Andrews Run (Bulldog Excavating) Passive Treatment System
Design Justification
Prepared by Hedin Environmental
November 28, 2016

Background

The Andrews Run site is a reclaimed surface mine that was mined by Bulldog Excavating. After cessation of mining polluted discharges developed from the toe of spoil that polluted an unnamed tributary to Andrews Run, a tributary to Sewickley Creek in Westmoreland County, PA. With Bulldog Excavating's bankruptcy, water treatment responsibilities were transferred to the PA Department of Environmental Protection (PADEP). In 2009 PADEP contracted with Hedin Environmental to develop a passive treatment plan for the discharges. The treatment plans were delivered to the PADEP in 2011 and were used by Sewickley Creek Watershed Association to develop a treatment proposal that was submitted to the PA Growing Greener Program in 2012. The project was funded in 2013 and the system was installed in 2016. This report explains the treatment system design and also provides trouble-shooting recommendations.

Water Chemistry

The primary Andrews Run discharge was collected in 2011 and flows and chemistry were measured between 2011 and 2015. The average conditions are shown below.

	Flow	**pH**	**Alk**	**Acid**	**Fe**	**Mn**	**Al**	**SO4**
	Gpm		mg/L $CaCO_3$		mg/L	mg/L	mg/L	mg/L
6" Pipe	2-14, ave 8	5.9	60	67	34	46	<1	1128

The discharge is acidic and contaminated with Fe and Mn. This chemistry is well suited for treatment with an Anoxic Limestone Drain (ALD), which should generate alkalinity, and the precipitation of Fe and Mn by oxidative processes.

Treatment System Design

The passive system design includes an anoxic limestone for alkalinity generation, a settling pond for oxidation and settling of Fe, an oxic aggregate bed for removal of Mn, and final settling pond. The design of the system was influenced by landowner concerns. The original plan was to build the entire system on the north side of the unnamed tributary on two properties owned by Hermine #2 Hunting Association and Nathan Polinsky. Between the original conceptual design and funding of the construction project, Mr. Polinsky improved the portion of property planned for the settling ponds and aggregate bed. This required modification of the treatment plans so that all construction was on property owned by the Hermine #2 Hunting Association. This revised plan placed the ALD on the north side of the UNT and the oxidative units on the south side of the UNT. The system construction plans are attached.

Because of elevation constraints, the ALD was installed in October 2015 to ascertain the elevation of water needed to be carried across the UNT to the oxidative treatment units. The ALD contains 265 tons of Vanport AASHTO#3 limestone obtained from Allegheny Mineral's Worthington Mine. The ALD is wrapped in a 30 mil liner. The discharge from the ALD has averaged 320 mg/L alkalinity which is enough to assure circumneutral pH conditions as Fe and Mn are precipitated in the oxidative units.

Water in the ALD is collected in a manifold and piped to the oxidation pond on the south side of the UNT. The pipe contains a valve cleanout at its low-point near the UNT. The influent to the pond is distributed the width of the pond and is passively aerated. The pond has an empty volume of 60,700 gallons which provides a theoretical retention time for the average 8 gpm flow of 126 hours. This is sufficient to decrease Fe concentrations to less than 3 mg/L by the time water reaches the pond effluent. The pond discharges to an oxic bed of aggregate that is intended to removal Mn through the growth of biogenic Mn oxides. The Mn removal bed contains 666 tons of aggregate which will provide an average flow (8 gpm) with approximately 80 hours of retention time.

The Mn removal bed discharges to a second settling pond with an empty volume of 63,500 gallons. The pond is intended to receive continuous flow during routine treatment operations (99.9% of the time) and provide final polishing. The pond is also intended to receive flow from the Mn removal bed when it is flushed or drained empty. These activities will produce water with suspended solids that will settle in the pond. The pond volume is larger than the flush volume (40,000 gallons when the Mn bed is drained empty). This will allow the system operator to retain flow in the pond until the solids have settled.

