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Date: 24 Sept 2002

Route To: Fishlake Leadership Team, Frank Fay

Subject: Watershed Monitoring Report for 2001 the Rocky Mountain ATV Jamboree

To: Mary Erickson, Forest Supervisor

*"To protect your Rivers...
Protect your Mountains."*

Attached is a summary of the effects monitoring done for the 2001 Rocky Mountain ATV Jamborees. Thanks is due to the Division of Water Quality for generously providing the lab analyses. Please let me know if you have additional needs or questions.

Prepared by: \s\ Dale Deiter
Fishlake Hydrologist

TYPE OF MONITORING: Effects

PROJECT NAME: 2001 Rocky Mountain ATV Jamboree – Water Quality Monitoring

OBJECTIVES: Quantify if and how event-based OHV use affects water quality and stream conditions so that potential effects to beneficial uses can be assessed, and so that OHV management can be adapted as needed.

SITE LOCATIONS: Deer Creek 4.6 miles above the confluence with the Sevier River, UTM = N 4260734.0, E 384550.2
Dry Creek 1.9 miles above the confluence with Clear Creek, UTM = N 4267446.5, E 383365.9
Maps 1 and 2 display the locations of each of the sampling sites and the locations of roads, trails and stream crossings (UTM Zone 12, NAD27). Both streams support a fishery, although Dry Creek only marginally so. Deer and Dry Creek were chosen as study areas because they have numerous forded crossings and a high percentage of their road and trail systems adjacent to or near the stream channels. It is critical to consider this fact if one wants to extrapolate or generalize the results presented in this report.

EVENT DATES: September 17th through September 24th, 2001

ALPHA LEVEL USED TO DETERMINE STATISTICAL SIGNIFICANCE: 0.05 (assigned prior to data collection and analysis)

METHODOLOGY

Channel Dimensions and Profile

Channel dimension and profile measurements were not taken on Deer and Dry Creeks based on the lack of detectable changes that occurred on Chalk Creek during the Fillmore ATV Jamboree and due to time limitations.

Bed Materials

Pre and post-event Wolman pebble counts were taken below the Deer Creek study crossing, but not at Dry Creek due to lack of time (although visually the channel bed was dominated by fine sediment before and after the event). The pre and post-event counts were done on the 17th and 24th of September, respectively. The pre-event pebble count was taken early on the 17th before any organized rides. .

Water Quality

Pre and post-event field observations of temperature, specific conductance, dissolved oxygen, pH, salinity, and turbidity were made using a Quanta hydrolab that was calibrated using standard buffers and manufacturer recommended procedures with the exception that filtered distilled water was used for a zero NTU standard. NTUs are a measure of how much light is either absorbed or reflected when passing through the water column. NTU values go up as water clarity goes down. Water samples were taken at the Deer and Dry Creek sites on September 17th (pre-event), September 20th (during-event), and September 24th (post-event). The Deer Creek during-event BTEX sample was taken during the peak turbidity, about 2 minutes after the first of 23 ATVs had passed. There were no recent crossings by ATVs at the Dry Creek site prior to taking the during-event BTEX sample. The water was processed using the BTEX lab method (8021B GC/PID Purgeables for the before and during the event samples, and TPH (total petrol hydrocarbons) EPA method 524.2 8260B GC/MS Purgeables for the post-event samples. The BTEX/TPH samples were preserved with acid and kept on ice and refrigerated. The samples were analyzed by the Utah Department of Health: Division of Epidemiology and Laboratory Services. Field observations of turbidity were recorded just prior to the crossing by ATV groups and were logged continuously on 10-second intervals until the NTU values returned to near original background levels. The number of riders within each 10-second interval was also recorded.

