Middle Santa Ana River
Quality Assurance Project Plan

PREPARED BY
CDM

ON BEHALF OF

Santa Ana Watershed Project Authority
San Bernardino County Stormwater Program
Riverside County Flood Control District
Cities of Chino, Chino Hills, Claremont, Corona, Fontana, Montclair, Norco, Ontario, Pomona, Rancho Cucamonga, Rialto, Riverside, and Upland
Milk Producers Council, and Chino Watermaster Agricultural Pool

Version 2.0

May 2011

Summary of Revision History

- Revised cover page
- Added Summary of Revision History page
- Revised project management names on approval signature page
- Revised distribution list
- Global revisions: Revised text throughout QAPP to make the document more general and not specific to previous Grant-related project, which included monitoring and evaluation of BMP effectiveness.
- Revised Section 4.1 to describe potential future changing roles of involved parties. Changes will be described in future report submittals to the Regional Board.
- Table 4-1: revised personnel list
- Section 4.2: added text to describe QAQC to be included in wet and dry season report monitoring reports.
- Section 4.4: updated Organization Chart
- Section 5.1: removed the BMP Efffectiveness monitoring project that was specific to the past Grant project.
- Section 5.5: revised QAPP purpose
- Section 6.1:
    - added footnote regarding removal of Icehouse Canyon watershed-wide compliance monitoring site.
    - revised overview sections for USEP and AgSEP Monitoring programs
- Section 6.4: revised to include general language that schedules will be updated per Monitoring Plan updates
- Table 9-1 revised in Reports section
- Section 10: revised sample frequency and schedule
- Section 12: removed specific references to past project contractors and replaced with general reference - "Monitoring Contractor"
- Table 13-1: revised units for conductivity to be µS/cm instead of mS/cm

- Revised Table 15-1: replaced past specific named contractor to general reference to "Monitoring Contractors"
- Section 21: Revised reports to management section
- Appendix D: Updated TMDL Taskforce Contact List

Group A: Project Management
Approval Signatures

Title	Name	Signature	Date*
SAWPA Project Director	Mark Norton		
SAWPA Project Coordinator	Rick Whetsel		
Strategic Planner, Risk Sciences	Tim Moore		
CDM Project Manager	Richard Meyerhoff		
CDM QA Officer	Barbara Wells		
Agricultural/Dairy Representative	Pat Boldt		
USEP Monitoring Manager	TBD		
USEP Monitoring QA Officer	TBD		
San Bernardino County Flood Control District (SBCFCD) Monitoring Manager	Dan Ilkay (or his designee)		
SBCFCD Monitoring QA Officer	Janet Dietzman		
Orange County Public Health Water Quality Laboratory	Dr. Richard Alexander		
Orange County Public Health Water Quality Laboratory	Joseph Guzman		
OCWD Laboratory Director	Donald Phipps		
OCWD Laboratory QA Officer	Menu Leddy		
UC Davis Laboratory Director	Dr. Stefan Wuertz		
UC Davis Laboratory QA Officer	Laboratory Manager		

Santa Ana Regional Water Quality Control Board

Title	Name	Signature	Date*
Contract Manager	William Rice		
QA Officer	William Ray		

* This is a contractual document. The signature dates indicate the earliest date when the project can start.

2. Table of Contents

FIGURES

ATTACHMENTS

APPENDICES

3. Distribution List

Title	Name (Affiliation)	Tel. No.	QAPP No.
Santa Ana Regional Water Quality Board ("Regional Board") Contract Manager	William Rice (Regional Board)	951-782-4130	8839
Regional Board QA Officer	William Ray (State Board)	916-341-5583	8839
Grantee Project Director	Mark Norton (SAWPA)	951-354-4220	8839
Grantee Project Coordinator	Rick Whetsel (SAWPA)	951-354-4220	8839
MSAR TMDL Task Force	see Appendix D		8839
Contractor Strategic Planner	Tim Moore (Risk Sciences)	615-370-1655	8839
Contractor Project Manager	Richard Meyerhoff (CDM)	909-579-3500	8839
Contractor QA Officer	Barbara Wells (CDM)	909-579-3500	8839
Ag/ Dairy Representative	Pat Boldt	951-808-8531	8839
USEP Monitoring Contractor Manager			8839
USEP Monitoring Contractor QA Officer			8839
Monitoring Contractor Manager	Dan Ilkay [or his designee] (SBCFCD)	909-387-8109	8839
Monitoring Contractor QA Officer	Janet Dietzman (SBCFCD)	909-387-8109	8839
OC Public Health Water Quality Laboratory Director	Dr. Richard Alexander	714-834-8379	8839
OC Public Health Water Quality Laboratory QA Officer	Joseph Guzman	949-219-0423	8839
Orange County Water District (OCWD) Laboratory Director	Donald Phipps	714-378-3200	8839
OCWD Laboratory QA Officer	Menu Leddy	714-378-3200	8839
University of California-Davis (UC Davis) Laboratory Director	Dr. Stefan Wuertz	530-754-6407	8839
UC Davis Laboratory QA Officer	Laboratory Manager	530-752-1755	8839

*** This distribution list will be updated accordingly as participant change.**

4. Project/Task Organization

4.1 Involved Parties and Roles

In order to carry out the goal and objectives of this study, the Middle Santa Ana River (MSAR) Bacterial Indicator TMDL Task Force will be working with various agencies and contractors to carry out the Watershed-Wide, Urban Source Evaluation Plan (USEP), and Agricultural Source Evaluation Plan (AgSEP) monitoring programs as described by the MSAR Water Quality Monitoring Plan. The following outlines the roles of each of the participating parties in the monitoring program. The roles of involved parties may change over time and will be noted in reports that are submitted to the Regional Board as part of the Watershed–wide, USEP, or AgSEP Monitoring Programs.

SAWPA

- Administer MSAR TMDL Task Force activities
- Administer project funding from Proposition 40 grant funds and funds received from Task Force members
- Administer contracts established with contractors
- Manage project database

MSAR TMDL Task Force

- Provide oversight and guidance of MSAR monitoring activities conducted as part of the implementation of the MSAR Bacterial Indicator TMDL , including selection of contractors to implement monitoring activities.
- Coordinate TMDL implementation activities with other basin planning processes within the Santa Ana River watershed
- Support funding of activities conducted as part of the implementation of the TMDL

Risk Sciences

- Provide strategic planning services to SAWPA to ensure that monitoring and reporting activities support TMDL implementation requirements

CDM

- Obtain the necessary permits (if required) to access the sampling sites and collect samples
- Develop sampling protocols
- Update the monitoring plan and the QAPP, as necessary
- Provide the monitoring design for the study (list of sampling sites, list of indicators, map of the study area depicting the sampling sites, etc.)
- Coordinate with all parties involved in the study
- Coordinate with Monitoring Contractors selected by MSAR TMDL Task Force
- Coordinate with each of the laboratories conducting analyses for data reporting and payment of analytical services
- Coordinate with the laboratories for analysis of samples
- Coordinate with the laboratories to obtain data from the analyses

- Analyze the laboratory data results
- Conduct annual quality reviews
- Compile the data and use for TMDL-related activities
- Conduct field sampling activities as assigned according to MSAR Water Quality Monitoring Plan. This role includes:
  - Providing sampling personnel and probe for each sampling activity according to MSAR Water Quality Monitoring Plan
  - Calibrating Horiba Multiparameter probe (pH, temperature, conductivity, dissolved oxygen, turbidity) prior to sampling activities
  - Calibrating Marsh-McBirney Model 2000 flow meter, if used, prior to sampling activities
  - Coordinating with each of the laboratories prior to sample collection events (request bottles, scheduling, etc.)
  - Ensuring that all necessary chain-of-custody forms are completed prior to surrendering samples to the laboratory
  - Transporting the samples to each of the laboratories for analysis within the required holding times

Monitoring Contractors: USEP/AgSEP Monitoring (as selected by the MSAR TMDL Task Force), and San Bernardino County Flood Control District (Watershed-Wide Monitoring)

- Conduct field sampling activities as assigned according to MSAR Water Quality Monitoring Plan
- Provide sampling personnel and probe for each sampling activity according to MSAR Water Quality Monitoring Plan
- Calibrate Horiba Multiparameter probe (pH, temperature, conductivity, dissolved oxygen, turbidity) prior to sampling activities
- Calibrate Marsh-McBirney Model 2000 flow meter, if used, prior to sampling activities
- Coordinate with each of the laboratories prior to sample collection events (request bottles, scheduling, etc.)
- Ensure that all necessary chain-of-custody forms are completed prior to surrendering samples to the laboratory
- Transport the samples to each of the laboratories for analysis within the required holding times

Orange County Public Health Water Quality Laboratory

- Provide the necessary containers, preservatives (if required), chain of custody forms for the samples
- Analyze the samples for constituents as indicated in QAPP
- Operate according to laboratory quality assurance and quality control program in accordance with guidelines established by the State of California and the U.S. EPA
- Provide data in electronic and hard copy format to CDM

OCWD Laboratory

- Provide the necessary containers, preservatives (if required), chain of custody forms for the samples
- Conduct *Bacteroides* analyses
- Operate according to laboratory quality assurance and quality control program in accordance with guidelines established by the State of California and the U.S. EPA
- Provide data in electronic and hard copy format to CDM

UC Davis Laboratory

- Provide the necessary containers, preservatives (if required), chain of custody forms for the samples
- Conduct *Bacteroides* analyses
- Operate according to laboratory quality assurance and quality control program in accordance with guidelines established by the State of California and the U.S. EPA
- Provide data in electronic and hard copy format to CDM

Table 4-1. Personnel Responsibilities

Name	Organizational Affiliation	Title	Contact Information
William Rice	RWQCB	Grant Manager	951-782-4130
Mark Norton	SAWPA	Grantee Project Director	951-354-4220
Rick Whetsel	SAWPA	Grantee Project Manager	951-354-4220
Tim Moore	Risk Sciences	Strategic Planner	615-370-1655
Richard Meyerhoff	CDM	Contractor Project Manager	303-298-1311
Barbara Wells	CDM	Contractor Quality Assurance Officer	909-579-3500
Thomas Lo	CDM	Contractor Monitoring Manager	909-579-3500
TBD	TBD	Contractor Monitoring Manager	TBD
TBD	TBD	Contractor Monitoring QA Officer	TBD
Dan Ilkay (or his designee)	SBCFCD Staff	Contractor Monitoring Manager	909-387-8109
Janet Dietzman	SBCFCD Staff	Contractor Monitoring QA Officer	909-387-8109
Dr. Richard Alexander	OC Public Health Water Quality Lab	OC Public Health Water Quality Laboratory Director	714-834-8379

Joseph Guzman	OC Public Health Water Quality Lab	OC Public Health Water Quality Laboratory QA Officer	949-219-0423
Donald Phipps	OCWD	OCWD Laboratory Director	714-378-3200
Menu Leddy	OCWD	OCWD Laboratory QA Officer	714-378-3200
Dr. Stefan Wuertz	UC Davis	UC Davis Laboratory Director	530-754-6407
Laboratory Manager	UC Davis	UC Davis Laboratory QA Officer	530-752-1755

4.2 Quality Assurance Officer Role (QA Officer)

The QA Officer's role is to establish the quality assurance and quality control procedures found in this QAPP as part of the sampling, contract field analysis, and contract laboratory analysis procedures. Barbara Wells, CDM, will serve as the QA officer and work with the CDM Project Manager and QA Officers affiliated with the monitoring contractor and laboratories to ensure QAPP procedures are followed. CDM's QA Officer will be responsible to ensure sampling protocols are followed by the Monitoring Contractor staff.

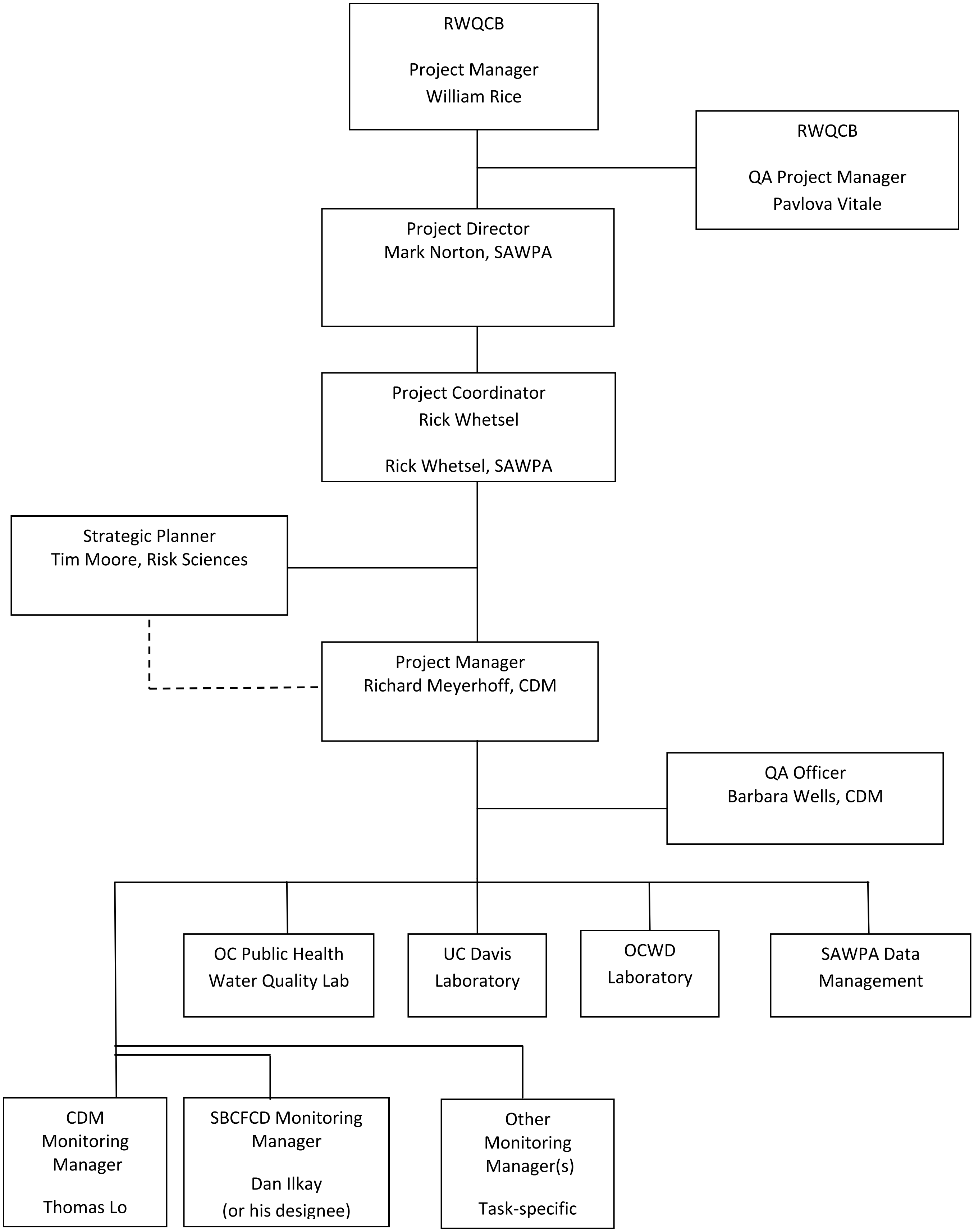
The results of a QA/QC analysis, validation, and evaluation will be included with the wet and dry season monitoring reports.

CDM's QA Officer may stop all actions, including those conducted by any subcontractor if there are significant deviations from required practices or if there is evidence of a systematic failure.

4.3 Persons Responsible for QAPP Update and Maintenance

Changes and updates to this QAPP may be made after a review of the evidence for change by CDM's Project Manager and Quality Assurance Officer, and with the concurrence of other project participants, especially SAWPA and the Regional Board's Contract Manager and Quality Assurance Officer. CDM will be responsible for making the changes, submitting drafts for review, preparing a final copy, and submitting the final for signature.

4.4 Organizational Chart and Responsibilities



5. Problem Definition/Background

5.1 Introduction

Various waterbodies in the Middle Santa Ana River watershed are listed on the state 303(d) list of impaired waters due to high levels of fecal coliform bacteria. The Middle Santa Ana River (MSAR) Bacterial Indicator Total Maximum Daily Load (TMDL) was adopted by the Santa Ana Regional Water Quality Control Board (RWQCB) and approved by the State Water Resources Control Board (SWRCB) to address these fecal coliform impairments. Environmental Protection Agency (EPA) Region 9 approval is pending. As part of the TMDL Implementation Plan, three bacteria monitoring programs for the MSAR watershed are being implemented:

(a) Long term watershed-wide monitoring program to assess compliance with TMDL targets;

(b) A study to investigate potential sources of bacteria in the urban environment;

(c) A study to investigate the potential sources of bacteria from agricultural lands; and

This QAPP describes these three monitoring programs.

5.2 Regulatory Background

Table 3-1 of the Santa Ana Regional Water Quality Control Plan (Basin Plan) designates beneficial uses for surface waters in the Santa Ana River watershed (RWQCB 1995). The beneficial uses applicable to waterbodies in the MSAR watershed include Water Contact Recreation (REC-1), which is defined in the Basin Plan as follows:

> "waters are used for recreational activities involving body contact with water where ingestion of water is reasonably possible. These uses may include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, whitewater activities, fishing, and use of natural hot springs" (Basin Plan, page 3-2).

The Basin Plan (Chapter 4) specifies fecal coliform as a bacterial indicator for pathogens ("bacterial indicator"). Fecal coliform present at concentrations above certain thresholds are believed to be an indicator of the presence of fecal pollution and harmful pathogens, thus increasing the risk of gastroenteritis in bathers exposed to the elevated levels. The Basin Plan currently specifies the following water quality objectives for fecal coliform:

REC-1 - *Fecal coliform: log mean less than 200 organisms/100 mL based on five or more samples/30 day period, and not more than 10% of the samples exceed 400 organisms/100 mL for any 30-day period.*

The EPA published new bacteria guidance in 1986 (EPA 1986). This guidance advised that for freshwaters *Escherichia coli* (*E. coli*) is a better bacterial indicator than fecal coliform. Epidemiological studies found that the positive correlation between *E. coli* concentrations and the frequency of gastroenteritis was better than the correlation between fecal coliform concentrations and gastroenteritis.

The RWQCB is currently considering replacing the REC-1 bacteria water quality objectives for fecal coliform with *E. coli* objectives. This evaluation is occurring through the work of the Stormwater Quality Standards Task Force (SWQSTF). The SWQSTF is comprised of representatives from various stakeholder interests, including the Santa Ana Watershed Protection Authority, the counties of Orange, Riverside, and San Bernardino, Orange County Coastkeeper, Inland Empire Waterkeeper, the RWQCB, and EPA Region 9.

In 1994 and 1998, because of exceedances of the fecal coliform objective established to protect the REC-1 use, the RWQCB added various waterbodies in the MSAR watershed to the state 303(d) list of impaired waters. The MSAR Watershed TMDL Task Force ("TMDL Task Force"), which includes representation by many key watershed stakeholders, was subsequently formed to address this impairment through the development of a TMDL for the watershed. The MSAR Bacterial Indicator TMDL addresses bacterial indicator impairments in the following MSAR watershed waterbodies (Figure 1):

- Santa Ana River, Reach 3 – Prado Dam to Mission Boulevard in the City of Riverside
- Chino Creek, Reach 1 – Santa Ana River confluence to beginning of hard lined channel south of Los Serranos Road
- Chino Creek, Reach 2 – Beginning of hard lined channel south of Los Serranos Road to confluence with San Antonio Creek
- Mill Creek (Prado Area) – Natural stream from Cucamonga Creek Reach 1 to Prado Basin
- Cucamonga Creek, Reach 1 – Confluence with Mill Creek to 23rd Street in City of Upland
- Prado Park Lake

The implementation plan contained in the MSAR Bacterial Indicator TMDL requires that, no later than six months from the effective date of the TMDL (date of EPA approval), the U.S. Forest Service, the County of San Bernardino, the County of Riverside, the cities of Ontario, Chino, Chino Hills, Montclair, Rancho Cucamonga, Upland, Rialto, Fontana, Norco, Riverside, Corona, Pomona, and Claremont, and agricultural operators in the watershed submit as a group (or individually) to the RWQCB for approval, a watershed-wide monitoring program that will provide the data necessary to review and update the adopted TMDL. The TMDL also requires the development and implementation of two plans: (1) the USEP to identify activities, operations, and processes in urban areas that contribute bacterial indicators to MSAR watershed waterbodies; and (2) the AgSEP to identify activities, operations, and processes in agricultural areas that contribute bacterial indicators to MSAR watershed waterbodies. The TMDL requires that the USEP and AgSEP be submitted to the RWQCB for approval by November 30, 2007.

