

SMC California LID Evaluation & Analysis Network (SMC CLEAN)

Work Plan

Final

August 10, 2017

Introduction

This document constitutes the Work Plan for the Southern California Stormwater Monitoring Coalition California Evaluation and Analysis Network Project (SMC CLEAN). The Work Plan was developed by the SMC CLEAN Consulting Team with input from the SMC CLEAN Technical Advisory Committee (TAC). The Work Plan is designed to guide the implementation of the five tasks of the SMC CLEAN Project and identifies how each task will be performed.

Project Background

In 2006 the SMC, led by Dr. Matt Yeager, in collaboration with the California Stormwater Quality Association (CASQA) submitted a State Proposition 40 grant proposal for the LID Guidance and Training Project. The project grant submittal was successful and \$600,000 of funding was awarded to complete the following Tasks 1) Compile and Evaluate Existing Information on LID BMP Effectiveness; 2) Coordinate with other Stakeholders; 3) Conduct Field Monitoring of LID Features; 4) Develop an LID Technical Manual with results of field monitoring. A technical advisory committee (TAC) was formed to guide the LID Project, which included representatives from the six coastal southern California Counties, the Santa Ana Regional Water Board, the development community, and other stakeholders. The TAC met over half a dozen times and provided significant comment on the development of the Southern California LID Manual. The duration of this initial phase of the project was from 2006 -2010, which culminated with posting of the Southern California LID Manual on the California LID Portal (www.californialid.org) in April of 2010.

In 2011 Dr. Yeager continued project coordination with the SMC to develop a revised approach to evaluate LID BMP effectiveness; an approach that includes water quality monitoring, and extensive coordination and data collection from other LID implementation projects in southern California. In 2011 and 2012 a draft revised Scope of Work was developed. The revised scope included updates to the monitoring and LID BMP effectiveness evaluation tasks for the Project, to coordinate completion of revised Scope tasks, and coordinate with CASQA and stakeholders to update the LID Manual as appropriate, based on effectiveness results and to manage the project progress in coordination with the SMC.

From 2013 to 2014, Dr. Yeager, with the assistance from Daniel Apt and Scott Taylor of RBF, worked with the SMC members to develop a Scope of Work (SOW) for this project, funded from remaining SMC funds allocated to the overall project. This project was discussed at length at SMC quarterly meetings, progressing from a project outline, to a draft SOW, to a final SOW which was reviewed and approved by the SMC in the fall of 2014. To support development of the SOW, a questionnaire was distributed to the SMC members and Municipal Separate Storm Sewer System (MS4) permittees to determine if local jurisdictions required effectiveness monitoring for LID BMP installations. Very few jurisdictions were found to require monitoring for LID BMPs and such monitoring was mostly limited to grant funded LID projects. Therefore, a key feature of this project is the development of a standard methodology for monitoring LID BMPs, so future monitoring data will be more comparable.

Project Overview

SMC CLEAN is designed to: understand the effectiveness of LID BMPs through the development of specific LID research questions; research existing LID monitoring data; develop a standard methodology for monitoring LID BMPs including coordination with other SMC projects concerned with monitoring methodology; coordinate ongoing LID monitoring; implement LID monitoring through the standard methodology and monitoring protocol developed; compile and analyze LID monitoring data; and develop recommendations and conduct a review and update of the Southern California LID Manual. The primary purpose of SMC CLEAN is to understand the effectiveness of various LID BMPs with different designs and configurations so that design, construction, maintenance, and monitoring recommendations can be made in an updated LID Manual to ensure that LID BMPs are implemented in the most effective manner.

As LID and green infrastructure (GI) become ever more prevalent in the stormwater management world a comprehensive and quantitative understanding of the effectiveness of LID and GI becomes more important. It has been almost 10 years since LID implementation requirements first started appearing in MS4 Permits in California. The emphasis on LID was focused in the Land Development sections of the MS4 Permits where permittees must ensure that new and redevelopment projects implement LID to comply with volume-based retention standards instead of implementing conventional stormwater quality treatment devices. LID site design and planning principles were also integrated into the MS4 permits. MS4 permits now require the development of LID ordinances requiring implementation of LID and a review and update of municipal codes and general plans to remove LID implementation barriers and to encourage LID implementation. Most current MS4 permits allow permittees to develop watershed management plans which must ensure that discharges will achieve Water Quality Based Effluent Limits and not cause or contribute to exceedances of receiving water limitations. As these plans have been developed, LID in the form of GI has been identified as a significant piece of the compliance schema. Due to constraints of land availability and the high cost of land acquisition, (GI) is identified in most of the watershed management plans as a primary watershed control measure. As LID and GI have become more prevalent in the stormwater quality regulatory schema, and serve as a fundamental tool for watershed and receiving water protection, understanding their true effectiveness becomes ever more relevant.

