Southern California Stormwater Monitoring Coalition Five-Year Research Agenda 2019-2024

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Southern California Coastal Water Research Project

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The Southern California Stormwater Monitoring Coalition is indebted to the members of the Expert Panel who, through creativity and vision, created this five-year research agenda.

EXECUTIVE SUMMARY

For nearly two decades, the Southern California Stormwater Monitoring Coalition (SMC) has been working as a partnership to conduct the research necessary to improve regional stormwater management. Because the SMC's 15 members include both the regulated dischargers and the regulatory agencies that oversee them, all SMC projects are initiated and vetted collaboratively, ensuring project outcomes can be rapidly adopted into stormwater management, including into National Pollutant Discharge Elimination System (NPDES) permits. To date, the coalition has funded more than 27 research projects valued at $17 million, with half of the effort coming as leveraged non-member in-kind resources, underscoring the value of collaborative research.

Recognizing that collaboration is foundational to the SMC's enduring success, the original SMC master agreement was signed in 2000 and has been renewed three times – in 2009, 2015 and 2019 – providing the formal framework for the coalition's interactions and the ability to add a long-term research perspective to management needs. The newest master agreement, signed in October 2019 and spanning five years, calls for the development of a forward-looking research agenda that can guide the SMC's priorities and directions through 2024.

This document defines the SMC's 2019-2024 Research Agenda. It is intended to help shape and guide the SMC's collaborative research initiatives over the next five years and beyond. The Research Agenda provides a common framework for SMC members to evaluate potential projects and decide if, when, and how to move forward with them. As the SMC encounters opportunities to obtain grant funding and/or build off the research and monitoring programs run by individual SMC members and their co-permittees, the 2019-2024 Research Agenda can serve as a roadmap for making these decisions. The Research Agenda is intended to offer a menu of timely, managerially relevant SMC candidate projects that SMC members can choose from.

This research agenda was developed by an external panel of seven knowledge leaders in their respective disciplines (chemistry, ecology, microbiology, hydrology, best management practices [BMPs], monitoring, and information technology). Blended with this diverse array of outside experts were three local experts (a regulated municipality, a regulatory agency, and a non-governmental environmental advocacy organization). The panel met for three days (November 20-22, 2019) at the Southern California Coastal Water Research Project (SCCWRP). Panelists listened to testimony from SMC members about their research needs and priorities, then developed 64 project concepts. Next, panelists honed these concepts into a list of 24 priority projects organized into six thematic areas:

- **Microbiology and Human Health Risk (4 projects)**: These projects focus on improving the SMC's capability and capacity to quantify and protect human health, primarily during water-contact recreation. The projects are intended to help SMC members move away from their reliance on traditional fecal indicator bacteria (i.e., *Enterococcus*, *E. coli*, coliforms) – which offer limited and incomplete insights into health risks associated with water-contact recreation – and toward standardizing next-generation technologies that can help SMC members gain more relevant, actionable insights about human health risks to set relevant priorities for remediation and compliance.

- **BMP Monitoring, Implementation and Effectiveness (5 projects)**: These projects focus on filling fundamental, essential knowledge gaps in managers' understanding of

stormwater BMP design, monitoring and lifecycle performance. The projects are wide-ranging, from improving fundamental understanding of BMP mechanisms and processes that can inform BMP selection, design and standardization, to an integrated and coordinated regionwide monitoring of BMP installations that can help the SMC ascertain effectiveness and optimize maintenance strategies. The ultimate goal is to help managers get maximum bang for their BMP buck as they prepare to spend billions of dollars in the coming decades to implement and manage BMPs.

- **Innovative Technology and Science Communication (4 projects)**: These projects focus on turning data into information and insights that SMC members can use for management, modeling and reporting, as well as to improve data-sharing among SMC member agencies. The emphasis is on addressing key shortcomings and gaps in data collection and data analysis efforts, with the goal to gain more relevant, insightful information faster.

- **Expanding the Utility of Biomonitoring (4 projects)**: With biological monitoring becoming an increasingly insightful and foundational line of evidence for tracking ecosystem health, these projects focus on extracting more – and more managerially relevant – insights from biomonitoring to better understand stormwater impacts on receiving water quality. Projects range from diagnosing condition in the nonperennial streams (streams that do not flow all year) which comprise the majority of streams in southern California, to leveraging recent advances in DNA-based technology that identify the entire community of organisms in a stream (e.g., bacteria, plants, invertebrates, vertebrates) at less cost and in less time than it currently takes to measure just one assemblage.

- **Improving Stormwater Monitoring Effectiveness (5 projects)**: With many stormwater quality monitoring efforts years or even decades old, and scientific and management needs evolving rapidly, these projects are intended to revisit monitoring efforts by SMC member agencies to ensure they are optimally responsive, relevant, and useful to managers and other stakeholders. By evaluating existing SMC monitoring, continuing regionwide quality control initiatives, and developing recommendations for updates and upgrades to monitoring programs, the SMC will remain optimally positioned to address pressing management needs and priorities in the coming years.

- **Emerging Challenges (4 projects)**: These projects focus on improving the foundational understanding of up-and-coming issues which are likely to become front and center for SMC member agencies over the long term. These issues cover diverse areas, including trash, climate change, emerging pollutants, and water quality impacts from people experiencing homelessness. The issues largely fall outside current regulatory paradigms, and little progress has been made to date, underscoring the critical importance of getting a head start on these issues before they become front and center.

The 26 projects in this research agenda represent a wide range of potential information that will greatly assist both regulated and regulatory SMC member agencies with stormwater management. As in the past research agendas, these projects can be cost-effectively implemented and designed to be efficiently integrated into their respective monitoring and management programs. Furthermore, multiple projects can be leveraged off one another to create even more cost-saving synergies, such as projects that build towards a desired outcome in the microbiology theme or merging projects from the technology/science communication theme with monitoring improvement projects or BMP development theme.

Southern California Stormwater Monitoring Coalition (SMC) Member Agencies

The Southern California Stormwater Monitoring Coalition (SMC) is a collaboration of 15 public agencies, including the region's major regulated municipalities and the State regulatory agencies that oversee them, who collectively are responsible for managing discharges of dry- and wet-weather runoff into streams, rivers and oceans across coastal Southern California. The SMC's mission is to collaboratively conduct the research necessary to improve regional stormwater management. The SMC's ecologically diverse region spans from Ventura to San Diego, from Los Angeles to the Inland Empire, and encompasses a population of 28 million people. The combination of valuable resources and intense urbanization presents a number of complex stormwater management challenges.

- County of Orange
- Los Angeles County Flood Control District
- County of San Diego
- Riverside County Flood Control and Water Conservation District
- San Bernardino County Flood Control District
- Ventura County Watershed Protection District
- City of Long Beach
- City of Los Angeles
- City of San Diego
- California Department of Transportation (CALTRANS)
- Regional Water Quality Control Board - Los Angeles Region (Los Angeles Regional Board)
- Regional Water Quality Control Board - Santa Ana Region (Santa Ana Regional Board)
- Regional Water Quality Control Board - San Diego Region (San Diego Regional Board)
- State Water Resources Control Board (State Water Board)
- Southern California Coastal Water Research Project (SCCWRP)

The United States Environmental Protection Agency, through its Office of Research and Development, National Risk Management Research Laboratory, is a participant with the SMC in facilitating and promoting the transfer of information on the performance and effectiveness of stormwater management practices.

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1.0 INTRODUCTION

Collaboration is a powerful vehicle for creating common understanding, and the Southern California Stormwater Monitoring Coalition (SMC) stands as a testament to the effectiveness of collaborative synergy. Since the SMC's original master agreement was signed in 2000, the coalition has been working to fill foundational gaps in knowledge about best practices for stormwater management. Through the SMC, the region's stormwater management community has developed monitoring infrastructure, deciphered stormwater mechanisms and processes, and assessed receiving water impacts. These projects have helped both dischargers and regulators make tremendous leaps in how they address the challenges of wet- and dry-weather runoff.

All SMC projects consist of applied research that has direct, tangible impacts on stormwater management across southern California. Cumulatively, the SMC and its project partners have completed more than 27 research projects valued at over $17 million to fill key data gaps. Virtually every project the SMC has undertaken has led to some change in stormwater management and/or policy (Table 1). For example, when the SMC addressed peak flow hydromodification, the outcome was interim peak flow criteria and the development of monitoring and management tools for identifying and minimizing hydromodification impacts in at-risk stream segments. Similarly, when the SMC addressed stream biological assessments, the outcome was an integrated, coordinated regionalized monitoring program that provides holistic views of ecosystem health and has become one of the foundations of California's forthcoming stream biointegrity program. Likewise, when the SMC addressed low impact development (LID), the outcome was a practitioners' manual and training program for LID designs.

Since the first stormwater discharge permits were issued in the 1990s, the science of stormwater management has evolved rapidly. Initially, permits required managers to focus on routine jurisdictional BMPs and the characterization and improved understanding of the fundamentals of stormwater science. Today, permits commonly cross municipal boundaries, emphasizing watershed-based approaches and restoration of the natural hydrological cycle. The SMC has been front and center in developing, vetting, and implementing scientific advances in watershed-based management.

At the same time, numerous stormwater issues persist across southern California that pose challenges for both regulatory and regulated agencies. While many of the easily resolved issues have been addressed, the remaining challenges will be much more difficult to solve. For example, SMC members are planning to implement hundreds of structural and non-structural stormwater control measures over the next several years, even though optimal guidance regarding design and maintenance has yet to be defined for the various precipitation and geologic conditions found throughout southern California. Another pervasive challenge confronting the SMC members is the limitation of existing fecal indicator bacteria. In southern California, water quality for body contact recreation is a nationally recognized beneficial use and major driver of the local economy. Although new, human-specific fecal indicators offer a promising alternative to traditional indicators, their utility has not yet been accepted as a regulatory option. Finally, with the SMC continuing to invest millions of dollars in routine monitoring, it is becoming increasingly critical that the SMC is able to use new technology to effectively turn the wealth of raw data into actionable insights, and to make this information accessible and readily sharable.

