ODNR, DIVISION OF MINERAL RESOURCES MANAGEMENT

GUIDELINES

SUBJECT: Overburden Analysis Guidelines

EFFECTIVE: October 16, 2009

PURPOSE: Provide guidelines and methodologies for implementing the Acid Base Accounting (ABA) provisions of Ohio Revised Code Chapter 1513

INTRODUCTION:

Effective April 6, 2007, the Ohio Revised Code (ORC) was amended to establish additional provisions for the characterization and analysis of the acid- or toxic-mine-drainage-producing potential of a proposed coal mining permit area. The amended language in ORC Sections 1513.07 and 1513.075(A)(7) addresses data requirements and methodologies for determining when more intensive acid base accounting is necessary and for assessing the results of that acid base accounting.

The Division chartered various workgroups to address implementation of the amendments to the ORC. These guidelines address the following chartered task:

> "Recommend preliminary and final procedures and methodologies for implementing the Acid Base Accounting (ABA) provisions of ORC 1513, including permitting, monitoring and enforcement. Recommend language for a Standard Operating Procedure (SOP) to include the range of allowable ABA methodologies with qualifications consistent with OSM and workgroup recommendations. The recommended language should include, at a minimum, standardization of rock density numbers, standards for developing volume calculations and mass, and specifications for sampling interval requirements/criteria."

BACKGROUND INFORMATION:

Provisions in the ORC and the Ohio Administrative Code (OAC) address requirements for test hole information throughout a proposed coal mining operation. Acid base accounting information on individual strata is addressed at OAC 1501:13-4-04(C)(3)(a)(iii): "Chemical analyses to include pH, neutralization potential, potential acidity, total or pyritic sulfur, and calcium carbonate deficiency of each stratum" are required. Based on the analysis of the probable hydrologic consequences per OAC 1501:13-4-05(E)(2), acid base accounting across the proposed area or portions of the proposed area has been required by the Chief on a case by case basis. The ORC amendments addressed in these guidelines provide standardized approaches to implement acid base accounting, results of

which impact permitting decisions. These guidelines apply to all coal mining operations involving the excavation of overburden for the purpose of obtaining coal, based on the use of the term “permit area” in the ORC cited below and on the definition of “permit area” at OAC 1501:13-1-02(GGGG).

CHANGES TO THE OHIO REVISED CODE:

The amended ORC contains definitions of potential acidity and neutralization potential and contains methodologies for using those values in assessing whether a site may produce acid-or-toxic-mine drainage.

Section 1513.075 Division (A) of the ORC defines "potential acidity" as “a laboratory measurement of the amount of acidity that could be produced by material in a rock strata proposed to be disturbed by mining and that is expressed by a numeral indicating the number of tons of that acidity that would be present in one thousand tons of disturbed overburden.” Division C of Section 1513.075 of the revised code states, “The measurement of potential acidity may be based on laboratory analyses of the sulfur content of the coal and overburden to be disturbed by mining. If the results of test borings or core samplings include laboratory analyses of the pyritic form of sulfur, the applicant may base the calculation of the potential acidity for the area on the pyritic sulfur content of the coal and overburden to be disturbed by mining rather than on the total sulfur content.”

Section 1513.075 Division (A) of the ORC further defines "neutralization potential" as “a laboratory measurement of the alkalinity of a rock stratum expressed as the amount of acidity that would be neutralized by material proposed to be disturbed by mining and that is expressed by a numeral indicating the number of tons of that alkalinity that would be present in one thousand tons of disturbed overburden.”

Section 1513.07 Division (B)(1)(o) addresses the results of test borings from the proposed permit area, and states, “If the test borings or core samplings from the permit area indicate the existence of potentially acid forming or toxic forming quantities of sulfur in the coal or overburden to be disturbed by mining, the application also shall include a statement of the acid generating potential and the acid neutralizing potential of the rock strata to be disturbed…”

Section 1513.075. Division (D) states, "The tons of rock in the area represented by each core hole resulting from test boring or core sampling may be estimated and used to calculate the tons of potential acidity and tons of neutralization potential for each rock stratum. The sum of those values across the proposed permit area may be used to calculate the site's overall neutralization potential and potential acidity.”

