Appendix 3

O&M Plan and Schematic

Maiden Passive System Rehabilitation Treatment System

Dunkard Township, Greene County, Pennsylvania

Operation & Maintenance Plan

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Prepared by:

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

Prepared for:

Stream Restoration Incorporated
PO Box 837, Slippery Rock, PA 16057
www.streamrestorationinc.org

Operation & Maintenance Plan Update

(See 2007 O&M Plan for More Information)

Section 1 – Project Information

Project Name	**Maiden Passive System Rehabilitation**
Location	(39.7483°, -79.9659°)
Site Access	Taylortown Rd, Dilliner, PA
Hydrologic Order	Unnamed Tributary → Dunkard Creek → Monongahela River
Landowner	Mepco, LLC
Project Designer	BioMost, Inc., Mars, PA, www.biomost.com
Project Contractor	Solid Rock Excavating, Inc.

Design Summary	
Max Hydraulic Design Flow	1,500 GPM
Max Treatment Design Flow	600 GPM
Average Design Flow	360 GPM

Raw Loading Rates		
Treatment Load	**Max**	**Average**
Acid Load	2,000 lb/day	1200 lb/day
Iron Load	500 lb/day	180 lb/day
Aluminum Load	200 lb/day	80 lb/day
Design Life: 15-25 Years		

Section 2 – Overview

The Maiden Passive Treatment System (PTS) in Dunkard Township, Greene County, was installed in 2006 to treat two abandoned mine discharges, including one of the most acidic sources in the Dunkard Creek Watershed. Funded by PA DEP and EPA grants, the initial project was a public-private partnership involving nonprofits, government agencies, private companies, and local citizens. However, a year after completion, the landowner revoked access, preventing maintenance. Efforts to regain access failed until 2015 when MEPCO, LLC purchased the property to restore system functionality. After nearly a decade without maintenance, the system was in poor condition. Initial repairs in 2016 improved water quality, but further upgrades were needed to expand treatment capacity.

Section 3 – System Components

3.1 – Previous Treatment System

The larger 117-1 discharge flows from an underground mine entry, through a 1.5-ft H-Flume, along a channel into 2000 ton limestone-only vertical flow pond (VFP1) then a settling pond (SP1). An oxidation-precipitation channel (OPC – a/k/a Terraced Iron Formation or TIF) then conveys this effluent to a limestone and organic media mixed vertical flow pond (VFP2A) through a channel. This pond overflows into another 3500 T limestone-only vertical flow pond (VFP2B) before flowing into another settling pond (SP2), then a 0.75 acre wetland (WL), before finally discharging into a 4000 ton horizontal flow limestone bed (HFLB). The second smaller system collects the discharge VFP3 Sump (measure flow at inlet to VFP3) via a PVC pipe that drains to a 1000 ton limestone only vertical flow pond 3 (VFP3). All the VFPs discharge to a large, previously degraded wetland area that is bisected by the access road.

3.2 – Upgraded Limestone-Only Vertical Flow Ponds (VFP1, VFP2B, VFP3)

3.2.A – Description and Purpose

VFP1 and VFP2B contain about 2200 and 4500 tons of AASHTO #1-sized limestone respectively. The underdrains in VFP1 and VFP2B consist of four 8-inch DR-17 HDPE perforated pipes that feed a concrete siphon vault housing a 12-inch siphon with a 48-inch draw down by Fluid Dynamic Siphons, Inc. (model number 1248). These siphons outlet to SP1 and SP2 respectively. VFP3 contains approximately 1200 tons of PADOT #3 limestone with one 10-inch SDR35 PVC perforated pipe underdrain that feeds another concrete siphon vault housing a 6-inch siphon with 48-inch draw down (model number 648). VFP3 outlets to the large, common wetland.

