Hamilton Passive System and Potato Garden Run Evaluation Report

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Project Background

The Hamilton Passive System, one of five passive treatment systems in the Raccoon Creek watershed, is located in Findlay Township, Allegheny County within the Potato Garden Run sub-watershed. Potato Garden Run was placed on the 303(d) list of impaired waters in 1996 due to AMD impacts. A Total Maximum Daily Load for the watershed was completed and approved in 2003. Applicable water quality criteria goals identified in the TMDL are presented in Table 1.

Table 1. TMDL Applicable Water Quality Criteria

Parameter	Criterion Value
Aluminum - Total	0.75 mg/L
Iron - Total	1.5 mg/L
Iron - Dissolved	0.3 mg/L
Manganese - Total	1.0 mg/L
pH	6.0 – 9.0 standard units

The Hamilton Passive System was installed to treat an abandoned mine discharge known as Hamilton 3 (H3) that emanates from an underground coal mine located beneath a landfill owned by the Mazzaro Coal and Disposal Co. The H3 Discharge was identified in the Raccoon Creek Watershed Abandoned Mine Drainage (AMD) Survey and Preliminary Restoration Plan as one of 7 primary discharge sites in the Raccoon Creek watershed that need to be treated. Reportedly, the discharge location developed when the operator of the landfill accidentally broke into the abandoned underground coal mine during installation of either a diversion/collection channel or leachate collection system.

In 2002, a passive treatment system was designed by the Pennsylvania Department of Environmental Protection Bureau of Abandoned Mine Reclamation (PADEP BAMR) under contract # AMD02(0642)101.1. The system was constructed in 2003 as part of a public-private partnership effort that included the Washington County Conservation District (WCCD), Raccoon Creek Watershed Association (RCWA), Independence Conservancy (IC), and PADEP BAMR with funding provided by the Pennsylvania Turnpike Commission, US Office of Surface Mining and other sources.

The Hamilton system was the pride and joy of the RCWA who used the site as a show piece for providing education programs related to AMD, passive treatment, watershed restoration, etc. (See Photos). In addition, the treatment system was regularly monitored by the PADEP and meticulously maintained by the RCWA, IC, and the WCCD until the property was sold to Alan Eberhardt ca. 2008. Even though there had been a recorded easement, after purchasing the property, Eberhardt refused to allow access to the site by anyone, including the PA DEP, which prevented maintenance from occurring. In addition, the system was damaged and vandalized during this time with construction materials and other heavy debris dumped into the ponds and channels (See Photos).

Several years later, the property was purchased by Edward Novak who contacted the Washington County Conservation District regarding noticeable problems with the system. The WCCD contacted Stream Restoration Incorporated (SRI) in June 2012 to request technical assistance through SRI's Operation & Maintenance Technical Assistance Grant (O&M TAG) program. A site investigation was conducted on 8/14/12 to assess the effectiveness of the treatment system, identify maintenance/repair needs, collect water samples, etc. In addition, historical water quality data was compiled and reviewed. Based on the available data at the time, the system often did not perform well and it was believed that the passive system needed to be repaired and expanded. Initially, Mr. Novak supported rehabilitation and expansion of the system and even gained the support of Mazzaro Coal & Disposal Co. who was willing to allow access to their property in order to capture and pre-treat the AMD before entering the existing passive system. A partnership was formed to repair and expand the passive system. Growing Greener applications were submitted in 2012 and 2013. An ACT 13 grant application was also submitted in 2013. None of the grant applications were approved.

Upon contacting the PA DEP, the following reasons were provided as to why the project was not funded:

- Available data did not indicate whether expanding the system would partially or fully restore Potato Garden Run;
- Available data did not present a clear understanding of the current characteristics of the mine pool. Inconsistencies in the sampling data and breaks in time between data have shown possible drastic changes in water quality over time;
- Reviewer was concerned about the ability to passively treat the discharge;
- Reviewer felt unsure of the benefit due to lack of stream water quality data;

Pam Milavec of PA DEP BAMR recommended that water monitoring be conducted monthly for one year to develop a better understanding of the current water quality and flow rate of the discharge. Also, additional stream water monitoring was recommended to have a better understanding of the environmental benefits especially in terms of miles of stream restored and to what level of restoration has been obtained and what further improvements could be achieved.

Funding was obtained in the summer of 2014 through a grant from the Foundation for Pennsylvania Watersheds to conduct monthly water quality monitoring of the discharge, treatment system, and receiving streams for one year to document the current water quality characteristics and evaluate the potential need/benefits of expanding the system. In addition, a conceptual design and cost estimate was to be developed based upon the new data obtained during this project to be used to prepare future grant proposals. Shortly after the project began, an opportunity arose to fund the maintenance, system expansion, and a long-term O&M fund via a reclamation-in-leu-of-fee associated with a violation by a natural gas company. A conceptual design (See attached) and cost estimate were developed. Unfortunately, negotiations to obtain landowner agreements with the two landowners dissolved and all future work at the Hamilton system was terminated by the landowners including water monitoring of the passive treatment system. The funds from the gas company were then transferred to the Milk Run project in the nearby Montour Run watershed. In June 2015, Stream Restoration Incorporated requested permission from the Foundation to utilize the remaining funds to expand water monitoring efforts to include a limited number of sampling events at strategic locations within the Potato Garden Run watershed to help identify and document the need for other restoration efforts.

This final report provides an evaluation of the Hamilton Passive System based on available data as well as a brief evaluation of the current conditions of Potato Garden Run.

