

# Stormwater Infiltration using Dry Wells as a Low Impact Development (LID) Tool

**Presented by:**

*Connie Nelson, CFM*

*City of Elk Grove/Willdan Engineering*



*June 4, 2014*

# Today's Discussion

- **Background**
  - California's water situation
  - Groundwater recharge (hydrologic cycle)
  - Effects of urbanization
  - Stormwater as a resource
- **Use of Dry Wells as a Low Impact Development Tool**
  - What is Low Impact Development?
  - What are dry wells?
- **Elk Grove Dry Well Projects**
  - State funded projects
  - Other projects



# Background

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

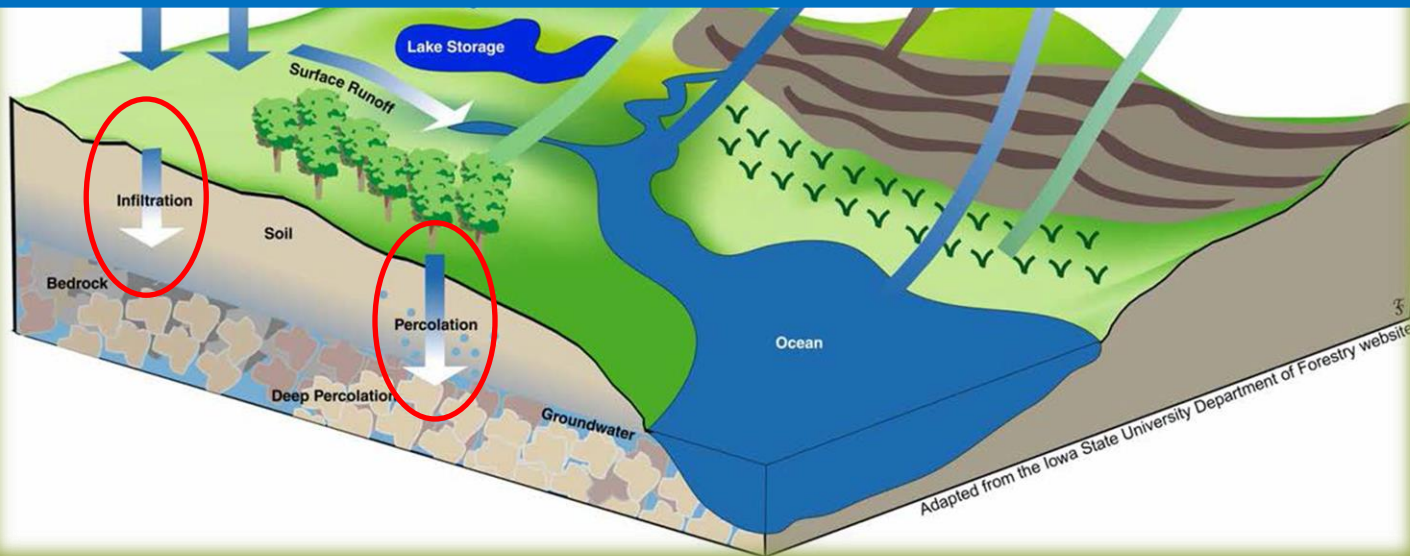
Groundwater recharge is a hydrologic process where water moves downward from the surface water to groundwater.

The Water Cycle



Surface water and groundwater have always been interconnected!

Naturally occurring process and is the primary input to the aquifer

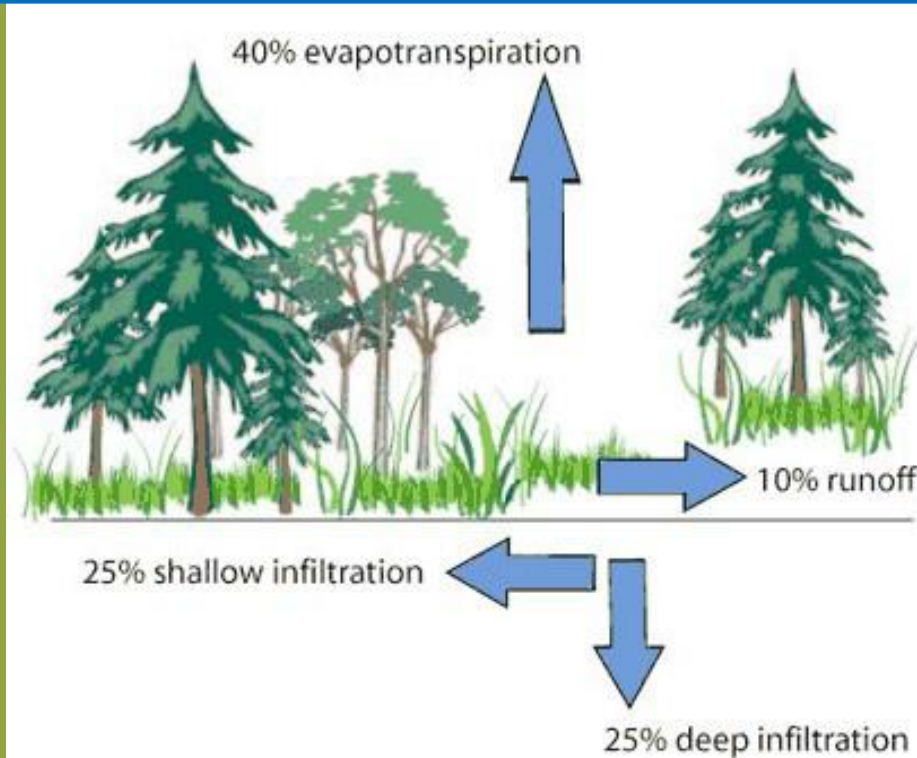


# Effects of Urbanization

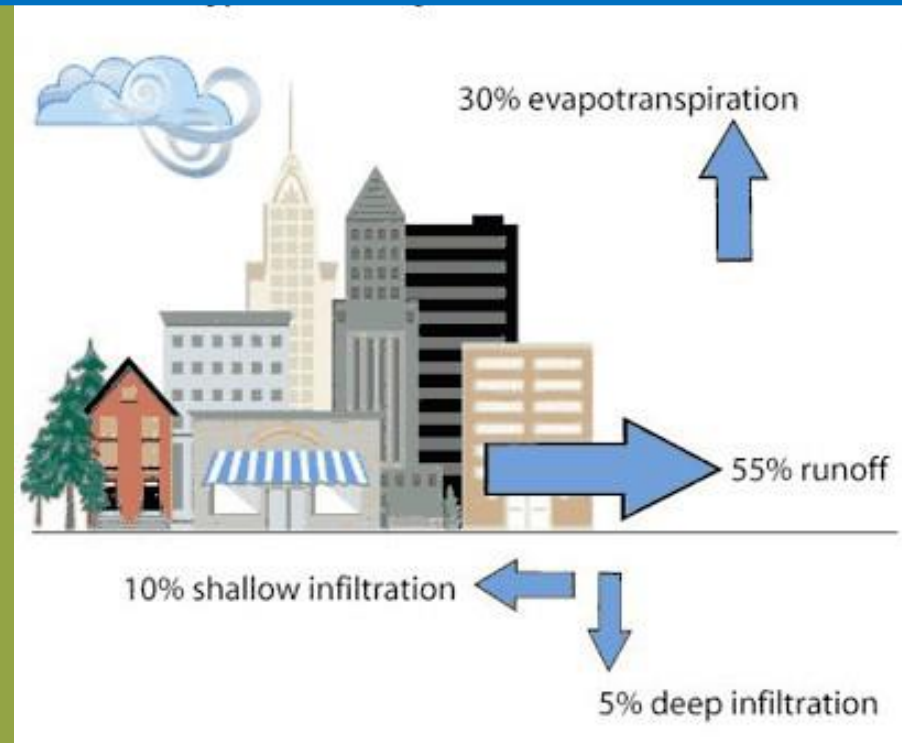
- Decrease in the infiltration of rain water due to hardscapes such as building and roads
- This alteration in the natural flow patterns is called hydromodification
  - Impacts aquatic ecosystem
  - Increased flood risk

# Effects of Urbanization

Typical cycle in an undeveloped area.



