TRUCKEE RIVER WATER QUALITY MONITORING PLAN

Final Plan

Prepared for Placer County and the Town of Truckee

September 15, 2008

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1.0 EXECUTIVE SUMMARY

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1.1 Purpose

The Truckee River Water Quality Monitoring Plan (TRWQMP) has been created in response to an order issued by the Lahontan Regional Water Quality Control Board (the Board). The California Water Code Section 13267 Board order, issued to both Placer County (the County) and the Town of Truckee (the Town) on March 9, 2007 and July 3, 2007, respectively, requires the creation of a comprehensive monitoring program for the middle Truckee River. Though regulated under separate board orders, the County and Town chose to coordinate efforts in the development of a monitoring program to ensure the cost-effective collection, integration and analysis of water quality data within the watershed.

The TRWQMP is just one element of a much larger stormwater program in the Truckee River Watershed. Both the County and the Town have developed and are implementing Stormwater Management Programs (SWMPs). The respective SWMPs detail the specific actions each jurisdiction (County and Town) will implement in order to protect surface water. The purpose of the TRWQMP is to design a strategy which will allow the County and Town to assess the effectiveness of their ongoing SWMPs with respect to protecting downstream water resources.

There are two distinct categories of assessment when evaluating the effectiveness of the SWMPs—**compliance assessment** and **performance assessment**. **Compliance assessment** includes inspections, record keeping, data tracking and reporting of SWMP actions. **Performance assessment** focuses on evaluating the water quality of stormwater and receiving waters. The TRWQMP does not enforce compliance with SWMP guidelines or implement pollutant control measures. Rather, the TRWQMP provides a framework and strategy to develop a consistent, reliable and cost-effective water quality monitoring plan to track the water quality of stormwater and the condition of surface water resources. The results of the TRWQMP inform the adaptive management process of the SWMPs so that local agencies can continue to implement the actions that best protect the quality of the local surface water resources.

The TRWQMP is required to satisfy certain criteria outlined by the Section 13267 board orders, NPDES permits, the County and Town's SWMPs, and Clean Water Act Section 303(d) Total Maximum Daily Load (TMDL) programs developed for Squaw Creek and the middle Truckee River by the Board. The key requirements for the TRWQMP outlined by these regulatory and planning documents include:

- the evaluation of the effectiveness of the County and Town's Storm Water Management Programs (SWMPs) in protecting and/or enhancing surface water quality,

- a comprehensive stormwater monitoring program that includes cooperation and coordination with other monitoring entities,
- the identification and tracking of key sources of stormwater pollutants of concern,
- the implementation of bioassessment monitoring in Squaw Creek, as mandated by the TMDL,
- the resolution of the piece-meal approach to monitoring in Martis Valley, and
- the evaluation of long-term trends in receiving water quality.

1.2 Goals and Objectives

These regulatory requirements were used to develop a set of goals and objectives for the TRWQMP (Section 2.0).

TRWQMP Goal 1: Ensure regulatory compliance for Placer County and Town of Truckee with the NPDES permit, Lahontan Board Orders, Middle Truckee River Sediment TMDL, Squaw Creek Sediment TMDL, and the Martis Valley Community Plan.

TRWQMP Goal 2: Develop water quality monitoring datasets that will be scientifically defensible and provide accurate data to evaluate the effectiveness of Stormwater Management Programs in protecting surface water resources.

TRWQMP Goal 3: Develop a TRWQMP that is economically feasible to implement and maintain over time.

TRWQMP Goal 4: Ensure that the TRWQMP allows collaboration, effort-sharing and integration of multiple independent private and public monitoring efforts.

Objectives:

- Provide a comprehensive and integrated data collection, data analysis and reporting framework to evaluate and track the status of surface water resources within the project area spatially and over time.
- Prioritize monitoring resources on spatial locations determined to be existing and/or future potential source areas.
- Focus monitoring resources on pollutants of concern and indicators that are clearly rationalized for each location of monitoring. Prioritize pollutants based on greatest risk to surface water resources due to specific land use activities.
- Maximize monitoring resources by including a range of monitoring types that vary in frequency of collection, relative cost to complete and statistical accuracy.
- Focus monitoring resources on times (season, storm events, etc.) when potential source area water quality is expected to deviate greatest from observations at minimally impacted locations.

1.3 Project Area

The project area covered under the TRWQMP includes the main stem of the middle Truckee River and all areas contributing surface water runoff between its outlet from Lake Tahoe and its confluence with Juniper Creek (approximately 210 square miles). The project area includes 15 sub-watersheds (Figure 3.1), which drain to the main stem of the Truckee River either through tributaries, direct runoff, or stormwater infrastructure. Since fiscal resources limit the scope and scale of the monitoring plan, a preliminary screening for potential source areas was conducted using an integration of GIS data on land use, land condition, and other human disturbances.

This analysis resulted in the classification of each sub-watershed as low, medium or high disturbance. The 7 high disturbance sub-watersheds are Bear Creek, Big Chief Corridor, Donner/Cold Creeks, Martis Creek, Squaw Creek, Trout Creek, and Truckee Town Corridor (Figure 3.4). The TRWQMP was subsequently designed to focus monitoring resources and efforts on those high disturbance sub-watersheds where water quality is expected to be the most impaired and where the majority of actions under the County and Town SWMPs are expected to be implemented.

Preliminary stormwater routing descriptions and maps were subsequently created for the high disturbance sub-watersheds. These efforts are the first step in the development of more detailed stormwater routing descriptions under the County and Town's SWMPs. A schedule for future mapping tasks to be completed by Placer County and the Town of Truckee related to storm sewer system mapping, stormwater routing investigations or outfall inventories is also presented (Section 3.3).

1.4 Spatial Scale of Observations

The TRWQMP focuses on the evaluation of three primary spatial scales as part of the performance assessment: community level, tributary level, and the main stem of the Truckee River. Community assessments focus on areas of development, activities, or land uses that are known or suspected to be priority sources of pollutants of concern (e.g. parking lot at Squaw Valley Ski Resort). Tributary assessments are conducted at sub-watershed outlets and provide a measure of the integrated water quality signals from both developed and undeveloped land within the respective tributary. Main stem assessments focus on the downstream cumulative effects of water quality impacts in the Truckee River related to tributaries and community source areas.

1.5 Assessment Types

The TRWQMP includes the implementation of 5 different performance assessment types that vary in cost, level of expertise necessary to obtain data, and relative statistical accuracy and precision. The results of each assessment type provide a different evaluation of the surface water resource condition within the project area. When integrated, the results from the various assessment types address a number of key questions regarding water quality and biotic health in the project area, the pollutant load contribution of a number of key community developments, and the effectiveness of the SWMPs. Collectively, these assessment types are designed to meet the goals and objectives of the TRWQMP (Section 2.0).

For each assessment type, the TRWQMP contains an in-depth description and depiction of the role it will play in the comprehensive monitoring plan for the middle Truckee River (Section 4.0). The plan outlines the following characteristics of each assessment type:

- Advantages
- Disadvantages
- Relevance to SWMPs
- Spatial scale of observations
- Frequency
- Level of expertise necessary

Understanding the advantages, disadvantages and applicability of each assessment type is critical to proper data analysis, data interpretation, and hypothesis testing. Individually, none of the assessment types are sufficiently inexpensive, rigorous, logistically feasible and statistically accurate for widespread application. Therefore, the TRWQMP takes the approach of applying and combining a range of assessment types. A brief description of each assessment type is presented below:

GIS Sub-watershed Source Area Analysis

A GIS sub-watershed source area analysis is a cost-effective means of determining the relative risk or potential for generating pollutants within each sub-watershed in the project area. The analysis uses existing GIS data to evaluate conditions such as density of impervious surfaces, ski run density, dirt road density, ski areas, legacy sites, and areas at risk for future development. The results of this assessment provide cost-effective means to prioritize areas for SWMP actions and evaluations of SWMP effectiveness. One major disadvantage of this method is that, at this time, it is not based on actual water quality data on stormwater, tributaries, or the main stem of the Truckee River.

Rapid Assessment Methodologies

Rapid assessment methodologies rely on simple and repeatable observations of site or habitat conditions. Rapid assessment protocols are designed to produce relatively-accurate, low-cost, quantitative spatial data that are consistent with, and comparable to, data from more rigorous evaluations. The rapid assessment observations focus upon the density and distribution of fine sediment within the stream channels themselves, mimicking SWAMP substrate condition protocols developed for bioassessment techniques. These evaluations are a cost-effective means of tracking changes in relative fine sediment distribution at specific locations over time on a relative scale. The low cost allows for data collection over a much greater spatial area and helps prioritize resource expenditures for other more rigorous assessment types. However, the precision and accuracy of measurements taken under this assessment type are lower than other assessment types utilized by the TRWQMP.

Bioassessments

Bioassessments focus on characterizing the biological composition observed within a surface water resource. The primary assumption of this assessment type is that the assemblage of ecological communities in aquatic systems provides an overall measure of the health of that system. The absence of sensitive species that are known to have previously existed in the system suggests that the conditions have become intolerable due to a combination of water quality, habitat condition and other factors. Bioassessments directly measure ecological quality of the surface water streams, which reflects the integrated signal from all natural and anthropogenic impacts. The primary disadvantage of bioassessments is that the enumeration of benthic invertebrates is costly, difficult, and time consuming, making it difficult to apply over a large spatial area. The TRWQMP implements the SWAMP protocols for stream bioassessment work in Sierra Nevada fresh water streams.

Discrete Water Quality

Discrete water quality measurements include both the collection of discrete grab water samples for submission to an analytical laboratory and spot measurements of specific water quality parameters using hand-held probes. Discrete water quality measurements are conducted at a discrete location at a discrete time. Thus, discrete observations provide a snap-shot of the water quality where and when the measurements are taken.

Under the TRWQMP, discrete water quality measurements are used to characterize both stormwater quality emanating from specific community developments (community level) and surface water quality in tributaries (tributary level) throughout the project area. Community level discrete water quality assessments are designed to capture the “worst-case scenario” of stormwater quality from localized areas of development. These first flush samples can be analyzed for a range of pollutants depending upon the catchment land use and associated pollutants of concern.

Tributary level discrete water quality assessments are a cost-effective technique to compare and track the cumulative water quality impacts on a sub-watershed scale. This discrete stream sampling technique focuses on evaluating the pollutant concentration and estimates of event loads during high flow conditions when pollutant transport is most likely. Tributary level discrete water quality assessments combine strategically placed passive sampling devices and continuous hydrology to capture in-stream water quality signals during the rising limbs of high flow events, including summer thunderstorms, winter rains and rain on snow events. Spring snow melt will be sampled manually using comparable techniques to minimize hydrologic variability in the observations. Long-term seasonal and annual tributary level assessments will allow comparisons of sub-watershed water quality over time as a result of human activities and SWMP actions to mitigate potential water quality impacts.

Near-Continuous Water Quality

Near-continuous monitoring includes two distinct types of water quality observations:

- *In situ* water quality probes that conduct automated measurements at specific locations on nearly any time interval and store the time-series data internally.
- Automated water sampling instruments that collect water samples at specific locations on either specific time intervals or during specified flow conditions. One distinct advantage of automated samplers is that sample collection can be linked to measurement of stage (depth) or turbidity. This improves the accuracy and precision of total load estimates.

The continuous datasets provided by *in situ* probes are extremely valuable to evaluate processes and long-term trends. *In situ* monitoring is recommended to track the status and trends for the priority pollutant of concern—sediment—within the Truckee River. Continuous turbidity records along the main stem will be used to estimate event, season, and annual loads of suspended sediment.

Automated sampling instruments allow for the remote collection of flow-weighted water samples during specific flow conditions and/or at predetermined times. Automated samplers are typically linked with *in situ* probes that measure discharge (i.e., stage and velocity) on near-continuous intervals. Water sample collection during known flow conditions allows representative calculations of flow-weighted event mean concentrations (EMCs) and pollutant loading for the pollutants of concern. The high-resolution automated sampler data will be used to characterize in-stream event EMCs downstream of specific community developments of concern. The high cost of installing, operating and maintaining these instruments only makes them feasible at a small number of locations throughout the watershed.

1.6 Phased Approach to the TRWQMP

The implementation of the TRWQMP is presented in three distinct sequential Phases (Section 5.0). The Phases are defined as assessment priorities based on the goals and objectives of the TRWQMP (Section 2.0) and the reality of available funding. Each Phase represents an ideal achievable level of water quality assessment efforts throughout the project area based on existing information. Each Phase also includes the integration of a number of potentially valuable existing assessment efforts that are currently being conducted by others, in hopes to coordinate efforts in the future. However, the actual implementation of each component and the actual time required to complete each Phase will be **dependent upon the following conditions:**

- The ability of Placer County and the Town of Truckee to secure funding to implement and maintain all components of Phases I and II. Both Placer County and the Town of Truckee will utilize the contents of this TRWQMP to seek grants and obtain funds necessary to implement and maintain this Plan over the next 15 years (through 2023).
- The cooperation of implementers of existing assessment efforts in potentially modifying their protocols to meet the standards and protocols outlined in this Plan.
- The cooperation of implementers of assessment efforts in submitting the necessary assessment data to the County of Placer and the Town of Truckee in the manner outlined in this Plan. The data must be submitted in the time frame necessary to meet the TRWQMP reporting requirements.

Table 1.1 summarizes the recommendations for the Phased approach to the implementation of the TRWQMP. Table 1.2 identifies each of specific station locations recommend for assessment, annual cost estimates, phase of implementation, and a summary of the information and/or data each station will contribute to the TRWQMP.

Phase	Main Components	Approximate Time Frame*
Phase I	***Minimum recommended plan*** • Comprehensive monitoring plan for Martis Valley • Squaw Creek TMDL Bioassessment • Main stem near-continuous turbidity monitoring (DWR stations) • Rapid assessment • Discrete stormwater sampling from communities of concern	Years 1-3
Phase II	***Strategic expansion*** • Additional near-continuous turbidity station at downstream end of Town of Truckee • Additional community and tributary discrete sampling stations in high-disturbance sub-watersheds • GIS sub-watershed source area prioritization (based on data availability)	Years 4-5
Phase III	***Adaptive management of TRWQMP*** • Re-evaluation and potential modification of TRWQMP components based on data, findings, and funding	Years 6-15

**Timing and level of implementation of TRWQMP Phases depends on funding, and cooperation of other permittees and stakeholders.*

Table 1.1. Phased approach for the TRWQMP.

Table 1.2 TRWQMP Components for Implementation

Jurisdiction	Sub-watershed	Assessment Type	Station ID (s)	Cost to implement station(s) (Year 1)	Average annual O&M costs	Implemented Phase I or Phase II?	Existing station?	Justification and Purpose
Placer County	Project Area	GIS Source Area Prioritization	N/A	$4,000	$500	Phase II	N/A	Evaluate changes in land use, development, etc. to prioritize resource allocations for TRWQMP based on locations with greatest potential risk to downstream water quality.
Placer County	Martis Creek	Rapid Assessment	**4 stream miles**	$8,000	$6,000	Phase I	N	• Cost-effective method to track fine sediment deposition in priority areas. • Assess distribution of fine sediment in downstream miles of branches of Martis Creek.
Placer County	Martis Creek	Bioassessment	**Bio-MC1**	$11,000	$3,500	Phase I	Y	• Incorporate established station with existing dataset into TRWQMP. • Assess stream biotic condition upstream of Martis Camp and Lahontan developments.
Placer County	Martis Creek	Bioassessment	**Bio-MC2**	$11,000	$3,500	Phase I	Y	• Incorporate established station with existing dataset into TRWQMP. • Assess stream biotic condition downstream of Martis Camp and Lahontan developments.
Placer County	Martis Creek	Bioassessment	**Bio-MC3**	$11,000	$3,500	Phase I	Y	• Incorporate established station with existing dataset into TRWQMP. • Assess stream biotic condition downstream of Northstar-at-Tahoe Ski Area.
Placer County	Martis Creek	Bioassessment	**Bio-MC4**	$11,000	$3,500	Phase I	Y	• Incorporate established station with existing dataset into TRWQMP. • Assess stream biotic condition downstream of Northstar-at-Tahoe golf course.
Placer County	Martis Creek	Bioassessment	**Bio-MC5**	$11,000	$3,500	Phase I	Y	• Incorporate established station with existing dataset into TRWQMP. • Assess stream biotic condition downstream of confluence of highly developed Upper and West Martis Creeks.
Placer County	Martis Creek	Bioassessment	**Bio-MC6**	$11,000	$3,500	Phase I	Y	• Incorporate established station with existing dataset into TRWQMP. • Assess stream biotic condition on less developed East Martis Creek.
Placer County	Martis Creek	Discrete Sampling (Community)	**DSC-MC1**	$15,000	$11,000	Phase I	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality from primary drainage point from Martis Camp development.
Placer County	Martis Creek	Discrete Sampling (Community)	**DSC-MC2**	$15,000	$11,000	Phase I	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality from primary drainage point from Lahontan development.
Placer County	Martis Creek	Discrete Sampling (Community)	**DSC-MC3**	$15,000	$11,000	Phase I	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality from primary drainage point from Northstar-at-Tahoe Ski Area, including parking lot and/or construction site land uses
Placer County	Martis Creek	Discrete Sampling (Community)	**DSC-MC4**	$15,000	$11,000	Phase I	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality from primary drainage point in Northstar-at-Tahoe golf course, focusing on nutrients.
Placer County	Martis Creek	Discrete Sampling (Tributary)	**DST-MC1**	$30,000	$20,000	Phase I	N	• Stream water sample collection focusing on water quality and pollutants of concern during elevated stream flow conditions, when pollutants are most likely to be mobilized from source and transported in streams. • Track tributary water quality at downstream end of high disturbance sub-watershed. • Place particular attention on nutrient concentrations, as Martis Creek Lake has shown nutrient enrichment and the dam controls sediment loading to the main stem.
Placer County	Martis Creek	Near-continuous Turbidity Probes	**TURB-MC1**	$59,000	$38,000	Phase I	Y	• Incorporate established station with existing dataset into TRWQMP. • Evaluate sediment (and potentially nutrient) loads in West Martis Creek downstream of Northstar-at-Tahoe.
Placer County	Martis Creek	Near-continuous Automated Samplers	**NCAS-MC1**	$114,000	$80,000	Phase I	Y	• Incorporate established station with existing dataset into TRWQMP. • Evaluate event, seasonal, and annual loads downstream of confluence of Upper and West Martis Creeks.

Table 1.2 TRWQMP Components for Implementation (continued)

Jurisdiction	Sub-watershed	Assessment Type	Station(s)	Cost to implement station(s) (First Year)	Average annual O&M costs	Implemented Phase I or Phase II?	Existing station?	Justification and purpose
Placer County	Squaw Creek	Rapid Assessment	**1 stream mile**	$2,000	$2,000	Phase I	N	• Cost-effective method to track fine sediment deposition in priority stream reaches. • Assess distribution of fine sediment in downstream mile of Squaw Creek.
		Bioassessment	**Bio-SC1 Bio-SC2 Bio-SC3**	$33,000	$11,000	Phase I	N	• Assess stream biotic condition in lower reach of Squaw Creek downstream of Squaw Valley Ski Corporation, Resort at Squaw Creek, and Village at Squaw. • 3 stations are mandated by Squaw Creek Sediment TMDL.
		Discrete Sampling (Community)	**DSC-SC1**	$15,000	$11,000	Phase II	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality from primary drainage point from Squaw Valley Ski Corporation parking lot, focusing on trace metals and hydrocarbons.
			DSC-SC2	$15,000	$11,000	Phase II	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality from primary drainage point from Resort at Squaw Creek.
			DSC-SC3	$15,000	$11,000	Phase II	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality from primary drainage point from residential developments on north side of Squaw Creek.
		Discrete Sampling (Tributary)	**DST-SC1**	$30,000	$20,000	Phase II	N	• Stream water sample collection focusing on water quality and pollutants of concern during elevated stream flow conditions, when pollutant are most likely to be mobilized from source and transported in streams. • Track tributary water quality at downstream end of high disturbance sub-watershed.
	Big Chief Corridor	Rapid Assessment	**13 stream miles**	$24,000	$18,000	Phase I	N	• Cost-effective method to track sediment deposition in priority stream reaches. • Map distribution of fine sediment in main stem of Truckee River along a reach that receives flow from several tributaries and runoff from HW 89.
		Discrete Sampling (Community)	**DSC-BCC1**	$15,000	$11,000	Phase II	N	• Sample stormwater quality of road runoff along HW 89. Results can inform the impacts of road sanding on local stream conditions.
			DSC-BCC2	$15,000	$11,000	Phase II	N	• Sample stormwater quality of road runoff along HW 89. Results can inform the impacts of road sanding on local stream conditions.
			DSC-BCC3	$15,000	$11,000	Phase II	N	• Sample stormwater quality of road runoff along HW 89. Results can inform the impacts of road sanding on local stream conditions.
		Near-continuous Turbidity Probes	**TURB-MS1**	$59,000	$38,000	Phase I	Y	• Incorporate established station with existing dataset into TRWQMP. • Evaluate sediment loads along main stem of Truckee River at upstream end of project area.
			TURB-MS2	$59,000	$38,000	Phase I	Y	• Incorporate established station with existing dataset into TRWQMP. • Evaluate sediment loads along main stem of Truckee River downstream of confluences with Squaw and Bear Creeks.
			TURB-MS3	$59,000	$38,000	Phase I	Y	• Incorporate established station with existing dataset into TRWQMP. • Evaluate sediment loads in main stem of Truckee River upstream of the Town of Truckee.
	Bear Creek	Rapid Assessment	**1 stream mile**	$2,000	$2,000	Phase I	N	• Cost-effective method to track fine sediment deposition in priority stream reaches. • Map the distribution of fine sediment in downstream mile of Bear Creek.

Table 1.2 TRWQMP Components for Implementation (continued)

Jurisdiction	Sub-watershed	Assessment Type	Station(s)	Cost to implement station(s) (First Year)	Average annual O&M costs	Implemented Phase I or Phase II?	Existing station?	Justification and purpose
Town of Truckee	Project Area	GIS Source Area Prioritization	N/A	$4,000	$500	Phase II	N/A	Evaluate changes in land use, development, etc. to prioritize resource allocations for TRWQMP based on locations with greatest potential risk to downstream water quality.
	Truckee Town Corridor	Rapid Assessment	**10 stream miles**	$21,000	$14,000	Phase I	N	• Cost-effective method to track fine sediment deposition in stream reaches. • Assess distribution of fine sediment in main stem of Truckee River along the Truckee Town Corridor.
		Discrete Sampling (Community)	**DSC-TT1**	$15,000	$11,000	Phase I	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality from a primary drainage point within the developed area of downtown Truckee
			DSC-TT2 DSC-TT3	$30,000	$22,000	Phase II	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality from 2 new primary drainage points at locations of new development in the Truckee Town Corridor
		Near-continuous Turbidity Probes	**TURB-TT1**	$59,000	$38,000	Phase II	N	Evaluate sediment loads in main stem of Truckee River downstream of the Town of Truckee.
	Donner/Cold Creeks	Rapid Assessment	**1 stream mile**	$2,000	$2,000	Phase I	N	• Cost-effective method to track fine sediment deposition in priority stream reaches. • Assess distribution of fine sediment in downstream mile of Donner Creek.
		Discrete Sampling (Community)	**DSC-DCC1**	$15,000	$11,000	Phase I	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality of runoff from primary drainage point within developed area of Donner Creek sub-watershed.
			DSC-DCC2	$15,000	$11,000	Phase II	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality of road runoff along I-80. Impacts of road sanding will be evaluated.
			DSC-DCC3	$15,000	$11,000	Phase II	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality from primary drainage point within urban development.
		Discrete Sampling (Tributary)	**DST-DCC1**	$30,000	$20,000	Phase II	N	• Stream water sample collection focusing on water quality and pollutants of concern during elevated stream flow conditions, when pollutant are most likely to be mobilized from source and transported in streams. • Track tributary water quality at downstream end of high disturbance sub-watershed.
	Trout Creek	Rapid Assessment	**1 stream mile**	$2,000	$2,000	Phase I	N	• Cost-effective method to track fine sediment deposition in priority stream reaches. • Assess distribution of fine sediment in downstream mile of Trout Creek.
		Discrete Sampling (Community)	**DSC-TC1**	$15,000	$11,000	Phase I	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality of runoff from primary drainage point within developed area of Trout Creek sub-watershed.
		Discrete Sampling (Tributary)	**DST-TC1**	$30,000	$20,000	Phase II	N	• Stream water sample collection focusing on water quality and pollutants of concern during elevated stream flow conditions, when pollutant are most likely to be mobilized from source and transported in streams. • Track tributary water quality at downstream end of high disturbance sub-watershed.

Notes:

- Cost estimates are based on consultants to complete work using accredited analytical laboratories and other professional services.
- For new stations that could address the monitoring needs of multiple permitees, potential cost sharing opportunities are noted but not incorporated into the cost estimates provided.
- For existing stations that could be integrated into the TRWQMP, potential cost sharing with existing operators is noted but not incorporated into the cost estimates provided.
- Permitting and easement costs ranging from $3,000 to $6,000 per station are included in cost estimates.

Additional details, justification and cost analyses for each recommended component are provided in Section 5.0. Detailed breakdowns of cost estimates, including equipment lists, estimated labor time, and all assumptions are clearly outlined by assessment type in Appendix B. A projected 15-year fiscal analysis is also provided (Table 5.4).

1.7 Data Collection and Management Protocols by Assessment Type

To ensure the collection of a consistent and integrated data set, it is critical that data are collected in a consistent format using standardized methods. The protocols and standards documented in the TRWQMP will form the backbone of the data generation, management and reporting that is assumed to be conducted by a diverse group of independent parties.

Samples must be collected using standardized sampling strategies and field protocols, laboratory analyses must focus on the same pollutants of concern and report the same units, and data storage and reporting must be centralized and consistent. To that end, the TRWQMP contains extensive and detailed data collection and reporting protocols for all performance assessment types which include the following information (Section 6.0):

- Station selection and instrument installation protocols
- Event sampling strategy
- Field evaluation protocols
- Laboratory analysis protocols
- Data management protocols
- Quality control requirements
- Reporting protocols to TRWQMP database

Section 6.0 *STATION IMPLEMENTATION AND DATA COLLECTION PROTOCOLS* includes a high level of detail documenting the protocols and standards necessary to implement all aspects of each of the six assessment types utilized by the TRWQMP. Complete, stand-alone data collection and data reporting protocols are provided for each assessment type within Section 6.0 (namely, Sections 6.3, 6.4, 6.6, 6.7, 6.8 and 6.9). Each independent party that may implement any one of the TRWQMP assessment types in the future can rely upon the protocols and standards contained with the respective sub-sections of 6.0 in entirety to complete independent quality assurance protection plans (QAPPs), Sampling Plans or other technical QA/QC documents by assessment type. The stand alone nature of each standards and protocols section does equate to some repetition in details across assessment type protocols in Section 6.0.

These detailed protocols for field and laboratory procedures, data storage, and reporting will be applied to all new performance assessments initiated under the TRWQMP, and efforts will be made to integrate existing monitoring programs into the TRWQMP by adopting these procedures. Implementation of the TRWQMP will require access to lands not owned or managed by the County or Town. Section 6.0 also presents and overview of the requirements for obtaining permits, easements, and/or approvals that may be required by permitting authorities, funding agencies (Section 6.1.1) or landowners (Section 6.1.2). Detailed investigations of site-specific requirements will be conducted once the final plan has been approved and funding has been obtained to implement elements of the plan.

1.8 TRWQMP Data Management and Reporting

The TRWQMP provides guidelines on structuring data integration, data management, and annual reporting to meet the goals of the TRWQMP (Section 7.0). The TRWQMP will include a central database to store relevant data collected using the TRWQMP assessment protocols outlined in Section 6.0. A TRWQMP Data Manager will be named and responsible for coordination of independent groups generating data as well as the actual integration and management of the TRWQMP database itself. The TRWQMP assessment year will follow the water year and span from October 1 to September 30. All independently collected datasets for the previous water year will be submitted to the TRWQMP database by October 15. Once the data are integrated into the database, a trained water quality expert will be responsible for data analysis and reporting, summarized in the TRWQMP Annual Report submitted to the Board on January 15 of each year.

Section 7.0 of the TRWQMP provides a recommended structure of the TRWQMP database, guidelines to integrate and present datasets by assessment type in the Annual Report and a recommended Annual Report outline. Guidelines for the analysis and reporting of the comprehensive annual datasets include both recommendations for data presentation and specific plots and tables to be produced for each assessment type, across sites and over time. The first few years of execution of the TRWQMP will finalize the plan's framework, develop the database and produce the TRWQMP annual reports.

1.9 Next Steps and Challenges for the TRWQMP

In order for the TRWQMP to succeed as a long-term integrated and comprehensive water quality evaluation program, the array of independent data collection, monitoring and observation efforts must buy into the universal procedures outlined within this document. The public and private entities conducting water quality evaluations within the project area now and in the future must subscribe to the TRWQMP standards and protocols. Existing and future water quality monitoring within the project area must select from one of the five assessment types included in this Plan to meet the respective evaluation needs. All future efforts must follow the protocols and standards outlined to ensure consistent and comparable data is collected. In addition, the County and Town must identify a TRWQMP Data Manager who is responsible for coordination, collaboration and management of each the datasets generated by the independent groups. The datasets must be managed and digitally provided to the TRWQMP in the exact formats requested to ensure integration and comparability. The annual analysis and evaluation of the multiple datasets submitted to the TRWQMP database must be conducted by a trained water quality expert for the initial years of implementation to ensure the development of a technically sound format and insightful analysis of the multiple datasets.

The guidelines and framework contained within this document have been developed for the cost-effective collection of valuable data, but they intentionally include a degree of flexibility for the team implementing the TRWQMP in the future. The areas of flexibility include the locations of data collection, the timing of implementation of these locations and annual TRWQMP reporting guidelines. The locations of actual data collection should be modified as data is obtained to inform strategies on areas of potential pollutant loading concern or water quality impairment, given the existing resources available. This will actualize the adaptive management process of the TRWQMP to continue to inform the performance of the respective SWMPs to protect downstream water quality.

The TRWQMP annual data reporting, integration and management procedures are flexible in this document to allow the initial years of implementation to provide a tangible example of the actual TRWQMP data management and annual reporting procedures and formatting. The procedures implemented in the initial years will form the templates that should be followed over the life of the TRWQMP.

The area where few changes should occur in the TRWQMP over time is the data collection protocols and/or the respective assessment types themselves. One of the primary issues with any water quality sampling program is the difficulty of obtaining accurate and precise estimates in the face of the enormous variability (in space and time) of both stream discharge and pollutant concentrations. The data collection strategies and protocols within the TRWQMP have numerous considerations to minimize the inherent variability and improve the ability of long-term datasets to evaluate both water quality impacts of upstream activities and SWMP effectiveness. Maintaining data collection consistency across sites and over time is necessary to realize the technical goals of the TRWQMP to develop an integrated and informative long-term water quality dataset. If implemented as outlined in this document, the TRWQMP has the potential to be a local model for how multiple groups can collaborate to consistently measure and track the water quality of local surface waters over time.

2.0 TRUCKEE RIVER WATER QUALITY MONITORING PLAN GOALS AND OBJECTIVES

2.0 TRUCKEE RIVER WATER QUALITY MONITORING PLAN GOALS AND OBJECTIVES

TRWQMP Goal 1: Ensure regulatory compliance for Placer County and Town of Truckee with the NPDES permit, Lahontan Board Orders, Middle Truckee River Sediment TMDL, Squaw Creek Sediment TMDL, and the Martis Valley Community Plan.

TRWQMP Goal 2: Develop water quality monitoring data sets that will be scientifically defensible and provide accurate data to evaluate the effectiveness of Stormwater Management Programs in protecting surface water resources.

TRWQMP Goal 3: Develop a TRWQMP that is economically feasible to implement and maintain over time.

TRWQMP Goal 4: Ensure that the TRWQMP allows collaboration, effort-sharing and integration of multiple independent private and public monitoring efforts.

Objectives:

- Provide a comprehensive and integrated data collection, data analysis and reporting framework to evaluate and track the status of surface water resources within the project area spatially and over time.
- Prioritize monitoring resources on spatial locations determined to be existing and/or future potential source areas.
- Focus monitoring resources on pollutants of concern and indicators that are clearly rationalized for each location of monitoring. Prioritize pollutants based on greatest risk to surface water resources due to specific land use activities.
- Maximize monitoring resources by including a range of monitoring types that vary in frequency of collection, relative cost to complete and statistical accuracy.
- Focus monitoring resources on times (season, storm events, etc.) when potential source area water quality is expected to deviate greatest from observations at minimally impacted locations.

2.1 Role of Truckee River Water Quality Monitoring Plan

The Truckee River Water Quality Monitoring Plan (TRWQMP) is just one element of a much larger stormwater program in the Truckee River Watershed. Both Placer County and the Town of Truckee have developed and are implementing Stormwater Management Program documents (SWMPs). These SWMP documents, developed in response to regulatory requirements of the Lahontan Regional Water Quality Control Board (the Board), were approved by the Board in 2008. The respective SWMPs detail the specific actions each jurisdiction

(County and Town) are proposing to implement in order to protect surface water resources. The general role of the TRWQMP is to design a monitoring plan which will allow the County and Town to effectively assess the water quality impacts and effectiveness of their ongoing SWMPs with respect to protecting downstream resources.

Figure 2.1 is a schematic illustrating the functional relationship between the two SWMPs and the Truckee River Water Quality Monitoring Plan. There are two distinct components to evaluating the effectiveness of the SWMPs—**compliance assessment** and **performance assessment**. **Compliance assessment** includes inspections of drainage and stormwater infrastructure, construction sites and other localized activities which may impact the volume and quality of stormwater runoff. Compliance by property owners, developers, service districts and other entities should be evaluated using simple, but repeatable, inspections to enforce the actions to protect receiving surface water quality as outlined in the SWMPs. The site-specific compliance and enforcement inspections are not included as components of the TRWQMP, as they are implemented by the County and Town as part of their respective SWMPs.

The TRWQMP provides a framework for the County and Town to conduct **performance assessments** using techniques to evaluate the relative water quality condition of the receiving surface waters. The TRWQMP does not enforce compliance with SWMP guidelines or implement pollutant control measures. Rather, the TRWQMP provides a framework and specific details to develop a consistent, reliable and cost-effective water quality monitoring plan to track the condition of the surface water resources. The information and data generated can be used by public agencies, regulators and stakeholders to evaluate the performance and success of the local SWMPs in protecting the waters within the project area. Over time, the water quality information and data can be used to continue to prioritize the potential source areas that could have a disproportionate impact on receiving surface water quality. The results of the TRWQMP inform the adaptive management process of the SWMPs so that local agencies can continue to implement the actions that best protect the quality of the local surface water resources.

2.2 Placer County and Town of Truckee Coordination

The middle Truckee River watershed contains lands under the jurisdictions of both Placer County and the Town of Truckee. Though the County and Town are under two separate NPDES permits and have developed separate SWMPs, a comprehensive monitoring plan for the Truckee River requires the integration and analysis of data throughout the watershed. The County and Town have therefore agreed to coordinate efforts and share costs for data collection, data management, and data analysis so that the monitoring plan provides the most possible value in guiding their respective SWMPs.

2.3 Regulatory Requirements

The TRWQMP is an integrated document prepared by Placer County and the Town of Truckee to meet their respective regulatory requirements as imposed by the Board. The Water Quality Control Plan for the Lahontan Region (Lahontan Basin Plan) designates the following beneficial uses for the Truckee River:

- Municipal and Domestic Supply (MUN)
- Agricultural Supply (AGR)
- Industrial Supply Service (IND)

SWMP Goals

Comply with regulatory requirements and improve the quality of receiving surface water resources.

SWMP Actions

Primary pollutant control actions include:

- Public education, outreach and participation on stormwater impacts
- Illicit discharge detection and elimination
- Construction site stormwater runoff control
- Post-construction stormwater management
- Pollution prevention/good housekeeping for municipal operations

SWMP EFFECTIVENESS EVALUATIONS

A. SWMP Compliance Assessment

Assessment Type	Area Assessed	Example of Assessment	Main Question Addressed

The best management practices outlined in the SWMP, if implemented as designed and planned, are assumed to protect the receiving waters from water quality degradation. Compliance assessment includes the inspection of specific locations of concern to ensure that developers, business and other entities are complying with specific SWMP BMP guidelines. Compliance assessment is **not** included in the TRWQMP, but rather it is being implemented by the SWMPs.

B. Performance Assessment

Assessment Type	Area Assessed	Example of Assessment	Main Question Addressed

The TRWQMP will provide a framework to evaluate the water quality of receiving surface waters (within source areas, tributaries and Truckee River main stem) throughout the project area. The TRWQMP dataset will allow the Town and County to determine if the SWMPs, when implemented and enforced, are achieving the goal of improving the water quality of receiving surface waters.

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Schematic representing the functional relationship between the Truckee River Water Quality Monitoring Plan (TRWQMP) and Stormwater Management Programs (SWMPs).

ROLE OF TRWQMP

FIGURE 2.1

- Ground Water Recharge (GWR)
- Freshwater Replenishment (FRSH)
- Hydropower Generation (POW)
- Water Contact Recreation (REC-1)
- Noncontact Water Recreation (REC-2)
- Commercial and Sportfishing (COMM)
- Cold Freshwater Habitat (COLD)
- Wildlife Habitat (WILD)
- Rare, Threatened, or Endangered Species (RARE)
- Migration of Aquatic Organisms (MIGR)
- Spawning, Reproduction, and Development (SPWN)

Existing regulatory requirements imposed mandates on the local jurisdictions to identify, prioritize and implement actions that protect the beneficial uses of the surface water resources. Both Squaw Creek and the middle Truckee River are listed on the Clean Water Act Section 303(d) list for impairment by sediment. Donner Lake is listed for impairment by priority organics. In response to the 303(d) listings, "Total Maximum Daily Loads" (TMDLs) have been developed in for both Squaw Creek and the middle Truckee River to outline plans to meet water quality objectives for sediment and to protect beneficial uses.

The main regulatory documents guiding the TRWQMP are listed below. Each document is assigned an acronym to simplify reference of these documents in Table 2.1 below:

- (**PCL**) Order to submit technical report in accordance with Section 13267 of the California Water Code – Placer County. March 9, 2007. From Harold Singer (the Board) to Bob Costa (Placer County).

- (**TTL**) Order to submit technical report in accordance with Section 13267 of the California Water Code – Town of Truckee. July 9, 2007. From Harold Singer (the Board) to Tony Lashbrook (Town of Truckee).

- (**NPDES**) NPDES General Permit No. CAS000004. Order Number 2003-005-DWQ. Prepared by State Water Resources Control Board.

- (**LBP**) Lahontan Regional Water Quality Control Board (LRWQCB). 1995. Water Quality Control Plan for the Lahontan Region (Lahontan Basin Plan). March 31, 1995.

- (**SCTMDL**) Lahontan Regional Water Quality Control Board (LRWQCB). 2006. Total Maximum Daily Load for Sediment, Squaw Creek, Placer County. April 2006.

- (**TRTMDL**) Lahontan Regional Water Quality Control Board (LRWQCB). 2008b. Total Maximum Daily Load for Sediment, Middle Truckee River, Placer, Nevada and Sierra Counties (Public Review Draft). Draft February 2008.

Additional relevant documents guiding the TRWQMP are listed below:

- (**TRSWMP**). Truckee River Basin Stormwater Management Program, Program Years 2007-2012 December 14, 2007. Prepared for Lahontan Regional Water Quality Control Board. Prepared by Placer County Department of Public Works.

- (**TTSWMP**) Town of Truckee Stormwater Management Program. December 6, 2007. Prepared for Lahontan Regional Water Quality Control Board. Prepared by Town of Truckee.

- (**MVCP**) Martis Valley Community Plan. December 16, 2003. Prepared by Placer County.
- (**MVCPEIR**) Martis Valley Community Plan Environmental Impact Report.

Table 2.1 is a synthesis of existing regulatory language as extracted from existing documentation for both Placer County and the Town of Truckee. The synthesis is based on the documents listed above, which identify programmatic goals and specific actions for both the jurisdictions' stormwater programs, as well as program monitoring. An attempt was made to summarize the exact language from each document in the middle column. For those statements where the language was vague or unclear with respect to the role of the TRWQMP, the language was ~~struck~~ and clarifying language was inserted. Goals and actions of the regulatory document that are to be implemented under the Placer County and Town of Truckee SWMPs are indicated in gray.

The top section of Table 2.1 presents the goal statements identified from each of the regulatory documents. Based on this synthesis of regulatory documents, the primary regulatory goal of the TRWQMP has been defined as follows:

- Goal: To design and implement a comprehensive water quality monitoring plan which assesses the performance effectiveness of the County and Town SWMPs.

The lower portion of Table 2.1 is broken into three distinct action categories. The three action categories include Inspections and Source Area Evaluations Sampling and Reporting. The TRWQMP only addresses Source Area Evaluations, Sampling and Reporting. Below we clarify some of the specific data collection efforts to be accomplished based on these regulatory requirements.

- Inspections: Inspection requirements are typically focused on drainage infrastructure or site specific projects. Inspections are a key component of compliance monitoring (see Figure 2.1) to ensure that land owners, developers, service districts and others are implementing BMPs in accordance with the procedures outlined in the respective Stormwater Management Programs (SWMPs). Compliance monitoring is not a component of the TRWQMP.

- Source Area Evaluations: For the purposes of designing an informed monitoring plan, the TRWQMP includes a cursory evaluation of the land use in the project area, development activities, and other characteristics that have the potential to impair the quality of surface water resources. Within each project area sub-watershed, these indicators of human impact have been integrated and evaluated to identify potential source areas that focus the data collection and observations conducted under the TRWQMP.

  The TRWQMP includes a preliminary mapping of stormwater drainage systems in the high priority potential source areas using available spatial information. A more detailed facilities inventory and mapping of stormwater related features will be conducted by Placer County and the Town of Truckee under their respective SWMPs (see Section 3.3).

- Sampling: The regulatory documents contain a variable level of specificity with respect to sample collection type, sample collection purpose, protocols, pollutants of concern, locations of collection, and other sampling characteristics. The data collection strategies of the TRWQMP outlined in the Technical Approach (Section 4.0) incorporates the gamut of regulatory sampling requirements to assess the potential impacts of source area stormwater on surface water resources. Sampling protocols listed in Table 2.1 are considered but not necessarily included in the TRWQMP. Additional sampling protocols not included in the regulatory documents have been adopted in order to meet the goals of the TRWQMP (Sections 4.0, 5.0 and 6.0).

2.4 Stakeholder Considerations

There are numerous potential stakeholders, in addition to Placer County, Town of Truckee and the Board, who may have a specific interest in the development and implementation of the TRWQMP. Table 2.2 groups each of the primary stakeholders by stakeholder type and identifies draft general goals for each stakeholder group with respect to the TRWQMP. The primary stakeholder groups include non-government organizations (NGOs), land owner/land developers, service districts, public agencies, and recreational users. Not included in Table 2.2 are research groups, who were contacted during the development of the TRWQMP for existing water quality information and technical insight, but who do not fall under the typical stakeholder classification.

In 2005, participating agencies under the Truckee River Operating Agreement (TROA) executed a Memorandum of Understanding to establish a Biological Resources Monitoring Program (BRMP). One of the stated goals of the BRMP is “to assist in meeting biological/ecosystem objectives within the Truckee River basin”. Though not complete, the BRMP and its implementation may provide opportunities for cooperation, collaboration, and sharing of resources as related to implementation of the TRWQMP. Several of the stakeholders listed in Table 2.2 are also participants in the TROA. It is anticipated that these stakeholders will collaborate on opportunities that may be available to improve efficiencies and avoid duplication of effort.

The project team has solicited information from stakeholders to (1) ensure the stakeholders’ goals relative to the WQMP are identified and considered, (2) obtain and review any previous and/or existing water quality monitoring efforts, and (3) determine if and how any existing monitoring may be integrated into the TRWQMP. Appendix A includes a detailed summary of any existing and/or recent water quality monitoring efforts by sub-watershed at the time this TRWQMP plan was developed (2008).

	Regulatory Language	Document required by[1]
Goals of Monitoring Plan	Develop and implement a comprehensive storm water monitoring plan and implementation schedule for Placer County and Town of Truckee. Cooperate and participate with other entities in establishing monitoring plan to reduce redundancy in monitoring and promote consistency and quality of data.	PCL, TTL, NPDES, TRSWMP, TTSWMP, SCTMDL, TRTMDL, MVCP
	Measure and improve the effectiveness of the SWMP.	TRSWMP, NPDES
	Describe the monitoring needed to evaluate stormwater discharges and receiving water effects.	PCL, TTL
	Provide data to determine if discharges are causing or contributing ~~Discharges shall not cause or contribute~~ to an exceedance of water quality standards per Receiving Water Limitations A.1.	NPDES
	~~Include~~ Track the effectiveness of pollution control measures required by the General NPDES Permit, Middle Truckee River TMDL and the Squaw Creek TMDL (Placer County only) and implemented under the TTSWMP and TRSWMP.	TTL, PCL, NPDES, TRTMDL, SCTMDL
	Identify significant source areas and ~~minimize~~ track the contribution of storm water pollutants of concern from these source areas.	PCL, TTL, NPDES, TRTMDL, TRSWMP, TTSWMP
	Include the bioassessment monitoring specified in the Squaw Creek TMDL.	PCL, SCTMDL
	Resolve the piece-meal approach to monitoring currently being used in the Martis Valley area.	PCL, MVCP
	Evaluate long-term trends in receiving water quality.	NPDES
Category	**Actions To Be Considered to Meet Goals of Monitoring Plan**	
Inspections and Source Area Evaluations	Conduct source area management inspections that include dry and wet season inspections of storm water facilities and construction sites. (Covered by SWMP)	PCL, TTL, NPDES, TRSWMP, TTSWMP
	Conduct mapping and prioritization of pollutant source areas.	PCL, TTL, NPDES, TRSWMP, TTSWMP, SCTMDL, TRTMDL
	Conduct facilities inventory, mapping (and operation) of storm water related facilities. (Preliminary mapping effort included in TRWQMP, complete effort implemented under SWMP)	PCL, TTL, NPDES, TRSWMP, TTSWMP, SCTMDL, TRTMDL
	For new development, estimate peak storm water discharge rates to track whether they ~~shall not~~ exceed pre-development where there is the potential to increase downstream erosion. ~~Incorporate volumetric or flow-based treatment control design standards for new development (B.2).~~	NPDES
Sampling (methods to consider)	Report information on the water quality characteristics of stormwater discharges, pollutant loading, and the effects the discharges may have on water quality.	PCL, TTL, NPDES, TRSWMP, TTSWMP, SCTMDL, TRTMDL
	Conduct source area management monitoring that includes near continuous (autoprobes/dataloggers) to capture turbidity, pH, EC, temperature, and stage at few selected tributaries that represent conditions associated with major developments.	PCL, TTL, TTSWMP, TRSWMP
	Conduct grab sampling for key numeric water quality objectives (WQO) as set for the Truckee River Hydrologic Unit in the Lahontan Basin Plan.	PCL, TTL, TTSWMP, SCTMDL, TRSWMP
	~~Meet the~~ Provide data to determine if the Truckee River is meeting water quality objectives as outlined in the Lahontan Basin Plan that apply to all surface waters and certain water bodies (Truckee River Hydrologic Unit).	PCL, TTL, NPDES, TRSWMP, TTSWMP, LBP, SCTMDL, TRTMDL, MVCP, MVCPEIR
	Conduct cumulative effects assessment.	PCL, TTL
	Conduct bioassessment sampling as outlined in the Squaw Creek TMDL	PCL
	Analyze physical habitat ~~indicators~~ conditions using Herbst protocols and indicators.	SCTMDL
	Establish 3 sampling sites on the meadow reach of Squaw Creek.	SCTMDL
	~~Require~~ Define how pre- and post-bioassessment monitoring for new development project would be conducted.	PCL, TTL, TTSWMP
	Coordinate with Snap Shot Day monitoring activities.	TRSWMP, TTSWMP
	Incorporate DWR continuous sampling with periodic grab sampling into TRWQMP.	PCL, TTL
	~~Placer County is the primary agency for monitoring~~ Monitor the mitigation measure implementation associated with the MVCP.	MVCP, MVCPEIR
	Track road sand application and recovery amounts. Recover to MEP.	TRTMDL, TTSWMP, TRSWMP
Reporting	~~Submit~~ Define monitoring reporting structure to ensure data generated under the TRWQMP is accessible, comparable, and easily interpreted by public agencies, regulators and stakeholders to evaluate the results with respect to TRWQMP goals listed above. Annual reports shall be submitted by September 15th of each year. ~~The report shall summarize the activities performed throughout the reporting period (July 1 through June 30) and must include: status of compliance with permit conditions, an assessment of the effectiveness of identified BMPs, status of identified measurable goals, results of collected/analyzed information and monitoring data, summary of activities planned for next reporting cycle, proposed changes to the SWMP and justification, and changes in personnel implementing the SWMP.~~	NPDES, TRSWMP, TTSWMP

1 See regulatory document acronyms listed in text above; For those statements where the regulatory language was vague or unclear with respect to the role of the TRWQMP, the language was ~~struck~~ and clarifying language was inserted. Text in grey indicates effort covered under SWMP.

Table 2.1. Synthesis of Regulatory Documents

Entity Type	Stakeholder Goal with respect to TRWQMP	Stakeholder	Spatial location(s) of Concern	Current Runoff Water Quality Data Collection?	Specific suggestions for TRWQMP	Regulatory Requirements on Stakeholder
NGO	(1) To provide a reliable and available dataset to track the relative impacts of urban development and human activities on the Truckee River and its key tributaries.	Truckee River Watershed Council	Entire project area	Volunteer program	Ensure data is accessible	None
		Sierra Watch	Entire project area	No		
		Mountain Area Preservation Foundation	Martis Valley and other potential future development	No		
		Sierra Club	Entire project area	No		
		Truckee Donner Land Trust	Donner Creek, Cold Creek, Truckee Town Corridor sub-watersheds	No		
		Sierra Nevada Alliance	Entire project area	No		
		Friends of Squaw Creek	Squaw Creek sub-watershed	No		
Private Land Owners and Developers	(1) To be compatible with, and incorporate, current monitoring and existing regulatory requirements. (2) To minimize additional financial burden on developers.	DMB Highlands	Martis Creek sub-watershed	Yes		NPDES
		JMA Ventures (Alpine Meadows)	Bear Creek sub-watershed	No		None
		Lahontan Development	Martis Creek sub-watershed	Yes		NPDES
		Timilik	Martis Creek sub-watershed	Yes		NPDES
		East West Partners (EWP)	Truckee Town Corridor	Yes		NPDES
		Northstar at Tahoe and EWP	Martis Creek sub-watershed	Yes		NPDES
		Squaw Valley Ski Corporation	Squaw Creek sub-watershed	Yes		NPDES, TMDL
		The Resort at Squaw Creek	Squaw Creek sub-watershed	Yes		NPDES, TMDL
		Intrawest Village at Squaw Valley	Squaw Creek sub-watershed	Yes		NPDES, TMDL
Service Districts	(1) To be compatible with, and incorporate, current monitoring and existing regulatory requirements. (2) To provide information on the state of Truckee River watershed surface water resources	Truckee Tahoe Airport District	Martis Creek and Truckee Town Corridor	Yes		CA General Industrial Stormwater Permit
		Tahoe-Truckee Sanitation Agency	Entire project area	Yes		General WDR Permit
		Truckee Sanitary District	Truckee Town Corridor	No		General WDR Permit
		Truckee Donner Public Utility District	Truckee Town Corridor	No		
		Placer County Water Agency	Martis Valley	No		
		Squaw Valley Public Service District	Squaw Valley	Discharge only		NPDES
		Caltrans	HW 89, HW 267, I-80	No		NPDES
		Placer County Department of Facility Services	Cabin Creek sub-watershed	Yes		NPDES
Public Agencies	(1) To provide information on the state of Truckee River watershed surface water resources.	Army Corp of Engineers	Martis Creek Sub-watershed	Yes		None
		Department of Water Resources	Entire project area	Yes		
		U.S. Forest Service	USFS lands in project area	Yes		
		CA Department of Fish and Game	Entire project area	Yes		
		U.S. Fish and Wildlife Service	Entire project area	No		
Recreational Users	(1) To provide a reliable and available dataset to track the relative impacts of urban development and human activities on the beneficial recreational uses of the Truckee River.	Recreational users	Entire project area	No		None
		Businesses serving recreational users	Entire project area	No		

Table 2.2. Summary of primary stakeholder groups

3.0 PROJECT AREA DESCRIPTION

3.0 PROJECT AREA DESCRIPTION

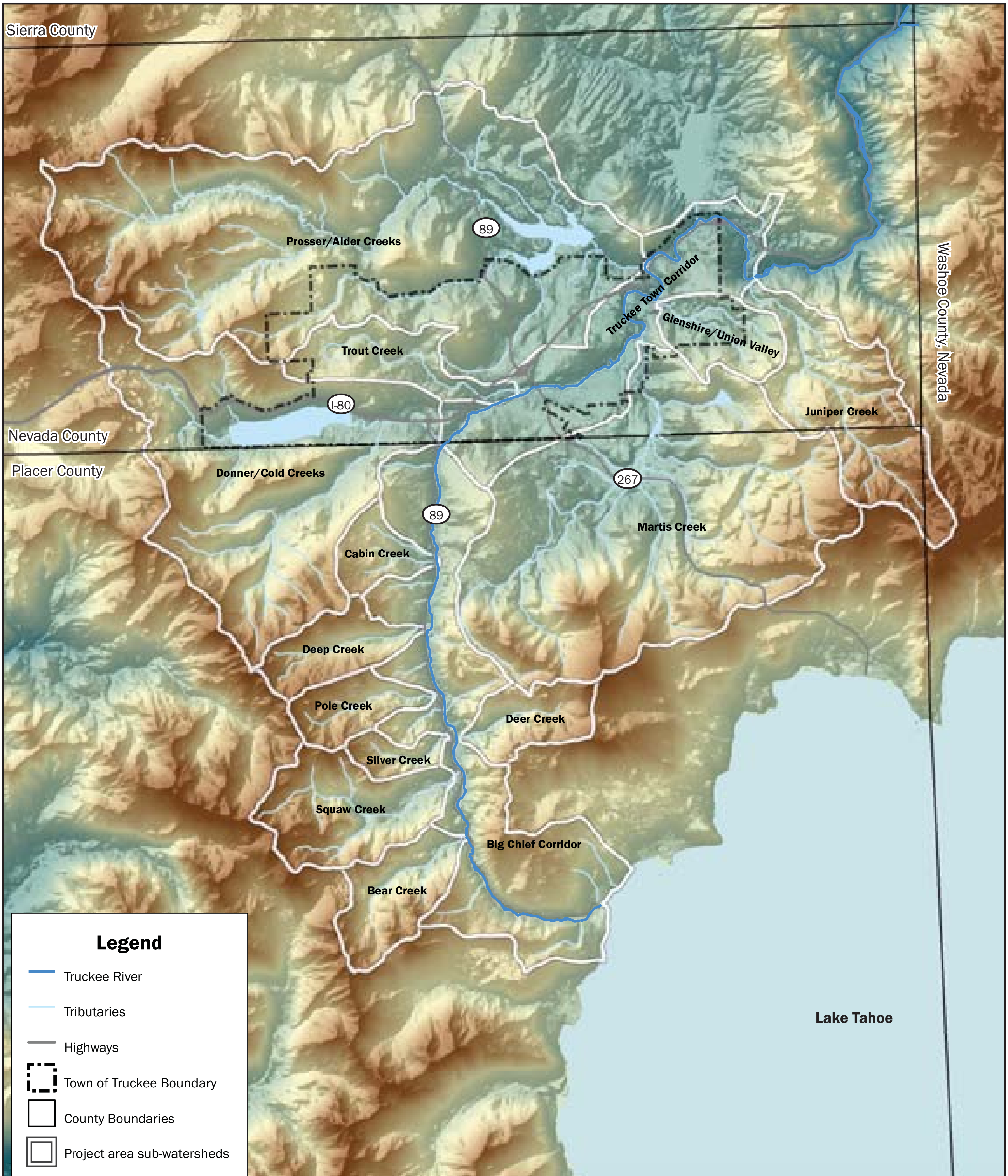
Section 3.0 presents a brief description of the project area included in the Truckee River Water Quality Monitoring Plan (TRWQMP). This section also includes a prioritization of potential source areas at the sub-watershed scale based on GIS data. For those areas determined to have a high level of human disturbance based on the GIS screening, a description of existing data available on stormwater routing is provided. Section 3.3 also includes a schedule and list of tasks and products to be conducted by Placer County (County) and the Town of Truckee (Town) in the near future to provide stormwater routing descriptions in compliance with the respective Stormwater Management Programs (SWMPs).

3.1 Project Area

Figure 3.1 delineates the 15 sub-watersheds of the TRWQMP project area. All lands under the jurisdiction of Placer County and the Town of Truckee are the priorities for evaluation as part of the TRWQMP. The Truckee River area of concern is bounded upstream by the outlet from Lake Tahoe and downstream by the Juniper Creek sub-watershed. The total project area is approximately 210 square miles.

All of the tributary sub-watersheds of the Truckee River at least partially contained within Placer County are included in the project area. This includes the sub-watersheds of Bear Creek, Big Chief Corridor, Cabin Creek, Deep Creek, Deer Creek, Donner/Cold Creeks, Juniper Creek, Martis Creek, Pole Creek, Silver Creek and Squaw Creek.

The sub-watersheds that are partially contained within the Town of Truckee boundaries are also included in the project area. These include the sub-watersheds of Prosser/Alder Creeks, Glenshire/Union Valley, Truckee Town Corridor and Trout Creek. The Little Truckee River sub-watershed, which drains to the Stampede and Boca Reservoirs north of the Town of Truckee, is not included in the project area because, except for the outlet, the sub-watershed is entirely



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Project area map with delineation of sub-watersheds and the boundaries of Placer County and the Town of Truckee.

0 1 2 3 4 Miles

N

FIGURE 3.1

outside the Town boundaries. The project area delineated in Figure 3.1 is consistent with the sub-watershed areas included in the Town of Truckee SWMP. Portions of the project area sub-watersheds outside of the County and Town boundaries are included to ensure consideration of any potential sources of water quality impairment upstream of the respective jurisdictions.

3.2 GIS Sub-watershed Source Area Prioritization

The TRWQMP prioritizes resources to evaluate water quality at the locations where (1) density of human development on the Truckee River and its tributaries are expected to be the greatest, and (2) where the majority of SWMP actions are expected to be implemented in order to improve the quality of surface water resources. A desktop screening process was used to compare the relative level of disturbance within each project area sub-watershed using available Geographic Information Systems (GIS) spatial data. The purpose of the GIS potential source area evaluation is to prioritize areas for water quality assessment based on the relative densities of land use characteristics assumed to affect surface water resources using cost-effective methods.

The 15 project area sub-watersheds (Figure 3.1) were ranked as high, moderate, or low disturbance source areas based on the following analysis of key land use data, including impervious coverage density, residential development density, dirt roads density, graded ski run density, and potentially erodible soils as depicted on existing GIS data layers. These land use characteristics are all assumed to represent potential sources of the range of pollutants that can impair downstream water quality.

The detailed GIS Sub-watershed Source Area Prioritization protocols are documented in Section 6.2.

3.2.1 GIS Sub-watershed Source Area Prioritization Results

Table 3.1 summarizes the results of this analysis for each sub-watershed. This analysis serves as an initial, low-cost, repeatable desktop screening of potential source areas by ranking sub-watersheds along a gradient of human development and differentiating those areas that have a high level of disturbance from those with a relatively low level of disturbance. This sub-watershed source area screening was supplemented with an additional evaluation of the sub-watersheds that fell between these bookend conditions (the moderate disturbance sub-watersheds), based on other observations and information about known pollutant sources or areas of concern within the sub-watersheds. Additional analysis suggests that the Big Chief Corridor should be designated as high disturbance sub-watershed despite the moderate ranking based on the process described above.

Sub-watershed Name	Impervious Coverage (%)	Developed, Medium-High Intensity (%)	Potentially Erodible (%)	Private Lands (%)	Dirt Road Length Density	Ski Area: Graded Ski Runs	Sub-watershed Source Area Score	Sub-watershed Disturbance Level
Squaw Creek	3	2	2	3	3	3	2.67	High
Martis Creek	2	3	1	3	3	3	2.50	High
Truckee Town Corridor	3	3	3	3	2	0	2.33	High
Bear Creek	3	2	3	2	1	2	2.17	High
Donner/Cold Creeks	3	3	2	3	2	0	2.17	High
Trout Creek	3	3	3	3	1	0	2.17	High
Big Chief Corridor	2	3	2	2	3	0	2.00	High
Glenshire Union Valley	2	2	3	3	2	0	2.00	Moderate
Prosser/Alder Creeks	2	2	2	2	3	1	2.00	Moderate
Juniper Creek	1	1	3	3	2	0	1.67	Moderate
Cabin Creek	2	2	1	1	3	0	1.50	Low
Deep Creek	1	1	2	1	1	0	1.00	Low
Pole Creek	1	1	1	1	2	0	1.00	Low
Deer Creek	1	1	1	1	1	0	0.83	Low
Silver Creek	1	1	1	1	1	0	0.83	Low

Table 3.1. Source area characteristic values and disturbance level by sub-watershed.

Figure 3.2 displays the level of disturbance of project area sub-watersheds based on the integrated results of the above analysis. It must be noted that many of GIS land use layers used in this analysis were last updated in 2001 and thus may not reflect the most recent disturbances in the Truckee River Watershed.

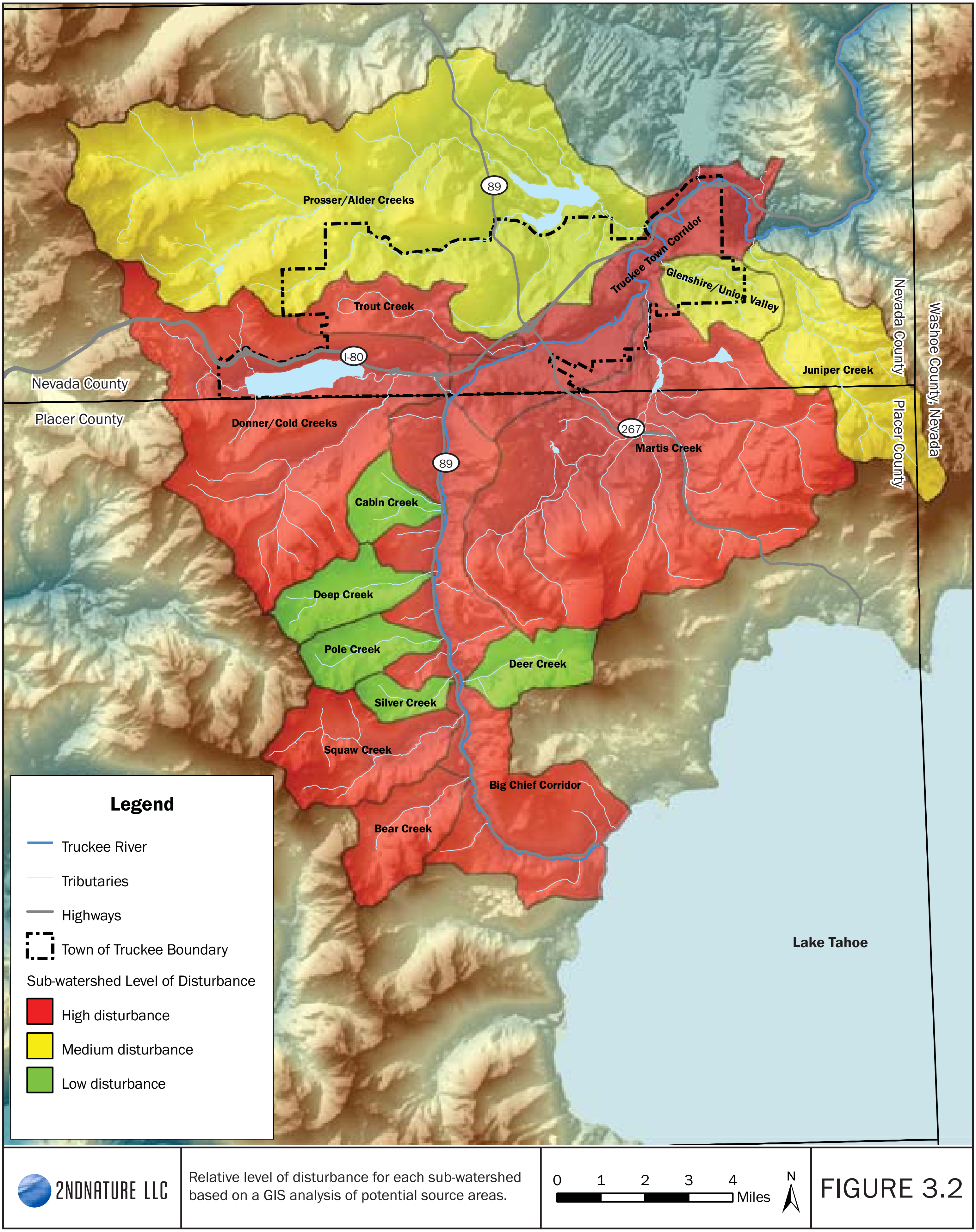
The sub-watershed source area prioritization was used to inform the assessment site selection process by indicating the areas where more rigorous assessment was necessary (high disturbance sub-watersheds) (see Section 5.0). A main goal of the TRWQMP is to evaluate and track the performance of the County and Town SWMPs, and high disturbance subwatersheds are coincidently where a large fraction of SWMP actions will be conducted. TRWQMP assessments within the moderate disturbance sub-watersheds will be included based on the resources available to evaluate these areas.

3.2.2 Sub-watershed Source Area Descriptions

Brief descriptions and activities of concern within each sub-watershed are provided below.

3.2.2.1 High Disturbance Sub-watersheds

<u>Squaw Creek Sub-watershed</u>
The Squaw Creek sub-watershed (8.2 mi^2) is the site of a large mountain recreation area (Squaw Valley Ski Corporation) with over 4,000 acres of terrain and multiple residential developments. These developments are in close proximity to Squaw Creek and consist of large impervious areas with high hydrologic connectivity to the creek. The sub-watershed also has the highest dirt road density in the project area (5.8 mi/mi^2; Maholland 2002). The golf course at the Resort at Squaw Creek is a potential source of nutrients and pesticides.



Relative level of disturbance for each sub-watershed based on a GIS analysis of potential source areas.

FIGURE 3.2

In 2006, the Board developed a TMDL for sediment to address impacts of sedimentation on stream habitat and aquatic life. The Squaw Creek Sediment TMDL (2006) estimates that controllable sediment sources, including dirt roads, graded ski runs, and residential/commercial areas, account for 58% of the total sediment load to the creek.

Martis Creek Sub-watershed
The Martis Creek sub-watershed (40.9 mi^2) contains several large residential developments, including Lahontan and Northstar-at-Tahoe. Additional residential developments, such as Martis Camp, are currently under construction, and thousands of residential units are slated for future development (Pacific Municipal Consultants 2003; Hall 2004). The Northstar-at-Tahoe resort contains 2,940 acres of terrain for year-round recreation, mostly consisting of graded ski runs, which could be a significant sediment source to Martis Creek. Additionally, the Martis Creek sub-watershed has one of the highest dirt road densities in the project area. Lahontan Golf Club and the Northstar-at-Tahoe Golf Course are adjacent to Martis Creek and could be potential sources of nutrients and pesticides to surface waters. In addition, State Highway 267 runs through the sub-watershed, paralleling the middle fork of Martis Creek and intersecting the west fork. Snow and ice management activities on this major high-elevation roadway, including road abrasive application, pose a risk to surface water quality. Martis Creek is dammed at the Martis Creek Reservoir (20,400 acre-feet) approximately 2 miles upstream of its confluence with the Truckee River.

Truckee Town Corridor
The urbanized corridor containing the Town of Truckee (14.1 mi^2) contains a high density of commercial and residential development adjacent to the Truckee River main stem. The Town Corridor contains heavily trafficked roads that receive significant road abrasive application, including I-80, State Highway 267, and State Highway 89. The hydrologic connectivity of the urban areas and local highways within the corridor to the Truckee River poses a risk of high urban pollutant loading from these areas. Old Greenwood and Gray's Crossing Golf Courses are potential sources of nutrients and pesticides to surface waters. The Truckee River Sediment TMDL Public Review Draft (2008) also identified significant legacy site impacts from historic development within this area.

Bear Creek Sub-watershed
The Bear Creek sub-watershed (5.3 mi^2) contains the Alpine Meadows ski facility (2,400 acres of terrain). Residential and commercial developments around this ski facility are potential sources of urban pollutants to surface waters, but the density of these land uses are relatively less than the sub-watersheds above.

Trout Creek Sub-watershed
The Trout Creek sub-watershed (4.9 mi^2) is a relatively small but highly developed area within the Town of Truckee jurisdiction. Medium to high density development and associated impervious surfaces pose the risk of increased generation and transport of urban pollutants to surface waters. The Tahoe Donner Golf Course and Coyote Moon Golf Course are located within this small sub-watershed and are potential sources of nutrients and pesticides to Trout Creek.

Donner Creek/Cold Creek Sub-watershed
The Donner Creek and Cold Creek sub-watersheds convene downstream of the Donner Lake dam before connecting to the main stem of the Truckee River. The Donner Creek portion of the sub-watershed (17.0 mi^2) contains a high level of residential/commercial development adjacent

to surface waters resources. Interstate 80 runs in close proximity to portions of Donner Creek and Donner Lake and is a potential source of sediment and other pollutants due to high traffic density and road abrasive application. The Cold Creek sub-watershed (12.8 mi^2) is relatively undeveloped, but several legacy sites associated with past railroad construction, gravel mining, and logging exist. In particular, an undersized culvert underneath a railroad bridge over Cold Creek is known to cause a significant amount of localized stream bank erosion. These legacy sites continue to contribute to water quality impairment in this sub-watershed.The Donner Creek/Cold Creek sub-watershed also contains moderate amount of dirt roads (2.3 mi/mi^2).

<u>Big Chief Corridor</u>

The preliminary subwatershed source area prioritization ranked Big Chief Corridor (23.4 mi^2) as a moderate disturbance sub-watershed. However, visual inspections of Highway 89 during March 2008 indicated that Highway 89 is potentially a very high sediment source due to high levels of road abrasive accumulation on unprotected road shoulders. In addition, this chronic potential sediment source is located within 500 to 1000 ft from the primary surface water resource of concern—the Truckee River. The proximity and high hydrologic connectivity between the roadway and the main stem of the Truckee River suggest potential anthropogenic impacts on stream habitat and beneficial uses within this reach. As a result, the Big Chief Corridor has been classified as a high disturbance subwatershed. The maintenance activities of Highway 89 are operated by CalTrans and are not conducted by the County or the Town SWMPs. The significant potential annual anthropogenic source of fine sediment to the Truckee River main stem from Highway 89 may well exceed the annual sediment loading from other specific upstream land uses. The achievable sediment load reductions from SWMP activities in other high disturbance upstream sub-watersheds (Bear Creek and Squaw Creek) may not be measurable in the Truckee River main stem until CalTrans controls the annual fine sediment loads generated within Big Chief Corridor.

3.2.2.2 Moderate Disturbance Sub-watersheds

<u>Prosser Creek/Alder Creek Sub-watershed</u>

The Prosser Creek/Alder Creek sub-watershed (54 mi^2) drains into the Prosser Creek Reservoir before connecting to the Truckee River main stem via the lower portion of Prosser Creek. The sub-watershed contains urbanized portions of the Town of Truckee as well as a small ski facility (Tahoe Donner). The dam at Prosser Creek Reservoir regulates flow from the Prosser and Alder Creek watersheds to the Truckee River, and dam-regulated tributaries are estimated to be the largest sediment contributors under low-flow conditions (Truckee River Sediment TMDL Public Review Draft 2008). A high dirt road density (3.1 mi/mi^2) could be a potential sediment source to surface waters in this sub-watershed.

