West Branch Susquehanna River Headwaters AMD (Cambria County)

Technical Report provided by Hedin Environmental through the Trout Unlimited AMD Technical Assistance Program TUTAG-16

June 27, 2006

Introduction
This Technical Assistance Grant (TAG) was requested by the West Branch Susquehanna Rescue. The goals of this technical assistance are to

- Provide a technical opinion on the appropriateness of the existing WBSR-5A/5B treatment plan; and
- Further the objectives of the existing Restoration Plan by developing new conceptual plans for three other high priority discharges

The discharges addressed in this TAG are all located within the headwaters of the West Branch Susquehanna River (WBSR) between Bakerton and Carrolltown in Cambria County. Conceptual treatment plans have been developed for discharges identified as WBSR-2, the WBSR-5 discharges, WBSR-7, and a deep mine discharge not identified as an individual source in the WBSR Headwaters AMD Assessment and Restoration Plan (Vapco Engineering, 2000). Flow from this discharge is included among other discharges at WBSR-9. This deep mine discharge was identified in the WBSR Operation Scarlift Report (Gwin, Dobson and Foreman, Inc., 1972) as Weir 12. This name will be retained in this report.

An initial site visit was conducted on March 29, 2006 that was attended by representatives from Hedin Environmental, DEP, West Branch Susquehanna Rescue and the Cambria County Conservation District. All discharge sites were visited and sampled on April 13th and 19th 2006 by Hedin Environmental. Additionally, in-stream samples were collected and flows measured at four locations during the April 19th site visit. The sampling locations are shown on the attached map.

In-Stream Loading
In-stream sampling was conducted on April 19th to determine the relative contribution of each discharge. Samples were collected and flows measured in-stream at No. 6 Road and Goodway Road downstream of WBSR-9 (see attached location map).

Interpretation of the results is complicated due to the influence of a lime treatment plant that discharges within the study reach. The alkaline effluent of the treatment plant masks the true in-stream impact of untreated discharges. As a result, only general statements about in-stream water quality can be made. All data collected under this TAG is included as an attachment to this report.

The in-stream sample taken at No. 6 Road includes influence from the WBSR-5 (A through D) and WBSR-2 discharges as well as the effluent from the lime treatment plant. At No. 6 Road, the WBSR is circum-neutral in terms of both pH (6.2) and net acidity (3.3 mg/L). Abatement of the WBSR-2 discharge and the discharges at the WBSR-5 site would result in water quality improvement at No. 6 Road.

In the reach between No. 6 Road and Goodway Road the WBSR takes on a much more acidic character with the pH declining from 6.2 to 4.6 and net acidity increasing from 3.3 mg/L to 27.2 mg/L. The WBSR-7 and Weir 12 discharges do not account for this change. Historical data included in the WBSR assessment suggest that the bulk of the impairment to this reach results from diffuse seepages emanating from large refuse piles that flank the river. Removal of these piles could significantly and permanently reduce loading to the WBSR. More detailed study could be performed in order to quantify the impact these piles have on the WBSR to justify funding for removal of the piles. Removal of these piles was discussed in greater detail in the Operation Scarlift Report.

WBSR-2

Discharge Description

The WBSR-2 Discharge is located just upstream of the Myers Road bridge near Carrolltown Road. The discharge flows from an 18” asbestos pipe providing the first significant impairment to the WBSR. The invert of the pipe is at or slightly below the elevation of the stream bed. The discharge emanates from the abandoned Victor No. 9 & 10 deep mine complex in the B seam (Lower Kittanning).

Water Quality and Flow Characteristics

The fact that the discharge emanates from a pipe whose invert is submerged in the stream makes accurate flow measurement impossible. In-stream flows and samples were collected above and below the discharge. From these data, WBSR-2 discharge flow rate can be estimated using dilution calculations. It is assumed that WBSR-2 is the only contributor of sulfate in this reach. No other flows were observed. This approach yielded an estimated flow rate of 157 gpm.

WBSR-2 In-Stream Sulfate Loading for WBSR-2 Flow Calculation

Location	Sulfate (mg/L)	Flow (gpm)	Sulfate (ppd)
Above	84.7	306	311
Below	156.0	462	865
Difference – presumed to be entirely from WBSR-2	295.0*	156.5**	554**

*measured
**calculated

Water quality data available for this discharge is limited. What data are available show a discharge that is weakly acidic with elevated iron and aluminum concentrations. Unlike most discharges from mines in the B seam, which are generally strongly acidic (WBSR-7 is an example), the WBSR-2 discharge shows alkaline influence. The source of this alkalinity is likely from the poorly regraded surface mines in the D seam (Lower Freeport) above the deep mined area. Mining in the D seam generally produces alkaline drainage.

The discharge was sampled twice as part of this TAG on April 13 and 19, 2006. The historical data set includes data from only three samples taken in 2001. Flows reported for these samples were estimated and are considered unreliable. Sampling of this discharge was also conducted as part of the Operation Scarlift Report. However, this sampling did not include analysis for aluminum or manganese so it cannot be used for remediation planning. Water quality data are shown in the following table.

