Project Assessment and Evaluation Plan Proposition 84 Stormwater Planning and Monitoring Grant

Separating Fact from Fiction: Assessing the Use of Dry Wells as an Integrated Low Impact Development (LID) Tool for Reducing Stormwater Runoff while Protecting Groundwater Quality in Urban Watersheds

September 30, 2013

City of Elk Grove

Agreement No. 12-424-550

Signature Page

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I. Project Summary

A. Funding Program

The project is supported by the Proposition 84 - Stormwater Planning and Monitoring Grant Program and local and State matching funds.

B. Project Description

A project funded by the State Water Resources Control Board and Proposition 84's Stormwater Grant Program could open up new opportunities for dealing with stormwater runoff while recharging the groundwater supply. The City of Elk Grove (City), Cal/EPA's Office of Environmental Health Hazard Assessment (OEHHA), and consulting hydrologists have teamed together to study the potential environmental benefits and/or risks associated with the use of dry wells as a low impact development (LID) practice. The project is located within the Laguna Creek and Grant Line watersheds in Elk Grove, California.

The purpose of the project is to determine whether dry wells, in concert with other LID practices, are a cost-effective way to infiltrate stormwater, alleviate localized flooding, and recharge the aquifer without adversely affecting groundwater quality. Two sites with different surrounding land uses have been selected for the study as depicted in Exhibit 1. Site 1 is a residential neighborhood whose stormwater drains into a large water quality basin while Site 2 is a commercial/light industrial area with a large parking lot.

