Reassessment of Acid Mine Drainage Pollution in the Twomile Run Watershed, August – December 2010 Kettle Creek Watershed, Clinton County

Technical Report Provided by Hedin Environmental through the Trout Unlimited AMD Technical Assistance Program

June 2011

Introduction

The Kettle Creek Watershed Association requested technical assistance to repeat water quality snapshots that were performed in 2005. Like in the 2005 snapshots, a high flow and low flow round of samples were collected. The results of the 2010 sampling events were combined with the 2005 data as well other historical sample data in order to assess changes in the stream over time.

Sampling

A total of 22 samples were collected in 2010 as part of this project. The results are included at the end of this report. The locations of the sampling stations are shown in Map 1. A comparison of the 2005 and 2010 snapshots is shown in Table 1.

Table 1. Sampling Comparison for Twomile Run AMD loading studies

Snapshot	# samples	Flow, gpm*
Lower Flow		
August 10, 2005	15	71
July 27, 2010	7	184
Higher Flow		
May 4, 2005	20	618
December 7, 2010	15	2,481

*Measured in Twomile Run above Middle Branch

The May 2005 and December 2010 sampling rounds covered the same points with the exception of the Swamp Collection systems. The collection systems were not sampled in December 2010 because the downstream station (Swamp at Pipeline) includes these flows.

Sampling in 2010 was conducted under higher flow conditions than the 2005 snapshots. An attempt to conduct a sampling round was abandoned on December 2, 2010 because of dangerously high stream flows. Flows had decreased enough by December 7th to allow flow measurements but the flow was still substantially higher than that observed in 2005.

To better determine the change in water quality over time, sample results from the historical database were included in the calculations. Not all samples were suitable, however. Those missing flow measurements were not included nor were those collected before 1990.

Results
Overall, stream quality has improved at all in-stream sites except Huling Branch Mouth. The only restoration projects completed to date in the Huling Branch watershed are the installation of AMD collection systems. These systems have dried up seeps and decreased the extent of kill zones, but they have not treated water. For this reason the Huling Branch Mouth site is used as a reference to rule out natural attenuation as the cause for observed improvements in water quality elsewhere in the watershed. Figure 1 shows acidity concentrations versus flow rates for the Huling Branch Mouth site. Data from 2010 match the 1999-2005 data very well indicating that water quality has not improved at the Huling Branch Mouth site.

Twomile Run Above Huling Branch
Moving upstream to Twomile Run above the confluence with Huling Branch, an improvement in water quality is apparent. Figure 2 shows acidity concentrations plotted against flow rate for the station. Under low flow conditions the in-stream acidity concentration was 50-60% lower than that found in the historical data under similar flow conditions. Acidity concentrations under high flow conditions have not changed.

Since 1999 the pH measured in Twomile Run above Huling Branch has increased by 0.4 units. Three projects occurred in the watershed above this sampling point. In 2004 a surface mine in the Robbins Hollow headwaters was reclaimed and revegetated. Also in 2004, the Robbins Hollow Headwaters passive treatment systems were finished. These systems treat highly acidic discharges to Robbins Hollow. In 2006 the Middle Branch system was rehabilitated. This project decreased contaminant loadings and greatly improved the effectiveness of the passive system. The effect of these projects on the pH of Twomile Run above Huling Branch is shown in Figure 3.

Robbins Hollow
The headwaters of Robbins Hollow contain several passive treatment systems that were constructed in 2004. Six years of monitoring has established that the systems effectively treat the headwaters AMD. However, the untreated 10A and 10B discharges that are located downstream of the passive systems re-acidify the small stream. As a result, the mouth of Robbins Hollow has shown only modest improvement. Figure 4 shows acidity plotted against flow at the Robbins Hollow Mouth station. Under very low flow conditions, there is no improvement because most of the treated headwater seeps dry up, while the 10A and 10B discharges continue to flow. When the headwater seeps are flowing and the treatment systems are discharging alkaline water, improved conditions at the mouth are apparent.

Middle Branch
Middle Branch has shown the greatest improvement in water quality. The rehabilitation of the passive treatment system has eliminated the only known source of AMD in the watershed. Since rehabilitation of the system the water quality at the mouth has been comparable to that upstream monitoring point above the influence of mining. Figure 5 shows acidity concentration plotted against flow at the Middle Branch Mouth station.

The greatest improvement to water quality at the Middle Branch Mouth station is under low flow conditions. This is a reversal of the typical response of an AMD impacted stream wherein pollutant concentrations increase under low flow due to contaminated groundwater inputs that

persist through dry periods. Data collected at the Middle Branch Mouth station suggests that the stream is now protected from these inputs.

