BIG BEAR LAKE
NUTRIENT TMDL COMPLIANCE PROGRAM
WATERSHED-WIDE
MONITORING PLAN

Prepared for

Big Bear Lake Nutrient TMDL Task Force

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1. INTRODUCTION

1.1 Background

Big Bear Lake rests 7,000 feet above sea level in the San Bernardino mountains of southern California. When full, the lake covers approximately 3,000 surface acres and holds more than 72,000 acre-feet of water. On average, the lake is about 30 feet deep and provides habitat for numerous fish and other aquatic organisms. Bald eagles are known to roost in the area and forage in the lake for food.

The 25,000 acre watershed surrounding Big Bear Lake is largely comprised of undeveloped national forest lands. However, a thriving small community of 15,000 people has grown up along the south shore to support the nearly 6 million tourists who visit the City of Big Bear Lake each year. These folks come to enjoy fishing, boating, water-skiing and swimming during the summer and snow-skiing, snow-boarding, tubing and sledding at the nearby resorts in the winter. Because the local economy is based almost entirely on tourism, maintaining the health and integrity of Big Bear Lake is high priority for the people who live and work in the area.

Several years ago, the Santa Ana Regional Water Quality Control Board (Regional Board) added Big Bear Lake and three of its major tributaries to California's list of impaired water bodies due to elevated levels of nitrogen and phosphorus measured in the lake and tributaries[1]. These chemicals act as fertilizers to stimulate excess algae growth, which can cause fish kills by reducing dissolved oxygen, and aquatic weed infestation, which can out-compete native aquatic plant habitat. The weeds and algae also interfere with recreational uses in and on the water.

Although nitrogen and phosphorus occur naturally in runoff from the surrounding forest to the lake, human development often increases the concentration of these nutrients. Consequently, in 2006, the Regional Board adopted a Total Maximum Daily Load (TMDL) to regulate nutrient concentrations and prevent further impairment of water quality in Big Bear Lake[2].

Initially, the TMDL sets targets for the total phosphorus loads that can flow into Big Bear Lake during relatively dry years. However, as more and better data becomes available, the Regional Board intends to develop a TMDL to control nutrient loads during years of moderate and high precipitation. To achieve these goals, the Regional Board directed local stakeholders to prepare and submit a watershed-wide nutrient Monitoring Plan[3]. This document is intended to fulfill that requirement.

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[1] See Clean Water Action Section 303(d) List of Water Quality Limited Segments in California (http://www.waterboards.ca.gov/tmdl/303d_lists.html)

[2] California Regional Water Quality Control Board #8 – Santa Ana Region. Resolution No. R8-2006-0023. Resolution Amending the Water Quality Control Plan for the Santa Ana River Basin to Incorporate a Nutrient Total Maximum Daily Load (TMDL) for Dry Hydrological Conditions for Big Bear Lake. April 21, 2006.

[3] California Regional Water Quality Control Board #8 – Santa Ana Region. Attachment to Resolution No. R8-2006-0023. Resolution Amending the Water Quality Control Plan for the Santa Ana River Basin to California Regional Water Quality Control Board #8 – Santa Ana Region. Attachment to Resolution No. R8-2006-0023. Resolution Amending the Water Quality Control Plan for the Santa Ana River Basin to Incorporate a Nutrient Total Maximum Daily Load (TMDL) for Dry Hydrological Conditions for Big Bear Lake. April 21, 2006. See Task 4.1 on page 10 of 18.

1.2 Purpose

In the TMDL, the Regional Board set forth four specific objectives for the Watershed-Wide Monitoring Plan:

1. To review and update the Big Bear Lake Nutrient TMDL.
2. To determine specific sources of nutrients.
3. To develop TMDLs for other hydrologic conditions (wet & moderate years).
4. To determine compliance with the Big Bear Lake Dry Nutrient TMDL, including the load and waste load allocations.

Over the last few years, with considerable support from state and federal grant funds, local stakeholders developed studies, including comprehensive monitoring programs of the watershed and the lake itself[4]. A large database of water quality information was created as part of these studies. The watershed-wide Monitoring Plan is intended to continue and enhance existing datasets to characterize water quality in the runoff draining to Big Bear Lake. One reason additional research is necessary is that, over the last few years, local stakeholders have implemented several new projects designed to improve water quality in Big Bear Lake (Table 1-1). It is important to confirm and quantify the effect of these remediation efforts in order to determine what additional steps must be taken to ensure long term protection of the lake.

Table 1-1. Projects Designed to Restore and Protect Beneficial Uses in Big Bear Lake

Remediation Project Dates	Dates
Lake Level Stabilization	1977 – present
Aquatic Weed Control - Harvesting	1980 – 2002
Aquatic Weed Control - Herbicides	2002 – present
Alum Application	2003 – 2004
Sediment Trapping Basins	2000 – present
Deep Water Aeration Systems	2004 – present
Active Fishery Management	2005 – present
Sediment Dredging	1980 – 2005

More data are also required to fill the gaps that presently preclude the Regional Board from calibrating water quality models to manage pollutant loads under moderate and wet weather conditions. The vast majority of nutrient loads are carried into the lake during the rainiest and snowiest years. Therefore, long-term success reducing nutrient impairments in Big Bear Lake depends on a better understanding of the dynamic and complex local hydrology.

It is important to note that the Regional Board also required stakeholders to prepare and submit a separate water quality monitoring program for the lake itself[5]. Although the two plans share many of the same purposes, they are, in fact, separate documents. Big Bear Municipal Water District (BBMWD) independently developed and implemented the In-Lake Monitoring Program. The other stakeholders (City of Big Bear Lake, Big Bear Municipal Water District, San Bernardino County, Big Bear Mountain Resorts, State of California Department of Transportation and the U.S. Forest Service) took responsibility for developing and

[4] California State Water Resources Control Board Agreement No. 04-204-558-0 (Proposition 13)

[5] California Regional Water Quality Control Board #8 – Santa Ana Region. Attachment to Resolution No. R8-2006-0023. Resolution Amending the Water Quality Control Plan for the Santa Ana River Basin to Incorporate a Nutrient Total Maximum Daily Load (TMDL) for Dry Hydrological Conditions for Big Bear Lake. April 21, 2006. See Task 4.2 on page 13 of 18.

implementing the Watershed-Wide Monitoring Plan. Whenever and wherever possible, the stakeholders intend to coordinate and integrate the monitoring efforts to improve data utility and reduce cost. However, this document addresses only Task 4.1 in the adopted TMDL. Task 4.2, the In-Lake Monitoring Plan, is provided as a separate submittal to the Regional Board.

Finally, the stakeholders recognize that it will be useful to review and revise both monitoring plans in response to new information and regulatory requirements. To that end, the Watershed-Wide Monitoring Plan proposed in this document is not intended to establish permanent obligations or commitments. It establishes a reasonable starting point with every expectation that the sampling locations, collection schedule, analytical parameters, and other key elements may change periodically, provided the Regional Board approves such modifications to the Monitoring Plan.

2. DATA QUALITY OBJECTIVES

This section identifies the Data Quality Objectives (DQO), Measurement Quality Objectives (MQOs) and Data Quality Indicators (DQI) for the monitoring elements associated with this project (See Tables 2-1 through 2-4). The procedures and practices described below are designed to generate data of the type and quality necessary to support decision making as discussed in the Introduction to this Plan and ensure Surface Water Ambient Monitoring Program (SWAMP) comparability.

2.1 Big Bear Lake Watershed-Wide Nutrient Monitoring Plan:

- Tributary Water Quality, and Flow Data
  - Tributary nutrient monitoring efforts will be conducted near the mouths of 303d listed tributaries, including Rathbun Creek, Summit Creek, Grout Creek, and Knickerbocker Creek. Nutrient and supporting water quality data monitoring of the Bear Creek Outlet (Dam Outlet) will also occur, and Boulder Creek will be monitored as a "reference tributary".
  - The tributary nutrient monitoring efforts consist of the collection and analyses of discrete manual grab (IMG) samples or alternatively, samples may be collected using automated sampling equipment.
  - In order to ensure that a reasonable number of tributary water quality samples are collected for seasonal flow regimes, the following sample number target goals have been established:
    - Baseline Flow: Monthly samples from each applicable tributary (includes visual documentation when flow is absent).
    - Snow Melt Flow: Four monthly samples from each applicable tributary (once a month between February and May when representative flow is present).
    - Storm Event Flow: Sample two separate storm events and collect eight samples from each event over the hydrograph.
  - The project MQOs/DQIs for Completeness, Sensitivity, Precision, and Accuracy for analytical methods have been established in accordance with the SWAMP guidelines and are sufficient for the characterization of nutrient levels in tributaries.

Table 2-1 Data Quality Objectives for Conventional Water Quality Parameters (Field Monitoring*)								
Parameter	Principle	Units	Range	TRL	Accuracy	Precision	Recovery	Completeness
Temperature	Thermistor	Degrees Celsius (ºC)	0 – 50 oC	N/A	+/- 0.1 ºC	No SWAMP requirement; will use + 0.5 or 5%	N/A	No SWAMP requirement; will use 90%
Dissolved Oxygen	Membrane/ galvanic cell	mg/L	0 – 19.9	0.2	+/- 0.1 mg/L	No SWAMP requirement; will use + 0.5 or 10%	N/A	No SWAMP requirement; will use 90%
pH	Glass Electrode	s.u.	0 – 14.0	N/A	+/-0.1 s.u.	No SWAMP requirement; will use + 0.5 or 5%	N/A	No SWAMP requirement; will use 90%
Conductivity	Alternating four-electrode	uS/cm	0 - 100	2	+/-1 uS/cm	No SWAMP requirement; will use + 5%	N/A	No SWAMP requirement; will use 90%
Turbidity	Scattering/ transmitting light	NTUs	0 - 800	5	+/-1 NTU	No SWAMP requirement; will use + 10% or 0.1, whichever is greater	N/A	No SWAMP requirement; will use 90%

*Equipment is Horiba U-10 or other multi-parameter meter; accuracy verified with the manufacturer.