WBSR-2 Water Quality

Date	pH	Alkalinity (mg/L)	Net Acidity (mg/L)	Total Fe (mg/L)	Total Mn (mg/L)	Total Al (mg/L)	TSS (mg/L)
2/20/2001	6.2	37.7	38.4	6.4	0.2	0.8	6
5/29/2001	4.9	2.4	39.1	14.9	0.6	2.5	28
8/11/2001	3.6	0	34.0	17.4	0.8	3.2	24
4/13/2006	5.6	14.1	32.9	18.0	0.59	2.0	16
4/19/2006	6.0	18.1	11.6	14.7	0.45	1.8	5
Average	5.3	14.5	31.2	14.3	0.5	2.0	15
Max	6.2	37.7	39.1	18.0	0.8	3.2	28
Min	3.6	0	11.6	6.4	0.2	0.8	5

Sampling conducted on 4/19/06 included analysis for dissolved metals from the discharge as well as in-stream below the discharge. A sample was collected upstream of the discharge but did not include dissolved metals analysis. The upstream sample was collected approximately 50 ft upstream of the discharge. The downstream sample was collected at the outfall of the concrete culvert under Myers Road. The following table displays the results of this sampling.

WBSR-2 Discharge and In-Stream Samples

Location	Flow (gpm)	pH	Net Acidity (mg/L)	Total Fe (mg/L)	Dissolved Fe (mg/L)	Total Al (mg/L)	Dissolved Al (mg/L)	Sulfate (mg/L)
Above	306	7.9	-85.7	0.2	n.s.	0.1	n.s.	84.7
WBSR-2	156*	6.0	11.6	14.7	14.7	1.8	0.9	295
Below	462	6.7	-45.1	7.4	6.5	0.7	0.3	156

n.s. – not sampled

* This flow represents the flow rate required to produce the change in sulfate loading observed in-stream.

Treatment Options

This discharge is weakly acidic with elevated iron and aluminum concentrations. Iron and aluminum will readily precipitate at the discharge pH. Subsequently, settling is suggested prior to contact with limestone to generate a net alkaline discharge. A conceptual treatment system would consist of a settling pond followed by a wetland with limestone amended substrate. Sizing of the system components cannot be estimated until reliable flow measurements are obtained.

Numerous areas are available downstream for treatment system construction. An attractive location is a refuse pile located approximately 1,500 ft downstream of the WBSR-2 discharge that could be removed and/or reclaimed and the land utilized for treatment system construction. Transporting the discharge to the treatment location would involve intercepting the existing discharge pipe and connecting it to a new pipeline to the treatment location. The present discharge location and proposed treatment area are on private land. Landowner permission and cooperation is required for this project to proceed.

Non-Treatment Options

Piping the discharge downstream would immediately improve if not fully restore a portion of the WBSR. Piping the discharge 1,500 ft downstream would not only dramatically improve 1,500 ft of the WBSR, but it would allow for the installation of a flow measurement device at the outfall of the pipe. Accurate flow measurements cannot be made at the current discharge location. Accurate flow measurements are required for treatment system design.

Once the discharge is relocated, monitoring of the discharge should be conducted monthly and after significant precipitations events. Additionally, monitoring at several in-stream locations should be conducted to determine the degree of improvement realized by relocating the discharge.

Recommendations

- Relocate discharge by piping downstream to point near potential treatment locations.
- Collect raw and filtered samples monthly for at least one year and after significant precipitation events
- Investigate options for refuse pile removal to facilitate treatment system construction.
- Design and construct a passive treatment system once sufficient water quality and flow data have been collected.

WBSR-5A, WBSR-5B, WBSR-5C and WBSR-5D

Discharge Descriptions

These discharges are located along Mitchel Road and flow into a tributary to the West Branch Susquehanna River downstream of Bakerton Reservoir. Initially, only two discharges were identified for study at this site, WBSR-5A and WBSR-5B. However, during the initial site investigation, it was discovered that there are four distinct sources of mine drainage at the site. For consistency, the additional discharges have been identified as WBSR-5C and WBSR-5D.

WBSR-5A originates as a diffuse area of seepage just below Mitchel Road. WBSR-5B originates as a diffuse area of seepage just below Mitchel Road, approximately 500 ft east/southeast of WBSR-5A. Site WBSR-5C originates on the opposite side of Mitchel Road from WBSR-5A. WBSR-5D is a 4" field drain pipe located at the western edge of the site near Deveaux Street. In previous assessments, flow from WBSR-5A and WBSR-5C were sampled together and were considered one discharge. WBSR-5D was not identified in previous assessments but may have been included in measurements at WBSR-5A Weir #2. It appears that the 4" drain pipe from which WBSR-5D flows has been recently installed during the construction of a municipal water or sewer project.

The site is narrow and is bound by the receiving stream to the south and west, Deveaux Street to the northwest, and Mitchel Road and utility right of ways (electrical and municipal water) to the north and east.

