Seasonal Progress Report #17
SR431 Treatment Vault Effectiveness Monitoring

Agreement Number: P367-18-018

Submitted by: Tahoe Resource Conservation District

Submitted to: Nevada Department of Transportation

Current Contract Term: July 1, 2021 – June 30, 2023

Water Year: 2021

Period: Spring Season, June 1, 2021 –Sept 30, 2021

Submission Date: October 31, 2021

Two stormwater cartridge filter vaults, a Contech Media Filtration System (MFS) and a Jellyfish Filter, were installed by the Nevada Department of Transportation (NDOT) on State Highway 431 (SR431) above Incline Village, Nevada in 2013. Monitoring equipment was installed at the inflows and outflows of these two vaults. The Tahoe Resource Conservation District (Tahoe RCD) continued the effectiveness monitoring efforts of the Desert Research Institute (DRI) at the four monitoring stations on May 1, 2015 and will continue to monitor through the spring of water year 2023 (May 31, 2023) and beyond if funding allows. A new contract was executed for July 1, 2021 - June 30, 2023 to allow for this. Tahoe RCD follows sampling protocols outlined in the Regional Stormwater Monitoring Program Framework and Implementation Guidance document (RSWMP FIG Update, Tahoe RCD et al 2017). 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 a summary of tasks, due dates and percent completion to date for the current agreement. ASWMR refers to the Annual Stormwater Monitoring Report submitted each year to the Nevada Division of Environmental Protection (NDEP) on March 31st as part of the IMP partnership.

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

Task	Description	Due Date	% Of Work Complete	Date Submitted
1	Project Administration			
1.1	Quarterly Invoices	10/31/21, 1/31/22, 4/30/22, 7/31/22, 10/31/22, 1/31/23, 4/30/23, 7/31/23	ongoing	pending
1.2	Seasonal Progress Reports	10/31/21, 3/31/22, 6/30/22, 10/31/22, 3/31/23, 6/30/23	ongoing	11/4/21
2	Stormwater Monitoring			
2.1	Collect continuous flow and turbidity data at four monitoring stations	5/31/2023	ongoing	Available on Acuity
2.2	Collect stormwater runoff samples during eight events per year	5/31/2023	ongoing	NA
2.3	Collect three diurnal non-event snowmelt events if conditions allow	5/31/2023	ongoing	NA
2.4	Collect flow bypass data in both vaults	5/31/2023	ongoing	Available in Seasonal Progress Reports
2.5	Provide precipitation data to date	5/31/2023	ongoing	Available in Seasonal Progress Reports
2.6	Provide hydrograph, turbidity, and sample distribution graphs to date	5/31/2023	ongoing	Available in Seasonal Progress Reports
3	Condition Assessments			
3.1	Estimate Road RAM score prior to eight sampled events	Discontinued as of June 1, 2021	100%	NA
3.2	Measure depth of sediment in both vaults after sampled events	5/31/2023	ongoing	Available in Seasonal Progress Reports
4	Final Report			
4.1	Provide raw data	3/31/2022, 3/31/2023	ongoing	ASWMR
4.2	Provide treatment effectiveness analysis	3/31/2022, 3/31/2023	ongoing	ASWMR
4.3	Correlate Road RAM score to pollutant concentration and load	Discontinued WY20	100%	ASWMR

4.4	Provide mass loading v. volume calculations for select events	6/30/2016	100%	3/31/16, 6/30/16

Task 1: Project Administration

1. Invoices

Quarterly invoices will be submitted for this project covering the following periods:

1) July 1, 2021 - September 30, 2021 (due October 31, 2021)
2) October 1, 2021 - December 31, 2021 (due January 31, 2022)
3) January 1, 2022 - March 31, 2022 (due April 30, 2022)
4) April 1, 2022 - June 30, 2022 (due July 31, 2022)
5) July 1, 2022 - September 30, 2022 (due October 31, 2022)
6) October 1, 2022 - December 31, 2022 (due January 31, 2023)
7) January 1, 2023 - March 31, 2023 (due April 30, 2023)
8) April 1, 2023 - June 30, 2023 (due July 31, 2023)

2. Progress Reports

Progress reports are not concurrent with quarterly invoices. Seasonal progress reports will be submitted for this project covering the following periods (report number is consistent with prior agreement's reports beginning May 2015):

#17: Summer: June 1, 2021 - September 30, 2021 (due October 31, 2021)
#18: Fall/winter: October 1, 2021 - February 29, 2022 (due March 31, 2022)
#19: Spring: March 1, 2022 - May 31, 2022 (due June 30, 2022)
#20: Summer: June 1, 2022 - September 30, 2022 (due October 31, 2022)
#21: Fall/winter: October 1, 2022 - February 29, 2023 (due March 31, 2023)
#22: Spring: March 1, 2023 - May 31, 2023 (due June 30, 2023)

Please accept this report as seasonal progress report #17 for the summer season of water year 2021.

Task 2: Stormwater Monitoring

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

The summer season of WY21 began on June 1, 2021 and ended September 30, 2021. Continuous flow and turbidity were successfully monitored for the summer season at all sites.