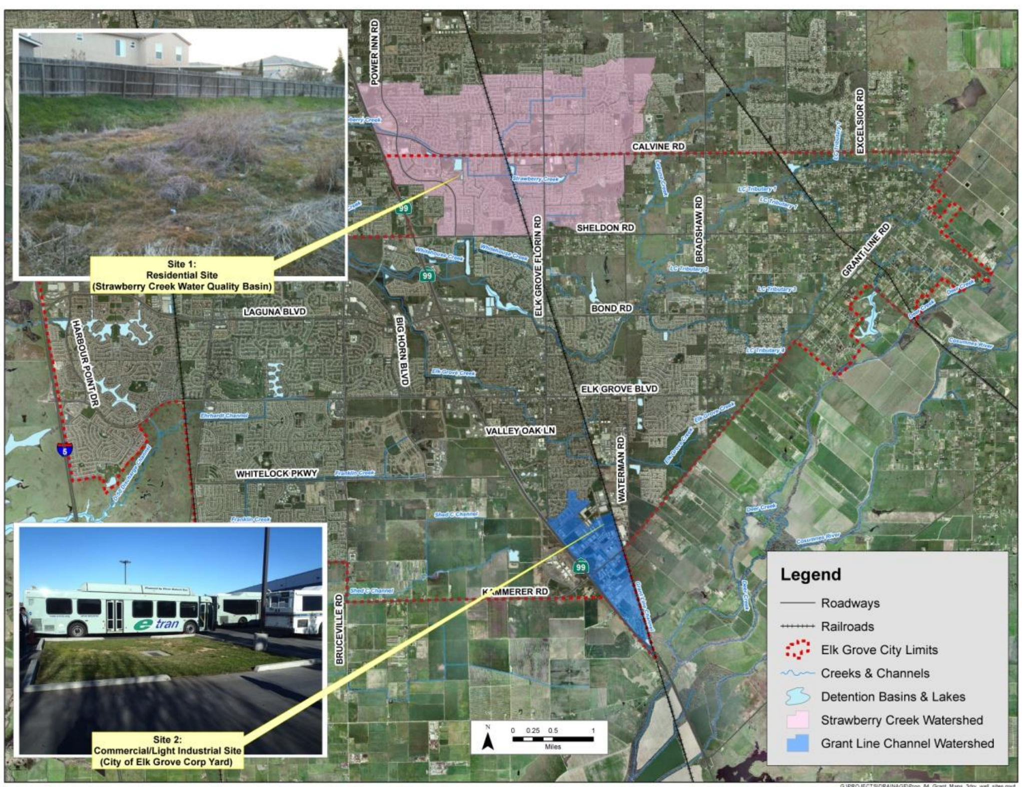

Exhibit 1: Location Map

The project involves a combination of reviewing existing research on dry wells and their effects on groundwater quality as well as conducting new research at the identified two locations with different land uses. The project will design and construct one dry well system with a groundwater monitoring well network. The dry well system is a treatment train of three features: 1) a vegetated pre-treatment area that will infiltrate and/or slow and filter sediment out of stormwater runoff, 2) a sedimentation well that permits particles and associated pollutants to settle, and 3) the dry well with additional filtration through sand and rock.

At each site, three groundwater monitoring wells will be installed: one up-gradient and two down-gradient of the dry well system to facilitate the assessment of the introduction of contaminants through the dry well. The upgradient well will provide information on the baseline water quality while the two downgradient wells will assess the affects, if any, of the dry well on downgradient groundwater quality. One downgradient vadose zone well will also be installed within 20 feet downgradient of the dry well as an aide to trace the movement of contaminants that pass through the dry well.

Monitoring of total suspended sediment and pyrethroid concentrations will be measured at the entrance to the vegetated area and just prior to entering the dry well in order to determine the effectiveness of the pre-treatment features at reducing two common urban contaminants: excess sediment and pyrethroids. Stormwater and groundwater samples will be analyzed for organic and inorganic contaminants commonly found in stormwater, including pesticides, metals, and volatile/semi-volatile organics. Samples from both wet and dry seasons will be compared to assess changes in groundwater quality.

Results from the project will be posted on a project's website, along with progress reports, a literature review of scientific and government reports, presentations, factsheets, a lessons learned document, a draft scientific paper, and other information relevant to the project. In addition to posting information on the project's website, this information will be widely distributed through education and outreach efforts at local and regional conferences and meetings of stakeholders' organizations. Outreach efforts will be targeted to interested stakeholders with the goal of sustaining the monitoring effort beyond the term of the grant.

The project will provide valuable information which can be used by local, regional, and State agencies to help fill the gaps in the knowledge and understanding about the appropriate use of dry wells in urban watersheds. It will also assess the potential for the use of dry wells as a stormwater management tool for future improvement projects in Elk Grove.

C. <u>Problem Statement</u>

In many areas throughout California, the use of LID practices is challenging due to poor infiltrative capabilities associated with clay soils. Dry wells offer a solution to this problem because they allow runoff to bypass the upper layers of clay, thus avoiding a major obstacle to infiltration. In neighboring states such as Arizona and Oregon, dry wells are used extensively as stormwater management tools. However, in California, they are used infrequently and with caution due to the concern that they provide a conduit for contaminants to enter the groundwater.

The basis for this concern is that dry wells allow stormwater to bypass much of the natural filtration and degradation of contaminants that occurs in the upper, aerobic units of the soil, allowing pollutants to pass directly into the deeper, vadose zone. Although two studies conducted in California suggest the risk of groundwater contamination is minimal, in many cases regulators and stormwater/groundwater managers have been reluctant to use or permit these types of wells. In addition, stormwater runoff that drains into local creeks may cause degradation of water quality and damages aquatic habitat and LID practices could help to minimize this problem. Therefore, the purpose of this study is to help fill in data gaps, quantify the risk of groundwater contamination, and investigate the effectiveness of vegetated pre-treatment and natural attenuation through a systematic, field-based investigation.