Water Quality and Flow Characteristics
Historically, a portion of the flow from WBSR-5C was included in the WBSR-5A sampling location. The culvert that carries WBSR-5C under Mitchel Road is collapsed, causing most of the discharge to flow on the northeast side of Mitchel Road to the ditch along Deveaux Street. The collapsed culvert limits the amount of flow that can pass under Mitchel Road to the WBSR-5A weir to a few gpm. As a result the flows measured at the WBSR-5A weir are assumed to slightly overstate flow for WBSR-5A but could still be used for treatment system design. However, very limited chemistry and flow rates exist for the 5A and 5C discharges at their sources. Good flow rate information is available for the WBSR-5B discharge. Historically, a total of 17 flow rates have been recorded, primarily in 2003. No historical data exists for the WBSR-5D discharge.

All four sites were sampled twice under this TAG. Pipes were installed at the WBSR-5A and 5B discharges for monitoring. The results of the sampling conducted under this TAG as well as historical averages are found in the following tables.

WBSR-5A Water Qualtiy Data

Date	Flow (gpm)	pH	Net Acidity (mg/L)	Total Iron (mg/L)	Total Mn (mg/L)	Total Al (mg/L)	Sulfate (mg/L)
8/11/05	2.0	3.0	115.4	55.2	1.8	0.1	644
2/27/06	n.a.	3.1	205.8	58.6	2.2	4.3	724
4/13/06	12.0	3.0	166.5	33.8	2.0	3.2	512
4/19/06	10.5	3.0	174.2	46.3	1.9	3.1	232
Recent Average	8.2	3.0	165.5	48.5	1.9	2.7	528
Historical Average*[a]	18.2	2.9	186.2	36.2	2.2	4.6	640

*Includes some flow from WBSR-5C
[a]16 flow measurements and 14 samples taken March through October 2003
n.a. – not available

WBSR-5B Water Quality Data

Date	Flow (gpm)	pH	Net Acidity (mg/L)	Total Iron (mg/L)	Total Mn (mg/L)	Total Al (mg/L)	Sulfate (mg/L)
8/11/05	3	6.0	168.6	89.0	3.7	0.1	811
2/27/06	n.a.	6.0	120.2	46.7	2.4	0.1	614
4/13/06	2.8	5.7	116.8	65.2	2.6	0.2	571
4/19/06	2	5.7	108.2	66.4	2.5	0.2	280
Recent Average	2.6	5.9	128.4	66.8	2.8	0.1	569
Historical Average*	7.3	3.4	140.0	60.0	2.7	0.3	590

*16 flow measurements and 12 samples taken March through October 2003
n.a. – not available

WBSR-5C Water Quality Data

Date	Flow (gpm)	pH	Net Acidity (mg/L)	Total Iron (mg/L)	Total Mn (mg/L)	Total Al (mg/L)	Sulfate (mg/L)
8/11/05	2.0	3.1	321.6	79.3	2.3	14.8	874
2/27/06	n.a.	3.4	323.4	94.5	2.5	16.6	946
4/13/06	4.0	3.4	289.1	102.1	2.5	14.8	862
4/19/06	2.0	3.1	295.4	85.0	2.3	17.5	768

n.a. – not available

WBSR-5D Water Quality Data

Date	Flow (gpm)	pH	Net Acidity (mg/L)	Total Iron (mg/L)	Total Mn (mg/L)	Total Al (mg/L)	Sulfate (mg/L)
2/27/06	n.a.	5.8	232.6	129	3.65	0.1	1106
4/13/06	13.5	5.71	249.87	176	2.91	0.3	873
4/19/06	13.5	5.9	212.54	141	2.87	0.49	864

n.a. – not available

There appears to be at least two distinct types of water quality present at this site. One is high in iron, low in aluminum and with measurable alkalinity. WBSR-5B and 5D discharges fall into this category. The other type of water quality is a strongly acidic discharge with high concentrations of iron and aluminum. The WBSR-5C discharge falls into this category. The WBSR-5A discharge is a combination of these two water qualities.

An explanation for the variety of water qualities found at the site would be that the discharges represent leakage from the Lancashire No. 20 mine. Water discharging from a drift entry of the Lancashire No. 20 mine just northeast of the WBSR-5 site along Deveaux Street is treated with lime at a treatment plant. Complicating the geochemistry of the Lancashire No. 20 mine is the fact that water discharging from the main portal is treated and pumped over the Laurel Hill anticline to allow for gravity drainage to the drift entry along Deveaux Street. The range of water qualities observed at the WBSR-5 site is likely the result of varying degrees of mixing treated and untreated mine water.

The WBSR-5C discharge appears to emanate from a deep mine feature on the opposite side of Mitchel Road from the WBSR-5A discharge. This feature may have been a blowout that was sealed in order to direct flow to the treatment plant. The seal is imperfect and seepages have emerged along approximately 100 ft of Mitchel Road. Seepage from the Lancashire No. 20 mine along Mitchel Road was documented in the Operation Scarlift Report. The seepages were sampled at Weir 7 and had an average flow rate of 3.8 gpm. It is unclear if the WBSR-5A and WBSR-5B discharges were present at the time of the Operation Scarlift study.

It is likely that water from the WBSR-5C discharge is seeping through the road base and mingling with the WBSR-5A discharge. This would explain the elevated aluminum concentrations observed in the WBSR-5A discharge. However, it would not explain the pH values that are lower than the WBSR-5C. It is possible that the water quality is altered by the fill material used in the road base.

