Truckee Meadows Regional Storm Water Quality Management Program

2017 Stormwater Sampling and Analysis Plan

Stormwater discharge to the Truckee River from an urban outfall, City of Reno, Nevada

Prepared for:

CITY OF RENO

In Cooperation with: City of Sparks, Washoe County, and Nevada Department of Transportation

Prepared by:

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A REPORT PREPARED FOR:

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(NPDES MS4 Discharge Permit No. NV000001)

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ACKNOWLEDGMENTS

Balance Hydrologics staff wish to express their gratitude to Jeff Curtis (Stantec Consulting Services, Inc.) for allowing Balance the reproduction of some material in this document originally produced by Stantec Consulting Services, Inc. We view this Plan as an evolving document as components of the program change each year. Many of the sections in the Stantec document are pertinent to on-going monitoring of storm water in the Truckee Meadows; and therefore, are maintained in this version.

We would also like to acknowledge Desert Research Institute for their previous efforts and recommendations to improve the monitoring program. Some of those recommendations have been incorporated into this document.

1 INTRODUCTION

Monitoring ambient and storm water quality is an important component of most Storm Water Management Programs (SWMPs). With sufficient, accurate and representative data, the effectiveness of the program can be evaluated and new or revised storm water Best Management Practices (BMPs) can be developed. Storm event water quality samples have been collected since 2003 as part of the Truckee Meadows Regional Storm Water Quality Management Program. When the existing program changes or is modified, a revised Sample Analysis Plan (SAP) is submitted to the Nevada Division of Environmental Protection (NDEP) that outlines the general sampling program and approach. This SAP document describes the storm water sampling activities to be conducted by (or under the direction of) the Truckee Meadows Storm Water Permit Coordinating Committee (SWPCC) during Fiscal Year 2018, beginning on July 1, 2017.

1.1 Storm Water Management in the Truckee Meadows

The discharge of municipal urban storm water runoff is regulated under a single discharge permit, jointly issued to the cities of Reno and Sparks and Washoe County. NDEP issued a Municipal Separate Storm Sewer System (MS4) discharge permit to all three entities as co-permittees (Permit No. NVS000001, hereafter referenced as the “Permit”). The Permit cycle is five years in length. Administration of the Permit is the responsibility of the SWPCC. The SWPCC is made up of two members from each of the three entities, with an Interlocal Agreement in place to define each party’s responsibilities.

The Permit allows the City of Reno, the City of Sparks, and Washoe County to discharge municipal storm water runoff, and requires the co-permittees to develop, administer, implement and enforce a SWMP. The SWMP is a comprehensive program that has been developed over the past 15 years through a series of meetings and workshops attended by local government representatives, area professionals, and private citizens. The SWMP has been designed to address the unique political, socioeconomic, geographic and climatic conditions of the Truckee Meadows, as well as the conditions of the Permit. The most recent version of the Truckee Meadows Storm Water Management Program document was issued in December of 2011(revised in 2014). The SWMP document describes the various programs and activities that collectively help prevent storm water pollution to the maximum extent practicable (MEP).

1.2 Permit Requirements Relating to Monitoring

Section V.A. of the Permit outlines the requirements for storm water monitoring. Sampling locations or collection frequencies are not specified in the Permit. Section V.A.1 requires the permittees to submit a Storm Water Monitoring Plan to NDEP each year. It is important to note that "monitoring" is simply defined as the regular observation, recording of events and activities and is not limited to simple sample collection for water quality determinations. Numerous monitoring activities carried out by the co-permittees are described in the SWMP document. This document outlines monitoring efforts specifically related to water sample collection activities. Permit Section V.A.2 lists sampling requirements to be followed when collecting, analyzing and reporting of any water samples collected. Table V.A of the Permit in presented in the blue text box below (blue text boxes are used throughout the document to indicate the exact Permit language):

V. STORM WATER MONITORING, RECORDKEEPING & ANNUAL REPORT

V.A. Storm Water Monitoring

V.A.1 The Permittees shall submit a Storm Water Monitoring Plan to NDEP for the following year on or before October 1 each year. In developing the plan, the Permittees must evaluate and update as necessary how monitoring may assist in making decisions about program compliance, the appropriateness of identified BMPs, and progress toward achieving identified measurable goals. Pending submittal of the annual monitoring plan, the Permittees shall continue to implement the existing monitoring plan.

V.A.2 When the Permittees conduct monitoring at the Permittees' MS4, the Permittees are required to comply with the following:

V.A.2.a Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge. This requirement does not prevent Permittees from analyzing or reporting samples that are representative of a limited situation (e.g. concentration at peak flow).

V.A.2.b Test procedures for the analysis of pollutants shall conform to regulations (40 CFR, Part 136) published pursuant to Section 304(h) of the Act, unless other procedures are approved by NDEP.

V.A.2.c Records of monitoring information shall include:

V.A.2.c.i The date, exact place, and time of sampling or measurements;

V.A.2.c.ii The names(s) of the individual(s) who performed the sampling or measurements;

V.A.2.c.iii The date(s) analyses were performed;

V.A.2.c.iv The name(s) of the individual(s) who performed the analyses;

V.A.2.c.v The analytical techniques or methods used; and

V.A.2.c.vi		The results of such analyses
V.A.2.d	Analyses shall be performed by a State of Nevada-certified laboratory. Laboratory reports shall be provided if requested by NDEP.	
V.A.2.e	If the Permittees perform storm water monitoring more frequently than required by the Storm Water Monitoring Plan, the results of such monitoring shall be reported in the Annual Report.	

Record-keeping requirements can be found in Section V.B of the Permit. Section V.B.1 of the Permit specifies that the co-permittees must retain records that are associated with any monitoring and sampling activities for at least three years. This includes records of water quality field instrument calibration.

V.B. Recordkeeping	
V.B.1	The Permittees must retain records of all monitoring information, including: all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, a copy of the NPDES permit, and records of all data used to complete the application for this permit, for a period of at least three (3) years from the termination date of this permit. This period may be extended at the direction of NDEP at any time.

Section IV.C requires the co-permittees to review characterization data previously submitted, and evaluate if the current sampling program should be modified to improve the characterization of storm water discharge, effects of BMPs or ambient water quality. This review can be found in Section 2.5.2 of the 2011 SWMP document.

IV.C. Characterization Data	
IV.C.1	The updated SWMP shall evaluate characterization data previously submitted and include additional data collected in the same manner, and evaluate whether existing data collection programs should be modified to improve characterization of storm water discharges, effects of BMPs, or ambient water quality. This information shall be submitted for approval as part of the Annual Monitoring Plan required in Part V.A.

Inferences of a monitoring component or where monitoring may potentially assist in satisfying the permit requirement can be found in Section II.A (Impaired Waters), Section II.B (Total Maximum Daily Load), Section IV.G (Illicit Discharge and Detection) and Section IV.H (Industrial Facility Monitoring and Control) of the Permit. The latter two programs are well developed and fully described in the SWMP.

1.3 Present Storm Water Sampling Approach

The sampling program maintains two different activities: 1) scheduled ambient (baseflow) sampling in tributaries, and 2) unscheduled storm event sampling in tributaries and urban outfalls. Ambient sampling is conducted at eleven fixed stations on eight tributaries of the Truckee River. Storm event samples are collected from these same stations and from four additional storm drain outfalls that discharge directly to the Truckee River. Outfall sampling is limited to storm events because outfalls typically only discharge runoff during storms and remain dry during non-storm periods. Locations of tributary and outfall sampling stations are illustrated in **Figure 1-1**.

Ambient and storm event monitoring consist of both field and laboratory measurements. In the field, water temperature (T), dissolved oxygen (DO), pH, specific conductance (SC), turbidity, and flow rate are measured or recorded. Laboratory measurements include total dissolved solids (TDS), total suspended solids (TSS), total phosphorus (Total-P), ortho-phosphate (Ortho-P), and total nitrogen (Total-N), conducted by a State of Nevada certified laboratory. E. coli and nitrate (NO_3) are analyzed for select stations only.

Selection of tributary sampling stations is based on the List of Impaired Waters, or 303(d) list (**Table 1-1**, NDEP, 2014), and experience of the SWPCC. Every two years, NDEP is required to prepare and submit an updated 303(d) list to the U.S. Environmental Protection Agency (USEPA). The most recent list (NDEP, 2014) includes nine tributaries, three lakes/ponds, and the Truckee River within the Truckee Meadows. Impairment differs between listed water bodies, but constituents of concern include nutrients, bacteria, metals, and general physical parameters such as pH and temperature (see **Table 1-1**). NDEP (1994) has also established Total Maximum Daily Loads (TMDLs) for three constituents (Total-N, Total-P, and TDS) on the Truckee River and its tributaries (**Table 1-2**).