Typical cycle in an developed area.



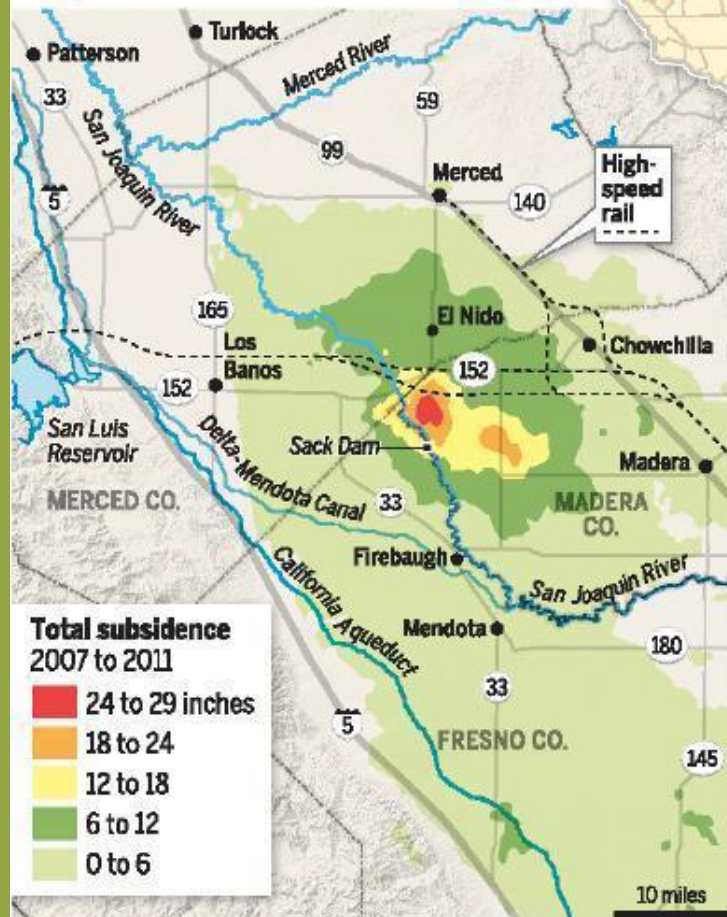
*5-fold increase in urban runoff in a developed area.*



# Groundwater Supplies Depleting in Central Valley in Northern California

## SINKING LAND

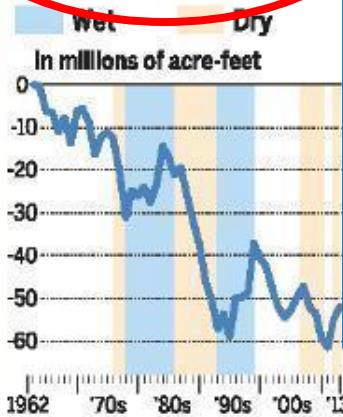
Groundwater pumping and the resulting land subsidence has harmed vital irrigation infrastructure in the San Joaquin Valley – such as the Delta-Mendota Canal. The proposed high-speed rail route would cross one of the most heavily affected areas.



Sources: California Water Foundation, UC Center for Hydrologic Modeling

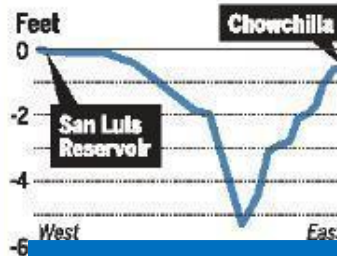
## Groundwater losses

Since 1962, the Central Valley has lost about 50 million acre-feet of groundwater, with the biggest declines occurring during times of drought.



## Elevation cross section

Highway 152, which parallels part of the high-speed rail route, sunk up to 5 feet between 1972 and 2004.



- Sinking Land
- 50 million acre feet groundwater lost

Source: Sacramento Bee, April 2014

# One Solution is to Treat Stormwater as a Resource

- Improve water quality
- Reduce urban runoff
- Provide groundwater argumentation
- Reduce localized flooding
- Provide habitat enhancement and protects aquatic resources
- Aesthetically pleasing



<http://www.nwri-usa.org/documents/Boehm.pdf>

*“Greener approach...return to natural hydrologic regime.”*



# Dry Wells as a Low Impact Development Tool

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# What is Low Impact Development?

## Innovative stormwater management approach

- Mimics natural hydrology
- Manage stormwater at the source
- Captures, stores, cleanses and slowly releases stormwater (reducing peak flows)
- Water quality treatment through filtration
- Recharges stormwater to groundwater
- Treats small to medium storm events
- Mitigate flooding, erosion and reduction in sedimentation

