Seasonal Progress Report #1

SR431 Treatment Vault Effectiveness Monitoring

Agreement Number: P423-13-019

Submitted by: Tahoe Resource Conservation District

Submitted to: Nevada Department of Transportation

Period: Fall/Winter Season, October 1, 2015 – February 29, 2016

Submission Date: March 31, 2016

Two stormwater treatment vaults, a Contech MFS and a Jellyfish, were installed by the Nevada Department of Transportation (NDOT) on State Highway 431 (SR431) above Incline Village, Nevada. Monitoring equipment was installed at the inflows and outflows of these two vaults. The Tahoe Resource Conservation District (Tahoe RCD) took over effectiveness monitoring at the four monitoring stations on May 1, 2015 and will continue to monitor through the end of water year 2016 (September 31, 2016). The Tahoe RCD follows sampling protocols outlined in the Regional Stormwater Monitoring Program Framework and Implementation Guidance document (RSWMP FIG, Tahoe RCD et al 2015).

The Tahoe RCD appreciates the opportunity to provide these water quality monitoring services for NDOT and looks forward to continuing the partnership.

Tasks and subtasks associated with this project and a summary of work completed to date are described below. Table 1 provides due dates and percent completion to date for each task.

Task 1: Project Administration

1. Invoices

   Five invoices will be submitted for this project covering the following periods:
   #1: May 1, 2015 – September 30, 2015
   #2: October 1, 2015 – December 31, 2015
   #3: January 1, 2016 – March 31, 2016
   #4: April 1, 2016 – June 30, 2016
   #5: July 1 – September 30, 2016

2. Progress Reports

   Progress reports will not be concurrent with quarterly invoices. Three seasonal progress reports for water year 2016 will be submitted for this project covering the following periods:
   #1: Fall/winter – October 1, 2015 – February 29, 2016
   #2: Spring – March 1, 2016 – May 31, 2016
   #3: Summer – June 1, 2016 – September 30, 2016
   (Note that the period from May 1, 2015 to September 30, 2015 was covered by DRI.)

Task 2: Stormwater Monitoring

1. Maintain four stormwater monitoring stations to collect continous flow and turbidity data.

   All four stormwater monitoring stations have been dependably collecting continuous flow and turbididty data since the Tahoe RCD took over the project on May 1, 2015 and through the rain event that began March 4, 2016. After this event, it was discovered that accumulated sediment is prohibiting monitoring equipment from collecting reliable continuous data and samples. NDOT was notified that the vaults needed to be cleaned out via email on March 6, 2016. On March 8, 2016, NDOT responded that vactor trucks could come up the following week if weather permitted. During a site visit on March 16, 2016, visual inspections were made and sediment depth measurements were taken in various places throughout the system. The vault that should reliably split incoming flows equally between the Contech MFS and the Jellyfish filters had 21 inches of accumulated sediment in it, causing the flow to preferentially enter the Jellyfish. The pipes between the splitter vault and the inflow flumes where flow is measured and samples are taken were one third to one half full of sediment. The inflow flumes were full of sediment and the continuous turbidimeters were completely buried. The Contech MFS had about 7 inches of sediment accumulated in the bottom of the vault, and the Jellyfish had about 14 inches. Fortunately, the outflow flumes were relatively clear of sediment but dirty snowmelt was entering through the gap around the outside of the manhole cover and raining down on the flumes giving false outflow data. On March 17, 2016, Tahoe RCD was made aware that the NDOT vactor truck was out for repairs. It was decided that Tahoe RCD would refrain from taking water quality samples during events, but would continue collecting continous flow and turbidity data even though it may not be accurate. Tahoe RCD will await NDOT’s go-ahead to resume event monitoring once the system has been cleaned.

2. Collect stormwater runoff samples at four monitoring sites during eight runoff events per year.

   Tahoe RCD successfully collected samples at all four monitoring sites during four fall/winter runoff events to date: a thunderstorm on 10/1/15, rain on 11/1/15, rain on 12/10/15, and rain on snow on 1/29/16.

3. If conditions allow for non-event snowmelt sampling, analyze a rising and a falling limb composite during three diurnals (counts as one of the eight events).

   Due to accumulated sediment fouling sensors, non-event snowmelt sampling will occur after the NDOT vactor truck has cleaned out the system and if snowmelt runoff occurs.

4. Install a pressure transducer in each treatment vault to identify when there is bypass flow.

   Pressure transducers installed in each of the vaults between September 30, 2015 and January 6, 2016 were removed so that data could be offloaded and analyzed. Data indicates that the Jellyfish never bypassed and the Contech MFS only bypassed slightly in three non-consecutive time intervals on October 1, 2015. New pressure transducers will be installed as soon as NDOT provides them to Tahoe RCD staff.

5. Provide precipitation data to date.

   Table 2 provides summary data for all 23 fall/winter precipitation events at the SR431 monitoring site including event start and end dates, total precipitation, peak precipitation, minimum and maximum temperature, and preciptation type. Events highlighted in pink were sampled for water quality (see task 2.2 above).

6. Provide hydrograph, continuous turbidity, and sample distribution graphs for each sampled event.

See Figures 1-16 below for hydrographs, continous turbidity and sample distributions for each of the four events sampled in the fall/winter season. Hydrographs at this site are generally very spikey, likely due to the high percentage of impervious area in the catchment. The high imperviousness causes sites to respond quickly to rapidly fluctuating precipitation intensity which causes the spikes in the flow data. In general, turbidity stays high for the duration of the event as opposed to peaking at the beginning of the event and tapering off. This is likely due to the fact that the dominant land use is primary road, which may be a constant source of sediment. It is interesting to note that during the 1/29/16 event, all sites did experience an initial pulse of turbidity that gradually tapered off. This could indicate that traction abrasives were applied to the highway for the icey conditions of January and were quickly washed off with the rain.

Task 3: Condition Assessments

1. Estimate Road RAM score prior to monitored runoff events.

This task was not initiated until November 2015 following a meeting between the Tahoe RCD and NDOT where it was decided that estimating a Road RAM score prior to runoff events was valuable. Therefore the first two of the four events did not receive a Road RAM score prior to sampling. At this time three scores have been estimated; two prior to the 12/10/15 event, and one prior to the 1/29/16 event. Roads are given a score from 1 to 5 based on how dirty they are (dirtyness is determined by a series of tests measuring sediment). The scores below indicate that the roads were relatively dirty prior to the 12/10/15 and 1/29/16 runoff events. The roads may have been swept between 12/2/15 and 12/8/15 causing the score to go up, but this has not been verified.

Date Time	Road Ram Score
12/2/15 15:30	1.6
12/8/15 9:30	2.1
1/28/15 8:10	1.7

According to the Road RAM Users' Manual (2NDNATURE et al 2015) scores greater than 1 and less than or equal to 2 fall into the "degraded" category. The range of FSP concentrations that can be expected in runoff from these roads is 291-679 mg/L. This is close to the event mean concentrations for the 12/10/15 event of 728 and 717 mg/L of FSP at the Contech MFS inflow and Jellyfish inflow respectively and 1,110 and 825 mg/L for the 1/29/16 event respectively. Road RAM scores greater than 2 and less than or equal to 3 fall into the "fair" category where the range of expected FSP concentrations in runoff is 124-290. FSP concentrations that low were not measured during the 12/10/15 event so it is possible that the 12/8/15 score was overestimated slightly.

2. Measure depth of sediment in vaults after eight monitored runoff events.

This task was not initiated until November 2015 following the meeting between Tahoe RCD and NDOT mentioned above where it was determined that post event sediment depth was valuable information. Thus, sediment depth was only measured one time during the fall/winter season. The depths below represent the average depth in each vault.

Date Time	Contech MFS	Jellyfish
12/30/15 10:30	0.33 ft.	0.92 ft.

Task 4: Final Report

1. Provide raw data.

   This task has not yet begun but raw data can be provided at any time upon request.

2. Provide treatment effectiveness analysis following formats outlined in the RSWMP FIG.

   This task has not yet begun. The analysis will be provided in the final report.

3. Correlate Road RAM score to pollutant concentration and load.

   This task has not yet begun. The analysis will be provided in the final report.

4. Provide mass loading v. volume calculations for select events.

   Attached to this progress report is a memo that describes our findings under this task to date. The study was based on four events that occurred in the late spring and early summer of water year 2015, not events sampled during the current reporting season. The Tahoe RCD would like to continue this study and include events from the fall/winter reporting season in the next seasonal progress report once fall/winter data has been thoroughly quality assured. Please see Attachment A.

Table 1: Summary of tasks, due dates, and percent completion to date.

Task	Description	Due Date	% Of Work Complete	Date (s) Submitted
1	Project Administration			
1.1	Five Quarterly Invoices	10/31/15, 1/31/16, 4/30/16, 7/31/16, 10/31/16	40%	10/31/15, 1/31/16
1.2	Three Seasonal Progress Reports	3/31/16, 6/30/16, 10/31/16	33%	3/31/2016
2	Stormwater Monitoring			
2.1	Collect continous flow and turbidity data at four monitoring stations	9/30/2016	42%	
2.2	Collect stormwater runoff samples during eight events per year	9/30/2016	63%	
2.3	Collect three diurnal non-event snowmelt events if conditions allow	5/31/2016	0%	
2.4	Collect flow bypass data in both vaults	9/30/2016	0%	
2.5	Provide precipitation data to date	9/30/2016	42%	3/31/16
2.6	Provide hydrograph, turbidity, and sample distribution graphs to date	9/30/2016	63%	3/31/16
3	Condition Assessments			
3.1	Estimate Road RAM score prior to eight sampled events	9/30/2016	60%	3/31/16
3.2	Measure depth of sediment in both vaults after sampled events	9/30/2016	40%	3/31/16
4	Final Report			
4.1	Provide raw data	3/15/2017	0%	
4.2	Provide treatment effectiveness analysis	3/15/2017	0%	
4.3	Correlate Road RAM score to pollutant concentration and load	3/15/2017	0%	
4.4	Provide mass loading v. volume calculations for select events	3/15/2017	0%	3/31/16

Table 2: Summary of fall/winter precipitation events at SR431.