Twomile Run Above Middle Branch

Two projects have occurred in the Twomile Run watershed above the inflow of Middle Branch. In 2004, AMD seeps in the "Swamp" were collected with several french drains. The collection systems dried up seeps which prompted reductions in size of kill zones, but there was no treatment of the AMD discharges. Also in 2004 the surface mine above the Swamp was reclaimed. The project involved minor regrading of spoils, application of a biosolids amendment, and revegetation by standard reclamation practices. No alkaline addition occurred. The project successfully established vegetative growth on spoils that previously were barren.

Figure 6 shows acidity plotted against flow rate for Twomile above the inflow of Middle Branch. While the limited data make definitive conclusions difficult, in-stream acidity has decreased under low flow and increased slightly under high flow since the projects were completed. This change is not due changes in Twomile Run above the Swamp as the unpolluted stream's weakly alkaline chemistry did not change after the reclamation project. Sampling of the Swamp discharge has shown no change in AMD chemistry since the reclamation occurred. If the quality of the discharge has not changed then perhaps its quantity has. The reclamation was intended to increase runoff from the mine site and thereby reduce infiltration into the acidic spoils. In theory, the amount of polluted base flow is diminished. Surface runoff may still be quite acidic due bare acidic soils in the Swamp and in portions of the reclaimed surface mine. The net result is a "spiky" AMD discharge hydrograph with more rapid responses to precipitation. Conceptually superimposing such a hydrograph on the in-stream conditions would create a scenario where low flow acidity would actually decrease due to decreased base-flow from the mine and high flow acidity would increase due to increased acidic runoff during wet weather. By more closely matching the stream and discharge hydrographs the reclamation appears to have had the net result of lowering in-stream pollution concentrations.

