Middle Truckee River
Total Maximum Daily Load (TMDL)
Suspended Sediment Monitoring Report
Water Year 2013
Nevada County, California

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 Project Assignment No.: 210011

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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 two federally-listed fish species, cui-ui and Lahontan cutthroat trout. The Lahontan Regional Water Quality Control Board (Lahontan Water Board) has developed a Total Maximum Daily Load (TMDL) for suspended-sediment concentration (Middle Truckee River Sediment TMDL) to attain sediment-related water quality objectives in the Middle Truckee River, the segment of the Truckee River extending 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 third 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 in response to land management, sediment control strategies, and other implementation measures outlined in the TMDL.

Measurements and observations on three tributaries (Cold, Trout and Donner Creek) continued during water year 2013 at four stations. Monitoring, analysis and computations have been used to characterize suspended-sediment production and delivery (i.e. loads) from watersheds with differing land cover, and compare suspended-sediment loads for water year 2013 to measurements and estimates from previous years. We also have compared suspended-sediment loads and load durations to the target 90th percentile 25 mg/L suspended-sediment concentration benchmark set forth in the TMDL.

On Trout Creek and Cold Creek, we calculated suspended-sediment loads using two methods: 1) establishing relationships between instantaneous suspended-sediment loading rates and instantaneous streamflow (streamflow-suspended sediment rating curve), then 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. In the absence of a continuous-logging turbidity meter, loading on Donner Creek was calculated using only the streamflow-based rating curve method.

Our conclusions can be summarized as follows:

- Water year 2013 was the second year in a row with below-average precipitation, at roughly 64 percent of the long-term average; however, the annual peak flow in water year 2013 (December 2, 2012) was the largest measured in the three years of monitoring and was attributed to a rain-on-snow event. Below average snowpack and early snowmelt in April 2013 resulted in lower total annual runoff than previous years.

- o The two methods of calculating suspended-sediment loads at stations with turbidity probes produced different calculations of total loading, but similar loading trends. Total annual suspended-sediment loading from Cold Creek during water year 2013 was calculated to be 884 tons using the streamflow-based method, and 610 tons using the turbidity-based method. Total suspended sediment loading from Trout Creek during water year 2013 was calculated to be 22.4 tons using the streamflow-based method, and 13.4 tons using the turbidity-based method. Comparison of results between both methods suggests a continuous record of turbidity is better able to capture discrete events or more accurately assess changes in loading during an event, while the standard sediment rating curve may over-predict loads during winter-spring interstorm periods.
- o Water year 2013 was noted for the rain-on-snow event which caused streamflow to peak on December 2, 2012. Suspended-sediment loads measured during this single day were also notable and equaled between 13 percent to as high as 64 percent of total annual load, depending on the gaging station.
- o When water year 2013 suspended-sediment loads are normalized by watershed area, our results continue to indicate Donner Creek at West River as a point where yields are the greatest (54 tons/square mile); while Cold Creek (tributary to Donner Creek) also registered measurable yields this year (48 tons/square mile). Suspended-sediment yields on Trout Creek at Donner Pass Road were calculated to be 3 tons/square mile, significantly less than the other tributaries.
- o Three monitoring stations in the Donner/Cold Creek watershed provide an opportunity to evaluate loading and yields between stations. Based on this analysis, monitoring results continue to highlight abundant loading or yield (323 tons or 800 tons/square mile) that occurs along the last 0.5 mile of stream along Donner Creek between State Route 89 and the confluence with the Truckee River. Review of Town of Truckee draft stormwater maps suggest heavily trafficked, impervious areas drain directly to Donner Creek in this reach.
- o In water year 2013, load duration curves for Cold Creek, Donner Creek and Trout Creek showed that these streams met the target 90^{th} percentile suspended-sediment concentration of less than or equal to 25 mg/L established in the Middle Truckee River Sediment TMDL.

While results from suspended-sediment monitoring continue to show compliance with the Middle Truckee River sediment TMDL, results from other metrics and studies indicate that beneficial uses in the Middle Truckee River continue to be impaired. Recent bioassessment studies conducted by Dr. David Herbst show that beneficial uses including “Cold Freshwater Habitat” and “Spawning Reproduction and Development” are likely to not be fully supported in the Middle Truckee River due to impacts on the base of the food web and excess deposited fine sediment. These results may suggest that the TMDL for suspended-sediment may require review and possible revision, or perhaps that suspended sediment concentration may not be the best indicator of impairment.

1. INTRODUCTION AND PROJECT PURPOSE

1.1 Introduction

This report is the third 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, the segment of the Truckee River extending from the outflow of Lake Tahoe at Tahoe City to the California-Nevada state line near Farad, California (**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 Total Maximum Daily Load (TMDL) for Sediment, Middle Truckee River Watershed (Middle Truckee River Sediment TMDL), established by the Lahontan Regional Water Quality Control Board (Lahontan Water Board).

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 SWRCB reclassified the Middle Truckee River from intermediate to impaired for excessive sediment and placed it on the 303(d) list under the Clean Water Act (Amorfini and Holden, 2008; Lahontan RWQCB, 2008). Effects of excessive sediment on aquatic habitat have been well-documented in the literature.

In response to the 303(d) listing, the Lahontan Water Board developed a TMDL for sediment to attain sediment-related water quality objectives for protection of in-stream aquatic life and beneficial uses (Amorfini and Holden, 2008). The Middle Truckee River Sediment TMDL establishes sediment load allocations for particular subwatersheds and intervening areas, with the total sediment load allocation for the entire Middle Truckee River watershed (**Figure 1**) set at 40,300 tons per year. The TMDL consists of a number of indicators and target values for each indicator. However, 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 at Farad, the downstream terminus of the Middle Truckee River segment at the Nevada state line. 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 and erosion control on ski slopes, as well as for restoration activities such as decommissioning of dirt roads and repair of legacy sites. In order to evaluate the effectiveness of control measure implementation, targeted tributaries or subwatersheds of concern must be monitored, 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 (on file with TRWC), unless otherwise noted.

Figure 2 shows the locations of the four Middle Truckee River monitoring stations used for this study. Balance installed two of the gaging stations, then monitored continuous streamflow and turbidity and collected suspended-sediment samples over a range of flows and at each station during water year 2013 (WY 2013). [1]

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

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

Balance staff also collected suspended-sediment samples over a range of flows at two locations on Donner Creek during WY 2013:

3. U.S. Geological Survey (USGS) streamflow gaging station: Donner Creek at Highway 89 near Truckee, California (DC89; USGS 10338700)

4. Donner Creek at West River Street (DCWR), Truckee, California

The hydrologic setting and description for each of these gaging stations is presented in greater detail in subsequent sections.

Similar studies are currently being carried out on the mainstem of the Truckee River by CDM Smith and Balance Hydrologics which began in January 2013. As part of that work, Suspended-sediment loads are being computed for two stations: 1) Truckee River above Truckee at USGS 10334800, and; 2) Truckee

[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 2013 began on October 1, 2012 and ended on September 30, 2013.

River at Boca Bridge, USGS 10344505. Results from partial WY 2013 are reported in CDM Smith and Balance Hydrologics (2013).

1.2 Project Purpose

This report presents monitoring results from WY 2013, the third year of a multi-year monitoring program at three tributaries to the Truckee River and the second year of monitoring at station DCWR. The objectives of this report are to:

- Briefly describe what, where, and how measurements were made for parameters such as streamflow, suspended-sediment concentration, turbidity, specific conductance, and water temperature[2];
- Interpret the resulting flow, turbidity and suspended-sediment monitoring data;
- Summarize and report daily and annual streamflows, and suspended-sediment loads for all four stations, and;
- Compare WY 2013 suspended-sediment loads with loads from previous water years collected as part of this study and historical loads computed from previous studies.

1.3 Hydrologic Setting

As shown in **Figure 1**, the Upper Truckee River Basin includes the waters of Lake Tahoe. The Middle Truckee River flows out of Lake Tahoe at Tahoe City, and then passes through Truckee, with this segment terminating at the Nevada State line. The lower Truckee River flows from the state line east through Reno, Nevada, finally discharging into Pyramid Lake.

The hydrology of the Middle Truckee River Basin has been described in detail by others (Amorfini and Holden, 2008, Nichols Consulting Engineers, 2008; MacGraw and others, 2001). 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 of Donner Creek in the Town of Truckee, California. The drainage area is approximately 12.6 square miles at the gaging station, located approximately 1,500 feet upstream from the confluence with Donner Creek. The watershed ranges in elevation from 5,940 feet in Truckee to

[2] Water temperature and specific conductance were measured on a monthly basis, or sometimes more frequent basis; while these two parameters are important in evaluating aquatic habitat conditions, they are not pertinent to the focus of this report and are not discussed further herein.

8,836 feet[3] at the crest of the Sierra Nevada Mountains and receives a total average-annual precipitation of 48.9 inches (USGS Streamstats, 2013). 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 pattern of streamflow tends to be dominated by spring snowmelt, punctuated by increases from occasional rain events.

The Cold Creek watershed[4] 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). Historical 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 (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, with expanses of granitic bedrock exposed in the upper watershed.

1.3.2 Donner Creek

Donner Creek drains a 29.1-square mile watershed at the USGS gage at Highway 89; this area increases to 29.5 square miles at West River Street where it discharges to the Truckee River. The Cold Creek watershed accounts for almost half of this area (12.6 square miles). In addition, approximately 14.3 square miles of the upper watershed for Donner Creek drains to Donner Lake, which is regulated by a small dam. Thus, while streamflow in Donner Creek is influenced by snowmelt and rainstorms, it is also regulated by detention in and controlled releases from Donner Lake as described in more detail below.

The Donner Creek watershed ranges in elevation between 5,890 feet at the mouth of Donner Creek and 8,836 feet at the crest of the Sierra Nevada Mountains. Total average-annual precipitation over the watershed is 46.9 inches (USGS Streamstats, 2013). Vegetation varies with elevation, aspect and soil type, but is primarily a conifer forest with areas of exposed bedrock, scrub and brush. Similar to Cold

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

[4] Also identified on USGS maps and known locally as 'Coldstream Canyon'

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, which left behind large-scale moraine features, deposits and outwash (Birkeland, 1963). Historic land uses within the Donner Creek watershed include mining, construction of the Union Pacific railroad and timber harvesting. Construction of I-80 and other local roads resulted in channel realignment and modifications. Today, the lower watershed below Donner Lake includes portions of I-80, as well residential and commercial areas of Truckee, which drain through stormwater outfalls to the reach of Donner Creek downstream of Highway 89. To assess suspended-sediment contributions from these sources, the study added another station at West River Street and monitoring began in WY 2012.

As mentioned above, Donner Creek is regulated at Donner Lake. 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 flood control requirements. 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 without detention (Berris and others, 2001).

1.3.3 Trout Creek

Trout Creek drains a mostly low-density residential area in the upper watershed and a small urban component in the lower watershed with contributions from Interstate-80. The watershed ranges in elevation between 5,820 feet at the confluence with the Truckee River and 7,412 feet at the divide with Donner Creek. This watershed is located slightly east of the crest of the Sierra Nevada Mountains and as a result, differs slightly in its precipitation regime. Total average-annual precipitation over the watershed is 37.4 inches (USGS Streamstats, 2011). Similar to the Donner Creek/Cold Creek watershed, 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). The lower watershed, where Trout Creek formed an alluvial fan at the confluence with the Truckee River, has also been subject to considerable disturbance due to construction of the Union Pacific Railroad and development of the Town of Truckee. The Town is currently implementing a phased restoration of the lower reaches of Trout 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 intermittently operated a stream gage on Donner Creek at Donner Lake (USGS 10338500) from WY 1910 to the present. Flows recorded at this gage have been regulated by the dam on Donner Lake since 1928. Mean annual flows after 1928 have ranged from 7.7 to 83.3 cubic feet per second (cfs). The peak instantaneous flow for the period of record was measured at 863 cfs on January 2, 1997.

The USGS operates another 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. The peak instantaneous flow for the period of record was measured at 2,500 cfs on January 2, 1997. This study utilizes this station (Donner Creek at Highway 89, DC89) for evaluation of suspended-sediment loads in Donner Creek.

1.4.2 Sediment load monitoring

In supporting development of the Middle Truckee River Sediment TMDL, McGraw and others (2001) used historical data to develop a relationship between streamflow and suspended-sediment load and estimate annual sediment loads for 10 major tributaries to the Truckee River, including Donner Creek and Trout Creek. Based on this information, the Lahontan Water Board (Amorfini and Holden, 2008) established the Middle Truckee River Sediment TMDL, identified a sediment loading capacity, and computed 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 Donner Creek and Trout Creek, but not for Cold Creek, although sediment contributions from the Cold Creek subwatershed are embedded in these historical Donner Creek data.

River Run Consulting (2007) completed a watershed assessment for Cold Creek. The report discusses sediment sources and developed estimates of suspended-sediment loads based on surveyed sediment sources as well as work completed by McGraw and others (2001).

1.4.3 Bioassessment

Herbst and others (2013) used a large number of patch-scale or small-scale area samples along the Middle Truckee River to evaluate changes in macroinvertebrate communities in relation to the cover of fine and sand particles on the bed.

1.4.4 Bed Conditions Assessment

Prior to Herbst studies, Balance Hydrologics completed baseline bed conditions monitoring in WY 2010 and WY 2011 (Donaldson and Shaw, 2012). Monitoring included bed conditions mapping at three representative reaches along the mainstem of the Truckee River using standard and acceptable hydrographic practices.

2. STATION DESCRIPTIONS

Measurement of streamflow and establishment of a streamflow record is the first step towards computation of a sediment load. This chapter provides descriptions of the stream gaging stations used in this study. The streamflow gaging instrumentation and methods used to create a record of streamflow are described in **Appendix A**. The different types of sediment transport and the methods and equipment used to collect suspended-sediment samples or measure turbidity are described in **Chapter 3**.

2.1 Cold Creek at Teichert Bridge (CCTB) Description

The location of the Cold Creek gaging station (CCTB) 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 right (east) bank of the Teichert Quarry property, approximately 1,500 feet upstream from the confluence with Donner Creek at latitude/longitude 39º19’13.1”N, 120º13’36.7”W (WGS84). The watershed area above the gaging station is approximately 12.6 square miles. Water-level (stage) at this gage is occasionally affected by ice.

2.2 Trout Creek at Donner Pass Road (TCDP) Description

The location of the Trout Creek gaging station (TCDP) 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. Stage at this gage is occasionally affected by ice.

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

The location of the Donner Creek at Highway 89 (DC89) gaging station is shown in **Figure 2.** The period of streamflow record for this gage is from March 1993 (WY 1993) through the current water year and operated and maintained by the USGS. The station is located at 39°19’15.5”N, 120°12’28.6”W (WGS84), 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. The watershed area above the DC89 gaging station is 29.1 square miles and includes the Cold Creek subwatershed (12.6 square miles). This report uses a watershed area of 14.8 square miles for computation of suspended-sediment yields at this gage, specifically excluding the upper watershed including Donner Lake (14.3 square miles). As in previous studies, we have assumed that the lake is an effective trap for sediment emanating from the upper watershed[5]. Stage at this location is regulated and is occasionally affected by ice.

2.4 Donner Creek at West River Street (DCWR) Description

The location of the Donner Creek at West River Street (DCWR) station is shown in **Figure 2.** This station does not include instrumentation; it is used for collection of suspended sediment samples and limited streamflow measurements. Both sampling and measurements are conducted at the West River Street Bridge, approximately 0.57 miles downstream from the Donner Creek at Highway 89 station and approximately 150 feet upstream of the confluence with the Middle Truckee River at the point 39°18’59” N, 120°12’3.7”W (WGS84). The watershed area above this gaging station is 29.5 square miles and includes the Cold Creek subwatershed. There are no natural tributaries that enter Donner Creek between DC89 and DCWR; however, there are at least 6 stormwater outfalls. For the purposes of computing suspended-sediment yields at this gage, this report uses streamflow[6] reported upstream at USGS 10338700 and a watershed area of 15.2 square miles which excludes the upper watershed area and Donner Lake for the same reasons described above.

[5] Balance hydrologists have made several observations at the dam outlet when Donner Lake is spilling to Donner Creek to support this assumption.

[6] Balance hydrologists have made several manual measurements of streamflow at DCWR over a range of stage and found that they roughly equal flows reported by USGS.

2.5 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 (**Figure 2**), including:

- Truckee River near Truckee, USGS 10338000
- Truckee River at Boca Bridge near Truckee, USGS 10344505

In WY 2013, both of these gages were used as part of the Town of Truckee's Truckee River Water Quality Monitoring Program to develop estimates of sediment loading upstream and downstream from the tributaries assessed in this report (CDM Smith and Balance Hydrologics, 2013).

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 suspended 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 or saltates along the streambed, 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 and transported at a rate approaching the mean velocity of flow. This study supports the Middle Truckee River Sediment TMDL through collection and interpretation of suspended-sediment samples; bedload sediment is not sampled for this study.

3.2 Suspended-Sediment Sampling Equipment

Balance staff used standard equipment and methods adopted by the Federal Interagency Sedimentation Project (FISP) to make measurements of suspended-sediment transport. This equipment 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

Suspended-sediment samples were collected at channel locations exhibiting the most ideal characteristics (i.e., straight reach) for the flow event sampled, but always in close proximity to the gaging station. Streamflow was measured or estimated each time sediment was sampled. Suspended-sediment samples were collected using the Equal Transit Rate (ETR) method: each sample is collected by raising and lowering the sampler at a number of equally-spaced verticals across the stream channel; collection in each vertical is integrated across the full depth of the water column; and a constant transit rate is maintained while raising and lowering the equipment 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 elapsed seconds per sample. Following this protocol to expedite sampling avoids the confounding effects of significant changes in sediment transport rates due to rapidly fluctuating streamflows.

Each sample is then transferred to a clean 500 milliliter (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 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 parameters, suggesting that both TSS and SSC are reliable for calculating suspended-sediment loads, especially at flows of less than 500 cfs[7]. For the remainder of this report, we use the term SSC when referring to suspended-sediment concentrations of samples collected for this study.

Use of the suspended-sediment data to calculate suspended-sediment transport rates ('loads') is explained in the next chapter.

3.4 Turbidity Monitoring

Turbidity was measured at the Cold Creek (CCTB) and Trout Creek (TCDP) stations using Optical Back-Scatter (OBS 3+) submersible turbidity probes with a range of up to 4,000 NTUs. Near-continuous turbidity values, measured in nephelometric turbidity units (NTUs), were recorded every 15 minutes together with measurements of stream stage.

[7] The fundamental difference between SSC and TSS analytical methods is the use of the sample; a TSS analysis generally entails withdrawal of an aliquot of the original sample for subsequent analysis, while the SSC method uses the entire water-sediment mixture to calculate SSC values.

4. CREATING A RECORD OF SUSPENDED-SEDIMENT LOAD

In this section, we describe the two methods used in this study 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 instantaneous streamflow, either from concurrent manual measurements or from the electronic record. Samples are analyzed at the laboratory for TSS (mg/L), and then the results are converted to suspended-sediment loads by multiplying the TSS concentration by the instantaneous streamflow (cfs) and applying a factor of 0.0027 to convert the units into tons/day. This approach allows SSC loading data to be graphed against 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 variation and error in sediment load computations, we evaluated potential temporal patterns in the data. Data was separated by season (e.g., pre-snowmelt peak runoff vs. post-snowmelt peak runoff) and position on the storm hydrograph (e.g., rising limb vs. falling limb). Where differences were observed, separate relationships (equations) were developed. 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 additional 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 and TCDP), measurements of instantaneous turbidity (NTU) at the time of suspended-sediment sample collection (SSC, in mg/L) results in a definable relationship that, according to the literature (MacDonald and others, 1991), can explain at least 80 percent of the variation in suspended-sediment concentrations. 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 Creek and Trout Creeks, where near-continuous turbidity data were available, turbidity values were used as a second technique, in addition to the streamflow-to-suspended-sediment load method described above, to estimate suspended-sediment loading in WY 2013.

We note that 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 visits in WY 2013 to evaluate site conditions and instrument integrity. Furthermore, the station equipment was upgraded during the summer of 2013 to provide real-time internet monitoring of field data[8] resulting in faster identification and correction of these conditions when they occurred.

[8] Real-time data can be viewed at http://www.balancehydro.com/onlinegaging.php

5. WATER YEAR 2013 HYDROLOGIC SUMMARY

Balance staff visited the stream gages monthly and made 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 WY 2013 precipitation and snowmelt trends and concludes with a description of flow conditions during the period, including peak flows, baseflows, and other relevant observations.

5.1 Annual Precipitation

Precipitation data used for this study was evaluated from two precipitation stations, both operated by the USDA Natural Resources Conservation Service: 1) Station 'Truckee 2' in Placer County at 6,400 feet (CDEC Station ID: TK2), and; 2) the Central Sierra Snow Laboratory (CSSL), at 6,950 feet near Donner Pass (CDEC Station ID: CSSL). These stations provide precipitation measurements covering the range of elevations present in the gaged watersheds considered in this study. Data from CSSL provides context for evaluating snowpack and snow-melt water-equivalency in relation to the spring snowmelt hydrology.

Cumulative annual precipitation for Truckee, California is illustrated in **Figure 3** for WY 2011, WY 2012, and WY 2013. Snowpack as snow-water equivalent is presented in **Figure 4** for WY 2011, WY 2012, WY2013. Approximately 25.9 inches of precipitation were recorded for WY 2013, similar to WY 2012 and about 64 percent of the long-term average annual precipitation of 40.34 inches for the TK2 station (CDEC, 2013). WY 2013 is the second consecutive year with well below average precipitation. WY 2013 also had below average snowpack during much of the year, similar to WY 2012, but in contrast to the very high snowfall and snowpack during WY 2011 (see **Figure 4**).

WY 2013 began with several snow events in the fall, a 2.1-inch storm between October 23 and 25, 2012. A rain-on-snow event beginning on November 28, 2012 and continuing through December 5, 2012 dropped 7.0 inches of rain on the Middle Truckee River and tributaries. Late December was characterized by a cold period with heavy snow accumulation, and brought the snowpack to near normal conditions by January 1, 2013.

After the late December snow, conditions remained relatively dry and cold period. While these conditions maintained the snowpack, no additional accumulation was noted until early March and early April. On March 1, snowpack was 63 percent below long-term average. The spring was unusually early – the snowpack had melted by late April. Peak snowmelt also occurred in April, more than 45 days earlier than the historical average peak runoff. The summer was relatively warm, punctuated with a few afternoon thunderstorms, notably on May 7-8, 2013 (1.2 inches), and September 22-23 (0.6 inches).

Rainfall amounts and intensities vary geographically with localized storms and the effects on streamflows differ. For instance, a thunderstorm on June 26, 2013 generated 1 to 2 inches of rainfall along Sierra Crest and caused an increase in streamflow in tributaries draining the Sierra Crest, including Cold Creek. During this event, however, only 0.1 inches was measured in Truckee. Similarly, on July 3, 2013, 1.6 inches of precipitation was measured in a 3 hour period at Squaw Valley (CDEC ID: SQV, 2013) and resulted in considerable runoff to Squaw Creek and the Truckee River. No rainfall or increases in streamflow were recorded in Truckee or at stations used for this study. These events also highlight the importance of tributary monitoring.

5.2 Cold Creek at Teichert Bridge (CCTB): 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 streamflow is illustrated in **Figure 5**.

WY 2013 began with baseflow of less than 0.5 cfs, much less than previous years and likely the result of a dry WY 2012. Streamflow gradually increased through the fall with small peaks resulting from rain and rain-on-snow at higher elevations in the watershed. Before streamflow could recede to baseflow conditions, a significant rain-on-snow event during the period November 28 and December 5, 2012 resulted in considerable runoff and the annual peak flood (1,004 cfs, December 2, 2012). Streamflow receded to winter baseflows (10 cfs) during the subsequent cold period with measurable snowfall in late December. Dry, but continued cold conditions, persisted through January and most of February with steady winter baseflows. Warmer conditions prevailed in early March and initiated the beginning of the spring snowmelt runoff period. Peak snowmelt runoff (115 cfs) occurred on April 29, 2013, roughly an order of magnitude less than the annual peak flood from earlier in the water year. This difference illustrates the influence of rain-on-snow events on hydrology and suspended sediment loading, but also reflects the much below-average snowpack in WY 2013. Streamflow receded through May and through the summer months with only several notable increases as the result of thunderstorms or fall frontal storms. These included May 28, 2013 (63.7 cfs), June 25, 2013 (50.3 cfs), September 13, 2013 (1 cfs), and September 21, 2013 (1.3 cfs). Similar to the beginning of the water year, baseflows fell below 0.5 cfs through the end of the water year. The annual mean flow for Cold Creek at Teichert Bridge in WY 2013 was 21 cfs, equal to annual runoff of 14,884 acre-feet.

5.3 Donner Creek at Highway 89 (DC89; 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 flows for WY 2013 at Donner Creek above Highway 89. **Table 2** documents Balance observations and measurements made during site visits to the gage. The WY 2013 streamflow hydrograph for DC89 is illustrated in **Appendix B2.**

Donner Creek is a regulated creek and streamflow typically increases with releases averaging about 100 cfs between September and late October. Upon cessation of Donner Lake releases in WY 2013, baseflows averaged around 15 cfs in early November. Streamflow gradually increased through the fall with small peaks resulting from rain and rain-on-snow at higher elevations in the watershed. A significant rain-on-snow event during the period November 28 and December 5, 2012 resulted in considerable runoff and the annual peak flood (1,150 cfs, December 2, 2012), most of which originated from Cold Creek. Streamflow receded to winter baseflows (between 30 cfs and 45 cfs) during the subsequent cold period with measurable snowfall in late December. Dry and cold conditions persisted through January and most of February and maintained winter baseflows at this rate. Warmer conditions prevailed in early March and initiated the beginning of the spring snowmelt runoff period. Peak streamflow (161 cfs) as the result of snowmelt occurred on March 31, 2013, significantly earlier than Cold Creek (April 29, 2013) and is likely due to the fact that the watershed below Cold Creek and Donner Lake is more urbanized; snowmelt is more rapid in these areas. Streamflow receded through May and through the summer months. Releases from Donner Lake began in late August and continued through end of the water year at a steady 60 cfs. The annual mean flow for Donner Creek at Highway 89 in WY 2013 was 58 cfs, equal to annual runoff of 42,125 acre-feet.

5.4 Donner Creek at West River Street (DCWR): Hydrology

Table 3 documents observations and measurements made during site visits to Donner Creek at West River Street. The Donner Creek drainage area increases by 0.4 square miles between Highway 89 and West River Street. The expanded area does not include any natural tributaries; however it does include a number of stormwater outfalls within the Town of Truckee. In an effort to evaluate differences in streamflow between Highway 89 and West River Street, three streamflow measurements were made over a range of flows during WY 2012 and the results were compared to streamflows measured at the Donner Creek at Highway 89 station, as reported by the USGS. There was no appreciable difference between streamflow at the two stations. Thus, the USGS streamflow record at the DC89 station and the pattern of annual streamflow described above (Section 5.3) for DC89 are applicable to DCWR and has been used for interpretation of hydrology and computation of sediment loading at DCWR.

5.5 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 WY 2013. **Table 4** documents observations and measurements made during site visits to the gage. Daily streamflow is illustrated in **Figure 6**.

WY 2013 began with baseflow between 0.3 cfs and 0.5 cfs. Streamflow gradually increased through the fall with small peaks resulting from rain. A significant rain-on-snow event during the period November 28 and December 5, 2012 resulted in considerable runoff and the annual peak flood (81 cfs, December 2, 2012). Streamflow receded to winter baseflows (10 cfs) during the subsequent cold period with measurable snowfall in late December. Streamflow during the period December 13, 2013 through February 14, 2013 was affected by ice, so mean daily flow for this period was correlated with a nearby stream gage of similar elevation and size (Sagehen Creek near Truckee, California, USGS 10343500). Warmer conditions prevailed in early March and initiated the beginning of the spring snowmelt runoff period. Peak streamflow (17.6 cfs) as the result of snowmelt runoff occurred on March 20, 2013. Trout Creek's lower watershed elevation, greater distance east from the Sierra Nevada crest, and more urbanized watershed likely contributed to an earlier snowmelt runoff peak relative to other tributaries. After peak snowmelt runoff occurred, streamflow receded through the spring and summer months with only several notable increases as the result of thunderstorms or frontal storms. These included May 6, 2013 (5.2 cfs), May 28, 2013 (2.4 cfs), June 25, 2013 (1.4 cfs), and September 21, 2013 (2.0 cfs). Baseflows at the end of the water year were similar to those recorded in the beginning of the water year (0.4 cfs). The annual mean flow for Trout Creek at Donner Pass Road in WY 2013 was 2.2 cfs, equal to annual runoff of 1,587 acre-feet.

6. WATER YEAR 2013 SUSPENDED-SEDIMENT LOAD AT A STATION

This chapter summarizes and compares the suspended-sediment loads calculated for each of the gaging stations monitored in WY 2013. Loads were computed using streamflow-based methods at all four stations and turbidity-based methods at the two stations equipped with turbidity probes (i.e., CCTB, TCDP).

Langlois and others (2005) studied the relationship between streamflow and suspended-sediment concentration in snowmelt-dominated systems on the eastern (Nevada) side of Lake Tahoe. They found that the relationship differs during the rising and falling limbs of the snowmelt-dominated hydrograph, with greater loading measured on the rising limb than on the falling limb for a given streamflow. 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, *unless* these relationships can be defined with adequate sampling and monitoring. In an effort to address this concern, we evaluated our data on a temporal scale to identify such trends in our streamflow-based sediment-rating curves. Use of a continuous record of turbidity is an alternative approach for computation of a more accurate record of annual sediment loading.

In the sections below, we describe how suspended sediment loading was computed using both streamflow-based rating curves and continuous records of turbidity. When using streamflow-based rating curves to compute loads, we identified separate relationships or rating curves for each station where the data supports a segmented approach, such as when hysteresis is observed or for different event-types (e.g., runoff from snowmelt vs. thunderstorm).

6.1 Cold Creek at Teichert Bridge: Suspended-Sediment Load

Table 5 summarizes observations and instantaneous loading calculations for the Cold Creek at Teichert Bridge (CCTB) gage. **Form 3** presents WY 2013 daily and annual suspended-sediment loads computed by the two different methods for this station. The relationship between streamflow and suspended-sediment load is shown in **Figure 7.** The relationship between turbidity and SSC is shown in **Figure 8.** Daily suspended-sediment loads calculated using each method are graphically compared in **Figure 9**.

To date, we have not identified in the Cold Creek record any hysteresis effects related to streamflow-based suspended-sediment loading of the kind Langlois and others (2005) observed in streams east of Lake Tahoe. However, our data (**Figure 7)** does suggest unique relationships in the streamflow-to-suspended-sediment data for different hydrologic event types such as rain-on-bare-ground and rain-on-snow events which appear to differ relative to snowmelt runoff. Data collected in the last three years suggest that sediment loading from fall or summer rain-on-bare-ground events and rain-on-snow events can be roughly an order of magnitude greater than during snowmelt runoff. In calculating a record of suspended-sediment load for the CCTB station, the equation derived for the higher load rating was applied to the record of streamflow during rain-on-ground and rain-on-snow events in WY 2013.

Using the streamflow-based suspended-sediment rating curve, we estimate WY 2013 annual suspended-sediment loading in the Cold Creek subwatershed to be 884 tons (70 tons/sq. mile), with a maximum daily load of 492 tons on December 2, 2012 (56 percent of total annual load). Using the continuous turbidity record as a proxy for suspended sediment concentration and loading, we estimate the annual suspended-sediment loading to be 610 tons (48 tons/sq. mile), with a computed maximum daily load of 396 tons on December 2, 2012 (65 percent of total annual load). In general, the two methods appear to track similar trends, but the loads computed using a continuous record of turbidity likely captures the variability in suspended-sediment transport rates which is unrelated to streamflow.

6.2 Donner Creek above Highway 89: Suspended-Sediment Load

The Donner Creek at Highway 89 (DC89) gaging station operated by the USGS is **not** equipped with a continuous-logging turbidity meter. **Table 6** summarizes observations and instantaneous loading calculations for this station, computed using a streamflow-to-sediment-discharge rating curve. **Form 4** presents the calculated WY 2013 daily and annual suspended-sediment loads. The relationship between streamflow and suspended-sediment transport rate is shown for DC89 in **Figure 10.**

After three years of data collection at the Donner Creek at Highway 89 station, the suspended-sediment sampling results suggest the same type of hysteresis effect associated with sediment loading that Langlois and others (2005) observed for watersheds east of Lake Tahoe. Data for DC89 also suggest that during the snowmelt season there is an order of magnitude greater loading on the rising limb of the hydrograph as compared to the falling limb of the hydrograph. We may observe this pattern on Donner Creek while not on Cold Creek because of differing land-use patterns in their watersheds. Donner Creek receives a significant portion of stormwater runoff from a stormwater collection system—conveying runoff to the stream faster relative to natural surfaces (i.e., Cold Creek watershed), often laden with recently-applied road traction sand. It may be these dynamics in runoff conveyance to the creek that generates a higher loading rate on the rising limb of the hydrograph.

