Slippery Rock Passive Treatment Rehab & Maintenance

Venango & Washington Townships, Butler County, Pennsylvania

41°06'08.0"N 79°51'31.0"W, 41°05'54.0"N 79°51'34.0"W, 41°05'58.0"N 79°50'30.0"W, 41°05'43.0"N 79°49'37.0"W

A Slippery Rock Watershed Coalition Project

Final Report

PA DEP Growing Greener Grant

(Project Number: C990000637)

US OSMRE WCAP Grant

(Project Number: S20AC20018

December 2023

Project Sponsor:

STREAM RESTORATION INCORPORATED

A PA Non-Profit Organization 501(c)(3)

PO Box 837, Slippery Rock, PA 16057

724-279-5080 sri@streamrestorationinc.org

www.streamrestorationinc.org

Project Narrative:

I. Overview

The headwaters of the Slippery Rock Creek Watershed in northern Butler County have been extensively mined since at least the 1880s, leaving the landscape scarred with unreclaimed, abandoned coal mines. Over 4,000 acres of land within this watershed are underlain by abandoned underground mine workings, and 8,000 acres have been subject to surface mining activities, causing Slippery Rock Creek to be the recipient of numerous acid mine drainage (AMD) discharges. The Slippery Rock Watershed Coalition (SRWC) was formed in 1994 to address this issue by restoring the degraded headwaters of Slippery Rock Creek. Since SRWC's formation, the group had successfully installed over 20 passive systems treating more than 30 AMD discharges. Based upon available data, each year, the systems are estimated to collectively treat more than 900 million gallons of mine drainage, neutralize more than 450 tons of acidity, and prevent more than 130 tons of iron, 13 tons of aluminum, and 28 tons of manganese, from entering Slippery Rock Creek. Reaches of streams that were once devoid of life were found to support ecosystems following the installation and operation of these passive systems, with fish being observed in at least 6 miles of stream for the first time in a century.

Some of the earliest passive treatment systems installed by the SRWC were constructed on Pennsylvania State Game Lands No. 95 (SGL #95) property, including Big Bertha, Ferris Complex (SR85/86, SR87/88), SR81, SR96, SR101A, SR109, SR114 B & D, and SR115. All of these systems were constructed between the years 1995 to 2002 and have been effectively neutralizing acidity and removing metals for over two decades. Unlike active systems that continuously need to add chemical reagents and requiring intensive and frequent maintenance, passive systems require low maintenance and normally have an expected design life of 20 to 25 years due to dissolution of limestone, sludge build up, and degradation of treatment media over time. Due to the systems' critical role in the restoration of Slippery Rock Creek and their increasing age, Stream Restoration Incorporated (SRI) and the SRWC began to seek funding in 2018 to rehabilitate and/or conduct major maintenance of select older systems.

SRI received a Pennsylvania Department of Environmental Protection (PA DEP) Growing Greener grant in 2019 for the Slippery Rock Passive System Rehab & Maintenance project which was to rehabilitate or maintain five of the passive systems located at SGL #95 including the Ferris Complex, SR81, SR101A, SR114B and SR114D for the purpose of sustaining effective, if not improved treatment, of AMD. Additional funding was obtained from the US Office of Surface Mine Reclamation and Enforcement (OSMRE) Watershed Cooperative Agreement Program (WCAP), the Foundation of Pennsylvania Watersheds, the Butler County Conservation District's Game Lands 95 O&M fund, and match contributions donated by our project partners. The provided funding was utilized for design, permitting, maintenance, and reconstruction. Stream Restoration Incorporated acted as the fiscal agent, provided project management, outreach and monitoring. BioMost, Inc., completed the designs, permitting and construction oversight, and Spur Excavation, LLC completed the majority of the construction and maintenance work. BioMost also completed the construction and maintenance work at the SR101A system. The

SRWC provided assistance with education/outreach efforts and water monitoring. A brief overview of the background, problems, and rehabilitation of each system is provided below.

1. ***Ferris SR85/86 and SR87/SR88 Systems:***

The Ferris Complex was originally constructed by the PA DEP Knox District Mining Office in 1997 to address four acidic, metal bearing AMD discharges, SR85, SR86, SR87, and SR88, emanating from abandoned deep mine and surface mine activity reportedly associated with the Clarion coal seam. The original treatment complex consisted of two passive treatment systems known as the VK (SR85/SR86) and JP (SR87/SR88) systems that each flowed into a shared settling pond and wetland component and then into an additional wetland. Both systems had a similar unique design where the AMD flowed first into a Vertical Flow Pond (VFP) with a compost and limestone mixture and then immediately discharged into a second limestone only VFP before discharging to the wetland. These systems had been maintained by the Knox DMO until their funding source to do so was eliminated. The SRWC began including the system as part of the Statewide Passive Treatment Snapshots around 2012 and identified various maintenance issues in 2015 including most of the water bypassing the VK system. Maintenance of the VK system was conducted by BioMost in 2017 through SRI's O&M TAG program which included an attempt to backflush and stir the VK1 VFP which was unsuccessful. Water was then temporarily diverted to completely bypass VK1 and enter directly into VK2, the limestone only vertical flow pond, for partial treatment before full rebuild of the VFPs could ensue. During monitoring events of the JP (SR87/SR88) system, little to no water was found to be flowing into the system and therefore was not originally included in the plan of the grant application.

Through this project, the Ferris VK SR85/86 system was redesigned by BioMost, Inc., and rebuilt by Spurr Excavation, LLC in 2021. During the design process, the original design drawings were found which provided additional insight into the JP SR87/88 system and led to additional investigations. A decision was made to expand the project by including maintenance of the JP system. The following provides a description of the rehabilitation and maintenance efforts conducted at the Ferris treatment complex. Additional details are contained within the as-built drawings.

<u>Terraced Iron Formation:</u> The SR86 discharge is initially collected by a pre- existing forebay (aka collection pond) that was originally designed to collect and convey flow to VK1. A terraced iron formation (TIF) was constructed to encourage the removal of iron at low pH. The TIF extends approximately 120 feet from this collection pond to a flow splitter box. The TIF is lined with 0.5 feet of calcareous AASHTO #1 aggregate. Dimensions of the TIF include a 3-foot depth, with a width of 22 feet at the surface and a width of 10 feet at the bottom due to sloped sides. The exact location of discharge SR85 is uncertain. It is believed to either be intercepted by the TIF or more likely within the VK1 JVFP as a seep zone was previously encountered during the maintenance conducted in 2017.

<u>Flow Splitter Box:</u> At the end of the TIF, the SR85/86 discharge flows into a 10'x8.5' concrete splitter box by entering the weir frame through a 5'x1.5' rectangular inlet window. Inside the flow splitter box is a 6'x6' stainless steel weir frame containing three 2' wide 90° V-notch weirs,

two of which empty into a 10" PVC outlet pipe to Jennings-style vertical flow pond west (JVFPW aka VK2) and one which empties into a 10" PVC outlet pipe to Jennings-style vertical flow pond east (JVFPE aka VK1). A stainless-steel baffle exists in the flow splitter box between the outlets of Weir A and Weir B to separate outflows.

<u>VK1 and VK2 Jennings-style Vertical Flow Ponds:</u> Vertical flow ponds (VK1 and VK2) were redesigned and rebuilt into Jennings-style vertical flow ponds (JVFPs) that operate in parallel. The old treatment media was washed to recover and utilize remaining limestone as feasible. Old piping was removed and disposed of. Treatment media and sludge which could not be utilized were placed on site in the designated fill placement area. The new treatment media contains a mixture of spent mushroom compost and woodchips combined with AASHTO #67 (92% calcium carbonate) limestone. Jennings-style vertical flow pond west (JVFPW aka VK2) was reconstructed with 1,728 tons AASHTO #67 limestone, 903 cubic yards of spent mushroom compost, and 457 cubic yards of woodchips, while Jennings-style vertical flow pond east (JVFPE aka VK1) was reconstructed with 1,081 tons AASHTO #67 limestone, 544 cubic yards of spent mushroom compost, and 187 cubic yards of woodchips. The treatment media was mixed on a pad prior to placement within the ponds. Both JVFPs contain 1.5 feet of filter stone (AASHTO #1 limestone) beneath the 4.5 feet of treatment media mix. Within the filter stone layer an underdrain piping system was installed consisting of 4 separate cells. Within each cell, 4" SDR35 PVC perforated lateral pipes are spaced at 4-foot intervals which are connected to a 6" DR17 HDPE header pipe (one for each cell) acting as the JVFP outlet piping. Each outlet header pipe is then connected to a 6" riser pipe with an inserted adjustable 4" SCH40 PVC peri-pipe with 90°elbow connected with a 6" X 4" flexible coupler. A 6" Valterra drain valve was also installed within a meter pit for each header pipe to allow for draining of the VFP.

<u>JP1 and JP2 Vertical Flow Ponds:</u> While the original grant application did not intend to do any work at the JP SR87/88 side of the Ferris complex, a decision was made prior to construction to conduct various maintenance activities. During site investigations it was discovered that the SR88 discharge was supposed to be conveyed to the system via a culvert pipe under the access road that had become plugged. This culvert was removed, a new larger culvert pipe was installed, and the inlet area deepened to allow for flow measurements. The inlet area for the SR87 discharge was also improved by installing a pipe to measure flow. An attempt was made to stir the mixed media of JP1, but the treatment media was found to be in such poor degraded condition that it would not allow water to pass through. Therefore, a spillway was installed along the berm of JP1 that allowed JP1 to function just as a forebay and the AMD to be conveyed to the JP2 VFP which is limestone only. The limestone within JP2 was stirred and washed.

<u>Wetlands:</u> Both the VK and JP passive systems discharge into the shared Wetland 1 which then flows into Wetland 2. It is uncertain if Wetland 2 was designed and constructed as part of the original system or if this was just an existing wetland on game land property that was utilized to convey the flow from the treatment system to Slippery Rock Creek. During the 2020 snapshot, it was discovered that at some point the culvert pipe which conveyed the flow from Wetland 1 to Wetland 2 beneath the access road had become compromised and a large dangerous hole had

eroded within the access road. This may have been related to beaver activity which had caused the wetland to overflow the access road along another section. While not part of the original grant application, project partners worked together to replace the culvert with a drivable rock-lined spillway which required the access road to be redesigned and reconfigured to have a long, gently sloping grade to and from the discharge point to permit continued access to the Ferris JP (SR87/SR88) system while eliminating the recurring issues with the original culvert.

2. *SR81 System:*

The SR81 passive treatment system was originally designed by BioMost, Inc., and constructed in 2002 to address two acidic, metal-bearing discharges through an anoxic limestone drain (ALD), settling pond, and aerobic wetland. During construction in 2002, the mine pool was unintentionally broken into causing the location of the discharges to change and flow entering the system to increase from the average design flow of 60 gpm to about 200 gpm. Despite having increased flow and pollutant loading entering the ALD, the system performed well for 21 years by neutralizing more than an estimated 90,000 pounds of acidity per year and by removing 35,000 pounds of iron per year. Even so, the SR81 system was dramatically undersized for the load it was treating and has not always produced net-alkaline water.

Through this rehab project, the SR81 passive system was redesigned by BioMost, Inc., and rebuilt by Spurr Excavation, LLC in 2023. The following provides a description of the rehabilitation and maintenance efforts conducted at the SR81 treatment system. Additional details are contained within the as-built drawings.

<u>Anoxic Limestone Drains (ALD1 and ALD2):</u> ALD 1 is the first component of the treatment system and the original ALD constructed in 2002 which the AMD flows into from the mine. When originally constructed, ALD1 contained 1,3505 tons of AASHTO #1 (92% calcium carbonate) limestone wrapped in geotextile lining and then buried with a minimum of 3 feet of dirt. During the rehabilitation project, the ALD was unearthed, and measurements were made. It was estimated that approximately 470 tons of limestone remained. Approximately 816 tons of fresh limestone were added for a new total of 1,286 tons. At the far end of ALD 1 is a 6-inch SDR35 PVC perforated pipe to collect, convey, and distribute the partially treated drainage to ALD 2. ALD2 was built within the area of the original settling pond. ALD2 is larger in size with 2,576 tons of AASHTO #1 (92% calcium carbonate) limestone wrapped in a geotextile lining and buried with a minimum of 3 feet of dirt. The drainage is collected by a 6-inch SRD35 PVC perforated pipe and then exits ALD 2 through a 6-inch SCH40 PVC solid pipe to a rock spillway that directs flow into the settling pond.

<u>Settling Pond (SP) & Wetland (WL) Complex:</u> What remained of the original settling pond and wetland were reconfigured, with the new settling pond making up 13,400 square feet of the eastern most section and the new constructed wetland making up 4,200 square feet of the western tip. The settling pond contains 2 windowed baffle curtains, both connected to the sides of the pond by stainless steel cables and each consisting of a foam float at the top, a stainless-steel bar guard, a turbidity curtain spanning the depth of the pond, a chain weight at the bottom of the curtain, and 2-foot-wide custom cut windows at the top of the curtain. Leading to

the wetland side of the complex is a directional baffle curtain, which unlike the windowed baffle curtains, does not span the entire width of the pond/wetland. Drainage exits the wetland into the Z-pile moat.

Z-Pile Moat: A moat constructed with a berm made of PVC z-piling was designed to not only convey the water from the constructed wetland into the natural wetland, but also to spread out and distribute the flow to improve utilization of the natural wetland. The moat consists of a 2,800 square foot channel, with ~3.5-foot-high z-piles lined up on the outward side leading to the natural wetland. Water flows out of the moat through several 6-inch 90° V-notch weirs that have been cut into the side of the z-piles to help distribute the flow.

Natural Wetland: The area that lies north of the SR81 treatment components is an existing natural wetland, which has always received the flow from the passive system since construction and the untreated AMD prior to 2002. The wetland now receives the treated water from the z-pile moat used to distribute the water across the natural wetland. Conveyance of drainage through this natural wetland should promote further oxidation of metals and settling of solids that were not removed in the previous treatment steps. A rock distribution berm was also constructed within the natural wetland directly east of Kohlmeyer Road approximately 70 feet north of the z-pile moat for the purpose of distributing the flow across the wetland to promote more iron oxidation and increased settling and removal of solids.

Dewatering Basin: A dewatering basin was constructed on top of the hill south of the SR81 treatment components to store sludge and debris that had been removed from the settling pond and wetland prior to system reconfiguration and expansion. It was constructed to hold a maximum capacity of 3,825 cubic yards at a depth of 10 ft. Both an overflow pipe and a riser pipe were installed to direct any water to the settling pond. The basin provides additional capacity for sludge removal in the future.

3. SR101A System:

The SR101A passive treatment system was originally designed by BioMost, Inc., and constructed in 1998 consisting of a 900-ton ALD, settling pond, and ¼ acre wetland. Since its construction, the system on average removes about 10,600 pounds of iron per year. The system has now been in operation for 25 years and for most of its lifespan has required very little maintenance. At the time of grant application, the system was only 21 years old and still producing significant alkalinity and net-alkaline water; however, a buildup of sludge and organic debris within the wetlands was causing the water to backup and overflow the berms, bypassing treatment and reducing treatment efficiency. Based on the longevity of the ALDs at the SR114 systems, a decision was made at that time to only seek funding to remove sludge from the settling pond and wetlands.

As part of this grant, the maintenance and rehabilitation work consisted of removing iron sludge and organic debris from the treatment components and increasing the elevation of the berms with onsite material. BioMost, Inc., completed the design work, construction of the sludge pond and maintenance in 2021. Sludge and debris were removed from the settling pond and wetlands and placed in the newly constructed dewatering basin (sludge pond). The sludge pond was designed with a maximum fluid capacity of 1,560 cubic yards and dewatering and overflow is directed to a 4-inch SDR35 PVC perforated riser into Wetland 2. Unfortunately, the dewatering basin intercepts a significant source of ground water and therefore does not dewater and dry out. Over time, the pond may seal itself off. At this time, it is uncertain whether something could be done in the future. If not, future sludge removal may require the use of geotubes to dewater the sludge. The wetlands were not replanted after sludge removal as it was assumed there would still be a significant seed bank left and a natural wetland was in very close proximity. It may be necessary to seed or plant the wetlands within the next year if plants do not naturally colonize the wetland. Eventually the limestone within the ALD will need to be replaced.

4. SR114 B & D Systems:

Two of the oldest passive systems in the watershed, SR114 B & SR114 D are separate individual systems in close proximity to one another that were installed in the summer of 1995 to treat AMD believed to be related to underground coal mines in the area. The systems were originally designed by a collaboration of Hedin Environmental and CDS Associates, Inc. The B system consisted of an ALD and settling pond, while the D system consists of an ALD, settling pond, and 3 wetland cells. These systems had successfully operated for 28 years with very little maintenance and were still typically producing net-alkaline water. Prior to rehabilitation, ALDB had very low flow and most of the water being treated was from a seep that had developed, likely due to either plugging and/or compromised piping associated with the collection system. The 114D system was functioning well, however a "karst-like" depression in the area of the ALD assumed to be due to dissolution of limestone indicated a need to replace the limestone and the settling pond and wetlands were very full of iron and vegetation.

Through this rehab project, the SR114B and SR114D passive systems were redesigned by BioMost, Inc., and rebuilt by Spurr Excavation, LLC in 2023. The following provides a description of the rehabilitation and maintenance efforts conducted at the SR114 B & D treatment system complex. Additional details are contained within the as-built drawings.

<u>SR114 B Anoxic Collection System:</u> The anoxic collection system collects the SR114 B discharge underground and then conveys the AMD into ALD B with the intention of keeping the water in an anoxic condition. The anoxic collection system consists of a 6" SDR35 perforated PVC pipe buried within non-calcareous AASHTO #57 gravel. The gravel layer is covered with a geotextile top and backfilled.

<u>Anoxic Limestone Drain B (ALDB):</u> During the rehabilitation project, ALD B was unearthed, and measurements were made. It was estimated that approximately 148 tons of the original 350 tons of limestone remained. The ALD was expanded and approximately 319 tons of fresh AASHTO #1 (92% calcium carbonate) limestone were added for a total of 467 tons. The limestone is wrapped in a geotextile liner and then backfilled with five feet of dirt. The inlet manifold pipe consists of a 4" SDR35 PVC pipe while the outlet manifold consists of 4" SDR35 perforated pipe connected by a 6" tee to a 6" SCH40 PVC pipe. A 6" wye was installed with a 6"

riser effluent pipe for normal flow operation and a 6" Valterra gate valve to drain the ALD if needed.

Pond B: Pond B receives flow from the SR114 B ALD. Pond B was cleaned out and then significantly expanded (60%) in size from 6,605 square feet to 10,513 square feet in area and deepened by about a foot during the rehabilitation project. A windowed baffle curtain was installed and spans the width of the pond. Post-construction water monitoring has indicated that Pond B is now intercepting a significant source of AMD that was previously not present and not part of the original design. The cause of this increased flow is currently uncertain, but may be related to changes in flow to the SR114D ALD. This is discussed further in the ALD section below as well as in the system performance section.

Anoxic Limestone Drain D: The SR114 D discharge originally emanated from old oil/gas wells and there appeared to have been possibly two sources of AMD that were captured as part of the original system. During the rehabilitation project, ALD D was unearthed, and measurements were made. It was estimated that approximately 573 tons of the original 1150 tons of limestone remained. The ALD was expanded and approximately 995 tons of fresh AASHTO #1 (92% calcium carbonate) limestone were added for a total of 1568 tons. ALD D lies between 3 and 9 feet below the surface and the limestone wrapped in a geotextile liner.

During a post-construction inspection in August 2023, ALD D was found to have little water flowing out of the effluent pipe. This prompted concern and additional inspections. BioMost indicated that the likely cause was that the well(s) which were the conduits of the AMD into the ALD had become plugged, collapsed, or compromised in some manner. Over the following few months, BioMost took various actions to attempt to restore flow including using a power snake and hiring a small drill rig to "open up" the hole and clean out the well. The flow rate has since increased at the ALD but is still not back to typical "historical" values. Increased flow at Pond B may indicate that a portion of the water has since found a new discharge point. This is further discussed in the performance section.

Pond D1: Pond D1 was cleaned with the sludge placed into the dewatering basin. A new directional baffle curtain was installed as well as a new spillway to Wetland D2.

Wetlands D2, D3, and D4: Water from Pond D1 enters a series of wetlands starting with Wetland D2, followed by Wetland D3, and ending with Wetland D4, all of which are 6,500 square feet, 6,400 square feet, and 6,200 square feet, respectively. As part of the rehabilitation, the wetlands were cleaned with sludge placed into the dewatering basin. Flow from each wetland enters the next in the series by conveyance through new spillways containing AASHTO #1 limestone. The final spillway at the outflow of Wetland D4 empties into a natural wetland which then travels a short distance into Slippery Rock Creek.

Dewatering Basin: A dewatering basin was constructed to hold sludge that had been removed from the wetlands and pond. The dewatering basin can hold a maximum capacity of 3,200 cubic yards. A 6" SDR35 PVC dewatering riser pipe connected to a drainpipe conveys water from the pond to Wetland D3. The basin should contain sufficient capacity for future maintenance.

II. System Performance and Environmental Impact

While construction and maintenance of Ferris and SR101A were completed in 2021, the remaining systems SR81, SR114B, and SR114D were not officially completed until about mid-December 2023. Due to the short period between the construction end date and the grant end date, limited time was available to assess treatment system performance after the rehabilitation of the five systems. Sampling took place on December 19th and 20th of 2023 to monitor the five systems and to monitor five receiving stream points along Slippery Rock Creek. The Ferris system was also monitored in July 2023 as part of the 2023 Statewide Snapshot event. Water quality results are presented for each system in "Appendix 2 – Water Monitoring Data", are posted onto Datashed, and are described in more detail below. It is important to keep in mind that that post-rehabilitation evaluation is essentially based on one sampling event in December of 2023. Additional monitoring will be conducted in 2024 utilizing funding provided by the Foundation for Pennsylvania Watersheds (FPW). In addition to the monitoring data collected post-rehabilitation, historic monitoring data for each system has been provided as a source of comparison. Site schematics provided in Appendix 3 can be referenced to help match the location of sample points to the data as can mapping available on Datashed.

Ferris Complex Performance
Water monitoring was conducted at the Ferris passive treatment complex post-construction on 7/11/23 (Table 2, Appendix 2) and 12/19/23 (Table 3, Appendix 2). At the VK (SR85/SR86) portion of the Ferris passive treatment complex, the SR86 discharge is collected by a pond and directed into the terraced iron formation (TIF). A TIF is a long channel designed to remove low pH iron through the work of naturally occurring iron oxidizing bacteria. Low pH iron oxidation and precipitation was observed to be occurring evidenced by the accumulation of iron solids coating the limestone along the entire reach of the TIF; however, the water quality data from two sampling events indicated different effectiveness, although in neither instance was a lot of iron removed. One potential reason is that iron concentrations were generally very low to start and significantly lower than historic data. This may be indicating the iron is precipitating before it gets to the collection pond. Another potential reason for this could be due to additional sources of AMD that maybe intercepted by the TIF but were not identifiable and therefore not measured directly during the sampling event. Weather conditions could certainly have played a difference as the December sampling event was below freezing. Other causes are possible and will be evaluated in future assessments.

The reconfigured Jennings-style vertical flow ponds (JVFPs) VK1 and VK2 are functioning as designed by increasing pH, neutralizing acidity, increasing alkalinity, and removing metals. The effluent from both JVFPs, VK1 and VK2, were found on both sampling events to be net alkaline, a pH above 7.0, and with decreased aluminum concentrations (<0.10 mg/L). The JVFPs generated more alkalinity in the July sampling event despite higher flow rates, likely due to increased biological activity during the warmer summer months. ORP values in the July sampling also indicated much more reducing conditions within the JVFP providing further evidence of the increased biological activity.

On the opposite side of the complex, the JP (SR87/88) system, the JP2 limestone-only vertical flow pond was also found to be functioning well due to the conducted maintenance. As previously mentioned, the treatment media within JP1 is too degraded to pass water and now essentially functions as a collection pond for the two sources of AMD. The collected AMD now flows over a spillway into JP2. During both sampling events, the outflow from the JP2 VFP contained a pH of 8.0 in the field, alkalinity >50 mg/L, net-alkaline, and aluminum and iron concentrations of <0.10 mg/L (Table 2 and 3, Appendix 2). The effluent of the VK1, VK2, and JP2 VFPs all enter Wetland 1 (WL1). The two wetlands (WL1 and WL2) appeared to function to further remove metals from the neutralized water.

