Sterling Run AMD: Conceptual Passive Treatment Recommendations

Technical Report prepared by Hedin Environmental through the Trout Unlimited AMD Technical Assistance Program TUTAG-24

June 2007

Background
A Technical Assistance Grant was requested by and awarded to the Cameron County Conservation District in order to develop conceptual remediation plans for AMD discharges to Portable Run. On January 22, 2007 the Portable Run watershed was visited by Hedin Environmental and the Cameron County Conservation District. This report provides a summary of new and existing data as well as remediation recommendations.

Existing Data
AMD impacts in Portable Run were investigated as part of the "AMD Assessment of May Hollow Run and Potable Run" prepared by the Cameron County Conservation District. The Assessment is based upon a comprehensive and well planned sampling scheme. Flow rates are provided for every sampling event and sampling events were conducted in "rounds" so that mass balances can be calculated. Sampling was conducted under a wide range of flow conditions. Overall, the existing data set is of high quality and will be very useful in the development of future projects as well as serving as baseline data for quantifying in stream improvements. The only aspect of the data that warrants caution is the fact that the metals concentrations are total recoverable. Reporting metals concentrations as total recoverable is standard procedure for most samples. However, this can become problematic in moderately impacted streams like Portable Run because particulate metals (that is, metals that have precipitated) are digested in the analytical process and can skew results upward. Collecting filtered samples removes particulate metals and allows for determination of dissolved metals concentration.

Data collected at PORT 11, an in-stream monitoring point immediately downstream of the known AMD contributions, shows a stream that is chemically capable of supporting aquatic life much of the time but suffers from episodes of water with higher acidity and aluminum concentrations. Aluminum is of particular concern because it is known to be toxic to fish and benthic macroinvertebrates at concentrations as low as 0.5 mg/L. In times of low flow, the discharges are dry and stream water quality improves. Likewise, in times of high surface runoff, the effect of the discharges is diluted leading to improved water quality. However, in the intermediate flow condition, when surface runoff is low but discharge flows are high, the stream suffers poor water quality. Figure 1 shows the relationship between instream concentrations of aluminum and flow rate.