Similarly, we wanted to understand how releases from Donner Lake affect suspended-sediment loading in Donner Creek. We found that the rising limb of annual Donner Lake releases did not generate considerable loading, but instead exhibited loading rates similar to the rising limb of the hydrograph during snowmelt. Additionally, through discrete sampling, we have observed higher sediment loading during summer thunderstorms (see **Figure 10**); however, we have limited data at this time to develop any conclusive relationships in this regard.

Based solely on a streamflow-based sediment rating curve, we estimate the annual suspended-sediment load in Donner Creek at Highway 89 to be 498 tons (34 tons/sq. mile)[9] in WY 2013, with a maximum daily load of 223 tons on December 2, 2013 (45 percent of total annual load).

6.3 Donner Creek at West River Street: Suspended-Sediment Load

The loading calculations for the Donner Creek at West River Street (DCWR) station utilizes suspended-sediment samples collected at this location and streamflow measured at the USGS station (DC89) a short distance upstream. **Table 7** summarizes observations and instantaneous loading calculations for DCWR computed using a streamflow-to sediment-discharge rating curve. **Form 5** presents WY 2013 daily and annual suspended-sediment loads. The relationship between streamflow and suspended-sediment load is shown in **Figure 11.** The daily suspended-sediment load at DCWR is shown graphically in **Figure 12**, which also presents the daily suspended-sediment load at the upstream station (DC89) for comparison.

Since our computations for the DC89 and DCWR stations used the same record of streamflow, it is not surprising that the DCWR data shows similar relationships or sediment rating curves both with the rising and falling limb of the snowmelt hydrograph, and separately for summer thunderstorms-- albeit based on less data, since WY 2013 was only the second year of monitoring at DCWR. With that caveat, we provide preliminary results of suspended-sediment loading calculations and in Section 6.5 below, and make some preliminary comparisons with DC89.

We estimate the WY 2013 annual suspended-sediment load in Donner Creek at West River Street to be 819 tons (54 tons/sq. mile)[10], with a maximum daily load of 306 tons on December 2, 2012 (37 percent of total annual load). The annual load at this station is roughly 40 percent higher than the upstream station: Donner Creek at Highway 89 and is likely the result of additional stormwater outfalls located between these stations. Based on the Town of Truckee stormwater maps, these outfalls appear to drain large urbanized or impervious surfaces such as shopping centers, State Highway 89 and portions of Interstate-80.

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[9] Normalized loads computed for DC89 exclude the upper watershed area above Donner Lake.

[10] For reasons discussed in detail in Section 2.3, normalized sediment loads computed for DCWR exclude the upper watershed area above Donner Lake.

6.4 Trout Creek at Donner Pass Road: Suspended Sediment Load

Table 8 summarizes observations and instantaneous loading calculations for the Trout Creek at Donner Pass Road (TCDP) gage. **Form 6** presents WY 2013 daily and annual suspended-sediment loads for this station, computed by the two different methods. The streamflow-to-suspended-sediment load rating curve is shown in **Figure 13.** The turbidity-to-suspended-sediment concentration rating curve is shown in **Figure 14.** Daily suspended-sediment loads calculated using each method are graphically compared in **Figure 15**.

Using a standard streamflow-based sediment rating curve, we estimate the WY 2013 annual suspended-sediment loading in Trout Creek at 22.4 tons (5 tons/sq. mile) with a maximum daily load of 2.9 tons on December 2, 2012 (13 percent of total annual load). In comparison, using the continuous record of turbidity, total loading is calculated to be 13.4 tons (3 tons/sq. mile) with a maximum daily load of 1.8 tons on December 2, 2012 (13 percent of total annual load).

6.5 Comparison of suspended-sediment yields across stations, WY 2013

In this section, we normalize sediment loads at each station by: 1) watershed area (tons/square mile), and 2) runoff volume (tons/1,000 acre-feet) to compute yields and facilitate comparison between watersheds of different drainage areas and/or differing hydrology. In this section, we report suspended-sediment loads and yields at TCDP and CCTB as computed from continuous turbidity records, whereas other stations (DC89 and DCWR) suspended-sediment loads and yields are based on streamflow-based methods in the absence of turbidity probes at these stations. We reiterate that all sediment yields computed for Donner Creek in this report exclude the upper watershed area above Donner Lake.

6.5.1 Suspended-sediment loads normalized by watershed area, WY2013

A comparison of suspended-sediment loads between stations for WY 2013, normalized by watershed area is shown in **Figure 16a**. When normalized by watershed area, Cold Creek exhibited yields between 48 and 70 tons/square mile, depending on the method used. Donner Creek exhibited a yield of 34 tons/square mile at Highway 89, but increased downstream to 54 tons/square mile at West River Street. Trout Creek exhibited significantly less sediment yield, between 3 and 5 tons/square mile, depending on method used. These yields suggest increased storage of fine sediment in Donner Creek downstream of Cold Creek to Highway 89. Conversely, the data also suggests increased loading in Donner Creek downstream of Highway 89. Increases in loading may be the result of additional urban inputs (e.g., road sand) or channel bed and bank scour. Observations of the channel in WY2013 did not identify channel instabilities from hydromodification and therefore may suggest the increase in loading is primarily from urban sources.

6.5.2 Suspended-sediment loads normalized by runoff volume, WY2013

A secondary technique of evaluating suspended-sediment loads between stations is to normalize loads by runoff volume (**Figure 16b)**. When normalized by hydrology, Cold Creek exhibited 41 and 60 tons/1,000 acre-feet, depending on method used. Donner Creek shows considerably less yield at Highway 89 (12 tons/1,000 acre-feet). Reduced yield in Donner Creek maybe attributed to sediment retention and storage in Donner Lake, as noted above, but also may be attributed to dam releases from Donner Lake. These releases occur in the months of September and October and were observed to contribute significantly to total flow, but with limited sediment transport. We observed an increase in yield in Donner Creek between Highway 89 and West River Street (19 tons/1,000 acre-feet). We attribute this increase to urban sediment inputs as described above. Trout Creek exhibited between 8 and 13 tons/1,000 acre-feet, significantly less than Cold Creek and similar to Donner Creek.

6.5.3 Suspended-sediment loads normalized by intervening areas of nested stations: Donner/Cold Creek watershed

In an effort to better identify source areas for suspended-sediment in the Donner/Cold Creek watershed, we evaluated loading from the intervening areas using the three nested stations (CCTB, DC89, and DCWR). **Figure 17** depicts these intervening areas and the sediment loads (tons) and yields (tons/square mile) for these intervening areas**.** Loads for each area are computed using the difference between the loads calculated for a station and the station above (DC89 – CCTB = DC89 below CCTB). Similarly, yields are computed using these values divided by the intervening areas. CCTB has a contributing watershed area of 12.6 square miles, while the area between CCTB and DC89 has a contributing watershed area of 2.2 square miles, and the area between DC89 and DCWR has a contributing watershed area of roughly 0.4 square miles. Based on this approach, WY2013 data suggest Cold Creek generated 610 tons or 48 tons/square mile, while downstream Donner Creek at Highway 89 exhibited 498 tons or -51 tons/square mile between State Highway 89 downstream to the confluence of the Truckee River and suggests suspended sediment storage above this station. In contrast, Donner Creek at West River Street exhibited a significant increase in loading and yield (321 tons or 803 tons/square mile).

Higher sediment yields to Donner Creek downstream of Highway 89 may be attributed to urban stormwater. The Town of Truckee has preliminarily identified 24 stormwater outfalls to Donner Creek (**Figure 18**). These stormwater outfalls collect runoff from a generally small area, but areas that are mostly impervious surfaces and include measurable sections of Highways I-80, State Route 89, commercial services at the Donner Pass Road interchange with Interstate-80, Donner Creek Mobile Home Park, Sierra College, Deerfield Plaza, McDonalds, and the Truckee Crossroads Plaza. While only 9 stormwater outfalls were identified downstream of Highway 89, they all drain a very concentrated area of urban runoff with limited opportunities for sediment storage or settling (see Figure 18). Because each of these areas collects measurable fines from road-sand applications during the winter months it is logical that they might produce higher sediment loading to this reach during snowmelt runoff or after a major rain-on-snow event.

6.6 Comparison of suspended-sediment loads across all years and stations, WY 2011, WY 2012, and WY 2013

After 3 years of data collection we can begin to compare loads across water years for each station. For this analysis, we have normalized loads by hydrology or runoff volume (acre-feet) to account for differences in wet years (i.e., WY 2011) and dry years, (i.e., WY 2012 and WY 2013). For instance, total runoff volume for Cold Creek in WY 2011 exceeded 42,500 acre-feet, while in WY 2013 runoff volume was less than 15,000 acre-feet for the same station. **Table 9** compares suspended-sediment loads and yields across all stations for WY 2011, WY 2012, and WY 2013. **Figure 19** illustrates suspended-sediment loads, normalized by runoff volume for each station and across all three water years.

From these comparisons, we can draw four salient conclusions:

- Suspended-sediment yields for Cold Creek exhibited 12 tons/1,000 acre-feet in WY 2011 (wet year), increasing to 21 tons/1,000 acre-feet in WY 2012 (dry year), and increasing again to 41 tons/1,000 acre-feet in WY 2013 (dry year); these results may suggest loading may not be dependent upon year type, but rather the type of events occurring in a given year;
- Suspended-sediment yields at Donner Creek at Highway 89 seem to remain consistent regardless of water year type (i.e., dry or wet) and ranged between 8 and 12 tons/1,000 acre-feet;
- Suspended-sediment yields immediately downstream in Donner Creek at West River Street exhibited slightly higher values in WY 2012 (16 tons/1,000 acre-feet) and WY 2013 (19 tons/1,000 acre-feet)[11] with no measurable increase in runoff volume and suggests additional sediment sources to the creek, perhaps related to particular types of runoff events;
- In contrast with Cold Creek, Trout Creek exhibited higher yields in WY 2011 (15 tons/1,000 acre-feet) relative to WY 2012 (6 tons/1,000 acre-feet) and WY 2013 (8 tons/1,000 acre-feet);

[11] Suspended-sediment was not measured at DCWR in WY 2011.

It seems counterintuitive that suspended-sediment yields are higher in dry years (WY 2013) and lower in wet years (WY 2011). However, the differences in suspended-sediment yields at one station across water years may be the result of storm characteristics or types of events that occurred in that water year. For instance, a large percentage of the total annual load at all stations in WY 2013 was the result of a rain-on-snow event on December 2, 2012, but this particular storm may be more unusual for the higher-elevation Cold Creek watershed.

Events such as rain-on-snow events have been shown to generate gully erosion and landslides in the glacially eroded valley of Coldstream Canyon[12] (River Run Consulting, 2007). Additionally, much of the Coldstream Valley is underlain by weakly consolidated volcanic rocks and highly erodible soils. Existing and historical disturbances in the watershed may also be important sediment sources (River Run Consulting, 2007). Erosion of the Coldstream Valley landscape can provide a sustained or persistent source of sediment during the event. In contrast, rain-on-snow events may produce an initial increase in loading as a "first flush" in urbanized watersheds such as Donner Creek, below Donner Lake Dam, but loading may not be sustained through the event.

Ultimately, a multi-year study provides for evaluation of suspended-sediment loading over a range of year types and captures variability and long-term averages. As mentioned above, comparison of suspended-sediment loads, normalized by hydrology, may be complicated by sediment-free releases from Donner Lake Dam, so we also focus on a comparison of loads, normalized by watershed area. Table 9 shows the 3-year average yield (tons/square mile) at each station, leading to a preliminarily conclusion that both Cold Creek and Donner Creek are sources of suspended-sediment with loading increasing with distance downstream in the lower reach of Donner Creek. Efforts to reduce suspended-sediment loading to these creeks are on-going and include floodplain restoration in Cold Creek (Weld, 2012) and enhanced street sweeping practices by the Town of Truckee and CalTrans.

[12] Coldstream Canyon is the name given to the larger watershed drained by Cold Creek.

7. COMPARISON OF WY 2013 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 2013. We then compare these values to the benchmark load limit of 25 mg/L at Farad as established under the Middle Truckee River Sediment TMDL (Amorfini and Holden, 2008). We note that the benchmark for the Truckee River was established by the Lahontan Water Board based on a literature review of suspended-sediment targets and criteria to protect aquatic life beneficial uses. The Lahontan Water Board identified 25 mg/L as being at the lower end (most protective) of the range of values to protect juveniles, larvae, and eggs, as well as adult fish. The suspended sediment target is expressed as an annual 90th percentile value; therefore, up to 10 percent of the data could fall above 25 mg/L 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), we can compare loadings between tributaries by converting concentrations into in daily (tons/day) or annual (tons) suspended-sediment loads. This conversion is accomplished by first converting the 15-minute turbidity (NTU) values for each tributary into SSC (mg/L), then multiplying each value by the corresponding 15-minute streamflow (cfs) for that creek. We can then apply these loads in the form of a load duration curve to evaluate the occurrences and percentage of time which loads equal or exceed the TMDL standard for a particular tributary.

We also compare streamflow-to-suspended-sediment rating curve data, developed as part of this study, with historical rating curve data (McGraw and others, 2001) for the two watersheds (i.e., Donner Creek and Trout Creek) where such data are available for comparison. Any changes in the relationship between streamflow and suspended-sediment load can be identified by a “shift” in the suspended-sediment rating curve. Because changes in SSC with time may result from landscape processes or human disturbances in the 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 also for assessing changes in fine sediment supply due to implementation of restoration activities and BMPs (Hecht, 2008). As sediment supply within 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.

7.1 Cold Creek at Teichert Bridge: Suspended Sediment Loading in WY 2013

Figure 20 illustrates a suspended-sediment load duration curve for Cold Creek using the continuous 15-minute record of turbidity from WY 2013. Benchmark load limits based on the 25 mg/L target established for the Truckee River were also computed for Cold Creek. We can draw four main conclusions from these data:

- Suspended-sediment loading in Cold Creek exceeded the TMDL benchmark across a range of streamflows; however, these exceedances only comprised 1.5 percent of the total in WY 2013, well below the 90^{th} percentile benchmark limit for the TMDL;
- Instantaneous loading rates (converted to daily rates) ranged between < 0.001 tons/day and 2,382 tons/day in WY 2013 over the range of streamflows recorded;
- Higher instantaneous loading rates were associated with the rain-on-snow event that began on November 30, 2012 and persisted through December 5, 2012.

7.2 Donner Creek: Suspended Sediment Loading in WY 2013

We divide this section into two subsections to differentiate the two stations on Donner Creek where we measure suspended sediment: 1) Donner Creek at Highway 89 (DC89) and; 2) Donner Creek at West River Street (DCWR), 0.58 miles further downstream. **Figure 21** illustrates suspended-sediment load duration curves for both of these gages, developed using the streamflow-based sediment-load rating curves as continuous records of turbidity were unavailable for these stations. Note that the load duration curves reflect the difference in loading identified with the rising limb relative to the falling limb of the hydrograph (see Figure 19). As stated in Section 5.4, simultaneous streamflow measurements conducted on Donner Creek at West River Street and at Highway 89 suggested that flows there were nearly identical. Therefore, the USGS record of flow was used to compute loadings at West River Street and to calculate a benchmark load limits for both stations based on the 25 mg/L target.

7.2.1 Donner Creek at Highway 89 (DC89)

As calculated using the streamflow-based sediment rating curve, suspended-sediment loading at the DC89 station was well below the established benchmark in WY 2013. Only about 0.5 percent of the data exceeded the 25 mg/L suspended sediment target, well within the 90^{th} percentile. The observed exceedances were attributable to runoff from a rain-on-snow event that began on November 30, 2012 and persisted through December 5, 2012.

7.2.2 Donner Creek at West River Street (DCWR)

Suspended-sediment loadings immediately downstream at DCWR were also mostly below the established benchmarks in WY 2013 (**see Figure 21**). At this station, about 2.2 percent of all data exceeded the 25 mg/L benchmark, still well within the 90th percentile.

We note that a load duration curve populated with loads calculated from a standard sediment rating curve may not be as useful as loads computed from a continuous record of turbidity. As such, an evaluation of temporal variability or identification of non-storm loading events cannot be assessed. Future efforts by the Town of Truckee may include instrumenting this station with a turbidity probe.

7.3 Trout Creek at Donner Pass Road Suspended Sediment Loading in WY2013

Figure 22 illustrates a suspended-sediment load duration curve for Trout Creek computed using a turbidity-based sediment rating curve. The benchmark load limit based on the 25 mg/L suspended-sediment target is also illustrated. We draw three main conclusions from these data:

- In general, loading exceeds the TMDL benchmark across a range of different streamflows. When the data is examined more carefully, these exceedances are associated with first-flush rain events and thunderstorms (low- to moderate-magnitude events), and rain-on-snow events (high-magnitude events).
- Daily sediment loading rates ranged between <0.01 and 15.6 tons per day in WY 2013, over the range of flows recorded;
- 1.5 percent of the WY 2013 data for Trout Creek exceeded the 25 mg/L benchmark, indicating that suspended-sediment loads in this stream were well within the 90th percentile in WY 2013.

7.4 Discussion of Suspended-sediment Loads from Different Years

McGraw and others (2001) and Amorfini and Holden (2008) reported estimated annual suspended-sediment loads and streamflow-sediment discharge relationships in 10 major tributaries of the Middle Truckee River. Their work includes data for Donner Creek and Trout Creek from WY 1997 (last major flood) and WY 2004 (average year), allowing for a comparison of sediment loading under current and historical conditions. These comparisons are provided for each stream in the sections below. For a full description of the conditions and analysis associated with the historical data, please refer to Amorfini and Holden (2008).

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

Comparative current and historical annual flow statistics and suspended-sediment loads for Donner Creek in **Table 10** provide insight regarding sediment transport and suspended-sediment loads in the watershed over time.

From Table 10, annual runoff volume appears to be dependent on annual precipitation, as expected. However, annual suspended-sediment loads do *not* correlate well with total annual precipitation. Rather, differences in suspended-sediment loads between years may be attributed to characteristics of hydrologic events occurring in those years as noted above. For instance, WY 1997 was an average rainfall year, but included an extreme rain-on-snow event on January 3, 1997 that resulted in some of the largest peak flows on record for the Truckee region and a total runoff volume of 84,600 acre-feet and total suspended-sediment loads of 2,250 tons. In contrast, WY 2011 was a very wet year with the fourth largest snowpack on record. Although WY 2011 resulted in significantly more runoff (101,300 acre-feet) than WY 1997, total annual load in WY 2011 (804 tons) was less than half of the load in WY 1997 (2,250 tons). McGraw and others (2001) have noted many storm-triggered landslides in tributaries to the Middle Truckee River as a result of the 1997 event which may account for the magnitude in loads that year.

Historical and current sediment rating-curve data can also be compared to assess if there are potential shifts in the relationship between streamflow and sediment transport rates over time for a particular station. For instance, a shift to the right in the rating curve may show reduced suspended-sediment loading at a given discharge due to a reduction in sediment sources in the watershed or implementation of erosion- or sediment-control BMPs. **Figure 23** presents historical (WY 1996, WY 1997, and WY 2000) and current (WY 2011, WY 2012, and WY 2013) suspended-sediment load data for Donner Creek at Highway 89.

Overall, recent sediment loading rates at this station appear to be comparable to historical loading rates. We have begun to detect temporal trends or patterns that are better able to explain the high variability of loads at a given streamflow. For example, we are finding that Donner Creek exhibits higher loading on the rising limb of the storm hydrograph as opposed to the falling limb (see Figure 10). Separately, recent efforts under this study have captured loads at higher streamflows than historical studies. Preliminary data may suggest a threshold exists at which the rate of loading increases more markedly above roughly 300 cfs at this station. This pattern has been observed in other streams where areas further from the channel become hydrologically connected over the duration of an event or storm and provide additional sources of sediment. Furthermore, we observe significantly higher loading during rain on bare ground or thunderstorm events. These patterns either did not exist before or were not recognized in earlier studies, but may be important indicators of stormwater processes in an urbanized watershed, with associated implications for stormwater management. We continue to further evaluate these trends in WY 2014.

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

Table 11 compares historical (WY 1997 and WY 2004) and recent (WY 2011through WY 2013) annual flow statistics and suspended-sediment loads for Trout Creek. We note that the historical loadings for this station were calculated using streamflow-based sediment rating curves, whereas the current loadings were computed based on continuous records of turbidity. In this study, we have measured between 46 and 67 percent higher loads using a streamflow-based sediment rating curve when compared to loads computed with a continuous record of turbidity.

In addition, we note the challenge in comparing current and historical data for Trout Creek because historical sediment loads were computed using a synthetic record of flow in the absence of a streamflow station. More specifically, correlation with mean daily flows in Sagehen Creek near Truckee (USGS 10343500). Finally, WY 2011 was a partial record (January 21-September 30, 2011). These conditions should be considered when reviewing the comparisons discussed below.

Based on the results shown in Table 11, we conclude that:

- Trout Creek transported the lowest annual suspended-sediment load during WY 2012 (10.6 tons, turbidity-based) and the highest during WY 1997 and WY 2011, at 61 and 59 tons, respectively;
- Suspended-sediment yields were greatest in WY 1997, but relatively similar to WY 2011. Given that WY 2011 was a partial water year, these data may suggest that suspended-sediment loading in Trout Creek may be higher during wet years when snowmelt runoff is the dominant peak flow event type, in contrast to WY 1997 when a major rain-on-snow event occurred.

Figure 22 presents historical and recent data for Trout Creek used for assessing potential changes sediment-rating curves. The WY 2011 through WY 2013 data shows considerable scatter but was found to be associated with event type, whereas higher loads are measured during rain on bare ground events and rain on snow events. Historical data may not have been evaluated based on event type and therefore, it’s difficult to evaluate if trends in loading have improved or remained the same.

8. BIOASSESSMENT RESULTS IN CONTEXT OF SEDIMENT MONITORING

A monitoring program directed by Dr. David Herbst of U.C. Santa Barbara – Sierra Nevada Aquatic Research Laboratory evaluated fine sediment deposition and resulting impairment to macroinvertebrates within the Middle Truckee River (Herbst, 2011 and 2013). The results of these studies strongly supported that beneficial uses are impaired in the Truckee River. We summarize below the key results from the bioassessment studies.

In 2010, Herbst (2011) conducted a "reference-test" study comparing several sites along the Truckee River to similar eastern Sierra streams with less watershed disturbance (Carson River, Walker River, and Markleeville Creek) using the Eastern Sierra Index of Biological Integrity (IBI). IBI is a scientific tool used to identify and classify water pollution problems, in this case, using biosurveys. Compared to similar reference streams, the Middle Truckee River consistently scored lower on the Eastern Sierra IBI. All sampling sites on the Middle Truckee River scored below the "not supporting of beneficial uses" or "partially supporting" thresholds. Reference streams scored as "supporting" or "partially supporting".

Based upon work conducted in 2010, the TRWC worked with Balance and Dr. Herbst and completed additional monitoring in 2011 to more specifically examine the relationship between sediment deposition and biological communities and co-locating surveys with on-going bed conditions monitoring (Donaldson and Shaw, 2012). A "patch-scale" study (Herbst, 2013) was completed to examine the relationship between deposited fine- sediment and biological condition of the benthic community. There were significant differences in biological conditions where fine-sediment deposition exceeded 20 percent. At 80 percent or greater sediment coverage there were very significant decreases in biological condition. Biological condition was defined by the decrease in the quantity and quality of food resources, meaning that both the number and size of benthic macroinvertebrates decreased with increasing sediment coverage. Separately, the benthic macroinvertebrate community shifted towards organisms tolerant of pollution or more tolerant of poor water quality.

These studies indicate that beneficial uses including "Cold Freshwater Habitat" and "Spawning Reproduction and Development" are likely to not be fully supported in the Middle Truckee River due to impacts on the base of the food web and excess deposited fine sediment. These results are in direct contrast to the TMDL threshold and may imply that suspended-sediment concentration may not be an effective monitoring component by itself or the Middle Truckee River TMDL standards for impairment may require further review and revision.

9. FUTURE MONITORING

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 concentration-to-streamflow relations should be based on local, frequent sample collection and, if possible, on multi-year data sets. Future comparisons between water years and of contemporary data to historical data sets will likely result in fresh insights and more definitive conclusions. Balance continues to operate and maintain the gaging stations on Cold Creek and Trout Creek and continues to collect suspended sediment data at the USGS-operated Donner Creek at Highway 89 station and at the Donner Creek at West River Street station during WY 2014.

In response to recent bioassessment results and at the request of TRWC, Balance will repeat bed conditions monitoring in the summer of 2014 following the protocols used in 2011.

10. 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 California 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 Balance Hydrologics 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:	**2013**
Stream:	Cold Creek
Station:	at Teichert Bridge (CCTB)
County:	Nevada County, California

Form 1. Annual Hydrologic Record, WY 2013

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 diversions are known to occur upstream, Drainage area is 12.6 square miles.

Station Location Map

Mean Annual Flow

Mean annual flow for WY 2013 is 21 cfs; for WY 2012 is 21 cfs; for WY 2011 is 60 cfs.

Peak Flows (WY 2013)

Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)	Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)
11/30/12	11:00	4.21	247				
12/2/12	**11:00**	**6.60**	**1004**				
12/5/12	8:15	4.80	358				
4/4/13	22:00	3.06	102				
4/29/13	20:00	3.19	115				
5/12/13	19:45	3.10	108				

Extreme for period of record (WY2011-2013) is 1,004 cfs on December 2, 2012

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 2013 Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1	0.2	1.2	124.2	11.6	11.3	11.0	50.6	68.8	29.5	5.8	0.8	0.2
2	0.2	0.9	407.3	11.3	11.4	12.0	48.4	61.3	29.8	5.2	0.8	0.3
3	0.2	0.8	111.3	11.4	11.4	15.1	52.6	66.8	28.8	4.9	0.8	0.4
4	0.2	0.8	68.3	11.1	11.5	15.2	74.3	64.5	28.1	4.5	0.8	0.3
5	0.2	0.8	225.5	10.7	11.7	15.7	74.9	58.3	27.3	4.1	0.7	0.3
6	0.2	0.7	109.3	10.3	11.7	16.4	63.0	67.1	25.6	3.7	0.7	0.3
7	0.3	0.7	66.5	10.2	11.8	15.8	61.2	64.1	24.2	3.5	0.6	0.3
8	0.3	0.9	50.8	10.0	11.6	14.8	58.2	67.6	24.2	3.2	0.6	0.3
9	0.3	1.0	42.1	10.2	11.3	14.2	49.4	68.9	22.7	3.0	0.6	0.3
10	0.2	1.1	35.7	10.1	11.3	14.4	48.6	75.4	21.2	2.8	0.6	0.2
11	0.2	1.2	31.1	9.7	11.2	15.1	60.2	81.5	18.2	2.6	0.6	0.2
12	0.3	1.3	29.1	9.4	11.0	17.7	61.8	85.6	16.1	2.5	0.6	0.3
13	0.3	1.4	25.8	9.3	10.9	22.5	66.4	82.7	14.0	2.4	0.5	0.2
14	0.3	1.4	22.9	9.6	11.0	28.7	65.5	77.9	12.1	2.2	0.5	0.4
15	0.3	1.4	20.1	9.7	11.4	31.5	57.8	72.7	10.7	2.1	0.5	0.5
16	0.3	1.4	19.2	9.5	11.5	31.7	47.7	65.4	9.8	1.9	0.4	0.4
17	0.3	15.8	22.6	9.4	11.4	31.0	42.2	54.9	9.0	1.8	0.4	0.3
18	0.3	12.3	20.0	9.2	11.3	29.9	40.1	48.7	8.2	1.7	0.4	0.3
19	0.3	6.2	18	9.1	11.5	30.8	42.4	46.2	7.7	1.6	0.5	0.3
20	0.3	5.1	17.6	9.0	11.1	44.2	48.8	43.3	7.3	1.5	0.5	0.4
21	0.3	14.1	16.8	8.8	10.8	44.1	55.2	43.9	6.8	1.4	0.5	0.3
22	0.6	9.5	16.2	8.6	10.7	38.3	62.3	38.8	6.3	1.3	0.5	0.7
23	0.8	5.6	17.0	8.5	10.7	34.8	60.1	32.7	6.1	1.2	0.4	0.9
24	0.7	4.5	16.9	8.9	10.4	34.1	56.6	30.0	9.5	1.2	0.4	0.6
25	0.7	3.9	15.5	12.8	10.3	35.9	55.6	28.8	29.2	1.1	0.4	0.4
26	0.7	3.4	15.0	15.7	10.2	36.7	61.6	27.8	18.7	1.1	0.4	0.4
27	0.7	3.0	13.9	13.1	10.1	38.8	72.6	26.9	11.7	1.0	0.4	0.4
28	0.7	3.8	13.3	11.8	10.1	43.5	74.5	44.8	9.2	1.0	0.4	0.5
29	0.7	13.9	12.7	11.6		45.9	86.0	37.1	7.6	0.9	0.4	0.5
30	0.8	156.0	12.3	11.3		50.7	84.4	32.5	6.6	0.9	0.3	0.4
31	0.7		11.9	11.3		58.4		31.3		0.9	0.3	
MEAN	0.4	9.1	52.6	10.4	11.1	28.7	59.4	55	16	2	0.5	0.4
MAX. DAY	1	156.0	407	15.7	11.8	58.4	86	86	30	6	0.8	0.9
MIN. DAY	0.2	0.7	11.9	8.5	10.1	11.0	40.1	26.9	6.1	0.9	0.3	0.2
cfs days	12	274	1629	323	311	889	1783	1696	486	73	16	11
ac-ft	24	543	3231	642	616	1763	3536	3364	964	144	32	23

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.
2. Data are subject to revision, should additional measurement or observer account warrant adjustment of the new rating curve.
3. Real-time provisional data available at www.balancehydro.com/truckee/cold/index/php

Water Year 2013 Totals:		
Mean flow	**21**	(cfs)
Max. daily flow	**407**	(cfs)
Min. daily flow	**0.17**	(cfs)
Annual total	**7,504**	(cfs-days)
Annual total	**14,884**	(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:	**2013**
Stream:	Trout Creek
Station:	Donner Pass Road (TCDP)
County:	Nevada County, California

Form 2. Annual Hydrologic Record, WY 2013

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, approximately 150 feet upstream of Donner Pass Road bridge
Land uses includes urban, residential, former quarrying, Interstate Highway 80, and open space.
Flows are unregulated; no diversions are known to occurr upstream.
Drainage area is 4.6 square miles.

Mean Annual Flow

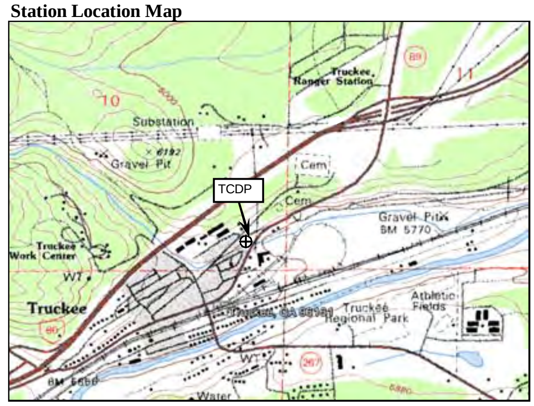
Mean daily flow for WY 2013 is 2.2 cfs, WY 2012 is 2.5 cfs; partial WY 2011 is 14.8 cfs.

Peak Flows (WY 2013)

Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)	Date	Time (24-hr)	Gage Ht. (feet)	Discharge (cfs)
11/30/12	12:15	4.76	33.9				
12/2/12	**11:15**	**5.18**	**80.9**				
12/5/12	9:15	4.64	40.6				
3/20/13	17:00	4.26	17.6				

Extreme for period of record (partial WY2011-WY2013) is 80.9 cfs on December 2, 2012

Station Location Map



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).