The water quality assessment conducted at Ferris on July 11th and December 19th indicates the system components are functioning as designed to treat the four AMD discharges entering the system. The effluent of the treatment system can be characterized as circumneutral, net-alkaline water with low metal concentrations. Overall loading results averaged for the 7/11/2023 and 12/19/2023 sampling events suggest that about 80,000 pounds of acidity, 280 pounds of iron, and 425 pounds of aluminum are being removed through treatment in the rehabilitated Ferris system per year (Table 15, Appendix 2). Metal loading reductions are lower than historical data due to what appears to be an improvement in water quality of the discharges over time; however further evaluation may be warranted. Another item of note, water monitoring data collected on December 19th measured the combined flow exiting the vertical flow ponds and entering into the wetlands to be ~120 gpm, which is significantly less than the flow measured exiting Wetland 2 at ~200 gpm. This indicates there may be one or more additional sources of flow into the wetlands that are not being monitored. Considerable decreases in conductivity and sulfates between WL1 to WL2 indicates that the source(s) that enter WL2 are likely not severely impacted and may even be good quality; however, investigations during future assessments would be needed to document. In addition, Wetland 2 was often not typically monitored in the past and it is uncertain if it was even part of the original system design.

SR81 Performance

The SR81 passive system was sampled on 12/19/23 (Table 5, Appendix 2). ALD1 and ALD2 are connected and only the effluent of ALD2 can be sampled. The ALDs at the SR81 system were found to be functioning as designed by generating alkalinity, neutralizing acidity, and increasing pH. Water exiting ALD 2 contained circumneutral pH, alkalinity 167 mg/L, and acidity –64 mg/L. Total iron concentration at ALD 2 was 33.25 mg/L, and aluminum was fairly low at 0.66 mg/L but was higher than data collected in previous years (Table 4, Appendix 2). The pH remained neutral as the treated AMD passed through the remainder of the system. Water exiting the constructed wetland (sample point WL) contained decreased iron and aluminum concentrations, but iron levels still remained relatively high at 10.89 mg/L, however this total iron value may be skewed due to high total suspended solids in the sample. Water at the newly constructed rock distribution berm (NWLA) in the existing natural wetland contained lowered iron concentrations of 1.24 mg/L and aluminum concentrations <0.10 mg/L and sample point NWL within the existing natural wetland close to the stream had iron concentrations of 0.53 mg/L. Both NWLA and NWL had circumneutral pH and were net-alkaline. Effective metal removal was measured during the single sampling event on 12/19/2023, with a calculated load reduction totaling >14,900 pounds of iron, >1000 pounds of manganese, and about 250 pounds of aluminum estimated to be removed per year (Table 15, Appendix 2). A comparison of historic data in Table 4 with this sampling event demonstrates greater alkalinity production, significantly more net-alkaline through the entire system and improved iron concentration at the end of the system. One thing that must be monitored during future assessments is clogging of the z-piles due to buildup of vegetation and debris.

SR101A Performance
Post-maintenance water monitoring of the SR101A passive system was conducted on 12/20/23 (Table 7, Appendix 2). After 25 years of operation, water exiting the ALD at SR101A was still net-alkaline with field alkalinity measured at 186 mg/L, acidity at –18 mg/L, and neutral pH which is comparable to average data over the life of the system (Table 6, Appendix 2). The ALD contained high concentrations of iron at 98 mg/L. The final effluent of the system at sample point WL2 had a pH of 7.00 in the field and was net-alkaline with excess alkalinity remaining. Iron concentrations in the final effluent were surprisingly high at 25.8 mg/L compared to past values; however, so was the influent iron concentration. Based upon the TSS values, a large portion of the remaining iron was likely solids that had not settled yet, although 75% of the iron had been removed from the discharge. It should be noted that the wetland vegetation at SR101A did not appear to have re-established since cleaning took place in 2021 and may need to be replanted, although sampling was conducted in December. This lack of wetland vegetation likely played a role in the high iron concentrations found at the effluent of the system compared to past treatment performance (Table 6, Appendix 2). Fortunately, the effluent of the system enters an existing natural wetland that is not monitored where the majority of the remaining iron is expected to be removed before flowing into Slippery Rock Creek.

SR114 B&D Performance
Evaluation of the success of SR114 B & D passive treatments is difficult and perhaps not truly feasible at this time. This is particularly true for the B system. Sampling of the rehabilitated systems was conducted on 12/20/23. Both the SR114B and SR114D systems did generate sufficient alkalinity to produce circumneutral pH, net-alkaline water and reduced the concentrations of iron in the final effluent.

At the SR114 B system, ALD B contained net-alkaline water with field alkalinity 150 mg/L, acidity of -73 mg/L, and circumneutral pH (Table 9, Appendix 2). The final effluent at Pond B had a circumneutral pH, field alkalinity of 32 mg/L and was net-alkaline with an acidity of -18 mg/L. Although the metal concentrations were lower at the effluent (Pond B) than the influent (ALD B), metal load reductions initially appeared to not be achieved as the load reduction calculations comparing Pond B to ALD B suggested that there are higher loads of iron, manganese, and aluminum leaving Pond B than were entering the system at ALD B. Upon closer examination of the data, it can be seen that the flow rate at Pond B of 71 gpm was 5x higher than the effluent of ALD B at 14 gpm indicating that Pond B is intercepting a large source of water. As sulfate concentration increased about 19% while manganese concentration decreased by about 20% even though the flow increased by more than 400% between the ALD and Pond B, indicates that the water intercepted was almost certainly AMD. The water quality of ALD D on this date also shows lower manganese and higher sulfate concentrations than that of ALD B. An analysis of the flow rates and manganese and sulfate concentrations estimating the concentrations of Pond B through weighted averages closely estimates the actual concentrations measured at Pond B. While difficult to state definitively, it is likely that this increase in AMD at Pond B is related to the decrease in flow at the SR114 D system discussed below and likely the source of this intercepted water. In order to better estimate load reductions, assumptions were made. If we assume that the water entering Pond B is the same water quality as the source water of ALD D and use the metals data from the ALD D sample point and the difference in flow between ALD B and Pond B to estimate the loading of this extra source of AMD, then the results suggest an estimated reduction of 5,000 pounds of iron per year (Table 15, Appendix 2). No aluminum was calculated to be removed through treatment at SR114B as it was below detection throughout the system and manganese loading did not seem to change.

At the SR114D system, ALD D effectively neutralized the AMD and contained field alkalinity 181 mg/L, was net-alkaline with an acidity –105 mg/L, and field pH of 7.10. Total iron was high at ALD D at 25.83 mg/L. Treatment through the three wetland cells (WLD2, WLD3, WLD4) resulted in decreased iron concentrations with ~7.7 mg/L leaving WLD4 and still remained net-alkaline (Table 11, Appendix 2). Iron concentrations were higher in the effluent than the historical average which is likely related to the fact that the wetland vegetation was removed during cleaning and have not had time to re-establish. Loading calculated from the single sampling event on 12/20/2023 suggests that >2,500 pounds of iron is removed through treatment of SR114D per year. Aluminum concentrations are below detection throughout SR114D, and manganese concentrations are quite low. (Table 15, Appendix 2).

As discussed in several locations within this report, flow rates at the SR114 D system have been significantly lower since construction compared to the historical average of about 115 gpm (Table 10, Appendix 2) and a range of 60-150 gpm (Datashed). This was first discovered shortly after construction during a site visit in August 2023 when no water was flowing from the ALD. While difficult to prove without a doubt, it is believed that the “missing AMD” is likely now the “extra” source of water entering Pond B. While actions have been taken and the flow has increased from ALD D, the flow has not yet returned to pre-rehabilitation rates. This could partly be due to sampling during relatively low flow conditions. Further monitoring and evaluation will be conducted over the next year. The decrease in flow rate to the system is also believed to be the reason for the decreased iron loading removal compared to the historical performance. (Table 15, Appendix 2).

Water Quality of Receiving Stream Points

Water quality was monitored at five stream points along Slippery Rock Creek on 12/20/23 (Table 14, Appendix 2). Descriptions and coordinates can be found in Table 12, Appendix 2 or on Datashed.org under the Slippery Rock Creek project. In addition, each point location is described briefly below and is listed from furthest upstream to furthest downstream:

- Point 43 - farthest point upstream of all systems located at the Branchton Road Bridge.
- Point 59 – located below Higgins Road Bridge downstream from SR114 and upstream of SR101A.
- Point 64 – located at Kohlmeyer Bridge, downstream from Ferris, SR81, and SR101A.
- Point 67 – located at Cemetery Road Bridge, upstream of the confluence with Seaton Creek and downstream of all rehabilitated systems.
- Point 65 – located behind Boyer's Sportsman's Club downstream from the confluence of Seaton Creek and Slippery Rock Creek. Out of the five points, 65 is furthest downstream and historically used as the downstream point for restoration of the headwaters area.

Data collected on December 20, 2023 (Table 14, Appendix 2), indicated that all five stream points were circumneutral with pH above 6.5 and net-alkaline. Alkalinity was 10 mg/L or above, acidity was below –3 mg/L, and total iron, manganese, and aluminum concentrations were below 1 mg/L at all sample points. A continual increase in alkalinity and a decrease in acidity was measured as the sample point location moves further downstream. For instance, acidity starts at –3 mg/L at Point 43 and eventually reaches –29 mg/L downstream at Point 65. Similarly, field alkalinity starts at 13 mg/L at Point 43 and increases to 24 mg/L at Point 65. This suggests that the rehabilitated passive systems provide excess alkalinity to the streams to buffer AMD.

The first passive treatment systems were installed in the headwaters area in the summer of 1995. Currently, Datashed does not have data on Slippery Rock Creek prior to 1995. Available data from 1996 and 1997 (Table 12, Appendix 2) was found and used as "pre-restoration" data to provide some level of comparison to current conditions but is not truly representative of pre-restoration conditions. Averaged historical data of these same sample points collected from 2002 to 2021 (Table 13, Appendix 2) have also been provided as a reference point. A comparison of water quality data of these sample points collected on 12/20/23 with "pre-restoration" and the averaged historical data collected from 2002 to 2021 indicates a general continual improvement of increased pH and alkalinity, decreased acidity to being net-alkaline, and lower metal concentrations. Additional sampling will be conducted in 2024.

Load Reduction Comparison to Pre-Rehabilitation Data

Acidity, metals, and alkalinity loading data for the five systems collected post-rehabilitation in 2023 was compared to the averaged loading data over the life of the system since original construction in Table 15 of Appendix 2. An accurate representation of acid load reductions was difficult to achieve for systems SR81, SR101A, and SR114 B & SR114 D due to the inaccessibility of raw discharges, which are all collected and treated in the ALDs prior to coming to the surface. Therefore, the ALD inflow points are already largely neutralized. To account for this misrepresentation, historic data of the raw discharges was found for systems SR81, SR101A, and SR114 B&D (labelled "RAW" in Tables 4, 6, 8, and 10) and was utilized as the acidity for inflow data when calculating acid load reductions at the systems containing ALDs. As the metals are generally assumed to be somewhat conservative, metal concentrations from the ALDs were utilized for the raw metal concentrations.

Combined acid load reductions achieved by the five systems were somewhat similar prior to rehabilitation as after, with a combined total 228,900 pounds of acidity neutralized per year prior to rehabilitation and a calculated total of 207,000 pounds of acidity neutralized per year from the 2023 data. Alkalinity loading was calculated to be over twice as high following rehabilitation, with combined alkalinity load to Slippery Rock Creek being 59,000 lb/year as averaged before the project and being 139,300 lb/year after rehabilitation in 2023. Metal load reductions, however, were found to be less considerable following rehabilitation in December 2023 as compared to the metal load reductions averaged before the project. The combined metal (Fe, Mn, and Al) reduction for the five systems prior to rehabilitation was calculated to be 69,900 lb/year, while the combined metal reduction for those systems after the project equaled just 32,400 lb/year. As the treatment systems are performing well, the most likely potential explanations for the difference in metal loading removal is an improvement in water quality of the discharges with reduced metal concentrations. In almost every case, the metal concentrations measured within the discharge or ALD in December 2023 were less than the historical average for that sample point. The one exception was SR101A which had higher iron concentrations than the average. In addition, it is necessary to note that the load reductions following rehabilitation were compiled from a single sampling event taking place at the end of fall, during a traditionally low flow period of the year and therefore likely impacting loading of metals and acidity entering and being removed by treatment in each system. Additionally, the changes in flow rates at the SR114B and SR114D systems have impacted loading. Of course, one sampling event is not feasible to clearly evaluate system performance. Stream Restoration Incorporated will be conducting additional water sampling events in 2024 to monitor the systems for further evaluation.

These five rehabilitated systems located on PA State Game Lands No. 95 are expected to continue to provide treatment of their respective discharges for many years and sustain the improvements of water quality and aquatic habitat achieved in Slippery Rock Creek. Due to its location in Butler County, its proximity to the Greater Pittsburgh area, and the presence of the North County Trail, the Game Land property is heavily visited and provides important recreational opportunities for hikers, hunters, birders, and more.

III. Operation & Maintenance Plan

In 2007, the Slippery Rock Watershed Coalition, Stream Restoration Incorporated, and BioMost, Inc., worked together to develop and create the "Slippery Rock Watershed Coalition Comprehensive Operation and Maintenance Plan for Watershed Restoration Projects". The plan provided for generalized information about AMD and passive treatment systems as well as instructions on how to successfully conduct site inspections, water monitoring and complete simple maintenance tasks. In addition, for every project, a site-specific inspection form was developed along with a site schematic which together is utilized to help guide a person to conduct the inspections and take notes while in the field. The plan, schematics and forms were all uploaded to Datashed. As part of this rehabilitation project, new site schematics and updated inspection forms have been developed and are included as part of this final report (Appendix 3) as well as uploaded to Datashed. The SRWC, like all watershed groups in Pennsylvania has access to SRI's Operation and Maintenance Technical Assistance Program as long as it remains funded. In addition, the SRWC also has a small O&M fund managed by SRI and held by the Clean Streams Foundation.

IV. Growing Greener Report Questions

a. What was the project supposed to accomplish?

The Slippery Rock Passive Treatment Rehab & Maintenance project's purpose was to rehabilitate and/or maintain five AMD passive treatment systems within the Slippery Rock Watershed located on State Game Lands #95, all of which were built between 1995 and 2002. The goal was to sustain treatment of the AMD and improvements in stream water quality achieved by the original construction of the systems while trying to utilize the existing pond structures as much as possible. An additional goal was to improve treatment effectiveness when possible and create additional excess alkalinity with the purpose of providing increased buffering capacity to Slippery Rock Creek. A brief description of the proposed deliverables are summarized below. Additional details regarding pre-existing conditions, plans and actual implementation are provided within the overview section.

Deliverable 1: Redesign and Rehab of Ferris SR85/86 System – Vertical flow ponds VK1 and VK2 were to be redesigned, rebuilt, and reconfigured as Jennings-style mixed media vertical flow ponds (JVFPs) containing a mixture of limestone, spent mushroom compost, and woodchips that operate in parallel. The existing treatment media of the original system was to be washed in order to recover and reuse the limestone as feasible. Old piping was to be removed and disposed of. Sludge and old media not recovered was to be placed on site. New underdrain piping systems were also to be installed within the JVFPs.

Deliverable 2: Expansion and Cleaning of SR81 – To account for increased flow rate and contaminant loads that occurred due to a break in the mine pool during original construction of SR81, the SRWC proposed to expand the system. The ALD was to be expanded by converting the existing settling pond and part of the wetland into a second ALD containing 3,500 tons of limestone. Part of the wetland was to be reconfigured into a settling pond, and the wetland was to be expanded on the west side. In addition, the plan was to install PVC z-piles within the naturally existing wetland to act as directional barriers to improved retention time and iron removal. Iron sludge and organic debris were proposed to be removed from the settling pond and wetland and placed on Game Land property.

Deliverable 3: Cleaning and Rehabilitation of SR101A – Due to the high amount of iron sludge and organic debris present in the SR101A settling ponds and wetlands, the sludge was to be removed and placed on Game Land property.

Deliverable 4: Expansion and Rehabilitation of SR114B & D – At SR114 B, ALD B was to be replaced and increased to 500 tons of limestone while Settling Pond B was to be cleaned out, expanded and directional baffle curtains added. At SR114D, the ALD was to be replaced and increased to 1,500 tons of limestone while iron and organic debris was to be removed from all settling ponds and wetlands and be placed in a newly constructed dewatering basin (sludge pond) on the property.

Additional Goals: In addition to the defined project deliverables, the project was to conduct water monitoring of the discharges, passive treatment system components, and select stream points to evaluate the effectiveness of the treatment systems and impacts to stream water quality. The SRWC Comprehensive Operation and Maintenance Plan was also to be updated to reflect changes to systems by creating new schematics and updating the inspection forms.

b. What you actually did and how it differs from your plan?
The majority of the work completed during the rehabilitation project generally matched what was intended and described in the proposal and summarized in the sections above with some subtle differences between what was proposed in the conceptual design versus the final design. Most of the differences were related to amounts of limestone that would be recovered from the existing systems versus new purchase limestone and decisions related to baffle curtains or other minor details. The following provides some of those differences while additional details regarding pre-existing conditions, plans and actual implementation are provided within the overview section.

At the Ferris system, there were additional elements added to the project that were not proposed as part of the grant application. In the original conceptual design of the application, a pool with pipes was to be used to split the AMD between two VFPs. Instead, a concrete flow splitter box using three 90° v-notched weirs was used to split the flow which provides a better way to split the flow as desired. In the proposal, there was no defined plan to deal with the sludge. A fill placement area was created to place and bury the sludge on site. Additionally, although not proposed in the original plan, the JP side of the Ferris Complex system was maintained through installation of a new culvert pipe to convey the SR88 discharge to the system, improvements to SR87/88 discharge inlet areas, creation of a spillway to bypass JP1, and a thorough stirring and washing of limestone in JP2. Another plan change occurred at Ferris when a dangerous hole was discovered within the access road due to a compromised culvert between Wetland 1 and Wetland 2. To fix this issue, the compromised culvert was replaced with a rock-line spillway which required the access road to be redesigned as well.

At SR101A, the original plan was to utilize geotubes for sludge dewatering. During the design phase, it was realized that the proposed location was not suitable for geotubes and would require clearing of trees and significant level of earth disturbance to create a level pad to place and store the geotubes. A decision was made to build a dewatering basin in a different location instead.

At SR114, it was proposed that ALD B would be increased to 500 tons of limestone while ALD D would be increased to 1,500 tons of limestone. Instead, ALD B was constructed to contain 467 tons of limestone while ALD D was reconstructed with 1,568 tons of limestone. These ALDs resulted in very similar limestone amounts as were first predicted. Other changes in the plan versus what occurred during the rehabilitation project involved baffle curtains and the use of directional barriers. In the grant application, directional barriers constructed of PVC Z-piles were proposed to be installed in SR114D wetlands D3 and D4, but a decision was made to keep them free flowing and open as originally designed. Directional baffle curtains were additionally proposed to be installed in Pond B of SR114, but instead, a windowed baffle curtain was installed in Pond B which spans the entire length of the pond.

For SR81, the application proposed to create a new ALD2 of 3,500 tons, but it was uncertain if anything would be done to the original. Instead, 816 tons of new limestone was added to ALD1 to be a total of 1,286 tons and ALD2 was constructed to contain 2,576 tons. The z-pile moat at the end of the system to help distribute flow into the natural wetland was not part of the original conceptual design included in the grant application. In addition, in the original conceptual design, PVC Z-piles were going to be installed as directional barriers within the natural wetland, but due to permitting, concerns of impact to the wetland, and construction concerns of being able to get the equipment to where it needed to get to and not get stuck or sunk within the natural wetland, a decision was made to instead permit and construct rock distribution berm. This reduced impacts to the wetland as well as provided a way to build the berm as the equipment progressed to not get stuck.

c. What were your successes and reasons for your success?

Five existing passive systems were successfully rehabilitated and/or maintained. Based on data collected in December 2023 (Appendix 2), the five rehabilitated systems are estimated to collectively neutralize at least 207,000 pounds of acidity and prevent at least 30,000 pounds of metals from entering Slippery Rock Creek each year. Furthermore, water monitoring results suggest the five rehabilitated systems will provide nearly 140,000 pounds of alkalinity to Slippery Rock Creek each year. This demonstrates that the systems are successfully treating their designated AMD discharges to sustain the improvements to Slippery Rock Creek as well as provide excess alkalinity for partial treatment of AMD and other sources of acidity that may be entering the creek downstream.

Success of the project is due to the collective efforts and contributions of all project partners involved and the long-term dedicated commitment of the Slippery Rock Watershed Coalition who have been working to improve the headwaters of Slippery Rock Creek for nearly 30 years. The project would not have been possible without the funding provided by the PA DEP Growing Greener program, OSMRE's WCAP program, the Foundation for PA Watersheds, and the Butler County Game Lands 95 O&M Fund. Without the ongoing and long-term support of the PA Game Commission, who owns the property of all five systems, these projects would not exist. The professional expertise provided as well as the donated services and reduced fees of our various project partners, especially BioMost, Inc., was invaluable. The primary construction contractor Spur Excavation, LLC provided efficient quality work and were easy to work with.

d. What problems were encountered and how did you deal with them?

Several problems were encountered during the project. First, in 2022, a decision was made by several of SRI's board members to reorganize and restructure various aspects of the board and the way SRI was organized, functioned and operated. This necessitated hiring an Executive Director and a new staff member to manage projects and conduct various tasks that were previously being conducted by consultants. This required adjusting the budget. Second, over the course of the project, costs associated with engineering, permitting, and construction oversight were much higher than what was proposed in the budget. Third, due to the pandemic, supply chain issues were encountered that sometimes required using alternative materials and also resulted in increased costs. To address these issues, SRI was able to obtain additional funding which allowed for the budget to be revised and offset increased costs. In addition, BioMost generously increased the amount of in-kind services provided.

The most serious potential problem to be encountered during the project occurred after the construction of the SR114 B & D systems in 2023. During a post-construction inspection/monitoring event, it was discovered that very little water was flowing from the SR114 ALD D and much more water was flowing from the SR114 Pond B than what was flowing from the SR114 ALD B. It is believed that the influent well/borehole to the SR114 D ALD had collapsed or become compromised in some way preventing the AMD to enter the ALD and likely causing the water to find another location to discharge. It is possible that the other location was within Pond B. Another possible explanation is that during the expansion of Pond B, another preferential pathway for the AMD could possibly have been created. It is possible that both are contributing factors. To address this, the borehole at ALD D was first cleaned out with a power snake and then when unsuccessful a drill was brought in to cleanout/reestablish the well/borehole. Flow has since increased at SR114D, but still not to the previous flow rates. It should be noted that the monitoring was conducted in December, which is traditionally still considered a low flow time of year. This situation will be further monitored and evaluated in 2024 before deciding if additional action is needed.

e. How your work contributed to solution of original problems?

