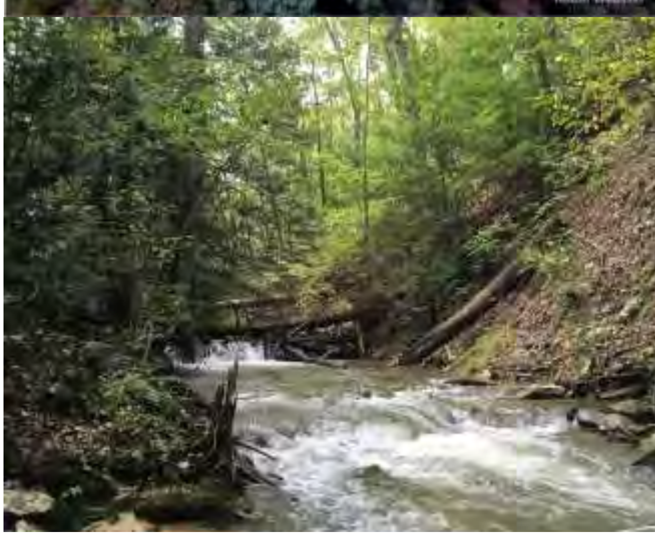
December 2019

# North Fork Greens Run Watershed Based Plan

## Friends of the Cheat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**ACKNOWLEDGEMENTS**

The North Fork Greens Run Watershed Based Plan Project was made possible by a §319 grant from the West Virginia Department of Environmental Protection Nonpoint Source Program.  Friends of the Cheat would like to give special thanks to the mentorship and guidance given by Martin Christ, Tim Craddock, and Tiff Hilton in the use of AMDTreat.  We would like to thank Jon Knight, Sheila Vukovich, and Ladd Williams for their help with data acquisition and site location.  Thank you to the landowners for welcoming us and guiding us onto their properties. Thank you to West Virginia University for offering their services with three single pass electrofishing surveys to better understand the aquatic community present in North Fork Greens Run, as well as Nick Murray for training Friends of the Cheat in WVDEP WAB benthic macroinvertebrate sampling protocol.  Thank you to WV DNR, WVDEP WIB and WVDEP WAB for providing input on sharing critical information about Greens Run with FOC.

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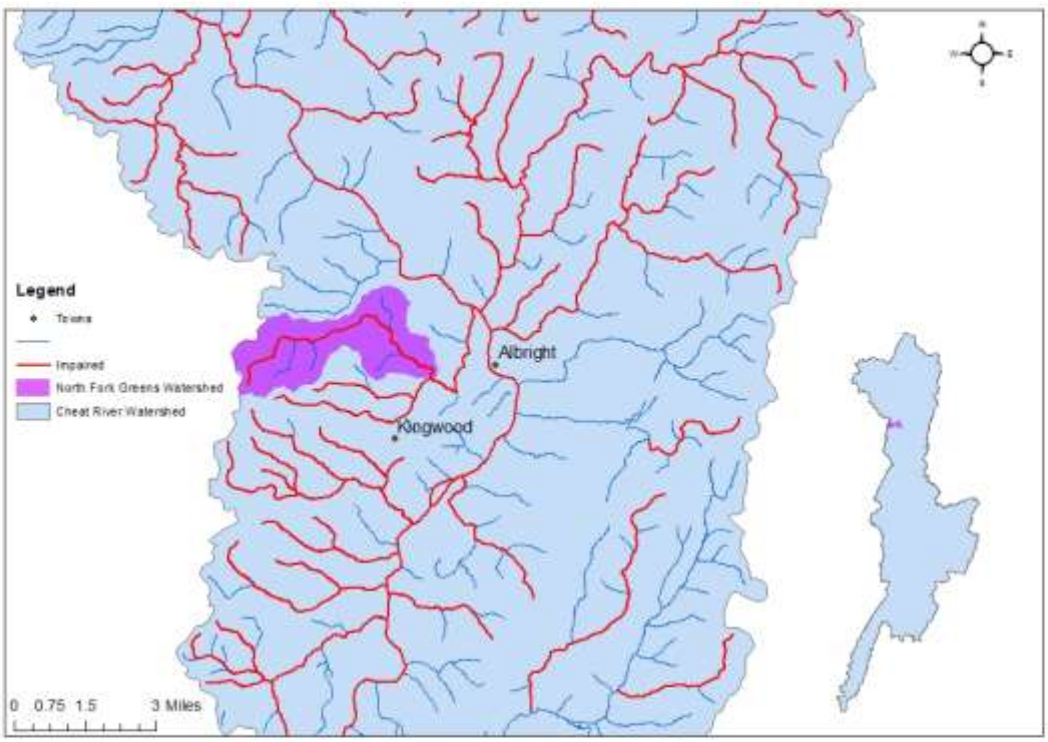
# 1. INTRODUCTION

## 1.1 Purpose

This Watershed Based Plan covers the North Fork of Greens Run watershed in West Virginia, including all tributaries (Figure 1). North Fork of Greens Run and its tributaries are impaired by Fe, Al, pH, and CNA-biological. This document serves as a plan for Friends of the Cheat (FOC) and partnering agencies to implement projects that improve the water quality in the North Fork of Greens Run and its tributaries. Funding for these projects will come from the Environmental Protection Agency under the Clean Water Act Section 319, Office of Surface Mining and Reclamation (OSMRE), West Virginia Department of Environmental Protection (WVDEP), non-government organizations, in-kind donations from interested persons, and volunteers.

This document outlines a restoration plan for the North Fork of Greens Run watershed based on the United States Environmental Protection Agency's Nine Elements of a Watershed Based Plan (1), focusing on the most significant water quality problem, acid mine drainage (AMD).

***Figure 1: North Fork Greens Watershed Map***




## 1.2 Background

From its headwaters in Randolph and Pocahontas Counties, West Virginia, the Cheat River flows 157 miles north to the Pennsylvania state line through Tucker and Preston counties. In its lower 20 miles, the river has been severely polluted by acid mine drainage. Much of this damage has been caused by coal mines that were abandoned before the passage of the Surface Mining Control and Reclamation Act in 1977. Despite efforts by Friends of the Cheat and its partners with support from US EPA, WV DEP, and US Office of Surface Mining, the legacy of AMD persists through the loss of habitat and wildlife, deteriorated aesthetic value of polluted waterways, degraded drinking water, and economic losses from diminished opportunities for recreation such as boating and fishing.

The North Fork of Greens Run, which is a tributary to the Cheat River, currently hosts species of fish and there is community support in favor of restoring North Fork of Greens Run into a viable trout fishery. For these reasons, Friends of the Cheat and its partners have targeted North Fork of Greens Run to create a Watershed Based Plan to assess and address sources of point and nonpoint pollution within the watershed. Previous AMD remediation projects include “Railroad Refuse” and “Dinkenburger” projects. These projects were implemented with CWA §319 funds and have improved water quality within the watershed.

In the past FOC has chosen project sites based primarily on landowner interest. While still considering landowner interest, this plan is designed to make the stream system meet water quality standards based on the goals set by the 2011 Cheat River Basin TMDL. This plan will act as a guide for FOC to prioritize restoration efforts based on feasibility and projected water quality success. Landowners in priority restoration sites are listed in Appendix C.

## 2. IDENTIFICATION OF CAUSES AND SOURCES OF IMPAIRMENT

The Clean Water Act section 303(d) requires states to identify and list streams that do not meet water quality standards. Water quality standards are based on the designated uses of the stream. The numeric water quality standards in **Error! Reference source not found.** are relevant for the pollution problems addressed by this watershed-based plan. Impairments in the North Fork of Greens Run Watershed include pH, dissolved Al, Fe, and CNA biological. Fe, Al, and pH impairments are commonly a result of AMD (acid mine drainage) in this region. This watershed-based plan focuses on these AMD - caused impairments, which may also cause the CNA biological listing. Table 2 lists the streams designated as impaired by pH, dissolved Al, or Fe on the 303(d) list of impaired streams in the North Fork of Greens Run Watershed that also are listed on the TMDL with required reductions of pollutants from AMLs.  Figure 2 highlights these streams in red.

***Table 1: West Virginia State Water Quality Criteria***

| Pollutant | Designated Use | | | | |
|---|---|---|---|---|---|
| | Aquatic Life | | | | Human Health |
| | Warmwater Fisheries | | Trout Waters | | Contact Recreation & Public Water Supply |
| | Acute[a] | Chronic[b] | Acute[a] | Chronic[b] | |
| Aluminum, dissolved (µg/L) | 750 | 750 | 750 | 87 | -- |
| Iron, total (mg/L) | -- | 1.5 | -- | 0.5 | 1.5 |
| pH | No values below 6.0 or above 9.0 | No values below 6.0 or above 9.0 | No values below 6.0 or above 9.0 | No values below 6.0 or above 9.0 | No values below 6.0 or above 9.0 |

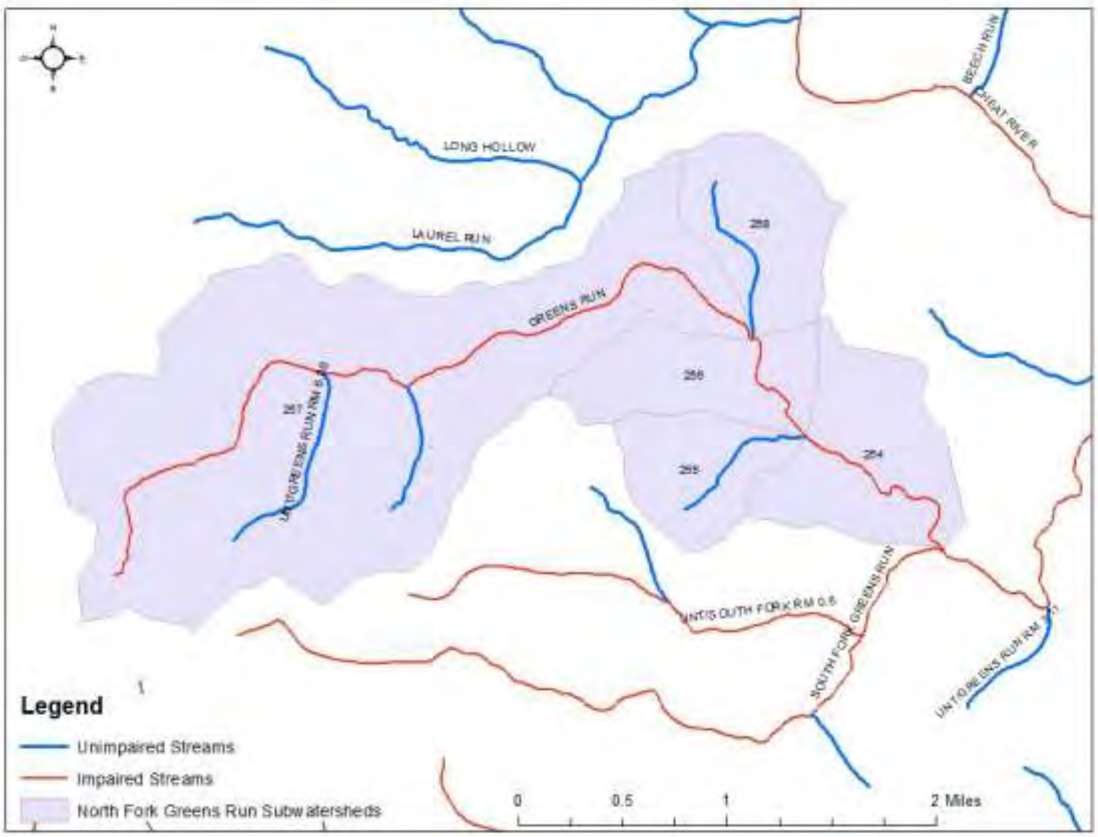
[a] One-hour average concentration not to be exceeded more than once every 3 years on the average.
[b] Four-day average concentration not to be exceeded more than once every 3 years on the average.
Source: 47 CSR, Series 2, *Legislative Rules, Department of Environmental Protection: Requirements Governing Water Quality Standards (2)*.

*Table 2: Impaired Streams in North Fork of Greens Watershed*

| Stream Name | NHD Code | Stream Code | SWS Code | HUC 12 Code | pH | Fe | Al | Bio |
|---|---|---|---|---|---|---|---|---|
| Greens Run | WV-MC-38 | WVMC-16 | SWS 254 | 050200040705 | X | X | X | X |
| Greens Run | WV-MC-38 | WVMC-16 | SWS 256 | 050200040705 | X | X | X | X |
| Greens Run | WV-MC-38 | WVMC-16 | SWS 257 | 050200040705 | X | X | X | X |

An "x" identifies parameters that impair the stream. Source: All are from the 2014 303(d) list Supplemental Tables B and E (WVDEP, 2014a). This table also includes the WV Stream Code used in the 2011 Cheat TMDL and NHD codes in the 2014 303(d) list (3).

*Figure 2: pH, Fe, and/or Al Impaired Streams in the North Fork of Greens Watershed*




A total maximum daily load (TMDL) is the maximum amount of pollution a stream can receive and meet water quality standards. The goal of this watershed based plan is to meet required reductions of Fe, Al, and acidity loads from AML seeps set by the 2011 Cheat River Basin TMDL, developed by the West Virginia Department of Environmental Protection. The endpoint goals of the TMDL are shown in Table 3. The TMDL accounts for waste load allocations (WLA) from permitted point sources and load allocations (LA) from nonpoint sources. The TMDL includes a margin of safety (MOS) to account for uncertainty in the TMDL process. The TMDL is expressed as, TMDL = ΣWLA + ΣLA + MOS (4).