A main goal of SMC CLEAN is to coordinate with others evaluating the effectiveness of LID and those performing LID monitoring. The study will coordinate with partners to research and evaluate LID monitoring data. The types of LID BMPs to be evaluated and monitored will be identified. SMC CLEAN will perform analysis of this data and the aim is that the project will eventually serve as a clearinghouse and coordination network for LID monitoring effectiveness information for California.

There are however many challenges with LID monitoring and understanding the true effectiveness of LID BMPs. Many LID features were not designed to be monitored and so accurately obtaining data and understanding the effectiveness of the LID BMPs can be challenging. Improved standard LID BMP designs are needed that facilitate monitoring by incorporating features that provide access for flow instrumentation and influent/effluent sample collection. Existing LID monitoring efforts do not use consistent monitoring protocols or test for consistent suites of analytes. Development of a consistent

monitoring protocol with a suggested standard set of analytes will support the development of LID effectiveness data that can be properly compared. The variety of design configurations for the same LID BMPs also poses a challenge for LID monitoring, however understanding how these design configurations affect BMP performance will be critical moving forward. Proper construction of LID designs is also an issue that needs to be considered. Finally, maintenance and its inconsistent implementation also poses a challenge for LID monitoring but understanding how maintenance of LID BMPs affects performance will be a critical piece to understanding the effectiveness of LID BMPs.

The following tasks have been developed to accomplish the primary purpose of the project of understanding of the effectiveness of LID BMPs. The tasks also consider that there is a significant amount of knowledge and experience in California regarding LID, that there are many partners evaluating the effectiveness of LID, that there is a significant amount of existing LID data available, as well as the LID monitoring challenges needs as identified above.

SMC CLEAN Mission, Goals, and Objectives

Discussions with the SMC CLEAN Technical Advisory Committee identified two primary needs associated with the project. The first is a short term need for a quantification of LID performance in Southern California, needed for use in providing empirical data to calibrate estimates for compliance measures such as the recently developed watershed programs (i.e. EWMPs, WQIPs, etc.) and their associated watershed/water quality models (i.e. RAA, RAS). The second is more of a long term need to serve as collaboration entity and clearinghouse of LID monitoring data in order to obtain enough data to understand the effectiveness of various LID BMPs overtime and understand how the differences in design, construction, and maintenance affect their performance. The following mission statement is intended to guide the SMC CLEAN project to address the short and long-term goals:

The mission of SMC CLEAN is to develop a thorough understanding of the effectiveness of LID BMPs in California both in the short term for use in calibration of watershed programs and the long term for modification of LID design, construction, and maintenance, through coordination with project partners and others performing LID monitoring and serving as a clearing house for LID monitoring information, developing targeted LID research questions and performing targeted LID monitoring based on these questions, analysis of LID monitoring data, and recommendations for the design, construction, maintenance, and monitoring of LID in updates to the Southern California LID Manual to ensure that LID BMPs are implemented in the most effective manner.

The mission statement above was developed to better guide the SMC CLEAN project and based on the mission statement the following goals and associated objectives were developed. These goals are also related to specific tasks in the Work Plan that are identified below and provide more specifics. The goals and objectives are identified here as an expansion of the mission statement and so a snapshot of the project can be referenced in one location.

Goal #1: Development and Ongoing Facilitation of a Technical Advisory Committee to assist in accomplishing the SMC CLEAN Mission & Goals.

- Objective #1A: Identify Potential Research Questions
- Objective #1B: Develop Work Plan
- Objective #1C: Develop branding for the project.
- Objective #1D: Ongoing coordination with consulting team and review comment of project products
- Objective #1E: Ongoing identification of project partners

Goal #2: Provide Ongoing Collaboration with Project Partners and Others Performing LID Monitoring and Serving as a Clearing House for LID Monitoring Information.