RESULTS and DISCUSSION

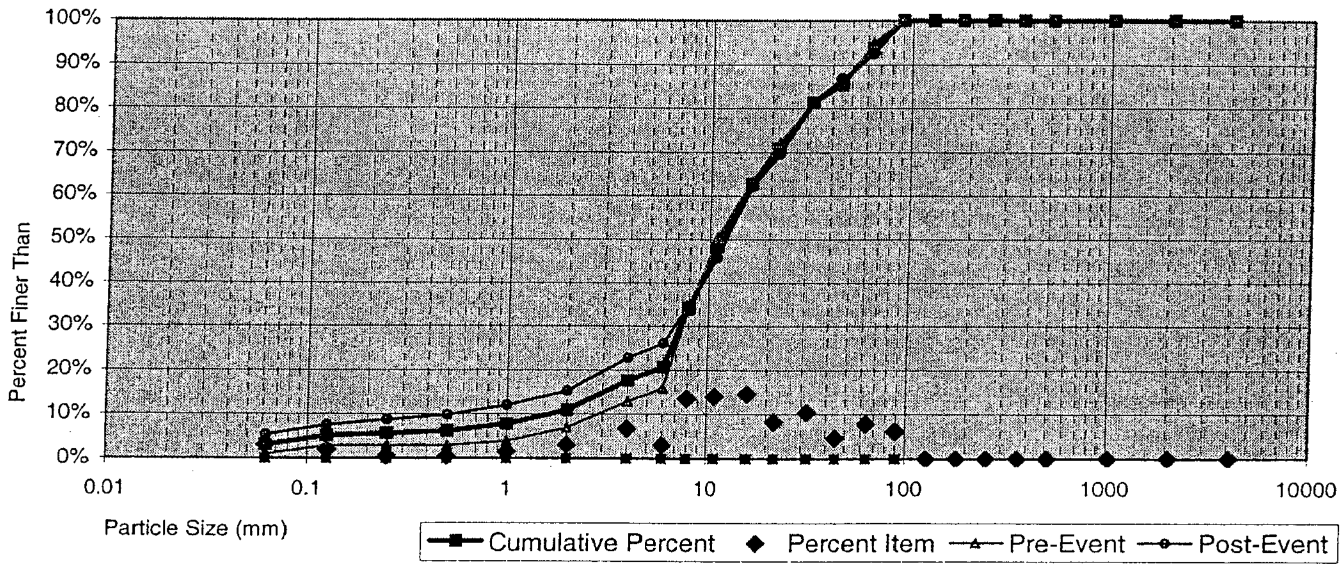
Data Storage & Analyses

The data and analyses are stored in the 2001rocky_mtn_jamboree_deer_and_dry_creeks.xls excel spreadsheet that is filed in \fsfiles\unit\est\hydro\monitoring\ohv_effects\rocky_mtn_ohv_jamboree. The original field and lab sheets are in the permanent watershed files. The pebble count data were analyzed in the "Size-Class Pebble Count Analyzer v1 2001.xls" spreadsheet located in \fsfiles\unit\est\hydro\monitoring\reference_reaches.

Bed Materials

The post-event pebble count data indicate an increase in fine sediments relative to pre-event conditions. The difference amounts to recording 7 more particles smaller than 1mm post-event than for the pre-event. The direction of change towards increased fine sediment is in the direction that would be expected from the increase in turbidity created at the crossing just above the sampling site, and is statistically significant. However, the sample sizes are small (n=101 particles for pre-event and n=92 particles for post-event) so interpretation and extrapolation should be approached cautiously.

Figure 1. Deer Creek - Wolman Pebble Counts



Water Quality

The field observation and water sample data are summarized in the Tables 1 through 4, and displayed in Figures 2 through 5. The individual field observations taken before, during and after the ATV events do not indicate any appreciable or significant change in the water quality parameters measured, including turbidity. However, Figures 2, 3, and 4 clearly show that there are high intensity, relatively short duration turbidity responses associated with ATV and automobile use of unimproved forded crossings.

There is a beaver dam on Deer Creek that was preventing downstream fish passage at the time of the events. The dam was also maintaining a deep, but coverless pool in which dozens of fish were trapped as evidenced by the fact that they did not retreat up or downstream while I was standing at the edge of the water. This pool water was clear before and after the event and turbid during. No signs of fish kill were evident following the conclusion of the jamboree.

Table 1. Deer Creek – Field Observations										
Quanta Hydrolab	Date & Time	Air temp °C	h2o temp °C	Specific Conductivity µS/cm	Dissolved Oxygen mg/L	pH	Salinity PSS	Turbidity NTUs	Flow cfs
pre-event	17 Sept at 1350	-	9.0	123	9.1	7.9	0.06	0.5	0.8
during	20 Sept at 0930	8.0	6.0	125	9.6	7.8	0.06	0.1	-
during	20 Sept at 1316	15.0	8.6	124	8.8	8.0	0.06	8.4	0.7
post-event	24 Sept at 1439	24.5	9.4	123	9.0	7.8	0.06	2.2	0.7