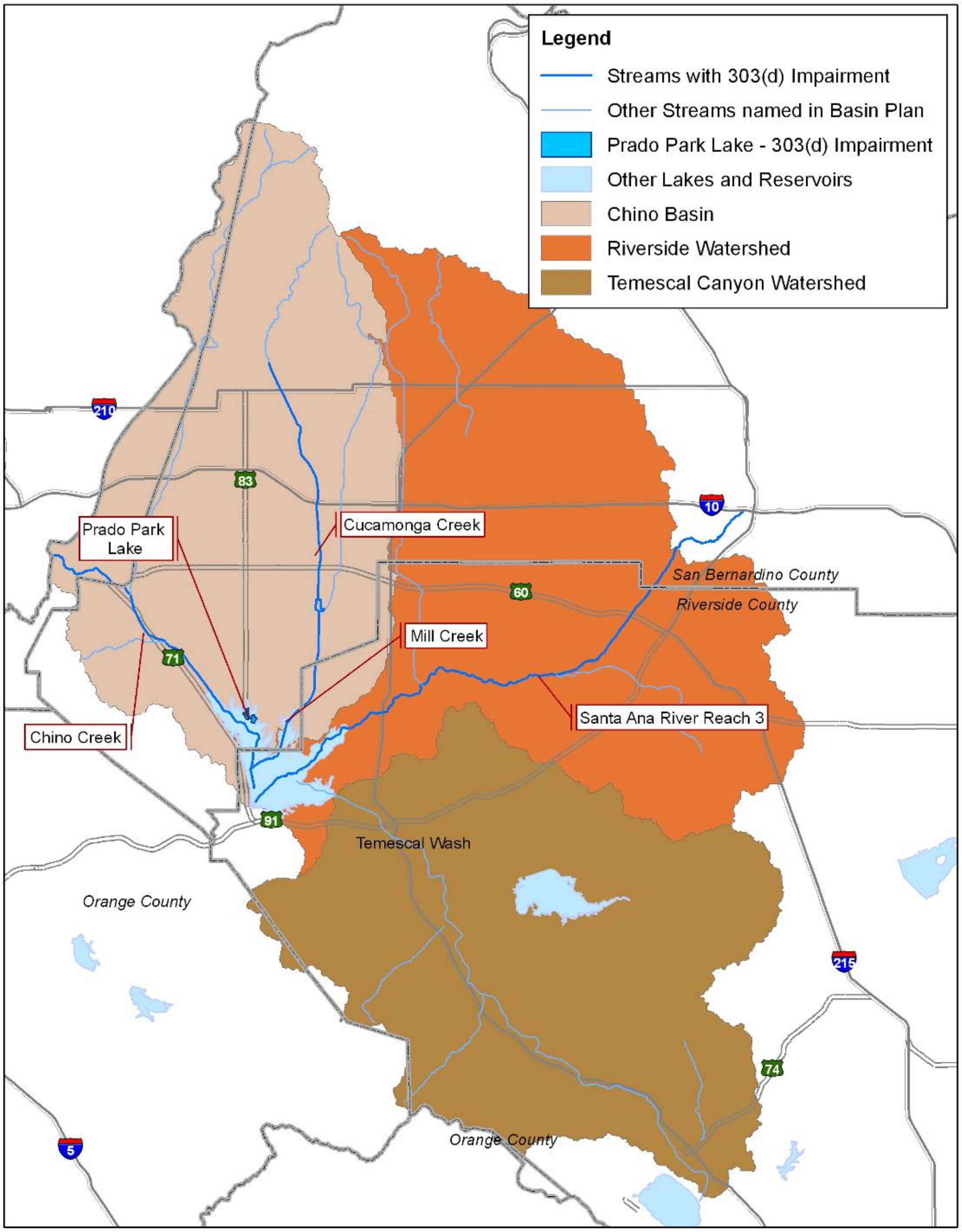


Figure 5-1
Bacterial Indicator Impairments in the MSAR Watershed

5.3 Proposition 40 State Grant

In anticipation of an approved TMDL, the Santa Ana Watershed Project Authority (SAWPA), in cooperation with the San Bernardino County Flood Control District (SBCFCD), Riverside County Flood and Water Conservation District (RCFWCD), and Orange County Water District (OCWD) submitted a Proposition 40 grant proposal to the SWRCB to support the implementation of TMDL requirements. This grant proposal, *Middle Santa Ana River Pathogen TMDL – BMP Implementation* (Grant Project), was developed, in part, to characterize urban bacteria sources within the watershed. This characterization provided the basis for the development and implementation of the USEP requirements of the TMDL. The grant proposal also included a study to evaluate selected BMPs for their efficacy in removing or reducing bacteria in urban runoff. The state approved the grant proposal in fall 2006 and the funded project was implemented from 2007-2010.The Grant Project was completed in 2010.

5.4 Agricultural Community Funding

In summer 2007, representatives of the Milk Producers Council and Chino Watermaster Agricultural Pool approved funding to support initiation of TMDL implementation tasks that are the responsibility of the agricultural community, i.e., development of the AgSEP which includes the Agricultural Source Evaluation Monitoring Program.

5.5 Watershed Description

The MSAR watershed covers approximately 488 square miles and lies largely in the southwestern corner of San Bernardino County, and the northwestern corner of Riverside County. A small part of Los Angeles County (Pomona/Claremont area) is also included. The MSAR watershed includes three sub–watersheds (see Figure 5-1):

- Chino Basin (San Bernardino County, Los Angeles County, and Riverside Counties) – Surface drainage in this area, which is directed to Chino Creek and Mill-Cucamonga Creek, flows generally southward, from the San Gabriel Mountains toward the Santa Ana River and the Prado Flood Control Basin.
- Riverside Watershed (Riverside County) – Surface drainage in this area is generally westward or southeastward from the City of Riverside and the community of Rubidoux to Reach 3 of the Santa Ana River.
- Temescal Canyon Watershed (Riverside County) – Surface drainage in this area is generally northwest to Temescal Creek.

Land uses in the MSAR watershed include urban, agriculture, and open space. Although originally developed as an agricultural area, the watershed is rapidly urbanizing. Incorporated cities in the MSAR watershed include Chino, Chino Hills, Claremont, Corona, Fontana, Montclair, Norco, Ontario, Pomona, Rancho Cucamonga, Rialto, Riverside, and Upland. In addition, there are several pockets of urbanized unincorporated areas. Open space areas include National Forest lands and State Park lands.

The current population of the watershed, based upon 2000 census data, is approximately 1.4 million people. The principal remaining agricultural area in the watershed is the area formerly known as the Chino Dairy Preserve. This area is located in the south central part of the Chino Basin subwatershed and contained approximately 300,000 cows at the time of TMDL development (RWQCB 2005). As of January 2009, this number was down to about 138,500 (email communication, Ed Kashak [RWQCB] to Pat Boldt, December 8, 2009). Recently, the cities of Ontario, Chino, and Chino Hills annexed the San Bernardino County portions of this area. The remaining portion of the former preserve, which is in Riverside County, remains unincorporated.

5.5 Purpose of the QAPP

This QAPP supports the MSAR Water Quality Monitoring Plan which was prepared to fulfill three objectives:

(1) Establish and implement the Bacterial Indicator Watershed-Wide Monitoring Program required by the TMDL. The monitoring described for this program will continue until the numeric targets described in the MSAR Bacterial Indicator TMDL are achieved and waterbodies are removed from the 303(d) list upon adoption of the TMDL.

(2) Implement monitoring to characterize urban sources of bacteria within the watershed and support the USEP element of the TMDL. The monitoring described for this program will occur only between July 1, 2007 and March 31, 2008.

(3) Implement monitoring to characterize agricultural sources of bacteria within the watershed and support the AgSEP element of the TMDL

It is important to recognize that the Monitoring Plan elements associated with the USEP and AgSEP Monitoring Programs should be considered distinct from the Monitoring Plan elements associated with the Watershed-Wide Monitoring Program. That is, once USEP and AgSEP monitoring activities are complete, unless directed by the TMDL Task Force, the only elements of this QAPP that will continue are the elements associated with the Watershed-Wide Monitoring Plan.

6. Project/Task Descriptions

6.1 Work Statement and Produced Products

Three MSAR Bacterial Indicator TMDL-related monitoring tasks are addressed by this QAPP:

- Watershed-Wide Monitoring Program
- USEP Monitoring Program
- AgSEP Monitoring Program

Following is a description of the monitoring activities associated with each program.

Watershed-Wide Monitoring Program

Overview - The purpose of the Watershed-Wide Monitoring Program is to assess compliance with REC-1 use water quality objectives for fecal coliform and evaluate numeric targets established for *E. coli*. As noted above, the Basin Plan currently relies solely on fecal coliform as the bacterial indicator for protection of the REC-1 use. However, the RWQCB is currently evaluating the use of *E. coli* for the REC-1 use water quality objective in place of fecal coliform. In anticipation of the adoption of new *E. coli* water quality objectives, both fecal coliform and *E. coli* targets were incorporated into the TMDL and will be evaluated in water samples collected under this Watershed-Wide Monitoring Plan.

The TMDL compliance targets for fecal coliform and *E. coli* are equal to the water quality objectives set forth in the Basin Plan with a 10% margin of safety, and are presented below:

- *Fecal coliform:* 5-sample/30-day Logarithmic Mean less than 180 organisms/100 mL and not more than 10% of the samples exceed 360 organisms/100 mL for any 30-day period.
- *E. coli:* 5-sample/30-day Logarithmic Mean less than 113 organisms/100 mL and not more than 10% of the samples exceed 212 organisms/100 mL for any 30-day period.

In order to evaluate the geometric mean of 5 samples within a 30-day period, weekly sampling is necessary. A detailed schedule of sampling is documented in Section 10 of this QAPP for wet and dry season activities.

Sample Locations - As noted above, the purpose of the watershed-wide monitoring effort is to measure compliance with numeric targets established by the TMDL, which are derived from Basin Plan objectives established to protect the REC-1 beneficial use. Two key factors were used to select watershed sites:

The sites should be located on waterbodies that are impaired and thus incorporated into the TMDL. The pathogen 303(d) list impairments where compliance will be assessed are:

a. Santa Ana River Reach 3 – 26 miles

b. Chino Creek – 7.8 miles

c. Mill Creek (Prado area) – 1.6 miles

d. Cucamonga Creek – 9.6 miles

e. Prado Park Lake – 90 acres

The selected sites are located in reaches of the impaired waterbodies where REC-1 activity is most likely to occur, i.e., there is an increased risk from exposure to pathogens. One site was selected to assess background water quality conditions in the upstream watershed.

Using the impaired waters list, recreational use data developed by the Santa Ana River Watershed Stormwater Quality Standards Task Force, and recommendations from Regional Board staff, six sites were selected (Figure 6-1):

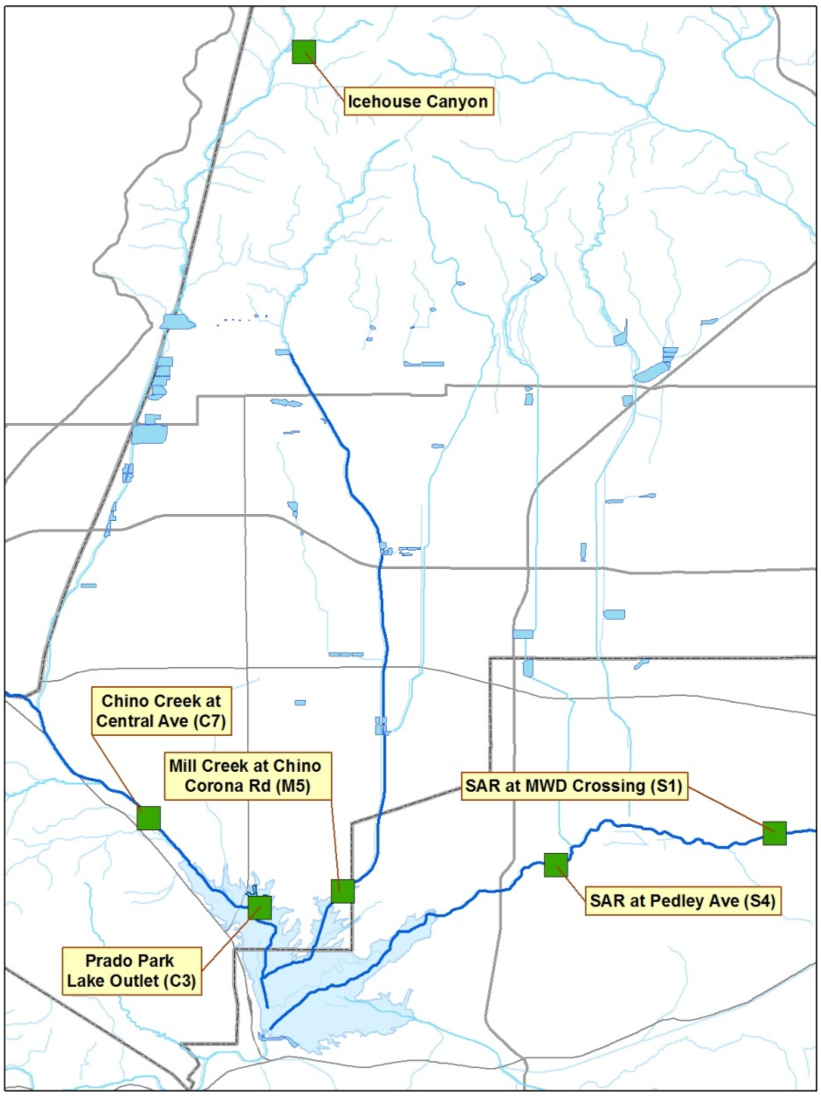


Figure 6-1
Watershed-Wide Monitoring Program

- Icehouse Canyon Creek[1]
- Chino Creek at Central Avenue
- Santa Ana River at Pedley Avenue
- Santa Ana River at MWD Crossing
- Prado Park Lake at Lake Outlet
- Mill Creek at Chino-Corona Road

Table 6-1 provides a brief site description and GPS coordinate location for each of these six Watershed-Wide Monitoring Program sample locations.

[1] Prior to the 2009 dry season, Icehouse Canyon was included as a watershed-wide compliance monitoring site. However, with RWQCB approval the Task Force removed this site from the sampling program prior to the start of the 2009 dry season monitoring program.

Table 6-1. Watershed-Wide Monitoring Program Sample Locations			
Site No.	**Site Description**	**Longitude**	**Latitude**
WW-C1	Icehouse Canyon Creek *	-117.6290	34.2604
WW-C3	Prado Park Lake at Lake Outlet	-117.6473	33.9400
WW-C7	Chino Creek at Central Avenue	-117.6884	33.9737
WW-M5	Mill Creek at Chino-Corona Rd	-117.6156	33.9460
WW-S1	Santa Ana River Reach 3 @ MWD Crossing	-117.4479	33.9681
WW-S3	Santa Ana River Reach 3 @ Pedley Ave	-117.5327	33.9552

Coordinates are shown as Geographic WGS 1984 World Datum
(*) With RWQCB approval, site eliminated prior to 2009 dry season monitoring

Urban Source Evaluation Monitoring Program

Overview - Elevated levels of indicator bacteria have been documented in most monitored waterbodies within the MSAR watershed; however, the sources of bacteria remain unknown. Thus, the primary goal of the USEP Monitoring Program is to guide efforts to control bacteria sources derived from discharges covered by MS4 NPDES permits. The water quality sampling and analyses conducted for this effort will be coordinated with the Watershed-Wide Monitoring Program described above.

Any future USEP Monitoring will be presented in annual or semi-annual USEP plans or any plans that may supersede the USEP Monitoring Program. The plans will include a map and brief sample site description with GPS coordinates.

AgSEP Monitoring Program

Overview - Elevated levels of indicator bacteria have been documented in most monitored waterbodies within the MSAR watershed; however, the sources of bacteria remain unknown. Thus, the primary goal of the AgSEP Monitoring Program is to guide efforts to control bacteria sources derived from agricultural discharges which include stormwater runoff, wastewater release, and tailwater runoff from agricultural lands. Agricultural land uses in the MSAR watershed include concentrated animal feeding operations (CAFO) and irrigated and dry-land farming.

The water quality sampling and analyses conducted for this effort will be coordinated with the Watershed-Wide Monitoring Program as described above.

Sampling occurred for the AgSEP Monitoring Program from November 2008 through March 2009. No additional sample collection from the AgSEP sample locations is currently planned. However, based upon findings from the monitoring carried out at AgSEP sites, the TMDL Task Force may determine that additional monitoring is necessary.

If additional monitoring is to be implemented, it will be indicated in annual or semi-annual AgSep plan submittals of any superseding plans. Sampling dates and locations for any future AgSEP Monitoring will include a map and brief sample site description with GPS coordinates.

6.2. Constituents to be Monitored and Measurement Techniques

The following water quality indicators will be measured at the Watershed-Wide, USEP, and AgSEP Monitoring sites, respectively.

Watershed-Wide Monitoring Program

Consistent with the TMDL, the following water quality indicators will be analyzed in water samples collected at each site on each sample date:

- *Field Analysis*: Temperature, conductivity, pH, dissolved oxygen, and turbidity will be measured with a Horiba Multiparameter probe
- *Flow*: During each time a site is sampled, if conditions are safe, flow will be characterized using a volumetric, cross-section velocity profile, or visual estimate method
- *Water Quality Analysis*: Fecal coliform, *E. coli*, and total suspended solids (TSS) concentrations in grab samples will be analyzed by Orange County Public Health Water Quality Laboratory or another qualified laboratory.

USEP Monitoring Program

The following data will be collected when each USEP Monitoring Program site is sampled:

- *Field Analysis*: Temperature, conductivity, pH, dissolved oxygen, and turbidity will be measured with a Horiba Multiparameter probe
- *Water Quality Analysis*: Fecal coliform, *E. coli*, and TSS concentrations in grab samples will be analyzed by Orange County Public Health Water Quality Laboratory or another qualified laboratory.
- *Flow*: During each time a site is sampled, if conditions are safe, flow will be characterized using a volumetric, cross-section velocity profile, or visual estimate method
- *Bacteroides Analysis*: A qualified laboratory will assay water grab samples for *Bacteroides* host-specific markers for humans, ruminant, and domestic canine to determine if they are present and to provide a semi-quantitative estimate of their relative abundance.

In addition to measuring flow at USEP sites, samplers will assess the hydrologic connectivity of the surface flow at each site to the downstream impaired waterbody (Santa Ana River Reach 3, Mill Creek, Cucamonga Creek, and Chino Creek Reach 1 and 2) to evaluate if the tributary drain is actually discharging any runoff to the downstream waterbody. If there is no connection of surface waters, then the flow rate is assumed to be zero. A full characterization of hydrologic connectivity will be conducted during at least one field sampling event in each 30-day sampling period. In addition, the hydrologic connectivity will be characterized to the extent possible during storm event sampling.