Due to the extensive mining that had occurred throughout the Slippery Rock Watershed, the SRWC has been working to restore the headwater impacted by AMD through land reclamation and the installation of numerous passive treatment systems. Despite the treatment systems' successes over the years, the passive systems have a finite design life of 20-25 years. This project provided for the rehabilitation and/or maintenance of five of those passive treatment systems thereby continuing to provide treatment and watershed restoration improvements that were accomplished through the original construction of these systems. The treatment systems not only neutralize acidity and prevent metals from entering the watershed, but also produce excess alkalinity to provide additional buffering compacity to the stream.

f. What else needs to be done?
The project itself is complete. Additional water monitoring of the treatment systems and select stream points will be needed in order to document the effectiveness of the treatment systems and help identify sections of stream that need additional work. There may be a need to take additional action at the SR114 site to increase flow into ALD D, but further monitoring and evaluation is needed prior to making this decision. SRI and the SRWC will need to regularly inspect the treatment systems and conduct maintenance as needed. SRI and the SRWC will also need to continue to evaluate the performance of existing older treatment systems within the Slippery Rock Watershed and seek funding to rehabilitate them as needed.

g. What are the plans for disseminating the project results?
Project information including water monitoring data, as-built drawings, and final report information will be posted online to Datashed (www.datashed.org) for free public access. Project information, updates, and successes will be shared at SRWC watershed meetings, our monthly newsletter The Catalyst and through social media posts. In addition, the project will likely be discussed and/or presented at public events, tours, and conferences such as the annual Pennsylvania Abandoned Mine Reclamation, American Society of Reclamation Sciences, and West Virginia Mine Drainage Taskforce.

h. How well did spending align with the budget request?
Overall, the projected spending for construction of the treatment systems was somewhat under the actual cost with certain expenses costing more due to inflation and supply chain issues; however, some costs were lower which allowed us to conduct additional work such as related to the Ferris SR87/SR88 system. Contractual costs associated with engineering, permitting and construction oversight were significantly higher than anticipated in the grant application; however, project partner BioMost, Inc., was able to generously donate a large portion of these excess costs as in-kind services and funds shifted from the Growing Greener construction budget to contractual covered the difference. Reorganization and restructuring of Stream Restoration Incorporated shifted more responsibility of project management and other tasks to SRI which also required funding to be shifted from construction to Salary & Benefits that were not part of the original budget. Additional funding was obtained from the US OSMRE WCAP, Foundation for Pennsylvania Watersheds, and the Butler County Conservation District Game Lands 95 O&M Fund to help offset all the increased costs.

Appendix 1

Photographs

Ferris Complex

Top Photos: During the 2020 snapshot, a large hole was discovered to have formed within the access road after the culvert pipes conveying flow from Wetland 1 to Wetland 2 had become compromised (2020). While not part of the original project, project partners developed a plan to address this issue. The culvert pipes were removed and replaced with a drivable rock-lined spillway. The spillway permits continued access to the Ferris JP (SR87/SR88) passive treatment system while eliminating recurring issues associated with the original culvert.

Bottom Photo: Wetland 1 at the newly constructed rock-lined spillway that replaced the compromised culvert.

Top Photo: Wetland 2, the final treatment component, prior to the rehabilitation project. (2020)

Bottom Left: Wetland 1 receives drainage from both the Ferris West (VK) and Ferris East (JP) treatment systems. (2020)

Bottom Right: Beaver were regularly damming both the culvert outlet pipes and the emergency spillway in Wetland 1. This on-going activity caused the effluent of the treatment system to overtop the embankment and likely contributed to the hole in the access road noted above. (2020)

Top Left: Pre-rehabilitation photo of VK2 (JVFP West), the limestone-only vertical flow pond that followed VK1. Due to clogging issues of VK1, the water was directed to bypass the VK1 treatment media and enter directly into VK2 until rehabilitation could take place. The Agri Drain outlet structure (foreground) had numerous stop logs stuck and was no longer fully operational. (2020)

Top Right: Sediment, debris, and algae had accumulated in VK2 after 23 years of operation. (2020)

Bottom Left: Pre-rehabilitation photo of VK1 (JFVP East). The treatment media had degraded over two decades to the point where almost no flow was able to pass through the treatment media. (2020)

Bottom Right: During previous maintenance efforts the media of VK1 (now JVFP East) was found to be in poor condition with low permeability. (2017)

Top Photo: Limestone in VK2 (JVFP West) was drained, cleaned, and re-used as under drain stone. (2021)

Bottom Photo: Due to pandemic-related supply chain issues, six-inch SCH40 PVC pipe, typically used for outlet piping was not available and HDPE piping was used to allow construction to progress. (2021)

Top Left: Terraced iron formation (TIF), also known as oxidation precipitation channel (OPC), installed at the inlet Ferris West treatment system that treats the SR85/86 discharges. (2022)

Top Right: Staff gauge inside of the TIF flow splitter box used to measure the depth of flow over the three 90-degree V-notch weirs. (2022)

Bottom: Inlet of the TIF as the mine drainage enters the treatment system. (2022)

Top Left: The VK1 vertical flow pond was reconfigured into a Jennings-type vertical flow pond now referred to as JVFP East. (2022)

Top Right: The TIF provides initial treatment while conveying AMD to the flow splitter box that directs 33% of the flow to JVFP East and 67% of the flow to JVFP West.

Middle: Flow from JVFP East exits all four adjustable outlet risers and as it enters a rock-lined spillway to Wetland 1. Each of the two reconfigured JVFPs have a four-cell underdrain system. (2022)

Bottom: Each cell of the underdrain in each JVFP has an individual drain valve housed in a valve box (12" N12 pipe with Polylok lid) that can be used to dewater the JVFP and during maintenance work. (2022)

Top Left: Water exits JVFP East and enters Wetland 1 after two years of operation. (2023)

Top Right: Pink/purple coating inside the JVFP outlet pipes are photosynthetic purple sulfur reducing microorganisms. (2023)

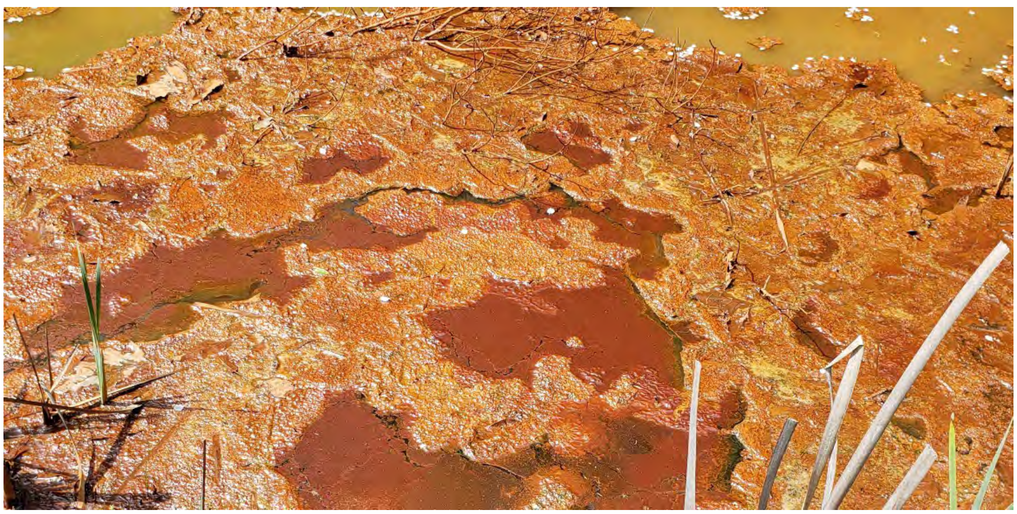
Bottom: The Ferris East passive treatment system was also rehabilitated. New pipes were installed to permit flow measurement as the discharges enter the system. The first cell was found to be essentially exhausted, and the spillway was improved to permit flow to enter the second limestone-only cell. The limestone was washed to restore treatment efficacy. (2023)

SR101A




Above Photos: After 22 years of operation, the ponds and wetlands of the SR101A treatment system were essentially filled with iron precipitates. The system has functioned as intended by preventing the iron from entering Slippery Rock Creek. (2020)





Top Left: Pre-rehabilitation photo of the settling pond at SR101A containing a yellow-orange color due to precipitated iron in the settling pond. (2020)

Top Right: Photo of the settling pond on the other side. Clumps of iron sludge with algae can be seen floating across the surface of the settling pond. (2020)

Bottom: Close-up of clumps of iron solids and biofilms at the surface of the settling pond. (2020)

Top Left: SR101A wetland with vegetation and sludge in it prior to rehabilitation. (2021)

Top Right: Wildlife utilizing the constructed wetlands, despite the buildup of sludge. (2021)

Bottom: Due to the high water levels caused by accumulated iron precipitates, the embankment of Wetland 2 was saturated causing a five-ton excavator to sink at the beginning of rehabilitation efforts. (2021)

Top Left: Photo of settling pond (left) and wetland 1 (right) in SR101A after sludge/debris removal. (2023)

Top Right: Photo of wetland 1 (left) and wetland 2 (right) in SR101A after sludge/debris removal. (2023)

Bottom Left: Wetland 2 emptying into a natural existing wetland directly south of the treatment components directed by a rock spillway. (2023)

Bottom Right: Photo of the dewatering basin constructed on site to hold sludge removed from treatment components. (2023)

SR114 B&D

Top: Pre-rehab photo of Wetland D2 (WL D2). After 26 years of operation the component was filled with iron precipitates and vegetation. (2021)

Bottom: Pre-rehab photo of ALDB outlet pipe. The channel was filled with iron precipitates. (2021)




Top Pictures: Pre-rehab pictures of wetlands in SR114D system filled with iron sludge. (2020)

Bottom Left: First of the three wetlands in SR114D, named Wetland D2, with iron sludge build-up. (2020)

Bottom Right: Iron sludge build-up surrounding the ALD B outlet pipe prior to rehabilitation. (2020)




Top Photos: Reconstruction and expansion of SR114 Pond B. (2023)

Bottom Left: Surveys completed by BioMost, Inc. during reconstruction and expansion of the anoxic limestone drain (ALD B). (2023)

Bottom Right: Old and degraded piping removed from the anoxic limestone drain ALD B. (2023)

Top Photos: ALD D was excavated by Spur Excavation, LLC to evaluate the quantity of remaining limestone. (2023)

Middle: As Spur Excavation, LLC works to uncover ALD D, BioMost, Inc. conducts survey work to determine the quantity remaining limestone. (2023)

Bottom: Prior to covering the ALD D with earth fill, geotextile was placed to separate the high-calcium carbonate limestone from the overlying soil material. (2023)

Top: Due to the soft soil conditions and deep sludge, specialty equipment such as the track truck pictured was used to transport sludge and debris from Pond D1 (right) and Wetlands D2 to D4 (left) to the dewatering basin. (2023)

Middle Left: Dewatering basin constructed to hold sludge and debris from ponds and wetlands. (2023)

Middle Right: Two of the three wetland cells (Wetlands D3 through D4) after sludge removal. (2023)

Bottom: The drainpipe from the dewatering basin (right) enters Wetland D4 (left) via the valve located in the valve box (foreground). (2023)

SR81

Top Left: Photo of settling pond at SR81 passive treatment system prior to rehabilitation. (2020)

Top Right: The settling pond (foreground) followed by constructed wetlands (background). (2023)

Bottom: Close-up photo of thick iron-laden water in the settling ponds. Red-orange sludge is built-up around the vegetation. (2020)

Top Left: Vegetation overgrowth SR81 wetlands prior to rehabilitation. (2020)

Top Right: Natural wetlands situated to the north of the constructed wetland and settling pond. (2020)

Bottom: Effluent of the SR81 passive treatment systems enters a natural wetland with a large portion of the flow entering Slippery Rock Creek through this channel. This location is sample point NWL. (2020)

All Above Photos: A wetland delineation was completed to obtain a restoration waiver to facilitate flow distribution efforts placed in the natural wetland to reduce channelization and increase retention time and treatment effectiveness. (2022)

Top Left: Construction of the dewatering basin to hold sludge and debris removed from the SR81 settling pond and wetland. (2023)

Top Right: Spur Excavation, LLC placing sludge and vegetation from the SR81 settling pond to the dewatering basin. (2023)

Bottom Left: Spur Excavation removing the sludge and vegetation from the bottom of the settling pond and placing it in the track truck to be hauled up gradient to the dewatering basin. (2023)

Bottom Right: Dewatering basin holding sludge and debris from the settling pond and wetlands. (2023)

Top Photos: Spur Excavation, LLC uncovered the ALD (now ALD1) to assess the condition and quantity of remaining limestone. (2023)

Bottom Left: The outlet of the dewatering pipe (left) and overflow pipe (right) from the dewatering basin enter the settling pond. (2023)

Bottom Right: A Z-pile moat used to distribute flow from the constructed wetland to the natural wetland in an effort to increase retention time and treatment efficacy in the natural wetland. (2023)

Top Photo: Cleaned settling pond (left), ALD 2 after placement of cover material (center), and ALD 1 prior to installation of new limestone (right). (2023)

Bottom Photos: Settling Pond after the site was graded, seeded, and mulched. (2023)

Top Photos: Construction of the rock distribution berm in the natural wetland which receives flow from the SR81 passive system. (2023)

Bottom Left: Rock distribution berm extends from Kohlmeyer Road. (2023)

Bottom Right: Finished rock distribution berm reaching partway (approximately 360 feet) into the natural wetland. The berm helps to distribute flow from the SR81 treatment system (to right of photo) in the natural wetland to improve iron removal prior to the AMD reaching Slippery Rock Creek (to left of photo). (2023)

Appendix 2

Water Monitoring Data

Table 1: Ferris Complex Average Water Quality Data Prior to Rehabilitation Project (1996 to 2021)

Point	Description	Flow (gpm)	pH Field	pH Lab	Cond. Field	ORP Field	Alk. Field	Alk. Lab	Acidity	T. Fe	T. Mn	T. Al	SO4	TSS	Alk. Field Load	Acid Load	T. Fe Load	T. Mn Load	T. Al Load
SR86	Primary inflow to VK system	89	3.54	3.31	704	418	0	0	80	3.94	1.64	4.77	341	7	0.0	84.7	4.2	1.7	4.8
VK2	Outflow of VK system prior to reconstruction	81	6.15	6.64	684	136	19	91	1	1.11	1.57	1.56	381	12	39.6	0.5	1.0	1.5	1.5
SR87	AMD source JP system	10	3.84	3.43	400	390	0	0	71	3.00	1.74	4.95	182	6	0.0	7.4	0.2	0.2	0.5
SR88	AMD source JP system	9	-	3.44	-	-	-	0	91	5.07	1.69	7.37	322	7	0.0	9.2	0.3	0.2	0.7
JP2	Effluent of JP2	18	7.39	7.03	302	100	43	95	0	0.86	1.09	1.45	246	12	4.4	1.6	0.2	0.2	0.4
WL 1	Effluent of Wetland 1 combined effluent of VK & JP systems	203	5.54	5.71	659	213	21	11	3	1.38	1.49	0.93	284	7	70.8	-21.3	1.8	2.6	0.5

Units for specific conductivity are in µmhos/cm; oxidation-reduction potential (ORP) in millivolts (mV), and all units for alkalinity, acidity, metals, sulfate, and total suspended solids (TSS) are in mg/L. Units for loading are in lb/day.

Table 2: Ferris Complex Water Quality Post Rehabilitation on 7/11/2023

Point	Flow (gpm)	pH Field	pH Lab	Temp. Field	Cond. Field	ORP Field	Alk. Field	Alk. Lab	Acidity	T. Fe	T. Mn	T. Al	Sulfate	TSS	Alk. Field Load	Acid Load	T. Fe Load	T. Mn Load	T. Al Load
SR86	*140	3.60	3.88	17.8	535	407	0	<0.1	34	1.02	1.47	1.00	209	7	0.0	57.2	1.7	2.5	1.7
TIF	140	3.87	4.10	19.5	556	392	0	<0.1	20	0.68	1.43	1.06	257	9	0.0	33.6	1.1	2.4	1.8
VK1	28	7.05	7.65	19.2	894	-290	252	199	-194	0.95	1.70	<0.10	322	12	84.8	-65.3	0.3	0.6	0.0
VK2	111	7.18	7.59	23.0	678	-309	218	162	-138	<0.10	1.10	<0.10	152	5	290.8	-184.1	0.1	1.5	0.1
SR88	4	3.39	3.65	20.6	498	422	0	<0.1	40	2.72	0.82	2.72	195	5	0.0	1.9	0.1	0.0	0.1
SR87	1	3.12	3.33	28.0	501	462	0	<0.1	93	2.55	1.19	1.33	139	6	0.0	1.1	0.0	0.0	0.0
JP2	4	8.04	7.63	24.7	412	154	53	43	-34	<0.10	<0.05	<0.10	141	7	2.5	-1.6	0.0	0.0	0.0
WL1	*150	7.29	7.20	25.4	665	-1	141	119	-111	0.51	1.28	<0.10	198	9	254.2	-200.1	0.9	2.3	0.2

Units for all temperature measurements are in degrees Celsius, specific conductivity are in µmhos/cm; oxidation-reduction potential (ORP) in millivolts (mV), and all units for alkalinity, acidity, metals, sulfate, and total suspended solids (TSS) are in mg/L. Units for loading are in lb/day. Any flow measurement with an asterisk* in front is an estimated value based off flow measurements of other points within the system.

Table 3: Ferris Complex Water Quality Post Rehabilitation on 12/19/2023

Point	Flow (gpm)	pH Field	pH Lab	Temp. Field	Cond. Field	ORP Field	Alk. Lab	Acidity	T. Fe	T. Mn	T. Al	Sulfate	TSS	Alk. Lab Load	Acid Load	T. Fe Load	T. Mn Load	T. Al Load
SR86	*110	3.32	3.68	4.6	766	303	<0.1	63	1.32	2.11	0.70	364	<5	<0.1	82.9	1.7	2.8	0.9
TIF	*110	3.77	3.74	4.3	770	400	<0.1	66	1.66	1.92	0.94	376	<5	<0.1	87.3	2.2	2.5	1.2
VK1	54	7.48	7.15	4.7	915	36	109	-87	1.30	1.46	<0.10	376	<5	70.3	-55.7	0.8	0.9	<0.1
VK2	56	7.67	7.04	4.4	811	11	75	-58	<0.10	1.22	<0.10	382	<5	50.8	-38.9	<0.1	0.8	<0.1
SR88	1	3.93	3.82	1.2	554	414	<0.1	65	2.28	0.99	0.66	261	<5	0.0	0.9	0.0	0.0	0.0
SR87	4	3.85	3.67	0.8	404	464	<0.1	79	1.14	1.04	0.79	162	<5	0.0	3.3	0.1	0.0	0.0
JP2	8	8.10	7.48	3.8	412	222	52	-23	<0.10	0.11	<0.10	174	<5	4.7	-2.1	0.0	0.0	0.0
WL1	*120	7.53	7.28	1.6	788	124	79	-62	1.11	1.28	<0.10	350	<5	113.5	-90.0	1.6	1.9	<0.1
WL2	200	7.58	7.23	2.4	690	246	63	-44	0.48	0.85	<0.10	273	5	150.3	-104.6	1.2	2.0	<0.2

Field alkalinity values are not included for the Ferris samples due to difficulties with the alkalinity kit at the site resulting in errored measurements. Units for all temperature measurements are in degrees Celsius, conductivity in µmhos/cm, oxidation-reduction potential (ORP) in mV, and all units for alkalinity, acidity, metals, sulfate, and total suspended solids (TSS) are in mg/L. Units for loading are in lb/day. Any flow measurement with an asterisk* in front is an estimated value based off flow measurements of other points within the system.

Table 4: SR81 Average Water Quality Data Prior to Rehabilitation Project (2002 to 2023)

Point	Description	Flow (gpm)	pH Field	pH Lab	Cond. Field	ORP Field	Alk Field	Alk Lab	Acidity	T. Fe	T. Mn	T. Al	Sulfate	TSS	Alk. Field Load	Acid Load	T. Fe Load	T. Mn Load	T. Al Load
RAW	Weighted averages of SR81 discharges before ALD construction (1995-2002)	*181	5.16	3.62	870	-	-	2	118.9	61.02	9.31	0.27	390	6	-	258.6	132.7	20.2	0.59
ALD	Effluent of SR81 ALD; accessible inflow to system	181	6.69	6.27	675	30	92	57	9	43.26	6.29	0.20	331	16	231.1	16.2	98.0	15.5	0.2
WL	Effluent of wetland and of original system	182	6.65	6.22	636	158	31	21	0	9.99	5.89	0.14	339	12	79.1	-3.7	30.6	14.7	0.3
NWL	Natural wetland: collected at a channel that drains much of the wetland	134	6.71	6.45	518	190	25	18	-7	2.81	3.04	0.10	243	7	30.3	-16.3	0.6	3.6	0.1

Units for specific conductivity are in µmhos/cm, oxidation-reduction potential in millivolts (mV), and all units for alkalinity, acidity, metals, sulfate, and total suspended solids (TSS) are in mg/L. Units for loading are in lb/day. Due to inaccessibility of raw AMD discharge after the construction of the ALD, historic data is included for the raw SR81 discharge (labelled "RAW") collected before original construction of the system. Any flow measurement with an asterisk* in front is an estimated value based off flow measurements of other points within the system.

Table 5: SR81 Water Quality Post Rehabilitation on 12/19/2023

Point	Flow (gpm)	pH Field	pH Lab	Temp Field	Cond. Field	ORP Field	Alk Field	Alk. Lab	Acidity	T. Fe	T. Mn	T. Al	Sulfate	TSS	Alk. Field Load	Acid Load	T. Fe Load	T. Mn Load	T. Al Load
ALD	104	7.08	6.65	8.4	698	-62	167	101	-64	33.25	4.49	0.66	271	52	208.7	-80.1	41.6	5.6	0.8
WL	*104	7.37	6.89	3.0	646	117	94	81	-57	10.89	4.02	0.30	295	23	117.5	-71.2	13.6	5.0	0.4
NWLA	*104	7.45	7.26	0.1	496	174	73	67	-64	1.24	3.78	<0.10	169	<5	91.2	-79.9	1.6	4.7	<0.1
NWL	*104	7.08	7.46	0.7	590	193	72	82	-56	0.53	2.18	<0.10	230	<5	90.0	-69.99	0.66	2.72	0.12

Units for all temperature measurements are in degrees Celsius, conductivity in µmhos/cm, oxidation-reduction potential (ORP) in mV, and all units for alkalinity, acidity, metals, sulfate, and total suspended solids (TSS) are in mg/L. Units for loading are in lb/day. Any flow measurement with an asterisk* in front is an estimated value based off flow measurements of other points within the system.

Table 6: SR101A Average Water Quality Data Prior to Rehabilitation Project (1998 to 2021)

Point	Description	Flow (gpm)	pH Field	pH Lab	Cond. Field	ORP Field	Alk. Field	Alk. Lab	Acidity	T. Fe	T. Mn	T. Al	Sulfate	TSS	Alk. Field Load	Acid Load	T. Fe Load	T. Mn Load	T. Al Load
RAW	SR101A discharge (1991-2010)	23	-	4.93	-	-	-	23	165	78.57	2.64	0	548	-	-	45.5	21.7	0.73	0.00
ALD	Outflow of ALD; Inflow of the system	30	6.82	6.50	1,056	-8	188	178	-9	85.37	2.08	0.13	597	44	66.4	-9.7	30.1	0.7	0.2
WL2	WL2 & System outflow	28	6.96	6.59	1,011	211	54	67	-13	7.28	1.71	0.10	601	8	17.8	-10.0	0.9	0.4	0.1

Units for specific conductivity are in µmhos/cm, oxidation-reduction potential in millivolts (mV), and all units for alkalinity, acidity, metals, sulfate, and total suspended solids (TSS) are in mg/L. Units for loading are in lb/day. Due to inaccessibility of raw AMD discharge after the construction of the ALD, historic data is included for the raw SR101A discharge (labelled "RAW") collected mostly before original construction of the system.

Table 7: SR101A Water Quality Post Rehabilitation on 12/20/2023

Point	Flow (gpm)	pH Field	pH Lab	Temp. Field	Cond. Field	ORP Field	Alk. Field	Alk. Lab	Acidity Lab	T. Fe	T. Mn	T. Al	Sulfate	TSS	Alk. Field Load	Acid Load	T. Fe Load	T. Mn Load	T. Al Load
ALD	24	6.93	6.12	8.4	1113	-42	186	54	-18	98.07	1.94	0.70	534	32	53.6	-5.3	28.3	0.6	0.2
WL2	*24	7.00	6.35	2.3	956	90	64	33	-15	25.77	1.77	0.10	465	28	18.5	-4.2	7.4	0.5	0.0

Units for all temperature measurements are in degrees Celsius, conductivity in µmhos/cm, oxidation-reduction potential (ORP) in mV, and all units for alkalinity, acidity, metals, sulfate, and total suspended solids (TSS) are in mg/L. Units for loading are in lb/day. Any flow measurement with an asterisk* is an estimated value based off flow measurements of other points within the system.