Station ID	Precip Event (#)	Precipitation event start (PST)	Event end (PST)	Event duration (hr:mm)	Interevent duration (hr:mm)	Event precipitation (inches)	Event peak precipitation (inch/10min)	Event minimum temp (°C)	Event maximum temp (°C)	Type of Precipitation
NDOT	NDOT-15-41	9/30/15 10:00	10/1/15 16:00	30:00	na	0.278	0.094	2	25	thunderstorm
NDOT	NDOT-16-01	10/3/15 20:15	10/4/15 4:20	8:05	52:15	0.068	0.008	4	6	rain
NDOT	NDOT-16-02	10/16/15 9:00	10/18/15 3:45	42:45	292:40	0.744	0.035	4	17	thunderstorm
NDOT		10/19/15 15:40	10/19/15 15:40	0:00	35:55	0.004	0.004	7	7	spurious
NDOT	NDOT-16-03	10/27/15 14:40	10/28/15 15:05	24:25	191:00	0.274	0.023	3	7	rain
NDOT	NDOT-16-04	11/1/15 11:25	11/3/15 23:45	60:20	92:20	1.325	0.027	-6	6	rain, snow
NDOT	NDOT-16-05	11/8/15 16:30	11/10/15 7:25	38:55	112:45	0.672	0.031	-6	1	snow
NDOT	NDOT-16-06	11/15/15 13:45	11/15/15 22:45	9:00	126:20	0.246	0.019	-7	-2	snow
NDOT	NDOT-16-07	11/24/15 11:35	11/26/15 5:45	42:10	204:50	0.396	0.016	-13	-3	snow
NDOT		11/29/15 11:15	11/29/15 11:15	0:00	77:30	0.004	0.004	0	0	spurious
NDOT	NDOT-16-08	12/3/15 16:25	12/4/15 13:55	21:30	101:10	0.260	0.016	-5	1	snow
NDOT	NDOT-16-09	12/10/15 0:55	12/11/15 11:05	34:10	131:00	1.439	0.023	-6	4	snow
NDOT	NDOT-16-10	12/13/15 1:25	12/14/15 0:25	23:00	38:20	1.159	0.019	-9	-1	snow
NDOT		12/15/15 13:45	12/15/15 13:45	0:00	37:20	0.004	0.004	-5	-5	spurious
NDOT		12/17/15 11:45	12/17/15 11:45	0:00	46:00	0.004	0.004	2	2	spurious
NDOT	NDOT-16-11	12/19/15 1:10	12/19/15 6:25	5:15	37:25	0.208	0.012	-3	-2	snow
NDOT	NDOT-16-12	12/20/15 13:20	12/25/15 11:45	118:25	30:55	2.436	0.016	-14	4	rain/snow
NDOT	NDOT-16-13	12/28/15 3:05	12/28/15 19:10	16:05	63:20	0.020	0.004	-8	-3	snow
NDOT	NDOT-16-14	12/30/15 6:35	12/30/15 11:30	4:55	35:25	0.012	0.008	-8	-1	snow
NDOT	NDOT-16-15	1/4/16 15:00	1/7/16 11:30	68:30	123:30	1.097	0.023	-9	0	snow
NDOT	NDOT-16-16	1/9/16 2:05	1/9/16 13:15	11:10	38:35	0.028	0.008	-6	2	snow
NDOT	NDOT-16-17	1/13/16 6:00	1/16/16 17:30	83:30	88:45	1.711	0.019	-9	4	snow, rain
NDOT	NDOT-16-18	1/17/16 18:35	1/19/16 17:40	47:05	25:05	0.592	0.016	-3	4	rain/snow
NDOT	NDOT-16-19	1/22/16 11:55	1/25/16 10:45	70:50	66:15	0.388	0.016	-8	3	rain/snow
NDOT	NDOT-16-20	1/29/16 5:35	2/1/16 9:20	75:45	90:50	0.120	0.004	-15	4	rain/snow
NDOT	NDOT-16-21	2/2/16 10:15	2/2/16 11:45	1:30	24:55	0.012	0.008	-7	-5	snow
NDOT	NDOT-16-22	2/17/16 9:35	2/18/16 21:30	35:55	357:50	0.152	0.004	-6	5	rain, snow
NDOT	NDOT-16-23	2/25/16 19:25	2/26/16 0:00	4:35	165:55	0.016	0.004	-1	13	rain

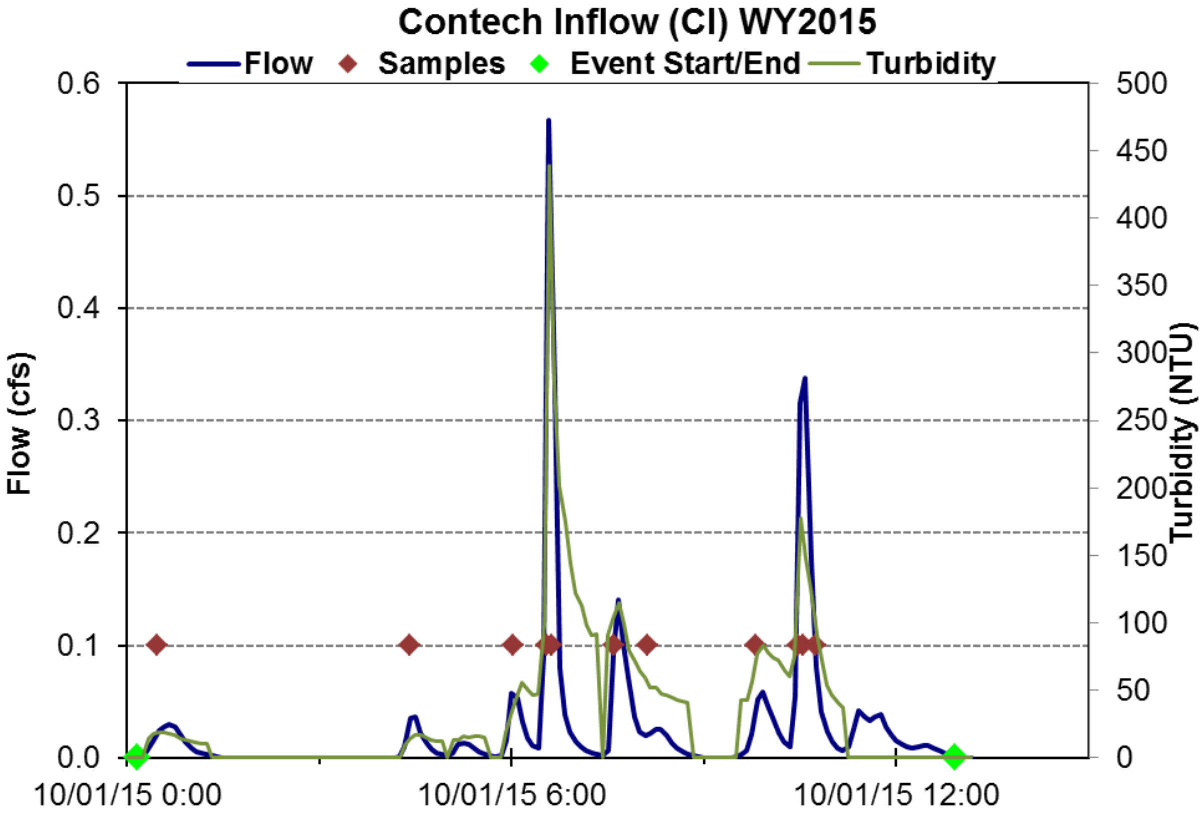

Figure 1: Hydrograph, continuous turbidity and sample distribution at the Contech MFS inflow for the 10/1/15 thunderstorm event.

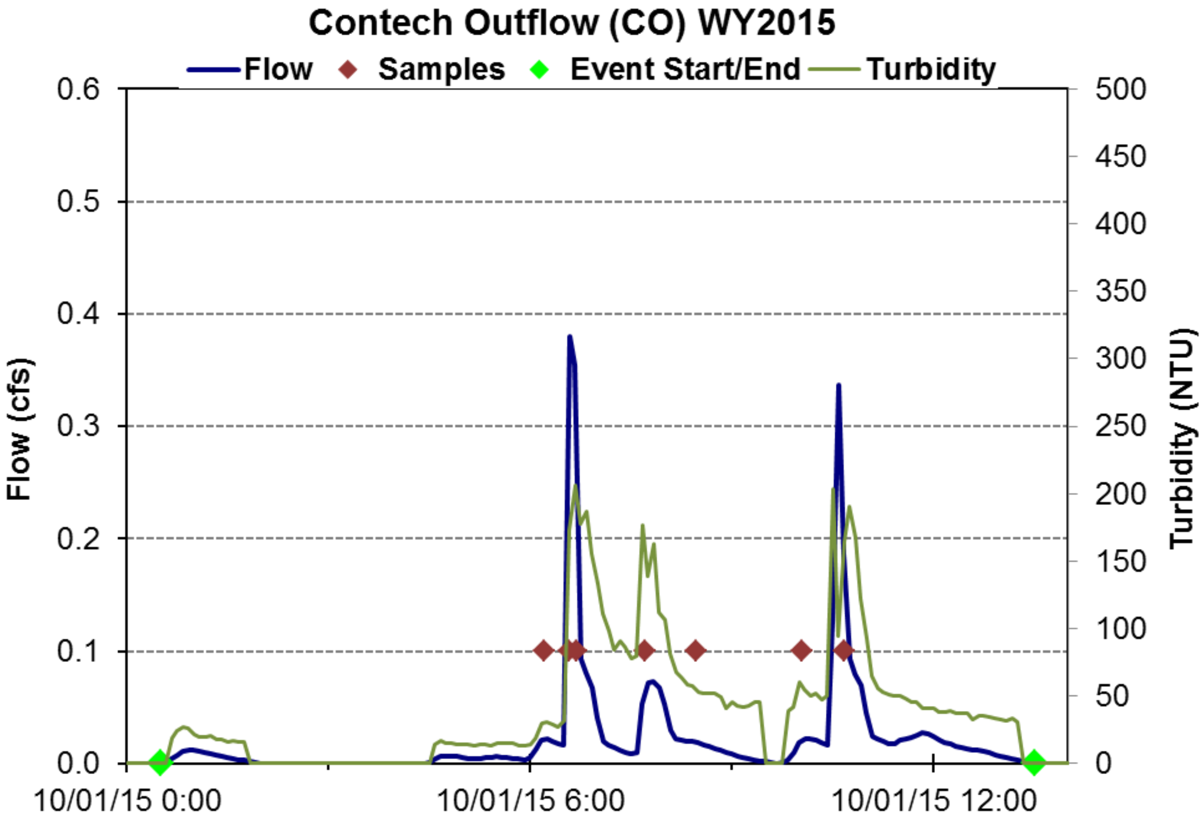

Figure 2: Hydrograph, continuous turbidity and sample distribution at the Contech MFS outflow for the 10/1/15 thunderstorm event.