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

There was very little runoff during summer of WY21. For the July 26, 2021 thunderstorm event, samples were taken at Contech Inflow, Jellyfish Inflow, and Jellyfish Outflow. Samples were not successful at Contech Outflow due to a wire that was disconnected at the relay, possibly due to the earthquake that happened earlier in the season. For the September 9-10, 2021 thunderstorm event samples were succesful at all sites. Typically 6-12 samples should be taken per event at each site, however due to low flow and brief events this was not possible for any event to date this water year with the exception of Jellyfish Inflow during the September 9-10, 2021 event which had 6 samples (see Appendix A, Figures 8-15 at the end of this report for hydrographs, continous turbidity, and sample distributions for the events sampled). The successful samples were composited and sent to the lab for analysis. Samples were taken at the SR431 site for every time period of flow at both the inflows and outflows, however, samples failed at the Contech Outflow during the February 13, 2021 event snowmelt and the July 26, 2021 thunderstorm event, and samples failed at the Jellyfish Outflow during the March 18, 2021 rain on

snow event. This brings the water year total to seven sampled events for Jellyfish Inflow and Contech Inflow, five sampled events at Contech Outflow, and six sampled events for Jellyfish Outflow.

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)

This task is only applicable in the spring season.

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

New pressure transducers were installed in June 2016 and linked to the remote access data management system currently used at the SR431 monitoring site. Data indicate that during the summer of WY21 as well as the entire water year both the Contech MFS cartridge filters and the Jellyfish filters were bypassed zero times (Figures 1 & 2).

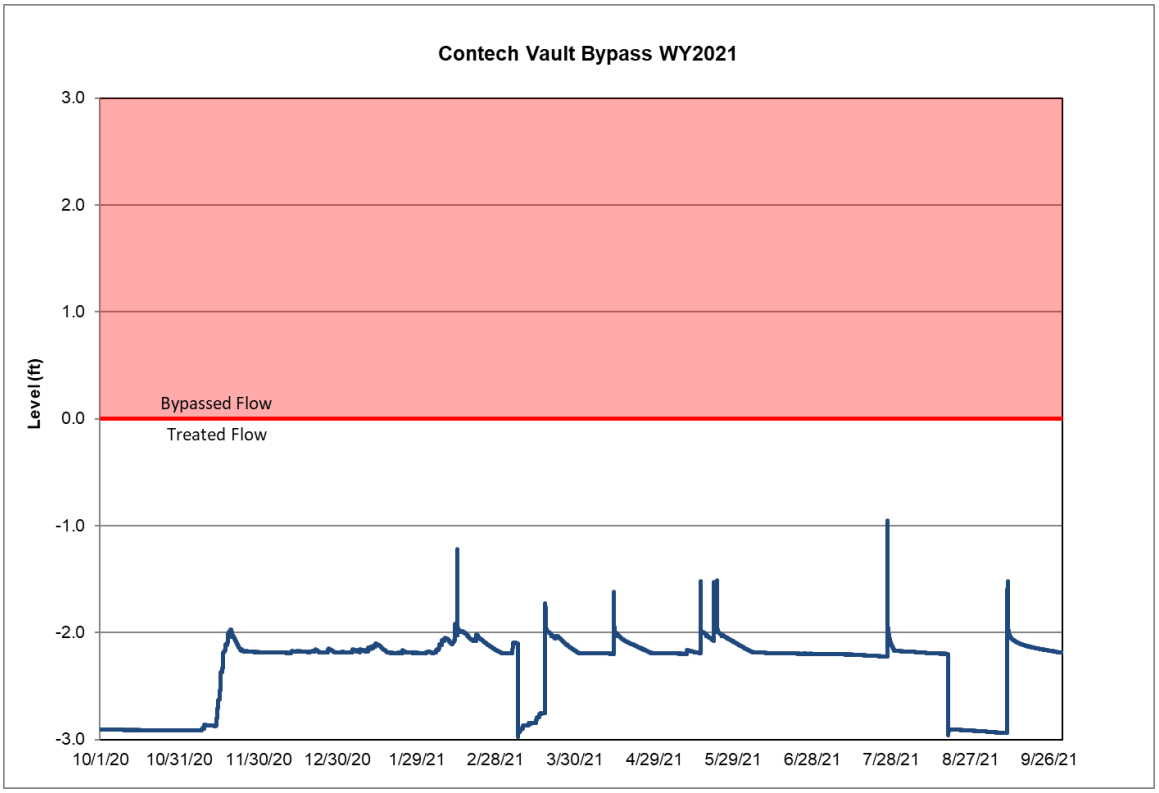

Figure 1: Bypassed flow in the Contech MFS vault for WY21.

