North Fork of the Blackwater River Watershed Based Plan

Submitted to:

United States Environmental Protection Agency, Region III & West Virginia Department of Environmental Protection

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Table of Abbreviations

Al	Aluminum
AMD	acid mine drainage
AML	abandoned mine land
AML&R	Abandoned Mine Lands and Reclamation department of WVDEP
dis.	Dissolved
Fe	Iron
FOB	Friends of Blackwater
gpm	gallons per minute
L	Liter
LA	load allocations
LAT	latitude
LONG	longitude
MDE	Maryland Department of the Environment
mg/L	milligrams per liter
MOS	Margin of safety
Mn	manganese
MPPRP	Maryland Power Plant Research Project
MRB	manganese removal bed
NMLRC	National Mine Land Reclamation Center
NPDES	National Pollution Discharge Elimination System
NR	not reported
NRCS	Natural Resources Conservation Service
NTU	nephelometric turbidity unit
OAMLR	Office of Abandoned Mine Lands and Reclamation
OLC	oxic (or open) limestone channel
OSMRE	Office of Surface Mining, Reclamation and Enforcement
PA	problem area
PAD	problem area description number
RAPS	reducing and alkalinity producing system
SAPS	successive alkalinity producing systems
SMCRA	Surface Mining Control & Reclamation Act of 1977
SRG	Stream Restoration Group
TMDL	Total Maximum Daily Load
tot.	Total
µg/L	microSiemens per liter
UNT	unnamed tributary
USEPA	United States Environmental Protection Agency
WAB	Watershed Assessment Branch
WALD	wetland anoxic limestone drain

WCAP	Watershed Cooperative Agreement Program
WIB	Watershed Improvement Branch
WLA	waste load allocation
WVDEP	West Virginia Department of Environmental Protection
WVDNR	West Virginia Division of Natural Resources

Introduction

This Watershed Based Plan covers the North Fork of the Blackwater River ("North Fork") in West Virginia, from its headwaters at Fairfax Summit to the mouth, including all tributaries (Figure 1). The North Fork and three main tributaries are impaired by acid mine drainage (AMD) pollutants, fecal coli form, and sedimentation.

Presently, the North Fork is degraded by non-point source pollution to the extent that it no longer supports aquatic life. This document serves as a plan for Friends of Blackwater (FOB) and partnering agencies to implement projects that improve the watershed. Funding for these projects will come from 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 person, and volunteers.

After summarizing the range of impairments documented in the watershed, this plan focuses on AMD—by far it's most significant water quality problem—and documents the nonpoint sources of AMD (Element A). In elements B and C, load reductions are determined, management measures are recommended, and costs are projected. This plan also addresses technical and financial assistance needs (Element D), proposes an implementation schedule (Element F) with milestones (Element G) and measurable goals (Element H), and documents an outreach and education program (Element E) that will help make this plan a reality.

This Watershed Based Plan corresponds to the following Hydrologic Unit Codes (HUC); Cheat River – 05020004 (8-digit), Blackwater River – 0502000402 (10-digit), Lower Blackwater River – 050200040203 (12-digit).

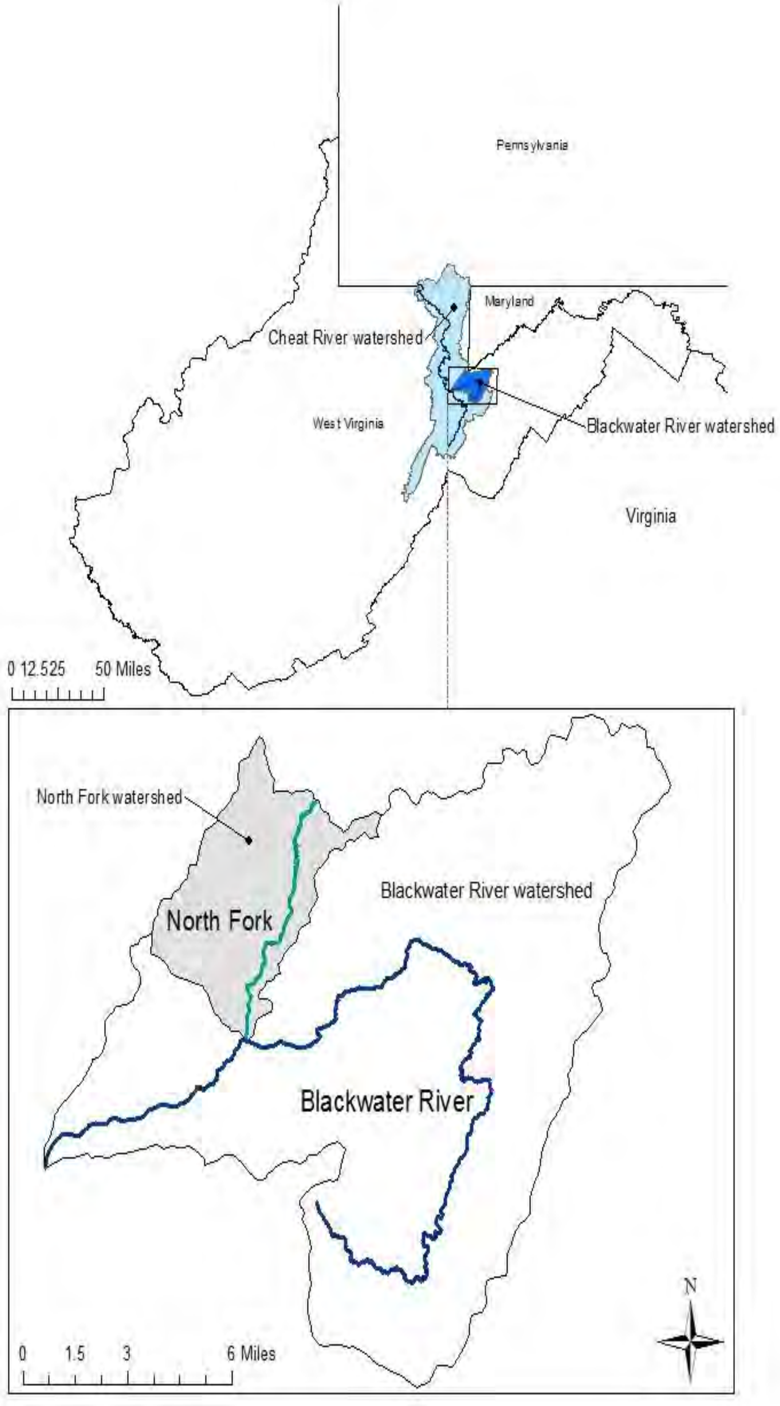


Figure 1: North Fork of the Blackwater River and vicinity.

Geography of the North Fork

The North Fork is a principal tributary of the Blackwater River which forms part of the Cheat watershed. The water draining the Cheat ultimately flows to the Mississippi River Basin via the Monongahela and Ohio rivers. The North Fork watershed is 18.2 square miles and is located within Tucker County, West Virginia. The river flows 7.4 miles from its source at Fairfax Summit to the confluence with the Blackwater River. The main stem of the North Fork takes on four distinct characteristics. It begins as a gentle stream that flows into two lakes in series at the town of Thomas. Thomas Lake, the first and largest, is 8 acres in size and was impounded for municipal water supply for the town of Thomas. The second lake, impounded by an abandoned hydroelectric dam, forms a shallow, 2-acre reservoir that runs the length of Thomas's East Avenue. After the lake, adjacent hillslopes constrict the river valley, gradient increases, and principal tributaries contribute to its increase in size and volume. Then at Douglas Falls the stream plunges into a narrow v-shaped canyon descending over numerous cataracts towards its confluence with the Blackwater River. Over the course of the river, five main tributaries Glade Run, Sand Run, Snyder Run, Middle Run, and Long Run contribute to its third order stream classification.

Hydrology

The climate, geology, soils and land cover of the North Fork influence the quantity, timing, and quality of the water exiting the watershed. When precipitation enters the catchment it is partitioned first by intercepting vegetation and litter layers. Water that is not lost to the atmosphere through evapotranspiration travels to the stream network via 3 flow paths: overland, shallow subsurface, and deep groundwater. Along its course to the stream channel, water interacts with minerals, organic material, and sources of pollution and transports them downstream. The resulting water chemistry and concentration of pollutants is influenced by many factors, including flow path, residence time, and magnitude of storm events.

The North Fork watershed is positioned at temperate latitudes on the windward side of the Allegheny Mountains. Air masses often originate from the north (polar continental) or the south (Gulf maritime) and produce frequent storm events and variable temperatures (Weedfall and Dickerson 1965). In the winter, frontal storm systems bring cold temperatures and frequent rain and snowfall, resulting in frequent storm events. Summers are warm and humid and are dominated by local and regional convective storms. Rainfall averages of 60 inches annually are distributed relatively evenly over winter, spring, and summer. Precipitation in fall is less than in other seasons, but it is highly variable because of tropical storms (Leonard and Law 2012). The distribution of precipitation is the principal driver of streamflow, but vegetation's demand for water during the growing season (May through October) can reduce streamflow by as much as 60% (Young 2014). This results in low flows during the growing season and above average flows in the dormant season.

Geology, Coal, and Mining

AMD accounts for most of the damage to the water quality in the North Fork, and several details about local coal geology and mining history are important background for this plan.

The North Fork watershed lies in the Allegheny Mountain sub-province of the Central Appalachian Mountains. The bedrock strata in this area do not lie flat but rather have a series of parallel ridges and valleys oriented NNE to SSW. The North Fork watershed is in the North Potomac Syncline. Not only do bedrock layers slope from the sides of the syncline towards its axis, but the entire syncline is sloped toward NNE. If the ground surface followed the bedrock layers exactly, water would flow into the axis of the anticline and then flow NNE toward Maryland.

The land surface does not exactly follow the bedrock layers, however. Older bedrock (Pottsville formation) appears on the surface at the northwestern boundary of the watershed. It dips to the southeast and is covered by the Allegheny and Conemaugh formations in the central part of the North Fork watershed. The Allegheny and Conemaugh Formations both contain several coal seams which are often mined. In this area, the Upper Freeport Coal Seam, which is the uppermost stratum in the Allegheny Formation, and the Bakerstown Coal Seam in the Conemaugh Formation have been mined extensively.

Because of the orientation of the bedrock layers and because of the mining in at least two coal seams, water can move through the coal seam from one watershed to another. This possibility affects this WBP plan in a few different instances. Land reclamation and water treatment outside the watershed should lead to load reductions inside the watershed. The shape of the coal seam also causes a large pool of AMD to accumulate and discharge in a small area.

Long Run, a tributary to the North Fork, flows from west to east near the southern boundary of the North Fork watershed. Finley Run and Tub Run have watersheds adjacent to that of Long Run, but they flow directly into the Blackwater River and not into the North Fork. The Office of Abandoned Mine Lands and Reclamation (OAMLR) has found evidence of mining in the Finley and Tub Run watersheds. The dip of the coal in this area leads back to Long Run, where OAMLR has wet-sealed a number of portals that still discharge AMD (Figure 2). Openings in the coal underneath Tub and Finley Runs is probably draining water from outside the North Fork watershed into Long Run.

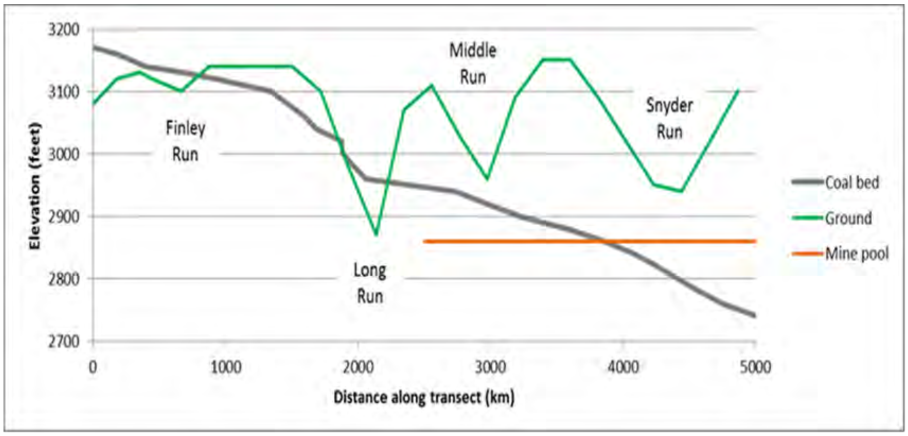


Figure 2: The Upper Freeport Coal Seam dip as it traverses tributaries of the North Fork watershed. The coal seam is the origin of and conduit for acid mine drainage that enters the streams.

Burns Blowout is an AMD source next to the North Fork. Its elevations suggests that it is draining the Coketon Mine Pool, but that part of the Mine Pool is most likely being fed by a large area of underground mines just southeast of Burns Blowout. These mines were also accessed from an area outside the North Fork watershed, and in fact, water has been seen draining into a borehole into the mine.

The Coketon Mine Pool is an underground body of water in the void left by coal mining. Its surface is determined by the elevation of various seeps through which water escapes the mine pool. It is probably fed mostly by water moving down through higher areas where the coal seam has been mined out. On the downslope side of the mine pool, a barrier of unmined coal prevents the water in the mine pool from running north-northeast toward the Kempton Mine Pool, which lies under Kempton, MD. If the various portals discharging from the mine pool cannot let water escape quickly enough, the water may rise high enough to flow around the coal barrier and then down to the Kempton Mine Pool.

Mining History

Mining in the Thomas/ Coketon area was begun by the Davis Coal and Coke Company in 1882 in what was called the "Upper Potomac Coal Field." Henry Gassaway Davis's railroad (later called the Western Maryland Railroad) arrived in 1884. The early mines in the Thomas area were of the drift entry type, which are easier to create than vertical shaft mines and cost less. These mines were located where an outcrop of coal was found on a hillside, which allowed miners to tunnel directly and horizontally into the seam. Some vertical shafts were opened up for ventilation and to run electric lines into the mines. The Kempton borehole is one such shaft.

Davis Coal and Coke (DC&C) used the room-and-pillar method. Parallel main tunnels called entries from the entry point toward the mine's other side. Mining then proceeded in reverse fashion, from the farthest point back toward the front. The rectangular block of coal outlined by the side entries and the mains—perhaps 500 by 2,000 feet—created a panel. Miners then opened rooms with connecting breakthroughs through this panel. Smaller blocks of coal—for instance 75 by 80 feet—between breakthroughs and adjacent rooms, known as pillars, were left in place to support the roof. Additional supports were fashioned with large wooden timbers from DC&C's lumber operations.

Maps of this system of mine tunnels were found in the company's engineering building in the 1990's. The Coketon Mine Complex and the Kempton Mine Complex north of it (carved out at a lower level coal seam underground) are now flooded (Figure 3). The mine tunnels, covering a 14 square miles produce AMD. AMD is created where the Upper Freeport coal seam containing pyrite is exposed to oxygen and water. The bad water runs to the lowest point in the tunnel system which at Coketon is at Mine Portal 29. Another consequence of abandoned mine tunnels is subsidence of the surface as the wooden mine supports rot and fall down. Subsidence threatens many buildings in and around Thomas and the West Virginia Office of Abandoned Mine Lands has installed cement pillars under houses to keep them stable. (There is federal protection for subsidence resulting from underground coal mines. Surface Mining Control and Reclamation Act at 29 USC section 1266 (entitled "Surface effects of underground coal mining").

Coking

During its roughly 65-year existence, DC&C dominated coal production in the Upper Potomac Coal Field. Much of the coal mined around Coketon was made into coke for steel production using beehive coke ovens located near mine openings. It was a leader in coal and coke production in West Virginia from its inception in 1888 until ca. 1915, when production began a slow decline and southern coal fields in the state rose to prominence. The company halted coke production by ca. 1920 (due to advances in technology which did away with beehive ovens) but continued producing coal from numerous mines until its closure in 1950. As the mines closed one by one as the seams played out, and technological advances reduced the need for miners, employment in the region declined. Even after DC&C's closure in 1950, the DC&C Engineering Building and its subsequent owners were managing the properties of what was once the DC&C, and employing a dwindling number of local people.

After 1950, strip mining took over in the region, often carried out by small companies leasing mineral rights from the railroad's land holdings. Major strip jobs were done above Douglas and across the North Fork from Douglas covering the North Fork Valley below Thomas. This was usually done in the Bakerstown coal seam which did not produce acid mine drainage. Strip mining did however disturb the surface to the point where rainwater and groundwater could more easily penetrate the overburden and move into old mine tunnels. This infiltration added to the acid load coming out of old mine portals and seeps in the hillsides around Coketon. Strip mining reached its height during the 1970s and early 1980s, at which point most of the recoverable coal was exhausted. The Western Maryland Railroad still in control of the former DC&C lands, timber, and mineral rights, as well as the railroad so closely associated with DC&C since its inception, operated at the DC&C Engineering Building and Headquarters in Thomas until ca. 1980 when the Western Maryland Railroad name was retired and its properties were fully incorporated into CSX Transportation. Unfortunately, DC&C would also leave in its path long-term damage to the region, especially acid mine drainage problems and surface disturbances which are dealt with to this day and will be into the foreseeable future. (West Virginia Encyclopedia and Mike Caplinger National Register form for DC&C Engineering Building)

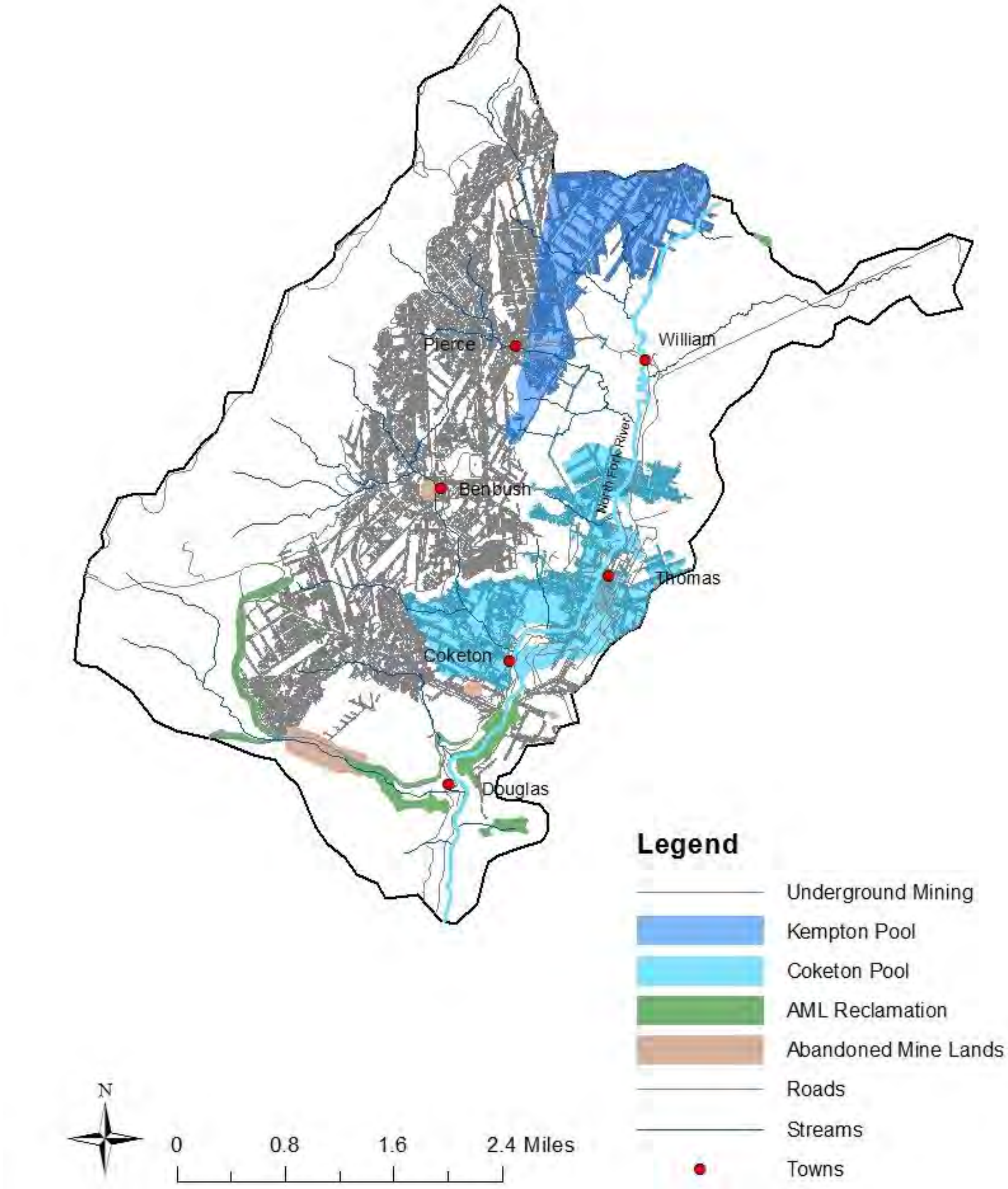


Figure 3: Underground mines shafts and mine pools of the North Fork watershed.

Land Cover and Land Use

Today the dominant land cover of the North Fork watershed is a temperate, mixed mesophytic forest. It is recognized as one of the most biologically diverse forests in the world. It supports a wide variety of large tree species, rich understories of herbaceous plants, fungi, and diverse animal communities (Loucks et al., 2016). Forest composition varies with elevation and aspect. At lower elevations a variety of forest types exist of oaks, maples, hickories, walnuts, birches, elms, hemlock, sycamore, cherry, beech, and others. At higher elevations unique red-spruce and red-spruce-northern hardwood forests are present. These forests are a relic from the last ice age and harbor rare species, such as the West Virginia northern flying squirrel, cheat mountain salamander, and snowshoe hare. These forests also support some of the world's most diverse freshwater ecosystems, which are teaming with unique and endemic species of invertebrates, muscles, amphibians, and fish.

However, the majority of the North Fork watershed is unable to sustain a fishery due to the mining-related pollution entering the watershed. A fishery does exist in Thomas Park Lake on the main stem of the North Fork just upstream of the first major AMD pollution source. The impoundment is stocked with trout once every month from February through May by West Virginia Division of Natural Resources (WVDNR). The impoundment also contains largemouth bass and bullhead catfish (WVDNR, 2005).

Forest covers approximately 87% of the land, with 5.87% of that being reforested strip mines (including SMCRA and Pre-SMCRA). Before Surface Mining Control and Reclamation Act of 1977 laws it was common practice to leave mined areas and refuse un-reclaimed. Many of these area have since revegetated and are forests today. Reclaimed AMLs are often covered in grass instead of trees to minimize infiltration of water in the subsurface. Grassland and pasture account for 5.09%, barren and grass covered mines make up 1.5% of the land cover (Table 1). Barren mine lands are predominantly the result of present day mining and quarrying. Extensive limestone quarries exist along backbone ridge spanning across sub-watersheds long Run, Snyder Run, Sand Run and Glade Run. Only .82% is developed (Figure 4). Developed lands include town centers and residential areas, as well as an industrial scale wind turbine complex. The wind turbines are located on backbone ridge and span across sub-watersheds long Run, Snyder Run, Sand Run and Glade Run. This development has deforested the ridge for the windmill pad sites and access roads.

Table 1: Land Cover and Land Use of the North Fork watershed.

Land Use / Land Cover	Percent Area	Acres	Square Miles
Forested	81.23	9661.44	15.10
Grassland/Pastureland	5.09	605.25	0.95
Barren/Developed	0.82	97.31	0.15
Open Water	0.47	55.36	0.09
Mine Grass	0.83	98.89	0.15
Mine Barren	0.67	80.04	0.13
Forested in SMCRA	2.43	288.51	0.45
Pre-SMCRA Grass	0.98	116.13	0.18
Pre-SMCRA Barren	0.14	16.87	0.03
Pre-SMCRA Forested	3.44	409.28	0.64
Herbaceous Wetlands	0.16	19.45	0.03
Woody Wetlands	1.67	199.17	0.31
Census Roads	2.07	246.76	0.39
Total	100.00	11894.46	18.59

Source: Strager and Yuill (2012) Note: The data source used in this table do not reflect most recent AML reclamation projects. Therefore, area of Pre-SMCRA Grass Has likely increased and Pre-SMCRA Forested has decreased.

Figure 4: Land cover and land uses in the North Fork watershed.

Today the major population center in the North Fork watershed is Thomas, with a population of 568 (United States Census Bureau, 2010). Other populated towns in the North Fork watershed include Coketon, Douglas, Benbush, Pierce, and William (Figure 5). Today, county residents are employed in a number of different sectors. The largest employer is tourism and hospitality followed by education and health care. (US Census 2010-14) Other employers include retail, professional services, recreation, and forestry. The median family income in the Tucker County was $36,445 (Small Business and Housing Needs Assessment, 2014).

Local attractions, such as the Monongahela National Forest, State Parks, Little Canaan Wildlife Management Area and Canaan Valley National Wildlife Refuge draw visitors to the area every year for mountain biking, boating, fishing, skiing, hunting, and other forms of outdoor recreation. Jessica Scowcroft of the Tucker County Convention and Visitors Bureau estimates that at least half of the visitors to Tucker County are there to experience the outdoors and scenery (Personal communication, Scowcroft J., 2015). In 2014, Blackwater Falls State Park drew 850,000 visitors and Canaan Valley State Park close to 300,000. Skiing is also a big attraction, which drew in 125,000-150,000 visitors to three resorts: Timberline, White Grass, and Canaan Valley. Altogether, it is safe to say that over one million visitors were drawn to Tucker County for its natural beauty. (Personal communication, Scowcroft J., 2015).

The North Fork: A High Restoration Priority

The North Fork is a sub-watershed to the Blackwater River, which encompasses 141.8 square miles. Although the North Fork accounts for only 13 % of the Blackwater watershed's total area, the acid mine drainage pollution likely impacts aquatic assemblages more than 10 km downstream (Petty et al., 2010) of its confluence. Merovich and Petty et al., (2013), showed that the North Fork watershed has the highest restoration priority because it maximizes watershed-scale (10 digit HUCs) restorability of receiving watersheds. In other words the North Fork is surrounded by high quality streams. Yet the pollution contributed by the North Fork impairs the receiving streams such that the health of the greater aquatic ecosystem is impacted. By repairing the water quality of the North Fork the distribution of aquatic organisms will be improved throughout major streams: the Blackwater, Black Fork, Dry Fork, Upper Cheat, and there sub-watersheds. In light of these studies restoring the North Fork should be a priority for decision makers. The following sections outline how the waters of the North Fork watershed can be restored.

