BAY AREA MUNICIPAL
STORMWATER COLLABORATIVE (BAMSC)

QUALITY ASSURANCE PROJECT PLAN

VERSION 1.1 - LOW IMPACT DEVELOPMENT MONITORING

Submitted in compliance with the San Francisco Bay Municipal Regional Stormwater National Pollutant Discharge Elimination System (NPDES) Permit, Order No. R2-2022-0018, Provision C.8.d.

Final

Prepared on behalf of:

Alameda Countywide Clean Water Program
Contra Costa Clean Water Program
San Mateo Countywide Water Pollution Prevention Program
Santa Clara Valley Urban Runoff Pollution Prevention Program
Solano Stormwater Alliance

October 31, 2024

1. (A1) Title and Approval Sheet

Program Title	Low Impact Development Monitoring for the Bay Area Municipal Stormwater Collaborative Stormwater Programs
Lead Organization	Bay Area Municipal Stormwater Management Collaborative (BAMSC)
Primary Contact	Lisa Sabin
Effective Date	10/31/2024
Responsible Organization	BAMSC
Revision Number	1.1

1.1. Approval Signatures:

Table 1-1. Project Team Approval Signatures

Title	Name	Signature	Date
BAMSC Lead	Lisa Sabin		
ACCWP Rep	Jim Scanlin		
CCCWP Rep	Karin Graves		
SCVURPPP Rep	Adam Olivieri		
SMCWPPP Rep	Reid Bogert		
SSA Rep	Meg Herston		
Water Board Rep	Keith Lichten		
QAPP Author	Paul Salop		

2. (A2) Table of Contents

List of Figures

List of Tables

3. (A3) Distribution List and Contact Information

Table 3-1. QAPP Distribution List

Title	Name and Affiliation	Contact Information (Telephone; Email)	QAPP #
QAPP Author	Paul Salop, AMS	925-373-7142 salop@amarine.com	1
BAMSC Project Lead	Lisa Sabin, EOA	510-832-2852 x108 ldsabin@eoainc.com	2
ACCWP Program Mgr	Jim Scanlin, ACCWP	510-578-4539 James.scanlin@newark.org	3
CCCWP Program Mgr	Karin Graves, CCCWP	925-313-2042 Karin.Graves@pw.cccounty.us	4
SCVURPPP Program Mgr	Adam Olivieri, SCVURPPP	510-832-2852 awo@eoainc.com	5
SMCWPPP Program Mgr	Reid Bogert, SMCWPPP	650-599-1433 rbogert@smcgov.org	6
SSA Program Mgr	Meg Herston, SSA	707-429-8930 mherston@fssd.com	7
Water Board Liaison	Keith Lichten	510-622-2380 keith.lichten@waterboards.ca.gov	8
Lab Project Mgr, Caltest	Sonya Allahyari	707-258-4000 Sonya_Allahyari@caltestlabs.com	9
Lab Project Mgr, Enthalpy Analytical (formerly Vista Analytical)	Kathy Zipp	916-673-1520 x112 kathy.zipp@enthalpy.com	10

4. (A4) Program Organization

4.1. Involved Parties and Roles

The Bay Area Municipal Stormwater Collaborative (BAMSC) was organized in June 2021 by the Bay Area Stormwater Management Agencies Association (BASMAA) Board of Directors to continue the information sharing and permittee advocacy functions of BASMAA in an informal manner after BASMAA's dissolution. BAMSC has taken on an organizing role in supporting the Bay Area stormwater Programs in meeting the permit requirements of the re-issued Municipal Regional Stormwater Permit (MRP3) issued May 2022 (Order No. R2-2022-0018, NPDES Permit No. CAS612008).

Section C.8.d of MRP3 specifies permit requirements associated with Low Impact Development (LID) monitoring. MRP3 identifies specific monitoring intensities to be completed during the permit term by the following agencies: (1) Alameda Countywide Clean Water Program (ACCWP), (2) Contra Costa Clean Water Program (CCCWP), (3) San Mateo Countywide Water Pollution Prevention Program (SMCWPPP), (4) Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP), and (5) Solano Stormwater Alliance (SSA). These five Programs have agreed to work in a collaborative fashion to implement an LID monitoring project (the Project), with Programs responsible for all monitoring conducted within that Program's jurisdiction, and coordinated efforts to address planning, assessment, and reporting needs common to all.

The collaborative effort will be supported by a Technical Advisory Group (TAG) convened to assist with planning and implementation. TAG members will not be responsible for data collected through project implementation, but will support overall monitoring design and adaptive management.

Individual Programs will be responsible for all data collection, management, quality assurance, and reporting associated with monitoring conducted within their jurisdiction. As such, each will be responsible for ensuring that monitoring efforts meet the specifications of this QAPP.

Contract laboratories (Caltest and Enthalpy) will be responsible for some aspects of supporting field sampling programs (e.g., equipment cleaning, blanking, sample handling) as coordinated with individual stormwater Programs and all laboratory analyses. Enthalpy will be responsible for analysis of PCBs and PFAS, while Caltest will be responsible for all other Project analyses. Each will be responsible for ensuring that methods employed are consistent with internal QA programs and standard methods.

Figure 4-1 shows the organization structure. Table 3-1 contains contact information for key project participants. Responsibilities of key project personnel are detailed in the sections that follow.

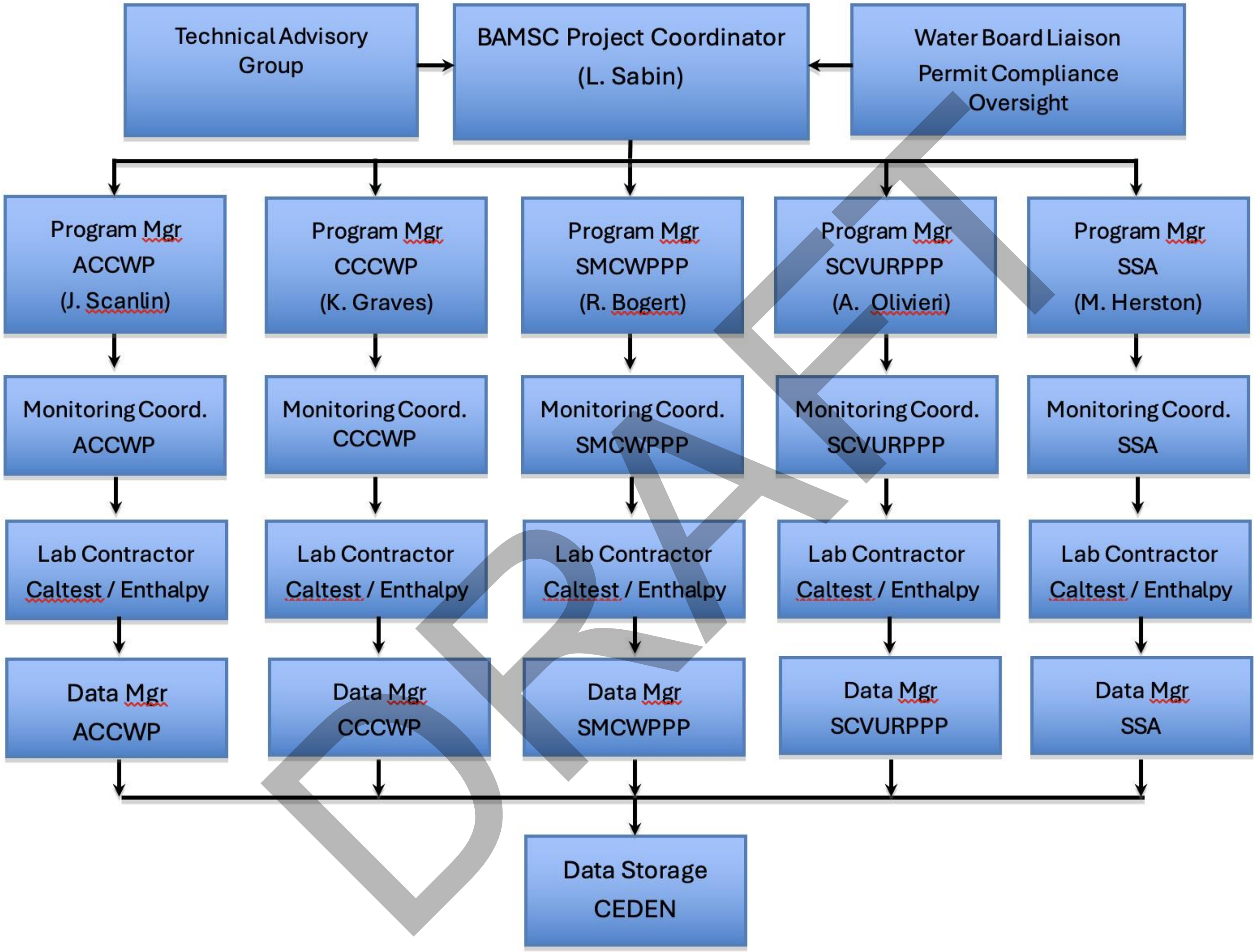

Figure 4-1. LID Monitoring Project Organizational Structure

4.1.1.BAMSC Project Coordinator

The BAMSC Project Coordinator (PC) will be responsible for coordinating efforts that are completed on a regional basis in support of the Project. They will be responsible for management of any projects initiated to support tasks of regional benefit, including development of the project QAPP. The PC will also be responsible for convening the TAG and supporting TAG members in completion of required efforts.

4.1.1.Technical Advisory Group Role

The PC will be assisted in design and implementation of programmatic activities by a Technical Advisory Group (TAG) consisting of representatives from academia, agencies, and other acknowledged experts in the field of LID monitoring. TAG members will assist the PC in developing a monitoring design that can both practical and informative while best ensuring compliance with MRP3 permit requirements.

4.1.1.Stormwater Program Manager

Each Stormwater Program Manager (SPM) will be responsible for managing all Project-associated activities conducted under the jurisdiction of a given county stormwater Program. In this role, the SPM will be responsible for day-to-day management or oversight of Project-related activities for their Program, including permitting, budgeting, reporting, and oversight of subcontractors.

4.1.2.Monitoring Coordinator

Each Monitoring Coordinator (MC) will be assigned at the stormwater Program level and will be responsible for all monitoring-related activities conducted for that stormwater Program. As such, the MC will be responsible for all aspects of monitoring conducted on behalf of the individual stormwater Program, including data collection, data management, quality assurance, and reporting.

4.1.3.Laboratory Project Manager Role

Each Laboratory Project Manager (LPR) and chemists at each selected analytical laboratory contractor will be responsible for ensuring that the laboratory's quality assurance program and standard operating procedures (SOPs) are consistent with this QAPP, and that laboratory analyses meet all applicable requirements or explain any deviations. Each LPM will also be responsible for coordinating with the individual MCs or their designees as required for the project.

4.1.4.Data Manager Role

Each Data Manager (DM) will be assigned at the Program level and will be responsible for taking laboratory deliverables through the QA review and data management process. The DM will oversee a review process to confirm that laboratory deliverables meet all Project requirements and will coordinate with LPRs to generate revised submittals as appropriate. DMs will be responsible for submittal of approved Project EDDs to the California Environmental Data Exchange Network (CEDEN).

4.1.5.Water Board Liaison Role

5. The Water Board Liaison will be responsible for oversight of the overall Program for Permit compliance. The Liaison will also serve as the link between stormwater Programs and TAG and will serve as initial point of contact for stormwater Programs as part of the

adaptive management component of monitoring program design and implementation. (A5) Problem Definition/Background

5.1. Problem Statement

PCBs, mercury and other sediment-bound pollutants are found in San Francisco Bay water, sediments, and biota. Concentrations of PCBs and mercury in certain Bay fish exceed target levels and may pose a health risk to people who consume fish caught in the Bay. As a result, the California Office of Environmental Health Hazard Assessment issued an advisory on the consumption of fish from the Bay. Thus it was established that a vital beneficial use of the Bay, commercial and sport fishing, is not attained, with local subsistence fishers and their families being of particular concern. This led to the Bay being designated an impaired water body on the Clean Water Act "303(d) list" due to PCBs and mercury. In response, the Regional Water Board has developed comprehensive TMDL programs to identify and control sources of PCBs and mercury to the Bay and restore water quality.

It has long been suspected that municipal stormwater discharges may contribute to the PCB and mercury water quality problem in the Bay, but before the year 2000 there was little direct evidence to support this hypothesis. BASMAA agencies addressed this data gap by surveying concentrations of PCBs and mercury in bedded sediments collected from stormwater conveyances (e.g., catch basins, storm drain system piping, stormwater pump station sumps, flood control channels, and creeks) throughout the Bay Area during the fall of 2000 and 2001. This project is referred to as the Joint Stormwater Agency Project (JSAP). PCB and mercury concentrations were highly variable in urban locations, but ranged up to three orders of magnitude higher than in open space areas. Concentrations were also up to two orders of magnitude higher in urban sediment than in Bay surface sediments collected and analyzed by the Regional Monitoring Program for Water Quality in the San Francisco Estuary (RMP), suggesting that urban runoff may impact the Bay.

Over the next several years following the JSAP, individual stormwater programs performed case studies in selected urban areas with relatively elevated pollutant concentrations to begin identifying sources and controls, with a focus on PCBs. The techniques employed included further collection and analysis of bedded sediment samples and research on historical and current land use.

In the early 2010s, the Bay Area Stormwater Management Agencies Association (BASMAA) was awarded a multi-million dollar grant from USEPA San Francisco Bay Water Quality Improvement Fund to assist stormwater management agencies in understanding and addressing high priority pollutants to San Francisco Bay. The purpose of the Clean Watersheds for a Clean Bay (CW4CB) project was to contribute to the development of a comprehensive regional strategy for reducing PCBs and mercury loads in urban runoff to the Bay in accordance with the Total Maximum Daily Load (TMDL) plans for those pollutants. The project focused its efforts in watersheds that are suspected of contributing important loads of PCBs and other pollutants to San Francisco Bay. The CW4CB project consisted of multiple related efforts such as pilot testing pollutant control measures in locations where benefits were expected to be the greatest and evaluating the load reduction effectiveness of those measures, as well as public risk communication and other outreach efforts.

Of particular relevance to this effort, one task conducted through CW4CB used federal and local matching funds to design and install multiple urban stormwater treatment retrofit projects throughout the Bay Area and monitoring their pollutant removal efficiencies. Given the constraints of the CW4CB project, a monitoring design was developed to assess treatment retrofit projects that focused on collection of multiple discrete water quality samples collected around the hydrograph peak for analysis of the priority pollutants mercury, PCBs, and convention parameters. Monitoring was further constrained by the limited number of viable storms that presented during the Grant period, which resulted in an extension of the project to capture additional storms, and individual structural controls that did not perform as intended (e.g., tidal influence that limited on-station time at one facility, infiltration of pollutants from underlying contaminated soils at another).

MRP3 contains permit language associated with both implementation of LID concepts in the environment as well as requirements for monitoring their hydrologic function and pollutant removal capability. Monitoring Project implementation is intended to address both of these areas.

5.2. Decisions or Outcomes

The Project objective is to further evaluate a variety of potential control options to reduce mass loadings of priority pollutants in urban stormwater runoff to the Bay and thus lay the groundwork for achieving TMDL waste load allocations in the future. The Project will build upon the understanding that was gained through CW4CB implementation. It will incorporate monitoring at locations that represent a broad range of LID options, including some that were monitored immediately after construction through CW4CB, and others that have been developed outside of CW4CB.

The Project does differ from CW4CB monitoring in some key areas. First, the proposed monitoring will incorporate additional analytes not included in the original CW4CB monitoring and, in some cases, for which there is limited relevant data available for stormwater in the Bay Area. Monitoring requirements will include analysis of total and dissolved copper, total and dissolved zinc, pH, hardness, TPH, and PFAS in addition to the CW4CB priority constituents (PCBs, Hg, TSS). It should be kept in mind that not all analytes are conducive to collection via a single autosampler (e.g., PFAS, TPH, Hg); this issue is expected to be discussed and resolved through coordination with the Project TAG (see discussion in Section 11.1.1).

Project-related monitoring activities will also rely on full-storm monitoring to generate event mean concentrations (EMCs) rather than focusing on a subset of the overall storm; this requirement does come with some additional risk (e.g., vandalism or other equipment failure), which should be kept in mind during the planning and reporting process.

The successful Project outcome will further inform a comprehensive regional strategy for reducing pollutant loads in urban runoff while achieving the LID monitoring requirements of MRP3.

6. (A6) Program/Task Description

6.1. Work Statement and Produced Products

Project efforts will include automated sampling of constructed stormwater treatment facilities to gauge hydrologic condition and pollutant removal efficiencies. Monitored facilities will cover a variety of treatment types and will be spread through the five-county region. Prospective treatment facilities to be monitoring through Project implementation are identified in Table 6-1.

Table 6-1. Prospective Structural Treatment Monitoring Locations

Program	Site ID	Lat (Centroid)	Long (Centroid)	Facility Description
ACCWP	OAB-18E	37.81997	-122.29929	Lined bioretention facility with underdrain
ACCWP	OAB-18W	37.81990	-122.29955	Lined bioretention facility with underdrain
CCCWP	Ohlone Grnwy	37.90186	-121.29802	Unlined bioretention with underdrain
SMCWPPP	SMD	37.68361	-122.40281	Unlined bioretention facility with underdrain
SMCWPPP	SMS	37.68110	-122.39895	Unlined bioretention facility with underdrain
SCVURPPP	TCM4	37.42473	-121.97160	Unlined bioretention facility with underdrain
SCVURPPP	TCM6	37.42423	-121.96960	Unlined bioretention facility with underdrain
SSA	SSA-LOTZ	38.24377	-122.03914	Unlined bioretention facility with underdrain

6.2. Sampling Detail

The Project will include water quality sampling to evaluate effectiveness of stormwater treatment structural controls. These efforts are briefly described below and will be discussed in more detail in Monitoring Plans (MPs) developed by individual stormwater Programs and reviewed by the TAG.