Section 1513.075. Division (E) provides the following guidance: “The proposed permit area may not be considered to have the potential to create acid or other toxic mine drainage if either of the following applies: (1) The numeral that

indicates the site's overall neutralization potential divided by the numeral that indicates the site's overall potential acidity results in a quotient that is equal to or greater than two. (2) The numeral that indicates the neutralization potential subtracted from the numeral that indicates the potential acidity results in a remainder that is equal to or less than either of the following: (a) Negative five (-5) in the case that the total sulfur content of rock strata is used to calculate potential acidity; (b) Negative ten (-10) in the case that the pyritic sulfur content of rock strata is used to calculate potential acidity."

Section 1513.07 Division (E)(8) of the ORC states, "In the case of the issuance of a permit that involves a conflict of results between various methods of calculating potential acidity and neutralization potential for purposes of assessing the potential for acid mine drainage to occur at a mine site, the permit shall include provisions for monitoring and record keeping to identify the creation of unanticipated acid water at the mine site."

ACID BASE ACCOUNTING:

Acid base accounting (ABA) is basically a screening process that balances the amount of acidity and alkalinity that can potentially be produced by rock strata on a given site. It does not reveal how fast or when reactions will occur, and therefore, interpretation of ABA data involves more than comparing the potential acidity and neutralization potential values. ABA is not only used as a permitting decision-making tool, it is also used as a management tool to determine the best management practices for avoidance and remediation of mine drainage pollution. The acid base accounting technique and interpretation is still evolving.

The measurements of potential acidity and neutralization potential are critical. Neutralization potential analyses involve the use of chemical procedures as surrogates for mineralogical determinations. However, neither mineralogical nor chemical analysis methodologies can completely quantify the actual potential of the material, which can be either overestimated or underestimated.

An evaluation of whether a site will be acid-producing does not necessarily mean that levels of metals such as iron, manganese, and aluminum will not be problematic.

DATA COLLECTION AND PROCESSING:

In addition to the existing requirement that analyzed overburden intervals should be no greater than five feet in thickness, with each lithologic unit analyzed, for purposes of Section 1513.07 Division (B)(1)(o), sampling intervals should decrease immediately above the coal seams, since such stratigraphic positions often contain greater amounts of sulfide minerals, and compositing intervals that are too large may give unrepresentative results.

There are a number of methods for sulfur determination available, although the methods for total sulfur have a relatively high degree of precision with few notable interferences and precautions, while methods for determination of the forms of pyritic sulfur have lesser degrees of precision and more numerous potential interferences (Brady, et al, 1990). A modified version of the Sobek method for determining neutralization potential, which uses hydrogen peroxide (H_2O_2) as an additional step to correct for siderite, is the chosen laboratory technique. (Sobek, et al, 1978). The hydrogen peroxide (H_2O_2) step can expedite oxidation and precipitation of iron, which should help eliminate interferences in the neutralization potential determination when siderite is present in significant amounts. The hydrogen peroxide step will need to be incorporated into the laboratory analysis, and this should be stated in any submittal.

GENERAL APPLICATION REQUIREMENTS:

It is essential to properly locate test holes and to obtain representative overburden samples from those test holes for analysis and use in ABA. It may be more beneficial to complete exploratory drilling throughout the entire area before drilling for overburden analysis begins. Preliminary drilling enables the determination of depth to coal and the lateral extent of strata. This information can then be used to locate overburden holes best suited to represent the lithologic variation and degree of weathering within the site. This may reduce the need for additional drilling and ABA after the permit application has been submitted for review and consideration. Therefore, in the Geology Information section of the application, submit a description of the procedures used to obtain overburden samples.

If the required test hole drilling does not reveal the presence of acid-forming or toxic-forming amounts of sulfur, the more intensive acid base accounting required under ORC Section 1513.075 may not be required [ORC Section 1513.07 Division (B)(1)(o)]. The burden of proof will be on the applicant to clearly document that the full acid base accounting of Section 1513.075 is unnecessary.

For the purposes of calculating rock tonnage specified under Division (D) of Section 1513.075, the area represented by each test hole should be documented

and the methods used to calculate that area should be submitted. One common method is to draw Thiesson Polygons. In Thiessen Polygons, the area within each polygon would be closer to the test hole on which the polygon is based than to any other test hole. Provide a description of the methodology used to apportion the area to each test hole, and submit a map showing the area represented by each test hole.