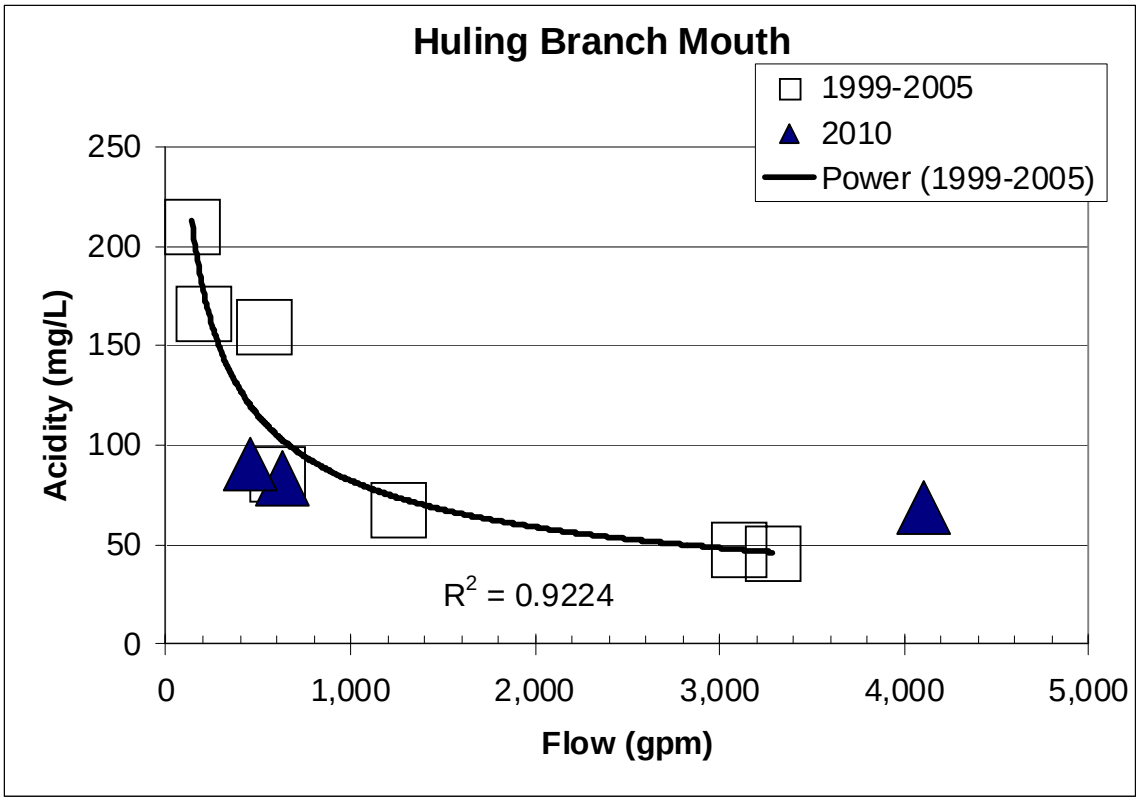


Figure 1*. Acidity vs. Flow at the Huling Branch Mouth site*

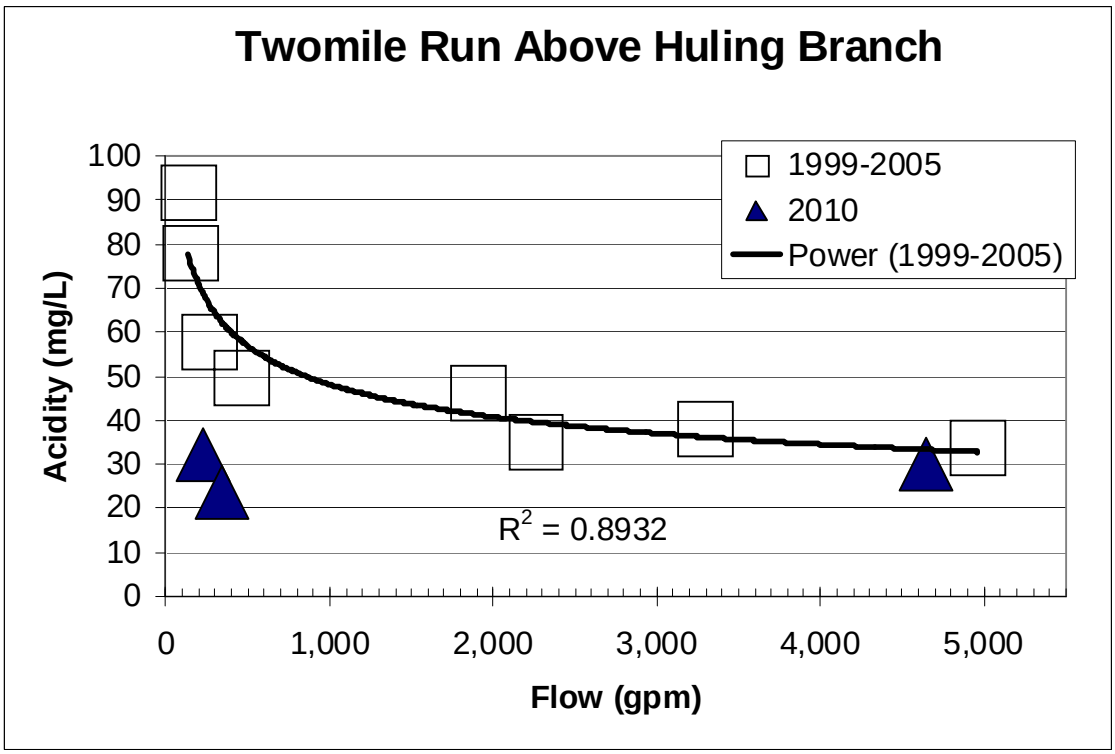


Figure 2. *Acidity vs flow in Twomile Run above the inflow of Huling Branch*

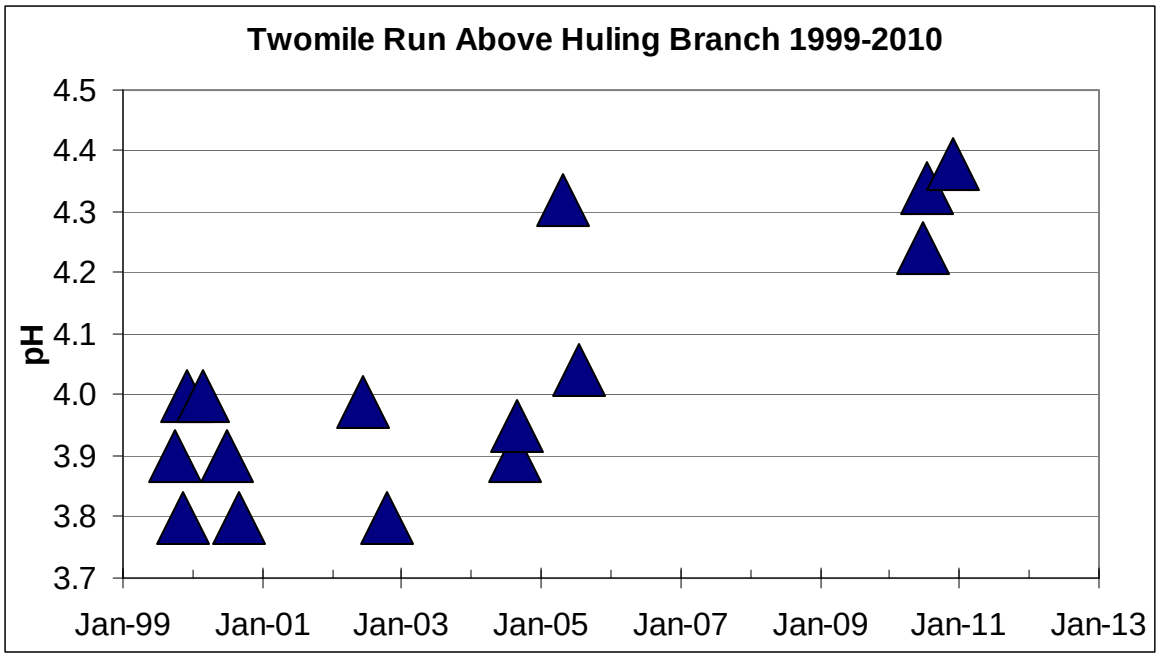