*Table 3: TMDL Endpoints for Applicable Water Quality Criteria*

| Water Quality Criterion | Designated Use | Criterion Value | TMDL Endpoint |
|---|---|---|---|
| Total Iron | Aquatic life, warm water fisheries | 1.5 mg/L (4-day average) | 1.425 mg/L (4-day average) |
| Dissolved Aluminum | Aquatic life, trout waters | 0.087 mg/L (4-day average) | 0.0827 mg/L (4-day average) |

TMDL Endpoints are used to establish the TMDL and are based on water quality standard 47 CSR, Series 2, Legislative Rules, Department of Environmental Protection: Requirements Governing Water Quality Standards (3).

## 2.1 WLAs – Permitted Sources of Pollution

Wasteload allocations are for specific point sources, which require National Pollutant Discharge Elimination System (NPDES) permits. While many of these sites contribute significant amounts of AMD, they are not discussed in detail in this watershed-based plan as the focus is on nonpoint sources that do not have a responsible party for treatment. FOC expects that WVDEP, through its enforcement branches, will work with permittees to prevent permitted discharges from exceeding wasteload allocations.

### *Bond Forfeiture Sites*

Bond Forfeiture (BF) sites are sites on which the operator did not sufficiently reclaim the land or water after mining. These occur when the operator abandons the property prior to reclamation, or when, due to violations, WVDEP forces operations to cease prior to reclamation. BF sites are considered to be point sources and are assigned wasteload allocations.

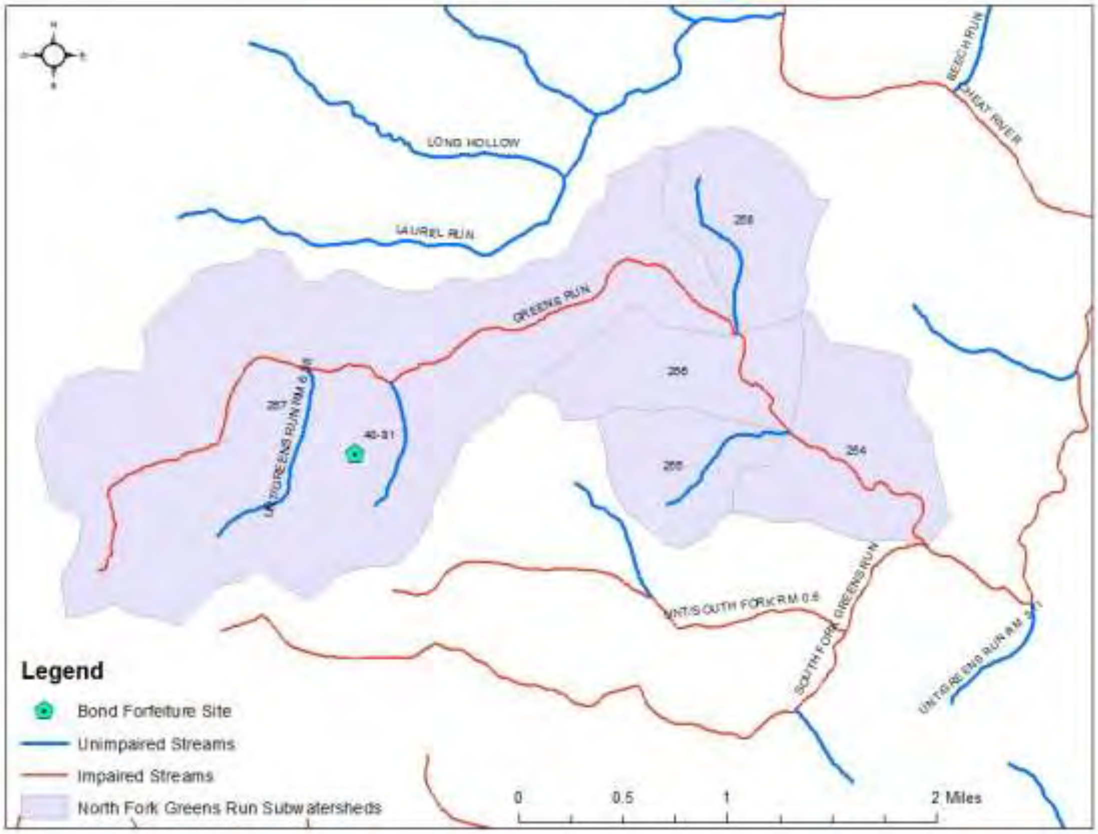
Table 4 lists bond forfeiture sites in the North Fork of Greens Run watershed that have load reduction goals in the TMDL. A GIS database from WVDEP Office of Special Reclamation (OSR) was used to check whether BF sites are meeting the TMDL reduced load goal according to the latest data from 2018.

Figure 3 shows the single bond forfeiture site in the watershed as of 2019. The results of court decision West Virginia Highlands Conservancy and West Virginia Rivers Coalition vs. Randy Huffman, known as the "The Keeley Decision", requires these bond forfeiture sites to be treated to meet water quality standards by OSR. Therefore, this watershed based plan will not provide pricing or restoration plans for these BF sites and will assume that these will meet required reduction.

*Table 4: Bond Forfeiture Site from 2011 Cheat River TMDL and OSR Database in the North Fork of Greens Run Watershed*

| **Stream Code** | **Stream Name** | **SWS** | **Permit** | **Metal** | **Baseline Load (lbs/yr)** | **Reduced Load (lbs/yr)** | **Data Source** | **Status** |
|---|---|---|---|---|---|---|---|---|
| **WV-MC-38** | Greens Run | 257 | 40-81 | Aluminum | 469 | 469.48 | TMDL | Active |
| | | | | Iron | 1155 | 541.57 | | |

*Figure 3: Bond Forfeiture Site within the North Fork of Greens Watershed*




### *Active Mining Permits*

There are no current active mining permits with NPDES permits in the North Fork Greens watershed. Other point sources include non-mining NPDES permits (Table 5).

### *Active Non-Mining Permits*

Other point sources include active non-mining NPDES permits, listed below (Table 5).

*Table 5: Active Non-mining WLAs within North Fork of Greens Run watershed from 2011 Cheat River Basin TMDL*

| Stream Code | Stream Name | Metal | SWS | PERMIT | Baseline Load (lbs/yr) | Allocated Load (lbs/yr) | Permit Type |
|---|---|---|---|---|---|---|---|
| WV-MC-38 | Greens Run | Iron | 254 | WVG610152 | 3 | 3 | Stormwater Industrial |
| WV-MC-38 | Greens Run | Iron | 257 | WVG610880 | 8 | 8 | Stormwater Industrial |

## 2.2 Nonpoint Source Impairments

The model used to develop the 2011 Cheat River Basin TMDL considers land use and known features in order to estimate the pH, Al, and Fe runoff from nonpoint sources like abandoned mines, harvested forest, oil and gas, barren land, urban areas, and roads. "Other nonpoint sources" and stream bank erosion are also considered in the total baseline load but excluded in the calculations of required load reduction (4).

According to the 2011 Cheat River Basin TMDL  load allocations spreadsheet, the acidity, Fe, and Al loads from abandoned mines comprise the highest percentage of the nonpoint source baseline load of Fe and Al (other than the aforementioned "other nonpoint sources" and stream bank erosion) and require the highest reductions. Therefore, this watershed-based plan aims to accomplish the total required reduction from AMLs in the stream as set by the 2011 Cheat Basin TMDL in order to remove the stream from the 303(d) list. This plan will only accomplish the load allocation for abandoned mine lands as set by the TMDL. Any remaining impairment will be addressed by a second phase of restoration to be guided with a new WBP focusing on fecal coliforms, sediment, stream bank protection, and other types of measures.

### *Abandoned Mine Lands*

Discharges from the 2011 Cheat River Basin TMDL and seeps from the FOC database were assessed in order to form the following list of all of the known seeps in the North Fork of Greens Run watershed (Table 6). The baseline load and reduced loads are from the 2011 Cheat River Basin TMDL. The required reduction was calculated using the baseline load and reduced load (4). If the seeps were not listed on the 2011 Cheat River Basin TMDL, the baseline load was calculated from FOC data and the required reduction is listed as 100%. Appendix B displays maps of each SWS watershed, known TMDL AMD sources, as well as FOC discovered seeps (Unnamed Seep to North Fork Greens Run, shown in Figures 4, 5, and 6).

*Table 6: Causes and Sources of Impairment from Abandoned Mine Lands in North Fork of Greens Watershed*

*indicates that the seep is not listed on the TMDL.  Baseline Load was created by averaging FOC water quality data.  Because seep is not described in TMDL, FOC assumes Required Reduction is 100% of load.

| WV NHD Stream Code | Stream Name | SWS | Seep Name | Metal | Baseline Load (lbs/yr) | Reduced Load (lbs/yr) | Required Reduction (lbs/yr) |
|---|---|---|---|---|---|---|---|
| WV-MC-38 | Greens Run | 257 | MC38-100-1 | Al | 1286 | 19 | 1267 |
| | | | | Fe | 2581 | 38 | 2543 |
| WV-MC-38-F | Greens Run | 257 | MC38-300-1 | Al | 1767 | 28 | 1739 |
| | | | | Fe | 1762 | 56 | 1706 |
| WV-MC-38-F | Greens Run | 257 | MC38-300-2 | Al | 514 | 5 | 509 |
| | | | | Fe | 228 | 10 | 218 |
| WV-MC-38-G | Greens Run | 257 | MC38-350-1 | Al | 245 | 92 | 153 |
| | | | | Fe | 189 | 184 | 5 |
| WV-MC-38-F | Greens Run | 257 | Unnamed Source* | Al | 509 | 0 | 509 |
| | | | | Fe | 103 | 0 | 103 |

## 3. EXPECTED LOAD REDUCTIONS

Load reductions, or "required reductions" are an estimate of how much of the current pollutant load must be removed in order for the pollutant loads to meet the load allocations set by the TMDL for the Cheat River watershed.
The required reductions for the seeps in the impaired SWSs are set by the 2011 Cheat River Basin TMDL to eliminate the excess load in that SWS. Therefore, load reduction goals are set by the load reductions of each seep on the TMDL and expected load reductions are listed for each seep and summed for each SWS in Table 7 and Table 8.

It is important to note that according to FOC's water quality data several SWSs met water quality standards despite being classified as 'Impaired' in West Virginia Department of Environmental Protection's Integrated Report for pH, Fe, Al. There are no functional AMD treatment sites to contribute this improvement in water quality to. The perceived improvement in water quality may be due to the fact that some of the SWSs were modeled for impairment without physical data, or several years have passed since the most recent state sample event. Data was collected between 2006 and 2007 for the SWSs of North Fork Greens Run for the 2011 Cheat River Basin TMDL, allowing the possibility of changes in water quality conditions since 2007.

No reductions are planned for SWSs where mouth data collected by FOC showed that water quality standards were met specifically for Fe, Al, and pH. However, FOC plans to work with the WVDEP Watershed Improvement Branch and WVDEP Watershed Assessment Branch to continue to assess for future listing decisions for SWSs of North Fork Greens Run by WVDEP in regard to Fe, Al, and pH.

For those seeps and SWSs where intervention is clearly needed, treatments are sized to reduce 100% of dissolved Al and total Fe for seeps for which FOC was able to gather water quality data. Proposed treatment measures are sized to remove 100% of total Fe and total Al for seeps for which FOC was not able to gather water data, because the TMDL data that are available for each seep only list total Al. Treatment to remove 100% of total Al will remove 100% of dissolved Al to meet WV water quality standards.

2011 Cheat River Basin TMDL states, "TMDLs for pH impairments were developed using a surrogate approach where it was assumed that reducing instream metal (iron and aluminum) concentrations allows for attainment of pH water quality criteria." (4) This watershed based plan outlines plans to treat to the required reduction of metals set by 2011 Cheat River Basin TMDL, with the understanding that this will also treat the pH.

*Table 7: Dissolved Aluminum Allocations, reductions required, and reductions achieved*

| WV NHD Stream Code | Stream Name | SWS | Discharge Number | Required Reduction of Seep (lbs/yr) as listed in TMDL | Reduction of Seep (lbs/yr) from Mgmt. Measures | % Reduction | Notes |
|---|---|---|---|---|---|---|---|
| WV-MC-38 | Greens Run | 257 | MC38-100-1 | 1,267 | 1,267 | Treated 100% | FOC 'Railroad Refuse' Passive Treatment Site |
| WV-MC-38-F | Greens Run | 257 | MC38-300-1 | 1,739 | 1,739 | 100% | Existing FOC 'Dinkenberger' Passive Treatment Site – Priority Improvement Project Site |
| WV-MC-38-F | Greens Run | 257 | MC38-300-2 | 512 | 512 | Treated 100% | Seep is believed to be collected and treated by 'Hallelujah' Bond Forfeiture Site. Unable to find on ground except for concrete channel leading to 'Hallelujah' BF SI. |
| WV-MC-38-G | Greens Run | 257 | MC38-350-1 | 153 | 0 | No reduction planned | Low Priority—Low flow that is funneled into landowner's livestock pond. No obvious outlet or |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | | direct connectivity to North Fork of Greens Run, nearest tributary unimpaired. |
| WV-MC-38-F | Greens Run | 257 | Unnamed Source* | 509 | 509 | 100% | High Priority Future Treatment Site |
| WV-MC-38 | Greens Run | 257 | TOTAL of all required seep reductions | 4,180 | 4,027 | 96% | |

*Table 8: Total Iron Allocations, reductions required, and reductions achieved*

| WV NHD Stream Code | Stream Name | SWS | Discharge Number | Required Reduction of Seep (lbs/yr) as listed in TMDL | Reduction of Seeps (lbs/yr) from Mgmt. Measures | % Reduction | Notes |
|---|---|---|---|---|---|---|---|
| WV-MC-38 | Greens Run | 257 | MC38-100-1 | 2,543 | 2,543 | Treated 100% | FOC 'Railroad Refuse' Passive Treatment Site |
| WV-MC-38-F | Greens Run | 257 | MC38-300-1 | 1,706 | 1,706 | 100% | Existing FOC 'Dinkenberger' Passive Treatment Site –High Priority Site - Improvement Project Site |
| WV-MC-38-F | Greens Run | 257 | MC38-300-2 | 218 | 218 | Treated 100% | Seep is believed to be collected and treated by 'Hallelujah' Bond Forfeiture Site. |
| WV-MC-38-G | Greens Run | 257 | MC38-350-1 | 5 | 0 | No reduction planned | Low Priority—Low flow that is funneled into landowner's livestock pond. No obvious outlet or direct connectivity to North Fork of Greens Run. |
| WV-MC-38-F | Greens Run | 257 | Unnamed Source* | 103 | 103 | 100% | High Priority Future Treatment Site |
| WV-MC-38 | Greens Run | 257 | TOTAL of all required seep reductions | 4,575 | 4,570 | 99% | |

# 4. PROPOSED MANAGEMENT MEASURES

## 4.1 AMDTreat Calculations

AMDTreat (5.0.2 + PHREEQ) was used to estimate cost for each of the AML discharges in the North Fork Greens Run watershed identified in the 2011 Cheat River Basin TMDL and for which FOC determined reductions were necessary (5). Although the program is capable of designing both active and passive treatment systems, only passive treatment was considered in this plan (Table 10).