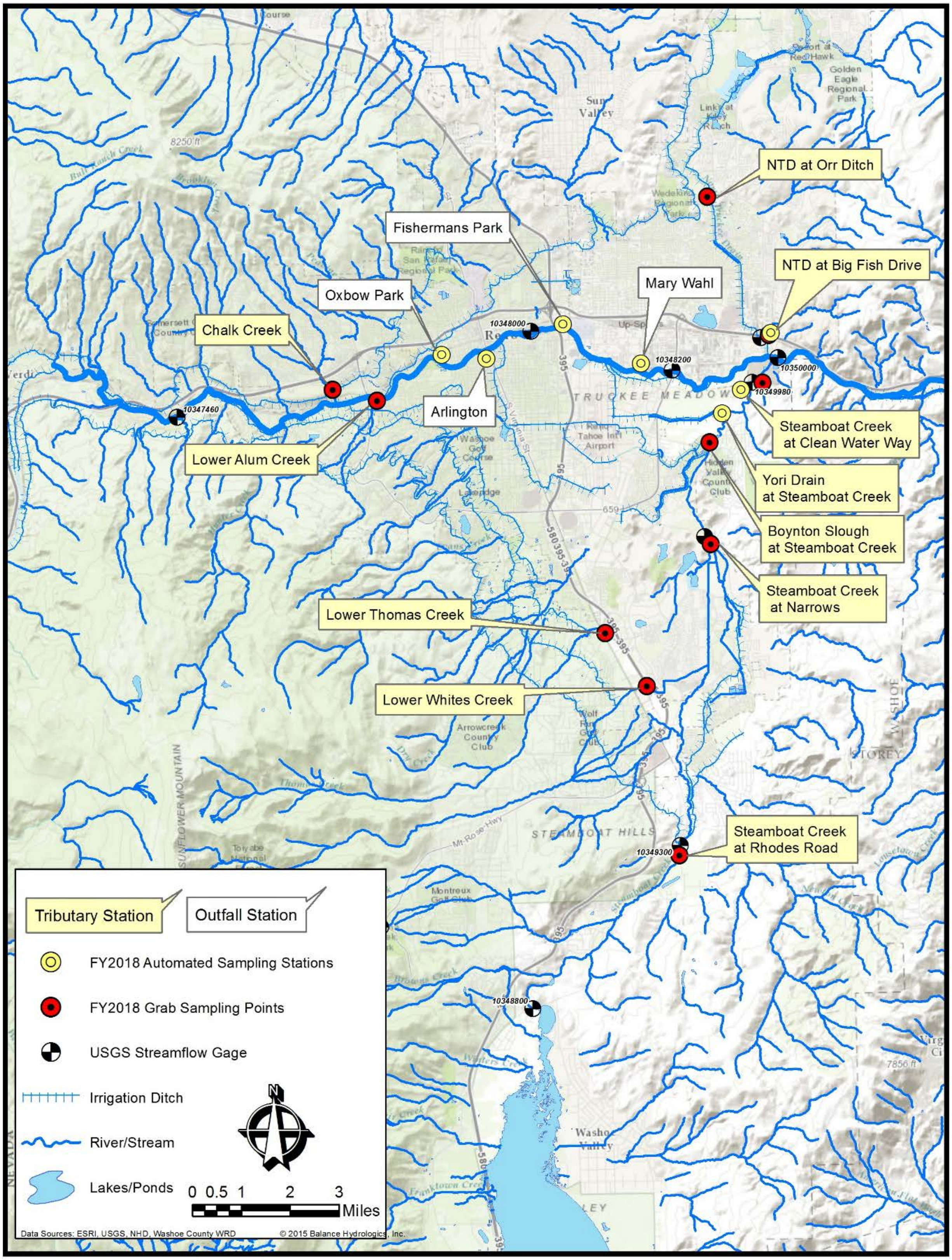


Figure 1-1 Truckee Meadows Storm Water Monitoring Stations, FY2018.

Table 1-1 2014 Impaired Waters and Listed Constituents, 303(d) List, Truckee Meadows, Nevada (NDEP, 2014)

Water Name	Reach Impaired	Impairment	Impaired Beneficial Use
Truckee River	From NV-CA state line to E. McCarran	Water Temperature	AQL
Alum Creek	Entire reach	pH Total-P OP Water Temperature TDS TSS	PWL, RWC AQL, RWC AQL, RWC AQL MDS AQL
Chalk Creek	Entire reach	Nitrate Total-P OP Selenium Sulfates Temperature TDS TSS	AQL, RWC AQL, RWC AQL, RWC AQL MDS AQL MDS AQL
Sparks Marina	Entire reservoir	Total-N Total-P TDS	AQL, RWC AQL, RWC MDS
Tracy Pond	Entire area	pH	AQL, PWL, RWC
Dry Creek	headwaters to Boynton Slough	E-coli	RWC
Evans Creek	HWY 395 to Dry Creek	E-coli	RWC
Franktown Creek	From irrigation diversion to Washoe Lake	Iron	AQL
Galena Creek	(see NDEP, 2014)	pH	AQL, PWL, RWC
Steamboat Creek	Little Washoe Lake to USGS 10349300 USGS 10349300 to Truckee River	E-coli Arsenic Boron E-coli Iron	RWC AQL, IRR, WLS IRR, WLS RWC AQL
Thomas Creek	Below Steamboat Ditch	Arsenic Boron	AQL, IRR, WLS IRR, WLS
Washoe Lakes	Entire lakes	Mercury in fish tissue	FC
Whites Creek	Middle Fork North and South Forks and Whites Creek North Fork	E-coli Iron Total-P pH Total-P E-coli	RWC AQL AQL, RWC AQL, PWL, RWC AQL, RWC RWC

Notes:

AQL = aquatic life, FC = fish consumption, IRR = irrigation, MDS = municipal domestic supply, PWL = propagation of wildlife,

RNC = recreation not involving contact with water, RWC = recreation involving contact with water, WLS = watering of livestock.

Table 1-2 Total Maximum Daily Loads, Truckee River at Lockwood (NDEP, 1994)

Total Maximum Daily Load	Total Nitrogen	Total Phosphorus	Total Dissolved Solids
Point of Compliance	*lbs/day*	*lbs/day*	*lbs/day*
TMDL			
Truckee River at Lockwood	1,000	214	900,528
Non-Point Source or Load Allocation			
Truckee River at Lockwood	500	80	780,360

In an effort to better quantify constituent loading, three tributaries (Steamboat Creek at Clean Water Way, North Truckee Drain at Big Fish Drive, and Yori Drain at Steamboat Creek) and four urban outfall monitoring stations have been instrumented with automated samplers. Automated samplers allow for multiple samples to be obtained during a single event, and are paired with a streamflow gaging station to facilitate quantification of stream discharge and constituent loading over the course of the storm. Constituent loads, once quantified, can then be compared to TMDLs established for the Truckee River. Procedures for quantifying loads are explained in further detail in **Section 3**.

Streamflow gaging stations have been added to four other tributary monitoring stations (Chalk Creek at Chalk Bluff, Alum Creek at Truckee River, Whites Creek at Old Virginia Highway, and Thomas Creek at S. Meadow Parkway) to allow for calculation of instantaneous constituent loading at those locations (see **Figure 1-1** and **Table 2-3**). When combined with stream discharge data, total storm constituent loads can also be estimated at these stations.

1.4 Truckee River Monitoring

An extensive number of water quality studies and monitoring efforts have been and continue to be conducted on the Truckee River and its tributaries. In 2010, the Truckee River Coordinated Monitoring Program (CMP) was established to identify all of the different agencies and groups that conduct various types of monitoring activities on the Truckee River (Truckee River Memorandum of Understanding Group, 2010). The motivation behind the CMP was the need for better data sharing and efficiencies among the resource management agencies and non-profit organizations involved in the general management and stewardship of the Truckee River. In 2010, these agencies and organizations developed and signed a memorandum of understanding (MOU) that sets goals for improving the exchange of river monitoring data and other related activities. Groups collecting water quality or flow measurements are listed in **Table 1-2**.

Table 1-3 Agencies Currently Conducting Monitoring or Water Quality Studies on the Truckee River and Its Tributaries in Nevada

Agency	Purpose of Monitoring
Truckee Meadows Water Reclamation Facility (TMWRF)	CWA, NPDES Permit
Nevada Division of Environmental Protection (NDEP)	CWA, Identifying impaired waters
Truckee Meadows Water Authority (TMWA)	Safe Drinking Water Act compliance
Truckee River Flood Management Authority (TRFMA)	Monitor flow data
Truckee Meadows Watershed Committee (TMWC)	CWA, NPDES MS4 Permit
Pyramid Lake Paiute Tribe (PLPT)	CWA, Identifying impaired waters
Desert Research Institute (DRI)	Research
Tahoe Truckee Sanitation District (T-TSA)	NPDES Permit
University of Nevada, Reno (UNR)	Research
Nevada Department of Transportation Stormwater Data Management System (NDOT)	Improve monitoring capabilities and benefits of making continuous water quality data available
United States Geological Survey (USGS)	Monitor flow data

The main objectives of the CMP are to find efficiencies in sampling efforts, share data, and to facilitate a better understanding of health and processes in the Truckee River and its tributaries. The CMP document outlines a) definitions and protocols to clarify procedures and nomenclature, b) a general basis for data consolidation and format (metadata), and c) information on what monitoring related data are being collected, by whom, and the frequency of collection. The CMP sets forth a common sampling site naming protocol and sampling and analysis definitions intended to clarify reporting procedures.

Historically, both the Truckee Meadows Water Reclamation Facility (TMWRF) and staff from the Desert Research Institute (DRI) have conducted major monitoring programs on the Truckee River. TMWRF's monitoring efforts have consisted of: 1) monthly grab samples at nine sites; 2) quarterly sampling of benthic macroinvertebrates at four sites; and, 3) continuous (hourly) monitoring using water quality sondes at two sites (DRI, 2011). The TMWRF monitoring program is largely driven by NPDES discharge permit requirements for that facility, separate from the program outlined in this document.

Since the late 1960's, DRI has conducted baseline water quality monitoring in the Truckee River Basin (DRI, 2011). Up until the late 1980's, the program consisted of over 30 sites on the main-stem and tributaries. In 2010, the collection program consisted of sample collection at six sites in California and three in Nevada. In the past, DRI's Truckee River Monitoring Program (TRMP) has been funded by the United States Environmental Protection Agency (USEPA) and the Nevada System of Higher Education (NSHE). The primary objective of DRI's existing TRMP is to provide ambient water quality data to several stakeholders in the Truckee River Basin (DRI, 2011).

Starting in 2012, a large portion of the water quality monitoring efforts have been conducted by DRI. In response to TMWRF and NSHE budget shortfalls, DRI was awarded grant funds to conduct monitoring on the Truckee River at some of the sites that were scheduled to be discontinued for budget reasons. The Water Quality Monitoring Plan encompasses much of the historical DRI program along with key elements from the TMWRF program. The DRI monitoring program consists of four basic components: 1) review of historical river data collected on the main-stem Truckee; 2) monthly "grab" samples at 13 locations on the main-stem of the Truckee River; 3) maintenance of one continuous monitoring site at Marble Bluff Dam; and, 4) quarterly field collection of benthic macroinvertebrate data at four sites on the main-stem. Grab samples are analyzed for most routine inorganic constituents, including metals.

1.5 Document Organization

This Truckee Meadows Sampling and Analysis Plan is organized as follows:

- **Section 1 – Introduction**: Section 1 is an introduction to storm water management in the Truckee Meadows, a brief review of the existing storm water monitoring program, a summary of monitoring efforts on the Truckee River, and details the organization of the document.
- **Section 2 – Storm Water Monitoring Activities**: Section 2 includes the goals and objectives of this SAP and describes the three different monitoring approaches – Tributary and Outfall Sampling and Special Studies.

- **Section 3 – Methods and Procedures**: Section 3 describes the methods and procedures to be used in collecting samples, including laboratory methods, sample identification, event preparation, sampling activities, automated sampler programming and operations, field measurements, reporting, data handling, and project quality control requirements.
- **Section 4 – References**: Section 4 is a listing of the various documents used and referenced in this document.

2 STORM WATER MONITORING ACTIVITIES

Program goals and objectives have been established and four sampling programs developed to facilitate goal attainment. This section presents the program goals and objectives and these four programs: 1) an ambient tributary monitoring program, 2) a storm water tributary monitoring program, 3) an urban outfall monitoring program, and 4) a special studies program. Sampling procedures and methods are discussed in the next section of this document.

In 2017, the SWPCC approved a change to the monitoring period to coincide with the City of Reno fiscal year. The fiscal year begins on July 1 and ends on June 30 of the named year (i.e., FY2018). Conducting storm water monitoring using the fiscal year schedule allows a consultant to sample year-round whereas in previous years there would be a contractual gap between June 30 and October 1. This gap previously precluded sampling during the summer months, thereby reducing the opportunities to sample during seasonal convective precipitation or thunderstorms.