Figure 3*. In-stream pH of Twomile Run above the inflow of Huling Branch, 1999-2010*

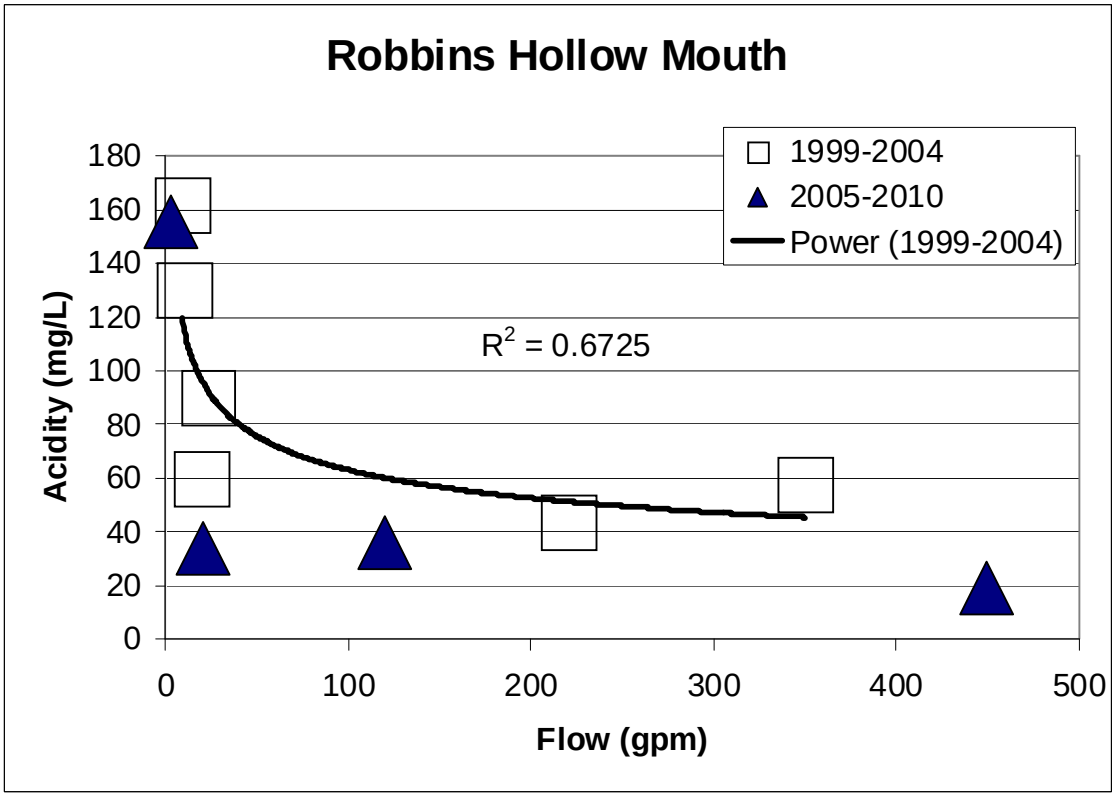


Figure 4. *Acidity vs flow for the mouth of Robbins Hollow before and after construction of the Robbins Hollow Headwaters Passive Treatment System Complex*