WY 2013 Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1	0.41	1.52	8.89	*2.7*	*2.7*	2.12	6.63	1.74	0.97	0.25	0.14	0.07
2	0.42	1.06	31.45	*2.5*	*2.6*	2.60	5.96	1.70	0.90	0.23	0.16	0.07
3	0.37	0.88	7.35	*2.6*	*2.5*	3.56	5.77	1.71	0.84	0.24	0.17	0.09
4	0.38	0.82	8.09	*2.7*	*2.5*	3.67	6.58	1.75	0.78	0.22	0.16	0.06
5	0.39	0.77	23.94	*2.7*	*2.4*	3.64	6.57	1.92	0.74	0.18	0.14	0.05
6	0.42	0.73	11.14	*2.5*	*2.5*	3.55	5.69	3.65	0.72	0.15	0.13	0.05
7	0.43	0.70	7.72	*3.0*	*2.3*	3.27	5.50	4.23	0.70	0.14	0.12	0.04
8	0.45	0.77	6.15	*4.9*	*2.5*	2.93	5.83	4.12	0.62	0.16	0.16	0.06
9	0.46	0.80	5.24	*3.3*	*2.5*	2.87	5.05	3.22	0.59	0.14	0.17	0.07
10	0.46	1.10	4.65	*2.2*	*2.4*	3.04	4.66	2.54	0.62	0.14	0.18	0.09
11	0.47	1.12	4.39	*2.2*	*2.5*	3.42	5.00	2.26	0.58	0.13	0.17	0.06
12	0.52	0.83	4.67	*2.1*	*2.3*	4.33	4.38	2.02	0.53	0.12	0.18	0.07
13	0.49	0.82	*6.0*	*2.1*	*2.2*	5.64	4.08	1.83	0.51	0.13	0.17	0.15
14	0.49	0.84	*5.0*	*2.1*	*2.3*	7.42	3.83	1.67	0.52	0.14	0.15	0.16
15	0.47	1.15	*4.7*	*2.0*	1.76	7.77	3.77	1.52	0.49	0.14	0.12	0.12
16	0.48	0.88	*5.0*	*2.1*	1.83	7.97	3.62	1.57	0.45	0.15	0.10	0.09
17	0.44	2.75	*3.9*	*2.1*	1.88	7.75	3.47	1.55	0.44	0.16	0.10	0.09
18	0.38	2.70	*3.8*	*2.2*	1.87	7.32	3.23	1.43	0.41	0.15	0.09	0.12
19	0.38	1.87	*3.8*	*2.5*	1.83	7.91	3.05	1.41	0.41	0.14	0.15	0.16
20	0.38	1.51	*4.3*	*3.1*	1.80	13.27	2.92	1.24	0.42	0.12	0.22	0.16
21	0.40	1.97	*3.6*	*3.3*	1.71	10.90	2.81	1.22	0.42	0.11	0.17	0.71
22	0.62	1.41	*3.5*	*2.9*	1.79	8.44	2.63	1.20	0.39	0.10	0.20	0.79
23	0.70	1.18	*3.4*	*2.8*	1.64	7.16	2.50	1.21	0.40	0.15	0.13	0.41
24	0.64	1.06	*3.3*	*2.7*	1.69	6.88	2.43	1.22	0.71	0.20	0.13	0.39
25	0.68	0.99	*3.3*	*2.6*	1.70	6.83	2.44	1.17	1.25	0.18	0.13	0.37
26	0.73	1.10	*3.4*	*2.6*	1.60	6.65	2.32	1.13	0.96	0.30	0.16	0.46
27	0.83	1.25	*3.0*	*2.6*	1.68	6.65	2.12	1.16	0.57	0.19	0.13	0.45
28	0.93	1.47	*3.1*	*2.5*	1.69	6.82	2.03	1.86	0.44	0.18	0.14	0.41
29	1.02	2.34	*2.9*	*2.5*		6.75	1.95	1.42	0.33	0.14	0.11	0.38
30	1.10	15.93	*2.7*	*2.5*		6.56	1.84	1.21	0.28	0.13	0.06	0.38
31	1.23		*2.8*	*2.6*		7.81		1.07		0.17	0.06	
MEAN	0.6	1.7	6.3	2.6	2.1	6.0	4.0	1.8	0.6	0.2	0.1	0.2
MAX. DAY	1.2	15.9	31.5	4.9	2.7	13.3	6.6	4.2	1.3	0.3	0.2	0.8
MIN. DAY	0.4	0.7	2.7	2.0	1.6	2.1	1.8	1.1	0.3	0.1	0.1	0.0
cfs days	18	52	195	81	59	185	119	57	18	5	4	7
ac-ft	35	104	387	162	116	368	235	113	36	10	9	13

Monitor's Comments

1. Daily mean values are based on 15-minute measurements of stage, several stage shifts have been applied to account for scour and fill.
2. This station can be affected by ice; the period 12/13/12 through 2/14/13 was estimated using correlation to streamflow at Sagehen Creek (USGS 10343500) and are represented in italics.
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
5. Real-time data are available at www.balancehydro.com/truckee/trout/index.php

Water Year 2013 Totals:		
Mean flow	**2.2**	(cfs)
Max. daily flow	**31.5**	(cfs)
Min. daily flow	**0.20**	(cfs)
Annual total	**800**	(cfs-days)
Annual total	**1587**	(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: 2013

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

Form 3. Annual Suspended-Sediment Load Record WY 2013

WY 2013 Daily Suspended-Sediment Load *(tons)* Streamflow-based sediment rating-curve method

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1	0.00	0.00	45.37	0.05	0.05	0.04	0.39	0.92	0.14	0.02	0.00	0.00	
2	0.00	0.00	491.59	0.05	0.05	0.05	0.35	0.67	0.14	0.02	0.00	0.00	
3	0.00	0.00	38.00	0.05	0.05	0.06	0.44	0.87	0.13	0.02	0.00	0.00	
4	0.00	0.00	15.10	0.04	0.05	0.06	1.27	0.76	0.13	0.02	0.00	0.00	
5	0.00	0.00	141.89	0.04	0.05	0.07	1.18	0.58	0.13	0.01	0.00	0.00	
6	0.00	0.00	21.13	0.04	0.05	0.07	0.72	0.85	0.12	0.01	0.00	0.00	
7	0.00	0.00	0.85	0.04	0.05	0.07	0.66	0.75	0.11	0.01	0.00	0.00	
8	0.00	0.00	0.40	0.04	0.05	0.06	0.58	0.87	0.11	0.01	0.00	0.00	
9	0.00	0.00	0.23	0.04	0.05	0.06	0.37	0.93	0.10	0.01	0.00	0.00	
10	0.00	0.00	0.17	0.04	0.05	0.06	0.36	1.21	0.09	0.01	0.00	0.00	
11	0.00	0.00	0.15	0.04	0.05	0.06	0.64	1.50	0.08	0.01	0.00	0.00	
12	0.00	0.00	0.14	0.04	0.04	0.08	0.68	1.73	0.07	0.01	0.00	0.00	
13	0.00	0.00	0.12	0.04	0.04	0.10	0.85	1.57	0.06	0.01	0.00	0.00	
14	0.00	0.00	0.10	0.04	0.04	0.13	0.80	1.31	0.05	0.01	0.00	0.00	
15	0.00	0.00	0.09	0.04	0.05	0.15	0.57	1.07	0.04	0.01	0.00	0.00	
16	0.00	0.00	0.08	0.04	0.05	0.15	0.33	0.79	0.04	0.01	0.00	0.00	
17	0.00	0.08	0.10	0.04	0.05	0.15	0.24	0.49	0.03	0.01	0.00	0.00	
18	0.00	0.05	0.09	0.04	0.05	0.14	0.20	0.35	0.03	0.01	0.00	0.00	
19	0.00	0.02	0.08	0.04	0.05	0.14	0.25	0.31	0.03	0.00	0.00	0.00	
20	0.00	0.02	0.08	0.04	0.04	0.27	0.36	0.26	0.03	0.00	0.00	0.00	
21	0.00	0.06	0.07	0.03	0.04	0.27	0.52	0.27	0.03	0.00	0.00	0.00	
22	0.00	0.04	0.07	0.03	0.04	0.19	0.71	0.20	0.02	0.00	0.00	0.00	
23	0.00	0.02	0.07	0.03	0.04	0.17	0.63	0.15	0.02	0.00	0.00	0.00	
24	0.00	0.02	0.07	0.03	0.04	0.16	0.53	0.14	0.04	0.00	0.00	0.00	
25	0.00	0.01	0.07	0.05	0.04	0.17	0.51	0.13	0.16	0.00	0.00	0.00	
26	0.00	0.01	0.06	0.07	0.04	0.18	0.7	0.13	0.08	0.00	0.00	0.00	
27	0.00	0.01	0.06	0.05	0.04	0.20	1.12	0.12	0.05	0.00	0.00	0.00	
28	0.00	0.01	0.05	0.05	0.04	0.26	1.16	0.30	0.04	0.00	0.00	0.00	
29	0.00	0.35	0.05	0.05		0.30	1.81	0.18	0.03	0.00	0.00	0.00	
30	0.00	76.47	0.05	0.05		0.40	1.62	0.15	0.02	0.00	0.00	0.00	**Qss**
31	0.00		0.05	0.05		0.58		0.15		0.00	0.00		**Annual**
TOTAL	0.0	77.2	756.4	1	1.2	5	21	20	2	0.2	0.0	0.0	**884**
Max.day	0.0	76.5	491.6	0	0.0	0.6	2	2	0.2	0.0	0.0	0.0	**492**

WY 2013 Daily Suspended-Sediment Load *(tons)* Continuous record of turbidity

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1	0.00	0.03	5.35	0.03	0.03	0.03	0.30	0.54	0.18	0.03	0.00	0.00	
2	0.00	0.01	396.30	0.03	0.03	0.04	0.25	0.42	0.19	0.02	0.00	0.00	
3	0.00	0.01	23.05	0.04	0.04	0.06	0.23	0.60	0.18	0.02	0.00	0.00	
4	0.00	0.01	2.44	0.04	0.04	0.05	1.98	0.51	0.18	0.02	0.00	0.00	
5	0.00	0.01	64.39	0.03	0.04	0.06	1.01	0.36	0.17	0.02	0.00	0.00	
6	0.00	0.00	4.34	0.04	0.04	0.06	0.43	0.60	0.16	0.02	0.00	0.00	
7	0.00	0.00	1.16	0.04	0.04	0.04	0.40	0.52	0.15	0.01	0.00	0.00	
8	0.00	0.00	0.47	0.04	0.04	0.04	0.33	0.76	0.16	0.01	0.00	0.00	
9	0.00	0.00	0.26	0.04	0.04	0.04	0.23	0.90	0.20	0.01	0.00	0.00	
10	0.01	0.00	0.16	0.05	0.05	0.04	0.24	1.20	0.29	0.01	0.00	0.00	
11	0.00	0.00	0.13	0.04	0.03	0.05	0.41	1.39	0.21	0.01	0.00	0.00	
12	0.00	0.00	0.11	0.05	0.03	0.06	0.40	1.88	0.10	0.01	0.00	0.00	
13	0.00	0.00	0.09	0.05	0.03	0.12	0.57	1.90	0.07	0.01	0.00	0.00	
14	0.00	0.00	0.08	0.05	0.03	0.21	0.57	1.41	0.06	0.01	0.00	0.00	
15	0.01	0.00	0.06	0.05	0.03	0.16	0.35	0.92	0.06	0.01	0.00	0.00	
16	0.00	0.00	0.06	0.06	0.03	0.13	0.28	0.65	0.05	0.01	0.00	0.00	
17	0.00	1.29	0.09	0.05	0.03	0.12	0.28	0.42	0.05	0.01	0.00	0.00	
18	0.00	0.11	0.06	0.02	0.03	0.10	0.32	0.35	0.05	0.01	0.00	0.00	
19	0.00	0.03	0.07	0.02	0.03	0.13	0.39	0.32	0.04	0.01	0.00	0.00	
20	0.00	0.03	0.05	0.02	0.03	0.39	0.45	0.30	0.04	0.01	0.00	0.00	
21	0.00	3.97	0.05	0.02	0.03	0.29	0.55	0.34	0.06	0.01	0.00	0.00	
22	0.00	0.04	0.06	0.02	0.03	0.16	0.62	0.27	0.19	0.01	0.00	0.00	
23	0.01	0.02	0.07	0.02	0.03	0.13	0.57	0.22	0.09	0.01	0.00	0.00	
24	0.00	0.01	0.07	0.02	0.03	0.13	0.42	0.19	0.08	0.01	0.00	0.00	
25	0.00	0.01	0.05	0.05	0.03	0.13	0.33	0.21	0.53	0.00	0.00	0.00	
26	0.00	0.01	0.05	0.06	0.03	0.17	0.45	0.18	0.13	0.01	0.00	0.00	
27	0.00	0.01	0.04	0.04	0.03	0.16	1.02	0.16	0.07	0.00	0.00	0.00	
28	0.00	0.01	0.04	0.03	0.03	0.21	0.93	0.56	0.05	0.00	0.00	0.01	
29	0.00	0.11	0.04	0.03		0.26	2.23	0.26	0.03	0.00	0.00	0.00	
30	0.00	57.78	0.03	0.03		0.40	1.26	0.20	0.03	0.00	0.00	0.00	**Qss**
31	0.00		0.03	0.03		0.50		0.20		0.00	0.00		**Annual**
TOTAL	0	63.5	499.3	1	0.9	4	18	19	4	0.3	0.1	0.1	**610**
Max.day	0.0	57.8	396.3	0	0.0	0	2	2	1	0.0	0.0	0.0	**396**

Daily values are based on calculations of suspended-sediment load at 15-minute intervals.
Streamflow-based suspended-sediment load computation uses a correlation between streamflow and suspended-sediment concentration and is based on a provisional streamflow record
Turbidity-based suspended-sediment load computation uses a correlation between instantaneous turbidity (NTU) and suspended-sediment concentration (mg/L) and is converted to tons/day

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

Water Year: 2013

Stream: Donner Creek
Station: at Highway 89 (DC89, USGS 10338700)
County: Nevada County

Form 4. Annual Suspended-Sediment Load Record WY 2013

WY 2013 Daily Suspended-Sediment Load *(tons)*
Streamflow-based suspended-sediment Rating Curve Method

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1	0.40	0.11	27.16	0.27	0.24	0.19	2.17	0.44	0.21	0.06	0.02	0.03	
2	0.51	0.10	223.41	0.26	0.23	0.21	0.44	0.39	0.21	0.06	0.02	0.04	
3	0.55	0.10	5.92	0.25	0.23	0.24	0.42	0.42	0.21	0.06	0.02	0.04	
4	0.56	0.09	2.95	0.24	0.24	0.24	0.56	0.42	0.20	0.05	0.02	0.06	
5	0.54	0.08	60.52	0.23	0.24	0.25	0.57	0.38	0.20	0.05	0.02	0.16	
6	0.57	0.08	4.66	0.23	0.24	0.29	0.49	0.44	0.19	0.05	0.02	0.46	
7	0.60	0.07	2.38	0.22	0.24	0.28	0.48	0.43	0.18	0.05	0.02	0.63	
8	0.57	0.07	1.40	0.22	0.24	0.27	0.46	0.44	0.17	0.04	0.02	0.62	
9	0.54	0.07	1.03	0.22	0.24	0.26	0.40	0.43	0.16	0.04	0.02	1.21	
10	0.56	0.07	0.88	0.22	0.23	0.25	0.37	0.45	0.15	0.04	0.02	2.12	
11	0.58	0.07	0.78	0.21	0.23	0.43	0.45	0.49	0.14	0.04	0.02	2.93	
12	0.55	0.07	0.73	0.20	0.22	0.70	0.47	0.51	0.12	0.04	0.02	1.02	
13	0.56	0.07	0.67	0.19	0.22	0.86	0.50	0.50	0.11	0.04	0.02	0.66	
14	0.59	0.07	0.60	0.19	0.22	1.13	0.51	0.47	0.10	0.04	0.02	0.65	
15	0.55	0.07	0.56	0.19	0.21	1.35	0.46	0.44	0.10	0.04	0.02	0.63	
16	0.49	0.07	0.53	0.19	0.21	1.54	0.40	0.40	0.09	0.03	0.02	0.48	
17	0.58	0.26	0.58	0.18	0.21	1.44	0.35	0.33	0.09	0.03	0.02	0.31	
18	0.57	0.20	0.53	0.18	0.22	1.44	0.37	0.30	0.08	0.03	0.02	0.31	
19	0.43	0.16	0.48	0.18	0.22	1.54	0.37	0.29	0.08	0.03	0.02	0.31	
20	0.34	0.15	0.45	0.17	0.22	3.08	0.40	0.27	0.08	0.03	0.03	0.30	
21	0.29	0.38	0.42	0.17	0.21	3.56	0.45	0.27	0.07	0.03	0.03	0.32	
22	0.26	0.20	0.43	0.17	0.21	3.11	0.51	0.25	0.07	0.03	0.03	0.31	
23	0.26	0.17	0.45	0.17	0.20	2.66	0.49	0.22	0.07	0.03	0.03	0.30	
24	0.22	0.16	0.44	0.18	0.20	2.39	0.44	0.20	0.09	0.03	0.03	0.29	
25	0.19	0.15	0.42	0.21	0.19	2.42	0.40	0.20	0.31	0.03	0.03	0.30	
26	0.17	0.15	0.42	0.24	0.19	2.27	0	0.19	0.14	0.03	0.03	0.31	
27	0.15	0.14	0.38	0.24	0.19	2.21	0.5	0.19	0.10	0.03	0.03	0.31	
28	0.14	0.24	0.36	0.23	0.18	2.72	0.47	0.40	0.08	0.03	0.03	0.31	
29	0.12	0.60	0.33	0.23		3.04	0.54	0.24	0.08	0.02	0.03	0.30	
30	0.11	31.48	0.31	0.23		3.65	0.53	0.22	0.07	0.02	0.03	0.30	**Qss**
31	0.11		0.29	0.23		4.96		0.21		0.02	0.03		**Annual**
TOTAL	12.7	35.7	340.5	6.5	6.1	49.0	15	10.8	3.9	1.2	0.8	16.0	**498**
Max.day	0.6	31.5	223.4	0.3	0.2	5.0	2	0.5	0.3	0.1	0.0	2.9	**223**

WY 2013 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 loads calculated using the standard rating curve method is based on provisional streamflow data and suspended sediment samples collected between WY 2011 - WY 2013; 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: 2013
Stream: Donner Creek
Station: at West River Street (DCWR)
County: Nevada County

Form 5. Annual Suspended-Sediment Load Record WY 2013

WY 2013 Daily Suspended-Sediment Load *(tons)*
Streamflow-based suspended-sediment Rating Curve Method

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1	0.33	0.10	89.93	0.23	0.20	0.17	5.23	0.37	0.18	0.06	0.02	0.03	
2	0.42	0.09	306.21	0.22	0.20	0.18	0.35	0.33	0.18	0.06	0.02	0.03	
3	0.46	0.09	8.10	0.21	0.20	0.21	0.35	0.35	0.18	0.05	0.02	0.03	
4	0.46	0.08	3.14	0.21	0.21	0.21	4.29	0.35	0.18	0.05	0.02	0.04	
5	0.44	0.08	79.13	0.20	0.21	0.22	1.20	0.32	0.17	0.05	0.02	0.09	
6	0.47	0.07	5.84	0.20	0.21	0.24	0.40	0.37	0.17	0.04	0.02	0.19	
7	0.49	0.07	2.35	0.19	0.21	0.24	0.40	0.36	0.16	0.04	0.02	0.25	
8	0.47	0.07	1.15	0.19	0.21	0.23	0.38	0.37	0.15	0.04	0.02	0.25	
9	0.45	0.07	0.82	0.19	0.20	0.22	0.33	0.36	0.14	0.04	0.02	1.82	
10	0.46	0.07	0.71	0.19	0.20	0.22	0.31	0.37	0.13	0.04	0.02	0.48	
11	0.48	0.07	0.63	0.18	0.20	0.64	0.37	0.40	0.12	0.04	0.02	0.54	
12	0.46	0.07	0.60	0.18	0.19	1.52	0.39	0.42	0.11	0.04	0.02	0.56	
13	0.46	0.07	0.55	0.17	0.19	2.24	0.41	0.41	0.10	0.04	0.02	0.54	
14	0.48	0.07	0.49	0.17	0.19	3.38	0.42	0.39	0.09	0.03	0.02	0.53	
15	0.46	0.06	0.46	0.17	0.18	4.06	0.39	0.36	0.09	0.03	0.02	0.51	
16	0.41	0.06	0.43	0.16	0.18	4.56	0.34	0.33	0.08	0.03	0.02	0.40	
17	0.48	0.38	0.48	0.16	0.18	4.28	0.29	0.28	0.08	0.03	0.02	0.26	
18	0.47	0.18	0.44	0.16	0.19	4.29	0.31	0.26	0.07	0.03	0.02	0.26	
19	0.36	0.14	0.40	0.15	0.19	4.55	0.31	0.24	0.07	0.03	0.02	0.26	
20	0.29	0.13	0.37	0.15	0.19	8.42	0.34	0.23	0.07	0.03	0.03	0.26	
21	0.24	0.19	0.35	0.15	0.18	9.61	0.4	0.23	0.07	0.03	0.03	0.27	
22	0.22	0.18	0.36	0.15	0.18	8.51	0.4	0.21	0.06	0.03	0.03	0.26	
23	0.22	0.15	0.38	0.15	0.17	7.41	0.41	0.19	0.06	0.03	0.03	0.25	
24	0.19	0.14	0.37	0.16	0.17	6.73	0.37	0.18	0.08	0.03	0.03	0.25	
25	0.17	0.13	0.35	0.18	0.17	6.82	0.3	0.17	0.16	0.03	0.03	0.25	
26	0.15	0.13	0.35	0.21	0.17	6.42	0	0.17	0.12	0.03	0.03	0.26	
27	0.13	0.12	0.32	0.20	0.16	6.29	0	0.16	0.09	0.03	0.03	0.26	
28	0.12	0.36	0.30	0.20	0.16	7.55	0.4	0.24	0.08	0.02	0.03	0.26	
29	0.11	1.23	0.28	0.20		8.34	0.44	0.20	0.07	0.02	0.03	0.25	
30	0.10	112.04	0.26	0.19		9.80	0.44	0.19	0.06	0.02	0.03	0.25	**Qss**
31	0.10		0.25	0.20		12.89		0.18		0.02	0.03		**Annual**
TOTAL	10.5	116.7	505.8	5.7	5.3	130.4	21	9	3.4	1.1	0.7	9.9	**819**
Max.day	0.5	112.0	306.2	0.2	0.2	12.9	5	0.4	0.2	0.1	0.0	1.8	**306**

WY 2013 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													
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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 loads are calculated using the standard rating curve method is based on provisional streamflow data and suspended-sediment samples collected in WY 2012; 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: 2013

Stream: Trout Creek
Station: Donner Pass Road (TCDP)
County: Nevada County

Form 6. Annual Suspended-Sediment Load Record, WY 2013

WY 2013 Daily Suspended-Sediment Load *(tons)*
Streamflow-based suspended-sediment rating curve method

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1	0.00	0.01	1.20	0.03	0.03	0.02	0.10	0.01	0.01	0.00	0.00	0.00	
2	0.00	0.01	7.65	0.02	0.02	0.03	0.09	0.01	0.01	0.00	0.00	0.00	
3	0.00	0.00	0.12	0.02	0.02	0.04	0.08	0.01	0.00	0.00	0.00	0.00	
4	0.00	0.00	0.14	0.03	0.02	0.04	0.10	0.01	0.00	0.00	0.00	0.00	
5	0.00	0.00	0.71	0.03	0.02	0.04	0.10	0.02	0.00	0.00	0.00	0.00	
6	0.00	0.00	0.22	0.02	0.02	0.04	0.08	0.32	0.00	0.00	0.00	0.00	
7	0.00	0.00	0.13	0.03	0.02	0.04	0.08	0.42	0.00	0.00	0.00	0.00	
8	0.00	0.00	0.09	0.07	0.02	0.03	0.08	0.28	0.00	0.00	0.00	0.00	
9	0.00	0.00	0.07	0.04	0.02	0.03	0.07	0.03	0.00	0.00	0.00	0.00	
10	0.00	0.01	0.06	0.02	0.02	0.03	0.06	0.02	0.00	0.00	0.00	0.00	
11	0.00	0.01	0.05	0.02	0.02	0.04	0.07	0.02	0.00	0.00	0.00	0.00	
12	0.00	0.00	0.06	0.02	0.02	0.05	0.05	0.02	0.00	0.00	0.00	0.00	
13	0.00	0.00	0.09	0.02	0.02	0.08	0.05	0.01	0.00	0.00	0.00	0.00	
14	0.00	0.00	0.07	0.02	0.02	0.12	0.04	0.01	0.00	0.00	0.00	0.00	
15	0.00	0.01	0.06	0.02	0.01	0.13	0.04	0.01	0.00	0.00	0.00	0.00	
16	0.00	0.00	0.07	0.02	0.01	0.13	0.04	0.01	0.00	0.00	0.00	0.00	
17	0.00	0.24	0.04	0.02	0.02	0.13	0.04	0.01	0.00	0.00	0.00	0.00	
18	0.00	0.21	0.04	0.02	0.02	0.12	0.03	0.01	0.00	0.00	0.00	0.00	
19	0.00	0.02	0.04	0.02	0.01	0.13	0.03	0.01	0.00	0.00	0.00	0.00	
20	0.00	0.01	0.05	0.03	0.01	0.29	0.03	0.01	0.00	0.00	0.00	0.00	
21	0.00	0.02	0.04	0.04	0.01	0.21	0.03	0.01	0.00	0.00	0.00	0.04	
22	0.02	0.01	0.04	0.03	0.01	0.14	0.03	0.01	0.00	0.00	0.00	0.03	
23	0.03	0.01	0.04	0.03	0.01	0.11	0.02	0.01	0.00	0.00	0.00	0.00	
24	0.00	0.01	0.04	0.03	0.01	0.11	0.02	0.01	0.00	0.00	0.00	0.00	
25	0.00	0.01	0.04	0.03	0.01	0.11	0.02	0.01	0.05	0.00	0.00	0.00	
26	0.00	0.01	0.04	0.03	0.01	0.10	0.02	0.01	0.02	0.00	0.00	0.00	
27	0.00	0.01	0.03	0.02	0.01	0.10	0.02	0.01	0.00	0.00	0.00	0.00	
28	0.01	0.01	0.03	0.02	0.01	0.10	0.02	0.10	0.00	0.00	0.00	0.00	
29	0.01	0.02	0.03	0.02		0.10	0.02	0.01	0.00	0.00	0.00	0.00	
30	0.01	2.89	0.03	0.02		0.10	0.01	0.01	0.00	0.00	0.00	0.00	**Qss**
31	0.01		0.03	0.03		0.13		0.01		0.00	0.00		**Annual**
TOTAL	0.1	3.5	11.3	0.8	0.5	2.9	1.5	1.5	0.1	0.0	0.0	0.1	**22.4**
Max.day	0.0	2.9	7.6	0.1	0.0	0.3	0.1	0.4	0.1	0.0	0.0	0.0	**7.6**

WY 2013 Daily Suspended-Sediment Load *(tons)*
Continuous record of turbidity

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	
1	0.00	0.02	0.16	0.01	0.01	0.01	0.06	0.01	0.01	0.00	0.00	0.00	
2	0.00	0.01	1.83	0.01	0.01	0.02	0.05	0.01	0.01	0.00	0.00	0.00	
3	0.00	0.01	0.10	0.01	0.01	0.03	0.04	0.02	0.01	0.00	0.00	0.00	
4	0.00	0.01	0.09	0.01	0.02	0.03	0.05	0.02	0.01	0.00	0.00	0.00	
5	0.00	0.01	0.45	0.01	0.04	0.43	0.05	0.02	0.02	0.00	0.00	0.00	
6	0.00	0.01	0.11	0.01	0.04	0.26	0.04	0.09	0.01	0.00	0.00	0.00	
7	0.00	0.00	0.06	0.01	0.01	0.06	0.04	0.06	0.01	0.00	0.00	0.00	
8	0.00	0.01	0.04	0.02	0.01	0.01	0.04	0.05	0.01	0.00	0.00	0.00	
9	0.00	0.00	0.03	0.03	0.01	0.01	0.04	0.03	0.01	0.00	0.00	0.00	
10	0.00	0.01	0.03	0.01	0.02	0.02	0.07	0.02	0.01	0.00	0.00	0.00	
11	0.00	0.01	0.03	0.01	0.01	0.02	0.07	0.02	0.01	0.00	0.00	0.00	
12	0.00	0.00	0.02	0.01	0.01	0.03	0.14	0.02	0.00	0.00	0.00	0.00	
13	0.00	0.00	0.03	0.01	0.01	0.05	0.03	0.02	0.00	0.00	0.00	0.00	
14	0.00	0.00	0.03	0.01	0.01	0.08	0.03	0.02	0.00	0.00	0.00	0.00	
15	0.00	0.01	0.02	0.01	0.01	0.06	0.03	0.01	0.01	0.00	0.00	0.00	
16	0.01	0.00	0.03	0.01	0.01	0.06	0.02	0.01	0.01	0.00	0.00	0.00	
17	0.00	0.13	0.14	0.01	0.01	0.06	0.02	0.01	0.00	0.00	0.00	0.00	
18	0.00	0.04	0.03	0.01	0.01	0.05	0.02	0.01	0.00	0.00	0.00	0.00	
19	0.00	0.02	0.05	0.01	0.01	0.06	0.02	0.01	0.00	0.00	0.00	0.00	
20	0.00	0.01	0.02	0.01	0.01	0.21	0.03	0.01	0.00	0.00	0.00	0.00	
21	0.00	0.02	0.02	0.02	0.01	0.10	0.04	0.01	0.00	0.00	0.00	0.40	
22	0.17	0.01	0.04	0.01	0.01	0.06	0.05	0.01	0.00	0.00	0.00	1.67	
23	0.01	0.01	0.03	0.01	0.02	0.05	0.03	0.01	0.00	0.00	0.00	0.31	
24	0.01	0.01	0.02	0.02	0.02	0.05	0.04	0.01	0.01	0.00	0.00	0.28	
25	0.01	0.01	0.02	0.02	0.01	0.05	0.02	0.01	0.02	0.00	0.00	0.01	
26	0.01	0.01	0.02	0.02	0.02	0.05	0.02	0.01	0.01	0.00	0.00	0.01	
27	0.01	0.01	0.02	0.01	0.02	0.05	0.02	0.01	0.01	0.00	0.00	0.01	
28	0.01	0.04	0.02	0.01	0.01	0.05	0.01	0.02	0.00	0.00	0.00	0.01	
29	0.01	0.03	0.02	0.01		0.05	0.02	0.01	0.00	0.00	0.00	0.01	
30	0.01	1.33	0.01	0.01		0.05	0.01	0.01	0.00	0.00	0.00	0.01	**Qss**
31	0.01		0.01	0.01		0.08		0.01		0.00	0.00		**Annual**
TOTAL	0.3	1.8	3.5	0.4	0.4	2.2	1.1	0.6	0.2	0.0	0.0	2.7	**13.4**
Max.day	0.2	1.3	1.8	0.0	0.0	0.4	0.1	0.1	0.0	0.0	0.0	1.7	**1.8**

Daily values are based on calculations of sediment loads at 15-minute intervals.
Sediment loads are calculated using the 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 loads are 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
www.balancehydro.com

TABLES

Table 1. Station Observer Log:
Cold Creek at Teichert Bridge (CCTB), water year 2013

