MANAGEMENT PLAN FOR ACID MINE DRAINAGE
FOR THE QUINSAM COAL MINE

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INTRODUCTION

Acid generation in surface mines requires a source of sulphide minerals, moisture and oxygen. To accelerate the reaction, iron and sulphur-loving bacteria present in the atmosphere will grow in large populations when the conditions surrounding the active materials (sulphides) are optimum. This process, important as it is, remains only one component of acid mine drainage.

Acid mine drainage (AMD) defined by the U.S. Environmental Protection Agency as, "any acidic water draining or flowing on, or having drainage or flow off any area of land affected by mining." Therefore, water is the second important component of AMD.

Water from groundwater, surface water and precipitation removes acid sulphate salts from the reactive surfaces of sulphite minerals providing clean surfaces for the reaction to continue and movement of acidic waters away from the spot of acid generation. Thus, the second part of AMD is accomplished.

The third important component of AMD is management. Management of the total mining system can be viewed as a catalyst like the bacteria are to the sulphide oxidation process or as a major component of AMD. The latter view is gaining in popularity in most major coal producing areas of the world.

Total management of the mining process includes water control, overburden handling procedures, reclamation plans, and environmental impact amelioration scenarios integrated in the total mining operations system. This component of AMD is the most important factor of AMD.

It is the third component of AMD "management of the total mining system", that I would like to share with you Quinsam's experience.

As in any management system it is important to know what we are dealing with.
Quinsam as part of the initial Stage II submission in 1979-80, took five samples of coal and two grab samples of waste rock for test work at B.C. Research. The results of these tests indicated that all the samples except one coal sample had acid generating potential. The two waste rock samples were grab samples from the South Pit areas. No interpretation as to their original locations in the rock strata or the quantity of materials they represented could be ascertained.

The conclusion developed was that all overburden had acid generating potential and a mine, reclamation, water control plan was developed on these assumptions. Clearly not enough data collection was carried out at that time to carry out a proper overburden analysis to assess AMD potentials.

When Brinco became involved with Quinsam in 1981, it commissioned a detailed groundwater evaluation by Brown Erdman & Associates. The results of the initial test work on acid generation seemed to be in contradiction to the findings of the groundwater investigation. The groundwater study observed that the sandstone and shale were significantly calcareous in the mine area and that the groundwater in the area had a high pH in the range of 8.2 to 8.8.

As part of the Stage II Addendum work, cored holes were drilled. Full sections of core, including coal and partial sections representative of the major sandstone and shale series were analyzed and tested at B.C. Research for acid generating potential.

The conclusions drawn from these new samples were as follows:

(a) Majority of waste rock to be mined is acid-consuming rather than acid generating.

(b) Certain parts of shales associated with the coal seams could have acid generating potential. This material was estimated at 6 percent of total material mined. In addition, preparation plant rejects were assumed to have acid generating potential and represent about 2 percent of total material mined.

(c) The normal mining sequence is such that the materials with acid generating potential will be placed near the bottom of the backfilled pits where they will be covered with acid-consuming sandstone and shales. The
The majority of this material will be beneath the water table in the post-mining situation.

Although we were getting more detailed data on acid generation potential there were still deficiencies in our understanding of what we had.

While the Stage II Addendum was under review in 1983, the Provincial Ministry of Environment commissioned Sturm Environmental Services to carry out an evaluation of Acid Generation on the Quinsam Coal Project. To quote from this report, "We think the problem of acid mine drainage and correlated conditions can be vastly simplified and brought under technical control by realizing that the entire complex of variables and what can be done about them depends upon how much acid-forming materials and how much neutralizing materials we have to deal with. This is the familiar acid base account, which can be quantified by relatively simple laboratory measurements, and can be reasonably identified with recognizable rocks and earth materials on the mine site. Thus, we can pin down the location and ultimate magnitude of acid sources on the one hand, and of neutralizing materials on the other.

The acid base account not only indicates where and how much acid and neutralizers are available for use, but they identify where the materials occur in the coal or overburden material. It also provides a basis for judging how to minimize the acid by controlled excavation and placement, and how to make the most of the neutralizers."