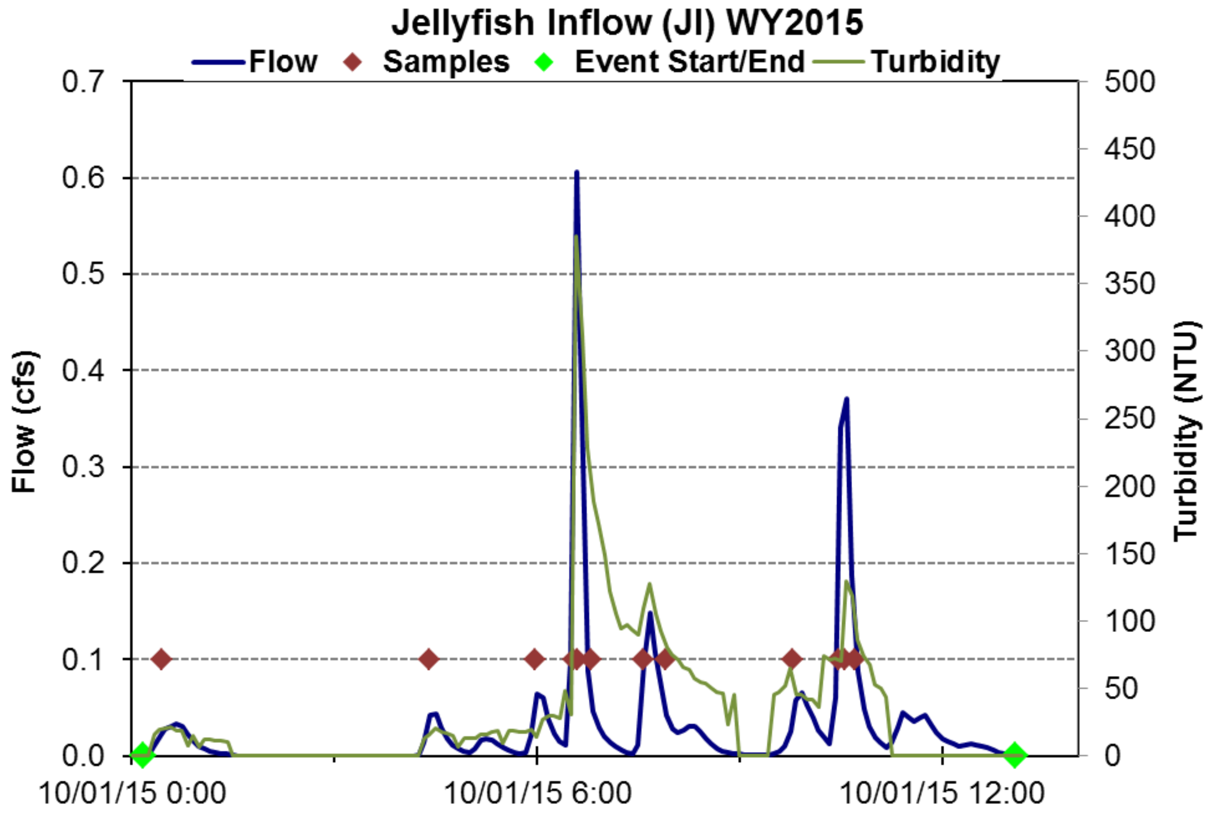

Figure 3: Hydrograph, continuous turbidity and sample distribution at the Jellyfish inflow for the 10/1/15 thunderstorm event.

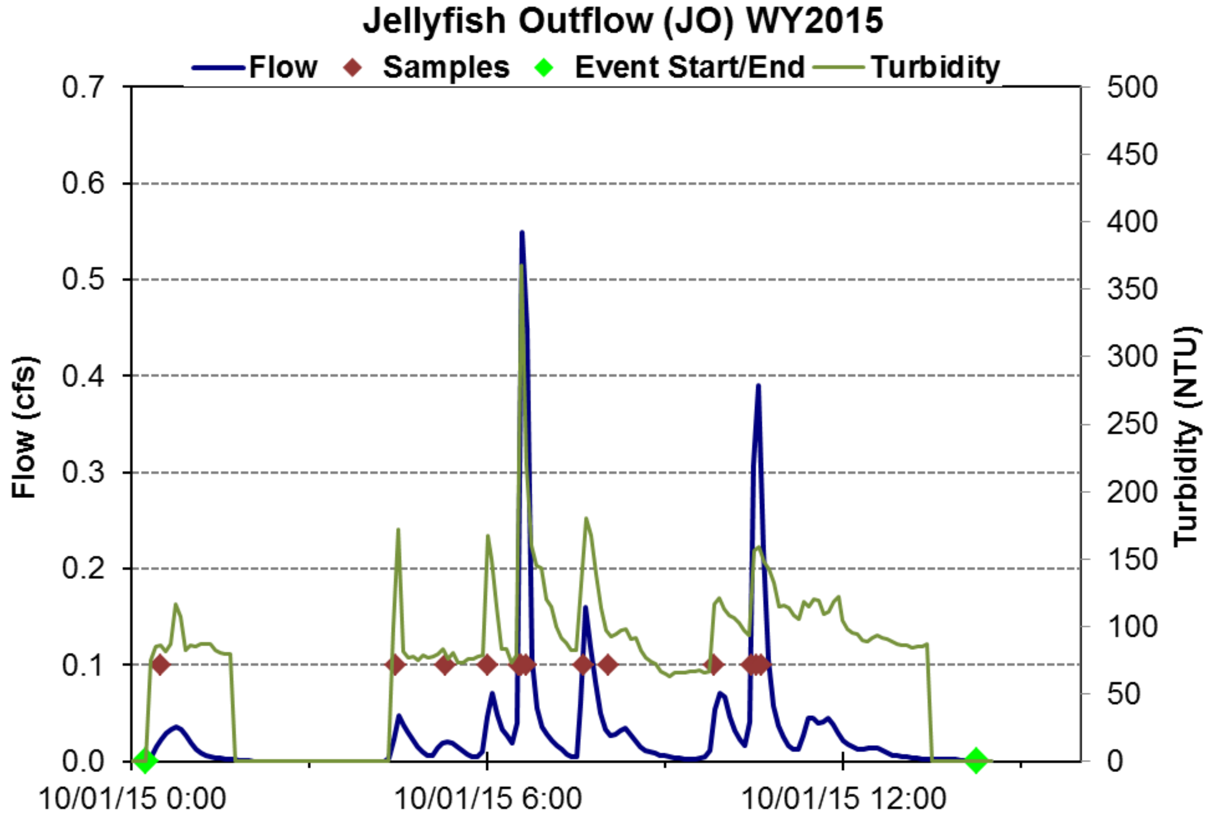

Figure 4: Hydrograph, continuous turbidity and sample distribution at the Jellyfish outflow for the 10/1/15 thunderstorm event.

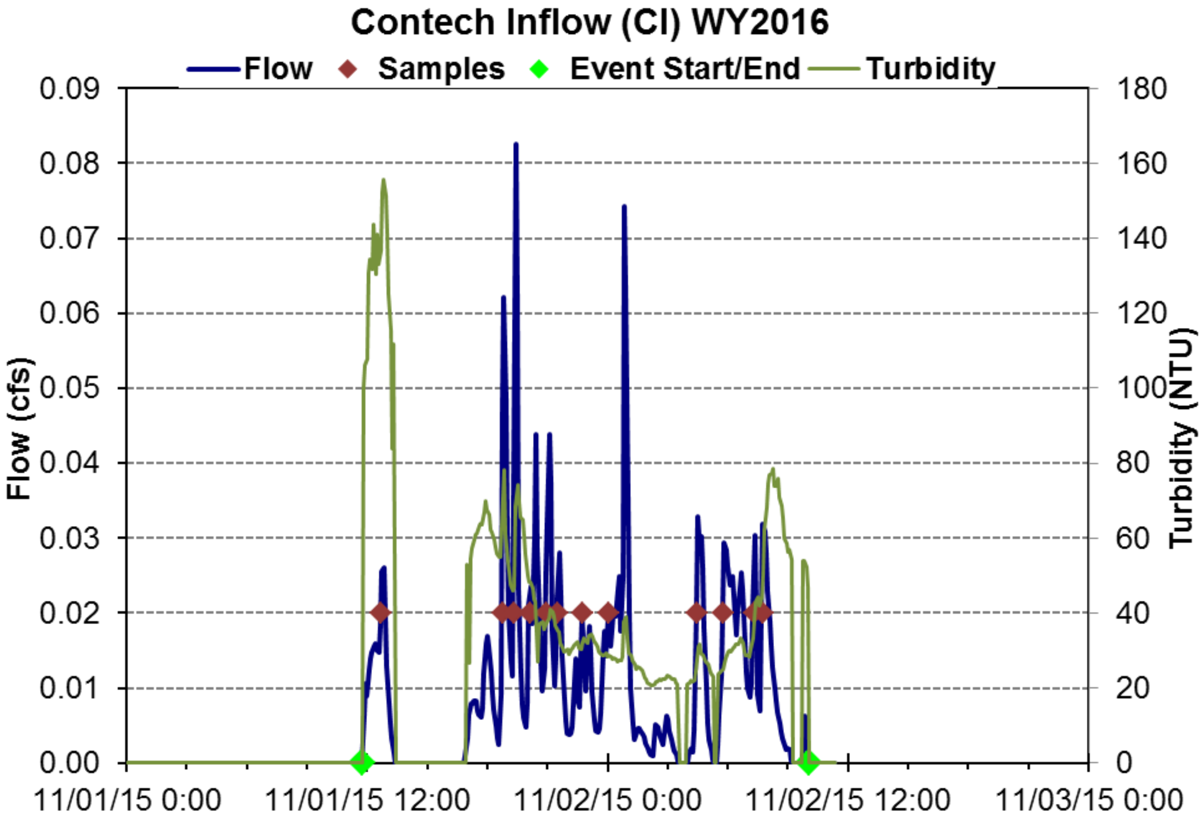

Figure 5: Hydrograph, continuous turbidity and sample distribution at the Contech MFS inflow for the 11/1/15 rain and snow event.