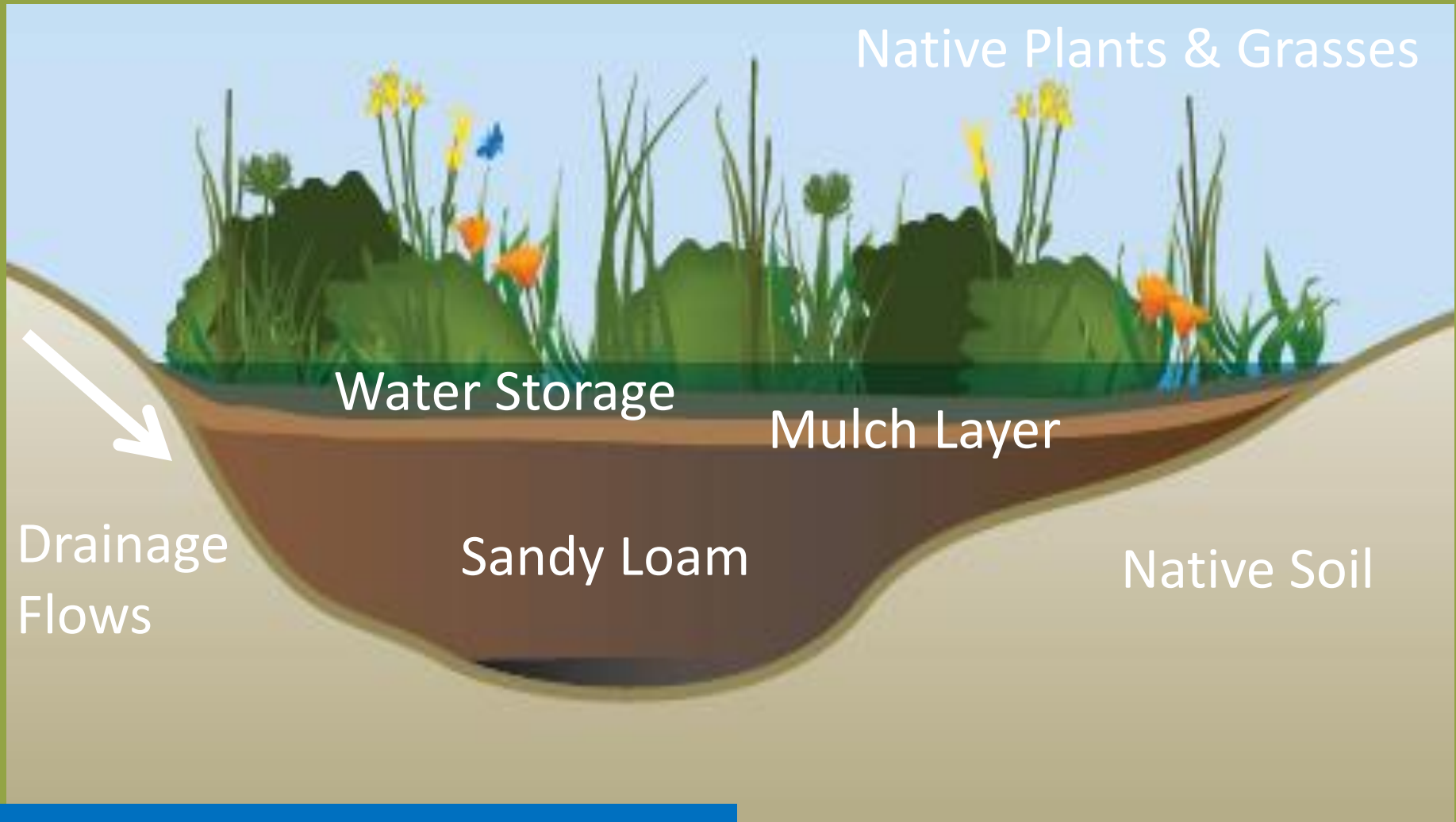


# Example of Low Impact Development



*Bioretention and grassy swale*

# Example of Low Impact Development



*Rain gardens*

# What are Dry Wells?

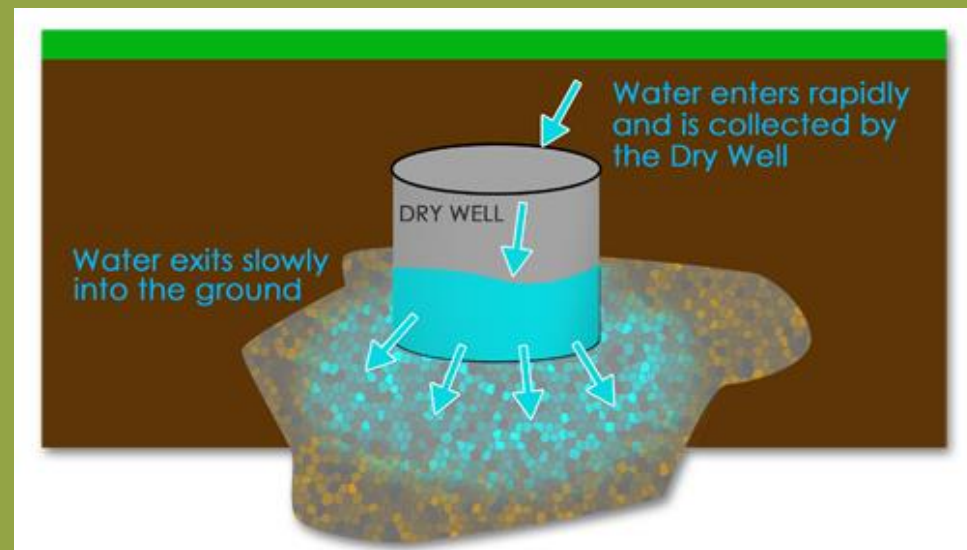
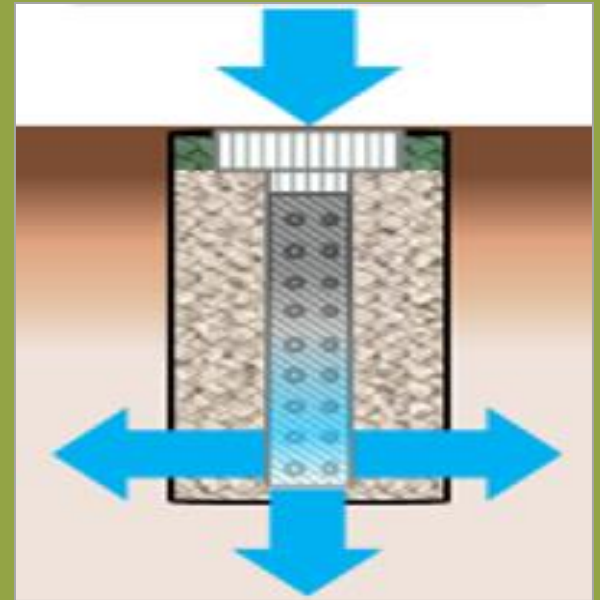
- Promote infiltration of stormwater runoff to recharge groundwater
- Can infiltrate stormwater through clay soils
- Use in conjunction with Low Impact Development practices