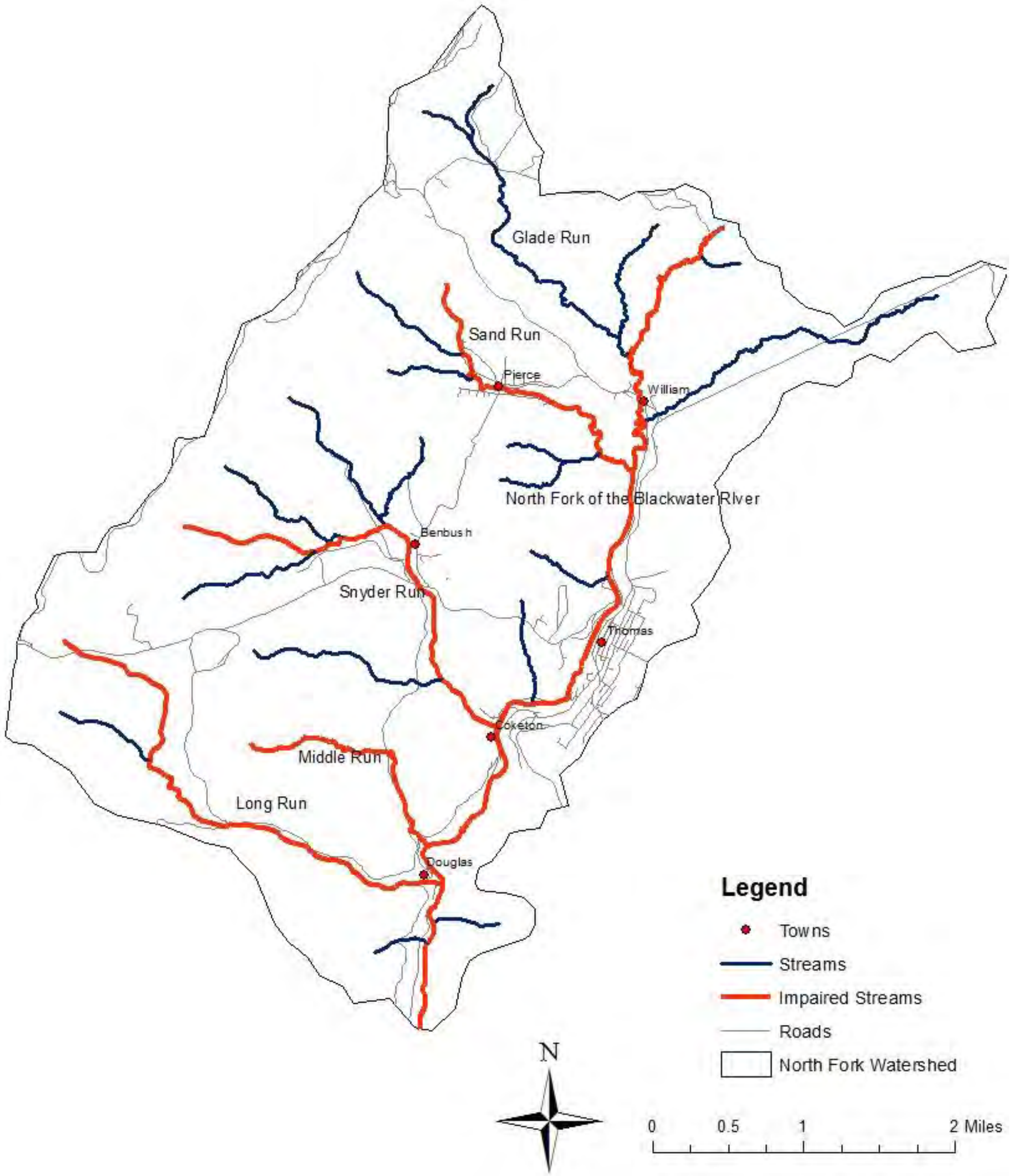


Figure 5: Towns and impaired streams in the North Fork watershed.

A. 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. Numeric and narrative water quality standards are based on the designated use of the stream (Table 2 and Table 3). The North Fork and some of its tributaries are impaired because they fail to support one or more designated uses: public water supply, maintenance and propagation of aquatic life (warm water fishery streams or trout waters), or water contact recreation (Table 4).

Table 2: West Virginia State Water Quality Criteria.

Pollutant	**Designated Use**				
	Aquatic Life				**Human Health**
	Warm water 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
Manganese, total (mg/L)	--	--	--	--	1.0[c]
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
Fecal coliform bacteria	**Human Health Criteria** Maximum allowable level of fecal coliform content for Primary Contact Recreation (either MPN [most probable number] or MF [membrane filter counts/test]) shall not exceed 200/100 mL as a monthly geometric mean based on not less than 5 samples per month; nor to exceed 400/100 mL in more than 10 percent of all samples taken during the month.				

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.
c Not to exceed 1.0 mg/L within the five-mile zone upstream of known public or private water supply intakes used for human consumption.
Source: 47 CSR, Series 2, *Legislative Rules, Department of Environmental Protection: Requirements Governing Water Quality Standards.*

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 Iron	Aquatic life, trout waters	0.5 mg/L (4-day average)	0.475 mg/L (4-day average)
Total Aluminum	Aquatic life, warm water fisheries	0.75 mg/L (1-hour average)	0.7125 mg/L (1-hour average)
Dissolved Aluminum	Aquatic life, trout waters	0.087 mg/L (4-day average)	0.0827 mg/L (4-day average)
Total Manganese	Public Water Supply	1.0 mg/L (within 5 upstream miles of a public water intake)	0.95 mg/L
Fecal Coliform	Water Contact Recreation and Public Water Supply	200 counts / 100 mL (Monthly Geometric Mean)	190 counts / 100 mL (Monthly Geometric Mean)

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.

Table 4: Supported Use of Impaired Streams in the North Fork Watershed

Stream	**Stream Code**	**Length**	**Warm Water Fishery**	**Trout Waters**	**Public Water Supply**	**Water Contact Recreation**
North Fork	WVMC-60-D-3	8	Not Supporting		Not Supporting	Not Supporting
Long Run	WVMC-60-D-3-A	3.6	Not Supporting		Not Supporting	Not Supporting
Middle Run	WVMC-60-D-3-B	1.8	Not Supporting		Not Supporting	Not Supporting
Snyder Run	WVMC-60-D-3-C	2.8	Not Supporting		Not Supporting	Not Supporting
Sand Run	WVMC-60-D-3-E	2.2		Not Supporting	Not Supporting	Not Supporting

Source: 2011 Cheat TMDL.

In 2011, West Virginia Department of Environmental Protection (WVDEP) developed the total maximum daily load (TMDL) for the Cheat River Basin, including the North Fork watershed. A TMDL is the maximum amount of pollution a stream can receive and meet water quality standards. Therefore this plan, as it relates to the 2011 Cheat TMDL is also based on the same water quality standard. The TMDL accounts for permitted point source and nonpoint source pollution, also known as waste load allocation (WLA) and load allocation (LA), respectively. In addition, the TMDL includes a margin of safety (MOS) to account for uncertainty in the TMDL process. The TMDL is expressed as,

$$\text{TMDL} = \sum \text{WLA} + \sum \text{LA} + \text{MOS}.$$

Improving water quality so that these streams are once again clean and can be removed from the 303d list is the primary goal of this plan. Segments of the North Fork watershed covered by this plan are listed for AMD-related pollutants (pH, aluminum, iron, manganese), or biological impairment (WVDEP, 2012) (Table 5).

Table 5: Impaired Streams of North Fork Watershed.

Stream	WV Stream Code	NHD Code	Length	pH	Fe	Al	Fecal Coliform	Bio
North Fork	WVMC-60-D-3	WV-MC-124-K-15	8	x	x	x		
Long Run	WVMC-60-D-3-A	WV-MC-124-K-15-H	3.6	x	x	x		x
Middle Run	WVMC-60-D-3-B	WV-MC-124-K-15-E	1.8	x	x*	x*		
Snyder Run	WVMC-60-D-3-C	WV-MC-124-K-15-D	2.8	x				
Sand Run	WVMC-60-D-3-E	WV-MC-124-K-15-C	2.2		x	x	x	x

An "x" identifies parameters that impair the stream. An "*" indicates impairment was modeled. Source: All are from the 2014 303(d) list Supplemental Tables B and E (WVDEP, 2014a), which lists 8 impaired miles for dissolved aluminum for North Fork Blackwater, but no mileages for the any other AMD impairments. Miles of stream impaired for Long, Middle, and Snyder Runs are from the 2014 303(d) list (WVDEP, 2014), which lists all four streams as impaired by pH and metals from mine drainage. This table also includes the WV Stream Code used in the 2011 Cheat TMDL and NHD codes in the 2014 303(d) list.

A.1 Sources of Impairment

Streams of the North Fork that are designated impaired by the 303 (d) list do not meet numeric water quality standards, including metal concentration (iron, aluminum, and manganese), pH toxicity, and the numbers of fecal coliform bacteria (Table 5). The sources of pollution originate from permitted point source (WLA) and nonpoint source pollution (LA).These sources are described below.

A.1.1 Permitted Point Source Impairments

There are currently 7 WLA in the North Fork. These entities include permitted sites under the National Pollution Discharge Elimination System (NPDES) and the Construction Storm Water permit programs.

- Fairfax Materials, INC., WV0092398, Sandstone Quarry, discharges into Long Run of North Fork of Blackwater River. LAT 39.150000, LONG:-79.551944
- City of Thomas, WV0024856, Waste Water Treatment Plant, discharges into North Fork of Blackwater, LAT 39.1453, Long -79.5028
- Davis Coal and Coke, WVDEP OAMLR, WVR107550, Storm Water Construction, discharges into Middle Run/City of North Fork of the Blackwater River. LAT 39.1375, LONG -79.5167
- Sunrise Sanitation Services Inc., WVRNE0089, Storm Water Industrial, discharges in North Fork of the Blackwater River. LAT 39.1472, LONG -79.4994
- Cortland Acres Assoc., WVR107858, Storm Water Construction, discharges into the North Fork of the Blackwater River. LAT 39.1506, LONG -79.5047
- WV Division of Highway Salt Shed, WVR105361, Storm Water Construction, discharges into the North Fork of the Blackwater River. LAT 39.1419, LONG -79.4956
- Roger Camp Hill, WVDEP OAMLR, WVR106205, Storm Water Construction, discharges into North Fork of the Blackwater River. LAT 39.1842, LONG -79.4764

A.1.2 Non-Point Source Impairments

Acid mine drainage

The most severe nonpoint source pollution in the North Fork watershed is AMD from abandoned mine lands (AMLs). AMLs are sites that were mined prior to the Surface Mining Control and Reclamation Act of 1977. Before SMCRA mining law it was common practice to leave mined areas and refuse un-reclaimed. This practice exposed sulfur-rich minerals such as pyrite and other iron sulfide minerals, which react with air and water to form sulfuric acid and dissolved iron. The water draining these areas is highly acidic and is laden with metals: aluminum, iron, manganese. Water drains from mining refuse, seeps from underground mines, and pollutes streams and wetlands.

AML sites have received special attention from the Office of Surface Mine Reclamation and Enforcement because of the danger un-reclaimed mines pose to human health and the environment. Friends of Blackwater has partnered with the OAMLR and OSMRE to reclaim 10 out of the 12 AML sites in the North Fork watershed (Table 6 & 7). These projects have focused on protecting human safety by removing hazards posed by highwalls, spoil piles, and mine openings. Future land reclamation projects are planned that will emphasize water quality improvement as well as human safety.

This section describes the AMD pollution effecting the North Fork and its sub watersheds (SWS). In some cases the 2011 Cheat TMDL lists streams as impaired, but data collected by WVDEP, OAMLR, and FOB proves that it should not be considered as such. Justification for not including parts of Sand Run, Snyder Run and Middle Run in this management plan are also provided below.

Table 6: AML sites of the North Fork watershed.

Site Name (PAD#)	Location and Receiving Stream	Notes: This section will include any necessary information to further understand the site.
Blackwater Manor (4)	Unnamed tributary on east side of south Fork.	Completed project includes three sealed portals and water treatment measures.
Coketon Mine Portal (275) (aka Mine portal 29 or M29)	Large portal on west side of North Fork	This is the largest AMD load in the watershed, and is thought to be the major discharge from the Coketon mine pool. A WALD treatment system was installed, to treat 1/3rd of flow but it no longer functions today. During the project, some of the flow changed its path, and a wet seal was placed upstream to control the flow at that point.
Albert Highwall (1622) and Long Run (3)	Portals along Long Run and Middle Run	The completed Albert Highwall project includes extensive land reclamation and several water treatment cells, effecting both Long Run and Middle Run. Treatment cells no longer function.
Douglas Highwall #2 (1623)	Smaller portals on east side of North Fork	There are a number of mine portals that discharge lesser flows into the North Fork below the Coketon Portal. These sites are not being treated.
Long Run Strip (1799)	Discharges to headwaters of Long Run	Large un-reclaimed areas of refuse coal contribute AMD load to Long Run upstream from the Albert Highwall project.
Snyder Run HW No. 4 (3191)	Discharges to Middle Run	AMD was not identified at this site by OAMLR, but highwalls at this site would be up dip, and probably discharge AMD that accounts for the AMD load measured in Middle Run upstream from the Albert Highwall project.
Burns Blowout (4642)	Discharges to North Fork just upstream from Douglas Highwall #2 on river left side	The location of this source suggests it is a discharge from the Coketon mine pool.
Thomas (Collett) AMD (5799)	Discharges to North Fork between Thomas and Douglas.	Intermittent AMD source. No flows or chemistry recorded.
Thomas (Sunrise Sanitation) Mine Drainage (5937)	Discharges to North Fork in Thomas	This AMD source discharges from the Bakerstown seam in the middle of the town of Thomas. The one SRG measurement indicates the water is not acidic. The water carries an unsightly white precipitate usually presumed to be aluminum hydroxide. (Reclamation on source, Pendleton Run, completed)
Roger Camp Hill refuse (6233)	Discharges to the North Fork above the intersection of State Route 90 and 219 North	About 2 acres of exposed coal refuse. (reclamation completed)

This table includes site names with PAD #, location of the discharge site, and site description. Note, that the problem area number (PAD #) is a number that is an identifier in the WVDEP Abandoned Mine Lands system.

Table 7: AML reclamation projects past, present, and future.

Project Name	**PAD #**	**Status**	**Date Completed**	**Cost ($)**
Davis Highwall	WV-1674	Abated	1991	153,415.00
Davis Highwall #2	WV-1620	Abated	1991	151,999.00
Davis Strip #2	WV-2125	Abated (Partially)	1991	
Benbush Refuse Pile	WV-1798	Abated	1992	214,451.00
Burns Blowout	WV-4642	Abated	1994	12,619.00
Pierce Refuse Pile #1	WV-0001	Abated	1994	198,596.00
Albert Highwall Phase 1	WV-1622	Abated	1996	3,650,807.97
Douglas Run Highwall #1	WV-1623	Abated	1996	1,446,449.00
Long Run	WV-0003	Abated	1996	
Blackwater Manor	WV-0004	Abated	1997	239,929.00
Albert Highwall Enhancement A		Abated	2008	187,974.40
Pendleton Creek Highwall	WV-1515	Abated	2010	
Pendleton Creek Strip Phase I	WV-2128	Abated	2010	763,450.00
Thomas (Sunrise Sanitation) Blowout	WV-5937	Abated	2010	549,832.00
Long Run Highwall #1	WV-3187	Abated	2011	
Pierce Refuse Pile #2	WV-1801	Unabated		
Tub Run Highwall & Refuse Phase I & II	WV-2279	Abated	2011 & 2014	4,281,502.00
Albert Highwall Phase II	WV-1622	Abated	2015	
Roger Camp Hill Refuse	WV-6233	Abated	2014	210,085.00
Pendleton Creek Strip Phase II	WV-2128	In Design		
Davis Coal & Coke	WV-0002	In Design		
Tub Run Highwall and Refuse Phase III	WV-22789	In Design		

The North Fork Main Stem

The North Fork is impaired for 8 miles. The source of pollution comes from tributary streams that drain AMLs and AMD seeps that discharge directly into the stream. Of the tributaries that contribute to AMD, Long Run is by far the most damaging. After Long Run, the North Fork increases iron and aluminum loads by 80% and 50% respectively (Figure 6 & 7).

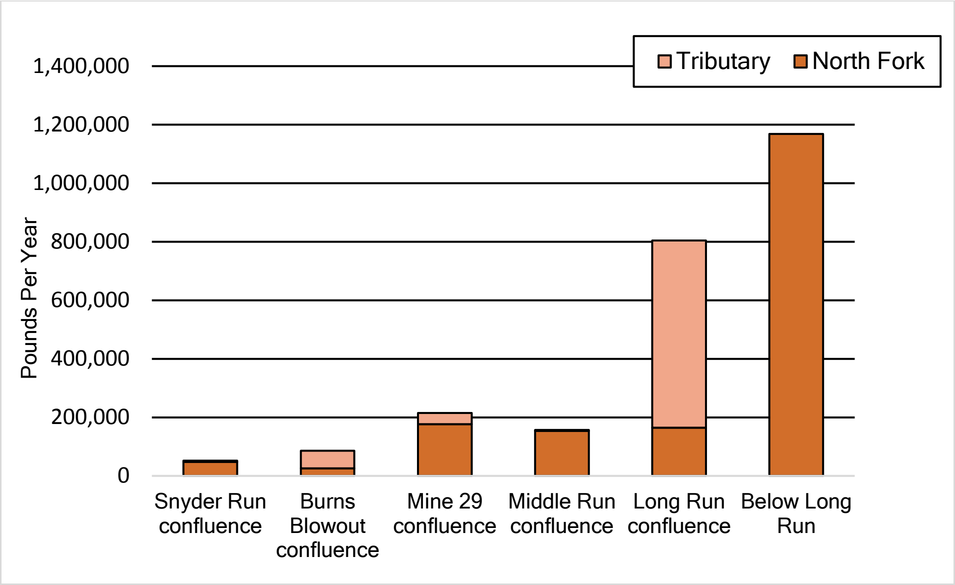


Figure 6: Annual Iron loads measured in the North Fork below tributaries (Snyder Run, Middle Run which includes mine outflow the wetland anoxic limestone drain Long Run) and mine outflows (Burns Blowout, M29). Long Run increases the iron load in the North Fork by 80%.

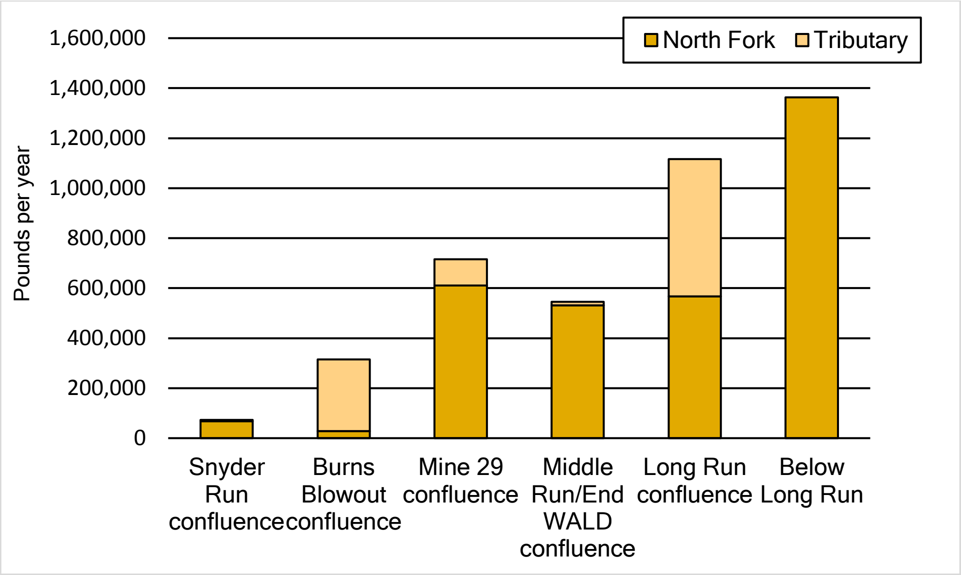


Figure 7: Annual aluminum loads measured in the North Fork bellow tributaries (Snyder Run, Middle Run which includes mine outflow the WALD, Long Run) and mine outflows (Burns Blowout, M29). Long Run increases the aluminum load in the North Fork by 50%.

AMD from mine portals and seeps that drain directly into the stream are the predominant source of impairment upstream of Long Run (Figure 8). The 2011 TMDL lists 21 AML sources draining directly into the main stem. Of these, underground mine discharge Mine Portal 29 (M29) and Burns Blowout (not accounted for in the TMDL) are the most damaging.

The massive underground Upper Freeport Coketon mine pool underlies a large part of the North Fork watershed and discharges into the North Fork (Figure 3). The mine pool is adjacent to the Kempton mine pool, which discharges to the North Branch Potomac River watershed in Maryland. Because of the size and potential impact of these mine pools Maryland Department of the Environment and Frostburg State University studied the issue, and mapped the mine pools to measure water movement from one to the other.

In West Virginia, the main outlets from the Coketon mine pool are the portals at the Douglas Highwall #2 and Coketon Portal sites. Flows from five outlets on the west side of the North Fork average a total of 1,350 gpm, and four flows on the east side average a total of 610 gpm (MDE, 2002b). This water is highly acidic (Leo, 2005b). An additional site, Burns Blowout, is in the same area and likely discharges from this pool. Two other AMLs, Albert Highwall on the west side of the North Fork and Blackwater Manor on the east side, are connected to the same mine void, but lie at a higher elevation and do not drain the same pool.

Other AML remediation projects include Roger Camp Hill Refuse (Figure 8). Roger Camp Hill Refuse project, completed in 2014 to reduce the human health hazard. The OAMLR staff believe that water from this site flows to the North Branch of the Potomac. .

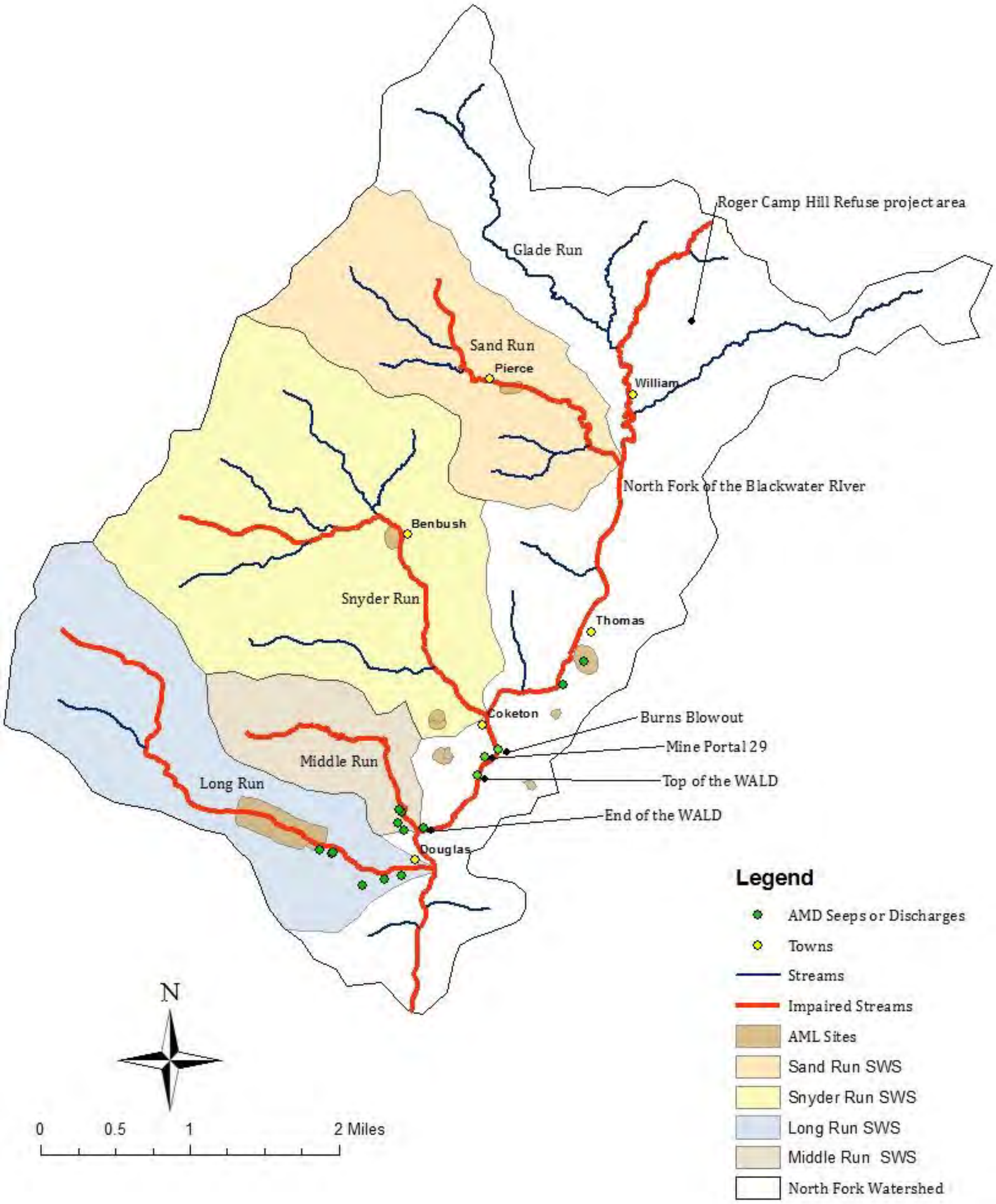


Figure 8: Sources of AMD include seeps and mine discharges from AML and underground mines. The Coketon mine pool discharges at Burns Blowout, Mine Portal 29, and the Top of the WALD.

Sand Run

The TMDL list Sand Run as impaired for 2.2 miles by metal toxicity; iron and aluminum. With this impairment and others, it cannot meet the required designated use of trout fishery. The upper reaches of this watershed are impacted by a limestone quarry which held three NPDES mining permits. Since the last TMDL written these permits have been terminated for unknown reasons. Two pre-SMCRA AML refuse piles exist at Pierce, known as Pierce Refuse #1 and #2. Pierce Refuse # 1 has been reclaimed but # 2 has not.

Justification for Sand Run being removed from the TMDL. The Cheat 2011 TMDL list Sand Run for violation of Aluminum, Iron, pH, and fecal coliform pollutants. However, data downloaded from the WVDEP website (WVDEP, 2015) shows pH are within numeric water quality standards. The WVDEP data shows pH averages 6.66, with 100% of all values collected between the numeric water quality standard (higher than 6.0 and lower than 9.0) (Appendix: Table 20). In addition, data collected by the WVDEP between 1996 and 2011 show that Aluminum (.09 mg/L) and Iron (1.10 mg/L) are slightly above numeric water quality criteria (aluminum = .087 mg/L, Iron = .50 mg/L). This stream meets the numeric water quality standards for pH.

Snyder Run

Snyder Run is one of the main tributaries in the North Fork watershed. The TMDL list pH as the single cause of impairment. There is an AML site called Benbush Refuse, PAD number- WV1798, which does not have any current reclamation work completed.

Justification for Snyder Run being removed from the TMDL. The Cheat 2011 TMDL list Snyder Run for having pH impairment. However, data downloaded from the WVDEP website shows that average pH over the last ten years is 6.75, with more than 90% of all values collected between the numeric water quality standard (higher than 6.0 and lower than 9.0). In addition pH measured by FOB between x and y years also meet this criteria (Appendix: Table 20). This stream meets the numeric water quality standards therefore it should not be on the 2011 Cheat TMDL nor on the 303 (d) list of impaired streams.

Middle Run

Middle Run is impaired for 1.8 miles due to metal toxicity (aluminum and iron) and low pH. Known sources of AMD include 4 seeps and a discharge from the Coketon Mine pool called the End of WALD. The seeps have been diverted into a fabric form channel that is directed into Middle Run. This fabric form constructed channel is part of the Albert Highwall project completed by WVDEP AML division. The End of WALD is a name given to the discharge point of the wetland anoxic limestone drain (WALD). The WALD is a mile long passive treatment system that was built to treat one third of the outflow from the Coketon mine pool. Anoxic conditions along with limestone lining the channel were designed to neutralize acidity and precipitate metals out. However, functionality was diminished when the limestone became armored and the integrity of the structures failed. Although aluminum loads, pH, and dissolved oxygen have not been effected, iron is reduced by nearly fifty percent (Table 8).