Site Conditions				Streamflow			Water Quality Observations					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?	
		(feet)	(R/F/S/B)	(cfs)	(AA/PY)	(e/g/f/p)	(oC)	(µmhos/cm)	(at 25 oC)	(NTU)	(Qbed, etc.)	
10/1/2012 9:20	BKH	0.35	--	--	--	--	--	--	--	--	--	Cleaned NTU probe, water clear, construction and diversion continue upstream. Weather has been hot - warmer than average (80F). Willows beginning to turn color. Stage 0.35-0.345
10/10/2012 15:30	BKH	0.43	B	0.22	PY	F	12.3	72	97	--	--	Sunny, 62F, water clear. Lots of algae on bed, leaves still on trees, alders still green, removed leaf dam at 15:22, Cleaned algae from NTU window at 15:20. GH @ 1520 = .43, GH @ 1525 = .42, GH @ 1550 = .425
10/16/2012 12:00	CS, BKH	0.425	B	--	--	--	--	--	--	--	--	Wiped turbidity probe, abundant algae on bed, water clear, no leaf dams, leaves beginning to drop, construction ended 10/15?, yesterdays turbidity pulse could have been real (diversion removal)?
11/6/2012 14:00	BKH	0.55	--	--	--	--	--	--	--	--	--	Water clear, cleaned NTU probe, algae found waving in front of probe window. Likely responsible for noise last few days. NTU about 10 on 11/1/12 real.
11/13/2012 15:30	CS	0.68	B	1.38	PY	G	1.3	52	94	--	--	Overcast, 45F, water clear. 12"-18" snow last weekend (cold storm cycle). Temps slowly warming each day. Patchy snow at gage on banks. Debris floating in channel (leaves and detached algae). Cleaned turbidity probe at 15:10. GH @ 1515 = .68, GH @ 1545 = .68.
11/17/2012 9:30	CS	0.79	R	1.92	PY	G	3.0	48	84	0.22	TSS	Rain showers, moderate to heavy rain overnight (about 0.5"), snow level 7000-7500'. Leaves and detached algae floating in channel, water clear, no snow on Teichert lot, no snow on banks. TSS @ 9:30. GH @ 915 = 0.79., GH @ 948 = .79
11/17/2012 14:00	CS	1.35	R	9.37	PY	G	3.0	40	69	9.70	TSS	Steady rain most of day, temps dropping, water slightly cloudy. Lots of coarse organic material in suspension (leaves and sticks). TSS @ 1347, GH @ 1347 = 1.34, GH @ 1415 = 1.37 +/- .01.
11/30/2012 11:00	CS, BKH	4.50	R	--	--	P	0.3	15	28	116.6, 100.8	TSS (2)	Moderate rain overnight (1.5-2"), rain, 40 degrees, water turbid, lots of debris floating in channel. Sample collected for TSS from left bank near probe at 11:00 and 11:02, unable to wade for flow measurements. GH @ 1100 = 4.5' +/- .2, GH @ 1126 = 4.6 +/- .2. Lots of pillowing against staff plate.
12/2/2012 8:15	CS, DS	6.10	R	--	--	P	1.2	15	27	209.10	TSS	heavy rain overnight (up to 2"), cold rain, windy, 37 degrees, lots of dirty sheet flow from teichert lot entering creek at several locations, u/s restoration flood plain under water. Flood watch in effect for truckee. GH @ 800 = 5.9 +/- .5, GH @ 815 = 6.1 +/- .5. Significant pillowing against staff plate made numbers difficult to read. TSS from left bank at 8:00.
12/2/2012 15:15	CS, BKH	5.20	F	--	--	P	--	--	--	85.7	TSS	Heavy rain overnight (up to 2"), cold rain, changed to wet snow by noon, about 4" of new wet snow on ground, switching back to rain showers, event ending, water very dirty, lots of debris floating, stage receding, temps cooling slighly. GH @ 1515 = 5.3 +/- .3, GH @ 1545 = 5.0 +/- .2. TSS from left bank at 1516.
12/2/2012 0:00	CS	--	--	--	--	--	--	--	--	--	--	Turbidity probe potentially being partially affected by debris attached to housing. Need to wait for flows to recede before cleaning.
12/3/2012 9:15	BKH	2.77	--	--	--	G	--	--	--	--	--	Inspected turbidity probe. Still too deep and swift to wade. Real time showing erroneous data. Peak in 12/4/12 not real. Water clear. GH = 2.77' +/- .02 @ 915. Possible sediment filling stilling well or needles/leaves caught in front of window. will need to clean later today before on set of more rain. Assume turbidity is background 5-8 NTU. Need to collect sample and test.
12/5/2012 14:45	BKH, DS	4.35	F	242.26	AA	G	0.5	21	39	15.66	TSS	1" rain overnight. Cloudy, 40 degrees, flows increased to near 11/30 high. Swift at x section, maximum stage safe to wade. Water slightly turbid, bedload movement. GH @ 1430 = 4.35 +/- .01, GH @ 1500 = 4.35 +/- .01
12/7/2012 10:30	BKH	--	--	--	--	--	--	--	--	1.60	--	Cleaning turbidity probe difficult. Still too deep and swift to reach. Brushing sed away from stilling well. Moving sed away from bed with a long brush. TSS collected u/s to evaluate real-time NTU. Water clear. Something is causing erroneous readings. In general, minimum values of range should be used as real data.
12/14/2012 14:45	CS	2.04		--	--	--	--	--	--	--	--	Cleaned turbidity window, GH +/- .02
12/23/2012 0:00	CS	--	--	--	--	--	--	--	--	--	--	Online gage shows turbidity spikes. More than likely due to snowfall. About 5' of snow has fallen between 12/21 and 12/26.
12/27/2012 16:00	CS	--	--	--	--	--	--	--	--	--	--	Water clear, overcast, 30 degrees, lots of snow on banks. No ice in channel. Turbidity readings seem to be ok. Potential for snow banks to give way and cause temporary dams to build-up d/s of gage.
1/17/2013 14:45	CS	1.37	B	9.91	PY	G	-1.5	33	65	--	--	Sunny, 40F, night lows about 15F, water clear. Changes in bed surface d/s of bridge boulders. Sediment became mobile during early Dec storms. 3' of snow on banks. No ice in channel. Some ice at outfall below gage, but it doesn't seem to be affecting stage. wiped turb probe window. small drop in NTU post cleaning. GH @ 1415 = 1.37 +/- .01, GH @ 1500 = 1.36 +/- .01
2/14/2013 13:30	CS	1.39	B	10.68	PY	G	2.0	36	64	--	--	Sunny, 50F, night lows around 20F, water clear, some snow on banks. No ice in channel. No significant precip in past 4 weeks. Feels like spring. Turb probe raised and cleaned. For some reason turb readings bumped up about 1NTU after raising and cleaning. Could be reflecting off nearby boulder. GH @ 1315 = 1.39 +/- .01, GH @ 1345 = 1.39 +/- .01, GH @ 1400 = 1.39 +/- .01
2/18/2013 8:30	CS	1.40	B	--	--	--	--	--	--	--	--	Sunny, no runoff since last visit. Turbidity probe readings off since last visit. Checked probe and it was loose in housing. Tightened and cleaned. Readings back to normal.
3/6/2013 10:00	CS	--	--	--	--	--	--	--	--	--	--	Snow seems to be affecting NTU

Table 1. Station Observer Log:
Cold Creek at Teichert Bridge (CCTB), water year 2013

Site Conditions				*Streamflow*			*Water Quality Observations*					*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?	
		(feet)	(R/F/S/B)	(cfs)	(AA/PY)	(e/g/f/p)	(oC)	(µmhos/cm)	(at 25 oC)	(NTU)	(Qbed, etc.)	
3/7/2013 16:45	CS	1.57	B	--	--	--	--	--	--	--	--	Snowing lightly, water clear, 5" new snow overnight, no ice in channel.
3/12/2013 16:00	CS	1.61	B	17.16	PY	G	5.5	38	62	0.13	TSS	Sunny, start of spring warming trend. Water clear, turbidity window wiped at 1540, temps forecasted to increase to low 60's during the week. About 6" of snow on ground, south slopes have bare ground, no ice in channel. GH = 1.61 +/- .01 @ 1545, GH = 1.62 +/- .01 @ 1615.
3/14/2013 18:15	BKH	2.00	B	--	--	--	--	--	--	2.60	TSS	GH +/- .03, water clear, did not freeze last night. Tonight forecast 33F low. Warm days in the high 50's to low 60's
3/20/2013 14:15	CS	2.36	U	45.55	AA	G	2.2	30	54	1.46	TSS	Wate clear, rain showers since 10pm last night. Snow levels 7500-7000'. About .75" of rain in truckee. No snow on tiechert lot. Front passing soon. Turbidity probe cleaned at 1400. GH @ 1400 = 2.35 +/- .05, GH @ 1432 = 2.36 +/- .02
4/2/2013 14:45	CS	2.32	U	--	--	--	--	--	--	--	--	Sunny, water clear, temps in the 50's. rain showers over past week with little accumulation. Turbidity window wiped, probe raised to prepare for spring melt. GH =/- .02
4/29/2013 12:45	CS	2.70	U	70.11	AA	G	6.7	27	42	1.34	TSS	Sunny, 70 degrees, water clear, nights above freezing, days near 70. could be peak snowmelt for the season. Turb probe wiped at 1215 and pointed d/s to avoid light scattering from 8am-12pm. Grass growing on tiechert lot, willows starting to leaf out. GH = 2.70 +/- .05 @ 1215, GH = 2.70 +/- .05 @ 1300
5/5/13-5/7/13	CS	--	--	--	--	--	--	--	--	--	--	T-storms over entire area. About 1.5-2" rain over three days
5/10/2013 16:15	CS	2.85	U	--	--	--	--	--	--	2.32	TSS	Sunny, 70 degrees, water mostly clear, turbidity probe cleaned (some of the scattering seen in previous data was from a small stick waving in front of window), probe aligned more d/s to avoid light scattering seen between 8am and 11am. GH @ 1615 = 2.85 +/- .05
5/12/2013 18:45	CS	3.20	R	106.32	AA	G,F	7.1	21	33	11.92	TSS	Sunny, 70 degrees, water slightly turbid, lots of organic material in suspension, could be peak seasonal snowmelt, water surging at staff plate. GH @ 1830 = 3.2 +/- .05, GH @ 1900 = 3.2 +/- .05.
6/11/2013 18:30	BKH	1.64	B	--	--	--	--	--	--	--	--	Warmer weather is causing flows to rapidly fall to summer baseflows, cleaned branch from turbidity probe, cable is hanging out and could catch debris, probe will need to be lowered within the next two weeks to avoid being out of water. GH @ 1830 = 1.64 +/- .01
6/25/2013 12:45	CS	2.02	R	31.02	PY	G	9.2	29	42	4.37	TSS	Rain in past 24 hours. About 1-2" fell on crest and about 0.5" fell in town. Turbidity probe cleaned at 1230. Water slightly cloudy. Rain showers, 60F. GH@1215 = 2.0+/-.04, GH @ 1300 = 2.04+/- .04
7/24/2013 17:45	CS	0.60	B	1.05	PY	G	18.6	72	82	0.36, 0.36	TSS (2)	Water clear, sunny, 75F, very little algae growing on rocks. Lowered turbidity probe by cutting a section of PVC off the bottom of the housing at 17:50. PT elevations should remain unchanged. Replicate TSS samples collected. GH @ 1715 = 0.60', GH @ 1745 = 0.60'.
8/30/2013 15:15	CS	0.44	B	0.35	PY	G	19.6	84	93	--	--	Water clear, very low flows, lots of green algae on rocks, turbidity probe cleaned. Thick smoke in area for past 2-3 weeks. GH@1500=.44, GH@1515=.44
9/10/2013 9:45	BKH	0.43	B	--	--	--	--	--	--	--	--	Sunny, warm, TRWC is conducting instream work upstream - requires stream diversion. Return flow is just upstream of gage. May see some turbidity spikes over next two-three weeks. Cleaned turbidity probe. Algae on rocks, water clear, low flow.
9/20/2013 16:15	CS	0.42	B	0.22	PY	F	16.0	72	88	--	--	Sunny, windy, 70 degrees, water clear, cold front blowing through tonight. Chance of rain tomorrow. Turbidity window wiped at 1600. Construction traffic crossing bridge. Road being watered to keep down dust. GH@1600 = .42, GH@1615 = .42
9/21/2013 0:00	CS	--	R	--	--	--	--	--	--	--	--	Moderate rain all day, no site visit, small increase in stage

Observer Key: (ds) is David Shaw, (bkh) is Brian Hastings, (cs) is Collin Strasenburg
Streamflow gaging station operated by USGS; Flow values are provisional, as reported by the USGS for station 10338
Stage: Water level observed at outside staff plat
Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), or baseflow (
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 conducta
Additional Sampling: Qss = Suspended sedimer

Table 2. Station Observer Log: Donner Creek at Highway 89 (DC89), USGS 10338700, water year 2013

Site Conditions				Streamflow			Water Quality Observations					Remarks
Date/Time (observer time)	Observer	Stage	Hydrograph	USGS flow	Instrument Used	Estimated Accuracy	Water Temperature	Field Specific Conductance	Adjusted Specific Conductance	Turbidity	Additional sampling?	
		(feet)	(R/F/S/B)	(cfs)	(AA/PY)	(e/g/f/p)	(oC)	(µmhos/cm)	(at 25 oC)	(NTU)	(Qbed, etc.)	
10/1/2012 9:00	BKH	--	R	48	--	--	--	--	--	2.44	TSS	Donner release ramping up about 60cfs, water clear with some particluate matter in suspension. Expected to continue to rise to 120cfs
10/2/2012 8:25	BKH	--	R	102.0	--	--	--	--	--	1.35	TSS	Water clear, a review of desktop NTU suggests that higher flows may show lower NTU. This may be the result of initial flushing of summer fines and algae.
10/16/2012 11:45	BKH	--	U	93.0	--	--	--	--	--	0.48	TSS	
11/17/2012 10:17	CS	--	R	13.0	--	--	5.6	81	128	2.16	TSS	Heavy rain shower for past 15 minutes. Ponding on roadways, lots of urban runoff entering d/s of sample location. About 0.5" rain fell overnight. Water clear. McDonalds pipe flowing hard and dirty (about 1/4 full and estimate about 1cfs).
11/17/2012 14:42	CS	--	R	26.0	--	--	--	--	--	16.1	TSS	Moderate rain all day, 40F, water slightly cloudy. All urban pipes are flowing.
11/18/2012 9:15	DS	--	U	34	--	--	--	--	--	--	TSS	Light rain, light covering of wet snow overnight, sampled TSS at weir, just u/s of gage from the left bank. Shell station outfall flowing at about 20gpm (mostly clear), right bank culvert flowing at about .25-.4cfs (fairly clear, a little sudsy at outfall pool, white tint). TSS @ 915.
11/18/2012 14:45	BKH	--	F	32	--	--	4.4	64	--	--	TSS	Water mostly clear, light rain, most snow on banks melted, roads wet but no runoff. Falling limb. Rain on bare ground/snow event. TSS collected u/s of weir.
11/30/2012 10:45	CS, BKH	--	R	426	--	--	--	--	--	90.08	TSS	Water turbid, raining, wood in transport, lots of organics/sand/silt in suspension, urban pipes flowing hard and very dirty. TSS sampled on left bank about 1/3 of the way across channel.
12/2/2012 8:50	CS, DS	--	R	988	--	--	--	--	--	172.9, 193.5	TSS (2)	Heavy rain overnight, flood watch for truckee, raining hard, urban pipes flowing, but first flush has passed, lots of ponding on roadways, water very dirty, lots of organics and wood in suspension. TSS @ 850 and a rep at 851
12/2/2012 14:40	CS, BKH	--	F	824	--	--	--	--	--	81.5	TSS	rain all day, changing to wet snow around noon. About 4" of wet snow melting on roads, temps rising and switching back to rain showers, water dirty, urban pipes flowing. Noticeable silts/sands in floodplain, HWM noticeable. Sample collected from left bank.
12/5/2012 15:20	BKH	--	F	509	--	--	3.8	42	72	--	TSS	1" rain overnight, light rainfall today, water moderately turbid, flow falling, releasing from donner lake. TSS collected.
3/12/2013 16:25	CS	--	B	60	--	--	--	--	--	0.55	TSS	Water clear, no snow on banks, brown algae on rocks, <.1cfs of urban runoff contribution from McDonalds pipe (brown water)
3/20/2013 12:15	CS	--	R	122	--	--	2.7	55	96	4.82	TSS	Water slightly turbid, rain showers started at 10pm last night. About .5'-.75" rain fell since start. Stormwater pipes flowing from McDonalds and shell station pipes. Urban flows are low but turbidity very high
4/29/2013 13:30	CS	--	B	82	--	--	8.6	38	56	1.91	TSS	Water clear, very little algae on rocks, no urban stormwater inputs.

Table 2. Station Observer Log:
Donner Creek at Highway 89 (DC89), USGS 10338700, water year 2013

Site Conditions				*Streamflow*			*Water Quality Observations*					*Remarks*
Date/Time (observer time)	Observer	Stage	Hydrograph	USGS flow	Instrument Used	Estimated Accuracy	Water Temperature	Field Specific Conductance	Adjusted Specific Conductance	Turbidity	Additional sampling?	
		(feet)	*(R/F/S/B)*	*(cfs)*	*(AA/PY)*	*(e/g/f/p)*	*(oC)*	*(µmhos/cm)*	*(at 25 oC)*	*(NTU)*	*(Qbed, etc.)*	
5/6/2013 7:10	BKH	--	B	86	--	--	--	--	--	7.2	TSS	Water mostly clear, outfalls d/s of sample location active and turbid
5/12/2013 19:15	CS	--	B	118	--	--	--	--	--	7.8	TSS	Water slightly turbid, no urban inputs, snowmelt, about 100cfs coming from cold creek, sunny, 70 degrees.
6/25/2013 11:45	CS	--	R	33	--	--	8.8	32	46	1.8	TSS	Water clear, light rain, 60F, about 1" of precip on crest in past 24 hours, significantly less rain as you go east toward Martis, urban inputs flowing moderately with cloudy water
7/24/2013 17:00	CS	--	B	5	--	--	23.5	142	145	0.65	TSS	Water clear, some algae growing on rocks, sunny, 75F
9/10/2013 10:00	BKH	--	B	105	--	--	17.6	89	--		TSS	Donner lake releasing over last few days. TSS collected u/s of wier, sample may contain slgae as flows increase. Water mostly clear.

Observer Key: (ds) is David Shaw, (bkh) is Brian Hastings, (cs) is Collin Strasenburgł
Streamflow gaging station operated by USGS; Flow values are provisional, as reported by the USGS for station 1033870(
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. Stream gaging observer log:
Donner Creek at West River Road (DCWR): water year 2013

Site Conditions				*Streamflow*				*Water Quality Observations*					*Remarks*
Date/Time (observer time)	Observer	Stage	Hydrograph	Streamflow	Instrument Used	Estimated Accuracy	USGS streamflow (10338700)	Water Temperature	Field Specific Conductance	Adjusted Specific Conductance	Turbidity	Additional sampling?	
		(feet)	(R/F/S/B)	(cfs)	(AA/PY)	(e/g/f/p)	(cfs)	(oC)	(µmhos/cm)	(at 25 oC)	(NTU)	(Qss, Qbed)	
11/17/2012 10:21	CS	--	R	--	--	--	13	5.5	82	132	5.80	TSS	Heavy rain shower for past 15 minutes. Ponding on roadways, lots of urban runoff entering u/s. About 0.5" rain fell overnight. Water slightly cloudy. Kokanee salmon under bridge (10-12" long).
11/17/2012 14:50	CS	--	R	--	--	--	26	--	--	--	21.02	TSS	Moderate rain all day, 40F, water moderately cloudy (can't see bottom), urban pipes are flowing.
11/18/2012 9:30	DS	--	U	--	--	--	34	--	--	--	2.29	TSS	Light rain, light covering of wet snow overnight, sampled TSS under WR bridge, water slightly cloudy, can see bottom, no sig difference in color between DC and the TR.
11/18/2012 14:15	BKH	--	F	--	--	--	32	4.2	66	--	1.5	TSS	Mostly cloudy with showers, water clear with some organics, falling limb, TSS @ 1420
11/30/2012 10:30	CS, BKH	--	R	--	--	--	426	--	--	--	97.0	TSS	Heavy rain overnight, rain, 40 degrees, water too high to wade, muddy, donner is still flowing freely into truckee. Lots of organics and wood in suspension. See DC89 for more details. TSS collected d/s of bridge from both banks.
12/2/2012 9:00	CS, DS	--	R	--	--	--	988	--	--	--	200.3	TSS	Heavy rain overnight, rain, 40 degrees, water too high to wade, very turbid, water only barely more turbid in DC than TR. TSs collected from left bank d/s of bridge.
12/2/2012 14:15	CS, BKH	--	F	--	--	--	824	--	--	--	79.4	TSS	SEE DC89 notes for details on weather. Water less turbid than morning, TSS collected from left bank d/s of bridge.
12/5/2012 15:30	DS, BKH	--	F				509				9.4	TSS	Water slightly turbid
3/12/2013 16:30	CS	--	B	--	--	--	60.00	--	--	--	0.7	TSS	Water clear, no snow on banks, brown algae growing on rocks, <.1cfs of urban runoff contributing from McDonalds pipe (brown water)
3/20/2013 12:05	CS, BKH	--	R	--	--	--	122.00	2.8	57	99	4.2	TSS	Water slightly turbid, rain showers started at 10pm last night. About .5'-.75" rain fell since start. Stormwater pipes flowing from McDonalds and shell station pipes. Urban flows are low but turbidity very high
4/29/2013 13:35	CS	--	B	--	--	--	82.00	--	--	--	1.8	TSS	
5/6/2013 7:15	BKH	--	B	--	--	--	86.00	--	--	--	6.8	TSS	Water slightly cloudy, TSS collected under bridge, rain beginning to stop, snow level at 7K'.
5/12/2013 19:20	CS	--	B	--	--	--	118.00	--	--	--	7.4	TSS	Water slightly turbid, no urban inputs, snowmelt, about 100cfs coming from cold creek, sunny, 70 degrees.
6/25/2013 11:50	CS	--	R	--	--	--	33.00	8.9	50	72	3.96	TSS	Light rain, 60F, about 1" of precip on the crest in past 24 hours. Significantly less rain as you go east toward Martis. Water mostly clear. Urban inputs flowing moderately with cloudy water.
7/24/2013 16:50	CS	--	B	--	--	--	5.40	22.3	141	149	1.5	TSS	Water clear, very little algae growing on rocks, sunny, 75F.
9/10/2013 10:15	BKH	--	B	--	--	--	105.00	17.6	88	--	--	TSS	Water clear, donner lake releasing, some algae scoured from bed.

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)
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 Donner Pass Road (TCDP), water year 2013

Site Conditions				Streamflow			Water Quality Observations					Remarks
Date/Time (observer time)	Observer	Stage (feet)	Hydrograph (R/F/S/B)	Measured Discharge (cfs)	Instrument Used (AA/PY)	Estimated Accuracy (e/g/f/p)	Water Temperature (oC)	Field Specific Conductance (µmhos/cm)	Adjusted Specific Conductance (at 25 oC)	Turbidity (NTU)	Additional sampling? (Qbed, etc.)	
10/1/2012 9:10	BKH	3.54	U	--	--	--	--	--	--	--	--	water clear, willows dropping leaves, cleaned probe, cleaned willow from cage
10/17/2012 16:00	BKH	3.54	B	0.5	PY	F	8.2	127.0	185.0	--	--	Sunny, warm, 69F, water clear, leaves falling from trees, removed leaf dam at 1548, abundant fines on bed, first flush will generate high turbidity in rising linb, need to remove cage before predicted rain, expect more leaf dams, cleaned cage at 1615. GH @ 1545 = 3.56, GH @ 1600 = 3.54, GH @ 1615 = 3.54.
10/22/2012 8:45	BKH	3.54	B	--	--	--	--	--	--	--	--	water clear with slush, removed cage at probe and kicked leaves through station. 6" snow overnight and should continue to snow through morning, expecting runoff from I-80 and other urban sources by midday to elevate stage and turbidity.
10/22/2012 14:20	BKH	3.66	R	--	--	--	--	--	--	75.80	TSS	Very turbid, collected TSS @ 14:20, removed leaf from probe, moderate snowfall melting on roads, expected to cool again and more snow overnight (2"-4"). Real-time record will show neg values or values >500NTU. Likely a peak near 100NTU and short lived (about 1hr).
11/13/2012 16:30	CS	3.67	B	0.9	PY	F	1.5	84.3	--	--	--	Overcast, 45F, water clear, lots of leaves floating in channel. Potential for occasional leaf dam build-up. Right half of channel covered in thin ice. Doesn't seem to be affecting stage. Some ice in turbidity probe screen. Ice cleared from around probe and window wiped. U/S flow xsection covered in ice. Broke ice at d/s grade to measure flow, which caused stage to decrease to 3.67'. GH @ 1600 = 3.68, GH @ 1615 = 3.67, GH @ 1638 = 3.67.
11/17/2012 11:00	CS	3.92	F	3.7	PY	G,F	1.2	168	--	101.9, 63.51	TSS (2)	Rain, 45F, moderate to heavy rain overnight (about 0.5"). Moderate to heavy rain for past 45 minutes. Otherwise, light rain showers all morning. Water very dirty with lots of debris (leaves) in suspension. Difficult to take a flow measurement due to leaves hanging up on meter. Stage dropping and water beginning to clear up. TSS @ 1045 and 1115. GH @ 1046 = 3.94 +/- .01, GH @ 1105 = 3.92 +/- .01, GH @ 1115 = 3.91 +/- .01.
11/17/2012 15:45	CS	4.02	R	4.8	PY	G	1.3	86.2	--	66.79	TSS	Moderate rain all day, 40F, water mostly cloudy, used headphones for flow, lots of leaves and sticks in suspension. TSS @ 1530, GH @ 1530 = 4.01 +/- .01, GH @ 1550 = 4.03 +/- .01
11/18/2012 9:00	DS	3.88	U	--	--	--	--	--	--	--	--	light rain, light covering of wet snow overnight, water is very slightly turbid, can see bottom. GH @ 9:00 = 3.88, GH @ 10:17 = 3.88'
11/18/2012 14:00	BKH	3.92'	R	--	--	--	1.2	85.0	--	--	TSS	water clear or slightly turbid, cloudy with showers. Rain on snow and rain on bare ground event. GH = 3.92 @ 1400. TSS sample at 1405.
11/30/2012 10:15	CS, BKH	4.67	R	25.2	AA	G,F	0.7	73.0	--	72.69, 59.47	TSS (2)	moderate rain, about 1.5-2" overnight, 40 degrees, heavy rain overnight, rain continues with a flood watch in effect for truckee watershed. Snow levels about 7500 and rising. Lots of organics and sand/silt in transport, water brown, leaves continuing to attach to AA meter. GH @ 955 = 4.65 +/- .02, GH @ 1000 = 4.66 +/- .02, GH @ 1015 = 4.67 +/- .02. TSS @ 1000 and 1015.
11/30/2012 12:45	CS	--	--	--	--	--	--	--	--	--	--	POTENTIAL STAGE SHIFT AT PEAK OF EVENT
12/2/2012 9:30	CS, DS	4.98	R	54.2	AA	G	2.5	58	101	64.08	TSS	raining hard, cold, significant rain overnight (1-2"), flood watch in effect for truckee, bed is mobile, smells like horse manure (stables on left bank), rain intensity picking up during qmeas, switching to freezing rain/snow. GH @ 915 = 4.93 +/- .05, GH @ 930 = 4.98 +/- .05, GH @ 945 = 4.98 +/- .05. TSS @ 915.
12/2/2012 14:00	CS, BKH	5.05	F	60.2	AA	G,F	0.7	49	--	36.6	TSS	raining hard all day/night, flood watch in effect for truckee, water moderately turbid, but less than morning sampling. 4" new wet snow on ground with rain showers, stage dropping, lots of organics in suspension. GH @ 1348 = 5.1 +/- .03, GH @ 1400 = 5.05 +/- .05, GH @ 1405 = 5.04 +/- .05, TSS @ 1348.
12/5/2012 15:45	BKH	4.41	G	--	--	--	--	--	--	--	TSS	water mostly clear, possible sediment accumulation at gage. GH +/- .02
12/14/2012 13:45	CS	--	F	--	--	--	--	--	--	--	--	water clear, cleared snow from around probes. Redirected flow toward probes to prevent ice buildup. Cleaned sensor. GH dropped to 3.92' @ 14:00 once snow was cleared.
12/17/2012 0:00	BKH	--	--	--	--	--	--	--	--	--	--	Ice affecting stage from 12/13/12-12/17/12. Cold temps and lower flows have created freezing conditions near the gage and gage pool. Turbidity is affected. Background NTU = 2. Some rain today, mixed with snow is elevating stage. Increases in turbidity are likely to be greater than 10NTU. Significant sand/fines on roadways.
12/19/2012 13:15	BKH	3.87	F	4.1	PY	F	0.1	76.0	--	1.1	--	Mostly sunny, 32 degrees, very cold nights last few days has led to ice affected flows. Ice at gage, broke up ice in pool/riffle crest at 13:00. removed ice from NTU probe. Might have disturbed riffle crest when removing ice - STAGE SHIFT?. Or ice remaining on edge of channel causing shift. Ice in channel, slush in flow. Diurnal peak and min flow expected. water clear. NTU sample collected for desktop check against real time. GH @ 1258 = 4.12, GH @ 1305 = 3.865, GH @ 1330 = 3.865.
12/20/2012 10:45	CS	3.90	F	--	--	--	--	--	--	--	--	sunny, 30 degrees, water clear, some ice is around turbidity probe and at grade control. Broke ice and stage dropped to 3.77' at 11:00

Table 4. Station observer log:
Trout Creek at Donner Pass Road (TCDP), water year 2013

Site Conditions				*Streamflow*			*Water Quality Observations*					*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?	
		(feet)	*(R/F/S/B)*	*(cfs)*	*(AA/PY)*	*(e/g/f/p)*	*(oC)*	*(µmhos/cm)*	*(at 25 oC)*	*(NTU)*	*(Qbed, etc.)*	
12/22/2012 0:00	CS	--	--	--	--	--	--	--	--	--	--	heavy snow and cold temps causing ice/snow build-up in channel. Stage readings greatly affected by this. Channel still covered in ice as of 12/27/12, and probably will be until temps warm to the 40's. Turbidity readings unreliable until 12/27/12
12/27/2012 9:15	CS	--	--	--	--	--	--	--	--	--	--	sunny, 30 degrees, water clear, entire channel covered in ice and snow both u/s and d/s of gage. Snow removal pile in channel about 30' u/s of gage. Snow in this pile is very dirty. Broke ice from around probes. Rest of channel remains covered in ice. Cleaned a piece of plastic from in front of turbidity window.
1/17/2013 0:00	CS	3.72/ICE	U	--	--	P	--	--	--	--	--	channel surface frozen. PT in ice. Turbidity probe cleared of ice and cleaned. Post cold snap. Sunny, 40F during day and 15F night. Ice affecting stage 1/13-1/19 - probably longer.
1/25/2013 10:06	BKH	3.74/ICE	U	--	--	--	--	--	--	--	--	cloudy, fog, 37F, rain in forecast. Stage is ice affected. Cobble rolled onto turbidity probe. Removed cobble nad cleaned probe. Ice/snow still covering most of channel.
1/29/2013 12:30	BKH	3.67	B	2.5	PY	G	--	--	--	--	--	sunny, breezy, 40F. Warmer temps predicted through week with cold nights. Ice affected flow. Leaf on turbidity probe. Removed ice at gage. Significant ice in channel. Had to break ice to create flow cross section. Ice across 50-70% at gage. instruments free in flowing water. 1230 removed about .5' of ice at gage xsection. water clear. GH @ 1215 = 3.67', GH @ 1230 = 3.665, GH @ 1245 = 3.705.
2/1/2013 12:00	CS	ICE	B	--	--	--	--	--	--	--	--	Sunny, warm, 50F, channel 1/2 frozen, probes in flowing water, turbidity probe cleaned. Water clear
2/10/2013 13:15	CS	3.72	B	--	--	--	--	--	--	--	--	Sunny, 45F, channel 1/2 frozen, probes in free flowing water, water clear, turbidity probe cleaned. Pine needles in front of probe affecting online NTU.
2/13/2013 13:45	CS	3.67	B	--	--	--	--	--	--	--	--	Sunny, 40F, water clear. Broke ice at d/s grade control and flow xsection. Probably changed grade control d/s of gage. SHIFT. GH @ 1345 = 3.67, GH @ 1415 = 3.65'
2/14/2013 12:30	CS	3.64	B	2.1	PY	G	-0.8	81	--	--	--	sunny, 50F, water clear, very little ice. GOOD POINT TO CHECK FLOWS. Most of ice is along banks. Confident that readings are good. Turbidity probe cleaned. Some snow removal piles of snow left but no snow on roads or parking lots. Almost no significant precip in past 4 weeks. GH @ 1215 = 3.64, GH @ 1230 = 3.64, GH @ 1246 = 3.64.
2/21/13 4am-1015am	CS	--	--	--	--	--	--	--	--	--	--	Ice affecting stage over 6 hour period. No precip, no runoff. Assuming water is clear.
2/22/13 4am	CS	--	--	--	--	--	--	--	--	--	--	Ice affecting stage over 6 hour period. No precip, no runoff. Assuming water is clear. Problem through 2/24/13
3/6/2013 17:45	BKH	3.78	B	--	--	--	--	--	--	--	--	water clear, 6" new snow, adjusted probe shade structure, removed leaf from probe, wiped window. 3/5-3/7 ice affecting turbidity
3/7/2013 17:00	CS	3.76	B	--	--	--	--	--	--	--	--	water clear, no ice, turbidity probe turned downstream to aviod light scattering.
3/12/2013 17:15	CS	3.85	R	4.9	PY	G	2.4	82	145	1.7	TSS	water clear, no ice or snow, start of warming trend, temps increasing to low 60's by end of week, night lows 28-35. Turbidity probe wiped at 1657, sunny, 55 degrees. GH @ 1700 = 3.84 +/- .01, GH 1715 = 3.85 +/- .01.
3/14/2013 18:00	BKH	4.09	R	11.7	PY	G	--	--	--	5.1	TSS	sunny, warm, 63F, higher flow and turbidity, slightly turbid, GH = @ 1752 = 4.08 +/- .02, GH @ 1800 = 4.09 +/- .02
3/19/2013 15:30	CS	4.02	R	8.7	PY	G	5.1	83	134	--	--	overcast, breezy, 50F, water clear, flows up from last visit, less than .5" rain forecasted for tonight through wed night. Snow levels expected to be above 7K'. Turbidity probe Iceaned at 1528. GH @ 1521 = 4.01 +/- .01, GH @ 1530 = 4.02 +/- .01, GH @ 1545 = 4.03 +/- .01
3/20/2013 12:45	CS	4.14	R	12.1	PY	G	1.6	72	--	3.9	TSS	rain showers, 45F, water mostly clear, turbidity probe wiped and shade reinstalled. Rain showers since about 10pm last night. About .5-.75" rain so far. Snow levels 7500-7000'. Front expected to pass this evening. No ice in channel or on banks. GH @ 1230 = 4.12 +/- .02, GH @ 1247 = 4.14 +/- .02
4/2/2013 16:00	CS	3.89	B	6.3	PY	G	--	--	--	--	--	water clear, sunny, rain showers and overcast with temps in the 50's for past week. All snow in town has melted, sensors cleaned at 1605. GH @ 1545 = 3.89 +/- .02, GH @ 1604 = 3.89 +/- .01
4/12/2013 12:04	CS	3.84	B	--	--	--	--	--	--	--	--	water clear, turbidity probe wiped, algae starting to grow on wall
4/24/2013 16:34	BKH	3.68	B	--	--	--	--	--	--	--	--	water clear, small leaf dam upstream, wiped turbidity probe,
4/29/2013 14:00	CS	3.68	B	2.2	PY	G	13	116	151	1	TSS	water clear, sunny, 70 degrees, some algae growing on bed surface, turbidity probe cleaned, willows full of leaves. GH @ 1345 = 3.68, GH @ 1415 = 3.68
5/6/2013 7:00	BKH	3.80	R	--	--	--	--	---	--	31.90	TSS	light to moderate rain over last several hours, runoff observed on roadways, urban outfalls active, water cloudy, Turbidity probe cleaned, snow level 7K'.
5/6/2013 12:30	CS	3.89	U	5.2	PY	G	6.3	102	158	6.99, 5.84	TSS (2)	Water slightly turbid, overcast, rain/t-storms overnight, about .5"-.75" rain in past 24 hours. Turbidity probe cleaned at 1215, no precip at time of sampling, temps in the 50's. GH @ 1215 = 3.89 +/- .01, GH @ 1230 = 3.89 +/- .01.