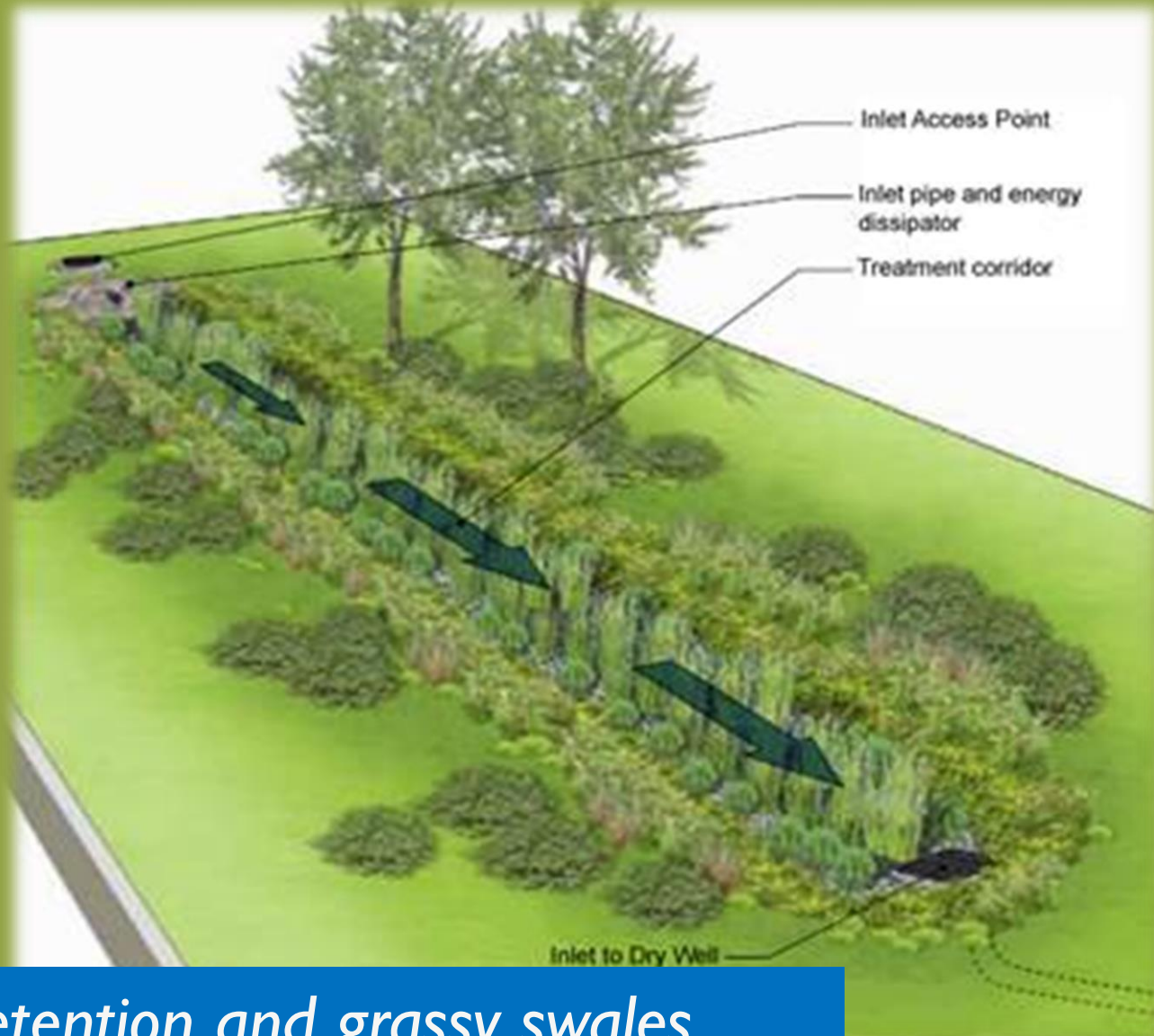


# How does it Work?

- Receives water from one or more entry points
- Collect, store and disburse water
- Discharges water through small openings
- Bottom of dry well is placed at permeable soils



# Example Grassy Swale and Dry Well



*Bioretention and grassy swales*

# Challenges

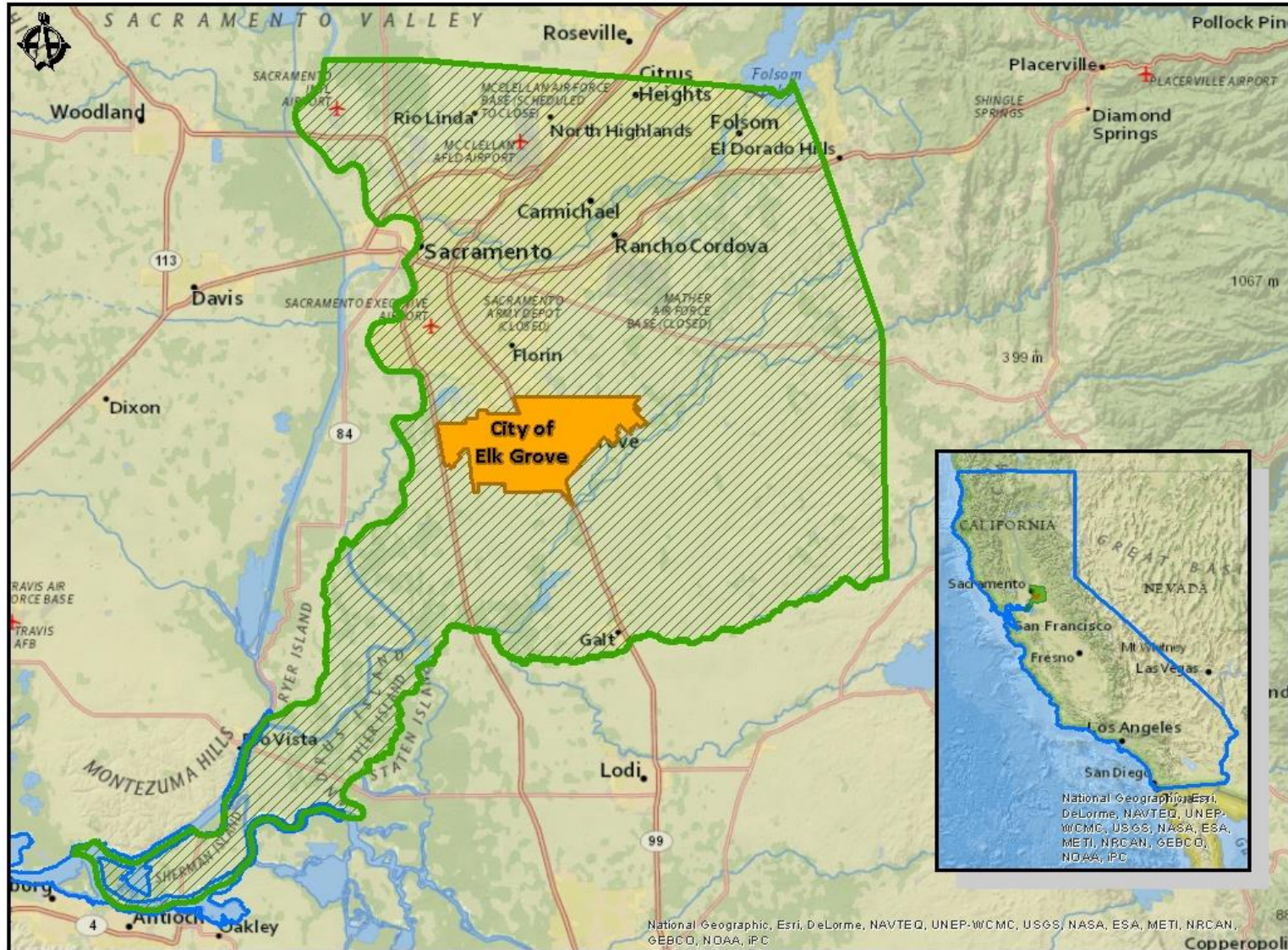
- Competing regulations:
  - Water Code 13710: guidelines to prevent surface water entering water well (DWR Bulletin 74-81/90)
  - State Water Board promotes stormwater infiltration and dry wells are an important tool in the Low Impact Development tool kit
- Perception that dry wells contribute to groundwater contamination

# Elk Grove Dry Well Projects

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# City of Elk Grove, California





# Project I: Dry Wells as Low Impact Development

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# Background

- State funded Stormwater Grant Program
- Total project budget \$825,000
- Received grant funding amount \$489,820
- In-kind services \$335,180



# Project Purpose

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

- Infiltrate stormwater runoff
  - Alleviate localized flooding
  - Recharge groundwater
- ...without negatively impacting quality of groundwater.

