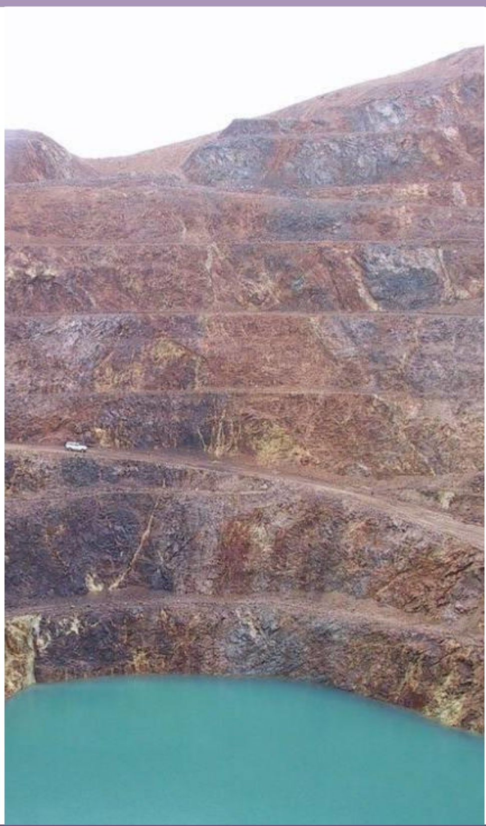
Yaouré Geochemical Characterisation
Waste Rock, Construction Materials and Tailings
Yaouré Gold Project – Côte d'Ivoire
April 2015



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EXECUTIVE SUMMARY

The Yaouré Gold Project has a long history of mining - both commercial and artisanal. Until now the Project has exploited solely the oxidised ore. The proposed mining expansion will lead to the mining of the sulphide minerals, requiring additional waste characterisation. It is likely that the climatic condition at Yaouré will lead to the generation of drainage during particular seasons of the year.

This report details the results (Phase I) of the geochemical testwork programme commissioned by Amara Mining PLC for the Yaouré Gold Project. Amec Foster Wheeler designed and managed a geochemical testing programme to characterise the waste rock, tailings and potential construction materials that will be generated as a result of the implementation of the Yaouré project.

Waste Rock

A total of 76 representative waste rock samples were specifically selected from waste lithologies to cover the whole planned open pit, both the CMA pit area and Yaouré Central pit areas, in terms of spatial and representative lithological distribution as the initial step of the characterisation study.

The waste rock samples were characterised by Acid Base Accounting (ABA) and Net Acid Generation (NAG). There was a good correlation between total sulphur and sulphide sulphur, suggesting that most of the sulphur is present as sulphide. Almost 59% of the samples had total sulphur <0.1%, which is one of the criteria used by the European Union in the classification of inert waste. Only two samples with higher total sulphur results were considered potentially acid generating according to Net Neutralisation Potential (NNP) and Neutralisation Potential Ratio (NPR) results.

Seven samples - representing the range of sulphur content and the different lithologies - were selected for further characterisation using X-Ray Fluorescence (XRF), X-Ray Diffraction (XRD) including Rietveld analysis and short-term leaching using the US EPA Synthetic Precipitation Leaching Procedure (SPLP). XRF trace element results indicated that there are some elements of potential concern in terms of metal leachability, having concentrations significantly higher than those of the average Earth's crust. The mineralogical characterisation confirmed the ABA / NAG results, with some samples containing sufficient calcite to indicate that a neutral pH would be maintained, and others with little sulphide content and therefore limited driving force for acid generation. Based upon the short term leaching results, metal leachability is not expected to be a significant issue.

Construction Materials

A total of 23 construction material samples were subjected to total sulphur via LECO and XRF major and trace elements analyses.

The results from the construction materials samples showed that they are more mineralized than the waste rock, with a peak in samples with total sulphur between 0.1% and 0.2%. It was not possible to conclude that there are not potential issues in terms of Acid Rock Drainage (ARD) or Metal Leachability (ML) from these samples.

Tailings

Six tailings samples representing different domains (Oxide, Transition, CMA Sulphide Upper, CMA Sulphide Lower, Sulphide Upper and Sulphide Lower) were provided for geochemical testwork. The samples are being subjected to ABA, NAG, XRF, XRD Mineralogy (including Rietveld quantification) and SPLP testwork. These samples were generated simulating a conventional milling and cyanidation circuit.

The tailings samples had total sulphur values up to 1%. The ABA and NAG results showed that Y CMA L tailings are potentially acid generating. The oxide tailings (YO) might have metal leachability with respect to Arsenic. It is not possible to provide a definite conclusion without developing a geochemical model charting the evolution of the chemistry of the tailings facility as the different tailings types are deposited.

Recommendations

It is recommended that further characterisation work is carried out for the construction material samples with higher total sulphur values in order to assess their acid generation and metal leachability potential.

A larger number of samples should be tested for total sulphur in order to provide a higher degree of confidence for the sulphur levels across the waste rock material and increase the statistical reliability of the database as part of the next phase of the Project development.

If it is necessary to establish the quality of the seepage for the tailings then it is recommended that a geochemical model is developed.

It is also recommended that the baseline water quality data is reviewed by an ARD specialist when complete and available.

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1.0 INTRODUCTION

In June 2014, Amec Foster Wheeler Earth and Environmental (UK) Ltd (AMEC Foster Wheeler) was retained to carry out testwork management for Amara Mining PLC's (Amara) Yaouré Gold Project (Yaouré or the Project). This testwork programme included process, geotechnical and geochemical testwork programmes.

Amec Foster Wheeler designed and managed the geochemical testing programme to characterise the waste rock, tailings and potential construction materials that will be generated as a result of the implementation of the Yaouré project. The aim of this study is to document the likely behaviour of the future waste rock, tailings and construction materials and provide mitigation if required and inform the waste management. This report summarises the findings of this testwork.

Amec Foster Wheeler have been reliant upon background information from the scoping report for the ESIA carried out by Amec Foster Wheeler (Report no. A152-14-R2267). Further information will be available from the baseline studies being carried out as part of the ESIA by Amec Foster Wheeler, along with further definition of the project design.

The terms of reference for this report are:

- Review background information and generate a sample list for testing, site visit can be coordinated with geotechnical visit to minimize costs
- Define a testing programme, request quotations from at least two laboratories, review them and recommend the preferred bidder to Amara
- Liaise with the selected laboratories to ensure smooth progression of the testing programme and check the quality of the outputs
- Interpretation of the results; and
- Generate a report suitable to stand alone or be integrated into another agreed

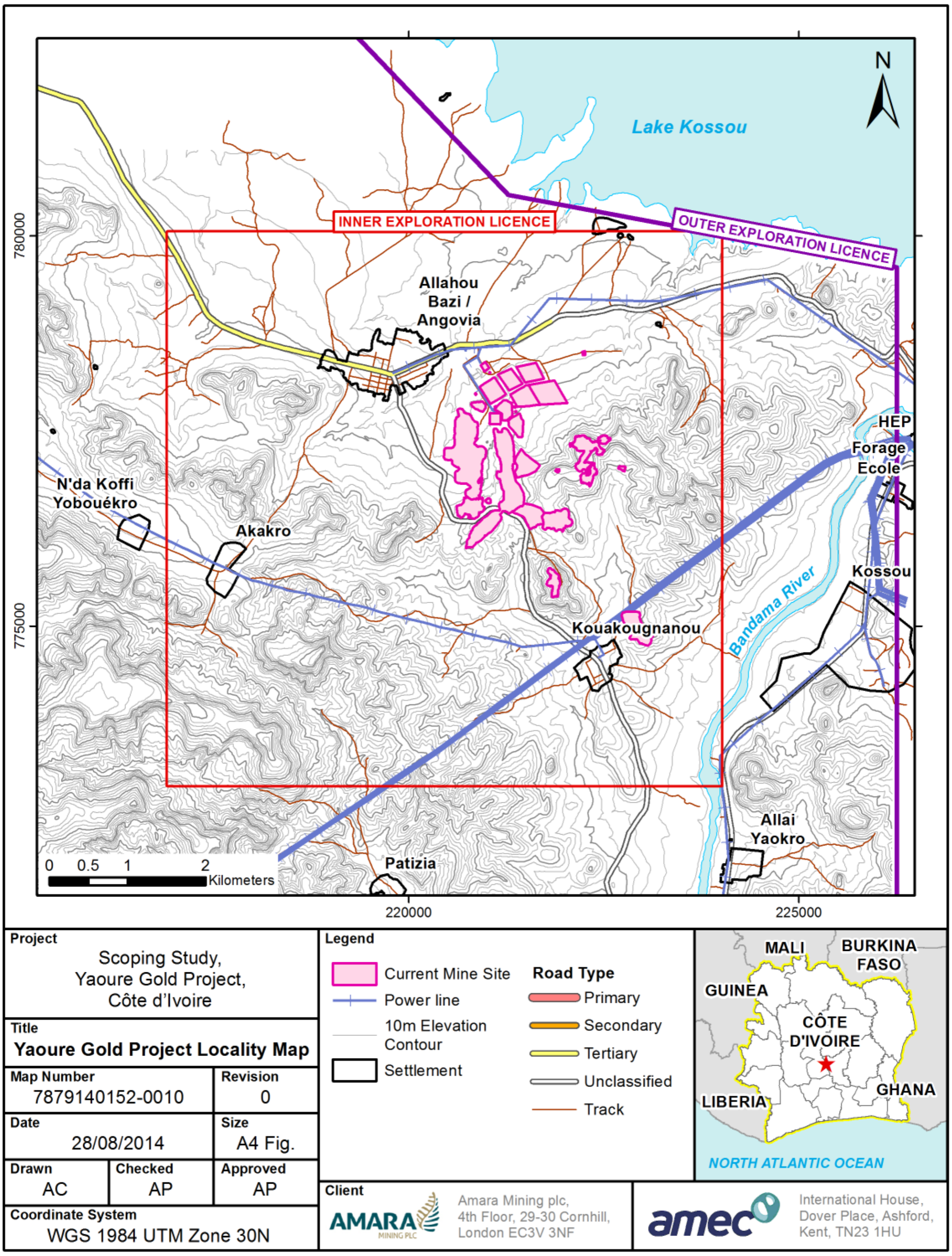
2.0 BACKGROUND

2.1 Project Location

The Yaouré Gold Project is located in the Bouaflé Prefecture of the Marahoué Region in Côte d'Ivoire. The Project is approximately 40 km northwest of the political capital Yamoussoukro, 260 km northwest of the administrative capital Abidjan and 25 km from the regional capital Bouaflé. The mine is located approximately 6 km west from Lake Kossou and the associated hydro-power station. The Project location is indicated in Figure 2-1.

The Project is a brownfields open pit gold mining operation which has historically and recently been subjected to various gold mining activities.

Figure 2-1: Amara Yaouré Project Location



2.2 Climate

2.2.1 General Climate of Côte d'Ivoire

The climate of Côte d'Ivoire is influenced by the Inter-tropical Conversion Zone. This gives rise to an equatorial climate in the south, tropical climate in the centre and semi-arid climate in the north of the country. Average temperatures range between 25°C and 32°C, while the average rainfall for the country is approximately 1000 mm.

According to the 2007 ESIA conducted by SGS for Cluff Mining, four definite seasons can be distinguished in Côte d'Ivoire:

- Dry season (December-May)
- Wet season (May-July)
- Dry season (July-October)
- Wet season (October-November).

The winds are moderate, generally from the south-west quadrant, except for September and January when the Harmattan blows from the north-north-east (LaSource, 1997).

2.2.2 Climate for the Yaouré Project Site

Climate data at the Yaouré site have been gathered since 2009. A new weather station was installed on site in 2014, providing temperature and rainfall data.

Temperature

Site specific average and maximum temperatures are included in Table 2-1. Average temperatures range from 22°C to 32°C throughout the year.

Table 2-1: Yaouré Project Average Monthly Temperature, °C, 2009-2013 (Amara Weather Station)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	39.8	29.4	28.5	28.4	27.7	27.3	25.3	25.3	26.2	26.8	26.9	27.8
2010	28.5	29.3	29.8	29.5	28.8	27.1	25.8	25.7	26.6	27.3	28.0	27.3
2011	26.6	29.0	29.1		28.0	27.0	25.4	25.8	26.9	27.3	27.9	26.5
2012	27.4	28.8	29.8	28.5	22.2	26.5	25.3	25.0	26.5	26.9	22.2	26.9
2013	26.7	29.7	29.0	29.0	27.7	26.8	25.5	25.1	26.1	27.1	27.5	26.8

Rainfall

Rainfall at Yaouré has been monitored at site since 2009, with some gaps in data. The mean monthly rainfall for the period 2009-2013 is presented in Table 2-2.

Annual average rainfall for the Project area is approximately 1100 mm. The average monthly data are similar to the data for Kossou and Yamoussoukro. May 2013 was especially wet.

Table 2-2: Yaouré Monthly Rainfall: 2009-2013 (Source: Amara)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2009	0.0	35.2	219.8	153.1	105.8	67.8	46.8	16.4	48.4	102.0	88.8	0.0
2010	6.0	8.6	76.8	90.4	199.6	167.3	143.2	137.0	137.4	171.6	29.4	9.6
2011	0.0	103.0	20.8		128.8	152.0	118.0	208.0	137.0	171.2	0.2	0.0
2012	0.2	90.0	132.0	175.4	202.4	245.5	33.4	119.2	167.2	188.1	48.2	3.6
2013	0.0	42.2	138.7	309.8	422.6	65.0	12.0	74.4	129.5	102.8	69.2	13.0

Further historical rainfall data can be gathered from the regional stations and is documented in the Amec Foster Wheeler scoping ESIA report.

Humidity and Evaporation

Table 2-3 includes the monthly average evaporation, absolute humidity, solar insolation data for Lake Kossou weather station located 5.5 km ESE of the project. Rainfall at Kossou exceeds the evaporation, making this a water surplus area.

Table 2-3: Evaporation, Humidity and Insulation Data for Kossou (Source: LaSource, 1997)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
Evaporation (mm)	108	109	102	80	60	48	49	51	44	48	50	71	**788**
Absolute Humidity (mm)	63.1	64.3	68.8	73.3	77.1	79.4	80.2	79.9	79.1	77.8	72.6	69.6	**74.0**
Insolation (h)	201	190	201	208	204	154	111	96	119	171	174	153	**1986**

The data for mean annual precipitation and pan evaporation is used to carry out an initial evaluation of percolation in waste rock dumps. As a rule of thumb, if annual precipitation is less than 250 mm and pan evaporation rate is above 1,900 mm, it is very likely that natural percolation will not occur in measurable quantities. In areas where precipitation exceeds 500 mm, it can be assumed that some measurable percolation will occur. In the case of the Yaouré project, the climatic conditions are such that drainage is likely to occur during the wet seasons.

2.3 Hydrology

2.3.1 Rivers and Catchments

The project site is mainly drained by perennial and non-perennial drainage lines of the Bandama River. Many stream courses are ephemeral, only flowing during one of the wet seasons.

The whole of the Project site lies within the same sub-catchment whose waters all flow into either Kossou Lake or the Bandama (Blanc) River south of Kossou Dam, north of Toumbokro. This sub-catchment boundary also encloses the Inner Exploration Licence area and runs south from Kossou Lake to N'da Koffo Yobouékro, southwest to Lotanzia, and then ESE to the Bandama north of Toumbokro. The Bandama River is the longest in Cote d'Ivoire at 800 km, flowing almost north-south through the centre of the country to discharge into the Tagba Lagoon and the Gulf of Guinea.

2.3.2 Surface Water Quality

The site has a long history of mining activity, including a heap leach operation and both historical and present artisanal mining.

Surface water monitoring has been carried out the site intermittently since 2006, with regular monitoring implemented since 2014, testing for standard physical and chemical parameters including heavy metals. This will provide baseline surface water quality measurements for the site, details of which will be reported in the ESIA.

2.4 Geology

The regional geology of the Project area (SRK, 2008[1]) is comprised of a series of Archaean, Birimian, greenstone belts separated by older migmatites and granites. The Angovia deposit itself occurs within one of the Birimian greenstone belts and is hosted by the Yaouré Unit, which is comprised of a mafic and metavolcanic series, felsic instusives and minor conglomerates in association with calk-alkaline and ultramafic intrusives, all of which strike in a north-north-east orientation.

The majority of the Project area is underlain by mafic volcanics, which are predominantly massive and in the form of pillowed basalts. The north part of the area is intruded by massive granodiorite that locally has a subtle porphyritic texture. Elsewhere, but mainly associated with the main Yaouré Zone, there are numerous porphyry sills. A volcaniclastic unit, mainly of epiclastic origin, is situated near the contact of the granodiorite to the north. The granodiorite intrusive to the north is not mineralised while the one in the Yaouré pit contains quartz veins which are well mineralised.

The mineralisation at Yaouré is contained within two shallow dipping (<30 Degrees) gold bearing north-south trending packages controlled by a thick zone of brittle-ductile shearing. The Yaouré Central package is a 200 metre thick, lower grade mineralised zone with higher grade lenses and cross-cutting high grade sub-vertical quartz veins. The CMA package is a more discrete, relatively continuous 20 metre thick zone approximately 140 metres above the Yaouré Central body.

The Yaouré unit forms a syncline of tholeiitic basic metavolcanics and sediments overlain by more acidic volcanic rocks. The tholeiitic rocks are thought to have been formed following hydrothermal alteration and are composed of chert, disseminations and veinlets of pyrite, pyrrhotite, chlorite, epidote, tourmaline and carbonates. The overlying acidic to intermediate volcano-sedimentary rocks are thought to represent pyroclastic and acidic pyroclastic flows.

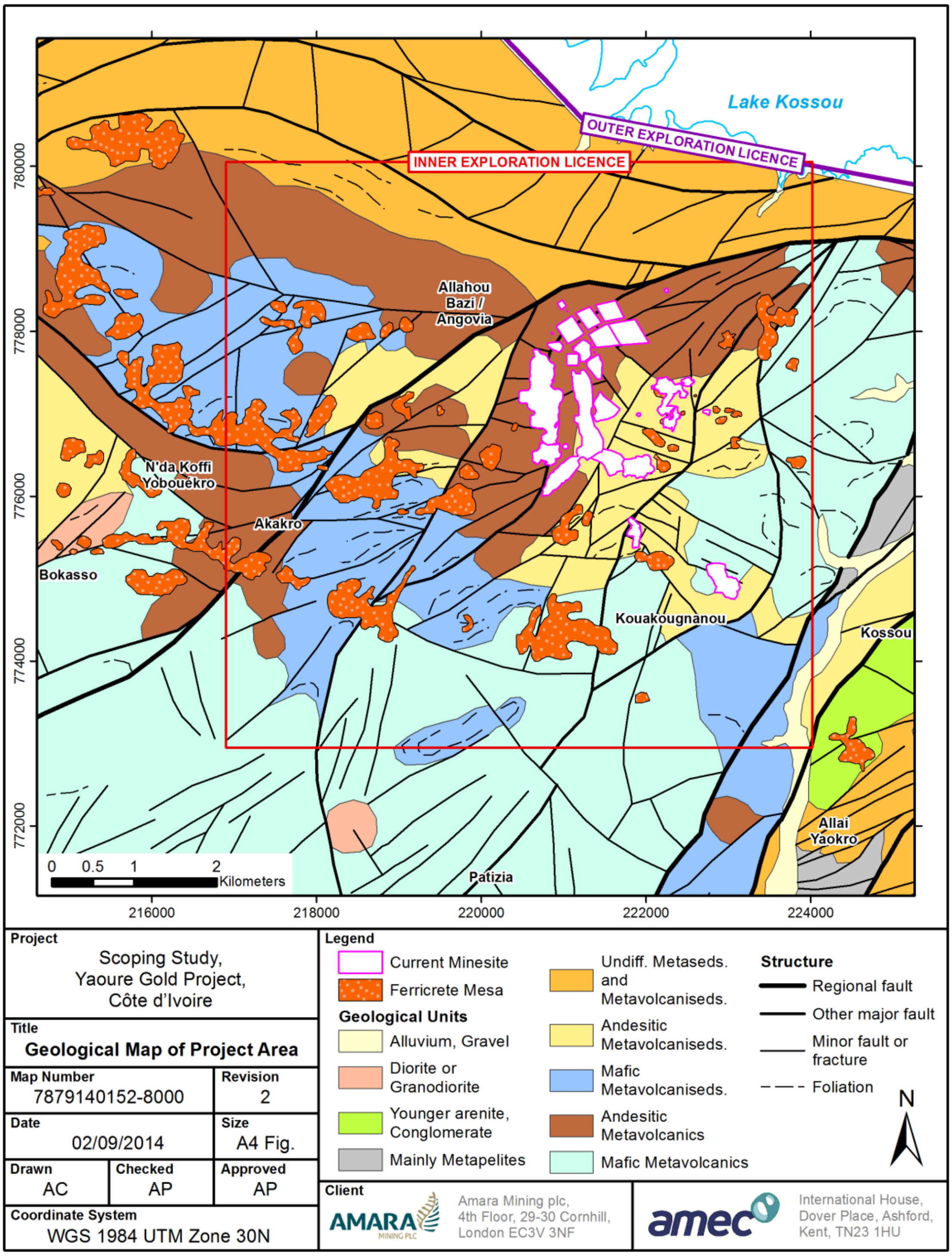
All of the above rocks have been intruded by basic to ultra-basic plutonic rocks and acidic intermediate calc-alkaline volcano-plutonic rocks and the whole package is in turn overlain by the Benou polygenic conglomerate. All of these have been deformed by a series of east west striking shear zones and intruded by associated greyish quartz veining.

Primary and secondary lateritic weathering profiles have also developed throughout the area above the conglomerate. The gold mineralisation itself appears to be primarily located in structurally controlled alteration zones in intermediate volcanic rocks.

The geology of the Project is indicated in Figure 2-2.

[1] SRK, Technical Review of the Angovia Gold Mine, Mount Yaouré, Cote d'Ivoire (NI 43-101 Report), 2008

Figure 2-2: Geology of the Yaouré Project (Source: Amara Mining)



2.5 Technical Description of Yaouré Gold Project

Amara intends to commence mining at Yaouré, through the expansion of the brownfields site. Expansion will involve upgrade of existing facilities and construction of new facilities where required. The life of mine (LoM) is expected to be 13 years. It is expected that the project will consist of the following:

- Expansion/deepening of existing open pits to cover an area of approximately 179.2 hectares (ha).
- Establishment of new mine waste facilities including a Tailings Management Facility (TMF), waste rock dump (WRD), process water dams and overburden stockpiles.
- Mineral & Ore Stockpiles
- Processing Plant.
- Ancillary Facilities.

2.6 Acid Rock Drainage

One important problem associated with mining minerals which might be sulphide related is the potential for acid rock drainage (ARD) to occur. ARD takes place when reactive sulphides come into contact with oxygen and water in the presence of iron/sulphur oxidising bacteria and there is insufficient or ineffective alkaline material to stop the oxidation reaction or to neutralise its products. ARD is a dynamic and spatial problem and occurs if the acidity generated is higher than the neutralisation capacity of the system at any stage of the life cycle of the natural phenomenon of sulphide oxidation. The term ARD is applied to the resulting leachate, seepage or drainage.

The two main sulphide minerals associated with ARD are the gangue minerals pyrite and pyrrhotite. Pyrite is relatively abundant and is not usually recovered in the processing of ore. When pyrite and pyrrhotite are not recovered or oxidised in the processing of the ore they may become the source of acidity. Carbonate-bearing rock (e.g. limestone) and reactive silicates usually provide the naturally occurring neutralisation capacity of the system.

Acidic drainage is generated according to the following three overall equations:

$$2FeS_2 + 7O_2 + 2H_2O \xrightarrow{bacteria} 2FeSO_4 + 2H_2SO_4 ; \qquad (1)$$

$$4FeSO_4 + 2H_2SO_4 + O_2 \xrightarrow{bacteria} 2Fe_2(SO_4)_3 + 2H_2O ; \qquad (2)$$

$$FeS_2 + Fe_2(SO_4)_3 \rightarrow 3FeSO_4 + 2S . \qquad (3)$$

The neutralisation aspect of the problem is usually represented by the following equation:

$$H_2SO_4 + CaCO_3 + H_2O \rightarrow CaSO_4.2H_2O + CO_2 . \qquad (4)$$

Equations 1 to 4 represent, in very general terms, the basic chemistry of ARD, however its manifestation can vary depending on the physical and mineralogical characteristics of the material, method of disposal and the local climatic conditions. It is due to the interactions of these factors that ARD is considered a site-specific problem. In some cases even when the material is not ARD generating there might be a problem of leachability of trace elements. This is usually assessed by using short-term leachability tests.

The quality of the drainage from waste rock dumps is particularly influenced by the particle size distribution of the materials deposited in the dump. The fine particles have a disproportionate influence on the quality of the drainage and therefore particular care should be taken when predicting future drainage quality from a waste rock dump.

2.7 Summary

Up to now mining at the Project has exploited the oxidised ore that is not prone to ARD generation. SGS undertook sampling to determine ARD potential in July 2010, and the results confirmed that there was no ARD problem associated with the operations at that stage.

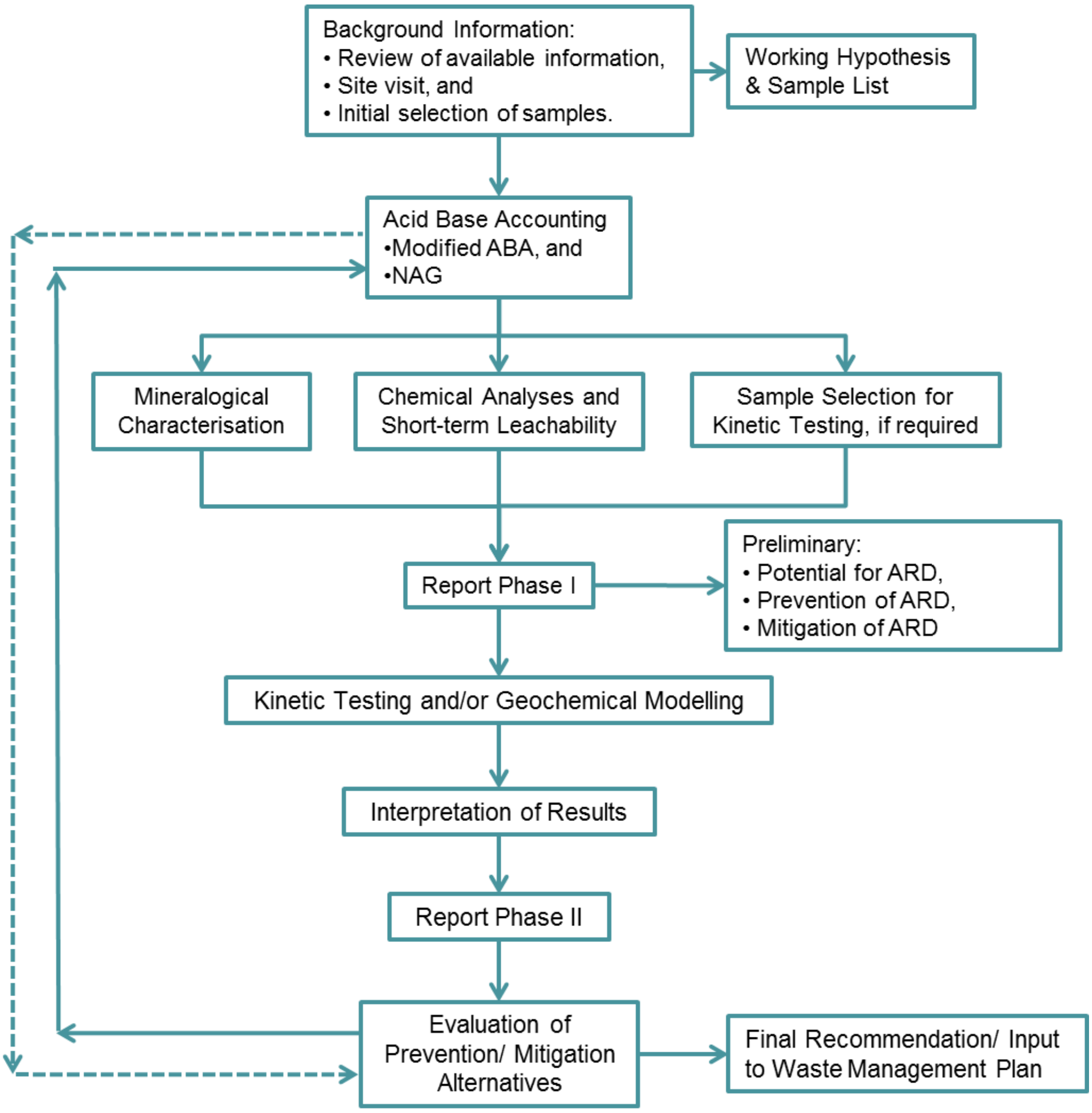
The proposed mining expansion will lead to the mining of the sulphide minerals and additional ARD testing will be undertaken. The manifestation of ARD can vary depending on the physical and mineralogical characteristics of the material, method of disposal and the local climatic conditions. It is due to the interactions of these factors that ARD is considered a site-specific phenomenon. The key to ARD generation is that the presence of sulphide is the driving force for acid generation and therefore without sulphide no ARD occurs. It is likely that the climatic condition at Yaouré will lead to the generation of drainage during particular seasons of the year.

Should a significant potential for generation of ARD be indicated during the geochemistry assessment then the Project may be suitably designed to include best industry practice for its effective management. This aspect will be investigated in the ESIA study.

3.0 APPROACH TO THE PROGRAMME

Figure 3-1 illustrates the sequence of methods and techniques used during the investigation in order to achieve confidence in the predictions and mitigation measures proposed, if required. The methodology is general and therefore it is applied to different waste streams with different emphasis.

Figure 3-1: General Methodology of Waste Characterisation.



Central to the characterisation of potentially acid generating samples is the possibility for mis-classification by Acid Base Accounting (ABA) into the incorrect category. In order to minimise this possibility it is recommended to test the samples by at least two different ABA methods.

Sample selection was carried out by Amara under the supervision of an Amec Foster Wheeler Geotechnical Engineer.

3.1 Stage 1 - Total Sulphur Determination

The measurement of total sulphur via LECO® (high temperature combustion followed by infrared detection) gives an indication of the potential presence of sulphides, which are the driving force of acid generation. Total sulphur is a conservative approach, as it includes sulphur as sulphate, elemental sulphur and sulphur as sulphide.

3.2 Stage 2

3.2.1 Acid Base Accounting (ABA)

ABA is usually the first step in the prediction and evaluation of ARD. In general, ABA aims to determine on one hand the acid generation potential (directly related to the sulphide content of the sample) and on the other hand, the neutralisation potential. By comparing these two values, samples may be classified as potentially acid generating, lying within a zone of uncertainty or unlikely to generate ARD. ABA can be considered to be equivalent to characterising the chemical thermodynamics of a system, i.e. ABA indicates what can happen but it does not guarantee that it will happen and if it happens it does not indicate when or at what speed it will occur. If a sample is potentially acid generating then in order to confirm whether a sample will generate ARD and to what degree of intensity, kinetic testing is necessary.

There are a considerable number of methods available to carry out ABA. Experience has shown that those methods using the calculation of acid generation based on total sulphur and/or the neutralisation potential of every alkalinity generating material in the sample are more prone to misclassify the sample into the wrong category. The method chosen here for ABA testing is the "Modified ABA" (Lawrence and Wang, 1997[2]) which is considered (on the basis of comparative testwork) to provide a more realistic value for the acid and neutralisation potentials. Net Acid Generation (NAG) testing (described in Section 3.2.2) was also undertaken in order to check and complement the results obtained using ABA and as the basis of potential waste rock classification in the field. The methods used in ABA and NAG testing are described in Appendix A.

Two parameters are usually calculated to classify material in terms of ARD. These are as follows:

- The net neutralisation potential (NNP) which is neutralisation potential (NP) minus the acid potential (AP)
- The neutralisation potential ratio (NPR) which is the NP divided by the AP.

The ABA screening criteria adopted in this interpretation are mainly those recommended by the British Columbia Ministry of Employment and Investment of Canada and reproduced in Table 3-1. The AP and NP are expressed in the same unit which is kg $CaCO_3$/tonne of material. In this section the word "acidity" denotes the presence of mineral acidity (free hydrogen ions) in the sample. Most life processes in natural waters are seriously impaired if the pH lies outside the range 4.5 to 10.3. If the pH of water falls below 4.5 this indicates the presence of mineral acidity (that is, if any further hydrogen

[2] Modified Acid Base Accounting Procedure, R.W. Lawrence and Y. Wang. 4th International Conference on Acid Rock Drainage. May 31 – June 6, 1997 Vancouver, B.C. Canada. p.464.

ions are added, from whatever process, these hydrogen ions will remain as such in solution). Acidity is the result of the acid potential being realised.

Table 3-1: ABA Screening Criteria – NPR.

Potential for ARD	Initial NPR	Comments
Likely	< 1:1	Likely ARD generating.
Possibly	1:1 to 2:1	Possibly ARD generating if NP is insufficiently reactive or is depleted at a faster rate than sulphides.
Low	2:1 to 4:1	Not potentially ARD generating unless significant preferential exposure of sulphides or extremely reactive sulphides in combination with insufficiently reactive NP.
None	> 4:1	No further testing is required unless material is going to be used as a source for alkalinity.

An alternative screening criterion is the Net Neutralization Potential (NNP) as shown in Table 3-2.

Table 3-2: ABA Screening Criteria – NNP.

NNP (kg $CaCO_3$/t)	Potential for ARD	Comments
<-20	Potentially acid generating	Equivalent to Likely
Between –20 and +20	Zone of uncertainty	Equivalent to Possibly/Low
>+20	Not potentially acid generating	Equivalent to None

The NNP criterion is more relevant to samples with sulphide content of less than 1% and a relatively low or negative NP.

3.2.2 Net Acid Generation (NAG) testing

NAG tests use hydrogen peroxide (H_2O_2), a strong oxidising agent capable of rapidly oxidising sulphide minerals, to assess whether a sample is capable of neutralising the potential acidity produced by sulphide oxidation. This test can be carried out in the field or in a laboratory.

Hydrogen peroxide is added to a ground up sample, oxidising the sulphides. The acidity (pH) of the NAG liquor indicates the net amount of un-neutralised acidity produced per unit weight of sample. This is used to determine the sample classification.

As shown in Table 3-3, a sample is defined as non-acid forming (NAF) when it has a final NAG pH > 4.5. A sample is defined as potentially acid forming (PAF) when it has a final NAG pH <4.5.[3]

Table 3-3: NAG classification.

Classification	Final NAG pH
Non-acid forming (NAF)	>4.5
Potentially acid forming (PAF)	<4.5

An indication of the form of the acidity is provided by initially titrating the NAG liquor to pH 4.5, then continuing the titration up to pH 7, using sodium hydroxide (NaOH). The titration value at pH 4.5 includes acidity due to free acid (i.e. H_2SO_4) as well as soluble iron and

[3] ARD Test handbook – Project P387A Prediction and Kinetic Control of Acid Mine Drainage", AMIRA International Ltd., May 2002

aluminium. The titration value at pH 7 also includes metallic ions that precipitate as hydroxides at pH values between 4.5 and 7 and the acidity of hydrogen peroxide. The acidity from hydrogen peroxide will depend on the degree of decomposition but can be up to 20 kg $CaCO_3$ equivalents per tonne in each single additional NAG test. Like all laboratory tests, it is important to consider differences from field conditions when using these data.

3.2.3 Paste pH

Paste pH provides an indication of the history of the sample. Usually 20 g of sample is mixed with an equal amount of water and the pH of the paste generated is measured.

Paste pH is a simple, rapid, and inexpensive screening tool that indicates the presence of readily available NP (generally from carbonate) or stored acidity. The outcome of the test is governed by the surficial properties of the solid material being tested, and more particularly, the extent of soluble minerals, which may provide useful information regarding anticipated mine water quality. For example, acidic paste pH values in combination with elevated sulphate sulphur generally suggest the presence of acidic sulphate salts that could cause short-term or long-term water quality issues.

3.3 Stage 3

3.3.1 XRF/XRD

Selected samples were subjected to whole rock mineralogical characterisation in order to determine whether the NP obtained from the ABA tests is reactive or not, and to indicate the type of sulphide and sample matrix. Mineralogical characterisation is an important tool and check on the interpretation of the other testing carried out as part of the geochemical analysis. X-ray Diffraction (XRD) is used to identify crystalline phases and X-ray Rietveld analysis allows quantification of the different phases present.

3.3.2 Synthetic Precipitation Leaching Procedure (SPLP)

The purpose of short-term leachability tests is to provide an indication of the mobility of various metals when waste is exposed to a leaching agent. In this study the Synthetic Precipitation Leaching Procedure (SPLP) developed by the US EPA is used. This was developed to simulate the leachate that would be generated from acid rain falling on and percolating through a mine waste pile. The results from this test indicate whether samples may be classified as hazardous or non-hazardous under US EPA regulations. If the sample is classified as hazardous, then there are specific regulations governing the materials disposal. The results can also be used as the basis for planning the sweep of elements to be analysed as part of a kinetic testing programme, if required. Further details of the procedure are provided in Appendix B.

4.0 METHODOLOGY

4.1 Lithology Database Review

A geological database was provided with simplified coding, which was based on selection according to the first two characters of the geological code in the original database (Bill Bond coding), and screened to include sections lying only in the PEA pit. The resulting codes are:

- MINERAL – Mineralised: all samples with ≥0.5 g/t Au
- WASTE: <0.5 g/t, coded as below
  - 1_OV_LAT – overburden + laterite
  - 2_SAPROL – saprolite
  - 3_SAPROK – saprock
  - 4_FR_OXI – fracture oxidation (equivalent to transition zone)
  - 5_BAS_VC – basalt volcanic – the dominant unit (over 50% of the sampled intersections)
  - 6_BAS_PO – basalt porphyry
  - 7_GD_POR – granodiorite and other porphyry intrusives
- OTHER – other codes which are only a small proportion of the overall sampled metres.

Since the drilling is fairly regularly spaced, the sampled lengths were used as a proxy for the relative volumes of material falling within the pit. This information was used to guide the number of samples per lithology, as detailed in Table 4-1.

Table 4-1: Lithology distribution and sample numbers.

Lithology Code	Sum of Length (m)	Percentage (of ALL)	Percentage (of WASTE)	Number of Samples
1_OV_LAT	973.00	4.65%	5.14%	6
2_SAPROL	2438.19	11.66%	12.89%	13
3_SAPROK	978.51	4.68%	5.17%	6
4_FR_OXI	1306.91	6.25%	6.91%	7
5_BAS_VC	10116.36	48.39%	53.49%	27
6_BAS_PO	2006.02	9.60%	10.61%	11
7_GD_POR	1094.32	5.23%	5.79%	6
MINERAL	1831.96	8.76%		
OTHER	160.57	0.77%		
Sum (ALL)	**20905.83**			
Sum (WASTE)	**18913.31**			**76**

4.2 Sample Selection

A total of 99 core samples were collected as part of the geochemical characterisation programme of which:

- 23 samples were obtained from the same locations as geotechnical samples in order to sample the proposed construction materials – these samples will be herein identified as the “construction material samples”.

- 76 waste rock samples were specifically selected from waste lithologies to cover the whole planned open pit, both the CMA pit area and Yaouré Central pit areas, in terms of spatial and representative lithological distribution. These samples were selected through analysing the west-east geological sections reproduced in Appendix C.

The number of samples per lithology for both waste rock and construction material samples is given in Table 4-2. Figure 4-1 and Figure 4-2 show the locations of the waste rock and construction material samples respectively. Details of the locations, sample numbers and lithology is given in Appendix D.

Table 4-2: Number of samples per lithology.

Lithology	Number of Waste Rock Samples	Number of Construction Material Samples
1_OV_LAT	6	0
2_SAPROL	13	3
3_SAPROK	6	0
4_FR_OXI	7	0
5_BAS_VC	27	18
6_BAS_PO	11	2
7_GD_POR	6	0
Grand Total	**76**	**23**

Figure 4-1: Waste rock sample locations.