Table 8: SR114B Average Water Quality Data Prior to Rehabilitation Project (1996 to 2023)

Point	Description	Flow (gpm)	pH Field	pH Lab	Cond. Field	ORP Field	Alk. Field	Alk. Lab	Acidity	T. Fe	T. Mn	T. Al	Sulfate	TSS	Alk. Field Load	Acid Load	T. Fe Load	T. Mn Load	T. Al Load
Raw	SR114B&D discharge before construction (1995)	*45	5.50				30		50	40.00	1.00	<1.0			16.22	27.0	21.6	0.5	<0.5
ALD B	Inflow to SR114 B System	32	6.93	6.65	585	45	157	134	-30	14.33	1.38	0.03	191	9	11.9	-7.8	5.9	0.6	0.02
SR114-B2 Seep	Mixes with ALD B before entering Pond B	15	6.25	5.89	320	190	17	12	5	6.86	0.97	0.10	120	8	3.0	1.0	1.1	0.2	0.02
Pond B	Effluent of SR114 B System	42	6.98	6.67	368	184	43	72	-6	4.35	1.28	0.02	174	6	10.5	-5.4	2.5	0.7	0.04

Units for specific conductivity are in µmhos/cm, oxidation-reduction potential in millivolts (mV), and all units for alkalinity, acidity, metals, sulfate, and total suspended solids (TSS) are in mg/L. Units for loading are in lb/day. Due to inaccessibility of raw AMD discharge after the construction of the ALDs at SR114 B&D, historic data is included for combine SR114 B&D discharge (labelled "RAW") collected before original construction of the system.

Table 9: SR114B Water Quality Post Rehabilitation on 12/20/2023

Point	Flow (gpm)	pH Field	pH Lab	Temp. Field	Cond. Field	ORP Field	Alk. Field	Alk. Lab	Acidity	T. Fe	T. Mn	T. Al	Sulfate	TSS	Alk. Field Load	Acid Load	T. Fe Load	T. Mn Load	T. Al Load
ALD B	14	6.88	6.99	9.5	555	43	150	137	-73	10.70	1.09	<0.10	161	8	25.8	-12.6	1.8	0.2	0.0
Pond B Seep (Estimated off ALD D)	57									25.83	0.80	<0.10					17.7	0.6	<0.1
POND B	71	6.42	6.93	4.7	441	263	30	32	-18	6.79	0.89	<0.10	191	<5	25.6	-15.1	5.8	0.8	<0.1

Units for all temperature measurements are in degrees Celsius, conductivity in µmhos/cm, oxidation-reduction potential (ORP) in mV, and all units for alkalinity, acidity, metals, sulfate, and total suspended solids (TSS) are in mg/L. Units for loading are in lb/day. A considerable increase in flow occurred at Pond B, while a similarly sized decrease in flow occurred at ALD D. For this reason, it is predicted that the seep entering Pond B is from ALD D, and Pond B Seep is included above and assumed to have the same metal concentrations as ALD D. Pond B Seep is used in the metal load reduction calculations at SR114B.

Table 10: SR114D Average Water Quality Data Prior to Rehabilitation Project (1996 to 2023)

Point	Description	Flow (gpm)	pH Field	pH Lab	Cond. Field	ORP Field	Alk. Field	Alk. Lab	Acidity	T. Fe	T. Mn	T. Al	Sulfate	TSS	Alk. Field Load	Acid Load	T. Fe Load	T. Mn Load	T. Al Load
Raw	SR114B&D discharge (1995)	*115	5.50				30		50	40.00	1.00	<1.0			41.5	69.1	55.3	1.4	<1.4
ALD D	Inflow to SR114 D System	114	6.51	6.42	567	57	98	118	-5	34.95	1.06	0.03	243	17	125.3	-28.8	47.7	1.5	0.2
WLD4	Effluent of SR114D System	117	6.91	6.67	522	152	59	71	-9	11.33	1.00	0.02	233	15	72.5	-41.1	16.4	1.4	0.2

Units for specific conductivity are in µmhos/cm, oxidation-reduction potential in millivolts (mV), and all units for alkalinity, acidity, metals, sulfate, and total suspended solids (TSS) are in mg/L. Units for loading are in lb/day. Due to inaccessibility of raw AMD discharge after the construction of the ALDs at SR114 B&D, historic data is included for combined SR114 B&D discharge (labelled "RAW") collected before original construction of the system.

Table 11: SR114D Water Quality Post Rehabilitation on 12/20/2023

Point	Flow (gpm)	pH Field	pH Lab	Temp. Field	Cond. Field	ORP Field	Alk Field	Alk Lab	Acidity	T. Fe	T. Mn	T. Al	Sulfate	TSS	Alk. Field Load	Acid Load	T. Fe Load	T. Mn Load	T. Al Load
ALD D	32	7.10	6.86	9.8	644	51	181	128	-105	25.83	0.80	<0.10	205	<5	69.4	-40.3	9.9	0.3	<0.04
WLD2	*32	7.39	7.33	5.8	625	133	143	133	-109	7.29	0.75	<0.10	264	<5	55.0	-41.9	2.8	0.3	<0.04
WLD3	*32	7.78	7.76	3.8	649	234	135	126	-113	3.66	0.71	<0.10	211	<5	51.9	-43.5	1.4	0.3	<0.04
D4A	0.3																		
WLD4	*32	7.24	7.60	3.6	569	88	118	98	-78	7.73	0.62	<0.10	195	11	45.4	-30.1	3.0	0.2	<0.04

Units for all temperature measurements are in degrees Celsius, conductivity in µmhos/cm, oxidation-reduction potential (ORP) in mV, and all units for alkalinity, acidity, metals, sulfate, and total suspended solids (TSS) are in mg/L. Units for loading are in lb/day. Any flow measurement with an asterisk* is an estimated value based off flow measurements of other points within the system.

Table 12: Average Water Quality Data Along Slippery Rock Creek Prior to (Most) SRWC Restoration Efforts (1996-1997)

Point	Description	Coordinates	pH Field	pH Lab	Alk. Field	Alk. Lab	Acidity	T. Fe	T. Mn	T. Al	Sulfate	TSS
43	Point in SR Creek at Branchton Rd bridge downstream of the Argentine coal refuse pile, upstream of the four rehabbed systems	41.095129, -79.815668	-	6.05	-	23	2	0.47	0.98	0.50	99	3
59	Point along the main branch of SR Creek below Higgins Road Bridge, downstream from SR114.	41.097084, -79.835082	-	6.26	-	27	2	1.25	1.10	0.50	115	6
64	Point in SR Creek at Kohlmeyer Rd bridge, downstream of Ferris, SR81, SR114, SR101A	41.100019, -79.860692	-	5.51	-	10	9	1.12	0.85	0.51	120	4
67	Point in SR Creek at Cemetery Rd bridge just before the confluence with Seaton Creek	41.109656, -79.884435	-	6.04	-	19	1	2.02	0.68	0.50	137	4
65	Point in the main branch of SR Creek, behind Boyer's Sportsman's Club, downstream of the confluence of Seaton and SR Creek and Ferris, SR81, SR114, SR101A.	41.109505, -79.907480	-	6.10	-	23	4	0.75	4.54	0.50	267	3

Units for alkalinity, acidity, metals, sulfate, and total suspended solids (TSS) are in mg/L. No field pH or field alkalinity data was found for these stream points prior to the year 2000. Note: stream points are in order from most upstream (sample point 43) to most downstream (sample point 65).

Table 13: Water Quality Data Along Slippery Rock Creek Prior to Rehabilitation Project (2002 to 2021)

Point	pH Field	pH Lab	Alk. Field	Alk. Lab	Acidity	T. Fe	T. Mn	T. Al	Sulfate	TSS
43	6.94	6.07	13	7	2	1.17	0.47	0.28	122	6
59	7.18	6.60	27	18	10	1.06	0.98	0.34	94	7
64	6.96	6.21	24	14	20	1.41	1.09	0.38	111	6
67	7.45	6.72	23	16	5	0.67	0.90	0.26	116	8
65	7.28	6.79	36	24	0	0.70	1.14	0.29	171	4

Units for alkalinity, acidity, metals, sulfate, and total suspended solids (TSS) are in mg/L.

Table 14: Water Quality Data Along Slippery Rock Creek Post Rehabilitation on 12/20/2023

Point	pH Field	pH Lab	Temp. Field	Cond. Field	ORP Field	Alk. Field	Alk. Lab	Acidity	T. Fe	T. Mn	T. Al	Sulfate	TSS
43	7.08	6.55	1.4	766	203	13	10	-3	0.92	0.22	<0.10	45	<5
59	6.80	6.84	1.4	273	218	19	20	-6	0.92	0.47	<0.10	72	5
64	7.07	6.97	0.1	273	218	18	23	-16	0.58	0.50	0.13	81	6
67	7.12	6.97	0.0	284	215	20	36	-11	0.29	0.25	<0.10	85	<5
65	7.02	7.14	0.3	440	209	24	41	-29	0.36	0.67	<0.10	156	<5

Units for all temperature measurements are in degrees Celsius, conductivity in µmhos/cm, oxidation-reduction potential (ORP) in mV, and all units for alkalinity, acidity, metals, sulfate, and total suspended solids (TSS) are in mg/L.

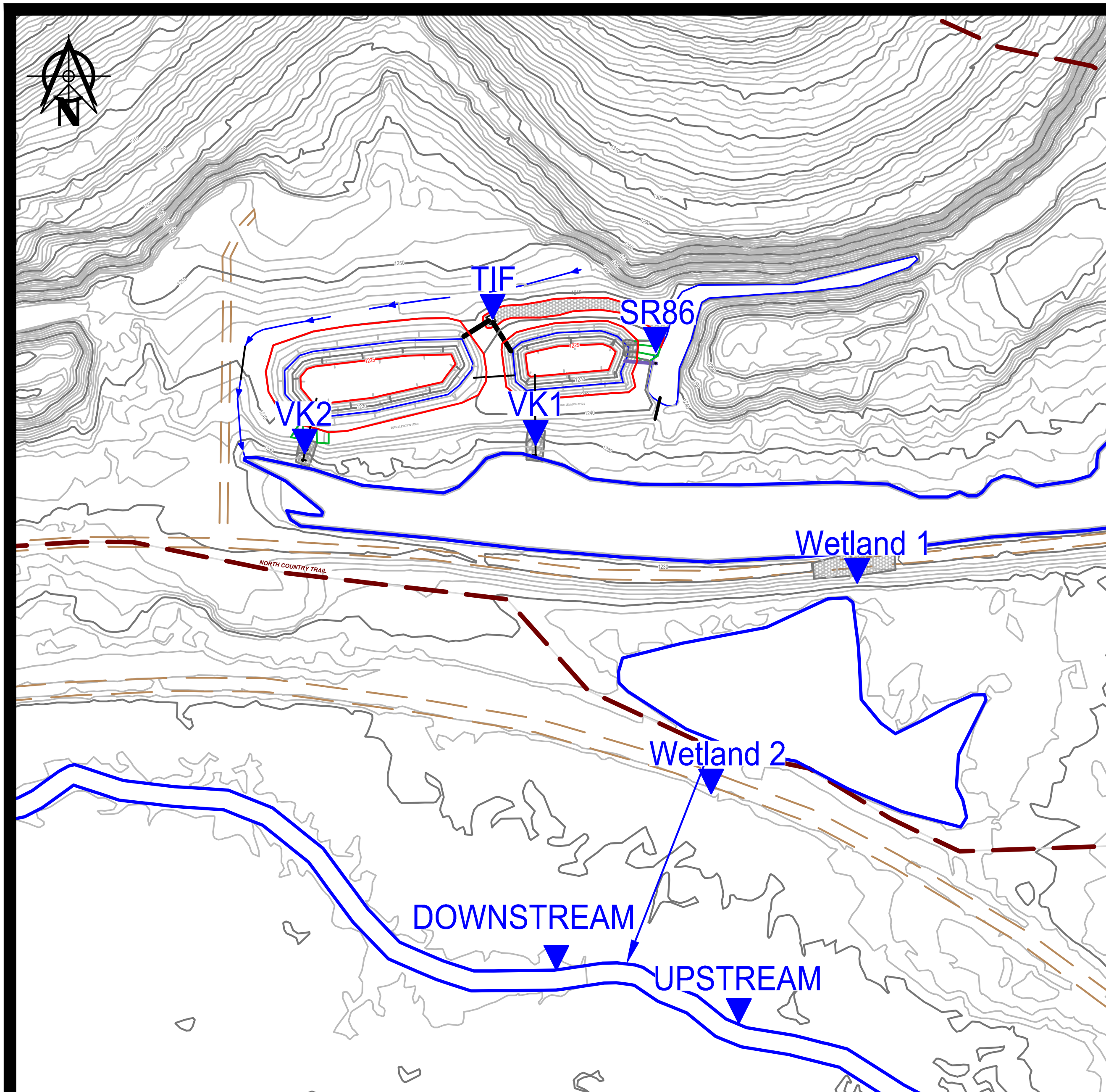
Table 15: Load Reductions and Alkalinity Load to Stream Pre (Red) and Post (Blue) Rehabilitation (lb/year)

System	Acid Load Reduction	T. Fe Load Reduction	T. Mn Load Reduction	T. Al Load Reduction	Alkalinity Load to Stream
Ferris (1996-2021)	56,243	3,238	-69	2,873	12,512
Ferris (2023)	82,508	283	183	425	73,821
SR81 (2002-2023)	100,353	35,536	4,336	66	11,060
SR81 (2023)	79,785	14,929	1,055	256	32,850
SR101A (1998-2021)	20,287	10,654	128	15	5,216
SR101A (2023)	18,195	7,614	18	62	6,753
SR114B (1996-2023)	11,826	1,672	40	-4	3,822
SR114B (2023)	8,563	5,015	-9	0	9,344
SR114D (1996-2023)	40,223	11,403	18	22	26,452
SR114D (2023)	17,958	2,530	26	0	16,571

Units for all load reductions and for alkalinity loads to Slippery Rock Creek are in lb/year. Due to the raw discharges being inaccessible at SR81, SR101A, and SR114 B&D, a true representation of acid neutralization by treatment in those four systems is not feasible. For the acidity load reduction calculations, it was assumed that the raw AMD discharges at SR81, SR101A, and SR114 B&D maintained similar acidity as before original construction of the systems, so historic data of pre-construction raw discharges (labelled "RAW" in Tables 4, 6, 8, and 10) were used as the inflow points for their given systems with flows estimated based on flows measured at other points during the December sampling event.

Appendix 3

SRWC Comprehensive O&M Plan Updates



LEGEND

- PTS COMPONENT
- INDEX CONTOUR
- INTERMEDIATE CONTOUR
- NORTH COUNTY TRAIL
- WATERLINE / WATER BODY
- ROAD (UNPAVED)
- DIVERSION DITCH
- DOWNSTREAM ▼ WATER SAMPLING POINT

mining & reclamation services
434 SPRING STREET EXT.
MARS, PA 16046
www.biomost.com

SCALE: 0 100' 200'

LATITUDE: 41.102805
LONGITUDE: -79.857438

FERRIS PASSIVE TREATMENT SYSTEM COMPLEX
SR85-SR86 & SR87-SR88

DATE: 12/11/2023 (Rev. 01/19/2024)

SITE SCHEMATIC

DRAWING NUMBER: 1 of 1

PASSIVE TREATMENT SYSTEM O&M INSPECTION REPORT

Rev 12/2023

Inspection Date: ______________	Project Name:	**Ferris Passive Treatment System Complex**	
Inspected by: ______________	Municipality:	**Venango Township**	
Organization: ______________	County:	**Butler**	State: **PA**
Time Start: ________ End: ________	Project Coordinates:	**41° 06' 08''** Lat	**79° 51' 31''** Long
Receiving Stream: **Slippery Rock Creek**	Subwatershed:	Slippery Rock Creek	Watershed: **Slippery Rock Creek**

Weather (circle one): Snow Heavy Rain Rain Light Rain Overcast Fair/Sunny **Temp(°F):** ≤32 33-40 41-50 51-60 60+

Is maintenance required? Yes/No If yes, provide explanation:

INSPECTION SUMMARY

A. Site Vegetation (Uplands and Associated Slopes)

Overall condition of vegetation on site: 0 1 2 3 4 5 (0=poor, 5=excellent, circle one) (See instructions.)

Is any reseeding required? Yes/No If yes, describe area size and identify location on Site Schematic: ______________________________

____

____

B. Site Access and Parking

Is the access road passable for operation and monitoring? Yes/No?
Does the access road need maintenance? Yes/No?
Describe maintenance performed and remaining (Identify location on Site Schematic.): ______________________________

____

____

C. Vandalism and "Housekeeping"

Is there litter around or in the passive system? Yes/No? If Yes, was the litter picked up? Yes/No?
Is there litter that may be considered hazardous or dangerous that requires special disposal? ? Yes/No?
Is there evidence of vandalism to the passive system? Yes/No?
Additional comments: ______________________________

D. Ditches, Channels, Spillways

Channel Identification	Erosion Rills (Y/N)	Debris Present (Y/N)	Maintenance Performed (Y/N)	Maintenance Performed and Remaining (Indicate ditch by number i.e. 2b = VK2)
1. Diversion Ditch				
2. Spillways				
a. JVFP East (VK1)				
b. JVFP West (VK2)				
c. JP1				
d. JP2				
e. Wetland 1				
f. Wetland 2				
3. Emergency Spillways				
a. JVFP East (VK1)				
b. JVFP West (VK2)				
c. Existing Collection Pond				
4. TIF & Flow splitter box				

E. Wildlife Utilization

Animals sighted or tracks observed ______________________________
Invasive plants observed ______________________________
Describe any damage caused to treatment system by wildlife (especially muskrats) and required maintenance:

F. Passive Treatment System Components

Component	Erosion Rills (Y/N)	Berms Stable (Y/N)	Vegetation Successful (Y/N)	Siltation Significant (Y/N)	Water Level Change (Y/N)	Valves Operable (Y/N)	**Maintenance Performed and Remaining** Indicate which component i.e. VFP1
TIF						*N/A*	
JVFP East (VK1)							
JVFP West (VK2)							
JP1							
JP2							
Wetland 1						*N/A*	
Wetland 2						*N/A*	

Additional Comments: ____

____

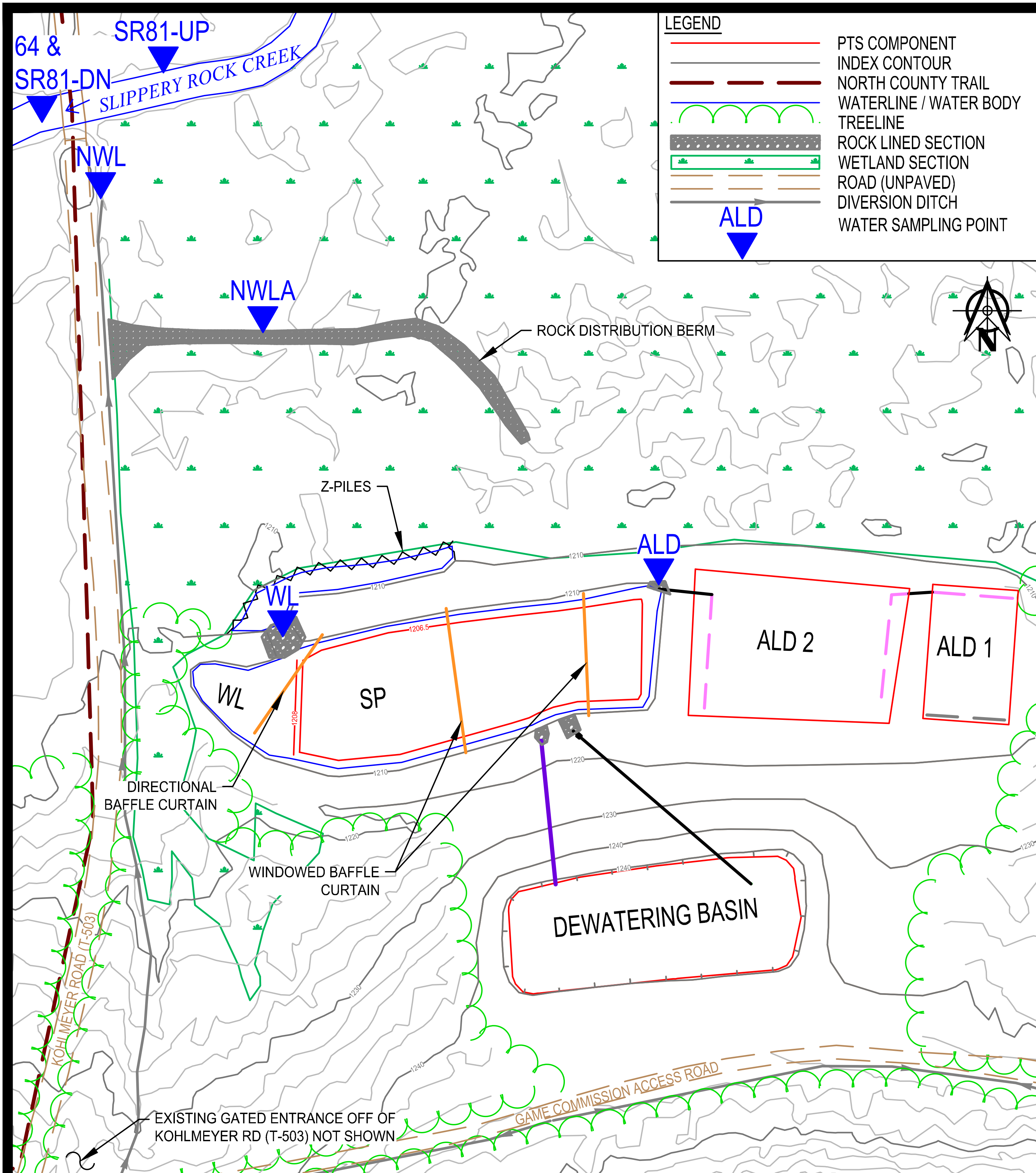
____

____

G. Field Water Monitoring and Sample Collection - Raw water sample locations as marked on plan. For passive components sample effluent.

☐ - Not monitored

Sampling Point	Flow		pH	Temp (°C)	ORP	Alkalinity (mg/L)	DO (mg/L)	Iron (mg/L)	Comments	Bottle #	Bottle # (total metals)	Bottle # (diss. metals)
	gals	sec.										
SR86	(not monitored)	(not monitored)										
TIF												
VK1												
VK2												
SR87												
SR88												
JP1												
JP2												
Wetland 1												
Wetland 2												
Upstream												
Downstream												



mining & reclamation services

434 SPRING STREET EXT.
MARS, PA 16046
www.biomost.com

SCALE:
0 50' 100'

LATITUDE: 41.098461
LONGITUDE: -79.858386

SR81 REHABILITATION PROJECT

DATE:
12/11/2023 (Rev. 1/19/2024)

SITE SCHEMATIC

DRAWING NUMBER:
1 of 1

PASSIVE TREATMENT SYSTEM O&M INSPECTION REPORT

Rev 12/2023

Inspection Date: ______	Project Name: **SR 81**		
Inspected by: ______	Municipality: **Washington Township**		
Organization: ______	County: **Butler**		State: **PA**
Time Start: ______ End: ______	Project Coordinates:	**41° 05' 54"** Lat	**79° 51' 34"** Long
Receiving Stream: **Slippery Rock Creek**	Sub-watershed: **Slippery Rock**	Watershed:	**Slippery Rock**

Weather (circle one): Snow Heavy Rain Rain Light Rain Overcast Fair/Sunny **Temp (°F):** ≤32 33-40 41-50 51-60 60+

Is maintenance required? Yes/No If yes, provide explanation: ______

______

______

INSPECTION SUMMARY

A. Site Vegetation

Overall condition of vegetation on site: 0 1 2 3 4 5 (0=poor, 5=excellent, circle one) (See instructions.)