Table 8: Average change in aluminum, iron, pH, and dissolved oxygen from the top of the WALD to the end of the WALD just before it enters Middle Run. The WALD is an anoxic limestone drain created to treat AMD originating from the Coketon mine discharge.

Water Quality Parameters	**Top of the WALD**	**End of the WALD**
Aluminum- total (mg/L)	11.9	11.4
Iron- total (mg/L)	2.2	1.2
pH	3.4	3.6
Dissolved Oxygen (mg/L)	3.5	9.6

<u>Justification for Middle Run being removed from the TMDL:</u> The End of WALD, a critical source of AMD, discharges in Middle Run feet before its mouth. Yet, the AMD originates outside of the Middle Run watershed via the WALD passive treatment system. Data used to inform the TMDL process was sampled below the End of WALD, hence Middle Run is designated as impaired. However, this plan argues that Middle Run is not an impaired stream above this source. Data sampled above the End of WALD by the WVDEP show 90% of measurements for aluminum concentration and iron concentration are below .75 (mg/L) and 1.50 (mg/L), respectively (Appendix: Table 20). Therefore, Middle Run is not in violation of metals Aluminum and Iron. Considering the same datasets pH averages x and occurs within numeric water quality standards x % of the time. Therefore, following the 10% rule, Middle Run is in violation of pH numeric water quality standards and should remain on the 2011 cheat TMDL for pH.

Long Run

Long Run is the last main tributary to the North Fork and the key restoration stream in the watershed. This stream contributes a majority of the AMD that discharges into the North Fork (Figure 6 & 7). The WVDEP identifies 6 AMD seeps contributing high aluminum and iron loads. The heavy pollution has detrimental effects on the North Fork and the Blackwater River.

Two AML sites, Long Run Strip (1799) and Long Run Highwall #1 (3187) may account for substantial loads of AMD in Long Run upstream of the Albert Highwall project. Neither problem area description (PAD) mentions water discharges, but the AMD loads are assigned to Long Run Strip because it reports 15 acres of gob or refuse. These AMD seeps cause biological stressors such as metal toxicity and pH toxicity within the 3.6 miles of Long Run that is designated impaired. Albert Highwall has been reclaimed by OAMLR two projects Albert Highwall # 1 and Albert Highwall # 2. This project, Albert Highwall #1 Phase II, includes the completion of the Box Cut reclamation site as well. These projects constructed drainage channels and culverts to safely carry water off the site. While these projects addressed safety issues within the area they also diverted water that could have added AMD to the stream. Whether or not these projects neutralized acidity or decreased the sources of underground contamination is unknown at this time and further investigation is needed.

Several projects have been implemented and completed to increase the health of the stream. These projects include the Albert Highwall Enhancement Projects. This project created two successive alkalinity producing systems (SAPS) and installation of an underdrain. One side of these treatment systems contained a thick layer of high calcium carbonate limestone covered with 12 inches of organic material. A heavy plastic liner was place beneath the limestone to prevent leaking and groundwater infiltration. Due to the lack of maintenance the limestone drains become armored with iron precipitates and ceased neutralizing acid.

A.3 Biological impairment

Streams are listed for biological impairment based on a survey of their benthic macroinvertebrate communities. A West Virginia Stream Condition Index score is generated from this survey. Streams with a score of 60.6 or less are considered biologically impaired and placed on the list. Long Run and Sand Run (Table 5) are biologically impaired due to the lack of benthic macroinvertebrates present. This issue is caused by impairments such as metals, low pH, sedimentation, and fecal coliform. According to 2011 Cheat TMDL, implementing management strategies to reduce metals toxicity, pH toxicity, and sedimentation can be a surrogate for addressing biological impairments especially in Long Run and Sand Run. Such surrogates are further described in section B.

A.3.1 Fecal coliform

WVDEP has found that fecal coliform bacteria impair many West Virginia waters. The 2014 303 (d) list currently states that Sand Run (Table 5) has exceeded the fecal coliform water quality criterion of 200 counts/100mL (Table 3). The stream is impaired for 2.2 miles and the 2011 Cheat watershed TMDL stated that the presence of the fecal coliform is due to, “inadequate onsite sewage systems.” There are currently 6 septic systems present in the Sand Run watershed. Further inspection of these septic tanks and the reduction of the presence of fecal coliform bacteria must be considered in order to remove this biological stressor from the 303 (d) list of impaired streams.

A.3.2 Sediment

Sediment sources and loads currently entering the North Fork watershed are not fully understood at this time, and the 2014 303(d) list does not list any stream segments for sediment impairment. The 2011 Cheat watershed TMDL listed Sand Run as having presented sediment deposition as a marginal problem, but is not listed as an impairment on the most recent 2014 303 (d) list.

Sources of sediment likely include, but are not limited to, mining, logging, dirt roads, mismanaged agricultural lands, and stream bank erosion. It is suggested that a study be completed to identify sediment impairments and sources.

B. Expected Load Reductions

B.1. Load Reductions

This plan focuses on meeting numeric water quality standards (pH, dissolved Al, total Fe,) with the belief that the violation of narrative criteria (CNA biological impairment) will also be eliminated. Utilizing the stressor identification guidelines in the 2011 Cheat TMDL the reduction of AMD will be surrogate for the following impairments.

- The reduction of aluminum and iron is surrogate for metals toxicity, pH toxicity, and sedimentation caused biological impairment.

Once metal load reductions have been achieved fecal coliform impairment will be reevaluated.

In this plan, the TMDL for the Cheat watershed, which includes the North Fork watershed provides load reduction targets necessary to meet water quality standards (Cheat TMDL, 2011). The applicable TMDL targets are defined using LAs of nonpoint source pollutants at the watershed and sub-watershed scales. In addition, TMDL targets are identified at specific AMD sources (i.e. seeps, mine portal discharge). Load reductions (LR) are an estimate of how much the pollutant load needs to be reduced and are calculated by subtracting the LA portion of the TMDL from current pollutant loads, which have been measured by FOB and in the TMDL, as follows

$$\text{LR} = \text{pollutant loads} - \text{LA}.$$

Metal load reductions are calculated for impaired streams (Table 9) and at major AMD sources along the North Fork (Table 10, Table 11). These tables display data from three sources (FOB, OAMLR, and in the TMDL) to provide a comprehensive list of reductions and to facilitate the comparison of results between data sources. Such comparison is used to develop appropriate management strategies.

Table 9: Reductions to meet TMDL targets for impaired streams. Source describes origin of the data to highlight the difference in values.

Stream Code	Sub Watershed	Metal	Source	LA TMDL Target (lbs/year)	Measured Load (lbs/year)	Reduction (lbs/year)	Reduction (%)
WV-MC-124-K-15	North Fork	Al	FOB	11,460.6	265,905.4	254,444.8	95.7
			TMDL		138,758.1	127,297.6	91.7
		Fe	FOB	61,027.1	175,640.3	114,613.2	65.3
			TMDL		136,768.0	75,740.8	55.4
WV-MC-124-K-15-C	Long Run	Al	FOB	2,033.4	169,552.7	167,519.3	98.8
			TMDL		22,508.9	20,475.5	91.0
			OAMLR*		193,887.3	191,853.9	99.0
		Fe	FOB	8,215.2	150,834.5	142,619.2	94.6
			TMDL		32,004.5	23,789.3	74.3
			OAMLR*		65,362.9	57,147.7	87.4
WV-MC-124-K-15-D	Middle Run**	Al	FOB	1,243.4	1,433.1	189.7	13.2
			TMDL		24,953.3	23,709.9	95.0
			OAMLR***		1,002.4	-241.0	-24.0
		Fe	FOB	4,072.0	8,467.6	4,395.6	51.9
			TMDL		12,823.3	8,751.3	68.2
			OAMLR***		2,027.2	-2,044.8	-100.9
WV-MC-124-K-15-H	Sand Run	Al	TMDL	713.0	779.5	66.5	8.5
		Fe	TMDL	6,455.9	13,271.5	6,815.6	51.4

*Average of 9 measurements over three years; 3 in 2012, 1 in 2013, 5 in 2015

** FOB and QAMLR sample above Coketon mine discharge End of WALD. The TMDL sample site is below this discharge.

*** Average of 5 Measurements over the year 2015

Table 10: Aluminum load reductions at AMD discharges. Source describes origin of the data to highlight the difference in values.

Discharge Code	Common Name	Source	Measured Load (lbs/year)	LA TMDL Target (lbs/year)	Load Reduction (lbs/year)	Load Reduction (%)
North Fork						
MC124K15-100-1		TMDL	33,067.7	1,693.7	31,374.0	94.9
MC124K15-200-1	M29 Combo	TMDL	50,556.2	1,660.6	48,895.6	96.7
		FOB	59,595.0	1,660.6	57,934.4	99.7
MC124K15-200-2		TMDL	1,007.3	148.1	859.2	85.3
MC124K15-300-1		TMDL	184.1	46.0	138.1	75.0
MC124K15-300-2		TMDL	229.3	34.0	195.4	85.2
MC124K15-300-3		TMDL	229.9	35.9	194.0	84.4
MC124K15-300-4		TMDL	271.1	73.0	198.1	73.1
MC124K15-400-1		TMDL	21.1	21.1	0.0	0.0
MC124K15-500-1		TMDL	268.5	6.8	261.7	97.5
NA	Burns Blowout	FOB	135,667.5			
		OAMLR*	42,538.4			
Long Run						
MC124K15C-10-1		TMDL	5,360.7	694.4	4,666.3	87.0
MC124K15C-100-1		TMDL	3,381.7	152.7	3,229.1	95.5
MC124K15C-100-2		TMDL	3,843.5	199.9	3,643.5	94.8
MC124K15C-100-3		TMDL	2,728.3	138.3	2,590.1	94.9
MC124K15C-100-4		TMDL	5,489.1	158.0	5,331.1	97.1
MC124K15C-100-7		TMDL	0.0	0.0	0.0	0.0
MC124K15C-100-8		TMDL	0.0	0.0	0.0	0.0
Middle Run						
MC124K15D-100-1	End of WALD	TMDL	23,857.0	927.1	22,929.9	96.1
		FOB	24,176.0	1,693.7	22,482.3	93.0
MC124K15D-100-2		TMDL	796.6	72.4	724.2	90.9
MC124K15C-100-5		TMDL	0.0	0.0	0.0	0.0
MC124K15C-100-6		TMDL	0.0	0.0	0.0	0.0
MC124K15C-100-9		TMDL	21.9	21.9	0.0	0.0
Sand Run		NA				

* Average of 4Measurements over the year 2015.

Table 11: Iron load reductions at AMD discharges. Source describes origin of the data to highlight the difference in values.

Discharge Code	Common Name	Source	Measured Load (lbs/year)	LA TMDL Target (lbs/year)	Load Reduction (lbs/year)	Load Reduction (%)
North Fork						
MC124K15-100-1		TMDL	10,345.8	10,345.8	0.0	0.0
MC124K15-200-1	M29 Combo	TMDL	18,190.4	2,214.1	15,976.2	87.8
		FOB	13,242.5	2,214.1	11,028.4	83.3
MC124K15-200-2		TMDL	79.0	79.0	0.0	0.0
MC124K15-300-1		TMDL	116.6	61.3	55.2	47.4
MC124K15-300-2		TMDL	221.5	45.3	176.2	79.5
MC124K15-300-3		TMDL	241.9	47.8	194.0	80.2
MC124K15-300-4		TMDL	277.6	97.4	180.3	64.9
MC124K15-400-1		TMDL	33.7	33.7	0.0	0.0
MC124K15-500-1		TMDL	140.9	9.1	131.8	93.6
NA	Burns Blowout	FOB	26,339.3	NA		
		OAMLR*	6,664.8	NA		
Long Run						
MC124K15C-10-1		TMDL	3,342.3	925.9	2,416.5	72.3
MC124K15C-100-1		TMDL	3,061.5	203.6	2,857.9	93.4
MC124K15C-100-2		TMDL	2,197.5	266.6	1,931.0	87.9
MC124K15C-100-3		TMDL	779.8	184.3	595.4	76.4
MC124K15C-100-4		TMDL	6,973.3	210.6	6,762.7	97.0
MC124K15C-100-7		TMDL	0.0	0.0	0.0	0.0
MC124K15C-100-8		TMDL	0.0	0.0	0.0	0.0
Middle Run						
MC124K15D-100-1	End of WALD	TMDL	8,603.3	1,236.1	7,367.2	85.6
		FOB	2,824.4	1,236.1	1,588.3	56.2
MC124K15D-100-2		TMDL	1,052.5	96.6	956.0	90.8
MC124K15C-100-5		TMDL	0.3	0.2	0.1	27.3
MC124K15C-100-6		TMDL	0.0	0.0	0.0	0.0
MC124K15C-100-9		TMDL	59.5	59.5	0.0	0.0
Sand Run		NA				

* Average of 4Measurements over the year 2015.

Metals contribute to the acidity of AMD. Treatment of AMD requires the neutralization of this acidity. Hot acidity, a measure of acidity can be calculated as,

$$50*(3*[Al]/27 + 3*[Fe]/56 + 2*[Mn]/55 + 1000*10(-pH)) - \text{Alkalinity}.$$

Hot acidity is equivalent to the amount of alkaline material needed to neutralize AMD in the stream. Acidity needs to be reduced at impaired streams (Table 12) and at major AML sources along the North Fork (Table 13).

Table 12: Acid load of Impaired Streams.

NHD Code	Sub watershed	Hot Acidity (Ton of CaCO3)	Acid Load or Alkalinity needed to neutralize Acidity (Ton/year)
WV-MC-124-K-15	North Fork	38.1	1,240.4
WV-MC-124-K-15-C	Long Run	176.2	2,923.4
WV-MC-124-K-15-D	Middle Run	-10.2	-51.2
WV-MC-124-K-15-H	Sand Run*	NA	NA

*Metals in Sand Run are not measured by FOB, nor is Acidity calculated by the 2011 Cheat TMDL

Table 13: Acidity of Coketon Mine Discharge.

NHD Code	Mine Discharge	Hot Acidity (Ton of CaCO3)	Acid Load or Alkalinity needed to neutralize Acidity (Ton/year)
WV-MC-124-K-15	Burns Blow Out	245.6	747.4
WV-MC-124-K-15	Coketon Mine M29 Combo	128.3	215.3
WV-MC-124-K-15	Top of WALD	107.5	43.1

B.2. Load Reductions and Proposed Management Measures for Each Source.

To meet the TMDL targets of the North Fork and sub-watersheds, this plan prioritizes reducing loads at the greatest sources of AMD: Long Run and mine outflows Burns Blowout, M29, and WALD (Table 14). Proposed management measures of land reclamation, passive treatment, and active treatment will be implemented in a phased approach. The first phase includes land reclamation projects targeted at improving water quality in Long Run and at mine outflow Burns Blowout. After the completion of phase I projects load reduction criteria will be evaluated. Based on this evaluation, phase II will address the remaining critical sources though passive and active treatment. Throughout phase II, performance of management measures will be evaluated. If load reductions criteria are not meet than management measures will be adjusted accordingly in phase III. This includes implementing management measures at AMD sources with lesser priority. Two options for reducing loads are presented below. Option one differs from option two, by actively treating the combined Coketon mine outflows Burns Blowout, M29, and WALD instead of using passive treatment.

Table 14: Load reduction and proposed management measure at AMD sources using land reclamation and active treatment option. Reductions were estimated using FOB data and AMDTreat.

Current load				BMP Information			Estimated Final Load	
NHD Code	**Source**	**Aluminum Load (lbs./year)**	**Iron Loads (lbs/year)**	**BMP**	**Cost**	**Expected Reduction (%)**	**Final Aluminum Load**	**Final Iron Load**
WV-MC-124-K-15-C	Long Run Phase I	169,552.7	150,834.5	Land Reclamation	1,330,415	50%	3,391.1	37,708.6
WV-MC-124-K-15-C	Long Run Phase II	84,776.3	75,417.2	Active	224,693	100%		
NA*	Burns Blowout Phase I	135,667.5	26,339.3	Land Reclamation	901,044	50%	2,383.8	6,621.2
MC124K15-200-1	Combine Flows of Coketon Mine Outflow **	168,995.1	31,934.6	Active Treatment	421,639	100%		
	Total	474,215.3	209,108.4		2,877,791		5,774.9	44,329.9
WV-MC-124-K-15	North Fork LA TMDL Target	11,460.6	61,027 .1				11,460.6	61,027.1

* Burns Blowout is not described in the 2011 Cheat TMDL nor given a NHD code; pollutant loads are calculated using FOB data. *** Combine Flows of Coketon Mine Outflow is the sum of Burns Blowout after phase I is complete, M29, and WALD, corresponding to Aluminum loads (lbs/year) of 168,995.1 = 67,833.7 + 59,595.0 + 41,566.4 and Iron loads (lbs/year) of 31,934.6 = 13.169.6 + 13,242.5 + 5,522.5. This data can be found in Tables 10 and 11.*

Table 15: Load reduction and proposed management measure at AMD sources using land reclamation and passive treatment option. Reductions were estimated using FOB data and AMDTreat.

Current load				BMP Information			Estimated Final Load	
NHD Code	**Source**	**Aluminum Load (lbs./year)**	**Iron Loads (lbs/year)**	**BMP**	**Cost ($)**	**Expected Reduction (%)**	**Final Aluminum Load**	**Final Iron Load**
WV-MC-124-K-15-C	Long Run Phase I	169,552.7	150,834.5	Land Reclamation	1,330,415	50%	847.8	754.2
WV-MC-124-K-15-C	Long Run Phase II	84,776.3	75,417.2	Active	224,693	100%		
NA	Burns Blowout Phase I	135,667.5	26,339.3	Land Reclamation	901,044	50%	678.3	6,584.8
NA	Burns Blowout Phase II	67,833.7	13,169.6	Passive	919,219	100%		
MC124K15-200-1&2	M29	59,595.0	13,242.5	Passive	671,020	60%	23,838.0	5,297.0
MC124K15D-100-1&2	WALD	41,566.4	5,522.5	Passive	402,643	42%	24,108.5	3,203.0
	Total	406,381.6	461,699.3		4,449,034		52,863.7	53,547.6
WV-MC-124-K-15	North Fork LA TMDL Target	11,460.6	61,027.1				11,460.6	61,027.1

** Burns Blowout is not described in the 2011 Cheat TMDL nor given a NHD code; pollutant loads are calculated using FOB data.*

C. Proposed Management Measures

C.1 AMD

This section identifies, characterizes, critiques, and prioritizes AMD management measures with in the North Fork watershed.

C.1.1 Identification of potential management measures

The following describes the various measures that are used to reduce AMD. Numbers in parentheses following the name of the method indicate the potential load reductions when the method is used correctly and in the proper situation.

Land reclamation (100%)

- Removing acid-forming material: The removal of acid-forming material has the potential to eliminate acid loads originating on the surface. In the North Fork watershed, acid-forming materials are abundant on the surface and have been found cost prohibitive to remove. In the past OAMLR has covered them caped them with an impervious layer and revegetated.
- Isolating acid-forming material from flow paths: 1) Sealing from above: Infiltration of water into acid-forming material can be slowed by covering the material with low-permeability material, such as clay, and covering that layer with a vegetated layer to stabilize it. Effective reclamation and revegetation is thought to eliminate a large portion of the AMD from a given site. However in the North Fork there is a lack of evidence to support this claim. 2) Isolating from below: Interactions between water and acid-forming materials can be further minimized by separating the waste material from impermeable bedrock below with conductive materials, such as coarse stone. Water may then flow beneath the spoil and be conducted away from it rapidly, so the water table does not rise into the spoil.
- Surface water management: Rock-lined ditches or grouted channels can be used to convey surface water off site before it can infiltrate into acid-forming material. Limestone is often used in such channels to neutralize acidity (discussed below).

Passive AMD treatment (90%)

Passive treatment of AMD is appealing because it uses naturally occurring chemical processes that are self-sufficient and require little maintenance. Passive systems are engineered to neutralize acidity and precipitate metals over long time periods across variable hydrologic conditions. In general passive systems encompass large construction areas to accommodate large quantities of limestone, long retention times, and multiple reactors in series.

Although passive system are designed for a 20 year life span, the intended 90% load reductions can decline after several years of operation (Skousen and Ziemkiewicz 2005, Watzlaf et al., 2004). In such cases declines can be restored through regular maintenance, including renovating limestone substrate and organic matter as well as dredging sludge from settling ponds. For systems treating high metal loads, like AMD produced from the Upper Freeport Coal bed, regular scheduled maintenance is a much needed strategy (Skousen and Ziemkiewicz 2005).

Where Passive treatment is applicable, the correct system is selected based on water chemistry, flow, pH, cost, and design limitations imposed by geography. The appropriate passive water treatment system has been determined through consultation with the US Department of Interiors OSMRE, watershed groups, private consulting firms who have successfully treated AMD with similar characteristics. In addition, research publications have provided objective criteria from which to evaluate options (Hedin et al., 2013, Skousen and Ziemkiewicz 2005, Watzlaf et al., 2004, Ziemkiewicz 2003, Skousen 2000).

The best management measure for treating AMD through passive methods is a system that uses a combination of technologies in series. This includes, automatic flushing limestone leach beds with siphon, settling ponds, and constructed wetlands. FOB worked extensively with two AMD hydrologist from OSMRE on design and cost estimation for the correct passive treatment system. Detailed sizing and cost assumptions are included in the Appendix. The following describes available passive treatment technology.

- Reducing and Alkalinity Producing Systems (RAPS): In these systems, also known as "successive alkalinity producing systems" and "vertical flow ponds," water encounters two or more treatment cells in series. First, water passes through organic material to deplete dissolved oxygen. Several helpful reactions take place in the anoxic environment. First, bacteria reduce ferric iron to ferrous Iron. Iron in the Ferrous form will not armor limestone as it is neutralized and precipitates. In a second cell, the anoxic solution comes into contact with limestone where H+ acidity is neutralized. Additional alkalinity dissolves into the water as well. Water then runs through an aeration and settling pond, in which ferrous iron oxidizes and then precipitates out of solution as ferric hydroxide. The acidity released in this process is neutralized by the alkalinity that has accumulated in the solution.
- Iron oxidation channels: In extremely acidic water that contains iron in the ferrous form, terraced iron formations (TIFs) appear. TIFS, a hard dark red crust, helps reduce iron concentrations as AMD flows over it. OLCs often generate TIFs, but designers are experimenting with channel conditions that might accentuate TIF formation and accelerate iron oxidation.
- Limestone leach beds: Limestone leach beds are most effective when water has a pH of 3 or less, and when water retention times are short (~90 minutes). The low pH promotes rapid limestone dissolution, but the short retention time prevents armoring. Systems can include a siphon, which automatically flushes treated waters to further reduce armoring and remove precipitate.
- Steel slag leach beds: Steel slag leach beds are not exposed to AMD. Rather, neutral feed water passes through these leach beds, and that water is then mixed with AMD to reduce its acidity drastically.
- Compost wetlands: Constructed wetlands can serve multiple functions in AMD treatment. Wide areas of exposure to the atmosphere allow metals in solution to oxidize. Slower waters allow precipitates to fall out of suspension. Anaerobic zones in sediments allow for sulfate reduction, which consumes acidity. Inclusion of limestone and organic compost in the substrate provides an additional alkalinity source and helps maintain conditions that support sulfate reduction.

Active AMD treatment (100%)

- Doser: This method uses an automated mechanical system to mix alkaline material with water to raise pH, neutralize acidity, and precipitate metals. The mixture is added directly to the stream or aerated and passed through ponds allowing metal hydroxides to settle out as sludge.

- In-Stream Limestone Sand Dumping: Limestone sand is placed directly in the stream. Stream power, especially during high flow events entrains limestone sand and distributes it throughout the stream channel. Effectively, dissolving the limestone sand and introducing $CaCO_3$ to the water column to raise pH and precipitate metals.

C.1.2 Best management measures

Due to the severity of Acid Mine Drainage in the North Fork, treatment will require an-all-the-above approach. In other words, the appropriate management strategy will include a combination of land reclamation, passive treatments, and active treatments. Above all, the correct management measures must be efficient and indefatigable. A unified team led by Friends of Blackwater or similar entity will oversee implementation of projects addressed in this plan.

FOB and OAMLR are currently in the development phase of three land reclamation projects. Due to the potential changes these projects could have on water quality, time is needed to assess the projects impacts. Therefore management measures are performed in three phases. The first phase includes land reclamation projects targeted at improving water quality in Long Run and at mine outflow Burns Blowout. After the completion of phase I projects load reduction criteria will be evaluated. Based on this evaluation, phase II will address the remaining critical sources through passive and active treatment. During phase II, performance of phase II management measures will be evaluated and if needed further management measures will be implemented in phase III. The following describes the best management measure that will be implemented on a watershed by watershed bases.

Coketon Mine Outflows

The characteristics of the Coketon mine outflows (M29, Top of WALD, and Burns Blowout) of high loads, low pH, and limited space make treating AMD discharge through passive systems very challenging (Table 16). Thus, in phase II we propose treating all three discharges with active treatment. In this scenario Burns Blowout would be combined with M29 and Top of WALD via 250 feet of piping. Treatment would take place on a 3 acre site adjacent to the M29 discharge point (Figure 9). The active treatment will include an oxidation pond, lime doser, and settling ponds (Appendix: Figure 17). The system will be managed by a staff person and will require 20 year commitment of materials and maintenance. Estimated costs are projected at $421,639 for construction and $ 257,069 a year for materials and maintenance. If funding for annual materials and maintenance are not secured AMD will be treated by a passive system at individual sites.

Table 16: Average Concentrations and Discharge of Critical AMD Sources.

NHD CODE	Site	Al (mg/L)	Fe (mg/L)	Flow (gpm)	Mn (mg/L)	pH	Sulfate (mg/L)
NA	Burns Blowout	30.0	6.0	794.9	10.3	3.2	823.2
MC124K15-200-1	M29	14.2	3.2	1,108.1	4.0	3.4	414.7
MC124K15D-100-1&2	Topo of WALD	12.8	1.9	772.9	3.6	3.2	361.1
WV-MC-124-K-15-C	Long Run	8.2	8.7	3,939.7	0.6	3.5	176.0
	Combined Raw Water by Mass Balance Calculator in AMDTreat						
NA	M29 + Burns + Top of WALD	18.5	3.7	2,675.9	5.7	3.2	NA

Burns Blowout

In phase I, OAMLR will implement the land reclamation project named “Old Buffalo strip” in the Pendleton creek watershed. Although not in the North Fork watershed, AMD from the Buffalo Coal bond forfeiture sites are being diverted to a sink hole that is believed to be linked to Burn Blowout. The reclamation project will seal the sink hole and divert treated water to Pendleton Run. This project is currently in the planning/monitoring phase. Engineering is expected to commence through 2017, and construction is tentatively scheduled for 2018. Although too early to be accurate, OAMLR estimates cost to be $901,044. This project is expected to reduce flow and metal concentration and increase pH. Load reductions at Burn Blowout are preliminarily estimated at 50%. FOB will monitor flow and water chemistry to assess load reduction criteria and determine phase II projects accordingly.