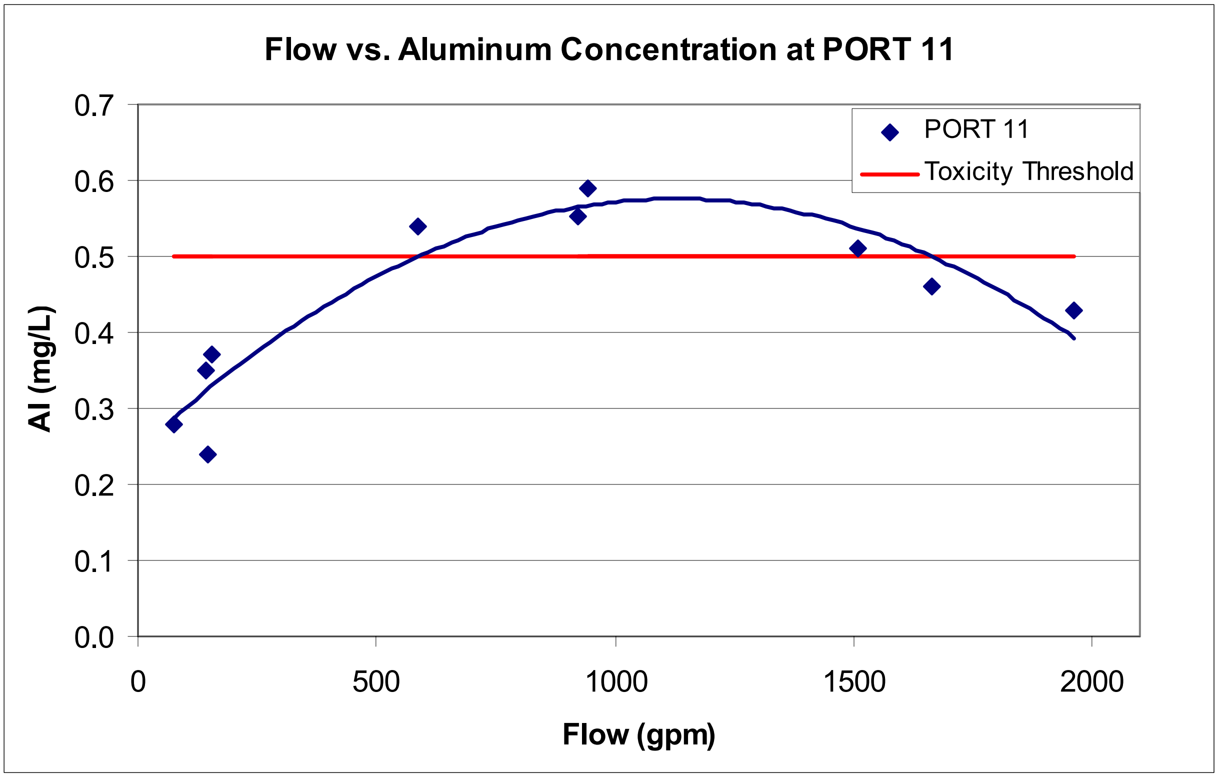


Figure 1. In-stream relationship of flow rate and aluminum concentration at PORT 11.

During times of poor water quality, most vertebrates (such as fish) can move to avoid impacted stream reaches. Macroinvertebrates, on the other hand, cannot move and are greatly reduced in number, resulting in a decrease in the overall aquatic ecosystem.

Discharge Characterization

The discharges that are the subject of this TAG were identified in the Assessment as PORT 13 and 14. Discussion of PORT 12 is also included due to its close proximity to PORT 13 and 14 and their common source (See Map 1).

As described in the Assessment, the AMD discharges emerge downslope of an abandoned surface mine in the area known locally as the “Hogback Basin”. The surface mine is vegetated with mature evergreen trees but has not been properly graded or backfilled.

Water samples were collected and flow rates measured. Samples were collected at existing weir locations. Sampling results are compared to Assessment averages in the Tables 1 and 2.

Table 1. Comparison of January 22, 2007 sampling results to historical average values.

Site	Date	Lab pH	Alk (mg/L)	Acid (mg/L)	Fe (mg/L)	Mn (mg/L)	Al (mg/L)	SO4 (mg/L)
PORT 12	1/22/07	4.2	0	29	0.3	2.2	2.4	109
PORT 12	Historical average	4.0	1	34	0.5	3.5	3.8	155
PORT 13	1/22/07	3.6	0	35	0.1	0.1	2.4	90
PORT 13	Historical average	3.5	0	43	0.2	1.3	3.5	94
PORT 14	1/22/07	4.2	0	36	0.2	0.1	3.5	158
PORT 14	Historical average	4.0	1	38	0.2	3.1	4.6	163

Table 2. Comparison of January 22, 2007 flow rates to historical maximum flow.

Site	1/22/07 Flow	Historical Max. Flow	Difference
PORT 12	60 gpm	34 gpm	174%
PORT 13	31 gpm	17 gpm	182%
PORT 14	117 gpm	81 gpm	143%

The chemical characteristics of the AMD collected in January 2007 agreed well with the historical data (Table 1). Conversely, flow rates measured during the site visit were substantially higher than any previously documented flow rates (Table 2). Flow rates were obtained by the timed-volume method which involved the temporary installation of a pipe at each sampling location. The time to collect a known volume of water in a bucket was measured. This is the most reliable flow measurement method available. The January 2007 flows were 40-80% higher than the historical maximum flow rates for the discharges.

During the month of January rainfall for Cameron County was approximately 28% above normal (according to the Mid Atlantic River Forecast Center). However, there were no major precipitation events in the week prior to the site visit. The cause of the high flow rates measured during the site visit appears to be precipitation events during the first half of the month, especially the period between January 5 and January 16 when 3.2 inches of precipitation fell. The January 22 flows represent high flow, but not anomalous conditions.

During the site visit it was noted that the flow in the PORT 13 and 14 channels increased below the monitoring locations. A flow rate measured where the PORT 13 discharge crosses under the logging road confirmed that the flow rate had increased from 31 gpm to 61 gpm. A small contributing flow of water was observed to be emanating from a recently constructed drilling pad. An analysis of a sample of this flow is shown in Table 3. The nature of the channel prohibited flow rate measurement but the flow was estimated to be less than 10 gpm – far less the 30 gpm observed increase in flow. The water quality of the flow from the well pad revealed that it is indeed AMD as shown in the following table.