Table 2. Dry Creek – Field Observations									
Quanta Hydrolab	Date & Time	Air temp °C	h2o temp °C	Specific Conductivity µS/cm	Dissolved Oxygen mg/L	pH	Salinity PSS	Turbidity NTUs	Flow cfs
pre-event	17 Sept at 1625	-	12.6	267	8.5	8.3	0.13	26.3	0.3
during	19 Sept at 0854	8.0	7.3	270	9.7	8.1	0.13	21.3	-
during	19 Sept at 1237	17.0	12.0	266	8.1	8.4	0.13	29.2	0.3
during	20 Sept at 1520	27.5	13.4	267	8.2	8.5	0.13	26.8	0.3
post-event	24 Sept at 1653	22.5	12.0	267	8.5	8.2	0.13	18.7	0.2

Of the numerous parameters assessed, naphthalene was the only petrol chemical detected. Naphthalene is a white solid that is found naturally in fossil fuels. Burning tobacco or wood produces naphthalene. The only likely sources in an unburned wildland setting are from the burning of fossil fuels, thus ATVs and automobiles are the most likely sources. Naphthalene binds weakly to soils and sediment, and is destroyed by bacteria or evaporates into the air when in water. More information can be found at http://www.atsdr.cdc.gov/tfacts67.html. Utah does not list a standard for naphthalene in its water quality criteria. However, the EPA recommends that levels be below 20.0 micrograms per liter (µg/L) for water consumed over a lifetime. The levels detected are well below this threshold. Deer Creek is only accessible by 4-wheel drive automobiles and ATVs while Dry Creek can be driven by 2-wheel drives. ATVs and vehicles were observed in both Deer and Dry Creeks before the events, which likely explains why detectable levels of naphthalene were found in the Dry Creek samples prior to the event. In addition to the parameters listed in Tables 3 and 4, Appendix-A lists the parameters from the Total Petrol Hydrocarbons testing that were undetected in the post-event water samples. None of these other chemicals (aka. Methal-ethal-bad-stuff) were detected in either the Deer or the Dry Creek samples at the end of the ATV event.

Table 3. Deer Creek – Water Samples				
BTEX Lab Results	Method Reporting Limit	Pre-Event Lab Result	During-Event Lab Result	Post Event Lab Result*
	µg/L	µg/L	µg/L	µg/L
Methyl T-Butyl Ether	1.0 / 0.5*	U	U	U
Benzene	0.5	U	U	U
Toluene	0.5	U	U	U
Ethylbenzene	0.5	U	U	U
m/p-Xylene	1.0	U	U	U
o-Xylene	0.5	U	U	U
Naphthalene	1.0 / 0.5*	U	4.10	U
U = Under the Method Reporting Limit				

Table 4. Dry Creek – Water Samples				
BTEX Lab Results	Method Reporting Limit	Pre-Event Lab Result	During-Event Lab Result	Post Event Lab Result*
	µg/L	µg/L	µg/L	µg/L
Methyl T-Butyl Ether	1.0 / 0.5*	U	U	U
Benzene	0.5	U	U	U
Toluene	0.5	U	U	U
Ethylbenzene	0.5	U	U	U
m/p-Xylene	1.0	U	U	U
o-Xylene	0.5	U	U	U
Naphthalene	1.0 / 0.5*	4.20	3.60	U
U = Under the Method Reporting Limit				

Figure 2 displays the turbidity measurements that were taken on 10-second intervals for Deer Creek. The first peak, about 2 minutes after the first group of 23 riders had passed, is missing because that is when the BTEX water sample was taken. The response that starts about 11:30 after the passage of 28 riders is likely similar in shape, but greater in magnitude than what occurred during the missed first peak at 2 minutes. This is implied by the magnitudes of the humps displayed at about 11:00 and 11:58, which are measuring turbidity generated from two separate upstream crossings. The farther of the two upstream crossings is only about a 45 second ride by ATV from where the turbidity readings were taken (see Map 1). The rise in turbidity at 11:00 is from when the first group of 23 riders crossed the upstream crossings in a span of about 12 minutes. The 11:58 turbidity pulses from upstream was caused by 28 riders crossing within 6 ½ minutes. It is interesting to note then that the peak NTUs at 11:58 peak are a little more than double the peak NTUs at 11:00 even though the time spent above base NTU levels did not change. This indicates that the number of riders per unit time (intensity), and not just the total number of riders, is an important determinant of the magnitude of the maximum peak turbidity for a given stream crossing.

Figure 3 displays the turbidity measurements for Dry Creek. As with Deer Creek, Dry Creek also has 2 upstream crossings that are less than a 1-minute ride by ATV from the crossing where the turbidity measurements were taken. In addition, response from a third crossing much further upstream can be seen to cause a small rise in turbidity at around 11:34. As with the Deer Creek observations, each of these blips in turbidity was caused by the same group of riders. The riders likely crossed the upstream crossings at similar intervals and intensity given that the other sites are in such close proximity to the crossing where turbidity was recorded. Dry Creek has more fines in the channel than Deer Creek. The Dry Creek watershed appears to have elevated sediment production and delivery relative to Deer Creek, both from natural sources and overgrazing, and has less water and energy to flush the accumulated fines. These factors may account for the higher peak turbidities measured in Dry Creek, relative to Deer Creek, when crossed by a similar number of riders. Figure 4 shows the response to a single truck crossing on Dry Creek.