Each County Stormwater Program will be responsible for conduct of effectiveness evaluations at identified stormwater treatment structural controls; minimum levels of effort to be completed during the permit term are identified in MRP3 §C.8.d, Table 8.d.2, LID Monitoring Intensities and Parameters. Using appropriate techniques, Project staff will collect water samples for chemical analysis from appropriate locations to evaluate and quantify the removal of select pollutants by the stormwater treatment structural controls. The goal will be to expand our understanding of the function of monitored facilities in their capabilities to help reduce loadings of high priority pollutants to receiving waters and their practicality for further expansion in the developed environment.

As part of Project implementation, field crews will collect water quality samples for analysis of total and dissolved mercury, total PCBs, total suspended solids (TSS), per-and polyfluoroalkyl substances (PFAS), total petroleum hydrocarbons (TPH) as diesel / motor oil, total and dissolved copper, total and dissolved zinc, total hardness, and pH from influent and effluent locations at a given structural treatment facility. Consistent with MRP3 permit requirements, samples will be collected as flow-weighted composite samples collected over the effective duration of the storm event in order to generate event mean concentration (EMC) results for analytical parameters. Time-weighted composites are allowed if they have many subsamples and can be closely approximated as flow-weighted composites. Full details associated with monitoring conducted by each collaborating Stormwater Program are included in Program-specific monitoring plans (AMS 2023, CCCWP 2023, SMCWPPP 2023, SCVURPPP 2023, and SSA 2023).

6.3. Project Schedule

The schedule of activities related to Project fieldwork and reporting deliverables is summarized in Table Table 6-2.

Table 6-2. Schedule of Project Activities.

Activity	Date of Initiation	Planned Date of Completion	Deliverable
Draft project QAPP to TAG	9/30/22	11/15//22	Draft QAPP
Final project QAPP	11/15//22	3/31/23	Approved QAPP
Draft MPs to TAG (4, county-based)	11/1/22	2/29/23	Draft MPs
Monitoring planning and prep	10/1/22	9/30/23	Permitting, equipment procurement and testing, lab contracting
Water Year (WY)23 status update	10/1/23	3/31/24	LID Monitoring Status Report in UCMR
WY24 monitoring	10/1/23	4/30/24	MRP3 Table 8.d.2 minimum Level of Effort (LOE)
WY24 data mgmt. and reporting	5/1/24	9/30/24	Data mgmt., quality assurance, interpretation
WY24 status update	10/1/24	3/31/25	LID Monitoring Status Report in UCMR
WY24 electronic data delivery	10/1/24	3/31/25	Data delivery to CEDEN
WY25 monitoring	10/1/24	4/30/25	MRP3 Table 8.d.2 minimum LOE
WY25 data mgmt. and reporting	5/1/25	9/30/25	Data mgmt., quality assurance, interpretation
WY25 status update	10/1/25	3/31/26	LID Monitoring Status Report in Integrated Monitoring Report (IMR)
WY25 electronic data delivery	10/1/25	3/31/26	Data delivery to CEDEN
WY26 monitoring	10/1/25	4/30/26	MRP3 Table 8.d.2 minimum LOE
WY26 data mgmt. and reporting	5/1/26	9/30/26	Data mgmt., quality assurance, interpretation
WY26 status update	10/1/26	3/31/27	LID Monitoring Status Report in

Activity	Date of Initiation	Planned Date of Completion	Deliverable
			UCMR
WY26 electronic data delivery	10/1/26	3/31/27	Data delivery to CEDEN
WY27 monitoring	10/1/26	4/30/27	MRP3 Table 8.d.2 minimum LOE
WY27 data mgmt. and reporting	5/1/27	9/30/27	Data mgmt., quality assurance, interpretation
WY27 status update	10/1/27	3/31/28	LID Monitoring Status Report in UCMR
WY27 electronic data delivery	10/1/27	3/31/28	Data delivery to CEDEN

Mobilization time for each individual sampling activity will be used to conduct all the preparations and training sessions needed to get the field crews ready and equipped. The sampling trips will be conducted at varying frequencies and times dependent on Project needs and requirements; exact timing will be determined based upon outcomes of prioritization efforts, personnel availability, weather conditions, and ability to obtain access. Laboratory analyses will follow sample collection efforts, and the above-mentioned reporting products will provide and interpret findings of laboratory investigations. Individual Program-specific MPs will provide additional detail.

6.4. Geographical Setting

Field operations will be conducted in selected watersheds within the San Francisco Bay region, within the counties of San Mateo, Santa Clara, Alameda, Contra Costa, and Solano. Study areas will be in selected urbanized portions of watersheds within those counties with appropriate structural facilities capable of being monitored. Catchments are described briefly below and in more detail in Program-specific MPs and list of initial sampling sites is shown in Figure 6-1.

6.4.1. ACCWP

ACCWP Project-related activities will be conducted at a lined bioretention planter box located in an area of Bay fill near the eastern end of the San Francisco Bay Bridge. The surrounding area sits within the Oakland Army Base (OAB) redevelopment project and is characterized by significant industrial, commercial, and transportation uses. Drainage from this catchment flows directly to the Bay through an outfall near the western end of Burma Rd. The MS4 system here is tidally-influenced, but tidal flow is not anticipated to affect monitoring operations at the proposed project location.

6.4.2. CCCWP

All CCCWP monitoring will conducted at the Ohlone Greenway Rain Garden, a bioretention basin located at the southwestern corner of Fairmont Avenue and Richmond Street in El Cerrito. This facility was constructed in 2014 and provides treatment of approximately 1.7 acres along the south side of Fairmont Avenue, including runoff from older single family residential and mixed land uses.

6.4.3. SMCWPPP

SMCWPPP Project-related activities will be conducted at two treatment facilities in the same catchment. These facilities are both public green streets in the City of Brisbane that are located within Watershed Management Area (WMA) #17. Stormwater in this catchment drains to Guadalupe Valley Creek. The catchment consists of 9 acres of new urban, 191 acres of old industrial, 90 acres of old commercial/transportation, 324 acres of old residential, and the rest is open space.

6.4.4. SCVURPPP

SCVURPPP Project-related activities will be conducted at two facilities located within the 181 square mile Guadalupe River watershed in San Jose, CA. The two facilities are part of the Top Golf Public Green Street Bioretention Project, which is located within a 240 acre catchment located in the Alviso neighborhood of the City of San Jose. The catchment is located within the lower portion of the Guadalupe River watershed. Stormwater in the catchment flows roughly to the north-east and drains to the Alviso Pump Station, where is it pumped directly into the Guadalupe River just upstream of where the river connects to the Alviso Slough. Land uses in the catchment include approximately 30 acres of old industrial, 20 acres of old commercial/transportation, 100 acres of old residential, 41 acres of new urban, and the remaining areas are open space.

6.4.5. SSA

SSA’s proposed treatment retrofit is associated with an existing Amtrak Park and Ride Lot located between Lotz Way and Highway 12 in Suisun City. The surrounding drainage area is approximately 4.3 acres with narrow landscaped islands between the parking bays and conventional drainage infrastructure including curbs, gutters, and curb inlets that allow the runoff to flow into the storm drain system. The overall retrofit project incorporates two trash capture devices and 4,856 square feet of bioswale creation at the eastern edge of the existing parking lot. There are multiple influent and effluent points for the bioswale, but monitoring will focus on an area on the north end of the swale that will be isolated with single influent and effluent sampling points. The Park and Ride Lot is located within Caltrans’ right-of-way and the project will be implemented in partnership with Caltrans District 4 through a Cooperative Implementation Agreement.

Figure 6-1. LID Monitoring Sites

6.5. Constraints

Lack of sufficient rainfall, problems in accessing the planned monitoring locations for a given storm, complexities associated with instrumentation of individual sampling sites, vandalism or equipment failure at unstaffed locations, or unanticipated analytical difficulties (such as interferences requiring selection of other methods, accepting higher detection levels, or requiring additional clean-up of samples prior to their analysis) could result in fewer locations or samples being reported in a given year or across the permit term.

Sampling and sample handling protocols differ across the various methods that make up the analytical program, which means that trade-off must be made in sampling methodologies employed and may result in collection methods deviating from standard methods. Lower measurement quality would result in lowering data quality objectives for the project. Specifically, using a single sampling apparatus to collect sample media in order to generate EMC monitoring data means that sampling protocols are not tailored to individual analytes, but are selected as best fit for the entire analytical program. For example, Teflon™ tubing that is used typically for collection of low-level mercury samples would be wholly inappropriate for collection of PFAS samples, which are typically collected directly into individual pre-cleaned sample containers. Sampling protocols have therefore been designed to satisfy permit terms while generating meaningful comparisons between influent and effluent concentrations and are discussed in more detail in Section 11 and Program-specific MPs.

Another constraint is the uncertainty associated with sampling wet weather events. This project is complicated by the uncertain relationship between precipitation timing and intensity and the onset and duration of flow at the project stations. Communication with the Monitoring Coordinator will limit the probability of false starts, but there is no control over drought conditions should they occur. To minimize the occurrence of unsampled discharge events and false starts, mobilization criteria will be established for each monitoring station based on discharge statistics once they are developed. For the first storm at a station, such statistics may not exist. In this case, estimates of catchment areas and runoff coefficients, and rainfall forecasts will be used to estimate probabilities of sampleable stormwater flow.

A final constraint is monitoring blackout dates surrounding holidays when monitoring will not take place despite the presence of a qualifying storm event. Following are the typical wet season monitoring blackout periods:

- Thanksgiving holiday (Wednesday through Sunday)
- Christmas/New Year’s Day holiday period (Christmas Eve through New Year’s Day)
- President’s Day Weekend (Saturday and Sunday)
- Easter Weekend (Saturday and Sunday)

7. (A7) Quality Objectives and Criteria for Measurement Data

The quantitative measurements that estimate the true value or concentration of a physical or chemical property always involve some level of uncertainty. The uncertainty associated with a measurement generally results from one or more of several areas: (1) natural variability of a sample; (2) sample handling conditions and operations; (3) spatial and temporal variation; and (4) variations in collection or analytical procedures. Stringent QA and QC procedures are essential for obtaining unbiased, precise, and representative measurements and for maintaining the integrity of the sample during collection, handling, and analysis, and for measuring elements of variability that cannot be controlled. Stringent procedures also must be applied to data management to assure that accuracy of the data are maintained.

Data Quality Objectives (DQOs) are established through a project-specific planning process to ensure that data collected are sufficient and of adequate quality for the intended use. DQOs include both quantitative and qualitative assessment of the acceptability of data.

Data quality indicators (DQIs) are the quantitative measures and qualitative descriptors used to set limits of acceptable levels of data error. The principal DQIs are precision, accuracy/bias, comparability, completeness, and representativeness. The quantitative measures include precision, bias, and sensitivity, while accuracy (in general), representativeness, and comparability are qualitative descriptors (SWAMP 2022). Completeness is unique and can be described by both quantitative measures and qualitative descriptors. DQIs are used as a means to specify Measurement Quality Objectives (MQOs) which inform determinations of data quality. This provides a method to set an acceptable amount of uncertainty for each data point during project planning, and ultimately, to assess project performance and confidence in the results.

Field records for the Project consist primarily of notes taken at the collection site and any known watershed activities that might influence data interpretation, with narrative notes to pinpoint the precise location and details of the sample collection. The goal for completeness is to have notes for all (>99%) sites at multiple timepoints over Project duration.

DQOs for the laboratory analytical components of the Project are described in narrative form in the sections below. Specific DQOs for the Project will be based on MQOs for each analyte. Data acquisition activities will include both field measurements and laboratory analyses, with MQOs for each specified in Appendix B for PFAS, and Appendix A for all other Project measurements / analytes.

7.1. Representativeness

The representativeness of data is the ability of the sampling locations and the sampling procedures to adequately represent the true condition of the sample sites. Field personnel will strictly adhere to the field sampling protocols to ensure the collection of representative, uncontaminated samples. The most important aspects of quality control associated with chemistry sample collection are as follows:

- Field personnel will be thoroughly trained in the proper use of sample collection equipment and will be able to distinguish acceptable versus unacceptable samples in accordance with pre-established criteria as identified in each Program-specific SAP.

- Field personnel are trained to recognize and avoid potential sources of sample contamination (e.g., dirty hands, insufficient field cleaning).

- Samplers and utensils that come in direct contact with the sample will be made of non-contaminating materials (to the extent practical), and will be thoroughly cleaned between sampling stations.

- Sample containers will be pre-cleaned and of the recommended type (to the extent practical).

7.2. Comparability

Comparability is the degree to which data can be compared directly to other relevant studies. For this investigation, sampling and analytical methods were adapted from those employed for CW4CB to quantify analytes / measurements assessed as part of that investigation. For non-CW4CB analytes, Programs will employ commercial laboratories employing standard methods. In most cases, Project participants have a long history with contract laboratories used for the Project.

7.3. Completeness

Completeness is defined as the percentage of valid data collected and analyzed compared to the total expected to be obtained under normal operating conditions. Overall completeness accounts for both sampling (in the field) and analysis (in the laboratory). Valid samples include those for compounds in which the concentration is determined to be below detection limits.

Completeness is expressed as overall completeness for a given parameter for each component of the Project. Under ideal circumstances, the objective is to collect 100 percent of all field samples desired, with successful laboratory analyses on 100 percent of measurements (including QC samples). However, circumstances surrounding sample collections and subsequent laboratory analysis are influenced by numerous factors, including weather, shipping damage or delays, sampling crew or lab analyst error, and QC samples failing DQOs. An overall completeness of greater than 90% is considered acceptable for the project.

7.4. Sensitivity

Different indicators of the sensitivity of an analytical method to measure a target parameter are often used including instrument detection limits (IDLs), method detection limits (MDLs), estimated detection limits (EDLs), and reporting limits (RLs). Each of these indicators is described in general below:

The MDL is the minimum concentration of a substance that can be measured in a matrix and reported with 99% confidence that the analyte concentration is distinguishable from method blank results (82 FR 40939, Aug. 28, 2017). An MDL is determined using the procedure provided in 40 CFR 136, and may be referred to as the “limit of detection (LOD).” MDL values must be adjusted for dilutions or sample size variations.

The RL is considered to be the lowest level that can be quantified within the specified limits of precision and accuracy during routine laboratory operating conditions. It is often the lowest non-zero point of the calibration curve. RLs are commonly reported as a laboratory’s Practical Quantitation Limit (PQL). RL values must be adjusted for dilutions or sample size variations.

To be consistent with CEDEN data rules, results of analyses will be quantified down to the MDL in laboratory deliverables. Results below the MDL are not quantifiable, and will be assigned an appropriate ResQualCode to indicate their status (i.e., ND).

Target RLs were defined for the Project with two main objectives in mind: (1) to best achieve the Project's goals by measuring individual analytes at environmentally-relevant concentrations and (2) to best ensure comparability with the California Surface Water Ambient Monitoring Program (SWAMP) Quality Assurance Project Plan (SWAMP 2022) analytes (where applicable). Laboratory-derived RLs will be reported for all Project analyses and compared with Project target RLs as a means of assessing performance related to analytical sensitivity (i.e., sufficiently-sensitive analyses should fall at or below target RLs). Target RLs for this study are listed in Appendix C.

7.5. Precision

Precision is used to measure the degree of mutual agreement among individual measurements of the same property under prescribed similar conditions. Overall precision usually refers to the degree of agreement for the entire sampling, operational, and analysis system. It is derived from replicate analysis of individual samples (laboratory replicates) or multiple collocated samples (field replicates) analyzed on equivalent instruments and expressed as the relative percent difference (RPD) or relative standard deviation (RSD). Analytical precision can be determined from duplicate analyses of field samples, laboratory matrix spikes, and/or reference material samples. The analytical precision of duplicate measurements of samples or spikes will be used to assess overall precision during this project.

Analytical precision is expressed as the RPD for duplicate measurements.

$$RPD = ABS\ ([X1 - X2] / [(X1 + X2) / 2])$$

Where: $X1$ = the first sample result
$X2$ = the duplicate sample result.

In cases where more than one replicate is measured from a single sample or taken from a given site (on a scale presumed to be homogenous), rather than deriving RPDs for each pairwise combination, RSD can instead be calculated:

$$RSD = [stdev\ (X, X2\ ,..XN)] / [average\ (X, X2\ , ..XN)]$$

Where: $X1$ = the first sample result
XN = each successive sample result

If the laboratory-reported RPD (or RSD) exceeds the target for over 30% of the parameters in an analysis, the analysis is rerun. If after rerunning the analysis, RPD (or RSD) for a substantial number of analytes still exceeds the target, the problem is further investigated to identify whether potential problems originate in field sampling or laboratory handling and analysis. Additional corrective actions including flagging of data or reanalysis of samples are taken where possible and as needed.

In cases where there is insufficient field sample to analyze both lab duplicates and matrix spike duplicates, a duplicate of the unspiked sample is generally preferred, due to the possibility of spiking too high, resulting in precision measurement for a concentration range not found in typical samples. Analyzing a laboratory replicate for a field sample different from that used for matrix spikes can alleviate a problem of insufficient sample material. In extreme cases where there is sufficient material for only a single analysis of each sample from the project, other samples such as blank spikes, reference materials, or samples from another project may be used to evaluate analytical precision, again with caveats on the relevance of evaluations for samples with much higher concentrations.

