Changes to In-Stream Suspended Sediment and Turbidity Following Improvements to a Forest Road
Annual Progress Report

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Objectives:

A forest road was constructed through a watershed in summer 2002. It was left in poor condition from fall 2002 through mid-summer 2003. In mid-summer 2003 its condition was improved through the installation of more and better water control features, sediment traps, seeding of the fill slopes and cut banks, and graveling of the driving surface.

Turbidity and suspended sediment levels in both the control and treatment watersheds fell within expected ranges during the 3 pretreatment years prior to road construction. By contrast, both parameters increased to very high levels on the treatment watershed during the spring and early summer 2003 before the road condition was improved and finalized. After road improvements were finalized, reductions in turbidity and suspended sediment were observed on the treatment watershed. The control watershed stayed within the pretreatment turbidity and suspended sediment ranges during the entire posttreatment period.

The purpose of this study is to continue stream water sampling through spring 2006 to specifically determine whether:

1) the rapid recovery is real or simply an artifact of the numbers and characteristics of the storms that have occurred since the road has been completed and improved,
2) storms with certain attributes, particularly very large ones, continue to result in extremely elevated turbidity and suspended sediment (presumably due to sediment stored in the channel), even if more "average" storms no longer have elevated sediment,
3) recovery is linear, exponential, or it levels off at some point in time, and
4) suspended sediment and turbidity increase again in the future as some situations develop over time, such as extension of erosion features below culvert outlets toward the stream channel.

Methods:

A paired watershed approach is being used for this study. The two watersheds are located along the Left Fork of Clover Run, on the Monongahela National Forest, Tucker County, WV. One watershed is used as the treated watershed and one as the control watershed. Many parameters are being monitored as a part of this study; in this report we describe only those associated with the objectives given above.

Near the mouth of both watersheds, a stream monitoring station was established in 1999. At each site, stream stage is measured every 5 minutes with an American Sigma depth/velocity probe. Rating curves to establish the relationship between stage and discharge measurements are currently under development for both watersheds. These are being developed by measuring velocity and discharge using a USGS type pygmy AA current meter over a range of stages. If reasonable rating curves cannot be developed, discharge will be estimated using Manning's n to determine velocity across a variety of stages, and discharge will be determined as the product of velocity x cross sectional area (determined from surveying the stream cross section where velocity is measured).

Two automatic stream samplers (ISCO and American Sigma) are housed in shelters at the mouth of each watershed. One of the samplers collects a sample every 24 hours, while the other sampler is actuated during storms using precipitation actuation (Edwards and Owens 1995). Storm samplers are programmed to collect a stream water sample every half hour during the summer when stormflow responses are flashy and peak sediment occurs early in the event, or hourly during the dormant season when stormflow responses are less flashy and require a substantially longer time to return to baseflow. Each ISCO or Sigma case has 24 1-L bottles. If the storm is continuing, new cases of bottles are placed in the field in order to characterize the sediment characteristics throughout the storm. The time that each sample is collected is recorded internally in the automatic collector's memory.

Most storms have been sampled since 1999 on both watersheds. The principal reasons that some storms have not been sampled or have not been sampled during the entire event are that equipment has malfunctioned or the flow in the 5 fords that must be crossed is too high to traverse safely, even in a full sized truck.

The samplers and data loggers are operated using separate 12-V marine batteries that are changed regularly, when the voltage drops to approximately 10 V. This assures that sufficient charge is available to operate the sampler or loggers throughout each storm or over the required time period. During the winter, the shelters are heated to above freezing using small propane lights. The heat given off by the lights is sufficient to 1) keep the collected samples above freezing, avoiding bottle cracking, 2) keep the instruments in a temperature range to assure operation, and 3) provide sufficient light to allow the technician to service them easily in the limited light situations commonly experienced during the winter.

Samples are processed at the US Forest Service's Timber and Watershed Laboratory. Each stream water sample is processed first for turbidity and then for suspended sediment. Turbidity is determined using a Hach Ratio Turbidimeter. The sample is agitated in the bottle to distribute sediment particles evenly throughout the sample. An appropriate amount of the agitated sample is immediately poured into the sample vial and then placed into the turbidimeter. After approximately 10 seconds, the reading is recorded. The appropriate scale on the turbidimeter is used, depending upon the degree of turbidity in the sample. Results expressed at Nepholometric Turbidity Units (NTU).

After the reading is taken, the sample is poured back into the original bottle and then suspended sediment concentrations are determined. The bottle (and lid) with the sample is weighed, and the bottle and lid weight are then subtracted to obtain the weight and volume of the sample. Following standard protocols, the volume in ml is assumed to

be equal to the weight in g, since the density of water is approximately 1 g/cm^3, and 1 ml = 1 cm^3. Each sample is vacuum filtered through one or more pre-dried and pre-weighed ashless GF/C glass microfiber filters. Most samples require only 1-3 filters, depending upon the level of suspended sediment and amount of organic material present, though some require more. Each bottle is rinsed with water as many times as needed to remove all of the suspended material. The rinse water also is filtered. The filter(s) from each sample are dried at 100 ºC for 2 hours and then re-weighed after cooling in a dessicator. This weight, minus the initial dry filter weight, is the total weight of suspended material (mineral + organic) in the sample (g/L). Once weighed, the filters then are burned in a muffle furnace at 550 ºC for 1 hour and then re-weighed. The burned weight, minus the initial filter weight, is the weight of the mineral material only (mg/L), or suspended sediment. These data are recorded along with the sample number, and time and date of sample collection so that stream discharge can be applied to the suspended material and suspended sediment values to determine the total suspended material and total suspended sediment that were exported from the watershed during the storm or over the time period (e.g., annually) in question.

Pretreatment samples were collected from fall 1999 through summer 2002 from both watersheds. A forest road was pioneered through the treatment watershed in summer 2002; essentially no BMPs were applied to the road until summer-fall 2003, when the road in the watershed was completed. Stream water samples continued to be collected daily and during storms after the pretreatment period on both watersheds, and are expected to continue to be collected until spring/early summer 2006.

Results:

Data analyses on the turbidity and suspended sediment samples have just begun. However, initial review of the data show that turbidity and suspended sediment levels in both the control and treatment watersheds were in expected ranges during the 3 pretreatment years prior to road construction. Generally turbidity levels remained below 50 NTU for all but the largest storms (e.g., storms with peakflow recurrence intervals of 5-10 years). Even for the largest storms, turbidities rarely exceeded 100 NTUs on either watershed prior to road construction. By contrast, both parameters increased to very high levels during the spring and early summer 2003 before the road condition was improved. After road improvements were finalized, cursory evaluation of the data suggest that reductions in turbidity and suspended sediment have occurred, though turbidity and suspended sediment reductions during storm events often still appear to be elevated for a longer period of time than prior to road construction. However, these results will be verified with more rigorous statistical analyses conducted between June 2005 and Spring 2006.

Conclusions: Because data analysis is incomplete, no conclusions concerning the objectives have yet been made.

Publications: To date, no publications have resulted from this work. A masters thesis and one or more subsequent journal articles are anticipated within the next ~12-15 months.

Information Transfer Program: None to date.

Student Support: Will Sharp, a M.S. student, is being supported by this project.

Notable Achievements and Awards: None to date.