ALD Performance and Trouble Shooting

The ALD is tied directly to a buried collection system that drains water off the crop of the abandoned surface mine. At the time of this report's preparation, the ALD discharged water with ~300 mg/L alkalinity. Efficient operation of the oxidative portions of the treatment system requires a minimum 180 mg/L alkalinity. If the ALD effluent drops to less than 180 mg/L alkalinity cleaning of the limestone is required. If water stops flowing at the distribution pipe in the aeration cell on southern side of tributary the system, several explanations are possible: 1) the discharge could have ceased flowing; 2) the collection system could be plugged with solids; 3) the ALD limestone or ALD internal piping could be plugged with iron solids, or 4) the pipe between ALD and aeration pond could be plugged with iron solids.

A walk around the ALD downslope of the system could reveal leakage if the collection system has failed. There is an observation port at influent end of ALD with a cap. Remove cap and see if ALD is full of water, if not, the liner may have developed a leak. If the ALD is full of water and there is leakage around the ALD or along the slope it is possible that the line between ALD and aeration pond is plugged backing up water into ALD. A measurement with survey equipment from top of water inside the observation port between ALD and aeration pond "V" notches will indicate if the pipe is plugged with solids. If the pipe is plugged it can be accessed with cleaning equipment at a valve located next to the UNT. If the pipe is clean and there is no head loss between ALD and aeration trough, then the collection system may be leaking. If water level in ALD is down the liner could either be leaking or collections system has failed allowing water to back flow though collection system and into leak into coal crop barrier.

During installation of the pipeline a 4 inch Schedule 40 pipe containing AMD was found below the ALD and tied into the pipeline. A look in this area for leakage should be considered.

Aeration Pond Performance and Trouble Shooting
The aeration pond receives flow from the ALD that is distributed across the width of the pond in an open trough. The aeration should promote the formation of iron oxides solids that settle in the pond. The current pond does not contain any structures that would discourage preferential flow paths. If the pond does not decrease Fe to low levels (< 5 mg/L), the installation of a curtain should be considered.

Mn Removal Bed: Performance and Trouble Shooting
The aeration pond and Mn removal bed are separated by an earthen dam with a HDPE "V" notch weir to provide aeration of water during the transfer to the Mn Bed. The aggregate bed is intended to remove Mn through oxidative microbial processes. The system is a downflow design. Water is collected at the bottom of the Mn Bed with a 6" PVC perforated pipe that is connected by solid pipe to an inline water level control structure (WLCS). The Mn removal bed can also be flushed or drained by opening an 8 inch gate valve that is connected to perforated pipe at the influent end of the aggregate bed. This pipe is intended to remove iron solids that accumulated at the influent end of the bed. It is recommended that the Mn Bed be drained empty on a semi-annual basis.

<u>Mn Removal Bed Permeability</u>
The water level in the Mn bed should be just below the aggregate surface. Some water may be visible above the aggregate due to irregularities in the aggregate level, especially under high flow conditions when the water level will rise. If the entire aggregate surface is submerged the outlet plumbing should be inspected for obstructions. If the water level inside the water level control structure is lower than the water level in the DLB then there is a permeability problem within the aggregate. Permeability problems can be addressed by increasing the frequency of draining the Mn Bed empty. This action will remove easily mobilized solids and increase the aggregate porosity and reactivity. If increased flushing does not solve the treatment or permeability problem, then mechanical cleaning of the aggregate is required. Mechanical cleaning can be accomplished with an excavator and pump. The solids produced should be washed or pumped into Settling Pond 2.

Settling Pond 2 Performance and Trouble Shooting
Settling Pond 2 is intended to polish the Mn Bed effluent and provide solids settling during O&M events. Water discharges from the pond through a 6" PVC pipe connected to a WLCS that discharges to an aggregate-lined channel. The water level in the pond is controlled by the WLCS. The channel produces the final discharge to the UNT.

The discharge from the pond could be impeded by blockage in the WLCS created by animals or vandals. Any blockage should be removed during system inspections.

The settling pond is intended to collect solids produced when the Mn Bed is drained or the aggregate is cleaned. It is possible the accumulation of solids (sludge) will reach a point that degrades the ability of the pond to settle solids. If this condition develops, solid in the bed will need to be removed and properly disposed of. Because of the pond's size, sludge cleanout is not anticipated to be necessary for at least 20 years.