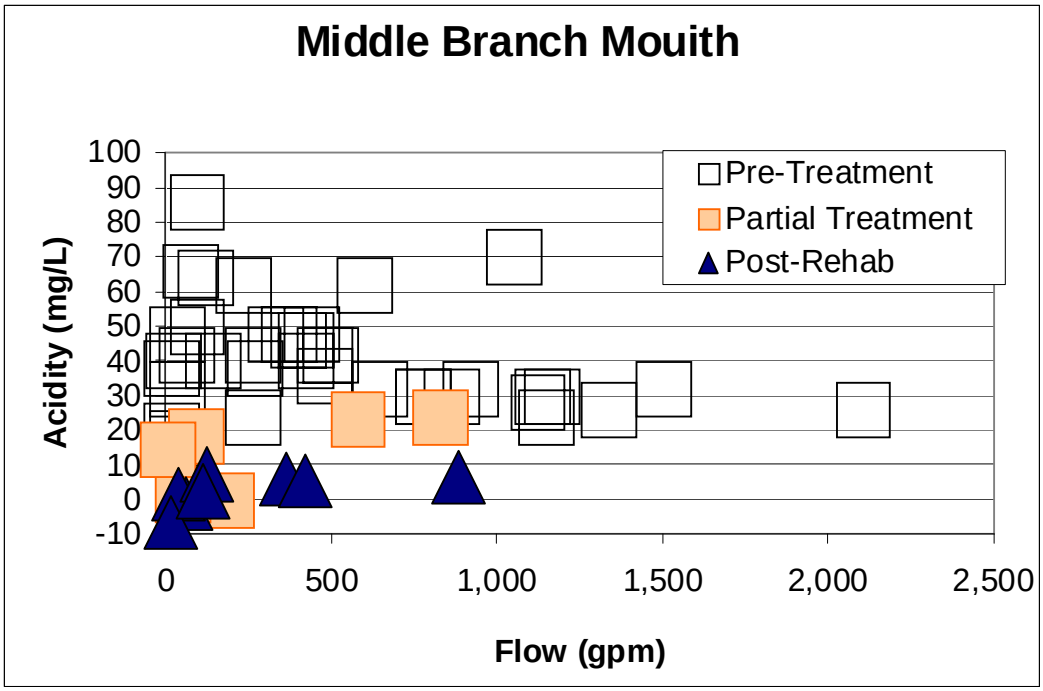


Figure 5. *Acidity vs flow at the mouth of Middle Branch before treatment, during partial treatment and following rehabilitation of the treatment system*

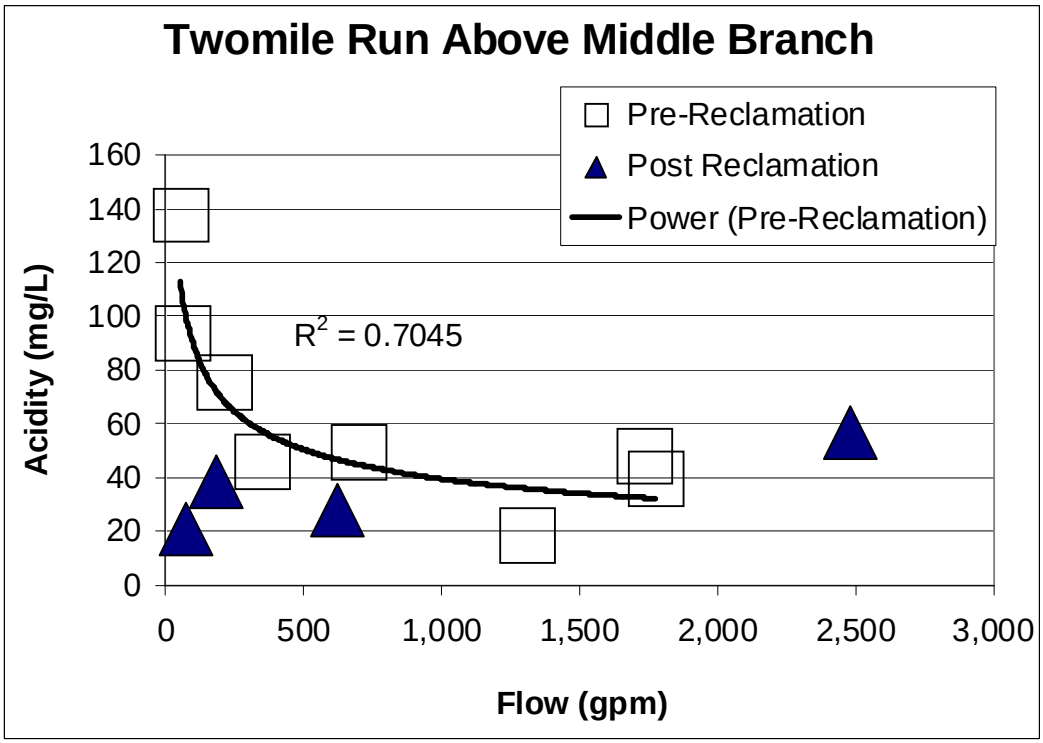


Figure 6. *Acidity vs flow for Twomile Run above the inflow of Middle Branch before and after the Twomile Run Reclamation Project*

Potential for Improvement

The Twomile Run TMDL was developed based on sampling of the stream in 1999 prior to any significant restoration effort had been initiated. At that time the Swamp at Pipeline station contributed 57% of the acidity loading measured in Twomile Run above Huling Branch (Figure 7). In 2010 that number had increased to 83% due largely to the decrease in acidity loading contributed by both Middle Branch and Robbins Hollow.