3.2.B – Maintenance

Each of the three limestone-only vertical flow ponds, VFP1, VFP2B, and VFP3 should be inspected during each monitoring event. It is recommended that they are inspected at least quarterly. Upon arrival on site, measure down to the water level in each vault, and return at least one hour later to check the water level. If the VFPs are not actively flushing the water levels should be noted to be rising. The only exception is VPF2B which should be sent to allow about 10-30 gallons per minute (gpm) of water to continually drain out of the pond at all times via the 8” drain pipe. This is so that water is not retained for extended periods of time, especially during dry or low-flow periods. If the VFP2B drain valve needs to be opened, measure the height of the valve stem before opening and re-set the valve as needed.

If fill and flush cycles are found be less than about four hours, or if water is flowing on top of the limestone and into the top of the siphon vault, the limestone should be cleaned. The drain valve should be opened to drain the pond. It is recommended to use leave about two to three feet of water in the pond, agitate the limestone to remove solids, and use other water to flush the solids from limestone. Continue to flush the solids through the siphon vaults and into the downstream component (either settling pond or wetland). Expose all the pipes and ensure that they are clean both inside and out prior to replacing the limestone. The pipes can be temporarily removed for cleaning. Place the pipes in the approximately original position and no higher than the minimum water elevation shown on the As-Built Plan. Replace the limestone and level within about one-half foot. In order to avoid short circuiting in VFP1 and VFP2B, inlet channels should be dug into the top four to five feet of stone and extended along at least two sides of the VFPs to direct water into the ponds as far away from the siphon vaults as possible.

3.3 – Settling Ponds (SP1 & SP2)

3.3.A – Description and Purpose
Settling ponds are designed to settle and store the metal precipitates from the upstream VFP. Settling Pond 1 (SP1) has a bypass pipe that allows the pond to be drained into the final wetland.

3.3.B - Maintenance
Check effluent channels for sediment or debris that could block flow or cause water to bypass the channels. Over time, solids swill accumulate in SP1 and SP2, reducing retention time during flushes from the siphons in VFP1 and VFP2B. When ponds can no longer retain precipitates effectively, remove and dewater the sludge. Dispose of sludge according to applicable laws and regulations.

3.4 – Moat

3.4.A – Description and Purpose
The OPC (a/k/a TIF) was modified to function as a series of two long, narrow ponds (Moat A and Moat B) to convey water from SP1 to VFP2A, VFP2B, and VFP2C. There is an eight-inch pipe just upstream of the culvert at the end of Moat A that directs flow into VFP2C. An assembly of pipe fittings are dry fit (not glued) on the inlet end of the eight inch pipe to reduce the inlet size to four inches to restrict the amount of flow that can enter VFP2C. The initial design flow for VFP2C is about 160 gpm using the four-inch inlet. The flow to VFP2C can be increased to 360 gpm with a six-inch inlet or 640 gpm with an eight-inch inlet. Alternatively, a cap could be installed with a custom-sized inlet if desired. Since the Moats are designed as ponds, no channel lining (i.e., rock) was installed.

3.2.B – Maintenance
Remove solids and vegetation as needed to maintain a free-flowing condition in both Moat segments. Ensure that the culvert between Moat A and Moat B is unobstructed.

3.5 – Jennings-Type Vertical Flow Pond (VFP2A & VFP2C)

3.5.A – Purpose and Description
The JVFPs utilize a by-volume media mixture consisting of limestone and organic material as specified on the updated as-built drawing. This blend neutralizes acidity, generates alkalinity, and facilitates the precipitation of metals, particularly aluminum and iron. Each Jennings-type VFP includes a multi-cell underdrain system composed of perforated laterals and header pipes.

Each underdrain cell discharges through adjustable riser pipes, vertically connected to an adjustable riser with flexible rubber couplers. Operators can manipulate riser heights to adjust water levels or direct flow through selected treatment zones. Each JVFP includes three potential outlets: the primary outlet via riser pipes, secondary overflow emergency spillways, and a tertiary outlet at the drainpipe. VFP2A has a total of three drainpipes connected to each of the underdrain cells that outlet to SP2 while VFP2C utilized an existing 12-inch drain pipe that is connected to the header pipe of cell four of the underdrain.