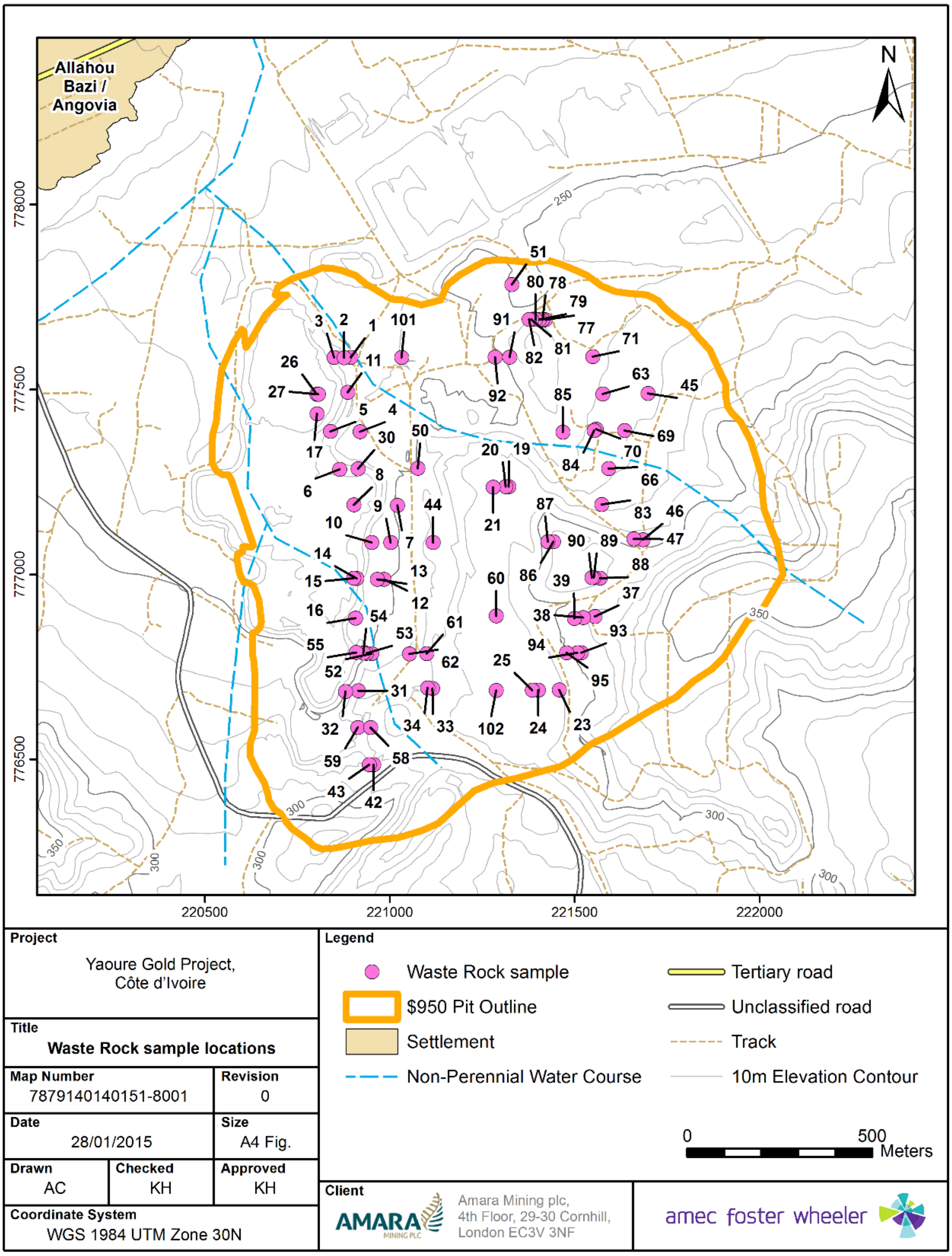
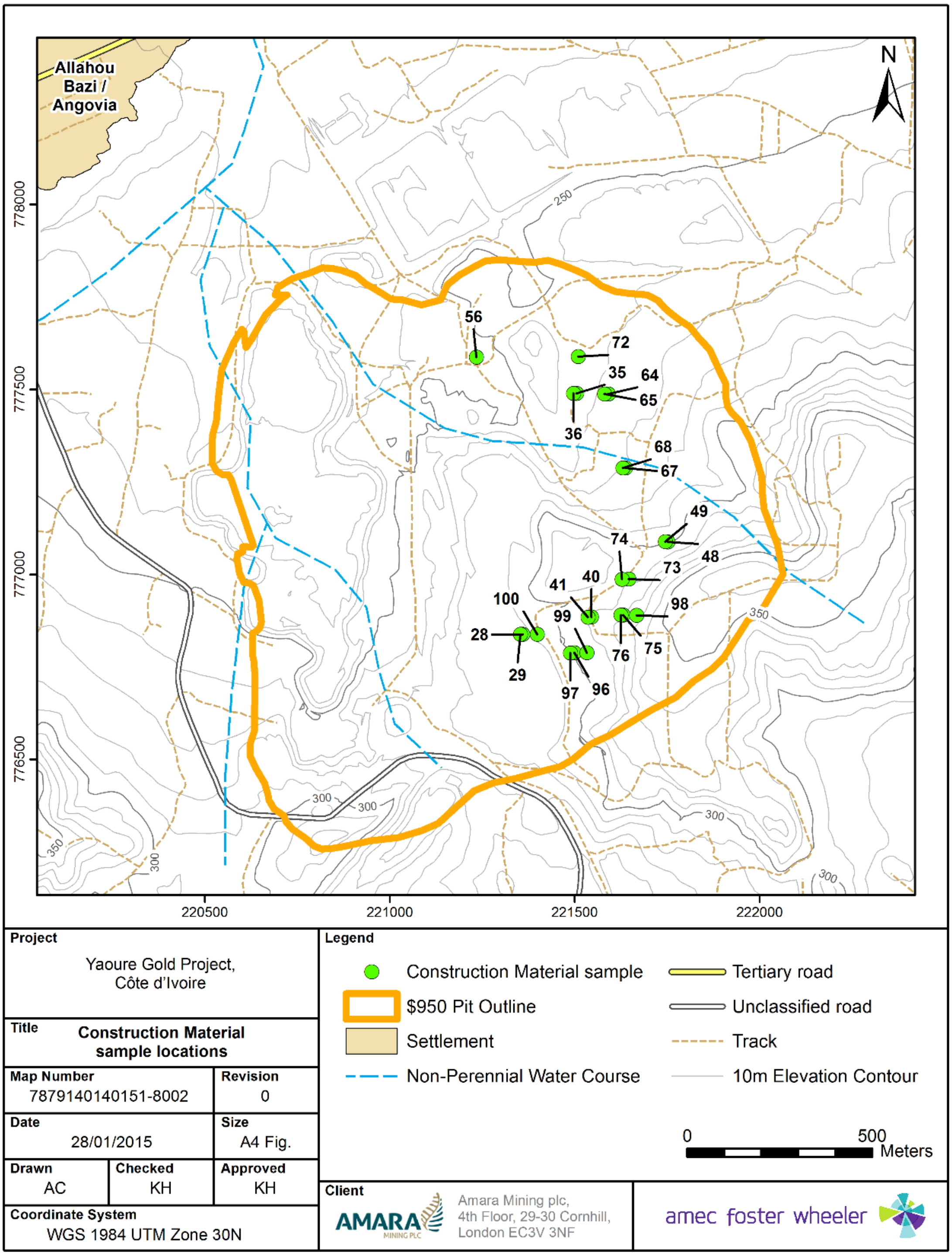


Figure 4-2: Construction material sample locations.



4.3 Sample Testwork

The testwork for Yaouré can be split into the following stages:

1. a. Sample preparation for all samples (99)

   b. Total Sulphur via LECO for Construction Material samples (23)

c. Acid Base Accounting (ABA) (Modified Sobek Method, Lawrence and Wang) and Net Acid Generation (NAG) for all Waste Rock samples, this includes Total Sulphur and Total Sulphate (76)

2. a. X-Ray Fluorescence (XRF) (Major and Trace elements) for all Construction Material Samples (23)

   b. XRF and X-Ray Diffraction (XRD) Mineralogy (including Rietveld quantification) for selected Waste Rock samples (7)

3. Synthetic Precipitation Leaching Procedure (SPLP) (US EPA method 1312) for the selected Waste Rock samples (7)

Six tailings samples were made available following metallurgical testwork and were subjected to ABA, NAG, XRF, XRD Mineralogy (including Rietveld quantification) and SPLP testwork.

4.4 Logistics

Waste rock & construction material samples were shipped by Amara to the SGS Laboratory in Cornwall, who carried out the sample preparation, total sulphur via LECO® testing and ABA and NAG testing.

Following this testing, samples were transported to Royal Holloway University of London (RHUL) laboratories, where they were prepared for XRF and XRD analyses, and the SPLP leaching procedure was carried out with leachates dispatched to ALcontrol laboratories.

Six tailings samples were provided following testwork at Wardell Armstrong laboratories in Cornwall, UK. The tailings sample was dried and prepared at SGS, where it was then split, with SGS carrying out ABA and NAG testwork, and RHUL carrying out XRF, XRD and SPLP leaching. The SPLP leachate was analysed at ALcontrol.

4.5 Laboratories

SGS Minerals Services UK Ltd
Wheal Jane, Truro
Cornwall, UK, TR3 6EE

RHUL Laboratories
Department of Earth Sciences
Royal Holloway, University of London
Egham, Surrey TW20 0EX, UK

ALcontrol Laboratories
Hawarden Business Park, Manor Road,
Flintshire, UK, CH5 3US

4.6 Summary

A summary of the logistical information is provided in Table 4-3.

Table 4-3: Summary of sample numbers and laboratories used during the study.

	Testwork	Laboratory	# Samples
Construction Material Samples	Sample Preparation	SGS Cornwall	23
	Total Sulphur via LECO®	SGS Cornwall	23
	XRF	RHUL	23
Waste Rock Samples	Sample Preparation	SGS Cornwall	76
	ABA	SGS Cornwall	76
	NAG	SGS Cornwall	76
	XRF	RHUL	7
	XRD	RHUL	7
	SPLP Leaching Procedure	RHUL	7
	SPLP Leachate Analysis	ALcontrol	7
Tailings Sample	Sample Preparation	SGS Cornwall	6
	ABA	SGS Cornwall	6
	NAG	SGS Cornwall	6
	XRF	RHUL	6
	XRD	RHUL	6
	SPLP Leaching Procedure	RHUL	6
	SPLP	ALcontrol	6

5.0 RESULTS AND DISCUSSION

Laboratory results certificates are provided in Appendices E (SGS), F (RHUL) and G (ALcontrol).

5.1 Waste Rock Samples

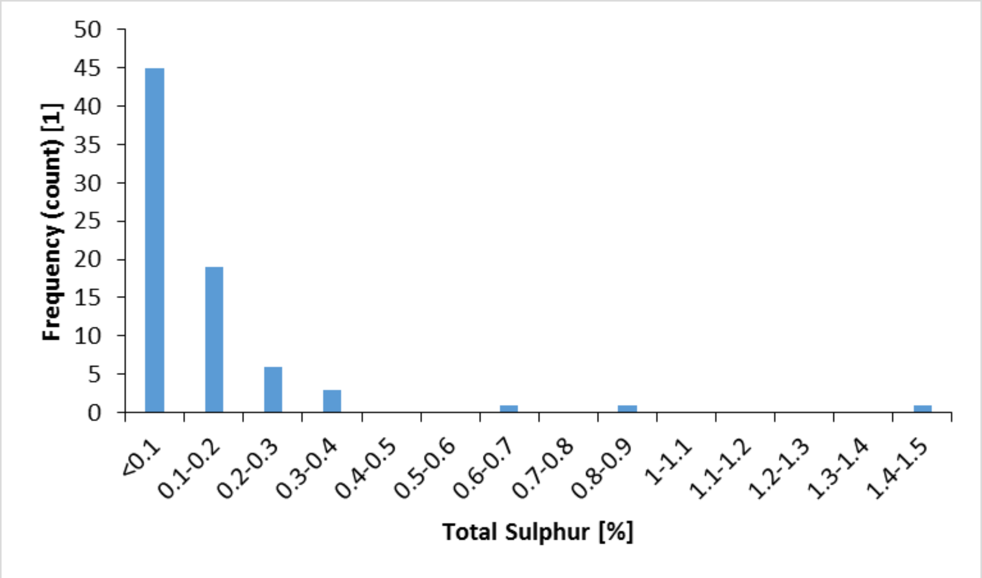
5.1.1 ABA and NAG

The 76 waste rock samples were subjected to ABA and NAG testwork, as discussed in Section 3.2.

Total Sulphur

As part of the ABA and NAG results for the 76 waste rock samples, total sulphur is measured. A histogram of the data overall is presented in Figure 5-1. The same data is shown according to lithology in Figure 5-2.

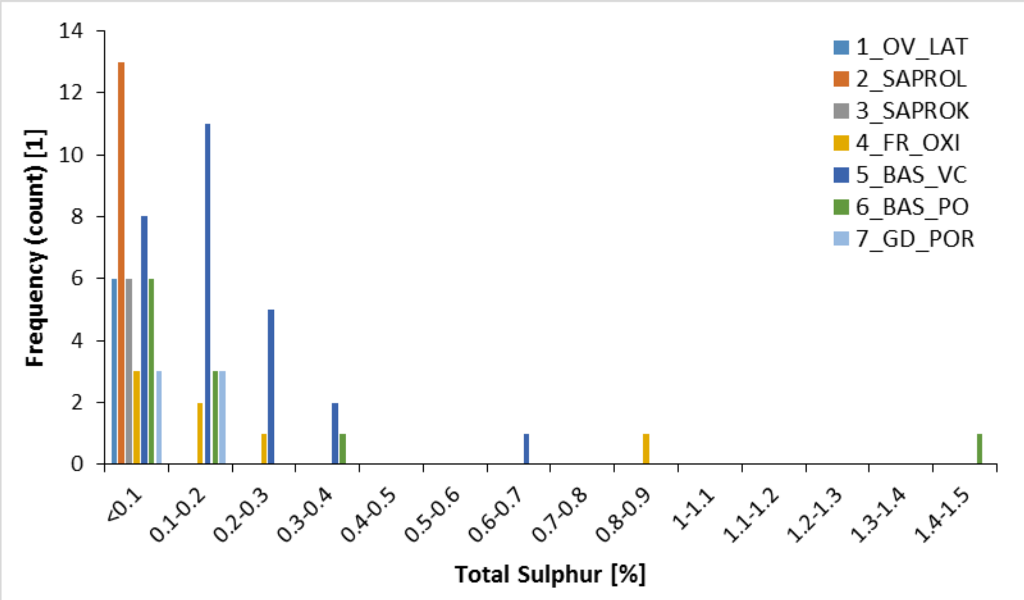
Figure 5-1: Histogram showing the total sulphur results for the waste rock samples.



59% (45/76) of the waste rock samples had total sulphur <0.1%. This is one of the EU Inert Waste classification criteria[4].

[4] EU Commission Decision of 30 April 2009 completing the definition of inert waste in implementation of Article 22(1)(f) of Directive 2006/21/EC of the European Parliament and the Council concerning the management of waste from extractive industries *(notified under document number C(2009) 3012)* (2009/359/EC).

Figure 5-2: Histogram showing total sulphur results per lithology for the waste rock samples.

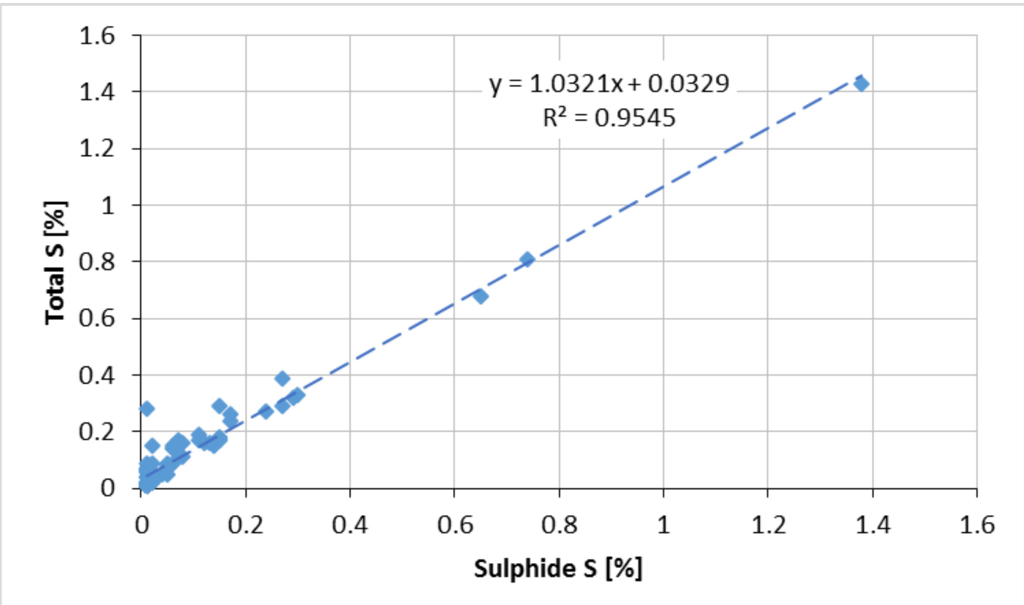


For waste rock samples, in terms of lithology, the samples coded as 1_OV_LAT, 2_SAPROL and 3_SAPROK all had total sulphur <0.1%, suggesting that these lithologies are unlikely to cause acid drainage. The other lithologies presented samples with total sulphur >0.1%, with lithology 5_BAS_VC presenting a notable peak in samples with 0.1% to 0.3% total sulphur. The highest total sulphur results were in lithologies 5_BAS_VC (0.68%), 4_FR_OXI (0.81%) and 6_BAS_PO (1.43%).

Sulphide Sulphur

There was a strong correlation between total sulphur and sulphide sulphur as shown in Figure 5-3, suggesting that total sulphur can be used as a good proxy for sulphide sulphur.

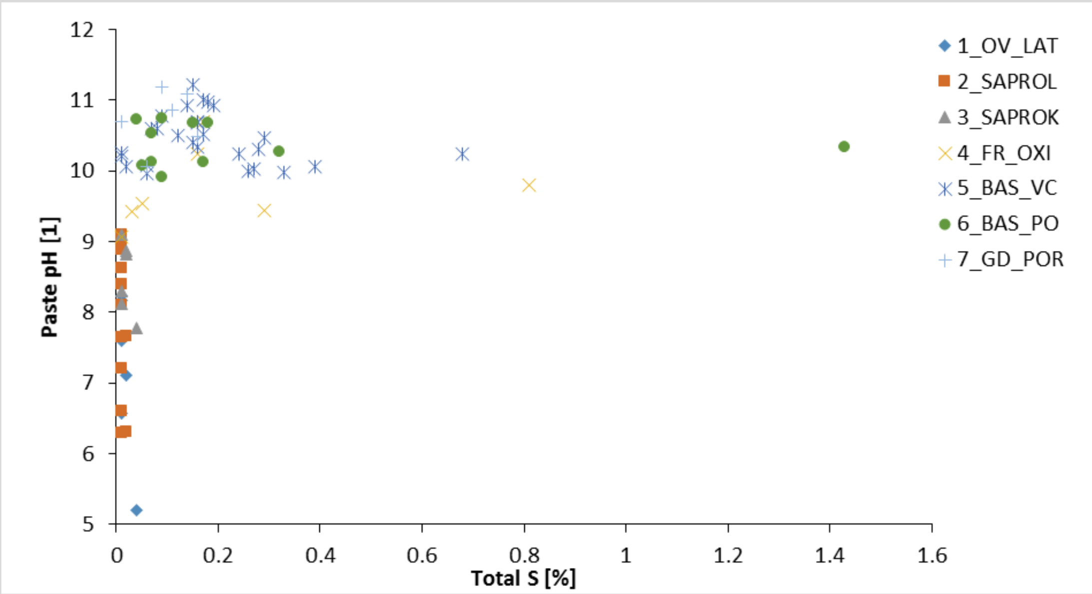
Figure 5-3: Plot showing good correlation between total sulphur and sulphide sulphur.



Paste pH

The paste pH results are displayed graphically in Figure 5-4. The average paste pH value for the 76 samples was 9.54, with a median of 10.07, minimum 5.20 and maximum 11.20.

Figure 5-4: Paste pH vs total sulphur results by lithology for the waste rock samples.



As can be seen in Figure 5-4, samples with total sulphur >0.1% all had paste pH results >9. The samples with paste pH <9 all had low total sulphur and are from the lithologies that would be expected to be oxidised, thus likely to contain mainly sulphate rather than sulphide, namely 1_OV_LAT, 2_SAPROL and 3_SAPROK.

The high paste pH values indicate that the samples have been stored/handled correctly and that if they contain sulphides, these are not oxidised on contact with the solution.

ABA - NNP

The NNP criteria is considered most appropriate assessment tool for the classification of these samples. As presented in Figure 5-5 and Table 5-1, 7 of 76 NNP results were classified as "Uncertain", with NNP's in the range -20- to +20 and Total Sulphur >0.1% with the remainder being classed as "not potentially acid generating". No samples were classified as "potentially acid generating" (NNP <-20, total sulphur >0.1%). This suggests that there may be neutralising minerals sufficient to neutralise any acid that may be generated.

Figure 5-5: NNP vs total sulphur results by lithology for the 76 waste rock samples.

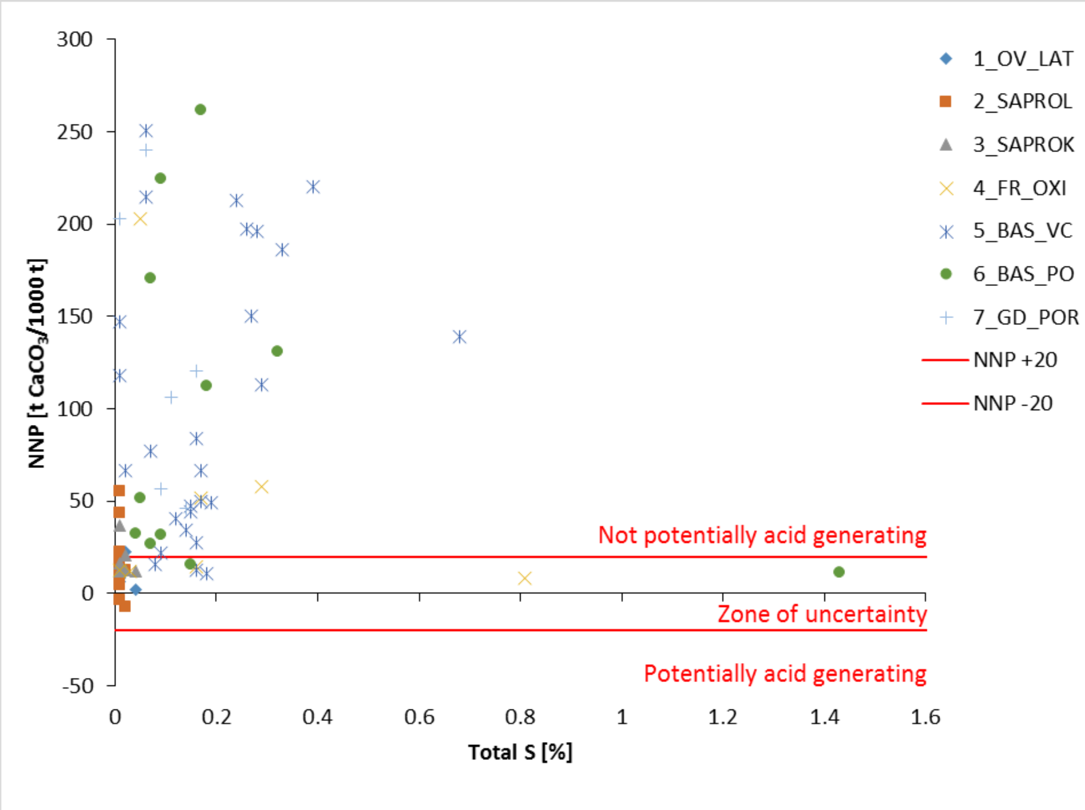


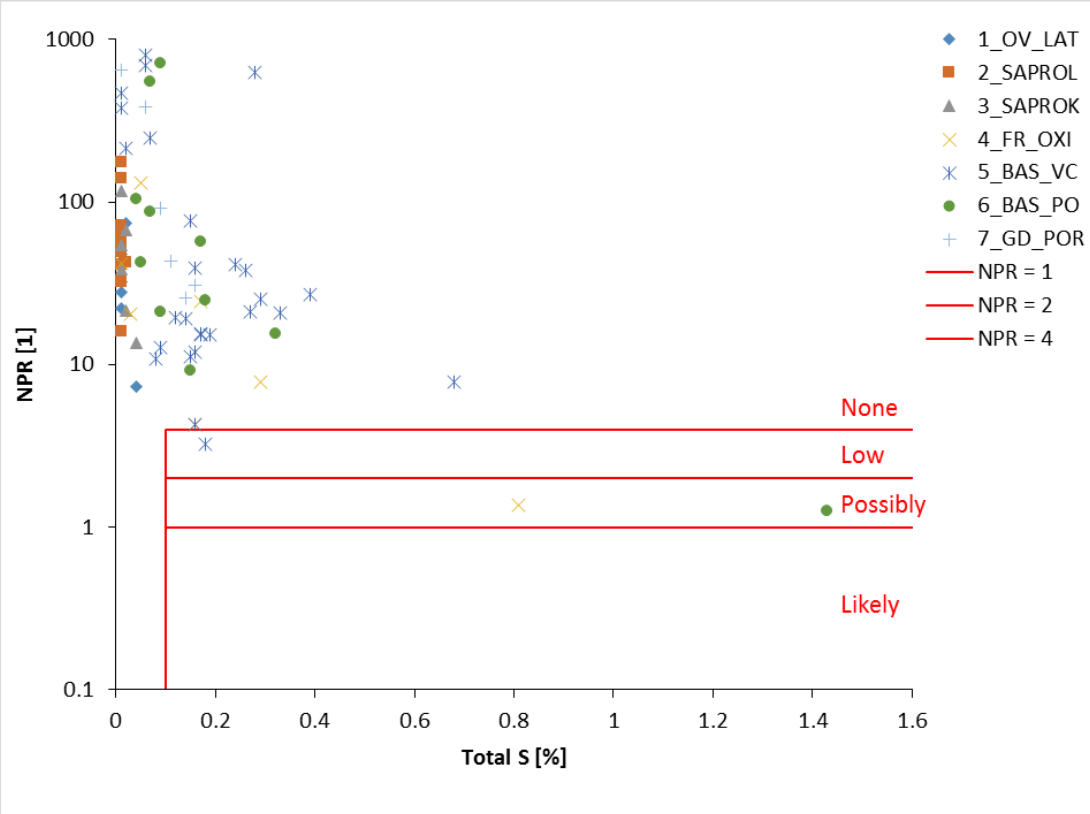
Table 5-1: Summary of the ABA NNP results by lithology.

Lithology	Not-PAG	Uncertain	Total
1_OV_LAT	6		*6*
2_SAPROL	13		*13*
3_SAPROK	5	1	*6*
4_FR_OXI	5	2	*7*
5_BAS_VC	25	2	*27*
6_BAS_PO	9	2	*11*
7_GD_POR	6		*6*
Total	**69**	**7**	***76***

ABA - NPR

The ABA NPR results are presented graphically in Figure 5-6 and summarised in Table 5-2. The two samples that were highlighted in the NNP results with high total sulphur and uncertain classification with regards to ARD potential are here classified as "possibly" acid generating (NPR between 1 - 2).

Figure 5-6: ABA NPR Results vs. total sulphur for waste rock samples.



Note: Two samples with negative NPs and therefore negative NPR, with total sulphur <0.01% are not displayed on this graph.

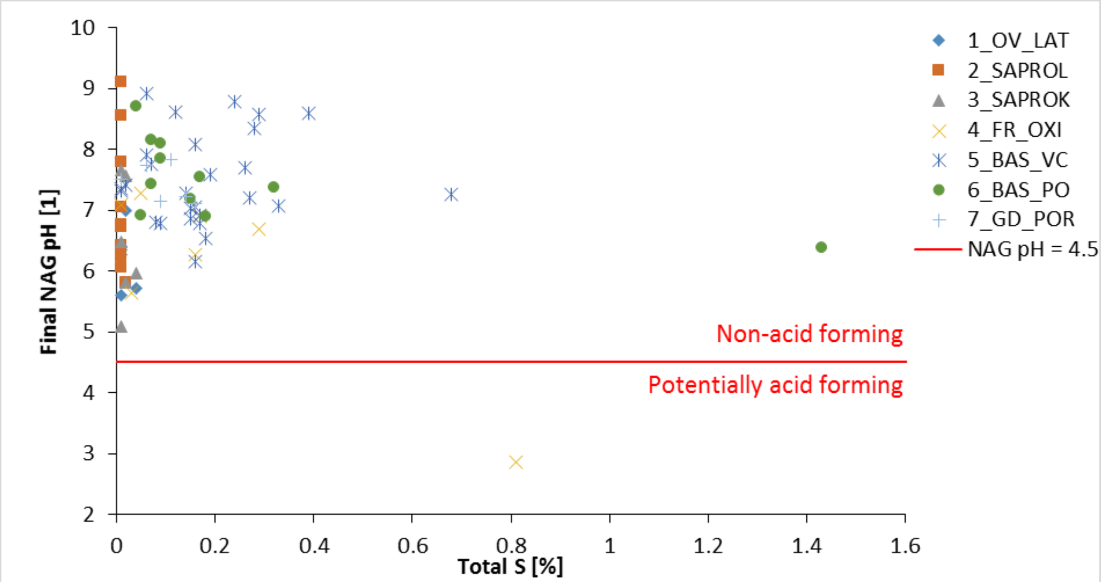
Table 5-2: Summary of the ABA NPR results by lithology.

Lithology	None	Low	Possibly	*Total*
1_OV_LAT	6			*6*
2_SAPROL	13			*13*
3_SAPROK	6			*6*
4_FR_OXI	6		1	*7*
5_BAS_VC	26	1		*27*
6_BAS_PO	10		1	*11*
7_GD_POR	6			*6*
Total	**73**	**1**	**2**	***76***

NAG Classification

Only one sample (lithology 4_FR_OXI, Sulphide S 0.74%) had a final NAG pH such that it was classified as “potentially acid forming” (final NAG pH <4.5), as is shown in Figure 5-7. The remaining 75 samples that were analysed were classified as “Non-acid forming”.

Figure 5-7: Final NAG pH vs total sulphur for waste rock samples. Only one sample was considered potentially acid forming with a NAG pH of 2.86.



Whilst the NAG results suggest that the sample with 1.43% total sulphur (Lithology 6_BAS_PO) is not acid generating, it should be borne in mind that single stage NAG testing was carried out, and for samples with total sulphur >1%, sequential NAG is recommended as the full acid potential may not have been realised.

Based on these results, seven samples as detailed in Table 5-3 were selected from the waste rock samples for further analysis through XRF, XRD and SPLP in order to characterise the different lithologies and covering the range of sulphur content of all the samples tested.

Table 5-3: Details of the waste rock samples selected for further analysis.

Sample Ref.	Lithology	Borehole ID	Total S [%]
003	7_GD_POR	YDD0031	0.11
046	6_BAS_PO	YDD0095	0.09
051	2_SAPROL	YDD0105	0.01
059	5_BAS_VC	YDD0121	0.68
062	6_BAS_PO	YDD0130	1.43
066	5_BAS_VC	YDD0137	0.16
086	4_FR_OXI	YDD0151	0.16

5.1.2 Whole Rock Analysis

XRF Results

The XRF results for major oxides and trace elements are given in Table 5-4 and Table 5-5 respectively for the waste rock samples. High 'loss on ignition' (LOI) values relate to high volatile contents (e.g. water and carbon dioxide) and a high ferrous iron content.

Table 5-4: Major Oxides XRF results for the 7 waste rock samples (%).

Sample Ref.	003	046	051	059	062	066	086	Average Earth Crust[5]
Lithology	7 GD_POR	6 BAS_PO	2 SAPROL	5 BAS_VC	6 BAS_PO	5 BAS_VC	4 FR_OXI	
SiO_2	61.01	51.79	51.53	44.82	47.89	48.81	48.90	59.07
TiO_2	0.48	1.02	1.23	0.98	1.03	1.09	0.82	1.03
Al_2O_3	14.00	14.42	17.17	12.78	13.67	14.33	14.15	15.22
Fe_2O_3	4.84	13.67	16.71	12.88	13.68	14.82	12.48	3.1
MnO	0.05	0.21	0.32	0.19	0.19	0.22	0.19	
MgO	2.65	7.49	1.92	6.26	6.24	6.77	7.62	3.45
CaO	4.60	11.16	0.71	11.26	10.98	9.86	9.67	5.1
K_2O	1.26	0.14	0.07	0.32	0.07	0.09	0.25	3.11
Na_2O	3.89	2.10	0.04	1.10	1.56	1.85	2.38	3.71
P_2O_5	0.19	0.09	0.07	0.08	0.09	0.09	0.07	0.3
Sum	**93.0**	**102.1**	**89.8**	**90.7**	**95.4**	**97.9**	**96.5**	
LOI	7.0	-2.1	10.2	9.3	4.6	2.1	3.5	

The average Earth's crust content has been included in Table 5-4 in order to put the composition of the samples into context. The granodiorite (sample 003) shows in general a similar composition to the Earth's crust composition and therefore significant change to the composition of this material would not be expected by being exposed to the atmosphere. For the rest of the samples tested, silica, sodium, potassium and phosphorus are below the average, while in general iron and calcium are above the average composition. The high concentration of calcium would support the results from the ABA testing indicating that a very small percentage of samples are potentially acid forming.

[5] From Levinson, A A, 1974. *Introduction to Exploration Geochemistry.* Reproduced in Australian Institute of Metallurgy *Field Geologists' Manual*, 4th ed., 2001.

Table 5-5: Trace element XRF results for the 7 waste rock samples (values in ppm unless stated otherwise).

Sample Ref.	003	046	051	059	062	066	086	Average Earth's Crust[5]
Lithology	7 GD_POR	6 BAS_PO	2 SAPROL	5 BAS_VC	6 BAS_PO	5 BAS_VC	4 FR_OXI	
As	18	10	6	<5	16	<5	5	1.8
Ba	685	34	341	39	37	37	44	425
Bi	5	5	6	4	6	6	6	0.17
Ce	58	19	34	26	14	21	27	60
Cl (%)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.013
Co	13	37	49	36	38	40	36	25
Cr	108	231	233	214	208	218	232	100
Cu	12	103	148	88	104	99	109	55
Ga	16	12	21	14	15	16	14	15
Ge	3	<3	<3	<3	<3	<3	<3	1.5
Hf	6	4	4	<3	<3	7	3	3
I	9	7	<2	6	3	2	5	0.5
La	23	<5	15	<5	<5	<5	<5	30
Mo	<2	<2	6	2	5	3	6	1.5
Nb	5	3	4	3	3	4	3	20
Ni	50	116	145	111	95	100	129	75
Pb	6	3	2	3	0.9	<1	5	12.5
Rb	34	3	2	11	1	2	10	90
S (%)	<0.005	0.009	<0.005	0.128	0.095	0.055	0.054	
Sb	15	<2	6	4	4	2	8	0.2
Sc	24	<15	243	<15	<15	<15	<15	16
Se	<3	<3	<3	<3	<3	<3	<3	0.05
Sn	10	11	9	8	10	13	13	2
Sr	369	134	16	108	127	127	126	375
Th	12	8	8	8	9	8	5	10
U	<3	<3	<3	<3	<3	<3	<3	2.7
V	86	298	398	324	305	323	276	135
W	<3	<3	<3	<3	<3	<3	<3	1.5
Y	11	22	47	22	25	25	19	30
Zn	40	89	318	93	93	99	87	70
Zr	109	60	83	61	62	64	50	165

The waste rock samples showed elevated As, Bi, I and Sb with respect to the average Earth's crust, indicating that these may be elements of environmental concern, with Cr and V also high in all samples except the Granodiorite (003).The Limit of Detection (LoD) for Se was too high with respect to the average Earth's crust to allow a conclusion to be reached.

Mineralogy (XRD Rietveld Quantification)

It is clear from the number of peaks in the XRD traces (see Figure 5-8) that the mineralogy of the samples is complex. However, the mineralogy is mostly dominated by plagioclase feldspar, chlorite, amphibole, calcite and K-mica (with lesser pyroxene, hematite and quartz in some samples).

For the quantification, additional minerals were identified and included in the calculations. The weight % of minerals present, derived from Rietveld quantification, is given in Table 5-6. Note that values below about 4% are less accurate and the presence of those phases given as below 1% is uncertain. Plagioclase feldspar has been modelled as albite and andesine; K-feldspar as orthoclase; amphibole as actinolite; and K-mica as muscovite and biotite.

Figure 5-8: XRD traces for the 7 waste rock samples.

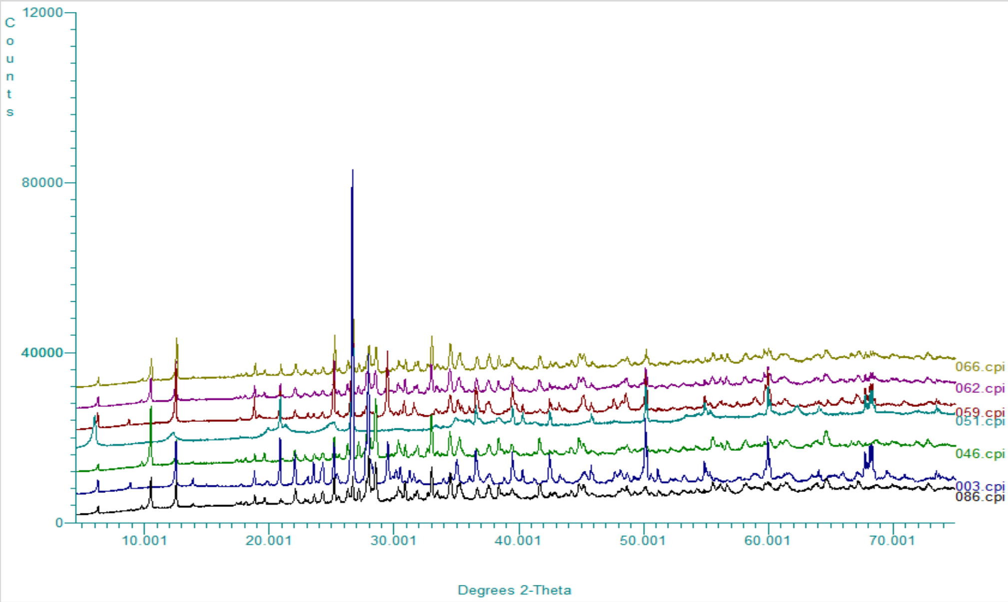


Table 5-6: XRD Rietveld Quantification Mineralogy results for the 7 waste rock samples.

Sample Ref.	003	046	051	059	062	066	086
Lithology	7 GD_POR	6 BAS_PO	2 SAPROL	5 BAS_VC	6 BAS_PO	5 BAS_VC	4 FR_OXI
Quartz	19.3	2.4	20.3	16.8	7.3	5.8	2.2
Graphite	7.0	0.6	6.7	8.8	4.6	2.8	0.9
Albite	39.1	30.0	3.2	15.2	20.4	22.6	29.6
Andesine	0.2	2.5	0.0	0.0	2.5	0.0	0.0
Muscovite	7.0	0.0	0.0	2.5	2.1	2.3	3.1
Biotite	0.7	0.3	1.5	3.9	0.9	0.9	0.9
Calcite	8.8	0.9	0.1	19.5	9.3	1.5	1.2
Kaolinite	0.9	0.4	28.5	0.1	0.0	0.0	0.0
Orthoclase	0.0	2.1	0.0	3.1	3.0	3.5	4.7
Garnet (Ca-Fe)	0.7	2.1	0.7	3.5	2.0	2.6	2.8
Pyroxene, ortho	10.1	4.0	0.0	0.5	1.2	1.7	4.6
Hematite	0.0	0.0	2.9	0.0	0.0	0.0	0.0
Pyrite	0.0	4.4	0.0	0.6	3.1	4.0	4.1
Jarosite	0.6	0.6	1.1	1.1	0.7	0.8	0.5
Actinolite	0.0	35.2	0.0	1.6	27.2	32.4	31.4
Chlorite	5.4	14.6	34.8*	22.7	15.7	19.0	14.0

* Abundant smectite (montmorillonite) present and included in this figure; possibly as a mixed layer phase.

The mineralogy of the waste rock samples analysed by XRD is dominated by ferromagnesian silicates (amphibole, chlorite, mica) and plagioclase feldspar. Some samples also contain elevated amounts of calcite, kaolinite and other silicates. This observation is supported by the XRF chemical analyses, which show high Fe, Mg, Ca, Al and Si.

There are some discrepancies between the pyrite content derived by Rietveld and from the total sulphur determinations. Assuming that the total sulphur analyses are correct, then the Rietveld analysis is over-predicting the pyrite content for samples 046 (6_BAS_PO), 066 (5_BAS_VC) and 086 (4_FR_OXI). In general the accuracy of Rietveld around 4% content is less reliable as noted previously.

Different minerals have different rates at which they release their neutralisation potential. Carbonates and fast weathering aluminium silicates are able, if present in sufficient quantity, to sustain a neutral pH. The mineralogy described in Table 5-6 is consistent with a limited number of samples with potential for acid generation. The granodiorite (sample ref 003) and basalt volcanic and porphyry (samples ref 059 and 062) have relatively high proportions of calcite in comparison with the average sulphide sulphur content for the samples tested and therefore this confirms that these samples are not acid forming.

Samples ref 046, 066 and 086 contain over 70% albite, actinolite and chlorite. Although these minerals are not fast weathering; they are able to release some alkalinity into the system. Therefore even if these samples contained the level of pyrite as calculated by Rietveld, significant acid generation would not be expected.

The saprolite sample (ref. 051) has no potential to generate acidity and contains significant amounts of clay minerals.

5.1.3 SPLP Leachate

Table 5-7 presents the pH and conductivity readings from the SPLP leachate. The SPLP leachates were alkaline pH. Table 5-8 presents the multi-element ICP sweep results for the leachate, with US EPA limits for key metals[6].

Table 5-7: SPLP leachate pH and Conductivity results for the 7 waste rock samples.

Sample	pH	Conductivity (µS/cm)
003	8.4	135
046	8.8	80
051	7.9	40
059	8.1	90
062	7.9	135
066	8.2	85
086	8.3	80

[6] US EPA SW846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods - Method 1312

Table 5-8: SPLP Leachate analysis results for the 7 waste rock samples.

	Units	LOD	003	046	051	059	062	066	086	US EPA[6]
Fluoride	**mg/l**	**<0.5**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Sulphate	**mg/l**	**<2**	<2	<2	<2	<2	<2	<2	<2	
Chloride	**mg/l**	**<2**	<2	<2	<2	<2	<2	<2	<2	
Nitrate as NO_3	**mg/l**	**<0.3**	0.335	<0.3	3.58	<0.3	<0.3	<0.3	<0.3	
Aluminium	**µg/l**	**<2.9**	657	820	421	556	572	653	330	
Mercury	**µg/l**	**<0.01**	<0.01	<0.01	0.0135	<0.01	<0.01	<0.01	<0.01	
Antimony	**µg/l**	**<0.16**	1.18	<0.16	<0.16	1.38	1.05	0.811	0.488	
Calcium	**mg/l**	**<0.012**	6.56	7.66	3.58	10.2	8.49	8.84	8.6	
Arsenic	**µg/l**	**<0.12**	10.8	1.87	0.281	0.325	1.01	0.38	0.877	5,000
Sodium	**mg/l**	**<0.076**	2.14	1.51	2.1	1.14	1.2	1.21	1.74	
Barium	**µg/l**	**<0.03**	41.1	1.86	0.988	4.43	1.75	0.835	7.45	100,000
Magnesium	**mg/l**	**<0.036**	0.617	1.29	1.53	1.18	1.12	1.25	1.75	
Beryllium	**µg/l**	**<0.07**	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	
Potassium	**mg/l**	**<1**	1.67	<1	<1	3.45	<1	<1	<1	
Silver	**µg/l**	**<1.5**	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	
Iron	**mg/l**	**<0.019**	<0.019	0.62	0.148	<0.019	<0.019	0.167	0.104	
Boron	**µg/l**	**<9.4**	<9.4	<9.4	<9.4	<9.4	<9.4	<9.4	<9.4	
Cadmium	**µg/l**	**<0.1**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1,000
Chromium	**µg/l**	**<0.22**	12	9.71	9.05	8.34	1.51	1.88	1.85	
Cobalt	**µg/l**	**<0.06**	<0.06	0.278	0.117	<0.06	<0.06	0.097	0.076	
Copper	**µg/l**	**<0.85**	<0.85	1.63	1.73	1.12	<0.85	<0.85	<0.85	
Lead	**µg/l**	**<0.02**	<0.02	0.036	<0.02	<0.02	<0.02	<0.02	0.1	5,000
Manganese	**µg/l**	**<0.04**	0.82	8.34	4.69	5.47	1.24	3.08	2.35	
Molybdenum	**µg/l**	**<0.24**	<0.24	<0.24	0.732	<0.24	0.41	0.274	10.5	
Nickel	**µg/l**	**<0.15**	<0.15	0.854	0.8	0.19	0.23	0.316	0.579	
Phosphorus	**µg/l**	**<6.3**	<6.3	34.1	<6.3	31.8	7.23	18.2	14.3	
Selenium	**µg/l**	**<0.39**	0.531	0.404	0.573	<0.39	0.614	0.639	0.708	
Strontium	**µg/l**	**<0.05**	59.1	10.3	9.86	22	10.2	27	10.3	
Tellurium	**µg/l**	**<2**	<2	<2	<2	<2	<2	<2	<2	
Thallium	**µg/l**	**<0.96**	<0.96	<0.96	<0.96	<0.96	<0.96	<0.96	<0.96	
Tin	**µg/l**	**<0.36**	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	
Uranium	**µg/l**	**<1.5**	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	
Titanium	**µg/l**	**<1.5**	<1.5	21.2	9.34	<1.5	<1.5	7.63	5.33	
Vanadium	**µg/l**	**<0.24**	1.42	6.21	2.6	0.507	1.58	2.46	3.85	
Zinc	**µg/l**	**<0.41**	<0.41	0.739	4.36	<0.41	<0.41	<0.41	<0.41	

Arsenic, bismuth, indium and antimony were identified as elements of concern in terms of metal leachability in Section 5.1.2. Considering that the waste rock samples were found that have no or limited potential for acid generation, the results presented in Table 5-8 suggest that the metal leachability of these elements are unlikely to be significant under neutral pH.