i. Identify or Characterize Baseline Data

Baseline data has not been collected on either stormwater or groundwater at the two study sites. However, receiving water in both Elk Grove Creek and Laguna Creek has been monitored for over five years. This monitoring was performed as part of the Sacramento Stormwater Quality Partnership's requirements under their National Pollutant Discharge Elimination System (NPDES) permit. Appendix 3 of the project's Quality Assurance Project Plan (QAPP) contains a summary of key findings from these sites. Briefly, the key contaminants that exceeded a health protective standard were bacteria and selected metals. In addition, combustion by-products such as polycyclic aromatic hydrocarbons, pesticides, and semi-volatile organics were detected, but levels did not exceed any regulatory value such as the Maximum Contaminant Level (MCL).

ii. Identify Pollution Source Categories

The pollution source are linked to two different land uses: a commercial/ light industrial property and a residential neighborhood. The specific pollutants that will be monitored are typically found in urban runoff and have been detected in monitoring performed by the Sacramento Stormwater Quality Partnership. Anticipated contaminants are as follows:

- Commercial/Light Industrial: Oil and grease, volatile and semi-volatile PAHs, pyrogenic PAHs.
- Residential: Pyrethroid pesticides, herbicides such as 2,4-D, nutrients (nitrogen and phosphate), possibly oil and grease.

iii. Identify and Describe Current Restoration Activities; BMPS; Load Reduction Activities; Prevention Activities.

Current Restoration Activities: The existing restoration conditions at the two sites are as follows:

Residential: The residential site has an existing water quality detention basin with existing vegetation.
Commercial/Light Industrial: The commercial/light industrial site has a grassy area surrounding the drainage inlet.

Proposed Restoration Activities/Prevention: The goal of this project is to test the usefulness and safety of including dry wells with pre-treatment features in the LID toolbox. The intention of the LID practices is to prevent harm to the environmental that is associated with the hydrologic alterations caused by urbanization. Each study site will be modified with pre-treatment features (i.e. grassy swales, soil amendments and sedimentation well) specifically designed to prevent contaminants from entering the dry well and ultimately the aquifer. If results of this project demonstrate that dry wells can be safely used, then the wider use of dry well systems could help prevent damage to aquatic resources and reduce localized flooding.

iv. <u>Describe the Manner in which the Proposed Best Management Practices or Management Measures will be Implemented.</u>

The best management practices for this project will be implemented through the design of the vegetated bioretention feature, sedimentation well, and the dry wells. Two types of vegetated pre-treatment will be used. At the residential site, a pre-existing water quality basin will pre-treat stormwater while at the commercial/industrial site, a swale will serve the same role. The pre-treatment feature at both sites will meet the minimum 7-minute contact time recommended for storing and filtering stormwater. In addition, the swale and water quality basin will reduce peak discharge rates and total runoff by using soil amendments to increase infiltration. The second stage of pre-treatment, the sedimentation well, will trap and filter out additional sediment before runoff is discharged into the dry well. The dry well itself has been designed to capture any remaining suspended solids by including both sand and gravel layers at the top of the well. While the dry well will be completed in a pervious geologic layer with a high infiltration rate, the alluvium will be underlain by a layer of clay soils that will cause water to move horizontally and will function as a final attenuation and treatment zone. Exhibit 2 depicts a diagram of the vegetated pre-treatment feature, the sedimentation well, and dry well that will be constructed for the project.