Phase II management measures at Burns Blowout are contingent on the effectiveness of the Old Buffalo strip project and availability of funding for lime dozing project described above. If passive treatment is chosen a three acre site downstream of the discharge point will be utilized (Figure 10). The passive system includes automatic flushing limestone leach beds with siphon, and settling ponds. The estimated construction costs are $919,219 (Appendix: Figure 18, 19, 20).

M29

Phase II management measures at M29 are contingent on the availability of funding for lime dozing project described above. If passive treatment is the only available option it will be constructed on a three acre site adjacent to the discharge point (Figure 10). The passive system includes automatic flushing limestone leach beds with siphon, and settling ponds. Treating one hundred percent of the flow through a passive treatment system is considered high risk because of high loadings (Table 15) and limited construction area (Cavazza, E. et al., 2008). In result the passive system will treat only 60% of the load, discharging the remainder of raw water into the North Fork. The estimated construction costs is $671,020 (Appendix: Figure 21, 22, 23).

Top of WALD

Phase II management measures at Top of WALD are contingent on the availability of funding for lime dozing project described above. If passive treatment is the only available option it will be constructed on a 1.37 acre site that is 20 ft. x 3,000 ft. (Figure 10). The passive system includes a series of automatic flushing limestone leach beds with siphon, and settling ponds. Treating one hundred percent of the flow through a passive treatment system is considered high risk because of high loadings (Table 15) and limited construction area (Cavazza, E. et al., 2008). In result the passive system will treat only 42% of the load, discharging the remainder of raw water into the North Fork. The estimated construction costs is $402,643 (Appendix: Figure 24, 25, 26).

Long Run

In phase I, OAMLR will implement land reclamation project named "Tub Run Phase III" in the long Run Watershed and adjacent watersheds Tub Run and Finley Run of the Blackwater River. Although Tub Run and Finley Run are not in the North Fork watershed, water infiltrates into underground mines and follows the coal seam across watershed boundaries into Long Run. FOB has been working closely with OAMLR and the Monongahela National Forest to identify areas of infiltration, resulting in the addition of Finley Run to the Tub Run Phase III project. The reclamation project will excavate, fill, cap, and grout ditches of a 20 acre area that contains spoil piles and subsided lands. This project is currently in the planning/monitoring phase. Engineering is expected to commence through 2017, and construction is tentatively scheduled for 2018. Although too early to be accurate, OAMLR estimates cost to be $1,330,415. This project is expected to reduce flow and metal concentration and increase pH. Load reductions at Long Run are preliminarily estimated at 50%. FOB will monitor flow and water chemistry to assess load reduction criteria and determine phase II projects accordingly.

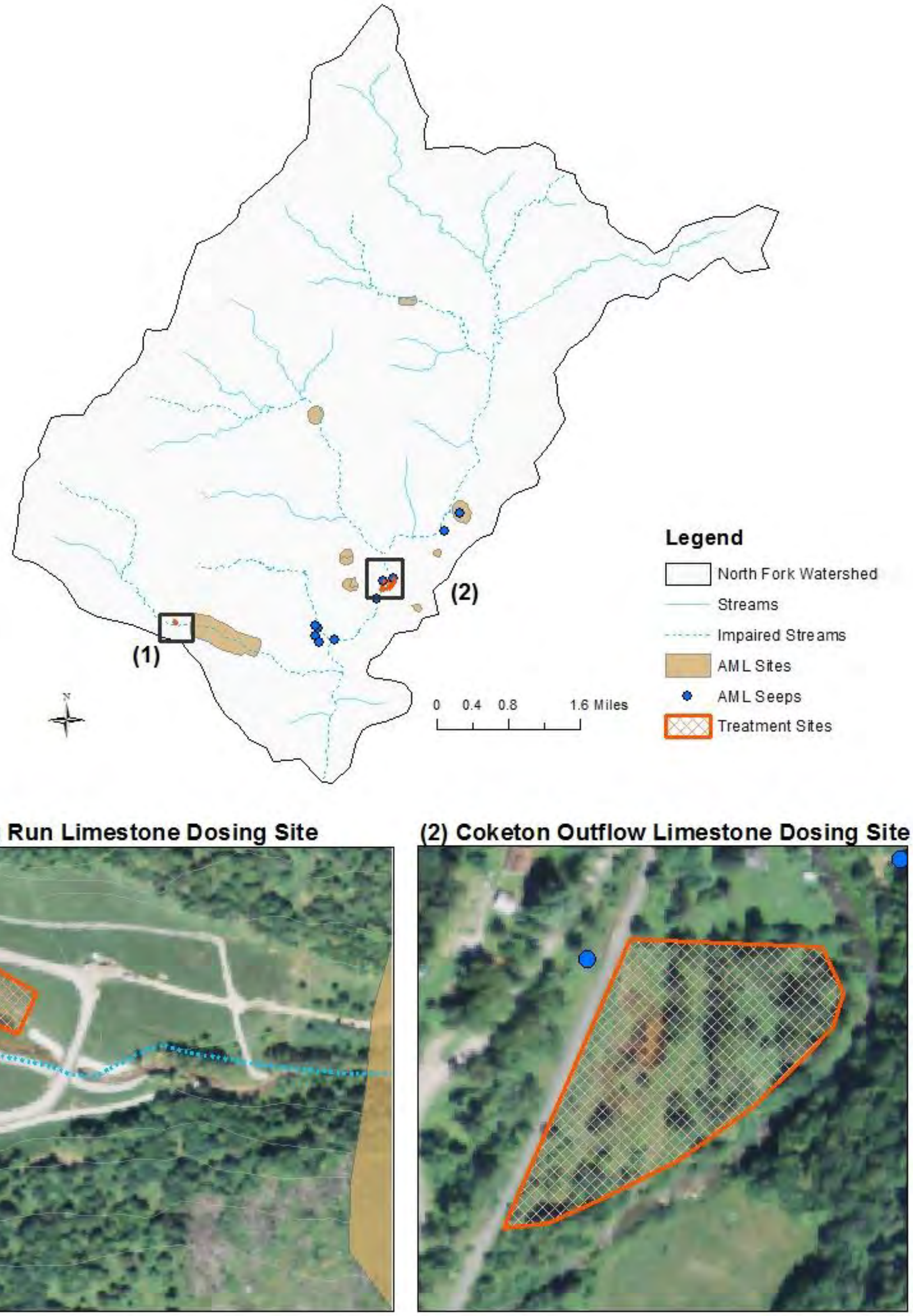
Phase II management measures in the Long Run watershed are contingent on the effectiveness of the Tub Run III project. With that said, this plan recommends the construction of a large scale in-stream doser (Figure 9). The system will be managed by a staff person and will require 20 year commitment of materials and maintenance. Estimated costs are projected at $224,693 for construction and $ 168,236 a year for materials and maintenance (Appendix: Figure 16).

Sand Run

Based on numeric water quality standards and the 2011 Cheat TMDL for a trout stream, the waters of Sand Run are impaired by Aluminum and Iron. Consulting data collected by the WVDEP between 1996 and 2011 show that Aluminum (.09 mg/L) and Iron (1.10 mg/L) are slightly above numeric water quality criteria (aluminum = .087 mg/L, Iron = .50 mg/L). Because water quality is only slightly impaired, and some management measures such as dumping limestone fines can have side effects, FOB will monitor chemistry and discharge for one year in Phase I. Then, assess load reduction criteria and determine the appropriate management measure to be implemented in phase II.

C.1.3 Management Measure Feasibility and Identification of Management areas.

The Friends of Blackwater has partnered with the Monongahela National Forest and OALMR to overcome logistical challenges associated with land access. The U.S. Forest Service has granted access to its property. This land corridor includes the main stem of the North Fork, confluences of major impaired tributaries, and three critical discharges of the Coketon mine pool. This land is currently used to access stream monitoring sites and presents the most accessible lands for management measures because it is easily accessible by vehicle. Gaining access to Western Pocahontas lands, the majority land owner of the watershed would present more monitoring and treatment options. In the past, projects have been implemented through OAMLR whom has access to this property. Many of OAMLR past and future land reclamation projects take place on these lands. All management measures except passive treatment option for Burns Blowout and active treatment on Long Run are proposed for accessible lands. Figure 9 and 10 identify proposed sites for implementing best management measures for the active treatment option and for the passive treatment options, respectively. If phase III requires additional AMD sources to be treated, management measures will be implemented at AMD source on a watershed by watershed bases (Figure 11, 12, and 13).



(1) Long Run Limestone Dosing Site

(2) Coketon Outflow Limestone Dosing Site

Figure 9: Best management practices active treatment systems option.

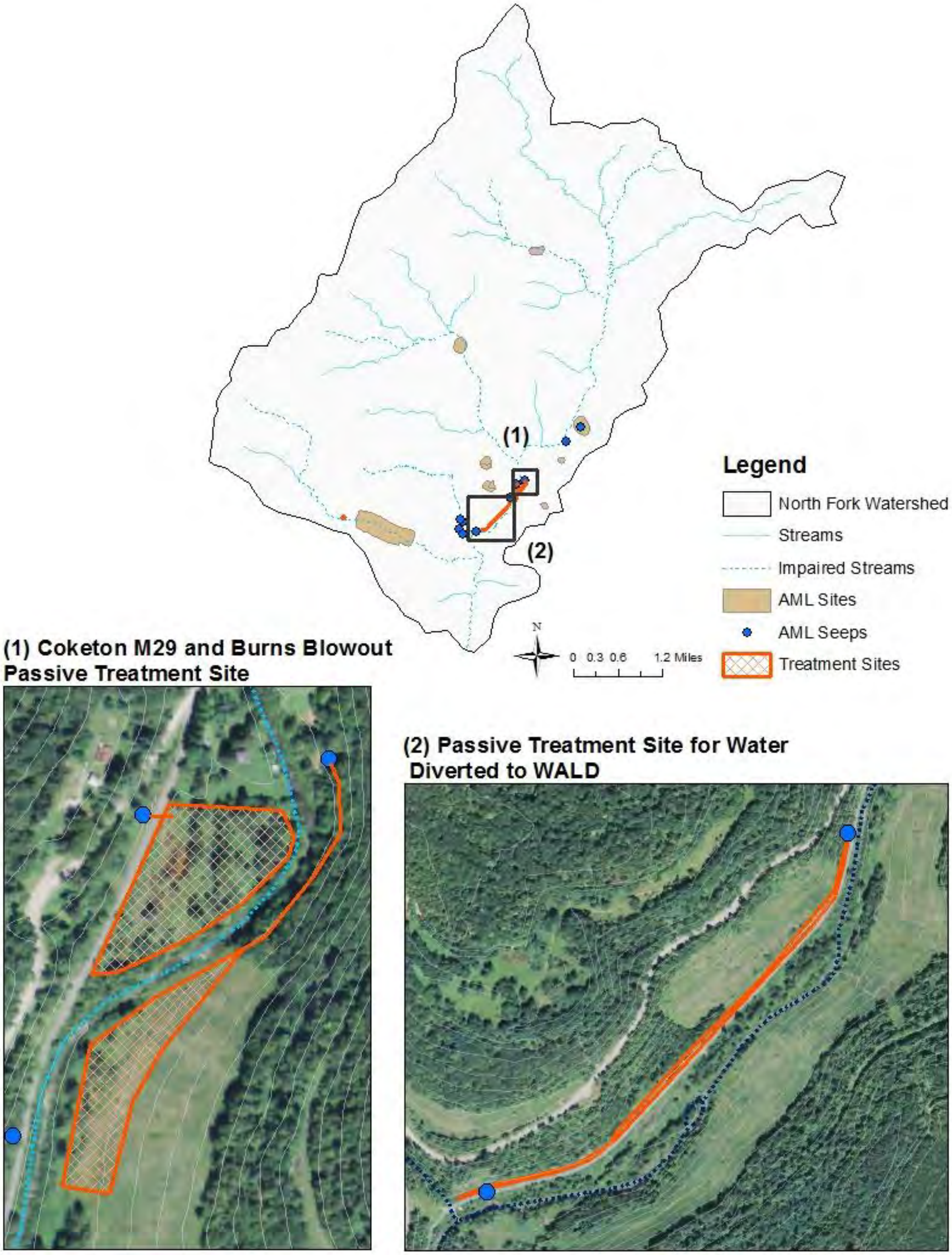


Figure 10: Best management practices passive treatment system option. Inset (1); Coketon M29 is on left side and Burns Blowout is shown on the right.

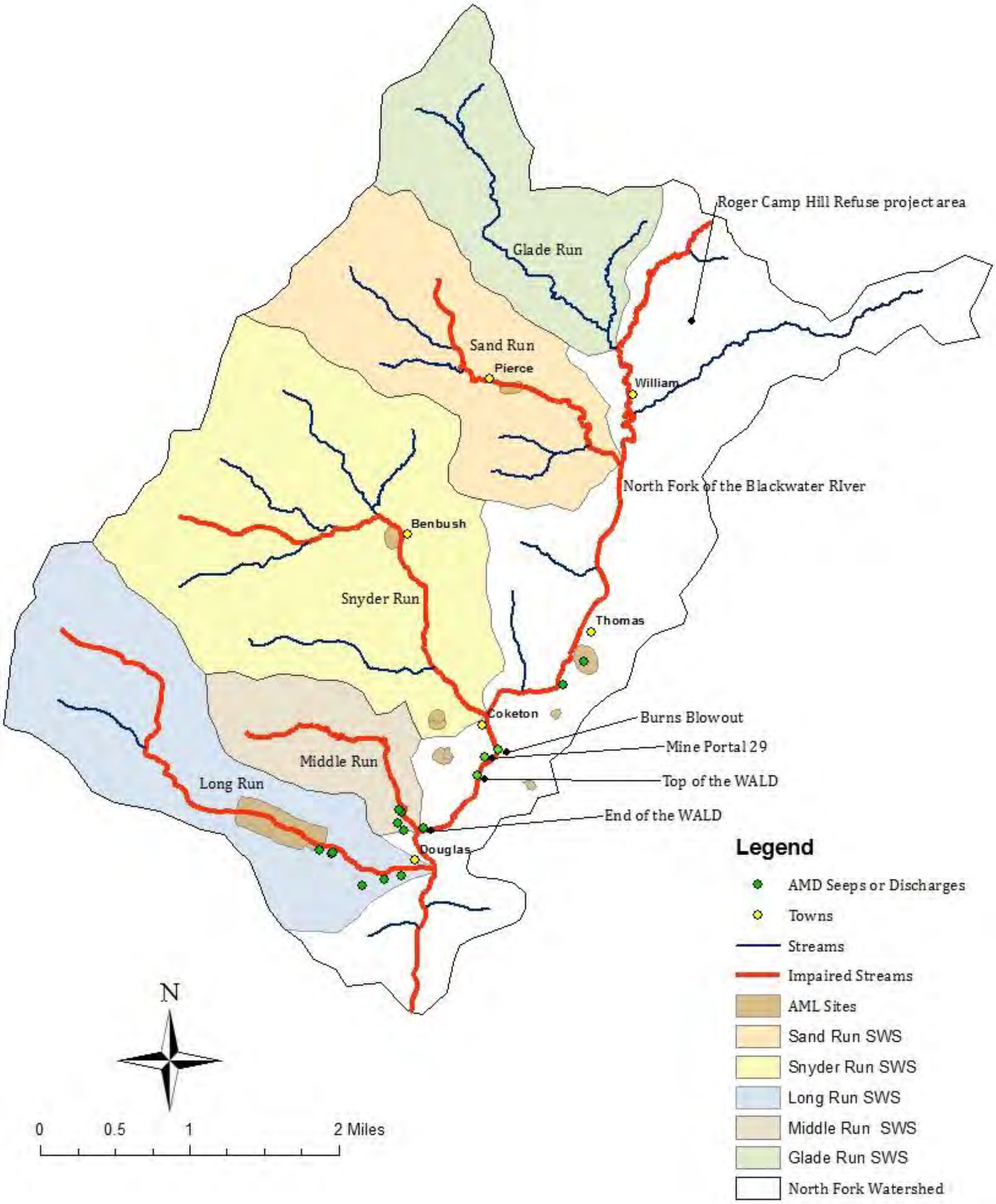


Figure 11: AMD seeps or discharges in the North Fork watershed.

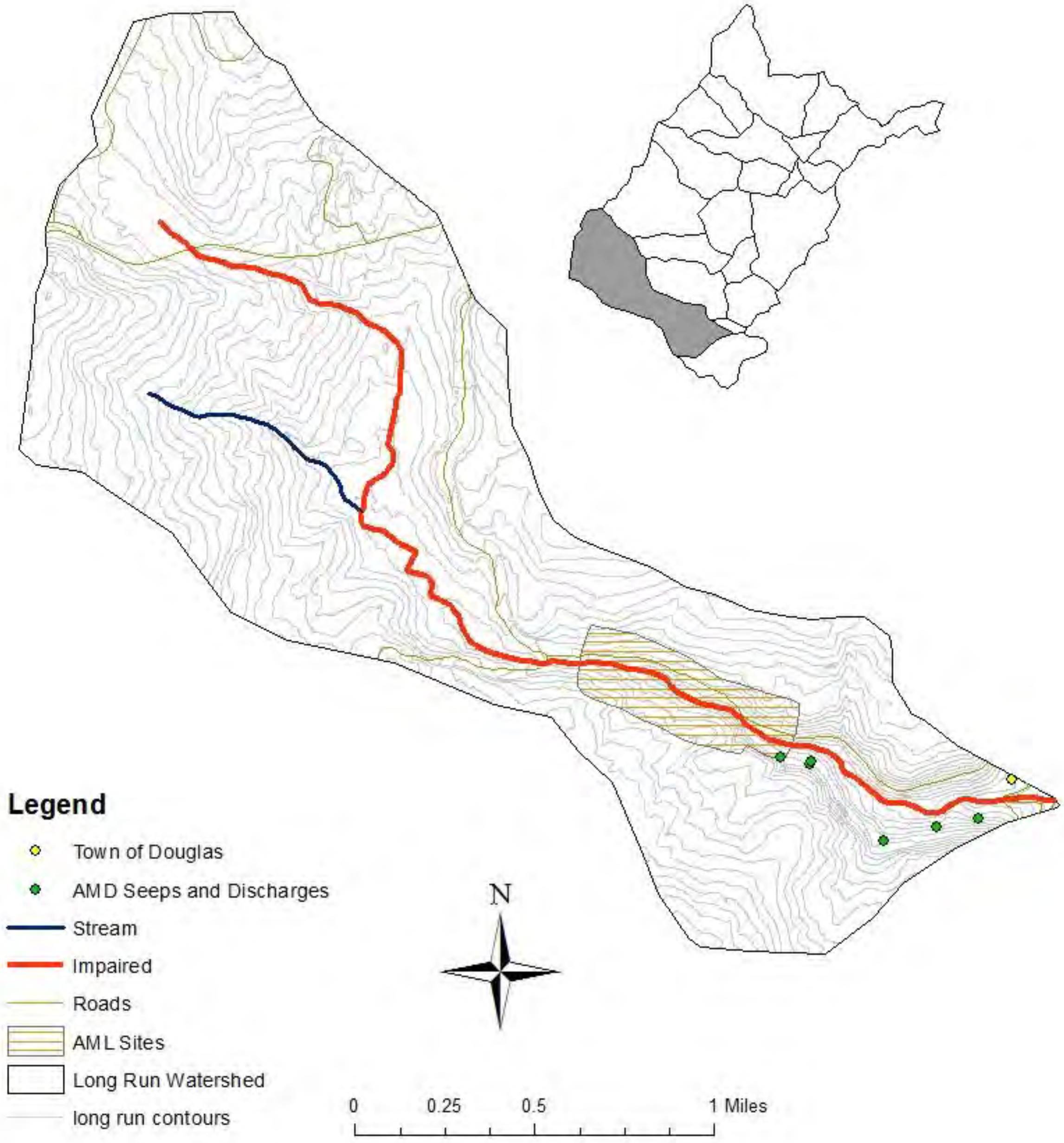


Figure 12: AMD seeps and discharges in Long Run watershed.

Figure 13: AMD seeps and discharges in Middle Run watershed.

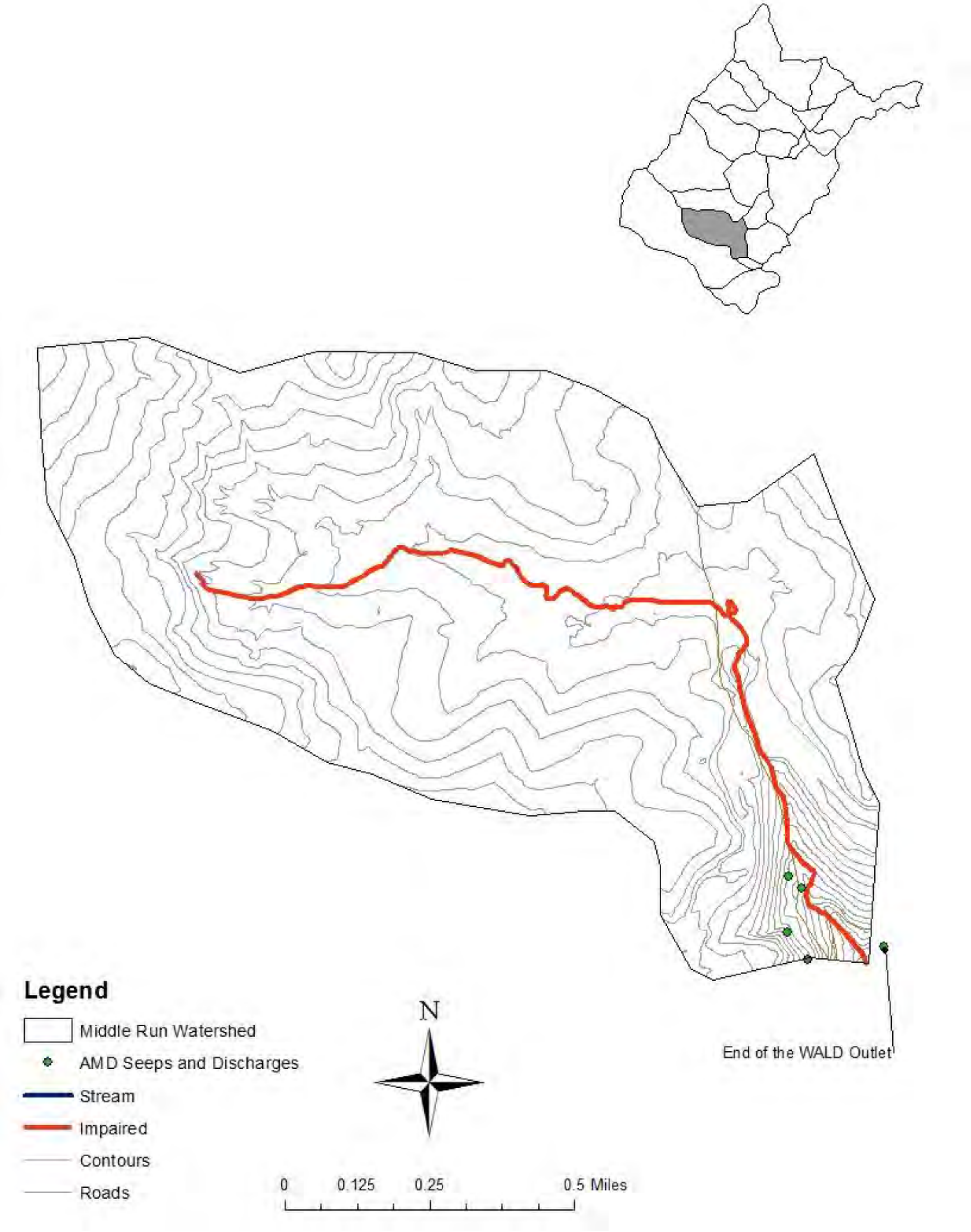


Figure 13: AMD seeps and discharges in Middle Run watershed.

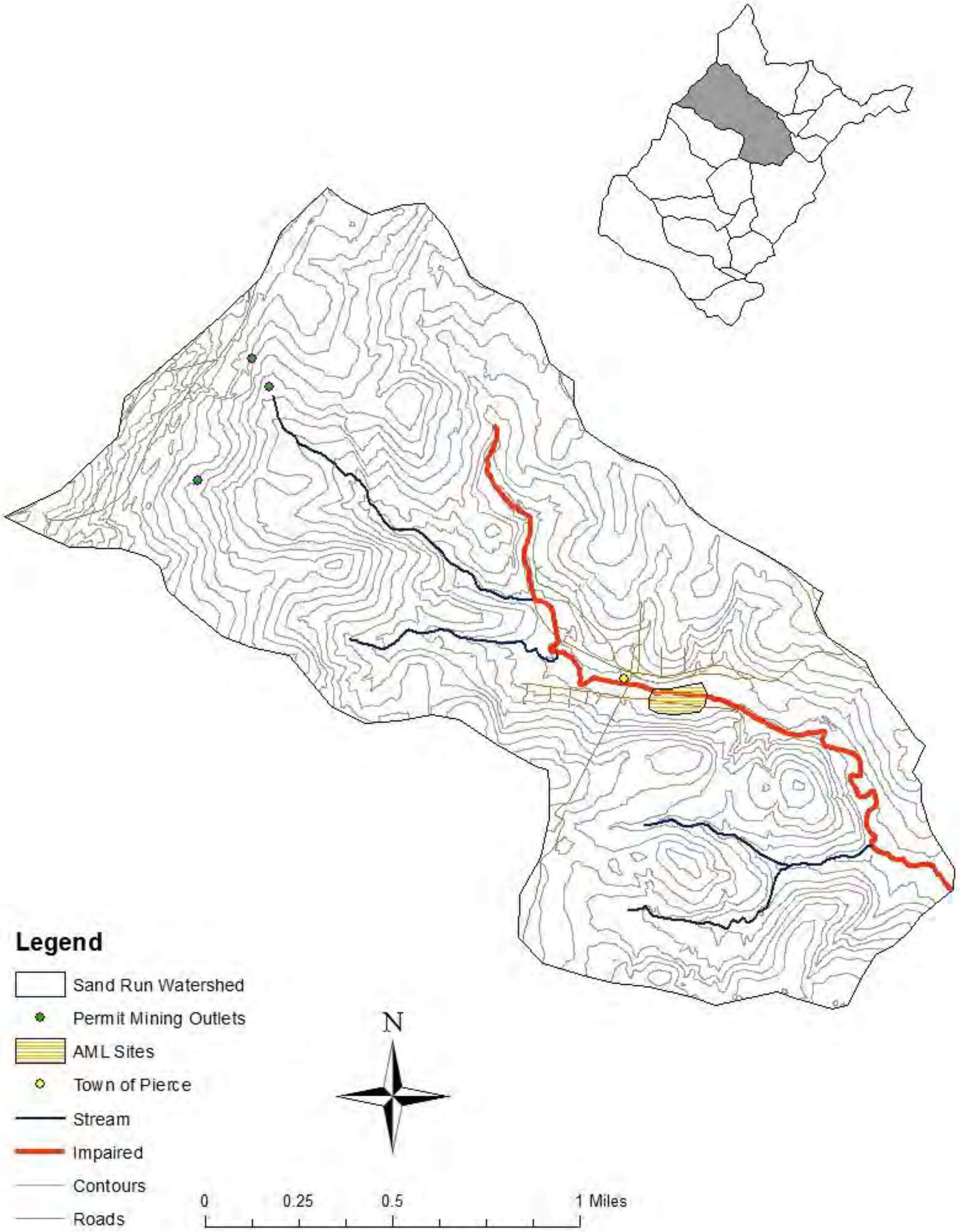


Figure 14: Permit mining sites in Sand Run watershed.