Both Robbins Hollow and Swamp at Pipeline will be affected by the planned construction of Swamp and Robbins 10A/10B passive treatment systems. Funding has been secured for both systems. The Swamp system has been designed and permitted and is scheduled for construction 2011. The Robbins 10A/10B system will be designed and permitted in 2011 and could be constructed in 2012.

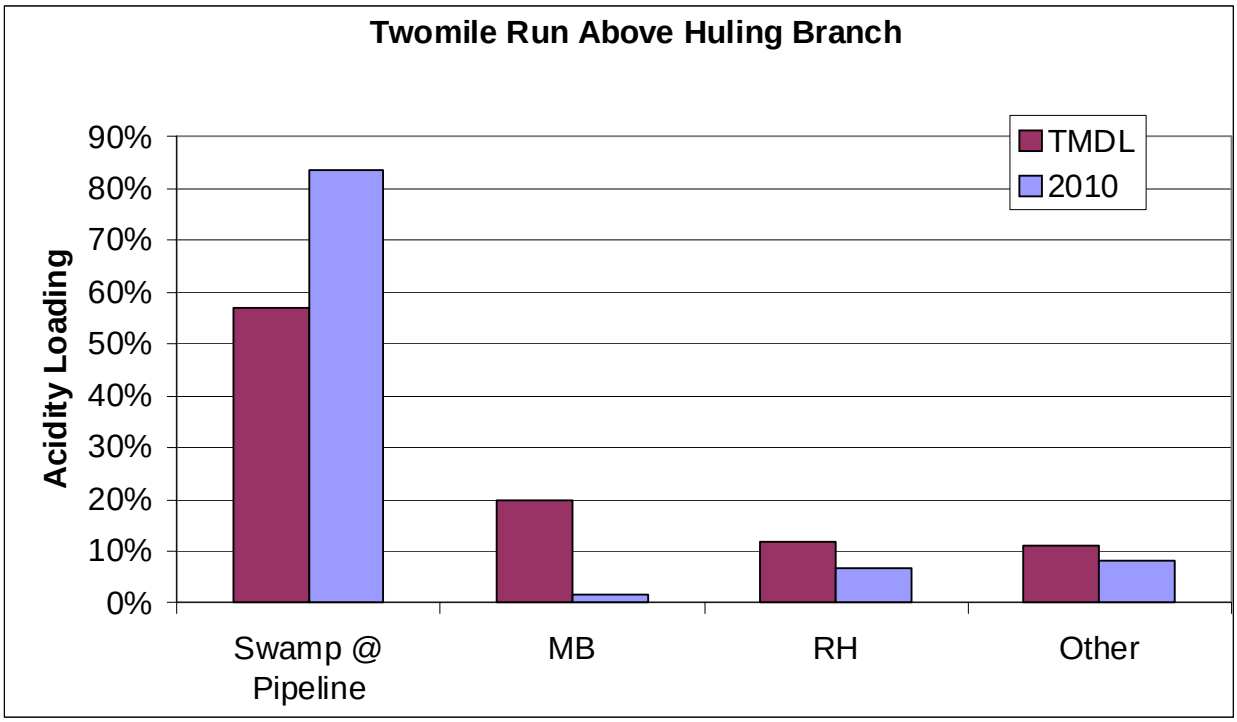


Figure 7. *Historic and current partitioning of acidity loading for Twomile Run above the inflow of Huling Branch*

Using the 2010 snapshot data, anticipated changes in water quality due to treatment of both the Swamp and Robbins 10A/10B discharges were calculated. For the July sample all of the acidity loading measured at the Twomile Above Huling station could be accounted for by the Swamp discharge. The Robbins 10A/10B discharges were not sampled on this date so their impact cannot be quantified. Under the conditions observed in July 2010, treatment of the Swamp discharge alone would result in net alkaline conditions in Twomile Run for its entire length above Huling Branch (Table 2).