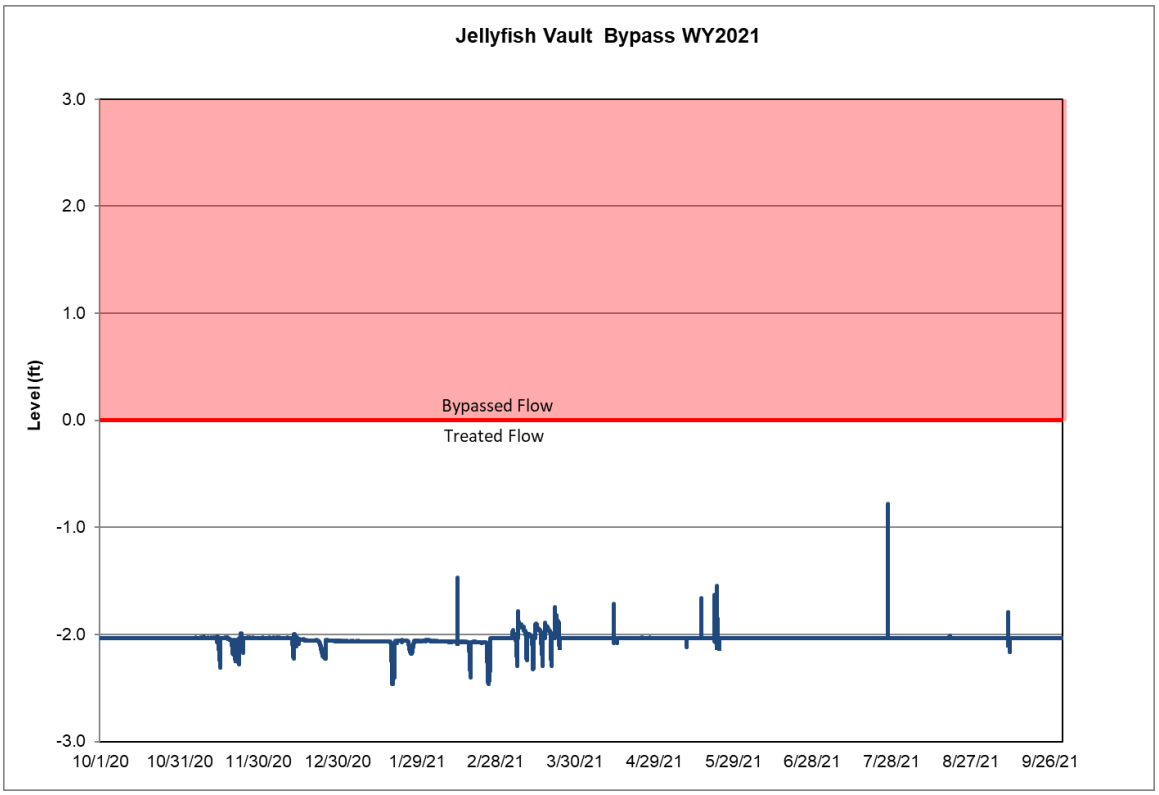

Figure 2: Bypassed flow in the Jellyfish vault for WY21.

5. Provide precipitation data to date

Table 2 provides summary data for all 38 fall/winter, spring, and summer WY21 precipitation events recorded at the NDOT meteorological stations including event start and end dates, total precipitation, peak precipitation, minimum and maximum temperature, and precipitation type. Events highlighted in pink were sampled for water quality. Because of its high elevation, precipitation often falls as snow during fall/winter and spring and thus does not always generate sufficient runoff for sampling. In general, events consisting of less than 0.5 inches of rain do not produce sufficient runoff for sampling. However, some events less than 0.5 inches can be successfully sampled if their peak precipitation rates (inches/5 minutes) is high enough.

Table 2: Summary of fall/winter precipitation, spring, and summer events at SR431 for WY21. Highlighted rows indicate events that were sampled.

