OPERATIONS, MAINTENANCE, AND REPLACEMENT PLAN

BOYCE PARK AMD REMEDIATION PROJECT

PREPARED FOR

ALLEGHENY COUNTY DEPARTMENT OF PUBLIC WORKS
501 COUNTY OFFICE BUILDING
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TREATMENT SYSTEMS

ACCD received Growing Greener Grant funding for the design and construction of passive treatment systems at these three high-priority AMD discharges within Boyce Park. Skelly and Loy, the selected AMD consultant, designed the passive treatment systems for an estimated 20- to 25-year life and assisted with the supervision of their construction. Based on water quality data and flow data provided by TCWA and from the site surveys conducted by Skelly and Loy, Skelly and Loy evaluated alternatives for treating and routing the three AMD discharges at the site. One extensive treatment system was proposed and constructed for treating all three discharges due to the close proximity and available land at the site. The design for each component of the passive treatment system for the three discharges included the determination of the configurations of limestone/VFW and settling ponds and a final polishing wetland.

In the limestone pond used for treating the BP2 discharge, the AMD passes through the high calcium carbonate limestone (typically greater than 80% $CaCO_3$) and dissolves the limestone to impart alkalinity and neutralize acidity. Similarly, in the VFWs for BP3 and BP4, a layer of compost material is placed on top of a limestone bed to help control the precipitation and coating of iron within the limestone bed and to enhance the limestone dissolution by trapping carbon dioxide. The net alkaline water is then routed out of the limestone bed via piping networks at the bottom of the ponds and through settling or retention ponds for precipitation of the metals, primarily iron and aluminum. Skelly and Loy designed both manual flushing systems and automatic dosing siphons to aid in the removal of aluminum and iron precipitates from the void spaces in the limestone ponds and VFWs. Finally, the water from all three discharges is combined in a final polishing wetland before discharge to an existing wetland area in the headwaters of Piersons Run. Before their treatment the individual AMD discharges were characterized as follows.

BOYCE PARK RAW AMD DISCHARGES CHARACTERIZATION

SITE	FLOW (GPM)	PH (SU)	ALKALINITY (MG/L)	ACIDITY (MG/L)	TOTAL IRON (MG/L)	TOTAL ALUMINUM (MG/L)	TOTAL MANGANESE (MG/L)
BP2	19	4.6	12.4	55.8	0.48	13.4	0.29
BP3	29	3.3	0.0	257.0	5.0	25.3	0.7
BP4	7	3.5	1.7	467.5	15.0	71.9	1.7

Between the ACCD and Allegheny County Department of Public Works, long-term OM&R activities will be performed or delegated as indicated for the designed life of the constructed passive AMD treatment systems at the Boyce Park site. The project site within the Boyce Park property is located off of Center Park Drive near the existing Ski Lodge in Plum Borough. An access road was constructed off of Center Park Drive to a picnic pavilion located at the eastern end of the treatment system. Split rail and chain-link fence were installed around most of the treatment system components to restrict public access, while allowing public observation of the treatment system components for environmental education and awareness as part of the Boyce Park Nature Center Program.

BP2

The sources of all three AMD discharges are related to abandoned coal mining operations around the project site which have been continuously producing a source of degradation to the headwaters of Piersons Run along the county/regional park property. The BP2 discharge originates from a constructed rock face with a small buried pipe discharging the AMD just downslope of Center Park Drive. This AMD discharge is characterized as moderate flow with moderate aluminum and low iron concentrations. The portion of the passive treatment system for the BP2 discharge was designed to use a limestone pond, BP2-Limestone Pond, for alkalinity generation followed by a large settling pond, BP2/BP3-Pond, for detention of the treated water to capture the aluminum precipitates. The AMD discharge is piped from an inlet box adjacent to Center Park Drive into the limestone pond. Based on the flow and water chemistry of this discharge and 20- to 25-year design life, approximately 313 tons of limestone would produce enough alkalinity to raise the pH and precipitate the aluminum. The limestone layer was to be approximately three feet deep. Available clay material from the project site was installed in the bottom of the limestone pond to prevent infiltration of the AMD prior to treatment with the limestone. The settling pond following the limestone pond, BP2/BP3-Pond, was sized based on available space and ease of construction. The BP2/BP3-Pond was also lined with available on-site clay material to help reduce leaks in the pond. The treatment system is expected to reduce aluminum concentrations by 90% and remove all of the acidity in the final system outfall.