Treatment Options

The existing treatment plan involves construction of anoxic limestone drains (ALDs) for treatment of the WBSR-5A and 5B discharges. This plan was presented in the Interim Project Report: 5A5B Conceptual Treatment Plan. However, this plan was formulated prior to the completion of this TAG. In light of new insights revealed during this TAG investigation, it is recommended that non-treatment actions should be taken prior to proceeding with design and construction of a treatment system. These options are discussed in the next section.

Pumping of treatment system effluent into the mine could result in discharge water quality variability. Such variability could result in passive treatment system failure. Any passive treatment system design and construction should only proceed with this caution in mind. A potentially more reliable solution would involve treatment by mixing with lime plant effluent and settling. Permitting issues associated with this option are unclear at this time but should be investigated prior to system design.

Non-Treatment Options

It is recommended that options are investigated for sealing the outcrop area above the WBSR-5. Sealing of the outcrop would result in much, if not all of the flow from the discharges to be redirected to the existing treatment plant constructed for treating discharge flow from the Lancashire No. 20 mine. Such an investigation would involve review of mine maps, consultation with individuals associated with the mine, exploratory drilling and private landowner cooperation.

Additional monitoring of all four discharges should be conducted regardless of the course of action. If the sealing option is investigated and proves feasible, the pre-grouting monitoring data will be critical for assessing the success of the effort. Samples and flow rates at the point of discharge should be collected monthly and after significant precipitation events.

Recommendations

- Continue monitoring all four discharges and the Lancashire No.20 discharge that is treated at the lime treatment plant.
- Investigate options for sealing the coal outcrop to redirect discharge flow to the existing lime treatment plant.
- If feasible, perform coal outcrop sealing operation
- Monitor discharge to determine sealing effectiveness.
- Consider treatment by mixing with lime plant effluent and settling.

<u>Weir 12 and WBSR-9</u>

Discharge Description

The Weir 12 discharge emanates from a wet seal in an abandoned B seam deep mine. The discharge is located on the hillside upslope of an abandoned railroad grade east of Deveaux Street between Number 6 Road and Goodway Road. The discharge flows downslope in a zig-zag pattern as it is intercepted first by the railroad grade and then by a ditch on the west side of Deveaux Street. The ditch on the west side of Deveaux Street was installed to convey the flow along the northeast edge of a large refuse pile that was reclaimed under the RAMP program. Reclamation of the pile did not eliminate the discharges that emerge from the northern toe of the pile.

Flow through the WBSR-9 weir includes all of the flow from Weir 12 as well as some seepage from the refuse pile. However, much of the flow from the refuse pile does not reach the WBSR-9 monitoring point. The WBSR has eroded into the pile in at least one location and seepage was observed flowing directly into the river at a number of locations.

Water Quality and Flow Characteristics

The WBSR-9 sampling point includes flow from Weir 12 and an area of seepage at the base of a refuse pile. However, much of the flow from the refuse pile flows directly to the WBSR and is not included in sampling conducted at WBSR-9. As a result, the data are incomplete and not useful for remediation planning. Collecting the discharge to a single point for the purpose of monitoring would involve the installation of several hundred feet of ditch or numerous discrete sampling points. Since water quality and flow characteristics for the WBSR-9 discharge are incomplete and a non-treatment means for eliminating the discharge exists (remove the refuse pile) the discharge will not be discussed here.

A total of twelve flow measurements at Weir 12 are included in the Operation Scarlift Report. The average of these flows is 22.8 gpm. However, one exceptionally large flow of 156 gpm skews this average. Excluding this one high flow gives an average flow rate of 10.6 gpm. Flows measured on April 13th and 19th as part of this TAG were 10 and 12.5 gpm respectively.

No reliable historical water quality data are available for the Weir 12 discharge. Data included in the Operation Scarlift Report does not include analysis for Al and Mn so it cannot be used for treatment design. The following table shows the results of sampling performed as part of this TAG.

Weir 12 Water Quality Data

Date	Flow (gpm)	pH	Net Acidity (mg/L)	Total Iron (mg/L)	Total Mn (mg/L)	Total Al (mg/L)	Sulfate (mg/L)
Scarlift*	10.6*						
4/13/06	10.0	3.2	73.1	0.5	0.3	5.2	171
4/19/06	12.5	3.3	66.0	0.5	0.2	5.2	153

*Excludes one high flow measurement, see text.

Treatment Options

Very little water quality data are available for the Weir 12 discharge. Monitoring of both flow and chemistry monthly and after significant precipitation events is necessary before detailed treatment designs can be prepared. A conceptual treatment system design has been prepared based on the limited available data. The system consists of a vertical flow pond (VFP) followed by a settling pond. Compost is not required due to the low observed iron concentration, however additional monitoring may indicate that compost is required. A conceptual plan for a system of this type has been prepared using the following design assumptions.