<u>Glenshire/Union Valley Basin</u>

The Glenshire/Union Valley Basin (4.1 mi^2) is a small catchment that contains a relatively moderate density of primarily residential land uses. Drainage from Glenshire Pond to the Truckee River is ephemeral and is not considered to be a significant source of pollutants to the Truckee River.

<u>Juniper Creek Sub-watershed</u>

The Juniper Creek sub-watershed (10.8 mi^2) currently has a low level of residential and commercial development. However, a high percentage of lands near the stream are privately owned and have the potential for future development. Potential sediment sources include a high dirt road density (2.83 mi/mi^2) and high percentage of erodible areas within the stream zone (64.3%).

3.2.2.3 Low Disturbance Sub-Watersheds

Cabin Creek, Deep Creek, Deer Creek, Pole Creek, and Silver Creek Sub-watersheds
Cabin, Deep Deer, Pole, and Silver Creek sub-watersheds are low disturbance source areas based on our preliminary screening of source area characteristics. Water quality observations conducted using standardized and cost-effective techniques in low disturbance catchments can inform evaluators of "baseline" water quality characteristics in the project area. The results from these assessments can be used to place water quality data from high disturbance sub-watersheds in a regional and "potentially achievable" context.

3.3 Stormwater Routing Description

Section 3.3 presents a basic overview of stormwater routing within the high disturbance sub-watersheds as selected by the GIS Sub-watershed Source Area Prioritization (Section 3.2). The overview includes storm drainage maps based on existing Town and County data and brief narrative stormwater routing descriptions.

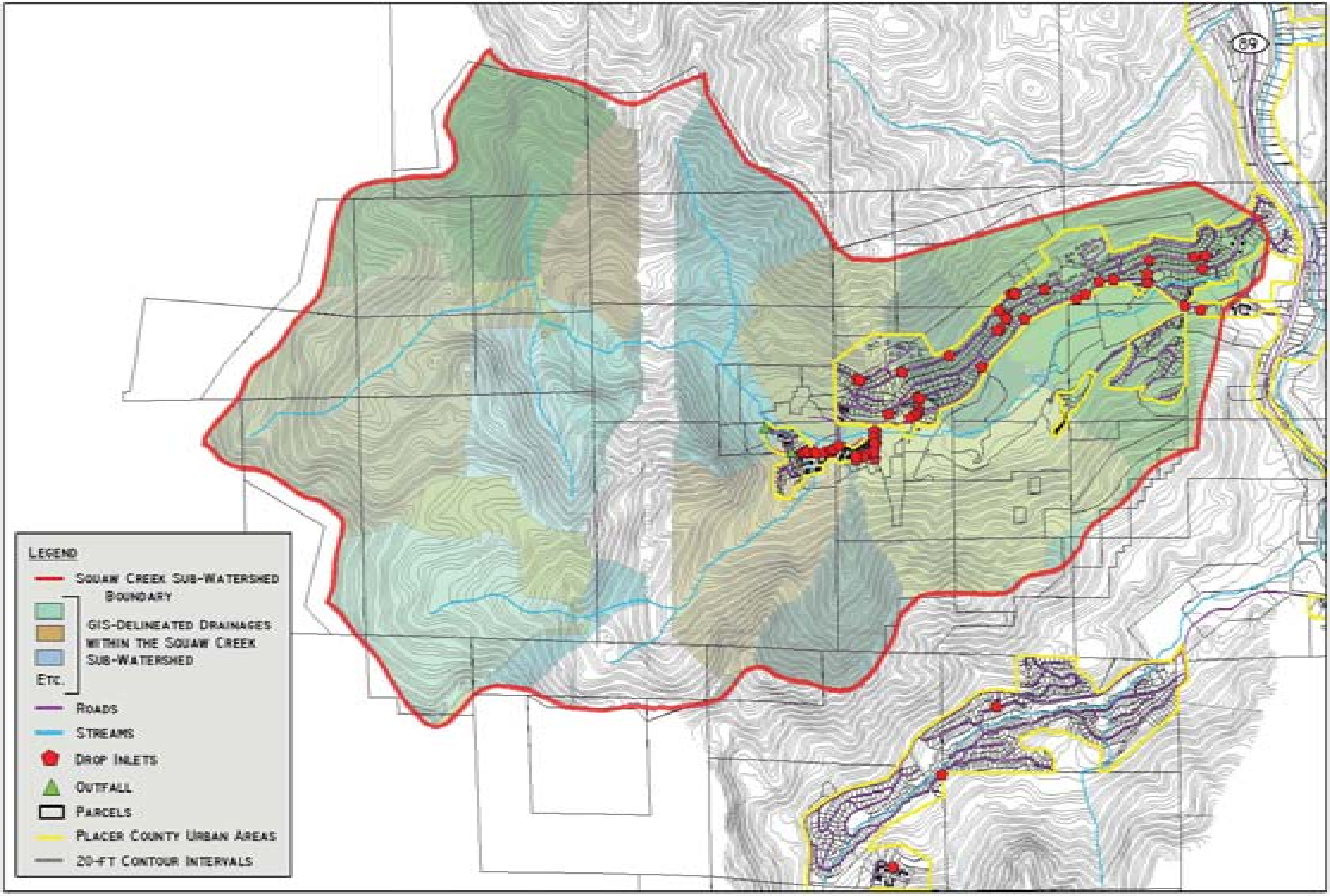
3.3.1 Mapping

Stormwater routing base maps were developed in GIS using existing data for watersheds, streams, topography, roads, and parcels. Existing stormwater infrastructure data provided by Placer County and the Town of Truckee was also integrated into the base maps. ESRI Spatial Analyst Extension was used to delineate topographic-based drainages within each priority sub-watershed. The drainage basins are represented on the base maps as smaller shaded areas within each sub-watershed. The purpose of delineating the drainage basins was to identify general drainage patterns and key discharge points within each sub-watershed. Since there is limited existing mapping of storm drainage facilities for most sub-watersheds, this information will help inform decisions regarding the placement of potential monitoring stations. The stormwater routing base maps include unshaded or white areas which abruptly and unnaturally end drainage basin delineations. This anomaly is due to the way the Spatial Analyst Extension analyzed the digital elevation data. These unshaded areas occur where two quadrangles meet; if necessary, additional analysis can be performed to rectify this issue.

Mapping was verified in the field on April 23 and June 20, 2008. General topography, natural drainage features, constructed storm drainage features, and basic flow paths were checked. The general drainage patterns, basic stormwater routing, and available mapping of storm drainage infrastructure for each of the high priority sub-watersheds are discussed below. General descriptions of each sub-watershed can be found in Section 3.2.2.

3.3.1.1 Squaw Creek Sub-watershed

Jurisdiction: Placer County (Figure 3.3)
Squaw Creek begins in and flows through undeveloped land in the western half of the sub-watershed, then flows through a ski resort, residential area, and golf course before its confluence with the main stem of the Truckee River. Squaw Creek ultimately receives all runoff, both urban and natural, from the sub-watershed. The developed portion of the sub-watershed consists of three primary drainage areas:



Nichols Consulting Engineers, Chtd.

TRUCKEE RIVER WATER QUALITY MONITORING PLAN
PLACER COUNTY AND TOWN OF TRUCKEE

SQUAW CREEK SUB-WATERSHED

SOURCES: PLACER COUNTY; 2NDNATURE

DRAWN BY: MS/NCE JUNE 2008

FIGURE: 3.3

- The western portion of the developed area consists of the Squaw Valley Ski Resort and Village complex, with existing storm drains leading to culverts that outlet directly into Squaw Creek. This section is densely developed and includes a massive contiguous impervious area consisting of maintenance facilities, hotel structures, commercial businesses, and the main ski resort parking lot. The impervious areas are directly adjacent to Squaw Creek, and runoff is captured and discharged to the creek through a number of culvert outfalls. A small portion (western edge) of the urban residential development that is north of Squaw Valley Road is also a part of this drainage area.

- The second major area is the residential neighborhood to the north and west of Squaw Valley Road which drains downhill towards the Squaw Creek meadow. As with most developed areas, stormwater routing generally follows the road network before discharging to the meadow through a series of culvert outfalls.

- The third major drainage area includes the Resort at Squaw Creek and its associated roads, parking lots, and golf course. This area is located on the south east side of Squaw Creek. Generally, runoff from the hotel structure and parking lot drain to the adjacent golf course. Runoff from the main parking facility appears to drain to a water feature or pond within the golf course before discharging to the meadow and ultimately the creek.

Existing infrastructure includes:

- Asphalt Concrete (AC) curb and gutter
- AC swales
- Concrete curb and gutter
- Numerous storm drain pipes (RCP and CMP)
- Earthen ditches
- Roadside ditches
- Drop inlets
- Catch basins
- CMP culverts

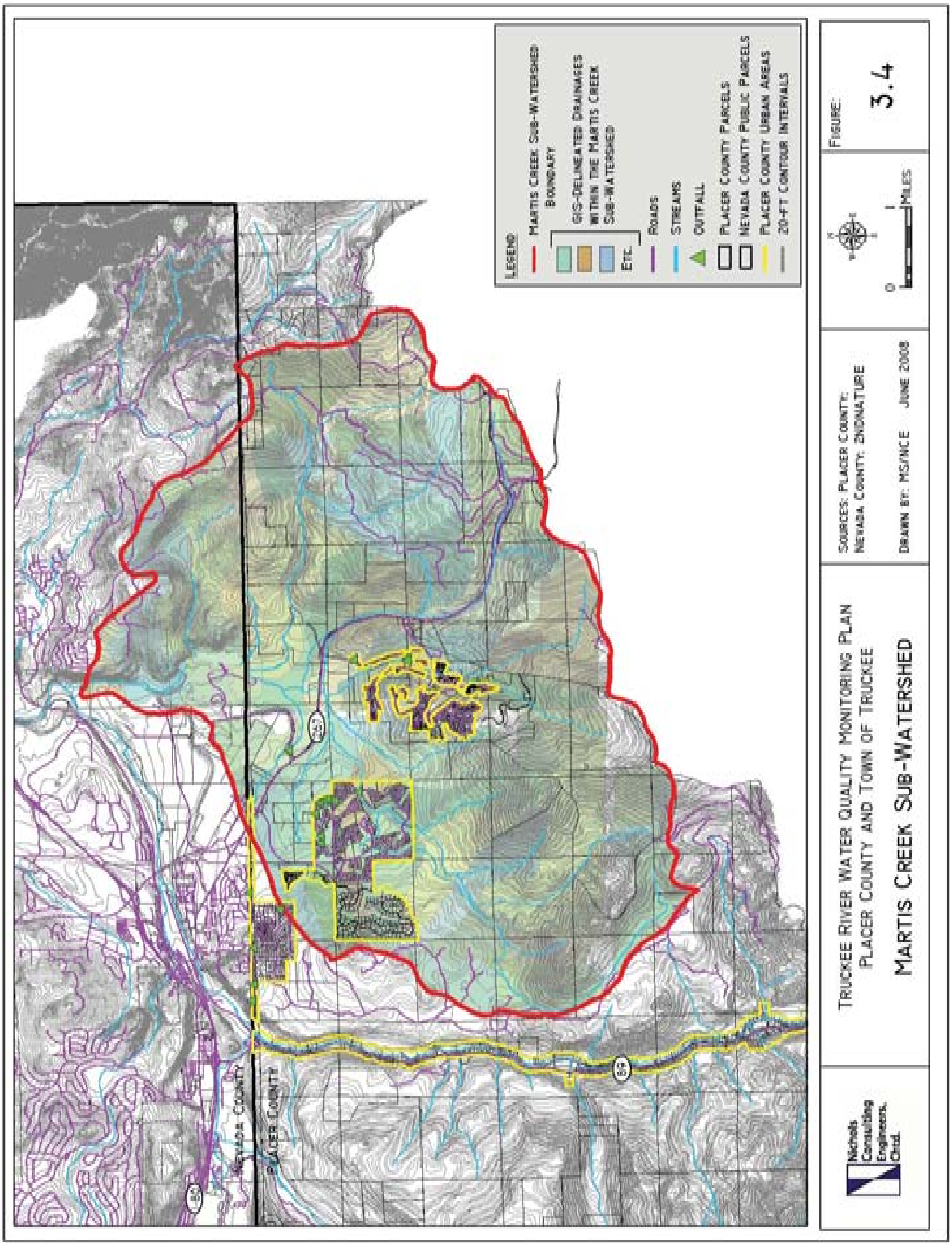
Other notes:

- The sub-watershed contains localized high density development.
- The residential sub-division to the north and east of the creek has little to no flow attenuation and water quality improvements are minimal.
- Given the scale of the figure provided by Placer County that shows existing storm drain features, it was difficult to determine whether or not the features are accurately mapped.

3.3.1.2 Martis Creek Sub-watershed

Jurisdiction: Placer County (Figure 3.4)
Martis Creek consists of three main forks that all flow into the Martis Creek Reservoir approximately 2 miles upstream from the Truckee River. Upland runoff generated west of Highway 267 flows through one of two urban areas that drain into the west fork of Martis Creek. Upland runoff generated east of Highway 267 does not flow through any major urban areas before discharging to the creek. Highway 267 parallels the middle fork of Martis Creek and receives substantial direct stormwater flows. The developed portion of the sub-watershed is separated into two main areas:

- New subdivisions are currently being constructed in the western portion of the sub-watershed. These sub-divisions include typical storm drainage infrastructure and will collect flows from impervious areas and discharge to the west fork of Martis Creek.


LEGEND
MARTIS CREEK SUB-WATERSHED BOUNDARY
GIS-DELINEATED DRAINAGES WITHIN THE MARTIS CREEK SUB-WATERSHED
ETC.
ROADS
STREAMS
OUTFALL
PLACER COUNTY PARCELS
NEVADA COUNTY PUBLIC PARCELS
PLACER COUNTY URBAN AREAS
20-FT CONTOUR INTERVALS
NEVADA COUNTY
PLACER COUNTY
267
89
80
Nichols Consulting Engineers, Chtd.
TRUCKEE RIVER WATER QUALITY MONITORING PLAN
PLACER COUNTY AND TOWN OF TRUCKEE
MARTIS CREEK SUB-WATERSHED
SOURCES: PLACER COUNTY; NEVADA COUNTY; 2NDNATURE
DRAWN BY: MS/NCE
JUNE 2008
0
1
MILES
FIGURE:
3.4

- The Northstar-at-Tahoe Ski Resort, golf course, and surrounding residential parcels comprise the developed area near the center of the sub-watershed. Approximately half of the developed area drains west to a tributary, and half drains east to a tributary which runs through the middle of the golf course. Both of those tributaries flow north and join with the west fork of Martis Creek.

Existing infrastructure includes:

- AC swales
- Concrete curb and gutter
- Numerous storm drain pipes (RCP and CMP)
- Earthen ditches
- Rock-lined ditches
- Drop inlets
- Catch basins
- CMP culverts
- Detention basins

Other notes:

- Existing storm drainage infrastructure and water quality treatments are more extensive than in the other high priority sub-watersheds, as the majority of the development in this sub-watershed is relatively new.
- Given the scale of the figure provided by Placer County that shows existing storm drain features, it was difficult to determine whether or not the features are accurately mapped.

3.3.1.3 Truckee Town Corridor Sub-watershed

Jurisdiction: Town of Truckee (Figure 3.5)
The main stem of the Truckee River flows through the center of the Town of Truckee. Throughout most of the urban town area, runoff is collected and discharged directly to the river through numerous culverts and outfalls. Runoff does not follow natural drainage paths due to the extensive street network and impervious surfaces that have modified the drainage patterns of the relatively flat section of town. Outside the main developed town area, runoff appears to follow expected topographic drainages and enters the Truckee River through small tributaries.

Existing infrastructure includes:

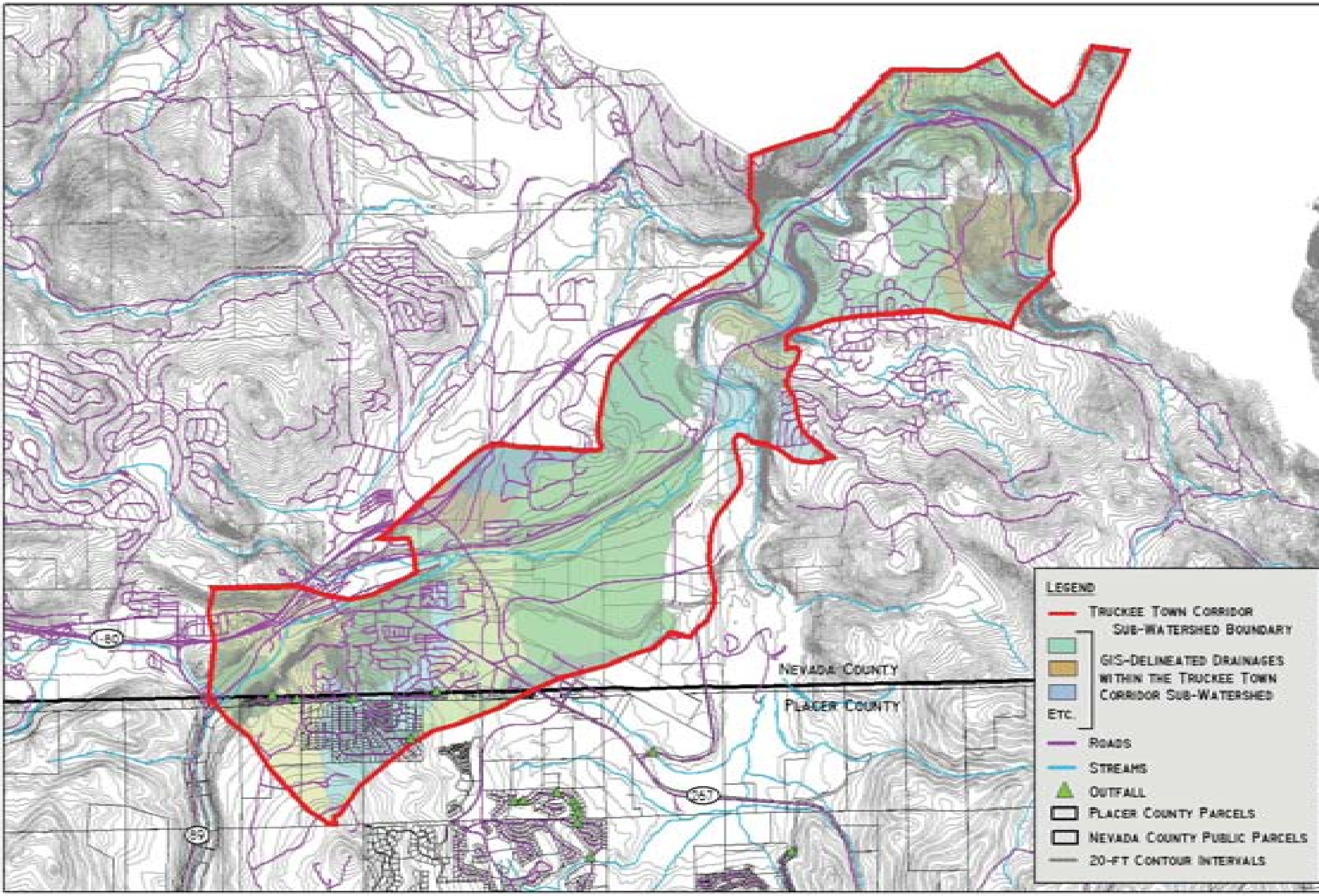
- Asphalt Concrete (AC) curb and gutter
- AC swales
- Concrete curb and gutter
- Numerous storm drain pipes (RCP and CMP)
- Roadside ditches
- Drop inlets
- Catch basins
- CMP culverts
- Concrete flumes

Other notes:

- The Truckee Town Corridor has the most complex drainage pattern of the 7 sub-watersheds investigated.
- There is little to no flow attenuation and water quality improvements are minimal.

3.3.1.4 Bear Creek Sub-watershed

Jurisdiction: Placer County (Figure 3.6)
Bear Creek begins in and flows through undeveloped land in the south west portion of the sub-watershed. It then passes through the Alpine Meadows Ski Resort and a developed residential area prior to its confluence with the main stem of the Truckee River. All runoff in the sub-watershed discharges directly to Bear Creek, and is generated by two main developed areas:



Nichols Consulting Engineers, Chtd.

TRUCKEE RIVER WATER QUALITY MONITORING PLAN
PLACER COUNTY AND TOWN OF TRUCKEE

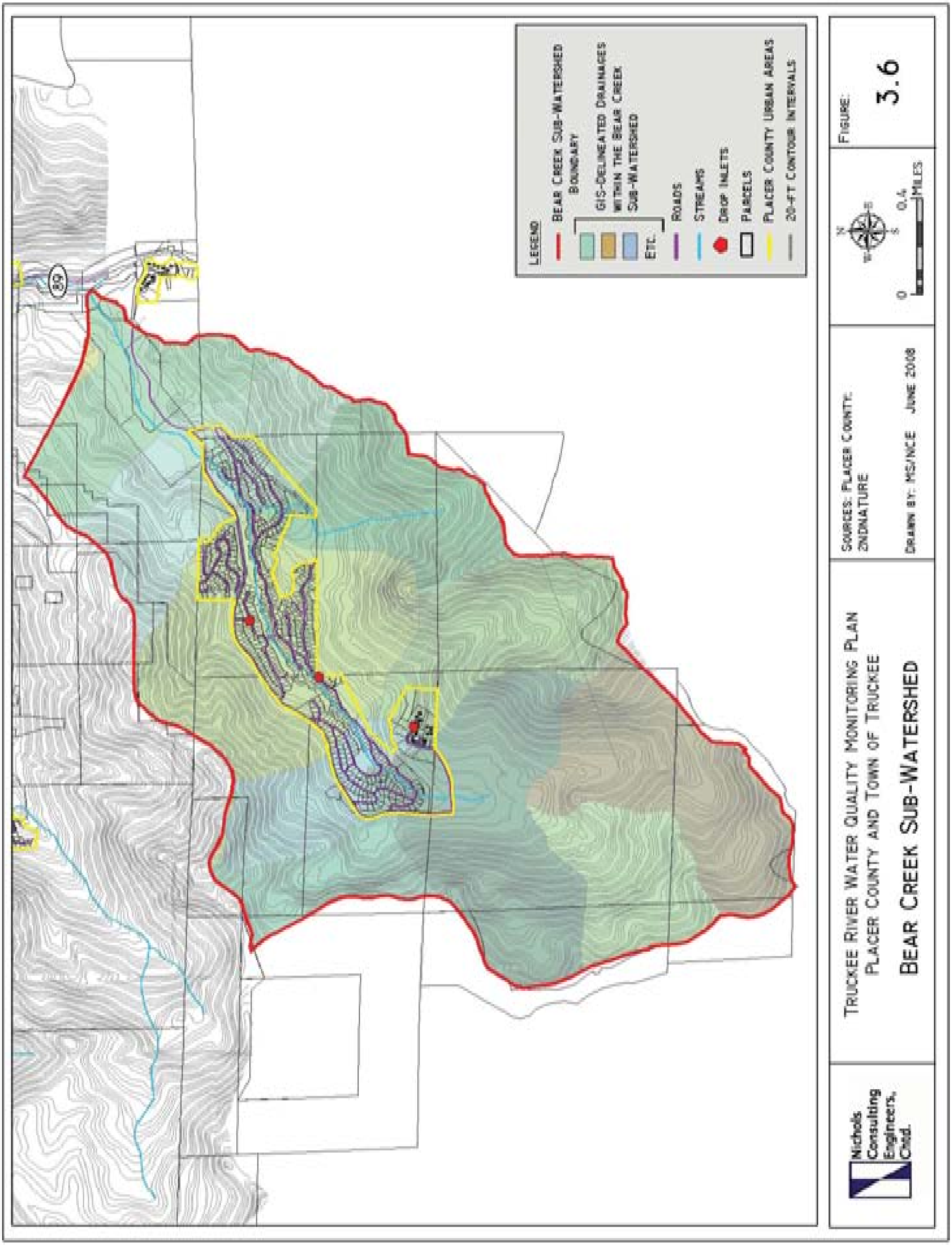
TRUCKEE TOWN CORRIDOR SUB-WATERSHED

SOURCES: PLACER COUNTY: NEVADA COUNTY: 2NDNATURE

DRAWN BY: MS/NCE JUNE 2008

0 1 MILES

FIGURE: 3.5


LEGEND
BEAR CREEK SUB-WATERSHED BOUNDARY
GIS-DELINEATED DRAINAGES WITHIN THE BEAR CREEK SUB-WATERSHED
ETC.
ROADS
STREAMS
DROP INLETS
PARCELS
PLACER COUNTY URBAN AREAS
20-FT CONTOUR INTERVALS
89
N
0
0.4
MILES
Nichols Consulting Engineers, Chtd.
TRUCKEE RIVER WATER QUALITY MONITORING PLAN
PLACER COUNTY AND TOWN OF TRUCKEE
BEAR CREEK SUB-WATERSHED
SOURCES: PLACER COUNTY; 2NDNATURE
DRAWN BY: MS/NCE
JUNE 2008
FIGURE:
3.6

- Upland natural surface runoff joins with runoff from the ski resort and discharges to Bear Creek at the upslope end of the residential development.

- Runoff generated in the residential area is primarily conveyed to Bear Creek via natural drainage channels, road shoulders, and roadside ditches.

Existing infrastructure includes:

- Concrete curb and gutter
- Storm drain pipes (RCP and CMP)
- Roadside ditches
- Drop inlets
- Catch basins
- CMP culverts
- Detention basins
- French drains

Other notes:

- A dam along Bear Creek near the junction of Bear Creek Drive and Park Drive creates a small pond for recreational use. The outflow from the pond again becomes the main channel of Bear Creek.
- There is little to no flow attenuation and water quality improvements are very minimal.
- Given the scale of the figure provided by Placer County that shows existing storm drain features, it was difficult to determine whether or not the features are accurately mapped.

3.3.1.5 Trout Creek Sub-watershed

Jurisdiction: Town of Truckee (Figure 3.7)
Trout Creek runs through residential development, two golf courses, under Interstate 80, and through a portion of the town of Truckee where it is diverted through a man-made concrete flume prior to its confluence with the Truckee River. Residential development and recreational facilities dominate the land use in the Trout Creek sub-watershed. Drainage throughout the sub-watershed primarily occurs through a system of unconnected drainage ditches and culverts that all discharge into Trout Creek.

Existing infrastructure includes:

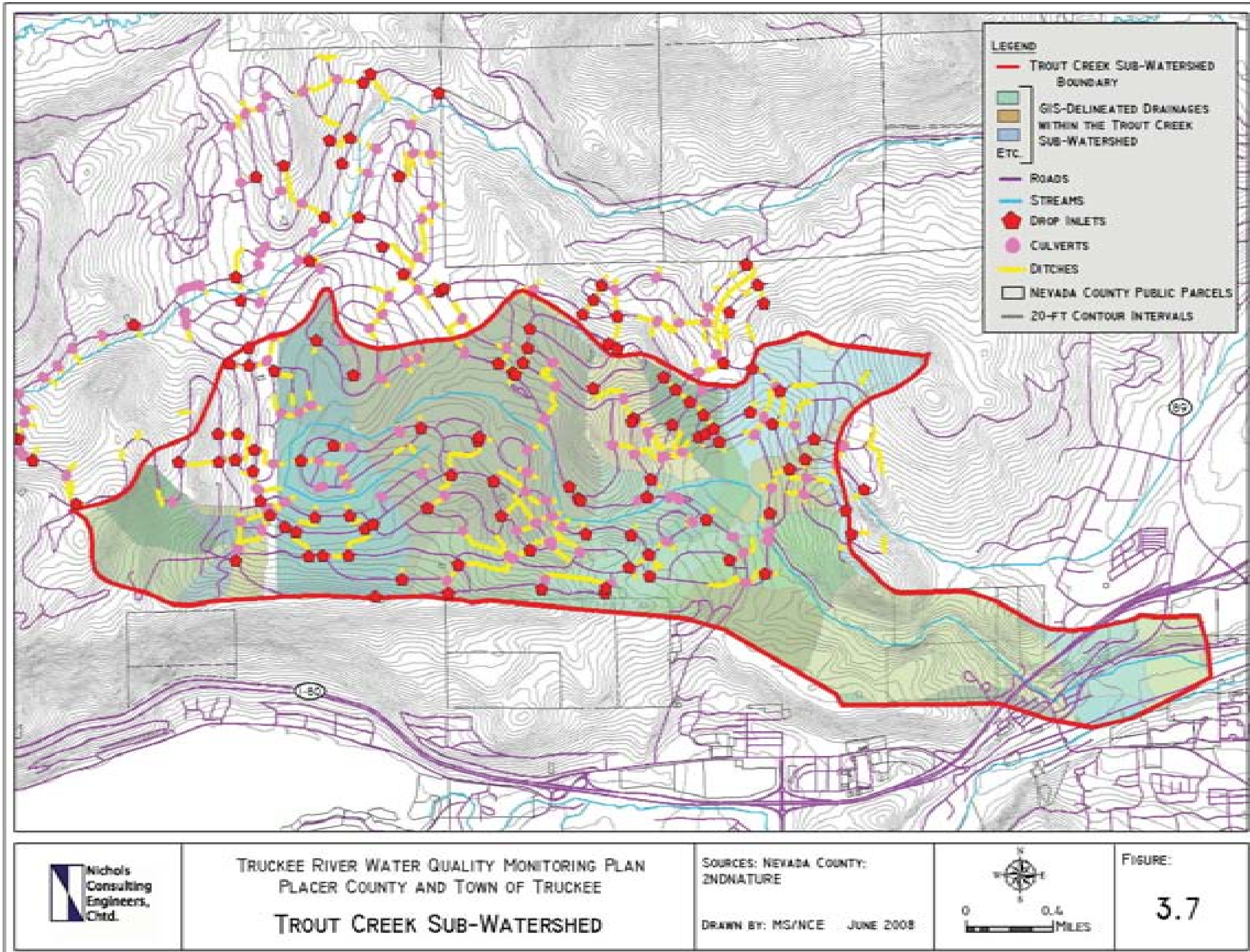
- Concrete curb and gutter
- Storm drain pipes (RCP and CMP)
- Roadside ditches
- Earthen ditches
- Drop inlets
- Catch basins
- CMP culverts

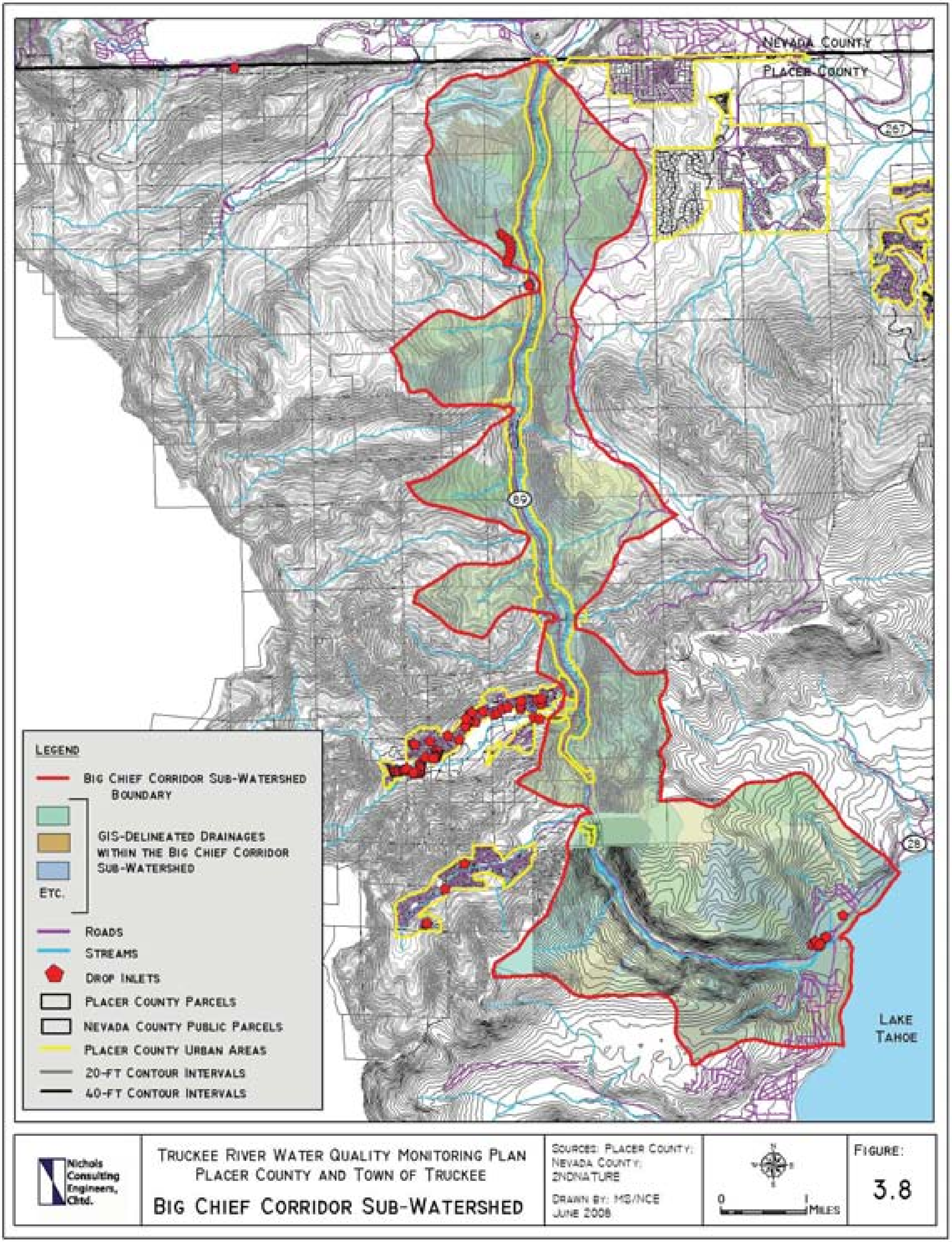
Other notes:

- There is little to no flow attenuation and water quality improvements are minimal.
- Existing mapping of drop inlets, culverts, and ditches from the Town of Truckee is extensive and accurate.

3.3.1.6 Big Chief Corridor Sub-watershed

Jurisdiction: Placer County (Figure 3.8)
The main stem of the Truckee River parallels Highway 89 for the entirety of the Big Chief Corridor sub-watershed. Surface runoff from the highway flows directly into the river through regular breaks in the curb. In addition, a number of intermittent streams and scattered residential parcels discharge directly into the river through defined channels or as overland flows. The numerous discharge points into the river result in a general lack of flow concentration from all runoff sources.


LEGEND
TROUT CREEK SUB-WATERSHED BOUNDARY
GIS-DELINEATED DRAINAGES WITHIN THE TROUT CREEK SUB-WATERSHED
ETC.
ROADS
STREAMS
DROP INLETS
CULVERTS
DITCHES
NEVADA COUNTY PUBLIC PARCELS
20-FT CONTOUR INTERVALS
89
I-80
Nichols Consulting Engineers, Chtd.
TRUCKEE RIVER WATER QUALITY MONITORING PLAN
PLACER COUNTY AND TOWN OF TRUCKEE
TROUT CREEK SUB-WATERSHED
SOURCES: NEVADA COUNTY; 2NDNATURE
DRAWN BY: MS/NCE JUNE 2008
0 0.4 MILES
FIGURE:
3.7



Nevada County
Placer County
267
89
28
Lake Tahoe
Legend
Big Chief Corridor Sub-Watershed Boundary
GIS-Delineated Drainages within the Big Chief Corridor Sub-Watershed
Etc.
Roads
Streams
Drop Inlets
Placer County Parcels
Nevada County Public Parcels
Placer County Urban Areas
20-ft Contour Intervals
40-ft Contour Intervals
Nichols Consulting Engineers, Chtd.
Truckee River Water Quality Monitoring Plan
Placer County and Town of Truckee
Big Chief Corridor Sub-Watershed
Sources: Placer County; Nevada County; 2NDNATURE
Drawn By: MB/NCE
June 2008
0
1
Miles
Figure:
3.8

Existing infrastructure includes:
- Asphalt Concrete (AC) curb and gutter with curb cuts
- Roadside ditches
- CMP culverts

Other notes:
- Bear Creek and Squaw Creek are highly developed sub-watersheds that discharge into the Truckee River at the upper end of the Big Chief Corridor sub-watershed.
- There is no flow attenuation and water quality improvements are minimal.

3.3.1.7 Donner Creek/Cold Creek Sub-watershed

Jurisdiction: Placer County and Town of Truckee (Figure 3.9)
The Donner Creek/Cold Creek sub-watershed can be considered two separate sub-watersheds which converge immediately before discharging into the Truckee River: The Donner Creek portion includes the area surrounding Donner Creek and Donner Lake in the north half of the sub-watershed, and the Cold Creek portion includes all of the areas surrounding Cold Creek in the southern portion of the sub-watershed. The area surrounding Cold Creek is undeveloped, with the exception of the railroad, several abandoned mines, and dirt roads. Upland runoff generally sheet flows into one of many tributaries of Cold Creek, which joins with Donner Creek just before its convergence with the Truckee River. Residential development in the north half of the sub-watershed surrounds Donner Lake, and all stormwater runoff from urban areas flows into Donner Lake or Donner Creek prior to its confluence with the Truckee River. Most residential areas within the sub-watershed have a network of culverts and earthen ditches; however, some areas do not have any stormwater improvements.

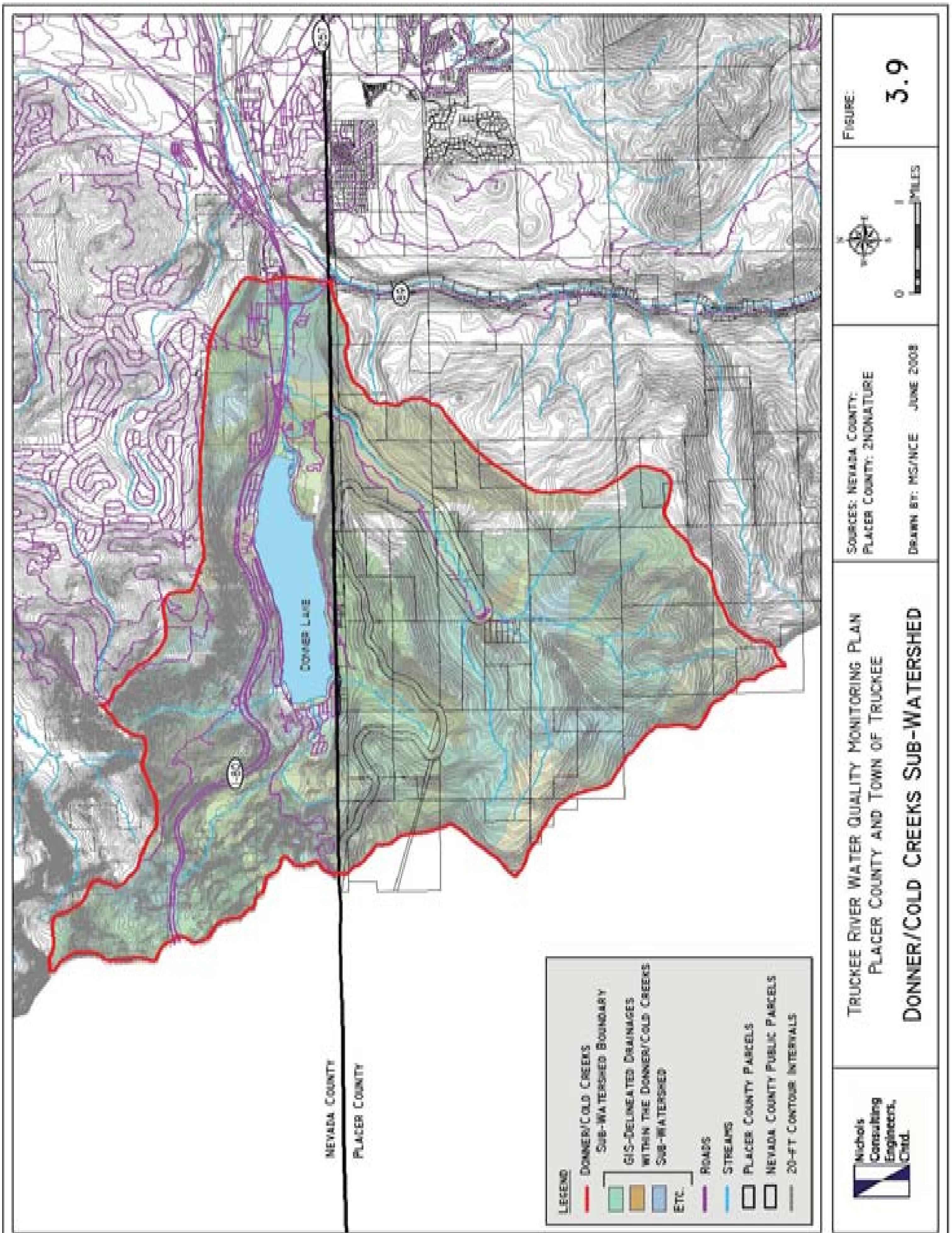
- On the north side of Donner Lake, along Donner Pass Road, a ditch on the north side of the road collects water and discharges it directly to the lake through numerous culvert outfalls.

- There is one new development surrounding Michael's Way in which AC curb and gutter and drop inlets have been installed. Runoff is captured and directed to the ditch along Donner Pass Road, where it is then discharged to the lake.

- The residential neighborhood accessed by Oriole Lane and Robin Lane consists of unpaved dirt roads, and therefore does not have any existing stormwater infrastructure. The residential neighborhood accessed by Eddy Avenue and James Avenue consists of a single-lane asphalt road, and does not have any existing stormwater infrastructure. Overland flows from these areas travel downhill to the ditch along Donner Pass Road, and are then discharged to the lake.

- The communities on the west and south sides of Donner Lake have a network of earthen ditches and culverts which transport runoff directly into the lake, or into nearby tributaries which flow to the lake.

Existing infrastructure includes:
- CMP culverts
- Earthen ditches
- Drop inlets
- AC curb and gutter


Nevada County
Placer County
Donner Lake
Legend
Donner/Cold Creeks Sub-Watershed Boundary
GIS-Delineated Drainages within the Donner/Cold Creeks Sub-Watershed
Etc.
Roads
Streams
Placer County Parcels
Nevada County Public Parcels
20-ft Contour Intervals
0
1
Miles
Nichols Consulting Engineers, Chtd.
Truckee River Water Quality Monitoring Plan
Placer County and Town of Truckee
Donner/Cold Creeks Sub-Watershed
Sources: Nevada County: Placer County: 2NDNATURE
Drawn by: MS/NCE June 2008
Figure:
3.9

Other notes:

- Interstate 80 runs through the sub-watershed north of Donner Lake, and likely contributes stormwater runoff to Donner Lake and Donner Creek, and eventually to the Truckee River. Donner Creek flows into Donner Lake at the west end and out of Donner Lake at the east end of the lake.

3.3.2 Summary of Future Stormwater Mapping Tasks

Tables 3.2 and 3.3 below present a summary of the future mapping tasks to be completed by Placer County and the Town of Truckee related to storm sewer system mapping, stormwater routing investigations or outfall inventories. The table also includes information about when the task is to be completed, who is responsible and the purpose of the task. It is recommended that the County and Town coordinate future efforts to develop consistent definitions, nomenclature, and processes for identifying and mapping stormwater infrastructure.

<table>
<tr><th>Jurisdiction</th><th>Storm Water Management Program Document</th><th>Tasks and Deliverables^</th><th>Schedule of Tasks and Deliverables*</th><th>Responsible Department</th><th>Purpose of Deliverables/ Products</th></tr>
<tr><td rowspan="4">Placer County</td><td>"Develop, if not already completed, a storm sewer system map, showing the location of all outfalls and the names and locations of all waters of the U.S. that receive discharges from those outfalls" (p45)</td><td>Gather outfall information and incorporate into a GIS database to address sec. D.2.c.2 (p46). Complete development of a database and base maps. Produce a map of the outfall locations.</td><td>By Program Year 3</td><td>Public Works and Facility Services</td><td>Identifies location of all outfalls or inputs to receiving water bodies and allows jurisdiction to map contributing drainage areas and land uses affiliated with each outfall. Useful in monitoring inputs to receiving water bodies and assessing or tracking the implementation of Storm Water Management Program activities.</td></tr>
<tr><td></td><td>Report newly constructed outfalls and their receiving waters in the annual report (p46)</td><td>Ongoing after Year 3 (after mapping is completed)</td><td>Public Works and Facility Services</td><td>Ensures mapping is current.</td></tr>
<tr><td>Board Order**</td><td>Tasks and Deliverables^</td><td>Schedule of Tasks and Deliverables*</td><td>Responsible Department</td><td>Purpose of Deliverables/ Products</td></tr>
<tr><td>"The plan must include a detailed description of the storm water drainage system…" (p3)</td><td></td><td>July 1, 2008</td><td>Public Works</td><td>Inform the development of a comprehensive water quality monitoring plan for the Truckee River Hydrologic Unit.</td></tr>
</table>

* Program Years are based on fiscal year from July 1 to June 30. Year 1 = March 2008 (SWMP approval) – June 3, 2008; Year 2 = 2008/2009; Year 3 = 2009/2010; Year 4 = 2010/2011; Year 5 = 2011/2012
^ Tasks and deliverables include those tasks affiliated with references to storm sewer system mapping, stormwater routing investigations or outfall inventories in the NPDES General Permit, Board Orders or Stormwater Management Program Documents
****** Order to submit Technical Report in accordance with Section 13267 of the California Water Code – Placer County (13267 Letter)

Table 3.2. Summary of stormwater routing mapping tasks to be completed by Placer County.

Jurisdiction	Storm Water Management Program Document	Tasks and Deliverables^	Schedule of Tasks and Deliverables*	Responsible Department	Purpose of Deliverables/ Products
Town of Truckee	*"Develop, if not already completed, a storm sewer system map, showing the location of all outfalls and the names and locations of all waters of the U.S. that receive discharges from those outfalls"* (p26)	Gather information regarding locations of storm drain outfalls and their receiving waters. Complete development of a database and base maps. Produce a map of the outfall locations. (p27)	Year 2	Engineering Division (with assistance from the Dept. of Public Works and Planning Division)	Identifies location of all outfalls or inputs to receiving water bodies and allows jurisdiction to map contributing drainage areas and land uses affiliated with each outfall. Useful in monitoring inputs to receiving water bodies and assessing or tracking the implementation of Storm Water Management Program activities.
		"Complete the mapping of the storm sewer system map and the receiving waters in the program area." (p27)	Year 3	Engineering Division (with assistance from the Dept. of Public Works and Planning Division)	Same as above.
		Report newly constructed outfalls and their receiving waters in the annual reports and add to map. (p27)	Years 3-5	Engineering Division (with assistance from the Dept. of Public Works and Planning Division)	Ensures mapping is current.
	Board Order**	**Tasks and Deliverables^**	**Schedule of Tasks and Deliverables***	**Responsible Department**	**Purpose of Deliverables/ Products**
	"The plan must include a detailed description of the storm water drainage system…" (p3)		July 1, 2008	Engineering Division	Inform the development of a comprehensive water quality monitoring plan for the Truckee River Hydrologic Unit.

* Program Years are based on fiscal year from July 1 to June 30. Year 1 = March 2008 (SWMP approval) - June 30, 2008; Year 2 = 2008/2009; Year 3 = 2009/2010; Year 4 = 2010/2011; Year 5 = 2011/2012;
^ Tasks and deliverables include those tasks affiliated with references to storm sewer system mapping, stormwater routing investigations or outfall inventories in the NPDES General Permit, Board Orders or Stormwater Management Program Documents
****** Order to submit Technical Report in accordance with Section 13267 of the California Water Code – Town of Truckee (13267 Letter)

Table 3.3. Summary of stormwater routing mapping tasks to be completed by the Town of Truckee.

3.4 Section 3.0 References

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4.0 DEVELOPMENT OF TECHNICAL APPROACH

4.0 DEVELOPMENT OF TECHNICAL APPROACH

Section 4.0 overviews the technical approach utilized to meet the goals of the Truckee River Water Quality Monitoring Plan (Section 2.0). The technical approach defines the spatial scale over which assessments will take place, evaluates and summarizes the different types of assessment to be utilized, and prioritizes the pollutants of concerns based on assessment type and contributing land uses to the point where observations, samples and/or measurements will be conducted.

4.1 Key Components

- The TRWQMP must be economically feasible and logistically manageable. Since water quality conditions cannot be assessed at all locations and at all times, observations and assessments are prioritized using an interdisciplinary process-based rationale.

- There are two main approaches to aquatic resource assessments—targeted and random observations (USEPA 2002). The TRWQMP strategy follows a targeted sampling approach and prioritizes observations spatially and temporally. This prioritization focuses resources on the key locations and temporal conditions to produce a dataset that will best address the goals of the TRWQMP (Section 2.0).
    - The TRWQMP relies upon 5 different assessment types that vary in spatial and temporal scale of application, cost, and statistical accuracy. The integration of the observations and results generated from each of the 5 assessment types will be used to evaluate the performance of the County and Town Stormwater Management Programs (SWMPs).
    - Observations are spatially prioritized around the potential source areas (Section 3.2) where the greatest disturbances due to human activities occur. These locations are where SWMP actions are expected to be more prevalent.
    - The priority time of observation for each assessment type is different. Timing of assessments is dictated by sampling logistics and the conditions during which the deviations between high disturbance and low disturbance sites are expected to be the greatest.

- The integration of the 5 assessment types facilitates an evaluation of both 1) potential sources and 2) observed downstream impacts of priority pollutants. These assessment types will be employed across a range of spatial scales. Community level assessments evaluate the stormwater quality from localized areas of concern, such as Northstar-at-Tahoe, Squaw Village and the Town of Truckee. Tributary level assessments track and compare the relative water quality at the downstream extent of tributaries to the Truckee River within the project area during times and hydrologic conditions when the greatest deviation between high disturbance and low disturbance locations is expected. Assessments along the main stem of the Truckee River track the condition and water quality in the receiving waters of the Truckee River.

- The interpretation of the data and observations from high disturbance areas will greatly benefit from the evaluation and identification of the water quality conditions of the low disturbance areas. Over time these comparisons will provide the context in which to evaluate the relative water quality impacts of the high disturbance areas on surface water resources. Observations at low disturbance locations will also provide a realistic baseline for potentially approachable water quality conditions if the SWMPs are implemented successfully.

- The quality of surface water resources possesses an inherent natural variability due to seasonal and annual fluctuations in hydrology and climate. Variable anthropogenic impacts (e.g. seasonal road abrasive applications or temporary construction sites) also influence observed water quality concentrations and loads of the pollutants of concern. Foresight has been used in the sampling design to increase confidence that observed differences in concentrations and loads across sites and across samples are due to differences in upstream conditions and minimize differences due to hydrology, season, climate or other natural variables. However, the most effective approach to constrain the natural variability in water quality data is the development of a consistent long-term dataset.

- This document provides a recommended strategy for implementation of a surface water quality monitoring plan for the middle Truckee River watershed by Placer County and the Town of Truckee. The plan has been developed based on current (2008) levels of development, regulatory requirements, and existing monitoring. Some GIS land use data dating back to 2001 was also used to prioritize areas for assessment. There is an understanding that land use conditions, pollutant sources, locations of development, and other factors will certainly change over the next several years within the project area. As a result, the monitoring plan, including sampling activities, will need to be evaluated annually to ensure their relevancy. The structure of the TRWQMP allows flexibility for future modifications including sampling locations, frequency of observations, specific pollutants included in assessments and assessment types. Future augmentations should follow the data collection strategies for each of the selected assessment types as closely as possible to ensure the eventual long-term dataset is comparable and can lend to an evaluation of water quality conditions.

- The ability to definitively evaluate the effectiveness of the County and Town SWMPs is highly dependent upon the consistent and continued implementation of these efforts over many consecutive years.

4.2 Performance Assessment

A main objective of the TRWQMP is to monitor the condition of the surface water resources in the middle Truckee River, particularly as it relates to the impacts of human development. Placer County and the Town of Truckee's respective SWMP documents contain actions including control measures, performance standards and best management practices (BMPs) that, if implemented as presented, are assumed to reduce the amount of pollutants in stormwater discharged to surface water resources in the project area. The TRWQMP helps generate a dataset with which to evaluate the performance of the SWMP actions in controlling and reducing pollutants in stormwater and, in turn, the impact of stormwater on surface water resources. This evaluation is termed **performance assessment**.

A well implemented SWMP may result in an improvement in the conditions of surface water resources over time. Compliance with the SWMP is critical to reducing pollutants in stormwater, but not all of the actions implemented as part of the SWMP can be assessed through the evaluation or sampling of surface water resources. Conducting surveys, performing inspections and tracking public outreach activities are required elements of the SWMPs and should be evaluated through **compliance assessment** (See Section 2.1). Compliance assessment is outside the scope of the TRWQMP.

The results of the TRWQMP performance assessment should be evaluated simultaneously with the compliance assessment results prior to any SWMP plan modifications. Should the results of the performance assessment observations suggest impairment to water quality downstream of the high disturbance locations, it would be premature to modify the SWMPs until the compliance assessment indicates that the existing SWMP actions have been consistently implemented as designed.

4.3 Spatial Areas of Assessment

Figure 2.1 (Section 2.1) summarizes the three primary spatial areas which are evaluated as part of the performance assessment under the TRWQMP: community level, tributary level, and the main stem of the Truckee River. Community assessments focus on areas of development, activities, or land uses that are known or suspected to be priority sources of pollutants of concern. Tributary assessments are conducted at sub-watershed outlets and provide a measure of the integrated water quality signals from both developed and undeveloped land within the respective tributary. Main stem assessments focus on the downstream cumulative effects of water quality impacts in the Truckee River related to tributaries and community source areas. Below we detail the primary objectives for each spatial area and the value the data from each is expected to provide.

Community assessments focus on evaluating the immediate downstream impacts of selected existing dense, urban development (i.e. Squaw Village or Downtown Truckee), or locations where large scale construction projects are planned and/or ongoing (i.e. Martis Camp, Northstar-at-Tahoe). Distinct locations of assessment have been selected (Sections 5.1-5.2) to isolate and evaluate the quality of stormwater generated within, or impacted by, the respective community. Ideally, community level evaluations are to be conducted at distinct confluence points where stormwater discharges to the local tributary. Community impacts can also be determined using upstream and downstream boundary evaluations of the local tributary. However, differences in observations between upstream/downstream sites must be interpreted cautiously because it can be very difficult to separate natural differences in upstream/downstream sites from the effects of development.

The TRWQMP community assessments are conducted in a consistent manner that allows direct comparisons of the water quality across communities. Discrete water quality sampling downstream of communities prioritizes sample collection during runoff events when a large portion of the annual stormwater volumes and pollutant loads are transported. These are the times when areas with elevated pollutant sources are expected to show significantly degraded water quality relative to areas where pollutant sources are minimal or have been adequately controlled. This temporal prioritization focuses on the “worst case scenario” in locations downstream of development and land surface disturbance. The community level assessments utilize primarily one assessment type (discrete water quality sampling) and can address any and/or all of the pollutants of concern (Section 4.5) at various temporal scales.

The TRWQMP outlines minimum assessment needs for existing and/or future developed areas to allow for these direct comparisons. However, each community, developer or landowner may be under additional regulatory requirements to provide more detailed water quality data than outlined in the TRWQMP.

Tributary assessments focus on comparing and tracking the relative water quality and stream condition at the downstream extent of the high disturbance sub-watersheds indicated in Figure 3.2 (Section 3.2). The high disturbance sub-watersheds contain a higher density of development and conditions known to impair downstream water quality. The tributary assessments will track the relative water quality condition of high disturbance sub-watersheds and compare them to similar stations in one or two low disturbance sub-watersheds. Tributary assessments track and compare the cumulative effects of the activities, disturbances and land uses within select sub-watersheds that drain to the Truckee River. The results of the tributary assessments allow for the future prioritization of monitoring and SWMP activities in sub-watersheds that may be contributing a disproportionate amount of pollutants to the Truckee River. The TRWQMP tributary assessments include a number of the assessment types and will focus on the high priority pollutants of concern, sediment and nutrients.

Truckee River main stem assessment measures the overall condition of the middle Truckee River over time. The Truckee River is the primary receiving water, and its condition integrates all of the ongoing human activities within the project area. The Truckee River assessment focuses on the priority pollutant—sediment. The Truckee River main stem assessments track sediment loading at specific locations as well as the distribution of fine sediment deposition throughout the year to the extent possible based on available resources. Evaluation of additional pollutants of concern may also be considered.

4.4 Performance Assessment Types

The TRWQMP includes the implementation of 5 different assessment types that vary in cost, level of expertise necessary to obtain data, relative statistical accuracy and precision. The results of each assessment type provide a different spatial evaluation of the surface water resource condition within the project area. Collectively, the results from the various assessments address the goals and objectives of the TRWQMP (Section 2.0).

This section defines and identifies the objectives, and summarizes the advantages and disadvantages of each assessment type. Based on their relative costs and benefits, the assessment types are to be employed with different frequencies and at different locations. Table 4.1 presents a summary of the assessment types based on general timing and spatial area of assessment. The recommended spatial application of these assessment types is outlined in Section 5.0. The protocols necessary to complete each of these assessments are detailed in Section 6.0.

		Spatial Area of Assessment		
		Community Level	*Tributary Level*	*Main Stem of Truckee River*
Purpose		Assessment of water quality condition downstream of high disturbance communities (e.g. Northstar-at-Tahoe)	Assessment of stream and water quality condition at the outlets of select sub-watersheds	Long-term status and trend assessment of Truckee River water quality condition
Assessment Type	**Time of Assessment**	**Spatial Area of Assessment**		
		Community Level	*Tributary Level*	*Main Stem of Truckee River*
GIS Source Area Prioritization	Approximately every 5 years, depending on current GIS data availability	Conducted for entire project area		
Rapid Assessment Methodologies (RAM)	Annually, during low flow conditions		Conducted along downstream reaches of sub-watersheds near confluence with Truckee River	Conducted along reaches within project area
Bioassessments	Bi-annually, during low flow conditions		Locations upstream and downstream within areas of assumed impact	
Discrete Water Quality Measurements	During runoff events	Collected at points of stormwater discharge from high disturbance catchment	Collected at tributary and Truckee River confluence points	
Near-continuous Water Quality Measurements	Prioritize sample collection during storm event conditions, but include low flow conditions.		Conducted downstream of high disturbance areas along tributaries (autosamplers + turbidity)	Maintained at 2-3 locations along main stem within the project area (turbidity)

Table 4.1. Performance assessment types employed by the TRWQMP are compared by the spatial area evaluated and the general timing when the observations are conducted.

4.4.1 GIS Sub-watershed Source Area Prioritization

A GIS sub-watershed source area analysis is a cost-effective means of determining the relative risk or potential for generating pollutants within each sub-watershed in the project area. The analysis uses existing GIS data to evaluate conditions such as density of impervious surfaces, ski run density, dirt road density, roadway and relative traffic density, legacy sites, and areas at risk of future development. The analysis can be further refined by evaluating the density of these activities in terms of hydrologic connectivity. As an example, those conditions which occur or exist within 1000 ft of a tributary or the Truckee River would be considered to have high connectivity, and therefore a greater likelihood to reach surface water resources. The assumption is that the risk of pollutants reaching the stream decreases with increasing distance from the riparian corridor. A GIS source area prioritization was conducted during the development of this TRWQMP in 2008 and the results are presented in Section 3.2.

The results of the GIS source area prioritization do not provide any information as to the actual performance of the SWMPs, but rather inform the prioritization and allocation of TRWQMP resources spatially within the project area based on the density of priority land uses.

Advantages:

- Cost-effective screening for land use activities and human disturbances known to contribute pollutants to stormwater and influence downstream water quality.
- Simple to recreate every 5 years and/or when new GIS data layers become available. (Many layers used in 2008 were developed in 2001.)
- Provides useful prioritization of potential source areas based on relative density of disturbance activities for entire project area.
- Displays results clearly and visually, allowing for simple communication to all levels of understanding.
- Analysis can be performed by anyone with expertise in GIS analysis, but does not require intimate knowledge of water quality sampling or stormwater monitoring.

Disadvantages:

- Prioritization not based on actual water quality characteristics of stormwater, tributaries or the Truckee River.
- Ranking may need to be subjectively adjusted based on additional sub-watershed characteristics not easily integrated into GIS methodology.

Relevance to SWMPs: Provides cost-effective means of prioritizing areas for SWMP actions and evaluations of SWMP effectiveness.

Frequency: Repeat every 5 years, as new GIS layers on land use become available, and major changes in land use occur.

Level of expertise necessary: GIS skills.

4.4.2 Rapid Assessment Methodologies

Rapid assessment methodologies are becoming increasingly popular in natural resource management. They are often applied to determine the overall effectiveness of large scale protection efforts and/or compare the relative condition of specific habitat types over a large resource area at a very low cost. Examples of rapid assessment techniques include California Rapid Assessment Methodology (Collins et al. 2007), Rosgen's Stream Bank Erosion Risk Surveys (Rosgen 1996), Department of Fish and Game Fish Habitat Quality Rapid Assessment (Harris 2005), and the NRCS Stream Visual Assessment (NRCS 1998). Rapid assessment techniques rely on simple and repeatable observations of site or habitat conditions. Rapid assessment protocols are designed to produce relatively-accurate, low-cost, quantitative spatial data that are consistent with, and comparable to, data from more rigorous evaluations. These evaluations are a cost-effective means of tracking changes in conditions of specific locations over time on a relative scale. The rapid assessment protocols allow for a much lower cost-per-data-point than typical water quality measurements. The low cost allows for data collection over a much greater spatial area and helps prioritize resource expenditures for other more rigorous assessment types.

Rapid assessments focus on a few characteristics that are assumed to indicate the relative degree of stream or habitat condition. Rapid assessments prioritize a lower cost and increased spatial scale over the statistical accuracy of each measurement, yet they still provide confidence in the determination of relative overall condition. Spatial and temporal repetition of the rapid assessment observations allow comparisons such as: site A is in worse condition than site B, or site A is in better condition this year relative to last year. The relative conditions must be defined by limiting observations on a few characteristics that are assumed to make one site's condition worse than another's. The condition is expressed as a ranking, each corresponding to a deterministic set of observations. The results of a rapid assessment of relative stream reach condition can be displayed spatially using GIS where, for example, poor condition is denoted in red, good condition is noted in green, and intermediate conditions follow orange to yellow gradations (see Section 6.3 for details).

The rapid assessment methodologies employed by the TRWQMP include annual observations within the stream channels themselves during low flow conditions. The priority pollutant of concern within the TRWQMP project area is fine sediment (< 2 mm in diameter; see Section 4.5 for details). Human activities within the project area have resulted in a disproportionate amount of fine sediment delivery to the surface water streams (LRWQCB 2006; LRWQCB 2008b). These chronic sources of fine sediment have likely resulted in a reduction in substrate grain size of the Truckee River and of certain highly developed tributaries. An annual rapid assessment of the Truckee River and key tributaries for the current substrate condition allows for a simple and continuous ranking of stream conditions with respect to fine sediment accumulation and distribution. The focus on fine sediment characteristics for the rapid assessment is supported by the findings of Herbst (2002) in the Squaw Creek Bioassessment. The spatial comparison of the evaluated reaches provides valuable information on the relative magnitude of fine sediment accumulation throughout selected reaches within the project area. A long-term record of rapid assessment results will facilitate a simple tracking of the condition of specific locations over time, providing information on the performance of the SWMPs to protect water quality with respect to sediment.

Annual rapid assessments for the TRWQMP are conducted during low flow conditions when the stream channel is accessible. Grain size observations and measurements used to determine substrate condition are comparable to those employed by the SWAMP bioassessment protocols (SWAMP 2007). The rapid assessment includes:

- Designation of specific stream intervals based on easily discernable landmarks and locations where shifts in substrate condition may occur,
- A continuous survey tape record to document the location of each observation location within the stream interval,
- Five equally-spaced simple transect observations of channel grain size every 15m. Transect observations are integrated over 150m reaches to determine % fines, % sand, % cobble embeddedness and D50 as utilized by SWAMP (2007).

The rapid assessment methodologies allow two trained field personnel to evaluate 2-3 accessible stream miles per day. Field observations are entered into a simple spreadsheet and integrated to calculate a score for each cross-section observation and the reach results are displayed spatially using GIS. Conditions observed from low disturbance reaches within the project area can be used to characterize the grain size distribution of the low disturbance areas. Following the initial implementation and standardization of the procedures for the TRWQMP, the majority of observations and measurements for the rapid assessment may be coordinated and conducted by trained stakeholders and volunteers and may not require hydrologic professionals for annual data collection efforts.

Advantages:

- Low cost; majority of assessments can be implemented by stakeholders and volunteer groups following initial implementation.
- Provides relatively accurate comparisons of river and tributary condition with respect to channel substrate over a large spatial area.
- Results are repeatable and directly comparable to bioassessment stream condition measurements.
- Facilitates annual observations and site visits to stream locations during ambient conditions, increasing the likelihood that problem locations are identified.
- Displays results spatially over assessment area:
    - Identifies and prioritizes problem locations (spatial comparison for any one year).
    - Simply communicates results to all levels of understanding.
    - Tracks specific stream reach and reach condition over time (evaluates performance of SWMPs to improve condition of certain locations).

Disadvantages:

- Absolute precision and accuracy of measurements are lower than other assessment types.
- Fine sediment may be under-represented in visual grain size observations.
- There are no unmodified streams in the project area to characterize the natural substrate conditions. Reach condition scores will be relative to Truckee River endpoint conditions below the Lake Tahoe outlet and the downstream conditions observed in low-impact tributaries.

Relevance to SWMPs: Annual stream condition observations are used to assign each stream reach evaluated as % sand and finer. The results are displayed spatially using color codes in GIS. Comparison of the rapid assessment results across sites provides information on the stream reaches of concern with respect to fine sediment storage and can be used to infer potential sources. Annual observations over time provide a record of the integrated effectiveness of upstream sediment control measures under the SWMPs in reducing the loading of fine sediment to the surface water streams.

Spatial scale of observations: Subset of priority stream reaches as resources allow (tributaries and main stem).

Frequency of observations: Annually during ambient, low flow conditions.

Level of expertise necessary:

Field observations: Some knowledge of stream hydrology and sediment transport. Volunteers and other can perform following one half day of training and review of protocols.
Data input/management: Knowledge of spreadsheet data management and standard QA/QC techniques.
Results: GIS skills.

4.4.3 Bioassessments

Bioassessments focus on characterizing the biological composition observed within a surface water resource. The primary assumption of this assessment type is that the assemblage of ecological communities in aquatic systems provides an overall measure of the health of that system. The absence of sensitive species that are known to have previously existed in the system suggests that the conditions have become intolerable due to a combination of water quality, habitat condition and other factors. Benthic invertebrate community evaluations have become popular bioassessments in fresh water streams, and a number have been conducted along the Truckee River and Squaw Creek within the project area. The Squaw Creek TMDL requires an ongoing bioassessment in the meadow reach of Squaw Creek beginning in 2009 (LRWQCB 2008).

While biological community assemblages can indicate a variety of pollution impacts on downstream waters, the most prevalent pollutant impairing benthic community integrity within the project area is the elevated loading of fine sediment. The benthic macroinvertebrate community composition in streams is sensitive to the effects of fine sediment transport and deposition because of the significant impacts that large amounts of fine sediment have on the habitat quality. The increase in fine sediment deposition in alpine streams, such as the Truckee River, significantly reduces the quality of coarse sediment habitat that the native biota utilize. The extended macroinvertebrate life cycles (> 1 year) allow these communities to reflect long-term water quality conditions, integrating the influence of changes in hydrologic and water quality conditions over all seasons.

A bioassessment study is developed by evaluating the biotic assemblage at a range of habitat conditions during ambient conditions. The assumption is that indicators of biological community health will be related to the relative level of site disturbance—from low to high disturbance. Bioassessments require initial testing to identify if certain biological community characteristics consistently correlate with physical and chemical metrics at the same site locations. A successful biotic metric will show a predictable dose-response to changes in habitat condition.

Within the Squaw Creek sub-watershed, Herbst (2002) conducted benthic community enumerations and monitored a number of physical and water quality site characteristics at 6 locations along the Squaw Creek tributary and at 16 reference tributaries, including Pole Creek, Juniper Creek, Cold Creek, Prosser Creek, North Prosser Creek, Bear Creek and Trout Creek. Sites within Martis Creek were also included as potential low disturbance sites, but biotic metrics suggested impaired conditions. Herbst (2002) found that substrate grain size has a strong influence on the benthic community assemblage and integrity within the project area. Herbst (2002) defined the following water quality targets for the sediment dose measurements: a distributed load of less than 400 tons/upstream mile/meter of channel width, a D50 particle size greater than 40mm, and a percent substrate designated as sand-sized or smaller less than 25%. Bioassessment evaluations within the TRWQMP project area focus on the relationship between substrate sediment conditions and benthic community assemblages. The Sediment TMDL for Squaw Creek, approved in 2007 by the US EPA, will conduct substrate sediment and benthic invertebrate community monitoring at the 3 low-gradient sites along the meadow reach of Squaw Creek every 2 years (beginning in 2009) during the summer months (LRWQCB 2008). This assessment will follow the sampling and analysis methods used by Herbst (2002). The rapid assessment efforts under the TRWQMP (Section 4.4.2) greatly expand the spatial scale of similar substrate sediment observations in the project area and therefore integrate well with the bioassessments.

Advantages:

- Benthic community assemblages represent the overall condition of the stream at the location of observations.

- Benthic invertebrate studies have already been successfully completed within Squaw Creek and the Truckee River. In addition, the SWAMP bioassessment protocols have been successfully applied to many fresh water streams within the Lahontan region of California and were developed, tested and approved by the USEPA. The SWAMP protocols will be used for all other bioassessment efforts under the TRWQMP, with the exception of Squaw Creek.
- Provides opportunities for volunteer involvement in sample collection

Disadvantages:

- Enumeration of benthic invertebrate samples is timely, requires expertise and can be costly.
- Numerous and complex datasets for each station are required. Benthic invertebrate sample data are extensive and require advanced data management skills to integrate and reduce field observations into benthic metrics.

Relevance to SWMPs:

- Directly measures ecological quality of the surface water streams, which reflects the integrated signal from all natural and anthropogenic impacts.
- Tracks the conditions necessary to support several beneficial uses stated under the Lahontan Basin Plan, which the SWMPs and WDR permits are intended to protect.

Spatial scale of observations: Site observations represent stream reaches within tributaries and/or the main stem of the Truckee River. Bioassessment efforts are required to continue in Squaw Creek tributary as a component of the Squaw Creek TMDL every two years. Bioassessments will also be implemented in other high disturbance sub-watersheds (see Section 5.0).

Frequency of observations: Bi-annually during low flow conditions due to need to access stream.

Level of expertise necessary:

Field observations: Knowledge and training in benthic invertebrate sampling techniques.
Sample analysis: Training in benthic invertebrate taxonomy and/or sample submission to laboratory.
Data input/management: Expertise in managing extensive datasets, integration and reduction of benthic sample data and standard QA/QC techniques.

4.4.4 Discrete Water Quality Measurements

Discrete water quality measurements include both the collection of discrete grab water samples for submission to an analytical laboratory and spot measurements of specific water quality parameters using hand-held probes. Discrete water samples, or grab samples, are submitted to an analytical laboratory for a variety of chemical analyses, including sediment, nutrient, hydrocarbon, pesticides and/or trace metal concentrations. Hand-held water quality probes can be used to measure ancillary water quality parameters such as dissolved oxygen, pH, temperature, conductivity and turbidity with reliable accuracy *in situ*. Discrete water quality measurements are conducted at a discrete location at a discrete time. Thus, discrete observations provide a snap-shot of the water quality where and when the measurements are taken.

