Middle Truckee River
Total Maximum Daily Load (TMDL)
Suspended Sediment Monitoring Report
Water Year 2011
Nevada County, California

Report prepared for:

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May 2012

A report prepared for:
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Middle Truckee River Total Maximum Daily Load (TMDL) Suspended Sediment Monitoring Report, Water Year 2011 Nevada County, California

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May 31, 2012

Beth Christman
Restoration Director
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Truckee, CA 96162

Re: **Final Report: Middle Truckee River TMDL: Suspended-Sediment Monitoring Report, Water Year 2011**

Dear Beth,

We are pleased to submit the final report for monitoring year 2011 (WY2011). This final version reflects changes that address comments we received on May 9, 2012. The changes include the following:

1) We added the requested disclaimer language from the funder to our Limitations section in the report;
2) We added the TRWC logo to the signature page in our report, per your request;
3) We revised text associated with methods we used to calculate sediment loads at Donner Creek at Highway 89 to improve the reader's understanding;
4) We made a correction to units that describe sediment yields on page 21;
5) We revised text associated with the TMDL benchmark load limit to improve the reader's understanding and clarify how the benchmark load limit is used for this report.

In addition to the hard copies of this report we will provide you with an electronic copy for your files.

We are encouraged by our preliminary (1st year) monitoring results and we look forward to presenting them to stakeholder's meeting currently scheduled for June 26, 2012. At that time we may be able to provide some preliminary trends that we are seeing during water year 2012.

Thanks once again for the opportunity to work with the TRWC on this exciting project and we look forward to continuing our monitoring and reporting in subsequent years.

Please do not hesitate to contact me with any questions or concerns with your report.

Sincerely,

BALANCE HYDROLOGICS, Inc.

Brian Hastings

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EXECUTIVE SUMMARY

The Middle Truckee River is currently listed by the California State Water Resources Control Board as being impaired by excessive sediment. Water quality is of particular concern because the river is habitat for cui-ui and Lahontan cutthroat trout, both federally-listed species. The Lahontan Regional Water Quality Control Board (RWQCB) has developed a Total Maximum Daily Load (TMDL) for suspended sediment concentration to attain sediment-related water quality objectives in the Middle Truckee River, the segment of the Truckee River Basin which extends from the outflow of Lake Tahoe at Tahoe City to the California-Nevada state line, near Farad, California (Amorfini and Holden, 2008). This report is the first annual report of a multi-year study to: a) document suspended sediment loads in selected tributaries to the Middle Truckee River; b) evaluate the relationship between streamflow, suspended sediment concentration, and suspended sediment loads in these tributaries, and; c) document changes in these relationships over time that may occur in response to land management, sediment control strategies, and other implementation measures outlined in the TMDL.

Work carried out under this monitoring program included installation and management of suspended-sediment discharge gaging stations on Cold, Trout, and Donner Creeks. Suspended-sediment sampling at these stations, in conjunction with near-continuous turbidity and streamflow gaging, allows for computation of annual suspended-sediment loads using multiple lines of evidence. These computations have been used to characterize of suspended sediment production and delivery (i.e. loads) from watersheds with differing land cover, and compare suspended sediment loads during water year 2011 to measurements and estimates made for previous years. We also compare suspended sediment loads and load durations to benchmarks set forth in the TMDL.

The Cold Creek station was installed at the beginning of the water year on October 7, 2010, allowing for a near-complete annual record of streamflow and suspended sediment loading. The Trout Creek station was installed and sampling commenced on January 20, 2011, allowing for a limited record of sediment transport and loading for the year. Sediment sampling did not commence on Donner Creek until May 2011, necessitating use of an incomplete data set to calculate annual loads for water year 2011. Measurements and observations on all three tributaries are continuing during water year 2012, with expansion of the monitoring program to include real-time data access via the internet and additional suspended sediment sampling on Donner Creek at West River Road (confluence with Truckee River).

On Trout and Cold Creeks, suspended sediment loads were calculated using two methods: 1) establishing relationships between instantaneous suspended sediment loads and instantaneous streamflow ('streamflow-suspended sediment rating curve'), and applying that relationship to the near-continuous streamflow record, and; 2) establishing relationships between instantaneous suspended sediment concentration and turbidity ('turbidity-suspended sediment rating curve'), and applying that relationship to the near-continuous turbidity record. Loading on Donner Creek was calculated using only the streamflow rating curve method in the absence of a continuous-logging turbidity meter. Our conclusions are presented below:

- Water year 2011 was an above-average precipitation year, with annual precipitation roughly 150 percent of the long-term average, and included two significant peak flows of similar magnitude. A high-intensity rainstorm on October 24, 2010 and spring snowmelt both produced peak flows in the 2- to 5-year recurrence range on Cold Creek

- The two methods of calculating sediment loads produced generally consistent results. Total annual suspended sediment loading from Cold Creek during water year 2011 was calculated to be 710 tons and 508 tons using the streamflow and turbidity methods, respectively. Total suspended sediment loading from Donner and Cold Creeks combined was calculated to be 804 tons. Total suspended sediment loading from Trout Creek during the WY 2011 Trout Creek monitoring period (January 21 to September 30, 2011) was calculated to be 167 tons using the streamflow rating curve method. Equipment fouling resulted in limitations on the continuous turbidity data set for Trout Creek, but non-flow-related spikes in turbidity (and by extension, suspended sediment concentrations) were still detectable.

- Loadings from Cold and Donner Creeks during WY2011 are generally consistent with below-average water year load estimates as put forth in the Middle Truckee River TMDL for Sediment (Amorfini and Holden, 2008), but significantly lower than those estimated for above-average precipitation years. Loadings from Trout Creek were measured to be higher than previously estimated for a below- and above-average precipitation year.

- The Middle Truckee River Sediment TMDL establishes a target 90th percentile suspended sediment concentration of less than or equal to 25 mg/L. Load duration curves for Cold

Creek, Donner Creek and Trout Creek met this load duration criterion during the monitoring period (water year 2011).

1. INTRODUCTION AND PROJECT PURPOSE

1.1 Introduction

This report is the first annual report of a multi-year study of the relationship between streamflow and suspended-sediment concentrations and sediment loads in watersheds tributary to the Middle Truckee River, a portion of the larger Truckee River Basin (**Figure 1)**. This work is being conducted by Balance Hydrologics (Balance) for the Truckee River Watershed Council (TRWC), with funding provided by the State of California, State Water Resources Control Board (SWRCB) through Proposition 50, in order to support implementation of the Middle Truckee River Total Maximum Daily Load (TMDL) for sediment.

Excessive sediment and its effects on aquatic habitat have been well documented in the literature. Both non-native and native fish species are found in the Truckee River and its tributaries. Common native fish include Paiute sculpin, Lahontan redside shiner, Tahoe sucker, specked dace, mountain whitefish, and mountain sucker. The cui-ui and Lahonton cutthroat trout (LCT) are also found in the Truckee River; these species are federally listed as endangered and threatened, respectively (Amorfini and Holden, 2008). The Middle Truckee River between the Trout Creek and Gray Creek tributaries has been designated a Wild Trout Water by California Department of Fish and Game (CDFG) to support regulated angling of non-native rainbow and brown trout. In 1992, the Truckee River was reclassified from intermediate to impaired for excessive sediment and placed on the 303(d) list under the Clean Water Act (Amorfini and Holden, 2008, RWQCB, 2008).

In response to the 303(d) listing, the RWQCB developed a TMDL for sediment to attain sediment-related water quality objectives set to protect in-stream aquatic life and beneficial uses (Amorfini and Holden, 2008). The Truckee River TMDL for sediment establishes sediment load allocations for particular subwatersheds and intervening areas, with the total sediment load allocation for the entire Middle Truckee River watershed (see Figure 1) set at 40,300 tons per year. The TMDL consists of a number of indicators and target values for each indicator. The only direct indicator is suspended sediment concentration (SSC) in the Truckee River, with a target of less than or equal to 25 milligrams per liter (mg/ L) as an annual 90th percentile loading. This target was established based on a review of the scientific literature, analysis of suspended-sediment measurements taken in the Truckee River over a 30-year period, and continuous monitoring of turbidity during water years 2002 and 2003. Additional *indirect* indicators include successful implementation and maintenance of best management practices (BMPs) for road sand application, BMPs for ski runs, and restoration activities such as decommissioning of dirt roads and repair of legacy sites. In order to evaluate whether compliance with the TMDL is achieved, it is necessary to also identify whether reductions are taking place in targeted tributaries or subwatersheds of concern, in addition to monitoring the Truckee River at Farad.

This study evaluates relative suspended-sediment contributions from targeted Middle Truckee River tributaries and compares current trends in suspended-sediment loads to historical measurements. Methods used in this monitoring program adhere to the project Sampling and Analysis Plan, unless otherwise noted.

A map showing the Middle Truckee River and locations of monitoring stations used for this study is illustrated in **Figure 2**. Balance installed two gaging stations for this study then collected suspended-sediment samples over a range of flows and monitored continuous streamflow and turbidity at each station during water year[1] (WY) 2011:

1. Cold Creek at Teichert Bridge (CCTB), near Truckee, California

2. Trout Creek at Donner Pass Road (TCDP), Truckee, California

Separately, Balance collected suspended-sediment samples over a range of flows at a U.S. Geological Survey (USGS) streamflow gaging station during WY 2011:

3. Donner Creek at Highway 89 (DC89) near Truckee, California (USGS #10338700)

The settings for each of these three gaging stations are discussed in greater detail in subsequent sections.

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[1] Most hydrologic and geomorphic monitoring occurs for a period defined as a water year, which begins on October 1 and ends on September 30 of the named year. For example, water year 2011 began on October 1, 2010 and ended on September 30, 2011.

1.2 Project Purpose

This report presents the results of the initial year (WY 2011) of a multi-year monitoring program at each of the three monitoring stations and:

- Briefly describes what, where, and how measurements were made, for parameters such as streamflow, suspended-sediment concentration, turbidity, specific conductance, and water temperature;
- Summarizes the results of these measurements;
- Reports daily and annual streamflow, runoff and suspended-sediment loads for all three stations, and;
- Compares WY 2011 suspended-sediment loads with historical loads.

1.3 Hydrologic Setting

As shown in Figure 1, the Truckee River Basin originates above the waters of Lake Tahoe (Upper Truckee River), drains from Lake Tahoe through Truckee, California (Middle Truckee River) and flows east through Reno, Nevada, finally discharging into Pyramid Lake (Lower Truckee River). The hydrology of the Middle Truckee River Basin has been described in detail by others (Amorfini and Holden, 2008, Nichols Consulting Engineers, 2008). In this section we describe the hydrologic setting for the three tributaries monitored as part of this study.

1.3.1 Cold Creek

Cold Creek is a tributary to Donner Creek near the Town of Truckee, California. The drainage area is approximately 12.6 square miles at the gaging station, approximately 1,500 feet upstream from the confluence with Donner Creek. The watershed ranges in elevation from 5,940 feet in Truckee to 8,836 feet[2] at the crest of the Sierra Nevada Mountains and receives a total average-annual precipitation of 48.9 inches (USGS Streamstats, 2012). Most of the annual precipitation is received as snow during the winter months of November through March, with occasional early fall rainstorms, rain-on-snow events, and summer thunderstorms. Consequently, the annual

[2] All elevations are presented relative to mean sea level (msl).

pattern of streamflow tends to be dominated by spring snowmelt, punctuated by increases from occasional rain events.

The Cold Creek watershed[3] is underlain primarily by early- to mid-Tertiary volcanic rocks with some exposure of Cretaceous granitic rocks (Sylvester and others, 2007). The watershed is characterized by landforms and deposits typical of glaciation. For instance, valley sideslopes include moraine deposits comprised of boulders and non-cohesive sand and gravels, while valley bottoms are filled with similar materials derived from glacial outwash and alluvium (Birkeland, 1963). Historic land use within the Cold Creek watershed was directly linked to the geologic setting. Beginning in the 1960s, the glacial deposits along the valley floor and the near-channel environment were mined for sand and gravel during construction of highway Interstate 80 (or I-80). As a result, the channel in the lower watershed was realigned and later modified to contain and convey floods. Current land uses include the Union Pacific railroad, forestry and recreation under California State Parks and US Forest Service management, and staging for highway maintenance. Vegetation varies with elevation, aspect and soil type but is primarily a conifer forest with areas of scrub and brush.

1.3.2 Donner Creek

Donner Creek drains a 29.1 square mile watershed at the USGS gage at Highway 89. The watershed ranges in elevation between 5,890 feet and 8,836 feet at the crest of the Sierra Nevada Mountains and receives a total average-annual precipitation of 46.9 inches (USGS Streamstats, 2012). Cold Creek accounts for nearly half (12.6 square miles) of the 29.1-square-mile Donner Creek watershed. Streamflow in Donner Creek is also influenced by snowmelt and rainstorms, but is regulated by detention in and controlled releases from Donner Lake.

Similar to Cold Creek, the larger Donner Creek watershed is underlain primarily by early- to mid-Tertiary volcanic rocks, with some exposure of Cretaceous granitic rocks (Sylvester and others, 2007). The watershed was significantly influenced by past glaciations with large-scale moraine features, deposits and outwash (Birkeland, 1963). Approximately 14.3 square miles of the upper watershed for Donner Creek drains to Donner Lake, which is regulated by a small dam. Historic land uses within the Donner Creek watershed included mining, construction of the Union Pacific railroad and timber harvesting. Construction of I-80 and other roads resulted in channel realignment and modifications. Today, the lower watershed below Donner Lake

[3] Also known locally as 'Coldstream Canyon'

includes residential and commercial areas of Truckee, as well as portions of I-80. Vegetation varies with elevation, aspect and soil type, but is primarily a conifer forest with areas of exposed bedrock, scrub and brush.

As mentioned above, Donner Creek is regulated at Donner Lake. The Donner Lake Dam is operated in accordance with the Truckee River Operating Agreement. The lake is allowed to fill to the maximum elevation of 5,935.8 feet, typically between April 16 and June 15, with releases to maintain a 2.0 cfs minimum streamflow downstream of the lake. If the lake elevation is less than 5,932 feet, then no water can be released during the months of June, July, and August. Subsequently, the water-surface elevation of Donner Lake must be lowered to 5,926.9 feet by November 15 each year to meet a dam safety requirement. The lake lowering results in increased streamflow downstream of Donner Lake during the months of September, October and November. During normal operations, all inflows between November 15 and April 15 pass through the lake to downstream reaches (Berris and others, 2001).

1.3.3 Trout Creek

Trout Creek drains a mostly residential area within the Town of Truckee, slightly east of the crest of the Sierra Nevada Mountains. The watershed ranges in elevation between 5,820 feet and 7,412 feet and receives a total average-annual precipitation of 37.4 inches (USGS Streamstats, 2011). Similar to Cold Creek, most of the annual precipitation is received as snow during the winter months, and annual streamflow is dominated by spring snowmelt with occasional increases from rain events.

The Trout Creek watershed is underlain by mid- to late-Tertiary volcanic rocks and also exhibits landforms and deposits characteristic of past glaciations (Sylvester and others, 2007). For instance, the upper watershed's southern boundary is controlled by a glacial moraine crest which separates Trout Creek from Donner Lake (Birkeland, 1963). Trout Creek has formed an alluvial fan at the confluence with the Truckee River. Construction of the Union Pacific railroad and development of the Town of Truckee has resulted in significant modifications to the creek. For example, the Tahoe Donner residential development, of one of California's largest single developments, envelops much of Trout Creek's upper watershed. And in the lower watershed, transportation and urban infrastructure has resulted in channel realignment and alterations. The Town of Truckee is currently implementing a phased restoration of the lower Creek through the downtown area, extending to the confluence with the Truckee River.

1.4 Prior Work

1.4.1 Stream gaging

The USGS has operated a stream gage on Donner Creek at Donner Lake (USGS #10338500) intermittently from WY 1910 to the present. Flows recorded at this gage have been regulated by Donner Lake Dam since 1928. Mean annual flows after 1928 have ranged from 7.7 to 83.3 cubic feet per second (cfs). The maximum annual peak flow measured was 863 cfs on January 2, 1997.

The USGS also operates a stream gage on Donner Creek at Highway 89 (USGS #10338700). This gage is downstream from both the Donner Lake gage and the confluence with Cold Creek, and has a contributing area of 29.1 square miles. The period of record for this gage is from March 1993 through the current water year. Mean annual flows for the period of record have ranged from 26 to 142 cfs, whereas the maximum annual peak-flow for the period of record was measured at 2,500 cfs on January 2, 1997. This study utilizes the downstream, Donner Creek at Highway 89 gaging station for evaluation of suspended sediment loads in Donner Creek.

1.4.2 Sediment load monitoring

In supporting development of the TMDL for sediment in the Middle Truckee River, McGraw and others (2001) used historical data to develop a relationship between streamflow and suspended-sediment load and estimates of annual sediment loads for 10 major tributaries to the Truckee River Basin, including Donner and Trout Creeks.

The RWQCB (Amorfini and Holden, 2008) established the TMDL for the Middle Truckee River, identified a sediment loading capacity, and reported annual suspended-sediment loads for WY 2004 using sediment rating curves from McGraw and others (2001). Thus, data on WY 2004 sediment loads are available for both Donner Creek and Trout Creek, but not for Cold Creek.

River Run Consulting (2007) later completed a watershed assessment for Cold Creek. The report discusses sediment sources and estimates suspended-sediment loads based on several assumptions and work completed by McGraw and others (2001).

2. STATION DESCRIPTIONS

Measurement of flow and establishment of a streamflow record is a required step towards computation of sediment load. This chapter provides descriptions of the stream gaging stations used in this study. A description of the streamflow gaging instrumentation and methods used to create a record of streamflow may be found in **Appendix A**.

2.1 Cold Creek at Teichert Bridge (CCTB) Description

The location of the Cold Creek gaging station is illustrated in **Figure 2**. Balance installed a near-continuous stream gage at this site on October 8, 2010. The gaging station is located below a bridge and on the east bank of the Teichert Quarry property, approximately 1,500 feet upstream from the confluence with Donner Creek at latitude/ longitude 39º 19' 13.1"N / 120º 13' 36.7"W (WGS84). The watershed area above the gaging station is approximately 12.6 square miles. Streamflow at this gage may be affected by ice.

2.2 Trout Creek at Donner Pass Road (TCDP) Description

The location of the Trout Creek gaging station is illustrated in **Figure 2.** Balance installed a near-continuous stream gage at this site on January 21, 2011. The station was installed on the north bank approximately 150 feet upstream from Donner Pass Road and about 0.91 miles upstream from the confluence with the Middle Truckee River. The gaging station is located at 39° 19' 50" N / 120° 10′ 55″ W (WGS84). The watershed area above the gaging station is approximately 4.6 square miles. Streamflow at this location is occasionally affected by ice.

On August 29, 2011, stream restoration activities on the lower reach of Trout Creek required temporary relocation of the Trout Creek station. Balance staff and the Town of Truckee identified a location on the west bank, approximately 35 feet upstream from Jibboom Street, or approximately 850 feet upstream from Donner Pass Road. Streamflow at this location excludes several stormwater outfalls. The gage was moved back to its original location on November 3, 2011 (in WY 2012).

2.3 Donner Creek at Highway 89 (DC89; USGS 10338700) Description

The location of the Donner Creek gaging station is shown in **Figure 2.** The period of record for this gage is from March 1993 (WY1993) through the current water year. This USGS-operated gaging station is located approximately 50 feet upstream from the State Highway 89 box-culvert and approximately 0.59 miles upstream from the confluence with the Middle Truckee River at the point 39° 19′ 15.5″ N, 120° 12′ 28.6″ W (WGS84). The watershed area above this gaging station is 29.1 square miles and includes the Cold Creek subwatershed. Streamflow at this location is regulated and may also be affected by ice.

2.4 Other Stations in the Middle Truckee River Gaging Network

The USGS operates other real-time gaging stations on the Middle Truckee River above and below the gaging stations used for this report (**see Figure 2**). In future monitoring years, one or more of these gages may be used as part of the Town of Truckee and the TRWC's TMDL monitoring network. These gages are listed below in the order from upstream to downstream:

- Truckee River at Tahoe City, USGS 10337500
- Truckee River near Truckee, USGS 10338000
- Truckee River at Boca Bridge near Truckee, USGS 10344505
- Truckee River at Farad, USGS 10346000

3. FLUVIAL SEDIMENT MEASUREMENTS

This chapter describes the different types of sediment transport and the methods and equipment used to collect suspended-sediment samples or measure turbidity, the basis of evaluating fine sediment loads.

3.1 Types of Fluvial Sediment

We distinguish two types of sediment in transport, bedload and suspended sediment. Bedload includes sediment that rolls and saltates along the bed, commonly within the lowermost three inches of the water column. Movement can be either continuous or intermittent, but is generally much slower than the mean velocity of the stream. Suspended sediment consists primarily of fine sand, silt, and clay supported by turbulence within the water column, transported at a rate approaching the mean velocity of flow. This study supports the Middle Truckee River TMDL for sediment through collection and interpretation of suspended-sediment samples only, and not bedload sediment

3.2 Suspended-Sediment Sampling Equipment

Balance staff used standard equipment and methods, adopted by the Federal Interagency Sedimentation Program (FISP), to make measurements of suspended-sediment transport. This included a hand-held DH-48 suspended-sediment sampler with a 1/ 4-inch nozzle for use when flows were wadeable, and a bridge board with a D-95 suspended-sediment sampler for high (unwadeable) flows.

3.3 Suspended-Sediment Sampling and Analysis

Measurements of suspended-sediment transport were collected at a channel location exhibiting the most ideal characteristics (i.e., straight reach) for the flow event sampled, and at a location in close proximity to the gaging station. Suspended sediment was collected using the Equal Transit Rate (ETR) method where each sample is collected using a number of equally-spaced verticals in a cross-section, where collection in each vertical is integrated across the full depth and a constant transit rate is maintained until the sample bottle is just less than full (Edwards and Glysson, 1999). Suspended-sediment samples are collected from between three and eight verticals, and each vertical is executed within 5 to 15 seconds, for a total of 30 to 60 seconds per sample in order to avoid significant changes in sediment transport rates due to rapidly fluctuating streamflows.

Each sample is then transferred to a clean 500 mL or 1,000 mL high-density polyethylene (HDPE) bottle and transported to High Sierra Water Lab, near Truckee, California for analysis of total suspended solids (TSS) using EPA method 160.2 (gravimetric method). McGraw and others (2001) evaluated the relationship between total suspended solids (TSS) and suspended sediment concentration (SSC) at monitoring sites in the Middle Truckee River watershed, and found a nearly one-to-one relationship between the two, suggesting that both TSS and SSC are reliable for calculating suspended-sediment loads, especially at flows of less than 500 cfs.

Flow was measured or estimated each time suspended-sediment samples were collected. We evaluated suspended-sediment loads in transport to establish one or more streamflow-sediment rating curves for each station. Suspended-sediment transport rates ('loads') are reported in tons per day.

3.4 Turbidity Monitoring

Near-continuous turbidity values, measured in nephelometric turbidity units (NTUs), were recorded every 15 minutes (along with measurement and recording of stream stage). Turbidity is measured using an Optical Back-Scatter (OBS 3+) submersible turbidity probe with a range of up to 4,000 NTUs.

4. CREATING A RECORD OF SUSPENDED-SEDIMENT LOAD

In this section, we describe the two methods used to calculate annual records of suspended-sediment load: 1) through use of site-specific streamflow-to-suspended-sediment load relationships ('rating curves'); and 2) based on the relationship between the continuous record of turbidity and suspended sediment concentration (SSC).

4.1 Calculating Suspended-Sediment Load from a Streamflow-Based Rating Curve

Suspended-sediment samples collected in the field are correlated with an instantaneous streamflow from concurrent measurements or the electronic record. Samples are analyzed for SSC (mg/L) and converted to suspended-sediment loads by multiplying SSC times the instantaneous streamflow (cfs) and a conversion factor of 0.0027 to convert units into tons/day. This allows SSC data to be graphed with instantaneous streamflow data to develop a relationship using best-fit, empirical equations (power function). The resulting relationship is then applied to the (15-minute) record of streamflow to compute a 15-minute record of suspended-sediment load.

The error associated with streamflow-based, suspended-sediment rating curves has been reviewed in the literature and is generally assumed to have an inherent uncertainty of at least 25 to 50 percent (Walling, 1977, MacDonald and others, 1991). Significant scatter in instantaneous rates of suspended sediment loads can produce results differing by an order of magnitude at any given discharge.

In order to address the variation and error in sediment load computations, we evaluated potential temporal patterns in the data. Data was separated by season (e.g., pre-snow melt peak runoff vs. post-snow melt peak runoff) and position on the storm hydrograph (e.g., rising stage vs. falling stage). Where differences were observed, separate relationships (equations) were developed. We note that use of data that extends above or below the range of the rating curve may result in an increased magnitude of error in estimating suspended sediment load. Since ongoing sampling efforts may help extend the existing rating curves and improve their accuracy, the data presented in this report should be considered provisional and subject to revision when further data becomes available.

4.2 Calculating Suspended-Sediment Load from a Continuous Record of Turbidity

At the two gaging stations with a continuous record of turbidity (i.e., CCTB, TCDP), measurements of instantaneous turbidity (NTU) at the time of suspended-sediment sample collection (SSC in mg/L) results in a definable relationship that can explain at least 80 percent of the variation in suspended-sediment concentrations, as supported by the literature (MacDonald and others, 1991). The continuous record of turbidity can then be converted into a 15-minute record of suspended-sediment concentration (mg/L per 15 min.) and, through application of the streamflow record, converted into a daily suspended-sediment discharge (tons/day). Because turbidity can fluctuate independent of streamflow variations, continuous turbidity monitoring can help identify discrete events not related to rainfall or snowmelt runoff, such as bank failures. For Cold and Trout Creeks, where turbidity probe data was available, turbidity values were used as a second technique, in addition to the streamflow-to-suspended-sediment load method, to estimate suspended-sediment load and evaluate suspended-sediment loading in WY 2011.

Several factors can complicate collection and interpretation of continuous-logging turbidity data: a) algal growth on the optical sensor; b) ice or debris collecting on the probe; c) sedimentation of the probe; and/or d) probe exposure above the water column (unsubmerged) due to extreme low-flows. To reduce the chances of these conditions and to minimize instrument error, Balance staff made frequent site visits in WY 2011 to evaluate site conditions and instrument integrity. Furthermore, current plans are to modify the installations at the Trout Creek and Cold Creek stations to allow for real-time internet access to field data and, thus, faster identification and correction of these conditions when they occur.

5. WATER YEAR 2011 HYDROLOGIC SUMMARY

Balance staff visited the three gages on a monthly basis, including additional visits during rain and snowmelt events to observe water levels (stage), conduct flow measurements, and collect suspended-sediment samples. This chapter begins with a description of the WY 2011 rainfall season and concludes with a description of flow conditions during the period, including peak flows, baseflows, and any unusual observations in the watershed.

5.1 Annual Precipitation

Annual precipitation data used for this study is from two sources: 1) the Truckee Ranger District, located in Truckee, California at 6,020 feet and operated by the USFS (California Data Exchange Center, CDEC Station ID: TKE), and; 2) the Central Sierra Snow Lab, located near Donner Pass, at 6,950 feet.

The two stations provide precipitation measurements covering the range of elevations represented by the gaged watersheds considered in this study. In addition, the Snow Lab data provides context for evaluating snow pack and snow-melt water equivalency in relation to the spring snow-melt hydrology.

WY 2011 cumulative-annual precipitation for Truckee, California is illustrated in **Figure 3,** while the annual snowpack as snow-water equivalent is presented in **Figure 4**. Approximately 46.2 inches of precipitation were recorded for WY 2011, which is about 148% of the long-term average annual precipitation of 31.3 inches (CDEC, 2012). Regionally, WY 2011 recorded the highest annual snowfall depths since 1971 (Central Sierra Snow Lab, 2011). Annual precipitation was received in a number of large events, beginning with a relatively significant rain storm on October 24-25, 2010 (4.1 inches). Measurable snow fell in late November and late December. After a relatively dry period in January and early February, several significant snowfall events were recorded in mid-February, late-February and throughout the months of March and April. The spring was unusually late with a historically-high snowpack in April (Central Sierra Snow Lab, 2011). Several late-season snowstorms continued into May and early June, augmenting the already historic snowpack. This record-setting snowpack and cold spring resulted in a late peak snowmelt (mid- to late-June), approximately 30 to 45 days later than the historical average peak runoff. Trout Creek was an exception and experienced a peak snowmelt runoff much earlier (April), likely due to the lower watershed elevations and urbanized land cover. The summer was relatively cool with below average rainfall for this period.

5.2 Cold Creek at Teichert Bridge: Hydrology

Form 1 presents daily and peak flow values for WY 2011 at the Cold Creek at Teichert Bridge station (CCTB). **Table 1** documents observations and measurements made during site visits. Daily stage and streamflow are illustrated in **Figures 5 and 6**.