Rock density must be specified [ORC Section 1513.075. Division (D)]. The weights in the following table have been obtained from tables traditionally used by the Division as well as from other sources. These values should be used in acid base accounting calculations unless other more appropriate (e.g. site-specific) densities are documented. Stratigraphic intervals involving more than one material should be addressed by apportioning the weights appropriately.

Material	**Density (tons per acre-foot)**
Clay	3000
Shale	3670
Siltstone	3500
Sandstone	3070
Limestone	3600
Coal	1800
Sandy Shale	Based on ratio of sand and shale
Spoil	Based on composition of spoil

Describe and justify the procedures used to calculate the potential acidity and neutralization potential, per Amended Section 1513.075 Division (A). Clearly state if methodologies other than those indicated in that section are employed and provide documentation regarding their applicability. The tests used and the laboratory procedures followed must be included with any submittal. The same methods should be used for all samples throughout the lives of an application and permit, unless justification is submitted for using another method. In all cases, correction for siderite should be included.

If multiple methods have been used or are available for ABA, per Section 1513.07 Division (E)(8) of the ORC, and the results of those methods are at odds, then the response in the Geology Information section shall address the provisions of Division (E)(8).

In order to perform adequate ABA, the test holes must be adequately distributed per OAC 1501:13-4-04(C)(2)(b). The test holes should be located so that all strata are represented in the ABA in proportion to their interception by mining. The upper strata should not be underrepresented in the ABA.

Any questions regarding acid base accounting issues should be directed to the Division as early in the application process as possible, preferably prior to

submission of an application for review. If the results of the overburden analyses presented on the Drilling Report – Surface or of the ABA calculations themselves indicate that the targets listed above and specified in the amended ORC cannot be met, or that the proposed permit area may have the potential to create acid or other toxic mine drainage, a pre-submittal meeting with the Division should be scheduled to discuss options.

SPREADSHEET FOR ABA CALCULATIONS:

Based on the provisions of the ORC and the OAC, spreadsheets for calculation of ABA have been developed. The spreadsheets will provide the ABA results in the format specified in ORC Section 1513.075. Division (E), but they are applicable in general to ABA. The spreadsheets are presented here in a table format and are also available from the Division in electronic format. The spreadsheets should be submitted as an addendum to the Geology Information section of the application. A standardized spreadsheet format will simplify preparation and review of ABA data. Other spreadsheet formats may be accepted if they provide the information and analysis required by the ORC. However, submission of alternative formats may slow the application review process. (Note that "PA" refers to potential acidity and that "NP" refers to neutralization potential.)

Acid Base Accounting – Table A													
Analyses based on: (indicate total sulfur or pyritic sulfur)													
Test Hole: 1													
Surface Elevation:													
Lith. Unit	**Unit Thick, feet**	**Thick. Spoil-ed, feet**	**Unit Top elev, feet msl**	**Unit Btm elev, feet msl**	**Unit Mid. elev, feet msl**	**Area of Unit at Mid., acres**	**Vol Spoiled, acre-Feet**	**Lith. Unit Wt., tons/ acre-ft**	**Gross Lith. Unit Wt, If spoiled, tons**	**PA, tons $CaCO_3$/ 1000 tons of mat.**	**NP, tons $CaCO_3$/ 1000 tons**	**Gross Lith Unit PA, tons**	**Gross Lith Unit NP, tons**

Acid Base Accounting – Table B							
Analyses based on: (indicate total sulfur or pyritic sulfur)							
Test Hole Number	Gross Lithologic Unit Weight, If spoiled, Tons	Gross Lithologic Unit PA, tons	Gross Lithologic Unit NP, Tons	PA, Tons $CaCO_3$/ 1000 tons of material	NP, Tons $CaCO_3$/ 1000 tons of material	CCD, Tons $CaCO_3$/ 1000 tons of material	NP/PA

A separate **Table A** should be completed for each test hole on the proposed area, with the results of the test holes summarized, per ORC Section 1513.075 Division (E), in **Table B.**

Example tables, with explanations of entries, have been completed in the Appendix to these guidelines.