7.6. Accuracy

Accuracy describes the degree of agreement between a measurement (or the average of measurements of the same quantity) and an acceptable reference or true value. The “true” values of the parameters measured in the project are unknown and the overall accuracy (including representativeness) cannot be assessed. However, accuracy of certain portions of a measurement process can be evaluated. For this project, analytical accuracy, characterized through the use of reference samples and laboratory matrix spikes in the laboratory operation, is considered acceptable for assessing overall accuracy during this project. Accuracy is expressed as percent recovery for reference materials:

% Recovery = MV / EV

Where: MV = the measured value
EV = the true expected (reference) value.

For matrix spikes, recovery is calculated from the original sample result, the expected value (EV = native + spike concentration), and the measured value with the spike (MV):

% Recovery = (MV-N) x 100% (EV-N)

Where: MV = the measured value
EV = the true expected (reference) value
N = the native, unspiked result

standards are also spiked into samples for some analytical methods (e.g., PCBs) and used to evaluate method and instrument performance. While recoveries on surrogates for all analyses are to be reported for all relevant analyses, only results of PCBs and PFAS will be reported as surrogate-corrected values for the Project, consistent with EPA methods.

Recovery targets for Project analytes are shown in Appendix A and Appendix B (for PFAS). If a laboratory’s reported recovery falls outside of this range for over 30% of reported parameters in analysis of reference materials, the problems need to be identified, corrected, and the instrument re-calibrated, and samples in that batch rerun if possible. If the recovery for a matrix spike/duplicate falls outside of target range, possible causes must be investigated, and the analysis needs to be rerun where possible. If the spike continues to fall outside of the target range, the analysis will be rerun if sufficient material is available, and/or other corrective actions such as data flagging may be taken in consultation with the MC or their designee.

No individual analyte value shall exceed the target limits more than once in consecutive analyses without appropriate documentation and consultation with the SPM and MC. Additional leeway may be granted for analytes with reference but not certified values, or for those with 95% confidence intervals already outside the recovery targets. Due to the inherent variability in analyses near the method detection limit, control limit criteria for relative accuracy only apply to analytes with true values that are greater than three (3) times the MDL established by the laboratory.

In cases where project field samples have insufficient material, the laboratory may instead spike a similar blank matrix (e.g., sand for sediment) or samples from other projects with similar expected concentrations. Spikes should be at least double the native concentrations in samples to allow quantitative assessment, but less than 100 times higher. If spiking concentrations are found too high in the first analyzed batch, additions in later analysis batches must be reduced. If expected native concentrations are unknown, spikes should be made at approximately 100 times the MDL or 10 times the quantification limit, and adjusted upward in later batches as needed.

7.7. Bias

Collected samples may inadvertently be contaminated with target analytes at many points in the sampling and analytical process, from the materials shipped for field sampling, to the air supply in the analytical laboratory. Where appropriate, blank samples evaluated at multiple points in the process chain help ensure that pollutants measured in samples actually originated from the target matrix in the sampled environment and are not artifacts of the collection or analytical process.

The Project will incorporate multiple types of blank samples to assess potential bias due to sampling and analytical techniques employed. These will include laboratory method blanks, equipment blanks, and end of sampling year procedural blanks. Each of these types of samples are described more thoroughly in Section 14.

7.8. Data Quality Specific to PFAS Project Samples

Analytical methods and data quality objectives for PFAS analyses for the Project were selected in order to best ensure generation of high quality data consistent with other environmental monitoring projects. From an analytical perspective, this entails selection of an accredited laboratory with protocols capable of achieving the quality control / quality assurance requirements specified in EPA Method 1633, 4th Draft. A summary of quality criteria for the Project's analytical samples as identified in Enthalpy-EDH (2022) and QA metric acceptance criteria conforming to the EPA method is presented in Appendix B.

8. (A8) Special Training Needs / Certification

8.1. Specialized Training or Certification

All monitoring fieldwork will be performed by contractor staff that has appropriate levels of experience and expertise to conduct the work, as determined by the MC for each Program. As appropriate, sampling personnel may be required to undergo or have undergone OSHA training / certification for confined space entry in order to undertake particular aspects of sampling within areas deemed as such. Additional training on collection of non-standard analytes (i.e., PFAS) may also be required and shall be assigned at the direction of the MC.

Analytical laboratories are to be certified for the analyses conducted at each laboratory by California Environmental Laboratory Accreditation Program (ELAP), National Environmental Laboratory Accreditation Program NELAP, or an equivalent accreditation program as approved by the PC and SPMs. Current State of California ELAP accreditations are listed for each laboratory providing analytical services to the Project.

Table 8-1. Current ELAP Accreditations for Project Analytical Laboratories

Laboratory	ELAP Accreditation #
Caltest	1664
Enthalpy	2892

8.2. Training and Certification Documents

All laboratories contracted through this project are required to maintain their own training documents and certification records, and to make these available to Project participants as requested.

9. (A9) Documents and Records

Procedures for overall management of project documents and records are summarized below.

9.1. Field Documentation

All field data gathered for the project are to be recorded in field datasheets and field notebooks, and scanned or transcribed to electronic documents as needed to permit easy access by Project staff and other appropriate parties. An electronic data form using the Fulcrum application (or equivalent) will be considered as well.

9.1.1. Sampling Plans, COCs, and Sampling Reports

Field sampling, handling, and reporting procedures will be conducted in accordance with the Program-specific MPs. Field sampling crews will generate records of sample collection and will be responsible for maintaining these records in an accessible manner and submitting to the MC.

9.1.2. Datasheets

All field data gathered by this project will be recorded on standardized field data entry forms. Program-specific MPs will describe protocols for use with field datasheets or electronic field data forms.

9.1.3. Field Logbooks

In addition to completing field data sheets, sampling personnel will record other relevant information in bound logbooks or using electronic devices. Program-specific MPs will describe protocols for use with field logbooks.

9.1.4. Photographic Documentation

Program-specific MPs will describe protocols for handling photographic documentation.

9.2. Laboratory Documentation

The Project requires specific actions to be taken by contracted laboratories, including requirements for data deliverables, quality control, and on-site archival of project-specific information. Each of these aspects is described below.

9.2.1. Data Reporting Format

The analytical laboratory will report the analytical data to the Data Manager via an analytical report consisting of, at a minimum:

1. Letter of transmittal
2. Chain of custody information
3. Analytical results for field and quality control samples (Electronic Data Deliverable, EDD)
4. Case narrative

The MC or their designee will review the data deliverables provided by the laboratory for completeness, errors, and QA/QC. In addition to the laboratory's standard reporting format, all results meeting DQOs and results having satisfactory explanations for deviations from objectives shall be reported in tabular format on electronic media, in a California Environmental Data Exchange Network (CEDEN) comparable format.

As they become available, and after internal laboratory QA/QC review, draft data produced from laboratory analyses are sent in electronic format. These draft data are not for distribution or application in any manner, other than for the initial review by MC or their designee. Upon completion of their review of the draft data, the MC will provide any concerns/comments to the respective laboratory. The concerns (if any) must then be addressed in writing by the analytical lab. After the concerns are addressed and corrective actions taken (such as reviewing for transcription errors, reanalysis, and data flagging), data will be resubmitted as draft data for re-review. If all of their concerns have been addressed, the MC will notify the laboratory and approve the data as final.

Documentation for analytical data is kept on file at the laboratories. The documentation may be reviewed during external audits of the Project, as needed. These records include the analyst's comments on the condition of the sample and progress of the analysis, raw data, instrument printouts, and results of calibration and QC checks. Paper or electronic copies of all analytical data are kept by the project laboratories as part of the project archives for a minimum period of five years.

9.2.2. Other Laboratory QA/QC Documentation

All project laboratories will have the latest version of the LID Monitoring QAPP in electronic format. In addition, the following documents and information from the laboratories will be current, and they will be available to all laboratory personnel participating in the processing of Project samples:

1. Laboratory QA plan: Clearly defines policies and protocols specific to a particular laboratory, including personnel responsibilities, laboratory acceptance criteria, and corrective actions to be applied to the affected analytical batches, qualification of data, and procedures for determining the acceptability of results.

2. Laboratory SOPs: Contain instructions for performing routine laboratory procedures, describing exactly how a method is implemented in the laboratory for a particular analytical procedure. Where published standard methods allow alternatives at various steps in the process, those approaches chosen by the laboratory in their implementation (either in general or in specific analytical batches) are to be noted in the data report, and any deviations from the standard method are to be noted and described.

3. Instrument performance information: Contains information on instrument baseline noise, calibration standard response, analytical precision and bias data, detection limits, scheduled maintenance, etc.

4. Control charts: Control charts are developed and maintained throughout the project for all appropriate analyses and measurements for purposes of determining sources of an analytical problem or in monitoring an unstable process subject to drift. Control charts serve as internal evaluations of laboratory procedures and methodology and are helpful in identifying and correcting systematic error sources. Control limits for the laboratory quality control samples are ±3 standard deviations from the certified or theoretical concentration for any given analyte.

Records of all quality control data are signed and dated by the analyst. Quality control data include documentation of standard calibrations, instrument maintenance and tests, and, as appropriate, analyses of certified reference materials (CRMs). Control charts of the data are generated by the analysts monthly or for analyses done infrequently, with each analysis batch. The laboratory quality assurance specialist will review all QA/QC records with each data submission, and will provide QA/QC reports with each batch of submitted field sample data.

9.3. Project Management Documentation

Further aspects of the management of project documents and records are summarized below.

9.3.1. QAPP

This QAPP and its revisions will be kept by the PC and distributed to the appropriate parties involved with the Project. Copies will also be sent to the each participating analytical laboratory's project manager for review and internal distribution. Table 3-1 shows the QAPP distribution list.

Proposed revisions to the QAPP will be approved by the TAG and then the revised QAPP will be submitted to the list of project personnel shown on Table 3-1. The revised QAPP will be accompanied by a memorandum compiling and summarizing the proposed changes and with instructions indicating that the revision supersedes earlier versions of the QAPP.

9.3.2. Project Information Archival

Persons responsible for maintaining records for this project are shown in Table 9-1. A back-up copy of all electronic records will maintained off-site.

Table 9-1. Document and Record Retention, Archival, and Disposition

Type	Retention (years)	Archival	Disposition
Field Datasheets	5	MC	Maintain indefinitely
Chain of Custody Forms	5	MC	Maintain indefinitely
Calibration Logs for Field Equipment	5	MC	Maintain indefinitely
Raw Analytical Data	5	LPM	Recycling
Quality Control Records	5	LPM	Recycling
Electronic data deliverables	5	MC/PM	Maintain indefinitely
QAPP, MP, Project Reports	5	MC/PM	Maintain indefinitely

The MC will oversee the actions of all personnel with records retention responsibilities, and will arbitrate any issues relative to records retention and any decisions to discard records. As discussed previously, each analytical laboratory will archive all analytical records generated for this project. The appropriate field measurements and laboratory analytical data will be submitted to the California Environmental Data Exchange Network (CEDEN) with terminology indicative of stormwater influent / effluent monitoring.

10. (B1) Sampling Process Design

The Project is designed to address the Management Questions listed in Element 5 and to comply with the monitoring methods prescribed in MRP3 §C.8.d. Sample locations and the timing of sample collection will be selected using the directed sampling design principle. This is a deterministic approach in which points are selected deliberately based on knowledge of their attributes of interest as related to the environmental site being monitored. This principle is also known as "judgmental," "authoritative," "targeted," or "knowledge-based." Individual monitoring aspects are summarized below and will be described in more detail in the Program-specific MPs.

10.1. Water Quality Monitoring and Measurement

Water quality sampling will support the Project's effectiveness evaluations of stormwater treatment structural controls, as described previously (see Section 6.2). Program-specific Monitoring Plans (MPs) will provide more details regarding water quality monitoring and measurement methodologies and undergo review and approval by the TAG before this type of fieldwork commences.

10.2. Sampling Uncertainty

There are multiple sources of potential sampling uncertainty associated with the Project, including: (1) measurement error; (2) natural (inherent) variability; (3) sample misrepresentation (or poor representativeness); and (4) sampling bias (statistical meaning). Measures incorporated to address these areas of uncertainty are discussed below:

(1) Measurement error combines all sources of error related to the entire sampling and analysis process (i.e., to the measurement system). All aspects of dealing with uncertainty due to measurement error are described elsewhere within this QAPP.

(2) Natural (inherent) variability occurs in any environment monitored, and is often much wider than the measurement error. Previous studies have demonstrated the high degree of variability in environmental media and especially the heterogeneous nature of stormwater runoff. This will be taken into consideration when interpreting results of the effectiveness evaluations of the pollutant control measures tested.

(3) Sample misrepresentation happens at the level of an individual sample or field measurement where an individual sample collected or measurement taken is a poor representative for overall conditions encountered. To address this situation, the Project will implement a number of QA-related measures described elsewhere within this QAPP, including methods refined through implementation of prior, related investigations.

(4) Sampling bias relates to the sampling design employed and whether the appropriate statistical design is employed to allow for appropriate understanding of environmental conditions. To a large degree, the sampling design required for the Project is judgmental, which will therefore incorporate an unknown degree of sampling bias into the Project. There are small measures that have been built into the sampling design to combat this effect (e.g., collection of composite samples), but overall this bias will need to be taken into consideration when interpreting results of the various investigations.

Further detail on measures implemented to reduce uncertainty through mobilization, sampling, sample handling, analysis, and reporting phases will be described in each Program-specific MP.

11. (B2) Sampling Methods

The Project involves the collection of samples for a variety of analytes in structural facility influent and effluent. Field collections will be conducted by field contractors using techniques designed to respond to site-specific conditions, Project requirements, and associated constraints. These methods are summarized below and presented in more detail in each Program-specific MP. The Project will utilize several field sampling SOPs (Table 11-1) developed through implementation of previous, related projects.

11.1. Aqueous Sample Collection

All samples collected for analysis of trace metals, organics, and conventional constituents in water will be collected using clean techniques that minimize sample contamination. Sampling collection and handling techniques were designed to conform to EPA "clean" sampling methodology described in Method 1669 (EPA 1996), but have been modified in response to site-specific conditions and Project constraints. Specific methods are described below.

Samples will be collected within stormwater conveyances, in most cases by using a near-surface automatic sampler with collection points at street level or at sample ports or other appropriate locations built in to stormwater treatment structural controls. Samples will be collected into appropriate pre-cleaned carboys in the field and aliquoted into sample containers selected as best fit for the overall analytical program to be performed in the laboratory (see list of SWAMP-recommended Sample Handling Requirements in Table 12-1). During and after collection, field-collected samples will be stored at 4 ± 2°C until arrival at the contract laboratory.

In order to achieve compliance with MRP permit requirements and address management and monitoring questions associated with Project implementation, the monitoring design incorporates some measure of compromise in sampling protocol as the full suite of MRP analytes is not conducive to collection via a single sampling technique. For example, the Teflon™ tubing typically used to support trace metal sampling is not appropriate for collection of PFAS samples. The sampling and analysis methods for Project implementation were selected to best ensure compliance with permit requirements in a feasible manner while still generating meaningful information to address management questions. Project participants therefore have had to make trade-offs that in some cases deviate from standard sampling and analysis methods, as summarized below.

11.1.1. Stormwater Runoff

All participating Programs are employing autosampler-based, flow-proportioned (or time-proportioned) monitoring techniques associated with water quality sampling efforts. As mentioned above, compromises have been incorporated into the sampling design to allow for generation of meaningful data while best ensuring Permit compliance. Table 11-1 identifies all Project analytes and associated deviations from standard methods where applicable. The most notable deviations from standard sampling methods are likely to affect interpretation of analytical results for PFAS (typically collected as grab samples due to potential contamination issues), mercury (typically collected via grab sampling using protocols to minimize ambient contamination), dissolved Cu and Zn (typically filtered within 15 minutes of sample collection), and PCBs and inorganic suite (typically collected using Teflon tubing to minimize contamination). For stormwater samples, detailed methods will be identified within Program-specific MPs prior to onset of sampling operations.

Table 11-1. Deviations from Standard Methods Associated with Project Flow-proportioned Water Quality Sampling

Analyte	Project Protocol	Variance	Justification
Mercury (Total and dissolved, low level)	Collection by peristaltic pump sampler with stainless-steel intake strainer, HDPE intake tubing, and SEBS pump-roller tubing into a borosilicate glass composite carboy	Typically, low-level mercury is collected via grab sampling by clean hands/dirty hand method	Selected based upon overall suite of Project analytes. Will incorporate blanking of equipment for various analytes to assess effect of protocol. Precedent of pump collections by Alameda County Public Works Agency (ACPWA) Turner Court LID monitoring project
PCBs		Typically, PCBs are collected with Teflon® intake tubing.	Selected to optimize overall suite of Project analytes. Will incorporate blanking of equipment for various analytes to assess effect of protocol.
Total Suspended Solids (TSS)		None	N/A
PFAS		Typically, PFAS is collected via grab sampling	Selected based upon overall suite of Project analytes. Project will test / confirm SEBS tubing does not contain PFAS. Will incorporate blanking of equipment for various analytes to assess effect of protocol
TPH as Diesel (C 12-24), TPH as Motor Oil (C 24-36)		Typically TPH diesel and motor oil are collected via grab sampling	Selected based upon overall suite of Project analytes. Precedent of pump collections by Alameda County Public Works Agency (ACPWA) Turner Court LID monitoring project.
Dissolved Copper, Zinc		Method calls for samples to be filtered within 15 minutes of collection and preserved within 48 hrs. Project samples will be filtered at lab immediately upon receipt	Field filtering of individual aliquots not feasible. Field filtration can introduce contaminants. Filtering will be performed in a clean laboratory setting and data qualified to reflect variance. This is consistent with Caltrans (2020), which recommends filtering in the field is only conducted when filtering can be performed in a manner that minimizes contamination and the analytical lab is a substantial distance away.
Total Copper, Zinc		When collected with peristaltic pump, metals are typically collected using Teflon™ intake tubing. Project will employ HDPE intake tubing	Selected to optimize overall suite of Project analytes. Will incorporate blanking of equipment to assess effect of protocol.
Hardness (as $CaCO_3$)		None	N/A
pH		Intended to be measured immediately after collection. Will instead be measured in the field from event composite at conclusion of sample collection.	Infeasible to measure with autosampler

11.1.2. Physical Parameters

The effectiveness evaluations of stormwater treatment structural controls may include measurements of flow and *in situ* measurements of physical water quality parameters (e.g., flow, pH, soil moisture). As appropriate, Program-specific MPs will describe in detail how this will be accomplished. These MPs will undergo review and approval by TAG before this type of fieldwork commences.