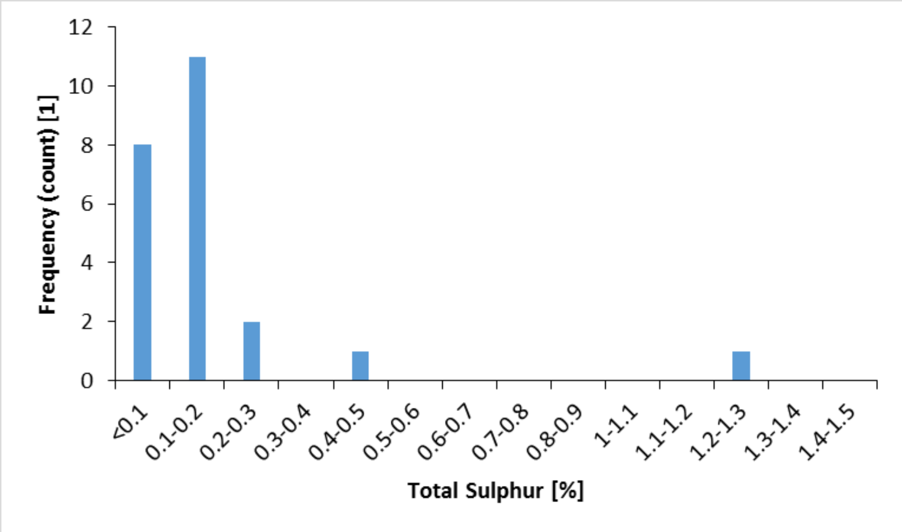
5.2 Construction Materials

The objective of the testing was to document whether mine waste could be used as construction material for the TMF. Samples that were selected for geotechnical testing were also characterised in a staged approach in order to minimise testing cost.

5.2.1 Total Sulphur

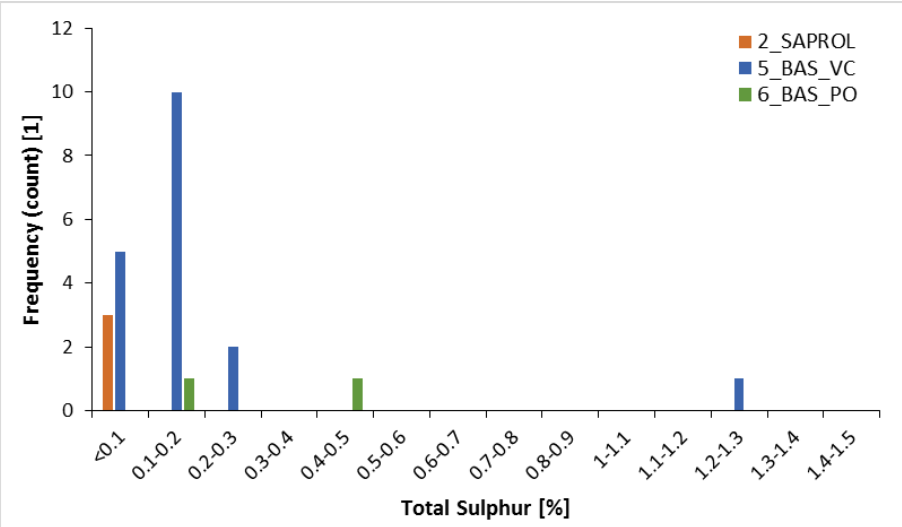
23 Construction Material samples were subjected to Total Sulphur via LECO analyses. Figure 5-9 shows the results for all samples, this is further split by lithology in Figure 5-10.

Figure 5-9: Histogram showing the total sulphur results for the construction material samples.



As discussed previously, without the presence of sulphides there is no driving force for acid generation and therefore this was the first step in the characterisation of the construction materials. Usually materials with less than 0.1% total sulphur have no or very limited capacity to generate acidity. This is one of the factors used by the European Union to classify samples as inert.

Figure 5-10: Histogram showing total sulphur results per lithology for the construction material samples.



The majority (18/23) of the construction material samples were of lithology 5_BAS_VC, which showed a peak in samples with 0.1-0.2% total sulphur, and one sample with 1.24% total sulphur. It is likely that this sample contains a veinlet of sulphidic material.

A comparison of the total sulphur content of the construction material and waste rock samples (see Figure 5-11, below) suggest that the construction material samples appear to have on average higher total sulphur than the waste rock samples.

Figure 5-11: Chart showing the relative proportions of waste rock and construction material samples in each total sulphur range.

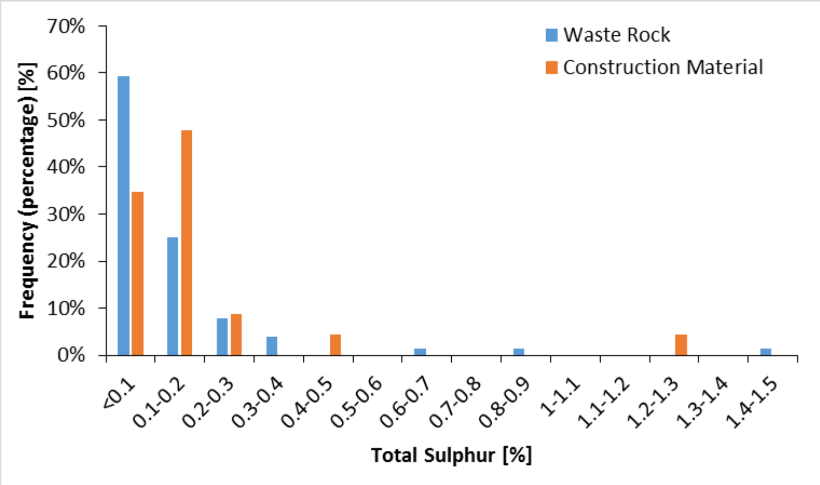
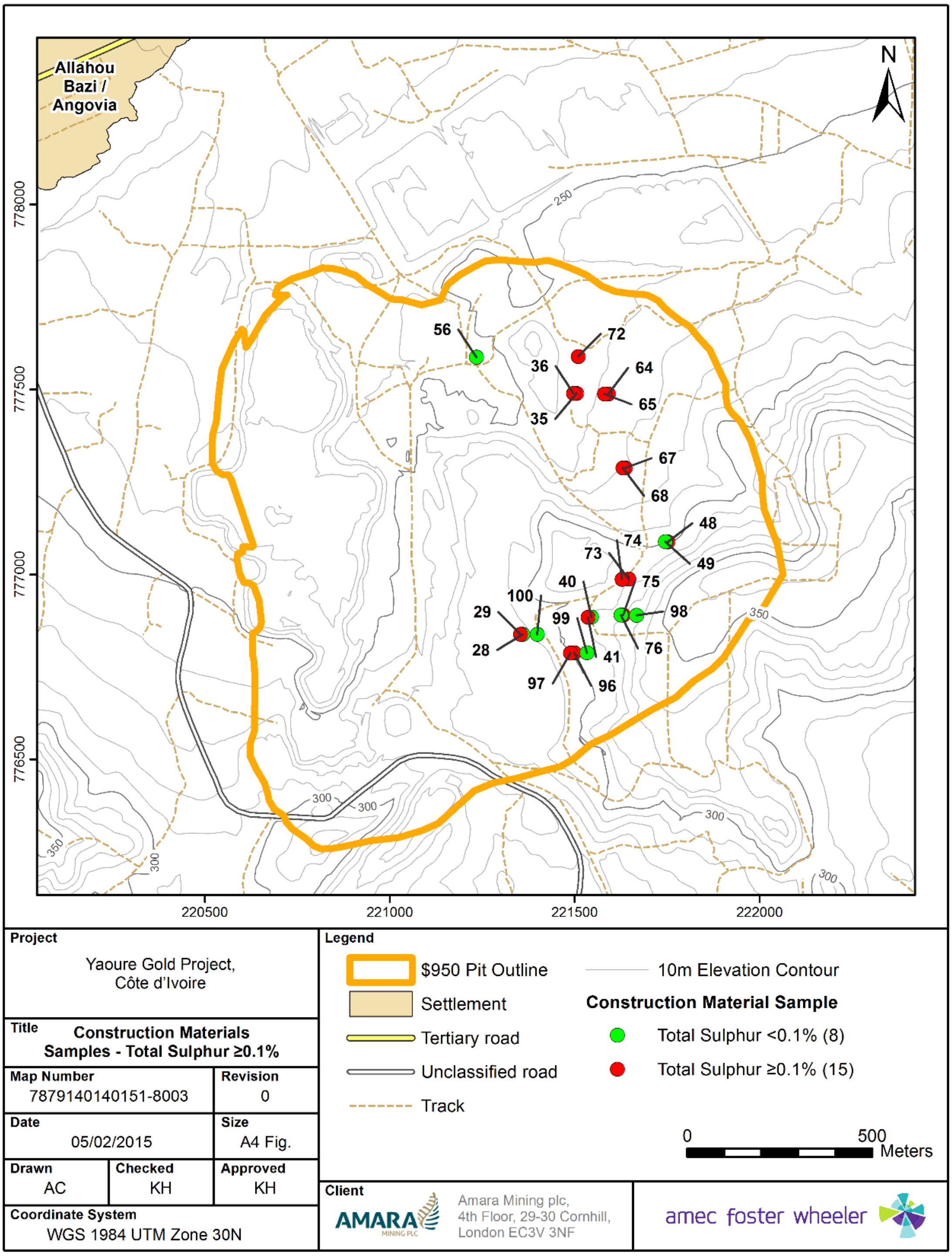


Figure 5-12 shows the location of the construction materials samples with a relatively higher total sulphur content.

Figure 5-12: Location of construction material samples with total sulphur ≥0.1%.



Looking at the distribution of the construction material samples, the ones with the relatively higher total sulphur content span between 61 and 118 metres in vertical spread and from the figure above across the designated area for the sources of construction materials. This would suggest that there is a need to better understand the likely behaviour of these materials whether they are used or not for the initial intended purpose.

5.2.2 XRF

The XRF results are summarised as averages per lithology in Table 5-9 for major oxides and Table 5-10 for trace elements.

Table 5-9: Average XRF major oxides by lithology for the construction material samples (%).

	2_SAPROL	5_BAS_VC	6_BAS_PO	Average Earth's Crust[5]
SiO_2	47.27	47.03	44.56	59.07
TiO_2	1.22	0.88	1.07	1.03
Al_2O_3	21.64	13.66	13.46	15.22
Fe_2O_3	18.57	12.34	14.36	3.10
MnO	0.15	0.18	0.20	
MgO	0.45	6.64	6.45	3.45
CaO	0.16	10.21	9.72	5.10
K_2O	0.41	0.25	0.03	3.11
Na_2O	<0.05	1.74	1.28	3.71
P_2O_5	0.06	0.07	0.09	0.30
Sum	89.99	93.01	91.20	
LOI	10.01	6.99	8.80	

The average results for the saprolite and the basalt samples are within the range of values expected for this type of lithology when compared with the average Earth's crust composition. However, all samples have above average iron content and in the case of the basalts have higher calcium and magnesium content than the average Earth's crust composition. This might be an indication of the presence of minerals with some neutralization potential.

Table 5-10: Average XRF trace elements by lithology for the construction material samples (values in ppm unless stated otherwise).

Element	2_SAPROL	5_BAS_VC	6_BAS_PO	Average Earth's Crust[5]
As	15.07	<9.11	<13.00	1.8
Ba	181.10	<32.73	23.00	425
Bi	5.83	5.24	5.45	0.17
Ce	33.67	25.38	25.65	60
Cl (%)	<0.005	<0.005	<0.005	0.013
Co	67.07	36.84	44.05	25
Cr	366.73	233.18	217.65	100
Cu	228.77	95.38	133.75	55
Ga	23.03	13.97	15.55	15
Ge	<3.10	<3.03	<3.00	1.5
Hf	5.60	<4.33	<3.00	3
I	<4.47	<4.55	<5.55	0.5
La	<6.83	<5.04	<5.00	30
Mo	<9.50	<8.21	<2.00	1.5
Nb	3.97	<2.51	3.30	20
Ni	164.27	123.23	106.15	75
Pb	<2.37	<2.35	4.35	12.5
Rb	12.27	<7.48	<1.00	90
S (%)	<0.005	<0.035	0.098	
Sb	8.00	<6.77	6.30	0.2
Sc	342.83	<15.77	<15.00	16
Se	<3.00	<3.00	<3.00	0.05
Sn	11.57	11.84	11.25	2
Sr	10.07	139.47	171.85	375
Th	7.40	7.79	8.40	10
U	<3.00	<3.00	<3.00	2.7
V	394.87	297.14	334.55	135
W	<12.60	<3.00	<3.00	1.5
Y	30.97	19.99	24.00	30
Zn	94.83	84.79	100.20	70
Zr	75.67	52.27	62.65	165

On average, the construction material samples had elevated As, Bi, Cr, Cu, I, Mo, Ni, Sb, Sn with respect to the average Earth's crust, indicating that these may be elements of environmental concern. Sc was elevated in the 2_SAPROL lithology. The Limit of Detection (LoD) for Se was too high with respect to the average Earth's crust to come to a conclusion.

By comparing the elements of environmental concern for the construction materials and the waste rock it appears that the construction materials are more mineralised than the waste rock and therefore also consistent with their higher total sulphur content.

Based on the limited testing undertaken it is not possible to conclude that these samples are not acid generating or present no metal leachability issues. Therefore, from a geochemical perspective, the waste rock as presented in section 5.1 seems to be a better construction material.

5.3 Tailings Samples

Six tailings samples were provided following the metallurgical testwork, as detailed in Table 5-11.

Table 5-11: Details of the 6 tailings samples and expected tonnages (from the PEA).

Code	Domain	SGS Sample No. (SGS 567-)	Tonnage (Mt)
YO	Yaouré Oxide	1006	4.87
YT	Yaouré Transition	1007	8.77
Y CMA U	Yaouré CMA Sulphide Upper	1008	13.36
Y CMA L	Yaouré CMA Sulphide Lower	1009	24.26
YU	Yaouré Sulphide Upper	1010	12.29
YL	Yaouré Sulphide Lower	1011	29.26

The procedure followed for the generation of these samples is consistent with a conventional milling and cyanidation circuit.

5.3.1 Pre-leaching results

Pre-leaching results were provided by the metallurgist.

Table 5-12: Key metals, Sulphur and Carbon results for the head samples, (pre-leach).

Element	Unit	YO	YT	Y CMA U	Y CMA L	YU	YL
Au	ppm	1.23	1.33	3.35	2.82	2.44	2.69
Calculated Au	ppm	1.5	1.64	2.85	2.88	2.03	1.75
ALS Check Au	ppm	1.29	2.29		2.85	3.14	3.5
Ag	ppm	0.61	0.28	0.4	0.34	0.5	0.32
Cu	%	0.016	0.015	0.007	0.007	0.019	0.014
Pb	%	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Zn	%	0.011	0.006	0.005	0.006	0.005	0.004
S(sul)	%	0.016	0.32	0.79	1	0.68	0.43
S(tot)	%	0.038	0.35	0.84	1.04	0.72	0.46
C(org)	%	0.03	0.01	0.01	0.02	0.02	0.01
C(tot)	%	0.064	1.6	3.18	3.15	1.37	1.81
ALS Check C(tot)	%	0.05	1.67	3.26	3.22	1.41	1.83

Table 5-13: XRD results for the head samples, (pre-leach) [%].

Mineral	YO	YT	Y CMA U	YCMA L	YU	YL
?Vermiculite	3.9	1.3	0.0	0.0	0.0	0.0
Illite+Mica	12.1	12.3	11.5	9.5	8.4	11.1
Serpentine	12.3	0.0	0.0	0.0	0.0	0.0
Chlorite	7.5	21.8	19.5	18.1	25.0	24.6
Quartz	41.4	26.8	18.5	23.4	30.6	25.1
K Feldspar	2.8	1.2	1.3	1.6	1.8	0.0
Plagioclase	8.3	15.8	13.4	14.1	15.0	13.3
Amphibole	0.0	0.0	TR	0.0	1.0	1.8
Calcite	0.0	2.1	1.0	1.6	7.3	7.2
Fe-Dolomite	0.0	18.6	32.1	28.6	7.7	14.2
Siderite	0.0	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.0	2.6	3.1	3.1	2.6
Hematite	2.1	0.0	0.0	0.0	0.0	0.0
Goethite	9.6	0.0	0.0	0.0	0.0	0.0
Total	*100*	*100*	*100*	*100*	*100*	*100*

Table 5-14: ICP results for the head samples, (pre-leach).

Element	Unit	YO	YT	Y CMA U	YCMA L	YU	YL
Ag	ppm	0.48	0.24	0.61	0.3	0.57	0.29
Al	%	7.29	6.19	5.73	5.75	6.27	6.28
As	ppm	40.9	17.3	7.9	8.2	13.9	21.8
Ba	ppm	230	240	260	320	240	260
Be	ppm	1.02	0.77	0.9	0.91	0.72	0.82
Bi	ppm	10.25	1	0.34	0.62	1.29	2.92
Ca	%	0.34	3.14	5.81	5.86	5.11	5.68
Cd	ppm	0.12	0.11	0.08	0.09	0.1	0.07
Ce	ppm	17.2	27.5	57.8	62.5	20.3	29.9
Co	ppm	57.8	38.3	36.9	38	35.1	34.7
Cr	ppm	281	215	197	197	133	156
Cs	ppm	1.94	1.68	1.24	1.44	1.39	2.53
Cu	ppm	144.5	130	84.1	81.7	169.5	141
Fe	%	8.41	6.08	6.64	6.48	5.77	5.67
Ga	ppm	16.7	16.8	14.1	14.55	15.85	16.05
Ge	ppm	0.2	0.15	0.18	0.2	0.15	0.17
Hf	ppm	1.1	1.6	1.4	1.4	1.5	1.7
In	ppm	0.064	0.057	0.054	0.055	0.054	0.05
K	%	0.99	1.08	1.09	0.98	0.81	1.13
La	ppm	8.8	11.8	26.3	25.1	9	12.9
Li	ppm	14.5	16.8	14.6	15	13.6	17
Mg	%	1.21	2.7	3.12	3.17	2.6	2.74
Mn	ppm	1230	971	1130	1110	939	994
Mo	ppm	8.97	8.25	8.87	16.35	5.46	15.35
Na	%	0.62	1.66	1.83	1.98	1.73	1.61
Nb	ppm	1.5	2.7	3.1	3.1	2.8	3
Ni	ppm	141.5	115	111.5	114.5	88.2	98
P	ppm	430	540	1090	1110	450	580
Pb	ppm	6.1	4.9	5	6.6	8.3	6
Rb	ppm	35.6	42.3	36.4	35.5	29.3	42.1
Re	ppm	0.002	0.009	0.004	0.004	0.006	0.008
S	%	0.01	0.33	0.85	1.07	0.73	0.47
Sb	ppm	3.35	2.53	3.2	3.22	2.33	2.47
Sc	ppm	36.2	30.3	27.5	27.5	24.8	26.3
Se	ppm	2	2	1	1	2	2
Sn	ppm	1.4	0.7	0.5	0.6	0.7	0.8
Sr	ppm	50	172	278	350	229	250
Ta	ppm	0.11	0.24	0.17	0.16	0.2	0.2
Te	ppm	2.61	0.59	0.91	1.12	0.87	2.01
Th	ppm	1.1	1.7	2.3	2.4	1.6	2
Ti	%	0.334	0.362	0.373	0.356	0.403	0.374
Tl	ppm	0.2	0.2	0.17	0.16	0.14	0.2
U	ppm	0.4	0.5	0.6	0.6	0.6	0.7
V	ppm	307	205	210	193	178	177
W	ppm	24.8	22.7	23.2	23.9	9.5	17.5
Y	ppm	9.6	10.4	9.1	8.6	13.2	12.3
Zn	ppm	117	78	82	79	72	69
Zr	ppm	38.1	54.4	53.9	59.4	48	56.1

5.3.2 ABA and NAG Results

The ABA and NAG results for the tailings are summarised in Table 5-15.

Table 5-15: Summary of the ABA and NAG results for the six tailings samples.

Parameter [units]	**YO**	**YT**	**Y CMA U**	**Y CMA L**	**YU**	**YL**
Paste pH [1]	8.48	8.10	8.77	8.57	8.75	8.57
Total Sulphur [%]	0.03	0.33	0.79	0.98	0.7	0.44
Sulphide [%]	0.02	0.3	0.76	0.95	0.66	0.41
Carbonate [%]	0.18	1.68	3.27	3.2	1.54	1.9
NP1 [t $CaCO_3$/1000 t]	12.4	138.2	242.0	24.1	132.0	161.2
AP [t $CaCO_3$/1000 t]	0.6	9.4	23.8	29.7	20.6	12.8
Net NP [t $CaCO_3$/1000 t]	11.8	128.8	218.3	-5.6	111.4	148.4
NP/AP [1]	19.9	14.7	10.2	0.8	6.4	12.6
NAG Final pH [1]	6.00	6.42	7.75	8.15	7.19	6.40

NB: [1] denotes that the measurement is dimensionless (has no units).

Based on the above ABA results presented in Table 5-15, the only sample that is potentially acid generating is Y CMA L. However the NAG test would suggest otherwise.

5.3.3 Whole (Rock) Tailings Analysis

XRF

The XRF results are presented for the tailings samples in Table 5-16 for major oxides and Table 5-17 for trace elements.

Table 5-16: Average XRF major oxides by lithology for the tailings samples (%).

	YO	**YT**	**Y CMA U**	**Y CMA L**	**YU**	**YL**	**Average Earth Crust**[5]
SiO_2	56.93	50.99	45.07	45.34	54.57	51.12	59.07
TiO_2	0.99	0.77	0.76	0.72	0.71	0.65	1.03
Al_2O_3	15.17	12.92	11.11	10.98	12.51	12.33	15.22
Fe_2O_3	13.35	9.87	10.02	9.64	9.11	8.73	3.1
MnO	0.16	0.14	0.15	0.15	0.13	0.14	
MgO	2.37	5	5.35	5.35	4.64	4.78	3.45
CaO	0.69	4.71	8.13	8.27	7.48	8.06	5.1
K_2O	1.34	1.46	1.36	1.24	1.06	1.43	3.11
Na_2O	0.96	2.38	2.41	2.54	2.35	2.14	3.71
P_2O_5	0.1	0.12	0.23	0.23	0.1	0.13	0.3
Sum	92.1	88.4	84.8	84.7	92.9	89.6	
LOI_{xrf}	7.9	11.6	15.2	15.3	7.1	10.4	

Iron content is above while sodium and potassium are below average

Table 5-17: XRF trace elements concentrations for the tailings samples (values in ppm unless stated otherwise).

	YO	YT	Y CMA U	Y CMA L	YU	YL	Average Earth Crust[5]
As	33	11	5	5	9	13	1.8
Ba	256	305	315	399	273	330	425
Bi	13	5	7	5	6	6	0.17
Ce	33	47	63	53	41	27	60
Cl (%)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	
Co	39	30	30	29	25	25	25
Cr	282	340	411	422	519	436	100
Cu	136	95	63	61	115	96	55
Ga	19	16	13	14	15	14	15
Ge	3	3	< 3	< 3	3	< 3	1.5
Hf	4	4	4	7	9	< 3	3
I	4	6	6	11	4	<2	0.5
La	9	6	27	29	<5	6	30
Mo	14	23	29	37	52	46	1.5
Nb	2	4	4	4	3	4	20
Ni	156	169	179	181	260	195	75
Pb	12	5	5	8	13	7	12.5
Rb	40	40	39	36	31	42	90
Sb	7	6	11	14	2	6	0.2
S (%)	<0.005	0.06	0.21	0.28	0.21	0.12	
Sc	186	55	<15	<15	<15	<15	16
Se	< 3	< 3	< 3	< 3	< 3	< 3	0.05
Sn	11	9	9	8	7	7	2
Sr	53	176	261	330	220	239	375
Th	< 3	7	5	9	5	6	10
U	< 3	< 3	< 3	< 3	< 3	< 3	2.7
V	389	280	287	265	215	220	135
W	24	6	17	15	< 3	< 3	1.5
Y	23	15	15	14	13	12	30
Zn	131	75	77	77	74	63	70
Zr	77	76	71	70	69	70	165

The results presented would suggest that the following elements are of potential environmental concern: As, Bi, I, Mo, Sb and W. Other elements that are above average are: Cr, Cu, Ni, Sn and V. The detection limit for Se did not allow to reach any conclusion.

Mineralogy (XRD Rietveld)

It is immediately clear from the number of peaks that the mineralogy of the samples is complex. However, the mineralogy is mostly dominated by quartz, plagioclase feldspar, chlorite, pyroxene, carbonates and K-mica. Figure 5-13 shows the XRD trace for tailings sample YO (Oxide tailings, Sample No.1006). The other 5 tailings samples showed broad similarity, demonstrated in Figure 5-14.

For the quantification, additional minerals were identified and included in the calculations. The weight % of minerals present, derived from Rietveld quantification, is given in Table 5-18. Note that values below about 4% are less accurate and the presence of those phases given as below 1% is uncertain. For the quantification, plagioclase feldspar has been modelled as andesine; K-feldspar as orthoclase; amphibole as hornblende (pargasite); K-mica as both muscovite and biotite; chlorite as an Fe-rich variety (chamosite); and pyroxene as a mixture of both ortho- and clino-varieties. Although calcite has been identified in some samples, there is also an abundance of another carbonate (the large peak at 31°); this has been modelled as ankerite (a Ca-Fe-Mg carbonate).

Although the main phases have been clearly identified, the matches between observed and modelled traces are not always ideal. This is probably due to problems with modelling the exact varieties of silicates present – especially feldspar, pyroxene, amphibole and chlorite.

Figure 5-13: XRD trace for sample 1006 with peak markers for the main minerals present.

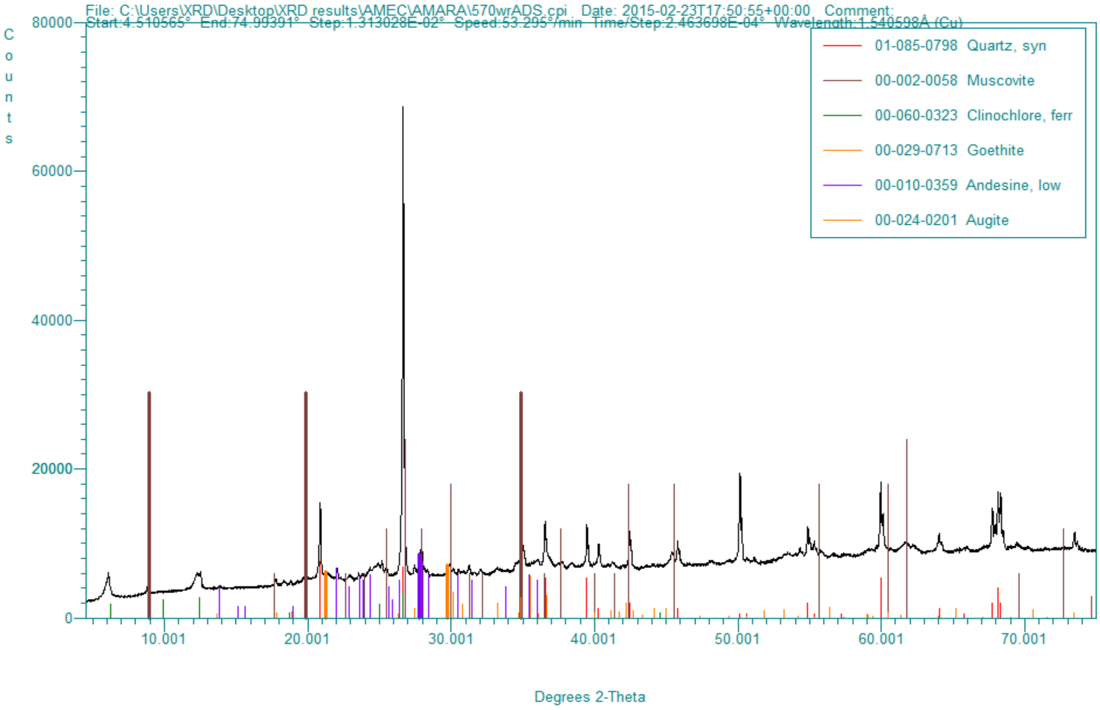


Figure 5-14: XRD traces for the 5 similar samples

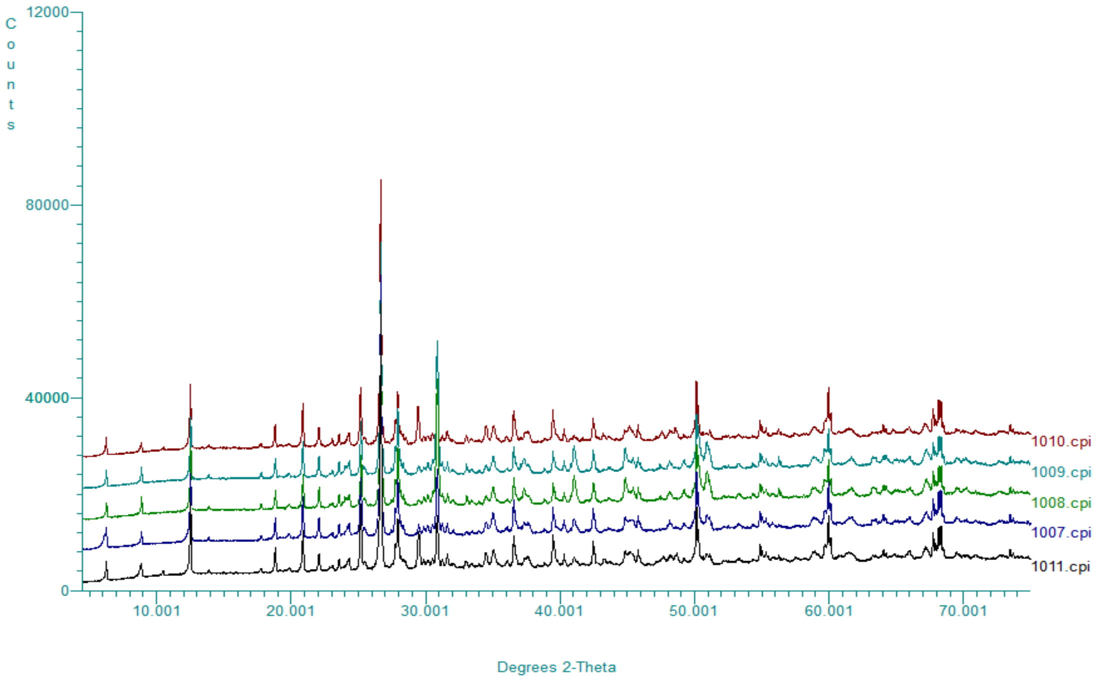


Table 5-18: XRD Rietveld Quantification Mineralogy results for the 6 tailings samples (wt %).

Phase	YO	YT	Y CMA U	Y CMA L	YU	YL
Quartz	40.1	22.6	19.3	18.8	24.7	23.8
Chlorite	28	17.9	12.1	12.2	19.9	17
Muscovite	9.3	9.5	9.7	6.9	5.6	6.9
Biotite	1.6	0.9	0.5	1.5	1.2	2.3
Calcite	0	1.8	0.9	1.2	6.9	7.4
Ankerite	1	15.9	29	19.7	11.3	12.1
Goethite	3.7	0.6	0.4	0.7	0.2	0.3
Hematite	0.6	0	0	0	0	0
Pyrite	0	0.7	1.3	2.1	2.4	2.1
Orthoclase	0	0.5	0.5	0.9	0	0.3
Andesine	7.4	13.7	14.1	17.4	19	17.5
Hornblende	2.1	1.8	1.3	0.9	2.9	4.4
Pyroxene	3.8	11.6	9.1	16.3	4.4	4.5
Diaspore	2.4	2.3	1.7	1.4	1.5	1.3

Sample 1006 (oxide tailings) is distinctive because it is dominated by quartz, Fe oxides/hydroxides, K-mica and chlorite. Carbonate content is low. The mineralogy of the other 5 samples is dominated by quartz, ferromagnesian silicates (amphibole, chlorite, mica) and plagioclase feldspar. Some samples also contain elevated amounts of carbonate (including calcite). This observation is supported by the chemical analyses, which show high Fe, Mg, Ca, Al and Si, and some K and Na.

5.3.4 SPLP Leachate

Table 5-19 presents the pH and conductivity readings from the SPLP leachate. The SPLP leachates were alkaline pH. Table 5-20 presents the multi-element ICP sweep results for the leachate, with US EPA limits for key metals[6].

Table 5-19: SPLP leachate pH and Conductivity results for the 6 tailings samples.

Sample	pH	Conductivity [µs/cm]
YO	9.1	230
YT	8.2	180
Y CMA U	8.2	180
Y CMA L	8.2	160
YU	7.7	175
YL	7.7	175

Table 5-20: SPLP Leachate analysis results for the 6 tailings samples.

	Units	LOD	YO	YT	Y CMA U	Y CMA L	YU	YL	US EPA
Fluoride	**mg/l**	**<0.5**	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	
Sulphate	**mg/l**	**<2**	<2	<2	<2	<2	<2	<2	
Chloride	**mg/l**	**<2**	<2	<2	<2	<2	<2	<2	
Nitrate as NO_3	**mg/l**	**<0.3**	0.411	<0.3	<0.3	<0.3	0.58	0.467	
Aluminium	**µg/l**	**<2.9**	171	29.7	286	358	288	188	
Mercury	**µg/l**	**<0.01**	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
Antimony	**µg/l**	**<0.16**	0.72	0.659	0.555	0.524	1.35	1.78	
Calcium	**mg/l**	**<0.012**	1.4	11.4	12.8	13.1	14.2	15.7	
Arsenic	**µg/l**	**<0.12**	14.7	1.87	0.725	0.828	0.792	1.74	5,000
Sodium	**mg/l**	**<0.076**	26.8	7.76	3.48	2.66	2.15	1.46	
Barium	**µg/l**	**<0.03**	0.449	1.38	93.5	86.7	5.48	4.56	100,000
Magnesium	**mg/l**	**<0.036**	0.268	2.76	4.8	4.77	2.97	2.23	
Beryllium	**µg/l**	**<0.07**	<0.07	<0.07	<0.07	<0.07	<0.07	<0.07	
Potassium	**mg/l**	**<1**	<1	1.47	2.95	2.89	2.7	4.16	
Silver	**µg/l**	**<1.5**	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	
Iron	**mg/l**	**<0.019**	0.427	<0.019	<0.019	<0.19	<0.019	<0.019	
Boron	**µg/l**	**<9.4**	<9.4	<9.4	<9.4	<9.4	<9.4	<9.4	
Cadmium	**µg/l**	**<0.1**	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1,000
Chromium	**µg/l**	**<0.22**	9.09	7.99	8.5	8.64	8.23	8.77	
Cobalt	**µg/l**	**<0.06**	1.31	0.101	0.356	0.251	0.143	0.098	
Copper	**µg/l**	**<0.85**	1.04	<0.85	<0.85	<0.85	<0.85	<0.85	
Lead	**µg/l**	**<0.02**	0.115	<0.02	<0.02	<0.02	0.051	<0.02	5,000
Manganese	**µg/l**	**<0.04**	3.23	2.16	3.93	3.99	5.23	5.13	
Molybdenum	**µg/l**	**<0.24**	6.27	1.51	2.03	3.22	1.41	1.1	
Nickel	**µg/l**	**<0.15**	4.02	0.161	0.399	0.351	0.319	0.307	
Phosphorus	**µg/l**	**<6.3**	138	<6.3	<6.3	<6.3	8.61	<6.3	
Selenium	**µg/l**	**<0.39**	0.667	1.66	0.934	1.1	1.39	1.64	
Strontium	**µg/l**	**<0.05**	3.76	25.5	110	428	48.8	58.9	
Tellurium	**µg/l**	**<2**	<2	<2	<2	<2	<2	<2	
Thallium	**µg/l**	**<0.96**	<0.96	<0.96	<0.96	<0.96	<0.96	<0.96	
Tin	**µg/l**	**<0.36**	<0.36	<0.36	<0.36	<0.36	<0.36	<0.36	
Uranium	**µg/l**	**<1.5**	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5	
Titanium	**µg/l**	**<1.5**	8.02	<1.5	<1.5	<1.5	2.88	<1.5	
Vanadium	**µg/l**	**<0.24**	26.2	3.37	0.939	1.11	0.757	0.488	
Zinc	**µg/l**	**<0.41**	0.602	0.5	<0.41	0.423	6.73	0.523	

The results presented in Table 5-20 above suggest that apart from for As for the oxide sample YO, metals leachability is of limited concern. The results suggest that the other elements of environmental concern will not solubilised on initial disposal.

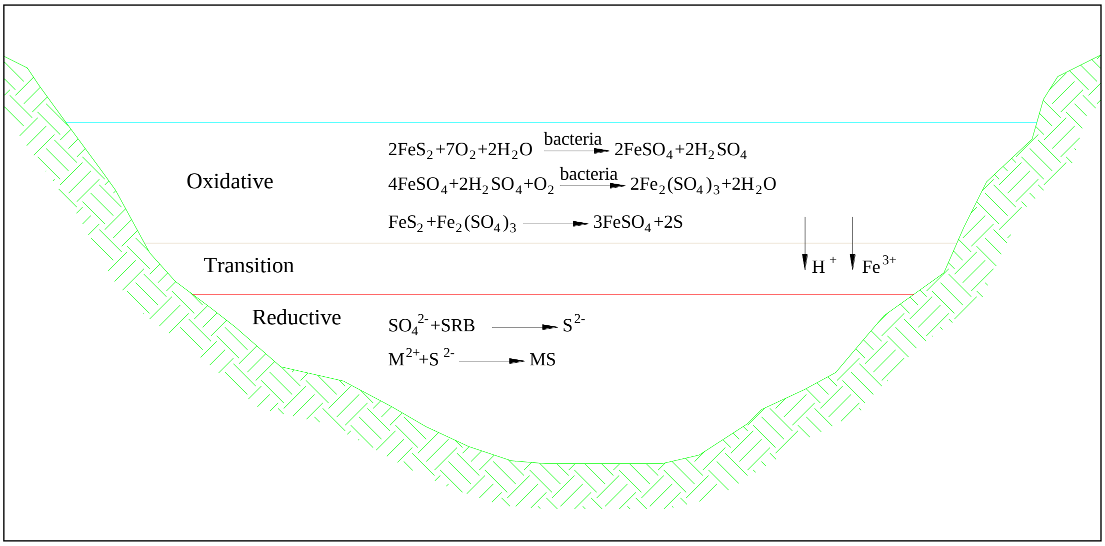
5.3.5 Seepage

The quality of the seepage in any tailings facility will be a function of the composition of the tailings (solid and liquid phases), method of deposition and containment, volume of seepage and stage of development of the facility. Figure 5-15 illustrates the three chemical environments that have been shown (by field studies) to develop with time in a TMF that contains sulphide minerals. The three chemical environments are as follows:

- **Oxidative:** This environment is characterised by the presence of oxygen and if sulphide minerals are present in the tailings there is potential for ARD generation in this layer.

- **Transition:** In this environment there is no oxygen; but the products from the oxidative process are still dominant.
- **Reductive:** This environment is characterised by a reductive potential, an environment suitable for Sulphate Reducing Bacteria (SRB). These bacteria have the capacity to reduce the sulphate-sulphur ion to sulphide-sulphur. In general this region has a positive effect on the quality of the seepage as the presence of sulphide-sulphur potentially will precipitate metal ions.

Figure 5-15: Chemical Environment in Tailings Management Facility Containing ARD Generating Minerals



Tailings facilities are complex dynamic systems from a chemical environment perspective. On initial deposition, all the tailings are under an oxidative environment; but as the tailings depth increases then a reductive environment will develop. In addition, the presence of CN makes the chemical system more complicated as different metals will complex with the CN and the pH will also have an influence.

In the case of Yaouré only the Y CMA L tailings appear to have some potential for acid generation and therefore the formation of a reductive environment will follow more rapidly; but the order of deposition of the different tailings might disrupt the expected evolution of the chemical environments in the facility. In order to establish the likely seepage quality will require the development of a geochemical model based on the expected sequence of deposition from the different tailings.

In order to establish the impact of the seepage quality, it will be necessary to set up a predictive model of the likely outcome in terms of source-pathway-receptor through the different phases of the project from initial deposition to closure of the TMF.

- The source to be considered would be the geochemistry of the tailings together with the level of predicted seepage. This would allow the calculation of loading and some sensitivity analysis.
- The pathway is the groundwater system, and in conjunction with understanding the receptor will require a hydrogeological model. It is understood that this is not available. Basically, the chemistry would be piggy back on top of this model.

- It is understood that the receptors would be drinking water wells used by the community.

So in conclusion, it appears that there is potential for metal leachability for As from the initial deposition of the oxide tailings. As the evolution of the facility occurs this might change; but without a geochemical model is not possible to establish this. In addition, even if a source of metal leachability is established at this stage of project development it is not possible to ascertain the pathways that would take the impacting seepage to the receptors.

