The pages in this document were taken from the "Millers Creek Watershed Improvement Plan" published in April 2004. The entire document can be found at http://www.aamillerscreek.org/Findings.htm.

Millers Creek Watershed Improvement Plan

Excerpt Showing an Example of Hydrology Documentation

April 2004

Hydrology
During the period from August 2002 to August 2003, the watershed received about 32 inches of rain. A continuous flow record from the pressure transducers at the Plymouth, Glazier and Meadows stations was collected between August 2002 and September 2003 (See **Appendix G** and **Table 5.4** below). Average annual daily flow at Plymouth was 0.35 cfs, but the continuous record showed that frequently the flow was near zero. Clearly, development north of this station has cut off much of the infiltration and the base flow from Thurston Pond (once the likely headwaters of the creek) and the upper part of the watershed. Interestingly, during dry weather the flow disappears under Huron Parkway just downstream of the University of Michigan Hospitals and Health Centers North Campus Administration Complex (2901 Hubbard). Dry weather flow "re-appears" downstream of the Pfizer restored wetland site coming out of the 84-inch culvert that passes under the intersection of Huron Parkway and the Hubbard/Hayward streets.

The Glazier and Meadows stations have nearly the same average annual daily flow at 1.20 cfs and 1.17 cfs, respectively. Summertime baseflows (groundwater contribution) for both stations were measured at approximately 0.7 to 0.8 cfs. Evidence of groundwater seeps, including oxidized orange-brown precipitant, has been seen at several locations below the Hubbard station. The Meadows station likely experiences the most overbank flow of these three stations. The lowest instantaneous peak flows of all three stations were recorded at Meadows and are probably the result of water "lost" to the floodplain during overbank flows.

The outlet elevation of Millers Creek is determined by the water level in the Huron River. Water elevation in the Huron River near Millers Creek is determined by the Geddes Dam (spillway elevation = 745.8 ft), located about 1.5 miles downstream of the creek (Township of Ann Arbor Federal Emergency Management Agency, 1979). During high flow periods in the Huron River, the backwater influence of the river can extend up Millers Creek to almost the Huron High School staff gage location.

A peak flow factor was calculated to illustrate creek "flashiness." This factor equals the instantaneous recorded peak flow rate divided by the average annual daily flow. The Plymouth site is clearly the flashiest, with a very low mean flow (0.35 cfs) and very high peak flows (95.8 cfs recorded maximum) yielding a peak factor of 274. By comparison the peak factor at Glazier is 211 and 60 at Meadows. The lower peak factor at Meadows is again likely a consequence of overbank flooding diminishing peak flow magnitudes.

Table 5.4 Flow characteristics during continuous recording (August 2002-April 2003)

Station	Average Annual Daily Flow (cfs)	Peak Instantaneous (cfs)	Peak Factor (Peak Instant./Mean Daily)
Plymouth	0.35	95.8 (8-21-2003)	274
Glazier	1.20	252.8 (8-21-2003)	211
Meadows	1.17	70.9 (4-4-2003)	60

Geomorphology

One way to think of rivers and streams is as water and earth-moving machines that rely on the conversion of potential energy (elevation) to the kinetic energy of flowing water to move sediment. On Millers Creek, the natural tendency of the stream to move its watershed to its base level (the Geddes dam elevation in the Huron River) is being accelerated by development in the watershed. The creek is cutting the stream bed down, “pulling” more and more of the landscape down with it. The stream bed and banks are being carried downstream. The wetland at Huron High School and the wetland complex between the High School and the Geddes site are basically the stream delta, where the sediment dislodged upstream comes to rest. The total suspended solids data collected for this project corroborate this description (**see Figure 5.6** below). The data shows increasing average and peak TSS concentrations up to Huron High School and then a clear reduction of TSS concentrations at the Geddes station. Geomorphology data can be found in **Appendix I**.

The high bed slope combined with extensive Directly Connected Impervious Area (DCIA) has led to some extreme downcutting. The downcutting has disconnected some of the stream from its floodplain. Some of the Hubbard reach above the 84-inch curved culvert, and most of the reach from the baffle box at the end of the 84-inch culvert down to Glazier, is incised. These conditions have led to undercut storm sewer outlets, failed outlets, failing retaining walls and extreme bank erosion (See **Figure 5.7**).