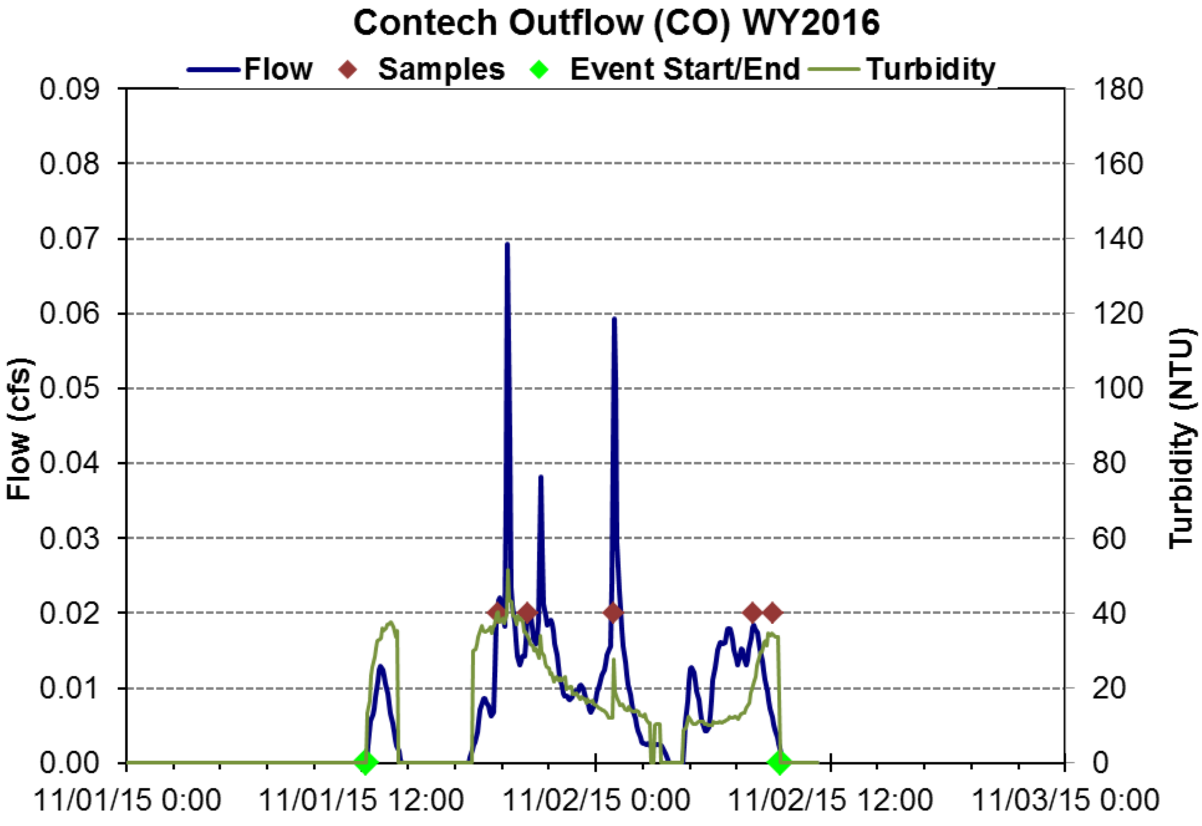

Figure 6: Hydrograph, continuous turbidity and sample distribution at the Contech MFS outflow for the 11/1/15 rain and snow event.

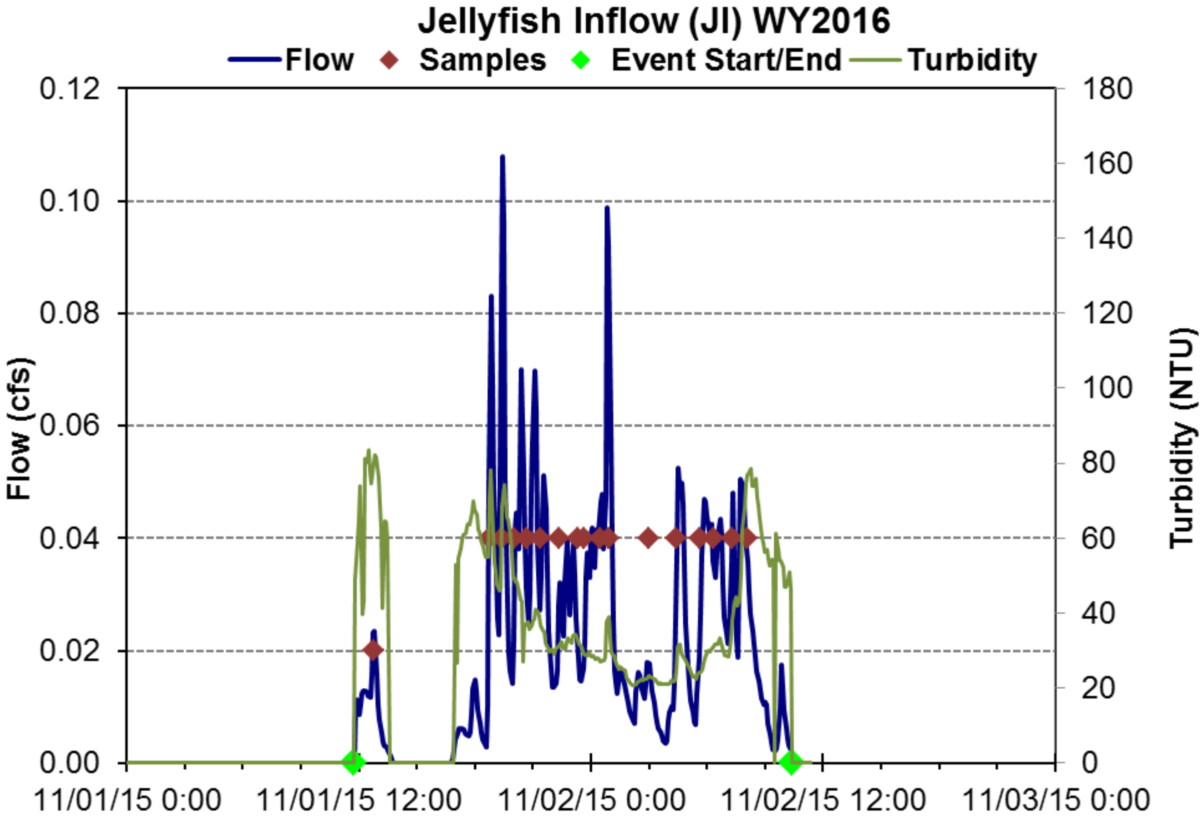

Figure 7: Hydrograph, continuous turbidity and sample distribution at the Jellyfish inflow for the 11/1/15 rain and snow event.

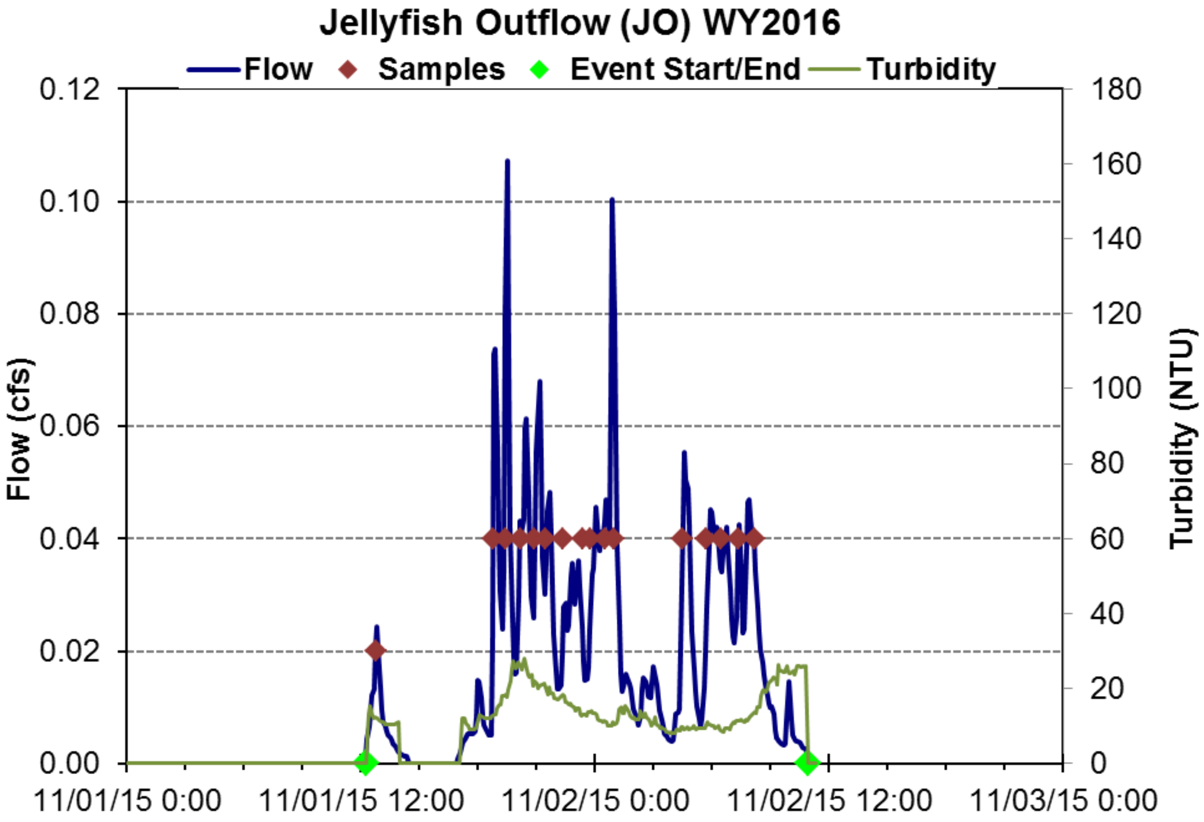

Figure 8: Hydrograph, continuous turbidity and sample distribution at the Jellyfish outflow for the 11/1/15 rain and snow event.

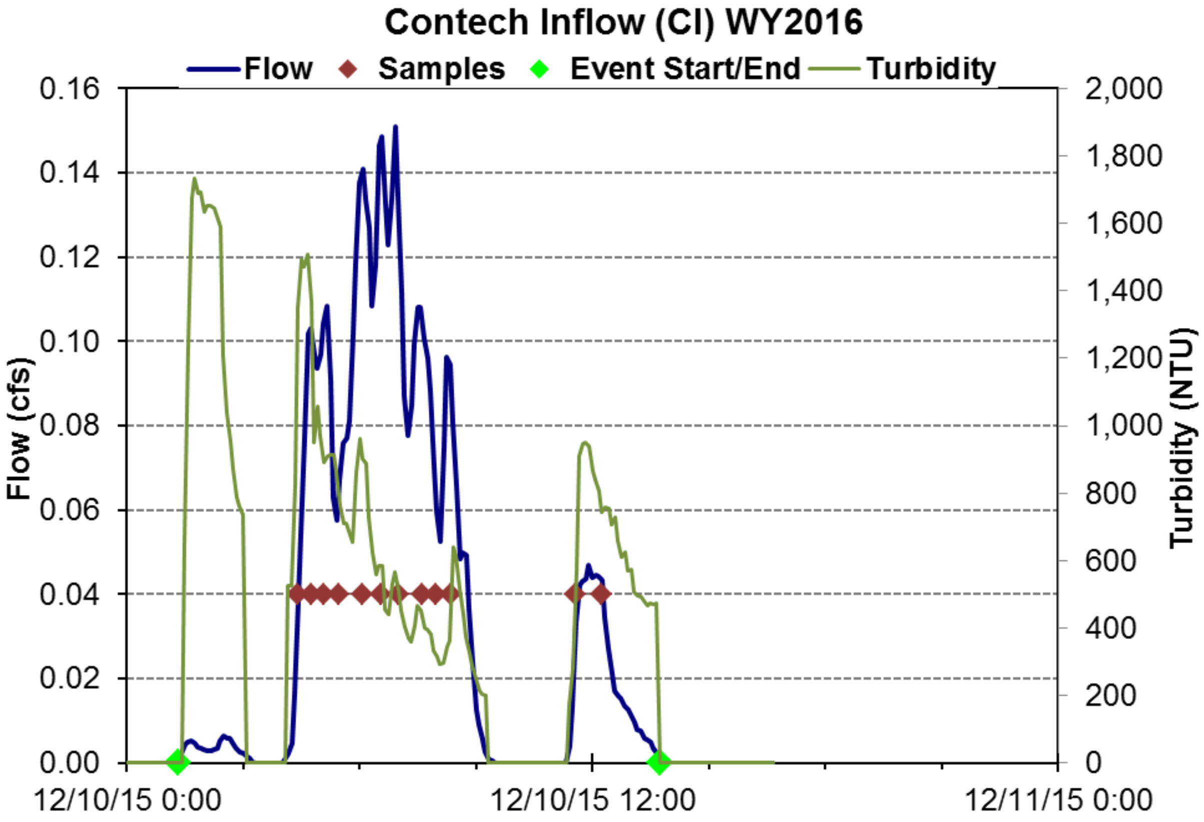

Figure 9: Hydrograph, continuous turbidity and sample distribution at the Contech MFS inflow for the 12/10/15 snow event.

