Regional Stormwater Monitoring Program

Implementers' Monitoring Program
Monitoring Plan Update

March 15, 2018

TAHOE
RESOURCE CONSERVATION DISTRICT

March 15, 2018

(Formerly Implementers' Monitoring Plan, April 30, 2013)

Submitted to:

Lahontan Regional Water Quality Control Board

Nevada Division of Environmental Protection

Submitted by the Tahoe Resource Conservation District in cooperation with:

El Dorado County

Placer County

City of South Lake Tahoe

Douglas County

Washoe County

Nevada Tahoe Conservation District

Nevada Department of Transportation

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LIST OF ACRONYMS

AV	Area-Velocity
BMP	Best Management Practice
CEDEN	California Environmental Data Exchange Network
cf	cubic feet
Tahoe RCD	Tahoe Resource Conservation District
DRI	Desert Research Institute
EMC	Event Mean Concentration
FSP	Fine Sediment Particles
IMP	Implementers' Monitoring Program
NDEP	Nevada Division of Environmental Protection
NDOT	Nevada Department of Transportation
NPDES	National Pollutant Discharge Elimination System
PLRM	Pollutant Load Reduction Model
QAPP	Quality Assurance Project Plan
QC	Quality Control
RAM	Rapid Assessment Method
RSWMP	Regional Storm Water Monitoring Program
SAP	Sampling and Analysis Plan
TN	Total Nitrogen
TMDL	Total Maximum Daily Load
TP	Total Phosphorus
TSS	Total Suspended Solids

INTRODUCTION

The Lake Tahoe Total Maximum Daily Load (TMDL) is a comprehensive, long-term plan to reverse the decline in deep-water transparency of Lake Tahoe and restore mid-lake clarity to the 1967-1971 level of 29.7 meters (97.4 feet). TMDL science suggests that up to two thirds of the decrease in clarity is attributable to fine sediment particles (FSP, <16 μm in diameter), and that the urbanized areas, roadways in particular, account for approximately 72% of FSP that eventually enter the lake (Lahontan and NDEP 2010).

Following the adoption of the TMDL in August 2011, the Lahontan Regional Water Quality Control Board approved a Municipal National Pollutant Discharge Elimination System (NPDES) permit (NPDES NO. CAG616001 Updated Waste Discharge Requirements and National Pollutant Discharge Elimination System (NPDES) Permit for Stormwater/Urban Runoff Discharges from El Dorado County, Placer County and the City of South Lake Tahoe within the Lake Tahoe Hydrologic Unit, Order No. R6T 2011-101A) on December 6, 2011, and later amended on October 12, 2012. The permit was updated and renewed on March 9, 2017, Order No. R6T 2017-0010. In May 2013, the Nevada Division of Environmental Protection (NDEP) signed Interlocal Agreements with the local Nevada jurisdictions. Requirements of the Nevada Interlocal Agreements are similar to the NPDES permit.

The California NPDES permit and the Nevada Interlocal Agreements require jurisdictions in the Lake Tahoe Basin to take measures to decrease pollutant loading from stormwater runoff in urbanized areas. Local jurisdictions must implement pollutant controls to decrease FSP and nutrient inputs, and must monitor and evaluate select urban catchment outfalls and Best Management Practices (BMPs) for flow volumes and sediment and nutrient loads in order to earn credits under the Lake Clarity Crediting Program (Crediting Program). While monitoring data is not used to assess credits earned under the Crediting Program for implementing effective pollutant controls, it provides empirical data that (1) assesses nutrient and sediment loading in chosen catchments, (2) evaluate BMP effectiveness at chosen BMPs, (3) inform assumptions used to estimate runoff volumes and pollutant loads modeled with the Pollutant Load Reduction Model (PLRMv2.1).