Fortunately, the SMC remains as committed as ever to tackling the next generation of stormwater management challenges. The SMC's Master Agreement – the document that binds the 15 SMC members together as an entity – was renewed in 2019, underscoring both regulated and regulatory agencies' commitment to collaborative stormwater research.

As part of the SMC's shared commitment, SMC members have prepared this document, a five-year Research Agenda that serves as a roadmap of projects to implement over the term of the 2019-2024 Master Agreement. SMC members will be able to use this Research Agenda as a menu for prioritizing and selecting from among numerous potential projects. The Research Agenda also serves as a beacon to non-member collaborators who are dealing with similar issues and interested in leveraged partnerships.

Table 1. Examples of previous SMC research projects and their management outcomes.

PROJECT	MANAGEMENT OUTCOME
Development of the SMC Data Portal and initial population with regional monitoring data	The portal integrates with the California Environmental Data Exchange Network and is used for 305(b) and 303(d) Assessments.
Stream Quality Index (SQI) and associated data visualization web tool	SQI assessment tool was adopted by the Statewide Perennial Stream Survey and will be used for assessing the next regional stream bioassessment program results.
SMC CLEAN	The project resulted in the creation of the Statewide LID Manual and training program.
Regional Freshwater Stream Bioassessment Monitoring Project	The program created regional benchmarks for Water Quality Improvement Plans, supported regional Biotic Ligand Model default values, and will serve as the technical foundation of the State's forthcoming stream biointegrity policy.
Toxicity Testing Laboratory Intercalibration Study	The study's Laboratory Guidance Manual supported modifications to the State's Toxicity Implementation Plan, is named in some permits, and gets used for shortlisting qualified contract laboratories.
Standardized MS4 Monitoring Program	The program developed the standardized monitoring designs used in nearly all member agency MS4 NPDES permits.
Stormwater Data Compilation Study	The study showed relative nutrient loading from stormwater was small compared to POTWs, effectively removing stormwater as a source responsible for ocean eutrophication issues.
Effects of Wildfires on Contaminant Runoff and Emissions	The study created an emergency wildfire response monitoring program used by several member agencies.
Regional Approaches to Trash Monitoring and Management	The study created standardized methods for ongoing NPDES and TMDL trash monitoring in California.
Chemistry Laboratory Intercalibration Study	The study's Laboratory Guidance Manual is named in some permits and gets used for shortlisting qualified contract laboratories.
Bacterial Reference Watershed Study	The study created the original reference condition for bacteria targets in TMDLs used throughout southern California.
Laboratory Intercalibration Study	The study's Laboratory Guidance Manual is named in some permits, and gets used for shortlisting qualified contract laboratories
Peak Flow Impacts	The hydromodification assessment tools developed via this study are at the core of most hydromodification management plans.
Microbial Source Tracking Method Comparison	The study identified the primary methods that are the basis of the State's Microbial Source Tracking Manual.

1.1 Approach to Developing the Research Agenda

The approach used to develop this agenda follows the SMC's approach to developing previous Research Agendas (SMC 2001, 2013), using an Expert Panel of recognized researchers and knowledge leaders. The 2019 Expert Panel consisted of seven experts, one each in the fields of chemistry, ecology, microbiology, hydrology, best management practices (BMPs), monitoring and information technology. Three additional members were selected to represent regulated, regulatory, and non-governmental representatives. The Panel was given the charge to:

- Develop a cohesive list of project concepts that will support stormwater management needs and address issues of concern
- Create a written summary of these project concepts for future use by the SMC

The Expert Panel was told that research should be regional in scale and not focused on site-specific or statewide concerns. However, it was clear that southern California region-wide issues are a reflection of site-specific and statewide problems. In addition, the Expert Panel was told that these needs should address medium- and long-term issues, not just short-term reactions to immediate needs.

The three-day workshop began with testimony from SMC member agencies presenting short descriptions of their programs and issues confronting them now and into the future. Then, the panel moved to closed session, where they identified 64 discrete project ideas and collaboratively refined and prioritized these research concepts into 26 project concepts, which they presented back to the SMC in a closing session. Ultimately, these 26 research concepts were cultivated into the project descriptions found in this document with input from the SMC Steering Committee.

The 26 research projects are organized into six research themes:

- Microbiology and Human Health Risk
- BMP Monitoring, Implementation and Effectiveness
- Innovative Technology and Science Communication
- Expanding the Utility of Biomonitoring
- Improving Stormwater Monitoring Effectiveness
- Emerging Challenges

This document is organized around these six themes. Each project description is comprised of a problem statement, desired outcome (products), tasks, schedule, and necessary resources (expertise, costs, and potential collaborators). The sequence in which the projects are presented does not constitute any sort of prioritization. The SMC will prioritize implementation of these projects based on collective needs and available funding.

1.2 Linkages Between Projects

Although this Research Agenda lists 26 stand-alone projects, the projects are not necessarily meant to be conducted independently. Many of the projects are interrelated and interdependent. These interrelated projects can be more cost-effectively implemented by integrating and coordinating among multiple projects, leveraging efficiencies wherever possible.

Numerous examples of interrelated projects abound. Some of the most obvious opportunities for synergy are in Section 3.0: BMP Monitoring, Implementation and Effectiveness, where one project focuses on mechanisms and processes, a second project focuses on field testing, and the third project transitions the field testing into a regional field monitoring program.

Other examples are less directly interdependent, even though there are clear synergy opportunities. Within Section 2.0: Microbiology and Human Health Risk, one project develops methods for identifying different human fecal sources of pollution, a second projects updates source tracking manuals for standardizing source identification, and a third creates health risk thresholds for protecting public health.

Other interrelated projects cut across the six research themes. For example, nearly all of the projects in Section 4.0: Innovative Technology and Science Communication cut across multiple themes. The project to develop a data ecosystem will support numerous other projects in topics ranging from biomonitoring to BMPs and monitoring effectiveness evaluations. Another example is the range of cross-cutting projects associated with changing flows, which includes flow measurement and modeling (Section 4.0), reference biological communities in streams with non-perennial flows (Section 5.0), ecohydrology monitoring (Section 6.0), and changing hydromodification requirements due to climate change (Section 7.0).

It is also important to note that the Expert Panel developed additional projects that were highly recommended, but that are not included in this Research Agenda. One important project is focused on developing guidance for a standardized BMP maintenance program; part of this research is embedded in Project 3.2: Field Assessments of Stormwater BMP Lifecycle Performance. This research, which is desperately needed by multiple SMC member agencies, is intended to make sure the investments in BMP installations are maximized, both in terms of their water quality treatment effectiveness, lifecycle cost, and their lifespan.

2.0 MICROBIOLOGY AND HUMAN HEALTH RISK

2.1 Quantifying Human Fecal Sources in Wet Weather

Subject Area / Key Words: Microbial source tracking, precipitation, fecal contamination

Problem Statement

Fecal pollution, as defined by fecal indicator bacteria levels, is pervasive in Southern California waterways during wet weather, necessitating improved understanding of the origin of the contamination (i.e., human versus non-human sources) by managers so resources can be targeted to sites representing the most meaningful health risks. The SMC has played a key role in advancing the technology that has enabled the use of microbial source tracking (MST) for detecting and quantifying human fecal pollution. Over a decade ago, one of the SMC's first projects was to identify a sensitive and specific marker of human and sewage fecal contamination; the best performing indicator was *Bacteroides* HF183, a well-conserved gene sequence in a common intestinal bacterium (Boehm et al. 2013). During dry weather, HF183 has made identification of human pollution relatively reliable because sources can readily be tracked and isolated to discrete upstream sources (Noble et al. 2006, Cao et al. 2015). Source tracking using HF183 in wet weather, however, has not provided managers with actionable insights because of the difficulty tracking the HF183 signal to a discrete upstream origin point. With the HF183 signal frequently detected across southern California waterways in wet weather (Cao et al. 2017, Steele et al. 2018), managers need to know more than just whether human fecal contamination is present – they also need to pinpoint which type of human source is present (i.e., municipal sewage, septic systems, and direct deposition by human individuals) so effective management actions can be taken. To achieve this level of source differentiation, a novel method or suite of methods may need to be developed.

Desired Outcome

This project will develop a method or suite of methods to discriminate among municipal sewage, septic systems, and direct deposition sources of human fecal contamination. This outcome will provide regulated and regulatory agencies with improved ability to identify and remediate specific sources of human fecal contamination during wet weather.

Tasks / Steps Required to Achieve the Desired Outcomes

1) Test method(s) for sensitivity and specificity on municipal sewage, septic system waste and human feces by spiking each source into a variety of matrices, including lab water, dry weather runoff, wet weather runoff, and seawater.

2) Test method(s) for specificity by spiking non-human fecal sources, e.g., dogs, birds, cattle.

3) Determine limit of detection and maximum dilution for method(s).

4) Specify any statistical analysis, code, bioinformatics pipeline, or other tools for data analysis and interpretation.

5) Field-test methods using a case study application.

6) Write standard operating procedures.

Project Schedule

This project will take between 24 and 36 months, depending on the success of the new method(s) and the number of storm events the method will be tested on. More iterations to ensure success or the more storm events for test applications will require more time.

Resources / Budget

This project is estimated to cost $250,000 to $500,000. There are several SMC members (City and County of San Diego, City and County of Los Angeles, County of Orange) embarking on similar projects that the SMC could use to leverage resources and effort. Similarly, there are a number of non-member agencies that are interested in the outcome of the study (wastewater agencies, reclaimed water agencies) that may be suitable project partners who can provide in-kind support.

2.2 Update MST Guidance Document (California Microbial Source Identification Manual)

Subject Area / Key Words: Identification of fecal sources, human health risk

Problem Statement

SCCWRP in collaboration with the SMC published the California Microbial Source Identification Manual more than six years ago to provide definitive guidance on the use of microbial source tracking (MST) methods for identifying host sources of fecal contamination at coastal sites; the manual, however, has not been updated since that time. The manual, which assists with remediation efforts for beach fecal contamination, helps SMC members work toward regulatory compliance, including for their TMDLs and NPDES permits. This manual was endorsed by the State Water Resources Control Board for conducting MST (Griffith et al. 2013), the first-of-its-kind in the nation. Today, many SMC members instruct their contractors to utilize the manual as these MST methods become more routine. Technology progresses rapidly, however, and improved methods for rapid detection of MST markers, fecal indicator bacteria and pathogens have evolved over this time period (Cao et al. 2015). Interpretation of data and relationships to pathogens and human health risks have also improved. Therefore, this MST guidance document needs to be updated.