An automatic dosing siphon was included in the design of the BP2 Limestone Pond to periodically remove aluminum and any iron precipitates from the void spaces in the limestone pond. The dosing siphon allows the limestone pond to fill to a specified elevation at which point water begins to discharge through it until a set lower water elevation is reached and at which point the discharge stops and the cycle repeats. This rapid drawdown provides the velocity required to flush aluminum and some iron precipitates from the void spaces in the limestone into the perforated piping network at the bottom of the pond. The dosing siphon, located in a concrete manhole, is hydraulically connected to the limestone pond by a network of solid and perforated PVC pipes. Manual flush valve #1 was also installed off of the flush piping network to allow manual draining of the limestone pond or to address problems with the automatic dosing siphon. A limestone-lined channel captures the outfalls from the dosing siphon and manual flushing valve and routes the water into the BP2/BP3-Pond. The settling pond (BP2/BP3-Pond) was constructed following the limestone pond for the purpose of metal precipitate removal using detention time and settling mechanisms. Inlet structure #1 was installed to allow for adjustment of the water elevation in the BP2/BP3-Pond in response to sediment and/or metals accumulation. Inlet structure #1 also allows for dewatering of the pond for maintenance purposes (e.g., sludge removal). The outfall from the settling pond inlet structure is directed into the constructed wetland for tertiary treatment prior to final discharge into an existing wetland area and eventually down to Piersons Run.

The limestone pond, BP2/BP3-Pond, and constructed wetland all have emergency spillways in case flows in the system exceed the capacity of the individual outlet structures or if they become clogged and have limited or no capacity. In addition, the limestone pond has been equipped with manual flush valve #1 that may be used to periodically flush the piping network in the pond or as a means of manually flushing the limestone if the dosing siphon does not function properly. The dosing siphon itself has a vertical overflow pipe that allows the water to outlet out of the manhole and limestone pond should the dosing siphon not work properly or receive excessive inflows beyond the design capacity.

BP3

The sources of all three AMD discharges are related to abandoned coal mining operations around the project site, which have been continuously producing a source of degradation to the headwaters of Piersons Run along the county/regional park property. The BP3 discharge originates at the upstream point of an existing wetland that eventually feeds into the headwaters of Piersons Run. This AMD discharge is characterized as moderate flow with high aluminum and moderate iron concentrations.

The portion of the passive treatment system for the BP3 discharge was designed to use a VFW, referred to as BP3-VFW, for alkalinity generation followed by a large settling pond, BP2/ BP3-Pond, for detention of the treated water to capture the aluminum and iron precipitates. Inlet box with grate #1 was installed to intercept the discharge and route it into the BP3-VFW. Based on the flow and water chemistry of this discharge and 20- to 25-year design life, approximately 558 tons of limestone covered by a 368 cubic yard layer of compost would produce enough alkalinity to raise the pH and precipitate the aluminum, while keeping the iron from precipitating. The limestone layer was to be approximately three feet deep overlain by a two-foot layer of compost, which helps to remove oxygen from the AMD as it enters the pond, helping to prevent oxidation and precipitation of the iron which tend to armor the limestone. The compost layer also helps to trap the carbon dioxide within the limestone bed, which increases the rate of limestone dissolution, helping to improve alkalinity generation. Available clay material from the project site was installed in the bottom of the VFW to prevent infiltration of the AMD prior to treatment with the limestone and compost. The settling pond following the limestone pond, BP2/BP3-Pond, was sized based on available space and ease of construction. The BP2/ BP3-Pond was also lined with available on-site clay material to help reduce leaks in the pond. The treatment system is expected to reduce aluminum concentrations by 90%, reduce iron concentrations by 85%, and remove all of the acidity in the final system outfall.