AMDTreat contains default values for various components used in the cost estimations.

For high priority sites, water quality data were collected at least two times. For other sites, water quality data for each AML discharge were obtained from the 2011 Cheat River Basin TMDL report (Appendix A). The flow (discharge) was converted to gallons per minute (GPM) and was input as the *Typical Flow*. The *Typical Flow* was multiplied by a 3x safety factor to estimate the *Design Flow. Total Iron, Total Aluminum, Manganese, pH,* and *Sulfate* were entered into the program. Both Lab results and flow were averaged to use as inputs for *Typical Flow, Total Iron, Total Aluminum, Manganese, pH, Alkalinity and Sulfate* in AMDTreat. Lab results without corresponding flow data were not included in the average, and only samples collected from 2014 – 2019 were considered, except data regarding MC38-300-2, which was provided by the 2011 Cheat River Basin TMDL. Data used to input into AMDTreat can be found in the 'AMDTreat Input' tab in the 'North Fork Greens Run Watershed Based Plan Master Spreadsheet' Excel File. AMDTreat Capital Cost Estimates per site can be found in Appendix E: AMDTreat Capital Cost Calculations.

## 4.2 Capital Cost Estimations

For each AML discharge, a theoretical passive treatment was designed to contain a 100-ft oxic limestone channel, a limestone bed, and a settling pond. The limestone bed was sized based on the estimated tons of limestone required *based on acidity neutralization*, plus the estimated tons of limestone required *based on retention time*, entered as the estimated tons of limestone *based on tons of limestone entered*. This sizing method ensures the limestone bed maintains a retention time of 16 hours and adequate acidity neutralization capabilities for a 10-year system life. Additionally, a synthetic liner and AMDTreat Piping Costs were included to the capital cost for each limestone bed. Future site assessment may deem a liner unnecessary for individual systems. A settling pond was sized for a 48 hour retention time. A synthetic liner was also included in the cost estimation.

## 4.3 Other Cost Estimations

In addition to the oxic limestone channel, limestone bed, and settling pond included in the capital cost estimate, a contingency cost of 10% of the capital cost was added to allow for variable economic fluctuations. Additionally, engineering cost was estimated as 10% of the capital cost.

Ancillary costs are included as a percentage of the estimated capital costs, based on site characterization (Table 10). Sites that are more remote and undeveloped require more ancillary cost than previously established sites. These costs include construction costs such as access road construction, clearing and grubbing, culverts and ditching, fencing and gates, incidental stone, mobilization, piping, regrading and revegetation, sediment control, etc. Cost estimates were also determined for remaining planned/ low priority sites (Table 11) and sites where no treatment is currently planned (Table 12) using the above methods.

*Table 1: Scheme for calculating ancillary costs, as a percentage of the capital cost of the passive treatment system.*

| % of estimated capital | Description |
|---|---|
| 60% | New site; poor access; no AML activity anticipated |
| 50% | Established access; no AML activity anticipated |
| 40% | AML reclamation anticipated or completed |
| 30% | Retrofit/improvements required to an existing treatment system |

*Table 2: Proposed Treatment Costs of High Priority Sites*

| Stream | SWS | Discharge | Capital Cost | Ancillary Cost | Contingency Cost | Engineering Cost | Total Cost |
|---|---|---|---|---|---|---|---|
| Greens Run | 257 | MC38-300-1 | $185,421.00 | $55,626.30 | $18,542.10 | $18,542.10 | $278,131.50 |
| Greens Run | 257 | Unnamed Source | $95,754.00 | $57,452.40 | $9,575.40 | $9,575.40 | $172,357.20 |
| Total Treatment Cost for High Priority Sites | | | | | | | $450,488.70 |

*Table 12: Treatment Costs of sites with no planned treatment in the North Fork of Greens Run watershed*

| Stream | SWS | Discharge | Ancillary % | Capital Cost | Ancillary Cost | Contingency Cost | Engineering Cost | Total Cost |
|---|---|---|---|---|---|---|---|---|
| Greens Run | 257 | MC38-300-2 | 50% | $25,443.00 | $12,721.50 | $2,544.30 | $2,544.30 | $43,253.10 |
| Greens Run | 257 | MC38-350-1 | 60% | $34,287.00 | $20,572.20 | $3,428.70 | $3,428.70 | $61,716.60 |
| Total Treatment Cost for Unplanned Sites | | | | | | | | $104,969.70 |

## 4.4 Existing Treatment Sites

Functioning FOC treatment sites (Railroad Refuse) in the North Fork of Greens Run watershed will require maintenance eventually, but calculated costs and methods are not outlined in this plan.

## 4.5 High Priority Treatment Implementation Areas

Treatment of seeps in the following subwatersheds is planned and prioritized because:

A. The 303(d) list lists these streams as impaired by Fe, dissolved Al, or pH.
B. The TMDL lists required reductions of Fe or dissolved Al from AMLs in these subwatersheds.
C. FOC data supports the stream impairments stated in the 303(d) list.

High Priority seeps selected for treatment have the following characteristics:

A. The landowner is interested in partnership.*

B. The seep is accessible for construction.
C. There is space and topsoil available for construction.
D. The seep flow is significant.
E. The pollutant load from the seep is significant.

Table 13 summarizes the known seeps in the sub-watersheds identified as priority treatment areas.

*Landowners designated as "interested in partnership" are designated as such because they were open to the discussion of treatment. We did not go any further with developing partnership, because often the landowners expect a big project to be completed quickly and it can take much longer than they anticipate. Also, communications about projects is difficult when there is Monitoring Coordinator/Project Manager turnover at FOC. It has been most successful to maintain communication, but to develop the partnership relationship closer to the start of the project. Landowner information can be found in Appendix C.

## *High Priority Subwatershed – SWS 257*

All North Fork Greens AML seeps, including the Unnamed Source, occur in SWS 257. Priority Seeps for treatment in SWS 257 include MC38-300-1 and an Unnamed Source, upstream of MC38-300-1 on WV-MC-38-F. An existing FOC treatment site named 'Dinkenberger' has historically treated MC38-300-1, however a Site Improvements project is in need.

Treatment for the Unnamed Source is also a priority. There is a possibility due to the proximity of both seeps to one another to treat these sources with one system, however the current landowner is concerned about the treatment footprint on his property. For the purposes of this plan, cost estimations were done separately for MC38-300-1 and the Unnamed Source, although treating both with one system would likely result in lower cost.

By treating these seeps at 100%, FOC will accomplish 96% of the required load reduction for dissolved Al and 99% of the required load reduction for total Fe within SWS 257, improving water quality downstream, such as at the mouth of SWS 257. Overall, treating these seeps in conjunction with the ongoing treatment of MC38-100-1 (FOC site 'Railroad Refuse') and MC38-300-2 (believed to be funneled into Bond Forfeiture Site 'Hallelujah') would remove 4027 lbs/yr of dissolved Al and 4570 lbs/yr total Fe from SWS 257 and ultimately North Fork of Greens Run.

FOC water quality data shows that the mouth of Nork Fork of Greens Run (SWS 254) has consistently met water quality standards since sampling from 2005. An electrofishing survey through assistance from West Virginia University revealed Creek Chub (*Semotilus atromaculatus)* in multiple age classes are utilizing this reach of North Fork Greens Run, evidence that water quality at the mouth can support aquatic life. Results of electrofishing Survey can be found in Appendix D. FOC is confident by treating MC38-300-1 and the Unnamed Source in MC-WV-38-F, as well as continued treatment of MC38-100-1 and MC38-300-2 that water quality will improve at SWS 257 Mouth to meet water quality standards, and likely improve water quality for SWS 256 and SWS 254. FOC water quality data has shown that SWS 254, SWS 255, and SWS 256, and SWS 258 are not impaired for pH, dissolved Al, or total Fe.

FOC will conduct post monitoring after completion of priority sites in order to assess success and will work with WVDEP WIB and WAB to assess future listing decisions of SWS 254, SWS 256, and SWS 257 if supported by data.

### MC38-300-1

This seep has historically been treated by an FOC passive treatment system—the "Dinkenberger" site. This site has been underperforming since 2013, and little treatment has occurred in more recent sampling, with only slight improvement from Dinkenberger System In to Dinkenberger System Out. Cause of treatment failure is thought to be due to limitations in the size of the limestone leach bed for current concentrations. The current landowner historically has been open to communication, but hesitant in increasing the size of the treatment system footprint on his property. However, new technology may be available since the last improvement project (2012) and FOC will continue to work with the landowner to reach a goal of treating MC38-300-1. The WV DEP Office of Abandoned Mine Lands is also interested in repairing the berm of the existing limestone bed that once treated MC38-300-1. This seep is the major untreated source of acidity, dissolved Al, and total Fe for the entire North Fork Greens Run watershed and thus is FOC's highest priority site.

## Unnamed Source

Upstream of MC38-300-1 water quality remains poor in WV-MC-38-F. Monitoring Coordinator Madison Ball walked the remainder of MC38-300-1 until the channel morphology becomes ephemeral, with poor water quality throughout the stream reach. By looking at LIDAR imagery (Figure 4) as well as USGS topography Kingwood WV quadrant (Figure 5) and aerial imagery (Figure 6) it is clear mining has occurred in the area, although an exact seep location has not been historically described. There appears to be no direct AMD source or seep, although once the channel morphology changes to intermittent the water quality remains poor throughout the stream reach. FOC proposes a passive treatment site for the Unnamed Source of acid mine drainage. FOC will work with an engineer and the landowner to determine the best treatment options available for this site. Although acidity, dissolved Al and total Fe loads are estimated using FOC data, they are noteworthy and treatment of both MC38-300-1 and the Unnamed Source would lead to much improved water quality of WV-MC-38-F, and remediate the two largest untreated sources of acidity, Al, and Fe to SWS 257 and the greater North Fork of Greens Run watershed.