Hamilton Passive System Evaluation

An evaluation of the discharge and the performance of the existing Hamilton passive system was conducted utilizing both available historic data and new water quality data collected from November 2014 through May 2015 covering both low and high flow periods. In addition, site investigations had been conducted to identify maintenance issues. All data is available on the website Datashed (http://www.datashed.org/hamilton).

Presumably, the original system was designed based on water quality data collected by the PA DEP from May of 1998 through June of 2000. There appears to be a break in available water monitoring data from June 2000 until the summer of 2003. Table 2 provides average, median, minimum and maximum water quality data of the discharge for select parameters during this time period (1998-2000) which is drastically different than the water quality data collected following installation of the treatment system as provided in Table 3.

Table 2. Water Quality of the Hamilton H3 Discharge 1998-2000

Statistical Parameter	Lab pH	Lab Alkalinity	Hot Acidity	Total Iron	Total Aluminum	Total Manganese	Sulfate
AVG	5.9	20	72	45	0	6	703
MED	5.9	20	64	42	0	6	709
MIN	5.3	11	0	4	0	3	408
MAX	6.5	40	122	76	0	9	924

pH in standard units; concentrations in mg/L

Table 3. Water Quality of the Hamilton Discharge 2003-2012

Statistical Parameter	Flow	Lab pH	Lab Alkalinity	Hot Acidity	Total Iron	Total Aluminum	Total Manganese	Sulfate	TSS
AVG	69	5.1	19	236	206	1.1	8	1085	71
MED	60	5.5	10	166	160	0.2	7	852	73
MIN	5	2.8	0	86	62	0.2	6	97	10
MAX	200	6.1	156	1513*	580	21	16	2481	152

*Flow in gallons per minute (gpm); pH in standard units; concentrations in mg/L; *Acidity 1513 mg/L reported on 11/1/04 by DEP lab may be spurious*

In comparison, Table 3 provides statistical water quality values for the raw, untreated discharge collected from June 2003 through August 2012. Based upon this second sample set, the discharge would be described as a net-acidic (typically having some alkalinity), iron-bearing discharge with elevated concentrations of manganese. As can be seen, the flow rate is quite variable from 5 gpm to probably over 200 gpm with total iron concentrations varying from 60 mg/L to over 600 mg/L. While the average flow rate is similar to what was reported in the restoration plan, the average iron concentration had increased nearly 5 fold (5x) from 45 mg/L to 206 mg/L and the average acidity concentration had increased 3 fold (3x) from 72 mg/L to 236 mg/L. During the period from November 2004 to October 2005 the average iron concentration was 368 mg/L which was an 8 fold (8X) increase over the data collected from 1998 to 2000. The cause of this drastic change in water quality is not fully understood; however, changes to the mine pool from local road construction activities (Findley Connector) and/or two hurricanes (Francis and Ivan in 2004) as well as possible sampling errors are likely culprits as the following additional data analysis reveals.

Note in Table 3 that the total suspended solids (TSS) are frequently excessive and the metals are presented as total metal concentrations indicating that the samples probably often contained metal solids, which could very well skew the data to appear to have higher metal concentrations than the actual values of the discharge. Comparing the total metal values with the alkalinity and acidity values also suggests that the total iron content may be significantly contributed to by sediment with the dissolved iron fraction being much lower. This could potentially be caused by disturbing the substrate during water sample collection or may just indicate a high metal solids content.

In addition, there appears to be a trend in the discharge data in which the iron concentrations drastically increase (300-600 mg/L) for about a period of 1 year starting around the time the system was being constructed and then begin to decrease. Reportedly, this increase followed construction activities associated with the PA Turnpike Commission Findley Conductor project. In addition, much of this monitoring occurred following Hurricanes Ivan and Francis in 2004. After this 1-year period, iron concentrations typically drop off to much lower values (160-300 mg/L). Nearly half, however, of all the available sampling events were conducted during the period of higher iron concentrations. This can also significantly skew the data. If the data before 2007 are removed from the sample set, the average total iron concentrations in the water drops from 393 mg/L to 170 mg/L. In 2012, during the initial investigation, one of the questions that remained and still somewhat remains is whether the water quality will continue to improve or whether it has developed a certain “level of equilibrium” and what are the chances that the water quality could get worse again in the future due to disturbances within the mine pool.

Table 4 provides the average water quality of the Hamilton passive treatment system (see Conceptual Design for sample point locations) from 2004-2012 where RAW is the mine discharge issuing from the abandoned underground mine on the landfill property, H3 is the water entering the passive treatment system, VFW is the effluent of the Vertical Flow Pond and SP is the effluent of the Settling Pond, which is also the final system effluent. With such a drastic change in water quality of the discharge, the passive system, which was designed based upon the 1998-2000 data provided in Table 2 could not have been expected to fully treat the AMD. As can be seen, on average, the final water quality leaving the system was net-acidic with significant iron content.

The basic data suggested that the average value for iron may not be the best parameter to describe central tendency due to the extremely high iron content in the water during the first two years of operation. Again, from 2007 onwards, the iron concentrations have been significantly less. As described above, if you remove the data before 2007, the average total iron concentrations in the RAW drops from 393 mg/L to 170 mg/L and the final effluent drops from 117 mg/L to 29 mg/L. In addition, a number of sampling events indicated net-alkaline or near net-alkaline final effluent. Nonetheless, the data during this time period indicated that additional treatment components were needed.