6.0 CONCLUSIONS & RECOMMENDATIONS

6.1 Waste Rock

ABA and NAG testing was carried out on 76 waste rock samples representing all the main lithologies and good spatial distribution of the deposit. There was a good correlation between total sulphur and sulphide sulphur, suggesting that most of the sulphur is present as sulphide. The high Paste pH results indicated that the samples had been stored and handled correctly; samples with low paste pH corresponded to lithologies that are expected to have been oxidised. Two samples with higher total sulphur results (0.81% and 1.43% from lithologies 4_FR_OXI and 6_BAS_PO respectively) were considered potentially acid generating, according to NNP and NPR results. The NAG results suggested that the 1.43% total sulphur sample may not be acid generating, however, this should not be assumed from a single stage NAG test with total sulphur >1%. The mineralogical characterisation of seven selected samples of the waste rock to represent all the lithologies and the range of sulphide content encountered indicated that in three samples there was sufficient calcite present to indicate that a neutral pH would be maintained. The saprolite sample has limited sulphide content and therefore no driving force for acid generation. The rest of the samples had an assemblage of albite, actinolite and chlorite in sufficient quantity when compared with the sulphide content that it would make it unlikely to generate any significant acidic drainage. In conclusion, based on the samples tested it seems that the deposit has a low level of sulphides while at the same time having sufficient neutralizing capacity and therefore it is unlikely that acidic drainage of any significance will be generated. It was also found that metal leachability is not expected to be significant as illustrated by the short term leaching results.

6.2 Construction Materials

The results from the construction materials samples showed that they are more mineralised than the waste rock and due to the stage by stage approach undertaken, it is not possible with the available data to disprove whether the basalts tested are potentially acid generating or present a metal leachability issue. However, if we assume that the construction materials will have to be mined and that they behave in a similar fashion to the waste rock samples (this is total sulphur = total sulphide and similar ABA/NAG results) then it is likely that these samples will be classified as having no or low potential for acid generation.

6.3 Tailings

Six different tailings samples were characterised. Y CMA L tailings are potentially acid generating while the oxide tailings (YO) might have metal leachability with respect to As. It is not possible to provide a definite conclusion without developing a geochemical model charting the evolution of the chemistry of the tailings facility as the different tailings types are deposited.

6.4 Recommendations

6.4.1 Waste Rock

In order to provide a sounder statistical basis for the conclusion reached in this report it is recommended to test at least 300 samples for total sulphur selected following the same principles as in this programme, as part of the next phase of project development.

6.4.2 Construction Materials

It is recommended that the 15 samples of construction materials with high total sulphur are tested using ABA and NAG in order to prove/ disprove if they are potentially acid generating or not;

Three selected samples to be characterised by XRD (Rietveld quantification) and short term leaching in order to assess their metal leachability.

6.4.3 Tailings

If it is necessary to establish the quality of the seepage then it is recommended that a geochemical model is developed

6.4.4 Others

It is also recommended that the baseline water quality data is reviewed when complete and available.

7.0 REFERENCES

1 - SRK, Technical Review of the Angovia Gold Mine, Mount Yaouré, Cote d'Ivoire (NI 43-101 Report), 2008

2 - Modified Acid Base Accounting Procedure, R.W. Lawrence and Y. Wang. 4th International Conference on Acid Rock Drainage. May 31 – June 6, 1997 Vancouver, B.C. Canada. p.464

3 - ARD Test handbook – Project P387A Prediction and Kinetic Control of Acid Mine Drainage", AMIRA International Ltd., May 2002

4 - EU Commission Decision of 30 April 2009 completing the definition of inert waste in implementation of Article 22(1)(f) of Directive 2006/21/EC of the European Parliament and the Council concerning the management of waste from extractive industries *(notified under document number C(2009) 3012)* (2009/359/EC).

5 - From Levinson, A A, 1974. *Introduction to Exploration Geochemistry.* Reproduced in Australian Institute of Metallurgy *Field Geologists' Manual*, 4th ed., 2001

6 - US EPA SW846 Test Methods for Evaluating Solid Waste, Physical/Chemical Methods - Method 1312

APPENDICES

APPENDIX A

ABA & NAG methodology

APPENDIX B

SPLP Procedure

APPENDIX C

Geological Cross-Sections

APPENDIX D

Waste Rock and Construction Material Samples List

Sample Reference	Sample Type	Borehole ID	Sampled From (m)	Sampled To (m)	Lithology	X (m, UTM)	Y (m, UTM)
001	Waste Rock	YDD0031	62	62.6	3_SAPROK	220895	777586
002	Waste Rock	YDD0031	99.54	100	5_BAS_VC	220876	777586
003	Waste Rock	YDD0031	155.44	156.01	7_GD_POR	220849	777587
004	Waste Rock	YDD0032	12	13.2	2_SAPROL	220920	777386
005	Waste Rock	YDD0032	171.24	171.8	5_BAS_VC	220840	777386
006	Waste Rock	YDD0036	40.44	40.89	5_BAS_VC	220864	777284
007	Waste Rock	YDD0042	36.54	36.82	4_FR_OXI	221020	777186
008	Waste Rock	YDD0042	265.8	266.38	5_BAS_VC	220903	777188
009	Waste Rock	YDD0043	74.7	75.25	5_BAS_VC	221002	777086
010	Waste Rock	YDD0043	181.21	181.9	7_GD_POR	220951	777086
011	Waste Rock	YDD0044	198.97	199.54	5_BAS_VC	220886	777492
012	Waste Rock	YDD0050	8	9.07	2_SAPROL	220984	776986
013	Waste Rock	YDD0050	46.99	47.59	6_BAS_PO	220966	776987
014	Waste Rock	YDD0050	161.81	162.39	5_BAS_VC	220910	776989
015	Waste Rock	YDD0050	178.72	179.29	7_GD_POR	220902	776990
016	Waste Rock	YDD0051	160.27	160.95	5_BAS_VC	220907	776882
017	Waste Rock	YDD0052	9.75	10	4_FR_OXI	220803	777434
019	Waste Rock	YDD0055	28.9	29.7	1_OV_LAT	221322	777237
020	Waste Rock	YDD0055	46	46.5	2_SAPROL	221313	777237
021	Waste Rock	YDD0055	115.74	116.29	5_BAS_VC	221279	777236
023	Waste Rock	YDD0056	65.62	66.2	4_FR_OXI	221458	776688
024	Waste Rock	YDD0056	179.28	179.77	6_BAS_PO	221401	776687
025	Waste Rock	YDD0056	212.54	213.19	5_BAS_VC	221385	776687
026	Waste Rock	YDD0059	58.36	58.77	5_BAS_VC	220802	777487
027	Waste Rock	YDD0059	98.69	99.08	6_BAS_PO	220807	777487
030	Waste Rock	YDD0067	40.63	41.1	7_GD_POR	220914	777285
031	Waste Rock	YDD0073	37.35	38.09	2_SAPROL	220915	776685
032	Waste Rock	YDD0073	105	105.37	5_BAS_VC	220880	776683
033	Waste Rock	YDD0076	157	157.5	6_BAS_PO	221115	776692
034	Waste Rock	YDD0076	183.05	183.5	5_BAS_VC	221102	776693
037	Waste Rock	YDD0082	59.3	59.62	3_SAPROK	221555	776886
038	Waste Rock	YDD0082	129.06	129.64	7_GD_POR	221523	776883
039	Waste Rock	YDD0082	182.25	182.67	5_BAS_VC	221498	776881
042	Waste Rock	YDD0084	66	66.37	3_SAPROK	220956	776486
043	Waste Rock	YDD0084	90	90.39	5_BAS_VC	220944	776486
044	Waste Rock	YDD0090	125.38	126	6_BAS_PO	221117	777087
045	Waste Rock	YDD0094	79.15	79.87	5_BAS_VC	221698	777489
046	Waste Rock	YDD0095	195	195.43	6_BAS_PO	221684	777093
047	Waste Rock	YDD0095	246.48	247.04	5_BAS_VC	221660	777096
050	Waste Rock	YDD0098	51.09	51.67	6_BAS_PO	221076	777287
051	Waste Rock	YDD0105	18	18.64	2_SAPROL	221330	777784
052	Waste Rock	YDD0109	2.1	2.38	1_OV_LAT	220951	776786
053	Waste Rock	YDD0109	32.1	33.8	3_SAPROK	220936	776787
054	Waste Rock	YDD0109	48.6	49.5	4_FR_OXI	220928	776787
055	Waste Rock	YDD0109	89.3	89.86	5_BAS_VC	220909	776789
058	Waste Rock	YDD0121	41.95	42.72	2_SAPROL	220948	776586
059	Waste Rock	YDD0121	112	112.35	5_BAS_VC	220913	776586
060	Waste Rock	YDD0122	49.3	50	1_OV_LAT	221288	776887
061	Waste Rock	YDD0130	68	68.55	2_SAPROL	221099	776786
062	Waste Rock	YDD0130	160.06	160.75	6_BAS_PO	221053	776785
063	Waste Rock	YDD0135	115.98	116.5	6_BAS_PO	221576	777488
066	Waste Rock	YDD0137	138.02	138.42	5_BAS_VC	221592	777286
069	Waste Rock	YDD0138	52	52.27	5_BAS_VC	221635	777389
070	Waste Rock	YDD0138	206	206.65	7_GD_POR	221557	777392

Sample Reference	Sample Type	Borehole ID	Sampled From (m)	Sampled To (m)	Lithology	X (m, UTM)	Y (m, UTM)
071	Waste Rock	YDD0140	13.6	14.3	2_SAPROL	221548	777588
077	Waste Rock	YDD0147	9.48	10	1_OV_LAT	221421	777688
078	Waste Rock	YDD0147	27	27.6	2_SAPROL	221413	777688
079	Waste Rock	YDD0147	49	49.6	3_SAPROK	221404	777689
080	Waste Rock	YDD0147	72	72.35	4_FR_OXI	221394	777689
081	Waste Rock	YDD0147	100	100.4	5_BAS_VC	221382	777689
082	Waste Rock	YDD0147	113.98	114.31	6_BAS_PO	221376	777689
083	Waste Rock	YDD0148	6.1	6.53	2_SAPROL	221573	777189
084	Waste Rock	YDD0150	15.4	15.85	2_SAPROL	221552	777389
085	Waste Rock	YDD0150	188	188.39	5_BAS_VC	221467	777384
086	Waste Rock	YDD0151	83	83.3	4_FR_OXI	221442	777088
087	Waste Rock	YDD0151	115	115.43	5_BAS_VC	221427	777088
088	Waste Rock	YDD0152	28	29.25	2_SAPROL	221568	776990
089	Waste Rock	YDD0152	63.02	63.43	5_BAS_VC	221551	776991
090	Waste Rock	YDD0152	72.99	73.32	6_BAS_PO	221546	776991
091	Waste Rock	YDD0155	75.1	75.52	3_SAPROK	221324	777587
092	Waste Rock	YDD0155	155	155.4	5_BAS_VC	221285	777587
093	Waste Rock	YDD0157	49.5	50	2_SAPROL	221518	776788
094	Waste Rock	YDD0157	70.85	71.28	4_FR_OXI	221507	776788
095	Waste Rock	YDD0157	131	131.38	5_BAS_VC	221478	776788
101	Waste Rock	YDD0039	10.23	11.15	1_OV_LAT	221032	777587
102	Waste Rock	YDD0104	50.5	51.35	1_OV_LAT	221287	776686
028	Construction Material	YDD0065	106.47	106.85	5_BAS_VC	221359	776838
029	Construction Material	YDD0065	117.82	118.22	5_BAS_VC	221353	776838
035	Construction Material	YDD0079	60.26	60.89	5_BAS_VC	221505	777489
036	Construction Material	YDD0079	76.32	76.87	5_BAS_VC	221497	777489
040	Construction Material	YDD0082	81.36	81.93	5_BAS_VC	221545	776885
041	Construction Material	YDD0082	100.39	100.88	5_BAS_VC	221536	776884
048	Construction Material	YDD0095	59.09	59.53	5_BAS_VC	221751	777088
049	Construction Material	YDD0095	72	72.5	5_BAS_VC	221745	777088
056	Construction Material	YDD0116	53.56	53.96	5_BAS_VC	221234	777587
064	Construction Material	YDD0135	87.66	88.02	6_BAS_PO	221591	777488
065	Construction Material	YDD0135	107.19	107.61	6_BAS_PO	221580	777488
067	Construction Material	YDD0137	47.02	47.35	5_BAS_VC	221637	777288
068	Construction Material	YDD0137	61.83	62.1	5_BAS_VC	221630	777288
072	Construction Material	YDD0140	92.94	93.47	5_BAS_VC	221509	777589
073	Construction Material	YDD0145	75.58	75.92	5_BAS_VC	221646	776987
074	Construction Material	YDD0145	112.67	113	5_BAS_VC	221628	776986
075	Construction Material	YDD0146	95.28	95.68	5_BAS_VC	221631	776890
076	Construction Material	YDD0146	108.29	108.74	5_BAS_VC	221624	776890
096	Construction Material	YDD0157	87.45	87.73	5_BAS_VC	221499	776788
097	Construction Material	YDD0157	110.47	110.9	5_BAS_VC	221488	776788
098	Construction Material	YDD0146	21.6	22.1	2_SAPROL	221667	776889
099	Construction Material	YDD0157	17.5	19.1	2_SAPROL	221533	776788
100	Construction Material	YDD0065	28.4	29	2_SAPROL	221398	776838

APPENDIX E

SGS Results Certificates

APPENDIX F

RHUL Results Reports

APPENDIX G

ALcontrol Results Certificates

APPENDICES

APPENDIX A

ABA & NAG methodology

The Modified Acid Base Accounting Procedure
(Lawrence and Wang, 1997)

Sample Preparation
The sample should pass 60 mesh.

Determination of "Fizz Factor"
Add a few drops of 25% HCl to 1 to 2g of pulverized sample on a watch glass. Observe the degree of reaction and assign a fizz rating of none, slight, moderate or strong.

Method for Neutralisation potential
1. Weigh about 2.00g of pulverized sample (to 4 places of decimal) into a sample bottle and add about 90 ml. of distilled water.
2. Add a known volume of standardised acid (1.0 N HCl in standard method but 0.1 N HCl is more accurate to use) according to the fizz rating previously given to the sample. (See Table below). This is time zero or T = 0. If using 0.1 N HCl multiply the volumes below by 10.

Fizz Rating	Volume of 1.0 N HCl (ml)	
	At T = 0	At T = 2
None	1.0	1.0
Slight	2.0	1.0
Moderate	2.0	2.0
Strong	3.0	2.0

3. Place the bottles on the reciprocating shaker and leave to shake for 2 hours. T= 2. Add the second aliquot of acid according to the table above.
4. Replace on shaker and leave to shake for a further 20 hours. T = 22.
5. At T = 22 remove the bottles from the shaker and measure the pH of the solutions. If the pH is greater than 2.5 add a measured amount of acid to bring the pH down to between 2.0 and 2.5. If the pH is below 2.0 then too much acid was added at T = 2 and the test will have to be redone at lower acid concentration.
6. Replace the bottles back on the shaker for a further 2 hours.
7. At T = 24, terminate the test and add distilled water to the bottle or flask to bring the volume to approximately 125 mL. Measure and record the pH, making sure it is in the required range of 2.0 to 2.5.
8. Titrate the content of the bottle or flask to a pH of 8.3 using certified or standardized 0.5 N or 0.1N NaOH.

The Modified NP in Kg $CaCO_3$/t is as follows:-

$$NP = \frac{[(N \times V_{mls\ HCl}) - (N \times V_{mls\ NaOH}) \times 50]}{\text{Weight of Sample (g)}}$$

The acid generating potential is then calculated on the basis of the Sulphide – sulphur content ($AP = S^{=} \times 31.25$).

Sulphide - sulphur is typically determined as the difference between total sulphur and sulphate – sulphur.

Reference
Modified Acid Base Accounting Procedure, R.W. Lawrence and Y. Wang. 4th International Conference on Acid Rock Drainage. May 31 – June 6, 1997 Vancouver, B.C. Canada. p.464.

DETERMINATION OF ACID GENERATION POTENTIAL – STATIC TEST FOR DETERMINATION OF ACID POTENTIAL – PREN15875 METHOD (STATIC ABA TESTING – MODIFIED SOBEK METHOD)

The test includes determinations of (1) acid potential, AP and (2) neutralization potential, NP.

In order to determine neutralization potential, the methodology described in European standard prEN 15875 will be applied. The neutralization potential is calculated following the treatment of the sample with hydrochloric acid for 24h in room temperature and determination of the amount of acid neutralized due to the dissolution of the contained alkaline materials (titration with NaOH to pH 8.3). The neutralization potential of the sample is calculated as calcium carbonate equivalent in unit of kg $CaCO_3$/tonne (dry).

Net neutralization potential (NNP), Neutralization potential ratio (NPR) and A negative NNP which corresponds to a NPR < 1, and indicates that the material is potentially acid generating, are all calculated.

DETERMINATION OF ACID GENERATION POTENTIAL - NET ACID GENERATING (NAG) TESTING

The NAG test is suitable for samples with sulphide content less than 1.5% and with low contents of metals such as copper, which can catalyze the decomposition of hydrogen peroxide.

The procedure of the test includes the addition of H_2O_2 solution to 2.5 grams of sample. After the end of reaction, the sample is gently heated. The sample is cooled to and then deionised water is added to give a final volume of 250 mL. The pH of the solution is recorded. This pH measurement is referred to as the NAGpH. The solution is titrated pH 4.5 while stirring with the appropriate NaOH solution. The net acid generation value (NAG, kg H2SO4/t) is then calculated. Based on the values obtained the sample is then categorised as either:

Non-acid forming (NAF), Potentially acid forming – lower capacity (PAF-LC), Potential acid forming (PAF).

APPENDIX B

SPLP Procedure

ABRIDGED SYNTHETIC PRECIPITATION LEACHING PROCEDURE (SPLP)
This method is based on the USEPA method # 1312. It was designed to determine the mobility of both organic and inorganic analytes present in liquids, soils and wastes.
For our analytical purposes the method described below is suitable for the determination of inorganics only.

A: Apparatus
1. End over – end agitator capable of rotating 4, 2l Nalgene bottles at a speed of 30 ± 2 rpm.
2. Laboratory balance.
3. 2l Nalgene bottles for extraction.
4. Filter holder.
5. Buchner flask 1l capacity.
6. A vacuum pump (water or mechanical, although water preferred.)
7. A trap to go between vacuum pump and buchner to stop back flow into the recovered solution.
8. Glass fibre filter papers 47mm diameter to fit filter holder with effective pore size of 0.6 – 0.8µM (Millipore AP40 or Whatman GFF are suitable). Papers should be acid washed with 5N Nitric acid and washed with reagent water before use.
9. pH meter.
10. Distilled or de-ionised water.
11. Sulphuric acid / Nitric acid solution (60:40 weight percent mixture): Carefully mix 6.0g concentrated Sulphuric acid with 4.0g concentrated Nitric acid.
12. 1ml of the 60:40 Sulphuric acid : Nitric acid made up to 1l with de-ionised water. Referred to as stock acid solution.
13. pH paper, range 1 – 14 and 1 – 5 preferable.
14. 1N Nitric acid solution.

B: Preparation of extraction fluids.
Extraction Fluid # 1: Add stock acid solution to de-ionised water until the pH is 4.20 ± 0.05.
Extraction Fluid # 2: Add stock acid solution to de-ionised water until the pH is 5.00 ± 0.05.

C: Preparation of samples.
The sample should be representative of the whole. A determination of percentage solids should be carried out on a known weight of sample. Slurries should be allowed to stand and the supernatant quantitatively removed. The solid portion should then be filtered through a weighed filter paper and the liquid bulked with the supernatant. The solid is then weighed and a calculation for solids performed as follows:-
Percent Solids = (Weight of Solid / Total weight of waste) x 100
A minimum of 100g of solids should be used for the extraction.

D: Which Extraction Fluid to Use.
The reference on which this method is based, and followed states that:-
"Extraction fluid #1……..is used to determine the leachability of soil from a site that is East of the Mississippi River, and the leachability of wastes and wastewaters".

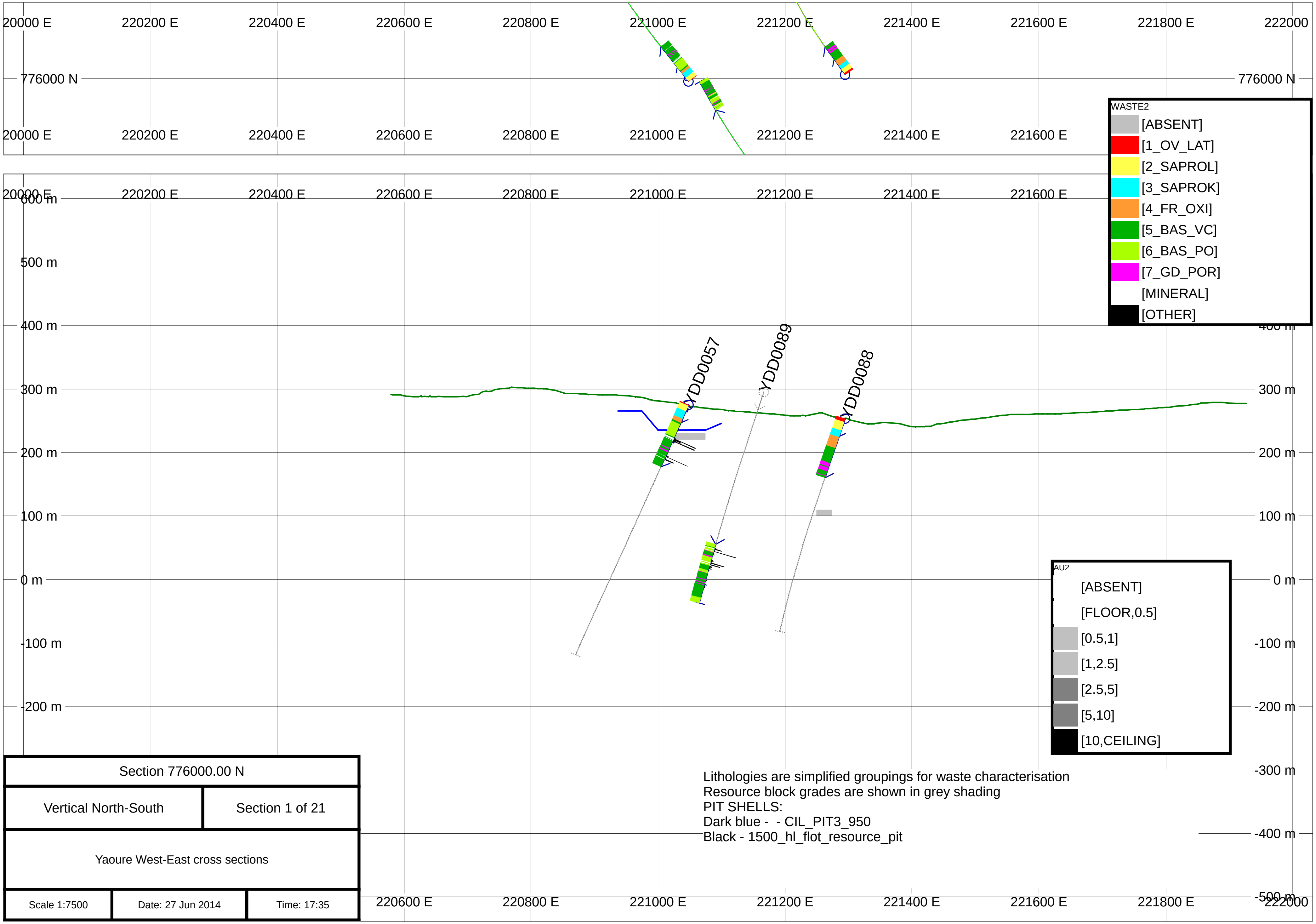
"Extraction fluid #2……..is used to determine the leachability of soil from a site that is West of the Mississippi River".
Thus for mine wastes the extraction fluid #1 should be used, unless otherwise directed by the customer.

E: Extraction procedure.
1. Weigh the equivalent of 100.00g of sample (dry weight)

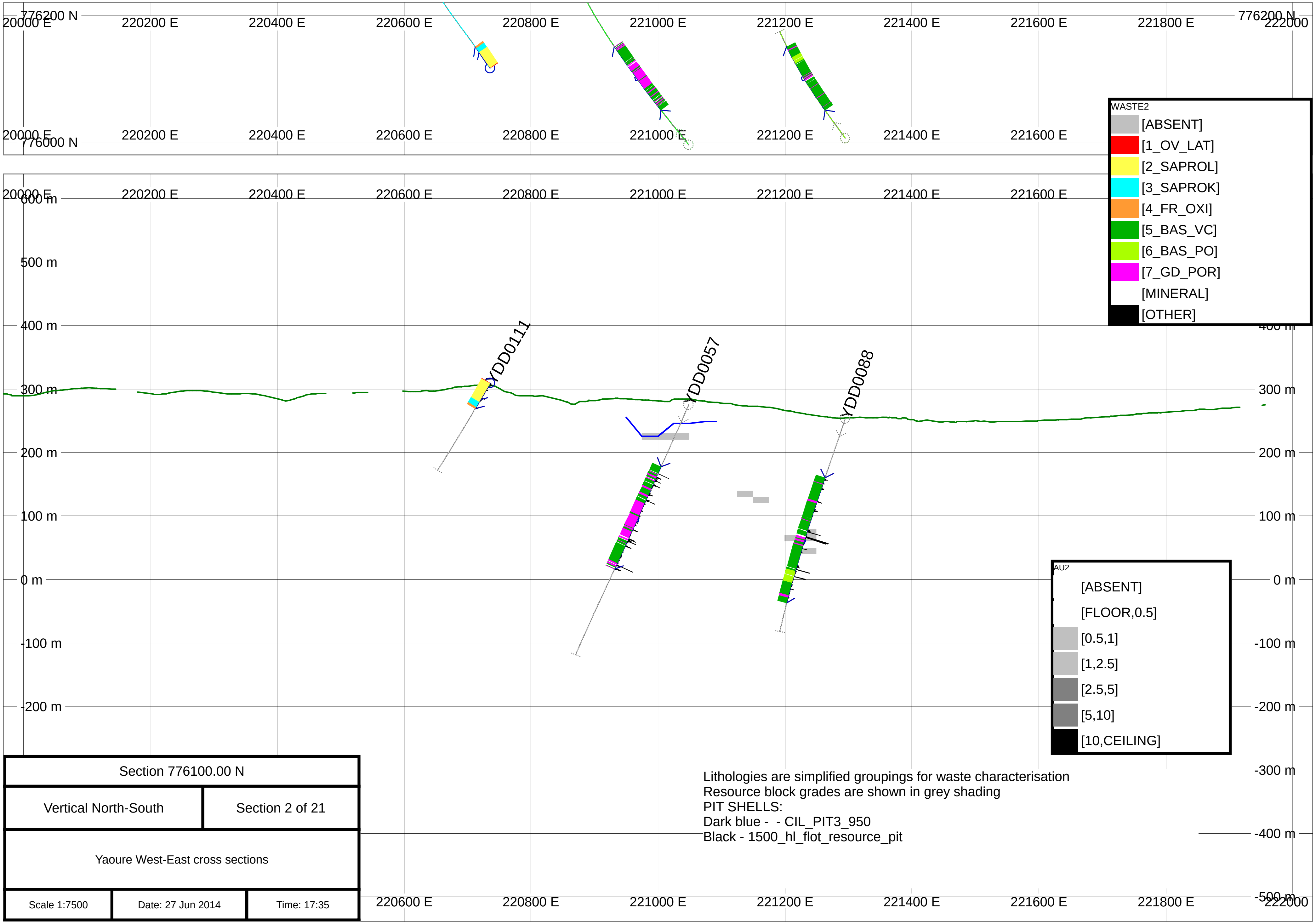
2. If there is visible free liquid present decant it off the solids and collect it for later.
3. If the sample is wet filter it through the filter unit and collect the liquid. Add it to the liquid decanted off in 2.
4. Carefully transfer the solid into a 2l Nalgene extraction bottle.
5. Add 2000mls of the appropriate extraction fluid as determined in ***D***.
6. Place on end – over – end rotator (four samples needed before rotator can be used if there is less than four than use bottles filled with 2l water to bring up to four.)
7. Set rotator to run for 18 hours making sure that the tops are securely fitted and not leaking. Check after ~ 2 hours to release any pressure that may have built up during the initial mixing of the sample.
8. Remove the sample from the rotator and allow to stand for about 2 hours until the solids have settled.
9. Filter the liquid through the filter unit and collect it together.
10. Add any liquid collected in 2. and 3. to the extraction liquid.
11. Divide the solution up into two 1l amber bottles. One bottle should be stored in the fridge and used for pH, Conductivity and acidity / alkalinity. The second bottle should be acidified to below pH 3 for metal and sulphate analysis.

APPENDIX C

Geological Cross-Sections



Note: Coordinates are UTM Projection: Zone 29N - WGS 1984 Datum

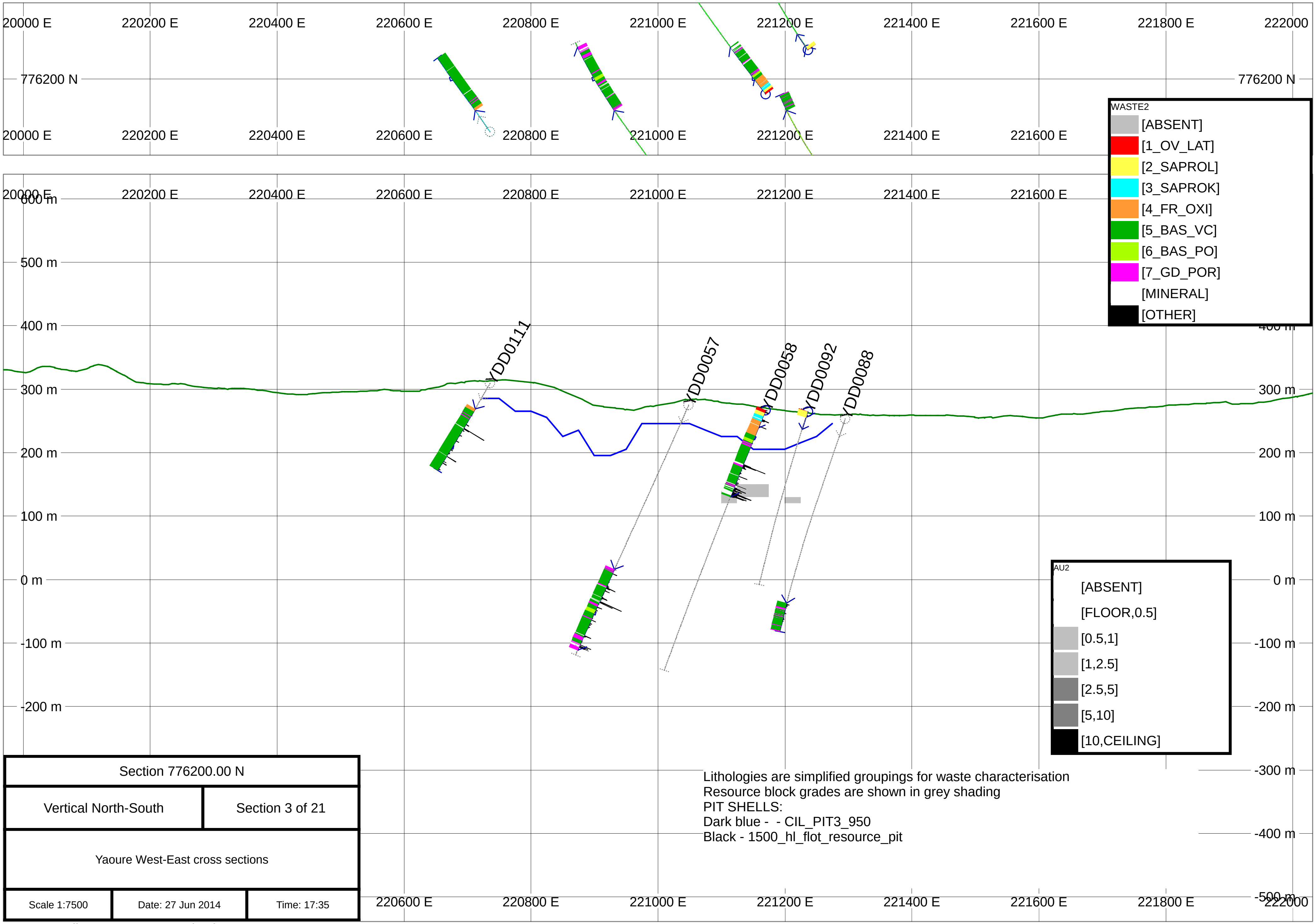


Section 776100.00 N	
Vertical North-South	Section 2 of 21
Yaoure West-East cross sections	

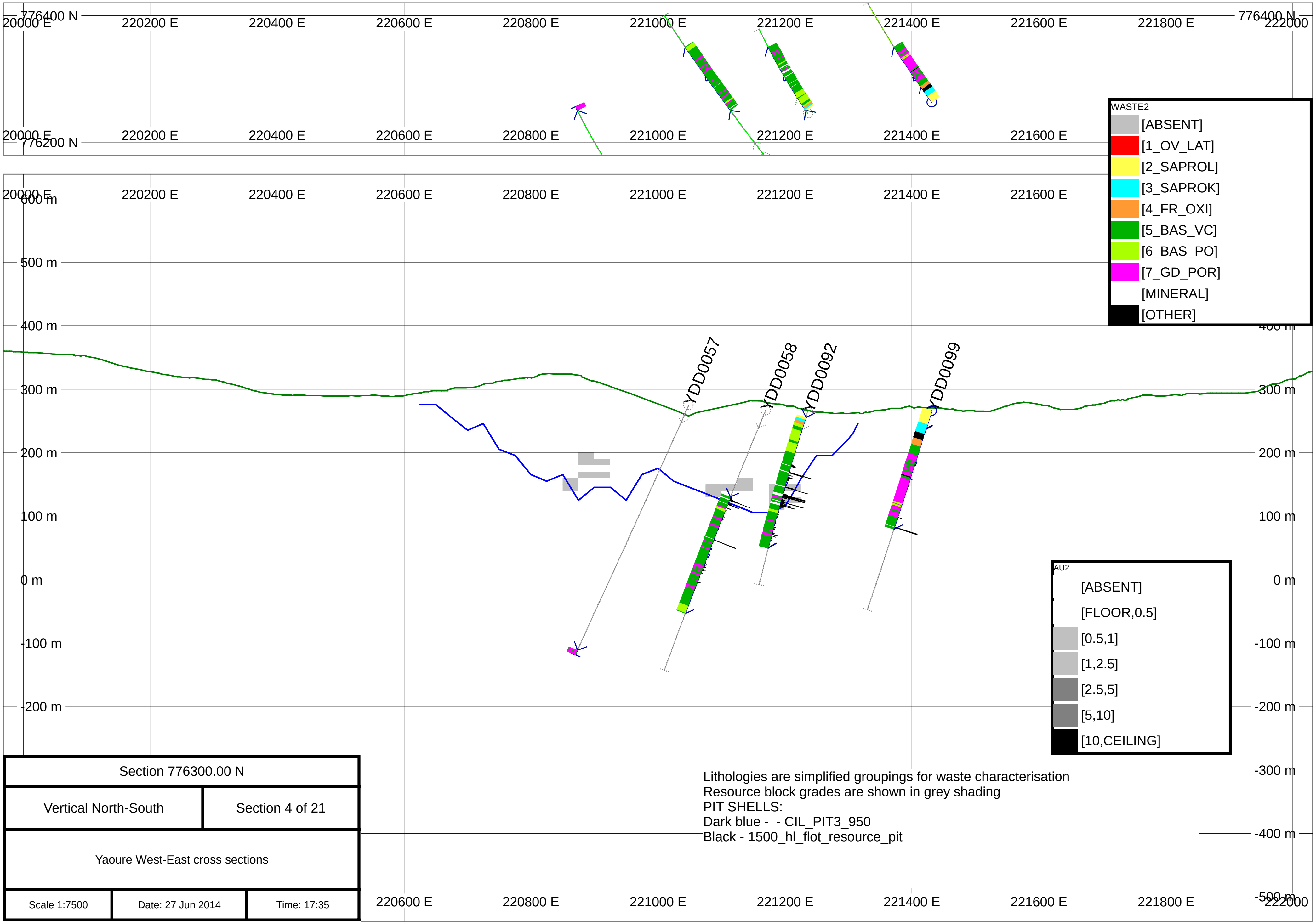
Scale 1:7500	Date: 27 Jun 2014	Time: 17:35

Lithologies are simplified groupings for waste characterisation
Resource block grades are shown in grey shading
PIT SHELLS:
Dark blue - - CIL_PIT3_950
Black - 1500_hl_flot_resource_pit

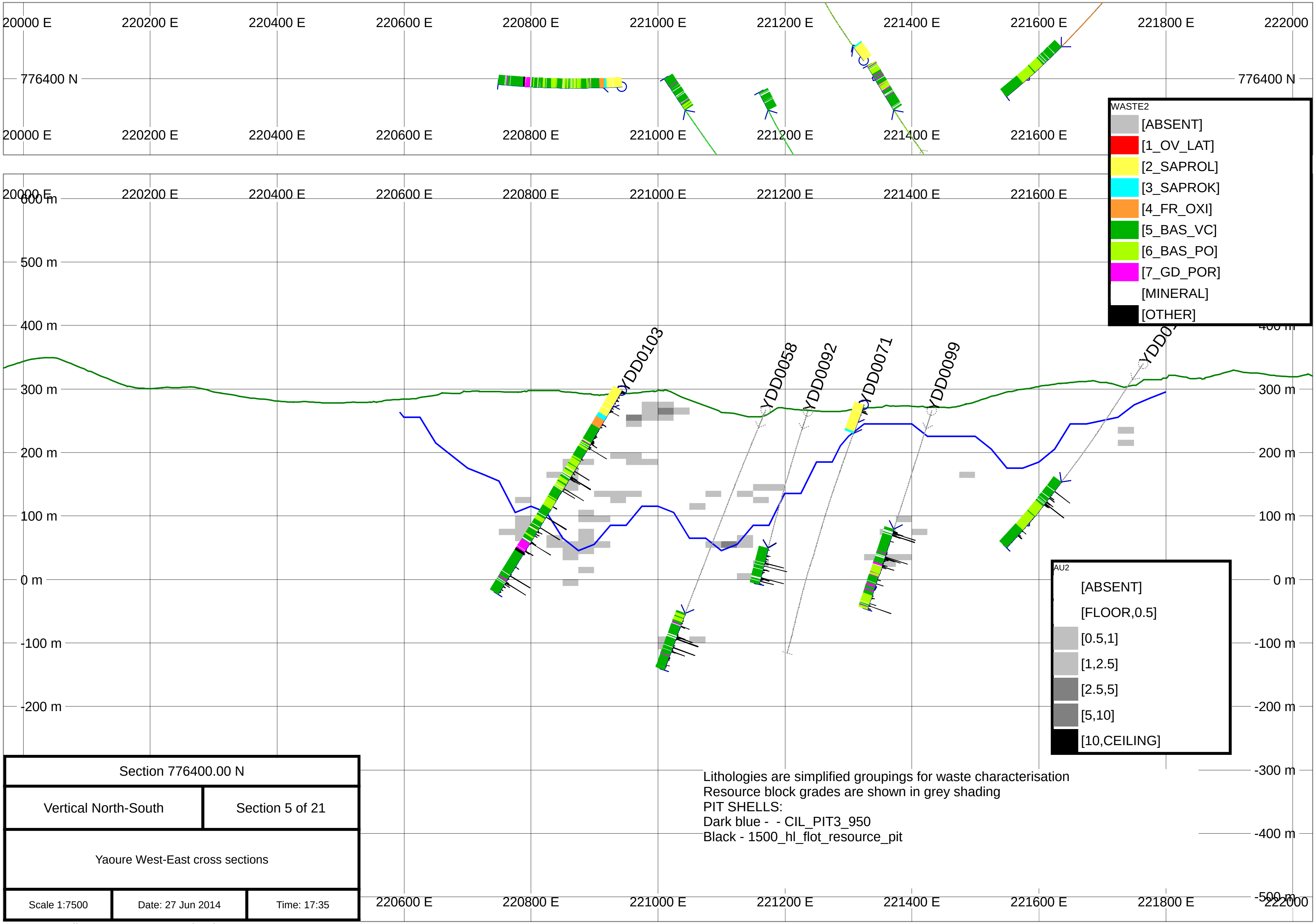
Note: Coordinates are UTM Projection: Zone 29N - WGS 1984 Datum



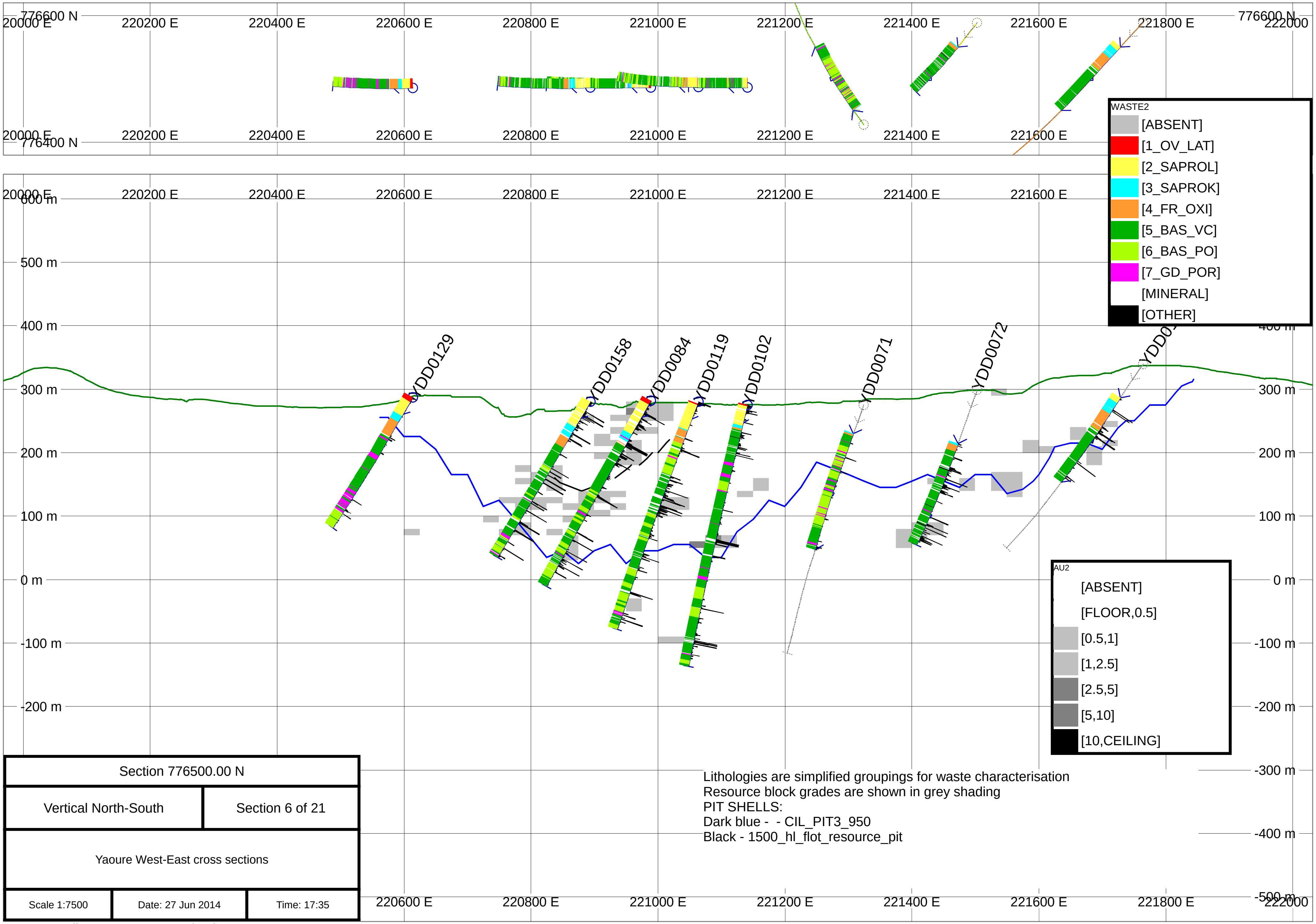
Note: Coordinates are UTM Projection: Zone 29N - WGS 1984 Datum