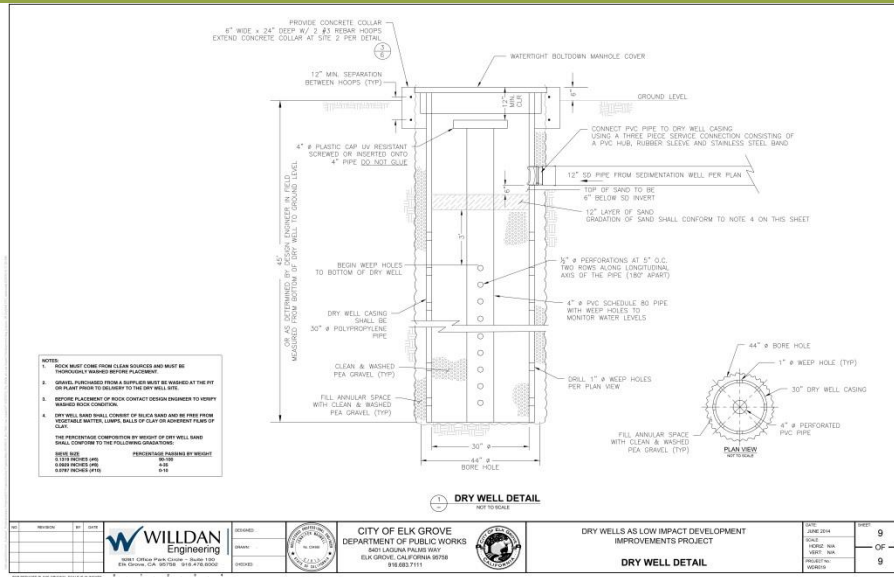
# Project Team



Hydrology | Hydraulics | Geomorphology | Design | Field Services

[www.cbecoeng.com](http://www.cbecoeng.com)





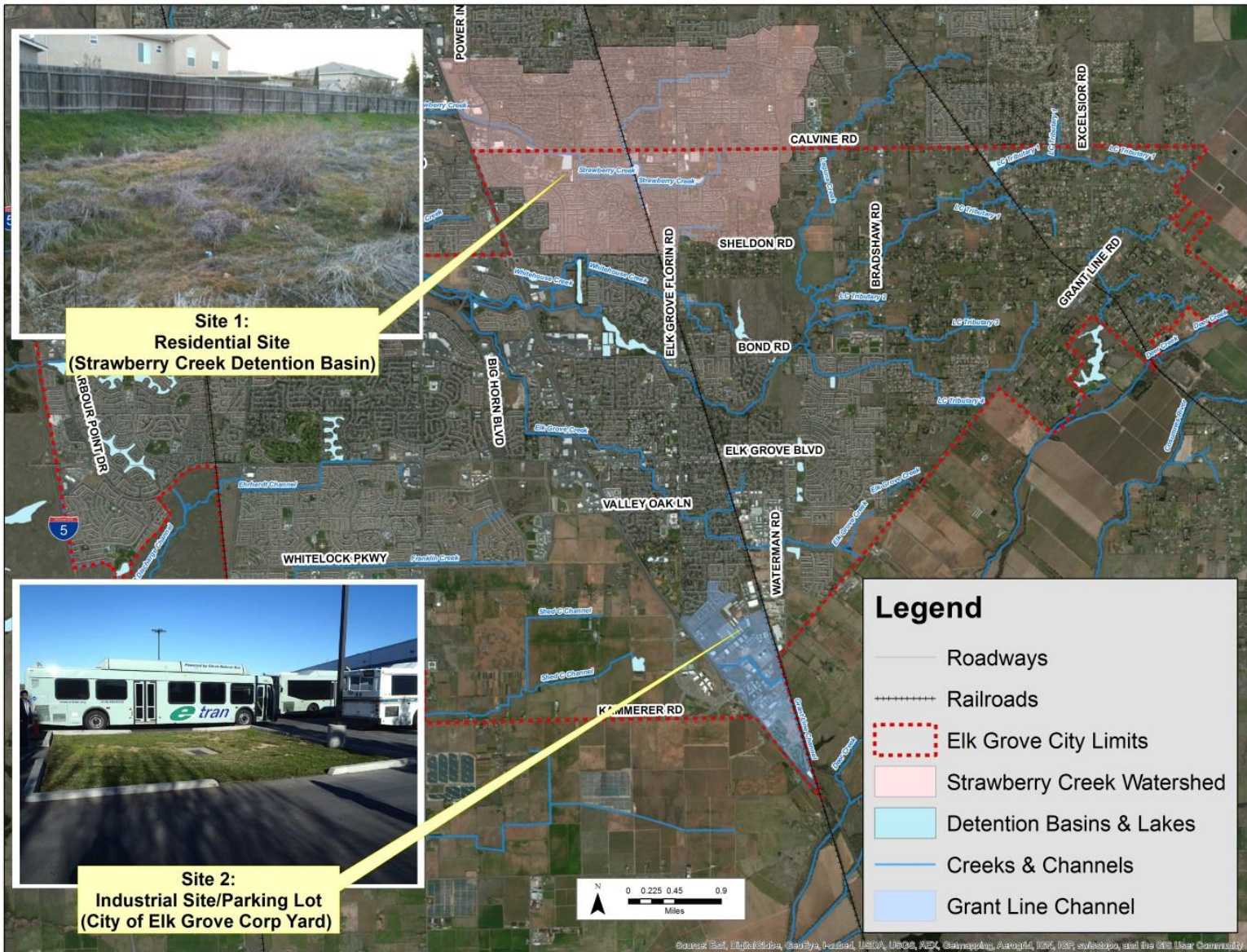
# Phase I: Site Selection, Design and Construction

2012 - 2014

<p><b>WILLDAN Engineering</b> 1801 Central Expressway, Suite 100 Elk Grove, CA 95758 916.476.8000</p>	<p><b>CITY OF ELK GROVE</b> DEPARTMENT OF PUBLIC WORKS 840 LACINA PALMS WAY ELK GROVE, CALIFORNIA 95759 916.683.7111</p>	<p>DRY WELLS AS LOW IMPACT DEVELOPMENT IMPROVEMENTS PROJECT</p> <p><b>DRY WELL DETAIL</b></p>	<table border="1"> <tr> <td>DATE: 04/14/14</td> <td>SHEET: 9</td> </tr> <tr> <td>SCALE: 1"=1'-0"</td> <td>OF: 9</td> </tr> <tr> <td>DESIGN: [Name]</td> <td></td> </tr> <tr> <td>CHECK: [Name]</td> <td></td> </tr> <tr> <td>DATE: [Date]</td> <td></td> </tr> </table>	DATE: 04/14/14	SHEET: 9	SCALE: 1"=1'-0"	OF: 9	DESIGN: [Name]		CHECK: [Name]		DATE: [Date]	
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# Project Site Locations