In recent years, significant efforts have been made to deploy automatic samplers on the major tributaries to the Truckee River with continuous recording streamflow to better characterize water quality over the duration of storm events and quantify constituent or pollutant loadings. Capturing samples over the duration of events and quantifying loads will result in fundamental data with respect to where the significant loadings originate from and where resources should be allocated to improve our understanding of storm water quality. The approach presented in this SAP reflects a continued transition towards quantifying constituent loadings in particular watersheds during runoff events. Identification of high-loading watersheds narrows the source areas of pollution such that future BMPs can be implemented.

"Grab" sampling will continue at some sampling locations along with instantaneous measurement of streamflow or runoff volume. Although the utility of grab samples is limited, current and historical data will be used to identify mean concentrations and trends over time. When combined with a record of continuous storm streamflow/discharge, constituent loadings are quantified and improve our understanding of storm water quality and sources of pollution.

2.1 Storm Water Monitoring Goals

Results of this program are being used to evaluate the effectiveness of control measures and BMPs and ultimately the success of the overall storm water management program

(SWMP). Storm water quality sampling provides quantitative (i.e., numeric) data to determine the extent of pollutant concentrations in runoff and loads. There are a variety of reasons that storm water sampling is important. After careful deliberation by the SWPCC, the motivation and overall goal of the Truckee Meadows Storm Water Sampling Program is:

"Through monitoring, research and investigation, develop a better understanding of how runoff affects the receiving waters within the MS4 Permit area over time."

In support of this overall program goal, four storm water monitoring objectives have been identified:

1. Continue to characterize the ambient and storm water quality in the major tributaries to the Truckee River;
2. Collect the data necessary to improve our understanding of storm water effects on the 303(d) listed waters and listed constituents;
3. Measure the ambient and storm water quality in selected outfalls, catchments and land use types within the MS4 permit area; and
4. Conduct special studies and investigations as the needs arise and funding is available to better understand storm water issues in the area.

Four different monitoring (sample collection) activities have been developed to accomplish the above objectives:

- Tributary Monitoring (ambient/baseflow)
- Tributary Monitoring (storm water);
- Outfall Storm Event Monitoring (storm water); and
- Special Studies and Projects.

Each of the four monitoring program activities are described in the following subsections.

2.2 Tributary Monitoring

Tributary Monitoring has two components:

1. Semi-annual tributary sample collection (scheduled, dry weather ambient sampling); and
2. Storm event grab sample collection (storm water).

The semi-annual, ambient tributary sample collection can be scheduled, while the rain event grab sample collection cannot. Monitoring locations, sampling frequency, and analytical parameters are discussed in the following subsections. Methods and procedures are presented in **Section 3** of this SAP document.

2.2.1 SAMPLING LOCATIONS AND WATERSHED CHARACTERISTICS - TRIBUTARIES

Under the direction of the SWPCC, storm water and ambient samples are collected at eleven fixed sites on eight tributaries to the Truckee River. Size and characteristics of the watersheds draining to these monitoring sites are described in **Table 2-1**.

The intent of this program has been to establish an understanding of nonpoint source pollution entering waterways from these tributaries, which have shown elevated concentration of constituents as well as high storm water runoff volumes. These sites were selected based on existing data, the need for additional data, representativeness of the entire watershed and land-uses, and proximity to existing streamflow gaging stations (see **Table 2-1**).

Steamboat Creek and North Truckee Drain are two of the largest tributaries to the Truckee River in the Truckee Meadows. In previous monitoring efforts, these tributaries have shown to contribute high pollutant concentrations and loads. To better isolate the sources of pollutants to these tributaries, a nesting approach or additional sampling stations were established upstream in these tributaries. Sampling stations are co-located with existing USGS streamflow gaging stations or outfitted with auto-samplers with area velocity modules to facilitate calculations of instantaneous and/or storm event loads. The following tributary stations have been added to this program in FY2018:

- Yori Drain at Steamboat Creek (YD@SBC)
- Boynton Slough at Steamboat Creek (BS@SBC)

Both stations are located on tributaries to Steamboat Creek and have been previously identified as ‘high-priority’ by the Committee.

Table 2-1 Tributary Watershed Characteristics

	Tributary	Sampling Location	Watershed Area (sq. miles)	Land-Use Type	Estimated Percent Impervious (%)
1	Steamboat Creek	Rhodes Road	123	Rural residential, agricultural, historical mining, geothermal, HWY 395A, geothermal operations	<5
2		Narrows	192	Mixed residential-commercial, agriculture, golf courses, historical mining, geothermal operations, new construction, SouthEast Connector	15
3		Clean Water Way	244	Mixed residential-commercial, agriculture, golf courses, historical mining, geothermal operations, new construction, airport, major roadways	25
4	Yori Drain	Steamboat Creek	3.8	Mixed residential-commercial, agriculture, golf courses, historical mining, geothermal operations, new construction, airport, major roadways	48
5	Boynton Slough	Steamboat Creek	52	Upper watershed is open space; lower: mixed residential-commercial, agriculture, golf courses, historical mining, geothermal operations, new construction, airport, major	35
6	Whites Creek	Old Virginia Highway	18.5	Upper watershed is mostly open space; lower: residential, commercial, golf course, new construction	<10
7	Thomas Creek	S. Meadows Pkwy	18.5	Upper watershed is mostly open space; lower: residential, commercial, some agriculture, golf course, new construction	<10
8	North Truckee Drain	Orr Ditch	76.1	Agricultural, residential, commercial	30
9		Big Fish Drive	n/a	Commercial, industrial, agricultural, residential	35
10	Chalk Creek	Chalk Bluff	4.6	Upper watershed is undeveloped; lower: residential, I-80, some commercial	45
11	Alum Creek	Truckee River	4.9	Upper watershed is undeveloped; lower: residential, commercial	30

2.2.2 Water Quality Parameters – Tributaries

Water quality parameters to be monitored include both laboratory and field measurements (**Table 2-3**). Field measurements of water temperature, SC, pH, DO, and turbidity will be performed at all sampling sites during all sampling events (rain and non-rain events). Laboratory parameters to be measured will vary by sampling site. As listed in **Table 2-3**, there are both standard and site specific analytes. Samples will be collected and analyzed for the standard analytical parameters at the sampling sites during sampling events (ambient and storm events).

Table 2-2 Tributary Water Quality Parameters

	Tributary	Sampling Location	Sample Type	Field Measured Parameters	Laboratory Analytical Parameters	Additional Parameters
1	Steamboat Creek	Rhodes Road	Grab	Temperature Dissolved oxygen pH Specific conductance Turbidity	Total dissolved solids Total suspended solids Total phosphorus Ortho-phosphates Total nitrogen	E. coli
2		Narrows	Grab			
3		Clean Water Way	Auto Composite			
4		Yori Drian	Auto Composite			
5		Boynton Slough	Grab			
4	Whites Creek	Old Virginia Highway	Grab			E. coli
5	Thomas Creek	S. Meadows Pkwy	Grab			
6	North Truckee Drain	Orr Ditch	Grab			
7		Big Fish Drive	Auto Composite			
8	Chalk Creek	Chalk Bluff	Grab			Nitrate as N
9	Alum Creek	Truckee River	Grab			E. coli

2.2.3 STREAMFLOW MEASUREMENT – TRIBUTARIES

All tributary sampling locations are co-located with continuous-recording streamflow gages (**Table 2-3**). Streamflow at the time of sample collection will be measured or recorded from existing gaging stations. These stations are operated and managed by the USGS, Washoe County, and Balance Hydrologics. Current and historical streamflow values at USGS and Washoe County stations are available on the internet (see **Table 2-3**).

Continuous streamflow gaging stations managed by Balance Hydrologics were installed in September 2015. Each station is instrumented with a Type A or C staff plate and In-Situ® water level logger secured within a stilling well. Instruments measure water pressure and require compensation with barometric pressure to obtain true water depth. An In-Situ® barometric pressure logger has been installed at Chalk Creek for compensation of this and other stations. Instruments record instantaneous values every 15-minutes, consistent with USGS standards. These stations require multiple manual streamflow measurements over a range of stages to establish accurate stage to discharge relationships, which will eventually be used to provide a record of continuous streamflow.

Table 2-3 Tributary Streamflow Gaging Information

	Tributary	Continuous Streamflow Station	Gage Manager	Gage ID	Period of Record	Real-Time Streamflow Access
1	Steamboat Creek	Rhodes Road	USGS	10349300	WY1961 to current	http://waterdata.usgs.gov/nwis/inventory
2		Narrows	USGS	10349849	WY1982 to current	http://waterdata.usgs.gov/nwis/inventory
3		Clean Water Way	USGS	10349980	WY1992 to current	http://waterdata.usgs.gov/nwis/inventory
4	Yori Drain	Steamboat Creek	Balance Hydrologics	YD@SBC	WY2017 to current	n/a*
5	Whites Creek	Old Virginia Highway	Washoe County	151642	partial WY2015	http://www.troa.net/tis/
6	Thomas Creek	S. Meadows Pkwy	Balance Hydrologics	TC@MP	begins WY2016	n/a*
7	North Truckee Drain	Orr Ditch	USGS	10348245	WY1992 to current	http://waterdata.usgs.gov/nwis/inventory
8		Big Fish Drive	USGS	10348295	WY2017 to current	http://waterdata.usgs.gov/nwis/inventory
9	Chalk Creek	Chalk Bluff	Balance Hydrologics	CC@CB	WY2016 to current	n/a*
10	Alum Creek	Truckee River	Balance Hydrologics	AC@TR	WY2016 to current	n/a*

**Stations may be upgraded in the future to real-time using telemetry.*

2.2.4 SAMPLING TYPE AND FREQUENCY – TRIBUTARIES

Sampling type and frequency are outlined in **Table 2-4**. It is the intention of this SAP to collect two storm and two non-storm event samples at each of the nine locations each year. Local precipitation records indicate that the "wet season" in the Truckee Meadows is between November and May, and the "dry season" is between June and October. Depending on the year, some of the tributaries may be dry. For the non-rain event sampling a winter sample will be collected sometime in February and a summer sample sometime in August each year. Rain event samples will be collected when possible during active, rain related discharge. Sampling frequencies (two storm and two non-storm event samples) are targets. Every effort will be made to collect these samples, however, the lack of rain or failure of rain events to produce runoff or dry tributaries may prevent sample collection.