Station ID	Precip Event (#)	Precipitation event start (PST)	Event end (PST)	Event duration (days)	Interevent duration (days)	Event precipitation (inches)	Event peak precipitation (inch/5min)	Event minimum temp (°C)	Event maximum temp (°C)	Type of Precipitation
NDOT	--	--	9/18/2020 7:35	--	--	--	--	--	--	--
NDOT	NDOT-21-01	11/7/2020 15:50	11/8/2020 23:40	1.326	50.3	0.224	0.016	-10	-4	Rain, Snow
NDOT	NDOT-21-02	11/13/2020 13:10	11/13/2020 18:50	0.236	4.6	0.432	0.016	-1	-1	Snow, Rain
NDOT	NDOT-21-03	11/17/2020 19:50	11/18/2020 22:15	1.101	4.0	1.539	0.023	-2	1	Rain, Snow
NDOT/TERC	NDOT-21-04	12/13/2020 6:10	12/14/2020 10:50	1.194	24.3	0.888	0.020	-6	0	Rain/Snow
NDOT/TERC	NDOT-21-05	12/17/2020 2:45	12/17/2020 11:45	0.375	2.7	0.324	0.016	-3	-1	Snow
NDOT/TERC	NDOT-21-06	12/25/2020 16:05	12/26/2020 11:20	0.802	8.2	0.212	0.012	-5	-1	Rain, Snow
NDOT/TERC	NDOT-21-07	12/31/2020 0:35	12/31/2020 3:50	0.135	4.6	0.020	0.004	-4	-3	Snow
NDOT/TERC	NDOT-21-08	1/4/2021 4:30	1/4/2021 16:55	0.517	4.0	0.200	0.016	-3	2	Rain, Snow
NDOT/TERC	NDOT-21-09	1/23/2021 6:20	1/23/2021 7:45	0.059	18.6	0.024	0.004	-7	-7	Snow
NDOT/TERC	NDOT-21-10	1/25/2021 4:05	1/25/2021 4:25	0.014	1.8	0.012	0.004	-8	-7	Snow
NDOT/TERC	NDOT-21-11	1/26/2021 22:50	1/29/2021 8:55	2.420	1.8	1.468	0.012	-8	-3	Snow
NDOT/TERC	NDOT-21-12	2/2/2021 15:10	2/3/2021 2:35	0.476	4.3	0.008	0.004	-5	-1	Snow
NDOT	NDOT-21-13	2/9/2021 6:30	2/9/2021 6:30	0.000	6.2	0.004	0.004	-2	-2	Snow
NDOT	NDOT-21-14	2/11/2021 15:00	2/13/2021 11:00	1.833	2.4	1.051	0.023	-6	3	Rain, Snow
NDOT	NDOT-21-15	2/14/2021 11:50	2/15/2021 21:55	1.420	1.0	0.056	0.008	-3	3	Rain/Snow
NDOT	NDOT-21-16	2/18/2021 13:10	2/20/2021 8:45	1.816	2.6	0.172	0.016	-8	4	Rain, Snow
NDOT	NDOT-21-17	3/6/2021 3:20	3/6/2021 5:30	0.090	13.8	0.140	0.012	-5	-3	Snow
NDOT	NDOT-21-18	3/8/2021 23:45	3/10/2021 12:40	1.538	2.8	0.120	0.012	-9	-1	Snow
NDOT	NDOT-21-19	3/11/2021 17:30	3/12/2021 3:00	0.396	1.2	0.080	0.008	-6	-5	Snow
NDOT	NDOT-21-20	3/14/2021 23:30	3/15/2021 15:45	0.677	2.9	0.108	0.012	-10	-3	Snow
NDOT	NDOT-21-21	3/18/2021 16:05	3/20/2021 18:35	2.104	3.0	0.415	0.019	-7	4	Rain, Snow
NDOT	NDOT-21-22	3/22/2021 9:05	3/23/2021 1:35	0.688	1.6	0.072	0.004	-5	3	Snow
NDOT	NDOT-21-23	4/5/2021 7:50	4/5/2021 10:05	0.094	13.3	0.012	0.004	-1	5	Snow
NDOT	NDOT-21-24	4/13/2021 16:35	4/14/2021 18:05	1.063	8.3	0.292	0.016	-5	4	Snow
NDOT	NDOT-21-25	4/20/2021 21:05	4/20/2021 21:25	0.014	6.1	0.016	0.004	3	4	Snow
NDOT	NDOT-21-26	4/25/2021 19:00	4/26/2021 17:35	0.941	4.9	0.024	0.004	-8	1	Snow
NDOT	NDOT-21-27	5/16/2021 17:55	5/16/2021 19:30	0.066	20.0	0.098	0.039	7	11	Thunderstorm
NDOT	NDOT-21-28	5/20/2021 12:10	5/23/2021 6:25	2.760	3.7	0.487	0.019	-5	5	Snow
NDOT	NDOT-21-29	6/24/2021 14:00	6/24/2021 19:40	0.236	32.3	0.060	0.016	10	17	Thunderstorm
NDOT	NDOT-21-30	6/29/2021 15:00	6/29/2021 18:30	0.146	4.8	0.024	0.012	18	26	Thunderstorm
NDOT	NDOT-21-31	7/3/2021 23:35	7/4/2021 0:45	0.049	4.2	0.044	0.008	13	15	Thunderstorm
NDOT	NDOT-21-32	7/18/2021 19:35	7/18/2021 19:35	0.000	14.8	0.035	0.035	20	20	Thunderstorm
NDOT	NDOT-21-33	7/25/2021 18:35	7/25/2021 18:35	0.000	7.0	0.004	0.004	20	20	Thunderstorm
NDOT	NDOT-21-34	7/26/2021 5:50	7/26/2021 5:50	0.000	0.5	0.008	0.008	17	17	Thunderstorm
NDOT	NDOT-21-35	7/26/2021 15:35	7/26/2021 19:25	0.160	0.4	0.142	0.039	14	21	Thunderstorm
NDOT	NDOT-21-36	7/29/2021 17:00	7/29/2021 18:10	0.049	2.9	0.040	0.008	14	16	Thunderstorm
NDOT	NDOT-21-37	9/9/2021 23:30	9/10/2021 12:40	0.549	42.2	0.235	0.035	10	18	Thunderstorm
NDOT	NDOT-21-38	9/27/2021 23:05	9/28/2021 2:00	0.122	17.4	0.016	0.004	5	7	Rain

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

See Appendix A, Figures 8-15 at the end of this report for hydrographs, continous turbidity, and sample distributions for the events sampled in the summer season of WY21.

Task 3: Condition Assessments

1. Estimate Road RAM score prior to monitored runoff events

This task was initiated in November 2015 following a meeting between Tahoe RCD and NDOT where it was decided that determining a Road RAM score prior to runoff events was valuable. However, after five and a half years of collecting this data, it is clear that there is no relationship between Road RAM score and event mean sediment concentration at the SR431 site and this task was discontinued beginning June 1, 2021 (summer season of water year 2021).

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

This task was initiated November 2015 following the meeting between Tahoe RCD and NDOT mentioned above where it was determined that post event sediment depth was valuable information. Negligible sediment accumulation occurred during the summer of WY21.

Task 4: Final Report

1. Provide raw data

Final reporting for each water year is provided as part of the Annual Stormwater Monitoring Report (due March 31st of each year), but raw data can be viewed at any time on Acuity.

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

Final reporting for each water year is provided as part of the Annual Stormwater Monitoring Report (due March 31st of each year) which includes treatment effectiveness evaluations for FSP, TN, and TP on a seasonal and annual basis as well as for sampled events. The data for FSP in the Annual Stormwater Monitoring Report is based on water quality samples. However, treatment effectiveness for FSP for WY21 is provided for all events for the Contech MFS in Table 5 and the Jellyfish in Table 6 based on continuous turbidity, a proxy measurement for FSP (2NDNATURE et al 2014). Removal efficiencies in red indicate that FSP was flushed from the system or that outflow turbidity sensors were inundated with accumulated sediment. A removal efficiency of 100% indicates no outflow from the Contech MFS vault, which occurs when influent volumes are less than 3,000 cubic feet (the approximate storage capacity of the Contech MFS vault) and the vault can accommodate the new flow. Sometimes the vault is full from a previous event and even small inflow volumes will result in outflow. The holding capacity of the Contech MFS is likely what allows it to generally be more efficient than the Jellyfish; not only because it often doesn't outflow, but also because sediment has the opportunity to settle out during the longer residence time in the vault.