Table 2-2 Data Quality Objectives for Water Quality Analyses (Laboratory)							
Parameter	Method	Units	MDL/ TRL	Accuracy	Precision	Recovery	Completeness
Total Nitrogen	SM 4500	mg/L	Calc	Standard Ref. within 95% CI	Laboratory duplicate 25% RPD	Matrix Spike 80 -120%	90%
Total Dissolved Nitrogen	SM 4500	mg/L	Calc	Standard Ref. within 95% CI	Laboratory duplicate 25% RPD	Matrix Spike 80 -120%	90%
Ammonia Nitrogen	SM 4500 NH3N	mg/L	0.1	Standard Ref. within 95% CI	Laboratory duplicate 25% RPD	Matrix Spike 80 -120%	90%
Nitrate-Nitrite Nitrogen	SM 4500 N02B EPA 300.0	mg/L	0.1	Standard Ref. within 95% CI	Laboratory duplicate 25% RPD	Matrix Spike 80 -120%	90%
Total Phosphorus	SM 4500 PBE	mg/L	No SWAMP requirement	Standard Ref. within 95% CI	Laboratory duplicate 25% RPD	Matrix Spike 80 -120%	90%
Total Dissolved Phosphorus	SM 4500 PBE	mg/L	No SWAMP requirement	Standard Ref. within 95% CI	Laboratory duplicate 25% RPD	Matrix Spike 80 -120%	90%
Ortho-Phosphate	Ascorbic acid	mg/L	0.01	Standard Ref. within 95% CI	Laboratory duplicate 25% RPD	Matrix Spike 80 -120%	90%
Total	SM 2540 D	mg/L	0.5/0.5	Standard Ref.	Laboratory	Matrix Spike	90%

Table 2-2 Data Quality Objectives for Water Quality Analyses (Laboratory)							
Parameter	Method	Units	MDL/ TRL	Accuracy	Precision	Recovery	Completeness
Suspended Solids (TSS)				within 95% CI	duplicate 25% RPD	80 -120%	
Dissolved Organic Carbon (DOC)	SM 5310 B	mg/L	0.6	Standard Ref. within 95% CI	Laboratory duplicate 25% RPD	Matrix Spike 80 -120%	90%
Biochemical Oxygen Demand (BOD)	SM 5210 B	mg/L	2	Standard Ref. within 95% CI	Laboratory duplicate 25% RPD	Matrix Spike 80 -120%	90%
Chemical Oxygen Demand (COD)	SM 5220 D	mg/L	5	Standard Ref. within 95% CI	Laboratory duplicate 25% RPD	Matrix Spike 80 -120%	90%
Volatile Suspended Solids (VSS)	SM 2540 E	mg/L	1.0/1.0	Standard Ref. within 95% CI	Laboratory duplicate 25% RPD	Matrix Spike 80 -120%	90%
Total Organic Carbon (TOC)	SM 5310 B	mg/L	0.1/0.6	Standard Ref. within 95% CI	Laboratory duplicate 25% RPD	Matrix Spike 80 -120%	90%
Alkalinity as CaCO3	SM 2320 B	mg/L	0.2/1.0	Standard Ref. within 95% CI	Laboratory duplicate 25% RPD	Matrix Spike 80 -120%	90%
Hardness as CaCO3	Man Ver 2 Buret Titration HACH 8266	mg/L	0.2/1.0	Standard Ref. within 95% CI	Laboratory duplicate 25% RPD	Matrix Spike 80 -120%	90%

N/A = Not Applicable; TBD = To Be Determined

An associated Quality Assurance Project Plan (QAPP) has been prepared for this project, and includes additional detail regarding data quality objectives. The QAPP will be submitted to the Task Force in late spring or early summer 2009 and will include additional detail and standard operation procedures (SOP).

3. MONITORING PROGRAM DESIGN

3.1 Sampling Locations

In the TMDL, the Regional Board specified seven mandatory sampling stations: one each on the major tributaries to Big Bear Lake (Bear Creek, Grout Creek, Summit Creek, Knickerbocker Creek and Boulder Creek) and two on Rathbun Creek (Table 3-1 and Figure 1). No sampling point may be deleted from the list without advanced authorization from the Regional Board. However, the stakeholders may add more sampling locations at any time without the need for Regional Board approval.

Table 3-1 Water Quality and Sediment Sampling Locations, Parameters, & SOPs						
Sampling Location	Location ID Number	GPS Coordinates	Matrix	Parameters	Sampling Schedule	Sampling SOPs
Rathbun Creek (@ Sandlewood Drive)	801MWDC04	Lat. 34.2531 Long. -116.887354	Water	Temp., DO, pH, conductivity, turbidity, TN, TDN, NH3-N, NO3+NO2, TP, TDP, Ortho-P, BOD, COD, DOC, Hardness, Alkalinity, TSS, VSS, Flow, Grain Size	12 Monthly Baseline, 4 Monthly Snowmelt (once per month, Feb-May); 1 Summer Storm, 1 Winter Storm	Form 11-4
Rathbun Creek (Below Zoo)	Input SWAMP station id nomenclature	TBD	Water	Temp., DO, pH, conductivity, turbidity, TN, TDN, NH3-N, NO3+NO2, TP, TDP, Ortho-P, BOD, COD, DOC, Hardness, Alkalinity, TSS, VSS, Flow, Grain Size	12 Monthly Baseline, 4 Monthly Snowmelt (once per month, Feb-May); 1 Summer Storm, 1 Winter Storm	Form 11-4
Grout Creek (@ Highway 38)	801MWDC03	Lat. 34.269447 Long. -116.948437	Water	Temp., DO, pH, conductivity, turbidity, TN, TDN, NH3-N, NO3+NO2, TP, TDP, Ortho-P, BOD, COD, DOC, Hardness, Alkalinity, TSS, VSS, Flow, Grain Size	12 Monthly Baseline, 4 Monthly Snowmelt (once per month, Feb-May); 1 Summer Storm, 1 Winter Storm	Form 11-4
West Summit Creek (@ Swan Drive)	801MWDC05	Lat. 34.248679 Long. -116.893777	Water	Temp., DO, pH, conductivity, turbidity, TN, TDN, NH3-N, NO3+NO2, TP, TDP, Ortho-P, Hardness, Alkalinity, TSS, VSS, Flow, Grain Size	12 Monthly Baseline, 4 Monthly Snowmelt (once per month, Feb-May); 1 Summer Storm, 1 Winter Storm	Form 11-4
Knickerbocker Creek (@ Highway 18)	801MWDC08	Lat. 34.243998 Long. -116.910525	Water	Temp., DO, pH, conductivity, turbidity, TN, TDN, NH3-N, NO3+NO2, TP, TDP, Ortho-P, BOD, COD, DOC, Hardness, Alkalinity, TSS, VSS, Flow, Grain Size	12 Monthly Baseline, 4 Monthly Snowmelt (once per month, Feb-May); 1 Summer Storm, 1 Winter Storm	Form 11-4
Boulder Bay Creek (@ Highway 18)	801MWDC13	Lat. 34.237411 Long. -116.953122	Water	Temp., DO, pH, conductivity, turbidity, TN, TDN, NH3-N, NO3+NO2, TP, TDP, Ortho-P, BOD, COD, DOC, Hardness, Alkalinity, TSS, VSS, Flow, Grain Size	12 Monthly Baseline, 4 Monthly Snowmelt (once per month, Feb-May); 1 Summer Storm, 1 Winter Storm	Form 11-4

The stakeholders may add more sampling stations where needed to trace specific sources. However, it is not possible to identify supplemental sampling sites until water quality data from the baseline monitoring program is collected and analyzed. In addition, the stakeholders may recommend deleting the sampling station on Rathbun Creek below the zoo (MWDC #6) at some future date. The zoo is planning to move to a location along the north shore of Big Bear Lake; thus there would not be a need to monitor directly downstream from the zoo, a suspected source of nutrients and other constituents.

Any additions or recommended modifications to the watershed-wide Monitoring Plan will be included in the Annual Reports submitted to the Regional Board beginning in February 2010.