The VFW uses a perforated piping network within the limestone bed that is attached to inline structure #1 for managing the VFW water level and to provide periodic manual flushes of accumulated metal precipitates in the void spaces of the limestone. The settling pond, BP2/ BP3-Pond was constructed following the VFW and BP2-Limestone Pond for the purpose of metal precipitate removal using detention time and settling mechanisms. Inlet water level control structure #1 was installed in BP2/BP3-Pond to allow for adjustment of the water elevation in response to sediment and/or metals accumulation. Inlet structure #1 provides the opportunity to lower the water level in BP2/BP3-Pond prior to manual flushing of BP3-VFW to allow the metal precipitates in the flush water enough retention time to settle out. Inlet structure #1 also allows for dewatering of the pond for maintenance purposes (e.g., sludge removal). The outfall from the BP2/BP3-Pond inlet structure #1 is directed into the constructed wetland for tertiary treatment prior to final discharge into an existing wetland area and eventually down to Piersons Run.

The VFW, BP2/BP3-Pond, and constructed wetland were constructed with emergency spillways to serve as back-up outlets in case the primary outlet structure should fail for any reason, which also helps to prevent failure of the constructed embankments. The three treatment ponds have either inline or inlet water level control structures as their primary outlet structures.

BP4

The sources of all three AMD discharges are related to abandoned coal mining operations around the project site, which have been continuously producing a source of degradation to the headwaters of Piersons Run along the county/regional park property. The BP4 discharge originates on the opposite side of Center Park Drive and was captured in a stormwater inlet and routed underneath the road and discharged out of a pipe from cut stone high wall onto the project site. This AMD discharge is characterized as low and intermittent flow with high aluminum and moderate iron concentrations. In addition to the identified BP4 discharge, an additional seep was identified on the project site in the vicinity of this discharge, which allowed for its capture and inclusion in the constructed treatment system.

The portion of the passive treatment system for the BP4 discharge was designed to use two VFW and settling pond systems in series for alkalinity generation. The two VFWs are referred to as BP4-VFW #1 and BP4-VFW #2 and the two settling ponds are referred to as BP4 Pond #1 and BP4 Pond #2. An existing inlet box on the opposite side of Center Park Drive with newly installed piping to intercept the discharge and route it under the road and into BP4-VFW #1. The additional seep found during the initial site investigation was designed for capture in the BP4 Pond #1. Based on the flow and water chemistry of this discharge and 20- to 25-year design life, approximately 360 tons of limestone covered by approximately 200 cubic yards of compost between the two VFWs would produce enough alkalinity to raise the pH and precipitate the aluminum, while keeping the iron from precipitating. The limestone layer in each VFW was to be approximately 5 feet deep overlain by a 1.5-foot (BP4-VFW #1) or a 2-foot (BP4-VFW #2) layer of compost, which helps to remove oxygen from the AMD as it enters the VFWs, helping to prevent oxidation and precipitation of the iron, which tends to armor the limestone. The compost layer also helps to trap the carbon dioxide within the limestone bed, which increases the rate of limestone dissolution, helping to improve alkalinity generation. Available clay material from the project site was installed in the bottom of the VFWs and settling ponds to prevent infiltration of the AMD prior to treatment with the limestone and compost. Each of the two settling ponds following the VFWs was sized based on available space and ease of construction. The treatment system is expected to reduce aluminum concentrations by 90%, reduce iron concentrations by 85%, and remove all of the acidity in the final system outfall.

The two VFWs for the BP4 discharge use a two-tiered perforated piping network within the limestone beds that are controlled by inline water level control structures and manual flush valves for managing the VFWs water level and to provide periodic flushing of accumulated metal precipitates in the void spaces of the limestone layers. BP4-VFW #1 has a lower perforated piping network approximately one-foot from the pond bottom that is connected to inline structure #2 that provides the normal course of flow out of the VFW but can also be used to flush accumulated metal precipitates from the lower portion of the limestone bed and into BP4-Pond #1. BP4-VFW #1 also has an upper perforated piping network that is approximately three feet from the pond bottom and is connected to manual flush valve #2 for periodic flushing of accumulated metal precipitates from the section of limestone bed just below the compost layer and into BP4-Pond #1. BP4-VFW #2 has a lower perforated piping network approximately one foot from the pond bottom that is connected to inline structure #3 that provides the normal course of flow out of the VFW and into BP4-Pond #2, but because of site constraints and elevation drop limitations, this structure is not capable of providing adequate flushing of the limestone bed. However, this lower perforated piping network is also connected to manual flush valve #3 along with the upper perforated piping network that is approximately three feet from the pond bottom for periodic manual flushing of accumulated metal precipitates from both sections of the limestone bed and into the constructed wetland.