Table 2-4 Sampling Type and Frequency

	Tributary	Sampling Location	Sample Type	Sampling Frequency
1	Steamboat Creek	Rhodes Road	Grab	2X baseflow, 2X storm event
2		Narrows	Grab	
3		Clean Water Way	Automated-composite*	
4	Yori Drain	Steamboat Creek	Automated-composite*	
5	Boynton Slough	Steamboat Creek	Grab	
6	Whites Creek	Old Virginia Highway	Grab	
7	Thomas Creek	S. Meadows Pkwy	Grab	
8	North Truckee Drain	Orr Ditch	Grab	
9		Big Fish Drive	Automated-composite*	
10	Chalk Creek	Chalk Bluff	Grab	
11	Alum Creek	Truckee River	Grab	

*Notes: * Automated-composite sampling conducted during ambient monitoring will be sampled hourly over a 24 hour period and separated into 4 composite samples.*

2.2.5 FUTURE MODIFICATIONS AND CHANGES – TRIBUTARIES

Future changes or addenda to the SAP will be provided to NDEP each year as required by the Permit. Balance is anticipating upgrading the Boynton Slough sampling site to an automated station beginning in FY2019, after the SE Connector construction has been completed.

2.3 Outfall Storm Event Monitoring

Under this SAP, samples will be automatically collected from four outfalls during rain events. The objective of this effort is to quantify constituent loads being discharged from the storm water network system in areas of the MS4 Permit area characterized by different land-use types. The four outfalls to be monitored this year are consistent with previous monitoring years and were selected by Reno, Sparks and Washoe county staff based on size, location, land use and the drainage size. Locations of the outfalls selected for sampling under this program are presented in **Figure 1-1**.

2.3.1 Sampling Locations – Outfalls

Outfall location descriptions, drainage area size, primary land-use type, and estimated percent of watershed imperviousness are summarized in **Table 2-5**. The outfalls drain directly to or in close proximity of the Truckee River. The outfalls drain watersheds that range from 0.32 to 5.1 square miles and with residential/commercial (Arlington and Oxbow) and commercial/industrial (Fisherman's Park II and Mary Wahl) land-uses. Every effort will be made to collect the outfall rain-event samples described in this SAP. In the event that unforeseen obstacles or the lack of precipitation prevents sample collection, NDEP will be notified and the issues described in the Annual Report to NDEP.

Table 2-5 Urban Outfall Watershed Characteristics

	Outfall	Sampling Location	Watershed Area	Land-Use Type	Estimated Percent Urbanization
			(sq. miles)		*(%)*
1	Oxbow Nature Park	Truckee River	0.36	Residential, commercial	80-90
2	Arlington	Truckee River	0.32	Residential, commercial	90-95
3	Fisherman's Park II	Truckee River	5.1	Mixed residential, commercial, industrical, agriculture, UPRR, new construction	75-85
4	Mary Wahl	Freeport Blvd	2.25	Mixed residential, commercial, industrical, agriculture, I-80, UPRR, new construction	85-95

2.3.2 Water Quality Parameters – Outfalls

Laboratory water-quality parameters to be monitored at outfalls are provided in **Table 2-6**. Field measurements include the usual suite of temperature, SC, pH, DO, and turbidity. We note that because specific water quality parameters can change while samples are temporarily retained within the automated samplers (i.e., temperature, DO), efforts to measure these parameters directly in the outfall will be prioritized during the event. Similarly, e. coli will be collected directly from the outfall when feasible and processed to address its short laboratory holding time (i.e. 8-hours). Laboratory parameters to be measured will be the same for all samples.

Table 2-6 Outfall Water-Quality Parameters

	Outfall	Sampling Location	Sample Type	Field Measured Parameters	Laboratory Analytical Parameters	Additional Parameters
1	Oxbow Nature Park	Truckee River	Auto Composite	Temperature Dissolved Oxygen pH Specific conductance Turbidity	Total dissolved solids Total suspended solids Total phosphorus Ortho-phosphates Total nitrogen	e. coli
2	Arlington	Truckee River	Auto Composite			e. coli
3	Fisherman's Park II	Truckee River	Auto Composite			e. coli
4	Mary Wahl	Freeport Blvd	Auto Composite			e. coli

2.3.3 Discharge Measurement – Outfalls

All four outfalls are instrumented with Teledyne® ISCO area-velocity modules and managed by Balance Hydrologics (**Table 2-5**). These modules measure near-continuous (5-minute intervals) depth and velocity. The dimensions of each culvert is programmed within the module and used with measures of depth and velocity to compute a record of near-continuous discharge.

Table 2-7 Outfall Discharge Gaging Information

	Outfall	Sampling Location	Gage Manager	Gage ID	Period of Record	Real-Time Streamflow Access
1	Oxbow Nature Park	Truckee River	Balance Hydrologics	C-24	Storm Only	Unavailable at this time
2	Arlington	Truckee River	Balance Hydrologics	H-19	WY2017 to current	http://www.balancehydrologics.com/reno/H-19/index.php
3	Fisherman's Park II	Truckee River	Balance Hydrologics	D-16	Storm Only	Unavailable at this time
4	Mary Wahl	Freeport Blvd	Balance Hydrologics	SDOE 008936	Storm Only	Unavailable at this time

2.3.4 Sampling Frequency – Outfalls

The target effort is to collect samples twice annually (**Table 2-8**). Ideally, after a successful sampling of a storm event, a dry period of 10 days should occur before another storm event is sampled. This guideline of waiting 10 days between storms may be waived due to calendar restrictions (i.e., late in the sampling season and the need for two observations), previous success, the long-term weather forecast, and other professional judgment.

Table 2-8 Outfall Sampling Type and Frequency

	Outfall	Sampling Location	Sample Type	Sampling Frequency
1	Oxbow Nature Park	Truckee River	Automated-composite	2X storm event
2	Arlington	Truckee River	Automated-composite	
3	Fisherman's Park II	Truckee River	Automated-composite	
4	Mary Wahl	Freeport Blvd	Automated-composite	

2.3.5 Future Modifications and Changes – Outfalls

At this time, we do not anticipate any modifications or changes to the urban outfall monitoring described in this program. Sample results and field observations are expected to largely guide future decisions. As required by the Permit, NDEP will be notified of any changes and an updated SAP document each year.

2.4 Special Studies and Projects

Over the past years, numerous special projects have been conducted to improve our understanding of storm water runoff and quality within the MS4 permit area. These projects have provided valuable insight and have improved the public's understanding of the effects of storm water on local water quality. The SWPCC has identified the desire to continue special studies and investigations as the needs arise and funding is available. Previous example studies, on-going, and possible future projects include:

- Water quality of irrigation ditch tail-waters (City of Reno, 2015);
- Nuisance flow (dry-weather) water quality and quantity (Hastings and others, 2016);
- Virginia Lake limnology and water quality (in progress); and
- Conduct a watershed assessment of Steamboat Creek to identify source areas of excess nutrients (possible future study).

A listing of desirable projects will be maintained by the SWPCC. Each year an effort will be made to apply for grant funding for new projects to improve the overall understanding of local storm water related issues and solutions.

3 METHODS AND PROCEDURES

Details relating to sampling, analysis, handling, reporting of program samples and data are presented in this section. Field and laboratory methods for data collection are specified. Also in this section are the data quality objectives and quality assurance (QA) procedures in place to assure that the data collected are of high quality and form the basis of sound decisions.

3.1 Sample and Analysis Requirements

The procedures and methods used to collect, process, measure and deliver samples to the laboratory are important steps in the collection of high quality data. In the following subsections, laboratory requirements, analytical methodology, sampling containers and approved holding times are specified.

3.1.1 Laboratory Selection

Section V.A.2.c.v of the Permit specifies that laboratory analyses be performed by a State of Nevada-certified laboratory. Western Environmental Testing Laboratory (WETLAB) in Sparks, Nevada has been selected for all of the parameters listed in this SAP.

3.1.2 Analytical Methods

Section V.A.2.b of the Permit requires that any samples submitted for laboratory analysis be analyzed using EPA approved methodology. Required analytical for both field and laboratory determinations are listed in **Table 3-1**. Methods listed were supplied by WETLAB. For several of the required parameters listed in **Table 3-1** there are multiple approved analytical methods. The laboratories may submit alternate methodologies (than those specified in **Table 3-1**) to the SWPCC for approval.

3.1.3 Sample Containers and Preservatives

Required sampling containers vary with the parameter(s) being tested, as the volume required, container material and preservative differ by analytical parameter. For this sampling effort, the required sampling container type (i.e. plastic or glass), minimum sample volume and the required preservative are listed in **Table 3-1**. Sample containers are to be supplied by the contract laboratory and certified as “clean” by the laboratory or manufacturer.

Table 3-1 Analytical Parameters, Abbreviations, Reporting Limits, Analytical Methods, Containers, Sample Volume, Preservatives, and Holding Times

Parameter (Field)	Abbreviation	Units	Reporting Limit[a]	Analytical Method[b]	Container Material	Volume Required	Preservative	Holding Time
Specific Conductance	SC	µmho/cm	1	EPA 120.1	N/A (Direct)	N/A[f] (Direct)	None (Field)	None
pH	pH	S.U.[e]	0.1	EPA 150.1	N/A (Direct)	N/A (Direct)	None (Field)	None
Turbidity	Turbidity	NTU	0.1	EPA 180.1	N/A (Direct)	N/A (Direct)	None (Field)	None
Temperature	Temp	°C	1	EPA 170.1	N/A (Direct)	N/A (Direct)	None (Field)	None
Dissolved Oxygen	DO	mg/L	0.1	EPA 360.1	N/A (Direct)	N/A (Direct)	None (Field)	None
Parameter (Laboratory)	**Abbreviation**	**Units**	**Reporting Limit**	**Analytical Method[c]**	**Container Material**	**Volume Required**	**Preservative**	**Holding Time**
Total Dissolved Solids	TDS	mg/L	10	SM 2540C	Poly[d]	1000 mL	< 4 ºC	7 days
Total Suspended Solids	TSS	mg/L	1.00	SM 2540D	Poly	1000 mL	< 4 ºC	7 days
Nitrate Nitrogen	NO_3	mg-N/L	0.10	EPA 300.0	Poly	500 mL	Sulfuric Acid	48 hours[j]
Total, Kjeldahl, Nitrogen	TKN	mg-N/L	0.40	SM 4500 NH3	Poly	500 mL	Sulfuric Acid	28 days
Total Nitrogen	Total-N	mg-N/L	1.00	EPA 351.3	Poly	500 mL	Sulfuric Acid	28 days
Total Phosphorus	Total-P	mg-P/L	0.01	EPA 365.3	Poly	500 mL	Sulfuric Acid	28 days
Ortho-Phosphate	Ortho-P	mg-P/L	0.01	EPA 300.0	Poly	500 mL	< 4 ºC	48 hours
E. Coli	E. Coli	Col/100mL[g]	P/A[h]	SM 9223B	Poly (Sterile)	125 mL	< 4 ºC[i]	8 hours

Notes

[a] Required laboratory reporting limit. For the field determinations the reporting limit refers to required instrument resolution

[b] To the extent possible, EPA methodology will be followed in the field

[c] Analytical Method reference courtesy of Alpha Analytical, Inc.; EPA = EPA Methods for Water Analysis, SM = Standard Methods for the Examination of Water and Wastewater

[d] Poly = plastic, linear polyethylene

[e] S.U. = Standard Units

[f] N/A = Not Applicable for this determination

[g] Colonies per 100 mL of sample

[h] P/A = Presence or absence with enumeration

[i] De-Chlorination (thiosulfate) not required

[j] EPA 353.2 Latchet method to detect NO_3 and NO_2 has hold time of 28 days

3.1.4 Holding Times

Each analytical parameter has an approved holding time. Holding times are calculated from the time of sample collection to the beginning of analysis in the laboratory. Laboratory method sample holding-times are listed in **Table 3-1**.

