Richard Passive System Rehabilitation

Cherryhill Township, Indiana County, Pennsylvania
41°03’28”/79°17’02”

A Blacklick Creek Watershed Association Project

Final Report

December 2021

Project Sponsor:

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PROJECT NARRATIVE

Overview

The Richards Passive System is located in Cherryhill Township, Indiana County, near Clymer, PA adjacent to Iron Horse Salvage along State Route 403 (SR-403). The original system was designed by VAPCO Engineering and constructed in 1999 (Phase 1) by the Blacklick Creek Watershed Association (BCWA) to treat an abandoned coal mine discharge, which was flowing directly into Two Lick Creek. The Phase 1 system included a single Vertical Flow Reactor (VFR1) and settling pond. The Richards Passive System was expanded by BCWA in 2003 (Phase 2) to include two additional Vertical Flow Reactors (VFR2A and VFR2B) and a wetland. During Phase 2, a concrete inlet catch basin was installed to collect mine drainage which was conveyed by a pipe under SR-403 and then split among the three VFRs. In 2015 and 2017 maintenance events were conducted to help improve diminished treatment; however, by 2018 and after two decades of treatment, it became apparent that the system would need to be rebuilt.

The rehabilitated Richards Passive System was put online in June 2021. To help prevent plugging of the collection and conveyance system, a 12" PVC pipe was inserted into the vertical concrete mine drain pipe. This new pipe was connected to the 12" PVC pipe installed during Phase 2 that extends under Route 403. The Phase 2 era three-valve manifold system was replaced with a flow splitter box that has three stainless steel V-notch weirs set at equal elevations to split the flow among Jennings-type Vertical Flow Pond 1 (JVFP1), JVFP2, and JVFP3. A 90-degree V-notch weir will direct about 40% of the flow to JVFP2 with the remaining 60% split evenly by two 74-degree V-notch weirs directing flow to JVFP1 and JVFP3. Using a representative total flow of 300 gpm, the weirs will direct 40% (120 gpm) to JVFP2 and the remaining 60% (181 gpm) will be split evenly between JVFP1 and JVFP3 (30% or 90 gpm each). JVFP2 has about 47% of the total treatment capacity while the similarly sized JVFP1 and JVFP3 have a combined total 53% of the treatment capacity, 28% and 25%, respectively based on the as-placed treatment media volume.

The treatment media in each JVFP consists of a mixture of AASHTO #67-sized high calcium carbonate limestone (Allegheny Mineral, Inc., Worthington, PA, 92% $CaCO_3$-Vanport Limestone), woodchips (D&D Wood Sales, Inc., Nicktown, PA), and spent mushroom compost (Full Circle Mushroom Compost, Rising Sun MD). The underdrain filter stone in JVFP1 and JVFP2 is re-used limestone recovered from the original VFRs and provides additional acid-neutralizing capacity while the underdrain in JVFP3 was constructed of locally sourced sandstone (Penn Run Quarry). The dissolution of limestone coupled with biological activity in the organic mix will increase pH and add alkalinity. Essentially all the aluminum and a portion of the iron is expected to be retained within these components. The effluent of JVFP1 flows into the Settling Pond (SP) before discharging to Two Lick Creek while the effluent from JVFP2 and JVFP3 enters the Wetland (WL) before flowing into Two Lick Creek. The Phase 2 Final Report documents from 2003 indicated that there is a flowing artesian corehole located in the Wetland that contributes degraded water to the final 1/3 of the wetland (approximate location shown on As-Built Plan). The documents also indicate there are other sources of degraded drainage within the Wetland.

System Performance and Environmental Impact

As construction of the system was completed in summer of 2021, limited water monitoring was able to be completed before the grant ended in December which greatly limits the ability to document and evaluate system performance and the environmental impact. Data collected is presented in the attached "Water Monitoring Data & Pollutant Load Reduction Evaluation" tables and has been uploaded to Datashed.

All three Jennings-style Vertical Flow Ponds (JVFP1, JVFP2, and JVFP3) effectively treat the Raw AMD emanating from the Mine Drain which was the primary objective of the project. The JVFPs produce net-alkaline water and remove essentially all of the aluminum and most of the iron from the discharge. The effluent of the JVFP1 to Settling Pond portion of the system is discharging good quality water to Two Lick Creek. Unfortunately, several additional sources of AMD emanate at various locations throughout the site at elevations that did not allow the AMD to be directed by gravity flow into any of the three JVFPs. One discharge (identified as Seep on the water quality table) was collected in a French drain that extends from the western side of JVFP3, across the north side of JVFP3 and then directed into the western side of the Wetland. This source of water is able to be sampled and flow rate measured at a 6" PVC pipe riser. Along the eastern side of the wetland, an artesian corehole allows an unspecified quality and quantity of mine water to enter the wetland. In addition, according to the 2003 final report for the Phase 2 system, additional degraded seeps of unspecified quality and quantity enter the Wetland. All of these additional AMD sources emanate within or are directed into the wetland where they mix with the effluent of JVFP2 and JVFP3 and are currently impacting the final effluent quality of that portion of the system that discharges into Two Lick Creek.

The three JVFPs neutralize not only all of the acidity of the Raw water from the mine drain, but the excess alkalinity produced also neutralizes all of the acidity from the additional sources of AMD. The final effluents of the Settling Pond and Wetland are net-alkaline. Water monitoring conducted on 12/17/21 demonstrated that the system was neutralizing more than 270 lb/day of acidity and contributing approximately 165 lb/day of excess alkalinity to Two Lick Creek. The system was also removing more than 15 lb/day of iron and 26 lb/day of aluminum that would otherwise be entering Two Lick Creek. The exact amount of acid and metal loading reductions was likely higher, but due to the inability to sample and measure flow of the corehole and other sources of AMD, it is currently impossible to document. Unfortunately, due to the fact that those seeps receive no prior treatment and mix with the treated water in the wetland, the final discharge of the wetland currently has higher iron concentrations than desired; however, in terms of overall water quality in Two Lick Creek, it is better to partially treat those additional sources of AMD than not at all. As construction was completed relatively recently, water from new JVFPs tend to be strongly reducing which could be inhibiting iron oxidation and precipitation and contributing to the higher iron concentrations of the effluent. In addition, there has not been enough time for wetland plants to become re-established which would also be expected to contribute to iron removal. It is anticipated that the final water quality will improve over the following year or two, but at this time it is uncertain to what degree. Water quality will continue to be monitored by the Blacklick Creek Watershed Association and Stream Team.

One set of pre-construction stream samples were collected during high flow conditions in March 2020 and one set of post-construction samples were collected during low flow in December 2021. With only one sample pre- and post- construction and at different flow conditions, completing an accurate and representative analysis is not possible at this time. Both pre- and post- construction sets of data show a decrease in lab pH and alkalinity and an increase in metals between the upstream and downstream samples. The decrease in water quality pre-construction was expected since the old system was not properly working, but was surprising post-construction because 270 lb/day of acid, 15 lb/day iron, and 26 lb/day of aluminum are no longer entering the stream and 165 lb/day acid neutralization potential is being added. While some of this decrease in water quality post-construction is likely due to elevated iron in the effluent of the system, that is probably not the only cause and may not even be the primary cause. Several other seeps of unknown quantity and quality do enter Two Lick Creek from the opposite bank and other various locations between the up-steam and down-stream sample points. These impacts are also likely more pronounced during low flow conditions. Visually the stream has noticeably less staining associated with the Richards mine discharge during post-construction sampling compared to prior to construction. In the grant proposal, Kiski-Conemaugh Stream Team was to conduct pre- and post- construction biological monitoring, but due to multiple staff turnover from the time of grant submission to grant completion, this work was not able to be completed. Additional stream water monitoring is needed to quantify the impacts to Two Lick Creek and there may be a need to conduct additional investigations into other sources of AMD.

a. What was the project supposed to accomplish?
The Richards Passive Treatment System Rehabilitation Project was to not only rebuild but improve the treatment capacity of the existing treatment system. The original and previously expanded passive treatment system (Phase 1 and Phase 2), was subject to various on-going operational issues including plugged inlet piping and treatment media. In addition to improving treatment efficacy, the system rehabilitation afforded the opportunity to allow accurate flow measurement that will help in monitoring long-term system performance. This effort treats the 2nd worst discharge to the main stem of Two Lick Creek and the 4th worst discharge in the entire watershed according to the Phase II Watershed Assessment and Restoration Plan for the Upper Two Lick Creek Watershed, Indiana University of Pennsylvania 2005.

b. What you actually did and how it differs from your plan?
In the initial conceptual design that was included in the grant application the AMD was to be split by a small pool feeding two Terraced Iron Formations (TIFs) that each discharged to a Jennings-type Vertical Flow Pond. Site elevations, field conditions, and other factors ultimately did not allow for the use of the pool and TIFs at the site. Based on the total volume of media needed to meet treatment goals, it was decided to modify the existing sludge holding basin (a/k/a flush pond), that would no longer be needed, to become a third JVFP and provide additional treatment capacity and operational flexibility. Other changes included installing an earthen directional baffle in the settling pond in place of a floating baffle curtain, plumbing directly on to the mine drain to reduce plugging issues, and installing an innovative flow splitter box that utilizes three weirs to proportionally distribute the flow among the three JVFPs while providing easy and accurate flow measurement. A culvert pipe was installed in a portion of the existing mine water conveyance channel to facilitate the placement of excess fill generated during system excavation. Once the system was constructed, as-built drawings and an Operation & Maintenance plan were completed which are attached to this report and have been uploaded to Datashed.

c. What were your successes and reasons for your success?
The treatment system was successfully expanded to allow for more treatment capacity even though the TIF component was removed. A direct tie-in at the raw water inlet structure allowed for better water handling and lessened the possibility of plugging the pipeline or conveying debris into the treatment components. Additional funding from the Foundation for Pennsylvania Watersheds allowed for the addition of the direct mine drain tie-in, flow splitter box, and other system improvements. A single staff gauge measurement allows the operator to quickly determine the entire flow as well as the flow rates to the individual JVFPs.

d. What problems were encountered and how you dealt with them?
Limited construction area resulted in the placement of excess fill to become difficult. To maximize treatment capacity, most available area was used for the construction of the three JVFPs. In response to these constraints, the baffle curtain in the settling pond was replaced with an earthen baffle as a way to utilize additional excess fill and a 36” culvert pipe was placed as a mine water conveyance channel to

permit the placement of excess fill adjacent to the vertical flow ponds. The system was placed on-line in June 2021 during a warm and relatively dry time of year. The fresh treatment media coupled with low-flow and elevated ambient temperatures resulted in very high system performance, especially from the biological sources of alkalinity (i.e., sulfate reduction). Though the system produced very high alkalinity, -417 and -167 mg/L acidity in the settling pond and wetland, respectively, this level of over-treatment came with a significant odor. Stream Restoration Incorporated was contacted by a local property manager about the noticeable odor in Clymer, PA, over one mile downstream of the treatment system. BioMost personnel quickly responded by using custom-made weir inserts to direct all the flow into only JVFP1 and adjust the outlet risers on 10/12/21 so that only one of the four underdrain cells was being utilized. This reduced the odor and eliminated the complaints. The system operated in this manner until 12/08/21 when the flow was directed into all three JVFPs and the outlet risers adjusted so that only one underdrain cell in each pond will discharge, effectively cutting the level of treatment to less than one quarter. The design of the outlet risers will allow for future adjustments as flow rates change and the treatment media matures in order to continue to provide a high level of treatment.

e. How your work contributed to solution of original problems?
Every passive treatment system has a finite design life and will ultimately need to be rehabilitated. Maintenance efforts extended the operational life of the Richards Passive System but finally water began passing through the system untreated or bypassed the system entirely. This project successfully rebuilt and expanded the treatment system and improves the AMD that once flowed untreated into Two Lick Creek. The treatment system will not only directly prevent acid and metals from entering the stream but will add additional buffering capacity in the form of excess alkalinity (negative acidity) in the effluent.

f. What else needs to be done?
The odor will need to continue to be monitored and the system adjusted as needed to achieve an appropriate balance between performance and odor. It is recommended that the cell discharging from each JVFP be changed on a monthly basis through the winter and early spring in order to “burn in” the treatment media. As warm weather and lower flow conditions return, one or more of the JVFPs may need to be taken offline to prevent odor problems. As the media matures, these adjustments should become less frequent and eventually not needed. As with any passive system, the performance needs to be regularly monitored and maintenance performed as needed. The Blacklick Creek Watershed Association should utilize the O&M plan to guide them on maintaining the system. The water elevation in the mine drain should be compared to the water level in the flow splitter box during each site visit as elevated water in the mine drain may indicate that the pipe under SR-403 is becoming plugged. Additional water monitoring of the treatment system and stream will be needed in order to document the effectiveness of the treatment systems as well as to document the impact of additional sources of AMD.

g. What are your plans for disseminating results of your work?
The project information including as-built drawings, water monitoring, and final report information will be posted online on www.datashed.org. The project may also be a topic of discussion or presentations at future American Society of Reclamation Sciences, West Virginia Mine Drainage Taskforce, Pennsylvania Abandoned Mine Reclamation, and other conferences. Preliminary discussions with Office of Surface Mining personnel indicate that the Richards site may be used for developing design size criteria of Jennings-type vertical flow ponds.

h. How well did your spending align with your budget request?
Overall, the projected spending was in line with actual cost. Minor modifications in work tasks essentially balanced out with additional funds obtained from the Foundation for Pennsylvania Watersheds used to install the direct tie-in to the mine drain and perform various other tasks throughout the site. Materials were purchased prior to the significant price increases realized in 2021 related to the Covid-19 pandemic.

Appendix 1
Photographs

Photo Log

Top: AMD emanates from an existing concrete riser on the far left and should flow into a concrete catch basin at the center right of the image. Due to plugging issues of the pipe that extends under SR-403 water flowed around the pipeline inlet and bypassed the treatment system by flowing down an existing channel directly to Two Lick Creek (4/14/20).

Bottom: Two Lick Creek shown with AMD seeping from the bank (12/21/15).

Top Left: Clearing the channel between the Mine Drain and the catch basin that began the existing Raw Water Pipeline that should convey the AMD to the treatment system (4/14/20).

Top Right: Discharge of AMD from the Mine Drain (4/14/20).

Bottom: VFR 2B drained to expose iron oxide on top of treatment media (4/14/20).

Top: VFR 1 was clogged with vegetation and sludge, no treatment of water through the media (7/23/18).

Bottom: VFR 1 sludge was removed, and existing stone was cleaned for re-use (6/5/20).

Top Left: Test pit for VFR2A media showed poor permeability was caused by clogging by sludge, accumulation of solids in the media, and breakdown of organic material (5/1/20).

Top Right: Lack of VFR permeability after stirring indicated that the media needed to be replaced (3/27/20).