Figure 2. Deer Creek - Turbidity (NTUs) and Cumulative Number of Riders vs. Time
20 September 2001

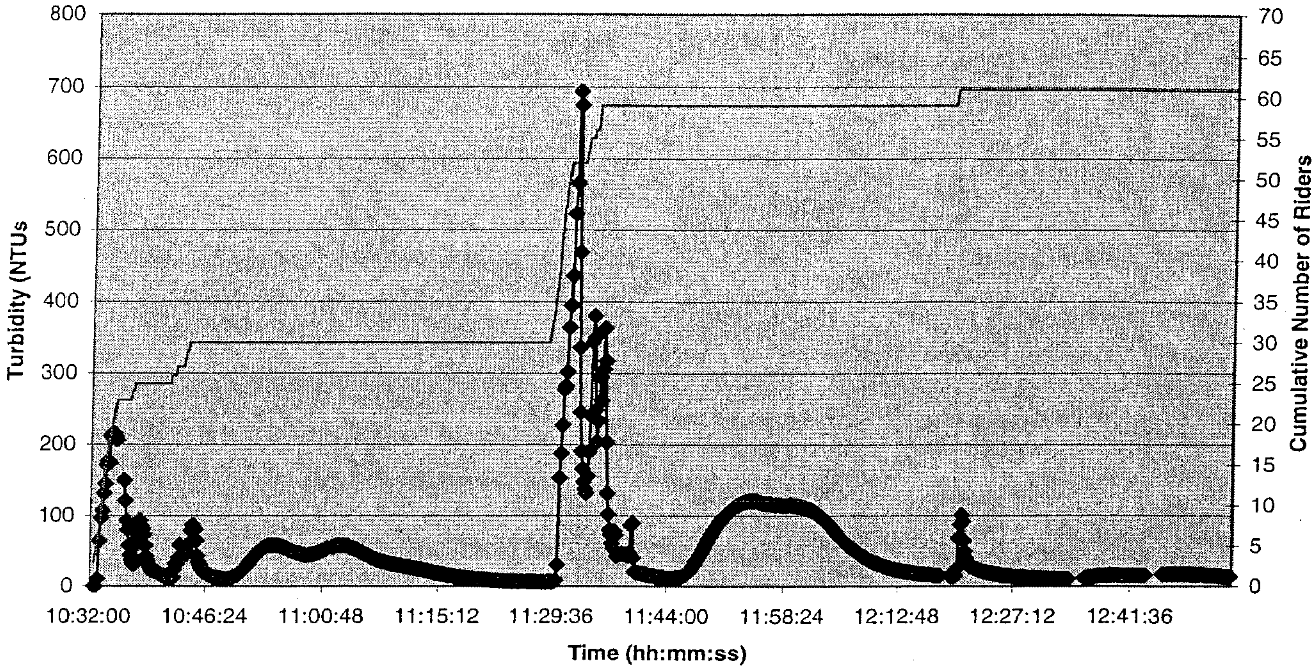


Figure 3. Dry Creek - Turbidity (NTUs) and Cumulative Number of Riders vs. Time
19 September 2001