3.5.B – Treatment Process and Odor Management
The treatment media's biological activity produces both alkalinity and hydrogen sulfide gas. During startup or early operation, and under conditions of low temperature or high flow, nuisance odors may

emerge. Operators can mitigate these odors by restricting flow to a single cell and rotating usage monthly during colder months. Alternatively, all underdrain cells can be active if flow rates remain low enough to control hydrogen sulfide production.

During warmer weather or periods of lower influent flow, further reduction of flow may be necessary. To assist in this, operators can install flow-reduction assemblies using dry-fit bushings and one-inch PVC ball valves at the four-inch riser elbows. This allows fine-tuned flow control without cell rotation. If odors persist, further restrict or temporarily halt flow, forcing ponded water to discharge via the emergency spillways. This partially treated water will mix with fully treated effluent in the downstream component. Over time, typically several years, odor issues diminish as the media matures. A persistent mild odor near outlet pipes signals proper system function, but operators should adjust treatment as needed to meet performance targets and minimize odor.

3.5.C – Treatment Media Maintenance

Over time, the treatment media may compact and accumulate metals both on top and/or within the media, reducing permeability to a point where water no longer passes through effectively. This condition can cause the pond water level to rise and overflow via the emergency spillway, thereby significantly diminishing treatment effectiveness. VFP2A should be able to pass at least 100 gpm, while VFP2C should be able to pass at least 200 gpm. When the riser pipes are set at their lowest elevation and total flow is less than stated, maintenance should be conducted. Removing accumulated solids on top of the media and/or stirring the treatment media typically restores permeability. To facilitate maintenance and maintain continuous operation, the JVFP units are installed in parallel, allowing one unit to remain online while the other undergoes servicing. The maintenance procedure is outlined below:

1. Divert flow from the JVFP scheduled for maintenance.
2. Open the drain valve(s) to fully dewater the selected JVFP.
3. Allow the treatment media to dry—typically one week or more, depending on weather conditions—to enable access by a mini excavator or other low-ground-pressure equipment.
4. If solids have accumulated on top of the media to a depth that can be effectively removed, excavate the solids as feasible and remove before subsequent steps.
5. Stir the full depth of media until loose and uncompacted, stopping at the underdrain stone. Avoid and repair any damage to underdrain piping. Close the drain valves and allow the pond to refill.
6. Reopen the drain valves to flush the stirred JVFP and remove fine materials from the piping system.
7. Close the drain valves once more, allow the pond to refill, and adjust the outlet risers to the normal operating elevation as needed.

3.5.D – Media or Underdrain Replacement

If stirring fails to restore flow, replace the treatment media and, if needed, underdrain stone and piping:

1. Divert flow from the targeted JVFP.
2. Fully dewater and allow the media to dry.
3. Remove spent media and underdrain components as necessary.
4. Transport and dispose of old media appropriately, then revegetate disposal areas.

5. Install new stone, piping, and mixed treatment media per the original specifications or updated design mixture.
6. Before replacement, reassess system performance needs and water quality trends.

3.6 – Wetlands

3.6.A – Purpose and Description
The treatment wetlands receive water from each of the VFPs and SP2. Over time, as organic matter, vegetation, and metal precipitates build up, the substrate will build up and the water level will gradually rise. The wetland has two primary functions:

1. Re-aerate water that enters in a reduced state from the Jennings-type VFPs.
2. Provide surface area for iron to oxidize and precipitate.

Treated water exits the wetland through dual culverts to an unnamed tributary to Dunkard Creek.

3.6.B – Maintenance
As the wetlands fill with accumulated material, cleanout is required when the buildup is within about one foot of the lowest berm elevation. Remove excess substrate and accumulated material and dispose of in an approved location, following all applicable regulations.