Bottom: Expansion of VFR2A & 2B to create JVFP2 included removal of an embankment and lining with mineral CSA (9/15/20).

Top: Sludge Pond that is to be expanded and reconfigured as JVFP3 (6/9/20).

Bottom: The Sludge Pond excavated and expanded to become JVFP3 (8/20/20).

Top: Finishing lining JVFP3 with mineral CSA (9/16/20).

Bottom: After the mineral CSA was placed in JVFP3, geotextile and bedding stone were placed and leveled to provide a solid, level base for the underdrain piping (10/6/20).

Top Left: Mixing new treatment media in JVFP3 (10/14/20).

Top Right: Compost delivery (8/18/20).

Bottom: Washing limestone from VFR2A, now JVFP2 (10/13/20).

Top: A flowing 6" Terracotta pipe was encountered along the right descending bank of the mine drainage conveyance channel (left side of image) in the area near were the Seep discharge was sampled, cleaned stone in JVFP1 and 36" culvert prior to installation can be seen in background and (6/23/20).

Bottom: French drain installed near the source of the Seep, the 6" terracotta was plumbed directly into one of the 6" PVC pipes using 8" CPP as shown (6/25/20).

Top: French drain pipeline (solid portion) extends along the north slope of JVFP3 and outlets to the Wetland (6/18/20).

Bottom: Solid portion of French drain piping was buried with a geotextile witness layer placed about 1 foot above the pipe 6/23/20.

Top: Installation of 36” culvert pipe in existing mine drainage conveyance channel (6/26/20).

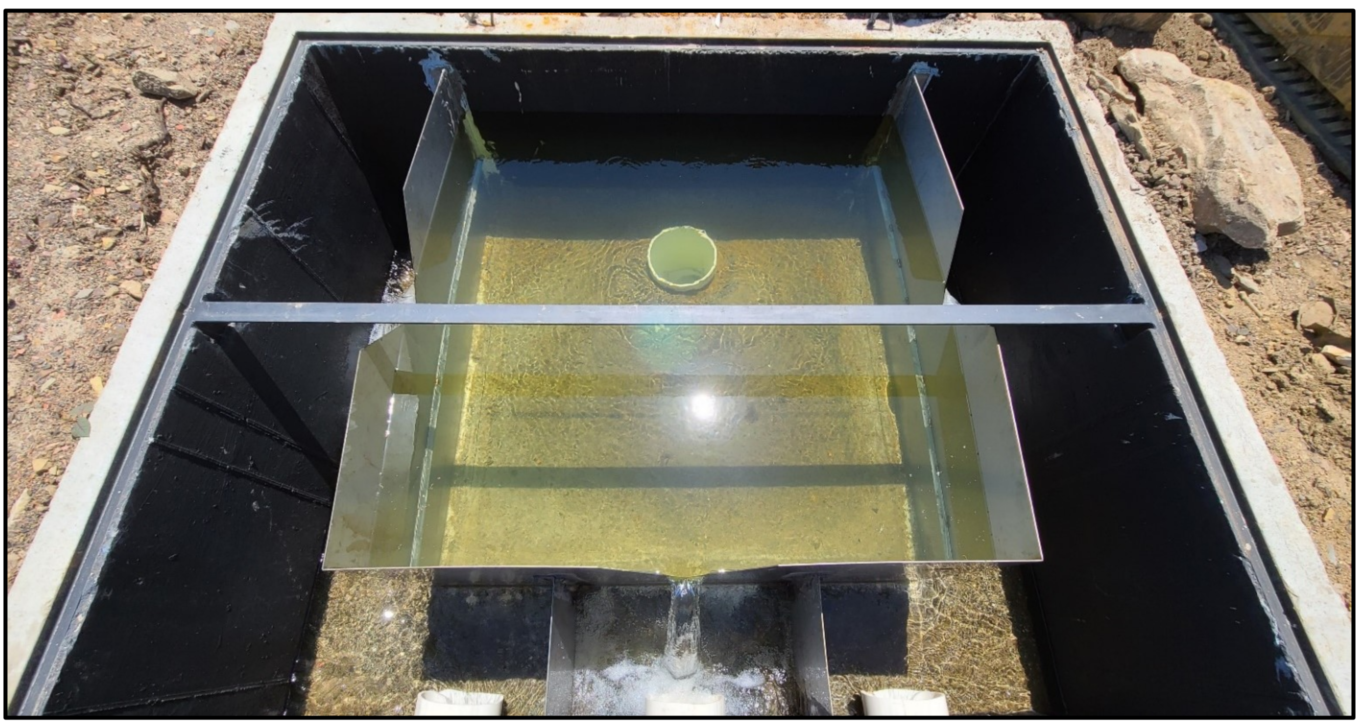
Bottom: Pipe delivery (7/28/20).

Top: JVFP3 outlet pipe installation (8/6/20).

Bottom: JVFP2 outlet pipe installation (1/15/21).

Top: JVFP1 with exposed underdrain outlets pipes before pipe was installed through the berm, filter stone was installed and leveled except for the area near the exit, and stockpiled media can be seen in the background (12/04/20).

Bottom: JVFP1 treatment media being pushed into the pond where it was mixed and 'fluffed' (12/8/20).



Top: Flow splitter box during installation of the pipeline to JVFP1 (5/13/21).

Bottom: Testing of the spitter box, water enters through the vertical 12" pipe in the bottom of the box then is split by the three weirs before entering a pipeline to its respective JVFP (5/19/21).

Top: JVFP3 treatment media placed and mixed prior to system being put online (6/18/21).

Bottom: 12" Raw Water Pipeline plumbed between concrete riser (Mine Drain) and existing 12" PVC pipe carrying water under SR-403 (5/6/21).

Top: JVFP2 outlet risers after system being put online (7/2/21).

Bottom: Completed system and placed on-line in June 2021. JVFP2 on the left, JVFP3 in the background, and Wetland on right, JVFP1 and the Settling Pond are not visible in the far background (7/2/21).

Appendix 2
Water Monitoring Data

WATER MONITORING DATA & POLLUTANT LOAD REDUCTION EVALUATION

There are essentially four sources of raw water at the Richards Passive System Site:

1) **Mine Drain** (Point 452): Emanating from a vertical concrete pipe on the south side of Route 403 near the Iron Horse Salvage yard. This the majority of mine drainage.

2) **10" Terracotta Pipe**: Pipe intercepted near the Mine Drain with an 8" PVC pipe during Phase 2 construction and plumbed into the 12" PVC pipe on the south side of SR-403 downstream of the concrete catch basin. No samples of this water were found. During 2021 construction, it was observed that the contribution from the 10" Terra Cotta Pipe may be negligible or non-existent.

Note: The combined sources 'Mine Drain' and '10" Terracotta Pipe' are sampled as "Raw" at the Flow Splitter Box. (For historic purposes this water should be comparable to Point 452.)

3) **Seep**: First documented in the Phase 2 passive system report uncovered during the construction of the west end of the Sludge Holding Pond (now JVFP3), collected by a 4" diameter French Drain during Phase 2 that outlet via a valved pipe to the existing channel close to Two Lick Creek and was sampled 4/8/02. This discharge apparently 'moved' upstream from the 4" pipe installed during Phase 2 to a point near the location of French drain manifold constructed in 2020. A 6" terracotta pipe was found and connected to the French drain piping (See 2021 Final Report photos). The current French drain has solid (non-perforated) piping that extends around VFP3 and outlets via a riser located near the JVFP3 spillway in the Wetland.

3) **Corehole**: A flowing arteian corehole near the eastern end of the Wetland unearthed during Phase 2. This water was sampled once on 7/8/02 during Phase 2. Samples collected by VAPCO and BioMost at the outlet of the Wetland on 12/20/02, 3/26/20, and 12/2/20 may provide an indication of the quality of this water as the samples were collected when no or little other water was entering the Wetland.

Note: Seep will be monitored at the 6" riser in the Wetland. It is impractical to sample the Corehole and consideration should be given to its impact to the Wetland effluent water quality. The Combined Raw Discharge (Raw+Seep) characteristics can be calculated as shown below. As the drainage is split to two separate systems, the combined treated flow can be calculated as shown below. Note that flow measurements taken at the Flow Splitter Box is used for JVFP1 and SP flows and the flow measured at Seep is added to the JVFP2 and JVFP3 flows measured at the Splitter Box.

Prior to construction BioMost, Inc. set temporary pipes in the channel below the Seep, which collected sources 1, 2, and 3 above and the outlet channel of the Wetland. The sample of the Wetland included essentially only the corehole water (no treated drainage) plus a small amount (~ 1 gpm) of drainage from road culverts. This is shown as the 3/26/20 data below and is used as the pre-construction event.

Combined Raw Discharges (Pre-Construction)

Point	Date	Flow	Temp	Cond.	F. pH	pH	F. Alk	Alk.	Acid.	Fe	D. Fe	Mn	D. Mn	Al	D. Al	Sulfate	TSS	Acid Load	Fe Load	Mn Load	Al Load
		gpm	˚C	umho/cm	s.u.	s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	lb/day	lb/day	lb/day	lb/day
Raw + Seep	03/26/17	211	11.9	1047	3.40	3.08	0	0	181	11.57	11.40	1.52	1.49	14.04	13.73	444	7	459.8	29.3	3.9	35.6
Wetlands(CH)	03/26/17	28	14.2	624	5.31	5.66	8	2	27	6.37	5.21	1.48	1.46	0.44	0.18	309	7	9.0	2.2	0.5	0.1
Combined Raw	**03/26/27**	**239**	**12.2**	**997**	**3.62**	**3.38**	**1**	**0**	**163**	**10.96**	**10.67**	**1.52**	**1.49**	**12.44**	**12.14**	**428**	**7**	**468.8**	**31.5**	**4.4**	**35.8**

Combined Raw Discharges (Post-Construction) (Does not include sample of Wetlands-CH)

Point	Date	Flow	Temp	Cond.	F. pH	pH	F. Alk	Alk.	Acid.	Fe	D. Fe	Mn	D. Mn	Al	D. Al	Sulfate	TSS	Acid Load	Fe Load	Mn Load	Al Load
		gpm	˚C	umho/cm	s.u.	s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	lb/day	lb/day	lb/day	lb/day
Raw	12/17/21	118	10.7	1268	3.19	3.14	0	0	162	18.36	17.24	1.87	1.73	16.20	14.73	383	0	229.8	26.0	2.7	23.0
Seep	12/17/21	25	11.1	1070	3.19	3.19	0	0	141	17.91	17.01	1.88	1.77	14.48	13.45	412	0	42.4	5.4	0.6	4.4
Combined Raw		**143**	**10.8**	**1233**	**3.19**	**3.15**	**0**	**0**	**158**	**18.28**	**17.20**	**1.87**	**1.74**	**15.90**	**14.51**	**388**	**0**	**272.1**	**31.4**	**3.2**	**27.3**

Raw flow measured at Splitter Box (sum of three weir readings); Seep is flow is measured with a bucket & stop watch.

Combined Treated Discharges (Post-Construction)

Point	Date	Flow	Temp	Cond.	F. pH	pH	F. Alk	Alk.	Acid.	Fe	D. Fe	Mn	D. Mn	Al	D. Al	Sulfate	TSS	Acid Load	Fe Load	Mn Load	Al Load
		gpm	˚C	umho/cm	s.u.	s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	lb/day	lb/day	lb/day	lb/day
SP	12/17/21	36	7.6	1106	5.92	7.79	72	169	-157	0.24	0.18	1.18	0.91	0.00	0.00	428	0	-67.2	0.1	0.5	0.0
Wetland	12/17/21	107	7.4	1032	6.49	6.58	101	84	-76	12.44	8.59	2.64	1.73	0.39	0.00	411	12	-97.8	16.0	3.4	0.5
Combined Treated		**143**	**7.4**	**1050**	**6.35**	**6.88**	**94**	**105**	**-96**	**9.40**	**6.49**	**2.28**	**1.53**	**0.29**	**0.00**	**415**	**9**	**-165.0**	**16.1**	**3.9**	**0.5**

SP flow is assumed to be the same flow as measured at the Splitter Box going into JVFP1; Wetland flow calculated by adding the inflow to JVFP2 and JVFP2 at Splitter Box to Seep flow measured with bucket & stopwatch.

Post-Const Δ			-3.3	-183	+3.16		+94	+105	-255	-8.88	-10.71	+0.40	-0.21	-15.61	-14.51	+27	+9	**-437.2**	**-15.3**	**+0.7**	**-26.8**

Stream Samples Above and Below Richards Treatment System

Point	Date	Flow	Temp	Cond.	F. pH	pH	F. Alk	Alk.	Acid.	Fe	D. Fe	Mn	D. Mn	Al	D. Al	Sulfate	TSS
		gpm	˚C	umho/cm	s.u.	s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Up-Stream	03/26/20	N.M.	9.8	193	6.33	7.55	73	34	-16	0.59	0.11	0.05	0.00	0.43	0.00	40	10
Up-Stream	12/17/21	N.M.	7.4	242	6.32	7.62	52	52	-43	0.35	0.15	0.07	0.06	0.25	0.00	40	0
Down-Stream	03/26/20	N.M.	6.0	201	8.26	7.28	15	30	-19	1.00	0.39	0.09	0.08	0.60	0.00	47	9
Down-Stream	12/17/21	N.M.	8.0	258	6.25	7.48	54	50	-41	1.01	0.99	0.13	0.13	0.32	0.00	48	0
Pre-Const Δ			-3.8	+8	+1.93	-0.27	-58	-4	-2	+0.41	+0.28	+0.04	+0.08	+0.17	0.00	+7	-1
Post-Const Δ			+0.6	+16	-0.07	-0.14	+2	-2	+2	+0.66	+0.84	+0.06	+0.07	+0.07	0.00	+8	0

Field pH recorded 03/26/20 indicates equipment issues, note decrease in field measured alkalinity and lab pH.

Red shading indicates pre-construction average — Blue shading indicates post-construction sample

All zero values indicate values below lab detection limits. See as-built plan for Point locations.