3.1.5 Sample Identification

All samples collected must be clearly labeled with the appropriate information. The sample identification numbering format needs to be consistent throughout the monitoring season. These requirements are specified in this sub-section.

3.1.6 Sample Identification, Labeling and Bottle Sets

The Truckee River Coordinated Monitoring Program recommends a naming convention of "River Name at/below Geographic Name" (The Truckee River Memorandum of Understanding Group, 2010). Both Tributary and Outfall monitoring efforts will follow this sample naming convention. Sample site identification for the Tributary Monitoring effort is shown in **Table 3-2** and **Table 3-3** for the Outfall Monitoring effort. Site abbreviations listed are subject to revision.

Bottle sets will be pre-assembled prior to field sampling events. Sample bottles will have pre-affixed labels. Labels will have a blank for the sampling crew to write in, the sample location, date, time, constituents for analysis, and any preservative. As a function of the analytical parameters, the required sample bottle sets consist of two or three different containers per sampling location. Required sample bottle sets are shown in **Table 3-2** and **Table 3-3**.

Table 3-2 Sample Site Identification and Bottle Requirements for Tributaries

Sample Site Identification		Laboratory Determinations	Sampling Container
Sample ID	Abbreviation		
Steamboat Creek @ the Narrows	SBC@NAR	TDS, TSS, Ortho-P	1000 mL poly, no-preservative
Steamboat Creek @ Clean Water Way	SBC@CWW		
Thomas Creek @ S. Meadows Pkwy	TC@SMP		
North Truckee Drain @ Orr Ditch	NTD@ORD		
North Truckee Drain @ Big Fish Dr.	NTD@BFD		
Yori Drain @ Steamboat Creek	YD@SBC	Total-P, Total-N	500 mL poly, H_2SO_4
Boynton Slough @ Steamboat Creek	BS@SBC		
Steamboat Creek @ Rhodes Road	SBC@RHR	TDS, TSS, Ortho-P	1000 mL poly, no-preservative
Whites Creek @ Old Virginia Hwy	WC@OVH	Total-P, Total-N	500 mL poly, H_2SO_4
Alum Creek @ Truckee River	AC@TR	e. Coli	125 mL poly, sterile
Chalk Creek @ Chalk Bluff	CR@CB	TDS, TSS, Ortho-P	1000 mL poly, no-preservative
		Total-P, Total-N, NO_3	500 mL poly, H_2SO_4

Table 3-3 Sample Site Identification and Bottle Requirements for Urban Outfalls

Sample Site Identification		Laboratory Determinations	Sampling Container
Outfall	ID Number		
Oxbow Nature Park	C-24	TDS, TSS, Ortho-P	1000 mL poly, no-preservative
Arlington (South)	H-19	Total-P, Total-N, NO_3	500 mL poly, H_2SO_4
Fisherman's Park II	D-16	e. Coli	125 poly, sterile
Mary Wahl Ditch	SDOE-008936		

3.1.7 Chain-of-Custody Forms

To assist in tracking and maintaining sample integrity the samples will be collected and handled under proper chain-of-custody (COC) procedures. The COC forms will be supplied by the laboratory and are to be signed by the sampler at the time the samples are transferred into the custody of the laboratory. The sampling team will retain a copy of the COC form. The form is the primary mechanism to instruct the laboratory as to what analyses are to be made, the samples ID, any special notes, data and times collected and the contact person.

3.2 Event Preparation

The sampling team will closely track weather systems and be as ready as possible. Because of the unpredictability of rainfall in the Truckee Meadows region, it is critical that all necessary preparations (bottles, coolers, labels, data sheets, and equipment) are made prior to deployment for storm water collection. Outlined in this sub-section are the requirements for weather tracking, project communications, equipment, and logistical preparations to be made prior to sampling.

3.2.1 Storm Event Tracking

Storm events will be tracked by the sampling team using a variety of resources. Resources to be used include National Weather Service (NWS) broadcasts, facebook posts, and twitter feed, radio forecasts, internet real-time rain gages, NDOT webcams, and other contacts in the Truckee Meadows. There are several smartphone apps used by the field teams such as: Storm, Wunderground, Storm Radar, MyRadar, and NOAA Radar. At this time, a subscription to a commercial monitoring and forecast service is not anticipated. Below are a list of on-line resources currently in use:

- The National Weather Service, Reno, NV: http://www.wrh.noaa.gov/rev/
- The National Weather Service, Reno, NV Twitter Feed: https://twitter.com/nwsreno
- The National Weather Service, Reno, NV Facebook page: https://www.facebook.com/NWSReno?fref=ts
- National Weather Service live webcam, Reno, NV: http://www.wrh.noaa.gov/rev/webcam.php
- National Weather Service Instant Messaging Service: https://nwschat.weather.gov/
- Precipitation Radar: http://www.intellicast.com/Local/WxMap.aspx
- Weather Underground: https://www.wunderground.com/weather/us/nv/reno

- California-Nevada River Forecast Center (measured rainfall): http://www.cnrfc.noaa.gov
- Western Regional Climate Center (regional rain gages): http://www.wrcc.dri.edu/weather/
- Washoe County rain gages: http://www.washoeet.dri.edu/washoeEt.html
- Nevada Department of Transportation webcams: http://oss.weathershare.org/#
- USGS real-time streamflow gage network: http://waterwatch.usgs.gov/
- Truckee River Operating Agreement (other real-time stations): http://www.troa.net

3.2.2 Communication Plan

Once the team(s) are identified, a team leader will be selected and a call list assembled. Each team will be provided a binder with site locations, directions, sampling and monitoring needs, access, check list of required equipment, contact information of other team members, City of Reno staff, and laboratory, emergency contacts, and safety procedures.

As a candidate storm approaches, radar observations, live-web cam observations, and rainfall totals in the outlying (preceding) areas will be monitored. The sampling team leader will make the determination for mobilization.

Often, rain events in the Truckee Meadows are spotty and location specific. It is conceivable that storm event sample collection may be equally spotty, with rain event sampling possible at only a few of the selected sites, especially during summer thunderstorms. Every effort will be made to collect the samples described in this plan. Based on previous experience, a minimum of 0.10 inches of precipitation is required to trigger a storm water discharge response in most urban outfalls and tributaries with high impervious surfaces, while a minimum of 0.25 to 0.35 inches may be required for tributaries with primarily non-urban land-uses. However, antecedent soil moisture conditions and rainfall intensity will also dictate runoff response.

3.3 Pre-Event Preparation

Pre-event tasks include supply acquisition, inventories, equipment maintenance, gathering and labeling sample bottle and various other tasks. Items to gather in advance include safety equipment, bottles, portable instruments, ice chests, ice, data sheets, and markers. If possible, a day before an anticipated sampling event the field instruments will be pre-calibrated and the coolers and equipment loaded. Some of the information on the COC forms can be filled out in advance (site ID, analytical parameters, etc.).

Sites instrumented with Teledyne® ISCO automated samplers will be inspected and programmed within hours before the event begins. The batteries powering the automated samplers will be checked for adequate voltage (>10.7 V) and the intake valves shall be visually inspected for any debris or issues that could prevent sample collection. Automated samplers are designed to capture up to 24 discrete samples. The automated samplers have been pre-programmed with information from the sampling site. An example of a program for the automated samplers is included in **Appendix A**. Pre-event programming decisions, as based on storm event tracking methods described above, are still required to effectively fill all 24 samples across a storm event. Below are two methods used for sample collection and selection of one method over the other will be determined by available site information, storm characteristics, and user experience.

3.3.1 Time-Interval Automated Sampling

Time-interval sampling is a simple and reliable procedure since accurate time intervals are easy to measure and clock failures are rare. However, if small time intervals are used, frequent sampling will produce a large number of samples and will limit the length of storm duration that can be sampled within sampler capacity. In general, sites draining larger catchments require larger time intervals to capture the entire storm event. For instance, Arlington (H-19) drains a small watershed measuring approximately 0.3 square miles and most storm events can be captured using 10 to 15 minute sampling intervals. Alternatively, Fisherman's Park II drains a watershed area of over 5 square miles and most storm events are typically captured using 20 to 30 minute intervals. For either case, the proper interval will depend on the anticipated storm conditions and professional judgement and experience.

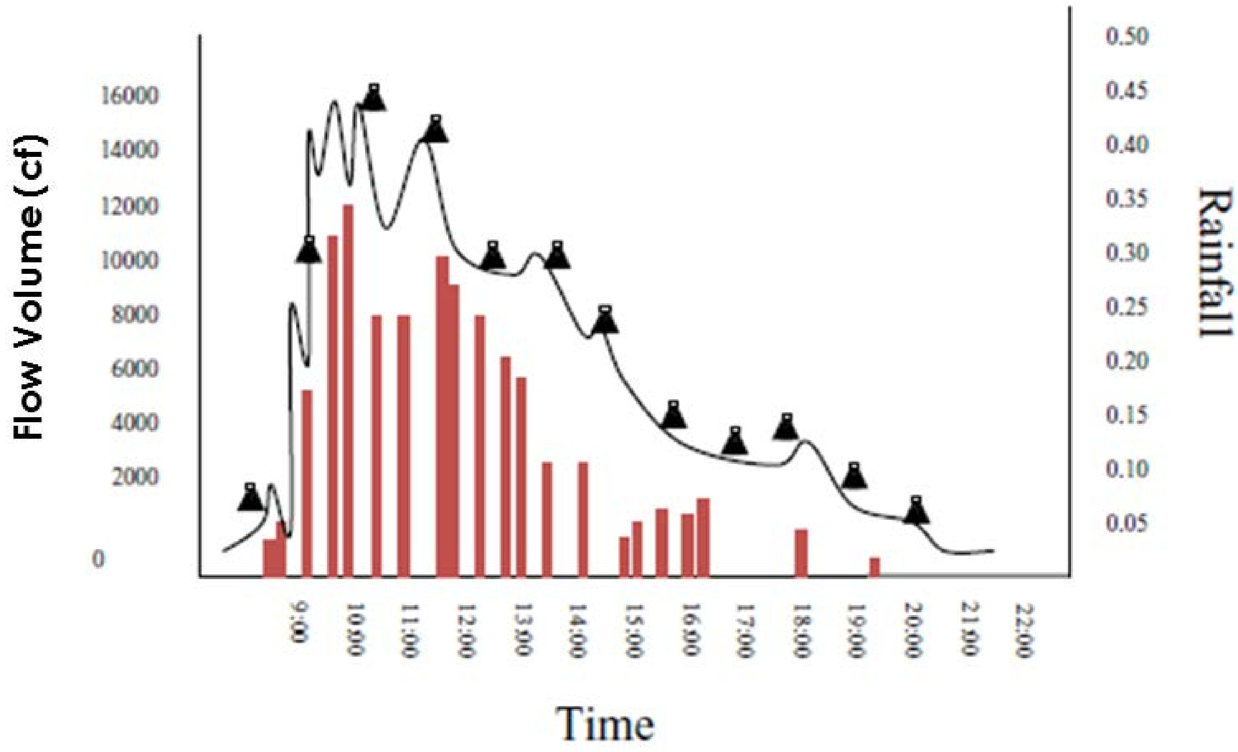


Figure 3-1 Example of Time-Interval Automated Sampling.