There was only one event during the fall/winter season of WY21, occurring on February 12-13, 2021. Both the Contech MFS and the Jellyfish performed similarly, reducing FSP by 71% and 73% respectively. There were four events during the spring season of WY21. Both vaults were vactored on March 8, 2021, and likely contributed to the very high removal efficiency by the Jellyfish during the 3/18/21 event. The Contech MFS does not show the same removal efficiency after the clean-out. Generally, the Contech MFS is more effective than the Jellyfish over time due to the longer holding time in the vault, but this was not observed during the spring of WY21. There were two events during the summer season of WY21, occurring on July 26, 2021 and September 9-10, 2021. The Contech MFS performed similarly to how it had been performing, with an average 60% removal efficiency for the year. The Jellyfish was more variable in its performance over the year, but had an average removal efficiency of 75%.

Table 5: Contech MFS FSP removal efficiency for each event of fall/winter, spring, and summer WY21.

CONTECH MFS WY21 Fall/Winter, Spring, and Summer: October 1, 2020 - September 30, 2021								
Runoff Start Date Time	Runoff End Date Time	Runoff Type	Event Duration	Influent Volume (cf)	Effluent Volume (cf)	Influent FSP (lbs)	Effluent FSP (lbs)	FSP Removal Efficiency
2/13/21 13:55	2/13/21 15:00	Rain on Snow	1:05	136	66	7.86	2.29	71%
3/18/21 19:05	3/19/21 1:00	Rain on Snow	5:55	84	56	4.80	2.22	54%
4/13/21 18:00	4/13/21 21:50	Event Snowmelt	3:50	67	57	2.91	1.03	65%
5/16/21 19:25	5/16/21 20:05	Thunderstorm	0:40	55	44	3.11	1.20	61%
5/21/21 20:55	5/23/21 1:45	Event Snowmelt	28:50	337	224	2.99	1.67	44%
7/26/21 15:55	7/26/21 16:50	Thunderstorm	0:55	115	88	4.01	1.55	61%
9/9/21 23:35	9/10/21 6:15	Thunderstorm	6:40	232	84	1.28	0.50	61%

Table 6: Jellyfish FSP removal efficiency for each event of fall/winter, spring, and summer WY21.

JELLYFISH WY21 Fall/Winter, Spring, and Summer: October 1, 2020 - September 30, 2021								
Runoff Start Date Time	Runoff End Date Time	Runoff Type	Event Duration	Influent Volume (cf)	Effluent Volume (cf)	Influent FSP (lbs)	Effluent FSP (lbs)	Removal Efficiency
2/12/21 11:15	2/13/21 15:50	Rain on Snow	28:35	193	78	7.71	2.06	73%
3/18/21 19:05	3/19/21 1:05	Rain on Snow	6:00	163	2	4.17	0.02	99%
4/13/21 17:55	4/14/21 1:40	Event Snowmelt	7:45	141	120	1.78	0.86	52%
5/16/21 19:25	5/16/21 20:20	Thunderstorm	0:55	66	60	3.43	0.91	74%
5/21/21 20:55	5/23/21 1:55	Event Snowmelt	29:00	335	235	3.75	1.61	57%
7/26/21 15:55	7/26/21 16:35	Thunderstorm	0:40	128	87	3.38	0.86	75%
9/9/21 23:35	9/10/21 6:25	Thunderstorm	6:50	302	40	2.37	0.19	92%

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

Seasonal Progress Report #3 provides this analysis for events that occurred in the fall/winter and spring of water year 2016. Seasonal Progress Report #1 included a similar study based on four events that occurred in the late spring and early summer of water year 2015. Analyses have consistently shown that in general, turbidities (and thus FSP) mirror the flow and therefore no first flush phenomenon exists at SR431 with respect to FSP. This may indicate that the primary road serves as a constant source of sediment. Due to consistent results this analysis has not been repeated since Seasonal Progress Report #3. This analysis can be repeated upon request.

Appendix A

Hydrographs, continuous turbidity, and sample distribution for all sampled events.

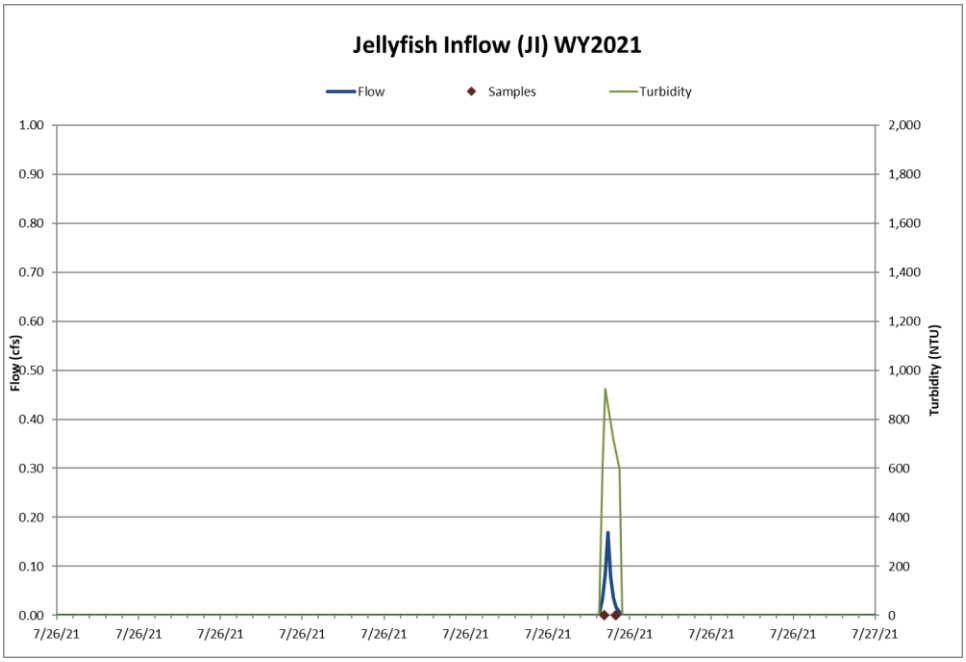

Figure 8: Hydrograph, continuous turbidity, and sample distribution at the Jellyfish Inflow for the 7/26/2021 thunderstorm event.