Table 3. Sample results for seepage from the well pad.

Site	Date	Lab pH	Alk (mg/L)	Acid (mg/L)	Fe (mg/L)	Mn (mg/L)	Al (mg/L)	SO4 (mg/L)
Well Pad	1/22/07	4.0	0	36	0.3	1.4	3.3	100

It is likely that the discharge from the well pad only exists during periods of high flow. The fact that the well pad discharged AMD suggests that excavations for treatment system construction could intercept AMD, particularly during periods of high flow. Treatment systems should be designed conservatively (larger) to account for this.

Remediation Options

There are three primary strategies for remediation of the AMD problems in Portable Run:

- Do Nothing
- Water Collection and Passive Treatment
- Reclamation

The recommended approach is passive treatment with Vertical Flow Ponds. However, descriptions of each alternative are presented below.

Remediation Option 1 – Do Nothing
This option represents the current condition and is considered unacceptable. While the source of acidity (sulfide minerals in the mine spoils) will someday be exhausted, it will likely take decades if not centuries to occur.

Remediation Option 2 – Water Collection and Passive Treatment
Treatment of the PORT 13 and 14 discharges would result in minor improvements in in-stream water quality. However, even minor improvements in water quality in Portable Run will result in significant recovery of aquatic ecosystems.

Ample room exists for construction of passive treatment systems for the PORT 13 and 14 discharges. It was noted that the flow of AMD in the discharge channels increased toward Portable Run. As a result, the location of discharge collection for treatment becomes critical. If the discharges are collected too high in the channel, much of the AMD will bypass the collection and will not be treated. Conversely, collecting too low in the channel limits available treatment area and increases the amount of flow that must be managed. This is especially critical for the PORT 14 discharge which is located in the center of a natural drainage (Hogback Basin) where management of surface water runoff from the 70+ acre watershed will be a challenge.

To determine if the bulk of the loading observed at PORT 14 could be intercepted at a higher elevation, a sample and flow rate was collected upstream of the monitoring point at a location in the left split of the channel. The results of this sampling are shown in Table 4.

Table 4. Comparison of water quality at two locations in the PORT 14 channel.

Site	Flow (gpm)	Lab pH	Alk (mg/L)	Acid (mg/L)	Fe (mg/L)	Mn (mg/L)	Al (mg/L)	SO4 (mg/L)
Left split above PORT 14	23	4.2	0	69	0.2	0.4	6.9	304
PORT 14	117	4.2	0	36	0.2	0.1	3.5	158

Metals concentrations were higher upstream of the normal PORT 14 monitoring location with aluminum increasing from 3.5 mg/L to 6.9 mg/L. Flow was substantially less at the upstream location, as expected. Loadings at the two locations are compared in Table 5.

Table 5. Comparison of loadings at two locations in the PORT 14 channel.

Site	Flow	Acidity (ppd)	Mn (ppd)	Al (ppd)	SO4 (ppd)
Above PORT 14 Left Split	22	19.0	0.1	1.9	82.1
PORT 14	117	34.8	0.2	4.9	221.1
% at Split	19%	55%	50%	39%	37%

ppd – pounds per day

Collection of PORT 14 just below the split of the channel would be advantageous. Additional sampling to better identify the highest elevation that the AMD can be captured is recommended. Until this information is obtained, collection of the discharge at the monitoring location is suggested.

It appears that the PORT 13 discharge is the location where the surface mine operator provided drainage for the pit while in operation. Capture of the discharge for treatment should include installation of a collection system on the pit floor to capture water within the mine. The collection system should consist of a trench, excavated to the pitfloor, which follows the greatest flows of water. The trench should be lined with geotextile and filled with non-reactive aggregate (sandstone) and perforated pipe. Once outside the water making zone, solid pipe should be used to convey the AMD to the treatment system. Collecting the water in this way will allow for exclusion of surface water and also potentially intercept some AMD flow that appears at PORT 12.

Once collected both discharges should be piped to the treatment location down slope of the logging road as shown on Map 2.