AgSEP Monitoring Program

The following data will be collected when each AgSEP Monitoring Program site is sampled:

- *Field Analysis*: Temperature, conductivity, pH, dissolved oxygen, and turbidity will be measured with a Horiba Multiparameter probe
- *Water Quality Analysis*: Fecal coliform, *E. coli*, and TSS concentrations in grab samples will be analyzed by Orange County Public Health Water Quality Laboratory or another qualified laboratory
- *Flow*: During each time a site is sampled, if conditions are safe, flow will be characterized using a visual estimate method.
- *Bacteroides Analysis*: A qualified laboratory will assay water grab samples for *Bacteroides* host-specific markers for humans, ruminant, and domestic canine to determine if they are present and to provide a semi-quantitative estimate of their relative abundance.

6.3 Constraints to Monitoring

Under some circumstances, collection of water samples or field measurements may not be possible. For instance, if flow in the channel is high enough to make conditions dangerous for taking a flow measurement by developing a cross section velocity profile. Another potential constraint would occur if channel is dry, thus making it impossible to collect surface water samples. The field team will document any constraints in the field. The data manager will incorporate observational data from these site visits into the water quality database, indicating the reason why data was not collected at a given site.

6.4 Project Schedule

The project schedule will follow the schedule as described in the MSAR Water Quality Monitoring Plan. The Monitoring Plan will be updated accordingly, as the Watershed-wide compliance, USEP, or AgSEP Monitoring Programs change.

7. Quality Objectives and Criteria for Measurement Data

Data Quality Objectives for this project include the following:

Measurement or Analyses Type	Applicable Data Quality Objective
▪ Field Measurements	▪ Accuracy, Precision, Completeness
▪ Bacterial Analyses	▪ Precision, Presence/Absence, Completeness
▪ TSS Analyses	▪ Accuracy, Precision, Recovery, Completeness

Accuracy will be determined by measuring one or more selected from performance testing samples or standard solutions from sources other than those used for calibration. Accuracy criteria for bacterial testing will be based on presence/absence testing rather than numerical limits owing to the difficulty in preparing solutions of known bacterial concentration.

Precision measurements will be determined on both field and laboratory replicates. The number of replicates for field measurements will be three, the number for TSS will be two, and for bacterial testing, the number of replicates will be five.

Recovery measurements will be determined by laboratory spiking of a replicate sample with a known concentration of the analyte. The target level of addition is at least twice the original sample concentration and is applicable only to TSS analyses.

Completeness is the number of analyses generating useable data for each analysis divided by the number of samples collected for that analysis.

Method sensitivity is dealt with by the inclusion of the required SWAMP Target Reporting Limits, where such values exist. Target Reporting Limits exist for fecal coliform, *E. coli*, and TSS.

No Target Reporting Limits were set for the field analyses.

Table 7-1. Data Quality Objectives for Field Measurements						
Group	**Parameter**	**Accuracy**	**Precision**	**Recovery**	**Target Reporting Limit**	**Completeness**
Field Measurements	Conductivity	+/-5%	No SWAMP requirement; will use ± 5%	NA	NA	No SWAMP requirement; will use 90%
Field Measurements	Dissolved Oxygen	±0.5 mg/L	No SWAMP requirement; will use ± 0.5 or 10%	NA	NA	No SWAMP requirement; will use 90%
Field Measurements	pH	+/- 0.5 units	No SWAMP requirement; will use ± 0.5 or 5%	NA	NA	No SWAMP requirement; will use 90%
Field Measurements	Temperature	+/- 0.5ºC	No SWAMP requirement; will use ± 0.5 or 5%	NA	NA	No SWAMP requirement; will use 90%
Field Measurements	Turbidity	No SWAMP requirement -suggest +/- 10% or 0.1, whichever is greater	No SWAMP requirement; will use ± 10% or 0.1, whichever is greater	NA	NA	No SWAMP requirement; will use 90%
Field Measurements	Flow (visual estimate)	No SWAMP requirement –suggest +/- 25% or 0.25, whichever is greater	No SWAMP requirement; Will use ± 25% 0r 0.25, whichever is greater	NA	NA	No SWAMP requirement; will use 90%
Field Measurements	Flow (via flow instruments)	No SWAMP requirement -suggest +/- 10% or 0.1, whichever is greater	No SWAMP requirement; will use ± 10% or 0.1, whichever is greater	NA	NA	No SWAMP requirement; will use 90%

Table 7-2. Data Quality Objectives for Laboratory Measurements						
Group	**Parameter**	**Accuracy**	**Precision**	**Recovery**	**Target Reporting Limits**	**Completeness**
Bacterial Analyses	Fecal Coliform & *E. coli*	Positive results for target organisms. Negative results for non-target organisms	R_{log} within 3.27*mean R_{log} (reference is section 9020B 18th, 19th, or 20th editions of *Standard Methods*)	NA	10 CFU/100 mL	90%
Conventional Constituents in Water	TSS	Standard Reference Materials (SRM, CRM, PT) within 95% CI stated by provider of material. If not available then with 80% to 120% of true value	Blind field duplicate and Laboratory duplicate, or MS/MSD 25% RPD	Matrix spike 80% - 120% or control limits at ± 3 standard deviations based on actual lab data, whichever is more stringent	1.0 mg/L	No SWAMP requirement; will use 90%

8. Special Training Needs/Certification

All persons involved in the field sampling activities for the Watershed-Wide, USEP, and AgSEP Monitoring Programs will be conducted prior to any field sampling. Training will take place prior to ensure that sampling field members are familiar with the protocols and sampling sites.

All individuals that participate in sampling activities are required to have attended (at a minimum) the "4-hour Basic Site Safety Training" provided by an appropriately qualified trainer and/or contractor of the Health and Safety branch of the State, and/or equivalent university training. The training will cover the general health and safety issues associated with fieldwork, including sampling. The monitoring manager will provide specific training, pertinent to the details of a particular sampling program. This training will include, but not be limited to, proper use of field equipment, health and safety protocols, sample handling protocols, and chain of custody protocols.

Field staff training is documented and filed at the Monitoring Contractor's office. Documentation consists of a record of the training date, instructor, whether initial or refresher, and whether the course was completed satisfactorily.

All commercial laboratories contracting with CDM or SAWPA will provide appropriate training to its staff as part of its Standard Operating Procedure (SOP). All contracting laboratories will maintain their own records of its training that comply with OSHA requirements. Those records can be obtained, if needed, from each contract laboratory through their Quality Assurance Officer.

9. Documents and Records

The following documentation and records procedures will be followed:

- The CDM Project Manager or QA Officer will maintain a record of all field analyses and samples collected and will be responsible to oversee the sampling collection training activities. All samples delivered to contract laboratories for analysis will include a Chain of Custody form (Attachment 2).
- All contracted laboratories will generate records for sample receipt and storage, analyses, and reporting.
- A MSAR Bacterial Indicator TMDL project database (as part of the Santa Ana Watershed Data Management System [SAWDMS]) will be maintained by SAWPA under the direction of the SAWPA Database Manager.
- All laboratory and field data submitted to SAWPA for inclusion in the database will follow the guidelines and formats established by California Surface Water Ambient Monitoring Program (SWAMP) (http://www.waterboards.ca.gov/swamp/qapp.html).
- All chemical monitoring records generated by these monitoring programs will be stored at SAWPA. Each of the contract laboratory records pertinent to the program will be maintained at the each of the contract laboratory main offices. Copies of all records held by the contract laboratories will be provided to SAWPA and stored in the SAWPA archives.
- Copies of this QAPP will be distributed to all parties involved with the project. Copies will be sent to each Contract Laboratory QA Officer for distribution to appropriate laboratory staff. Any future amended QAPPs will be held and distributed in the same fashion. All originals of this QAPP and its amendments will be held at SAWPA. Copies of versions, other than the most current, will be discarded so as not to create confusion.
- Each Project Administrator will provide interim and final reports to the Regional Board, State Board, or other applicable parties consistent with the requirements of their program.

Table 9-1. Document and Record Retention, Archival, and Disposition Information				
Identify Type Needed		**Retention**	**Archival**	**Disposition**
Sample Collection Records	Field Logs	SBCFCD or other monitoring contractor, and CDM (copy)	CDM will retain a copy and review after each event	SAWPA will retain a copy for final disposition.
Analytical Records	Lab results	OC Public Health Water Quality Lab, OCWD Lab, UC Davis Lab, CDM (Copy)	CDM will retain a copy and review after each event	SAWPA will retain a copy for final disposition.
	Chain-of-Custody Forms	, SBCFCD, or other monitoring contractor, and CDM (copy)	CDM will retain a copy and review after each event	SAWPA will retain a copy for final disposition.
Assessment Reports	QA/QC Updates	OC Public Health Water Quality Lab, OCWD Lab, UC Davis Lab	CDM will review and retain copy	SAWPA will retain a copy for final disposition.
	QA/QC Final Report	OC Public Health Water Quality Lab, OCWD Lab, UC Davis Lab	CDM will review and retain copy	SAWPA will retain a copy for final disposition.
	Field Sampling Review	Contractor QA Officer	SAWPA and CDM will retain a copy	SAWPA will retain a copy for final disposition.
	Internal Technical Audit of Database Management	SAWPA Database Manager	SAWPA and CDM will retain a copy	SAWPA will retain a copy for final disposition.
Reports	Dry Season Monitoring Report (Watershed-wide)	CDM	Regional Board & SAWPA will review and retain	SAWPA will retain a copy for final disposition.
	Wet Season Monitoring Report	CDM	Regional Board & SAWPA will review and retain	Regional Board & SAWPA will retain a copy for final disposition.

Group B: Data Generation and Acquisition

10. Sampling Process Design

Watershed-Wide Monitoring Program

Sample Frequency and Schedule

For monitoring activities at Watershed-wide monitoring sites, this sampling effort is generally described as follows:

- Water quality samples will be collected once per week during a 20-week period (see Table 10-1). This will allow for calculation of rolling geometric means based on the 5 most recent samples.
- *Wet Season (November 1 – March 31)*: The goal of the wet season sampling effort is to obtain samples from both dry and wet weather conditions during the wet season. To best accomplish this goal, a sample schedule with some built-in flexibility has been established:
    - *Fixed Sample Dates* – Eleven samples will be collected over an eleven week period from December to February/March. The collection of samples over a continuous 11-week period will provide the opportunity to calculate a rolling geometric mean. This weekly sampling will occur on a regular schedule regardless of whether flows are at base levels or elevated because of wet weather.
    - *Flexible (Storm Event) Sample Dates* – The goal of having flexible sample dates is to obtain data from the falling limb of the hydrograph following at least one storm event during the wet season. To the extent practical, taking into account the timing of the storm event, when a storm event occurs, four samples will be collected from each site as follows: Sample 1 will be collected on the day of the storm event and samples 2, 3 and 4 will be collected 48, 72, and 96 hours following the storm event. If no wet weather events have occurred by late February, then samples will be added to the end of the fixed sample dates.

Table 10-1 Start / End Weeks for Wet and Dry Season Watershed-wide Compliance Sampling		
Sampling Year	**Dry Season ***	**Wet Season ***
2009 – 2010	May 25 / Oct 5	Dec 21 / Mar 1
2010 – 2011	May 17 / Sept 27	Dec 20 / Feb 28
2011 – 2012	May 16 / Sept 26	Dec 19 / Feb 27
2012 – 2013	May 21 / Oct 1	Dec 17 / Feb 25
2013 – 2014	May 20 / Sept 30	Dec 16 / Feb 24
2014 – 2015	May 19 / Sept 29	Dec 15 / Feb 23
2015 – 2016		Dec 14 / Feb 22
2016 – 2017		Dec 19 / Feb 27
2017 – 2018		Dec 18 / Feb 26
2018 – 2019		Dec 17 / Feb 25
2019 – 2020		Dec 16 / Feb 24
2020 – 2021		Dec 14 / Feb 22
2021 - 2022		Dec 20 / Feb 28
2022 - 2023		Dec 19 / Feb 27
2023 - 2024		Dec 18 / Feb 26
2024 - 2025		Dec 16 / Feb 24
*Dates represent the Monday of the sample week.		

Urban Source Evaluation Monitoring Plan

Sample Frequency and Schedule

This sampling effort is generally described as follows:

- Water quality samples will be collected once a week during a specified period of at least five weeks. This sample frequency allows for calculation of rolling geometric means based on the 5 most recent samples. The actual number of consecutive weeks of sampling will be site or project-specific.
- *Wet Season (November 1 – March 31)*: The goal of the wet season sampling effort is to obtain samples from both dry and wet weather conditions during the wet season. To best accomplish this goal, a sampling schedule with some built-in flexibility has been established. Accordingly, the sample effort is divided into a combination of fixed and flexible sample dates:
    - *Fixed Sample Dates* –Sampling will occur regardless of whether flows are at base levels or are elevated because of wet weather. Water quality samples will be collected in accordance with the QAPP once a week during a specified period of at least five weeks. This sample frequency allows for calculation of rolling geometric means based on the 5 most recent samples. The actual number of consecutive weeks of sampling will be site or project-specific.

- *Flexible (Storm Event) Sample Dates* – The goal of having flexible sample dates is to obtain data from the falling limb of the hydrograph following at least one storm event during the wet season. To the extent practical, taking into account the timing of the storm event, when a storm event occurs, four samples will be collected from each site as follows: Sample 1 will be collected on the day of the storm event and samples 2, 3 and 4 will be collected 48, 72, and 96 hours following the storm event.

AgSEP Monitoring Plan

Sample Frequency and Schedule

A detailed schedule will be provided in any future AgSEP plans. This sampling effort is generally described as follows:

- *Wet Season (November 1 – March 31)*: The goal of the wet season sampling effort is to obtain samples from wet weather conditions during the wet season. To best accomplish this goal, a sampling schedule with some built-in flexibility has been established. Accordingly, the sample effort is comprised of flexible sample dates:
- *Flexible (Storm Event) Sample Dates* – The goal of having flexible sample dates is to obtain data from two storm events during the wet season. If two storm events do not occur in one wet season, then the second storm event will be sampled in the next wet season. To the extent practical, taking into account the timing of the storm event, when a storm event is sampled, two samples will be collected from each site as follows:
    - Sample 1 will be collected during the storm event upon arrival at the sample location;
    - Sample 2 will be collected 30 minutes after the collection of the first sample

11. Sampling Methods

11.1 Sample Collection

In-stream sampling consists of grab samples collected approximately mid-stream and at the water surface during designated sample activities following sampling methods. Water samples are best collected before any other work is done at the site. If other work is done prior to the collection of water samples (for example, flow measurement or other field measurements), it might be difficult to collect representative samples for water chemistry and bacteria analysis from the disturbed stream. Wading by sample collection staff shall not occur during collection of samples for bacterial and TSS analyses.

Water samples are collected from a location in the stream where the stream visually appears to be completely mixed. Ideally this would be at the centroid of the flow (*Centroid* is defined as the midpoint of that portion of the stream width that contains 50% of the total flow), but depth and flow do not always allow centroid collection. In addition, the sample should be collected in an area free of debris or algae. Samples shall not be collected if conditions are determined to be unsafe during an on- site assessment by the field team leader.

For sites where the samples will be taken from a distance, a sampling pole will be used. This sampling pole is approximately 7 feet long and has a mechanism that holds the sample bottle in place. The mechanism should be sterilized in the field with a 70 percent ethanol solution prior to the collection of each sample. Allow the pole to air-dry before the sample is taken. A similar sampling pole that extends to greater height may be used for sites where sampling from a bridge is necessary.

The following lists contain specific steps to take when collecting a water sample (adapted from EPA's Volunteer Stream Monitoring: A Methods Monitoring Manual, EPA 841-B-97-003, November 1997):

1) Label each container with Site ID, Sample ID, analysis information, Project ID, date, and time (some of this information may be pre-labeled on the containers). After sampling, secure the label by taping it around the bottle with clear packaging tape.
2) When wading (if applicable) to the sampling point, try not to disturb bottom sediment.
3) Stand in the water, facing upstream. Collect the water sample on your upstream side, in front of you. Hold the bottle upright under the surface while it is still capped. Open the lid carefully to slowly let water run in. Avoid touching the inside of the bottle or cap. If you accidentally touch the inside, use another bottle. Fill the bottle leaving a 1-inch air space so that the sample can be shaken just before analysis.
4) For fecal coliform and *E. coli* samples the bottle will contain sodium thiosulfate for chlorine elimination; therefore, the bottle cannot be held under the water to collect a sample. Therefore, use a new sterilized water collection bottle to collect water for these parameters at each site. Water can then be decanted from this bottle into the sample container for the laboratories.
5) The TSS sample containers will be sterilized by the lab so that they can be used for collection and decanting of water into the preserved fecal coliform and *E. coli* sample bottles.

6) Collect the water sample on your upstream side, in front of you. You may also tape your bottle to an extension pole to sample from deeper water. Hold the bottle near its base and plunge it (opening downward) below the water surface. If you are using an extension pole, remove the cap, turn the bottle upside down, and plunge it into the water, facing upstream.

7) Recap the bottle carefully, remembering not to touch the inside.

8) Place the bottles in a cooler with cold packs for transport to the laboratory. The maximum holding time prior to water quality analysis for bacteria concentrations is 6 hours; the maximum holding time prior to *Bacteroides* analysis is 24 hours. Bottles will be provided by the laboratories for each sample and will include:

   Water Quality Analysis Laboratory – A single 120 mL bottle for both fecal coliform and *E. coli*, and one 1000 mL bottle for TSS

   OCWD or UC Davis Laboratory – 1 (1000 mL) bottles for *Bacteroides* analysis

9) Field QA Samples:

Field Equipment Blanks – One set of field equipment blank samples (equal volume for each constituent) will be included for each sample event (Note: one sample event encompasses samples collected within a given week). Sterile deionized (DI) water is poured through any equipment used to collect samples at the site where the field equipment blank is being collected and then into the respective sample containers for each constituent.

Field Replicates – Field replicates will be collected from at least 5 percent of the total number of samples collected per sample event for the USEP or Watershed-Wide sampling efforts. This frequency results in one replicate collected for each week that the USEP sites are sampled and each week the Watershed-Wide sites are sampled. Field replicates are taken by collecting two sets of samples at the same location within five minutes of each other.

Table 11-1. Sampling Locations and Sampling Methods										
Sampling Location	**Location ID Number**	**Matrix**	**Depth (units)**	**Analytical Parameter**	**# Samples (include field duplicates)**	**Sampling SOP #**	**Sample Volume**	**Containers #, size, type**	**Preservation (chemical, temperature, light protected)**	**Maximum Holding Time: Preparation/ analysis**
Field Analyses										
See Section 10, Refer to Monitoring Plan (MP)	Refer to MP	Water	Water surface	Conductivity	NA	Refer to MP	Instream	NA	NA	Measured on site
Refer to MP	Refer to MP	Water	Water surface	Dissolved Oxygen	NA	Refer to MP	Instream	NA	NA	Measured on site
Refer to MP	Refer to MP	Water	Water surface	pH	NA	Refer to MP	Instream	NA	NA	Measured on site
Refer to MP	Refer to MP	Water	Water surface	Temperature	NA	Refer to MP	Instream	NA	NA	Measured on site
Refer to MP	Refer to MP	Water	Water surface	Turbidity	NA	Refer to MP	Instream	NA	NA	Measured on site
Refer to MP	Refer to MP	Water	Water surface	Flow	NA	Refer to MP	Instream	NA	NA	Measured on site
Laboratory Analyses										
Refer to MP	Refer to MP	Water	Water surface	*E. coli* & Fecal Coliform	580	Refer to MP	100 ml	1 bottle, 120 ml, sterile plastic (high density polyethylene or polypropylene) container	Sodium thiosulfate pre-added to the containers in the laboratory (chlorine elimination). Cool to 4°C; dark	6 hours at 4°C, dark; lab must be notified well in advance
Refer to MP	Refer to MP	Water	Water surface	TSS	580	Refer to MP	1000 ml	1 bottle, 1000 ml, Cool to 4ºC, dark	Cool to 4ºC, dark	7 days at 4ºC, dark
Molecular Analyses										
Refer to MP	Refer to MP	Water	Water surface	*Bacteroides* Assay	300	Refer to MP	1000 ml	2 bottles, 500 ml, Cool to 4°C; dark.	Cool to 4°C; dark.	24 hours at 4ºC, dark; lab must be notified in advance

11.2 Field Measurements

After collecting the water samples, record the water temperature, pH, conductivity, turbidity, and dissolved oxygen concentration. These parameters as well as other field data are measured and recorded using a Horiba Multiparameter probe. When field measurements are made with a multi-parameter instrument, it is preferable to place the sonde in the body of water to be sampled and allow it to equilibrate in the dissolved oxygen mode while water samples are collected. Field measurements are made at the centroid of flow, if the stream visually appears to be completely mixed from shore to shore. For routine field measurements, the date, time and depth are reported as a grab. Below is a brief discussion of each recorded field measurement:

Dissolved Oxygen – Calibrate the dissolved oxygen sensor on the multi-probe instrument at the beginning of each day of field measurements. Preferably, dissolved oxygen is measured directly in-stream close to the flow centroid. The dissolved oxygen probe must equilibrate for at least 90 seconds before dissolved oxygen is recorded to the nearest 0.1 mg/L. Since dissolved oxygen takes the longest to stabilize, record this parameter after temperature, conductivity, and pH.

pH – If the pH meter value does not stabilize in several minutes, out-gassing of carbon dioxide or hydrogen sulfide or the settling of charged clay particles may be occurring. If out-gassing is suspected as the cause of meter drift, collect a fresh sample, immerse the pH probe and read pH at one minute. If suspended clay particles are the suspected cause of meter drift, allow the sample to settle for 10 minutes, and then read the pH in the upper layer of sample without agitating the sample. With care, pH measurements should be accurately measured to the nearest 0.1 pH unit.