Table 4. Station observer log:
Trout Creek at Donner Pass Road (TCDP), water year 2013

Site Conditions				*Streamflow*			*Water Quality Observations*					*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?	
		(feet)	*(R/F/S/B)*	*(cfs)*	*(AA/PY)*	*(e/g/f/p)*	*(oC)*	*(µmhos/cm)*	*(at 25 oC)*	*(NTU)*	*(Qbed, etc.)*	
5/10/2013 16:30	CS	3.72	B	2.5	PY	G	11.7	116	155	1.9	TSS	sunny, 70 degrees, water clear, turbidity probe cleaned, willows full of leaves.
6/17/2013 18:45	BKH	3.47	B	0.6	PY	G	11.7	115	156	--	--	sunny, windy, 60F, no leaf dams, water clear, some litter in channel, lots of fine sediment on bed and in gaging pool, wiped turbidity probe at 19:00, may need to lower PT's in next couple of weeks. GH @ 1820 = 3.48, GH @ 1900 = 3.47
6/25/2013 13:30	CS	3.64	R	1.4	PY	G	9.3	123	176	4.1	TSS	overcast, 60F, light rain showers, water clear, light rain in past 24 hours. Less than .5" in truckee and 1-2" on sierra crest. Storm beginning to break. Tumbleweed in front of probe at 1320. Removed debris and cleaned turbidity window. TSS @ 1330. GH @ 1330 = 3.64, GH @ 1345 = 3.64
6/28/2013 18:00	CS	3.49	B	0.6	PY	G,F	--	--	--	--	--	sunny, 80 degrees, temps forecasted to be in the high 80's through the weekend, water clear, GH @ 1745 = 3.49, GH @ 1815 = 3.49, LOWERED PT's??
7/24/2013 16:30	CS	3.43	B	0.2	PY	F	18.3	176	202	1.0	TSS	sunny, 75F, water clear, very low flows, strange white/slimy algae growing on rocks, Trubidity window wiped at 16:20, A small amount of willow leaves accumulating around rocks at riffle crest d/s of gage, TSS @ 1630, GH @ 1618 = 3.43, GH @ 1645 = 3.43
8/30/2013 16:00	CS	3.38	B	0.1	PY	G,F	19.2	176	199	--	--	water clear, lots of brown algae on rocks, turbidity probe cleaned, thick smoke over area for past 2-3 weeks, GH @ 1545 = 3.38, GH @ 1603 = 3.38
9/12/2013 19:40	BKH	--	R	--	--	--	--	--	--	--	--	severe thunderstorm from 18:30-19:30. Turbidity increasing with only a minor increase in flows
9/20/2013 15:45	CS	3.42	B	0.2	PY	G,F	15.1	183	225	--	--	water clear, lots of algae on rocks, turbidity probe cleaned, very low flows, cold front pushing through tonight. Chance of rain tomorrow. Sunny, windy, 70 degrees, GH @ 1530 = 3.42, GH @ 1545 = 3.42

Observer Key: (ds) is David Shaw, (cs) is Collin Strasenburgh, (bkh) is Brian Hasting
Stage: Water level observed at outside staff plat
Hydrograph: Describes stream stage as rising (R), falling (F), steady (S), or baseflow (
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 visua
Estimated measurement accuracy: Excellent (E) = +/- 2%; Good (G) = +/- 5%; Fair (F) = +/- 9%; Poor (P) estimated percent accuracy gi
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 conducta

Additional Sampling: Qss = Suspended sediment

Table 5. Suspended-sediment concentration and calculated loading rates: Cold Creek at Teichert Bridge (CCTB), water year 2013

	Site Conditions						Suspended Sediment		
Sample Date:Time	**Observer(s)**	**Gage Height**	**Streamflow Discharge**	**Streamflow Value Source**	**Stream Condition**	**Event Type**	**Suspended-Sediment Concentration**	**15-minute Turbidity**	**Suspended-Sediment Transport Rate**
WY2013									
11/17/2012 9:30	CS	0.79	1.9	M	R	rain	1.20	1.19	0.01
11/17/2012 13:47	CS	1.35	9.37	M	R	rain	22.00	8.48	0.6
11/30/2012 11:00	CS, BKH	4.50	270	R	R	rain	191.0	102.0	138.9
11/30/2012 11:02	CS, BKH	4.50	270	R	R	rain	189.2	102.0	137.7
12/2/2012 8:00	CS, DS	6.10	559	R	R	rain on snow	345.0	149.7	519.8
12/2/2012 15:16	CS, BKH	5.20	393	R	F	rain on snow	143.0	133.3	151.3
12/5/2012 14:30	BKH, DS	4.35	242	M	F	rain on snow	30.4	24.3	19.8
3/12/2013 15:45	CS	1.61	17.2	M	B	snowmelt	1.60	0.92	0.1
3/14/2013 18:15	BKH	2.00	29	R	B		4.80	2.15	0.4
3/20/2013 14:00	CS	2.36	46	M	U	rain	4.00	2.50	0.5
4/29/2013 12:15	CS	2.70	70	M	U	snowmelt	3.20	2.65	0.6
5/10/2013 16:15	CS	2.85	79.7	R	U	snowmelt	5.20	4.17	1.12
5/12/2013 18:30	CS	3.20	106.3	M	R	snowmelt	16.80	5.45	4.81
6/25/2013 13:00	CS	2.02	31.0	M	R	rain	6.00	4.50	0.50
7/24/2013 17:30	CS	0.60	1	M	B	baseflow	1.20	1.27	0.003
7/24/2013 17:31	CS	0.60	1	M	B	baseflow	1.20	1.27	0.003

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

Values are preliminary and subject to revision

Table 6. Suspended-sediment concentrations and calculated loading rates
Donner Creek at Highway 89 (DC89), USGS 10338700, water year 2013

	Site Conditions						Suspended Sediment		
Sample Date:Time	Observer(s)	Gage Height	Streamflow Discharge	Streamflow Value Source	Stream Condition	Event Type	Suspended-Sediment Concentration	15-minute Turbidity	Suspended-Sediment Discharge Rate
		(ft)	*(cfs)*	*M,R,E*	*R,F,B,U,S*		*(mg/l)*	*(NTU)*	*(tons/day)*
WY 2013									
10/1/12 9:00	bkh		54	R	R	Donner Lake release	8.0	n/a	1.2
10/2/12 8:25	bkh		105	R	S	Donner Lake release	6.0	n/a	1.7
10/16/12 10:45	bkh		90	R	S	Donner Lake release	2.4	n/a	0.6
11/17/12 10:17	CS		13	R	R	rain	2.4	n/a	0.1
11/17/12 14:42	CS		26	R	R	rain	11.8	n/a	0.8
11/18/12 9:15	DS		34	R	F	post rain	3.0	n/a	0.3
11/18/12 14:45	BKH		32	R	F	post rain	3.2	n/a	0.3
11/30/12 10:45	CS, BKH		426	R	R	rain	156.0	n/a	179
12/2/12 8:50	CS, DS		988	R	R	rain	349.0	n/a	929
12/2/12 8:51	CS, DS		988	R	R	rain	375	n/a	1000
12/2/12 14:40	CS, BKH		824	R	F	rain	125.0	n/a	278
12/5/12 15:20	BKH		509	R	F	rain	14.0	n/a	19.2
3/12/13 16:25	CS		60	R	S	snowmelt	1.6	n/a	0.3
3/20/13 12:15	CS		122	R	R	rain	4.0	n/a	1.3
4/29/13 13:30	CS		82	R	S	snowmelt	3.6	n/a	0.8
5/6/13 7:10	BKH		86	R	S	snowmelt	7.2	n/a	1.7
5/12/13 19:15	CS		118	R	S	snowmelt	14.0	n/a	4.5
6/25/13 11:45	CS		33	R	R	rain	3.6	n/a	0.3
7/24/13 17:00	CS		5	R	S	baseflow	1.6	n/a	0.0
9/10/13 10:00	BKH		105	R	S	Donner Lake release	3.5	n/a	1.0

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
Values are preliminary and subject to revision

Table 7. Suspended-sediment concentrations and calculated loading rates
Donner Creek at West River Street (DCWR), USGS #10338700, water year 2013
USGS #10338700

Sample Date:Time	Observer(s)	Gage Height	Streamflow Discharge	Streamflow Value Source	Stream Condition	Event Type	Suspended-Sediment Concentration	15-minute Turbidity	Suspended-Sediment Discharge Rate
	Site Conditions						*Suspended Sediment*		
		(ft)	*(cfs)*	*M,R,E*	*R,F,B,U*		*(mg/l)*	*(NTU)*	*(tons/day)*
WY 2013									
11/17/2012 10:21	CS	--	13	R	R	rain	4.46	n/a	0.2
11/17/2012 14:50	CS	--	26	R	R	rain	15.58	n/a	1.1
11/18/2012 9:30	DS	--	34	R	F	post rain	2	n/a	0.2
11/18/2012 14:15	BKH	--	32	R	F	post rain	2	n/a	0.2
11/30/2012 10:30	CS, BKH	--	426	R	R	rain	172	n/a	197.5
12/2/2012 9:00	CS, DS	--	988	R	R	rain	396.19	n/a	1055
12/2/2012 14:15	CS, BKH	--	824	R	F	rain	133.3	n/a	296.0
12/5/2012 15:30	DS, BKH	--	509	R	F	rain	16	n/a	22.0
3/12/2013 16:30	CS	--	60	R	S	snowmelt	1.6	n/a	0.3
3/20/2013 12:05	CS, BKH	--	122	R	R	rain	6	n/a	2.0
4/29/2013 13:35	CS	--	82	R	S	snowmelt	3.6	n/a	0.8
5/6/2013 7:15	BKH	--	86	R	S	snowmelt	9.6	n/a	2.2
5/12/2013 19:20	CS	--	118	R	S	snowmelt	12.8	n/a	4.1
6/25/2013 11:50	CS	--	33	R	R	rain	4	n/a	0.4
7/24/2013 16:50	CS	--	5	R	S	baseflow	2	n/a	0.0
9/10/2013 10:15	BKH	--	105	R	S	Donner Lake release	2	n/a	0.6

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 values are reported from USGS #10338700, Donner Creek at Highway 89

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 (mg/L) by streamflow (cfs) and a conversion factor of 0.0027

Table 8. Suspended-sediment concentration and load rates:
Trout Creek at Donner Pass Road (TCDP), water year 2013

Sample Date:Time	Observer(s)	Gage Height	Streamflow discharge	Streamflow Value Source	Stream Condition	Event Type	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)*
WY 2013									
10/22/12 14:15	bkh	3.66	0.87	R	U	thunderstorm	59.33	60.19	0.14
11/17/12 10:45	cs	3.92	3.72	R	F	rain	95.00	58.11	0.95
11/17/12 11:15	cs	3.92	3.72	R	F	rain	60.00	48.45	0.60
11/17/12 15:30	cs	4.02	4.77	M	R	rain	52.00	22.87	0.67
11/18/12 14:00	bkh	3.92	2.68	R	R	rain	7.00	4.49	0.05
11/30/12 10:00	cs, bkh	4.67	25.22	M	R	rain on snow	97.17	74.50	6.60
11/30/12 10:15	cs, bkh	4.67	25.22	M	R	rain on snow	88.00	46.06	5.98
12/2/12 9:15	cs, ds	4.98	54.21	M	R	rain on snow	68.00	37.01	9.94
12/2/12 13:45	cs, bkh	5.05	60.18	M	F	rain on snow	23.00	18.89	3.73
12/5/2012 15:45	bkh	4.41	20.81	R	U	rain on snow	6.00	5.24	0.34
3/12/13 17:00	cs	3.85	4.91	M	R	snowmelt	1.60	2.22	0.02
3/14/13 17:45	bkh	4.09	11.68	M	R	snowmelt	10.00	6.57	0.31
3/20/13 12:45	cs	4.14	12.06	M	R	rain	6.00	4.04	0.20
4/29/13 14:15	cs	3.68	2.21	M	B	snowmelt	3.60	2.99	0.02
5/6/13 7:00	bkh	3.80	3.74	R	R	snowmelt	27.20	22.19	0.27
5/6/13 12:30	cs	3.89	5.23	M	U	snowmelt	9.20	7.51	0.13
5/6/2013 12:31	cs	3.89	5.23	M	U	snowmelt	9.80	7.51	0.14
5/10/13 16:45	cs	3.72	2.51	M	B	snowmelt	3.20	3.23	0.02
6/25/13 13:30	cs	3.64	1.45	M	R	rain	4.00	5.59	0.02
7/24/13 16:30	cs	3.43	0.19	M	B	thunderstorm	2.40	4.19	0.00
9/12/13 19:40	bkh	3.38	0.09	R	R		37.50	15.00	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

Values are preliminary and subject to revision

Table 9. Comparison of annual flow and suspended-sediment loads and yields
Cold Creek, Trout Creek, and Donner Creek, water years 2011 through 2013.

			Annual Flow[2]				Peak Flow			Suspended Sediment Load[3]			
Station	Water Year[1]	Watershed Area	Mean Daily Flow	Maximum Daily Flow	Minimum Daily Flow	Total Flow Volume	Peak Flow	Peak Stage	Date Time	**Suspended Sediment**	**Percent exceedance for TMDL standard**	**Normalized Suspended Sediment (yield)**	**Normalized Suspended Sediment (yield)**
			(cfs)	*(cfs)*	*(cfs)*	*(ac-ft)*	*(cfs)*	*(ft)*	*(mm/dd/yyyy)*	***(tons)***	***(%)***	***(tons/1,000 ac-feet)***	***(tons/sq. mile)***
Cold Creek at Teichert Bridge (CCTB)													
	WY 2011		60	335	0.9	42,624	447	5.73	6/22/2011	**508**	**1.5**	**12**	**40**
	WY 2012	12.6	21	384	0.2	15,374	546	5.89	4/26/2012	**327**	**1.5**	**21**	**26**
	WY 2013		21	407	0.17	14,884	1004	6.6	12/2/2012	**610**	**1.3**	**41**	**48**
											Average:	**25**	**38**
Donner Creek at Highway 89 (DC89)													
	WY 2011		140	774	5	101,308	921	--	6/29/2011	**804**	**--**	**8**	**54**
	WY 2012	14.8	48	862	3.1	34,925	1,090	--	4/26/2012	**406**	**1.1**	**12**	**27**
	WY 2013		58	676	3.7	42,125	1,150	--	12/2/2012	**498**	**0.5**	**12**	**34**
											Average:	**10**	**38**
Donner Creek at West River Street (DCWR)													
	WY 2011		--	--	--	--	--	--	--	**--**	**--**	**--**	**--**
	WY 2012	15.2	48	862	3.1	34,925	1,090	--	4/26/2012	**564**	**2.1**	**16**	**37**
	WY 2013		58	676	3.7	42,125	1,150	--	12/2/2012	**819**	**2.3**	**19**	**54**
											Average:	**18**	**45**
Trout Creek at Donner Pass Road (TCDP)													
	WY 2011		*15*	*63*	*1.1*	*3,469*	*70*	*5.16*	*4/21/2011*	***52***	***2.7***	***15***	***11***
	WY 2012	*4.6*	2.5	23.3	0.2	1,814	54	5.21	1/21/2012	**10.6**	**0.8**	**6**	**2**
	WY 2013		2.2	31.5	0.2	1,587	81	5.18	12/2/2012	**13.4**	**1.6**	**8**	**3**
											Average:	**10**	**6**

Notes:

1 Water years begin in October and end in September of the named water year; WY 2011 is a partial water year (January 21--September 30, 2011) for TCDP

2 Annual and Peak flow statistics based on 15-minute record of flow for stations managed and maintained by Balance Hydrologics, Inc. The Donner Creek (USGS 10338700) station is managed and maintained by USGS;
Donner Creek streamflow affected by regulation (Donner Lake); watershed area for Donner Creek stations exclude area above Donner Lake Dam (14.3 sq. miles) and includes Cold Creek.

3 Cold Creek and Trout Creek suspended-sediment loads are based on conversion of a continuous (15-min) record of turbidity to suspended sediment concentration.
Donner Creek suspended sediment loads are based on a standard streamflow-based sediment rating curve method

Table 10. Comparison of annual flow and suspended-sediment loads
Donner Creek at Highway 89 (DC89), USGS 10338700, water years 1997, 2004, 2011, 2012, and 2013.

	Annual Flow[2]				**Peak Flow[3]**			**Suspended Sediment Load[4]**		
Year[1]	Mean Daily Flow	Maximum Daily Flow	Minimum Daily Flow	Total Flow Volume	Peak Flow	Peak Stage	Date Time	Suspended Sediment	Normalized Suspended Sediment	Normalized Suspended Sediment
	(cfs)	*(cfs)*	*(cfs)*	*(ac-ft)*	*(cfs)*	*(ft)*	*(24-hr)*	*(tons)*	*(tons/1,000 ac-feet)*	*(tons/sq. mile)*
Donner Creek at Highway 89										
WY 1997	117	2,380	3.6	84,679	2,500	12.76	1/2/1997	2,253	27	148
WY 2004	55	245	3.1	39,546	268	5.28	3/22/2004	380	10	25
WY 2011	140	774	5.0	101,308	921	--	6/29/2011	804	8	54
WY 2012	48	862	3.1	34,925	1,090	--	4/26/2012	384	11	26
WY 2013	58	676	3.7	42,125	1,150	--	12/2/2012	498	12	34
mean	*84*			*60,517*	*1,186*			*864*	*13*	*63*
median	*58*			*42,125*	*1,090*			*498*	*11*	*34*

Notes:

1 WY 1997 and WY 2004 data are reported from Amorfini and Holden (2008) using sediment rating curve reported from McGraw and others (2001); WY 2011 - WY 2013 data were collected by Balance Hydrologics

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

3 Donner Creek peak flow and stage for WY 1997 is estimated by USGS; all Donner peak flows are affected by regulation at Donner Lake

4 Suspended sediment loads are 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); WY 2011- WY 2013: (Qss = 0.021*(Q^0.74)) for flows less than 200 cfs; (Qss = 0.00000002*(Q^3.36)) for flows greater than 200 cfs. (Hastings and others, this report); Separate sediment rating curves were developed and applied for the rising limb hydrograph of Donner Lake releases (0.0158*(Q^1.03) and rain on bare ground events (0.00075*Q^3.36) (See this report)

WY 1997 and WY 2004 normalized suspended-sediment load (tons/sq. mile) are based on a watershed area of 15.2 sq. miles as delineated from the confluence with Truckee River, but excluding watershed area above Donner Lake Dam (14.3 sq. miles)

WY 2011-WY 2013 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)

Table 11. Comparison of annual flow and normalized suspended-sediment loads
Trout Creek at Donner Pass Road (TCDP), water years 1997, 2004, 2011 (partial), 2012, and 2013

Year[1]	Annual Flow[2]				Peak Flow[3]			Suspended Sediment Load[4]		
	Mean Daily Flow	Maximum Daily Flow	Minimum Daily Flow	Total Flow Volume	Peak Flow	Peak Stage	Date Time	Suspended Sediment	Normalized Suspended Sediment	Normalized Suspended Sediment
	(cfs)	*(cfs)*	*(cfs)*	*(ac-ft)*	*(cfs)*	*(ft)*	*(24-hr)*	*(tons)*	*(tons/ac-feet)*	*(tons/sq. mile)*
WY 1997	8.0	195	3.3	5,809	--	--	--	61	**11**	**12**
WY 2004	4.1	9.4	3.0	3,002	--	--	--	21	**7**	**4**
partial WY 2011	*15*	*63*	*0.4*	*6,777*	70	5.16	4/21/2011	*59*	**9**	**13**
WY 2012	2.5	23	0.2	1,814	54	5.14	1/20/2012	10.6	**6**	**2**
WY 2013	2.2	32	0.2	1,587	81	5.18	12/2/2012	13.4	**8**	**3**
mean	*6.3*			*3,798*				*33*	*8*	*7*
median	*4.1*			*3,002*				*21*	*8*	*4*

Notes:

1 WY 1997 and WY 2004 data are reported from Amorfini and Holden (2008) and based on sediment rating curves from McGraw and others (2001); WY 2011 - WY 2013 data were collected by Balance Hydrologics

2 Annual flow statistics for WY 1997 and WY 2004 are synthesized from a record of flow at Sagehen Creek near Truckee [Trout Creek Q = 0.24*(Sagehen Q)+2.6563], McGraw and others (2001);
The Sagehen Creek gage is managed and maintained by USGS (USGS 10343500);
Annual flow statistics for WY 2011 and WY 2012 are based on continuous gaging record managed and maintained by Balance Hydrologics; WY 2011 is a partial water year (January 21 - September 30, 2011)

3 Because WY 1997 and WY 2004 represent annual flow data based on a synthetic record, peak flow data are unavailable.

4 WY 1997 and WY 2004 suspended-sediment loads are based on grab samples analyzed for suspended-sediment concentration and standard rating curve method (Qss = 1.30*(Q^2.05), McGraw and others, 2001;
WY 2011 and WY 2013 suspended-sediment loads are based on continuous record of turbidity and laboratory analysis of suspended-sediment concentration (SSC); SSC = 1.07*(NTU)^0.96
WY 1997 and WY 2004 normalized suspended-sediment yields (watershed area, sq. mile) are based on a watershed area delineated at Trout Creek confluence with Truckee River
(4.89 sq. miles, McGraw and others, 2001); watershed area delineated at Donner Pass Road (4.6 sq. miles) for WY 2011 - WY 2013

FIGURES

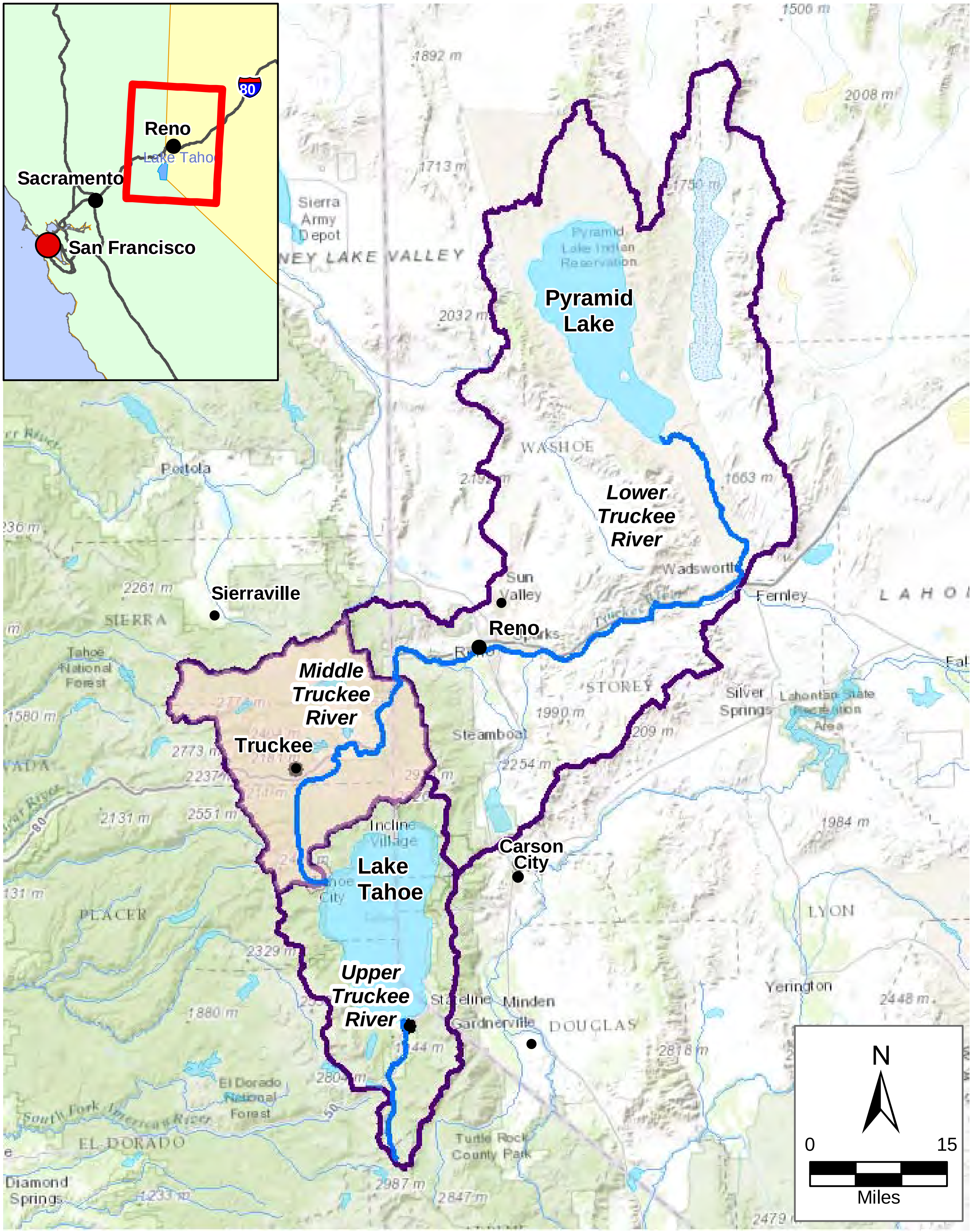
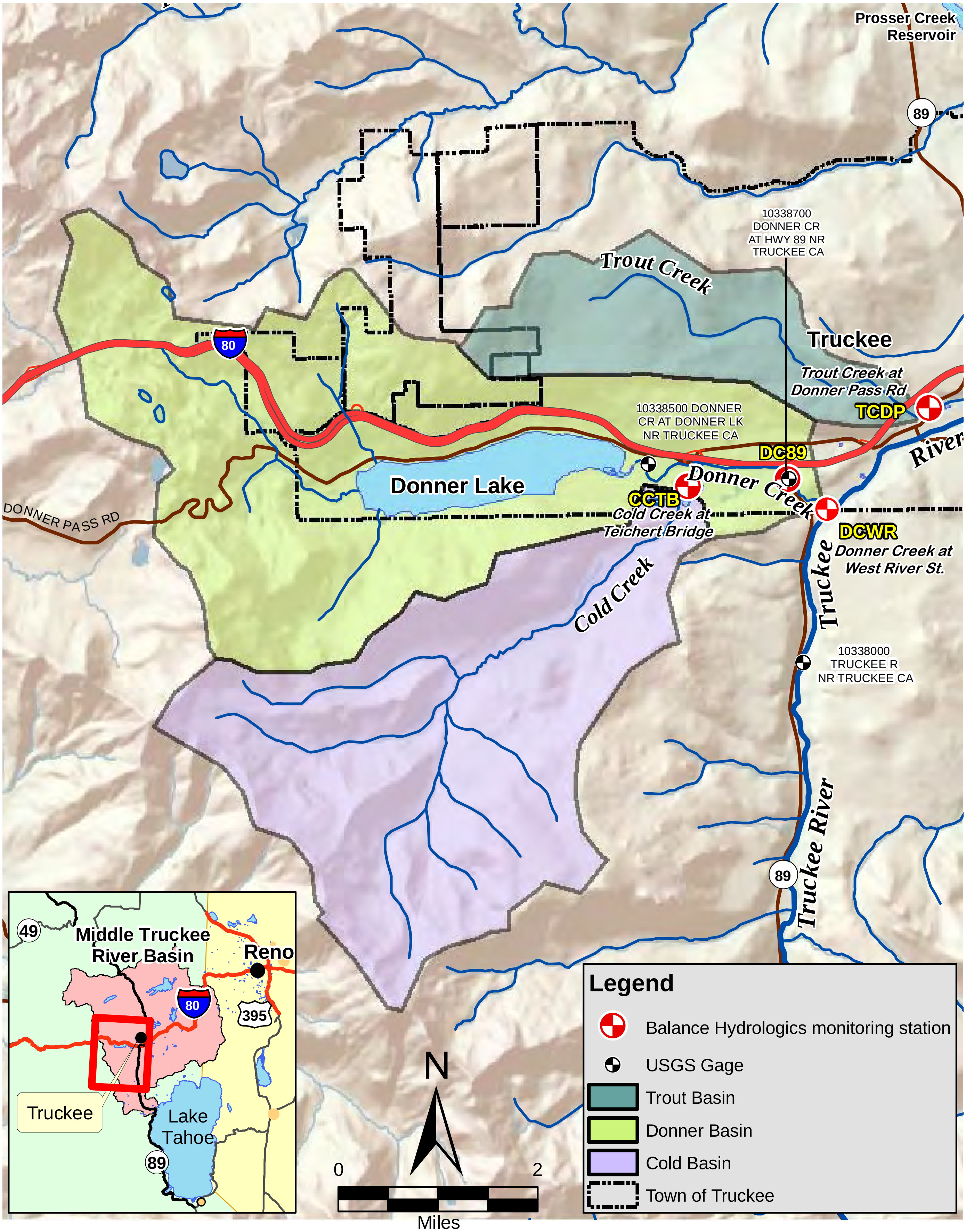


Figure 1. Truckee River Basin, California and Nevada.
The Middle Truckee basin is delineated from the Lake Tahoe outlet downstream to the California-Nevada border.

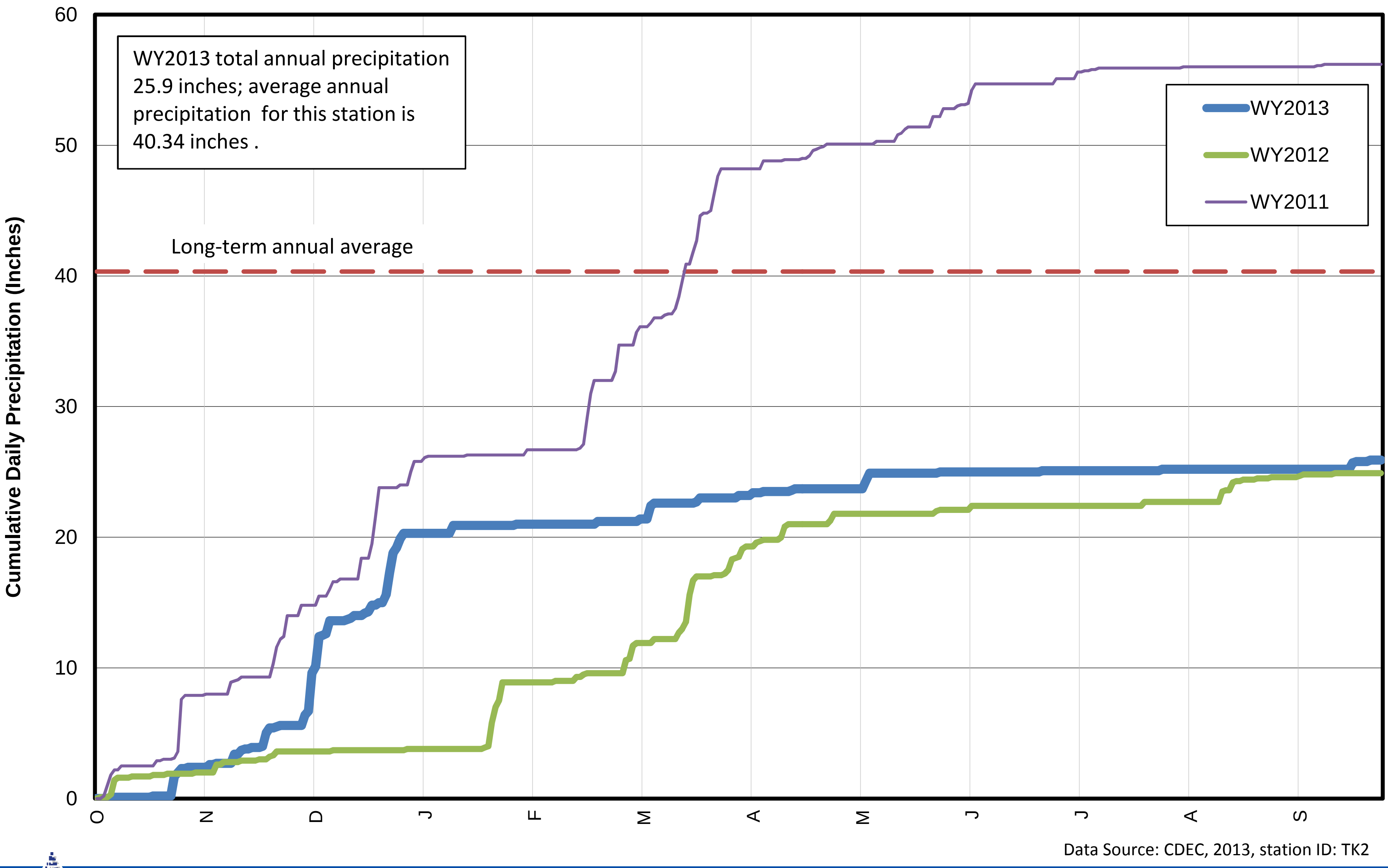
Balance Hydrologics, Inc.
210011 location.mxd



Balance Hydrologics, Inc.