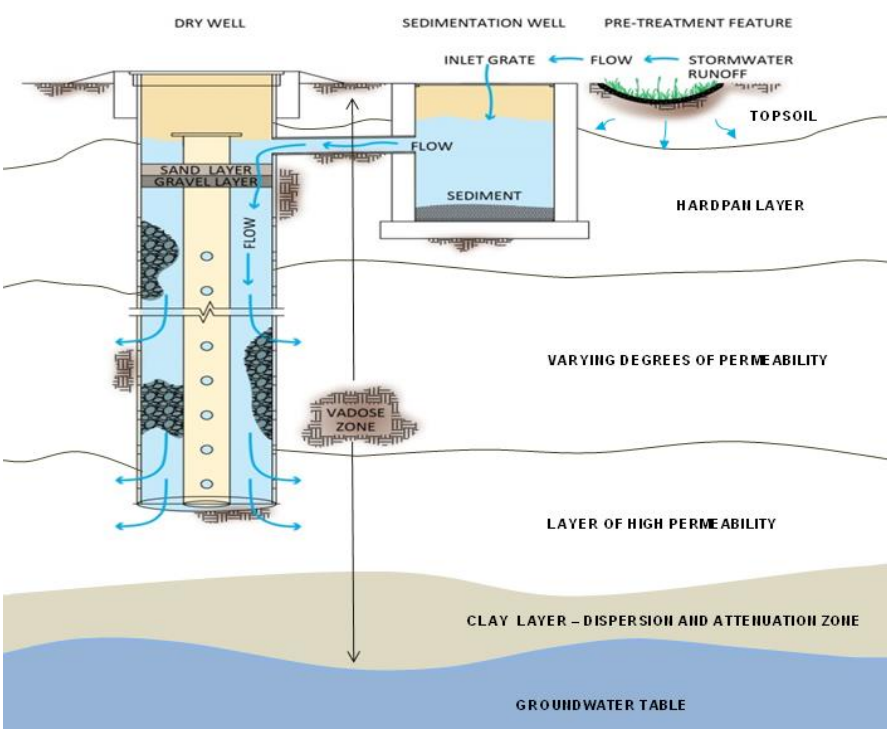

Exhibit 2. Diagram of Dry Well and Pre-treatment Features

v. Summarize How the Effectiveness of the Proposed Practices or Measures in Preventing or Reducing Pollution will be Determined.

Stormwater flow and quality, including total suspended solids, will be measured at the point of entry into the vegetated pre-treatment feature and just before entering the dry well. These measurements will quantify pollutant concentrations and test the effectiveness of the pre-treatment features at removing sediment. Furthermore, accumulation of sediment in the sedimentation well will be monitored, quantified, and removed as necessary. This will provide additional information on the effectiveness of the constructed facilities.

Groundwater data (levels and quality) will be collected via data loggers (level) and systematic manual monitoring using a network of four wells that was developed specifically for each site. One upgradient groundwater well, placed at an appropriate distance from the dry well to ensure the surrounding groundwater is not influenced by dry well releases and will report on background groundwater quality. One vadose zone well and two downgradient groundwater monitoring wells will be constructed approximately 10 and 100 feet, respectively, from the dry well to facilitate the evaluation of natural attenuation and transport of any contaminants that have passed through the dry well system (pre-treatment features and dry well). Tracer tests will be performed to evaluate the monitoring facilities and quantify any uncertainty related to the movement of contaminants in the subsurface. This work will build on existing information from studies conducted in Modesto, Los Angeles, and Portland.

vi. Determine "Changes in Flow Pattern" in Affected Water Bodies.

N/A. The project will not determine "changes in flow patterns" in the affected water bodies. The study does not involve work in any natural waterways.

vii. Determine Economic Benefits of Implementing the Project.

Dry well systems, as with all other LID features, reduce the need for the extensive drainage network of pipes that has characterized stormwater management practices. They will not eliminate the need for drainage infrastructure to manage large storm events, however, dry well systems can reduce costs associated with managing smaller (<10 year events) storms by minimizing the number and size of pipes and reducing the footprint of the BMP. Detention basins, and especially flow duration control basins, are usually large and many acres in size. In contrast, dry well systems use a very small amount of land and therefore, provide a significant cost savings and economic benefit. Dry well systems can also help manage the need for retrofitting of aging drainage infrastructure, particularly in communities in combined sewer/stormwater systems. By reducing the pressure on these older multi-purpose systems, dry well systems can help to reduce the demands on these systems, thus saving costly infrastructure fixes. Lastly, many communities in California are dealing with increasing populations and a falling water table. Future sources of drinking water are in jeopardy. This is especially true in many disadvantaged communities in the Central Valley and along the Central Coast. Dry wells are an inexpensive way to recharge the aquifer by using stormwater as a resource. Currently, many communities in California are exploring this option due to the favorable cost-benefit ratio.