Conductivity – Preferably, specific conductance is measured directly in-stream close to the flow centroid. Allow the conductivity probe to equilibrate for at least one minute before specific conductance is recorded to three significant figures (if the value exceeds 100 µS/cm). The primary physical problem in using a specific conductance meter is entrapment of air in the conductivity probe chambers. The presence of air in the probe is indicated by unstable specific conductance values fluctuating up to ±100 µS/cm. The entrainment of air can be minimized by slowly, carefully placing the probe into the water; and when the probe is completely submerged, quickly move it through the water to release any air bubbles.

Temperature - Temperature is measured directly in-stream close to the flow centroid. Measure temperature directly from the stream by immersing a Horiba Multiparameter instrument.

Turbidity - Turbidity is measured directly in-stream close to the flow centroid. Measure turbidity directly from the stream by immersing a Horiba Multiparameter instrument.

11.3 Instantaneous Flow Monitoring

For USEP Monitoring Program sites, flow measurements will be recorded by field personnel for every site visit during the period of the Grant Project. A depth-discharge rating curve can be developed by conducting multiple flow measurements at water depths in 0.1 ft increments. Once developed, only depth measurements would be required during site visits, assuming the depth of flow is within 0.1 ft of a previously completed flow measurement.

11.3.1 Measured Flow Estimate

Where possible, volumetric measurements and a cross-section velocity profile will be developed according to the following procedures:

Volumetric **-** Where possible, a volumetric flow measurement approach will be used. This method shall not be used if conditions are determined to be unsafe by an on-site assessment by the field team leader. A volumetric flow measurement entails estimation of the time in seconds (t) required to fill a 5 gallon bucket with concentrated runoff. Sites with low flow and a free outfall would allow for this type of flow measurement. The following equation would then give the flow rate for a test with one 5-gallon bucket of volume captured, Q (cfs) = 0.67 * t. If there are multiple points where runoff is concentrated, then volumetric measurements can be made at each point along the stream and summed to provide total discharge.

Cross-Section Velocity Profile **-** The following steps guide the development of a velocity profile for a streamflow cross section. This approach will require that the field personnel be equipped with a Marsh-McBirney flow meter or equivalent, top-setting wading rod (preferably measured in tenths of feet), and a tape measure (with gradations every tenth of a foot).

1. Stretch the measuring tape across the stream at right angles to the direction of flow. When using an electronic flow meter, the tape does not have to be exactly perpendicular to the bank (direction of flow). Avoid measuring flow in areas with back eddies. The first choice would be to select a site with no back eddy development. However, this cannot be avoided in certain situations. Measure the negative flows in the areas with back eddies. If necessary and possible, modify the measuring cross section to provide acceptable conditions by building dikes to cut off dead water and shallow flows, remove rocks, weeds, and debris in the reach of stream one or two meters upstream from the measurement cross section. After modifying a streambed, allow the flow to stabilize before starting the flow measurement
2. Record the following information on the flow measurement form (Attachment 3):
   - i. Site Location and Site ID
   - ii. Date
   - iii. Time measurement is initiated and ended
   - iv. Name of person(s) measuring flow
   - v. Note if measurements are in feet or meters
   - vi. Total stream width and width of each measurement section
   - vii. For each cross-section, record the mid-point, section depth, and flow velocity
3. Determine the spacing and location of flow measurement sections. Measurements will be taken at the midpoint of each of the flow measurement sections. Flow measurements will be taken at the following locations:
   - A point from the left bank representing 10% of the total width. This measurement will provide a velocity estimate for the section representing 0% – 20% of the total width from the left bank.

- A point from the left bank representing 50% of the total width. This measurement will provide a velocity estimate for the section representing 20% – 80% of the total width from the left bank.
- A point from the left bank representing 90% of the total width. This measurement will provide a velocity estimate for the section representing 80% – 100% of the total width from the left bank.

4. Place the top setting wading rod at each flow measurement point.
5. Using a tape measure, measure the depth of water to the nearest ½ inch.
6. Adjust the position of the sensor to the correct depth at each flow measurement point. The purpose of the top setting wading rod is to allow the user to easily set the sensor at 20%, 60%, and 80% of the total depth. On the wading rod, each single mark represents 0.10 foot, each double mark represents 0.50 foot, and each triple mark represents 1.00 foot. Position the meter at 60% of the total depth from the water surface (if depth of flow is greater than 2.5ft, then take two readings, at 20% and 80% of total depth).
7. Measure and record the velocity and depth. The wading rod is kept vertical and the flow sensor kept perpendicular to the cross section. Permit the meter to adjust to the current for a few seconds. Measure the velocity for a minimum of 20 seconds with the Marsh-McBirney meter. When measuring the flow by wading, stand in the position that least affects the velocity of the water passing the current meter. The person wading stands a minimum of 1.5 feet downstream and off to the side of the flow sensor.
8. Report flow values less than 10 ft^3/s to two significant figures. Report flow values greater than 10 ft^3/s to the nearest whole number, but no more than three significant figures.
9. Calculate flow by multiplying the width x depth (ft^2) to derive the area of each flow measurement section. The area of the section is then multiplied by the velocity (ft/s) to calculate the flow in cubic feet per second (cfs or ft^3/sec) for each flow measurement section. <u>Do not treat cross sections with negative flow values as zero.</u> Negative values obtained from areas with back eddies should be subtracted during the summation of the flow for a site. When flow is calculated for all of the measurement sections, they are added together for the total stream flow.

11.3.2 Visual Flow Estimate

Flow estimate data may be recorded for a non-tidally influenced stream when it is not possible to measure flows by the volumetric or cross section velocity profile methods described above either because flows are too high or so shallow that obtaining a velocity measurement is difficult or impossible. Visual flow estimates are subjective measures based on field personnel's experience and ability to estimate distances, depths, and velocities.

1. Observe the stream and choose a reach of the stream where it is possible to estimate the stream cross section and velocity. Estimate stream width (feet) at that reach and record.
2. Estimate average stream depth (feet) at that reach and record.
3. Estimate stream velocity (ft/s) at that reach and record. A good way to do this is to time the travel of a piece of floating debris. This can be done by selecting points of reference along

the stream channel which can be used as upper and lower boundaries for an area of measurement. After establishing the boundaries, measure the length of the flow reach. One person stands at the upper end of the reach and drops a floating object and says "start." A second person stands at the lower end of the reach and times the number of seconds for the floating object to float the reach. This measurement is conducted three times and the three results are averaged. The velocity is the length of the reach in feet divided by the average time in seconds.

If doing this method from a bridge (for example, because flows are too high to be in the channel), measure the width of the bridge. Have one person drop a floating object (something that can be distinguished from other floating material) at the upstream side of the bridge and say "start". The person on the downstream side of the bridge will stop the clock when the floating object reaches the downstream side of the bridge. Divide the bridge width by the number of seconds to calculate the velocity. The velocity should be measured at multiple locations along the bridge at least three times. These velocities are averaged.

Multiply stream width (feet) by average stream depth (feet) to determine the cross sectional area (ft^2) which when multiplied by the stream velocity (ft/s) and a correction constant, gives an estimated flow (ft^3/s).

12. Sample Handling and Custody

12.1 Pre-Sampling Procedures

Prior to the collection of field data, the sample teams will complete the following activities:

1. Horiba Multiparameter probe should be calibrated every morning prior to sampling (See the equipment operation manual for specific calibration instructions). Calibrations will be conducted by the QA officer for SBCFCD (Janet Dietzman) or other Monitoring Contractors (TBD). Sampling activities will not be conducted until calibrations can be completed per equipment operations manual.
2. Prepare ice coolers with ice packs or crushed ice to transport samples to the laboratory.
3. Obtain sample containers from labs, including field blanks and water collection bottles
4. Pre-label sampling containers with Site Identification Number (Site ID) and leave blank fields for date and time.
5. Prepare 70 percent ethanol solution for field sterilization of sampling equipment.
6. Pack a flat head screw driver to loosen the band that holds the sampling bottle to the sampling pole.
7. Pack safety gear such as waders, protective gloves, and safety vests.
8. Pack waterproof pen and field log book.
9. Make sure that a vehicle is available and fueled.
10. Pack supplies for shipping samples.
11. Pack chain of custody forms, field data sheets, camera, and zip lock bags.

12.2 Field Documentation

Field crews are required to keep a field log. Field documentation will be completed using indelible ink, with any corrections made by drawing a single line through the error and entering the correct value. The following items should be recorded in the field log for each sample collected at each sample location (An example Field Data Sheet Form is included as Attachment 1):

- Date and time of sample collection
- Site Name and Site ID
- Unique IDs for any replicate or blank samples collected from the site
- The results of any field measurements (conductivity, dissolved oxygen, flow, pH, temperature, and turbidity) and the time that measurements were made
- Qualitative descriptions of relevant water conditions (e.g. color, flow level, clarity) or weather (e.g. wind, rain) at the time of sample collection

- For USEP sites when such characterizations are required, a characterization of the hydrologic connectivity of the surface flow at the site to the downstream impaired water to which it is tributary. If no connectivity is observed, then the characterization shall, at a minimum, describe the general distance between the point where surface flow ceases and the channel confluences with the downstream impaired water. If connectivity is observed, then the characterization shall, at a minimum, describe the typical width and depth of the surface flow reaching the downstream impaired water, any observations that suggest that flows have recently been higher than what is currently observed.
- A description of any unusual occurrences associated with the sampling of that site, particularly those that may affect sample or data quality

Field crews are required to take digital photographs when sampling each site and maintain a photo log of all photographs taken. At a minimum, the following digital photographs should be taken at each site:

- A photograph which shows a view of the waterbody upstream of the sample site
- A photograph which shows a view of the waterbody downstream of the sample site.
- Photographs which characterize the width and depth of flow and aesthetic characteristics such as water clarity and algal growth

To the extent possible, the photographs that provide an upstream and downstream view of the waterbody should be taken from the same point during each site visit. A photo log of all photographs taken at each sample site shall be maintained that documents the purpose of the photo (for example, upstream or downstream view) and the date and time of the photograph.

12.3 Sampling Handling & Delivery to Laboratory

Proper gloves must be worn to prevent contamination of the sample and to protect the sampler from environmental hazards (disposable polyethylene, nitrile, or non-talc latex gloves are recommended). Wear at least one layer of gloves, but two layers help protect against leaks. One layer of shoulder high gloves worn as first (inside) layer is recommended to have the best protection for the sampler. Safety precautions are needed when collecting samples, especially samples that are suspected to contain hazardous substances, bacteria, or viruses.

Properly store and preserve samples as soon as possible. Usually this is done immediately after returning from the collection by placing the containers on top of bagged, crushed or cube ice in an ice chest (**do not bury sample containers under ice**). Sufficient ice will be needed to lower the sample temperature to at least 4°C within 45 minutes after time of collection. Sample temperature will be maintained at 4°C until delivered to the appropriate laboratory. Care should be taken at all times during sample collection, handling, and transport to prevent exposure of the sample to direct sunlight.

Samples that are to be analyzed for bacteria indicators must be kept on ice or in a refrigerator and delivered to **Orange County Public Health Water Quality Laboratory, (700 Shellmaker Road, Newport Beach, CA, 92660; 949-219-0423)** water quality laboratory within 6 hours.

Samples analyzed for *Bacteroides* must be kept on ice or in a refrigerator and delivered to the appropriate laboratory, **Orange County Water District laboratory (10500 Ellis Avenue, Fountain Valley, CA, 92708; 714-378-3313, contact Menu Leddy)** ***or*** **University California Davis laboratory (University of California, Department of Civil & Environmental Engineering, One Shields Avenue, Davis, CA 95616, 3157 Engineering III; 530-754-6407, contact Dr. Stefan Wuertz)** within 24 hours of collection.

A detailed sample delivery schedule is presented in Table 2-3, Table 3-2, and Table 4-2 of the Monitoring Plan. Every shipment must contain a complete Chain of Custody (COC) Form (see Attachment 2) that lists all samples taken and the analyses to be performed on these samples. COCs must be completed every time samples are transported to a laboratory. Include any special instructions to the laboratory. The original COC sheet (not the copies) is included with the shipment (insert into zip lock bag); one copy goes to the sampling coordinator; and the sampling crew keeps one copy. Samples collected should have the depth of collection and date/time collected on every COC.

Due to increased shipping restrictions, samples being sent via a freight carrier require additional packing. Although care is taken in sealing the ice chest, leaks can and do occur. Samples and ice should be placed inside a large plastic bag inside the ice chest for shipping. The bag can be sealed by simply twisting the bag closed (while removing excess air) and taping the tail down. Prior to shipping the drain plug of the ice chests have to be taped shut. Leaking ice chests can cause samples to be returned or arrive at the laboratory beyond the required holding time. Although glass containers are acceptable for sample collection, bubble wrap must be used when shipping glass.

Samples will be delivered to analytical laboratories by the SBCFCD or other Monitoring Contractor(s) either directly by sampling team personnel or via courier.

12.4 Chain of Custody

Every shipment must contain a complete Chain of Custody (COC) Form (see Attachment 2) that lists all samples taken and the analyses to be performed on these samples. The Chain of Custody form will identify the sample number, sampling location description, date, time, sample type, number of containers, tests required, and relinquishing signatures. COCs must be completed every time samples are transported to a laboratory. Include any special instructions to the laboratory. The original COC sheet (not the copies) is included with the shipment (insert into zip lock bag); one copy goes to the sampling coordinator; and the sampling crew keeps one copy. Samples collected should have the depth of collection and date/time collected on every COC.

Due to increased shipping restrictions, samples being sent via a freight carrier require additional packing. Although care is taken in sealing the ice chest, leaks can and do occur. Samples and ice should be placed separately inside large plastic bags and placed in the ice chest for shipping. The bags can be sealed by simply twisting the bag closed (while removing excess air) and taping the tail down. Prior to shipping the drain plug of the ice chests have to be taped shut. Leaking ice chests can cause samples to be returned or arrive at the laboratory beyond the required holding time. Although glass containers are acceptable for sample collection, bubble wrap must be used when shipping glass.

13. Analytical Methods

Tables 13-1 and Table 13-2 summarizes the analytical methods that will be used for the Watershed-wide, USEP, and AgSEP Monitoring Programs.

Table 13-1. Field Methods

Analyte	Laboratory / Organization	Project Action Limit (units, wet or dry weight)	Target Reporting Limit (units, wet or dry weight)	Field Method	
				Analytical Method/ SOP	Modified for Method yes/no
Conductivity *	Field monitoring	1.09 µS/cm	0 - 100 µS/cm	SM**2510B	No
Dissolved Oxygen	Field monitoring	5 mg/L	0 - 19.9 mg/L	SM4500OG	No
pH	Field monitoring	6.5 to 8.5	0 – 14 pH	SM4500-H+B	No
Temperature (water)	Field monitoring	June to Oct: not > 90 °F (32°C); Rest of Year: not > 78°F (25°C) as a result of controllable water quality factors	0 – 50 °C	SM2550B	No
Turbidity	Field monitoring	5 to 10 NTU	0 – 800 NTU	SM2130B	No
Flow	Field monitoring	NA	-0.5 to 19.99 ft/sec	Cross-section velocity profile or Visual flow estimate (see text)	No

Notes:

- Project Action Limits: Applied Basin Plan Water Quality Objectives for conductivity by converting a TDS value of 700 ppm to a conductivity value.
- SM: *Standard Methods for the Examination of Water and Wastewater*, 20th edition.

Table 13-2. Laboratory Analytical Methods							
Analyte	Laboratory /Organization	Project Action Limit (units, wet or dry weight)	Target Reporting Limit (units, wet or dry weight)	Analytical Method		Achievable Laboratory Limits	
				Analytical Method/ SOP	Modified for Method yes/no	MDLs	Method
E. coli	OC Public Health Water Quality Lab	See notes below	10 CFU/100mL	EPA 1603	No	Not applicable	10 CFU/100 mL
Fecal Coliform	OC Public Health Water Quality Lab	See notes below	10 CFU/100mL	SM 9222D	No	Not applicable	10 CFU/100 mL
Total Suspended Solids	OC Public Health Water Quality Lab	See notes below	1.0 mg/L	SM 2540D	No	Not applicable	1.0 mg/L

Notes: Project Action Limits for *E. coli*, Fecal Coliform, and TSS are as follows: (based on the TMDL)

- *E. coli*: 5-sample/30-day Logarithmic Mean less than 113 organisms/100 mL, and not more than 10% of the samples exceed 212 organisms/100 mL for any 30-day period.
- *Fecal coliform*: 5-sample/30-day Logarithmic Mean less than 180 organisms/100 mL, and not more than 10% of the samples exceed 360 organisms/100 mL for any 30-day period.
- TSS: Inland surface waters shall not contain suspended or settleable solids in amounts which cause a nuisance or adversely affect beneficial uses as a result of controllable water quality factors.

14. Quality Control

All laboratories contracted by SAWPA will follow quality assurance and quality control programs in accordance with guidelines established by the State of California and the U.S. EPA. Laboratories are required to submit a copy of their SOPs for laboratory quality control to the Quality Assurance Officer for review and approval (see Appendices to this QAPP for the SOPs of laboratories being used by this project).

All laboratory data will be entered into the project database (Santa Ana Watershed Data Management System [SAWDMS]), and will be filed in the project archives maintained by SAWPA along with related materials such as field forms, chain of custody forms, photographs, correspondence, etc.

The CDM Project Manager and QA Officer will review all laboratory data and will request additional re-analysis as warranted. Table 14-1 through Table 14-3 describe Sampling (Field) QC activities. Table 14-4 and Table 14-5 describe Analytical QC activities.