- Objective #2A: Ongoing collaboration with Project Partners to understand LID monitoring efforts, lessons learned.
- Objective #2B: Ongoing collaboration with Project Partners on potential future funding (i.e. grants) to make the SMC CLEAN project more robust and maximize the current funds allocated to the project.
- Objective #2C: Development of SMC CLEAN Website for Collaboration of Project Partners and a platform for the development of an LID Monitoring Clearing House
- Objective #2D: Evaluate development of an SMC CLEAN Online LID Data Submittal Tool/Clearing House

Goal #3: Development of Targeted LID Research Questions

- Objective #3A: Evaluate Current LID Monitoring Data & LID Research
- Objective #3B: Identify Gaps in LID Monitoring Data
- Objective #3C: Identify Target LID Research Questions to answer short term need for use in calibration of watershed programs
- Objective #3D: Identify Target LID Research Questions to answer long term for modification of LID design, construction, and maintenance

Goal #4: Development of LID Monitoring Plan Elements

- Objective #4A: Development of Standard LID Project Data-Information List
- Objective #4B: Development of Standard LID/GI Monitoring Protocol
- Objective #4C: Development of Data Sharing Protocol
- Objective #4D: Development of SMC CLEAN Database
- Objective #4E: Develop LID Operations Conceptual Model
- Objective #4F: Develop SMC CLEAN Monitoring Plan based on targeted LID research questions for short term and long term needs.

Goal #5: Perform Targeted LID Monitoring

- Objective #5A: Implement targeted LID monitoring to answer short term needs
- Objective #5B: Implement targeted LID monitoring to answer long term needs

Goal #6: Analyze LID Monitoring Data Collected

- Objective #6A: Analyze monitoring data to answer short term needs
- Objective #6B: Analyze monitoring data to answer long term needs

Goal #7: Make Recommendations & Update the Southern California LID Manual

- Objective #7A: Develop technical memorandum on bioretention/biofiltration performance for short term needs, for use in calibration of watershed programs and any associated recommendations for bioretention/biofiltration design, construction, maintenance, and monitoring.
- Objective #7B: Develop technical memorandum on bioretention/biofiltration performance and associated recommendations for long term needs for modification of bioretention/biofiltration design, construction, maintenance, and monitoring.
- Objective #7C: Develop Standard Bioretention/Biofiltration Monitoring Design Plans and Specifications.
- Objective #7D: Update the Southern California LID Manual to incorporate recommendations for bioretention/biofiltration design, construction, maintenance, and monitoring.
- Objective #7E: Development SMC CLEAN Phase 1 Project Report

Task 1 - Form and Coordinate a Project Technical Advisory Committee

Technical Advisory Committee

The purpose of the Technical Advisory Committee is to provide technical expertise and input in the development and implementation of the SMC CLEAN Work Plan. The make-up of the TAC includes MS4s, regulatory agencies, the environmental community, the development community, the academic community, industry, and other LID experts that are engaged in the implementation and monitoring of LID in California. The TAC represents a good cross section of those experts involved in LID in California and represents a significant amount of the LID knowledge and experience in California. The TAC will help to identify potential research questions (Objective #1A), provide input on the development of the Work Plan (Objective #1B), assist with developing branding for the SMC LID Effectiveness Study (Objective #1C), review and provide comments on the Consultant Team work products (Objective #1D), assist with identification of project partners (Objective #1E), provide input on the development of targeted research questions (Goal #3), and attend the TAC meetings.

The Consultant will formulate the TAC, schedule and facilitate TAC meetings, develop the Work Plan) and schedule, coordinate with the TAC regarding branding of the SMC CLEAN Project, develop a project website, and development of procedures for TAC review of draft Consultant products. The formulation of the TAC included a request to the funding agencies of the SMC to identify appropriate members of the TAC. The Consulting Team reached out to this list of people to identify their ability to serve on the TAC as well as an inquiry of other potential TAC members. The current roster of the TAC was a result of this process. It was agreed at the first TAC meeting that the schedule of TAC meetings will be quarterly. The primary location of the TAC Meetings will be at SCCWRP and the Consultant will schedule these meetings at least one meeting in advance.