The Implementers' Monitoring Program (IMP) is a partnership established in 2013 between the Tahoe Resource Conservation District, El Dorado County, Placer County, the City of South Lake Tahoe, Douglas County, Washoe County, the Nevada Tahoe Conservation District, and the Nevada Department of Transportation developed to collectively fulfill California permit requirements and Nevada Interlocal Agreement commitments. IMP was established prior to the development of RSWMP but has since fallen under its umbrella.

This document outlines a monitoring plan that aligns with the protocols recommended in the Tahoe Regional Stormwater Monitoring Program Framework and Implementation Guidance Document (RSWMP FIG) completed in March 2015 (Tahoe RCD et al 2015) and updated in October 2017 (Tahoe RCD 2017). The RSWMP FIG was developed primarily to achieve compliance with the requirements described in Attachment C, sections IIIA and IIIB of the California permit and the stormwater monitoring commitments in the Nevada Interlocal Agreements, as well as establish long-term urban status and trends monitoring sites in the Tahoe Basin.

BACKGROUND

Road systems and urban development have increased the total impervious area in the Tahoe basin, resulting in increased stormwater runoff volumes due to decreased natural infiltration. Stormwater runoff transports FSP, as well as nitrogen and phosphorus, resulting in more pollutant loading from the many highly impervious urban catchments located within each jurisdiction. Jurisdictions around the lake have spent tens of millions of dollars implementing projects to reduce impacts on Lake Tahoe from stormwater runoff. These projects often include numerous stormwater treatment strategies spread throughout the urban catchments, and may include stormwater infrastructure in the form of BMPs such as curb and gutter, sediment traps, a variety of treatment vaults and infiltration mechanisms, street sweepers, constructed wetlands, and source control measures like slope stabilization. Catchment scale runoff monitoring is needed to verify that cumulative implementation of pollutant control actions are resulting in measurable pollutant load reductions. BMP effectiveness monitoring is needed to verify that BMPs are reducing pollutant loads and to improve the installation and maintenance practices that will optimize water quality benefits. Furthermore, data collected under RSWMP, in conjunction with the Tahoe Basin's long-term tributary monitoring program, will become valuable in helping to determine long-term status and trends related to upland runoff.

The goals of water quality monitoring under this plan are to (1) comply with the monitoring requirements contained in the stormwater permits and agreements, (2) collect meaningful long-term data to assess status and trends in each monitored catchment, (3) inform jurisdictions' efforts to effectively and efficiently manage their stormwater programs, (4) track progress toward TMDL implementation goals, and (5) facilitate a better understanding of Pollutant Load Reduction Model (PLRM) performance under actual, site-specific conditions in the selected catchments. The PLRM incorporates the best possible assumptions valid basin-wide for multiple jurisdictions. Thus, the PLRM is consistent across all catchments and an important load crediting tool. However, actual conditions in particular catchments would be expected to vary from the basin-wide assumptions to some degree. Comparing model results to measured data is critical to verify model performance.

The monitoring plan includes:

- Measuring continuous flow at each monitoring station,
- Measuring continuous turbidity each monitoring station,
- Taking samples across the hydrograph during different storm event types in all seasons,
- Analyzing samples for total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), turbidity, and fine sediment particles (FSP),
- Calculating seasonal and annual runoff volumes and nutrient and sediment loads at each monitoring station.

The Tahoe Resource Conservation District (Tahoe RCD) is responsible for all equipment installations associated with collecting continuous flow, continuous turbidity, and water quality samples. Sampling tasks include, but are not limited to, collecting data and samples from the monitoring stations, making composite samples, and ensuring delivery of the samples to appropriate analytical laboratories. Tahoe RCD also coordinates site and equipment maintenance, database management, data analysis, and completes annual reporting.

