WATER QUALITY MONITORING OF 303(D) LISTED STREAMS ON THE SAN BERNARDINO NATIONAL FOREST

QUALITY ASSURANCE PROJECT PLAN

Prepared by:

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Title	Name	Signature	Date
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SUMMARY OF REVISION HISTORY

Amendment No.	Date	Brief Description of Amendment, include section and page number	Prepared and Approved By

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ACRONYMS AND ABBREVIATIONS

AGR – Agricultural Supply

ELAP—California Environmental Laboratory Accreditation Program

COLD – Cold Freshwater Habitat

CWA-U.S. Clean Water Act

DLR – Detection Limits Report

DQL – Data Quality Level

DQM – Data Quality Matrix

FR – Forest Road

FRVC – Fisheries Resource Volunteer Corps

GWR – Groundwater Recharge

IND – Industrial Service Supply

LCS – Laboratory Calibration Standard

MDL – Minimum Detection Limit

MS – Matrix Spike

MUN – Municipal and Domestic Supply

NAV - Navigation

PM – Project Manager

POW – Hydropower Generation

PROC – Industrial Process Supply

QA – Quality Assurance

QAPP – Quality Assurance Project Plan

QC – Quality Control

RARE – Rare, Threatened or Endangered Species

REC1 – Water Contact Recreation (Primary Contact Recreation)

REC2 – Non-contact Water Recreation (Secondary Contact Recreation)

RWQCB – Regional Water Quality Control Board

SAP – Sampling and Analysis Plan

SBNF – San Bernardino National Forest

SOP - Standard Operating Procedure

SPWN – Spawning, Reproduction and Development

SR – State Route

SWRCB --State Water Resources Control Board

SWAMP – Surface Water Ambient Monitoring Program

USFS – United States Forest Service

WARM – Warm Freshwater Habitat

WILD – Wildlife Habitat

A. PROJECT MANAGEMENT

A.1 Title and Approval Page

See Page 1

A.2 Table of Contents

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A.3 Distribution List

Participants in the SBNF monitoring program will receive electronic notification of the document and subsequent revisions. The official signed document shall be filed at the SBNF. The monitoring program is expected to continue through multiple years, the QAPP will be reviewed annually and revisions should be anticipated. The SBNF is not responsible for the control of reprinted copies of the original plan. It is the responsibility of the reader to ensure that they are using the most current QAPP. The SBNF PM may make revisions to this plan, which shall be approved by the signatories in section 1.1 above.

Table 1 is a current list of organizations and persons who will receive copies of the approved QA Project Plan and any subsequent revisions:

Table 1. Quality Assurance Project Plan distribution list.

Name	Title/Position	Organization	Telephone
Bill Wells	Forest Hydrologist	U.S. Forest Service, San Bernardino National Forest	(909) 793-0541
Erick Burres	Senior Environmental Scientist	California Water Resources Control Board	(213) 576-6788
Heather Boyd	Environmental Scientist	Santa Ana Regional Water Quality Control Board	(951) 320-2006
Alanna Misico	Environmental Scientist	Lahontan Regional Water Quality Control Board	(530) 542-5579
Sherri Craig	Field Coordinator	Fisheries Resource Volunteer Corps	(909) 528-1024
Gregory Nelson	Project Manager	Clinical Lab of San Bernardino, Inc.	(909) 825-7693

A.4 Project/Task Organization

A.4.1 Project Personnel

The San Bernardino National Forest (SBNF) is the lead agency on this effort and will manage all field activities and laboratory analyses. The SBNF will work with Clinical Lab of San Bernardino, Inc. for laboratory analyses and the Fisheries Resource Volunteer Corps (FRVC) for field monitoring. Table 2 lists the representatives and organizations who will assume all necessary project personnel roles to assure data quality and timely delivery of reliable and usable monitoring data. They will be responsible for all project tasks and deliverables. A project organizational chart in Figure 1 also illustrates the project organizational structure.

Table 2. Project Personnel, roles and contact information

Name	Organizational Affiliation	Title	Contact Information[1]
Bill Wells	USDA Forest Service, San Bernardino National Forest	Project Manager/QA Officer	(909) 382-2731 williamewells@fs.fed.us
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Sherri Craig	Fisheries Resource Volunteer Corps	Field Coordinator	(661) 644-3134 sparaon@live.com
Gregory Nelson	Clinical Lab of San Bernardino, Inc.	Project Manager	(909) 825-7693 nelson@clinical-lab.com