ANALYSIS AND ADDITIONAL DOCUMENTATION:

General:

Some of the values in the amended ORC, especially those relating to calcium carbonate deficiency (potential acidity minus neutralization potential), are within or close to ranges that research has shown are not definitive and can result in either acid or alkaline drainage from a mine site. In addition, sites that meet the NP/PA ratio of 2 to 1 may actually possess low NP values, or both the NP and PA values can be so low that small errors can change the ratio and the interpretation. Therefore, even in cases where the overall ABA meets the targets specified in HB 443, the Division reserves the right to request additional data or documentation to describe the potential of the proposed site to produce acid mine drainage. The risk of acid formation will increase with the degree of lateral segregation of acidic and alkaline rock sections. Judgment will be exercised to determine the degree of risk and the potential for lateral blending of spoils to achieve the required ABA criteria.

Nevertheless, the best prediction methods are those that consider all of the data and information that is available. ABA, in most cases should be considered only one component of an assessment of post-mining water quality issues. Factors such as mining and reclamation practices, overburden sampling techniques,

laboratory techniques, and exact mineralogy targeted by ABA procedures can influence whether ABA will actually predict post-mining water quality. Special precautions are also needed if an area or region is known to produce acid mine drainage. Submittal of additional information is especially appropriate, since amended ORC Section 1513.075. Division (E) indicates only that its guidelines "may" be used to make assessments related to the acid-producing potential of a proposed site, and allows for additional supporting information to be required.

Some jurisdictions suggest performing acid base accounting with what are termed "thresholds." It is considered that strata possessing NP and percent sulfur values that do not meet certain thresholds (such as +30 tons $CaCO_3$per 1000 tons of material for NP and 0.5 percent sulfur) do not contribute to either acid generation or neutralization, but instead "dilute" the overall calculations and give an erroneous result. While thresholds have not been used in Ohio ABA, their use will be considered with documentation. Using thresholds could be a means of further refining the original acid base accounting numbers. Use of threshold values should be discussed with the Division prior to their use.

Additional documentation can take two different forms: One is related to additional information to supplement the ABA, and the other is related to mining practices to address the results of the ABA.

Additional Data and Documentation:

The following additional data or documentation may be collected, analyzed, and submitted in support of ABA and Section 1513.07 Division (B)(1)(o) of the ORC:

1. Groundwater chemistry from previously mined areas or permits in the vicinity of the proposed site, assuming there are substantial similarities between the proposed site and the previously mined site.

2. Natural groundwater quality from adjacent unmined areas and/or the mine site, especially in verifying the accuracy of the NP measurements.

3. Information regarding the incidences of mine drainage, or other toxicity problems from other permits issued to the applying operator.

4. Permit specific criteria based on preliminary ABA. This could include the need for a denser drilling pattern in areas identified as problematic, with subsequently more detailed ABA. Additional detail can assist in refining the spoil handling plan either within the application or prior to entering a specific mining area on the permit.

5. A more detailed analysis of the geology of an area or region if the area is known to produce significant AMD.

6. Coring the overburden, rather than drilling by air rotary, to more precisely identify stratigraphic units and lithologic changes.

7. Reanalysis for other forms of sulfur – for example for pyritic sulfur if the total sulfur was originally analyzed, or vice versa.

8. Fizz test results to support the NP determinations. Samples with NP less than 20 tons per 1000 tons $CaCO_3$ generally will not fizz.

9. Evaluations of mineralogic and petrologic data to further refine the analysis of minerals that could contribute to AMD.

10. X-ray diffraction can provide additional information on the mineralogy of the overburden.

11. Kinetic (leaching) tests (leaching columns, humidity cells, soxhlet reactors) to simulate mine drainage.

12. Lithologic logs of drill holes without geochemical analyses for comparison with logs of holes where geochemical data was obtained. Based on similarities, geochemical analyses may be able to be extrapolated.

13. Pyrite morphology, to refine the types of pyrite present, since different forms of pyrite have different surface areas, and amount of available surface area may affect pyrite reactivity.