The measurement of a water quality parameter at one location can vary dramatically on daily, seasonal and annual time scales. The difficulty in interpreting the relative water quality across stations and/or within stations across observations lies in the ability to identify what fraction of the differences in chemical parameters are due to compounded differences from natural variability, discharge, sampling error and analytical error, and what fraction is attributable to differences in pollutant loading to the point of measure. This is referred to as the “signal-to-noise ratio”, where confidence in the ability to measure the signal of interest (influence of upstream land uses) must well exceed the inherent noise across each measurement.

The interpretation of the discrete water quality measurement results must include an understanding and consideration of hydrologic conditions, seasonal pollutant source differences, climate, location on the hydrograph, time of day, and other sources of natural inherent variability in the water quality parameter of interest. For example, there is significant daily variability in the surface water temperature of a stream during summer. If discrete observations are not controlled for time of day, two temperature measurements within the same stream on the same day could yield very different results. The difficultly in separating the natural variability from anthropogenic signals increases with parameters such as pH, dissolved oxygen, nutrients and other constituents that are influenced by both physical and biogeochemical processes. The value of discrete water quality measurement is significantly increased if the inherent signal from natural variability in water quality parameters is minimized by the data collection strategy, thereby increasing the confidence that differences in water quality observed across stations and/or over time are due to actual changes in pollutant inputs and not other natural and/or sampling variations.

Discrete water quality measurements are very common in applied water quality monitoring efforts, commonly termed grab samples. However, significant costs are often incurred to obtain concentrations for multiple chemical constituents from each sample that provide little additional value towards the goal of the monitoring efforts. The cost of laboratory analyses per water sample can range from $40 to over $800 depending upon the number and analytical complexity of the constituents measured. The purpose of any water quality sample collected for the TRWQMP is to provide data that informs the performance of the respective SWMPs upstream of the location of sample collection. Thus, samples submitted for analyses must be limited to the pollutants that may be potentially elevated given the contributing catchment land use activities (see Section 4.5 for more details).

The TRWQMP implements strategies to reduce costs and increase the direct comparability of discrete water samples across stations and over time. The locations where we expect a high intensity of SWMP activities correspond to the high disturbance sub-watersheds identified in Section 3.2. Discrete water quality measurements are targeted at spatial locations that best capture the water quality impacts within these high disturbance sub-watersheds both at the community and tributary scale. The discrete water quality measurements are compared to the water quality objectives documented in the Lahontan Basin Plan. Discrete water quality measurements should also include similar observations at low disturbance stations with similar geologic and topographic characteristics. Comparisons with data from low disturbance stations can place the water quality observed at the high disturbance stations into a regional context and allow for an objective determination of what is the potentially “achievable” water quality within the project areas.

Temporally, the most informative discrete water quality observations occur when the water quality signal from human impacts is expected to be the greatest. The performance of the

SWMPs is evaluated by the ability of the SWMP actions to reduce the water quality impact from the areas assumed to pose the greatest risk to downstream surface waters. The water quality signal during large storm events, especially on the rising limb of the hydrograph (Bertand-Krajewski et al, 1998; Stubblefield et al 2006) provides the “worst case scenario” of the water quality at the selected stations. These are the times when the water quality downstream of high disturbance locations is expected to deviate the most from low disturbance locations (i.e. when the signal of interest is likely to well exceed the noise). Thus, the majority of discrete water quality measurements will be targeted during storm runoff events on the rising limb of the hydrograph.

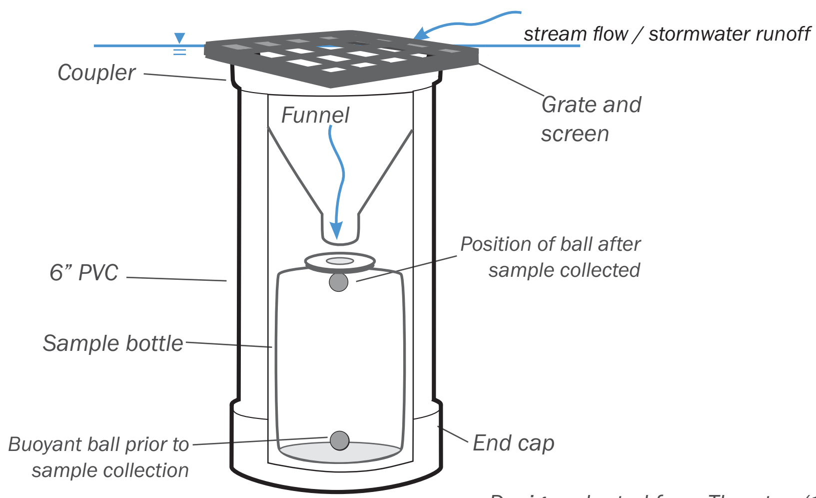
The majority of discrete water samples for laboratory analyses are collected under the TRWQMP using low-cost passive sampling devices to constrain the hydrologic variability of grab sampling data. Depending upon the application, site constraints and sample volume needs, passive sampling devices can either be fabricated using low-cost materials or a Nalgene Storm Water Sampler (1L capacity) can purchased from an environmental sampling supplier (see Figure 4.1).

For **community** discrete water sampling, passive sampling devices will be installed at the outlet of stormwater culverts and used to collect first flush volumes from a targeted community using techniques similar to those successfully employed in the Lake Tahoe Basin by 2NDNATURE (2006). The placement of the passive sampler in an ephemeral drainage allows the consistent collection of first flush samples during runoff events at each station, producing directly comparable water quality data across sites. The passive sampler preserves the discrete sample until field personnel can arrive on site (Figure 4.1). Passive samplers are extremely low cost to either purchase or build, and to install.

Passive samplers are also used to sample **tributary** water quality using discrete techniques. Three passive samplers are each installed and remain at the stream stage corresponding with 3 distinct targeted discharges of interest within the tributary to collect and preserve a water sample once the top of the device becomes inundated. The passive samplers collect water samples at the top of the water column once the targeted discharge is achieved. Passive sampling devices collect samples on the rising limb of the storm hydrograph, further constraining hydrologic variability across sites and over time. This sampling technique differs from the standard depth-integrated manual sampling methods used to obtain a “representative” sample of the stream chemical concentration at a distinct time (USGS 2006). While these manual depth-integrated techniques may provide a more “representative” sample of the stream at that specific time, it is virtually impossible to repeat manual sampling of stream chemistry at the same discharge on the rising limb of subsequent storm events at a specific location. The benefit of constraining both discharge and the sample collection on the rising limb of the hydrograph is the great improvement in the ability to compare stream chemistry results at one location over time (Bertand-Krajewski et al. 1998; Stubblefield et al. 2006). The constraint of hydrology for stream tributary sampling reduces the hydrologic noise inherent in the data and significantly increases confidence that the differences in sample concentrations at the same discharge at the same site over time are due to differences in pollutant supply to the location of interest.

At the time of station installation, the selection of the targeted discharge conditions should be conducted. The intent of the tributary passive samplers is to collect water samples during elevated flow conditions when pollutant loading is also expected to be elevated. Ideally, each

Fabricated Passive Sampler

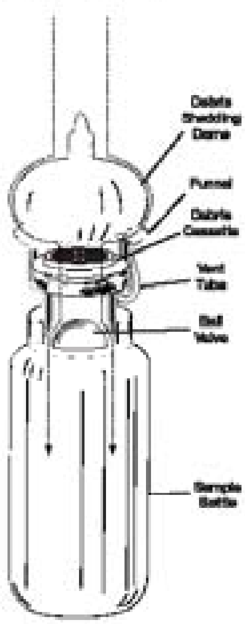


Design adapted from Thurston (1999)

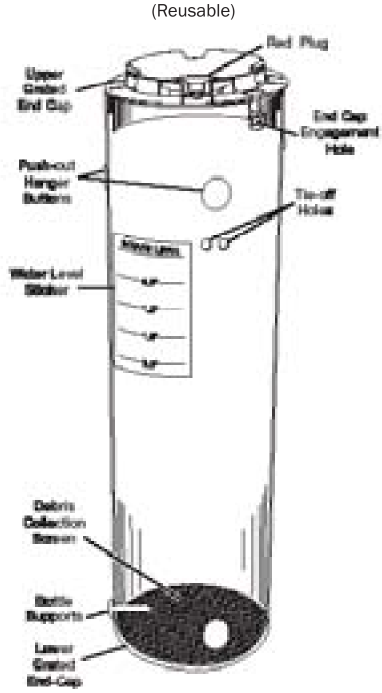
- *Sampler can be (1) buried in pervious flowpath to collect sample at grade, (2) hung in a stormwater drain to collect sample initial storm runoff volume, or (3) secured to vertical sign post in stream channel to collect targeted discharge events.*
- *Sample specifications can vary depending upon necessary sample volume, ranging from 1L-4L. Both HDPE or glass amber bottles can be used depending upon sample needs.*
- *Sample bottle equipped with ping pong ball and lid with hole in center (septa lid).*
- *Sample collected when water surface exceeds elevation of top of sampler. Sample flows over grate, through funnel and into bottle. As bottle fills with water during sampling event, ping pong ball floats to top and plugs hole in lid, sealing sample until collected by field personnel.*
- *Housing constructed using 6” PVC with end cap glued to PVC. Square top fitted to coupler and siliconed. Coupler glued to PVC.*
- *Funnel fitted to square top and siliconed in place under rubber flap. Mesh screen and grate placed at opening to minimize debris.*

Nalgene Storm Water Sampler

Storm Water Sampler
NALGENE Cat. Nos. 1100-1000
and 1120-1000
(Single Use Disposable)



Storm Water Mounting Kit
NALGENE Cat. Nos. 1160-1000
(Reusable)



- *Available for purchase from Nalgene authorized distributors or online at www.stormwatersampler.com.*
- *Samplers only compatible with 1L sample bottles, either HDPE or amber glass*
- *Reusable mounting kit can be installed in streams, ditches and storm grates.*
- *Disposable samplers are loaded into mounting kits prior to anticipated runoff event. Following collection, samplers are thrown away - preventing cross contamination between samples.*
- *Affordable compared to mechanical or automated samplers.*
- *Satisfies EPA sampling requirements.*

2NDNATURE LLC	Passive sampling devices can be purchased or fabricated using low-cost materials.	PASSIVE SAMPLER	FIGURE 4.1

tributary station (consisting of 3 samplers at different stream stages) will result in 20-25 discrete samples during an average hydrologic water year; dry years will have less, wet years will result in more annual samples. The selection of the 3 specific discharges (cfs) to sample at each location will consider the following:

- Each sampler should sample a different discharge at relatively the same location in the tributary,
- The lowest targeted discharge should be slightly above the assumed bankfull discharge corresponding to a reoccurrence interval of 1.5 – 2 yrs,
- The highest discharge should correspond with the average annual peak discharge, such that it would sample one time per year during an average annual water year, and
- The third sampler should be placed at the discharge directly between the high and low determined above.

Station instrumentation will require some local topographic surveying and hydrologic and geomorphic analyses to ensure strategic and successful installation. Hydrologic analyses, geomorphic indicators and well-established hydrologic equations (Dunne and Leopold, 1996) are used to determine the proper elevation for each of the passive samplers to meet the above objectives. The tributary sampling sites will include continuous stage recorders, staff plates and the development of a stage discharge rating curve over time. The hydrologic record over time will provide necessary data to allow future comparisons of the storm water quality observations across sites. Once the stations are properly instrumented and the hydrologic conditions for each sampler are known, the maintenance of these sampling devices is relatively cost-effective and simple.

See Section 6.4 for protocols, station instrumentation, station characterization, hydrologic calculations and other details of passive sampling devices.

Advantages

- Obtains water quality concentrations for a variety of chemical parameters.
- Provides targeted water quality data to compare to water quality numeric criteria in Lahontan Basin Plan.
- Utilizes cost-effective techniques to standardize hydrology and compare discrete water sample results across similar stations and over time.
- Passive samplers allow collection of first flush volumes to compare urban pollutant concentrations at the community level.
- Passive samplers allow collection of samples on rising limb of hydrograph when majority of pollutants are transported (Stubblefield et al. 2006) (Tributary level).
- Can install multiple sampling devices at one station to sample several discharge conditions during one storm.
- Similar discrete sampling techniques applied to stations that represent low disturbance catchments will provide regional context and achievable water quality conditions within project area.

Disadvantages:

- The analytical cost for discrete water samples can be significant, ranging from $40 per sample for basic nutrient and sediment analyses to over $800/sample for a complete analysis of trace metals, hydrocarbons, and other organic pollutants.
- The sample only provides a measure of the water quality parameters of interest at a discrete location at a specific flow condition at a specific point in time.

- Passive sampling devices sample the top of the water column for all stations. These sampling techniques vary from standard methods for representative water column sampling, including depth-integrated and/or collections at 6/10th depth within the deepest portion of the water column.
- While sampling designs include strategies to increase confidence that the differences observed across samples are due to upstream pollutant inputs and not due to natural daily, seasonal or annual variations, natural and sampling variability of many chemical parameters may still exist. Long-term consistent data collection will improve our ability to understand and constrain the natural variability within the TRWQMP stations.
- Samples for nutrients must be retrieved within holding times for the pollutants of concern, usually 24-72 hours depending upon air and water temperatures.

Relevance to SWMPs:
- The discrete water quality samples will be conducted to evaluate and compare across both community level and tributary water quality for a variety of pollutants of concern.
- The discrete water quality samples will be collected during runoff events (event-based monitoring) to focus resources on quantifying worst case conditions emanating from priority areas.
- The results of the event-based monitoring data will be compared to across sites, over time, and to the Water Quality Objectives to determine if community and tributary discharges are meeting numeric standards outlined in the Basin Plan and if SWMPs are reducing pollutant discharges to the Maximum Extent Practicable (MEP).
- The results from the low disturbance stations will provide baseline water quality values to determine the regional context of local water quality.
- Discrete water quality results over time will inform the performance evaluation of the SWMPs in each priority sub-watershed.

Spatial scale of observations: Discrete locations to measure discrete water quality downstream of communities and within tributaries of concern. See Section 5.0 for specific station locations.

Frequency of TRWQMP observations: Event-based sampling. Samples collected during each runoff event where stage exceeds stage of passive sampler placement.

Level of expertise necessary to maintain discrete sampling program:

Station selection and instrumentation: Expert knowledge in hydrology, sediment transport and field instrumentation.
*Field observations: K*nowledge of proper sample handling techniques and passive sampler operation. One-day training of field personnel is adequate.
Sample analysis: Accredited laboratory for analysis.
Data input/management: Knowledge of spreadsheet data management, load calculations and standard water quality data QA/QC techniques.

4.4.5 Near-continuous Water Quality Measurements

Near-continuous monitoring includes two distinct types of water quality observations:
- *In situ* water quality probes that conduct automated measurements at specific locations on nearly any time interval and store the time-series data internally.

- Automated water sampling instruments that collect water samples at specific locations on either specific time intervals or during specified flow conditions. One distinct advantage of automated samplers is that sample collection can be linked to measurement of stage (depth) or turbidity. This improves the accuracy and precision of total load estimates.

***In situ* water quality monitoring** is possible using a variety of water quality instruments with probes specific to the parameters of interest. The near-continuous datasets must be verified using periodic discrete measurements, and the instruments require variable levels of maintenance to increase the likelihood of reliable performance. *In situ* water quality instruments can provide relatively reliable measurements for the following parameters:

- turbidity
- water depth
- water velocity
- water temperature
- pH
- conductivity
- dissolved oxygen
- chlorophyll *a*

The continuous datasets provided by *in situ* probes are extremely valuable to evaluate processes and long-term trends. However, the cost to purchase and properly maintain *in situ* automated probes is extremely high, and datasets are lengthy and complex due to frequent (15-min. interval) measurements. *In situ* monitoring is recommended to track the cumulative status and trends for the priority pollutant of concern—sediment—within the Truckee River. Based on the consultants' experience with a number of available *in situ* probes, recommendations for specific manufacturers and models of *in situ* probes for the pollutants of concern are provided in Section 6.0. The obtainment of continuous water depth and/or velocity measurements is necessary for continuous hydrology at recommended stations. The other *in situ* parameters listed above are not priorities of the TRWQMP, but may be included if specific questions that these parameters address arise. All other parameters, such as nutrients, hydrocarbons, and metals, shall be evaluated by the analysis of discrete water samples.

Advantages of *in situ* automated probes:

- An improved ability to evaluate and constrain water quality results in the context of hydrologic, daily, seasonal variations.
- Near-continuous measurements significantly improve the ability to evaluate the fate and transport (total load) of pollutants and infer geochemical processes influencing water chemistry.
- Excellent approach to track the status and trend of the primary pollutant of concern—sediment; must obtain both continuous hydrology and turbidity in addition to total suspended sediment (TSS) v. turbidity rating curves to track continuous sediment loading.
- A continuous sediment discharge record is a valuable dataset in determining how sediment is transported through the Truckee River over time.

Disadvantages of *in situ* automated probes:

- Automated *in situ* probes are costly to purchase, maintain and operate properly.
- Near-continuous measurements result in extensive and complex datasets that require a high level of expertise to manage, analyze and maintain properly.

- A significant amount of data is collected at only one location, limiting the ability to interpret causal upstream factors since observations are an integration of contributing catchment conditions.
- The accuracy of water quality data obtained using deployable probes and instruments can widely vary. The more complicated the analytical probe, the greater the need for proper instrument maintenance, troubleshooting expertise and frequent calibration to improve the quality of data obtained.
- The use of *in situ* automated probes does not guarantee valid dataset due to instrument calibrations shifts, battery failures, user error and/or unexplained instrument failure.

Relevance to SWMPs:

- *Evaluating Cumulative Effects of the Truckee River:*
  Based on the cost and complexity of near-continuous monitoring efforts, the focus of near-continuous water quality measurements is to develop and maintain long-term datasets to evaluate the status and trend of the main stem of the Truckee River.

- *Evaluating Tributaries:*
  On sub-watershed tributaries that are already instrumented with automated probes, instrument stations are incorporated into the TRWQMP to characterize pollutant loading from these sub-watersheds and track the performance of the SWMPs over time.

Spatial scale of observations: Main stem of the Truckee River or in high disturbance sub-watershed tributaries.

Frequency of observations: 15-minute intervals with targeted discrete water quality samples for TSS to create turbidity v. TSS rating curves. The priority times of discrete sampling and manual discharge measurements at these stations are the infrequent storm conditions that transport the majority of the pollutants.

Level of expertise necessary:

Site selection and instrumentation: Expert knowledge in hydrology, sediment transport and field instrumentation.
Field observations: Advanced knowledge and digital equipment and instrument software to maintain, calibrate and operate instruments.
Data input/management: Knowledge of data management and data analysis techniques specific to hydrologic and sediment loading datasets.

Automated sampling instruments allow for the remote collection of flow-weighted water samples during specific flow conditions and/or at predetermined times. Automated samplers are typically linked with *in situ* probes that measure discharge (i.e. stage and velocity) on near-continuous intervals. *In situ* turbidity probes can also be linked to autosampler units. The automated sampling and continuous hydrology stormwater monitoring techniques are popular in individual BMP effectiveness evaluations conducted by researchers in the Lake Tahoe Basin. Water sample collection during known flow conditions allows representative calculations of flow-weighted event mean concentrations (EMCs) and pollutant loading for the pollutants of concern. However, these instruments are expensive to purchase, require advanced skills to operate and maintain, and create complex data outputs that require advanced knowledge of data management and data analysis techniques. In addition, instrument complication and failure is common.

Advantages of automated sampling instruments:

- Automated water samples can be collected during specific times and/or storm events of interest without field personnel present at the site.
- Increase statistical accuracy of water quality measurements in one location.
- Simplifies the calculations of flow-weighted EMCs when samples are collected on standardized flow increments.

Disadvantages of automated sampling instruments:

- Automated samplers are very costly to purchase, maintain and operate properly.
- Automated samplers require advanced knowledge to maintain, calibrate, troubleshoot and operate properly.
- The data generated from automated samplers result in extensive and complex datasets that require a high level of expertise to manage, analyze and maintain properly.
- Automated samplers and associate flow meter instrumentation failures and sampling complications are common due to sample line clogging, equipment freezing, backwater conditions that skew depth and velocity measurements, and/or unexplained instrument failure.

Relevance to SWMPs (similar to discrete water quality samples):

- Automated samplers are used to evaluate and compare both community level and tributary water quality for a variety of pollutants of concern.
- The majority of flow-weighted water quality samples are collected during runoff events (event-based monitoring) to focus resources on “worst case scenarios”.
- The results of the automated event based monitoring are compared to the Water Quality Objectives to determine if community and tributary discharges are meeting numeric standards outlined in the Basin Plan and if SWMPs are reducing pollutant discharges to the Maximum Extent Practicable (MEP).
- The across-site comparisons facilitate a continued prioritization of community level and tributaries where water quality impacts are observed.
- Event-based monitoring over time informs the performance evaluation of the SWMPs.

Spatial scale of observations: *In situ* probes and automated samplers are recommended in tributaries downstream of high disturbance areas assuming they are operated and maintained by experienced personnel who can preserve and extract the value of these highly complex and expensive datasets.

At this time, there are ongoing near-continuous evaluations with automated sampling instruments downstream of existing areas under development, including Martis Camp and Northstar (Appendix A). Automated sampling instruments are more than acceptable to generate the necessary community and/or tributary water quality datasets as required by the TRWQMP, but the number included in the TRWQMP is limited by cost. Monitoring plans utilizing automated sampling instrumentation must plan, implement and report event-based monitoring in a manner consistent with the discrete water quality measurements outlined in the TRWQMP and detailed in Section 6.0 to ensure data from the automated sampling units are comparable and can be integrated into the SWMP performance assessment dataset. Section 6.0 (Protocols) and Section 7.0 (Reporting) detail how independent evaluations of community level impacts using automated sampling techniques should sample and report their event results for the TRWQMP.

Level of expertise necessary:

Site selection and instrumentation: Expert knowledge in hydrology, sediment transport and field instrumentation.
Field observations: Advanced knowledge and digital equipment and instrument software to maintain, calibrate and operate instruments.
Data input/management: Knowledge of data management and data analysis techniques specific to hydrologic and sediment loading datasets.

4.5 Pollutants of Concern

The water quality pollutants of concern are presented in order of priority based on existing regulatory concerns and the relative magnitude of the sources of the pollutants within the project area (Table 4.2). The prioritization of pollutants focuses the allocation of resources for the TRWQMP on pollutants with the greatest likelihood to impair the ecological quality and beneficial uses within the project area. The fraction of resources and associated effort is smaller as the likelihood of ecological and water quality impacts decline.

The following section provides a discussion of the primary assessment types employed by the TRWQMP to measure and evaluate the temporal and spatial impacts of each of the key pollutants. A discussion of the chemical speciation of the pollutants of concern is also provided to focus allocation of analytical resources on the constituents that provide the most valuable water quality information with respect to the primary goal of the TRWQMP—tracking and evaluating the performance of the SWMPs. Table 4.2 summarizes the pollutant of concern analysis.

Pollutant	TRWQMP Priority rank	Primary constituents of concern	Rationale	Appropriate Assessment Types	Priority Spatial Area of Assessment	Land Uses of Concern
Sediment	1	Fine sediment (< 2mm)	Existing TMDLs, greatest impact on beneficial uses	ALL	Community Level Tributary Level Main stem	Roads, ski areas, logging areas, construction areas
Nitrogen	2	NOx, NH_4^+, TN	N-limited aquatic systems within project area	Discrete water quality measurements	*Community Level* *Tributary Level*	Roads, golf courses, residential and commercial developments
Phosphorous	3	SRP, TP	Less of a priority than N due to high P levels in native soils	Discrete water quality measurements	*Community Level* *Tributary Level*	Roads, golf courses, residential developments
Trace metals	4	Cu, Zn, Pb, etc.	Harmful ecological effects at elevated concentrations	Discrete water quality measurements	*Community Level*	Impervious surfaces, mines
Hydrocarbons	5	Oil & Grease, TEPH	Regulated constituent for discharge to surface waters. More cost-effective analyses than VOC's and other hydrocarbons.	Discrete water quality measurements	*Community Level*	Impervious surfaces, residential and commercial developments
Other organics	6	Pesticides, herbicides	Conditional evaluations if golf course or residential management practices are in question.	Discrete water quality measurements	*Community Level*	Golf courses, new residential developments

Table 4.2. Prioritization of the TRWQMP pollutants of concern

4.5.1 Sediment

Both Squaw Creek and the middle Truckee River are listed on the Clean Water Act Section 303(d) list for impairment by sediment. There is consensus that sediment is the primary pollutant of concern for the TRWQMP. The source area prioritization assessment (Section 3.2) integrated land use characteristics that have the potential to increase natural and anthropogenic sources of sediment to surface water resources. The high disturbance sub-watersheds where the anthropogenic sediment loading is expected to be the greatest are denoted in red on Figure 3.2. If the SWMPs are successfully implemented over time, sediment loading may decrease and substrate sediment conditions may improve at these high disturbance sites.

Sediment Impacts

Sediment is an integral part of fluvial systems and plays a key role in supporting in-stream biologic communities. However, excessive sedimentation, often due to human activities, can negatively affect habitat quality and the health of in-stream flora and fauna. In the water column, fine sediment (< 2 mm in diameter) can limit the light available for photosynthesis, thus negatively impacting primary productivity and the rest of the aquatic food chain (Waters 1995; Wood and Armitage 1997). Suspended fine sediment can also have lethal effects on fish by reducing disease tolerance and clogging gills. Fine sediment deposited on the stream bed negatively impacts habitat quality of benthic macroinvertebrates, plants, and fish. Fine sediment

deposition (1) infiltrates interstitial spaces in gravel beds, degrading fish spawning habitat and reducing reproductive success (Lisle 1989; Waters 1995; Wood and Armitage 1997); (2) alters substrate composition for benthic macroinvertebrates; (3) interferes with filter feeding; (3) negatively affects respiration; and (4) creates low oxygen conditions on stream beds (Wood and Armitage 1997). Overall, an increase in fine sediment in streams and rivers can cause harm to all resident biotic communities.

Other recreational and municipal beneficial uses of stream and river systems are impacted by fine sediment, including the use of stream water for drinking by municipalities. One example relevant to the TRWQMP was the temporary shutdown of the Reno-Sparks water treatment plant on two occasions (7/14/1992 and 7/18/1995) due to excessive quantities of mud from the Gray Creek watershed (NDWP 1997).

Sediment Sources

The main sources of sediment to the middle Truckee River are erosion of native material, anthropogenic application of road abrasives, and road and tire breakdown. These sources contribute an elevated amount of fine sediment (sand-sized material and smaller; defined by the TRWQMP as < 2mm) to the surface water resources. There is a natural level of sediment erosion within the project area, but development and land use modifications have led to accelerated erosion rates from ski runs, dirt roads, logging areas, road cuts and construction zones. Impervious surfaces such as roads, parking lots and buildings increase storm flow volumes and velocities, resulting in localized erosion in road side drainages, culvert outlets and other locations where impervious surfaces are routed to pervious (potentially erodible) areas.

Major highways run adjacent to the main stem and tributaries in the middle Truckee River. These high-elevation roads (Highway 89, Highway 267, Interstate 80) receive significant snowfall and require deicing and snow removal operations during the winter months. Traffic data collected by Caltrans in 2006 estimate an annual average daily traffic (AADT) of 20,600 vehicles on Highway 89 at its junction with Interstate 80, an AADT ranging from 29,000 and 31,500 vehicles along the portion of Interstate 80 between Donner Lake and Farad, and an AADT ranging from 10,900 to 17,200 on Highway 267 in the project area (Caltrans 2007a).

Winter road abrasive applications on these major roads are a significant source of sediment to the middle reach of the Truckee River (LRWQCB 2008b). Road abrasive material is imported to the watershed and is chronically applied to the highways and other primary roads during winter conditions to increase traction. From the winters of 2004-05 through 2006-07, an average of 500 tons, 109 tons, and 98 tons of road abrasive were applied per mile of Interstate 80, Highway 89 and Highway 267, respectively (Caltrans 2007b).

Road abrasive material and particles from road and tire breakdown are highly unconsolidated and extremely mobile during runoff events. Road maintenance practices that include roadside protection, rigorous street sweeping and road abrasive recovery efforts can significantly reduce the annual load of this material delivered to surface water resources (LRWQCB 2008c). Nonetheless, highways and primary right-of-ways are considered high risk sediment sources due to the large amount of non-native material that is highly mobile and in close proximity to the main stem of the Truckee River. Visual observations along Highway 89 within the project area during the spring of 2008 indicated excessive accumulation of road abrasives and unconsolidated sediment along the road shoulder, suggesting current road maintenance practices are well below the achievable levels to minimize the annual loading of sediment to the adjacent Truckee River. It should be noted that the highways adjacent to the main stem of the Truckee River are under the jurisdiction of Caltrans, and the sediment contributions from these roadways will not be reduced through County and Town SWMP actions.

Assessment of Sediment

The assessment of sediment within the TRWQMP project area will focus on the fate and transport of fine sediment. Coarse sediment (>2mm in diameter) is often transported along the stream bed in the “bed load.” Bed load typically travels slowly and, even if elevated over natural loads, poses less of a threat to stream habitats than finer grained material.

The majority of sediment mobilization and transport occurs during storm events through suspension within the water column. Typically, the suspended sediment load will increase proportionally with increasing discharge due to the ability of higher flows to entrain and transport larger particles and a greater overall number of them. Catchments containing a greater supply of sediment are expected to have much greater relative sediment loads during storm conditions than minimally impacted catchments.

The sediment condition within the project area is directly assessed using 3 of the 5 assessment types under the TRWQMP.

- Rapid assessment methods document the ambient tributary and main stem reach fine sediment (< 2 mm) distribution and condition.
- Discrete water sample collections conducted during storm events using passive sampling devices assess community level and tributary level sediment loads at locations of interest.
- Near-continuous automated instrumentation is used to obtain turbidity readings (NTU) in discrete locations along the Truckee River main stem on 15-minute intervals. Simultaneous instrumentation provides continuous discharge on the same time interval. Additional near-continuous data is acquired from stations currently being operated by DWR, East West Partners (Martis Creek), and DMB/Highlands (Martis Creek). Manual discharge measurements and discrete water sample collections are conducted at sites during a range of hydrologic conditions to create stage to discharge and turbidity to

suspended sediment concentration rating curves, respectively. The near-continuous time series of turbidity and discharge is reported as sediment loading rate over time (mg of sediment/second). Integration of these time series is conducted for specific events of interest, by season and annually for each year's observations.

GIS source area prioritization and bioassessments indirectly evaluate and track sediment condition. The GIS source area prioritization provides a ranking of all of the sub-watersheds in the project area based on potential risk of water quality impairment, primarily sediment pollution. The bioassessment methodology to be implemented in Squaw Creek relies on a strong correlation between sediment condition of the stream and biological integrity.

4.5.2 Nutrients

As of 2008, the Truckee River and other tributaries within the project area are not listed on the State of California Clean Water Act Section 303(d) list for nitrogen (N) or phosphorous (P) impairment. Nonetheless, the Lahontan Basin Plan (LRWQCB 1995) includes a variety of numeric objectives for nitrogen and phosphorous species for a several locations within the project area (Table 4.3). A number of previous and existing water quality monitoring efforts rely upon simple concentration comparisons to these numeric objectives. However, evaluations of N and P that consider the geochemical processes influencing nutrients and their associated ecological impacts can significantly improve the understanding and interpretations of nutrient data.
The concern with nitrogen and phosphorous loading in surface waters is the stimulation of photosynthetic activity resulting in elevated algal growth and eutrophication. Eutrophication is defined by elevated production rates of organic material and is directly related to the relative biological availability of nitrogen and phosphorous. Eutrophication has lead to poor water quality, species simplification and a number of detrimental ecological impacts in both fresh and coastal waters (National Research Council 1992).

	Objective (mg/L)[1]								
Surface Waters	**TDS**	**Cl**	**SO4**	**P**	**B**	**NO3-N**	**N**	**TKN**	**Fe**
Truckee River below Prosser Creek									
Truckee River below Martis Creek	80	10.0	5.0	0.05	-	0.20	0.40	0.20	0.29
Truckee River below Donner Creek									
Martis Creek at Mouth	150	25.0	8.0	0.05	-	1.00	1.45	0.45	0.40
Squaw Creek at Mouth	85	3.0	25.0	0.02	-	0.05	0.18	0.13	0.13
Truckee River above Squaw Creek	65	2.0	2.0	0.03	-	0.06	0.22	0.16	0.13
Truckee River below Bear Creek	65	2.0	2.0	0.03	-	0.02	0.21	0.16	0.13
Bear Creek at Mouth	65	2.0	2.0	0.02	-	0.05	0.15	0.10	0.10
Truckee River above Bear Creek	65	2.0	2.0	0.02	-	0.04	0.19	0.15	0.10

[1] Values are mean values.

Table 4.3. Lahontan Basin Plan Water Quality Objectives for the Truckee River Hydrologic Unit (LRWQCB 1995).

The primary receiving water within the project area is the perennial Truckee River. Stream systems have a higher tolerance of nutrient loading, such that stream communities are not impaired to the same degree by algae and biological growth as lakes and other standing water bodies. This difference is due to the continued water mixing and relatively lower water temperatures. The cold, flowing waters make nitrogen and phosphorous less available to photosynthetic organisms, primarily because photosynthetic rates increase exponentially with temperature and light availability (Wetzel 2001). Therefore, the biological effects of elevated nutrients may not be as apparent along the Truckee River and associated tributaries within the project area due to continued unidirectional water flow and cool temperatures. Smaller tributaries within the project area may be more susceptible to effects from nutrient enrichment. When nutrient-rich streams discharge into lakes or reservoirs where surface water temperatures increase, the ecological effects of the nutrient enrichment can magnify. Martis Creek Reservoir is one such body of water that has shown long-term impairment through nutrient enrichment.

Urban land uses and activities can be a significant source of nutrients. Nitrogen pollution in urban stormwater and downstream surface waters can be generated from leaky septic and/or sewer systems, fertilizer applications, automobile exhaust, fires, and industrial activities. Atmospheric deposition of nitrate on impervious surfaces in urban areas as a result of automobile exhaust and residential and forest fires also contribute to elevated nitrogen concentrations in downstream surface waters (USDA 2000). Over 50% of the nitrate inputs to Lake Tahoe are attributed to direct atmospheric deposition from anthropogenic sources (LRWQCB 2008c). The production of snow by ski resorts can use a nitrate-containing salt additive to harden ski runs for races and is another potential source of nitrogen to the surface waters within the project area (Rixen et al. 2003). Research throughout the U.S. (Petrovic 1990; Easton and Petrovic 2004) and within the Lake Tahoe Basin (2NDNATURE 2007) have identified golf course and turf grass maintenance with chronic anthropogenic applications of fertilizer as significant sources of both nitrogen and phosphorous in surface waters.

Phosphorous is released naturally by the weathering of phosphorous-rich volcanic and granitic rocks. However, phosphorus can also be delivered to surface waters from anthropogenic sources including, but not limited to, leaky septic and/or sewer systems, detergents, road abrasive applications, agricultural runoff, and the application of anthropogenic fertilizers. Truckee area granitic and volcanic deposits do have a relatively high natural content of phosphorous (USDA 2000), making the surface waters within the project area naturally elevated in P.

The speciation and cycling of nitrogen and phosphorus can be complicated. Further complicating the matter are inconsistencies in the measurement and reporting of different nitrogen species in environmental monitoring efforts throughout the project area and the Tahoe region. The nutrient species terminology presented herein will be used by TRWQMP to standardize evaluations and reporting.

4.5.2.1 Nitrogen

Figure 4.2 presents the actual geochemical nitrogen compounds that exist in aquatic systems based on the biological processes present. Nitrogen cycling in aquatic systems is very complex, and the nitrogen molecule can exist in 5 different oxidation states (Figure 4.2). Nitrate (NO_3^-) is the most stable form of nitrogen in oxygenated waters, and the preferential form for photosynthetic organisms to use for growth. When organic matter is respired, ammonia (NH_4^+) is the inorganic form released in a process known as mineralization. In the presence of oxygen, ammonia will be oxidized by bacteria to nitrite, which in turn is oxidized to nitrate. In anaerobic (oxygen-depleted) waters, nitrate can be utilized as an alternative energy source (instead of oxygen) to respire organic matter—termed denitrification—and convert nitrate to inert nitrogen gas (N_2).

Nutrients are physically transported in surface water as either dissolved compound or adhered to inorganic or organic particles. The filtration of a water sample through a 0.45um filter is the operational definition of "dissolved". It is assumed that when these compounds are adhered to inorganic particles and/or incorporated on organic particle larger than 0.45um, photosynthetic organisms cannot utilize them for photosynthesis. Only dissolved inorganic nutrient species are biologically available and consequently can stimulate photosynthetic growth.

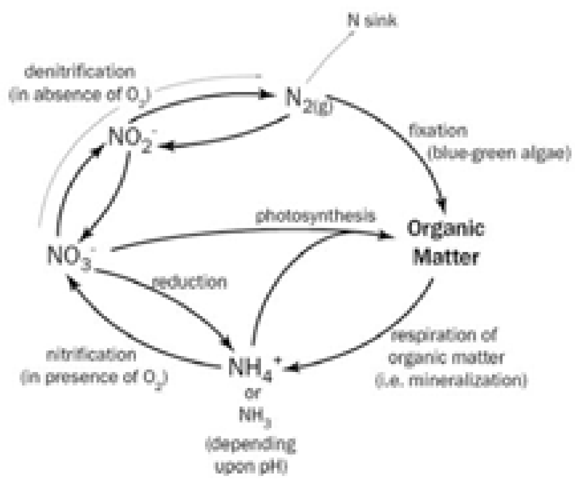


Figure 4.2. Nitrogen Cycle (modified from Stumm and Morgan, 1996).

Analytical techniques can measure the N species indicated in Figure 4.3. Total Kjeldahl Nitrogen (TKN) is an analytical fraction that includes the total organic nitrogen and ammonia (NH_4^+) in an unfiltered sample. NH_4^+ can be a common dissolved nitrogen species in stream systems, though it is generally very low in pristine mountain streams that are well-aerated. NOx represents the dissolved inorganic species (filtered) and is the product of an analytical method that measures the sum of nitrate and nitrite in a filtered sample (Figure 4.3). The analysis of NO_2^- is not expected to improve the water quality evaluations of the TRWQMP since nitrite concentrations are typically below analytical detection limits in surface water streams. Therefore, this analysis is not recommended, and NOx = NO_3^- for most samples analyzed for the TRWQMP. TN is calculated as the sum of TKN and NOx concentrations, and many times is annotated as simply N (Table 4.3).

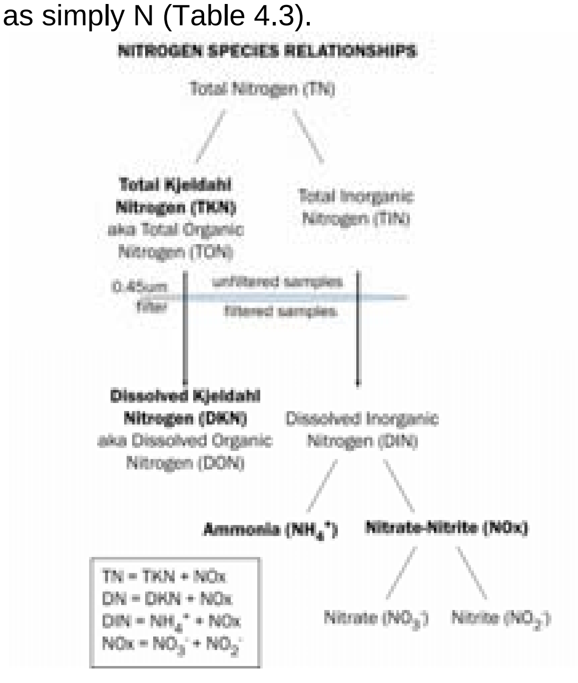


Figure 4.3. Analytical relationships of nitrogen species.

The nitrogen species of interest under the TRWQMP are TKN, NOx and NH_4^+. Results are reported (at a minimum) as TN, DIN and NOx concentrations and/or loads.

4.5.2.2 Phosphorous

The cycling of phosphorus (P) and the number of species are less complicated than for N. Typical and useful analytical P species include Total Phosphorus (TP; the concentration of all of the P contained within an unfiltered sample), Dissolved Phosphorus (DP; all of the phosphorous contained in the sample following filtration), and Soluble Reactive Phosphorus (SRP; only the inorganic fraction of the filtered sample) (Figure 4.4). Particulate Phosphorous (PP) is calculated using the difference between TP and DP values. TP, DP and SRP are typically analyzed in water quality monitoring efforts in Lake Tahoe, but TP is the only P species with a water quality numeric objective (Table 4.3).

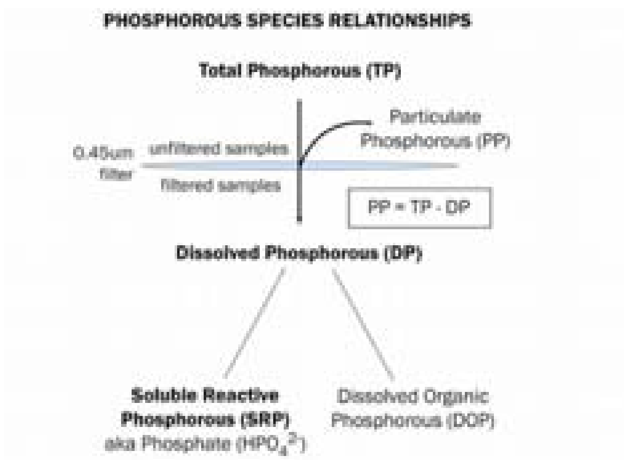


Figure 4.4. Analytical relationships of phosphorus species.

4.5.3 Hydrocarbons, Trace Metals and Other Pollutants

Non-point sources of trace metals and hydrocarbons in surface water can be significant in locations of high industrial activities and dense urban areas. The relatively rural setting of the project area makes the risk of significant trace metal and/or hydrocarbon concentrations in urban stormwater relatively unlikely in most locations. Areas within the project area with the greatest risks of trace metal or hydrocarbon sources include large, high-use parking lots and dense urban communities with auto repair shops or industrial operations. Both hydrocarbons and trace metals have a high chemical affinity to adhere to particles, thus soil-water interactions can significantly reduce the dissolved concentrations of these pollutants.

Trace metals and hydrocarbons (as well as nutrients and sediment) have been consistently reported to display elevated “first flush” signals. The first flush phenomenon is defined as the initial period of stormwater runoff during which the concentration and load of pollutants are substantially higher than during the later stages of the runoff event. The first flush of pollutants from urban surfaces during runoff events has been well documented, and an accepted quantitative definition is that 80% of the pollutant load will be transported in the first 30% of the event runoff volume (Bertrand-Krajewski et al. 1998).

If potential sources of these pollutants are of concern in specific locations, the most effective approach to sampling for these is to utilize discrete water quality measurements. Discrete samples should focus on capturing the first flush (initial volume) of a summer or winter runoff event following sustained dry antecedent conditions. Preliminary samples should be analyzed for oil and grease to determine if hydrocarbons may be a pollutant of concern from the catchment in question. Oil and grease is the only hydrocarbon constituent with regulatory thresholds for surface waters in the protection of beneficial uses and is relatively cost effective to analyze relative to other hydrocarbon constituents.

Most trace metals can be toxic to aquatic organisms at elevated levels, though some, such as cadmium, chromium and iron, are naturally occurring. Mining activities are a potential source of trace metals to streams in the project area, but the evaluations of these metal sources and in-stream impacts would not achieve the primary goal of the TRWQMP, to track the success of the local SWMPs. The most likely trace metals that could be elevated in local streams as a result of human activities would be copper and zinc. Discrete first flush samples downstream of golf courses may be evaluated for pesticides and/or herbicide constituents if certain practices are of concern.

Donner Lake is listed on the Clean Water Act Section 303(d) list for impairment by priority organics. Depending on available resources, discrete water quality measurements for priority organics may be conducted along Donner Creek downstream of the outlet of Donner Lake.

4.6 Section 4.0 References

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5.0 SUMMARY OF TRWQMP COMPONENTS

5.0 SUMMARY OF TRWQMP COMPONENTS

Section 5.0 summarizes the intended composition of the Truckee River Water Quality Monitoring Plan. The TRWQMP integrates a variety of assessments at strategic locations and times throughout the water bodies in the project area. Assessment types and associated spatial and temporal frequencies are prioritized based on the assumptions and strategies outlined throughout this document. Section 6.0 details the standards and protocols to implement each assessment type to ensure simple data integration and comparison across sites and over time. Section 7.0 outlines the data management framework and strategy to integrate and maintain a consistent and comparable dataset for the project area over time. The data obtained from each of the components of the TRWQMP will be integrated and maintained in one universal database (Section 7.0). Annual queries, analysis and reporting of the existing and available data stored within the TRWQMP database will allow informed performance evaluations of the respective Placer County and Town of Truckee SWMPs and tracking of surface water quality both spatially and temporally.

The implementation of the TRWQMP is presented in 3 distinct, sequential Phases. Assessment priorities for each phase are defined based on the goals and objectives of the TRWQMP (Section 2.0) with consideration for funding availability and feasibility. Each Phase includes the integration of a number of potentially valuable existing assessment efforts that are currently being conducted by others with the goal of coordinating efforts throughout the project area. The actual implementation of each component and the actual time required to complete each Phase will be **dependent upon the following conditions:**

- The ability of Placer County and the Town of Truckee to secure funding to implement and maintain all components of Phases I and II. Both Placer County and the Town of Truckee will utilize the contents of this TRWQMP to seek grants and obtain funds necessary to implement and maintain this Plan over the next 15 years (through 2023).
- The cooperation of implementers of existing assessment efforts in potentially modifying their protocols to meet the standards and protocols outlined in this Plan.
- The cooperation of implementers of assessment efforts in submitting the necessary assessment data to the County of Placer and the Town of Truckee in the manner outlined in this Plan. The data must be submitted in the time frame necessary to meet the TRWQMP reporting requirements.

If possible, additional water quality assessments undertaken within the project area should be designed to follow the standards and protocols outlined in this Plan for simple integration into the TRWQMP. Placer County and the Town of Truckee will encourage cooperation and cost-sharing where feasible with relevant entities (developers, researchers, NGOs, etc) to facilitate an integrated and comparable water quality monitoring program. Additionally, the County and Town may use discretionary project approvals to require participation in the TRWQMP in the form of actual implementation or funding participation. In some instances, regulatory assistance from Lahontan RWQCB may enhance coordination and cooperation.

5.1 Phase I

Phase I represents the minimum recommended monitoring plan to meet the goals and objectives of the TRWQMP. It includes a collection of assessment types across the main stem of the Truckee River and in the high disturbance sub-watersheds to (1) track the performance of the County and Town SWMPs, (2) evaluate cumulative effects of human development in the watershed, and to track the long-term status and condition of the main stem of the Truckee River. Based on funding constraints, Phase I focuses on integrating existing monitoring efforts whenever feasible to meet the goals and objectives of the TRWQMP. Table 5.1 summarizes the assessment types, locations, and the anticipated Year 1 implementation costs and subsequent annual operations and maintenance costs for the Phase I TRWQMP. Notes are provided to summarize any existing efforts, assumptions with respect to cost sharing, and other cost calculation details. The locations of each of the Phase I assessments are presented in Figures 5.1- 5.4. Figure 5.1 presents an overview of all Phase I stations for the entire project area, followed by Figures 5.2, 5.3, 5.4 that provide detailed station locations for Martis Creek, Squaw Creek and the Town of Truckee, respectively.

The intent is that Phase I will be implemented and fully operational within 3 years of the approval of this plan (by September 2011), but the actual implementation will be dependent upon the funding and cooperation conditions stated above. Phase I identifies existing assessment efforts that are anticipated to have a high feasibility for potential integration and cost-sharing into the TRWQMP. The actual coordination and cooperation will be conducted on a station by station, and entity by entity basis.

Phase I incorporates rapid assessment, bioassessment, discrete samples at the tributary and community level, near-continuous turbidity probes, and near-continuous automated samplers. Refer to Section 4.0 for a detailed description of the advantages and disadvantages of these assessment types. The locations and type of assessments are guided by the GIS sub-watershed source area prioritization conducted and outlined in Section 3.2.

Table 5.1. TRWQMP Phase 1

Jurisdiction	Sub-watershed	Component	Station(s)	Cost to implement station(s) (First Year)	Average annual operations and maintenance cost	Existing stations with potential for integration?	Station Justifications, Assumptions and Notes
Placer County	Martis Creek	Rapid Assessment[1]	**4 stream miles:** Downstream mile of Upper, West and East Martis Creek branches; 1 mile of Martis Creek upstream from confluence with Truckee River	$8,000	$6,000	N	• Cost-effective method to track fine sediment deposition in priority areas. • Assess distribution of fine sediment in downstream miles of branches of Martis Creek.
		Bioassessment[2]	**2 stations Upper Martis Creek:** Integrate bioassessment at existing Martis Camp stations (Bio-MC1, Bio-MC2)	$22,000	$7,000	Y	• Incorporate established stations with existing dataset into TRWQMP. • Assess stream biotic condition upstream and downstream of Martis Camp and Lahontan developments. • Potential full cost coverage by Martis Camp and/or Lahontan.
			3 stations West Martis Creek: Integrate bioassessment at existing Northstar stations (Bio-MC3, Bio-MC4) and TRWC station (Bio-MC5)	$33,000	$10,500	Y	• Incorporate established stations with existing dataset into TRWQMP. • Assess stream biotic condition upstream and downstream of Northstar developments. • Potential full cost coverage by Northstar.
			1 station East Martis Creek: Implement bioassessment (Bio-MC6)	$11,000	$4,000	N	• Assess stream biotic condition along low disturbance branch of Martis Creek.
		Discrete Sampling (Community)	**4 stations Martis Creek:** Confirm sites, install, operate and maintain (DSC-MC1, DSC-MC2, DSC-MC3, DSC-MC4)	$60,000	$44,000	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality from primary drainage point from Martis Camp, Lahontan development, Northstar-at-Tahoe Ski Area and golf course. Potential cost share with Martis Camp, Lahontan, and/or Northstar.
		Discrete Sampling (Tributary)	**1 station Martis Creek:** Confirm site, install, operate and maintain (DST-MC1)	$30,000	$20,000	N	• Stream water sample collection focusing on water quality and pollutants of concern during elevated stream flow conditions, when pollutants are most likely to be mobilized from source and transported in streams. • Track tributary water quality at downstream end of high disturbance sub-watershed. • Place particular attention on nutrient concentrations, as Martis Creek Lake has shown nutrient enrichment and the dam controls sediment loading to the main stem.
		Near-continuous Automated Turbidity Probes	**1 station West Martis Creek:** Operate and maintain existing Northstar station (TURB-MC1)	$59,000	$38,000	Y	• Incorporate established station with existing dataset into TRWQMP. • Evaluate sediment (and potentially nutrient) loads in West Martis Creek downstream of Northstar-at-Tahoe using high resolution data. • Potential full cost coverage by Northstar.
		Near-continuous Automated Samplers	**1 station Martis Creek:** Install, operate and maintain Martis Camp station near HW 267 (NCAS-MC1)	$114,000	$80,000	Y	• Evaluate event, seasonal, and annual loads downstream of confluence of Upper and West Martis Creeks using high resolution data. • Potential full cost coverage by Martis Camp.
		Data Management and Reporting		$47,000	$28,000	N/A	Assumes 50% of annual TRWQMP data management and reporting efforts are allocated to Martis Creek data.
		Martis Creek Phase I Total		**$384,000**	**$237,500**		
	Squaw Creek	Rapid Assessment[1]	**1 stream mile** upstream from confluence with Truckee River	$2,000	$2,000	N	• Cost-effective method to track fine sediment deposition in priority areas. • Assess distribution of fine sediment in downstream mile of Squaw Creek.
		Bioassessment[2]	**3 stations:** Implement bioassessment (Bio-SC1, Bio-SC2, Bio-SC3)	$33,000	$11,000	N	• Assess stream biotic condition in lower reach of Squaw Creek downstream of Squaw Valley Ski Corporation, Resort at Squaw Creek, and Village at Squaw. • 3 stations are mandated by Squaw Creek Sediment TMDL. • Potential cost sharing with Resort at Squaw, Village at Squaw, and/or Squaw Valley Ski Corporation.
		Data Management and Reporting		$10,000	$6,000	N/A	Assumes 10% of data management and reporting costs are allocated to Squaw Creek data
		Squaw Creek Phase I Total		**$45,000**	**$19,000**		

Table 5.1. TRWQMP Phase 1 (continued)

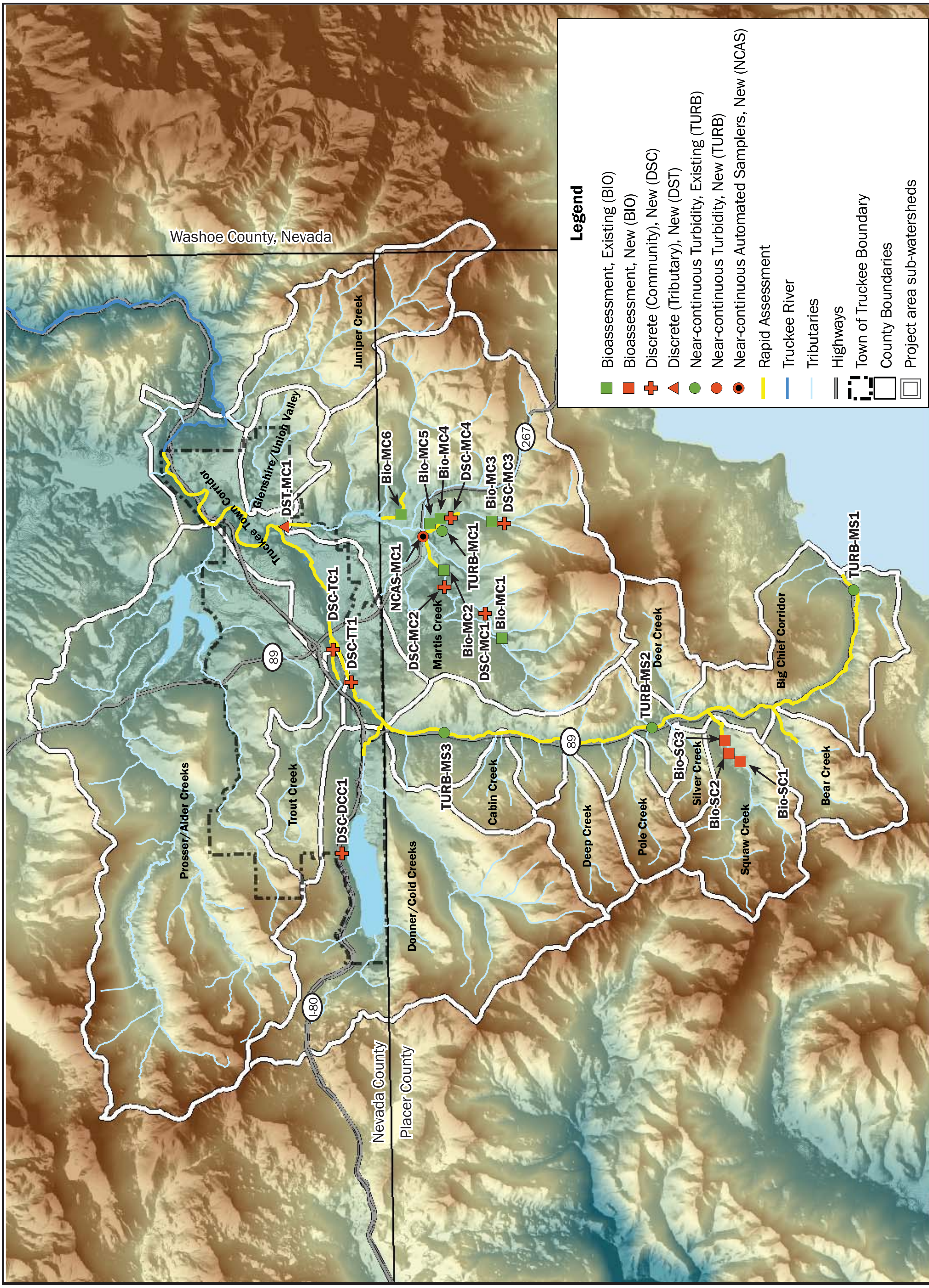
	Sub-watershed	Component	Station(s)	Cost to implement station(s) (First Year)	Average annual operations and maintenance cost	Existing stations with potential for integration?	Station Justifications, Assumptions and Notes
Placer County	Big Chief Corridor	Rapid Assessment[1]	**13 stream miles** along main stem between outlet at Lake Tahoe and Placer/Nevada County line	$24,000	$18,000	N	• Cost-effective method to track fine sediment deposition in priority areas. • Assess distribution of fine sediment along main stem of Truckee River
Placer County	Big Chief Corridor	Near-continuous Automated Turbidity Probes	**3 stations :** Operate and maintain existing DWR stations (TURB-MS1, TURB-MS2, TURB-MS3)	$177,000	$114,000	Y	• Incorporate established station with existing dataset into TRWQMP. • Evaluate sediment loads along main stem of Truckee River at upstream end of project area, downstream of Squaw/Bear Creeks, and upstream of Town of Truckee using high resolution data. • Potential full cost coverage by DWR • Potential improvement if Caltrans fiscal participation included.
Placer County	Big Chief Corridor	Data Management and Reporting		$19,000	$11,000	N/A	Assumes 20% of data management and reporting costs are allocated to Big Chief Corridor data.
Placer County	Big Chief Corridor	**Big Chief Corridor Phase I Total**		**$220,000**	**$143,000**		
Placer County	Bear Creek	Rapid Assessment[1]	**1 stream mile** upstream from confluence with Truckee River	$2,000	$2,000	N	• Cost-effective method to track fine sediment deposition in priority areas. • Assess distribution of fine sediment in downstream mile of Bear Creek.
Placer County	Bear Creek	**Bear Creek Phase I Total**		**$2,000**	**$2,000**		
Town of Truckee	Truckee Town Corridor	Rapid Assessment[1]	**10 stream miles** along main stem between Placer/Nevada county line and downstream boundary of project area	$19,000	$14,000	N	• Cost-effective method to track fine sediment deposition in priority areas. • Assess distribution of fine sediment in main stem fo Truckee River along Truckee Town Corridor.
Town of Truckee	Truckee Town Corridor	Discrete Sampling (Community)	**1 station:** Confirm sites, install, operate and maintain (DSC-TT1)	$15,000	$11,000	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality from a primary drainage point within the developed area of downtown Truckee.
Town of Truckee	Truckee Town Corridor	Data Management and Reporting		$19,000	$11,000	N/A	Assumes 20% of data management and reporting costs are allocated to Truckee Town Corridor data.
Town of Truckee	Truckee Town Corridor	**Truckee Town Corridor Phase I Total**		**$53,000**	**$36,000**		
Town of Truckee	Donner/Cold Creeks	Rapid Assessment[1]	**1 stream mile** upstream from confluence with Truckee River	$2,000	$2,000	N	• Cost-effective method to track fine sediment deposition in priority stream reaches. • Assess distribution of fine sediment in downstream mile of Donner Creek.
Town of Truckee	Donner/Cold Creeks	Discrete Sampling (Community)	**1 station:** Confirm sites, install, operate and maintain (DSC-DCC1)	$15,000	$11,000	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality from a primary drainage point within the developed area of the Donner Creek sub-watershed.
Town of Truckee	Donner/Cold Creeks	**Donner/Cold Creeks Phase I Total**		**$17,000**	**$13,000**		
Town of Truckee	Trout Creek	Rapid Assessment[1]	**1 stream mile** upstream from confluence with Truckee River	$2,000	$2,000	N	• Cost-effective method to track fine sediment deposition in priority stream reaches. • Assess distribution of fine sediment in downstream mile of Trout Creek.
Town of Truckee	Trout Creek	Discrete Sampling (Community)	**1 station:** Confirm sites, install, operate and maintain (DSC-TC1)	$15,000	$11,000	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality from a primary drainage point within the developed area of the Trout Creek sub-watershed.
Town of Truckee	Trout Creek	**Trout Creeks Phase I Total**		**$17,000**	**$13,000**		

TRWQMP Phase I Total Costs	**Jusidiction**	**Cost to implement station(s) (First Year)**	**Average annual cost to maintain and operate station(s)**
	Placer County	**$651,000**	**$402,000**
	Town of Truckee	**$87,000**	**$62,000**
	Total	**$738,000**	**$464,000**

[1] Rapid assessment costs are based on the assumption that 31 stream miles are assessed per year.
[2] Since bioassessments are conducted every other year, operations and maintenance costs are only incurred every other year. Therefore, bioassessment average annual costs equal half of the operations and maintenance costs to reflect this bi-annual frequency.

Table 5.1 Notes:

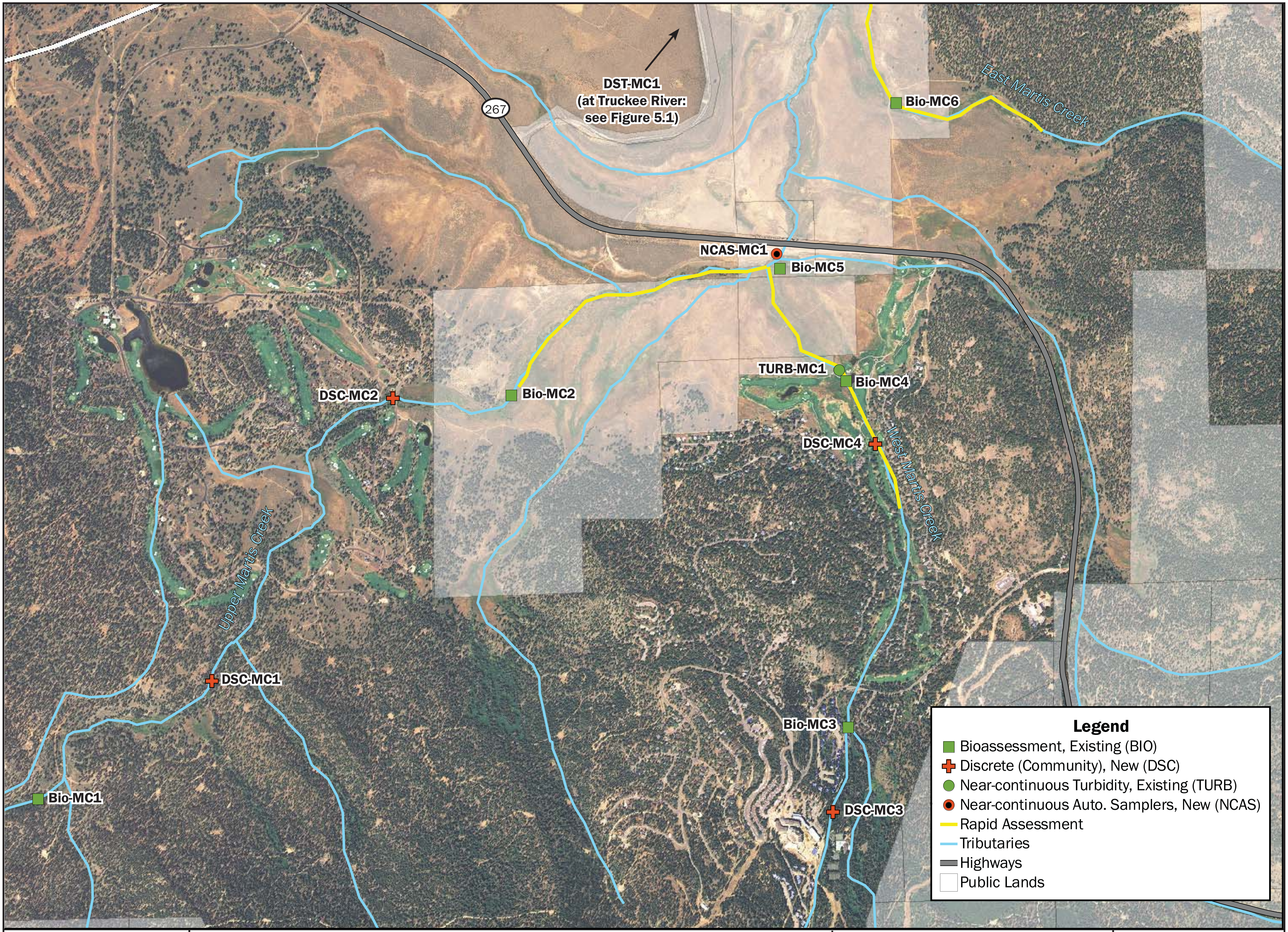
- Cost estimates are based on consultants to complete work using accredited analytical laboratories and other professional services.
- For new stations that could address the monitoring needs of multiple permittees, potential cost sharing opportunities are noted but not incorporated into the cost estimates provided.
- For existing stations that could be integrated into the TRWQMP, potential cost sharing with existing operators is noted but not incorporated into the cost estimates provided.
- Permitting and easement costs ranging from $3,000 to $6,000 per station are included in cost estimates.



2NDNATURE LLC

TRWQM Phase I Monitoring. Station locations based on available information in 2008. Final station locations will be determined during the actual implementation of each independent assessment effort.

FIGURE 5.1



2NDNATURE LLC

Martis Creek Phase I Monitoring. Station locations based on available information in 2008. Final station locations will be determined during the actual implementation of each independent assessment effort.

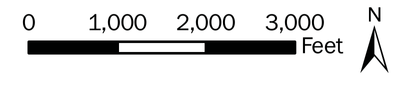
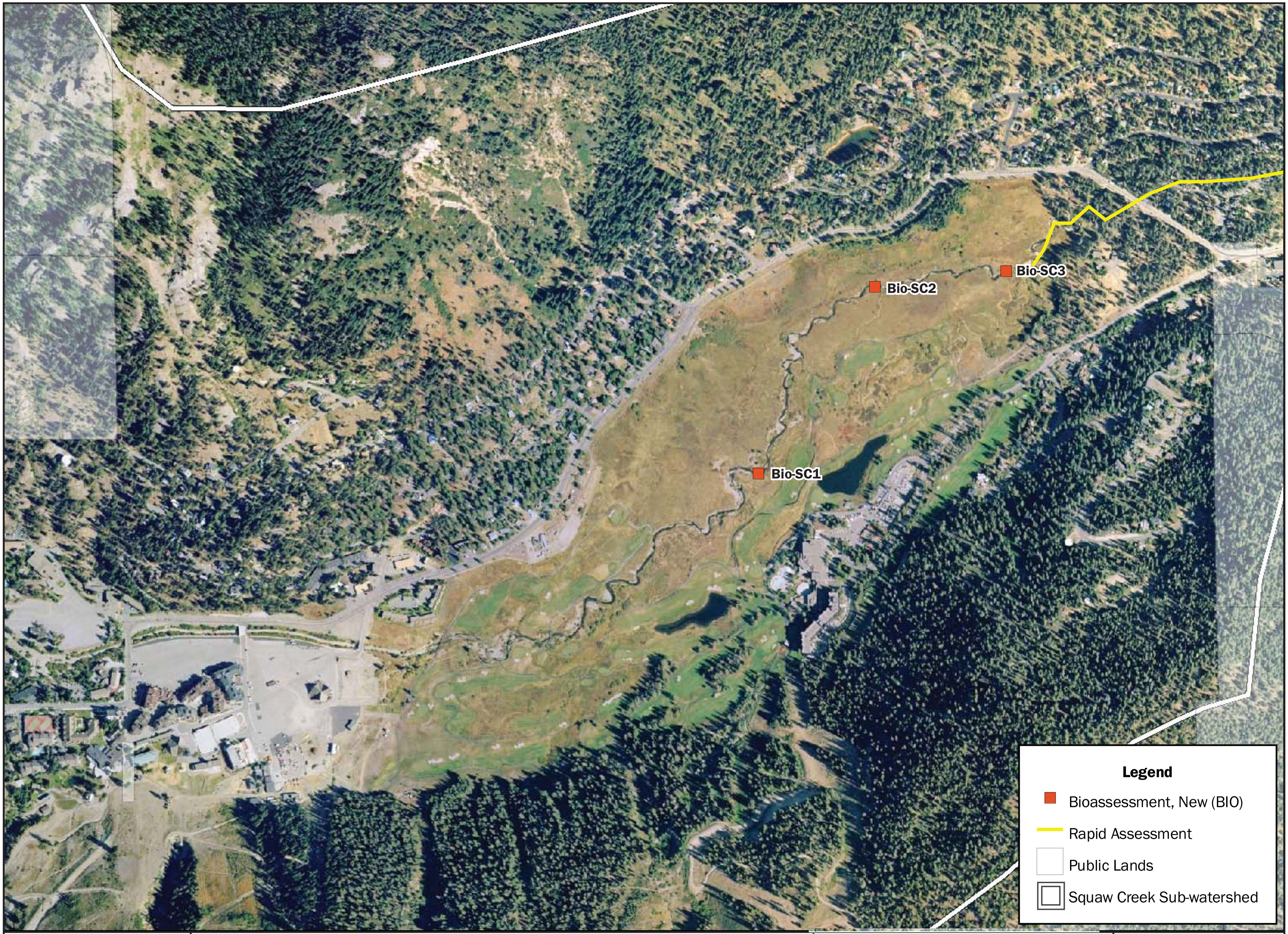


FIGURE 5.2



2NDNATURE LLC

Squaw Creek Phase I Monitoring. Station locations based on available information in 2008. Final station locations will be determined during the actual implementation of each independent assessment effort.

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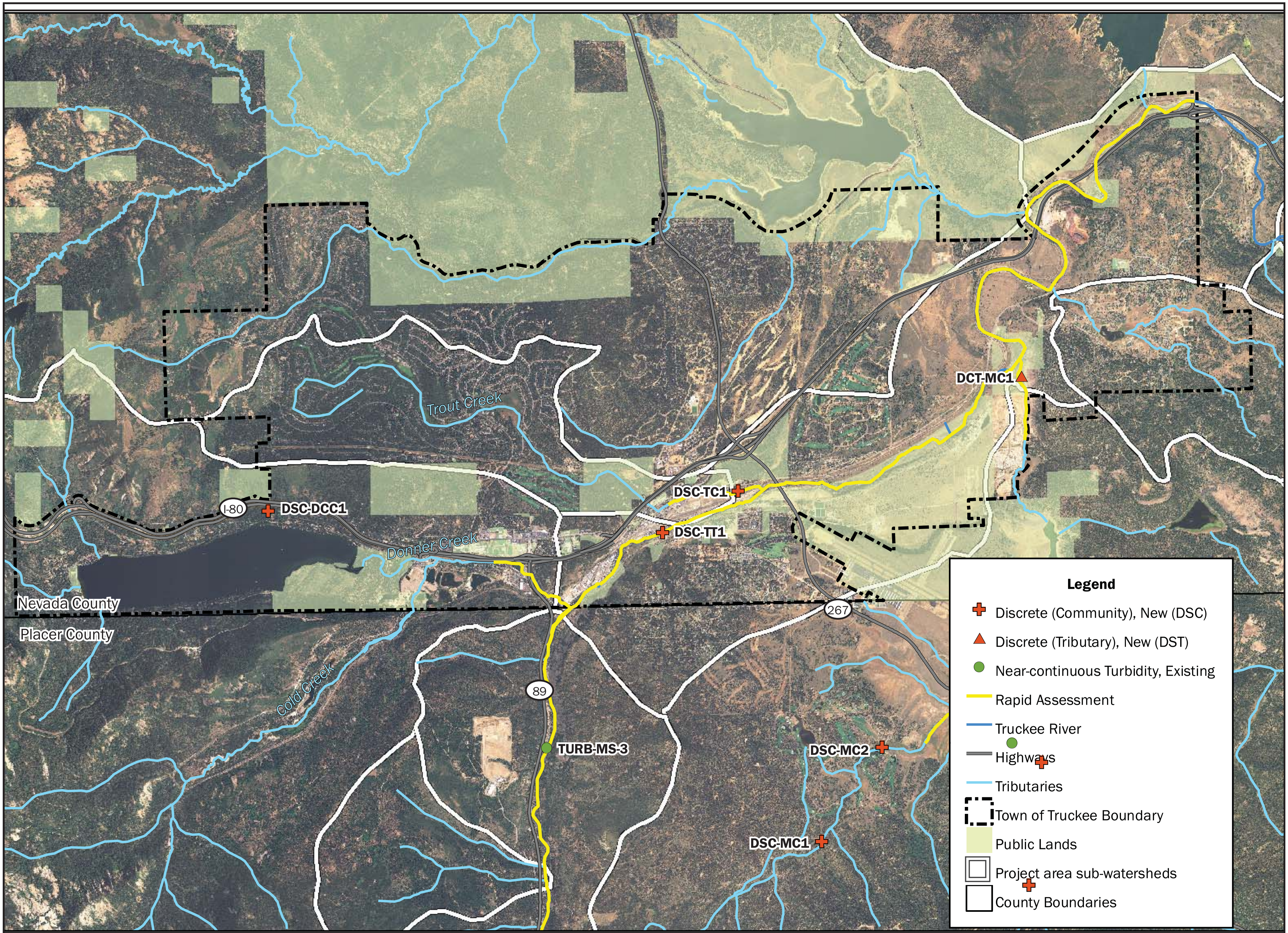
FIGURE 5.3



2NDNATURE LLC

Town of Truckee Phase I Monitoring. Station locations based on available information in 2008. Final station locations will be determined during the actual implementation of each independent assessment effort.