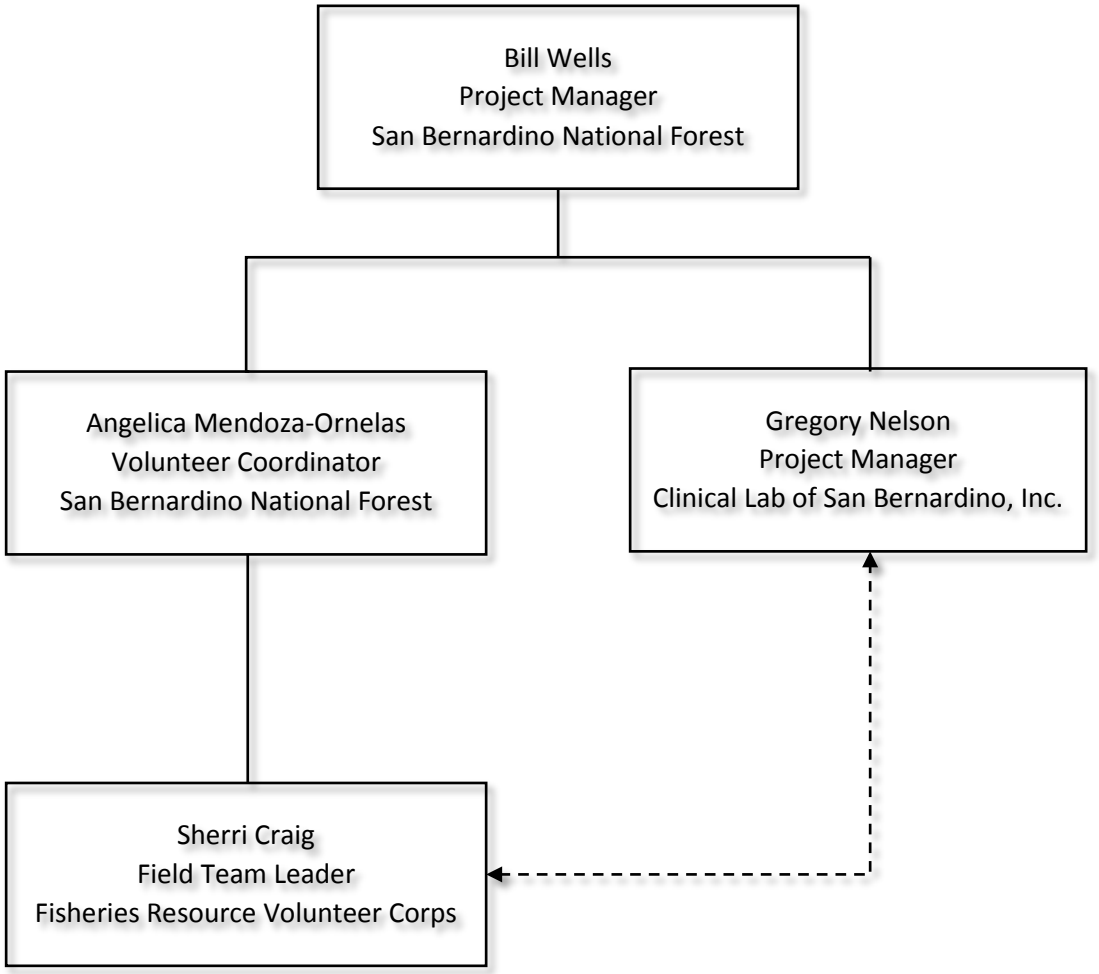

Figure 1. Project Organization Chart

[1] Telephone number, email address

A.5 Problem Definition/Background

The San Bernardino National Forest currently has twelve streams on the 303(d)-impaired waters list that are not meeting water quality standards. Many of the listed streams have not been monitored or assessed in over 10 years. In addition, some of the streams were not sampled on public lands managed by the San Bernardino National Forest.

Managing, maintaining, and providing high quality water has been identified as a Forest Service goal, objective, and strategy in both its National Strategic Plan and San Bernardino National Forest Land Management Plan (LMP). Excerpts from these documents include:

- Provide abundant clean water (USFS Strategic Objective "D")
- Maintain water of sufficient quantity and quality to sustain aquatic life and support terrestrial habitats, domestic uses, recreation opportunities, and scenic character (USFS Strategic Objective "D" Means and Strategies)
- Watersheds, streams, groundwater recharge areas, springs, wetlands and aquifers are managed to assure the sustainability of high quantity and quality water (San Bernardino National Forest Land Management Plan Goal 5.1 – Improve Watershed Condition)
- Take corrective actions to eliminate the conditions leading to State listing of 303(d)-impaired waters on National Forest System land. For those waters that are both on and off National Forest System land, ensure that Forest Service management does not contribute to listed water quality degradation (San Bernardino National Forest Land Management Plan Strategy WAT 2 – Water Management)

This monitoring effort will provide an updated sample set of water quality data collected in accordance with this plan and the sample and analysis plan within the boundary of the San Bernardino National Forest. Specifically, the project will answer the following question: ***Are the practices or activities of the San Bernardino National Forest supporting designated beneficial uses of the water.*** This data may be used by the Lahontan and Santa Ana Regional Water Quality Control Boards for status reporting (305b), comparison to Basin Plan water quality objectives (and 303d listing or de-listing), and watershed assessments.

A.6 Project/Task Description

Data collection will proceed in one line of inquiry. The Question – **"Are the practices or activities of the San Bernardino National Forest supporting designated beneficial uses of the water?"** - will be addressed via samples collected over a thirty month time period at a single location within the San Bernardino National Forest for each listed stream or river (Table 3). Access to sampling locations may be limited or restricted due to wildfire, impassable road, flooding, or other unexpected natural events. In addition, sampling may not be possible due to lack of streamflow.

Table 3. 303(d) list of impaired streams on the San Bernardino National Forest

Subwatershed	Stream	Pollutant	Beneficial Use(s)
Big Bear Lake			
	Grout Creek	Nutrients	MUN GWR REC1 REC2 COLD WILD SPWN
	Knickerbocker Creek (Reach 2)	Pathogens	MUN GWR REC1 REC2 COLD WILD
	Rathbone (Rathbun) Creek	Nutrients, Cadmium, Copper, Sedimentation/Siltation	MUN GWR REC1 REC2 COLD WILD
Santa Ana River			
	Santa Ana River (Reach 6)	Cadmium, Copper, Lead	MUN AGR GWR POW REC1 REC2 COLD WILD SPWN
Holcomb Creek			
	Holcomb Creek	Total Dissolved Solids	MUN AGR REC-1 REC-2 COMM COLD WILD
Upper Deep Creek			
	Crab Creek	Total Dissolved Solids	MUN AGR REC-1 REC-2 COMM COLD MUN SPWN
	Sheep Creek	Nitrate Total Dissolved Solids	MUN AGR GWR REC-1 REC-2 COMM M COLD WILD
Mill Creek			
	Mill Creek (Reach 2)	Pathogens	MUN AGR GWR POW REC1 REC2 COLD WILD
	Mountain Home Creek, East Fork	Pathogens	MUN GWR NAV POW REC1 REC2 COLD WILD SPWN
	Mountain Home Creek	Pathogens	MUN GWR POW REC1 REC2 COLD WILD
Cajon Wash – Lytle Creek			
	Lytle Creek	Pathogens	MUN AGR IND PROC GWR POW REC1 REC2 COLD WILD RARE
Upper Cucamonga Creek			
	Cucamonga Creek (Mountain Reach 2)	pH	MUN IND PROC GWR POW REC1 REC2 COLD WILD SPWN

Field activities will be led by FRVC staff, and lab analyses will be performed at Clinical Lab of San Bernardino, Inc. Two team leaders will be selected from FRVC staff, and each will lead a field crew augmented by trained FRVC volunteers. Field measurements (including field testing with probes and test kits) will be conducted including, but not limited to the following parameters: alkalinity, conductivity, dissolved oxygen, pH, salinity, specific conductivity, streamflow, temperature, total dissolved solids, and turbidity

The constituents that will be monitored using laboratory methods consist of the following:

- conventional constituents (nitrogen, phosphorous)
- bacteria and pathogens (*E. coli* and Total Coliform counts)
- metals (cadmium, copper, and lead)

Table 4 shows the major tasks that will be undertaken, and the anticipated time line for the performance of each task. Training and preparation (supplies, vehicles, safety, etc.) needed to get the field crews ready and equipped will be conducted in fall 2016. Sampling will be conducted beginning fall 2016 and continue through winter 2018. Following validation of the data, the draft technical report will be completed and distributed for review and comment from winter 2018 to spring 2019 and the final technical report will be completed by September 30, 2019.

The sampling schedule is subject to change based upon available funding, RWQCB basin plan(s), SWRCB delisting policy, available field personnel, workload priorities, sample site access, etc. For example, initial sampling is limited to the Mill Creek subwatershed (Mill Creek, Mountain Home Creek, and East Fork Mountain Home Creek) for pathogens. See Table 5 and Figure 2 for a listing and map of waterbodies and their sampling locations. Subsequent sampling schedule and locations will be determined at a later date based upon the previously mentioned issues. The number of samples will meet the minimum necessary to answer the project question and SWRCB delisting policy.

Table 4. Project timeline for major tasks.

Task	Spring 2016	Summer 2016	Fall 2016	Winter - Fall 2016 - 2018	Winter 2018	Spring 2019	Summer 2019
Quality Assurance Project Plan							
Training and sampling preparation							
Sampling and analysis							
Data validation, Technical Report (draft)							
Review/Comments, Technical Report (final)							

The San Bernardino National Forest is located approximately 70 miles east of Los Angeles, CA and includes the San Bernardino and San Jacinto Mountain Ranges totaling almost 680,000 acres of National Forest managed lands. The Forest drains predominately into the Santa Ana, San Jacinto, and Mojave River basins.