Table 14-1. Sampling (Field) QC (Field Parameters)

Matrix: Water		
Sampling SOP: per Monitoring Plan		
Analytical Parameter(s): Field Parameters		
Analytical Method/SOP Reference: NA		
Field QC	**Frequency/Number per sampling event**	**Acceptance Limits**
Other: Field Measurements	When taking readings, at least 1 minute or longer (if needed) shall be allowed for until stabilization of readings.	See Section 7, Table 5

Table 14-2. Sampling (Field) QC (TSS)

Matrix: Water		
Sampling SOP: per Monitoring Plan		
Analytical Parameter(s): TSS		
Analytical Method/SOP Reference: SM2540D		
Field QC	**Frequency/Number per sampling event**	**Acceptance Limits**
Equipment Blanks	1/sample event	< Target reporting limit
Cooler Temperature	4º C	4º C
Field Replicate Pairs	5 percent of total number of samples collected per sample event	< 25 percent

Table 14-3. Sampling (Field) QC (Fecal coliform, *E. coli*)

Field QC	Frequency/Number per sampling event	Acceptance Limits
Matrix: Water		
Sampling SOP: per Monitoring Plan		
Analytical Parameter(s): Fecal coliform, *E. coli*		
Analytical Method/SOP Reference: Fecal Coliform (SM9222D); *E. coli* (EPA 1603)		
Equipment Blanks	1/ sample event	No detectable amounts or <1/5 of sample concentration
Cooler Temperature	4º C	4º C
Field Duplicate Pairs	5 percent of total number of samples collected per sample event	< 25 percent

Table 14-4. Analytical QC (TSS)

Laboratory QC	Frequency/Number	Acceptance Limits
Matrix: Water		
Sampling SOP: per Monitoring Plan		
Analytical Parameter(s): TSS		
Analytical Method/SOP Reference: SM 2540D		
Method Blank	1/20 samples or 1/batch	< Target Reporting Limit
Laboratory Duplicate	1/20 samples or 1/batch	< 25 percent
Laboratory Matrix Spike	1/20 samples or 1/batch	80 - 120
Matrix Spike Duplicate	1/20 samples or 1/batch	80 – 120; RPD < 25 percent

Table 14-5. Analytical QC (Fecal coliform, *E. coli*)

Laboratory QC	Frequency/Number	Acceptance Limits
Matrix: Water		
Sampling SOP: per Monitoring Plan		
Analytical Parameter(s): Fecal Coliform; *E. coli*		
Analytical Method/SOP Reference: Fecal Coliform (SM9222D); *E. coli* (EPA 1603)		
Method Blank	1/lot minimum	No detectable amounts
Laboratory Duplicate	10 percent of samples or one sample per test run	< 3.27*R*
Laboratory Control sample (Accuracy)	For each lot of medium received, each laboratory prepared batch of medium, and each lot of purchased prepared medium	Verify appropriate response by testing with known positive and negative control cultures for the organism(s) under test

15. Instrument/Equipment Testing, Inspection, and Maintenance

All laboratories contracted by SAWPA will operate using quality assurance and quality control programs to maintain their equipment in accordance with their SOPs, which include those specified by the manufacturer and those specified by the analytical method. Laboratories are required to submit a copy of their SOPs for laboratory equipment maintenance to the Contract QA Officer for review and approval (see Appendices to this QAPP for the SOPs of laboratories being used by this project).

Instruments used to gather field measurements (temperature, conductivity, dissolved oxygen, pH and turbidity) will properly maintained and calibrated per the manufacturers requirements. Instruments will be tested prior to the start of field sampling to verify that the instrument is operating appropriately. If the instrument fails to operate within appropriate parameters the Monitoring Contractor will take the appropriate steps to ensure that the equipment is repaired or replaced in a timely manner.

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

Equipment / Instrument	Maintenance Activity, Testing Activity or Inspection Activity	Responsible Person	Frequency	SOP Reference
Horiba Multiparameter Monitoring	Maintenance and Calibrations	▪ Janet Dietzman (SBCFCD) ▪ Other Monitoring Contractors	▪ Maintenance – conducted per mfg specifications; ▪ Calibrations - prior to each sampling activity	Per manufacturer specifications
Marsh McBirney Model 2000 flow meter	Maintenance and Calibrations	▪ Janet Dietzman (SBCFCD) ▪ Other Monitoring Contractors	▪ Maintenance – conducted per mfg specifications; ▪ Calibrations - prior to each sampling activity	Per manufacturer specifications
Laboratory analytical instruments for Conventional Constituents	Maintenance and Calibrations	▪ Joseph Guzman (OC Public Health Lab) ▪ Menu Leddy (OCWD) ▪ Laboratory Manager (UC Davis)	▪ Maintenance – conducted per mfg specifications; External calibration with 3 – 5 standards covering the range of sample concentrations prior to sample analysis. At low end, the lowest standard at or near the MDL. Linear regression r2 < 0.995 ▪ Calibrations - verification every 20 samples after initial calibration. Standard source different that that used for initial calibration. Recovery 80% - 120%.	Per individual Lab SOP manual and per equipment maintenance specifications

16. Instrument/Equipment Calibration and Frequency

All laboratories will implement quality assurance and quality control programs to calibrate their equipment in accordance with their SOPs, which include those specified by the manufacturer and those specified by the method. Laboratories are required to submit a copy of their SOPs for laboratory equipment calibration to the Contract Quality Assurance Officer for review and approval (see Appendices to this QAPP for the SOPs of laboratories being used by this project).

A Horiba Multiparameter probe will be used to make field measurements for conductivity, dissolved oxygen, pH, temperature, and turbidity. It will be properly calibrated according to manufacturer specifications prior to each use.

A Marsh-McBirney Model 2000 flow meter will be used to make flow measurements. It will be properly calibrated according to manufacturer specifications prior to each use.

See Section 15, Table 15-1.

17. Inspection/Acceptance of Supplies and Consumables

Contract laboratories will supply all the sample containers necessary for the monitoring program. Other consumable supplies such as latex gloves, plastic storage bags, and waterproof pens.

All laboratories will implement quality assurance and quality control programs to calibrate their equipment in accordance with their SOPs, which include those specified by the manufacturer and those specified by the method. Laboratories are required to submit a copy of their SOPs for laboratory equipment calibration to the project Quality Assurance Officer for review and approval (see Appendices to this QAPP for the SOPs of laboratories being used by this project).

Table 17-1. Inspection/acceptance testing requirements for consumables and supplies.

Project-Related Supplies / Consumables	Inspection / Testing Specifications	Acceptance Criteria	Frequency	Responsible Individual
Sample bottles	Check bottles integrity; check for preservatives (*E. coli*/Fecal Coliform)	Ensure no cracks, intact bottle caps; preservative present	Prior to sample collection	Sampling team
Latex gloves	Look for tears/holes	Intact, no tears	Prior to use	Each sampler
Storage bags, pens	Presence/absence of supplies	Ensure supplies are in field bin	Prior to going to field	Sampling team

18. Non-Direct Measurements (Existing Data)

18.1 Data Sources and Uses

During the course of the monitoring programs previously existing relevant water quality and flow data from the sample locations will be gathered. Sources for these data include the Regional Board, SAWPA, U.S. Geological Survey, SBCFCD and RCFCD. These data will be included as appropriate to evaluate trends in water quality in relation to flow. This analysis will support the evaluation of compliance with TMDL numeric targets.

Descriptive data for each of the monitoring locations will be acquired through field observations, collection of GPS coordinates, and review of the MSAR Pathogen TMDL Staff Report. With approval from the entity which collected the data, it will be used to populate site information fields in the Project database. Existing data will be used by field sampling personnel to determine exact sample collection locations and specific procedures to be followed at each site.

Existing water quality data will be collected based on historical monitoring at each of the Watershed-Wide, USEP and AgSEP sites. Water quality results from this Project will be compared to historical data to assess temporal trends in water quality conditions. Existing data analysis from previous studies within the MSAR and other southern California watersheds will be reviewed and used to guide the data analysis approach for this Project. Other bacteria TMDL compliance monitoring programs will guide the analysis of data collected for the Watershed-Wide monitoring. For the USEP and AgSEP monitoring programs, other bacteria source studies in southern California will be collected and reviewed. Findings of the MSAR USEP and AgSEP studies will be compared to other watersheds where similar work is conducted.

18.2 Data Acceptability

Existing data will be considered acceptable for inclusion in data analyses to support the purposes of this study only if it meets the following criteria:

- Data was collected with an approved Quality Assurance Project Plan;
- The sampling methodology and timing are functionally equivalent, including the method for collecting the water samples and the timing of sample collection (e.g., collection during dry vs. wet weather or collection from base flows vs. storm flows); and
- The laboratory analysis methods are functionally equivalent.

Other existing data may be reviewed and discussed to provide additional waterbody or watershed information, but the use of the data is for qualitative purposes only and will not be incorporated into quantitative data analyses. If these data are used, the constraints associated with the use and interpretation of the data will be described.

19. Data Management

Data will be maintained as described in Section 9 (Documents and Records). The SAWPA Project Coordinator will maintain an inventory of data and its forms, and will periodically check the inventory against the records in their possession. Data samples will be collected according to the procedures outlined in Section 10 (Sampling Process Design). Field measurements will be recorded on standard Field Log forms included as Attachment 1. Analytical samples will be transferred to the laboratory under required COC procedures using a standard COC form included as Attachment 2. For any site where velocity cross section profile flow measurement is taken, standard forms will be used to record necessary measurements (Attachment 3).

All laboratory and field measurement data submitted to SAWPA for inclusion in the project database will follow the guidelines and formats established by SWAMP (http://www.waterboards.ca.gov/swamp/qapp.html). Data transmitted to SAWPA in a standard electronic format and uploaded to the database through batch set electronic means.

All contract laboratories will maintain a record of transferred records and will periodically assess their record of transferred records against those actually held by the SAWPA. Prior to upload, a QA/QC review will be conducted by the SAWPA Project Coordinator to check new data against existing data in the database for completeness, validity of analytical methods, validity of sample locations, and validity of sample dates. The QA/QC will involve using automated data checking tools, which assess that new data to be uploaded follow specified rules, including issues such as alpha-numeric formatting, units of measurement, missing information, and others. The sample location information will be checked to ensure that sites are correctly referenced and that identifiers and descriptions match corresponding records from the existing database. Data not passing this QA/QC review will be returned to the originating laboratory or generator for clarification and or correction. When all data within a batch set have passed QA/QC requirements, the data will be uploaded to the database. A unique batch number, date loaded, originating laboratory, and the person who loaded the data will be recorded in the database, so that data can be identified and removed in the future if necessary.

The project database is backed up using built-in software backup procedures. In addition, all data files will be backed up on tape on a weekly basis as part of SAWPA's SOP for disaster recovery. Back-up tapes are kept for a minimum of four weeks before they are written over. Tapes are rotated off-site for separate storage on a monthly (or more frequent) basis, in accordance with SAWPA Information Systems SOPs. Each back up session validates whether the files on tape are accurate copies of the original. SAWPA also maintains an access log showing who accessed the database, when, and what was done during the session. All changes to the database are stored in a transaction database with the possibility of rollback, if necessary.

Data will be stored on a Windows 2003 Server with a 2 GHz + CPU and 2Gb RAM with a fail-safe RAID 5 configuration. The server checks for operating system updates daily and downloads and installs patches and service packs as necessary. The current server is two years old, and as per SAWPA policy, will be replaced after a maximum of 4 years of service. The server is also protected with Norton Anti-Virus software which is updated daily. The database software is Microsoft SQL Server 2000 standard edition with Service Pack 4. The database administrator checks the Microsoft Website for new patches and service packs on a monthly basis and installs updates as necessary. The general policy for updating operating system and database software is to evaluate the software on a test machine after a new version has been out for approximately 1 year. The new version is then installed at the discretion of the network or database administrator.

The database will be operated with a transaction log recording all changes with ability to roll back if necessary. Full database backups will occur on a weekly basis and immediately before batch uploads. It is expected TMDL data will be loaded quarterly to twice per year. At the time when data is uploaded, the SAWPA Project Coordinator will check that the inventory of monitoring activities adequately matches with the number and type of records in the database.

Data will be exported from SAWDMS into the SWAMP format using a pre-made query that will map data fields from SAWDMS to the SWAMP template. The exported data will then be sent to the SWRCB IM Coordinator for processing into the SWAMP database. The data will be retrieved for analysis and report writing by exporting from SAWDMS using pre-made queries.

Group C: Assessment and Oversight

20. Assessments & Response Actions

All reviews will be made during preparation of seasonal reports. These reviews will be conducted by the Contractor QA Officer and, where appropriate, may include the Santa Ana Regional Board QA Program Manager. Periodic reviews will always include review of the data to be entered into the SWAMP compatible database to evaluate data accuracy and completeness. Where appropriate, e.g., situations where the laboratory results frequently suggest data quality concerns, audits of laboratory or field sampling teams will be scheduled and conducted. The seasonal reports will include a data quality assessment section, which will provide documentation of any identified data quality concerns.

If an audit discovers any discrepancy, the SAWPA Project Coordinator and Contractor QA Officer will discuss the observed discrepancy with the appropriate person responsible for the activity (see organizational chart). The discussion will begin with whether the information collected is accurate, what were the cause(s) leading to the deviation, how the deviation might impact data quality, and what corrective actions might be considered.

Internal reviews will be made in the form of a technical system audit of the project database and discussion of data management tasks with the responsible SAWPA Database Manager. The SAWPA Project Coordinator will check that the inventory of monitoring activities adequately matches with SAWDMS.

The SAWPA Project Coordinator and/or QA Officer have the power to halt all sampling and analytical work by contract laboratories if the deviation(s) noted are considered detrimental to data quality. Alternatively, the Contractor QA Officer can require that certain corrective actions be made within a defined time schedule. This approach could be used to keep to the monitoring schedule presented in Section 10.

21. Reports to Management

CDM will share data and preliminary analyses with the MSAR Watershed TMDL Task Force, including the RWQCB, in the form of oral presentations with supporting slides at regularly scheduled Taskforce meetings, when appropriate and in quarterly progress reports. All contract laboratories will prepare a QA/QC report, which summarizes the Projects overall adherence to established analytical SOPs, and responds to information from the results of the audit and on-site observations and final assessments by the Contractor QA Officer. Water quality data analysis and results of a QA/QC analysis, validation, and evaluation, etc., will be included with the wet and dry season monitoring reports. Reports will be prepared and submitted by December 31st (covering the results for the dry season) and May 31st (covering the results for the wet season) of each year.

Group D: Data Validation and Usability

22. Data Review, Verification, and Validation Requirements

Data generated by project activities will be reviewed by the Contractor QA Officer against the data quality objectives cited in Section 7 and the quality assurance/quality control practices cited in Sections 14, 15, 16 and 17. Data validation will be performed for each indicator regardless of water body. Data validation protocols are presented in Section 23 of this QAPP.

Data will be separated into three categories: (1) Data meeting all data quality objectives; (2) data failing precision or recovery criteria; and (3) data failing to meet accuracy criteria. Data meeting all data quality objectives, but with failures of quality assurance/quality control practices will be set aside until the impact of the failure on data quality is determined. Once determined, the data will be moved into either the first or last category.

Data falling in the first category are considered usable by the project. Data falling in the last category are considered not usable. Data falling in the second category will have all aspects assessed. If sufficient evidence is found supporting data quality for use in this project, the data will be moved to the first category, but will be flagged with a “J” as per EPA specifications.

23. Verification and Validation Methods

All data recorded in the field including field measurements, observations, and chain of custody will be checked visually by the Contractor QA Officer and recorded as checked by initials and dates. Field data will be checked to ensure that all necessary data and activities were completed; including collection of all water samples, field blanks, and field replicates, correct units of measurement are reported and values fall within expected ranges. The validation will also check to ensure that samples were delivered to laboratories within required holding times and that all sample handling and custody protocols were followed.

In addition to field data validation, there will be a validation of water quality analysis results. This will involve a review of 10% of all laboratory water quality analysis reports. The review will involve verifying that all required parameters were measured, reported in the correct units, and that results fall within expected ranges.

The Contractor Project Manager will be responsible for all field data validation reviews. Each of the contract Laboratory QA Officers will perform checks of all of its records and each of the contract Laboratory Directors will recheck 10%. All checks by the contract laboratories will be reviewed by appropriate Project personnel.

Issues, including missing data, incomplete site visits, reporting errors (such as incorrect units of measure or incorrect date/time information, etc.), or data management errors will be communicated to responsible party immediately and documented in the QA/QC Reports for either field sampling, laboratory activities, or database management. Reconciliation and correction will be done by a committee composed of the SAWPA Project Coordinator, Contractor Project Manager, Contractor QA Officer, Monitoring Manager, Regional Board Project Manager; and the Contract Laboratory QA Officers, and Laboratory Directors. Any corrections require a unanimous agreement that the correction is appropriate.

24. Reconciliation with User Requirements

The purposes of the monitoring programs addressed by this QAPP are described in the following sections.

24.1 Watershed-Wide Monitoring Program

The Watershed-Wide Monitoring Program, a required element of the MSAR Bacterial Indicator TMDL, is intended to gather data to demonstrate compliance with the TMDL numeric targets. Per the TMDL the objectives of the Watershed-Wide monitoring program are to: "provide data necessary to review and update the TMDL" and "[determine] compliance with the TMDLs, WLAs, and LAs." Accordingly this monitoring program will continue at least until it can be demonstrated that the following numeric targets are complied with on a regular basis during both dry and wet seasons.

- *Fecal coliform*: 5-sample/30-day Logarithmic Mean less than 180 organisms/100 mL, and not more than 10% of the samples exceed 360 organisms/100 mL for any 30-day period.
- *coli*: 5-sample/30-day Logarithmic Mean less than 113 organisms/100 mL, and not more than 10% of the samples exceed 212 organisms/100 mL for any 30-day period.

(However, note that per the TMDL, the fecal coliform targets become ineffective if the Regional Board replaces the fecal coliform objectives with *E. coli* objectives).

Water quality data results collected from Watershed-Wide Monitoring sites will be regularly compared to the above targets to evaluate compliance status. The results of this analysis will be reported in Triennial Reports to the RWQCB. If data gathered over a sufficient period time demonstrate compliance, then the Regional Board can de-list the waterbodies from the 303(d) list of impaired waters. To evaluate compliance, applicable descriptive statistics will be calculated, e.g., geometric means and frequency of exceedance of the compliance targets. In addition to evaluating compliance with the TMDL targets, other data analyses to be developed include:

- Temporal Trends – Trends in bacteria concentrations will be evaluated by graphically presenting sample results over time to illustrate current conditions and progress towards achieving compliance with TMDL targets. Trend evaluations will be developed on a waterbody specific basis and consider season and flow conditions.

- Correlations – Bacteria data results will be evaluated in the context of other data collected (field parameters, TSS, and flow) to identify any data relationships of interest, e.g., correlations between TSS concentrations or water temperatures with bacteria concentrations.

24.2 Urban Source Evaluation Monitoring Program

The purpose of USEP Monitoring Program is to drive the implementation of efforts to control bacteria sources derived from stormwater discharge facilities. USEP monitoring occurs early in the implementation of the TMDL so that efforts to control sources can be prioritized. The outcome of the USEP Monitoring Program will tell stakeholders where to focus efforts on implementation of controls and what follow-up studies are needed to narrow the identification of sources.

Specifically, the first step in identifying the "specific activities, operations and processes…that contribute bacterial indicators" (the purpose for conducting the USEP) is to identify the source waters that contribute the highest concentrations of bacteria to the MSAR impaired waterbodies. Once these waters are so categorized, then the next step is to identify which waters are of greatest concern with regards to the source of the bacteria.

Sites where human sources of bacteria are most commonly observed would have the highest priority for the implementation of source controls and/or additional monitoring efforts to further refine the sources. Lower priority sites would be those where the sources are non-human.

24.3 Agricultural Source Evaluation Monitoring Program

The purpose of AgSEP Monitoring Program is to drive the implementation of efforts to control bacteria sources derived from agricultural discharges. AgSEP monitoring occurs early in the implementation of the TMDL so that efforts to control sources can be prioritized. The outcome of the AgSEP Monitoring Program will tell stakeholders where to focus efforts on implementation of controls and what follow-up studies are needed to narrow the identification of sources.

Specifically, the first step in identifying the "specific activities, operations and processes…that contribute bacterial indicators" (the purpose for conducting the AgSEP) is to identify areas that contribute high concentrations of bacteria to the MSAR impaired waterbodies. Areas where anthropogenic bacteria sources related to agricultural activities are observed will be targeted for additional source investigation activities by the appropriate regional stakeholders.