# Project Site Schematic



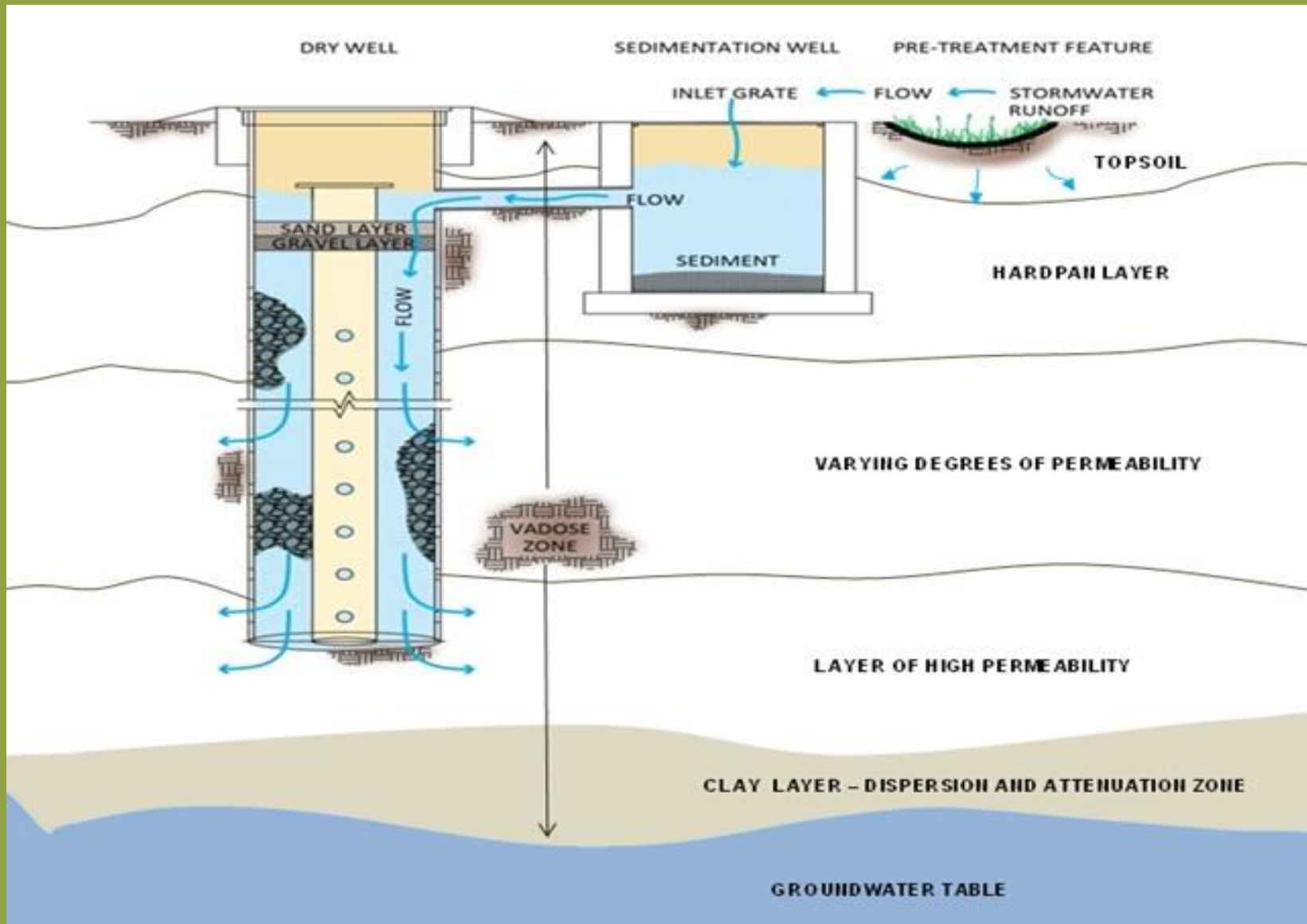
Shallow groundwater well: 55 feet  
Deep groundwater wells: 110 feet