WY 2011 began with baseflow of approximately 1.0 cubic feet per second (cfs). An intense rainstorm on October 24-25, 2010 generated a rapid and ephemeral peak flow of approximately 350 cfs which rapidly returned to near-baseflow conditions, slightly elevated to between 5 and 10 cfs. Steady rain and snow through December 2010 resulted in occasional peak flows over 70 cfs. Mid-winter snows and colder temperatures resulted in receding winter baseflows between 10 and 20 cfs. The annual peak flow of 447 cfs occurred on June 22, 2011, coincident with peak snowmelt. Flow and stage observations before and after the peak flows suggest that there were no substantial stage shifts and that the records of stage during periods of high flow were representative of the peak flows. After the annual peak in late June, streamflow slowly receded through the summer months, with baseflow again approaching 1.0 cfs towards the end of the water year in October. The annual mean flow for Cold Creek at Teichert Bridge in WY 2011 was 60 cfs, while the annual runoff totaled 42,624 acre-feet.

5.3 Donner Creek at Highway 89 (USGS #10338700): Hydrology

Streamflow for Donner Creek at Highway 89 (DC89) is reported by the USGS; data are provisional at the time of this report and subject to revision. **Appendix B1** presents USGS reported daily flow values for WY 2011 at Donner Creek above Highway 89. **Table 2** documents Balance observations and measurements made during site visits to the gage. The WY 2011 streamflow hydrograph for DC89 is illustrated in **Appendix B2** (a record of daily stage was unavailable for this gage). Below, we briefly describe provisional streamflow at this gaging station.

WY 2011 began with flows greater than 100 cfs, which can be attributed to regulated releases from Donner Lake. Based on the provisional 15-minute streamflow record, the October 24-25, 2011 rainfall event increased flows to a peak of 474 cfs. Subsequently, streamflow receded to near 30 cfs through late fall. Steady rain and snow through December 2010 resulted in occasional peak flows over 100 cfs. Mid-winter snow and colder temperatures resulted in daily streamflow between 40 and 70 cfs. The annual peak flow of 921 cfs occurred on June 29, 2011, coincident with peak snowmelt. After the annual peak flow occurred, streamflow slowly receded through the summer months in response to the high snow pack, falling to below 10 cfs towards the end of the water year. The annual mean flow for Donner Creek above Highway 89 in WY 2011 was 140 cfs, while annual runoff totaled 101,308 acre-feet (USGS, provisional data)

5.4 Trout Creek at Donner Pass Road: Hydrology

Form 2 presents daily and peak flow values for the Trout Creek at Donner Pass Road (TCDP) gage for the portion of WY 2011 following gage installation ('partial WY 2011'). **Tables 3 and 4** document observations and measurements made during site visits to the primary gage and the the temporarily relocated station at Trout Creek at Jibboom Street Bridge, respectively. Daily stage and streamflow data are illustrated in **Figures 7 and 8**.

At the time of gage installation on January 21, 2011, streamflow averaged between 4 and 5 cfs. Mid-winter snows and colder temperatures resulted in ice-affected flows for a short period. For this period, we estimated flows through correlation to the nearby Donner Creek at Highway 89 gage (USGS 10337800). Trout Creek's lower watershed elevation, distance east from the Sierra Nevada crest, and higher urbanization in the watershed likely contributed to earlier snowmelt relative to the other gaging stations discussed in this report. The annual peak flow from snowmelt (69.6 cfs), occurred on April 21, 2011, almost 2 months before the annual peak flows occurred in Cold Creek and Donner Creek. Mean daily streamflow fluctuated over the summer months with snowmelt and rainfall (at lower elevations). Streamflow slowly receded to between 2 and 3 cfs through the late summer.

The annual mean flow for Trout Creek at Donner Pass Road for partial WY2011 was 14.5 cfs, while runoff during the period totaled 6,777 acre-feet.

6. WATER YEAR 2011 SUSPENDED-SEDIMENT LOAD AT A STATION

This chapter summarizes the suspended-sediment loads calculated for each of the three gaging stations in WY 2011 and compares loads computed using streamflow-based methods at the three stations and turbidity-based methods for the two stations with turbidity probes (i.e., CCTB, TCDP). As stated previously, the values presented in this report are preliminary and subject to revision.

6.1 Cold Creek at Teichert Bridge: Suspended-Sediment Load

Form 3 presents WY 2011 daily and annual sediment loads for the Cold Creek at Teichert Bridge (CCTB) gage computed by the two different methods. The relationship between streamflow and suspended-sediment load is shown in **Figure 9.** The relationship between turbidity and SSC is shown in **Figure 10.** Daily suspended-sediment load using each method is graphically compared in **Figure 11**.

We identified two distinct relationships in the streamflow-to-suspended-sediment data which suggests that the early, intense rainfall in October supported a separate rating curve (see **Figure 9**), likely due to rainfall on bare soil. Data collected after this event and associated with snowmelt suggests suspended-sediment loads were lower at similar streamflows. The relationships derived in Figure 9 were applied to the record of streamflow where appropriate to calculate a record of suspended-sediment load.

In WY 2011, we estimate annual suspended-sediment loading in the Cold Creek subwatershed to be 710 tons (56 tons/ sq. mile) using the streamflow-based suspended-sediment rating curve, with a maximum daily load of 103 tons on October 24, 2010. In comparison, using the continuous record of turbidity, we estimate the annual suspended-sediment loading to be 508 tons (40 tons/ sq. mile) with the same computed maximum daily load of 103 tons October 24. A comparison between the two methods suggests that the continuous record of turbidity captures peaks in sediment loading unrelated to changes in streamflow. These may be associated with, but not limited to: streambank failures, construction activities, in-stream disturbances or illegal discharges. In contrast, the streamflow-based approach computes higher suspended-sediment loads during peak snowmelt. Langlois and others (2005) have studied the relationship between stream discharge and SSC in snowmelt-dominated systems of on the Nevada (eastern) side of Lake Tahoe and found that the relationship differs during the rising and falling limbs of the snowmelt-dominated hydrograph. Because of this 'hysteresis' effect, they concluded that streamflow-based sediment rating curves are poor predictors of suspended-sediment dynamics in the snowmelt-dominated streams of the region. It should be noted, however, that Cold Creek is underlain by differing geology and has been subjected to different land-uses relative to the east side of Lake Tahoe, and may have different suspended-sediment dynamics. Our observations and the turbidity record in Cold Creek during the peak snowmelt do suggest that actual suspended-sediment loading may be lower than the 710 tons predicted for WY 2011 by the streamflow-based rating curve. Continued monitoring should allow us to refine this preliminary conclusion.

6.2 Donner Creek above Highway 89: Suspended-Sediment Load

The Donner Creek at Highway 89 gaging station operated by the USGS is not equipped with a continuous-logging turbidity meter. **Form 4** presents WY 2011 daily and annual suspended-sediment load using a streamflow-to sediment-discharge rating curve, as shown in **Figure 12.** Daily suspended-sediment load is graphically illustrated in **Figure 13**.

We note that we were authorized in May 2011 to begin suspended-sediment sampling and analysis at this station. As a result, we were unable to evaluate how relationships between streamflow and suspended-sediment loads differed during the previous October (2010), as was observed at Cold Creek. Although we have used the data collected to compute an annual record of suspended-sediment load, in the absence of early WY 2011 data, we suspect the current relationship may underpredict sediment loads for the first half of WY 2011. However, the data collected in the latter half of the water year allowed us to identify two preliminary relationships between streamflow and suspended sediment load which suggest that suspended-sediment loads at this station increase at a greater rate when streamflow exceeds approximately 300 cfs (see **Figure 12**). This may be the result of greater runoff connectivity within the watershed facilitating sediment transport from greater distances to the creek channel.

We also note that Donner Creek is a regulated stream. Annual releases from Donner Lake Dam in excess of 100 cfs were observed in October of WY 2012. These discharges are typically characterized by clear water or water with limited suspended-sediment loads. Current relationships may not accurately capture sediment loads during periods of regulated releases and, in fact, may over-estimate loads based on our observations. Future observations and sampling should improve our understanding of how suspended-sediment loads vary seasonally in Donner Creek. The relationships derived in Figure 12 were therefore applied to the record of streamflow on a preliminary basis to calculate the WY 2011 record of suspended-sediment load.

In WY2011, we estimate the annual suspended-sediment load in Donner Creek at Highway 89 to be 804 tons (50 tons/ sq. mile), with a maximum daily load of 70 tons on June 29, 2011, coincident with peak snowmelt. In the absence of a continuous record of turbidity, no comparative calculation of sediment loading was made for this station.

6.3 Trout Creek at Donner Pass Road: Suspended-Sediment Load

Form 5 presents the calculated daily and annual sediment loads at the Trout Creek at Donner Pass Road station for partial WY 2011 (January 21 – September 30, 2011), according to the two different methods. The streamflow-to-suspended-sediment load rating curve is shown in **Figure 14.** The turbidity-to-suspended-sediment concentration rating curve is shown in **Figure 15.** Daily suspended-sediment loads calculated using each method are graphically compared in **Figure 16**.

For partial WY 2011, we estimate annual suspended-sediment loading in Trout Creek at 167 tons (36 tons/ sq. mile) using a standard streamflow-to-suspended-sediment rating curve, with a maximum daily load of 5.2 tons on April 21, 2011. In comparison, total loading is calculated to be much lower - 52 tons (11.3 tons/ sq. mile) - using the continuous record of turbidity, with a maximum daily load of 5.5 tons on April 3, 2011. Comparing the two methods at this station is difficult due to periods of erroneous data in the turbidity record. For instance, we were only able to report daily turbidity for 178 days out of 365 days. However, we again note that the turbidity record captured discrete events unrelated to streamflow. Future monitoring should provide a better understanding of sediment-streamflow relations in this more urbanized tributary to the Middle Truckee River.

6.4 Comparison of normalized suspended-sediment loads between stations, WY 2011

Figure 17 compares suspended-sediment loads between stations and on a monthly basis for the comparable period of record (February –September 2011). Loads shown in Figure 17 are normalized by watershed areas, and use streamflow-based rating curves for comparison of all three stations. As mentioned earlier, suspended-sediment sampling at Donner Creek at Highway 89 (DC89) was only initiated in May 2011, so computation of monthly and annual sediment loads for this station are based on only a limited number of samples (n = 11). Similarly, we have applied a uniform rating curve to the streamflow record, including periods of releases from Donner Lake in August and September, potentially over-estimating loads during these periods.

When sediment loading is normalized, two major points can be concluded from Figure 17:

- As is typical with streamflow-based rating curves peak, peak monthly sediment loads are concurrent with peak monthly snowmelt (April for Trout Creek; June for Cold Creek and Donner Creek; and

- Although no single tributary shows consistently higher monthly sediment yields for the period of record compared, Cold Creek exhibits a higher total load (47 tons/ sq. mile) than Trout Creek (36 tons/ sq. mile), followed by Donner Creek at Highway 89 (25 tons/ sq. mile). The low value for the latter station, which also includes the Cold Creek Watershed, reflects the fact that a substantial fraction of the sediment from the 14.3-square mile upper watershed is trapped and stored in Donner Lake.

7. COMPARISON OF WY2011 SUSPENDED-SEDIMENT LOADS WITH TMDL BENCHMARKS AND HISTORICAL DATA

In this chapter we utilize 15-minute, continuous records of streamflow and turbidity to compute suspended-sediment load durations for WY 2011, and compare these values to the benchmark load limit of 25 mg/L as established under the TMDL for the Middle Truckee River (Amorfini and Holden, 2008), as described above in Section 1.4 (Prior Work). We note that the benchmark for the Truckee River was established by the RWQCB and based on a literature review and guidelines to protect aquatic life. The RWQCB identified 25 mg/L as the lowest found in the range of data evaluated and used as a basis to protect juveniles, larvae, and eggs. This value is also expressed as an annual 90th percentile value; therefore, up to 10 percent of the data could fall above this benchmark and still be within the benchmark limit. The 90th percentile was chosen because it allows for seasonal or short-term variability while still fully supporting aquatic life beneficial uses under USEPA policy (Amorfini and Holden, 2008).

Because the benchmark limit is expressed as a concentration (mg/L) a comparison between tributaries is facilitated by converting concentrations into suspended-sediment loads expressed in daily loads (tons/day) or annual loads (tons). This conversion is executed for each tributary by first converting 15-minute turbidity (NTU) into SSC (mg/L) and then multiplying each value by the corresponding 15-minute streamflow (cfs).

We also compare WY 2011 streamflow-to-suspended-sediment rating curves with historical rating curves (McGraw and others, 2001) for the two watersheds where data are available for comparison (i.e., Donner Creek and Trout Creek) to identify any changes in the relationship between streamflow and suspended-sediment load, as shown by a "shift" in the suspended sediment rating curve. Because changes in SSC with time may result from landscape processes or human disturbances in a watershed (Warrick and Rubin, 2007), suspended sediment rating-curves are perhaps the best tool for establishing sediment baselines prior to restoration or BMP implementation and for assessing the change in fine sediment supply as restoration activities and BMPs are implemented (Hecht, 2008). As sediment supply within in a watershed diminishes, SSC at a given streamflow will also diminish. Therefore, tracking changes in the relationship between suspended sediment loads and streamflow allows for an evaluation of restoration or BMP effectiveness at a cumulative watershed scale.

Finally, we normalize WY 2011 suspended-sediment loads from the three tributaries by runoff volume and by watershed area to facilitate comparisons between subwatersheds and also to available historical data.

7.1 Cold Creek at Teichert Bridge: Suspended-Sediment Loading in WY 2011

Figure 18 illustrates a suspended-sediment load duration curve for Cold Creek using the continuous 15-minute record of turbidity from WY 2011. Benchmark load limits for the Truckee River are also illustrated. In general, we can draw the following four conclusions from these data:

- Generally, suspended-sediment loading increases with lower frequency events (higher streamflows) in Cold Creek, but may vary by more than two orders of magnitude at a given streamflow;

- 15-minute loading rates ranged between < 0.001 tons/ day and 869 tons/ day in WY 2011, over the range of streamflow recorded;

- 1.3 percent of the WY 2011 turbidity data for Cold Creek exceeded the 25 mg/ L benchmark limit for the Middle Truckee River, indicating that Cold Creek suspended-sediment loads were below the TMDL benchmark limit for WY 2011;

- WY 2011 suspended-sediment loads in Cold Creek that exceeded TMDL benchmarks were ephemeral and mostly associated with rainfall on bare ground (no snowpack).

Historical streamflow and suspended-sediment data are not available for Cold Creek. In the absence of specific data, we compare WY 2011 data for Cold Creek to current and historical data collected for the Donner Creek at Highway 89 gage (which includes Cold Creek).

7.2 Donner Creek at Highway 89: Suspended-Sediment Loading in WY 2011

Figure 19 illustrates a suspended-sediment load duration curve for Donner Creek at Highway 89 (DC89) using the streamflow-based sediment load rating curve. The benchmark load limit established for the Truckee River is also illustrated. A continuous record of turbidity is unavailable for this location. Based on the streamflow-based sediment rating curve, suspended-sediment loading in Donner Creek in WY 2011 was well below the established benchmarks. It should be noted that in the absence of a continuous record of turbidity, discrete loading events unrelated to streamflow cannot be identified. Similarly, the range of load variability cannot be evaluated.

Figure 20 presents a historical streamflow-based sediment load rating-curve for Donner Creek at Highway 89 together with the WY 2011 data. Although the WY 2011 suspended-sediment samples only represent a partial water year (May 5 –September 30, 2011), they suggest that sediment loading in Donner Creek is currently lower at most streamflows as compared to rates observed in the past. However, this conclusion is provisional as the WY 2011 data is preliminary and data collection did not extend over an entire water year.

7.3 Trout Creek at Donner Pass Road Suspended Sediment Loading in WY 2011

Figure 21 illustrates a suspended-sediment load duration curve for Trout Creek using a turbidity-based sediment rating curve. The benchmark load limit established for the Truckee River is also illustrated. We draw four main conclusions from Figure 21:

- Suspended-sediment loading increases with lower frequency events (higher streamflows) in Trout Creek, but may vary by as much as two orders of magnitude at any given streamflow, depending on storm and runoff characteristics;

- 15-minute sediment loading rates ranged between <0.01 and 17.3 tons per day in WY 2011 over the range of streamflows measured;

- 2.7 percent of the WY 2011 data for Trout Creek exceeded the 25 mg/ L benchmark load limit, indicating that Trout Creek suspended-sediment loads were still below the TMDL benchmark limit for WY 2011;

- Sediment loading rates that exceeded benchmarks limits were ephemeral and associated with peak snowmelt runoff and a rainstorm on June 5-7, 2011 (1.61 inches, storm total), and;

Figure 22 presents an historical streamflow-based sediment rating curve for Trout Creek together with the WY 2011 data. The recent data suggest significant variability, such that suspended-sediment discharge can range over more than one-order magnitude for a given streamflow; however, this is consistent with the historical data. The WY 2011 data also suggest little change when compared to historical data. However, these data are preliminary and limited (n = 19) and additional data should be collected and analyzed before drawing any firm conclusions.

7.4 Discussion of Suspended-sediment Loads from Different Years

McGraw and others (2010) and Amorfini and Holden (2008) reported estimated annual suspended-sediment loads from ten major tributaries of the Middle Truckee River. Pertinent to this study, these reports included loads for Donner Creek and Trout Creek from water years 1996, 1997, 2003 and 2004. Some effort was required to compare the differences between historical data and the WY 2011 data collected in this study. We briefly discuss these efforts and findings below.

First, we note that since the 1990s, significant changes in computing and analytical methods have allowed for collection of larger data populations and broader synthesis. For instance, historical sediment loads for the Middle Truckee River were computed using daily average values, whereas we now typically collect data and compute flow and sediment loads in 15-minute intervals. Computation of annual sediment loads using daily averages could potentially underestimate annual loads because they exclude the influence of peak flow events. However, in WY 2011, we found no significant differences between loads calculated using daily-average values compared with loads calculated using 15-minute values.

Second, historical annual sediment-loads were normalized by watershed area (McGraw and others, 2001). However, this approach assumes continuity of runoff and sediment loads through each watershed, a potentially problematic assumption when applied to Donner Creek. Donner Lake and operations of the Donner Lake Dam likely trap much of the suspended sediment emanating from the 14.3 square miles of upper watershed, a significant fraction of the reported 30-square mile Donner Creek watershed. Hence, the loads reported in McGraw and others (2001) are likely derived from a smaller watershed area of about 15.7 square miles, of which 12.6 square miles comprises the Cold Creek tributary. As a result, we highlight that average suspended-sediment loads for Donner Creek when normalized by area may be higher than reported by McGraw and others (2001). For example, using a revised watershed area of 15.7 square miles, the 1996 normalized loads would increase from 83 tons/ sq. mile to 158 tons/ sq. mile, and the 1997 normalized loads would increase from 100 tons/ sq. mile to 191 tons/ sq. mile.

Third, historical sediment loads for Trout Creek were based on synthesized records of flow; more specifically, correlation with mean daily flows in Sagehen Creek near Truckee (USGS 10343500). Although Sagehen Creek has an extensive period of record, its watershed location and characteristics are significantly different from Trout Creek. For example, Sagehen Creek has a higher average watershed elevation (7,100 feet) as compared to the Trout Creek watershed (6,480 feet), which typically results in varying hydrologic processing including precipitation depth, and the volume and timing of snowmelt runoff. Also, the Sagehen Creek watershed is largely forested while the Trout Creek watershed includes significant areas of residential and urban land uses. The effects of urban land uses on hydrologic processes, including timing, magnitude, and frequency of flows, are well documented in the literature (c.f. Bledsoe and Watson, 2001, Booth, 1991). Thus, we might suspect that correlating Trout Creek streamflows with the record from a less-urbanized watershed, as reported by McGraw and others (2001) and Amorfini and Holden (2008), might introduce some error into their calculations of suspended-sediment loads, and that collecting continuous streamflow and turbidity data directly from Trout Creek (as in this study) could provide better insight into actual suspended-sediment loading. This is simply to say that comparisons of the WY 2011 data collected as part of this study with historical data should be interpreted with caution.

Furthermore, comparisons between WY 2011 data and historical data should be considered in the context of possible land-use changes or recently-implemented best management practices (BMPs). The most prevalent examples might be the increased capture of road-sand in recently constructed sediment basins along major highways, or increased street-sweeping efforts by both state and local governments. In fact, the Town of Truckee reported a recovery rate of 63 percent of applied road-sand in WY 2010, the most recent year for which data were available (Town of Truckee, 2011)

Finally, comparison of annual sediment loads should be discussed in the context of year-type (e.g., dry, average, wet) and the characteristics of any major hydrologic events occurring in the years used for comparison. For instance, McGraw and others (2001) reported WY 1996 as a wet year with over 210 percent of average precipitation and a peak flow that coincided with peak snow-melt in the Middle Truckee Basin. In contrast, WY 1997 was an average year with 100 percent of average precipitation but the year included an extreme event on January 3, 1997 that resulted some of the largest peak flows on record for the Truckee region. This is significant as McGraw and others (2001) noted many storm-triggered landslides in tributaries to the Middle Truckee River as a result of this event. Although no sediment samples were reportedly collected during this storm, the effects of the storm likely increased sediment supply to the Middle Truckee River for a period of weeks or possibly months after this event.

The USGS (1998) has emphasized that because geologic properties, climatic conditions, and geomorphic and hydrologic processes are highly variable in space and time, suspended-sediment concentration-to-turbidity, or suspended-sediment concentrations-to-streamflow relations should be based on local, frequent sample collection and, if possible, on multi-year data sets. Therefore, we present these comparisons with the above discussion in mind and note that data presented in WY 2011 is the first installment of just such a multi-year study. Future comparisons between water years and of contemporary data to historical data sets will likely result in fresh insights and more definitive conclusions.

7.4.1 Donner Creek and Cold Creek: Comparison with historical annual flow and suspended-sediment loads

Comparative current (WY 2011)and historical annual flow statistics and suspended-sediment loads for Donner Creek are provided in **Table 9**. The historical data are those from WY 1997 and WY 2004, as reported by Amorfini and Holden (2008). From Table 9, we can conclude the following:

- Annual runoff volume is reflective of year-type (dry, average, wet): WY1997 (average year, 84,679 acre-feet), WY 2004 (dry year, 39,546 acre-feet), and WY 2011 (wet year, 101,308 acre-feet);

- In contrast to runoff volumes, annual suspended-sediment loads do *not* correlate well with year-type and ranged from 380 tons (dry year, WY2004), to 804 tons (wet year, WY 2011) and 2,253 tons (average year, WY1997);

- When suspended-sediment loads are normalized by runoff volume or watershed area, Donner Creek exhibited 3 to 6 times more loading in WY 1997, relative to WY 2004 and WY 2011.

As emphasized earlier, the differences in suspended-sediment loads between years may be attributed to characteristics of hydrologic events occurring in those years. For instance, landslides (large sediment sources) in the Truckee River Basin as the result of the January 2, 1997 flood were documented by McGraw and others (2001). Large landslides or streambank failures can be a chronic source of sediment until the source is eroded by streamflow or stabilized by vegetation. Separately, River Run Consulting (2007) documented significant channel movement and streambank erosion in Cold Creek, a tributary to Donner Creek, as a result of the 1997 event.

Table 10 compares WY 2011 annual flow statistics and suspended-sediment loads in Cold Creek with Donner Creek at Highway 89(which includes Cold Creek), in an effort to differentiate the source areas of suspended-sediment loads. In this case, both sediment loads are computed using only streamflow-based sediment rating curves. When normalized by watershed area, we find that in WY 2011, Cold Creek exhibited a normalized suspended-sediment load equal to Donner Creek at Highway 89 (56 tons/ sq. mile vs. 54 tons/ sq. mile). Since this Donner Creek station includes both Donner Lake (a sediment trap) and the Cold Creek tributary in its watershed, a major proportion of the sediment load appears to have originated in the Cold Creek subwatershed.

To further assess this possibility, we estimated the suspended-sediment load originating from Donner Creek below Donner Lake but excluding Cold Creek at 30 tons/ sq. mile (see Table 10). This estimate is based on the following assumptions: a) Donner Lake traps nearly 100 percent of the suspended sediment that originates from the 14.3 square mile upper portion of the total 29.1 square mile Donner Creek watershed, and; b) the 94-ton difference in annual suspended-sediment loads measured at the Donner Creek at Highway 89 station and the Cold Creek at Teichert Bridge station originates from the 3.1-square mile watershed area below Donner Lake.

In the absence of site-specific data, River Run Consulting (2007) concluded that most, if not all, of the suspended-sediment loads calculated for Donner Creek at Highway 89 originated from Cold Creek. This report further concluded that on a per unit-area basis, Cold Creek is one of the three principal sediment-producing streams in the Middle Truckee Basin. The fact that these conclusions were based on an assessment of watershed conditions and data from the same year as the 1997 flood lend them merit. However, the WY 2011 data suggest that another significant portion of the suspended-sediment load originates from the Donner Creek mainstem watershed extending from below Donner Lake Dam downstream to the confluence of the Truckee River. The reasons for this may be related to one or more of the following factors:

1) Donner Creek below Donner Lake includes a number of stormwater outfalls and also receives direct runoff from urban areas, and highways I-80 and 89;

2) Donner Creek below Donner Lake is a lower elevation area with fewer opportunities for interception of precipitation and runoff. Runoff originating from both rain and snowmelt have greater connectivity with the main channel and can transport urban sediment inputs; and

3) Donner Creek below Donner Lake was relocated in the 1950s to accommodate construction of I-80. The existing engineered channel has limited access to its former floodplain where suspended sediment was naturally stored.

This discussion highlights the importance of site-specific monitoring and use of continuous turbidity probes to facilitate computation of suspended-sediment loads. Related recommendations for improved monitoring in Donner Creek, based on the results of the first year of monitoring, are described in Chapter 8, below.

7.4.2 Trout Creek: Comparison with historical annual flow statistics and suspended-sediment loads

Table 11 compares historical and WY 2011 annual flow statistics and suspended-sediment loads for Trout Creek. Based on the results shown in Table 11, we can conclude the following:

- Despite having only a partial record for WY 2011 (January 21 through September 30, 2011), the measured suspended-sediment load for this period (167 tons) was much higher than in either WY 1997 (61 tons) or WY 2004 (21 tons);

- The total runoff volume in Trout Creek for this period in WY 2011 (6,777 ac-ft) was also higher than that estimated in WY 1997 (5,809 ac-ft) and WY 2004 (3,002 ac-ft);

- When suspended-sediment loads are normalized by runoff volume, sediment loads are similar across all years (0.01 tons/ acre-feet);

- When suspended-sediment loads are normalized by watershed area, suspended-sediment loads in WY 2011 (13 tons/ sq. mile) were similar to those estimated for WY 1997 (12 tons/ sq. mile) but more than three times higher than the WY 2004 estimate (4 tons/ sq. mile).

We should acknowledge that the conclusions for Trout Creek are preliminary and comparison to historical data is problematic as the historical sediment loads for this stream were based a synthetic record of flow, which has a higher risk of errors (see Section 7.4 above), and because the WY 2011 data represents only a partial water year. Further data collection should result in more robust analyses and comparisons between years.

8. FUTURE MONITORING

Balance continues to operate and maintain the gaging stations on Cold Creek and Trout Creek in WY 2012 and will continue to collect suspended sediment data at the USGS-operated Donner Creek at Highway 89 station.

In WY 2012, Balance and TRWC have agreed to augment our collection of suspended-sediment data by monitoring Donner Creek further downstream near the confluence with the Middle Truckee River. This additional location was identified to address observed turbidity from multiple stormwater outfalls below Highway 89. Working with the Town of Truckee, Balance is using GIS to evaluate the contributing areas and estimate increases in flow and sediment transport associated with these stormwater outfalls.

In addition, Balance and TRWC have agreed to upgrade the existing Balance-operated gaging stations to allow conditions to be monitored real-time via the internet. Both the TCDP and CCTB stations will be upgraded with a modem and cellular connection in WY 2012. Conditions, including stage, streamflow, and turbidity will be updated hourly and displayed on public-access web pages under www.balancehydro.com. We anticipate real-time data will be available beginning in April 2012.

In addition, Balance has the following suggestions for improving the monitoring program:

1. Making observations and collecting suspended-sediment samples in Donner Lake below Donner Lake Dam and in Donner Creek at Highway 89 during regulated releases (September, October and November) to address uncertainties in streamflow-related turbidity during this period;

2. Initial observations and sampling in Donner Creek at the West River Street Bridge suggest higher turbidity as compared to Donner Creek at Highway 89. Turbidity may also occur in discrete events unrelated to increases in streamflow. Future monitoring at this location may benefit from a continuous logging turbidity meter.

3. Strategic and more focused monitoring will allow for better evaluation of the nature of suspended-sediment variability in Trout Creek (i.e. during rising and falling limbs, rain on snow, rain on ground, snowmelt between storms, snowmelt with rain, etc.)

9. LIMITATIONS

This report was prepared in general accordance with the accepted standard of practice existing in Northern California at the time the investigations were performed. No other warranty is made or implied.