ATTACHMENT 1

EXAMPLE MSAR BACTERIAL INDICATOR TMDL
FIELD DATA SHEET FORM

MSAR Bacterial Indicator TMDL
Field Data Sheet Form

General Information:

Site Name: ____________________

Site ID: _______________________

Date: ___/___ /_____

Time (24-hr clock): ___________

Sampling Team: _________________ /____________________

Field Measurements:

Conductivity: ______________________ (m S/cm)

Dissolved Oxygen: __________________ (mg/L)

pH: ______________________________

Turbidity: __________________________ (NTU)

Temp (water): _______________________ (ºC)

For USEP and AgSEP Monitoring Program Sites Only:

Flow: _______________ (ft/sec)

Flow Connectivity (USEP Sites Only): Y/N (Describe)

____

____

Grab Sampling: Filled and labeled (check)

1 – 120 mL polyethylene bottle (includes sodium thiosulfate preservative) for ***E. coli*** and **Fecal Coliform**: _______

1 – 1,000 mL polyethylene bottle for **TSS**: _______

Additional Grab Sampling For USEP and AgSEP Monitoring Program Sites Only:

1 – 1,000 mL polyethylene bottle for ***Bacteroides*** _______

Note:

Additional bottles sets are included for field duplicates and field blanks (Check if applicable): _______

Other Observations:

ATTACHMENT 2

EXAMPLE CHAIN OF CUSTODY FORMS

County of Orange, Health Care Agency
Water Quality Laboratory
700 Shellmaker Rd.
Newport Beach, CA 92660
PHONE: (949) 219-0423 FAX: (949) 219-0426

ELAP #2545

STUDY: ____________________

SUBMITTING AGENCY: ____________________

WEATHER: ____________________

To be completed by Field Sampler				To be completed by Laboratory					
FIELD DATA				**LABORATORY REPORT**					
Date Collected				Date Received____________		Received by____________			
Sampler				Time In____________		Time Run____________		Date/Time Read____________	
Constituent	Time	Sample Type (Grab, Duplicate, Equipment Blank)	Station Number / Location of Sampling Station	Total Suspended Solids	Fecal Coliforms		Escherichia coli		
				TSS	m-FC Agar		m-TEC		Report Date/ Initials
				mg TSS/1L	CFU's	CFU/100ml	CFU's	CFU/100ml	
Laboratory No.									
FIELD DATA				**LABORATORY REPORT**					
Date Collected				Date Received____________		Received by____________			
Sampler				Time In____________		Time Run____________		Date/Time Read____________	
Constituent	Time	Sample Type (Grab, Duplicate, Equipment Blank)	Station Number / Location of Sampling Station	Total Suspended Solids	Fecal Coliforms		Escherichia coli		
				TSS	m-FC Agar		m-TEC		Report Date/ Initials
				mg TSS/1L	CFU's	CFU/100ml	CFU's	CFU/100ml	
Laboratory No.									
FIELD DATA				**LABORATORY REPORT**					
Date Collected				Date Received____________		Received by____________			
Sampler				Time In____________		Time Run____________		Date/Time Read____________	
Constituent	Time	Sample Type (Grab, Duplicate, Equipment Blank)	Station Number / Location of Sampling Station	Total Suspended Solids	Fecal Coliforms		Escherichia coli		
				TSS	m-FC Agar		m-TEC		Report Date/ Initials
				mg TSS/1L	CFU's	CFU/100ml	CFU's	CFU/100ml	
Laboratory No.									
FIELD DATA				**LABORATORY REPORT**					
Date Collected				Date Received____________		Received by____________			
Sampler				Time In____________		Time Run____________		Date/Time Read____________	
Constituent	Time	Sample Type (Grab, Duplicate, Equipment Blank)	Station Number / Location of Sampling Station	Total Suspended Solids	Fecal Coliforms		Escherichia coli		
				TSS	m-FC Agar		m-TEC		Report Date/ Initials
				mg TSS/1L	CFU's	CFU/100ml	CFU's	CFU/100ml	
Laboratory No.									

SUBMITTOR INFORMATION / SUBMITTOR NUMBER	Field or Lab Remarks:

ORANGE COUNTY WATER DISTRICT

10500 Ellis Avenue, Fountain Valley, CA 92708

Telephone: (714) 378-3200 Fax: (714) 378-3373

CHAIN OF COUSTODY RECORD

NO.	SAMPLING AGENCY	WRMS STATION NAME	Sample Date	Sample Time	Sampled BY	COMMENTS		NO. OF Bottles	ANALYSIS
1						EC=	Ph=		
						TEMP=	DO=		
2						EC=	Ph=		
						TEMP=	DO=		
3						EC=	Ph=		
						TEMP=	DO=		
4						EC=	Ph=		
						TEMP=	DO=		
5						EC=	Ph=		
						TEMP=	DO=		
6						EC=	Ph=		
						TEMP=	DO=		
7						EC=	Ph=		
						TEMP=	DO=		
8						EC=	Ph=		
						TEMP=	DO=		
9						EC=	Ph=		
						TEMP=	DO=		
10						EC=	Ph=		
						TEMP=	DO=		

RELINQUISHED BY:	DATE/TIME	ED BY:	
RELINQUISHED BY:	DATE/TIME	ED BY:	DATE/TIME
SPECIAL INSTRUCTIONS:		**BILL ACCOUNT NO.:**	

Dr. Wuertz

University of California, Davis   Civil & Environmental Engineering TEL: 530.754.6407 FAX: 530 752 7872

CHAIN-OF-CUSTODY **DATE** **Lab**

Origination ADDRESS PHONE FAX							REQUESTED								
SAMPLED															
PROJECT:															
Wuertz															
Wuertz PROJECT															
Client Sample	Sample Date	Sample Time	Sample Matric	Container #	Container Type	Container Pres.									Note

SENDER	RELIQUINSHED	
	Signature:	
	Print	
	Company	
	Date:	Time
LABORATORY	RECEIVED	
	Signature:	
	Print	
	Company	
	Date:	Time

ATTACHMENT 3

FLOW MEASUREMENT FORM

FLOW MEASUREMENTS

Location ________
Portable Flowmeter Used ________________ Recorder ________
Date ________
Time ________
Left Bank ______________ Right Bank ____________ Page ___ of ___

	Distance from IP	Width	Total Depth	Flow Velocity				Average V*	Area A**	Discharge (avg VXA)
				VO.6	VO.2	VO.8	VO.9			
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
									Total Discharge	

Stream Flow Conditions (I.e., muddy, clear, debris, etc…): ____________________

____

* Average Velocity =VO.6 for stream depths between 0.3 and 2.5 feet (six-tenths method).
=(VO.2 + VO.8)/2 for stream depths greater than 2.5 feet (two-point method).
=VO.9 if flow is less than 0.3 feet deep (maximum velocity X 0.9).
** Area =total depth x width
IP =Initial Point

APPENDICES

APPENDIX A

ORANGE COUNTY PUBLIC HEALTH WATER QUALITY LABORATORY STANDARD OPERATING PROCEDURES

County of Orange

Water Quality Department

Quality Assurance/Quality Control Manual

February 2004

County of Orange
Health Care Agency
Public Health Laboratory
Water Quality Department

700 Shellmaker Road
Newport Beach, CA 92660
(949) 219-0423
FAX (949) 219-0426

County of Orange
Quality Assurance/Quality Control Project Plan

Table of Contents

County of Orange
Health Care Agency
Public Health Laboratory
Water Quality Department

700 Shellmaker Road
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INTRODUCTION

1.1 Bacteriological Monitoring Quality Assurance/Quality Control Goals

The Orange County Health Care Agency (OCHCA) has been monitoring water quality at numerous locations for over ten years. The Water Quality Department Laboratory (WQDL) Quality Assurance and Quality Control (QA/QC) Plan was developed in compliance with the QA/QC requirements set by Orange County Public Health Laboratory, Standard Methods (1020.A-C, 1030.A-D, 1040.A-C, 1050.B, 1060.A-C, 1080.A-C, 1090.A-H, 1090.J, 1100.A-C, 9030.B, (20^{th} ed., American Public Health Association)) and Environmental Laboratory Accreditation Program (ELAP) requirements. The laboratory QA/QC plan consists of strict adherence to the (1) Quality Assurance and Quality Control manual and (2) Standard Operating Procedures (SOP) manual; training manuals; maintenance of QC records; ongoing review of QC procedures; and implementation of QA/QC improvements to provide quality results. California Department of Health Services (CDHS) also verifies the QA/QC plan by means of a laboratory inspection and annual requirement for acceptable analytical performance on performance evaluation (PE) studies. There is a 32-page ELAP on-site inspection list that is used by DHS to confirm laboratory compliance with ELAP required QA/QC. Additional information regarding ELAP requirements can be found at http://www.dhs.cahwnet.gov/.

Due to the large size of the electronic versions of the laboratory SOP and QA/QC manuals that also contain Excel spreadsheets, tables, photos and figures, the body of this QAPP contains limited sections of the manuals that are specific to meeting the objectives of this project. The laboratory SOP, QA/QC manuals and QC records or notebooks are available to project managers for review. References to sections of Standard Methods (SM) for the Examination of Water and Wastewater used by the WQD laboratory have been included. For example, analytical procedures that are detailed in the SOP, such as the membrane filtration technique to enumerate bacterial densities in water are not included in this document but referenced with the SM number. In addition, selections of QA/QC procedures from the WQDL QA/QC manual are located in Appendix A. This QAPP includes a general overview of the WQDL QA/QC practices.

1.2 Organizational Scheme

Title/Responsibility	Name	Phone number	E-mail
Laboratory Director	Douglas Moore, Ph.D.	(714) 834-8385	Dmoore@ochca.com
Laboratory Supervisor	Donna Ferguson	(949) 219-0424	DFerguson@ochca.com
Laboratory Staff	Martin Getrich	(949) 219-0423	Mgetrich_labhca@sbcglobal.net
Laboratory Staff	Mariam Zhowandai	(949) 219-0428	Mzhowandai_labhca@sbcglobal.net

2.0 SAMPLE COLLECTION, HOLDING TIME, AND TRANSPORT

2.1 SAMPLE COLLECTION

2.1.1 When collecting the sample, leave enough air space in the bottle to allow for proper mixing before examination. Collect samples that are representative of the water being tested. Flush or disinfect sample ports, and use aseptic techniques to avoid sample contamination. Keep the sample bottle closed until it is to be filled. Remove cap carefully to avoid contaminating the inner surface of the cap and neck of the bottle. Fill container without rinsing. Replace cap immediately. The volume of sample should be sufficient to carry out all tests required (not less than 100 ml). Provide complete and accurate sample identification information as specified on the sample collection sheet (chain of custody form).

2.1.2 Sample Containers

2.1.2.1 For bacteriological samples, use sterilized bottles of glass or plastic of appropriate size and shape. Bottles must be capable of holding a sufficient volume of sample for all required tests, while allowing for air space. Commercially available, wide-mouthed, autoclavable or pre-sterilized Polypropylene bottles of suitable size are satisfactory. Pre-sterilized plastic bags, with or without a de-chlorinating agent, may also be used. Water samples that may have residual chlorine or another halogen require sample bottles containing a reducing agent, such as sodium thiosulfate. Sodium thiosulfate neutralizes any residual halogen and prevents the continuation of bactericidal action during sample transit.

2.1.2.2 OCHD water collection bottles are quality controlled by batch (See Media QC Notebook). Sample bottles are stored in the water laboratory for use by Environmental Health personnel and other governmental agencies upon request.

2.1.3 Sample Types

2.1.3.1 Potable Water

- For drinking water analysis, collect samples consisting of finished water.
- Open tap fully and flush water for 2 - 3 minutes, or until a time sufficient to permit clearing the service line.
- Reduce water flow to permit filling bottle without splashing.
- Do not sample from leaking taps that allow water to flow over the outside of the tap.
- When sampling from a mixing faucet remove faucet attachments, run hot water for 2 minutes, then cold water for 2 to 3 minutes, and collect sample as indicated above.

- If the sample is taken from a well fitted with a hand pump, pump water for 5 minutes before collecting sample. .
- If the well is equipped with a mechanical pump, collect sample from a tap on the discharge.
- If there is no pumping machinery, collect a sample directly from the well.

2.1.3.2 Raw Water

For collecting samples directly from a river, stream, lake, reservoir, spring, or shallow well, obtain samples representative of the water that is the source of supply to consumers.

2.1.3.3 Surface Waters

Select sampling locations to include a baseline location upstream from the study area. Where a tributary stream is involved, select the sampling point near the confluence with the mainstream points. To monitor stream and lake water quality, establish sampling locations at critical sites. Sampling frequency may be seasonal.

2.1.3.4 Bathing Beaches

Sampling locations for recreational areas should reflect water quality within the entire recreational zone. Collect samples in the swimming area from a uniform depth of approximately 1 m. To obtain baseline data on marine and estuarine bathing water quality include sampling at low, high, and ebb tides. Relate sampling frequency directly to the peak bathing period.

2.1.3.5 Swimming Pools

A swimming pool is a body of water of limited size contained in a holding structure. The water is generally chlorinated potable water but may also be derived from thermal springs or saltwater. Collect samples in the area and time of maximum bather density. Collect samples where water is 1 m. (See Std. Methods17th Edition Section 9213 B. for further information.)

2.1.3.6 Sediment and Sludge

Sediments provide a stable index of the general quality of the overlying water. Sampling frequency may be related to seasonal changes in water temperatures and storm water runoff. Sludge monitoring may indicate the effectiveness of wastewater treatment processes. Bottom sediment sampling requires special apparatus. (See Std. Methods 9060 A. 3. g.)

2.2 HOLDING TIME AND TEMPERATURE

2.2.1 General

Start microbial analysis of water samples as soon as possible after collection to avoid unpredictable changes in the microbial population. Keep samples cold during transport to the laboratory (4-10ºC), if they cannot be processed within 1 hour after collection. Blue ice packs are preferred over ice. If using ice, avoid direct contact of samples with ice using plastic packing material.

2.2.2 Drinking Water for Compliance Purposes

Hold samples at 4-10ºC during transit to the laboratory. Analyze samples on day of receipt whenever possible and refrigerate overnight if arrival is too late for processing on same day. Do not exceed 30-hour holding time from collection to analysis for coliform bacteria. Do not exceed 8 hour holding time for heterotrophic plate counts.

2.2.3 Non-potable Water for Compliance Purposes

Hold source water, stream pollution, recreational water, and wastewater samples below 4-10ºC during a maximum transport time of 6 hours. Refrigerate these samples upon receipt in the laboratory and process within 2 hours. When transport of samples is longer than 6 hours consider using delayed incubation procedures.

2.2.4 Water for Non-compliance Purposes

Hold samples between 4-10ºC during transport and until time of analysis. Do not exceed 24-hour holding time.

3.0 SAMPLE MANAGEMENT AND DOCUMENTATION

3.1 Chain-of-Custody Procedures

3.1.1 Samples that are transferred from one agency to another agency for analysis require the use of Chain-of-Custody (COC) procedures that include the following requirements for the laboratory to accept custody of samples:

3.1.1.1 Sample Label
Samples must be properly labeled using waterproof ink to record the sample number/description, date and time collected.

3.1.1.2 Chain-of-Custody Forms
Orange County WQD Laboratory provides COC forms to field sampling personnel for detailed record keeping. There are two separate documents that make up the COC form. The field data sheet, referred to as the "Bacteriological Examination of Waters (BEW)" worksheet is the first COC form used and contains information such as the project name, sample identification, water type (marine, freshwater or other), weather, date and time of collection, sample location, field sampler name, field bottle number and tests requested. The BEW worksheet must accompany the sample during sample collection and transport to the laboratory. The second form is the "Water Lab Sign-In Sheet (WLSIS)" which is filled out at the lab upon sample delivery.

3.1.1.3 Transfer of Custody

Immediately following receipt of water samples to the laboratory, a laboratory assistant or microbiologist will conduct inventory and document information regarding sample transport and laboratory processing according to the "Logging in Membrane Filtration Samples" SOP. The inventory consists of checking the samples for proper labeling, cross-referencing sample labels with the BEW worksheet and reading the cooler thermometer to ensure proper transport conditions. Laboratory personnel receiving samples will record the date and time of sample receipt, number of samples, type of samples and cooler temperature and other pertinent comments on the "Water Lab Sign-In Sheet". The sample deliverer and the analyst receiving the samples must initial the WLSIS. Samples received leaking, broken, containing insufficient volumes, exceeding holding times or stored in coolers with temperatures above 10ºC will not be accepted. The sample anomalies will be pointed out to the sample deliverer and also noted on the WLSIS and BEW worksheet. The time of sample receipt will be recorded on the WQD "Bacteriological Examination of Waters (BEW)" worksheet that serves as the field data sheet and accompanies the samples. The BEW worksheet will be then be checked for completeness of field data information. Corrections to worksheets will be made by crossing out the incorrect information, recording the change and recording the date and initials of the analyst making the change. When the COC forms are completed, copies may be provided to the appropriate party(s).

3.2 Sample Log-In

3.2.1 Following transfer of custody, the samples are logged in with a laboratory number, which is used to track the sample throughout the analytical process. Laboratory numbers are assigned in sequential numeric order of receipt. Water samples for bacteriological testing are either tested immediately or refrigerated at 5 ºC to maintain sample integrity. Samples for compliance testing are tested within 2 hours of receipt in the laboratory and less than 6 hours from sample collection or up to 24 hours for noncompliance purposes.

3.2.2 Upon completion of bacterial analysis, the samples are stored for a minimum of 24 hours at 5ºC until they are either archived in storage areas or properly disposed.

3.3 Documentation of Field Data

Field data will be recorded in field notebooks and field data sheets. Field notebooks should be used to document field observations that are supplemental to field data recorded on the field data sheet.

4.0 DATA QA/QC OBJECTIVES

To produce acceptable testing results, the general data quality objectives for this QA/QC Manual are to ensure that the data is representative, comparable, complete, accurate, and precise. Acceptable results are those values that fall within the acceptable range specified. Corrective actions for unacceptable results for specific testing methods are detailed in the SOP and QA/QC manuals. All corrective actions taken are documented in the QA/QC manual. The laboratory will notify the Project Manager of any samples that are impacted by unacceptable QA/QC results.

4.1 Representativeness

Representativeness is the degree to which the data represent the actual condition of a sampling site. The following factors determine the representativeness of the data: sampling location, sampling frequency, sample type, sample collection methods, sample preservation, sample holding times and analytical methods used. These factors are critical components of a sampling plan designed to maximize representativeness of the data to the extent practicable.

4.2 Comparability

Comparability of data is the degree to which the data produced by one laboratory or study can be compared to another. The WQD laboratory uses EPA approved analytical methods where possible or methods that have been determined to produce measurement data of known and quality sufficient to meet the objectives of this project. The data will be reported in commonly used units.

4.3 Completeness

The completeness of data is the percentage of planned data that will be used to meet statistical criteria needed to reach study conclusions. Acquiring 100% of the data planned is difficult due to unexpected circumstances, adverse weather conditions, equipment problems, laboratory error, loss of samples or samples that are invalid because they do not meet all of the laboratory sample acceptance criteria. The goal of this project is to obtain 80% of data completeness. Percent completeness is the number of data values generated/number of samples collected multiplied by 100.

4.4 Accuracy

Accuracy is the degree to which the measurement is to its true value. Accuracy of the WQD laboratory methods is determined by means of testing the following: (1) performance evaluation (PE) samples consisting of known quantities of bacteria, (2) performance of culture media, (3) laboratory and field blanks and (4) split samples. In addition, equipment calibration checks are routinely done to ensure accuracy of measurements.

4.4.1 Performance evaluation studies

To assess laboratory accuracy and comparability of bacterial density estimation, the laboratory participates in performance evaluation (PE) studies once a year. Certified PE materials or challenge samples are purchased from vendors approved by the CDHS. These include samples spiked with known amounts of bacteria provided from the vendor. The vendor evaluates the PE sample testing results using target and range values generated from data produced by several laboratories using the same analytical methods. The results must fall within 3 standard deviations of mean bacterial counts obtained from participating laboratories. The results are sent to the laboratory and to CDHS. If the laboratory receives a “not acceptable” rating for a method, they must immediately review their work, implement the necessary corrective action and send a summary of the correction action to the CDHS. ELAP certified laboratories must receive an acceptable rating for ELAP approved fields of testing on an annual basis to meet the certification requirements.