D. Project Activities or Tasks:

Task 1. Project Management

1.1 Provide all technical and administrative services as needed for Agreement completion; monitor, supervise, and review all work performed; and coordinate budgeting and scheduling to ensure the Agreement is completed within budget, on schedule, and in accordance with the approved procedure, applicable laws, and regulations.

Task 2. Technical Advisory Committee (TAC)

2.1 Create, coordinate, and convene a TAC. Ensure that a representative from the Regional Water Board and/or State Water Board's Division of Water Quality is invited to be involved in the TAC.

2.2 Determine the roles and responsibilities the TAC members. Submit the final list of the TAC members, their roles and responsibilities.

Task 3. Final Site Selection and Monitoring Study Design

3.1 Conduct initial subsurface investigation borings, including a minimum of four (4) boreholes (monitoring wells) at a minimum of two (2) separate sites, to verify site suitability. Record and complete soil boring logs for monitoring wells.

3.2 Prepare dry well designs based on the subsurface investigation boring results and make field adjustment, as needed.

3.3 Assess existing pre-treatment (e.g., vegetative swales, filter strips, etc.) and prepare additional pre-treatment designs, as needed, at each site.

3.4 Design hydrologic and water quality monitoring facilities for each site.

3.5 Design groundwater quality monitoring wells for each site taking into account the site geology and groundwater gradients.

3.6 Submit the designs in items 3.2, 3.3, 3.4 and 3.5 to the TAC for review and feedback.

Task 4. Monitoring Wells and Dry Well Installation

4.1 Prepare specifications and bid documents to select contractor(s) to install a minimum of three groundwater monitoring wells, one vadose zone well, one dry well, one sedimentation well, and one vegetated pre-treatment feature at each site, based upon the site-specific designs.

4.2 Install a minimum of three groundwater monitoring wells, one vadose zone well, one dry well, one sedimentation well, and one vegetated pre-treatment feature at each site. Record and complete soil sample logs for dry wells.

Task 5. Stormwater Quality Monitoring

5.1 Review the preliminary plan for surface water monitoring and make edits to the Monitoring Plan (MP), as necessary, based upon the sampling results obtained from previous sampling activities.

5.2 Submit the MP to the TAC for review and feedback. Edit the MP, as necessary, based on TAC feedback.

5.3 Collect and analyze the surface water samples in accordance with the MP. The list of analytes could be modified based on results of the first year's collections.

Task 6. Groundwater Quality Monitoring

6.1 Collect groundwater quality samples from the groundwater monitoring wells completed in the vadose zone and water table at each location approximately four times per year for two consecutive years. The sample collection and analysis will follow the procedures described in the approved MP and Quality Assurance and Project Plan (QAPP) (or an equivalent document).

Task 7. Data Analysis and Interpretation

7.1 Analyze groundwater and surface water quality sample results using appropriate statistical methods.

7.2 Interpret the results, along with geologic data, to evaluate the efficacy of the dry well at infiltrating stormwater into the aquifer and determine/evaluate if the aquifer is impacted in a negative way by infiltration. Assess the potential for deployment of dry wells for as a stormwater management tool future Grantee development or improvements.

7.3 Review and discuss the results and interpretations from Item 7.2 with the TAC.

Task 8. Education, Outreach and Organization Capacity Building

8.1 Present results at a minimum of three stormwater and groundwater meetings to share information gathered from the project to TAC members, NPDES permittees, and other interested parties.

8.2 Prepare a minimum of two factsheets documenting findings of the project, regulatory infrastructure surrounding UIC use, and other topics as deemed appropriate by the TAC and Project Team.

8.3 Complete a literature review of scientific and government reports related to dry well use.

8.4 Complete a draft scientific paper and present the paper at a minimum of one professional meeting. Provide the draft scientific paper to the appropriate TAC members for peer review.