Is any reseeding required? Yes/No If yes, describe area size and identify location on Site Schematic: ______

______

______

B. Site Access and Parking

Is the access road passable for operation and monitoring? Yes/No?
Does the access road need maintenance? Yes/No?
Describe maintenance performed and remaining (Identify location on Site Schematic.): ______

______

______

C. Vandalism and "Housekeeping"

Is there litter around or in the passive system? Yes/No? If Yes, was the litter picked up? Yes/No?
Is there litter that may be considered hazardous or dangerous that requires special disposal? ? Yes/No?
Is there evidence of vandalism to the passive system? Yes/No?
Additional comments: ______

D. Ditches, Channels, Spillways

Channel Identification	Erosion Rills (Y/N)	Debris Present (Y/N)	Maintenance Performed (Y/N)	Maintenance Performed and Remaining (Indicate spillway by number i.e. 1b = Wetland)
1. Rock-Lined Spillways				
a. ALD				
b. Dewatering Basin outlets				
c. Wetland Effluent				
2. Diversion Ditch				
3. Rock Distribution Berm				

E. Passive Treatment System Components

Component	Erosion Rills (Y/N)	Berms Stable (Y/N)	Vegetation Successful (Y/N)	Siltation Significant (Y/N)	Water Level Change (Y/N)	**Maintenance Performed and Remaining** Indicate which component i.e. ALD
ALD 1						
ALD 2						
SP						
Constructed Wetland						
Natural Wetland						
Z-Pile Moat						
Dewatering Basin						

Other: ____

F. Wildlife Utilization

Animals sighted or tracks observed ____________________________

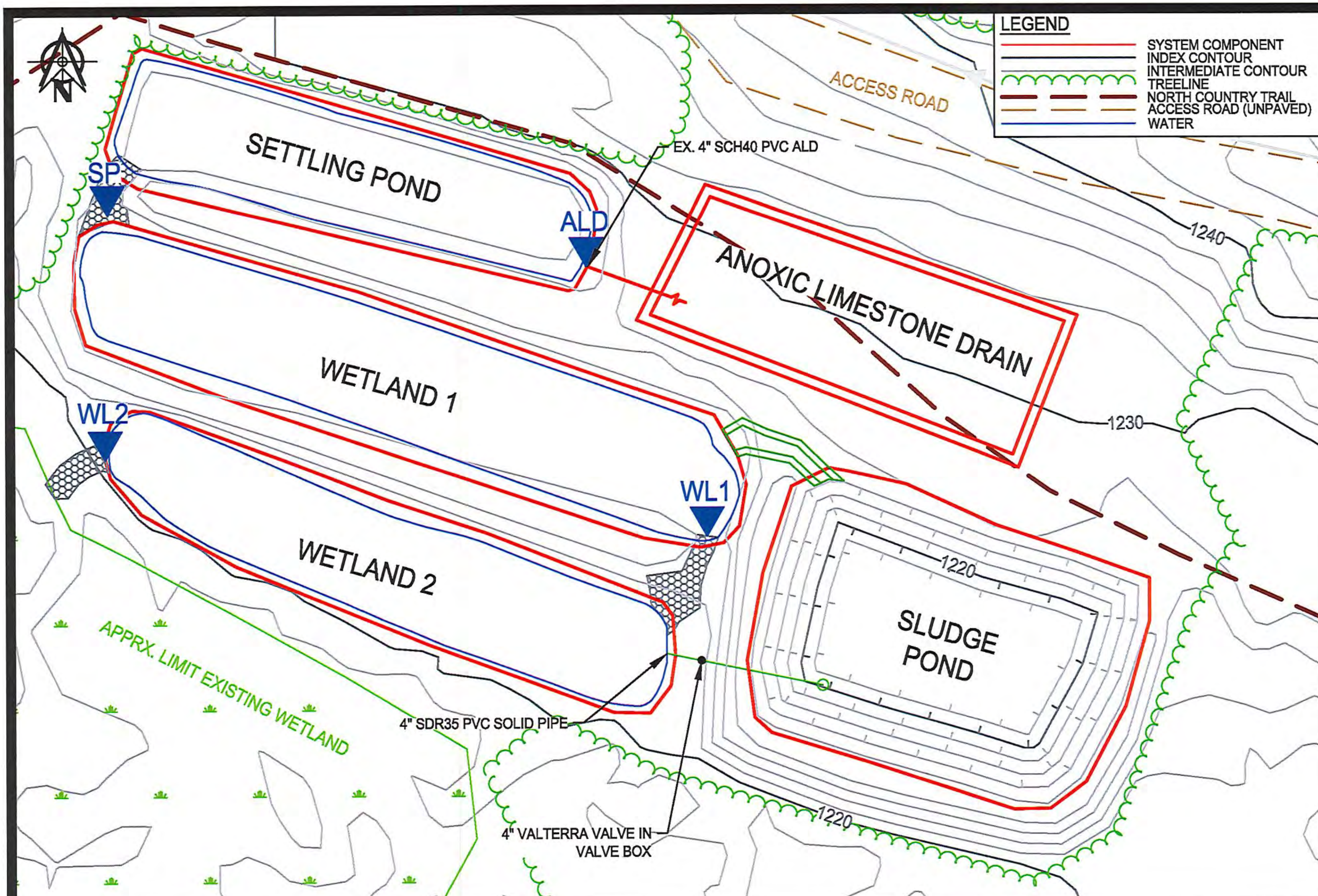
Invasive plants observed ____________________________

Describe any damage caused to treatment system by wildlife (especially muskrats) and required maintenance: ____________________________

G. Field Water Monitoring and Sample Collection - Raw water sample locations as marked on plan. For passive components sample effluent.

☐ **-** Not monitored

Sampling Point	Flow		pH	Temp (°C)	ORP	Alkalinity (mg/L)	DO (mg/L)	Iron (mg/L)	Comments	Bottle #	Bottle # (total metals)	Bottle # (diss. metals)
	gals	sec.										
ALD												
SR81 - Seep												
Wetland (WL)												
NWLA (Distribution Berm)												
Natural Wetland (NWL)												
SR81 - Upstream												
64 (Downstream)												



mining & reclamation services

434 SPRING STREET EXT.
MARS, PA 16046
www.biomost.com

SCALE: 0 20' 40'

LATITUDE: 41.099853
LONGITUDE: -79.841692

DATE: 12/08/2023

SR101 A PASSIVE TREATMENT SYSTEM

SITE SCHEMATIC

DRAWING NUMBER: 1 of 1

PASSIVE TREATMENT SYSTEM O&M INSPECTION REPORT

Rev 12/2023

Inspection Date:	______	Project Name:	**SR101A**
Inspected by:	______	Municipality:	**Washington Township**
Organization:	______	County:	**Butler** State: **PA**
Time Start: ______	End: ______	Project Coordinates:	**41° 05' 58"** Lat **79° 50' 30"** Long
Receiving Stream:	**Slippery Rock Creek**	Sub-watershed:	**Slippery Rock** Watershed: **Slippery Rock**

Weather (circle one): Snow Heavy Rain Rain Light Rain Overcast Fair/Sunny **Temp (°F):** ≤32 33-40 41-50 51-60 60+

Is maintenance required? Yes/No If yes, provide explanation: ______

______

______

INSPECTION SUMMARY

A. Site Vegetation

Overall condition of vegetation on site: 0 1 2 3 4 5 (0=poor, 5=excellent, circle one) (See instructions.)

Is any reseeding required? Yes/No If yes, describe area size and identify location on Site Schematic: ______

______

______

B. Site Access and Parking

Is the access road passable for operation and monitoring? Yes/No?
Does the access road need maintenance? Yes/No?
Describe maintenance performed and remaining (Identify location on Site Schematic.): ______

______

______

C. Vandalism and "Housekeeping"

Is there litter around or in the passive system? Yes/No? If Yes, was the litter picked up? Yes/No?
Is there litter that may be considered hazardous or dangerous that requires special disposal? ? Yes/No?
Is there evidence of vandalism to the passive system? Yes/No?
Additional comments: ______

D. Ditches, Channels, Spillways

Channel Identification	Erosion Rills (Y/N)	Debris Present (Y/N)	Maintenance Performed (Y/N)	Maintenance Performed and Remaining (Indicate spillway by number i.e. 1b = Wetland 1)
1. Rock-Lined Spillways				
a. Settling Pond				
b. Wetland 1				
c. Wetland 2				
2. Diversion Ditch				
3. Emergency Spillway				
a. Sludge Pond				

E. Passive Treatment System Components

Component	Erosion Rills (Y/N)	Berms Stable (Y/N)	Vegetation Successful (Y/N)	Siltation Significant (Y/N)	Water Level Change (Y/N)	Maintenance Performed and Remaining Indicate which component i.e. SP
Anoxic Limestone Drain						
Settling Pond						
Wetland 1						
Wetland 2						
Sludge Pond						

Additional Comments/ Maintenance Performed or Needed: ____

____
____
____
____

F. Wildlife Utilization

Animals sighted or tracks observed ____

Invasive plants observed ____

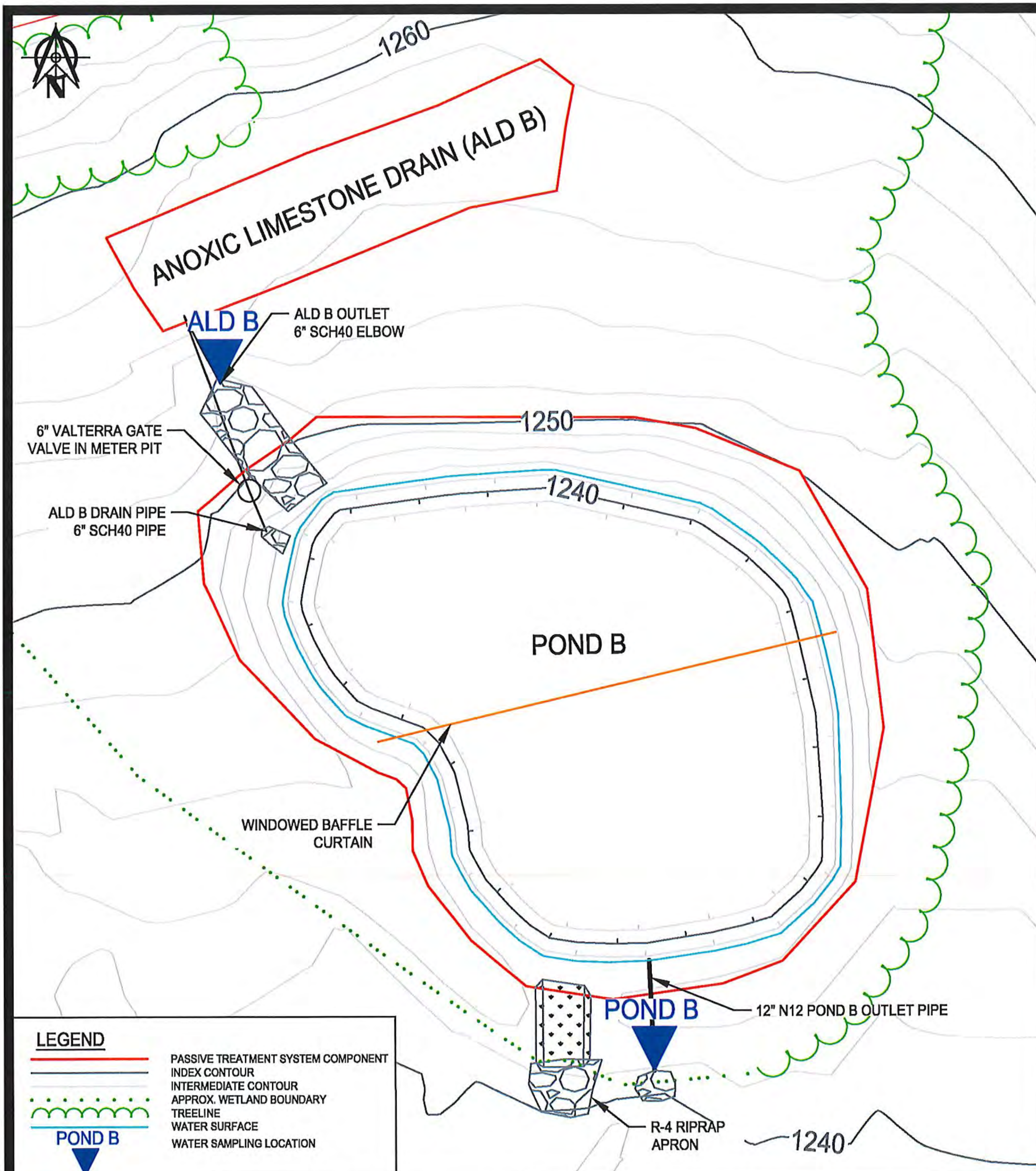
Describe any damage caused to treatment system by wildlife (especially muskrats) and required maintenance: ______________________________

____
____

G. Field Water Monitoring and Sample Collection - Raw water sample locations as marked on plan. For passive components sample effluent.

[shaded box] **-** Not monitored

Sampling Point	Flow		pH	Temp (°C)	ORP	Alkalinity (mg/L)	DO (mg/L)	Iron (mg/L)	Comments	Bottle #	Bottle # (total metals)	Bottle # (diss. metals)
	gals	sec.										
ALD												
Settling Pond	[shaded]	[shaded]										
Wetland 1	[shaded]	[shaded]										
Wetland 2	[shaded]	[shaded]										
46 (Upstream)	[shaded]	[shaded]										
60 (Downstream)	[shaded]	[shaded]										



mining & reclamation services
434 SPRING STREET EXT.
MARS, PA 16046
www.biomost.com

SCALE:
0 15' 30'

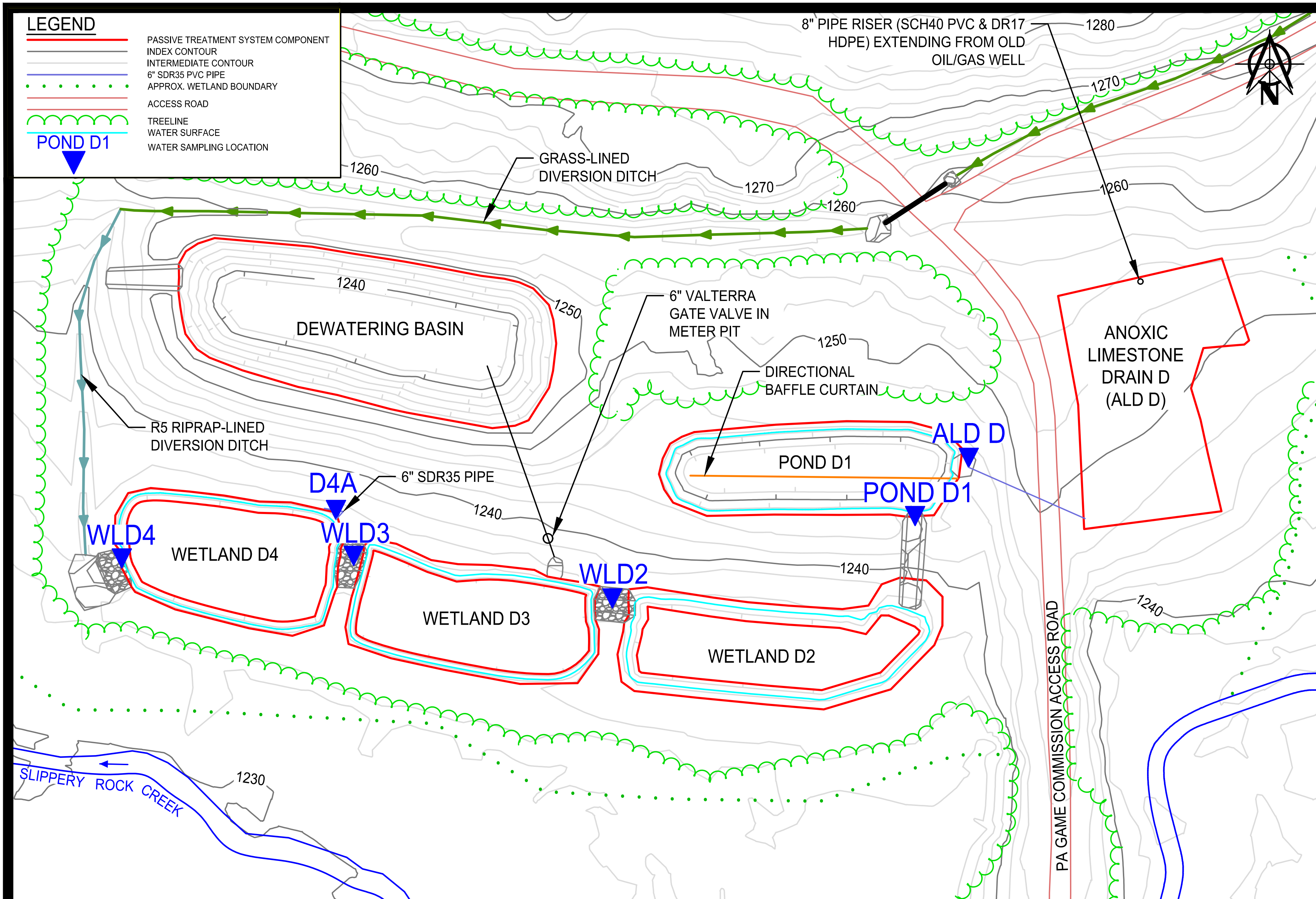
LATITUDE: 41.095097
LONGITUDE: -79.826869

DATE: 12/08/2023

SR114 B PASSIVE TREATMENT SYSTEM

SITE SCHEMATIC

DRAWING NUMBER:
1 of 1



mining & reclamation services
434 SPRING STREET EXT.
MARS, PA 16046
www.biomost.com

SCALE: 0 — 35' — 70'

LATITUDE: 41.095097
LONGITUDE: -79.826869

SR114 D PASSIVE TREATMENT SYSTEM

DATE: 12/11/2023

SITE SCHEMATIC

DRAWING NUMBER: 1 of 1

PASSIVE TREATMENT SYSTEM O&M INSPECTION REPORT

Rev.12/2023

Inspection Date: ____________		Project Name:	**SR 114B and SR114D**
Inspected by: ____________		Municipality:	**Washington Township**
Organization: ____________		County:	**Butler** State: **PA**
Time Start: ______	End: ______	Project Coordinates:	**41°05'43"** Lat **79°49'37"** Long
Receiving Stream:	**Slippery Rock Creek**	Sub-watershed:	**Slippery Rock** Watershed: **Slippery Rock**

Weather (circle one): Snow Heavy Rain Rain Light Rain Overcast Fair/Sunny **Temp (°F):** $\leq$32 33-40 41-50 51-60 60+

Is maintenance required? Yes/No If yes, provide explanation: ____________________

____

____

INSPECTION SUMMARY

A. Site Vegetation

Overall condition of vegetation on site: 0 1 2 3 4 5 (0=poor, 5=excellent, circle one) (See instructions.)

Is any reseeding required? Yes/No If yes, describe area size and identify location on Site Schematic: ____________________

____

____

B. Site Access and Parking

Is the access road passable for operation and monitoring? Yes/No?
Does the access road need maintenance? Yes/No?
Describe maintenance performed and remaining (Identify location on Site Schematic.): ____________________

____

____

C. Vandalism and "Housekeeping"

Is there litter around or in the passive system? Yes/No? If Yes, was the litter picked up? Yes/No?
Is there litter that may be considered hazardous or dangerous that requires special disposal? ? Yes/No?
Is there evidence of vandalism to the passive system? Yes/No?
Additional comments: ____________________

D. Ditches, Channels, Spillways

Channel Identification	Erosion Rills (Y/N)	Debris Present (Y/N)	Maintenance Performed (Y/N)	Maintenance Performed and Remaining (Indicate spillway by number i.e. 1c = Wetland D2)
1. Spillways				
a. ALD D				
b. Pond D1				
c. Wetland D2				
d. Wetland D3				
e. Wetland D4				
f. Dewatering Basin				
g. ALD B				
h. Pond B				
2. Emergency Spillways				
a. Dewatering Basin				
b. Pond B				
3. Diversion Ditch				
a. SR114 B				
b. SR114 D				

E. Passive Treatment System Components

Component	Erosion Rills (Y/N)	Berms Stable (Y/N)	Vegetation Successful (Y/N)	Siltation Significant (Y/N)	Water Level Change (Y/N)	**Maintenance Performed and Remaining** Indicate which component i.e. ALD
ALD D						
Pond D1						
Wetland D2						
Wetland D3						
Wetland D4						
Dewatering Basin						
ALD B						
Pond B						

Other maintenance conducted or needed (such as baffle curtain): ______________________________

____

____

____

F. Wildlife Utilization

Animals sighted or tracks observed ______________________________

Invasive plants observed ______________________________

Describe any damage caused to treatment system by wildlife (especially muskrats) and required maintenance: ______________________________

____

____

G. Field Water Monitoring and Sample Collection - Raw water sample locations as marked on plan. For passive components sample effluent.

☐ - Not monitored

Sampling Point	Flow		pH	Temp (°C)	ORP	Alkalinity (mg/L)	DO (mg/L)	Iron (mg/L)	Comments	Bottle #	Bottle # (total metals)	Bottle # (diss. metals)
	gals	sec.										
ALD D												
Pond D1												
Wetland D2												
Wetland D3												
D4A												
Wetland D4												
ALD B												
Pond B												
44 (Upstream)												
46 (Downstream)												

Appendix 4

As-Built Plans and Details

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)]. Roads and surface water features from PASDA breakline features.
2. The entirety of the project is located on Pennsylvania Game Commission Property, Gamelands No. 95.
3. All dimensions are in feet unless otherwise noted. All slope designations are H:V.
4. As-Built plan based on survey by BioMost, Inc. on 11/7/2023 with survey-grade GPS.

BioMost, Inc. Mining & Reclamation Services 434 Spring Street Ext. Mars, PA 16046 www.biomost.com	CLIENT: STREAM RESTORATION INC. SLIPPERY ROCK, PA (724)-279-5080 www.streamrestorationinc.org				

REVISIONS

NO.	BY	DATE	DESCRIPTION
1	LVH	01/29/2024	Title of Project

SIGNATURE / DATE

SUBMITTED BY:

CODY A. NEELY, P.E.
PROJECT DESIGNER - BioMost, Inc.

