Chapter 7

METHODS OF INVESTIGATION

7.1 Sampling

7.1.1 GIS maps

The data used to create the GIS maps were taken from databases compiled by Wates Meiring and Barnard (unpublished, 1998, pers.comm.) for a previous project, the CSIR Coal Bulletin No. 105 and the South African Water Quality Guidelines. Tables containing these source data are given in Appendix A.

The databases compiled by Wates Meiring and Barnard contained water quality data, generally including analysis for pH, conductivity, TDS, SO_4^{2-}, Mn, Al, Ca and Mg. The data was compiled over a 12-month period from 1997 to 1998 as part of a regional water quality monitoring programme that included the study area selected for this thesis.

The CSIR Coal Bulletin contains percentages moisture, ash, volatile matter, total sulphur and fixed carbon in raw coal, coal discard and beneficiated coal products.

The South African Water Quality Guidelines is a set of seven volumes providing threshold values for elements and compounds in water, in terms of the desired use for that water i.e. domestic, recreational, industrial, agriculture, livestock watering, aquaculture and/or aquatic ecosystems.

Each of the coal characteristics was represented against a full set of water quality parameters to determine the nature of the water pollution problem, if any, and also to identify any relationship between coal chemical characteristics and water quality at any specific site.

7.1.2 Collection of samples for chemical leaching studies

Sample sets, comprising 10 samples in total, were collected from 4 sites in the study area. Three samples were collected at each of 3 sites, and a fourth sample set was collected from a power station and its captive colliery. Grab samples were all collected directly from the middle of the face of the middle coal seam at a point that is representative of the seam's average width and mineralogy. Product samples were collected from within the plant once all beneficiation was complete. Discard samples were collected from waste dumps at approximately 50 cm depth. The power station ash was taken from a set of samples selected by the particular power station as a representative sample for the purpose of in-house analysis. These samples therefore included:

- Grab samples - 3
- Product samples - 3
- Discard samples - 3
- Power station ash -1

7.2. Analysis

7.2.1 Presentation of data by means of GIS

It is important to note that the GIS map yields information once the user has activated any icon representing a sample site. The user is then given the choice of quickly viewing a small text box, which has summarised the characteristics of that site, or to enter the original database to examine data sets and view graphical representations of any relationships found. For the purpose of this document, only one site has been selected in figure 12 to be viewed with the information text box, as would be seen on the computer screen.

7.2.2 Chemical leaching studies

Chemical leaching studies give an indication of the amount of directly leachable acid water generated during the test, from coal and coal discard samples that are exposed to water and oxygen over a specified time period. For this purpose, beaker studies were conducted on all the samples.

50g of each sample was suspended in 1l of water and continuously stirred, by means of a mechanical stirrer, over a 24 hour period. The change of the water composition against time elapsed was monitored at selected intervals over this period.

The water samples from the beaker tests were analysed for the following parameters:

- pH
- Sulphates
- Alkalinity
- Acidity
- Iron (II)

The methods of analysis are detailed below:

pH:

The pH electrode was calibrated with buffer 7 and buffer 4 before each suite of samples was tested. The pH was then read on each filtered sample.

Sulphates:

2ml of the filtered sample was made up to 50ml with distilled water in a 50ml volumetric flask. 2.5ml conditioning reagent and 1 spatula of barium chloride was then added. The solution was mixed until the barium chloride had completely dissolved. A turbidity reading was then taken. Sulphate concentration was then read off a spreadsheet of values devised by the CSIR.

Alkalinity:

Alkalinity tests were carried out on all samples with a pH value of more than 6. 5ml of the filtered sample was made up to 50ml with distilled water. The solution was then titrated with 0,02 N HCl until pH 4.3. Alkalinity was then calculated using the following equation:

$$\text{mg } CaCO_3/l = \text{titration volume} \times 200$$

Acidity:

5ml of the filtered sample was added to 45ml water and 0.2ml 1000 x diluted H_2O_2. 5ml 0.1N NaOH was then added to the solution. The solution was then titrated with 0.1N HCl to pH 8.3. Acidity was then calculated using the following equation:

$$\text{mg } CaCO_3/l = \text{titration volume} \times 1000$$

Iron (II):

10ml of the filtered sample was mixed with 10ml 1N H_2SO_4 and 10ml Zimmerman Reinhardt solution. The solution was then titrated with 0.1N $KMnO_4$ to a pink colour. Iron(II) concentration was calculated using the following equation:

$$\text{g Fe(II)}/l = 55.85 \times (0.1N \times \text{titration volume} / \text{volume of sample})$$

Tables containing the results of these tests are included in Appendix B.