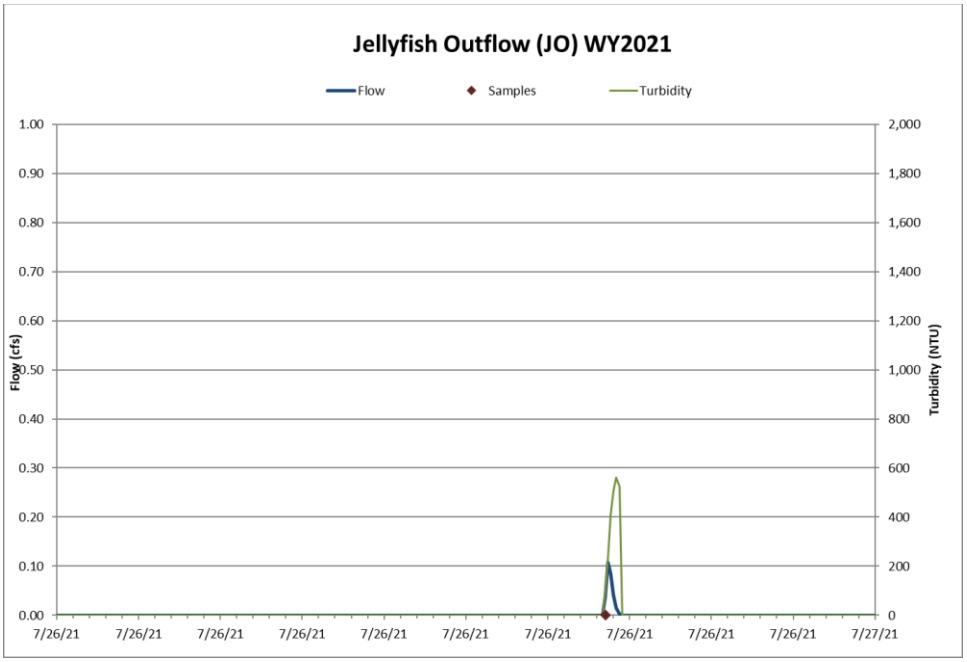

Figure 9: Hydrograph, continuous turbidity, and sample distribution at the Jellyfish Outflow for the 7/26/2021 thunderstorm event.

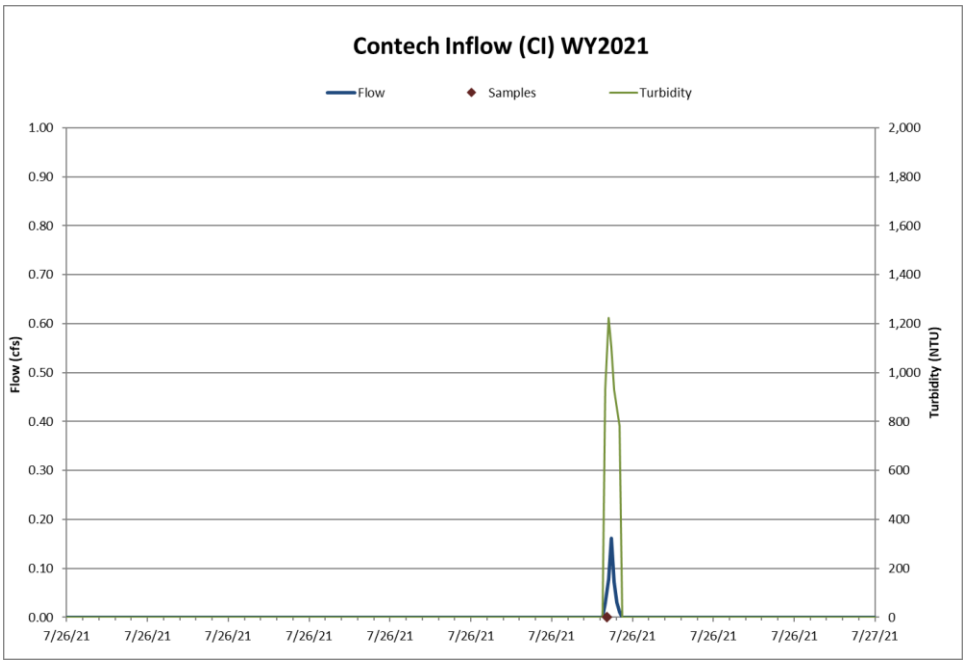

Figure 10: Hydrograph, continuous turbidity, and sample distribution at the Contech Inflow for the 7/26/2021 thunderstorm event.