FIGURE 5.4

During the implementation of Phase I, the County and Town will likely need to prioritize certain elements of the TRWQMP due to funding constraints. Phase I efforts are all high priority. Below are assessment are the justifications, but funding constraints will need to considered to determine the order in which assessment efforts are undertaken.

At the time of the TRWQMP development (2008), funding has been obtained by Placer County to implement a comprehensive monitoring plan in the Martis Creek sub-watershed. Therefore, **all** of Phase I assessments in the Martis Creek sub-watershed are a high priority to ensure the full development of this critical aspect of the TRWQMP.

The remaining assessment efforts for Phase I are listed below in order of perceived priority. However, per design, Phase I is the compilation of highest priority assessment efforts required to meet the minimum data collection needs. A higher priority is been assigned to those that are required under regulation, followed by the perceived cost/benefit of the assessments.

- **Bioassessment (Squaw Creek):** Bioassessment in Squaw Creek is required to begin in 2009 under the Squaw Creek Sediment TMDL. Bioassessment is a valuable tool in tracking the cumulative impacts of all pollutant sources within the sub-watershed on stream biotic health.

- **Community Level Discrete Samplers (Truckee Town Corridor, Donner Creek, Trout Creek):** Since many SWMP actions and compliance monitoring will be directed towards minimizing the impact of human activities and development, community level discrete water quality measurements will be used to characterize water quality in primary stormwater conveyance points for high density developments within the project area. The community level discrete sampling can be a useful tool to evaluate and compare the pollutant contribution from specific localized urban catchments. Data from these assessments will be used to evaluate (1) relative stormwater quality at developed areas and (2) changes in stormwater quality over time as a result of SWMP actions. Communities in the high disturbance sub-watersheds are expected to have the greatest potential impact on surface water quality within the Truckee River watershed. These are also the areas where the majority of County and Town SWMP actions are expected to be implemented by both public and private entities. Discrete water quality data sampling in these high disturbance areas during large storm events will capture the “worst case scenario” for stormwater quality. By collecting data across these stations over time using standardized procedures (Section 6.6), comparisons will be made between communities and within communities over time as actions are taken to mitigate the impact of human development on water quality.

- **Rapid Assessment:** Rapid assessment is the most cost-effective means to characterize and track stream habitat condition focusing on the primary pollutant of concern within the stream resource that SWMP actions are intended to ultimately protect. Rapid assessment results will form the basis for an adaptively managed TRWQMP. Rapid assessment results can be used to prioritize more costly assessment types to help ensure that funds for the TRWQMP are used efficiently and effectively. A long-term rapid assessment data set will allow tracking of the overall change in fine sediment loading throughout the project area. If particular reaches are identified as having a high level of fine sediment deposition over time, the TRWQMP can be modified to include more intense data collection efforts upstream of these reaches if not already included.

  Rapid assessment is recommended to be completed annually on the downstream mile of high disturbance tributaries (1) identify if areas of human disturbance are resulting in high levels of sediment deposition within tributaries, and (2) provide additional information on the fine sediment deposition patterns within the main stem of the Truckee River. If funding is limited, rapid assessment should be prioritized on the downstream end of the all of the contributing tributaries and 1 mile up and downstream of each respective confluence. The low cost of this assessment type makes the annual assessment of the entire main stem of the Truckee River also a feasible long-term priority.

- **Near-continuous Turbidity Probes (Main stem):** Near-continuous turbidity monitoring will be the primary method for collecting high-resolution water quality data on the primary resource of concern. Several years of data already exist for 3 stations within the project area that will be valuable in tracking the condition of the Truckee River in the future. If these stations continue to be operated by the California Department of Water Resources (DWR), the only costs to the County and Town will be to complete data integration. If the monitoring does not continue under DWR funding, it is highly recommended that these stations are reoccupied and operated by the County and Town to maintain this valuable long-term dataset.

5.2 Phase II

Phase II represents a strategic expansion of the spatial distribution of assessment types throughout the project area as necessary to best meet the goals and objectives of the TRWQMP. All of the Phase II components added to the TRWQMP are considered lower priority than the components recommended in Phase I. Phase II focuses on the high disturbance sub-watersheds based on land use, existing development activities, density of SWMP actions and current water quality concerns (Section 3.2). Phase II is intended to be implemented and in full operation by year 5 (September 2013), but is subject to the same conditional restrictions including funding availability and potential cost-sharing opportunities stated in Phase I. Table 5.2 summarizes the TRWQMP Phase II components, and Figures 5.5 – 5.8 spatially display the proposed station locations based on existing information. GIS sub-watershed source area prioritization will be conducted using updated land use layers and used to inform potential refinement of Phase II, assuming that the local resource agencies have created updated GIS land use layers for the project area within the next 3 to 5 years.

Tributary level discrete water quality measurements will be used to capture an integrated water quality signal of upstream pollutant sources. Tributary level assessments under Phase I are limited to the Martis Creek sub-watershed but expanded to the outlets of Squaw Creek, Donner/Cold Creek, Trout Creek, and Sagehen Creek (well-established reference station outside of project area; see Section 5.6) in Phase II. The tributary level assessment is a non-traditional assessment technique, designed to allow direct comparisons of tributary pollutant loading conditions during storm events. The implementation of these assessment stations may be a lower priority than rapid assessment or community level assessments if funding limitations exist.

Near-continuous automated turbidity probes are utilized under Phase I to provide valuable, high-resolution data from the Main Stem of the Truckee River over time and are used to evaluate cumulative effects. Pending potential collaboration and cost-sharing with the existing operation and maintenance of the DWR sites, it may not be feasible that these sites are operated in Phase I. Depending upon circumstances, the County and Town should identify resources to ensure the operation and maintenance of these stations is implemented and operated long-term in Phase II.

Table 5.2. TRWQMP Phase II

Jurisdiction	Sub-watershed	Component	Station(s)	Cost to implement new Phase II station(s) (First Year)	Average annual operations and maintenance cost for all stations	Existing stations with potential for integration?	Justification, Assumptions and Notes
Placer County	Project Area	GIS Sub-watershed Source Area Prioritization	N/A	$4,000	$500	N/A	• Evaluate changes in land use, development, etc. to prioritize resource allocations for TRWQMP based on locations with greatest potential risk to downstream water quality. • 50% of cost assumed by Placer County.
	Martis Creek	Rapid Assessment[1]	**4 stream miles:** Downstream mile of Upper, West and East Martis Creek branches; 1 mile of Martis Creek upstream from confluence with Truckee River	-	$6,000	N	• Cost-effective method to track fine sediment deposition in priority areas. • Assess distribution of fine sediment in downstream miles of branches of Martis Creek.
		Bioassessment[2]	**2 stations Upper Martis Creek:** Integrate bioassessment at existing Martis Camp stations (Bio-MC1, Bio-MC2)	-	$7,000	Y	• Incorporate established station with existing dataset into TRWQMP. • Assess stream biotic condition upstream and downstream of Martis Camp and Lahontan developments. • Potential full cost coverage by Martis Camp and/or Lahontan.
			3 stations West Martis Creek: Integrate bioassessment at existing Northstar stations (Bio-MC3, Bio-MC4) and TRWC station (Bio-MC5)	-	$11,000	Y	• Incorporate established station with existing dataset into TRWQMP. • Assess stream biotic condition upstream and downstream of Northstar developments. • Potential full cost coverage by Northstar.
			1 station East Martis Creek: Implement bioassessment (Bio-MC6)	-	$4,000	N	• Assess stream biotic condition along low disturbance branch of Martis Creek.
		Discrete Sampling (Community)	**4 stations Martis Creek:** Operate and maintain (DSC-MC4, DSC-MC5, DSC-MC6)	-	$44,000	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality from primary drainage point from Martis Camp, Lahontan development, Northstar-at-Tahoe Ski Area and golf course. • Potential cost share with Martis Camp, Lahontan, and/or Northstar.
		Discrete Sampling (Tributary)	**1 station Martis Creek** Operate and maintain (DST-MC1)	-	$20,000	N	• Stream water sample collection focusing on water quality and pollutants of concern during elevated stream flow conditions, when pollutants are most likely to be mobilized from source and transported in streams. • Track tributary water quality at downstream end of high disturbance sub-watershed. • Place particular attention on nutrient concentrations, as Martis Creek Lake has shown nutrient enrichment and the dam controls sediment loading to the main stem.
		Near-continuous Automated Turbidity Probes	**1 station West Martis Creek:** Operate and maintain existing Northstar station (TURB-MC4)	-	$38,000	Y	• Incorporate established station with existing dataset into TRWQMP. • Evaluate sediment (and potentially nutrient) loads in West Martis Creek downstream of Northstar-at-Tahoe using high resolution data. • Potential full cost coverage by Northstar.
		Near-continuous Automated Samplers	**1 station Martis Creek:** Operate and maintain Martis Camp station near HW 267 (NCAS-MC1)	-	$80,000	Y	• Incorporate established station with existing dataset into TRWQMP. • Evaluate event, seasonal, and annual loads downstream of confluence of Upper and West Martis Creeks using high resolution data. • Potential full cost coverage by Martis Camp.
		Data Management and Reporting		-	$28,000	N/A	Assumes 50% of annual TRWQMP data management and reporting efforts are allocated to Martis Creek data.
		Martis Creek Phase II Total		**$0**	**$238,000**		

Table 5.2. TRWQMP Phase II (continued)

Jurisdiction	Sub-watershed	Component	Station(s)	Cost to implement new Phase II station(s) (First Year)	Average annual operations and maintenance cost for all stations	Existing stations with potential for integration?	Justification, Assumptions and Notes
Placer County	Squaw Creek	Rapid Assessment[1]	**1 stream mile** upstream from confluence with Truckee River	-	$2,000	N	• Cost-effective method to track fine sediment deposition in priority areas. • Assess distribution of fine sediment in downstream mile of Squaw Creek.
Placer County	Squaw Creek	Bioassessment[2]	**3 stations:** Implement bioassessment (Bio-SC1, Bio-SC2, Bio-SC3)	-	$11,000	N	• Assess stream biotic condition in lower reach of Squaw Creek downstream of Squaw Valley Ski Corporation, Resort at Squaw Creek, and Village at Squaw. • 3 stations are mandated by Squaw Creek Sediment TMDL. • Potential cost sharing with Resort at Squaw, Village at Squaw, and/or Squaw Valley Ski Corporation.
Placer County	Squaw Creek	Discrete Sampling (Community)	**3 stations:** Confirm sites, install, operate and maintain (DSC-SC1, DSC-SC2, DSC-SC3)	$45,000	$33,000	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality from primary drainage point from Squaw Valley Ski Corporation parking lot (focusing on trace metals and hydrocarbons), Resort at Squaw Creek, and residential developments on north side of Squaw Creek.
Placer County	Squaw Creek	Discrete Sampling (Tributary)	**1 station:** Confirm site, install, operate and maintain (DST-SC1)	$30,000	$20,000	N	• Stream water sample collection focusing on water quality and pollutants of concern during elevated stream flow conditions, when pollutant are most likely to be mobilized from source and transported in streams. • Track tributary water quality at downstream end of high disturbance sub-watershed. • Potential cost sharing with Resort at Squaw, Village at Squaw, and Squaw Valley Ski Corporation.
Placer County	Squaw Creek	Data Management and Reporting		-	$6,000	N/A	Assumes 10% of data management and reporting costs are allocated to Squaw Creek data.
Placer County	Squaw Creek	**Squaw Creek Phase II Total**		**$75,000**	**$72,000**		
Placer County	Big Chief Corridor	Rapid Assessment[1]	**13 stream miles** along main stem between outlet at Lake Tahoe and Placer/Nevada County line	-	$18,000	N	• Cost-effective method to track fine sediment deposition in priority areas. • Assess distribution of fine sediment along main stem of Truckee River.
Placer County	Big Chief Corridor	Discrete Sampling (Community)	**3 stations:** Confirm sites, install, operate and maintain (DSC-BCC1, DSC-BCC2, DSC-BCC3)	$45,000	$33,000	N	• Sample stormwater quality of road runoff along HW 89. Results can inform the impacts of road sanding on local stream conditions. • Potential cost sharing with Caltrans.
Placer County	Big Chief Corridor	Near-continuous Automated Turbidity Probes	**3 stations:** Operate and maintain existing DWR stations (TURB-MS1, TURB-MS2, TURB-MS3)	-	$114,000	Y	• Incorporate established stations with existing dataset into TRWQMP. • Evaluate sediment loads along main stem of Truckee River at upstream end of project area, downstream of Squaw/Bear Creeks, and upstream of Town of Truckee using high resolution data. • Potential full cost coverage by DWR. • Potential improvement if Caltrans fiscal participation included.
Placer County	Big Chief Corridor	Data Management and Reporting		-	$11,000	N/A	Assumes 20% of data management and reporting costs are allocated to Big Chief Corridor data.
Placer County	Big Chief Corridor	**Big Chief Corridor Phase II Total**		**$45,000**	**$176,000**		
Placer County	Bear Creek	Rapid Assessment[1]	**1 stream mile** upstream from confluence with Truckee River	-	$2,000	N	• Cost-effective method to track fine sediment deposition in priority areas. • Assess distribution of fine sediment in downstream mile of Bear Creek.
Placer County	Bear Creek	**Bear Creek Phase II Total**		**$0**	**$2,000**		

Table 5.2. TRWQMP Phase II (continued)

Jurisdiction	Sub-watershed	Component	Station(s)	Cost to implement new Phase II station(s) (First Year)	Average annual operations and maintenance cost for all stations	Existing stations with potential for integration?	Justification, Assumptions and Notes
Town of Truckee	Project Area	GIS Sub-watershed Source Area Prioritization	N/A	$4,000	$500	N/A	• Evaluate changes in land use, development, etc. to prioritize resource allocations for TRWQMP based on locations with greatest potential risk to downstream water quality. • 50% of cost assumed by Town of Truckee.
	Truckee Town Corridor	Rapid Assessment[1]	**10 stream miles** along main stem between Placer/Nevada county line and downstream boundary of project area	-	$14,000	N	• Cost-effective method to track fine sediment deposition in priority areas. • Assess distribution of fine sediment in main stem fo Truckee River along Truckee Town Corridor.
		Discrete Sampling (Community)	**2 new stations:** Confirm sites, install, operate and maintain (DSC-TT2, DSC-TT3)	$30,000	$22,000	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality from primary drainage points from 2 new or future planned developments.
			1 station: Operate and maintain (DSC-TT1)	-	$11,000	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality from a primary drainage point within the developed area of downtown Truckee.
		Near-continuous Automated Turbidity Probes	**1 station:** Install, operate and maintain station at downstream end of Town boundary (TURB-TT1)	$59,000	$38,000	N	• Evaluate sediment loads along main stem of Truckee River near downstream end of project area using high resolution data.
		Data Management and Reporting		-	$11,000	N/A	Assumes 20% of data management and reporting costs are allocated to Truckee Town Corridor data.
		Truckee Town Corridor Phase II Total		**$89,000**	**$96,000**		
	Donner/ Cold Creeks	Rapid Assessment[1]	**1 stream mile** upstream from confluence with Truckee River	-	$2,000	N	• Cost-effective method to track fine sediment deposition in priority stream reaches. • Assess distribution of fine sediment in downstream mile of Donner Creek.
		Discrete Sampling (Community)	**2 new stations:** Confirm sites, install, operate and maintain (DSC-DCC2, DSC-DCC3)	$30,000	$22,000	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality of road runoff along I-80 as well as primary drainage point from urban development. Impacts of road sanding will be evaluated. • Potential cost sharing with Caltrans, Placer County, and Union Pacific Railroad.
			1 station: Operate and maintain (DSC-DCC1)	-	$11,000	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality from a primary drainage point within the developed area of the Donner Creek sub-watershed.
		Discrete Sampling (Tributary)	**1 station:** Confirm site, install, operate and maintain (DST-DCC1)	$30,000	$20,000	N	• Stream water sample collection focusing on water quality and pollutants of concern during elevated stream flow conditions, when pollutant are most likely to be mobilized from source and transported in streams. • Track tributary water quality at downstream end of high disturbance sub-watershed.
		Donner/Cold Creeks Phase II Total		**$60,000**	**$55,000**		
	Trout Creek	Rapid Assessment[1]	**1 stream mile** upstream from confluence with Truckee River	-	$2,000	N	• Cost-effective method to track fine sediment deposition in priority stream reaches. • Assess distribution of fine sediment in downstream mile of Trout Creek.
		Discrete Sampling (Community)	**1 station:** Operate and maintain (DSC-TC1)	-	$11,000	N	• Standardize stormwater sampling across sites and over time by sampling first flush using passive samplers. • Sample stormwater quality from a primary drainage point within the developed area of the Trout Creek sub-watershed.
		Discrete Sampling (Tributary)	**1 station:** Confirm site, install, operate and maintain (DST-TC1)	$30,000	$20,000	N	• Stream water sample collection focusing on water quality and pollutants of concern during elevated stream flow conditions, when pollutant are most likely to be mobilized from source and transported in streams. • Track tributary water quality at downstream end of high disturbance sub-watershed.
		Trout Creek Phase II Total		**$30,000**	**$33,000**		

Table 5.2. TRWQMP Phase II (continued)

Jurisdiction	Sub-watershed	Component	Station(s)	Cost to implement new Phase II station(s) (First Year)	Average annual operations and maintenance cost for all stations	Existing stations with potential for integration?	Justification, Assumptions and Notes
Outside of both jurisdictions: costs split equally	Sagehen Creek	Discrete Sampling (Tributary)	**1 station Sagehen Creek:** Confirm site, install, operate and maintain (DST-SHC1)	$30,000	$20,000	N	• Stream water sample collection focusing on water quality and pollutants of concern during elevated stream flow conditions, when pollutant are most likely to be mobilized from source and transported in streams. • Under Phase II a discrete tributary sampling station at the downstream end of Sagehen Creek will be installed to represent a low disturbance sub-watershed.
		Sagehen Creek Phase II Total		**$30,000**	**$20,000**		

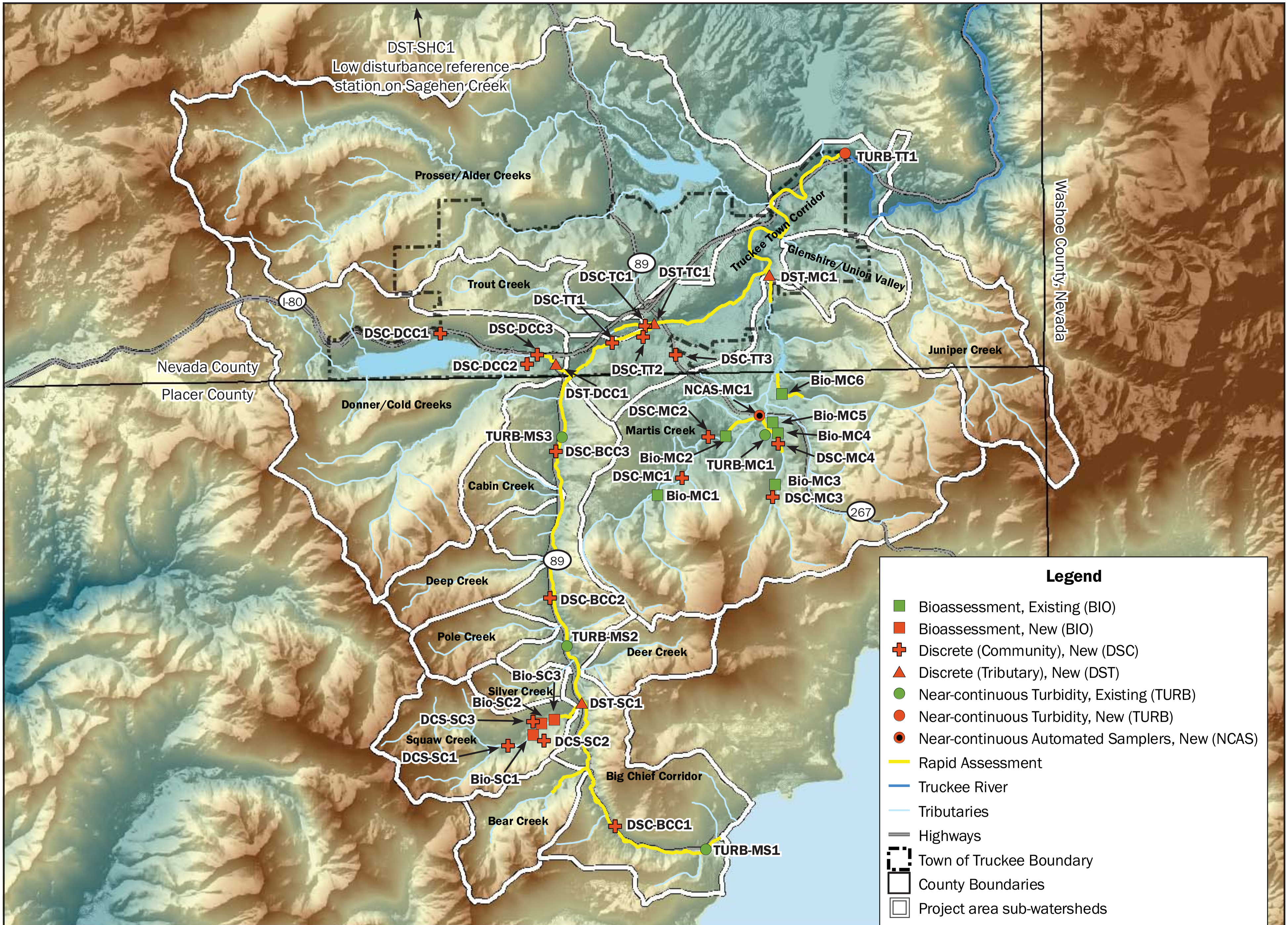
TRWQMP Phase II Total Costs	Jusidiction	Cost to implement new Phase II station(s) (First Year)	Average annual cost to maintain and operate all station(s)
	Placer County	**$139,000**	**$499,000**
	Town of Truckee	**$198,000**	**$195,000**
	Total	**$337,000**	**$694,000**

[1] Rapid assessment costs are based on the assumption that 31 stream miles are assessed per year.

[2] Since bioassessments are conducted every other year, operations and maintenance costs are only incurred every other year. Therefore, bioassessment average annual costs equal half of the operations and maintenance costs to reflect this bi-annual frequency.

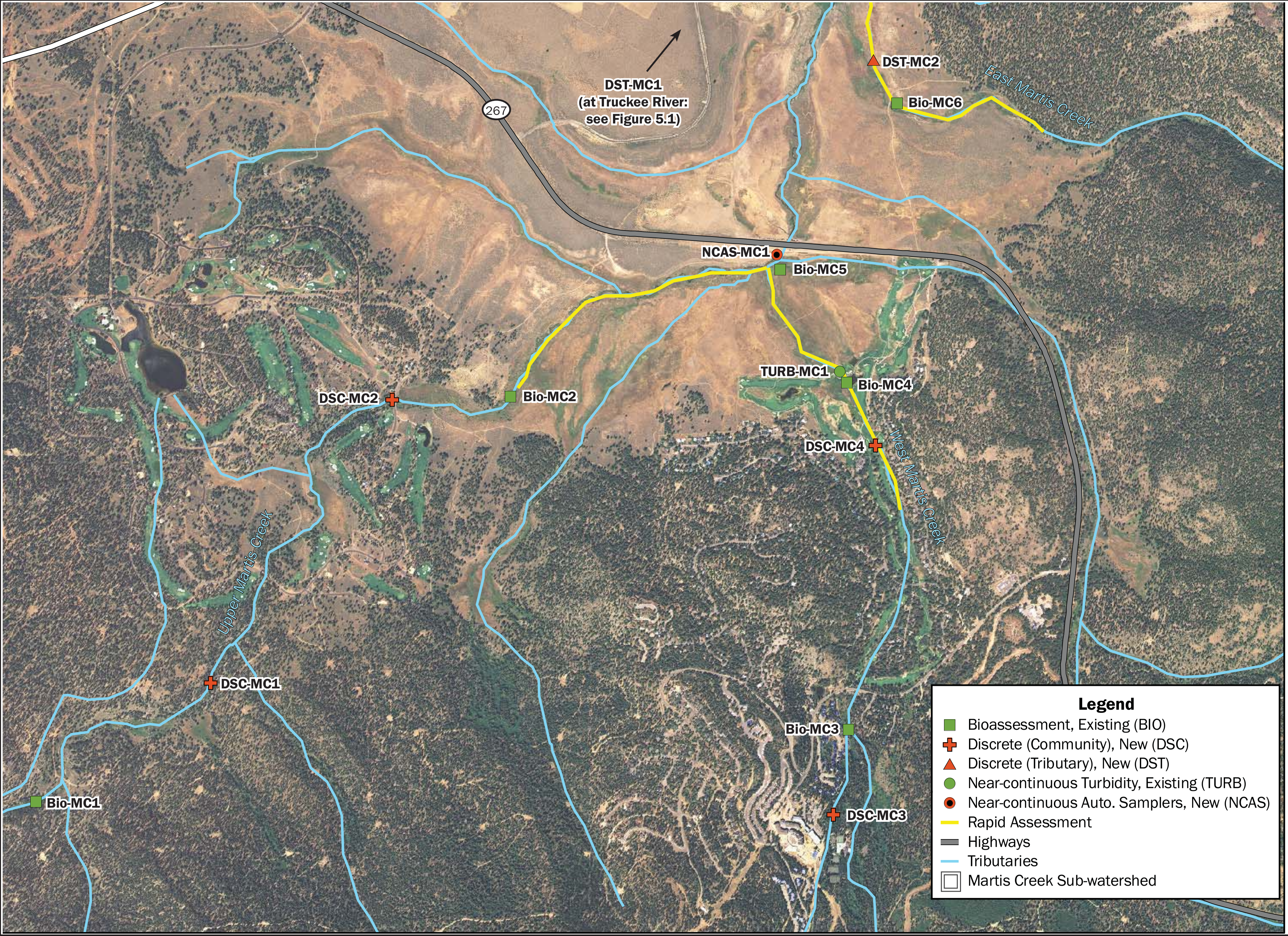
Notes:

- Cost estimates are based on consultants to complete work using accredited analytical laboratories and other professional services.
- For new stations that could address the monitoring needs of multiple permittees, potential cost sharing opportunities are noted but not incorporated into the cost estimates provided.
- For existing stations that could be integrated into the TRWQMP, potential cost sharing with existing operators is noted but not incorporated into the cost estimates provided.
- Permitting and easement costs ranging from $3,000 to $6,000 per station are included in cost estimates.



TRWQMP Phase II Monitoring. Station locations based on available information in 2008. Final station locations will be determined during the actual implementation of each independent assessment effort.

FIGURE 5.5



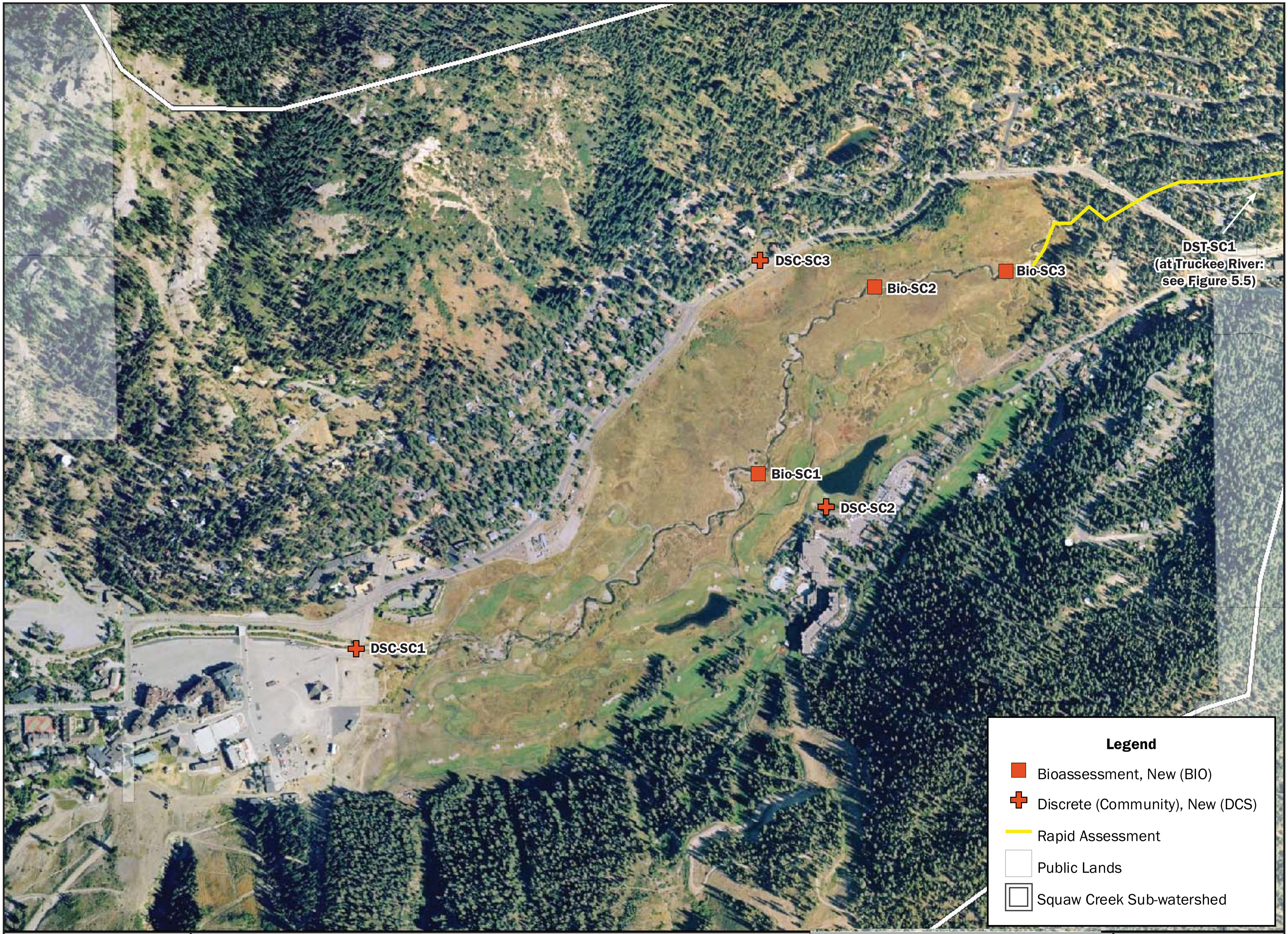
2NDNATURE LLC

Martis Creek Phase II Monitoring. Station locations based on available information in 2008. Final station locations will be determined during the actual implementation of each independent assessment effort.

0 1,000 2,000 3,000 Feet

N

FIGURE 5.6



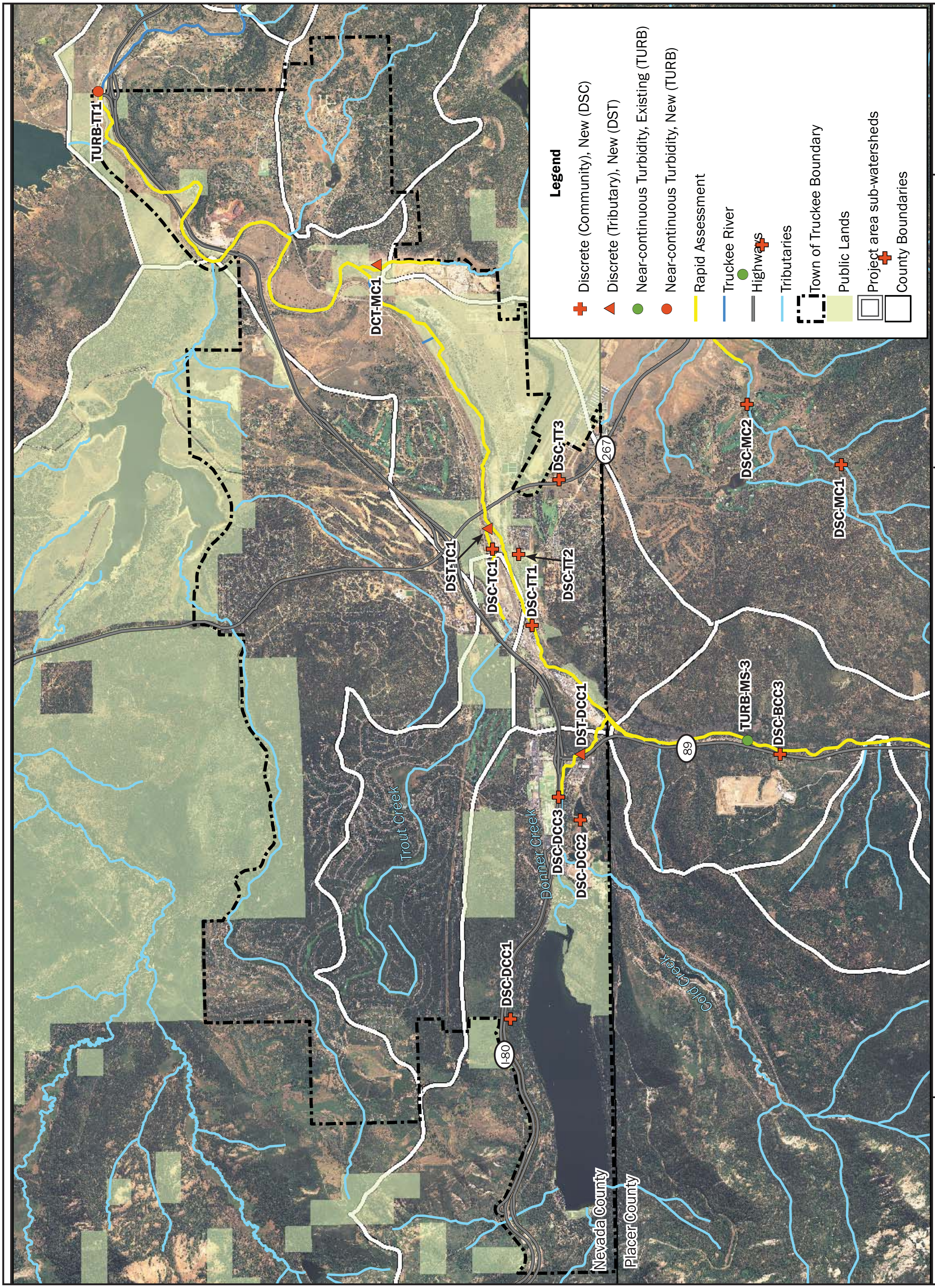
2NDNATURE LLC

Squaw Creek Phase II Monitoring. Station locations based on available information in 2008. Final station locations will be determined during the actual implementation of each independent assessment effort.

0 500 1,000 1,500 Feet

N

FIGURE 5.7



Town of Truckee Phase II Monitoring. Station locations based on available information in 2008. Final station locations will be determined during the actual implementation of each independent assessment effort.

2NDNATURE LLC

FIGURE 5.8

5.3 Phase III

Phase III will be the iterative definition of the TRWQMP following the complete implementation of Phase II of the TRWQMP. Phase III will be further defined based on the integration of existing land use conditions and TRWQMP monitoring results from Phases I and II. Phase III will include the evaluation and consideration of existing data and the knowledge gained therein, as well as an updated evaluation of existing land use conditions, new developments, permits and other relevant factors that may impact water quality. The assessment types, standards and protocols within this TRWQMP will be utilized to define Phase III in a manner most appropriate to meet the goals and objectives of the TRWQMP given future funding, knowledge and conditions.

For the purpose of providing a complete a 15 year fiscal analysis, the level of effort of Phase II is assumed to be maintained for 10 yrs (through 2023). The cost estimates include an annual 3% inflation rate (Section 5.8).

5.4 Station Selection and Justification (Placer County)

Specific stations have been selected for each assessment type given available and existing information. The final selection of the exact assessment station will be determined during actual implementation to select the most feasible exact location given the assessment type purpose (Section 4.0) and the associated logistics of particular instrumentation protocols and selection strategy (Section 6.0). The final station location selection will also need to consider access restrictions, land ownership and other potential permitting considerations (Section 6.1).

5.4.1 Martis Creek Sub-watershed

Martis Creek is designated a high disturbance, high priority sub-watershed (Section 3.2) due to the high amount of existing, ongoing, and potential land development. At the time of the TRWQMP development, Placer County has fiscal resources to implement and maintain Phase I components within Martis subwatershed. In 2002, Martis Creek showed a 20-25% impairment of biological integrity relative to reference conditions (Herbst 2002), raising concern about the impact of development on stream habitat quality. A number of existing independent bioassessments, discrete and near continuous water quality assessments are being conducted by the developers in the sub-watershed (e.g. Northstar Properties, Martis Camp and Lahontan (Appendix A)). Potential coordination with a selection of these efforts will be undertaken. In addition, Placer County has secured annual funds from developers for the initiation and long-term maintenance of a comprehensive water quality assessment program in this sub-watershed. Due to these immediately available funds, Phase I in the Martis Creek sub-watershed will satisfy the regulatory requirements (Section 2.3) for a comprehensive monitoring plan in this sub-watershed.

Phase I monitoring (Figure 5.2) includes six bioassessment stations that are currently being operated under the Northstar Mountain Properties LLC (2 stations; Bio-MC3, Bio-MC4) and Martis Camp (4 stations; Bio-MC1, Bio-MC2, Bio-MC5, Bio-MC6) monitoring programs on Upper, Middle and East Martis Creeks. In order for these data to be integrated into the TRWQMP, these existing monitoring programs must be modified to follow the SWAMP Bioassessment Procedures (2007).

Phase I also includes rapid assessment efforts along one mile of Martis Creek downstream from Martis Creek Lake, and 3 upstream miles of the creek along the Upper, West and East branches. The rapid assessments on Upper and West Martis Creeks will begin upstream of the backwater conditions created by Martis Dam.

Under Phase I, 4 community level discrete sampling stations will be operated in the Martis Creek sub-watershed (DSC-MC1 through DSC-MC4). The purpose of these stations is to characterize stormwater runoff from the Martis Camp, Lahontan and Northstar developments. At the outlet of Martis Creek to the Truckee River, a tributary level discrete sampling station will be operated under Phase I to evaluate cumulative water quality impacts from the sub-watershed at the confluence with its receiving waters.

Leveraging existing monitoring programs in the sub-watershed, Phase I will include two near-continuous stations: 1 near-continuous turbidity probe currently operated by Northstar (TURB-MC1), and 1 near-continuous automated sampler (NCAS-MC1) that has been installed but is not operational. Under Phase I, this station will be brought online and maintained.

Phase I and Phase II for the Martis Creek sub-watershed are identical. Changes in land use, additional development projects and/or results from TRWQMP data evaluations should be employed to make informed future modifications to the TRWQMP in Martis Creek as necessary.

5.4.2 Squaw Creek Sub-watershed

Squaw Creek is included on the Clean Water Act Section 303(d) list as impaired by sediment, and the Board is implementing a program to achieve a sediment TMDL for the waterbody. The required TMDL tracking is based on sampling and analysis of macroinvertebrates. Due to this particular regulatory requirement, Phase I monitoring in Squaw Creek (Figure 5.3) focuses on the required bi-annual bioassessment efforts under the TMDL. Implementation of this bio-assessment is the shared responsibility of the 4 dischargers in the subwatershed (Squaw Village Neighborhood Company, Placer County, Resort at Squaw Creek, Squaw Valley Ski Corporation; see Appendix A). This bioassessment is scheduled to begin in 2009 using protocols and sampling locations (Bio-SC1 through Bio-SC3) adapted from Herbst (2001, 2002) and SWAMP (2007). Rapid assessment will also be conducted at the downstream mile of this high disturbance, high priority sub-watershed.

Phase II in Squaw Creek (Figure 5.7) includes the coordination, operation and maintenance of 3 community level discrete water quality stations (DSC-SC1 through DSC-SC3). A number of existing independent discrete water quality measurement efforts are periodically conducted by Squaw Creek permittees. Under Phase II, it will be a priority to coordinate efforts with these groups to implement and follow the protocols and standards in the TRWQMP. Assistance by the Board in coordinating these monitoring efforts to comply with TRWQMP standards would improve the value of these community level evaluations. Phase II also includes the installation and maintenance of tributary level discrete water quality station (DST-SC1) at the mouth of this high disturbance, high priority sub-watershed.

5.4.3 Big Chief Corridor

The Big Chief Corridor contains 13 miles of the middle Truckee River between the outlet of Lake Tahoe and the Nevada/Placer County line. Water quality assessment in this reach is critical in evaluating cumulative effects on the resource as part of the comprehensive monitoring plan. Coordination and cooperation with 3 existing DWR near-continuous turbidity stations (TURB-MS1 through TURB-MS3) will be undertaken by the County and Town in an effort to operate and maintain these stations for integration into the TRWQMP. These stations provide a high-resolution record of water quality on the main stem of the Truckee River over time and are particularly useful due to their continues record dating back to 2003.

Rapid assessment will also be conducted along 13 miles of this high disturbance, high priority sub-watershed. This low-cost assessment will provide valuable information on sediment distribution patterns within the main stem, helping to identify legacy sites, tributaries or other local sources contributing a large amount of fine sediment to the main stem. Once the methodologies and procedures have been implemented locally, rapid assessments are suitable for future implementation by volunteer monitors due to the low level of expertise necessary. This provides opportunities to leverage existing local volunteer monitoring programs such as the Truckee River Watershed Council (TRWC) Snapshot Day and Aquatic Monitors Programs to conduct rapid assessments throughout the project area. The annual implementation of the rapid assessment will raise citizen awareness about the state of this important resource. The TRWC Snapshot Day currently covers the entire main stem of the Truckee River within the project area. It is recommended that the County and Town coordinate with the TRWC to integrate training on rapid assessments into its existing monitoring training with assistance from Consultants. Phase I and II cost estimates assume that consultants implement all components of the rapid assessment efforts. However, there is potential for volunteer groups to conduct significant portions of the annual observations and a local non-profit group could eventually train, lead and implement the majority of the annual efforts necessary to implement the rapid assessments.

Phase II (Figure 5.8) includes the placement of 3 community level discrete water quality stations (DSC-BCC1 through DSC-BCC3) to improve the evaluation of the direct fine sediment contribution of Highway 89 to the main stem of the middle Truckee River. It is recommended that efforts are made to include Caltrans in the cost-sharing program to maintain these sites.

5.4.4 Bear Creek Sub-watershed

Due to the low level of development and human disturbance in this sub-watershed relative to other high disturbance sub-watersheds, water quality assessments in this sub-watershed are not a high priority. Rapid assessment efforts will be conducted at the downstream mile of Bear Creek before it convenes with the Truckee River.

5.5 Site Selection and Justification (Town of Truckee)

5.5.1 Truckee Town Corridor

Truckee Town Corridor is designated a high disturbance, high priority sub-watershed (Section 3.2) due to the high density of existing development. There is currently little water quality assessment being conducted to track and assess impacts of stormwater from within the developed areas of the Town. Phase I (Figure 5.4) includes the installation and maintenance of a community level discrete water quality station (DSC-TT1) and the annual completion of the rapid assessment along 10 miles of the Truckee River within the Truckee Town Corridor.

Phase II (Figure 5.8) includes the addition of a near continuous turbidity station in the main stem of the middle Truckee River at the downstream boundary of the Town of Truckee jurisdiction (TURB-TT1). As new development is undertaken within the Town in the next 5 years, 2 additional community level discrete monitoring stations (DSC-TT2 and DSC-TT3) will be installed to evaluate the potential water quality impacts to downstream resources.

5.5.2 Donner/Cold Creeks

Phase I (Figure 5.4) includes rapid assessment at the downstream mile of this high disturbance, high priority sub-watershed, as well as the installation of a community level discrete water quality station (DSC-DCC1) to evaluate stormwater runoff from a primary drainage point within a developed area of the sub-watershed. Phase II (Figure 5.8) includes the installation and maintenance of a tributary level water quality station (DST-DCC1) at the downstream extent of Donner Creek and the installation of 2 additional community level discrete monitoring stations (DSC-DCC2 and DSC-DCC-3) to evaluate the potential water quality impacts of I-80 and planned development in this area.

5.5.3 Trout Creek

Phase I (Figure 5.4) includes rapid assessment at the downstream mile of this high disturbance, high priority sub-watershed. In addition, a community level discrete water quality station (DSC-TC1) will be implemented to evaluate stormwater runoff from a primary drainage point within a developed area of the sub-watershed. Phase II (Figure 5.8) includes the installation and maintenance of a tributary level water quality station at the downstream extent of Trout Creek.

5.6 Reference Site Selection and Justification

Phase II includes the integration of a low disturbance reference station along Sagehen Creek. Due to the extensive amount of development and planned development in the TRWQMP project area, a reference sub-watershed outside of the project area was selected. Sagehen Creek is the site of the Sagehen Creek Field Station, operated by the University of California, Berkeley since 1951.The creek has been a USGS Hydrologic Benchmark Network (HBN) site since October, 1953, resulting in a consistent, long-term hydrology dataset on the creek. Existing and future data will be useful if incorporated into the TRWQMP dataset analyses to inform conditions of a regional low impact watershed. It is recommended that the County and Town coordinate with the operators of the Field Station to allow for the installation of a tributary level discrete water quality station (DST-SHC1).

The use of water quality and hydrologic data from a reference site is highly recommended under Phase II because it will provide valuable context for the interpretation of water quality data from high disturbance sub-watersheds in the project area. These data can potentially be used to determine “achievable” pollutant concentrations and loads for the region, to understand temporal variability in a relatively undistributed sub-watershed, and to evaluate whether or not certain unimpaired waterbodies are meeting non-degradation criteria.

5.7 Strategy for Component Prioritization

Given the fact that funding opportunities and agency budgeting decisions are periodic and somewhat unpredictable, the County and Town will need to implement a strategy for prioritization of assessment type and location selection. This process will be iterative over time and based on the following information:

- Prioritization of community level assessments based on new developments, land use changes and other water quality impact concerns.
- Implementation and maintenance of the annual rapid assessment evaluations of the surface water stream resources that the local SWMPs are ultimately designed to protect.
- Prioritization of tributary level assessments based on new developments, land use changes and other water quality impact concerns.
- Consideration of new and existing developments that will require extensive SWMP actions to mitigate potential downstream water quality impacts.
- The issuance of new permits or other regulations for specific entities.
- The annual results, synthesis and interpretation of the water quality assessment data from implemented assessments included in the TRWQMP. Results may indicate (1) that

water quality impacts are not measureable from a specific location and perhaps the assessment efforts should be reduced and/or eliminated, or (2) that water quality impacts are identified and assessment efforts should be increased to gain more detailed information.

Given the phased approach set forth above and the conditional and iterative nature of the TRWQMP components, it is strongly recommended that the County of Placer and the Town of Truckee have a technical expert continually involved in the evaluation of existing data, prioritization of future implementation, and development of recommendations to ensure the goals, objectives and actions of the TRWQMP are continually met with the resources available.

Table 5.3 summarizes the acceptable and ideal assessment frequency for each assessment type, as well as the time of year the assessment is conducted. Cost estimates detailed in Appendix B and summarized in Tables 5.1 and 5.2 assume that the ideal assessment frequency is performed for each respective assessment type.

Assessment Type	Minimum Assessment Frequency	Ideal Assessment Frequency	Assessment Timing
GIS Source Area Prioritization	Every 5 years	Every 3 years	n/a
Rapid Assessment Methodologies (RAM)	Bi-annual	Annual	Between August and early October
Bioassessments	Bi-annual	Bi-annual	Between June and August
Discrete Water Quality Measurements (Community Level)	6-8 events per year	10 events per year	Runoff following sustained dry antecedent conditions
Discrete Water Quality Measurements (Tributary Level)	6-8 events per year	15 events per year	When tributary exceeds one of the 3 specific flow frequencies
Near-continuous Automated Turbidity Probes	15-minute intervals for hydrology and turbidity measurements; 10-15 events sampled prioritizing large discharge conditions	15-minute intervals for hydrology and turbidity measurements; 10-15 events sampled prioritizing large discharge conditions	Near-continuous
Near-continuous Automated Samplers	15-minute intervals for hydrology measurements; 8-10 storm events sampled	15-minute intervals for hydrology measurements; 10-15 storm events sampled	Near-continuous

Table 5.3. Assessment frequency and timing by assessment type.

5.8 Program Development, Data Management and Reporting

Phase I includes costs and efforts to initiate and coordinate all of the Phase I TRWQMP components. Tasks will include coordination and negotiations with entities conducting existing efforts, applying for and securing funding, and potentially obtaining consultants to implement and manage Phase I. A long-term goal of the TRWQMP is the development and maintenance of an integrated database to combine and store the independent datasets from each of the TRWQMP components. This consolidation of assessment data will provide validation that data are being maintained consistently and will simplify annual synthesis and reporting of the TRWQMP findings and future recommendations. The year one and annual maintenance costs for these efforts are distributed among the sub-watersheds to reflect the relative amount of data and associated level of effort contribution to the Phase I TRWQMP.

5.9 15-Year Fiscal Analysis

The Phase I and Phase II cost estimates per assessment station were derived based on detailed estimates per assessment type. Appendix B includes the detailed equipment, analytical, permitting, and consultant labor necessary to complete a typical unit assessment based on costs as of May 2008.

Table 5.4 presents the projected 15-year costs for the TRWQMP. All assumptions used to estimate annual costs by jurisdiction to implement and maintain the TRWQMP are noted in Table 5.4. The costs presented are the total estimated costs to implement the stations and assessment efforts included in Phase I and Phase II (Table 5.1 and Table 5.2), respectively. No cost reductions are accounted for as a result of potential cost-sharing or cost-saving with either existing monitoring programs or potential cost-sharing of future monitoring. The costs provided are the total costs to implement all components of the comprehensive TRWQMP. These estimates are based on costs as of May 2008 and are compounded for inflation using a 3% annual inflation rate.

Year	Phase	Anticipated Annual Cost			Notes/Assumptions
		Placer County	*Town of Truckee*	*Total*	
1	I	**$322,000**	**$44,000**	**$366,000**	Placer and Town of Truckee implement 50% of Phase I monitoring in year 1.
2	I	**$536,000**	**$77,000**	**$613,000**	Placer and Town of Truckee implement remaining 50% of Phase I monitoring in year 2.
3	I	**$421,000**	**$66,000**	**$487,000**	Phase I is fully implemented and is operating at the average annual operations and maintenance cost.
4	II	**$510,000**	**$177,000**	**$687,000**	Placer and Town of Truckee maintain Phase I and implement 50% of Phase II monitoring in year 4.
5	II	**$580,000**	**$259,000**	**$839,000**	Placer and Town of Truckee maintain Phase I and 1/2 of Phase II, and implement the remaining 50% of Phase II monitoring in year 5.
6	III	**$573,000**	**$227,000**	**$800,000**	Phase II is fully implemented. Phase III operates at average annual operations and maintenance cost for Phase II.
7	III	**$591,000**	**$234,000**	**$825,000**	
8	III	**$609,000**	**$241,000**	**$850,000**	
9	III	**$627,000**	**$248,000**	**$875,000**	
10	III	**$646,000**	**$256,000**	**$902,000**	
11	III	**$666,000**	**$264,000**	**$930,000**	
12	III	**$686,000**	**$272,000**	**$958,000**	
13	III	**$707,000**	**$280,000**	**$987,000**	
14	III	**$729,000**	**$289,000**	**$1,018,000**	
15	III	**$751,000**	**$297,000**	**$1,048,000**	

Notes:
- Costs include annual 3% inflation rate for years 2-15.
- Actual timing and level of implementation of Phases I and II will depend on available funds and cooperation of permit holders and stakeholders in the project area.

Table 5.4. Projected 15-year fiscal analysis for the TRWQMP.

6.0 STATION IMPLEMENTATION AND DATA COLLECTION PROTOCOLS

6.0 STATION IMPLEMENTATION AND DATA COLLECTION PROTOCOLS

Section 6.0 presents the details of data collection, management, and reporting for each assessment type. Section 7.0 presents the strategy for data integration and data management from each of the respective assessments throughout the project area. Section 7.0 also includes guidelines to focus the TRWQMP annual reporting efforts.

The TRWQMP implementation is divided into three phases. Phase I represents the minimum monitoring effort that should be implemented to achieve the goals of the TRWQMP. Phase II represents the ideal effort that should be implemented as more resources become available. Phase III will be defined as the periodic decisions are made via consultation between agencies/stakeholders, based on integration of existing land use conditions and monitoring results. The recommended station locations, assessment types and associated costs by jurisdiction and sub-watershed for Phases I and II are summarized in Section 5.0.

6.1 Permitting Requirements Summary

Prior to the implementation of any of the monitoring efforts, the potential permitting requirements by assessment type will need to be evaluated based on the specific desired location of implementation. The Truckee River Water Quality Monitoring Plan (TRWQMP) will require access to, and placement of, instrumentation on a number of parcels within the project area (Figure 3.1). As a result, Placer County (County) and the Town of Truckee (Town) may need to obtain permits, easements, and/or approvals to conduct the monitoring efforts. The necessary permits, easements, and/or approvals will be determined by the applicable permitting/funding agency (Section 6.1.1) or landowner (Section 6.1.2). There is the potential that other permits, easements, and/or approvals may be required depending on the funding source for the project.

6.1.1 Agency Requirements

<u>Placer County and Town of Truckee</u>

California Environmental Quality Act (CEQA)
The County/Town will need to make a CEQA determination for the adoption of the TRWQMP and the proposed monitoring effort. The TRWQMP and the resulting monitoring effort will qualify as *projects* under CEQA since public agencies (County/Town) are implementing the projects and there is the potential for the projects to impact the environment. The County stated that the adoption of the Plan should qualify as a categorical exemption under CEQA (Class 6 Exemption). If the project is determined to be exempt, the County/Town will file a Notice of Exemption with the State Clearinghouse based on the determination. The proposed monitoring effort, that will take place as a result of the adoption of the Plan, should qualify as a categorical exemption (Class 6 Exemption) or a Mitigated Negative Declaration. The County/Town will need to make this determination and conduct the necessary documentation process. The County contact for processing the CEQA determination is:

> *Gina Langford, Environmental Coordinator*
> *Community Development Resource Agency, Environmental Coordination Services*
> *530-745-3125*
> *glangford@placer.ca.gov*
> *www.placer.ca.gov/Departments/CommunityDevelopment/EnvCoordSvcs.aspx*

The Town contact for processing the CEQA determination is:

Truckee Planning Division
530-582-7820
www.townoftruckee.com

California Department of Fish and Game
If the instrumentation is to be installed within a tributary floodplain, the County or Town may require that the California Department of Fish and Game (CDFG) conduct a State agency review. If this review is determined to be required by the County or Town, a Lake and Streambed Alteration Notice will be required to be submitted to the CDFG. The contact for CDFG is:

California Department of Fish and Game
North Central Region Office
916-358-2929
www.dfg.ca.gov/habcon/1600/notification_pkg.html

U.S. Fish and Wildlife Service

If the instrumentation is to be installed within a threatened or endangered species habitat area, an endangered and threatened species permit may be required. The U.S. Fish and Wildlife Service (USFWS) should be contacted to determine if a permit will be required, as it is dependent upon the impact the activity could have on the species and whether an exemption would apply. If the USFWS determines that a permit is not required for the level of activity that will be conducted, a letter of concurrence should be issued to the County/Town as confirmation. At least one federally listed threatened species, the Lahontan Cutthroat Trout, has known habitat within the project area. The inquiry should be made to:

U.S. Fish and Wildlife Service
Sacramento Fish and Wildlife Office
2800 Cottage Way, Suite W-2605
Sacramento, California 95825
916-414-6492
www.fws.gov/sacramento/es/permits.htm

Other Agencies

Based on the assessment types included in the TRWQMP (Sections 4.0 and 5.0), it was determined that the following agencies will not require permits, easements, or approvals. If the scope of the TRWQMP expands, these agencies may need to be contacted to make a new determination.

Regional Water Quality Control Board
The TRWQMP is being developed in part to comply with the Board Order from the Regional Water Quality Control Board (Board). As a result, the Board is a member of the TRWQMP Extended Core Team and has reviewed and commented on all TRWQMP sections during development. The Board regulations include prohibitions on the discharge of waste, including earthen materials, within floodplain areas of the Truckee River and its tributaries that would be inundated by a flood with a 100-year return cycle. These prohibitions apply generally to activities and associated waste discharges in riparian and wetland areas. Review and approval will be needed for projects with actual or threatened waste discharges in these areas. Exemptions to the discharge prohibitions are available for installation of monitoring equipment and similar “projects solely intended . . . to mitigate existing sources of erosion or water pollution. . . “ and/or “projects necessary . . . to provide essential public services” such as managing storm water

programs. Exemptions are provided based on a demonstration that water quality protection criteria established in the *Water Quality Control Plan for the Lahontan Region* are met. If not prohibited (exemption granted), it is anticipated that minor construction activities and waste discharges associated with TRWQMP implementation may be regulated under the existing waste discharge requirements in Water Quality Order No. 2003-0005-DWQ (or its successor NPDES general permit), and the Storm Water Management Plans of the Town and/or Placer County. In some cases, activities may be conducted in 100-year floodplain areas that would not violate the discharge prohibitions mentioned (i.e., if all wastes are controlled).

U.S. Army Corps of Engineers
Based on the assessment types proposed in the TRWQMP, U.S. Army Corps of Engineers (USACE) permits will not be required. If the scope expands to include dredge or fill work within a Waters of the U.S. or work within a navigable waterway, a permit or letter of permission may be required. If the instrumentation is to be installed on USACE land, a NEPA determination may be required. If a federal permit is issued (by the U.S. Army or, rarely, U.S. EPA), that permit must be 'certified' by the State to be valid. Application to the Water Board for 'certification' that the federal permit is in compliance with State law is typically needed unless the federal permit has been previously certified, as occurs in some cases involving minor discharges. In all cases, the applicant for a federal permit will be notified if State certification or notification to the State is required to validate the federal permit. (See *Regional Water Quality Control Board* section, above.)

Bureau of Land Management
There is no Bureau of Land Management (BLM) land located within the TRWQMP project area; therefore, no permits or approvals will be required. If the instrumentation is to be installed on BLM land, a NEPA determination may be required.

6.1.2 Landowner Requirements

The County and/or Town may need to obtain permits, easements, and/or approvals dependent upon the specific landowner where access, data collection, and/or instrumentation will be located. The anticipated requirements based on the potential TRWQMP activities are outlined by landowner type below. Figure 6.1 indicates the respective land ownership within the project area.

<u>Private</u>

It is recommended that the County or Town have a legal agreement in place with each private landowner prior to conducting data collection on their parcel. There are four main types of access agreements that can be utilized:

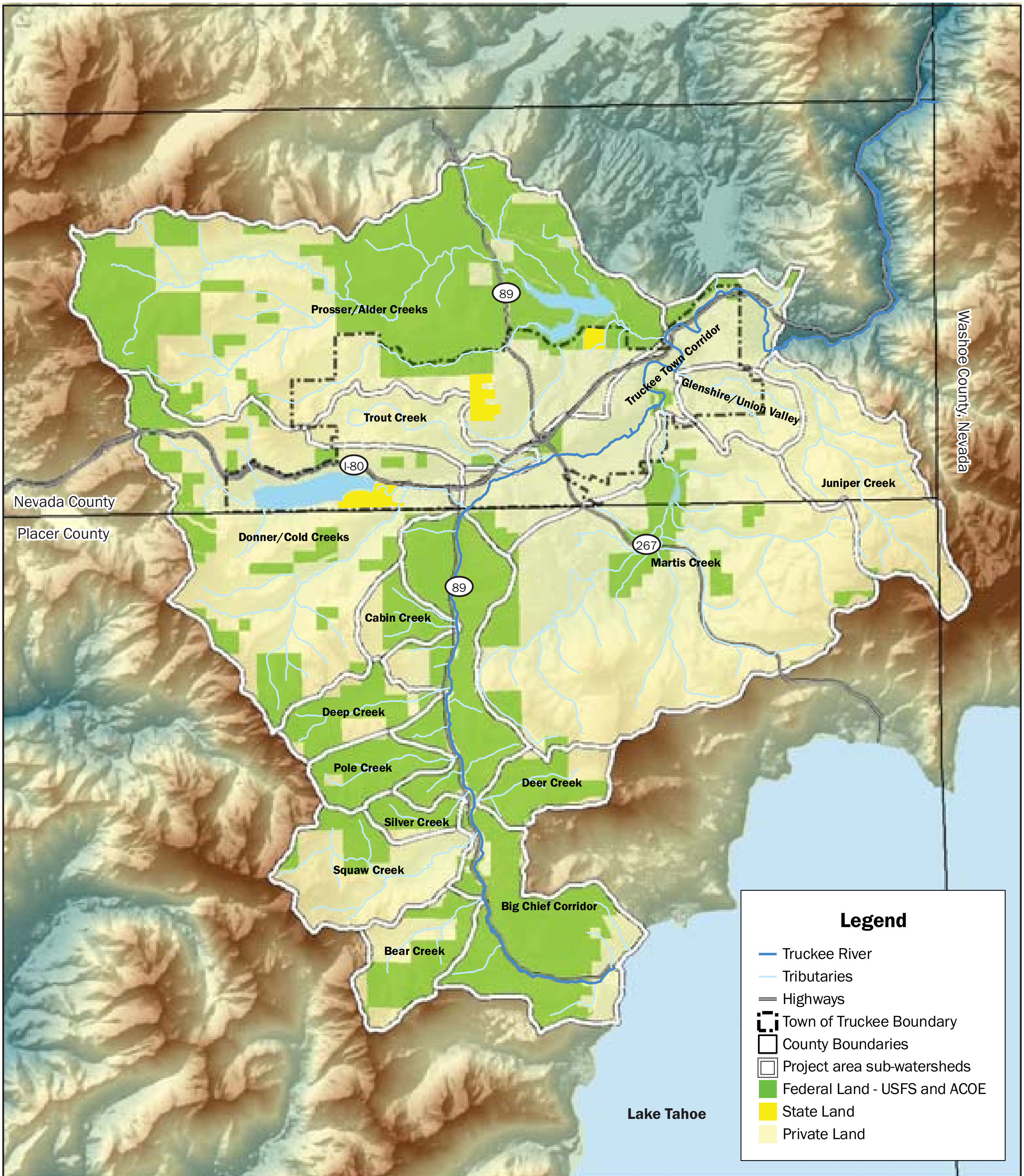
1. Temporary Easement
2. Permanent Easement
3. Right of Entry
4. Access Only Easement

A temporary or permanent easement is obtained for sites where some type of instrumentation will be installed (passive sampling devices, automated samplers, or *in situ* probes). A right of entry or access only easement can be utilized when a parcel needs to be accessed to make observations or measurements or in order to reach another parcel (rapid assessments or bioassessments). Written permission from the landowner for access is another option available to the County or Town, although these may not be legally binding like formal access agreements.

California Department of Parks and Recreation

If instrumentation is to be installed on a State-owned parcel (by Department of Parks and Recreation), the County and/or Town should contact the Department to determine if a special use permit or lease will be required. The Department will determine the need for a permit or lease on a site by site basis. If a parcel only needs to be accessed for visual monitoring, notification should be made to the District Office but a permit will likely not be required. The inquiry should be made by phone or written correspondence to:

California Department of Parks and Recreation
Sierra District Office
Attn: Sue Dower
P.O. Box 266
Tahoma, CA 96142
530-525-9522
www.parks.ca.gov



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Land ownership in the Truckee River watershed.

FIGURE 6.1

California State Lands Commission

If instrumentation is to be installed on a parcel owned by the State Lands Commission, an inquiry will need to be made to the Commission to determine if a special use permit or lease will be required. The Commission will determine the need for a permit or lease on a site by site basis. If a parcel only needs to be accessed for visual monitoring, notification should be made to the Commission, but a permit will likely not be required. The inquiry should be made by phone or written correspondence to:

California State Lands Commission
Northern California Division
Attn: Leasing Division
100 Howe Avenue, Suite 100 South
Sacramento, CA 95825-8202
Mary Hays, Manager
916-574-1812
www.slc.ca.gov

California Department of Transportation

If instrumentation is to be installed within the California Department of Transportation (Caltrans) right of way, a standard encroachment permit will be required from the Caltrans District 3 Encroachment Permit Office. The permit application should be submitted to:

Caltrans – District 3
Encroachment Permit Office
PO Box 911
Marysville, CA 95901
530-741-4403
http://www.dot.ca.gov/hq/traffops/developserv/permits/

USFS – Tahoe National Forest

If instrumentation is to be installed on a parcel owned by the United States Forest Service (USFS), a special use permit will be required from the USFS – Tahoe National Forest, Truckee Ranger District Office. Depending on the level of work to be conducted on USFS land, a NEPA determination may be required. If the parcel only needs to be accessed for visual monitoring, notification should be made to the District Office but a permit will not be required. The inquiry and/or permit application should be submitted to:

USFS – Tahoe National Forest, Truckee Ranger District
Attn: Adam McClory
9646 Donner Pass Road
Truckee, CA 96161-2949
530-478-6257
www.fs.fed.us/r5/tahoe

6.2 GIS Sub-watershed Source Area Prioritization Protocols

6.2.1 Frequency of Observations

The GIS sub-watershed source area prioritization should be conducted every 3-5 years (see Table 5.3), or as new GIS land use shape files become available. The GIS sub-watershed source area prioritization presented in Section 3.2 was conducted using many GIS layers that were last updated in 2001. This effort should be repeated as soon as updated land use GIS layers are developed for Placer County, Town of Truckee and Nevada County. Figure 6.2 (also Figure 3.2) summarizes the results of the 2008 GIS sub-watershed source area prioritization for comparison to future analyses.

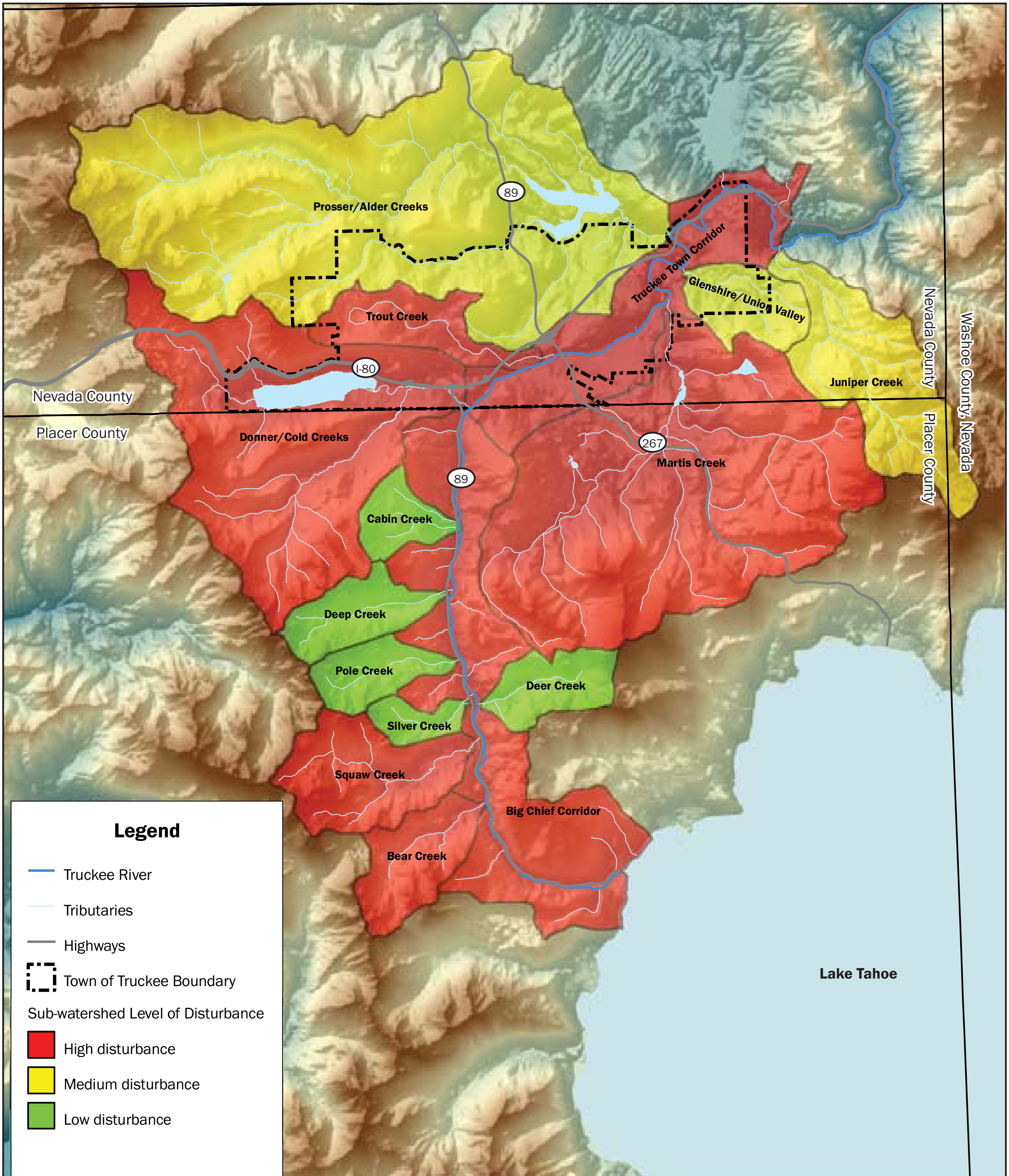
6.2.2 Data Analysis Protocols

GIS analysis is conducted using ArcMap 9.2 with the Spatial Analyst extension. The analysis is performed as follows:

1. Project all layers into U.S. State Plane California II FIPS 0402 (NAD1983).
2. Overlay hydrology and land use layers onto the delineated project area sub-watershed layer (Figure 6.3a).
3. Delineate a “stream zone” extending 1000 ft. from each bank for all of the surface water tributaries within the project area (Figure 6.3b) using the “Buffer” function in the Analysis toolbox. Urban areas in close proximity to streams have been shown to have a larger impact on in-stream water quality due to their high hydrologic connectivity to surface waters (Wang et al. 2001). For this analysis, a relatively large 1000 ft. stream zone is used to capture the land uses contributing runoff to surface waters through stormwater infrastructure.
4. Clip land use data to the stream zones to quantify the land use distribution and density within close proximity to the surface water tributaries (Figure 6.3c).
    a. Clip land use raster data to the stream zones using the “Extract by Mask” function in the Spatial Analyst toolbox.
    b. Clip land use polygon data to the stream zones using the “Clip” function in the Analysis toolbox.
5. Analyze land use data for the stream zones within the each sub-watershed.
    a. Summarize raster data using the “Thematic Raster Summary (by polygon)” tool from Hawth’s Analysis Tools v3.27.
    (free download at http://www.spatialecology.com/htools/tooldesc.php)
    b. Summarize polygon data using the “Polygon in Polygon Analysis” tool from Hawth’s Analysis Tools v3.27.