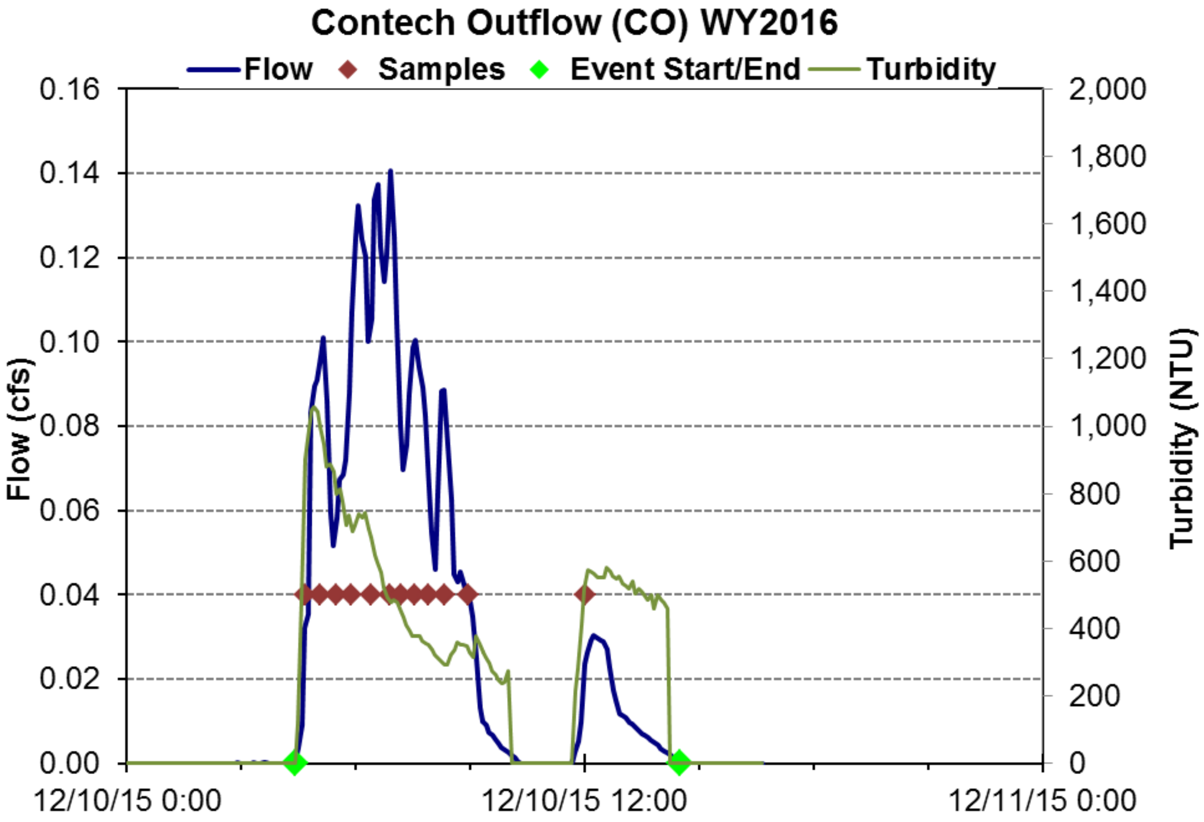

Figure 10: Hydrograph, continuous turbidity and sample distribution at the Contech MFS outflow for the 12/10/15 snow event.

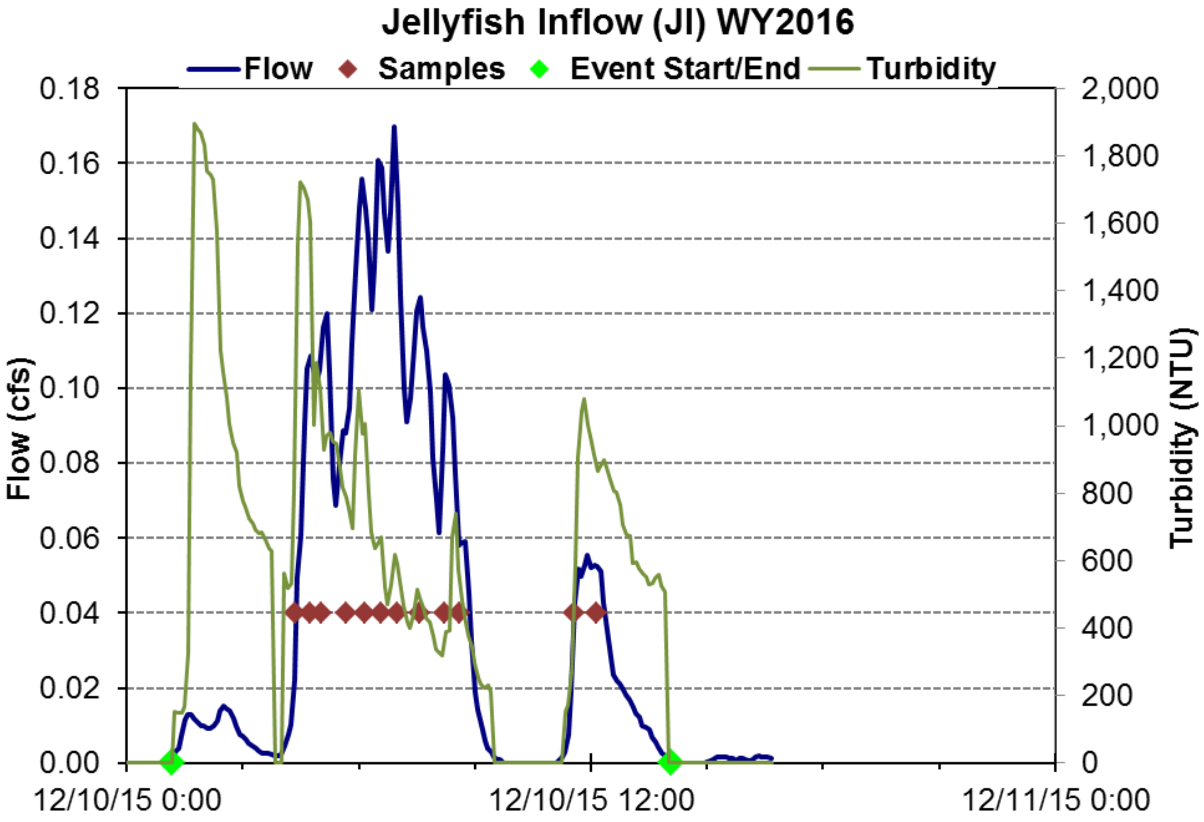

Figure 11: Hydrograph, continuous turbidity and sample distribution at the Jellyfish inflow for the 12/10/15 snow event.

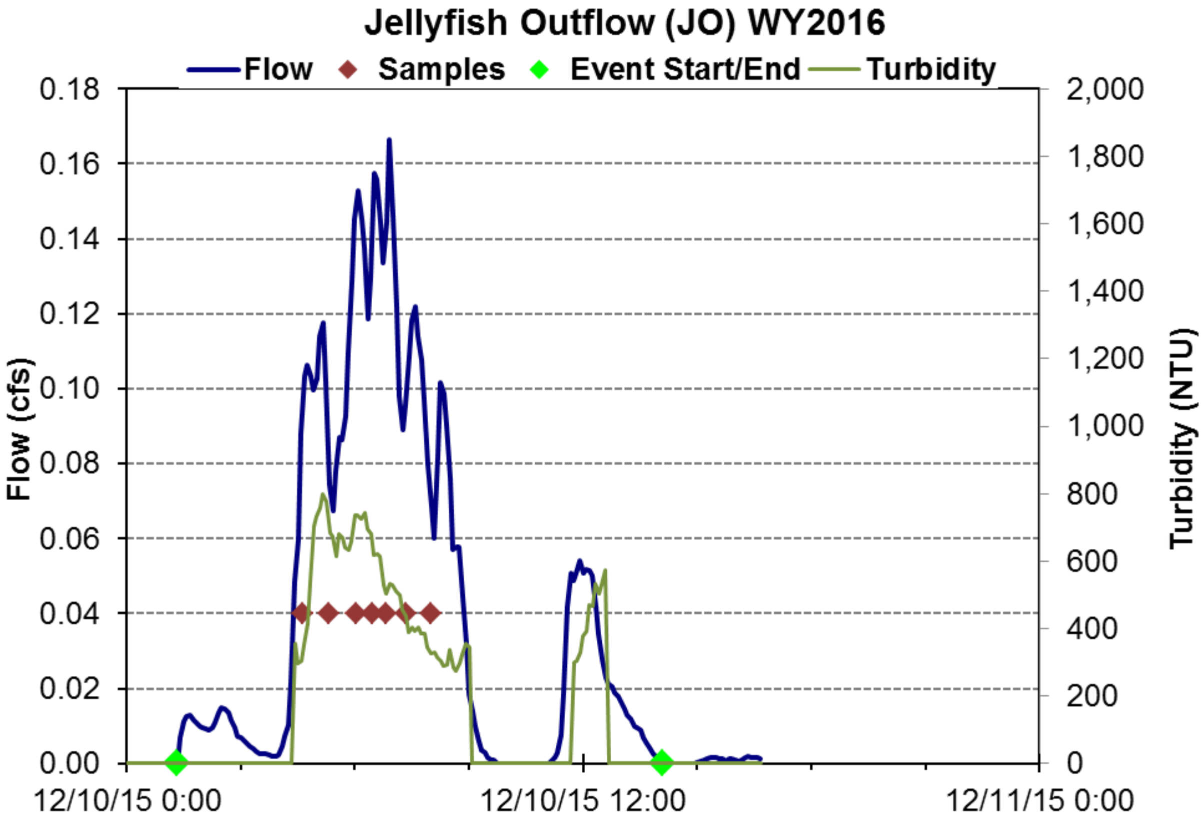

Figure 12: Hydrograph, continuous turbidity and sample distribution at the Jellyfish outflow for the 12/10/15 snow event.