Treatment of the PORT 13 and 14 discharges should take place in a common system that consists of a pair of identical vertical flow ponds (VFPs) followed by a small oxidation pond. Two parallel VFPs are recommended so major maintenance can occur on one VFP while the other continues to treat the water. Each VFP will consist of three feet of limestone topped with one foot of limestone-amended organic substrate. An underdrain system in the limestone will be connected to an inline water level control structure that will be set to maintain two feet of standing water above the compost. A separate flushing system is not recommended because of the low metals concentrations. The function of the small oxidation pond is primarily to ensure that the system does not discharge water that is dangerously anoxic.

The final effluent of the system should discharge into the existing wetland along Portable Run. This would allow net alkaline treatment system effluent to neutralize a portion of the PORT 12 discharge prior to its confluence with Portable Run.

Sizing of the system components is based on the assumptions presented in Table 6.

Table 6. Treatment System Sizing Assumptions

Item	**Assumption**
Flow Rate	48 gpm average, 150 gpm Max
Maximum Total Acidity Load	47.3 lb/day
VFP Alkalinity Generation Rate	35 g/m^2-day
Effluent Excess Alkalinity	35 mg/L
VFP Limestone Thickness	3 ft
VFP Organic Substrate Thickness	1 ft
Oxidation Pond Residence Time	18 hrs at average flow
Oxidation Pond Water Depth	4 ft

Flow rate into the system should be restricted to the design maximum flow rate of 150 gpm and any excess bypassed to the existing channel below PORT 14. During high flows the impact of AMD on the stream is reduced so bypass of excess untreated AMD is acceptable (See Figure 1). To limit the total maximum flow into the system to 150 gpm, the PORT 13 discharge should be limited to 30 gpm and the PORT 14 discharge should be limited to 120 gpm. These numbers were based on the observed flow rates on January 22, 2007. The treatable flow rate from PORT 13 is greater than the January 22 flow rate based on the likelihood that additional flow will be captured during installation of the collection system.

The cost to design and construct the system is estimated to be $228,000. The assumptions used in calculating the construction cost are shown in Table 7.

Table 7. Treatment System Component Size and Cost

Item	**Quantity**
VFP Area (total)	12,500 ft^2
VFP Limestone	1,300 Tons
Pond Volume	50,000 gal
Total System Footprint	1.0 Acre
Estimated Construction Cost	$188,000
Estimated Engineering Cost	$40,000*
Estimated Total Cost	**$228,000**

*Includes site mapping and permitting

Long term operation and maintenance costs for this system could be met with a trust fund. The fund is invested so that it produces enough income to pay all expenses for sampling, inspection, periodic replacement, periodic emergency maintenance and life cycle replacement. Experience has shown that a trust fund of similar value to the construction cost is sufficient for passive systems. If possible, the value of the trust should be calculated after the system is constructed and actual O&M costs are established. Routine operation of the system will include monthly inspections and sampling. Maintenance tasks will likely include replacement of compost on a 6-10 year interval and complete replacement of VFP contents (limestone and compost) on a 15-20 year interval. Additional maintenance tasks include routine maintenance of channels and flow control structures.

Remediation Option 3 – Reclamation

Approximately 200 acres of land has been surface mined according to the West Creek USGS quadrangle map (Maps 3 and 4). Only a small area of the mine upslope of PORT 13 was explored as a part of this study. This area is a poorly reclaimed "shoot and shove" surface mine. That is, the miner dynamited (shot) the overburden and simply shoved it downslope creating large spoil piles over the outcrop of the coal as well as vertical highwalls. The implication of this is that the large spoil piles obstruct runoff from the mine and direct runoff toward the open pit where it becomes acidified. It is likely that infiltration rates in some portions of the surface mine approach 100%. The spoil piles themselves are likely the primary source of AMD.

The Assessment listed reclamation targeting the PORT 12 discharge as the second highest priority (with treatment of PORT 13 and 14 as the highest priority). Passive treatment of the PORT 12 discharge is not practical due to its close proximity to the stream. However, it is likely that reclamation will impact not only the PORT 12 discharge but also the PORT 13 and 14 discharges depending on how the extent of the reclamation project. If reclamation is chosen as a remediation strategy, it should be conducted before treatment systems are constructed so that treatment system designs will be appropriate for post-reclamation conditions.