Desired Outcome

This project will create an updated version of the California Source Identification Manual. The updated document will include new or improved methods, identify new strategies and study designs based on past experience of what works (and what does not), and provide SMC members with a better understanding of the MST findings (including human health risk).

Tasks / Steps Required to Achieve the Desired Outcomes

1) Survey stakeholders, including SMC, nonprofits, university researchers to understand their questions, concerns, and perceived challenges to conducting MST studies and interpreting data.

2) Conduct a literature review to identify new information available since the document was written.
3) Identify methodological advances that should be incorporated into the "toolbox" for MST studies.
4) Identify new conceptual knowledge, e.g., survival of MST organisms in water bodies, relationships to pathogens, epidemiology data, quantitative microbial risk assessment (QMRA) using MST data.
5) Identify knowledge gaps or limitations to prevent misinterpretation.
6) Revise MST guidance document, including case studies, as appropriate.
7) Allow stakeholders to review document and comment prior to publication.

Project Schedule

This project will take between 12 and 18 months, depending on the number of case studies identified and level of review desired by the SMC. No additional laboratory testing will be required to complete this study, although new methods developed elsewhere may require local validation to be included in the revised manual.

Resources / Budget

This project will require expertise in environmental microbiology and microbial source tracking. This project is estimated to cost $50,000 to $100,000.

2.3 Improved Prediction of Swimmer Risk at Freshwater Sites

Subject Area / Key Words: Human health, swimming risk, risk communication, bacteria water quality monitoring

Problem Statement

In southern California coastal waterbodies, scientists have begun using computer-based forecast models for predicting beach water quality as a means of informing users about the potential health risks of body contact recreation at unmonitored sites (Thoe et al. 2014). To date, however, no such modeling tool has been developed for southern California freshwater recreation sites to predict and inform users of health risks related to fecal contamination. The lack of a comprehensive strategy for protecting public health at freshwater recreation sites is partly due to lack of monitoring, as well as a disorganized communication system for the public. Thus, there is a need for a comprehensive, universal strategy for protecting the hundreds of thousands of contact and non-contact recreational users in southern California rivers, streams and lakes each year. This will be particularly necessary as demand for southern California's freshwater recreation sites increases as people seek relief from longer, hotter summers.

Desired Outcome

This project will create a robust modeling tool that is based on existing monitoring protocols to predict risk, implement monitoring to validate the model, and create an effective tool to communicate predicted risk to the public.

Tasks / Steps Required to Achieve the Desired Outcomes

1) Create a Science Advisory Committee to guide and review the project.

2) Collate existing data on monitoring sites, bacteria concentrations, and relevant environmental data that influence bacteria concentrations at each site.

3) Create a computer model, including calibration and validation, that predicts bacteria concentrations with respect to existing water quality objectives and health risk thresholds.

4) Publish a peer-reviewed paper to ensure a rigorous model.

5) Utilize a communications expert to develop a report card and disseminate via web and app, as well as signs at popular freshwater recreation sites.

Project Schedule

This project is estimated to take 14 to 20 months, depending on availability of data and complexity of the model. The greater the number of sites and the greater the number of environmental variables, the more time that will be required to address model complexity. No new data collection is included in this scope.

Resources / Budget

This project will cost between $100,000 and $150,000. This project will require expertise in modeling and communications. Partnership with the relevant recreation site agency(ies) and local public health department(s) will be critical, as these organizations will ultimately be tasked with accepting and using the model predictions to inform public notifications.

2.4 Linking Indicators of Fecal Contamination to Human Health Risk

Subject Area / Key Words: Pathogens, microbial source tracking, fecal contamination, quantitative microbial risk assessment

Problem Statement

Existing regulatory thresholds designed to protect body-contact recreation in southern California are based on epidemiology studies that were conducted outside of southern California in dry weather when sewage was present (Wade et al. 2006). The thresholds focus on fecal indicator bacteria – primarily enterococci and *E. coli.* However, these indicator bacteria thresholds may not be relevant to actual health risk during wet weather for multiple reasons: sanitary sewers and storm sewers are separate in southern California, and not all enterococci and *E. coli* entering receiving waters in southern California in wet weather originate from human fecal sources; indeed, these bacteria may be endemic in soils and sediments. Furthermore, the most frequently used tool for detecting human fecal contamination, HF183, is not a pathogen and has not been correlated with human health risk in epidemiology studies. To effectively protect public health in wet weather, stormwater managers need to better understand the relationship between indicators of fecal pollution in southern California recreational waters and human health risk from pathogens. Several potential indicators of human fecal pollution exist that could be evaluated for risk correlations during wet weather: coliphage, HF183, specific genetic sequences from *Enterococcus faecium*, and *Lachnospiraceae* markers. Then, prediction of human health risk from a given level of existing or new indicators can be achieved by using risk assessment models such as quantitative microbial risk assessment (QMRA).

Desired Outcome

This project will identify an indicator that can be used to reliably and accurately assess human health risk during wet weather. The project is intended to pave the way for pursuing new, human specific indicators as a viable alternative to measuring indicator bacteria.

Tasks / Steps Required to Achieve the Desired Outcomes

1) Test selected indicator method(s) for sensitivity and specificity on various types of sewage.
2) Test method(s) for specificity on non-human fecal samples.
3) Determine limit of detection and maximum dilution for method(s).
4) Determine performance of method(s) in environmental water samples with spike and recovery testing.
5) Develop QMRA relationship(s), including measuring pathogens in wet weather.
6) Conduct field application testing.
7) Develop an SOP for candidate method(s).

Project Schedule

This project is estimated to take 24 to 36 months to optimize analytical method(s), quantify performance metrics, and conduct field testing.

Resources / Budget

This project is estimated to cost $250,000 to $500,000, depending on level of detection and potential inhibition from wet weather organic compounds. Ideally, this project should be combined with Project 2.1 to utilize a QMRA to create a HF183 threshold (i.e., how much HF183 is too much HF183) once a relationship between HF183 and pathogen levels is developed.

3.0 BMP Monitoring, Implementation and Effectiveness

3.1 Mechanistic Studies on Pollutant Removal by Stormwater BMPs

Subject Area / Key Words: BMPs, hydrologic modification, water quality, performance monitoring

Problem Statement

A mechanistic understanding of stormwater BMP performance is lacking for many pollutants and pollutant groups, which limits opportunities to identify design and implementation improvements for southern California watersheds. Stormwater BMPs can yield variable levels of hydromodification and water quality improvements based on the wide variety of possible stormwater input, design, and operating conditions. Even for sites within a similar catchment, it can be challenging to extend known BMP performance monitoring data to other locations. This lack of understanding for important pollutants of concern can prevent SMC members from effectively complying with TMDLs and NPDES requirements. Improved mechanistic understanding of BMP behavior would enhance the ability to extrapolate design and implementation improvements to more sites within a watershed and beyond, and to identify critical elements and their functions to prioritize maintenance activities.

Desired Outcome

This project will develop a mechanistic understanding of BMP behavior to aid in BMP design for a single pollutant or pollutant group. This project will help stakeholders adopt specific BMP designs in future catchments to re-create predicted performance. Additionally, this project will identify areas of future need for BMP design development/refinement.

Tasks / Steps Required to Achieve the Desired Outcome

1) Survey SMC members to prioritize the pollutant or pollutant group of concern and/or BMP type(s) of interest.

2) Conduct a literature review to compile understanding of pertinent BMP treatment mechanisms relative to the pollutant or pollutant group of concern.

3) Construct field-scale test BMPs (or retrofit existing BMPs). Ideally, multiple BMPs of the same type would be tested using a consistent methodology to create a robust data set, and to enable investigation of the influence of physical design elements (e.g., relative locations of inlet and outlet, hydraulic loading ratio [size of catchment relative to size of BMP], media or vegetation characteristics [where applicable]).

4) Conduct extensive monitoring of BMPs, including influent and effluent flow rates and water quality parameters. This will include the parameters of interest and ancillary measurements to support mechanistic understanding, such as pH, redox (ORP), turbidity, and other parameters as identified from the literature review. Flow should be measured continuously. In addition to total pollutant concentrations, pollutant speciation-level information should be captured. BMP maintenance information should be collected. Other benefits contributed by the BMP should be documented.

5) Inspect BMPs at selected time intervals, e.g., monthly during the wet season, and sample areas that accumulate pollutants (e.g., collected sediment, media) to quantify accumulations of pollutants of interest.

6) Conduct data analysis, including a fundamental analysis of removal and accumulation of the pollutants, with comparisons to possible predicted performance based on known water treatment unit processes. Additional analysis should include hydrologic calculations related to flow modification mechanisms (infiltration, evapotranspiration, beneficial use, other), and calculation of total pollutant load reductions. Operating conditions (with particular emphasis on maintenance condition) should also be considered.

Project Schedule

This project will require 24 to 36 months to complete based on the need to sample multiple wet seasons. Time may be extended for additional pollutants or BMPs, or shortened if the study uses lab mesocosms or simulated rainfall.

Resources / Budget

This project is estimated to require at least $500,000 per pollutant group, based on the need for wet weather sampling and analysis. More funds may be required for additional pollutants or BMP types. The budget does not include construction of the BMP, and therefore the project will need to leverage SMC member agency BMP installations. Additional leveraging may occur via the SMC CLEAN program.

3.2 Standardization of Bioretention/Biofiltration LID BMPs

Subject Area / Key Words: SMC CLEAN, BMPs, bioretention/biofiltration, standard plans, data submittal tool

Problem Statement

A focus of the SMC CLEAN Phase I project was on bioretention/biofiltration as the most common LID BMPs implemented in Southern California. Areas identified for further investigation included:

1) Evaluating the materials used for construction of these LID/Green Infrastructure (GI) systems.

2) Dealing with the variety of different designs for the same LID/GI system that make it difficult for contractors to construct these systems effectively.

