Stormwater Infiltration using Dry Wells as a Low Impact Development Tool

Connie Nelson, CFM[1]
Barbara Washburn, PhD[2]

[1]City of Elk Grove/Willdan Engineering
[2]Office of Environmental Health Hazard Assessment, California EPA

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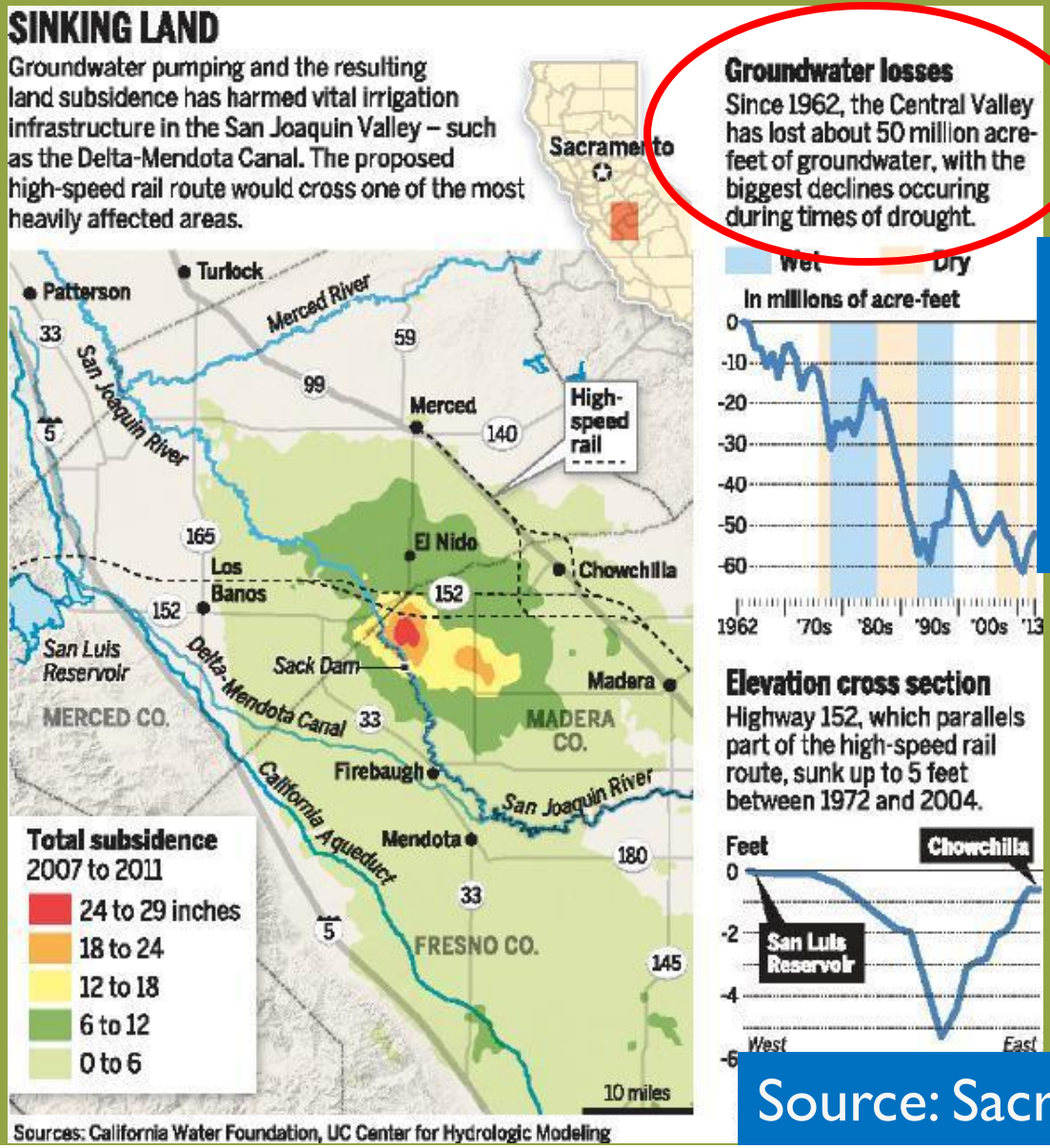
Today's Discussion

- California water situation and recharge opportunities
- What are dry wells
- How to integrate low impact development (LID) practices with dry wells
- Elk Grove Dry Well Project and results to date
- Regulations and permitting issues with dry wells

Background

- California is in a severe drought
- Legislation is calling for:
  - Water reuse
  - Treating stormwater as a resource
  - Strengthening groundwater management
- A solution may be the use of dry wells with LID practices for these challenges

Groundwater Supplies Depleting in Central Valley in Northern California



- Sinking Land
- 50 million acre feet groundwater lost

Source: Sacramento Bee, April 2014

Groundwater provides 30 percent of the California's water supply

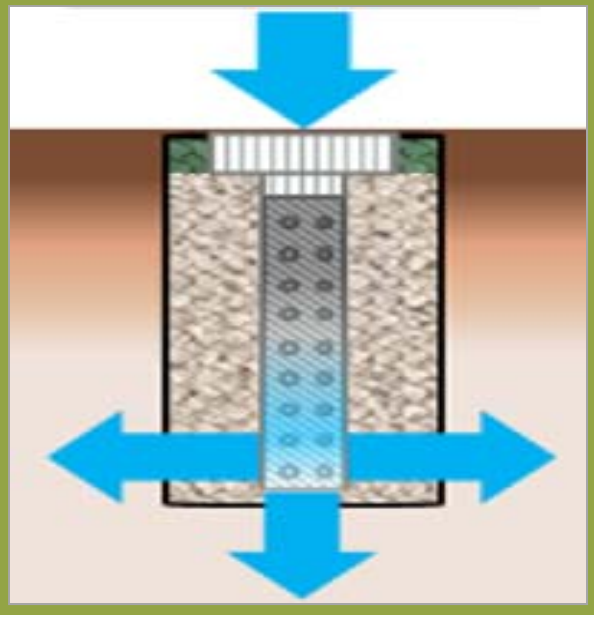
- 431 groundwater basins
- Covers 40% of the State
- Storage capacity:
  - ✓ 851 million acre-feet (not all useable)