Figure 5.7 Fallen end section in Glazier Reach

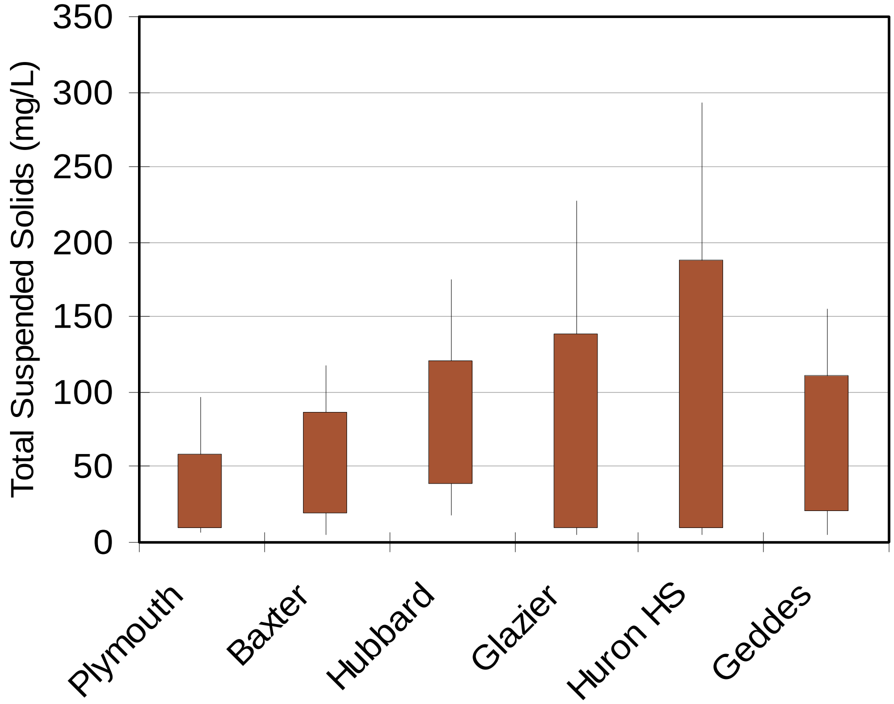

Figure 5.6 Measured Dry and Wet Weather Total Suspended Solids Concentrations
(top and bottom of bars = 25th and 75th percentile, top and bottom of lines = minimum and maximum concentrations)

Incision can be gauged by the Rosgen entrenchment ratio (See **Table 5.5** below). The entrenchment ratio equals the width of the channel at twice the bankfull depth divided by the width of the channel at bankfull depth. The more active a floodplain, the higher this ratio will be. When this ratio falls below two, there is little chance the stream ever reaches its floodplain. When a channel becomes completely disconnected from its floodplain, the flows, velocities and shear stresses are always concentrated within the banks, and channel response becomes even more dynamic and acute.

Incised channels are usually classified by Rosgen as F and G stream types. **Table 5.6** shows that except for the Plymouth cross-section, the areas of high velocity and shear stress are in reaches classified as F and G stream types. These are transitional stream types where active stream bank erosion and mass-wasting are feeding the stream high sediment loads. In time, when the channel has expanded sufficiently, these high sediment loads will become depositional features and promote development of a floodplain inside the existing channel.

Table 5.5 Rosgen Stream Classification Table for Representative Reaches

Name	Sec ID	Type	Bankfull depth (ft)	Bankfull Width (ft)	Bankfull W/d Ratio	Entrench-ment Ratio	Bed Slope (%)
Plymouth	37	E6	5.7	29.0	5.0	20.7	0.8
Baxter	30	E4	3.3	20.0	6.1	16.9	0.4
Hubbard – Up	26	E5	3.5	17.8	5.1	6.6	0.8
Hubbard - Dn	25	F4	3.0	29.0	9.7	1.2	1.7
Glazier - Up	21	F4	2.3	57.0	24.5	1.2	1.9
Glazier - Dn	18	G4c	5.1	30.0	5.9	1.5	0.9
Huron HS - Up	14	C5	3.5	39.0	11.1	4.6	0.5
Huron HS - M	11	E5	3.0	13.0	4.3	4.3	0.3
Huron HS –Dn	6	E5	2.8	11.2	4.0	33.5	0.3
Meadows	4	E6	2.6	11.4	4.4	14.6	0.9
Geddes	1	E6	2.6	15.1	5.7	24.0	-0.3

Table 5.6 Existing Velocity and Shear Stress for Bankfull Event

Name	Sec ID	Velocity (ft/sec)	Shear Stress (lbs/ft^2)	Shear Stress (N/m^2)
Plymouth	37	5.47	1.23	58.89
Baxter	30	3.41	0.86	41.18
Hubbard – Up	26	4.05	0.56	26.81
Hubbard - Dn	25	3.42	1.82	87.14
Glazier - Up	21	3.57	1.01	48.36
Glazier - Dn	18	5.56	1.33	63.68
Huron HS - Up	14	3.28	0.50	23.94
Huron HS - M	11	4.57	0.54	25.86
Huron HS –Dn	6	4.03	0.15	7.18
Meadows	4	2.12	0.61	29.21
Geddes	1	1.88	0.59	28.25

Some floodplain connection still exists between the Plymouth and Baxter sites, along the reach between Baxter and where Millers Creek first goes underneath Huron Parkway (just east of the Pfizer mitigation wetland) and south of Glazier down the Huron River. The reaches that still have an active floodplain, with the exception of the reach between Glazier and Lake Haven, are all classified as a Rosgen E4, E5 or E6 stream type (See **Table 5.5** above). The E-type (the numbers 4, 5 and 6 indicate that the median stream bed particle size is gravel, sand or silt/clay, respectively) generally has a stable bed and planform, unless the stream banks are disturbed and significant changes to the sediment supply and/or streamflow occur. The Plymouth reach is somewhat of an exception to this assessment because the channel has been straightened and the bed is composed mainly of clays. There are localized high velocities and shear stresses in this area due to channel straightening and high upstream flows, but these high velocities and shear stresses are causing localized bank erosion and are part of the reason that the banks near Pfizer's ponds have been failing. The clay bed has prevented local downcutting.