The following is an excerpt from the Stormwater Recharge Monitoring Method [MM-04]

SGM Grant Program Requirements for Post-Performance Monitoring and Reporting

Stormwater Recharge Monitoring Method

Project / Action Type	Providing groundwater recharge in an urban environment using Low Impact Development (LID), regional, and distributed structural best management practices (BMP) stormwater facilities.
Similar / Related Project Types	Groundwater recharge projects (Flood-MAR, Recharge Ponds, and ASR) are directly related and often use the same implementation approaches.
Metric	Groundwater levels. Applicable water quality constituents. Groundwater storage (situationally). Change in ground levels (situationally).
Measurement Unit	Groundwater levels measured in feet in a consistent vertical datum. Concentration or measurement of applicable groundwater quality constituents (typically mg/L), potential constituents include microbial communities, nitrogen, salts, metals, pesticides, or any other applicable constituent of concern.
Beneficial User	Municipal and domestic water supply (MUN) Agricultural water supply (AGR) Groundwater recharge (GWR) Freshwater replenishment to surface waters (FRSH)

Approach to Implementing Stormwater Recharge Monitoring

Stormwater infiltration projects deliver multiple benefits, such as water supply reliability, flood mitigation, groundwater recharge, habitat creation, and water quality improvements. Some of the main challenges with developing stormwater projects are related to costs, metering, data collection, and water supply yield. The relationship between stormwater capture and yield has not been extensively analyzed. In addition, most projects do not demonstrate a direct link to increased groundwater production or yield. This limits the ability to fully characterize stormwater capture project costs or to quantify the water supply benefit. Monitoring of stormwater projects has historically been limited, but monitoring is slowly being undertaken across different states as permitting agencies are starting to require more proof of treatment.

Justification

Achieving groundwater sustainability will require a multi-faceted approach. Distributed projects are usually designed for multiple benefits, with one of them being groundwater recharge. Distributed projects generally provide smaller capture volumes, yet meaningfully contribute to regional recharge if implemented on a broad scale. Additionally, because of their multiple benefits (e.g., water quality improvement, recreation, open space, and habitat restoration), there are ample partnership opportunities with other agencies that justify the importance of these projects for monitoring and review.

An analysis by the Pacific Institute, University of California, Santa Barbara (UCSB), and the Natural Resources Defense Council found that infiltration of runoff to recharge groundwater and rooftop rainwater capture in urbanized Southern California and the San Francisco Bay would provide an additional 420,000 to 630,000 acre-feet per year to local water supplies (Garrison, et al, 2014). This would represent approximately 5% to 8% of the average annual statewide urban water use.

Urban stormwater capture represents a significant opportunity to enhance community resiliency to climate change. With longer drought periods and heavier rainfall events becoming more common, effective urban stormwater capture provides an opportunity for addressing flood management and water quality impairments while also improving water supply reliability.

At a minimum, the monitoring methods for distributed and regional projects should measure the volume and quality of stormwater entering the facility. Most projects do not have flow monitoring in place because monitoring devices are expensive and/or there insufficient funding to support staff to collect metering data. This is a data gap that should be addressed to continue research and quantify the recharge benefits of stormwater.

Primary Monitoring

Local groundwater levels and groundwater quality are the primary monitoring needs for assessing benefits and impacts of distributed and regional stormwater projects. Individual monitoring for both distributed and regional systems can be challenging, and approaches where a representative stormwater facility is used and those rates applied to a larger community may be appropriate. The monitoring approaches for these parameters are discussed in detail in the step-by-step guide below.

Secondary Monitoring

The number of storms, volume of events, and percent of volume recharged to groundwater provide an understanding of recharge benefits of distributed and regional projects. Understanding groundwater recharge volume is the primary parameter to assess project effectiveness. Recharge volumes are generally assessed on an annual basis due to monthly variations in rainfall events.

Assessing the quality of the recharged water is also important, but more difficult to monitor as stormwater flow is event-based. However, periodic monitoring of water quality should be undertaken to understand the baseline water quality that is being recharged through the stormwater recharge systems.