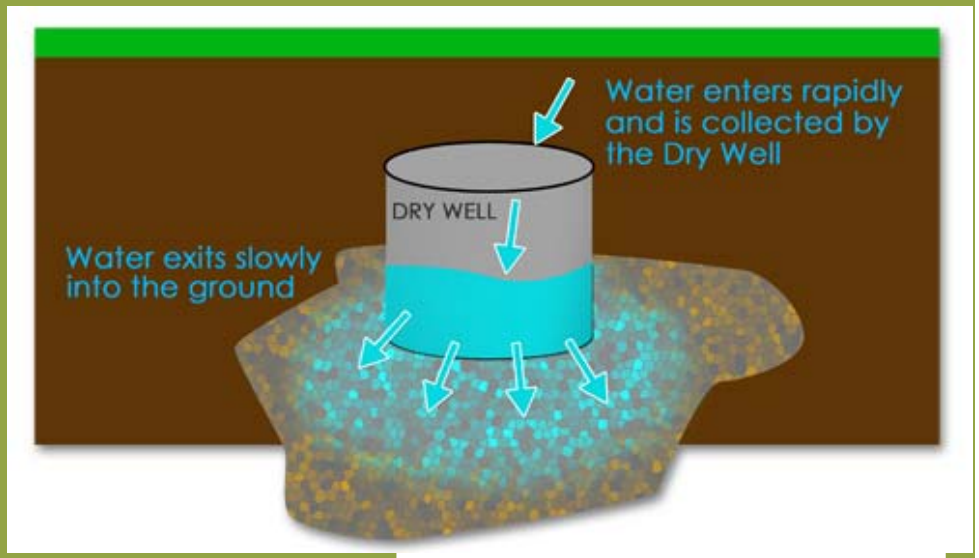
What are Dry Wells?

- Gravity fed excavated pits lined with perforated casing filled with gravel
- Deeper than width
  - 3 feet wide
  - 20 to 60 feet
- Can be used in conjunction with LID practices

How do they work?

- Receives water from one or more entry points
- Collects, stores, and disburses water
- Discharges water through small openings
- Bottom/sides of dry well placed at permeable soils

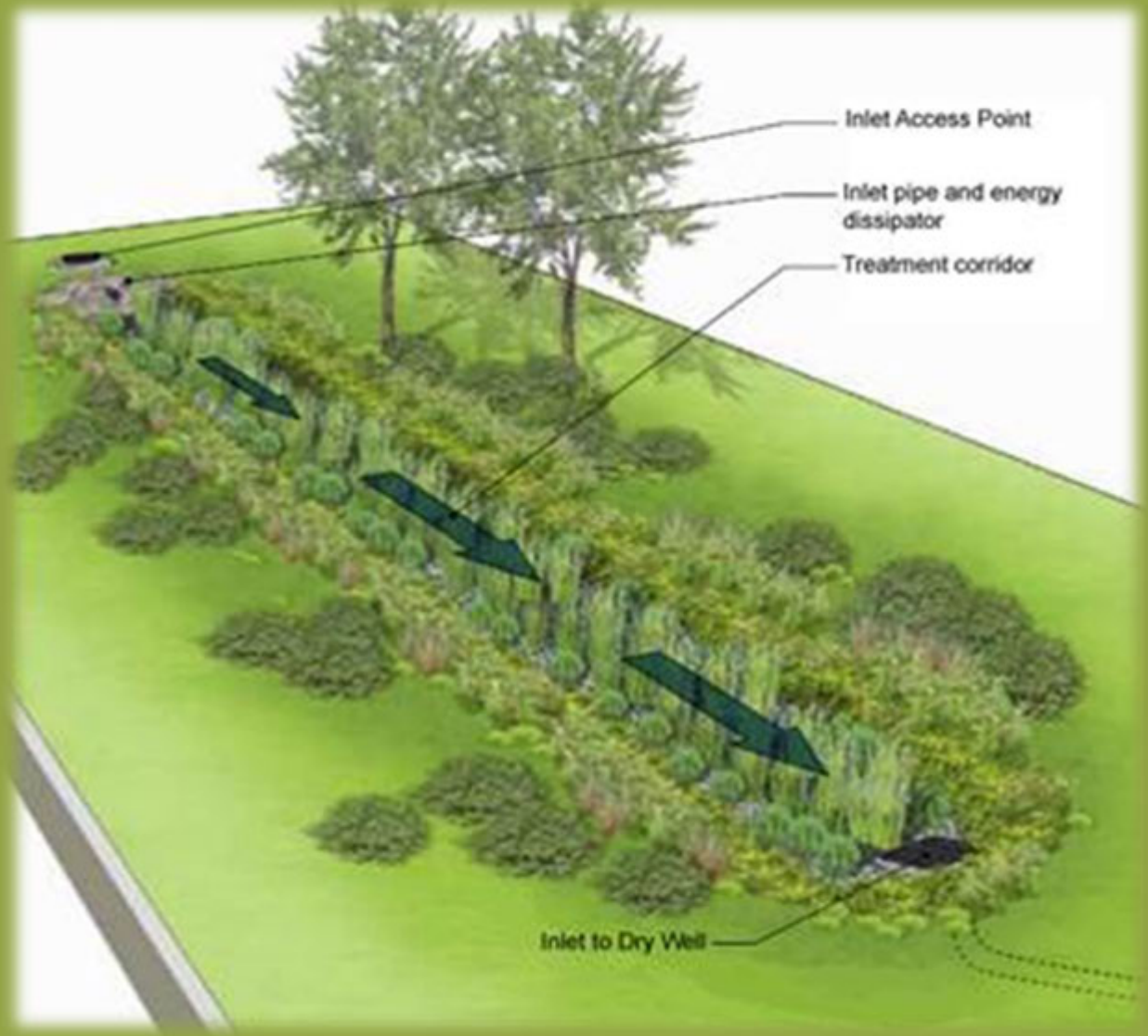




Value of Using Dry Wells in California

- Captures and stores urban stormwater runoff
- Facilitates stormwater infiltration **even in clay soils**
- Can improve surface water quality
- Facilitates groundwater recharge
- Helps meet hydromodification management goal
- Reduces localized flooding
- Sustainable change