Corehole/Wetlands-CH Raw Discharge (Approximate Characteristics)

Point	Date	Flow	Temp	Cond.	F. pH	pH	F. Alk	Alk.	Acid.	Fe	D. Fe	Mn	D. Mn	Al	D. Al	Sulfate	TSS	Acid Load	Fe Load	Mn Load	Al Load
		gpm	˚C	umho/cm	s.u.	s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	lb/day	lb/day	lb/day	lb/day
Wtlds CH	07/08/02	10		906	5.50	5.35		2	171	61.12		2.40		2.25		465		20.6	7.3	0.3	0.3
Wetland(CH)	03/26/20	28	14.2	624	5.31	5.66	8	2	27	6.37	5.21	1.48	1.46	0.44	0.18	309	7	9.0	2.2	0.5	0.1
Wetland(CH)+Seep	12/02/21	30	6.5	1069	3.80	3.28	0	0	96	22.28		2.35		5.74		469	10	34.7	8.0	0.8	2.1
Minimum		**10**	**6.5**	**624**	**3.80**	**3.28**	**0**	**0**	**27**	**6.37**	**5.21**	**1.48**	**1.46**	**0.44**	**0.18**	**309**	**7**	**9.0**	**2.2**	**0.3**	**0.1**
Maximum		**30**	**14.2**	**1069**	**5.50**	**5.66**	**8**	**2**	**171**	**61.12**	**5.21**	**2.40**	**1.46**	**5.74**	**0.18**	**469**	**10**	**34.7**	**8.0**	**0.8**	**2.1**
Average		**23**	**10.4**	**866**	**4.87**	**4.76**	**4**	**1**	**98**	**29.92**	**5.21**	**2.08**	**1.46**	**2.81**	**0.18**	**414**	**9**	**21.4**	**5.8**	**0.5**	**0.8**

All zero values indicate values below lab detection limits. VAPCO collected 2002 sample, BioMost collected 2020 and 2021 samples. 12/02/21 estimated flow and includes Seep water and is likely an overestimate.

Raw (Post Construction)

Point	Date	Flow	Temp	Cond.	F. pH	pH	F. Alk	Alk.	Acid.	Fe	D. Fe	Mn	D. Mn	Al	D. Al	Sulfate	TSS	Acid Load	Fe Load	Mn Load	Al Load
		gpm	˚C	umho/cm	s.u.	s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	lb/day	lb/day	lb/day	lb/day
Raw	07/15/21	128	12.4	1209	3.04	3.08	0	0	170	14.45	14.04	1.39	1.29	9.44	9.39	491	0	263.1	22.3	2.1	14.6
Raw	12/02/21	115	11.0		3.31	3.28	0			18.14		1.96		13.42					25.1	2.7	18.6
Raw	12/17/21	118	10.7	1268	3.19	3.14	0	0	162	18.36	17.24	1.87	1.73	16.20	14.73	383	0	229.8	26.0	2.7	23.0
Minimum		**115**	**10.7**	**1209**	**3.04**	**3.08**	**0**	**0**	**162**	**14.45**	**14.04**	**1.39**	**1.29**	**9.44**	**9.39**	**383**	**0**	**229.8**	**22.3**	**2.1**	**14.6**
Maximum		**128**	**12.4**	**1268**	**3.31**	**3.28**	**0**	**0**	**170**	**18.36**	**17.24**	**1.96**	**1.73**	**16.20**	**14.73**	**491**	**0**	**263.1**	**26.0**	**2.7**	**23.0**
Average		**120**	**11.4**	**1239**	**3.18**	**3.17**	**0**	**0**	**166**	**16.98**	**15.64**	**1.74**	**1.51**	**13.02**	**12.06**	**437**	**0**	**246.4**	**24.5**	**2.5**	**18.7**

The second bottle for the 12/02/21 emptied in transit.

JVFP1 (Post Construction)

Point	Date	Flow	Temp	Cond.	F. pH	pH	F. Alk	Alk.	Acid.	Fe	D. Fe	Mn	D. Mn	Al	D. Al	Sulfate	TSS	Acid Load	Fe Load	Mn Load	Al Load
		gpm	˚C	umho/cm	s.u.	s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	lb/day	lb/day	lb/day	lb/day
JVFP1	07/15/21	39	21.8	1164	6.99	7.40	520	476	-285	1.16	0.17	0.74	0.68	0.12	0.10	186	<5	-133.0	0.5	0.3	0.1
JVFP1	12/02/21	115	7.7	1192	7.65		168	177	-134	0.22		2.16		0.00		487	0	-185.3	0.3	3.0	0.0
JFVP1	12/17/21	36	7.1	1149	6.78	7.04	212	182	-172	0.17	0.16	2.38	1.95	0.00	0.00	432	0	-73.6	0.1	1.0	0.0
Minimum		**36**	**7.1**	**1149**	**6.78**	**7.04**	**168**	**177**	**-285**	**0.17**	**0.16**	**0.74**	**0.68**	**0.00**	**0.00**	**186**	**0**	**-185.3**	**0.1**	**0.3**	**0.0**
Maximum		**115**	**21.8**	**1192**	**7.65**	**7.40**	**520**	**476**	**-134**	**1.16**	**0.17**	**2.38**	**1.95**	**0.12**	**0.10**	**487**	**0**	**-73.6**	**0.5**	**3.0**	**0.1**
Average		**63**	**12.2**	**1168**	**7.14**	**7.22**	**300**	**278**	**-197**	**0.52**	**0.17**	**1.76**	**1.32**	**0.04**	**0.05**	**369**	**0**	**-130.6**	**0.3**	**1.4**	**0.0**

Flow assumed to be inflow as measured at Splitter Box for load calculations but was measured with bucket & stopwatch 12/02/21 and 12/17/21 at 128 and 33 gpm, respectively. There is a small additional flow to JVFP1.

SP (Post Construction)

Point	Date	Flow	Temp	Cond.	F. pH	pH	F. Alk	Alk.	Acid.	Fe	D. Fe	Mn	D. Mn	Al	D. Al	Sulfate	TSS	Acid Load	Fe Load	Mn Load	Al Load
		gpm	˚C	umho/cm	s.u.	s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	lb/day	lb/day	lb/day	lb/day
SP	07/15/21	39	29.0	1140	7.73	7.77	436	438	-417	0.98	0.47	0.81	0.67	0.13	0.00	210	0	-194.5	0.5	0.4	0.1
SP	*12/2/2021	115	6.4	1167	7.73	7.50	147	166	-121	0.15		1.97		0.00		483	0				
SP	12/17/21	36	7.6	1106	5.92	7.79	72	169	-157	0.24	0.18	1.18	0.91	0.00	0.00	428	0	-67.2	0.1	0.5	0.0
Minimum		**36**	**6.4**	**1106**	**5.92**	**7.50**	**72**	**166**	**-417**	**0.15**	**0.18**	**0.81**	**0.67**	**0.00**	**0.00**	**210**	**0**	***-194.5***	***0.1***	***0.4***	***0.0***
Maximum		**115**	**29.0**	**1167**	**7.73**	**7.79**	**436**	**438**	**-121**	**0.98**	**0.47**	**1.97**	**0.91**	**0.13**	**0.00**	**483**	**0**	***-67.2***	***0.5***	***0.5***	***0.1***
Average		**63**	**14.3**	**1138**	**7.13**	**7.69**	**218**	**258**	**-232**	**0.46**	**0.33**	**1.32**	**0.79**	**0.04**	**0.00**	**374**	**0**	***-130.8***	***0.3***	***0.4***	***0.0***

Flow assumed to be same as JVFP1 as measured at Splitter Box for load calculations but was measured with bucket & stopwatch 12/02/21 and 12/17/21 at 75 and 0 gpm, respectively (i.e., pond leaks up to about 53 gpm).

All zero values indicate values below lab detection limits. See as-built plan for Point locations.

**12/2/2021 sample event occurred when system was being run through one cell of JVFP1 for maximum odor control. These samples are shown for informational purposes but the data are excluded from load analysis.*

JVFP2 (Post-Construction)

Point	Date	Flow	Temp	Cond.	F. pH	pH	F. Alk	Alk.	Acid.	Fe	D. Fe	Mn	D. Mn	Al	D. Al	Sulfate	TSS	Acid Load	Fe Load	Mn Load	Al Load
		gpm	˚C	umho/cm	s.u.	s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	lb/day	lb/day	lb/day	lb/day
JVFP2	07/15/21	51	23.8	1060	6.83	7.07	515	454	-380	1.60	0.00	1.19	0.98	0.00	<0.10	122	0	-232.2	1.0	0.7	0.0
JVFP2	12/02/21	0																			
JVFP2	12/17/21	47	7.5	1042	6.54	6.82	244	200	-175	0.56	0.17	1.79	1.63	0.00	0.00	339	0	-97.8	0.3	1.0	0.0
Minimum		**0**	**7.5**	**1042**	**6.54**	**6.82**	**244**	**200**	**-380**	**0.56**	**0.00**	**1.19**	**0.98**	**0.00**	**0.00**	**122**	**0**	**-232.2**	**0.3**	**0.7**	**0.0**
Maximum		**51**	**23.8**	**1060**	**6.83**	**7.07**	**515**	**454**	**-175**	**1.60**	**0.17**	**1.79**	**1.63**	**0.00**	**0.00**	**339**	**0**	**-97.8**	**1.0**	**1.0**	**0.0**
Average		**32**	**15.7**	**1051**	**6.69**	**6.95**	**380**	**327**	**-278**	**1.08**	**0.09**	**1.49**	**1.31**	**0.00**	**0.00**	**230**	**0**	**-165.0**	**0.6**	**0.9**	**0.0**

Flow assumed to be inflow as measured at Splitter Box for load calculations but was measured with bucket & stopwatch 12/02/21 and 12/17/21 at 0 and 48 gpm, respectively.

JVFP3 (Post-Construction)

Point	Date	Flow	Temp	Cond.	F. pH	pH	F. Alk	Alk.	Acid.	Fe	D. Fe	Mn	D. Mn	Al	D. Al	Sulfate	TSS	Acid Load	Fe Load	Mn Load	Al Load
		gpm	˚C	umho/cm	s.u.	s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	lb/day	lb/day	lb/day	lb/day
JVFP3	07/15/21	39	23.9	1363	7.03	7.19	630	679	-528	1.03	0.16	1.94	1.73	0.11	0.00	61	0	-246.4	0.5	0.9	0.1
JVFP3	12/02/21	0																			
JVFP3	12/17/21	36	8.8	1644	6.40	6.86	170	192	-152	4.72	4.72	3.28	3.10	0.00	0.00	590	0	-65.0	2.0	1.4	0.0
Minimum		**0**	**8.8**	**1363**	**6.40**	**6.86**	**170**	**192**	**-528**	**1.03**	**0.16**	**1.94**	**1.73**	**0.00**	**0.00**	**61**	**0**	**-246.4**	**0.5**	**0.9**	**0.0**
Maximum		**39**	**23.9**	**1644**	**7.03**	**7.19**	**630**	**679**	**-152**	**4.72**	**4.72**	**3.28**	**3.10**	**0.11**	**0.00**	**590**	**0**	**-65.0**	**2.0**	**1.4**	**0.1**
Average		**25**	**16.4**	**1504**	**6.72**	**7.03**	**400**	**436**	**-340**	**2.88**	**2.44**	**2.61**	**2.42**	**0.06**	**0.00**	**325**	**0**	**-155.7**	**1.3**	**1.2**	**0.0**

Flow assumed to be inflow as measured at Splitter Box for load calculations but was measured with bucket & stopwatch 12/02/21 and 12/17/21 at 0 and 23 gpm, respectively.

Seep (Post Construction)

Point	Date	Flow	Temp	Cond.	F. pH	pH	F. Alk	Alk.	Acid.	Fe	D. Fe	Mn	D. Mn	Al	D. Al	Sulfate	TSS	Acid Load	Fe Load	Mn Load	Al Load
		gpm	˚C	umho/cm	s.u.	s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	lb/day	lb/day	lb/day	lb/day
Seep	07/15/21	N.M.																			
Seep	12/02/21	N.M.																			
Seep	12/17/21	25	11.1	1070	3.19	3.19	0	0	141	17.91	17.01	1.88	1.77	14.48	13.45	412	0	42.4	5.4	5.1	0.6

Riser added 12/8/21 to allow sampling and flow measurement of French Drain outlet.

Wetland (Post Construction)

Point	Date	Flow	Temp	Cond.	F. pH	pH	F. Alk	Alk.	Acid.	Fe	D. Fe	Mn	D. Mn	Al	D. Al	Sulfate	TSS	Acid Load	Fe Load	Mn Load	Al Load
		gpm	˚C	umho/cm	s.u.	s.u.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	lb/day	lb/day	lb/day	lb/day
Wetland	07/15/21	90	26.1	930	6.87	6.90	203	182	-167	11.64	9.10	1.55	1.33	0.30	0.00	287	12	-179.5	12.5	1.7	0.3
Wetland	*12/2/2021	30	6.5	1069	3.80	3.28	0	0	96	22.28		2.35		5.74		469	10				
Wetland	12/17/21	107	7.4	1032	6.49	6.58	101	84	-76	12.44	8.59	2.64	1.73	0.39	0.00	411	12	-97.8	16.0	3.4	0.5
Minimum		**30**	**6.5**	**930**	**3.80**	**3.28**	**0**	**0**	**-167**	**11.64**	**8.59**	**1.55**	**1.33**	**0.30**	**0.00**	**287**	**10**	***-179.5***	***12.5***	***1.7***	***0.3***
Maximum		**107**	**26.1**	**1069**	**6.87**	**6.90**	**203**	**182**	**96**	**22.28**	**9.10**	**2.64**	**1.73**	**5.74**	**0.00**	**469**	**12**	***-97.8***	***16.0***	***3.4***	***0.5***
Average		**76**	**13.3**	**1010**	**5.72**	**5.59**	**101**	**89**	**-49**	**15.45**	**8.85**	**2.18**	**1.53**	**2.14**	**0.00**	**389**	**11**	***-138.6***	***14.3***	***2.5***	***0.4***

Flow assumed to be the sum of the flow of JVFP2 and JVFP3 as measured at the Splitter Box plus the flow measured at Seep. The additional 10-28 gpm of flow from the corehole discharge is not included.

Note that flow measurements were not collected at Seep 07/15/21 and 12/02/21. The 12/02/21 flow is estimated. No treated water was flowing into the Wetland from JVFP2 or JVFP3 on 12/02/21.

All zero values indicate values below lab detection limits. See as-built plan for Point locations.

**12/2/2021 sample event occurred when system was being run through one cell of JVFP1 for maximum odor control. These samples are shown for informational purposes but the data are excluded from load analysis.*

Appendix 3
Operation, Maintenance, & Replacement Plan
(Prepared by BioMost, Inc.)

OPERATION, MAINTENANCE, and REPLACEMENT PLAN

Richards Passive System Rehabilitation

Project Information

System Components:	Mine Drain; Raw Water Pipeline; Flow Splitter Box; Jennings-type Vertical Flow Ponds 1, 2, & 3; Settling Pond; Wetland
Latitude/Longitude:	40°39'47.97" N/78°58'48.98" W
Municipality:	Cherryhill Twp., near Clymer, PA
Hydrologic Order:	Two Lick Creek→Blacklick Creek→Conemaugh R.→Kiskiminetas R.→Allegheny R. →Ohio R

Design Summary

Flow		Max Treatment Load	Average Treatment Load
Max Hydraulic Design	1,000 GPM	1,020 lb/day Acid	166 lb/day Acid
Max Treatment Design	747 GPM	148-296 lb/day Iron	23 lb/day Iron
Average Design	117 GPM	128 lb/day Aluminum	15 lb/day Aluminum
Design Life: 15-25 Years (Iron range represents 10-20 grams/m^2/day removal rate.)			