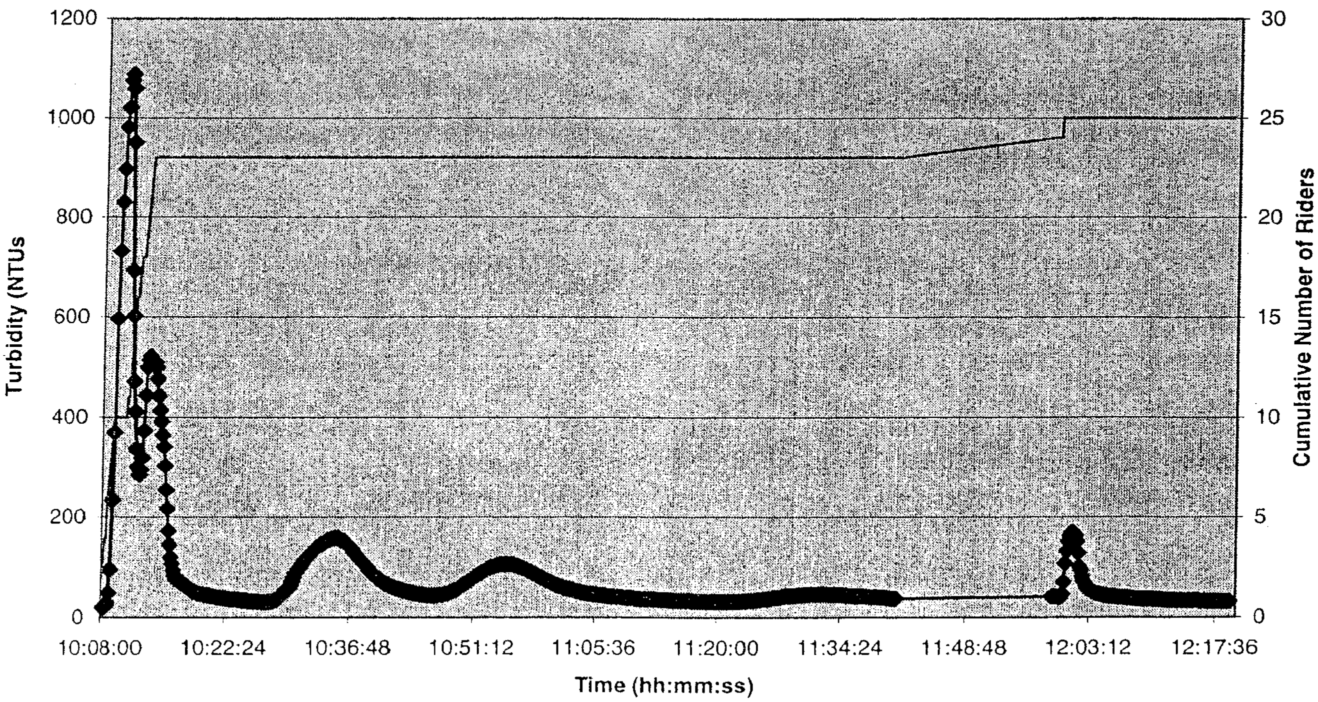
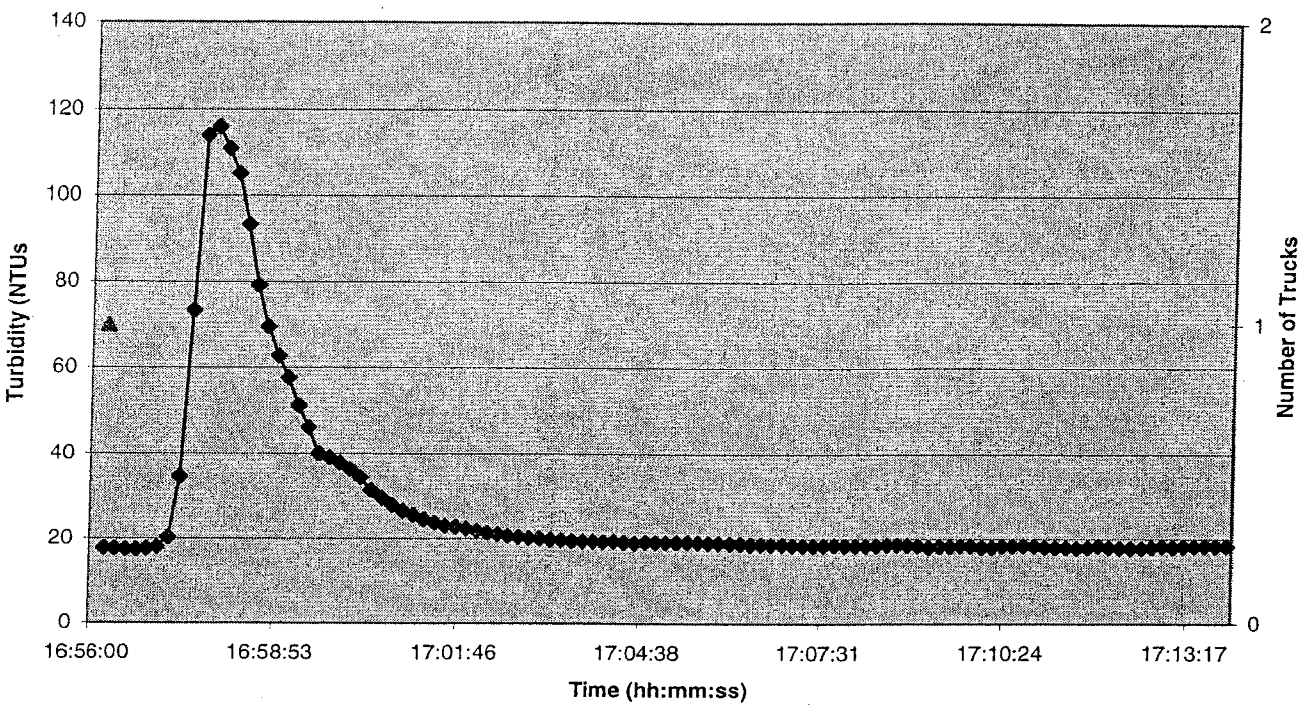