BP4-Pond #1 was constructed following BP4-VFW #1, and BP4-Pond #2 was constructed following BP4-VFW #2 for the purpose of metal precipitate removal using detention time and settling mechanisms. Inlet structure #2 (BP4-Pond #1) and inlet structure #3 (BP4-Pond #2) were installed in the two settling ponds to allow for adjustment of the water elevation in response to sediment and/or metals accumulation. Inlet structure #2 also provides the opportunity to lower the water level in BP4-Pond #1 prior to manual flushing of BP4-VFW #1 to allow the metal precipitates in the flush water enough retention time to settle out. Both inlet structures #2 and #3 also allow for dewatering of the ponds for maintenance purposes (e.g., sludge removal). Following the four BP4 treatment ponds, the water is discharged to a limestone-lined channel and into the constructed wetland where it combines with the other two treated AMD discharges, BP2 and BP3, to form one final treated discharge to an existing wetland and ultimately Piersons Run. The 0.2-acre constructed wetland provides tertiary treatment using biological and filtering mechanisms to remove any remaining metals for all three AMD discharges prior to final discharge from inlet structure #4 into an existing wetland area and eventually down to Piersons Run.

The two VFWs, two settling ponds, and constructed wetland were constructed with emergency spillways to serve as back-up outlets in case the primary outlet structure should fail for any reason, which also helps to prevent failure of the constructed embankments. The four BP4 treatment ponds have either inline or inlet water level control structures as their primary outlet structures.

OPERATIONAL CHECK-UPS

In order to ensure the proper operation of the passive treatment system for the three AMD discharges on-site at Boyce Park, periodic water quality sampling and flow measurements at various locations within the system must be collected and monitored. The water quality sampling and flow measurement events must be conducted prior to any manual or automatic flushing events from the different treatment system components, due to their potential impact on the results. Water quality sampling and flow measurements shall be collected at the indicated locations (see descriptions below and Figure 1) at least once every six months to provide periodic snapshots of the system operation.

Flow rates must be measured at all locations, wherever possible, where water (AMD) enters and leaves the passive treatment system. However, two of the raw AMD discharges, BP2 and BP3 may be difficult to measure flow because of the capture structures and the methods of introduction into their respective treatment ponds, but can be readily sampled for water chemistry. In addition, understanding flow rates of the limestone-containing ponds may help to identify problems associated with hydraulic conductivity or permeability of the treatment layers in the ponds. All locations identified as flow measurement locations for the passive treatment system shall be measured using the bucket and stopwatch approach or through visual estimation if necessary. It is recommended to survey and install staff gauges in front of each inlet structure (total of four) in order to make flow measurements at these locations easier, which eliminates the bucket and stopwatch approach and simply requires reading the water level on the staff gauge that correlates to a flow rate specific to each location. As indicated above, the flow measurements and water quality sampling shall be conducted every six months at a minimum at the following locations.

Flow and Water Chemistry Sampling Points

1 - Outlet of Inlet Structure #1 (BP2/BP3-Pond Outfall)
2 - Outlet of Inlet Structure #3 (BP4-Pond #2 Outfall)
3 - Outlet of Inlet Structure #2 (BP4-Pond #1 Outfall)
4 - Outlet of Pipe Into Inlet Box w/ Grate #2 (BP4 Raw)
5 - Outlet of Inlet Structure #4 (Constructed Wetland/Final Outfall)

Water Chemistry Only Sampling Points

1 - Outlet of Collapsed Pipe Structure Into BP2-Limestone Pond (BP2 Raw)
2 - Surface Discharge into Inlet Box w/ Grate #1 (BP3 Raw)

Flow Only Measurement Point

1 - Outlet of Inline Structure #1 Into BP2/BP3-Pond (BP3-VFW Outfall)

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Water quality sampling shall include both field measurements and water samples collected and sent for analysis to an off-site independent laboratory. Water samples collected and sent to an off-site independent laboratory for analysis shall be performed at least once every six months at the seven locations indicated above and shall include the following parameters for analysis.