Table 4. Average Water Quality Characteristics of the Hamilton Treatment System 2004-2012

Sample Point	Field pH	Lab pH	Field Alk.	Lab Alk.	Hot Acidity	Total Iron	Total Aluminum	Total Manganese	Sulfate	TSS
RAW	NM	5.3	NM	58	228	343	0.5	6	1360	103
H3	6.0	5.0	NM	12	238	216	1.1	7	1120	57
VFW	6.7	5.9	117	38	12	132	0.4	7	992	38
SP	5.8	4.2	53	9	86	117	0.4	7	922	26

pH in standard units; concentrations in mg/L

During the initial site investigation conducted by BioMost, Inc. on 8/14/12, the existing system was sampled for the first time in 3 years. Field testing was conducted and water samples were collected. Field tests included pH, alkalinity, ORP and DO. A comparison of the water quality data collected on this date (Table 5) with historic data provided further evidence that the quality of the discharge was probably changing over time with significantly decreased iron and acidity concentrations. Possibly the most interesting and compelling difference is the final effluent quality. This was one of several known sampling events which documented the existing passive treatment system as producing net-alkaline water, although iron and manganese concentrations remained elevated. Interestingly, the other documented known instances were in 2008 and 2009 providing further evidence that the water quality has improved and, at times, the existing system is able to greatly reduce pollutant loading. Based on the available data at the time, BioMost concluded that providing additional alkalinity source(s) and additional capacity for the precipitation and settling of metal solids, the system would likely produce good quality alkaline water with circum-neutral pH and low metal concentrations, but also noted that additional water monitoring would be needed to further verify the change in the raw water and level of success of the existing system before the final design is completed.

Table 5. 8/14/12 Water Quality Characteristics of the Hamilton Treatment System

Sample Point	pH		Alkalinity		Hot Acidity	Iron (T/D)	Aluminum (T/D)	Manganese (T/D)	Sulfate	TSS
	Field	Lab	Field	Lab						
RAW	5.7	5.9	238	156	136	204/198	0.2/<0.04	8/6	699	48
H3	6.3	5.6	118	18	100	146/102	0.1/0.04	8/6	688	113
VFW	6.7	6.2	136	66	-33	68/56	0.1/0.04	10/9	737	99
SP	6.9	6.4	76	55	-39	18/16	0.1/0.04	9/8	753	25

pH in standard units; concentrations in mg/L; both total and dissolved (T/D) metals are provided

During the 8/14/12 sampling event, additional RAW water was collected in order to conduct two cubitainer tests. A cubitainer test, essentially a container filled with limestone aggregate, is used in the design process in order to evaluate the expected alkalinity generation in conditions similar to an Anoxic

Limestone Drain (ALD). The container is left undisturbed for at least 10-15 hours to mimic standard design parameters for ALDs and then the alkalinity and pH are re-measured. Test results indicated that the alkalinity increased from 240 mg/L to 350 mg/L after 10 hours and from 240 mg/L to about 360 mg/L after 18 hours. Dissolved Oxygen measured in the field was 0.20 mg/L. As the pH of the water was greater than 3.5, all dissolved iron is assumed to exist in the ferrous (Fe^{+2}) state. All data indicated that an ALD was suitable for this site. Based on the existing historic water quality data, an ALD alone, however, would probably not be able to produce enough alkalinity to provide net-alkaline water, therefore, the existing Vertical Flow Pond would likely still be needed. The initial analysis also indicated that additional area would be needed to expand the amount of settling ponds and wetlands for iron removal.

As part of this project, water monitoring of the Hamilton passive system was conducted monthly for seven months from November 2014 until May 2015 when the landowners revoked their permission to access the property. The data collected during this time is provided in Table 6. The results were astonishing. The water quality of the RAW discharge had significantly improved compared to data collected from 2004 to 2012 with average Total Iron and Hot Acidity concentrations about 60% and 74% less respectively. The water quality had even significantly improved since the 2012 investigation that may indicate the water quality is still improving and moving towards the original discharge characteristics monitored from 1998 to 2000. As the quality of the discharge had improved, the system was now better able to provide much better treatment. Almost 40% of the iron is being removed in the wetland that has developed between the RAW discharge point and the water entering the VFP at sample point H3. Despite the condition of the Vertical Flow Pond, it is now consistently producing net-alkaline water. The final effluent of the system sampled at the Settling Pond (SP) can be described as net-alkaline water with neutral pH and relatively low metal concentrations. The system is neutralizing 100% of the acidity and removing 98% of the iron and almost half of the manganese. While the system could certainly benefit from maintenance and additional metal removal capacity in the form of settling ponds and wetlands, the system is performing amazingly well now and will likely continue to perform well as long as the water quality of the discharge does not change again and the system is properly maintained.

Table 6. Water Quality Characteristics of the Hamilton Treatment System 2014-2015

Sample Point	Flow	pH		Alkalinity		Hot Acidity	Iron (T/D)	Aluminum (T/D)	Manganese (T/D)	Sulfate	TSS
		Field	Lab	Field	Lab						
RAW	69	6.1	5.8	248	197	59	142/126	0.2/0.2	5.8/5.6	596	25
H3	68	7.0	6.0	102	41	14	56/48	0.1/<0.1	5.5/5.3	620	50
VFW	68	7.2	6.9	113	104	-79	5.6/4.7	0.1/0.1	4.1/3.9	545	10
SP	69	7.6	7.5	105	111	-86	3.2/2.2	0.1/<0.1	3.2/3.1	518	14

Flow in gallons per minute (gpm); pH in standard units; concentrations in mg/L; both total and dissolved (T/D) metals are provided

Monthly water monitoring was also conducted to document the impact of the passive system to the unnamed "Hamilton" tributary and Potato Garden Run. A map of all sampling point locations has been provided. The effluent of the Hamilton passive system forms a water course that flows approximately 1200 feet, then through a culvert under Washington Road and into the unnamed "Hamilton" tributary. While other sources of water likely contribute to the water course, it primarily consists of the treated AMD. Water samples were collected at the end of the water course at the road culvert (247-7) as well as immediately upstream (247-6) and downstream (247-5) along the "Hamilton" tributary. The data is provided in Table 7. As the effluent of the passive system is the main source to the water course (247-7) and does contain slightly elevated iron (mostly particulates), manganese and sulfate concentrations, there is a slight immediate impact to the "Hamilton" tributary, but overall the water quality meets typical TMDL goals.