Other Useful Monitoring

Stormwater facilities have a useful design life, generally based on the infiltration capacity of the underlying soil. Periodic checks on the soil infiltration rates can provide an understanding of the remaining useful life of the facility for groundwater recharge.

A Step-by-Step Guide to Applying Stormwater Recharge Method

Implementation of an appropriate and effective monitoring method for stormwater projects includes the following strategies and steps with references to relevant DWR's Best Management Practices (BMP) (DWR, 2016) for additional considerations and details:

1. **Project identification for groundwater recharge:** Identify the project, and if the project meets the criteria above to be monitored under the Stormwater Recharge Monitoring Method (MM-04). The underlaying hydrogeology will play an important part in understanding the ability for the project to provide beneficial groundwater recharge.
1. **Permitting:** Identify local agencies for NPDES MS4 permits or other regulations related to stormwater discharge permits. Work with the local agency design standards for stormwater control and treatment. NPDES MS4 permits will also set design standards based on the location of the project.
2. **Water rights:** Check and confirm the project proponent has access to water supply, such that other's water rights will not be infringed.
3. **System operations:** Step up an Operations and Maintenance / Monitoring Plan based on discharge permits, and primary, secondary, and/or additional monitoring requirements.

Primary Monitoring Method

1. **Safety plan:** All projects with fieldwork related activities should produce a Safety Plan. Planning for fieldwork and availability of access to the site, such as monitoring wells, is necessary to maintain project safety. Stormwater recharge projects may require a Safety Plan to address these and other potential safety concerns.
2. **Design a monitoring well network consistent with Groundwater Sustainability Plan Regulations and guidelines specified in DWR's BMP 2 Monitoring Networks and Identification of Data Gaps** (DWR, 2016)**:** Rely on existing wells and monitoring systems already in place. The monitoring network should be capable of capturing data on a sufficient temporal frequency and spatial distribution to demonstrate short-term, seasonal, and long-term trends. (Note that due to resolution associated with the groundwater monitoring wells, this may not be possible for any given location). For additional information, see the Recharge Ponds Monitoring Method (MM-02); however, given the generally smaller nature of stormwater recharge systems, not all the monitoring procedures presented in the Recharge Ponds Monitoring Method will be feasible. The economic feasibility of monitoring can play a role in the extent of monitoring that can be accomplished by the project proponent. The location of the monitoring network should be easily accessible such that gaining access to the site does not inhibit gathering and downloading data (refer to Step 1).
1. **Design a monitoring method for constituents of concern:** Based on the site and potential constituents of concern in the stormwater, various constituents may require monitoring. The parameters will generally be based on the local beneficial uses of the groundwater. Constituents of concern can include oil and greases, pH, turbidity, and fecal coliforms. Additional parameters may include metals, nitrates, salinity (or Total Dissolved Solids), toxicity, and radionuclides. Baseline monitoring of the constituents of concern should be performed prior to implementing any stormwater recharge project in order to identify any degradation to groundwater quality caused by the recharge project. The monitoring of the constituents of concern are separated into two systems:
   a. **Storm event water quality monitoring:** Monitoring of the stormwater runoff entering and exiting the system to monitor the treatment effectiveness of the facility.
   b. **Groundwater quality monitoring:** After storm events, groundwater quality for constituents of concern should be measured. The frequency should be dependent on the results, starting with monthly monitoring, and then reducing to annually at the conclusion of the wet season if constituent concentrations are not presenting a concern.
2. **Implement monitoring of monitoring wells:** Protocols for monitoring of groundwater levels and groundwater quality are addressed in DWR's BMP 1 Monitoring Protocols Standards and Sites (DWR, 2016). Conduct "baseline monitoring" in the monitoring wells prior to commencement of recharge operations to document groundwater levels and trends, and to characterize ambient groundwater quality and trends. While baseline monitoring for groundwater levels and quality should be conducted at a minimum prior to commencement of recharge operations, collecting baseline monitoring for at least one year before recharge operations during prior seasonal low and seasonal high groundwater

level periods is recommended. This would provide a more robust dataset to compare to project implementation data, should groundwater level or quality impacts occur.