D. Technical and Financial Assistance

A combination of federal and state agencies, academic institutions, watershed organizations, consultants, and citizens will be involved in providing technical and financial assistance for North Fork watershed projects.

While this Watershed Based Plan considers other pollutants too, the technical and financial assistance chapter focuses on AMD only. Before technical and financial assistance can be secured for biological, bacteria, and sediment impairments, further research is needed to more accurately identify the scope of the problems and the specific nonpoint sources of pollution.

Cost Estimates

AMDTreat was used to size and estimate treatment components using default values. Total capital costs include cost of components, ancillary costs, and engineering costs. Ancillary costs were estimated at 50% of component costs based on the work needed at each site. Engineering was estimated at 10% of components plus ancillary. Total capital costs include contingency costs. Total annual costs were calculated in AMDTreat based on default values. They include sampling costs, maintenance costs, and sludge removal. A growing body of knowledge recognizes that passive treatment systems do in fact need maintenance in order to perform as intended (Skousen and Ziemkiewicz 2005). Because AMD in the watershed is characterized as High risk (Cavazza, E. et al., 2008), this plan recommends turning over limestone and removing sludge every year (Table 17).

Table 17: Cost Estimate Breakdown for best management measures

Site	Acid Neutralization	AMDTreat Estimate	Ancillary Cost	Engineering Cost	Contingency Capital Costs	Total Capital Costs	Total Annual Costs
			Active Treatment Options				
Long Run	100%	$123,798	$61,899	$18,570	$20,427	$224,693	$168,236
Coketon outflow	100%	$232,308	$116,154	$34,846	$38,331	$421,639	$257,069
			Passive Treatment Options				
Burns	100%	$506,457	$253,229	$75,969	$83,565	$919,219	$30,000
M29	60%	$369,708	$184,854	$55,456	$61,002	$671,020	$30,000
TOP of WALD	42%	$221,842	$110,921	$33,276	$36,604	$402,643	$30,000

Funding Sources

Several funding sources are available for nonpoint source AMD remediation on AMLs and for water quality monitoring, including:

- Section 319 funds,
- The Abandoned Mine Land Trust Fund,
- The 10% AMD Set-Aside Fund,
- Watershed Cooperative Agreement Program grants,

- Stream Partners Program grants,
- Brownfields grants,
- Other government funding sources, and
- Private foundation grants.

These funding sources are described in turn below.

Section 319 funds

Clean Water Act Section 319 funds may be provided by USEPA to WVDEP to be used for reclamation of nonpoint source AMD sources. This Watershed Based Plan is being updated so that these funds can be allocated to the North Fork watershed. WVDEP's Division of Water Resources Non-Point Source Program sets priorities and administers the state Section 319 program (WVDEP, 2005c).

The Abandoned Mine Land Trust 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 AML Trust Fund. This fund, supported by a per-ton tax on mined coal, has been allocated to coal mining states for remediation projects, according to a formula that takes states' current coal production into account

Still, WVDEP has funded many AMD remediation projects on AMLs. But these projects are typically not designed to meet stringent water quality goals like those set out in this Watershed Based Plan. The agency typically uses a small number of cost-effective techniques, such as open limestone channels, 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).

10% AMD Set-Aside Fund

The 10% AMD Set-Aside Program allows states to reserve up to 10% of their annual AML Trust Fund allocations as an endowment for use on water quality projects. These funds are critically important, because while regular AML Trust Fund allocations can only be spent on capital costs, 10% AMD Set-Aside Fund allocations can be spent on operations and maintenance. These funds cannot be allocated to a watershed until after a Hydrologic Unit Plan is developed and approved by OSM. A new Hydrologic Unit Plan will be needed for the North Fork watershed.

Watershed Cooperative Agreement Program

Grants specifically for AMD remediation projects on AMLs are available through OSM's Watershed Cooperative Agreement Program (WCAP). The WCAP is 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 (OSM, 2004). A match is required to receive these grants and is typically met with Section 319 funds. Friends of Blackwater (FOB) has initiated discussions with OSM on the potential applicability of WCAP grants for AMD remediation in the North Fork.

Stream Partners Program

This 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, water quality monitoring, public education, stream restoration, and organizational development. FOB has received two Stream Partners grants to support education and outreach for their North Fork watershed project. Stream Partners grants will continue to be pursued in the future to compliment nonpoint source research, education, and reclamation projects in the watershed.

Brownfields grants

Brownfields grants of up to $200 thousand are available through a competitive process; these grants can be applied to mine scarred lands. Competitive site assessment grants can be used for inventory, planning, quantification of environmental risks, and development of risk management or remedial action plans. Competitive remediation grants can then be used to build treatment systems.

Other government funding sources

NRCS is funding AMD remediation in the Deckers Creek watershed in north-central West Virginia though a Public Law-566 watershed restoration project. The U.S. Army Corps of Engineers has funded an AMD study and is planning to fund AMD remediation work in the lower Cheat watershed, downstream from the Blackwater River. Pending successful outcomes of these projects, these federal agencies might be potential funders for AMD remediation in the North Fork watershed.

Private foundation grants

FOB has generated funding from at least one private foundation to support a staff member responsible for interfacing with agencies and raising funds for AMD remediation. FOB will seek additional foundation grants to continue these essential services.

Technical Assistance Providers

Technical assistance is needed for the following tasks:

- Coordinating and applying for the various funding sources;
- Collecting data at AMD sources in preparation for the design of remediation projects;
- Creating conceptual designs of remediation projects;
- Creating detailed engineering designs of remediation projects;
- Performing project management, including putting projects out for bid, managing projects, and tracking their progress; and
- Monitoring instream and source water quality following the installation of remediation projects to document their effectiveness.

West Virginia Department of Environmental Protection

Two WVDEP divisions will provide technical assistance. The Division of Water and Waste Management monitors the water quality of the watershed through its Watershed Assessment Program and its pre-TMDL monitoring program (WVDEP, 2005b). This division also provides technical assistance for the use of best management practices, 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 (WVDEP, 2005c). Martin Christ the Northern Basins Coordinator has helped extensively in developing this plan and collecting water monitoring data.

WVDEP's Office of Abandoned Mine Lands and Reclamation directs technical resources to watersheds to address AMLs. Through their Stream Restoration Group (SRG), the office conducts extensive source monitoring of AMLs—as well as instream monitoring—before remediation systems are designed.

Office of Surface Mining, Reclamation and Enforcement

OSMRE provides technical assistance by sharing their knowledge and experience in designing and financing AML remediation projects. Hydrologists Bradley Shultz and Omar Beckford helped design AMDTreat passive and active treatment systems.

West Virginia University

A number of the colleges and individuals at West Virginia University may provide assistance for projects in the watershed. The National Mine Land Reclamation Center (NMLRC), housed at the university, has experience providing conceptual site designs for reclamation projects and monitoring water quality produced by AMLs before and after projects are installed. NMLRC is dedicated to developing innovative AMD treatment technologies. Technical assistance may also be provided by departments within the university with expertise in fisheries and wildlife resources, mine land reclamation, and water quality improvement.

Other technical assistance providers

Other agencies and organizations may also provide technical assistance. Natural Resources Conservation Service (NRCS) engineers have designed AMD remediation projects in some West Virginia watersheds and may be available for assistance. Local conservation districts may also be a repository of information and assistance. In addition, USEPA staff with expertise in AMD from Region 3 and from headquarters may provide technical assistance.

E. OUTREACH AND EDUCATION

Friends of Blackwater has advocated for the North Fork watershed for 14 years. We have learned that protecting stream health requires more than a focus on water quality. Therefore, our outreach and educational initiatives engage the public in a variety of disciplines across local and regional scales. Our efforts have protected and improved the watershed through programs that link human interest with genuine environmental needs.

FOB educates the public through outreach, projects, and events. Currently there are several educational outreach programs that involve the North Fork River watershed and its parent Blackwater River watershed. These programs include a hands on approach, such as watershed litter cleans ups under the Adopt-A-Highway program, trail building and maintenance, history tours of the watershed, and water quality education centered on benthic macroinvertebrates. We also host education workshops and conferences such as the water workshop for teachers in Charleston, J.R. Clifford and Carrie Williams's history project, and the Alleghany Climate Change Conference. Other initiatives include: tours of environmental treatment systems, film festivals, and more. In the broader context these activities bring positive attention to the resource.

Newsletters and other Publications

The Friends of Blackwater publishes quarterly newsletters that are e-mailed to over 4,000 individuals, mailed to 1,000 with another 1,000 distributed through small businesses. The newsletter is also available on our website and announced on our Facebook page. The North Fork Watershed Project supporters and area residents are updated on the current work being done to improve the watershed and any educational events, volunteer opportunities, or projects through E-News announcements. In 2014 we wrote "The State of the Blackwater River Report" describing nonpoint source pollution and remediation. It included the work of the West Virginia Office of Abandoned Mine Land and Reclamation in abating the negative effects of the mine scarred lands in the North Fork Watershed. We will update this report as planned reclamation takes place. It has been distributed to elected officials, local planners, and civic groups throughout Tucker County

Youth education

The North Fork Watershed Project has been educating local youth since its inception in 2002. Each spring a representative from the North Fork Project meets with high school science classes to promote environmental literacy and to discuss the watershed. Discussions include the importance of healthy watersheds and how impaired watersheds like the North Fork are being improved. Each summer we perform biological stream assessments with school age children to teach them how benthic macro invertebrates are an indicator for water quality. In 2015, FOB toured schools across the state on its climate change awareness road show. Presentations informed high schoolers on the local and regional impacts of climate change. In the future we want to expand youth involvement in the following ways:

- Increase school based education
- Increase outdoor educational programs, including stream studies.
- Youth involvement in trail work in the watershed.
- Create a youth led watershed mapping project.
- Disseminate our kid's Nature Education Booklets to elementary school children.

Web site

The North Fork Project maintains a Web site, www.northforkwatershed.org, which highlights water pollution problems such as acid mine drainage, volunteer opportunities, and upcoming events in the watershed. It has background on historic mining in the watershed, past remediation projects, maps and publications to download. One special feature is interactive Google Earth virtual fly-over of the North Fork, which summarizes the watersheds challenges. A second fly-over features the North Branch of the Potomac. Information on the project can also be found at Friends of Blackwater's website: www.saveblackwater.org

Public outreach meetings, tabling and press

Representatives of the North Fork Watershed Project conduct an annual tour of the watershed to educate the public about the nonpoint source problems facing the watershed. Stakeholder meetings are arranged to allow state and federal mine reclamation specialists to explain their work in the North Fork Watershed to the public. The North Fork Watershed Project's work is presented at events such as the Harpers Ferry Outdoor Festival, Cheat Fest, Mountaineer Days in Thomas, Leaf Peepers Festival in Davis and the Forest Festival in Elkins. We also attend and distribute information at Environment Day at the West Virginia Legislature. Press releases about these events and our work are sent to the local paper, the Parsons Advocate, and to Elkins' Intermountain.

Partners: Since 2002, the Project has drawn support from the Office of Surface Mining, West Virginia Department of Environmental Protection, 319 Office, Office of Abandoned Mine Lands and Reclamation, WV Department of Natural Resources, U.S. Forest Service, Monongahela National Forest, Eastern Coal Regional Roundtable, Thomas Education Center, Friends of the Cheat, Tucker County Trails, Tucker County Historical Society, Maryland Department of Environment, the Appalachian Forest Heritage Area, Trout Unlimited and the Frostburg Geo Spatial Lab, the Maryland Bureau of Mines, Maryland DNR and the US Department of Energy. We have received funding from the Appalachian Stewardship Foundation, West Virginia Humanities Council, Appalachian Community Fund, Generations United, National Fish and Wildlife Foundation, Norcross Wildlife Foundation, Project Flow, NiSource, the Oakland Foundation, Marpat, Best Buy, American Hiking Society, Southern Partners, Tucker Community Foundation and the Town Creek Foundation. We have sponsored 15 Vistas in Davis and Thomas worth $330,000. Our reclamation work includes receiving $232,000 in grant money and in-kind services from the Office of Surface Mining, the EPA and the WV DEP to do reclamation on the Albert Highwall on Long Run of the North Fork. We have receive annual grants from the WV Stream partners Association worth $60,000

The West Virginia Office of Abandoned Mine Lands and Reclamation and the North Fork Project Share information of all reclamation and remediation projects in the watershed. The North Fork's water quality measurements are sent to the state office on a regular basis. We look forward to working with OAMLR to remediate Finley Run and thereby improve Long Run the major contributor of AMD to the North Fork. We expect more collaborations between the two in the future.

F. Schedule

Table 18. Implementation Schedule for AMD Remediation Activities

Stream Name	**Stream Code**	**AMD Source**	**Priority Level**	**Phase I**				**Phase II**				**Phase III**
				2016	2017	2018	2019	2020	2021	2022	2023	2024
Long Run	WV-MC-124-K-15-C		High	1	2	3	4	1	2	3	4	1
		Tub Run	High	1	2	3	4	1	2	3	4	1
		Finley Run	High	1	2	3	4	1	2	3	4	1
Sand Run	WV-MC-124-K-15-H	Pierce Refuse II	Low	1	2	3	4	1	1	1	1	1
North Fork	WV-MC-124-K-15	Burns Blowout	High	1	2	3	4	1	2	3	4	1
		M29	High	1	1	1	1	1	2	3	4	1
		Top of WALD	High	1	2	3	4	1	1	1	1	1

1	Planning and Monitoring
2	Engineering Phase
3	Construction Phase
4	Post-Construction Monitoring

G. Milestones

The success of projects will be determined according to the achievement of 3 objective milestones. The milestones follow the natural recovery of streams after the disturbance has been lifted. The first milestone of stream recovery is the improvement of water chemistry to numeric water quality standards and TMDL targets. FOB will continue to monitor water chemistry to track the changes after construction. The second milestone is the return of benthic macro invertebrates to the stream. FOB will perform annual biological assessments and summarize data using the West Virginia Stream Condition Index (WVSCI). The second milestone will be obtained through a WVSCI score of 60.6. The final ecological milestone assesses the quality of the physical habitat. Physical habitat improvements will be tracked through time using the WVSCI's supplemental Habitat Characterization assessment. Habitat improvement are indicators of successful long term watershed management and will be achieved as pollutant loadings, sediment loads, and fecal coliform is addressed.

Table 19. Estimated Timeline for Watershed Improvements

Stream Name	Stream Code	Actions Planned	Phase I				Phase II				Phase III..
			2019	2020	2021	2022	2023	2024	2025	2026	2027
Sand Run	WV-MC-124-K-15-H	Construct BMP	2	2	2	3	3	4	4	4	4
Long Run	WV-MC-124-K-15-C	Construct BMP	2	2	2	2	2	3	3	4	4
North Fork	WV-MC-124-K-15	Construct BMP	2	2	2	2	2	3	3	4	4

2	Improved Chemistry
3	Improved WVSCI
4	Improved Habitat

H. Load Reduction Criteria

The progress towards achieving milestones will be accessed through chemical, biological, and physical assessments. Continuous improvement in assessment data over time will indicate achievement of interim objectives and progress towards milestones. The following criteria will be used to measure progress towards goals.

Chemical Assessment

FOB will characterize water chemistry at locations above and below sources of AMD. Treatment effects will be characterized by performing water sampling before and after construction. Water chemistry variables will include acidity, alkalinity, pH, specific conductivity, dissolved oxygen, sulfate, aluminum (dissolved), iron (total and dissolved), manganese (dissolved), and calcium (dissolved).

Biological Assessment

Biological improvements will be assessed using the U.S. Environmental Protections Agencies Rapid Bioassessment Protocols for Use in Wadeable Streams and Rivers. Streams will then be scored according to WVSCI.

Habitat Assessment

Physical habitat improvements will be tracked through time using the WVSCI's supplemental Habitat Characterization assessment. Physical habitat assessment characterizes the following parameters: substrate, embeddedness, sediment deposition, bank stability, riparian vegetation, and more.

I. Monitoring Component

I.1. Introduction

The North Fork of the Blackwater River is impaired by the effects of pre-regulatory coal mining (operations prior to the Surface Mine Control and Reclamation Act of 1977). Impairments include elevated levels of acidity and metals (i.e., iron and aluminum). These impairments create degraded conditions for designated uses such as contact recreation and aquatic life (Section A). The best way to accurately define the persisting impairments currently in the watershed is to perform water chemistry measurement. The water quality measurements are performed monthly with quarterly testing of flow measurement and laboratory chemical analysis.

Water quality monitoring is performed to understand baseline conditions and fluctuations over time at 13 sites located on the main stem of the North Fork, sub watersheds, and AMD discharges. Water quality monitoring also measures the milestones of water treatment in the watershed and keeps a record of progress on projects. Measurements will be taken pre, post, and during construction of future projects implemented by this plan.

I.2. Quality Assurance/Quality Control (QA/QC)

The procedure for the quality assurance will correspond with the WVDEP standards. These standards are written out in the Quality Assurance Project Plan (QAPP). The QAPP will ensure that the data collected is of high quality

Records

After each sampling visit the day’s data is entered into a Microsoft Access database. To retrieve the most current copy of the water quality measurements contact Brandae Mullins at outreach@saveblackwater.org.

I.3. Water Quality Methods

FOB is currently measuring the chemical characteristics of the North Fork, its AMD impaired tributaries and AMD mine outflows at 13 sampling sites along one mile of the river. The coordinates for each sampling site have been recorded and sites are located using a Garmin Etrex 20 handheld GPS Unit. At several sites water is sampled above and below the pollution source to better understand acid loading at discrete points along the river and cumulative loading in the main stem of the North Fork.

Chemical Sampling

This type of sampling is important in determining whether or not the project is meeting the proposed improvements of the stream’s water quality as described in the Total Daily Minimum Load (TMDL) standards for the river.

Monthly

All of the sampling sites will be sampled monthly—weather and road and stream conditions permitting—with multi-parameter probes (e.g., Oakton PC 450) for the following parameters: pH, specific conductivity, total dissolved solids, dissolved oxygen, and water temperature. Specific conductivity’s measurement will allow the reader to understand the level of metal concentration in the water. The higher the reading the higher the metal content.

Quarterly

Flow is measured using a flow-measuring instrument (e.g., Marsh-McBirney Flow meter) and water samples will be collected and sent to a lab to determine pH, specific conductivity, sulfate content, hot acidity, alkalinity, dissolved and total: iron, aluminum, manganese, and calcium. Chemical analysis will prove which metals are present in the water. Quarterly measurements are designed such that loading data can be calculated and compared to the TMDL. Samples are picked up within two days of collection and stored in an iced container for preservation until pick-up.

Sampling Sites

The following list are sites along the main stem of the North Fork and major tributaries (Table 8 and Figure 1).

1. North Fork below Thomas dam – This site is located upstream of major acid mine drainage (AMD) discharges. This allows us to understand the chemistry of the stream prior to impairments caused by AMD.

2. Snyder Run – This major tributary does not appear to be impacted by AMD. This site will be monitored to ensure that desirable conditions continue to persist.

3. North Fork above Burns Blowout – This sample is taken at the Douglas road bridge to understand chemistry of the North Fork upstream of the first major contribution of AMD, Burn’s Blowout.

4. Burns Blowout – This Mine portal (4642) discharges from the Coketon mine pool and is located on the east side of the North Fork on Mr. Burns' property downstream of the Douglas road bridge.

5. North Fork above Mine 29 – This location characterizes the impacts of Burn's Blowout on the North Fork upstream of where Mine Portal 29 discharges into the stream.

6. Mine Portal 29 combined flow –Mine Portal 29 discharges from two wet seals, which are piped through culverts under the Forest Service owned rail trail. FOB measures the combined flow of these sources.

7. North Fork below Mine 29 discharge – Samples from this site show impacts of the Mine 29 discharge on the main stem of the North Fork.

8. Middle Run –FOB measures Middle Run above the WALD outflow and AMD source that runs down a fabric-form channel. Middle Run is listed on the TMDL as an impaired SWS.

9. Top of wetland anoxic limestone drain (WALD) – This passive treatment system was designed and constructed to treat one third of the AMD discharging from Mine Portal 29. This sample site is located where the discharge initially comes out of the mine before any treatment takes place.

10. End of WALD – This site is located at the end of the 2/3's of a mile long WALD, prior to it discharging into Middle Run. This sites allows us to understand if the treatment system is effective in increasing pH and removing metals (i.e., iron).

11. North Fork above Long Run – This site is located upstream of the Long Run-North Fork confluence.

12. Long Run– Long Run is listed on the TMDL as an impaired SWS.

13. North Fork below Long Run – This site shows the impact of Long Run.

Table 20: Sampling Site Coordinates

Site #	**Site Name**	**LATITUDE**	**LONGITUDE**
1	NF Below Thomas Dam	39° 8'47.10"	-79°30'2.77"
2	Snyder Run	39 08'27.9"	-79 30'41.3"
3	NF Burns Blowout	39° 8'15.33"	-79°30'36.38"
4	Burns Blowout	39° 8'14.80"	-79°30'36.03"
5	NF Above Mine Portal 29	39° 8'11.72"	-79°30'40.57"
6	Mine Portal 29 combined flow	39 08'14.7"	-79 30'41.1"
7	NF Below Mine Portal 29's combined flow	39° 8'3.23"	-79°30'46.28"
8	Middle Run	39 07'47.8"	-79 31'12.4"
9	Top of WALD	39° 8'6.84"	-79°30'45.74"
10	End of WALD	39 07'48.2"	-79 31'12.9"
11	NF Above Long Run	39 07'33.8"	-79 31'06.3"
12	Long Run	39° 7'34.02"	-79°31'6.25"
13	NF Below Long Run	39 07'30.8"	-79 31'07.4"