With time-interval sampling, flow measurements are needed for pollutant load calculations. The automated samplers are equipped with area-velocity sensors. Additional program requirements include entering the known ditch or culvert dimensions to properly convert depth and velocity measurements to flow rates.

3.3.2 Flow-Interval Automated Sampling

A major advantage of flow-interval based sampling is that sample volumes are proportional to the total runoff volume. More frequent sampling is completed during high flows, which can be used to better compute constituent loadings. Flow-interval samples are collected based on the storm runoff volume. Runoff volumes will vary based on rainfall depth and intensity, imperviousness of the watershed, and hydrologic connectivity. As such, each monitoring location has its own, unique relationship. Estimating storm runoff volume requires site-specific rainfall depth to runoff volume relationships or rating curves. These relationships require existing data and are often highly variable given the limited number of rain gages, proximity of the rain gage to the sampling location, and spatial and temporal variability in rainfall in the Truckee Meadows.

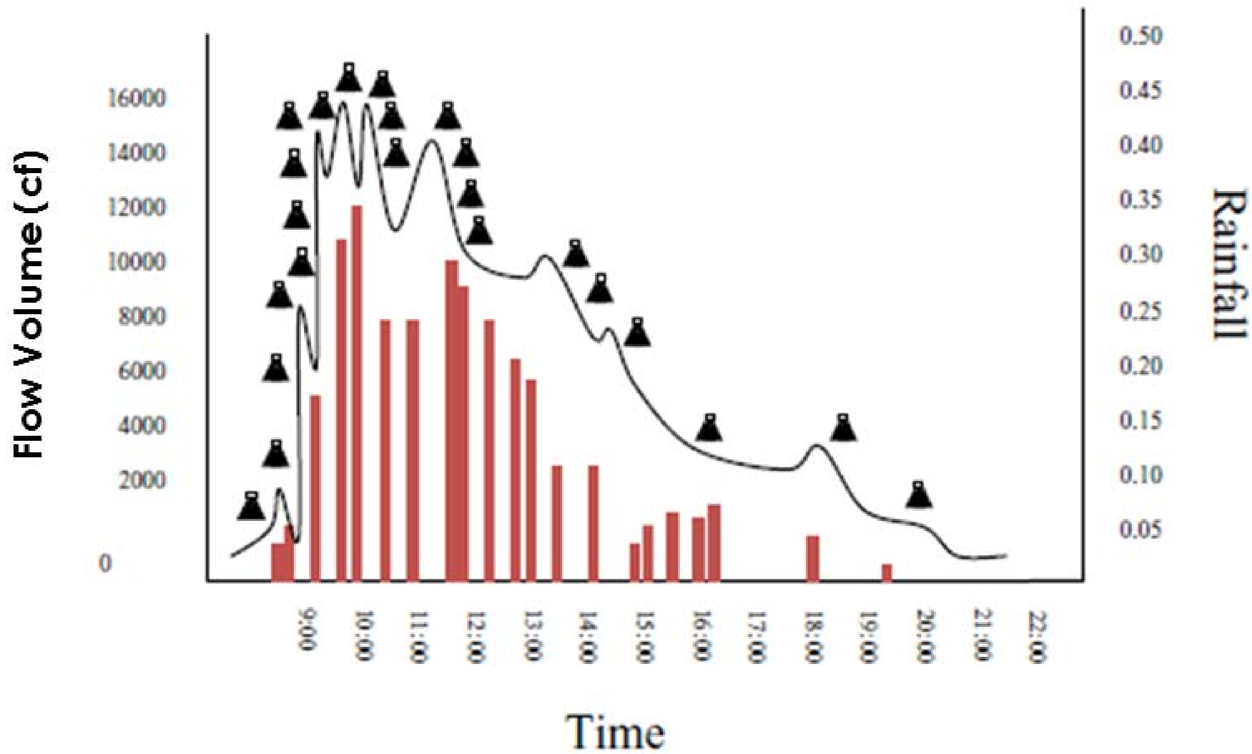
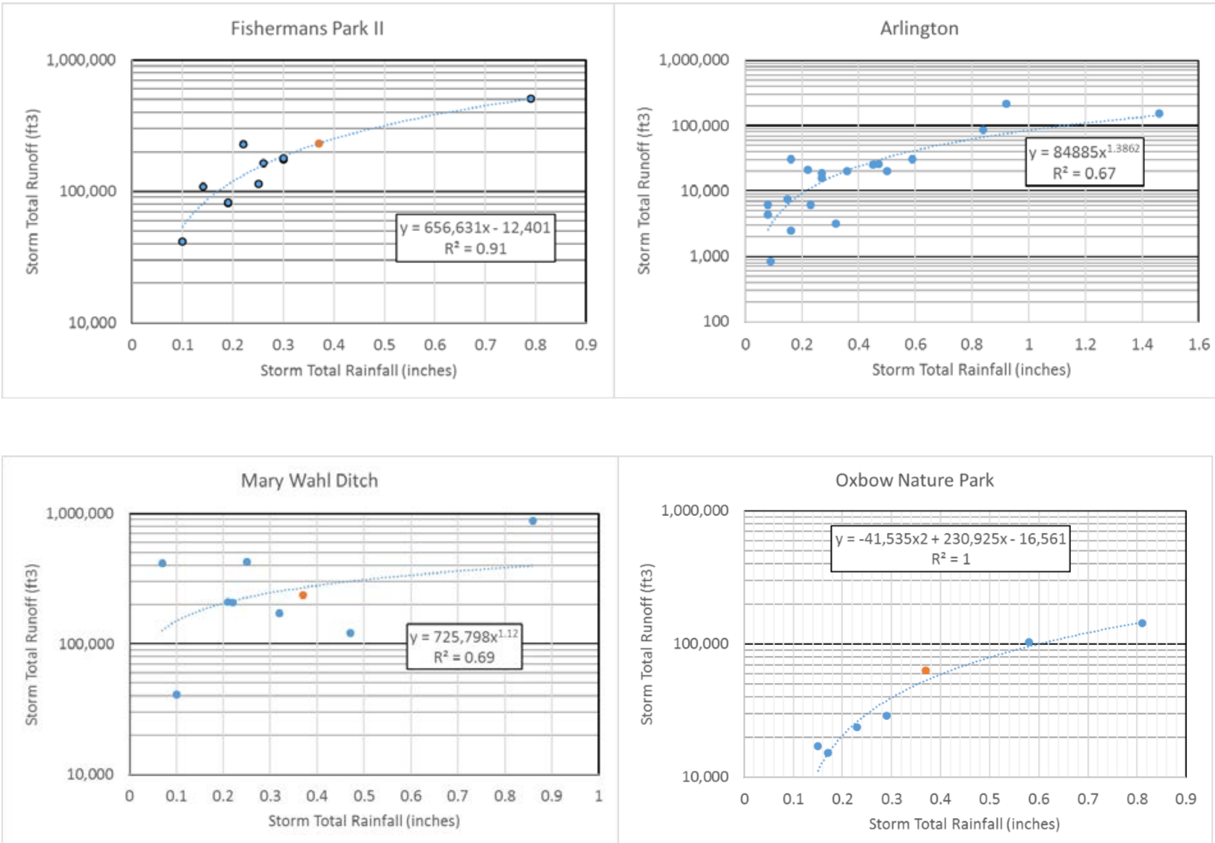


Figure 3-2 **Example of Flow-Interval Automated Sampling.** Balance Hydrologics developed rainfall depth-runoff volume rating curves for the existing sites instrumented with automated samplers (**Figure 3-2**) using nearby rain gages (**Table 3-4**) and recent runoff data from four automated sampling sites. Flow weighted sampling has been used at these sites since WY2016. Rainfall depth-runoff volume rating curve will be developed for the new station at Yori Drain (YD@SBC) in FY2018.

Table 3-4 **Automated Sampling Sites and Nearby Rain Gages**

	Automated Sampling Site	Nearest Rain Gage	Distance from Watershed Centroid	Real-Time Rainfall Access
1	Oxbow Nature Park	KNVRENO287	0.8 miles south	https://www.wunderground.com/personal-weather-station/dashboard?ID=KNVRENO287
2	Arlington	KNVRENO323	0.25 miles southeast	https://www.wunderground.com/personal-weather-station/dashboard?ID=KNVRENO323
3	Fisherman's Park II	UNR Campus	<0.5 miles west	https://wrcc.dri.edu/weather/unr.html
4	Mary Wahl	Reno-Tahoe Int'l Airport	2 miles southwest	http://w1.weather.gov/obhistory/KRNO.html
5	Yori Drain	Reno-Tahoe Int'l Airport	Unknown	http://w1.weather.gov/obhistory/KRNO.html

Figure 3-3 Preliminary Rainfall Depth-Runoff Volume Rating Curves, Urban Outfalls



If the expected rainfall depths are known then the equations for each of the above locations can be used to calculate an estimated total-storm runoff volume. Subsequently, the total-storm runoff volume can be divided by the number of samples desired to identify the flow-interval. For instance, if 0.25 inches of rainfall is predicted for a storm event, the estimated runoff volume for Fisherman's Park II would be roughly 154,000 cubic feet using the equation shown in **Figure 3-1**. If 24 sample bottles are desired across the storm hydrograph, the flow-interval equals 6,400 cubic feet.