Weir 12 Treatment Design Assumptions

Discharge Characteristics	
Average Flow (gpm)	12
Maximum Flow (gpm)	30
Net Acidity (mg/L)	58
Total Iron (mg/L)	0.5
Total Manganese (mg/L)	0.2
Total Aluminum (mg/L)	5.2

System Performance	
Excess Alkalinity (mg/L)	60
Alkalinity Generation Rate (g/m^2/day)	40
Design Life (years)	25

A conceptual passive treatment system with a design life of 25 years would include a VFP (without compost) containing 544 tons of limestone. In cross-section this VFP would contain 3 ft of limestone (plus 0.25 ft of bedding stone for plumbing) and 2 ft of standing water. Effluent from the VFP would flow into a settling pond with a water surface area of 748 ft^2 and a capacity of 22,383 gallons. This pond would provide a total of 24 hours retention after 25 years of metals accumulation. The sizing and capacities of each component of the conceptual system are summarized in the following table.

Weir 12 Passive Treatment System Components

Component	Surface Area (ft^2)	Capacity
VFP	5,186	1,310 yd^3
-Compost	0	0
-Limestone	4,098	403 yd^3 (544 Tons)
Settling Pond	748	22,383 gallons

A more innovative, but less studied approach would be a self-flushing limestone pond containing 600 tons of limestone. A self-flushing limestone pond utilizes an automatic dosing siphon to automatically flush solids from the limestone. More information on automatic dosing siphons can be found at www.siphons.com.

Non-Treatment Options
Few, if any source reduction opportunities exist for the Weir 12 discharge. Overall loading to the WBSR may be reduced if the Weir 12 discharge water is excluded from the refuse pile along Deveaux Street thereby reducing flow (and subsequently loading) from the refuse pile.

It is likely that some of the flow from Weir 12 is contributing to the refuse pile discharge flow via leakage in the ditch west of Deveaux Street. Flow at the mouth of the ditch was measured at 15 gpm. This represents a loss of 3 gpm from the 18 gpm measured at the outfall of the Deveaux Street culvert. Any flow lost from this ditch would contribute to the flow of acidic water from the refuse pile. Installing an impervious liner in this ditch would be a beneficial interim project until the refuse pile can be removed.

Since the discharges from the refuse pile (including much of the loading to WBSR-9) can be eliminated by removing the refuse pile, treatment of the discharge is not recommended. Rather, as recommended in previous assessments, the refuse pile should be removed.

Recommendations

- Remove and reclaim the refuse pile along Deveaux Street.
  - Test refuse material for possible use as fuel in cogeneration plant
  - Install impervious liner in ditch along Deveaux Street to reduce discharge flows until pile can be removed.
- Establish a monitoring program for the Weir 12 discharge that includes collection of flow and chemistry data monthly and after significant rain events for one year.
- Design and construct a passive treatment system as part of an overall restoration effort. The relatively minor loading from this discharge makes its treatment a low priority action.

WBSR-7

Discharge Description
The WBSR-7 discharge flows from an abandoned deep mine entry of the B seam (Lower Kittanning) Sterling No. 6 mine. The discharge is located on the north side of No. 6 Road approximately 1,100 ft from Deveaux St. The heading appears to be at least partially collapsed and may be impounding water. Under low to normal flow conditions, all flow is lost into a large refuse pile at the discharge site.

Water Quality and Flow Characteristics
Very little flow was observed during the site visits made as part of this TAG. All flow is lost into spoil within 10 to 20 ft of the point of discharge. Consequently, no flow reached the weir that is located some 50 ft below the entry. A pipe was installed closer to the discharge to allow for flow measurement before the discharge is lost to the spoil.

In addition to the two samples collected as part of this TAG, existing monitoring data include 41 flow measurements and 43 samples collected between November 1994 and September 2001. These data are summarized in the following table.

WBSR-7 Data Summary

	Flow (gpm)	pH	Net Acidity* (mg/L)	Total Iron (mg/L)	Total Mn (mg/L)	Total Al (mg/L)	Sulfate (mg/L)
Average	18.8	2.6	471.2	78.1	1.7	23.1	887
Maximum	45.8	2.9	718.2	159.0	3.5	37.4	1331
Minimum	4.9	2.3	207.8	27.7	0.7	11.7	100
4/13/06	3.0	2.6	342	35.3	2.1	23.3	838
4/19/06	0.6	2.6	351	40.2	1.9	22.6	870

*Calculated based on metals concentrations and pH

The WBSR-7 discharge is characterized by high iron and aluminum concentrations and depressed pH. There is no relationship between flow and chemistry. Although the chemistry is severe, the loading produced by this discharge is minor. Loadings are shown in the following table.

WBSR-7 Loading

	Acidity	Iron	Aluminum
Average Load (ppd)	10.5	18.1	5.1

Treatment Options

The impact of this discharge on the WBSR is minimal when compared to that of the numerous other sources in the headwaters of the WBSR. Treatment of the WBSR-7 discharge is the lowest priority watershed remediation action.

High iron and aluminum concentrations in the WBSR-7 discharge will make reliable passive treatment a challenge. A vertical flow pond with compost (also known as SAPS or RAPS) would be appropriate for water of this quality. A conceptual plan for a system of this type has been prepared using the following design assumptions.