NF = North Fork

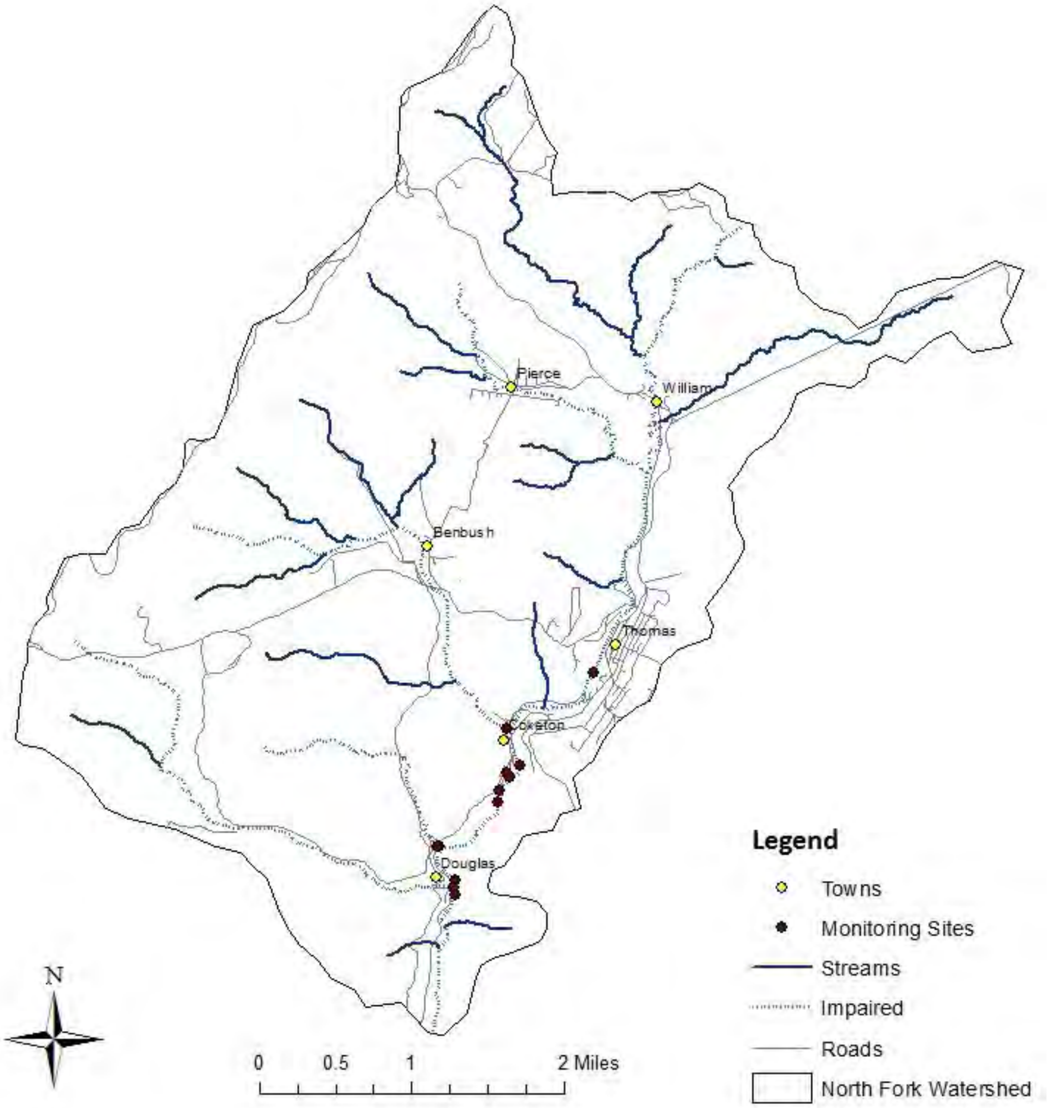


Figure 15: Water Quality Sample Sites

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Appendix

Table 21. AML problem areas located in or near the Nork Fork watershed

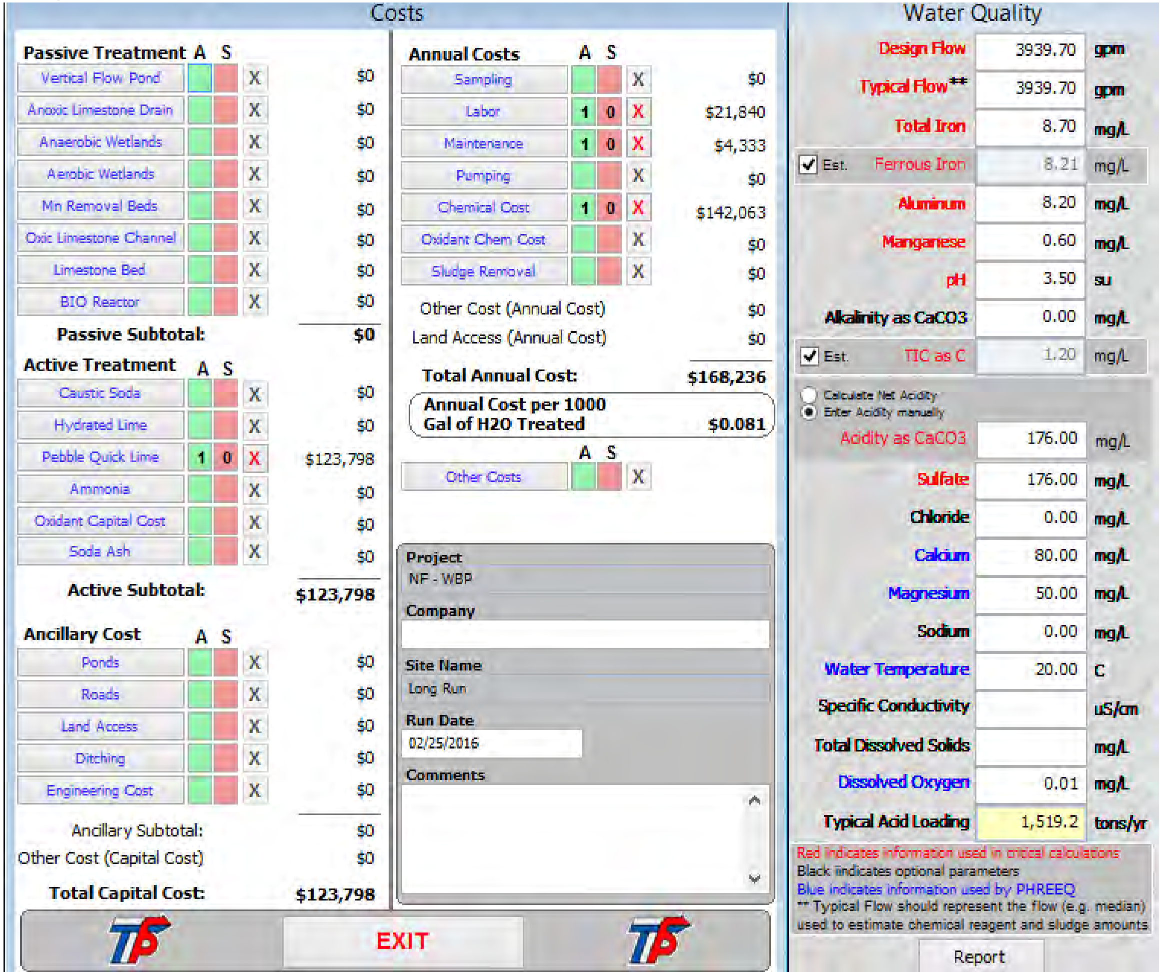
PAD NAME	PAD NUMBER
LONG RUN	WV000003
THOMAS (REYNOLDS) SUBSIDENCE	WV005330
THOMAS (BROWN STREET) SUBSIDENCE	WV005730
"THOMAS (NORTHEAST) SUBS. PH. 1	2
SNYDER RUN HIGHWALL #4	WV003191
THOMAS (ARNOLD) SUBSIDENCE	WV005461
LONG RUN	WV000003
SNYDER RUN HIGHWALL #2	WV003189
COKETON MINE BLOWOUT	WV000276
Quality Hill (Wilfong) Drainage	WV006564
THOMAS (DOUGLAS ROAD) SUBSIDENCE	WV005872
THOMAS (UNITED METHODIST CHURCH) SUBSIDENCE	WV005205
COKETON PORTALS	WV000275
THOMAS (EUCLID AVE) SUBS. PHASE 1+2	WV004914
BLACKWATER MANOR	WV000004
TUB RUN HW AND REFUSE	WV002279
Davis Coal and Coke	WV000002
THOMAS (LAMBERT) SUBSIDENCE	WV005236
ROGER CAMP HILL REFUSE AND SPOIL	WV006233
DOUGLAS HIGHWALL #2	WV001623
BLACKWATER HIGHWALL #1	WV001625
PIERCE REFUSE PILE #2	WV001801
KEMPTON REFUSE	WV005546
FAIRFAX STONE REFUSE & HIGHWALL	WV000520
RAILROAD HILL ROAD (NELSON) SUBSIDENCE	WV005200
MIDDLE RUN HIGHWALL	WV001434
THOMAS PORTALS SUBSIDENCE	WV000277
THOMAS (PENNINGTON) SUBSIDENCE	WV005283
PIERCE REFUSE PILE	WV000001
THOMAS (HARDY) SUBSIDENCE	WV004643
LONG RUN STRIP	WV001799
BENBUSH REFUSE	WV001798
THOMAS (SUNRISE SANITATION) BLOWOUT	WV005937
Davis Coal and Coke	WV000002
SNYDER RUN HIGHWALL #1	WV003188
ALBERT HIGHWALL #1 PHASE II	WV001622
THOMAS (MAIN STREET) DRAINAGE	WV006446
COKETON HIGHWALL	WV001433
SNYDER RUN HIGHWALL #3	WV003190
BURNS BLOWOUT	WV004642
SIMMONS SUBSIDENCE	WV004997
Community of Douglas WL Extension	WV006541
ALBERT HIGHWALL ENHANCEMENT A	WV006153

Table 22: Supplemental data for select sub-watersheds provided by WVDEP

Date	Watershed	Al Dissolved (mg/L)	Fe Total (mg/L)	PH (S.U)
07/17/00	Snyder Run			6.30
06/07/05	Snyder Run	0.13	0.53	7.56
06/12/05	Snyder Run	0.18	0.53	6.36
06/29/10	Snyder Run	0.34	0.38	6.18
08/30/10	Snyder Run	0.43	0.52	5.65
09/28/10	Snyder Run	0.12	0.41	7.32
10/04/10	Snyder Run	0.12	0.26	7.40
10/05/10	Snyder Run	0.16	0.46	6.39
10/11/10	Snyder Run	0.14	0.22	7.25
10/12/10	Snyder Run	0.25	0.34	6.29
11/07/10	Snyder Run	0.28	0.31	6.51
11/08/10	Snyder Run	0.16	0.19	7.02
12/12/10	Snyder Run	0.14	0.19	6.75
01/16/11	Snyder Run	0.37	0.28	6.54
02/14/11	Snyder Run	0.11	0.42	6.70
03/13/11	Snyder Run	0.22	0.27	6.90
03/14/11	Snyder Run	0.35	0.52	6.06
04/24/11	Snyder Run	0.23	0.33	6.87
05/30/11	Snyder Run	0.13	0.41	7.51
06/19/11	Snyder Run	0.09	0.53	7.40
07/18/00	Sand Run	0.05	1.07	6.94
06/12/05	Sand Run	0.13	0.96	6.34
06/29/10	Sand Run	0.11	1.58	6.48
08/30/10	Sand Run	0.05	1.94	6.67
09/28/10	Sand Run	0.05	1.42	6.39
10/05/10	Sand Run	0.06	0.94	6.38
10/12/10	Sand Run	0.09	0.82	6.36
11/08/10	Sand Run	0.07	0.89	6.65
12/13/10	Sand Run	0.19	0.49	6.71
01/16/11	Sand Run	0.11	0.95	6.78
02/14/11	Sand Run	0.17	0.68	6.63
03/14/11	Sand Run	0.09	0.63	6.81
04/24/11	Sand Run	0.07	1.44	6.98
05/30/11	Sand Run	0.06	1.50	6.79
06/19/11	Sand Run	0.07	1.30	6.88
06/03/15	Sand Run	0.09	1.10	6.66
07/17/00	Middle Run	NA	NA	6.45
06/07/05	Middle Run	0.10	1.33	6.83
06/29/10	Middle Run	0.16	0.58	5.64
08/30/10	Middle Run	0.12	1.56	5.64
09/28/10	Middle Run	0.05	1.48	6.90
10/04/10	Middle Run	0.06	0.97	6.12
10/11/10	Middle Run	0.09	0.50	6.02
11/08/10	Middle Run	0.07	0.36	6.11
12/12/10	Middle Run	0.07	0.55	6.83
01/16/11	Middle Run	0.18	0.94	5.69
02/13/11	Middle Run	0.07	0.88	6.71
03/13/11	Middle Run	0.13	0.24	5.90
04/24/11	Middle Run	0.10	0.46	6.45
05/30/11	Middle Run	0.05	0.99	6.22
06/19/11	Middle Run	0.05	1.10	6.88

AMDTreat Reports - Active Treatment

Long Run



Costs

Passive Treatment	**A**	**S**		
Vertical Flow Pond	🟩	🟥	X	$0
Anoxic Limestone Drain	🟩	🟥	X	$0
Anaerobic Wetlands	🟩	🟥	X	$0
Aerobic Wetlands	🟩	🟥	X	$0
Mn Removal Beds	🟩	🟥	X	$0
Oxic Limestone Channel	🟩	🟥	X	$0
Limestone Bed	🟩	🟥	X	$0
BIO Reactor	🟩	🟥	X	$0
Passive Subtotal:				**$0**

Active Treatment	**A**	**S**		
Caustic Soda	🟩	🟥	X	$0
Hydrated Lime	🟩	🟥	X	$0
Pebble Quick Lime	1	0	X	$123,798
Ammonia	🟩	🟥	X	$0
Oxidant Capital Cost	🟩	🟥	X	$0
Soda Ash	🟩	🟥	X	$0
Active Subtotal:				**$123,798**

Ancillary Cost	**A**	**S**		
Ponds	🟩	🟥	X	$0
Roads	🟩	🟥	X	$0
Land Access	🟩	🟥	X	$0
Ditching	🟩	🟥	X	$0
Engineering Cost	🟩	🟥	X	$0
Ancillary Subtotal:				$0
Other Cost (Capital Cost)				$0
Total Capital Cost:				**$123,798**

Annual Costs	**A**	**S**		
Sampling	🟩	🟥	X	$0
Labor	1	0	X	$21,840
Maintenance	1	0	X	$4,333
Pumping	🟩	🟥	X	$0
Chemical Cost	1	0	X	$142,063
Oxidant Chem Cost	🟩	🟥	X	$0
Sludge Removal	🟩	🟥	X	$0
Other Cost (Annual Cost)				$0
Land Access (Annual Cost)				$0
Total Annual Cost:				**$168,236**
Annual Cost per 1000 Gal of H2O Treated				**$0.081**

	A	**S**		
Other Costs	🟩	🟥	X	

Project
NF - WBP

Company

Site Name
Long Run

Run Date
02/25/2016

Comments

Water Quality

	Design Flow	3939.70	gpm
	Typical Flow**	3939.70	gpm
	Total Iron	8.70	mg/L
☑ Est.	Ferrous Iron	8.21	mg/L
	Aluminum	8.20	mg/L
	Manganese	0.60	mg/L
	pH	3.50	su
	Alkalinity as CaCO3	0.00	mg/L
☑ Est.	TIC as C	1.20	mg/L

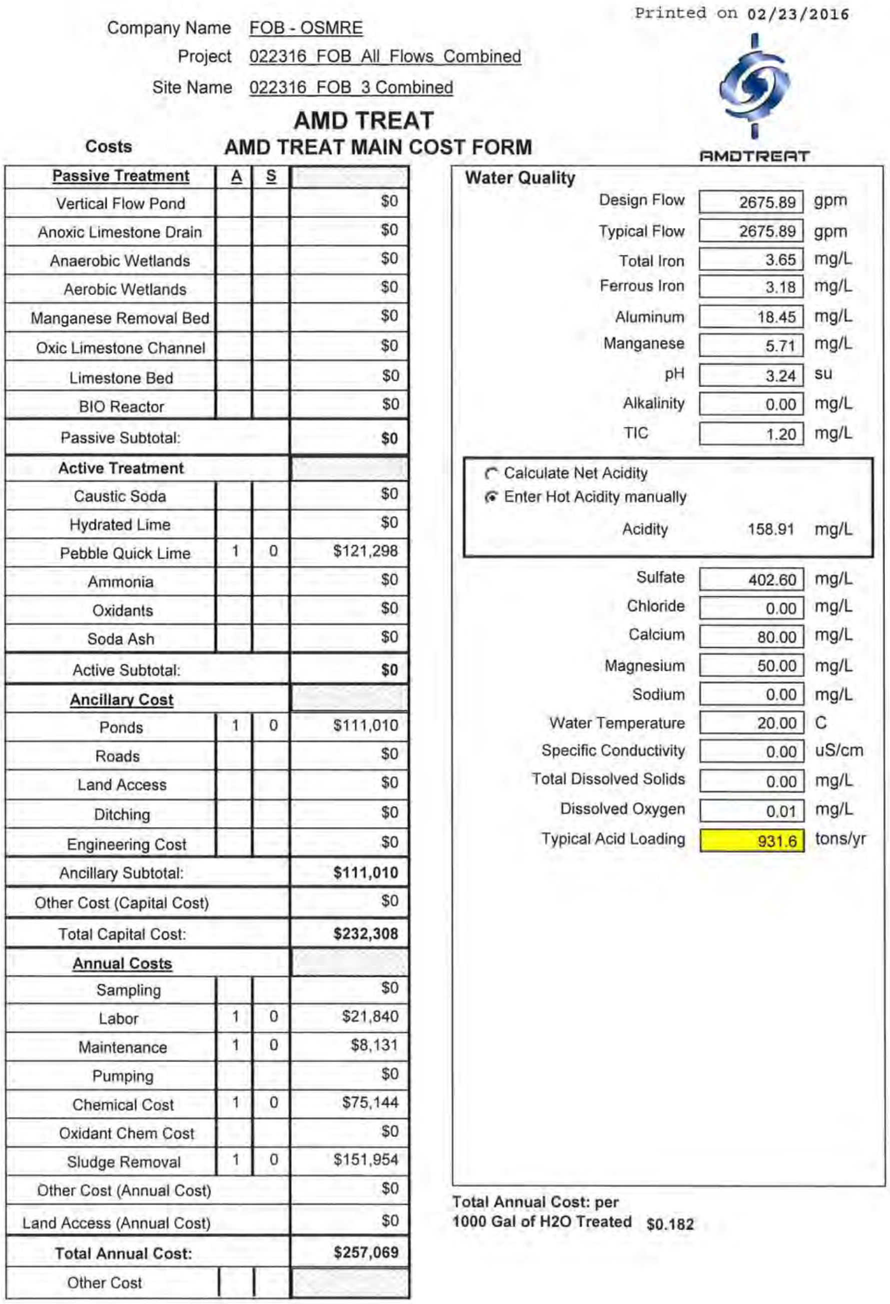
○ Calculate Net Acidity
● Enter Acidity manually

Acidity as CaCO3	176.00	mg/L
Sulfate	176.00	mg/L
Chloride	0.00	mg/L
Calcium	80.00	mg/L
Magnesium	50.00	mg/L
Sodium	0.00	mg/L
Water Temperature	20.00	C
Specific Conductivity		uS/cm
Total Dissolved Solids		mg/L
Dissolved Oxygen	0.01	mg/L
Typical Acid Loading	1,519.2	tons/yr

Red indicates information used in critical calculations
Black iindicates optional parameters
Blue indicates information used by PHREEQ
** Typical Flow should represent the flow (e.g. median) used to estimate chemical reagent and sludge amounts

Figure 16: AMDTreat Report: Long Run active treatment site

Combined Flow of M29, Burns Blowout, WALD



Printed on 02/23/2016

Company Name FOB - OSMRE
Project 022316_FOB_All_Flows_Combined
Site Name 022316_FOB_3 Combined

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			$0
Limestone Bed			$0
BIO Reactor			$0
Passive Subtotal:			**$0**
Active Treatment			
Caustic Soda			$0
Hydrated Lime			$0
Pebble Quick Lime	1	0	$121,298
Ammonia			$0
Oxidants			$0
Soda Ash			$0
Active Subtotal:			**$0**
Ancillary Cost			
Ponds	1	0	$111,010
Roads			$0
Land Access			$0
Ditching			$0
Engineering Cost			$0
Ancillary Subtotal:			**$111,010**
Other Cost (Capital Cost)			$0
Total Capital Cost:			**$232,308**
Annual Costs			
Sampling			$0
Labor	1	0	$21,840
Maintenance	1	0	$8,131
Pumping			$0
Chemical Cost	1	0	$75,144
Oxidant Chem Cost			$0
Sludge Removal	1	0	$151,954
Other Cost (Annual Cost)			$0
Land Access (Annual Cost)			$0
Total Annual Cost:			**$257,069**
Other Cost			

Water Quality

Design Flow	2675.89	gpm
Typical Flow	2675.89	gpm
Total Iron	3.65	mg/L
Ferrous Iron	3.18	mg/L
Aluminum	18.45	mg/L
Manganese	5.71	mg/L
pH	3.24	su
Alkalinity	0.00	mg/L
TIC	1.20	mg/L

○ Calculate Net Acidity
● Enter Hot Acidity manually
Acidity 158.91 mg/L

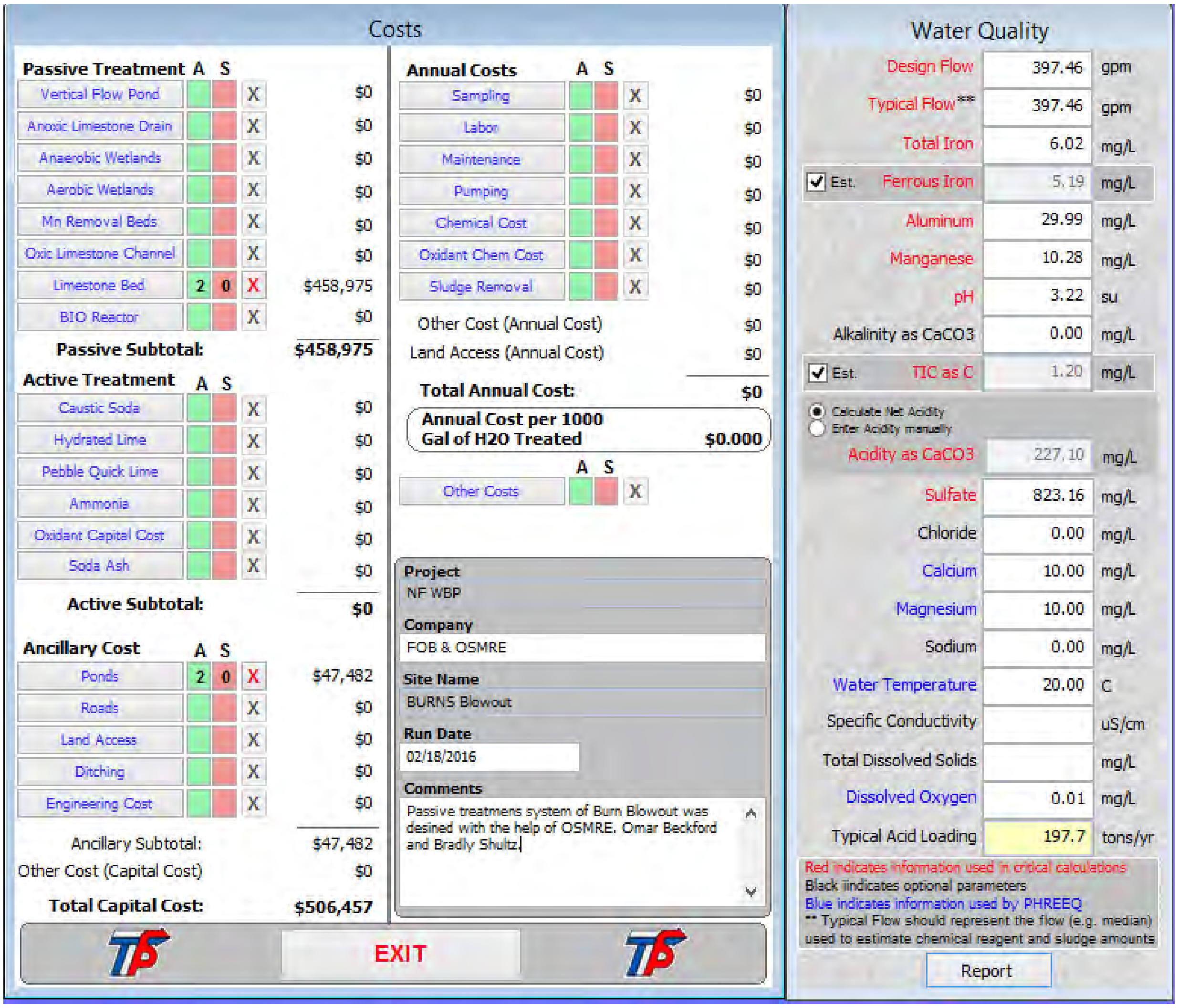
Sulfate	402.60	mg/L
Chloride	0.00	mg/L
Calcium	80.00	mg/L
Magnesium	50.00	mg/L
Sodium	0.00	mg/L
Water Temperature	20.00	C
Specific Conductivity	0.00	uS/cm
Total Dissolved Solids	0.00	mg/L
Dissolved Oxygen	0.01	mg/L
Typical Acid Loading	931.6	tons/yr

Total Annual Cost: per 1000 Gal of H2O Treated $0.182

Figure 17: AMDTreat Report: active treatment system for combined flow from Coketon mine outflow Burns Blowout, M29, WALD

AMDTreat Reports - Passive Treatment

Burns Blowout



Passive Treatment	A	S		
Vertical Flow Pond	🟩	🟥	X	$0
Anoxic Limestone Drain	🟩	🟥	X	$0
Anaerobic Wetlands	🟩	🟥	X	$0
Aerobic Wetlands	🟩	🟥	X	$0
Mn Removal Beds	🟩	🟥	X	$0
Oxic Limestone Channel	🟩	🟥	X	$0
Limestone Bed	2	0	X	$458,975
BIO Reactor	🟩	🟥	X	$0
Passive Subtotal:				**$458,975**

Active Treatment	A	S		
Caustic Soda	🟩	🟥	X	$0
Hydrated Lime	🟩	🟥	X	$0
Pebble Quick Lime	🟩	🟥	X	$0
Ammonia	🟩	🟥	X	$0
Oxidant Capital Cost	🟩	🟥	X	$0
Soda Ash	🟩	🟥	X	$0
Active Subtotal:				**$0**

Ancillary Cost	A	S		
Ponds	2	0	X	$47,482
Roads	🟩	🟥	X	$0
Land Access	🟩	🟥	X	$0
Ditching	🟩	🟥	X	$0
Engineering Cost	🟩	🟥	X	$0
Ancillary Subtotal:				$47,482
Other Cost (Capital Cost)				$0
Total Capital Cost:				**$506,457**

Annual Costs	A	S		
Sampling	🟩	🟥	X	$0
Labor	🟩	🟥	X	$0
Maintenance	🟩	🟥	X	$0
Pumping	🟩	🟥	X	$0
Chemical Cost	🟩	🟥	X	$0
Oxidant Chem Cost	🟩	🟥	X	$0
Sludge Removal	🟩	🟥	X	$0
Other Cost (Annual Cost)				$0
Land Access (Annual Cost)				$0
Total Annual Cost:				**$0**
Annual Cost per 1000 Gal of H20 Treated				**$0.000**
	A	S		
Other Costs	🟩	🟥	X	

Project
NF WBP

Company
FOB & OSMRE

Site Name
BURNS Blowout

Run Date
02/18/2016

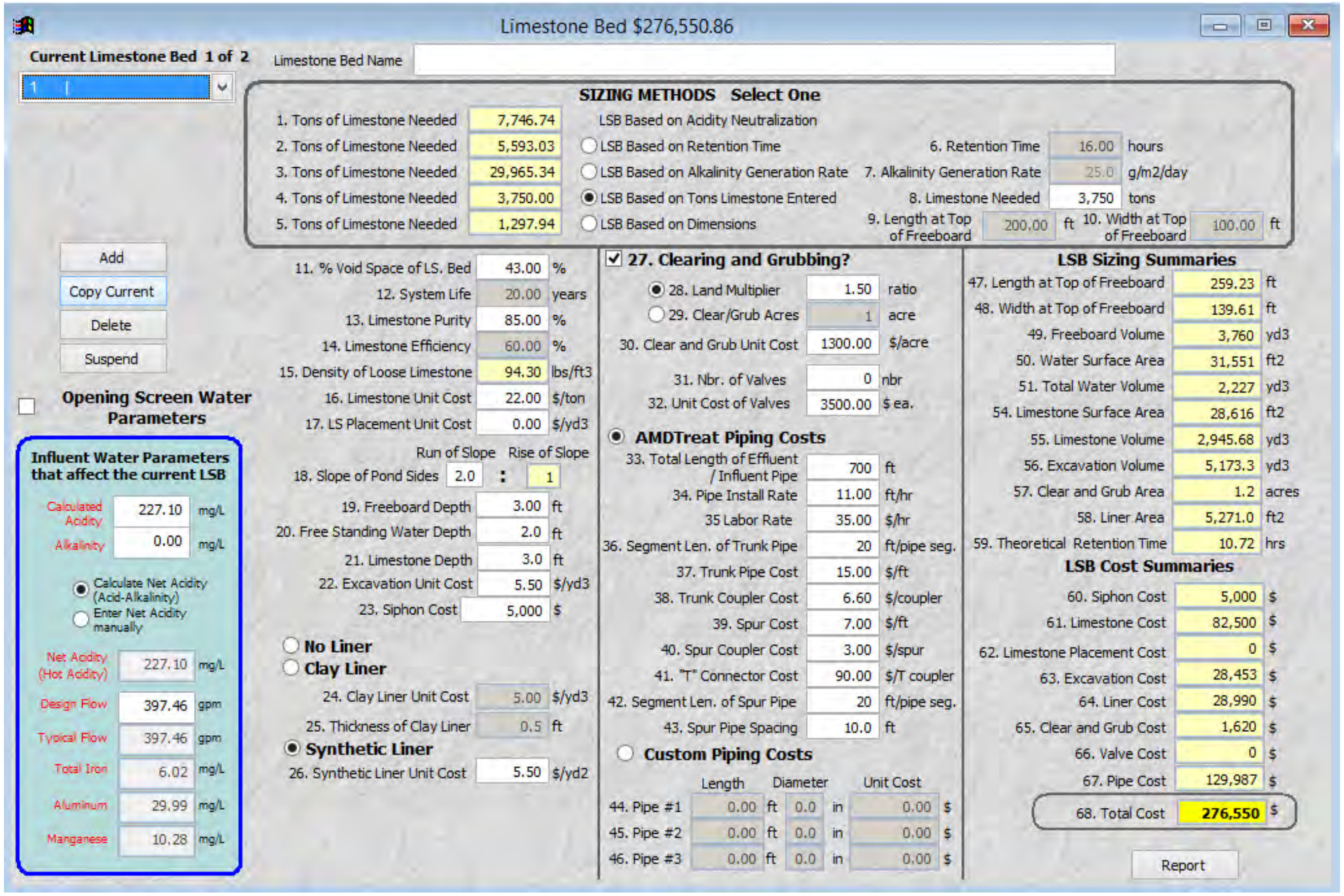
Comments
Passive treatmens system of Burn Blowout was desined with the help of OSMRE. Omar Beckford and Bradly Shultz.