Funding for this project has been provided in full or in part through an agreement with the State Water Resources Control Board (SWRCB). The contents of this document do not necessarily reflect the views and policies of the SWRCB, nor does mention of trade names of commercial products constitute endorsement or recommendations for use.

Readers are asked to contact us if they have additional relevant information, or wish to propose revisions or modified descriptions of conditions, such that the best data can be applied at the earliest possible date.

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FORMS

Water Year:	**2011**
Stream:	Cold Creek
Station:	at Teichert Bridge
County:	Nevada County, California

Form 1. Annual Hydrologic Record, WY2011

Station Location Map

Station Location / Watershed Descriptors

Location: 39º 19' 13.1"N, 120º 13' 36.7"W (WGS84), in Truckee, California. Gage is located approximately 1,500 feet upstream from the confluence with Donner Creek.
Land use includes former quarrying, timber harvesting, open space, Union Pacific RR, Caltrans road maintenance area and rural residential; Flows are unregulated; no diversion are known to occur upstream, Drainage area is 12.6 square miles.

Mean Annual Flow

Mean annual flow for WY2011 is 60 cfs.

Peak Flows (WY2011)

Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)	Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)
10/24/10	18:45	5.25	350	5/24/11	23:30	4.15	196
4/18/11	4:45	3.88	171	6/14/11	20:30	5.52	407
5/6/11	20:45	4.68	268	**6/22/11**	**19:15**	**5.73**	**447**
5/13/11	20:15	4.67	266	6/29/11	7:30	5.28	367
				07/02/11	21:00	5.05	328.62

Extreme for period of record (WY2011) is 447 cfs on June 22, 2011.

Period of Record

Staff plate, turbidity probe, and water level recorder were installed on October 8, 2010.
Gaging is sponsored by the Truckee River Watershed Council

WY 2011 Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1		7.0	7.0	22.6	19.8	12.2	40.9	85.6	93.4	216.6	43.2	3.4
2		6.1	7.3	21.2	19.4	14.7	57.4	94.6	83.2	233.0	37.1	3.2
3		5.7	11.4	20.4	18.7	15.3	65.3	117	78.7	227.8	31.8	3.0
4		5.4	10.3	19.6	18.1	13.3	62.3	135	81.6	227.3	28.1	2.8
5		4.9	11.8	18.5	17.8	12.7	72.5	162	120	219.5	24.5	2.7
6		4.5	18.2	17.6	17.8	13.4	77.4	208	179	227.0	22.0	2.6
7		10.2	14.7	16.8	18.0	13.6	74.6	226	156	224.8	20.3	2.5
8	0.9	12.2	14.5	16.3	18.0	13.1	65.3	206	185	189.1	18.1	2.4
9	0.9	8.8	30.9	15.7	17.4	13.7	58.6	155	218	167.1	16.1	2.3
10	0.9	8.3	63.5	15.4	17.0	14.2	56.1	133	247	140.5	14.5	2.5
11	1.0	7.5	52.7	14.8	16.4	14.8	56.0	147	255	125.7	13.2	2.5
12	1.0	7.0	41.3	14.7	16.0	15.4	56.7	184	256	118.3	12.0	2.7
13	1.0	6.9	33.8	17.8	15.8	16.6	57.1	212	296	108.5	10.7	3.1
14	1.0	8.1	52.8	19.8	16.1	26.1	53.7	223	316	105.3	9.9	5.0
15	1.0	13.1	49.6	17.6	16.7	42.4	53.1	190	331	97.6	9.3	3.3
16	1.0	10.4	39.7	19.1	14.2	59.7	60.0	141	282	91.2	8.4	2.8
17	1.1	8.4	37.1	25.3	14.8	48.5	88.2	116	256	86.7	7.8	2.6
18	1.3	7.6	53.0	24.8	16.4	43.8	149.4	102	252	88.4	7.1	2.5
19	1.1	7.5	101	23.3	17.1	41.0	144.5	94	270	85.3	6.6	2.3
20	1.1	6.7	73.1	22.9	15.9	39.2	142.4	101	277	79.5	6.4	2.2
21	1.0	6.2	55.6	22.5	15.8	36.0	149	130	301	73.8	6.2	2.1
22	1.1	7.5	48.2	22.2	14.7	33.3	118	152	335	70.0	5.8	2.0
23	1.4	5.5	43.0	22.3	14.0	32.4	96.3	158	329	68.8	5.4	1.9
24	152.0	8.0	38.6	21.8	13.8	30.4	93.6	166	273	70.0	5.2	1.8
25	55.5	7.7	35.6	21.5	9.9	30.5	92.1	160	233	63.3	5.1	1.7
26	19.6	7.6	33.8	21.4	13.8	29.5	85.0	128	211	56.1	4.8	1.7
27	11.9	7.5	29.6	21.0	14.7	28.0	84.8	114	231	49.8	4.6	1.6
28	8.9	7.3	28.4	20.6	13.3	27.4	93.0	103	235	47.6	4.4	1.5
29	7.3	6.8	28.4	20.6		27.2	89.4	92.4	297	49.1	4.1	1.5
30	7.0	7.1	24.7	21.3		29.5	83.8	86.6	223	50.1	3.8	1.4
31	8.6		23.1	20.3		34.8		89.9		47.5	3.5	
MEAN	12.0	7.6	35.9	20.0	16.1	26.5	82.5	142	230	120	12.9	2.4
MAX. DAY	152	13.1	101	25.3	19.8	59.7	149	226	335	233	43.2	5.0
MIN. DAY	0.9	4.5	7.0	14.7	9.9	12.2	40.9	85.6	78.7	47.5	3.5	1.4
cfs days	288	228	1112	619	451	823	2476	4413	6900	3705	400	73
ac-ft	571	451	2206	1229	895	1632	4911	8754	13687	7349	793	146

Monitor's Comments

1. Daily mean values are based on 15-minute measurements of stage; several stage shifts have been applied to account for changes in sedimentation (scour and fill) over the course of the monitoring program.
3. Data are subject to revision, should additional measurement or observer account warrant adjustment of the new rating curve.

Water Year 2011 Totals:		
Mean flow	**60**	(cfs)
Max. daily flow	**335**	(cfs)
Min. daily flow	**0.9**	(cfs)
Annual total	**21,489**	(cfs-days)
Annual total	**42,624**	(ac-ft)

Balance Hydrologics, Inc. PO Box 1077, Truckee, CA 96161 phone: (530) 550-9776, Berkeley (Main Office) (510) 704-1000
www.balancehydro.com

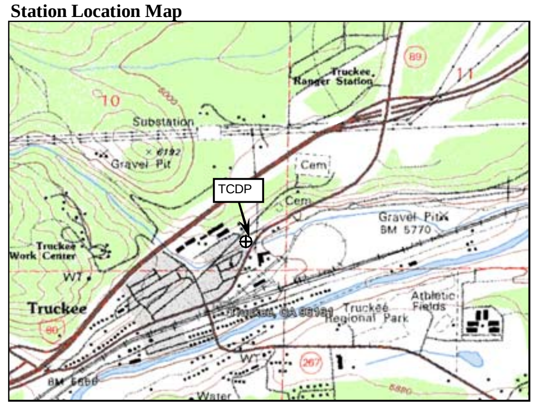
Water Year:	**2011 (partial)**
Stream:	Trout Creek
Station:	Donner Pass Road
County:	Nevada County, California

Form 2. Annual Hydrologic Record, Partial WY2011

Station Location / Watershed Descriptors

Location: 39° 19' 50" N, 120° 10' 55" W (WGS84), near Truckee, California. Gage is located along the north bank of the channel, approxiamtely 150 upstream of Donner Pass Road bridge
Land use includes urban, residential, former quarrying, Interstate Highway 80, and open space.
Flows are unregulated; no diversions are known to occur upstream.
Drainage area is 4.6 square miles.

Station Location Map



Mean Annual Flow

Mean daily flow for partial WY2011 is 14.8 cfs.

Peak Flows (partial WY2011)

Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)	Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)
4/5/11	20:00	4.66	37.3	5/7/11	19:15	5.30	64.8
4/21/11	**18:45**	**5.16**	**69.6**	5/13/11	20:00	5.11	52.3
4/24/11	18:15	4.95	54.4	6/6/11	2:45	5.12	53.7
4/28/11	19:15	5.07	57.8				

Extreme for period of record (partial WY2011) is 69.6 cfs on April 21, 2011.

Period of Record

Staff plate, turbidity sensor and water level recorder were installed on January 21, 2011. Gaging is sponsored by the Truckee River Watershed Council, Prop 50 funding (California State Water Resources Control Board).

Partil WY2011 Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1					5.8	4.4	19	39	23	8.5	3.1	--
2					5.3	5.1	25	43	22	8.1	3.0	1.4
3					5.1	5.6	29	46	20	7.6	2.8	1.5
4					4.8	5.2	29	45	21	7.3	2.8	1.5
5					4.8	4.0	33	47	26	7.3	2.7	1.5
6					4.7	4.6	35	51	46	7.5	2.7	1.4
7					4.8	4.6	32	52	32	7.0	2.6	1.4
8					4.8	4.7	27	50	30	6.2	2.6	1.4
9					4.6	5.2	25	41	28	5.8	2.6	1.4
10					4.5	5.5	24	39	27	5.5	2.6	1.4
11					4.4	6.3	27	39	26	5.2	2.6	1.5
12					4.4	7.0	28	40	24	5.0	2.6	1.8
13					4.4	7.4	27	42	24	4.9	2.6	1.7
14					4.6	8.9	25	42	23	4.8	2.5	1.5
15					4.8	11.7	27	38	21	4.7	--	1.4
16					4.0	13.6	33	31	19	4.4	--	1.3
17					5.2	15.7	40	29	17	4.3	--	1.3
18					7.8	12.4	46	27	16	4.2	--	1.2
19					7.9	11.4	49	25	15	4.2	--	1.2
20					6.9	10.2	57	26	14	4.0	--	1.2
21				4.4	6.3	10.3	63	30	13	3.8	--	1.2
22				4.5	5.8	9.5	51	31	12	3.7	--	1.2
23				4.2	5.2	9.3	44	30	11	3.7	--	1.1
24				4.4	5.1	8.8	46	29	10	3.6	--	1.1
25				4.4	5.4	11.3	47	29	9.2	3.4	--	1.1
26				4.3	5.8	8.9	44	30	8.8	3.2	--	1.1
27				4.2	5.4	9.0	44	25	8.5	3.1	--	1.1
28				4.2	4.8	9.5	48	24	8.0	3.1	--	1.2
29				4.5		10.2	44	25	12.0	3.2	--	1.1
30				4.4		12.3	39	22	9.1	3.2	--	1.0
31				4.1		15.6		22		3.1	--	
MEAN				4.3	5.3	8.6	36.9	35.2	19.2	5.0	2.7	1.3
MAX. DAY				4.5	7.9	15.7	62.7	52.4	45.6	8.5	3.1	1.8
MIN. DAY				4.1	4.0	4.0	19.0	21.7	8.0	3.1	2.5	1.0
cfs days				48	148	268	1107	1092	577	154	38	38
ac-ft				95	293	532	2196	2166	1144	305	75	76

Monitor's Comments

1. Due to construction, this gaging station required temporary relocation for the period 9/2/11 through the end of the water year
2. This station can be affected by ice; the period 2/16/11 through 2/28/11 was estimated using correlation to streamflow at nearby gage
3. Mean daily values are based on 15-minute measurements of stage; several stage shifts have been applied to account for ice and changes in sedimentation at the gage over the course of the monitoring program.
4. Data are subject to revision, should additional measurement or observer account warrant adjustment of the new rating curve.
5. "--" indicates daily data are unavailable as a result of construction activities associated with Trout Creek Restoration

Water Year (partial) 2011 Totals:		
Mean flow	**14.8**	(cfs)
Max. daily flow	**62.7**	(cfs)
Min. daily flow	**1.05**	(cfs)
Annual total	**3469**	(cfs-days)
Annual total	**6881**	(ac-ft)

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www.balancehydro.com

Water Year: 2011
Stream: Cold Creek
Station: at Teichert Bridge (CCTB)
County: Nevada County

Form 3. Annual Suspended-Sediment Load Record WY2011

WY2011 Daily Suspended-Sediment Load *(tons)* Streamflow-based

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	Qss Annual
1	--	0.0	0.0	0.1	0.1	0.0	0.2	0.7	0.8	8.4	0.2	0.0	
2	--	0.0	0.0	0.1	0.1	0.0	0.3	0.9	0.6	10.5	0.2	0.0	
3	--	0.0	0.0	0.1	0.1	0.0	0.4	1.6	0.5	9.6	0.1	0.0	
4	--	0.0	0.0	0.1	0.1	0.0	0.4	2.3	0.6	9.7	0.1	0.0	
5	--	0.0	0.0	0.1	0.1	0.0	0.5	4.0	1.9	8.8	0.1	0.0	
6	--	0.0	0.1	0.1	0.1	0.0	0.5	7.6	4.8	9.6	0.1	0.0	
7	--	0.1	0.0	0.0	0.1	0.0	0.5	9.3	3.4	9.2	0.1	0.0	
8	0.0	0.1	0.0	0.0	0.1	0.0	0.4	7.3	5.6	5.9	0.1	0.0	
9	0.0	0.0	0.1	0.0	0.1	0.0	0.3	3.3	8.6	4.1	0.0	0.0	
10	0.0	0.0	0.4	0.0	0.0	0.0	0.3	2.2	12.3	2.6	0.0	0.0	
11	0.0	0.0	0.3	0.0	0.0	0.0	0.3	3.0	13.0	1.9	0.0	0.0	
12	0.0	0.0	0.2	0.0	0.0	0.0	0.3	5.5	13.1	1.6	0.0	0.0	
13	0.0	0.0	0.1	0.1	0.0	0.0	0.3	8.0	20.0	1.3	0.0	0.0	
14	0.0	0.0	0.3	0.1	0.0	0.1	0.3	8.8	23.8	1.2	0.0	0.0	
15	0.0	0.1	0.3	0.1	0.0	0.2	0.3	5.8	26.2	1.0	0.0	0.0	
16	0.0	0.0	0.2	0.1	0.0	0.3	0.3	2.6	16.9	0.8	0.0	0.0	
17	0.0	0.0	0.2	0.1	0.0	0.2	0.8	1.5	13.0	0.7	0.0	0.0	
18	0.0	0.0	0.3	0.1	0.0	0.2	3.0	1.1	12.7	0.7	0.0	0.0	
19	0.0	0.0	1.1	0.1	0.0	0.2	2.7	0.9	15.4	0.7	0.0	0.0	
20	0.0	0.0	0.5	0.1	0.0	0.2	2.6	1.1	16.2	0.6	0.0	0.0	
21	0.0	0.0	0.3	0.1	0.0	0.1	3.0	2.1	21.3	0.5	0.0	0.0	
22	0.0	0.0	0.2	0.1	0.0	0.1	1.6	3.2	28.3	0.4	0.0	0.0	
23	0.0	0.0	0.2	0.1	0.0	0.1	0.9	3.5	26.5	0.4	0.0	0.0	
24	102.9	0.0	0.2	0.1	0.0	0.1	0.8	4.0	15.7	0.4	0.0	0.0	
25	5.3	0.0	0.1	0.1	0.0	0.1	0.8	3.7	10.1	0.4	0.0	0.0	
26	0.2	0.0	0.1	0.1	0.0	0.1	0.6	2.0	7.7	0.3	0.0	0.0	
27	0.1	0.0	0.1	0.1	0.0	0.1	0.6	1.4	10.3	0.3	0.0	0.0	
28	0.0	0.0	0.1	0.1	0.0	0.1	0.8	1.1	10.4	0.2	0.0	0.0	
29	0.0	0.0	0.1	0.1		0.1	0.7	0.8	19.6	0.2	0.0	0.0	
30	0.0	0.0	0.1	0.1		0.1	0.6	0.7	9.1	0.3	0.0	0.0	
31	0.0		0.1	0.1		0.1		0.8		0.2	0.0		
TOTAL	109	1	6	2	1	3	25	101	368	92	1	0	**710**
Max.day	103	0	1	0	0	0	3	9	28	11	0	0	**103**

WY2011 Daily Suspended-Sediment Load *(tons)* Turbidity-based

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	Qss Annual
1	--	0.0	0.0	0.1	0.0	0.0	0.3	0.4	0.4	4.5	0.2	0.0	
2	--	0.0	0.0	0.0	0.1	0.0	6.4	0.6	0.3	5.3	0.2	0.0	
3	--	0.0	0.1	0.0	0.0	0.0	0.4	1.1	0.3	5.2	0.2	0.0	
4	--	0.0	0.0	0.0	0.0	0.0	0.6	1.7	0.4	5.2	0.2	0.0	
5	--	0.0	0.1	0.0	0.0	0.0	0.8	5.6	1.6	5.0	0.1	0.0	
6	--	0.0	0.1	0.0	0.0	0.0	0.5	11.6	3.4	5.6	0.1	0.0	
7	--	0.0	0.1	0.0	0.0	0.0	0.4	11.5	2.1	4.5	0.1	0.0	
8	0.0	0.0	0.1	0.0	0.0	0.0	0.2	7.7	6.7	3.3	0.1	0.0	
9	0.0	0.0	0.4	0.0	0.0	0.0	0.2	3.2	6.8	2.7	0.1	0.0	
10	0.0	0.0	1.6	0.0	0.0	0.0	0.1	1.3	8.4	2.1	0.1	0.0	
11	0.0	0.0	0.5	0.0	0.0	0.0	0.1	1.4	5.9	1.9	0.1	0.0	
12	0.0	0.0	0.3	0.0	0.0	0.0	0.2	4.4	5.3	1.8	0.1	0.0	
13	0.0	0.0	0.3	0.0	0.0	0.0	0.2	7.9	9.9	1.7	0.1	0.0	
14	0.0	0.0	0.7	0.0	0.0	0.1	0.2	7.9	10.4	1.7	0.1	0.3	
15	0.0	0.0	0.5	0.0	0.0	0.6	0.2	3.3	10.3	1.5	0.1	0.0	
16	0.0	0.0	0.4	0.0	1.1	0.9	0.3	1.0	7.3	1.4	0.2	0.0	
17	0.0	0.0	0.3	0.1	0.1	1.2	1.9	0.7	5.2	1.5	0.1	0.0	
18	0.0	0.0	0.5	0.1	0.0	0.2	6.1	0.6	5.9	1.6	0.1	0.0	
19	0.0	0.0	2.5	0.1	0.0	0.2	2.7	0.5	7.3	1.9	0.1	0.0	
20	0.0	0.0	0.5	0.1	0.0	1.2	2.7	0.7	6.9	2.5	0.1	0.0	
21	0.0	0.0	0.2	0.1	0.1	0.1	1.9	1.3	13.4	1.0	0.1	0.0	
22	0.0	0.0	0.1	0.1	0.0	0.1	0.8	1.5	22.1	0.6	0.2	0.0	
23	0.0	0.0	0.1	0.1	0.0	0.1	0.5	1.6	15.2	0.6	0.0	0.0	
24	93.0	0.0	0.1	0.0	0.0	0.9	0.4	2.0	7.7	0.6	0.0	0.0	
25	7.2	0.0	0.1	0.0	0.1	0.2	0.4	1.7	5.0	0.5	0.0	0.0	
26	0.9	0.0	0.1	0.0	0.0	0.2	0.4	0.8	4.1	0.8	0.0	0.0	
27	0.1	0.0	0.1	0.0	0.0	0.1	0.4	0.7	5.9	0.6	0.0	0.0	
28	0.0	0.0	0.1	0.0	0.0	0.1	0.4	0.5	5.7	0.4	0.0	0.0	
29	0.0	0.0	0.1	0.0		0.1	0.4	0.4	10.8	0.5	0.0	0.0	
30	0.0	0.1	0.1	0.0		0.1	0.4	0.3	4.9	0.4	0.0	0.0	
31	0.0		0.1	0.0		0.2		0.4		0.3	0.0		
TOTAL	101	1	10	1	2	7	30	84	200	67	3	1	**508**
Max.day	93	0	2	0	1	1	6	12	22	6	0	0	**93**

Daily values are based on calculations of sediment discharge at 15-minute intervals.
Sediment discharge, calculated using standard rating curve method, is based on a record of flow; preliminary and subject to revision
Sediment discharge, calculated using a continuous record of turbidity is based on correlation between instantaneous turbidity (NTU) and suspended sediment concentration (mg/L) and converted to tons/day
"--" indicate days where no data are available; prior to gage installation.

Balance Hydrologics, Inc. PO Box 1077, Truckee, CA 96161, (530) 550-9776, Berkeley, CA (main office) (510) 704-1000

Water Year: 2011
Stream: Donner Creek
Station: at Hwy 89 (DC89, USGS 10338700)
County: Nevada County

Form 4. Annual Suspended-Sediment Load Record WY2011

WY2011 Daily Suspended-Sediment Load *(tons)*
Sediment Rating Curve Method

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1	0.6	0.5	0.4	0.6	0.6	0.5	0.7	1.0	0.8	9.1	0.5	0.2	
2	0.7	0.5	0.4	0.6	0.5	0.5	0.8	1.0	0.8	4.6	0.5	0.2	
3	0.7	0.5	0.4	0.6	0.5	0.5	0.8	1.0	0.8	4.6	0.5	0.2	
4	0.7	0.4	0.4	0.6	0.5	0.5	0.8	1.1	0.8	7.4	0.4	0.2	
5	0.7	0.4	0.5	0.6	0.5	0.5	0.9	1.2	0.9	8.6	0.4	0.2	
6	0.7	0.4	0.5	0.5	0.5	0.5	0.9	2.1	5.2	7.7	0.4	0.2	
7	0.7	0.4	0.5	0.5	0.5	0.5	0.9	2.6	4.0	5.8	0.4	0.2	
8	0.7	0.5	0.5	0.5	0.5	0.5	0.9	2.3	3.3	2.8	0.4	0.2	
9	0.7	0.4	0.6	0.5	0.5	0.5	0.9	1.4	4.7	1.7	0.3	0.2	
10	0.7	0.4	0.7	0.5	0.5	0.5	0.8	1.1	6.2	1.2	0.3	0.2	
11	0.7	0.4	0.8	0.5	0.5	0.5	0.8	1.0	6.2	1.1	0.3	0.2	
12	0.7	0.4	0.7	0.5	0.5	0.5	0.8	1.1	9.5	1.0	0.3	0.2	
13	0.7	0.4	0.7	0.5	0.5	0.6	0.8	1.2	24.1	0.9	0.3	0.2	
14	0.8	0.4	0.8	0.5	0.5	0.6	0.8	1.2	40.1	0.9	0.3	0.2	
15	0.8	0.4	0.8	0.5	0.5	0.7	0.8	1.1	41.0	0.8	0.3	0.2	
16	0.8	0.4	0.8	0.5	0.5	0.9	0.8	1.0	26.3	0.8	0.3	0.2	
17	0.8	0.4	0.7	0.6	0.5	0.8	0.9	1.0	12.7	0.8	0.3	0.2	
18	0.7	0.4	0.8	0.6	0.6	0.8	1.3	0.9	10.6	0.8	0.3	0.2	
19	0.7	0.4	1.0	0.6	0.6	0.8	1.6	0.9	12.1	0.8	0.3	0.2	
20	0.6	0.4	0.9	0.6	0.6	0.8	1.6	0.9	15.8	0.7	0.3	0.2	
21	0.6	0.4	0.9	0.6	0.6	0.8	1.8	1.0	25.6	0.7	0.3	0.2	
22	0.6	0.4	0.8	0.6	0.6	0.7	1.4	1.0	43.7	0.7	0.3	0.2	
23	0.5	0.4	0.8	0.6	0.5	0.7	1.1	1.0	52.2	0.6	0.3	0.2	
24	2.3	0.4	0.7	0.6	0.5	0.7	1.1	1.0	40.0	0.6	0.3	0.2	
25	0.8	0.4	0.7	0.6	0.5	0.7	1.0	1.0	18.3	0.6	0.3	0.2	
26	0.7	0.4	0.7	0.6	0.6	0.7	1.0	0.9	7.8	0.5	0.2	0.2	
27	0.7	0.4	0.7	0.6	0.5	0.7	1.0	0.9	10.9	0.5	0.2	0.3	
28	0.6	0.4	0.7	0.6	0.5	0.6	1.0	0.9	13.4	0.5	0.2	0.3	
29	0.6	0.4	0.7	0.6		0.6	1.0	0.8	70.2	0.5	0.2	0.4	
30	0.5	0.4	0.7	0.6		0.6	1.0	0.8	37.4	0.5	0.2	0.6	**Qss**
31	0.5		0.6	0.6		0.7		0.8		0.5	0.2		**Annual**
TOTAL	23	12	21	17	15	20	30	35	545	68	10	7	**804**
Max.day	2	0	1	1	1	1	2	3	70	9	1	1	**70**

WY2011 Daily Suspended-Sediment Load *(tons)*
Continuous Record of Turbidity

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
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													
26													
27													
28													
29													
30													**Qss**
31													**Annual**
TOTAL													
Max.day													

A continuous record of turbidity is not available for this gaging station

Daily values are based on calculations of streamflow at 15-minute intervals as reported by the USGS for station 10338700; streamflow values are provisional and subject to change (USGS)
Sediment discharge calculated using standard rating curve method is based on provisional streamflow data and suspended sediment samples collected in WY2011; preliminary and subject to revision

Balance Hydrologics, Inc. PO Box 1077, Truckee, CA 96161 phone: (530) 550-9776, Berkeley (Main Office) (510) 704-1000
www.balancehydro.com

Water Year:	2011 (partial)
Stream:	Trout Creek
Station:	Donner Pass Road (TCDP)
County:	Nevada County

Form 5. Annual Suspended-Sediment Load Record, Partial WY2011

WY2011 Daily Suspended-Sediment Load *(tons)* Discharge-Sediment Rating Curve Method

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1					0.1	0.0	0.7	2.4	1.0	0.2	0.0	0.0	
2					0.1	0.0	1.1	2.8	0.9	0.2	0.0	0.0	
3					0.2	0.0	1.4	3.2	0.8	0.2	0.0	0.0	
4					0.1	0.0	1.4	3.1	0.8	0.1	0.0	0.0	
5					0.1	0.1	1.8	3.3	1.2	0.1	0.0	0.0	
6					0.1	0.1	2.0	3.8	3.1	0.1	0.0	0.0	
7					0.1	0.1	1.7	3.9	1.7	0.1	0.0	0.0	
8					0.1	0.1	1.3	3.6	1.5	0.1	0.0	0.0	
9					0.1	0.1	1.1	2.6	1.4	0.1	0.0	0.0	
10					0.1	0.1	1.1	2.3	1.3	0.1	0.0	0.0	
11					0.1	0.1	1.2	2.4	1.2	0.1	0.0	0.0	
12					0.0	0.1	1.4	2.5	1.1	0.1	0.0	0.0	
13					0.0	0.1	1.3	2.7	1.0	0.1	0.0	0.0	
14					0.0	0.2	1.1	2.7	1.0	0.1	0.0	0.0	
15					0.1	0.3	1.2	2.3	0.8	0.1	0.0	0.0	
16					0.1	0.4	1.8	1.6	0.7	0.1	0.0	0.0	
17					--	0.5	2.4	1.4	0.6	0.1	0.0	0.0	
18					--	0.3	3.2	1.3	0.5	0.1	0.0	0.0	
19					--	0.3	3.6	1.1	0.5	0.1	0.0	0.0	
20					--	0.2	4.5	1.2	0.4	0.1	0.0	0.0	
21				0.1	--	0.3	5.2	1.6	0.4	0.0	0.0	0.0	
22				0.1	--	0.2	3.7	1.6	0.3	0.0	0.0	0.0	
23				0.1	--	0.2	2.9	1.5	0.3	0.0	0.0	0.0	
24				0.1	--	0.2	3.1	1.5	0.2	0.0	0.0	0.0	
25				0.1	--	0.3	3.2	1.5	0.2	0.0	0.0	0.0	
26				0.1	--	0.2	2.9	1.5	0.2	0.0	0.0	0.0	
27				0.1	--	0.2	3.0	1.2	0.2	0.0	0.0	0.0	
28				0.1	--	0.2	3.4	1.1	0.2	0.0	0.0	0.0	
29				0.1		0.3	2.9	1.1	0.3	0.0	0.0	0.0	
30				0.1		0.3	2.4	0.9	0.2	0.0	0.0	0.0	**Qss**
31				0.1		0.5		0.9		0.0	0.0		**Annual**
TOTAL				0.6	1.2	6.2	67.9	64.3	24.0	2.4	0.4	0.3	**167**
Max.day				0.1	0.2	0.5	5.2	3.9	3.1	0.2	0.0	0.0	**5**

WY2011 Daily Suspended-Sediment Load *(tons)* Continuous Record of Turbidity

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1					--	0.02	1.2	--	0.2	--	0.00	--	
2					--	0.13	3.4	--	--	--	0.03	0.01	
3					--	0.03	5.5	--	0.1	--	0.02	0.01	
4					--	0.02	3.5	--	0.1	--	0.02	0.01	
5					0.02	0.03	4.1	--	0.3	0.1	0.00	0.01	
6					0.03	0.1	0.9	0.9	1.8	0.2	0.00	0.01	
7					0.03	0.0	0.3	0.8	0.3	0.1	0.02	0.01	
8					0.02	0.0	0.2	0.6	0.3	--	0.03	0.02	
9					--	0.1	0.2	0.4	0.3	--	0.00	0.02	
10					--	0.1	0.2	0.4	0.3	--	0.03	0.02	
11					--	0.0	0.2	0.0	0.2	--	0.03	0.04	
12					0.02	0.0	0.2	0.4	--	--	0.03	0.07	
13					0.02	0.1	0.2	0.5	0.2	--	0.03	0.09	
14					--	0.2	0.2	0.8	0.2	0.03	0.02	0.08	
15					--	0.3	0.2	1.0	0.2	--	--	0.02	
16					--	0.3	0.5	1.0	0.2	0.04	--	0.02	
17					--	0.2	0.9	0.3	0.1	0.03	--	0.02	
18					--	0.1	1.2	--	0.1	0.03	--	0.01	
19					--	0.1	1.5	--	0.1	0.03	--	0.02	
20					--	0.1	1.1	0.2	0.2	0.04	--	0.02	
21				--	--	0.1	1.3	0.3	0.1	0.03	--	0.01	
22				--	--	0.1	0.6	0.3	0.1	--	--	0.01	
23				--	--	0.1	0.4	0.4	0.1	0.03	--	0.01	
24				--	--	0.1	0.5	--	0.1	0.04	--	0.01	
25				--	--	0.1	0.5	--	0.1	0.03	--	0.01	
26				--	--	0.1	0.5	0.2	0.0	0.03	--	0.01	
27				--	--	0.1	0.5	0.2	0.1	--	--	0.01	
28				0.01	--	0.1	0.6	0.2	0.1	0.03	--	0.02	
29				0.02		0.1	0.7	0.2	--	0.03	--	0.03	
30				0.05		0.3	--	0.1	--	0.03	--	--	**Qss**
31				0.00		0.6		0.2		0.03	--		**Annual**
TOTAL				0.1	0.1	3.6	31.2	9.1	5.8	0.9	0.3	0.6	**52**
Max.day				0.1	0.0	0.6	5.5	1.0	1.8	0.2	0.0	0.1	**5**

Daily values are based on calculations of sediment discharge at 15-minute intervals.