*Figure 4: LIDAR imagery of Unnamed Seep*

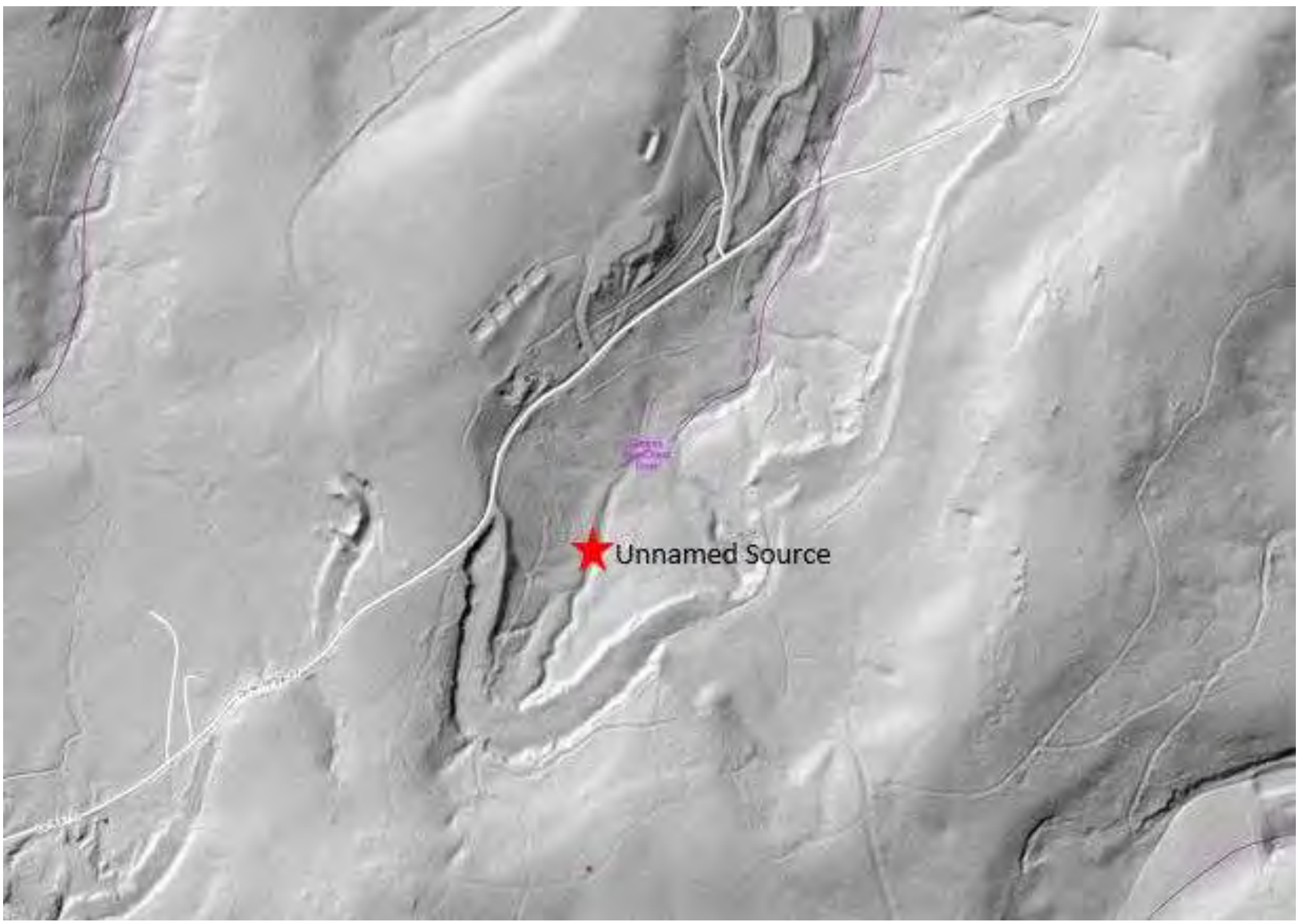


*Figure 5: USGS Topography of Unnamed Seep*

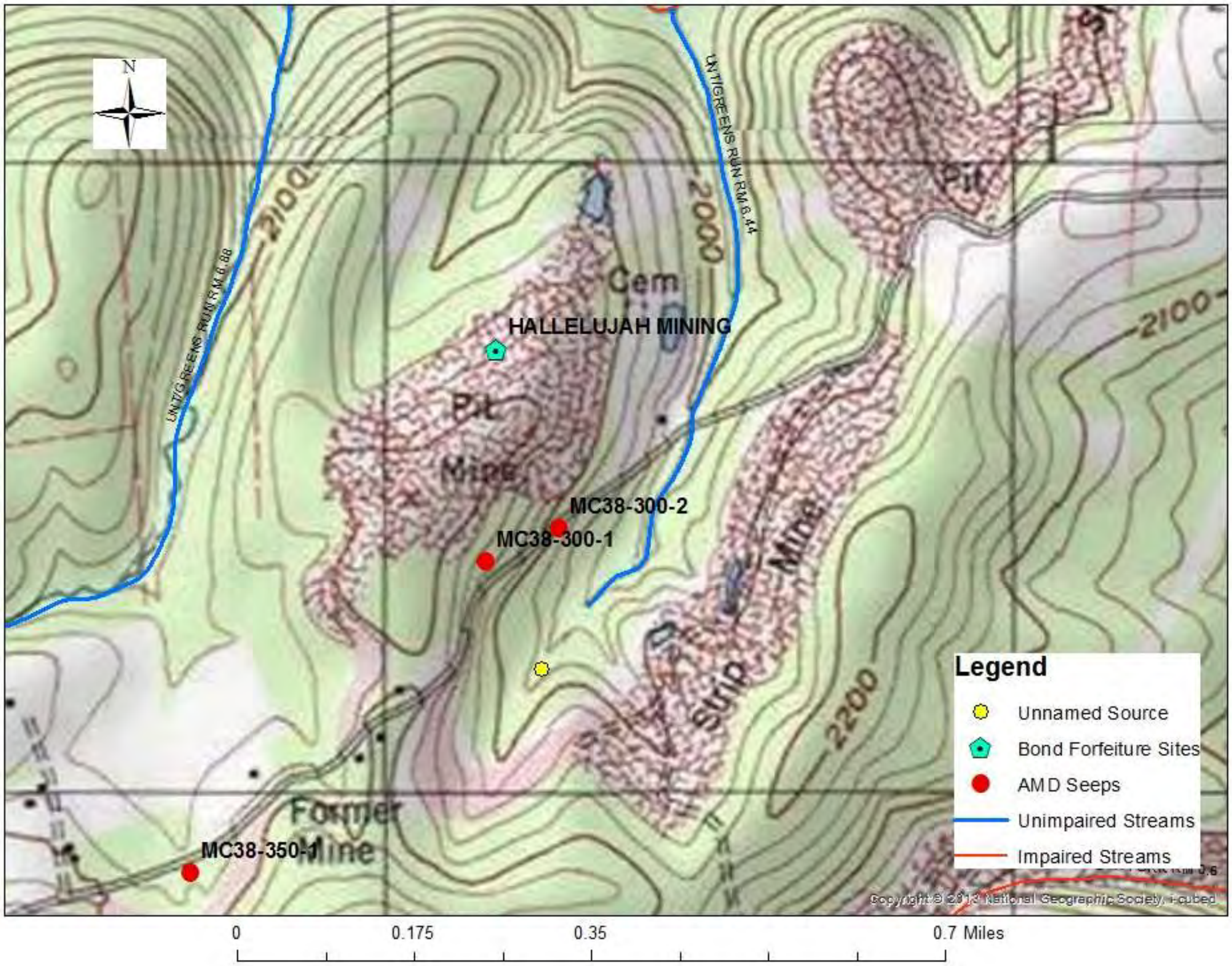
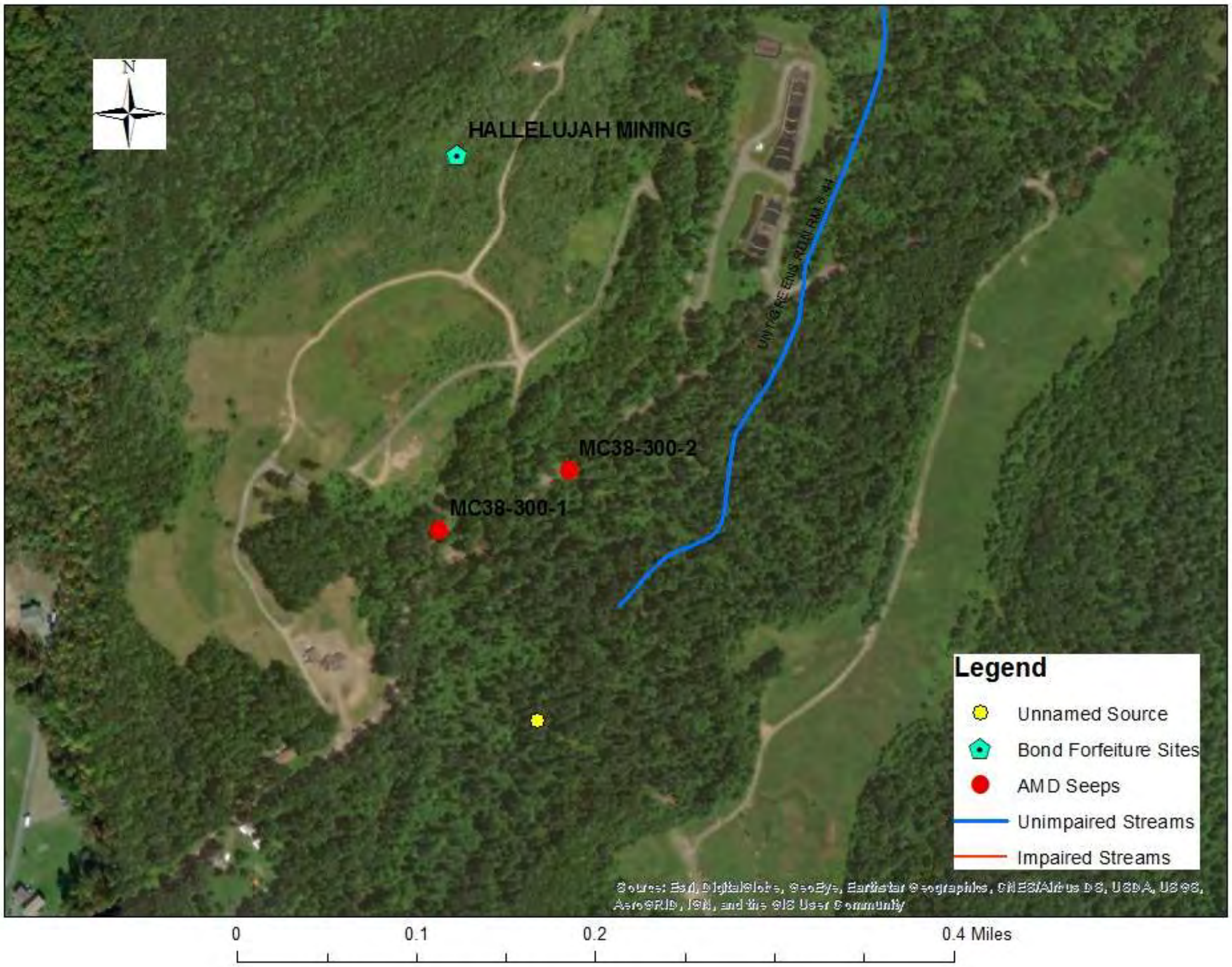


*Figure 6: Aerial Imagery of Unnamed Seep*




## MC38-300-2

FOC and WV DEP Department of Special Reclamation believe MC38-300-2 is being treated by the neighboring bond forfeiture site “Hallelujah” (Permit 40-81). FOC Monitoring Coordinator Madison Ball tracked the seep via GPS coordinates provided by WV DEP Watershed Improvement Branch and found no prevailing source that was not being collected via a drainage ditch to and treated by the “Hallelujah” Bond Forfeiture Site. Because of this, MC38-300-2 is not a priority site for this plan. Data obtained from the 2011 Cheat River Basin TMDL report also reveals very little flow from this seep. Disregarding the issue of location, MC38-300-2 would be a low priority for FOC due to low flow (<1.5 gpm).

## MC38-350-1

Seep MC38-350-1 is a low priority site. FOC water quality data reveals relatively low concentrations of acidity, Fe, and Al, as well as low flows from this seep. The seep drains across Dinkenberger Rd (CR 7/10) via a culvert which then feeds a landowner’s livestock pond. There does not appear to be any direct connectivity between MC38-350-1 and the nearest North Fork Greens Run tributary, WV-MC-38-G, which has met water quality standards for pH, Fe, and Al for every FOC sampling effort. Thus, MC38-350-1 is a low priority for the restoration of North Fork Green Run.

### MC38-100-1

MC38-100-1 is currently being treated by the FOC passive treatment site “Railroad Refuse” since 2015 and is actually adding alkalinity to SWS 257. The lowest pH recorded for the system out, “RR WL OUT” was 7.08. Dissolved Al is often non-detect at system out, and the highest recording was 0.0822 mg/L. Total Fe is at times non-detect at system out, and the highest recording was 0.923. Both Dissolved Al and Total Fe have consistently been below the water quality criteria limits for aquatic life at “RR WL OUT”. FOC considers this site a success story and will maintain the site as needed now and into perpetuity.

*Table 13: Known Seeps in the North Fork Greens Watershed*

| Stream Code | Stream Name | SWS | Discharge numbers | Notes |
|---|---|---|---|---|
| WV-MC-38-F | UNT/GREENS RUN RM 6.44 | 257 | MC38-300-1 | Failing FOC passive treatment project, “Dinkenberger” |
| WV-MC-38-F | UNT/GREENS RUN RM 6.44 | 257 | Unnamed Source | Undescribed source |
| WV-MC-38-F | UNT/GREENS RUN RM 6.44 | 257 | MC38-300-2 | Treated by Bond Forfeiture Site “Hallelujah” |
| WV-MC-38-G | UNT/GREENS RUN RM 6.88 | 257 | MC38-350-1 | Low Priority Treatment Site |
| WV-MC-38 | GREENS RUN | 257 | MC38-100-1 | Current successful FOC passive treatment project, “Railroad Refuse” |

## *Low Priority Subwatersheds*

Table 14 lists the low priority subwatersheds of North Fork Greens Run, some without any listed impairments, and others listed for pH, Fe, Al, and CNA Biological. The TMDL is produced using a model and limited samples, monitoring of which primarily occurred between June 2006 and June 2007. In Table 15, the following streams have measured impairments and/or modeled impairments in the 2014 303(d) list, but FOC analysis at the SWS mouths indicate that the streams have consistently met water quality standards for pH, Fe, and Al. There are no known AML discharges or AMD seeps within the below SWSs for either tables.

*Table 14: Low Priority Subwatersheds*

| WV NHD Stream Code | Stream Name | Impairment | SWS | Lowest FOC lab pH | Highest FOC dissolved Al (mg/L) | Highest FOC total Fe (mg/L) |
|---|---|---|---|---|---|---|
| WV-MC-38 | GREENS RUN | pH, Fe, Al | 254 | 6.12 | 0.62 | 0.401 |
| WV-MC-38-D | UNT/GREENS RUN RM 3.79 | None | 255 | 7.37 | Non-detect | 0.77 |
| WV-MC-38 | GREENS RUN | pH, Fe, Al | 256 | 6.54 | Non-detect | 0 .596 |
| WV-MC-38-C | UNT/GREENS RUN RM 4.42 | None | 258 | 6.54 | Non-detect | 0.226 |

*Table 15: SWSs with required reductions for AMLs but without known AMD Seeps*

| WV NHD Stream Code | Stream Name | SWS |
|---|---|---|
| WV-MC-38 | Greens Run | 254 |
| WV-MC-38 | Greens Run | 256 |

### SWS 254 – Greens Run

SWS 254 is assigned load reductions for Fe and Al in the current TMDL. However, lowest recorded pH from FOC data at SWS 254 Mouth was 6.12, highest dissolved Al was 0.62 mg/L, and highest total Fe was 0.401 mg/L, all within water quality criteria for aquatic life. FOC believes that SWS 254 meets criteria for pH, dissolved Al, and total Fe and will work in conjunction with the WVDEP Watershed Improvement Branch and the WVDEP Watershed Assessment Branch to assess future listing decisions moving forward. FOC in partnership with West Virginia University conducted an electrofishing survey in SWS 254 in which two fish species were present, Creek Chub (*Semotilus atromaculatus*) and Green Sunfish (*Lepomis cyanellus*). For *S. atromaculatus*, multiple life stages were present in the survey, indicating that the population is healthy enough to reproduce, and water quality is stable enough to support aquatic life. The data collected in the electrofishing survey helps support FOC's stance that water quality in SWS 254 is no longer impaired for pH, dissolved Al, and total Fe, although more studies may need to occur to consider removing SWS 254 from the Impaired Streams list for pH, dissolved Al, and total Fe. Fish Data can be found in Appendix D.