Table 7. Impact of the Hamilton Passive System on the Unnamed "Hamilton" Tributary 2014-2015

Sample Point	Flow	pH		Alkalinity		Hot Acidity	Iron (T/D)	Aluminum (T/D)	Manganese (T/D)	Sulfate	TSS
		Field	Lab	Field	Lab						
247-6	317	7.9	7.7	117	112	-88	0.6/0.1	0.2/<0.1	0.4/0.4	199	12
247-7	179	7.9	7.8	103	99	-81	1.8/0.1	0.2/<0.1	2.2/2.0	397	11
247-5	583	7.9	7.7	115	109	-85	0.7/0.1	0.2/<0.1	0.8/0.7	236	9

Flow in gallons per minute (gpm); pH in standard units; concentrations in mg/L; both total and dissolved (T/D) metals are provided

Water samples were also collected at the mouth of the "Hamilton" tributary (247-4) as well as immediately upstream (247-3) and downstream (247-2) on Potato Garden Run. The data is provided in Table 8. While the data might suggest that the "Hamilton" tributary is negatively impacting Potato Garden Run, the data is slightly skewed by the fact that sample point 247-3 has more samples collected over time including two sampling events when iron and aluminum concentrations were less than 1 mg/L. When comparing individual sampling dates when both upstream and downstream were sampled, typically the "Hamilton" tributary slightly improves Potato Garden Run or has no measurable impact. Regardless of the limited impact of the "Hamilton" tributary, Potato Garden Run is significantly impacted by AMD sources upstream, which is further discussed in the Potato Garden Run section of this report.

Table 8. Impact of the Unnamed "Hamilton" Tributary on Potato Garden Run 2014-2015

Sample Point	n	Flow	pH		Alkalinity		Hot Acidity	Iron (T/D)	Aluminum (T/D)	Manganese (T/D)	Sulfate	TSS
			Field	Lab	Field	Lab						
247-3	10	3680	7.7	7.6	102	98	-75	5.4/0.9	2.8/0.1	2.8/2.6	1140	38
247-4	7	1570	7.9	7.8	98	96	-79	0.6/<0.1	0.4/<0.1	0.4/0.4	316	13
247-2	6	NA	7.6	7.6	120	104	-71	7.1/0.9	3.4/0.1	2.5/2.3	983	60

Number of samples (n); flow in gallons per minute (gpm); pH in standard units; concentrations in mg/L; both total and dissolved (T/D) metals are provided

Hamilton Passive System Recommendations

The monitoring data conducted in 2014 and 2015 indicated that the system was producing relatively good water that is likely due to the improved quality of the discharge and the development of the wetland in between the raw source and H3. At this time, there does not appear to be a need to expand the system assuming that the water quality does not change again for the worse. If the water quality of the discharge were to once again become much worse, the attached conceptual design that had been developed may provide sufficient treatment, although there would likely be a need to reevaluate. The cost of constructing the system is estimated to be about $725,000 plus additional funding will be needed for final design, permitting, and construction oversight.

It has now been 3 years since the last set of samples of the system were collected, therefore the current status of the system is unknown. An effort has recently begun to contact the landowner to try to re-establish a good relationship that will allow for regular monitoring and maintenance of the treatment system. At the time of writing this report, that relationship has not been successfully established. It is likely that many of maintenance items identified in 2012 still exist and should be addressed. Completing these items may also help to improve the relationship with the landowner. Those maintenance items include:

- The existing outlet structures of the VFP and SP need to be replaced.
- The sampling dock at the existing SP needs to be replaced or removed.
- Construction/misc. debris dumped into the VFP and SP needs to be removed.
- Iron sludge on top of the VFP will need to be removed in the future.
- Sections of the split-rail fence and gates needs repaired/replaced.
- Large brush and trees along the fence line needs to be cleared.
- Existing access road is in need of repair including placement of additional stone.

SRI’s O&M TAG program could likely address a portion of these maintenance items, but additional funding would likely be needed. The estimated cost for these items is approximately $20,000 except for the sludge and debris removal and stone for the access road. These items have not been included in the estimate due to several unknown factors that would significantly impact the estimate.

Potato Garden Run Evaluation and Recommendations

After the negotiations to obtain landowner agreements dissolved, access to the treatment system for water monitoring was no longer permitted by the landowner. In June 2015, Stream Restoration Incorporated requested permission from the Foundation to utilize the remaining funds to expand water monitoring efforts to include a limited number of sampling events at strategic locations within the Potato Garden Run watershed to document the need for other restoration efforts. A plan was developed that included both new and existing monitoring points. Sampling events were conducted in October 2015, March 2016, and June 2016 to capture low, high and “base” flow conditions. Sample point locations are identified on the Potato Garden Run Water Sample Map. Data is available on Datashed (https://www.datashed.org/potatogardenrun).