Section 4 – Monitoring

The design of the passive treatment system is focused on neutralizing the acidity of the raw water and removing iron and aluminum found in the raw water. The treatment system is expected to consistently remove up to the maximum design acid, iron, and aluminum loads while generating excess alkalinity as indicated by negative acidity reported on laboratory analysis. It is expected that the system will produce effluent with a pH of at least six when operating within design flow parameters. If flows or pollutant loads exceed the design parameters, effluent with a pH below six and/or positive acidity can be expected. This may occur for short periods during high flow conditions, however, based on observations of other passive systems, the effluent quality should improve once the pollutant load and/or flow return to the design range. If average or maximum conditions are exceeded on a frequent basis, increased maintenance and decreased system life should be expected.

To ensure that the system is functioning as designed, the influent and effluent acid loads will need to be calculated using the total flow rate measured at the flume located just downstream of the 117-1 discharge and the collection pipe to VFP3 (for VFP3 Sump). Laboratory-determined acidity values using the hot-peroxide method will also be needed to accurately quantify the system performance. Calculating acid load removal is explained in Equations 1 through 3 below. Note the wetlands are not designed to provide alkalinity to the system. To assess the overall function of the system, the total influent acid load as calculated from the two influent points (H-flume and VFP3 collection) should be used with the system effluent load. The effluent acidity is measured at the single outlet point (117-4) and the effluent load is calculated using the combined influent flow rates.

Equation 1: Influent Acid Load
Instructions: Collect sample at H-Flume and VFP3 Collection Pipe and measure flow at both locations
Flow (gpm) X Acid Concentration (mg/L $CaCO_3$) X 0.01202 (conversion factor) = Acid Load lb/day

Add the acid loads from each influent point to obtain the total acid influent load.

Equation 2: Effluent Acid Load
Instructions: Collect sample at the single outlet (117-4).
Combined Influent Flow (gpm) X Acid Concentration (mg/L $CaCO_3$) X 0.01202 (conversion factor) = Acid Load lb/day

Equation 3: Acid Load Removed
Combined Influent Acid Load (lb/d) minus Effluent Acid Load = Acid Load Removed
When the effluent acidity is negative, subtracting a negative acid load from the positive influent acid load will result in a total acid load removed greater than the total influent acid load.

To calculate the metal load removed, follow the above equations, substituting the metal concentration (mg/L) for acidity concentrations (mg/L $CaCO_3$). As manganese only contributes less than one percent of the total acid load, the system was not designed to remove this metal, and no appreciable manganese removal is expected. However, manganese removal may still be observed.

Section 5 – O&M Schedule

Monthly (Frequency may be reduced based on system performance)