In-stream data on Portable Run indicates that small reductions in loading will result in significant improvement in-stream. Reducing loading through source reduction is a more sustainable option than treatment since its effects are permanent. Passive treatment systems require ongoing maintenance and eventual replacement. While passive treatment systems may be cheaper in terms of capital costs, they only address a symptom of the problem where reclamation reduces or eliminates the problem itself.

It is difficult to estimate the amount of effort and cost that such a reclamation project would entail. Based on the limited information that can be obtained from the single site visit and from airphotos (Map 4), it appears that at least 32 acres of surface mine contribute directly to the Port 11/12/13 discharges and should be reclaimed. In addition, approximately 38 acres of surface mine on the Finley Run side of the surface mine appears to be in a poorly reclaimed state. Although no surface discharges have been identified emanating from this surface mine, benefits to Finely Run could be realized through reclamation by reducing or eliminating contaminated baseflow. Reclamation of the surface mine on Finely Run are not discussed here.

All of the spoil piles appear to support vegetative growth as indicated by the fairly dense forest that has been established. This characteristic as well as the moderate nature of the AMD produced suggests that the spoils require only minor alkaline addition to make them net alkaline. The amount of alkaline addition would be based on the objectives of the reclamation project. Three general strategies can be taken.

1) If the goal is to reduce AMD loading by increasing surface runoff (thereby reducing infiltration), then only minimal alkaline addition would be required. This is the least expensive and least effective strategy. However, it is likely that even small improvements in water quality will result in recovery of aquatic ecosystems in much of Portable Run.

2) If the goal is to reduce AMD and ensure long term forest growth then regrading and amendment of the top four feet of spoils should be performed. This strategy is substantially less expensive than complete amendment of all spoils but less effective in terms of water quality improvement though improvement could still be substantial.

3) If the goal is to substantially reduce AMD at the site, then all spoils should be regraded and amended at a rat that produces net alkaline spoils (NNP +12). This strategy is the most effective in terms of improvement of water quality but is often cost prohibitive. Project costs could easily exceed $1 million.

To develop a reclamation plan the following items are required:

- Landowner permission
- Topographic mapping of the site at two foot contour intervals. The size of the site makes mapping from aerial photography the most cost effective mapping option.
- Samples of spoils to determine acid/base accounting. Data in the form of Acid Potential (AP) and Neutralization Potential (NP) will be used to calculate Net Neutralization Potential (NNP).
- Thorough exploration of the site guided by detailed topographic mapping to delineate those areas most in need of reclamation.
- A design and specification package for the reclamation job. The grading plans must provide positive drainage. Cut/fill quantities calculated from the grading plans provide a basis for construction costs.
- Reclamation plans should include installation of a collection system on the pit floor to capture any water before it leaves the mine.
- Project permitting, including wetland delineation, notifications, etc.