WBSR-7 Treatment Design Assumptions

Discharge Characteristics	
Average Flow (gpm)	20
Maximum Flow (gpm)	50
Net Acidity (mg/L)	471
Total Iron (mg/L)	78
Total Manganese (mg/L)	2
Total Aluminum (mg/L)	23

System Performance	
Excess Alkalinity (mg/L)	60
Alkalinity Generation Rate ($g/m^2/day$)	40
Design Life (years)	25

A conceptual passive treatment system with a design life of 25 years would include a VFP with compost containing 5,200 tons of limestone and 720 yd^3 of limestone amended compost. In cross-section this VFP would contain 3 ft of limestone (plus 0.25 ft of bedding stone for plumbing), 1 ft of compost and 2 ft of standing water. Effluent from the VFP would pass through an aeration drop before entering a series of two settling ponds. The two identical settling ponds would each have a water surface area of 4,600 ft^2 and a capacity of 140,000 gallons. These ponds would provide a total of 24 hours retention after 25 years of metals accumulation. Following the settling ponds would be a 10,000 ft^2 wetland for final metals polishing. The sizing and capacities of each component of the conceptual system are summarized in the following table.

WBSR-7 Passive Treatment System Components

Component	**Surface Area (ft^2)**	**Capacity**
VFP	38,824	11,460 yd^3
-Compost	35,735	720 yd^3
-Limestone	34,239	3,843 yd^3 (5,188 Tons)
Settling Ponds (each, 2 total)	4,600	140,000 gallons
Wetland	9,600	36,000 gallons

Non-Treatment Options

Few source reduction opportunities exist for the WBSR-7 discharge. At best flow from the discharge could be piped beyond the refuse to prevent additional acidity generation within the refuse until a treatment system is installed. Construction of the treatment system could be combined with removal or reclamation of the refuse on the site.

Recommendations

- Sufficient water quality and flow data exist to prepare detailed treatment design. However, loading contribution from this discharge is small in relation to other discharges in the watershed.
- Consider installation of a pipeline to convey the discharge beyond the refuse on site until a treatment system is installed. This would require approximately 200 ft of trenching and 4" pipe to accomplish.
- As the final step in a watershed remediation effort, design and construct a passive treatment system for the WBSR-7 discharge.

Prioritized Watershed Restoration Actions

1. Continue to collect water quality and flow data for all discharges.
2. Pipe WBSR-2 discharge downstream ~1,500 ft to proposed treatment location (present refuse pile) and install flow measurement device.
    a. Monitor discharge water quality and flow rate for one year and after significant precipitation events.
    b. Remove and reclaim refuse piles on proposed treatment location (concurrent with 2.a.).
    c. Design and construct passive treatment system for WBSR-2 discharge.
3. Investigate options for sealing the WBSR-5 discharges.
    a. Perform sealing if feasible
    b. Monitor discharges then design and construct treatment system if required
4. Remove refuse piles between No.6 Road and Goodway Road.
5. Design and construct a passive treatment system for the Weir 12 discharge.

    a. Could potentially utilize the refuse pile site for construction after removal of the pile between No 6 Road and Goodway Road.
6. Design and construct a passive treatment system for the WBSR-7 discharge.
7. Perform biological assessments to determine if aquatic ecosystem recovery is taking place. Biological assessments should be performed at various steps in the restoration effort in order to quantify improvement.

Water Quality and Flow Data Collected Under TUTAG 16

SAMPLE ID	DATE	FLOW gpm	FIELD pH	LAB pH	COND. umhos	TEMP DEG C	ALK. mg/L	FIELD ALK mg/L	NET ACIDITY mg/L	IRON TOTAL mg/L	IRON DIS. mg/L	MANG. TOTAL mg/L	MANG. DIS. mg/L	ALUM. TOTAL mg/L	ALUM. DIS. mg/L	SO4 mg/L	TSS mg/L
WBSR-2 Upstream	4/19/06	306	7.35	7.94	479		102.9	90.0	-85.7	0.2		0.0		0.1		84.7	1
WBSR-2	4/13/06		5.71	5.60	666	11.7	14.1	7.0	32.9	18.0		0.6		2.0		347.4	16
WBSR-2	4/19/06		5.80	6.00	610		18.1	25.0	11.6	14.7	14.7	0.5	0.4	1.8	0.9	295.0	5
WBSR-2 Downstream	4/13/06		6.20	6.29	496		52.6	60.0	-32.1	6.0		0.2		0.5		121.1	13
WBSR-2 Downstream	4/19/06	462	6.16	6.69	537		58.4	68.0	-45.1	7.4	6.5	0.3	0.2	0.7	0.3	156.0	7
WBSR-5A	4/13/06	12	2.90	2.96	1429	21.1	N.D.		166.5	33.8		2.0		3.2		512.0	2
WBSR-5A	4/19/06	11	2.95	3.02	1426	17.7	N.D.		174.2	46.3	41.7	1.9	1.9	3.3	3.0	232.3	6
WBSR-5B	4/13/06	3	5.27	5.72	1009	17.1	12.4	21.0	116.8	65.2		2.6		0.2		571.2	9
WBSR-5B	4/19/06	2	5.98	5.71	1025	15.0	6.1		108.2	66.4	65.4	2.5	2.5	0.2	0.1	280.6	4
WBSR-5C	4/13/06	4	3.44	3.39	1535		N.D.		289.1	102.1		2.5		14.8		862.1	9
WBSR-5C	4/19/06	2	3.30	3.12	1608	10.3	N.D.		295.4	85.0		2.3		17.5		768.0	3
WBSR-5D	4/13/06	14	5.80	5.71	1577	14.6	29.5	50.0	249.9	176.0		2.9		0.3		873.7	10
WBSR-5D	4/19/06	14	5.67	5.90	1550	12.1	26.2	62.0	212.5	141.0		2.9		0.5		864.7	6
WBSR at No.6 Road	4/19/06	826	6.15	6.19	591		7.8	39.0	3.3	3.8		0.5		2.1		247.9	8
WBSR-7	4/13/06	3	2.49	2.64	1940	11.8	N.D.		388.9	35.3		2.1		23.3		838.7	8
WBSR-7	4/19/06	1	2.68	2.64	1993	12.40	N.D.		397.1	40.2		1.9		22.6		870.7	1
Weir 12	4/13/06	10	2.39	3.24	511	11.8	N.D.		73.1	0.5		0.3		5.2		171.2	2
Weir 12	4/19/06	13	3.39	3.28	513	11.20	N.D.		66.0	0.5		0.2		5.2		153.6	1
WBSR at Goodway	4/19/06	1001	4.91	4.56	613		0.3	3.0	27.2	3.4		0.9		4.5		269.6	7