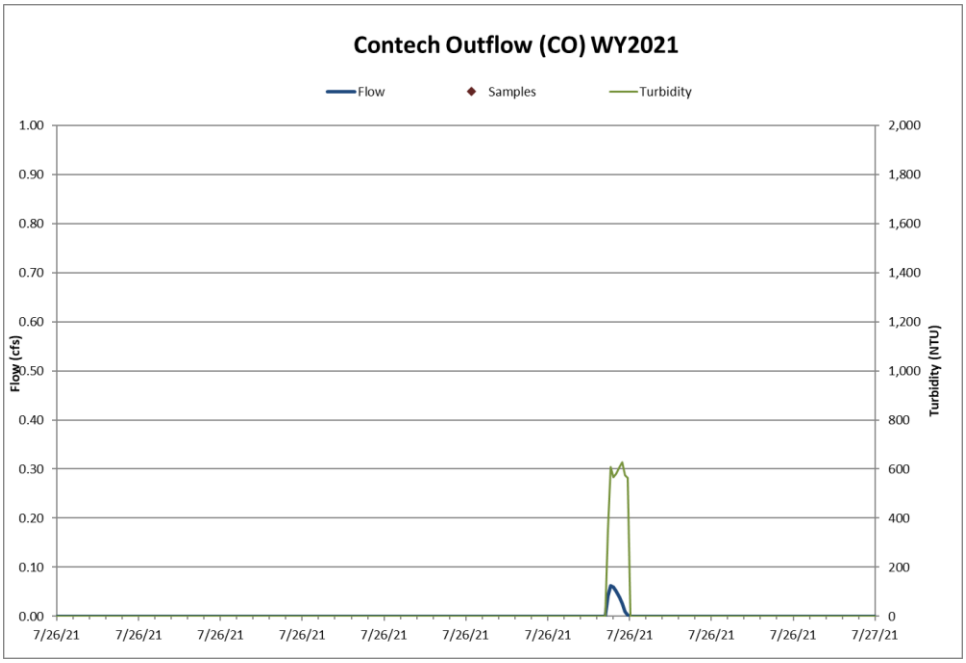

Figure 11: Hydrograph and continuous turbidity at the Contech Outflow for the 7/26/2021 thunderstorm event. Samples failed at this site due to a disconnected wire at the relay.

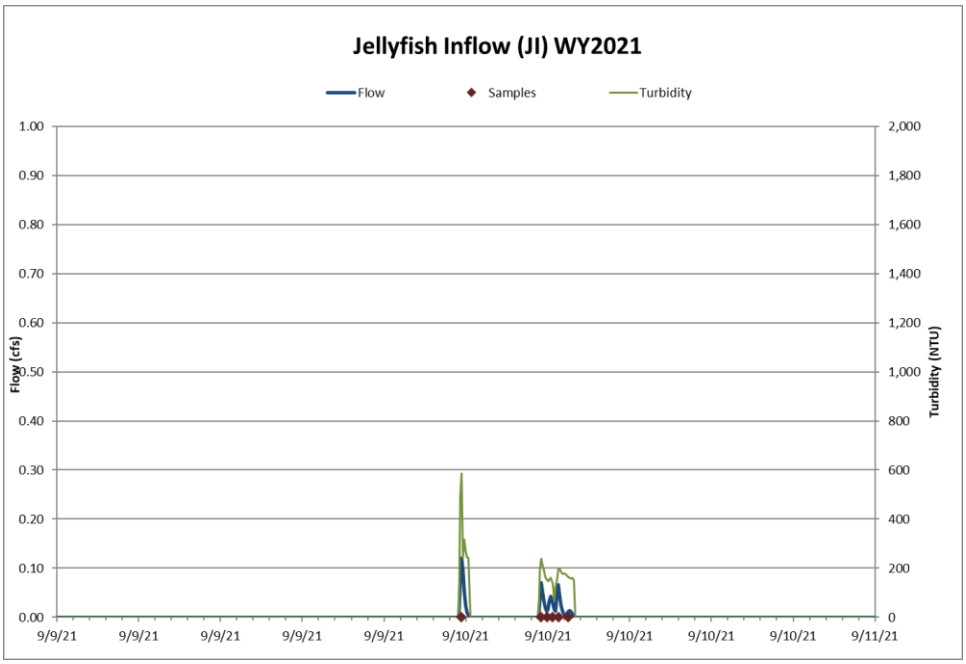

Figure 12: Hydrograph, continuous turbidity, and sample distribution at the Jellyfish Inflow for the 9/10/2021 thunderstorm event.