Branding of the SMC CLEAN (Objective #1C) took place with TAC input with ideas being suggested by the Consulting Team. The result of the branding discussion at the February 25, 2016 TAC Meeting and the name of the project going forward was identified as SMC CLEAN – California LID Evaluation & Analysis Network. SMC CLEAN will be used by the Consultant for all project materials. The branding of SMC CLEAN will also be used in the development of the project website. The website will include project information and potentially a data submittal tool and data sharing site for LID monitoring data. The website will be a resource for TAC members and interested parties regarding LID monitoring. The Consultant Team will also develop a procedure for TAC review of draft Consultant products that will be developed in coordination with the TAC.

Objective 1A: Definition of Potential Research Questions

The first Objective #1A identified above is for in collaboration with the TAC is to work with the consulting team to define potential research questions which will help with Objective #1B of developing the Work Plan in that these questions will further define and articulate the details within the scope of work for the SMC CLEAN project that will provide the greatest benefit to the state of LID science in California. Specific research questions which have been identified by the TAC for potential exploration are as follows:

- What is the magnitude of pollution removal benefits of different forms of LID infrastructure?
- What is the mechanism by which the greatest benefit is achieved i.e. reduction in concentration or reduction in volume of stormwater?
- What is the expected range of performance for different pollutant / chemical / biological categories provided by LID treatment
- What are the benefits to different physical fractions during treatment? Is all benefit in the particulate form?
- How do different LID designs affect LID performance?
- How does the bioretention soil matrix affect bioretention performance?
- How does the plant pallet affect LID performance?
- How do the different climate zones in California affect LID performance?
- How does construction and construction sequencing affect LID performance?
- What are the effects of maintenance on LID performance?
- How do proprietary BMPs perform in the real-world setting compared to manufacturer specifications?

Through research and coordination performed by the SMC CLEAN Consulting Team and discussion of the potential research questions with the TAC with acknowledgement of the limited funding of the SMC CLEAN Project it was decided that the initial phase of the SMC CLEAN project would focus on bioretention/biofiltration as the most common LID BMP being implemented in Southern California. The initial approach of the SMC CLEAN project was more inclusive with data gathering and evaluation of other LID BMPs as well, and subsequent phases of the SMC CLEAN project, if funds are available, should implement the initial broader approach. The focus of the current phase of the SMC CLEAN project is to identify the pollutant removal and hydrologic effectiveness of bioretention/biofiltration BMPs. This

decision and focus helped to guide the identification of the targeted research questions (Goal #3) which is discussed under Task 2.

Task 1 Work Products

- TAC Collaboration & Facilitation
- Potential Research Questions
- Work Plan
- Project Branding
- Ongoing identification of Project Partners

Task 2 - Research Existing Data

The primary purpose of this task is to explore and evaluate the existing literature, resources, and data to identify the SMC CLEAN targeted research questions (Goal #3). The first step for this goal is to identify and evaluate existing LID monitoring data and existing LID research regarding LID BMP performance (Objective #3A). A key component of this is the identification and compilation of sources of existing LID BMP monitoring data from local municipalities and organizations conducting LID monitoring, literature, and existing database sources. This information will be used to make preliminary characterization of LID of performance. Based on these findings data gaps will be determined (Objective #3B) and priorities and targeted research questions are to be identified to guide future project activities. These data gaps will be presented to the TAC to guide the development of a strategy to acquire additional information to evaluate the targeted research questions in a qualitative and/or quantitative manner or revise project objectives and expectations. Options to be considered could include initiation of new projects by stakeholders, supplementation of existing studies by this project, or inclusion of literature data or national BMP database from sources outside of the southern California.

The most promising sources of data for this project will come from stakeholders who have past and ongoing LID monitoring / evaluation projects. Outreach will be conducted to potential partners to introduce the project and its goals with the intentions of gaining support of the project and approval to share data with the research team. Organizations holding LID monitoring data and willing to contribute to the study will be asked to share complete data sets. Important to evaluating the performance of LID BMPs is not just monitoring data but also the meta data (i.e. design plans, maintenance information) associated with an LID monitoring projects so a standard LID project data-information list (Objective #4A) will be developed. To ensure a consistent approach to monitoring an obtaining comparable data a standard LID/GI monitoring protocol (Objective #4B) will also be developed for use by all SMC CLEAN LID monitoring. A data sharing protocol (Objective #4C) will be developed for use in this initial phase as well as the active data collection phase of the project.