MONITORING SITES

Catchment outfall sites and BMP effectiveness sites are selected based on several characteristics as outlined in the RSWMP FIG sections 7.3 and 9.3. All sites are chosen because of their high direct hydrologic connectivity to Lake Tahoe. Catchment outfall sites were selected based on a diversity of land uses, a range of catchment sizes, and a reasonably equitable distribution of sites among the participating jurisdictions. BMP effectiveness sites were selected because of their potential efficacy in treating storm water runoff characteristic of the Lake Tahoe basin, the broad interest in and lack of conclusive data regarding the efficiency of the selected BMPs in reducing runoff volumes and pollutant loads, especially FSP, and the importance of determining the maintenance required to retain effectiveness. Descriptions of selected sites are included in the Annual Stormwater Monitoring Report submitted to the Lahontan Regional Water Quality Control Board and Nevada Division of Environmental Protection each year on March 15th. Most sites have remained consistent since the inception of this program in water year 2014, but some additions, deletions, and substitutions have occurred and are expected to occur in the future.

STATION INSTRUMENTATION

Each monitoring station is instrumented with equipment as suggested in the Regional Storm Water Monitoring Program Quality Assurance Project Plan (RSWMP QAPP, DRI et al 2011a) section 11.1 and the Regional Storm Water Monitoring Program Sampling and Analysis Plan (RSMWP SAP, DRI et al 2011b) section 6.4. Each station has a Job Box to house all instrumentation and prevent loss of data and equipment from vandalism or theft.

The instrumentation at each station includes:

- An ISCO brand automated sampler for logging stage and turbidity readings, calculating flows, and collecting samples installed in accordance with suggestions outlined in the RSWMP SAP section 6.1.
- A bubbler module for measuring stage or area-velocity sensor for measuring stage and velocity (dependent on site characteristics)
- An FTS DTS-12 continuous turbidimeter for measuring turbidity
- A solar panel for charging Marine Cycle 12V batteries to power equipment (unless access to electricity is available).
- A nearby meteorological station to record, at a minimum, localized precipitation and ambient temperature. The meteorological station has a heated tipping bucket to record precipitation so that an accurate reading can be made when precipitation falls as snow.

SITE AND EQUIPMENT MAINTENANCE

The area surrounding each sampling station, as well as the equipment installed at each station is maintained in accordance with guidelines outlined in the RSWMP SAP section 6.5 and the RWSMP QAPP sections 11.1 and 15. This includes (1) manual seasonal calibration of flow monitoring equipment, turbidity and other sensors, (2) cleaning of equipment and housings, (3) verifying that hoses, intake strainers, and electronics are in good condition, (4) clearing flumes of accumulated sediment and debris, and (5) any other site-specific maintenance activities as determined by monitoring staff.

CONTINUOUS FLOW MEASUREMENT

Flow is measured continuously at each monitoring station via a bubbler module or area-velocity sensor (AV sensor) as described in the RSWMP SAP section 6.2 and in the RSWMP FIG section 10.2. The use of a bubbler module or AV sensor depends on site-specific characteristics. A bubbler module is preferred if site characteristics are such that flow monitoring is most accurate using a flume or weir. The bubbler logs stage, and flow is calculated using an equation specific to the flume or weir. If a bubbler module is mounted in a culvert pipe, stage is converted to flow using the Manning's equation. An AV sensor can be used in a culvert pipe assuming laminar flow and less than 5% slope. Laminar flow can be achieved with a smooth walled pipe insert.

All monitoring stations are configured such that there is positive outfall from each flow measuring device (i.e. flume, weir, or culvert pipe). No station will experience back-watering as it greatly confounds the flow data and is nearly impossible to correct.

Flow data is collected on a continuous basis at all monitoring stations to support seasonal [fall/winter (October 1-February 28), snowmelt (March 1-May 31), and summer (June 1-September 30)] and annual volume reporting.

CONTINUOUS TURBIDITY MEASUREMENT

Studies have suggested that a significant site-specific correlation exists between turbidity and FSP concentration (2NDNATURE and DRI 2014). Therefore, turbidity is measured continuously at all sites unless site specific characteristics determine that the site is unsuitable for turbidimeter instrumentation. Equations relating turbidity to FSP concentration are expected to allow for reasonable estimation of FSP loading from each site.