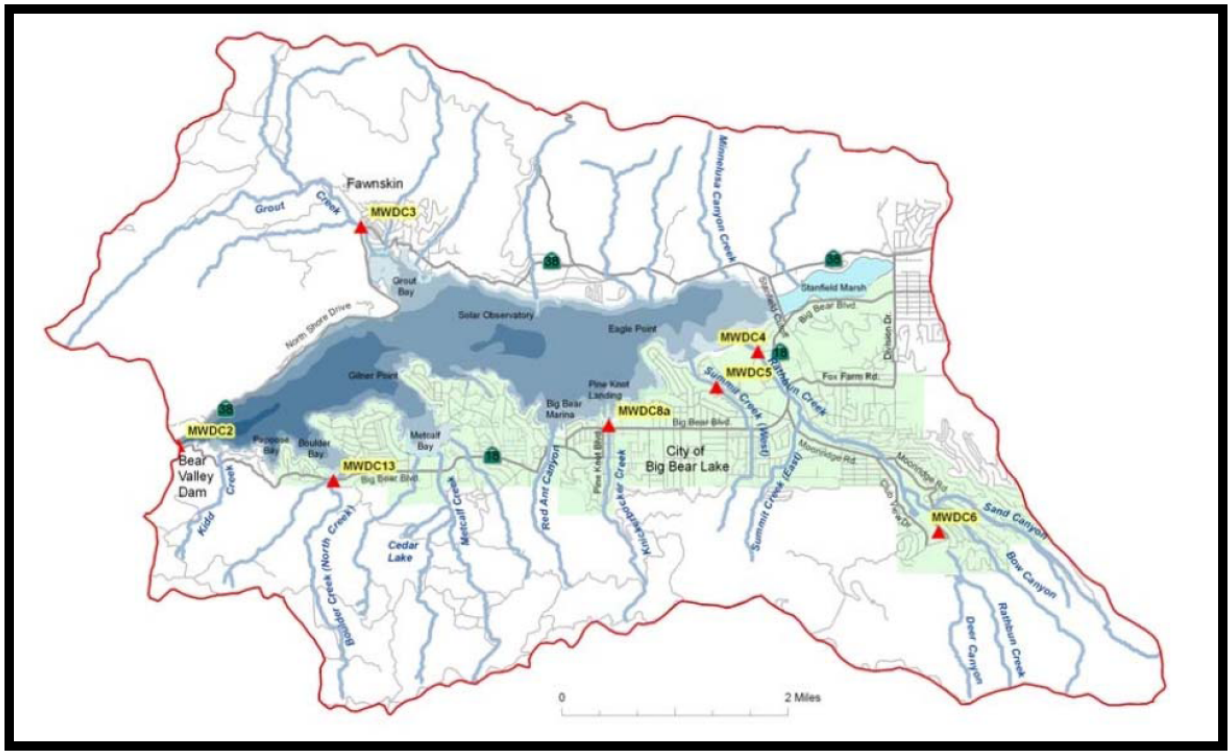

Figure 1. Sampling Locations in Big Bear Lake Watershed

3.2 Analytical Parameters

As with the sampling locations, the Regional Board mandated in the TMDL that certain water quality parameters be analyzed and reported. The specific field and laboratory parameters to be analyzed are presented in Table 3-2, along with information regarding the methods, units, method detection limit, and target reporting limit. Data regarding accuracy, precision, recovery, and completeness were presented above in Tables 2-1 and 2-2. No analyte may be deleted from the list without advanced authorization from the Regional Board. However, the stakeholders may add more analytes at any time without the need for Regional Board approval.

Table 3-2 Analytical Methods for Water Quality Parameters (Field and Laboratory)					
Parameter	Laboratory	Units	Analytical Method	MDLs	Target Reporting Limits
Temperature	B&C Staff	°C	Thermometer (-5 to 50oC)	NA	NA
Dissolved Oxygen	B&C Staff	mg/L	Field – Horiba Meter	NA	0.2 mg/L
pH	B&C Staff	s.u.	Field – Horiba Meter	NA	NA
Conductivity	B&C Staff	mS/cm	Field – Horiba Meter	NA	2.0 mg/L
Turbidity	B&C Staff	NTU	Field – Horiba Meter	NA	5.0 mg/L
Biochemical Oxygen Demand (BOD)	E.S. Babcock	mg/L	SM 5210B	1.0 mg/L	5.0 mg/L
Chemical Oxygen Demand (COD)	E. S. Babcock	mg/L	SM 5220D	1.0 mg/L	5.0 mg/L
Total Organic Carbon (TOC)	E.S. Babcock	mg/L	SM 5310B	0.1 mg/L	0.6 mg/L
Dissolved Organic Carbon (DOC)	E.S. Babcock	mg/L	SM 5210B	0.1 mg/L	0.6 mg/L
Total Nitrogen	E.S. Babcock	µg/L	4500-N B	4 µg/L	4 µg/L
Total Dissolved Nitrogen	E.S. Babcock	µg/L	4500-N B	4 µg/L	4 µg/L
Ammonia Nitrogen	E.S. Babcock	µg/L	SM 4500-NH3, 10-107-06-3-D	3 µg/L	3 µg/L
Nitrate/Nitrite Nitrogen	E.S. Babcock	µg/L	SM 4500-NO2B 10-107-04-1-B	5 µg/L	5 µg/L
Total Phosphorus	E.S. Babcock	µg/L	SM 4500 PBE 10-115-01-1-U	2 µg/L	2 µg/L
Total Dissolved Phosphorus	E.S. Babcock	µg/L	SM 4500 PBE 10-115-01-1-U	2 µg/L	2 µg/L
Ortho-Phosphate	E.S. Babcock	µg/L	SM 4500 PE 10-115-01-1-T	3 µg/L	3 µg/L
Total Suspended Solids	E.S. Babcock	mg/L	SM 2540 D	0.5 mg/L	0.5 mg/L
Volatile Suspended Solids	E.S. Babcock	mg/L	SM 2540 E	1.0 mg/L	1.0 mg/L
Alkalinity as CaCO3	E.S. Babcock	mg/L	SM 2320 B	0.2 mg/L	1.0 mg/L
Hardness as CaCO3	E.S. Babcock	mg/L	SM 3120 B HACH 8266	0.2 mg/L	1.0 mg/L

3.3 Sampling Schedule

The stakeholders propose to collect and analyze samples based on the schedule presented in Table 3-3.

Table 3-3: Sampling Schedule to Characterize Water Quality of Runoff in Watershed

Type of Analysis	Sampling Period	Sampling Frequency
Baseline Quality (Dry Weather)	Jan. 1st – Dec. 31st	Once per month when representative flow is present
Snowmelt Quality	Feb. 1st – May 31st	Four samples, once per month, between February and May when representative flow is present
Winter Storms	Oct. 1st – Mar. 31st	One storm event where est. rainfall >0.5"/24 hrs
Summer Storms	Apr. 1st – Sept. 1st	One storm event where est. rainfall >0.5"/24 hrs

Sampling will begin no later than 60 days after the Regional Board staff approves this Final Monitoring Plan. Storm events that occur after business hours or on the weekends will not be sampled due to safety issues and manpower constraints.

3.4 Changes to the Sampling Design and Schedule

The proposed sampling design and schedule differs from that specified in the TMDL. Several factors affect the ability of the stakeholders to accomplish the proposed sampling schedule. There are insufficient resources available in the small rural community of Big Bear Lake City, to support the level of effort required to collect all of the recommended samples recommended in the TMDL. For example, the TMDL had specified weekly visual observations, extensive snow melt sampling, and sampling three storm events. In discussions at the Task Force meetings, it was decided that weekly observations were not necessary, as sampling would be conducted monthly, and that would be sufficient to determine when the streams are flowing. Similarly, the Task Force decided that single day sampling of snowmelt once a month between February and May would be adequate to characterize this form of runoff (rather than the more prescriptive sampling schedule provided in the TMDL). Finally, the remote location of the watershed makes it virtually impossible to contract sampling services for storm events; therefore, the stakeholders must rely on training resident personnel. Consequently, the Task Force decided that two storm events per year was the maximum number of storms that can be feasibly sampled (one in each season at each sampling location) rather than the three events requested by the Regional Board.

It may not be possible to collect samples from all locations during a single storm event. Sampling may be divided, with some locations being collected during an early season storm and remaining locations during a late season storm. This fragmented schedule will make best use of available staff and resources (particularly automated samplers). Per the SWAMP, completeness is the fraction of planned data that must be collected in order to fulfill the statistical criteria of the project. A target of 90 percent completeness is reasonable as it accounts for the possibility of adverse weather conditions, safety concerns, and equipment problems.

3.5 Sampling Protocols

This Monitoring Plan includes three Standard Operating Procedures (SOP) that detail how the field parameters will be sampled, equipment needed, calibration schedule, maintenance routines, and where records will be kept (SOP 11-4, Big Bear Lake Tributary Water Quality Sampling SOP and Record, SOP 15-1, Big Bear Lake Horiba Instrument Maintenance SOP and Record, and SOP 16-1, Big Bear Lake Horiba Instrument Calibration SOP and Record). This SOP is included as an Appendix to this Monitoring Plan. In addition, this Plan includes a SOP for watershed-wide sampling which details how the water samples will be collected, equipment needed, calibration schedule, maintenance routines, sample containers, preservation and storage, holding times, how samples will be labeled, and how samples will be packed for transportation to the lab (SOP 11-4 Big Bear Lake Tributary Water Quality Sampling SOP and Record), which is also included in the Appendix to this Plan. Specific details regarding field methods and procedures are described below in Section 4.0.

This Monitoring Plan specifies that samples will be collected when representative flow is present. Extreme low flow and flash flood conditions will not be sampled. Samples will only be collected when it is safe and prudent to do so.

Low flows usually percolate before reaching the lake and are, therefore, irrelevant to assessing TMDL compliance. In addition, low flow conditions create difficult sampling conditions as it is difficult to fill containers without disturbing the underlying sediment thereby contaminating the samples. Analytical results collected under such conditions would not accurately characterize true water quality and could severely distort subsequent interpretation and modeling efforts. Photographs will be used to document low flow conditions when and where they occur.