Secondary Monitoring Method

1. **Implement monitoring of water deliveries starting at commencement of recharge operations:** Monitoring for instantaneous flow rates should be as frequent as practicable, if conducted manually, and should be no less frequent than hourly, if measured electronically (data stored in a datalogger or web-based application). Measurements of total cumulative volume should be obtained commensurate with instantaneous flow rate measurements. Verify that the system is maintained for recharge as designed.

Other Useful Monitoring Method

1. **Implement monitoring of infiltration rates:** Use either the wetting cycle calculation method (volume infiltrated during wet weather) or falling-head method (rate of water level decline in a pond); for both methods, the water volume lost to evapotranspiration can be factored in. The frequency of monitoring will depend on the condition of the soil and observational assessment of the infiltration rates.

Data and Protocol - Fundamentals

For stormwater recharge projects to be eligible for monitoring they should be large enough, or a collection of enough small projects in a similar area to justify the cost associated with the monitoring equipment and labor. The projects should also be able to show that infiltrated water has the capacity to reach the groundwater based on hydrogeologic conditions. A conceptual model of the site, underlying geology, and groundwater conditions would be needed. Table 1 provides an example of summary parameters to use in a monitoring report for stormwater recharge projects.

***Table 1*. Example Data Monitoring Report (Generally Annually)**

Annual Monitoring Report	
Number of storm events	XXX
Total stormwater volume Wet weather volume Dry weather volume	XXX AF Total XXX AF XXX AF
Total stormwater captured	XXX AF
Total stormwater that reaches pumping aquifer	XXX AF
Percent of capture that reaches pumping aquifer	XXX %
Groundwater Basin Recharged	XX Basin
Incurred Costs	$XXX

Data Analysis and Reporting

1. **Analyze monitoring data:** Monitoring data should be used to evaluate the effectiveness and performance, determine any limiting factors on performance, and identify options for improving performance if needed. This assessment also includes evaluating possible increasing concerns, as recharge continues, for causing unreasonable harm to nearby land or beneficial water uses and if/how recharge operations can be better managed to avoid significant risks.
2. **Prepare reports and manage data:** Includes compliance with regulatory and grant requirements and providing data to DWR, which is addressed in the Data Management and Monitoring Method (MM-12). Generally, data will be uploaded to the DWR system annually and progress on project implementation and monitoring will be provided in the annual report.

Key Protocols

The local NPDES MS4 permit specifies the effluent limitations for pollutants and establishes intervals for stormwater monitoring and water sampling at receiving waterbodies. **NPDES** MS4 permit requirements need to be followed for the type, location, frequency, and constituents sampled. For additional information see the NPDES Storm Water Sampling Guidance Document (EPA,1992).

In addition to sampling receiving water bodies for water quality trends, a clear method should be implemented to quantify water supply benefits. Typically, this can be done using a design storm event approach that a project will capture and forecasting how many of those full capture events will occur annually.

Data Standards

Groundwater, surface water, and water quality monitoring data should conform to the technical and reporting standards of the California Water Code (CWC) §352 et seq.

Groundwater elevation – Measurements should be recorded relative to a consistent vertical datum.

Groundwater quality – Concentrations of groundwater quality constituents of concern should be compared to **maximum contaminant levels (MCLs)** available from the California State Water Resources Control Board.

KEY TERMS

The **National Pollutant Discharge Elimination System (NPDES)** permit program addresses water pollution by regulating point sources that discharge pollutants to waters of the United States.

Drinking water standards are called **maximum contaminant levels (MCLs)**. MCLs are found in Title 22 of the California Code of Regulations.

Primary MCLs address health concerns. Esthetics such as taste and odor are addressed by secondary MCLs

State regulations addressing the treatment, storage, processing, or disposal of waste are contained in Title 27 of the California Code of Regulations. Waste discharges that can be exempted from requirements are issued **waste discharge requirements** and are regulated by the Waste Discharge Requirement Program

The sustainable management criteria in the regional Groundwater Sustainability Plan will help identify when groundwater recharge is needed to achieve sustainability and project benefits. Concentrations of groundwater quality constituents of concern should be compared to MCLs from the State Water Resources Control Board. NPDES permits or **waste discharge requirements** may be applicable to the project.