The majority of the samples collected were along Potato Garden Run. The data is provided in Table 9. The furthest upstream sample point (247-12) was collected about 100 feet upstream of where the PGD1 coal refuse discharge enters the stream. In this part of the watershed, Potato Garden Run flows through a wetland area with large coal refuse piles located on each side of the valley. Even though the water has a good pH and is net-alkaline, the stream at this location is being impacted by AMD as evidenced by elevated metals and sulfate concentrations. This sample point should probably have been located further upstream although it may have still been impacted. While there are likely multiple discharges, seeps, and coal refuse sediment entering Potato Garden Run, the largest known source that has been historically viewed as the primary source of pollution is the PGD1 AMD discharge which collects at the base of the western coal refuse pile and then flows through a culvert under Potato Garden Run Road and then into Potato Garden Run. The discharge and the impact to the stream is quite visible in aerial photographs (See photos). As the stream is highly alkaline, it has sufficient buffering capacity to neutralize all of the acidity and the metals quickly begin to precipitate within the stream as evidenced by the next downstream sample point 247-10 (See photos), which is located at Burgettstown Road next to the Westport Area Booster Station where essentially all of the aluminum is in the solid form and Total Suspended Solids (TSS) are high. As the stream flows in a generally northern direction through wetlands and combines with better sources of water, metal precipitates continue to form and settle along the stream bottom thus slowly improving the water quality of Potato Garden Run (247-11), but destroying the benthic habitat. As discussed earlier the "Hamilton" tributary (247-4) enters and generally improves Potato Garden Run about 50 feet downstream of sample point 247-3 and 100+ feet upstream of sample point 247-2. While the stream is greatly improved, it remains impacted even as far downstream as 247-1 and really does not meet TMDL goals identified in Table 1 until sometime between sample point 247-9 monitored at the Hebron Strouss Road bridge and sample point 247-8 at Clinton-Frankfort Road bridge close to the mouth.

Table 9. Potato Garden Run Water Monitoring 2014-2016

Sample Point	n	Flow	pH		Alkalinity		Hot Acidity	Iron (T/D)	Aluminum (T/D)	Manganese (T/D)	Sulfate	TSS
			Field	Lab	Field	Lab						
247-12	2	200	7.6	7.8	403	362	-345	2.1/0.5	1.7/0.2	4/4	1426	23
PGD1 (AMD)	3	30	3.7	3.5	0	0	315	125/119	15/15	19/18	2628	31
247-10	3	500	6.7	6.5	126	90	-59	25/18	18/0.1	6/6	1773	97
247-11	3	NM	6.7	7.3	75	83	-64	8/3	4/<0.1	5/5	1537	36
247-3	10	3680	7.7	7.6	102	98	-75	5.4/0.9	2.8/0.1	2.8/2.6	1140	38
247-4 Hamilton Trib	7	1570	7.9	7.8	98	96	-79	0.6/<0.1	0.4/<0.1	0.4/0.4	316	13
247-2	6	NA	7.6	7.6	120	104	-71	7.1/0.9	3.4/0.1	2.5/2.3	983	60
247-1	10	4100	7.8	7.7	103	97	-69	2.3/0.1	1.4/0.1	7.8/1.5	954	18
247-9	3	2700	8.2	7.9	90	89	-74	0.9/<0.1	0.8/<0.1	0.8/0.8	793	5
247-8	3	2500	7.9	7.9	113	88	-72	0.1/<0.1	0.2/<0.1	0.5/0.4	721	3

Number of samples (n); Flow in gallons per minute (gpm); pH in standard units; concentrations in mg/L; both total and dissolved (T/D) metals are provided

While there are likely other sources of mine drainage within the watershed, no other major sources were identified and most of the tributaries entering Potato Garden Run were visually observed and tested for pH at a minimum. Based on the limited site investigations, the two primary sources of mine drainage identified within the watershed are the Hamilton discharge which is being treated and the pollution emanating from the coal refuse piles. Therefore, the water quality data obtained during this project indicates that almost the entire length of Potato Garden Run is being polluted by the coal refuse piles located in the headwaters of the stream. The coal refuse piles are identified by the PA DEP BAMR as Priority Area 0638. While no official publicly available reports were found to document the quantity and quality of the material, an estimate of at least 1-2 million cubic yards of material is believed to be present. The ideal solution to addressing this source of pollution would be to excavate the coal refuse and transport to a Circulating Fluidized Bed (CFB) electric power plant. This of course assumes that the material is of suitable quality to be burned. Alkaline CFB ash could then be brought back to the site and utilized to properly reclaim the site, which would significantly improve, if not eliminate, the major sources of AMD to the headwaters of Potato Garden Run. Unfortunately, the proposed Beech Hollow plant that was to be built in the area could not be constructed due to permitting issues and the project has since been abandoned. The material would now need to be trucked to another plant located far away, which may prove to be economically prohibitive. There may be a need to conduct a short study to drill and collects a number of samples of the pile to determine quantity and quality. Grant funding would likely be needed. Another option would be to regrade the pile while adding alkaline materials, capping, and then revegetating the site.

Alternatively, or while waiting for an opportunity to reprocess the coal refuse pile, a passive treatment system could be installed to treat the mine water. As Potato Garden Run appears to have sufficient alkalinity to neutralize all of the acidity, one option would be to construct settling ponds as well as enlarge/enhance the existing wetlands within the highly degraded stream valley to capture all of the metals. Other passive components such as Auto-Flushing Limestone-Only Vertical Flow Ponds and/or mixed media Jennings-style Vertical Flow Ponds could be used to neutralize acidity and promote metal removal of one or more discharges prior to entering the settling pond/wetland complex. Due to the nature of coal refuse piles in general, size and extent of these particular refuse piles as well as the fact that there are piles on each side of the stream, capturing all of the mine water and piping it to a treatment system would be challenging if not impossible.