	Design Flow	397.46	gpm
	Typical Flow**	397.46	gpm
	Total Iron	6.02	mg/L
☑ Est.	Ferrous Iron	5.19	mg/L
	Aluminum	29.99	mg/L
	Manganese	10.28	mg/L
	pH	3.22	su
	Alkalinity as CaCO3	0.00	mg/L
☑ Est.	TIC as C	1.20	mg/L
	Acidity as CaCO3	227.10	mg/L
	Sulfate	823.16	mg/L
	Chloride	0.00	mg/L
	Calcium	10.00	mg/L
	Magnesium	10.00	mg/L
	Sodium	0.00	mg/L
	Water Temperature	20.00	C
	Specific Conductivity		uS/cm
	Total Dissolved Solids		mg/L
	Dissolved Oxygen	0.01	mg/L
	Typical Acid Loading	197.7	tons/yr

● Calculate Net Acidity
○ Enter Acidity manually

Red indicates information used in critical calculations
Black iindicates optional parameters
Blue indicates information used by PHREEQ
** Typical Flow should represent the flow (e.g. median) used to estimate chemical reagent and sludge amounts

Figure 18: AMDTreat Report: Burns Blowout passive treatment option



Limestone Bed $276,550.86

Current Limestone Bed 1 of 2

Limestone Bed Name

SIZING METHODS Select One

1. Tons of Limestone Needed 7,746.74 LSB Based on Acidity Neutralization
2. Tons of Limestone Needed 5,593.03 ○ LSB Based on Retention Time
3. Tons of Limestone Needed 29,965.34 ○ LSB Based on Alkalinity Generation Rate
4. Tons of Limestone Needed 3,750.00 ● LSB Based on Tons Limestone Entered
5. Tons of Limestone Needed 1,297.94 ○ LSB Based on Dimensions

6. Retention Time 16.00 hours
7. Alkalinity Generation Rate 25.0 g/m2/day
8. Limestone Needed 3,750 tons
9. Length at Top of Freeboard 200.00 ft
10. Width at Top of Freeboard 100.00 ft

☐ **Opening Screen Water Parameters**

Influent Water Parameters that affect the current LSB

Calculated Acidity 227.10 mg/L
Alkalinity 0.00 mg/L
● Calculate Net Acidity (Acid-Alkalinity)
○ Enter Net Acidity manually
Net Acidity (Hot Acidity) 227.10 mg/L
Design Flow 397.46 gpm
Typical Flow 397.46 gpm
Total Iron 6.02 mg/L
Aluminum 29.99 mg/L
Manganese 10.28 mg/L

11. % Void Space of LS. Bed 43.00 %
12. System Life 20.00 years
13. Limestone Purity 85.00 %
14. Limestone Efficiency 60.00 %
15. Density of Loose Limestone 94.30 lbs/ft3
16. Limestone Unit Cost 22.00 $/ton
17. LS Placement Unit Cost 0.00 $/yd3
18. Slope of Pond Sides (Run of Slope : Rise of Slope) 2.0 : 1
19. Freeboard Depth 3.00 ft
20. Free Standing Water Depth 2.0 ft
21. Limestone Depth 3.0 ft
22. Excavation Unit Cost 5.50 $/yd3
23. Siphon Cost 5,000 $

○ **No Liner**
○ **Clay Liner**
24. Clay Liner Unit Cost 5.00 $/yd3
25. Thickness of Clay Liner 0.5 ft
● **Synthetic Liner**
26. Synthetic Liner Unit Cost 5.50 $/yd2

☑ **27. Clearing and Grubbing?**
● 28. Land Multiplier 1.50 ratio
○ 29. Clear/Grub Acres 1 acre
30. Clear and Grub Unit Cost 1300.00 $/acre
31. Nbr. of Valves 0 nbr
32. Unit Cost of Valves 3500.00 $ ea.

● **AMDTreat Piping Costs**
33. Total Length of Effluent / Influent Pipe 700 ft
34. Pipe Install Rate 11.00 ft/hr
35 Labor Rate 35.00 $/hr
36. Segment Len. of Trunk Pipe 20 ft/pipe seg.
37. Trunk Pipe Cost 15.00 $/ft
38. Trunk Coupler Cost 6.60 $/coupler
39. Spur Cost 7.00 $/ft
40. Spur Coupler Cost 3.00 $/spur
41. "T" Connector Cost 90.00 $/T coupler
42. Segment Len. of Spur Pipe 20 ft/pipe seg.
43. Spur Pipe Spacing 10.0 ft

○ **Custom Piping Costs**

	Length		Diameter		Unit Cost	
44. Pipe #1	0.00	ft	0.0	in	0.00	$
45. Pipe #2	0.00	ft	0.0	in	0.00	$
46. Pipe #3	0.00	ft	0.0	in	0.00	$

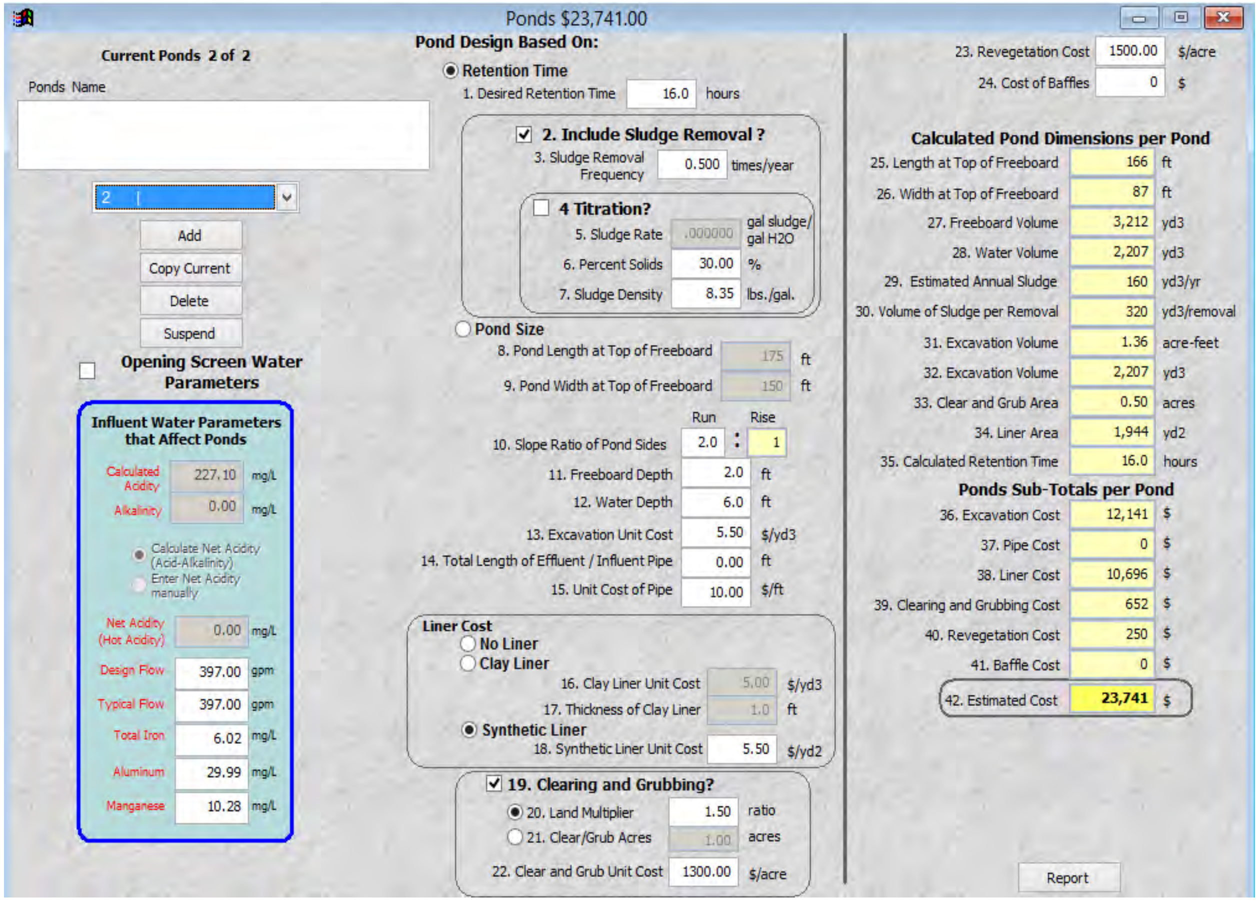
LSB Sizing Summaries

47. Length at Top of Freeboard 259.23 ft
48. Width at Top of Freeboard 139.61 ft
49. Freeboard Volume 3,760 yd3
50. Water Surface Area 31,551 ft2
51. Total Water Volume 2,227 yd3
54. Limestone Surface Area 28,616 ft2
55. Limestone Volume 2,945.68 yd3
56. Excavation Volume 5,173.3 yd3
57. Clear and Grub Area 1.2 acres
58. Liner Area 5,271.0 ft2
59. Theoretical Retention Time 10.72 hrs

LSB Cost Summaries

60. Siphon Cost 5,000 $
61. Limestone Cost 82,500 $
62. Limestone Placement Cost 0 $
63. Excavation Cost 28,453 $
64. Liner Cost 28,990 $
65. Clear and Grub Cost 1,620 $
66. Valve Cost 0 $
67. Pipe Cost 129,987 $
68. Total Cost 276,550 $

Figure 19: AMDTreat Report: limestone leachbed for Burns Blowout passive treatment system



Current Ponds 2 of 2

Ponds Name

☐ Opening Screen Water Parameters

Influent Water Parameters that Affect Ponds

Calculated Acidity	227.10	mg/L
Alkalinity	0.00	mg/L

● Calculate Net Acidity (Acid-Alkalinity)
○ Enter Net Acidity manually

Net Acidity (Hot Acidity)	0.00	mg/L
Design Flow	397.00	gpm
Typical Flow	397.00	gpm
Total Iron	6.02	mg/L
Aluminum	29.99	mg/L
Manganese	10.28	mg/L

Pond Design Based On:

● Retention Time

1. Desired Retention Time 16.0 hours

☑ 2. Include Sludge Removal ?

3. Sludge Removal Frequency 0.500 times/year

☐ 4 Titration?

5. Sludge Rate .000000 gal sludge/ gal H2O

6. Percent Solids 30.00 %

7. Sludge Density 8.35 lbs./gal.

○ Pond Size

8. Pond Length at Top of Freeboard 175 ft

9. Pond Width at Top of Freeboard 150 ft

10. Slope Ratio of Pond Sides Run 2.0 : Rise 1

11. Freeboard Depth 2.0 ft

12. Water Depth 6.0 ft

13. Excavation Unit Cost 5.50 $/yd3

14. Total Length of Effluent / Influent Pipe 0.00 ft

15. Unit Cost of Pipe 10.00 $/ft

Liner Cost

○ No Liner

○ Clay Liner

16. Clay Liner Unit Cost 5.00 $/yd3

17. Thickness of Clay Liner 1.0 ft

● Synthetic Liner

18. Synthetic Liner Unit Cost 5.50 $/yd2

☑ 19. Clearing and Grubbing?

● 20. Land Multiplier 1.50 ratio

○ 21. Clear/Grub Acres 1.00 acres

22. Clear and Grub Unit Cost 1300.00 $/acre

23. Revegetation Cost 1500.00 $/acre

24. Cost of Baffles 0 $

Calculated Pond Dimensions per Pond

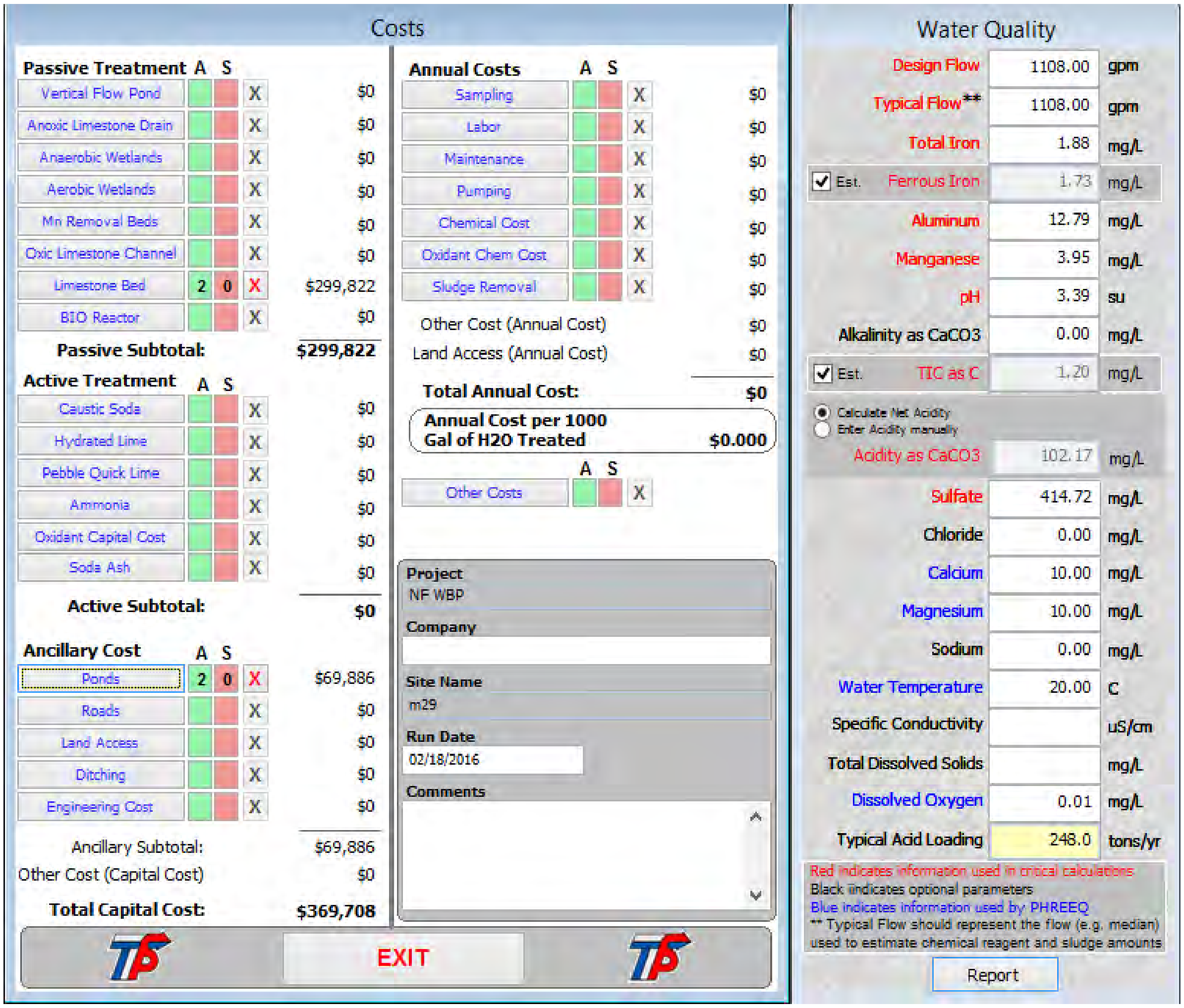
25. Length at Top of Freeboard	166	ft
26. Width at Top of Freeboard	87	ft
27. Freeboard Volume	3,212	yd3
28. Water Volume	2,207	yd3
29. Estimated Annual Sludge	160	yd3/yr
30. Volume of Sludge per Removal	320	yd3/removal
31. Excavation Volume	1.36	acre-feet
32. Excavation Volume	2,207	yd3
33. Clear and Grub Area	0.50	acres
34. Liner Area	1,944	yd2
35. Calculated Retention Time	16.0	hours

Ponds Sub-Totals per Pond

36. Excavation Cost	12,141	$
37. Pipe Cost	0	$
38. Liner Cost	10,696	$
39. Clearing and Grubbing Cost	652	$
40. Revegetation Cost	250	$
41. Baffle Cost	0	$
42. Estimated Cost	23,741	$

Figure 20: AMDTreat Report: pond design for Burns Blowout passive treatment system

M29



Costs

Passive Treatment	A	S		
Vertical Flow Pond	🟩	🟥	X	$0
Anoxic Limestone Drain	🟩	🟥	X	$0
Anaerobic Wetlands	🟩	🟥	X	$0
Aerobic Wetlands	🟩	🟥	X	$0
Mn Removal Beds	🟩	🟥	X	$0
Oxic Limestone Channel	🟩	🟥	X	$0
Limestone Bed	2	0	X	$299,822
BIO Reactor	🟩	🟥	X	$0
Passive Subtotal:				**$299,822**

Active Treatment	A	S		
Caustic Soda	🟩	🟥	X	$0
Hydrated Lime	🟩	🟥	X	$0
Pebble Quick Lime	🟩	🟥	X	$0
Ammonia	🟩	🟥	X	$0
Oxidant Capital Cost	🟩	🟥	X	$0
Soda Ash	🟩	🟥	X	$0
Active Subtotal:				**$0**

Ancillary Cost	A	S		
Ponds	2	0	X	$69,886
Roads	🟩	🟥	X	$0
Land Access	🟩	🟥	X	$0
Ditching	🟩	🟥	X	$0
Engineering Cost	🟩	🟥	X	$0
Ancillary Subtotal:				$69,886
Other Cost (Capital Cost)				$0
Total Capital Cost:				**$369,708**

Annual Costs	A	S		
Sampling	🟩	🟥	X	$0
Labor	🟩	🟥	X	$0
Maintenance	🟩	🟥	X	$0
Pumping	🟩	🟥	X	$0
Chemical Cost	🟩	🟥	X	$0
Oxidant Chem Cost	🟩	🟥	X	$0
Sludge Removal	🟩	🟥	X	$0
Other Cost (Annual Cost)				$0
Land Access (Annual Cost)				$0
Total Annual Cost:				**$0**
Annual Cost per 1000 Gal of H20 Treated				**$0.000**
Other Costs	🟩	🟥	X	

Project
NF WBP

Company

Site Name
m29

Run Date
02/18/2016

Comments

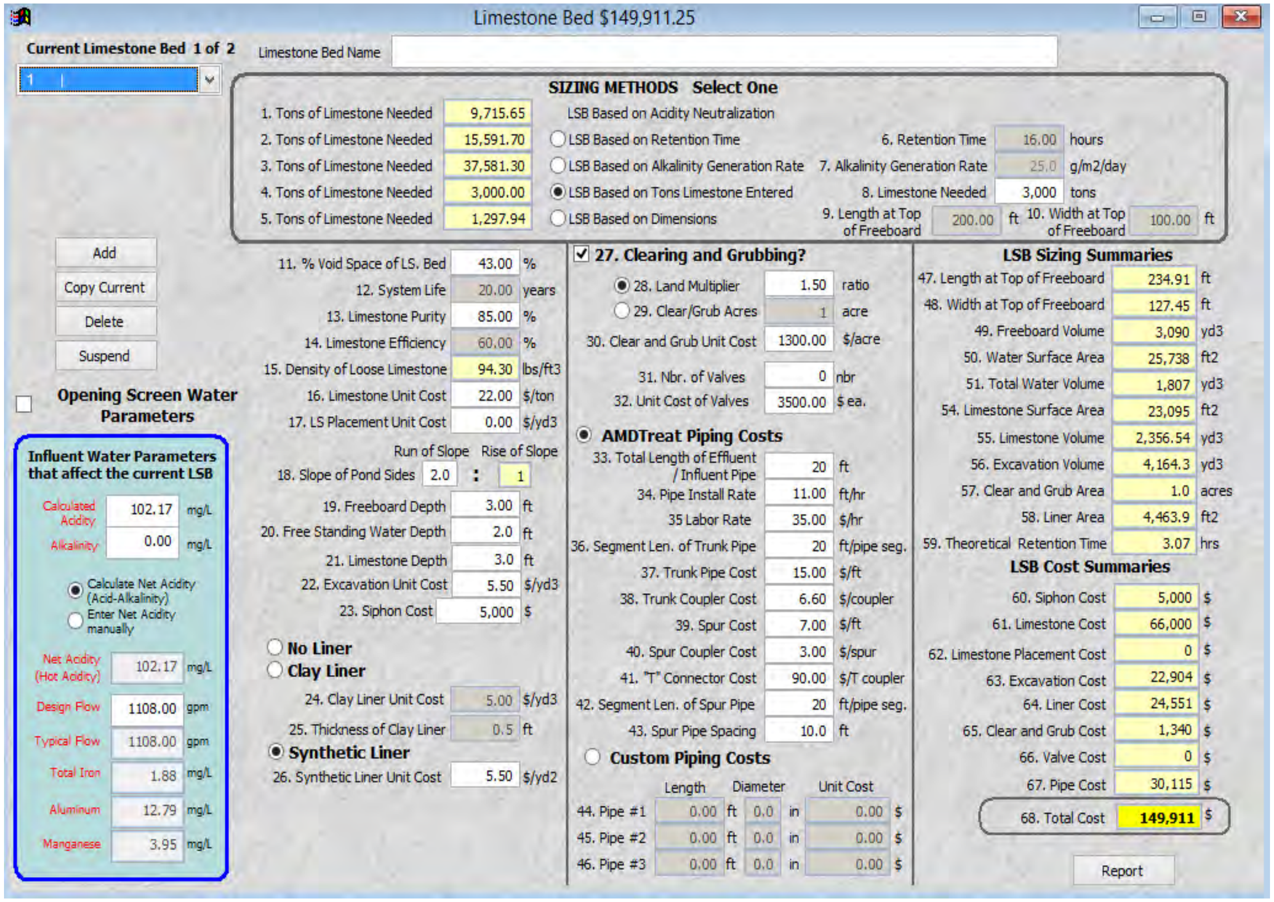
Water Quality

	Design Flow	1108.00	gpm
	Typical Flow**	1108.00	gpm
	Total Iron	1.88	mg/L
☑ Est.	Ferrous Iron	1.73	mg/L
	Aluminum	12.79	mg/L
	Manganese	3.95	mg/L
	pH	3.39	su
	Alkalinity as CaCO3	0.00	mg/L
☑ Est.	TIC as C	1.20	mg/L
	Acidity as CaCO3	102.17	mg/L
	Sulfate	414.72	mg/L
	Chloride	0.00	mg/L
	Calcium	10.00	mg/L
	Magnesium	10.00	mg/L
	Sodium	0.00	mg/L
	Water Temperature	20.00	C
	Specific Conductivity		uS/cm
	Total Dissolved Solids		mg/L
	Dissolved Oxygen	0.01	mg/L
	Typical Acid Loading	248.0	tons/yr

● Calculate Net Acidity
○ Enter Acidity manually

Red indicates information used in critical calculations
Black indicates optional parameters
Blue indicates information used by PHREEQ
** Typical Flow should represent the flow (e.g. median) used to estimate chemical reagent and sludge amounts

Figure 21: AMDTreat Report: M29 passive treatment system option



Current Limestone Bed 1 of 2: 1

Limestone Bed Name:

☐ Opening Screen Water Parameters

Influent Water Parameters that affect the current LSB

Calculated Acidity: 102.17 mg/L
Alkalinity: 0.00 mg/L
● Calculate Net Acidity (Acid-Alkalinity)
○ Enter Net Acidity manually
Net Acidity (Hot Acidity): 102.17 mg/L
Design Flow: 1108.00 gpm
Typical Flow: 1108.00 gpm
Total Iron: 1.88 mg/L
Aluminum: 12.79 mg/L
Manganese: 3.95 mg/L

SIZING METHODS Select One

1. Tons of Limestone Needed: 9,715.65 — LSB Based on Acidity Neutralization
2. Tons of Limestone Needed: 15,591.70 — ○ LSB Based on Retention Time — 6. Retention Time: 16.00 hours
3. Tons of Limestone Needed: 37,581.30 — ○ LSB Based on Alkalinity Generation Rate — 7. Alkalinity Generation Rate: 25.0 g/m2/day
4. Tons of Limestone Needed: 3,000.00 — ● LSB Based on Tons Limestone Entered — 8. Limestone Needed: 3,000 tons
5. Tons of Limestone Needed: 1,297.94 — ○ LSB Based on Dimensions — 9. Length at Top of Freeboard: 200.00 ft — 10. Width at Top of Freeboard: 100.00 ft

11. % Void Space of LS. Bed: 43.00 %
12. System Life: 20.00 years
13. Limestone Purity: 85.00 %
14. Limestone Efficiency: 60.00 %
15. Density of Loose Limestone: 94.30 lbs/ft3
16. Limestone Unit Cost: 22.00 $/ton
17. LS Placement Unit Cost: 0.00 $/yd3
18. Slope of Pond Sides (Run of Slope : Rise of Slope): 2.0 : 1
19. Freeboard Depth: 3.00 ft
20. Free Standing Water Depth: 2.0 ft
21. Limestone Depth: 3.0 ft
22. Excavation Unit Cost: 5.50 $/yd3
23. Siphon Cost: 5,000 $

○ **No Liner**
○ **Clay Liner**
24. Clay Liner Unit Cost: 5.00 $/yd3
25. Thickness of Clay Liner: 0.5 ft
● **Synthetic Liner**
26. Synthetic Liner Unit Cost: 5.50 $/yd2

☑ **27. Clearing and Grubbing?**
● 28. Land Multiplier: 1.50 ratio
○ 29. Clear/Grub Acres: 1 acre
30. Clear and Grub Unit Cost: 1300.00 $/acre
31. Nbr. of Valves: 0 nbr
32. Unit Cost of Valves: 3500.00 $ ea.