Figure 4. Dry Creek - Turbidity (NTUs) and Number of Riders vs. Time - 24 September 2001



An important piece of information needed to evaluate the cumulative impacts from forded crossings is to know how quickly the fine sediments settle out of the water column while traveling downstream. The two upstream crossings on Deer Creek are close enough that their peaks are superimposed on one another. In other words, the sediment pulse from the second upstream crossing arrives before turbidity levels have recovered from the sediment delivered from the first upstream crossing. This causes the second upstream pulse to have a higher peak than it would otherwise, as measured at the downstream study site. Therefore, a curve showing the dissipation or decay of turbidity as one proceeds downstream could not be relied upon for Deer Creek. However, the graph of Dry Creek shows that the peaks from upstream crossings are largely independent and not superimposed on one another. Therefore, these data have been used to fit a power curve that estimates the percent of peak turbidity remaining as a function of distance downstream from the forded crossing. This function assumes that the upstream crossings have peaks of similar magnitude and duration as those recorded at the study crossing. The attenuated responses from the upstream crossings that are recorded at the study site are then interpreted to be a measure of how much the peak turbidity has been reduced by distance. This assumption seems reasonable as visually, the upstream crossings are of a similar size and configuration, and the same ATVs likely cross at a similar interval and intensity as those at the measured crossing. The data point from the second crossing upstream of the Deer Creek study site would plot even closer to the Dry Creek curve if the peak NTU values had not been superimposed with the other upstream crossing. Deer Creek data points plot close to the Dry Creek decay curve nonetheless.