- Total and Dissolved Iron
- Total and Dissolved Aluminum
- Total Manganese
- Total Alkalinity
- Hot Acidity
- pH

For the dissolved iron and aluminum analyses, the water sample can be either filtered in the field or sent to the laboratory unpreserved for filtering. In addition to these standard analyses performed at least twice a year, other field analyses should be performed more frequently to closely track the system operation to serve as indicators of maintenance. Field kits and meters can be used to easily measure parameters at the site for such things as acidity, alkalinity, total iron, and pH. Since certain components of the treatment system may require somewhat frequent maintenance, as often as once a month for flushing some of the VFW ponds, it would be advantageous to simultaneously measure some of the parameters easily measured in the field such as acidity, alkalinity, and pH at certain locations. However, it is important to note that water quality measurements should not be collected for an outfall of a pond during a flushing event from the upstream pond(s). A good example of this would be, while BP2-Limestone Pond is flushing from the automatic dosing siphon into BP2/BP3-Pond, water quality samples or flow measurements should not be collected for either pond, BP2-Limestone Pond or BP2/BP3-Pond. Locations recommended for field testing of water quality (at a minimum pH, acidity, and alkalinity) during more frequent maintenance activities should include the following.

Water Quality and Flow Sampling Points:

1 - Outlet of Inlet Structure #1 (BP2/BP3-Pond Outfall)
2 - Outlet of Inlet Structure #2 (BP4-Pond #1 Outfall)
3 - Outlet of Inlet Structure #3 (BP4-Pond #2 Outfall)
5 - Outlet of Inlet Structure #4 (Constructed Wetland/Final Outfall)

MAINTENANCE ACTIVITIES

In order to maintain the functionality and longevity of the passive treatment system for the three AMD discharges at the Boyce Park site, periodic maintenance must be performed. While certain components of the treatment system may require more frequent monitoring and maintenance and a basic outline can be set forth in this document to provide guidelines for performing maintenance on the system components, flow rates and water quality data collected from the site at the locations indicated above will ultimately provide the best information necessary for performing maintenance activities at the site. Each component of the passive treatment system is discussed below relative to potential maintenance activities and the estimated frequency associated with each activity. Following the component specific maintenance activities, general maintenance items associated with the site will be mentioned.

BP2 - LIMESTONE POND

The limestone pond is operated by an automatic dosing siphon which performs automatic flushes of the limestone bed regularly based on flow rates of the BP2 discharge. However, checking the operation of the manhole with dosing siphon, manually flushing the limestone using the manual flush valve #1, and stirring of the limestone material will all need to be performed on differing frequencies to keep this component functioning properly. Depending on the duration of maintenance site visits, it may be difficult to discern the cycle of the automatic dosing siphon, since the unit may operate for a few hours, then shut off for several hours or days before activating. The main goal is to check to make sure that the dosing siphon is performing this cycle and to make sure that it is not constantly discharging water or never discharging water at all. The manual flush valve #1 can be opened periodically to check the amount of accumulated materials in the limestone bed, which may help to allow the dosing siphon to work more efficiently. Prior to opening the manual flush valve #1 for the BP2-Limestone Pond, the water level must be dropped in BP2/BP3-Pond. This will also be necessary for conducting flush events in BP3-VFW, so it is important to drain enough water out of BP2/BP3-Pond to accommodate flushes from both ponds. Removing the top two stoplogs in inlet structure #1 should be sufficient volume to handle flushes from both upstream ponds. Once the water level has reached the top of the remaining stoplogs and water is no longer discharging from inlet structure #1, replace the two stoplogs. Then, opening the manual flush valve #1 in the BP2-Limestone Pond for ten minutes at least once per quarter should be sufficient for assisting the dosing siphon with accumulated metal precipitate removal from the limestone void spaces. Finally, if after manually flushing BP2-Limestone Pond the AMD is not being treated adequately or if visual observations of the limestone bed indicate short-circuiting of water across the top of the limestone due to material accumulation or armoring on the surface, then arrangements should be made to stir up the top few feet of limestone with a piece of equipment such as a backhoe, making sure to not damage the perforated piping network at the bottom of the pond.