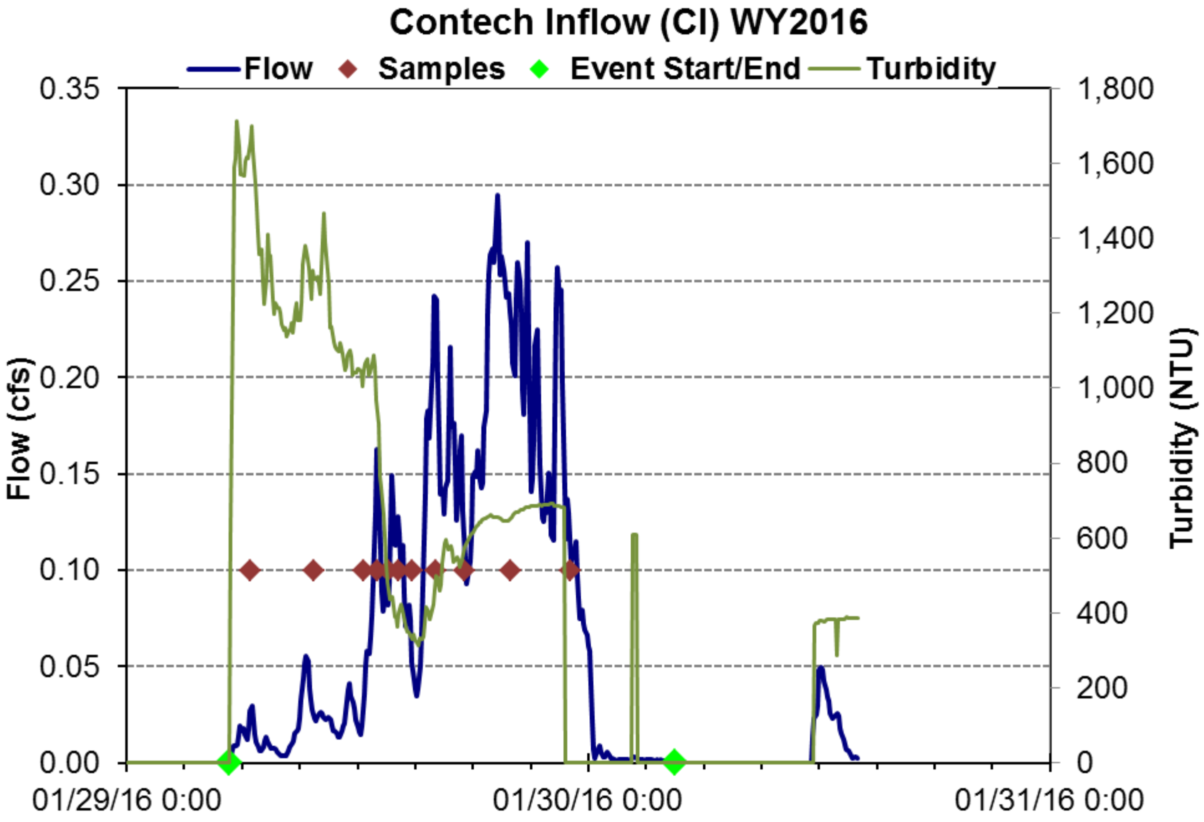

Figure 13: Hydrograph, continuous turbidity and sample distribution at the Contech MFS inflow for the 1/29/16 mixed rain and snow event.

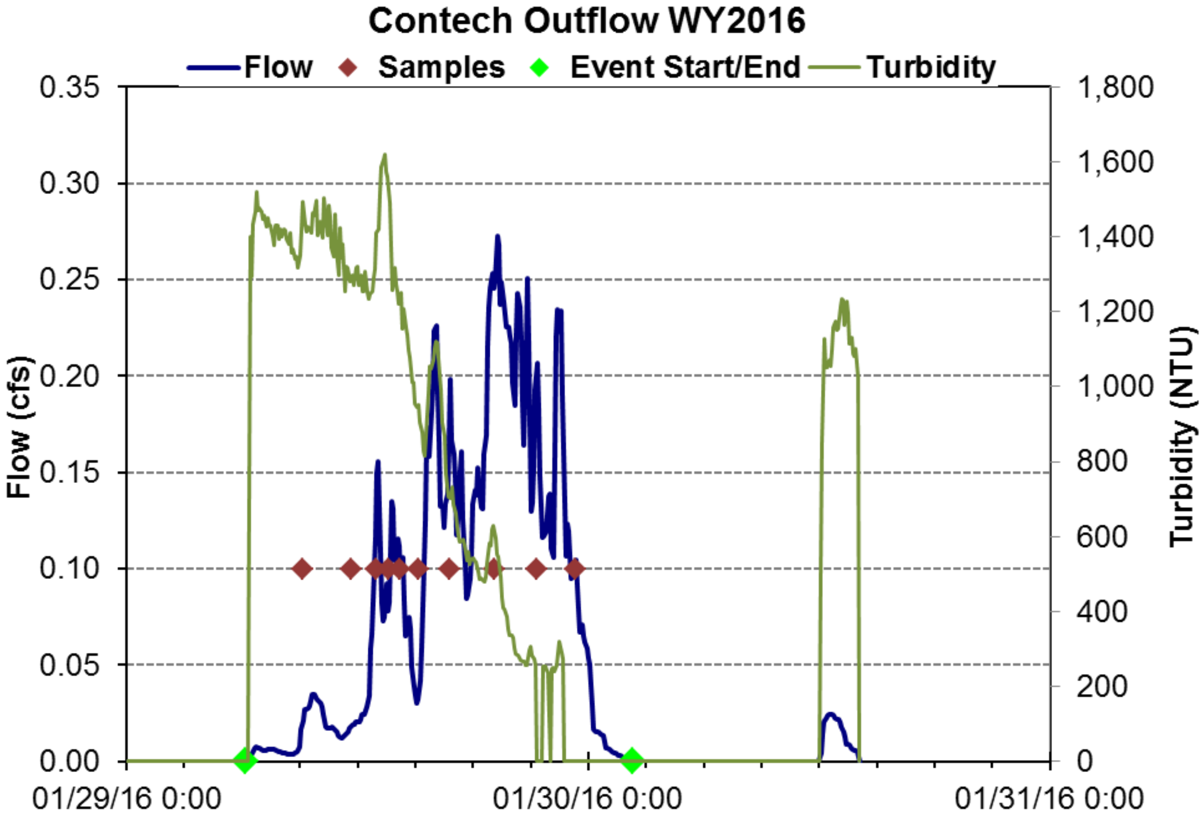

Figure 14: Hydrograph, continuous turbidity and sample distribution at the Contech MFS outflow for the 1/29/16 mixed rain and snow event.

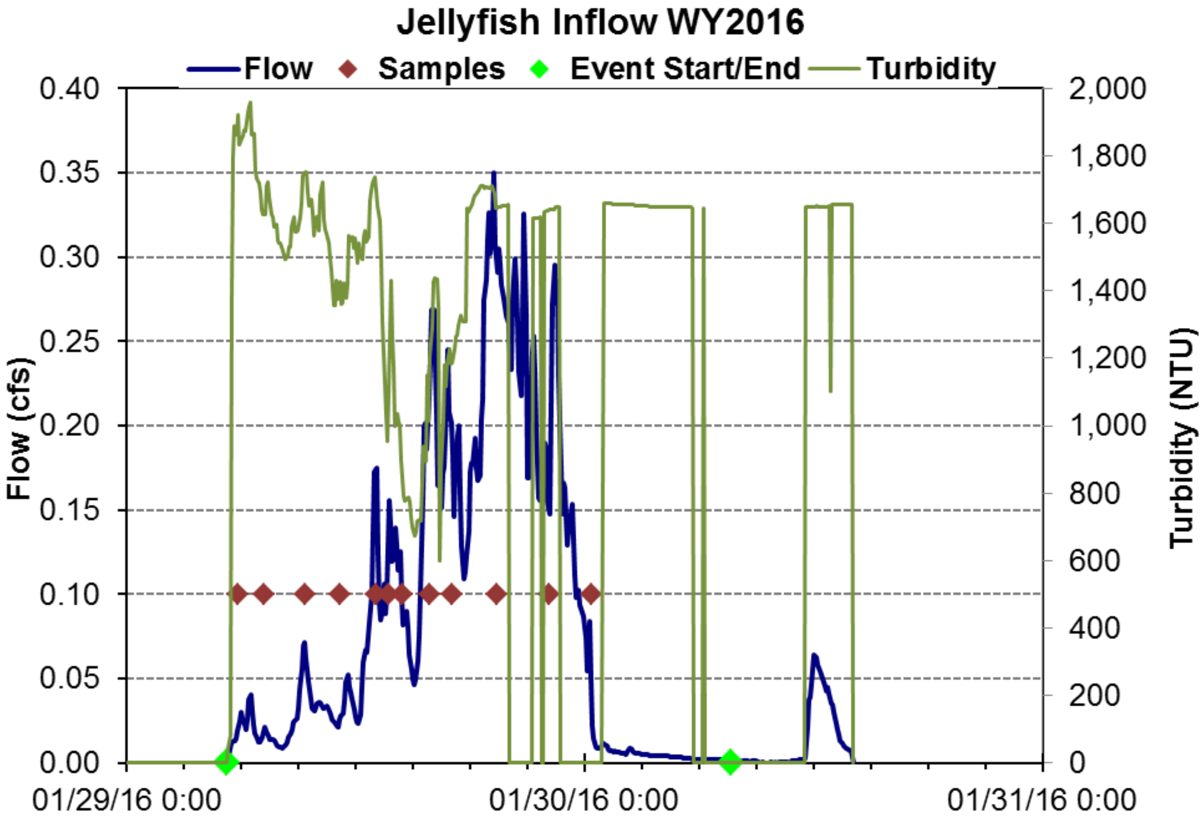

Figure 15: Hydrograph, continuous turbidity and sample distribution at the Jellyfish inflow for the 1/29/16 mixed rain and snow event.