Table 5. List of waterbodies and sampling locations.

Waterbody Name (Field ID)	Sample Location
Cucamonga Creek (CCMCR1)	Forest Service Road (FSR) 1N35 - T1N R7W Section 8
Lytle Creek (LYTCR1)	T2N R6W Section 27 - Lytle Creek Road near Green Mountain Ranch
Sheep Creek (SHPCR1)	FSR 2N18 - T2N R2W Section 19 - Lake Arrowhead Boy Scout Camp
Crab Creek (CRBCR1)	FSR 2N33Y - T2N R2W Section 16 - Tent Peg Group Campground
Holcomb Creek (HLCCR1)	FSR 3N16 - T2N R2W Section 11
Grout Creek (GRTCR1)	FSR 2N70 - T2N R1W Section 10
Knickerbocker Creek (KNCCR1)	FSR 2N08 - T2N R1E Section 29
Rathbun Creek (RTHCR1)	T2N R1E Section 26 - Above Bear Mountain Ski Area
Santa Ana River 1. SAR1 2. SAR2 3. SAR3	1. T1N R1W Section 20 – Near confluence with Bear Creek 2. T1N R1W Section 14 - Middle Control Road - West of Weesha Club 3. South Fork Campground and Picnic Area – T1N R2E Section 18
Mill Creek 1. MLLCR1 2. MLLCR2 3. MLLCR3	1. Thurman Flats Picnic Area - T1S R1W Section 8 2. Valley of the Falls Blvd – 1 mile east of SR-38 – T1S R1W Section 12 3. Vivian Creek Trailhead – T1S R1E Section 16
East Fork Mountain Home Creek (EFMNTCR1)	State Route 38 - T1N R1W Section 34
Mountain Home Creek (MNTCR1)	Mountain Home Creek Road near Loch Leven - T1S R1W Sec. 4

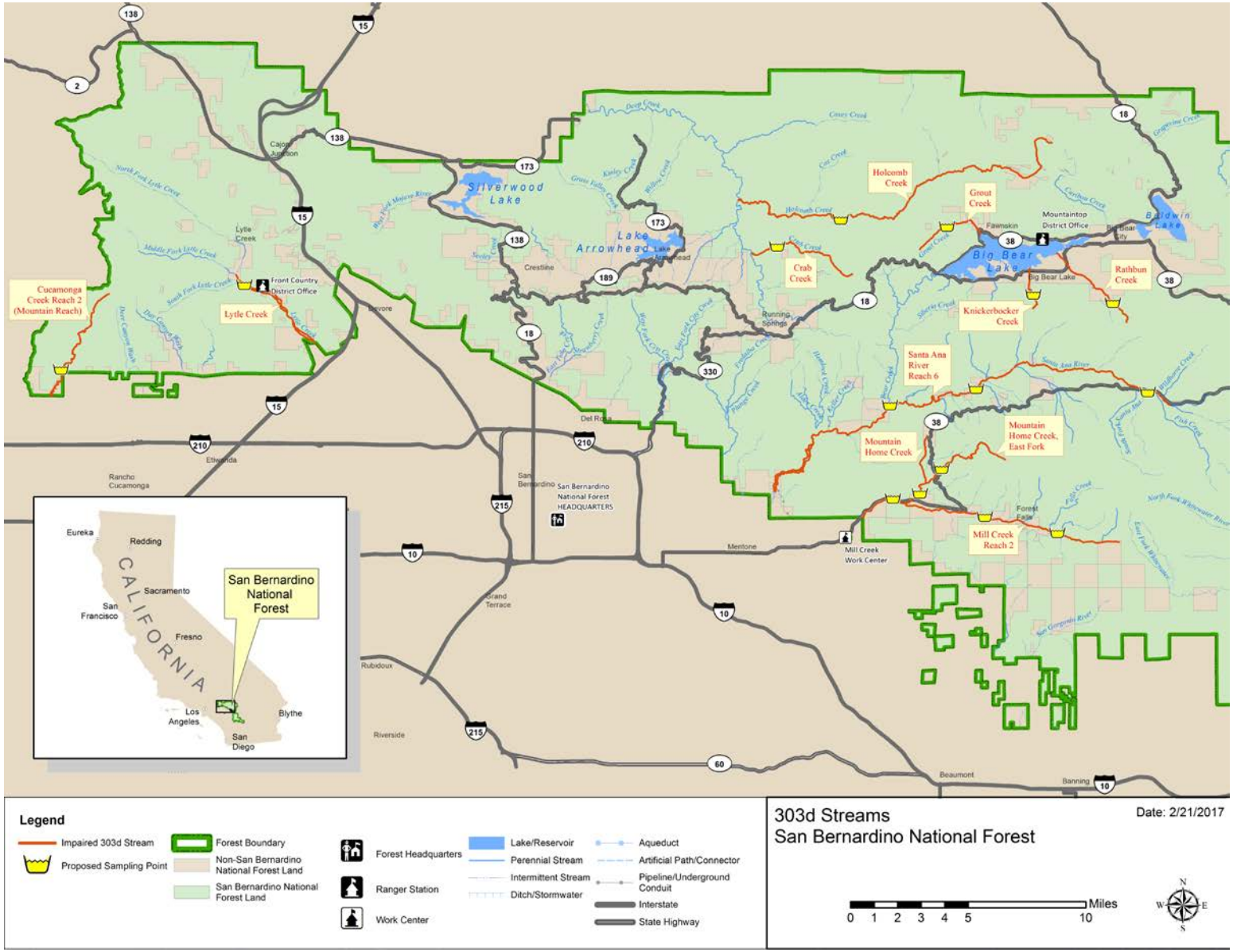

Figure 2. Map of sampling sites.

A.7 Quality Objectives and Criteria for Measurement Data

For water quality data to inform decision making it is critical that the quality of the results themselves be assessed in order to understand the sampling error and the error of the measurements themselves.

Sampling error will be determined by the natural variability of the environmental parameter, the distribution and type of samples in space and time, and the total number of samples.

Measurement error is influenced by imperfections in the measurement and analysis system. Random and systematic measurement errors are introduced in the measurement process during physical sample collection, sample handling, sample preparation, sample analysis, and data processing.

Specific QA objectives for the 303(d) monitoring water quality program are i) collect a sufficient number of samples, sample duplicates, and field blanks to evaluate the sampling and measurement error; ii) analyze a sufficient number of QC standards, blanks and duplicates during analysis to effectively evaluate results against numerical QA goals established for precision and accuracy; and iii) implement sampling techniques in such a manner that the analytical results are representative of the media and conditions being sampled.

The Data Quality Objectives for this project provide quality specifications for the level of the study in question and are listed below. Data acquisition activities will include both field measurements and laboratory analyses, and the quality objectives depend on the amount of error that can be tolerated. The quality objectives for field measurements are listed in Table 6 and Table 7 shows the quality objectives for laboratory analyses and bacterial counts.