8.5 Provide a lessons learned document for feasibility analysis, site selection, design and construction of the dry well systems and associated monitoring network, suggested sampling, and monitoring regimen.

8.6 Work with regional stakeholders to establish a consortium of stormwater and groundwater management agencies willing to discuss methods to sustain the dry well and groundwater monitoring effort beyond the four (4) year period of the project.

Task 9. Project Assessment and Reporting

9.1 Assess the project after the first sampling season, at the midway point, and four years into the grant.

E. Category of Project Activities or Tasks

Task		**Category**
1	Project Management	Planning, Research, Monitoring, and Assessment
2	Technical Advisory Committee (TAC)	Planning, Research, Monitoring, and Assessment
3	Final Site Selection and Monitoring Study Design	Planning, Research, Monitoring, and Assessment
4	Monitoring Well and Dry Well Installation	Planning, Research, Monitoring, and Assessment
5	Stormwater Quality Monitoring	Planning, Research, Monitoring, and Assessment
6	Groundwater Quality Monitoring	Planning, Research, Monitoring, and Assessment
7	Data Analysis and Interpretation	Planning, Research, Monitoring, and Assessment
8	Education, Outreach and Organization Capacity Building	Education, Outreach and Capacity Building
9	Project Assessment and Reporting	Planning, Research, Monitoring, and Assessment

II. Project Goals and Desired Outcomes

The primary project goals are to:

- Assess the potential for contamination of groundwater associated with the use of dry wells with pre-treatment features for infiltrating stormwater runoff from different land uses.

- Assess the ability of the various pre-treatment features to remove suspended solids and contaminants from stormwater.

- Provide education and outreach on the use, benefits, and limitations of dry wells with pre-treatment features.

The desired project outcomes are to:

- The quality of groundwater will not be degraded as a result of infiltrating stormwater through dry well systems.

- Development of a design for vegetated pre-treatment, sedimentation wells, and dry wells that removes suspended solids and contaminants from stormwater.

- An assessment of the effectiveness of pre-treatment features at removing pollutant-laden sediments.

- Development of a design for vegetated pre-treatment, sedimentation wells, and dry wells that minimizes clogging and maintenance.

- Improved knowledge among scientists, engineers, stormwater/groundwater managers, and other interested stakeholders of dry wells with pre-treatment features and their effects on groundwater quality.

- Development of a list of stakeholders interested in the project.

- Development of a lessons learned white paper that summarizes the project outcomes.

- Cultivation of working relationships with stakeholders to encourage future monitoring after the term of the grant expires.

- Project results that can be used by regulators and decision makers for the development of guidelines for dry well systems in California.

III. Project Performance Measures Tables

Planning, Research, Monitoring, and Assessment

Project Goals	Desired Outcomes	Output Indicators	Outcome Indicators	Measurement Tools and Methods	Targets
1. Assess the potential for contamination of groundwater associated with the use of dry wells with pre-treatment features for infiltrating stormwater runoff from different land uses.	1. The quality of groundwater will not be degraded as a result of infiltrating stormwater through dry well systems.	1. Data on pollutant concentrations for stormwater and groundwater will be produced, as defined in the project's QAPP.	1. Infiltrate stormwater to recharge the aquifer while maintaining the concentration of pollutants below the California Maximum Contaminant levels for all anthropogenic contaminants.	1. **Tools:** Analytical instrumentation (e.g. HPLC, GC/MS), flow meters, monitoring wells, and pressure transducers. **Methods**: Established methods for analysis of contaminants and conventional water quality parameters, as defined in the project's QAPP.	1. Concentrations of contaminants in the aquifer will remain below the California Maximum Contaminant Levels for all anthropogenic contaminants. 2. There will be no statistically significant difference in the groundwater quality in the upgradient and downgradient monitoring wells (using Mann-Kendall statistic).
2. Assess the ability of the various pre-treatment features to remove suspended solids and contaminants from stormwater.	1. Development of a design for vegetated pre-treatment, structural pre-treatment sedimentation wells, and dry well that remove suspended	1. Dry wells with sedimentation wells and pre-treatment constructed according to approved design/ specifications at two sites .	1.Pollutant levels significantly reduced after pre-treatment of stormwater. 2. Document required maintenance of vegetated pre-treatment and	1. **Tools**: Analytical instrumentation (e.g. HPLC, GS/MS, etc.). **2. Methods:** Measurement of total suspended solids using established methods as described in	1. Statistically significant reduction in TSS and pyrethroids in stormwater by the pre-treatment feature (using Mann Whitney U

