Post-Lahar Channel Adjustment of the Muddy River, Mount St. Helens, Washington

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Abstract. The Muddy River basin, on the northeast flank of Mount St. Helens, was affected by lahars (volcanic debris flows) and a lateral blast during the May 18, 1980 eruption of the volcano. The Muddy River was inundated during the course of the day by several lahars that traveled the length of the river. The lahars were 3.5 m to 8.7 m deep and deposited up to 2.5 meters of sediment along the valley floor. Smith Creek, a major tributary of the Muddy River, has deposits up to 15 m thick from a combination of lateral blast and lahar deposition. The Smith Creek/Muddy River valley has two distinct morphologies. The upper valley, including Smith Creek, is 200-500 m wide with the slope varying from 0.008 to 0.028. The lower valley, cut into older volcanoclastic deposits, has a width of 60-200 m and a slope of 0.006. Repeated cross section surveys were used to investigate the control on channel adjustments to the disturbance by valley morphology.

Twenty eight cross sections were monumented, and surveyed at least yearly between 1980 and 1986, to monitor the channel adjustments along Smith Creek and the Muddy River. An exponential curve was fitted to the cross section data to calculate relaxation times, total amount of adjustment for thalweg elevation and volume of sediment storage. Channel adjustments to this catastrophic disturbance were varied. Thalweg elevation changes varied from 7 m to -15 m and volume of sediment storage varied from 1200m^3 to -1600 m^3 per unit length. Valley morphology was described at each cross section using valley width, valley slope, valley sinuosity, drainage area, distance upstream to the nearest constriction, downstream to the nearest constriction and distance upstream to the nearest tributary.

Preliminary statistical analysis shows that distance upstream to the nearest valley constriction, downstream to the nearest valley constriction, valley sinuosity, and valley gradient are the most significant variables explaining differences in channel adjustments. The valley constrictions and valley sinuosity are on a scale that would not have an effect on anything but the largest floods; therefore, these variables are controlling the channel adjustments by controlling the deposition during lahar inundation. Valley gradient is correlated with the time to relaxation for the thalweg elevation. Increased stream power with increased gradient would account for the faster relaxation times with higher gradients.