Utilizing limited sample and flow data for Potato Garden Run sample point 247-10, “average” loading data in pounds/day is provided in Table 10. Based on the limited loading data and utilizing a metal removal rate of $10g/m^2/day$, an estimated 5-7 acres of settling ponds and wetlands would be needed. Permitting could be quite difficult and costly due to stream and wetland impacts that would be caused by building the system within the stream valley. Therefore, the preferred action would be to remove the coal refuse.

Table 10. Potato Garden Run Loading at Sample Point 247-10 (Pounds/Day)

Sample Point	Alkalinity		Hot Acidity	Iron (T/D)	Aluminum (T/D)	Manganese (T/D)
	Field	Lab				
247-10	582	434	-320	97/56	119/0.4	39/36

Selected References

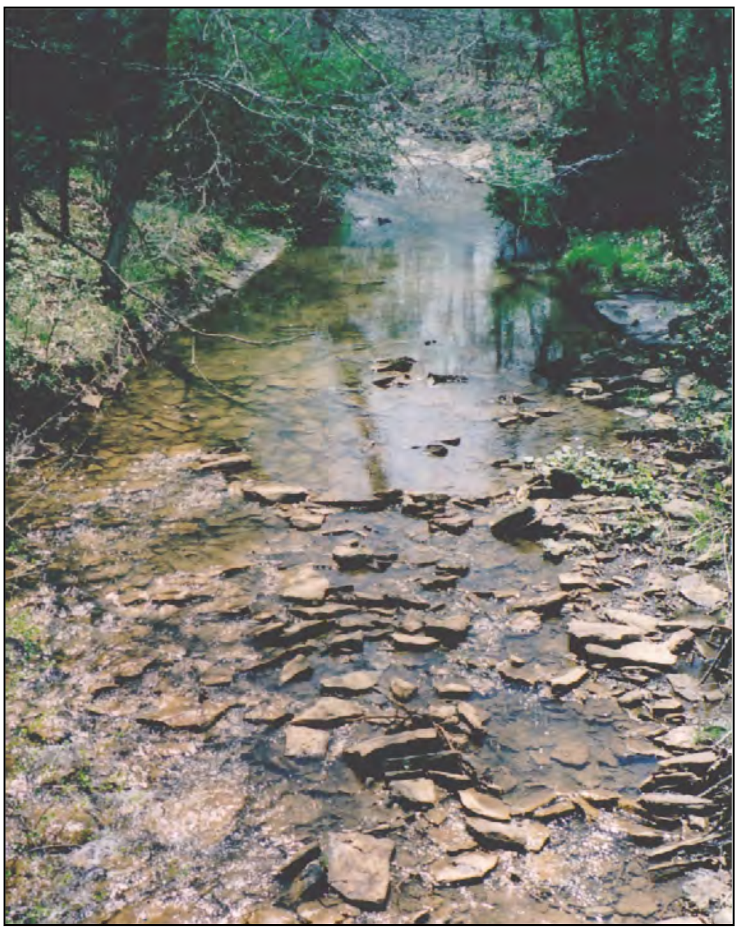
Datashed. https://www.datashed.org/hamilton

PA Dept. of Environmental Protection, 2/25/03, Potato Garden Run Watershed Final TMDL, Allegheny County, 59pp. (EPA approved 04/9/03). https://www.datashed.org/sites/default/files/raccooncreektmdlreport.pdf

Skelly and Loy, Inc., 2000, Raccoon Creek Watershed Abandoned Mine Drainage (AMD) Survey and Preliminary Restoration Plan, 109 pp. https://www.datashed.org/sites/default/files/raccoon_creek_restoration_plan_.pdf