3) Developing a LID/GI BMP data submittal tool so that there is a central repository for collected LID/GI monitoring and meta data in Southern California so that adequate data analysis can be performed to understand the primary elements that affect performance of LID/GI BMPs in southern California.

4) Conducting life cycle performance monitoring on standardized LID/GI systems after 1), 2) and 3) have been completed – see Project 3.3.

Desired Outcome

1) Greater standardization will potentially reduce the cost of bioretention/biofiltration LID/GI BMPs and result in improved construction standards and performance, more formal standards and standard plans.

2) A submittal tool and database of meta data and monitoring data of LID/GI BMPs to help evaluate their performance helping to lead to improvements to LID/GI BMP standards and standard plans.

Tasks / Steps Required to Achieve the Desired Outcomes

1) Use the results of the SMC CLEAN materials survey to formulate a scope for bioretention/biofiltration materials study that may include column testing of the components bioretention soil media (BSM) sourced from suppliers of BSM materials and testing of identified BSM specifications in the state (e.g., BASMAA BSM Specification).

2) Evaluate, and update and or develop, LID/GI BMP standard plans and specifications for bioretention/biofiltration systems applicable to southern California at a minimum.

3) Develop and test a LID/GI BMP data submittal tool and database based on the SMC CLEAN Standard LID/GI project data-information list.

4) Construct LID/GI BMP prototypes based on 1), 2) and 3) above and design and implement a life cycle performance monitoring program – see Project 3.3.

5) Develop and provide training on the LID/GI BMP standard plans and specifications and related monitoring and inspections of the standard LID/GI systems as well as the BMP submittal tool.

Project Schedule

Tasks 1, 2 and 3 above will take 24 months to complete. 4) will commence after 1), 2) and 3) and require a minimum of 36 months – see Project 3.3. 5) above will be completed after Task 2) and 3) are completed and require a minimum of 6 months.

Resources / Budget

This project is estimated to require at least $500,000 due to the need to integrate science with material systems, engineering and the economics of the supply chain and excludes the cost of the BMP prototypes.

3.3 Field Assessments of Stormwater BMP Lifecycle Performance

Subject Area / Key Words: BMPs, hydrologic modification, water quality, performance monitoring

Problem Statement

The SMC lacks long-term data sets derived from long-term monitoring campaigns of BMP performance to assess the efficacy of BMP implementation with confidence over their full lifecycle. Recent analyses of California-specific BMP effectiveness data show that performance varies widely and is driven by at least two factors – monitoring designs and age (Afrooz et al. 2019). However, insufficient data exists to assess the degree to which either factor is influencing performance and, more importantly, how long SMC members should expect BMP performance to last. This level of long-term information is needed for many pollutants and pollutant groups.

Desired Outcome

This project will build a foundation for tracking BMP performance over extended time periods. This project involves developing standard methods for BMP monitoring throughout the SMC, conducting a controlled BMP monitoring program, and establishing long-term monitoring plans to evaluate BMP lifecycle performance. Maintenance needs and other BMP benefits will be documented for each BMP, in addition to water quality and hydrologic performance.

Tasks / Steps Required to Achieve the Desired Outcomes

1) Compile literature review of pertinent information on standardized BMP monitoring from other organizations, e.g., TAPE protocol from Washington, International BMP Database guidelines, operations and maintenance manuals from various jurisdictions.

2) Develop monitoring protocols, performance metrics, and quality assurance procedures to obtain desired/required BMP monitoring information. Modifications are expected to existing protocols to account for southern California's climate.

3) Develop guidance on selection of BMP types and locations to provide most valuable information to SMC, followed by selection of specific BMPs.

4) Monitor selected BMPs using approved standard methods. Collect meta data on BMPs to quantify multiple benefits beyond stormwater quality and hydromodification. Document BMP maintenance needs.

5) Conduct data analysis, including appropriate statistical analysis, to appropriately document BMP performance.

6) Load all BMP performance data to appropriate BMP database.

Project Schedule

This project will require 36 months to complete based on the need to sample multiple wet seasons. Time may be extended for additional pollutants or BMPs, or shortened if the study uses lab mesocosms or simulated rainfall. The actual long-term monitoring program will continue well beyond when this project is completed.

Resources / Budget

This project is estimated to require at least $500,000 based on the need for wet weather sampling and analysis. More funds may be required for additional pollutants or BMP types. The budget does not include construction of the BMP; therefore, it will need to utilize SMC member agency BMP installations. Additional leveraging may occur with the SMC CLEAN program.

3.4 Development of a Regional BMP Monitoring Network

Subject Area / Key Words: BMP, water quality, regional coordination, field data

Problem Statement

Thousands of BMPs have been installed across southern California, and thousands more could be installed over the next 20 years for regulatory compliance, even as little is known about their long-term performance for improving water quality and managing runoff. Despite the growing investment in BMPs, there is a dearth of field data documenting BMP performance for water quality treatment, hydromodification mitigation, operations and maintenance requirements, and other potential benefits. The performance effectiveness programs that currently exist have used different study designs, measured inconsistent indicators, and utilized varying quality assurance requirements. Finally, even if comparable data were collected, there is no uniform framework for sharing these critical monitoring data. A regional approach to comparable site-scale BMP performance monitoring that encompasses multiple sites monitored concurrently, and where many agencies monitor a subset of BMP types, would be a cost-effective and efficient way to collect large amounts of data in a short amount of time to inform BMP design improvements, as well as operation and maintenance requirements.

Desired Outcome

This project will develop a regional BMP monitoring program to generate robust, statistically relevant data sets covering a range of BMP types, serving multiple land uses, across a spectrum of operating conditions. These data will be used to improve BMP selection guidance, streamline annual reporting, and develop cost-effective asset management programs.

Tasks / Steps Required to Achieve the Desired Outcomes

1) Invite SMC members to identify monitoring questions that are prioritized in a stakeholder workshop.

2) Generate consensus on relevant performance metrics, such as %-removal, vs. numeric discharges, vs. long-term mass load analysis (links to Project 3.1).

3) Inventory existing BMPs across jurisdictions, including site visits as necessary to assess feasibility for monitoring, and representation of different BMP types.

4) Create a technically robust study design to answer the relevant monitoring questions based on the consensus metrics and inventory of existing BMPs.

5) Establish mechanisms to coordinate among existing stakeholder asset management databases (links to Project 4.1) and to expand the California BMP Database to include O&M, as it relates to BMP performance.

6) Establish field tech support team to ensure ongoing, reliable data collection; track and share lessons learned.

7) Conduct pilot regional survey to test monitoring program design and evaluate ability to achieve goals, then make refinements as necessary.

8) Conduct ongoing base level monitoring, including annual workshops/meetings, to actively evaluate collected performance data to ensure that objectives are being met.

Project Schedule

This project will require approximately 36 months to initiate the network and pilot the regional monitoring program, and then will require ongoing investment to collect long-term performance data.

Resources / Budget

This project is estimated to require $150,000 to $250,000 to initiate and pilot the regional monitoring. Much like the SMC's Regional Stream Bioassessment Program, in-kind effort will be required from participating SMC member agencies for conducting the individual BMP field monitoring and laboratory analysis. Project costs vary depending upon the number of questions to be asked, the level of effort needed for the BMP inventory, and investments in quality assurance to ensure comparability. Additional cost leveraging can be accomplished by utilizing the SMC's existing regional data portal for sharing data. This project supports other BMP performance monitoring projects, including Project 3.1: Mechanistic Studies on Pollutant Removal by Stormwater BMPs and Project 3.5: Development of a Research Work Plan for Assessing the Effectiveness of Non-Structural Stormwater BMPs. This project would be supported by Project 4.3 on improving data integration for the California BMP Database.

3.5 Develop a Work Plan for Assessing the Effectiveness of Non-Structural Stormwater BMPs

Subject Area / Key Words: Non-structural BMPs, water quality, load reduction

Problem Statement

The efficacy of non-structural stormwater BMPs can vary widely and is difficult to accurately quantify, even as all SMC members rely on non-structural BMPs as a first option for pollutant removal. Non-structural BMPs consist of programmatic activities, such as street sweeping or public education, as well as source control (e.g., plastic bag bans). Virtually no quantitative effectiveness data exist, however, for some non-structural BMPs, and even where data may exist, they may not be from southern California. More reliable and quantitative information for these programs would allow greater confidence in predicting their improvements on receiving water bodies – and thus reduce dependence on typically more costly structural BMPs.

Desired Outcome

This project will create a comprehensive set of recommendations and associated workplans for specific research to quantify the contributions of non-structural BMPs to water quality improvements. This recommendation guide will prioritize subsequent SMC research projects on non-structural BMPs, document challenges and benefits of specific research projects, and estimate project costs.

Tasks / Steps Required to Achieve the Desired Outcomes

1) Conduct a comprehensive literature review to compile available and pertinent information on the ability of non-structural BMPs to reduce pollutant loads, and associated program costs. This review will include available reports and gray literature.

2) Identify data gaps, projects, and priorities for non-structural BMP research projects in consultation with an SMC subcommittee.

3) Develop research project workplans for non-structural BMPs. Workplans will include project scope, objectives, project benefits, specific tasks, project schedule, project deliverables, and resources/budget.

Project Schedule

This project will require 12 months to complete. An SMC subcommittee will help rank and prioritize non-structural BMPs to be studied, with the actual monitoring to be funded separately.

Resources / Budget

This project is estimated to cost $50,000 to $100,000 depending on number of non-structural BMPs evaluated. In many respects, the assessment of the effectiveness of non-structural stormwater BMPs (including source controls) in this research project has overlapping elements with research project 7.4 which seeks to prioritize true (regulatory) source control efforts. To the extent that effectiveness also underpins the prioritization of true source control efforts, consideration should be given to combining 3.5 and 7.4 into a single non-structural BMP effectiveness assessment and prioritization project.