BP3 - VFW

This VFW will require periodic flushing using inline structure #1 and monitoring of outfall water quality to determine when the limestone and/or compost layer needs stirred or replaced (compost only). Flushing of the VFW will require drawing down of the water volume in BP2/BP3-Pond in order to provide enough capacity in the settling pond to accommodate the flush as well as from the BP2-Limestone Pond when necessary. If only the VFW is to be flushed, only one stoplog needs to be removed from inlet structure #1 in BP2/BP3-Pond, which needs re-placed once the water level drops to the top of the remaining stoplogs and then the stoplog should be replaced. The BP3-VFW should be flushed at least once per quarter for approximately 15 minutes by removing all of the stoplogs from inline structure #1. After 15 minutes, replace all of the removed stoplogs, making sure to provide a 2-foot water column over the compost layer in the VFW. Finally, if after manually flushing the BP3-VFW the AMD is not being treated adequately or if visual observations of the compost layer indicate short-circuiting of water across the top of the compost due to iron precipitates (orangish-red colored material) on the surface, then arrangements should be made to stir up the compost layer and if possible to remove the accumulated iron. The top layer of limestone just beneath the compost layer should also be stirred to loosen up accumulated aluminum precipitates with a piece of heavy equipment such as a backhoe, making sure to not damage the perforated piping network near the bottom of the pond. The water level in the VFW will need to be lowered to perform the maintenance on the compost and upper limestone layers by removing enough stoplogs in inline structure #1 to keep the water level below the layer to be stirred.

BP4 - VFW #1

This VFW will require frequent manual flushing using inline structure #2 and manual flush valve #2 attached to upper and lower piping networks within the limestone bed. It is imperative to rely on monitoring of the outfall water quality to determine when the limestone and/or compost layer needs to be stirred or replaced (compost only). Flushing of the VFW will require drawing down of the water volume in BP4-Pond #1 in order to provide enough capacity in the settling pond to accommodate the flush volume. Only one stoplog needs to be removed from inlet structure #2 in BP4-Pond #1, which needs to be replaced once the water level drops to the top of the remaining stoplogs and then the stoplog should be replaced. BP4-VFW #1 should be flushed at least once a month for approximately 15 minutes by removing all of the stoplogs from inline structure #2 and operating the manual flush valve #2. After 15 minutes, shut off the manual flush valve #2 and replace all of the removed stoplogs in the inline structure #2 making sure to provide a 2-foot water column over the compost layer in the VFW. Finally, if after manually flushing the BP4-VFW #1 the AMD is not being treated adequately or if visual observations of the compost layer indicate short-circuiting of water across the top of the compost due to iron precipitates on the surface, then arrangements should be made to stir up the compost layer and if possible to remove the accumulated iron material. The top layer of limestone just beneath the compost layer should also be stirred to loosen up accumulated aluminum precipitates with a piece of heavy equipment such as a backhoe, making sure to not damage the perforated piping network near the bottom of the pond. The water level in the VFW will need to be lowered to perform the maintenance on the compost and upper limestone layers by removing enough stoplogs in inline structure #2 to keep the water level below the layer to be stirred.

BP4 - VFW #2

This VFW will require frequent manual flushing using inline structure #3 and primarily manual flush valve #3 attached to upper and lower piping networks within the limestone bed. It is imperative to rely on monitoring of the outfall water quality to determine when the limestone and/or compost layer needs to be stirred or replaced (compost only). Flushing of the VFW will require drawing down of the water volume in BP4-Pond #2 in order to provide enough capacity in the settling pond to accommodate the flush volume. The water level in the constructed wetland will not require a drawdown since the volume is fairly significant and other inflows will affect the ability to draw it down in a reasonable time frame. Only one stoplog needs to be removed from inlet structure #3 in BP4-Pond #2, which needs to be replaced once the water level drops to the top of the remaining stoplogs and then the stoplog should be replaced. BP4-VFW #2 should be flushed at least once every two months for approximately 15 minutes by removing all of the stoplogs from inline structure #3 and operating the manual flush valve #3. After 15 minutes, shut off the manual flush valve #3 and replace all of the removed stoplogs in the inline structure #3 making sure to provide a 2-foot water column over the compost layer in the VFW. Finally, if after manually flushing BP4-VFW #2 the AMD is not being treated adequately or if visual observations of the compost layer indicate short-circuiting of water across the top of the compost due to iron precipitates on the surface, then arrangements should be made to stir up the compost layer and if possible to remove the accumulated iron material. The top layer of limestone just beneath the compost layer should also be stirred to loosen up accumulated aluminum precipitates with a piece of heavy equipment such as a backhoe, making sure to not damage the perforated piping network near the bottom of the pond. The water level in the VFW will need to be lowered to perform the maintenance on the compost and upper limestone layers by removing enough stoplogs in inline structure #3 to keep the water level below the layer to be stirred.