DATE: 12/01/2023	LAT: 41.1024622 LONG:-79.8565173	SCALE: 1" = 30' (30' 15' 0 30') UNLESS OTHERWISE NOTED
DRAWN BY: LVH	CHECKED BY: TPD	
ACAD FILE NAME: 2592 - FerrisAB.dwg		

ALL EXISTING CONDITIONS SHALL BE CHECKED AND VERIFIED BY THE CONTRACTOR AT THE SITE AS APPLICABLE

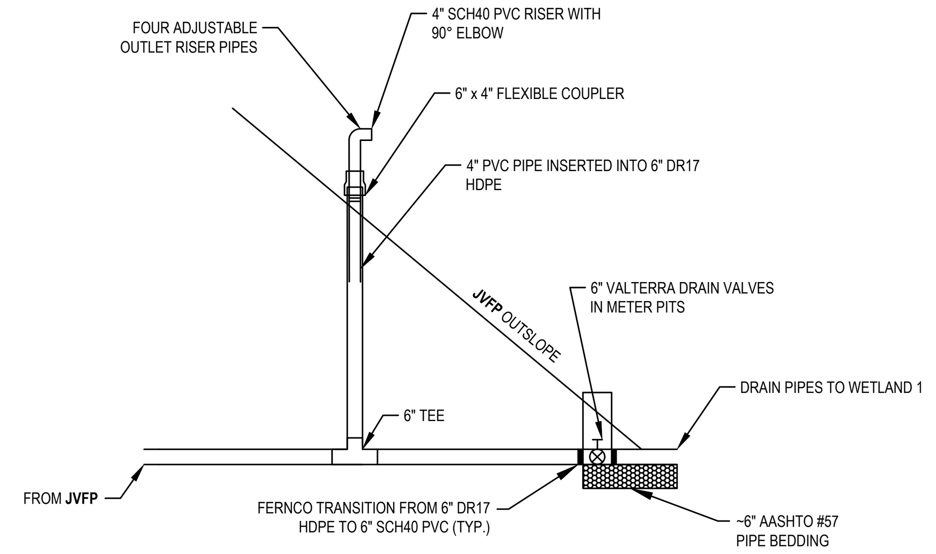
Ferris SR85/86 Rehabilitation Project
As-Built

VENANGO TOWNSHIP

BUTLER COUNTY/PA

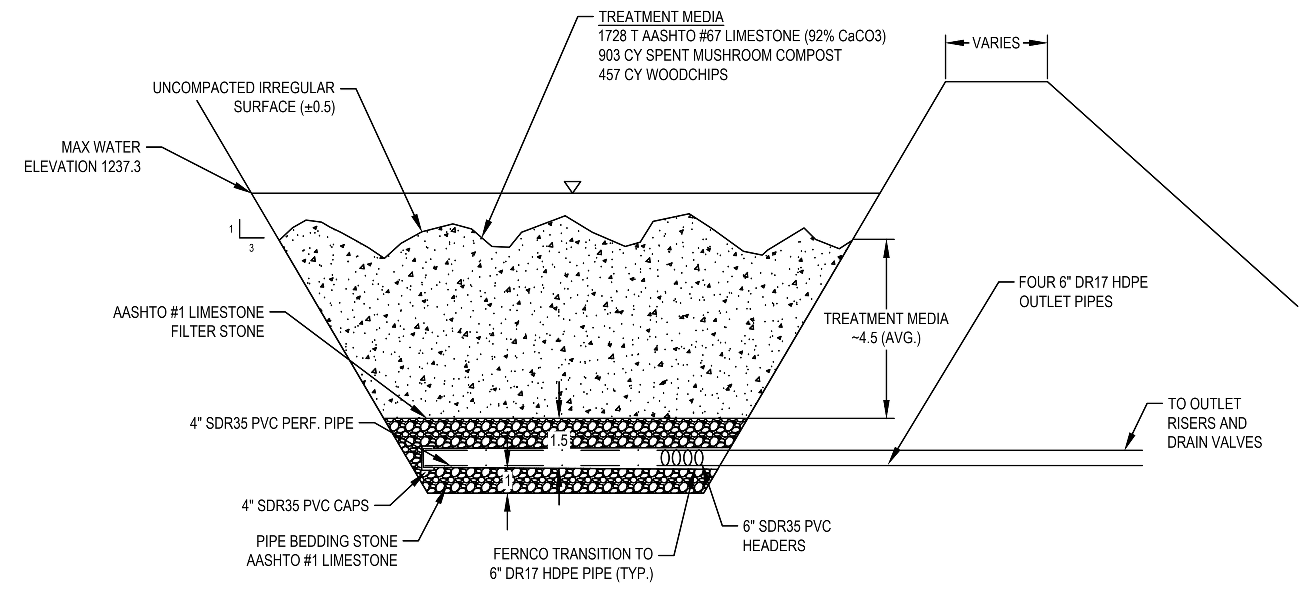
PLAN VIEW

DRAWING NUMBER: 1 of 2



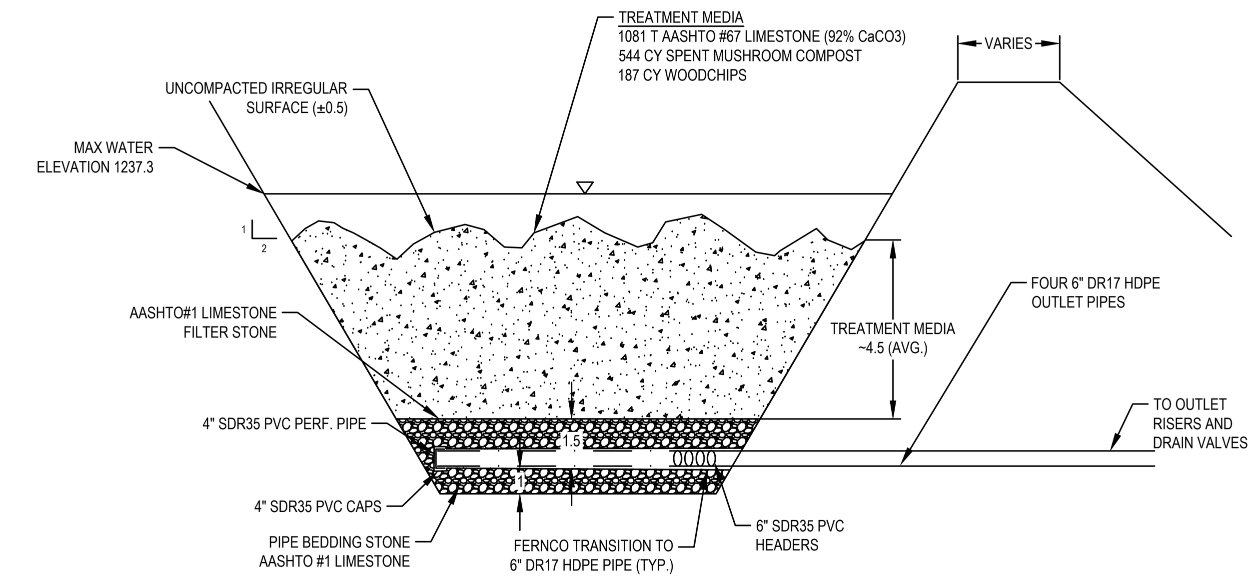
JVFP OUTLET PIPING (TYP.)

Horizontal Scale: None Vertical Scale: None



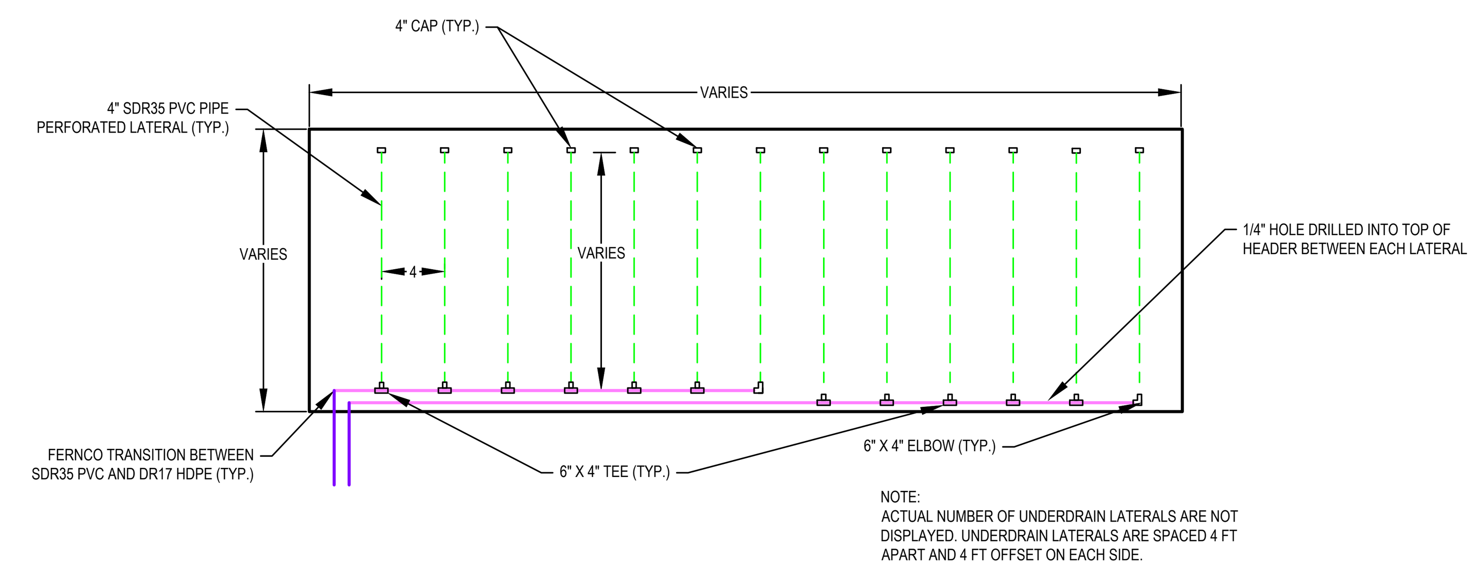
JENNINGS-TYPE VERTICAL FLOW POND (JVFP) WEST

Horizontal Scale: None Vertical Scale: None



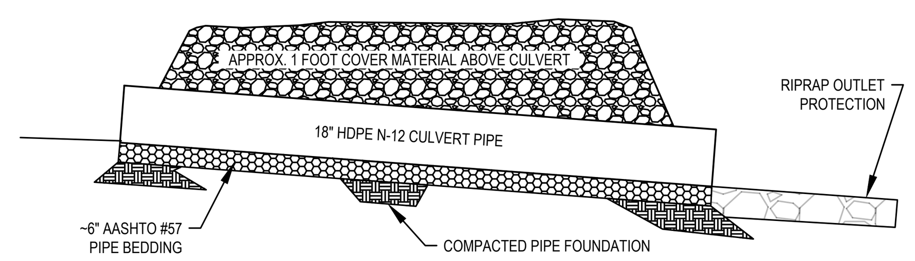
JENNINGS-TYPE VERTICAL FLOW POND (JVFP) EAST

Horizontal Scale: None Vertical Scale: None



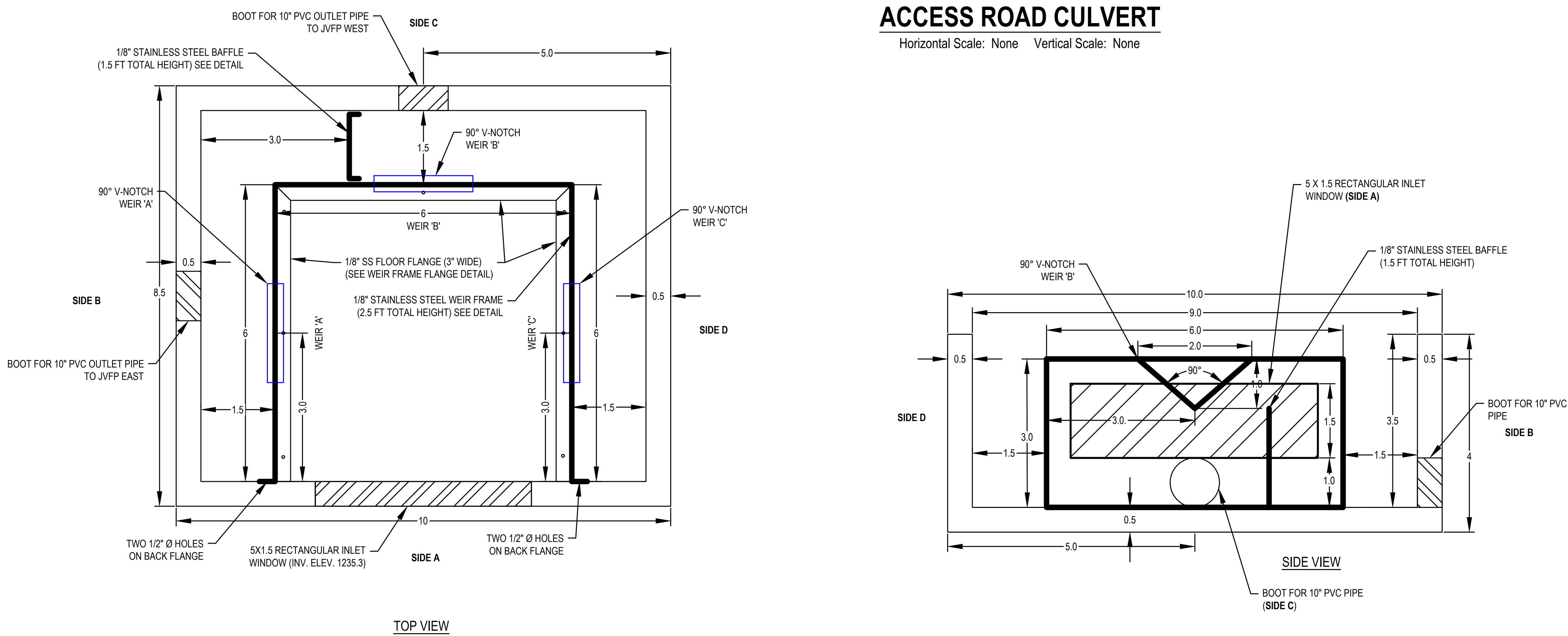
JVFP UNDERDRAIN PIPING SCHEMATIC (TYP.)

Horizontal Scale: None Vertical Scale: None



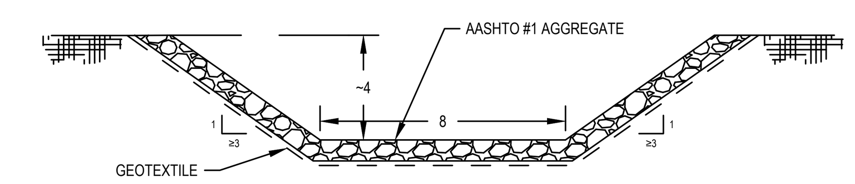
ACCESS ROAD CULVERT

Horizontal Scale: None Vertical Scale: None



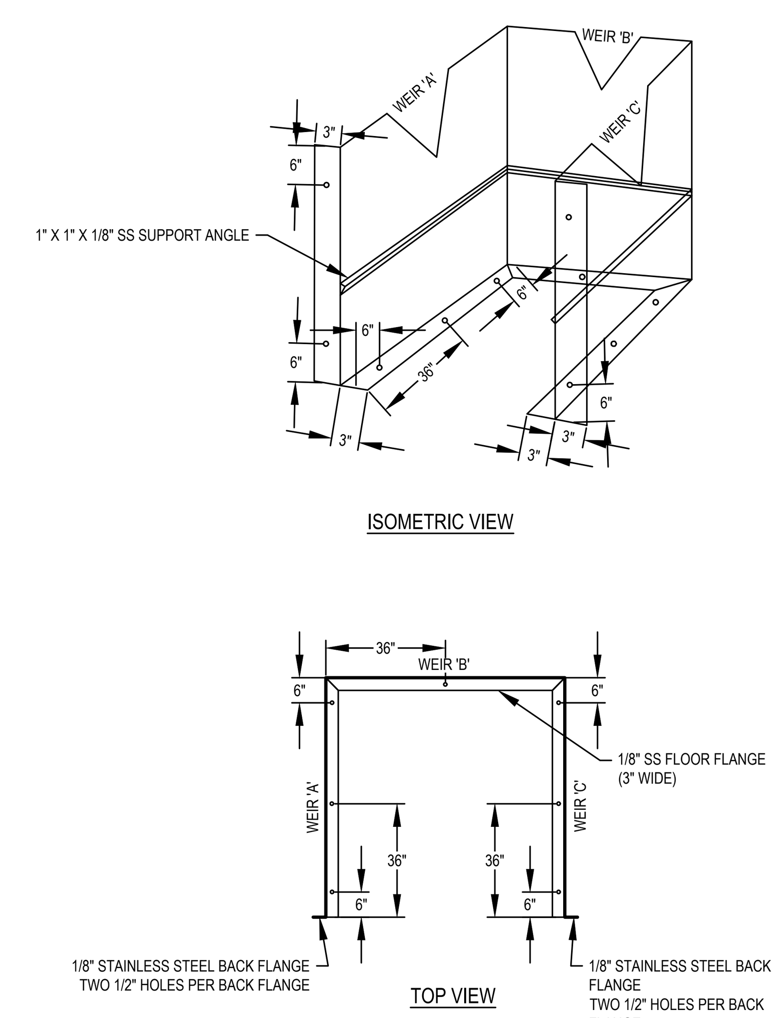
FLOW SPLITTER BOX

Horizontal Scale: None Vertical Scale: None



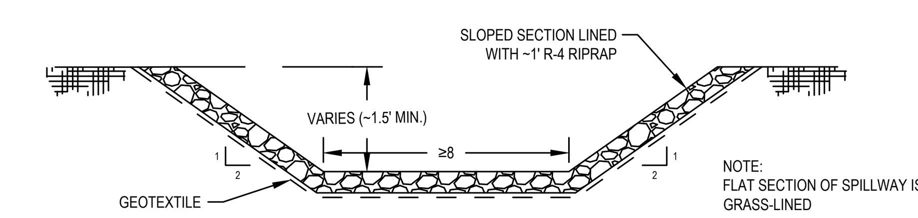
WETLAND OUTLET CHANNEL

Horizontal Scale: None Vertical Scale: None



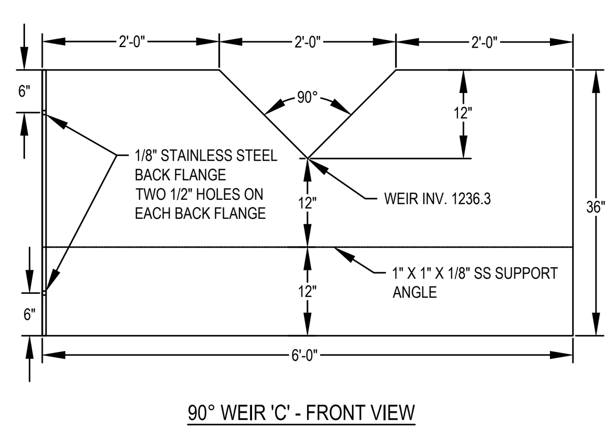
WEIR FRAME FLANGES

Horizontal Scale: None Vertical Scale: None



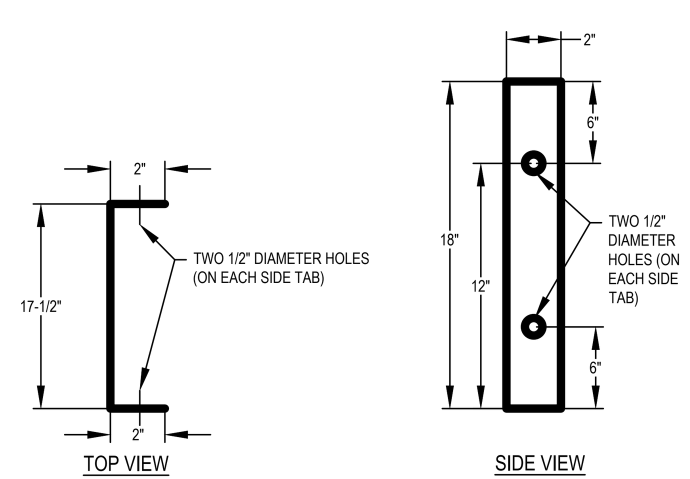
EMERGENCY SPILLWAY AND OUTLET CHANNEL

Horizontal Scale: None Vertical Scale: None



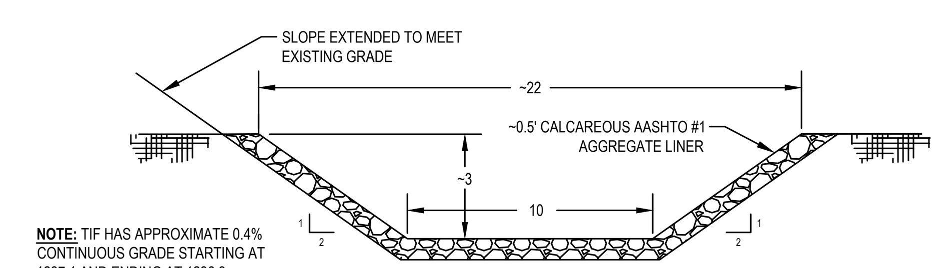
V-NOTCH WEIR CUTOUTS (90°) ON WEIR FRAME

Horizontal Scale: None Vertical Scale: None



STAINLESS STEEL BAFFLES

Horizontal Scale: None Vertical Scale: None



TERRACED IRON FORMATION (TIF)

Horizontal Scale: None Vertical Scale: None

BioMost, Inc.
Mining & Reclamation Services
434 Spring Street Ext.
Mars, PA 16046
www.biomost.com

CLIENT:
STREAM RESTORATION INC.
SLIPPERY ROCK, PA
(724)-279-5080
www.streamrestorationinc.org

NO.	BY	DATE	DESCRIPTION
1	LVH	01/29/2024	Title of Project

REVISIONS

SIGNATURE / DATE
SUBMITTED BY:
CODY A. NEELY, P.E.
PROJECT DESIGNER - BioMost, Inc.

DATE: 12/01/2023 | LAT: 41.1024622 LONG:-79.8565173 | SCALE: NO SCALE UNLESS OTHERWISE NOTED
DRAWN BY: LVH | CHECKED BY: TPD
ACAD FILE NAME: 2592 - FerrisAB.dwg

ALL EXISTING CONDITIONS SHALL BE CHECKED AND VERIFIED BY THE CONTRACTOR AT THE SITE AS APPLICABLE

Ferris SR85/86 Rehabilitation Project
As-Built

VENANGO TOWNSHIP BUTLER COUNTY/PA

DETAILS

DRAWING NUMBER:

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)]. Roads and surface water features from PASDA breakline features.
2. The entirety of the project is located on Pennsylvania Game Commission Property, Gamelands No. 95.
3. All dimensions are in feet unless otherwise noted. All slope designations are H:V.
4. Wetlands shown include only areas delineated by BioMost, Inc. personnel. Please refer to Wetland Report for additional information and mapping.
5. Effluent samples should be taken where flowing water is noted on downstream side of distribution berm nearest to sample point (NWL) show on this map.
5. More information may be obtained from As-Built prepared by BioMost, Inc., 2004, for Stream Restoration Incorporated. Note that vertical datum on this plan is 2.3 feet higher than 2004 As-built.

LEGEND

- EXISTING INDEX CONTOUR
- EXISTING INTERMEDIATE CONTOUR
- AS-BUILT INDEX CONTOUR
- AS-BUILT INTERMEDIATE CONTOUR
- AS-BUILT COMPONENT
- EXISTING DITCH
- EX. 6" SCH40 PVC PIPE
- 6" SCH40 PVC PIPE
- 6" SDR35 PVC PIPE (SOLID)
- 6" SDR35 PVC PIPE (PERF.)
- 8" N12 PIPE
- WATERLINE
- NORTH COUNTY TRAIL
- WETLAND BOUNDARY
- EX. ROADS
- UTILITY LINES
- TREELINE
- ROCK DISTRIBUTION BERM
- NATURAL WETLAND
- ALD — WATER MONITORING LOCATION
- PROPOSED ROCK-LINED SPILLWAY

BioMost, Inc.
Mining & Reclamation Services
434 Spring Street Ext.
Mars, PA 16046
www.biomost.com

CLIENT:
STREAM RESTORATION INC.
SLIPPERY ROCK, PA
(724)-279-5080
www.streamrestorationinc.org

NO.	BY	DATE	DESCRIPTION

REVISIONS

SIGNATURE / DATE
SUBMITTED BY:
CODY A. NEELY, P.E.
PROJECT DESIGNER - BioMost, Inc.