A.7.1 Precision and Accuracy

Precision is how close two measurements or analyses of the same thing are to each other. It's also stated as the degree of agreement among repeated measurements of the same characteristic on the same sample or on separate samples collected as close as possible in time and place. Precision will be reported as relative percent difference (RPD), which is the difference between replicate tests or measurements or matrix spike and matrix spike duplicate, expressed as a percentage of their average. The smaller the relative percent difference, the more precise are the measurements.

$$RPD = \frac{(X_1 - X_2)}{(X_1 + X_2) \div 2} \times 100$$

Accuracy is the measure of confidence in a measurement. The smaller the difference between the measurement of a parameter and its "true" or expected value, the more accurate the measurement. How close the results are to the perceived 'true value', will be assured by calibration adjustments for adjustable field instruments before every trip, as specified in this QAPP, or in accordance with manufacturer recommendations. Accuracy will be checked by comparing the readings of all instruments and kits (both adjustable and non-adjustable), when placed in established Standard solutions, with the 'true value' of these Standards. Field instruments will undergo accuracy checks after each trip, and the difference between the instrument's reading and the Standard value will be recorded. This value, the 'instrument drift', will be used to report accuracy (in measurement units, e.g., for pH, or as a percentage of the true value of the Standard). Calibration Standards will be selected at values that are as close as possible to expected ambient values.

Accuracy for laboratory analyses will be determined by running laboratory control samples of known concentrations, and/or standard reference materials, in each analytical batch at the same conditions as the samples. It will be reported as percent distance of the result from of the nominal value. Spike recovery will be another measure of accuracy, that takes the matrix effect into account, and recovered concentration will be reported as the percent of the nominal concentration spiked.

Table 6 and 7 list the precision and accuracy targets for standard water quality monitoring parameters collected as part of the 303(d) monitoring water quality program. Any data collected which does not meet the accuracy and precision limits defined below will be downgraded to a lower Data Quality Level (DQL) in accordance with the DQM and should only be considered in analysis after considering the cause of the data quality downgrade.

Table 6. Measurement quality objectives (MQOs) and other quality objectives for field measurements.

Characteristic (Parameter)	Unit	Accuracy (Unit or Percent)[2]	Precision (Unit or RPD)[3]	Resolution	Completeness	Measurement Range
Alkalinity (as $CaCO_3$)	ppm	0 to 4 ppm	±10%	4 ppm	90%	0 to 200 ppm
Conductivity	µS/cm	±1% of reading or 1 µS/cm, whichever is greater	±10%	1 µS (0 to 500 µS) 10 µS (501 to 50,000 µS)	90%	0 to 200,000 µS/cm
Dissolved Oxygen	mg/L	0 to 20 mg/L (±2% of the reading or 0.2 mg/L, whichever is greater)	±0.5 or 10%	0.01 mg/L 0.1% air saturation	90%	0 to 50 mg/L
pH	pH	±0.2 units	±0.2	0.01 units	90%	0 to 14 units
Salinity	ppt	±1.0% of reading or 0.1 ppt, whichever is greater	Per Manufacturer	0.01 ppt	90%	0 to 70 ppt
Specific Conductivity	µS/cm	±1% of reading or 1 µS/cm, whichever is greater	±10%	1 µS/cm	90%	0 to 200,000 µS/cm
Temperature	°C	±0.2°C	±0.5	0.1°C	90%	-5 to 70°C
Total Dissolved Solids	mg/L	-	±10%	0.01 mg/L	90%	0 to 100 mg/L
Turbidity	NTU	0.5 NTU or ±5% of reading (whichever is greater)	±0.2 or 10%	0.1 NTU 1 NTU	90%	0.00 to 50.00 NTU 50 to 1000 NTU

Table 7. Measurement quality objectives (MQOs) and other quality objectives for laboratory analyses and bacterial counts.

Characteristic (Parameter)	Unit	Accuracy (LCS)	Precision (LCS, RPD)	DLR / MDL	Spike Recovery	Completeness	Measurement Range
Bacteria (Total Coliform and *E. coli*)	MPN/100mL	-	± 50%	-	Not Applicable	90%	1 cfu/100 mL and above (*E. coli*; Colilert-18)
Cadmium	ug/L	± 10%	± 20%	1.0 / 0.07	± 30%	90%	1.0 and above
Copper	ug/L	± 15%	± 20%	50 / 6.5	± 30%	90%	50 and above
Lead	ug/L	± 10%	± 20%	5.0 / 0.80	± 30%	90%	5.0 and above

[2] Unit or percentage, whichever is greater.

[3] RPD – Relative percent Difference – is the difference between two repeated measurements expressed as a percentage of their average.

A.7.2 Representativeness

Representativeness is the extent to which measurements actually depict the true environmental condition or population being evaluated. Field operators will conduct measurements and collect samples in a manner that will assure the representativeness of the data (in terms of what each data point represents in the environment).

A.7.3 Completeness

Completeness is a measure of the number of samples that must be taken to be able to use the information, as compared to the number of samples originally planned for. The number of successful activities (measurements or sampling and analyses that have yielded valid data) expressed as a percentage of the total activities planned for the Project is calculated as Percent Completeness (%C):

$$\%C = \frac{v}{T} \times 100$$

A.7.4 Sensitivity

Sensitivity relates to the ability of an analytical method to quantify concentrations relevant to a study and the ability of the study design to successfully answer the monitoring question.

Study design sensitivity is the power of the expected results to answer the intended monitoring question. The variability of the population being sampled, the number of samples collected, the timing and distribution of site visits, and the required confidence in answering the monitoring question are all factors in determining if the study design is expected to successfully meet the goal(s). The characteristics of each population cannot be changed; but by defining specific ecologically significant populations characterize in the monitoring question it may be able to reduce variability in the population and improve the subsequent sensitivity of the analysis.

A.7.5 Comparability

Comparability is the extent to which data from one study can be compared directly to either past data from the current project or data from another study. The monitoring data collected in this effort will be comparable to SWAMP in terms of sampling protocols, units of reporting, site selection, measurement quality objectives, and QA requirements fulfilled.

A.8 Training Requirements and Certification

Hydrologist(s) and environmental scientist(s) from the US Forest Service and SWRCB will provide training sessions for FRVC personnel. The FRVC project manager will coordinate the training of all volunteers before any monitoring activities are done, and schedule refresher training sessions as needed. FRVC staff will receive training on sample collection, processing and analysis, and safety considerations. Newly trained volunteers will be supervised until the FRVC project manager is assured the new individual(s) are confident in conducting the tests.

All Training materials, handouts, class rosters, and certification records related to this Project will be kept at the San Bernardino National Forest, Supervisors office.

Laboratory analysis will be conducted by Clinical Lab of San Bernardino, Inc., an ELAP accredited laboratory. ELAP provides evaluation and accreditation of environmental testing laboratories to ensure

the quality of analytical data used for regulatory purposes to meet the requirements of the State's drinking water, wastewater, shellfish, food, and hazardous waste programs. ELAP-accredited laboratories have demonstrated capability to analyze environmental samples using approved methods.

A.9 Documentation and Records

Participants in the SBNF monitoring program will receive electronic notification of the QAPP and subsequent revisions. The official signed document shall be filed at the SBNF. The monitoring program is expected to continue through multiple years, thus revisions should be anticipated. The SBNF is not responsible for the control of reprinted copies of the original plan. It is the responsibility of the reader to ensure that they are using the most current QAPP. The SBNF PM may make revisions to this plan, which shall be approved by the signatories in section 1.1.