Overview

The Richards Passive System is located in Cherryhill Township near Clymer, PA adjacent to Iron Horse Salvage along State Route 403 (SR-403). The rehabilitated Richards Passive System was put online in June 2021. Flow from an abandoned underground coal mine drain (concrete riser) is piped to a three-way flow splitter box and proportionally distributed among three Jennings-type vertical flow ponds (JVFPs) that flow to either a settling pond or wetland as shown in Figure 1. A seep located between JVFP2 and JVFP3 is captured in a French drain and piped to the wetland. A flowing artesian corehole discovered during previous construction efforts contributes degraded water to the final 1/3 of the wetland. This OM&R Plan has been prepared as part of the final report documents prepared December 2021 and uploaded to www.datashed.org. Other final report documents include: One-page summary, Narrative, Photographs, Water Monitoring Data, and As-Built Drawings (2 sheets).

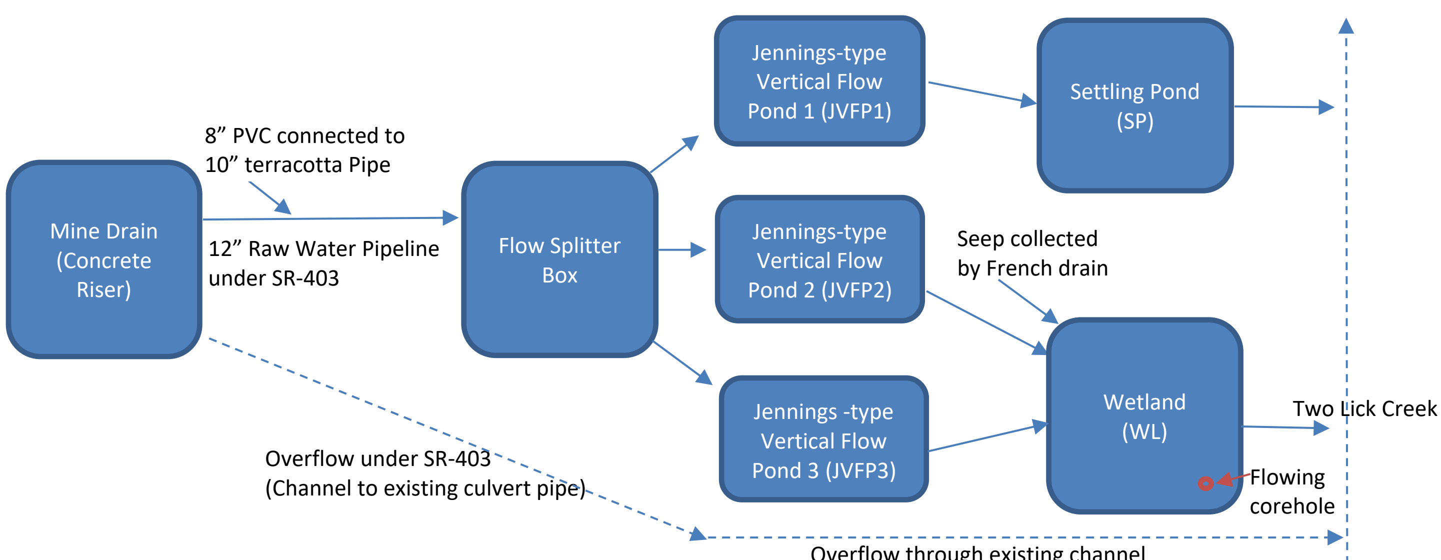


Figure 1. System Flow Diagram

System Components

Mine Drain and Raw Water Pipeline

Mine water flows from the underground coal mine through an existing vertical concrete riser (Mine Drain). A cover constructed of HDPE and stainless steel prevents unwanted access by animals and to exclude debris. A 12” SCH40 PVC pipe (Raw Water Pipeline) extends from a hole cut into the side of the Mine Drain, under SR-403, and into the Flow Splitter Box. The annulus of the hole in the concrete riser was not sealed around the PVC pipe so that other AMD that may be in the subsurface around the Mine Drain may flow into the Raw Water Pipeline and enter the treatment system. An overflow channel was installed near the mine drain to direct overflow and surface runoff to the 33” stainless steel corrugated metal culvert under SR-403.

The initial approximate 20’ of the Raw Water Pipeline is newly installed. The new pipe is connected to an existing 12” SCH40 PVC pipe with a flexible coupler (Fernco) installed in an existing concrete box. Both the pipe and concrete box have been covered with fill material. Downstream of the concrete box and prior to SR-403, an 8” pipe that extends from a 10” terracotta pipe, likely a historic mine drain, joins the 12” pipe. The existing 12” pipe runs under SR-403 in a 15” steel casing and to the north edge of the road right-of-way, then newly installed 12” SCH40 PVC pipe extends into the bottom of the flow splitter box via a 12” SCH40 PVC tee and riser pipe. Downstream of the flow splitter box a 12” Bypass Valve (Valterra gate valve) was installed to allow flow to bypass the Flow Splitter Box and discharge the full flow directly into JVFP2. The gate valve is located within a capped valve box and should typically be kept closed under normal operating conditions.

The Raw Water Pipeline should be evaluated on at least an annual basis or as needed. **If the depth of water above the 12” pipe in the Mine Drain is 0.3’ greater than reading on the staff gauge, the 12” pipe under Route SR-403 may need to be cleaned.** Note that the water in the Mine Drain is turbulent and a visual approximate average should be used for evaluation purposes. The elevation of top of the concrete riser is 1271.46, which is 0.27’ above the top of the stainless-steel baffle in the Flow Splitter Box. If water is flowing over the top of the stainless-steel baffle with all three weirs flowing at maximum capacity, the total flow would be in excess of 2,700 gpm. At no time should mine drainage exit the top of the Mine Drain, which would indicate that the 12” pipe should be cleaned immediately. The 12” pipe can be cleaned by flushing, achieved by opening the 12” Bypass Valve and allowing the pipe to flow full. Temporarily closing the Bypass Valve and allowing the water level to reestablish in the Flow Splitter Box and opening the valve again will allow the operator to repeatedly flush the pipe. If needed, the Raw Water Pipeline can be either snaked or jetted by accessing the pipe at the outlet in JVFP2, the bottom of the Flow Splitter Box, or at the Mine Drain. If cleaning the 12” pipe does not establish the desired conditions, the concrete riser may need to be extended, and the project designer or other qualified professional should be contacted.

The Mine Drain should be inspected during every site visit to ensure that the cover is in place and there is no overflow.

Flow Splitter Box

The flow splitter box is a 10’x8.5’ concrete box with a galvanized steel grate cover. Within the flow splitter box is a stainless-steel three-sided baffle with V-notch weirs cut into each side to proportionally direct flow to the three Jennings-type vertical flow ponds (JFVPs). Weirs that direct flow into JVFP1 and JVFP3 are cut at a 74° angle while the weir that feeds JVFP2 is cut at a 90° angle. A weir lookup table can be found below as Table 1. A copy of this table is to be kept in the valve box of the 12” bypass valve. Water elevations should be read directly from the staff gauge mounted on the inside wall of the concrete splitter box. Alternatively, the flow can be determined by measuring down from the galvanized steel grate (within 1’ of the staff gauge). Both staff gauge and ‘measure down’ readings are included on the lookup table. Please note that the values presented in the lookup table for the 74° (VFP1/3) will be the flow rate for each JVFP1 and JVFP3 and is NOT a total value of the two. Also note that the Total Flow provided in the table for a given staff gauge reading is only valid for when all three JVFPs are flowing. When flow is not being directed to all 3 JVFPs, the individual values for the 90° and 74° weirs at a given staff gauge reading are still valid, but the total flow will need to be calculated. For example, if the staff gauge reading is 0.34 ft, but only VFP1 and VFP2 have flow and VFP3 is off line, the flow rates will be 57.5 gpm for JVFP1 and 75.6 gpm for JVFP2 for a total flow of 133.1 gpm.

During maintenance events it may be necessary to block flow to one or more JVFP. To divert flow away from both JVFP1 and JVFP3 at the same time, the 12" Bypass Valve downstream of the flow splitter box may be opened to direct all flow into JVFP2. To divert water away from just JVFP2 a removeable insert, specially fabricated for a 90° weir, can be installed into the weir opening, therefore blocking water from entering the pipeline feeding water into JVFP2. All flow would then be split to JVFP1 and JVFP3. A second removable insert was fabricated to block flows through either of the 74° weirs. Flows can then be diverted away from either JVFP1 or JVFP3 without the entire flow going into JVFP2. These inserts are to be kept in the Bypass Valve box.

To ensure accurate flow measurement, the weirs should be kept free of debris or buildup. The staff gauge should be cleaned as needed. The seams between the box and stainless-steel weirs should be inspected to ensure no leaks have developed. Leaks can be addressed by cleaning the affected area and coating with Flex Seal or similar coating. The inlets to the pipes extending to the JVFPs should be cleaned as needed to ensure free flow. The 12" bypass can be opened as needed to drain the box to facilitate maintenance activities. After opening the bypass valve, please allow sufficient time for the Flow Splitter Box, Raw Water Pipeline, and Mine Drain to fill prior to taking a flow measurement.

French Drain Seep Collection (SEEP)

A mine drainage seep that appeared to be emanating from an existing 6" terracotta pipe and likely served as some sort of mine drain was found. The seep was at an elevation that prevented the mine drainage from being directed into any of the JVFPs. The seep was collected in a 6" French drain that extends from the western side of JVFP3, across the north side of JVFP3 and then outlets into the western side of the wetland. A riser was installed on the outlet to allow for flow measurements and water sampling.

Jennings-type Vertical Flow Pond 1 (JFVP1)

Jennings Vertical Flow Pond 1 lies farthest to the west and is the only JVFP to discharge into the Settling Pond (SP). JVFP1 contains a mixture of limestone, wood chips, and mushroom compost (treatment media). There are four separate underdrain cells that flow through the west side of the pond and into the SP. Riser pipes can be individually raised or lowered to control the amount of treatment media being used and the overall level of treatment provided by JVFP1. Drainpipes are located adjacent to the riser pipes and are controlled via four 6" Valterra valves located in individual valve boxes (N-12 pipes) with red metal caps. Opening these valves will drain the entirety of JVFP1 into the SP.

Jennings-type Vertical Flow Pond 2 (JVFP2)

Jennings Vertical Flow Pond 2 lies to the southeast of JVFP1 parallel to SR-403 and discharges into the Wetland (WL). JVFP2 contains a treatment media mixture similar to JVFP1. The pond has 5 separate underdrain cells that flow through the northeast side of the pond and into the WL. Riser pipes can be individually raised or lowered to control the amount of treatment media being used and the overall level of treatment provided by JVFP2. Drainpipes are located adjacent to the riser pipes and are controlled via five 6" Valterra valves located in a single concrete valve box with a red metal lid. Opening these valves will drain the entirety of JVFP2 into the WL.

Jennings-type Vertical Flow Pond 3 (JVFP3)

Jennings Vertical Flow Pond 3 lies to the north of JVFP2 parallel to Two Lick Creek and discharges into the WL. JVFP3 contains a treatment media mixture similar to JVFP1. The pond has 4 separate underdrain cells that flow through the northeast side of the pond and into the WL. Riser pipes can be individually raised or lowered to control the amount of treatment media being used and the overall level of treatment provided by JVFP3. Drainpipes are located adjacent to the riser pipes and are controlled via four 6” Valterra valves located in individual black valve boxes with red metal caps. Opening these valves will drain the entirety of JVFP3 into the WL.

Settling Pond

JVFP1 flows to an existing pond, around a newly installed earthen baffle, and discharges through a corrugated N-12 culvert pipe to Two Lick creek. An auxiliary outlet is located approximately five feet above the primary outlet if needed during extreme flooding or if the primary outlet becomes inoperable. Prior to construction and after system startup, it was noted that this pond leaks up to about 50 gpm. This does not seem to result in any known stability issues and the leaking water will be alkaline.

Wetland

An existing wetland was reconfigured and receives water from both JVFP2 and JVFP3 and discharges to Two Lick Creek via a rock-lined spillway. The wetland also receives the seep what is collected by the French drain. Seven Z-pile baffles have been installed to increase retention times and maximize the use of the wetland by utilizing stagnant areas and eliminated preferential flow paths. Wetland depth varies between one and two feet which should allow for good variability in wetland plant biodiversity. During previous construction efforts, it was reported that an artesian flowing corehole was discovered near the eastern end of the wetland and reportedly contributes degraded water to the last 1/3 of the wetland. The flowing corehole as well as the Seep and other sources reported to emanate within the Wetland likely impact the final water quality, however, the excess alkalinity generated by JVFP2 and JVFP3 should be more than sufficient to overcome the acid load associated with the corehole water.

Types of Maintenance

System Startup and Odor Control

The rehabilitated Richards Passive System is rated to treat up to about 1,000 pounds per day of acidity using a treatment media mixture of limestone and organic material. The biological activity in the treatment media will produce both alkalinity and hydrogen sulfide gas. Depending on flow, temperature, and the age of the treatment media, nuisance odors may occur. After the system was first turned on in June 2021, the system created odor that was reported to be noticeable in Clymer, PA. The inserts were placed in the weirs feeding JVFP2 and JVFP3 to direct all the flow to JVFP1 and the riser for JVFP1 cell 1 was lowered to force all the flow through a single underdrain cell. This proved to be an effective means to control odor; However, in the future, either JVFP2 or JVFP3 should be utilized when only using one of the JVFPs in order to provide treatment for the corehole, Seep, and other in-wetland sources. In December 2021, the weir inserts were removed and both Cell 1 risers in JVFP2 and JVFP3 were lowered to split the flow among the three JVFPs and utilize only one underdrain cell per JVFP. It is recommended that the treatment media be ‘burned in’ by changing which cell is used in each JVFP on a monthly basis through the colder months. As the weather warms and the flow potentially decreases, one or more of the JVFPs may need to be taken off line to control odor. Over time, which may be several years, the odor should abate as the treatment media ages. Eventually all the JVFPs should be operated year-round utilizing all of the underdrain cells (i.e., no weir inserts and all riser pipes set at equal elevations in each JVFP). There should always be a noticeable odor near the outlets of the JVFPs, which indicates they are functioning as designed; However, as long as the treatment goals are being met, the level of treatment should be adjusted as needed to control nuisance odors. To provide mixing in the wetland to help overcome pollutant loads from the seep and corehole, it is preferred that sufficient flow be directed through JVFP2 and/or JVFP3 at all times.