For the 2008 analysis, the following statistics were calculated within each sub-watershed 1000 ft. stream zone (the shapefiles sources are provided in parentheses for reference):

1. Percent impervious coverage (USGS Land Use/Land Cover (LULC) 2001)
2. Percent medium and high intensity residential development (USGS LULC 2001)
3. Percent potentially erodible areas (landscape_sensf.shp GIS layer from McGraw 2001)
4. Percentage of lands under private ownership (Placer County GIS 2003; Nevada County GIS 2006). Figure 6.4 displays the relative level of privately owned lands within the 1000 ft. stream zones of each sub-watershed at the time the GIS data was developed (Placer County 2003; Nevada County 2006). All private lands have the future risk of development and thus the identification and consideration of these locations are necessary when considering the long-term potential impacts on surface water quality.



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Relative level of disturbance for each sub-watershed based on a GIS analysis of potential source areas.

FIGURE 6.2

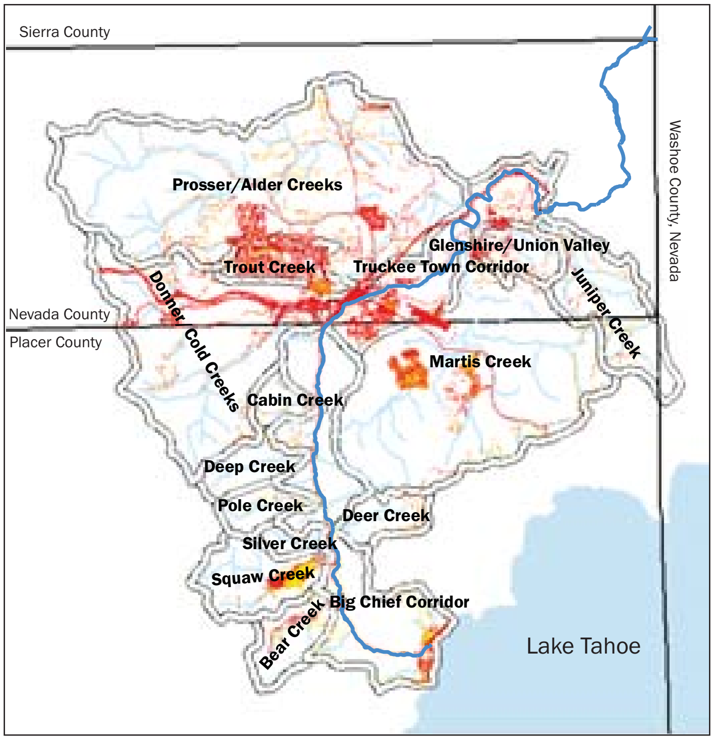


Figure 6.3a. Impervious coverage density within project area.

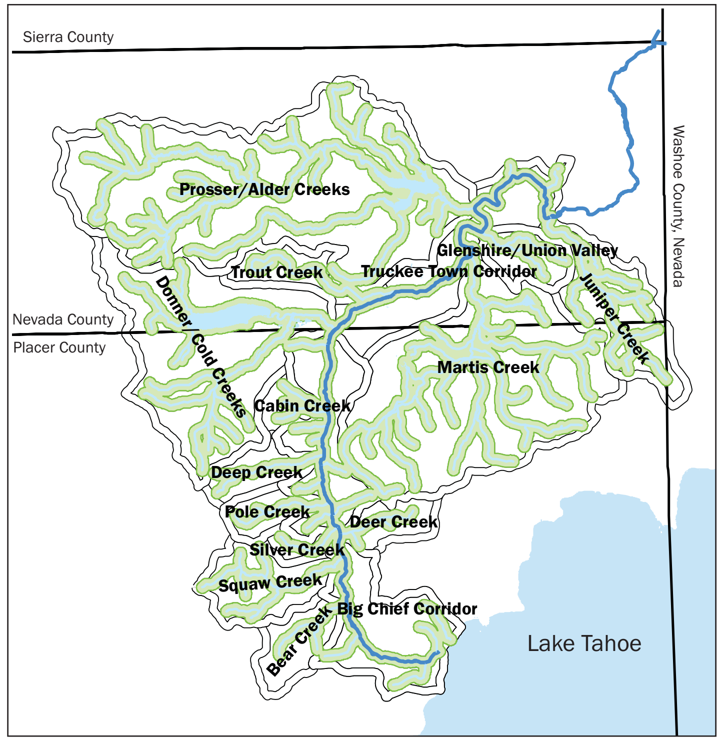
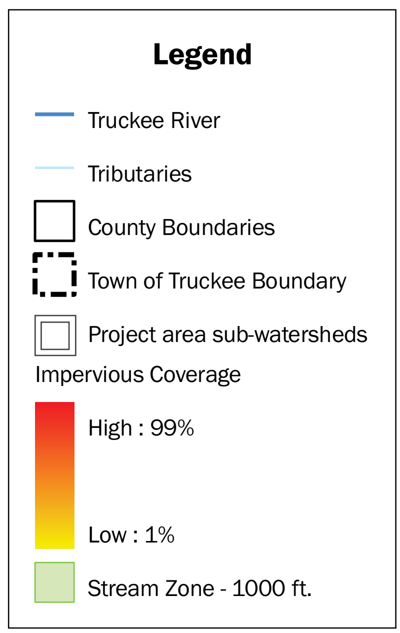
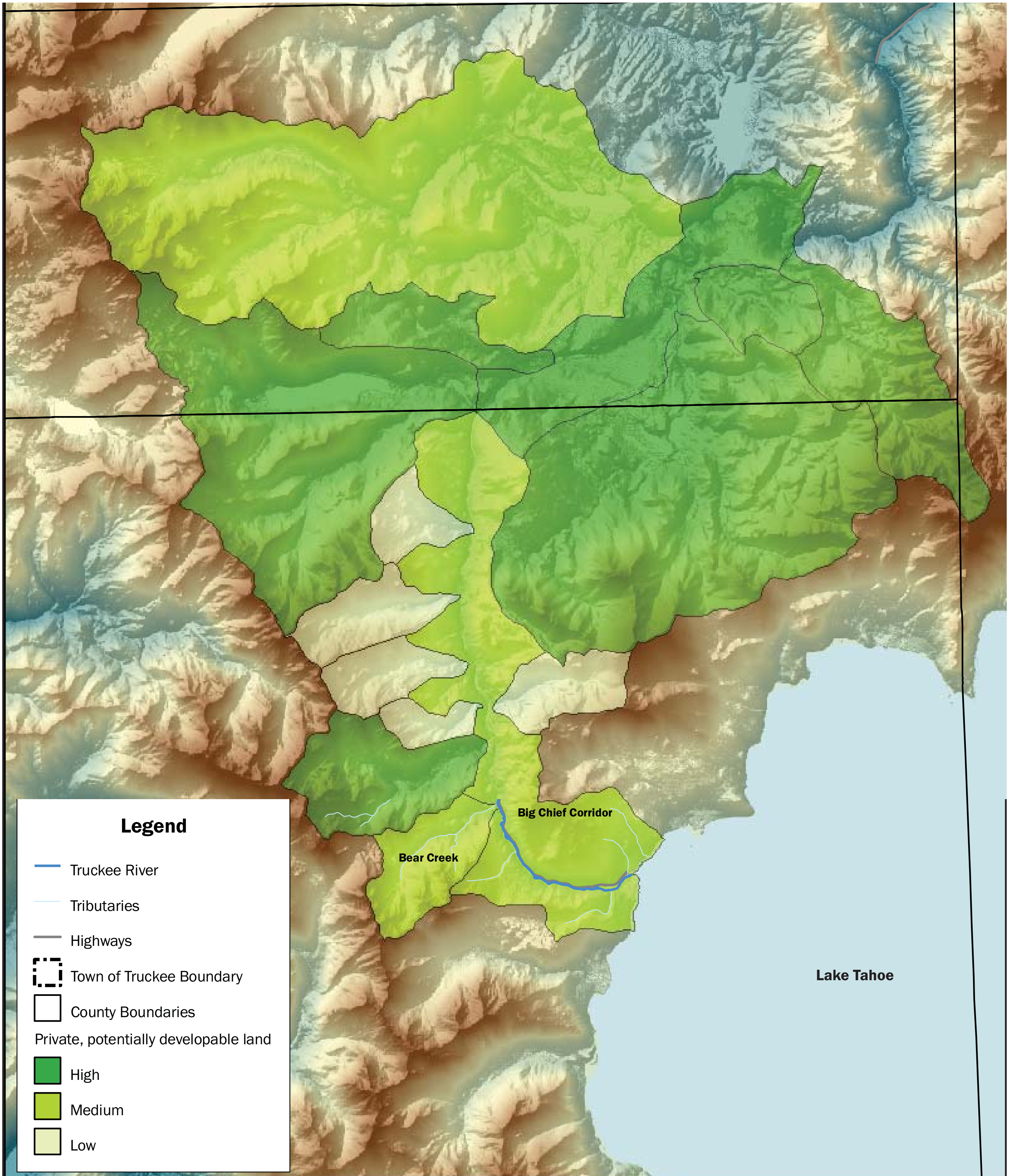


Figure 6.3b. 1000 ft. stream zone around surface water tributaries within project area.

Figure 6.3c. Impervious coverage density layer clipped to the stream zone for analysis.



2NDNATURE LLC	Sample GIS analysis of land use in the stream zone.	0 1 2 3 4 Miles N	FIGURE 6.3



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Relative level of private, potentially developable land within 1000 ft. of the surface water tributaries in each sub-watershed

0 1 2 3 4 Miles N

FIGURE 6.4

Ski run and dirt road density are two non-urban land use characteristics that are assumed to have a potential impact on surface water quality. Since the density of these land uses have been previously quantified at the sub-watershed scale instead of within the stream zones (LRWQCB 2008b; Maholland 2002), these existing values are directly incorporated into the source area analysis:

5. Graded ski run density
    - For the 2008 analysis ski area rankings were taken directly from LRWQCB (2008b) and range from 0-3 (Score=0 if no graded ski runs are present in the sub-watershed).
6. Dirt road density
    - Sub-watershed dirt road density calculated using dirtroadssf.shp GIS layer (McGraw 2001) and validated against LRWQCB (2008b). Value for Squaw Creek sub-watershed taken directly from Maholland (2002), as this study was determined to include a more detailed analysis. Values are expressed as a ratio of miles of dirt road:sub-watershed area in square miles.

The 15 sub-watersheds are then assigned a score from 0-3 for each of the 6 source area characteristics as follows:

- The 33rd and 66th percentiles were calculated for the range of values for each source area characteristic.
- Sub-watershed source area characteristic values were compared to the percentiles and given a score:
    - Source area characteristic not applicable (e.g., no ski runs in sub-watershed) = 0
    - Source area characteristic value < 33rd percentile = 1
    - 33rd percentile ≤ Source area characteristic value ≤ 66th percentile = 2
    - Source area characteristic value > 66th percentile = 3

The 6 source area characteristic scores were averaged to assign each sub-watershed a single sub-watershed source area score between 0 and 3. Based on that score, an initial sub-watershed disturbance level was assigned as follows:

- Sub-watershed source area score < 33rd percentile = Low disturbance (sub-watershed source area score range: 0 – 1.6)
- 33rd percentile ≤ sub-watershed source area score < 66th percentile = Moderate disturbance (sub-watershed source area score range: 1.6 – 2.16)
- Sub-watershed source area score ≥ 66th percentile = High disturbance (sub-watershed source area score range: 2.17 – 3.00)

These sub-watershed disturbance levels are then displayed spatially on a GIS map according to the following color designations. (See Figure 6.2 for the 2008 product.)

- Green = Low disturbance (sub-watershed source area score range: 0 – 1.6)
- Yellow = Moderate disturbance (sub-watershed source area score range: 1.6 – 2.16)
- Red = High disturbance (sub-watershed source area score range: 2.17 – 3.00)

Future iterations of the GIS analysis could be modified or expanded to include other relevant spatial data as they becomes digitally available, such as stormwater outfalls, road sand applications, and legacy sites. Additional data layers should be analyzed and scored using the methodology described above and averaged into the overall sub-watershed source area score. It should be noted that adding layers to the GIS analysis will make it more difficult to compare the GIS Sub-watershed Source Area Prioritization results over time. Changes to the protocol should only be made if the new data are expected to significantly improve the prioritization of sub-watersheds for water quality monitoring or SWMP performance evaluation. Detailed methods should be documented to ensure subsequent GIS analyses can remain as consistent as possible with previous techniques employed.

Water quality data (collected through the TRWQMP) and SWMP implementation data could also be incorporated into future GIS analyses as follows:

1) Overlay active TRWQMP stations on the sub-watershed source area layer. Compare water quality data from stations utilizing the same assessment type and rank the stations based on the relative level of water quality impairment across the project area.
2) Create a GIS layer of relative intensity of SWMP actions (BMP implementation, site inspections, etc.) and overlay on the sub-watershed source area layer. Rank the sub-watersheds based on the level or intensity of implementation of each major category of SWMP actions. If evaluating the number of SWMP actions, normalize for the sub-watershed area (or area of high-density development) to assist in comparisons across sub-watersheds.

The above spatial products can be used to address to following conditions:

1) Sub-watersheds where SWMP actions are prevalent but TRWQMP data collection stations are either minimal or results indicate stormwater quality impairment can be increased in monitoring priority.
2) High disturbance sub-watersheds with extensive SWMP actions and TRWQMP data that indicate minimal or no water quality impairment can be decreased in monitoring priority.

If water quality data or SWMP implementation data are incorporated into future GIS analyses, it is recommended that these metrics are evaluated independently and not directly integrated to adjust the sub-watershed source area scores. Tracking changes in the density of human disturbances and pollutant source areas in the sub-watersheds over time separately from the measures taken to control them will be useful in adapting the TRWQMP to changing conditions.

6.2.3 Reporting Protocols to TRWQMP Database

The GIS source prioritization results should be compiled, analyzed and digitally submitted to the TRWQMP database every 3-5 years as the updated shapefiles become available. The GIS map should also be submitted in PDF format. Section 7.0 details the recommended data management structure and associated procedures to facilitate data integration into the TRWQMP database.

- GIS source prioritization should be reported in a Microsoft Excel spreadsheet, named TRWQMP_GIS_Year.xls (ex: TRWQMP_GIS_2012.xls).
- Column headings and field formatting requirements for GIS analysis data, including data type, format, units, and precision level are presented in Table 6.1. It is critical that all data is submitted to the database in the standardized format, especially in the <u>required units</u>, to ensure compatibility with all other submitted data and proper integration into the TRWQMP database.
    - There should be one row per sub-watershed.
    - There should be no blank cells – for each row of data there should be corresponding information in each column.

Table 6.1					
Field Name	**Description**	**Database Field Type, Size, Format**	**Units**	**Precision[A]**	**Standardized Format**
Sub-watershed	Sub-watershed analyzed	Text	n/a	n/a	Provided by TRWQMP data manager
SubAnalysisDate	Year of GIS analysis	Date – Short Date	n/a	n/a	MM/DD/YYYY
SubArea	Area of sub-watershed	Number – Double	acres	2	Positive number
%Imperv	Percent impervious coverage from GIS analysis	Number – Double – Percent	%	2	Ranging from 0-100
%ResDev	Percent medium and high density residential development from GIS analysis	Number – Double – Percent	%	2	Ranging from 0-100
%Erod	Percent potentially erodible lands from GIS analysis	Number – Double – Percent	%	2	Ranging from 0-100
%Private	Percentage of lands under private ownership from GIS analysis	Number – Double – Percent	%	2	Ranging from 0-100
DirtRoadDensity	Ratio of miles of dirt road to sub-watershed area in square miles from GIS analysis	Number – Double	miles/square miles	2	Positive number
ImpervScore	Source area score based on percentile analysis of % impervious coverage calculations	Number – Integer	n/a	0	Ranging from 0-3
ResDevScore	Source area score based on percentile analysis of % residential calculations	Number – Integer	n/a	0	Ranging from 0-3
ErodScore	Source area score based on percentile analysis of % potentially erodible lands calculations	Number – Integer	n/a	0	Ranging from 0-3
PrivScore	Source area score based on percentile analysis of % private lands calculations	Number – Integer	n/a	0	Ranging from 0-3
SkiScore	Graded ski run density rankings from GIS analysis	Number – Integer	n/a	0	Ranging from 0-3
DirtRoadScore	Source area score based on percentile analysis of ratio of miles of dirt road to sub-watershed area calculations	Number – Integer	n/a	0	Ranging from 0-3
SubScore	Sub-watershed source area score based on GIS analysis (average of 6 source area scores)	Number – Double	n/a	2	Ranging from 0.00 to 3.00
SubDisturb	Sub-watershed disturbance level based on source area score	Text	n/a	n/a	Low, Moderate or High

[A]*Precision is the number of digits to the right of the decimal place (e.g., 2 means value is reported as #.##).*

Table 6.1. TRWQMP database field types and reporting requirements for GIS analysis.

6.3 Rapid Assessment Monitoring Protocols

Rapid assessments monitor relative condition with respect to fine sediment across the majority of the project area. See Section 5.0 for specific location of observations and justification for selection.

6.3.1 Station Selection and Instrument Installation Protocols

Rapid assessment stations are termed intervals - distinct stream lengths designated by easily discernable features in the field such as bridge crossings, tributary confluences or significant morphologic stream features. The initial year of the rapid assessment requires the designation, naming and mapping of each of the potential stream intervals that comprise the entire Truckee River Main stem and the respective last 1 mile of key tributaries. Stream intervals range in length from 2500m to no more than 3,500m and ideally are lengths that can be assessed in one field day by two trained personnel. Rapid assessment reaches are conducted within each respective interval and are 150m in length. An example interval would be TRMS1 that extends from the outlet of Lake Tahoe to the fourth bridge crossing downstream (counting Lake Tahoe Blvd), spanning approximately 3,500m. If resources are limited, the respective stream intervals completed each year should be prioritized based on the following criteria:

- Stream intervals downstream of high priority sub-watersheds.
- Stream intervals with previously observed high density of sand substrate.
- Repeat interval at the upstream extent of the Truckee River Main stem as a low sand density control.

No instrument installation is required for the rapid assessments.

6.3.2 Event Sampling Strategy

Rapid assessments are conducted, at a minimum, bi-annually, but ideally annually, during the late summer/ early fall (see Table 5.3). Summers following above average precipitation are prioritized for rapid assessment implementation. The exact timing of the assessment is initiated when Truckee River at Lake Tahoe discharge is below 100 cfs (USGS gage #10337500 Truckee River at Tahoe City, CA). By conducting the assessment under the same flow conditions each year, inter-annual comparisons are possible, thus records are maintained on annual flow conditions and each subsequent rapid assessment are conducted at a similar flow condition as the year previous to the extent possible. Since flow conditions are determined in part by dam releases at Tahoe City, coordination with the dam management (Federal Watermaster's Office in Reno, NV) is necessary on an annual basis. For the reaches just downstream of the Lake Tahoe Dam, coordination with the local rafting operations may be necessary.

6.3.3 Field Evaluation Protocols

A. Designate Stream Intervals (*Year 1 only*).

Objective: Designate stream intervals using specific landmarks easily discernable from high-resolution aerial maps (e.g., bridges, tributary confluences, etc.). Ideally these intervals are 2500-3500m in total length and can be completed by 2 trained field personnel in one day.

Personnel Needed: 1 GIS-trained office personnel 2-4 hours to designate potential stream intervals, to be verified in the field during Year 1

For year 1 of the rapid assessment implementation, consultants/personnel should create a catalog of the designated stream intervals for the project area. Stream intervals should be identified on both high-resolution aerials, described in a comprehensive table to ensure consistent interval and reach designation each year, and marked with rebar stakes in the field. Interval designations should be based on easily discernable landmarks visible on high-resolution aerials and in the field. Possible landmarks/shifts include:

- Bridges
- Confluences with tributaries
- Large structures visible from the stream channel

The resources created in Year 1 are used by subsequent field personnel to ensure intervals and reaches are being delineated comparably from year to year. Once delineated, the stream intervals should remain consistent for the life of the TRWQMP.

B. Conduct Field Evaluation.

Objective: These protocols have been adapted from SWAMP Bioassessment Protocols (2007) to document substrate condition within a stream. Within the designated stream intervals, define 150m stream reaches and every 15m, record 5 equally-spaced channel grain size observations along each of the 11 channel transects (starting at 0m, ending at 150m). These 55 grain size measurements (11 transects * 5 observations per transect) are integrated over the 150m reach and used to calculate % fines, % sand, % <2mm, % cobble embeddedness, and D50 for each reach. A GIS visual display of the reach percent fines category communicates the spatial distribution of sediment conditions throughout the Truckee River watershed.

Personnel Needed: 2 trained field personnel 8-10 hours to cover 2-3 stream miles

Equipment Needed:

- high-resolution aerial maps with designated stream intervals
- stream interval and stream reach ID tables (see Section 6.3.3.A)
- RAM Protocols (Section 6.3.3.B)
- RAM field datasheets (Figure 6.5)
- metric survey tape
- waders
- small metric ruler
- stadia rod
- graduated rod marked with centimeter intervals
- camera
- pen/pencil
- field notebook

Field Observations and Data Collection:

Keys to good field work:

- Follow the protocols closely and review prior to each field mobilization. Use the provided datasheets.
- Take detailed field notes in a field notebook. At the end of the field day, spend several minutes reviewing notes and adding any additional information, observations, problems encountered, suggestions, etc. before leaving the site.

Truckee River Water Quality Monitoring Plan
Rapid Assessment

Stream Name: ______________________ Start Time: ______________________
Date: ______________________ Start Location: ______________________
Field Personnel: ______________________ Stop Time: ______________________
Interval ID: ______________________ Stop Location: ______________________
Survey Tape Location: Right Bank Left Bank Reach ID ______________________

Reach Information

		Left Edge of Water	Left Center	Center	Right Center	Right Edge of Water
Reach Distance (m)	Water Depth (cm)					
	Particle Size Class					
	Particle Size (mm)					
	% Cobble Embeddedness					
Reach Distance (m)	Water Depth (cm)					
	Particle Size Class					
	Particle Size (mm)					
	% Cobble Embeddedness					
Reach Distance (m)	Water Depth (cm)					
	Particle Size Class					
	Particle Size (mm)					
	% Cobble Embeddedness					
Reach Distance (m)	Water Depth (cm)					
	Particle Size Class					
	Particle Size (mm)					
	% Cobble Embeddedness					
Reach Distance (m)	Water Depth (cm)					
	Particle Size Class					
	Particle Size (mm)					
	% Cobble Embeddedness					
Reach Distance (m)	Water Depth (cm)					
	Particle Size Class					
	Particle Size (mm)					
	% Cobble Embeddedness					
Reach Distance (m)	Water Depth (cm)					
	Particle Size Class					
	Particle Size (mm)					
	% Cobble Embeddedness					
Reach Distance (m)	Water Depth (cm)					
	Particle Size Class					
	Particle Size (mm)					
	% Cobble Embeddedness					
Reach Distance (m)	Water Depth (cm)					
	Particle Size Class					
	Particle Size (mm)					
	% Cobble Embeddedness					
Reach Distance (m)	Water Depth (cm)					
	Particle Size Class					
	Particle Size (mm)					
	% Cobble Embeddedness					
Reach Distance (m)	Water Depth (cm)					
	Particle Size Class					
	Particle Size (mm)					
	% Cobble Embeddedness					

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RAPID ASSESSMENT METHODOLOGY FIELD DATASHEET

FIGURE 6.5

- Take photos to document stream condition and identify reaches. Establish photo points (location, camera orientation) and repeat every year, documenting stream changes over time. Detail the locations of each photo on field datasheet or in field notebook.
- All stream work is referenced by view/context looking downstream (e.g., right bank is defined as the bank on your right when looking downstream).
- All rapid assessments field observations are conducted by progressing from upstream to downstream.

1. Identify interval and reach start location.
   a. Arrive at upstream boundary of stream interval; all rapid assessment observations are conducted from upstream to downstream.
   b. Use aerial maps, interval and reach descriptions, and interval and reach ID tables to determine beginning of reach.
   c. Complete top portion of field datasheet (see Figure 6.5) with stream name, date, start time, field personnel names, interval ID, reach ID, etc.
   d. Lay tape starting at interval boundary and extending downstream along accessible bank. Note tape location (right or left bank) on field data sheet.
   e. Grain size measurements will be taken every 15m transect for a 150m reach beginning at distance = 0m. (See Step 2. Record transect grain size observation details below.)
   f. When end of survey tape is reached, pull up tape and lay out again, starting where the previous tape ended.
   g. Where possible, reaches should maintain a standard of 150m, resulting in 11 transects per reach. However, to ensure consistency in reach delineation from year to year, total reach length can vary ±30m to make use of existing landmarks to define reaches.

2. Record transect grain size observations.
   a. The stream reach is evaluated in cross-section every 15m and these cross sections are termed transects. Five sediment observations are recorded along the wetted width of each transect. Take first measurement at the beginning of the reach (distance = 0m).
   b. Transect measurements are taken at the left edge of water, right edge of water, and at three evenly spaced distances between the edge of water points. Intermediate points in channel (designated left center, center, and right center) can either be visually estimated or measured using the stadia rod. All references are made facing downstream.
   c. At each of the five transect positions, lower a graduated rod perpendicular to the flow and objectively select the particle located at the tip of the rod. If the particle selected is organic material, randomly select another particle until an inorganic particle is selected.
   d. Using the graduated rod, measure depth from water surface to top of particle and record on field datasheet (see Figure 6.5) to nearest hundredth of a meter.
   e. Remove particle and use metric ruler to measure and record the length of its intermediate axis (see Appendix C for visual definition of intermediate axis) to the nearest mm on field datasheet (see Figure 6.5). For particles smaller than can be seen, fines are characterized as those particles that slide between the fingers and sands roll between fingers. Table 6.2 provides further particle size definitions. As an alternative to removing the particle from the streambed, a field borescope may be used to view particles underwater and determine measurements.

Table 6.2			
Size Class Code	**Size Class Description**	**Common Size Reference**	**Size Class Range**
RS	Bedrock, smooth	Larger than car	> 4 m
RR	Bedrock, rough	Larger than car	> 4 m
XB	Boulder, larger	Meter stick to car	1 – 4 m
SB	Boulder, small	Basketball to meter stick	25 cm – 1.0 m
CB	Cobble	Tennis ball to basketball	64 – 250 mm
GC	Gravel, coarse	Marble to tennis ball	16 – 64 mm
GF	Gravel, fine	Ladybug to marble	2 – 16 mm
SA	Sand	Gritty to ladybug	0.06 – 2 mm
FN	Fines	Not gritty	< 0.06 mm

Table 6.2. Particle size measurement definitions and descriptions. Taken from SWAMP 2007.

f. If particle is cobble-sized (64-250mm), record the percent of the particle that is embedded by fine particles (<2mm) to the nearest 5% on field datasheet (see Figure 6.5).
   i. Remove cobble and visually estimate percentage of cobble's volume that has been buried by fine particles.
   ii. Due to high amount of potential observer error, field personnel should routinely calibrate estimates with each other and other field crews.
g. To accurately quantify cobble embeddedness, a minimum of 12 measurements must be taken. At the end of reach, count to ensure at least 12 cobble-sized particles were measured. If less than 12 cobbles were observed, complete a random walk through the reach to identify additional cobbles for measurement.
   i. Start at one random point along the reach and randomly choose an angle at which to walk to the other bank.
   ii. Randomly select points at which to perform Steps 2.a-f along this new transect.
   iii. Once the other bank is reached, randomly select an angle to walk back to the first bank.
   iv. Continue selecting particles until a total of 12 cobbles have been measured for the reach and recorded on field datasheet (see Figure 6.5).
   v. If 12 cobble-sized particles are not present in the entire reach, record values for all cobbles present.
h. Proceed to next reach, following Steps 2.a-g.
i. Take photographs of reaches, including key landmarks and general stream conditions. Record photo number, description, time in field notebook for each respective reach to ensure knowledge of photo location when returning to office.
j. At end of day, record stop location and stop time on field datasheet (see Figure 6.5). Ensure all pages are sequentially numbered and bind pages together.

6.3.4 Laboratory Analysis Protocols

No sample collection and analysis is required for the rapid assessments.

6.3.5 Data Management Protocols

1. Set up computer files.
   a. Download photos from camera to office computer/server. Photos should be identified by date, interval/reach id, and photo point.
   b. Open Microsoft Excel spreadsheet. Be sure to identify files and/or spreadsheet tabs by stream and observation date. Column headings should include at a minimum:
      - Metadata

A. stream
B. date
C. field personnel
D. start/stop times and locations
E. discharge at USGS gage #10337500
F. interval ID

- Reach information
  A. ID
  B. total length
- Particle observations
  A. size class code (see Table 6.2)
  B. size (mm)
  C. % embeddedness
- Analysis calculations
  A. % sand
  B. % fines
  C. % cobble embeddedness
  D. D50 (mm)

2. Enter field data.
   a. Verify that all field datasheets are present. Consult with field personnel if any are missing.
   b. Enter field data from completed field datasheets into spreadsheet.
   c. For particle observations, if particle was not measured with ruler in field, use Table 6.2 to estimate size in mm.
      - For particles greater than sand, use median value in size class range.
      - For sand, use 1mm.
      - For fines, use 0.05mm.

3. Analyze data.
   a. % Sand
      i. Count number of 55 reach particles classified as sand.
      ii. Divide by 55 (total number of reach particles observed, excluding any extra cobble observations).
   b. % Fines
      i. Count number of 55 reach particles classified as fines.
      ii. Divide by 55 (total number of reach particles observed, excluding any extra cobble observations).
   c. % < 2mm
      i. Sum results of Steps 3a and 3b.
   d. % Cobble Embeddedness
      i. Average all cobble embeddedness values recorded, including any extra cobble observations.
   e. D50
      i. Calculate median particle size (mm) for 55 reach particles observed, excluding any extra cobble observations.
   f. GIS Analysis
      i. In Year 1, create shapefile delineating each reach and include Reach IDs using standard GIS methods, aerial field maps, reach descriptions, and field photos.
      ii. Using annual reach % <2mm results (Step 3c), create a GIS map with reaches color coded according to Table 6.3.

Table 6.3	
% < 2mm Range	**Shapefile Color**
0 - 10%	Green
10 – 50%	Yellow
50 – 90%	Orange
90 – 100%	Red

Table 6.3. Designations for creating RAM GIS maps.

4. QA/QC.
   a. All data entries and calculations should be verified by a secondary staff member for data accuracy and completeness. If possible, spot-check 5-10 reach rankings with previous years' results to ensure data is comparable (i.e., the reach ranking did not change from a green to red, or vice versa, in one year). Flag any questionable data for further review by project manager.
   b. All field datasheets should be stored in the field agency office for at least 5 years following the completion of the project.
   c. Once established, nomenclature (interval ID, reach ID, etc.) should remain consistent over the life of the TRWQMP.

6.3.6 Reporting Protocols to TRWQMP Database

The rapid assessment results obtained each year should be compiled, analyzed and digitally submitted to the TRWQMP database. Data should be submitted to the database manager annually and only include the data from the past year. Previously submitted data should not be re-submitted unless QA/QC procedures have resulted in changes in data values. The GIS map should also be submitted in PDF format. Section 7.0 details the recommended data management structure and associated procedures to facilitate the integration of the TRWQMP data annually.

- Rapid assessment results should be reported in a Microsoft Excel spreadsheet, named TRWQMP_RAM_Year_SubmittingAgency.xls (ex: TRWQMP_RAM_2010_TRWC.xls).
- Column headings and field formatting requirements for RAM data, including data type, format, units, and precision level are presented in Table 6.4. It is critical that all data is submitted to the database in the standardized format, especially in the <u>required units</u>, to ensure compatibility with all other submitted data and proper integration into the TRWQMP database.
  - There should be one row per reach.
  - There should be no blank cells – for each row of data there should be corresponding information in each column.
  - QA/QC should always be "Yes." It is verification by submitting agency that all data was properly checked according quality assurance standards. Any explanation of flagged, missing, or questionable data should be included in the DataNotes field.

Table 6.4					
Field Name	**Description**	**Database Field Type, Size, Format**	**Units**	**Precision[A]**	**Standardized Format**
StreamInterval	Rapid assessment stream interval	Text	n/a	n/a	Provided by TRWQMP data manager
ReachID	Rapid assessment reach	Text	n/a	n/a	Provided by TRWQMP data manager
ObservationDate	Date of monitoring	Date - Short Date	n/a	n/a	MM/DD/YYYY
FieldAgency	Agency performing monitoring	Text	n/a	n/a	Provided by database manager
FieldPersonnel	Personnel performing monitoring	Text	n/a	n/a	First Initial. Last Name (individuals separated by commas)
%Sand	% reach substrate as sand	Number – Integer - Percent	%	2	Ranging from 0 to 100
%Fines	% reach substrate as fines	Number – Integer - Percent	%	2	Ranging from 0 to 100
%<2mm	% reach substrate less than 2mm	Number – Integer – Percent	%	2	Ranging from 0 to 100
%CobbEmbed	% embeddedness of cobbles in reach substrate	Number – Integer - Percent	%	2	Ranging from 0 to 100
D50	Median particle size in reach substrate	Number – Integer	mm	0	Positive number
QAQC	QA/QC performed on data	Yes/No	n/a	n/a	Yes, No
DataNotes	Explanation of flagged, missing, or questionable data	Memo	n/a	n/a	If none, enter NONE.

[A]Precision is the number of digits to the right of the decimal place (e.g., 2 means value is reported as #.##)

Table 6.4. TRWQMP database field types and reporting requirements for rapid assessment analysis.

6.4 Bioassessment Protocols

Bioassessments evaluate the integrated impacts of habitat disturbance on stream biological integrity. See Section 5.0 for specific location of observations and justification for selection.

6.4.1 Station Selection and Instrument Installation Protocols

Each bioassessment station consists of a 150 or 250m reach (depending on width of wetted channel) with 11 main cross section transects and 10 inter-transects. SWAMP provides the following suggestions on selecting a station:

- Access to the stream channel should be relatively easy and safe for field personnel.
- Reach should be representative of the larger stream segment being studied.
- Stations should be upstream of bridges when possible.

No instrument installation is required for the bioassessments.

6.4.2 Event Sampling Strategy

The Squaw Creek Total Maximum Daily Load for Sediment requires bioassessment along Squaw Creek every two years (see Table 5.3). Sampling must take place between June and August, after the peak snowmelt but before low flow conditions where riffle habitat may not be observed (LRWQCB 2006; LRWQCB 2008a). Bioassessments in Martis Creek, along the main stem of the Truckee River, and any other bioassessments in the project area should follow the same sampling frequency and timing to allow for comparisons of data across stations. If yearly bioassessments at the two existing stations on Northstar Mountain Properties (Bio-MC3 and Bio-MC4) should continue, the bioassessment data need only be provided to the TRWQMP database biannually for the same odd years the other bioassessment efforts are conducted within the project area.

6.4.3 Field Evaluation Protocols

Bioassessment monitoring in the Truckee River watershed (excluding Squaw Creek) follows the SWAMP Bioassessment Procedures (2007) (presented as Appendix C). In Squaw Creek, monitoring follows the field evaluation protocols outlined in LRWQCB (2008a) for Squaw Creek (Appendix D). Below we provide a brief summary of the SWAMP data collection, analysis, and management methods, however consult Appendix C in detail prior to conducting bioassessment monitoring. Suggestions and considerations are provided for integrating the Squaw Creek data into the TRWQMP database (Section 6.4.7). For details on bioassessment monitoring in Squaw Creek, see Appendix D.

A. Designate Station (*Year 1 only*).

For Year 1 of the bioassessments, consultants/personnel should determine the exact location of the station. Stations should be identified by an easily-identifiable, permanent landmark that designates either the upstream or downstream extent of the reach. Reach lengths are either 150 or 250m in length, depending upon the width of the wetted channel. If the wetted channel is <10m wide, the total reach length is 150m; if the wetted channel is >10m, total reach length is 250m. Create a catalog of the designated stream intervals for the project area. Station and reach locations should be described in a comprehensive table and on a high-resolution aerial to ensure consistent station and reach designation each year. The resources created in Year 1 are used by subsequent field personnel to ensure stations and reaches are being delineated comparably from year to year. Once delineated, the stations and reaches should remain consistent for the life of the TRWQMP.

B. Conduct Field Evaluation.

Objective: At each designated station, collect benthic macroinvertebrate samples using 2 different methods: target riffle composite (TRC) and reach-wide benthos (RWB). In addition, record physical habitat and water quality data.

Personnel Needed: 2-3 professionally trained field personnel 2-4 hours per station

Equipment Needed:
See Table 2 in Appendix C for complete list. Basic supplies include:

- station/reach map and location description table (see Section 6.4.3.A)
- survey tape
- stadia rod
- stopwatch
- flagging
- D-frame kick net with 500um mesh
- standard #35 sieve
- wide-mouth plastic jars (500-1000ml)
- white sorting pan
- 95% ethanol
- Forceps
- 10-20L bucket
- waders
- Bioassessment field datasheets (Figure 6.6 attached at the end of this section)
- Bioassessment Protocol (Section 6.4.3.B)
- sample labels (Figure 6.8 attached at the end of this section)
- chain of custody (Figure 6.9 attached at the end of this section)
- camera
- pens/pencils
- water quality meter (pH, DO, temperature, conductivity, field alkalinity).

Field Observations and Data Collection:
Keys to good field work:

- Follow the protocols closely and review prior to each field mobilization. Use the provided data sheets.
- Take detailed field notes in a field notebook. At the end of the field day, spend several minutes reviewing notes and adding any additional information, observations, problems encountered, suggestions, etc.
- Take photos documenting stream condition, reach location, and macroinvertebrate species collected. Establish photo points (location, camera orientation) and repeat every year, documenting station changes over time. Detail the locations of each photo on field datasheet or in field notebook.
- All stream work is referenced by view/context looking downstream (e.g., right bank is defined as the bank on your right when looking downstream).

Do not disturb channel substrate prior to the collection of macroinvertebrates. Follow protocol order to ensure samples are collected properly.

- Take all precautions to avoid sample contamination.
    - Be aware of the pollutant of concern and take all precautions to avoid contamination. Sources of contamination vary with different pollutants.

- Clean sample bottles, field equipment, etc. with distilled, de-ionized water as necessary.
- Properly label samples according to protocols and accurately complete chain of custody forms.

1. Arrive at site and set up station.
   a. Fill out initial information on field datasheet (see Figure 6.6).
   b. Using station map and description table, identify reach endpoints.
   c. Delineate reach length. If wetted width is <10m, reach length is 150m; wetted width >10m, 250m reach length.
   d. Establish and mark 11 main transects with flagging (15m or 25m apart, depending on designated reach length) and 10 inter-transects (equidistant between main transects). Be aware to not disturb channel substrates prior to collection of macroinvertebrate samples.
   e. Collect water quality parameters (temperature, pH, specific conductivity, DO, alkalinity, turbidity, silica) at downstream end of station. Record on datasheet (see Figure 6.6). Take care to not disturb channel substrates prior to collection of macroinvertebrate samples.
   f. Take photos, record station conditions and dominant land use on field datasheets (see Figure 6.6).

2. Collect macroinvertebrate samples.
Note: For ambient bioassessment monitoring of wadeable streams in California, two methods are used per station: TRC (targeted riffle composite) and RWB (reach-wide benthos) methodologies.
   a. TRC methodology – 8 sub-samples
      i. Randomly select 8 riffle habitats within the reach. Give preference to larger riffles. If fewer than 8 riffles exist in reach, a riffle can be sampled more than once. Start at the downstream-most riffle and move upstream.
      ii. Using the random number generation as outlined in the SWAMP protocols (Appendix C), select a location within the riffle.
      iii. Place D-frame net in stream, facing upstream and perpendicular to flow.
      iv. Gently disturb substrate in 1 square foot quadrant directly upstream of net. Place any large organisms (mussels, snails, etc.) directly into net. Gently scrub large rocks, washing material into net. Once rubbed, remove coarser substrate from quadrant. For smaller grain sizes, dig fingers to a depth of 10cm, rinsing materials into net.
      v. Carefully lift net and walk to next targeted riffle. Following the above steps (2.a.ii-iv), all 8 riffles are sampled. If net becomes too full to properly sample next riffle, empty net into sample jars (Step 3 below) as frequently as necessary.
   b. RWB methodology – 11 subsamples
      i. Samples will be collected from each of the 11 established main transects. Start at the downstream-most transect and move upstream.
      ii. Sample collection at each transect will be alternated between left, center and right positions (25, 50, and 75% of wetted width, respectively).
      iii. Sample collection is similar to TRC methodology, following Steps 2.a.iii-v.

3. Transfer macroinvertebrate samples to wide-mouth plastic sample jars.
   a. Samples are either transferred completely to jars or elutriated (decanted). Multiple jars can be used as necessary to preserve entire sample. Jar should not be filled more than two-thirds full with sample to allow for proper preservation with ethanol.

b. Complete one label (see Figure 6.8 attached at the end of this section) in pencil and place inside jar. Label should include, at minimum, project, stream and station name, bottle #, date, time, and field personnel.
c. Fill jar with 95% ethanol and close lid. Gently rotate jar to ensure ethanol is evenly distributed throughout sample and contacts all organisms.
d. Complete second label (see Figure 6.8 attached at the end of this section) in pen and secure to outside of jar.
e. Complete chain of custody (see Figure 6.9 attached at the end of this section) for all sample bottles.

4. Record physical habitat conditions.
   a. Record on field datasheets the physical habitat characteristics at each of the 11 main transects (refer to Appendix C for details). Measurements include, but are not limited to:
      - wetted width
      - bankfull width and depth
      - particle size
      - particle class code coarse particulate organic matter (CPOM)
      - cobble embeddedness
      - canopy cover
      - gradient
      - sinuosity
      - human influence
      - riparian vegetation
      - instream habitat complexity
   b. Record on field datasheets the measurements taken at the 10 inter-transects. These include:
      - pebble counts (particle size and % cobble embeddedness)
      - flow habitats
   c. Calculate stream discharge at station using either velocity area or naturally buoyant object method. Record on field datasheet. (See Appendix E for USGS protocols on stream discharge measurements.)
   d. Take photographs of reaches, including key landmarks and general stream conditions. Record photo number, description, time in field notebook for each respective reach to ensure knowledge of photo location when returning to office.
   e. At end of samplings, ensure field datasheets are complete and record any additional notes in field notebook. Sequentially number and bind all field datasheets together.

5. Deliver samples and completed chain of custody to laboratory. Keep a copy of chain of custody for records.

6.4.4 Laboratory Analysis Protocols

The TRC and RWB samples are treated separately, with the following analysis being performed on each of the samples individually. *Note: The Index of Biological Integrity (IBI) adopted by LRWQCB is the Eastern Sierra Macroinvertebrate IBI, calculated for riffle habitat collections (as of summer 2008). No IBIs have been adopted for RWB samples at this time. Therefore it may be more cost-effective to analyze only the TRC samples and wait to analyze the RWB samples until further direction is provided by LRWQCB.*

1. Analyze sample.
   a. Invertebrate field samples are subsampled in the laboratory using a rotating drum splitter or a grid-tray, sorted from subsamples under a magnifying visor and microscope, and identified to the lowest practical taxonomic level possible (usually genus; species when possible based on the availability of taxonomic keys, except for oligochaetes and ostracods).
   b. A minimum count of 550 organisms is removed from each replicate for identification (in practice averaging about 600-1000). Data analysis yields information on taxonomic composition by density and relative abundance.
   c. Using a statistical resampling method, such as Monte Carlo permutation test, take a random sample of the analyzed sample in Step 1b to generate a 500-fixed count sample to be used for data analysis.

2. QA/QC.
   a. No field replicates are collected. One laboratory replicate is analyzed per year by subsampling the field sample a second time. Variability is established through separate counts on lab subsamples from within one sample. Less than a 10% difference in IBI calculations (detailed below) between the samples is expected.
   b. All stages of sample processing and identification are checked using quality control procedures to assure uniformity, standardization and validation. These procedures include a cross-check of all taxa IDs, verification of all taxa counts entered on the datasheets, ensuring minimum counts are achieved, and ensuring that there is less than a 5% error in removing all specimens from subsamples.
   c. The laboratory reports will be checked for completeness, typographical errors, suspect values, and for conformity between the chain of custody forms and the lab reports.

6.4.5 Data Management Protocols

Note: The following data management protocols are only provided for the TRC samples. Currently there is no established and accepted IBI for RWB samples.

1. Set up computer file.
   a. Download photos from camera to office computer/server. Photos should be identified by date, station id, and photo point.
   b. Open Microsoft Excel spreadsheet. Be sure to identify files and/or spreadsheet tabs by station name and observation date. Not all data collected in the field needs to be input into the spreadsheet. Column headings should include at a minimum:
      - Metadata
        A. station ID
        B. date
        C. field personnel
        D. start time
        E. reach length
      - Discharge measurements
        A. cross section distance
        B. depth
        C. velocity
      - Physical habitat data
        A. transect/inter-transect ID
        B. transect location
        C. particle class code

D. particle size (mm)
E. % cobble embeddedness

- Habitat analysis calculations
  A. discharge
  B. % sand
  C. % fines
  D. %<2mm
  E. % cobble embeddedness
  F. D50
- Sample analysis results
  A. station ID
  B. species taxonomy
  C. species tolerance value
  D. species functional feeding group
  E. sample individual counts
- TRC metric calculations
  A. total taxa richness
  B. Ephemeroptera richness
  C. Plecoptera richness
  D. Trichoptera richness
  E. Acari richness
  F. % Chiro richness
  G. % tolerant taxa richness
  H. % shredder abundance
  I. % dominance 3
  J. biotic index
  K. IBI score

2. Enter field data.
   a. Verify that all field datasheets are present. Consult with field personnel if any are missing.
   b. For particle observations, if particle was not measured with ruler in field, use Table 6.2 to estimate size in mm.
      - For particles greater than sand, use median value in size class range.
      - For sand, use 1mm.
      - For fines, use 0.05mm.

Table 6.2			
Size Class Code	**Size Class Description**	**Common Size Reference**	**Size Class Range**
RS	Bedrock, smooth	Larger than car	**>** 4 m
RR	Bedrock, rough	Larger than car	**>** 4 m
XB	Boulder, larger	Meter stick to car	1 – 4 m
SB	Boulder, small	Basketball to meter stick	25 cm – 1.0 m
CB	Cobble	Tennis ball to basketball	64 – 250 mm
GC	Gravel, coarse	Marble to tennis ball	16 – 64 mm
GF	Gravel, fine	Ladybug to marble	2 – 16 mm
SA	Sand	Gritty to ladybug	0.06 – 2 mm
FN	Fines	Not gritty	< 0.06 mm

Table 6.2. Particle size measurement definitions and descriptions. Taken from SWAMP 2007.

3. Analyze data.
   a. Discharge

   i. Calculate Q (depth * width * velocity) for station. Equations vary based on field measurement method used (see Appendix E for details).
b. Station % sand
   i. Count number of substrate data points classified as sand.
   ii. Divide by 105. (The total number of substrate data points = (11 main transects + 10 inter-transects) * 5 data points per transect.)
c. Station % fines
   i. Count number of substrate data points classified as fines.
   ii. Divide by 105. (The total number of substrate data points = (11 main transects + 10 inter-transects) * 5 data points per transect.)
d. Station %<2mm
   i. Sum results of Steps 3b and 3c.
e. Station % cobble embeddedness
   i. Average the % cobble embeddedness for each cobble-sized particle observed.
f. Station D50.
   i. Calculate median particle size (mm) for 105 substrate data points.

4. Enter laboratory data.
   a. Verify laboratory sample list with chain of custody to ensure results for all submitted samples are present.
   b. For each species observed, include tolerance values, functional feeding groups and individual count.

5. Analyze macroinvertebrate sample data.

Note: TRC metrics are calculated on the 500-fixed count sample (Step 1.c of Section 6.4.4).Taxa is defined as the lowest taxonomic level identified by the laboratory, usually genus; species when possible based on the availability of taxonomic keys, except for oligochaetes and ostracods.

   a. Total taxa richness
      i. Sum the total number of taxa found in sample.
   b. Ephemeroptera richness
      i. Sum the total number of Ephemeroptera (mayfly) taxa in sample.
   c. Plecoptera richness
      i. Sum the total number of Plecoptera (stonefly) taxa found in sample.
   d. Trichoptera richness
      i. Sum the total number of Trichoptera (caddisfly) taxa found in sample.
   e. Acari richness
      i. Sum the total number of Acari (water mite) taxa found in sample.
   f. % Chiro richness
      i. Sum the total number of Chironomidae (midge) taxa found in sample.
      ii. Divide by total taxa richness (step a).
   g. % tolerant taxa richness
      i. Sum the total number of taxa with tolerance values ranging from 7 to 10.
      ii. Divide by total taxa richness (step a).
   h. % shredder abundance
      i. Sum the total number of individuals in shredder functional feeding group.
      ii. Divide by 500 (the total number of individuals in fixed count sample).
   i. % dominance 3
      i. Identify the top three most common taxa in sample.
      ii. Sum the total individual count for these top 3 taxa.
      iii. Divide by 500 (the total number of individuals in fixed count sample).

j. Biotic index (modified Hilsenhoff)
   i. Calculate composite community tolerance for sample. For each taxa, multiply tolerance value by number of individuals.
   ii. Sum all values.
   iii. Divide by 500 (the total number of individuals in fixed count sample).
k. Calculate the scaled Eastern Sierra Macroinvertebrate IBI.
   i. Determine metric score (0-10) based on Table 6.5. Metric values are defined for a score of 0 and 10. For metric values falling between that range, scores are calculated using a scaled calculation. Round calculated scores to the nearest whole number.
   ii. Sum the 10 metrics to calculate IBI.

Table 6.5				
Metric	**Score**			
	0	**10**	**Metric Value Range**	**Scaled-Metric Score Calculation**
Total Taxa Richness	≤30	≥50	30 - 50	10*(Rich-30)/(50-30)
Ephemeroptera Richness	≤3	≥9	3 - 9	10*(E.rich-3)/(9-3)
Plecoptera Richness	≤1	≥6	1 – 6	10*(P.rich-1)/(6-1)
Trichoptera Richness	≤2	≥8	2 - 8	10*(T.rich-2)/(8-2)
Acari Richness	≤1	≥6	1 – 6	10*(A.rich-1)/(6-1)
% Chiro Richness	≥43.4%	≤26.4%	26.4 – 43.4%	10*(43.4-%C.rich)/ (43.4-26.4)
% Tolerant Taxa	≥34.1%	≤18.7%	18.7 – 34.1%	10*(34.1-%Tol.rich)/ (34.1-18.7)
% Shredder Abundance	0	≥2.7%	0 – 2.7%	10*(Shredabund%0)/ (2.7-0)
% Dominance 3	≥65.9%	≤42.9%	42.9 – 65.9%	10*(65.9-%Dom3)/ (65.9-42.9)
Biotic Index	≥5.79	≤4.05	4.05 – 5.79	10*(5.79-BI)/ (5.79-4.05)

Table 6.5. Scaled calculation for Eastern Sierra Macroinvertebrate IBI. Contact Dave Herbst (herbst@lifesci.ucsb.edu) for additional information.

6. QA/QC.
   a. All data entries and calculations should be verified by a secondary staff member for data accuracy and completeness. Any missing or questionable data should be flagged for review by project manager.
   b. All field datasheets should be stored in the field agency office for at least 5 years following the completion of the project.
   c. Once established, nomenclature (station ID, etc.) should remain consistent over the life of the TRWQMP.

6.4.6 Reporting Protocols to TRWQMP Database

The bioassessment results obtained each year should be compiled, analyzed and digitally submitted to the TRWQMP database. Data should be submitted to the database manager biannually and only include the data from the past year. Previously submitted data should not be re-submitted unless QA/QC procedures have resulted in changes in data values. Section 7.0 details the recommended data management structure and associated procedures to facilitate the integration of the TRWQMP data biannually.

- Bioassessment results should be reported in a Microsoft Excel spreadsheet named TRWQMP_StationName_Year.xls
(ex: TRWQMP_Bio-MC4_2009.xls).
- Column headings and field formatting requirements for bioassessment data, including data type, format, units, and precision level are presented in Table 6.6. It is critical that all data is submitted to the database in the standardized format, especially in the required units, to ensure compatibility with all other submitted data and proper integration into the TRWQMP database.
  - There should be one row per bioassessment station.
  - There should be no blank cells – for each row of data there should be corresponding information in each column.
  - QA/QC should always be "Yes." It is verification by submitting agency that all data was properly checked according quality assurance standards. Any explanation of flagged, missing, or questionable data should be included in the DataNotes field.

Table 6.6

Field Name	Description	Database Field Type, Size, Format	Units	Precision[A]	Standardized Format
StationID	Observation station	Text	n/a	n/a	Provided by TRWQMP data manager
ObservationDate	Date of monitoring	Date - Short Date	n/a	n/a	MM/DD/YYYY
FieldAgency	Agency performing monitoring	Text	n/a	n/a	Provided by TRWQMP data manager
FieldPersonnel	Personnel performing monitoring	Text	n/a	n/a	First Initial. Last Name (individuals separated by commas)
Discharge	Stream discharge at station	Number – Double	cfs	2	Positive number, enter 0 if first flush.
TotTaxRich	Total taxa richness	Number – Integer	n/a	0	Ranging from 0 to 10
ERich	Ephemeroptera richness	Number – Integer	n/a	0	Ranging from 0 to 10
PRich	Plecoptera richness	Number – Integer	n/a	0	Ranging from 0 to 10
TRich	Trichoptera richness	Number – Integer	n/a	0	Ranging from 0 to 10
ARich	Acari richness	Number – Integer	n/a	0	Ranging from 0 to 10
%CRich	% chiro richness	Number – Integer	n/a	0	Ranging from 0 to 10
%TolTaxa	% tolerant taxa	Number – Integer	n/a	0	Ranging from 0 to 10
%Shred	% shredder abundance	Number – Integer	n/a	0	Ranging from 0 to 10
%Dom3	% dominance 3	Number – Integer	n/a	0	Ranging from 0 to 10
BiotIndex	Biotic index	Number – Integer	n/a	0	Ranging from 0 to 10

Table 6.6					
Field Name	**Description**	**Database Field Type, Size, Format**	**Units**	**Precision[A]**	**Standardized Format**
IBIScore	Eastern Sierra Macroinvertebrate IBI score	Number – Integer	n/a	0	Ranging from 0 to 100
%Fines	Average % fine substrate at station	Number – Double - Percent	%	2	Ranging from 0 to 100
%Sand	Average % sand substrate at station	Number – Double - Percent	%	2	Ranging from 0 to 100
%<2mm	% substrate less than 2mm at station	Number – Integer – Percent	%	2	Ranging from 0 to 100
%CobbEmbed	Average % cobble embeddedness at station	Number – Double - Percent	%	2	Ranging from 0 to 100
D50	Median station substrate particle size	Number – Double	mm	2	Positive number
QAQC	QA/QC performed on data	Yes/No	n/a	n/a	Yes, No
DataNotes	Explanation of flagged, missing, or questionable data	Memo	n/a	n/a	If none, enter NONE.

[A]*Precision is the number of digits to the right of the decimal place (e.g., 2 means value is reported as #.##).*

Table 6.6. TRWQMP database field types and reporting requirements for bioassessment analysis.

6.4.7 Converting Squaw Creek Data for Inclusion in TRWQMP Database

- Consult Herbst and Silldorff (2004) for a more detailed discussion of translating the Squaw Creek bioassessment data and metric analysis into the TRWQMP database format.
- Generally, each of the 5 targeted riffle samples from Squaw Creek can be statistically resampled to randomly generate 100 count samples. These five samples can then be used in aggregate (creating a 500 count sample) to calculate the Eastern Sierra IBI metrics.

TRUCKEE RIVER WATER QUALITY MONITORING PLAN
FIGURE 6.6 BIOASSESSMENT FIELD DATASHEET

REACH DOCUMENTATION

Standard Reach Length (wetted width ≤ 10 m) = 150 m Distance between transects = 15 m
Alternate Reach Length (wetted width >10 m) = 250 m Distance between transects = 25 m

Project Name:	Date:	Time:
Stream Name:	Site Name/ Description:	
Site Code:	Crew Members:	
Latitude: ºN	**datum:** **NAD83**	
Longitude: ºW	*other:*	

AMBIENT WATER QUALITY MEASUREMENTS		*all meters calibrated?*		Yes ☐ No ☐			
Temp (°C)		pH		Alkalinity (mg/L)		Turbidity (ntu, ***optional***)	
Dissolved O_2 (mg/L)		Specific Cond. (µS)		Salinity (mg/L)		Dissolved Silica (***optional***)	

REACH LENGTH (see reach length guidelines at top of form)	
Actual Length (m)	
Explanation:	

DISCHARGE MEASUREMENTS

1st measurement = left bank (looking downstream)

check if discharge measurements not possible ☐ (explain in field notes section)

VELOCITY AREA METHOD (preferred) **Transect Width:**

	Distance from Left Bank (cm)	Depth (cm)	Velocity (m/sec)		Distance from Left Bank (cm)	Depth (cm)	Velocity (m/sec)
1				11			
2				12			
3				13			
4				14			
5				15			
6				16			
7				17			
8				18			
9				19			
10				20			

BOUYANT OBJECT METHOD (use ONLY if velocity area method not possible)

	Float 1	Float 2	Float 3
Distance			
Float Time			

Float Reach Cross Section

width (m) depth	Upper Section	Middle Section	Lower Section
Width			
Depth 1			
Depth 2			
Depth 3			
Depth 4			
Depth 5			

NOTABLE FIELD CONDITIONS (check one box per topic)

Evidence of recent rainfall (enough to increase surface runoff)	NO		minimal		>10% flow increase	
Evidence of fires in reach or immediately upstream (<500 m)	NO		< 1 year		< 5 years	
Dominant landuse/ landcover in area surrounding reach	Agriculture		Forest		Rangeland	
	Urban/ Industrial		Suburb/Town		Other	

ADDITIONAL COBBLE EMBEDDEDNESS MEASURES (carry over from transect forms if needed; measure in mm)

1	2	3	4	5	6	7	8	9	10	11	12	13
14	15	16	17	18	19	20	21	22	23	24	25	

Site Code:	Date: __ __ / __ __ / __ __ __ __

SLOPE and BEARING FORM (transect based - for Full PHAB only)

AUTOLEVEL	
CLINOMETER	
HANDLEVEL	

Starting Transect	MAIN SEGMENT (record percent of inter-transect distance in each segment **if supplemental segments are used**)					SUPPLEMENTAL SEGMENT (record percent of inter-transect distance in each segment **if supplemental segments are used**)				
	Stadia rod measurements	Slope (%) or Elevation Difference (cm / %)	Segment Length (m)	Bearing (0°-359°)	Percent of Total Length (%)	Stadia rod measurements	Slope or Elevation Difference (cm / %)	Segment Length (m)	Bearing (0°-359°)	Percent of Total Length (%)
K										
J										
I										
H										
G										
F										
E										
D										
C										
B										
A										
additional calculation area										

ADDITIONAL HABITAT CHARACTERIZATION

Parameter	Optimal	Suboptimal	Marginal	Poor
Epifaunal Substrate/ Cover	Greater than 70% of substrate favorable for epifaunal colonization and fish cover (50% for low-gradient streams); mix of submerged logs, undercut banks, cobble or other stable habitat	40-70% mix of stable habitat (30-50% for low-gradient streams); well-suited for full colonization potential	20-40% mix of stable habitat (10-30% in low-gradient streams); substrate frequently disturbed or removed	Less than 20% stable habitat (10% in low-gradient streams); lack of habitat is obvious; substrate unstable or lacking
Score:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Sediment Deposition	Little or no enlargement of islands or point bars and less than 5% of the bottom affected by sediment deposition (<20% in low-gradient streams)	Some new increase in bar formation, mostly from gravel, sand, or fine sediment; 5-30% of the bottom affected (20-50% in low-gradient streams)	Moderate deposition of new gravel, sand, or fine sediment on bars; 30-50% of the bottom affected (50 - 80% in low-gradient streams)	Heavy deposits of fine material, increased bar development; more than 50% of the bottom changing frequently (>80% in low-gradient streams)
Score:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern	Some channelization present, (e.g., bridge abutments); evidence of past channelization (> 20yrs) may be present but recent channelization not present	Channelization may be extensive: embankments or shoring structures present on both banks; 40 to 80% of stream reach disrupted	Banks shored with gabian or cement; Over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely
Score:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Site Code:	Site Name:	Date: __ __ / __ __ / __ __ __ __
Wetted Width (m):	Bankfull Width (m):	Bankfull Height (cm):

Transect A

TRANSECT SUBSTRATES					Cobble Embed-dedness (%)
Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

BANK STABILITY (score zone 5m up and 5m downstream of transect between bankfull - wetted width)			
Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

HUMAN INFLUENCE (circle only the closest to wetted channel)	0 = Not Present B = On Bank C = Between Bank and 10 m from Channel P = >10 m + <50 m from Channel Channel (record Yes or No)		
	Left Bank	Channel	Right Bank
Walls/ Rip-rap/ Dams	P C B 0	Y N	0 B C P
Buildings	P C B 0	Y N	0 B C P
Pavement/ Cleared Lot	P C B 0		0 B C P
Road/ Railroad	P C B 0	Y N	0 B C P
Pipes (Inlet/ Outlet)	P C B 0	Y N	0 B C P
Landfill/ Trash	P C B 0	Y N	0 B C P
Park/ Lawn	P C B 0		0 B C P
Row Crops	P C B 0		0 B C P
Pasture/ Range	P C B 0		0 B C P
Logging Operations	P C B 0		0 B C P
Mining Activity	P C B 0	Y N	0 B C P
Vegetation Management	P C B 0		0 B C P
Bridges/ Abutments	P C B 0	Y N	0 B C P
Orchards/ Vineyards	P C B 0		0 B C P

RIPARIAN VEGETATION (facing downstream)	0 = Absent (0%) 3 = Heavy (40-75%) 1 = Sparse (<10%) 4 = Very Heavy>75%) 2 = Moderate (10-40%) **circle one**	
Vegetation Class	**Left Bank**	**Right Bank**
Upper Canopy (>5 m high)		
Trees and saplings >5 m high	0 1 2 3 4	0 1 2 3 4
Lower Canopy (0.5 m-5 m high)		
All vegetation 0.5 m to 5 m	0 1 2 3 4	0 1 2 3 4
Ground Cover (<0.5 m high)		
Woody shrubs and saplings <0.5 m	0 1 2 3 4	0 1 2 3 4
Herbs/ grasses	0 1 2 3 4	0 1 2 3 4
Barren, bare soil/ duff	0 1 2 3 4	0 1 2 3 4

INSTREAM HABITAT COMPLEXITY	0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)
Filamentous Algae	0 1 2 3 4
Aquatic Macrophytes/ Emergent Vegetation	0 1 2 3 4
Boulders	0 1 2 3 4
Woody Debris >0.3 m	0 1 2 3 4
Woody Debris <0.3 m	0 1 2 3 4
Undercut Banks	0 1 2 3 4
Overhang. Vegetation	0 1 2 3 4
Live Tree Roots	0 1 2 3 4
Artificial Structures	0 1 2 3 4

DENSIOMETER READINGS (0-17) *count covered dots*	
Center Left	
Center Upstream	
Center Downstream	
Center Right	
Left Bank (optional)	
Right Bank (optional)	

Inter-transect: AB

Wetted Width (m):

FLOW HABITATS (% between transects, total=100%)	
Channel Type	**%**
Cascade/ Falls	
Rapid	
Riffle	
Run	
Glide	
Pool	
Dry	

INTER-TRANSECT SUBSTRATES (measure in mm or use size classes)					Cobble Embedded-ness (%)
Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

TAKE PHOTOGRAPHS
(check box if taken and record photo code)

Downstream (**required**) ☐

Upstream (**optional**) ☐

Note**: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of size class categories listed on the supplemental page **(direct measurements are preferred)

Site Code:	Site Name:	Date: __ __ / __ __ / __ __ __ __
Wetted Width (m):	Bankfull Width (m):	Bankfull Height (cm):

Transect B

TRANSECT SUBSTRATES					Cobble Embed-dedness (%)
Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

BANK STABILITY (score zone 5m up and 5m downstream of transect between bankfull - wetted width)			
Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

HUMAN INFLUENCE (circle only the closest to wetted channel)	**0** = Not Present **B** = On Bank **C** = Between Bank and 10 m from Channel **P** = >10 m + <50 m from Channel **Channel (record Yes or No)**		
	Left Bank	Channel	Right Bank
Walls/ Rip-rap/ Dams	P C B 0	Y N	0 B C P
Buildings	P C B 0	Y N	0 B C P
Pavement/ Cleared Lot	P C B 0		0 B C P
Road/ Railroad	P C B 0	Y N	0 B C P
Pipes (Inlet/ Outlet)	P C B 0	Y N	0 B C P
Landfill/ Trash	P C B 0	Y N	0 B C P
Park/ Lawn	P C B 0		0 B C P
Row Crops	P C B 0		0 B C P
Pasture/ Range	P C B 0		0 B C P
Logging Operations	P C B 0		0 B C P
Mining Activity	P C B 0	Y N	0 B C P
Vegetation Management	P C B 0		0 B C P
Bridges/ Abutments	P C B 0	Y N	0 B C P
Orchards/ Vineyards	P C B 0		0 B C P

RIPARIAN VEGETATION (facing downstream)	0 = Absent (0%) 3 = Heavy (40-75%) 1 = Sparse (<10%) 4 = Very Heavy>75%) 2 = Moderate (10-40%) **circle one**	
Vegetation Class	Left Bank	Right Bank
Upper Canopy (>5 m high)		
Trees and saplings >5 m high	0 1 2 3 4	0 1 2 3 4
Lower Canopy (0.5 m-5 m high)		
All vegetation 0.5 m to 5 m	0 1 2 3 4	0 1 2 3 4
Ground Cover (<0.5 m high)		
Woody shrubs and saplings <0.5 m	0 1 2 3 4	0 1 2 3 4
Herbs/ grasses	0 1 2 3 4	0 1 2 3 4
Barren, bare soil/ duff	0 1 2 3 4	0 1 2 3 4

INSTREAM HABITAT COMPLEXITY	0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)
Filamentous Algae	0 1 2 3 4
Aquatic Macrophytes/ Emergent Vegetation	0 1 2 3 4
Boulders	0 1 2 3 4
Woody Debris >0.3 m	0 1 2 3 4
Woody Debris <0.3 m	0 1 2 3 4
Undercut Banks	0 1 2 3 4
Overhang. Vegetation	0 1 2 3 4
Live Tree Roots	0 1 2 3 4
Artificial Structures	0 1 2 3 4

DENSIOMETER READINGS (0-17) *count covered dots*	
Center Left	
Center Upstream	
Center Downstream	
Center Right	
Left Bank (optional)	
Right Bank (optional)	

Inter-transect: BC

Wetted Width (m):

FLOW HABITATS (% between transects, total=100%)	
Channel Type	%
Cascade/ Falls	
Rapid	
Riffle	
Run	
Glide	
Pool	
Dry	

INTER-TRANSECT SUBSTRATES (measure in mm or use size classes)					Cobble Embedded-ness (%)
Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

Note**: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of size class categories listed on the supplemental page **(direct measurements are preferred)

Site Code:	Site Name:	Date: __ __ / __ __ / __ __ __ __
Wetted Width (m):	Bankfull Width (m):	Bankfull Height (cm):

Transect C

TRANSECT SUBSTRATES					Cobble Embed-dedness (%)
Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

BANK STABILITY (score zone 5m up and 5m downstream of transect between bankfull - wetted width)			
Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

HUMAN INFLUENCE (circle only the closest to wetted channel)	**0** = Not Present **B** = On Bank **C** = Between Bank and 10 m from Channel **P** = >10 m + <50 m from Channel	**Channel (record Yes or No)**	
	Left Bank	Channel	Right Bank
Walls/ Rip-rap/ Dams	P C B 0	Y N	0 B C P
Buildings	P C B 0	Y N	0 B C P
Pavement/ Cleared Lot	P C B 0		0 B C P
Road/ Railroad	P C B 0	Y N	0 B C P
Pipes (Inlet/ Outlet)	P C B 0	Y N	0 B C P
Landfill/ Trash	P C B 0	Y N	0 B C P
Park/ Lawn	P C B 0		0 B C P
Row Crops	P C B 0		0 B C P
Pasture/ Range	P C B 0		0 B C P
Logging Operations	P C B 0		0 B C P
Mining Activity	P C B 0	Y N	0 B C P
Vegetation Management	P C B 0		0 B C P
Bridges/ Abutments	P C B 0	Y N	0 B C P
Orchards/ Vineyards	P C B 0		0 B C P

RIPARIAN VEGETATION (facing downstream)	0 = Absent (0%) 3 = Heavy (40-75%) 1 = Sparse (<10%) 4 = Very Heavy>75%) 2 = Moderate (10-40%) **circle one**	
Vegetation Class	Left Bank	Right Bank
Upper Canopy (>5 m high)		
Trees and saplings >5 m high	0 1 2 3 4	0 1 2 3 4
Lower Canopy (0.5 m-5 m high)		
All vegetation 0.5 m to 5 m	0 1 2 3 4	0 1 2 3 4
Ground Cover (<0.5 m high)		
Woody shrubs and saplings <0.5 m	0 1 2 3 4	0 1 2 3 4
Herbs/ grasses	0 1 2 3 4	0 1 2 3 4
Barren, bare soil/ duff	0 1 2 3 4	0 1 2 3 4

INSTREAM HABITAT COMPLEXITY	0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)
Filamentous Algae	0 1 2 3 4
Aquatic Macrophytes/ Emergent Vegetation	0 1 2 3 4
Boulders	0 1 2 3 4
Woody Debris >0.3 m	0 1 2 3 4
Woody Debris <0.3 m	0 1 2 3 4
Undercut Banks	0 1 2 3 4
Overhang. Vegetation	0 1 2 3 4
Live Tree Roots	0 1 2 3 4
Artificial Structures	0 1 2 3 4

DENSIOMETER READINGS (0-17) *count covered dots*	
Center Left	
Center Upstream	
Center Downstream	
Center Right	
Left Bank (optional)	
Right Bank (optional)	

Inter-transect: CD

Wetted Width (m):

FLOW HABITATS (% between transects, total=100%)	
Channel Type	%
Cascade/ Falls	
Rapid	
Riffle	
Run	
Glide	
Pool	
Dry	

INTER-TRANSECT SUBSTRATES (measure in mm or use size classes)					Cobble Embedded-ness (%)
Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

Note**: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of size class categories listed on the supplemental page **(direct measurements are preferred)

Site Code:	Site Name:	Date: __ __ / __ __ / __ __ __ __
Wetted Width (m):	Bankfull Width (m):	Bankfull Height (cm):

Transect D

TRANSECT SUBSTRATES Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	Cobble Embed-dedness (%)
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

BANK STABILITY (score zone 5m up and 5m downstream of transect between bankfull - wetted width)

Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

HUMAN INFLUENCE (circle only the closest to wetted channel)

0 = Not Present **B** = On Bank **C** = Between Bank and 10 m from Channel **P** = >10 m + <50 m from Channel **Channel (record Yes or No)**

	Left Bank	Channel	Right Bank
Walls/ Rip-rap/ Dams	P C B 0	Y N	0 B C P
Buildings	P C B 0	Y N	0 B C P
Pavement/ Cleared Lot	P C B 0		0 B C P
Road/ Railroad	P C B 0	Y N	0 B C P
Pipes (Inlet/ Outlet)	P C B 0	Y N	0 B C P
Landfill/ Trash	P C B 0	Y N	0 B C P
Park/ Lawn	P C B 0		0 B C P
Row Crops	P C B 0		0 B C P
Pasture/ Range	P C B 0		0 B C P
Logging Operations	P C B 0		0 B C P
Mining Activity	P C B 0	Y N	0 B C P
Vegetation Management	P C B 0		0 B C P
Bridges/ Abutments	P C B 0	Y N	0 B C P
Orchards/ Vineyards	P C B 0		0 B C P

RIPARIAN VEGETATION (facing downstream)

0 = Absent (0%) 3 = Heavy (40-75%)
1 = Sparse (<10%) 4 = Very Heavy>75%)
2 = Moderate (10-40%) **circle one**