Turbidity is measured continuously at each monitoring station via a FTS DTS-12 turbidimeter as described in the RSWMP QAPP Amendment 2015 and in the RSWMP FIG section 10.2.

Turbidity data is collected on a continuous basis at all monitoring stations to support seasonal [fall/winter (October 1-February 28), snowmelt (March 1-May 31), and summer (June 1-September 30)] and annual load reporting.

EVENT PREPARATION, MONITORING AND SAMPLING

All monitoring staff are trained in accordance with guidelines outlined in the RWSMP SAP sections 7 and 8 and the RSWMP QAPP sections 11.2 and 11.3. This includes weather monitoring, sample bottle preparation, equipment preparation, auto-sampler programming, and sample collection.

WATER QUALITY SAMPLING SCHEDULE

Samples are taken at each monitoring station associated with catchment outfall sites according to the requirements outlined in the NPDES permit, Attachment C.III.A. Samples are taken at each monitoring station associated with BMP effectiveness sites according to the requirements outlined in the NPDES permit, Attachment C.III.B. The sampling requirements outlined in C.III.A and C.III.B are similar and therefore the same sampling strategy is used for both catchment outfalls and BMP effectiveness sites.

All sampling events occur during runoff events and sampling is triggered at a site-specific water level (stage). Runoff events, as defined by the permit, are the result of (a) fall rain, (b) rain-on-snow, (c) spring snowmelt, and (d) summer thunderstorms. These four event types are each sampled at least once during the water year at each monitoring station as conditions permit. Fall rain generally occurs in October and November; rain on snow generally occurs December through February; spring snowmelt generally occurs March through May; and summer thunderstorms generally occur June through September.

Samplers are programmed to capture six to twelve samples across the event hydrograph for the fall rain, rain on snow, and thunderstorm event types. For snowmelt events, hydrographs typically follow a diurnal pattern that can repeat for many consecutive days. Due to this duration and complexity, samples from consecutive snowmelt diurnals are collected and analyzed. These consecutive diurnals are called one snowmelt event. Snowmelt sampling events generally occur on spring days warm enough to produce melt (typically over 50 degrees Fahrenheit). An attempt will be made to capture the highest diurnal peaks in the hydrograph over the course of spring snowmelt.

The sampling frequency presented in this monitoring plan is designed to meet the minimum requirements of the NPDES permit. It should also be adequate for beginning to address the secondary goal of enhancing the Permittees' existing load estimations, condition assessment methods, and the effectiveness of their overall pollutant load reduction program.

The monitoring methods implemented for this plan are outlined in RSWMP FIG section 10 and 11. These methods have been developed over a decade, have withstood the rigors of intensive monitoring, and are generally used by the monitoring community in Lake Tahoe.

METEOROLOGICAL DATA

Meteorological data is collected within 0.5 miles of the monitoring site. Depending on site specific characteristics, the data is collected on a 5, 10 or 15 minute time interval and include, at a minimum, inches of precipitation and ambient temperature. These readings, coupled with long-term regional meteorological data, allow for an assessment of whether the season was dry, average, or wet. In addition, collecting meteorological data is imperative to understanding runoff response to rain (e.g. calculating runoff coefficients (runoff volume per inch of rain) in each catchment). Determining rainfall-runoff response gives information as to the impervious connectivity, rainfall-runoff relationships, rainfall intensity and associated peak flows.

SAMPLE HANDLING AND PROCESSING

Sample handing and processing follow guidelines outlined in the RSWMP SAP section 9 and the RSWMP QAPP section 12. This includes proper labeling of samples in the field, transporting samples to a laboratory immediately after collection in a cooler, compositing single samples on a flow-weighted basis, filtering samples within a 24-hour period before shipping to an analytical laboratory, and proper chain-of-custody procedures.