General Concept of LID Features with a Dry Well



Elk Grove Dry Well Project

- Background
- Stormwater and groundwater monitoring
- Fate and transport of contaminants
- Education and outreach

Monitoring event November 2, 2014 at Strawberry Creek Water Quality Basin

Background

- State funded Stormwater Grant Program
- Total project budget $825K
- Received grant funding amount $490K
- In-kind services $335K
  - City of Elk Grove $195K
  - OEHHA $140K
- Fate and Transport Modeling (complementary, $135K)
- Grant term 4-years

Project Team

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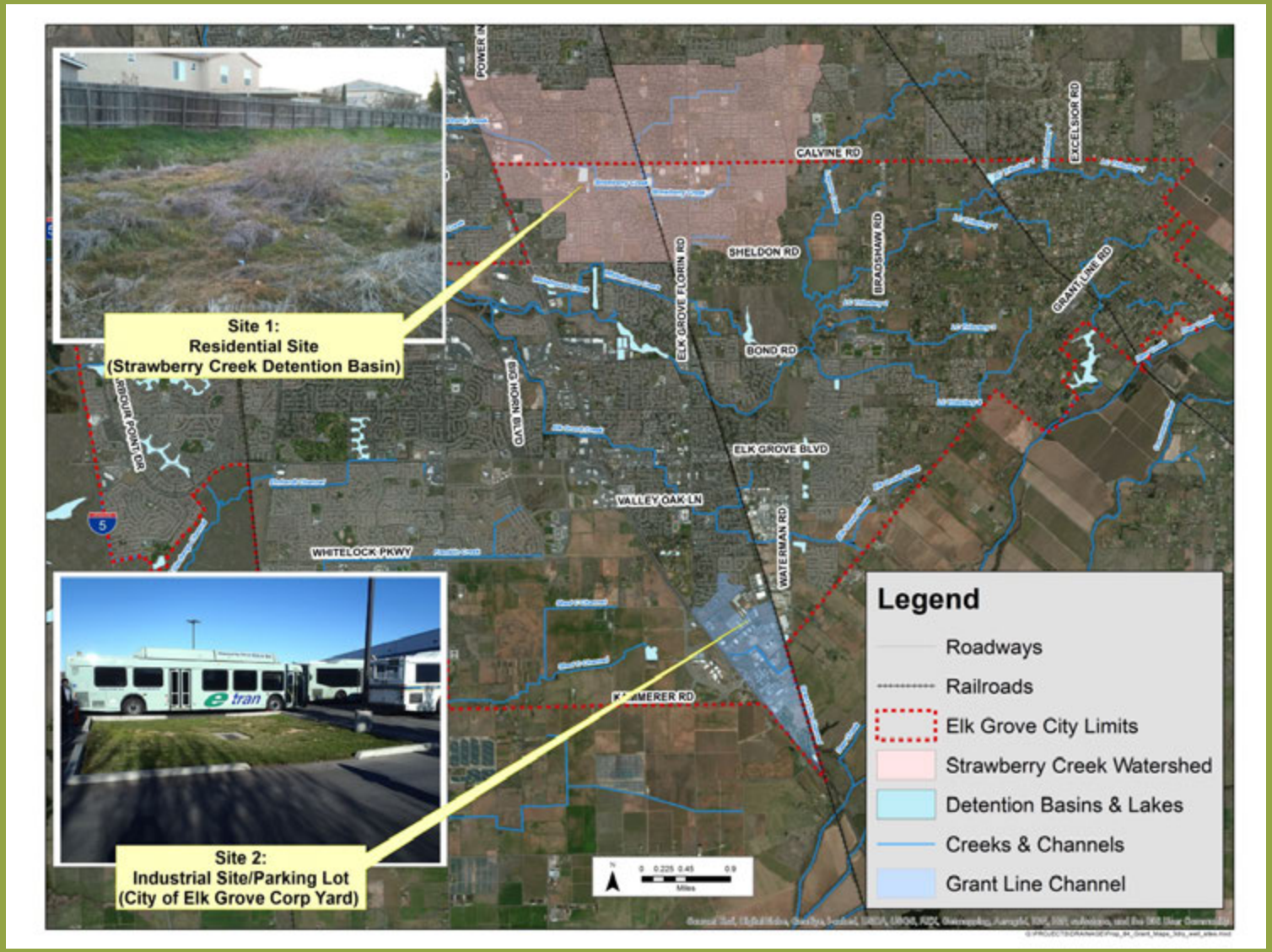
Project Purpose

Evaluate the potential of using dry wells, in combination with low impact development practices, to:

- Infiltrate stormwater runoff
- Alleviate localized flooding
- Recharge groundwater