Routine Inspection/Operation/Maintenance (Quarterly)

Routine inspections and regular maintenance should be performed on a Quarterly basis by the Blacklick Creek Watershed Association to ensure that the mine drainage flows through all components of the system and that the treatment goals for the final effluent are being met. These efforts are intended to be suitable for completion by one individual.

- Check the Mine Drain to ensure that the entire discharge is being conveyed to the Flow Splitter Box and that no AMD is entering the emergency overflow channel.
- Clean debris and buildup from weirs and from around the inlets to the 10" pipelines in the Flow Splitter Box and take a flow reading. Verify no water is leaking around the stainless-steel baffle (weir structure) and repair as needed.
- Exercise 12" Bypass Valve.
- Remove debris and unwanted vegetation from any ditches or channels as needed.
- Check embankments, channels, ditches, and overall site for erosion or unstable conditions. Fill and stabilize with onsite material.
- In order to generally characterize the performance of the passive treatment system, field water monitoring of at least the SP and WL effluent should be measured on a quarterly basis including pH, alkalinity, and flow rates where feasible. Ideally, flow rates should be determined and reported for all influent sources of AMD (Raw and Seep) and both the SP and WL. When flow cannot be directly measured, an assumed estimated value based on other flow measurements should be calculated and reported. Excessive reducing conditions from the JVFPs may inhibit oxidation and settling of iron in the WL or SP. If this occurs flows may need to be consolidated or cells of a pond may need turned off to increase the oxidation potential and increase settling rates.
    - The Settling Pond and Wetland should have pH above 6 and field alkalinity greater than 20 mg/L
    - If samples are collected, the Settling Pond and Wetland should always have negative acidity
        - Aluminum should always be less than 1 mg/L
        - Iron should always be less than 3 mg/L (though the influence of the corehole and seeps may cause the total iron to be up to 7 mg/L at the outlet of the Wetland)
        - Manganese was not a targeted parameter as the raw concentration is about $\leq$2 mg/L

Long-Term Maintenance (~5 to 10-Year Projected Need)

Stir JVFP Treatment Media

Over time, compaction of the treatment media and accumulation of metals may reduce permeability to the point where water can no longer readily pass through the treatment media. Water level in the pond will increase and eventually discharge through the emergency spillway, significantly reducing treatment. Stirring of the treatment media can often address this issue.

1. Open drain valves (4 valves for JVFP1 and JVFP3, 5 valves for JVFP2).
2. Allow the JVFP to drain below the treatment media elevation.
3. Allow media to dry to facilitate use of mini-excavator or other small equipment with relatively low ground pressure to run on the media.
4. Stir entire volume of treatment media, leaving behind loose uncompacted material. Take care not to damage underdrain piping, repair piping as needed. Stirring should stop at the underdrain stone/treatment media interface.
5. Close drain valves and allow pond to fill.
6. Open drain valves to flush JVFP in order to wash fine material from piping system.

7. Close drain valves and allow pond to fill. Reset, as needed, the adjustable outlet risers to the normal operating elevation.

Raw Water Pipeline
Although not expected, cleaning of the Raw Water Pipeline may be necessary, especially if quarterly maintenance is not completed and metal precipitates are allowed to build within the pipe.

1. Open bypass valve.
2. Using a pipe snake or a jetter, start clearing the pipeline from the JVFP2 side of the pipeline working upstream.
3. Once cleaned, flush one or two volumes of water through the pipeline to clear any remaining debris.
4. Close valve and return system to normal operation

Rehabilitation (~15- to 25-Year)

Flow Splitter Box and Raw Water Pipeline
Rehabilitation of the Flow Splitter Box and Raw Water Pipeline will generally be dependent on any vandalism that may happen. If debris is removed from the box and the weirs are kept clean on a quarterly basis there are not any foreseen wear items within the box, though the staff gauge may need to be replaced. Ensure that the ‘0’ mark be set at the exact same elevation, which is level with the elevation of the weir crests (bottom of ‘V’).

Replace JVFP Treatment Media/Underdrain System
The complete replacement of treatment media will most likely be done in phases to continue treatment of the raw water by diverting water to JVFP2 during replacement of JVFP1 and/or JVFP3, then diverting water to JVFP1 and/or JVFP3 during replacement of the other JVFPs.

1. Divert flow away from the JVFP to be rehabilitated.
2. Open all drain valves and completely drain the subject JVFP
3. Allow media to dry to facilitate removal.
4. Remove spent treatment media and, if needed underdrain bedding stone and piping.
5. Spread and level spent treatment media and bedding stone onsite and cover with ~1’ soil, revegetate with grass-legume seed mix. Alternatively, material can be disposed of off-site in accordance with all federal, state, and local regulations.
6. Replace underdrain stone and piping if needed and thoroughly mix and place fresh treatment media. The existing system quantities can be found on the as-built drawing or within the pond descriptions within this document. New developments in water treatment technologies, as well as potential changes in water quality and flow should be evaluated prior to replacing the treatment media.
7. Repeat steps 1 – 6 as needed for the two other JVFPs

Triggers to Initiate Maintenance Activities

Several maintenance triggers have been developed to help assist in identifying needed maintenance. The following is a listing of selected action items (numbered) with a brief description of suggested maintenance activities.

Trigger #1: Final Effluent of Wetland or Settling Pond pH below 6
The system is designed to discharge at a pH ≥6 from the Wetland and Settling Pond during normal flow conditions. Routine inspections are recommended to include measuring the pH of the effluent flows in the field using a colorimetric kit or a pH meter. Effluent water with a pH <6 when the flow rate is <747 gpm typically

indicates that a JVFP is not functioning optimally. The decrease in treatment by the JVFP could be caused by insufficient hydraulic conductivity, short-circuiting of the treatment media, worse-than-designed-for influent water chemistry, exhausted treatment media, and/or other factors.

Improving the final effluent pH can be approached in a step-wise manner starting with low-cost alternatives performed by a single person, using only hand tools, and proceed to activities requiring power equipment.

STEP ONE: Determine that water chemistry and loading are not above the maximum design quantities. Flows or water chemistry above the design rate may cause depressed pH readings in the effluent making the treatment system appear to be underperforming when in fact it may be performing at or greater than designed on a load-basis.

STEP TWO: Reconfigure outlet risers to a higher elevation to increase the residence time within the JVFP to improve treatment. If increasing the residence time does not restore the effluent to a 6 pH, proceed to the third step. *Note: Take care not to extend the outlet risers to the point that the water is bypassing the JVFP through its emergency spillway.*

STEP THREE: Stir the treatment media in the JVFP as described above.

FINAL STEP: If stirring does not restore the desired pH and alkalinity, then the treatment media may need to be enhanced, increased, or replaced. Alternatively, the system may need to be otherwise evaluated and upgraded. Conferring with someone familiar with current passive treatment technology is advised before replacing the JVFP treatment media as described above.

Trigger #2: JVFP Hydraulic Conductivity

If water is flowing in the emergency spillway of the JVFP on a regular basis, this indicates that the actual flow rate is greater than the design flow rate, piping has plugged, and/or the hydraulic conductivity (permeability) of the treatment media has substantially decreased. If the influent flow rate is greater than 1000 gpm, check the system on a regular basis to ensure that the higher-than-maximum flow rate does not damage the spillways or embankments. If the flow rate is within the normal operating range and water is discharging through an emergency spillway, efforts to restore adequate flow through the treatment media or piping of the JVFP is needed. An initial first step is to lower the adjustable outlet riser of that JVFP, which will temporarily increase the driving head and potentially force the water through the treatment media until the water level stabilizes at the new outlet level. If lowering the outlet riser is not successful then additional action is required. Next drain the JVFP treatment media. As a loss in hydraulic conductivity may be caused by an accumulation of iron solids on the surface of the treatment media, draining the JVFP and allowing the iron solids to dry will encourage the formation of “cracks” that may be sufficient to restore adequate hydraulic conductivity. If draining and drying are not sufficient, the sludge may need to be removed prior to stirring the treatment media.

Trigger #3: Sludge Accumulation

If sludge has accumulated in the JVFPs, Wetland, or Settling Pond to a point where solids are (or about to be) carried out of the component during normal flow conditions, the recommendation is to remove the sludge. The material can be removed from the ponds and/or wetland and placed on-site, as feasible. There are a variety of mechanical means that can be provided by local companies including sludge pumping and/or excavation.

Rehabilitation/Replacement

Prior to initiating the previously discussed rehabilitation procedures for the passive components, an evaluation of any changes in raw discharge characteristics and advancements in technology is recommended. For instance, higher flow rates and poorer water quality can substantially affect future system performance; therefore, revisions to the size and/or design of the system may be applicable.

Rehabilitation/replacement considerations include, but are not limited to:

- Estimating Best Management Practice (BMP) design life;
- Determining replacement responsibility, including a successor, as necessary;
- Determining approximate costs for the following possible needs:
  - removing accumulated sediments;
  - replacing defective valves, water control structures, etc.;
  - replacing media in treatment components; and
  - re-sizing the system to accommodate changed water quality or quantity.

Table 1. Richards Flow Splitter Box Lookup Table.

Richards Flow Splitter Box Lookup Table

(Direct read staff guage or measure down from top of grate. Raw water sample may be collected in the box or at the pipes discharging to JVFP2 or JVFP3.)

Staff Reading	Staff Reading	Measure Down*	Measure Down*	90˚ (VFP2)	74˚ (VFP1/3)	TOTAL (3 VFPS)	Staff Reading	Staff Reading	Measure Down*	Measure Down*	90˚ (VFP2)	74˚ (VFP1/3)	TOTAL (3 VFPS)	Staff Reading	Staff Reading	Measure Down*	Measure Down*	90˚ (VFP2)	74˚ (VFP1/3)	TOTAL (3 VFPS)
Head (ft)	Head (in)	(ft)	(in)	(gpm)	(gpm)	(gpm)	Head (ft)	Head (in)	(ft)	(in)	(gpm)	(gpm)	(gpm)	Head (ft)	Head (in)	(ft)	(in)	(gpm)	(gpm)	(gpm)
0.01	1/8	1.32	15 7/8	0.0	0.0	0.0	0.34	4 1/8	0.99	11 7/8	75.6	57.5	190.6	0.67	8	0.66	8	412.3	309.9	1032.1
0.02	2/8	1.31	15 6/8	0.1	0.1	0.2	0.35	4 2/8	0.98	11 6/8	81.3	61.8	204.9	0.68	8 1/8	0.65	7 7/8	427.9	321.5	1070.9
0.03	3/8	1.30	15 5/8	0.2	0.2	0.5	0.36	4 3/8	0.97	11 5/8	87.3	66.2	219.7	0.69	8 2/8	0.64	7 6/8	443.8	333.4	1110.6
0.04	4/8	1.29	15 4/8	0.4	0.3	1.0	0.37	4 4/8	0.96	11 4/8	93.4	70.9	235.2	0.70	8 3/8	0.63	7 5/8	460.0	345.6	1151.2
0.05	5/8	1.28	15 3/8	0.6	0.5	1.7	0.38	4 4/8	0.95	11 4/8	99.9	75.7	251.4	0.71	8 4/8	0.62	7 4/8	476.6	358.0	1192.6
0.06	6/8	1.27	15 2/8	1.0	0.8	2.7	0.39	4 5/8	0.94	11 3/8	106.6	80.8	268.1	0.72	8 5/8	0.61	7 3/8	493.6	370.7	1234.9
0.07	7/8	1.26	15 1/8	1.5	1.2	3.9	0.40	4 6/8	0.93	11 2/8	113.5	86.0	285.6	0.73	8 6/8	0.60	7 2/8	510.9	383.6	1278.2
0.08	1	1.25	15	2.0	1.7	5.4	0.41	4 7/8	0.92	11 1/8	120.8	91.4	303.7	0.74	8 7/8	0.59	7 1/8	528.6	396.8	1322.3
0.09	1 1/8	1.24	14 7/8	2.7	2.2	7.1	0.42	5	0.91	11	128.3	97.1	322.4	0.75	9	0.58	7	546.6	410.3	1367.3
0.10	1 2/8	1.23	14 6/8	3.5	2.8	9.2	0.43	5 1/8	0.90	10 7/8	136.0	102.9	341.9	0.76	9 1/8	0.57	6 7/8	565.0	424.1	1413.2
0.11	1 3/8	1.22	14 5/8	4.5	3.6	11.7	0.44	5 2/8	0.89	10 6/8	144.1	109.0	362.0	0.77	9 2/8	0.56	6 6/8	583.8	438.1	1460.0
0.12	1 4/8	1.21	14 4/8	5.6	4.4	14.5	0.45	5 3/8	0.88	10 5/8	152.4	115.2	382.9	0.78	9 3/8	0.55	6 5/8	602.9	452.4	1507.8
0.13	1 4/8	1.20	14 4/8	6.8	5.4	17.6	0.46	5 4/8	0.87	10 4/8	161.0	121.7	404.4	0.79	9 4/8	0.54	6 4/8	622.4	467.0	1556.4
0.14	1 5/8	1.19	14 3/8	8.2	6.5	21.1	0.47	5 5/8	0.86	10 3/8	169.9	128.4	426.6	0.80	9 5/8	0.53	6 3/8	642.3	481.9	1606.0
0.15	1 6/8	1.18	14 2/8	9.8	7.6	25.1	0.48	5 6/8	0.85	10 2/8	179.1	135.2	449.6	0.81	9 6/8	0.52	6 2/8	662.6	497.0	1656.6
0.16	1 7/8	1.17	14 1/8	11.5	9.0	29.4	0.49	5 7/8	0.84	10 1/8	188.6	142.3	473.3	0.82	9 7/8	0.51	6 1/8	683.2	512.4	1708.1
0.17	2	1.16	14	13.4	10.4	34.2	0.50	6	0.83	10	198.4	149.7	497.7	0.83	10	0.50	6	704.2	528.1	1760.5
0.18	2 1/8	1.15	13 7/8	15.4	12.0	39.3	0.51	6 1/8	0.82	9 7/8	208.4	157.2	522.9	0.84	10 1/8	0.49	5 7/8	725.6	544.1	1813.9
0.19	2 2/8	1.14	13 6/8	17.7	13.7	45.0	0.52	6 2/8	0.81	9 6/8	218.8	165.0	548.8	0.85	10 2/8	0.48	5 6/8	747.4	560.4	1868.2
0.20	2 3/8	1.13	13 5/8	20.1	15.5	51.1	0.53	6 3/8	0.80	9 5/8	229.5	173.0	575.5	0.86	10 3/8	0.47	5 5/8	769.6	577.0	1923.5
0.21	2 4/8	1.12	13 4/8	22.7	17.5	57.6	0.54	6 4/8	0.79	9 4/8	240.4	181.2	602.9	0.87	10 4/8	0.46	5 4/8	792.2	593.8	1979.8
0.22	2 5/8	1.11	13 3/8	25.5	19.6	64.7	0.55	6 5/8	0.78	9 3/8	251.7	189.7	631.1	0.88	10 4/8	0.45	5 4/8	815.1	611.0	2037.1
0.23	2 6/8	1.10	13 2/8	28.5	21.9	72.2	0.56	6 6/8	0.77	9 2/8	263.3	198.4	660.1	0.89	10 5/8	0.44	5 3/8	838.5	628.4	2095.3
0.24	2 7/8	1.09	13 1/8	31.7	24.3	80.3	0.57	6 7/8	0.76	9 1/8	275.2	207.3	689.8	0.90	10 6/8	0.43	5 2/8	862.2	646.2	2154.6
0.25	3	1.08	13	35.1	26.9	88.8	0.58	7	0.75	9	287.5	216.5	720.4	0.91	10 7/8	0.42	5 1/8	886.4	664.2	2214.8
0.26	3 1/8	1.07	12 7/8	38.7	29.6	97.9	0.59	7 1/8	0.74	8 7/8	300.0	225.9	751.7	0.92	11	0.41	5	910.9	682.5	2276.0
0.27	3 2/8	1.06	12 6/8	42.5	32.5	107.5	0.60	7 2/8	0.73	8 6/8	312.9	235.5	783.9	0.93	11 1/8	0.40	4 7/8	935.9	701.2	2338.2
0.28	3 3/8	1.05	12 5/8	46.5	35.6	117.7	0.61	7 3/8	0.72	8 5/8	326.1	245.4	816.9	0.94	11 2/8	0.39	4 6/8	961.3	720.1	2401.5
0.29	3 4/8	1.04	12 4/8	50.8	38.8	128.4	0.62	7 4/8	0.71	8 4/8	339.6	255.5	850.6	0.95	11 3/8	0.38	4 5/8	987.0	739.3	2465.7
0.30	3 5/8	1.03	12 3/8	55.3	42.2	139.7	0.63	7 4/8	0.70	8 4/8	353.5	265.9	885.3	0.96	11 4/8	0.37	4 4/8	1013.2	758.9	2531.0
0.31	3 6/8	1.02	12 2/8	60.0	45.7	151.5	0.64	7 5/8	0.69	8 3/8	367.7	276.5	920.7	0.97	11 5/8	0.36	4 3/8	1039.8	778.7	2597.3
0.32	3 7/8	1.01	12 1/8	65.0	49.5	163.9	0.65	7 6/8	0.68	8 2/8	382.2	287.4	957.0	0.98	11 6/8	0.35	4 2/8	1066.8	798.9	2664.6
0.33	4	1.00	12	70.2	53.4	177.0	0.66	7 7/8	0.67	8 1/8	397.1	298.5	994.1	0.99	11 7/8	0.34	4 1/8	1094.2	819.4	2733.0