Vegetation Class	Left Bank	Right Bank
Upper Canopy (>5 m high)		
Trees and saplings >5 m high	0 1 2 3 4	0 1 2 3 4
Lower Canopy (0.5 m-5 m high)		
All vegetation 0.5 m to 5 m	0 1 2 3 4	0 1 2 3 4
Ground Cover (<0.5 m high)		
Woody shrubs and saplings <0.5 m	0 1 2 3 4	0 1 2 3 4
Herbs/ grasses	0 1 2 3 4	0 1 2 3 4
Barren, bare soil/ duff	0 1 2 3 4	0 1 2 3 4

INSTREAM HABITAT COMPLEXITY

0 = Absent (0%)
1 = Sparse (<10%)
2 = Moderate (10-40%)
3 = Heavy (40-75%)
4 = Very Heavy (>75%)

Filamentous Algae	0 1 2 3 4
Aquatic Macrophytes/ Emergent Vegetation	0 1 2 3 4
Boulders	0 1 2 3 4
Woody Debris >0.3 m	0 1 2 3 4
Woody Debris <0.3 m	0 1 2 3 4
Undercut Banks	0 1 2 3 4
Overhang. Vegetation	0 1 2 3 4
Live Tree Roots	0 1 2 3 4
Artificial Structures	0 1 2 3 4

DENSIOMETER READINGS (0-17) *count covered dots*

Center Left	
Center Upstream	
Center Downstream	
Center Right	
Left Bank (optional)	
Right Bank (optional)	

Inter-transect: DE

Wetted Width (m):

FLOW HABITATS (% between transects, total=100%)

Channel Type	%
Cascade/ Falls	
Rapid	
Riffle	
Run	
Glide	
Pool	
Dry	

INTER-TRANSECT SUBSTRATES (measure in mm or use size classes)

Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	Cobble Embedded-ness (%)
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

Note**: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of size class categories listed on the supplemental page **(direct measurements are preferred)

Site Code:	Site Name:	Date: __ __ / __ __ / __ __ __ __
Wetted Width (m):	Bankfull Width (m):	Bankfull Height (cm):

Transect E

TRANSECT SUBSTRATES					Cobble Embed-dedness (%)
Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

BANK STABILITY (score zone 5m up and 5m downstream of transect between bankfull - wetted width)			
Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

HUMAN INFLUENCE (circle only the closest to wetted channel)	**0** = Not Present **B** = On Bank **C** = Between Bank and 10 m from Channel **P** = >10 m + <50 m from Channel **Channel (record Yes or No)**		
	Left Bank	Channel	Right Bank
Walls/ Rip-rap/ Dams	P C B 0	Y N	0 B C P
Buildings	P C B 0	Y N	0 B C P
Pavement/ Cleared Lot	P C B 0		0 B C P
Road/ Railroad	P C B 0	Y N	0 B C P
Pipes (Inlet/ Outlet)	P C B 0	Y N	0 B C P
Landfill/ Trash	P C B 0	Y N	0 B C P
Park/ Lawn	P C B 0		0 B C P
Row Crops	P C B 0		0 B C P
Pasture/ Range	P C B 0		0 B C P
Logging Operations	P C B 0		0 B C P
Mining Activity	P C B 0	Y N	0 B C P
Vegetation Management	P C B 0		0 B C P
Bridges/ Abutments	P C B 0	Y N	0 B C P
Orchards/ Vineyards	P C B 0		0 B C P

RIPARIAN VEGETATION (facing downstream)	0 = Absent (0%) 3 = Heavy (40-75%) 1 = Sparse (<10%) 4 = Very Heavy>75%) 2 = Moderate (10-40%) **circle one**	
Vegetation Class	**Left Bank**	**Right Bank**
Upper Canopy (>5 m high)		
Trees and saplings >5 m high	0 1 2 3 4	0 1 2 3 4
Lower Canopy (0.5 m-5 m high)		
All vegetation 0.5 m to 5 m	0 1 2 3 4	0 1 2 3 4
Ground Cover (<0.5 m high)		
Woody shrubs and saplings <0.5 m	0 1 2 3 4	0 1 2 3 4
Herbs/ grasses	0 1 2 3 4	0 1 2 3 4
Barren, bare soil/ duff	0 1 2 3 4	0 1 2 3 4

INSTREAM HABITAT COMPLEXITY	0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)
Filamentous Algae	0 1 2 3 4
Aquatic Macrophytes/ Emergent Vegetation	0 1 2 3 4
Boulders	0 1 2 3 4
Woody Debris >0.3 m	0 1 2 3 4
Woody Debris <0.3 m	0 1 2 3 4
Undercut Banks	0 1 2 3 4
Overhang. Vegetation	0 1 2 3 4
Live Tree Roots	0 1 2 3 4
Artificial Structures	0 1 2 3 4

DENSIOMETER READINGS (0-17) *count covered dots*	
Center Left	
Center Upstream	
Center Downstream	
Center Right	
Left Bank (optional)	
Right Bank (optional)	

Inter-transect: EF

Wetted Width (m):

FLOW HABITATS (% between transects, total=100%)	
Channel Type	**%**
Cascade/ Falls	
Rapid	
Riffle	
Run	
Glide	
Pool	
Dry	

INTER-TRANSECT SUBSTRATES (measure in mm or use size classes)					Cobble Embedded-ness (%)
Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

Note**: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of size class categories listed on the supplemental page **(direct measurements are preferred)

Site Code:	Site Name:	Date: __ __ / __ __ / __ __ __ __
Wetted Width (m):	Bankfull Width (m):	Bankfull Height (cm):

Transect F

TRANSECT SUBSTRATES					Cobble Embed-dedness (%)
Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

BANK STABILITY (score zone 5m up and 5m downstream of transect between bankfull - wetted width)

Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

HUMAN INFLUENCE (circle only the closest to wetted channel)

0 = Not Present **B** = On Bank **C** = Between Bank and 10 m from Channel **P** = >10 m + <50 m from Channel **Channel (record Yes or No)**

	Left Bank	Channel	Right Bank
Walls/ Rip-rap/ Dams	P C B 0	Y N	0 B C P
Buildings	P C B 0	Y N	0 B C P
Pavement/ Cleared Lot	P C B 0		0 B C P
Road/ Railroad	P C B 0	Y N	0 B C P
Pipes (Inlet/ Outlet)	P C B 0	Y N	0 B C P
Landfill/ Trash	P C B 0	Y N	0 B C P
Park/ Lawn	P C B 0		0 B C P
Row Crops	P C B 0		0 B C P
Pasture/ Range	P C B 0		0 B C P
Logging Operations	P C B 0		0 B C P
Mining Activity	P C B 0	Y N	0 B C P
Vegetation Management	P C B 0		0 B C P
Bridges/ Abutments	P C B 0	Y N	0 B C P
Orchards/ Vineyards	P C B 0		0 B C P

RIPARIAN VEGETATION (facing downstream)

0 = Absent (0%) 3 = Heavy (40-75%) 1 = Sparse (<10%) 4 = Very Heavy>75%) 2 = Moderate (10-40%) **circle one**

Vegetation Class	Left Bank	Right Bank
Upper Canopy (>5 m high)		
Trees and saplings >5 m high	0 1 2 3 4	0 1 2 3 4
Lower Canopy (0.5 m-5 m high)		
All vegetation 0.5 m to 5 m	0 1 2 3 4	0 1 2 3 4
Ground Cover (<0.5 m high)		
Woody shrubs and saplings <0.5 m	0 1 2 3 4	0 1 2 3 4
Herbs/ grasses	0 1 2 3 4	0 1 2 3 4
Barren, bare soil/ duff	0 1 2 3 4	0 1 2 3 4

INSTREAM HABITAT COMPLEXITY

0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)

Filamentous Algae	0 1 2 3 4
Aquatic Macrophytes/ Emergent Vegetation	0 1 2 3 4
Boulders	0 1 2 3 4
Woody Debris >0.3 m	0 1 2 3 4
Woody Debris <0.3 m	0 1 2 3 4
Undercut Banks	0 1 2 3 4
Overhang. Vegetation	0 1 2 3 4
Live Tree Roots	0 1 2 3 4
Artificial Structures	0 1 2 3 4

DENSIOMETER READINGS (0-17) *count covered dots*

Center Left	
Center Upstream	
Center Downstream	
Center Right	
Left Bank (optional)	
Right Bank (optional)	

Inter-transect: FG

Wetted Width (m):

FLOW HABITATS (% between transects, total=100%)

Channel Type	%
Cascade/ Falls	
Rapid	
Riffle	
Run	
Glide	
Pool	
Dry	

INTER-TRANSECT SUBSTRATES (measure in mm or use size classes)

Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	Cobble Embedded-ness (%)
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

TAKE PHOTOGRAPHS
(check box if taken and record photo code)

Downstream (**required**) ☐

Upstream (**required**) ☐

Note**: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of size class categories listed on the supplemental page **(direct measurements are preferred)

Site Code:	Site Name:	Date: __ __ / __ __ / __ __ __ __
Wetted Width (m):	Bankfull Width (m):	Bankfull Height (cm):

Transect G

TRANSECT SUBSTRATES Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	Cobble Embed-dedness (%)
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

BANK STABILITY (score zone 5m up and 5m downstream of transect between bankfull - wetted width)

Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

HUMAN INFLUENCE (circle only the closest to wetted channel)

0 = Not Present **B** = On Bank **C** = Between Bank and 10 m from Channel **P** = >10 m + <50 m from Channel **Channel (record Yes or No)**

	Left Bank	Channel	Right Bank
Walls/ Rip-rap/ Dams	P C B 0	Y N	0 B C P
Buildings	P C B 0	Y N	0 B C P
Pavement/ Cleared Lot	P C B 0		0 B C P
Road/ Railroad	P C B 0	Y N	0 B C P
Pipes (Inlet/ Outlet)	P C B 0	Y N	0 B C P
Landfill/ Trash	P C B 0	Y N	0 B C P
Park/ Lawn	P C B 0		0 B C P
Row Crops	P C B 0		0 B C P
Pasture/ Range	P C B 0		0 B C P
Logging Operations	P C B 0		0 B C P
Mining Activity	P C B 0	Y N	0 B C P
Vegetation Management	P C B 0		0 B C P
Bridges/ Abutments	P C B 0	Y N	0 B C P
Orchards/ Vineyards	P C B 0		0 B C P

RIPARIAN VEGETATION (facing downstream)

0 = Absent (0%) 3 = Heavy (40-75%) 1 = Sparse (<10%) 4 = Very Heavy>75%) 2 = Moderate (10-40%) **circle one**

Vegetation Class	Left Bank	Right Bank
Upper Canopy (>5 m high)		
Trees and saplings >5 m high	0 1 2 3 4	0 1 2 3 4
Lower Canopy (0.5 m-5 m high)		
All vegetation 0.5 m to 5 m	0 1 2 3 4	0 1 2 3 4
Ground Cover (<0.5 m high)		
Woody shrubs and saplings <0.5 m	0 1 2 3 4	0 1 2 3 4
Herbs/ grasses	0 1 2 3 4	0 1 2 3 4
Barren, bare soil/ duff	0 1 2 3 4	0 1 2 3 4

INSTREAM HABITAT COMPLEXITY

0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)

Filamentous Algae	0 1 2 3 4
Aquatic Macrophytes/ Emergent Vegetation	0 1 2 3 4
Boulders	0 1 2 3 4
Woody Debris >0.3 m	0 1 2 3 4
Woody Debris <0.3 m	0 1 2 3 4
Undercut Banks	0 1 2 3 4
Overhang. Vegetation	0 1 2 3 4
Live Tree Roots	0 1 2 3 4
Artificial Structures	0 1 2 3 4

DENSIOMETER READINGS (0-17) *count covered dots*

Center Left	
Center Upstream	
Center Downstream	
Center Right	
Left Bank (optional)	
Right Bank (optional)	

Inter-transect: GH

Wetted Width (m):

FLOW HABITATS (% between transects, total=100%)

Channel Type	%
Cascade/ Falls	
Rapid	
Riffle	
Run	
Glide	
Pool	
Dry	

INTER-TRANSECT SUBSTRATES (measure in mm or use size classes)

Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	Cobble Embedded-ness (%)
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

Note**: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of size class categories listed on the supplemental page* ***(direct measurements are preferred)

Site Code:	Site Name:	Date: __ __ / __ __ / __ __ __ __
Wetted Width (m):	Bankfull Width (m):	Bankfull Height (cm):

Transect H

TRANSECT SUBSTRATES					Cobble Embed-dedness (%)
Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

BANK STABILITY (score zone 5m up and 5m downstream of transect between bankfull - wetted width)			
Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

HUMAN INFLUENCE (circle only the closest to wetted channel)	0 = Not Present B = On Bank C = Between Bank and 10 m from Channel P = >10 m + <50 m from Channel **Channel (record Yes or No)**		
	Left Bank	Channel	Right Bank
Walls/ Rip-rap/ Dams	P C B 0	Y N	0 B C P
Buildings	P C B 0	Y N	0 B C P
Pavement/ Cleared Lot	P C B 0		0 B C P
Road/ Railroad	P C B 0	Y N	0 B C P
Pipes (Inlet/ Outlet)	P C B 0	Y N	0 B C P
Landfill/ Trash	P C B 0	Y N	0 B C P
Park/ Lawn	P C B 0		0 B C P
Row Crops	P C B 0		0 B C P
Pasture/ Range	P C B 0		0 B C P
Logging Operations	P C B 0		0 B C P
Mining Activity	P C B 0	Y N	0 B C P
Vegetation Management	P C B 0		0 B C P
Bridges/ Abutments	P C B 0	Y N	0 B C P
Orchards/ Vineyards	P C B 0		0 B C P

RIPARIAN VEGETATION (facing downstream)	0 = Absent (0%) 3 = Heavy (40-75%) 1 = Sparse (<10%) 4 = Very Heavy>75%) 2 = Moderate (10-40%) **circle one**	
Vegetation Class	**Left Bank**	**Right Bank**
Upper Canopy (>5 m high)		
Trees and saplings >5 m high	0 1 2 3 4	0 1 2 3 4
Lower Canopy (0.5 m-5 m high)		
All vegetation 0.5 m to 5 m	0 1 2 3 4	0 1 2 3 4
Ground Cover (<0.5 m high)		
Woody shrubs and saplings <0.5 m	0 1 2 3 4	0 1 2 3 4
Herbs/ grasses	0 1 2 3 4	0 1 2 3 4
Barren, bare soil/ duff	0 1 2 3 4	0 1 2 3 4

INSTREAM HABITAT COMPLEXITY	0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)
Filamentous Algae	0 1 2 3 4
Aquatic Macrophytes/ Emergent Vegetation	0 1 2 3 4
Boulders	0 1 2 3 4
Woody Debris >0.3 m	0 1 2 3 4
Woody Debris <0.3 m	0 1 2 3 4
Undercut Banks	0 1 2 3 4
Overhang. Vegetation	0 1 2 3 4
Live Tree Roots	0 1 2 3 4
Artificial Structures	0 1 2 3 4

DENSIOMETER READINGS (0-17) *count covered dots*	
Center Left	
Center Upstream	
Center Downstream	
Center Right	
Left Bank (optional)	
Right Bank (optional)	

Inter-transect: HI

Wetted Width (m):

FLOW HABITATS (% between transects, total=100%)	
Channel Type	**%**
Cascade/ Falls	
Rapid	
Riffle	
Run	
Glide	
Pool	
Dry	

INTER-TRANSECT SUBSTRATES (measure in mm or use size classes)					Cobble Embedded-ness (%)
Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

Note**: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of size class categories listed on the supplemental page* ***(direct measurements are preferred)

Site Code:	Site Name:	Date: __ __ / __ __ / __ __ __ __
Wetted Width (m):	Bankfull Width (m):	Bankfull Height (cm):

Transect I

TRANSECT SUBSTRATES					Cobble Embed-dedness (%)
Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

BANK STABILITY (score zone 5m up and 5m downstream of transect between bankfull - wetted width)			
Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

HUMAN INFLUENCE (circle only the closest to wetted channel)	0 = Not Present B = On Bank C = Between Bank and 10 m from Channel P = >10 m + <50 m from Channel Channel (record Yes or No)		
	Left Bank	Channel	Right Bank
Walls/ Rip-rap/ Dams	P C B 0	Y N	0 B C P
Buildings	P C B 0	Y N	0 B C P
Pavement/ Cleared Lot	P C B 0		0 B C P
Road/ Railroad	P C B 0	Y N	0 B C P
Pipes (Inlet/ Outlet)	P C B 0	Y N	0 B C P
Landfill/ Trash	P C B 0	Y N	0 B C P
Park/ Lawn	P C B 0		0 B C P
Row Crops	P C B 0		0 B C P
Pasture/ Range	P C B 0		0 B C P
Logging Operations	P C B 0		0 B C P
Mining Activity	P C B 0	Y N	0 B C P
Vegetation Management	P C B 0		0 B C P
Bridges/ Abutments	P C B 0	Y N	0 B C P
Orchards/ Vineyards	P C B 0		0 B C P

RIPARIAN VEGETATION (facing downstream)	0 = Absent (0%) 3 = Heavy (40-75%) 1 = Sparse (<10%) 4 = Very Heavy>75%) 2 = Moderate (10-40%) **circle one**	
Vegetation Class	Left Bank	Right Bank
Upper Canopy (>5 m high)		
Trees and saplings >5 m high	0 1 2 3 4	0 1 2 3 4
Lower Canopy (0.5 m-5 m high)		
All vegetation 0.5 m to 5 m	0 1 2 3 4	0 1 2 3 4
Ground Cover (<0.5 m high)		
Woody shrubs and saplings <0.5 m	0 1 2 3 4	0 1 2 3 4
Herbs/ grasses	0 1 2 3 4	0 1 2 3 4
Barren, bare soil/ duff	0 1 2 3 4	0 1 2 3 4

INSTREAM HABITAT COMPLEXITY	0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)
Filamentous Algae	0 1 2 3 4
Aquatic Macrophytes/ Emergent Vegetation	0 1 2 3 4
Boulders	0 1 2 3 4
Woody Debris >0.3 m	0 1 2 3 4
Woody Debris <0.3 m	0 1 2 3 4
Undercut Banks	0 1 2 3 4
Overhang. Vegetation	0 1 2 3 4
Live Tree Roots	0 1 2 3 4
Artificial Structures	0 1 2 3 4

DENSIOMETER READINGS (0-17) *count covered dots*	
Center Left	
Center Upstream	
Center Downstream	
Center Right	
Left Bank (optional)	
Right Bank (optional)	

Inter-transect: IJ

Wetted Width (m):

FLOW HABITATS (% between transects, total=100%)	
Channel Type	%
Cascade/ Falls	
Rapid	
Riffle	
Run	
Glide	
Pool	
Dry	

INTER-TRANSECT SUBSTRATES (measure in mm or use size classes)					Cobble Embedded-ness (%)
Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

Note**: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of size class categories listed on the supplemental page* ***(direct measurements are preferred)

Site Code:	Site Name:	Date: __ __ / __ __ / __ __ __ __
Wetted Width (m):	Bankfull Width (m):	Bankfull Height (cm):

Transect J

TRANSECT SUBSTRATES Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	Cobble Embeddedness (%)
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

BANK STABILITY (score zone 5m up and 5m downstream of transect between bankfull - wetted width)

Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

HUMAN INFLUENCE (circle only the closest to wetted channel)

0 = Not Present **B** = On Bank **C** = Between Bank and 10 m from Channel **P** = >10 m + <50 m from Channel **Channel (record Yes or No)**

	Left Bank	Channel	Right Bank
Walls/ Rip-rap/ Dams	P C B 0	Y N	0 B C P
Buildings	P C B 0	Y N	0 B C P
Pavement/ Cleared Lot	P C B 0		0 B C P
Road/ Railroad	P C B 0	Y N	0 B C P
Pipes (Inlet/ Outlet)	P C B 0	Y N	0 B C P
Landfill/ Trash	P C B 0	Y N	0 B C P
Park/ Lawn	P C B 0		0 B C P
Row Crops	P C B 0		0 B C P
Pasture/ Range	P C B 0		0 B C P
Logging Operations	P C B 0		0 B C P
Mining Activity	P C B 0	Y N	0 B C P
Vegetation Management	P C B 0		0 B C P
Bridges/ Abutments	P C B 0	Y N	0 B C P
Orchards/ Vineyards	P C B 0		0 B C P

RIPARIAN VEGETATION (facing downstream)

0 = Absent (0%) 3 = Heavy (40-75%) 1 = Sparse (<10%) 4 = Very Heavy>75%) 2 = Moderate (10-40%) **circle one**

Vegetation Class	Left Bank	Right Bank
Upper Canopy (>5 m high)		
Trees and saplings >5 m high	0 1 2 3 4	0 1 2 3 4
Lower Canopy (0.5 m-5 m high)		
All vegetation 0.5 m to 5 m	0 1 2 3 4	0 1 2 3 4
Ground Cover (<0.5 m high)		
Woody shrubs and saplings <0.5 m	0 1 2 3 4	0 1 2 3 4
Herbs/ grasses	0 1 2 3 4	0 1 2 3 4
Barren, bare soil/ duff	0 1 2 3 4	0 1 2 3 4

INSTREAM HABITAT COMPLEXITY

0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)

Filamentous Algae	0 1 2 3 4
Aquatic Macrophytes/ Emergent Vegetation	0 1 2 3 4
Boulders	0 1 2 3 4
Woody Debris >0.3 m	0 1 2 3 4
Woody Debris <0.3 m	0 1 2 3 4
Undercut Banks	0 1 2 3 4
Overhang. Vegetation	0 1 2 3 4
Live Tree Roots	0 1 2 3 4
Artificial Structures	0 1 2 3 4

DENSIOMETER READINGS (0-17) *count covered dots*

Center Left	
Center Upstream	
Center Downstream	
Center Right	
Left Bank (optional)	
Right Bank (optional)	

Inter-transect: JK

Wetted Width (m):

FLOW HABITATS (% between transects, total=100%)

Channel Type	%
Cascade/ Falls	
Rapid	
Riffle	
Run	
Glide	
Pool	
Dry	

INTER-TRANSECT SUBSTRATES (measure in mm or use size classes)

Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	Cobble Embedded-ness (%)
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

Note**: Substrate sizes can be recorded either as direct measures of the median axis of each particle or one of size class categories listed on the supplemental page **(direct measurements are preferred)

Site Code:	Site Name:	Date: __ __ / __ __ / __ __ __ __
Wetted Width (m):	Bankfull Width (m):	Bankfull Height (cm):

Transect K

TRANSECT SUBSTRATES					Cobble Embed-dedness (%)
Position	Dist from LB (cm)	Depth (cm)	mm/ size class	CPOM	
Left Bank				P A	
Left Center				P A	
Center				P A	
Right Center				P A	
Right Bank				P A	

BANK STABILITY (score zone 5m up and 5m downstream of transect between bankfull - wetted width)			
Left Bank	eroded	vulnerable	stable
Right Bank	eroded	vulnerable	stable

0 = Not Present **B** = On Bank **C** = Between Bank and 10 m from Channel **P** = >10 m + <50 m from Channel **Channel (record Yes or No)**

HUMAN INFLUENCE (circle only the closest to wetted channel)	Left Bank	Channel	Right Bank
Walls/ Rip-rap/ Dams	P C B 0	Y N	0 B C P
Buildings	P C B 0	Y N	0 B C P
Pavement/ Cleared Lot	P C B 0		0 B C P
Road/ Railroad	P C B 0	Y N	0 B C P
Pipes (Inlet/ Outlet)	P C B 0	Y N	0 B C P
Landfill/ Trash	P C B 0	Y N	0 B C P
Park/ Lawn	P C B 0		0 B C P
Row Crops	P C B 0		0 B C P
Pasture/ Range	P C B 0		0 B C P
Logging Operations	P C B 0		0 B C P
Mining Activity	P C B 0	Y N	0 B C P
Vegetation Management	P C B 0		0 B C P
Bridges/ Abutments	P C B 0	Y N	0 B C P
Orchards/ Vineyards	P C B 0		0 B C P

RIPARIAN VEGETATION (facing downstream)

0 = Absent (0%) 3 = Heavy (40-75%) 1 = Sparse (<10%) 4 = Very Heavy>75%) 2 = Moderate (10-40%) **circle one**

Vegetation Class	Left Bank	Right Bank
Upper Canopy (>5 m high)		
Trees and saplings >5 m high	0 1 2 3 4	0 1 2 3 4
Lower Canopy (0.5 m-5 m high)		
All vegetation 0.5 m to 5 m	0 1 2 3 4	0 1 2 3 4
Ground Cover (<0.5 m high)		
Woody shrubs and saplings <0.5 m	0 1 2 3 4	0 1 2 3 4
Herbs/ grasses	0 1 2 3 4	0 1 2 3 4
Barren, bare soil/ duff	0 1 2 3 4	0 1 2 3 4

INSTREAM HABITAT COMPLEXITY

0 = Absent (0%) 1 = Sparse (<10%) 2 = Moderate (10-40%) 3 = Heavy (40-75%) 4 = Very Heavy (>75%)

Filamentous Algae	0 1 2 3 4
Aquatic Macrophytes/ Emergent Vegetation	0 1 2 3 4
Boulders	0 1 2 3 4
Woody Debris >0.3 m	0 1 2 3 4
Woody Debris <0.3 m	0 1 2 3 4
Undercut Banks	0 1 2 3 4
Overhang. Vegetation	0 1 2 3 4
Live Tree Roots	0 1 2 3 4
Artificial Structures	0 1 2 3 4

DENSIOMETER READINGS (0-17) *count covered dots*

Center Left	
Center Upstream	
Center Downstream	
Center Right	
Left Bank (optional)	
Right Bank (optional)	

No Inter-transect Measures

TAKE PHOTOGRAPHS
(check box if taken and record photo code)

Upstream (**required**) ☐

Downstream (**optional**) ☐

Site Code:	Date: __ __ / __ __ / __ __ __ __	**FULL FORM**

Site Map:

Field Notes/ Comments:

ADDITIONAL PHOTOGRAPHS

Description	Photo Code	Description	Photo Code

Flow Habitat Type	DESCRIPTION
Cascades	Short, high gradient drop in stream bed elevation often accompanied by boulders and considerable turbulence
Falls	High gradient drop in elevation of the stream bed associated with an abrupt change in the bedrock
Rapids	Sections of stream with swiftly flowing water and considerable surface turbulence. Rapids tend to have larger substrate sizes than riffles
Riffles	Shallow sections where the water flows over coarse stream bed particles that create mild to moderate surface turbulence; (< 0.5 m deep, > 0.3 m/s).
Runs	Long, relatively straight, low-gradient sections without flow obstructions. The stream bed is typically even and the water flows faster than it does in a pool; (> 0.5 m deep, > 0.3 m/s). A **step-run** is a series of runs separated by short riffles or flow obstructions that cause discontinuous breaks in slope
Glides	A section of stream with little or no turbulence, but faster velocity than pools; (< 0.5 m deep, < 0.3 m/s)
Pools	A reach of stream that is characterized by deep, low-velocity water and a smooth surface; (> 0.5 m deep, < 0.3 m/s)

Size Class Code	Size Class Range	Size Class Description	Common Size Reference
RS	> 4 m	bedrock, smooth	larger than a car
RR	> 4 m	bedrock, rough	larger than a car
XB	1 - 4 m	boulder, large	meter stick to car
SB	25 cm - 1.0 m	boulder, small	basketball to meter stick
CB	64 - 250 mm	cobble	tennis ball to basketball
GC	16 - 64 mm	gravel, coarse	marble to tennis ball
GF	2 – 16 mm	gravel, fine	ladybug to marble
SA	0.06 – 2 mm	sand	gritty to ladybug
FN	< 0.06 mm	fines	not gritty
HP	< 0.06 mm	hardpan (consolidated fines)	
WD	NA	wood	
RC	NA	concrete/ asphalt	
OT	NA	other	

BANK STABILITY

Although this measure of the degree of erosive potential is subjective, it can provide clues to the erosive potential of the banks within the reach. Assign the category whose description best fits the conditions in the area between the wetted channel and bankfull channel (see figure below)

Eroded	Banks show obvious signs of erosion from the current or previous water year; banks are usually bare or nearly bare
Vulnerable	Banks have some vegetative protection (usually annual growth), but not enough to prevent erosion during flooding
Stable	Bank vegetation has well-developed roots that protect banks from erosion; alternately, bedrock or artificial structures (e.g., concrete/ rip-rap) prevent bank erosion

CPOM/ COBBLE EMBEDDEDNESS

CPOM: Record presence (P) or absence (A) of coarse particulate organic matter (>1.0 mm particles) within 1 cm of each substrate particle

Cobble Embeddedness: Visually estimate % embedded by fine particles (record to nearest 5%)

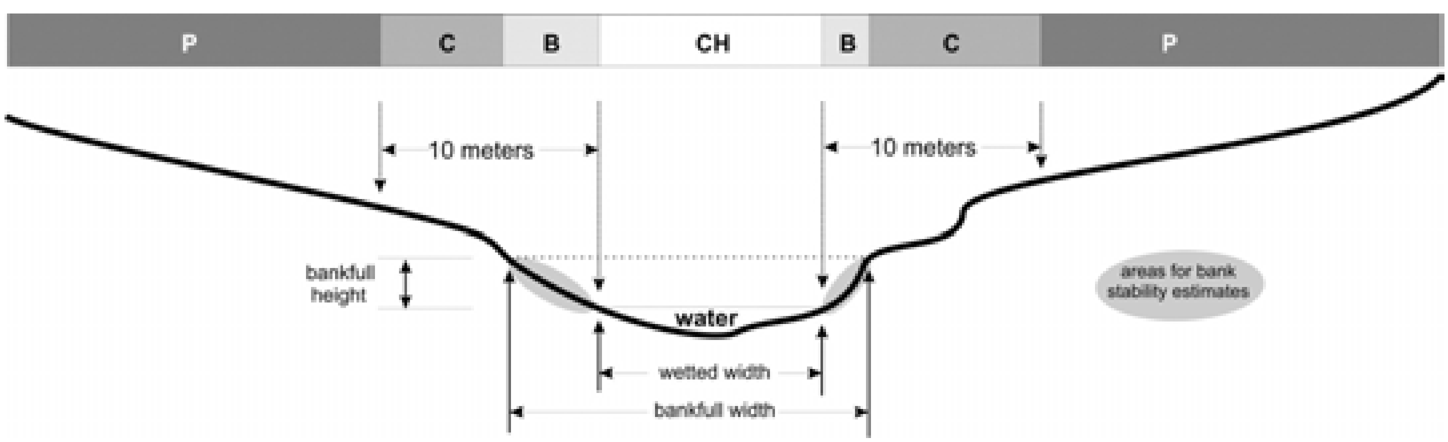


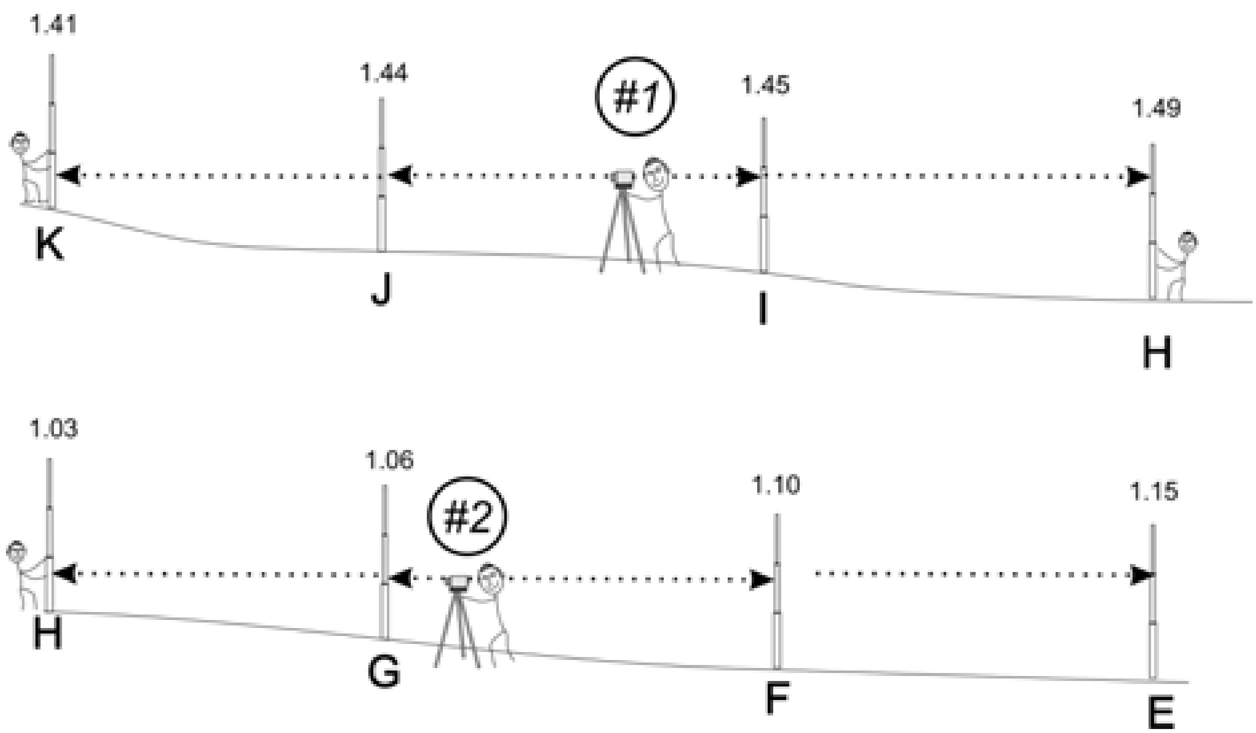
Figure 1. Cross-sectional diagram of stream transect indicating regions for assessing human influence measures:

- The measurement zone extends 5 meters upstream and 5 meters downstream of each transect
- Record one category for each bank and for the wetted channel (3 values possible)
- In reaches with wide banks, region “C” may be entirely overlapped by region “B”; in these cases, circle “B”
- Region “P” extends from 10 meters to the distance that can be seen from the channel, but not greater than 50 m

SLOPE and BEARING FORM **EXAMPLE**

AUTOLEVEL	X
CLINOMETER	
HANDLEVEL	

Starting Transect	MAIN SEGMENT (record percent of inter-transect distance in each segment **if supplemental segments are used**)						SUPPLEMENTAL SEGMENT (record percent of inter-transect distance in each segment **if supplemental segments are used**)					
	Stadia rod measurements		Slope (%) or Elevation Difference (cm ■ % ☐)	Segment Length (m)	Bearing (0°-359°)	Percent of Total Length (%)	Stadia rod measurements		Slope or Elevation Difference (cm ☐ % ☐)	Segment Length (m)	Bearing (0°-359°)	Percent of Total Length (%)
K	**1.41**											
J	**1.44**		**3**	**15**	**140**	**100**						
I	**1.45**		**1**	**15**	**145**	**100**						
H	**1.49**	**1.03**	**4**	**15**	**150**	**100**						
G		**1.06**	**3**	**15**	**143**	**100**						
F		**1.10**	**4**	**15**	**187**	**100**						
E		**1.15**	**5**	**15**	**195**	**100**						



1. Level the autolevel at Position #1
2. Place base of stadia rod at water level every time
3. Sight to stadia rod at Transect K, then Transect J
4. Rotate scope and sight to Transects I and H.
5. Move level to Position #2 and re-level
6. Re-sight to stadia rod at Transect H, then Transect G
7. Rotate scope and sight to Transects F and E

Note: sites will vary in the number of separate level positions needed to survey the reac

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

2NDNATURE LLC | TRWQMP SAMPLE BOTTLE LABELS | FIGURE 6.7

CHAIN OF CUSTODY RECORD

PAGE ____ OF ____

PROJECT NAME AND JOB #: ____________________

SEND CERTIFIED RESULTS TO: ____________________

ELECTRONIC DELIVERABLE FORMAT: YES NO

Sampler: ____________________

Date: ____________________

LABORATORY: ____________________

TURNAROUND TIME: Standard | 24hr Rush | 48hr Rush | 72hr Rush

GLOBAL I.D.: ____________________

Sample Identification	Sample Date	Time Sampled	Sample Filtered?	SAMPLE CONTAINERS			REQUESTED ANALYSIS										
				Sample Volume (ml)	Container Type (HDPE, Glass, etc)	Preservation (H_2SO_4, HNO_3, HCl)	Nutrients								Additional Analysis		
							Filtered								TSS	Oil and Grease	Trace Metals
							NO_x^-	NO_2^-	NH_4^+	SRP	DP	DKN	TKN	TP			

RELEASED BY:	Date & Time		RECEIVED BY:	Date & Time	SAMPLE CONDITION (circle one)
1.		→			Ambient Refrigerated Ice
2.		→			Ambient Refrigerated Ice
3.		→			Ambient Refrigerated Ice
4.		→			Ambient Refrigerated Ice
5.		→			Ambient Refrigerated Ice

NOTES:

2NDNATURE LLC

SAMPLE CHAIN OF CUSTODY

FIGURE 6.8

6.5 Water Sample Collection; Selection of Analytical Pollutants of Concern

The four remaining assessment types (Discrete-Community, Discrete-Tributary, Near-continuous Turbidity, and Near-continuous Auto Sampling) require the collection and analysis of water samples using a variety of techniques. Different analytical techniques have different sampling volume, sample bottle and sample handing requirements. Section 6.5 provides direction to select the appropriate assessment type and sampling protocols based on the targeted pollutants of concern.

Table 6.7 provides the recommended instrumentation for each assessment type, including the necessary equipment for water sample collection. The discrete and automated water sampling techniques and instrumentation can be used to obtain stream and/or stormwater runoff samples for laboratory analysis of a variety of pollutants.

Table 6.7		
Assessment Type	**Recommended Instrumentation**	**Website / Reference**
Discrete Sampling – Community	Nalgene Storm Water Samplers and Mounting Kits[A]	http://www.stormwatersampler.com
Discrete Sampling – Tributary	Nalgene Storm Water Samplers and Mounting Kits[A], In-Situ LevelTroll 500[B]	http://www.stormwatersampler.com. www.in-situ.com
Near-continuous Water Quality – Turbidity	FTS DTS-12 Turbidity Sensor, FTS HDL1 Hydrology Logger, and In-Situ LevelTroll 500[B]	www.ftsinc.com www.in-situ.com
Near-continuous Water Quality – Automated Samplers	Sigma 900 Max Portable Sampler, Sigma 950 Flow Meter	www.hach.com

[A] *The TRWQMP recommends the Nalgene Storm Water Samplers and Mounting Kits because they are pre-fabricated and require less expertise to install and deploy. However, passive samplers can also be fabricated in-house. These passive samplers have the advantage of being designed to hold a larger volume of water, which could reduce the number of passive samplers installed at a site. Examples of self-fabricated passive samplers are available in 2NDNATURE (2006, 2008).*

[B] *In-Situ LevelTrolls can be purchased in vented and un-vented models. If the un-vented model is selected, 15-minute barometric pressure data is required to correct the un-vented data. An In-Situ BaroTroll can be used in conjunction with the pressure transducers. Note: Once BaroTroll can be installed within the watershed and used to multiple un-vented instruments, as the barometric pressure differences across the watershed are expected to be minimal.*

Table 6.7. Recommended instrumentation per assessment type.

Table 6.8 summarizes the potential pollutants of concern for subsequent laboratory analyses by assessment type. However, there is nothing preventing the inclusion of additional analyses for any water sample as long as field sample collection and handling protocols are conducted properly for the specific analyses of interest. In general, the Discrete-Community sampling techniques should be used to evaluate the potential hydrocarbon, pesticide and trace metal sources in small catchments that can isolate specific land uses of concern. This localized focus on these urban pollutants is mostly due to the excessive analytical costs per sample for these constituents. The remaining 3 assessment types (Discrete-Tributary, Near-continuous Turbidity and Near-continuous Auto Sampling) should be used to focus water quality evaluations on the priority pollutants of concern in the project area: sediment and nutrients (see Section 4.5).

Table 6.8	
Assessment Type	**Potential Laboratory Analyses**
Rapid Assessment (RAM)	No water sample collection
Bioassessment (Bio)	No water sample collection
Discrete Sampling – Community (DSC)	Sediment, Nutrients, Hydrocarbons, Trace metals, and/or Pesticides
Discrete Sampling – Tributary (DST)	Sediment, Nutrients
Near-continuous Water Quality – Turbidity (TURB)	Sediment
Near-continuous Water Quality – Automated Samplers (NCAS)	Sediment, Nutrients, Hydrocarbons

Table 6.8. Pollutants of concern to monitor based on assessment type.

The analytical evaluations of water samples collected using the Discrete-Community sampling techniques are unique to each station and should be focused based on the contributing land uses. Tables 6.9 provides a strategy based on the contributing and/or primary land use of the catchment to focus analytical needs for samples collected from stormwater runoff from specific communities.

Table 6.9		
Land Use/ Land Use Activity	**Pollutants of Concern (in order of priority)**	**Temporal Sampling Strategy 'Worst Case' Scenarios**
Paved roads	Nutrients, Hydrocarbons, Trace metals	Storms following prolonged antecedent dry conditions; Storms/snowmelt following winter road maintenance activities
Unpaved roads	Sediment	Storms following prolonged antecedent dry conditions; Storms/snowmelt following winter road maintenance activities
Residential	Sediment, Nutrients	Storms following prolonged antecedent dry conditions
Commercial (Dense Urban)	Nutrients, Hydrocarbons, Trace metals	Storms following prolonged antecedent dry conditions
Golf courses	Nutrients, Pesticides	Spring/summer storms and irrigation following fertilizer applications
Parking lots	Hydrocarbons, Trace metals	Storms following prolonged antecedent dry conditions; Storms/snowmelt following winter road maintenance activities
Ski areas	Sediment, Nutrients	Storms following prolonged antecedent dry conditions
Logging areas	Sediment, Nutrients	Storms following prolonged antecedent dry conditions
Active construction sites	Sediment, Hydrocarbons	Spring/summer storms during construction times
Mines	Trace metals	Storms following prolonged antecedent dry conditions

Table 6.9. Pollutants of concern to monitor based on predominant land use of community catchment.

Based on the pollutant of concern designated for each water quality sampling station, Table 6.10 provides the necessary sample volume and bottle collection requirements for each analysis of interest. The volume requirements per analyses and the sample bottle type will inform the field personnel on the most appropriate field sampling techniques at each station to meet the analytical requirements. For discrete community and automated sampling, it may be necessary to deploy both HDPE and glass sample collection bottles if some combination of both sediment/nutrients/trace metals and hydrocarbons/pesticides are targeted. When field personnel collect samples for laboratory analysis, field samples may need to be transferred to an appropriately preserved laboratory bottle, depending on the targeted pollutants of concern. In other cases, it may be possible to submit the field collection bottle directly to the lab. Table 6.11 presents the analytical and laboratory QA/QC details necessary to ensure data is standardized and comparable across stations and assessment types. Please note that there are many analytical laboratories available for stormwater sample analysis. The TRWQMP protocols have been developed based on the requirements of High Sierra Water Lab for sediment and nutrient analyses and Western Environmental Testing Laboratory (WETLab) for hydrocarbon, trace metal, and pesticide analyses. All details on sample volumes, holding times and preservation provided in TRWQMP are based on High Sierra and WETLab's standard operating procedures. Should other labs be used, the details in Tables 6.10 and 6.11 may need to be adjusted per their requirements.

Table 6.10							
Pollutant of Concern	**Constituents**	**Sample Volume Necessary (ml)[A]**	**Sample Collection Bottle Type[A] (Nalgene Cat No)**	**Holding Time in Passive Sampler (if properly sealed)**	**Pre-cleaned bottle**	**Holding Time to Lab[A]**	**Preservation[A]**
Sediment	TSS	1000[B]	HDPE (1100-1000)	18 hours	Triple rinsed with DI[E] water, dried completely, stored with cap	48 hrs	on ice
Nutrients	Dissolved[C]: NH_4^+, NOx, DP, SRP Total: TKN, TP	1000[B]	HDPE (1100-1000)	12 hours		48 hrs	on ice
Hydro-carbons	Oil and Grease	1000	Glass Amber (1120-1000)	18 hours	Triple rinsed with DI[E], stored capped and full of DI	28 days	HCl, on ice
	TEPH	1000	Glass Amber (1120-1000)	18 hours	Triple rinsed with DI[E], stored capped and full of DI	14 days	on ice
Trace Metals	ICP Scan	500 [B]	HDPE (1100-1000)	12 hours	Same as nutrients	6 mo	HNO_3, on ice
	Mercury	500 [B]	HDPE (1100-1000)	12 hours	Same as nutrients	28 days	HNO_3, on ice
Pesti-cides[D]	Organochlorine, Organophosphorous, Organonitrogen, n-methyl carbamates	1000	Glass Amber (1120-1000)	12 hours	Same as hydrocarbon	7 days	on ice

[A] Numerous labs are available to perform the work described in the TRWQMP. The requirements stated above are for analysis by High Sierra Water Lab and Western Environmental Testing Laboratory. Other analytical labs may have different required sample volumes, holding times, and preservation protocols. These details would all have to be known prior to installing instrumentation at the station.

[B]Sample volumes are presented as if that pollutant of concern is the only one submitted for analysis. If a station is to be monitored for both TSS and nutrients, a total volume of 1000 ml is sufficient (as opposed to 2000ml.) Additionally, if a sample is submitted to lab for both ICP scan and mercury analysis, a total volume of 500ml is sufficient (as opposed to 1000ml).

[C]TRWQMP is interested in the dissolved fraction for NH_4^+, NOx, DP, and SRP. Prior to performing these analytical techniques, samples must be filtered through a 0.45um filter.

[D]Details are provided for a multiresidue screen, which is a combination of four Modified EPA methods: EPA 8141B (GC-FPD), EPA 8081B (GC-ECD), EPA 8270D (GC-MS, SIM mode) and EPA 8321B (HPLC-MS). It includes over 170 pesticides comprised of organochlorine, organophosphorous, organonitrogen and n-methyl carbamates. More targeted analyses are possible with potentially lower detection limits, though this may change some of the listed bottle requirements.

[E] DI water is distilled, de-ionized water.

Table 6.10. Analytical sample requirements by pollutant of concern.

Table 6.11					
Constituent	**Analysis Method**	**MDL**	**Accuracy**	**Precision**	**Recovery**
TSS	EPA 160.2	0.1 mg/L	70-130% recovery	Replicates within ± 10%.	70-130%
NOx (dissolved) [A]	EPA 350.1	1 ug/L	Standard Reference Materials (SRM, CRM) within 95% of CI stated by provider of material.	Laboratory control sample; Blind field triplicate; Replicates within ± 20%.	Matrix spike 80-120% or control limits ± 3 standard deviations based on actual lab data.
NH_4^+ (dissolved) [A]	EPA 353.1	1 ug/L			
TN	Sum of NOx and TKN (EPA 351.2)	35 ug/L			
SRP (dissolved) [A]	SM 4500-PE	1 ug/L			
DP (dissolved) [A]	EPA 365.3	1 ug/L			
TP	EPA 365.3	1 ug/L			
Oil and Grease	EPA 1664	5.0 mg/L	70-130% recovery	Replicates within ± 30%.	70-130%
TEPH	EPA 8015M	100 ug/L	70-130% recovery	Replicates within ± 30%.	70-130%
Trace Metal ICP Scan[B] (Copper, Lead, Zinc, etc.)	EPA 200.7 (m); EPA 200.8	Range from 0.1 – 5.0 ug/L	Range from 50-150% recovery	Laboratory control sample; Blind field triplicate; Replicates within ± 30%.	Matrix spike 70-130% or control limits ± 3 standard deviations based on actual lab data. Matrix spike duplicate.
Mercury	EPA 200.8 (m)	0.01 ug/L	60-140% recovery	Laboratory control sample; Blind field triplicate; Replicates within ± 30%.	Matrix spike 70-130% or control limits ± 3 standard deviations based on actual lab data. Matrix spike duplicate.
Pesticides[C]	EPA 8081B; EPA 8141B; EPA 8270D; EPA 8321B	Range from 0.12 – 6.0 ug/L	70-130% recovery	Replicates within ± 30%.	Method blank. Laboratory control sample, laboratory control sample duplicate.

[A]Dissolved nutrient constituents ($NH^{4}{}_{+}$, NOx, SRP, DP) must be filtered through a 0.45um filter prior to laboratory analysis.

[B]As many as 22 metals can be analyzed as part of the ICP suite. Copper, lead and zinc have been identified as potential pollutants of concern by theTRWQMP; for a complete list of metals analyzed and the specific MDL and accuracy QA/QC details, contact WETLab. Critical to the evaluation of metal results with respect to Water Quality Standards is the obtainment of hardness of the sample. Discussions with the analytical laboratory used should include if hardness is included in the cost for metal analyses. Evaluations of the metal results to protect aquatic life in California waters should follow the Californian Toxics Rule (CTR) Federal Register Vol. 65, No 97, May 18 2000. 40 CFR Part 131, pp. 13682-31719.

[C]Details are provided for a multiresidue screen, which is a combination of four Modified EPA methods: EPA 8141B (GC-FPD), EPA 8081B (GC-ECD), EPA 8270D (GC-MS, SIM mode) and EPA 8321B (HPLC-MS). It includes over 170 pesticides comprised of organochlorine, organophosphorous, organonitrogen and n-methyl carbamates. More targeted analyses are possible with potentially lower detection limits.

Table 6.11. Laboratory analyses requirements.

6.6 Community Level; Discrete Water Quality Monitoring Protocols

Discrete water quality measurements sample stormwater runoff from specific community areas of concern. Locations of observations and associated justification are outlined in Section 5.0.

6.6.1 Site Selection and Instrument Installation Protocols

A. Site Selection Strategy

When reviewing and selecting community catchment sites for sampling, the following considerations should be made to prioritize catchments:

- Size of catchment – community catchments should not exceed 20 acres in size if possible. The goal is to target specific land use areas that have the potential to contribute a disproportionate amount of pollutants to the local surface waters during runoff events.
- Predominant land use characteristics and pollutants of concern being generated from catchment (see Table 6.9 in Section 6.5).
- Surface water routing pathways through catchment – can the surface water runoff from the community be properly constrained and sampled?
- Proximity to surface water resources – is the catchment likely to impact the water quality of the Truckee River?
- Ephemeral drainage – catchments with consistent baseflow complicate sample of the initial stormwater runoff.
- Security – stations should be located in places where vandalism is unlikely to occur, or proper precautions should be taken to ensure equipment security.
- Access – safety and logistics. Field personnel must be able to easily and safely get to the sampling station. If station is located on private property, permission to enter property must be granted to field personnel prior to station installation.

A preliminary GIS spatial analysis on the potential catchments using the data files and methods described in Section 6.2 can help with site selection and prioritizing stations. Calculations may include the following characteristics:

- Catchment size
- Land use distribution (% of each land use type)
    - Designated categories:
        - Paved roads
        - Unpaved roads
        - Residential
        - Commercial (dense urban)
        - Golf courses
        - Parking lots
        - Ski areas
        - Logging areas
        - Active construction sites
        - Mines
    - Based on land use analysis, determine the dominant land use that is assumed to have the greatest influence on the water quality observed at the sampling station. This will determine the targeted pollutant(s) of concern (see Table 6.9 in Section 6.5).
- % impervious
- Average catchment slope

B. Determine Pollutants of Concern and Sampler Type.

The GIS analysis of land use contribution of the catchment should be used to determine the pollutants of concern for the respective discrete sampling station (see Table 6.9 in Section 6.5). Consult Table 6.10 in Section 6.5 to determine the bottle type (HDPE, glass) and volume necessary to sample the targeted pollutants of concern. Based on volume and bottle type needs, community stations can be instrumented with either pre-made Nalgene Storm Water Samplers (see Table 6.7 in Section 6.5) or fabricated passive samplers that can be built to accommodate a range of sample bottle volume needs. *For the purposes of these protocols, it assumed the Nalgene Storm Water Samplers will be used.* Nalgene Storm Water Samplers are cost-effective, EPA compliant, convenient and versatile, however the Nalgene units are limited to a 1L sample bottle. Thus, to ensure the ability to collect field triplicate samples, 3 Nalgene units must be installed in each location.

C. Choose Installation Method.

Instruments are installed at the downstream end of the catchment, in the flowpath of the stormwater runoff. Two installation strategies are possible depending upon the condition of the selected sampling location. Samplers can be mounted to hang from a grate on the inside of a drop inlet, or installed in a ditch when the flow path is pervious so that the samples are collected at grade.

D. Install Instrument.

Objective: Install passive samplers at the downstream end of a targeted community catchment to collect initial stormwater runoff ('first flush') from areas that may contribute a disproportionate amount of particular pollutants to the local surface waters.

Recommended Equipment: The TRWQMP summarizes the installation and approach using Nalgene Storm Water Samplers (see Table 6.7 in Section 6.5), as they are cost-effective, EPA compliant, convenient and versatile. The one drawback is that they collect only 1L of sample volume. To ensure the ability to collect field triplicate samples, 3 Nalgene units must be installed in each location. Larger-volume passive samplers can be fabricated for installation to increase the flexibility to submit water samples for multiple pollutant analyses, if desired.

Personnel Needed: 1-2 field personnel 4-6 hours to install 3 samplers

Equipment Needed (assumes use of Nalgene units):

- three (3) Nalgene Storm Water Samplers [Cat. No. 1100-1000 (HDPE) and/or 1120-1000 (Glass) depending on targeted pollutants of concern]
- three (3) Nalgene Storm Water Mounting Kits (includes mounting tube, clamp, wire hanger, cable tie, and mounting stake)
- slot-headed screwdriver
- flagging
- shovel
- digging bar
- Nalgene Installation Guide (Appendix F)
- Installation Protocols (Section 6.6.1.D)
- lock

<u>*Installation*</u>:
Note: The most effective installation materials, housing and configuration for each station will depend upon site conditions and limitations. Trained and experienced field personnel should be used to ensure proper and safe installation of equipment.
Note: The Storm Water Sampler should be used during installation of the Storm Water Mounting Kit to ensure the setup will properly collect a sample. To avoid contamination the sampler should not be left on-site. It should be installed in the mounting tube just prior to an anticipated runoff event.

1. Follow the instructions provided in the Nalgene Installation Guide (Appendix F), briefly summarized below.
   a. Grate mounting
      i. Hang mounting tube from stormwater grate near the edge of the storm drain chamber using wire hanger (provided in mounting kit), cable, or string.
   b. Ditch mounting
      i. Dig a hole deep enough to set the sampler at grade. Be sure to place dirt at the downstream end of the hole.
      ii. Drive mounting stake into downstream side of hole with open side of V facing upstream.
      iii. Set mounting tube at grade and secure to stake using screwdriver and clamp.
      iv. Backfill the hole, ensuring that water is directed towards the passive sample.
2. If necessary, secure Mounting Kit against vandalism using lock.
3. Test placement of Storm Water Sampler within Mounting Kit. Use level to ensure sampler rests evenly on housing. Make any adjustments necessary.

6.6.2 Event Sampling Strategy

Discrete water quality measurements from community catchments focus on stormwater runoff events when high pollutant concentrations and/or loads are expected to be transported to surface waters (i.e., the worst case scenarios). Table 5.3 presents the recommended frequency and timing of discrete water quality measurements at the community level, ideally 10 events per year. Sampling times should be coordinated across the project area to allow for the most direct comparisons between community stations.

A Discrete Community sampling event is defined as any change in climate (temperature, precipitation) that produces stormwater runoff from the catchment. Events are characterized by their type (winter rain, rain on snow, snowmelt, summer thunderstorm, irrigation) and the number of days prior to the event without rainfall or runoff (dry antecedent conditions). The events targeted for sampling are dependent on the dominant land use in the catchment (see Table 6.9 in Section 6.5). Below are some potential strategies for determining when an event is anticipated and the Storm Water Samplers should be deployed for sample collection.

- Focus on worst-case scenarios based on the land use distribution of the catchment (see Table 6.9 in Section 6.5). Ideally a range of runoff event types and magnitudes will be targeted during the monitoring season.
- Closely track weather forecasts and conditions. The following websites are included for reference, but any reliable, accurate weather service can be used. It is important to consider both the weather station's proximity to the discrete community station, as well as its similarity in elevation, its position relative to the storm front (i.e., will the event hit the weather station or sampling station first, and what will be the difference in timing between the two stations), etc.
  - Check www.wunderground.com. Possible stations include:

        - Tahoe Truckee Airport (KTRK)
        - Truckee #2 CA US SNOTEL (MTRUC1)
        - Alder Creek Middle School (KCATRUCK24)
        - Truckee-Glenshire ES CA US DRI (MGLSH)
        - RAWS Stampede (MSMDC1)
    - Check NOAA National Weather Service (http://www.nws.noaa.gov/).
    - Check the Weather Channel (www.weather.com).
- For snowmelt runoff events:
    - Track the daily high temperature patterns at the weather stations listed above. Several consecutive days of above freezing temperatures may trigger snowmelt in the catchment.
    - If possible, frequently monitor the conditions at the sampling station. Look for signs of runoff and track changes in snow depth.
    - Monitor streamflow at USGS gage #10338000, Truckee River near Truckee, CA. A rising trend in the daily streamflow pattern is a sign of snowmelt within the watershed and can provide clues as to when snowmelt in the catchment can be anticipated.
- For irrigation events:
    - Consult with appropriate maintenance personnel to determine irrigation schedule and anticipated water volumes applied to catchment.
    - Worst-case conditions occur following fertilizer application. Consult with maintenance personnel to determine timing of catchment fertilization.

6.6.3 Field Evaluation Protocols

Objective: Arrive at the station in anticipation of runoff event to prepare sampler for sample collection. Following runoff event, return to collect sample and deliver to laboratory for analysis. Also track and record event details.

Personnel Needed: 1 field personnel 1-2 hours to prep sampler prior to event and 1-2 hours to collect sample following event

Equipment Needed:

Sampler deployment:

- Nalgene Storm Water Sampler
- tarp
- distilled, de-ionized water
- camera
- field notebook
- pen/pencil
- Protocols (Section 6.6.3)
- station visit log (Figure 6.10 attached at the end of this section)

Sample collection:

- sample analysis bottle (see Table 6.10 in Section 6.5 for necessary bottle volume, type and chemical preservation)
- cooler and ice
- Ziploc
- camera
- sharpie
- sample labels (Figure 6.8 attached at the end of this section),
- chain of custody (Figure 6.9 attached at the end of this section)

- station visit log (Figure 6.10 in attached at the end of this section)
- field notebook
- pen/pencil
- Protocols (Section 6.6.10)
- tarp
- distilled, de-ionized water

Field Observations and Data Collection:

Keys to good field work:

- Be safe. Event sampling is by nature hazardous due to storm conditions. Field personnel should always wear proper protective clothing when outside during a storm. Personnel safety always comes first. Use best professional judgment. If conditions do not allow safe access to the sampler, personnel should wait until safe conditions exist.
- Follow the protocols closely and review prior to each field mobilization. Use the provided data sheets.
- Take detailed field notes in a field notebook. At the end of the field visit, spend several minutes reviewing notes and adding any additional information, observations, problems encountered, suggestions, etc.
- Take photos detailing station location, runoff conditions, etc. Establish photo points (location, camera orientation) and repeat every field visit, documenting station changes over time, events, and seasons. Detail the locations of each photo on field datasheet or in field notebook.
- All field work is referenced by view/context looking downstream (e.g., right bank is defined as the bank on your right when looking downstream).
- Take all precautions to avoid sample contamination.
  - Be aware of the pollutant of concern and be cautious to avoid contamination. Sources of contamination vary with different pollutants.
  - Clean sampling bottles, field equipment, etc. with distilled, de-ionized (DI) water.
  - Properly label samples according to protocols and accurately complete chain of custody forms.
  - Field triplicates should be collected a minimum of once per year. For field triplicates, three samples are collected at the same time at the same location by the same field personnel and submitted to the laboratory for QA/QC purposes.

1. Deploy Storm Water Samplers.
   a. Arrive at station 24-48 hours prior to anticipated runoff event. In the case of summer thunderstorms that come with little warning, there may be insufficient time to deploy the samplers prior to the beginning of the event. While not a preferred method, sample bottles can be deployed and remain in the field in preparation for summer thunderstorm sampling. However, if this technique is used, the sample bottles in the field must be checked and cleaned twice weekly to minimize the potential contamination of material in the bottle prior to the occurrence of a runoff event.
   b. Check condition of each mounting tube to ensure the sampler is properly and securely installed to collect stormwater runoff from catchment. If there are any problems, fix if possible. If it cannot be fixed immediately or prior to runoff event, describe problem on station visit log and report to project manager. Housing should be fixed prior to any subsequent sampling, to ensure the catchment runoff is being sampled properly.
   c. Avoid contamination. Place all materials on tarp while prepping station. Rinse materials with distilled, de-ionized water as necessary.
   d. Based on targeted pollutants of concerns, install proper sampler type (HDPE or glass) in mounting tube, following protocols in Appendix F.

e. Depending on volume and field triplicate requirements, more than one Storm Water Sampler may need to be deployed for an event.
f. Ensure stormwater runoff will be routed into the sampler(s). Remove any obstructions in flowpath and adjust installation as necessary.
g. Take photos. Complete necessary information in station visit monitoring log (Figure 6.10 attached at the end of this section).

2. Collect samples.
   a. Arrive at the station within 6- 12 hours of the onset of stormwater runoff (and anticipated sample collection).
   b. Remove Storm Water Sampler from mounting tube and immediately seal top with lid.
   c. Sample must have been properly collected in order to be submitted to lab.
      - If sample has exceeded the proper holding time in the passive sampler (see Table 6.10 attached at the end of this section), then samples cannot be submitted to lab. Sediment holding times are lengthy. Samples to be submitted for nutrients, hydrocarbons, trace metals, and pesticides can remain at site up to 4 days if water/air temperatures are below 38^{o}C. Evaluations of sample condition must be made in field based on conditions prior to submission to laboratory.
      - If the runoff volume was not great enough to fill the bottle and properly seal the lid, sample in unusable - the exception being that field personnel arrived within an hour of sample collection. In this case, sample can be submitted to lab, but must be flagged as “unsealed”.
   d. Consult Table 6.10 in Section 6.5, if analyses require chemical preservation transfer sample to appropriate sample analysis bottle.
   e. Complete label (see Figure 6.8 attached at the end of this section) for each bottle and firmly secure to bottle. Label should include, at minimum, project name, station name, date, time, and field personnel.
   f. For field triplicates, transfer samples into appropriate analysis bottles as necessary and include replicate number on label.
   g. Place all bottles in Ziploc in cooler with ice and complete chain of custody (see Figure 6.9 attached at the end of this section).
   h. Take photos. Complete necessary information in station visit monitoring log (see Figure 6.10 attached at the end of this section).
   i. Deliver samples and completed chain of custody to appropriate laboratory within stated holding times. Keep a copy of chain of custody for records.

3. Detail event.
   - Use a weather station with similar characteristics to the station site (location, elevation, etc.) to collect and record the event details. Determine:
     - event type (winter rain, rain on snow, snowmelt, summer thunderstorm, irrigation)
     - number of days prior to event without rainfall and/or runoff (antecedent conditions)
     - start date and time
     - total precipitation
   - It can be difficult to standardize the onset and end of a storm event. The following parameters are suggested when looking at rainfall data to determine total event precipitation. Ideally 30-minute data is available, however hourly data can also be used.
     - An event has no more than a 4-hr gap in rainfall (i.e., there are no more than 8 consecutive 30-minute intervals without rainfall).
     - An event begins when there are 4 consecutive 30-minute intervals with rain.
     - An event ends when no rainfall has fallen in longer than 4 hours.

6.6.4 Laboratory Analysis Protocols

Note: Many analytical laboratories are available. The TRWQMP was developed based on the requirements of High Sierra Water Laboratory for sediment and nutrient analyses and Western Environmental Testing Laboratory (WETLab) for hydrocarbon, trace metal, and pesticide analyses. Lab QA/QC SOPs are provided in Appendices G and H, respectively.

QA/QC

a. Table 6.11 in Section 6.5 summarizes the laboratory analysis protocols and necessary QA/QC requirements for High Sierra Water Laboratory and WETLab. If another lab is chosen for analytical work, the details of Table 6.11 may need to be revised.
b. All laboratory reports are checked for completeness, typographical errors, suspect values, and for conformity between the chain of custody forms and the lab reports.

6.6.5 Data Management Protocols

1. Set up computer files.
   a. Download photos from camera to office computer/server. Photos should be identified by date, station ID, and photo point.
   b. Open a Microsoft Excel worksheet for station. Spreadsheets should be maintained for catchment, sample, lab, and event data. Column headings should include at a minimum:
      - Catchment characteristics
        A. total area
        B. dominant land use
        C. % impervious
      - Sample analytical results
        A. station ID
        B. date
        C. time
        D. field personnel
        E. concentrations per constituent
      - Laboratory replicate results
        A. station ID
        B. date
        C. time
        D. constituent
        E. lab concentrations
        F. average concentration
      - Event information
        A. date
        B. type
        C. # days antecedent dry conditions
        D. total precipitation

2. Summarize catchment characteristics.
   - Catchment area
   - Predominant land use, as determined by GIS analysis.
   - Percent impervious, as determined by GIS analysis.
   - These characteristics will only need to be updated as new GIS data becomes available (approximately every 3-5 years).

3. Enter laboratory data into spreadsheet.
   a. Verify laboratory sample list against the chain of custodies to ensure results for all submitted samples are present.
   b. Enter all laboratory data, including field and laboratory replicate data.
      - There should be one row for each sample submitted to the lab (including a row for each field triplicate).
      - If reported value is below detection limit, write detection limit value (see Table 6.11 in Section 6.5).
      - If sample wasn't analyzed for a constituent, leave cell blank.
      - If a lab replicate was run, constituent value should be the average of the replicate results. (See Step 4a.)

4. Analyze data.
   a. Average laboratory replicate values.
   b. Summarize sample data.
      - There should be one row per station per event date.
      - Column headings should include: station id, date, time, concentrations for each constituent analyzed.
      - For field triplicates, constituent concentration should be reported as the average of the triplicates.
      - If reported value is below detection limit, write detection limit value.
   c. Calculate field precision as average percent error.
      i. For each group of field triplicates, calculate StDev (3 samples) / Average (3 samples) for each constituent.
      ii. Average all values to calculate field precision for each constituent.
      iii. Count total number of values used to calculate precision value.
   d. Calculate laboratory precision.
      i. For each replicate, calculate Absolute (sample1 – sample 2) / Average of the 2 samples for each constituent.
      ii. Average all values to calculate laboratory precision for each constituent.
      iii. Count total number of values used to calculate precision value.

5. Summarize event data (see Section 6.6.3, Step 3).
   - Event date - standardized as the day the precipitation/runoff began.
   - Event type – winter rain, rain on snow, snowmelt, summer rain, irrigation
   - Number of days of antecedent dry conditions – number of consecutive days with no precipitation/runoff prior to event start.
   - Event precipitation – total number of inches of precipitation during event.

6. QA/QC.
   a. All data entries and calculations should be verified by a secondary staff member for data accuracy and completeness. Any missing or questionable data should be flagged for review by project manager.
   b. All field datasheets should be stored in the field agency office for at least 5 years following the completion of the project.
   c. Once established, nomenclature (station ID, etc.) should remain consistent over the life of the TRWQMP.

6.6.6 Reporting Protocols to TRWQMP Database

The Community Level Discrete Sampling results obtained each year should be compiled, analyzed and digitally submitted to the TRWQMP database. Data should be submitted to the database manager annually and only include the data from the past year. Previously submitted data should not be re-submitted unless QA/QC procedures have resulted in changes in data values. Section 7.0 details the recommended data management structure and associated procedures to facilitate the integration of the TRWQMP data annually.

- Discrete water quality results should be reported in one Microsoft Excel spreadsheet named TRWQMP_ StationName_Year.xls (ex: TRWQMP_ DSC-MC4_2009.xls) that has four separate worksheets: Catchment Characteristics, WQ Results, WQ Precision, and Event Information.
- Column headings and field formatting requirements for Discrete Community Sampling data, including data type, format, units, and precision level are presented in Table 6.12 for each worksheet. It is critical that all data is submitted to the database in the standardized format, especially in the <u>required units</u>, to ensure compatibility with all other submitted data and proper integration into the TRWQMP database.
  - Catchment Characteristics only need to be included with the first submission to the database manager and following any updates to the calculations given new GIS data and analysis.
  - For WQ Results
    - There should be one row per station per event date.
    - There should only be blank data if a specific constituent was not included in the laboratory analysis.
    - QA/QC should always be “Yes.” It is verification by submitting agency that all data was properly checked according quality assurance standards. Any explanation of flagged, missing, or questionable data should be included in the DataNotes field.
  - For WQ Precision
    - There should be one row per station.
    - Precision is calculated using all available data from all years of data collection. Values should be updated annually using the complete dataset.
    - There should only be blank cells if no field replicates have been collected and submitted to the lab for a constituent, or if the lab has not performed a replicate analysis for that constituent.
  - For Event Information
    - There should be one row per event.

TABLE 6.12

Field Name	Description	Database Field Type, Size, Format	Units	Precision[A]	Standardized Format
CATCHMENT CHARACTERISTICS					
StationID	Observation station	Text	n/a	n/a	Provided by TRWQMP data manager
AnalysisDate	Date of GIS analysis	Date – Short Date	n/a	n/a	MM/DD/YYYY
Sub-watershed	Sub-watershed where station is located	Text	n/a	n/a	Provided by TRWQMP data manager

TABLE 6.12					
Field Name	**Description**	**Database Field Type, Size, Format**	**Units**	**Precision[A]**	**Standardized Format**
CatchArea	Area of catchment	Number – Double	acres	2	Positive number
CatchLandUse	Dominant land use in catchment	Text	n/a	n/a	Choose from list in Table 6.9
Catch%Imperv	Percent impervious coverage in catchment	Number – Double – Percent	%	2	Ranging from 0 to 100
WQ RESULTS					
StationID	Observation station	Text	n/a	n/a	Provided by TRWQMP data manager
EventDate	Date of sample collection	Date - Short Date	n/a	n/a	MM/DD/YYYY
FieldAgency	Agency performing monitoring	Text	n/a	n/a	Provided by TRWQMP data manager
FieldPersonnel	Personnel performing monitoring	Text	n/a	n/a	First Initial. Last Name (individuals separated by commas)
SampleType	Type of sample collected based on assessment type	Text	n/a	n/a	DSC
ConcTSS	Total Suspended Solids concentration	Number – Double	mg/L	2	if ND = 0.10
ConcNOX	Nitrate concentration	Number – Double	ug/L	2	if ND = 1.00
ConcNH4	Ammonia concentration	Number – Double	ug/L	2	if ND = 1.00
ConcTN	Total Nitrogen concentration	Number – Double	ug/L	2	if ND = 35.00
ConcSRP	Soluble Reactive Phosphorous concentration	Number – Double	ug/L	2	if ND = 1.00
ConcTP	Total Phosphorous concentration	Number – Double	ug/L	2	if ND = 1.00
ConcOG	Oil and Grease concentration	Number – Double	mg/L	2	if ND = 5.00
ConcTEPH	Total Extractable Petroleum Hydrocarbon concentration	Number – Double	ug/L	2	if ND = 100.00
ConcCu	Copper concentration	Number – Double	ug/L	2	if ND = 0.40
ConcPb	Lead concentration	Number – Double	ug/L	2	if ND = 0.10
ConcHg	Mercury concentration	Number – Double	ug/L	2	If ND = 0.01
ConcZn	Zinc concentration	Number – Double	ug/L	2	if ND = 0.10
ConcPesticides[B]	Pesticide concentration	Number – Double	ug/L	2	ND depends on the targeted pesticide.