West Branch Susquehanna Rescue
TUTAG-16

Interim Project Report: 5A/5B Conceptual Treatment Plan

The purpose of this report is to discuss the existing data and conceptual treatment plan for discharges 5A and 5B and to present an alternative conceptual plan.

Caveats and Recommendations for Going Forward

The data and conceptual plan presented in this report are based on several assumptions, which are discussed in the following sections. Recommendations for treatmetn have been made without the benefit of a site visit. In order to complete the design of the treatment complex that is described below, the following should take place:

- Continued sampling of chemistry at each distinct discharge. Samples should be taken as close to the discharge points as possible. Care should be taken to collect "clean" samples without suspended particles. Ideally, the discharges should be sampled quarterly for one year.
- Flow measurements of each distinct discharge. Ideally, flows should be measured monthly for a year.
- A field visit by Hedin Environmental personnel to view the site
- Limestone incubation tests of 5A(083) and 5B to predict the performance of ALDs.
- The watershed group should work with the landowner(s) to get permission for the project.

Existing Data and Assumptions

There appear to be 3 distinct sources of mine drainage on the site. Site 5A(084) originates as a distinct source just above Mitchel Road. Site 5A(083) originates as a diffuse area of seepage just below Mitchel Road, approximately 140 feet east/southeast of 5A(084). Site 5B originates as a diffuse area of seepage just below Mitchel Road, approximately 500' east/southeast of 5A(083).

Historically, the combined flow of 5A(803) and 5A(804) were sampled at a single weir after they combined. Good flow rate information is available for the combined flow. However, very limited chemistry and no flow rates exist for the 5A discharges at their source. For the purposes of this discussion, the following assumptions will be used:

Point	Ave. Flow (gpm)	High Flow (gpm)	Total Iron (mg/L)	Al (mg/L)	Net Acid (mg/L)
5A(084)	16	26	80	15	320
5A(083)	16	26	55	<0.5	115
5B	7	17	65	<0.5	170

Note that these chemistry results must be verified. The reported metals concentrations would result in an acidity that is lower than what is reported.

For 5B, existing flow and chemistry information from the restoration plan was used. For 5A(804) and 5A(803), it was assumed that the historical flow rate at the combined weir was split evenly between the two discharges.

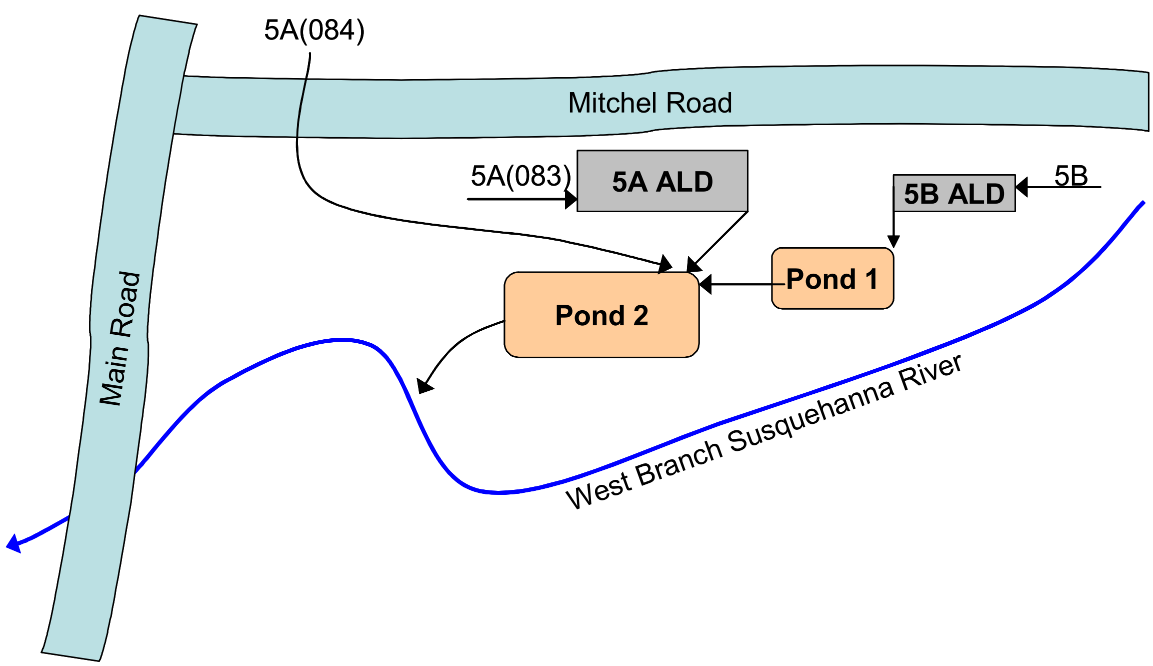
This assumption appears to be valid when samples taken on 8/11/05 at each source are examined in comparison with the combined chemistry at the weir.