11.2. Sampling Containers

All sampling containers used for the Project will be provided pre-cleaned by contracted analytical laboratories or monitoring consultants, or purchased factory-clean for one-time use. The individual Programs will be responsible for ensuring integrity of the containers. If sampling containers lose their integrity during the sample handling process they will be discarded and replaced with a spare container. Details of sampling containers used by a specific Program to collect field samples will be identified in Program-specific MPs.

Following sample collection, containers will be delivered to the prime analytical contract laboratory, Caltest, for processing. Upon receipt, Caltest will aliquot sample material for each analysis and each laboratory in a clean setting. Caltest will be responsible for delivering subsampled material to the subcontract organics lab, Enthalpy, following specifications of respective analytical methods and hold times as summarized in Table 12-1. Finally, Caltest will clean and return borosilicate glass carboys to MCs, as appropriate, for use in future events.

11.3. Sample ID Numbers

Every sample must have a unique sample number so that the analytical results from each sample can be differentiated from every other sample. This information should follow the sample through the chain-of-custody (COC), analytical, and interpretation and reporting processes. The naming convention is described within each Program-specific MP.

11.4. Sample Equipment Cleaning

Cleaning and decontamination techniques required for sampling equipment will vary depending on the location and media sampled and analyte measured. Cleaning and decontamination procedures will be described in each Program-specific MP.

11.5. Waste Disposal

Proper disposal of all waste is an important component of field activities. At no time will any waste be disposed of improperly. The proper methods of waste disposal will be described in each Program-specific MP.

11.6. Responsibility and Corrective Actions

If monitoring equipment fails, sampling personnel will report the problem in the comments section of their field notes and will not record data values for the variables in question. Actions will be taken to replace or repair broken equipment prior to the next field use.

11.7. Standard Operating Procedures

SOPs associated with sampling and sample handling expected to be used as part of implementation and are included in Table 11-1. Additionally, detailed sample container information, required preservation, holding times, and sample volumes for all Project analytes are listed in Table 12-1 of Section 12.

Table 11-2. List of Project Field SOPs

SOP	Location
Collection of Flow-proportioned Stormwater Samples via Autosampler	Program-specific MPs
Collection of End of Season Field Blanks M	Appendix E

In addition, contractor-specific plans and procedures may be required for specific aspects of Project implementation (e.g., health and safety plans, shipping procedures for hazardous items).

12. (B3) Sample Handling and Custody

Sample handling and chain of custody procedures are described in detail in Program-specific MPs. One member of each sampling team will be identified as "Team Lead", and will be responsible for overall collection and custody of samples during field sampling. The field crews will have custody of samples during field sampling and COC forms will accompany all samples to the analyzing laboratory. COC procedures require that possession of samples be traceable from the time the samples are collected until completion and submittal of analytical results. Each contracted analytical laboratory will maintain custody logs sufficient to track each sample submitted and verify analysis or preservation of each sample within specified holding times. Each analytical laboratory must have a sample custodian who examines the samples for correct documentation, proper preservation and holding times. Each laboratory will follow sample custody procedures as outlined in its QA plans.

All samples will be packed in sufficient wet ice or frozen ice packs during shipment, so that they will be kept at 4 ± 2º C. When used, wet ice will be double bagged in Zip-top bags to prevent contamination via melt water. Where appropriate, samples may be frozen by the laboratory to prevent degradation (e.g., PFAS). If samples are to be shipped frozen on dry ice, then appropriate handling procedures will be followed, including ensuring use of appropriate packaging materials and appropriate training for shipping personnel.

12.1. Shipping Containers

All samples will be handled, prepared, transported, and stored in a manner so as to minimize bulk loss, analyte loss, contamination, or degradation. Sample containers will be clearly labeled with an indelible marker. All caps and lids will be checked for tightness prior to shipping. Shipping containers will be sealed with packing tape before shipping. Samples will be placed in the ice chest with enough ice or frozen ice packs to completely fill the ice chest. COC forms will be placed in a zip-top bag and placed inside of the ice chest. Additional detail on sample handling is included in RMC SOP FS-9 (Table 11-1) (BASMAA 2016).

12.2. Commercial Vehicle Transport

Transport of samples to the contracted laboratories will be by commercial carriers. As required, pickup will be pre-arranged with the carrier and all required shipping forms will be completed prior to sample pickup by the commercial carrier.

12.3. Sample Hold Times

Information on sampling containers, preservation techniques, and hold times are compiled in **Error! Reference source not found.** (aqueous samples).

Table 12-1. Specifications for Sample Handling for Project Analytes in Surface Water. Specifications based upon SWAMP MQOs where available.

Analyte	Analyte Group	Sample Container Material & Property	Preservative	Holding Time (at 4 ± 2º C)
Dissolved Hg	Inorganics	Glass, Polyethylene, or other autoclavable plastic	Filter within 24 hours and preserve with 0.5% v:v pretested 5% BrCl or 12N HCl within 48 hours	90 days at room temperature following acidification
Total Hg	Inorganics	Glass, Polyethylene, or other autoclavable plastic	Preserve with 0.5% v:v pretested 5% BrCl or 12N HCl within 48 hours	90 days at room temperature following acidification
PCBs (as RMP 40 congeners[1])	Synthetic Organic Compounds in Water	Amber glass	Cool to 6º C	1 year until extraction, 1 year after extraction
Total Suspended Solids (TSS)	Conventional	Glass, Polyethylene	Cool to 6º C	7 days
PFAS	Synthetic Organic Compounds in Water	HDPE	Freeze as soon as possible after collection	90 days from collection to extraction if stored frozen at < -20 °C. 28 days from collection to extraction if stored at 0 – 6º C
TPH as Diesel / Motor Oil	Semi-volatile Organic Compounds in Water	Glass	Cool to 6º C	7 days until extraction, 40 days after extraction
Dissolved Cu, Zn	Inorganics	Polyethylene	Filter within 15 minutes of collection; HNO3 to pH<2 within 48 hours and at least 24 hours prior to analysis	6 months at room temperature following acidification
Total Cu, Zn	Inorganics	Polyethylene	HNO3 to pH<2 within 48 hours and at least 24 hours prior to analysis	6 months at room temperature following acidification
Hardness (as $CaCO_3$)	Conventional	Polyethylene	Cool to ≤6 ºC; HNO3 or H2SO4 to pH<2	6 months

---

[1] List of 40 congeners originally developed by SFEI for the Regional Monitoring Program for Water Quality in San Francisco Bay and replicated in a wide variety of studies in San Francisco Bay and its watersheds. Available at https://www.sfei.org/sites/default/files/project/Updated_DMMO_PCB_Congener_and_PAH_Analyte_Lists.pdf

13. (B4) Method Selection

13.1. Reporting Limits

Method Reporting Limits (MRLs) applicable for Project sampling and analysis are presented in Appendix C.

13.2. Performance Based Measurement System

Multiple analytical laboratories will provide the analyses for samples that are submitted for laboratory analysis. All of the methods that will be used are listed in Table 13-1.

Contracted laboratories used for the Project sampling and analysis program will be encouraged to use a Performance Based Measurement System (PBMS). A performance-based approach permits the use of any scientifically appropriate method that demonstrates the ability to meet established method performance criteria (e.g., accuracy, sensitivity, bias, precision) and complies with specified data quality needs or requirements. Using PBMS the data quality needs, mandates, or limitations of the program or project are specified. These will serve as criteria for selecting measurement processes (i.e., methods), which will meet those needs in a cost-effective manner, rather than the use of a mandated method.

Nevertheless, validated and accredited methods are required for measurements, with each laboratory demonstrating proficiency and data comparability through compliance with required accreditation elements and routine analysis of performance evaluation samples, split samples, and reference materials representing actual sample matrices.

13.3. PBMS Methods Validation

Each analytical laboratory should adhere to its individual QA program for method validation techniques for specific methods. Individual QA plans should be maintained on-site and be made available to Project representatives upon request. When using the PBMS for the Project, the labs will have to follow all PBMS procedures related to obtaining quality data, but the labs are not required to submit the results to anyone except upon request. The results are to be kept on file by each individual lab.

13.4. Method Failures

Each MC will be responsible for facilitating corrective actions that may be needed in the event that methods fail to produce data of acceptable quality for their Program’s monitoring events. If a method fails to provide acceptable data for any reason, including analyte or matrix interferences, instrument failures, etc., then the involved samples will be analyzed again if possible. The laboratory in question's SOP for handling these types of problems will be followed. When a method fails to provide data of acceptable quality, then the laboratory's SOP for documenting method failures will be used to document the problem and what was done to rectify it.

13.5. Sample Disposal

After analysis of the Program’s samples have been completed by the laboratory and results have been accepted by the MC, they will be disposed by each laboratory of in compliance with all federal, state, and local regulations. The laboratory has standard procedures for disposing of its waste, including left over sample materials.

13.6. Laboratory Sample Processing

Field samples sent to the laboratories will be processed within their recommended hold time (Table 12-1). Each sample may be assigned unique laboratory sample identification (ID) numbers for tracking processing and analyses of samples within the laboratory. This laboratory sample ID (if differing from the field team sample ID) must be included in the data submission, within a lookup table linking the field sample ID to that assigned by the lab.

Samples arriving at the laboratory are to be stored under conditions appropriate for the planned analytical procedure(s), unless they are processed for analysis immediately upon receipt. Samples to be analyzed should only be removed from storage when laboratory staff is ready to proceed.

Table 13-1. Laboratory Analytical Methods for Project Analytes in Water

Analyte	Sampling Method	Laboratory	Recommended Analytical Method	Reporting Units
Mercury, Total and Dissolved	Autosampler, Flow-weighted composite	Caltest	EPA 1631	ug/L
PCBs	Autosampler, Flow-weighted composite	Enthalpy	EPA 1668 (RMP 40 congeners)	pg/L
TSS	Autosampler, Flow-weighted composite	Caltest	SM 2540D	mg/L
PFAS	Autosampler, Flow-weighted composite	Enthalpy	EPA Method 1633, 4th Draft (July 2023)	ng/L
TPH as diesel / motor oil	Autosampler, Flow-weighted composite	Caltest	EPA 8015	ug/L
Copper, Total and Dissolved	Autosampler, Flow-weighted composite	Caltest	EPA 200.8	ug/L
Zinc, Total and Dissolved	Autosampler, Flow-weighted composite	Caltest	EPA 200.8	ug/L
Hardness (as $CaCO_3$)	Autosampler, Flow-weighted composite	Caltest	SM 2340C	mg/L

14. (B5) Quality Control

Concentrations of pollutants in environmental samples are often low. Therefore, a quality-assurance program for the chemical analysis of samples requires stringent laboratory conditions and careful control over all aspects of the analyses. Each step in the analytical process is a potential source of contamination and must be consistently monitored to ensure that the final measurement is not adversely affected by any processing steps.

Laboratories providing analytical support for the project will have the appropriate facilities to store, prepare, and process samples in an ultra-clean environment, and will have appropriate instrumentation and staff to perform analyses and provide data of the required quality within the time period dictated by the project. The laboratories are expected to satisfy the following:

1. Demonstrate capability through pertinent certification and satisfactory performance in inter-laboratory comparison exercises.
2. Provide qualification statements regarding their facility and personnel.
3. Maintain a program of scheduled maintenance of analytical balances, laboratory equipment, and instrumentation.
4. Conduct routine checking of analytical balances using a set of standard reference weights (American Society of Testing and Materials Class 3, NIST Class S-1, or equivalents). Analytical balances are serviced at six-month intervals or when test weight values are not within the manufacturer's instrument specifications, whichever occurs first.
5. Conduct routine checking and recording the composition of fresh calibration standards against the previous lot. Acceptable comparisons are within 2% of the previous value.
6. Record all analytical data in bound (where possible) logbooks, with all entries in ink, or electronically.
7. Monitor and document the temperatures of cold storage areas and freezer units on a continuous basis.
8. Verify the efficiency of fume/exhaust hoods.
9. Have a source of reagent water meeting specifications described in Section 8.0 available in sufficient quantity to support analytical operations.
10. Label all containers used in the laboratory with date prepared, contents, initials of the individual who prepared the contents, and other information as appropriate.
11. Date and safely store all chemicals upon receipt. Proper disposal of chemicals when the expiration date has passed.
12. Have QAPP, SOPs, analytical methods manuals, and safety plans readily available to staff.
13. Have raw analytical data readily accessible so that they are available upon request.

In addition, laboratories involved in the Project are required to demonstrate capability continuously through the following protocols:

1. Strict adherence to routine QA/QC procedures.
2. Routine analysis of Certified Reference Materials (CRMs), if available.
3. Regular participation in annual certification programs.
4. Satisfactory performance at least annually in the analysis of blind Performance Evaluation

Samples and/or participation in inter-laboratory comparison exercises.

14.1. Laboratory Quality Control

Laboratory QC samples must satisfy Project MQOs and frequency requirements. MQOs are specified in Appendix A and Appendix B (for PFAS) and summarized in Table 14-1 below. Frequency requirements are provided on an analytical batch level. The Project defines an analytical batch as 20 or fewer samples and associated quality control that are processed by the same instrument within a 24-hour period (unless otherwise specified by method). Details regarding sample preparation are method- or laboratory SOP-specific, and may consist of extraction, digestion, or other techniques.

14.1.1. Calibration and Working Standards

All calibration standards must be traceable to a certified standard obtained from a recognized organization. If traceable standards are not available, procedures must be implemented to standardize the utilized calibration solutions (*e.g*., comparison to a CRM – see below). Standardization of calibration solutions must be thoroughly documented, and is only acceptable when pre-certified standard solutions are not available. Working standards are dilutions of stock standards prepared for daily use in the laboratory. Working standards are used to calibrate instruments or prepare matrix spikes, and may be prepared at several different dilutions from a common stock standard. Working standards are diluted with solutions that ensure the stability of the target analyte. Preparation of the working standard must be thoroughly documented such that each working standard is traceable back to its original stock standard. Finally, the concentration of all working standards must be verified by analysis prior to use in the laboratory.

14.1.2. Instrument Calibration

Prior to sample analysis, utilized instruments must be calibrated following the procedures outlined in the relevant analytical method or laboratory SOP. Each method or SOP must specify acceptance criteria that demonstrate instrument stability and an acceptable calibration. If instrument calibration does not meet the specified acceptance criteria, the analytical process is not in control and must be halted. The instrument must be successfully recalibrated before samples may be analyzed.

Calibration curves will be established for each analyte covering the range of expected sample concentrations. Only data that result from quantification within the demonstrated working calibration range may be reported unflagged by the laboratory. Quantification based upon extrapolation is not acceptable. Data reported outside of the calibration range must be flagged as “Detected not Quantified”.

14.1.3. Initial Calibration Verification

The initial calibration verification (ICV) is a mid-level standard analyzed immediately following the calibration curve. The source of the standards used to calibrate the instrument and the source of the standard used to perform the ICV must be independent of one another. This is usually achieved by the purchase of standards from separate vendors. Since the standards are obtained from independent sources and both are traceable, analyses of the ICV functions as a check on the accuracy of the standards used to calibrate the instrument. The ICV is not a requirement of all SOPs or methods, particularly if other checks on analytical accuracy are present in the sample batch.

14.1.4. Continuing Calibration Verification

Continuing calibration verification (CCV) standards are mid-level standards analyzed at specified intervals during the course of the analytical run. CCVs are used to monitor sensitivity changes in the instrument during analysis. In order to properly assess these sensitivity changes, the standards used to perform CCVs must be from the same set of working standards used to calibrate the instrument. Use of a second source standard is not necessary for CCV standards, since other QC samples are designed to assess the accuracy of the calibration standards. Analysis of CCVs using the calibration standards limits this QC sample to assessing only instrument sensitivity changes. The acceptance criteria and required frequency for CCVs are detailed in Appendix A and Appendix B (for PFAS). If a CCV falls outside the acceptance limits, the analytical system is not in control, and immediate corrective action must be taken.

Data obtained while the instrument is out of control is not reportable, and all samples analyzed during this period must be reanalyzed. If reanalysis is not an option, the original data must be flagged with the appropriate qualifier and reported. A narrative must be submitted listing the results that were generated while the instrument was out of control, in addition to corrective actions that were applied.

14.1.5. Laboratory Blanks

Laboratory blanks (also called method blanks) are used to assess the background level of a target analyte resulting from sample preparation and analysis. Laboratory blanks are carried through precisely the same procedures as the field samples. For both organic and inorganic analyses, a minimum of at least one laboratory blank must be prepared and analyzed in every analytical batch. Some methods may require more than one laboratory blank with each analytical run. Acceptance criteria for laboratory blanks are detailed in Appendix A and Appendix B (for PFAS). Blanks that are too high require corrective action to bring the concentrations down to acceptable levels. This may involve changing reagents, cleaning equipment, or even modifying the utilized methods or SOPs. Although acceptable laboratory blanks are important for obtaining results for low-level samples, improvements in analytical sensitivity have pushed detection limits down to the point where some amount of analyte will be detected in even the cleanest laboratory blanks. The magnitude of the blanks must be evaluated against the concentrations of the samples being analyzed and against project objectives.