4.0 INNOVATIVE TECHNOLOGY AND SCIENCE COMMUNICATION

4.1 Demonstrate a Data Ecosystem for Integrating Stormwater Data and Communicating Information to Multiple Audiences, including Data Quality

Subject Area / Key Words: Science communication, Data quality, Checker, Open data, Interoperability, Data lake, Cloud, Ambient water quality data, Effluent data, BMP effectiveness data, MS4 Annual Report data, Community science

Problem Statement

SMC members do not have a way to quickly and easily integrate all types of data they collect to optimize their management of stormwater resources. Although much of this information is routinely collected, it is not collated and integrated in a way to allow ready access for extracting information. This lack of integrated insights hinders decision-making at all levels, ranging from operational (e.g., where and when to do inspections, implementing BMPs) to executive (e.g., policy decisions, program performance, financially significant interventions). However, information technology has reached a point where a platform can be created that ingests data of disparate types from various locations into a single unified system, or "data ecosystem." Even so, implementation of the technology itself is not the be-all, end-all solution, as it also will be critical to document data quality to ensure the usability of the data for various decision-making applications.

Desired Outcome

This project will create a platform that can ingest data from multiple sources, including data quality fields, and make this data interoperable so that integration of datasets can inform management questions by SMC members and the SMC's partners and stakeholders.

Tasks / Steps Required to Achieve the Desired Outcomes

1) Create a list of management questions, such as the CASQA-recommended management questions.

2) Evaluate the universe of desired (and some subset of pilot) stormwater datasets needed and their data structure/schema.

3) Evaluate accessibility of these datasets (e.g., Are they available via API, CSV file? Are they machine readable?).

4) Note the data quality fields collected for each dataset.

5) Use or build logic to aggregate data quality fields to inform (e.g., index of data quality).

6) Design and/or create common data standards (i.e., "ideal data model") to integrate the datasets.

7) Manually integrate datasets to conform to a common data model, noting along the way the transformations needed.

8) Build transformations or scripts to transform existing datasets into ideal data model(s).

9) Build a prototype cloud "data ecosystem" to ingest and perhaps transform the data.

10) Build prototype business intelligence tools based on the prioritized management questions (or use cases) from Task 1).

11) Use focus groups to iterate on the data, business intelligence tools and other elements.

12) Scale up and consider how to make production version(s) of the data platform(s).

Project Schedule

This project will take between 30 and 42 months to complete. Timing will vary based on how many data sets are aggregated and their accessibility. Timing will also vary based on how much data piloting is necessary for business intelligence tools or how much data engagement is necessary with decision-makers.

Resources / Budget

This project is estimated to cost $125,000 to $250,000. Cost estimates include cloud space for the project duration. (Note: Cloud space beyond project completion will require additional funds.) This project can leverage existing data sets developed by SMC members. This project will require experienced programmers/data scientists as well as a project manager that can link data scientists with SMC member agencies.

4.2 Streamline Data Collection for Stormwater Annual Reporting and Prototype Interfaces for Program Effectiveness Information

Subject Area / Key Words: Science communication, Program effectiveness, Implementation, Mass loading data, BMP effectiveness data, MS4 Annual Report data, Nonstructural BMPs, Open Data, Digitization, Machine readable, Data model, Ambient water quality data, Effluent data, BMP effectiveness data, MS4 Annual Report data, Civic data engagement

Problem Statement

Although SMC member agencies spend hundreds to thousands of person-hours each year to produce "annual reports" as a compliance requirement, there is little guidance for reporting these compliance requirements. As a result, annual reports are difficult to read and understand, are almost always comprised of non-machine-readable data, and rarely get used beyond their one-time specific application. Both regulated and regulatory agencies are left with a feeling of wasted effort, incomplete outcomes, and lost opportunities to glean more information and insight. Because both regulated and regulatory agencies are members of the SMC, there is an opportunity to dramatically streamline guidance for annual reporting, focusing on performance metrics that provide the key information for decision-making and that facilitate the reports' production using an automated, seamless, and transparent process.

Desired Outcome

This project will create guidance for an Annual Report format that streamlines production while producing more actionable information.

Tasks / Steps Required to Achieve the Desired Outcomes

1) Evaluate the universe of stormwater annual reporting drivers (permits, orders, etc.) and how they relate and differ.

2) Use a focus group to define what metrics should be used to define the compliance determinations held in common among all SMC members.

3) Build a data model to accommodate the annual report metrics, including formats and specific fields, and build a common vocabulary.

4) Build an interface to test annual reporting pilots to give feedback on the data format and vocabulary to "build" a standard annual report.

5) Use a focus group to evaluate the new Annual Report format.

6) Scale up and consider how to make production version(s) of the Annual Report format customized for each SMC member.

Project Schedule

This project will require 18 to 24 months to complete an alternate Annual Report format. Additional time will be necessary for customizing the Annual Report for each SMC member. The SMC should consider time for interacting between regulatory and regulated agencies and exploring the concept with agencies outside of the SMC.

Resources / Budget

This project is estimated to cost $175,000 to $250,000 to complete. The project will require time investment from both regulatory and regulated agencies, and reliance on data sets collected by member agencies. This project is most effectively implemented in coordination with the data ecosystem from Project 4.1, which will reduce costs as similar efforts are leveraged.

4.3 Advancing the California BMP Database

Subject Area / Key Words: database, BMPs, southern California

Problem Statement

The International BMP Database is a unique and valuable asset for stormwater managers tasked with BMP planning and design (http://www.bmpdatabase.org/). However, utilization of the International BMP database to design stormwater projects being implemented in southern California is problematic. Input of data to the International BMP database requires that specific observational data is collected, there is complex data formatting, and submission is through a consulting firm/management group. Utilizing the data system for southern California is also not ideal as there are few projects in the international BMP database that are specific to the region, the quality of data observations is variable, data are not necessarily available at the space and time scales needed. Recently, however, a California specific BMP database was compiled

(Afrooz et al. 2019; https://sccwrp.shinyapps.io/bmp_eval/) which overcame some, but not all, of the limitations with the International BMP database. The largest issue with the California BMP database is that it was not specifically designed for SMC member applications, and it is not being grown and maintained to incorporate new information as it is collected.

Desired Outcome

This project will improve the flow of data into the California BMP Database, as well as provide routine maintenance and quality control of data sources/projects entered into the California BMP Database. The goals of this project are to create a more forward-facing database that promotes usability and is populated with project data that are relevant to regional stakeholders and users.

Tasks / Steps Required to Achieve the Desired Outcomes

1) Evaluate gaps/problems in current infrastructure of database (e.g., usability, data formats, tracking of usage by stakeholders and community).
2) Identify critical parameters or constituents of interest for southern California (i.e., bacteria or pesticides) that the California BMP Database should track.
3) Evaluate current capacity of the system (i.e., volume) and its ability (i.e., user friendliness) to integrate new technologies and BMP types.
4) Develop a mechanism for QA/QC of data streams and maintenance of the database.
5) Cross-link the California BMP Database to other relevant databases to enable data gathering across scales and platforms.
6) Improve visibility (i.e., communication, front-facing presence) so that more projects are included, and regional stormwater managers and firms know of its existence.

Project Schedule

This project will require 20 to 24 months to complete. Timing will be dependent on how much additional data fields or project information is added to the current database.

Resources / Budget

This project is estimated to cost $100,000 to $200,000 to complete, depending on how much additional data needs to be compiled. Costs will include all support during the study. However, additional funds will be necessary after the project is completed to curate and maintain the database to the enhanced standards.

4.4 Low Flow Monitoring and Modeling

Subject Area / Key Words: low flows, dry weather, TMDLs, hydrologic modeling, beneficial uses

Problem Statement

Most SMC members rely on sophisticated computer models for watershed planning (as an example, see https://safecleanwaterla.org). These models are almost exclusively based on precipitation. However, simulation and prediction of inter-storm and low flow conditions has significant uncertainty in hydrologic models because low flows are not driven by precipitation and most flow gauges used for flood control are not well-suited to low flow conditions. However, hydraulic models for low flows are becoming increasingly critical for a range of regulatory needs in southern California such as evaluating TMDL compliance during dry weather, formulating restoration efforts, understanding ecological flows in river systems, evaluating climate change and hydrologic impacts, and modeling surface-groundwater interactions, amongst other applications. To create accurate and reliable low flow models, there is a significant need for discharge observations during low flow conditions that can be used to calibrate and validate these models and improve our prediction of inter-storm and baseflow conditions.

Desired Outcome

This project will expand the observational network for low-flow and inter-storm monitoring in regional rivers and streams. The project will produce rating curves and stage-discharge relationships for low-flow conditions, improved hydrologic predictions for inter-storm and dry season periods, and a peer-reviewed journal paper on analysis and drivers of low flow variability.

Tasks / Steps Required to Achieve the Desired Outcomes

1) Identify gaps in the current low-flow observational network and associated uncertainties.
2) Install monitoring system/sensors in critical areas of need (e.g., restoration efforts, critical habitats, surface-groundwater interfaces).
3) Identify opportunities for community science engagement.
4) Develop a mechanism for QA/QC of collected data.
5) Provide a mechanism for storage, maintenance and distribution of data streams.
6) Utilize observations to improve/update hydrologic and hydraulic models being utilized for stormwater applications.

Project Schedule

This project will require 24 to 36 months to complete, assuming a minimum of two years of low-flow monitoring.

Resources / Budget

This project is estimated to cost $150,000 and $300,000, depending on the number of locations and length of time for monitoring. The project will require a hydrologist and includes funding for sensor purchase and installation.

5.0 EXPANDING THE UTILITY OF BIOMONITORING

5.1 Piloting a New Toxicity Assessment Framework for Stormwater

Subject Area / Key Words: Toxicity, method development, quality assurance, ecological risk

Problem Statement

Although the State Water Board is considering updates to the Inland Surface Waters Plan and Ocean Plan that would increase toxicity testing provisions for regulated dischargers, many stormwater agencies have concerns about using traditional toxicity testing for stormwater discharges. These whole effluent toxicity tests were originally designed for treated wastewater discharges, not stormwater discharges. Stormwater managers are specifically concerned about: (1) differences in exposure resulting from the high variability in flow and concentrations in stormwater vs. the typically consistent flow and concentration in treated wastewater; (2) the types of test organisms and toxicity endpoints used for wastewater, which may have little relevance to stormwater; and (3) the lack of correlation between whole community impacts in receiving waters and the toxicity test results from a single species. Adding to the concerns are the results from the most recent SMC toxicity intercalibration (Schiff and Greenstein 2016), which indicated poor comparability among toxicity testing laboratories for the *Ceriodaphnia* reproduction test, the most common test utilized across SMC member agencies. A re-evaluation of current toxicity testing approaches is required, and a new approach to toxicity testing may be needed.