### SWS 255 – UNT/Greens Run RM 3.79

SWS 255 is not assigned any load reductions in the current TMDL. FOC water quality data supports this conclusion as lowest lab pH recorded was 7.37, all samples have had non-detect levels of dissolved Al, and the highest total Fe was 0.77 mg/L.

### SWS 256 – Greens Run

SWS 256 is assigned load reductions for Fe and Al in the current TMDL. Lowest recorded pH from FOC data was 6.54, dissolved Al has consistently been non-detect, and highest total Fe was 0.596 mg/L, all within water quality criteria for aquatic life. FOC believes SWS 256 meets criteria for pH, dissolved Al, and total Fe and will work in conjunction with the WVDEP Watershed Improvement Branch and the WVDEP Watershed Assessment Branch to assess future listing decisions moving forward.

### SWS 258 – UNT/Greens Run RM 4.42

SWS 258 is not assigned any load reductions in the current TMDL. FOC water quality supports this conclusion as lowest lab pH was 6.54, all samples have had non-detect levels of dissolved Al, and highest total Fe was 0.226 mg/L. FOC Monitoring Coordinator Madison Ball has also sighted undetermined species of fish utilizing SWS 258 as habitat in summer months.

## 5. TECHNICAL AND FINANCIAL ASSISTANCE NEEDS

Technical and financial assistance is needed for water sample analysis at AMD sources for designing treatment projects and measuring the effectiveness of the projects, creating conceptual designs and detailed engineering designs, and managing the projects through bidding, construction, operation, and maintenance. Financial assistance is needed to design and build the selected remediation projects. Many funding sources are available for nonpoint source AMD remediation on AMLs and for water quality monitoring, including:

- Section 319 funds,
- Abandoned Mine Reclamation (AMR) Fund, including money in the AMD Set-Aside Fund,
- Watershed Cooperative Agreement Program grants,
- Stream Partners Program grants,
- Private Foundation grant opportunities,
- local government contributions,
- business contributions,
- service donations from businesses,
- private donations

OSM grants specifically for AMD remediation projects on AMLs are available through the WCAP, part of the Appalachian Clean Streams Initiative. Grants of up to $100,000 are awarded to not-for-profit organizations that have developed cooperative agreements with other entities to reclaim AML sites (6). A match from 319 funds is required to receive these grants and is sometimes met with money from the AMR Fund or WVDEP's Stream Restoration Fund.

Two WVDEP divisions will provide technical assistance. The Division of Water and Waste Management provides technical assistance for the use of BMPs, educates the public and land users on nonpoint source issues, enforces water quality laws that affect nonpoint sources, and restores impaired watersheds through its Watershed Improvement Branch (6).

Clean Water Act Section 319 funds are provided by USEPA to WVDEP and can be used for reclamation of nonpoint source AMD discharges. This watershed-based plan is being developed so that these funds can be allocated to the North Fork Greens Run Watershed. WVDEP's Watershed Improvement Branch sets priorities and administers the state Section 319 program (6).

A second division within WVDEP, the Office of Abandoned Mine Lands and Reclamation (OAMLR), directs technical resources to watersheds to address AMLs.

OAMLR also funds AML remediation projects via the AMR Fund. Before 1977 when the Surface Mining Control and Reclamation Act was enacted, coal mines generally did not manage acid-producing material to prevent AMD or treat the AMD that was produced. These "pre-law" mines continue to be significant AMD sources and are treated as nonpoint sources under the Clean Water Act.

To reclaim these AMLs, the Act established the AMR Fund. This fund, supported by a per-ton tax on mined coal, is allocated to coal mining states for remediation projects. WVDEP has funded many AMD remediation projects on AMLs, but these projects are typically not designed to meet stringent water quality goals. The agency typically uses a small number of cost-effective techniques, such as OLCs, and chooses the layout for these measures based on how much land is available (for example, the distance between a mine portal and the boundary of properties for which the agency has right-of-entry agreements). The AMR Fund is slated to sunset in 2022, meaning that Fund allocations may not be sufficient to reclaim many AML sites—even for safety issues.

OAMLR also administers a closely linked source of funding: the AMD Set-Aside Fund. In the past, up to 10% of states' annual AMR Fund allocations could be reserved as an endowment for use on water quality projects. States can now reserve up to 30%. These funds are critically important, because while regular AMR Fund allocations can only be spent on capital costs, AMD Set-Aside Fund allocations can be spent on O&M.

### *Office of Surface Mining, Reclamation, and Enforcement*

OSM has helped place summer interns and AmeriCorps*Volunteers in Service to America (OSM/VISTA) volunteers to assist with AMD-related projects.

OSM grants specifically for AMD remediation projects on AMLs are available through the WCAP, part of the Appalachian Clean Streams Initiative. Grants of up to $100,000 are awarded to not-for-profit organizations that have developed cooperative agreements with other entities to reclaim AML sites (11).  A match from 319 funds is required to receive these grants and is sometimes met with money from the AMR Fund or WVDEP's Stream Restoration Fund.

### *Stream Partners Program*

The Stream Partners Program offers grants of up to $5,000 to watershed organizations in West Virginia. Grants can be used for range of projects including small watershed assessments and water quality monitoring, public education, stream restoration, and organizational development. Stream Partners grants will be pursued in the future to compliment nonpoint source research, education, and reclamation projects in the watershed as well as possibly fund research to support new listing status for SWSs FOC believes should no longer be listed as 'Impaired' for pH, Al, or Fe.

## 6. INFORMATION, EDUCATION, AND PUBLIC PARTICIPATION

### *State of the Cheat River Watershed Outreach Event Series*

Friends of the Cheat completed a three part series of outreach events for the public called the State of the Cheat River Watershed. This outreach initiative aimed to educate the public about past challenges, current successes, and future goals to restore, preserve, and promote the watershed. The series highlighted remediation efforts including treatment projects and watershed based plans and asked landowners to report known AMD on their property. Friends of the Cheat plans to continue this series annually.

### *Cheat River Festival*

Every spring, for 25 years, FOC has been hosting the Cheat River Festival. This is FOC's largest outreach and fundraising event. Thousands of patrons come to learn about all aspects of FOC's mission, including restoration initiatives. FOC will have information regarding restoration successes and plans at the informational area in the festival. FOC also invited landowners and other restoration stake holders to learn more about how they can be involved and to teach the public about their current involvement in restoration.

### *Newsletters*

FOC newsletters are distributed in print every quarter. They are also available online. Newsletters will continue to update readers about planned nonpoint source remediation projects and about remediation priorities.

### *Youth education*

FOC has developed curriculum to teach youth about the Cheat River Watershed, its tributaries, and the importance of stream health.  In summer of 2018 FOC partnered with the U.S. Forest Service to host three snorkel outreach events among the local community to foster stewardship and appreciation of the Cheat's unique freshwater ecological resources The Cheat River Snorkel Program continued into 2019 to host 3 events. FOC visits a local 4-H camp each year and attends many music festivals to teach participants about ecology and pollution in streams. Hosting outreach and education events to youth and the general public is one effective strategy FOC utilizes for building long-term support for the watershed's remediation priorities.

### *Web site*

FOC also maintains a website, www.cheat.org with information about remediation projects and priorities.

### *Landowner Handbook*

FOC created a handbook for landowners to describe the reclamation process and updated this book in 2017. The booklet describes monitoring, implementation, funding, and regulation to landowners and potential landowner partners.

| | Pre | Year 1 | Year2 | Year3 | Year 4 | Year 5 | Post |
|---|---|---|---|---|---|---|---|
| Planning | | | | | | | |
| Develop WBP | <-- | | | | | | |
| Collect Monitoring Data | | | | | | | |
| Assess Project Sites | | | | | | | |
| Feasibility Study | | | | | | | |
| Landowner Contact | | | | | | | |
| Apply for Funding | | | | | | | |
| Receive Funding | | | | | | | |
| Implementation | | | | | | | |
| Engineering Services | | | | | | | |
| Environmental Permitting | | | | | | | |
| Construction | | | | | | | |
| Operation and Maintenance | | | | | | | |
| Operation and Maintenance | | | | | | | |

*Table 16: General example of a watershed project timeline*

### *River of Promise*

River of Promise began in 1995. The premise was to bring together stakeholders including industry, state and federal agencies, watershed groups, and the public to share information and work on solving AMD issues. Quarterly River of Promise meetings are open to the public. Information on nonpoint source remediation projects and priorities will be freely available to all who attend these meetings.

## 7. SCHEDULE AND MILESTONES

FOC hopes to secure funds to address and treat all priority sites between the years 2021 - 2030 in the North Fork Greens Watershed Based Plan. After each priority site is developed, the site and the subsequent SWS will be monitored through the course of one year to ensure the pollutant loads are appropriately reduced. If loads are not appropriately reduced, low priority seeps will be revisited for proposals until proper load reduction for specific SWS is met. Sites in which landowner cooperation is not currently viable will be revisited if/when property changes ownership. Milestones for the North Fork Watershed Based Plan are as follows:

- Secure Funding For Priority Sites
- Implement Site Design and Construction of Priority Sites
- Conduct Post Monitoring of Priority Sites
- Evaluate Success of Priority Sites
- Reassess Low Priority Sites and Site Ownership
- Secure Funding for Low Priority Sites as needed for Load Reduction
- Implement Site Design and Construction for Low Priority Sites as needed
- Conduct Post Monitoring of Low Priority Sites
- Routine Sampling of Sites to Ensure System Outs are Meeting Water Quality Standards

A general example of the timeline for a watershed project is provided in Table 16. Tables 17a – 17b provide anticipated schedule for the implementation of the high priority sites. Because of FOC's North Fork Greens Run Watershed Based Plan, FOC has moved out the milestone schedule to fall after all Big Sandy Creek Watershed Based Plan High Priority Sites have been implemented. If a new funding source or additional §319 funding can be provided to complete two projects, FOC will move up the implementation schedule as needed.

There is also potential to merge passive treatment projects for MC38-300-1 and the Unnamed Source, due to proximity. If funding allows and Awarded Engineer finds feasible, FOC would move forward with merging the projects, proposing to cover both sources with one site.

***Table 17a: Implementation Schedule for MC38-300-1***

**AMD Source:** *MC38-300-1*
**Stream:** *Greens Run*
**Project:** *Dinkenberger Improvements Project*

| | **2023** | **2024** | | | | **2025** | | | | **2026** | | | | **2027** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Implementation Schedule** | Q2 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Submit§319 proposal | X | | | | | | | | | | | | | | | | |
| Receive §319 funding | | | | | X | | | | | | | | | | | | |
| Procure engineer | | | | | | | X | X | X | X | X | X | X | X | | | |
| Apply for match funding | | | | | | | | | X | | | | | | | | |
| Obtain necessary landowner agreements | | | | | | | | | X | | | | | | | | |
| Water quality monitoring | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Obtain necessary construction permits | | | | | | | X | X | X | X | X | | | | | | |
| Procure construction contractor | | | | | | | | | | | X | | | | | | |
| Construct treatment system | | | | | | | | | | | | X | X | X | | | |
| Post Construction Monitoring | | | | | | | | | | | | | | | X | X | X |

***Table 17b: Implementation Schedule for Unnamed Source***

**AMD Source:** *Unnamed Source*
**Stream:** *Greens Run*
**Project:** *Dinkenberger Headwaters Project*

| | **2024** | **2025** | | | | **2026** | | | | **2027** | | | | **2028** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Implementation Schedule** | Q2 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 | Q1 | Q2 | Q3 | Q4 |
| Submit§319 proposal | X | | | | | | | | | | | | | | | | |
| Receive §319 funding | | | | | X | | | | | | | | | | | | |
| Procure engineer | | | | | | | X | X | X | X | X | X | X | X | | | |
| Apply for match funding | | | | | | | | | X | | | | | | | | |
| Obtain necessary landowner agreements | | | | | | | | | X | | | | | | | | |
| Water quality monitoring | | | | | X | X | X | X | X | X | X | X | X | X | X | X | X |
| Obtain necessary construction permits | | | | | | | X | X | X | X | X | | | | | | |
| Procure construction contractor | | | | | | | | | | | X | | | | | | |
| Construct treatment system | | | | | | | | | | | | X | X | X | | | |
| Post Construction Monitoring | | | | | | | | | | | | | | | X | X | X |

# 8. LOAD REDUCTION EVALUATION CRITERIA

The long-term measurable goals are to achieve required reduction for each seep set by the TMDL and verified by FOC for iron, aluminum, and pH. Achieving these goals should lend to the resolution of in-stream pH, Al, Fe, biological, and sedimentation impairments, however it might not accomplish all West Virginia water quality standards in-stream since AMD is not the only source of these impairments.