Periods of missing or erroneous data are indicated by "--"; missing or erroneous data may result from freezing (ice), fogging of the turbidity optical window or debris (e.g., leaf) caught on instrument or extreme low water

Sediment discharge calculated using standard rating curve method is based on a record of flow; as measured by Balance Hydrologics (station TCDP); data are preliminary and subject to revision

Sediment discharge calculated using a continuous record of turbidity is based on correlation between instantaneous turbidity (NTU) and suspended sediment concentration (mg/L) and converted to tons/day

Balance Hydrologics, Inc. PO Box 1077, Truckee, CA 96160, (530) 550-9776, Berkeley, CA (main office) (510) 704-1000
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TABLES

Table 1. Station Observer Log:
Cold Creek at Teichert Bridge (CCTB), water year 2011

Site Conditions				Streamflow			Water Quality Observations					High-Water Marks		Remarks
Date/Time (observer time)	Observer	Stage	Hydrograph	Measured Discharge	Instrument Used	Estimated Accuracy	Water Temperature	Field Specific Conductance	Adjusted Specific Conductance	Turbidity	Additional sampling?	Estimated stage at staff plate	Inferred dates?	
(mm/dd/yr)		(feet)	(R/F/S/B)	(cfs)	(AA/PY)	(e/g/f/p)	(oC)	(µmhos/cm)	(at 25 oC)	(NTU)	(Qbed, etc.)	(feet)	(mm/dd/yr)	
10/15/10 14:25	bkh, ds	0.63	B	0.97	PY	g	11.2	55	75	--	--	--	--	Partly cloudy, 68 degrees. water is clear, some algae in low velocity areas. Some coarse sand @ stilling well since last visit. Turbidity window cleaned at 15:07. Cross section preparation may have artifically increased turbidity readings.
10/24/10 11:30	ds	3.04	R	112	AA	g,f	--	--	--	--	Qss (3)	--	--	Measurement taken 75' downstream of bridge, leaves and small sticks in water, steady rain, cool, 45 degrees. SSC(1) @10:52: taken at bridge with 2 verts. SSC(2) @11:50: taken at Qmeas station with 9 verts and labeled 1245. SSC(3) @12:19: taken at bridge with 9 verts and labeled 1210. GH @ 10:50 = 2.86+/-.04. GH @ 11:06 = 2.92+/-.04. GH @ 11:47 = 3.16+/-.05. GH @ 12:18 = 3.25+/-.05.
10/24/10 16:00	ds	4.62	R	467	FLOAT	p	6.1	18	28	--	Qss (2)	--	--	Steady rain, NWS reporting .5" rain/hour. GH @ 15:35 = 4.5+/-.1, GH @ 16:07 = 4.65+/-.07, GH @ 16:20 = 4.70 +/- .1,
10/25/10 9:08	ds	2.36	R	47.4	AA	e,g	3.7	24	40	--	Qss	--	--	Water relatively clear, light brown tint, 2-3" rain in past 24 hours, cold 32 degrees with scattered snow showers. Estimated peak 10/24/10 at 20:00. GH @ 8:27 = 2.38 +/- .04. GH @ 9:38 = 2.33 +/- .04 . NOTE DATE CHANGED FROM 10/24 to 10/25 (entry error)
10/26/2010 8:45	ds	1.74	R	18.9	AA	e	2.9	28	49	--	Qss	--	--	Weather is cold and clear, patchy fog, approximate peak 10/24/10 at 23:00. water is clear. GH @ 8:12 = 1.75 +/- .02. GH @ 9:09 = 1.74 +/- .02.
11/7/2010 15:12	ds	1.64	R	14.5	AA	e	5.6	33	53	--	Qss	--	--	Steady rain all day, snow level about 6500'. Hydrograph uncertain
12/5/2010 15:44	ds	1.51	U	11.5	PY	g	5.0	36	58	--	--	--	--	Water clear. Thin layer of fines on bottom. Snow down to water. Sunny, warm, about 1-1.5" rain in watershed on snowpack over last 48 hours. Hydrograph uncertain (F or B). PC time 1545, DL time 1645
12/14/2010 10:45	ds	2.46	R	55.8	AA	g	--	--	--	--	Qss (2)	--	--	Rain, heavy at times, snow level 7500'. water level appears to be about 3" below recent high water mark. GH @ 10:00 = 2.42 +/- .03. GH @ 11:08 = 2.48 +/- .03
1/28/2011 14:50	cs, ds	1.84	B	20.4	PY	e	--	--	--	--	Qss	--	--	Water is clear. Sunny and warm. 4 weeks of dry weather preceding visit. Snow still on banks but not in channel. Wiped algal film from turbidity probe window.
2/1/2011 15:00	cs, ds	1.79	B	--	--	--	2.7	32	--	--	--	--	--	GH @ 15:00 +/-.02, reinstalled turbidity probe, moved and drefixed PT's at 14:00,
2/10/2011 14:50	cs	1.77	U	--	--	--	--	--	--	--	--	--	--	Water clear, sunny, 45 degrees, no precip in last week
2/23/2011 12:30	cs, ds	1.76	B	18.6	PY	g	0.5	33	--	--	Qss	--	--	Water is clear. Sunny and 34 degrees. 3' new snow in past week. Willows obstructing flows at stations 4 and 6. Snow on banks down to water, no ice. GH @ 12:00 - 1.8 +/-.02. GH @ 13:05 1.72 +/- .02. Baseflow conditions with diurnal on the way down. PC time 1304, DL time 1401, Watch time 1304
3/10/11, 14:10	cs	1.84	U	--	--	--	3.6	36	61	0.59	Qss	--	--	Rain/wet snow, snow level 6900', high winds all day, about 3' old snow on ground, channel free of ice, water clear. GH@1410=1.84+/-.02, turbidity sensor window cleaned
3/15/2011 10:05	ds, bkh	2.07	R	34.5	PY	g	--	--	--	0.95	Qss	--	--	Mixed precip, 39 degrees, flows elevated, mostly clear, more rain expected today/night, no snow obstructing channel, orange algae in water on REW d/s from steel pipe, snow on banks down to water level. GH @ 9:40 = 2.04+/- .04, GH @ 10:33 = 2.1 +/-.04
4/6/2011 12:40	cs, bkh	2.76	B	75.7	AA	e	4.4	33	54	1.31	Qss	--	--	Sunny, 48 degrees, water clear, no new snow and warm temps in past week, spring melt started, several feet of snow on banks, no ice in channel. Turbidity window wiped at 13:13. GH @ 12:23 = 2.76+/-.04, GH @ 12:55 = 2.76+/-.04

Table 1. Station Observer Log:
Cold Creek at Teichert Bridge (CCTB), water year 2011

Site Conditions				*Streamflow*			*Water Quality Observations*					*High-Water Marks*		*Remarks*
Date/Time (observer time)	Observer	Stage	Hydrograph	Measured Discharge	Instrument Used	Estimated Accuracy	Water Temperature	Field Specific Conductance	Adjusted Specific Conductance	Turbidity	Additional sampling?	Estimated stage at staff plate	Inferred dates?	
(mm/dd/yr)		*(feet)*	*(R/F/S/B)*	*(cfs)*	*(AA/PY)*	*(e/g/f/p)*	*(oC)*	*(µmhos/cm)*	*(at 25 oC)*	*(NTU)*	*(Qbed, etc.)*	*(feet)*	*(mm/dd/yr)*	
4/18/2011 10:45	ds	3.65	U	172	est	p	--	--	--	7.46	Qss	--	--	GH @ 10:41 = 3.65+/-.05, GH @ 10:57 = 3.65+/-.05, flow estimated
5/5/2011 12:45	cs, bkh	3.45	U	132	AA	e	6.4	29	45	1.5	Qss	--	--	Sunny, warm, breezy, 65 degrees, water clear, willows beginning to bud, no snow on banks, lots of snow left in upper watershed, water pillowing up against staff plate. GH @ 1231 = 3.45+/- .05, GH @ 1305 = 3.45+/-.05.
5/27/2011 12:55	cs	3.26	U	107	AA	e	--	--	--	0.2	Qss	--	--	Overcast, breezy, 50 degrees, water clear. Willows putting on leaves. Water surging at staff plate, which could cause error in readings. Significant amount of moisture inside campbell datalogger box. Desiccant removed for dehydration. Flags left for Cindy at 2 locations at 13:45. GH @ 12:35 = 3.26 +/- .06, GH @ 13:20 = 3.26 +/- .06
6/6/2011 13:00	cs, bkh	3.88	U	170	AA	e	--	--	--	1.5	Qss	--	--	Cool, overcast, windy, 1" snow overnight, 42 degrees, heavy rain last night turned to snow by morning, water mostly clear, willows starting to bud/leaf. GH @ 12:10 = 3.88 +/- .01, GH @ 12:45 = 3.88 +/- .01, GH @ 13:15 = 3.88 +/- .01
6/14/2011 11:45	cs, bkh	4.55	U	251	AA	g	--	--	--	5.4	Qss	--	--	Sunny, warm, 70's, peak snowmelt beginning, water moderately turbid, bedload moving, difficult to measure velocity, coarse organic material in suspension, willows leafed out in last 7 days. GH @ 11:@0 = 4.5 +/- .1, GH @ 12:00 = 4.55 +/- .15, GH @ 12:30 = 4.55 +/- .1, GH @ 13:00 +/- .10
6/15/2011 15:45	cs	4.90	U	--	--	--	--	--	--	--	--	--	--	Warmest day of the season, peak snowmelt taking place today. water changed from green to brown around 15:00
6/16/2011 20:20	cs	4.90	R	--	--	--	--	--	--	11	Qss	--	--	Peak runoff may have occurred overnight last night. Daily temps cooler than previous days and skies were overcast. Sample collected using DH from bank near probes. GH @ 20:25 = 4.9 +/- .1
6/23/2011 14:45	cs, bkh	5.00	R	351	AA	f	6.9	19	29	18	Qss	--	--	Warm, windy, 72 degrees, unable to wade thalweg. Collecting direct velocity and depth measurements on both LB and RB. Water turbid, organics in suspension. Use hydraulic geometry to get center velocity. GH @ 14:28 = 4.9 +/-.1, GH @ 14:45 5.0 +/- .1, GH @ 1500 = 5.1 +/- .1
7/15/2011 11:30	ds	2.90	B,F	84.3	AA	e	7.8	22	32	2.9	Qss	--	--	Water clear, sunny, warm, diurnal rising. GH @ 11:12 = 2.89 +/- .04, GH @ 12:00 = 2.92 +/- .04
8/5/2011 11:45	bkh	1.82	B	25.1	PY	g	--	--	--	0.3	Qss	--	--	Sunny, embedded substrate. GH @ 11:23 = 1.82 +/- .02, GH @ 11:58 = 1.82 +/- .02
9/20/2011 16:00	bkh	0.78	B	2.07	PY	g	16.1	52	63	0.5	Qss	--	--	Sunny, turbidity sensor is above current water level. Sensor moved lower at 1630, cleaned window, dirty macroinvert stuck to window. GH @ 1543 = .78, GH @ 1615 = .78

Observer Key: (ds) is David Shaw, (bkh) is Brian Hastings, (cs) is Collin Strasenburgh
Stage: Water level observed at outside staff plate
Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), or baseflow (B)
Instrument: If measured, typically made using a standard (AA) or pygmy (PY) bucket-wheel ("Price-type") current meter. If estimated, from rating curve (R) or visual (V).
Estimated measurement accuracy: Excellent (E) = +/- 2%; Good (G) = +/- 5%; Fair (F) = +/- 9%; Poor (P) estimated percent accuracy given
High-water mark (HWM): Measured or estimated at location of the staff plate
Specific conductance: Measured in micromhos/cm in field; then adjusted to 25degC by equation (1.8813774452 - [0.050433063928 * field temp] + [0.00058561144042 * field temp^2]) * Field specific conductance
Additional Sampling: Qbed = Bedload, Qss = Suspended sediment, Nutr = nutrients; other symbols as appropriate

Table 2. Station Observer Log:
Donner Creek at Highway 89 (DC89), water year 2011
USGS #10338700

Site Conditions				Streamflow	Water Quality Observations					High-Water Marks		Remarks
Date/Time (observer time)	Observer	Stage	Hydrograph	USGS flow	Water Temperature	Field Specific Conductance	Adjusted Specific Conductance	Turbidity	Additional sampling?	Estimated stage at staff plate	Inferred dates?	
(mm/dd/yr)		(feet)	(R/F/S/B)	(cfs)	(oC)	(µmhos/cm)	(at 25 oC)	(NTU)	(Qbed, etc.)	(feet)	(mm/dd/yr)	
5/5/11 13:30	cs, bkh	--	U	290	--	--	--		Qss	--	--	Sample collected using DH-48 on right half of channel
5/27/11 14:45	cs	4.55	U	180	--	--	--	0.21	Qss	--	--	Overcast, breezy, 50 degrees, water clear. Sample collected using DH-48 on right half of channel GH @ 14:45 4.55 +/- .05
6/6/11 14:00	cs, bkh	5.28	U	330	--	--	--	1.63	Qss (2)	--	--	Overcast, breezy, 40 degrees. Heavy rain overnight. Sample collected using bridge board at three cross sections. Collected to 6/10 depth. Water mostly clear. Comparison sample collected using DH-48 from the left and right banks only. Sample time for that sample was 14:14 and turbidity was 2.97 NTU
6/14/11 10:50	cs, bkh	5.74	U	627	--	--	--	4.31	Qss	--	--	Sunny, warm, 70 degrees, approaching peak snowmelt. Water is a murky green color. Lots of suspended organic material present. Sample taken with bridge board at three cross sections. Comparison sample collected using DH-48 from the left and right banks only. Sample time for that was 11:00 and turbidity was 4.17 NTU.
6/16/11 20:35	cs	5.75	U	595	--	--	--	6.58	Qss	--	--	Daytime temps cooler than previous days, overcast skies all day. Sample collected using DH-48 from left and right banks only. GH @ 20:37 = 5.75 +/- .05
6/23/11 15:45	cs, bkh	--	U	763	11.5	42.9	57.7	10.91	Qss	--	--	Sunny, warm, 75 degrees. Water turbid. Peak melt taking place. Sample collected using bridge board at three intervals across channel at 15:45. Sample collected from both sides using DH-48 at 15:52
7/15/11 12:22	ds	4.27	U	159	--	--	--	0.80	Qss	--	--	
8/5/11 12:10	bkh	3.42	U	26.0	--	--	--	0.85	Qss	--	--	

Observer Key: (ds) is David Shaw, (bkh) is Brian Hastings, (cs) is Collin Strasenburgh
Streamflow gaging station operated by USGS; Flow values are provisional, as reported by the USGS for station 10338700
Stage: Water level observed at outside staff plate
Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), or baseflow (B)
High-water mark (HWM): Measured or estimated at location of the staff plate
Specific conductance: Measured in micromhos/cm in field; then adjusted to 25degC by equation (1.8813774452 - [0.050433063928 * field temp] + [0.00058561144042 * field temp^2]) * Field specific conductance
Additional Sampling: Qss = Suspended sediment

Table 3. Station Observer Log:
Trout Creek at Donner Pass Road (TCDP), partial water year 2011

Site Conditions				*Streamflow*				*Water Quality Observations*					*High-Water Marks*		*Remarks*
Date/Time (observer time)	Observer	Stage	Hydrograph	Measured Discharge	Instrument Used	Estimated Discharge	Estimated Accuracy	Water Temperature	Field Specific Conductance	Adjusted Specific Conductance	Turbidity	Additional sampling?	Estimated stage at staff plate	Inferred dates?	
(mm/dd/yr)		*(feet)*	*(R/F/S/B)*	*(cfs)*	*(AA/PY)*		*(e/g/f/p)*	*(oC)*	*(µmhos/cm)*	*(at 25 oC)*	*(NTU)*	*(Qbed, etc.)*	*(feet)*	*(mm/dd/yr)*	
1/21/11 15:35	bkh, cs	4.065	F	4.49	PY		e	1.0	81	148	--	Qss	5	10/24/2010	Site installed. Stage came up .03' in 4 hours. Water clear, sunny and 50 degrees. Flow taken 100' upstream of gauge. GH @ 14:55 = 4.07. GH @ 15:35 = 4.06
1/28/11 11:42	ds	4.045	--	--	--		--	--	--	--	--	--	--	--	Staff plate observation; relocated turbidity probe to staff plate location at 9:00-11:30.
2/1/11 8:39	ds	4.25	--	--	--		--	--	--	--	--	--	--	--	Ice in stilling well and staff plate and building at riffle crest downstream of pts.
2/8/11 9:15	ds	4.06	--	--	--		--	--	--	--	--	--	--	--	Minimal ice
	ds	4.28	--	--	--		--	--	--	--	--	--	--	--	Ice build up at riffle crest, water flowing over ice, see photos
2/12/11 13:18	ds	4.02	--	--	--		--	--	--	--	--	--	--	--	Warm, no ice
2/13/11 16:15	ds	4.04	--	--	--		--	--	--	--	--	--	--	--	No ice except for mimimal snow on right band, downstream of riffle crest. Small fish about 5" seen
2/23/11 14:00	cs, ds	5.20	--	--	--		--	--	--	--	--	--	--	--	Channel covered in ice. Significant enough flow along left bank to prevent ice from building up around probes. Ice cleared from around probes by DS at 13:40. Gauge readings went from 5.0' to 5.18' in 15 minutes.
3/2/2011 13:45	ds	4.01	S	4.33	PY		f	0.7	112	207	--	Qss	--	--	Steady rain,35-40 degrees, snow level 6500-7000 and falling, water turbid, flowing in response to steady rain through am, secchi depth about .5', water milky-gray, some ice floating by, decreasing turbidity during break in rain, not much decrease in stage or Q, turned to snow at 2pm
3/9/2011 8:48	ds	4.075	--	--	--		--	--	--	--	--	--	--	--	Snow on bar u/s of gaging pool, water clear, snowbank on right bank doesn't seem to be affecting rating curve, but possibly could at higher flows
3/10/2011 15:45	cs	4.135	S	6.08	AA		e	1.2	208	378	84.2	Qss	--	--	Rain/wet snow, snow level 6900', water clear at 12:50, precip started around 12:45, water brown at 14:50, precip decreased significantly during sampling, water getting clearer as measurements were taken. Turbidity sensor window cleaned. GH @ 1250=4.1, GH @ 1450=4.14, GH @ 1525=4.14, GH @ 1601=4.13.
3/14/2011 17:30	bkh	4.26	R	--	Visual	4.0	p	0.5	76	141	9.2	Qss	--	--	Moderate showers all day, water slightly turbid to mostly clear, flow estimated at 4 cfs
3/18/2011 9:30	ds	4.31	--	--	--		--	--	--	--	--	--	--	--	GH 4.31+/-.01, no obstructions from ice
4/2/2011 16:07	bkh	4.53	R	29.1	AA		g	0.3	66	123	26	Qss	--	--	Partly cloudy, warm, 50 degrees, last few nights temps have not been below 32 degrees, water moderately turbid, pool at meter too deep to clear turbidimeter. About 3gpm of water entering channel from culvert between gage and measured xs. GH @ 15:55 = 4.52+/-.04, GH @ 16:17 = 4.54+/-.03
4/4/2011 8:30	bkh	4.48	--	--	--		--	--	--	--	--	--	--	--	Stage observations only; water mostly clear
4/6/2011 10:00	cs	4.58	U	--	--		--	--	--	--	--	--	--	--	Sunny, warm, water clear. Turbidity window wiped at 10:07. NTU went from 71 to 3.
4/15/2011 12:45	bkh	4.38	--	--	--		--	--	--	--	--	--	--	--	Water clear, snow melted from gaging station, GH = 4.38+/-.02
4/18/2011 11:58	ds	4.69	F	45.1	AA		g	--	--	--	6.0	Qss	--	--	Light rain, heavy rain overnight, water slightly turbid/greenish tint, no snow/ice, Qest with float test at 9:15, turbidity probe wiped at 11:32, GH @ 9:10 = 4.71+/-.02, GH @ 11:30 = 4.71+/-.04, GH @ 12:11 = 4.69+/-.04
5/3/2011 11:30	ds	4.83	--	--	--		--	--	--	--	--	--	--	--	Water slightly turbid
5/5/2011 11:50	cs, bkh	4.86	U	38.1	AA		e	7.3	67	103	2.5	Qss	--	--	Sunny, warm, breezy, 65 degrees, water mostly clear, willows beginning to bud, lots of sant/silt along roads with no significant rain event yet this spring. Turbidity window wiped at 12:07. GH @ 1130=4.86+/-.02

Preliminary and subject to revision

Table 3. Station Observer Log:
Trout Creek at Donner Pass Road (TCDP), partial water year 2011

Site Conditions				*Streamflow*				*Water Quality Observations*					*High-Water Marks*		*Remarks*
Date/Time (observer time)	Observer	Stage	Hydrograph	Measured Discharge	Instrument Used	Estimated Discharge	Estimated Accuracy	Water Temperature	Field Specific Conductance	Adjusted Specific Conductance	Turbidity	Additional sampling?	Estimated stage at staff plate	Inferred dates?	
(mm/dd/yr)		*(feet)*	*(R/F/S/B)*	*(cfs)*	*(AA/PY)*		*(e/g/f/p)*	*(oC)*	*(µmhos/cm)*	*(at 25 oC)*	*(NTU)*	*(Qbed, etc.)*	*(feet)*	*(mm/dd/yr)*	
5/19/2011 15:00	cs	4.66	--	--	--		--	--	--	--	--	--	--	--	Cleaned algae from turbidity probe, long filamentous algae waving in front of probe.
5/27/2011 11:36	cs	4.68	B	24.7	AA		e	--	--	--	0.7	Qss	--	--	Overcast, breezy, 60 degrees, water clear. Willows putting on leaves, green algae growing on staff plate, all around turbidity probe and rocks. Turbidity window wiped at 12:00. GH @ 11:28 = 4.68 +/- .02. GH @ 11:45 = 4.68 +/- .02. GH @ 12:00 = 4.68 +/- .02.
6/5/2011 23:09	cs	4.82	R	--	--		--	--	--	--	15.5	Qss	--	--	Heavy rain falling at time of sampling, water dirty
6/6/2011 11:27	cs	5.03	U	47.4	AA		e	--	--	--	4.5	Qss	3.95	6/6/2011	Overcast, water slightly turbid. Over 1" heavy rain fell overnight. GH @ 10:52 = 5 +/- .02, GH @ 11:15 = 5.02 +/- .02, GH @ 11:37 = 5.02 +/- .02
6/6/2011 15:10	cs	5.04	U	47.4	AA		e	--	--	--	--	--	--	--	Overcast, water clear. GH @ 14:59 = 5.04 +/- .02, GH @ 15:18 = 5.04 +/- .02
6/14/2011 13:30	cs	4.60	U	23.1	AA		e	--	--	--	2.0	Qss	--	--	Sunny, warm, 70 degrees, water clear, willows full of leaves, filamentous green algae growing on rocks, wiped turbidity window at 13:40, GH @ 13:15 = 4.6 +/- .02, GH @ 13:38 = 4.6 +/- .02
6/23/2011 17:30	cs	4.34	U	11.4	AA		e	16.5	91	110	1.7	Qss	--	--	Sunny, warm, 75 degrees, water clear, willows releasing seeds, no changes in bed since last visit. Cleaned turbidity probe window at 17:42, GH @ 17:15 = 4.34 +/- .02, GH @ 17:40 = 4.34 +/-.02
7/13/2011 16:57	bkh	4.07	B	5.13	PY		g	13.9	106	137	1.0	Qss	4.90	June	Cleaned staff plate and turbidity probe window. Garbage in creek; willows leafed out and overhanging creek
7/29/2011 9:03	bkh	4.00	B	3.06	PY		e	10.1	105	150	1.7	Qss	--	--	Cleaned turbidity probe window; lots of algae along wall and along bed, some particles in suspension

Observer Key: (ds) is David Shaw, (cs) is Collin Strasenburgh, (bkh) is Brian Hastings
Stage: Water level observed at outside staff plate
Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), or baseflow (B)
Instrument: If measured, typically made using a standard (AA) or pygmy (PY) bucket-wheel ("Price-type") current meter. If estimated, from rating curve (R) or visual (V).
Estimated measurement accuracy: Excellent (E) = +/- 2%; Good (G) = +/- 5%; Fair (F) = +/- 9%; Poor (P) estimated percent accuracy given
High-water mark (HWM): Measured or estimated at location of the staff plate
Specific conductance: Measured in micromhos/cm in field; then adjusted to 25degC by equation (1.8813774452 - [0.050433063928 * field temp] + [0.00058561144042 * field temp^2]) * Field specific conductance
Additional Sampling: Qss = Suspended sediment

Table 4. Station Observer Log:
Trout Creek at Jiboom Street Bridge, WY 2011

Site Conditions				***Streamflow***			***Water Quality Observations***					***High-Water Marks***		***Remarks***
Date/Time (observer time)	Observer	Stage	Hydrograph	Measured Discharge	Instrument Used	Estimated Accuracy	Water Temperature	Field Specific Conductance	Adjusted Specific Conductance	Turbidity	Additional sampling?	Estimated stage at staff plate	Inferred dates?	
(mm/dd/yr)		*(feet)*	*(R/F/S/B)*	*(cfs)*	*(AA/PY)*	*(e/g/f/p)*	*(oC)*	*(µmhos/cm)*	*(at 25 oC)*	*(NTU)*	*(Qbed, etc.)*	*(feet)*	*(mm/dd/yr)*	
										--				
9/2/2011 15:15	bkh	7.43	B	1.46	PY	g	--	--	--	2.0	Qss	--	--	Water slightly milky, gage moved to about 25' above Jiboom St., sunny. GH @ 1500 = 7.43, GH @ 1524 = 7.43, GH @ 16:15 = 7.42
9/13/2011 9:15	bkh	7.45	F	2.0	PY	g	10.3	116	165	3.3	Qss	--	--	Water slightly cloudy, about .5" rain overnight, abundant algae on bed, measurement taken about 150' u/s of old gage, GH @ 8:50 = 7.445, GH @ 9:30 = 7.445
9/13/2011 17:00	bkh	7.50	F	2.7	PY	F	--	--	--	17	Qss	--	--	Heavy rain event @ 1615. missing significant inputs from culvert downstream of jiboom bridge. Measurement taken about 100' above jiboom bridge. Readings fair due to rapidly dropping flows. GH @ 1635 = 7.54 +/- .01, GH @ 1640 = 7.52, GH @ 1700 = 7.46
9/20/2011 17:00	bkh	7.40	--	--	--	--	--	--	--	--	--	--	--	Water clear, data offloaded
10/5/2011 9:45	bkh	7.66	U	4.7	PY	g	4.8	149	246	23	Qss	--	--	About .75" rain overnight, snowing. 1' new snow on donner pass, water turbid, lots of organics, GH @ 8:15 = 7.67 +/- .02, GH @ 9:15 = 7.66 +/- .02, GH @ 10:00 = 7.65 +/- .02
10/18/2011 15:00	bkh	7.43	B	1.12	PY	g	7.4	104	160	--	Qss	--	--	Significant leaf fall; possible leaf dams over next couple weeks; water clear, 4-inch fish in pool
10/31/2011 15:00	cs	7.54	B	1.43	PY	f	--	--	--	--	--	--	--	Leaf dams building at riffle crests; download; cleaned turbidity window at 14:00