Recommendation Summary

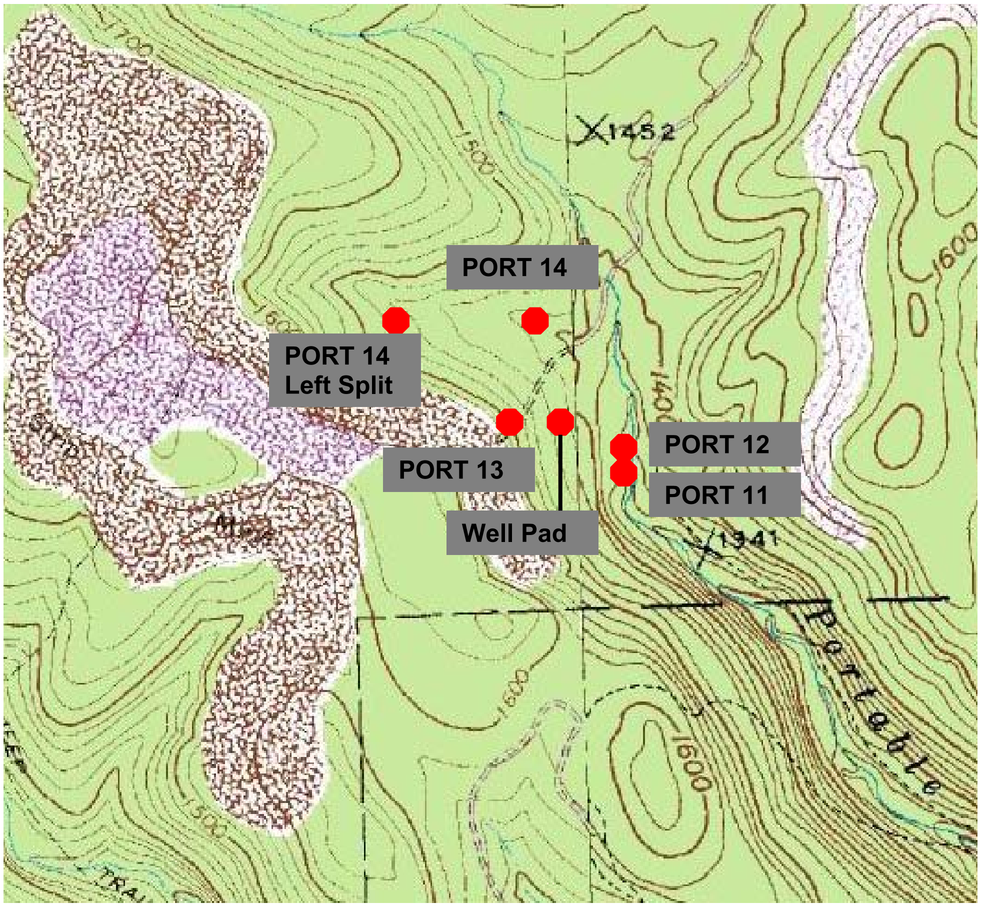
Construction of a passive treatment system for the PORT 13 and 14 discharges is the recommended alternative because:

- Only minor improvements in in-stream water quality are required
- Chemical characteristics of the discharges are well within the limits of passive treatment
- Passive treatment is the most cost effective option

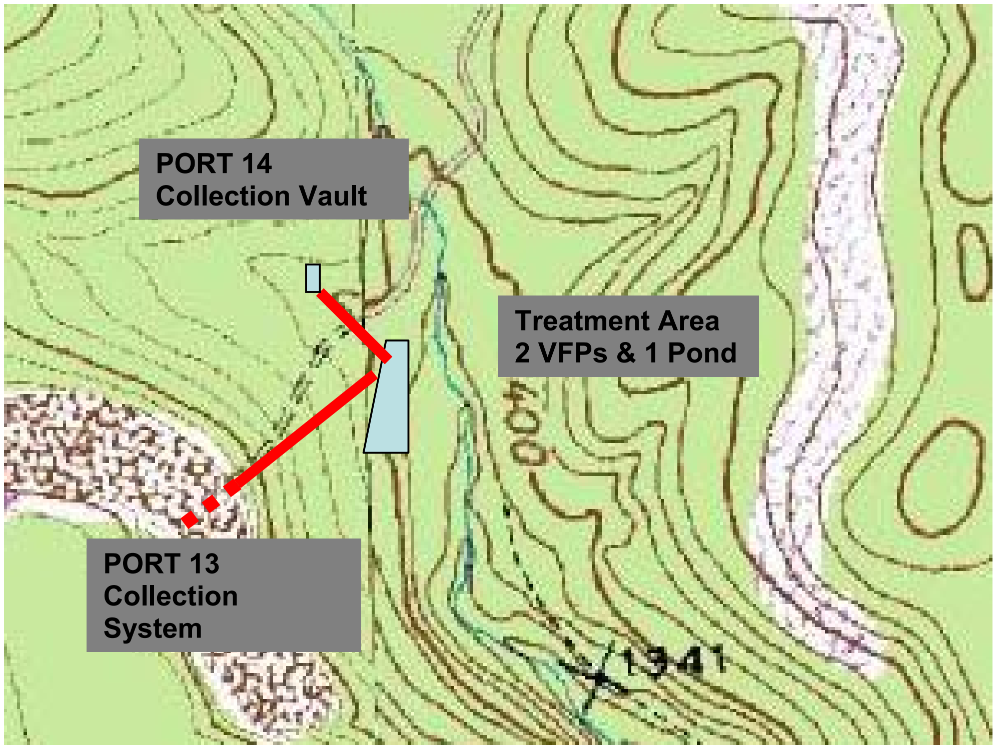
Such a system would cost approximately $228,000 to construct.