14. CO_2 coulometry as an alternative method for determining carbonate content of overburden.

Mining and Reclamation Practices:

Depending on the results of ABA, the following mining and reclamation practices could be incorporated or enhanced:

1. A description of remining activities and accompanying data collection and analysis.

2. Alkaline addition, to include at a minimum: amount and type of material to be used, purity information, application rates, handling and mixing plans, locations (placement), and monitoring plan. As a note, alkaline addition is most effective when it is incorporated into the backfill concurrently with mining and reclamation and when implemented in conjunction with other best management practices.

3. Special, or selective, overburden handling plans to place acidic or alkaline strata in such a way as to minimize acid production and transport, and to maximize the alkalinity generation within the mine spoil. These plans are often used to adjust the locations of acid-and-toxic-forming and alkaline strata to control contact with water. There are generally several methods used for selective handling, which include: blending, which is mixing naturally occurring calcareous overburden with potentially toxic-forming material; placement, which is placing the material below the water table, such as on the pit floor, or placing toxic-forming material high above the reestablished water table and away from drainage locations or flow paths; and alkaline redistribution, which involves transferring material from one section of the operation to another. Special handling could also involve subdividing the proposed area and implementing an intensified drilling program to refine the ABA analysis and pinpoint areas needing attention. It may be beneficial to place alkaline materials in locations that would increase their likelihood of water contact. Special handling requires that the proper equipment be stated and described within the application, that the sequence of mining operations be detailed, and that the overburden be analyzed with sufficient detail to properly identify acid- and toxic-forming materials in the field. It most instances, it will be necessary to include more specific post-mining hydrogeologic conditions and hydraulic characteristics on the mine site, such as re-established water table location, seasonal fluctuations, spoil characteristics, etc.

4. Special management of water on the mine site, such as the exclusion of infiltrating surface water and the exclusion of laterally migrating ground water. This might include pit floor drains, overland diversion ditches, etc. Detailed construction plans and cross sections, materials and monitoring plan must be included.

5. Encapsulation, or capping with low permeable material. This method is used to segregate and isolate acid-forming material by preventing downward leaching, or upward migration of oxidized metals.

6. Adjusting the mining plan to intercept needed alkaline material or to avoid acid-producing overburden. Assurance or consideration should be given to addressing contingencies should the mining operation stop short of encountering needed strata.

7. Use of bactericides to control or limit water quality problems.

8. Intensified monitoring, including where necessary the use of monitoring wells, with declared plans to adjust the mining operation as a result of ongoing monitoring.

ADDITIONAL CONSIDERATIONS:

ABA cannot be the sole factor in decisions on permit applications. The items discussed under the Analysis and Additional Documentation section of these guidelines address what must be submitted if the ABA falls into the acknowledged 'gray' areas. The additional information required under numerous sections of the ORC and OAC, and described in other documents and guidelines, must always be submitted. Therefore, the acid base accounting specified in the ORC will be used as only one of a number of factors that the Division will consider in permitting decisions.

Incorporating coal refuse and/or coal combustion by-products into the backfill must follow established guidelines, which are already written and in place.

ABA does not directly predict concentrations of metal such as iron, manganese, and aluminum. Therefore, additional data, such as the water quality information discussed above is critical.

In cases where the ABA meets the targets specified above, but other information is available that would indicate continuing concern regarding the ability of the area to prevent acid and toxic drainage, supplemental information or alterations to mining and reclamation practices may still be required.

Regardless of whether the ABA meets the specific numerical criteria in these guidelines or in other sources, the Division will use all available information to make permitting decisions.

Overburden samples should be analyzed within two to three months of collection. The sulfur content may be affected by holding the sample or keeping it in a damp storage environment, since oxidation of pyrite may occur. As a result, even though the total sulfur content would not change, the sulfur fractions could be altered, with less pyrite and more sulfate sulfur than at the time of sample collection. Neutralization potential may not be as sensitive to storage times. In order to reduce the possibility of changes in sample composition and inaccurate acid base accounting, the following are suggested: deliver the samples to the laboratory as soon as possible; air dry the samples as soon as possible; store the samples in a climate-controlled building; avoid extremes of temperature and humidity; store the air dried samples in air tight plastic containers such as zip lock bags; and analyze the samples as soon as practical. If the pyrite fraction of the sample is reacting, with changes in the proportion of sulfate and pyritic sulfur, "greasy spots" of yellow and/or white sulfate salts may be visible in the sample.