All information gained will be compiled into a database (Objective #4D) and examined to understand where overlap exists to make site to site comparisons for LID performance. This matrix will also allow for a comparison of available data to requirements necessary to address the identified targeted research questions. These will be divided as applicable to the targeted research questions to answer short term

need for use in calibration of watershed programs (Objective #3C) and the long-term questions for modification of LID design, construction, and maintenance (Objective #3D).

Data will first be characterized to estimate LID BMP performance and to develop a conceptual model of LID operations (Objective #4E) and a companion method for performance calculation. Performance calculations will be mass balance based and look to evaluate the TAC approved targeted LID research questions. Finally, based on the targeted research questions a monitoring plan (Objective #4F) will be developed for the SMC CLEAN Project.

Task 2 Work Products

- Research & Evaluate Current LID Monitoring Data
- LID Monitoring Database
- Identification of Gaps in LID Monitoring Data
- Targeted LID Research Questions to answer short term needs
- Targeted LID Research Questions to answer long term needs
- LID Operations Conceptual Model
- Standard LID Project Data-Information List
- Standard LID/GI Monitoring Protocol
- Data Sharing Protocol
- SMC CLEAN Monitoring Plan

SMC CLEAN Targeted LID Research Questions

Objective 3C: Identify Target LID Research Questions to answer short term need for use in calibration of watershed programs

To answer the short-term need for use in calibration of watershed programs the focus is two-fold, 1) verification and understanding the pollutant removal of LID systems and 2) understanding the hydrologic benefits of LID systems. Since bioretention systems (with and w/o underdrains) are the most commonly implemented LID BMPs in southern California, and with a need for a targeted focus of the initial phase of the SMC CLEAN it is proposed to focus on bioretention systems to answer this 2-part focus. Data availability is the primary criteria for the selection of BMPs to evaluate. Other LID data will be collected and evaluated to the extent feasible, however the focus of the initial phase of the SMC CLEAN project will be on bioretention systems. The watershed calibration will use information regarding bioretention systems to understand if 1) the assumed pollutant removal effectiveness associated with bioretention systems which is used to support water quality outcomes that are integrated into watershed plans is accurate and 2) are bioretention systems achieving one of the primary purposes of LID of mimicking pre-development (naturally occurring) hydrology for the drainage areas in which they are implemented. Watershed plans can then be modified to optimize bioretention size based on understanding of pollutant removal and hydrologic benefit. The questions below will be answered using data obtained from the SMC CLEAN project partners and with the data resulting from the monitoring to be performed as part of the project. With the 2-part focus of understanding the pollutant removal

and hydrologic benefits of bioretention systems the following specific research questions have been identified to accomplish Objective 3C:

- What are the pollution removal benefits of bioretention systems in Southern California?
 - Calculate/characterize the pollutant removal benefits of bioretention systems with underdrains
 - Calculate/characterize the pollutant removal benefits of bioretention systems without underdrains.
 - If possible, discern whether changes in the bioretention soil matrix (BSM) being implemented in Southern California affects performance across pollutants.
- What are the hydrologic benefits of bioretention systems in Southern California?
 - Calculate/characterize the volume reduction of bioretention systems with underdrains.
 - Calculate/characterize the flow duration effects of bioretention systems.
 - Compare/evaluate the measured hydrologic benefits (volume and flow attenuation) with bioretention system design parameters.

The answers to the questions above should be completed by June of 2018 (2 wet seasons).

Objective 3D: Identify Target LID Research Questions to answer long term for modification of LID design, construction, and maintenance

To answer the long-term need to understand how the differences in design, construction, and maintenance affect LID performance the focus will be on gathering existing data not currently accessible (i.e. Prop 84 data) including the meta data (design, construction, and maintenance information) and evaluate how these elements effect pollutant removal and hydrologic performance. The focus of the long-term effort will be bioretention systems and will incorporate to the extent feasible research and monitoring being performed by project partners and evaluation of the meta data to understand what elements affect performance. Data collected and evaluated to date suggest that it is possible and perhaps likely that even with access to data sets not currently available the data and information may not yet exist to adequately answer the questions identified below. If the data and information to answer these questions cannot be obtained within the constraints of this project, then the priority focus of Objective 3D will be to identify critical data needs and to provide clear guidelines for LID data collection so that more robust data are generated from projects in the future. With better datasets, these questions can be more and more effectively addressed going forward. ensure that the standard LID data/information is generated for future LID projects so that the questions below can be answered in the long-term. The following specific research questions have been identified to accomplish Objective 3D, however these questions will take a longer time frame to answer and the SMC CLEAN project will establish a standard LID monitoring protocol and identify the process studies that would need to be performed and identify those that have been performed and are being performed to quantify the kinetics of removal processes in bioretention systems, both helping to answer the following long-term questions:

- How do specific bioretention designs/configurations affect pollutant removal and hydrologic performance?