Total flow is the 90˚ weir plus 2X the 74˚ weir reading. The 74˚ weir reading is for a single weir. If JVFP2 is turnd off with flow to both JVFP1 and JVFP3, the total flow is the flow for the 74˚ weir multipled by two.

*Measure within 1 foot of staff guage. (Distance measured from top of grate to 0.0 on staff gugage was 1.33' (16.0") on 7/2/21.

Note: '0' Mark (weir crest) elevation: 1270.19; Elevation at top of 12" PVC pipe in Mine Drain at inside wall of concrete riser: 1270.13

Appendix 4
As-Built Drawings

DESIGN SUMMARY

DESIGN LIFE: 15 - 25 YEARS (ASSUMING PROPER MONITORING AND MAINTENANCE)

DESIGN FLOW
MAX HYDRAULIC DESIGN: 1,000 GPM
MAX TREATMENT DESIGN: 747 GPM
AVERAGE DESIGN: 117 GPM

DESIGN TREATMENT LOAD
MAX DESIGN TREATMENT LOAD:
1,020 LB/DAY ACIDITY
148-296 LB/DAY IRON
128 LB/DAY ALUMINUM
AVERAGE DESIGN TREATMENT LOAD:
166 LB/DAY ACIDITY
23 LB/DAY IRON
15 LB/DAY ALUMINUM

NOTE:
THE DIFFERENCE IN THE WATER ELEVATION BETWEEN THE CONCRETE RISER AND FLOW SPLITTER BOX **SHOULD BE LESS THAN 0.3'**. AN INCREASE IN HEAD DIFFERENTIAL BETWEEN WATER ELEVATION IN THE CONCRETE RISER VERSES WATER ELEVATION IN THE FLOW SPLITTER BOX MAY BE A RESULT OF PLUGGING OF THE RAW WATER PIPELINE, INDICATING THAT THE PIPE SHOULD BE CLEANED.

GENERAL NOTES

1. 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)]. Select topographic and cultural features from 2006 PAMAP aerial photos obtained from www.pasda.psu.edu and USGS 7.5' Commodore, PA (PR1993). Additional information from 2020 / 2021 site investigations by BioMost, Inc. Elevation bench marks set by BioMost, Inc Mars, PA.
2. Vertical Control established by setting a GPS control point with a survey-grade GPS unit (BM1).
3. All dimensions are in feet unless otherwise noted. All slope designations are H:V.
4. For simplicity, the property lines, and tree lines are not shown on this map. All aspects of this project lay entirely within the property owned / controlled by Dennis J Richards. **This is not a property survey.**
5. #67 Limestone supplied by Allegheny Mineral, Worthington, PA 92.47% CaCO3 (Vanport Limestone).
6. Dashed contours are closed depressions.
7. Jennings-type Vertical Flow Pond (JVFP) acid load treatment capacity (i.e., lb acid/cy/day) follows information presented at the American Society of Reclamation Sciences 2019 Annual Conference, Big Sky, Montana, *"Performance Evaluation of the North Fork Montour Run Passive Treatment System"*: https://www.asrs.us/wp-content/uploads/2021/09/8A_1100_Danehy.pptx

AS-BUILT SITE PLAN VIEW

RICHARDS PASSIVE SYSTEM REHABILITATION

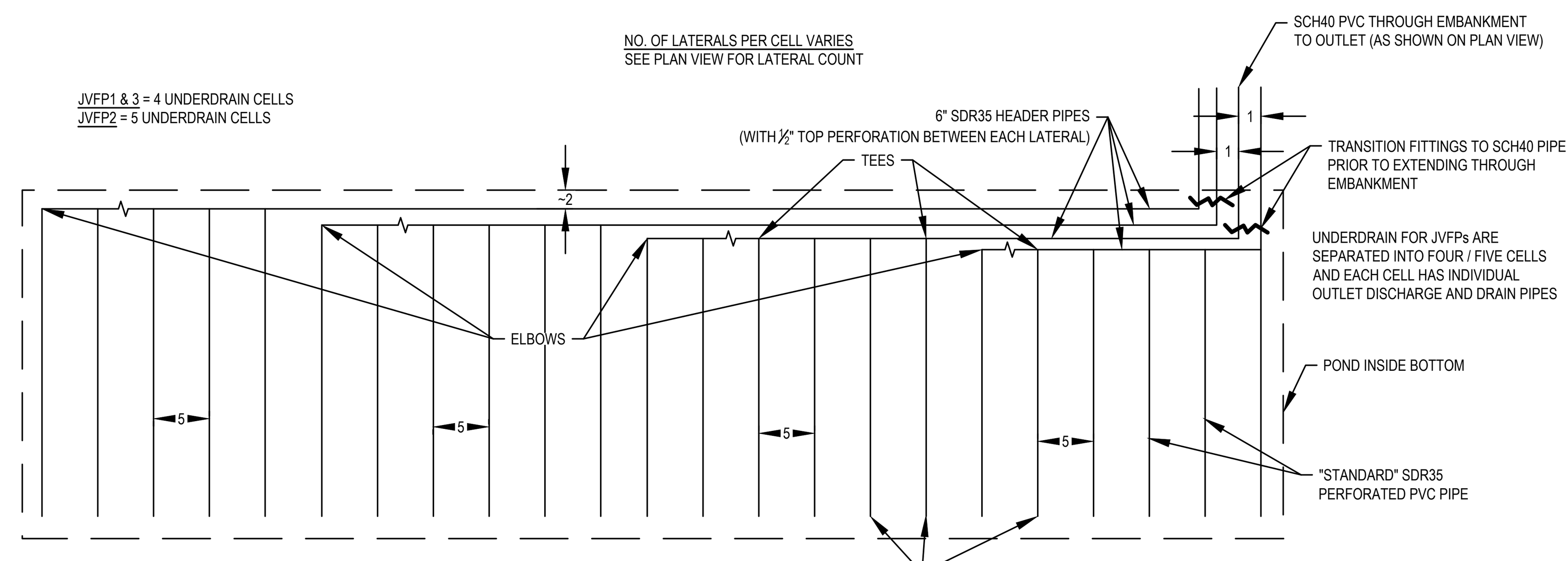
for
Blacklick Creek Watershed Association
Cherryhill Township, Indiana County, Pennsylvania

Scale: 1"=50' December 2021

Center of Project
Lat: 40-39-47
Lon: -78-58-52
Deg-Min-Sec

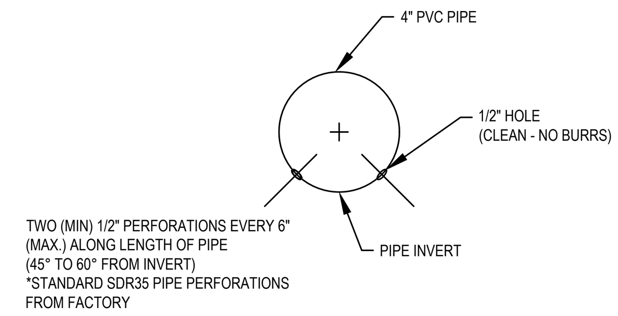
BioMost, Inc., Mars, Pennsylvania
Mining and Reclamation Services www.biomost.com

50 25 0 50



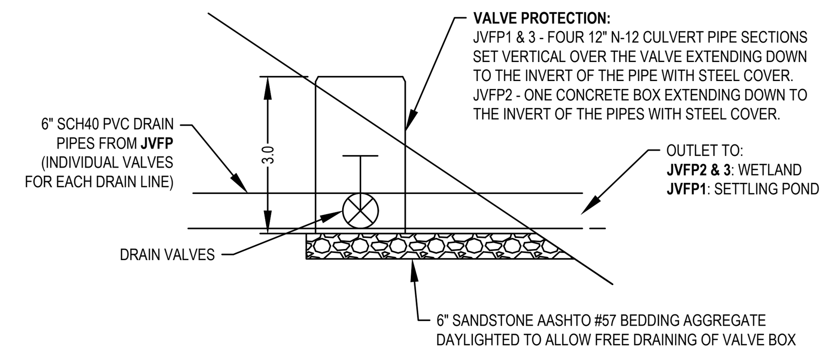
JENNINGS VERTICAL FLOW POND (JVFP) PIPE PLAN (TYPICAL)

Horizontal Scale: None Vertical Scale: None



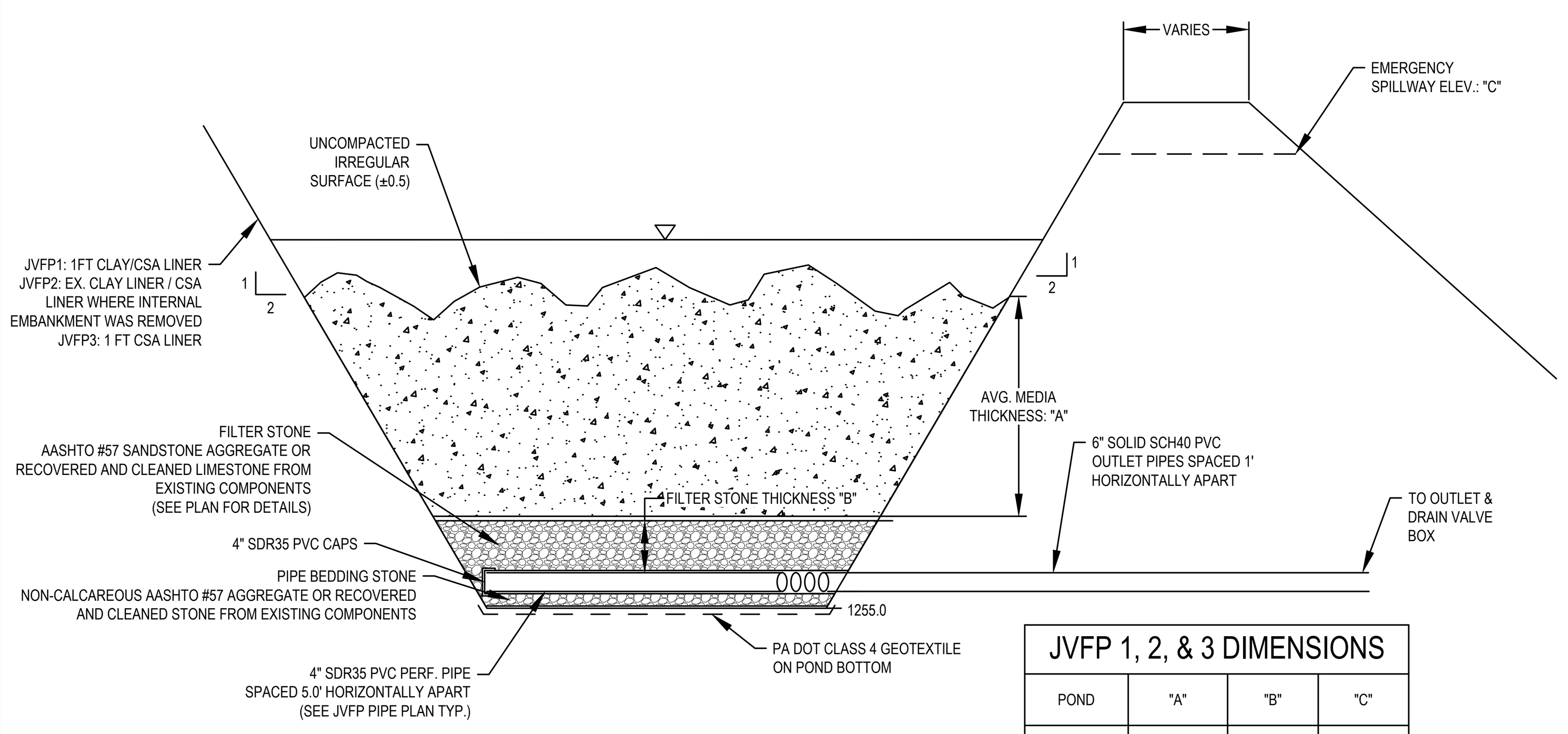
JVFP PIPE PERF. DETAIL

Horizontal Scale: None Vertical Scale: None



DRAIN VALVE / PROTECTION STRUCTURE (TYPICAL)