without negatively impacting groundwater quality

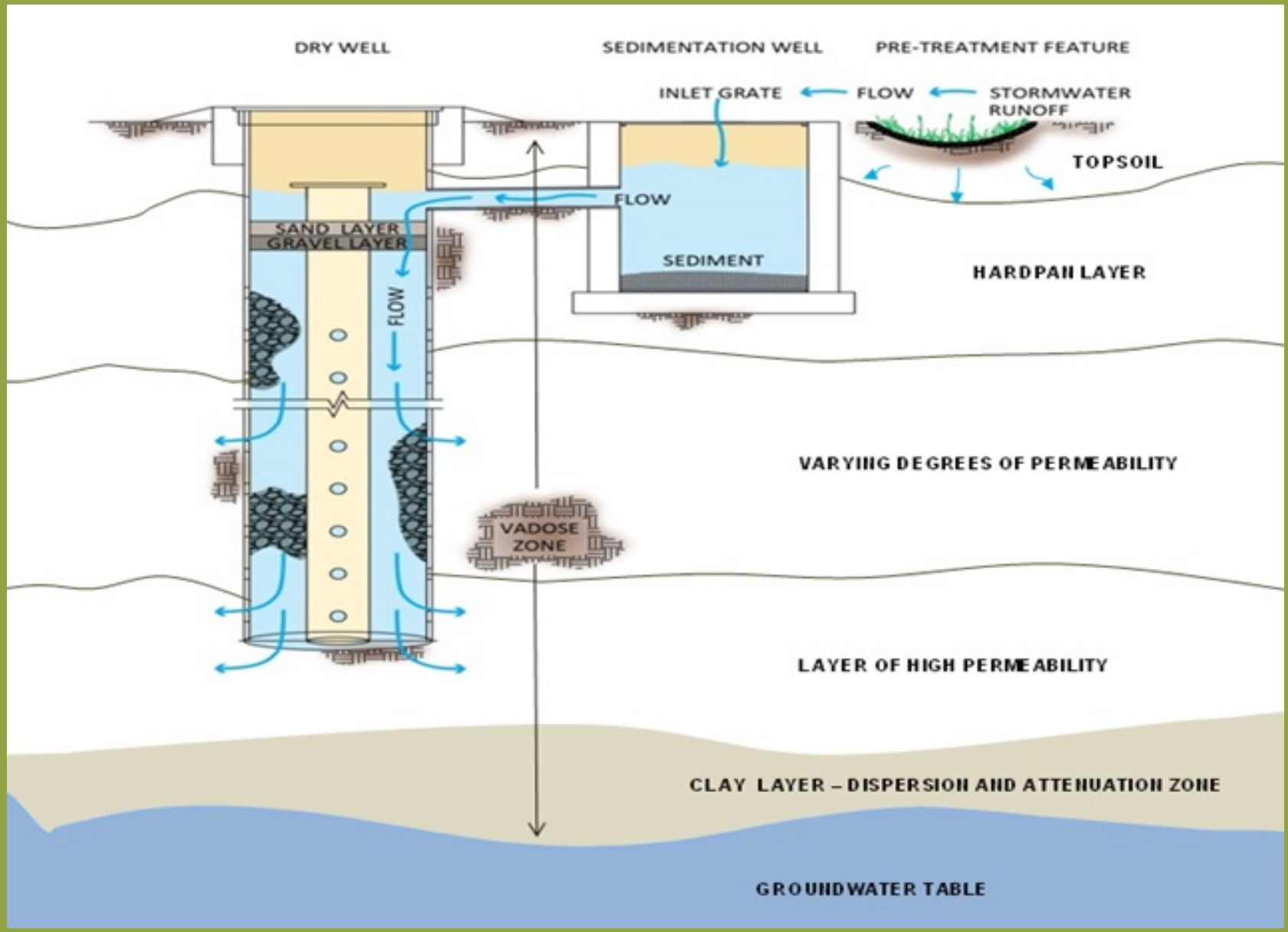
Project Site Locations



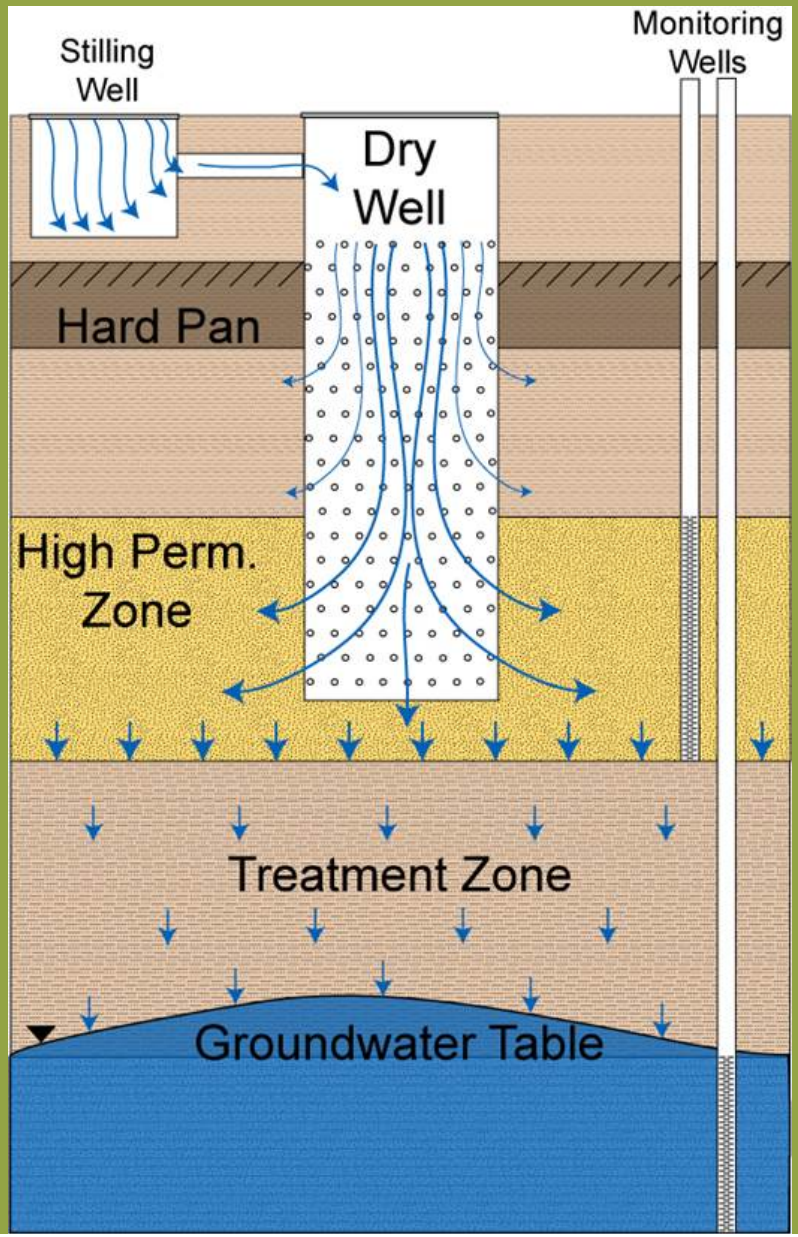
Project Site Schematic

Vadose zone well: 55 feet, water table wells: 110 feet

Dry Well Design



General Concept: Bypass Hardpan



Monitoring event November 2, 2014 at Strawberry Creek Water Quality Basin

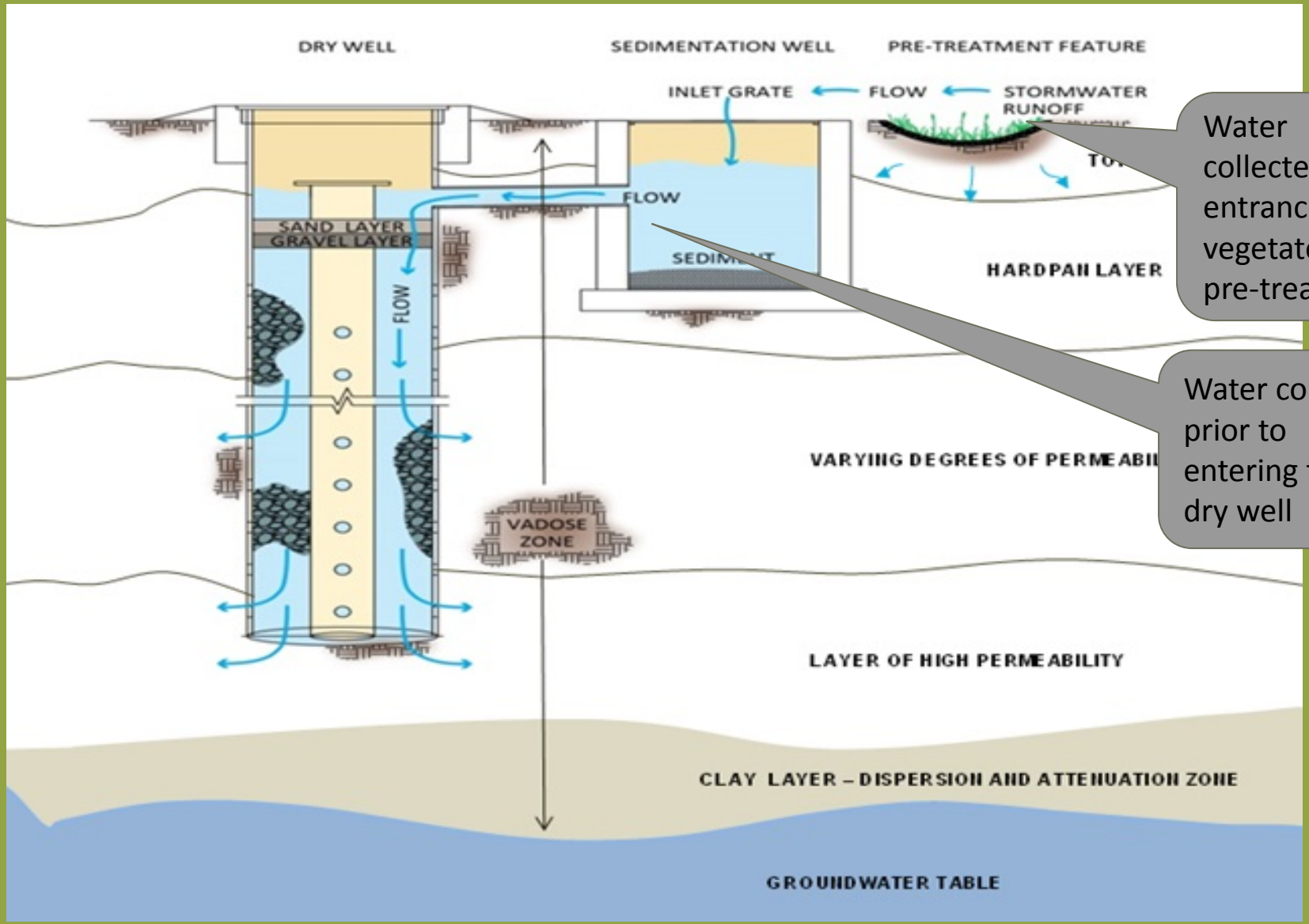
Stormwater and Groundwater Monitoring

Fall 2014 – Spring 2016

Water Quality Monitoring Plan

- Collect and sample stormwater and groundwater for 2 years
  - 6 wet weather stormwater samples
  - 6 wet and 2 dry weather groundwater samples
- Flow weighted composite samples collected over 80% of storm volume

Stormwater Sampling



Water Chemistry

- Constituents to be tested in stormwater and groundwater
  - General physical and chemical
  - Metals
  - Volatiles
  - Semi-volatiles
  - Herbicides
  - Pyrethroids
  - Total petroleum hydrocarbons - gas diesels