14.1.6. Reference Materials and Demonstration of Laboratory Accuracy

Evaluation of the accuracy of laboratory procedures is achieved through the preparation and analysis of reference materials with each analytical batch. Ideally, the reference materials selected are similar in matrix and concentration range to the samples being prepared and analyzed. The acceptance criteria for reference materials are listed in Appendix A and Appendix B (for PFAS). The accuracy of an analytical method can be assessed using CRMs only when certified values are provided for the target analytes. When possible, reference materials that have certified values for the target analytes should be used. This is not always possible, and often times certified reference values are not available for all target analytes. Many reference materials have both certified and non-certified (or reference) values listed on the certificate of analysis. Certified reference values are clearly distinguished from the non-certified reference values on the certificate of analysis.

14.1.7. Reference Materials vs. Certified Reference Materials

The distinction between a reference material and a certified reference material does not involve how the two are prepared, rather with the way that the reference values were established. Certified values are determined through replicate analyses using two independent measurement techniques for verification.

The certifying agency may also provide “non-certified or “reference” values for other target analytes. Such values are determined using a single measurement technique that may introduce bias. When available, it is preferable to use reference materials that have certified values for all target analytes. This is not always an option, and therefore it is acceptable to use materials that have reference values for these analytes. Note: Standard Reference Materials (SRMs) are essentially the same as CRMs. The term “Standard Reference Material” has been trademarked by the National Institute of Standards and Technology (NIST), and is therefore used only for reference materials distributed by NIST.

14.1.8. Laboratory Control Samples

While reference materials are not available for all analytes, a way of assessing the accuracy of an analytical method is still required. Laboratory control samples (LCSs) provide an alternate method of assessing accuracy. An LCS is a specimen of known composition prepared using contaminant-free reagent water or an inert solid spiked with the target analyte at the midpoint of the calibration curve or at the level of concern. The LCS must be analyzed using the same preparation, reagents, and analytical methods employed for regular samples. If an LCS needs to be substituted for a reference material, the acceptance criteria are the same as those for the analysis of reference materials. These are detailed in Appendix A and Appendix B (for PFAS).

14.1.9. Prioritizing Certified Reference Materials, Reference Materials, and Laboratory Control Samples

Certified reference materials, reference materials, and laboratory control samples all provide a method to assess the accuracy at the mid-range of the analytical process. However, this does not mean that they can be used interchangeably in all situations. When available, The Project requires the analysis of one certified reference material per analytical batch. Certified values are not always available for all target analytes. If no certified reference material exists, reference values may be used. If no reference material exists for the target analyte, an LCS must be prepared and analyzed with the sample batch as a means of assessing accuracy. The hierarchy is as follows: analysis of a CRM is favored over the analysis of a reference material, and analysis of a reference material is preferable to the analysis of an LCS. Substitution of an LCS is not acceptable if a certified reference material or reference material is available.

14.1.10.Matrix Spikes

A matrix spike (MS) is prepared by adding a known concentration of the target analyte to a field sample, which is then subjected to the entire analytical procedure. Matrix spikes are analyzed in order to assess the magnitude of matrix interference and bias present. Because matrix spikes are analyzed in pairs, the second spike is called the matrix spike duplicate (MSD). The MSD provides information regarding the precision of the matrix effects. Both the MS and MSD are split from the same original field sample. In order to properly assess the degree of matrix interference and potential bias, the spiking level should be approximately 2-5x the ambient concentration of the spiked sample. To establish spiking levels prior to sample analysis, laboratories should review any relevant historical data. In many instances, the laboratory will be spiking samples blind and will not meet a spiking level of 2-5x the ambient concentration. In addition to the recoveries, the relative percent difference (RPD) between the MS and MSD is calculated to evaluate how matrix affects precision. The MQO for the RPD between the MS and MSD is the same regardless of the method of calculation. These are detailed in Appendix A and Appendix B (for PFAS). Recovery data for matrix spikes provides a basis for determining the prevalence of matrix effects in the samples collected and analyzed. If the percent recovery for any analyte in the MS or MSD is outside of the limits specified in Appendix A and Appendix B (for PFAS), the chromatograms (in the case of trace organic analyses) and raw data quantitation reports should be reviewed. Data should be scrutinized for evidence of sensitivity shifts (indicated by the results of the CCVs) or other potential problems with the analytical process. If associated QC samples (reference materials or LCSs) are in control, matrix effects may be the source of the problem. If the standard used to spike the samples is different from the standard used to calibrate the instrument, it must be checked for accuracy prior to attributing poor recoveries to matrix effects.

14.1.11.Laboratory Duplicates

In order to evaluate the precision of an analytical process, a field sample is selected and prepared in duplicate. Specific requirements pertaining to the analysis of laboratory duplicates vary depending on the type of analysis. The acceptance criteria for laboratory duplicates are specified in Appendix A and Appendix B (for PFAS).

14.1.12.Laboratory Duplicates vs. Matrix Spike Duplicates

Although the laboratory duplicate and matrix spike duplicate both provide information regarding precision, they are unique measurements. Laboratory duplicates provide information regarding the precision of laboratory procedures. The matrix spike duplicate provides information regarding how the matrix of the sample affects both the precision and bias associated with the results. It also determines whether or not the matrix affects the results in a reproducible manner. Because the two concepts cannot be used interchangeably, it is unacceptable to analyze only an MS/MSD when a laboratory duplicate is required.

14.1.13.Replicate Analyses

The Project will adopt the same terminology as SWAMP in defining replicate samples, wherein replicate analyses are distinguished from duplicate analyses based simply on the number of involved analyses. Duplicate analyses refer to two sample preparations, while replicate analyses refer to three or more. Analysis of replicate samples is not explicitly required.

14.1.14.Surrogates

Surrogate compounds accompany organic measurements in order to estimate target analyte losses during sample extraction and analysis. The selected surrogate compounds behave similarly to the target analytes, and therefore any loss of the surrogate compound during preparation and analysis is presumed to coincide with a similar loss of the target analyte. Surrogate compounds must be added to field and QC samples prior to extraction, or according to the utilized method or SOP. Surrogate recovery data are to be carefully monitored. If possible, isotopically labeled analogs of the analytes are to be used as surrogates.

14.1.15.Internal Standards

To optimize gas chromatography mass spectrometry (GC-MS) and Inductively Coupled Plasma Mass Spectrometry (ICP-MS) analyses, internal standards (also referred to as “injection internal standards”) may be added to field and QC sample extracts prior to injection. Use of internal standards is particularly important for analysis of complex extracts subject to retention time shifts relative to the analysis of standards. The internal standards can also be used to detect and correct for problems in the GC injection port or other parts of the instrument. The analyst must monitor internal standard retention times and recoveries to determine if instrument maintenance or repair or changes in analytical procedures are indicated. Corrective action is initiated based on the judgment of the analyst. Instrument problems that affect the data or result in reanalysis must be documented properly in logbooks and internal data reports, and used by the laboratory personnel to take appropriate corrective action. Performance criteria for internal standards are established by the method or laboratory SOP.

14.1.16.Dual-Column Confirmation

Due to the high probability of false positives from single-column analyses, dual column confirmation should be applied to all gas chromatography and liquid chromatography methods that do not provide definitive identifications. It should not be restricted to instruments with electron capture detection (ECD).

14.1.17.Dilution of Samples

Final reported results must be corrected for dilution carried out during the process of analysis. In order to evaluate the QC analyses associated with an analytical batch, corresponding batch QC samples must be analyzed at the same dilution factor. For example, the results used to calculate the results of matrix spikes must be derived from results for the native sample, matrix spike, and matrix spike duplicate analyzed at the same dilution. Results derived from samples analyzed at different dilution factors must not be used to calculate QC results.

14.1.18.Laboratory Corrective Action

Failures in laboratory measurement systems include, but are not limited to: instrument malfunction, calibration failure, sample container breakage, contamination, and QC sample failure. If the failure can be corrected, the analyst must document it and its associated corrective actions in the laboratory record and complete the analysis. If the failure is not resolved, it is conveyed to the respective supervisor who should determine if the analytical failure compromised associated results. The nature and disposition of the problem must be documented in the data report that is sent to the SPM.

14.2. Field Quality Control

Field QC results must meet the MQOs and frequency requirements specified in Appendix A and Appendix B (for PFAS), where frequency requirements are provided on a sample batch level. The Project defines a sample batch as 20 or fewer field samples prepared and analyzed with a common set of QC samples. Specific field quality control samples may also be required by the method or SOP selected for sample collection and analysis. If project MQOs conflict with those prescribed in the utilized method or SOP, the more rigorous of the objectives must be met.

14.3. Equipment Blanks

Equipment blanks are generated by the personnel responsible for cleaning sampling equipment. Equipment blanks must be analyzed before the equipment is shipped to the sampling site. In order to accommodate any necessary corrective action, equipment blank results should be available well in advance of the sampling event. To ensure that sampling equipment is contaminant-free, water known to be low in the target analyte(s) must be processed though the equipment as during sample collection. The specific type of water used for blanks is selected based on the information contained in the relevant sampling or analysis methods. The water must be collected in an appropriate sample container, preserved, and analyzed for the target analytes (in other words, treated as an actual sample). The inclusion of field blanks is dependent on the requirements specified in the relevant MQO tables, or in the sampling method or SOP. Typically, equipment blanks are collected when new equipment, equipment that has been cleaned after use at a contaminated site, or equipment that is not dedicated for surface water sampling is used. An equipment blank must be prepared for dissolved metals in water samples whenever a new lot of filters is used.

The equipment blanking requirement for the Project is met by performing the following procedures:

1. After a batch of borosilicate glass carboys is cleaned, a bottle blank (rinsate blank) on one randomly selected vessel from the batch at a rate of 5% (1 blank for every 20 carboys cleaned); equipment blanks are not required if using single-use, factory-clean containers.

2. Prior to the beginning of monitoring for a season, after a batch of intake tubing, pump-roller tubing, and strainers have been cleaned, perform an equipment blank (rinsate blank) on the tubing and strainers.

3. If one or more of the equipment items show evidence of unacceptable contamination, the equipment must be recleaned and the analyses run again until no further unacceptable contamination is found.

14.4. Field Blanks

A field blank is collected to assess potential sample contamination levels that occur during field sampling activities. Field blanks are taken to the field, transferred to the appropriate container, preserved (if required by the method), and treated the same as the corresponding sample type during the course of a sampling event. The inclusion of field blanks is dependent on the requirements specified in the relevant MQO tables or in the sampling method or SOP. Field blanks for other media and analytes should be conducted upon initiation of sampling. If field blank performance is acceptable, further collection and analysis of field blanks should be performed on an as-needed basis. Acceptable levels for field blanks are specified in Appendix A and Appendix B (for PFAS). The water used for field blanks must be free of target analyte(s) and appropriate for the analysis being conducted.

Given Project objectives and constraints, Project field blanks are not easily collected in the field in the same manner as field blanks for grab samples. This is because of the automated sampling approach that includes a stainless-steel intake strainer, HDPE intake tubing, and SEBS pump-roller tubing and automated sampling equipment. Methods adopted for collection of field blanks are detailed in Appendix E. Field blanks will be collected at all monitoring sites (influent and effluent samples) in Year 1 of Project implementation. Programs will review results of these analyses with TAG to determine need for additional testing in future years of the Project.

14.5. Pour Blanks

A pour blank is collected to assess potential sample contamination levels that occur in the laboratory when composite sample material from carboys is transferred to individual sample containers for laboratory analysis. Pour blanks are generated by the prime laboratory in the same location and using the same equipment as is used to prepare individual sample containers for specific analyses. Acceptable levels for pour blanks, where required, are specified in Appendix A (for mercury) and Appendix B (for PFAS). The water used for pour blanks must be free of target analyte(s) and appropriate for the analysis being conducted.

14.6. Procedural Blanks

Procedural blanks are equipment blanks that are run following the conclusion of field sampling efforts for a given year, using field-used sample tubing as a means of better understanding any bias in analytical results that may be associated with sample collection techniques. Similar to the equipment blank protocol, water known to be low in the target analyte(s) will be processed though the reclaimed tubing that is left in place during the course of the sampling year. The water must be collected in an appropriate sample container, preserved, and analyzed for the target analytes (in other words, treated as an actual sample).

After a set of sample intake tubing, pump-roller tubing, and strainers have been returned from the field, a bottle blank (rinsate blank) on each set of tubing will be prepared and delivered to the analytical laboratory for analysis of the full suite of Project analytes (PFAS and non-PFAS analytes). Results of these analyses will be used to inform interpretation of Project results.

14.7. Field Duplicates

Field samples collected in duplicate provide precision information as it pertains to the sampling process. The duplicate sample must be collected in the same manner and as close in time as possible to the original sample. This effort is to attempt to examine field homogeneity as well as sample handling, within the limits and constraints of the situation.

Given constraints associated with Project implementation, field duplicate samples will be collected as split samples in place of true field duplicate samples. Protocols for sample collection are contained within each Program's respective monitoring plan.

14.8. Corrective Actions

Corrective and Preventative Action Reports (CPARs) are reports that are developed in response to an incident of non-conformance at any stage of data collection, from site visitation to sample collection to sample analysis. CPARs are to be filled out by field crew members and laboratory personnel when a deviation from standard or required protocol has occurred. A CPAR template is included as Appendix D; laboratories may choose to use their company format instead as long as similar information is documented. Corrective and preventative actions both include investigation, action, review, and further action if so required. CPARs must include the following information:

- Clearly identify the non-conformance including, but not limited to, the date, location, analysis/sample(s)/procedure/instrument affected, and the resulting effect
- Clearly identify the root cause of the discrepancy or deviation
- Suggest or summarize corrective actions taken to:
    - Address the immediate issue
    - Prevent future occurrences.

The CPAR is to be submitted to the affected stormwater Program Manager for review and approval. Documentation of the problem and follow-up actions will be included in associated annual reports.

Table 14-1. Frequency of Checks for Sample Integrity, Laboratory Accuracy, Laboratory Precision, and Process Reproducibility for non-PFAS Project Analytes in Water. Refer to Appendix B for PFAS specifications.

Analyte	Method Group	Trip / Field Blank Frequency	Equipment Blank Frequency	Split Sample Frequency	CRM or LCS Frequency	Matrix Spike / MS Duplicate Frequency	Lab Duplicate Frequency
Mercury (Total and Dissolved), Copper (Total and Dissolved), Zinc (Total and Dissolved)	Inorganics	Not required	5% on lab-cleaned bottles, before use on eqpt.	5% of samples	Per 20 samples or per analytical batch (whichever is more frequent)	Per 20 samples or per analytical batch (whichever is more frequent)	Per analytical method
PCBs	Synthetic Organics	Not required	5% on lab-cleaned bottles, before use on eqpt.	5% of samples	Per 20 samples or per analytical batch	Per 20 samples or per analytical batch (whichever is more frequent)	Per analytical method
TPH as diesel / motor oil	Semivolatile Organic Compounds	Not required	5% on lab-cleaned bottles, before use on eqpt.	5% of samples	Per 20 samples or per analytical batch	Per 20 samples or per analytical batch (whichever is more frequent)	Per analytical method
Hardness	Conventional	Not required	5% on lab-cleaned bottles, before use on eqpt.	5% of samples	Per 20 samples or per analytical batch (whichever is more frequent)	Per 20 samples or per analytical batch (whichever is more frequent)	Per analytical method
TSS	Solids	Not required	5% on lab-cleaned bottles, before use on eqpt.	5% of samples	Per 20 samples or per analytical batch (whichever is more frequent)	Per 20 samples or per analytical batch (whichever is more frequent)	Per analytical method

15. (B6) Instrument/Equipment Testing, Inspection and Maintenance

Any field measurement equipment used will be checked for operation in accordance with manufacturer's specifications. This includes battery checks and routine replacement and/or cleaning of parts as specified by the manufacturer. All equipment will be inspected for damage when first employed and again when returned from use. As required, maintenance logs will be kept and each piece of equipment will have its own log that documents the dates and description of any problems, the action(s) taken to correct problem(s), maintenance procedures, system checks, follow-up maintenance dates, and the person responsible for maintaining the equipment. A list of anticipated field measurement equipment to be used for Project monitoring is shown in Table 15-1.

As mentioned previously, the effectiveness evaluations of stormwater treatment structural controls may include measurements of flow and *in situ* measurements of physical water quality parameters (e.g., pH, conductivity, dissolved oxygen, temperature, turbidity). As appropriate, Program-specific MPs will describe in detail how this will be accomplished and the testing, inspection and maintenance of the associated equipment.

Table 15-1. Testing, Inspection and Maintenance of Field Sampling Equipment

Instrument / Equipment	Test / Maintenance	Frequency of Checking	Responsible Person
Flow meter	Battery check	Before each use	MC
Autosampler	Battery check, programming, tubing replacement	Before each use	MC
pH probe	Battery check, calibration	Before each use	MC
Rain gauge	Battery check, calibration	Before each use, annual calibration	MC
Soil moisture probe	Battery check, calibration	Prior to deployment	MC
Others	TBD	TBD	MC

16. (B7) Instrument/Equipment Calibration and Frequency

16.1. Field Measurements

Any monitoring equipment used should be visually inspected during mobilization to identify problems that would result in loss of data. As mentioned earlier, the effectiveness evaluations of stormwater treatment structural controls may include measurements of flow and *in situ* measurements of physical water quality parameters (e.g., pH, conductivity, dissolved oxygen, temperature, turbidity). As appropriate, Program-specific MPs will describe calibration of the associated equipment. The revisions will undergo review and approval by the TAG before this type of fieldwork commences.