This is a temporary station that was used during construction and dewatering for the Town of Truckee's Trout Creek Restoration Project (Reach 3)
Observer Key: (ds) is David Shaw, (cs) is Collin Strasenburgh, (bkh) is Brian Hastings
Stage: Water level observed at outside staff plate
Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), or baseflow (B)
Instrument: If measured, typically made using a standard (AA) or pygmy (PY) bucket-wheel ("Price-type") current meter. If estimated, from rating curve (R) or visual (V).
Estimated measurement accuracy: Excellent (E) = +/- 2%; Good (G) = +/- 5%; Fair (F) = +/- 9%; Poor (P) estimated percent accuracy given
High-water mark (HWM): Measured or estimated at location of the staff plate
Specific conductance: Measured in micromhos/cm in field; then adjusted to 25degC by equation (1.8813774452 - [0.050433063928 * field temp] + [0.00058561144042 * field temp^2]) * Field specific conductance
Additional Sampling: Qbed = Bedload, Qss = Suspended sediment, Nutr = nutrients; other symbols as appropriate

Table 5. Suspended-sediment concentration and loading rates: Cold Creek at Teichert Bridge (CCTB), water year 2011

Sample Date:Time	Observer(s)	Gage Height	Streamflow Discharge	Streamflow Value Source	Stream Condition	Suspended-Sediment Concentration	15-minute Turbidity	Suspended-Sediment Transport Rate
	Site Conditions					*Suspended Sediment*		
		(ft)	*(cfs)*	*M,R,E*	*R,F,B,U,S*	*(mg/l)*	*(NTU)*	*(tons/day)*
10/24/10 10:52	ds	2.86	88	R	R	52.00	26.03	12.33
10/24/10 11:50	ds	3.16	112	R	R	95.33	37.74	28.78
10/24/10 12:19	ds	3.25	119	R	R	98.00	43.54	31.43
10/24/2010 15:45	ds	4.55	260	R	R	247.1	104.8	173.1
10/24/2010 16:15	ds	4.68	292	R	R	235.3	112.3	185.2
10/25/10 8:35	ds	2.37	58	R	F	11.14	16.42	1.74
10/26/10 9:10	ds	1.74	19.9	R	F	2.40	10.50	0.13
11/7/10 11:27	ds	1.41	8.30	R	R	1.71	0.70	0.04
12/9/10 14:30	ds	2.09	35.7	R	R	4.00	*1.25*	0.38
12/14/2010 10:15	ds	2.43	55.2	R	R	3.80	3.78	0.57
12/14/2010 11:00	ds	2.47	56.4	R	R	3.00	3.77	0.46
1/28/11 15:10	ds, cs	1.84	21.0	M	B	1.00	0.60	0.06
2/23/11 12:45	ds, cs	1.75	17.5	R	B	1.71	1.05	0.08
3/10/11 14:05	cs	1.84	14.3	R	B	1.20	0.86	0.05
3/15/11 10:25	ds, bkh	2.09	35.0	R	R	4.00	1.58	0.38
4/6/11 12:55	cs, bkh	2.76	76.0	M	B	3.20	1.60	0.66
4/18/11 10:45	ds	3.65	147	E	F	13.60	6.39	5.39
5/5/11 13:00	cs, bkh	3.45	130	M	R	2.60	2.39	0.91
5/27/11 13:15	cs	3.26	110	M	F	1.80	1.18	0.53
6/6/11 12:45	cs, bkh	3.88	176	M	F	4.40	2.76	2.09
6/14/11 12:05	cs, bkh	4.55	254	M	F	17.60	5.14	12.05
6/16/11 20:25	cs	4.90	300	M	R	16.00	6.78	12.94
6/23/11 15:00	cs, bkh	5	287	M	R	40.8	7.93	31.56
7/15/11 11:55	ds	2.9	87.4	M	B	2.6	3.75	0.61
8/5/11 11:30	bkh	1.82	24.0	M	B	0.82	1.33	0.05
9/20/11 16:45	bkh	0.78	2.0	M	B	1.2	1.0	0.01

Notes

Observer Key: ds = Dave Shaw, bkh = Brian Hastings, cs = Collin Strasenburgh

Streamflow is the measured or 15-minute recorded flow when sediment was sampled, and usually differs from the daily streamflow.

Streamflow Value Source: M = measured; R = rating curve; E = estimated

Stream Condition: R = rising, F = falling, B = baseflow, U = uncertain, S = steady

Turbidity is the 15-minute recorded value when sediment was sampled; turbidity values in *italics* are estimates from laboratory analysis

Suspended-sediment load (tons/day) is calculated by multiplying SSC by streamflow (cfs) and a conversion factor of 0.0027

Table 6. Suspended-sediment concentrations and calculated loading rates Donner Creek at Highway 89 (DC89), water year 2011

USGS #10338700

	Site Conditions					*Suspended Sediment*		
Sample Date:Time	**Observer(s)**	**Gage Height**	**Streamflow Discharge**	**Streamflow Value Source**	**Stream Condition**	**Suspended-Sediment Concentration**	**15-minute Turbidity**	**Suspended-Sediment Discharge Rate**
		(ft)	*(cfs)*	*M,R,E*	*R,F,B,U*	*(mg/l)*	*(NTU)*	*(tons/day)*
5/5/2011 13:30	bkh, cs	--	290	R	U	1.4	n/a	1.1
5/27/11 14:45	cs	4.55	180	R	U	1.4	n/a	0.7
6/6/11 14:00	cs, bkh	5.28	401	R	U	6.0	n/a	6.5
6/6/11 14:12	cs, bkh	5.28	443	R	U	4.8	n/a	5.7
6/14/11 10:52	cs, bkh	5.74	629	R	F	11.2	n/a	19.0
6/14/11 11:00	cs, bkh	5.74	627	R	F	10.4	n/a	17.6
6/16/11 20:35	cs	5.75	595	R	U	11.6	n/a	18.6
6/23/11 15:45	cs, bkh	--	763	R	R	29.6	n/a	60.9
6/23/11 15:52	cs, bkh	--	765	R	R	31.2	n/a	64.3
7/15/11 12:22	ds	4.27	159	R	F	2.2	n/a	0.9
8/5/11 12:10	bkh	3.42	30	R	B	4.8	n/a	0.4

Notes

Observer Key: ds = Dave Shaw, bkh = Brian Hastings, cs = Collin Strasenburgh

Streamflow is the measured or 15-minute recorded flow when sediment was sampled, and usually differs from the daily streamflow

Streamflow Value Source: M = measured; R = rating curve; E = estimated

Stream Condition: R = rising, F = falling, B = baseflow, U = uncertain, S = steady

Turbidity is unavailable for this station

Suspended-sediment load (tons/day) is calculated by multiplying SSC by streamflow (cfs) and a conversion factor of 0.0027

Table 7. Suspended-Sediment Discharge Measurements: Trout Creek at Donner Pass Road, water year 2011

Sample Date:Time	Observer(s)	Gage Height	Streamflow discharge	Streamflow Value Source	Stream Condition	Suspended-Sediment Concentration	15-minute Turbidity	Suspended-Sediment Load
Site Conditions								
		(ft)	*(cfs)*	*M,R,E*	*R,F,B,U*	*(mg/l)*	*(NTU)*	*(tons/day)*
1/21/2011 16:05	bkh, cs	4.06	4.49	M	F	1.56	0.85	0.02
3/2/11 13:10	ds	4.01	3.35	M	R	35.00	44.00	0.32
3/2/11 13:50	ds	4.01	3.38	M	R	8.50	12.70	0.08
3/10/11 14:45	cs	4.13	6.07	M	U	68.00	35.00	1.11
3/10/11 14:46	cs	4.14	6.07	M	U	71.00	43.00	1.16
3/14/11 15:30	bkh	4.24	9.63	M	R	13.60	8.77	0.35
4/2/11 16:20	bkh	4.53	29.08	M	R	32.00	26.40	2.51
4/18/11 11:10	ds	4.71	45.50	M	U	6.80	8.98	0.83
5/5/11 12:02	cs, bkh	4.86	38.11	M	U	2.80	3.30	0.29
5/27/11 11:45	cs	4.68	24.80	M	F	2.40	1.96	0.16
6/5/2011 23:09	cs	4.82	36.19	M	R	22.40	10.01	2.18
6/6/11 11:45	cs	5.02	47.77	M	U	6.40	5.46	0.82
6/14/11 13:47	cs	4.61	23.25	M	R	3.00	3.01	0.19
6/23/11 17:15	cs	4.32	10.62	M	F	3.20	2.63	0.09
7/13/11 17:15	bkh	4.07	5.08	M	F	1.60	2.24	0.02
7/29/11 9:20	cs	4.00	3.12	M	R	3.20	2.30	0.03

Notes

Observer Key: ds = Dave Shaw, bkh = Brian Hastings, cs = Collin Strasenburgh

Streamflow is the measured or 15-minute recorded flow when sediment was sampled, and usually differs from the daily streamflow.

Streamflow Value Source: M = measured; R = rating curve; E = estimated

Stream Condition: R = rising, F = falling, B = baseflow, U = uncertain, S = steady

Turbidity is the 15-minute recorded value when sediment was sampled; turbidity values in *italics* are estimates from laboratory analysis

Suspended-sediment load (tons/day) is calculated by multiplying SSC by streamflow (cfs) and a conversion factor of 0.0027

Table 8. Suspended-Sediment Discharge Measurements:
Trout Creek above Jibboom Street Bridge (TCJB), water year 2011

Sample Date:Time	Observer(s)	Gage Height	Streamflow discharge	Streamflow Value Source	Stream Condition	Suspended-Sediment Concentration	15-minute Turbidity	Suspended-Sediment Load
		Site Conditions						
		(ft)	*(cfs)*	*M,R,E*	*R,F,B,U,S*	*(mg/l)*	*(NTU)*	*(tons/day)*
9/2/11 16:15	bkh	7.43	1.47	M	B	2.40	2.63	0.01
9/13/11 8:55	bkh	7.45	2.00	M	B	3.60	11.00	0.02
9/13/11 16:35	bkh	7.46	3.00	M	F	21.20	14.25	0.17

Notes
Observer Key: bkh = Brian Hastings
Streamflow is the measured or 15-minute recorded flow when sediment was sampled, and usually differs from the daily streamflow.
Streamflow Value Source: M = measured; R = rating curve; E = estimated
Stream Condition: R = rising, F = falling, B = baseflow, U = uncertain, S = steady
Turbidity is the 15-minute recorded value when sediment was sampled; turbidity values in *italics* are estimates from laboratory analysis
Suspended-sediment load (tons/day) is calculated by multiplying SSC by streamflow (cfs) and a conversion factor of 0.0027

Table 9. Long-term comparison of annual flow and suspended-sediment loads Donner Creek at Highway 89 (DC89), water years 1997, 2004 and 2011.

Year[1]	Annual Flow[2]				Suspended Sediment Load[3]			Peak Flow[4]		
	Mean Daily Flow	Maximum Daily Flow	Minimum Daily Flow	Total Flow Volume	Suspended Sediment	Normalized Suspended Sediment	Normalized Suspended Sediment	Peak Flow	Peak Stage	Date Time
	(cfs)	*(cfs)*	*(cfs)*	*(ac-ft)*	*(tons)*	*(tons/ac-feet)*	*(tons/sq. mile)*	*(cfs)*	*(ft)*	*(24-hr)*
Donner Creek at Highway 89										
WY1997	117	2,380	3.6	84,679	2,253	**0.03**	153	2,500	12.76	1/2/1997
WY2004	55	245	3.1	39,546	380	**0.01**	24	268	5.28	3/22/2004
WY2011	140	774	5.0	101,308	804	**0.01**	54	921	--	6/29/2011
mean	*104*			*75,178*	*1,146*	*0.01*		*1,230*		
median	*117*			*84,679*	*804*	*0.01*		*921*		

Notes:

1 WY1997 and WY2004 reported from Amorfini and Holden (2008) using sediment rating curved reported from McGraw and others (2001); WY2011 data collected by Balance Hydrologics

2 Annual flow statistics based on record of flow managed and maintained by USGS, Donner Creek at Highway 89 (USGS 10338700); flows affected by regulation (Donner Lake)

3 Suspended sediment loads based on grab samples analyzed for suspended sediment concentration and standard rating curve method (Qss = 1.78*(Q^3.31) for 1996, 1997 (McGraw and others, 2001); WY2011: (Qss = 0.084*(Q^0.45)) for flows less than 290 cfs; (Qss = 0.00000000006*(Q^4.2)) for flows greater than 290 cfs. (Hastings and Shaw, this report);
WY1997 and WY2004 normalized suspended-sediment load (tons/sq. mile) is based on a watershed area of 15.7 sq. miles as delineated from the confluence with Truckee River, but excluding watershed area above Donner Lake Dam (14.3 sq. miles)
WY2011 normalized suspended-sediment load (tons/sq. mile) is based on a watershed area of 14.8 sq. miles as delineated from Highway 89, but excluding watershed area above Donner Lake Dam (14.3 sq. miles)

4 Donner Creek peak flow and stage for WY1997 is estimated by USGS; all Donner peak flows are affected by regulations (Donner Lake)

Table 10. Comparison of annual flow and suspended-sediment loads between Donner Creek at Highway 89 (DC89) and Cold Creek at Teichert Bridge (CCTB) (tributary to Donner Creek), water year 2011

Year[1]	Annual Flow[2]				Suspended Sediment Load[3]		Peak Flow[4]		
	Mean Daily Flow	Maximum Daily Flow	Minimum Daily Flow	Total Flow Volume	Suspended Sediment	Normalized Suspended Sediment	Peak Flow	Peak Stage	Date Time
	(cfs)	*(cfs)*	*(cfs)*	*(ac-ft)*	*(tons)*	*(tons/sq. mile)*	*(cfs)*	*(ft)*	*(24-hr)*
Donner Creek at Highway 89									
WY2011	140	774	5.00	101,308	804	**54**	921	--	6/29/2011
Cold Creek at Teichert Bridge (Tributary to Donner Creek)									
WY2011	60	335	0.9	42,624	710	**56**	447	5.44	6/22/2011
Donner Creek below Donner Lake and excluding Cold Creek[4]									
WY2011	--	--	--	--	*94*	***30***	--	--	--

Notes:

1 WY2011 data collected, analyzed and reported by Balance Hydrologics

2 Annual flow statistics for Donner Creek are based on a gaging station with a record of flow managed and maintained by USGS (Donner Creek at Highway 89, USGS #10338700);
Annual flow statistics for Cold Creek are based on a record of flow from a gaging station managed and maintained by Balance Hydrologics

3 Suspended sediment loads computed for Donner Creek are based on grab samples analyzed for suspended sediment concentration and a streamflow to suspended-sediment rating curve (Qss = 0.084*(Q^0.45)) for flows less than 290 cfs; (Qss = 0.00000000006*(Q^4.2)) for flows greater than 290 cfs.
Suspended-sediment loads computed for Cold Creek are based on a continuous record of turbidity and a instantaneous turbidity to suspended-sediment concentration (SSC) rating curve (SSC = 1.39*(NTU^1.06))
WY2011 normalized suspended-sediment load (tons/sq. mile) is based on a watershed area of 14.8 sq. miles as delineated from Highway 89, but excluding watershed area above Donner Lake Dam (14.3 sq. miles)

4 Values for Donner Creek below Donner Lake is an estimate based on the assumption that the estimated load is the difference between loads from Donner Creek at Highway 89 and Cold Creek at Teichert Bridge

Table 11. Long-term comparison of annual flow and normalized suspended-sediment loads Trout Creek near Truckee, CA

Year[1]	Annual Flow[2]				Suspended Sediment Load[3]			Peak Flow[4]		
	Mean Daily Flow	Maximum Daily Flow	Minimum Daily Flow	Total Flow Volume	Suspended Sediment	Normalized Suspended Sediment	Normalized Suspended Sediment	Peak Flow	Peak Stage	Date Time
	(cfs)	*(cfs)*	*(cfs)*	*(ac-ft)*	*(tons)*	*(tons/ac-feet)*	*(tons/sq. mile)*	*(cfs)*	*(ft)*	*(24-hr)*
WY1997	8.0	195	3.3	5,809	61	**0.01**	**12**	--	--	--
WY2004	4.1	9.4	3.0	3,002	21	**0.01**	**4**	--	--	--
partial WY2011	*15*	*63*	*0.4*	*6,777*	*59*	**0.01**	**13**	70	5.16	4/21/2011
mean	*8.87*			*5,196*	*47*	*0.01*	*10*			
median	*8.00*			*5,809*	*59*	*0.01*	*12*			

Notes:

1 WY1997 and WY2004 data reported from Amorfini and Holden (2008) and based on sediment rating curves from McGraw and others (2001); WY2011 data collected by Balance Hydrologics

2 Annual flow statistics for WY1997 and WY2004 are synthesized from a record of flow at Sagehen Creek nr Truckee [Trout Creek Q = 0.24*(Sagehen Q)+2.6563], McGraw and others (2001);
Sagehen Creek gage managed and maintained by USGS (USGS 10343500);
Annual flow statistics for WY2011 based on continuous gaging record managed and maintained by Balance Hydrologics; WY2011 is partial water year (January 21 - September 30, 2011)

3 WY1997 and WY2004 suspended-sediment loads based on grab samples analyzed for suspended sediment concentration and standard rating curve method (Qss = 1.30*(Q^2.05), McGraw and others, 2001;
WY2011 suspended-sediment loads based on continuous record of turbidity and laboratory analysis of suspended-sediment concentration (SSC); SSC = 1.1*(NTU)^1.03
WY1997 and WY2004 normalized suspended-sediment yields (watershed area, sq. mile) is based on a watershed area delineated at Trout Creek confluence with Truckee River
(4.89 sq. miles, McGraw and others, 2001); WY2011 watershed area delineated at Donner Pass Road (4.6 sq. miles)

4 Because WY1997 and WY2004 represent annual flow data based on a synthesized record, peak flow data are unavailable.

FIGURES

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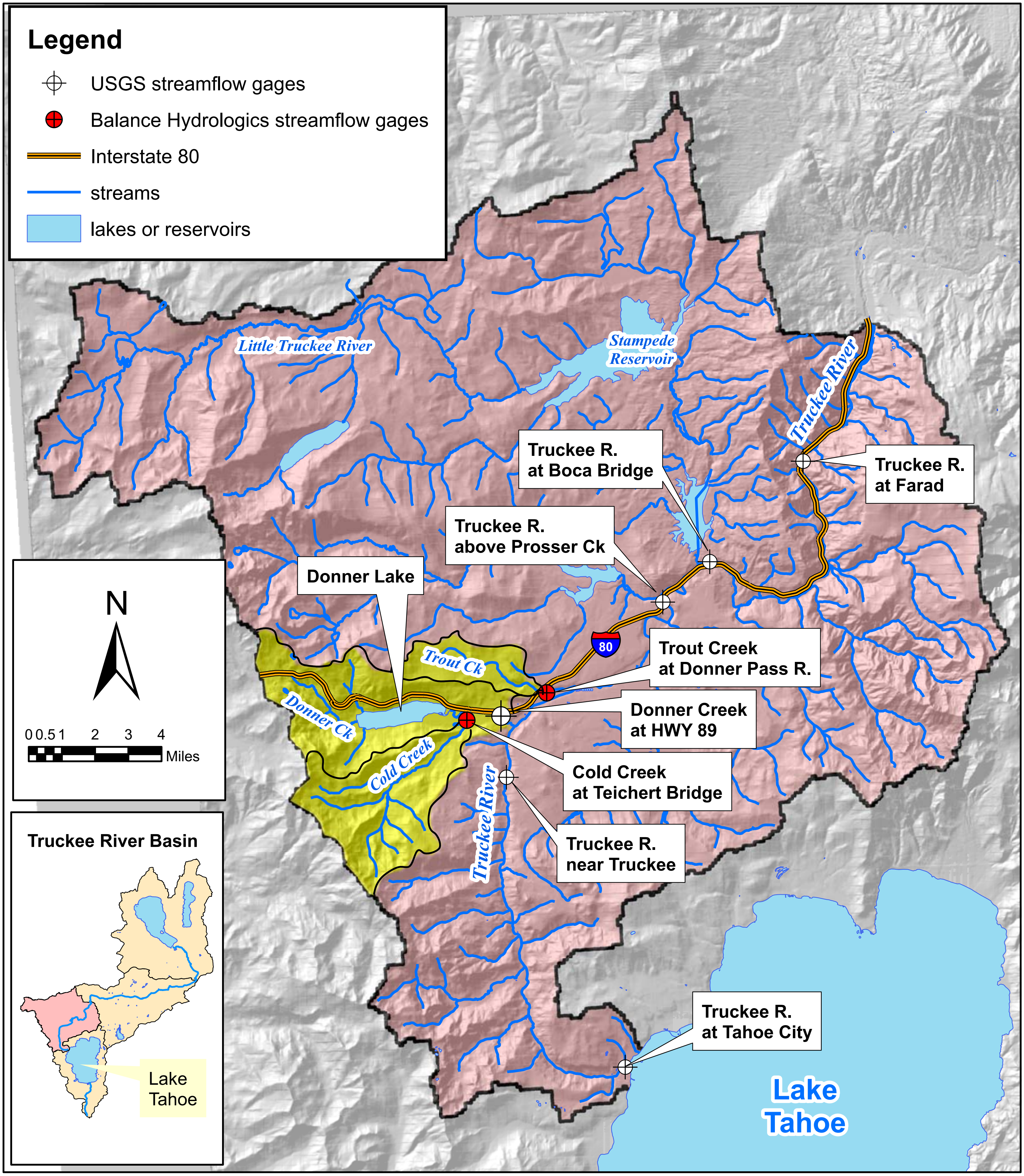
209116 streamgage locations.mxd

Figure 1. Truckee River Basin, California and Nevada

The Middle Truckee Basin is delineated from the Lake Tahoe outlet downstream to the California-Nevada border.



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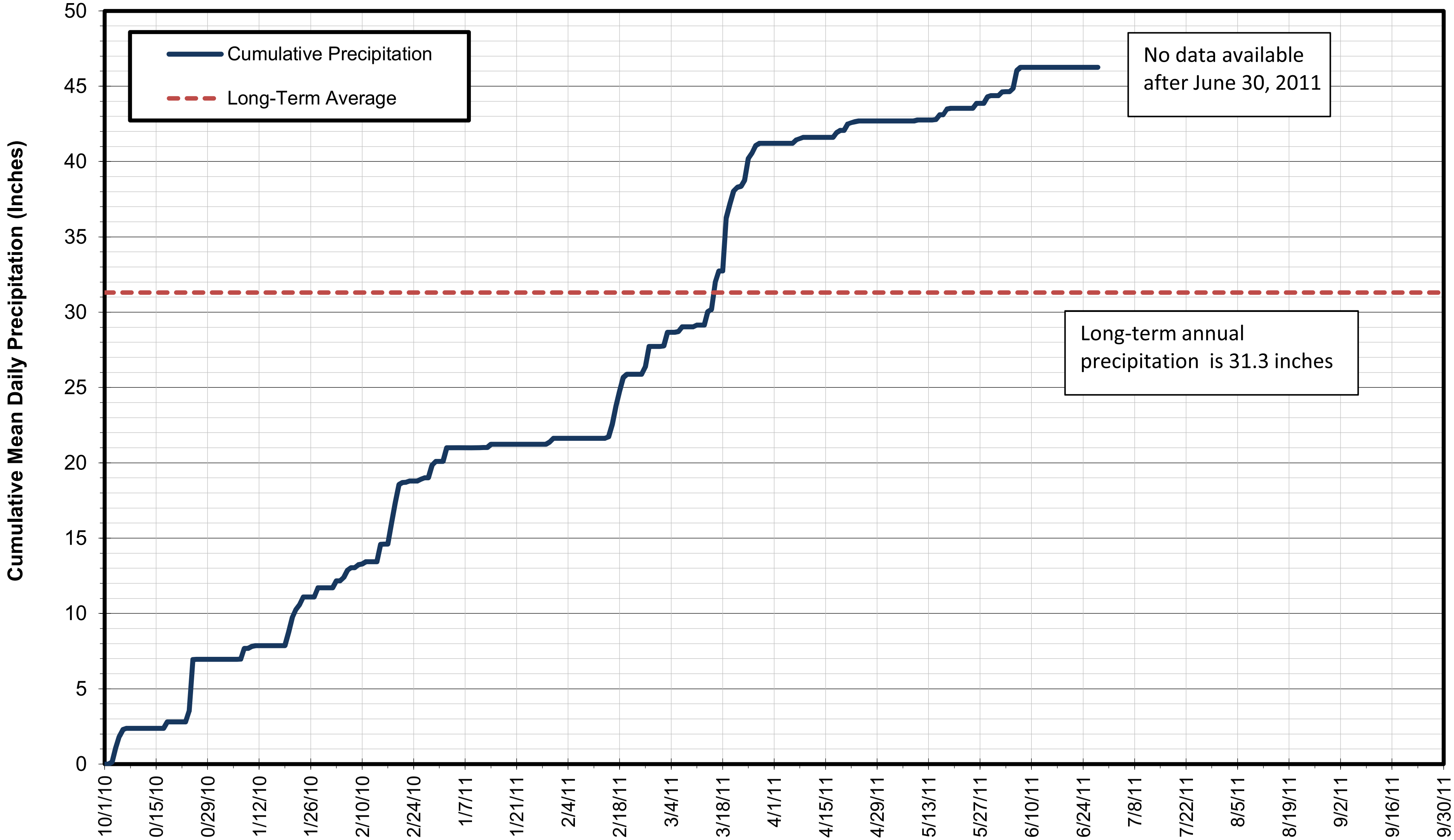
209116 streamgage locations.mxd

Figure 2. **Middle Truckee River, California and Nevada. Locations of streamflow gages and watersheds evaluated for this study**



Data Source: CDEC, 2011, station ID: TKE

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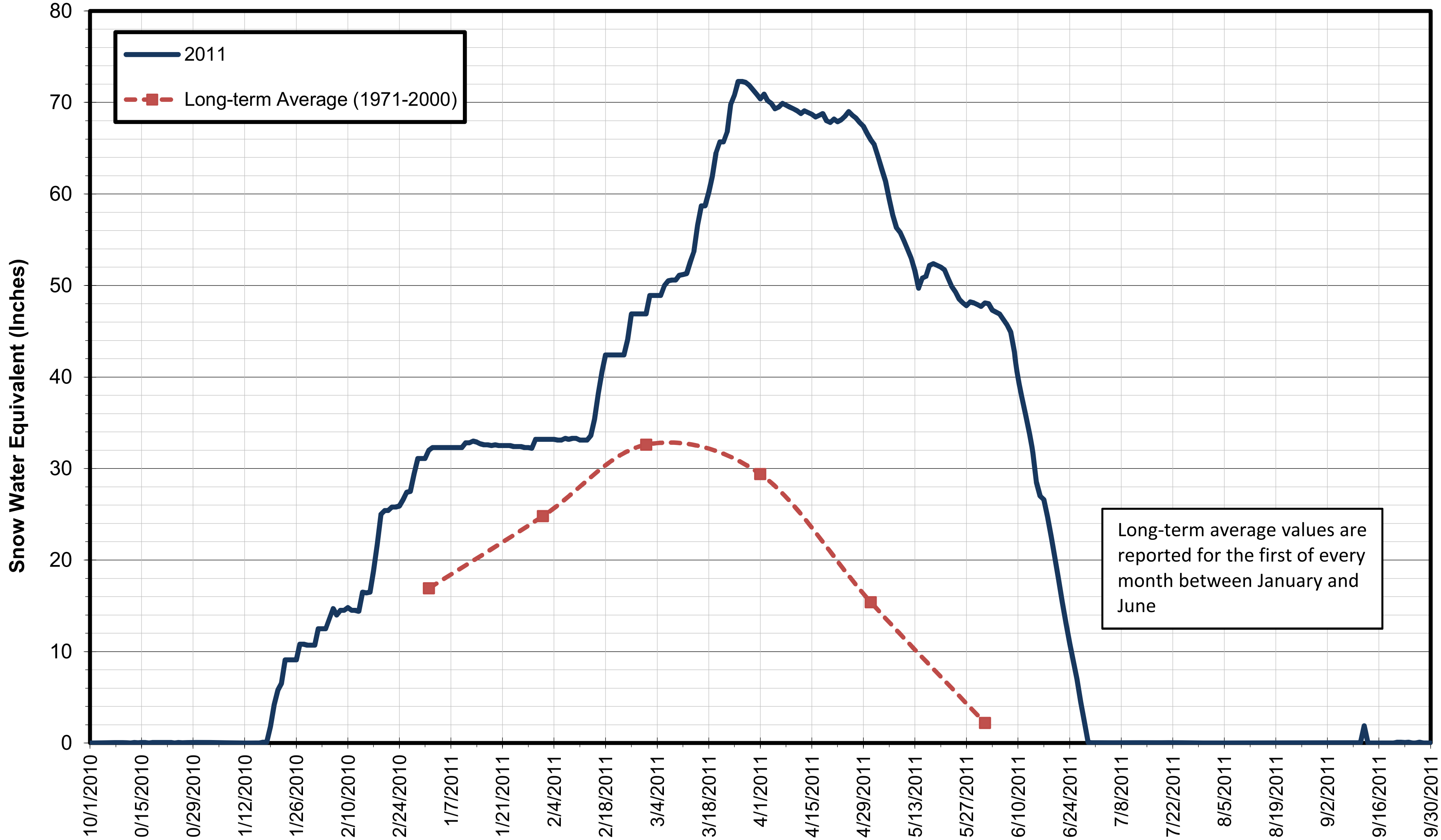
Figure 3. **Cumulative precipitation, Truckee Ranger District, Truckee, California, Water Year 2011.** Weather station located approximately 0.5 miles northeast of Trout Creek gaging station at 6,020 feet elevation.