  - Pyrogenic polycyclic aromatic hydrocarbons
  - Total coliform

Water Quality Monitoring Findings: Year 1

Date	Strawberry Creek Water Quality Basin
8/4/14 **Groundwater**	Mn: 240 ppb (50; aesthetics)

2/6/15 **Stormwater** (composite collected at stormwater outfall)	• Organoleptic metals stormwater outfall (Al, Fe)
	• Bifenthrin:
	  • Stormwater outfall: 97 pptr
	  • Sedimentation well: 63 pttr
	• Trace amts other pyrethroids

2/6/15 **Groundwater**	• Bifenthrin: 7 pptr vadose zone • Dalaphon: 3 ppb downgradient • Total coliform: 1600 MPN/100 ml vadose & downgradient wells

Results: Year 1

Date	Strawberry Water Quality Basin

4/24/15 **Stormwater** (composite collected at outfall)	• Toluene 0.84 ppb (150)
	• Coliform >1600
	• Bifenthrin:
	  • Stormwater outfall: 2.2
	  • Sedimentation well: 5

4/24/15 **Stormwater** (composite collected at stormwater outfall)	• Toluene 0.84 ppb (150)
	• Coliform >1600
	• Bifenthrin:
	  • Stormwater outfall: 2.2
	  • Sedimentation well: 5