16.2. Laboratory Analyses

16.2.1. In-house Analyses

There are no in-house laboratory-based analyses planned for this project.

16.2.2. Contract Laboratory Analyses

The procedures for and frequency of calibration will vary depending on the chemical parameters being determined. Equipment is maintained and checked according to the standard procedures specified in each laboratory's instrument operation instruction manual.

Upon initiation of an analytical run, after each major equipment disruption, and whenever on-going calibration checks do not meet recommended DQOs (see Appendix A and Appendix B (for PFAS)), analytical systems will be calibrated with a full range of analytical standards. Immediately after this procedure, the initial calibration must be verified through the analysis of a standard obtained from a different source than the standards used to calibrate the instrumentation and prepared in an independent manner and ideally having certified concentrations of target analytes of a CRM or certified solution. Frequently, calibration standards are included as part of an analytical run, interspersed with actual samples.

Calibration curves will be established for each analyte and batch analysis from a calibration blank and a minimum of three analytical standards of increasing concentration, covering the range of expected sample concentrations. Only those data resulting from quantification within the demonstrated working calibration range may be reported by the laboratory.

The calibration standards will be prepared from reference materials available from the EPA repository, or from available commercial sources. The source, lot number, identification, and purity of each reference material will be recorded. Neat compounds will be prepared weight/volume using a calibrated analytical balance and Class A volumetric flasks. Reference solutions will be diluted using Class A volumetric glassware. Individual stock standards for each analyte will be prepared. Combination working standards will be prepared by volumetric dilution of the stock standards. The calibration standards will be stored at -20º C. Newly prepared standards will be compared with existing standards prior to their use. All solvents used will be commercially available, distilled in glass, and judged suitable for analysis of selected chemicals. Stock standards and intermediate standards are prepared on an annual basis and working standards are prepared every three months.

Sampling and analytical logbooks will be kept to record inspections, calibrations, standard identification numbers, the results of calibrations, and corrective action taken. Equipment logs will document instrument usage, maintenance, repair and performance checks. Daily calibration data will be stored with the raw sample data.

17. (B8) Inspection/Acceptance for Supplies and Consumables

Each sampling event conducted for Project sampling and analysis will require use of appropriate consumables to reduce likelihood of sample contamination (e.g., solvents for field cleaning sampling equipment, appropriate gloves). MCs will be responsible for ensuring that all supplies are appropriate prior to their use. Inspection requirements for sampling consumables and supplies are summarized in Table 17-1.

Table 17-1. Inspection / Acceptance Testing Requirements for Consumables and Supplies

Project-related Supplies	Inspection / Testing Specifications	Acceptance Criteria	Frequency	Responsible Person Sampling Containers
Sampling supplies	Visual	No evident contamination or damage	Each purchase and use	MC

18. (B9) Non Direct Measurements, Existing Data

The Project builds upon previous investigations conducted MRP3 Permittees. These previous investigations included sampling and analysis of PCBs, mercury, TOC, and other analytes in both soils and water collected from various parts of the stormwater conveyance system in a number of watersheds tributary to San Francisco Bay.

These previous efforts will be used to inform sampling site selection and interpretation for the Project. In addition to data generated through implementation of MRP-related monitoring, the previous studies that may inform Project actions include previous BASMAA agency efforts (e.g., Geosyntec 2016, Gunther et al. 2001, KLI and EOA 2002), follow-on BASMAA source investigations (EOA 2002, EOA 2004, EOA 2007, City of San Jose and EOA 2003, Salop et al. 2002, SMSTOPPP 2003, SMSTOPPP 2004), and a variety of other regional projects (e.g., Kleinfelder 2005, Kleinfelder 2006, Yee and McKee 2010).

In addition to contaminant concentration and hydrological data obtained from prior monitoring efforts, Programs may incorporate measurement data from weather stations proximate to sampling sites. To the extent possible these will be NOAA reporting stations, but local weather stations may be substituted as appropriate.

Acceptance of external data for use will depend on the relevance of the matrix, location of the samples, and the methods that were used for collection and analysis. External data that fails to meet acceptance criteria will not be used by the Project. There are no known or expected constraints to using the proposed external data.

19. (B10) Data Management

The MC or their designee will be responsible for management of all data generated in the field and laboratory throughout the data collection, management, and reporting process. It is anticipated that approved Project data will be incorporated into CEDEN with monitoring application-specific identifiers as defined in Table 19-1.

Table 19-1. CEDEN Terminology for Project Data Deliverables

Sampling Point	Location Code	Geometry Shape	Collection Device	Collection Method Code	Matrix	Position Water Column
LID Influent	Inflow	Point	ISCO Auto Sampler	AutosamplerStorm	Samplewater	Not recorded
LID Effluent	Outflow1	Point	ISCO Auto Sampler	AutosamplerStorm	Samplewater	Not recorded

19.1. Field Data Management

Record keeping of field measurements data for the proposed project will employ standard record-keeping and tracking practices. All field measurements will be entered in bound log books and/or field datasheets while in the field, or equivalent electronic devices.

Example field will be described in the Program-specific MPs. The MC will be responsible for field measurement data management.

Field measurement data that was entered into bound log books / field datasheets in the field will be entered into an Excel file and then quality control (QC) checked for entry errors by a different person. Backup copies of all data files will be made by the person performing data entry on the same day that the files were generated or that any changes were made to them. Field measurement data entered into electronic devices will be downloaded in Excel format and then QC checked by field personnel familiar with the data that was collected.

19.2. Laboratory Data Management

Record keeping of laboratory analytical data for the Project will employ standard record-keeping and tracking practices. All laboratory analytical data will be entered into electronic files by the instrumentation being used or, if data is manually recorded, then it will be entered by the analyst in charge of the analyses. All analytical data will contain unique identification numbers for tracking.

Laboratory analytical data that will be recorded using various analytical instruments will be formatted to Project specifications and delivered to the MC after specified quality control checks are completed. Backup copies of all data files will be made at the laboratory at the end of every day. Laboratory analytical data will be formatted using the Excel templates provided by the MC or PC. Additionally, all analytes associated with laboratory data will be identified using the standardized list that is provided by MC or PC.

20. (C1) Assessments and Response Actions

20.1. Mobilization

The MC or their designee will review all field equipment, instruments, containers, and paperwork to ensure that everything is ready prior to each sampling event. All sampling personnel will be given a brief review of the goals and objectives of the sampling event and the sampling procedures and equipment that will be used to achieve them. It is important that all field equipment be clean and ready to use when it is needed. Therefore, prior to using all sampling and/or field measurement equipment, each piece of equipment will be checked to make sure that it is in proper working order. Equipment maintenance records will be checked to ensure that all field instruments have been properly maintained and that they are ready for use. Essential items (e.g., preservatives, bottles, labels, waterproof pens) will be checked before each field event to make sure that there are sufficient supplies to successfully support each sampling event. It is important to make sure that all field activities and measurements are properly recorded in the field. Therefore, prior to starting each field event, necessary paperwork such as logbooks and chain of custody record forms will be checked to ensure that sufficient amounts are available for the field event. In the event that a problem is discovered during a readiness review it will be noted in the field logbook and corrected before the field crew is deployed. The actions taken to correct the problem will also be documented in the field logbook.

20.2. Demobilization

At the conclusion of field sampling events, the MC should debrief sampling personnel and, as necessary, document any problems that arose during sampling activities, along with recommendations for correcting the problem. These reviews will ensure that any deviations from planned methodologies are documented and addressed.

20.3. Laboratory Data Reviews

The MC or their designee will be responsible for reviewing the laboratory's data for completeness and accuracy. The data will also be checked to make sure that the specified methods were used and that all required QC data were provided with the sample analytical results. Laboratory data reviews will be conducted following receipt of each data package from a laboratory in order to ensure that all information is complete and any deviations from planned methodologies are either corrected or the reasons for deviations are documented. Any laboratory data that is discovered to be incorrect or missing will immediately be reported to the both the laboratory project manager and SPM. Laboratory personnel will consult the laboratory's QA manual for the procedures that will be followed to correct any invalid or missing data. The SPM and MC have the authority to request re-testing if a data review reveals any factors that would compromise the quality of the data and resulting conclusions from the project.

21. (C2) Reports to Management

The anticipated reporting requirements associated with the Project are described below and summarized in Table 21-1. MCs are expected to stay in close communication with SPMs on Project progress, but no formal reporting mechanisms are required to document that communication.

21.1. Data Delivery

Analytical data will be delivered by each laboratory contractor to each respective MC as a two-part package: (1) CEDEN comparable EDD template, and (2) written narrative with raw data, QA results, and a summary of QA issues associated with the deliverable. The MC's designee shall review the draft results against QAPP requirements and identify any deficiencies requiring resolution. At the point where there are no remaining QA concerns, the CEDEN template will be considered final and will be submitted to a CEDEN data node for inclusion in CEDEN.

21.2. Progress Reports

Progress will be reported annually through the updates submitted by each Program as part of UCMR reporting requirements.

This information is summarized in Table 21-1 below. Draft or final reports may also be made available upon request to Project participants not listed below, including municipalities and TAG members.

Table 21-1. Reports to Management

Type of Report	Frequency	Projected Delivery Dates(s)	Person(s) Responsible for Report Preparation	Report Recipients
Interim progress reports (UCMR)	Annual	March 31st of each monitoring year (except 2026)	SPM	WB
Integrated Monitoring Report (IMR)	Once	March 31, 2026	SPM	WB

22. (D1) Data Review, Verification, and Validation

Defining data review, verification, and validation procedures helps to ensure that project data will be reviewed in an objective and consistent manner. Data review is the in-house examination to ensure that the data have been recorded, transmitted, and processed correctly. The MC will assign a designee responsible for data review. This includes checking that all technical criteria have been met, documenting any problems that are observed and, if possible, ensuring that deficiencies noted in the data are corrected.

In-house examination of Project data will be conducted to check for typical types of errors. This includes checking to make sure that the data have been recorded, transmitted, and processed correctly. The kinds of checks that will be made will include checking for data entry errors, transcription errors, transformation errors, calculation errors, and errors of data omission.

Data generated by project activities will be reviewed against MQOs that were developed and documented in Section 7 and Appendix A and Appendix B (for PFAS).

QA/QC requirements are documented in Sections 14, 15, 16, and 17 and the data will be checked against this information. Checks will include evaluation of field and laboratory duplicate results, field and laboratory blank data, matrix spike recovery data, and laboratory control sample data pertinent to each method and analytical data set.

Field data consists of all information obtained during sample collection and field measurements, including that documented in field log books and/or recording equipment, photographs, and chain of custody forms. Checks of field data will be made to ensure that it is complete, consistent, and meets the data management requirements documented in Section 19.

Lab data consists of all information obtained during sample analysis. Initial review of laboratory data will be performed by the laboratory QA Officer in accordance with the lab's internal data review procedures. However, upon receipt of laboratory data, the MC-designated QA reviewer will perform independent checks to ensure that it is complete, consistent, and meets the data management requirements that were developed and documented in Section 19. This review will include evaluation of field and laboratory QC data and also verifying that the data are reported in compliance with procedures developed and documented in Sections 12, 13, and 14.

Data verification is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual specifications. Each Program will conduct data verification, as described in Section 14.

Data validation is an analyte- and sample-specific process that evaluates the information after the verification process (i.e., determination of method, procedural, or contractual compliance) to determine analytical quality and any limitations. Data validation evaluates whether data are of acceptable quality with respect to the intended end use as described in Section 5.2 (Decisions or Outcomes).

Data will be separated into three categories: (1) data that meet all acceptance requirements, (2) data determined unacceptable for use, and (3) data that may be conditionally used and are flagged per EPA specifications.

23. (D2) Verification and Validation Methods

Defining the methods for data verification and validation helps to ensure that project data are evaluated objectively and consistently. Many of these methods have been described in Section 22. Additional information is provided below.

All of the laboratory's data will be checked as part of the verification methodology process. Each contract laboratory will conduct reviews of all laboratory data for verification of their accuracy. The designed QA reviewer will perform independent re-checks of at least 10% of them as the validation methodology.

Any data that are discovered to be incorrect or missing during the verification or validation process will immediately be reported to the MC and SPM. If errors involve laboratory data then this information will also be reported to the laboratory's QA Officer. Laboratory personnel will follow the procedures in each laboratory's QA manual to correct any invalid or missing data. The MC will be responsible for reporting and correcting any errors that are found in the data during the verification and validation process.

If there are any data quality problems identified, the MCs and SPMs will coordinate to try to identify whether each problem is a result of project design issues, sampling issues, analytical methodology issues, or QA/QC issues (from laboratory or non-laboratory sources). If the source of the problems can be traced to one or more of these basic activities then the person or people in charge of the areas where the issues lie will be contacted and efforts will be made to immediately resolve the problem. If the issues are too broad or severe to be easily corrected then the appropriate people involved will be assembled to discuss and try to resolve the issue(s) as a group. The SPM has the final authority to resolve any issues that may be identified during the verification and validation process.

24. (D3) Reconciliation with User Requirements

The purpose of this project is to generate an improved understanding of the effectiveness of stormwater management practices in the Bay Area. Information from field personnel, laboratory data reviews, reviews of data versus MQOs, reviews against QA/QC requirements, data verification reports, data validation reports, independent data checking reports, and error handling reports will be used to determine whether or not the Project's objectives have been met. Laboratory data will be analyzed for completeness to ensure that project DQOs are met. Laboratory measurements will be statistically analyzed for bias (as percent recovery) and precision (as RPD). The field statistical data will be compared against the MQOs documented in Section 7 and Appendix A and Appendix B (for PFAS).

Data from all monitoring measurements will be summarized in tables. Additional data may also be represented graphically when it is deemed helpful for interpretation purposes.

Project data will be collected from a wide variety of sites with differing land use conditions and sampling environments. As the Bay Area in general is highly urbanized, matrix interferences may affect the ability of some analyses to achieve DQOs (e.g., elevated MRLs relative to targets).

The above evaluations will provide a comprehensive assessment of how well the Project meets its objectives.

The data obtained through Project implementation by the collaborating stormwater Programs will improve management of TMDL pollutants in stormwater in the San Francisco Bay area by expanding our collective knowledge of BMP effectiveness and clarifying conditions where BMPs may be most successful. The products and information from this Project will inform efforts to effectively allocate resources to reduce loads of priority pollutants.

25. References

AMS 2023. Municipal Regional Stormwater Permit NPDES Permit No. CAS612008 Order No. R2-2022-0018 Provision C.8 Low Impact Development Monitoring Plan for Alameda County, Draft. Prepared for the Alameda Countywide Clean Water Program.

AMS 2023a. Municipal Regional Stormwater Permit NPDES Permit No. CAS612008 Order No. R2-2022-0018 Provision C.8 Low Impact Development Monitoring Plan for Solano County, Draft. Prepared for the Solano Stormwater Alliance.

BASMAA 2012. *Sampling and Analysis Plan: Clean Watersheds for a Clean Bay – Implementing the San Francisco Bay's PCBs and Mercury TMDLs with a Focus on Urban Runoff, Task 3, EPA San Francisco Bay Water Quality Improvement Fund Grant # CFDA 66.202.* Prepared by Applied Marine Sciences, Inc. September 4, 2012.

BASMAA 2016. *BASMAA Regional Monitoring Coalition Standard Operating Procedures for Creek Status Monitoring.* Prepared by AMS, ARC, and EOA for the Regional Monitoring Coalition. Version 3, March 2016.

California Department of Transportation (Caltrans) 2022. Highway 33 Open Graded Friction Course (OGFC) Water Quality Analysis Quality Assurance Project Plan (QAPP), Caltrans Document Number CTSW-PL-22-421.01.01, November 2022.

California Department of Transportation (Caltrans), 2020. Caltrans Stormwater Monitoring Guidance Manual. Document No. CTSW-OT-20-350.04.01. August 2020.

EOA 2023. Municipal Regional Stormwater Permit NPDES Permit No. CAS612008 Order No. R2-2022-0018 Provision C.8 Low Impact Development Monitoring Plan for San Mateo County, Draft. Prepared for the San Mateo County Water Pollution Prevention Program. February 29, 2023.

EOA 2023a Municipal Regional Stormwater Permit NPDES Permit No. CAS612008 Order No. R2-2022-0018 Provision C.8 Low Impact Development Monitoring Plan, Draft. Prepared for the Santa Clara Valley Urban Runoff Pollution Prevention Program. February 29, 2023.

KEI 2023. Municipal Regional Stormwater Permit NPDES Permit No. CAS612008 Order No. R2-2022-0018 Provision C.8 Low Impact Development Monitoring Plan for Contra Costa County, Draft. Prepared for the Contra Costa County Clean Water Program. February 29, 2023.

City of San Jose and EOA 2003. *Year Two Case Study Investigating Elevated Levels of PCBs in Storm Drain Sediments in San Jose, California*. July 2003.

EOA 2004. *Review of Potential Measures to Reduce Urban Runoff Loads of PCBs to San Francisco Bay*. Prepared for the Santa Clara Valley Urban Runoff Pollution Prevention Program by EOA, Inc. March 2004.

EOA 2007. *Summary of Polychlorinated Biphenyls (PCBs) Data in Sediment Collected from Richmond, California Streets and Storm Drains*. Prepared for the City of Richmond by EOA, Inc. October 2007.