Note: Coordinates are UTM Projection: Zone 29N - WGS 1984 Datum



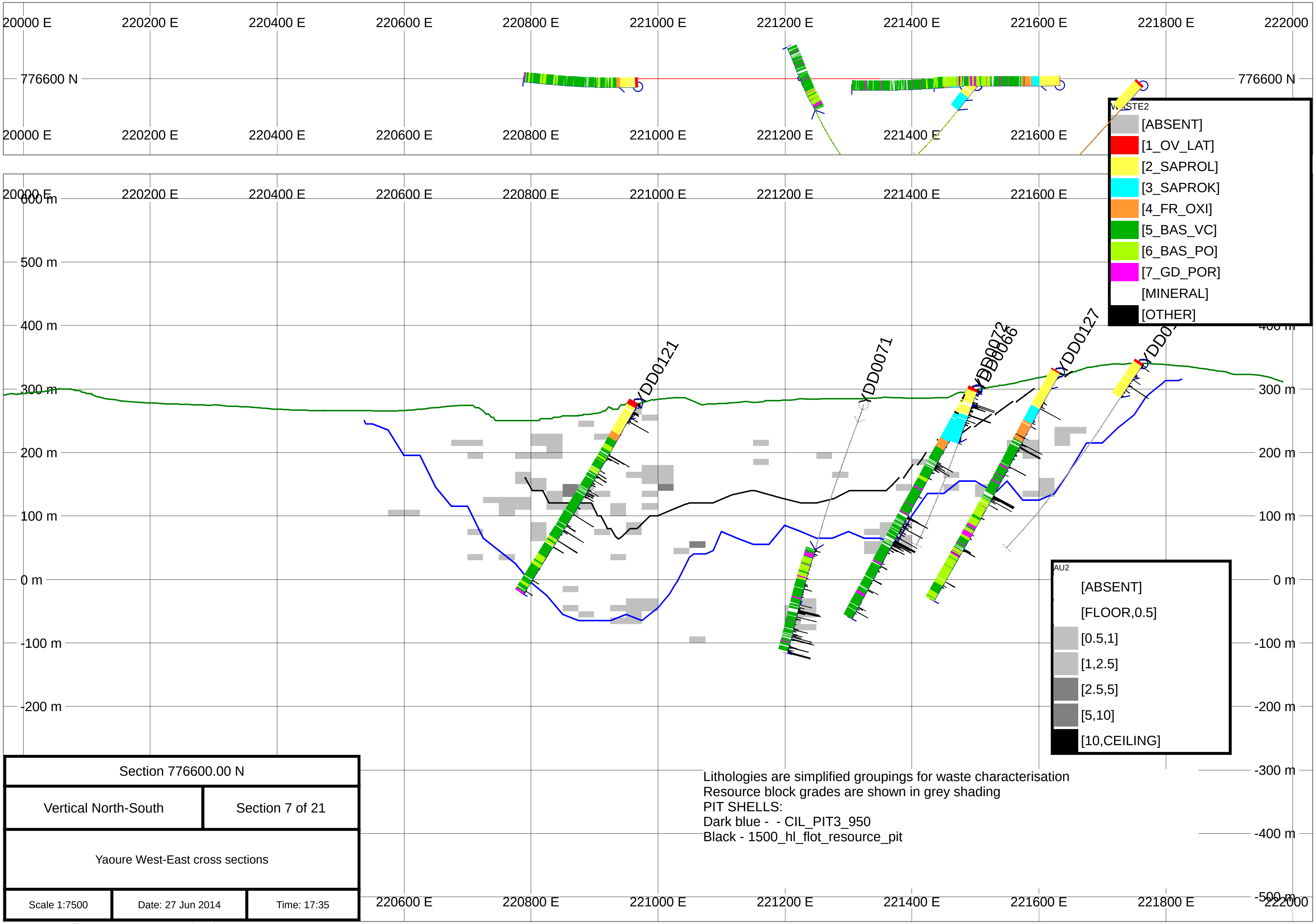
Note: Coordinates are UTM Projection: Zone 29N - WGS 1984 Datum



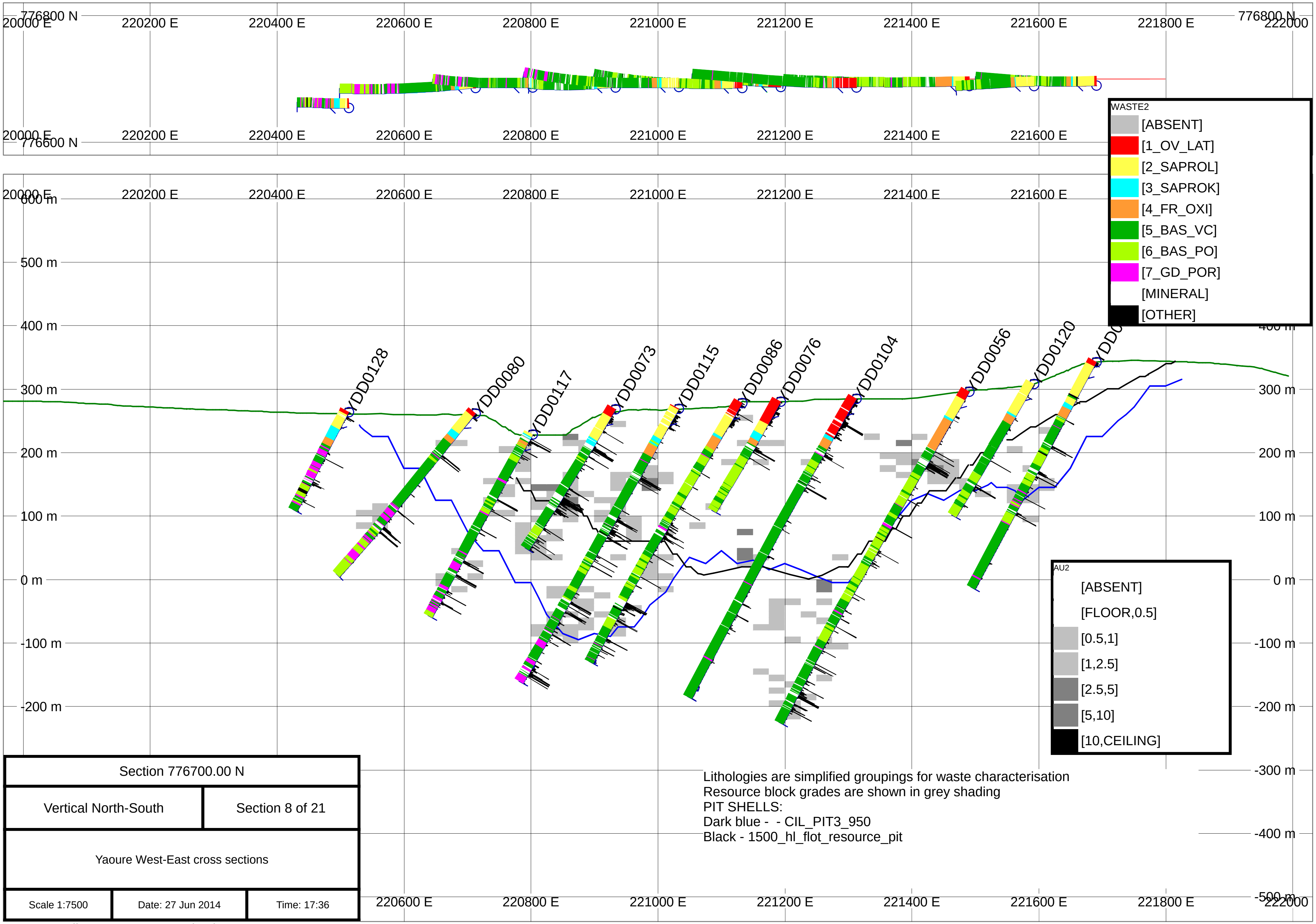
Section 776500.00 N	
Vertical North-South	Section 6 of 21
Yaoure West-East cross sections	

Scale 1:7500	Date: 27 Jun 2014	Time: 17:35

Note: Coordinates are UTM Projection: Zone 29N - WGS 1984 Datum



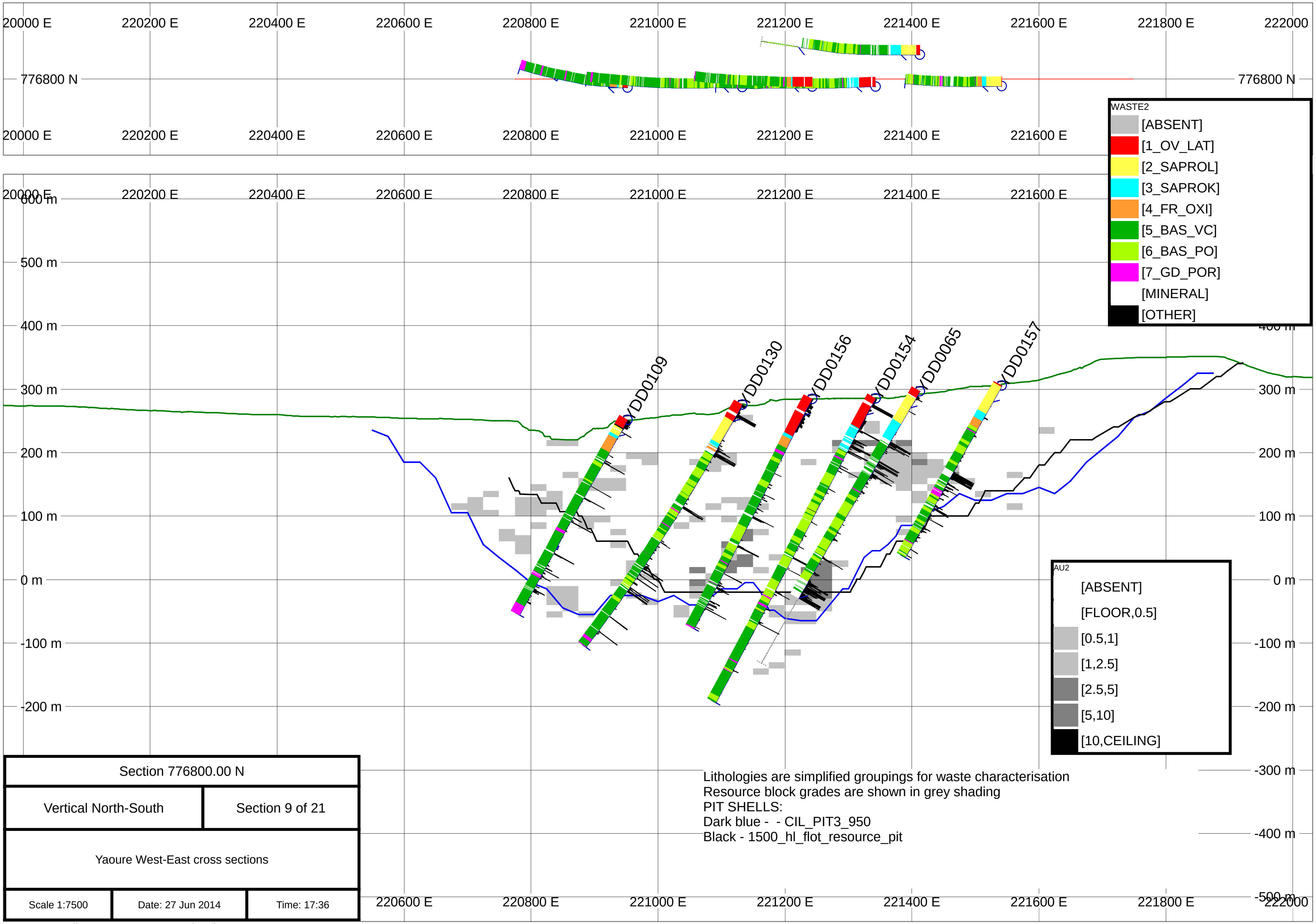
Note: Coordinates are UTM Projection: Zone 29N - WGS 1984 Datum



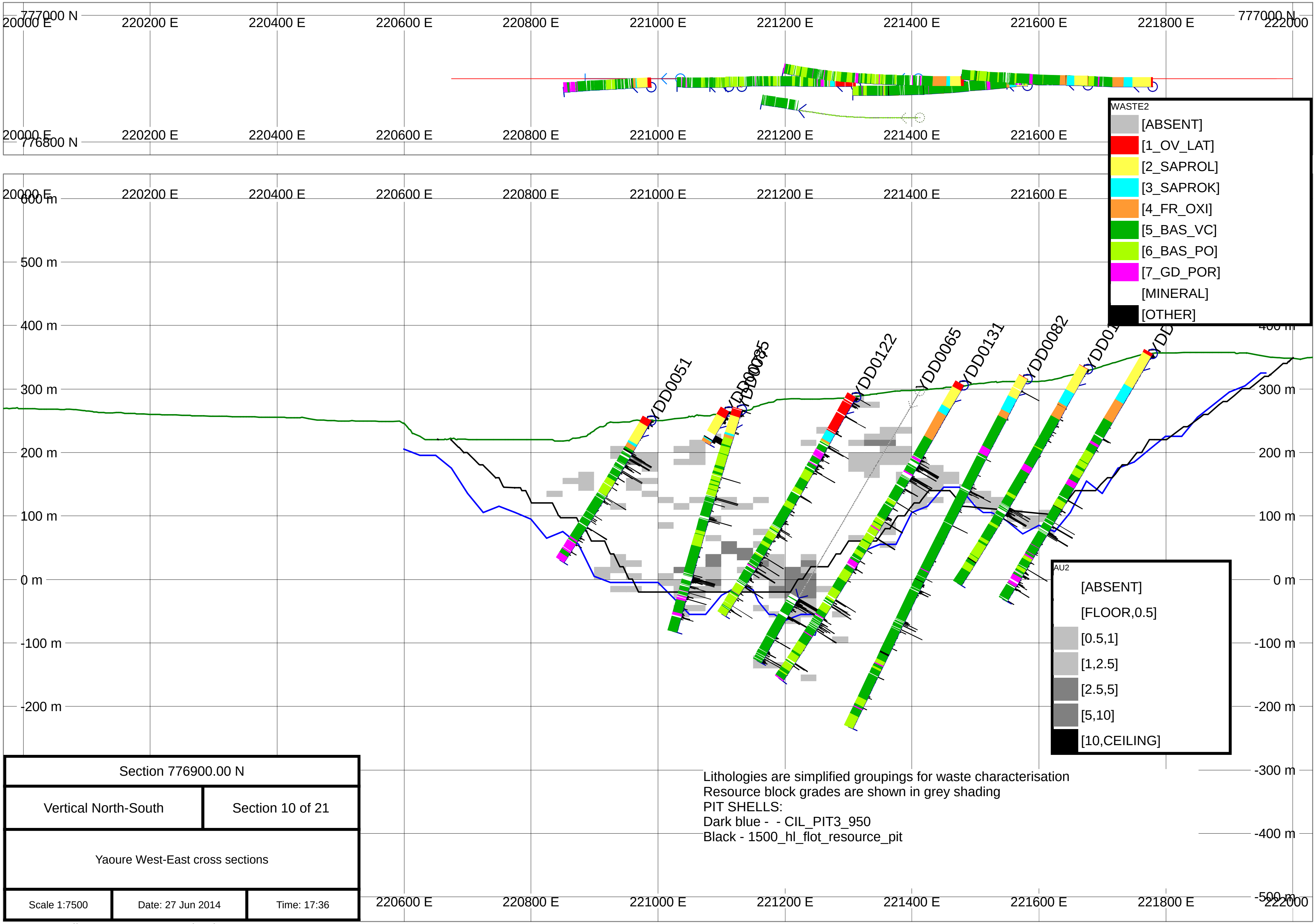
Lithologies are simplified groupings for waste characterisation
Resource block grades are shown in grey shading
PIT SHELLS:
Dark blue - - CIL_PIT3_950
Black - 1500_hl_flot_resource_pit

Section 776700.00 N			
Vertical North-South		Section 8 of 21	
Yaoure West-East cross sections			
Scale 1:7500	Date: 27 Jun 2014	Time: 17:36	

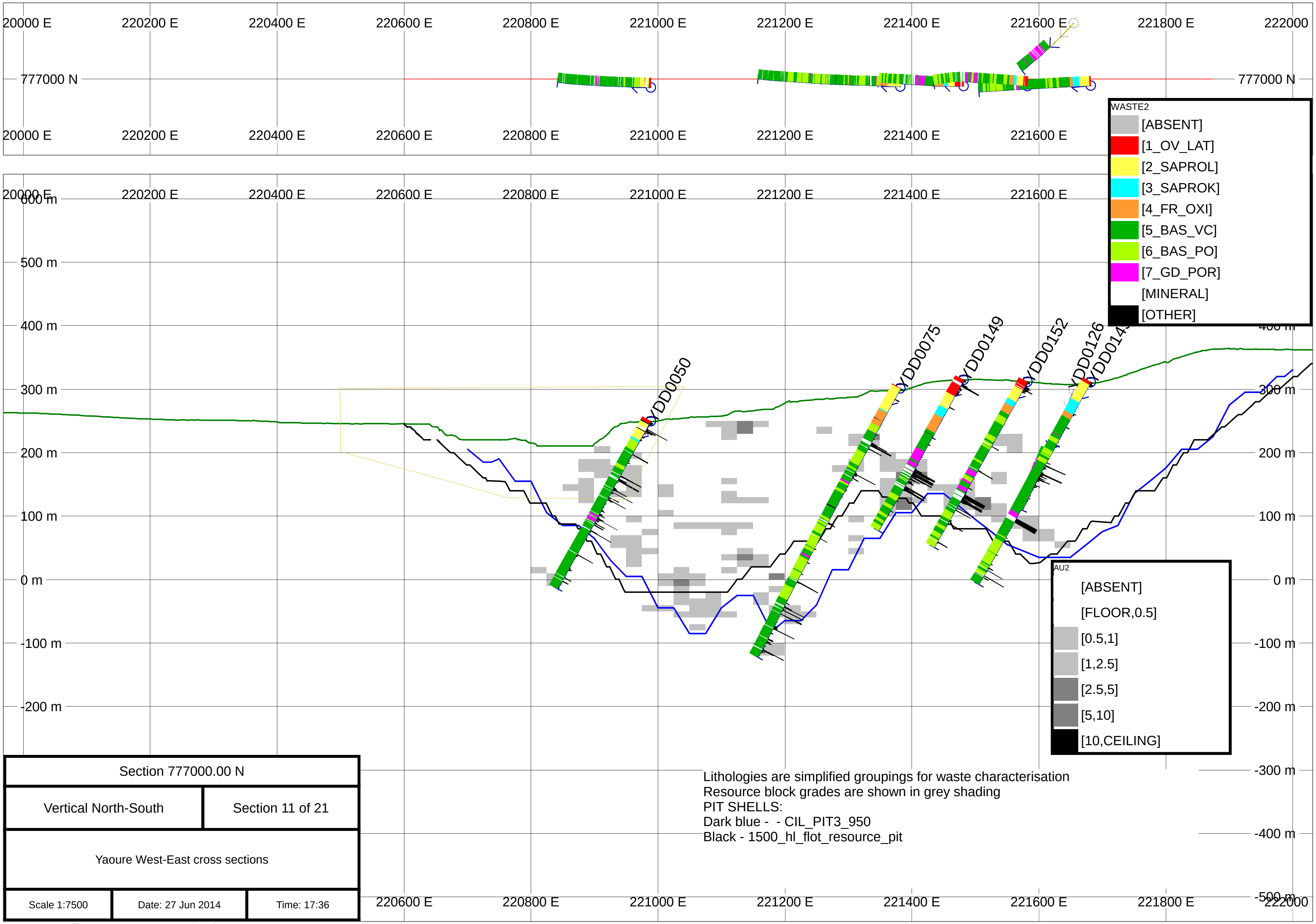
Note: Coordinates are UTM Projection: Zone 29N - WGS 1984 Datum



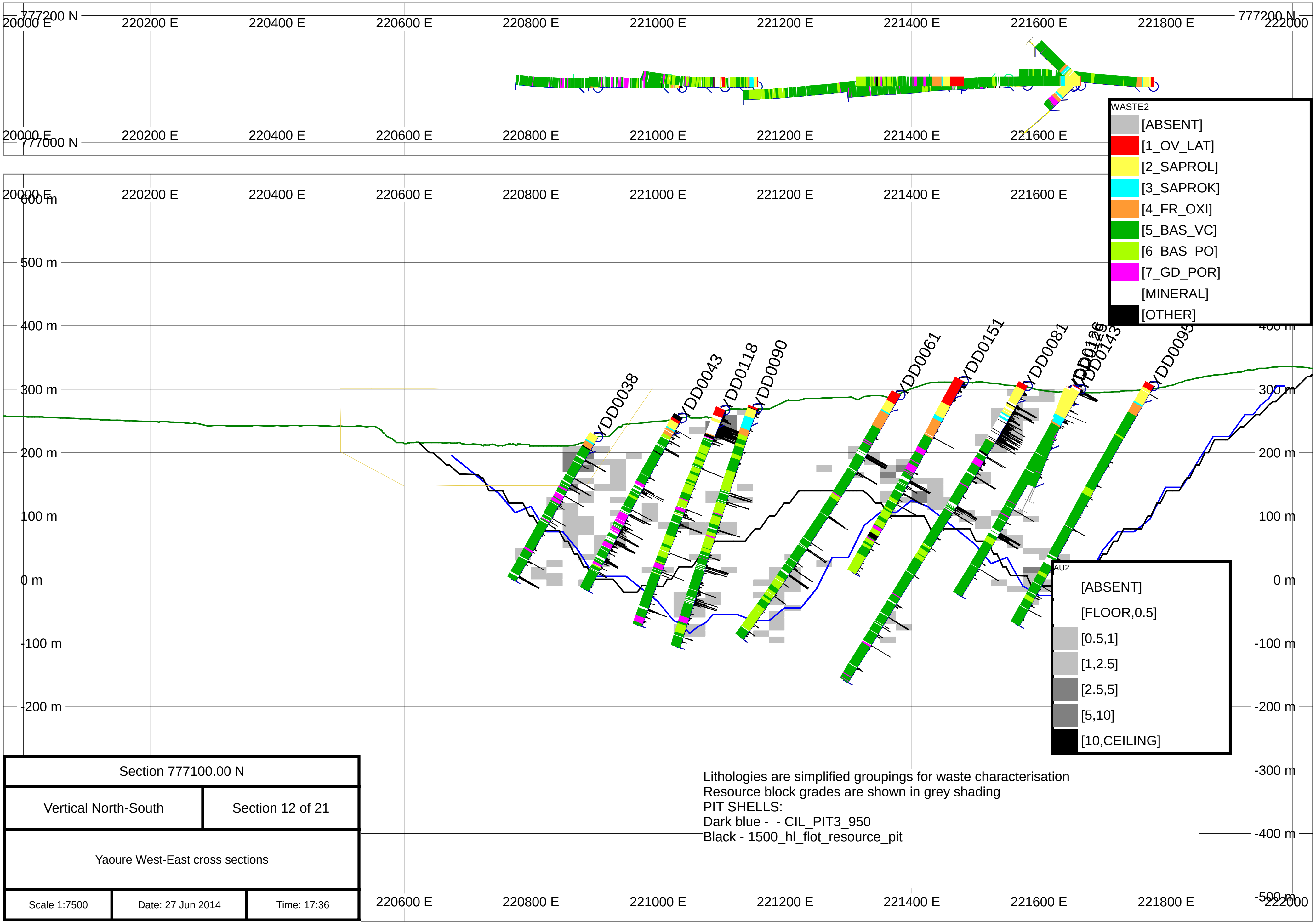
Note: Coordinates are UTM Projection: Zone 29N - WGS 1984 Datum



Note: Coordinates are UTM Projection: Zone 29N - WGS 1984 Datum



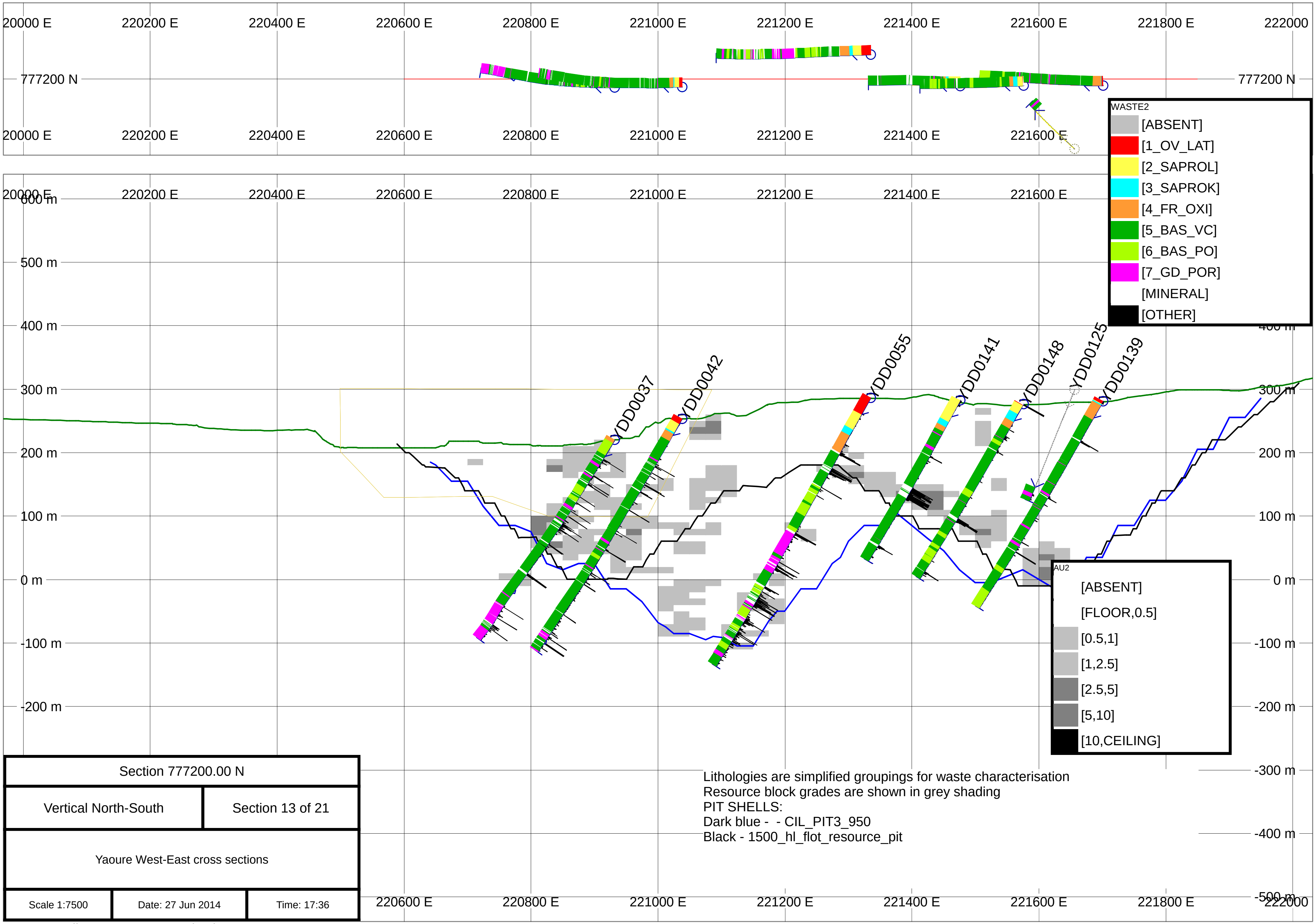
Note: Coordinates are UTM Projection: Zone 29N - WGS 1984 Datum



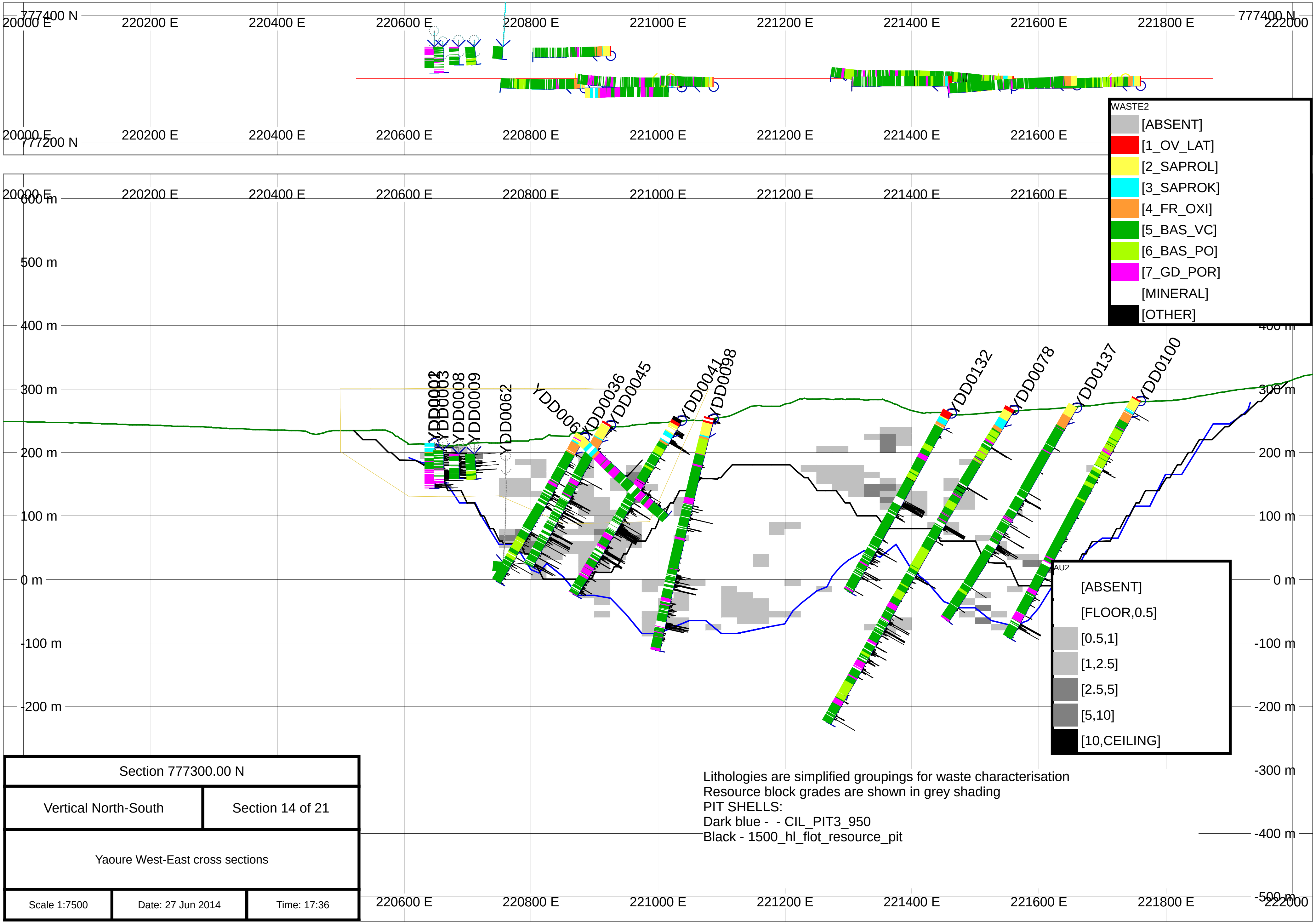
Lithologies are simplified groupings for waste characterisation
Resource block grades are shown in grey shading
PIT SHELLS:
Dark blue - - CIL_PIT3_950
Black - 1500_hl_flot_resource_pit

Section 777100.00 N		
Vertical North-South	Section 12 of 21	
Yaoure West-East cross sections		
Scale 1:7500	Date: 27 Jun 2014	Time: 17:36

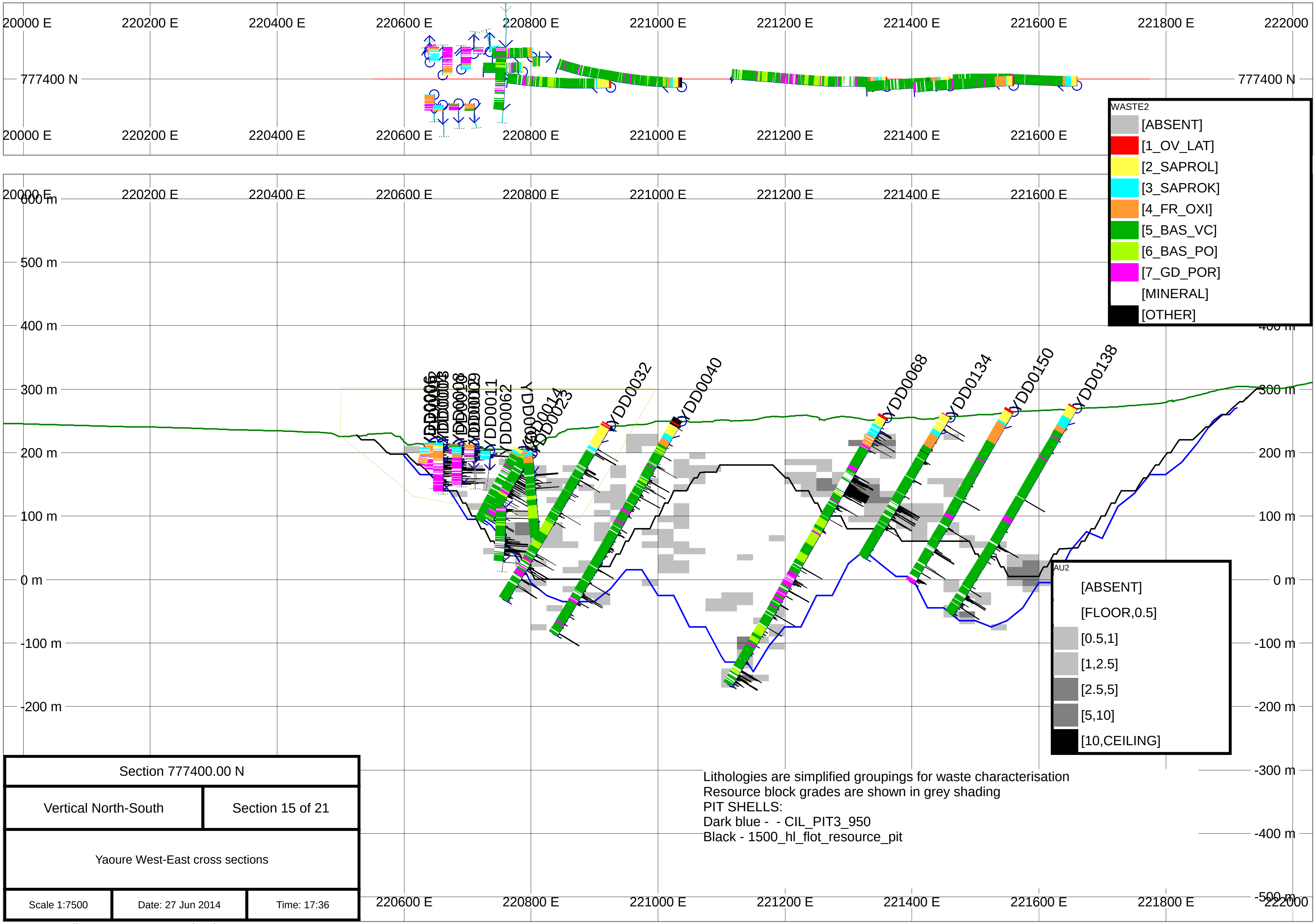
Note: Coordinates are UTM Projection: Zone 29N - WGS 1984 Datum



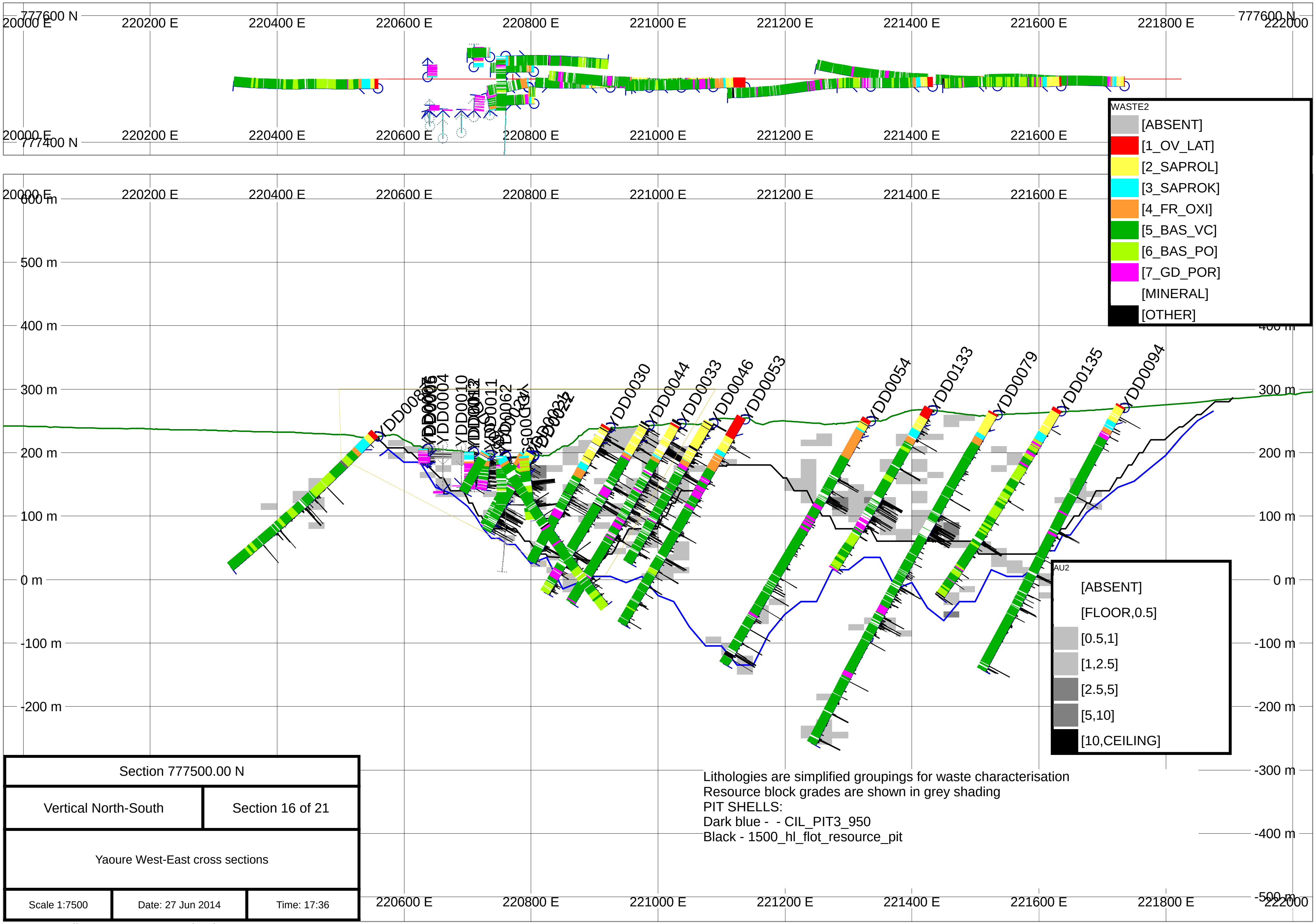
Note: Coordinates are UTM Projection: Zone 29N - WGS 1984 Datum