After the submission of the Stage II Addendum, another seven holes were drilled in the pits to obtain coal samples representative of the first five years of the coal to be mined. Samples of the cuttings from the waste rock at various intervals ranging from five to ten feet were collected. In addition to these samples, an additional thirty-five samples of core material adjacent to the No. 2 and No. 1 seams in the 3N and 2-3S pits were also logged and analyzed to further determine the base to acid ratio. Please refer to Acid Base Account #1.

The results confirmed that the overall column of material to be mined has high CaCO$_3$/S ratios as was identified in the Stage II Addendum.

The majority of acid generating potential material is associated with the No. 2 seam horizon and the No. 1 Rider Seam.
The interburden between No. 2 and No. 1 seam is very low in sulphur.

The interpretation of all the exploratory work done in connection with acid generation potential in Pits 3N, 2N and 2-3S, was that the average amount of acid generating potential material to total volume of pit material is around 9 percent.

Mine plans have been developed such that the material with acid generating potential will be placed near the bottom of the mined out pits and the majority of this material will be beneath the groundwater in the post-mining situation. Preparation plant rejects will also be deposited near the bottom of the mined out pits. It should also be noted that during the course of the mining operations, there will be some mixing of the calcareous material with the acid generating material.

In summary, the following Management Practices have been implemented to preclude the formation of acid mine drainage.

(a) Detailed physical and chemical analysis of representative core will be carried out on an ongoing basis for acid base accounting.

(b) Mining operations will place the material with acid generating potential, including preparation plant rejects, near the pit bottom.

(c) The aforementioned practices will ensure that the material with acid generating potential will be placed so that they are surrounded by acid-consuming material. Also, the majority of the material will be beneath the water table in the post-mining situation.

(d) Till and topsoil will be placed on backfilled pits within a few years and vegetation growth will be quickly established.

We have developed contingency plans to treat any acid drainage before it leaves the open pit. A simple, inexpensive lime addition water circulation system in the pit sump can be installed. This system can be set up within 24 hours.
This was the level of information that Quinsam had when it was the subject of a Public Inquiry in the fall of 1983.

The conclusion and recommendations of the Commission were as follows regarding the Mine Plan, Acid Generation and Heavy Metals:

"Provided the mine plan is followed, no acid generation or heavy metal discharge should take place. If, for some reason, small quantities of acid are generated or heavy metals do leach into the mine effluent, there are mitigative or contingency measures which could be taken to prevent these substances from entering the Quinsam River system."

Quinsam Coal has developed the acid base accounting techniques and procedures as presented in Sturm Environ-métal Services report.

The lesson to be learned here is that if the techniques of AMD evaluation using the acid base accounting had been applied in the initial stages of environmental assessment, Quinsam's road through the government approval process would have been less "rocky." But, in all fairness, the government agencies and Quinsam Coal were on a learning curve as regards AMD environmental assessment.

From the company's perspective, too little information can lead to wrong conclusions. Looking at individual grab samples and testing them for acid mine drainage to decide if you have a potential acid mine drainage problem, is like trying to decide if you have a gold mine by picking a few grab samples of rock and analyzing them for gold.

The acid base accounting forms the basis of the third important component of AMD, that is management. The acid base accounting is analogous to the mineral geological inventory of a potential mine whether it be gold, copper or coal.

How can a mine operation be managed successfully if there is not a good understanding of the quantity and grade of ore and its physical location relative to waste rock?

The same can be said how can the total mining system be managed to prevent AMD if there is not a good understanding of the quantity, magnitude and location of acid producing
and neutralizing materials.

During the fall of 1985 and through 1986, Quinsam has been mining coal on a test basis with approximately 11,000 tonnes having been mined and 7,500 tonnes sold for tests in various industrial boilers.

SHOW SLIDES

The following work on acid base accounting of high wall sampling on small scale test pit, confirms projections made from acid base accounting test work from drill core data. Refer to Acid Base Account #2 and 3.
Acid Base Account #1
Acid Base Account #2
Acid Base Account #3.