In order to assure data quality over time the SBNF will follow the document retention policy outlined in Table 8 (or USFS policy, whichever is longer) for all documents relevant to this study.

Table 8: Document Retention Policy

Document or Record Name and Description	Storage Location	Storage Time
Quality Assurance Project Plan (QAPP) – QAPP project description and assurance procedures	SBNF Supervisors Office	5 years
SBNF Sampling and Analysis Plan – Specific sampling information	SBNF Supervisors Office	5 years
Equipment Notebooks – Records of quality control checks, calibrations and maintenance	SBNF Supervisors Office	5 years
Field Data Sheets– Field forms containing sampling meta data and raw field data	SBNF Supervisors Office	5 years
Chain of Custody Sheets – Sheets documenting what sample containers were collected where, at what time, by whom, and when sent to and received by an analytical laboratory.	SBNF Supervisors Office	5 years
Equipment Documentation - Manufacturer user guides and technical manuals	SBNF Supervisors Office	1 year
Database - CEDEN user guides, templates, input files	SBNF Supervisors Office	5 years

B. DATA GENERATION AND ACQUISITION

B.1 Sampling Process Design

A total of 12 streams and rivers will each be sampled at a single site located at the most downstream representative point on National Forest System lands nearest the Forest boundary that is easily accessible from the nearest road. Sampling site locations were determined using professional judgement and historical knowledge of the stream or river. Where possible, previously established sampling sites, such as those on NFS lands where samples have been collected and used for 303(d) listing purposes, will be used for this project.

All samples will be collected from the thalweg of flowing water except during high flows when samples will be collected from the streambank. All sampling locations will be recorded using global positioning system (GPS) equipment. The sample locations, names, rationale for selecting each sampling location, and parameter(s) collected are summarized in Table 3 and Table 5.

In addition to the parameters listed in Table 4, field sampling will also include air and water temperature, pH, dissolved oxygen, conductivity (as specific conductance), salinity, streamflow, alkalinity, and turbidity. At a minimum, samples will be collected monthly when flowing water is present over a 3-year period. In order to meet delisting policy and beneficial uses standards, the sample schedule will be adjusted depending on flow regime, i.e., 5 samples within a 30 day period for bacteria sampling, sample twice per month for six months during the fall and winter when flowing water is present, etc.

B.2 Sampling methods

All samples will be collected using the field collection procedures as described in the U.S. Geological Survey, National field manual for the collection of water-quality data: U.S. Geological Survey Techniques of Water-Resources Investigations, book 9, chaps. A1-A10, available online at http://pubs.water.usgs.gov/twri9A. If the field manual is updated or revised, the updated or revised chapter will be used for the subsequent sampling event(s). Any revisions/updates to chapters will be documented in an amendment to the QA Project Plan. All field instruments will be calibrated (according to the manufacturer's instructions) at the beginning of each date of sampling and checked at the end of each day. Field instrument calibration and sample measurement data will be recorded in the field logbook.

Water samples will be collected at or below the water's surface depending on available flow. At each sampling location, all sample bottles/containers designated for a particular analysis (e.g., anions) will be filled sequentially before containers designated for another analysis are filled (e.g., metals). If a QC sample is to be collected at a given location, all containers designated for a particular analysis for both the sample and QC sample will be filled sequentially before containers for another analysis are filled. For field duplicate samples, containers with two different sample designations (e.g., metals designation SW1 and metals designation SW-11 [duplicate of SW-1]) will be filled alternately.

All water samples will be collected directly into sample bottles/containers appropriate for the specific analysis or field measurement. All the sampling locations are accessible from the shoreline or with minimal wading into the stream downstream of the sample collection point. Preservatives will be added

after sample collection, if required, to avoid losing the preservatives and dilution of preservatives during sampling. The pH of the metal samples will be checked after addition of nitric acid to ensure that sufficient acid was added to achieve the pH<2 required. Once the samples are collected and preserved, they will be kept chilled (if appropriate) and processed for shipment to the laboratory. Adherence to good field practices and other clean sampling procedures such as wearing disposable, powderless gloves during sample collection and preservation are required, so as not to potentially contaminate the sample. The sample bottle/containers, volumes, and preservation requirements for each analysis and field measurement are summarized in Table 9.

Table 9: SWQCB Recommended sample container, holding times and preservation for water/aqueous samples.

Parameter	Sampling Equipment	Sample Holding Container	Min. Volume (mL)	Preservation	Holding Time (days)
Cadmium	Grab	250-mL HDPE (high density polyethylene or polypropylene)	100	HNO_3	6 Months
				None	14
Copper	Grab	250-mL HDPE	100	HNO_3	6 Months
				None	14
Lead	Grab	250-mL HDPE	100	HNO_3	6 Months
				None	14
Nitrogen, Nitrate (NO_3)	Grab	125-mL HDPE	50	None	48 Hours
Phosphorous, Total	Grab	250-mL Glass	100	H_2SO_4 & 4°C	28
Total Dissolved Solids	Grab	1-L HDPE	1000	4 °C	7
	Probe	N/A	N/A	N/A	N/A
pH	Probe	N/A	N/A	None	N/A
Temperature	Probe	N/A	N/A	None	N/A
Dissolved Oxygen	Probe	N/A	N/A	None	N/A
Conductivity	Probe	N/A	N/A	None	N/A
Turbidity	Portable Unit	N/A	N/A	None	N/A
Total Coliform / *E. Coli*	Idexx Colilert-18	120-ml sterile HDPE	100	10 °C	8 Hours
Alkalinity	Field Kit	N/A	N/A	None	N/A

B.3 Sample Handling and Custody

Surface water samples will generally be analyzed streamside for temperature, conductivity, total dissolved solids, DO, pH, salinity, alkalinity and turbidity. Analyzing as many parameters at the site as possible eliminates the potential for sample degradation or loss and allows for immediate follow-up sampling if problems or questionable results are identified. Field results will be recorded immediately onto a field sheet, field notebook or field computer.

Escherichia coli bacteria samples will be transported on ice, in a cooler, and analyzed within the designated holding time (6 hours). Protocols for bacteria analysis using the IDEXX Laboratories, Inc. Colilert-18 test kit will be followed. Other analyte holding times and preservatives, if required, are listed in Table 9.

B.3.1 Sample Containers and Preservatives

The San Bernardino National Forest Project Manager will work with the Laboratory Project Manager to determine the number of sample containers, and associated sizes/volumes and materials, needed for this monitoring project. The containers will be provided precleaned from the laboratory directly and require no washing or rinsing by the field samplers prior to sample collection.

Preservatives (i.e., nitric acid for metals analysis) will also be provided by the laboratory. Container and preservative information will be documented in the field logbook. Analyte sample containers and preservatives are listed in Table 9.