210011 Figure 2 gages & wsheds.mxd

Figure 2. Locations of monitoring stations and watersheds evaluated for this study, Middle Truckee River, California and Nevada.



Balance Hydrologics, Inc.

Figure 3. **Cumulative daily precipitation, near Truckee, California, water years 2011, 2012, and 2013.** The station located approximately 2 miles south of Truckee, California at 6,400 feet elevation. Total annual rainfall in WY2013 was 25.9 inches, below average for the second consecutive year. Most of the annual precipitation in WY2013 fell between November and December.

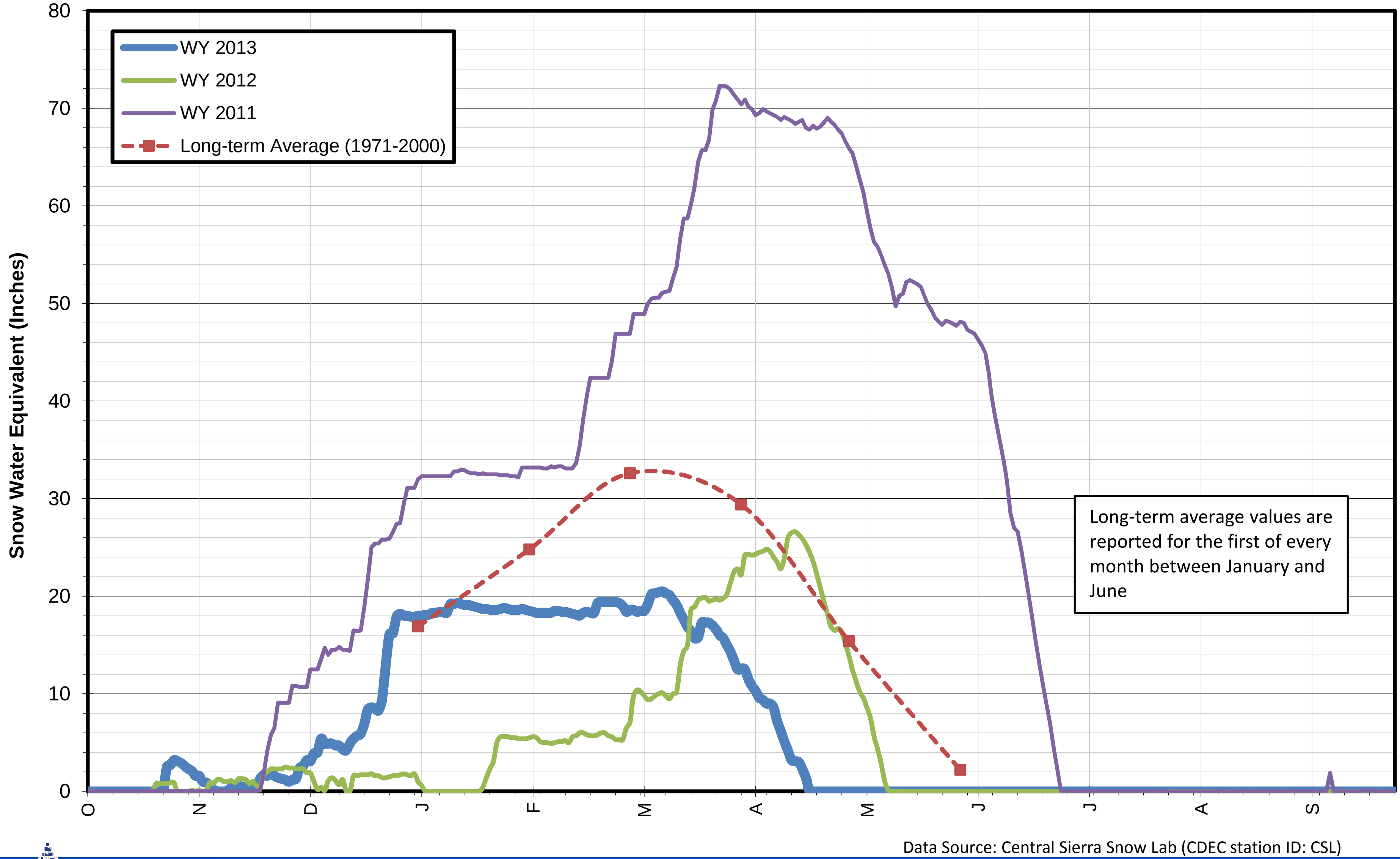


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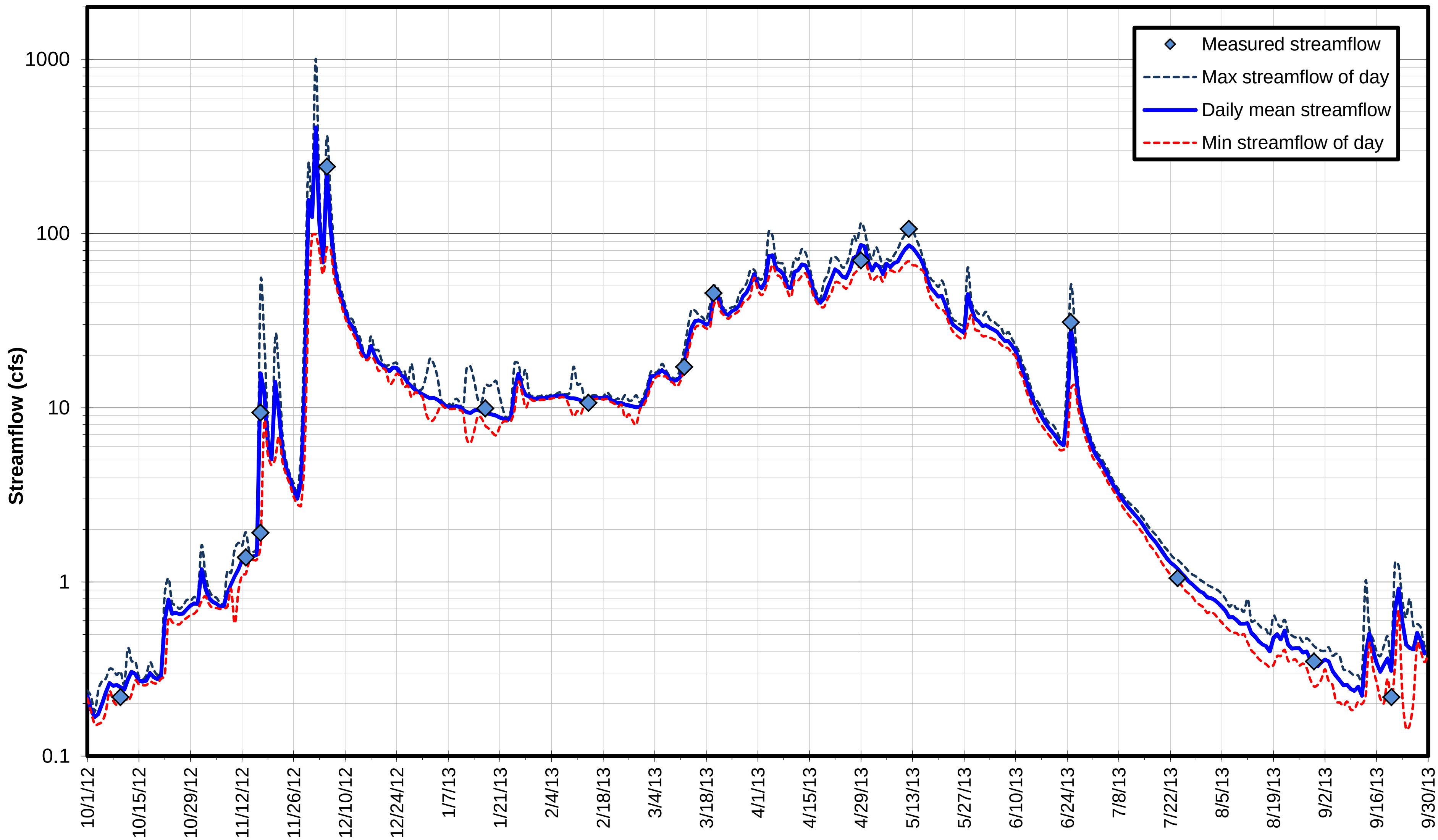
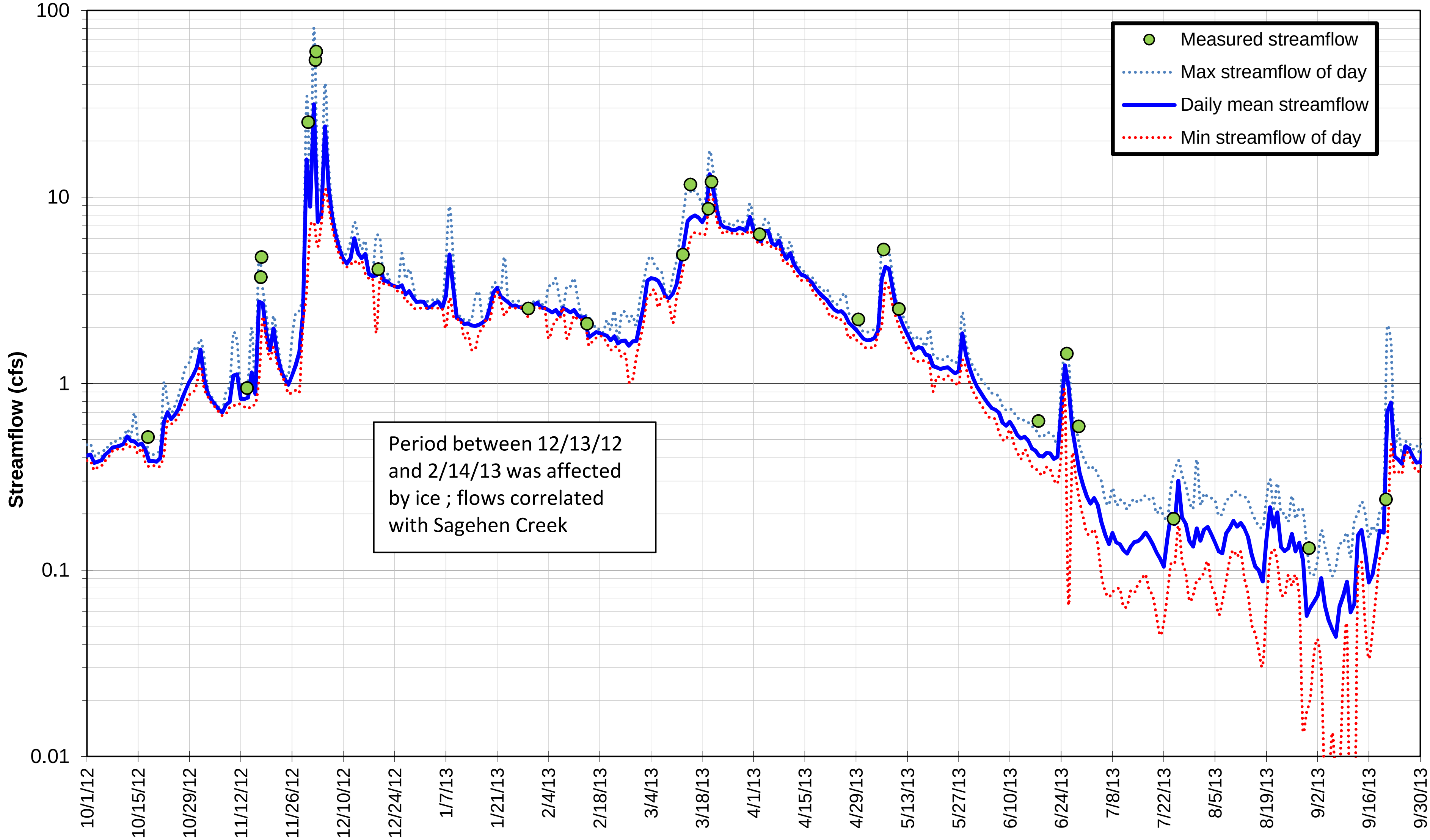
Figure 4. **Snow-water equivalent, Central Sierra Snow Lab, Soda Springs, California, water years 2011, 2012, and 2013.** The Central Sierra Snow Lab is located approximately 7.5 miles west of the Cold Creek gaging station at 6,950 feet elevation. WY 2013 exhibited snowfall much below long-term averages for the second consecutive year in a row.



Note that the flow axis is logarithmic.

Balance Hydrologics, Inc.

Figure 5. **Streamflow hydrograph, Cold Creek at Teichert Bridge (CCTB), Truckee, California, water year 2013.** The peak streamflow for WY 2013 was 1,004 cfs recorded on December 2, 2012 during a rain-on-snow event. Peak flow during spring snowmelt runoff was roughly an order of magnitude less at 115 cfs and occurred on April 29, 2013



Note that the flow axis is logarithmic.

Balance Hydrologics, Inc.

Figure 6. **Streamflow hydrograph, Trout Creek at Donner Pass Road (TCDP), Truckee, California, water year 2013.** The peak streamflow for WY 2013 was 80.8 cfs and occurred December 2, 2012 during a rain-on-snow event. Peak snowmelt runoff was 17.6 cfs and occurred March 30, 2013, slightly earlier than other watersheds.

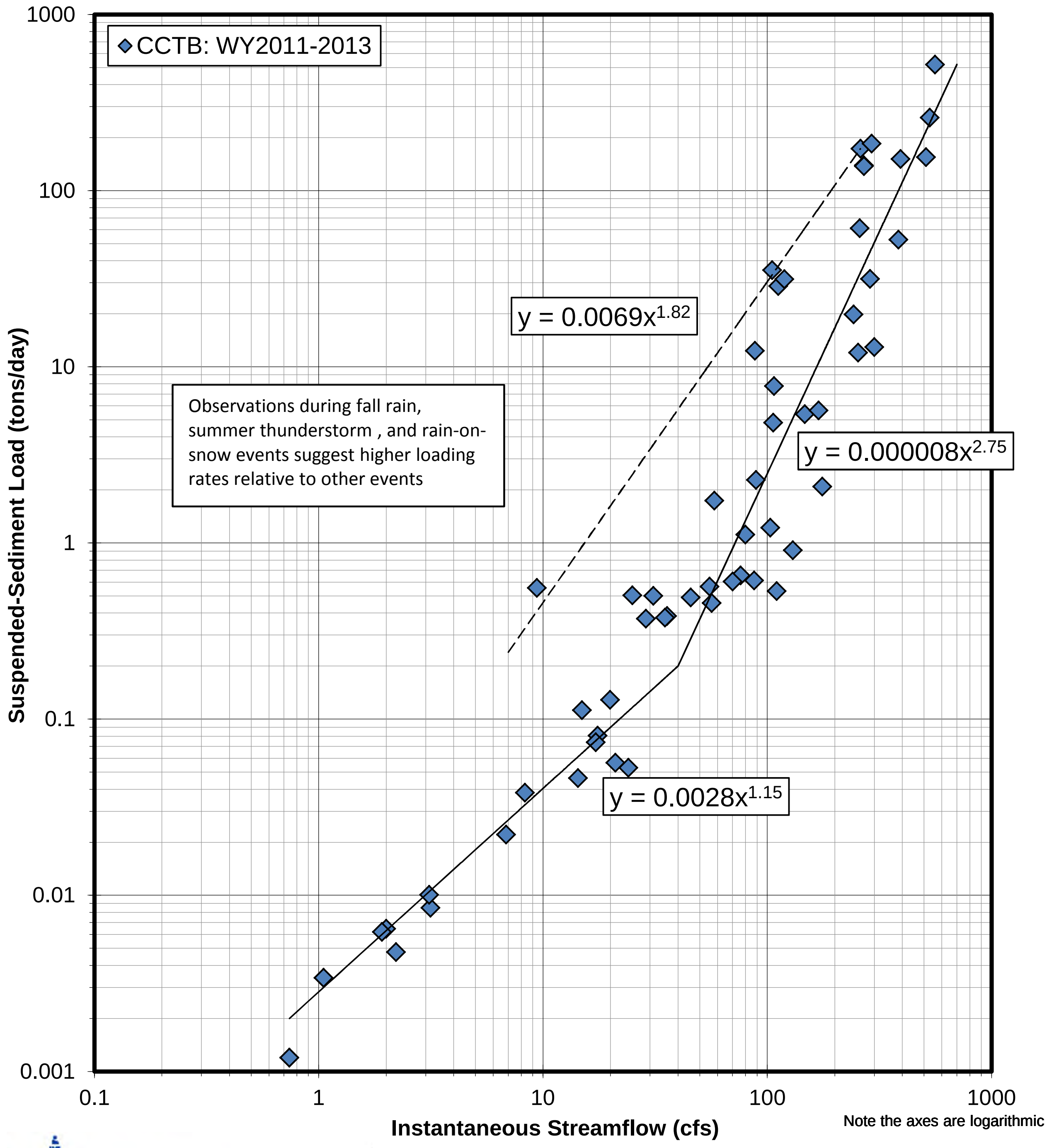


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Figure 7. Relationship between streamflow and suspended-sediment load, Cold Creek at Teichert Bridge (CCTB), Truckee, California, water years 2011-2013. As is typical, more suspended sediment is transported at higher streamflows. The equations derived here are applied to the streamflow record to calculate suspended-sediment loading.

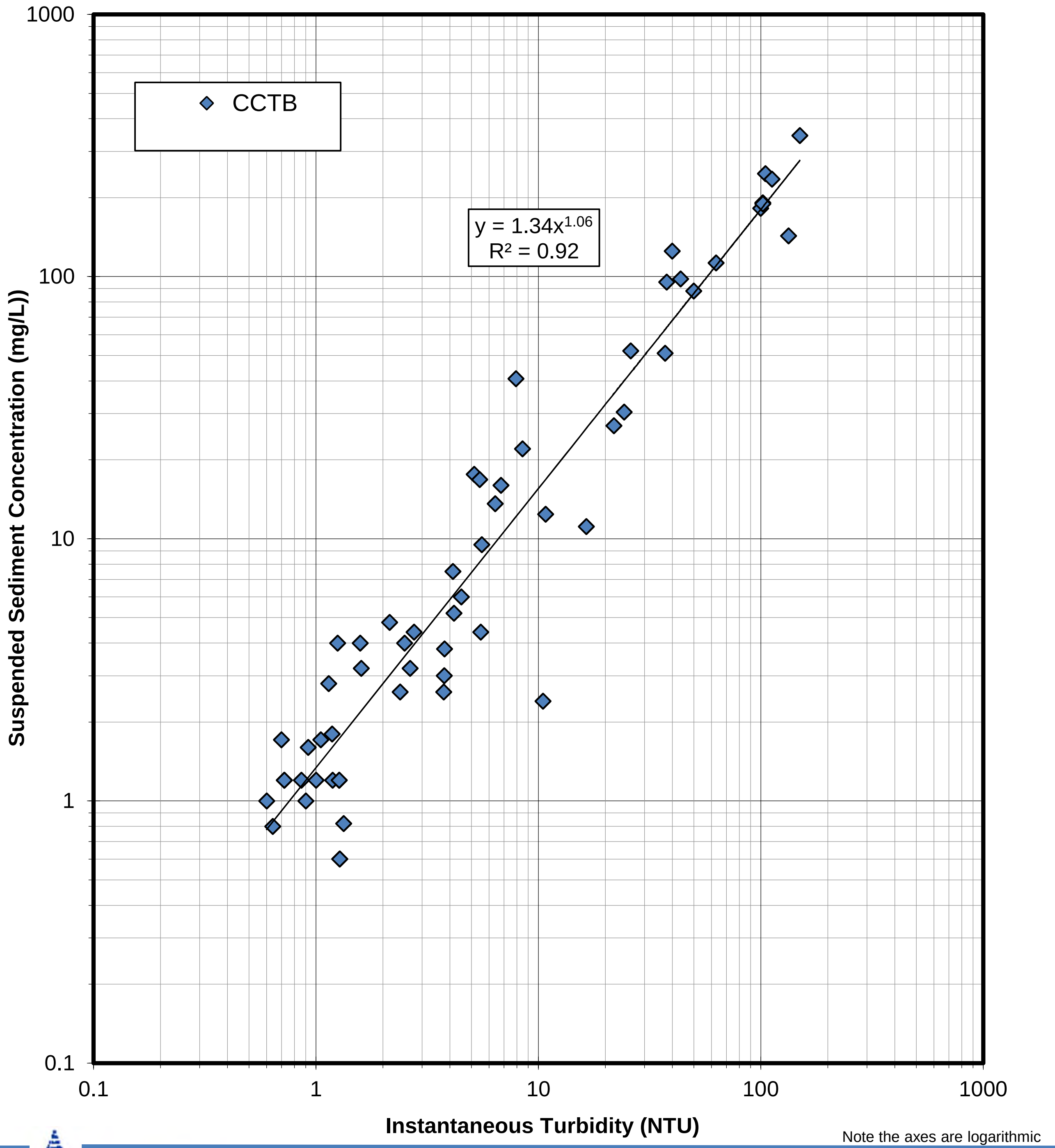
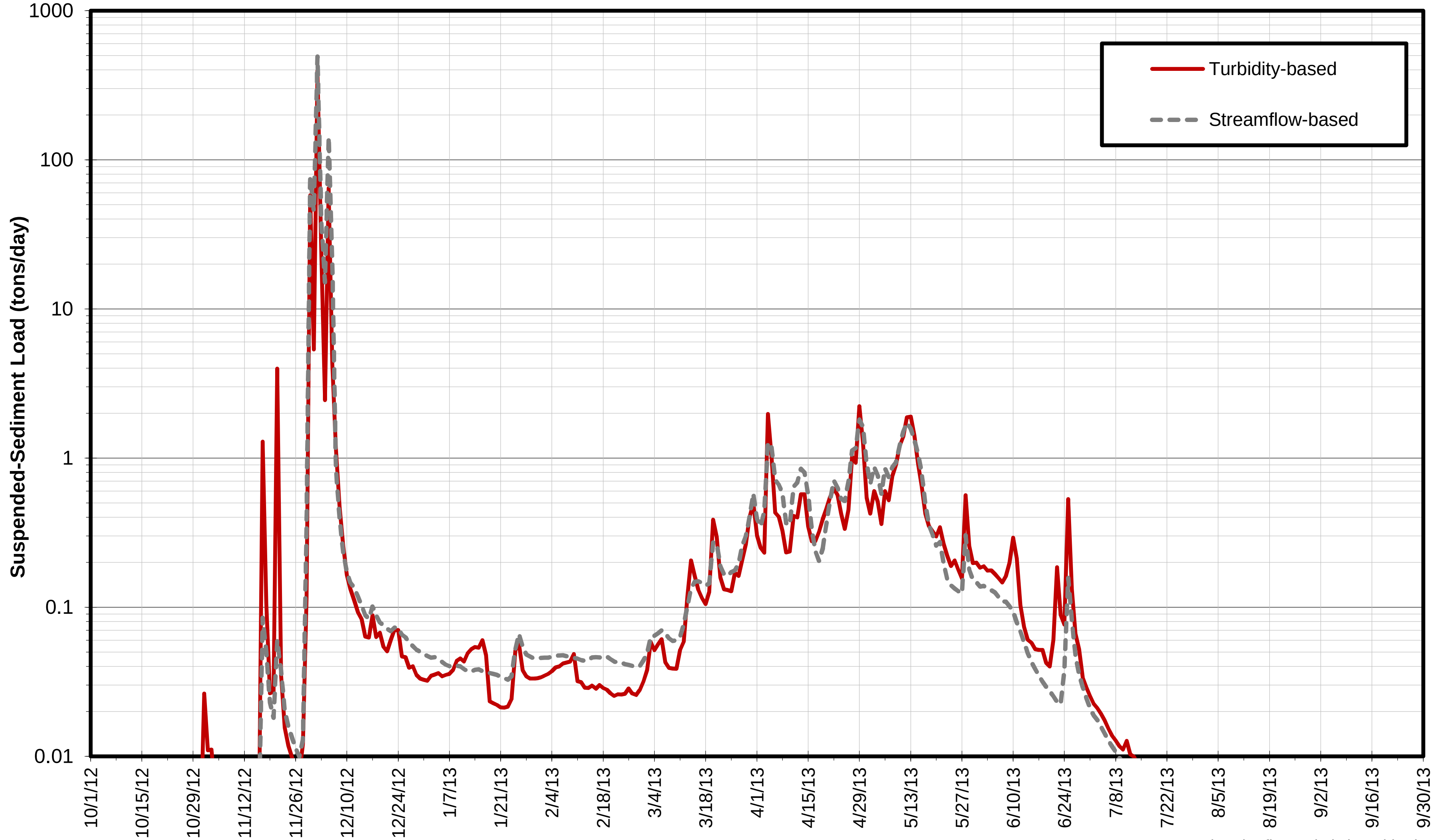


Figure 8. Relationship between turbidity and suspended-sediment concentration, Cold Creek at Teichert Bridge (CCTB), Truckee, California, water years 2011-2013. The equation derived here is applied to the continuous record of turbidity to calculate suspended-sediment loading.



Note that the flow axis is logarithmic.

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Figure 9. **Daily suspended-sediment load calculated based on turbidity and streamflow, Cold Creek at Teichert Bridge (CCTB), Truckee, California, water year 2013.**

210011 CCTB Daily Sums_WY13

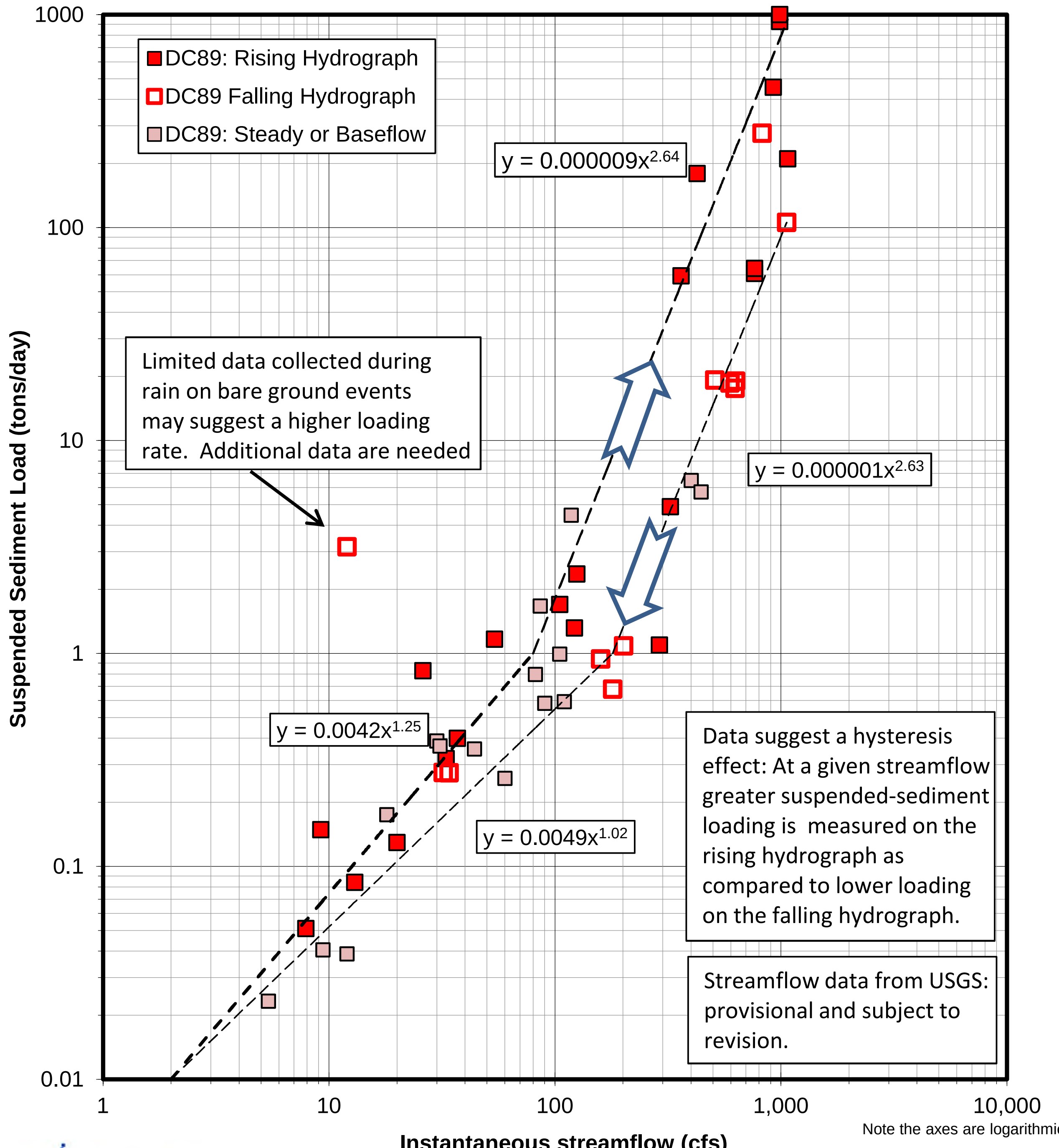

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Figure 10. **Relationship between streamflow and suspended-sediment load, Donner Creek at Highway 89 (DC89), Truckee, California, water years 2011-2013.**
A preliminary hysteresis effect is identified at this station. The equations derived here are applied to the streamflow record to calculate suspended sediment loading

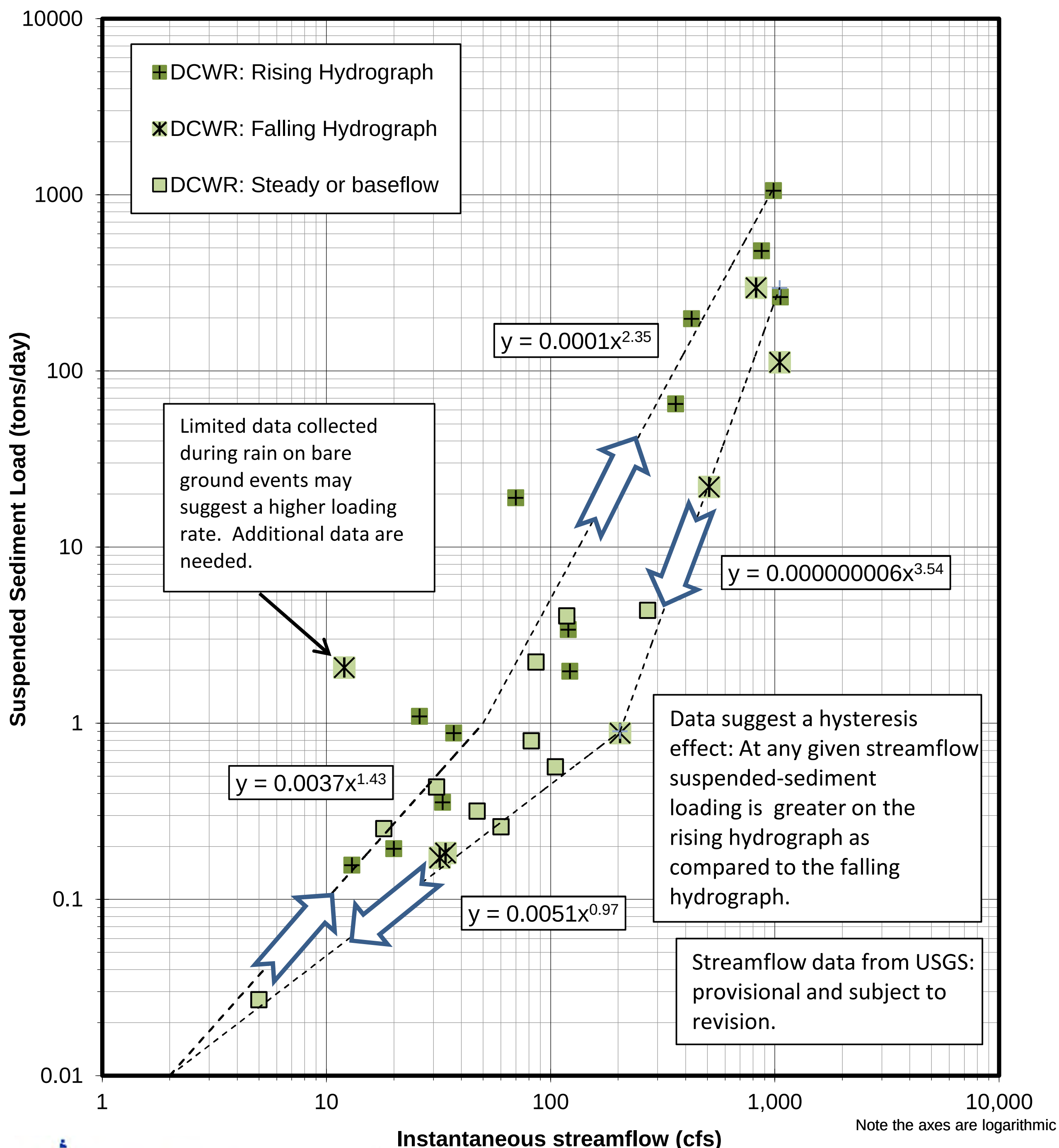

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Figure 11. Relationship between streamflow and suspended-sediment load, Donner Creek at West River Street (DCWR), Truckee, California, water years 2011-2013. The equations derived here are applied to the record of streamflow to compute a record of suspended-sediment loading.