BP2/BP3 - POND

This settling pond receives two different outfalls - the first is from inline structure #1 that constantly discharges water from the BP3-VFW and the second is from the rock-lined channel that receives the discharge from the BP2-Limestone Pond dosing siphon and manual flush valve #1. The BP2/BP3-Pond uses inlet structure #1 as its primary outlet with an emergency spillway in the downstream berm to handle excess flows in the pond or problems with the primary outlet. Each time that a site visit is conducted for maintenance, which is monthly for other components of the treatment system, inlet structure #1 should be inspected for debris accumulation around the top stoplog and removed as needed. During manual flush events for the BP2-Limestone Pond and BP3-VFW, the water level in the BP2/BP3-Pond must be reduced to allow for retention of the flush volume within the settling pond. This is accomplished by removing one stoplog per pond to be flushed, so if just BP2-Limestone Pond needs to be flushed, one stoplog is removed from inlet structure #1 and is replaced upon dewatering the pond to the point of no discharge and then the BP2-Limestone Pond is manually flushed.

Sludge accumulation within the settling pond is dependent on the treatment efficiency of the two upstream ponds and flow rates entering the pond. However, every two years, the sludge levels in the bottom of the pond should be measured. Once the sludge levels accumulate to more than 1.5 feet at any location within the pond, steps should be taken to perform a sludge clean-out event. Depending on the method used for sludge cleanout, dewatering most or all of the water from the pond will be necessary by removing stoplogs from inlet structure #1 as well as potentially routing the two inflows around the pond temporarily. Methods of sludge removal include the use of a vacuum truck, pumping and dewatering the sludge material in a geomembrane textile bag, or completely dewatering the pond and using heavy equipment with a bucket to remove the material and place it in a pile on the site for drying before hauling off-site. Upon removal of the sludge material, the stoplogs should be replaced in inlet structure #1 and the two inflows may be directed back into the pond.

BP4-POND #1 AND BP4 - POND #2

These two settling ponds each receive an outfall from a VFW. BP4-Pond #1 receives the BP4-VFW #1 outfall from inline structure #2 and manual flush valve #2, and BP4-Pond #2 receives the BP4-VFW #2 outfall from inline structure #3. The BP4-VFW #1 inline structure #2 and manual flush valve #2 both discharge into a short rock-lined channel that outlets into the BP4-Pond #1. The BP4-VFW #2 inline structure #3 discharges into the BP4-Pond #2. BP4-Pond #1 uses inlet structure #2 and BP4-Pond #2 uses inlet structure #3 as their primary outlets with emergency spillways in the downstream berms to handle excess flows in the pond or problems with the primary outlet. Each time that a site visit is conducted for maintenance, which is monthly for other components of the treatment system, the inlet structure #2 and inlet structure #3 should be inspected for debris accumulation around the top stoplog and removed as needed. During manual flush events for the BP4-VFW #1, the water level in the BP4-Pond #1 must be reduced to allow for retention of the flush volume within the settling pond. This is accomplished by removing one stoplog from inlet structure #2 and replacing it upon dewatering the pond to the point of no discharge and then the BP4-VFW #1 is manually flushed. During manual flush events for the BP4-VFW #2, the water level in the BP4-Pond #2 must be reduced to allow for retention of the flush volume within the settling pond. This is accomplished by removing one stoplog from inlet structure #3 and replacing it upon dewatering the pond to the point of no discharge and then the BP4-VFW #2 is manually flushed from inline structure #3.

Sludge accumulation within the settling ponds is dependent on the treatment efficiency of the upstream VFW pond and flow rates entering the ponds. However, every two years, the sludge levels in the bottom of the ponds should be measured. Once the sludge levels accumulate to more than two feet at any location within the ponds, steps should be taken to perform a sludge clean-out event. Depending on the method used for sludge cleanout, dewatering most or all of the water from the ponds will be necessary by removing stoplogs from inlet structure #2 or inlet structure #3 as well as potentially routing the inflow from inline structure #2 or inline structure #3 around the ponds temporarily. Methods of sludge removal include the use of a vacuum truck, pumping and dewatering the sludge material in a geomembrane textile bag, or completely dewatering the pond and using heavy equipment with a bucket to remove the material and place it in a pile on the site for drying before hauling off-site. Upon removal of the sludge material from either pond, the stoplogs should be replaced in respective inlet structure, #2 or #3, and the inflow may be directed back into the pond.