Enthalpy-EDH 2022. *Enthalpy-EDH SOP-70 Rev.0, PFAS by EPA 1633-Draft (2022).*

EPA Office of Water 2023. *4th Draft Method 1633; Analysis of Per- and Polyfluoroalkyl Substances*

(PFAS) in Aqueous, Solid, Biosolids, and Tissue Samples by LC-MS/MS. EPA 821-D-23-001. July 2023.

EPA 1996. *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels*. July 1996.

Geosyntec, 2016. *Clean Watersheds for a Clean Bay (CW4CB) Task 5 Individual Retrofit Pilot Project Report.* Prepared for the Alameda Countywide Clean Water Program. August 2016.

Gunther, A., Salop, P., Bell, D., Feng, A., Wiegel, J., and Wood, R., 2001. *Initial Characterization of PCBs, Mercury, and PAH Contamination in the Drainages of Western Alameda County, CA*. Prepared for the Alameda Countywide Clean Water Program, March 2001.

Kleinfelder 2005. *Sediment Sampling Report: Ettie Street Pump Station Watershed, Oakland, California*. July 29, 2005.

Kleinfelder 2006. *Final Project Report Ettie Street Pump Station Watershed Oakland, California*. Kleinfelder, Inc. September 29, 2006.

KLI and EOA 2002. *Final Report Joint Stormwater Agency Project to Study Urban Sources of Mercury, PCBs and Organochlorine Pesticides*. Prepared by Kinnetic Laboratories Incorporated (KLI) in association with EOA, Inc. April 2002.

Salop, P., Hardin, D., Abu-Saba, K., Gunther, A., and Feng, A., 2002. *Analysis of 2000-01 Source Investigations in Ettie Street Pump Station and Glen Echo Creek Watersheds, Oakland, California*. Prepared for the Alameda Countywide Clean Water Program. August 28, 2002.

SMSTOPPP 2003. *Case Study Investigating Elevated Levels of PCBs in Storm Drain Sediments in the Pulgas Creek Pump Station Drainage, San Carlos, California*. Prepared for San Mateo Countywide Stormwater Pollution Program by EOA, Inc. June 2003.

SMSTOPPP 2004. *Case Study Investigating PCBs in Storm Drain Sediments from Colma Creek, Colma California*. Prepared for San Mateo Countywide Stormwater Pollution Program by EOA, Inc. May 2004.

SWAMP 2022. Surface Water Ambient Monitoring Program Quality Assurance Project Plan, Version 2.0. January 2022.
https://www.waterboards.ca.gov/water_issues/programs/swamp/quality_assurance.html#qaprp

Yee, D., and McKee, L.J., 2010. *Task 3.5: Concentrations of PCBs and Hg in soils, sediments and water in the urbanized Bay Area: Implications for best management.* A technical report of the Watershed Program. SFEI Contribution 608. San Francisco Estuary Institute, Oakland. CA. March 31, 2010.

26. Appendix A – Measurement Quality Objectives for Project Non-PFAS Analytes

Tables 26-1 through 26-5 present target MQOs compiled from SWAMP (2022).

Table 26-1. Measurement Quality Objectives for Possible Project Field Measurements

Analyte	Units	Accuracy (unit)	Precision (unit or RPD) [1]	Resolution[2]
pH	pH	±0.2	±0.2	±0.1
Temperature	(°C)	±0.2	±1 or ±10%	±0.1
Flow	(L/s or m^3/s)	NA	±0.2 or ±10%	±0.1
Moisture	(m^3/m^3)	±5%	±10%	±0.1

[1] Relative Percent Difference (RPD) is the difference between two repeated measurements expressed as a percentage of their average. *%RPD = (sample result - duplicate result) * 100*

[2] Resolution refers to the capability of a method or instrument to recognize small differences between values. This term is often used to assess if an instrument or method is useful to a study and is provided by the manufacturer.

Table 26-2. Measurement Quality Objectives for Conventional Analytes (e.g., Hardness) in Water*

Laboratory Quality Control	Frequency of Analysis	Measurement Quality Objective
Calibration Standard	Per analytical method or manufacturer's specifications	Per analytical method or manufacturer's specifications
Laboratory Blank	Per 20 samples or per analytical batch, whichever is more frequent	<RL for target analyte
Reference Material	Per 20 samples or per analytical batch, whichever is more frequent	80-120% recovery
Matrix Spike	Per 20 samples or per analytical batch, whichever is more frequent (n/a/ for chlorophyll and pheophyton a)	80-120% recovery
Matrix Spike Duplicate	Per 20 samples or per analytical batch, whichever is more frequent (n/a/ for chlorophyll and pheophyton a)	80-120% recovery RPD<25% for duplicates
Laboratory Duplicate	Per 20 samples or per analytical batch, whichever is more frequent	RPD<25% (n/a if native concentration of either sample<RL)
Internal Standard	Accompanying every analytical run as method appropriate	Per method
Field Quality Control	**Frequency of Analysis**	**Measurement Quality Objective**
Field Split	5% of total project sample count	RPD<25% (n/a if native concentration of either sample<RL)
Equipment Blank	5% of total project sample count (reusable containers); once per batch cleaning (equipment)	<RL for target analyte
Field Blank	1/site in Year 1; follow-on contingency upon analytical results	<RL for target analyte

Table 26-3. Measurement Quality Objectives for Conventional Analytes – Solids (e.g., TSS) in Water

Laboratory Quality Control	Frequency of Analysis	Measurement Quality Objective
Laboratory Blank[1]	Per 20 samples or per analytical batch, whichever is more frequent	<RL for target analyte
Laboratory Duplicate[2]	Per 20 samples or per analytical batch, whichever is more frequent	RPD<25% (n/a if native concentration of either sample<RL)
Field Quality Control	**Frequency of Analysis**	**Measurement Quality Objective**
Field Split	5% of total project sample count	RPD<25% (n/a if native concentration of either sample<RL)
Equipment Blank	5% of total project sample count (reusable containers); once per batch cleaning (equipment)	<RL for target analyte

[1] Not applicable to volatile suspended solids

[2] Applicable only to total suspended solids, total dissolved solids, and ash-free dry mass

Table 26-4. Measurement Quality Objectives for Inorganic Analytes (e.g., Mercury, Copper, Zinc) in Water

Laboratory Quality Control	Frequency of Analysis	Measurement Quality Objective
Calibration Standard	Per analytical method or manufacturer's specifications	Per analytical method or manufacturer's specifications
Calibration Verification	Per 10 analytical runs	80-120% recovery
Laboratory Blank	Per 20 samples or per analytical batch, whichever is more frequent	<RL for target analyte
Reference Material	Per 20 samples or per analytical batch, whichever is more frequent	75-125% recovery (70 – 130% for mmHg)
Matrix Spike	Per 20 samples or per analytical batch, whichever is more frequent	70-130% recovery (70 – 130% for mmHg)
Matrix Spike Duplicate	Per 20 samples or per analytical batch, whichever is more frequent	70-130% recovery (70 – 130% for mmHg); RPD<25%
Internal Standard	Accompanying every analytical run when method appropriate	60-125% recovery
Field Quality Control	**Frequency of Analysis**	**Measurement Quality Objective**
Field Split	5% of total project sample count	RPD<25% (n/a if native concentration of either sample<RL)
Equipment Blank	5% of total project sample count (reusable containers); once per batch cleaning (equipment)	<RL for target analyte
Pour Blank (Hg, PFAS only)	1 per event	<RL for target analyte
Field Blank	1/site in Year 1; follow-on contingency upon analytical results	<RL for target analyte

Table 26-5. Measurement Quality Objectives for Synthetic Organic Compounds (e.g., PCBs) in Water[1]

Laboratory Quality Control	Frequency of Analysis	Measurement Quality Objective
Tuning[2]	Per analytical method	Per EPA method 1668C
Calibration	Initial method setup or when the calibration verification fails	• • Per EPA method 1668C
Calibration Verification	Beginning of each 12-hr shift	75-125% for native compounds; 50-145% for labeled compounds
Laboratory Blank	Per 20 samples or per analytical batch, whichever is more frequent	<RL for target analytes
Reference Material	Per 20 samples or per analytical batch (preferably blind)	Blank spike recovery limits 60-135% for native compounds; 15-145% for labeled compounds
Surrogate (aka Cleanup Recovery Standard)	Included in all samples and all QC samples	60 – 135% (analytes 13-PCB-79 AND 13-PCB-178)
Internal Standard	Included in all samples and all QC samples	Per laboratory procedure (see Table 26-6)
Field Quality Control	**Frequency of Analysis**	**Measurement Quality Objective**
Field Split	5% of total project sample count	RPD<25% (n/a if native concentration of either sample<RL)
Equipment Blank	5% of total project sample count (reusable containers); once per batch cleaning (equipment)	<RL for target analyte
Field Blank	1/site in Year 1; follow-on contingency upon analytical results	<RL for target analyte

[1] All detected analytes must be confirmed with a second column, second technique, or mass spectrometry.

[2] Mass spectrometry only

Table 26-6. Acceptance Limits for PCB Internal Standard Compounds in All Aqueous Matrices and QC Samples, Recovery (%).

Compound	Recovery (%)
^{13}C12-PCB 009	5-145
^{13}C12-PCB 028	5-145
^{13}C12-PCB 032	5-145
^{13}C12-PCB 047	5-145
^{13}C12-PCB 052	5-145
^{13}C12-PCB 070	5-145
^{13}C12-PCB 079	10-145
^{13}C12-PCB 080	10-145
^{13}C12-PCB 095	10-145
^{13}C12-PCB 097	10-145
^{13}C12-PCB 101	10-145
^{13}C12-PCB 105	10-145
^{13}C12-PCB 118	10-145
^{13}C12-PCB 123	10-145
^{13}C12-PCB 138	10-145
^{13}C12-PCB 141	10-145
^{13}C12-PCB 153	10-145
^{13}C12-PCB 155	10-145
^{13}C12-PCB 156	10-145
^{13}C12-PCB 159	10-145
^{13}C12-PCB 170	10-145
^{13}C12-PCB 178	10-145
^{13}C12-PCB 180	10-145
^{13}C12-PCB 188	10-145
^{13}C12-PCB 194	10-145
^{13}C12-PCB 202	10-145

Table 26-7. Measurement Quality Objectives for Semi-volatile Organic Compounds (e.g., TPH) in Water[1]

Laboratory Quality Control	Frequency of Analysis	Measurement Quality Objective
Tuning[2]	Per analytical method	Per analytical method
Calibration	Initial method setup or when the calibration verification fails	• Correlation coefficient (r^2 >0.990) for linear and non-linear curves • If RSD<15%, average RF may be used to quantitate; otherwise use equation of the curve • First- or second-order curves only (not forced through the origin) • Refer to SW-846 methods for SPCC and CCC criteria[2] • Minimum of 5 points per curve (one of them at or below the RL)
Calibration Verification	Per 12 hours	• Expected response or expected concentration ±20% • RF for SPCCs=initial calibration[2]
Laboratory Blank	Per 20 samples or per analytical batch, whichever is more frequent	<RL for target analytes
Reference Material	Per 20 samples or per analytical batch	70-130% recovery if certified; otherwise, 50-150% recovery
Matrix Spike	Per 20 samples or per analytical batch, whichever is more frequent	50-150% or based on historical laboratory control limits (average±3SD)
Matrix Spike Duplicate	Per 20 samples or per analytical batch, whichever is more frequent	50-150% or based on historical laboratory control limits (average±3SD); RPD<25%
Surrogate	Included in all samples and all QC samples	Based on historical laboratory control limits (50-150% or better)
Internal Standard	Included in all samples and all QC samples	Per laboratory procedure
Field Quality Control	**Frequency of Analysis**	**Measurement Quality Objective**
Field Split	5% of total project sample count	RPD<25% (n/a if native concentration of either sample<RL)
Equipment Blank	5% of total project sample count (reusable containers); once per batch cleaning (equipment)	<RL for target analyte
Field Blank	1/site in Year 1; follow-on contingency upon analytical results	<RL for target analyte

[1] All detected analytes must be confirmed with a second column, second technique, or mass spectrometry.

[2] Mass spectrometry only

27. Appendix B – Measurement Quality Objectives for PFAS in Water

Information contained within this appendix is excerpted from Enthalpy-EDH SOP-70 Rev.0 (Enthalpy-EDH 2022), which is the method currently being run by Enthalpy for analysis of PFAS in surface water, and EPA Method 1633, 4th Draft (EPA 2023). The following tables identify MQOs, corrective actions, and acceptance criteria for Project PFAS analyses.

Table 27-1. Analytical Instrument Calibration Table for Measurement of PFAS in Surface Water.[1]

Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action
Mass Calibration	Perform Mass Calibration, prior to initial calibration, for new instrument, annually, after major maintenance, when the instrument is moved, when QC fails or ion masses fall outside the mass window.	▪ All masses between 22.9898 – 1971.6149 must be present. ▪ The most recent mass calibration must be used for every standard, QC and sample.	▪ If the mass calibration fails, then recalibrate. If it fails again, consult manufacturer instructions on corrective maintenance. ▪ No samples may be analyzed under a failing mass calibration. ▪ Flagging is not appropriate.
Mass Calibration Verification	▪ Following mass calibration (above) and before ICAL ▪ Fragment a small number of precursor ions in a mid-level calibration standard	▪ Mass range must bracket the masses of interest (qualitative and quantitative) ▪ Peak width at ½ height is 0.5 ± 0.1 AMU (atomic mass unit) ▪ Peak apex within ± 0.1 AMU of expected mass	▪ If the verification fails, perform maintenance and recalibrate. If it fails again, consult manufacturer instructions on corrective maintenance. ▪ No samples may be analyzed under a failing mass calibration. ▪ Flagging is not appropriate.
Ion transitions (precursor-> product)	Every field sample, standard, blank, and QC sample.	▪ Use the masses listed in 1633 Table 2. ▪ If these transitions are not used, the reason must be technically justified and documented (e.g., alternate transition was used due to observed interferences).	▪ Flagging is not appropriate. ▪ If interferences make the Table 2 masses unusable, the client must approve any alternative quantitation ion. ▪ Provide justification in the case narrative.
Ion Ratio	All analytes found in every field sample, standard, blank, and QC sample.	Use the typical ion ratios listed in 1633 Table 2 as guidance.	▪ Apply flag to the associated failure. ▪ Document & discuss the failure in the case narrative.
ICAL	▪ Establish when instrument is first installed, after major instrument maintenance, after instrument conditions are changed, or whenever the ISC or CCV fails and maintenance does not correct the problem. ▪ After mass calibration check and before sample analysis. ▪ Minimum 6 points for linear regression, 5 of which must be within the quantitation range.	▪ S/N ratio ≥ 3:1 for lowest ICAL point, within the quantitation range, used for each compound ▪ %RSD ≤ 20 - or - %RSE ≤ 20 (relative standard error; re-quantitation against the new curve yields recoveries within 80-120%)	▪ Confirm that the correct peak is selected and properly integrated. ▪ If a single calibration standard is causing the curve to fail, it may be immediately rerun, so long as no sample extracts were injected since the last calibration standard and all compounds are calibrated using the second run.

Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action
	Minimum 7 points required for quadratic, with at least 5 within the quantitation range. ▪ Isotope Dilution quantitation is used for 24 targets. ▪ Extracted Internal Standard (EIS) quantitation is used for 16 target compounds.		▪ Perform maintenance or prepare new standards to correct the problem, then repeat ICAL. ▪ Extracts may not be analyzed without a valid ICAL
Initial Calibration Verification Standard (ICV)	▪ After ICAL curve and before samples, using standards prepared from a different manufacturer than the standards used to establish the ICAL curve. ▪ If a second manufacturer is not available, use different lot # from the primary vendor	▪ Method Sect 9.6 recommends use of 2nd source for calibration verification ▪ Use same acceptance limits as for CCV/VER	▪ Prepare fresh standard. Perform instrument maintenance and recalibrate. ▪ Flagging is not appropriate.
Bile Salts Interference Check (TDCA)	▪ After the ICAL and prior to analysis of any Tissue samples	▪ TDCA retention time should fall outside the PFAS retention window by at least 1 minute	Adjust instrument conditions to meet the separation requirement, then recalibrate
Retention Times (Calibration, RT & resolution)	▪ Once per ICAL and at the beginning of the analytical sequence. ▪ Set position for each analyte, extracted internal standard (EIS) and injected internal standard (NIS).	▪ Set position using the midpoint standard of the ICAL on days when an ICAL is performed; in subsequent samples and batch QC, RT of EIS and targets must be within ± 0.4 minutes of midpoint ▪ Set position using the initial CCV on days an ICAL is not performed; in subsequent samples and batch QC, RT of EIS and targets must be within ± 0.4 minutes of initial CCV ▪ EIS analyte must be within ± 0.1 minute of its target analyte	Determine cause and correct the problem. Rerun affected samples and QC.
Instrument Sensitivity Check (ISC)	▪ Beginning of each analytical sequence, prior to the opening VER/CCV standard. ▪ Concentration at the lowest ICAL point.	***Draft-1633 interim limits:*** ▪ S/N ratio ≥ 3:1 ▪ For 90% of native and labeled compounds, recoveries within 70-130% ▪ Remaining compounds must meet 50-150%	▪ Compare the NIS peak areas from the QC and field samples to the average area of the NIS in calibration standards to determine if the problem is an injection error or loss of sensitivity. Sample/QC area should be within 50 – 200% of CAL standards. Low area counts in only some runs indicates injection error. ▪ Correct the problem then rerun the ISC or affected samples. If the problem persists, perform additional maintenance and recalibrate.
CCV/VER	▪ Prior to sample analysis, after every 10 or fewer field samples, and at the end of the analytical sequence.	▪ Native and labeled compounds, recoveries within 70-130%	▪ Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If

Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action
	▪ Use mid-level calibration standard. *Note: ISC does not substitute for the opening CCV*		either fails, or if two consecutive CCVs cannot be run, perform corrective action(s) and repeat CCV and all associated samples since last successful CCV. ▪ Alternately, recalibrate then reanalyze all associated samples since the last acceptable CCV.
Qualitative Identification Standards	▪ Beginning of analytical sequence, after CCV and before samples or prep batch QC ▪ Use "Technical" standard for those branched isomers that do not have a quantitative standard. ▪ Used only for identification; quantitation is based on the response of the linear isomer.	▪ Branched isomers will elute just prior to the linear isomer. ▪ Determine retention times, transitions and transition ion ratios. ▪ Quantitate samples by integrating the total response (i.e., accounting for peaks that are identified as linear and branched isomers) and calculating the concentration using the initial calibration curve of the linear isomer quantitative standard.	N.A

Notes:

1. The instrument is calibrated using standards that have both linear and branched components, when commercially available, with known amounts of each.
2. Isotope dilution method is used as an internal standard for quantitation.