B.3.2 Sample Packaging and Shipping

All sample containers will be placed in a sturdy shipping container (e.g., a plastic cooler). The following outlines the packaging procedures that will be followed for this project:

1. Prepare bags of ice to be used to keep the samples cool during transport. Pack the ice in doubled, zip-locked plastic bags.
2. Check the sample bottle screw caps for tightness and, if not full, mark the sample volume level of liquid samples on the outside of the sample bottles with indelible ink.
3. Seal all sample containers in heavy-duty plastic zip-lock bags. Write the sample numbers on the outside of the plastic bags with indelible ink.
4. Place sample containers (wrapped and sealed) into the cooler. Place the bagged ice on top and around the samples to chill them to the correct temperature. Coolers will contain a thermometer to ensure samples are kept at the required temperature.
5. Enclose the appropriate chain-of-custody(s) in a zip-lock plastic bag.
6. Close the lid of the cooler.

B.3.3 Sample Custody

The field sampler is responsible for custody of the samples until they are delivered to the laboratory. Chain-of-custody forms must be completed in the field. Each time one person relinquishes control of the samples to another person; both individuals must complete the appropriate portions of the chain-of-custody form by filling in their signature as well as the appropriate date and time of the custody transfer.

Once at the laboratory, the sample receipt coordinator will open the coolers and sign and date the chain-of-custody form. The laboratory personnel are then responsible for the care and custody of samples. The analytical laboratory will track sample custody through their facility using a separate sample tracking form, as detailed in the laboratory QA manual.

A sample is considered to be in one's custody if:

- The sample is in the sampler's physical possession,
- The sample has been in the sampler's physical possession and is within sight of the sampler,
- The sample is in a designated, secure area, and/or
- The sample has been in the sampler's physical possession and is locked up.

All samples will be labeled with indelible ink with the following information; sample description (parameter), sample location, date and time, preservative, sampler name, and sample ID#.

B.3.4 Sample Disposal

Following sample analysis, the laboratory will store the unused portions up to the maximum holding time. At that time, the laboratory will properly dispose of all the samples after confirming lab results with the San Bernardino National Forest project manager. Sample disposal procedures at the laboratory are discussed in the laboratory's QA Manual. Coliform samples will be placed in a hazardous waste container or bag and disposed of at an authorized hazardous waste disposal location.

B.4 Analytical Methods

All samples will be analyzed at Clinical Lab of San Bernardino, Inc. Analyses and test procedures will be in accordance with approved CWA chemical test methods outlined in 40 CFR Part 136. The Laboratory QA/QC Officer must notify the Laboratory Project Manager if there is any knowledge of the SOPs not being followed.

The laboratory will summarize the data and associated QC results in a data report, and provide this report to the San Bernardino National Forest Project Manager prior to the expiration of the parameters holding time. The San Bernardino National Forest Project Manager/QA Officer will review the data reports and associated QC results to make decisions on data quality and usability in addressing the project objectives.

B.5 Quality Control

B.5.1 Field Sampling Quality Control

Field sampling QC consists of collecting field QC samples to help evaluate conditions resulting from field activities. Field QC is intended to support a number of data quality goals:

- Combined contamination from field sampling through sample receipt at the laboratory (to assess potential contamination from field sampling equipment, ambient conditions, sample containers, sample transport, and laboratory analysis) - assessed using field blanks;
- Sample shipment temperature (to ensure sample integrity and representativeness that the sample arriving at the laboratory has not degraded during transport) - assessed using temperature blanks; and
- Combined sampling and analysis technique variability, as well as sample heterogeneity - assessed using field duplicates.

For the current project, the types and frequencies of field QC samples to be collected for each field measurement and off-site laboratory analysis are listed in Table 10. These include field blanks, and field duplicates.

Field Blanks - Field blanks will be collected during each sampling event to evaluate whether contaminants have been introduced into the samples during the sample collection due to exposure from ambient conditions or from the sample containers themselves. Field blank samples will be obtained by pouring deionized water into a sample container at the sampling location.

Field blanks will be preserved, packaged, and sealed in the same manner described for the surface water samples. A separate sample number and station number will be assigned to each blank. Field blanks will be submitted blind to the laboratory for analysis of metals.

If target analytes are found in field blanks, sampling and handling procedures will be reevaluated and corrective actions taken. These may consist of, but are not limited to, obtaining sampling containers from new sources, training of personnel, discussions with the laboratory, invalidation of results, greater attention to detail during the next sampling event, or other procedures felt appropriate.

Temperature Blanks - For each cooler of samples that is transported to the analytical laboratory, a 40-ml VOA vial (prepared by the laboratory) will be included that is marked "temperature blank." This blank will be used by the laboratory's sample custodian to check the temperature of samples upon receipt to ensure that samples were maintained at the temperature appropriate for the particular analysis.

For the current project, temperature blanks will be included in all coolers containing samples requiring temperature preservation, as identified in Table 9.

Field Duplicate Samples - Field duplicate samples will be collected to evaluate the precision of sample collection through analysis. Field duplicates will be collected at designated sample locations by alternately filling two distinct sample containers for each analysis. Field duplicate samples will be preserved, packaged, and sealed in the same manner described for the surface water samples. A separate sample number and station number will be assigned to each duplicate. The samples will be submitted as "blind" (i.e., not identified as field duplicates) samples to the laboratory for analysis.

For the current project, field blanks and duplicates will be collected for each analytical parameter, and field measurement parameter, at the frequencies shown in Table 10. If target analytes are found in field blanks or criteria are exceeded than sampling and handling procedures will be reevaluated and corrective actions taken. These may include obtaining sampling containers from new sources, retraining of personnel, review of laboratory procedures, invalidation of results, and/or greater attention to detail during the next sampling event, etc.

Table 10. Summary of field QC sampling.

Parameter	QC Sample	Frequency
Bacteria	Field Blank	1 sample per 10
Metals	Field Duplicate Field Blank	1 sample per 10 1 per sample site

B.5.2 Laboratory Analysis Quality Control (Off-Site)

Laboratory QC is the responsibility of the personnel and QA/QC department of the contracted analytical laboratory. The laboratory's Quality Assurance Manual details the QA/QC procedures it follows. The following elements are part of standard laboratory quality control practices:

- Analysis of method blanks,
- Analysis of laboratory control samples,
- Instrument calibration (including initial calibration, calibration blanks, and calibration verification),
- Analysis of matrix spikes, and
- Analysis of duplicates.

The data quality objectives for Clinical Lab of San Bernardino, Inc. (including frequency, QC acceptance limits, and corrective actions if the acceptance limits are exceeded) are detailed in its QA Manual. Any excursions from these objectives must be documented by the laboratory and reported to the San Bernardino National Forest Project Manager/QA Officer.

Method Blanks - A method blank is an analyte-free matrix, analyzed as a normal sample by the laboratory using normal sample preparation and analytical procedures. A method blank is used for monitoring and documenting background contamination in the analytical environment. Method blanks will be analyzed at a frequency of one per sample batch (or group of up to 20 samples analyzed in sequence using the same method).

Corrective actions associated with exceeding acceptable method blank concentrations include isolating the source of contamination and re-digesting and/or re-analyzing the associated samples. Sample results will not be corrected for blank contamination, as this is not required by the specific analytical methods. Corrective actions will be documented in the laboratory report's narrative statement.