Flash floods occur frequently in mountain streams during rain storms, creating hazardous sampling conditions. While every effort will be made to collect all samples as required by the Regional Board, at no time will stakeholders allow sampling personnel to take undue risk to fulfill this obligation.

3.6 Data Management

The Big Bear Lake Nutrient TMDL Task Force will maintain a record of all field analyses and sample records collected through the monitoring program. SAWPA has an existing database of laboratory and field measurement data from previous studies. This database, along with all future data, will be maintained by SAWPA under the direction of the Monitoring Program Manager. Laboratory data will be reported and delivered in SWAMP format (http://swamp.mpsl.mlml.calstate.edu/resources-and-downloads/database-management-systems/swamp-25-database). All laboratory and field measurement data submitted to SAWPA for inclusion in the SAWDMS database will follow the guidelines and formats established by SWAMP (http://www.waterboards.ca.gov/swamp/qapp.html). Data will be 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 Task Force. Prior to upload, QA/QC tools will check new data against existing data in the database for completeness, validity of analytical methods, validity of sample locations, validity of sample dates, and data outliers. Data not passing QA/QC tests 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, 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.

All chemical monitoring records generated by these programs will be stored at SAWPA. The contract laboratory's records pertinent to the program will be maintained at the contract laboratory's main office.

Copies of all records held by the contract laboratory will be provided to the Task Force and stored in the Task Force archives.

All records will be passed on to the Santa Ana Regional Board TMDL Program Manager, and/or other State Agencies as required and appropriate for each project at project completion. Copies of the chemical monitoring records will be maintained by SAWPA and each laboratory contracted by the Task Force for five years after project completion then discarded, except for the database, which will be maintained without discarding. Copies of other monitoring records will be maintained by the Program Administrator for the Project for five years after project completion then discarded.

The Task Force's 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. The Task Force 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 2Ghz + 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.

Data will be exported from SAW DMS into the SWAMP format using a pre-made query that will map data fields from SAW DMS 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 SAW DMS using pre-made queries.

The Quality Assurance Manager will conduct reviews of sampling procedures on an annual basis. Reviews will be observed practices against those found in the QAPP. The Quality Assurance Manager will audit all contract laboratories annually. The review will be observed method practices against contract laboratory's SOPs and an audit of data from the contract laboratory's quality assurance and quality control program.

If an audit discovers any discrepancy, the Quality Assurance Manager will discuss the observed discrepancy with the appropriate person responsible for the activity. 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. The Quality Assurance Managers has the power to halt all sampling and analytical work by both Task Force and contract laboratory if the deviation(s) noted are considered detrimental to data quality.

All data records will be checked visually and recorded as checked by initials and dates. The Quality Assurance Manager will do all reviews, and the Task Force Program Coordinator will perform a check of 10% of the reports. The contract laboratory's Quality Assurance Officers will perform checks of all of its records and

the contract's Laboratory Director will recheck 10%. All checks by the contract laboratory will be reviewed by appropriate Task Force personnel.

Issues will be noted. Reconciliation and correction will be done by a committee composed of the Field Supervisor, Analyst, and appropriate Quality Assurance Manager; and the contract laboratory's Quality Assurance Officer and Laboratory Director. Any corrections require a unanimous agreement that the correction is appropriate.

The Task Force will meet regularly to review results from the monitoring program and make any appropriate adjustments to ensure the utility and integrity of data collected. The Regional Board will be notified of all such meetings and is welcome to participate in the process.

3.7 Reporting

All data collected will be comparable with the state's Surface Water Ambient Monitoring Program (SWAMP). The results of all sampling and analyses performed as part of this watershed-wide Monitoring Plan will be reported annually, in writing and electronically, to the Regional Board beginning in February 2010. The Annual Reports will include a statistical summary of the data noting any relevant spatial or seasonal differences observed. The annual report will also evaluate the sampling data to assess compliance with the load allocations, wasteload allocations or other relevant water quality objectives.

Copies of all laboratory reports, including any QA/QC data, will be included (on CD) as an appendix to the annual report. A copy of the electronic database, containing all data collected to support the Big Bear Lake TMDL effort, will also be provided (on CD) with the Annual Report. Hard copies will be made available at the request of the RWQCB.

Any deviations or exceptions from the approved watershed-wide Monitoring Plan will be identified and explained in the transmittal letter that accompanies the Annual Report when it is delivered to the Regional Board. Where appropriate, the stakeholders will also describe the specific steps taken to avoid similar deviations or exceptions in the future.

Where appropriate, the annual report may recommend changes to the watershed-wide Monitoring Plan. However, the number of sampling locations, specific analytes, or sampling frequency will not be reduced without prior authorization from the Regional Board. The stakeholders may also elect, at their option, to merge the annual reports for watershed-wide monitoring program with the in-lake monitoring program unless the Regional Board objects.

3.8 Period of Performance

It is likely that some sort of comprehensive watershed-wide monitoring program will be necessary for at least twenty years. This plan is only intended to cover the period from 2008 through 2012. This is necessary because the stakeholders cannot legally commit themselves or their agencies to expend public funds far into the indefinite future. The stakeholders will submit a revised Monitoring Plan by December 31, 2011. The revised Monitoring Plan should be evaluated and authorized during the regular Regional Board TMDL review scheduled to occur in 2012. Therefore, the commitment to perform the tasks described in this Monitoring Plan will expire on December 31, 2012 unless reauthorized by the Regional Board prior to that date.

3.9 Responsible Parties

The following firms, agencies, and individuals will be responsible for implementing the monitoring program. Important contacts and telephone numbers are provided in Table 3-4.

Brown and Caldwell

Nancy Gardiner is the Project Manager for Brown and Caldwell. Brown and Caldwell is responsible for preparing the Monitoring Plan and training staff from Big Bear Mountain Resorts, the City of Big Bear Lake, Big Bear Municipal Water District, and the U.S. Forest Service in proper sampling methods. As part of this training, staff from the stakeholder groups will "shadow" Brown and Caldwell staff during two dry weather season sampling events.

Stakeholders

Trained staff from Big Bear Mountain Resorts, the City of Big Bear Lake, Big Bear Municipal Water District, and the U.S. Forest Service will be responsible for conducting subsequent sampling efforts for dry weather, snow melt, and wet weather sampling events. In the event these staff are unavailable for this work, Brown and Caldwell may be called upon to assist with a portion of the effort.

Edward S. Babcock and Sons, Inc.

Edward S. Babcock and Sons, Inc. (Babcock) will serve as the analytical laboratory for this program. Babcock is certified under the State of California Environmental Laboratory Accreditation Program (ELAP). Cathy Iijima is responsible for supplying the sample bottles, coolers and chain of custody forms to Brown and Caldwell. Hsin-Yi Lee is responsible for coordinating the sample analyses and for addressing any changes with respect to sample analyses. Upon written request, the sampling teams can collect identical split samples to be shipped and analyzed by an independent laboratory selected by the Regional Board. There will be no charge for collecting the split samples; however, the Regional Board must pay for the cost of shipping and analyzing the samples to their laboratory.

Table 3-4. Important Contact Information

Name	Agency	Role	Office Phone	Cell
Nancy Gardiner	Brown and Caldwell	Project Manager	(858) 571-6742	(858) 337-4061
Lisa Skutecki	Brown and Caldwell	Field Team Member	(858) 571-6739	(619) 857-5472
Laura Carpenter	Brown and Caldwell	Field Team Member	(858) 571-6762	(858) 361-3971
Brett Bennetts	Brown and Caldwell	Field Team Member	(858) 571-6713	(858) 228-0867
Jim Atkinson	Brown and Caldwell	Field Team Member	(858) 571-6755	(858) 337-4064
Tim Moore	Risk Sciences	Task Force Consultant	(615) 370-1655	
Hope Smythe	Regional Water Quality Control Board	Regulatory Oversight	(951) 782-4493	
Michael Perez	Regional Water Quality Control Board	Regulatory Oversight	(951) 782-4306	
Heather Boyd	Regional Water Quality Control Board	Regulatory Oversight	(951) 320-2006	
Karl Klouzer	Big Bear Mountain Resorts	Task Force Member	(909) 866-5766 x 124	
Scott Heule	Big Bear Municipal Water District	Task Force Member	909-866-5796	
Cathy Jochai	California Department of Transportation	Task Force Member	(909) 381-5817	
David Lawrence	City of Big Bear Lake	Task Force Member	(909) 866-5831 x198	
Matt Yeager	San Bernardino County	Task Force Member	(909) 387-8112	
Mark Norton	Santa Ana Watershed Project Authority	Task Force Member	(951) 354-4221	
Rick Whetsel	Santa Ana Watershed Project Authority	Task Force Member	(951) 354-4222	
Robert Taylor	U.S. Forest Service	Task Force Member	(909) 382-2660	
Hsin-Yi Lee	Edward S. Babcock and Sons, Inc.	Analytical Laboratory	(951) 653-3351 x251	(909) 837-0903
Cathleen S. Iijima	Edward S. Babcock and Sons, Inc.	Analytical Laboratory	(951) 653-3351	(951) 205-7625

4. FIELD METHODS AND PROCEDURES

Water quality samples will be collected using one of the two following techniques:

- Instantaneous Manual Grab (IMG), or
- Automated Equipment (AE).

Beginning in spring 2009, instantaneous manual grab sampling will be used to collect baseflow, snow melt and storm event samples at the seven tributary stations. Corresponding tributary flows at the time of sampling will be recorded by the available flow equipment (i.e., pressure transducers). In the absence of flow measuring equipment, tributary flows will be estimated by water depth flowing over the constructed weir or a flow equation/calculation using dimension information about the channel.