Appendix

Photographs
Hamilton Conceptual Design
Water Sampling Map

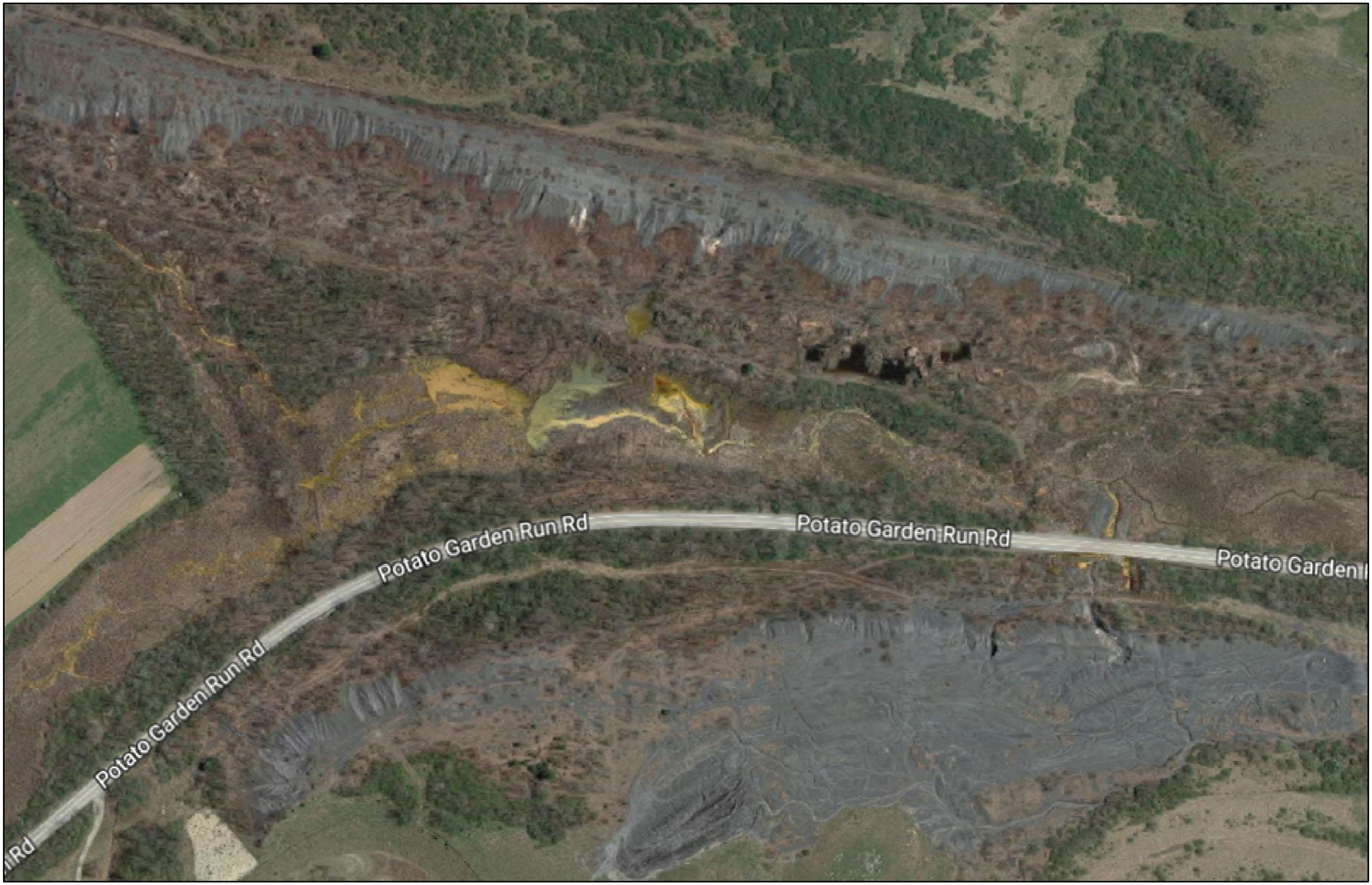


The Hamilton Discharge (H3) emanates from an abandoned underground coal mine. The discharge was reportedly created, when the operator of the Mazzaro landfill accidentally broke into the mine. Prior to construction of the Hamilton Passive Treatment System, the Hamilton discharge impacted both an unnamed tributary (Top) and Potato Garden Run. The impact to Potato Garden Run was visibly noticeable by comparing the upstream (Bottom Left) and downstream (Bottom Right) of confluence with the unnamed tributary.

The Hamilton Passive Treatment System was installed in 2003. As can be seen from the photos above, the system was meticulously maintained and was effective at removing large quantities of iron from the discharge. The site was the pride and joy of the Raccoon Creek Watershed Association and was used as a “show piece” for providing education programs related to AMD, passive treatment, and watershed protection/restoration and careers in conservation.

In 2008, a new landowner purchased the property who then prevented the RCWA from accessing the site to conduct maintenance. The system was vandalized and fell into disrepair. After the property was sold again, SRI was contacted in 2012 to address maintenance issues. A field investigation was conducted in which a variety of needs were determined. For instance, debris including bricks and furniture were dumped into system components and portions of the split-rail fence were either broken or stolen. The Agri Drain water level control structures have also corroded and need to be replaced with either stainless steel or plastic devices. In addition, available water monitoring of the treatment system indicated that the system needed to be expanded to increase treatment performance.

Massive coal refuse piles containing an estimated 1-2 million cubic yards of material line both sides of the valley in the headwaters of Potato Garden Run, which flows through a large wetland complex. The coal refuse is the source of various acidic metal-laden seeps and discharges that flow into the stream and at times degrades most of the length of Potato Garden Run, exceeding the TMDL goals. In addition, at times, the culverts carrying the AMD become plugged with iron and flow across the road creating hazardous driving conditions.