Desired Outcome

This project will explore new or improved test methods and approaches to data interpretation, paving the way for potential alterations to monitoring requirements for stormwater agencies to produce more realistic and applicable testing that, in turn, produces more actionable information. This project also will assess a new toxicity assessment framework to address problems with existing methods – one that incorporates multiple methods for assessing toxicity and is responsive to multiple different types of toxicity associated with stormwater. Ultimately, this project aims to improve the quality and consistency of the current laboratory techniques, including updated standard operating procedures or laboratory guidance manuals.

Tasks / Steps Required to Achieve the Desired Outcomes

1) Survey regulators and discharges to identify specific needs and opportunities.

2) Evaluate current conceptual models and risk models to identify data gaps where relevant data collection is needed.

3) Improve overall performance of current toxicity testing by focusing on:

    a) Selecting partner laboratories

    b) Testing/refining lab approaches

    c) Updating SOPs and establishing performance standards

    d) Auditing labs, e.g., in coordination with ELAP

4) Develop a new pilot toxicity framework that includes methods related to:
    a) new endpoints
    b) episodic exposures
    c) new risk model
5) Host SMC workshop or meeting to discuss how to integrate improvements into monitoring programs.

Schedule

This project can be divided into two phases. The first phase (Tasks 1-3) addresses the need to improve existing methods and will require approximately 24 months to complete. The second phase evolves the current toxicity testing framework and will require 36 months or more, depending on intensity of method development and level of regulated-regulatory agency engagement.

Resources / Budget

Phase I is estimated to cost $250,000 to $500,000 to complete, depending on the number of labs involved and complexity of method refinement.

5.2 Establish a Reference Network Across a Range of Flow Permanence

Subject Area / Key Words: Reference condition, flow, ecohydrology, hydromodification

Problem Statement

The SMC's regional stream monitoring program is a national leader in bioassessment monitoring of perennial streams (Mazor 2015). Fundamental to the SMC's bioassessment of stream ecological health is a scoring tool built upon the definition of reference condition – this determines the biological expectation of unaltered perennial streams – and California has a well-established network of reference sites in perennial streams to support that definition (Ode et al. 2016). However, the majority of stream miles in southern California are non-perennial and encompass a wide range on the flow continuum, from flowing most months to flowing for just a few days per year (Mazor et al. 2014). Because the existing reference network was built using sites on the wet end of the continuum, there is a significant gap in knowledge of the expected biological characteristics of drier systems. An important first step to bridging this gap would be a network of reference sites across the range of flow permanence to establish biological expectations across the flow permanence continuum.

Desired Outcomes

This project will create a network of monitoring sites that represents the full range of flow permanence in the SMC region. The data from these non-perennial reference sites will be used to support a wide range of stormwater management needs, including developing or adapting biological scoring tools to these habitats, helping to identify appropriate restoration targets, and identifying high-quality waters for protection.

Tasks / Steps Required to Achieve the Desired Outcomes

1) Coordinate with programs to obtain the best models of flow permanence within the region and ground-truth flow estimates with observational data to verify that they have sufficient accuracy.

2) Assemble existing datasets (spatial) documenting human influence (e.g., land-use, transportation, known discharges).

3) Establish criteria for screening candidate sites and screen these sites to create a pool of reference sites (minimum = 100 sites).

4) Establish a monitoring program (biological, chemical, physical indicators) to collect samples and ancillary data, process samples, and manage data.

5) Use data to develop or adapt biological scoring tools for non-perennial systems in the SMC region.

Schedule

This project will be divided into two phases. The first phase will require 12 months to complete and includes preliminary data acquisition, developing screening criteria and screening candidate sites. The second phase will consist of ongoing routine monitoring of selected reference sites.

Resources / Budget

Phase 1 of this project is estimated to cost $75,000 to $150,000, depending upon how much field screening and flow monitoring needs to occur. Phase 2 of this project is scalable but is estimated to cost $150,000 to $250,000 annually for sampling and analysis of up to 20 sites per year. Cost leveraging can occur via the existing SMC regional stream monitoring program and the State Water Board’s Surface Water Ambient Monitoring Program.

5.3 Establish a Framework for Characterizing How Development Affects Ecological Potential of SMC Streams

Subject Area / Key Words: Bioassessment, ecological potential, stream alteration

Problem Statement

Many streams in highly developed parts of the SMC region have been altered from their natural state in ways that make them unlikely to support fully intact biological communities, even when all readily controllable factors are controlled (Beck et al. 2019). Although stream alterations have the potential to significantly limit biological potential, there is no standard way to gauge a sites’ biological potential. Different mechanisms of alteration (e.g., channelization, channel hardening, groundwater alteration) can have variable influences on biological integrity. Given that some of these influences may create more severe limits on biological potential than others, there is need for agreement on the standard interpretation of biological data from these highly altered streams relative to the biological condition expected at reference sites. The lack of an interpretation framework hinders productive communication between regulators and the regulated community regarding appropriate management decisions and priorities for these systems.

Desired Outcomes

This project will create a framework for evaluating biological condition data in highly developed landscapes and support informed management options and prioritization in developed landscapes. In turn, this will improve communication between regulated and regulatory agencies about biological potential of stream condition and the ability to make more informed management decisions in these systems.

Tasks / Steps Required to Achieve the Desired Outcomes

1) Establish general categories of alteration (e.g., channelization, flow management, groundwater alterations), and develop a process for assigning individual stream segments to these categories.
2) Identify data resources and data gaps, including where, when and which data types.
3) Use existing and new data to describe the range of biological characteristics found in these systems, including taxonomic composition and condition metrics/indices for both benthic invertebrates and benthic algae assemblages.
4) Assemble findings into a framework for evaluating the biological condition of a given stream reach relative to others with similar levels and types of alteration.
5) Invite stakeholders/regulators to test usefulness and refine framework as appropriate.

Schedule

This project will require between 18 and 24 months to complete depending upon data availability and level of effort to test and refine framework for decision making. Allocating sufficient time for engaging regulatory and regulated agencies is essential.

Resources / Budget

This project is estimated to cost $100,000 to $175,000 to complete.

5.4 Developing Metagenomic Techniques for Assessing "Whole Community" Status and Function

Subject Area / Key Words: Metagenomics, DNA barcoding, DNA sequencing

Problem Statement

Traditional stream bioassessment tools have focused on single assemblages, such as benthic invertebrates or algae. Using this approach, California and the SMC have built among the most technically robust stream biological condition assessment tools in the nation (Mazor et al. 2016). However, comprehensive ecological condition assessments ideally should measure the status of the entire community living in a stream, from microbes to vertebrates. The whole-community approach is important because each assemblage may be sensitive to different stressors, there may be important interactions among assemblages, and some assemblages may either be more sensitive or more responsive than others to different sources of stress. Until recently, technology did not exist to support whole community assessments, especially for projects that assess multiple sites, like the SMC survey. However, the state of the science is changing rapidly. Emerging metagenomic techniques – techniques that identify organisms through their DNA shed into the water they are living in – offer incredible promise for overcoming the limitations of single-assemblage bioassessment tools. There is strong potential that these techniques will eventually provide ecological condition assessment tools that are more informative, have better performance and are more cost effective than current approaches. Investments in the new technology have the potential to provide long-term cost benefits, reducing both field and laboratory effort by more than 50% and reducing turnaround times by months. Managers may be able to use metagenomics technology to build everyday, effective tools for assessing and managing the whole-community health of SMC streams.

Desired Outcome

This project will develop a metagenomics-based assessment tool for assessing whole-community status and function, with the goal that it will perform better than current methods for precision, sensitivity and accuracy. Along the way, standard metagenomic methods will be developed for field collection, laboratory processing, data management and data interpretation.

Tasks / Steps Required to Achieve the Desired Outcomes

1) Conduct a literature review of current metagenomic techniques, including coordination with the California Water Quality Monitoring Council's Molecular Methods Working Group to refine methods, and develop a workplan for method refinement to suit the SMC's application.

2) Establish a network of sampling sites across a range of ecological settings, including both natural environmental gradients (e.g., stream size, elevation, gradient) and disturbance gradients (e.g., existing networks of reference and non-reference sites).

3) Calibrate and validate appropriate metagenomic techniques by conducting pilot studies that focus on:

    a) Field sampling (matrices: water, benthos; techniques for obtaining representative DNA samples)

    b) Laboratory/analytical techniques (sequences, target genes, integration across trophic levels)

4) Test and refine data analysis techniques, with an emphasis on techniques that enable holistic/integrated measures of condition.

5) Evaluate effectiveness and utility of the new technology in a routine monitoring and regulatory setting using case studies.

6) Develop SOPs and training curriculum.

Schedule

This project will require up to five years to complete; the timeline will be dependent on the success of novel DNA techniques and the ability to integrate them into a regulatory setting.

Resources / Budget

This project is expected to cost at least $1,000,000. However, multiple cost-leveraging opportunities could be pursued, including with the SMC's existing regional stream monitoring program, the State's Molecular Methods Working Group, local university partners and the Los Angeles County Natural History Museum, which are already pursuing metagenomic research.

6.0 IMPROVING STORMWATER MONITORING EFFECTIVENESS

6.1 Optimize the Monitoring Program Network to Achieve Efficiencies and Address Current and Future Regulatory and Scientific Needs

Subject Area / Key Words: water quality monitoring programs, data analysis, optimization, data gaps, data portal

Problem Statement

The volume and variety of water-quality monitoring programs in Southern California has increased dramatically since the last comprehensive inventory and assessment of monitoring was conducted around 2000 (Schiff et al. 2002). Furthermore, not all water-quality monitoring is conducted by stormwater agencies or is stormwater-related; treated wastewater and other dischargers also conduct extensive monitoring in southern California. The range of water quality monitoring requirements and programs includes (but is not limited to) comprehensive municipal stormwater monitoring program and monitoring requirements related to total maximum daily loads (TMDLs), the Industrial General Permit (IGP), the Construction General Permit (CGP), the Statewide Trash Amendments, and other Waste Discharge Requirements (WDRs) and National Pollutant Discharge Elimination System (NPDES) permits. Because the volume and variety of monitoring regionally has increased dramatically in recent decades and involves multiple sectors, there is a need to re-compile the inventory to identify synergies, data gaps, and opportunities to improve the efficiency and effectiveness of environmental monitoring through coordination and collaboration.