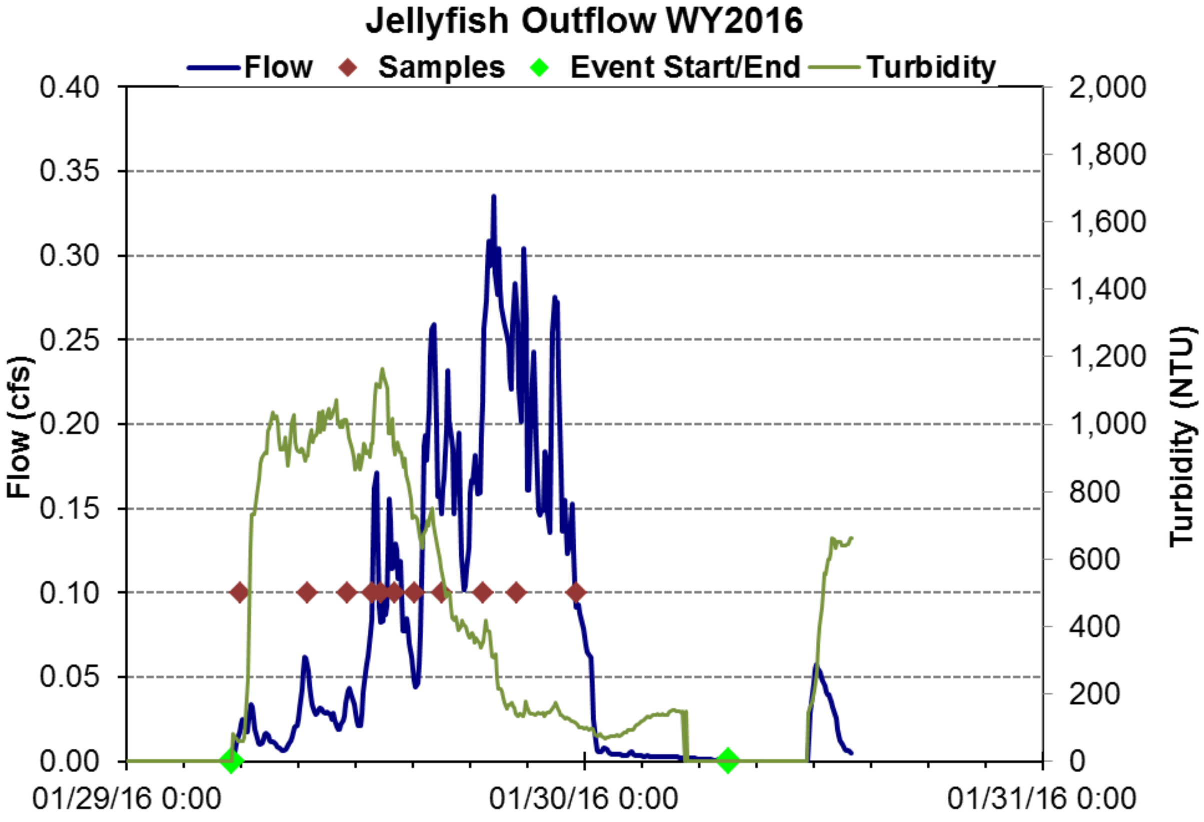

Figure 16: Hydrograph, continuous turbidity and sample distribution at the Jellyfish outflow for the 1/29/16 mixed rain and snow event.

References

Tahoe Resource Conservation District, 2NDNATURE, Desert Research Institute, Northwest Hydraulic Consultants. 2015. *RSWMP Framework and Implementation Guidance Document*. Submitted the California State Water Board. March 30, 2015.

2NDNATURE LLC, Northwest Hydraulic Consultants, Environmental Incentives, 2015. *Road Rapid Assessment Methodology (Road RAM) User Manual v2, Tahoe Basin. Final Document*. Prepared for the Nevada Division of Environmental Protection and Lahontan Regional Water Quality Control Board. May 2015.

ATTACHMENT A

Seasonal Progress Report #1

SR431 Treatment Vault Effectiveness Monitoring

Temporal Delivery of TSS, FSP, and TP

Introduction

Urban stormwater managers must often comply with a range of regulations and permit requirements to reduce pollutants discharged to local water bodies. As such, managers are constantly presented with the task of maximizing the effectiveness of stormwater Best Management Practices (BMPs). The task of efficiently reducing pollutant discharge is often challenged by a variety of constraints including available funding, site-specific physical restrictions, personnel availability, and BMP implementation and maintenance costs. With such considerations in mind, stormwater managers need to capture pollutants exiting a catchment in the most effective manner possible. One option that has been proposed for its cost-efficiency is to capture and treat only the first flush. There are two types of first flush; a concentration first flush and a mass first flush. A concentration first flush occurs when the initial pulse of runoff contains high concentrations of pollutants relative to the runoff later in the storm event. As the precipitation event continues, the pollutant concentrations get progressively lower as the catchment area is “washed clean”. A mass first flush (pollutant concentration times flow rate) is flow dependent and occurs when both concentrations and the initial flow rates are high relative to concentrations and flow rates in the later runoff (Stenstrom et al 2005).

Since the Tahoe Basin is primarily focused on reducing pollutant loads to Lake Tahoe, it was more important for this study to focus on the mass first flush since load and mass are equivalent. Different studies have suggested different thresholds for mass first flush, but in general they agree that the phenomenon of first flush exists if the majority of the pollutant load is delivered in the early part of the storm. Some studies suggest that the phenomenon exists if approximately 80% of the load is delivered in the first 20-40% of the total stormwater runoff volume, while others suggest that 30-50% must be delivered in the first 10-20% of the total stormwater runoff volume (Stenstrom et al 2005).

The Tahoe Resource Conservation District (Tahoe RCD) has conducted a preliminary analysis of temporal pollutant load delivery during four events in 2015 at Nevada Department of Transportation (NDOT) State Route 431 (SR431) stormwater monitoring stations in order to determine if the mass first flush phenomenon exists at this site. The presence of a mass first flush would afford the opportunity to capture and treat only a given initial percentage of stormwater runoff, thereby maximizing the cost-efficiency of stormwater treatment.

Background

Stormwater runoff in this 1.35 acre catchment is generated primarily from the 96% impervious primary road. Stormwater enters a drop inlet and is conveyed by a 12-inch corrugated plastic pipe to a splitter vault that evenly splits and diverts incoming flow into two separate treatment BMPs. The TRCD actively manages stormwater monitoring equipment at four separate locations at the SR431 site; the inflows and outflows of the Contech MFS and Jellyfish treatment vaults (BMPs). Monitoring equipment at each of these locations measures continuous flow and turbidity and takes water quality samples on a flow-weighted basis.

Relationships between turbidity and total suspended sediment (TSS), fine sediment particles (FSP), and total phosphorus (TP) have been developed with the intent of using continuous turbidity data as a proxy for continuous TSS, FSP, and TP data (Heyvaert et al 2015). These relationships are advantageous to stormwater managers because they allow for a cost-effective manner to estimate annual pollutant loading from catchments based on readily available continuous turbidity data, rather than costly lab analysis for individual stormwater samples. Through the development of linear fit relationships derived from data collected at the SR431 sites during 2014 and 2015, researchers at the Desert Research Institute developed the following site-specific log-linear relationships between turbidity (measured in Nephelometric Turbidity Units (NTU)) and TSS, TP, and FSP estimated in milligrams per liter (mg/l):

$$\mathbf{Log(TSS\ (mg/L)) = 0.3573445 + 1.0081966*Log(Turbidity\ (NTU))}$$

$$\mathbf{Log(FSP\ (mg/L)) = -3.325219 + 0.921735*Log(Turbidity\ (NTU))}$$

$$\mathbf{Log(TP\ (mg/L)) = -4.744326 + 0.8183639*Log(Turbidity\ (NTU))}$$

These equations were applied to continuous turbidity measurements (collected every 10 minutes) to estimate TSS, FSP, and TP concentrations at 10 minute intervals. The instantaneous pollutant concentration multiplied by the instantaneous flow rate multiplied by 10 minutes results in a pollutant mass generated every 10 minutes. Similarly, the flow rate can be multiplied by 10 minutes to result in a runoff volume every 10 minutes. Pollutant mass and runoff volume can then each be aggregated to determine cumulative pollutant load and cumulative runoff volume throughout the storm.

Analysis

The analysis described above was applied to four runoff events occurring on 5/6/15, 5/14/15, 5/22/15, and 6/9/15. The percentages presented in Tables 1-4 below represent the average of these four events at each of the four monitored sites. For example, at the Contech MFS Inflow site (Table 1), 42% of the total TSS, 40% of the total FSP, and 39% of the total TP was delivered in the first 30% of the runoff volume. Though this indicates that % pollutant loads are greater than % runoff volume, the difference is small. As stated above, closer to 80% of the load should be delivered in the first 20-40% of the runoff volume in order to confirm the presence of a first flush (Stenstrom 2005).

Figures 1-4 illustrate the Tables 1-4 visually and indicate that the relationship between runoff volume and pollutant load is virtually linear for all pollutants across all sites. (All three pollutants have very similar curves as they are all based on continuous turbidity readings). These linear relationships, with very high R^2 values, indicate the absence of a first flush phenomenon at all four SR431 monitoring sites for these events. Had there been a mass first flush, the curves in Figures 1-4 would have risen quickly in the first 30-50% of the runoff volume and tapered off to almost flat in the later part of the storm. It is not surprising that the data from the outflows of both BMPs do not show the presence of the first flush phenomenon as accumulated sediments in the vaults are likely flushed out at a relatively constant rate throughout the storm. However, the absence of a mass first flush at the inflows to both BMPs indicates that pollutants are delivered consistently throughout the whole storm, generally in direct proportion to the flow rate. In other words, either there is a consistent source of pollutants that does not get washed clean or these storms did not generate enough runoff to wash the road clean. If this is the case, there is little to no opportunity to treat only the initial pulse of stormwater runoff to get a relatively large load reduction. Thus, filters such as the Contech MFS and Jellyfish may be an effective way to reduce pollutants at this site as they theoretically treat runoff continuously throughout the event. The Tahoe RCD would like to continue doing this analysis for additional events to investigate whether the absence of a mass first flush is particular to late spring/early summer events, or applicable to all or most events throughout the water year. Different relationships between runoff volume and pollutant load delivery may exist under different road operation schemes, weather patterns in different seasons, or higher or lower pollutant input concentrations for example.

Table 1: Percent of total cumulative TSS, FSP, and TP loads presented at 10% runoff volume intervals at the Contech MFS Inflow monitoring station. Percent of total pollutant load is an average of four events during May and June 2015.