Data Source: Central Sierra Snow Lab

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Figure 4. **Snow water equivalent, Central Sierra Snow Lab, Soda Springs, California, Water Year 2011.** Snow Lab is located approximately 7.5 miles west of the Cold Creek gaging station at 6,950 feet elevation.

210011 TKE and SSL data

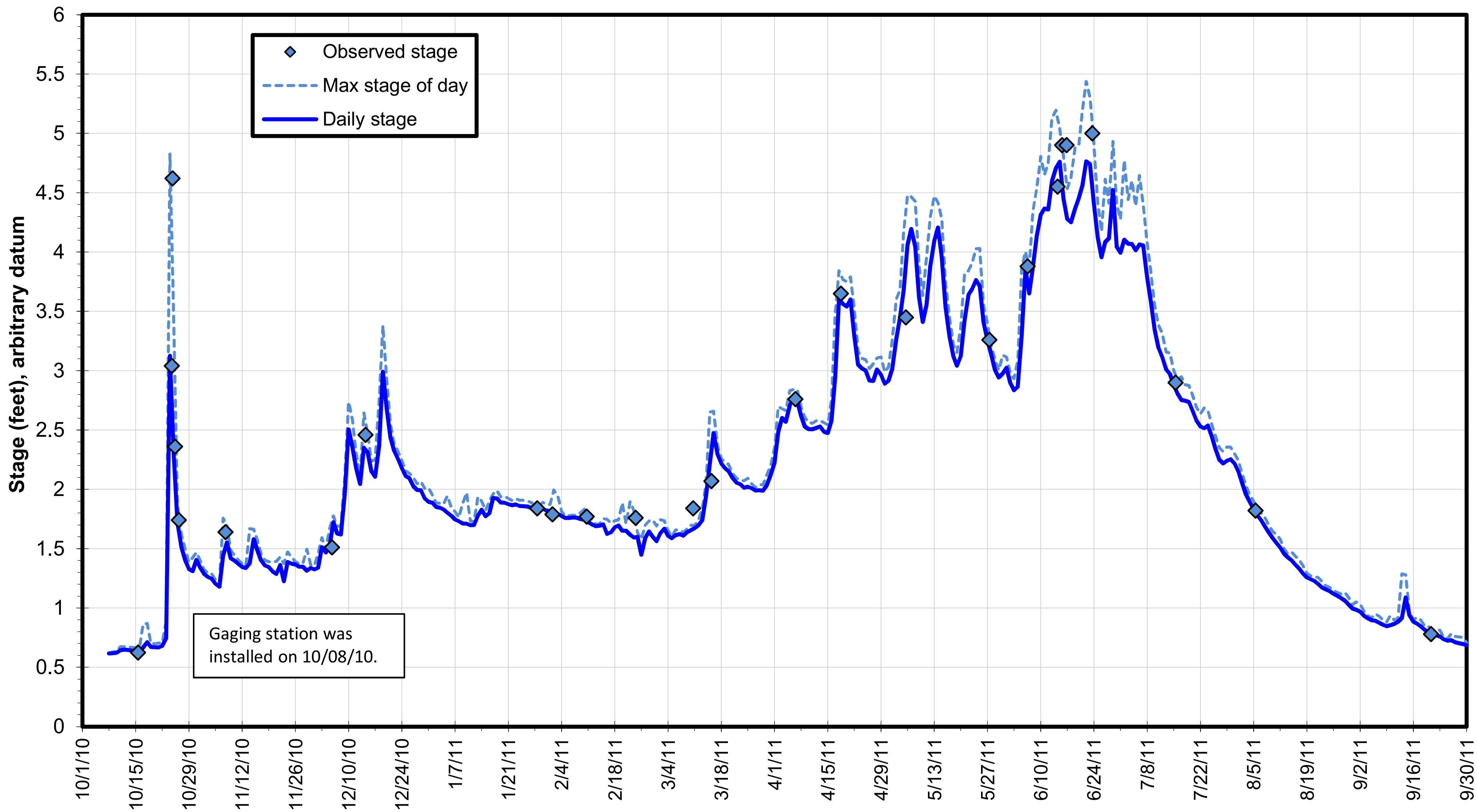

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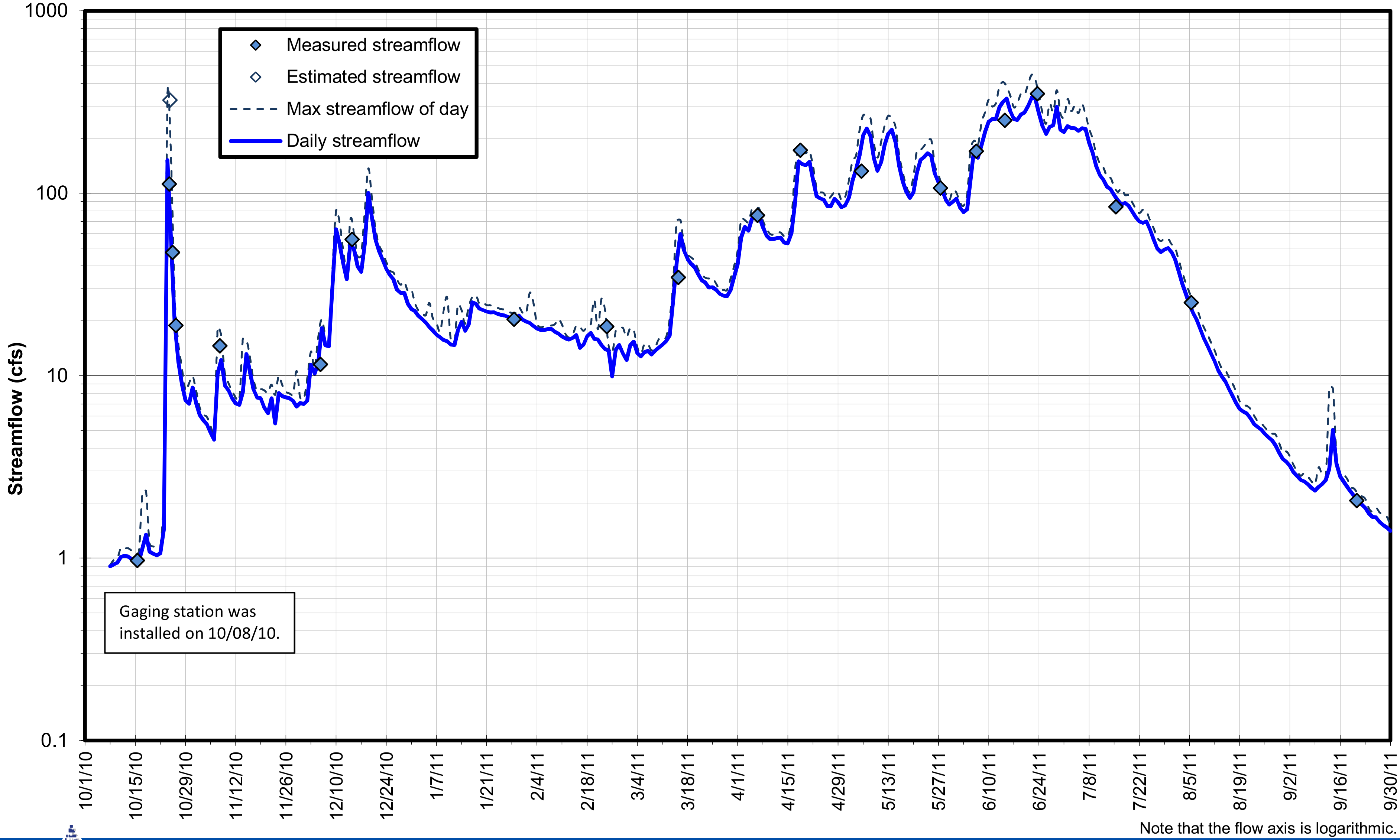
Figure 5. Daily stage, Cold Creek at Teichert Bridge (CCTB), Truckee, California, Water Year 2011. The highest stage (5.44 feet) of WY2011 occurred on June 22, 2011 and coincident with peak snowmelt. Interestingly, a maximum stage of 4.83 feet occurred on October 24, 2010 and was the result of a rain event.

210011 CCTB Daily Sums.111207



Note that the flow axis is logarithmic.

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Figure 6. **Streamflow hydrograph, Cold Creek at Teichert Bridge (CCTB), Truckee, California, Water Year 2011.** The maximum daily streamflow for WY2011 was 447 cfs recorded on June 22, 2011 and coincident with peak snowmelt. A rain event on October 24, 2010 generated a maximum daily streamflow of 350 cfs.

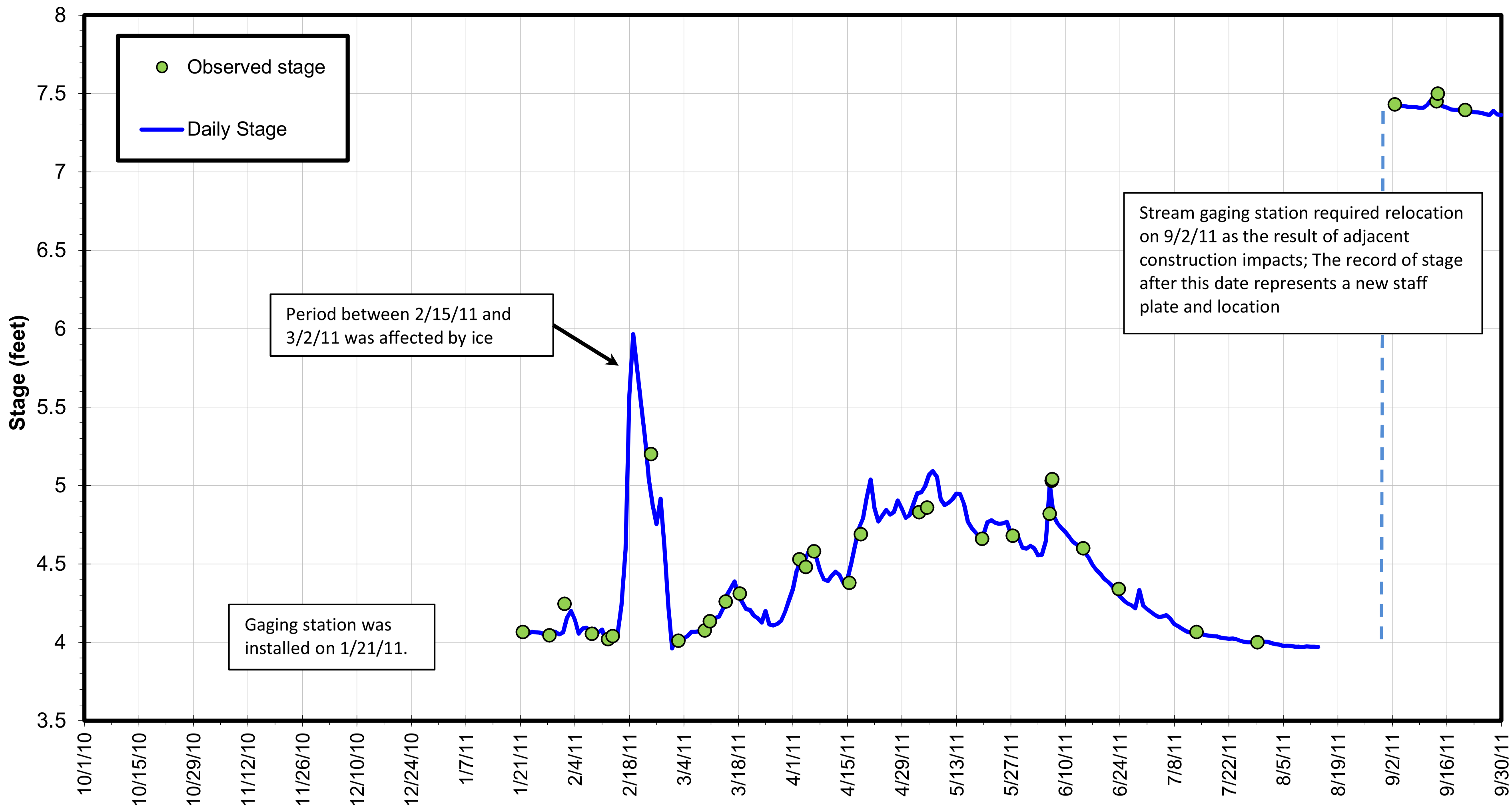

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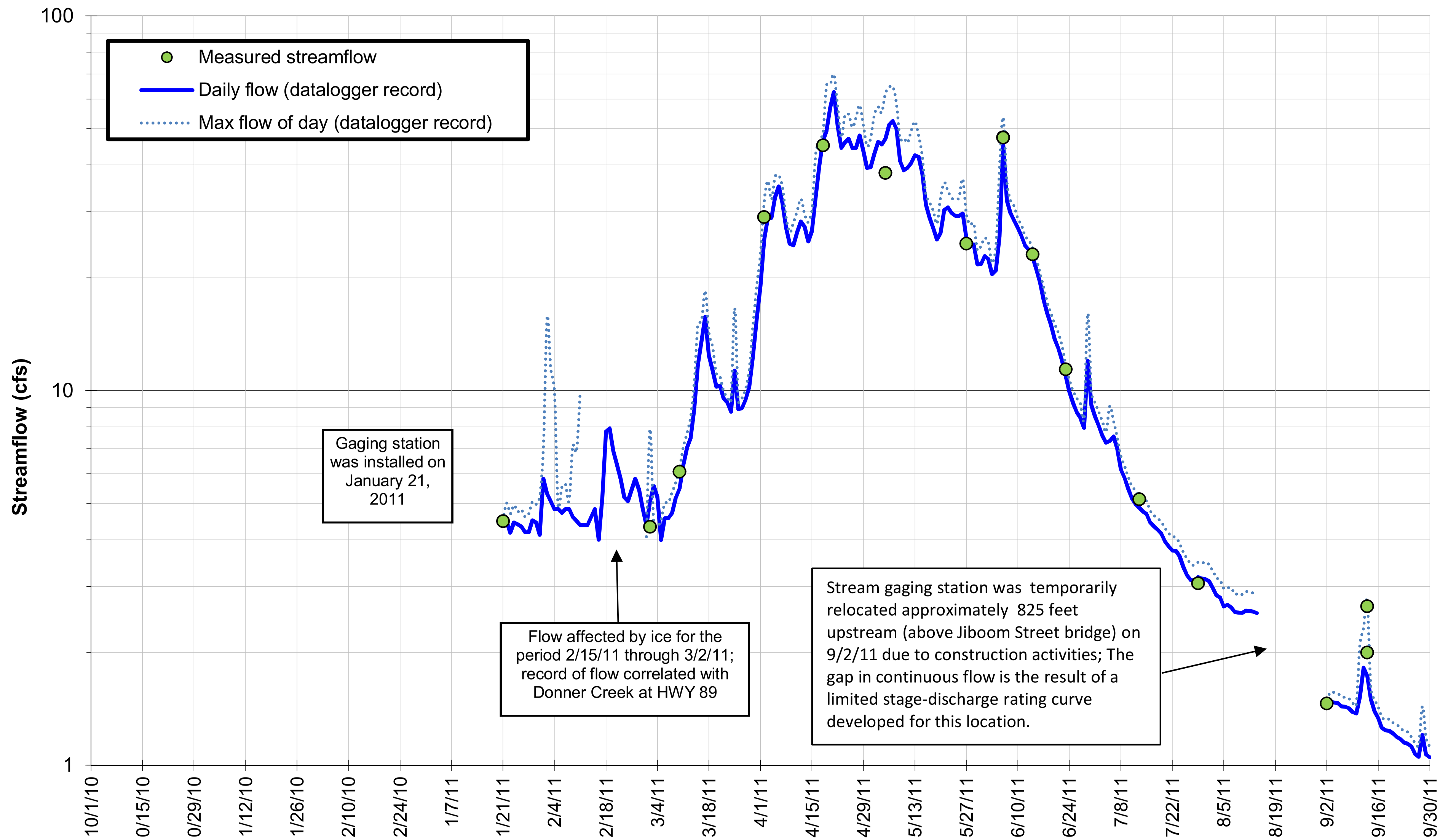
Figure 7. Daily stage, Trout Creek at Donner Pass Road (TCDP), Truckee, California, Water Year 2011. "Stage" is water level in the creek as read against the staff plate; the staff plate is set at an arbitrary datum, so stage is relative and does not represent the absolute depth of water in the creek.



Note that the flow axis is logarithmic.

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Figure 8. **Streamflow hydrograph, Trout Creek above Donner Pass Road (TCDP), Truckee, California, Water Year 2011.** Peak flow (69.6 cfs) occurred April 21, 2011, earlier than other nearby creeks--and most likely a result of the lower elevation and urbanization in the Trout Creek watershed.

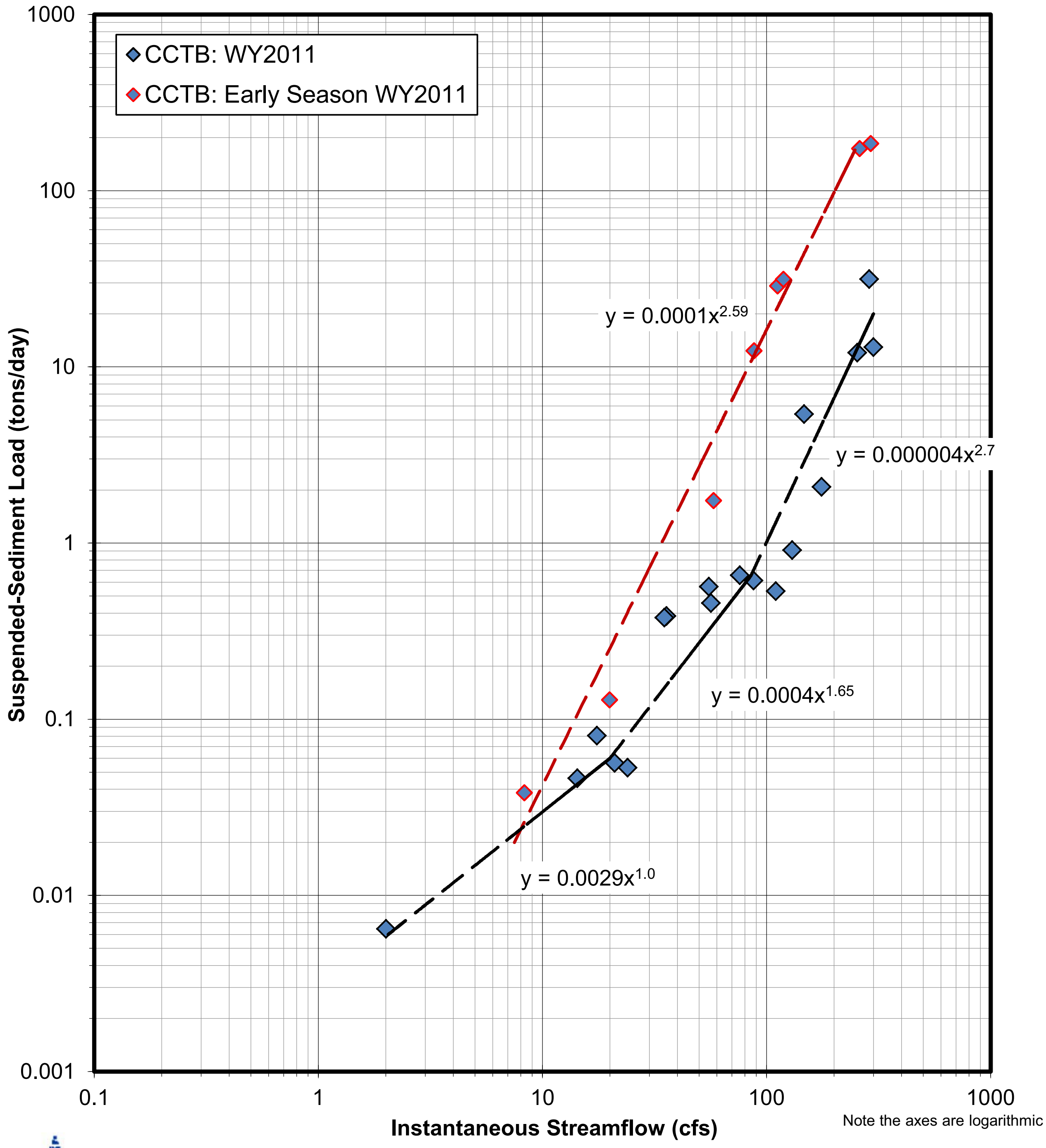
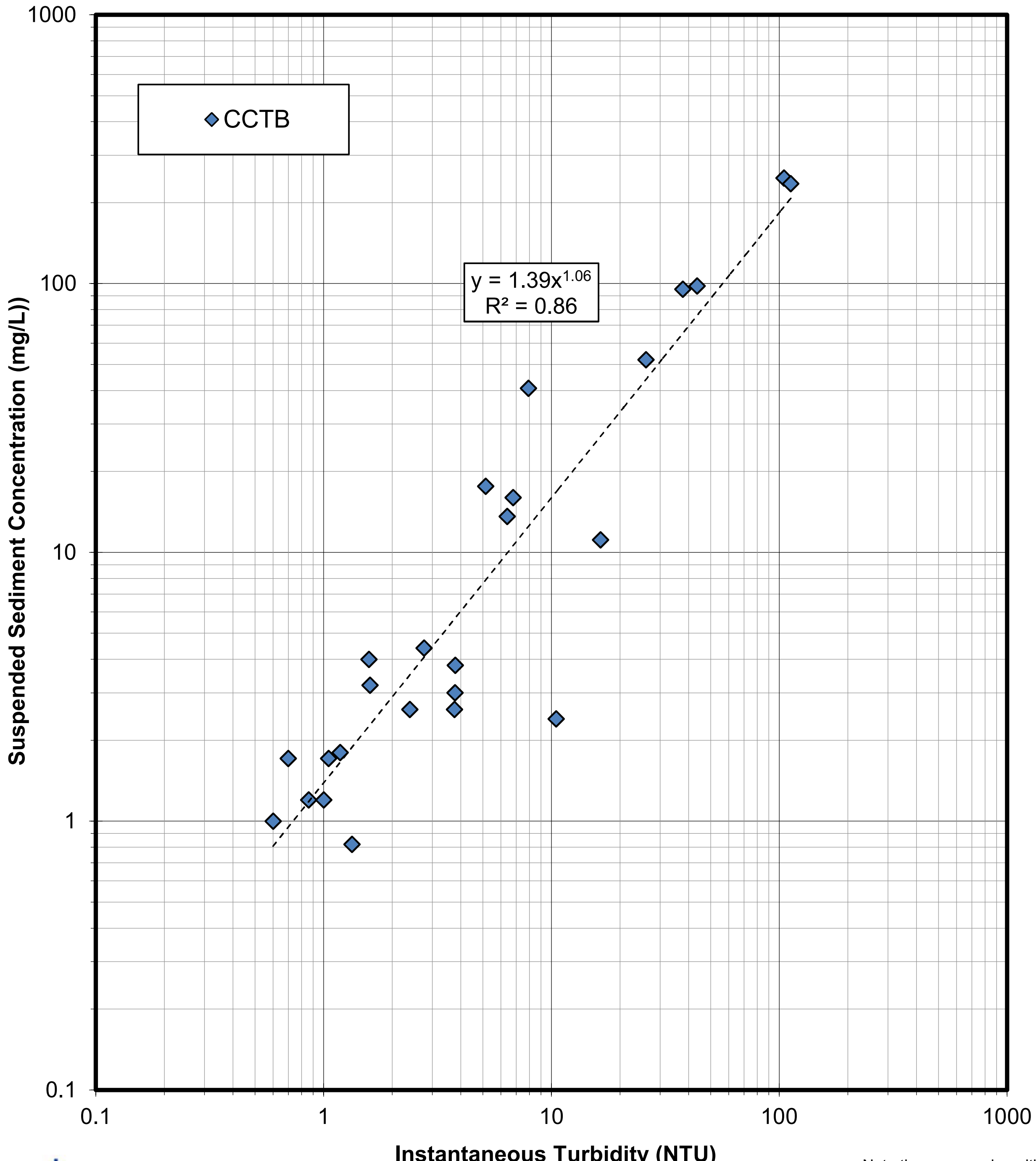


Figure 9. Relationship between streamflow and suspended-sediment load, Cold Creek Teichert Bridge (CCTB), Water Year 2011. As is typical, more suspended sediment is transported at higher streamflows. The relationships derived here are applied to the streamflow record to calculate suspended-sediment loading.



Note the axes are logarithmic

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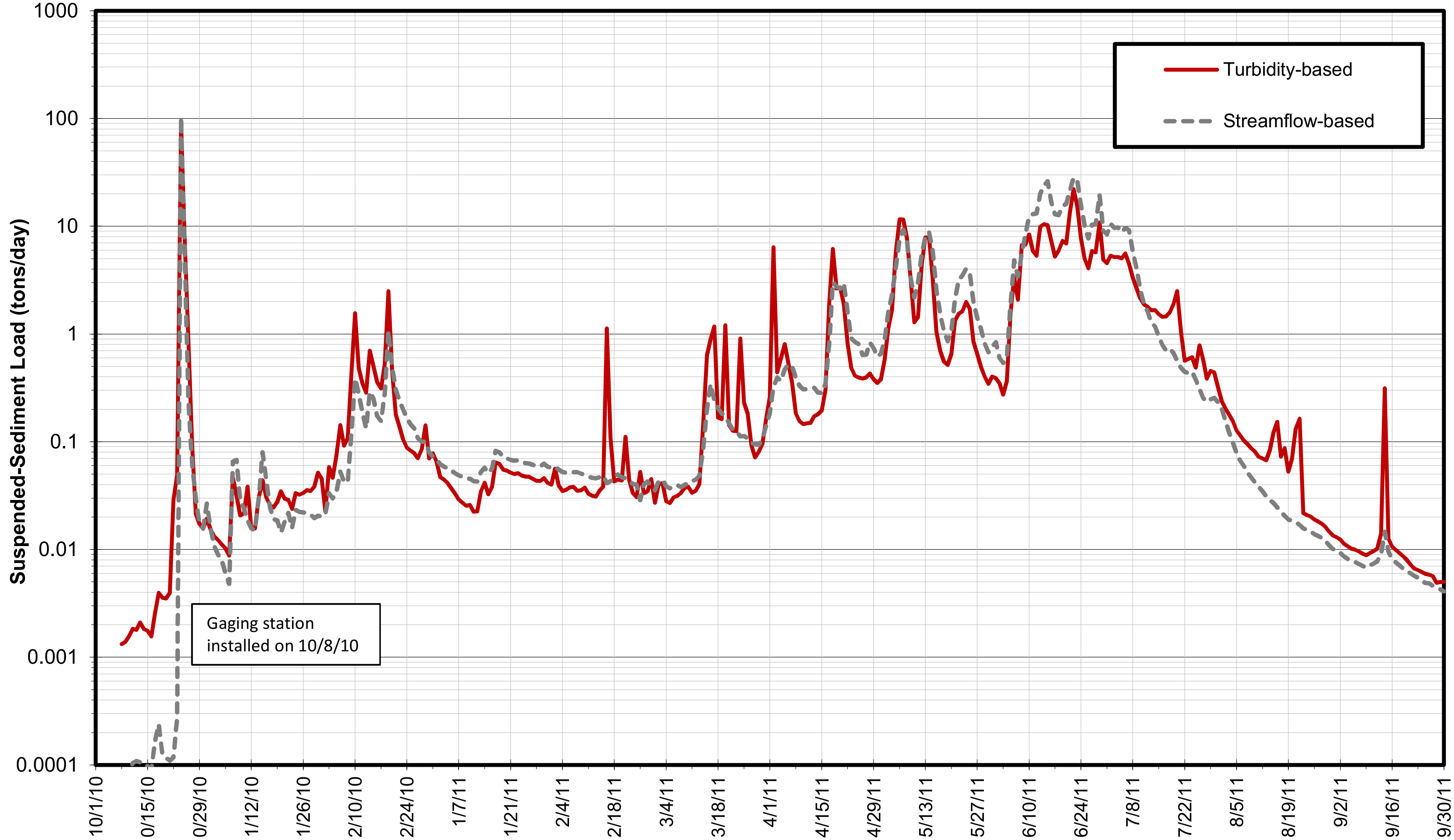
Figure 10. Relationshiop between turbidity and suspended sediment concentration, Cold Creek at Teichert Bridge (CCTB), Water Year 2011. The equation derived here is applied to the continuous record of turbidity to calculate suspended-sediment loading.