To prepare a final treatment system design, the following items will be required

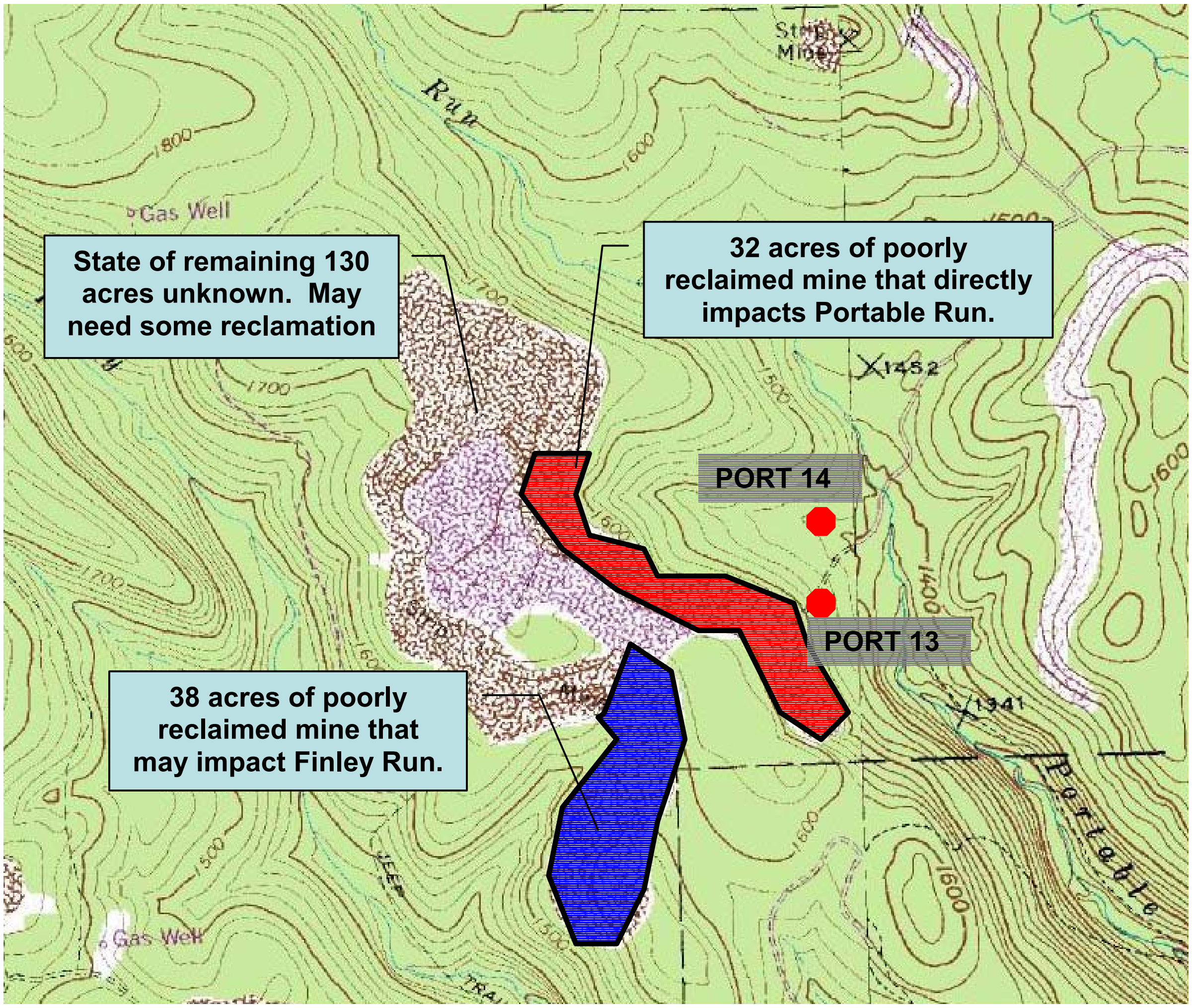
- Landowner permission
- Site mapping at 2' contour interval
- Collection system installation for PORT 13
    - Monitor effects on PORT 12
    - Continued PORT 13 and 14 monitoring, particularly flow rates
- Detailed construction plans and specifications
- Project permitting, including wetland delineation, notifications, etc.