When setting a sampling interval, it is important to realize that sampling equipment is limited in terms of time required to collect a sample. Automated samplers purge the sample line before taking a sample, collect a sample, and then clear the sample line again. This process can take from 1 to 2 minutes depending on the length of the sample tube and sample volume. For time-interval sampling, this does not pose a problem because time-intervals greater than 5 min are generally required to produce a reasonable number of samples. For flow-interval sampling, however, this equipment limitation may be a problem in rare cases (Harmel and others, 2003).

Under this program, two of the seven automated samplers are co-located with USGS streamflow gages (Steamboat Creek at Clean Water Way and North Truckee Drain at Big Fish Dr.). These samplers will require time-interval sampling since there are no communications established between the stream gage and the automated sampler, which are required for flow-interval automated sampling.

3.3.3 Field Equipment Calibration

All field instruments and meters will be calibrated and maintained in accordance with the manufacturer's instruction and approved EPA methods. A record of calibration activities will be kept of both the pre and post-calibration activities and provided as an appendix to the annual report.

Teledyne® ISCO automated samplers also require calibration checks at least once a year. Maintenance and calibration are thoroughly detailed in user guides provided by Teledyne®.

3.3.4 Observations Logs

Observation logs are kept for each monitoring location to summarize when sites were visited, and samples were collected. They provide a summary of field observations at the end of the monitoring year to communicate site conditions, storm characteristics, potential issues and future improvements. Observation Logs will include:

- Personnel on-site, date, time;
- Storm characteristics;
- Field water quality readings (pH, SC, T, DO, turbidity);
- Streamflow measured or estimated, stage observed;
- Visual observations, odors; and
- Special conditions, equipment issues, and/or sampling constraints.

An example of an observation log for the Truckee Meadows is provided in **Appendix B**.

3.4 Sampling Event Activities

The methods and procedures used to collect, measure, process and deliver samples to the laboratories are important steps in the collection of high quality data. In the following subsections, sample collection, handling, processing, documentation and transport are outlined. **Appendix C** includes "monitoring-site summary sheets" for each monitoring location to assist samplers in locating the sampling station, identifying constituents to be sampled, indicating the bottle types and volumes needed, and highlighting the field parameters to be measured and laboratory analyses to be requested.

3.4.1 Grab Sampling

A grab sample is typically collected using a DH-48 sampler with a 470mL glass bottle or a 500 mL polyurethane bottle secured to a telescoping sampling rod. Grab sample containers will be triple rinsed with deionized or distilled water or the water being sampled before used at each site. A minimum of 1,625 mL of storm water is required to fill the total volume of laboratory-provided bottles. In this case, multiple grab samples will be composited into a surrogate container. Surrogate containers may be a bucket, a bottle or possibly a portable pump and hose. In all cases, the surrogate container will be triple rinsed with deionized or distilled water or the water being sampled before laboratory-provided bottles are filled. The sample in the surrogate container will be carefully mixed before filling the sampling bottles.

All personnel involved with sample collection will wear nitrile gloves and follow clean sample collection techniques to minimize the potential for introducing contamination to the storm water samples. Sample bottles received from the laboratory are certified as "clean" and do not require rinsing with the sample being collected. Sample bottles should never be reused. Only one of the sampling containers contains a preservative (sulfuric acid (H_2SO_4) for the preservation of Total-N, Total-P and NO_3). Care is required when filling this bottle so as not to overfill and dilute the concentration of the preservative. Depending on the preference and experience of the sampling team, the sulfuric acid preservative can be added to the container by the field team after filling using a dropper bottle. No field filtration is required.

3.4.2 Composite Sampling (Automated Samplers)

Once automated samplers (ISCOs) have successfully sampled a storm event the following steps should be followed to process four composited samples representing the four distinct components of the hydrograph: a) first flush, b) rising limb, c) peak flow, and d) falling limb. These procedures require preliminary knowledge of Teledyne® ISCO Rapid Transfer Device (RTD) and FlowLink® software.

1. Review ISCO sample collection data report and note number of samples and times of collection;

2. Download ISCO discharge data using the RTD and transfer these data to a laptop using FlowLink® software;

3. Review the storm hydrograph in relation to sample collection times and segregate samples into the 4 components of the hydrograph;

4. For each of the four components of the hydrograph, composite samples into a clean surrogate container and mix. Each sample representing a component of the hydrograph will be given a unique identifier to differentiate it from other hydrograph components. For example, the Arlington urban outfall site ID is H-19; the first flush sample will be represented by H-19(1), rising limb represented by H-19(2), and so forth; and

5. In each composited sample, and after laboratory bottles have been filled, physical water quality parameters shall be measured from the remaining composite (temperature and dissolved oxygen may not be representative given the time elapsed since samples were collected by the ISCO). Surrogate container and water-quality meters shall be triple rinsed with distilled water before the next sample is composited and measured.

As with grab samples, all personnel involved with sample collection will wear nitrile gloves and follow clean sample collection techniques. Sample bottles received from the laboratory are certified as “clean” and do not require rinsing with the sample being collected. Care is required when filling bottles with preservative so as not to overfill and dilute the concentration of the preservative. Depending on the preference and experience of the sampling team, the preservatives can be added to the container by the field team after filling using a dropper bottle. No field filtration is required.

3.4.3 Bacteria Sampling

Analysis of bacteria in waters requires a strict 8 hour hold time. Sampling during evenings and weekends presents challenges to meeting this hold time. In addition, the use of ISCO automated samplers precludes the appropriate sampling conditions for accurate results. As such, the sample collection for bacteria analysis will only occur under the following conditions:

- Samples can be collected and delivered to the receiving laboratory within a 6-hour period;
- Samples can be collected directly from the source waters (Sites instrumented with ISCOs will require a manual sample collection from the source water during the event).

3.4.4 Sample Processing

Upon collection, samples will immediately be placed into a cooler with ice and the lid closed. All samples will be kept on ice until delivery to the laboratory. Ice will be checked and replaced regularly to ensure that the samples are maintained as close to 4°C as possible. Importantly, a closed ice chest limits sample exposure to sunlight (especially important for E. coli samples). We should note that storm water collected from a summer thunderstorm often exhibits water temperatures greater than 20°C; these conditions should be noted and also used to inform the laboratory personnel upon transfer.

Standard e. coli analysis provides a maximum bacteria count in the 2,400 range. Many samples have been found to exceed this count by an order of magnitude. COC should indicate the need to dilute to 24,000 or even 240,000 depending on the site. Special instructions for receiving laboratory should include dilution of e. coli samples.

3.4.5 Visual Observations

In addition to sample collection, the sampling team is required to make visual observations and notes at each of the sampling sites. Some typical observations of the runoff itself include the presence of floating and suspended materials, oil and grease, discoloration, turbidity, odor, or foam. It is imperative that observations are paired with the date, time and location of the observations along with the names of the personnel performing the inspection. Where possible, photographs will be taken.

3.4.6 Streamflow Measurements

Storm water discharge or streamflow shall be measured at every location immediately after sample collection. Data will be recorded on a discharge worksheet (**Appendix D**) for subsequent calculations and evaluations. Discharge or streamflow can be measured using standard hydrologic procedures and velocity instruments approved or used by the USGS. Type of instrument and calibration will be noted. Duration of a measurement will be established according to how fast the stage is rising or falling. At least two stage observations (from staff plate) shall be recorded during the measurement.

3.4.7 Field Water Quality Measurements

Field water-quality measurements of temperature, pH, conductivity, turbidity and dissolved oxygen will be recorded at the time of sampling. As previously described, sample collection may entail the use of a surrogate container. Field chemistry measurements will be made directly from the source when feasible or from a portion removed and collected in a surrogate sample container.

Where possible, for continuity in measurement technique, one team member will be given the primary responsibility of conducting the field water-quality measurements. That person is responsible for calibrating all instruments, that calibration is checked and verified throughout the day, and that all samples have been measured and recorded accurately.

Included in the routine analysis of field water-quality samples is the analysis of a field duplicate. Samples sent to the laboratory as field duplicates will be processed in duplicate in the field. QC samples will be discussed in detail in **Section 3.4**.

3.4.8 Data Recording and Handling

Field data and observations will be recorded in waterproof field notebooks and discharge worksheets. When the sampling day has concluded the care of the field data has the highest priority of care.

3.4.9 Sample Transport and Chain-of-Custody Forms

Samples will be delivered to the laboratory within the specified holding times by the sampling team and kept on ice until they are surrendered into laboratory custody. Throughout the day, the sampling team will provide periodic updates to the contact laboratory and making any necessary logistical arrangements.

COC forms have spaces for the documentation of sampling date, sample identification, preservative and analyses required for each sample set. A copy of the completed COC form will be filed by the sampling team once the laboratory receiving clerk has signed.

3.5 Post Event Activities

Post sampling event activities include organizing the documentation (field notes and discharge worksheets scanned and properly filed, observation log data entered, photographs downloaded, etc.), performing field equipment post calibration and cleaning and maintaining instruments and equipment. Annual monitoring reports are required to be submitted annually to NDEP (as part of the Truckee Meadows Storm Water Program Annual Report).

3.5.1 Post Event Memorandum

At the conclusion of a sampling event, the sampling team will put together a brief post-event memorandum. The memorandum will include the names of the individuals performing the work, dates, times, and any important observations. The memorandum is to include precipitation data (time and amount) and if possible flow data and hydrographs from selected gages. The data does not need to be analyzed, but simply gathered and placed in the project directory while the activities and observations are still recent.

3.5.2 Field Equipment Post-Calibration

Field instruments will be calibrated before, during (calibration check), and after use in the field. The post sampling event testing and calibration will be conducted as soon as possible following sampling activities. All calibration activities will be recorded and the records kept. After calibration, the instruments and equipment (buckets and sampling devices) will be cleaned.

3.5.3 Streamflow Data Management

15-minute streamflow data from real-time stations (USGS, Washoe County) will be downloaded after each sampled storm event and saved in a spreadsheet for calculation of constituent loadings. Real-time data can be downloaded from the websites provided in **Table 2-3**.

Non real-time gaging stations (Balance) will be downloaded after a sampled storm event and all data will be saved into their appropriate spreadsheet files for development of a continuous streamflow record for calculation of constituent loadings; assuming a stage-to-discharge relationship has been established. If a stage-to-discharge relationship is not yet available, stage data will be developed from raw water level data and stored for later translation to streamflow values.

Stage-to-discharge relationships for each station will be evaluated after each new measurement for stage shifts or improved rating equations following standard hydrologic practices. If improved rating equations are developed, they may be retroactively applied to historical data, as appropriate.

3.5.4 Data Handling

As soon as possible following a sampling event, field notes, water quality measurements, and measured discharge will be entered into the Observer Logs so that any changes or critical observations at a particular site are apparent. All files and notes will be consolidated into a single directory and filed accordingly. Post sampling event activities include verifying that the documentation is in order (field notes scanned, data entered, photographs downloaded, etc.). Post event data handling records include making back up and duplicate records. Both electronic and paper duplicates will be maintained.