QUALITY CONTROL

A minimum of 10% of all samples analyzed are quality control (QC) samples to identify problems related to field sampling and sample processing. The samples include the following QC types: field blanks, method blanks, and field replicates as defined in the RSWMP SAP section 11 and the RSWMP QAPP section 14.1. These samples are used to ensure proper instrument function, sample handling procedures, and laboratory methods. This equates to approximately three QC samples per storm event, rotating sites and QC sample type throughout the year.

SAMPLE ANALYSIS

Samples are analyzed for the Lake Tahoe TMDL pollutants of concern: FSP concentration, total nitrogen (TN) concentration, and total phosphorus (TP) concentration. Samples may also be analyzed for secondary nutrients such as ammonia (NH4), soluble reactive phosphorus (SRP), and dissolved phosphorus (DP). In addition, samples are analyzed for total suspended solids (TSS) and turbidity. In order to determine FSP concentration, the recommended bin sizes for reporting particle size distribution analysis are taken from the phi series (Heyvaert et al 2011) and are from 0.5µm to <1, <2, <4, <8, <16, <31, <63, <125, <250, <500, <1000, and <2000 µm. FSP concentration is the sum off all bin sizes 16 µm and less.

Analytical laboratories are selected in accordance with the RSWMP QAPP section 13 and require certification or prior approval from regulators. Samples are analyzed using methods recommended in Table 1, or a proven similar method, and follow quality control requirements outlined in the RSWMP QAPP section 14.2.

Table 1: Recommended analytical methods and reporting limits.

Analyte	Methods	Description	Detection Limit	Target Reporting Limit
Total Phosphorus as P	TERC Low Level Method	Colorimetric, Total Phosphorus, Persulfate digestion, low level	2 ug/L	10 ug/L
Total Kjeldahl Nitrogen	EPA 351.1; or EPA 351.2	Colorimetric, block digestion, phenate	40 ug/L	100 ug/L
Nitrate + Nitrite	TERC Low Level Method	Colorimetric, NO3 + NO2 Hydrazine Method, low level	2 ug/L	10 ug/L
Total Nitrogen as N	N/A	Total Kjeldahl Nitrogen + Nitrate + Nitrite	40 ug/L	100 ug/L
Total Suspended Solids	EPA 160.2 or SM 2540-D	Gravimetric	0.4 mg/L	1 mg/L
Turbidity	EPA 180.1 or SM 2130-B	Nephelometric	0.05 NTU	0.1 NTU
Particle Size Distribution	SM 2560 or RSWMP addendum SOP	Laser backscattering	0.5 mg/L	1 mg/L

DATA MANAGEMENT

Continuous data series and sample dates and times are collected and managed via the RSWMP Data Management System (DMS). Data is viewed and downloaded at the time samples are collected, maintenance is required, or every two weeks during dry periods. All data are input into Excel workbooks for storing continuous parameters and sample dates and times. Any other field measurements and observations are recorded in a field notebook and transcribed into the same Excel workbooks.

Samples are transported to a processing lab immediately after collection. The DMS automatically calculates the recipe for compositing single samples into an event composite for each monitoring station. These composite samples represent the flow weighted Event Mean Concentration (EMC). All composite samples are measured for turbidity and values are recorded on standard data sheets in the laboratory and entered into an Excel workbook for storing nutrient and sediment data. All samples are sent to proper laboratories within appropriate holding times for TN, TP, TSS, and PSD analysis as described in RSWMP QAPP section 12. Results from analytical laboratories are entered into the same Excel workbook for storing nutrient and sediment data. All Excel workbooks are housed on one central server (with backup device) and managed by Tahoe RCD staff. All data management procedures described above follow protocols outlined in the RSWMP FIG section 10.2.1. See RSWMP FIG Update 2017 section 6.4 for a complete description of the DMS.