During 2009, all samples will be collected using manual grab sampling methods while BBMWD's existing ISCO samplers are evaluated, repaired, and/or reconditioned for potential future use. Other existing automated samplers and flow-measuring devices may also be used for sampling. The installation and use of these devicesis managed by a number of state and federal agencies including, but not limited to: U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, U.S. Forest Service, U.S. Environmental Protection Agency, U.S. Geological Survey, California Department of Fish and Game, California Regional Water Quality Control Board - Santa Ana Region, California State Water Resources Control Board, California Department of Water Resources, San Bernardino County Flood Control District and the City of Big Bear Lake. Stream access and use of necessary sampling/measuring equipment is dependent upon receiving all necessary permits and authorization.

Each sample will be carefully documented using a field data collection sheet for the sampling technique utilized as well as the type of flow sampled. Automated samplers will also maintain an electronic sampling record.

4.1 Water Quality Sample Types

In the Big Bear Lake watershed, water flowing in tributaries (or flow type) is most likely the result of one or a combination of the following:

- Baseflow (generally spring fed flow);
- Snow Melt; and,
- Storm Event (rain precipitation).

Note: In all cases, it is extremely important for field personnel to clearly identify in the field notes and the chain-of-custody, the type of flow (or nature of the discharge) that was sampled.

Tributary water quality sampling frequency and sampling approach is dependent on the type of flow event and the time of year. Under this plan, tributary monitoring will be performed at the following frequencies for these established flow types:

- Baseflow – January through December – at a frequency of once per month when baseflow is present. If flow is absent, conduct visual monitoring (with photo documentation) only;
- Snow Melt – February through May – Snow melt sampling efforts are to be initiated a after a substantial snowfall event resulting in an accumulation of 1.0 foot or more of snow and after February 1st of each year; and,
- Storm Events – January through December - The storm event sampling objective is to capture a total of two storm events. Specifically, the goal will be to collect representative storm data from one (1) storm

event during Southern California's wet season (October – March) and one (1) summer storm event during California's dry season (April – September).

Sample types will be designated as one of the following types:

- First Flush (FF)
- Hydrograph Discreet (HD #1-8)
- Flow Composite (FC)

First Flush samples capture the first 30 minutes of tributary discharge during a storm event. The highest concentrations of contaminants (e.g., nutrients and sediments) are often found in the "first flush" discharges, which occur during the first major storm event after an extended dry period. First flush samples may be collected either as instantaneous grab samples or using automated samplers.

Hydrograph Discreet #1 - #8 samples are discrete samples that will be intended to characterize water quality concentrations at discrete points along the hydrograph. Ideally, the storm event sampling program will enable the collection of 8 discrete water quality samples over the entire hydrograph associated with a given storm event. These 8 samples will be submitted for individual analysis, and also combined for a flow composite analysis.

Flow Composite samples are flow-weighted composite samples collected by automated samplers during the entire period of the hydrograph. Storm samples will be combined into 24-hour flow-weighted composites for laboratory analysis as described in this Monitoring Plan. Historic data were collected as a time-weighted composite over a 2.5 hour interval which may not have captured the entire hydrograph.

Other Samples

For storm event, snow melt, and/or baseflow samples collected manually, the person sampling will document the date and time of sample collection, type of flow observed, and flow velocity. For snow melt and rain events, the sampler will make every attempt to document the start time of the event, the start time of the first observed discharge, the duration of the event, and any other informational observations. A field data collection sheet will be provided for this purpose.

4.2 Tributary Water Quality Sampling Parameters

A list of water quality sampling parameters, together with their analytical methods, units, method detection limits, target reporting limits, accuracy, precision, recovery, and completeness was presented above in Section 3.2. No analyte may be deleted from the list without advanced authorization from the Regional Board. However, the stakeholders may add more analytes, at any time without the need for Regional Board approval. Water quality indicators such as water temperature, conductivity, and pH will be measured using a multiparameter portable field meter (YSI 556-02, Horiba U-10, or equivalent). Field data sheets will be provided to report data measured and recorded in the field. All other samples will be submitted to Babcock Laboratories for analyses.

4.3 Tributary Flow Monitoring Stations

Tributary flow monitoring stations will be established at the following locations:

- **Boulder Creek** at Hwy. 18 (801MWDC13);
- **Grout Creek** (801MWDC03);
- **Rathbun Creek** @ Sandalwood (801MWDC04);
- **Knickerbocker Creek** at Hwy. 18 (801MWDC08);and,

Note: West Summit Creek will not be equipped with a flow measuring structure or device. Although this station will periodically be monitored for water quality parameters, this tributary often has insufficient surface flow for consistent monitoring.

Boulder Creek – At this location, just upstream of the Highway 18 crossing and a water level pressure transducer, an existing compound weir (5 cfs rectangular and v-notch weir) will be utilized to collect flow data. This weir is located below the lake high water line (HWL), therefore, flow data at this location will not be available when it is submerged by backwater. If resources and time allows, the BBMWD may install a partial flume and a second water level pressure transducer upstream of both the existing weir and lake backwater. Physical restraints at the upstream location may prevent the installation of the partial flume, therefore, the potential for installation is only tentative. A data logging pressure transducer and a U.S. Geological Survey staff gage (0 to 6 feet in depth range) are also scheduled to be installed in Boulder Creek. The pressure transducer and staff gage will measure water level in the stream, which can then be converted to stream flow data.

Grout Creek – Flow measurements from Grout Creek are extremely critical to project efforts as flows from this tributary primarily drain property owned by the U.S. Forest Service. Grout Creek is currently the only tributary to provide monitoring data from the north shore of the lake.

Grout Creek currently enters the lake under three archways associated with the Highway 38 bridge. BBMWD plans to construct a broad-crested concrete weir along the base of all three arches, approximately 12 inches in total height above the stream bed, which would include the embedding of a compound v-notch/rectangular weir in the center archway.

A data logging pressure transducer and a U.S. Geological Survey staff gage (covering a range of 0 to 6 feet) will also be installed at this location adjacent to the weir. The devices will provide continuous water level measurements in the stream, stream flow data, and peak flow information. Additionally, a continuous dissolved oxygen meter is planned for installation, to collect that data during stream flow.

Rathbun Creek – An existing 50 cfs compound weir structure on the downstream side of the culvert at the Sandalwood Road crossing of Rathbun Creek, will be utilized for flow measurements. However, this weir may be modified to eliminate the wooden wingwalls and extend the concrete portion of the weir to the sides of the existing concrete box culvert. A sharp-edged steel weir will be installed along the full length of the existing concrete weir to improve the accuracy of flow measurements, and will be bolted to the top edge of the concrete weir. In addition, one or two check structures are also proposed for Rathbun Creek. These check structures would be located upstream of the box culvert on Sandalwood Road to protect the weir and culvert from sediment accumulation behind the weir. The check structures would provide a more convenient location for cleaning out accumulated sediment.

As with the other tributary locations, self-powered data logger pressure transducer, a U.S. Geological Survey staff gage, and a dissolved oxygen meter will also be installed in Rathbun Creek near the slightly modified concrete weir.

Knickerbocker Creek – BBMWD plans to install a weir, data logging pressure transducer, U.S.G.S. staff gage and dissolved oxygen meter on the rip-rap armored segment of Knickerbocker Creek, downstream of the Highway 18 crossing. Specifically, BBMWD anticipates that the weir structure will be installed on top of an existing abandoned concrete structure in the streambed. A broad-crested weir, consisting of a small concrete wall with a sharp-edged steel weir, would also be installed from the primary weir out to the channel edges, for flows that exceed the capacity of the primary weir.

4.4 Sample Bottles and Labels

Babcock Laboratories will supply appropriate sampling bottles to the field staff. The field staff will prepare sample labels and affix them to the sample bottles. The following information will be identified on each sample label:

1. Project name "BBL Nutrient TMDL."
2. Sample Number which identifies sample location, date, and aliquot (see sample assignment numbers shown in Table 4-3) - to be completed by the sampling crew in the field
3. Date and Time sample collected - to be completed by the sampling crew in the field
4. Initials of individuals who collected the sample - to be completed by field sampling crew

Each crew will be supplied with the bottles necessary to collect the samples at each site prior to the anticipated storm event. Portions of the labels should be filled in prior to going out in the field (#1 and #2). A waterproof marker should be used to make sure information on the label does not become distorted. Label information must also be entered on the Chain of Custody, as described in Section 4.6. Table 4-2 details the types of containers, preservation, and holding time requirements for all analyses.