Desired Outcome

The goal of this project is to evaluate the current monitoring program requirements, as well as anticipated future requirements, to identify gaps and synergistic opportunities within the region, so that individual monitoring programs may leverage their resources to meet their regulatory and scientific needs. This project will result in a summary of the current monitoring programs (e.g., management questions, station locations, frequency, constituents/parameters monitored, etc.), summary of the data and information gaps within the region, and opportunities for monitoring program collaboration and optimization, and development of a Geographic Information System (GIS) spatial database and interactive mapping tool to assist with the visualization of the gaps and synergistic opportunities.

Tasks / Steps Required to Achieve the Desired Outcomes

1) Identify the range of monitoring programs in the region, including which of those should be included in this evaluation.

2) Create an inventory of monitoring design and implementation details, including quality assurance and reporting.

3) Identify future anticipated monitoring requirements and/or scientific needs.

4) Assess the selected monitoring programs and develop a series of comparative matrices for the critical parameters/attributes.

5) Develop the GIS spatial database and mapping tool.

6) Identify the data/information gaps, e.g., spatial, temporal (seasonality), stations locations (discharge, ambient), media, constituents/parameters, and range of related optimization opportunities.

7) Recommend high-value priorities for optimization.

Project Schedule

This project will take 12 to 18 months to complete. It is recommended this project be launched sooner rather than later to take advantage of the renewal process for multiple municipal stormwater permits (Los Angeles Region, Santa Ana Region, San Diego Region) that will likely require the modification and/or submittal of a revised monitoring program.

Resources / Budget

This project is estimated to cost approximately $100,000 to $150,000, including the development of the GIS mapping tool. This project ideally should coincide with Project 6.4: Optimizing Monitoring for Changes/Trends Due to Climate Change.

6.2 Implement "Easy-to Measure" Monitoring to Support Ecohydrology and/or Other Biological Evaluations

Subject Area / Key Words: ecohydrology, receiving water, baseline conditions, biological evaluations, data portal

Problem Statement

Alterations to flow patterns in southern California can have significant impacts on in-stream ecological health, but few data sets are available to predict flow-related impacts to vulnerable biological communities (Giraldo et al. 2019). This lack of comprehensive spatial and temporal data sets of baseline hydrologic conditions hampers management efforts to extend greater protections to biological communities. The relationship between flow patterns and biological condition, known as ecohydrology, is a particularly important issue to understand in drought-prone southern California, where the competition for scarce water resources is intense – and continually intensifying. Between water conservation, wastewater recycling, and stormwater capture, there may not be enough water to support healthy stream and estuarine ecosystems. This demand on flow resources complicates management efforts on a range of issues, including stormwater capture decisions, hydromodification requirements, and biointegrity goals. Anticipated future changes in flow patterns due to changing climatic conditions are expected to further complicate effective flow management in southern California. To optimally manage limited flow resources in southern California, it is necessary to collect "easy-to measure" ecohydrology monitoring data for multiple important hydrological parameters, including timing and magnitude of flow, changes in temperature, and alterations in conductivity.

Desired Outcome

This project will create a data set of flow, temperature and conductivity throughout the SMC region that will improve understanding of ecohydrology and its relevance to future management decisions. This, in turn, will support future site-specific management decisions regarding stormwater capture, hydromodification requirements, and biointegrity goals. Flow, temperature and conductivity are relatively easy to measure using existing technology such as sensors, probes and data loggers.

Tasks / Steps Required to Achieve the Desired Outcomes

1) Identify the hydrologic parameters and their methods to characterize ecohydrological relationships between flow and biological integrity.
2) Identify the monitoring programs that are collecting the desired data and compile a summary of the currently available datasets (e.g., locations, timeframe, constituents).
3) Identify the critical management questions and data gaps.
4) Develop a monitoring plan for the collection of the additional data necessary, and subsequent data evaluations or models.
5) Coordinate with SMC member agencies to implement the plan.
6) Upload the data to the SMC data portal.
7) Conduct ecohydrology/biological evaluations as needed.

Project Schedule

This project will require between 12 and 24 months to complete, depending on whether one or two seasons are necessary to establish flow-ecology relationships.

Resources / Budget

This project is estimated to cost approximately $75,000 to $150,000, which includes development of the GIS mapping tool. This project will require a skilled hydrologist and experienced biologist to create the flow-biological relationships.

6.3 Trash Source Identification and Monitoring Method Development

Key Words: trash, TMDLs, Statewide Trash Amendments, true source control, community science, machine learning tools

Problem Statement

Municipal stormwater agencies are focused on capturing and removing trash from the public right-of-way, but the effectiveness of these trash capture efforts in southern California is limited because the programs are not complemented by robust source control efforts that prevent trash from being generated in the first place. Indeed, comparatively little effort in southern California has been focused on true source control. As a result, despite long-term public outreach and education campaigns, trash continues to be generated and deposited in the right of way. Furthermore, compliance with trash load reduction requirements – as codified in the adopted trash Total Maximum Daily Loads (TMDLs) and Statewide Trash Amendments – has been difficult. To meet compliance requirements, stormwater managers need to build a foundational understanding of the major sources of trash in waterways, as well as develop clarity around how to effectively and cost-efficiently monitor trash levels and types in southern California waterways.

Desired Outcome

This project will focus on increasing stormwater managers' capacity to engage in true source control in southern California. The project involves collecting key source-related data (e.g., type of trash, manufacturer, brand), and identifying currently available, cost-efficient methods to collect the data (i.e., machine learning tools, community scientists) and/or other methods that will generate trash source-specific information.

Tasks / Steps Required to Achieve the Desired Outcomes

1. Identify management questions for trash identification and the data necessary to answer the questions.
2. Identify currently available tools and applications.
3. Identify opportunities to augment existing tools and/or develop image-processing/machine learning tools to collect trash data.
4. Pilot-test and/or modify the methodologies. (This step potentially ties into work that is being completed by the State Water Resources Control Board and the City of West Sacramento.)
5. Develop the standard method.
6. Distribute the standard method for use by SMC member agencies.

Project Schedule

This project will require 18 to 36 months to complete. The schedule will vary based on the effort expended on pilot testing.

Resources / Budget

This project is estimated to cost $50,000 to $100,000, not including the pilot testing. The cost for pilot testing cannot be estimated until the method(s) to be used is known. The costs of pilot testing can be defrayed by leveraging existing monitoring efforts by SMC member agencies.

6.4 Optimizing Monitoring for Changes/Trends Due to Climate Change

Key Words: Climate change, monitoring program, power analysis, discharge quality, receiving water quality, beneficial uses

Problem Statement

Climate change is anticipated to be a significant driver of impacts to water quality and quantity in southern California in the coming years, even as relatively little is known about how to measure its incremental impacts. These climate change-induced impacts will manifest in multiple ways, including increases to annual temperature, reductions in annual precipitation, and increases to extreme episodic events with concomitant increases in flooding. To manage water resources effectively in the face of climate change, managers will need to be able to discern these relatively subtle changes as they are occurring, so they have enough advanced notice to meaningfully intervene. The challenge is that existing monitoring programs may not be able to discern the impacts of climate change until they become more readily apparent and there is no longer sufficient time to respond. Thus, managers need to ensure monitoring programs are optimized to detect the subtle, incremental impacts of climate change.

Desired Outcome

This project will optimize existing stormwater water quality monitoring programs so they can discern subtle, long-term trends and ultimately answer management questions about when, where and how intense climate change-related impacts will be. This project includes development of a white paper to demonstrate the need for this long-term monitoring investment, a workplan for conducting this climate change detection monitoring, and an optional case study application.

Tasks / Steps Required to Achieve the Desired Outcomes

1. Conduct a literature review to identify climate change effects that existing stormwater monitoring programs may address (e.g., USEPA https://www.epa.gov/arc-x/climate-adaptation-and-stormwater-runoff).
2. Identify the management questions associated with the effects of climate change and the requisite data needed to track the effects.
3. Conduct a power analysis to determine what magnitude of change can be detected with various monitoring approaches.
4. Develop guidance for monitoring program modifications.
5. (optional) Apply the monitoring approach via a case study

Project Schedule

It will take 18 to 36 months to complete the monitoring program design and white paper. The case study could be initiated once the design is optimized; long-term monitoring will be ongoing.

Resources / Budget

This project is estimated to cost $75,000 to $150,000 to complete. The cost could be less if the monitoring re-design is limited to a single SMC member's monitoring program. Costs for the case study implementation are not included but will be partially offset by existing monitoring.

6.5 Laboratory Quality Performance Assessments Through Intercalibrations and Other Assessment Techniques

Key Words: Quality Assurance, Intercalibration, Stormwater Chemistry

Problem Statement

One goal of the SMC is to compile monitoring data from separate monitoring programs to make regionwide assessments. The SMC has begun integrating their monitoring programs by agreeing on goals, objectives, and study designs as part of development of a southern California Model Monitoring Program. As part of the model monitoring program, 11 analytical laboratories that perform chemical analysis of runoff samples for SMC member agencies conducted an intercalibration study to assess interlaboratory variability and enhance comparability.

The laboratory intercalibration study quantified the range of variability both within and among laboratories that SMC member agencies can expect when examining their own data or combining data with other agencies. It was successful because the laboratories worked together to minimize interlaboratory variability through the use of performance-based limits for accuracy, precision, and sensitivity. The intercalibration study also defined a series of protocols for specific analytical techniques where performance-based guidelines needed to be enhanced with methodological consistency to ensure comparability. Finally, the intercalibration and resulting guidelines/protocols were documented in a Laboratory Guidance Manual for SMC member agency laboratories.