- What are the most common bioretention designs/configurations (isolate soil depth, aggregate depth, and underdrain configuration as the differentiating factors) being implemented in Southern California (identify maximum 3 configurations)?
- How do different bioretention plants affect pollutant removal and hydrologic performance?
 - How do systems with and without plants affect pollutant removal and hydrologic performance?
 - What are the effects of different plants as identified in studies by others?
- How does maintenance for bioretention systems affect pollutant removal and hydrologic performance?
 - What is the frequency of monitoring for an individual LID BMP that would need to be performed to identify the pollutant removal and hydrologic performance effects of maintenance of an individual LID BMP?
 - What type of maintenance records are needed to identify the pollutant removal and hydrologic performance effects of maintenance of an individual LID BMP?
 - Can preliminary conclusions be drawn regarding pollutant removal and hydrologic performance effects of maintenance with information currently being collected and if so what are they?
- What kind of impacts are evident from improper construction of bioretention systems and how are these impacts affecting pollutant removal and hydrologic performance?
 - What are the typical construction errors that are seen with bioretention systems?
 - What are the qualitative impacts affecting pollutant removal and hydrologic performance of the typical construction errors that are seen with bioretention systems?
- What Southern California specific factors (i.e. climate) effect affect pollutant removal and hydrologic performance in comparison to bioretention data from project partners outside of Southern California?
 - What are the translators for Southern California of performance from bioretention studies performed elsewhere?
 - How do bioretention design parameters (soil depth, aggregate depth, and underdrain configuration) affect the translators?

Task 3 - Implement initial monitoring procedures in a beta test phase

The purpose of this task is to conduct monitoring activities needed to support the project research questions. A prioritized list of monitoring options will be created to fill the identified data gaps using existing data and information from ongoing projects identified in Task 2 and guidance from the TAC. Prioritization will be based on filling data gaps related to the highest priority questions with the goal of having representative and reproducible results within study sites and across multiple study sites.

Due to limited funds, priority will be given to existing projects that can be augmented. Based on needs and opportunities these efforts could include monitoring additional events, sampling/testing for additional analytes, monitoring receiving waters at sites within a project, or resampling a previously monitored site. Options for supporting this work include providing in-kind labor, providing funding for

labor, or providing funds for lab / equipment. One other option could be the inclusion of additional stakeholder funding or other in-kind efforts from stakeholders.

Data will be collected according to the SMC CLEAN Monitoring Plan (Objective #4F) utilizing the Standard LID Project Data-Information List (Objective #4A) and the Standard LID/GI Monitoring Protocol (Objective #4B). The monitoring will include collecting data for the short-term needs (Objective #5A) and long term needs (Objective #5B).

Task 3 Work Products

- Implementation of targeted LID monitoring to answer short term needs
- Implementation of targeted LID monitoring to answer long term needs

Task 4 - Summarize all monitoring data, make recommendations, and update the LID Manual

Task 4A - Summarize and analyze of all monitoring data

The purpose of this task is to analyze and summarize existing and new monitoring data compiled during Tasks 2 and 3 and to answer the targeted research questions (Goal #3) based on the available information.

The SMC CLEAN database (Objective #4D) will be used for query of data for comparison to address the SMC CLEAN Targeted LID Research Questions (Goal #3). Using the database, inlet /outlet concentrations as well as volume reductions, pollution removal, and other pertinent meta data will be compared for the different bioretention/biofiltration systems monitored. Data from other LID BMPs besides bioretention/biofiltration systems that has been collected will also be evaluated to the extent possible. Event based data for each site will be calculated for end point metrics including percent removal and load reductions based on concentration and volume of influent vs. effluent. Effluent water quality will also be examined with respect to water quality objectives. These performance evaluations will be compared across the different bioretention/biofiltration systems monitored. Where possible other factors including design, environmental factors, rain event size vs design size, lifetime performance, and maintenance will be summarized. This information will be used to determine if qualitative or quantitative answers can be made for the SMC CLEAN Targeted LID Research Questions (Goal #3).and to identify management approaches which could be examined in future research.