CONSTRUCTED WETLAND

The constructed wetland is the final design component of the treatment system that receives all three of the treated AMD discharges from the site and provides final polishing/ tertiary treatment for the water before discharging to an existing wetland feature and ultimately Piersons Run. The constructed wetland receives the BP4-VFW #2 outfall from manual flush valve #3 and the combined outlet from a rock-lined channel that includes the outfall from the BP4-Pond #2 inlet structure #3 and the outfall from the BP2/BP3-Pond inlet structure #1. The constructed wetland uses inlet structure #4 as its primary outlet with an emergency spillway in the downstream berm to handle excess flows in the pond or problems with the primary outlet. Each time that a site visit is conducted for maintenance, which is monthly for other components of the treatment system, the inlet structure #4 should be inspected for debris accumulation around the top stoplog and removed as needed. During manual flush events for the BP4-VFW #2, the water level in the constructed wetland does not need to be reduced.

Sludge accumulation within the constructed wetland is dependent on the treatment efficiency of the upstream ponds and flow rates entering the wetland. However, every two years, the sludge levels in the bottom of the wetland should be measured. Once the sludge levels accumulate to more than one foot at any location within the wetland, steps should be taken to perform a sludge clean-out event. Depending on the method used for sludge cleanout, dewatering most or all of the water from the ponds will be necessary by removing stoplogs from inlet structure #4 as well as potentially routing the inflow from inlet structures #1 and #3 around the wetland temporarily. Methods of sludge removal include the use of a vacuum truck, pumping and dewatering the sludge material in a geomembrane textile bag, or completely dewatering the wetland and using heavy equipment with a bucket to remove the material and place it in a pile on the site for drying before hauling off-site. Care should be taken during the sludge removal process to minimize impacts to the wetland vegetation and to maintain the deep pockets in the wetland for additional sludge volume accumulation. Upon removal of the sludge material from the wetland, the stoplogs should be replaced in inlet structure #4, and the inflow may be directed back into the pond.

GENERAL SITE MAINTENANCE RECOMMENDATIONS

In addition to the maintenance needs for each pond or wetland of the passive AMD treatment system, other components do require some basic inspection and infrequent maintenance work. These items include the two inlet boxes with grates, #1 and #2, that capture two of the raw AMD discharges and route them into the treatment system. Inlet box with grate #1 is the primary concern for maintenance since the BP3 discharge surfaces just upslope of the grate and flows into the top of the inlet box. This grate will need inspection at least once per quarter and cleaned off as needed. The BP4 discharge enters inlet box with grate #2 subsurface, so there is little maintenance required; however, this grate must be kept clear and in working order to allow periodic sampling for water chemistry and flow of the BP4 raw discharge.

All constructed berms/embankments involved with the treatment ponds should be inspected at least twice a year to monitor for burrowing rodent activity and potential failure caused by either excessive flows or areas of surface erosion. Any areas experiencing significant erosion should be immediately regraded and stabilized with seed and mulch. In addition, there are three segments of rock-lined channel on the site that either convey treatment cell outfalls and/or convey surface runoff associated with rainfall events. These rock-lined channels should be inspected and monitored for both coating of the limestone with metal precipitates from the treatment process (either white or orangish-red material) and wash-out of the stone. It may be necessary to periodically replace the stone following a wash-out or simply the stir-up the stone to remove any coatings.

REPLACEMENT OF TREATMENT COMPONENTS/MATERIALS

The treatment cells containing limestone are designed to provide adequate treatment for 25 years. After 25 years of operation, the contents of the treatment cells must be replenished. However, care must be taken to avoid damaging the piping networks in the bottom (and middle for the BP4 VFWs) of the limestone layers. For the BP2-Limestone Pond, this is simply a matter of dumping more limestone in and perhaps mixing the fresh stone into the existing stone with a backhoe or excavator. With the VFWs, the compost layer must be replaced and additional limestone added. The old compost may be blended in with the new compost if it appears to be in suitable condition (absence of significant orangish-red sludge). Otherwise, it must be disposed of off-site at additional cost. Once the contents of the treatment cells have been replenished, they should provide adequate treatment for another 25 years.