The laboratory Guidance Manual and intercalibration effort, however, was incomplete in three areas. The first area was the need to repeat the intercalibration periodically as new laboratories, or new personnel at existing laboratories, come along. The second area was the need to intercalibrate on additional constituents. The original laboratory calibration focused on suspended solids (TSS), nutrients, and trace metals. Organic constituents such as chlorinated hydrocarbons (CHC), organophosphorus pesticides (OP), and polycyclic aromatic hydrocarbons (PAH) were not included. Third, the laboratory performance-based guidelines were insufficiently integrated into monitoring programs. While the Laboratory Manual could be used as citation for monitoring agencies or regulatory compliance, no specific permitting or contractual language was provided for SMC member agencies.

Desired Outcome

The goal of this proposal is to complete the three areas of missing information to make the Laboratory Guidance Manual an ongoing and effective document. It will involve three steps: 1) repeat the laboratory intercalibration for TSS, nutrients, and trace metals; 2) initiate an intercalibration for organic constituents; and 3) create draft contract language for integration into stormwater monitoring programs.

Tasks / Steps Required to Achieve the Desired Outcomes

1. Create a Technical Committee comprised of participating laboratory managers
2. Create a study design with the Technical Advisory Committee to evaluate quality and comparability

3. Create and distribute challenge samples with known concentrations utilizing a variety of matrices (i.e., in DI water, in Stormwater from different watersheds, etc.) including blanks, blind to participating laboratories
4. Compile data and score each laboratory on comparability, as defined in Task 2 (prior to running samples)
5. Update existing Laboratory Guidance Manual with results from Tasks 1-4.

Project Schedule

It will take 18 to 24 months to complete this project, with potentially longer time if many organic constituents are attempted

Resources / Budget

This project is estimated to cost $75,000 to $150,000 to complete, depending on the number of contaminants the SMC wishes to intercalibrate. In general, organic contaminants are more challenging than general constituents, nutrients or trace metals.

7.0 EMERGING CHALLENGES

7.1 Understanding Water Quality Impacts of Unsheltered People Experiencing Homelessness

Subject Area / Key Words: Homeless, Trash, Bacteria

Problem Statement

SMC member agencies are charged with protecting water quality in areas where unsheltered people are experiencing homelessness, but their jurisdictional authority to address homelessness is limited. Meanwhile, the agencies that do have jurisdictional authority for homelessness do not have a mandate for water quality. The result is a perceived large and ongoing water quality impact by trash and bacteria in receiving waters from unsheltered people experiencing homelessness. Trash has the potential to accumulate because of a lack of solid waste collection near homeless encampments, and bacteria has the potential to accumulate if people are defecating in or near rivers, creeks and storm drains. If the actual extent and magnitude of these problems can be quantified, SMC member agencies will have a technical foundation upon which to engage in conversations with jurisdictional partners about how to optimally address these water quality issues, keeping these sites in compliance with statewide trash policies and bacteria TMDLs while supporting efforts to end homelessness.

Desired Outcome

This project will form a technical basis for formally engaging with the other agencies that have jurisdictional responsibilities for managing unsheltered people experiencing homelessness. The goal is to produce sufficient data to catalyze conversations about how to work collaboratively to achieve mutual goals of protecting people experiencing homelessness and maintaining water quality.

Tasks / Required to Achieve the Desired Outcomes

1) Conduct more frequent and targeted counts of people experiencing homelessness to enable more accurate counts of homeless populations near waterbodies of concern.

2) Consolidate trash and human waste data routinely collected when homeless encampments are “cleaned up.”

3) Plot these data in GIS to produce maps that illustrate the extent and magnitude of waste.

4) Target data collection efforts where data gaps exist.

5) Utilize Regional Stream Monitoring trash data to contextualize the extent and magnitude of trash pollution from homeless encampments.

6) Review case studies to evaluate how interventions (e.g., outreach services, legislative mandates) alter magnitude and extent of water quality impacts.

7) Conduct a workshop with agencies with homelessness jurisdictions to present data and plan future interactions.

Project Schedule

This project will require 12 months to complete. More time may be necessary based on increasing spatial scales.

Resources / Budget

This project is estimated to cost $50,000 to $75,000 to complete, depending on the accessibility of existing data and geographic extent of the mapping task. Bacteria studies to quantify inputs from people experiencing homeless already are being conducted in San Diego and the Inland Empire, so these efforts could be leveraged. A strong facilitator will be needed for the workshop to craft actionable steps for organizations that haven't interacted previously.

7.2 Ecological and Human Health Risks from Emerging Pollutants

Subject Area / Key Words: Emerging Pollutants, Health Risks

Problem Statement

SMC members have little information about potential impacts from contaminants of emerging concern (CECs) – sometimes called emerging pollutants – in runoff despite growing interest and concern about this issue from executive management and the public. Emerging pollutants include a wide variety of potentially harmful substances, from new pesticides to personal care products and pharmaceuticals to microplastics. Virtually no emerging pollutant data has been collected in dry- and wet-weather discharges, leaving SMC members empty-handed when asked questions about the presence of emerging contaminants in runoff. Without these data, SMC members also do not have the ability to correct potentially inaccurate perceptions about impacts from emerging contaminants, or offer a strategy for what should be done should impacts potentially occur. Thus, SMC members should be proactive in studying emerging pollutants to effectively manage real or perceived concerns.

Desired Outcome

This project will increase awareness of emerging contaminants and their impacts in runoff, and provide information needed to respond to potential problems or effectively minimize concerns about non-issues. The project will utilize a workshop to identify the riskiest emerging contaminants for SMC members and create a workplan for quantifying occurrence in runoff.

Tasks / Steps Required to Achieve the Desired Outcomes

1) Conduct a literature review to determine a list of emerging contaminants and their concentrations in southern California runoff.

2) Use the literature review to rank and prioritize the list of emerging contaminants to evaluate.

3) Utilize an Expert Workshop to review the risks from the list of emerging contaminants and whether they necessitate storm water program attention.

4) Produce SMC member agency guidance for addressing non-issue emerging contaminants and a workplan for emerging contaminants that require attention. The workplan may include

collecting additional data on concentrations in southern California if they currently do not exist.

Project Schedule

This project will require 12 months to complete, depending on the number of emerging contaminants to evaluate. Timing may need to be extended, depending on the availability of experts for the workshop.

Resources / Budget

This project is estimated to cost approximately $50,000 to complete, including travel and honorariums for expert workshop participants. The project team should include a chemist/toxicologist to conduct the literature review and a facilitator for the workshop. The State Water Board is running its own expert workshop on emerging contaminants for recycled water, which could be leveraged to support this project.

7.3 Predicting Future Hydromodification Impacts from Climate Change

Subject Area / Key Words: Hydromodification, Climate Change

Problem Statement

Hydromodification management strategies for protecting at-risk southern California streams may need to be updated to account for altered precipitation patterns stemming from climate change. Existing hydromodification plans required of most SMC members are based on a combination of slope, geology (erodibility), and historical climate (precipitation). These hydromodification plans were based, at least in part, on concepts and tools built by the SMC (Stein and Bledsoe 2013). However, with climate change generally predicting fewer, but more intense, rainfall events, these hydromodification management requirements may not be adequate to protect at-risk stream segments. Updates to hydromodification plans based on future climate scenarios may be necessary.

Desired Outcome

This project will produce updated risk maps for improved management decision-making associated with drainage-related standards and requirements. These maps may be adopted by SMC member agencies for updating their hydromodification plans.

Tasks / Steps Required to Achieve the Desired Outcomes

1) Down-scale regional predictions in rainfall and associated climate data.

2) Utilize existing hydromodification mapping tools to map at-risk and low-risk stream segments based on the new down-scaled precipitation predictions.

3) Identify changes to engineering standards and requirements.

Project Schedule

This project will be completed in 12 to 15 months. Because existing mapping tools will be used, the longest portion of the study is the temporal and spatial extent of precipitation down-scaling.

Resources / Budget

This project is estimated to cost $50,000 to $100,000, depending on the temporal and spatial extent of precipitation down-scaling. Researchers are already pursuing precipitation down-scaling work at UCLA and UCSD, which may be leveraged to reduce costs. Changes in engineering standards and requirements will be done by each individual SMC member agency, at their discretion, and is not part of the project budget.

7.4 Prioritization of True (Regulatory) Source Control Efforts

Subject Area / Key Words: True Source Control, Pollutants Regulations

Problem Statement

True source control is the SMC's preferred method for cleaning up stormwater, but this form of source control requires legislative or regulatory processes – an approach that is oftentimes slow and cumbersome and that SMC member agencies have only limited ability to influence. Despite these challenges, keeping pollutants out of the MS4 system is more effective than treating runoff for these pollutants. Multiple high-profile success stories underscore the effectiveness of true source control including removal of lead in gasoline, organophosphorus pesticides from agricultural and residential use, PBDEs as flame retardants, mercury in mining, and PCBs in transformers. Because of the probability for success, but the political challenges associated with source control implementation, SMC members need to be prudent and selective about which pollutants they pursue true source control for.

Desired Outcome

This project will produce a screening cost/benefit exercise, producing information for which pollutant(s) to prioritize for true source control efforts. The pollutants that can most effectively be controlled through true source control (instead of treatment) will be prioritized. Then, the project will identify agencies and other potential partners for pursuing these priority source control efforts. The actual source control legislation or regulation will be a separate project.

Tasks / Steps Required to Achieve the Desired Outcomes

1) Identify a list of potential pollutants for source control efforts.

2) Determine cost to implement regulatory source control vs. other management strategies to achieve the same outcome (benefit) for each pollutant/pollutant category.

3) Conduct a technical workshop with the SMC to validate data and findings.

4) Utilize the SMC to lead information sharing with interested parties.

Project Schedule

This project will require 15 to 20 months to complete, depending on the number of pollutants to be considered and number of options to be evaluated.

Resources / Budget

This project is estimated to cost $100,000 to $150,000, including the cost/benefit analysis, the workshop, and the outreach to interested parties. Although the project will utilize standard, accepted practices, the project will require an economist and a stormwater manager familiar with the pollutant(s) of concern and viable management options. There may be limitations based on availability of pollutant data and extrapolation of cost estimates. A potential project partner is CASQA who have been a track record of successful true source control efforts.

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