As part of this analysis the LID conceptual model may need to be revised to identify how to control for/isolate each of the major study variables such as; design, soil matrix, construction vs installation, and BMP maintenance variability.

The SMC CLEAN Monitoring Plan (Objective #4F) and specific monitoring plans for each bioretention/biofiltration site and the design elements incorporated to facilitate monitoring will also be summarized. The site-specific monitoring plans will be examined to determine which elements are most effective at producing representative data and helping to answer management questions. The best elements will be used to make any modifications to the Standard LID/GI Monitoring Protocol (Objective

#4B). Also, an evaluation of event sample sets for statistical power will be conducted to determine recommended sampling events to characterize a site.

The analysis matrix of monitoring data to answer short term needs will accomplish Objective #6A, analysis of monitoring data to answer short term needs. Based on the compiled results, an expected performance range will be estimated for bioretention and biofiltration BMPs. This analysis matrix will provide real world empirical estimates of performance to guide the refinement of watershed models used to estimate pollutant concentrations in discharges, pollutant loads, and potentially to demonstrate compliance with permit requirements. These results will be compared to performance data from the literature and from BMP manufacturers in other areas.

The analysis matrix of monitoring data to answer long term needs will begin to accomplish Objective #6B, analysis matrix will be developed from monitoring data to answer long term needs. This will be a qualitative assessment of the performance of bioretention design elements and construction and maintenance. Here data will be examined to determine if measurable differences are observed from the data available. Performance under different antecedent conditions and performance over time will be examined. Longer term data needed to continue to characterize LID performance over time will be identified.

Task 4A Work Products

- Analysis matrix: monitoring data to answer short term needs
- Analysis matrix: monitoring data to answer long term needs

Task 4B - Make recommendations and update the LID Manual

The purpose of this task is to use the information and analysis developed in the other tasks to make recommendations and update the Southern California LID Manual. The first work product for this task is a technical memorandum on bioretention/biofiltration performance for short term needs, for use in calibration of watershed programs and any associated recommendations for bioretention/biofiltration design, construction, maintenance, and monitoring (Objective #7A). This memorandum will address the short term targeted LID research questions and will also provide any recommendations for the short term prior to the updates to the Southern California LID Manual being updated.

The second work product will be a technical memorandum on LID performance and associated recommendations for long term needs for modification of bioretention/biofiltration design, construction, maintenance, and monitoring (Objective #7B). This memorandum will identify any recommended modifications of bioretention/biofiltration design, construction, maintenance, and monitoring, based on data to date but will provide a document outside of the manual update, as it is likely that the long-term needs will not be able to be fully answered by this first phase of the SMC CLEAN Project.

The third work product will be the development of a set of Standard Bioretention/Biofiltration Monitoring Design Plans and Specifications (Objective #7C) for use by future bioretention/biofiltration monitoring projects. Information gathered through the implantation of the SMC CLEAN

bioretention/biofiltration monitoring and the CASQA Standard Bioretention/Biofiltration Design Plans and Specifications will be used for developing this deliverable.

The updates to the LID Manual (Objective #7D) will include identification of the sections of the manual that will need to be updated and the LID monitoring data required to support the changes. Any recommendations based the technical memorandums as well as any recommendations based on any data evaluation performed for other LID BMPs besides bioretention/biofiltration BMPs will be integrated into the manual. The SMC CLEAN Project will coordinate with CASQA to post the updated Manual to the California LID Portal. The recommendations and updates to the Southern California LID Manual are expected to include the following based on the information, data, and analysis to date:

- Bioretention/Biofiltration Monitoring
 - Standard LID Project Data-Information List (Objective #4A)
 - Standard LID/GI Monitoring Protocol (Objective #4B)
 - LID Operations Conceptual Model (Objective #4E)
 - Standard Bioretention/Biofiltration Monitoring Design Plans and Specifications (Objective #7C)
- Any Bioretention/Biofiltration design and soil matrix recommendations
 - Bioretention/Biofiltration BMP design considerations
 - Hydrologic modeling/calculations
 - Site specific considerations
 - Soil matrix configurations
- Bioretention/Biofiltration Construction/Installation recommendations
 - Construction/installation specifications
 - Protocol to ensure Bioretention/Biofiltration features are installed as designed, including all specified materials.
 - Documentation required before final approval.
 - LID inspection frequencies (Plans, final grading, during construction)
- LID BMP Maintenance recommendations
 - O&M plan preparation, timing and responsibilities
 - LID elements to be inspected and maintained
 - Use available maintenance documentation to develop a consistent approach.
- Update approval/recordation process