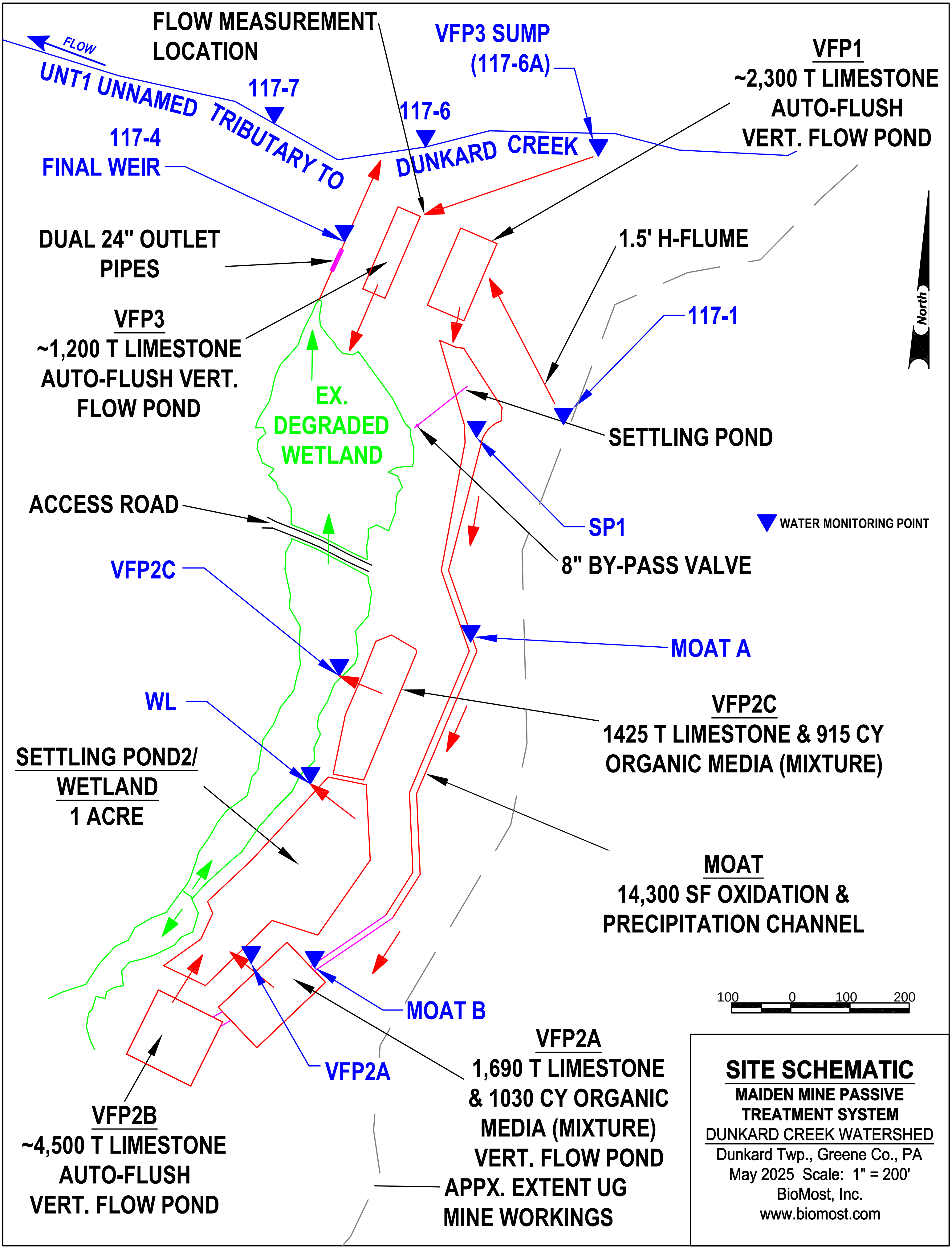
- Measure and record flow at H-flume.
- Measure flow at VFP3 inlet (for VFP3 Sump) (open 4” drain valve as needed to lower water elevation)
- Inspect siphons in VFP1, VFP2B and VFP3 for evidence of uniform filling and flushing
  - Check each siphon at least twice during each site visit, with an hour between inspections
- Visual inspection of all components, channels, ditches, etc.
- Check pH at system effluent, 117-4
  - pH should always be >6.0
- Upload all monitoring data to www.datashed.org

Annually

- During typical high-flow (February – May) collect samples for laboratory analysis at:
  - Discharge point 117-1, VFP3 inlet, Moat A (at the culvert near the VFP2C inlet pipe), VFP2A (composite of 3 pipes), VFP2C (composite of 4 pipes), and the system effluent 117-4 (See Attachment 1: Schematic)
    - Minimum parameters to include per sample point: pH, conductivity, acidity, alkalinity, iron, aluminum, manganese
      - At system effluent, iron should be <3.0 mg/L
    - Measure flow at H-Flume, VFP2C inlet pipe, VFP2A, and VFP2C outlet pipes
      - Flow can be measured by taking the sum of each individual riser pipe outlet and combining for each respective JVFP total
    - Upload all monitoring data to www.datashed.org

- Open the drain valves for all VFPs to evacuate solids and, in the case of VFP2A and VFP2C, trapped gases

As Needed
- Remove unwanted vegetation from spillways, channels, pipes, etc.
- Remove woody vegetation from embankments.
- Maintain of ditches, level spreaders, etc. as described herein.
- Replace or stir treatment limestone or mixed media as described herein.



SITE SCHEMATIC
MAIDEN MINE PASSIVE TREATMENT SYSTEM
DUNKARD CREEK WATERSHED
Dunkard Twp., Greene Co., PA
May 2025 Scale: 1" = 200'
BioMost, Inc.
www.biomost.com