4/24/15 **Groundwater**	• No collection

Results: Year 1

Date	Corporation Yard
8/4/14 **Groundwater**	NO_3: 57 ppm (45)
4/24/15 **Stormwater** (composite collected at sedimentation well)	• Organoleptic metals (Fe, etc.) • Coliform: >1600 MPN;/100 ml • Bifenthrin: • Curbcut: 4 pptr

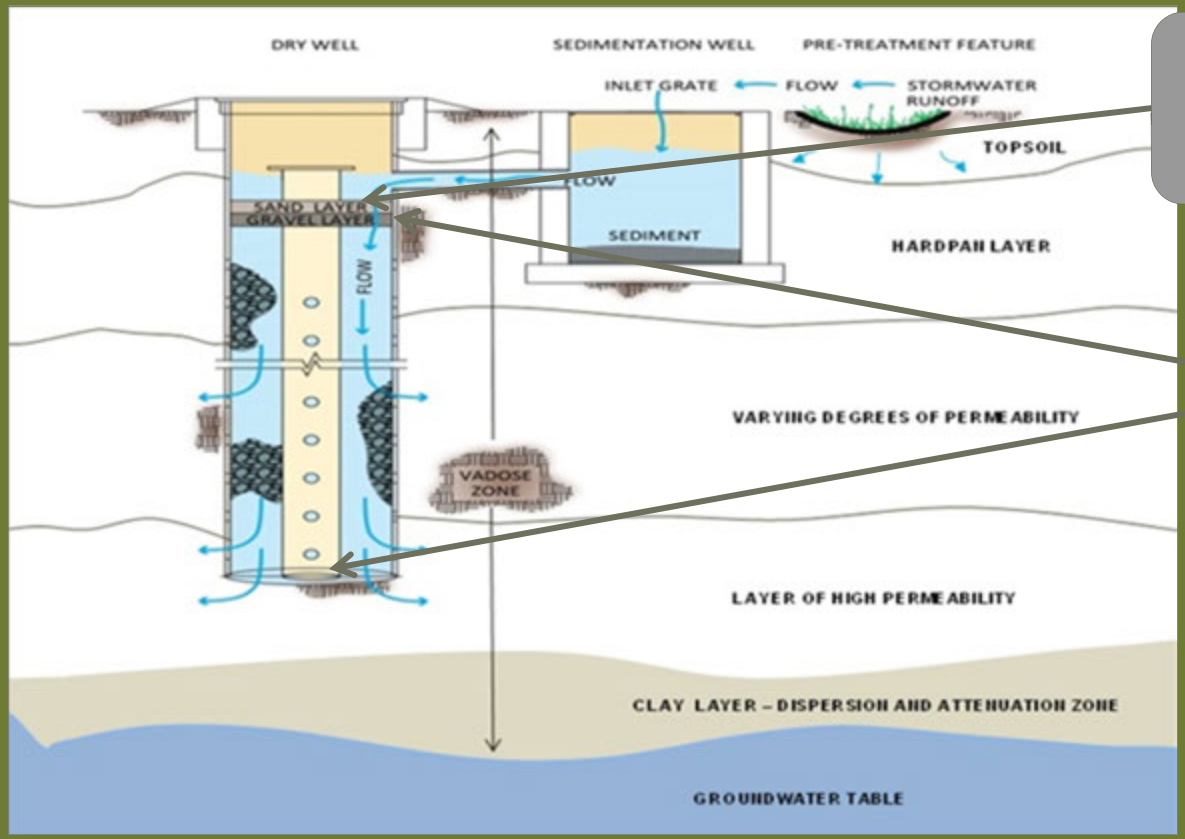
Few contaminants detected
in dry well system

- Pretreatment removes over 50% of suspended solids
- Subsurface attenuation

Monitoring Plan: 2015-2016

- 5 monitoring events
- 1st flush event includes 2 flow-weighted composites
  - Early phase of runoff (highest contaminants)
  - Middle-later phase up to 80% of total
- 3 monitoring events
  - Flow weighted composites
    - ✓Modify analytes:
      - Remove VOCs, SVOCs, PAHs, herbicides
      - Add neonicitinoids (imidacloprid) and phenylpyrazoles (fipronil, and/or PPCPs)

Recharge and Infiltration Capacities



Velocity sensor to monitor flow

Pressure transducers to estimate stage

Preliminary infiltration rate:

Corporation Yard: 20 - 97 gpm (varies by intensity of storm event)

Strawberry Creek Water Quality Basin: 70 - 80 gpm

Logging boring soil samples at well sites

Fate and Transport of Contaminants

Fate and Contaminant Modeling

- UCD hydrologists (G. Fogg, T. Harder and E. Edwards)
- Address two major concerns:
  - How far might contaminants migrate from bottom of dry well over many years?
  - Could naturally occurring metals (e.g. As, U) be mobilized as a result of stormwater influx?

City of Elk Grove Corporation Yard dry well system

Education and Outreach

Education and Outreach

- Factsheets
  - Regulations
  - Dry well programs other states
  - Findings of the project
- Annotated Bibliography
- Lessons Learned Report
- Journal article

Dry Wells

Uses, Regulations, and Guidelines in California and Elsewhere

Purpose: This fact sheet consolidates existing information on design and regulations on the use of dry wells.

Dry Well Description and Use

Dry wells are gravity-fed excavated pits lined with perforated casing and often backfilled with gravel or stone. Dry wells penetrate layers of clay soils with poor infiltration rates to reach more permeable layers of soil, allowing for more rapid infiltration of stormwater. They can be used in conjunction with low impact development (LID) practices to reduce the harmful effects that traditional stormwater management practices have had on the aquatic ecosystem. Dry wells not only aid in stormwater runoff reduction, but they can also increase groundwater recharge, are economical, and have minimal space requirements.