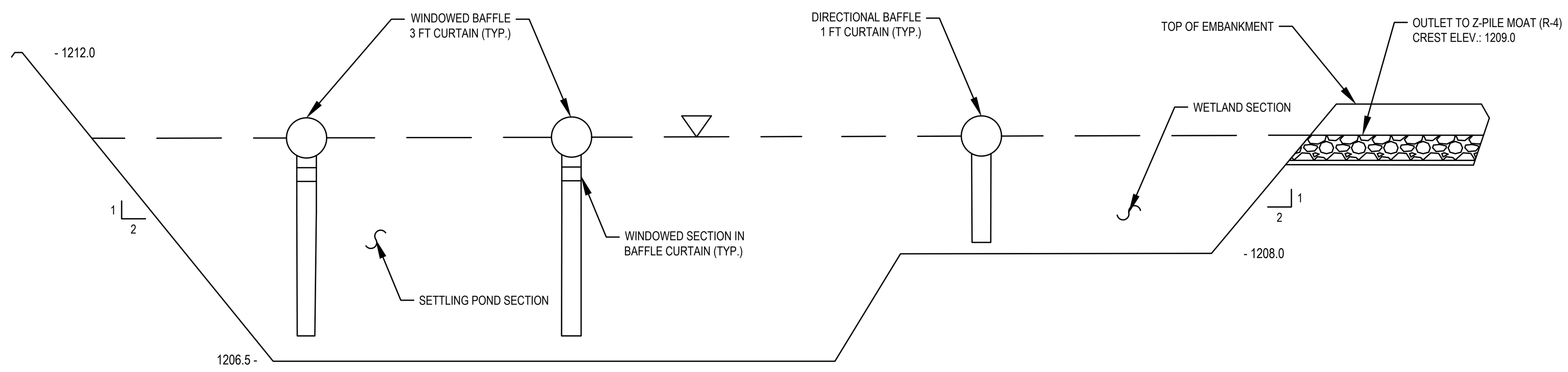
DATE: 12/01/2023
LATITUDE: 41.09803611
LONGITUDE: -79.86025556
SCALE: 1" = 30'
30' 15' 0 30'
DRAWN BY: LVH
CHECKED BY: TPD
ACAD FILE NAME: 2592 - SR81AB.dwg

SR81 Rehabilitation Project As-Built

Washington Township
Butler County, PA

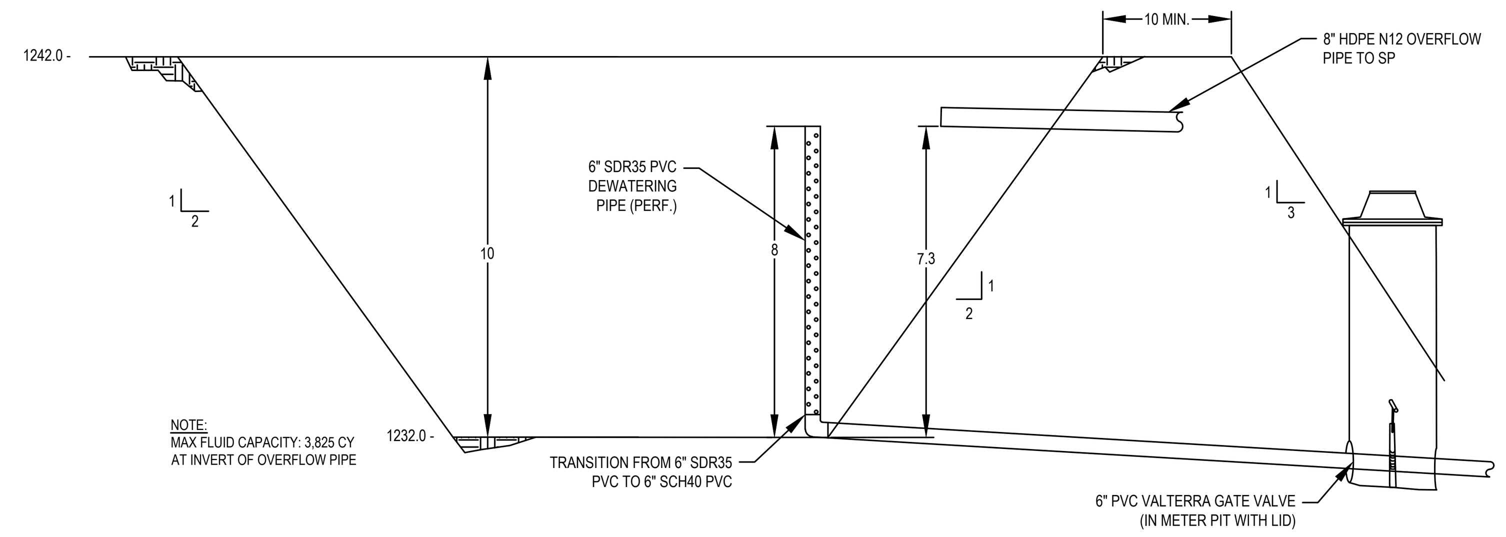
PLAN VIEW

DRAWING NUMBER: 1 of 2



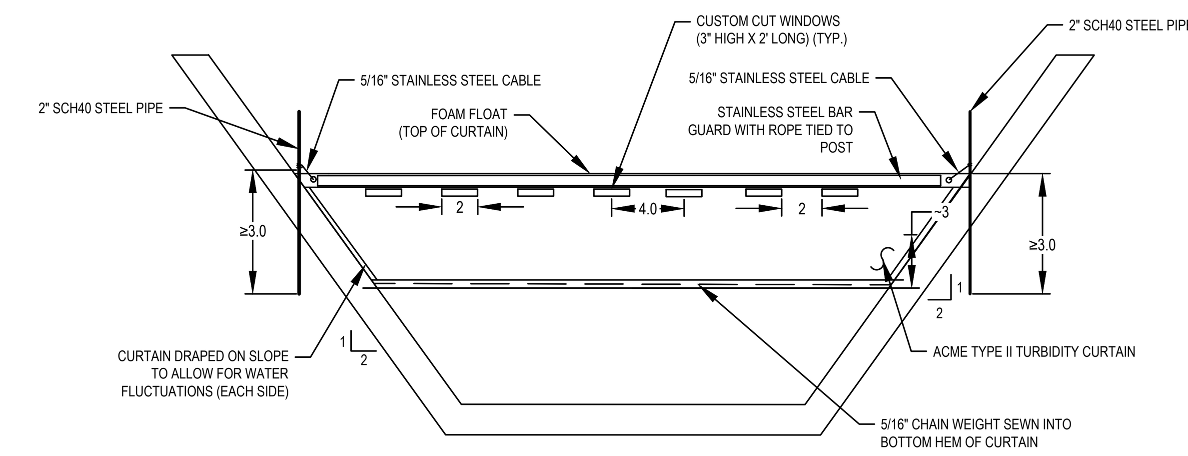
SETTLING POND & WETLAND

Horizontal Scale: None Vertical Scale: None



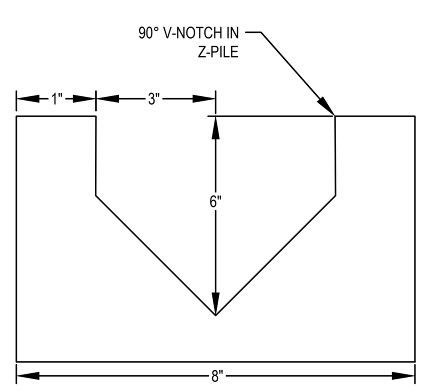
DEWATERING BASIN DETAIL

Horizontal Scale: None Vertical Scale: None



WINDOWED BAFFLE CURTAIN DETAIL

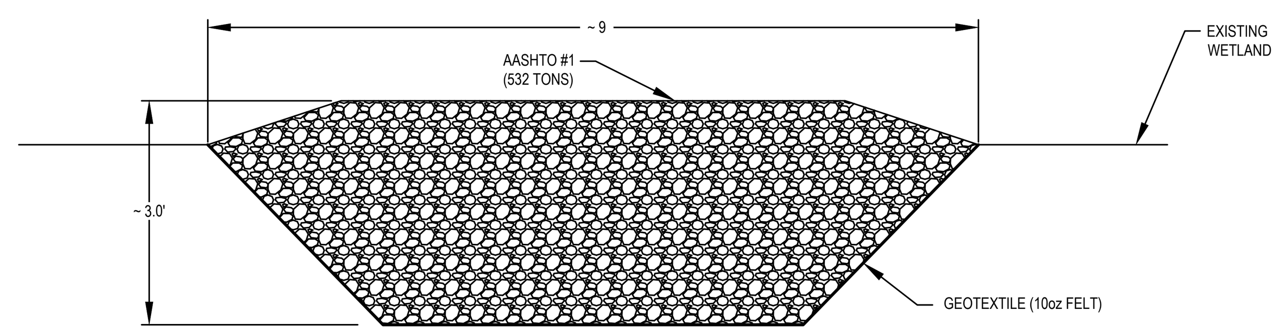
Horizontal Scale: None Vertical Scale: None



Z-PILE V-NOTCH

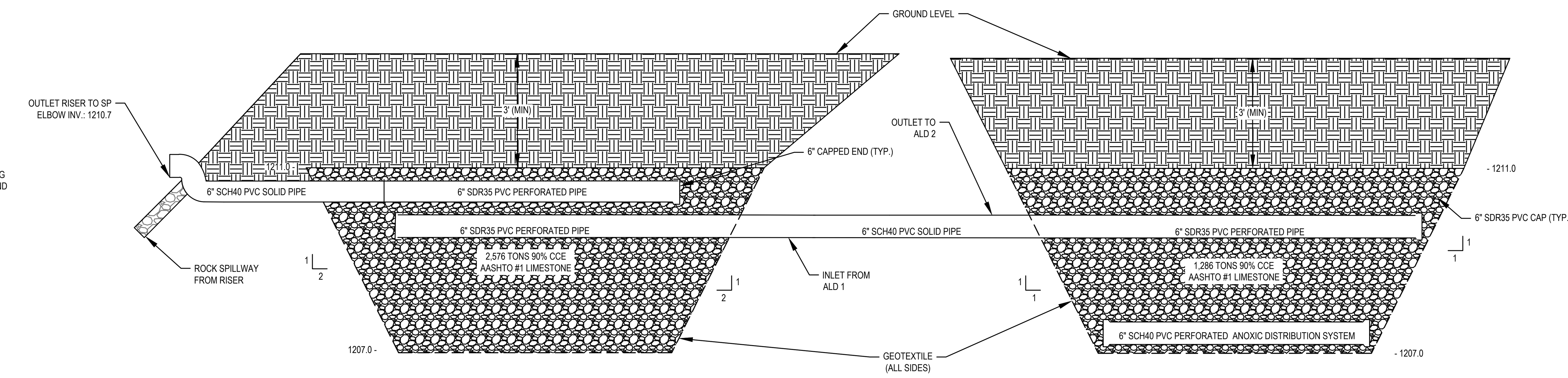
Horizontal Scale: None Vertical Scale: None

NOTE:
-V-NOTCH CUT EVERY 8 PIECES AND ON THE FRONT FACING SECTION OF THE Z-PILE



DISTRIBUTION BERM DETAIL

Horizontal Scale: None Vertical Scale: None

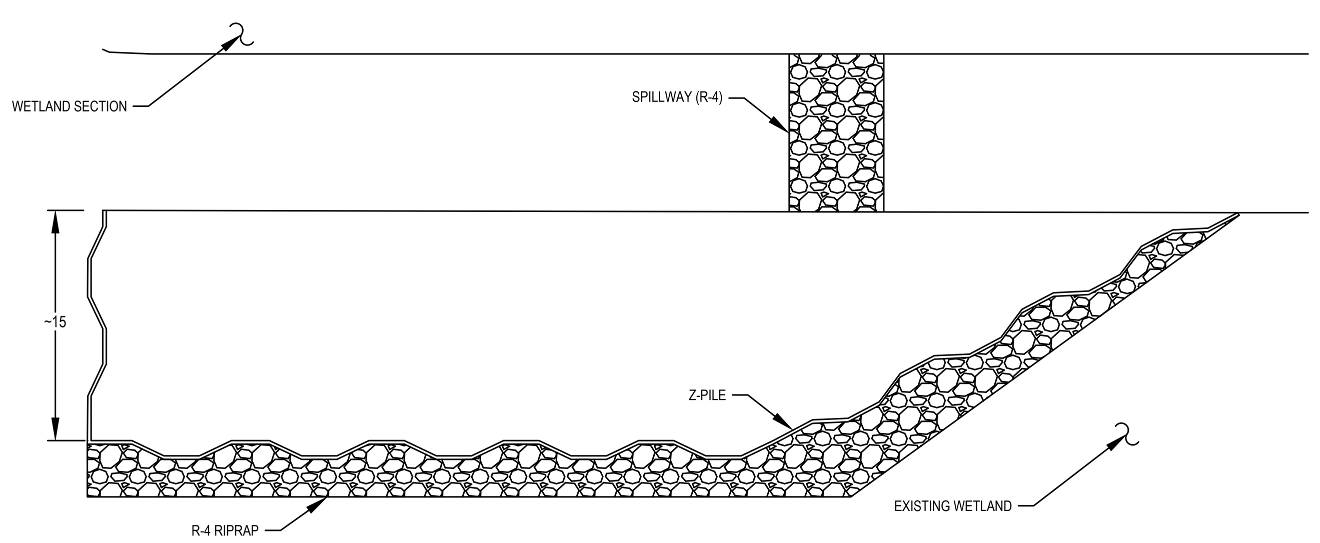


ALD 2 SECTION VIEW

Horizontal Scale: None Vertical Scale: None

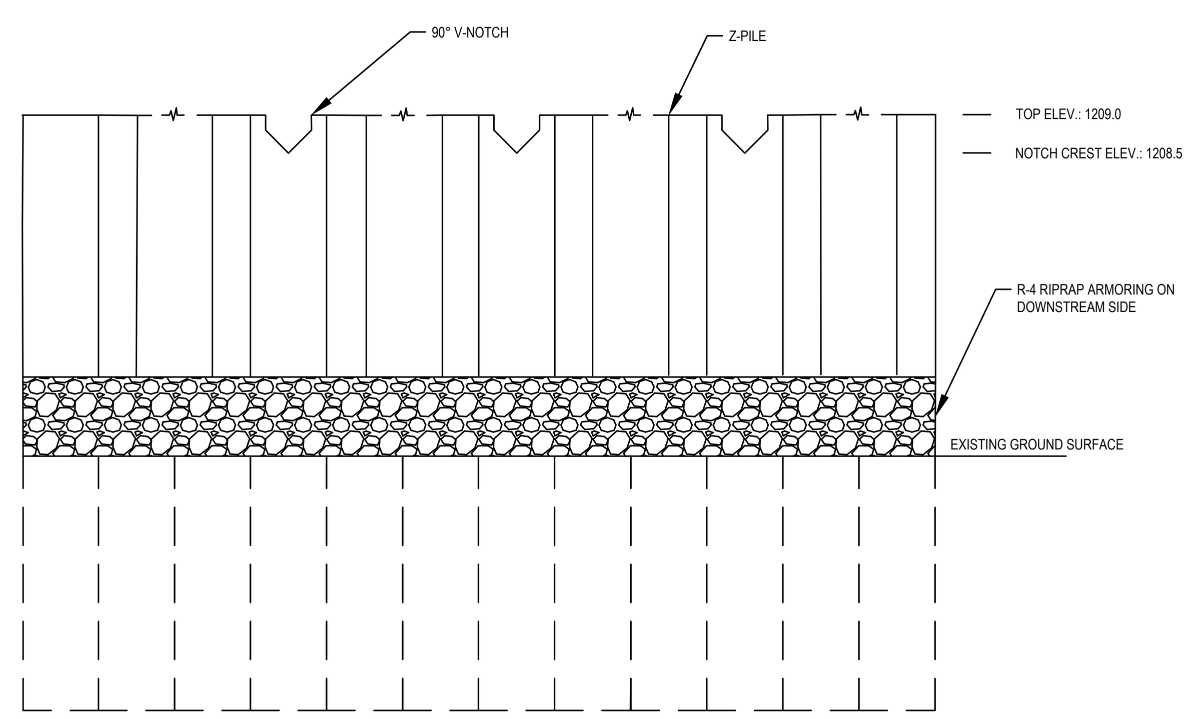
ALD 1 SECTION VIEW

Horizontal Scale: None Vertical Scale: None



Z-PILE MOAT (TOP VIEW)

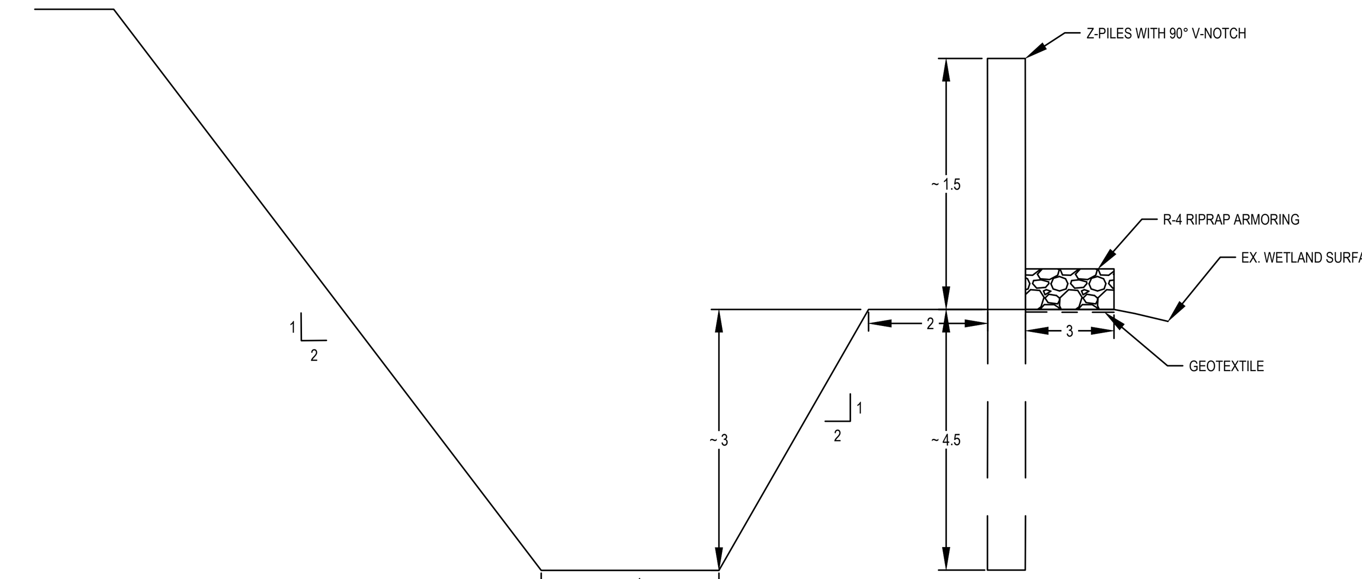
Horizontal Scale: None Vertical Scale: None



Z-PILE MOAT (FRONT VIEW)

Horizontal Scale: None Vertical Scale: None

NOTE:
TIDEWALL TW-25 Z-PILE USED AND PUSHED TO REFUSAL APPROX. 3.5 FT. AND CUT TO APPROX. TOP ELEV. INDICATED



Z-PILE MOAT (SIDE VIEW)

Horizontal Scale: None Vertical Scale: None

BioMost, Inc. Mining & Reclamation Services 434 Spring Street Ext. Mars, PA 16046 www.biomost.com	CLIENT: STREAM RESTORATION INC. SLIPPERY ROCK, PA (724)-279-5080 www.streamrestorationinc.org	

NO.	BY	DATE	DESCRIPTION

REVISIONS

SIGNATURE / DATE
SUBMITTED BY:
CODY A. NEELY, P.E.
PROJECT DESIGNER - BioMost, Inc.

DATE: 12/01/2023	LATITUDE: 41.09803611 LONGITUDE: -79.86025556	SCALE: NONE
DRAWN BY: LVH	CHECKED BY: TPD	
ACAD FILE NAME: 2592 - SR81AB.dwg		

SR81 Rehabilitation Project As-Built

Washington Township Butler County, PA

DETAILS

DRAWING NUMBER: 2 of 2

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)]. Roads and surface water features from PASDA breakline features.
2. The entirety of the project is located on Pennsylvania Game Commission Property, Gamelands No. 95.
3. All dimensions are in feet unless otherwise noted. All slope designations are H:V.
4. As-Built based on survey by BioMost, Inc., 11/07/2023 using survey-grade GPS.
5. More information may be obtained from As-Built prepared by BioMost, Inc., 1999, for Hedin Environmental, Inc. Elevation differences may be reconciled using ALD outlet invert elevation.

LEGEND

- EXISTING INDEX CONTOUR
- EXISTING INTERMEDIATE CONTOUR
- EXISTING TREATMENT COMPONENT
- EXISTING DIVERSION DITCH
- AS-BUILT INDEX CONTOUR
- AS-BUILT INTERMEDIATE CONTOUR
- TREATMENT COMPONENT
- 4" SDR35 PVC PIPE (SOLID)
- WATER
- TREELINE
- BENCHMARK
- WETLAND BOUNDARY
- UNPAVED ROAD
- NORTH COUNTY TRAIL

BioMost, Inc.
Mining & Reclamation Services
434 Spring Street Ext.
Mars, PA 16046
www.biomost.com

CLIENT:
STREAM RESTORATION INC.
SLIPPERY ROCK, PA
(724)-279-5080
www.streamrestorationinc.org

NO.	BY	DATE	DESCRIPTION

REVISIONS

SIGNATURE / DATE
SUBMITTED BY:
CODY A. NEELY, P.E.
PROJECT DESIGNER - BioMost, Inc.

DATE: 12/01/2023
LAT: 41.0995579,
LONG: -79.8418173
SCALE: 1" = 20'
20' 10' 0 20'
UNLESS OTHERWISE NOTED
DRAWN BY: LVH
CHECKED BY: TPD
ACAD FILE NAME: 2592 - SR101A AB.dwg
ALL EXISTING CONDITIONS SHALL BE CHECKED AND VERIFIED BY THE CONTRACTOR AT THE SITE AS APPLICABLE

SR101A Rehabilitation Project As-Built

WASHINGTON TWP. BUTLER CO., PA

PLAN VIEW & DETAIL

DRAWING NUMBER: 1 of 1

LIMESTONE QUANTITIES (TONS)	ALD D	ALD B
ORIGINALLY PLACED	1150	350
MEASURED REMAINING	573	148
ADDED	995	319
TOTAL	1568	467

LEGEND

- PASSIVE TREATMENT SYSTEM COMPONENT
- EXISTING INDEX CONTOUR
- EXISTING INTERMEDIATE CONTOUR
- AS-BUILT INDEX CONTOUR
- AS-BUILT INTERMEDIATE CONTOUR
- 4" SDR35 PVC PIPE (PERFORATED)
- 6" SDR35 PVC PIPE
- 6" SDR35 PVC PIPE (PERFORATED)
- APPROX. WETLAND BOUNDARY
- ACCESS ROAD
- TREELINE
- STREAM
- WATER SURFACE
- D1 D1 SECTION VIEW (SEE DETAIL)
- POND D1 WATER SAMPLING LOCATION

GENERAL NOTES:

1. Existing base map contours derived from a bare-earth digital elevation model constructed from LiDAR data (QL2) collected in Fall 2019/Spring 2020 by US Geologic Survey [PA State Plane - South (US Survey Foot) NAD83, Vertical datum - NAVD88)]. Select topographic and cultural features from 2018 Pennsylvania Emergency Management Agency (PEMA) 0.5-foot orthoimagery obtained from www.pasda.psu.edu. Additional information by BioMost, Inc. from limited 2021-2022 site investigations.
2. The bench mark elevations and as-built topographic lines are based off of GPS points taken by BioMost Inc., using a sub-centimeter grade, dual frequency JAVAD GPS unit.
3. Approximate wetland boundary shown was obtained from As-Built Plan, Passive Treatment System, Argentine Site, 11/95 by CDS Associates, Inc., prepared for Hedin Environmental.
4. Existing seep entering Wetland D4 was established as a new monitoring point: D4A.
5. All dimensions are in feet unless otherwise noted. All slope designations are H:V.
6. This As-Built drawing is a reasonable representation of the system as constructed, field verification of actual conditions is recommended.
7. Dewatering Basin capacity measured from bottom to the emergency spillway crest.
8. Remaining limestone quantity likely affected during excavation.

BioMost, Inc.
Mining & Reclamation Services
434 Spring Street Ext.
Mars, PA 16046
www.biomost.com

CLIENT:
STREAM RESTORATION INCORPORATED
PO BOX 837,
SLIPPERY ROCK, PA 16057

NO.	BY	DATE	DESCRIPTION

REVISIONS

SUBMITTED BY:
CODY A. NEELY, P.E.
PROJECT DESIGNER - BioMost, Inc.