Site: Contech MFS Inflow			
% of total runoff volume	% TSS	% FSP	% TP
0%	0%	0%	0%
10%	22%	19%	19%
20%	31%	31%	28%
30%	42%	40%	39%
40%	48%	47%	45%
50%	59%	58%	56%
60%	73%	71%	69%
70%	83%	81%	80%
80%	90%	89%	88%
90%	96%	95%	95%
100%	100%	100%	100%

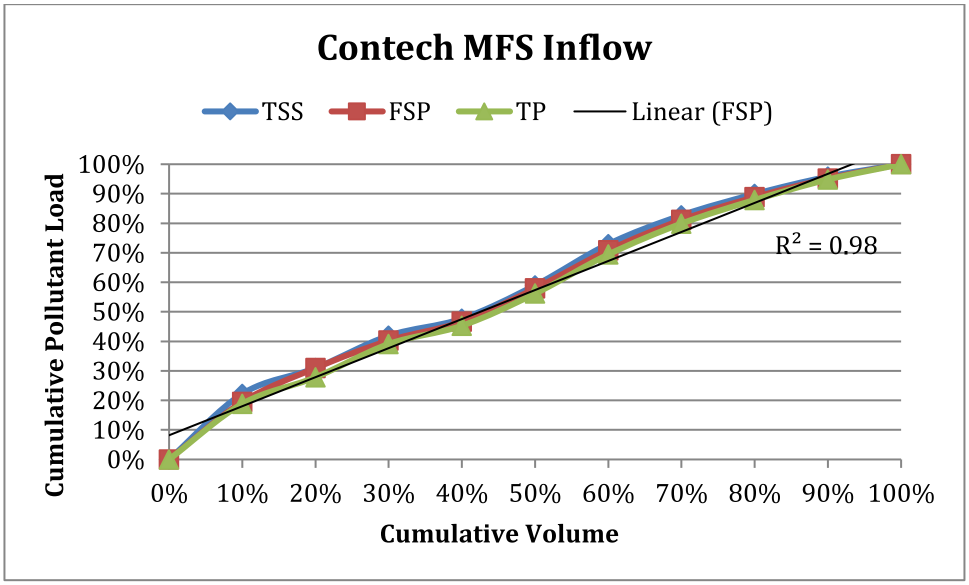

Figure 1: Percent of total cumulative TSS, FSP, and TP loads presented at 10% runoff volume intervals at the Contech MFS Inflow monitoring site. The relationship is very nearly linear for all three pollutants illustrated by an R^2 value of 0.98 for FSP. Percent of total pollutant load is an average of four events during May and June 2015.

Table 2: Percent of total cumulative TSS, FSP, and TP loads presented at 10% runoff volume intervals at the Contech MFS Outflow monitoring station. Percent of total pollutant load is an average of four events during May and June 2015.

Site: Contech MFS Outflow			
% total volume	AVG % TSS	AVG % FSP	AVG % TP
0%	0%	0%	0%
10%	11%	11%	11%
20%	22%	22%	22%
30%	30%	30%	30%
40%	37%	40%	37%
50%	50%	53%	50%
60%	64%	65%	63%
70%	77%	77%	75%
80%	86%	86%	85%
90%	94%	94%	94%
100%	100%	100%	100%

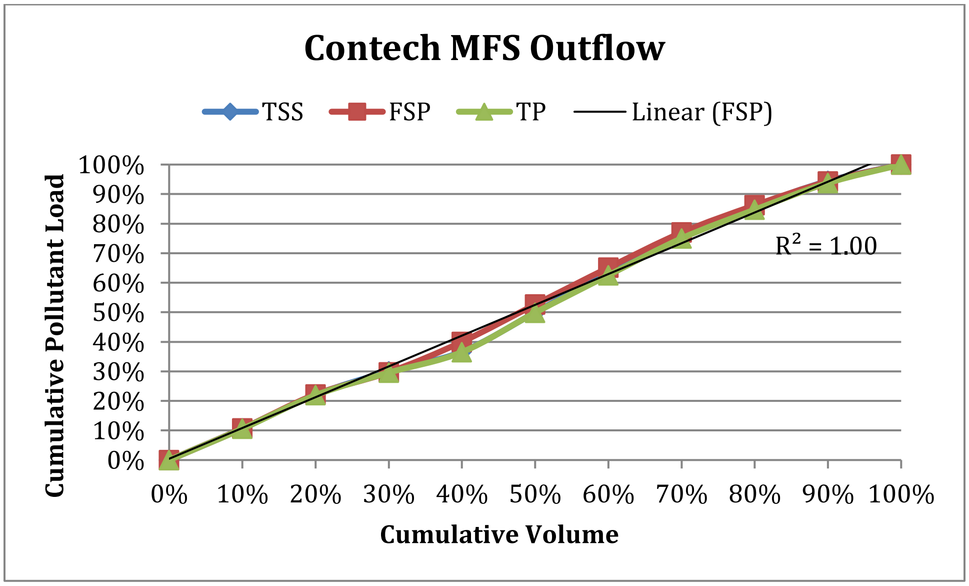

Figure 2: Percent of total cumulative TSS, FSP, and TP loads presented at 10% runoff volume intervals at the Contech MFS Outflow monitoring site. The relationship is linear for all three pollutants illustrated by an R^2 value of 1.00 for FSP. Percent of total pollutant load is an average of four events during May and June 2015. The TSS curve is so similar to the FSP and TP curves that it is not visible behind these two curves.

Table 3: Percent of total cumulative TSS, FSP, and TP loads presented at 10% runoff volume intervals at the Jellyfish Inflow monitoring station. Percent of total pollutant load is an average of four events during May and June 2015.

Site:Jellyfish Inflow			
% total volume	AVG % TSS	AVG % FSP	AVG % TP
0%	0%	0%	0%
10%	17%	16%	15%
20%	29%	28%	27%
30%	37%	36%	35%
40%	44%	43%	42%
50%	56%	55%	54%
60%	71%	70%	68%
70%	81%	80%	78%
80%	89%	88%	87%
90%	95%	94%	94%
100%	100%	100%	100%

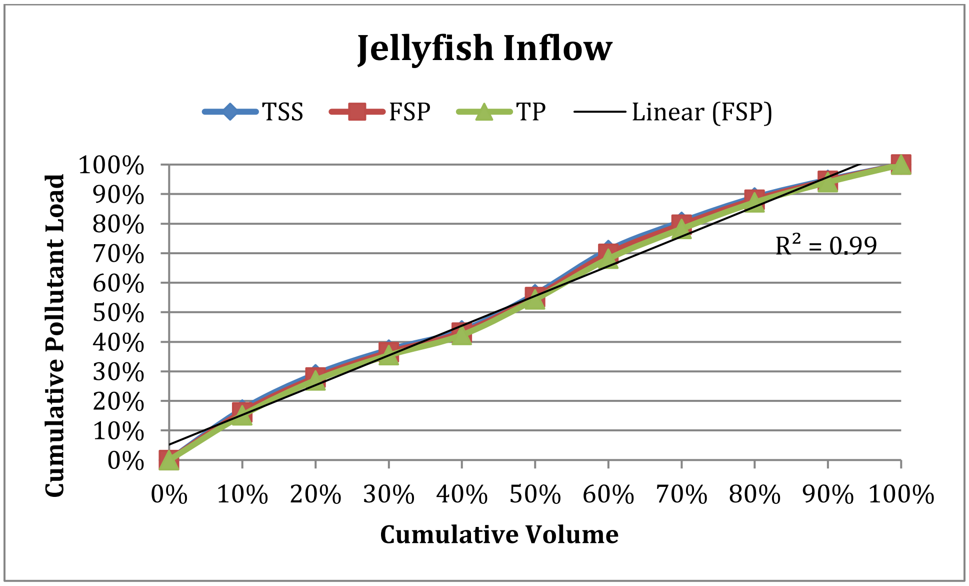

Figure 3: Percent of total cumulative TSS, FSP, and TP loads presented at 10% runoff volume intervals at the Jellyfish Inflow monitoring site. The relationship is very nearly linear for all three pollutants illustrated by an R^2 value of 0.99 for FSP. Percent of total pollutant load is an average of four events during May and June 2015.

Table 4: Percent of total cumulative TSS, FSP, and TP loads presented at 10% runoff volume intervals at the Jellyfish Outflow monitoring station. Percent of total pollutant load is an average of four events during May and June 2015.

Site: Jellyfish Outflow			
% total volume	AVG % TSS	AVG % FSP	AVG % TP
0%	0%	0%	0%
10%	11%	11%	11%
20%	21%	21%	20%
30%	31%	31%	31%
40%	38%	38%	38%
50%	48%	48%	48%
60%	63%	63%	62%
70%	76%	75%	74%
80%	86%	85%	84%
90%	94%	94%	93%
100%	100%	100%	100%

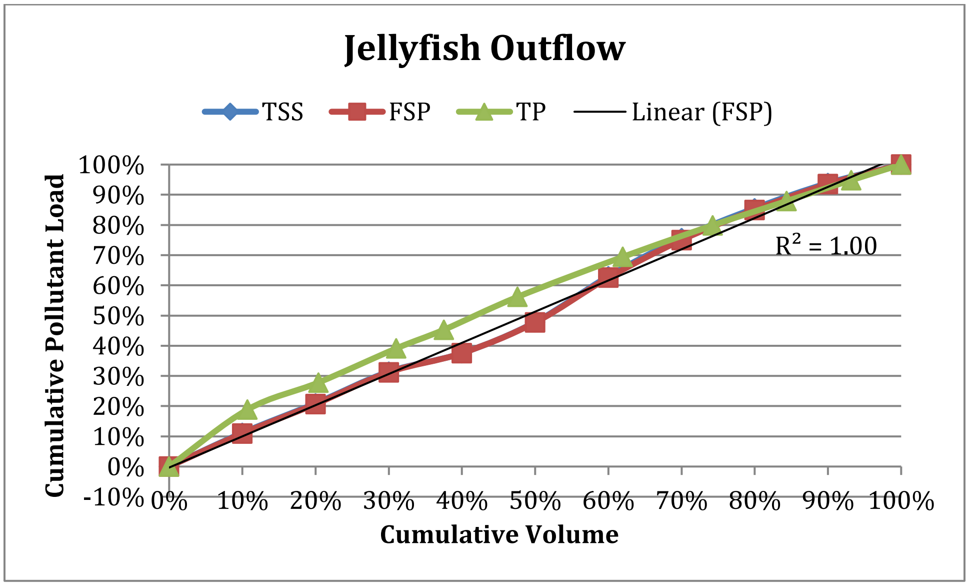

Figure 4: Percent of total cumulative TSS, FSP, and TP loads presented at 10% runoff volume intervals at the Jellyfish Outflow monitoring site. The relationship is linear for all three pollutants illustrated by an R^2 value of 1.00 for FSP. Percent of total pollutant load is an average of four events during May and June 2015. The TSS curve is so similar to the FSP and TP curves that it is not visible behind these two curves.

References

Heyvaert, Alan C., Richard B. Susfalk, Brian Fitzgerald, and Andrea Buxton. *Performance Evaluation of Two Stormwater Draft: Filtration Treatment Devices Installed by the Nevada Department of Transportation*. Rep. N.p.: n.p., 2015.

Stenstrom, Michael K., and Masoud Kayhanian. *First Flush Phenomenon Characterization*. Sacramento, CA: California Department of Transportation Division of Environmental Analysis, 2005. Web. 3 Mar. 2016.