Samples will be collected and analyzed quarterly for one year after construction to assess treatment effectiveness. FOC will assess to see if required load reductions are being met at the treatment 'System Out.' SWS mouth will also be sampled quarterly to evaluate impairment. If the SWS is still impaired after all high priority projects in the SWS are completed, FOC will reconsider implementing low priority sites until load reduction is achieved.

Evaluation of load reduction will be accomplished by:

1. Comparing the instream water quality upstream of the seep and downstream of the seep
2. Comparing the pollutant loads in the water entering the system to the pollutant loads in the water exiting the system
3. Comparing the water quality at the SWS mouth before and after the treatment system is implemented.

# 9. MONITORING COMPONENT

Monitoring parameters include temperature, flow, pH, conductivity, acidity, alkalinity, sulfate, total aluminum, dissolved aluminum, total iron, dissolved iron, total manganese, and dissolved manganese. FOC will monitor water quality pre-construction, during construction, and post-construction. FOC will monitor annually until §319 or alternative funds are secured. After securing funds, during the pre-construction period FOC will collect and analyze upstream, downstream and seep samples monthly, likely straddling two fiscal years. During the construction period upstream, downstream, and seep samples will be collected and analyzed quarterly. Quarterly post construction samples will be collected and analyzed upstream of treatment, downstream of treatment and after each treatment component for one year, and then biannually after.

FOC uses a monitoring cost calculation spreadsheet that factors in lab fees, mileage, and staff time cost using 8 hours per sampling visit per site, which includes, preparing, driving, sampling, returning the samples to the lab, cleaning up the equipment, entering the data, and initially analyzing the data.

Table 18 outlines the monitoring plan and Table 19 outlines the monitoring budget including staff time and lab fees in order to carry out the restoration efforts, with Table 20 as reference to the constants used to calculate the monitoring budget. Each of the sites that are selected for treatment in the Priority Implementation Section are listed in Table 18 and 19.

The order of the project implementation for those listed in Table 18 and Table 19 may be subject to change, based on landowner partnerships.

*Table 18: Monitoring efforts per Priority site per year*

| Site | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 |
|---|---|---|---|---|---|---|---|---|---|---|
| MC38-300-1 | 4 | 1 | 1 | 1 | 1 | 6 | 8 | 4 | 2 | 2 |
| Unnamed Source | 2 | 1 | 1 | 1 | 1 | 1 | 6 | 8 | 4 | 2 |

*Table 19: Monitoring Budget*

| Projections | | | | | Sampling Cost | | | |
|---|---|---|---|---|---|---|---|---|
| Project Name | Mileage (Site-Office) | # Sample Sites | Sample Period (Yrs) | Sample Frequency (Visits/Year) | Travel | Lab | Personnel | Total |
| Dinkenberger Improvements Pre Construction | 6 | 6 | 1 | 12 | $ 83.52 | $ 5,400.00 | $ 1,035.65 | $ 6,519.17 |
| Dinkenberger Improvements Construction | 6 | 6 | 1 | 4 | $ 27.84 | $ 1,800.00 | $ 345.22 | $ 2,173.06 |
| Dinkenberger Improvements Post Construction | 6 | 6 | 1 | 4 | $ 27.84 | $ 1,800.00 | $ 345.22 | $ 2,173.06 |
| Dinkenberger Improvements Remaining Grant Period | 6 | 6 | 1 | 2 | $ 13.92 | | $ 172.61 | $ 186.53 |
| Dinkenberger Headwaters Pre Construction | 6 | 3 | 1 | 12 | $ 83.52 | $ 2,700.00 | $ 712.01 | $ 3,495.53 |
| Dinkenberger Headwaters Construction | 6 | 3 | 1 | 4 | $ 27.84 | $ 900.00 | $ 237.34 | $ 1,165.18 |
| Dinkenberger Headwaters Post Construction | 6 | 4 | 1 | 4 | $ 27.84 | $ 1,200.00 | $ 273.30 | $ 1,501.14 |
| Dinkenberger Headwaters Remaining Grant Period | 6 | 4 | 1 | 2 | $ 13.92 | $ 600.00 | $ 136.65 | $ 750.57 |

*Table 20: Monitoring Budget Table of Constants*

| Table of Constants | | | | | |
|---|---|---|---|---|---|
| Cost/Sample ($) | Cost/Mile ($) | Personnel Pay ($/hr) | Personnel Time/Mile (min) | Personnel Prep Time (min) | Personnel Time/Sample (min) |
| $ 75.00 | $ 0.58 | $ 17.98 | 1.5 | 90 | 30 |

# 10. REFERENCES


1. **United States Environmental Protection Agency.** *Handbook for Developing Watershed Plans to Restore and Protect Our Waters, Chapter 2.* 2008.

2. **Department of Environmental Protection Water Resources.** *47 CSR, Series 2, Legislative Rules, Department of Environmental Protection: Requirements Governing Water Quality Standards.* 2016.

3. **West Virginia Department of Environmental Protection .** *2012 Draft Section 303(d) List.* 2012.

4. **West Virginia Department of Environmental Protection.** *Total Maximum Daily Loads for Selected Streams in the Cheat River Watershed, West Virginia.* s.l. : Division of Water and Waste Management, Watershed Protection Branch, TMDL Section, 2011.

5. **Office of Surface Mining, Reclamation, and Enforcement.** AMD Treat. Pittsburgh, Pennsylvania : s.n., 2014.

6. **West Virginia Department of Environmental Protection.** Nonpoint Source Web page. [Online] Division of Water and Waste Management, 2014. http://www.dep.wv.gov/WWE/Programs/nonptsource/Pages/home.aspx.

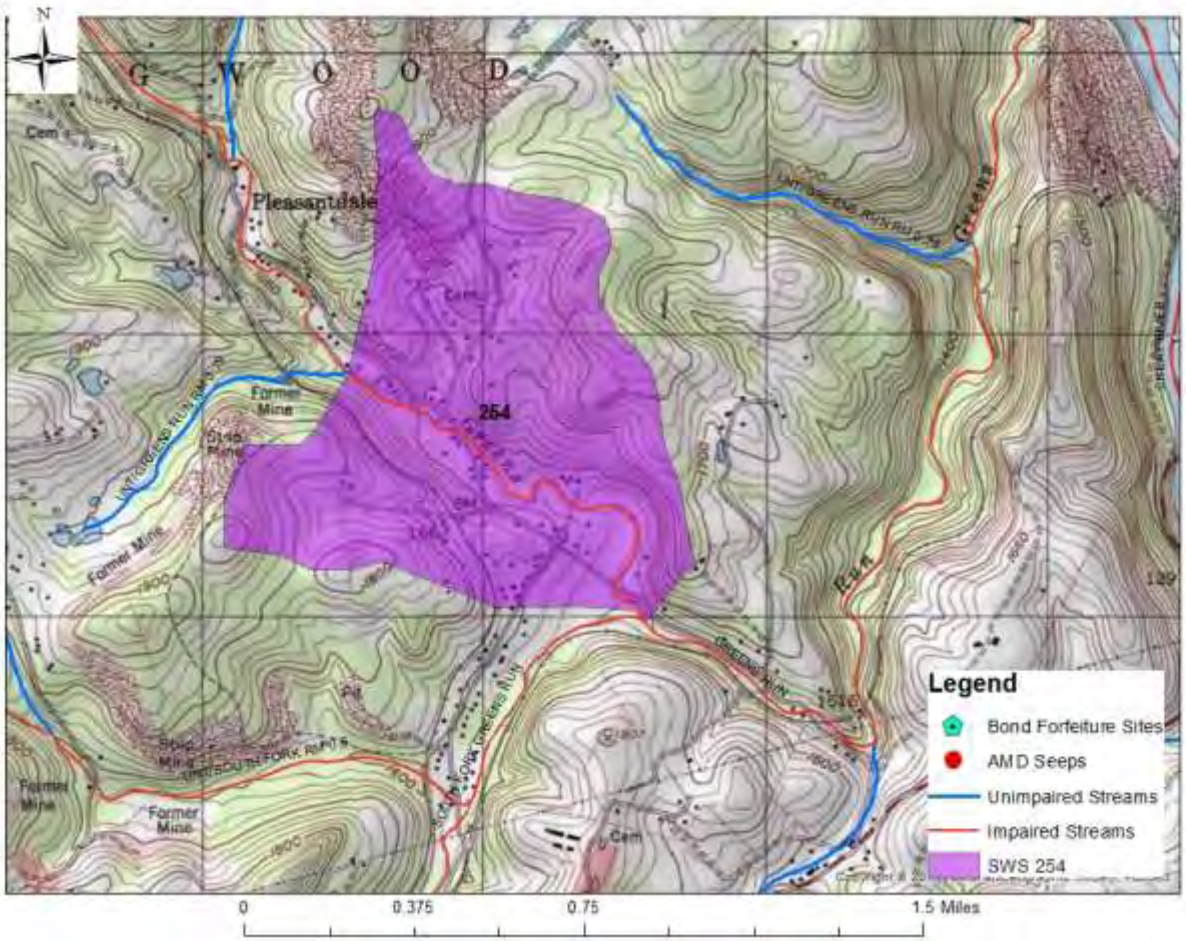
# 11. APPENDIX

## APPENDIX A: TMDL SEEP DATA

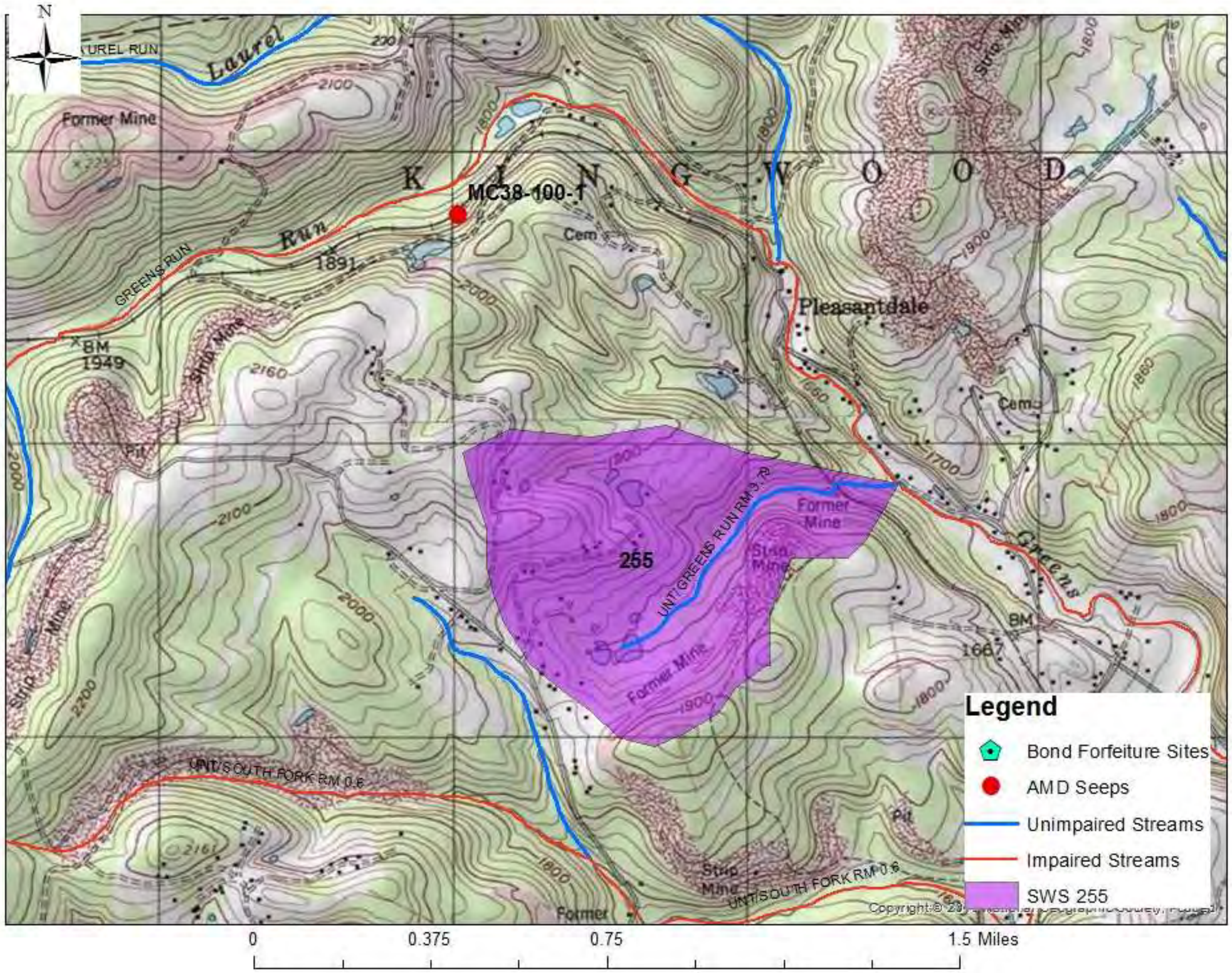
| Discharge | Flow_CFS_ | Flow_GPM | pH | Total_Al | Total_Fe | Total_Mn | ALKALINITY | SULFATE |
|---|---|---|---|---|---|---|---|---|
| MC38-100-1 | 0.012899 | 4.820744 | 2.914615 | 50.615385 | 101.553846 | 3.226154 | 0.707692 | 872.076923 |
| MC38-300-1 | 0.018938 | 7.077701 | 3.03 | 47.375 | 47.22 | 7.225 | 0.05 | 678 |
| MC38-300-2 | 0.003342 | 1.249006 | 3.6 | 78 | 34.7 | 8.68 | 0.1 | 471 |
| MC38-350-1 | 0.062384 | 23.31478 | 5.01 | 1.99 | 1.54 | 0.868 | 0.1 | 36 |