4.4.2 Culture media QC

The performance of culture media used to enumerate bacterial densities is also tested to ensure accuracy of bacterial enumeration using membrane filtration. Refer to the "Membrane Filtration Media Quality Control" procedure in Appendix A. Briefly, a known amount of indicator bacteria is spiked into phosphate buffered water and filtered as routine samples. The membrane is placed on culture media, incubated overnight and the colonies on membrane filters are enumerated. The media is also tested using negative control bacteria that should not grow on selective media. The number and appearance of bacterial colonies is recorded. Each new lot of media is checked in parallel with the old lot.

4.4.3 Field blanks

Field blanks are used to check for background contamination as well as handling and storage problems that may affect the results. A field blank for bacterial analysis should be tested for each sampling event or at least once a month for each storm drain sampling site. The blank may be prepared using reagent water (i.e., double distilled water or sterile de-ionized water) that has been bottled in a laboratory or is commercially available. The field sampler or personnel from an agency external to the lab should prepare the blank in the field by pouring reagent water into the sample bottle using sterile techniques i.e., wearing sterile gloves and avoiding aerosol production/exposure. The field blank should be included with the routine samples delivered to the WQD laboratory. The blank should not yield a value higher than that allowed by the acceptance limits (Table X). In the case of membrane filtration of reagent water, the counts should be below detection limits i.e., no colony forming units should be detected.

4.4.4 Laboratory blanks

The membrane filtration equipment, membrane filters and dilution buffers used to process the samples are tested for possible bacterial contamination that can occur from carryover contamination due to insufficient sterilization of the filtration apparatus between samples. The WQDL uses sterile, disposable pipettes, funnels, and forceps to minimize potential bacterial contamination and to increase sample throughput. To test the sterility of supplies and equipment, sterile dilution buffer is processed similarly as a water sample at the beginning, middle and end of the membrane filtration test run (uninterrupted series of analyses). If any contamination is found, the supervisor is notified immediately. An investigation of the source is initiated and the analytical data from samples tested with these materials is rejected (SM 9020B.8.a.5). Refer to "Membrane Filter Manifold Sterility Check" and "Sterility Testing" sections in Appendix A.

4.4.5 Calibration checks

Laboratory instruments are inspected and calibrated by laboratory personnel or equipment maintenance contractors using standards as per manufacturers instructions or the SOP. Electronic instruments for water analyses performed in the field will be calibrated once a day, prior to use.

4.5 Precision

Precision is the degree of agreement of repeated measurements of the sample, usually reported in standard deviation or relative percent difference (RPD). The precision of bacterial enumeration for the membrane filtration method is determined using the "Precision of Quantitative Methods" and "Duplicate Analyses" procedures.

4.5.1 Precision of Quantitative Methods

Initial demonstration of capability is conducted by each analyst before performing any analysis of samples and annually thereafter. The precision in performing the membrane filtration method is determined as outlined in "Method of Precision" in Appendix A. Briefly, analysts perform duplicate analyses on the first 15 positive samples tested for indicator bacteria testing. Since the laboratory currently analyzes over 200 samples per week, the precision criterion for each analyst can easily be determined. The precision criterion is calculated as 3.27 times the mean relative range value, "R" of duplicate results and is determined for each analyst of the WQD laboratory. The precision criterion for each analyst is determined annually. Precision between analysts in counting colonies on culture media plates is also assessed monthly following the "Analyst Comparison of Plate Counts" in Appendix A.

4.5.2 Duplicate Analyses

Duplicate samples are analyzed to assess the reproducibility of the sampling and analysis methods.

4.5.2.1 Laboratory Duplicates
To asses precision of the membrane filtration method, duplicate analysis is performed on 10% of all samples or at least one sample per test run. Refer to "Method of Precision" in Appendix A. The duplicate analyses is also used to determine the precision criterion for each analyst performing water testing and the results are compared for all analysts using an Excel spreadsheet.

4.5.2.2 Field Duplicates
Field duplicates will be tested to assess the repeatability of sampling. A field duplicate is a second sample that is collected at the same time or immediately following collection of the first sample. At least one field duplicate per sampling event or a minimum of one per month from each storm drain sampling site will be tested for indicator bacteria.

4.6 Sensitivity (Method Detection Limits)

Method Detection Limit is the lowest possible concentration that the equipment or analysis can detect. In the case of bacterial enumeration by membrane filtration, the "minimum detection limit" of bacterial colony forming units (CFU) using membrane filtration is based on the volume of water tested. Fecal indicator bacterial standards are based on bacterial counts per 100 ml of water. If 100 ml of sample is filtered and no bacteria are detected, the count is reported as "less than" (<) 1 CFU/100 ml because bacteria may have been present but not detected. Thus, "1 CFU/ 100 ml" is also the minimum detection limit. If only 10 ml of the 100 ml sample is filtered and no bacteria are detected, the count is reported as "less than 10 CFU/100 ml". The minimum detection limit in this case is also 10 CFU/100 ml. For membrane filtration of stormdrain water samples, a minimum of 3 dilutions or volumes of water will be filtered to optimize detection of bacteria. Testing volumes should result in bacterial counts in the "countable range" as per Standard Methods to ensure accuracy of results. If the total number of bacterial counts exceeds 200 per membrane, or if the colonies are not distinct enough for accurate counting, the results will be reported as greater than or equal to (≥) the maximum number countable.

5.0 DATA MANAGEMENT AND HANDLING

5.1 Bacteriological Examination of Waters Worksheet (BEW)

5.1.1 Laboratory results include the following information documented on the BEW worksheet as described in the "Reporting Water Lab Results" section of the SOP:

- Date and time that the samples are processed
- Date and time analysis was completed
- Testing results
- Corrective actions

5.1.2 The laboratory results are checked by a second analyst (Microbiologist) for accuracy of the calculations (colony forming units (CFU)/100 ml) and completeness of the worksheet. Both the analyst that records the results and microbiologist who confirms calculations sign off on the results.

5.1.3 Corrective actions regarding sample collection, preservation and transport are documented on the worksheet in the "Field or Lab Remarks" section. This documentation includes the date, analyst, sample affected, problem and resolution.

5.2 Data Management

5.2.1 The laboratory results will be entered into an electronic spreadsheet (MS Excel) that is available to the project manager after the laboratory has reviewed the database for correctness of data entry. The BEW worksheets and back-up disks are kept at the laboratory for five years and also are made available to the Project Manager upon request.

5.3 Data Handling

5.3.1 Distribution of analytical results

Bacterial densities in environmental waters are highly variable, ranging from many values below detection to a few high ones. In such cases the data would be positively skewed and not normally distributed about the mean. Since statistical analysis assumes a normal distribution of data, the numbers must be converted to their logarithms to approximate a symmetrical distribution. The best estimate of central tendency of log-normal data is the geometric mean or antilog of the arithmetic mean of the logarithms.

5.3.2 "Less than" (<) values

Water samples with no indicator bacterial detected are reported with "less than" (<) values using the calculations in Standard methods (9222B.6). If no colonies are detected, the calculation is done as if there was 1 colony detected and reported with the "less than" qualifier "<". With the exception to <1/100 ml values reported for testing 100 ml volumes of, test volumes should be adjusted, when possible to avoid the use of qualifiers.

If there are large numbers of values with the "less than" or "greater than" qualifiers, the qualifier can be omitted so that the values can be included in the data analysis. However, values with "less than" qualifiers may also be converted to 1, 0 or ½ (values halfway between zero and the "less than" value) depending on the value, the detection limit and distribution of values in the data set.

5.3.3 "Greater than or equal to" (≥) values, TNTC and Confluent Counts

Water samples with high levels of indicator bacteria, particularly total coliforms, may result in counts reported as "greater than or equal to" values, "too numerous to count" (TNTC) or "confluent" (CONF). Such samples usually contain bacteria other than the specific indicator bacteria being tested, such as non-coliforms that can also grow on the membranes. High levels of non-coliforms or atypical bacteria may interfere with the detection of typical coliform bacteria such that the actual number of total coliforms in the sample may be greater or equal to the number detected. In this case, the number of typical coliform colonies is reported but with the " ≥ "qualifier. If no total coliforms are detected and there are greater than 200 colonies, the results are reported as "TNTC". If the total number of bacteria colonies (coliforms plus non-coliforms) exceeds 200 per membrane, the number of total coliforms detected is reported with the notation "(TNTC)". For example, if 10 total coliforms are detected, but there are greater than 200 total coliforms and non-coliforms on the membrane, the results are reported as "10 (TNTC)". If colonies cover the entire membrane and are not discrete enough for accurate counting, the results are reported as "confluent growth with coliforms present" or "confluent growth without coliforms detected". In each of these situations, additional samples should be collected. However, this may not be possible for samples collected during special events or circumstances. For noncompliance samples, the analysis can be repeated using additional volumes to obtain countable colonies or an "endpoint". Since the analysis is performed beyond 24 hours of sample collection, the results will not be highly accurate. Therefore, the project manager and laboratory should assess the significance of including these results in the data analysis.

6.0 ANALYTICAL METHODS

The WQDL uses EPA compliance methods for detection of total coliform, fecal coliform, *E. coli* and enterococci indicator bacteria. The total coliform and fecal coliform methods are described in the most current EPA approved versions of Standard Methods for the Examination of Water and Wastewater (20^{th} edition). The *E. coli* and enterococci methods are described in "Improved Enumeration Methods for the Recreational Water Quality Indicators: Enterococci and *Escherichia coli* " (USEPA). The membrane filtration methods used by the WQDL are well established and have known levels of bias and variability. These methods have been combined into a single document in the SOP entitled "Membrane Filtration Technique".

6.1 SOP Overview

The SOP describes all operating procedures and analytical methods used at the WQDL and are inclusive of compliance methods as well as research methods. Compliance methods are published by the USEPA in the Federal Register and are used to determine compliance with EPA water quality standards for drinkable or swimmable waters. Research methods may include non-approved EPA methods that involve measurements that are considered developmental. Research protocols developed or used by the laboratory are generally methods that have been published in scientific peer reviewed journals. Prior to implementation, the laboratory establishes the precision, accuracy and quality control of experimental methods. Any modifications to these methods are discussed between laboratory director, laboratory supervisor and project managers prior to implementing changes.

The SOP and QA/QC manual are updated on a regular basis and reviewed by the laboratory director. Strict adherence to the SOP is required of sample collectors and laboratory analysts to ensure consistency of sampling procedures and to produce data of high quality.

The SOP includes the following information:

- Analytical methods to be used in the laboratory
- Description of materials, reagents and culture media
- Description of sample types
- Sample collection
- Sample transport
- Procedures used to estimate bacterial densities
- Spreadsheets for calculation purposes
- References to methods
- Safety considerations
- Waste management

7.0 QUALITY ASSURANCE/QUALITY CONTROL PROCEDURES

The Quality Assurance/Quality Control (QA/QC) procedures used at the Water Quality Department Laboratory to meet the project data quality objectives are listed below. The purpose for each QA/QC procedure and the method references are provided. A description of each procedure is also included following this list.

7.1 QA/QC Manual Overview

Quality Assurance and Quality Control requirements and procedures contained in the WQL Quality Assurance/Quality Control Manual are inclusive of the following information:

- Organizational structure
- Laboratory floor plan
- Personnel qualifications
- Personnel responsibilities and duties

- Analyst training, performance and competency record
- Procedures for handling and receiving samples
- Sample control and documentation procedures
- Equipment, instrumentation and reference standard measurements used
- Equipment preventive maintenance procedures
- Internal quality control activities
- Procedures and documentation for calibration, verification, maintenance of instrumentation and equipment
- QA/QC charts and forms
- Data verification practices, including intra-laboratory comparison and proficiency testing programs
- ELAP accreditation information
- Procedures and documentation of proficiency evaluation (PE) sample testing
- Corrective actions procedures
- Procedures for assessing data precision and accuracy
- Procedures for data reduction, validation and reporting
- Procedures for records archiving

7.2 Analytical QA/QC Procedures

7.2.1 Membrane filtration verification (*Standard Methods* 20th Edition, 1998; 9020B.9) or confirmation of total coliform, fecal coliform, *E. coli* and enterococci is performed monthly. (Refer to Membrane Filtration procedure in SOP).

7.2.1.1 The identification of bacterial colonies isolated from positive samples is confirmed using biochemical reactions and growth characteristics.

7.2.2 Verification of Membrane Filtration Manifold Sterility (*Standard Methods* 20th Edition; 1998; 9020B.8.a.5)

7.2.2.1 The sterility of media, membrane filters, buffered dilution and rinse water, pipettes, flasks and dishes, and equipment used during the membrane filtration procedure is determined.

7.3 Analyst QA/QC Procedures

7.3.1 Analyst Comparison of Plate Counts (*Standard Methods* 20th Edition, 1998; 9020B.8.a.2)

7.3.1.1 The ability to accurately enumerate bacterial colonies on solid media is determined for each analyst. The count differences between analysts must not exceed 10%.

7.3.2 Measurement of Method Precision (*Standard Methods* 20th Edition, 1998; 9020B.8.b) and Duplicate Analysis (*Standard Methods* 20th Edition, 1998; 9020B.8.a.4)

7.3.2.1 The precision of analyzing duplicate samples is determined for each analyst.

7.4 QA/QC of Laboratory Equipment

7.4.1 Sample Preservation and Storage (*Standard Methods* 20th Edition, 1998; 9060B.1).

7.4.1.1 Samples that are transported to the laboratory are held at 10ºC until they can be refrigerated or analyzed.

7.4.2 Sample Collection Bottle Sterility

7.4.3 Inhibitory Residue Testing (*Standard Methods* 20th Edition, 1998; 9020B.4.a.2)

7.4.3.1 The presence of bacteriostatic residues on glassware and plasticware from wetting agents or detergents is determined.

7.4.4 pH Check of Glassware (*Standard Methods* 20th Edition, 1998; 9020B.4.a.1)

7.4.4.1 The presence of alkaline or acid residue on glassware is determined.

7.4.5 Sample collection (*Standard Methods* 20th Edition, 1998; 9060A)

7.4.5.1 Standardized collection methods as described in Standard Methods are followed.

7.4.6 Equipment Temperature Checks (*Standard Methods* 20th Edition, 1998; 9020B.3)

7.4.6.1 Incubators, refrigerators, freezers, waterbaths, autoclave.

7.4.6.1.1 Temperatures of incubators and refrigerators are monitored on a regular basis using calibrated thermometers to maintain required temperatures for sample storage and bacterial growth. The required temperature ranges for all equipment are recorded on temperature charts at least once every day of laboratory use and/or operation. Autoclave temperature is checked with every use.

7.4.7 Thermometer Calibration (*Standard Methods* 20th Edition, 1998; 9020B.3.a)

7.4.7.1 Thermometers are calibrated annually using a certified National Institute of Standards and Technology (NIST) thermometer.

7.5 QA/QC of Media, Buffer, and Reagents

7.5.1 Membrane Filtration Media Quality Control (*Standard Methods* 20th Edition, 1998; 9020B.4.i.)

7.5.1.1 The performance and sterility of the membrane filtration media performance is determined using positive and negative control organisms.

7.5.1.2 Media tested: m-Endo (Total Coliforms), m-FC (Fecal Coliforms), mEI (Enterococci), m-TEC (*E. coli*).

7.5.1.3 Media that fails media QC procedures are not used.

7.5.2 Membrane Filtration Manifold Sterility Check

7.5.2.1 To determine the sterility of the manifold at set points throughout the Membrane Filtration process.

8.0 SAFETY

General laboratory safety procedures and work practices are detailed in the Orange County Public Health Laboratory (1) Exposure Control Plan manual, (2) Chemical Hygiene Plan manual and (3) Basic Safety Rules (SOP). Safety training, including the use of universal precautions and sterile techniques is provided to employees prior to working in the laboratory and on an ongoing basis. Laboratory personnel receive immunizations to pathogens, including Hepatitis B virus and tetanus prior to working with these organisms or environmental samples that may contain such pathogens. The laboratory microbiologists and laboratory assistants wear personal protective equipment. The laboratory is equipped with safety eyewashes, first aid kits and fire extinguishers that are tested annually.

Table 1 Quality Control Tests, Frequencies, and Acceptable Limits.

Quality Control Test	Testing Frequency	Acceptable Limits
Performance Evaluation (PE) Testing for Bacterial Water Quality	1x/year	Within 3 std. dev. of mean
Membrane Filtration Media	Each new lot number or shipment of media	UUPositive control organism: Counts within countable range Typical colonial morphology Negative control organism & Sterility: No Growth
Indicator Bacteria Confirmation/Verification	1x/month	Confirmation of at least 10 colonies per positive sample.
Inhibitory Residue on Glassware	1x/year or when using a new supply of glassware detergent	Refer to SM 9020B.4.a
QC Reagent Grade Water (In-house Milli-Q or Type I water)	Conductivity: each use pH: each use Heterotrophic plate count (HPC): monthly Total chlorine residual : monthly Heavy metals: annually	Conductivity: < 2μmhos/cm at 25ºC pH: 5.5 – 7.5 HPC: <1,000 CFU/ml Total chlorine residual: <0.01 mg/L Heavy metals: <0.05 mg/L
Test for the Bacteriological Quality (bactericidal properties) of Reagent Grade Water (Milli-Q or Type I)	1x/year	Growth ratio between 0.8 and 3.0 to control water
Test pH of glassware	2x/year	Neutral pH
Field Blank	Each sampling event or at least 1x/month	< 1 CFU
Membrane Filtration Sterility Check (Laboratory Blank)	Dilution buffer blank every 10 samples each day of use	< 1 CFU
Sterility Check of Labware (including sample bottles), Media and Reagents	Each new lot number.	< 1 CFU
Microbiological Media	Each new lot number	Typical growth or biochemical reaction for positive and negative organisms (Refer to SOP)
Analyst Precision Criterion	1x/year	3.27 R (R = mean of the range of the logarithms of duplicate counts for 15 samples)
Analyst Plate Count Comparison	Monthly	< 10% difference

Duplicate Samples	**Lab Duplicates:** Duplicate analysis: 10% of all samples Duplicate plate counts : monthly **Field Duplicate:** Each sampling event or at least 1x/month	Lab Duplicates: Within 5% agreement for the same analyst or 10% between analysts Field Duplicate: Within 95% confidence limit (SM Table 9222:II)

Table 2 Water Sample Parameters, Methods, Sampling Requirements, and Units.