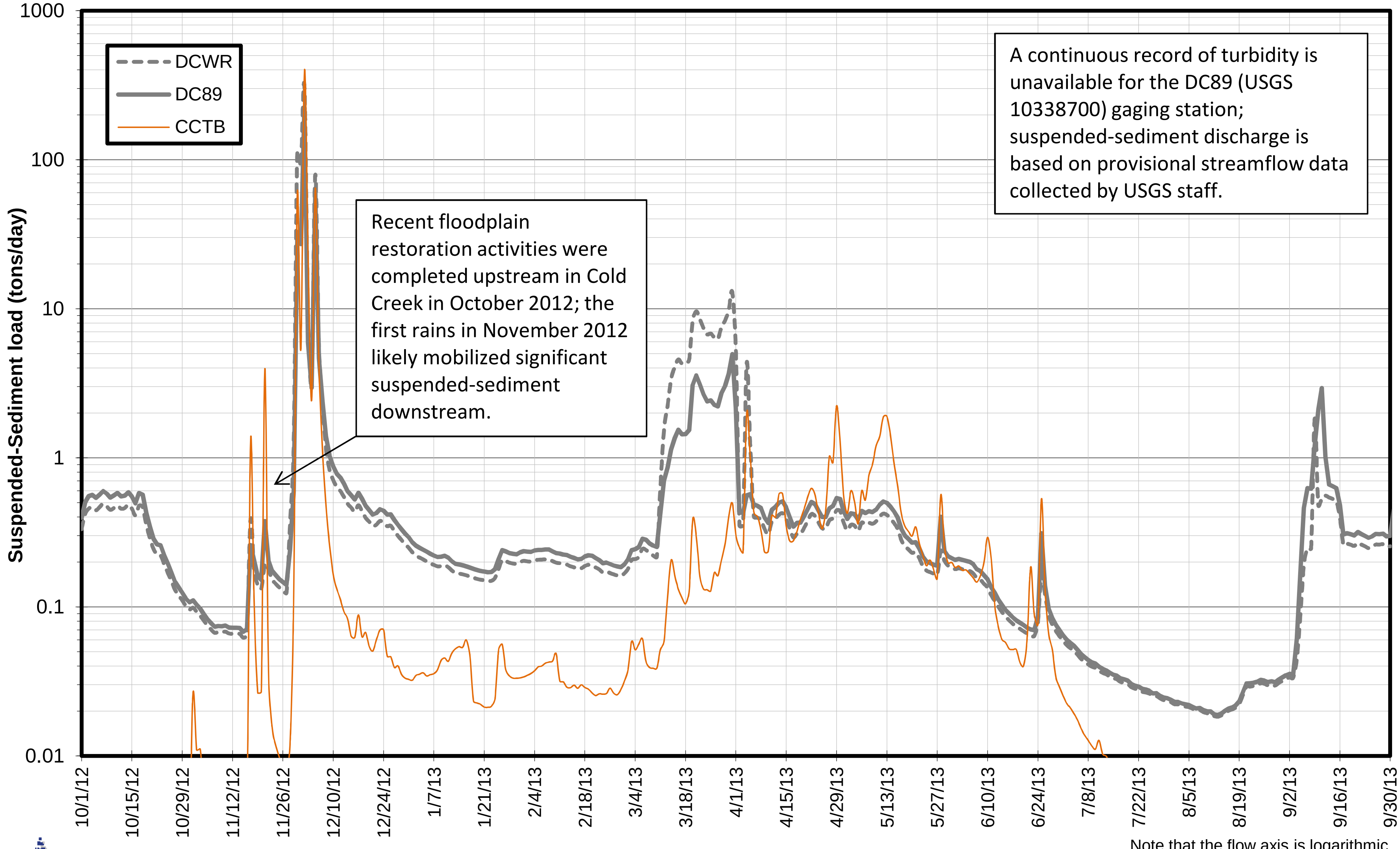

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Figure 12. **Daily suspended-sediment loads, Donner Creek at Highway 89 (DC89) and Donner Creek at West River Street (DCWR), Truckee, California, water year 2013.** The suspended-sediment load for the DCWR station was calculated based on the provisional streamflow record for DC89 station, a short distance upstream. Cold Creek is shown for comparison (data based on near-continuous turbidity).

210011 DC89 Daily Sums WY2013

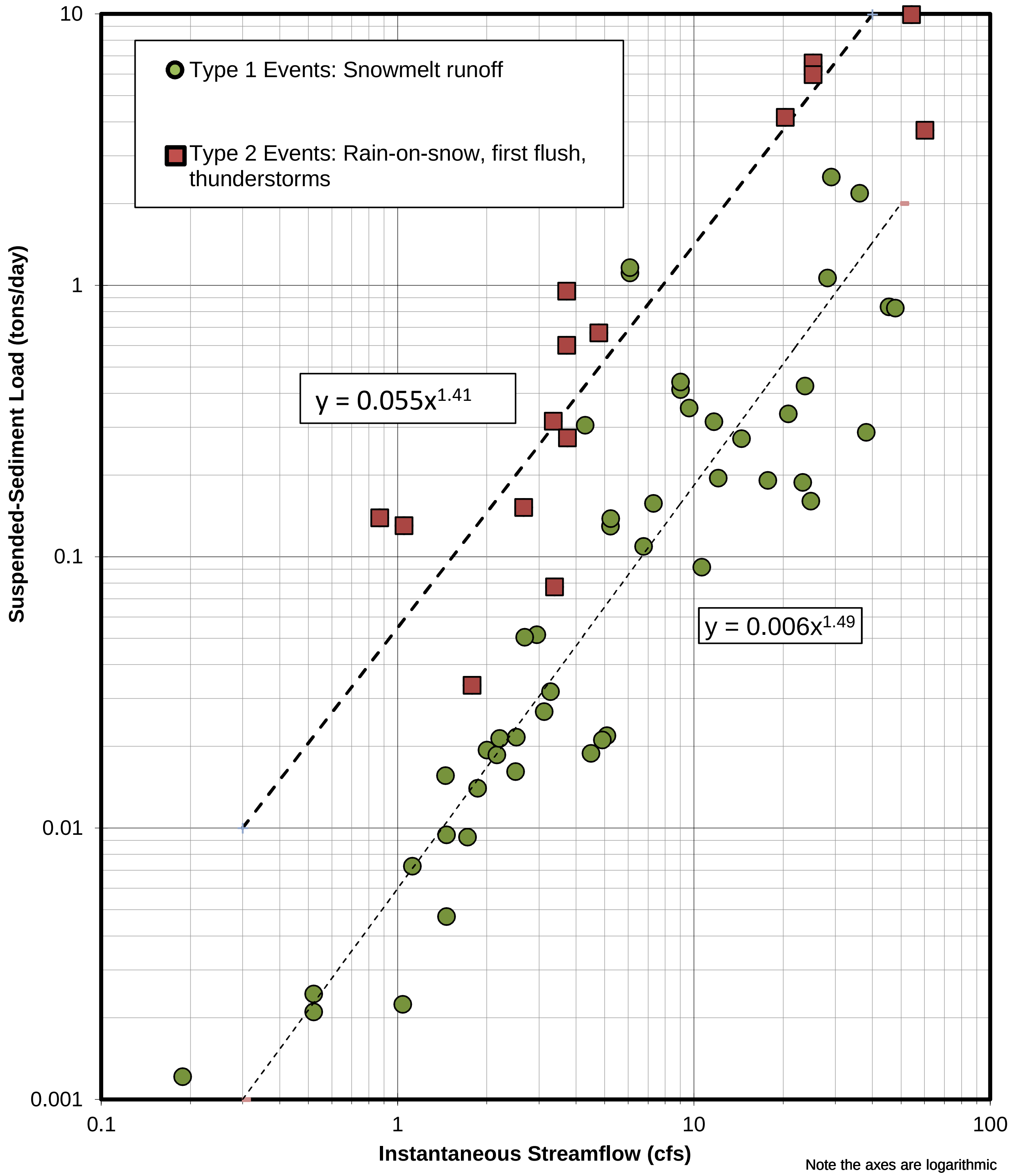

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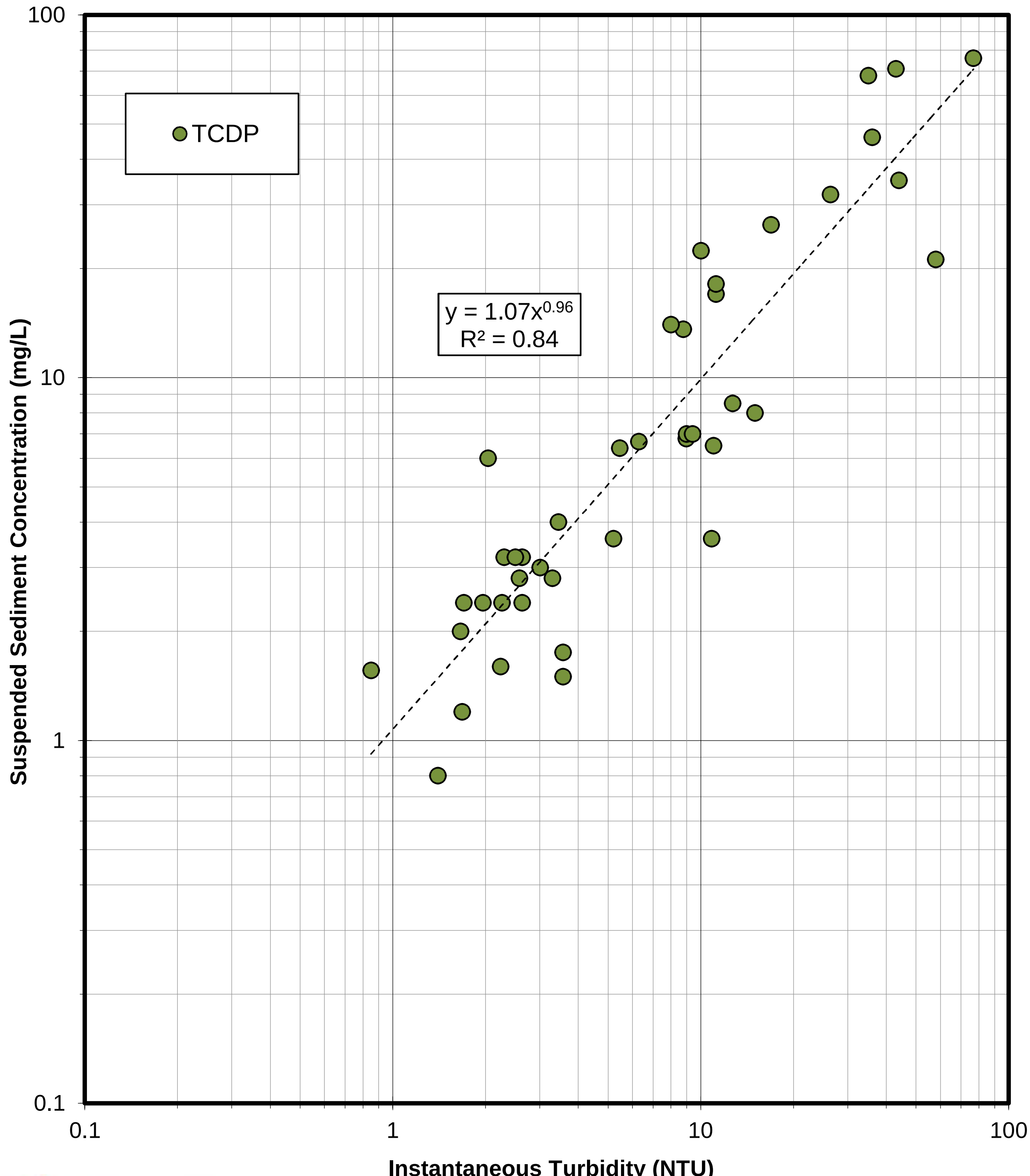
Figure 13. **Relationship between streamflow and suspended sediment load, Trout Creek at Donner Pass Road (TCDP), Truckee, California, water years 2011-2013.**



Note the axes are logarithmic

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Figure 14. **Relationship between turbidity and suspended - sediment concentration, Trout Creek at Donner Pass Road (TCDP), Truckee, California, water years 2011-2013.** The equation derived here is applied to the continuous record of turbidity to calculate suspended-sediment loading.

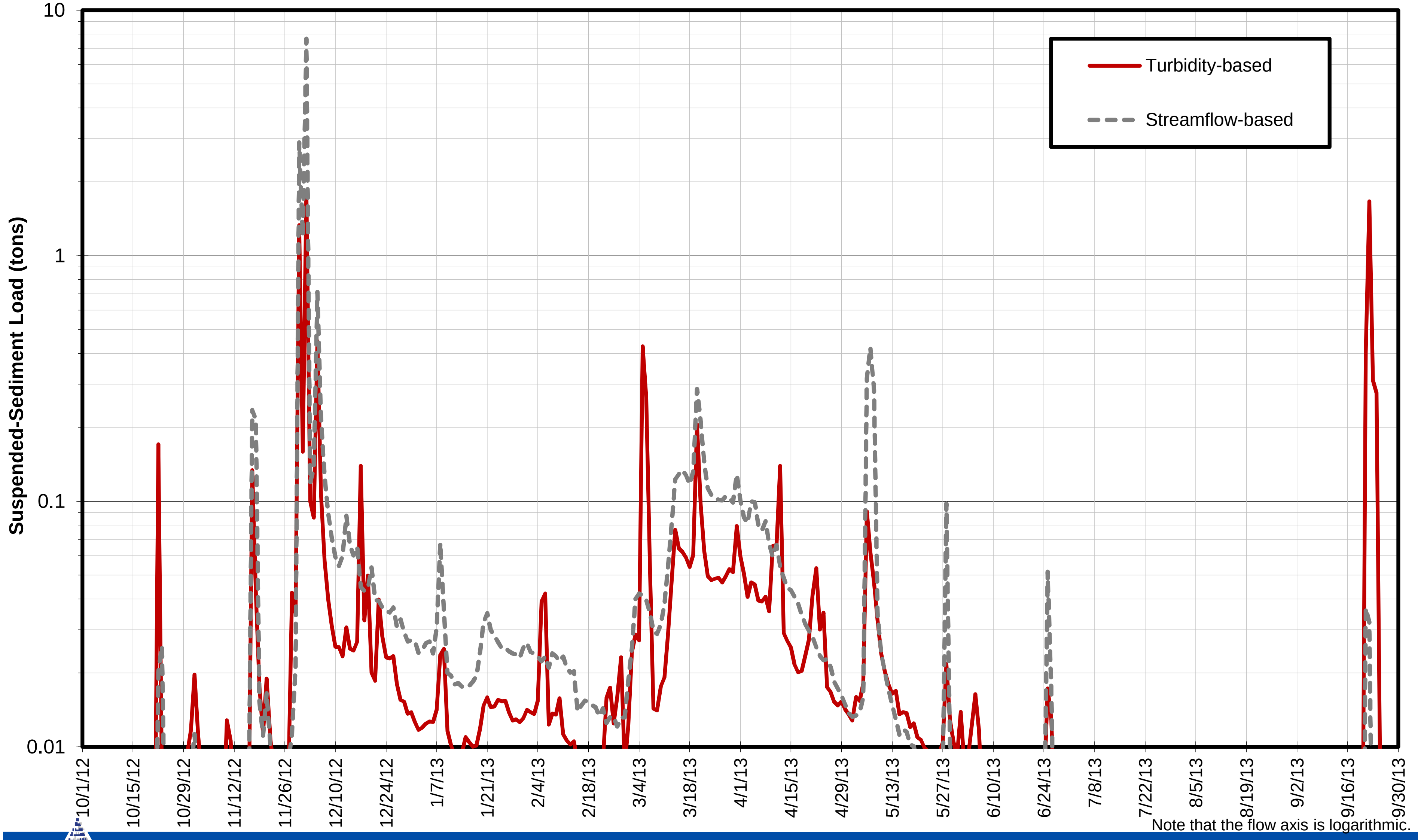

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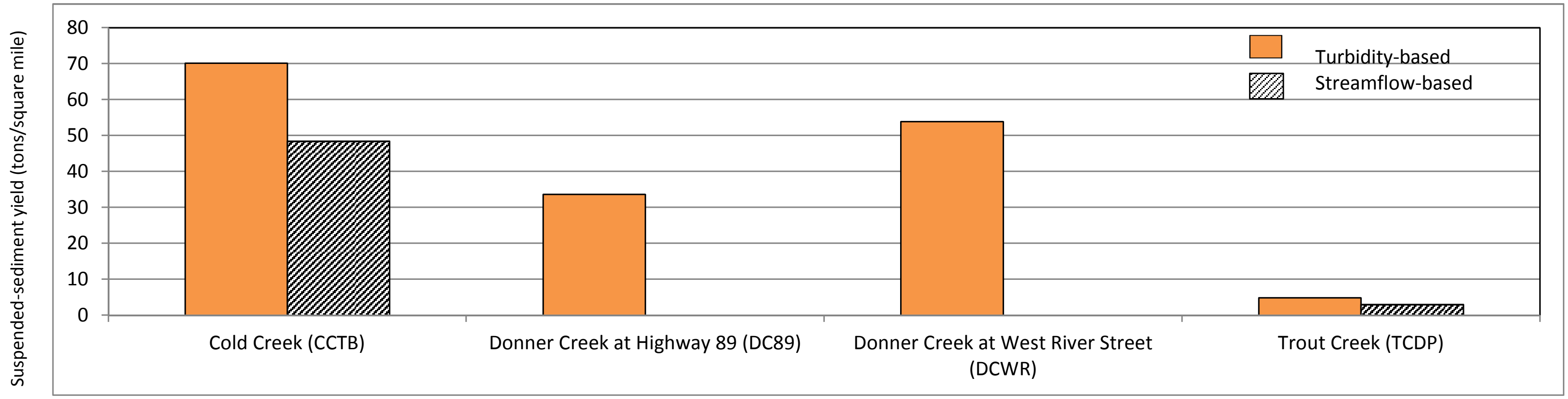
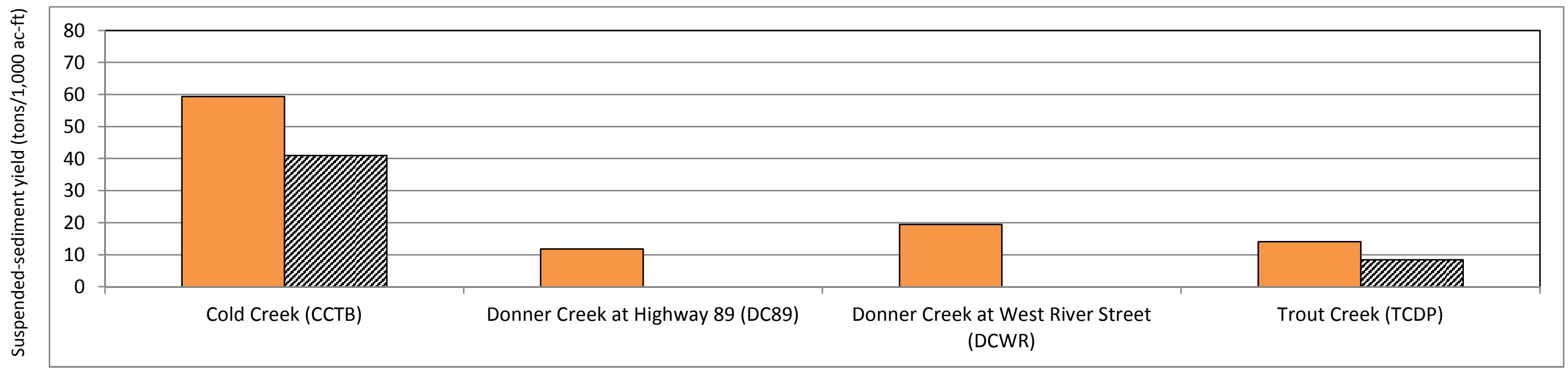
Figure 15. **Daily suspended-sediment load,Trout Creek at Donner Pass Road (TCDP), Truckee, California, water year 2013.** A comparison between both methods suggests a continuous record of turbidity is better able to capture discrete events and spring snowmelt runoff; while the standard sediment rating curve may overpredict interstorm loading during winter flows.



(16a) Suspended-sediment loads, normalized by watershed area



(16b) Suspended-sediment loads, normalized by hydrology

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Figure 16 A+B. **Total annual suspended-sediment loads across all stations, normalized by watershed area (a) and runoff volume (b), Donner Creek, Cold Creek, and Trout Creek, near Truckee, California, WY 2013.** Data suggests Cold Creek was a large contributor of suspended-sediment in WY 2013. The rain-on-snow event of December 2, 2012 likely increased landslides, gully erosion, and bank erosion in CCTB.

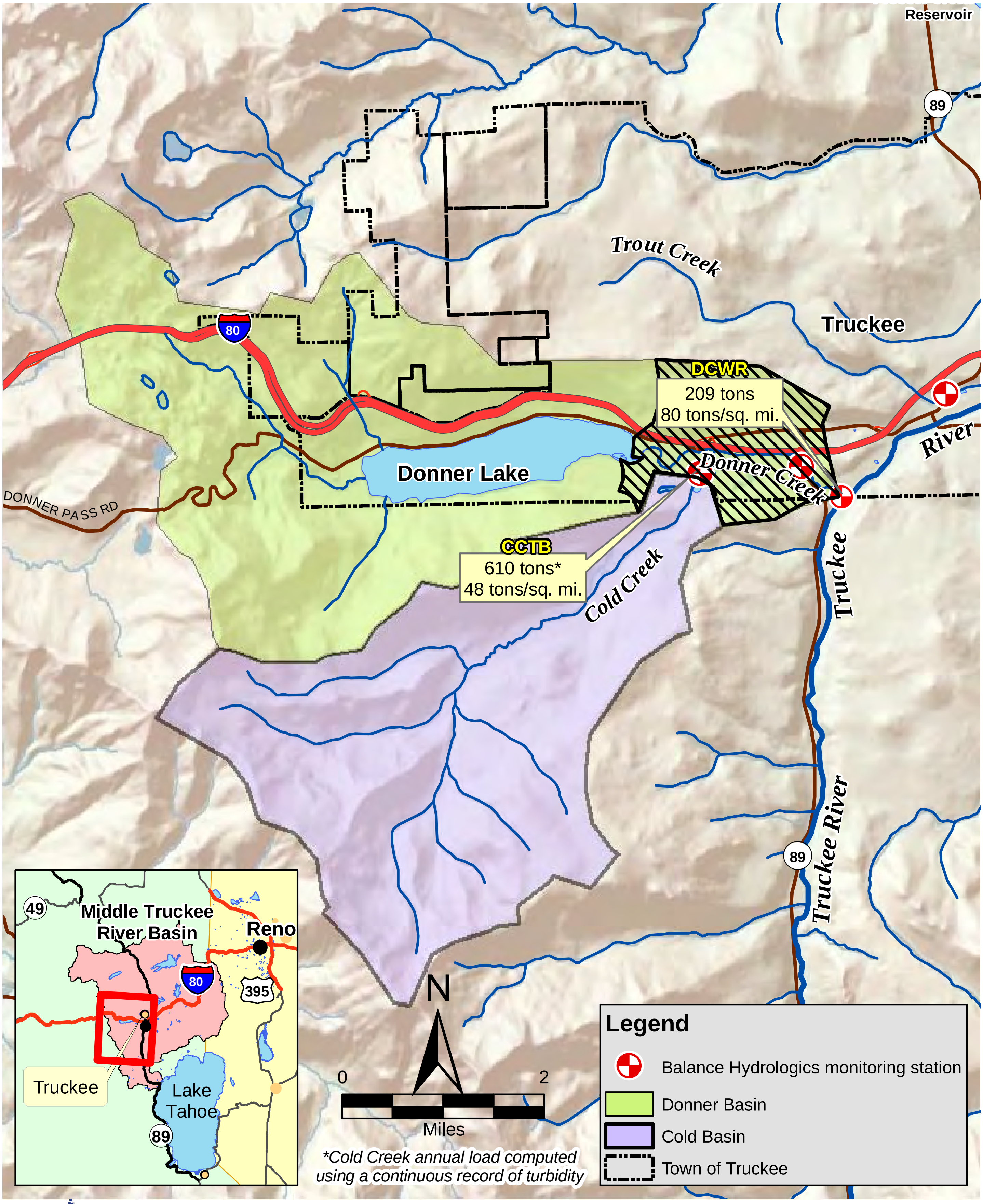

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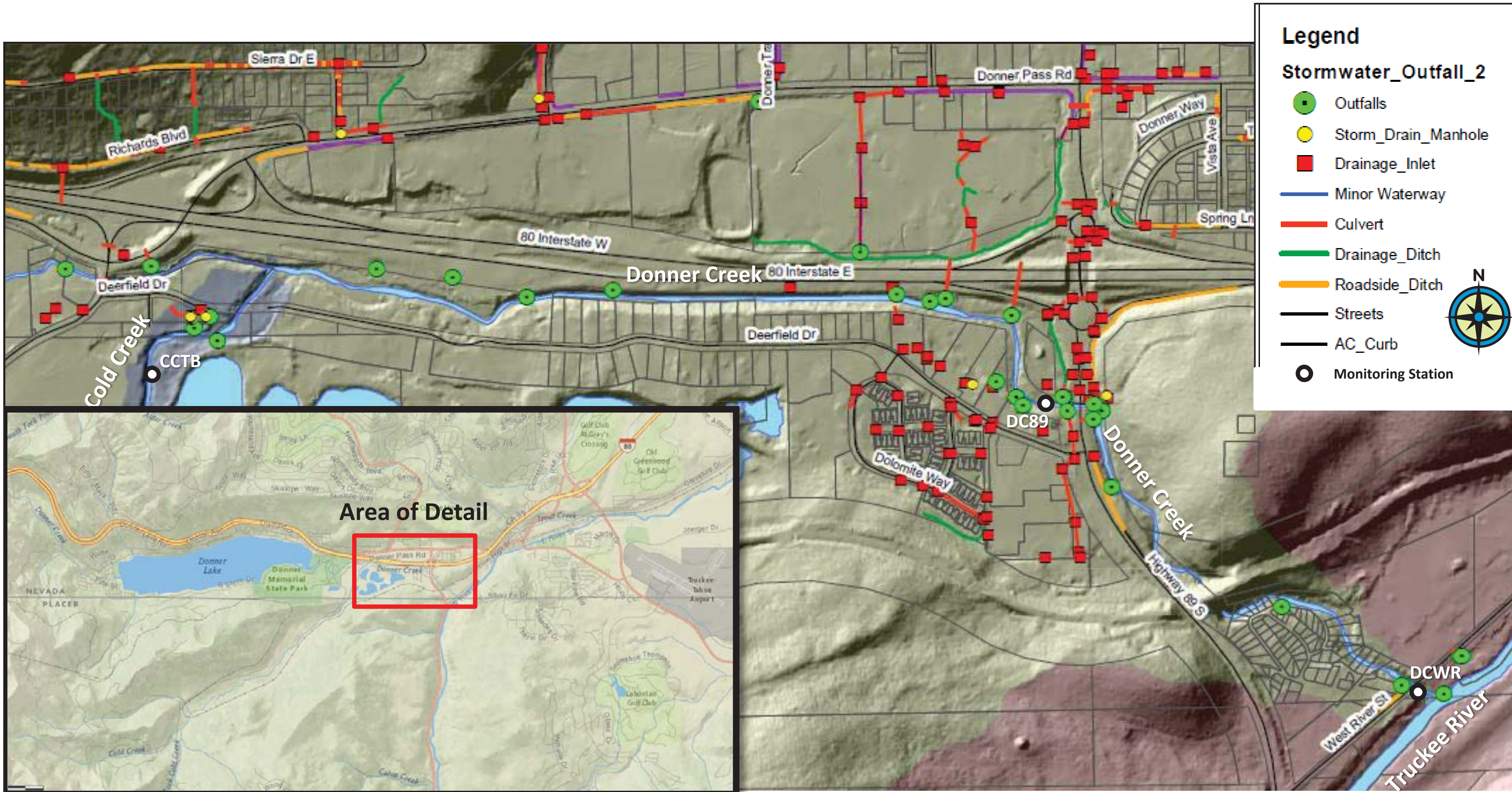
Figure 17. Comparison of suspended-sediment loads and yields between stations, Donner and Cold Creek watersheds, Water Year 2013.
Water Year 2013 data suggests significant suspended sediment loads originate in urban areas (Town of Truckee) in the lower portion of the Donner Creek watershed.

210011 Figure 17 sed-load comparison.mxd



Map Source: Town of Truckee, 2011

Balance Hydrologics, Inc.

Figure 18. **Stormwater drainage (preliminary), Donner Creek below Cold Creek, Town of Truckee, California**

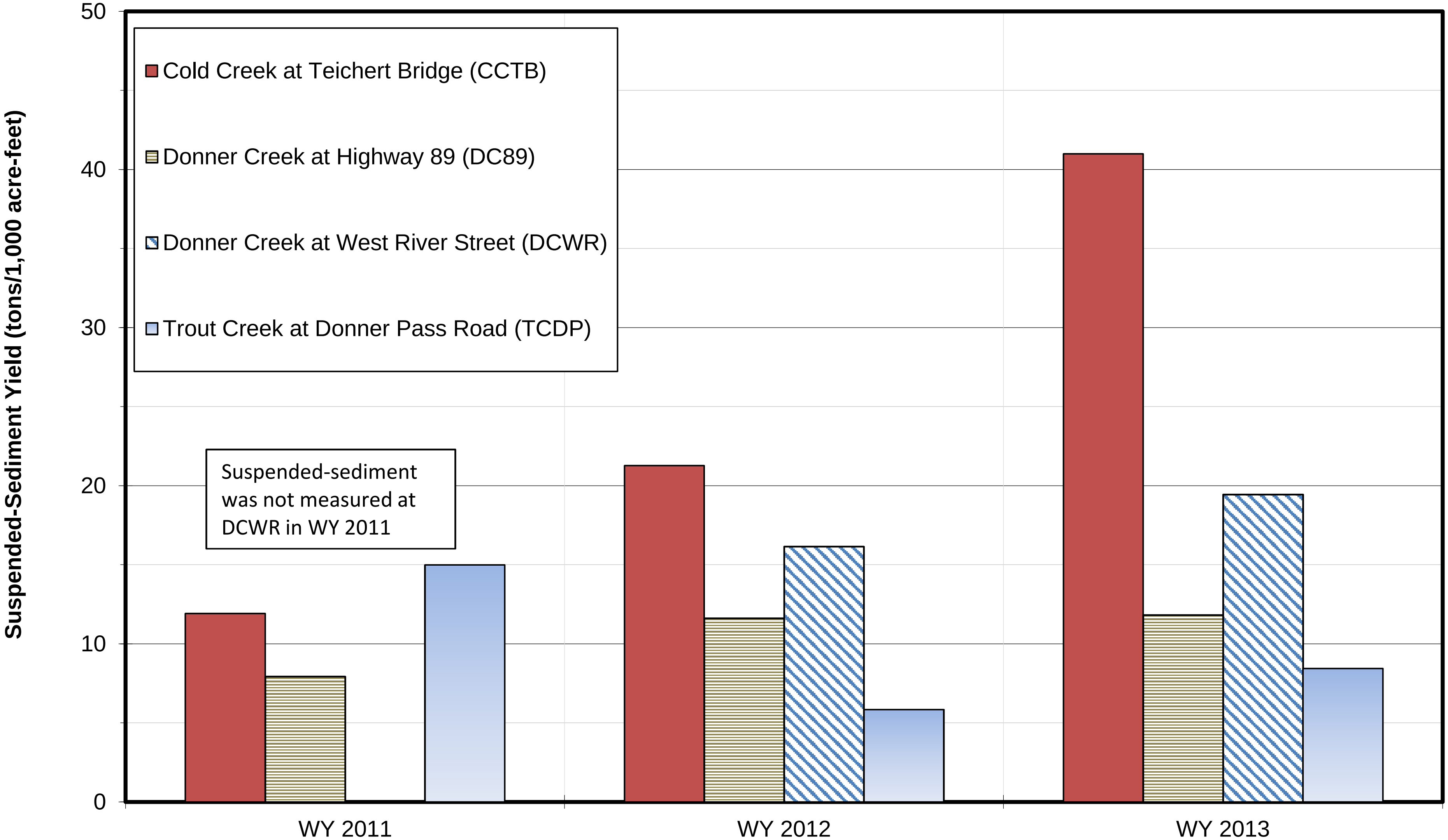


Figure 19. Comparison of suspended-sediment loads across all stations and across all years, normalized by streamflow volume, Donner Creek, Cold Creek, and Trout Creek, near Truckee, California,. Increases in yield over time may be the result of event types or watershed disturbances. For instance, the WY 2013 rain-on-snow event may have triggered gully erosion or landslides in Cold Stream Canyon.