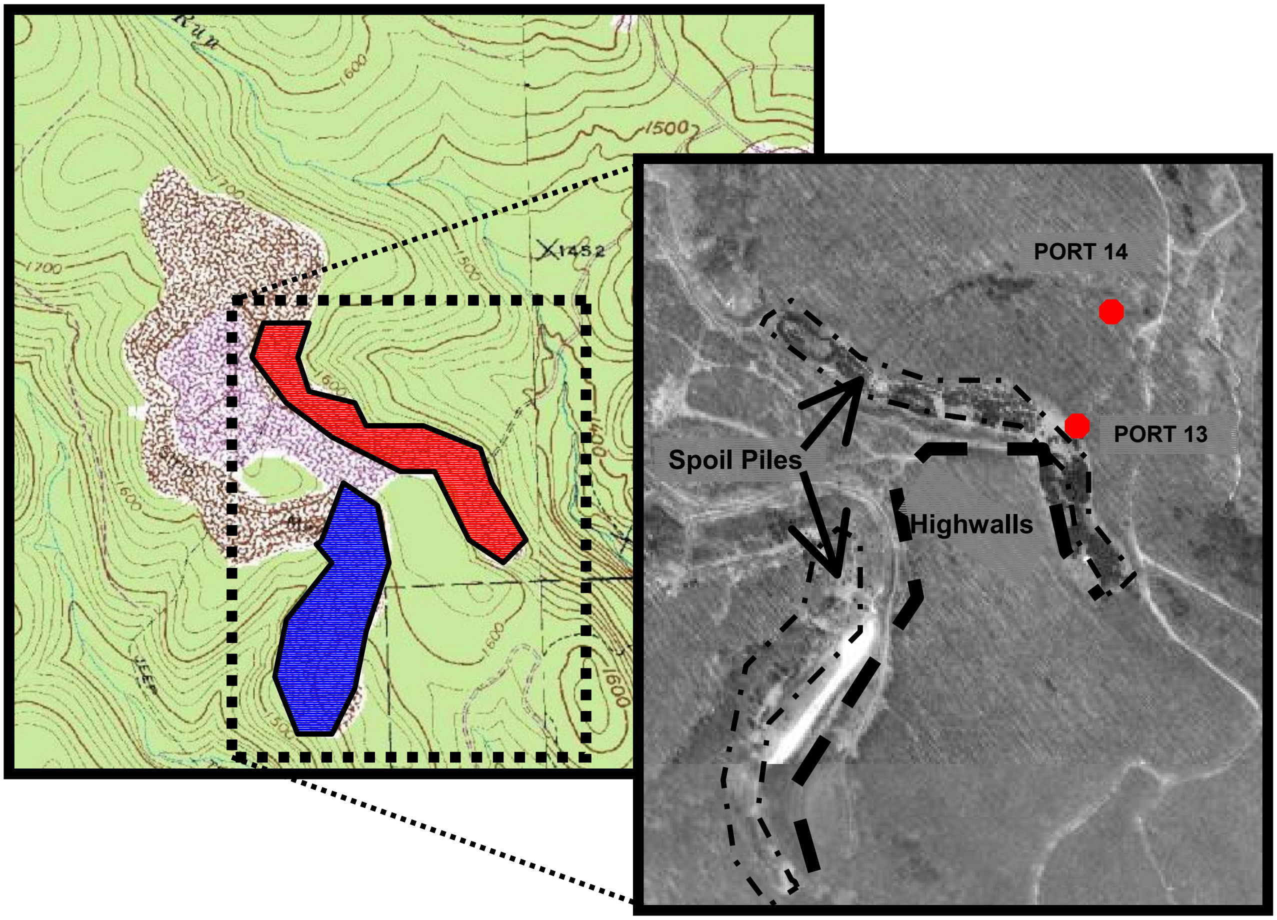
Map 1: Sampling Locations



Map 2: Treatment Components



Map 3: Preliminary Reclamation Recommendations



Map 4: Air Photo Showing Known Unreclaimed Surface Mine Features