CONCLUSION:

Many of the concepts and procedures discussed in these guidelines continue to be researched, and these guidelines should allow for alterations in laboratory methodology and data interpretation as warranted. These guidelines are not comprehensive and cannot cover the wide range of possibilities in data collection and analysis. Many aspects of coal mining and reclamation are site specific. Consequently, particular tests cannot be prescribed for all scenarios.

Questions regarding the overburden analyses should be directed to the Division as early in the application process as possible, preferably prior to submission of an application.

REFERENCES:

The following is a list of some references that may be consulted for more information:

- The Pennsylvania Department of Environmental Protection, "Coal Mine Drainage Prediction and Pollution Prevention in Pennsylvania," October, 1998, James M. Seif, Director

- "Evaluation of Acid Base Accounting Data Using Computer Spreadsheets," Michael W. Smith and Keith Brady, 1990 Mining and Reclamation Conference and Exhibition, Charleston, West Virginia, April 23-26, 1990

- Journal of Environmental Quality, "Acid-Base Accounting to Predict Post-Mining Drainage Quality on Surface Mines," J. Skousen, J. Simmons, L.M. McDonald, and P. Ziemkiewicz, 2002

- "Prediction of Water Quality at Surface Coal Mines," Acid Drainage Technology Initiative of The National Mine Land Reclamation Center, West Virginia University, Robert L.P. Kleinmann, editor, 2000

- "Field and Laboratory Methods Applicable to Overburdens and Minesoils," Andrew A. Sobek, William A. Schuller, John R. Freeman, and Richard M. Smith West Virginia University In Cooperation with the West Virginia Geological and Economic Survey, Morgantown, West Virginia 26506 EPA-600/2-78-054 Environmental Protection Technology Series March 1978

- "The ADTI Manual on Predicting Water Quality at Surface Coal Mines," Robert L. P. Kleinmann, National Energy Technology Laboratory, U.S. Dept. of Energy, 2001

- "Effects of Siderite on the Neutralization Potential in the Acid-Base Account," B. Leavitt, J. Skousen, and P. Ziemkiewicz, 1995. In: Proc., WV Surface Mine Drainage Task Force Symp., Morgantown, WV.

- "Overburden Sampling and Testing Manual," Dennis A. Noll, Timothy W. Bergstresser, and Jeffrey Woodcock, Earthtech and Geochemical Testing Divisions of Energy Center, Inc, under contract with the Pennsylvania Department of Environmental Regulation, April 29, 1988

- "Acid Base Accounting (ABA)," Chris Mills, InfoMine Inc. Vancouver BC, Canada

- "Acid Base Accounting (ABA) Test Procedures," Chris Mills, InfoMine Inc. Vancouver BC, Canada

- Journal of Environmental Quality, "Effect of Peroxide on Neutralization-Potential Values of Siderite and Other Carbonate Minerals," J. L. Jambor, J. E. Dutrizac, M. Raudsepp, and L. A. Groat, 2003

- "Guidelines For Metal Leaching and Acid Rock Drainage at Minesites in British Columbia," William A. Price and John C. Errington, Ministry of Energy and Mines, August 1998

- "Neutralization Potential of Overburden Samples Containing Siderite, Skousen, J., Renton, J., Brown, H., Evans, P., Leavitt, B., Brady, K., Cohen, L. and Ziemkiewicz, P. (1997), Journal of Environmental Quality, v26, n3, p673-681.

Appendix – Acid Base Accounting Tables:

Table A:

Acid Base Accounting – Table A													
Analyses Based On: (indicate total sulfur or pyritic sulfur)													
Test Hole: 1													
Surface Elevation: 1048 feet, msl													
Lithologic Unit	**Unit Thick-ness, feet**	**Thick-ness Spoiled, feet**	**Unit Top elev., feet msl**	**Unit Bottom elev., feet msl**	**Unit Middle elev., feet msl**	**Area of Unit at Middle, acres**	**Volume Spoiled, acre-Feet**	**Lithologic Unit Weight, Tons per acre-ft**	**Gross Lithologic Unit Weight, If spoiled, tons**	**PA, tons $CaCO_3$ per 1000 tons of material**	**NP, tons $CaCO_3$ per 1000 tons of material**	**Gross Lithologic Unit PA, tons**	**Gross Lithologic Unit NP, tons**
Topsoil	.5												
Subsoil	2												
SS	5	0	1045.5	1040.5	1043	0.25	0	3070	0.00	0.31	2.28	0.00	0.00
SS	5	0	1040.5	1035.5	1038	1.68	0	3070	0.00	0.31	1.49	0.00	0.00
SH	5	5	1035.5	1030.5	1033	3.11	15.55	3670	57068.5	0.63	4.20	35.95	239.69
SH	3	3	1030.5	1027.5	1029	4.25	12.76	3670	46836.5	7.50	8.92	351.27	417.78
SS	5	5	1027.5	1022.5	1025	5.4	26.99	3070	82859.3	1.56	22.10	129.26	1831.19
SS	5	5	1022.5	1017.5	1020	6.83	34.14	3070	104809.8	4.06	0.89	425.53	93.28
SS	5	5	1017.5	1012.5	1015	8.26	41.29	3070	126760.3	6.25	11.01	792.25	1395.63
SH	5	5	1012.5	1007.5	1010	9.69	48.44	3670	177774.8	28.13	20.93	5000.81	3720.83
SH	2	5	1007.5	1005.5	1006.5	10.69	53.45	3670	196143.2	15.94	16.62	3126.52	3259.90
Coal	4	.17	1005.5	1001.5	1003.5	11.55	1.96	1800	3533.4	78.13	12.28	276.06	43.39
Clay	5	0	1001.5	996.5	999	12.83	0	3400	0.0	55.31	6.81	0	0.00
TOTALS									**795785.8**			**10137.66**	**11001.69**

Due to vertical, horizontal, and weight differences among the various strata on a proposed mine site, the strata must be proportionately weighted when inputting into ABA. The portion of the unit that is returned to the backfill must also be addressed. The acid base accounting as presented factors in these differences, and then sums those values across the proposed permit area, to conclude with the calculations presented in the ORC.

For all entries in the spreadsheet, provide documentation to support the information submitted.
Submit a separate Table A for each test hole.

Analyses Based On: Indicate either total sulfur or pyritic sulfur as the basis for the potential acidity analyses. Since the amended ORC provides different target values for pyritic and total sulfur, analyses should not be mixed. In other words, use only pyritic sulfur values or only total sulfur values.

Test Hole: Identify the test hole.

Surface Elevation: Indicate the elevation at the top of the test hole in feet above mean sea level.

Lithologic Unit: Provide the lithology from the Drilling Report – Surface.

Unit Thickness: Provide the thickness in feet from the Drilling Report – Surface.

Thickness Spoiled: If the entire unit will be spoiled, indicate the total thickness. If only a portion of a unit will be intercepted, indicate that thickness. Also, for seams that will be mined and removed, state the amount in feet that will not be recovered, but will remain in the pit or backfill. For coal, a value of 2 inches is appropriate for pit loss. For other strata, such as limestone, an appropriate value should be used. Do not include strata below the coal in the totals unless they will be intercepted or mined. It may be appropriate to include some of the material in the pit floor, such as the clay if its upper portion will be disturbed and have the potential to influence water quality, even though it will not be mined.

Unit Top Elevation, Unit Bottom Elevation, Unit Middle Elevation: Indicate the elevation in feet above mean sea level for the top, bottom, and middle of each unit.

Acreage of Unit at Middle: Specify the acreage of the middle of the lithologic unit. For sloping terrain**,** this should basically average the acreage of the top and bottom of the unit. In many cases, it is not necessary to actually measure the acreage of each individual lithologic unit; but instead, the acreage can be estimated by interpolation. As an alternative, the acreage for the uppermost and lowermost units can be determined, and interpolation can be done for the intervening units. For all cases, describe/show the method used to calculate the acreage. Area values should increase with depth, reflecting the greater areal extent of the deeper rocks, unless perhaps multiple highwalls are involved.
Volume Spoiled: For units to be spoiled, multiply the thickness in feet by the acreage, and report the results in acre-feet.

