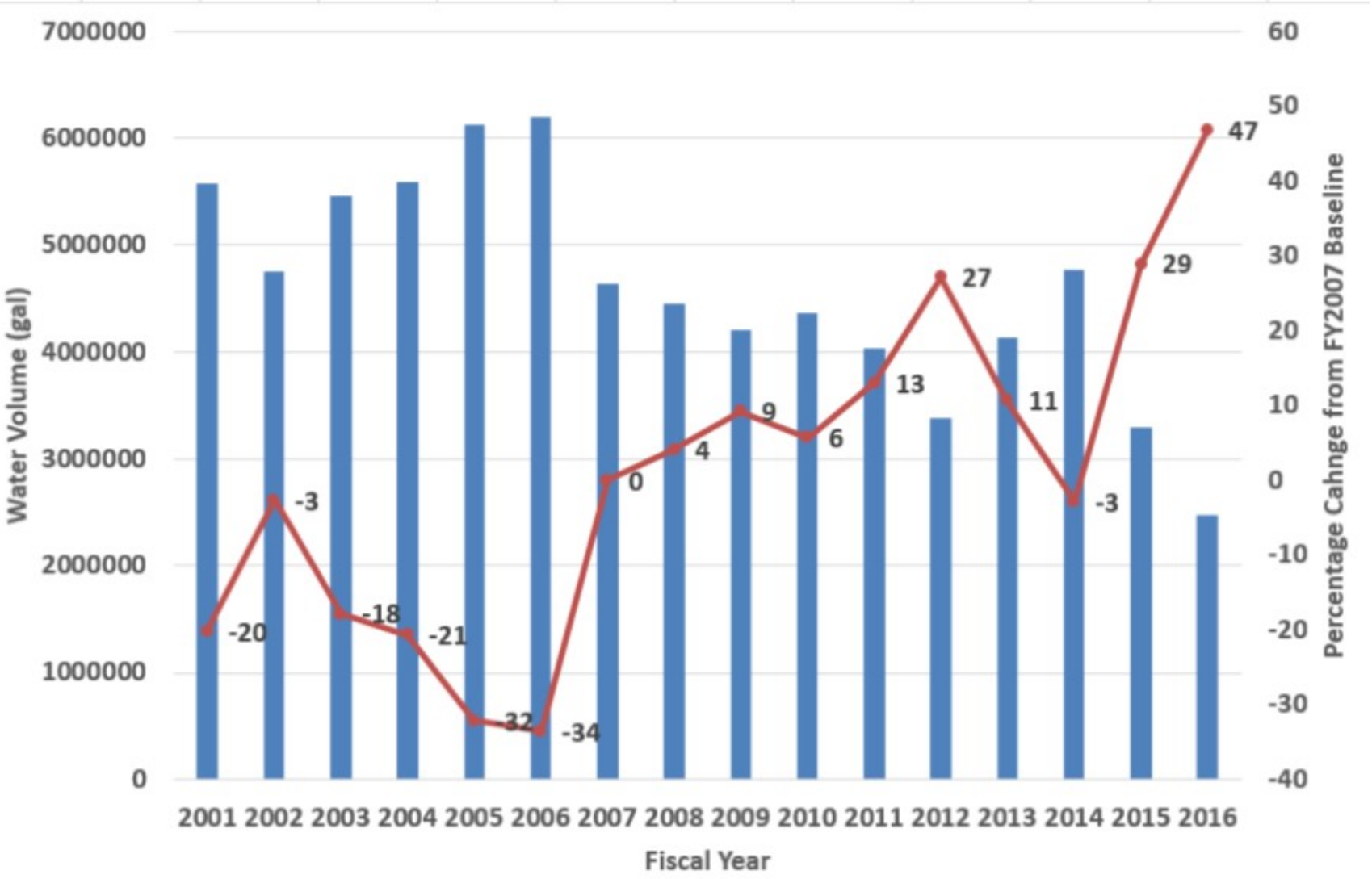
O'Connor and Amin (2015)