TABLE 6.12					
Field Name	**Description**	**Database Field Type, Size, Format**	**Units**	**Precision[A]**	**Standardized Format**
QAQC	QA/QC performed on data	Yes/No	n/a	n/a	Yes, No
DataNotes	Explanation of flagged, missing, or questionable data	Memo	n/a	n/a	If none, enter NONE.
WQ PRECISION					
StationID	Observation station	Text	n/a	n/a	Provided by TRWQMP data manager
CalculationDate	Most recent sample date used in precision calculations	Date – Short Date	n/a	n/a	MM/DD/YYYY
FP_*Constituent*	Calculated field precision (% error) for each constituent	Number – Double - Percent	%	2	Ranging from 0 to 100
LP_*Constituent*	Calculated lab precision (% error) for each constituent	Number – Double – Percent	%	2	Ranging from 0 to 100
FPC_ *Constituent*	# samples used in field precision calculation	Number – Integer	n/a	0	Positive number
LPC_ *Constituent*	# samples used in lab precision calculation	Number - Integer	n/a	0	Positive number
EVENT INFORMATION					
StationID	Observation station	Text	n/a	n/a	Provided by TRWQMP data manager
EventDate	Date of sample collection	Date - Short Date	n/a	n/a	MM/DD/YYYY
EventType	Runoff event type	Text	n/a	0	Choose from: winter rain, rain on snow, snowmelt, summer rain, irrigation
EventAntecedent	Number of days prior to event with no precipitation	Number – Integer	days	0	Positive number
EventTotal	Total event precipitation	Number – Double	inches	2	Positive number

[A]Precision is the number of digits to the right of the decimal place (e.g., 2 means value is reported as #.##).

[B]Over 170 pesticides can be analyzed in the multiresidue screening. The concentrations which are reported are highly specific to the catchment and its land management practices. Therefore the TRWQMP does not specify the concentrations of which pesticides should be reported. This should be addressed on a catchment by catchment basis.

ND is non-detect, or below detection limit.

Table 6.12. TRWQMP database field types and reporting requirements for discrete community sampling assessment analysis.

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

2NDNATURE LLC	TRWQMP SAMPLE BOTTLE LABELS	FIGURE 6.7

CHAIN OF CUSTODY RECORD

PAGE ____ OF ____

PROJECT NAME AND JOB #: ______________________

SEND CERTIFIED RESULTS TO: ______________________

ELECTRONIC DELIVERABLE FORMAT: YES NO

Sampler: ______________________

Date: ______________________

LABORATORY: ______________________

TURNAROUND TIME: Standard | 24hr Rush | 48hr Rush | 72hr Rush

GLOBAL I.D.: ______________________

Sample Identification	Sample Date	Time Sampled	Sample Filtered?	SAMPLE CONTAINERS			REQUESTED ANALYSIS										
				Sample Volume (ml)	Container Type (HDPE, Glass, etc)	Preservation (H_2SO_4, HNO_3, HCl)	Nutrients								Additional Analysis		
							Filtered								TSS	Oil and Grease	Trace Metals
							NO_x^-	NO_2^-	NH_4^+	SRP	DP	DKN	TKN	TP			

RELEASED BY:	Date & Time		RECEIVED BY:	Date & Time	SAMPLE CONDITION (circle one)
1.		→			Ambient Refrigerated Ice
2.		→			Ambient Refrigerated Ice
3.		→			Ambient Refrigerated Ice
4.		→			Ambient Refrigerated Ice
5.		→			Ambient Refrigerated Ice

NOTES:

2NDNATURE LLC

SAMPLE CHAIN OF CUSTODY

FIGURE 6.8

Station Visit Log - Please fill out every time a monitoring station is visited.

Date	Time	Station	Personnel	Site Conditions	Photos Taken?	Staff Plate Reading	Batt OK	Sampler Deployed		Sample Collected			Notes
								Number	Type	Number	Type	Field Trips?	

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STATION VISIT MONITORING LOG

FIGURE 6.9

6.7 Tributary Level Discrete Water Quality Monitoring Protocols

Tributary water quality measurements capture the integrated water quality signal of upstream pollutant sources with respect to sediment and nutrients during 'worst-case scenarios'. These measurements are collected through the use of both passive samplers installed in-stream to sample targeted stream discharges and grab samples collected during peak spring snowmelt conditions. Locations of observations and associated justification are outlined in Section 5.0.

6.7.1 Station Selection and Instrument Installation Protocols

A. Site Selection Strategy

When reviewing and selecting tributaries for sampling, the following considerations should be made to prioritize sampling stations:

- Disturbance level within sub-watershed (GIS source prioritization results, Section 3.1). Ideally, the inclusion of a low disturbance sub-watershed occurs to provide regional context.
- Stable cross section – accurate and consistent hydrology measurements depend upon a cross section that minimally aggrades or degrades over time and is not predisposed to bank erosion.
- Location at downstream end of tributary to characterize entire sub-watershed.
- Straight reaches typically have more uniform and well-mixed flow to collect a more representative sample.
- Security – stations should be located in places where vandalism is unlikely to occur, or proper precautions should be taken to ensure security of equipment.
- Access – safety and logistics. Field personnel must be able to easily and safely get to the sampling station. If station is located on private property, permission to enter property must be granted to field personnel prior to station installation.

B. Pre-Installation Site Analysis

Objective: Reconnaissance and survey site. Use basic hydrologic and geomorphic equations to determine the relative elevation of the targeted discharges (slightly below bank-full, 10-year instantaneous peak, and an intermediate halfway between the two) at the station.

Personnel Needed:

Field Work: 2 field personnel 6-8 hours to recon and survey site
Office Calculations: 1 office personnel 8 hours to perform hydrologic calculations

Equipment Needed:

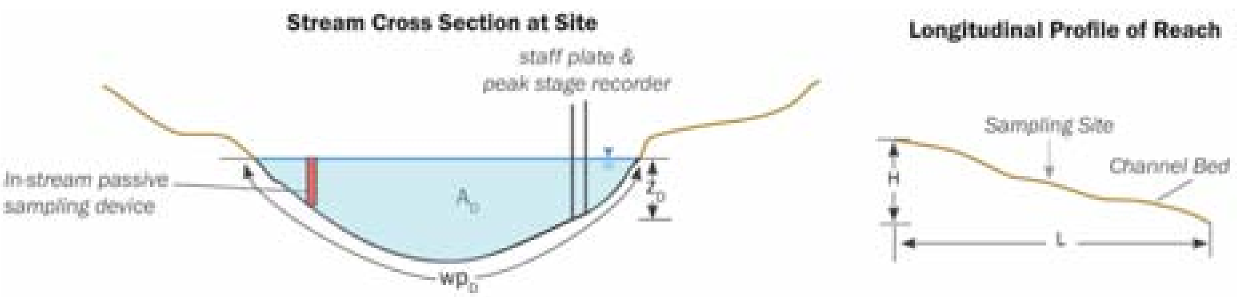
- survey equipment (level transit, tripod, survey tape, stadia rod, etc.)
- flow measurement equipment (flow meter, survey tape, stopwatch, etc.)
- flagging
- nail/stake for benchmark and cross section monuments
- camera
- protocols (Section 6.7.1.B)
- field notebook
- pens/pencils
- steel sign/fence post
- staff plate
- drill

- screws
- wooden post
- radiator clamps

1. Field Work:
    a. Select stable cross-section for station installation.
    b. Visual geomorphic and hydrologic observations are conducted to identify and flag channel indicators of specific discharge conditions. Features are flagged and noted during survey. The purpose is to identify the elevation of specific flow conditions within the stream. Geomorphic and hydrologic features in the stream channel include:
        - Bankfull indicators, described in detail in Rosgen (1996)
        - Top of highest depositional features (e.g., point bars, central bars within active channel)
        - Break in bank slope
        - Change in particle size distribution in bank
        - Rock stain elevations or other evidence of flow
        - Flow debris in riparian vegetation
        - Exposed roots in bank indicating persistent erosion.
    c. Install staff plate to measure channel stage instream at station where measurements can be taken from field personnel standing on the bank. Place in active channel to allow accurate representation of stream flow conditions. Ideally staff plate is installed within cross section where passive samplers will be installed.
        i. Size and cut wooden post to fit to vertical steel sign or fence post.
        ii. Using drill, screw staff plate to wooden post, ensuring that bottom of staff plate is even with bottom of wooden post.
        iii. Secure vertical steel sign/fence post or rebar in channel substrate. Generally sign post should be buried 1-2ft in substrate for stabilization.
        iv. Attach wooden post to vertical steel sign post using radiator clamps. Wooden post should be placed on channel bottom to ensure staff plate readings are equal to actual water depth in channel. Radiator clamps should be spaced evenly along the length of wooden post to properly secure staff plate.
    d. Field personnel survey longitudinal profile and 5-8 stream cross sections to document topography within the selected reach. The cross section locations must include each station where any instrumentation will be installed (staff plate and stage recorder, passive samplers).
        i. Establish local benchmark well above the highest flood level, using steel rebar. Mark with flagging and detail location description in field notebook. True elevations are not necessary.
        ii. Survey 0ft on staff plate.
        iii. Survey longitudinal profile.
            - Longitudinal profile should extend at least 50ft upstream and downstream of the desired installation location.
            - Record measurements every 10ft.
        iv. Survey 5-8 cross sections along longitudinal profile.
            - Extend cross sections a minimum of 20ft beyond evidence of flow on each bank.
            - Establish cross section endpoints using nails/stakes. Mark with flagging and detail location description in field notebook.
            - Run survey tape between monuments, perpendicular to flow.
            - Record measurements at every break in slope. Include edge of water measurements.

e. Measure flow using six-tenths depth method (see Appendix E for details) at the cross section where instrumentation will be installed.

2. Office Calculations.
   a. Graphically plot longitudinal profile and cross-sections.
   b. Calculate stream discharge (see Appendix E).
   c. Use visual field observations, cross section and longitudinal morphology, and stream discharge measurements to develop best estimates of the specific stage-discharge relationships at the selected site. Hydrologic data sets generated over time will improve the specific quantification of discharge for each sampler installed. The long-term benefit of these stations is consistent sampling of high flow conditions during the same discharge on the rising limb of every subsequent hydrograph.
      i. Select the 3 elevations that are assumed to represent bank-full, the 10-year instantaneous peak, and halfway in between.
      ii. Estimate the discharge at each of these elevations. Use Figure 6.10, equations and relationships below in developing the estimates. The passive samplers are installed at the corresponding stages and final installed locations are surveyed.



z_D is the stream stage (ft) as determined from staff plate measurements.

- Discharge (Q, cfs) at site when sample is collected, $Q_D = v_D * A_D$, where
  - velocity (v, ft/s) is determined using Manning's equation, $v_D = (1.49 * R_D^{2/3} * s_D^{1/2})/n$, where R_D is the hydraulic radius (ft), expressed as A_D/wp_D.
    - A_D (blue shaded area in Figure 6.10) is the cross-sectional area (ft^2) of the stream when sample is collected .
    - wp_D (black line in Figure 6.10) is the wetted perimeter (ft) of the channel when sample is collected.
    - s_D is the slope of the channel, defined as change in height (H, ft) over change in length (L, ft).
    - n is the Manning's roughness coefficient for the site. Use Dunne and Leopold (1978) to determine appropriate Manning's coefficient based on site channel characteristics.
  - A_D (blue shaded area in Figure 6.10) is the cross-sectional area (ft^2) of the stream at elevation/stage where sample is collected.

Figure 6.10. Geomorphic equations necessary to estimate stage v. discharge rating curve for tributary discrete water quality measurement station.

d. Create and populate Table 6.13 following above calculations. This table can be used in the field to determine the proper elevation of the sampler installations given the exact location within the cross section. It should be populated with several cross section distances to allow for maximum flexibility during instrument installation.

Table 6.13							
Cross Section Location (dist from left bank)	Channel Stage (staff plate reading)	Bankfull		10-year peak		Intermediate	
		Height above Streambed	Estimated Discharge	Height above Streambed	Estimated Discharge	Height above Streambed	Estimated Discharge

Table 6.13. Tributary water quality calculation results for field installation.

C. Instrument Installation

Objective: Install three discrete passive samplers instream to sample the water column for sediment and nutrient concentrations on the rising limb during three pre-determined stream discharges consistently over time in the same location. Install pressure transducer to collect near-continuous water depth data on 15-minute intervals. Survey all installed equipment relative to local benchmark to verify and update initial discharge calculations.

Recommended Products:
The TRWQMP summarizes the installation and approach using Nalgene Storm Water Samplers (see Table 6.7 in Section 6.5), as they are cost-effective, EPA compliant, convenient and versatile. The one setback is that they collect only 1L of sample volume. Larger-volume passive samplers can be fabricated for installation to increase the flexibility to submit water samples for multiple pollutant analyses, if desired.

In-Situ LevelTroll 500 pressure transducers are recommended (see Table 6.7 in Section 6.5) based on their track record of performance and reliability in the Lake Tahoe climate. The pressure transducers are available in vented and un-vented models. If the un-vented model is installed on-site, access to 15-minute barometric pressure is necessary (see Table 6.7 in Section 6.5, footnote A). Pressure transducers with similar specifications to the In-Situ LevelTroll 500 in terms of sensor accuracy, precision and range, data storage memory, battery life, and reliability in cold weather may be used as well.

Personnel Needed: 1-2 experienced field personnel 6-8 hours per station to install passive samplers and instrumentation.

Equipment Needed:
- three (3) Nalgene Stormwater Samplers [Cat. No. 1100-1000]
- three (3) Nalgene Stormwater Mounting Kits (includes mounting tube, clamp, wire hanger, cable tie, and mounting stake)
- slot-headed screwdriver
- flagging
- shovel
- digging bar
- Nalgene Installation Guide (Appendix F)
- vertical steel sign/fence post or rebar
- side braces
- un-vented/vented pressure transducer
- BaroTroll housing (3ft long 8” PVC, top, lock)
- wire/cable
- perforated PVC
- PVC end cap
- lock

- post driver
- level
- radiator clamps
- survey gear (transit, tripod, survey tape, stadia rod)
- tools
- drill
- Protocols (Section 6.7.1.C)
- Table 6.13 (cross section stage/discharge measurements)
- flow measurement instruments (survey tape, AA or pygmy meter, stopwatch, etc.)

<u>*Installation:*</u>
Note: The most effective installation materials, housing and configuration for each station will depend upon site conditions and limitations. Trained and experienced field personnel should be used to ensure proper and safe installation of expensive equipment in stream.

1. Calibrate and setup instruments (In-Situ LevelTroll 500, In-Situ BaroTroll if necessary) in office.
    a. Follow software instructions provided in user manuals.
    b. Check that date and time are accurate.
    c. Set to record data on 15 minute intervals.
        - Water depth as feet. Calibrated and corrected for elevation (barometric pressure differences).
        - Pressure in psi. Calibrated and corrected for elevation.
        - If an un-vented instrument is to be installed, access to vented barometric pressure data is required. A vented instrument can be set to record on same 15 minute interval and installed on-site, in the office, or at another nearby station. One BaroTroll instrument can be used to correct multiple unvented gages. The In-Situ software can link unvented instrument data and vented data to correct the water depth time series automatically. The barometric corrections can also be conducted manually.

2. Install passive samplers.
Note: For best results, samplers should be installed during low flow conditions when access to the channel is the greatest. To avoid contamination Storm Water Samplers should not be left at site between sampling events.
    a. Determine cross section distance of installation location.
    b. Installation and housing must be secure and sturdy enough to remain in place during high flow events and potential collisions with debris.
        - Secure vertical steel sign post/rebar in stream bed so (1) it is buried 1-2ft in channel substrate for stabilization and (2) it rises at least 1ft higher above the streambed than channel stages calculated in Table 6.13.
        - If possible, place side braces into the stream bank to further secure vertical post.
        - Depending on the differences in stage between targeted discharges, it may be possible to secure more than one sampler to a single vertical sign post.
    c. Based on location within the cross section, calculated height above the streambed (Table 6.13), and location of vertical sign post holes, determine the position of each sampler housing to ensure proper sampling of the targeted discharges. Top of Storm Water Sampler should be at the height above streambed at that cross section location corresponding to targeted discharge.
    d. Install Nalgene Mounting Kit according to the details in Appendix F for stream mounting. Install kit on upstream side of sign post to reduce obstruction of sample.

e. Test placement of Storm Water Sampler at station. Use level to ensure that sampler will rest evenly on housing. Make any adjustments necessary.

3A. Install un-vented pressure transducers.

a. Secure vertical sign post/rebar in streambed, buried 1-2ft in channel substrate. If possible, use a sign post already installed for passive samplers. Place side braces into the stream bank to further secure housing, if necessary.
b. Attach PVC (with perforations along bottom 1-2ft) to post/rebar using radiator clamps. Radiator clamps should be spaced evenly along the length of PVC to properly secure it to the post/rebar.
c. Install pressure transducer within PVC. Attach sufficient length of stainless cable to instrument to ensure placement at the bottom of PVC.
d. Loop cable through PVC cap and lock cap to PVC to prevent theft or vandalism.
e. One vented pressure transducer (In-Situ BaroTroll, see Table 6.7 in Section 6.5) will need to be installed somewhere in the project area to record and allow correction for barometric pressure differences. It is not necessary to install one at every station. One vented transducer can be used for the entire watershed, as long as data is recorded on 15-minute intervals and widely available to all agencies operating instruments and reporting to the TRWQMP. To install a programmed In-Situ BaroTroll on-site:
   - Choose location above the high flow line to ensure instrument cannot be inundated.
   - Bury a 3ft long 8” PVC piece in ground. Place BaroTroll in PVC.
   - Lock top in place to prevent theft and/or vandalism.

OR:

3B. Install vented pressure transducer.

a. Secure vertical steel sign post/rebar in streambed, buried 1-2ft in channel substrate. If possible, use a sign post already installed for passive samplers. Place side braces into the stream bank to further secure housing, if necessary.
b. Attach PVC (with perforations along bottom 1-2ft) to post/rebar using radiator clamps. Radiator clamps should be spaced evenly along the length of PVC to properly secure it to the post/rebar.
c. Install pressure transducer within PVC. Run instrument cable with PC attachment to bank.
   - Ensure vented LevelTroll is purchased with sufficient length of cable to extend instrument to desired location in stream.
   - Special care should be taken to ensure cable does not kink or bend.
   - End of cable should be installed in location above the high flow line to ensure cable top is not inundated.
d. Cable should be locked to prevent theft or vandalism of instrument.
e. No BaroTroll is needed if all Level Trolls used are vented.

4. Measure flow at established cross section using six-tenths depth method (see Appendix E for details).

5. Survey the station.

a. Survey elevation of all installed instrumentation relative to the local benchmark and location within the channel cross section. Include top of passive samplers, 0ft on staff plate, pressure transducer, etc.
b. Upon return to office, use updated survey to recalculate targeted discharge at which passive samplers collect water.

6.7.2 Event Sampling Strategy

Near-continuous pressure transducers collect water depth data year-round on 15-minute intervals (see Table 5.3).

Discrete tributary stations are monitored using two methods: (1) samples collected from the in-stream passive samplers based on specific stream discharges within the tributary and (2) grab samples collected in-stream during the spring snowmelt peak. Strategies for anticipating a sampling event for both methods are provided below.

A. Targeted Discharge In-stream Passive Samplers

This method increases the comparability of samples across stations and over time. The three passive samplers are each installed to sample the water column on the rising limb at the stage corresponding to a specific discharge. Ideally in an average water year, 10-15 discrete water samples are collected. Field personnel must track climate and regional streamflow conditions to determine when potential sample collection may occur at stations.

- Become familiar with the streamflow patterns from USGS gage #10338000, Truckee River near Truckee, CA and/or #10346000, Truckee River at Farad, CA. These USGS gages were selected on the assumption that the tributary itself is not gaged. If real-time streamflow data is available on the tributary at a location with similar characteristics (elevation, watershed area, etc.) as the discrete tributary station, this data should be used instead as it more accurately portrays the conditions on-site.
    - Study the historical streamflow patterns to understand the seasonal changes (timing, discharge increases) at the gage station and to understand the corresponding discharges at the tributary station. Use field discharge measurements to develop better understanding of discharge relationship between the stations.
    - Frequently check the real-time data to anticipate when a sampling event may occur.
- Monitor weather to assist with anticipation of targeted discharges associated with winter rain, rain on snow and summer thunderstorm events.
    - Check www.wunderground.com. Possible stations include:
        - Tahoe Truckee Airport (KTRK)
        - Truckee #2 CA US SNOTEL (MTRUC1)
        - Alder Creek Middle School (KCATRUCK24)
        - Truckee-Glenshire ES CA US DRI (MGLSH)
        - RAWS Stampede (MSMDC1)
    - Check NOAA National Weather Service (www.nws.noaa.gov).
    - Check the Weather Channel (www.weather.com).

B. Spring Snowmelt Grab Sample

This method characterizes pollutant transport during spring snowmelt conditions. Samples are collected with each incremental increase in discharge during spring snowmelt to ensure the rising limb of the snowmelt peak is characterized. Samples are collected at each tributary station between 8:00-9:00am to ensure consistent and comparable results. Ideally, 8-12 samples are collected annually to characterize the spring snowmelt, however it is of utmost importance to collect samples over the duration of the rising limb of the snowmelt peak. Additional samples may be necessary to ensure proper sampling.

- During peak snowmelt times (March through June) monitor daily the streamflow at USGS gage #10338000, Truckee River near Truckee, CA and/or #10346000, Truckee River at

Farad, CA. These USGS gages were selected on the assumption that the tributary itself is not gaged. If real-time streamflow data is available on the tributary at a location with similar characteristics (elevation, watershed area, etc.) as the discrete tributary station, this data should be used instead as it more accurately portrays the conditions on-site.

- Become familiar with the relationship between discharge at the USGS gage and at the tributary station. Use field discharge calculations to develop better understanding.
- Initiate snowmelt sampling following a 20% increase in the baseflow at the USGS gage.
- Check the USGS gage daily to determine if there has been an increase in discharge compared to the previous sample collection. Sample only if an increase in discharge from the previous snow melt sample is observed. Continue daily sampling until it is clear that the seasonal snow melt peak has passed and daily increases in streamflow are no longer observed.
- Often times multiple snowmelt peaks can be observed in one season. For subsequent snowmelts, only sample at those discharges that have not already been sampled. For example, if a sample in March was collected at 150cfs, then 150cfs should not be sampled again in May. Continue to check daily to monitor additional increases in stream discharge.
- Samples should be collected consistently between 8 and 9am. Observations made at both USGS gages (#10346000 and #10338000) show peak daily streamflow during spring snowmelt conditions occur between 10pm and 4am. It would not be safe nor logistically appropriate to presume field personnel could sample at these times. Additional analysis shows that the morning hours (8-9am) have consistently higher discharges on average than the afternoon hours (4-5pm).

- Track the daily high temperature patterns at the weather stations listed in the section above. Several consecutive days of above freezing temperatures may trigger snowmelt in the catchment.
- If possible, frequently monitor the conditions at the sampling station. Look for signs of runoff and track the changes in snow depth.

6.7.3 Field Evaluation Protocols

Objective: Regularly maintain and download the data from the near-continuous pressure transducer recording depth on 15-minute intervals to create station discharge time series. Prior to a targeted event sampling, arrive at the station to prep sampler. Following the targeted event, return to collect sample and submit it to the laboratory for analysis.

Personnel Needed:

Instrument Maintenance: 1 field personnel 1-2 hours per month for instrument maintenance, data download, calibration, etc.
Targeted Discharge Events: 1 field personnel 1-2 hours prior to an event to prep sampler and 2 field personnel 2-4 hours following event to collect sample and measure discharge.
Spring Snowmelt: 2 field personnel 2-4 hours to collect grab sample and measure discharge.

Equipment Needed:

Monthly Maintenance:

- charged computer
- appropriate instrument cables
- extra computer battery
- calibration materials
- camera
- field notebook

- pens/pencils
- instrument logs (Figure 6.11 attached at the end of this section)
- instrument batteries (if replaceable)

Targeted Discharge Event:

- Nalgene Storm Water Sampler
- tarp
- distilled, de-ionized water
- camera
- field notebook
- pen/pencil
- protocols (Section 6.7.3)
- cooler and ice
- Ziploc
- sharpie
- sample labels (Figure 6.7 attached at the end of this section),
- chain of custody (Figure 6.8 attached at the end of this section)
- station visit log (Figure 6.9 attached at the end of this section)
- field notebook
- flow measurement instruments (survey tape, AA or pygmy meter, stopwatch, etc.)

Spring Snowmelt:

- depth-integrated sediment sampler
- sample analysis bottle (see Table 6.10 in Section 6.5 for necessary bottle volume, type and chemical preservation)
- tarp
- distilled, de-ionized water
- camera
- field notebook
- pen/pencil
- Protocols (Section 6.7.3)
- cooler and ice
- Ziploc
- sharpie
- sample labels (Figure 6.7 attached at the end of this section),
- chain of custody (Figure 6.8 attached at the end of this section)
- station visit log (Figure 6.9 attached at the end of this section)
- field notebook
- flow measurement instruments (survey tape, AA or pygmy meter, stopwatch, etc.)

Field Observations and Data Collection:

Keys to good field work:

- Be safe. Event sampling is by nature hazardous due to storm conditions. Field personnel should always wear proper protective clothing when outside during a storm. Personnel safety always comes first. Use best professional judgment. If conditions do not allow safe access to the sampler, personnel should wait until safe conditions exist.
- Follow the protocols closely and review prior to each field mobilization. Use the provided data sheets.
- Take detailed field notes in a field notebook. At the end of the field day, spend several minutes reviewing notes and adding any additional information, observations, problems encountered, suggestions, etc.

- Take photos detailing station conditions and discharge events. Establish photo points (location, camera orientation) and repeat every visit to document changes over time, discharges, seasons. Detail the locations of each photo on field datasheet or in field notebook.
- All field work is referenced by view/context looking downstream (e.g., right bank is defined as the bank on your right when looking downstream).
- Take all precautions to avoid sample contamination.
  - Be aware of the pollutant of concern and be cautious to avoid contamination. Sources of contamination vary with different pollutants.
  - Clean sampling bottles, field equipment, etc. with distilled, de-ionized water.
  - Properly label samples according to protocols and accurately complete chain of custody forms.
  - Field triplicates should be collected a minimum of once per year. For field triplicates, three samples are collected at the same time at the same location by the same field personnel and submitted to the laboratory for QA/QC purposes.

1. Monthly Maintenance
   a. Connect instruments to computer.
      i. For In-Situ pressure transducers, cable connects to computer via 9-pin serial port.
   b. Use instrument software to connect to instrument. Follow instructions in instrument user manual. Contact company technical assistance for troubleshooting advice for instruments.
      i. Download data to computer. Check data to ensure there are no data gaps and the data seems accurate.
      ii. Check date and time.
      iii. Check battery level. Change if below 50%.
      iv. Clean/wipe off probes. Recalibrate if necessary, depending on cleanliness and comparison of data to conditions observed at station.
      v. Fill out instrument maintenance log (see Figure 6.11 attached at the end of this section).
   c. Set up instrument to start recording again on 15-minute intervals.
   d. Secure instrument in housing.
   e. Complete station visit log (see Figure 6.9 attached at the end of this section). Take photos. Record staff plate measurement.

2. Targeted Discharge Event Monitoring
   a. Deploy Storm Water Sampler.
      i. Arrive at station 24-48 hours prior to anticipated target discharge.
      ii. Check mounting kit to ensure it has not been damaged since last visit, is still secure, and will allow for proper sample collection. If there are any problems, fix if possible. If it cannot be fixed immediately or prior to targeted discharge, describe problem on station visit log and report to project manager. Housing should be fixed prior to any subsequent sampling, to ensure the targeted stream discharge is being sampled properly.
      iii. Avoid contamination. Place all materials on tarp while prepping station. Rinse materials with distilled, de-ionized water, as necessary.
      iv. Deploy Storm Water Sampler in mounting tube at station in the housing associated with the targeted discharge.
      v. Record staff plate reading. Take photos. Complete necessary information in station visit monitoring log (see Figure 6.9 in attached at the end of this section).
   b. Collect sample.

i. Arrive at the station when discharge has receded and conditions allow safe entry into the stream.
ii. Remove Storm Water Sampler from mounting tube and immediately seal top with lid. Sample must have been properly collected in order to be submitted to lab.
  - If sample has exceeded the proper holding time in the passive sampler (see Table 6.10 in Section 6.5), then samples cannot be submitted to lab. Sediment holding times are lengthy. Samples to be submitted for nutrients can remain at site up to 4 days if water/air temperatures are below 38^{o}C. Evaluations of sample condition must be made in field based on conditions prior to submission to laboratory.
  - If the runoff volume was not great enough to fill the bottle and properly seal the lid, sample in unusable - the exception being that field personnel arrived within an hour of sample collection. In this case, sample can be submitted to lab, but must be flagged as 'unsealed'.
iii. Consult Table 6.10 in Section 6.5, if analyses require chemical preservation transfer sample to appropriate sample analysis bottle.
iv. Complete label (see Figure 6.7 attached at the end of this section) for each bottle and firmly secure to bottle. Label should include, at minimum, project, stream and station name, date, time, and field personnel.
v. Place all bottles in Ziploc in cooler with ice and complete chain of custody (see Figure 6.8 attached at the end of this section).
vi. Take photos. Record staff plate measurement. Complete necessary information in station visit monitoring log (see Figure 6.9 attached at the end of this section).
vii. Deliver samples and completed chain of custody to appropriate laboratory within stated holding times. Keep a copy of chain of custody for records.

c. Measure discharge at established cross section.
  i. Consult Appendix E to determine the proper protocols during high flow conditions. Field personnel safety is of the utmost importance.
  ii. Discharge is measured to verify the stage to discharge relationships calculated in Section 6.7.1.B. Building a rating curve is an iterative process. Discharge should be measured frequently in the initial years of station development to ensure the proper discharge is being sampled. Subsequently flow measurements should only be performed occasionally, or after a high, infrequent event to verify station conditions have not changed. Even if field personnel are not present at station during the targeted discharge, measuring over a range of discharges better constrains the stage-discharge relationships and improves calculations to estimate the sampled conditions.

3. Spring Snowmelt Monitoring
  a. Monitor USGS streamflow gage according to guidelines in Section 6.7.2. Arrive at site between 8 and 9am when sampling condition guidelines have been achieved (initial 20% discharge increase over baseline flow, increase in discharge from previous day).
  b. Collect grab sample. Follow protocols in Appendix I to collect a depth-integrated, discharge-weighted sample. If flow conditions preclude this method, follow protocols in Appendix I for high flow conditions.
    i. At least one time per year, field triplicates should be submitted to the lab to calculate field precision.
    ii. Complete label (see Figure 6.7 attached at the end of this section) for each bottle and firmly secure to bottle. Label should include, at minimum, project and station name, date, time, and field personnel.

iii. Place all bottles in Ziploc in cooler with ice and complete chain of custody (see Figure 6.8 attached at the end of this section).

c. Take photos. Record staff plate measurement. Complete necessary information in station visit monitoring log (see Figure 6.9 attached at the end of this section).
d. Measure discharge at established cross section.
   i. Consult Appendix E to determine the proper protocols during high flow conditions. Field personnel safety is of the utmost importance.
   ii. Discharge measurements are conducted to gain understanding on the relationship between the local conditions and the USGS streamflow gages. Flow measurements should be taken frequently in the initial years of station development to gain a proper, comprehensive understanding of the relative conditions. Once personnel can reliably predict the snowmelt discharge conditions at the station using the USGS streamflow data, flow measurements should be conducted only occasionally to verify the relationship.
e. Deliver samples and completed chain of custody to appropriate laboratory within stated holding times. Keep a copy of chain of custody for records.

4. Bi-annual Station Survey
   a. Every 1-2 years resurvey instrument elevations to verify the relative elevation and calculated targeted discharge.
   b. Every 1-2 years resurvey channel cross section to determine aggradation or degradation. The rating curves should be adjusted accordingly.
   c. If any instrumentation (passive samplers, pressure transducer, staff plate) is replaced, elevations of new instrumentation must be surveyed.
   d. Based on updated survey, recalculate targeted discharges sampled by the in-stream passive samplers.

6.7.4 Laboratory Analysis Protocols

Note: Many analytical laboratories are available. The TRWQMP was developed based on the requirements of High Sierra Water Laboratory for sediment and nutrient analyses. Appendix G summarizes the lab's QA/QC SOPs.

QA/QC
   a. Table 6.11 in Section 6.5summarizes the laboratory analysis protocols and necessary QA/QC requirements for High Sierra Water Laboratory. If another lab is chosen for analytical work, the details of Table 6.11 may need to be revised.
   b. All laboratory reports are checked for completeness, typographical errors, suspect values, and for conformity between the chain of custody forms and the lab reports.

6.7.5 Data Management Protocols

1. Set up computer files.
   a. Download photos from camera to office computer/server. Photos should be identified by date, station ID and photo point.
   b. Open a Microsoft Excel worksheet for station. Spreadsheets should be maintained for instrument elevation, depth, flow and sample data. Column headings should include at a minimum:
      - Relative instrument elevations
        A. discharge
        B. stage – bankfull passive sampler

C. stage – intermediate passive sampler
D. stage – 10-yr passive sampler
E. stage – LevelTroll
F. stage – staff plate

- Depth data
  A. station ID
  B. date
  C. time
  D. unvented pressure
  E. vented pressure
  F. baro-corrected pressure
  G. baro-corrected depth
  H. staff corrected depth
  I. discharge
  J. volume
- Flow measurement data
  A. station ID
  B. date
  C. time
  D. staff reading
  E. corresponding instrument depth reading
  F. calculated discharge measurement
- Sample data
  A. station id
  B. date
  C. time
  D. field personnel
  E. discharge
  F. concentrations per constituent
- Laboratory replicate results
  A. station ID
  B. date
  C. time
  D. constituent
  E. lab concentrations
  F. average concentration
- Event information
  A. date
  B. type
  C. # days antecedent dry conditions
  D. total precipitation

2. Complete relative instrument elevations corresponding to discharges.
   a. Based on field observations, instrument depth data and calculations performed in Section 6.7.1.B, create a table relating stream discharge to corresponding instrument depths/elevations. Use Table 6.14 as an example.

Table 6.14					
Discharge (cfs)	**Bankfull Passive Sampler Stage (ft)**	**Intermediate Passive Sampler Stage (ft)**	**10-yr Passive Sampler Stage (ft)**	**LevelTroll Depth (ft)**	**Staff Plate Reading (ft)**

Table 6.14. Example tables for instrument elevation relative to discharge.

3. Add pressure transducer data to spreadsheet.
   a. Append latest download to existing data.
   b. Correct unvented data for changes in barometric pressure using vented data, if necessary.
   c. QA/QC data
      i. Plot time series of corrected depth data.
      ii. Keep raw data in raw data column.
      iii. In baro-corrected depth column remove any data when instrument was out of water or any suspect data that cannot be reasonably adjusted based on other available site information.
   d. Enter all staff plate observations to spreadsheet. Add corrected depth reading from the same date and time.
   e. Correct depth data based on differences between staff plate measurements and baro-corrected readings from pressure transducer.

4. Create water volume time series.
   a. For each field flow measurement, calculate stream discharge (Appendix E).
   b. Create/update stage to discharge rating curve.
      i. Plot staff plate readings (i.e., stage) versus discharge.
      ii. Create trendline through data, finding the trendline type that creates the best R-square value.
      iii. Include equation and R-square on plot.
   c. Using the trendline equation above, convert all staff corrected depth data to discharge.
   d. Integrate discharge data over 15-minute intervals to calculate total water volume. Be aware of corrected data gaps. If appropriate, integrate discharge data over a longer time interval to account for gaps.
   e. Plot water volumes over monitoring time period.

5. Enter laboratory data into spreadsheet.
   a. Verify laboratory sample list against the chain of custodies to ensure results for all submitted samples are present.
   b. Enter all laboratory data, including field and laboratory replicate data.
      - There should be one row for each sample submitted to the lab (including a row for each field triplicate).
      - If reported value is below detection limit, write detection limit value.
      - If sample wasn't analyzed for a constituent, leave cell blank.
      - If a lab replicate was run, constituent value should be the average of the replicate results. (See Step 6a.)

6. Analyze data.
   a. Average laboratory replicate values.
   b. Summarize sample data.
      - There should be one row per station per event date.
      - Column headings should include: station id, date, time, concentrations for each constituent analyzed.
      - For field triplicates, constituent concentration should be reported as the average of the triplicates.
      - If reported value is below detection limit, write detection limit value.
   c. Calculated field precision as average percent error.

i. For each group of field triplicates, calculate StDev (3 samples) / Average (3 samples) for each constituent.
ii. Average all values to calculate field precision for each constituent.
iii. Include count total number of values used to calculate precision value.

d. Calculate laboratory precision.
   i. For each replicate, calculate Absolute (sample1 – sample 2) / Average of the 2 samples for each constituent.
   ii. Average all values to calculate laboratory precision for each constituent.
   iii. Include count of total number of values used to calculate precision value.

7. Determine discharge associated with each sample.
   a. For targeted discharge events, assume sample was collected at the targeted discharge.
      i. Verify assumption using discharge time series. Targeted discharge should have occurred during time period when sampler was deployed at station.
   b. For spring snowmelt samples:
      i. If field discharge measurement was taken at time of sampling, use this value.
      ii. If not measurement was taken, use calculated discharge from instrument data time series for date and time corresponding to sample collection.

8. Summarize event data.
   - Event date - standardized as the day the precipitation/runoff began.
   - Event type – winter rain, rain on snow, snowmelt, summer rain, irrigation
   - Number of days of antecedent dry conditions – number of consecutive days with no precipitation/runoff prior to event start.
   - Event precipitation – total number of inches of precipitation during event.
   - It can be difficult to standardize the onset and end of a storm event. The following parameters are suggested when looking at rainfall data to determine total event precipitation. Ideally 30-minute data is available, however hourly data can also be used.
     - An event has no more than a 4-hr gap in rainfall (i.e., there are no more than 8 consecutive 30-minute intervals without rainfall).
     - An event begins when there are 4 consecutive 30-minute intervals with rain.
     - An event ends when no rainfall has fallen in longer than 4 hours.

9. QA/QC.
   a. All data entries and calculations should be verified by a secondary staff member for data accuracy and completeness. Any missing or questionable data should be flagged for review by project manager.
   b. All field datasheets should be stored in the field agency office for at least 5 years following the completion of the project.
   c. Once established, nomenclature (station ID, etc.) should remain consistent over the life of the TRWQMP.

6.7.6 Reporting Protocols to TRWQMP Database

The Tributary Level Discrete Sampling results obtained each year should be compiled, analyzed and digitally submitted to the TRWQMP database. Data should be submitted to the database manager annually and only include the data from the past year. Previously submitted data should not be re-submitted unless QA/QC procedures have resulted in changes in data values. Section 7.0 details the recommended data management structure and associated procedures to facilitate the integration of the TRWQMP data annually.

- Discrete water quality results should be reported in one Microsoft Excel spreadsheet named TRWQMP_ StationName_Year (ex: TRWQMP_DST-MC2_2010) that has four separate worksheets: Instrument Data, WQ Results, WQ Precision and Event Information.
- Column headings and field formatting requirements for Discrete Tributary Sampling data, including data type, units, and precision level are presented in Table 6.15 for each worksheet. It is critical that all data is submitted to the database in the standardized format, especially in the required units, to ensure compatibility with all other submitted data and proper integration into the TRWQMP database.
  - For InstrumentData
    - Each row should correspond to each 15-minute time interval available with QA/QC'd data. Gaps in the time series should not be represented with blank rows. Only include time intervals with data.
    - There should be no blank cells – for each row of data there should be corresponding information in each column.
  - For WQ Results
    - There should be one row per station per event date.
    - QA/QC should always be "Yes."It is verification by submitting agency that all data was properly checked according quality assurance standards. Any explanation of flagged, missing, or questionable data should be included in the DataNotes field.
  - For WQ Precision
    - There should be one row per station.
    - Precision is calculated using all available data from all years of data collection. Values should be updated annually using the complete dataset.
    - There should only be blank cells if no field replicates have been collected and submitted to the lab for a constituent, or if the lab has not performed a replicate analysis for that constituent.
- For Event Information
    - There should be one row per event.

Table 6.15					
Field Name	**Description**	**Database Field Type, Size, Format**	**Units**	**Precision[A]**	**Standardized Format**
INSTRUMENT DATA					
StationID	Observation station	Text	n/a	n/a	Provided by TRWQMP data manager
InstDateTime	Date and time as recorded by instrument. If station has more than one sensor, data is merged into one dataset.	Date – Short Date	n/a	n/a	MM/DD/YYYY
InstDepth	Baro and stage-corrected depth reading recorded by pressure transducer.	Number – Double	ft	2	Positive number
InstDischarge	Discharge as determined from station depth to discharge rating curve.	Number – Double	cfs	2	Positive number
InstVolume	Water volume calculated through integration of discharge data.	Number – Double	L	2	Positive number
WQ RESULTS					
StationID	Observation station	Text	n/a	n/a	Provided by TRWQMP data manager
EventDate	Date of monitoring	Date - Short Date	n/a	n/a	MM/DD/YYYY
FieldAgency	Agency performing monitoring	Text	n/a	n/a	Provided by TRWQMP data manager
FieldPersonnel	Personnel performing monitoring	Text	n/a	n/a	First Initial. Last Name (individuals separated by commas)
Discharge	Stream discharge at station at time of sample collection	Number – Double	cfs	2	Positive number.
SampleType	Type of sample collected based on assessment type	Text	n/a	n/a	DST
ConcTSS	Total Suspended Solids concentration	Number – Double	mg/L	2	if ND = 0.10
ConcNOX	Nitrate concentration	Number – Double	ug/L	2	if ND = 1.00
Conc NH4	Ammonia concentration	Number – Double	ug/L	2	if ND = 1.00
ConcTN	Total Nitrogen concentration	Number – Double	ug/L	2	if ND = 35.00
ConcSRP	Soluble Reactive Phosphorous concentration	Number – Double	ug/L	2	if ND = 1.00

Table 6.15					
Field Name	**Description**	**Database Field Type, Size, Format**	**Units**	**Precision[A]**	**Standardized Format**
ConcTP	Total Phosphorous concentration	Number – Double	ug/L	2	if ND = 1.00
QAQC	QA/QC performed on data	Yes/No	n/a	n/a	Yes, No
DataNotes	Explanation of flagged, missing, or questionable data	Memo	n/a	n/a	If none, enter NONE.
WQ PRECISION					
StationID	Observation station	Text	n/a	n/a	Provided by TRWQMP data manager
CalculationDate	Most recent sample date used in precision calculations	Date – Short Date	n/a	n/a	MM/DD/YYYY
FP_*Constituent*	Calculated field precision (% error) for each constituent	Number – Double - Percent	%	2	Ranging from 0 to 100
LP_*Constituent*	Calculated lab precision (% error) for each constituent	Number – Double – Percent	%	2	Ranging from 0 to 100
FPC_ *Constituent*	# samples used in field precision calculation	Number – Integer	n/a	0	Positive number
LPC_ *Constituent*	# samples used in lab precision calculation	Number - Integer	n/a	0	Positive number
EVENT INFORMATION					
StationID	Observation station	Text	n/a	n/a	Provided by TRWQMP data manager
EventDate	Date of sample collection	Date - Short Date	n/a	n/a	MM/DD/YYYY
EventType	Runoff event type	Text	n/a	0	Choose from: winter rain, rain on snow, snowmelt, summer rain, irrigation
EventAntecedent	Number of days prior to event with no precipitation	Number – Integer	days	0	Positive number
EventTotal	Total event precipitation	Number – Double	inches	2	Positive number

[A]Precision is the number of digits to the right of the decimal place (e.g., 2 means value is reported as #.##). ND is non detect, or below detection limit.

Table 6.15. TRWQMP database field types and reporting requirements for discrete tributary sampling assessment analysis.

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

2NDNATURE LLC	TRWQMP SAMPLE BOTTLE LABELS	FIGURE 6.7

CHAIN OF CUSTODY RECORD

PAGE ____ OF ____

PROJECT NAME AND JOB #: ______________________

SEND CERTIFIED RESULTS TO: ______________________

ELECTRONIC DELIVERABLE FORMAT: YES NO

Sampler: ______________________

Date: ______________________

LABORATORY: ______________________

TURNAROUND TIME: Standard | 24hr Rush | 48hr Rush | 72hr Rush

GLOBAL I.D.: ______________________

Sample Identification	Sample Date	Time Sampled	Sample Filtered?	SAMPLE CONTAINERS			REQUESTED ANALYSIS										
				Sample Volume (ml)	Container Type (HDPE, Glass, etc)	Preservation (H_2SO_4, HNO_3, HCl)	Nutrients								Additional Analysis		
							Filtered										
							NO_x^-	NO_2^-	NH_4^+	SRP	DP	DKN	TKN	TP	TSS	Oil and Grease	Trace Metals

RELEASED BY:	Date & Time		RECEIVED BY:	Date & Time	SAMPLE CONDITION (circle one)
1.		→			Ambient Refrigerated Ice
2.		→			Ambient Refrigerated Ice
3.		→			Ambient Refrigerated Ice
4.		→			Ambient Refrigerated Ice
5.		→			Ambient Refrigerated Ice

NOTES:

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SAMPLE CHAIN OF CUSTODY

FIGURE 6.8

Station Visit Log - Please fill out every time a monitoring station is visited.

Date	Time	Station	Personnel	Site Conditions	Photos Taken?	Staff Plate Reading	Batt OK	Sampler Deployed		Sample Collected			Notes
								Number	Type	Number	Type	Field Trips?	

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STATION VISIT MONITORING LOG

FIGURE 6.9

INSTRUMENT CHECKLIST - PLEASE FILL OUT EVERY TIME INSTRUMENT IS SERVICED / DOWNLOADED / CHECKED / ETC.
Fl - flow meter, Ba - baroTroll, Lvl - pressure transducer, Sam - automatic sampler

Date	Time	Station	Personnel	Gage	File Extracted	Data OK	Batt OK	New Test				Notes
								Name	Interval	Mode / Trigger	Start Time	
				Fl / Ba / Lvl / Sam								
				Fl / Ba / Lvl / Sam								
				Fl / Ba / Lvl / Sam								
				Fl / Ba / Lvl / Sam								
				Fl / Ba / Lvl / Sam								
				Fl / Ba / Lvl / Sam								
				Fl / Ba / Lvl / Sam								
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				Fl / Ba / Lvl / Sam								
				Fl / Ba / Lvl / Sam								

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INSTRUMENT MAINTENANCE LOG

FIGURE 6.11

6.8 Near-continuous Water Quality Measurements – Turbidity Protocols

Near-continuous turbidity measurements create long-term high resolution records of sediment transport. Locations of observations and associated justification are outlined in Section 5.0.

6.8.1 Site Selection and Instrument Installation Protocols

A. Site Selection Strategy

Continuous turbidity sampling is costly and in most instances should only be employed along the Truckee River Main stem and/or at the downstream extent of high disturbance tributaries. When reviewing and selecting locations for automated turbidity sampling, the following considerations should be made to prioritize sampling stations:

- Disturbance level of contributing catchment with respect to potential fine sediment generation (see GIS prioritization results, Section 3.1).
- Location of other existing turbidity stations – Does planned station provide the best spatial extension of near-continuous turbidity observations within project area?
- Stable cross section – Accurate and consistent hydrology measurements depend upon a cross section that neither aggrades or degrades over time and is not predisposed to bank erosion.
- Straight reaches typically have more uniform and well-mixed flow to collect a representative sample.
- Security – stations should be located in places where vandalism is unlikely to occur, or proper precautions should be taken to ensure security of equipment.
- Access – safety and logistics. Field personnel must be able to easily and safely get to the sampling station. If station is located on private property, permission to enter property must be granted to field personnel prior to station installation.

B. Instrument Installation

Objective: Install one near-continuous automated turbidity probe and one near-continuous pressure transducer instream to collect turbidity, depth, etc. data on 15-minute intervals.

Recommended Products: The TRWQMP recommends FTS DTS-12 turbidity sensor and In-Situ LevelTroll 500 pressure transducer (see Table 6.7 in Section 6.5) given their strong track record of performance and reliability in the Lake Tahoe climate. The pressure transducers are available in vented and un-vented models. If the un-vented model is installed on-site, access to 15-minute barometric pressure is necessary (see Table 6.7 in Section 6.5, footnote A).). Turbidity sensors and pressure transducers with similar specifications to the recommended products in terms of sensor accuracy, precision and range, data storage memory, battery life, and reliability in cold weather may be used as well.

Personnel Needed: 1-2 field personnel 20 hours to establish station and install equipment.

Equipment Needed:

- Turbidity sensor
- Datalogger
- Battery
- cables necessary to connect sensor to datalogger and datalogger to battery
- secure housing for datalogger and battery
- un-vented/vented pressure transducer
- wire cable/rope

- BaroTroll housing (3ft long 8in PVC, top, lock)
- perforated PVC
- PVC end cap
- locks
- vertical steel sign/fence post or rebar
- digging bar
- post driver
- level
- side braces
- radiator clamps
- shovel
- tools
- drill
- survey gear (transit, tripod, survey tape, stadia rod)
- staff plate
- wooden post
- screws
- flow measurement instruments (survey tape, AA or pygmy meter, stopwatch, etc.)

Instrument Installation:
Note: The most effective installation materials, housing and configuration for each station will depend upon site conditions and limitations. Trained and experienced field personnel should be used to ensure proper and safe installation of expensive instream equipment in stream.

1. Calibrate and setup instruments (FTS DTS-12 turbidity sensor, In-Situ LevelTroll 500, In-Situ BaroTroll if necessary) in office.
    a. Follow software instructions provided in user manuals.
    b. Check that date and time are accurate.
    c. Set to record data on 15 minute intervals.
        - Turbidity values as NTU. Calibrated according to instrument specifications and software manual.
        - Water depth as feet. Calibrated and corrected for elevation (barometric pressure differences).
        - Pressure in psi. Calibrated and corrected for elevation.
        - If an un-vented instrument is to be installed, access to vented barometric pressure data is required. A vented instrument can be set to record on same 15 minute interval and installed on-site, in the office, or at another nearby station. One BaroTroll instrument can be used to correct multiple unvented gages. The In-Situ software can link non-vented instrument data and vented data to correct the water depth time series automatically. The barometric corrections can also be conducted manually.

2. Install turbidity sensor and datalogger.
    a. FTS (http://www.ftsinc.com/) provides substantial installation support for their turbidity sensors and data loggers. Appendix J provides visual examples of successful installations. Additionally http://www.fs.fed.us/psw/topics/water/tts/ is a good resource.
    b. DTS-12 is housed in PVC that is perforated at the end to allow stream flow through to the sensor. Sensor should be placed in channel to collect a representative reading of stream sediment conditions.
    c. Datalogger and battery are placed in secure, dry location well above flood conditions. Instrument housing should be installed with a locking device to deter vandalism.

3A. Install un-vented pressure transducers.

a. Secure vertical steel sign post/rebar in streambed, buried 1-2ft in channel substrate. If possible, use a sign post already installed for passive samplers. Place side braces into the stream bank to further secure housing, if necessary.
b. Attach PVC (with perforations along bottom 1-2ft) to post/rebar using radiator clamps. Radiator clamps should be spaced evenly along the length of PVC to properly secure it to the post/rebar.
c. Install pressure transducer within PVC. Attach sufficient length of stainless cable to instrument to ensure placement at the bottom of PVC.
d. Loop cable through PVC cap and lock cap to PVC to prevent theft or vandalism.
e. One vented pressure transducer (In-Situ BaroTroll, see Table 6.7 in Section 6.5) will need to be installed somewhere in the project area to record and allow correction for barometric pressure differences. It is not necessary to install one at every station. One vented transducer can be used for the entire watershed, as long as data is recorded on 15-minute intervals and widely available to all agencies operating instruments and reporting to the TRWQMP. To install a programmed In-Situ BaroTroll on-site:
   - Choose location above the high flow line to ensure instrument cannot be inundated.
   - Bury a 3ft long 8" PVC piece in ground. Place BaroTroll in PVC.
   - Lock top in place to prevent theft and/or vandalism.

OR:

3B. Install vented pressure transducer.

a. Secure vertical steel sign post/rebar in streambed, buried 1-2ft in channel substrate. If possible, use a sign post already installed for passive samplers. Place side braces into the stream bank to further secure housing, if necessary.
b. Attach PVC (with perforations along bottom 1-2ft) to post/rebar using radiator clamps. Radiator clamps should be spaced evenly along the length of PVC to properly secure it to the post/rebar.
c. Install pressure transducer within PVC. Run instrument cable with PC attachment to bank.
   - Ensure vented LevelTroll is purchased with sufficient length of cable to extend instrument to desired location in stream.
   - Special care should be taken to ensure cable does not kink or bend.
   - End of cable should be installed in location above the high flow line to ensure cable top is not inundated.
d. Cable should be locked to prevent theft or vandalism of instrument.
e. No BaroTroll is needed if all Level Trolls used are vented.

4. Install staff plate to measure channel stage.

a. Size and cut wooden post to fit to vertical sign post/rebar.
b. Using drill, screw staff plate to wooden post, ensuring that bottom of staff plate is even with bottom of wooden post.
c. Attach wooden post to vertical sign post housing pressure transducer using radiator clamps. Wooden post should be placed on channel bottom to ensure staff plate readings are equal to actual water depth in channel. Radiator clamps should be spaced evenly along the length of wooden post to properly secure staff plate.

5. Set up cross section for flow measurements.

a. Install left and right bank pins outside of anticipated high discharge mark.
b. Mark with orange survey flagging.
c. Detail locations in station monitoring log.

6. Measure discharge at established cross section using six-tenths depth method (see Appendix E for details).

6.8.2 Event Sampling Strategy

Near-continuous automated turbidity probes and samplers collect water quality data year round on 15-minute intervals (see Table 5.3).

Discrete TSS samples are collected and discharge is measured throughout the monitoring season to develop turbidity to TSS and stage to discharge rating curves. The infrequent storm conditions that transport the majority of pollutants are targeted and sampling events should focus on measuring discharge and TSS during these conditions. It is an iterative process to build the rating curve, focusing event monitoring on those events that extend and fill the gaps of the existing rating curve to better constrain the calculations. Ideally 10-15 events will be monitored annually (see Table 5.3). Events are characterized by their event type (winter rain, rain on snow, snowmelt, summer thunderstorm). Strategies for anticipating targeted sampling events are provided below.

- Become familiar with the streamflow patterns from USGS gage #10338000, Truckee River near Truckee, CA and/or #10346000, Truckee River at Farad, CA. These USGS gages were selected on the assumption that the tributary itself is not gaged. If real-time streamflow data is available at a location closer to the turbidity station and has similar characteristics (elevation, watershed area, etc.), this data should be used instead as it more accurately portrays the conditions on-site.
  - Study the historical streamflow patterns to understand the seasonal changes (timing, discharge increases) at the gage station and to anticipate the peak snowmelt discharges. Use field discharge measurements to develop understanding of discharge relationship between the stations.
  - Frequently check the real-time data to anticipate when a sampling event may occur.
- Monitor weather data from office to anticipate targeted discharges associated with storm events and to follow the temperature increases that may lead to snowmelt in the watershed.
  - Check www.wunderground.com. Possible stations include:
    - Tahoe Truckee Airport (KTRK)
    - Truckee #2 CA US SNOTEL (MTRUC1)
    - Alder Creek Middle School (KCATRUCK24)
    - Truckee-Glenshire ES CA US DRI (MGLSH)
    - RAWS Stampede (MSMDC1)
  - Check NOAA National Weather Service (www.nws.noaa.gov).
  - Check the Weather Channel (www.weather.com).

6.8.3 Field Evaluation Protocols

Objective: Regularly visit station to maintain and download the near-continuous automated turbidity probe and pressure transducer recording turbidity and depth on 15-minute intervals. Over a range of discharges, collect TSS samples and measure discharge to create turbidity to TSS and stage to discharge rating curves for station and to calculate sediment loads on event, seasonal and annual time frames.

Personnel Needed:

Monthly Maintenance: 1 field personnel 1-2 hours per month per station for instrument maintenance, data download, calibration, etc.

Event Monitoring: 2 field personnel 2-3 hours per targeted event to collect TSS samples and measure discharge

Equipment Needed:

Monthly Maintenance:

- charged computer
- appropriate instrument cables
- extra computer battery
- calibration materials
- camera
- field notebook
- pens/pencils
- instrument logs (Figure 6.11 attached at the end of this section)
- instrument batteries (if replaceable)

Event Monitoring:

- depth-integrated sediment sampler
- sample bottle
- pens/pencils
- field notebook
- distilled, de-ionized water
- camera
- ice
- cooler
- sample labels (Figure 6.7 attached at the end of this section)
- chain of custody (Figure 6.8 attached at the end of this section)
- station monitoring log (Figure 6.9 attached at the end of this section)
- flow measurement instruments (flow meter, stopwatch, survey tape)

Field Observations and Data Collection:

Keys to good field work:

- Be safe. Event sampling is by nature hazardous due to storm conditions. Field personnel should always wear proper protective clothing when outside during a storm. Personnel safety always comes first. Use best professional judgment. If conditions do not allow safe access to the sampler, personnel should wait until safe conditions exist.
- Follow the protocols closely and review prior to each field mobilization. Use the provided data sheets.
- Take detailed field notes in a field notebook. At the end of the field day, spend several minutes reviewing notes and adding any additional information, observations, problems encountered, suggestions, etc.
- Take photos detailing station conditions, discharge events, etc. Establish photo points (location, camera orientation) and repeat every field visit to document changes over time, discharge events. Detail the locations of each photo on field datasheet or in field notebook.
- All field work is referenced by view/context looking downstream (e.g., right bank is defined as the bank on your right when looking downstream).
- Take all precautions to avoid sample contamination.

- Be aware of the pollutant of concern and take all precautions to avoid contamination. Sources of contamination vary with different pollutants.
- Clean sample bottles, field equipment, etc. with distilled, de-ionized (DI) water.
- Properly label samples according to protocols and accurately complete chain of custody forms.
- Field triplicates should be collected a minimum of once per year. For field triplicates, three samples are collected at the same time at the same location by the same field personnel and submitted to the laboratory for QA/QC purposes.

1. Monthly Maintenance
    a. Connect instruments to computer.
        i. For FTS turbidity sensor, datalogger is connected to computer via USB port.
        ii. For In-Situ pressure transducers, cable connects to computer via 9-pin serial port.
    b. Use instrument software to connect to instrument. Follow instructions in instrument user manual. Contact company technical assistance for troubleshooting advice for instruments.
        i. Download data to computer. Check data to ensure there are no data gaps and the data seems accurate.
        ii. Check date and time.
        iii. Check battery level. Change if below 50%.
        iv. Clean/wipe off probes. Recalibrate if necessary, depending on cleanliness and comparison of data to conditions observed at station.
        v. Fill out instrument maintenance log (Figure 6.11 in attached at the end of this section).
    c. Set up instrument to start recording again on 15-minute intervals.
    d. Secure instrument in housing.
    e. Complete station visit log (Figure 6.9 in attached at the end of this section). Take photos. Record staff plate measurements.

2. Event Monitoring
    a. Measure discharge at established cross section.
        i. Consult Appendix E to determine the proper protocols during high flow conditions. Field personnel safety is of the utmost importance.
        ii. Discharge is measured to create the stage to discharge rating curve. Measure discharge at a well-represented range of conditions, thus the most infrequent high discharge events are the most critical points to capture in the quest for a representative rating curve.
    b. Collect a manual TSS grab sample. Follow protocols in Appendix I to collect a depth-integrated, discharge-weighted sample. If flow conditions preclude this method, follow protocols in Appendix I for high flow conditions.
        i. At least one time per year, field triplicates should be submitted to the lab to calculate field precision.
        ii. Complete label (see Figure 6.7 attached at the end of this section) for each bottle and firmly secure to bottle. Label should include, at minimum, project and station name, date, time, and field personnel.
        iii. Place all bottles in Ziploc in cooler with ice and complete chain of custody (see Figure 6.8 attached at the end of this section).
        iv. Deliver samples and completed chain of custody to appropriate laboratory within stated holding times. Keep a copy of chain of custody for records.
    c. Take photos. Record staff plate measurement. Complete necessary information in station visit monitoring log (see Figure 6.9 attached at the end of this section).

3. Bi-annual Station Survey
    a. Every 1-2 years resurvey instrument elevations to verify the relative elevation.
    b. Every 1-2 years resurvey channel cross section to determine aggradation or degradation. Adjustments should be made to rating curve accordingly.
    c. If any instrumentation is replaced, elevations of new instrumentation must be surveyed.

6.8.4 Laboratory Analysis Protocols

Note: Many analytical laboratories are available. The TRWQMP was developed based on the requirements of High Sierra Water Laboratory for sediment and nutrient analyses. Appendix G summarizes the lab's QA/QC SOPs.

QA/QC
    a. Table 6.11 in Section 6.5 summarizes the laboratory analysis protocols and necessary QA/QC requirements for High Sierra Water Laboratory. If another lab is chosen for analytical work, the details of Table 6.11 may need to be revised.
    b. All laboratory reports are checked for completeness, typographical errors, suspect values, and for conformity between the chain of custody forms and the lab reports.

6.8.5 Data Management Protocols

1. Set up computer files.
    a. Download photos from camera to office computer/server. Photos should be identified by date, station ID, and photo point.
    b. Open a Microsoft Excel worksheet for station. Spreadsheets should be maintained for turbidity, depth, flow, sample, and lab data. Column headings should include at a minimum:
        - Depth data
            A. station ID
            B. date
            C. time
            D. unvented pressure
            E. vented pressure
            F. baro-corrected pressure
            G. baro-corrected depth
            H. staff corrected depth
            I. discharge
            J. volume
        - Flow measurement data
            A. date
            B. time
            C. staff reading
            D. corresponding instrument depth reading
            E. calculated discharge measurement
        - Turbidity data
            A. station ID
            B. date
            C. time
            D. raw turbidity data
            E. corrected turbidity

F. TSS concentration
G. TSS load

- Sample data
  A. station ID
  B. date
  C. time
  D. field personnel
  E. discharge
  F. TSS concentration
- Laboratory replicate results
  A. station ID
  B. date
  C. time
  D. constituent
  E. lab concentrations
  F. average concentration

2. Add pressure transducer data to spreadsheet.
   a. Append latest download to existing data.
   b. Correct unvented data for changes in barometric pressure using vented data, if necessary.
   c. QA/QC data
      i. Plot time series of corrected depth data.
      ii. Keep raw data in raw data column.
      iii. In baro-corrected depth column remove any data when instrument was out of water or any suspect data that cannot be reasonably adjusted based on other available site information.
   d. Enter all staff plate observations to spreadsheet. Add corrected depth reading from the same date and time.
   e. Correct depth data based on differences between staff plate measurements and baro-corrected readings from pressure transducer.

3. Create water volume time series.
   a. For each field flow measurement, calculate stream discharge (see Appendix E).
   b. Create/update depth to discharge rating curve.
      i. Plot staff plate measurements (i.e., stage) versus discharge.
      ii. Create trendline through data, finding the trendline type that creates the best R-square value.
      iii. Include equation and R-square on plot.
   c. Using the trendline equation above, convert all staff corrected depth data to discharge.
   d. Integrate discharge data over 15-minute intervals to calculate total water volume. Be aware of corrected data gaps. If appropriate, integrate discharge data over a longer time interval to account for gaps.
   e. Plot water volumes over monitoring time period.

4. Add turbidity sensor data to spreadsheet.
   a. Append latest download to existing data.
   b. QA/QC data
      i. Plot time series of turbidity data.
      ii. Keep raw data in raw data column.

    iii. In corrected turbidity column remove any data when instrument was out of water or any suspect data that cannot be reasonably adjusted based on other available site information.

5. Enter laboratory data into spreadsheet.
    a. Verify laboratory sample list against the chain of custodies to ensure results for all submitted samples are present.
    b. Enter all laboratory data, including field and laboratory replicate data.
        - There should be one row for each sample submitted to the lab (including a row for each field triplicate).
        - If reported value is below detection limit, write detection limit value.
        - If sample wasn't analyzed for a constituent, leave cell blank.
        - If a lab replicate was run, constituent value should be the average of the replicate results. (See Step 7a.)

6. Create sediment loading time series.
    a. Create TSS to turbidity rating curve using sample data.
        i. Plot turbidity versus TSS concentration for each sample analyzed by the lab.
        ii. Create trendline through data, finding the trendline type that creates the best R-square value.
        iii. Include equation and R-square on plot.
    b. Using the trendline equation above, convert corrected turbidity data to TSS concentrations.
    c. Using water volume values calculated in Step 3e, convert TSS concentrations to sediment loading rate.
    d. Plot sediment loading rate over monitoring time period.
    e. Integrate curve to calculate total annual sediment load per year that was observed by site.

7. Analyze data.
    a. Average laboratory replicate values.
    b. Summarize sample data.
        - There should be one row per station per event date.
        - Column headings should include: station ID, date, time, concentrations for each constituent analyzed.
        - For field triplicates, constituent concentration should be reported as the average of the triplicates.
        - If reported value is below detection limit, write detection limit value.
    c. Calculate field precision as average percent error.
        i. For each group of field triplicates, calculate StDev (3 samples) / Average (3 samples) for each constituent.
        ii. Average all values to calculate field precision for each constituent.
        iii. Count total number of values used to calculate precision value.
    d. Calculate laboratory precision.
        i. For each replicate, calculate Absolute (sample1 – sample 2) / Average of the 2 samples for each constituent.
        ii. Average all values to calculate laboratory precision for each constituent.
        iii. Count total number of values used to calculate precision value.

8. Determine discharge associated with each sample.
    a. If field discharge measurement was taken at time of sampling, use this value.

   b. If not measurement was taken, use calculated discharge from instrument data time series for date and time corresponding to sample collection.

9. QA/QC.
   a. All data entries and calculations should be verified by a secondary staff member for data accuracy and completeness. Any missing or questionable data should be flagged for review by project manager.
   b. All field datasheets and instrument files should be stored in the field agency office for at least 5 years following the completion of the project.
   c. Once established, nomenclature (station ID, etc.) should remain consistent over the life of the TRWQMP.

6.8.6 Reporting Protocols to TRWQMP Database

The Near-Continuous Turbidity results obtained each year should be compiled, analyzed and digitally submitted to the TRWQMP database. Data should be submitted to the database manager annually and only include the data from the past year. Previously submitted data should not be re-submitted unless QA/QC procedures have resulted in changes in data values. Section 7.0 details the recommended data management structure and associated procedures to facilitate the integration of the TRWQMP data annually.

- Near-continuous turbidity and depth data should be reported in one Microsoft Excel spreadsheet named TRWQMP_StationName_Year.xls (ex: TRWQMP_TURB-MC4_2011.xls) that has three separate worksheets: InstrumentData, WQResults, and WQPrecision.
- Column headings and field formatting requirements for Near-Continuous Turbidity data, including data type, format, units, and precision level are presented in Table 6.16 for each worksheet. It is critical that all data is submitted to the database in the standardized format, especially in the <u>required units</u>, to ensure compatibility with all other submitted data and proper integration into the TRWQMP database.
  - For InstrumentData
    - Each row should correspond to each 15-minute time interval available with QA/QC'd data. Gaps in the time series should not be represented with blank rows. Only include time intervals with data.
    - There should be no blank cells – for each row of data there should be corresponding information in each column. The exception being if there are periods of time where one sensor (turbidity, depth) worked properly, while the other sensor did not.
  - For WQ Results
    - There should be one row per station per event date.
    - QA/QC should always be "Yes." It is verification by submitting agency that all data was properly checked according quality assurance standards. Any explanation of flagged, missing, or questionable data should be included in the DataNotes field.
  - For WQ Precision
    - There should be one row per station.
    - Precision is calculated using all available data from all years of data collection. Values should be updated annually using the complete dataset.
    - There should only be blank cells if no field replicates have been collected and submitted to the lab for a constituent, or if the lab has not performed a replicate analysis for that constituent.

Table 6.16					
Field Name	**Description**	**Database Field Type, Size, Format**	**Units**	**Precision[A]**	**Standardized Format**
INSTRUMENT DATA					
StationID	Observation station	Text	n/a	n/a	Provided by TRWQMP data manager
InstDateTime	Date and time as recorded by instrument. If station has more than one sensor, data is merged into one dataset.	Date – Short Date	n/a	n/a	MM/DD/YYYY
InstTurb	Corrected turbidity value recorded by turbidity sensor.	Number – Double	NTU	2	Positive number
InstTSSConc	TSS concentration as determined from station turbidity to TSS rating curve.	Number – Double	mg/L	2	Positive number
InstDepth	Baro and stage-corrected depth reading recorded by pressure transducer.	Number – Double	ft	2	Positive number
InstDischarge	Discharge as determined from station depth to discharge rating curve.	Number – Double	cfs	2	Positive number
InstVolume	Water volume calculated through integration of discharge data.	Number – Double	L	2	Positive number
WQ RESULTS					
StationID	Observation station	Text	n/a	n/a	Provided by TRWQMP data manager
EventDate	Date of monitoring	Date - Short Date	n/a	n/a	MM/DD/YYYY
FieldAgency	Agency performing monitoring	Text	n/a	n/a	Provided by TRWQMP data manager
FieldPersonnel	Personnel performing monitoring	Text	n/a	n/a	First Initial. Last Name (individuals separated by commas)
Discharge	Stream discharge at station when sample collected.	Number – Double	cfs	2	Positive number.
SampleType	Type of sample collected based on assessment type	Text	n/a	n/a	TURB

Table 6.16					
Field Name	**Description**	**Database Field Type, Size, Format**	**Units**	**Precision[A]**	**Standardized Format**
ConcTSS	Total Suspended Solids concentration	Number – Double	mg/L	2	if ND = 0.10
QAQC	QA/QC performed on data	Yes/No	n/a	n/a	
DataNotes	Explanation of flagged, missing, or questionable data	Memo	n/a	n/a	If none, enter NONE.
WQ PRECISION					
StationID	Observation station	Text	n/a	n/a	Provided by TRWQMP data manager
CalculationDate	Most recent sample date used in precision calculations	Date – Short Date	n/a	n/a	MM/DD/YYYY
FP_TSS	Calculated field precision (% error) for each constituent	Number – Double - Percent	%	2	Ranging from 0 to 100
LP_TSS	Calculated lab precision (% error) for each constituent	Number – Double – Percent	%	2	Ranging from 0 to 100
FPC_TSS	# samples used in field precision calculation	Number – Integer	n/a	0	Positive number
LPC_TSS	# samples used in lab precision calculation	Number - Integer	n/a	0	Positive number

[A]*Precision is the number of digits to the right of the decimal place (e.g., 2 means value is reported as #.##).*
ND is non detect, or below detection limit.

Table 6.16. TRWQMP database field types and reporting requirements for near-continuous turbidity assessment analysis.

Project:___________________________
Stream: ___________________________
Sample ID: _______________________
Date/Time: _______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:___________________________
Stream: ___________________________
Sample ID: _______________________
Date/Time: _______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:___________________________
Stream: ___________________________
Sample ID: _______________________
Date/Time: _______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:___________________________
Stream: ___________________________
Sample ID: _______________________
Date/Time: _______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:___________________________
Stream: ___________________________
Sample ID: _______________________
Date/Time: _______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:___________________________
Stream: ___________________________
Sample ID: _______________________
Date/Time: _______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:___________________________
Stream: ___________________________
Sample ID: _______________________
Date/Time: _______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:___________________________
Stream: ___________________________
Sample ID: _______________________
Date/Time: _______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

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TRWQMP SAMPLE BOTTLE LABELS

FIGURE 6.7

SAMPLE CHAIN OF CUSTODY

FIGURE 6.8

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CHAIN OF CUSTODY RECORD

PAGE ____ OF ____

PROJECT NAME AND JOB #: ______________________

SEND CERTIFIED RESULTS TO: ______________________

ELECTRONIC DELIVERABLE FORMAT: YES NO

Sampler: ______________________

Date: ______________________

LABORATORY: ______________________

TURNAROUND TIME: Standard | 24hr Rush | 48hr Rush | 72hr Rush

GLOBAL I.D.: ______________________

Sample Identification	Sample Date	Time Sampled	Sample Filtered?	SAMPLE CONTAINERS			REQUESTED ANALYSIS										
				Sample Volume (ml)	Container Type (HDPE, Glass, etc)	Preservation (H_2SO_4, HNO_3, HCl)	Nutrients								Additional Analysis		
							Filtered										
							NO_x^-	NO_2^-	NH_4^+	SRP	DP	DKN	TKN	TP	TSS	Oil and Grease	Trace Metals

RELEASED BY:	Date & Time		RECEIVED BY:	Date & Time	SAMPLE CONDITION (circle one)
1.		→			Ambient Refrigerated Ice
2.		→			Ambient Refrigerated Ice
3.		→			Ambient Refrigerated Ice
4.		→			Ambient Refrigerated Ice
5.		→			Ambient Refrigerated Ice

NOTES:

Station Visit Log - Please fill out every time a monitoring station is visited.