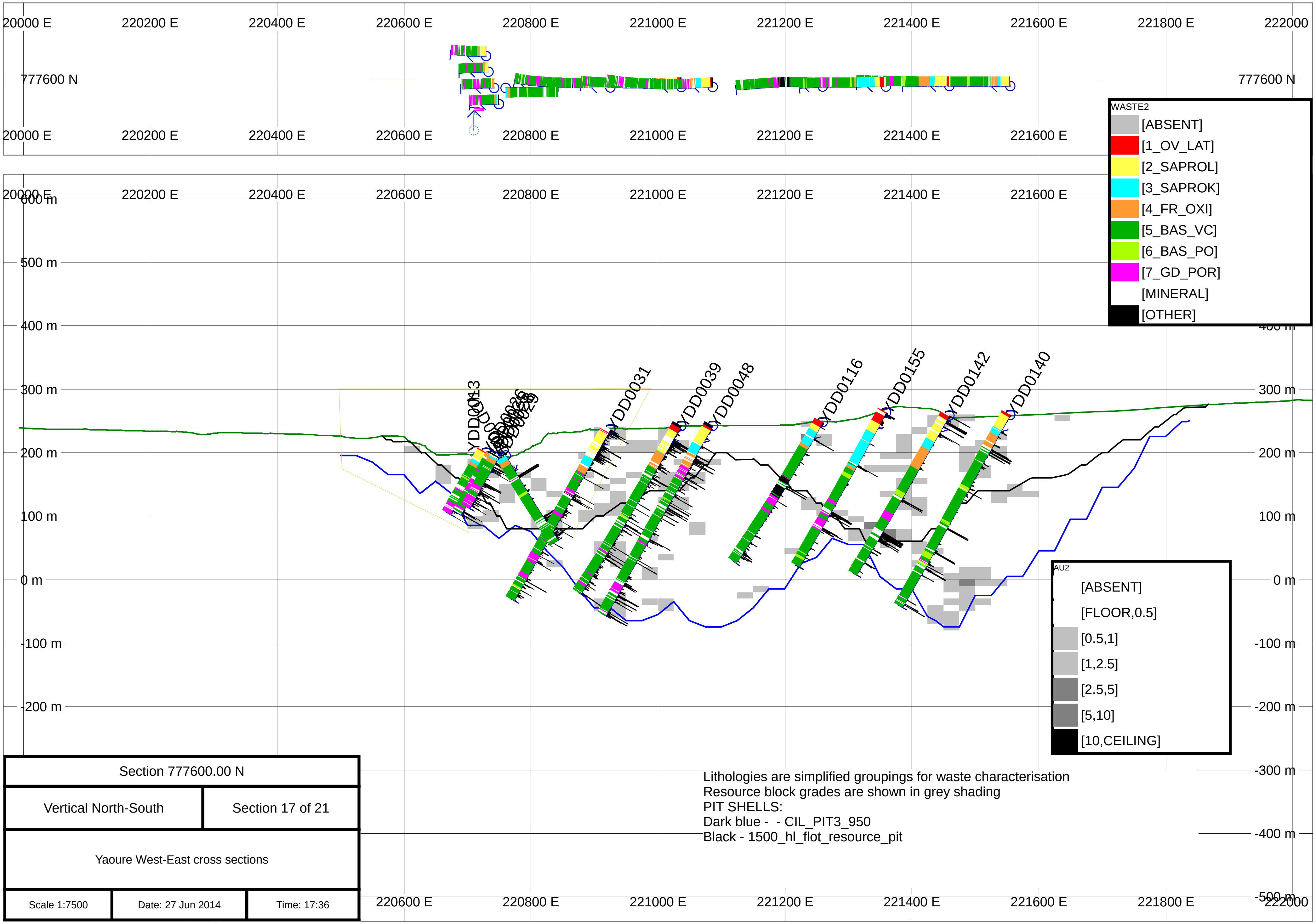
Note: Coordinates are UTM Projection: Zone 29N - WGS 1984 Datum



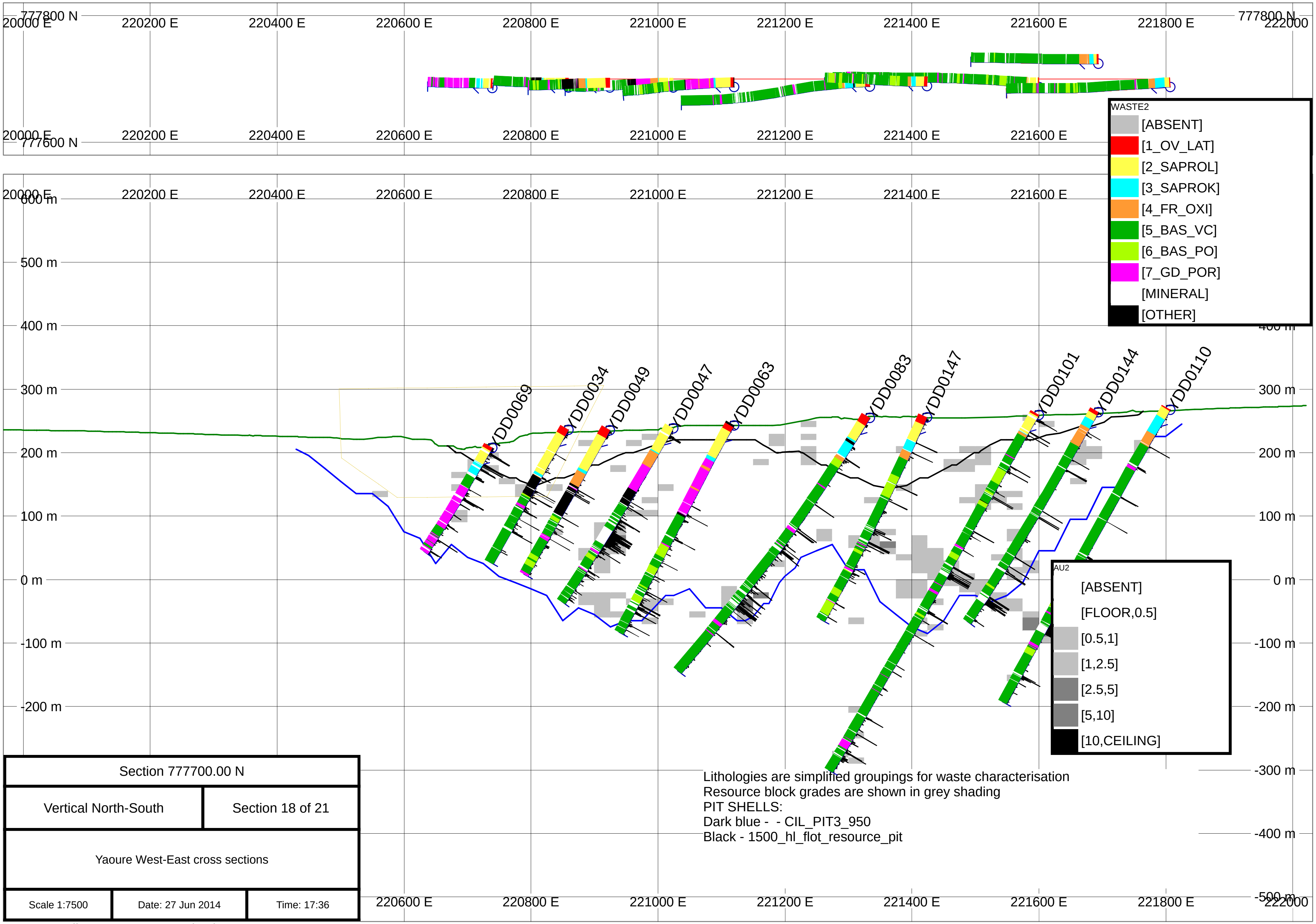
Note: Coordinates are UTM Projection: Zone 29N - WGS 1984 Datum



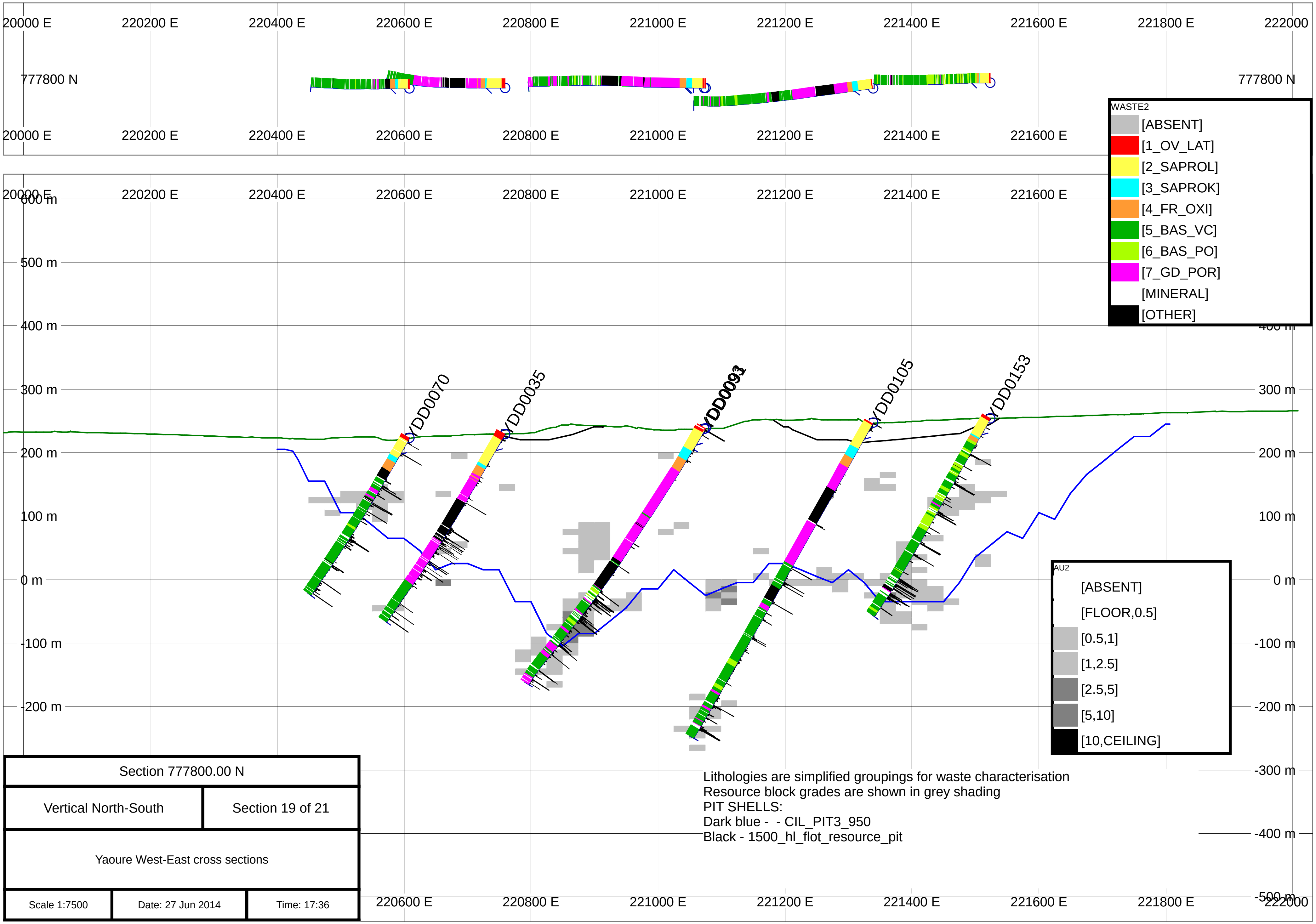
Note: Coordinates are UTM Projection: Zone 29N - WGS 1984 Datum



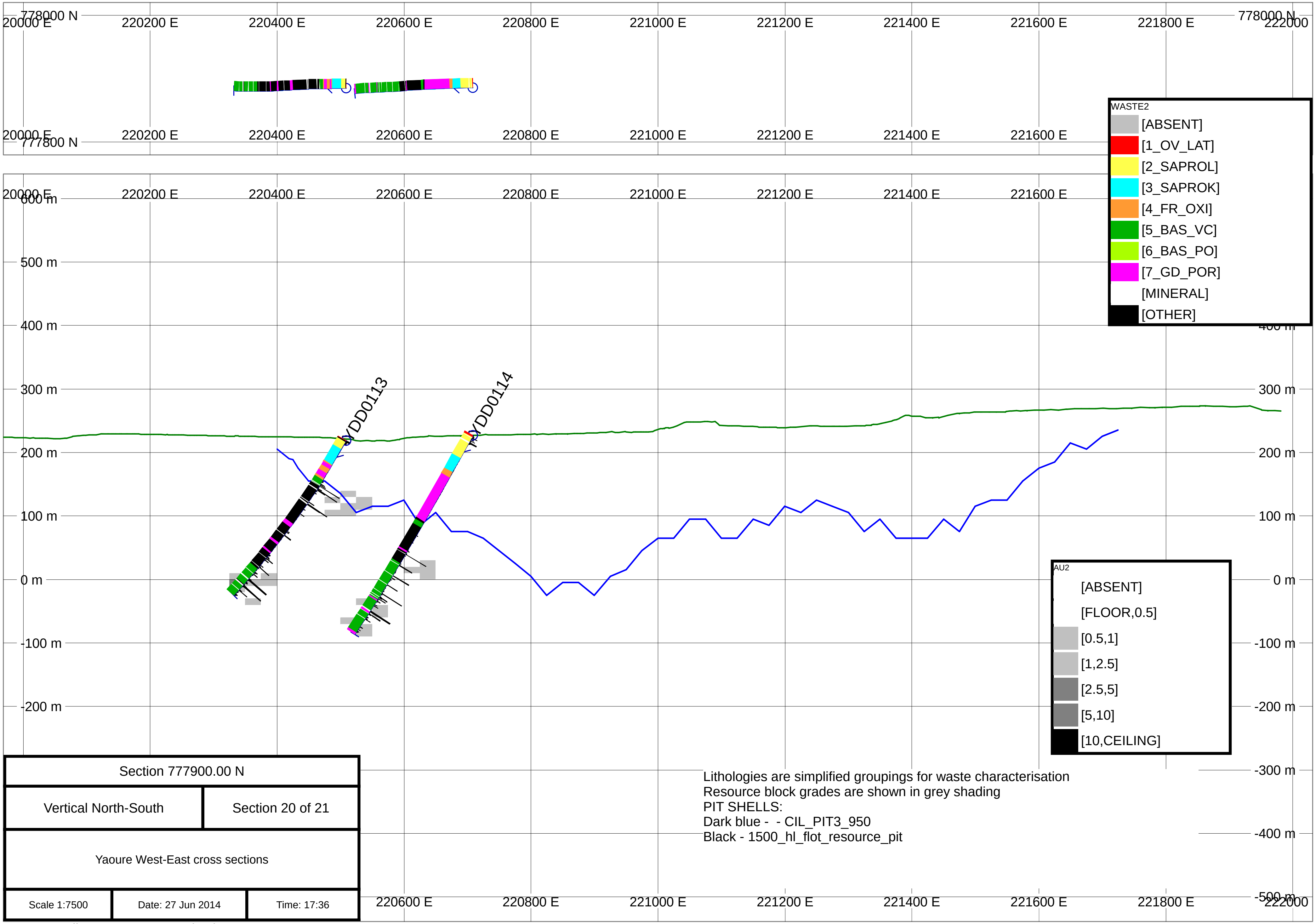
Note: Coordinates are UTM Projection: Zone 29N - WGS 1984 Datum



Note: Coordinates are UTM Projection: Zone 29N - WGS 1984 Datum



Note: Coordinates are UTM Projection: Zone 29N - WGS 1984 Datum



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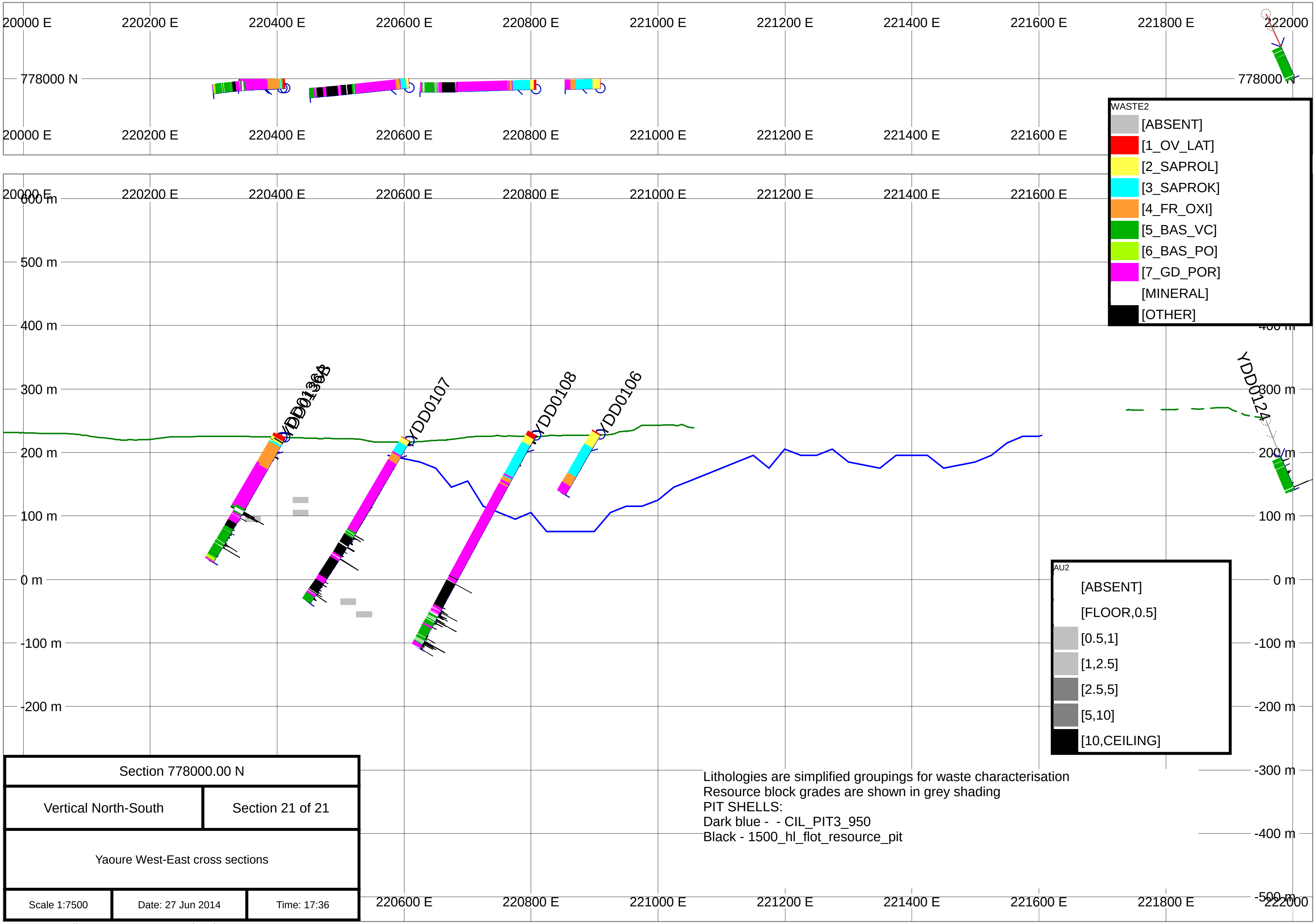

Note: Coordinates are UTM Projection: Zone 29N - WGS 1984 Datum

APPENDIX D

Waste Rock and Construction Material Samples List

Sample Reference	Sample Type	Borehole ID	Sampled From (m)	Sampled To (m)	Lithology	X (m, UTM)	Y (m, UTM)
001	Waste Rock	YDD0031	62	62.6	3_SAPROK	220895	777586
002	Waste Rock	YDD0031	99.54	100	5_BAS_VC	220876	777586
003	Waste Rock	YDD0031	155.44	156.01	7_GD_POR	220849	777587
004	Waste Rock	YDD0032	12	13.2	2_SAPROL	220920	777386
005	Waste Rock	YDD0032	171.24	171.8	5_BAS_VC	220840	777386
006	Waste Rock	YDD0036	40.44	40.89	5_BAS_VC	220864	777284
007	Waste Rock	YDD0042	36.54	36.82	4_FR_OXI	221020	777186
008	Waste Rock	YDD0042	265.8	266.38	5_BAS_VC	220903	777188
009	Waste Rock	YDD0043	74.7	75.25	5_BAS_VC	221002	777086
010	Waste Rock	YDD0043	181.21	181.9	7_GD_POR	220951	777086
011	Waste Rock	YDD0044	198.97	199.54	5_BAS_VC	220886	777492
012	Waste Rock	YDD0050	8	9.07	2_SAPROL	220984	776986
013	Waste Rock	YDD0050	46.99	47.59	6_BAS_PO	220966	776987
014	Waste Rock	YDD0050	161.81	162.39	5_BAS_VC	220910	776989
015	Waste Rock	YDD0050	178.72	179.29	7_GD_POR	220902	776990
016	Waste Rock	YDD0051	160.27	160.95	5_BAS_VC	220907	776882
017	Waste Rock	YDD0052	9.75	10	4_FR_OXI	220803	777434
019	Waste Rock	YDD0055	28.9	29.7	1_OV_LAT	221322	777237
020	Waste Rock	YDD0055	46	46.5	2_SAPROL	221313	777237
021	Waste Rock	YDD0055	115.74	116.29	5_BAS_VC	221279	777236
023	Waste Rock	YDD0056	65.62	66.2	4_FR_OXI	221458	776688
024	Waste Rock	YDD0056	179.28	179.77	6_BAS_PO	221401	776687
025	Waste Rock	YDD0056	212.54	213.19	5_BAS_VC	221385	776687
026	Waste Rock	YDD0059	58.36	58.77	5_BAS_VC	220802	777487
027	Waste Rock	YDD0059	98.69	99.08	6_BAS_PO	220807	777487
030	Waste Rock	YDD0067	40.63	41.1	7_GD_POR	220914	777285
031	Waste Rock	YDD0073	37.35	38.09	2_SAPROL	220915	776685
032	Waste Rock	YDD0073	105	105.37	5_BAS_VC	220880	776683
033	Waste Rock	YDD0076	157	157.5	6_BAS_PO	221115	776692
034	Waste Rock	YDD0076	183.05	183.5	5_BAS_VC	221102	776693
037	Waste Rock	YDD0082	59.3	59.62	3_SAPROK	221555	776886
038	Waste Rock	YDD0082	129.06	129.64	7_GD_POR	221523	776883
039	Waste Rock	YDD0082	182.25	182.67	5_BAS_VC	221498	776881
042	Waste Rock	YDD0084	66	66.37	3_SAPROK	220956	776486
043	Waste Rock	YDD0084	90	90.39	5_BAS_VC	220944	776486
044	Waste Rock	YDD0090	125.38	126	6_BAS_PO	221117	777087
045	Waste Rock	YDD0094	79.15	79.87	5_BAS_VC	221698	777489
046	Waste Rock	YDD0095	195	195.43	6_BAS_PO	221684	777093
047	Waste Rock	YDD0095	246.48	247.04	5_BAS_VC	221660	777096
050	Waste Rock	YDD0098	51.09	51.67	6_BAS_PO	221076	777287
051	Waste Rock	YDD0105	18	18.64	2_SAPROL	221330	777784
052	Waste Rock	YDD0109	2.1	2.38	1_OV_LAT	220951	776786
053	Waste Rock	YDD0109	32.1	33.8	3_SAPROK	220936	776787
054	Waste Rock	YDD0109	48.6	49.5	4_FR_OXI	220928	776787
055	Waste Rock	YDD0109	89.3	89.86	5_BAS_VC	220909	776789
058	Waste Rock	YDD0121	41.95	42.72	2_SAPROL	220948	776586
059	Waste Rock	YDD0121	112	112.35	5_BAS_VC	220913	776586
060	Waste Rock	YDD0122	49.3	50	1_OV_LAT	221288	776887
061	Waste Rock	YDD0130	68	68.55	2_SAPROL	221099	776786
062	Waste Rock	YDD0130	160.06	160.75	6_BAS_PO	221053	776785
063	Waste Rock	YDD0135	115.98	116.5	6_BAS_PO	221576	777488
066	Waste Rock	YDD0137	138.02	138.42	5_BAS_VC	221592	777286
069	Waste Rock	YDD0138	52	52.27	5_BAS_VC	221635	777389
070	Waste Rock	YDD0138	206	206.65	7_GD_POR	221557	777392

Sample Reference	Sample Type	Borehole ID	Sampled From (m)	Sampled To (m)	Lithology	X (m, UTM)	Y (m, UTM)
071	Waste Rock	YDD0140	13.6	14.3	2_SAPROL	221548	777588
077	Waste Rock	YDD0147	9.48	10	1_OV_LAT	221421	777688
078	Waste Rock	YDD0147	27	27.6	2_SAPROL	221413	777688
079	Waste Rock	YDD0147	49	49.6	3_SAPROK	221404	777689
080	Waste Rock	YDD0147	72	72.35	4_FR_OXI	221394	777689
081	Waste Rock	YDD0147	100	100.4	5_BAS_VC	221382	777689
082	Waste Rock	YDD0147	113.98	114.31	6_BAS_PO	221376	777689
083	Waste Rock	YDD0148	6.1	6.53	2_SAPROL	221573	777189
084	Waste Rock	YDD0150	15.4	15.85	2_SAPROL	221552	777389
085	Waste Rock	YDD0150	188	188.39	5_BAS_VC	221467	777384
086	Waste Rock	YDD0151	83	83.3	4_FR_OXI	221442	777088
087	Waste Rock	YDD0151	115	115.43	5_BAS_VC	221427	777088
088	Waste Rock	YDD0152	28	29.25	2_SAPROL	221568	776990
089	Waste Rock	YDD0152	63.02	63.43	5_BAS_VC	221551	776991
090	Waste Rock	YDD0152	72.99	73.32	6_BAS_PO	221546	776991
091	Waste Rock	YDD0155	75.1	75.52	3_SAPROK	221324	777587
092	Waste Rock	YDD0155	155	155.4	5_BAS_VC	221285	777587
093	Waste Rock	YDD0157	49.5	50	2_SAPROL	221518	776788
094	Waste Rock	YDD0157	70.85	71.28	4_FR_OXI	221507	776788
095	Waste Rock	YDD0157	131	131.38	5_BAS_VC	221478	776788
101	Waste Rock	YDD0039	10.23	11.15	1_OV_LAT	221032	777587
102	Waste Rock	YDD0104	50.5	51.35	1_OV_LAT	221287	776686
028	Construction Material	YDD0065	106.47	106.85	5_BAS_VC	221359	776838
029	Construction Material	YDD0065	117.82	118.22	5_BAS_VC	221353	776838
035	Construction Material	YDD0079	60.26	60.89	5_BAS_VC	221505	777489
036	Construction Material	YDD0079	76.32	76.87	5_BAS_VC	221497	777489
040	Construction Material	YDD0082	81.36	81.93	5_BAS_VC	221545	776885
041	Construction Material	YDD0082	100.39	100.88	5_BAS_VC	221536	776884
048	Construction Material	YDD0095	59.09	59.53	5_BAS_VC	221751	777088
049	Construction Material	YDD0095	72	72.5	5_BAS_VC	221745	777088
056	Construction Material	YDD0116	53.56	53.96	5_BAS_VC	221234	777587
064	Construction Material	YDD0135	87.66	88.02	6_BAS_PO	221591	777488
065	Construction Material	YDD0135	107.19	107.61	6_BAS_PO	221580	777488
067	Construction Material	YDD0137	47.02	47.35	5_BAS_VC	221637	777288
068	Construction Material	YDD0137	61.83	62.1	5_BAS_VC	221630	777288
072	Construction Material	YDD0140	92.94	93.47	5_BAS_VC	221509	777589
073	Construction Material	YDD0145	75.58	75.92	5_BAS_VC	221646	776987
074	Construction Material	YDD0145	112.67	113	5_BAS_VC	221628	776986
075	Construction Material	YDD0146	95.28	95.68	5_BAS_VC	221631	776890
076	Construction Material	YDD0146	108.29	108.74	5_BAS_VC	221624	776890
096	Construction Material	YDD0157	87.45	87.73	5_BAS_VC	221499	776788
097	Construction Material	YDD0157	110.47	110.9	5_BAS_VC	221488	776788
098	Construction Material	YDD0146	21.6	22.1	2_SAPROL	221667	776889
099	Construction Material	YDD0157	17.5	19.1	2_SAPROL	221533	776788
100	Construction Material	YDD0065	28.4	29	2_SAPROL	221398	776838

APPENDIX E

SGS Results Certificates

AMARA Sulphur by LECO, & ABA & NAG Testing

Prepared for

Nigel Tamlyn

AMARA Mining

Project Number – 10866- 540

09 February 2015

Prepared By Michael R. Cook BSc(HONS), MSc, MCSM

Project Metallurgist, Metallurgical Operations, UK

Authorised By N.J. MacDonald, BSc, EngTech

Operations Manager, Metallurgical Operations, UK

NOTE:

This report refers to the samples as received.

The practice of this company in issuing reports of this nature is to require the recipient not to publish the report or any part thereof without the written consent of SGS Mineral Services UK Ltd

Disclaimer

Table of Tables

1 INTRODUCTION

SGS Minerals Services UK Ltd were contracted to perform sulphur by LECO analysis, acid base accounting, and net acid generation testing on selected samples submitted by AMARA Mining Plc.

2 HEAD SAMPLES

2.1 SAMPLE PREPARATION

On receipt each sample was logged in to the SGS sample tracking data base and assigned a sample number. The list of received samples and the allocated sample numbers can be seen in Table 1 table # and #.and Table 2

Where required Eeach of the samples was then dried where required and where required was crushed before splitting out of test charges. A sub-sample of 300g was then split from the mass received from each sample. This 300g mass was then pulverised. Sub-samples from the pulverised mass was then submitted to for the required testing.

Table 1 - List of received samples and test requirements

ORE NUMBER	SAMPLE SERIAL	PRODUCT NAME LEVEL 1	PRODUCT NAME LEVEL 2		Quantity (T)	Unit
SGS540	0001	Chem001	Test 1	ABA & NAG	1.40	Kg
SGS540	0002	Chem002	Test 1	ABA & NAG	1.25	Kg
SGS540	0003	Chem003	Test 1	ABA & NAG	1.20	Kg
SGS540	0004	Chem004	Test 1	ABA & NAG	1.30	Kg
SGS540	0005	Chem005	Test 1	ABA & NAG	1.45	Kg
SGS540	0006	Chem006	Test 1	ABA & NAG	1.15	Kg
SGS540	0007	Chem007	Test 1	ABA & NAG	1.15	Kg
SGS540	0008	Chem008	Test 1	ABA & NAG	1.65	Kg
SGS540	0009	Chem009	Test 1	ABA & NAG	1.30	Kg
SGS540	0010	Chem010	Test 1	ABA & NAG	1.40	Kg
SGS540	0011	Chem011	Test 1	ABA & NAG	1.45	Kg
SGS540	0012	Chem012	Test 1	ABA & NAG	1.35	Kg
SGS540	0013	Chem013	Test 1	ABA & NAG	1.55	Kg
SGS540	0014	Chem014	Test 1	ABA & NAG	1.50	Kg
SGS540	0015	Chem015	Test 1	ABA & NAG	1.45	Kg
SGS540	0016	Chem016	Test 1	ABA & NAG	1.65	Kg
SGS540	0017	Chem017	Test 1	ABA & NAG	1.20	Kg
SGS540	0019	Chem019	Test 1	ABA & NAG	1.60	Kg
SGS540	0020	Chem020	Test 1	ABA & NAG	1.40	Kg
SGS540	0021	Chem021	Test 1	ABA & NAG	1.45	Kg
SGS540	0023	Chem023	Test 1	ABA & NAG	2.20	Kg
SGS540	0024	Chem024	Test 1	ABA & NAG	1.30	Kg
SGS540	0025	Chem025	Test 1	ABA & NAG	1.10	Kg
SGS540	0026	Chem026	Test 1	ABA & NAG	1.45	Kg
SGS540	0027	Chem027	Test 1	ABA & NAG	1.65	Kg
SGS540	0028	Chem028	Test 2	Total S via Leco	1.10	Kg
SGS540	0029	Chem029	Test 2	Total S via Leco	1.35	Kg
SGS540	0030	Chem030	Test 1	ABA & NAG	1.65	Kg
SGS540	0031	Chem031	Test 1	ABA & NAG	1.50	Kg
SGS540	0032	Chem032	Test 1	ABA & NAG	1.45	Kg
SGS540	0033	Chem033	Test 1	ABA & NAG	1.40	Kg
SGS540	0034	Chem034	Test 1	ABA & NAG	1.50	Kg
SGS540	0035	Chem035	Test 2	Total S via Leco	1.20	Kg
SGS540	0036	Chem036	Test 2	Total S via Leco	1.50	Kg
SGS540	0037	Chem037	Test 1	ABA & NAG	1.35	Kg
SGS540	0038	Chem038	Test 1	ABA & NAG	1.45	Kg
SGS540	0039	Chem039	Test 1	ABA & NAG	1.05	Kg
SGS540	0040	Chem040	Test 2	Total S via Leco	1.50	Kg
SGS540	0041	Chem041	Test 2	Total S via Leco	1.05	Kg
SGS540	0042	Chem042	Test 1	ABA & NAG	1.85	Kg
SGS540	0043	Chem043	Test 1	ABA & NAG	1.30	Kg
SGS540	0044	Chem044	Test 1	ABA & NAG	1.50	Kg
SGS540	0045	Chem045	Test 1	ABA & NAG	1.65	Kg
SGS540	0046	Chem046	Test 1	ABA & NAG	1.15	Kg
SGS540	0047	Chem047	Test 1	ABA & NAG	1.55	Kg
SGS540	0048	Chem048	Test 2	Total S via Leco	1.15	Kg
SGS540	0049	Chem049	Test 2	Total S via Leco	1.35	Kg
SGS540	0050	Chem050	Test 1	ABA & NAG	1.60	Kg
SGS540	0051	Chem051	Test 1	ABA & NAG	1.55	Kg

Table 2 - List of received samples and test requirements, Cont'd

ORE NUMBER	SAMPLE SERIAL	PRODUCT NAME LEVEL 1	PRODUCT NAME LEVEL 2		Quantity (T)	Unit
SGS540	0052	Chem052	Test 1	ABA & NAG	1.40	Kg
SGS540	0053	Chem053	Test 1	ABA & NAG	1.40	Kg
SGS540	0054	Chem054	Test 1	ABA & NAG	1.80	Kg
SGS540	0055	Chem055	Test 1	ABA & NAG	1.55	Kg
SGS540	0056	Chem056	Test 2	Total S via Leco	1.45	Kg
SGS540	0058	Chem058	Test 1	ABA & NAG	1.35	Kg
SGS540	0059	Chem059	Test 1	ABA & NAG	1.35	Kg
SGS540	0060	Chem060	Test 1	ABA & NAG	1.45	Kg
SGS540	0061	Chem061	Test 1	ABA & NAG	1.45	Kg
SGS540	0062	Chem062	Test 1	ABA & NAG	1.55	Kg
SGS540	0063	Chem063	Test 1	ABA & NAG	1.95	Kg
SGS540	0064	Chem064	Test 2	Total S via Leco	1.60	Kg
SGS540	0065	Chem065	Test 2	Total S via Leco	1.80	Kg
SGS540	0066	Chem066	Test 1	ABA & NAG	1.85	Kg
SGS540	0067	Chem067	Test 2	Total S via Leco	1.35	Kg
SGS540	0068	Chem068	Test 2	Total S via Leco	1.20	Kg
SGS540	0069	Chem069	Test 1	ABA & NAG	1.20	Kg
SGS540	0070	Chem070	Test 1	ABA & NAG	1.55	Kg
SGS540	0071	Chem071	Test 1	ABA & NAG	1.20	Kg
SGS540	0072	Chem072	Test 2	Total S via Leco	2.05	Kg
SGS540	0073	Chem073	Test 2	Total S via Leco	1.35	Kg
SGS540	0074	Chem074	Test 2	Total S via Leco	1.40	Kg
SGS540	0075	Chem075	Test 2	Total S via Leco	1.55	Kg
SGS540	0076	Chem076	Test 2	Total S via Leco	1.65	Kg
SGS540	0077	Chem077	Test 1	ABA & NAG	1.25	Kg
SGS540	0078	Chem078	Test 1	ABA & NAG	1.40	Kg
SGS540	0079	Chem079	Test 1	ABA & NAG	1.65	Kg
SGS540	0080	Chem080	Test 1	ABA & NAG	1.20	Kg
SGS540	0081	Chem081	Test 1	ABA & NAG	1.75	Kg
SGS540	0082	Chem082	Test 1	ABA & NAG	1.55	Kg
SGS540	0083	Chem083	Test 1	ABA & NAG	1.75	Kg
SGS540	0084	Chem084	Test 1	ABA & NAG	1.75	Kg
SGS540	0085	Chem085	Test 1	ABA & NAG	1.70	Kg
SGS540	0086	Chem086	Test 1	ABA & NAG	1.90	Kg
SGS540	0087	Chem087	Test 1	ABA & NAG	1.90	Kg
SGS540	0088	Chem088	Test 1	ABA & NAG	1.40	Kg
SGS540	0089	Chem089	Test 1	ABA & NAG	1.60	Kg
SGS540	0090	Chem090	Test 1	ABA & NAG	1.45	Kg
SGS540	0091	Chem091	Test 1	ABA & NAG	1.55	Kg
SGS540	0092	Chem092	Test 1	ABA & NAG	1.95	Kg
SGS540	0093	Chem093	Test 1	ABA & NAG	1.40	Kg
SGS540	0094	Chem094	Test 1	ABA & NAG	1.40	Kg
SGS540	0095	Chem095	Test 1	ABA & NAG	1.85	Kg
SGS540	0096	Chem096	Test 2	Total S via Leco	1.35	Kg
SGS540	0097	Chem097	Test 2	Total S via Leco	2.15	Kg
SGS540	0098	Chem098	Test 2	Total S via Leco	1.80	Kg
SGS540	0099	Chem099	Test 2	Total S via Leco	1.15	Kg
SGS540	0100	Chem100	Test 2	Total S via Leco	1.20	Kg
SGS540	0101	Chem101	Test 1	ABA & NAG	2.00	Kg
SGS540	0102	Chem102	Test 1	ABA & NAG	1.90	Kg

3 RESULTS

3.1 SULPHUR BY LECO ANALYSIS

The results of the total sulphur by LECO analysis are shown in Table 3 table # below

Table 3 - Results of LECO analysis for total sulphur

Project	Serial No.	Client ID	Description	Analysis	%S Total
SGS540	1026	Chem028	Sub Sample	Total S via Leco	0.03
SGS540	1027	Chem029	Sub Sample	Total S via Leco	0.18
SGS540	1033	Chem035	Sub Sample	Total S via Leco	0.12
SGS540	1034	Chem036	Sub Sample	Total S via Leco	0.15
SGS540	1038	Chem040	Sub Sample	Total S via Leco	0.07
SGS540	1039	Chem041	Sub Sample	Total S via Leco	0.12
SGS540	1046	Chem048	Sub Sample	Total S via Leco	0.12
SGS540	1047	Chem049	Sub Sample	Total S via Leco	0.08
SGS540	1054	Chem056	Sub Sample	Total S via Leco	0.07
SGS540	1061	Chem064	Sub Sample	Total S via Leco	0.48
SGS540	1062	Chem065	Sub Sample	Total S via Leco	0.14
SGS540	1064	Chem067	Sub Sample	Total S via Leco	0.13
SGS540	1065	Chem068	Sub Sample	Total S via Leco	1.24
SGS540	1069	Chem072	Sub Sample	Total S via Leco	0.25
SGS540	1070	Chem073	Sub Sample	Total S via Leco	0.19
SGS540	1071	Chem074	Sub Sample	Total S via Leco	0.15
SGS540	1072	Chem075	Sub Sample	Total S via Leco	0.13
SGS540	1073	Chem076	Sub Sample	Total S via Leco	0.04
SGS540	1093	Chem096	Sub Sample	Total S via Leco	0.11
SGS540	1094	Chem097	Sub Sample	Total S via Leco	0.24
SGS540	1095	Chem098	Sub Sample	Total S via Leco	0.03
SGS540	1096	Chem099	Sub Sample	Total S via Leco	0.01
SGS540	1097	Chem100	Sub Sample	Total S via Leco	0.01

3.2 Acid Base Accounting

The results for the ABA testing is given in the below tables. In many instances the measured sulphide species were below detection. This has meant that the calculation of the ABA result for these samples was not possible.