Table 4-2 Water Quality Sample Container, Preservation, & Holding Time Requirements

Parameter	Sample Volume	Sample Container	Preservation	Preferred / Maximum Holding Times
Temperature	N/A	Sample directly with Horiba meter	None	Immediately
Dissolved Oxygen	N/A	Sample directly with Horiba meter	None	Immediately
pH	N/A	Sample directly with Horiba meter	None	Immediately
Conductivity	N/A	Sample directly with Horiba meter	None	Immediately / refrigerate up to 24 hours
Turbidity	500 mL	Sample directly with Horiba meter	None	Immediately / store in dark for up to 24 hours
Total Suspended Solids	1000 mL	Plastic bottle	Cool to 4ºC	7 days
Volatile Suspended Solids	1000 mL	Plastic bottle	Cool to 4ºC	7 days
Alkalinity	100 mL	Plastic bottle	Cool to 4ºC, store in the dark	14 days
Hardness	200 mL	Plastic bottle	Cool to 4ºC; acidify to pH<2 with HNO_3	6 months
Total Organic Carbon (TOC)	40 mL	Glass bottle	Cool to 4ºC; acidify to pH<2 with HCl or H_2SO_4	28 days
Dissolved Organic Carbon (DOC)	40 mL	Glass bottle	Cool to 4ºC	28 days
Biochemical Oxygen Demand (BOD)	4000 mL	Plastic bottle	Cool to 4ºC, store in the dark	48 hours
Chemical Oxygen Demand (COD)	1000 mL	Glass bottle	Cool to 4ºC; acidify to pH<2 with H_2SO_4	28 days
Total Nitrogen	500 mL	Plastic bottle	Cool to 4ºC	Immediately / refrigerate in dark for up to 48 hours

Table 4-2 Water Quality Sample Container, Preservation, & Holding Time Requirements				
Parameter	Sample Volume	Sample Container	Preservation	Preferred / Maximum Holding Times
Total Dissolved Nitrogen	500 mL	Plastic bottle	Cool to 4ºC, store in the dark	Immediately / refrigerate in dark for up to 48 hours
Ammonia-N	500 mL	Plastic bottle	Cool to 4ºC, store in the dark	48 hours
Nitrate+Nitrite-N	150 mL	Plastic bottle	Cool to 4ºC, store in the dark	48 hours
Orthophosphate-P	150 mL	Plastic bottle	Cool to 4ºC, store in the dark	48 hours
Total Dissolved Phosphorus	300 mL	Plastic bottle	Cool to 4ºC, store in the dark	28 days
Total Phosphorus	300 mL	Plastic bottle	Cool to 4ºC, store in the dark	28 days

4.5 Assignment of Sample Numbers

A code will be used to uniquely identify each sample taken. Each code segment will be separated by a dash. The first segment will be "BBL-W" for Big Bear Lake Watershed. The next segment will be the sampling location number. Table 6 identifies the code information to be used for each location. The next segment will consist of 6 characters identifying the date of the sampling event (mmddyy). The final segment, will not be separated by a dash. It will be an alpha character to identify the sampling order within the event. For example, sample number BBL-W-801MWDC03-020609 C C stands for a sample that was collected in the Big Bear Lake Watershed at Location 3 (Grout Creek), and on February 6, 2009; this sample was the third sample of that event.

The sample location numbers will be assigned as follows.

Table 4-3. Sample Assignment Numbers		
Location	Location Number	Sample Number
Grout Creek	801MWDC03	BBL-W-801MWDC03_mmddyy A, B, C, D, E, …
Rathbun Creek	801MWDC04	BBL-W-801MWDC04_mmddyy A, B, C, D, E, …
Summit Creek	801MWDC05	BBL-W-801MWDC05_mmddyy A, B, C, D, E, …
Rathbun Creek (Below Zoo)	801MWDC06	BBL-W-801MWDC06_mmddyy A, B, C, D, E, …
Knickerbocker Creek	801MWDC08	BBL-W-801MWDC08_mmddyy A, B, C, D, E, …
Boulder Creek	801MWDC13	BBL-W-801MWDC13_mmddyy A, B, C, D, E, …

4.6 Field Data Sheets

4.6.1 Watershed-wide Monitoring Field Data Sheets

Field Data sheets will be completed at each sample location, for each event. See Appendix A for a sample data sheet. Field data collection sheets ensure that the data collected for this project are SWAMP-

comparable. Digital photographs will also be taken at each site, showing the actual sample collection point, as well as conditions upstream and downstream of the sampling site. Each crew will complete the field data sheets and turn them in to the Field Team Leader. The data from the field sheets will be entered into the database and will then be submitted to Rick Whetsel of SAWPA/Big Bear Lake Nutrient TMDL Task Force for inclusion in the Big Bear Lake Nutrient TMDL file.

4.6.2 Chain of Custody Forms

Babcock Laboratories will supply the chain of custody (COC) forms. As much as possible of the COC information should be entered prior to going out in the field (items # 1-6). The sampling crews will fill out these forms with the following information for each event:

1. Contact Person and Telephone Numbers: Nancy Gardiner (or designee), 858-571-6742
2. Name of Study: **Big Bear Lake Nutrient TMDL Watershed-Wide Sampling**.
3. Sample number (one per line).
4. Analyses to be performed (specific to each sample number line)
5. Type of sample collected, matrix "Liquid." (specific to each sample number line)
6. Number of bottles per sample and preservatives used (per bottles provided by the analytical laboratory). (specific to each sample number line)

Each sampling crew will also complete the following information on the COC form (while on site, in the field) for each sample:

7. Date and time sample collected. (specific to each sample number line)
8. Name of sampling staff and signature (filled out one per COC sheet).

After entering the field data at each location, the COC should be protected in a sealed baggie, to prevent smearing and water damage to the form. If an error is made on data entry, line completely through the ENTIRE line, and re-enter on a new line. Do not try to write over an error or make a partial correction. Multiple COCs may be required for an event, and each should be numbered 1 of #, 2 of #, etc., so that the entire event chain stays together. Chain of custody protocols will be followed as samples are transferred to the lab. This may require multiple signatures (i.e. field crew to field team leader to courier). Each separate COC sheet for the event must be signed.

Copies of field forms and Chain-of-Custody forms are provided in Appendix A.

4.7 Sample Handling and Transport

In the field, all samples will be placed on wet ice or frozen ice packs until delivery to lab. Identification information for each sample will be recorded on the field data sheets (if utilized) and chain-of-custody forms). Samples that are not processed immediately in the field will be labeled with the water body name, sample location, sample number, date and time of collection, sampler's name, and method used to preserve sample (if any). Samples will be handled, prepared, transported, and stored in a manner so as to minimize loss, misidentification, contamination, and/or degradation. Samples will be transported on ice and in insulated containers (e.g., insulated cooler). All caps and lids will be checked for tightness prior to transport. It is assumed that samples in a sealed cooler are secure regardless of method of transportation to the selected analytical laboratory. Sample packaging will include the following steps:

- Each sample will either be sealed with electrical tape around the sample lid and/or placed in a sealed plastic bag (Ziploc) to prevent leakage.

- Glass sample containers will be wrapped with protective plastic insulating material to prevent contact with other sample containers and the inner walls of the cooler.
- Ice (double bagged in plastic trash bags) and/or reusable "blue ice" packs will be placed in the cooler with the samples to maintain the samples at 4° C during shipment.
- Samples will be packaged in thermally insulated, rigid coolers.
- The Chain-of-Custody (COC) record will be enclosed in a waterproof plastic bag inside the cooler, and if shipped, taped to the underside of the cooler lid.

The collected samples are to be delivered to the laboratory for analyses as soon as practicable. Any delay in the receipt of the samples by the laboratory could necessitate a re-sampling and analysis effort.

At the end of the sampling activities, each crew will deliver the samples for chemical analyses with the respective COC forms to Babcock, or coordinate with a reliable courier for sample drop off. Table 4-4 provides contact information and driving directions to Babcock Laboratories. In the event that samples need to be dropped off on a weekend or after standard hours of operation, the Brown and Caldwell Project Manager will call Cathy Iijima to make special arrangements for laboratory staff to be available.

Additionally, if samples are shipped, rather than being transported directly to the lab, ice chests are sealed with tape prior to shipment. Efforts will be taken to minimize the leakage of any melted ice from the sample shipment container.

- Each cooler prepared for shipment will be securely taped shut with reinforced or other suitable tape (strapping tape)
- When shipping a cooler by commercial carrier, such as Federal Express, all coolers should be shipped "Priority Overnight" and air bills will be completed and attached to the exterior lids of the containers.

Table 4-4. Sample Drop Off Location/Responsible Staff

Cathy Lijima Babcock Laboratories 6100 Quail Valley Court Riverside, CA 92507 (951) 653 – 3351
Driving Directions
From I-215: Exit on Eastridge/Eucalyptus; Turn right on Eastridge to the west; turn right onto Box Springs Blvd. (north) Stay on it for half a mile; turn left at stop sign, still on Box Spring Blvd., turn right on Quail Valley Ct. Lab is at the end of the cul-de-sac. Hours of Operation: Monday – Friday: 8:00am to 5:00pm (or by appointment).

Contract laboratories will follow the sample custody procedures outlined in their QA plans. These QA plans are on file with each respective laboratory. If discrepancies are noted between the COC and the sample labels, the project contact listed on the COC will be notified immediately. Contract lab will follow QA for storage of samples prior to and after analyses have been performed.

4.8 Storm Event Definition

The Monitoring Plan requires that one winter (wet season) and one summer (dry season) storm event be sampled. A storm event will be declared and sampled only as directed by the project manager. Each location

will have sampling for one wet season and one dry season storm. Not every location will be sampled in one storm.

A storm event is defined as either:

- Precipitation of more than 0.25 inches in a 24-hour period, or
- A doubling of flow within a 24-hour period, as indicated by a stream gauge, or as visually estimated.

4.9 Site Inaccessibility Issues

Some conditions may render a site inaccessible. Sampling protocols or locations may need to be modified if a site becomes inaccessible. Proceedures for various circumstances of inaccessibility are described below.