Date	Time	Station	Personnel	Site Conditions	Photos Taken?	Staff Plate Reading	Batt OK	Sampler Deployed		Sample Collected			Notes
								Number	Type	Number	Type	Field Trips?	

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STATION VISIT MONITORING LOG

FIGURE 6.9

INSTRUMENT CHECKLIST - PLEASE FILL OUT EVERY TIME INSTRUMENT IS SERVICED / DOWNLOADED / CHECKED / ETC.
Fl - flow meter, Ba - baroTroll, Lvl - pressure transducer, Sam - automatic sampler

Date	Time	Station	Personnel	Gage	File Extracted	Data OK	Batt OK	New Test				Notes
								Name	Interval	Mode / Trigger	Start Time	
				Fl / Ba / Lvl / Sam								
				Fl / Ba / Lvl / Sam								
				Fl / Ba / Lvl / Sam								
				Fl / Ba / Lvl / Sam								
				Fl / Ba / Lvl / Sam								
				Fl / Ba / Lvl / Sam								
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				Fl / Ba / Lvl / Sam								
				Fl / Ba / Lvl / Sam								

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INSTRUMENT MAINTENANCE LOG

FIGURE 6.11

6.9 Near-continuous Water Quality Measurements - Automated Samplers Protocols

Near-continuous automated sampler measurements provide high-resolution data on event, seasonal, and annual pollutant loads. By controlling sampling proportionally with discharge, they greatly improve the calculation of total load. Locations of observations and associated justification are outlined in Section 5.0.

6.9.1 Site Selection and Instrument Installation Protocols

A. Site Selection Strategy

When reviewing and selecting stations for sampling, the following considerations should be made to prioritize sampling stations:

- Constrained cross section/pipe – flow meters need a consistent stable cross section with normalized flow and minimal turbulence to properly calculate flow.
- Slope of flow location to be sampled – backwater during wet periods can severely impair quality of data. Desired site should be evaluated both up and down stream to ensure backwater conditions at point of monitoring will not occur during most events.
- The sampler must be housed in a level spot above the sampling source. Area must be large enough to accommodate 36” diameter CMP placed vertically.
- Surface water routing pathways through catchment – can the surface water runoff from the catchment be properly constrained and sampled?
- Security – stations should be located in places where vandalism is unlikely to occur, or proper precautions should be taken to ensure security of equipment.
- Access – safety and logistics. Field personnel must be able to easily and safely get to the sampling station. If station is located on private property, permission to enter property must be granted to field personnel prior to station installation.

A preliminary GIS spatial analysis on the potential catchments using the data files and methods described in Section 6.2 can help with site selection and prioritizing stations. Calculations may include the following characteristics:

- Catchment size
- Detailed land use distribution
- % impervious

B. Determine Pollutants of Concern and Sampler Type

Determine pollutants of concern, bottle type and volume necessary to sample the targeted pollutants of concern (see Section 6.5, Tables 6.8-6.10). Sigma has numerous bottle configurations available for autosamplers. However, the TRWQMP recommends the selection of the 8 bottle configuration, either as 2.3L-HDPE or 1.9L glass bottles, depending on the targeted pollutants of concern.

C. Instrument Installation

Objective: Install an automated sampler at downstream end of catchment or within a tributary to collect flow-weighted water samples. Install samplers in conjunction with near continuous probes that record stage and velocity and allow for the calculation of station discharge time series.

Recommended Products: The TRWQMP recommends the use of a Sigma 900 Max Portable Sampler and a Sigma 950 Flow Meter (see Table 6.7 in Section 6.5) given their track record of performance and reliability in the Lake Tahoe climate. Samplers and flow meters with similar specifications to the recommended Sigma products in terms of sensor accuracy, precision and range, data storage memory, battery life, sample volume capacity, sampling frequency, and reliability in cold weather may be used as well.

__Personnel Needed:__ 1-2 field personnel 20 hours to install equipment
__Equipment Needed:__

- Sigma 950 Flow Meter (including submerged area/velocity sensor, sensor cable, power cable, computer cable, battery pack)
- optional flow meter mounting kits (wall mounting, suspension harness, or manhole rung hanger)
- Sigma 900 Max Portable Sampler (including pump tubing, intake line, tubing connectors, intake strainer, bottles, battery pack)
- 36" CMP housing
- lock
- drill
- computer
- instrument maintenance log (Figure 6.11 attached at the end of this section)

__Instrument Installation:__
Note: The most effective installation materials, housing and configuration for each station will depend upon site conditions and limitations. Trained and experienced field personnel should be used to ensure proper and safe installation of expensive equipment in stream.

1. Install sampler per instructions provided in instrument manual.
    a. Install 36" CMP housing on level ground above and adjacent to sampling source. Choose location where inside of CMP housing will remain dry.
    b. Connect pump tube to body. Consider the following issues when installing the intake tube:
        - Tube should be as short in length as possible and free of kinks.
        - Tube should slope downward from sampler to allow complete drainage between sampling.
        - Tube should be placed in area of well-mixed flow.
        - Tube should be well placed vertically in water column to ensure sample collected is representative of entire water column.
    c. Set up bottles.
    d. Install and align distributor arm.
    e. Install full bottle shutoff device.
    f. Connect to power source

2. Install area/velocity sensor per instructions provided in instrument manual.
    a. Mount device. Consider the following:
        - Sensor should be installed in area of uniform flow with minimal turbidity.
        - Sensor should be installed where channel area can be confined.
        - Sensor and sampler must be in close proximity for proper connection.
    b. Connect to power source.
    c. Connect to sampler.

3. Program and calibrate area/velocity meter per instructions provided in instrument manual.
    - Level in feet.
    - Velocity in feet per second
    - Flow as liters per second

- 15 minute intervals
- Submerged area/velocity
- Enter appropriate channel criteria to calculate flow

4. Secure housing with lock.

6.9.2 Event Sampling Strategy

Near-continuous flow meters will collect water quality data year round on 15-minute intervals (see Table 5.3).

A. Select Targeted Events

Automated samplers will be operated to submit a minimum of 40 samples each year over a range of events and flows, ideally monitoring 10-15 storm events annually (see Table 5.3). The targeted events per year should represent a range of event types (winter rain, rain on snow, snow melt and summer thunderstorm) and operators should avoid over sampling one type relative to another. In general, the seasonal sampling strategy should follow the proportion of the annual hydrograph distribution with the amount of samples per year following the below distribution:

- Spring snowmelt: 40%
- Winter rain: 25%
- Rain on snow: 20%
- Summer thunderstorm: 15%

Strategies for anticipating targeted sampling events are provided below.

- Become familiar with the streamflow patterns from USGS gage #10338000, Truckee River near Truckee, CA and/or #10346000, Truckee River at Farad, CA.
  - Study the historical streamflow patterns to understand the seasonal changes (timing, discharge increases) at the gage station and to anticipate the peak snowmelt discharges. Use instrument discharge data to develop better understanding of discharge relationships between the stations.
  - Frequently check the real-time data to anticipate when a sampling event may occur.
- Monitor weather data from office to anticipate targeted discharges associated with storm events and to follow the temperature increases that may lead to snowmelt in the watershed.
  - Check www.wunderground.com. Possible stations include:
    - Tahoe Truckee Airport (KTRK)
    - Truckee #2 CA US SNOTEL (MTRUC1)
    - Alder Creek Middle School (KCATRUCK24)
    - Truckee-Glenshire ES CA US DRI (MGLSH)
    - RAWS Stampede (MSMDC1)
  - Check NOAA National Weather Service (www.nws.noaa.gov).
  - Check the Weather Channel (www.weather.com).

B. Establish Sample Trigger Volumes per Event

The goal of flow weighted event sampling is to select an appropriate trigger volume to distribute the collection of composited samples over the entire event hydrograph to ensure accurate representation of pollutant loading throughout the event. If monitoring is conducted in an open channel and the instrument automated calculations of flow may be inaccurate, the sample collection trigger may need to be conducted using incremental level increases. All directions below substitute level for flow if flow trigger sampling is not realistic.

All samplers (regardless of model) use the 8-bottle configuration (either 2.3L HDPE or 1.9L glass, depending on targeted pollutant) and 20 aliquots (115ml or 95ml in volume depending on selected bottle type) are collected in each bottle, equating to a maximum of 160 flow-weighted aliquots over the event duration. Each of the sample bottles filled during the event will be submitted for analysis, resulting in a maximum of 8 samples per event.

1. Determine targeted event type.
    - Select from winter rain, rain on snow, snowmelt, or summer thunderstorm based on recommended distribution described above.

2. Approximate anticipated event volume.
    a. General strategies and considerations
        - Review station hydrograph to understand baseline flow conditions at station. Targeted event volumes are in addition to the baseline discharge.
        - Review previous hydrologic data from station. The ability to estimate the appropriate trigger volume improves as more data and experience is gained from each respective station.
        - Use culvert or stream channel sizing and catchment characteristics to estimate storm volumes. Record estimates and check against actual storm measurements as they occur to track and refine hydrologic conditions at site.
        - Monitor weather to assist with anticipation of targeted discharges. Record and track event climate (total precipitation, total duration, snow level, etc) and compare against estimates and actual storm total measurements to continue to improve ability to estimate hydrology.

    b. For rain events (winter rain, rain on snow, summer thunderstorm):
        - Consider the number and size of events in previous month to determine the potential influence of soil saturation and infiltration capacity.

    c. For snowmelt events:
        - Review historical snowmelt hydrology data from station and/or USGS gage. Understand the timing and magnitude of snowmelt discharge.
        - Snowmelt events are sampled on 48-hour increments. Determine total event volume based on this duration.

3. Calculate sampling trigger volume.
    a. Divide the anticipated total event volume by 150.
    b. When estimating the flow trigger volume, it is better to over-estimate the trigger volume and not exceed the sample bottle capacity during the event, than under-estimate and not sample a portion of the event hydrograph.
    c. Adjust the recording interval of the flow meter as necessary to collect more frequent samples. Typically the flow meter is programmed to take measurements every 15 minutes. For smaller, flashier events (i.e., summer thunderstorms), the interval may need to be shortened to appropriately sample the hydrograph.

6.9.3 Field Evaluation Protocols

Objective: Visit station monthly to download flow data and ensure instrumentation is working properly. Prior to a targeted event, program sampler to collect samples based on volume or time considerations (Section 6.9.2.B). Following an event, retrieve samples and submit to laboratory for analysis.

Personnel Needed:

Monthly Maintenance – 1 field personnel 1-2 hours to download data, calibrate and maintain instruments
Event Sampling - 1 field personnel 1-2 hours per targeted event for pre-event preparation of instrument; 1 field personnel 1-2 hours per targeted event to collect samples following event

Equipment Needed:

Monthly Maintenance:

- charged computer
- appropriate instrument cables
- extra computer battery
- calibration materials
- camera
- field notebook
- pens/pencils
- instrument logs (Figure 6.11 attached at the end of this section)
- instrument batteries (if replaceable)

Event Monitoring:

- sample analysis bottle (see Table 6.10 in Section 6.5 for necessary bottle volume, type and chemical preservation)
- computer
- cable
- sample analysis bottles
- distilled, de-ionized water
- ice
- cooler
- pens/pencils
- field notebook
- camera
- sample labels (Figure 6.8 attached at the end of this section)
- chain of custody (Figure 6.9 attached at the end of this section)
- station monitoring log (Figure 6.10 attached at the end of this section)
- instrument logs (Figure 6.11 attached at the end of this section)

Field Observations and Data Collection:

Keys to good field work:

- Be safe. Event sampling is by nature hazardous due to storm conditions. Field personnel should always wear proper protective clothing when outside during a storm. Personnel safety always comes first. Use best professional judgment. If conditions do not allow safe access to the sampler, personnel should wait until safe conditions exist.
- Follow the protocols closely and review prior to each field mobilization. Use the provided data sheets.
- Take detailed field notes in a field notebook. At the end of the field day, spend several minutes reviewing notes and adding any additional information, observations, problems encountered, suggestions, etc.
- Take photos detailing station condition, discharge events. Establish photo points (location, camera orientation) and repeat every field visit to document changes over time. Detail the locations of each photo on field datasheet or in field notebook.
- All field work is referenced by view/context looking downstream (e.g., right bank is defined as the bank on right when looking downstream).
- Take all precautions to avoid sample contamination.

- Be aware of the pollutant of concern and take all precautions to avoid contamination. Sources of contamination vary with different pollutants.
- Clean sample bottles, field equipment, etc. with distilled, de-ionized (DI) water.
- Properly label samples according to protocols and accurately complete chain of custody forms.

1. Monthly Maintenance
    a. Connect flow meter to field computer per instrument operations manual.
        i. Download data to computer. Check data to ensure there are no data gaps and the data seems accurate. Recalibrate sensor as necessary.
        ii. Check date and time.
        iii. Check battery level.
        iv. Set up instrument to start recording again on 15-minute intervals.
        v. Fill out instrument maintenance log (see Figure 6.11 attached at the end of this section). Take photos.
    b. Clean sensor of any debris.
    c. Check and maintain desiccants. Replace as necessary.
    d. Place instrument back into housing and lock in place.

2. Event Monitoring
    a. Pre-event
        i. Arrive at the station 24 hours prior to the targeted runoff event. In the case of summer thunderstorms that come with little warning, there may be insufficient time to deploy the samplers prior to the beginning of the event. While not a preferred method, sample bottles can be deployed and remain in the field in preparation for summer thunderstorm sampling. However, if this technique is used, the sample bottles in the field must be checked and cleaned twice weekly to minimize the potential for contamination of material on the bottle prior to the occurrence of a runoff event.
        ii. Connect computer to instruments. Verify that both flow meter and automated sampler are working properly. Check date/time, battery level, desiccants, probe conditions, etc.
        iii. Based on anticipated event volume and duration and established protocols (see Section 6.9.2.B), program sampler to collect samples on specific volume intervals.
        iv. As necessary, change interval of flow meter data collection.
        v. Ensure bottles in sampler are clean and empty.
        vi. Verify that sampler is properly connected and will collect runoff from proper location. Check intake tubing for kinks and dirt and distributor arm for proper alignment.
        vii. Complete instrument maintenance log (see Figure 6.11 attached at the end of this section). Take photos.
    b. Post-event
        i. Arrive at site within 12 hours after the event has ended.
        ii. Download sample history data.
            1) Connect sampler to computer and following instrument manual, download the sampling history for the event.
            2) Verify that number of samples collected by sampler match number reported by the instrument.
            3) Check date and time of each collected sample.
            4) Complete instrument maintenance log (see Figure 6.11 attached at the end of this section).
        iii. Collect samples.

1) All samples collected are submitted individually to the laboratory for analysis.
2) Consult Table 6.10 in Section 6.5, if analyses require chemical preservation transfer sample to appropriate sample analysis bottle.
3) Complete label (see Figure 6.8 attached at the end of this section) for each bottle and firmly secure to bottle. Label should include, at minimum, project and station name, date, time, and field personnel.
4) Place all bottles in Ziploc in cooler with ice and complete chain of custody (see Figure 6.9 attached at the end of this section).
5) Take photos. Record staff plate measurement. Complete necessary information in station visit monitoring log (see Figure 6.10 attached at the end of this section).
6) Deliver samples and completed chain of custody to appropriate laboratory within stated holding times. Keep a copy of chain of custody for records.

6.9.4 Laboratory Analysis Protocols

Note: Many analytical laboratories are available. The TRWQMP was developed based on the requirements of High Sierra Water Laboratory for sediment and nutrient analyses. Appendix G summarizes the lab's QA/QC SOPs.

QA/QC

a. Table 6.11 in Section 6.5 summarizes the laboratory analysis protocols and necessary QA/QC requirements for High Sierra Water Laboratory. If another lab is chosen for analytical work, the details of Table 6.11 may need to be revised.
b. All laboratory reports are checked for completeness, typographical errors, suspect values, and for conformity between the chain of custody forms and the lab reports.

6.9.5 Data Management Protocols

1. Set up computer files.
   a. Download photos from camera to office computer/server. Photos should be identified by date, station ID and photo point.
   b. Open a Microsoft Excel worksheet for station. Spreadsheets should be maintained for catchment, flow, sample, lab, event, and annual data. Column headings should include at a minimum:
      - Catchment characteristics
        A. area
        B. dominant land use
        C. % impervious
      - Flow data
        A. station ID
        B. date
        C. time
        D. depth
        E. velocity
        F. flow
      - Sample data
        A. station ID
        B. date
        C. time
        D. field personnel
        E. constituent concentration

F. lab replicate concentration
G. sample volume
H. sample load per constituent

- Laboratory replicate results
  A. station ID
  B. date
  C. time
  D. constituent
  E. lab concentrations
  F. average concentration
- Event data
  A. date
  B. type
  C. # days antecedent dry conditions
  D. total precipitation
  E. event volume
  F. event load by constituent

2. Summarize catchment characteristics.
   - Catchment area.
   - Predominant land use, as determined by GIS analysis.
   - Percent impervious, as determined by GIS analysis.
   - These characteristics will only need to be updated as new GIS data becomes available (approximately every 3-5 years).

3. Add flow data to spreadsheet.
   a. Append latest download to existing data.
   b. QA/QC data
      i. Plot time series of level, velocity and flow data.
      ii. Remove any data when instrument was out of water or any suspect data that cannot be reasonably adjusted based on other available site information.
   c. Integrate flow data for each time step to determine water volume.

4. Enter laboratory data into spreadsheet.
   a. Verify laboratory sample list against the chain of custodies to ensure results for all submitted samples are present.
   b. Enter all laboratory data, including laboratory replicate data.
      - There should be one row for each sample submitted to the lab.
      - If reported value is below detection limit, write detection limit value.
      - If sample wasn't analyzed for a constituent, leave cell blank.
      - If a lab replicate was run, constituent value should be the average of the replicate results. (See Step 5a.)

5. Perform basic sample calculations.
   a. Average laboratory replicate values.
   b. Calculate laboratory precision.
      i. For each replicate, calculate Absolute (sample1 – sample 2) / Average of the 2 samples for each constituent.
      ii. Average all values to calculate laboratory precision for each constituent.
      iii. Include count of total number of values used to calculate precision value.

6. Summarize event data.
   - Event date - standardized as the day the runoff began. Examine the discharge data from the flow meter to determine the beginning of event runoff at the station.
   - Event type – winter rain, rain on snow, snowmelt, summer rain
   - Number of days of antecedent dry conditions – number of consecutive days with no precipitation prior to event start.
   - Event precipitation – total number of inches of precipitation during event, if appropriate.

7. Analyze data.
   a. Determine the time period for the event.
      i. Plot the station hydrograph, including the 2 days prior to and following the sample collection.
      ii. Using the shape and distribution of flow, determine the beginning and end of the event looking for abrupt changes in flow measurements.
   b. Quantify the total event volume.
      i. Integrate discharge values over event duration.
      ii. Sum all volume values in time period of interest to calculate total event water volume.
   c. Plot the timing of sample collection on the event hydrograph to determine if event was properly sampled.
      i. Disregard any of the 8 sample bottles that collected samples prior to or following the event. If less than 50% of the aliquots in the sample bottle were collected within the event time period, sample bottle results should not be used in calculations.
      ii. Disregard entire event if more than 30% of the hydrograph was unsampled, based on total event water volume. This could be a result of an improperly set trigger volume that did not capture the beginning and/or end of the hydrograph.
   d. Calculate sample volumes and loads.
      i. For each sample collected during the event, determine the time segment of the hydrograph it represents.
         - Start of time segment is either start of runoff event (first bottle, see Step 7.a.ii for determining start of event) or right after the previous bottle was collected (all subsequent bottles).
         - End of time segment is when the last aliquot in the sample is collected, except for last bottle which is extended to the end of the runoff event. End of the runoff event is determined by examining the event hydrograph.
      ii. Determine water volume for each time segment.
      iii. Multiply pollutant concentrations by water volume to determine pollutant loads per sample. Be aware of units.
   e. Calculate event loads.
      i. For each constituent, sum the sample loads calculated in Step 7d.
   f. Calculate the event mean concentration (EMC) for each constituent.
      i. Divide the total event load per constituent by the total event volume.

8. QA/QC.
   a. All data entries and calculations should be verified by a secondary staff member for data accuracy and completeness. Any missing or questionable data should be flagged for review by project manager.
   b. All field datasheets and instrument files should be stored in the field agency office for at least 5 years following the completion of the project.
   c. Once established, nomenclature (station ID, etc.) should remain consistent over the life of the TRWQMP.

6.9.6 Reporting Protocols to TRWQMP Database

The Automated Sampler results obtained each year should be compiled, analyzed and digitally submitted to the TRWQMP database. Data should be submitted to the database manager annually and only include the data from the past year. Previously submitted data should not be re-submitted unless QA/QC procedures have resulted in changes in data values. Section 7.0 details the recommended data management structure and associated procedures to facilitate the integration of the TRWQMP data annually.

- Near-continuous automated sampler data should be reported in one Microsoft Excel spreadsheet named TRWQMP_StationName_Year.xls (ex: TRWQMP_NCAS-MC1_2010.xls) that has five separate worksheets: CatchmentCharacteristics, InstrumentData, WQResults, WQPrecision, and Event Information.
- Column headings and field formatting requirements for Automated Sampler data, including data type, format, units, and precision level are presented in Table 6.17 for each worksheet. It is critical that all data is submitted to the database in the standardized format, especially in the required units, to ensure compatibility with all other submitted data and proper integration into the TRWQMP database.
    - Catchment Characteristics only need to be included with the first submission to the database manager and following any updates to the calculations given new GIS data and analysis.
    - For InstrumentData
        - Each row should correspond to each 15-minute time interval available with QA/QC'd data. Gaps in the time series should not be represented with blank rows. Only include time intervals with data.
        - There should be no blank cells – for each row of data there should be corresponding information in each column. The exception being if one sensor (depth, velocity) worked properly while the other sensor did not.
    - For WQResults
        - There should be one row per station per event.
        - Concentrations should be reported as EMC.
        - QA/QC should always be "Yes." It is verification by submitting agency that all data was properly checked according quality assurance standards. Any explanation of flagged, missing, or questionable data should be included in the DataNotes field.
    - For WQPrecision
        - There should be one row per station.
        - Precision is calculated using all available data from all years of data collection. Values should be updated annually using the complete dataset.
        - There should only be blank cells if no field replicates have been collected and submitted to the lab for a constituent, or if the lab has not performed a replicate analysis for that constituent.
    - For Event Information
        - There should be one row per event.

Table 6.17

Field Name	Description	Database Field Type, Size, Format	Units	Precision[A]	Standardized Format
CATCHMENT CHARACTERISTICS					
StationID	Observation station	Text	n/a	n/a	Provided by TRWQMP data manager
AnalysisDate	Date of GIS analysis	Date – Short Date	n/a	n/a	MM/DD/YYYY
Sub-watershed	Sub-watershed where station is located	Text	n/a	n/a	Provided by TRWQMP data manager
CatchArea	Area of catchment	Number – Double	acres	2	Positive number
CatchLandUse	Dominant land use in catchment	Text	n/a	n/a	Choose from list in Table 6.9
Catch%Imperv	Percent impervious coverage in catchment	Number – Double – Percent	%	2	Ranging from 0 to 100
INSTRUMENT DATA					
StationID	Observation station	Text	n/a	n/a	Provided by TRWQMP data manager
InstDateTime	Date and time as recorded by instrument.	Date – Short Date	n/a	n/a	MM/DD/YYYY
InstDepth	Corrected depth reading recorded by flow meter.	Number – Double	ft	2	Positive number
InstVelocity	Velocity reading recorded by flow meter.	Number – Double	ft/s	2	Positive number
InstDischarge	Discharge reading recorded by flow meter.	Number – Double	cfs	2	Positive number
InstVolume	Water volume calculated through integration of discharge data.	Number – Double	L	2	Positive number
WQ RESULTS					
StationID	Observation station	Text	n/a	n/a	Provided by TRWQMP data manager
EventDate	Date of monitoring	Date - Short Date	n/a	n/a	MM/DD/YYYY
FieldAgency	Agency performing monitoring	Text	n/a	n/a	Provided by TRWQMP data manager
FieldPersonnel	Personnel performing monitoring	Text	n/a	n/a	First Initial. Last Name (individuals separated by commas)
SampleType	Type of sample collected based on assessment type	Text	n/a	n/a	NCAS

Table 6.17					
Field Name	**Description**	**Database Field Type, Size, Format**	**Units**	**Precision[A]**	**Standardized Format**
ConcTSS	Calculated TSS EMC	Number – Double	mg/L	2	if ND = 0.10
ConcNOX	Calculated Nitrate EMC	Number – Double	ug/L	2	if ND = 1.00
ConcNH4	Calculated Ammonia EMC	Number – Double	ug/L	2	if ND = 1.00
ConcTN	Calculated Total Nitrogen EMC	Number – Double	ug/L	2	if ND = 35.00
ConcSRP	Calculated Soluble Reactive Phosphorous EMC	Number – Double	ug/L	2	if ND = 1.00
ConcTP	Calculated Total Phosphorous EMC	Number – Double	ug/L	2	if ND = 1.00
ConcOG	Calculated Oil and Grease EMC	Number – Double	mg/L	2	if ND = 5.00
ConcTEPH	Calculated Total Extractable Petroleum Hydrocarbon EMC	Number – Double	ug/L	2	if ND = 100.00
QAQC	QA/QC performed on data	Yes/No	n/a	n/a	Yes, No
DataNotes	Explanation of flagged, missing, or questionable data	Memo	n/a	n/a	If none, enter NONE.
WQ PRECISION					
StationID	Observation station	Text	n/a	n/a	Provided by TRWQMP data manager
CalculationDate	Most recent sample date used in precision calculations	Date – Short Date	n/a	n/a	MM/DD/YYYY
FP_*Constituent*	Calculated field precision (% error) for each constituent	Number – Double - Percent	%	2	Ranging from 0 to 100
LP_*Constituent*	Calculated lab precision (% error) for each constituent	Number – Double – Percent	%	2	Ranging from 0 to 100
FPC_ *Constituent*	# samples used in field precision calculation	Number – Integer	n/a	0	Positive number
LPC_ *Constituent*	# samples used in lab precision calculation	Number - Integer	n/a	0	Positive number
EVENT INFORMATION					
StationID	Observation station	Text	n/a	n/a	Provided by TRWQMP data manager
EventDate	Date of sample collection	Date - Short Date	n/a	n/a	MM/DD/YYYY

Table 6.17					
Field Name	**Description**	**Database Field Type, Size, Format**	**Units**	**Precision[A]**	**Standardized Format**
EventType	Runoff event type	Text	n/a	0	Choose from: winter rain, rain on snow, snowmelt, summer rain, irrigation
EventAntecedent	Number of days prior to event with no precipitation	Number – Integer	days	0	Positive number
EventTotal	Total event precipitation	Number – Double	inches	2	Positive number
EventVolume	Total water volume for event	Number – Double	liters	2	Positive number
LoadTSS	Event TSS load	Number – Double	mg	2	Positive number
LoadNOX	Event Nitrate load	Number – Double	mg	2	Positive number
LoadNH4	Event Ammonia load	Number – Double	mg	2	Positive number
LoadTN	Event Total Nitrogen load	Number – Double	mg	2	Positive number
LoadSRP	Event Soluble Reactive Phosphorous load	Number – Double	mg	2	Positive number
LoadTP	Event Total Phosphorous load	Number – Double	mg	2	Positive number
LoadOG	Event Oil and Grease load	Number – Double	mg	2	Positive number
LoadTEPH	Event Total Extractable Petroleum load	Number – Double	mg	2	Positive number

[A]Precision is the number of digits to the right of the decimal place (e.g., 2 means value is reported as #.##). ND is non detect, or below detection limit.

Table 6.17. TRWQMP database field types and reporting requirements for automated sampling assessment analysis.

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

Project:_________________________
Stream: _________________________
Sample ID: ______________________
Date/Time: ______________________
Field Personnel: _________________

Truckee River Water Quality
Monitoring Plan

2NDNATURE LLC	TRWQMP SAMPLE BOTTLE LABELS	FIGURE 6.7

2NDNATURE LLC

SAMPLE CHAIN OF CUSTODY

FIGURE 6.8

CHAIN OF CUSTODY RECORD

PAGE ____ OF ____

PROJECT NAME AND JOB #: ______________________

SEND CERTIFIED RESULTS TO: ______________________

ELECTRONIC DELIVERABLE FORMAT: YES NO

Sampler: ______________________

Date: ______________________

LABORATORY: ______________________

TURNAROUND TIME: Standard | 24hr Rush | 48hr Rush | 72hr Rush

GLOBAL I.D.: ______________________

Sample Identification	Sample Date	Time Sampled	Sample Filtered?	SAMPLE CONTAINERS			REQUESTED ANALYSIS										
				Sample Volume (ml)	Container Type (HDPE, Glass, etc)	Preservation (H_2SO_4, HNO_3, HCl)	Nutrients								Additional Analysis		
							Filtered								TSS	Oil and Grease	Trace Metals
							NO_x^-	NO_2^-	NH_4^+	SRP	DP	DKN	TKN	TP			

RELEASED BY:	Date & Time		RECEIVED BY:	Date & Time	SAMPLE CONDITION (circle one)		
1.		→			Ambient	Refrigerated	Ice
2.		→			Ambient	Refrigerated	Ice
3.		→			Ambient	Refrigerated	Ice
4.		→			Ambient	Refrigerated	Ice
5.		→			Ambient	Refrigerated	Ice

NOTES:

Station Visit Log - Please fill out every time a monitoring station is visited.

Date	Time	Station	Personnel	Site Conditions	Photos Taken?	Staff Plate Reading	Batt OK	Sampler Deployed		Sample Collected			Notes
								Number	Type	Number	Type	Field Trips?	

2NDNATURE LLC

STATION VISIT MONITORING LOG

FIGURE 6.9

INSTRUMENT CHECKLIST - PLEASE FILL OUT EVERY TIME INSTRUMENT IS SERVICED / DOWNLOADED / CHECKED / ETC.
Fl - flow meter, Ba - baroTroll, Lvl - pressure transducer, Sam - automatic sampler

Date	Time	Station	Personnel	Gage	File Extracted	Data OK	Batt OK	New Test				Notes
								Name	Interval	Mode / Trigger	Start Time	
				Fl / Ba / Lvl / Sam								
				Fl / Ba / Lvl / Sam								
				Fl / Ba / Lvl / Sam								
				Fl / Ba / Lvl / Sam								
				Fl / Ba / Lvl / Sam								
				Fl / Ba / Lvl / Sam								
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INSTRUMENT MAINTENANCE LOG

FIGURE 6.11

6.10 Section 6.0 References

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7.0 TRWQMP DATA INTEGRATION, DATA MANAGEMENT AND ANNUAL REPORTING

7.0 TRWQMP DATA INTEGRATION, DATA MANAGEMENT AND ANNUAL REPORTING

A primary goal of the TRWQMP is to create an integrated and comprehensive program to track the effectiveness of the Placer County and Town of Truckee SWMPs in protecting surface water quality within the project area (Figure 3.1). Section 7.0 provides guidelines on structuring data integration, data management, and annual reporting to meet this goal. While this document provides a recommended structure based on present conditions, the monitoring plan must be adaptively managed as knowledge is gained, resources become available, and land uses change. The guidelines and framework of the TRWQMP have been developed for the cost-effective collection of valuable data, but they intentionally include a degree of flexibility for the team implementing the TRWQMP in the future. The initial year of implementation of the TRWQMP will be critical in putting data reporting, integration and management procedures in place and providing a tangible example of the TRWQMP annual report format. These procedures will form the template for subsequent integration and technical evaluations of the datasets over the life of the TRWQMP. Over time, the data collection protocols, data management structure and data reporting procedures should remain as consistent as possible with the end goal of developing and maintaining long-term, comparable datasets. Within the procedural framework laid out in the TRWQMP, future decisions and modifications should be made using sound rationale and a reliance on available knowledge and new assessment techniques, if it is assumed they will provide more reliable information on the resources in question.

The general process for annual data integration, management and reporting for the TRWQMP is as follows:

- Creation of an annual inventory of specific assessment efforts known to follow the data collection protocols outlined in Section 6.0 of the TRWQMP, including responsible parties and contact information. Annual assessment datasets will correspond with the water year and span from October 1 through September 30.
- Submission of annual assessment data generated per Sections 5.0 and 6.0 by independent data collection groups in digital spreadsheet format (MS Excel) to TRWQMP Data Manager by November 15 each year. The digital submissions must strictly adhere to the Reporting Protocols to TRWQMP Database as detailed at the end of protocols for each assessment type in Section 6.0.
- Verification that data submitted to TRWQMP meets protocols and requirements outlined in Section 6.0. Modification and resubmission of the data provided by independent data collection groups may be necessary to ensure data reporting protocols are met.
- Integration of digital data provided into MS Access TRWQMP_*year*db.mdb (see Figure 7.1 for structure).
- Once the MS Access TRWQMP_*year*db.mdb is compiled within the annual datasets, data are extracted and analyzed by a technical water quality professional to

document and summarize the water quality observations. The Annual TRWQMP Report will be submitted to the Board by January 15th each year.

- The TRWQMP_*year*db.mdb will be released and made publically available simultaneously with the TRWQMP Annual Report through The Truckee River Information Gateway (www.truckeeriverinfo.org).

7.1 Data Management Infrastructure

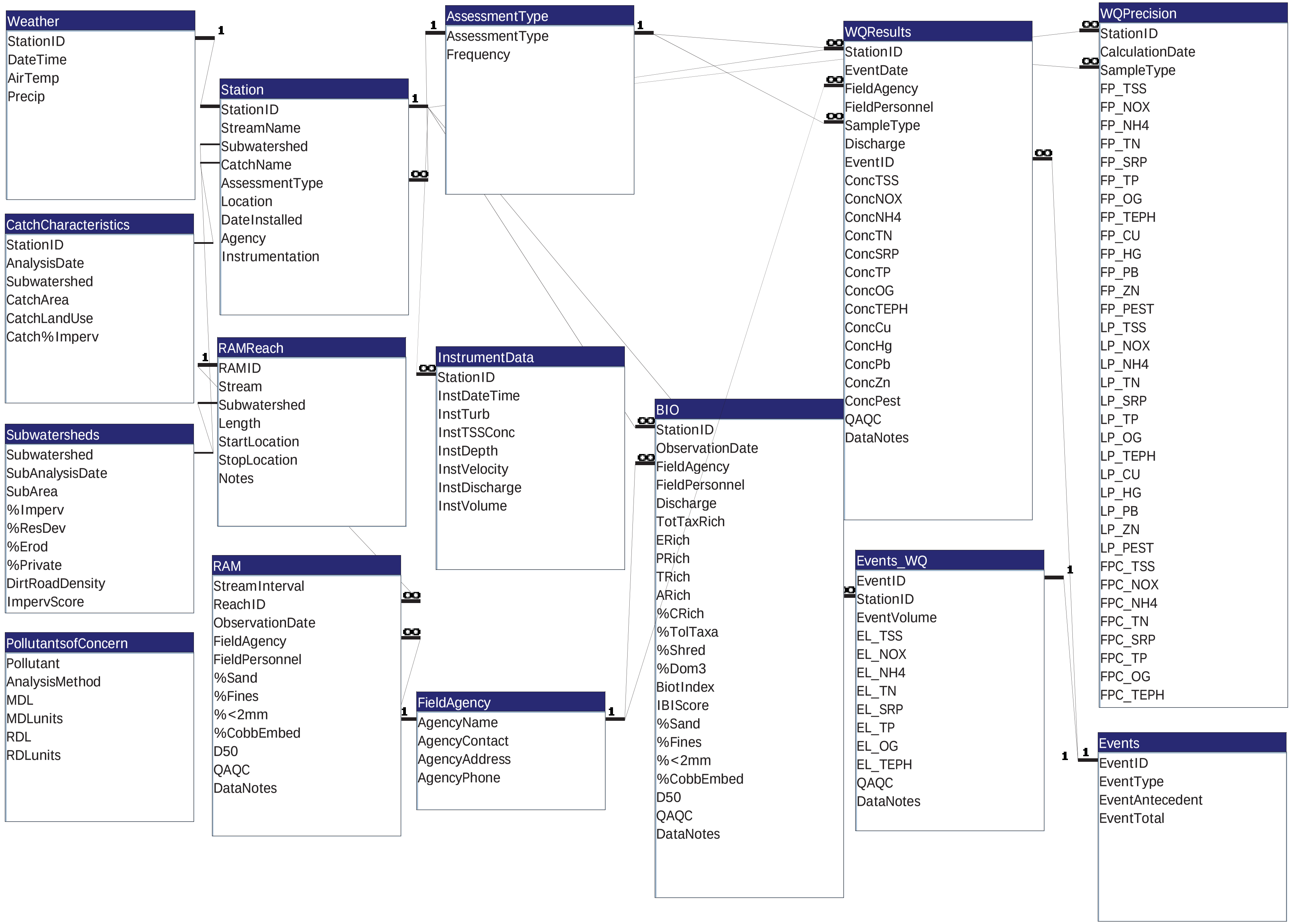
The TRWQMP database will be managed by one entity, hereafter referred to as the TRWQMP Data Manager. This role will be filled by either a County or Town personnel or a retained consultant who is skilled in working with large datasets in MS Excel and MS Access. A background in water quality is beneficial but not necessary for this position. The TRWQMP Data Manager will be responsible for the annual collection and integration of the independent assessment data generated within the project area. New data will be appended to the database annually, thus over time the TRWQMP database will contain all of the data generated utilizing the requirements and protocols outlined within this plan. A significant level of effort will be required by the TRWQMP Data Manager to coordinate with the independent data collection groups to obtain data on schedule in the formats requested.

Section 6.0 details the data collection and data reporting protocols by assessment type. The data reporting protocols outline the digital spreadsheet formats and reporting requirements for the independent data collection groups. There are a number of potential database platforms for the TRWQMP database that vary in capability, cost, and complexity. For simplicity, the recommendations in Section 6.0 and Section 7.0 assume that Microsoft products (MS Excel and MS Access) are the desired data sharing and data storage platforms due to their wide availability, minimal additional costs and user simplicity. There are limitations associated with MS platforms, therefore the TRWQMP data integration and management procedures should be continually evaluated to determine if additional functionality is needed, particularly with consideration to web-based data input, management and accessibility.

Figure 7.1 presents the recommended MS Access TRWQMP_*year*db.mdb structure that directly corresponds to the assessment type data reporting protocols outlined in Section 6.0. Efficient and consistent data input to the database requires that the reporting protocols by assessment type outlined in Section 6.0 are followed in detail, particularly with regards to using the specified units of measure and date/time format for every data point provided.

The TRWQMP database serves as a digital data storage tool that allows for:

- simple data input and storage as assessment datasets are generated and submitted annually,
- standardization of station and subwatershed nomenclature, data units, and basic data calculations,
- an organized and comprehensive data management strategy that allows for a growing dataset over time,
- integration of all data collected using TRWQMP protocols,
- data queries to simply extract data by assessment type, by sub-watershed, by year or any combination of these variables to evaluate data,
- data analysis to test hypothesis and answer key questions regarding water quality, and
- statistical integration of data sets.



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Recommended database structure for TRWQMP.

DATABASE STRUCTURE

FIGURE 7.1

7.2 Annual TRWQMP Data Analysis Guidelines

The TRWQMP data should be analyzed by a water quality expert, particularly during the initial 2-3 years of implementation. For each assessment type, clear and consistent graphical representations should be developed to effectively communicate annual and long-term datasets. The initial implementation of the TRWQMP data analysis and reporting should lay the framework and processes for how the data from each assessment type is analyzed, reported and presented. Below are a number of guidelines to improve and focus data analysis efforts, but the most effective approaches to data analysis and communication will undoubtedly be decided during the actual data analysis and reporting following year 1 of the TRWQMP implementation.

In general, water quality reporting must go beyond simple comparisons of data to numeric objectives. The results should be evaluated in the context of the potential physical, chemical and biological processes that are assumed to influence the observed results. Section 4.0 summarizes the information generated and hypotheses tested by each of the TRWQMP assessment types. The assessment results must be clearly communicated (ideally in graphical or tabular format) in a manner that preserves the value of the data, but also simplifies the main findings of the annual observations. The most effective means to analyze, compare, and communicate the data will vary by assessment type. Effective techniques and means to simply summarize annual results (such as annual metrics by assessment type) must also be created to allow for simple long-term comparisons of the results both spatially and temporally.

General data analysis and communication guidelines are provided below:

- Analyze the existing datasets in the context of the goals and objectives of the TRWQMP. All data need to be evaluated with respect to the performance of the SWMPs to protect and/or enhance the surface water quality within the project area.
- Communicate annual data graphically in a simple and clear format. Graphics should express the most relevant data necessary to achieve the objectives of the TRWQMP and drive the discussions of the findings.
- Create graphics that are information-rich, properly labeled with all units provided, and supplemented with supporting text that facilitate interpretation and understanding by the reader.
- To simplify visual comparisons of datasets keep axis value ranges consistent when comparisons across sites or over time are being conducted.
- Develop data analysis tools and graphical templates that accommodate effective comparisons of data from the same assessment types across stations and over time.
- Place the annual observations into a temporal context that includes hydrologic water year characteristics, comparisons to previous observations of the TRWQMP and relevant regional comparisons.
- Evaluate the assessment results in the context of the physical, chemical and/or biological processes that are assumed to influence observations and differences in observations across stations of similar type and/or over time.

- From year to year maintain consistent graphics, tables and other reporting methods to allow simple comparisons across TRWQMP annual reports.

Below are suggestions for effective graphics and presentation techniques by assessment type.

GIS Sub-watershed Source Area Prioritization Results

Data communication:

- Create GIS map to communicate spatial prioritization based on existing land use and other potential surface disturbance activities that may threaten downstream water quality (see Figure 3.2 for example).

Temporal analysis:

- Compare annual sub-watershed rankings over time. Note changes in individual measures of land use and surface disturbance over time (e.g., large increase in impervious area or large increase in medium-high density residential development).

Rapid Assessment Results

Data communication:

- Create GIS maps to communicate stream reach results using color codes defined in Section 6.4 (Figure 7.2).
- Summarize number of stream miles of assessment area of each fine sediment category (0-10%, 10-50%, 50-90%, >90%) in a table.

Temporal analysis:

- Create annual summary table comparing total stream miles per fine sediment category.
- Note changes in specific reach classification over time. Evaluate reaches classified as high fine sediment density (< 90%; red reach in Figure 7.2) based on contributing land uses, potential sources, conditions relative to bordering reaches, etc.

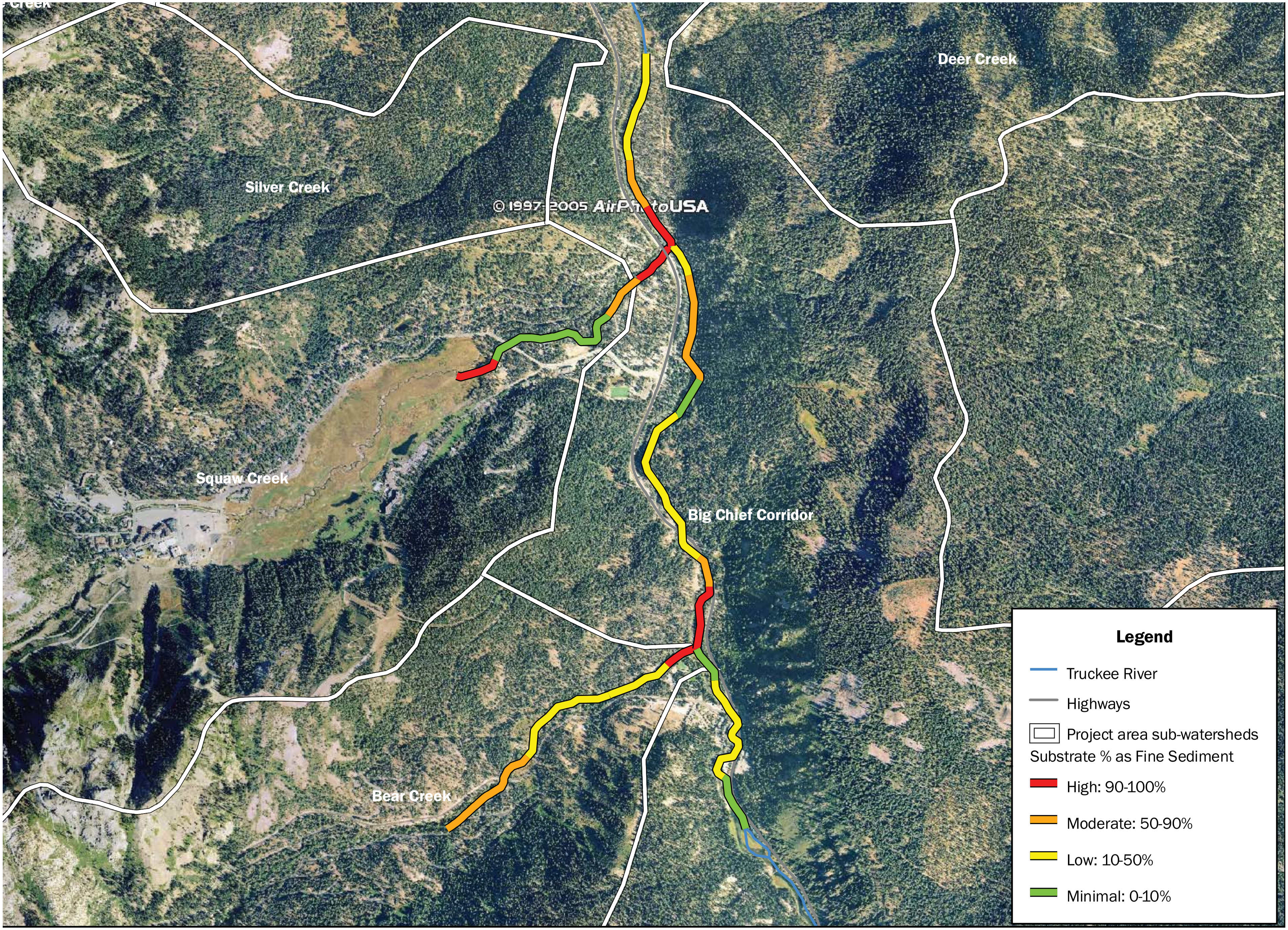
Bioassessment Results

Data communication:

- Create table of Index of Biological Integrity (IBI) scores, D50 particle size, and % <2mm (fines+sand) for each site. Scores are compared to TMDL targets (Table 7.1).
- Create GIS spatial maps of IBI scores by location within project area.

Temporal analysis:

- Create annual summary table comparing annual reach IBI values over time.
- Evaluate reaches with low IBI with respect to potential sources of sediment and/or nutrient impairment.



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Hypothetical data product indicating relative percentage of fine sediment in channel based on rapid assessment.

FIGURE 7.2

Upstream Tributary	IBI Score[a]
Bronco Creek	80
Trout Creek	77
Gray Creek	76
Squaw Creek	67
Canyon 24	67
Juniper Creek	62
Martis Creek	60
Bear Creek	55

a. Higher scores indicate better biologic community structure and diversity.

Table 7.1. Hypothetical results table from bioassessment (Table 3.4 from Lahontan (2008b))

Community- Discrete Water Quality Results

Data communication:

Annual site graphics should include the numeric criteria from the Lahontan Basin Plan Water Quality Objectives (Table 4.3) if applicable.

By site:

- Plot event date and type (x-axis) vs. pollutant of concern concentration (y-axis) for each station and event over the year.
- Group similar constituents on same graphic as appropriate. Evaluate all pollutants by site on same graphics page.
- Consider the potential influence of climate, hydrology, antecedent conditions, etc. on observed results within site.

Across sites:

- Plot station (x-axis) vs. pollutant of concern (y-axis). Report either annual average concentration +/- standard deviation, and/or maximum annual concentration observed at each site (comparison of worst-case scenarios across sites).
- Consider the potential influence of climate, hydrology, antecedent conditions, etc. on observed results across sites.

Temporal analysis:

- Plot community name (x-axis) vs. annual pollutant average concentration +/- standard deviation (y-axis) to compare across years.
- Create similar plot with maximum annual concentration observed at station to compare worst-case scenarios across years.
- Consider the potential influence of climate, hydrology, antecedent conditions, etc. on observed results across sites and over time.
- Focus additional analysis and evaluations on stations with poorest water quality and infer sources/causes based on all available information.

Tributary- Discrete Water Quality Results

Data communication:

Annual site graphics should include the numeric criteria from the Lahontan Basin Plan Water Quality Objectives (Table 4.3) if applicable.

By site:

- Plot stage (x-axis) vs. discharge (y-axis) rating curves based on manual discharge measurements, including equations and R^2 values.
- Plot time series of annual hydrograph and superimpose pollutant concentrations and/or event loads on secondary y-axis on dates observed. Pollutant results can be grouped per graphic as appropriate.
- Calculate discharge-weighted mean concentrations.
- Plot event date and type (x-axis) vs. event load of pollutant of concern (y-axis) for each event over annual observation. Evaluate all pollutants by site on same graphics page.

Across sites:

- Plot station (x-axis) vs. pollutant of concern EMC (y-axis). Compare event concentrations, discharge-weighted mean concentrations and/or loads at similar flow frequencies across sites.
- Create table of seasonal and annual pollutant loading estimates by tributary, continue over each WY observed.

Temporal analysis:

- Plot date of observation (x-axis) vs. pollutant of concern (y-axis). Report either annual average concentration +/- standard deviation, and/or maximum annual concentration observed to compare across years.
- Consider the potential influence of climatic, hydrologic, antecedent duration conditions, etc. on observed results.

Turbidity Near-Continuous Water Quality Results

Data communication:

Annual site graphics should include the numeric criteria from the Lahontan Basin Plan Water Quality Objectives (Table 4.3) if applicable.

By site:

- Plot stage (x-axis) vs. discharge (y-axis) and turbidity (x-axis) vs. TSS conc. (y-axis) rating curves for all data from respective stations. Display equations and R^2 values.
- Plot discharge and turbidity record on same time series (Figure 7.3).
- Plot annual hydrograph and time series of instantaneous TSS concentration on same graphic using two independent y-axes.
- Plot annual time series of sediment loading rate (g of sediment/sec) (Figure 7.4).
- Plot stacked histogram of annual sediment loads by event type at each site (Figure 7.5).

Across sites:

- Plot annual time series of sediment loading rate (g of sediment/sec) across sites (Figure 7.4).
- Compare annual sediment loads and event-type sediment loads across sites (Figure 7.5).
- Graphics of each station should allow visual and statistical comparison across stations as transition downstream through project area.

Temporal Analysis:

- Create tabular summary of each site's annual discharge (ac-ft) and annual sediment load (metric tons) for each year of record.
- Consider the potential influence of climatic, hydrologic, sources of sediment, etc. on observed annual differences.

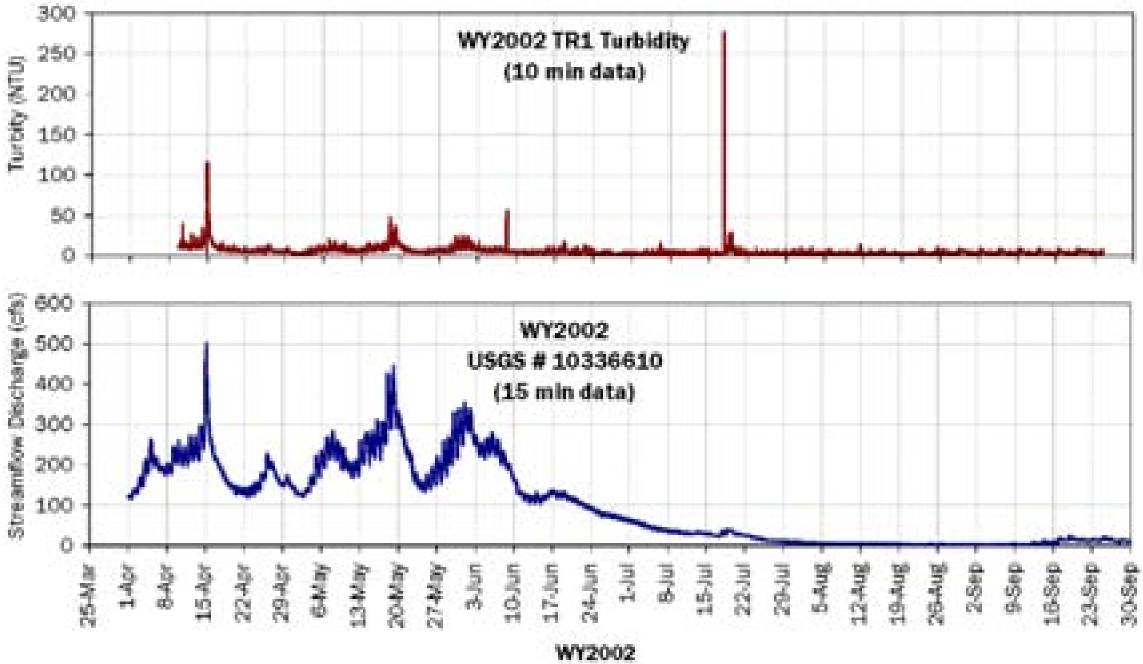

Figure 7.3. Graphical example of near continuous turbidity time series and relevant hydrograph for same time period (from 2NDNATURE 2006).

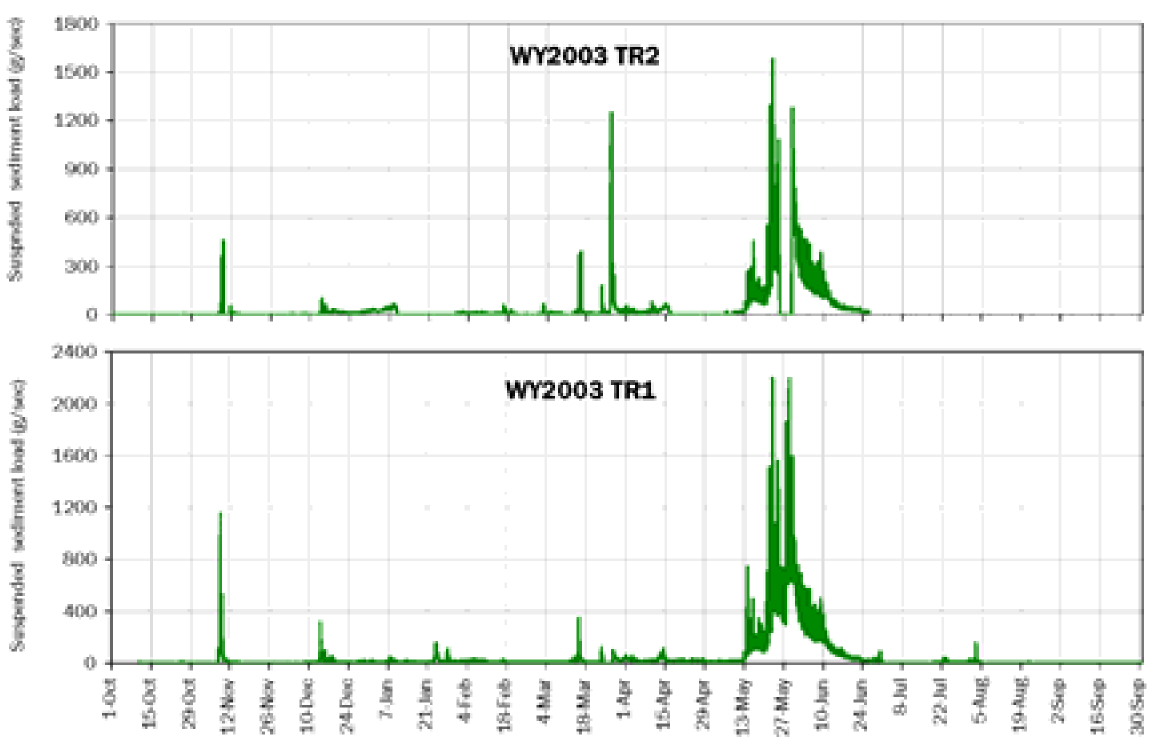

Figure 7.4. Graphical example of a comparison of annual instantaneous suspended sediment time series for two stations located approximately 2 river miles apart on the same tributary (from 2NDNATURE 2006).

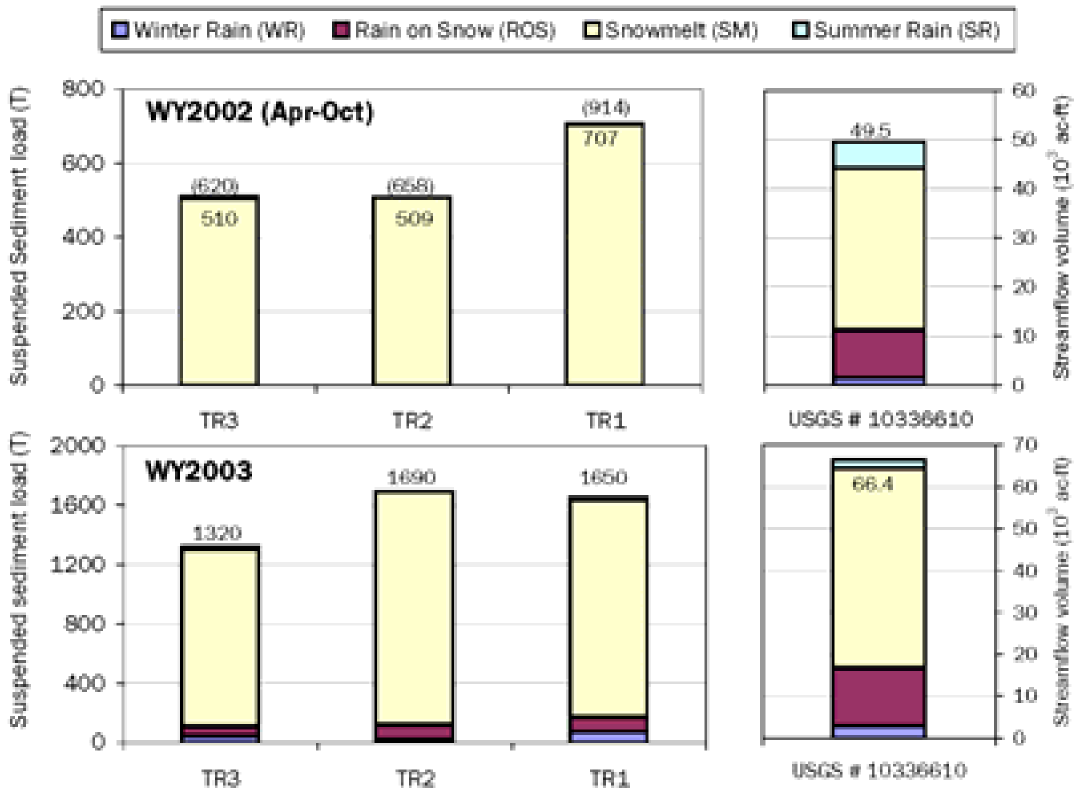

Figure 7.5. Example graphical summary of annual sediment load by station along the same stream reach. Histograms present total sediment loading observed at each near-continuous turbidity station (TR1, TR2, TR3) and the relative seasonal contribution of sediment loading to annual total (stacked histograms). The annual stream flow volume for each year of interest is also presented to provide the hydrologic context of the results (from 2NDNATURE 2006).

Auto Sampler Near-Continuous Water Quality Results

Data communication:

Annual site graphics should include the numeric criteria from the Lahontan Basin Plan Water Quality Objectives (Table 4.3) if applicable.

By site:

- Plot time series of station discharge with indication of events monitored.
- Summarize % of annual hydrograph sampled (total volume of events monitored/total annual volume). Summarize % of events monitored by event type and compare to targets in Section 6.9.2. Use to evaluate if annual data collection was representative of annual hydrology at station.
- Plot event date (x-axis) vs. pollutant of concern EMC (y-axis) for each event over annual observation (Figure 7.6).
- Provide annual mean EMC +/- standard deviation and total annual pollutant load in tabular form for each pollutant (Figure 7.6).
- Ensure annual load considers the fraction of the total annual hydrograph sampled. Limit to three pollutants results per graphic. All pollutants evaluated by site on same graphic page if possible.

Across sites:

- Plot station (x-axis) vs. pollutant of concern EMC (y-axis). Report either annual average EMC +/- standard deviation, and/or EMC average +/- standard deviation by event type for each station.
- Report discharge-weighted mean concentration for each constituent and station.
- Practice caution when comparing event, seasonal or annual loads across sites due to strong volume influence on loading.

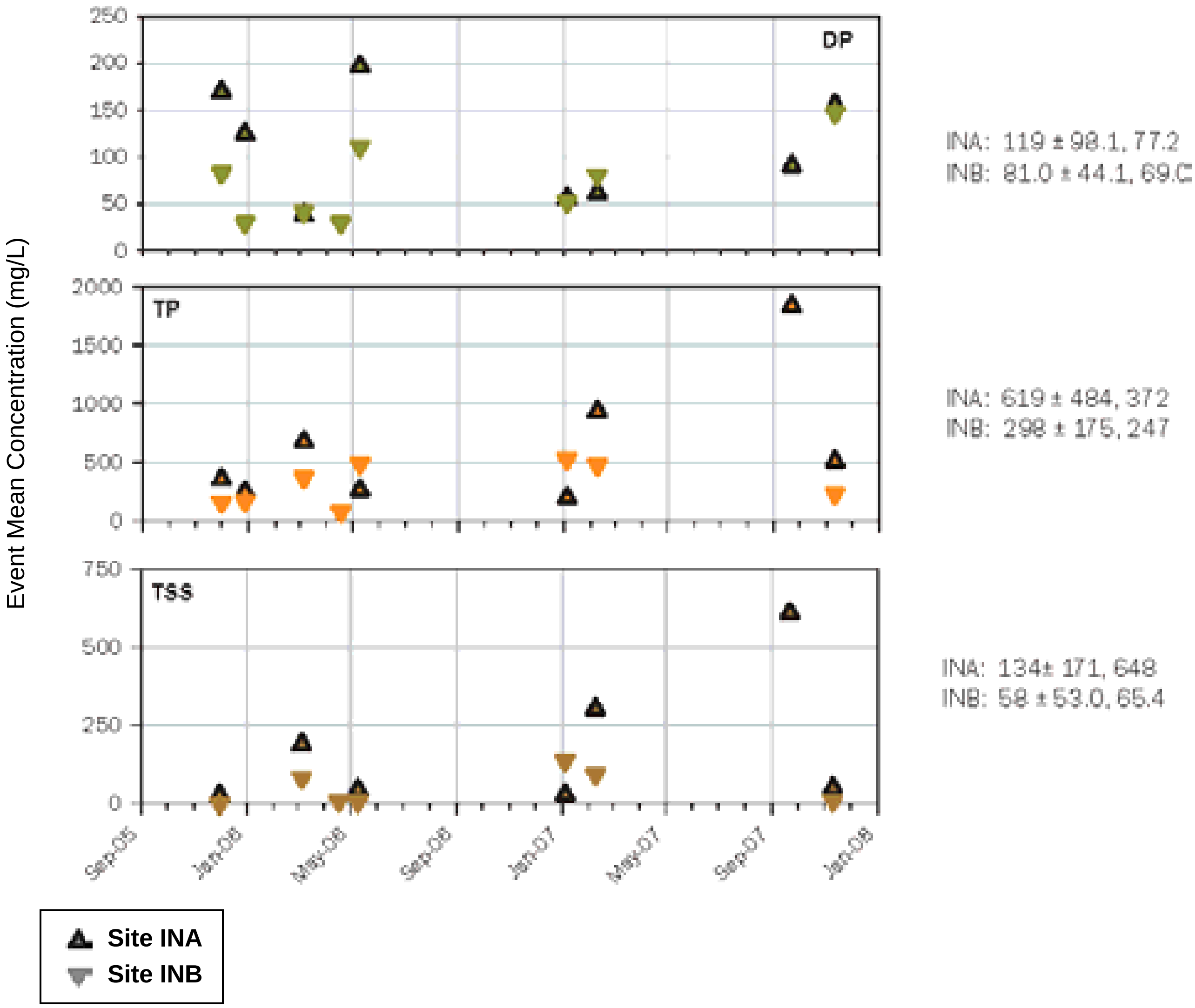

Figure 7.6. Example graphical summary of time-series plot of pollutant EMC data generated using near-continuous auto sampling assessment. Total project mean +/- standard deviation, median are summarized in the margins. The above site had two contributing catchments to the point of interest (INA and INB) (from 2NDNATURE 2008).

Temporal analysis:

- Plot date of observation (x-axis) vs. pollutant of concern (y-axis). Report annual average EMC +/- standard deviation, and/or concentration of maximum annual concentration observed (comparison of worst-case scenarios across years).

- Compare seasonal and annual loading over time for each respective site and consider role of hydrologic differences across years.
- Consider the potential influence of climatic, hydrologic, antecedent duration conditions, land use activities, etc. on observed results.

7.3 Discussion and Recommendation Questions

Over time, the TRWQMP database will be populated with data collected using a combination of the assessment types at numerous locations throughout the project area. The potential evaluations and comparisons of the datasets both spatially and temporally are limitless. It is critical that each annual report directly addresses the performance of the respective SWMPs using the data and information available. To focus the integration and analysis of assessment results, we provide the following questions that should be used to guide the Discussion and Recommendations section of the TRWQMP Annual Report.

- What do the data indicate about the performance of the respective SWMPs throughout the project area?

- How do the water quality conditions in the high disturbance areas compare? Do some catchments that are assumed to be high disturbance have relatively better water quality than others? If so, what are the assumed differences in the contributing catchment that may be driving these observed differences, including SWMP compliance?

- Where are the locations that continue to display relatively poor water quality based on the data and observations obtained? What are likely sources of this impairment? What is the level of SWMP compliance in the subject catchment and could compliance be improved? Do existing TRWQMP observations directly support these assumptions or could additional data and/or the implementation of a different assessment type refine the identification of these sources?

- Based on all years of TRWQMP data and observations, what is the water quality trend within the project area? Are SWMP actions being effective? Where are the areas of remaining concern?

- What questions still remain regarding the performance of the respective SWMPs? How can the TRWQMP be modified to better address these questions?

- How do the findings of this study compare to findings documented by other researchers? Efforts should be made to compare results from subject study to similar relevant findings by other studies (preferably from within the project area). This will integrate and build knowledge with each piece of new research.

Guiding principles for Discussion and Recommendations section:

- The integration of assessment results will likely lead to recommendations to modify the configuration the TRWQMP elements. The annual report should include a prioritization of existing sub-watershed assessment efforts to focus recommendations for potential new components of the TRWQMP and/or the removal of existing components based on existing data. This process will help to continually focus resources on the areas of most immediate concern.

- Limitations of the data collected under each assessment type should be clearly stated.

- Conclusions regarding water quality trends and SWMP performance should be firmly based in data and observations. Caution should be taken not to extend the conclusions and interpretations beyond the power of the specific data collected over the course of the TRWQMP.

7.4 TRWQMP Annual Reporting

The data results from the TRWQMP will be summarized in an annual report, generated each year and submitted to the Board by January 15th. The purpose of the annual report is to synthesize and communicate the annual dataset, compare the data to previous years, and apply the findings to adjust the TRWQMP components and inform management of SWMP performance and relative water quality conditions across the project area. Below is the recommended outline of the annual report. The TRWQMP Year 1 Annual Report will provide the tangible example of the report template. Subsequent reporting efforts should strive to remain as consistent and comparable as possible to simplify information extraction, review and understanding.

7.4.1 Recommended TRWQMP Annual Reporting Outline

I. Executive Summary

II. TRWQMP Summary

A. Summary of TRWQMP goals and objectives

B. Summary of past TRWQMP efforts
Describe past high level findings of TRWQMP. Include summary of how current efforts are meeting the goals and objectives of the TRWQMP. Outline current priority questions and data gaps. Place current assessment year in context of TRWQMP.

III. **Annual Summary (***year* being evaluated**)**

A. Regulatory requirements

B. Land use conditions
Describe changes in land use from previous year, land use developments of potential concern, or other events worth noting such as fires, landslides, etc. that may impact surface water quality within the project area.

C. Climatic data and context
Include graphics that summarize climatic conditions of the year of interest relative to average conditions and other years of record. Include annual hydrograph time series from USGS site on Truckee River, annual precipitation data, and summaries of the year's largest runoff events that are assumed to transport the majority of annual pollutant loads.

D. Summary of *year* assessments efforts
Include details of each station observations during the year, including assessment types, dates of data collection, dates of data failure, responsible parties and other relevant time series information of when, what, how and who conducted observations under the TRWQMP. The TRWQMP data collection map (see Figure 5.1 for example) should indicate station locations and assessment types using nomenclature consistent with TRWQMP and associated annual report text.

E. Problems encountered
Summarize any problems encountered, including funding, instrumentation failure, etc. that affected the quality and/or breadth of data collection during the year.

IV. Assessment and Data Analysis Methods (*year*)
Summarize methods for each assessment type with direct references to the TRWQMP protocols. Include discussion and rationale if any data collection methods or protocols had been modified from TRWQMP and/or previous years' protocols. If protocol modifications are considered valuable and permanent changes in the TRWQMP protocols, Section 6.0 should be appropriately revised and augmented to ensure a complete and accurate TRWQMP exists each year. Include any other relevant method information to ensure reader understands and has access to detailed techniques and protocols used to generate, manage and analyze data herein.

A. GIS Source Prioritization
B. Rapid Assessment
C. Bioassessment
D. Discrete WQ sampling-Community
E. Discrete WQ sampling-Tributary
F. Near continuous sampling-Turbidity
G. Near continuous sampling-Auto sampling

V. *Year* Results
Present results section in a clear and organized manner, rich with data presentation and light 5on text, as effective and well-developed graphics will need little supporting text. See Section 7.2 above for annual results display guidelines and continued comparisons of previous annual data by assessment type.

A. GIS Source Prioritization
B. Rapid Assessment
C. Bioassessment
D. Discrete WQ sampling-Community
E. Discrete WQ sampling-Tributary
F. Near-continuous sampling-Turbidity
G. Near-continuous sampling-Auto sampling

VI. Discussion (*See Section 7.3 for guidelines*)

A. Integration of assessment data
Highlight the specific findings of the annual and temporal dataset available, focusing in the areas and findings of concern where water quality impairments have been and/or continue to be observed.

B. Evaluation of SWMP performance (address by pollutant of concern)
   i. Placer County
   ii. Town of Truckee

C. Prioritization of existing TRWQMP elements
Rely upon existing water quality data, land use activities, existing regulatory requirements and resources available.

VII. Fiscal Summary

A. Summary of costs broken down by lab analysis, field work, administrative costs, reporting, etc.

VIII. Recommendations

A. TRWQMP Modifications
Recommend modifications to either implement new components or remove existing. Provide justification for modifications.

B. Management Recommendations

IX. References

7.5 Section 7.0 References

2NDNATURE. 2006. City of South Lake Tahoe Upper Truckee River Sediment Monitoring: Middle Reach (2002-2005). Prepared for the City of South Lake Tahoe. March 27 2006.

2NDNATURE. 2008. Water Quality Performance Evaluation of Park Avenue Detention Basins; South Lake Tahoe, CA. Draft Final Technical Report. Prepared for the City of South Lake Tahoe, Engineering Division. May 2 2008.

Lahontan Regional Water Quality Control Board (LRWQCB). 2008b. Total Maximum Daily Load for Sediment, Middle Truckee River, Placer, Nevada and Sierra Counties, Public Review Draft (Truckee River Sediment TMDL Public Review Draft). Draft February 2008.