***Table 2**. Calculated impact in July 2010 on downstream Twomile Run if the Swamp discharge was treated to an alkaline condition*

Site	Acidity, mg/L	Acidity, lb/day*
Swamp At Pipeline	480	101
Twomile Above Huling	24	96
Twomile Above Huling after Swamp At Pipeline Treatment	-5	-21

** negative number indicates net alkaline conditions*

The December 2010 sampling round included the Robbins Hollow 10A and 10B discharges so that the impact of their treatment could be calculated. Table 3 shows that on December 7, 2010 the acidity loading at Twomile Run Above Huling was 1,668 lbs/day. Treating the Swamp at Pipeline discharge and Robbins Hollow 10A/10B discharges will remove 1,030 and 58 lbs/day acidity, respectively. Further, the treatment systems will contribute alkalinity (i.e. negative acidity) to the stream. Similar passive systems treating severe AMD commonly discharge water with a net alkalinity of –75 mg/L. Assuming that the systems produce an excess of 75 mg/L of net alkalinity, then an additional 164 lbs/day of in-stream acid neutralization will be generated. In total, the systems will lower acidity loading at Twomile Run Above Huling by 1,252 lbs/day or by 75%. The result is an in-stream acidity concentration of 7 mg/L, which is the same concentration observed above the influence of AMD. Figure 8 shows the predicted acidity concentration at Twomile Run Above Huling Branch for the 2010 sampling rounds in comparison to past measurements.

***Table 3**. Calculated impact in December 2010 on downstream Twomile Run if the Swamp and RH 10A/10B discharges were treated to an alkaline condition*

Site	Acidity, mg/L	Acidity, lb/day
Twomile Above AMD	7	138
Swamp At Pipeline	592	1,030
Robbins Hollow 10A/10B	174	58
Twomile Above Huling	30	1,668
Twomile Above Huling after Swamp At Pipeline Treatment	7	416

Summary

In-stream conditions in Twomile Run watershed in 2010 were compared to those measured in 1999 – 2005. No improvement in water chemistry was observed for the Huling Branch tributary where no water treatment projects have occurred. Three major reclamation and AMD treatment projects were implemented in other portions of the watershed between 2004 and 2007. Twomile Run above Huling, where the restoration projects occurred, was substantially improved. In-stream acidity concentrations were 50-60% less in 2010 than 1999-2004, under similar flow conditions. Two treatment projects are scheduled for the Twomile Run watershed in 2011-12. The treatment benefits projected to result from these projects are calculated to restore good water quality to Twomile Run down to the inflow of Huling Branch.