Table 27-2. Laboratory and Field QC Specifications for Analysis of PFAS in Surface Water.

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action	DQI
Extracted Internal Standard (EIS)	Added to every field sample (including blanks) and prep QC sample prior to extraction. ▪ Using isotopically labeled compounds ▪ Report recoveries for all QC and samples; include diluted recoveries where the native is reported from a diluted analysis	Recoveries must be within limits listed in Method (see Table 27-3)	Perform additional cleanup; dilute aqueous samples; re-extract solid/tissue samples using a small aliquot. Apply Q-flag and discuss in the Case Narrative only if reanalysis confirms failures in exactly the same manner.	Accuracy/ Bias
Non-extracted Internal Standard (NIS)	Added to every sample and prep QC extract prior to injection on the UPLC	If ISC (instrument sensitivity check) fails, NIS Recovery: 50 – 200%	▪ If NIS areas are low for all samples and batch QC, recommend performing instrument maintenance to restore sensitivity. ▪ If sporadically low, rerun affected samples.	Accuracy/ Bias
Method Blank (MB)	***1633-Draft:*** ▪ Extract one (1) per preparatory batch of 20 or fewer samples ▪ Analyze following the instrument blank and before samples	***1633-Draft:*** No analytes detected: ▪ >LOQ	Correct problem. If required, re-extract and reanalyze all field samples processed with the contaminated blank. If reanalysis cannot be performed, data must be qualified (analyte B-flagged) and explained in the Case Narrative. Flagging is only appropriate in cases where the samples cannot be re-extracted and reanalyzed.	Accuracy/ Bias/ Contamination
Laboratory Control Sample / Duplicate (LCS/LCSD)	Added to every preparation batch	Recovery: 40 – 150% RPD ≤ 30%	Correct problem. If reanalysis cannot be performed, data must be qualified and explained in the Case Narrative. Flagging is only appropriate in cases where the samples cannot be re-extracted and reanalyzed.	Accuracy/ Bias; Precision
Pour Blank	▪ Analyze concurrent with field samples	***1633-Draft:*** No analytes detected: ▪ >LOQ, or ▪	Correct problem. Problem may lie in the sample handling rather than sample analysis stage.	Accuracy/ Bias/ Contamination
Field Blank	1/facility in Year 1; follow-on contingency upon analytical results	< RL	Review field protocols	Bias / Contamination
Field Duplicate	1/facility	RPD ≤ 30%	Review field protocols if regular exceedances	Precision

Table 27-3. Acceptance Limits for PFAS EIS and NIS Compounds in All Aqueous Matrices and QC Samples EIS Compound Recovery (%). Excerpted from EPA (2023).

Compound	Analyte Name	Recovery (%)
^{13}C4-PFBA	Perfluorobutanoate-13C4(IsoDilAnalogue)	10 - 130
^{13}C5-PFPeA	Perfluoropentanoate-13C5(IsoDilAnalogue)	0 - 130
^{13}C4-PFHpA	Perfluoroheptanoate-13C4(IsoDilAnalogue)	40 - 130
^{13}C8-PFOA	Perfluorooctanoate-13C8(IsoDilAnalogue)	40 - 130
^{13}C9-PFNA	Perfluorononanoate-13C9(IsoDilAnalogue)	40 - 130
^{13}C6-PFDA	Perfluorodecanoate-13C6(IsoDilAnalogue)	40 - 130
^{13}C7-PFUnA	Perfluoroundecanoate-13C7(IsoDilAnalogue)	30 - 130
^{13}C2-PFDoA	Perfluorododecanoate-13C2(IsoDilAnalogue)	10 - 130
^{13}C2-PFTeDA	Perfluorotetradecanoate-13C2(IsoDilAnalogue)	10 - 130
^{13}C3-PFBS	Perfluorobutanesulfonate-13C3(IsoDilAnalogue)	40 - 135
^{13}C3-PFHxS	Perfluorohexanesulfonate-13C3(IsoDilAnalogue)	40 - 130
^{13}C8-PFOS	Perfluorooctanesulfonate-13C8(IsoDilAnalogue)	40 - 130
^{13}C2-4:2FTS	Fluorotelomer Sulfonate-13C2, 4:2-(IsoDilAnalogue)	40 - 200
^{13}C2-6:2FTS	Fluorotelomer Sulfonate-13C2, 6:2-(IsoDilAnalogue)	40 - 200
^{13}C2-8:2FTS	Fluorotelomer Sulfonate-13C2, 8:2-(IsoDilAnalogue)	40 - 300
^{13}C8-PFOSA	Perfluorooctanesulfonamide-13C8(IsoDilAnalogue)	40 - 130
D3-NMeFOSA	Methyl-perfluorooctanesulfonamide-d3, N-(IsoDilAnalogue)	10 - 130
D5-NEtFOSA	Ethyl-perfluorooctanesulfonamide-d5, N-(IsoDilAnalogue)	10 - 130
D3-MeFOSAA	Methyl Perfluorooctane Sulfonamido Acetic Acid-d3, N-(IsoDilAnalogue)	40 - 170
D5-NEtFOSAA	Ethyl Perfluorooctane Sulfonamido Acetic Acid-d5, N-(IsoDilAnalogue)	25 - 135
D7-NMe-FOSE	Methyl-perfluorooctanesulfonamidoethanol-d7, N-(IsoDilAnalogue)	10 - 130
D9-Net-FOSE	Ethyl-perfluorooctanesulfonamidoethanol-d9, N-(IsoDilAnalogue)	10 - 130
^{13}C3-HFPO-DA	Perfluoro-2-Propoxypropanoic Acid-13C3(IsoDilAnalogue)	40 - 130
^{13}C4-PFBA	Perfluorobutanoate-13C4(IsoDilAnalogue)	50 - 200
^{13}C5-PFHxA	Perfluorohexanoate-13C5(IsoDilAnalogue)	50 - 200
^{13}C8-PFOA	Perfluorooctanoate-13C8(IsoDilAnalogue)	50 - 200
^{13}C9-PFNA	Perfluorononanoate-13C9(IsoDilAnalogue)	50 - 200
^{13}C6-PFDA	Perfluorodecanoate-13C6(IsoDilAnalogue)	50 - 200
^{18}C3-PFHxS	Perfluorohexanesulfonate-13C3(IsoDilAnalogue)	50 - 200
^{13}C8-PFOS	Perfluorooctanesulfonate-13C8(IsoDilAnalogue)	50 - 200

Notes:

[1] The recovery limits for the EIS compounds were derived by EPA from the aqueous sample data from multi-laboratory validation study. To simplify laboratory operations, EPA has applied the same EIS recovery limits used for field sample analyses to the EIS recoveries in the IPR, OPR, and LLOPR samples. There are no IPR mean or RSD criteria for the EIS compounds.

[2] Recovery of $_{13}$C$_{4}$-PFBA can be problematic in some field samples. Although the lower limit for recovery for this EIS is set below 10%, laboratories should routinely track recovery of this EIS and take reasonable steps to ensure that recovery is at least 10% in the majority of samples.

Table 27-4. IPR/OPR/LLOPR Acceptance Limits for Target Analytes in Aqueous Matrices. Excerpted from EPA (2023).

Compound		IPR		OPR/LLOPR Recovery (%)
		Mean Recovery (%)	RSD (%)	
PFBA	Perfluorobutanoate	70 – 135	21	70 – 140
PFPeA	Perfluoropentanoate	70 – 135	23	65 – 135
PFHxA	Perfluorohexanoate	70 – 135	24	70 – 145
PFHpA	Perfluoroheptanoate	70 – 135	28	70 - 150
PFOA	Perfluorooctanoate	65 - 155	27	70 - 150
PFNA	Perfluorononanoate	70 - 140	28	70 - 150
PFDA	Perfluorodecanoate	65 - 140	26	70 – 140
PFUnA	Perfluoroundecanoate	70 – 135	29	70 – 145
PFDoA	Perfluorododecanoate	70 – 130	21	70 – 140
PFTrDA	Perfluorotridecanoate	60 - 145	29	65 - 140
PFTeDA	Perfluorotetradecanoate	70 - 145	27	60 – 140
PFBS	Perfluorobutanesulfonate	70 - 140	23	60 - 145
PFPeS	Perfluoropentanesulfonate	70 – 135	25	65 - 140
PFHxS	Perfluorohexanesulfonate	70 – 135	27	65 - 145
PFHpS	Perfluoroheptanesulfonate	70 - 140	30	70 - 150
PFOS	Perfluorooctanesulfonate	70 - 140	29	55 - 150
PFNS	Perfluorononanesulfonate	70 – 135	29	65 – 145
PFDS	Perfluorodecanesulfonate	70 – 135	30	60 – 145
PFDoS	Perfluorododecanesulfonate	45 – 135	35	50 - 145
4:2FTS	Fluorotelomer Sulfonate, 4:2-	70 – 135	27	70 – 145
6:2FTS	Fluorotelomer Sulfonate, 6:2-	70 – 135	32	65 – 155
8:2FTS	Fluorotelomer Sulfonate, 8:2-	70 – 140	33	60 - 150
PFOSA	Perfluorooctanesulfonamide	70 – 135	22	70 – 145
N-MeFOSA	Methyl-perfluorooctanesulfonamide, N-	70 – 135	30	60 - 150
N-EtFOSA	Methyl Perfluorooctane Sulfonamido Acetic Acid, N-	70 – 130	26	65 - 145
MeFOSAA	Methyl Perfluorooctane Sulfonamido Acetic Acid, N-	65 – 140	32	50 - 140
NEtFOSAA	Ethyl Perfluorooctane Sulfonamido Acetic Acid, N-	70 – 135	28	70 – 145
N-MeFOSE	Methyl-perfluorooctanesulfonamidoethanol, N-	70 – 135	29	70 - 145
N-EtFOSE	Ethyl-perfluorooctanesulfonamidoethanol, N-	70 – 130	21	70 - 135
HFPO-DA	Perfluoro-2-Propoxypropanoic Acid	70 – 135	23	70 – 140
ADONA	Dioxa-3H-Perfluorononanoate Acid, 4,8-	70 – 135	23	65 - 145
PFMPA	Perfluoro-3-methoxypropanoate	65 – 145	23	55 - 140
PFMBA	Perfluoro-4-methoxybutanoate	60 – 140	27	60 - 150
NFDHA	Perfluoro-3,6-dioxaheptanoate	65 – 140	37	50 - 150
9Cl-PF3ONS	Chlorohexadecafluoro-3-Oxanonane-1-Sulfonic Acid, 9-	70 - 145	30	70 - 155
11Cl-PF3OUdS	Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid, 11-	50 – 150	35	55 - 160
PFEESA	Perfluoro(2-ethoxyethane)sulfonic acid	70 – 135	25	70 - 140
3:3FTCA	Fluorotelomer Carboxylic Acid, 3:3-	70 – 130	23	65 - 130
5:3FTCA	Fluorotelomer Carboxylic Acid, 5:3-	70 – 130	24	70 - 135
7:3FTCA	Fluorotelomer Carboxylic Acid, 7:3-	55 – 130	34	50 - 145

Notes:

[1] The recovery limits apply to the target analyte results for IPR, OPR, and LLOPR samples for aqueous matrices. Data for this matrix type are derived from the multi-laboratory validation study and are therefore the limits required for this method.

28. Appendix C – Project Target Reporting Limits

Tables 28-1 through 28-8 present target reporting limits for Project analytes. It should be noted that some RLs may not be achievable due to interferences present in urban runoff.

Table 28-1. Target Congener List and RLs for PCBs in Water

Congener	Water RL (pg/L)	Congener	Water RL (pg/L)
PCB 8	2000	PCB 118	2000
PCB 18	2000	PCB 128	2000
PCB 28	2000	PCB 132	2000
PCB 31	2000	PCB 138	2000
PCB 33	2000	PCB 141	2000
PCB 44	2000	PCB 149	2000
PCB 49	2000	PCB 151	2000
PCB 52	2000	PCB 153	2000
PCB 56	2000	PCB 156	2000
PCB 60	2000	PCB 158	2000
PCB 66	2000	PCB 170	2000
PCB 70	2000	PCB 174	2000
PCB 74	2000	PCB 177	2000
PCB 87	2000	PCB 180	2000
PCB 95	2000	PCB 183	2000
PCB 97	2000	PCB 187	2000
PCB 99	2000	PCB 194	2000
PCB 101	2000	PCB 195	2000
PCB 105	2000	PCB 201	2000
PCB 110	2000	PCB 203	2000

Table 28-2. Target RLs for Analytes TSS, Mercury, Cu, Zn, Hardness, TPH

Analyte	RL
Mercury	0.005 µg/L
Copper	0.5 µg/L
Zinc	1 µg/L
Hardness	5 mg/L
TPH as diesel	100 µg/L
TPH as motor oil	200 µg/L
TSS	3 mg/L

Table 28-3. Target RLs for PFAS in Water.

Analyte	CEDEN AnalyteName	Target RL (ng/L)
PFBA	Perfluorobutanoate	6.4
PFPeA	Perfluoropentanoate	3.2
PFHxA	Perfluorohexanoate	1.6
PFHpA	Perfluoroheptanoate	1.6
PFPeS	Perfluoropentanesulfonate	1.6
PFHxS	Perfluorohexanesulfonate	1.6
6:2 FTS	Fluorotelomer Sulfonate, 6:2-	6.4
PFOA	Perfluorooctanoate	2.0
PFHpS	Perfluoroheptanesulfonate	1.6
PFOS	Perfluorooctanesulfonate	1.6
PFNA	Perfluorononanoate	1.6
PFDA	Perfluorodecanoate	1.6
8:2 FTS	Fluorotelomer Sulfonate, 8:2-	6.4
PFOSA	Perfluorooctanesulfonamide	1.6
PFDS	Perfluorodecanesulfonate	1.6
PFUnA or PFUdA	Perfluoroundecanoate	1.6
PFDoA	Perfluorododecanoate	1.6
N-MeFOSA	Methyl-perfluorooctanesulfonamide, N-	1.6
N-MeFOSE	Methyl-perfluorooctanesulfonamidoethanol, N-	16
PFTrDA	Perfluorotridecanoate	1.6
N-EtFOSA	Methyl Perfluorooctane Sulfonamido Acetic Acid, N-	1.6
N-EtFOSE	Ethyl-perfluorooctanesulfonamidoethanol, N-	16
PFTeDA	Perfluorotetradecanoate	1.6
PFBS	Perfluorobutanesulfonate	1.6
EtFOSAA	Ethyl Perfluorooctane Sulfonamido Acetic Acid, N-	1.6
MeFOSAA	Methyl Perfluorooctane Sulfonamido Acetic Acid, N-	1.6
4:2 FTS	Fluorotelomer Sulfonate, 4:2-	6.4
PFNS	Perfluorononanesulfonate	1.6
HFPO-DA	Perfluoro-2-Propoxypropanoic Acid	6.68
ADONA	Dioxa-3H-Perfluorononanoate Acid, 4,8-	6.4
11Cl-PF3OUdS	Chloroeicosafluoro-3-Oxaundecane-1-Sulfonic Acid, 11-	6.4
9Cl-PF3ONS	Chlorohexadecafluoro-3-Oxanonane-1-Sulfonic Acid, 9-	6.4
FPrPA or 3:3 FTCA	Fluorotelomer Carboxylic Acid, 3:3-	8
FPePA or 5:3 FTCA	Fluorotelomer Carboxylic Acid, 5:3-	40
FHpHA or 7:3 FTCA	Fluorotelomer Carboxylic Acid, 7:3-	40
PFDoS	Perfluorododecanesulfonate	1.6
NFDHA	Perfluoro-3,6-dioxaheptanoate	1.2
PFMPA	Perfluoro-3-methoxypropanoate	3.2
PFMBA	Perfluoro-4-methoxybutanoate	3.2
PFEESA	Perfluoro(2-ethoxyethane)sulfonic acid	3.2

29. Appendix D – Corrective and Preventative Action Report Template

BAMSC LID Monitoring
Corrective and Preventative Action Report

Stormwater Program:	Date:
Reporting Party:	Date:

Non-conformance Type

☐ Sample collection / handling
☐ Laboratory analysis
☐ QA

☐ Data mgmt. / reporting
☐ Other

Subject:
Description of Problem:
Proposed Corrective / Preventative Action:
Affected Data (if applicable):
Dispensation of Data (if applicable):
Follow up:
Responsible Party:
Additional Comments:

Program Mgr / Date

30. Appendix E – Standard Operating Procedure for Collection of End of Season Field Blanks