210011 compare all WY13

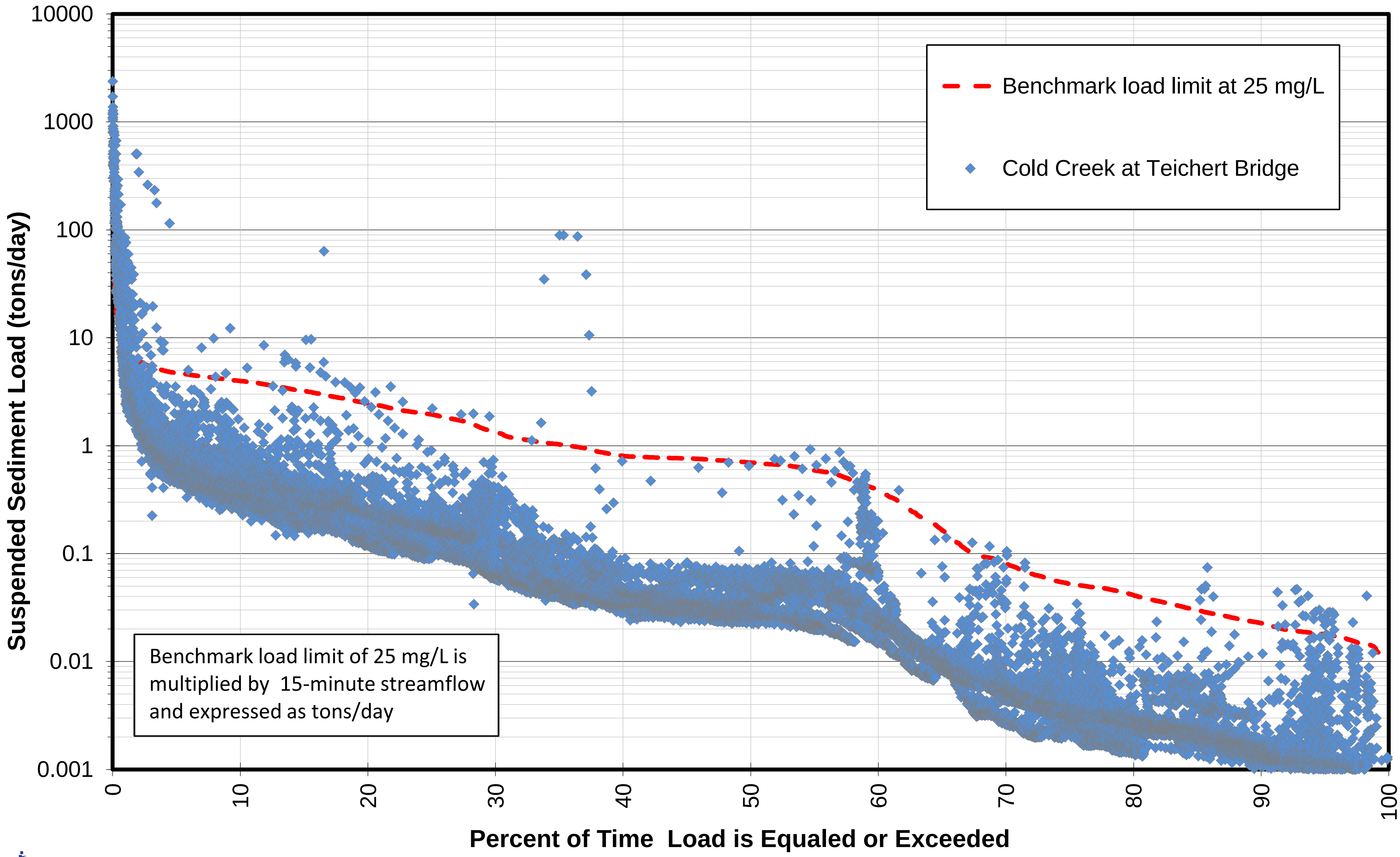


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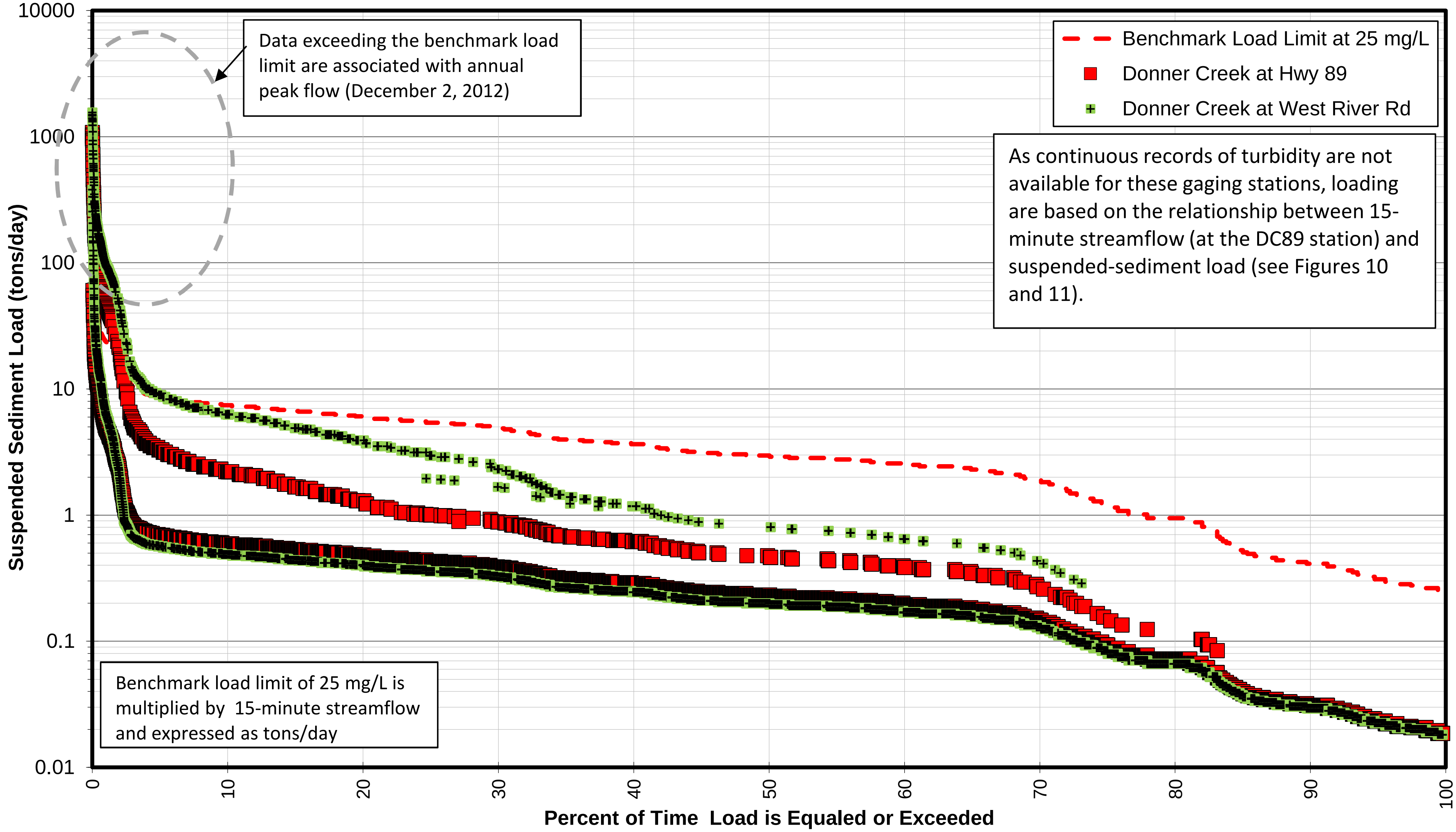
Figure 20. **Suspended-sediment load duration curve, Cold Creek at Teichert Bridge (CCTB), Truckee, California, water year 2013.** The 25 mg/L benchmark was exceeded less than 1.5 percent of the total time, based on 15-minute data and therefore met the TMDL.



Note that the flow axis is logarithmic.

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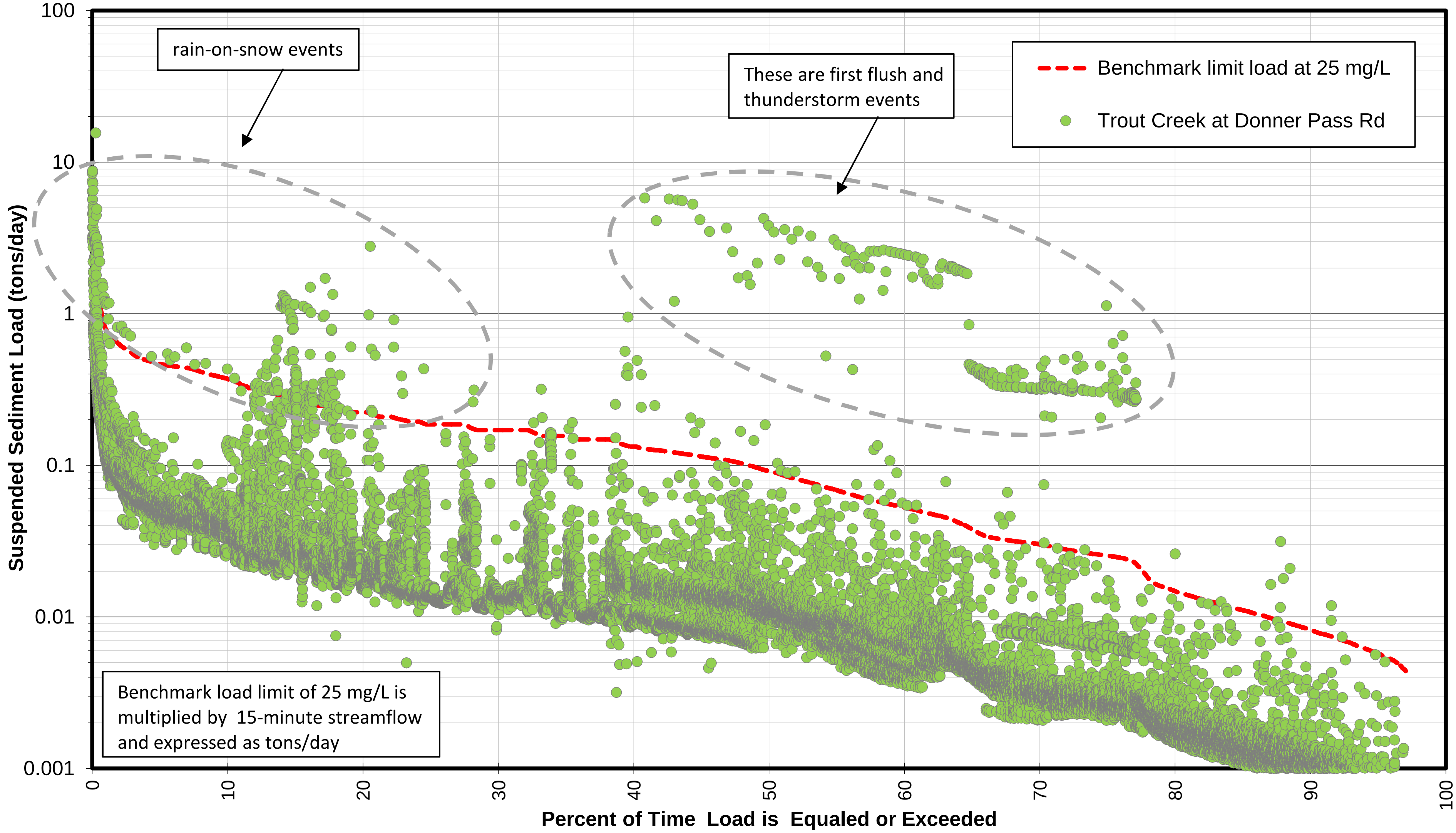
Figure 21. Suspended-sediment load duration curves, Donner Creek at Highway 89 (DC89) and Donner Creek at West River Street (DCWR), Truckee, California, water year 2013. The suspended-sediment loads for both stations are mostly below the benchmark load limits with the exception of the least frequent, higher magnitude streamflows and summer thunderstorms (DC89: 0.5 percent exceedance; DCWR: 2.3 percent exceedance).



Note that the flow axis is logarithmic.

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Figure 22. **Suspended-sediment load duration curve, Trout Creek at Donner Pass Road (TCDP), Truckee, California, partial water year 2013** Most of the time, suspended-sediment loads are well below the benchmark load limit for the Truckee River at Farad, The 25 mg/L benchmark load limit was exceeded approximately 1.5 percent of the total time, based on 15-minute data. Exceedence occurred during specific times such as rainfall on bare ground.

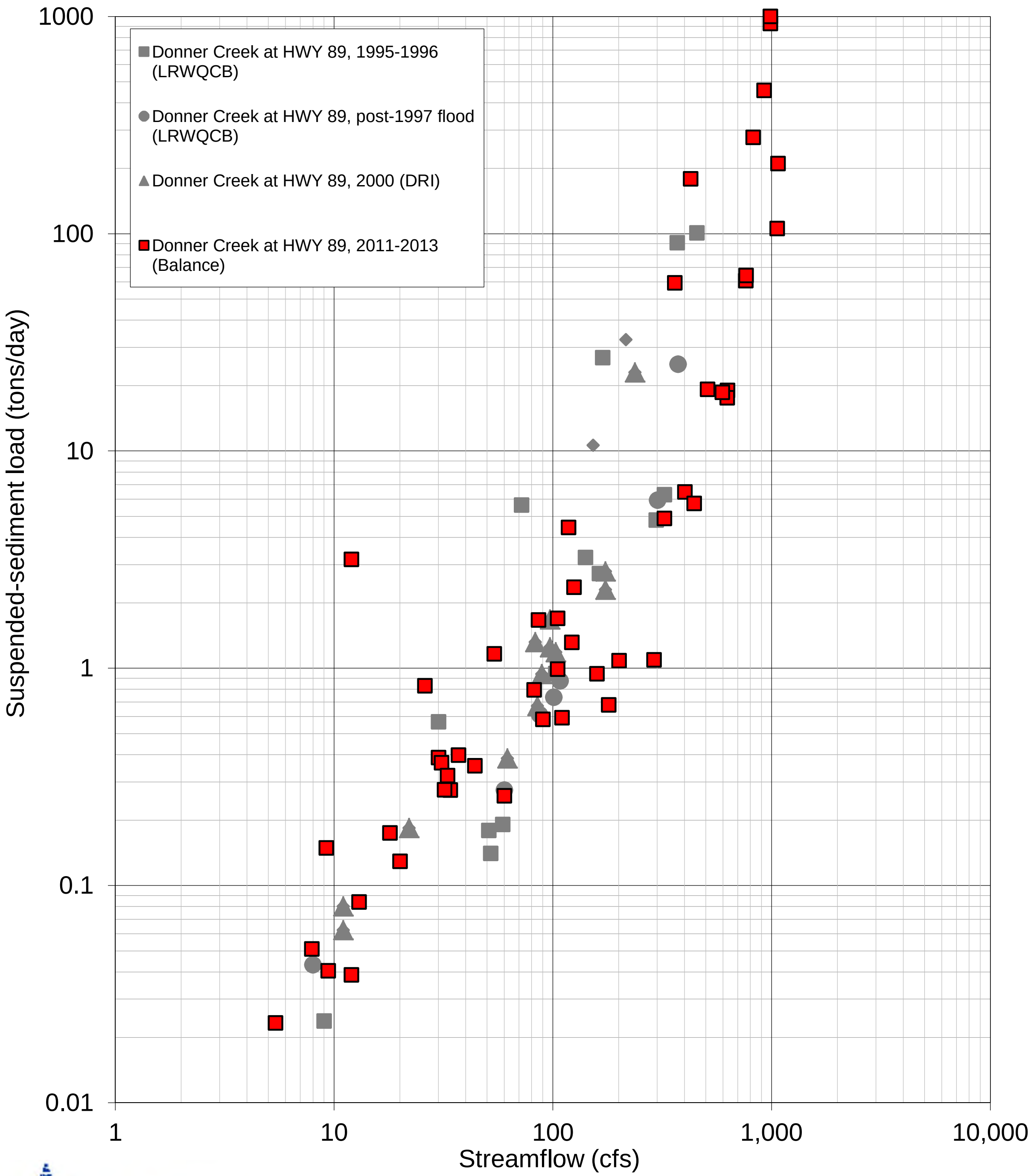

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Figure 23. **Relationship between streamflow and suspended-sediment load for Donner Creek at Highway 89 (DC89), Truckee, California, water years 1996, 1997, 2000, 2011, 2012, and 2013.** Recent suspended-sediment loading rates at this station appear to be similar to historical loading rates, perhaps with the exception of intermediate flows.

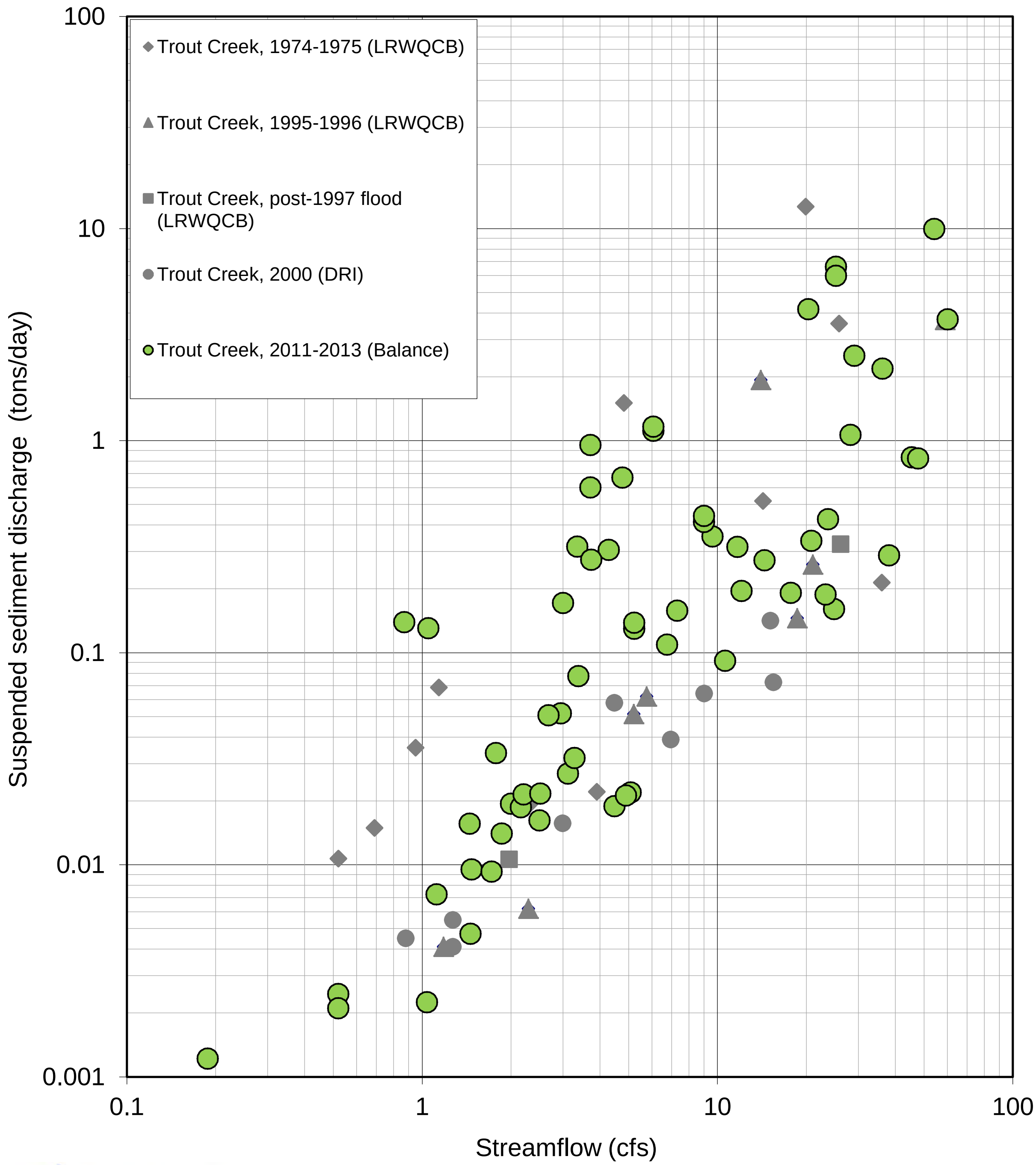

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Figure 24. Relationship between streamflow and suspended-sediment load, Trout Creek at Donner Pass Road (TCDP), Truckee, California, water years 1974, 1975, 1996, 1997, 2000, 2011, 2012, and 2013. Large scatter in both current and historical data may be correlated to event type, when higher loading may occur during rain on bare ground

APPENDICES

APPENDIX A

Streamflow gaging: Instrumentation and description of practice

APPENDIX A. DEVELOPING A RECORD OF STREAMFLOW

Station Instrumentation and Maintenance

The stream gages on Cold Creek and Trout Creek are equipped with Type C staff plates[1], continuous-logging, optical backscatter turbidity sensors (OBS 3+), and Druck® pressure transducers connected to a Campbell Scientific datalogger. Two pressure transducers are used at each station to improve data quality and to provide redundancy in the event that one sensor malfunctions or becomes blocked. Prior to installation, pressure transducers were tested and calibrated over the range of anticipated flow depths at each site. Sensor 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 then compared with the electronic record upon downloading. Turbidity sensors were also calibrated prior to installation using laboratory standards covering the range of anticipated turbidity levels. The optical window in the sensor is cleaned frequently. 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 WY 2012. During periods of rain or peak snowmelt, high-flow measurements were made more frequently. When manual flow and stage measurements were made, observers also recorded recent high-water marks (if visible), downloaded the dataloggers, inspected the probes, and replaced datalogger batteries and desiccant as necessary. In the event that any component is malfunctioning (i.e., pressure transducer), it is 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, +/- 8 percent of actual streamflow, and is provided to the public initially as provisional data. Maintenance and calibration of this stream gage is managed by USGS staff.

---

[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 using the datalogger and pressure transducers is converted to a flow record using the station-specific 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 (USGS 10338700), Truckee, California, water year 2013

Appendix B1. Annual hydrologic record, Donner Creek at Highway 89 (DC89), USGS 10338700, Truckee, California, water year 2013

WY 2013 Daily Mean Flow (cubic feet per second)

DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT
1	74.1	21.2	340.5	51.3	44.7	36.7	108.0	82	39.1	12.6	4.6	6.8
2	94.2	19.9	675.6	48.6	44.4	39.4	78.5	73	39.7	11.7	4.6	7.0
3	102.9	18.7	372.9	47.1	44.3	45.4	79.3	79	39.1	11.2	4.5	6.9
4	104.7	17.2	287.5	45.8	45.2	46.0	103.9	78	38.5	10.7	4.4	9.3
5	100	16.0	458.7	44.3	45.5	47.6	106.0	72	38.1	10.0	4.4	18.5
6	105	15.0	340.8	42.9	45.6	54.0	90.5	82	36.6	9.4	4.2	42.1
7	111	14.2	264.7	41.9	45.8	53.2	89.0	80	34.1	9.0	4.1	54.8
8	107	14.4	216.8	41.0	45.9	50.2	85.8	82	33.1	8.6	4.2	54.4
9	101	14.3	189.0	41.1	44.6	48.7	74.1	81	31.1	8.3	4.0	78.0
10	104	14.5	162.1	41.7	43.5	47.6	68.6	84	29.2	8.1	3.9	108.3
11	108	14.1	144.4	40.4	43.1	51.7	83.8	91	25.9	7.8	3.9	121.9
12	103	14.0	135.8	38.3	42.5	60.2	87.6	95	23.7	7.5	3.8	126.2
13	104	14.0	123.5	36.9	42.1	70.8	93.2	93	21.5	7.3	3.7	122.6
14	109	14.0	111.0	36.5	41.0	84.3	95.4	88	19.8	7.1	3.8	119.8
15	103	13.1	104.3	36.1	40.3	91.3	86.7	82	18.4	6.9	4.0	116.0
16	92	13.7	97.8	35.5	39.4	96.0	74.8	74	17.4	6.8	4.1	89.4
17	107.8	34.2	108.4	34.8	39.7	93.5	64.9	63	16.4	6.5	4.2	57.6
18	105.3	38.6	99.0	34.2	41.2	93.6	69	57	15.7	6.4	4.3	58.7
19	79.6	30.4	88.8	33.5	42.0	95.8	69	54	15.2	6.3	4.6	57.9
20	64.5	28.8	83.5	33.1	41.7	124.2	76	51	14.6	6.0	5.3	56.8
21	54.1	42.5	77.8	32.8	40.2	131.9	85	51	14.0	5.8	6.0	59.7
22	49.5	38.8	79.6	32.5	39.0	125.2	94	47	13.7	5.7	6.0	57.9
23	48.8	33.2	84.4	32.6	37.2	118.0	91	41.2	13.5	5.6	6.1	56.3
24	42.0	31.1	82.5	34.1	37.6	113.3	82	38.4	16.7	5.5	6.2	54.7
25	36.9	29.3	77.7	39.4	36.8	113.9	75	37.4	36.0	5.4	6.4	55.9
26	32.3	28.1	78.2	45.4	36.0	111.0	75	36.5	26.4	5.2	6.3	58.0
27	28.2	26.9	71.7	44.5	35.4	110.1	85	35.8	18.8	5.2	6.2	57.9
28	25.8	31.1	66.6	43.4	35.1	118.9	88	52.5	16.3	5.0	6.2	58.3
29	23.9	52.1	62.3	42.9		124.1	100	44.8	14.6	4.9	6.1	55.9
30	21.8	348.5	58.1	42.7		132.8	99	41.5	13.5	4.8	6.4	56.4
31	20.6		55.1	43.9		149.4		40.3		4.7	6.6	
MEAN	76	34.7	168	40.0	41.4	86.4	85	65	24	7	4.9	62.8
MAX. DAY	111	348.5	676	51.3	45.9	149	108	95	40	13	6.6	126.2
MIN. DAY	20.6	13.1	55.1	32.5	35.1	36.7	65	36	13	4.7	3.7	6.8
cfs days	2363	1042	5199	1239	1160	2679	2558	2005	731	226	153	1884
ac-ft	4686	2067	10312	2458	2300	5313	5074	3977	1449	448	304	3737

Monitor's Comments

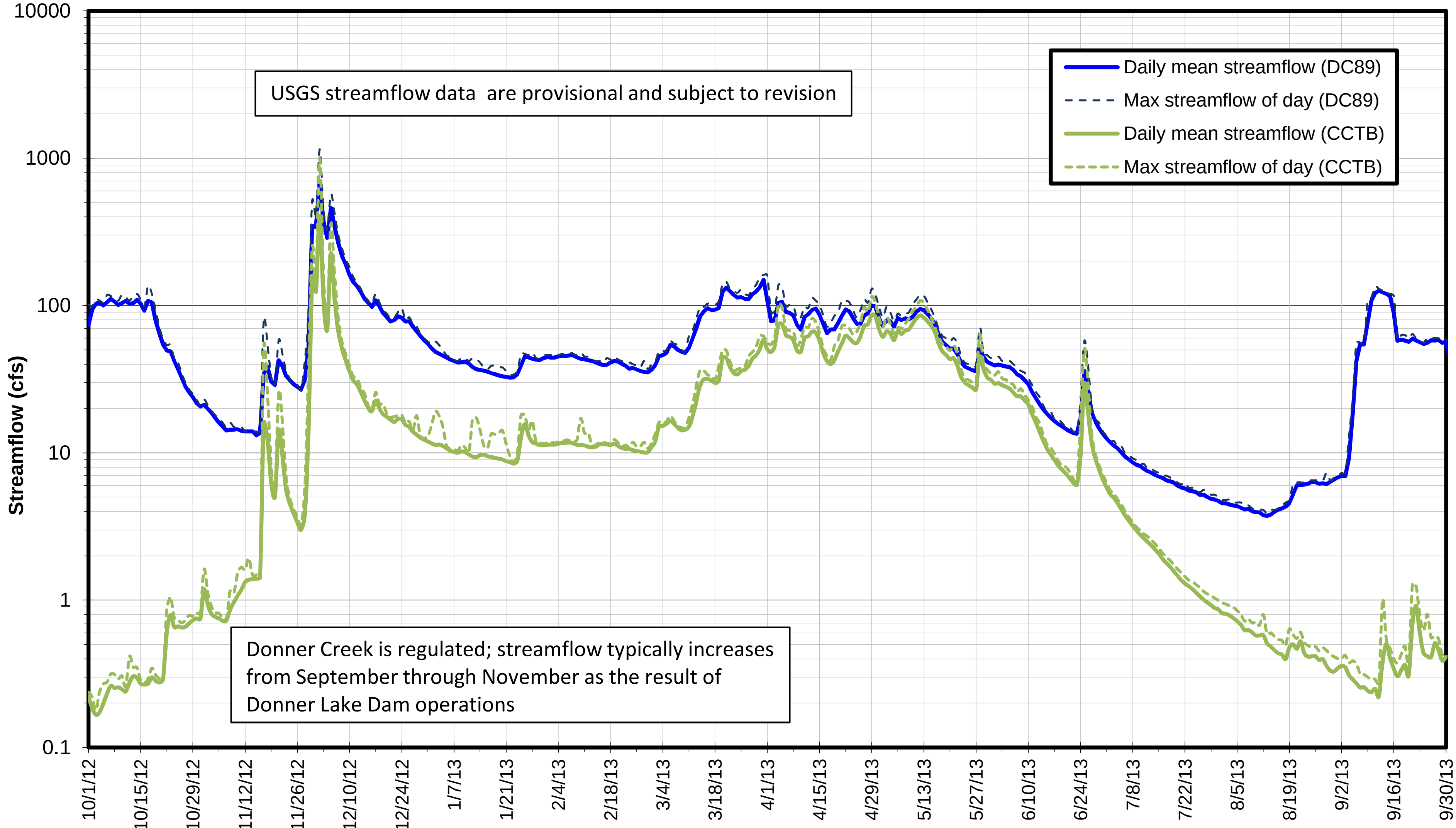
1. USGS provisional data, subject to revision
2. Gaging station location: 39° 19' 15.5" N, 120° 12' 28.6" W (WGS84), in Truckee, California. Gage is located approx. 0.59 miles upstream from the confluence with Truckee River
3. Drainage area is 29.1 square miles above the gaging station; land use includes 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 by Donner Lake Dam
5. Streamflow includes contributions from Cold Creek
6. Gaging station period of record: WY1993 to current water year
7. Real-time data available at http://www.waterdata.usgs.gov/ca/nwis

Water Year 2013 Totals:		
Mean flow	**58**	(cfs)
Max. daily flow	**676**	(cfs)
Min. daily flow	**3.7**	(cfs)
Annual total	**21,238**	(cfs-days)
Annual total	**42,125**	(ac-ft)

Data provided by United State Geological Survey (USGS), Truckee Field Office

APPENDIX B2

USGS streamflow hydrograph, Donner Creek at Highway 89 (USGS 10338700), Truckee, California, water year 2013



Note that the flow axis is logarithmic.

Balance Hydrologics, Inc.

Appendix B2. **Streamflow hydrograph, Donner Creek at Highway 89 (USGS 10338700), Truckee, California, water year 2013.** 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 and end of the record are related to annual releases to Donner Creek from Donner Lake.