Table 4 - ABA results, Chem 1 - Chem 10

		Chem 1	Chem 2	Chem 3	Chem 4	Chem 5	Chem 6	Chem 7	Chem 8	Chem 9	Chem 10
		AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d
	Sample #	Test	Test	Test	Test	Test	Test	Test	Test	Test	Test
Parameter	**Unit**	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**	**#7**	**#8**	**#9**	**#10**
Paste pH	units	8.30	10.07	10.85	8.89	11.21	10.92	10.70	11.00	10.46	11.19
Fizz Rate	---	1	2	2	1	1	1	1	1	2	2
Sample weigh	g	2.040	1.904	1.887	1.933	1.943	1.976	2.118	2.177	2.013	1.917
HCl added	mL	51.80	123.50	61.50	56.40	48.90	50.80	54.70	53.00	82.40	40.00
HCl	Normality	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH	Normality	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH to	pH=8.3 mL	36.80	41.70	20.50	35.00	30.20	30.10	32.00	29.80	35.10	18.00
Final pH	units	1.69	1.65	1.80	1.88	1.80	1.70	1.70	1.71	1.63	1.70
NP1	t CaCO3/1000 t	36.8	214.8	108.6	55.4	48.1	52.4	53.6	53.3	117.5	57.4
AP	t CaCO3/1000 t	#VALUE!	#VALUE!	2.5	#VALUE!	0.6	3.4	2.2	3.4	4.7	0.6
Net NP	t CaCO3/1000 t	#VALUE!	#VALUE!	106.1	#VALUE!	47.5	48.9	51.4	49.8	112.8	56.8
NP/AP	ratio	#VALUE!	#VALUE!	43.5	#VALUE!	77.0	15.2	24.5	15.5	25.1	91.8
S	%	0.01	0.06	0.11	0.01	0.15	0.19	0.17	0.17	0.29	0.09
SO4	%	0.01	0.06	0.03	0.01	0.13	0.08	0.1	0.06	0.14	0.07
Sulphide	%	<0.01	<0.01	0.08	<0.01	0.02	0.11	0.07	0.11	0.15	0.02
Carbonate	%	0.06	2.34	1.03	0.19	0.27	0.14	0.07	0.19	1.1	0.42
CO3 NP2	t CaCO3/1000 t	1.0	38.8	17.1	3.2	4.5	2.3	1.2	3.2	18.3	7.0
CO3 Net NP	t CaCO3/1000 t	#VALUE!	#VALUE!	14.6	#VALUE!	3.9	-1.1	-1.0	-0.3	13.6	6.3
CO3 NP/AP	Ratio	#VALUE!	#VALUE!	6.839	#VALUE!	7.171	0.676	0.531	0.918	3.895	11.155
Classification	based on ABA NP1	#VALUE!	#VALUE!	**PAN**	#VALUE!	**PAN**	**PAN**	**PAN**	**PAN**	**PAN**	**PAN**
Classification	based on CO3 NP2	#VALUE!	#VALUE!	**uncertain**	#VALUE!	**uncertain**	**PAG**	**PAG**	**PAG**	**uncertain**	**uncertain**
NP from CO3	%	2.7	18.1	15.7	5.7	9.3	4.4	2.2	5.9	15.5	12.2

Table 5 - ABA results, Chem 10 Dup - Chem 19

		Chem 10	Std.	Chem 11	Chem 12	Chem 13	Chem 14	Chem 15	Chem 16	Chem 17	Chem 19
		AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d
	Sample #	Duplicate	NBM-1a	Test	Test	Test	Test	Test	Test	Test	Test
Parameter	**Unit**	**#11**	**#12**	**#13**	**#14**	**#15**	**#16**	**#17**	**#18**	**#19**	**#20**
Paste pH	units	11.25	8.49	10.50	7.65	10.72	10.30	10.06	10.23	9.79	7.10
Fizz Rate	---	2	2	1	1	1	2	2	2	1	1
Sample weigh	g	2.054	2.054	2.114	1.940	1.958	1.872	1.943	1.979	2.198	1.933
HCl added	mL	40.00	40.00	47.30	20.00	29.40	101.60	124.50	116.90	37.80	29.90
HCl	Normality	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH	Normality	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH to	pH=8.3 mL	18.00	14.70	29.30	15.00	16.60	28.00	31.00	30.50	24.00	21.00
Final pH	units	1.70	2.00	1.86	1.90	1.92	1.91	1.99	1.91	1.56	1.53
NP1	t CaCO3/1000 t	53.6	61.6	42.6	12.9	32.7	196.6	240.6	218.3	31.4	23.0
AP	t CaCO3/1000 t	0.6	7.8	2.2	#VALUE!	#VALUE!	#VALUE!	0.6	5.3	23.1	#VALUE!
Net NP	t CaCO3/1000 t	52.9	53.8	40.4	#VALUE!	#VALUE!	#VALUE!	240.0	213.0	8.3	#VALUE!
NP/AP	ratio	85.7	7.9	19.5	#VALUE!	#VALUE!	#VALUE!	385.0	41.1	1.4	#VALUE!
S	%	0.09	0.28	0.12	0.01	0.04	0.28	0.06	0.24	0.81	0.02
SO4	%	0.07	0.03	0.05	0.01	0.04	0.28	0.04	0.07	0.07	0.02
Sulphide	%	0.02	0.25	0.07	<0.01	<0.01	<0.01	0.02	0.17	0.74	<0.01
Carbonate	%	0.42	2.88	0.14	0.11	0.17	1.82	2.63	2.08	0.09	0.20
CO3 NP2	t CaCO3/1000 t	7.0	47.8	2.3	1.8	2.8	30.2	43.7	34.5	1.5	3.3
CO3 Net NP	t CaCO3/1000 t	6.3	40.0	0.1	#VALUE!	#VALUE!	#VALUE!	43.0	29.2	-21.6	#VALUE!
CO3 NP/AP	Ratio	11.155	6.119	1.062	#VALUE!	#VALUE!	#VALUE!	69.853	6.499	0.065	#VALUE!
Classification	based on ABA NP1	**PAN**	**PAN**	**PAN**	#VALUE!	#VALUE!	#VALUE!	**PAN**	**PAN**	**uncertain**	#VALUE!
Classification	based on CO3 NP2	**uncertain**	**PAN**	**uncertain**	#VALUE!	#VALUE!	#VALUE!	**PAN**	**PAN**	**PAG**	#VALUE!
NP from CO3	%	13.0	77.6	5.5	14.2	8.6	15.4	18.1	15.8	4.8	14.4

Table 6 - ABA results, Chem 20 Dup - Chem 30

		Chem 20	Chem 20.	Std.	Chem 21	Chem 23	Chem 24	Chem 25	Chem 26	Chem 27	Chem 30
		AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d
	Sample #	Test	Duplicate	NBM-1b	Test	Test	Test	Test	Test	Test	Test
Parameter	**Unit**	**#21**	**#22**	**#23**	**#24**	**#25**	**#26**	**#27**	**#28**	**#29**	**#30**
Paste pH	units	9.09	9.10	8.50	10.21	9.06	10.68	10.69	10.05	10.27	10.70
Fizz Rate	---	1	1	2	2	1	2	2	2	2	2
Sample weigh	g	2.046	2.046	1.920	1.851	2.089	2.032	1.930	2.012	1.968	1.922
HCl added	mL	49.90	50.50	59.90	65.50	20.00	67.00	62.30	40.00	82.00	105.50
HCl	Normality	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH	Normality	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH to	pH=8.3 mL	32.00	33.00	29.50	21.70	14.50	19.50	29.00	13.00	26.90	27.50
Final pH	units	1.60	1.55	1.52	1.77	1.99	1.74	1.84	2.00	1.86	1.63
NP1	t CaCO3/1000 t	43.7	42.8	79.2	118.3	13.2	116.9	86.3	67.1	140.0	202.9
AP	t CaCO3/1000 t	#VALUE!	#VALUE!	7.8	#VALUE!	#VALUE!	4.7	2.2	#VALUE!	9.1	#VALUE!
Net NP	t CaCO3/1000 t	#VALUE!	#VALUE!	71.4	#VALUE!	#VALUE!	112.2	84.1	#VALUE!	130.9	#VALUE!
NP/AP	ratio	#VALUE!	#VALUE!	10.1	#VALUE!	#VALUE!	24.9	39.4	#VALUE!	15.4	#VALUE!
S	%	0.01	0.01	0.28	0.01	0.01	0.18	0.16	0.02	0.32	0.01
SO4	%	0.01	0.01	0.03	0.01	0.01	0.03	0.09	0.02	0.03	0.01
Sulphide	%	**<0.01**	**<0.01**	0.25	**<0.01**	**<0.01**	0.15	0.07	**<0.01**	0.29	**<0.01**
Carbonate	%	0.08	0.08	2.88	1.22	0.08	1.09	0.74	0.78	1.96	1.42
CO3 NP2	t CaCO3/1000 t	1.3	1.3	47.8	20.3	1.3	18.1	12.3	12.9	32.5	23.6
CO3 Net NP	t CaCO3/1000 t	#VALUE!	#VALUE!	40.0	#VALUE!	#VALUE!	13.4	10.1	#VALUE!	23.5	#VALUE!
CO3 NP/AP	Ratio	#VALUE!	#VALUE!	6.119	#VALUE!	#VALUE!	3.860	5.616	#VALUE!	3.590	#VALUE!
Classification	based on ABA NP1	#VALUE!	#VALUE!	**PAN**	#VALUE!	#VALUE!	**PAN**	**PAN**	#VALUE!	**PAN**	#VALUE!
Classification	based on CO3 NP2	#VALUE!	#VALUE!	**PAN**	#VALUE!	#VALUE!	**uncertain**	**uncertain**	#VALUE!	**PAN**	#VALUE!
NP from CO3	%	3.0	3.1	60.4	17.1	10.1	15.5	14.2	19.3	23.2	11.6

Table 7 - ABA results, Chem 31 Dup - Chem 42

		Chem 31	Chem 32	Chem 33	Chem 33	Std.	Chem 34	Chem 37	Chem 38	Chem 39	Chem 42
		AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d
	Sample #	Test	Test	Test	Duplicate	NBM-1c	Test	Test	Test	Test	Test
Parameter	**Unit**	**#31**	**#32**	**#33**	**#34**	**#35**	**#36**	**#37**	**#38**	**#39**	**#40**
Paste pH	units	6.31	10.68	10.68	10.64	8.05	10.93	9.09	11.09	10.00	8.82
Fizz Rate	---	1	2	1	1	1	2	1	2	2	1
Sample weigh	g	2.166	2.157	1.903	1.923	2.047	2.084	2.112	1.855	2.090	2.003
HCl added	mL	20.00	40.00	20.00	20.00	40.00	40.00	20.00	40.00	124.80	28.00
HCl	Normality	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH	Normality	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH to	pH=8.3 mL	23.00	27.10	13.40	13.30	18.50	25.00	14.90	22.20	40.10	19.60
Final pH	units	1.30	1.46	1.84	1.93	1.93	1.53	1.92	1.51	1.70	1.86
NP1	t CaCO3/1000 t	-6.9	29.9	17.3	17.4	52.5	36.0	12.1	48.0	202.6	21.0
AP	t CaCO3/1000 t	#VALUE!	2.5	1.9	1.9	7.8	1.9	#VALUE!	1.9	5.3	#VALUE!
Net NP	t CaCO3/1000 t	#VALUE!	27.4	15.5	15.5	44.7	34.1	#VALUE!	46.1	197.3	#VALUE!
NP/AP	ratio	#VALUE!	12.0	9.2	9.3	6.7	19.2	#VALUE!	25.6	38.1	#VALUE!
S	%	0.02	0.16	0.15	0.15	0.28	0.14	0.01	0.14	0.26	0.02
SO4	%	0.02	0.08	0.09	0.09	0.03	0.08	0.01	0.08	0.09	0.02
Sulphide	%	**<0.01**	0.08	0.06	0.06	0.25	0.06	**<0.01**	0.06	0.17	**<0.01**
Carbonate	%	0.07	0.24	0.14	0.14	2.88	0.28	0.1	0.42	1.82	0.1
CO3 NP2	t CaCO3/1000 t	1.2	4.0	2.3	2.3	47.8	4.6	1.7	7.0	30.2	1.7
CO3 Net NP	t CaCO3/1000 t	#VALUE!	1.5	0.4	0.4	40.0	2.8	#VALUE!	5.1	24.9	#VALUE!
CO3 NP/AP	Ratio	#VALUE!	1.594	1.239	1.239	6.119	2.479	#VALUE!	3.718	5.687	#VALUE!
Classification	based on ABA NP1	#VALUE!	**PAN**	**uncertain**	**uncertain**	**PAN**	**PAN**	#VALUE!	**PAN**	**PAN**	#VALUE!
Classification	based on CO3 NP2	#VALUE!	**uncertain**	**uncertain**	**uncertain**	**PAN**	**uncertain**	#VALUE!	**uncertain**	**PAN**	#VALUE!
NP from CO3	%	-16.8	13.3	13.4	13.3	91.0	12.9	13.7	14.5	14.9	7.9

Table 8 - ABA results, Chem 43 Dup - Chem 52

		Chem 43	Chem 44	Chem 45	Chem 46	Chem 47	Chem 47	Std.	Chem 50	Chem 51	Chem 52
		AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d
	Sample #	Test	Test	Test	Test	Test	Duplicate	NBM-1d	Test	Test	Test
Parameter	**Unit**	**#41**	**#42**	**#43**	**#44**	**#45**	**#46**	**#47**	**#48**	**#49**	**#50**
Paste pH	units	10.06	10.13	9.96	10.74	10.60	10.64	8.05	10.53	7.21	5.20
Fizz Rate	---	2	2	2	1	2	2	2	2	1	1
Sample weigh	g	2.014	1.924	1.892	1.943	2.045	2.061	2.143	1.969	2.149	2.179
HCl added	mL	147.20	96.10	134.00	42.50	56.10	55.80	40.00	40.00	20.00	20.00
HCl	Normality	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH	Normality	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH to	pH=8.3 mL	55.00	30.30	39.00	29.60	24.40	30.10	20.90	29.20	21.50	19.00
Final pH	units	1.56	1.83	1.72	1.53	1.74	1.67	1.87	1.63	1.55	1.31
NP1	t CaCO3/1000 t	228.9	171.0	251.1	33.2	77.5	62.3	44.6	27.4	-3.5	2.3
AP	t CaCO3/1000 t	8.4	#VALUE!	#VALUE!	1.6	0.3	0.3	7.8	0.3	#VALUE!	#VALUE!
Net NP	t CaCO3/1000 t	220.5	#VALUE!	#VALUE!	31.6	77.2	62.0	36.8	27.1	#VALUE!	#VALUE!
NP/AP	ratio	27.1	#VALUE!	#VALUE!	21.2	248.0	199.5	5.7	87.8	#VALUE!	#VALUE!
S	%	0.39	0.07	0.06	0.09	0.07	0.07	0.28	0.07	0.01	0.04
SO4	%	0.12	0.07	0.06	0.04	0.06	0.06	0.03	0.06	0.01	0.04
Sulphide	%	0.27	<0.01	<0.01	0.05	0.01	0.01	0.25	0.01	<0.01	<0.01
Carbonate	%	1.64	1.48	2.18	0.12	0.19	0.19	2.88	0.19	0.16	0.2
CO3 NP2	t CaCO3/1000 t	27.2	24.6	36.2	2.0	3.2	3.2	47.8	3.2	2.7	3.3
CO3 Net NP	t CaCO3/1000 t	18.8	#VALUE!	#VALUE!	0.4	2.8	2.8	40.0	2.8	#VALUE!	#VALUE!
CO3 NP/AP	Ratio	3.227	#VALUE!	#VALUE!	1.275	10.093	10.093	6.119	10.093	#VALUE!	#VALUE!
Classification	based on ABA NP1	PAN	#VALUE!	#VALUE!	PAN	PAN	PAN	PAN	PAN	#VALUE!	#VALUE!
Classification	based on CO3 NP2	uncertain	#VALUE!	#VALUE!	uncertain	uncertain	uncertain	PAN	uncertain	#VALUE!	#VALUE!
NP from CO3	%	11.9	14.4	14.4	6.0	4.1	5.1	107.3	11.5	-76.1	144.7

Table 89 - ABA results, Chem 53 Dup - Chem 62

		Chem 53	Chem 54	Chem 55	Chem 58	Chem 59	Chem 60	Chem 61	Chem 61	Std.	Chem 62
		AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d
	Sample #	Test	Test	Test	Test	Test	Test	Test	Duplicate	NBM-1e	Test
Parameter	**Unit**	**#51**	**#52**	**#53**	**#54**	**#55**	**#56**	**#57**	**#58**	**#59**	**#60**
Paste pH	units	7.77	9.44	10.97	6.30	10.24	8.24	8.63	8.68	8.05	10.33
Fizz Rate	---	1	2	1	1	2	1	1	1	2	2
Sample weigh	g	1.926	1.908	2.195	1.997	1.855	1.988	2.085	1.988	2.060	2.145
HCl added	mL	20.00	46.00	24.70	20.00	83.50	20.00	25.10	24.60	40.00	40.00
HCl	Normality	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH	Normality	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH to	pH=8.3 mL	15.10	20.80	18.00	18.00	24.50	16.00	18.70	19.00	17.00	16.60
Final pH	units	1.60	1.70	1.66	1.32	1.72	1.75	2.00	1.95	1.78	1.90
NP1	t CaCO3/1000 t	12.7	66.0	15.3	5.0	159.0	10.1	15.3	14.1	55.8	54.5
AP	t CaCO3/1000 t	0.9	8.4	4.7	#VALUE!	20.3	#VALUE!	#VALUE!	#VALUE!	7.8	43.1
Net NP	t CaCO3/1000 t	11.8	57.6	10.6	#VALUE!	138.7	#VALUE!	#VALUE!	#VALUE!	48.0	11.4
NP/AP	ratio	13.6	7.8	3.3	#VALUE!	7.8	#VALUE!	#VALUE!	#VALUE!	7.1	1.3
S	%	0.04	0.29	0.18	0.01	0.68	0.01	0.01	0.01	0.28	1.43
SO4	%	0.01	0.02	0.03	0.01	0.03	0.01	0.01	0.01	0.03	0.05
Sulphide	%	0.03	0.27	0.15	<0.01	0.65	<0.01	<0.01	<0.01	0.25	1.38
Carbonate	%	0.09	0.43	0.02	0.07	1.11	0.08	0.08	0.08	2.88	0.45
CO3 NP2	t CaCO3/1000 t	1.5	7.1	0.3	1.2	18.4	1.3	1.3	1.3	47.8	7.5
CO3 Net NP	t CaCO3/1000 t	0.6	-1.3	-4.4	#VALUE!	-1.9	#VALUE!	#VALUE!	#VALUE!	40.0	-35.7
CO3 NP/AP	Ratio	1.594	0.846	0.071	#VALUE!	0.907	#VALUE!	#VALUE!	#VALUE!	6.119	0.173
Classification	based on ABA NP1	uncertain	PAN	uncertain	#VALUE!	PAN	#VALUE!	#VALUE!	#VALUE!	PAN	uncertain
Classification	based on CO3 NP2	uncertain	PAG	PAG	#VALUE!	PAG	#VALUE!	#VALUE!	#VALUE!	PAN	PAG
NP from CO3	%	11.7	10.8	2.2	23.2	11.6	13.2	8.7	9.4	85.6	13.7

Table 910 - ABA results, Chem 63 Dup - Chem 80

		Chem 63	Chem 66	Chem 69	Chem 70	Chem 71	Chem 77	Chem 78	Chem 79	Chem 80	Chem 80
		AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d
	Sample #	Test	Test	Test	Test	Test	Test	Test	Test	Test	Duplicate
Parameter	**Unit**	**#61**	**#62**	**#63**	**#64**	**#65**	**#66**	**#67**	**#68**	**#69**	**#70**
Paste pH	units	9.91	10.34	9.97	10.48	9.01	7.60	8.94	8.87	9.53	9.51
Fizz Rate	---	2	1	2	2	1	1	1	1	2	2
Sample weigh	g	1.911	2.140	1.997	1.923	2.192	2.157	1.887	2.014	2.008	2.013
HCl added	mL	123.00	24.90	108.20	70.10	30.70	20.00	20.00	20.00	106.20	125.60
HCl	Normality	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH	Normality	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH to	pH=8.3 mL	37.10	18.00	30.20	22.20	22.80	17.00	12.70	14.60	24.00	36.60
Final pH	units	1.68	1.56	1.76	1.67	1.76	1.29	1.96	1.77	1.98	1.70
NP1	t CaCO3/1000 t	224.8	16.1	195.3	124.5	18.0	7.0	19.3	13.4	204.7	221.1
AP	t CaCO3/1000 t	#VALUE!	3.8	9.4	4.1	#VALUE!	0.3	0.3	0.6	1.6	1.6
Net NP	t CaCO3/1000 t	#VALUE!	12.4	185.9	120.5	#VALUE!	6.6	19.0	12.8	203.1	219.5
NP/AP	ratio	#VALUE!	4.3	20.8	30.7	#VALUE!	22.3	61.9	21.4	131.0	141.5
S	%	0.09	0.16	0.33	0.16	0.01	0.01	0.01	0.02	0.05	0.05
SO4	%	0.09	0.04	0.03	0.03	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sulphide	%	<0.01	0.12	0.3	0.13	<0.01	0.01	0.01	0.02	0.05	0.05
Carbonate	%	2.16	0.11	1.8	1.16	0.11	0.13	0.09	0.13	2.39	2.39
CO3 NP2	t CaCO3/1000 t	35.9	1.8	29.9	19.3	1.8	2.2	1.5	2.2	39.7	39.7
CO3 Net NP	t CaCO3/1000 t	#VALUE!	-1.9	20.5	15.2	#VALUE!	1.8	1.2	1.5	38.1	38.1
CO3 NP/AP	Ratio	#VALUE!	0.487	3.187	4.740	#VALUE!	6.906	4.781	3.453	25.391	25.391
Classification	based on ABA NP1	#VALUE!	uncertain	PAN	PAN	#VALUE!	uncertain	uncertain	uncertain	PAN	PAN
Classification	based on CO3 NP2	#VALUE!	PAG	PAN	uncertain	#VALUE!	uncertain	uncertain	uncertain	PAN	PAN
NP from CO3	%	16.0	11.3	15.3	15.5	10.1	31.0	7.7	16.1	19.4	17.9

Table 1011 - ABA results, Chem 81 Dup - Chem 89

		Std.	Chem 81	Chem 82	Chem 83	Chem 84	Chem 85	Chem 86	Chem 87	Chem 88	Chem 89
		AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d
	Sample #	NBM-1f	Test	Test	Test	Test	Test	Test	Test	Test	Test
Parameter	**Unit**	**#71**	**#72**	**#73**	**#74**	**#75**	**#76**	**#77**	**#78**	**#79**	**#80**
Paste pH	units	8.05	10.03	10.13	8.10	8.40	10.51	10.24	10.40	6.60	10.77
Fizz Rate	---	2	2	2	1	1	2	1	2	1	1
Sample weigh	g	1.999	1.892	2.134	2.188	2.149	1.988	2.054	2.105	1.976	2.029
HCl added	mL	40.00	87.10	140.20	25.10	31.30	46.50	20.00	40.00	20.00	25.20
HCl	Normality	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH	Normality	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH to	pH=8.3 mL	17.80	27.50	26.50	17.90	21.60	18.20	12.30	19.50	16.00	15.50
Final pH	units	1.74	1.67	1.83	1.74	1.74	1.67	1.80	1.66	1.18	1.53
NP1	t CaCO3/1000 t	55.5	157.5	266.4	16.5	22.6	71.2	18.7	48.7	10.1	23.9
AP	t CaCO3/1000 t	7.8	7.5	4.7	#VALUE!	#VALUE!	4.7	4.4	4.4	#VALUE!	1.9
Net NP	t CaCO3/1000 t	47.7	150.0	261.7	#VALUE!	#VALUE!	66.5	14.4	44.3	#VALUE!	22.0
NP/AP	ratio	7.1	21.0	56.8	#VALUE!	#VALUE!	15.2	4.3	11.1	#VALUE!	12.7
S	%	0.28	0.27	0.17	0.01	0.01	0.17	0.16	0.15	0.01	0.09
SO4	%	0.03	0.03	0.02	0.01	0.01	0.02	0.02	0.01	0.01	0.03
Sulphide	%	0.25	0.24	0.15	<0.01	<0.01	0.15	0.14	0.14	<0.01	0.06
Carbonate	%	2.88	1.84	2.11	0.03	0.09	0.62	0.14	0.41	0.14	0.16
CO3 NP2	t CaCO3/1000 t	47.8	30.5	35.0	0.5	1.5	10.3	2.3	6.8	2.3	2.7
CO3 Net NP	t CaCO3/1000 t	40.0	23.0	30.3	#VALUE!	#VALUE!	5.6	-2.1	2.4	#VALUE!	0.8
CO3 NP/AP	Ratio	6.119	4.073	7.472	#VALUE!	#VALUE!	2.196	0.531	1.556	#VALUE!	1.417
Classification	based on ABA NP1	PAN	PAN	PAN	#VALUE!	#VALUE!	PAN	uncertain	PAN	#VALUE!	PAN
Classification	based on CO3 NP2	PAN	PAN	PAN	#VALUE!	#VALUE!	uncertain	PAG	uncertain	#VALUE!	uncertain
NP from CO3	%	86.1	19.4	13.1	3.0	6.6	14.5	12.4	14.0	23.0	11.1

Table 1112 - ABA results, Chem 90 Dup - Chem 102

		Chem 90	Chem 90	Std.	Chem 91	Chem 92	Chem 93	Chem 94	Chem 95	Chem 101	Chem 102	Chem 102	Std.
		AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d	AND00-1d
	Sample #	Test	Duplicate	NBM-1g	Test	Test	Test	Test	Test	Test	Test	Duplicate	NBM-1h
Parameter	**Unit**	**#81**	**#82**	**#83**	**#84**	**#85**	**#86**	**#87**	**#88**	**#89**	**#90**	**#91**	**#92**
Paste pH	units	10.08	10.09	8.05	8.12	10.26	7.66	9.42	10.60	6.57	8.17	8.24	8.05
Fizz Rate	---	2	2	2	1	2	1	1	1	1	1	1	2
Sample weigh	g	1.958	1.875	1.962	1.927	2.034	2.008	1.955	2.067	1.853	1.832	1.875	2.054
HCl added	mL	40.00	40.00	40.00	20.00	82.40	20.00	20.00	20.00	20.00	20.00	20.00	40.00
HCl	Normality	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH	Normality	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH to	pH=8.3 mL	19.20	20.20	18.30	13.50	22.50	14.70	15.00	13.00	16.80	14.50	15.50	17.90
Final pH	units	1.60	1.54	1.66	1.50	1.80	1.76	1.56	1.86	1.40	1.63	1.74	1.85
NP1	t CaCO3/1000 t	53.1	52.8	55.3	16.9	147.2	13.2	12.8	16.9	8.6	15.0	12.0	53.8
AP	t CaCO3/1000 t	1.3	1.3	7.8	#VALUE!	#VALUE!	#VALUE!	0.6	1.6	#VALUE!	#VALUE!	#VALUE!	7.8
Net NP	t CaCO3/1000 t	51.9	51.6	47.5	#VALUE!	#VALUE!	#VALUE!	12.2	15.4	#VALUE!	#VALUE!	#VALUE!	46.0
NP/AP	ratio	42.5	42.2	7.1	#VALUE!	#VALUE!	#VALUE!	20.5	10.8	#VALUE!	#VALUE!	#VALUE!	6.9
S	%	0.05	0.05	0.28	**<0.01**	0.01	0.02	0.03	0.08	0.01	0.01	0.01	0.28
SO4	%	0.01	0.01	0.03	**<0.01**	0.01	0.02	0.01	0.03	0.01	0.01	0.01	0.03
Sulphide	%	0.04	0.04	0.25	**<0.01**	**<0.01**	**<0.01**	0.02	0.05	**<0.01**	**<0.01**	**<0.01**	0.25
Carbonate	%	0.44	0.44	2.88	0.09	1.42	0.07	0.09	0.17	0.15	0.15	0.15	2.88
CO3 NP2	t CaCO3/1000 t	7.3	7.3	47.8	1.5	23.6	1.2	1.5	2.8	2.5	2.5	2.5	47.8
CO3 Net NP	t CaCO3/1000 t	6.1	6.1	40.0	#VALUE!	#VALUE!	#VALUE!	0.9	1.3	#VALUE!	#VALUE!	#VALUE!	40.0
CO3 NP/AP	Ratio	5.843	5.843	6.119	#VALUE!	#VALUE!	#VALUE!	2.390	1.806	#VALUE!	#VALUE!	#VALUE!	6.119
Classification	based on ABA NP1	**PAN**	**PAN**	**PAN**	#VALUE!	#VALUE!	#VALUE!	**uncertain**	**uncertain**	#VALUE!	#VALUE!	#VALUE!	**PAN**
Classification	based on CO3 NP2	**uncertain**	**uncertain**	**PAN**	#VALUE!	#VALUE!	#VALUE!	**uncertain**	**uncertain**	#VALUE!	#VALUE!	#VALUE!	**PAN**
NP from CO3	%	13.8	13.8	86.5	8.9	16.0	8.8	11.7	16.7	28.8	16.6	20.8	88.9

3.3 Net Acid Generation

The results of the NAG testing are given in the below tables.

Table 1213 - NAG results, Chem 1 - Chem 10

		Chem 1	Chem 2	Chem 3	Chem 4	Chem 5	Chem 6	Chem 7	Chem 8	Chem 9	Chem 10
Net Acid Generation Testing	Sample #	Test	Test	Test	Test	Test	Test	Test	Test	Test	Test
Parameter	**Unit**	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**	**#7**	**#8**	**#9**	**#10**
Sample	weight [g]	2.545	2.525	2.521	2.503	2.584	2.530	2.512	2.532	2.651	2.474
Volume H_2O_2	mL	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
Final pH	units	6.48	7.91	7.83	7.80	7.03	7.58	6.90	6.92	8.58	7.14
NaOH	Normality	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Vol NaOH to pH 4.5	mL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vol NaOH from pH 4.5 to pH 7.0	mL	2.80	0.00	0.00	0.00	0.00	0.00	0.20	0.20	0.00	0.00
NAG @ pH 4.5	kg H_2SO_4/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NAG @ pH 7.0	kg H_2SO_4/t	5.39	0.00	0.00	0.00	0.00	0.00	0.39	0.39	0.00	0.00

Table 1314 - NAG results, Chem 10 - Chem 19

		Chem 10	Standard	Chem 11	Chem 12	Chem 13	Chem 14	Chem 15	Chem 16	Chem 17	Chem 19
Net Acid Generation Testing	Sample #	Duplicate	NBM-1a	Test	Test	Test	Test	Test	Test	Test	Test
Parameter	**Unit**	**#11**	**#12**	**#13**	**#14**	**#15**	**#16**	**#17**	**#18**	**#19**	**#20**
Sample	weight [g]	2.523	2.420	2.454	2.558	2.439	2.505	2.417	2.541	2.528	2.524
Volume H_2O_2	mL	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
Final pH	units	7.09	8.92	8.61	9.11	8.71	8.34	7.73	8.78	2.86	7.00
NaOH	Normality	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Vol NaOH to pH 4.5	mL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.20	0.00
Vol NaOH from pH 4.5 to pH 7.0	mL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.40	0.00
NAG @ pH 4.5	kg H_2SO_4/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.33	0.00
NAG @ pH 7.0	kg H_2SO_4/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	10.85	0.00

Table 1415 - NAG results, Chem 20 - Chem 30

		Chem 20	Chem 20.	Standard	Chem 21	Chem 23	Chem 24	Chem 25	Chem 26	Chem 27	Chem 30
Net Acid Generation Testing	Sample #	Test	Duplicate	NBM-1b	Test	Test	Test	Test	Test	Test	Test
Parameter	**Unit**	**#21**	**#22**	**#23**	**#24**	**#25**	**#26**	**#27**	**#28**	**#29**	**#30**
Sample	weight [g]	2.405	2.451	2.644	2.596	2.573	2.434	2.606	2.450	2.514	2.413
Volume H_2O_2	mL	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
Final pH	units	7.04	6.87	8.63	7.32	7.09	6.89	8.08	7.42	7.38	7.51
NaOH	Normality	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Vol NaOH to pH 4.5	mL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vol NaOH from pH 4.5 to pH 7.0	mL	0.00	0.20	0.00	0.00	0.00	0.50	0.00	0.00	0.00	0.00
NAG @ pH 4.5	kg H_2SO_4/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NAG @ pH 7.0	kg H_2SO_4/t	0.00	0.40	0.00	0.00	0.00	1.01	0.00	0.00	0.00	0.00

Table 1516 - NAG results, Chem 31 - Chem 42

		Chem 31	Chem 32	Chem 33	Chem 33	Standard	Chem 34	Chem 37	Chem 38	Chem 39	Chem 42
Net Acid Generation Testing	Sample #	Test	Test	Test	Duplicate	NBM-1c	Test	Test	Test	Test	Test
Parameter	**Unit**	**#31**	**#32**	**#33**	**#34**	**#35**	**#36**	**#37**	**#38**	**#39**	**#40**
Sample	weight [g]	2.588	2.529	2.553	2.451	2.608	2.530	2.461	2.459	2.510	2.437
Volume H_2O_2	mL	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
Final pH	units	5.81	7.05	7.19	7.08	8.65	7.28	7.66	7.23	7.70	7.56
NaOH	Normality	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Vol NaOH to pH 4.5	mL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vol NaOH from pH 4.5 to pH 7.0	mL	2.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NAG @ pH 4.5	kg H_2SO_4/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NAG @ pH 7.0	kg H_2SO_4/t	3.98	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table 1617 - NAG results, Chem 43 - Chem 52

		Chem 43	Chem 44	Chem 45	Chem 46	Chem 47	Chem 47	Std.	Chem 50	Chem 51	Chem 52
Net Acid Generation Testing	Sample #	Test	Test	Test	Test	Test	Duplicate	NBM-1d	Test	Test	Test
Parameter	**Unit**	**#41**	**#42**	**#43**	**#44**	**#45**	**#46**	**#47**	**#48**	**#49**	**#50**
Sample	weight [g]	2.470	2.483	2.560	2.452	2.568	2.440	2.474	2.513	2.509	2.424
Volume H_2O_2	mL	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
Final pH	units	8.60	8.16	8.91	8.09	7.75	7.65	8.34	7.43	6.4	5.72
NaOH	Normality	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Vol NaOH to pH 4.5	mL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vol NaOH from pH 4.5 to pH 7.0	mL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.20	3.40
NAG @ pH 4.5	kg H_2SO_4/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NAG @ pH 7.0	kg H_2SO_4/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.34	6.87

Table 1718 - NAG results, Chem 53 - Chem 62

		Chem 53	Chem 54	Chem 55	Chem 58	Chem 59	Chem 60	Chem 61	Chem 61	Standard	Chem 62
Net Acid Generation Testing	Sample #	Test	Test	Test	Test	Test	Test	Test	Duplicate	NBM-1e	Test
Parameter	**Unit**	**#51**	**#52**	**#53**	**#54**	**#55**	**#56**	**#57**	**#58**	**#59**	**#60**
Sample	weight [g]	2.462	2.434	2.462	2.436	2.596	2.444	2.453	2.462	2.490	2.368
Volume H_2O_2	mL	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
Final pH	units	5.96	6.68	6.53	6.25	7.26	6.35	6.42	6.50	8.45	6.39
NaOH	Normality	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Vol NaOH to pH 4.5	mL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vol NaOH from pH 4.5 to pH 7.0	mL	2.50	0.50	0.80	1.10	0.00	1.10	1.50	1.30	0.00	1.50
NAG @ pH 4.5	kg H_2SO_4/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NAG @ pH 7.0	kg H_2SO_4/t	4.98	1.01	1.59	2.21	0.00	2.21	3.00	2.59	0.00	3.10

Table 1819 - NAG results, Chem 63 - Chem 80

		Chem 63	Chem 66	Chem 69	Chem 70	Chem 71	Chem 77	Chem 78	Chem 79	Chem 80	Chem 80
Net Acid Generation Testing	Sample #	Test	Test	Test	Test	Test	Test	Test	Test	Test	Duplicate
Parameter	**Unit**	**#61**	**#62**	**#63**	**#64**	**#65**	**#66**	**#67**	**#68**	**#69**	**#70**
Sample	weight [g]	2.424	2.588	2.440	2.470	2.500	2.395	2.565	2.357	2.431	2.513
Volume H_2O_2	mL	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
Final pH	units	7.85	6.15	7.07	7.10	6.74	6.27	6.05	5.81	7.28	7.23
NaOH	Normality	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Vol NaOH to pH 4.5	mL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vol NaOH from pH 4.5 to pH 7.0	mL	0.00	1.30	0.00	0.00	0.70	1.00	2.50	7.00	0.00	0.00
NAG @ pH 4.5	kg H_2SO_4/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NAG @ pH 7.0	kg H_2SO_4/t	0.00	2.46	0.00	0.00	1.37	2.05	4.78	14.55	0.00	0.00

Table 1920 - NAG results, Chem 71 - Chem 80

		Standard	Chem 81	Chem 82	Chem 83	Chem 84	Chem 85	Chem 86	Chem 87	Chem 88	Chem 89
Net Acid Generation Testing	Sample #	NBM-1f	Test	Test	Test	Test	Test	Test	Test	Test	Test
Parameter	**Unit**	**#71**	**#72**	**#73**	**#74**	**#75**	**#76**	**#77**	**#78**	**#79**	**#80**
Sample	weight [g]	2.402	2.684	2.417	2.481	2.502	2.435	2.418	2.511	2.545	2.442
Volume H_2O_2	mL	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
Final pH	units	8.40	7.21	7.55	6.76	8.56	6.78	6.26	6.85	6.73	6.78
NaOH	Normality	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Vol NaOH to pH 4.5	mL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vol NaOH from pH 4.5 to pH 7.0	mL	0.00	0.00	0.00	0.40	0.00	0.80	1.90	0.40	0.70	1.00
NAG @ pH 4.5	kg H_2SO_4/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NAG @ pH 7.0	kg H_2SO_4/t	0.00	0.00	0.00	0.79	0.00	1.61	3.85	0.78	1.35	2.01

Table 2021 - NAG results, Chem 90 - Chem 102

		Chem 90	Chem 90	Standard	Chem 91	Chem 92	Chem 93	Chem 94	Chem 95	Chem 101	Chem 102	Chem 102	Standard
Net Acid Generation Testing	Sample #	Test	Duplicate	NBM-1g	Test	Test	Test	Test	Test	Test	Test	Duplicate	NBM-1h
Parameter	**Unit**	**#81**	**#82**	**#83**	**#84**	**#85**	**#86**	**#87**	**#88**	**#89**	**#90**	**#91**	**#92**
Sample	weight [g]	2.447	2.496	2.581	2.636	2.527	2.523	2.481	2.654	2.485	2.413	2.455	2.498
Volume H_2O_2	mL	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
Final pH	units	6.92	6.89	8.43	5.09	7.35	5.79	5.64	6.80	6.40	5.60	5.61	8.70
NaOH	Normality	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Vol NaOH to pH 4.5	mL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Vol NaOH from pH 4.5 to pH 7.0	mL	0.30	0.40	0.00	5.30	0.00	1.30	1.80	0.20	0.40	1.80	1.80	0.00
NAG @ pH 4.5	kg H_2SO_4/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NAG @ pH 7.0	kg H_2SO_4/t	0.60	0.79	0.00	9.85	0.00	2.52	3.56	0.37	0.79	3.66	3.59	0.00

APPENDICES

Sulphur by LECO, ABA & NAG Testing, AMARA Mining PLC

Wheal Jane Laboratory

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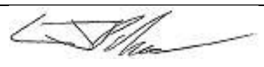
Test Report

WJL ID No: 77121-77130
Report No: 14092601b

Sample(s) Received: 24/09/14
Sample(s) Tested: 25/09-02/10/14
Tested By: NM LW
Test Procedure: M12, O2

For the attention of: Name: M. Cook
Company: SGS
Subject: Amara Batch 10

ple	% S(tot)	% S(sol)	% S(sol)	% C(tot)	% C(org)	% C(CO3)
540						
A CHEM 001	0.01	0.01	<0.01	0.10	0.04	0.06
A CHEM 002	0.06	0.06	<0.01	2.36	0.02	2.34
A CHEM 003	0.11	0.03	0.08	1.06	0.03	1.03
A CHEM 004	0.01	0.01	<0.01	0.23	0.04	0.19
A CHEM 005	0.15	0.13	0.02	0.29	0.02	0.27
A CHEM 006	0.19	0.08	0.11	0.16	0.02	0.14
A CHEM 007	0.17	0.10	0.07	0.10	0.03	0.07
A CHEM 008	0.17	0.06	0.11	0.21	0.02	0.19
A CHEM 009	0.29	0.14	0.15	1.13	0.03	1.10
A CHEM 010	0.09	0.07	0.02	0.55	0.13	0.42

Signed		Authorised Signatories:	Signed by:	Checked by:
		Clifford Rice, Laboratory Director		
		Liam Palmer, Laboratory Manager	X	
Dated	02/10/14	Rebecca Turner, Systems Administrator		X
		Fiona Dennis, Administrator		

Wheal Jane Laboratory
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Test Report

WJL ID No: 76995-77003
Report No: 14092401a

Sample(s) Received: 22/09/14 — Sample(s) Tested: 23-25/09/14
Tested By: LW NM — Test Procedure: M12, O2

For the attention of: Name: M. Cook
Company: SGS
Subject: Amara Batch 1

ple 540	% S(tot)	% S(sol)	% S(sul)	% C(tot)	% C(org)	% C(CO3)
A CHEM 011	0.12	0.05	0.07	0.19	0.05	0.14
A CHEM 012	0.01	0.01	<0.01	0.20	0.09	0.11
A CHEM 013	0.04	0.04	<0.01	0.20	0.03	0.17
A CHEM 014	0.28	0.28	<0.01	1.85	0.03	1.82
A CHEM 015	0.06	0.04	0.02	2.65	0.02	2.63
A CHEM 016	0.24	0.07	0.17	2.11	0.03	2.08
A CHEM 017	0.81	0.07	0.74	0.11	0.02	0.09
A CHEM 018	0.02	0.02	<0.01	0.29	0.09	0.20
A CHEM 019	0.01	0.01	<0.01	0.12	0.04	0.08

		Authorised Signatories:	Signed by:	Checked by:
Signed		Clifford Rice, Laboratory Director		
		Liam Palmer, Laboratory Manager	X	
Dated	25/09/14	Rebecca Turner, Systems Administrator		X
		Fiona Dennis, Administrator		

Wheal Jane Laboratory
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Test Report WJL ID No: 77104-77110

Report No: 14092501e

Sample(s) Received: 23/09/14 Sample(s) Tested: 24-29/09/14

Tested By: NM LW Test Procedure: M12, O2

For the attention of: Name: M. Cook
Company: SGS
Subject: Amara Batch 8

ple 540	% S(tot)	% S(sol)	% S(sul)	% C(tot)	% C(org)	% C(CO3)
)A CHEM 021	0.01	0.01	<0.01	1.24	0.02	1.22
A CHEM 023	0.01	0.01	<0.01	0.11	0.03	0.08
:A CHEM 024	0.18	0.03	0.15	1.11	0.02	1.09
;A CHEM 025	0.16	0.09	0.07	0.76	0.02	0.74
.A CHEM 026	0.02	0.02	<0.01	0.81	0.03	0.78
)A CHEM 027	0.32	0.03	0.29	1.99	0.03	1.96
;A CHEM 030	0.01	0.01	<0.01	1.44	0.02	1.42

Signed		Authorised Signatories:	Signed by:	Checked by:
		Clifford Rice, Laboratory Director	X	
		Liam Palmer, Laboratory Manager		
Dated	29/09/14	Rebecca Turner, Systems Administrator		X
		Fiona Dennis, Administrator		

Wheal Jane Laboratory

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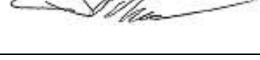
Test Report

WJL ID No: 77114-77120
Report No: 14092501f

Sample(s) Received: 23/09/14 | Sample(s) Tested: 25/09-02/10/14
Tested By: NM LW | Test Procedure: M12, O2

For the attention of: Name: M. Cook
Company: SGS
Subject: Amara Batch 9

ple	% S(tot)	% S(sol)	% S(sol)	% C(tot)	% C(org)	% C(CO3)
540						
A CHEM 031	0.02	0.02	<0.01	0.11	0.04	0.07
A CHEM 032	0.16	0.08	0.08	0.26	0.02	0.24
A CHEM 033	0.15	0.09	0.06	0.16	0.02	0.14
A CHEM 034	0.14	0.08	0.06	0.31	0.03	0.28
A CHEM 037	0.01	0.01	<0.01	0.12	0.02	0.10
A CHEM 038	0.14	0.08	0.06	0.44	0.02	0.42
A CHEM 039	0.26	0.09	0.17	1.85	0.03	1.82

		Authorised Signatories:	Signed by:	Checked by:
Signed		Clifford Rice, Laboratory Director		
		Liam Palmer, Laboratory Manager	X	
Dated	02/10/14	Rebecca Turner, Systems Administrator		X
		Fiona Dennis, Administrator		

Wheal Jane Laboratory

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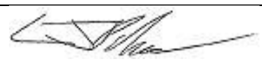
Test Report

WJL ID No: 77004-77010
Report No: 14092401b

Sample(s) Received: 22/09/14
Sample(s) Tested: 23-25/09/14
Tested By: LW NM
Test Procedure: M12, O2

For the attention of: Name: M. Cook
Company: SGS
Subject: Amara Batch 2

ple	% S(tot)	% S(sol)	% S(sul)	% C(tot)	% C(org)	% C(CO3)
540						
A CHEM 042	0.02	0.02	<0.01	0.13	0.03	0.10
A CHEM 043	0.39	0.12	0.27	1.66	0.02	1.64
A CHEM 044	0.07	0.07	<0.01	1.50	0.02	1.48
A CHEM 045	0.06	0.06	<0.01	2.20	0.02	2.18
A CHEM 046	0.09	0.04	0.05	0.14	0.02	0.12
A CHEM 047	0.07	0.06	0.01	0.65	0.02	0.63
A CHEM 050	0.07	0.06	0.01	0.21	0.02	0.19

Signed		Authorised Signatories:	Signed by:	Checked by:
		Clifford Rice, Laboratory Director		
		Liam Palmer, Laboratory Manager	X	
Dated	25/09/14	Rebecca Turner, Systems Administrator		X
		Fiona Dennis, Administrator		