Laboratory Control Samples - Laboratory control samples (LCS) are laboratory-generated samples analyzed as a normal sample and by the laboratory using normal sample preparation and analytical procedures. An LCS is used to monitor the day-to-day performance (accuracy) of routine analytical methods. An LCS is an aliquot of clean water spiked with the analytes of known concentrations corresponding to the analytical method. LCS are used to verify that the laboratory can perform the analysis on a clean matrix within QC acceptance limits. Results are expressed as percent recovery of the known amount of the spiked analytical parameter.

One LCS is analyzed per sample batch. Acceptance criteria (control limits) for the LCS are defined by the laboratory. In general, the LCS acceptance criteria recovery range is 70 to 130 percent of the known amount of the spiked analytical parameter. Corrective action, consisting of a rerunning of all samples in the affected batch, will be performed if LCS recoveries fall outside of control limits. Such problems will be documented in the laboratory report's narrative statement.

Matrix Spikes - Matrix spikes (MS) are prepared by adding a known amount of the analyte of interest to a sample. MS are used as a similar function as the LCS, except that the sample matrix is a real-time sample rather than a clean matrix. Results are expressed as percent recovery of the known amount of the spiked analytical parameter. Matrix spikes are used to verify that the laboratory can determine if the matrix is causing either a positive or negative influence on sample results.

One matrix spike is analyzed per sample batch. Acceptance criteria are the MS are defined by the laboratory. In general, the MS acceptance criteria recovery range is of 70 to 130 percent of the known amount of the spiked analytical parameter. Generally, no corrective action is taken for matrix spike results exceeding the control limits, as long as the LCS recoveries are acceptable. However, the matrix effect will be noted in laboratory report's narrative statement and documented in the tribe's reports for each sampling event.

Laboratory Duplicates - A laboratory duplicate is a laboratory-generated split sample used to document the precision of the analytical method. Results are expressed as relative percent difference between the laboratory duplicate pair.

One laboratory duplicate will be run for each laboratory batch or every 20 samples, whichever is more frequent. Acceptance criteria (control limits) for laboratory duplicates are specified in the laboratory QA Manual and SOPs. If laboratory duplicates exceed criteria, the corrective action will be to repeat the analyses. If results remain unacceptable, the batch will be rerun. The discrepancy will be noted in the laboratory report's narrative statement and documented in the tribe's reports for each sampling event.

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

B.6.1 Field Measurement Instruments/Equipment

Sampling equipment under the care of the San Bernardino National Forest Hydrology Program will be maintained according to the manufacturer's instructions. Maintenance logs will be kept in the office of the San Bernardino National Forest Project Manager/QA Officer. Each piece of equipment will have its own maintenance log. The log will document any maintenance and service of the equipment. A log entry will include the following information:

- Name of person maintaining the instrument/equipment,
- Date and description of the maintenance procedure,
- Date and description of any instrument/equipment problem(s),
- Date and description of action to correct problem(s),
- List of follow-up activities after maintenance (i.e., system checks), and
- Date the next maintenance will be needed.

B.6.2 Laboratory Analysis Instruments/Equipment (Off-Site)

Inspection and maintenance of laboratory equipment is the responsibility of Clinical Lab of San Bernardino, Inc. and is described in the laboratory's QA Manual.

B.7 Instrument/Equipment Calibration and Frequency

B.7.1 Field Measurement Instrument/Equipment

Calibration and maintenance of field equipment/instruments will be performed according to the associated SOP and recorded in an instrument/equipment logbook. Each piece of equipment/instrument will have its own logbook.

B.7.2 Laboratory Analysis Instruments/Equipment

Laboratory instruments will be calibrated according to the appropriate analytical methods. Acceptance criteria for calibrations are found in Clinical Lab of San Bernardino, Inc. calibrations procedures that are contained in their QA Manual.

B.8 Inspection/Acceptance of Supplies and Consumables

B.8.1 Field Sampling Supplies and Consumables

The Clinical Lab of San Bernardino, Inc. will provide sample containers and preservatives. Containers will be inspected for breakage and proper sealing of caps. Other equipment such as sample coolers and safety equipment will be acquired by the Forest. If reusable sampling equipment is acquired in the future, the Forest will purchase materials/supplies necessary for equipment decontamination; however, this is not necessary for the present study. Any equipment deemed to be in unacceptable condition would be replaced.

B.8.2 Field Measurement Supplies and Consumables

Field measurement supplies, such as calibration solutions, will be acquired from standard sources, such as the instrument manufacturer or reputable suppliers. Chemical supplies will be American Chemical Society reagent grade or higher. The lot number and expiration date on standards and reagents will be checked prior to use. Expired solutions will be discarded and replaced. The source, lot number, and expiration dates of all standards and reagents will be recorded in the field logbooks.

B.8.3 Laboratory Analysis (Off-Site) Supplies and Consumables

The laboratory's requirements for supplies and consumables are described in its QA Manual.

B.9 Non-direct Measurements

To supplement field measurements and laboratory analytical activities conducted under this project, other potential "external" data sources will be researched. These sources include, but are not limited to, the U.S. Geological Survey, California Department of Water Resources, County of San Bernardino, City of Big Bear Lake, the U.S. Environmental Protection Agency, and the Bureau of Reclamation. The primary use of this external data will be to help focus the Forest's data collection efforts (for example, the information may be used to identify new sites for future sampling).

If it appears that the "external" data might facilitate water body evaluation, the data will first be reviewed to verify that they are of sufficient quality to meet the needs of the project by examining: (1) the sample collection and location information; (2) the data to see whether they are consistent with known Forest-collected data from the same general vicinity; and (3) the QA/QC information associated with the data. If the data are of insufficient or unknown quality, limitations will be placed on its use in supporting project decisions. In general, it is anticipated that decisions for the current project will be based on data collected by the Forest following this current QA Project Plan.

B.10 Data Management

All data collected by the San Bernardino National Forest Hydrology Program will be maintained in appropriate bound notebooks and electronic databases. Data from the laboratory will be requested in both hard copy and electronic form. The electronic and hard copy results will be compared to ensure that no errors occurred in either format. If discrepancies are noted, the laboratory will be contacted to resolve the issues.

C. ASSESSMENT AND OVERSIGHT

C.1 Assessments and Response Actions

During the course of the project, it is important to assess the project's activities to ensure that the QA Project Plan is being implemented as planned. This helps to ensure that everything is on track and serves to minimize learning about critical deviations toward the end of the project when it may be too late to remedy the situation. For the current project, the ongoing assessments will include:

Field Oversight –

- Readiness review of the field team prior to starting field efforts,
- Field activity audits, and
- Review of field sampling and measurement activities methodologies and documentation at the end of each event, and

Laboratory Oversight –

- Evaluation of laboratory data generated for each monthly sampling event.

Details regarding these assessments are included below.