1. If it would be dangerous to approach the stream during a sampling event due to swift water or other hazardous conditions, it is considered inaccessible. In this event, the sampling team will delay sampling for 24 hours up to 48 hours after the storm event (as determined by protocol in section 4.8). Alternatively, if a bridge is available from which to conduct sampling, sampling will occur on schedule at that location from the bridge. In the event that a site is considered inaccessible, the field team will take photographs as documentation of the site condition.
2. If access to a sampling site is temporarily or permanently blocked by a physical obstruction, such as downed trees or evidence of land- or rockslide, or ice or snow, the sampling team may move 25-50 ft. upstream or downstream from the site and conduct sampling there. If there still is no suitable access, the project team may sample further away (up to 100 ft.) from the original station, with the approval of the project manager.
3. If the sampling site comes under new ownership, such that previously granted access is now denied, permission will be obtained from the new owner. If this is still denied, a permanent new location will be selected as near as possible to the original station, ideally within 1,000 feet, and not in a morphologically different stream reach.

In the event that a station is relocated or moved to facilitate sampling, field crews will record the GPS coordinates of the new location. This information will be recorded on the field form.

5. QUALITY ASSURANCE/QUALITY CONTROL

Water quality samples under programs described within this Monitoring Plan are being collected in order to ensure the collection of representative water samples from the entire watershed. Babcock Laboratories will follow quality assurance and quality control programs in accordance with guidelines established by the State of California and the U.S. EPA. Babcock Laboratories, and any other contract labs for this project, are required to submit a copy of their SOPs for laboratory quality control to the Quality Assurance Officer for review and approval.

Certified pre-cleaned sampling equipment will be used whenever possible; sampling equipment which is reused should be decontaminated between samples. One equipment blank will be submitted for analysis (all methods) during each sampling event. Field duplicates will be collected at the rate of 5 percent of the total project sample count and analyzed blind by the analytical laboratory.

All laboratory data will be entered into the project database, 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.

For the first two dry weather sampling events, the Brown and Caldwell Project Manager and QA Officer will review all laboratory data and will request additional re-analysis as warranted.

APPENDIX A

Sampling Forms and Example COC

Field Equipment Calibration Form

Equipment / Instrument	Calibration Description and Criteria	Pre-calibration	Post-calibration	Responsible Person

SWAMP Station Occupation Results

PG: OF PGS

Entered Dbase

*Station ID:

*Date: M M D D Y Y Y Y

*Project ID:

*Sample Time: (time of first sample)

Arrival Time:

Departure Time:

*Sample Season:

Event Type

Sample Type
FieldObs

SampleDepthCollection
-88

DistanceFromBank
-88

***Crew:**

Photos (RB & LB are assigned when facing downstream)
RB/LB/BB/ US/DS/##
RB/LB/BB/ US/DS/##
RB/LB/BB/ US/DS/##

***Precipitation**
dry
drizzle
rain
thunderstorm

Sea State (if applicable):
Calm
Rough
Choppy

***Sky**
clear
partly cloudy
overcast
fog

Wind Direction (from) / no wind = xx :
N W E S

***Habitat**
dry
non-wadeable stream
wadeable stream
wadeable concrete channel
standing water
other_____

Wind Speed (kts) :

***Water Color**
clear
green
yellow
brown
other

***Water Clarity**
clear
semi-clear
turbid

***Water Odor**
hydrogen sulfide
sewage
petroleum
mixed
none

***Sediment Color**
black
brown
gray
yellow
mixed
other

***Sediment Composition**
course sand
fine sand
silt / clay
cobble
gravel
mixed
other

***Sediment Odor**
none
hydrogen sulfide
sewage
petroleum
mixed
other

Station Occupation Comments

Access key required Yes / No

Contact Info:

Gaging Station #:

*Elevation (ft or m) :

* required field; underlined fields used as primary keys in dbase

SWAMP SOFDS 1/02/2003

SWAMP Shallow Water Sampling Event

Entered Dbase

*Station ID: | *Project ID: | *Sample Season: | PG: OF PGS

*Date: M M / D D / Y Y Y Y | *Sample Time: | Field Duplicates yes / no | SampleType= FieldBLDup

Event Type	Sample Type	*Sample Device:	*Occupation Method	*Sample Location
WaterTox_Chem WaterChem WaterTox	Grab Integrated	Indiv. Bottle by hand Indiv. Bottle by pole sampler Indiv. Bottle by bucket sampler Teflon Tubing Kemmer Sampler other_____	Walk In From Bridge R/V _____	Bank MidChannel Thalweg Open Water

*GPS / DGPS	Lat Degrees	sec / hunds	Long Degrees	sec / hunds
Nominal			-	
*Actual dec degrees			-	

*Starting Bank: LB / RB (facing downstream)

Accuracy (ft / m) | 5 decimals | *GPS Model: | 5 decimals | Datum: NAD 83 / other _____

*Station Water Depth (m): (point of sample) | *Stream Width (m): (point of sample)

Samples Taken (# of containers filled)

	DepthCollect (m)	*Inorganics	*Bacteria	*Chl a/Boron	*TSS	*TOC /DOC	*Total Mercury	*Dissolved Mercury	*Dissolved Metals	*Total Metals	*Organics	*Toxicity	TIE	
SUBSURF/MID/ BOTTOM ABOVE/THERMO/ BELOW														
				Vol Filt: (ml)				Preservative time						
								*Preserved	In lab	In lab				

Integrated; -88 in dbase; (describe depths in comments)

Event Type: WaterChem | Sample Type: FieldMeasure

Only enter if multiple distances are taken

	*Depth Collect (m or f)	*Distance from Bank (m or f)	Velocity (fps / mps)	Air temp C	H2O temp C	pH	O2 mg/L	O2 %	Specific Conductivity (mS uS /cm)	Turbidity ntu	
SUBSURF/MID/BOTTOM ABOVE/THERMO/ BELOW											
SUBSURF/MID/BOTTOM ABOVE/THERMO/ BELOW											
SUBSURF/MID/BOTTOM ABOVE/THERMO/ BELOW											
		*Instrument:									
		*Calibration date									

Sample Comments: (failure of probe parameter should be marked as "probe failure")

Meter Used:_____

Prop used: AA / Mini

____ rev. @ ____ (sec)

* required field; underlined fields used as primary keys in dbase

SWAMP WQFDS 1/02/2003

Stream Flow (Discharge) Measurement Form

Stream:____Date:____________________

Station Description:____

Time Begin:__________ Time End:___________ Meter Type:_________________________

Observers:________________ Stream Width*:___________ Section Width:_______________

Observations:____

Section Midpoint (ft) (m)	Section Depth (ft) (m) (cm)	Observational Depth** ft-m-cm	Velocity		Area W x D (ft^2) (m^2)	Flow (Q) V x A (m^3/s) (ft^3/s)
			At Point (ft/s) (m/s)	Average (ft/s)(m/s)		

$m^3/s \times 35.3 = ft^3/s$

Total Flow (Discharge) (3Q) (ft^3/s) ____________

* *Make a minimum of 10 measurements when the total width is > 5.0 ft, 20 measurements preferred.*

*** When water is < 2.5 ft deep take one measurement at each cross section. When water is > 2.5 ft deep, take two measurements at each cross section; one at .2 the total depth and the other at 2 x the total depth. Average the two velocity measurements. See SWAMP Procedures Manual for a detailed flow measurement method.*

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E.S. BABCOCK & SONS, INC.

Chain of Custody & Sample Information Record

Client: Contact: Phone No.

Project Name: _____
Project Location:

Turn Around Time: Routine 3-5 Days 48 Hours 24 Hours *(Rushes Require Approval, Additional Charges May Apply)*

Sampler Information
Name: _____
Employer: _____
Signature: _____

ESB #	Sample ID	Date	Time	# of Containers & Preservatives: Unpreserved	H_2SO_4	HCl	HNO_3	$Na_2S_2O_3$	NaOH	Total # of Containers	Analysis Requested	Matrix	Notes
												DW = Drinking Water WW = Wastewater GW = Groundwater S = Soil SG = Sludge L = Liquid M = Miscellaneous	

Relinquished By (sign)	Print Name / Company	Date / Time	Received By (Sign)	Print Name / Company

(For Lab Use Only) *Sample Integrity Upon Receipt*

Sample(s) Submitted on Ice? Yes No
Custody Seal(s) Intact? Yes No N/A
Sample(s) Intact? Yes No
Temperature ºC

Lab No. _____

Page _____ of _____

APPENDIX B

Standard Operating Procedures

SOP 11-4
Big Bear Lake Tributary Water Quality Sampling SOP and Record

Tributary Water Quality Monitoring Stations

Tributary sampling stations have been established at the following locations:

- Bear Creek Outlet (MWDC2)
- Grout Creek (MWDC3);
- Rathbun Creek @ Sandalwood (MWDC4);
- Rathbun Creek below Zoo (MWD -)
- West Summit Creek (MWDC5);
- Knickerbocker Creek at Hwy. 18 (MWDC8);and,
- Boulder Creek at Hwy. 18 (MWDC13).

The tributaries will be sampled in accordance with flow status (i.e., baseline, snow melt, and storm event) as described below.

Boulder Creek (MWDC13) will serve as a "reference tributary" for water quality monitoring purposes. The other tributaries, Grout Bay Creek, Rathbun Creek, West Summit Creek, and Knickerbocker Creek were 303d listed by the Regional Water Quality Control Board. These 303d listed tributaries are considered impaired water bodies and, therefore, are the primary focus of sampling activities.

In addition to actual water quality sampling, primary tributary sampling locations will be visually monitored at a frequency of no less than once every two weeks on a year round basis for the duration of this project. Tributary visual monitoring activities consist of completing the tributary monitoring form attached to this SOP (Form SOP 11-4).