Lithologic Unit Weight: Use either the values from the rock weight table in these guidelines, site-specific values, or other supportable data and report in tons per acre-foot.

Gross Lithologic Unit Weight: Multiply the lithologic unit weight by the volume spoiled, and report in tons.

PA (potential acidity): Use the value from the Drilling Report – Surface, and report in tons of $CaCO_3$ per 1000 tons of material. (The stoichiometry of AMD reactions can be interpreted to require either a factor of 31.25 or 62.5 in converting from sulfur percent to potential acidity. The most common convention is to use 31.25. This conversion will have been done on the Drilling Report – Surface.)

NP (neutralization potential: Use the value from the Drilling Report – Surface, and report in tons of $CaCO_3$ per 1000 tons of material.

Gross Lithologic Unit PA (potential acidity): Multiply the PA by the gross lithologic unit weight and divide by 1000. Report in tons.

Gross Lithologic Unit NP (neutralization potential): Multiply the NP by the gross lithologic unit weight and divide by 1000. Report in tons.

Totals: Sum the values in the Gross Lithologic Unit Weight, Gross Lithologic Unit PA, and Gross Lithologic Unit NP columns. (These values will be used Table B.)

Table B:

Acid Base Accounting – Table B							
Analyses based on: (indicate total sulfur or pyritic sulfur)							
Test Hole Number	**Gross Lithologic Unit Weight, If spoiled, Tons**	**Gross Lithologic Unit Potential Acidity, Tons**	**Gross Lithologic Unit Neutralization Potential, Tons**	**Potential Acidity, Tons $CaCO_3$ per 1000 tons of material**	**Neutralization Potential, Tons $CaCO_3$ per 1000 tons of material**	**Calcium Carbonate Deficiency, Tons $CaCO_3$ per 1000 tons of material**	**NP/PA**
1	795785.8	10138	11002	12.74	13.82		
2	770666.7	9843	16923	12.77	21.96		
Overall permit	**1566453**	**19980**	**27925**	**12.76**	**17.83**	**-5.07**	**1.40**

Use Table B to summarize multiple test holes across an application area and to arrive at the results discussed in ORC Section 1513.075. Division (E).

Analyses Based On: As with Table A, indicate either total sulfur or pyritic sulfur as the basis for the potential acidity analyses.

Test Hole Number: Identify each of the test holes.

Gross Lithologic Unit Weight: For each test hole, provide the value in tons from the TOTALS line from Table A.

Gross Lithologic Unit Potential Acidity: For each test hole, provide the value in tons from the TOTALS line from Table A.

Gross Lithologic Unit Neutralization Potential: For each test hole, provide the value in tons from the TOTALS line from Table A.

Potential Acidity (PA): Divide Gross Lithologic Unit Potential Acidity by Gross Lithologic Unit Weight and multiply by 1000. This would be the overall potential acidity for the area represented by the individual test hole.

Neutralization Potential (NP): Divide Gross Lithologic Unit Neutralization Potential by Gross Lithologic Unit Weight and multiply by 1000. This would be the overall neutralization potential for the area represented by the individual test hole.

Overall Permit: For Gross Lithologic Unit Weight, Gross Lithologic Unit Potential Acidity, and Gross Lithologic Unit Neutralization Potential, sum the values in the columns from each of the test holes. For Potential Acidity, divide Gross Lithologic Unit Potential Acidity by one-thousandth of the Gross Lithologic Unit Weight in the overall permit line. (The overall permit value is NOT the average of the values in the column.) For Neutralization Potential, divide Gross Lithologic Unit Neutralization Potential by one-thousandth of the Gross Lithologic Unit Weight in the overall permit line. (The Overall Permit value is NOT the average of the values in the column.) The Calcium Carbonate Deficiency can be calculated either by subtracting the Neutralization Potential from the Potential Acidity in the overall permit line or by subtracting the Gross Lithologic Unit Neutralization Potential from the Gross Lithologic Unit Potential Acidity and dividing by one-thousandth of the Gross Lithologic Unit Weight (all from the overall permit line). The NP/PA ratio can be obtained either by dividing the Neutralization Potential by the Potential Acidity or by dividing the Gross Lithologic Unit Neutralization Potential by the Gross Lithologic Unit Potential Acidity (all from the overall permit line).