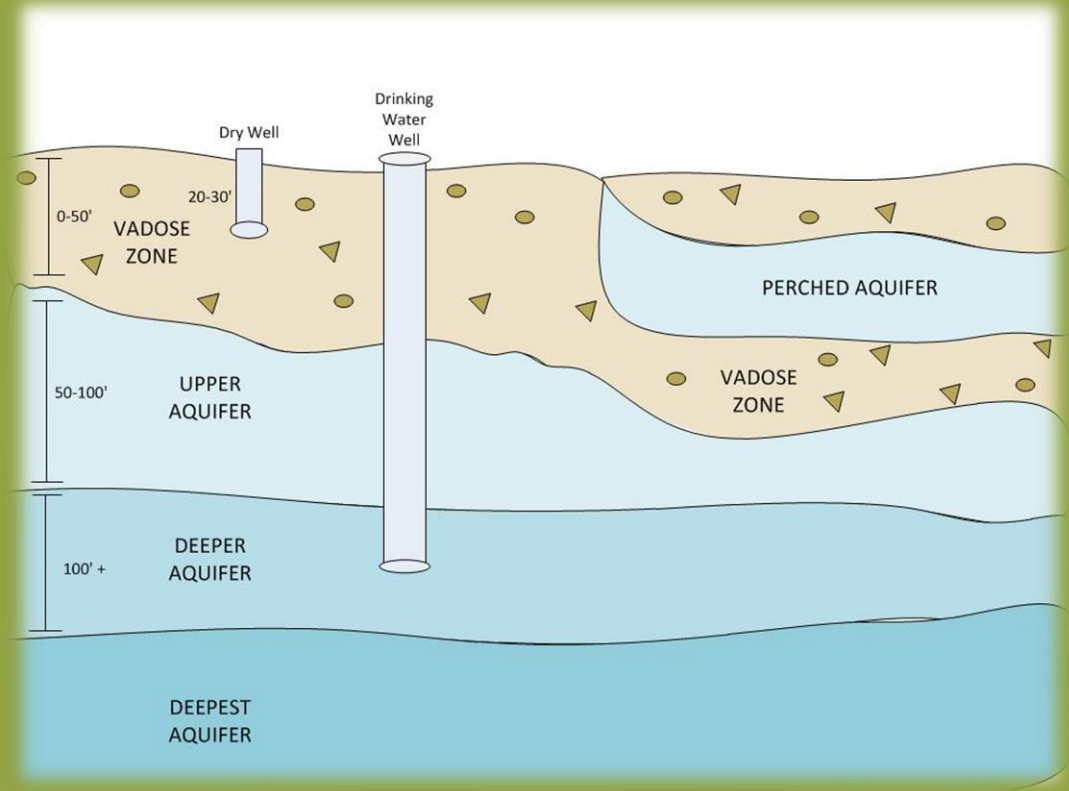
# Monitoring Well Network





# Dry Well Design





# Phase 2: Field Study

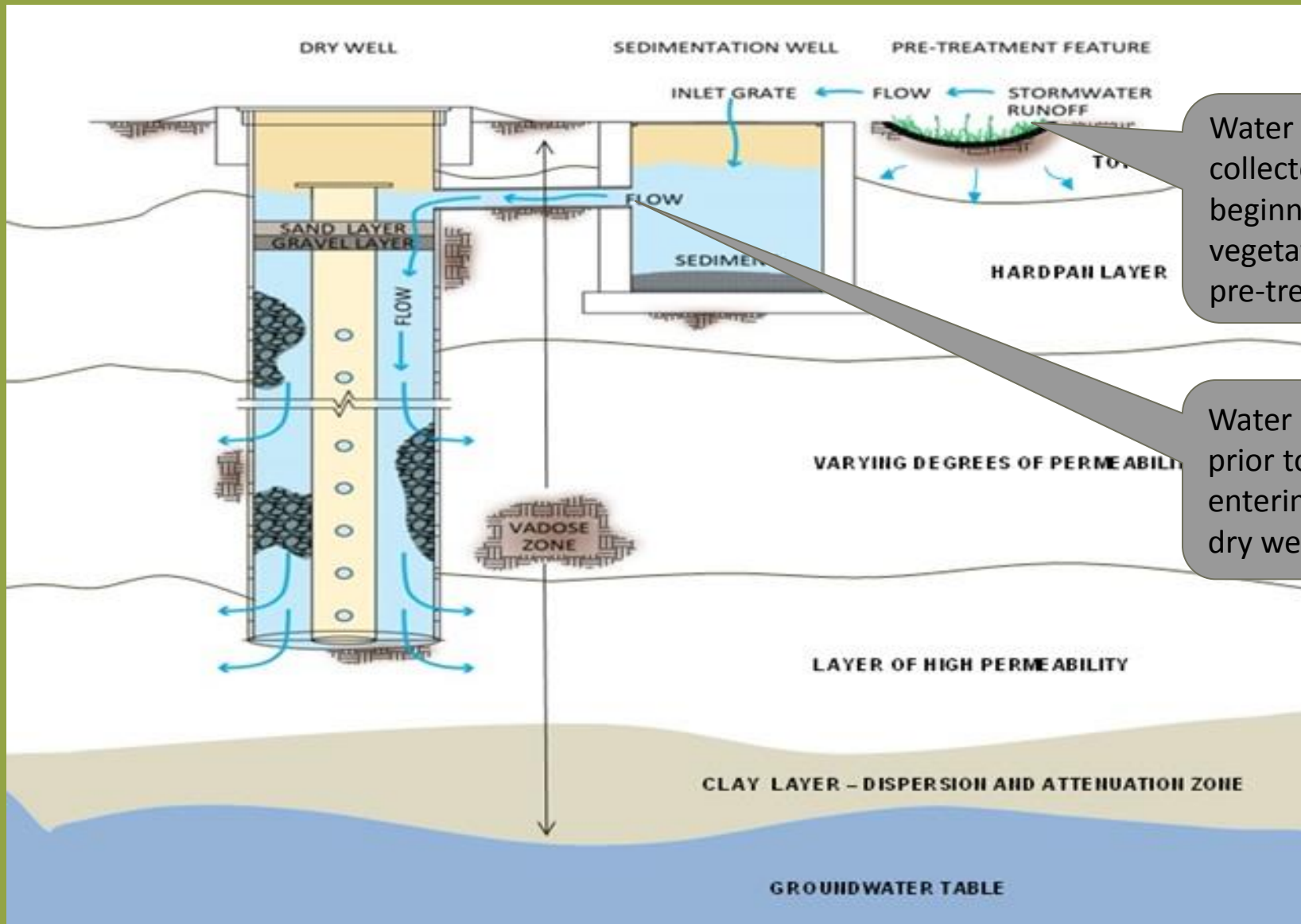
Begins Fall, 2014



# Field Study

- Collect and sample stormwater and groundwater for 2 years
  - 3 wet weather stormwater samples
  - 3 wet and 1 dry weather groundwater samples

# Stormwater Water Sampling

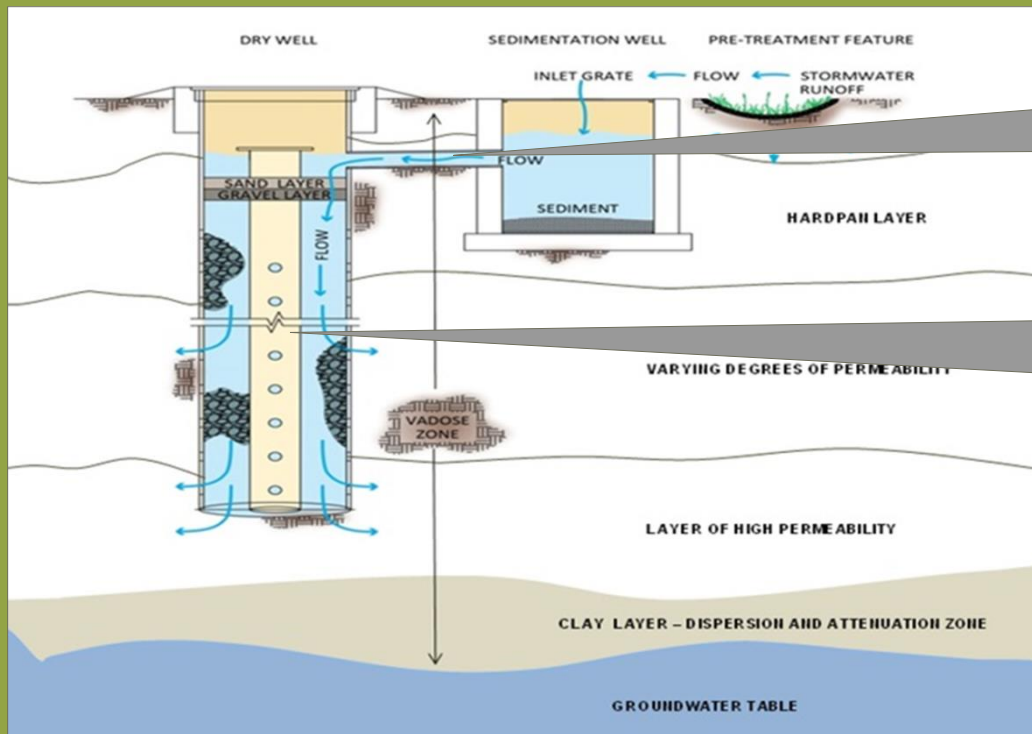


# Water Quality Chemistry

- Constituents to be tested in stormwater and groundwater
  - General physical & chemical
  - Metals (EPA 200)
  - Volatiles (EPA 8260)
  - Semi-volatiles (EPA 625)
  - Herbicides (EPA 515)
  - Pyrethroids (WPCL, DFW method)
  - TPH (EPA 8015)
  - Pyrogenic PAHs (EPA 8310)
  - Total coliform



# Estimate Recharge and Infiltration Capacities



Velocity sensor to monitor flow

Pressure transducer to estimate the volume of flow



Logging boring soil samples at well sites

# Phase 3: Fate and Transport Modeling

2014 - 2015

# Phase 4: Education and Outreach

Literature Review  
Factsheets  
Reports  
Website

**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 soil to reach more permeable layers, allowing for more rapid infiltration of stormwater. In conjunction with low impact development (LID) management practices, dry wells can reduce the harmful effects that stormwater runoff has on the environment. Dry wells not only aid in stormwater management but also increase groundwater recharge, and have minimal space requirements.

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



**A risk-based approach to dry well use:  
The Portland Underground Injection Control (UIC) Program**

**Program Background**  
Portland has about 9,000 public and 10,000 private underground injection control systems or UICs. UICs collect stormwater in a catch basin, filter it through a sedimentation manhole, and release the runoff into a dry well for infiltration between 20-30 feet below the ground. This runoff recharges the aquifer. In Portland, the public UICs typically collect stormwater from roads and other public right-of-ways into basins along the side of the street. In many parts east of the Willamette River, UICs are the only form of stormwater disposal. Portland developed UICs as a best management practice (BMP) to minimize the damaging effects of increased runoff volumes on the aquatic ecosystem. Due to increasing development and the prevalence of hardscape, rain is prevented from naturally infiltrating into the surface, increasing the volume of runoff and reducing groundwater recharge. UICs help to address these problems. Additionally, during exceptionally large storm events, UICs take in overflow that cannot be contained with other BMPs. UICs also save money by reducing the need to install costly piped infrastructure.

**Fig. 2 — Dry well installed to receive runoff flowing through a lawn (Source: B. Pitt)**



**U.S. Environmental Protection Agency (USEPA) Class V Injection Well**  
Dry wells and other buried infiltration devices are regulated by the U.S. Environmental Protection Agency (USEPA) as Class V injection wells, which is defined as a well that is used to inject fluids into the ground. The USEPA has no design requirements for Class V wells. However, the USEPA has set forth the following guidelines for their construction and use:

- Should not be constructed in areas where they would be subject to flooding.
- Follow local guidelines for siting and construction.
- Go through a thorough site investigation before construction.
- Utilize pre-treatment in areas where there is a high potential for clogging.
- Use backfill to improve dry well performance.