Note that the flow axis is logarithmic.

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Figure 11. **Daily suspended-sediment load, Cold Creek at Teichert Bridge (CCTB), Truckee, California, Water Year 2011.** A comparison between the two methods suggests that the turbidity-based method captures sediment loading during times unrelated to changes in streamflow. A maximum daily load of 103 tons for WY2011 was recorded by both methods on October 24, 2010 and likely resulted from rainfall on bare ground.

210011 CCTB Daily Sums.111207

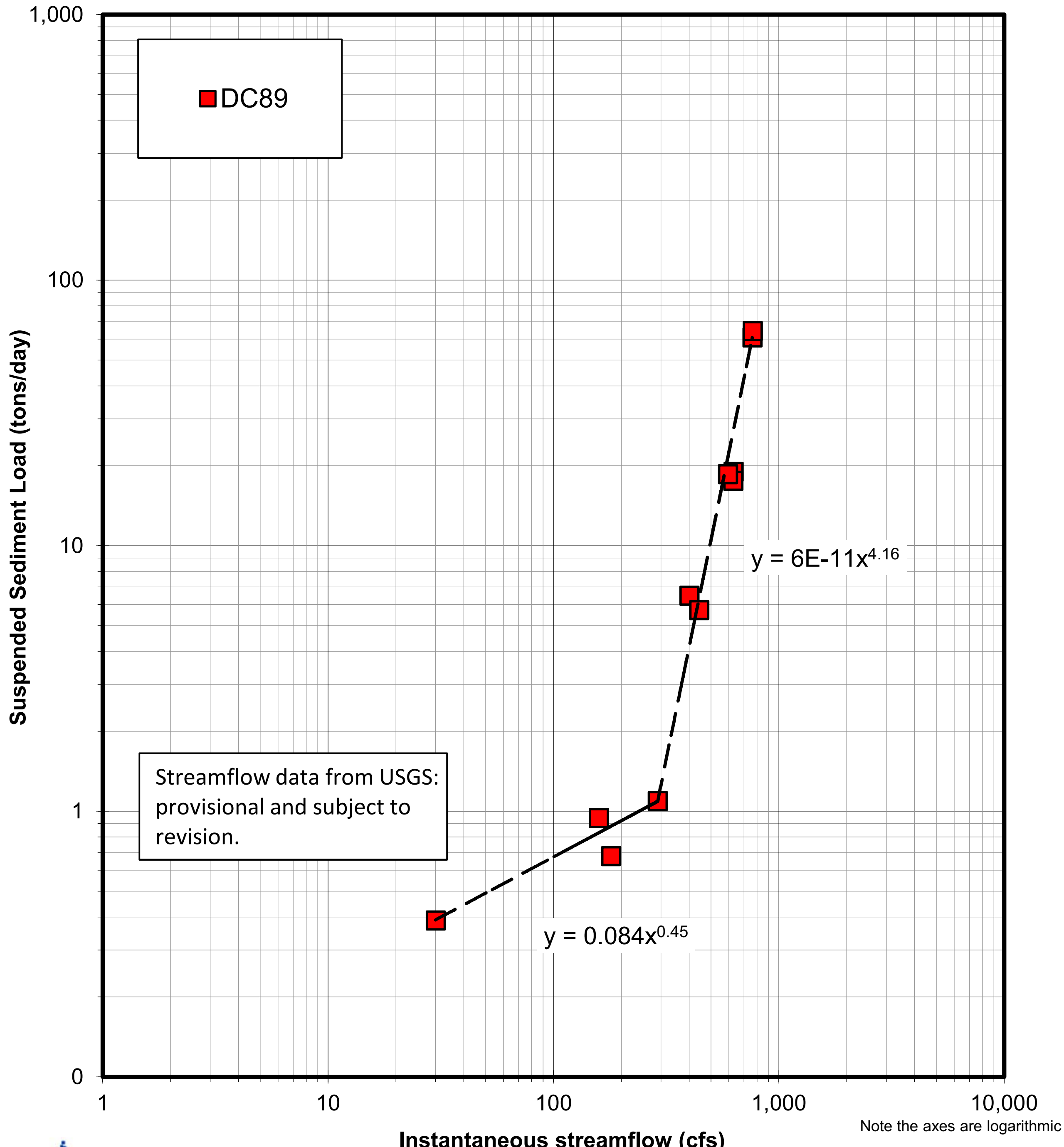

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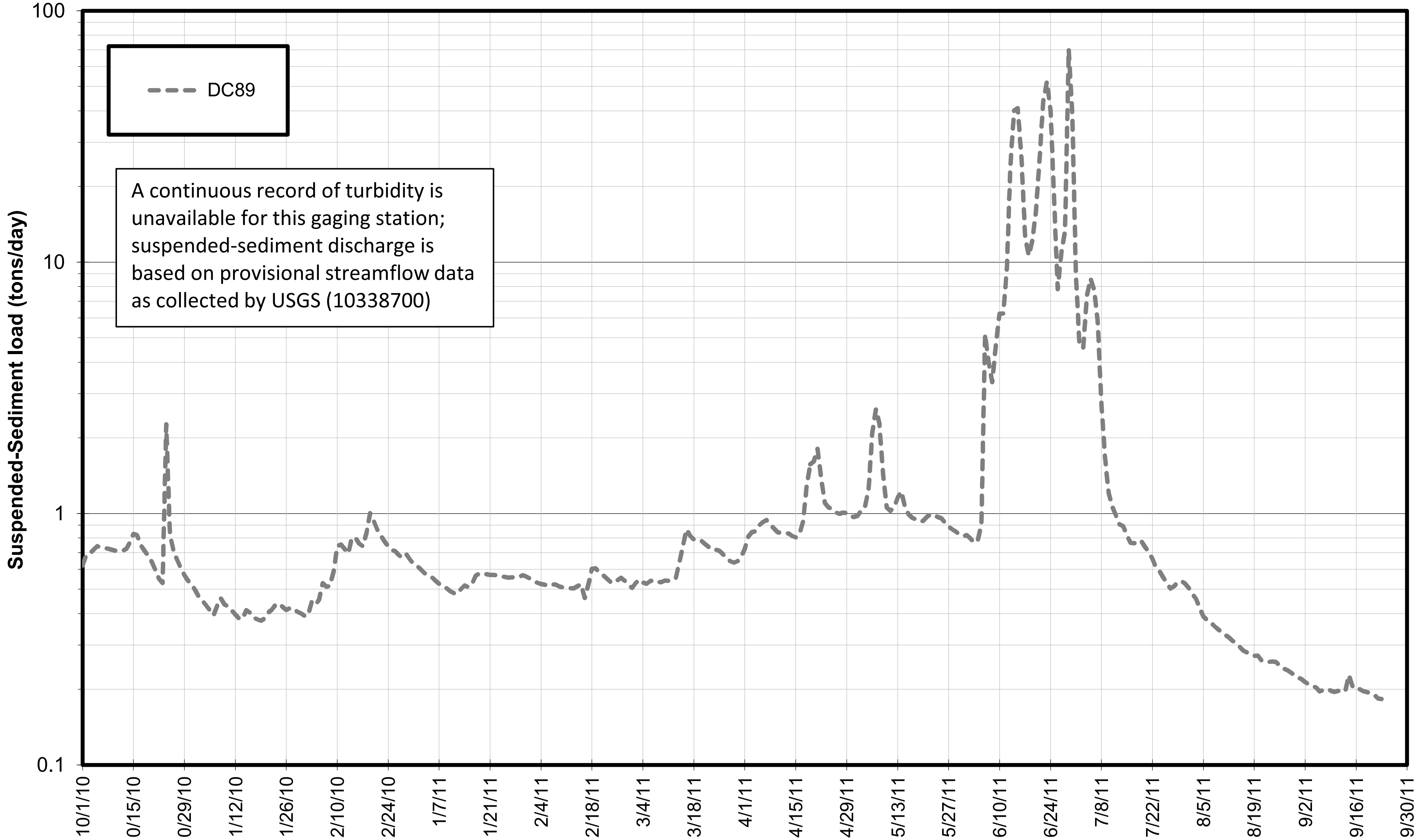
Figure 12. **Relationship between streamflow and suspended-sediment load, Donner Creek at Highway 89 (DC89), Water Year 2011.** Initial data suggests suspended-sediment loads increase at a greater rate when streamflows exceed approximately 300 cfs.



Note that the flow axis is logarithmic.

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Figure 13. **Daily suspended-sediment load, Donner Creek at Highway 89, Truckee, California, Water Year 2011.** Suspended-sediment loads during the October rainstorm may be underestimated due to the absence of sampling data during the first half of the water year.

210011 DC89 Daily Sums WY2011.120203

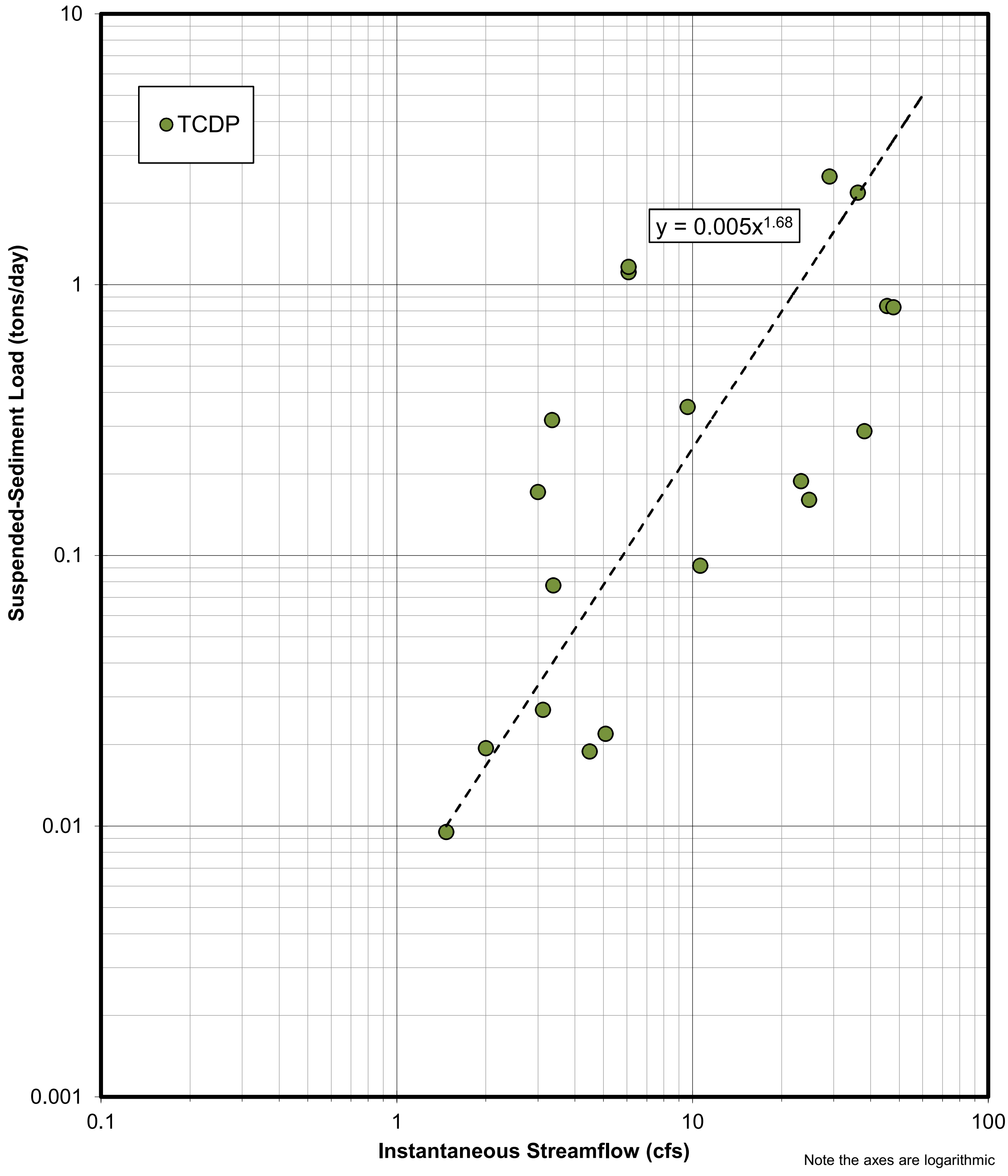

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Figure 14. Relationship between streamflow and suspended sediment load, Trout Creek at Donner Pass Road (TCDP), parital Water Year 2011.

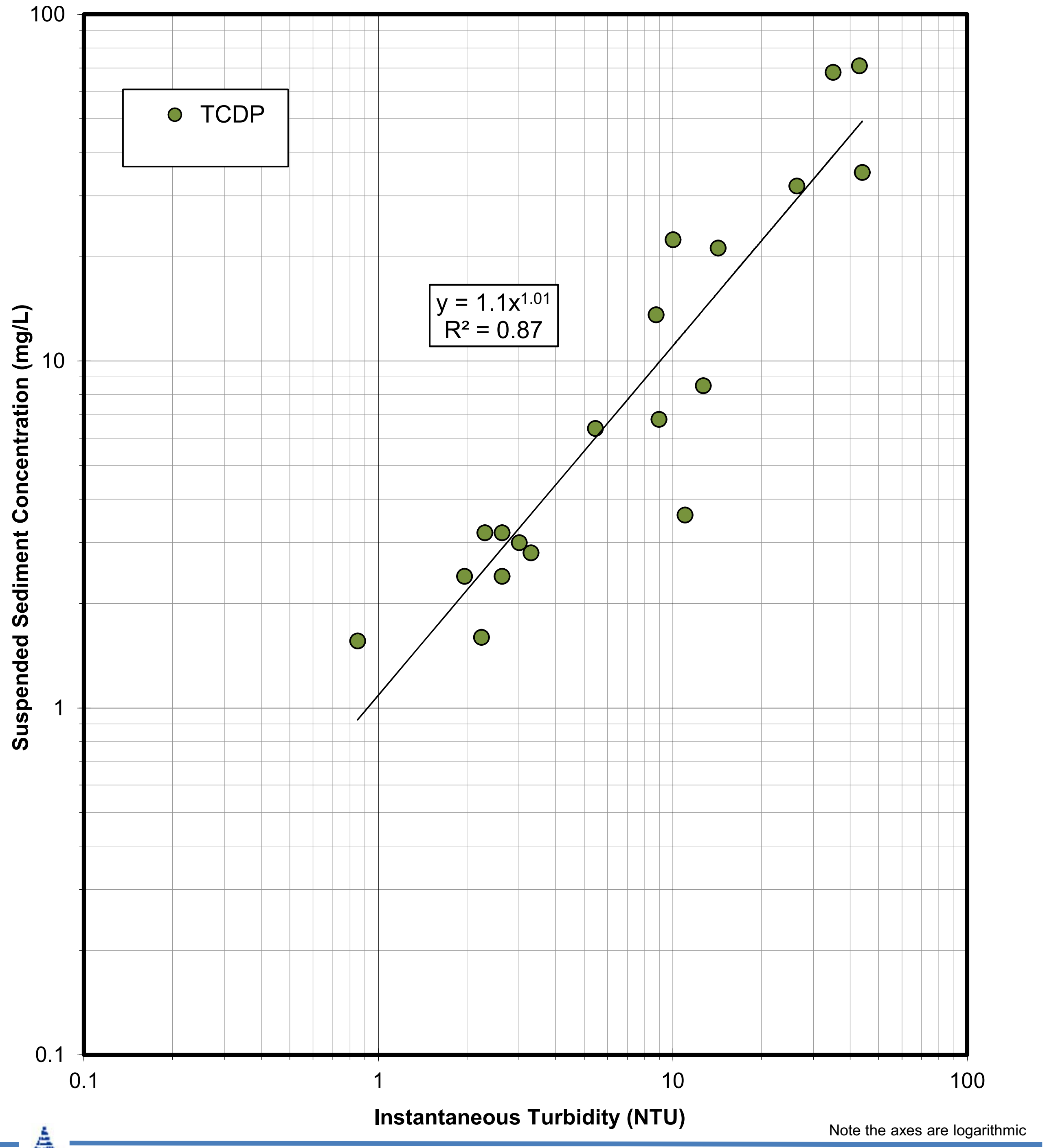

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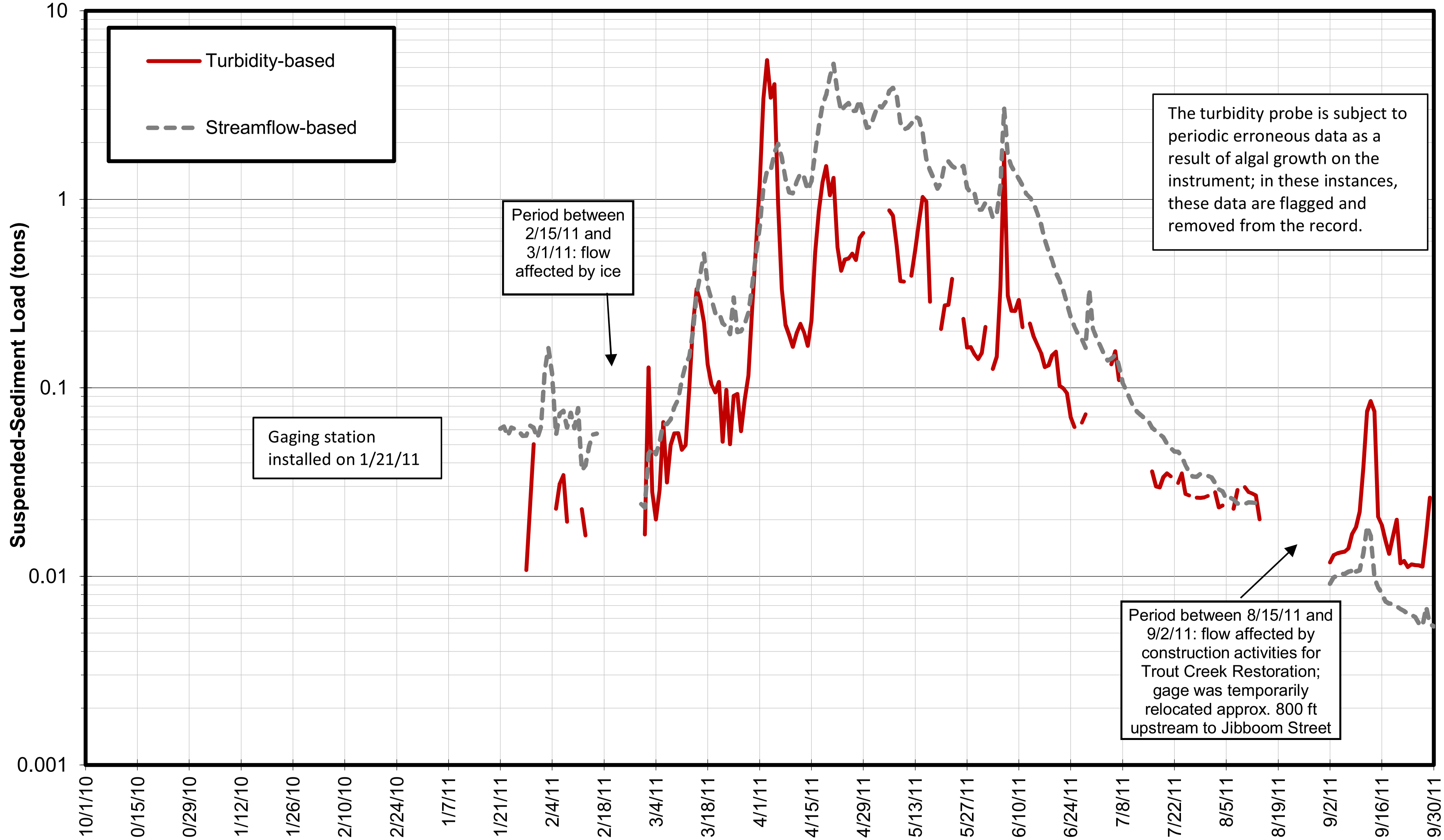
Figure 15. Relationship between turbidity and suspended - sediment concentration, Trout Creek at Donner Pass Road (TCDP), partial Water Year 2011. When compared with the streamflow-based suspended-sediment rating curve, turbidity and SSC show a stronger relationship (less data scatter)



Note that the flow axis is logarithmic.

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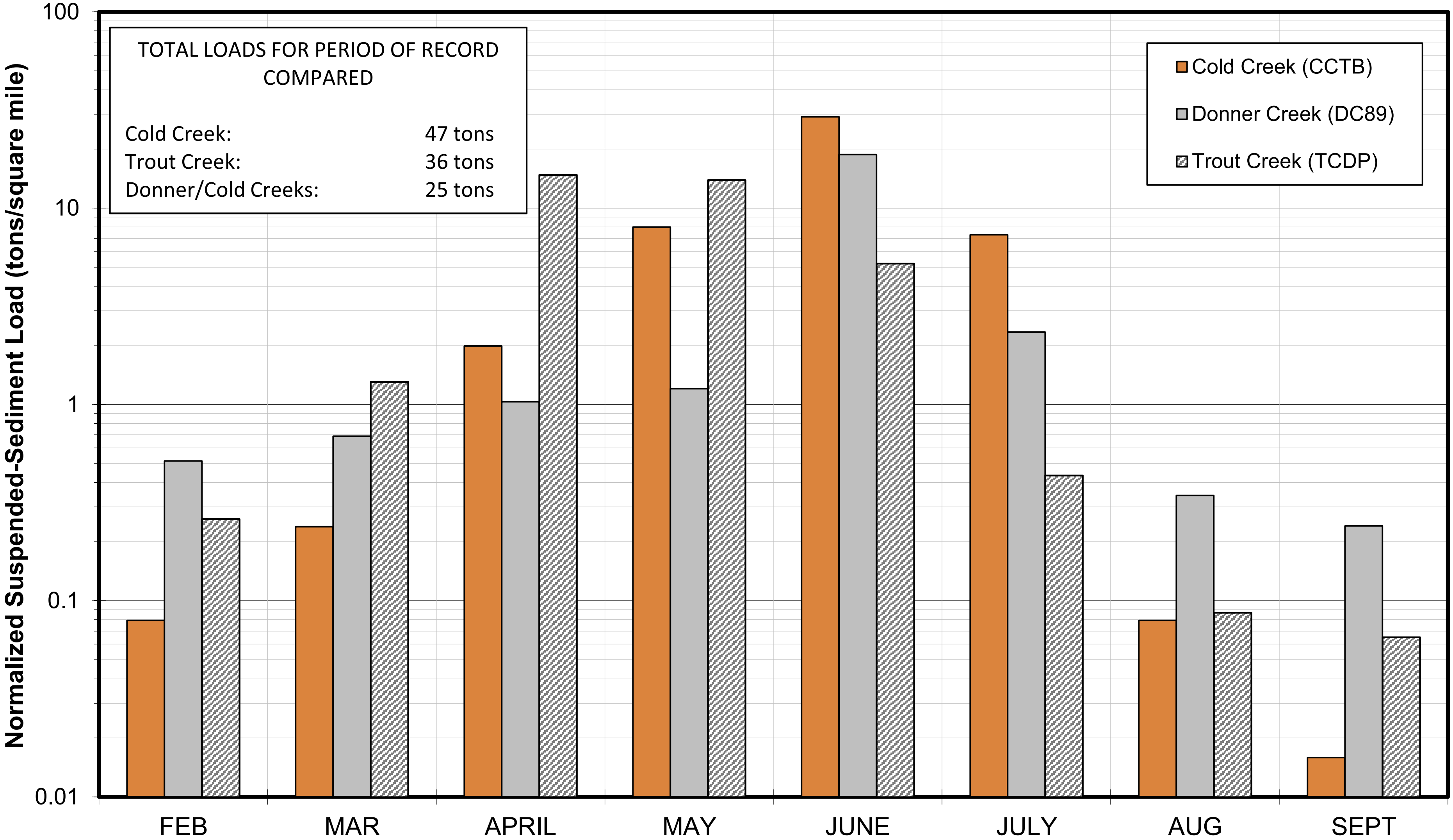
Figure 16. **Daily suspended-sediment load,Trout Creek at Donner Pass Road (TCDP), Truckee, California, Partial Water Year 2011.** The disparity in values between these two methods may be explainable by the wide variability in the streamflow-sediment transport relationship.



Note that the vertical axis is logarithmic.

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Figure 17. **Comparison of monthly normalized suspended-sediment loads, Donner/Cold Creeks and Trout Creek, near Truckee, California, partial Water Year 2011.** Data is computed from streamflow-based rating. Based on this parital water-year analysis most of the annual loads were measured during the months of peak snowmelt.