## APPENDIX B: MAPS OF SUBWATERSHEDS

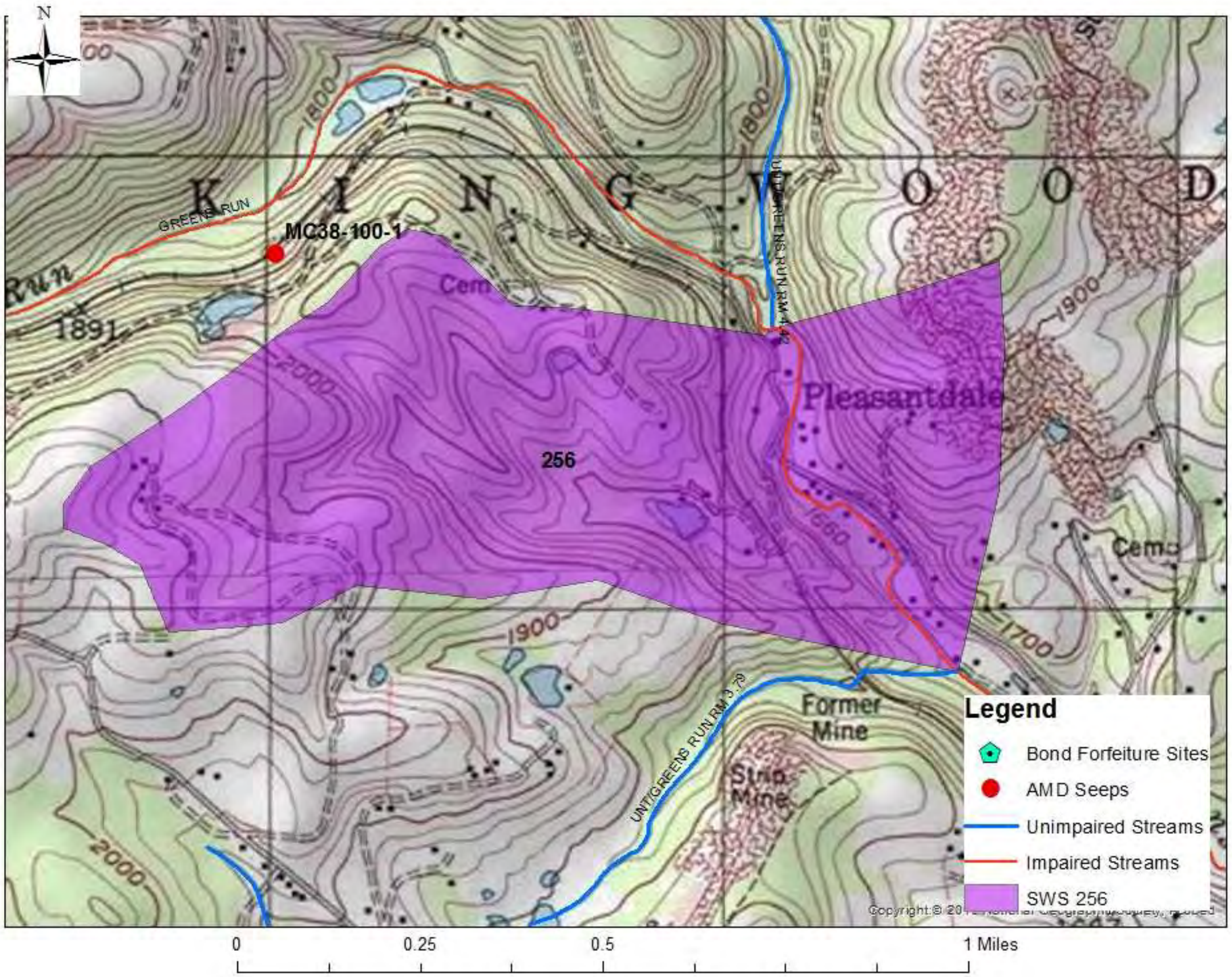
### *Greens Run SWS 254*



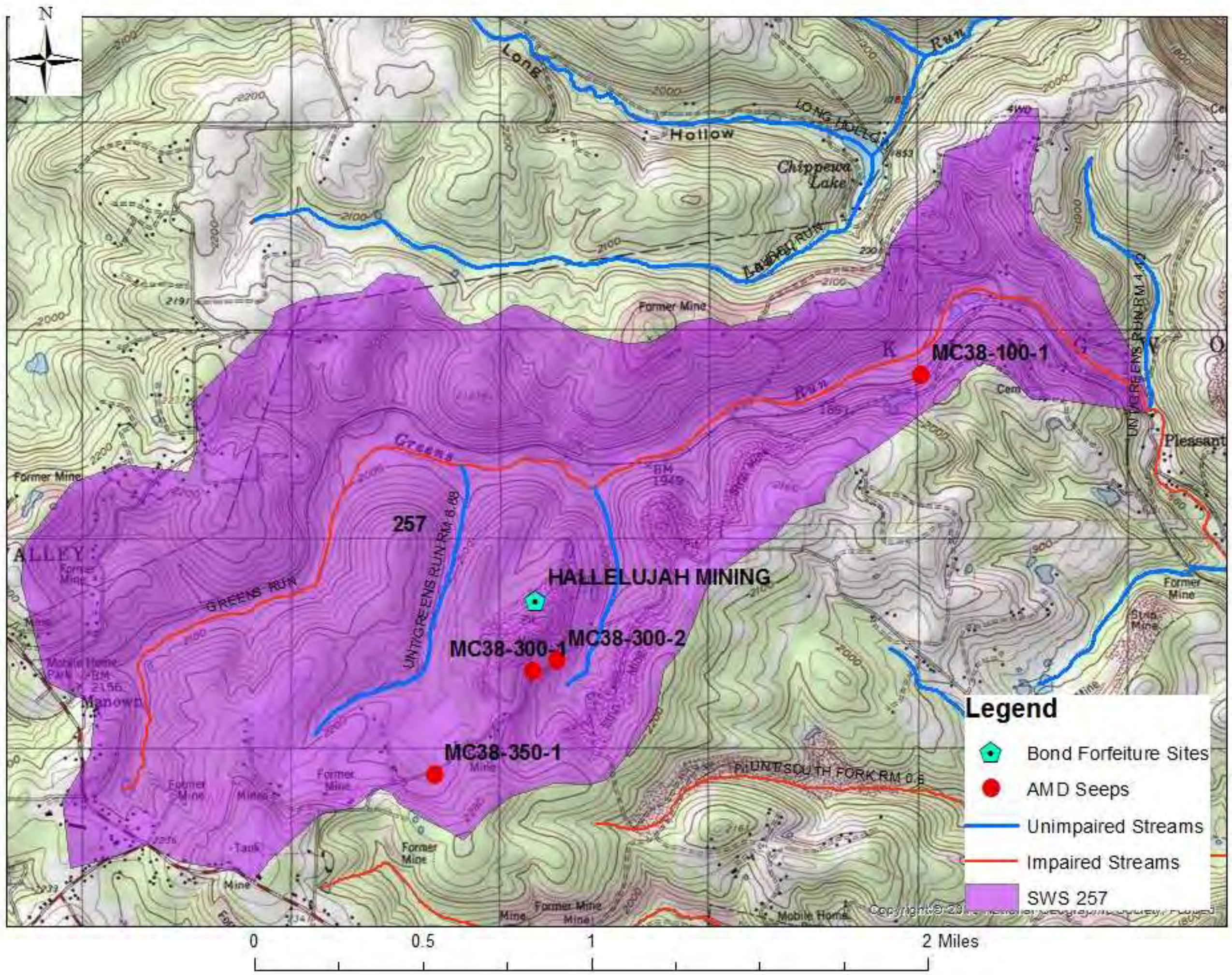
*Greens Run SWS 255*



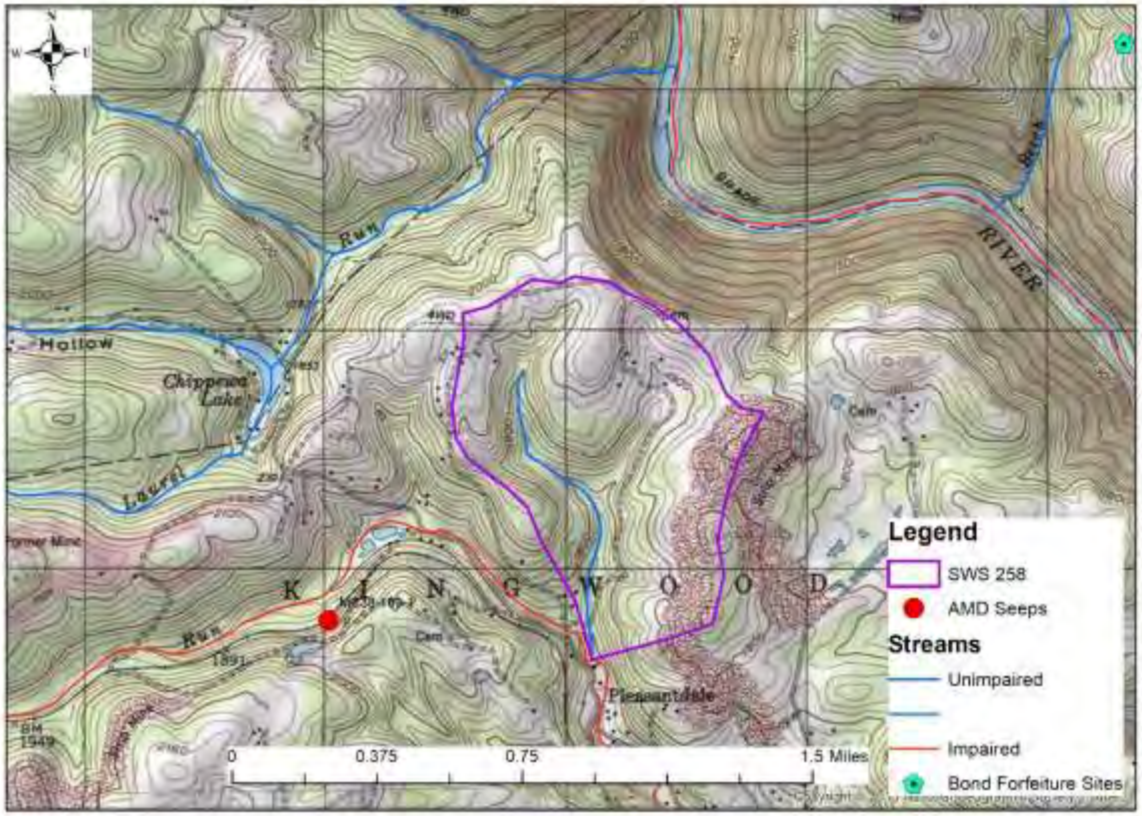
*Greens Run SWS 256*



### *Greens Run SWS 257*



*Greens Run SWS 258*



## APPENDIX C: LANDOWNERS

| Discharge Number | Coordinates | Name | Mailing Address | Parcel Address | Landowner Telephone | Landowner Notes |
|---|---|---|---|---|---|---|
| MC38-100-1 | 39.5064, -79.6971 | Robert and Elizabeth Peddicord | PO Box 545 Kingwood, WV 26537 | Glory Dr | | FOC has landowner access to reach top of Open Limestone Channel where mine water exits MC38-100-1. Water is treated in neighboring parcel in agreement with Bruce Castle. |
| MC38-300-1 | 39.493861, -79.718944 | Willard Jr. and Kathy Tasker | 991 Dinkenberger Rd Kindwood, WV 26537 | 991 Dinkenberger Rd Kindwood, WV 26537 | | The Taskers have expressed concerns about expansion of treatment on their property with past FOC Dinkenberger Site Improvements. However, this site being one of the last major contributors to AMD in North Fork Greens Run may be persuading. |
| MC38-300-2 | 39.494333, -79.717583 | Jasper and Mary Alice Sanders | 74 W Catherine St Rowlesburg, WV 26425 | Dinkenberger Rd | 304-454-9212 | The Sanders have expressed concerns about expansion of treatment on their property with past FOC Dinkenberger Site Improvements. However, this site being one of the last major contributors to AMD in North Fork Greens Run may be persuading. |

| | | | | | | |
|---|---|---|---|---|---|---|
| MC38-350-1 | 39.489472, -79.7245 | Kyle Compton and Kayla Lewis | 820 Goshen Road, Morgantown, WV 26708 | 434 Dinkenberger Rd | | Because of the proximity of the seep to the road crossings, samples were taken using the Dinkenberger Road culvert. Due to low priority status of Seep MC38-350-1, no contact had been issued with Mr. Compton or Ms. Lewis. |
| Unnamed Source | 39.491883, -79.718475 | Jasper and Mary Alice Sanders | 74 W Catherine St Rowlesburg, WV 26425 | Dinkenberger Rd | 304-454-9212 | The Sanders have expressed concerns about expansion of treatment on their property with past FOC Dinkenberger Site Improvements. However, this site being one of the last major contributors to AMD in North Fork Greens Run may be persuading. |