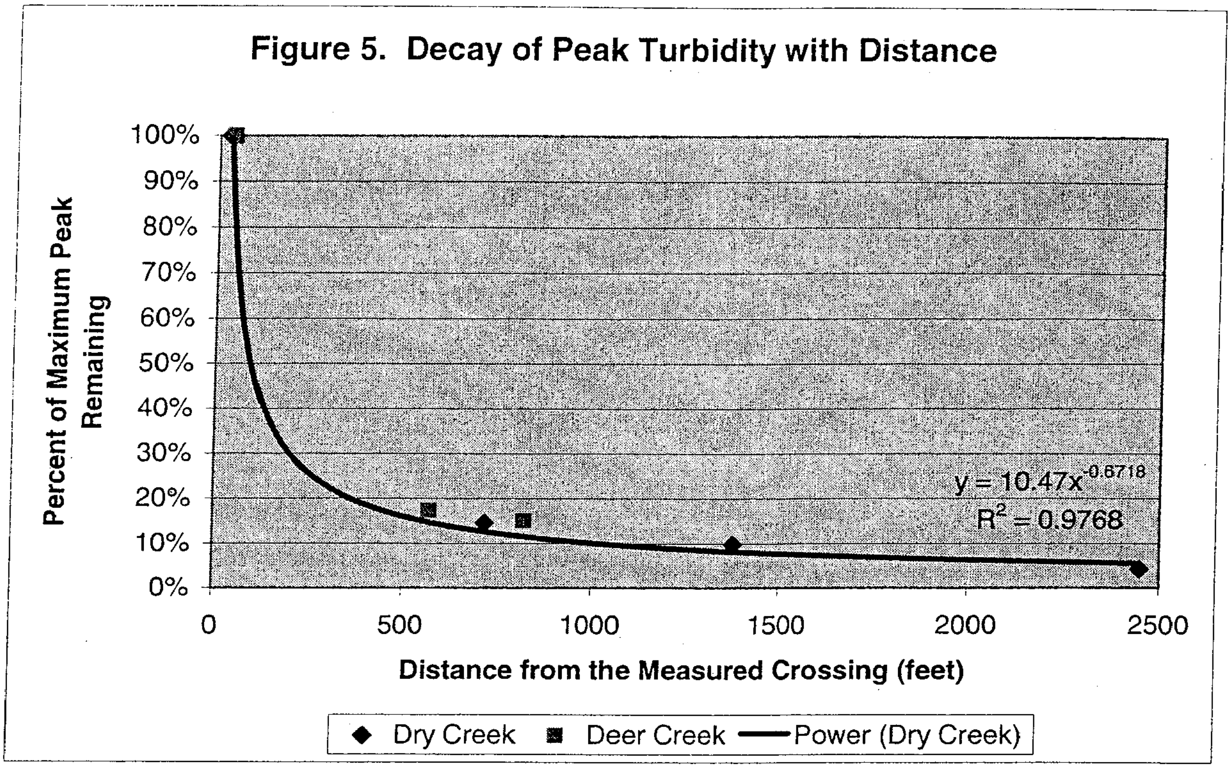


Table 5 displays how far downstream the turbidity pulse must travel to reduce to a given percentage of the original maximum turbidity measured. The Dry Creek calculations are based on the equation shown in Figure 5. The Deer Creek data are based on a similar power function, but the equation is not presented since the waves from the two upstream crossings are superimposed, and thus not independent. Even so, Deer Creek appears to have similar rates of decay in turbidity as the sediment pulse moves downstream as what was observed in Dry Creek. The table indicates that it takes about ¼ of a mile before the turbidity pulse decays to 10 percent of the initial peak NTU readings.

Table 5. Decay of Peak Turbidity with distance at selected percent reductions.

Downstream Peak Turbidity relative to Maximum Upstream Turbidity	Downstream Distance Required (Dry Ck)	Downstream Distance Required (Deer Ck)
% of Peak above Base	feet	feet
90	39	47
80	46	56
70	56	69
60	71	88
50	93	118
40	129	167
30	198	262
20	362	495
10	1016	1470

One question that was asked during the analysis for the OHV Event Environmental Assessment was if 50 riders fording a stream crossing in succession has the same effect as 50 riders crossing the channel individually over a longer period of time. We surmised that the size of the turbidity pulse would be larger when everyone crossed at once, but were unsure if cumulatively there were any appreciable differences. Calculating the area below the graph of peak turbidities provides a way to measure the magnitude and time spent above base turbidity levels. If the sum of the areas below 50 separate "1 rider at a time" curves is similar to one "50 riders at a time" curve, then both scenarios are resulting in similar cumulative effects as measured by turbidity and time. Table 6 displays the areas, in NTU Days, below the Dry Creek response curves shown in Figures 3 and Figure 4.

Table 6. Area in NTU Days Below 3 Separate Turbidity Responses on Dry Creek.

Start Time	Stop Time	Number and Type of Vehicles	Base Turbidity at the Start Time in NTUs	Area under Curve in NTU Days	Area in NTU Days per Vehicle	Area in NTU Days Normalized to 50 Fordings
10:08:37	10:26:37	23 ATVs	20.3	62.5	2.7	136
11:58:57	12:05:57	2 ATVs	37.9	4.5	2.3	113
16:56:45	17:03:45	1 truck	17.7	2.8	2.8	138

More samples are needed to make any generalizations. However, based on the current three data points, it appears that the two scenarios of individual versus group crossings may be resulting in similar cumulative effects as measured by turbidity and time.

CONCLUSIONS

Some impacts to water quality and channel morphology are evident as a result of the Rocky Mountain ATV Jamboree. It is evident from Figures 2, 3, and 4 that the magnitude of peak turbidity is strongly and positively correlated with the total number and intensity of vehicles crossing within a given period of time. The turbidity response is also strongly tied to sediment availability and the size classes of particles in the streambed. State water quality standards permit a 10 NTU increase in turbidity above background in streams that support cold-water aquatic life. It is clear from the graph that this standard is exceeded for durations as long as about 30 minutes following the ATV fordings at the studied stream crossings. After discussing these results with officials from the Utah Division of Water Quality, they indicated that they are typically concerned more with an operation that results in chronic or prolonged turbidity increases rather than with individual occurrences that are of relatively short duration. However, technically these are violations of the State water quality standards. In a practical sense, it takes only a minimal volume of fine particles to have a large effect on water turbidity measurements so NTUs are only a reasonable surrogate for sediment impacts if the inputs are relatively frequent or chronic as measured over a period of months or years. Field review indicates that the dominant sources of sediment are from the portions or the road and trail systems that are located within 300 feet of Deer and Dry Creeks, more so than from the sediment stirred up in the crossings. However, the Deer Creek pebble count data indicate that the crossings can have an impact to channel fines, at least immediately below the crossing. Overall, it appears that the inputs from forded crossings, attributable to the OHV event, are less important to water quality and channel morphology than are the chronic inputs that occur over a period of months or years.