Fig. 1 – Idealized drawing of stormwater infiltration through a dry well

Fig. 2 – Dry well installed to receive runoff flowing through a lawn (source: R. Pitt)

However, there is a concern that, due to their limited treatment capabilities, dry wells will introduce contaminants to groundwater. In urban environments, preliminary findings, based on results from a small body of literature, show a lack of correlation between the use of dry wells and groundwater contamination (Jurgens 2008, Los Angeles 2005). However, data gaps remain regarding dry well safety and the associated risks. The result is that many county stormwater/LID guidelines do not include dry wells in their plan. There are also inconsistencies between different Regional Water Quality Control Boards' Standard Urban Stormwater Management Plans' (SUSMP) technical specifications for dry well construction. It is also unclear how the Department of Water Resources' well regulations apply to stormwater infiltration through dry wells. Because of this, people are often hesitant to use them.

U.S. Environmental Protection Agency (EPA) - Region 9 Regulations

Dry wells and other buried infiltrative devices serving lots other than single-family homes are subject to the U.S. Environmental Protection Agency (US EPA) Underground Injection Control (UIC) regulations. A dry well is considered a Class V injection well, which is defined as a conduit for non-hazardous fluids that is deeper than it is wide. Dry wells may be authorized to operate as long as they are registered with the US EPA, and only injects uncontaminated stormwater. The US EPA has no design requirements for dry wells but it is recommended that dry wells:

- Should not be constructed deeper than the seasonal high water table.
- Follow local guidelines for setback distances from the dry well bottom to the water table.
- Go through a thorough site evaluation to prevent the spread of contaminants.
- Utilize pre-treatment in areas where clogging or hazardous spills may be an issue.
- Use backfill to improve dry well column stability.

The EPA also has set forth the following minimum requirements for Class V wells:

- Register injection wells at www.epa.gov/region09/water/groundwater/injection-wells-register.html
- Operate injection wells in a way that will not endanger underground sources of drinking water.
- Class V wells should be backfilled and closed, with notification to the US EPA, to prevent movement of contaminated fluids into underground sources of drinking water (USDW) when they are no longer in use.

Dry Well Regulations and Permitting

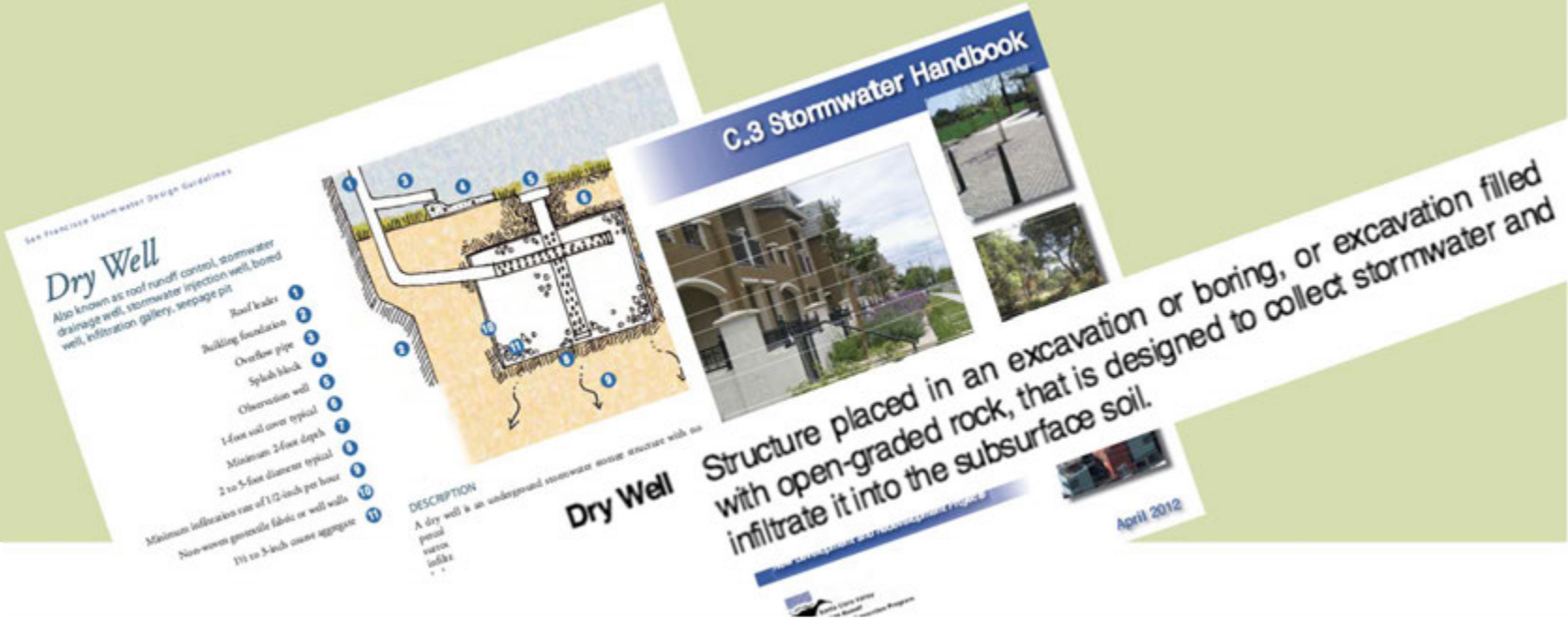
US EPA Underground Injection Control (UIC) Program

- 1989: Authorized use of UICs but runoff entering dry well cannot exceed MCL
- 1999: Performed large study, concluded:
  - Additional regulations unnecessary
  - No evidence of contamination problems
- 2002: EPA Region 9 Factsheet
  - EPA primary agency for overseeing Class V Injection Well Program in CA
  - Identified Regional Boards and local agencies to promulgate additional regulations and guidelines

Dry Well Regulations and Permitting

Municipalities follow two different set of rules:

1. US EPA guidelines for UIC wells
   - Southern California and San Francisco:
   - Southern California 10,000 dry wells
   - Santa Clara and San Francisco Peninsula



Dry Well Regulations and Permitting

2. Follows DWR Bulletin 74-81 and 74-90 – guidelines for drinking water wells; prevent surface water from entering subsurface to protect groundwater

   Sacramento region and other areas:

   – Interpretation assumes stormwater is a waste product
   – Wells "used for the injection of reclaimed waste water" including "dry wells," "drainage" wells and sewer wells
   – Waste defined as "sewage and all other waste substances of human or animal origin…."
   – Waste defined as Local interpretation: Dry well should be constructed to drinking water well standards and permitted as such

Dry Well Regulations and Permitting

Challenges

- Dry wells not commonly used in Sacramento region; difficult to obtain permit
- No regional guidelines for design, placement, monitoring, etc.
- Caution among stormwater managers

BUT…..