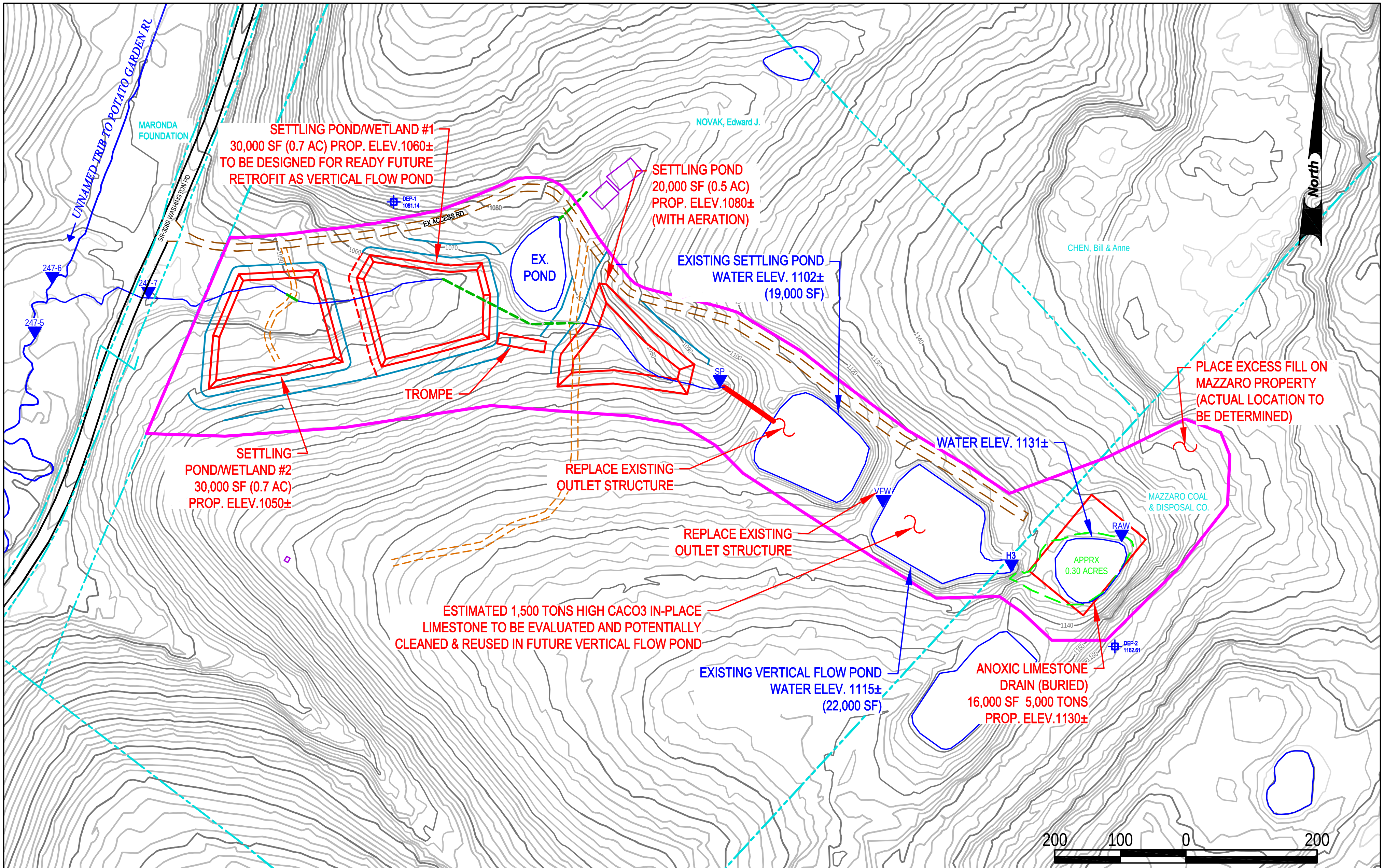
Aerial view of the massive Potato Garden Run coal refuse piles that line both sides of the valley and impact Potato Garden Run and associated wetlands.

"Zoomed-in" aerial view of the Potato Garden Run and associated wetlands that are severely degraded by acid mine drainage flowing from the coal refuse piles.

Directly upstream (Top) of the main coal refuse discharges, at sample point 247-12 Potato Garden Run is alkaline and only slightly impacted; however downstream the stream is highly impacted. At sample point 247-10 (Bottom) at Burgettstown Road next to the Westport Area Booster Station, aluminum solids are visible in the water as is iron staining on the bank and bridge deposited during higher flow events.

The impact to the stream from the coal refuse is visually observable for miles. At sample point 247-3 (Top), just upstream of the "Hamilton" tributary, iron solids tend to be more dominantly visible than aluminum. When the "Hamilton" tributary enters Potato Garden Run (Bottom), the water quality is so improved by the treatment system that it now improves Potato Garden Run and sometimes a "clean plume" can be observed.

As better quality sources of water enter the stream and metal precipitates settle on the bottom, Potato Garden Run begins to improve (Top). By the time the stream reaches sample point 247-8 (below) near the mouth and confluence with Raccoon Creek, the stream is in general much better quality with a good pH and meeting TMDL goals.



LEGEND

- EXISTING CONTOUR (INDEX)
- EXISTING CONTOUR (INTERMEDIATE)
- EXISTING ROAD (UNPAVED)
- EXISTING ROAD (PAVED)
- TRAIL
- EXISTING WATER
- PROJECT AREA
- PROPOSED TREATMENT COMPONENT
- WATER SAMPLE POINT LOCATION
- PROPERTY LINES (APPX.)

NOTES:

Base map contours derived from a 2006 bare-earth digital elevation model constructed from PAMAP LiDAR elevation points by PA DCNR, Bureau of Topographic and Geologic Survey [PA State Plane - South (US Survey Foot) NAD83 (Vertical datum - NAVD88)].

Property owner information and very approximate line location from Allegheny County PA tax assessment website accessed Oct 2012 (This is not a survey).

All proposed structures are approximate/representative and actual configuration/size/location will vary based on field conditions and other factors.

HAMILTON REBUILD & EXPANSION

PRELIMINARY CONCEPTUAL PLAN
Washington County Conservation District

Findlay Township, Allegheny County, PA
Scale: 1" = 200' February 2015
BioMost, Inc. Mining and Reclamation Services
Mars, PA www.biomost.com

2470/cncpt


BEAVER COUNTY
ALLEGHENY COUNTY
WASHINGTON COUNTY
Raccoon Creek
Potato Garden Run
Murdocksville
Clinton
Robinson
Hamilton PTS
30
376
576
247-8
247-9
247-1B
247-1
247-2
247-3
247-4
247-5
247-6
247-7
SP
VFW
H3
RAW
247-A
247-11
247-13
247-B
247-10
PGD1
247-12
Legend
Sample Point
Community
Stream
Coal Refuse Pile
Watershed Boundary
County Boundary
1,000 500 0 1,000
Feet
POTATO GARDEN RUN WATERSHED
HAMILTON PASSIVE SYSTEM &
POTATO GARDEN RUN EVALUATION
STREAM RESTORATION INCORPORATED
Allegheny, Beaver, and
Washington Counties, Pennsylvania
Scale: 1" = 1000 Feet December 2018
BioMost, Inc., Mars, PA