Project Goals	Desired Outcomes	Output Indicators	Outcome Indicators	Measurement Tools and Methods	Targets
	solids and contaminants to the maximum degree practical. 2. An assessment of the effectiveness of pre-treatment features at removing pollutant-laden sediments in stormwater. 3. Development of a design for vegetated pre-treatment, sedimentation wells and dry wells to minimize clogging and maintenance.	2. Data on total suspended solids and pyrethroids collected at the entrance and terminal end of the pre-treatment features at each site. 3. Analysis of data related to clogging of system with sediment and frequency of maintenance for sedimentation well and dry well.	sedimentation well and dry well.	project's QAPP. Removal of sediment from system.	test). 2. Removal of solids from sedimentation well not required more than once yearly.

Education, Outreach and Capacity Building

Project Goals	Desired Outcomes	Output Indicators	Outcome Indicators	Measurement Tools and Methods	Targets
1. Provide education and outreach on the use, benefits, and limitations of dry wells with pre-treatment features.	1. Improved knowledge among scientists, engineers, stormwater/ groundwater managers, and other interested stakeholders of dry wells with pre-treatment features and their effects on groundwater quality. 2. Development of a list of interested stakeholders in the project. 3. Development of a lessons learned white paper that summarizes the project outcomes. 4. Cultivation of working relationships with stakeholders to encourage future monitoring after the term of the grant expires. 5. Project results that	1. Two factsheets produced: (a) describing the use of dry wells, LID practices and the regulatory environment for dry wells in California, and (b) summarizing the results of the project (i.e., summarize stormwater/groundw ater monitoring results and potential risk to drinking water quality). 2. A literature review of scientific and government reports on the relationship between dry well systems and groundwater quality. 3. Document describing lessons learned summarizing key findings of the project. 4. Post on project	1. Improved understanding among engineers, scientists, managers, and stakeholders of the science and practices of using dry wells with pre-treatment features. 2. Interest among stakeholders to continue monitoring past the term of project. 3. Use of project results in development of guidelines and regulations on use of dry wells in California.	**Tools/Methods:** 1. Visits to project website. 2. Factsheets downloaded and distributed. 3. Literature review downloads. 4. Lesson learned document downloads. 5. Number of names on list of interested stakeholders. 6. Number of people attending presentations at meetings and conferences. 7. Meetings of stakeholders' working group with plans to extend monitoring efforts for existing wells. 8. Preparation of local or statewide guidance on dry well design/use.	1. 1,000 visits to project website. 2. 500 copies of each factsheet distributed and/or downloaded. 3. 500 downloads of literature review. 4. 500 downloads of lessons learned document. 5. List of > 100 interested stakeholders on project. 6. Presentations given to a minimum of 2000 people in target audience (scientists, engineers, and stormwater/ groundwater managers). 7. One or more meetings with the stakeholders'

Project Goals	Desired Outcomes	Output Indicators	Outcome Indicators	Measurement Tools and Methods	Targets
	can be used by regulators and decision makers for the development of guidelines for dry well systems in California.	website factsheets, literature review, lessons learned, and general information regarding the project. 5. List of interested stakeholders. 6. Presentations and poster sessions at meetings and conferences. 7. Multiple meetings with stakeholders. 8. Project results provided to decision makers and policy regulators.			working group. 8. One or more guidance documents on dry well design/use that are produced by local, regional, or State regulatory agencies.