● **AMDTreat Piping Costs**
33. Total Length of Effluent / Influent Pipe: 20 ft
34. Pipe Install Rate: 11.00 ft/hr
35 Labor Rate: 35.00 $/hr
36. Segment Len. of Trunk Pipe: 20 ft/pipe seg.
37. Trunk Pipe Cost: 15.00 $/ft
38. Trunk Coupler Cost: 6.60 $/coupler
39. Spur Cost: 7.00 $/ft
40. Spur Coupler Cost: 3.00 $/spur
41. "T" Connector Cost: 90.00 $/T coupler
42. Segment Len. of Spur Pipe: 20 ft/pipe seg.
43. Spur Pipe Spacing: 10.0 ft

○ **Custom Piping Costs**

	Length		Diameter		Unit Cost	
44. Pipe #1	0.00	ft	0.0	in	0.00	$
45. Pipe #2	0.00	ft	0.0	in	0.00	$
46. Pipe #3	0.00	ft	0.0	in	0.00	$

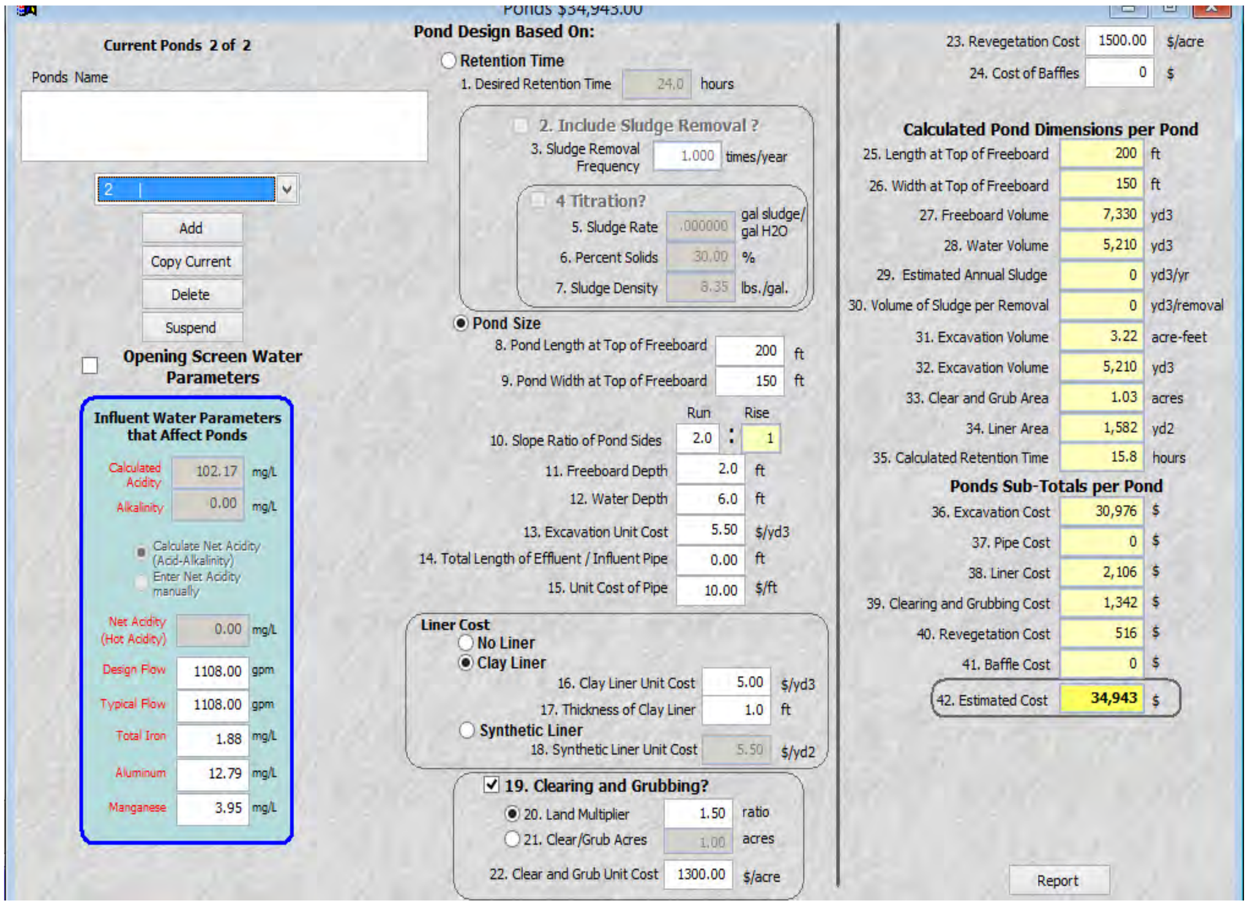
LSB Sizing Summaries

47. Length at Top of Freeboard: 234.91 ft
48. Width at Top of Freeboard: 127.45 ft
49. Freeboard Volume: 3,090 yd3
50. Water Surface Area: 25,738 ft2
51. Total Water Volume: 1,807 yd3
54. Limestone Surface Area: 23,095 ft2
55. Limestone Volume: 2,356.54 yd3
56. Excavation Volume: 4,164.3 yd3
57. Clear and Grub Area: 1.0 acres
58. Liner Area: 4,463.9 ft2
59. Theoretical Retention Time: 3.07 hrs

LSB Cost Summaries

60. Siphon Cost: 5,000 $
61. Limestone Cost: 66,000 $
62. Limestone Placement Cost: 0 $
63. Excavation Cost: 22,904 $
64. Liner Cost: 24,551 $
65. Clear and Grub Cost: 1,340 $
66. Valve Cost: 0 $
67. Pipe Cost: 30,115 $
68. Total Cost: 149,911 $

Figure 22: AMDTreat Report: limestone leachbed for M29 passive treatment system



Ponds $34,943.00

Current Ponds 2 of 2

Ponds Name

2

☐ Opening Screen Water Parameters

Influent Water Parameters that Affect Ponds

Calculated Acidity	102.17	mg/L
Alkalinity	0.00	mg/L

● Calculate Net Acidity (Acid-Alkalinity)
○ Enter Net Acidity manually

Net Acidity (Hot Acidity)	0.00	mg/L
Design Flow	1108.00	gpm
Typical Flow	1108.00	gpm
Total Iron	1.88	mg/L
Aluminum	12.79	mg/L
Manganese	3.95	mg/L

Pond Design Based On:

○ Retention Time

1. Desired Retention Time 24.0 hours

☐ 2. Include Sludge Removal ?

3. Sludge Removal Frequency 1.000 times/year

☐ 4 Titration?

5. Sludge Rate .000000 gal sludge/gal H2O

6. Percent Solids 30.00 %

7. Sludge Density 8.35 lbs./gal.

● Pond Size

8. Pond Length at Top of Freeboard 200 ft

9. Pond Width at Top of Freeboard 150 ft

10. Slope Ratio of Pond Sides Run 2.0 : Rise 1

11. Freeboard Depth 2.0 ft

12. Water Depth 6.0 ft

13. Excavation Unit Cost 5.50 $/yd3

14. Total Length of Effluent / Influent Pipe 0.00 ft

15. Unit Cost of Pipe 10.00 $/ft

Liner Cost

○ No Liner

● Clay Liner

16. Clay Liner Unit Cost 5.00 $/yd3

17. Thickness of Clay Liner 1.0 ft

○ Synthetic Liner

18. Synthetic Liner Unit Cost 5.50 $/yd2

☑ 19. Clearing and Grubbing?

● 20. Land Multiplier 1.50 ratio

○ 21. Clear/Grub Acres 1.00 acres

22. Clear and Grub Unit Cost 1300.00 $/acre

23. Revegetation Cost 1500.00 $/acre

24. Cost of Baffles 0 $

Calculated Pond Dimensions per Pond

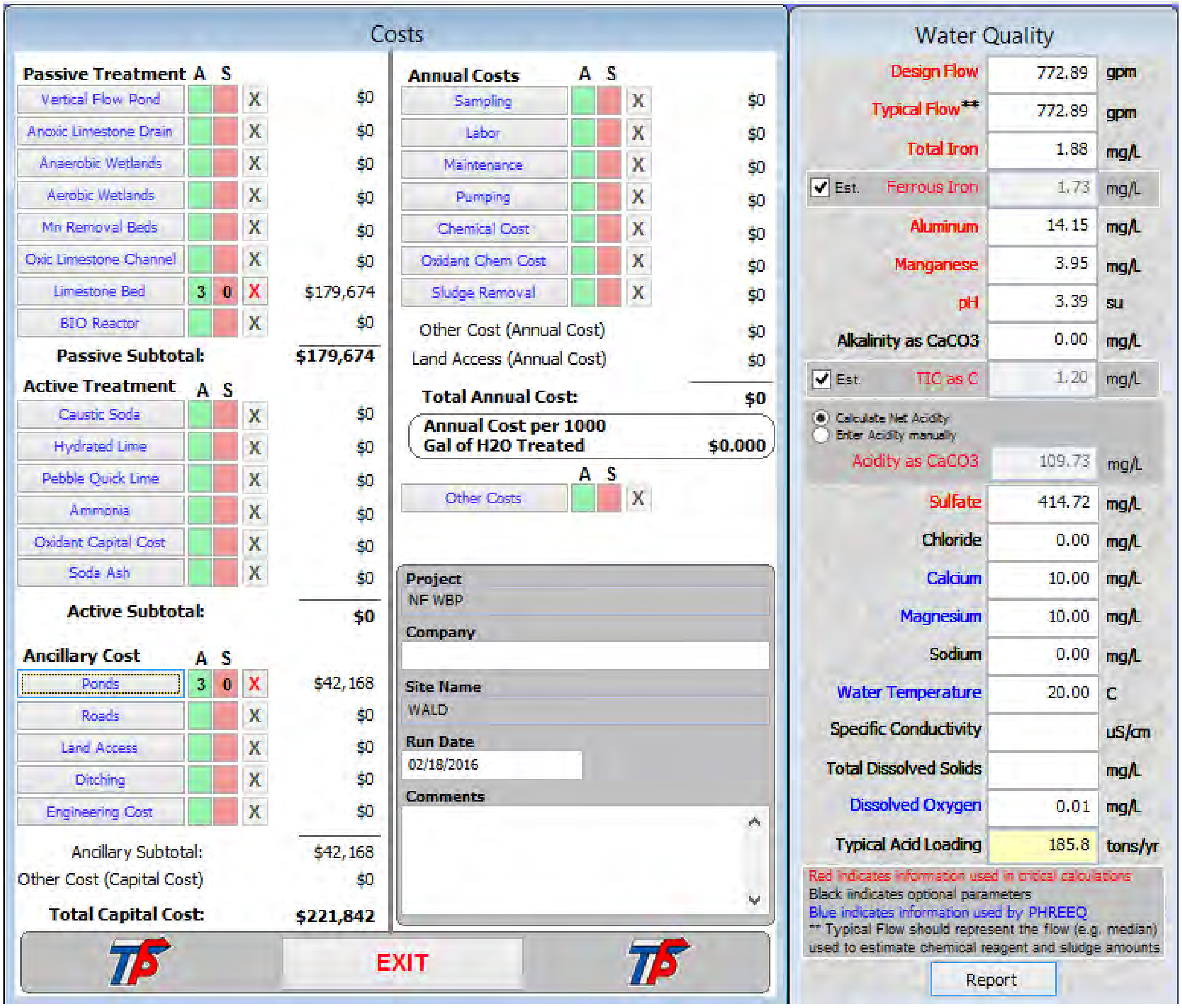
25. Length at Top of Freeboard	200	ft
26. Width at Top of Freeboard	150	ft
27. Freeboard Volume	7,330	yd3
28. Water Volume	5,210	yd3
29. Estimated Annual Sludge	0	yd3/yr
30. Volume of Sludge per Removal	0	yd3/removal
31. Excavation Volume	3.22	acre-feet
32. Excavation Volume	5,210	yd3
33. Clear and Grub Area	1.03	acres
34. Liner Area	1,582	yd2
35. Calculated Retention Time	15.8	hours

Ponds Sub-Totals per Pond

36. Excavation Cost	30,976	$
37. Pipe Cost	0	$
38. Liner Cost	2,106	$
39. Clearing and Grubbing Cost	1,342	$
40. Revegetation Cost	516	$
41. Baffle Cost	0	$
42. Estimated Cost	34,943	$

Figure 23: AMDTreat Report: pond design for M29 passive treatment system

WALD



Passive Treatment	A	S		
Vertical Flow Pond	🟩	🟥	X	$0
Anoxic Limestone Drain	🟩	🟥	X	$0
Anaerobic Wetlands	🟩	🟥	X	$0
Aerobic Wetlands	🟩	🟥	X	$0
Mn Removal Beds	🟩	🟥	X	$0
Oxic Limestone Channel	🟩	🟥	X	$0
Limestone Bed	3	0	X	$179,674
BIO Reactor	🟩	🟥	X	$0
Passive Subtotal:				**$179,674**

Active Treatment	A	S		
Caustic Soda	🟩	🟥	X	$0
Hydrated Lime	🟩	🟥	X	$0
Pebble Quick Lime	🟩	🟥	X	$0
Ammonia	🟩	🟥	X	$0
Oxidant Capital Cost	🟩	🟥	X	$0
Soda Ash	🟩	🟥	X	$0
Active Subtotal:				**$0**

Ancillary Cost	A	S		
Ponds	3	0	X	$42,168
Roads	🟩	🟥	X	$0
Land Access	🟩	🟥	X	$0
Ditching	🟩	🟥	X	$0
Engineering Cost	🟩	🟥	X	$0
Ancillary Subtotal:				$42,168
Other Cost (Capital Cost)				$0
Total Capital Cost:				**$221,842**

Annual Costs	A	S		
Sampling	🟩	🟥	X	$0
Labor	🟩	🟥	X	$0
Maintenance	🟩	🟥	X	$0
Pumping	🟩	🟥	X	$0
Chemical Cost	🟩	🟥	X	$0
Oxidant Chem Cost	🟩	🟥	X	$0
Sludge Removal	🟩	🟥	X	$0
Other Cost (Annual Cost)				$0
Land Access (Annual Cost)				$0
Total Annual Cost:				**$0**
Annual Cost per 1000 Gal of H20 Treated				**$0.000**
Other Costs	🟩	🟥	X	

Project
NF WBP
Company

Site Name
WALD
Run Date
02/18/2016
Comments

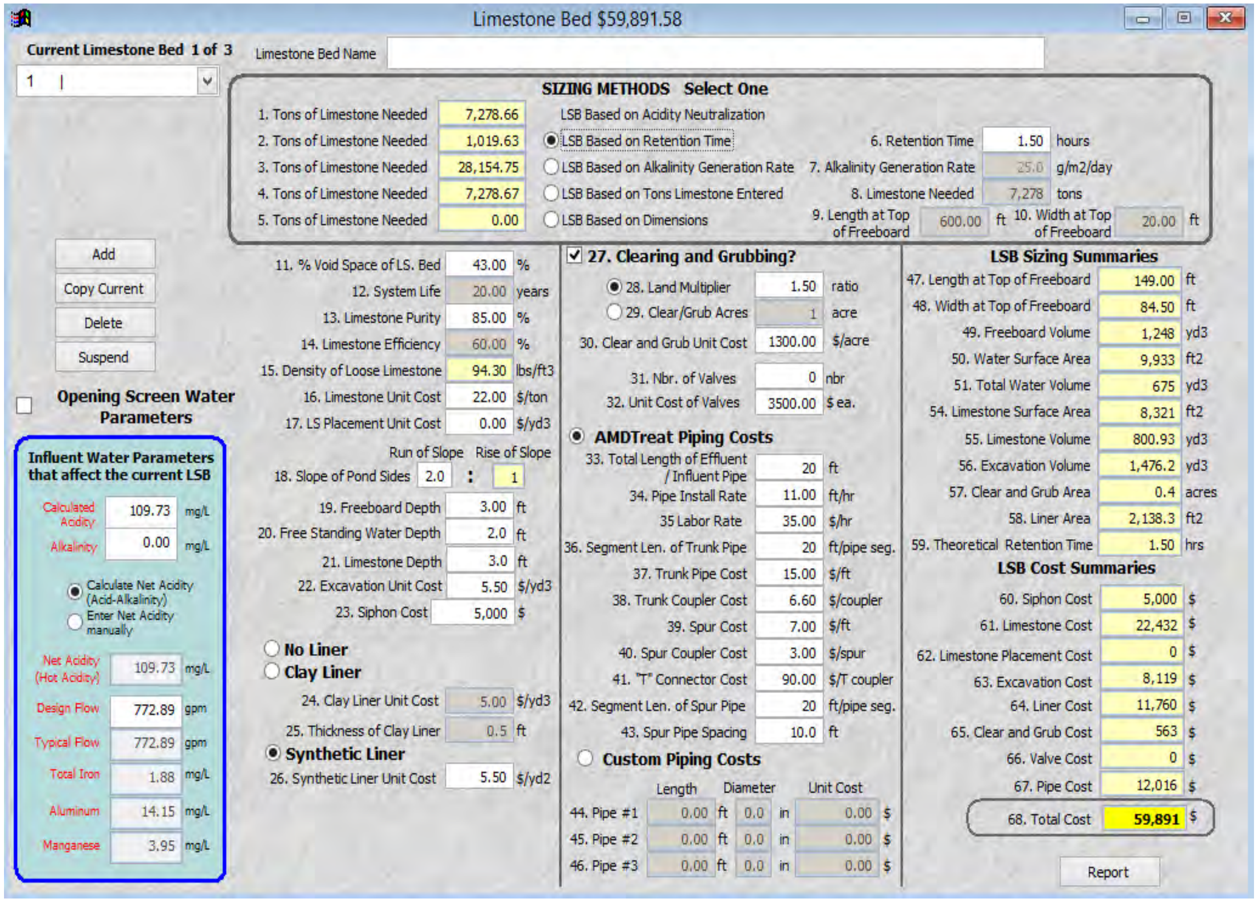
	Design Flow	772.89	gpm
	Typical Flow**	772.89	gpm
	Total Iron	1.88	mg/L
☑ Est.	Ferrous Iron	1.73	mg/L
	Aluminum	14.15	mg/L
	Manganese	3.95	mg/L
	pH	3.39	su
	Alkalinity as CaCO3	0.00	mg/L
☑ Est.	TIC as C	1.20	mg/L

● Calculate Net Acidity
○ Enter Acidity manually

Acidity as CaCO3	109.73	mg/L
Sulfate	414.72	mg/L
Chloride	0.00	mg/L
Calcium	10.00	mg/L
Magnesium	10.00	mg/L
Sodium	0.00	mg/L
Water Temperature	20.00	C
Specific Conductivity		uS/cm
Total Dissolved Solids		mg/L
Dissolved Oxygen	0.01	mg/L
Typical Acid Loading	185.8	tons/yr

Red indicates information used in critical calculations
Black indicates optional parameters
Blue indicates information used by PHREEQ
** Typical Flow should represent the flow (e.g. median) used to estimate chemical reagent and sludge amounts

Figure 24: AMDTreat Report: WALD passive treatment system option



Current Limestone Bed 1 of 3

1

Limestone Bed Name

SIZING METHODS Select One

1. Tons of Limestone Needed 7,278.66 ○ LSB Based on Acidity Neutralization
2. Tons of Limestone Needed 1,019.63 ● LSB Based on Retention Time
3. Tons of Limestone Needed 28,154.75 ○ LSB Based on Alkalinity Generation Rate
4. Tons of Limestone Needed 7,278.67 ○ LSB Based on Tons Limestone Entered
5. Tons of Limestone Needed 0.00 ○ LSB Based on Dimensions

6. Retention Time 1.50 hours
7. Alkalinity Generation Rate 25.0 g/m2/day
8. Limestone Needed 7,278 tons
9. Length at Top of Freeboard 600.00 ft
10. Width at Top of Freeboard 20.00 ft

☐ **Opening Screen Water Parameters**

Influent Water Parameters that affect the current LSB

Calculated Acidity 109.73 mg/L
Alkalinity 0.00 mg/L
● Calculate Net Acidity (Acid-Alkalinity)
○ Enter Net Acidity manually
Net Acidity (Hot Acidity) 109.73 mg/L
Design Flow 772.89 gpm
Typical Flow 772.89 gpm
Total Iron 1.88 mg/L
Aluminum 14.15 mg/L
Manganese 3.95 mg/L

11. % Void Space of LS. Bed 43.00 %
12. System Life 20.00 years
13. Limestone Purity 85.00 %
14. Limestone Efficiency 60.00 %
15. Density of Loose Limestone 94.30 lbs/ft3
16. Limestone Unit Cost 22.00 $/ton
17. LS Placement Unit Cost 0.00 $/yd3
18. Slope of Pond Sides (Run of Slope : Rise of Slope) 2.0 : 1
19. Freeboard Depth 3.00 ft
20. Free Standing Water Depth 2.0 ft
21. Limestone Depth 3.0 ft
22. Excavation Unit Cost 5.50 $/yd3
23. Siphon Cost 5,000 $

○ **No Liner**
○ **Clay Liner**
24. Clay Liner Unit Cost 5.00 $/yd3
25. Thickness of Clay Liner 0.5 ft
● **Synthetic Liner**
26. Synthetic Liner Unit Cost 5.50 $/yd2

☑ **27. Clearing and Grubbing?**
● 28. Land Multiplier 1.50 ratio
○ 29. Clear/Grub Acres 1 acre
30. Clear and Grub Unit Cost 1300.00 $/acre
31. Nbr. of Valves 0 nbr
32. Unit Cost of Valves 3500.00 $ ea.

● **AMDTreat Piping Costs**
33. Total Length of Effluent / Influent Pipe 20 ft
34. Pipe Install Rate 11.00 ft/hr
35 Labor Rate 35.00 $/hr
36. Segment Len. of Trunk Pipe 20 ft/pipe seg.
37. Trunk Pipe Cost 15.00 $/ft
38. Trunk Coupler Cost 6.60 $/coupler
39. Spur Cost 7.00 $/ft
40. Spur Coupler Cost 3.00 $/spur
41. "T" Connector Cost 90.00 $/T coupler
42. Segment Len. of Spur Pipe 20 ft/pipe seg.
43. Spur Pipe Spacing 10.0 ft

○ **Custom Piping Costs**

	Length		Diameter		Unit Cost	
44. Pipe #1	0.00	ft	0.0	in	0.00	$
45. Pipe #2	0.00	ft	0.0	in	0.00	$
46. Pipe #3	0.00	ft	0.0	in	0.00	$

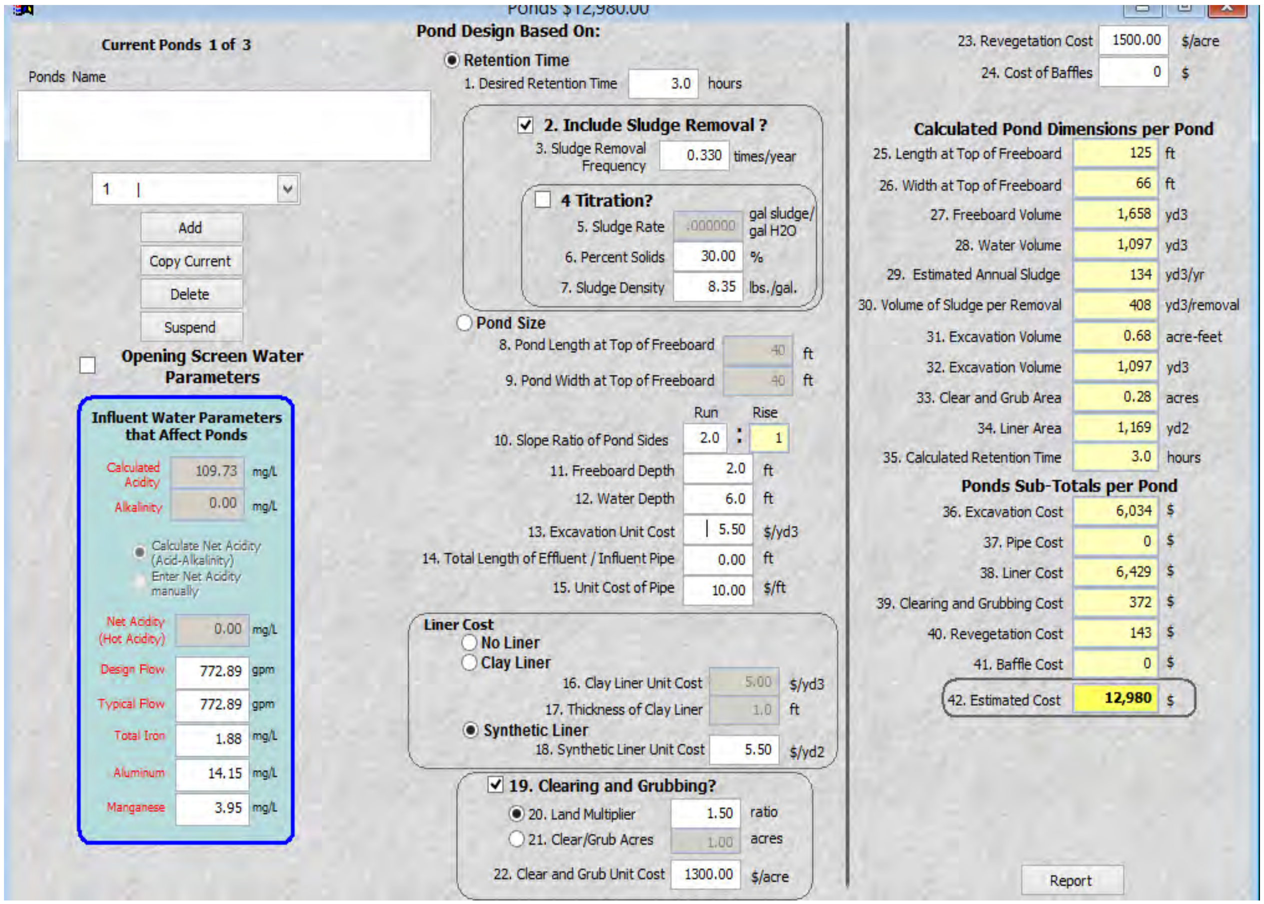
LSB Sizing Summaries

47. Length at Top of Freeboard 149.00 ft
48. Width at Top of Freeboard 84.50 ft
49. Freeboard Volume 1,248 yd3
50. Water Surface Area 9,933 ft2
51. Total Water Volume 675 yd3
54. Limestone Surface Area 8,321 ft2
55. Limestone Volume 800.93 yd3
56. Excavation Volume 1,476.2 yd3
57. Clear and Grub Area 0.4 acres
58. Liner Area 2,138.3 ft2
59. Theoretical Retention Time 1.50 hrs

LSB Cost Summaries

60. Siphon Cost 5,000 $
61. Limestone Cost 22,432 $
62. Limestone Placement Cost 0 $
63. Excavation Cost 8,119 $
64. Liner Cost 11,760 $
65. Clear and Grub Cost 563 $
66. Valve Cost 0 $
67. Pipe Cost 12,016 $
68. Total Cost 59,891 $

Figure 25: AMDTreat: Limestone leachbed for WALD passive treatment system



☐ Opening Screen Water Parameters

Influent Water Parameters that Affect Ponds

Calculated Acidity	109.73	mg/L
Alkalinity	0.00	mg/L

● Calculate Net Acidity (Acid-Alkalinity)
○ Enter Net Acidity manually

Net Acidity (Hot Acidity)	0.00	mg/L
Design Flow	772.89	gpm
Typical Flow	772.89	gpm
Total Iron	1.88	mg/L
Aluminum	14.15	mg/L
Manganese	3.95	mg/L

Pond Design Based On:

● Retention Time

1. Desired Retention Time 3.0 hours

☑ 2. Include Sludge Removal ?

3. Sludge Removal Frequency 0.330 times/year

☐ 4 Titration?

5. Sludge Rate .000000 gal sludge/gal H2O

6. Percent Solids 30.00 %

7. Sludge Density 8.35 lbs./gal.

○ Pond Size

8. Pond Length at Top of Freeboard 40 ft

9. Pond Width at Top of Freeboard 40 ft

10. Slope Ratio of Pond Sides Run 2.0 : Rise 1

11. Freeboard Depth 2.0 ft

12. Water Depth 6.0 ft

13. Excavation Unit Cost 5.50 $/yd3

14. Total Length of Effluent / Influent Pipe 0.00 ft

15. Unit Cost of Pipe 10.00 $/ft

Liner Cost

○ No Liner

○ Clay Liner

16. Clay Liner Unit Cost 5.00 $/yd3

17. Thickness of Clay Liner 1.0 ft

● Synthetic Liner

18. Synthetic Liner Unit Cost 5.50 $/yd2

☑ 19. Clearing and Grubbing?

● 20. Land Multiplier 1.50 ratio

○ 21. Clear/Grub Acres 1.00 acres

22. Clear and Grub Unit Cost 1300.00 $/acre

23. Revegetation Cost 1500.00 $/acre

24. Cost of Baffles 0 $

Calculated Pond Dimensions per Pond

25. Length at Top of Freeboard	125	ft
26. Width at Top of Freeboard	66	ft
27. Freeboard Volume	1,658	yd3
28. Water Volume	1,097	yd3
29. Estimated Annual Sludge	134	yd3/yr
30. Volume of Sludge per Removal	408	yd3/removal
31. Excavation Volume	0.68	acre-feet
32. Excavation Volume	1,097	yd3
33. Clear and Grub Area	0.28	acres
34. Liner Area	1,169	yd2
35. Calculated Retention Time	3.0	hours

Ponds Sub-Totals per Pond

36. Excavation Cost	6,034	$
37. Pipe Cost	0	$
38. Liner Cost	6,429	$
39. Clearing and Grubbing Cost	372	$
40. Revegetation Cost	143	$
41. Baffle Cost	0	$
42. Estimated Cost	12,980	$

Figure 26: AMDTreat Report: pond design for WALD passive treatment system