3.5.5 Reporting

An annual written monitoring summary will be prepared and all field and laboratory results summarized in tables and graphs. A draft annual report shall be submitted to the SWPCC for comment by November 15 of each year and reflect results from the previous monitoring year. A final annual report, with all comments addressed, shall be submitted by the SWPCC to NDEP by January 15 of each year.

In the annual report, all constituents will be presented as both concentrations and loadings. Calculation for constituent loads will be completed as follows:

Constituent Concentration (mg/L) x Runoff Volume (cf) x conversion factor = Load (lbs)

Where samples are collected using automated samplers, both hydrograph component loads and total storm loads for all constituents measured will be computed. An example is provided below in **Table 3-5**:

Table 3-5 Example of Constituent Loads Calculated Across a Storm Event

Hydrograph	Storm Runoff Volume	Total-N	NO3	TKN	Total-P	TDS	TSS
	(cubic feet)	(lbs)	(lbs)	(lbs)	(lbs)	(lbs)	(lbs)
First Flush	147,240	0.0	0.0	0.0	4.1	10,111	294
Rising Limb	201,870	6.4	0.0	6.4	5.9	13,862	630
Peak	269,100	9.9	0.0	9.9	8.1	16,799	1,596
Falling Limb	1,070,550	29	0.0	29	29	66,832	3,542
Totals	1,688,760	46	0.0	46	48	107,604	6,062

In addition to presenting data in a clear and concise format, the following is a list of minimum reporting requirements under the MS4 permit (completed by the SWPCC):

V.C. Annual Report

V.C.3.a Status of the Permittee's compliance with permit conditions;

V.C.3.b An assessment of the appropriateness of the identified BMPs, and any revisions to previous assessments if appropriate;

V.C.3.c Progress towards achieving the statutory goal of reducing the discharge of pollutants to the MEP;

V.C.3.d Status of the achievement of measurable goals;

V.C.3.e Results of information collected and analyzed, if any, during the reporting period, including monitoring data used to assess the success of the program at reducing the discharge of pollutants to the MEP, a description of any identified improvements to or degradation in water quality attributable to the program, and a description of any identified effects on attainment of water quality standards attributable to the program;

V.C.3.f A summary of the storm water activities the Permittees plan to undertake during the next reporting cycle (including an implementation schedule and a fiscal analysis);

V.C.3.g Changes to the SWMP, including changes to any BMPs or any identified measurable goals that apply to the program elements;

V.C.3.h Notice that the Permittees are relying on another government entity to satisfy some of the permit obligations (if applicable);

V.C.3.i Estimated reductions in loadings of pollutants from discharges of municipal storm sewer constituents from MS4s expected as the result of the municipal storm water quality management program. The assessment shall also identify known impacts of storm water controls on groundwater;

V.C.3.j A summary of inspections performed and enforcement activity taken during the report cycle; and

V.C.3.k Annual expenditures for the reporting period, with a breakdown for the major elements of the SWMP, and the budget for the year following the Annual Report.

3.6 QA/QC Project Plan

Presented in the following subsection are the quality control/quality assurance (QA/QC) requirements associated with both field and laboratory activities. Field QC samples are collected (blanks and duplicates) and the results used to evaluate potential contamination and sampling handling issues. Laboratory QC activities provide information needed to assess data precision, accuracy and potential sample contamination. Outlined in this section are the recommended monitoring program QC activities including data assessment and validation.

3.6.1 Field QA/QC Activities

Field quality control and assurance for this project includes the following:

- Use of experienced sampling team trained in the procedures to be followed;
- Adherence to approved methods and procedures;
- Calibration of field equipment and instruments;
- Field analysis of duplicates and reference materials (portable meters);
- Complete documentation of sampling and observations; and
- The collection of duplicate samples and bottle blanks for laboratory analysis.

Field QA/QC checks will include the collection and analysis of field equipment duplicate determinations and calibration checks and the collection of field duplicates and bottle blanks. Field QC samples are routinely submitted "blind" to the laboratory (no special markings on the sample bottle labels or the COC form to indicate the nature of the sample). Important field QC sample types and activities are presented and defined below.

Field Equipment Duplicate Determinations. A field duplicate is the measurement (using all of the different portable meters) of the same sample twice. At least one field duplicate will be collected each sampling event. Feedback will be used to assess analytical variability attributable to collection, technique and instrument variability.

Reference Material Calibration Checks. A reference material is a calibration solution from a source different from the solutions used for calibration. At least once a day in the field, the calibration of the portable instruments will be checked using a commercially available reference material and the value recorded. Reference materials are available for verifying pH, EC and turbidity readings (there are no reference materials for DO and temperature).

Field Duplicate Samples. At least twice during the monitoring season, a duplicate sample is to be collected and submitted to the laboratory. Field duplicates allow for the assessment of precision in both the field and laboratory activities.

Bottle Blanks. Bottle blanks are prepared by pouring de-ionized water directly into the sample containers, without the use of a secondary container. Both the bottles and the de-ionized water will be obtained from the contract laboratory. Bottle blanks are to be prepared twice per monitoring season. Bottle blanks allow evaluation of the contract laboratory clean procedures and verifies that the bottles obtained from the laboratory are clean and free from contamination.

3.6.2 LABORATORY QC ACTIVITIES

Commercial laboratories routinely integrate a number of QC checks in each determination. As part of the data assessment, this information will be requested and reviewed alongside the analytical results. In selecting the laboratory, a review of their QC program will be made by the sampling team.

As a minimum, the lab analytical quality assurance will include the following:

- Employing analytical chemists trained in the procedures to be followed;
- Adherence to documented procedures and methods (see **Section 3.1.1**);
- Strict adherence to a ELAP/NELP approved QA/QC program;
- Calibration of analytical instruments; and
- Complete documentation of sample tracking and analysis.

Routine laboratory QC checks must include the use of laboratory-generated duplicates, method blanks, matrix spikes/matrix spike duplicates (MS/MSDs), and laboratory control samples (LCSs). These QA/QC requirements are discussed below.

Laboratory Duplicates. The laboratory will generate and analyze a laboratory replicate (duplicate or laboratory split) approximately every 10 samples processed (typical).

Replicate analyses results are evaluated by calculating the relative percent difference (RPD) between the two sets of results. This statistic is typically the basis for the assessment of laboratory precision. The result must fall within the laboratory's self-generated upper and lower control limits. For this project, the reports will be reviewed to insured that the duplicate results fall within these control limits.

Method Blanks. The laboratory will run method blanks to determine the level of contamination associated with laboratory reagents and equipment. A method blank is a sample of a known matrix that has been subjected to the same complete analytical procedure as the submitted sample to determine if contamination has been introduced into the samples during processing. Blank analysis results will be checked against reporting limits for the analytes. Results should be less than the reporting limits for each analyte.

Matrix Spikes/Matrix Spike Duplicate (MS/MSD). MS/MSDs are used to assess the accuracy and precision of the laboratory's analytical methods and to evaluate potential chemical interferences present in a particular batch of storm water. The laboratory prepares matrix spike samples by splitting off three aliquots of the environmental sample and adding known amounts of target analytes to two of the three environmental sample aliquots. The results of the un-spiked environmental sample are then compared to the MS sample analysis results, and "percent recovery" of each spike is calculated to determine the accuracy of the analysis. The results of the MS analyses are compared to the calculated RPD as an additional measure of analytical precision. The result must fall within the laboratory's self-generated upper and lower control limits. For this project, the reports will be reviewed to insured that the MS/MSD results fall within these control limits.

Laboratory Control Samples (Matrix Spikes). Laboratory control samples (LCSs) involve spiking known amounts of the analyte(s) of interest into a known, clean matrix to assess the matrix effect on spike recoveries. High or low recoveries of analyte(s) in the LCSs may be caused by interferences in the sample matrix. Laboratory control samples assess these possible matrix affects because the matrix used is known to be free from interferences. Typically, LCSs are analyzed at a frequency of one per batch of twenty or fewer samples. The result must fall within the laboratory's self-generated upper and lower control limits. For this project, the reports will be reviewed to insured that the MS/MSD results fall within these control limits.

3.6.3 Data Quality Objectives (DQOs)

Data collected must be of sufficient quality to support the project goals and objectives. Numeric data quality objectives (DQOs) have been established for both field and analytical laboratory data collected and evaluated under this SAP. Various assessments (outlined in the following sections) of the data will be made as soon as the data are reported. Data that are not of sufficient quality will still be included in the monitoring database but will be preceded by a flag, or "qualifier" code. The following DQO objectives have been established:

DQO for Holding Time. Laboratory analysis of samples must be performed within the approved holding time (as listed in **Table 3-1**). The numerical DQO for holding time attainment is 100 percent (i.e., 100 percent of the project samples must be analyzed within approved sample holding times). All laboratory reports must be reviewed for holding time compliance.

DQO for Reporting Limit. A fundamental DQO is that the laboratory can (and does) provide results of sufficient resolution (i.e. reporting limit) so that assessments can be made. **Table 3-1** lists the required project reporting limits for each parameter. The DQO for compliance with established reporting limits is 100 percent. As the data are tabulated after each event, the reporting limits will be checked and verified.

Blank Contamination. Depending on the level, contamination of a field or laboratory blank may result in the qualification of the data and the loss of utility (i.e. how the data can be used and interpreted). So called "hits" in blank samples will be tabulated after each event. A DQO for blank contamination is that 95 percent of the blanks are below the laboratories practical quantitation limit (PQL).

Analytical DQOs for Precision and Accuracy. Listed in **Table 3-1** are the numeric DQOs for field and laboratory duplicate and spikes (standard addition) determinations. These data quality objectives are based on those typically used. Control limits used by the contract laboratory will supersede the target values listed in **Table 3-1**. Precision can be assessed by replicate determinations such as matrix duplicates (MD), digestion duplicates, run duplicates, field duplicates and matrix spike duplicates (MSD). Accuracy can be measured by the use of standard reference materials (SRMs), laboratory control samples (LCS) and performance evaluation (PE) samples.

3.6.4 DATA ASSESSMENTS AND VALIDATION

The project team shall designate a team member to perform the QC review. The laboratory results will be reviewed for achieving the DQOs. The analytical review will consist of:

- Conformity with the COC form;
- Completeness of laboratory data report;
- Holding times met;
- Blank contamination (field and method blanks);
- Analytical accuracy met (MS/MSD and LCS recoveries); and
- Precision met (MSD and laboratory sample duplicate RPDs).

The laboratory will be requested to provide results in electronic format to minimize paper. A team designee will review the reports and maintain an electronic database (Excel). If blank contamination is present, holding times are exceeded, or other QC issues exist, the data will be evaluated and qualified according to USEPA data qualifier guidelines. Data qualifier will be included in the database, preceding the entry to indicate determinations outside of acceptable QA limits.

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