DATA REVIEW

Continuous data series logged at each monitoring station consist of parameters measured in the field at a constant time interval. These data include, at a minimum, stage, flow, and turbidity readings. These series are reviewed and corrected following rules outlined in the RSWMP SAP section 12.2. The Excel workbooks for storing continuous parameters and sample dates and times allow for easy review of all series.

Analytical results are reviewed for accuracy and precision. Data quality is reviewed and data is accepted or rejected following rules outlined in the RSWMP SAP section 12.1.

DATA ANALYSIS AND REPORTING

Under Annual Reporting Requirements, Section IV of the permit's Monitoring and Reporting Program, the Tahoe RCD does not fulfill the requirements outlined in sections A-E or G-J. The Tahoe RCD is only responsible for section IV.F., Stormwater Monitoring Report. The Tahoe RCD, on behalf of the IMP, will submit a single annual report by March 15th of the year following the end of each water year (September 30th) to each participating jurisdiction, synthesizing all data collected for stormwater monitoring. The RSWMP DMS compiles and analyzes all raw data. It produces charts and tables to include in the Annual Stormwater Monitoring Report as outlined in the RSWMP FIG section 7.8 and 9.8.

- Continuous flow data is used to calculate event, seasonal, and annual flow volumes in cubic feet for fall/winter (October 1 – February 28), spring snowmelt (March 1 – May 31), and summer (June 1 – September 30) at each monitoring station.
- Flow volumes are reported in cubic feet (cf).
- Concentrations of TN and TP are reported in ug/L. Concentrations of FSP are reported in mg/L and number of particles per liter. Turbidity is reported in NTUs.
- FSP concentration is converted to number of particles per liter using a formula outlined in Heyvaert et al 2011.
- Event, seasonal, and annual TN, TP, and FSP loads are calculated and reported for each monitoring station using EMCs, continuous turbidity, and continuous flow data.
- Influent and effluent loads at BMP effectiveness sites are compared and the pollutant load reduction is reported on an event, seasonal, and annual basis.
- Loads are reported in pounds for TN, TP. Loads are reported in pounds and in number of particles for FSP.
- Equations relating turbidity and FSP (Heyvaert et al 2011) are applied to continuous turbidity data to result in seasonal and annual FSP calculations. This is a second method for determining FSP loads.
- Results from the QC samples collected for the year are summarized and reported.
- Catchments will be modeled using PLRM. Modeled estimates of runoff volumes and pollutant loads ("expected" conditions) are compared to empirical data ("actual" conditions) in the context of water year type (wet, average, dry).
- As condition assessments (i.e. Road RAM and BMP RAM) are performed and resulting RAM scores are obtainable, analysis may also include correlations between scores and monitoring data to better understand the relationship between observed catchment or BMP condition and measured pollutant loads.

Table 2 outlines the annual monitoring schedule for each water year monitored. All required details and discussions listed in Section IV.F.1-16 of the permit are included. This annual Stormwater Monitoring Report is meant to be included in each participating jurisdiction's larger NPDES report due March 15th of the year following the end of each water year to the Lahontan Regional Water Quality Control Board.

Table 2: Annual monitoring schedule for each water year monitored.

Annual Monitoring Schedule												
Tasks	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Planning												
Data Collection												
Data Analysis												
Reporting												

All electronic data will be in a format compatible with the Surface Water Ambient Monitoring Program (SWAMP) database and entered into the California Environmental Data Exchange Network (CEDEN). All monitoring data and associated analytical reports will be available to managers on permittees' websites. Stakeholders and members of the general public will be notified of the availability of electronic monitoring reports through notices distributed through appropriate means.

MONITORING PLAN UPDATE OR REVISION

This monitoring plan may be revisited and revised in response to modifications to permit or agreement language. Any proposed modifications would need to consider budget constraints and dollars available to implement a revised monitoring plan.

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