C.1.1 Field Oversight

C.1.1.1 Readiness Reviews

Sampling personnel will be properly trained by qualified personnel before any sampling begins and will be given a brief review of sampling procedures and equipment operation by the FRVC Field Team Leader before each sampling event. Equipment maintenance records will be checked to ensure all field instruments are in proper working order. Adequate supplies of all preservatives and bottles will be obtained and stored appropriately before heading to the field. Sampling devices will be checked to ensure that they have been properly cleaned (for devices which might be reused) or are available in sufficient quantity (for devices which are disposable). The sampling technician will assemble proper paperwork, logbooks, chain of custody forms, etc. The FRVC Field Team Leader will review all field equipment, instruments, containers, and paperwork to ensure that all is in readiness prior to the first day of each sampling event. Any problems that are noted will be corrected before the sampling team is permitted to depart the Forest's facilities.

C.1.1.2 Field Activity Audits

Each quarter, the San Bernardino National Forest Project Manager/QA Officer will assess the sample collection methodologies, field measurement procedures, and record keeping of the field team to ensure activities are being conducted as planned (and as documented in this QA Project Plan). Any deviations that are noted will be corrected immediately to ensure all subsequent samples and field measurements collected are valid. (Note: If the deviations are associated with technical changes and/or improvements made to the procedures, the San Bernardino National Forest PM/QA Officer will update the Field Log Book and addressed in an amendment to this QA Project Plan.) The San Bernardino National Forest PM/QA Officer may stop any sampling activity that could potentially compromise data quality.

The San Bernardino National Forest PM/QA Officer will document any noted issues or concerns in a QA Audit Logbook and discuss these items informally and openly with the FRVC Field Team Leader while on site. Once back in the office, he/she will formalize the audit findings (for each event) in a Field Audit Report, which will be submitted to the FRVC Field Team Leader.

C.1.2 Laboratory Oversight

Following receipt of the off-site laboratory's data package for each sampling event, the San Bernardino National Forest PM/QA Officer will review the data package for completeness, as well as to ensure that all planned methodologies were followed and that QA/QC objectives were met.

Due to the scope and objectives of the current project, the Forest is not planning any laboratory audits at this time. However, the Forest will check periodically to make sure that Clinical Lab of San Bernardino, Inc. is an ELAP-accredited facility and remains in good standing for those methods that the Forest is requesting.

D. DATA VALIDATION AND USABILITY

D.1 Data Review, Verification, and Validation

Setting data review, verification, and validation requirements helps to ensure that project data are evaluated in an objective and consistent manner. For the current project, such requirements have been defined for information gathered and documented as part of field sampling and field measurement activities, as well as for data generated by the off-site laboratory.

D.1.1 Field Sampling and Measurement Data

Any information collected during sample collection and field measurements is considered field "data." This includes field sampling and measurement information documented in field logbooks, photographs, and chain of custody forms.

Once the FRVC Field Team Leader returns to the office following a field event, he/she is responsible for conducting a technical review of the field data to ensure that all information is complete and any deviations from the planned methodologies are documented.

D.1.2 Laboratory Data

For the data generated by Clinical Lab of San Bernardino, Inc., the laboratory is responsible for its own internal data review and verification prior to submitting the associated data results package to the San Bernardino National Forest PM/QA Officer. The details of the review (including checking calculations, reviewing for transcription errors, ensuring the data package is complete, etc.) are discussed in the laboratory's QA Manual.

Once the laboratory data are received by the Forest, the San Bernardino National Forest PM/QA Officer is responsible for further review and validation of each data package. This review will include evaluation of the field and laboratory duplicate results, field and laboratory blank data, matrix spike recovery data, and laboratory control sample data pertinent to each analysis.

The San Bernardino National Forest PM/QA Officer will further evaluate each data package's narrative report and summary tables to see whether the laboratory "flagged" any sample results based on poor or questionable data quality and to ensure that any exceedances of the laboratory's QC criteria are documented. If a problem was noted by the laboratory, the San Bernardino National Forest PM/QA

Officer will evaluate whether the appropriate prescribed corrective action was taken by the laboratory, the action successfully resolved the problem, and the process and its resolution were accurately documented.

An effort will be made to identify whether any data quality problem is the result of laboratory issues and/or if it may be traced to some field sampling activity. If the laboratory is determined to be responsible, the San Bernardino National Forest PM/QA Officer will request information from the laboratory documenting that the problem has been resolved prior to submitting future samples. If some aspect of the field operation (e.g., sample collection, sample containers and/or preservation, chain-of-custody, sample shipment, paperwork, etc.) is identified as the possible problem, efforts will be made to retrain the FRVC field staff to minimize the potential of the problem recurring. If the problem is believed to be due to the sample matrix, the San Bernardino National Forest Project Manager/QA Officer will discuss the use of alternative analytical methods with the laboratory; and, if an alternative method is available that might minimize the problem, the QA Project Plan will be modified and/or amended accordingly.

D.2 Verification and Validation Methods

Defining the data verification and validation methods helps to ensure that project data are evaluated in an objective and consistent manner. For the current project, such methods have been described for information gathered and documented as part of the field sampling and field measurement activities, as well as the data generated by the off-site laboratory.

D.2.1 Field Sampling and Measurement Data

The methods associated with verification and validation of the field sampling and measurement data are included within the discussion provided in Section D.1.1.

D.2.2 Laboratory Data

The methods associated with verification and validation of the laboratory data are included within the discussion provided in Section D.1.2.

D.3 Reconciliation with User Requirements

The purpose of the continued monitoring of the San Bernardino National Forest is to assess whether the Forest's practices or activities are supporting designated beneficial uses of the water. Data must fulfill the requirements of this QA Project Plan to be useful for the overall project. This section describes the steps to be taken to ensure data usability (after all the data have been assembled, reviewed, verified, and validated) prior to summarizing the information in the Quarterly and Annual Reports.

Once all the data from the field and laboratory have been evaluated (as described in Sections D.1 and D.2), the San Bernardino National Forest PM/QA Officer will make an overall assessment concerning the final usability of the data (and any limitations on its use) in meeting the project's needs. The initial steps of this assessment will include, but not necessarily be limited to:

- Discussions with the FRVC Field Team Leader,
- Review of deviations from the QA Project Plan or associated SOPs to determine whether these deviations may have impacted data quality (and determining whether any impacts are widespread or single incidents, related to a few random samples or a batch of samples, and/or affecting a single or multiple analyses),

- Evaluation of the field and laboratory results and QC information,
- Review of any other external information which might influence the results, such as off-reservation activities up stream, meteorological conditions (such as storm events proceeding sampling that might contribute to high turbidity readings), and data from other sources,
- Evaluation of whether the completeness goals defined in this QA Project Plan have been met,
- Examination of any assumptions made when the study was planned, if those assumptions were met, and, if not, how the project's conclusions are affected.

After all this information has been reviewed, the San Bernardino National Forest Project Manager/QA Officer will incorporate their perspective on the critical nature of any problems noted and, ultimately, identify data usability and/or limitations in supporting project objectives and decision making. All usable data will then be compared to the Project Action Limits to identify whether these limits have been exceeded.

In addition, the San Bernardino National Forest Project Manager/QA Officer will assess the effectiveness of the monitoring program and data collection at the end of each calendar year. Sampling locations, frequency, list of analytical parameters, field measurement protocols, choice of the analytical laboratory, etc. will be modified as needed to reflect the changing needs and project objectives of the San Bernardino National Forest. This QA Project Plan will be revised and/or amended accordingly.