## APPENDIX D: FISH DATA

| Site Name | Latitude | Longitude | Date | Time | Reach Length (m) | Shocking Seconds | Common Name | Latin Name | Length (mm) |
|---|---|---|---|---|---|---|---|---|---|
| Greens Run ds Confluence | 39.48925 | -79.6667 | 07/24/2019 | 13:26 | 50 | 334 | | | |
| | | | | | | | Creek Chub | Semotilus atromaculatus | 102 |
| | | | | | | | Creek Chub | Semotilus atromaculatus | 86 |
| NF Mouth | 39.49004 | -79.6675 | 07/24/2019 | 13:42 | 50 | 462 | | | |
| | | | | | | | Creek Chub | Semotilus atromaculatus | 180 |
| | | | | | | | Creek Chub | Semotilus atromaculatus | 84 |
| | | | | | | | Green Sunfish | Lepomis cyanellus | 72 |
| | | | | | | | Creek Chub | Semotilus atromaculatus | 92 |
| | | | | | | | Creek Chub | Semotilus atromaculatus | 116 |
| | | | | | | | Creek Chub | Semotilus atromaculatus | 139 |
| | | | | | | | Creek Chub | Semotilus atromaculatus | 97 |
| | | | | | | | Creek Chub | Semotilus atromaculatus | 126 |
| | | | | | | | Creek Chub | Semotilus atromaculatus | 35 |
| | | | | | | | Creek Chub | Semotilus atromaculatus | 115 |
| | | | | | | | Creek Chub | Semotilus atromaculatus | 109 |
| | | | | | | | Creek Chub | Semotilus atromaculatus | 40 |
| SF Mouth | 39.48976 | -79.6675 | 07/24/2019 | 13:50 | 50 | 284 | | | |
| | | | | | | | N/A | | N/A |
| NFG DS RR | 39.50794 | -79.6965 | 07/24/2019 | 14:30 | 100 | 448 | | | |
| | | | | | | | N/A | | N/A |
| NFG US RR | 39.50779 | -79.6986 | 07/24/2019 | 15:00 | 100 | 994 | | | |
| | | | | | | | Spotted Bass | Micropterus punctulatus | 35 |

## APPENDIX E: AMDTreat CAPITAL COST CALCULATIONS

### *MC38-300-1*

08/29/2018

Company Name
Project
Site Name

**AMD TREAT**

**AMD TREAT MAIN COST FORM**

AMDTREAT

**Costs**

| Passive Treatment | A | S | |
|---|---|---|---|
| Vertical Flow Pond | | | $0 |
| Anoxic Limestone Drain | | | $0 |
| Anaerobic Wetlands | | | $0 |
| Aerobic Wetlands | | | $0 |
| Manganese Removal Bed | | | $0 |
| Oxic Limestone Channel | 1 | 0 | $2,139 |
| Limestone Bed | 1 | 0 | $174,922 |
| BIO Reactor | | | $0 |
| Passive Subtotal | | | **$177,061** |
| **Active Treatment** | | | |
| Caustic Soda | | | $0 |
| Hydrated Lime | | | $0 |
| Pebble Quick Lime | | | $0 |
| Ammonia | | | $0 |
| Oxidants | | | $0 |
| Soda Ash | | | $0 |
| Active Subtotal | | | **$0** |
| **Ancillary Cost** | | | |
| Ponds | 1 | 0 | $8,360 |
| Roads | | | $0 |
| Land Access | | | $0 |
| Ditching | | | $0 |
| Engineering Cost | | | $0 |
| Ancillary Subtotal | | | **$8,360** |
| Other Cost (Capital Cost) | | | $0 |
| Total Capital Cost | | | **$185,421** |
| **Annual Costs** | | | |
| Sampling | | | $0 |
| Labor | | | $0 |
| Maintenance | | | $0 |
| Pumping | | | $0 |
| Chemical Cost | | | $0 |
| Oxidant Chem Cost | | | $0 |
| Sludge Removal | | | $0 |
| Other Cost (Annual Cost) | | | $0 |
| Land Access (Annual Cost) | | | $0 |
| Total Annual Cost | | | **$0** |
| Other Cost | | | |

**Water Quality**

| | | |
|---|---|---|
| Design Flow | 41.34 | gpm |
| Typical Flow | 13.78 | gpm |
| Total Iron | 97.34 | mg/L |
| Ferrous Iron | 37.50 | mg/L |
| Aluminum | 42.78 | mg/L |
| Manganese | 5.28 | mg/L |
| pH | 2.75 | su |
| Alkalinity | 0.00 | mg/L |
| TIC | 1.20 | mg/L |

( ) Calculate Net Acidity
(•) Enter Hot Acidity manually

Acidity 1014.97 mg/L

| | | |
|---|---|---|
| Sulfate | 731.50 | mg/L |
| Chloride | 0.00 | mg/L |
| Calcium | 0.00 | mg/L |
| Magnesium | 0.00 | mg/L |
| Sodium | 0.00 | mg/L |
| Water Temperature | 20.00 | C |
| Specific Conductivity | 0.00 | uS/cm |
| Total Dissolved Solids | 0.00 | mg/L |
| Dissolved Oxygen | 0.01 | mg/L |
| Typical Acid Loading | 30.8 | tons/yr |

**Total Annual Cost: per 1000 Gal of H2O Treated $0.000**

# *Unnamed Source*

Printed on 08/29/2019

Company Name

Project

Site Name

AMDTREAT

## AMD TREAT

### AMD TREAT MAIN COST FORM

**Costs**

| Passive Treatment | A | S | |
|---|---|---|---|
| Vertical Flow Pond | | | $0 |
| Anoxic Limestone Drain | | | $0 |
| Anaerobic Wetlands | | | $0 |
| Aerobic Wetlands | | | $0 |
| Manganese Removal Bed | | | $0 |
| Oxic Limestone Channel | 1 | 0 | $2,139 |
| Limestone Bed | 1 | 0 | $76,109 |
| BIO Reactor | | | $0 |
| Passive Subtotal | | | **$78,248** |
| **Active Treatment** | | | |
| Caustic Soda | | | $0 |
| Hydrated Lime | | | $0 |
| Pebble Quick Lime | | | $0 |
| Ammonia | | | $0 |
| Oxidants | | | $0 |
| Soda Ash | | | $0 |
| Active Subtotal | | | **$0** |
| **Ancillary Cost** | | | |
| Ponds | 1 | 0 | $17,506 |
| Roads | | | $0 |
| Land Access | | | $0 |
| Ditching | | | $0 |
| Engineering Cost | | | $0 |
| Ancillary Subtotal | | | **$17,506** |
| Other Cost (Capital Cost) | | | $0 |
| Total Capital Cost | | | **$95,754** |
| **Annual Costs** | | | |
| Sampling | | | $0 |
| Labor | | | $0 |
| Maintenance | | | $0 |
| Pumping | | | $0 |
| Chemical Cost | | | $0 |
| Oxidant Chem Cost | | | $0 |
| Sludge Removal | | | $0 |
| Other Cost (Annual Cost) | | | $0 |
| Land Access (Annual Cost) | | | $0 |
| **Total Annual Cost:** | | | **$0** |
| Other Cost | | | |

**Water Quality**

| | | |
|---|---|---|
| Design Flow | 98.45 | gpm |
| Typical Flow | 32.81 | gpm |
| Total Iron | 0.76 | mg/L |
| Ferrous Iron | 0.75 | mg/L |
| Aluminum | 3.69 | mg/L |
| Manganese | 0.80 | mg/L |
| pH | 3.83 | su |
| Alkalinity | 0.00 | mg/L |
| TIC | 1.20 | mg/L |

(•) Calculate Net Acidity
( ) Enter Hot Acidity manually

| | | |
|---|---|---|
| Acidity | 30.74 | mg/L |
| Sulfate | 81.45 | mg/L |
| Chloride | 0.00 | mg/L |
| Calcium | 0.00 | mg/L |
| Magnesium | 0.00 | mg/L |
| Sodium | 0.00 | mg/L |
| Water Temperature | 20.00 | C |
| Specific Conductivity | 0.00 | uS/cm |
| Total Dissolved Solids | 0.00 | mg/L |
| Dissolved Oxygen | 0.01 | mg/L |
| Typical Acid Loading | 2.2 | tons/yr |

**Total Annual Cost: per 1000 Gal of H2O Treated** $0.000

*MC38-300-2*

08/29/2019

Company Name

Project

Site Name

## AMD TREAT

**Costs** **AMD TREAT MAIN COST FORM**

| Passive Treatment | A | S | |
|---|---|---|---|
| Vertical Flow Pond | | | $0 |
| Anoxic Limestone Drain | | | $0 |
| Anaerobic Wetlands | | | $0 |
| Aerobic Wetlands | | | $0 |
| Manganese Removal Bed | | | $0 |
| Oxic Limestone Channel | 1 | 0 | $2,139 |
| Limestone Bed | 1 | 0 | $18,304 |
| BIO Reactor | | | $0 |
| Passive Subtotal | | | **$20,443** |
| **Active Treatment** | | | |
| Caustic Soda | | | $0 |
| Hydrated Lime | | | $0 |
| Pebble Quick Lime | | | $0 |
| Ammonia | | | $0 |
| Oxidants | | | $0 |
| Soda Ash | | | $0 |
| Active Subtotal | | | **$0** |
| **Ancillary Cost** | | | |
| Ponds | 1 | 0 | $5,000 |
| Roads | | | $0 |
| Land Access | | | $0 |
| Ditching | | | $0 |
| Engineering Cost | | | $0 |
| Ancillary Subtotal | | | **$5,000** |
| Other Cost (Capital Cost) | | | $0 |
| Total Capital Cost | | | **$25,443** |
| **Annual Costs** | | | |
| Sampling | | | $0 |
| Labor | | | $0 |
| Maintenance | | | $0 |
| Pumping | | | $0 |
| Chemical Cost | | | $0 |
| Oxidant Chem Cost | | | $0 |
| Sludge Removal | | | $0 |
| Other Cost (Annual Cost) | | | $0 |
| Land Access (Annual Cost) | | | $0 |
| **Total Annual Cost:** | | | **$0** |
| Other Cost | | | |

**Water Quality**

| | | |
|---|---|---|
| Design Flow | 3.74 | gpm |
| Typical Flow | 1.24 | gpm |
| Total Iron | 34.70 | mg/L |
| Ferrous Iron | 33.30 | mg/L |
| Aluminum | 78.00 | mg/L |
| Manganese | 8.68 | mg/L |
| pH | 3.60 | su |
| Alkalinity | 0.10 | mg/L |
| TIC | 1.20 | mg/L |

☒ Calculate Net Acidity
☐ Enter Hot Acidity manually

| | | |
|---|---|---|
| Acidity | 525.30 | mg/L |
| Sulfate | 471.00 | mg/L |
| Chloride | 0.00 | mg/L |
| Calcium | 0.00 | mg/L |
| Magnesium | 0.00 | mg/L |
| Sodium | 0.00 | mg/L |
| Water Temperature | 20.00 | C |
| Specific Conductivity | 0.00 | uS/cm |
| Total Dissolved Solids | 0.00 | mg/L |
| Dissolved Oxygen | 0.01 | mg/L |
| Typical Acid Loading | 1.4 | tons/yr |

**Total Annual Cost: per 1000 Gal of H2O Treated** **$0.000**

*MC38-350-1*

08/29/2019

Company Name

Project

Site Name

## AMD TREAT

### AMD TREAT MAIN COST FORM

AMDTREAT

**Costs**

| Passive Treatment | A | S | |
|---|---|---|---|
| Vertical Flow Pond | | | $0 |
| Anoxic Limestone Drain | | | $0 |
| Anaerobic Wetlands | | | $0 |
| Aerobic Wetlands | | | $0 |
| Manganese Removal Bed | | | $0 |
| Oxic Limestone Channel | 1 | 0 | $2,139 |
| Limestone Bed | 1 | 0 | $26,808 |
| BIO Reactor | | | $0 |
| Passive Subtotal: | | | **$28,947** |
| **Active Treatment** | | | |
| Caustic Soda | | | $0 |
| Hydrated Lime | | | $0 |
| Pebble Quick Lime | | | $0 |
| Ammonia | | | $0 |
| Oxidants | | | $0 |
| Soda Ash | | | $0 |
| Active Subtotal: | | | **$0** |
| **Ancillary Cost** | | | |
| Ponds | 1 | 0 | $5,340 |
| Roads | | | $0 |
| Land Access | | | $0 |
| Ditching | | | $0 |
| Engineering Cost | | | $0 |
| Ancillary Subtotal: | | | **$5,340** |
| Other Cost (Capital Cost) | | | $0 |
| Total Capital Cost: | | | **$34,287** |
| **Annual Costs** | | | |
| Sampling | | | $0 |
| Labor | | | $0 |
| Maintenance | | | $0 |
| Pumping | | | $0 |
| Chemical Cost | | | $0 |
| Oxidant Chem Cost | | | $0 |
| Sludge Removal | | | $0 |
| Other Cost (Annual Cost) | | | $0 |
| Land Access (Annual Cost) | | | $0 |
| **Total Annual Cost:** | | | **$0** |
| Other Cost | | | |

**Water Quality**

| | | |
|---|---|---|
| Design Flow | 23.55 | gpm |
| Typical Flow | 7.85 | gpm |
| Total Iron | 6.48 | mg/L |
| Ferrous Iron | 6.48 | mg/L |
| Aluminum | 2.31 | mg/L |
| Manganese | 1.46 | mg/L |
| pH | 6.27 | su |
| Alkalinity | 0.00 | mg/L |
| TIC | 1.20 | mg/L |

(•) Calculate Net Acidity
( ) Enter Hot Acidity manually

| | | |
|---|---|---|
| Acidity | 27.13 | mg/L |
| Sulfate | 31.82 | mg/L |
| Chloride | 0.00 | mg/L |
| Calcium | 0.00 | mg/L |
| Magnesium | 0.00 | mg/L |
| Sodium | 0.00 | mg/L |
| Water Temperature | 20.00 | C |
| Specific Conductivity | 0.00 | uS/cm |
| Total Dissolved Solids | 0.00 | mg/L |
| Dissolved Oxygen | 0.01 | mg/L |
| Typical Acid Loading | 0.4 | tons/yr |

**Total Annual Cost: per 1000 Gal of H2O Treated** $0.000