Tributary Flow Type and Sampling Frequency

In the Big Bear Lake watershed, water flowing in tributaries (or flow type) is most likely the result of one or a combination of the following:

- Baseflow (spring fed flow);
- Snow Melt; and,
- Storm Event (rain precipitation).

It is extremely important to clearly note on the field data sheet and the chain-of-custody, the type of flow (or nature of the discharge) that was sampled.

Tributary sampling frequency and sampling approach is dependent on the type of flow event and the time of year. Sampling in accordance with flow status is described in the Tributary Monitoring Plan for this effort.

Manual Tributary WQ Sampling Procedures

Field measurements and water quality samples will generally be taken at the centroid of the flow. The centroid of the stream is defined as the midpoint of that portion of the stream width that contains 50% of the total flow. If a primary flow measurement device, such as a compound weir with a v-notch is available, then sample on the downstream side of the v-notch weir, just at the weir outlet. The Surface Water Ambient Monitoring Program (SWAMP) Quality Assurance Management Plan, Field Collection of Water Samples and Procedures for Conducting Routine Field Measurements in SWAMP, are a part of this SOP.

In accordance with SWAMP specifications, manual water quality samples and field measurements will be collected at the following depths in the stream:

Since tributary water depth in the Big Bear is generally less than 5 feet (1.5 m), then manual grab samples for water quality will be collected at approximately 4.0 inches (0.1 m) below the water surface.

Horiba U-10 sensor measurements and/or grab samples from which water quality field measurements will be taken at approximately 8.0 inches (0.2) below the water surface. Ideally, field measurements should be collected directly in-stream. However, when an in-stream measurement cannot be made, it can be measured in a bucket (Nalgene or plastic).

The project managers responsible for the sampling activities shall be notified of any problems encountered during the sampling activities (logistics, sampler malfunction, etc.).

Field Sequence – Water Quality Sampling

- Set GPS to collect data in decimal degrees to 5 digits with datum NAD83.
- Calibrate Horiba U-10 mulit-parameter probe according to SOP 16-1. Record pre- and post-calibration data on form.
- After reaching sample site, record parameters on field sheet.
- Record flow on stream discharge measurement form
- Collect a sample for field parameters (wearing gloves), using a clean bucket or spare bottle. Record all field parameters using Horiba U-10
- Collect grab samples (wearing gloves) and label bottles using sample numbering method described in Section 4.5 of MP
- Take one duplicate sample after every 20 samples – duplicate samples will not be labeled as "duplicate" but will be labeled using sample numbering method described in Section 4.5 of Monitoring Plan, followed by X, to ensure they are analyzed blind by the laboratory.
- Collect one equipment blank sample from one location per sampling event (to be analyzed for all constituents). Blank samples will not be labeled as "blank" but will be labeled using sample numbering method described in Section 4.5 of Monitoring Plan, followed by Z, to ensure they are analyzed blind by the laboratory.
- Complete chain of custody forms as described in Section 4.6.2 of Monitoring Plan.Place samples in a cooler on ice for transport to the analytical laboratory.
- Deliver samples to the laboratory in time to meet the shortest holding time for the analyses being conducted.

SOP 15-1
Big Bear Lake Horiba Instrument Maintenance SOP and Record

The primary instrument to be utilized for field data measurements is the Horiba U-10 multi-parameter sonde with a LCD display. All field staff will acquaint themselves with the details of operation and maintenance as per the manufacturer's specifications. While the U-10 is both rugged and precise, the key to accurate measurements is cleanliness and frequent calibration.

Prior to each use, inspect the Horiba instrument to ensure all components are clean and in good working order. Also inspect the display batteries that power both the display unit and the sonde.

Note: Document all Horiba maintenance activities on the appropriate record forms contained, and to be kept, within the Horiba carrying case.

Monthly Horiba Maintenance

1. Three of the U-10's sensors are replaceable: the pH sensor, the reference sensor and the dissolved oxygen (DO) sensor. They are simple to maintain, with the pH and DO sensor needing only a tap water flush.
2. Recharge the reference sensor with reference solution about once every two months as follows:
    a. Remove the liquid-junction rubber cap from the reference sensor and pour out the old solution.
    b. Fill the reference sensor completely with new reference solution. Make sure that there are no air bubbles present. Replace the liquid-junction rubber cap and carefully wash off all excess reference solution from the probe.
3. Inspect the turbidity and conductivity sensors. When needed, clean the sensors with a test tube brush. Never use abrasives or cleansers.
4. Ensure that the display is kept clean and dry. Check the batteries. Protect the display unit from excessive heat by keeping the unit in the carrying case. Do not store the unit or carrying case where it may be exposed to direct sunlight for prolonged period of time. Never leave the U-10 inside a vehicle with the windows closed.
5. Check to see that cables and connectors are in good working order.

Horiba Maintenance – After Event Measurement

1. Wash the probe thoroughly with tap water. Be sure to flush off the entire sample solution from the probe.

Short-Term Storage Guidelines (i.e., about 1 week or less)

No matter what sensors are installed in the Horiba meter, it is important to keep them moist. Horiba recommends that short-term storage of the instrument sonde be done by executing the following steps:

1. Fill the calibration cup with tap water and fit the probe over it;
2. The calibration cup is placed in the carrying case to minimize evaporation; and
3. Check the calibration cup periodically to ensure that tap water is still present.

Long-Term Storage Guidelines

Long-term storage of the Horiba meter is not anticipated for the next two to three years. Horiba recommends the following long-term storage guidelines:

1. The pH sensor must always be kept moist. Fill the small rubber cap with water and use it to cover the pH sensor.
2. The KCI internal solution in the reference sensor may seep over time. Place vinyl tape around the O-ring portion to prevent this.

3. Remove the battery from the main unit.

SOP 16-1
Big Bear Lake Horiba Instrument Calibration SOP and Record

General Information

The primary instrument for field data measurements is the Horiba U-10 multi-parameter sonde with an LCD display. An energy-saving function switches the instrument off automatically any time 30 minutes pass without any key being pressed. As the U-10 is powered by a standard 9-V battery, a spare should be kept within the carrying case. All pre- and post-calibration should be recorded in the calibration form provided in the MP.

Calibration procedures provided herein include the following parameters:

- Dissolved Oxygen (DO);
- pH;
- Conductivity (COND); and
- Turbidity (TURB)

Note: Sampling staff and instrument operators shall refer to the operations manual if additional information on instrument calibrations and/or maintenance is needed. Record all calibration activities on the appropriate record forms contained, and to be kept, within the Horiba carrying case.

Monthly Horiba Calibration

1. The U-10 may be calibrated either manually or automatically. The auto-calibration procedure is extremely simple. The Horiba uses just a single solution, dubbed Water Checker, to do a simultaneous calibration of the four parameters: pH, COND, TURB, and DO.
    a. Simply fill the calibration cup with the standard phthalate pH solution to the noted line (near two-thirds full) and fit the probe over it.
    b. With the power on, press the MODE key to put the unit into the MAINT mode. The lower cursor should be on the AUTO Sub-mode; if it is not, use the MODE key to move the lower cursor to AUTO.
    c. With the lower cursor on AUTO, press the ENT key. The readout should display CAL. Wait a moment, and the upper cursor will gradually move across the four parameters.
    d. When the auto-calibration process is complete, the readout will briefly show End and then will switch to the MEAS mode. Additionally, the upper cursor will blink while the auto-calibration is being made. When the auto-calibration has stabilized, the upper cursor will stop blinking.

Initial Manual (2-point) calibration for the pH Sensor

Given the more alkaline nature of Big Bear Lake water, the pH sensor for the Horiba U-10 meter should be manually calibrated with standard commercially available buffers of pH 7 and pH 10 for a higher accuracy measurement. A two-point calibration is performed. The pH buffers contain high concentrations of phosphate. Therefore, care must be taken to ensure that no traces of standard buffers remain on the instrument probes that could contaminate water samples. Buffer solutions must be replaced prior to their expiration date.

Preparation:

1. Wash the probe 2-3 times using de-ionized or distilled water.

Two-Point Calibration Steps:

A.) Zero calibration

1. Use the pH 7 solution for zero calibration. Place enough pH 7 standard buffer into a clean, dry calibration cup to immerse the pH sensor. Allow at least one minute for the temperature to equilibrate before reading.
2. With the power on, press the MODE key till the lower cursor is on ZERO.
3. Use the SELECT key to move the upper cursor to pH.
4. Once the readout has stabilized, use the UP/DOWN keys to set the proper value of pH 7 standard solution at the temperature of the sample. Refer to the manufacture's guidelines for actual pH vales of the standard solution at various temperatures.
5. After the reading has stabilized, press the ENT key to confirm the ZERO calibration for pH.

B.) Span calibration

1. Use the pH 10 solution for span calibration. Place enough pH 10 standard buffer into a clean, dry calibration cup to immerse the pH sensor. Allow at least one minute for the temperature to equilibrate before reading.
2. With the power on, press the MODE key till the lower cursor is on SPAN.
3. Confirm that the upper cursor is set to pH. If not, Use the SELECT key to move the upper cursor to pH.
4. As in step 5 above in the zero calibration, when the readout has stabilized, use the UP/DOWN keys to set the proper value of pH 10 standard solution at the temperature of the sample. Again, refer to the manufacture's guidelines for actual pH vales of the standard solution at various temperatures.
5. After the reading has stabilized, press the ENT key to complete the calibration for pH.