5A(083) and 5B appear to be well-suited for treatment using anoxic limestone drains (ALDs). ALDs are one of the most proven and reliable passive treatment methods. ALDs are very successful in treating water with low aluminum and low Fe^{3+}. Sample results taken from the discharges (not from downstream combined weirs) indicate that both discharges qualify for treatment using this method.

The chemistry of 5A(084) is not suitable for treatment using an ALD. While it would be possible to construct a vertical flow pond (VFP) or other passive system that is more suited for treating aluminum, another approach would be to use the excess alkalinity generated by ALDs on the other two discharges to neutralize the acidity in 5A(084). This option is preferred because the aluminum does not have to be directly treated.

Conceptual Treatment Design

The following design is recommended for the site based on the flow and chemistry assumed above. The design discussed below is shown schematically in the following figure. Note that this conceptual design was developed without the benefit of an on-site visit.



Two small ALDs should be constructed. The 5A(083) discharge requires 600 tons of limestone and the 5B discharge requires 330 tons of limestone. This quantity of limestone will provide sufficient treatment of the discharges for at least 25 years before more limestone needs to be added. Construction of the ALDs will require collection of the two diffuse seep zones in French drains. The water will then flow to the buried ALDs.

Because the 5B discharge is 10’ higher in elevation than the other 2 discharges, it is advisable to discharge the 5B ALD to its own pond (Pond 1 as shown above). This pond will be approximately 800 square feet of open water (4' deep) and 800 square feet of wetland (0.5' deep). This will remove the iron to a concentration of less than 3 mg/L. Excess alkalinity of approximately 110 mg/L should be present in the Pond 1 effluent.

The flow from Pond 1 will be mixed with the flow from the 5A(083) ALD and the untreated 5A(084) water in Pond 2. This pond will be approximately 3,0000 square feet of open water (4' deep).

Based on the flow and chemistry above and assuming that the ALDs generate 280 mg/L of alkalinity, 100% of the Al and 79% of the acidity from the three discharges will be treated. The discharge from the pond would have approximately 44 mg/L acidity and 20 mg/L iron.

Therefore, it may be desirable to follow Pond 2 with a constructed wetland that contains limestone fines in the substrate, with an open limestone bed, or with another small treatment cell to remove the remaining acidity and iron. However, since many assumptions about the quality and quantity of the discharges have been made (and because the metals and acidity numbers to not agree), further sampling should be performed before final conclusions are made.

Permitting

It will be possible to construct the proposed treatment system with minimal encroachment on the existing wetlands and the 50' stream barrier. It has been assumed in the following cost estimate that permitting will consist of a wetland delineation, Erosion and Sediment Control Plan, PNDI, PHMC, and county notifications, and limited DEP permitting requirements. A wetland delineation is necessary in order to determine if a Joint Encroachment Permit will be required. The costs in the following section assume that a Joint Permit will not be required.

This is a substantial change from the original design. The original design for the site involved significant stream channel realignment, significant work in an existing wetland, and numerous incursions into the 50' stream barrier. These items would require a full-scale Joint Encroachment Permit and substantially increase the cost and time requirements for permitting the site.

Cost Estimate

The following cost estimate has been prepared based on the conceptual design. Note that the actual cost of construction may vary if the design changes substantially based on new data and/or flow rate information.

Item	**Cost Estimate**	**Notes**
930 tons AASHTO #1 Limestone	$28,000	2 ALDs, Installed
Pond 1, Excavation	$3,000	Mostly cut
Pond 2, Excavation	$8,000	All cut
Channels and Water Collection	$16,000	2 French Drains, several channels
Plumbing and Geotextile	$5,000	Fabric ALD liners, ALD pipes, etc
E&S and Revegetation	$3,000	
Total, Construction	**$63,000**	
Design/Permitting/Oversight	$25,000	Includes review of all data, wetland delineation
TOTAL	**$88,000**	