Horizontal Scale: None Vertical Scale: None

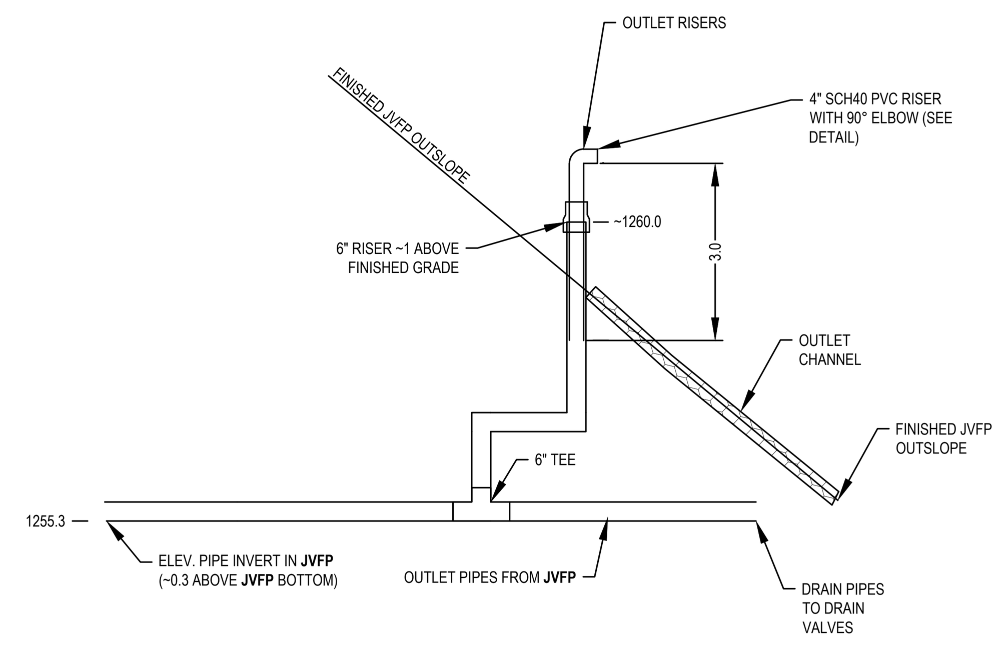


JVFP 1, 2, & 3 DIMENSIONS

POND	"A"	"B"	"C"
JVFP1	3.5	0.6	1264.0
JVFP2	4.1	0.9	1265.6
JVFP3	3.9	0.3	1263.6

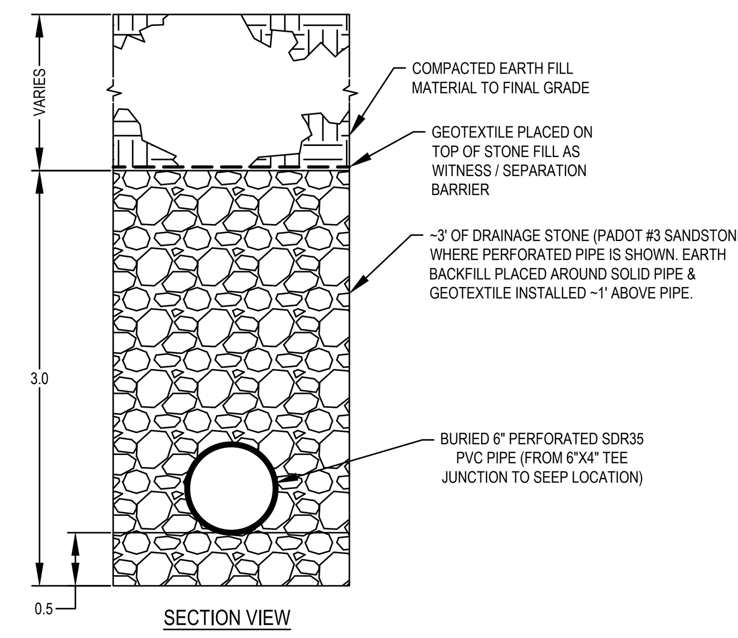
JENNINGS-TYPE VERTICAL FLOW POND 1, 2, & 3 (JVFP1, 2, & 3) TYPICAL

Horizontal Scale: None Vertical Scale: None



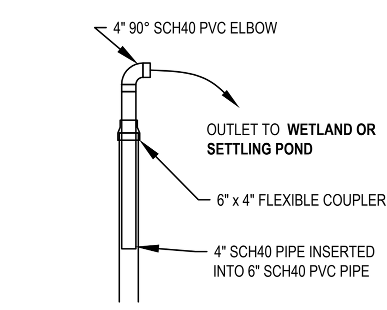
JVFP1, 2, & 3 OUTLET

Horizontal Scale: None Vertical Scale: None



FRENCH DRAIN

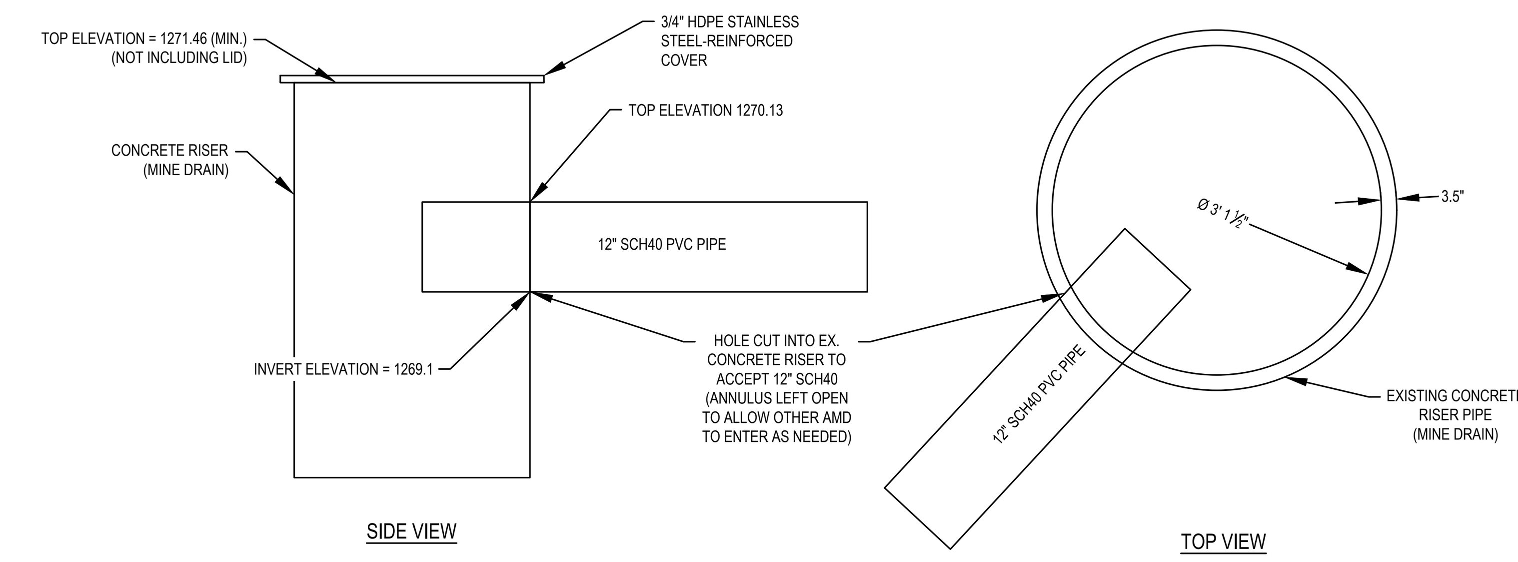
Horizontal Scale: None Vertical Scale: None



OUTLET RISER

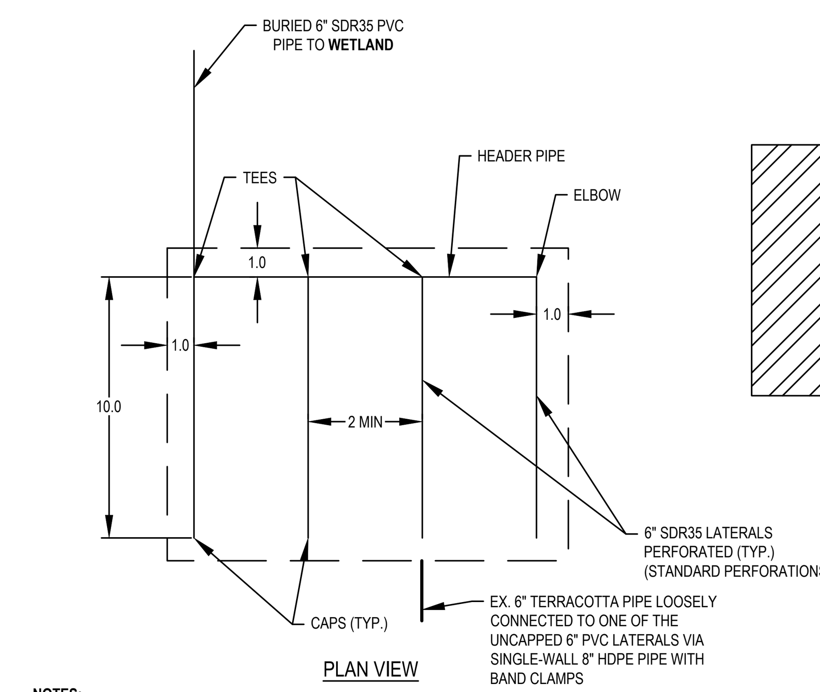
Horizontal Scale: None Vertical Scale: None

(US PATENT # 7,232,278 - USED BY PERMISSION)

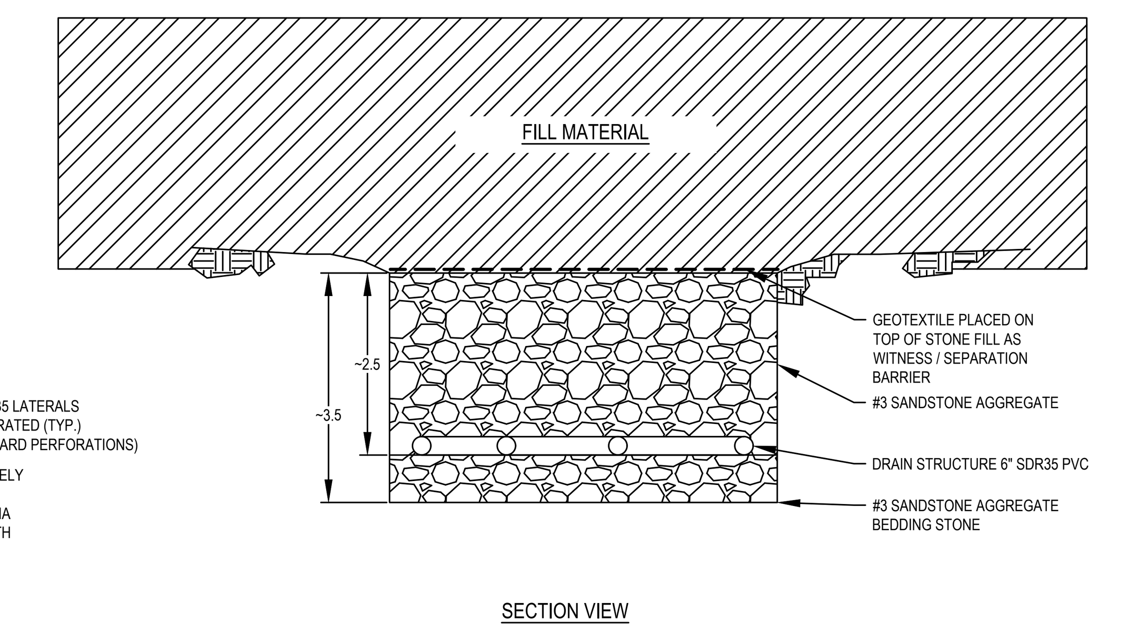


MINE DRAIN CONNECTION

Horizontal Scale: None Vertical Scale: None

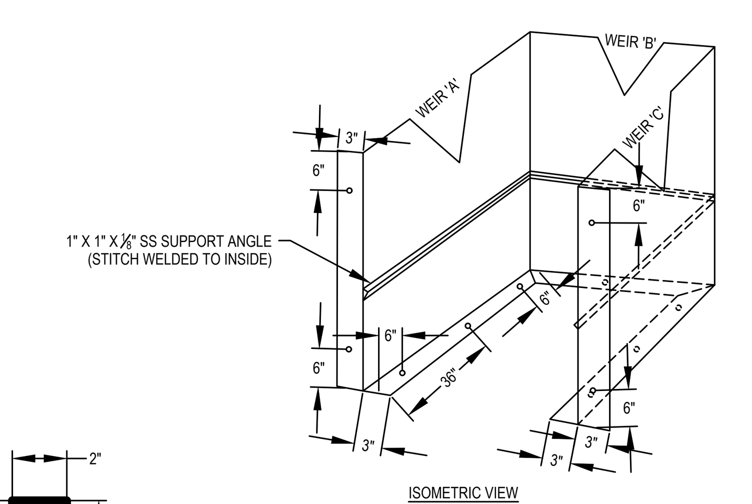


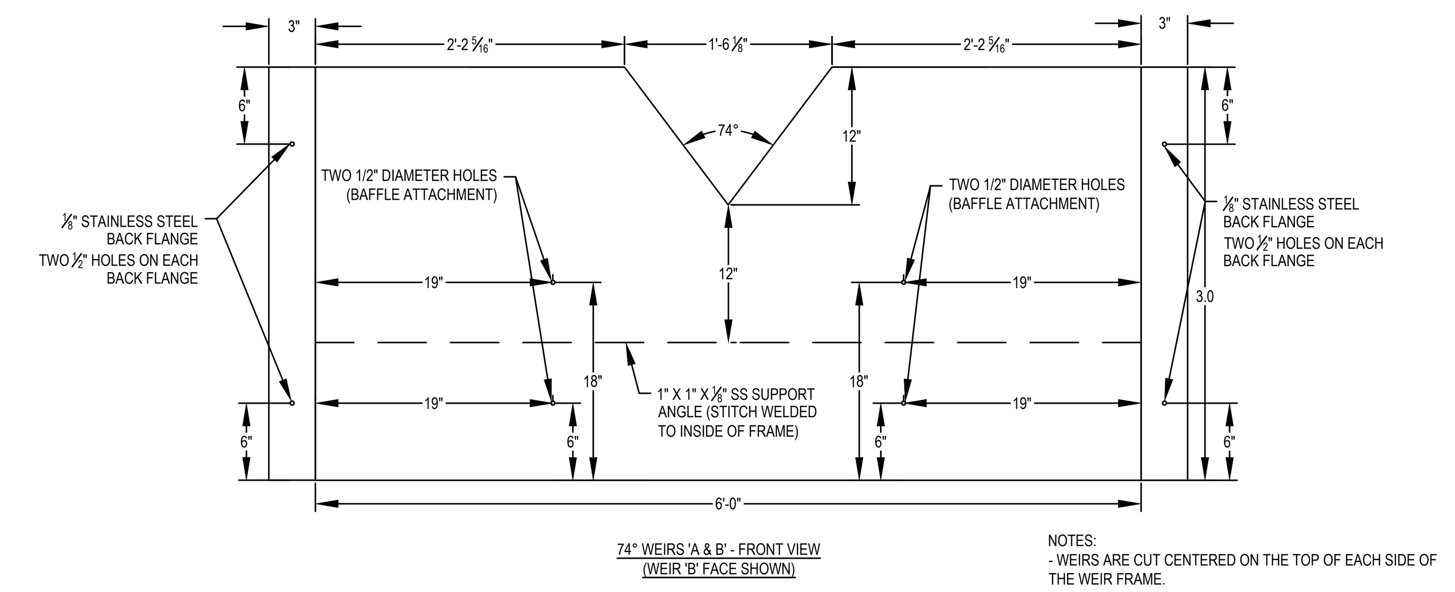
NOTES:
*LATERALS 6" SDR35 PIPE (PERFORATED)
*SINGLE 6" SDR35 HEADER (PERFORATED)
PERFORATED PIPE / STONE BACKFILL TO BE USED TO THE 6" X 4" TEE / LATERAL ALL PIPE AFTER THAT IS SOLID.