DATE: 12/1/2023
LATITUDE: 41.095097
LONGITUDE:-79.826869
SCALE: 30' 15' 0 30'
UNLESS OTHERWISE NOTED
DRAWN BY: DMC
CHECKED BY: TPD
ACAD FILE NAME: SR114 As-Built.dwg

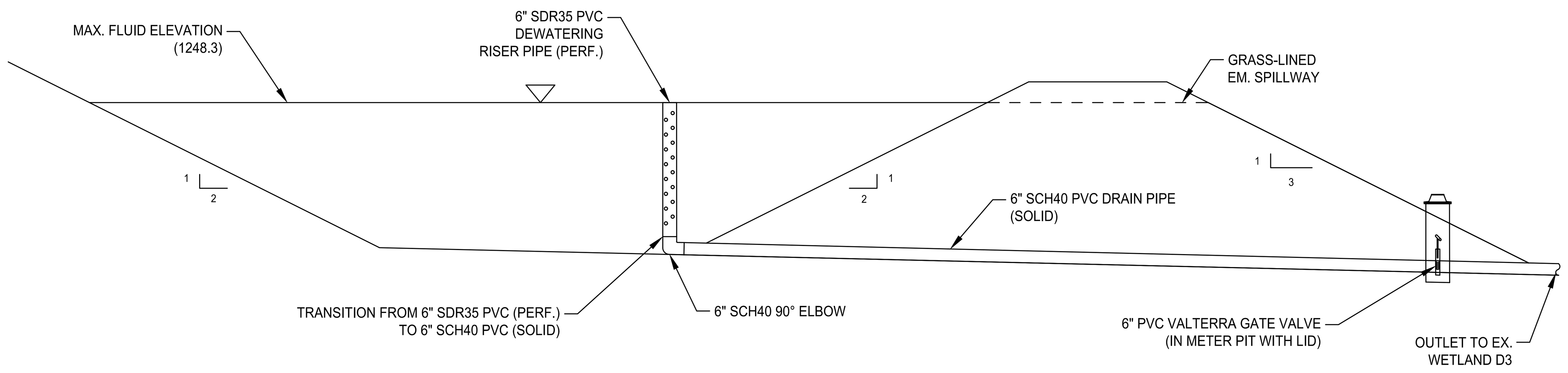
ALL EXISTING CONDITIONS SHALL BE CHECKED AND VERIFIED AT THE SITE PRIOR TO PERFORMING ANY MAINTENANCE WORK

SR114 Rehabilitation Project As-Built

WASHINGTON TOWNSHIP
BUTLER COUNTY

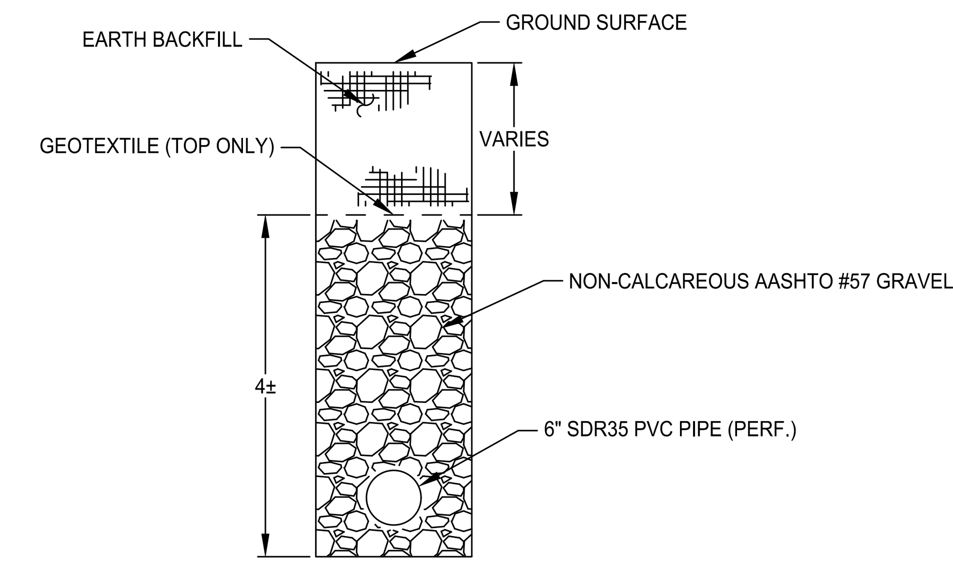
PLAN VIEW

DRAWING NUMBER:
1 of 2



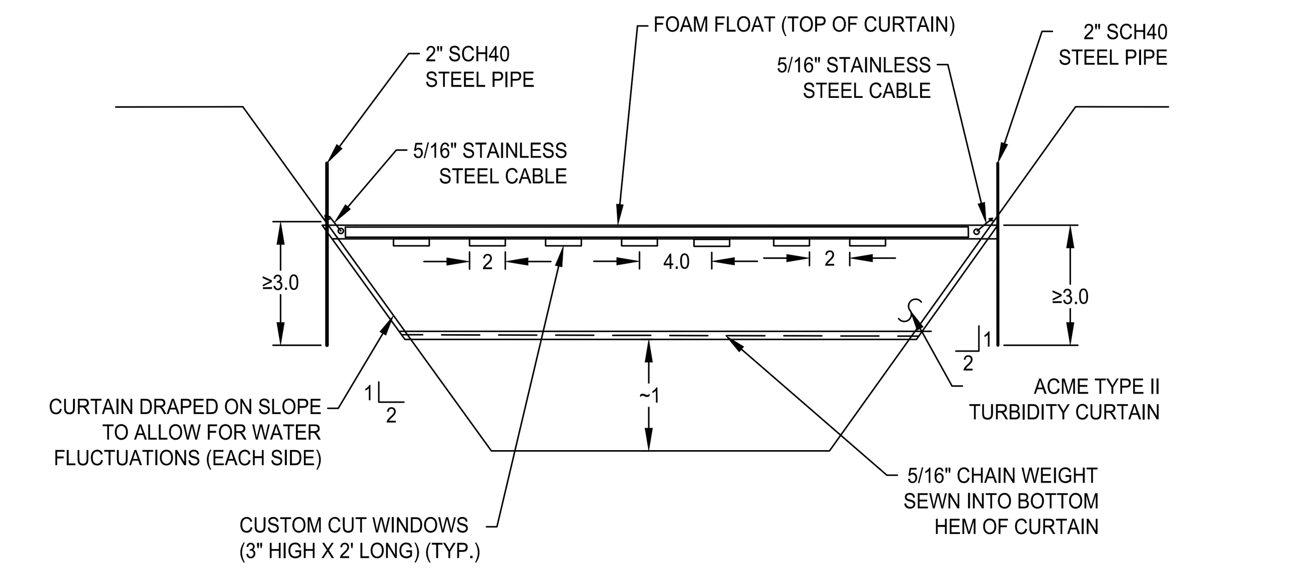
DEWATERING BASIN

Vertical Scale: None Horizontal Scale: None



ANOXIC COLLECTION SYSTEM (ACS)

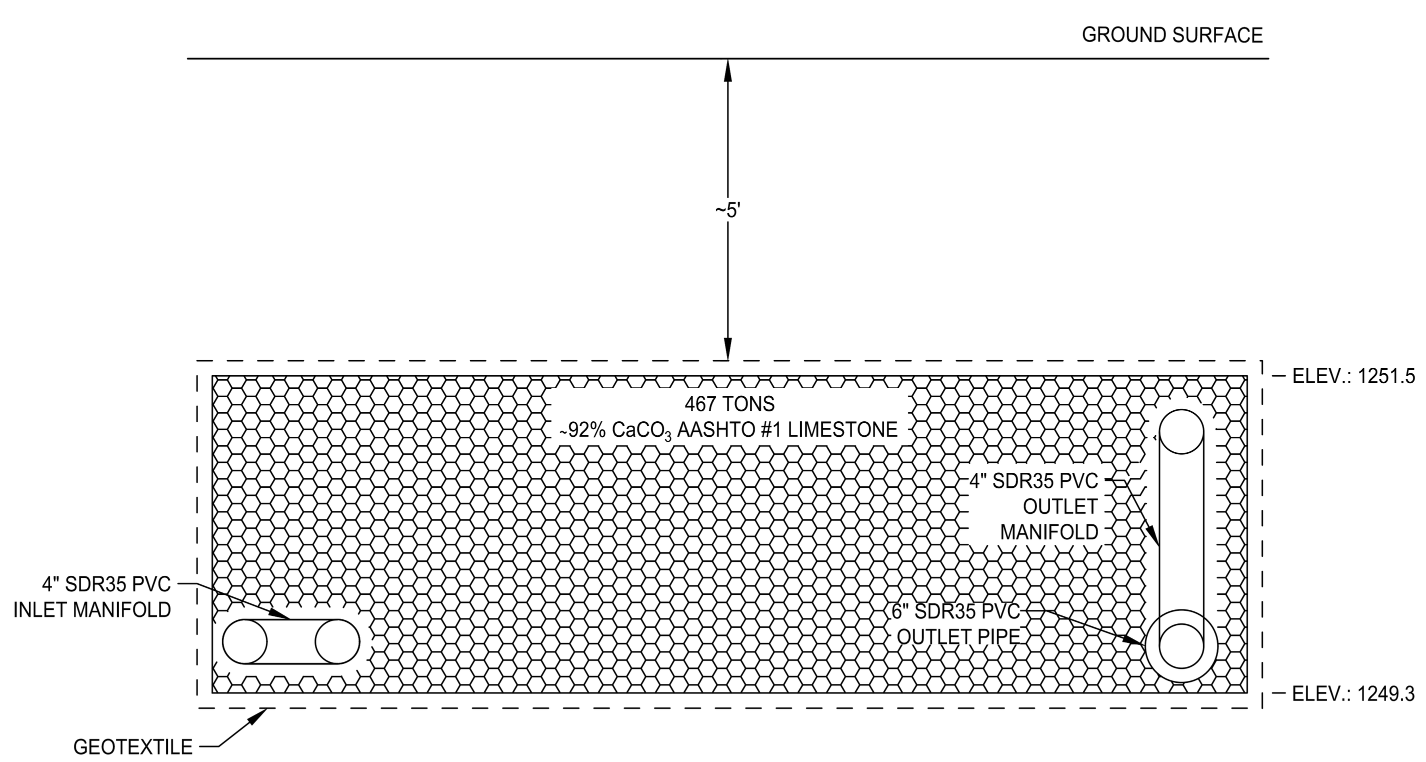
Vertical Scale: None Horizontal Scale: None



WINDOWED BAFFLE CURTAIN

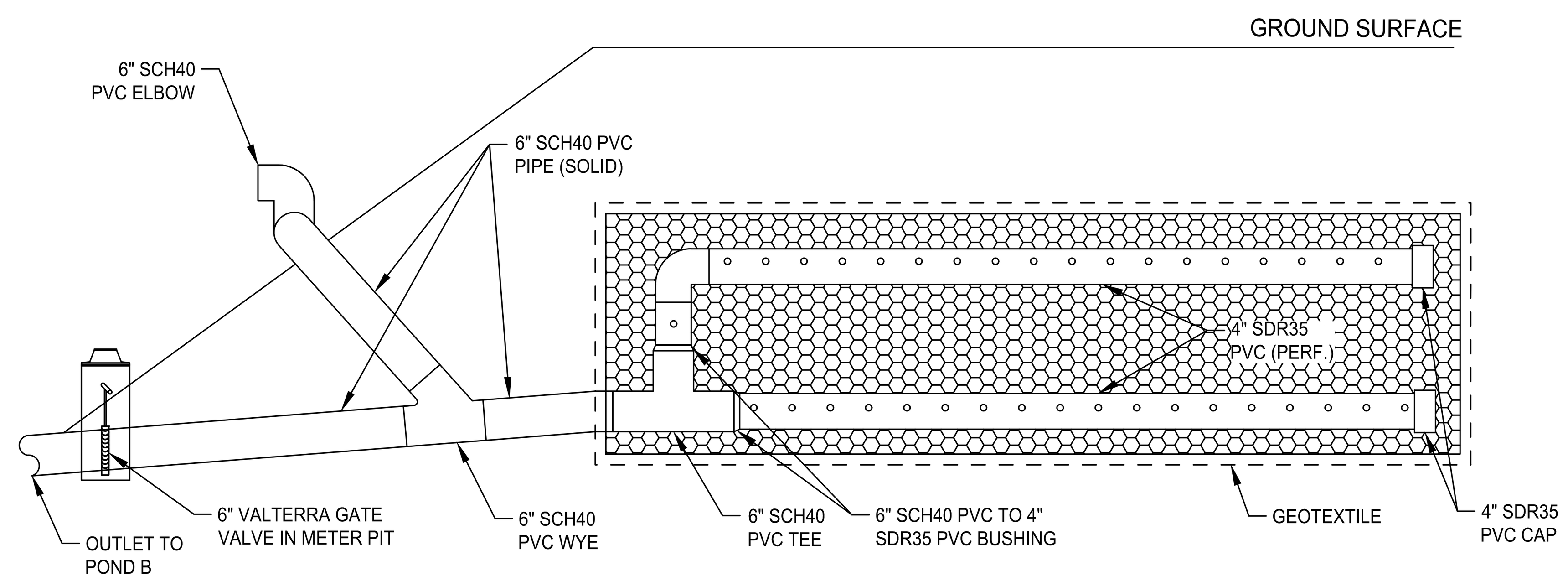
Horizontal Scale: None Vertical Scale: None

Note:
Pond D1 baffle curtain does not have windows cut into it, and does not extend across the entire pond (see plan view).



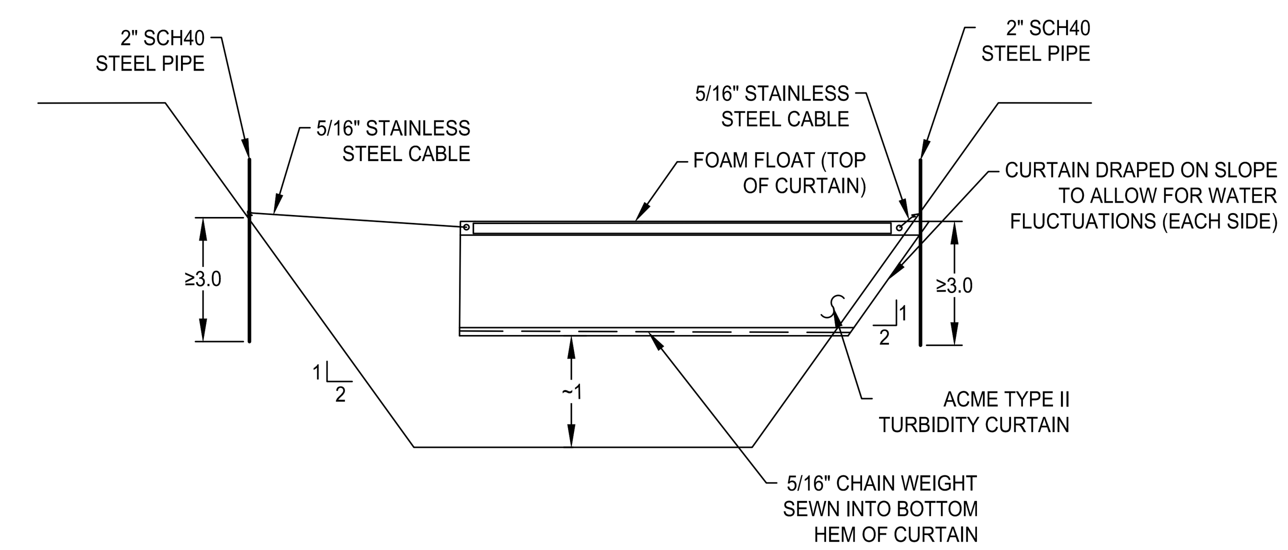
ANOXIC LIMESTONE DRAIN B (ALD B)
B1 SECTION VIEW

Vertical Scale: None Horizontal Scale: None



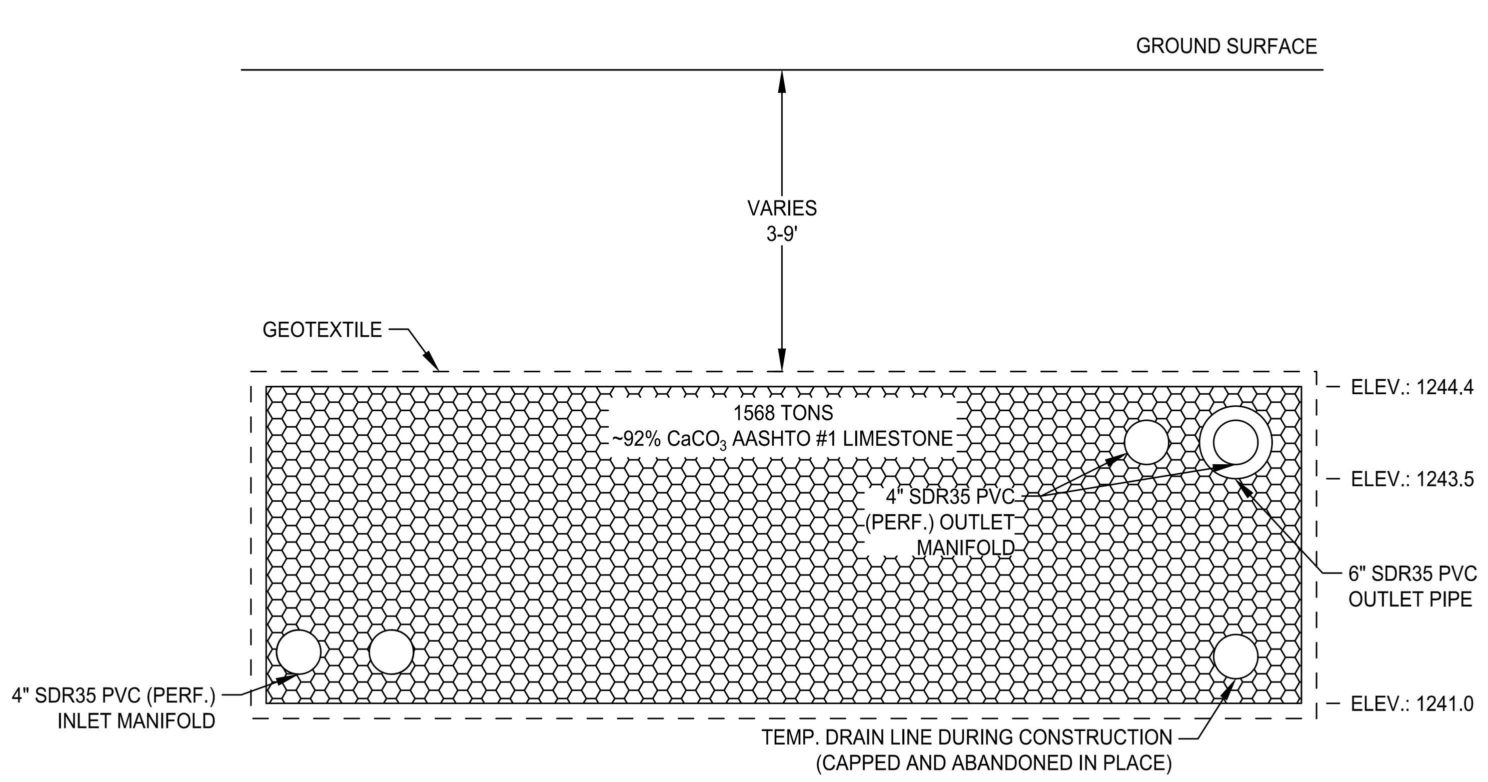
ANOXIC LIMESTONE DRAIN B (ALD B) OUTLET
B2 SECTION VIEW

Vertical Scale: None Horizontal Scale: None



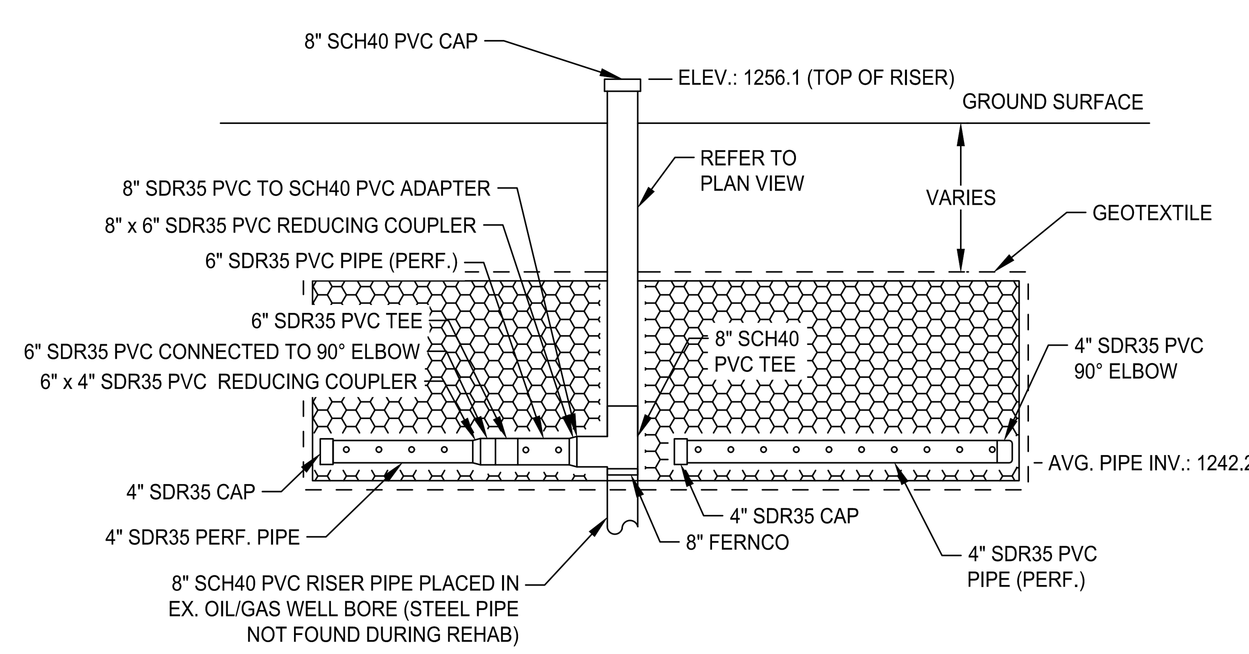
DIRECTIONAL BAFFLE CURTAIN

Horizontal Scale: None Vertical Scale: None



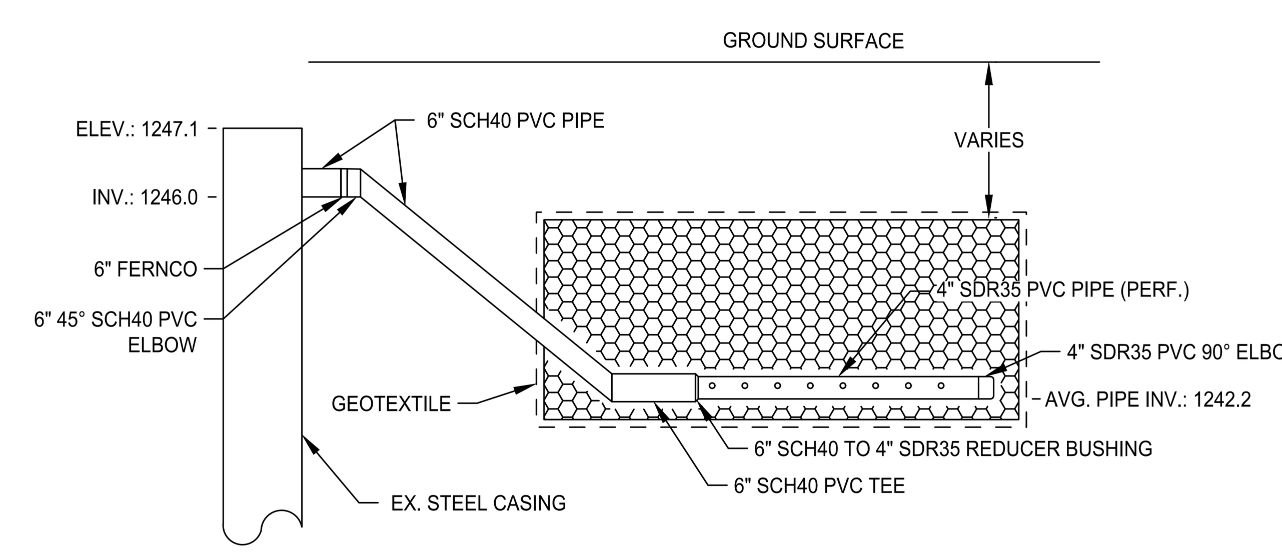
ANOXIC LIMESTONE DRAIN D (ALD D)

Vertical Scale: None Horizontal Scale: None



D1 SECTION VIEW

Vertical Scale: None Horizontal Scale: None



D2 SECTION VIEW

Vertical Scale: None Horizontal Scale: None

BioMost, Inc. Mining & Reclamation Services 434 Spring Street Ext. Mars, PA 16046 www.biomost.com	CLIENT: STREAM RESTORATION INCORPORATED PO BOX 837, SLIPPERY ROCK, PA 16057	

REVISIONS

NO.	BY	DATE	DESCRIPTION

SUBMITTED BY:	CODY A. NEELY, P.E. PROJECT DESIGNER - BioMost, Inc.
DATE: 12/1/2023	LATITUDE: 41.095097 LONGITUDE:-79.826869
SCALE:	NONE
DRAWN BY: DMC	CHECKED BY: TPD
ACAD FILE NAME:	SR114 As-Built.dwg

ALL EXISTING CONDITIONS SHALL BE CHECKED AND VERIFIED AT THE SITE PRIOR TO PERFORMING ANY MAINTENANCE WORK

SR114 Rehabilitation Project As-Built

WASHINGTON TOWNSHIP BUTLER COUNTY

DETAIL SHEET

DRAWING NUMBER: 2 of 2