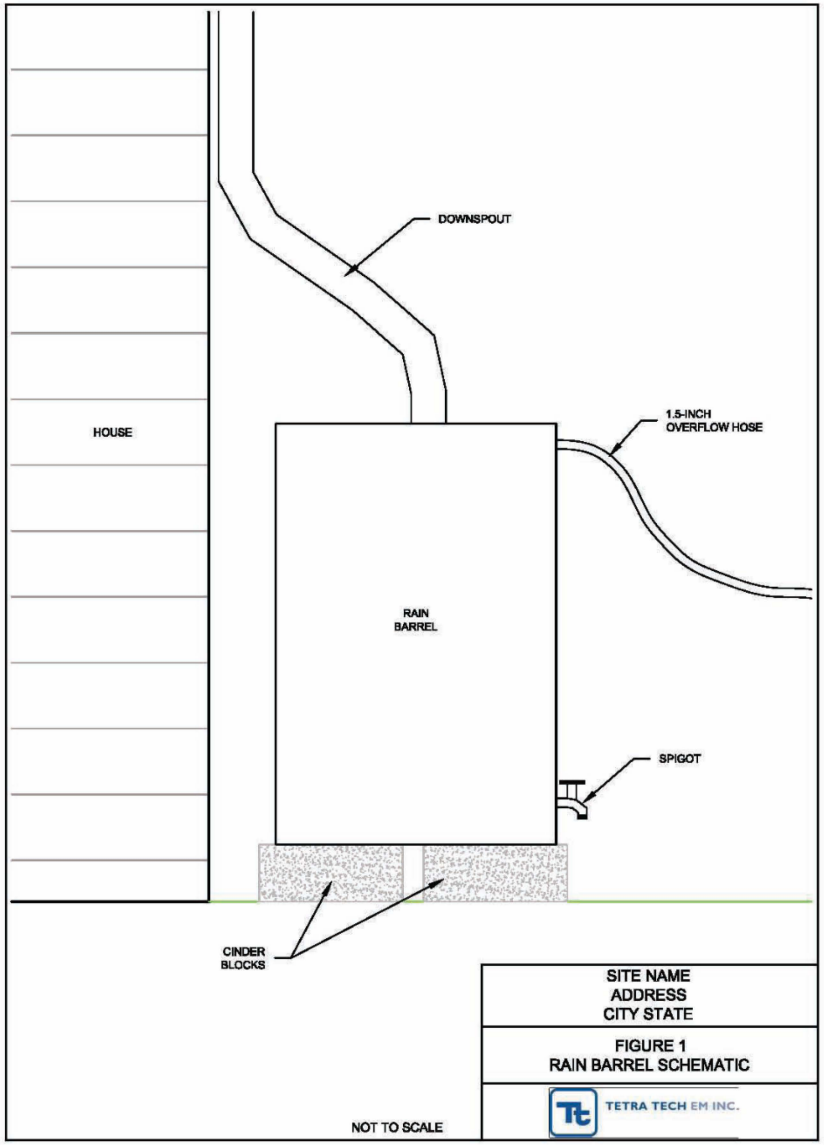
EEC Quarterly Water Consumption



O'Connor and Amin (2015)

EEC Annual Water Consumption – FY2007 Baseline




DOWNSPOUT
HOUSE
1.5-INCH
OVERFLOW HOSE
RAIN
BARREL
SPIGOT
CINDER
BLOCKS
SITE NAME
ADDRESS
CITY STATE
FIGURE 1
RAIN BARREL SCHEMATIC
TETRA TECH EM INC.
NOT TO SCALE

Referenced Publications

- R. Brown, T. P. O'Connor and M. Borst (2015). "Divergent Vegetation Growth Patterns Relative to Bioinfiltration Unit Size and Plant Placement" ASCE's Journal of Sustainable Water in the Built Environment (JSWBE), Vol. 1, No. 3. (http://ascelibrary.org/doi/abs/10.1061/JSWBAY.0000796)
- T. P. O'Connor and M. Amin (2015). "Rainwater Collection and Management from Roofs at the Edison Environmental Center" ASCE's JSWBE, Vol. 1, No. 1. (http://ascelibrary.org/doi/abs/10.1061/JSWBAY.0000792)
- E. Stander, A. A. Rowe, M. Borst and T. P. O'Connor (2013). "Novel Use of Time Domain Reflectometry in Infiltration-Based Low Impact Development Practices" ASCE's Journal of Irrigation and Drainage Engineering, Vol 139, No. 8, pp. 625–634 (http://dx.doi.org/10.1061/(ASCE)IR.1943-4774.0000595).
- Stormwater Best Management Design Guide
  - (EPA/600/R-04/121) (http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=901X0A00.txt)
  - (EPA/600/R-04/121A) (http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=901X0B00.txt)
  - (EPA/600/R-04/121B) (http://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=2000D1L8.txt)

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Questions?