The EPA also has set forth the following guidelines for the operation and maintenance of Class V wells:

- Register injection wells in a public database.
- Operate Class V wells in a manner that does not cause or contribute to the contamination of groundwater.
- Class V wells should be backfilled with fluids into underground aquifers.

**UICs: Construction and Design**  
Figure 1. A typical Portland UIC. UICs are comprised of three parts: a catch basin or sewer inlet, a sedimentation manhole, and a drywell. The main component of a UIC is the drywell, which is typically a precast reinforced concrete cylinder. To allow infiltration, they contain numerous perforations about two inches in diameter. The UICs vary in size and depth, but are typically four feet in diameter and 30 feet deep. Most UICs are also linked to a pre-treatment manhole to remove particulates before stormwater enters the drywell. This serves to reduce clogging and aids in pollutant removal since most contaminants are adsorbed onto particulate matter. The manholes are usually four feet in diameter, ten feet deep, and have an average sediment accumulation capacity of six feet. Publicly owned UICs are located in the street. UICs are not constructed in areas where spills might occur and potentially harm groundwater. A number of siting restrictions are defined by the City, including restricted use in commercial/industrial areas, 10 foot setbacks from buildings and 500 foot setback from public drinking water wells.

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





# Questions that will be Addressed

- **Primary question:**
  - Are contaminants introduced into groundwater through dry wells?
- **Secondary questions:**
  - How effective is pre-treatment at removing contaminants and sediment from stormwater?
  - What is groundwater recharge potential?
  - What are maintenance requirements?



# Project 2: Sleepy Hollow Detention Basin Retrofit

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# Background

- State funded Implementation Grant
- Total project budget \$850,000
- Received grant funding amount \$240,000
- In-kind services \$610,000



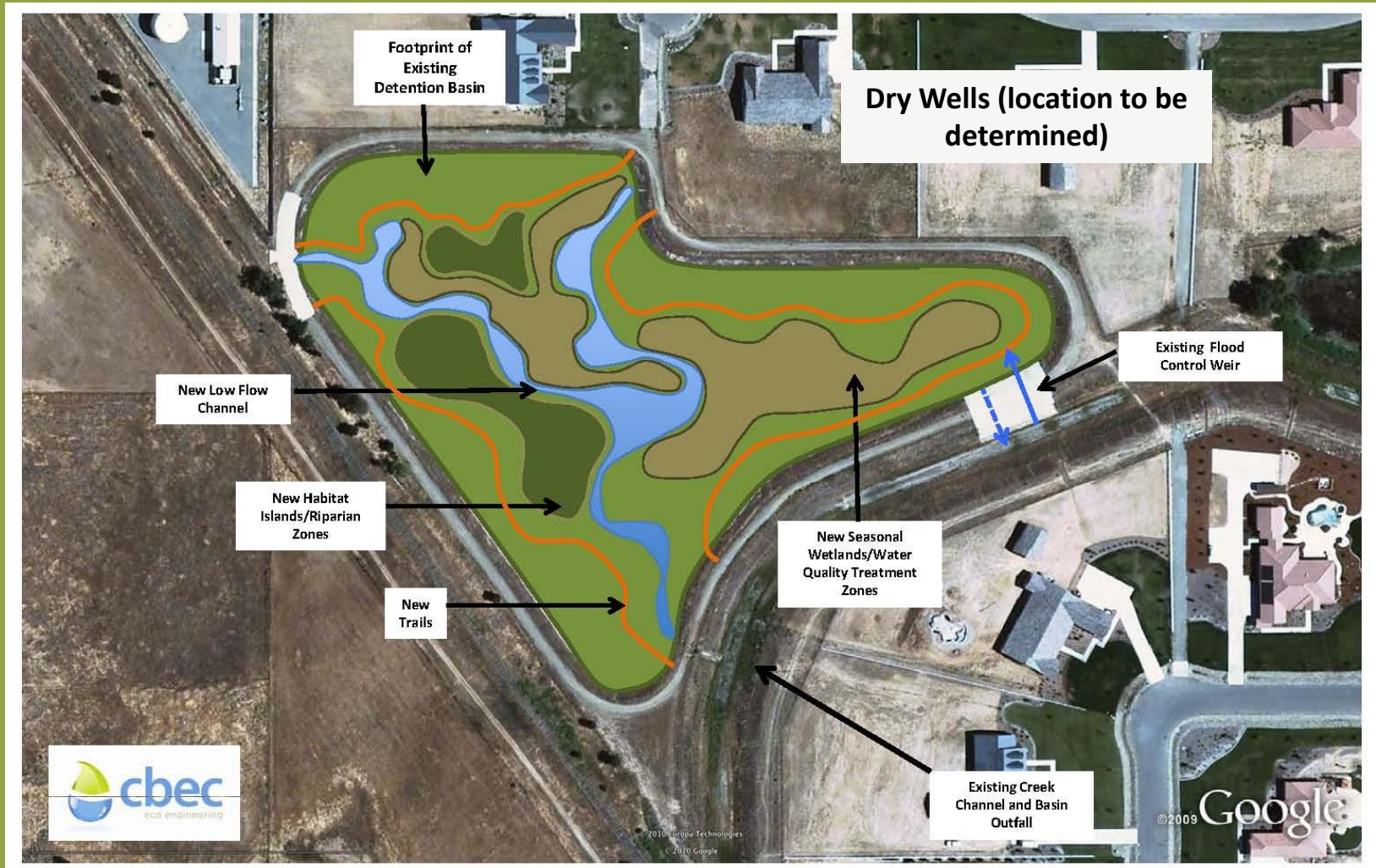
# Project Purpose

Retrofit an existing detention basin for multifunctional purposes to:

- Infiltrate stormwater runoff
- Alleviate localized flooding
- Recharge groundwater
- Improve water quality
- Provide habitat enhancement/riparian zones



# Sleepy Hollow Detention Basin





# Other Elk Grove Dry Well Projects

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# Dry Wells Rural Roadway



- **Alternative to typical storm drain system**
- **Localized flood control**
- **Less expensive**
- **Groundwater recharge potential**

# Elk Grove Rain Garden Plaza

- **Largest rain garden in California**
- **Educates sustainable stormwater practices**
- **Demonstrates Low Impact Development techniques**



*“9 State and Regional Awards”*

<http://www.elkgrovecity.org/rain-garden/>

# Conclusion

- Sustainable Water Resource Management
  - Multiple purposes and beneficial uses
- Incorporate into any project
- Maintain groundwater quality
- Proposition 84 Projects
  - Provide scientific data to help local and State agency on the beneficial uses of dry wells as a Low Impact Development tool



# Contacts

Project Manager: Connie Nelson, CFM  
City of Elk Grove/Willdan Engineering  
[cnelson@elkgrovecity.org](mailto:cnelson@elkgrovecity.org)

Q/A Officer: Barbara Washburn, PhD  
Office of Environmental Health Hazard Assessment,  
California EPA  
[Barbara.Washburn@oehha.ca.gov](mailto:Barbara.Washburn@oehha.ca.gov)







Questions?  
Thank you