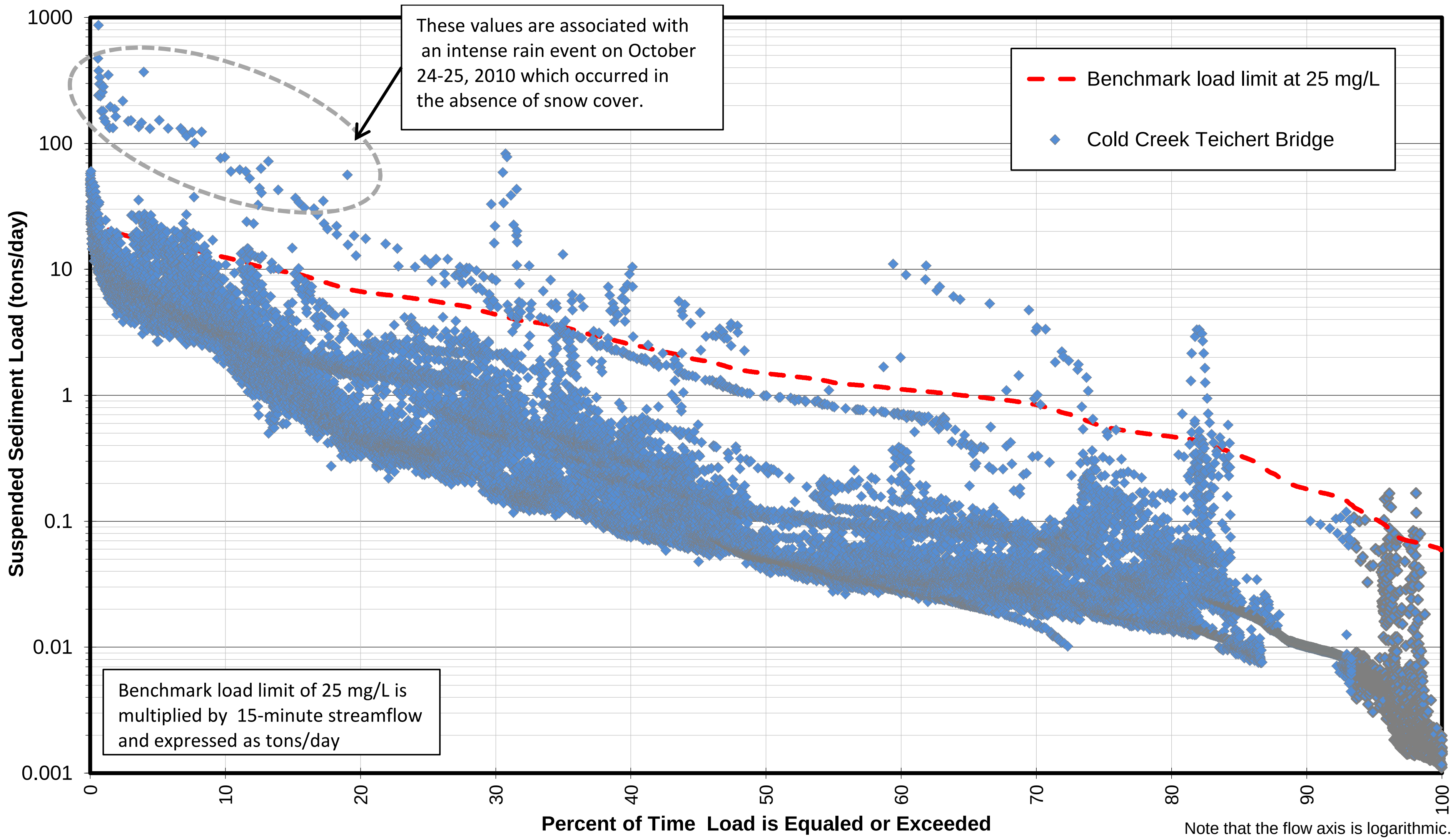

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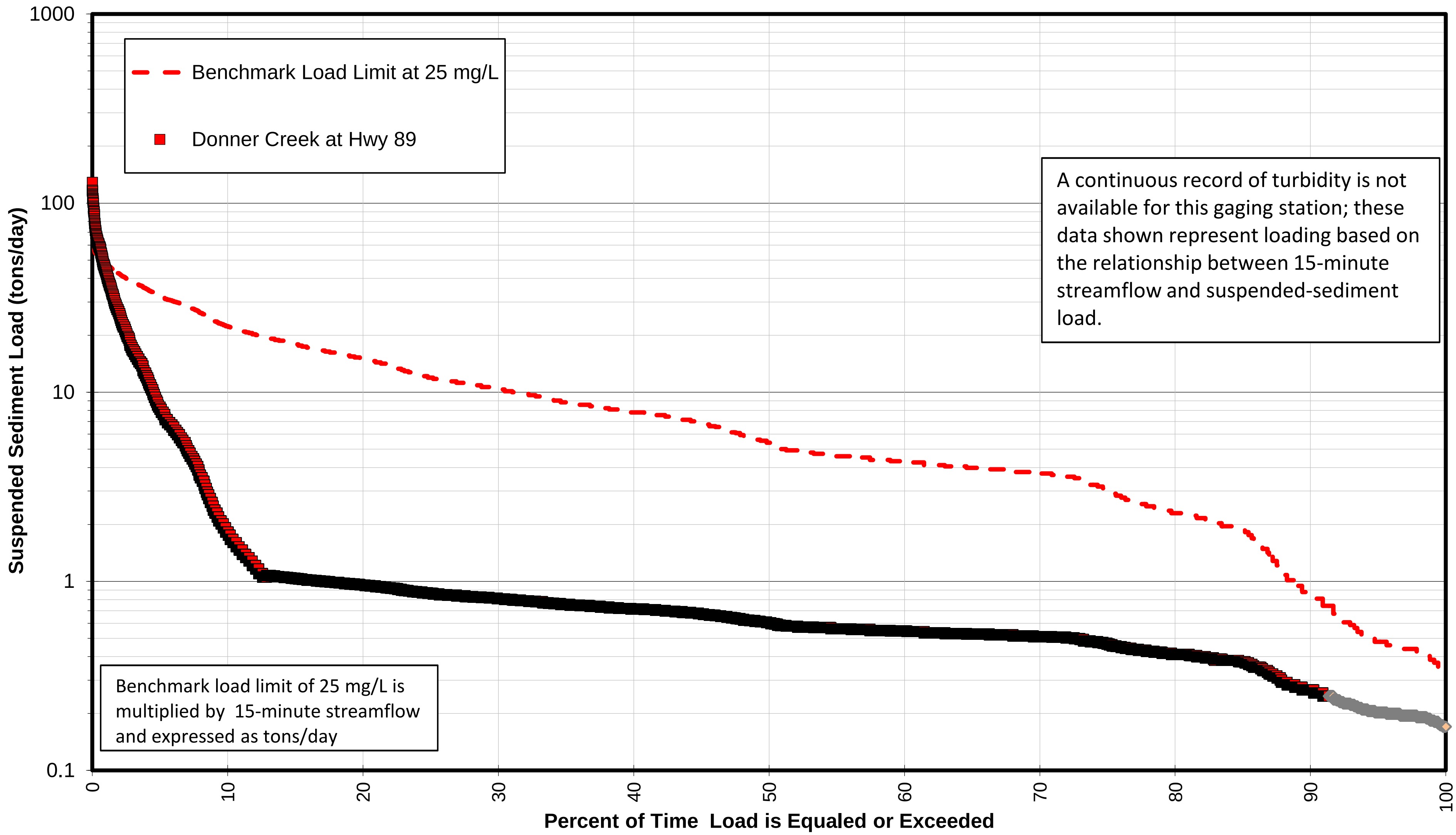
Figure 18. **Suspended-sediment load duration curve, Cold Creek at Teichert Bridge (CCTB), Truckee, California, water year 2011.** Most of the time suspended-sediment loads are well below the benchmark load limits for the Truckee River at Farad, but occasionally loads are higher. For instance, the first signficant rain event of the water year may generate a "first flush" of accumulated fines. The 25 mg/L benchmark was exceeded less than 1.5 percent of the total time according to the available data.



Note that the flow axis is logarithmic.

Figure 19. **Suspended-Sediment Load Duration Curve, Donner Creek at Hwy 89 (DC89), Truckee, California, water year 2011.** The suspended-sediment loads are significantly lower than the benchmark load limits with the exception of the least frequent or largest magnitude streamflows.

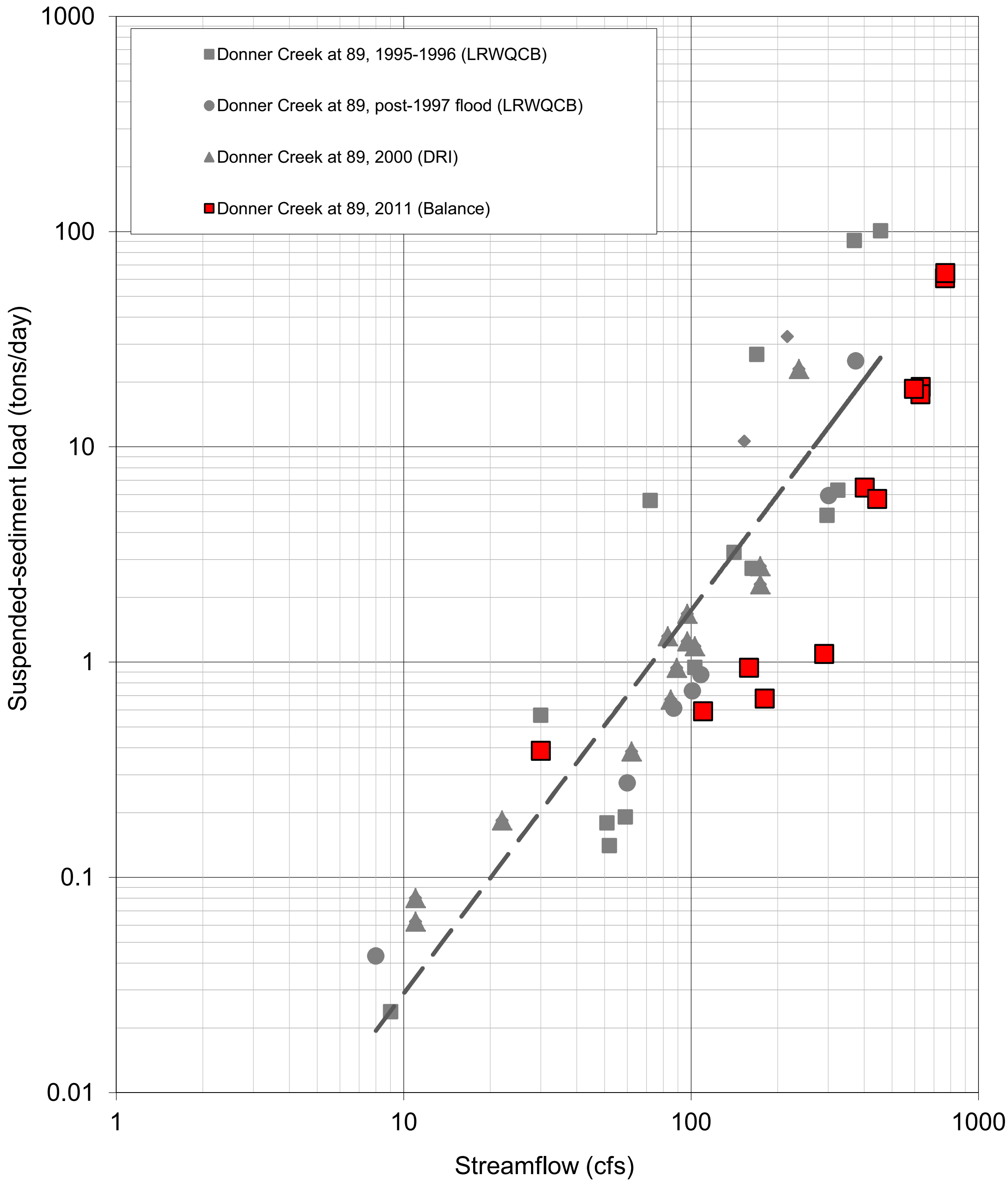


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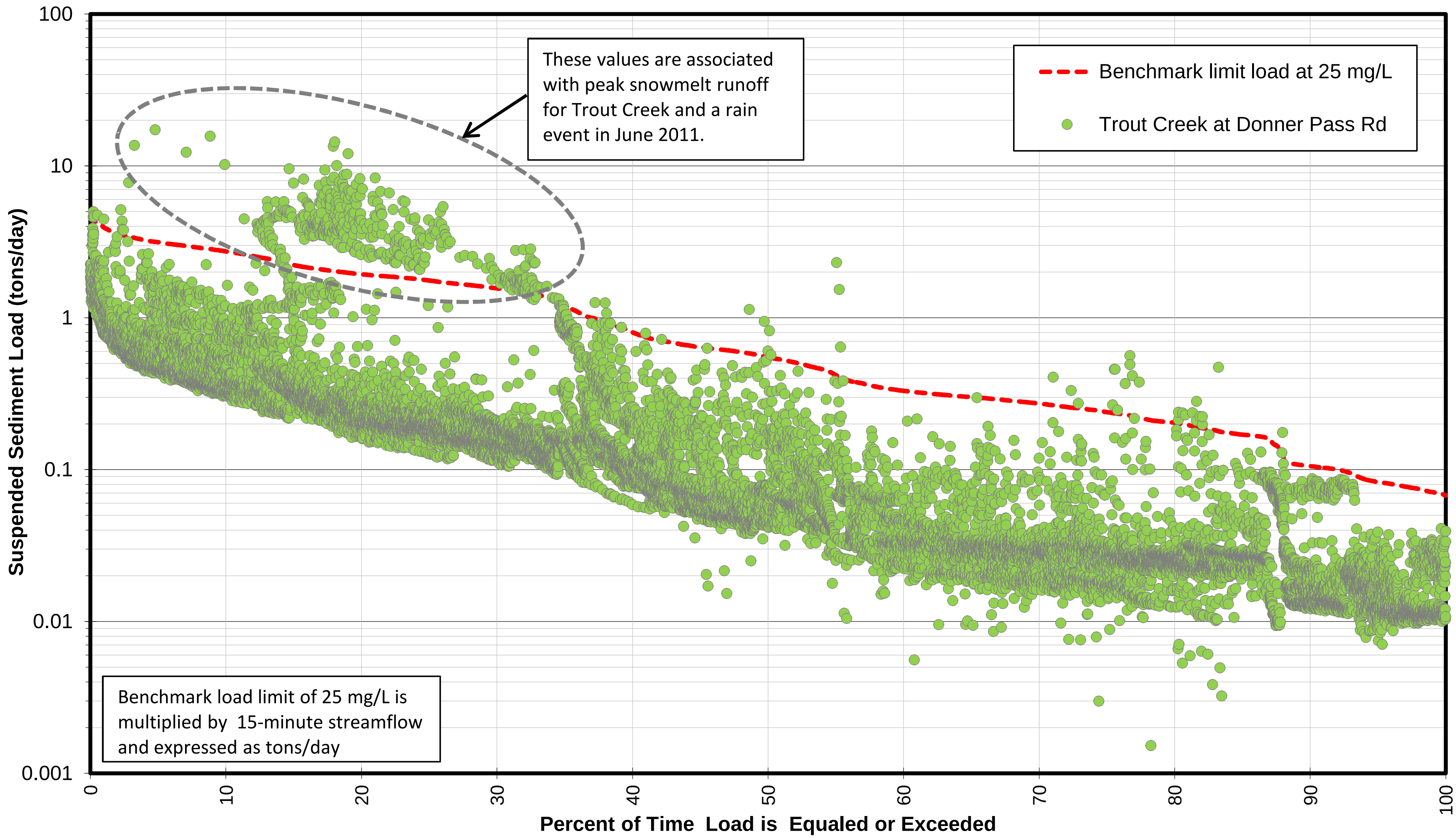
Figure 20. **Relationship between streamflow and suspended-sediment load for Donner Creek, WY1996-1997, WY2000, WY2011.** These data suggest that suspended-sediment loading from the watershed was lower



Note that the flow axis is logarithmic.

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Figure 21. **Suspended-sediment load duration curve, Trout Creek at Donner Pass Road (TCDP), Truckee, California, partial water year 2011** Most of the time, suspended-sediment loads are well below the benchmark load limit for the Truckee River at Farad, but occasionally loads are higher. In this case, less than 3 percent of the data exceeded the 25 mg/L benchmark load limit.

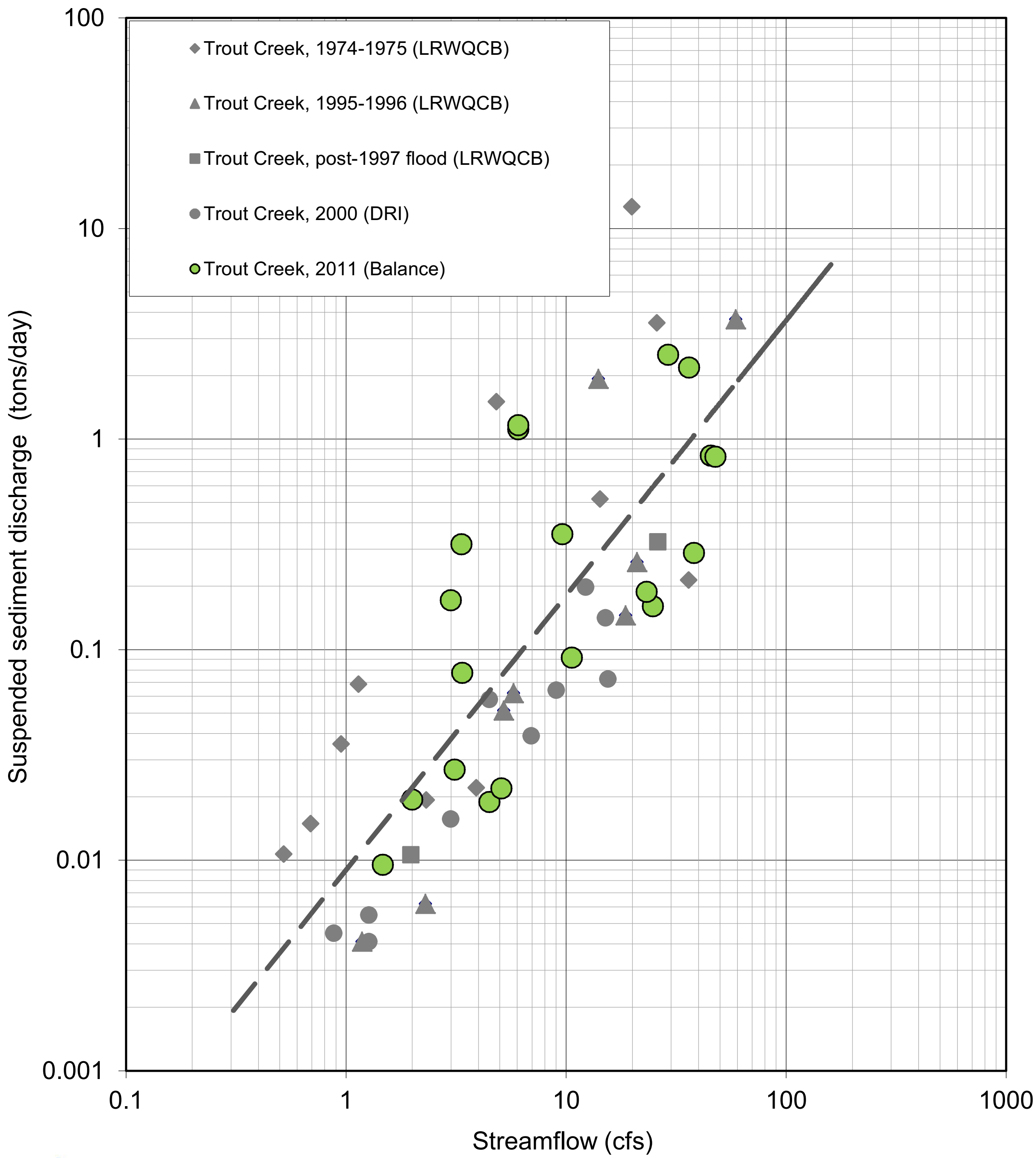

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Figure 22. **Relationship between streamflow and suspended-sediment load, Trout Creek above Donner Pass Road, WY1974-1975, WY1995-1997, WY2000, WY2011.** Data collected in WY2011 exhibit high variability but are similar to historical data.

APPENDICES

APPENDIX A
Streamflow gaging: Instrumentation and description of practice

APPENDIX A. STREAMFLOW GAGING METHODS

Station Instrumentation and Maintenance

The stream gages on Cold Creek and Trout Creek are equipped with Type C staff plates[1], continuous-logging, optical back-scatter turbidity sensors (OBS 3+), and Druck® pressure transducers connected to a Campbell Scientific datalogger. Two pressure transducers at each station are used for quality control and to provide redundancy in the event one malfunctions or becomes occluded. Pressure transducers were tested and calibrated over the range of anticipated depths of flow at each site prior to installation. Calibration while operating is documented by recording water levels at the time of each visit, as well as the height of any observed high-water marks deposited since the last visit. These observations are compared with the electronic record upon downloading. Turbidity sensors were calibrated using factory-calibrated solutions over a range of anticipated turbidity and the optical window is cleaned on a frequent basis. The dataloggers operate on a solar-powered 12-volt battery contained within a locked, water-resistant and sealed, hard-case enclosure.

Balance staff made roughly monthly visits to each gaging station during WY2011. During periods of rain or peak snow-melt, high-flow measurements were made more frequently. When manual flow and stage measurements were made, observers recorded the level of recent high-water marks, downloaded the dataloggers and inspected the instruments, and replaced datalogger batteries and desiccant as necessary. In the event that any instrument is malfunctioning (i.e., pressure transducer), they are repaired or replaced as soon as possible.

The stream gage on Donner Creek at Highway 89 is operated and maintained by the USGS Carnelian Bay Field Office. The quality of the data from this gage is rated as fair by USGS or +/- 8 percent of actual streamflow and is provided to the public initially as provisional data. Maintenance and calibration of this stream gage is presumed to be carried out by USGS on a regular basis.

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[1] Type C is 2.5 inches wide, graduated to hundredths and marked at every foot and every tenth.

Creating a Record of Streamflow

Balance utilizes standard streamflow equipment appropriate for the conditions encountered in the field, following standard USGS hydrographic practice (Carter and Davidian, 1968). This includes both hand-held, low-flow (Price Pygmy) and high-flow (Price Type-AA, or "Standard") bucket-wheel current meters. When conditions prevent safe entry into the stream, stream velocity-float measurements are conducted and a subsequent channel survey performed for the water level observed. Alternatively, when low-flow conditions prevail, alternative methods, acceptable by the USGS, are employed.

Based on periodic site visits, staff plate readings, and flow measurements, Balance creates and maintains a stage-to-discharge relationship ("stage-discharge rating curve") for each Balance-operated station where monitoring is conducted. Datalogger records of stream stage are corrected for instrument drift. The stage record obtained with datalogger and pressure transducer is converted to a flow record using the station stage-discharge rating curve. Stage shifts, usually caused by scour or deposition or ice and snow, are applied to the record of flow when necessary.

APPENDIX B1
USGS annual hydrologic record, Donner Creek at Highway 89, water year 2011 (USGS 10338700)

Appendix B1. Annual hydrologic record, Donner Creek at Highway 89 (DC89), Truckee, California, water year 2011

WY 2011 Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1	86.4	51.2	30.6	84.2	65.4	54.0	119	229	158	464	54.2	8.4
2	106	45.0	31.0	78.7	62.0	59.6	155	235	148	407	48.0	8.0
3	108	41.8	40.6	72.8	60.2	64.1	169	261	136	407	43.3	7.6
4	117	37.8	38.2	69.9	58.6	60.4	171	277	142	445	36.1	7.3
5	127	34.2	42.9	67.0	57.8	59.0	195	295	199	475	30.1	7.1
6	123	31.0	59.6	62.5	56.6	62.3	208	339	413	457	28.3	6.6
7	122	38.7	55.6	58.9	58.1	63.0	215	359	393	436	26.9	6.8
8	120	44.0	56.3	56.3	57.9	61.3	197	347	374	362	24.9	7.0
9	118	38.7	75.5	53.8	55.8	60.8	182	311	412	321	23.4	6.7
10	116	37.1	127	50.7	54.8	62.8	168	274	439	292	21.9	6.5
11	115	34.2	131	48.7	54.2	62.5	166	259	441	275	20.8	6.7
12	115	31.4	120	48.0	53.8	63.0	166	271	479	236	19.8	6.6
13	120	29.0	109	52.9	53.6	65.8	164	284	585	198	18.5	6.6
14	138	28.9	150	56.9	56.1	89.6	156	299	688	191	17.7	9.3
15	163	34.3	150	55.0	58.4	129	152	275	692	160	16.3	7.3
16	159	32.6	133	58.3	45.1	179	162	242	622	136	15.1	7.4
17	130	29.5	126	69.3	60.6	156	209	225	523	135	14.5	6.9
18	116	28.5	165	72.5	80.0	145	304	218	499	142	14.1	6.6
19	105	27.8	249	72.4	80.6	143	319	209	515	141	13.6	6.5
20	91.7	29.0	214	71.4	74.1	142	321	211	546	125	13.7	6.3
21	78.5	32.7	178	70.6	70.6	133	329	229	616	113	12.4	6.1
22	65.5	34.7	156	70.5	65.6	125	309	243	700	98.4	12.0	5.7
23	59.7	38.3	139	69.6	61.4	118	289	238	738	81.7	12.0	5.6
24	250	39.4	126	68.5	59.5	118	279	230	689	75.7	12.1	5.3
25	162	36.7	117	67.7	63.1	115	270	223	569	67.0	12.0	5.0
26	115	34.5	114	66.9	66.4	108	252	205	461	59.5	11.1	6.8
27	95.9	35.9	105	66.9	62.6	98.4	245	188	482	53.5	10.5	12.8
28	81.5	35.7	99.6	67.7	57.8	93.2	250	178	530	56.1	10.2	20.8
29	70.3	33.4	107	67.6		90.6	247	169	774	61.2	9.7	37.7
30	62.5	32.1	96.3	70.1		93.1	233	160	660	62.0	9.2	75.4
31	58.1		87.1	68.0		102.5		156		59.3	8.8	
MEAN	113	35.3	111	65.0	61.1	96.0	220	246	487	213	20.0	10.8
MAX. DAY	250	51.2	249	84.2	80.6	179	329	359	774	475	54.2	75.4
MIN. DAY	58.1	27.8	30.6	48.0	45.1	54.0	119	156	136	53.5	8.8	5.0
cfs days	3490	1058	3431	2014	1711	2976	6600	7640	14623	6589	621	323
ac-ft	6923	2099	6805	3995	3393	5902	13091	15154	29004	13069	1232	642

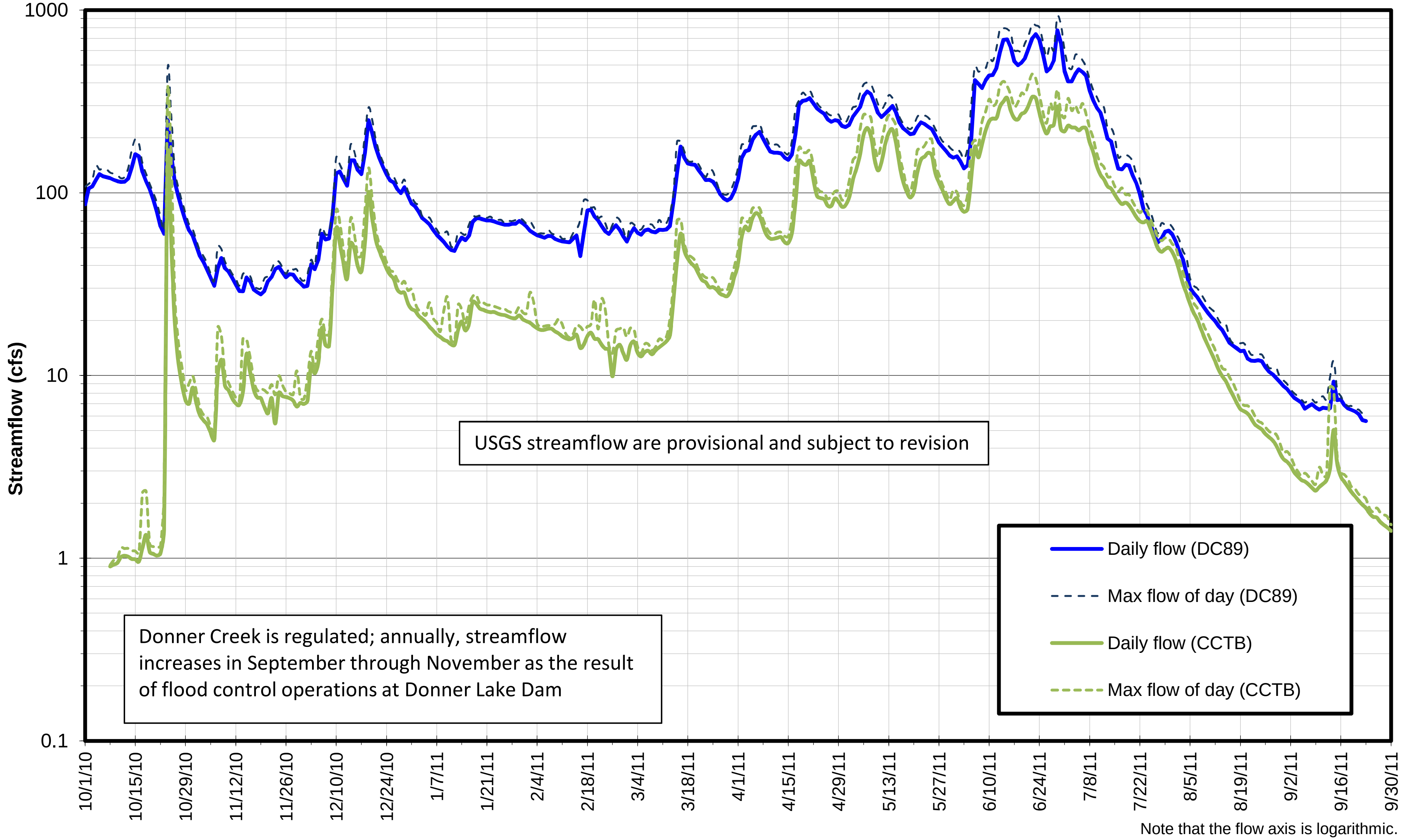
Comments

1. USGS provisional data, subject to revision
2. Gaging station location: 39° 19' 15.5" N, 120° 12' 28.6" W (WGS84), in Truckee, California. Gage is located approx. 0.59 miles upstream from the confluence with Middle Truckee River
3. Drainage area is 29.1 square miles above the gaging station; land use includes historical quarrying, timber harvesting, Union Pacific RR portions of Interstate Highway 80, residential and commercial zoned areas, and open space.
4. About half the drainage area is regulated at Donner Lake Dam
5. Streamflow includes contributions from Cold Creek tributary
6. Gaging station period of record: WY1993 to current water year

Water Year 2011 Totals:		
Mean flow	**140**	(cfs)
Max. daily flow	**774**	(cfs)
Min. daily flow	**5.0**	(cfs)
Annual total	**51,076**	(cfs-days)
Annual total	**101,308**	(ac-ft)

United State Geological Survey (USGS), Carnelian Bay Field Office

APPENDIX B2
USGS streamflow hydrograph, Donner Creek at Highway 89, water 2011 (USGS 10338700)



Appendix B2. **Streamflow hydrograph, Donner Creek at Highway 89 (USGS station ID10338700), Truckee, California, water year 2011.** Streamflow at Donner Creek at Highway 89 (DC89) includes the Cold Creek tributary. For comparison, the streamflow hydrograph for Cold Creek at Teichert Bridge (CCTB) is shown. Timing and magnitude of peak flows and trends are consistent between both gages. Differences in baseflow at the beginning of water year 2011 are related to annual releases to Donner Creek from Donner Lake Dam.