This task will also include the preparation of Project Report for Phase 1 of the SMC CLEAN Project (Objective #7E). The project report will be developed to summarize the completion of all of the tasks, document the recommendations of the study, and the updates to the Southern California LID Manual. The report will be reviewed by the TAC and changes will be based on TAC comments to finalize the report. Findings and recommendations of the report will also be linked to the SMC Research Agenda.

Task 4B Work Products

- Technical memorandum on LID performance for short term needs and any associated recommendations for LID design, construction, maintenance, and monitoring.

- Technical memorandum on LID performance and associated recommendations for long term needs for modification of LID design, construction, maintenance, and monitoring.
- Standard Bioretention/Biofiltration Monitoring Design Plans and Specifications
- Updates to the Southern California LID Manual to incorporate recommendations for LID design, construction, maintenance, and monitoring.
- SMC CLEAN Phase 1 Project Report

Task 5 - Ongoing Collaboration with Project Partners

The primary purpose of this task is to collaborate with the project partners and obtain LID monitoring information and in the future help to coordinate LID monitoring using the Standard LID Project Data-Information List (Objective #4A) and the Standard LID/GI Monitoring Protocol (Objective #4B).

Coordination will take place with the following project partners:

- Coordination with university project partners and identify opportunities for long-term collaboration.
- OCPW Glassel Campus LID Retrofit – Dr. Jian Peng
- RC Flood Control & Water Conservation District Campus LID Retrofit site
- UCCE site in Irvine (Darren Haver)
- UCI sites—Dr. Stanley Grant & Dr. Demerjian
- UCSD Scripps site-San Diego
- UCLA—Xavier Swamikannu and Institute of the Environment—internships
- Ballona Creek Bioretention Site/LMU – Dr. John Dorsey
- Council for Watershed Health
- City of Los Angeles
- CASQA
- Bay Area LID/Greenstreets Projects??
- Regional Boards
- SWRCB
- USEPA
- China Sponge City Initiative

Initial coordination with project partners will include identification of the LID with a focus on bioretention/biofiltration monitoring conducted or ongoing by the partner, identification of the LID data set available for analysis, and identification of future planned LID monitoring by the project partner. Coordination also includes obtaining design plans (as-builts) for the LID BMPs that are being monitored. Since the initial approach of the SMC CLEAN project was more inclusive with data gathering and evaluation of other LID BMPs besides bioretention/biofiltration systems data has been collected from project partners regarding LID BMPs besides bioretention/biofiltration systems as well. Coordination may also include a site visit to the LID BMPs that are being monitored. It is expected that the level of effort for the Project Partners will be minimized to providing data and information about the LID BMPs. Coordination will also include obtaining information about potential future project funding such as

grants as well as potentially teaming on grant pursuits (Objective 2B). Documentation of project coordination will be in the form of notes from each project partner coordination meeting and any site visits which will be provided to the TAC and interested parties. Project collaboration will also involve the development of the project website and platform for an LID monitoring clearing house and a place where LID monitoring project proponents can collaborate (Objective #2C). If feasible, due to locating funding for creation, an SMC CLEAN Online LID Data Submittal Tool/Clearing House (Objective #2D) will be developed. The SMC CLEAN Online LID Data Submittal Tool/Clearing House (Objective #2D) will be scoped out and funding will be sought for its development.

Task 5 Work Products

- Ongoing collaboration with Project Partners to understand LID monitoring efforts, lessons learned.
- Ongoing collaboration with Project Partners on potential future funding (i.e. grants)
- Development of SMC CLEAN Website for Collaboration of Project Partners and platform for the development of an LID/Data Submittal Tool Clearing House
- Scope and identification of potential funding sources for SMC CLEAN Online LID Data Submittal Tool/Clearing House
- SMC CLEAN Online LID Data Submittal Tool/Clearing House (If funding is located)