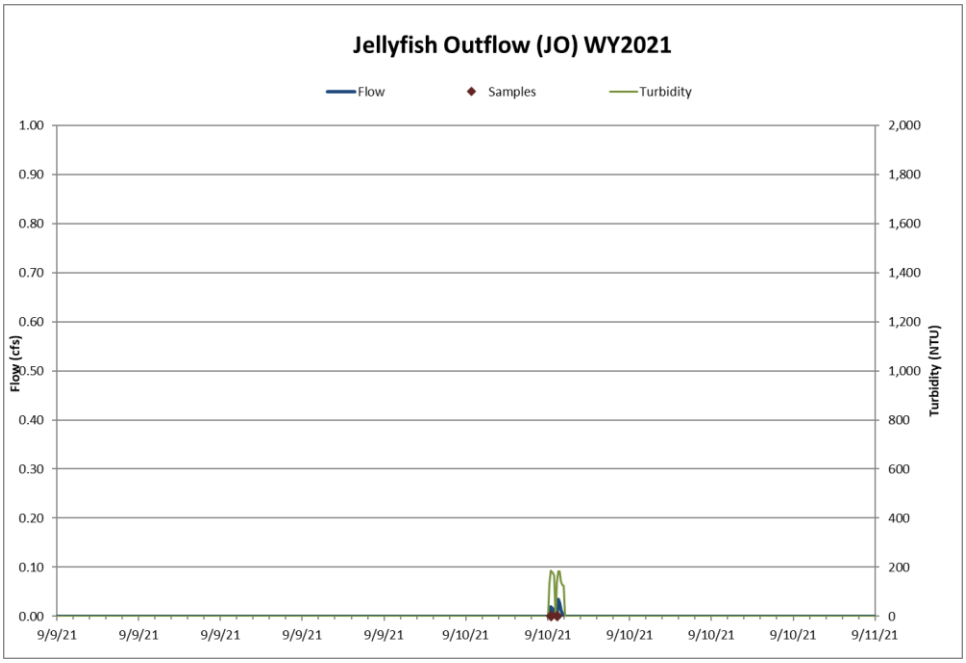

Figure 13: Hydrograph, continuous turbidity, and sample distribution at the Jellyfish Outflow for the 9/10/2021 thunderstorm event.

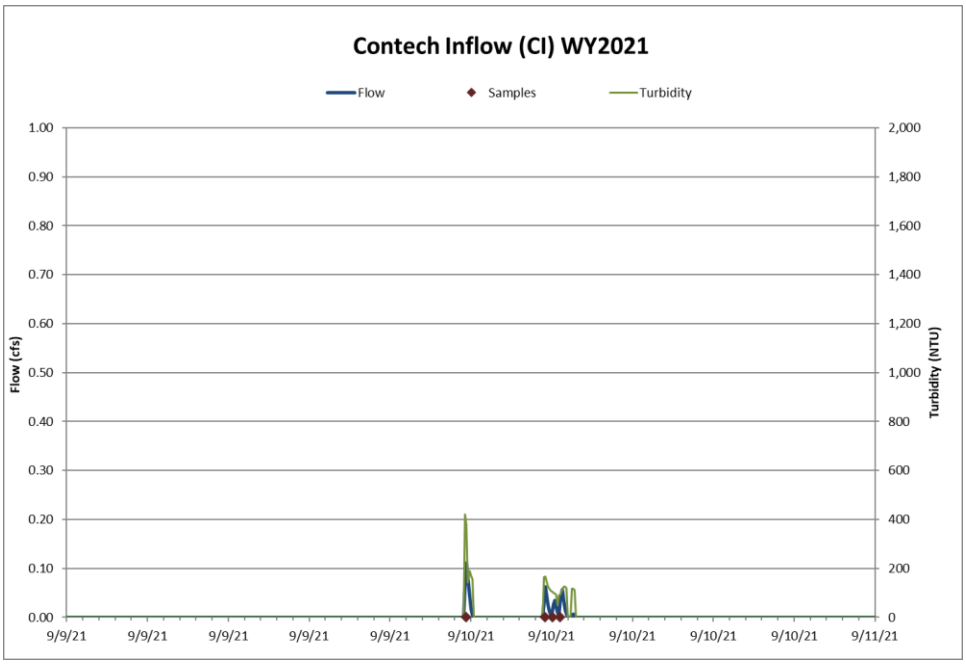

Figure 14: Hydrograph, continuous turbidity, and sample distribution at the Contech Inflow for the 9/10/2021 thunderstorm event.

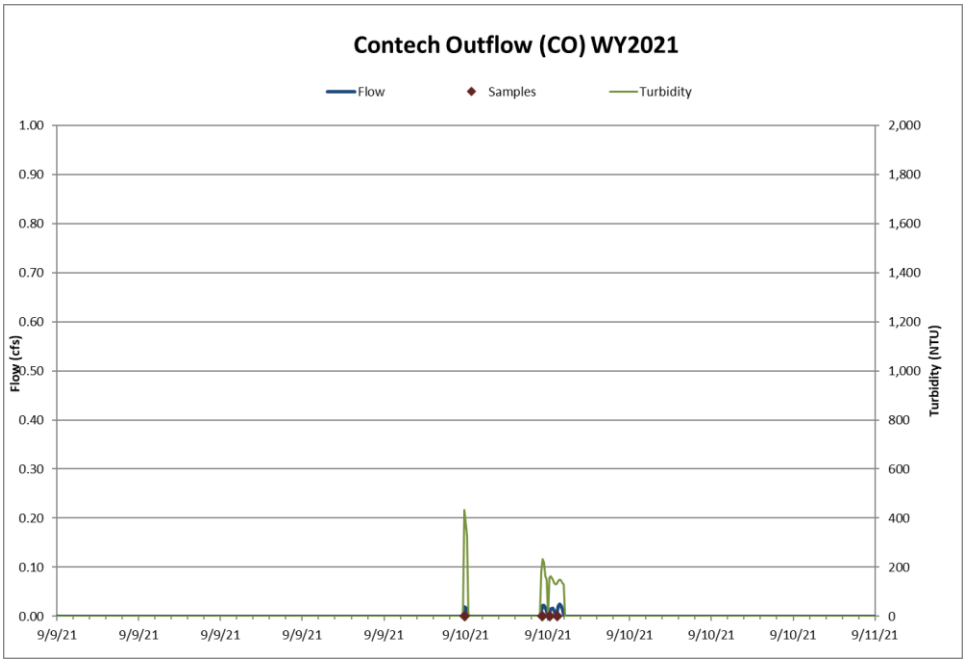

Figure 15: Hydrograph, continuous turbidity, and sample distribution at the Contech Outflow for the 9/10/2021 thunderstorm event.

References

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