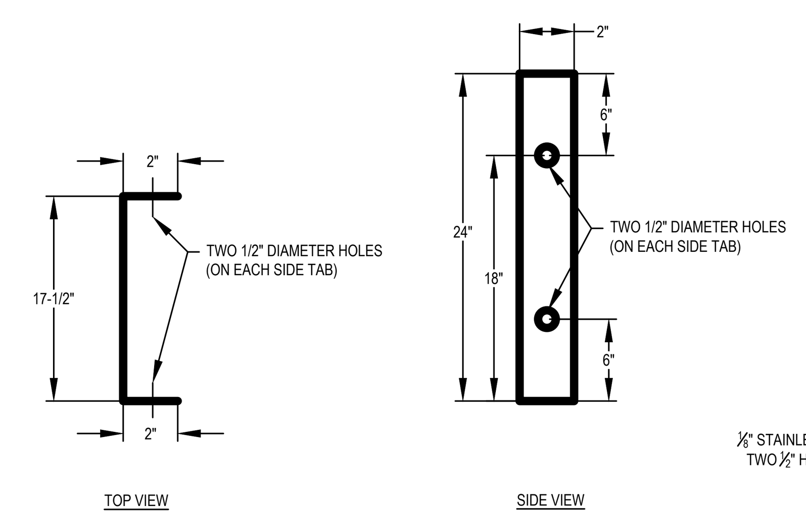
SEEP COLLECTION DRAIN

Horizontal Scale: None Vertical Scale: None



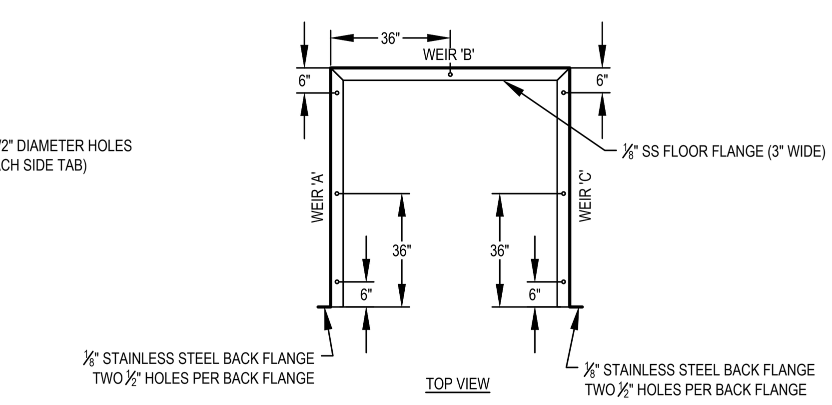


NOTES:
- WEIRS ARE CUT CENTERED ON THE TOP OF EACH SIDE OF THE WEIR FRAME.
-1" X 1" X ⅛" ANGLE STITCH WELDED TO INSIDE FACE OF WEIR FRAME 1 FT BELOW THE POINT OF THE WEIR TO PROVIDE SUPPORT TO THE STRUCTURE.
- WEIR A IS THE SAME AS WEIR B



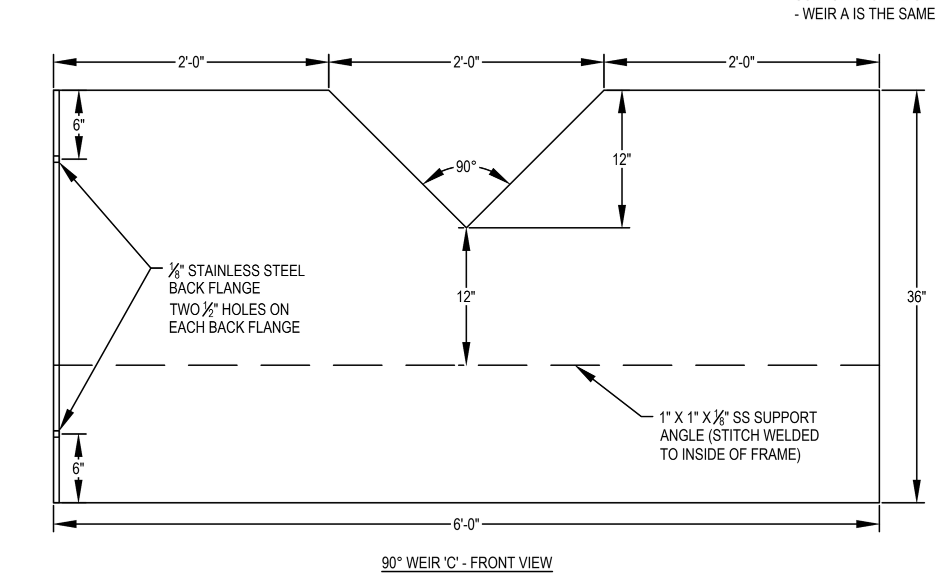
STAINLESS STEEL BAFFLES

Horizontal Scale: None Vertical Scale: None



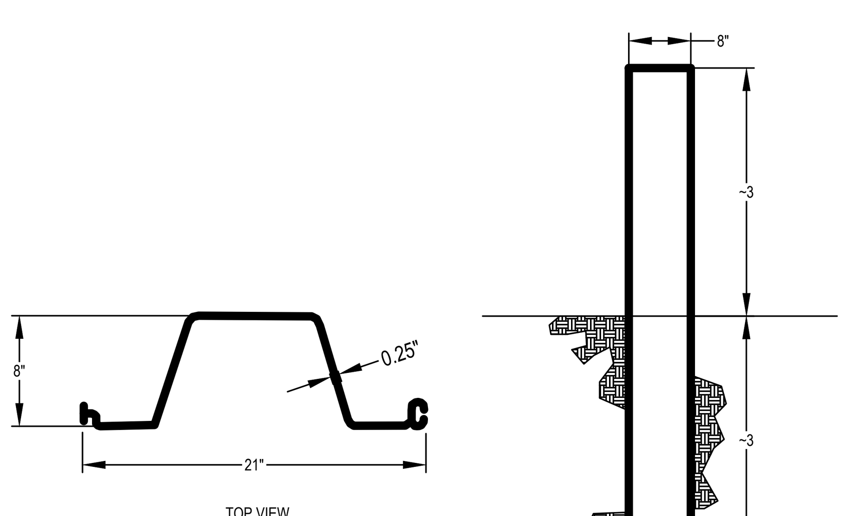
WEIR FLANGES

Horizontal Scale: None Vertical Scale: None



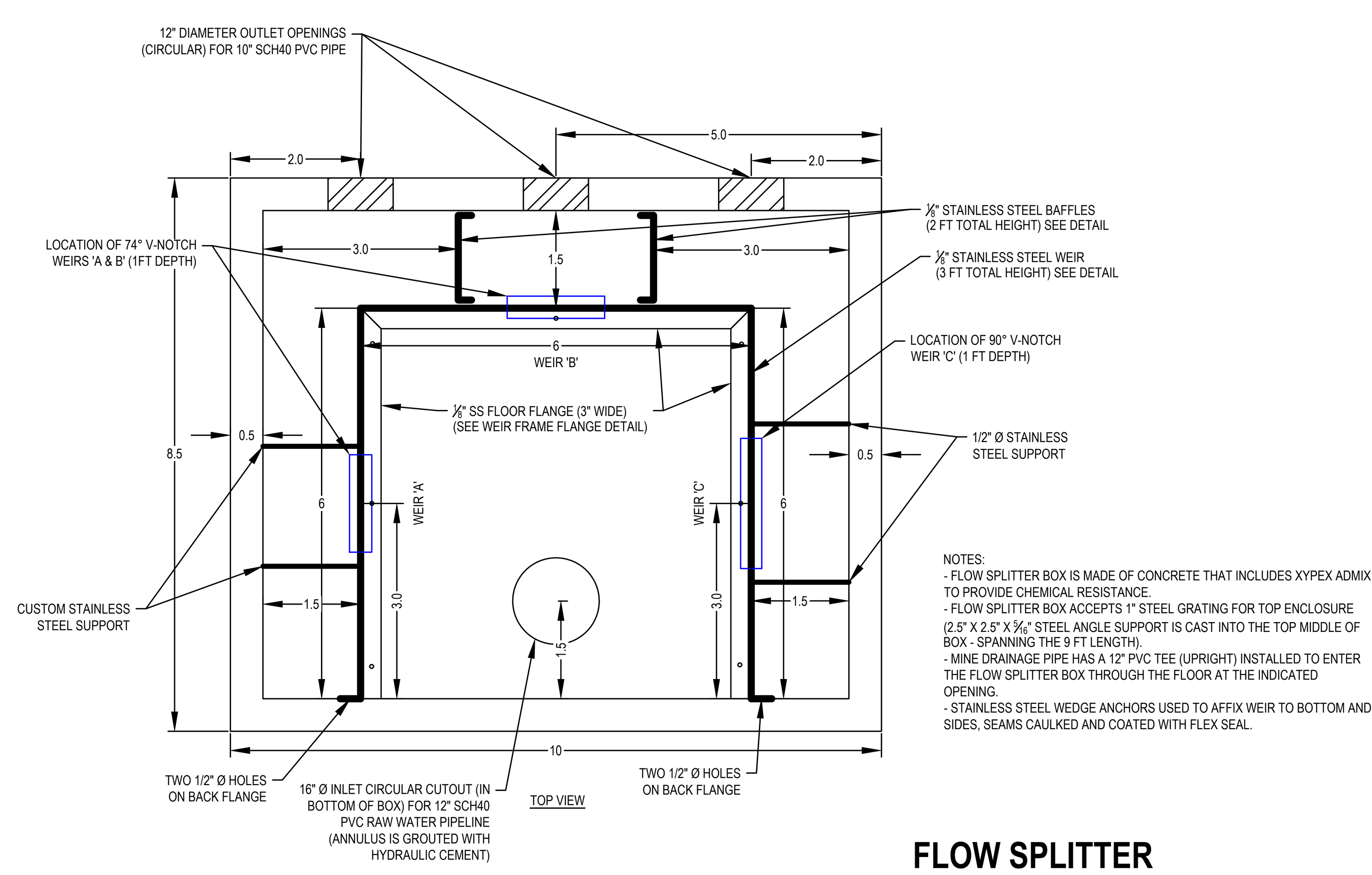
V-NOTCH WEIR CUTOUTS (90° & 74°)

Horizontal Scale: None Vertical Scale: None

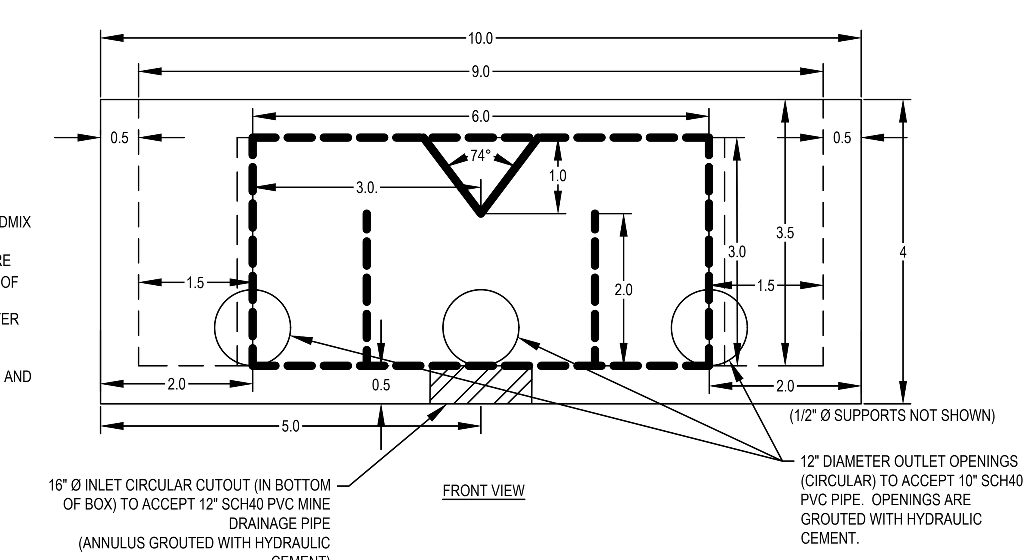


PVC Z-PILING

Horizontal Scale: None Vertical Scale: None



NOTES:
- FLOW SPLITTER BOX IS MADE OF CONCRETE THAT INCLUDES XYPEX ADMIX TO PROVIDE CHEMICAL RESISTANCE.
- FLOW SPLITTER BOX ACCEPTS 1" STEEL GRATING FOR TOP ENCLOSURE (2.5" X 2.5" X ⅜" STEEL ANGLE SUPPORT IS CAST INTO THE TOP MIDDLE OF BOX - SPANNING THE 9 FT LENGTH).
- MINE DRAINAGE PIPE HAS A 12" PVC TEE (UPRIGHT) INSTALLED TO ENTER THE FLOW SPLITTER BOX THROUGH THE FLOOR AT THE INDICATED OPENING.
- STAINLESS STEEL WEDGE ANCHORS USED TO AFFIX WEIR TO BOTTOM AND SIDES, SEAMS CAULKED AND COATED WITH FLEX SEAL.



FLOW SPLITTER

Horizontal Scale: None Vertical Scale: None

AS-BUILT DETAILS

RICHARDS PASSIVE SYSTEM REHABILITATION

for

Blacklick Creek Watershed Association

Cherryhill Twp., Indiana County, Pennsylvania

Scale: As Shown December 2021

BioMost, Inc., Mars, Pennsylvania

Mining and Reclamation Services www.biomost.com