RECOMMENDATIONS

The following recommendations are made based on the observations made to date, including preliminary data from the 2002 event monitoring. In considering this information, it is important to remember that all channels, dry and wet, make up the stream network that we need to be concerned about.

Prevention

- Keep new routes out of the riparian influence zone (roughly 300 feet on each side of the channel network) to the fullest extent possible.

- Continue public education efforts to communicate the importance of properly cleaning, maintaining, and operating their ATVs on National Forest lands.

Mitigation and Restoration

- Reduce the amount of existing routes that encroach on or cross channel floodplains, and that are located within riparian influence zones. This can be accomplished by realigning the existing prisms further upslope and/or by obliteration. If routes cannot reasonably be relocated or obliterated, then they should be redesigned to minimize alterations to normal slope hydrology and sediment production and delivery processes.

- Reduce the number of unimproved ford crossings where possible. The proposed solutions must be based on the specifics of each site and the values-at-risk. Bridged crossings have the added value that contact between the ATVs and water is minimized, but this is also usually the most expensive alternative and generally should only be used where justified by the values of the at-risk resources. The potential risk of adding fill for culverted crossings needs to be weighed against the benefits of using bridged crossings, or hardened or vented fords, or leaving the existing site as is.

- The Deer and Dry Creek trails specifically, but many Forest routes in general have a definite need to be maintained. The road and trail surfaces are frequently U-shaped acting as canals that intercept, concentrate, and reroute overland flows and intercepted groundwater. The roads and trails in Deer and Dry Creeks typically deliver erosion directly to the stream network because such a high percentage of the routes are in the channel floodplain or near the channel in the riparian influence zone. Improperly designed and maintained roads and trails are not sustainable because the process of tread erosion is self-reinforcing. The effects may be subtle in average years, but could be catastrophic during large, but infrequent flooding events. Only proper maintenance, redesign, or removal of the route can correct the existing situations. Watersheds with high value for aquatic resources, or with a high percentage of stream lengths where roads and trails are located within the riparian influence zone should have a higher standard and frequency of maintenance.

Further Study

The overall sampling scheme from 2002 should be continued in the OHV event monitoring scheduled for next year. However, next years monitoring efforts should be aimed at providing addition understanding of the following questions:

1. How quickly do turbidity pulses decrease while traveling downstream? What factors are important for determining this rate? And, how far downstream can forded crossing impacts be detected in terms of the fine sediment percentages in the channel bed?

2. How important is the crossing impact relative to the having large portions of road and trail systems located within the "riparian influence zone".

3. Do the cumulative impacts differ between individuals intermittently fording crossings versus groups of riders crossing in a short period of time? What are the cumulative impacts?

4. What measures and adaptive management techniques are needed to reduce OHV impacts to aquatic resources?

APPENDIX-A -- Undetected Petrol Hydrocarbons in Post-Event Samples

Carbon Tetrachloride	I, 2-Dichloroethane
I, I-Dichloroethylene	Para-Dichlorobenzene
I, I, I-Trichloroethane	Trichloroethylene
Vinyl Chloride	o-Dichlorobenzene
cis I, 2-Dichloroethylene	trans I,2-Dichloroethylene
I, 2-Dichloropropane	Monochlorobenzene
Styrene	Tetrachloroethylene
Xylenes (total)	Dichloromethane
I, 2, 4-Trichlorobenzene	I, I, 2-Trichloroethane
Ethylene Dibromide	I, 2-dibromo-3-chloropropane
Chloroform	Bromodichloromethane
Chlorodibromomethane	Bromoform
m-Dichlorobenzene	I, I-Dichloropropene
I, I-Dichloroethane	I, I, 2, 2,-Tetrachloroethane
I, 3-Dichloropropane	Chloromethane
Bromomethane	I, 2, 3-Trichloropropane
I, I, I, 2-Tetrachloroethane	Chloroethane
2, 2-Dichloropropane	o-Chlorotoluene
p-Chlorotoluene	Bromobenzene
cis-I, 3-Dichloropropene	trans-I-3-Dichloropropene
Dibromomethane	I, 2, 4-Trimethylbenzene
I, 2, 3-Trichlorobenzene	n-Propylbenzene
n-Butylbenzene	Hexachlorobutadiene
I, 3, 5-Trimethylbenzene	p-Isopropyltoluene
Isopropylbenzene	Tert-butylbenzene
Sec-bytylbenzene	Fluorotrichloromethane
Dichlorodifluoromethane	Bromochloromethane