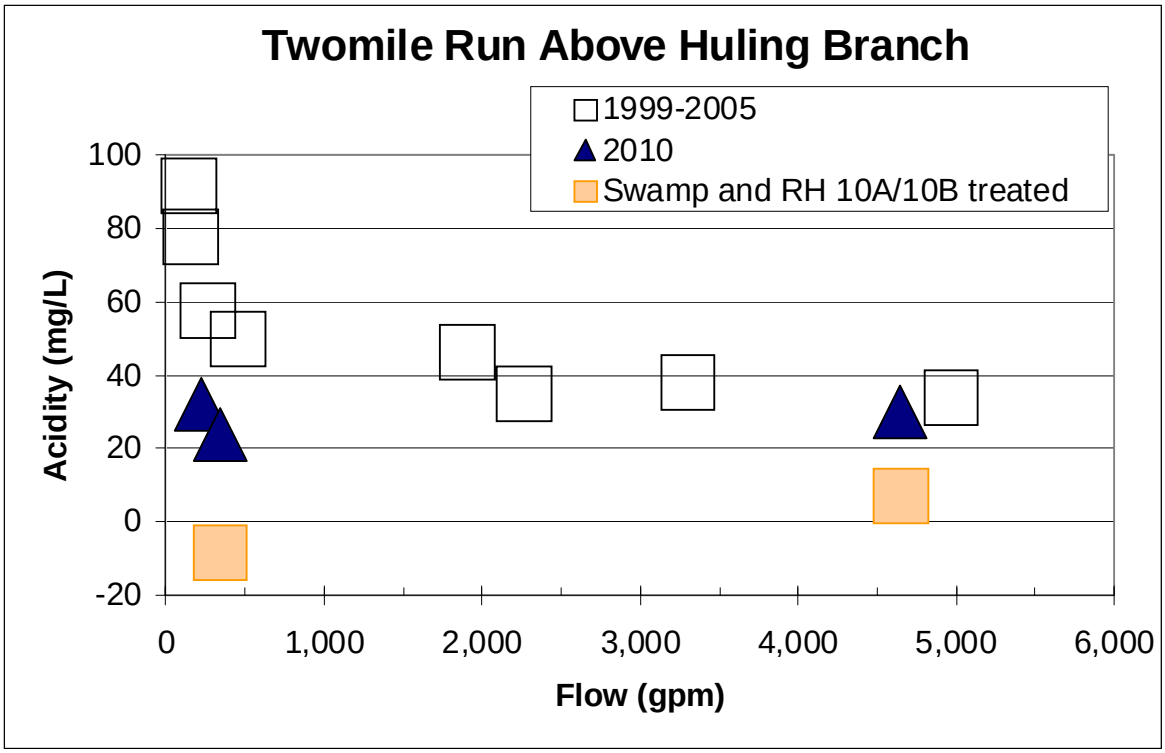
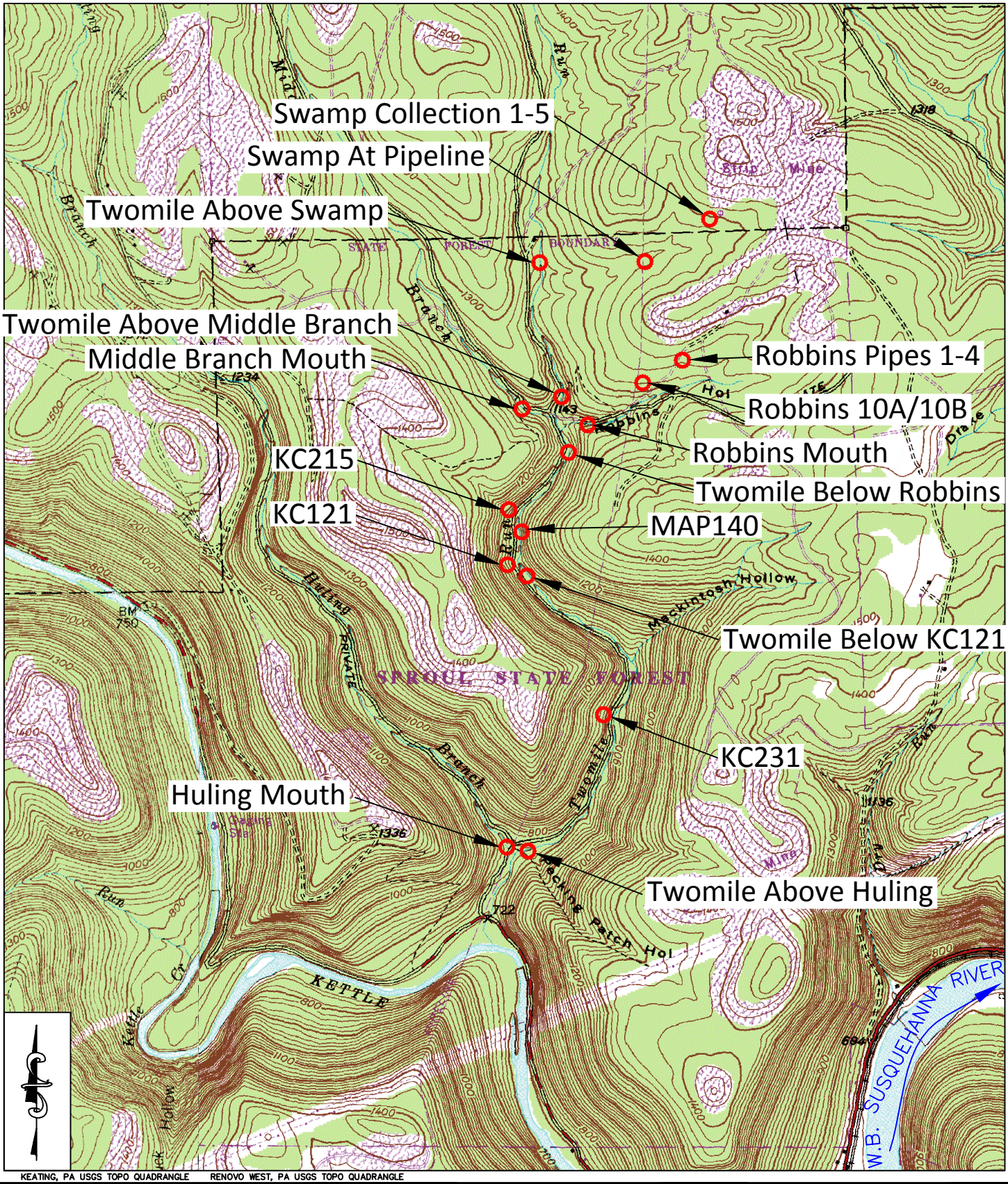


Figure 8. *Historic, current, and projected acidity concentrations for Twomile Run above the inflow of Huling Branch.*



KEATING, PA USGS TOPO QUADRANGLE RENOVO WEST, PA USGS TOPO QUADRANGLE

GRAPHIC SCALE

0 1000 2000

SCALE 1" = 2000

LEGEND:

Sampling Location

TROUT UNLIMITED

HedinEnvironmental
195 Castle Shannon Blvd.
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Map 1

Twomile Run Re-Evaluation Sampling Locations

MUNICIPALITY:	DATE:	FILE NAME:
NOYES & LEIDY TWPS.	April 2011	USGS FIGS.dwg
COUNTY:	DRAWN BY:	SCALE:
CLINTON COUNTY, PA	NAW	AS SHOWN