- LID/hydromodification requirements
- Water Board “Stormwater Initiative”
- Drought, climate change - all push for more infiltration and groundwater recharge

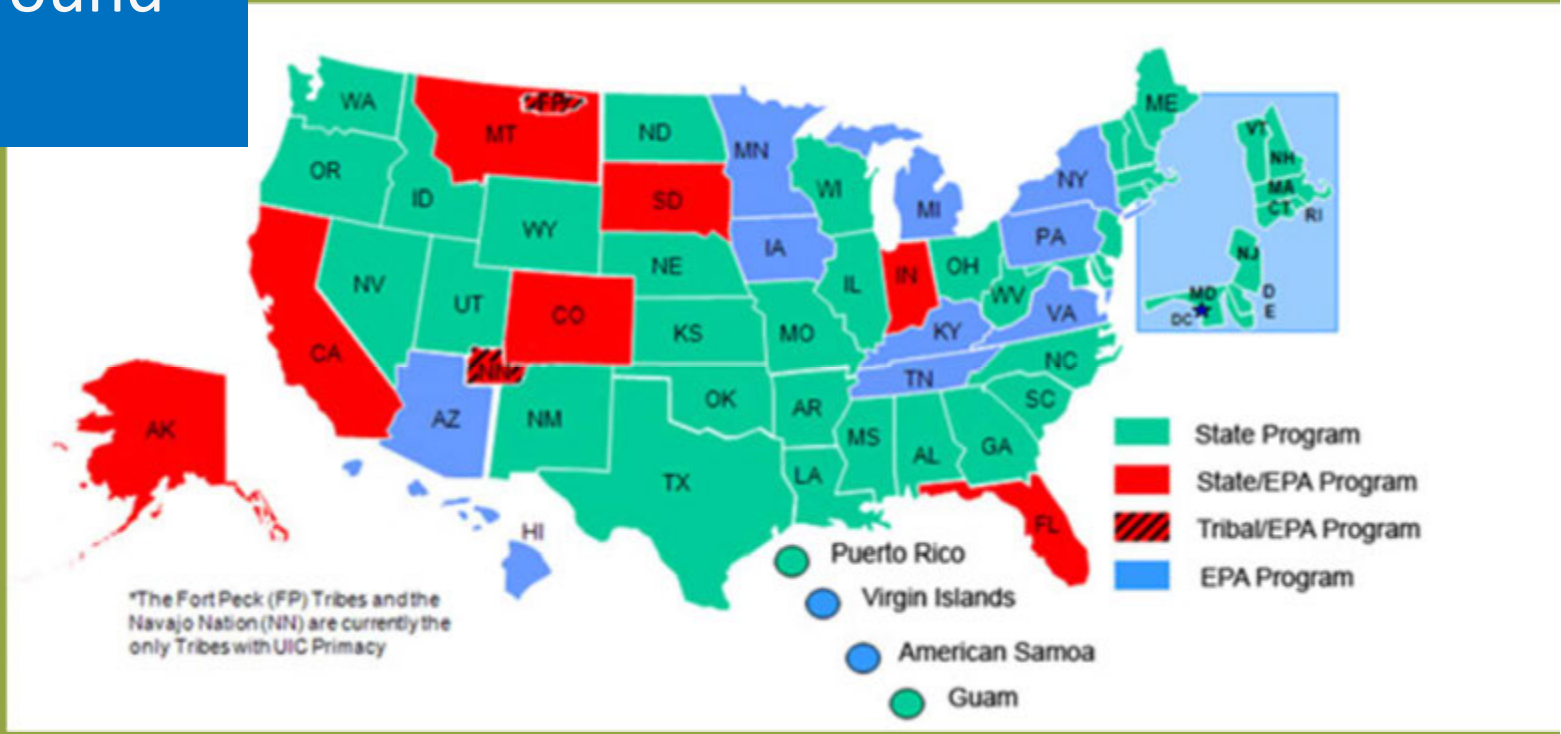
Dry Well Regulations and Permitting

Summary

- Sacramento region and other areas of CA
  - No streamlined municipalities guidelines
  - Lack of State Class V UIC Program: a barrier to effective use of dry wells for stormwater management and groundwater recharge

Primary Enforcement Responsibility throughout United States

Lack of statewide UIC program has led to piecemeal practices around the State



Oregon's Underground Injection Control Program

- Good example of a carefully designed program
- Permits given by Oregon Department of Environmental Quality (DEQ)
- Requirements of permit
  - Monitoring of runoff just prior to entering dry well to determine that it meets drinking water standards
  - Modeling of fate and transport
  - Prohibition of use of dry wells in high risk areas: industrial, gas stations, etc.

Oregon's Underground Injection Control Program: Portland

- 20,000 UICs – public and private
- Ten year Monitoring Program
  - 30 sites, 6 times/year, and extensive list of contaminants
- Model to determine fate and transport
- Received renewal of 1st 10 year permit
- Beginning second decade of UIC Program
- Identified little evidence of groundwater contamination

Elk Grove Dry Well Project

Preliminary Lessons Learned

- No evidence that dry wells contributed to groundwater contamination
  - Consistent with literature and experiences from other States
- Challenges to placement and construction of dry well systems

Bigger Picture

- Dry wells serves multiple benefits:
  - Aquatic ecosystem protection
  - Improved water quality
  - Groundwater recharge
- Need to use stormwater as a resource
- A key driver for use of dry wells with LID practices is drought and climate change

Contact

Connie Nelson, Project Manager
cnelson@elkgrovecity.org
(916) 478-3638
www.egpublicworks.org.....click the dry well tab

THANK YOU!