Parameter	Method	Sample bottle type/ preservative	Maximum Holding Time/Temp	Units
Total Coliforms	SM 9222B	IDEXX 120 ml with sodium thiosulfate	6 h/ 2 - 10°C in dark	Colony forming units (CFU)/100 milliliter (ml)
Fecal Coliforms	SM 9222D	IDEXX 120 ml with sodium thiosulfate	6 h/ 2 - 10°C in dark	CFU/100 ml
Enterococcus spp.	EPA Modified Enterococci Method 1600	IDEXX 120 ml with sodium thiosulfate	6 h/ 2 - 10°C in dark	CFU/100 ml
E. coli	EPA Modified *E. coli* Method	IDEXX 120 ml with sodium thiosulfate	6 h/ 2 - 10°C in dark	CFU/100 ml

APPENDIX A: SAMPLE CHAIN OF CUSTODY FORMS

BACTERIOLOGICAL EXAMINATION OF WATERS (BEW)

County of Orange, Health Care Agency Water Quality Laboratory 700 Shellmaker Rd. Newport Beach, CA 92660 ELAP #1275 Phone:(949)219-0423 FAX:(949)219-0426	STUDY: ____________________ SAMPLE TYPE: ____________________ ☐ Marine ☐ Freshwater ☐ Other__________________ WEATHER:____________________

FIELD DATA

Date Collected

Sampler

LABORATORY REPORT

Date Received____________________ Received by__________________

Time In____________ Time Run____________ Date/Time Read________________

Field Bottle #	Time	Station Number / Location	Sand Present		**Total Coliforms**		**Fecal Coliforms**		***E. coli***		***Enterococcus***		
					m-Endo Agar LES		m-FC Agar		modified M-TEC		m-EI Agar		Report Date
			O	Vol.	CFU's	CFU/100ml	CFU's	CFU/100ml	CFU's	CFU/100ml	CFU's	CFU/100ml	
☐ Total Coliforms			1	100.0									Micro Initial
☐ Fecal/E.coli				10.0									
☐ Enterococcus			2	1.0									
☐ Inc.Dil ________				0.5									
Laboratory No.			3	0.1									
				0.01									
				0.001									
					m-Endo Agar LES		m-FC Agar		modified M-TEC		m-EI Agar		Report Date
			O	Vol.	CFU's	CFU/100ml	CFU's	CFU/100ml	CFU's	CFU/100ml	CFU's	CFU/100ml	
☐ Total Coliforms			1	100.0									Micro Initial
☐ Fecal/E.coli				10.0									
☐ Enterococcus			2	1.0									
☐ Inc.Dil ________				0.5									
Laboratory No.			3	0.1									
				0.01									
				0.001									
					m-Endo Agar LES		m-FC Agar		modified M-TEC		m-EI Agar		Report Date
			O	Vol.	CFU's	CFU/100ml	CFU's	CFU/100ml	CFU's	CFU/100ml	CFU's	CFU/100ml	
☐ Total Coliforms			1	100.0									Micro Initial
☐ Fecal/E.coli				10.0									
☐ Enterococcus			2	1.0									
☐ Inc.Dil ________				0.5									
Laboratory No.			3	0.1									
				0.01									
				0.001									
					m-Endo Agar LES		m-FC Agar		modified M-TEC		m-EI Agar		Report Date
			O	Vol.	CFU's	CFU/100ml	CFU's	CFU/100ml	CFU's	CFU/100ml	CFU's	CFU/100ml	
☐ Total Coliforms			1	100.0									Micro Initial
☐ Fecal/E.coli				10.0									
☐ Enterococcus			2	1.0									
☐ Inc.Dil ________				0.5									
Laboratory No.			3	0.1									
				0.01									
				0.001									

SUBMITTER INFORMATION / SUBMITTER NUMBER	Field or Lab Remarks:

WATER LAB SIGN-IN SHEET (LSIS)						
DATE	TIME IN	AMOUNT OF SAMPLES		TEMPERATURE <10°C	INITIALS	COMMENTS
		RECREATIONAL	DOMESTIC			

APPENDIX B: MEMBRANE FILTRATION MEDIA QC PROCEDURE

Principle

For membrane filtration, QC procedures are followed when a new batch or lot of m-Endo, M-FC, m-EI or m-TEC media is received. The following protocol establishes which positive and negative control organisms to use, how to dilute out the organism suspensions to get countable plates, and how to record the results.

Equipment

Refer to Membrane Filtration SOP (Recreational)

Reagents

Media: m-Endo, m-FC, m-EI, m-TEC
95 % Ethanol
Phosphate buffered saline (PBS)
15-ml Centrifuge tubes
2ml Sterile PBS (4 tubes)
9.9ml Sterile PBS (12 tubes)

Quality Control Organisms for Media

Media	Control organisms
1. m-Endo	
Positive Control -	*Escherichia coli* ATCC 25922
Negative Control -	*Sal. typhimurium* ATCC 14028
Negative Control -	*Staph. aureus* ATCC 25923
2. m-FC	
Positive Control -	*Escherichia coli* ATCC 25922
Negative Control -	*Enterococcus faecalis ATCC* 29212
3. m-EI	
Positive Control -	*Enterococcus faecalis* ATCC 29212
Negative Control -	*Escherichia coli* ATCC 25922
4. m-TEC	
Positive Control-	*Escherichia coli* ATCC 25922
Negative Control-	*Enterococcus faecalis* ATCC 29212

Procedure

1. The membrane filtration (MF) media, m-Endo, m-FC and m-EI can be made in-house, in the Media Room located at the Orange County Public Health Laboratory. Currently, all MF media are purchased from outside vendors. Set up the QC for each new lot number received.

2. The media prepared in-house will be transported to the Water Quality Department in large plastic Tupperware® with bubble-wrap to keep plates from moving. The person receiving the media must also initial the requisition form.

3. Select 3 plates of m-Endo media for the control organisms and 1 plate from each Tupperware® container or 5% of the total shipment to set up sterility controls. Select 2 plates of M-FC media for the control organisms and 1 plate from each Tupperware® container or 5% of the total shipment to set up sterility controls. Select 2 plates of m-EI media for the control organisms and 1 plate from each Tupperware® container or 5% of the total shipment to set up sterility controls. Select 2 plates of m-TEC media for the control organisms and 5% of the total shipment for sterility controls. Allow the plates to reach room temperature and label them with the control organism and date.

4. Label 4 tubes of 2ml Sterile PBS with each of the control organisms (*E. coli, S. typhimurium, S. aureus, and E. faecalis*).

5. For each of the control organisms, use three tubes of 9.9-ml of Sterile PBS dilution blanks (12 total). Label them with the control organism and the three serial dilutions that will be made (1.5×10^6, 1.5×10^4, and 1.5×10^2).

6. Use a sterile swab to make a suspension for each of the control organisms to 0.5 McFarland turbidity, using the 0.5 McFarland turbidity standard for comparison. The suspension should have approximately 1.5×10^8 bacteria/ml.

7. Tightly cap the suspension and vortex the suspension for 10 seconds. Using a 1.0ml pipette, transfer 0.1ml of the 0.5 McFarland suspension to the 9.9-ml of Sterile PBS dilution blank labeled as the 1.5×10^6 dilution.

8. Tightly cap the 1.5×10^6 dilution and vortex the suspension for 10 seconds. Using a 1.0ml pipette, transfer 0.1ml of the 1.5×10^6 dilution to the 9.9-ml of Sterile PBS dilution blank labeled as the 1.5×10^4 dilution.

9. Tightly cap the 1.5×10^4 dilution and vortex the suspension for 10 seconds. Using a 1.0ml pipette, transfer 0.1ml of the 1.5×10^4 dilution to the 9.9-ml of Sterile PBS dilution blank labeled as the 1.5×10^2 dilution.

10. Tightly cap the 1.5×10^2 dilution and vortex the suspension for 10 seconds. Using a 1.0ml pipette, transfer 0.5ml of the 1.5×10^2 dilution to a funnel containing 10ml buffered water and filter. Refer to the diagram.

11. Filter the *E. coli* suspension 4 times on 4 separate filters. Transfer the first filter to the m-Endo positive control plate, the second to the M-FC positive control plate, the third to the m-EI negative control plate, and the fourth one to the m-TEC positive control plate (as needed).

12. Filter the *E. faecalis* suspension 3 times on 3 separate filters. Transfer the first filter to the m-EI positive control plate, the second to the M-FC negative control plate, and the third one to the m-TEC negative control plate.

13. Filter the *S. typhimurium* and the *S. aureus* suspensions once for each organism. Transfer the filters to the m-Endo negative control plates.

14. Incubate the plates within 30 minutes as follows:
    m-Endo at 35 ± 0.5ºC for 22-24 hours
    m-FC at 44.5 ± 0.2ºC for 24 hours
    m-EI at 41 ± 0.5ºC for 24 hours
    m-TEC at 35 ± 0.5ºC for 2 hours and 44.5 ± 0.2ºC for 22 hours

Reporting

Record results in the QC notebook. Record positive, negative, and sterility results. Indicate the date tested and the date the results were read. Record lot numbers and expiration dates. If QC results are atypical notify the Micro and do not use the media from that lot until discrepancy has been resolved.

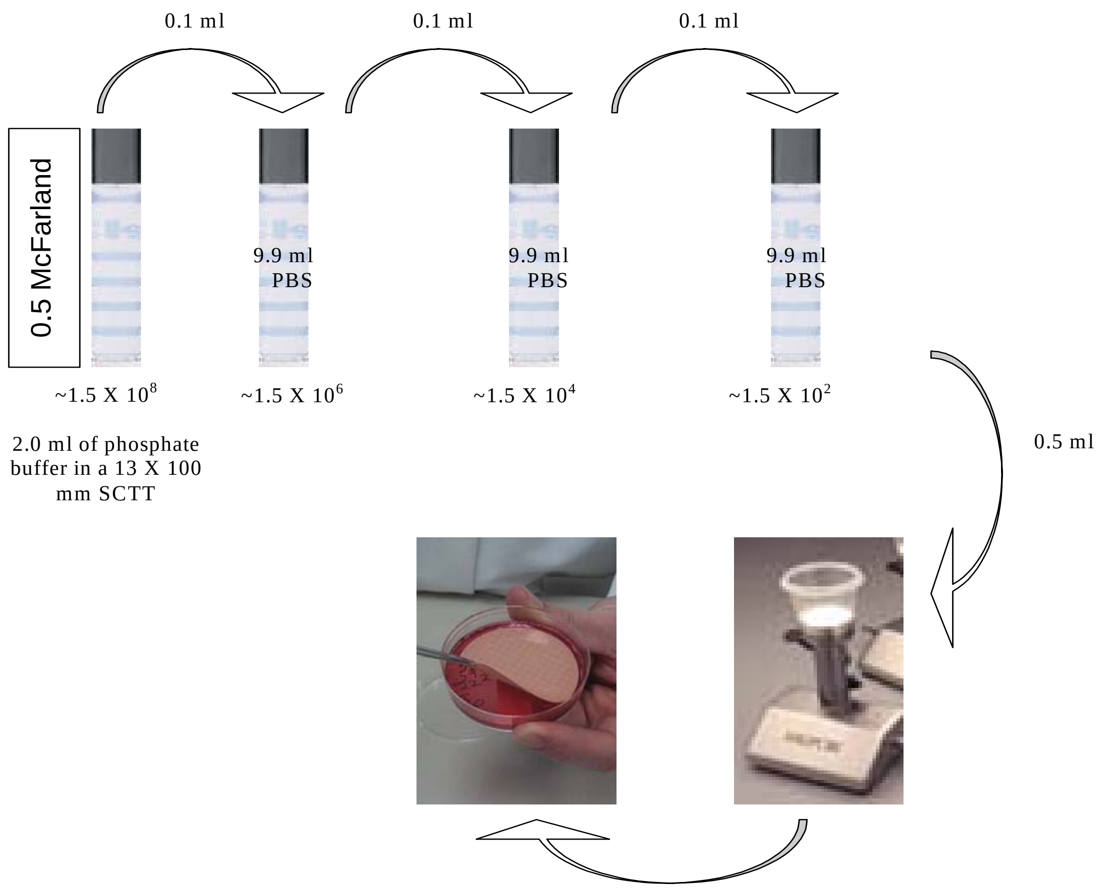


Diagram for setting up MF media quality control

TOTAL SUSPENDED SOLIDS

REFERENCE: Method 2540D, "Total Suspended Solids Dried at 103-105°C", Standard Methods etc., 19th or 20th edition

APPARATUS:
Pre-washed, pre-weighed glass fiber filter disks
Drying oven
Desiccator
Analytical balance
Filtration apparatus

PROCEDURE:

1. Heat oven at 103°C ± 2°C for a minimum of one hour.

2. Mix sample well. Exclude large floating particles or submerged agglomerates of nonhomogeneous materials from the sample if it is determined that their inclusion is not representative. Measure a volume of sample that will yield between 2.5 and 200 mg residue into a large graduated cylinder. Sample size shall not exceed one liter.

3. Remove pre-weighed glass fiber filter from the aluminum dish. Place filter on filter apparatus. Add a small amount of DI to filter and apply vacuum to seat filter. Filter sample. Wash cylinder and sides of filtration reservoir three times with 10-mL aliquots of DI water.

4. Place aluminum dish containing filter into drying oven. Dry at 103°C to 105°C at least 1 hour. Cool in a desiccator. Remove filter and weigh on an analytical balance. Repeat the cycle of drying, cooling, desiccating, and weighing until a constant weight is obtained.

5. Repeat cycle of drying, cooling, desiccating and weighing until a constant weight is obtained or until weight change is less than 4% of previous weight or 0.5 mg, whichever is less.

6. QA/QC: Analyze samples within 7 days. Store samples at 4°C. Analyze a minimum of 10% of samples in duplicate whenever possible. Duplicate determinations should agree within 5% of their average weight. Reported detection level (RDL) = 0.5 mg/L

7. **CALCULATION:**

$$\text{Total suspended solids mg/L:} = \frac{(A - B) \times 1000}{\text{Sample volume, mL}}$$

where: A = (weight of dried residue + filter), mg
B = weight of filter, mg

APPENDIX B

ORANGE COUNTY WATER DISTRICT LABORATORY STANDARD OPERATING PROCEDURES

Quality Assurance Project Plan

Water quality samplings are conducted according to established quality assurance/quality control protocols for environmental sampling. Routine monitoring of reference water samples are conducted by the Orange County Water District (OCWD) Main Laboratory, a California Department of Health Services (DHS) certified environmental laboratory (Certificate No. 1114). Water analyses are performed according to the EPA Manual and Standard Methods for the Examination of Water & Wastewater and approved by the Environmental Laboratory Accreditation Programs of DHS. Molecular analyses of reference samples are conducted by the Research and Development Department at OCWD. These analyses may include, but are not limited to, Microbial Community Analysis, Human-specific marker, 16s rRNA analysis for a specific genetic marker.

All reference grab samples are collected in duplicate or triplicate for accuracy, precision, resolution, and to identify detection limits. Reference water samples are collected using Nalgene “bacteriological” sampling bottles that are sterilized at 121^0C for 20 minutes prior to field sampling events. All bottles are labeled with the field site, duplicate reference number/letter, date, and appropriate readings of field conditions that are measured at the site. All sample bottles are placed in a cooler with a temperature probe. All water samples are transported in the cooler with ice packs to OCWD laboratories with a maximum holding time of six (6) hours. All chain-of-custody sheets for samples are signed by appropriate field sampling personnel and laboratory personnel upon receipt of reference samples. Generally, for 16s rRNA analysis, approximately 1000 ml of the reference water sample is collected. Total DNA is extracted directly from the reference water sample MoBio Ultra Clean Soil DNA isolation kit (MoBio, Solana Beach, CA) as specified by the manufacturer. Appropriate standards are provided by the manufacturer for extraction of DNA from the bacterial cells.

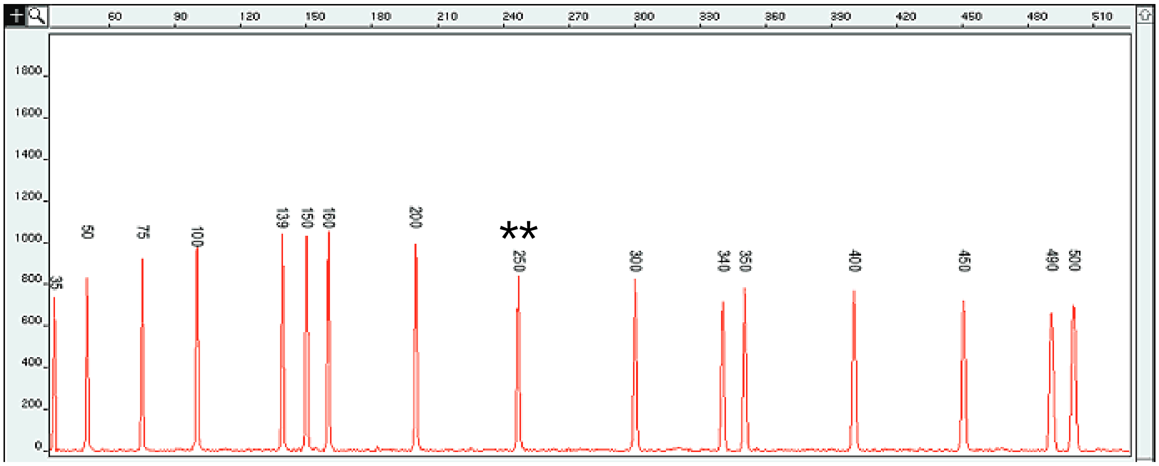
For 16s rRNA analysis of samples, all reagents are purchased from appropriate vendors and are “molecular biology grade”. Data collection for 16s rRNA analysis is performed on instruments that have been calibrated for accuracy and precision using appropriate calibration standards purchased from the manufacturer of the instrument and recommended for quality control. Quality control for 16s rRNA analysis is verified before each analytical run and involves generating standard calibration curves and applying appropriate standards and controls with each sample. Quality control for DNA extraction and PCR amplification involves known templates, reagent blanks, spikes, duplicates, and/or splits. Quality control assays for PCR amplification and amplification enzyme activity (AmpliTaq Gold DNA polymerase; Applied Biosystems; Part No. N808-0240) are performed with each sample. The following positive and negative controls are used for each reaction to demonstrate amplification activity and yield: Pseudomonas putida (ATCC strain 33015) as a positive control DNA reference sample, GeneAmp lambda as a negative control DNA (Applied

Biosystems, PCR kit, Part No. N801-0055) reference sample**,** and a non-DNA template reagent control. PCR amplification is performed on instruments calibrated using GeneAmp lambda control DNA (Applied Biosystems; Part No. N801-0055).

Data collection for 16s rRNA analysis is performed on instruments that have been calibrated using the following standards: Dye Primer Matrix standards (Applied Biosystems Part No. 401114), Taq DyeDeoxy Terminator Matrix standards (Applied Biosystems Part No. 401071) and GeneScan-500 Tamra size standard (Applied Biosystems Part No. 401733; Figure 1). The Matrix standards are used to generate a multicomponent matrix for capillary electrophoresis on Model 310 Genetic Analyzer. This matrix is used analyze four different color fluorescent-dye-labeled amplified DNA simultaneously in a single tube. The size standard is an internal lane standard used with each sample to obtain (+/-) one (1) base pair (bp) resolution and is used to size DNA amplicons in the range of 35-500 bp (Figure 1). All data is collected and analyzed according to manufacturer's specifications using the following software packages: ABI Prism 310 Collection software Version 2.1 (Applied Biosystems Part No. 904370), GeneScan Analysis software Version 2.1 (Applied Biosystems Part No. 904049) and DNA Sequencing Analysis software (Applied Biosystems Part No. 903564). All analysis is performed using the GeneScan Analysis software, and the size of amplicons or fragments is determined by capillary electrophoresis using the 310 Genetic Analyzer. The retention time, peak height, size (bp), peak area, and data point are calculated using the Tamara internal size standard (ABI) and Local Southern algorithm in GeneScan (ABI) Analysis software, version 2.1. All amplicons or fragments are aligned by hand to identify peak profiles generated from reference samples and control samples. Any peaks that differ by less than one base pair are considered shared when comparing profiles. All peaks are analyzed by eye; peak size and total area are copied from GeneScan Analysis software and recorded in Microsoft Excel for further analysis.

Orange County Water District (OCWD) Research and Development Department used custom software to design specific 16s rRNA gene PCR primer sets that target and amplify a specific region of the 16s rRNA gene for *Bacteroides thetaiotaomicron* (B.t.). PCR amplification is achieved by using the specific primer set, and performance of PCR enzyme and amplification is measured by the presence or absence of a visible band or peak that corresponds to approximately 551 bp along with positive and negative control samples. An additional amplicon of approximately 468 bp has also been observed from some individual environmental samples that contain DNA from a B.t. source. Any environmental samples in question are further verified using restriction endonucleases to identify the Terminal Restriction Fragment Length Polymorphism (TRFLP) patterns that are specific to all known sources of B.t.

Figure 1: GeneScan 500 size standard for capillary electrophoresis using denaturing conditions and POP4 polymer



APPENDIX C

UNIVERSITY CALIFORNIA DAVIS LABORATORY STANDARD OPERATING PROCEDURES

APPENDIX D

MSAR WATERSHED TMDL TASK FORCE CONTACT LIST

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