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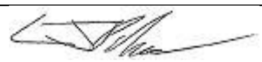
Test Report

WJL ID No: 77090-77097
Report No: 14092501c

Sample(s) Received: 23/09/14 | Sample(s) Tested: 24-29/09/14
Tested By: DP NM | Test Procedure: M12, O2

For the attention of: Name: M. Cook
Company: SGS
Subject: Amara Batch 6

ple 540	% S(tot)	% S(sol)	% S(sul)	% C(tot)	% C(org)	% C(CO3)
A CHEM 051	0.01	0.01	<0.01	0.20	0.04	0.16
A CHEM 052	0.04	0.04	<0.01	0.21	0.01	0.20
A CHEM 053	0.04	0.01	0.03	0.11	0.02	0.09
A CHEM 054	0.29	0.02	0.27	0.61	0.18	0.43
A CHEM 055	0.18	0.03	0.15	0.13	0.11	0.02
A CHEM 058	0.01	0.01	<0.01	0.08	0.01	0.07
A CHEM 059	0.68	0.03	0.65	1.53	0.42	1.11
A CHEM 060	0.01	0.01	<0.01	0.09	0.01	0.08

Signed		Authorised Signatories:	Signed by:	Checked by:
		Clifford Rice, Laboratory Director		
		Liam Palmer, Laboratory Manager	X	
Dated	29/09/14	Rebecca Turner, Systems Administrator		X
		Fiona Dennis, Administrator		

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Test Report

WJL ID No: 77098-77103
Report No: 14092501d

Sample(s) Received: 23/09/14
Sample(s) Tested: 24-29/09/14
Tested By: NM LW
Test Procedure: M12, O2

For the attention of: Name: M. Cook
Company: SGS
Subject: Amara Batch 7

ple 540	% S(tot)	% S(sol)	% S(sul)	% C(tot)	% C(org)	% C(CO3)
A CHEM 061	0.01	0.01	<0.01	0.13	0.05	0.08
A CHEM 062	1.43	0.05	1.38	0.48	0.03	0.45
A CHEM 063	0.09	0.09	<0.01	2.20	0.04	2.16
A CHEM 066	0.16	0.04	0.12	0.14	0.03	0.11
A CHEM 069	0.33	0.03	0.30	1.87	0.07	1.80
A CHEM 070	0.16	0.03	0.13	1.18	0.02	1.16

		Authorised Signatories:	Signed by:	Checked by:
Signed		Clifford Rice, Laboratory Director	X	
		Liam Palmer, Laboratory Manager		
Dated	29/09/14	Rebecca Turner, Systems Administrator		X
		Fiona Dennis, Administrator		

Wheal Jane Laboratory

Wheal Jane Services, Old Mine Offices, Wheal Jane, Baldhu, Truro, Cornwall TR3 6EE
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E-mail crice@wheal-jane.co.uk

Test Report

WJL ID No: 77011-77015
Report No: 14092401c

Sample(s) Received: 22/09/14 | Sample(s) Tested: 23-25/09/14
Tested By: AA NM | Test Procedure: M12, O2

For the attention of: Name: M. Cook
Company: SGS
Subject: Amara Batch 3

ple	% S(tot)	% S(sol)	% S(sul)	% C(tot)	% C(org)	% C(CO3)
540						
A CHEM 071	0.01	0.01	<0.01	0.14	0.03	0.11
A CHEM 077	0.01	<0.01	0.01	0.18	0.05	0.13
A CHEM 078	0.01	<0.01	0.01	0.11	0.03	0.09
A CHEM 079	0.02	<0.01	0.02	0.15	0.02	0.13
A CHEM 080	0.05	<0.01	0.05	2.41	0.02	2.39

		Authorised Signatories:	Signed by:	Checked by:
Signed		Clifford Rice, Laboratory Director		
		Liam Palmer, Laboratory Manager	X	
Dated	25/09/14	Rebecca Turner, Systems Administrator		X
		Fiona Dennis, Administrator		

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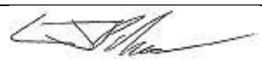
Test Report

WJL ID No: 77016-77025
Report No: 14092401d

Sample(s) Received: 22/09/14
Sample(s) Tested: 23-25/09/14
Tested By: AA NM
Test Procedure: M12, O2

For the attention of: Name: M. Cook
Company: SGS
Subject: Amara Batch 4

ple 540	% S(tot)	% S(sol)	% S(sul)	% C(tot)	% C(org)	% C(CO3)
A CHEM 081	0.27	0.03	0.24	1.88	0.04	1.84
A CHEM 082	0.17	0.02	0.15	2.13	0.02	2.11
A CHEM 083	0.01	0.01	<0.01	0.07	0.04	0.03
A CHEM 084	0.01	0.01	<0.01	0.12	0.03	0.09
A CHEM 085	0.17	0.02	0.15	0.64	0.02	0.62
A CHEM 086	0.16	0.02	0.14	0.16	0.02	0.14
A CHEM 087	0.15	0.01	0.14	0.45	0.04	0.41
A CHEM 088	0.01	0.01	<0.01	0.17	0.03	0.14
A CHEM 089	0.09	0.03	0.06	0.19	0.03	0.16
A CHEM 090	0.05	0.01	0.04	0.46	0.02	0.44

Signed		Authorised Signatories:	Signed by:	Checked by:
		Clifford Rice, Laboratory Director		
		Liam Palmer, Laboratory Manager	X	
Dated	25/09/14	Rebecca Turner, Systems Administrator		X
		Fiona Dennis, Administrator		

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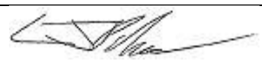
Test Report

WJL ID No: 77026-77032
Report No: 14092501b

Sample(s) Received: 23/09/14
Sample(s) Tested: 24-29/09/14
Tested By: DP NM
Test Procedure: M12, O2

For the attention of: Name: M. Cook
Company: SGS
Subject: Amara Batch 5

ple	% S(tot)	% S(sol)	% S(sul)	% C(tot)	% C(org)	% C(CO3)
540						
A CHEM 091	<0.01	<0.01	<0.01	0.10	0.01	0.09
A CHEM 092	0.01	0.01	<0.01	1.43	0.01	1.42
A CHEM 093	0.02	0.02	<0.01	0.08	0.01	0.07
A CHEM 094	0.03	0.01	0.02	0.10	0.01	0.09
A CHEM 095	0.08	0.03	0.05	0.20	0.03	0.17
A CHEM 101	0.01	0.01	<0.01	0.16	0.01	0.15
A CHEM 102	0.01	0.01	<0.01	0.16	0.01	0.15

Signed		Authorised Signatories:	Signed by:	Checked by:
		Clifford Rice, Laboratory Director		
		Liam Palmer, Laboratory Manager	X	
Dated	29/09/14	Rebecca Turner, Systems Administrator		X
		Fiona Dennis, Administrator		

Wheal Jane Laboratory

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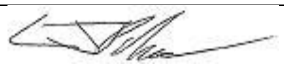
Test Report

WJL ID No: 77132-77154
Report No: 14092601d

Sample(s) Received: 24/09/14
Sample(s) Tested: 26/09/14
Tested By: IN
Test Procedure: M12, O2

For the attention of: Name: M. Cook
Company: SGS
Subject: Amara Batch 11

ple	% S(tot)
540	
A CHEM 028	0.03
A CHEM 029	0.18
A CHEM 035	0.12
A CHEM 036	0.15
A CHEM 040	0.07
A CHEM 041	0.12
A CHEM 048	0.12
A CHEM 049	0.08
A CHEM 056	0.07
A CHEM 064	0.48
A CHEM 065	0.14
A CHEM 067	0.13
A CHEM 068	1.24
A CHEM 072	0.25
A CHEM 073	0.19
A CHEM 074	0.15
A CHEM 075	0.13
A CHEM 076	0.04
A CHEM 096	0.11
A CHEM 097	0.24
A CHEM 098	0.03
A CHEM 099	0.01
A CHEM 100	0.01

		Authorised Signatories:	Signed by:	Checked by:
Signed		Clifford Rice, Laboratory Director		
		Liam Palmer, Laboratory Manager	X	
Dated	26/09/14	Rebecca Turner, Systems Administrator		X
		Fiona Dennis, Administrator		

CCRMP
Canadian Certified Reference Materials Project

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PCMRC
Projet canadien de matériaux de référence certifiés

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Certificate of Analysis

First issued: July 1994

Version: May 2007

NBM-1

Certified Reference Material for Acid Base Accounting

Table 1 - NBM-1 certified values

Test	Units	Mean	Between-Labs SD	Within-Lab SD	95% confidence interval of mean
AP-MS	kg$CaCO_3$/t	8.48	0.95	0.44	± 0.57
AP-S	kg$CaCO_3$/t	8.73	0.81	0.35	± 0.35
Paste pH	pH	8.45	0.11	0.04	± 0.05
S	%	0.28	0.03	0.01	± 0.01

Table 2 - Acronyms for acid base accounting tests

Sobek and modified Sobek methods	
AP	Acid potential
NP	Neutralization potential
S	Sobek method
MS	Modified Sobek method
m	Moderate fizz rating
s	Slight fizz rating

Table 3 - NBM-1 method-specific values

Test	Units	Mean	Between-Labs SD	Within-Lab SD	95% confidence interval of mean
NP-S-m	kg$CaCO_3$/t	72.1	8.5	2.1	± 10.7
NP-S-s	kg$CaCO_3$/t	49.6	3.0	1.8	± 1.9

Table 4 - NBM-1 informational values

Test	Units	Mean	SD
NP-MS-m	kgCaCO3/t	52.3	1.4
NP-MS-s	kgCaCO3/t	46.6	10.1
$S(SO_4)$	%	0.02	0.002

Table 5 - NBM-1 informational values for analytes

Analytes	Units	Mean	SD
Al	%	7.86	0.09
Ba	%	0.117	0.001
C	%	0.79	0.08
C (CO_3)	%	0.50	0.18
Ca	%	2.30	0.02
Fe	%	4.09	0.03
K	%	2.36	0.18
Loss on ignition	%	3.45	0.33
Loss of moisture	%	0.32	0.02
Mg	%	1.39	0.02
Mn	%	0.046	0.001
Na	%	2.70	0.13
P	%	0.10	0.00
Si	%	28.47	0.10
Ti	%	0.335	0.006

SOURCE

The raw material used to prepare NBM-1 was a biotic altered feldspar porphyry non-ore grade pit rock from the Bell Mine in Granisle, British Columbia and was donated by Noranda Minerals Incorporated.

DESCRIPTION

Major species in NBM-1 include sodium-plagioclase (30.7%), orthoclase (27.9%), quartz (21.8%), biotite (6.7%), kaolinite (3.7%), hematite plus magnetite (3.9%), siderite (2.5%), and ankerite (1.5%). Minor species include chalcopyrite (0.3%), and calcite, apatite, bornite, pyrite, and rutile, each with a concentration of 0.2%. Also, it was estimated visually that the weight ratio of hematite to magnetite is about 3:1.

INTENDED USE

NBM-1 is suitable for the analysis of rocks for sulphur and various static prediction tests for acid base accounting by the Sobek and modified Sobek methods as described in reference 1. Examples of intended use are for quality control in the analysis of samples of a similar type, method development, environmental assessment and the calibration of equipment.

INSTRUCTIONS FOR USE

NBM-1 should be used "as is", without drying. The contents of the bottle should be thoroughly mixed before taking samples. The contents of the bottle should be exposed to air for the shortest time possible. Unused material should be stored under an inert gas in a desiccator, or in a new, heat-sealed laminated foil pouch. The values herein pertain to the date when issued. CANMET is not responsible for changes occurring after receipt by the user.

HANDLING PRECAUTIONS

Normal safety precautions for handling fine particulate matter are suggested, such as the use of safety glasses, breathing protection, gloves and a laboratory coat.

METHOD OF PREPARATION

The raw material was crushed, ground, and sieved to separate a minus 74 µm fraction which was blended. The yield was 86%. The product was bottled in one size, 100-gram units. Each bottle was sealed under nitrogen in a laminated aluminum foil-mylar pouch to prevent oxidation.

HOMOGENEITY

The homogeneity of the stock with respect to iron and sulphur was investigated using twenty-two bottles chosen according to a stratified random sampling scheme. Two splits were analysed from each bottle for both elements. Samples of 0.25 g were analysed for sulphur using a combustion analyzer. For iron analysis, samples of 1.25 g were digested with four acids and a titration was performed with potassium dichromate after a stannous chloride reduction. Use of a smaller sub-sample will invalidate the use of the certified values and associated parameters. A one–way analysis of variance technique (ANOVA) was used to assess the homogeneity of these elements [(2)]. The ratio of the between-bottles to within-bottle mean squares was compared to the F statistic at the 95% level of probability. No evidence of inhomogeneity was observed for either element.

CERTIFIED VALUES

Twenty-six industrial, commercial, and government laboratories participated in an interlaboratory measurement program. Gravimetric and combustion methods for sulphur, and various static tests for acid base accounting [(1)] involving wet chemistry were performed at the discretion of each laboratory. A one-way analysis of variance technique was used to estimate the consensus value and other statistical parameters [(2)]. The certified value listed for each element or test is the best estimate of the "true" value based on the results of the interlaboratory measurement program. The mean values for AP-MS, AP-S, sulphur and paste pH were certified (see Table 1).

Full details of all phases of the work, including the statistical analyses, the methods and the names of the participating laboratories are contained in CCRMP Report 01-1E, Version 2.

UNCERTIFIED VALUES

Two tests for acid base accounting, NP-S-m and NP-S-s, were given "method-specific" values (see Table 3). "Method-specific" refers to the use of the Sobek and modified Sobek methods for acid base accounting, as described in reference 1. The term "method-specific", is not equivalent to "certified".

The value for NP-MS-m was derived from two sets of data and is therefore an "informational value." The value for NP-MS-s derived from sixteen sets of data was given the rating of an "informational value" due to the standard deviation (see Table 4).

Informational values for fifteen elements, shown in Table 5, were derived from the means of fewer than four sets of results.

TRACEABILITY

The values quoted herein are based on the consensus values derived from the statistical analysis of the data from the interlaboratory measurement program.

CERTIFICATION HISTORY

NBM-1 was originally released in 1994 with values for sulphur, NP-S-s. In 2002 a new certificate was issued with values for several acid base accounting tests as a result of an additional interlaboratory measurement program. This 2007 version of the certificate was issued due to the expiration of its predecessor. Based upon a reassessment of the data, two means, AP-MS and NP-S-m, have minor changes. The statistical parameters for some parameters have been revised also. The principle mineralogy of the source material has been changed to correct a typographical error. Additional information in the text has been included in accordance with ISO Guide 31:2000.

PERIOD OF VALIDITY

These certified values are valid until December 31, 2030. The stability of the material will be monitored every two years for the duration of the inventory. Updates will be made via CCRMP web site.

LEGAL NOTICE

CANMET has prepared this reference material and statistically evaluated the analytical data of the interlaboratory measurement program to the best of its ability. The purchaser, by receipt hereof, releases and indemnifies CANMET from and against all liability and costs arising out of the use of this material and information.

CERTIFYING OFFICER

Maureen E. Leaver

FOR FURTHER INFORMATION

The NBM-1 certification report is available free of charge upon request to:

Sales Officer, CCRMP
CANMET-MMSL (NRCan)
555 Booth Street
Ottawa, Ontario, Canada K1A 0G1
Telephone: (613) 995-4738
Facsimile: (613) 943-0573
E-mail: ccrmp@nrcan.gc.ca

REFERENCES

1. Coastech Research (1991), Acid Rock Drainage Prediction Manual, the Mine Environment Neutral Drainage (MEND) Program (Project 1.16.1b).

2. Brownlee, K.A., Statistical Theory and Methodology in Science and Engineering; John-Wiley and Sons, Inc.; New York; 1960.

ABA & NAG Testing

Prepared for

Nigel Tamlyn

AMARA Mining

Project Number – 10866- 567

20 March 2015

Prepared By Michael R. Cook BSc(HONS), MSc, MCSM

Project Metallurgist, Metallurgical Operations, UK

Authorised By N.J. MacDonald, BSc, EngTech

Operations Manager, Metallurgical Operations, UK

NOTE:

This report refers to the samples as received.

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Table of Tables

1 INTRODUCTION

SGS Minerals Services UK Ltd were contracted to perform acid base accounting and net acid generation testing on tailings samples submitted by AMARA Mining Plc.

2 HEAD SAMPLES

2.1 SAMPLE PREPARATION

On receipt each sample was logged in to the SGS sample tracking data base and assigned a sample number. The list of received samples and the allocated sample numbers can be seen in Table 1.

Each of the samples was dried where required. A sub-sample of 300g was then split from the mass received from each sample and shipped for additional testing (Table 2). A further sub-sample of approximately 200g was used as feed for the ABA and NAG testing (Table 3).

Table 1, Samples received for ABA and NAG testing

ORE NUMBER	SAMPLE SERIAL	PRODUCT NAME LEVEL 1	PRODUCT NAME LEVEL 2	Quantity (T)	Unit
SGS 566	1000	Yaoure LT 8 Oxide	-75µm Leach Residue	770.2	g
SGS 567	1001	Yaoure LT 8 Transition	-75µm Leach Residue	771.2	g
SGS 567	1002	Yaoure LT 8 CMA Upper	-75µm Leach Residue	787.3	g
SGS 567	1003	Yaoure LT 8 CMA Lower	-75µm Leach Residue	752.0	g
SGS 567	1004	Yaoure LT 8 'Yaoure' Upper	-75µm Leach Residue	781.2	g
SGS 567	1005	Yaoure LT 8 'Yaoure' Lower	-75µm Leach Residue	787.4	g

Table 2, Sub-sample extracted for shipment as per request of AMEC

ORE NUMBER	SAMPLE SERIAL	PRODUCT NAME LEVEL 1	PRODUCT NAME LEVEL 2	Quantity (T)	Unit
SGS 567	1006	Yaoure LT 8 Oxide	Shipment Sub Sample	306.8	g
SGS 567	1007	Yaoure LT 8 Transition	Shipment Sub Sample	302.6	g
SGS 567	1008	Yaoure LT 8 CMA Upper	Shipment Sub Sample	300.7	g
SGS 567	1009	Yaoure LT 8 CMA Lower	Shipment Sub Sample	305.8	g
SGS 567	1010	Yaoure LT 8 'Yaoure' Upper	Shipment Sub Sample	302.5	g
SGS 567	1011	Yaoure LT 8 'Yaoure' Lower	Shipment Sub Sample	307.7	g

Table 3, Sub-sample used as feedstock for ABA and NAG testing

ORE NUMBER	SAMPLE SERIAL	PRODUCT NAME LEVEL 1	PRODUCT NAME LEVEL 2	Quantity (T)	Unit
SGS 567	1012	Yaoure LT 8 Oxide	ABA NAG Feed	276.8	g
SGS 567	1013	Yaoure LT 8 Transition	ABA NAG Feed	184.9	g
SGS 567	1014	Yaoure LT 8 CMA Upper	ABA NAG Feed	201.5	g
SGS 567	1015	Yaoure LT 8 CMA Lower	ABA NAG Feed	196.3	g
SGS 567	1016	Yaoure LT 8 'Yaoure' Upper	ABA NAG Feed	196.7	g
SGS 567	1017	Yaoure LT 8 'Yaoure' Lower	ABA NAG Feed	201.0	g

3 RESULTS

3.1 ACID BASE ACCOUNTING

The results for the ABA testing is given in the below Table 4

.

Table 4 - ABA results of submitted samples

		YO	YT	Y CMA U	Y CMA L	YU	YL	YL Dup	NBM-1
	Sample #	1012	1013	1014	1015	1016	1017	1017 Dup	NBM-1
Parameter	**Unit**	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**	**#7**	**#8**
Paste pH	units	8.48	8.10	8.77	8.57	8.75	8.57	8.40	7.93
Fizz Rate	---	1	2	2	2	2	2	2	2
Sample weight	g	2.010	2.005	2.008	20.470	1.977	2.044	2.071	2.025
HCl added	mL	20.00	109.80	172.20	173.50	107.20	118.30	120.10	40.00
HCl	Normality	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH	Normality	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
NaOH to	pH=8.3 mL	15.00	54.40	75.00	75.00	55.00	52.40	54.10	20.20
Final pH	units	1.66	1.60	1.63	1.69	1.77	1.67	1.71	1.69
NP[1]	t $CaCO_3$/1000 t	12.4	138.2	242.0	24.1	132.0	161.2	159.3	48.9
AP	t $CaCO_3$/1000 t	0.6	9.4	23.8	29.7	20.6	12.8	12.8	8.1
Net NP	t $CaCO_3$/1000 t	11.8	128.8	218.3	-5.6	111.4	148.4	146.5	40.8
NP/AP	ratio	19.9	14.7	10.2	0.8	6.4	12.6	12.4	6.0
S	%	0.03	0.33	0.79	0.98	0.7	0.44	0.44	0.28
SO_4	%	0.01	0.03	0.03	0.03	0.04	0.03	0.03	0.02
Sulphide	%	0.02	0.3	0.76	0.95	0.66	0.41	0.41	0.26
Carbonate	%	0.18	1.68	3.27	3.2	1.54	1.9	1.9	0.5
CO_3 NP[2]	t $CaCO_3$/1000 t	3.0	27.9	54.3	53.1	25.6	31.5	31.5	8.3
CO_3 Net NP	t $CaCO_3$/1000 t	2.4	18.5	30.5	23.4	4.9	18.7	18.7	0.2
CO_3 NP/AP	Ratio	4.781	2.975	2.286	1.789	1.239	2.462	2.462	1.022
Classification	based on ABA NP[1]	**uncertain**	**PAN**	**PAN**	**PAG**	**PAN**	**PAN**	**PAN**	**PAN**
Classification	based on CO_3 NP[2]	**uncertain**	**uncertain**	**uncertain**	**uncertain**	**uncertain**	**uncertain**	**uncertain**	**uncertain**
NP from CO_3	%	24.0	20.2	22.4	220.8	19.4	19.6	19.8	17.0

3.2 Net Acid Generation

The results of the NAG testing are given in the below Table 5.

Table 5 - NAG results of submitted samples

		YO	YT	Y CMA U	Y CMA L	YU	YL	YL Dup	NBM-1
Net Acid Generation Testing	Sample #	1012	1013	1014	1015	1016	1017	1017 Dup	NBM-1
Parameter	**Unit**	**#1**	**#2**	**#3**	**#4**	**#5**	**#6**	**#7**	**#8**
Sample	weight [g]	2.493	2.508	2.500	2.503	2.505	2.496	2.499	2.492
Volume H_2O_2	mL	250.0	250.0	250.0	250.0	250.0	250.0	250.0	250.0
Final pH	units	6.00	6.42	7.75	8.15	7.19	6.40	6.57	7.48
NaOH	Normality	0.1	0.1				0.1	0.1	
Vol NaOH to pH 4.5	mL								
Vol NaOH from pH 4.5 to pH 7.0	mL	1.10	0.50				0.40	0.20	
NAG @ pH 4.5	kg H_2SO_4/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NAG @ pH 7.0	kg H_2SO_4/t	2.16	0.98	0.00	0.00	0.00	0.79	0.39	0.00

APPENDICES

ABA & NAG Testing, AMARA Mining PLC

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E-mail crice@wheal-jane.co.uk

Test Report

WJL ID No: 80304-80309
Report No: 15012601d

Sample(s) Received: 22/01/15
Sample(s) Tested: 23/01/15
Tested By: AA
Test Procedure: M12, O2

For the attention of: Name: M. Cook
Company: **SGS**
Address: SGS Minerals Services U.K. Limited Wheal Jane, Baldhu Truro, Cornwall TR3 6EE
Subject: Amara ABA NAG

Sample	% S(tot)	% S (sol)	% S (sul)	% C (tot)	% C (org)	% C (co3)
SGS 567						
LT 8						
1000A Yaoure Oxide	0.03	0.01	0.02	0.25	0.07	0.18
1001A Yaoure Transition	0.33	0.03	0.30	1.73	0.05	1.68
1002A Yaoure CMA Upper	0.79	0.03	0.76	3.32	0.06	3.27
1003A Yaoure CMA Lower	0.98	0.03	0.95	3.25	0.05	3.20
1004A Yaoure Upper	0.70	0.04	0.66	1.59	0.05	1.54
1005A Yaoure Lower	0.44	0.03	0.41	1.95	0.05	1.90

		Authorised Signatories:	Signed by:	Checked by:
Signed		Clifford Rice, Laboratory Director		
		Liam Palmer, Laboratory Manager	X	
Dated	27/01/2015	Rebecca Turner, Systems Administrator		X
		Fiona Dennis, Administrator		

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Canadian Certified Reference Materials Project

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Certificate of Analysis

First issued: July 1994 Version: May 2007

NBM-1

Certified Reference Material for Acid Base Accounting

Table 1 - NBM-1 certified values

Test	Units	Mean	Between-Labs SD	Within-Lab SD	95% confidence interval of mean
AP-MS	$kgCaCO_3/t$	8.48	0.95	0.44	± 0.57
AP-S	$kgCaCO_3/t$	8.73	0.81	0.35	± 0.35
Paste pH	pH	8.45	0.11	0.04	± 0.05
S	%	0.28	0.03	0.01	± 0.01

Table 2 - Acronyms for acid base accounting tests

Sobek and modified Sobek methods	
AP	Acid potential
NP	Neutralization potential
S	Sobek method
MS	Modified Sobek method
m	Moderate fizz rating
s	Slight fizz rating

Table 3 - NBM-1 method-specific values

Test	Units	Mean	Between-Labs SD	Within-Lab SD	95% confidence interval of mean
NP-S-m	$kgCaCO_3/t$	72.1	8.5	2.1	± 10.7
NP-S-s	$kgCaCO_3/t$	49.6	3.0	1.8	± 1.9

Table 4 - NBM-1 informational values

Test	Units	Mean	SD
NP-MS-m	kgCaCO3/t	52.3	1.4
NP-MS-s	kgCaCO3/t	46.6	10.1
S(SO_4)	%	0.02	0.002

Table 5 - NBM-1 informational values for analytes

Analytes	Units	Mean	SD
Al	%	7.86	0.09
Ba	%	0.117	0.001
C	%	0.79	0.08
C (CO_3)	%	0.50	0.18
Ca	%	2.30	0.02
Fe	%	4.09	0.03
K	%	2.36	0.18
Loss on ignition	%	3.45	0.33
Loss of moisture	%	0.32	0.02
Mg	%	1.39	0.02
Mn	%	0.046	0.001
Na	%	2.70	0.13
P	%	0.10	0.00
Si	%	28.47	0.10
Ti	%	0.335	0.006

SOURCE
The raw material used to prepare NBM-1 was a biotic altered feldspar porphyry non-ore grade pit rock from the Bell Mine in Granisle, British Columbia and was donated by Noranda Minerals Incorporated.

DESCRIPTION
Major species in NBM-1 include sodium-plagioclase (30.7%), orthoclase (27.9%), quartz (21.8%), biotite (6.7%), kaolinite (3.7%), hematite plus magnetite (3.9%), siderite (2.5%), and ankerite (1.5%). Minor species include chalcopyrite (0.3%), and calcite, apatite, bornite, pyrite, and rutile, each with a concentration of 0.2%. Also, it was estimated visually that the weight ratio of hematite to magnetite is about 3:1.

INTENDED USE
NBM-1 is suitable for the analysis of rocks for sulphur and various static prediction tests for acid base accounting by the Sobek and modified Sobek methods as described in reference 1. Examples of intended use are for quality control in the analysis of samples of a similar type, method development, environmental assessment and the calibration of equipment.

INSTRUCTIONS FOR USE
NBM-1 should be used "as is", without drying. The contents of the bottle should be thoroughly mixed before taking samples. The contents of the bottle should be exposed to air for the shortest time possible. Unused material should be stored under an inert gas in a desiccator, or in a new, heat-sealed laminated foil pouch. The values herein pertain to the date when issued. CANMET is not responsible for changes occurring after receipt by the user.

HANDLING PRECAUTIONS

Normal safety precautions for handling fine particulate matter are suggested, such as the use of safety glasses, breathing protection, gloves and a laboratory coat.

METHOD OF PREPARATION

The raw material was crushed, ground, and sieved to separate a minus 74 µm fraction which was blended. The yield was 86%. The product was bottled in one size, 100-gram units. Each bottle was sealed under nitrogen in a laminated aluminum foil-mylar pouch to prevent oxidation.

HOMOGENEITY

The homogeneity of the stock with respect to iron and sulphur was investigated using twenty-two bottles chosen according to a stratified random sampling scheme. Two splits were analysed from each bottle for both elements. Samples of 0.25 g were analysed for sulphur using a combustion analyzer. For iron analysis, samples of 1.25 g were digested with four acids and a titration was performed with potassium dichromate after a stannous chloride reduction. Use of a smaller sub-sample will invalidate the use of the certified values and associated parameters. A one–way analysis of variance technique (ANOVA) was used to assess the homogeneity of these elements [(2)]. The ratio of the between-bottles to within-bottle mean squares was compared to the F statistic at the 95% level of probability. No evidence of inhomogeneity was observed for either element.

CERTIFIED VALUES

Twenty-six industrial, commercial, and government laboratories participated in an interlaboratory measurement program. Gravimetric and combustion methods for sulphur, and various static tests for acid base accounting [(1)] involving wet chemistry were performed at the discretion of each laboratory. A one-way analysis of variance technique was used to estimate the consensus value and other statistical parameters [(2)]. The certified value listed for each element or test is the best estimate of the “true” value based on the results of the interlaboratory measurement program. The mean values for AP-MS, AP-S, sulphur and paste pH were certified (see Table 1).

Full details of all phases of the work, including the statistical analyses, the methods and the names of the participating laboratories are contained in CCRMP Report 01-1E, Version 2.

UNCERTIFIED VALUES

Two tests for acid base accounting, NP-S-m and NP-S-s, were given “method-specific” values (see Table 3). “Method-specific” refers to the use of the Sobek and modified Sobek methods for acid base accounting, as described in reference 1. The term “method-specific”, is not equivalent to “certified”.

The value for NP-MS-m was derived from two sets of data and is therefore an “informational value.” The value for NP-MS-s derived from sixteen sets of data was given the rating of an “informational value” due to the standard deviation (see Table 4).

Informational values for fifteen elements, shown in Table 5, were derived from the means of fewer than four sets of results.

TRACEABILITY

The values quoted herein are based on the consensus values derived from the statistical analysis of the data from the interlaboratory measurement program.

CERTIFICATION HISTORY

NBM-1 was originally released in 1994 with values for sulphur, NP-S-s. In 2002 a new certificate was issued with values for several acid base accounting tests as a result of an additional interlaboratory measurement program. This 2007 version of the certificate was issued due to the expiration of its predecessor. Based upon a reassessment of the data, two means, AP-MS and NP-S-m, have minor changes. The statistical parameters for some parameters have been revised also. The principle mineralogy of the source material has been changed to correct a typographical error. Additional information in the text has been included in accordance with ISO Guide 31:2000.

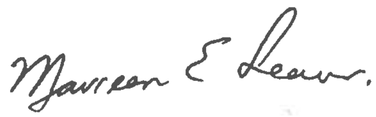
PERIOD OF VALIDITY

These certified values are valid until December 31, 2030. The stability of the material will be monitored every two years for the duration of the inventory. Updates will be made via CCRMP web site.

LEGAL NOTICE

CANMET has prepared this reference material and statistically evaluated the analytical data of the interlaboratory measurement program to the best of its ability. The purchaser, by receipt hereof, releases and indemnifies CANMET from and against all liability and costs arising out of the use of this material and information.

CERTIFYING OFFICER



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FOR FURTHER INFORMATION

The NBM-1 certification report is available free of charge upon request to:

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REFERENCES

1. Coastech Research (1991), Acid Rock Drainage Prediction Manual, the Mine Environment Neutral Drainage (MEND) Program (Project 1.16.1b).

2. Brownlee, K.A., Statistical Theory and Methodology in Science and Engineering; John-Wiley and Sons, Inc.; New York; 1960.

APPENDIX F

RHUL Results Reports

ROYAL HOLLOWAY UNIVERSITY OF LONDON

MINERALOGICAL AND CHEMICAL CHARACTERIZATION - ROCK SAMPLES (AMARA)

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Aims

Thirty samples of crushed rock were provided for analysis.

The aims were to:

1) Conduct a SPLP (synthetic precipitation leach procedure) on 7 selected samples,

2) Determine the major and trace element compositions of all samples by X-ray fluorescence (XRF), and

3) Determine the mineralogy of 7 selected samples using X-ray diffraction (XRD), including quantitative, Rietveld analysis.

The main conclusions of the work are noted at the end of this report.

Sample numbers and preparation: The sample details (numbers, requirements) are shown in Table 1.

As received the samples consisted each of approximately 1 kg of coarsely crushed, fairly dry, rock aggregate.

Addition of dilute HCl resulted in a visible ‘fizz’ in some samples and thus calcite is definitely present in elevated amounts.

Table 1: Sample numbers

SAMPLE Ref	TEST REGIME
CHEM003	XRF, XRD, SPLP
CHEM046	XRF, XRD, SPLP
CHEM051	XRF, XRD, SPLP
CHEM059	XRF, XRD, SPLP
CHEM062	XRF, XRD, SPLP
CHEM066	XRF, XRD, SPLP
CHEM086	XRF, XRD, SPLP
CHEM028	XRF
CHEM029	XRF
CHEM035	XRF
CHEM036	XRF
CHEM040	XRF
CHEM041	XRF
CHEM048	XRF
CHEM049	XRF
CHEM056	XRF
CHEM064	XRF
CHEM065	XRF
CHEM067	XRF
CHEM068	XRF
CHEM072	XRF
CHEM073	XRF
CHEM074	XRF
CHEM075	XRF
CHEM076	XRF
CHEM096	XRF
CHEM097	XRF
CHEM098	XRF
CHEM099	XRF
CHEM100	XRF

SPLP

The USGS methodology was followed. The powder of the 7 samples was added to an acid solution at a ratio of 1:20 (100g of solid to 2000mls of solution). The leach solution was a 60/40 H_2SO_4/HNO_3 mixture adjusted to pH 4.2. The samples were then mixed in an ‘end-over-end’ rotary agitator for 18 hours.

The solutions were then filtered and measured for pH and conductivity (Table 2). A representative portion of the leachate was sent for further chemical analysis.

Table 2: SPLP leachate analyses

Sample	pH	Conductivity
CHEM003	8.4	135
CHEM046	8.8	80
CHEM051	7.9	40
CHEM059	8.1	90
CHEM062	7.9	135
CHEM066	8.2	85
CHEM086	8.3	80

Conductivity units are µS cm^{-1}

XRF

Sample preparation: Approximately 20 grammes of sample were dried at 100°C overnight in an oven. The sample was then reduced to a fine powder by grinding in a tungsten carbide 'tema' mill for 3 minutes.

Method: For trace element analysis, a pressed powder pellet was produced at a pressure of 25 tonnes with a binder in a Herzog HT40 hydraulic press. A glass disc was made by fusing this heated sample with a flux of lithium tetraborate at 1100°C and a sample:flux ratio of 10:1. The samples were chemically analysed for a wide range of elements using a Philips Magix-Pro wavelength dispersive XRF spectrometer using a 4kW Rh end-window tube. International standards were also analysed for several elements as a check on the analytical accuracy and precision (about 0.5-1%) and precision (0.5% total).

XRF Results: The XRF results are presented in Table 3 as oxide weight % for the major constituents and Table 4 for 'trace' elements in parts per million.

Points to note:

1) Volatile content (e.g. water, CO_2) is given by the 'loss on ignition' value (LOI). This value has been determined as the difference between 100% and the sum of the other major constituents.

2) Total Fe is presented as ferric iron. However, the form of the iron in the rock is likely to be dominated by ferrous iron. However, the heat used to make the discs will oxidise any iron such that there will be a resultant increase in mass (analytical totals may exceed 100%). This explains why there are some apparently negative LOI values – it is because of high ferrous iron contents.

Table 3: Results of XRF analysis for major elements (wt %)

	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	K2O	Na2O	P2O5	S	Cl	Sum	LOIxrf
CHEM003	61.01	0.48	14.00	4.84	0.05	2.65	4.60	1.26	3.89	0.19	<0.005	<0.005	93.0	7.0
CHEM028	46.36	0.98	12.82	12.75	0.17	6.43	8.28	0.16	1.87	0.09	<0.005	<0.005	89.9	10.1
CHEM029	44.34	0.80	13.65	11.61	0.15	5.92	9.01	0.08	2.78	0.07	0.003	<0.005	88.4	11.6
CHEM035	48.58	1.05	13.98	13.27	0.19	6.32	11.39	0.09	1.28	0.09	0.031	<0.005	96.2	3.8
CHEM036	48.13	0.97	13.42	13.08	0.20	6.49	11.03	0.09	1.79	0.08	0.044	<0.005	95.3	4.7
CHEM040	49.21	0.79	14.55	12.30	0.19	8.57	11.18	0.22	1.49	0.06	0.001	<0.005	98.6	1.4
CHEM041	48.42	0.84	14.79	12.65	0.18	6.64	10.78	0.11	2.22	0.07	0.034	<0.005	96.7	3.3
CHEM046	51.79	1.02	14.42	13.67	0.21	7.49	11.16	0.14	2.10	0.09	0.009	<0.005	102.1	-2.1
CHEM048	49.94	0.97	14.13	13.19	0.19	6.47	10.85	0.19	2.48	0.08	0.025	<0.005	98.5	1.5
CHEM049	47.22	0.98	13.16	13.12	0.18	6.37	10.16	0.16	1.87	0.08	0.005	<0.005	93.3	6.7
CHEM051	51.53	1.23	17.17	16.71	0.32	1.92	0.71	0.07	0.04	0.07	<0.005	<0.005	89.8	10.2
CHEM056	49.23	0.78	13.51	11.74	0.24	7.49	7.97	0.01	0.79	0.07	<0.005	<0.005	91.8	8.2
CHEM059	44.82	0.98	12.78	12.88	0.19	6.26	11.26	0.32	1.10	0.08	0.128	<0.005	90.7	9.3
CHEM062	47.89	1.03	13.67	13.68	0.19	6.24	10.98	0.07	1.56	0.09	0.095	<0.005	95.4	4.6
CHEM064	44.93	1.19	14.42	16.33	0.22	6.77	9.99	0.02	0.24	0.09	0.194	<0.005	94.2	5.8
CHEM065	44.18	0.94	12.49	12.38	0.18	6.12	9.45	0.03	2.32	0.08	0.001	<0.005	88.2	11.8
CHEM066	48.81	1.09	14.33	14.82	0.22	6.77	9.86	0.09	1.85	0.09	0.055	<0.005	97.9	2.1
CHEM067	44.69	0.91	11.98	11.27	0.19	5.94	10.05	0.22	1.83	0.08	<0.005	<0.005	87.2	12.8
CHEM068	43.79	0.95	12.99	12.12	0.14	6.84	9.12	1.03	0.70	0.08	0.222	<0.005	87.8	12.2
CHEM072	44.73	0.95	12.81	12.13	0.17	6.07	9.32	0.04	2.35	0.08	<0.005	<0.005	88.6	11.4
CHEM073	46.87	0.76	13.78	12.27	0.16	5.70	11.34	0.06	1.25	0.06	0.066	<0.005	92.2	7.8
CHEM074	49.37	0.83	14.49	12.67	0.17	6.12	10.84	0.10	2.18	0.07	0.046	<0.005	96.8	3.2
CHEM075	44.32	0.79	13.16	11.77	0.18	7.35	9.75	1.14	1.42	0.06	<0.005	<0.005	89.9	10.1
CHEM076	43.54	0.78	13.27	11.49	0.18	7.26	9.75	0.28	1.50	0.06	<0.005	<0.005	88.1	11.9
CHEM086	48.90	0.82	14.15	12.48	0.19	7.62	9.67	0.25	2.38	0.07	0.054	<0.005	96.5	3.5
CHEM096	47.60	0.83	14.35	11.83	0.16	6.69	10.60	0.29	1.93	0.07	0.024	<0.005	94.3	5.7
CHEM097	50.25	0.88	15.09	12.89	0.18	6.81	12.44	0.20	1.67	0.07	0.098	<0.005	100.5	-0.5
CHEM098	45.38	1.33	22.81	20.41	0.27	0.24	0.14	0.10	<0.05	0.05	<0.005	<0.005	90.7	9.3
CHEM099	52.34	1.05	18.91	16.18	0.09	0.45	0.16	1.06	<0.05	0.11	<0.005	0.005	90.3	9.7
CHEM100	44.10	1.28	23.21	19.13	0.09	0.67	0.19	0.07	<0.05	0.03	<0.005	<0.005	88.8	11.2

Table 4: Results of XRF analysis for trace elements ppm)

	Co	Cr	V	Ni	Sc	Cu	Zn	Pb	Ba	Rb	Sr	Y	Zr	Nb	Th	U	Hf	La	Ce	Ga	As	Bi	Sn	Sb	W	Se	Ge	Moo	
CHEM003	13	108	86	50	24	12	40	6	685	34	369	11	109	5	12	<3	6	23	58	16	18	5	10	15	<3	<3	3	<2	
CHEM028	41	211	335	116	<15	61	86	3	15	5	125	22	58	3	7	<3	6	6	26	13	<5	5	13	12	<3	<3	3	<2	1
CHEM029	37	264	310	143	<15	93	81	2	30	2	133	18	47	3	5	<3	4	<5	21	13	<5	6	11	7	<3	<3	3	<2	
CHEM035	38	210	333	102	<15	98	92	<1	48	2	155	25	63	3	7	<3	4	<5	21	17	31	5	12	3	<3	<3	<3	2	<
CHEM036	39	194	299	109	<15	104	93	4	60	2	155	22	61	3	6	<3	3	<5	24	16	16	5	12	7	<3	<3	<3	3	<
CHEM040	35	227	256	184	<15	105	82	2	47	8	147	19	46	2	9	<3	4	<5	26	14	<5	5	13	7	<3	<3	<3	21	
CHEM041	37	239	280	147	<15	120	89	2	25	2	147	21	50	3	7	<3	4	<5	25	13	<5	5	14	10	<3	<3	<3	14	
CHEM046	37	231	298	116	<15	103	89	3	34	3	134	22	60	3	8	<3	4	<5	19	12	10	5	11	<2	<3	<3	<3	<2	
CHEM048	36	188	292	86	<15	121	91	5	34	5	182	22	56	3	8	<3	<3	<5	22	15	<5	5	12	7	<3	<3	3	8	
CHEM049	38	201	299	91	<15	98	90	1	30	6	101	22	61	2	9	<3	5	<5	19	16	<5	6	8	11	<3	<3	<3	2	
CHEM051	49	233	398	145	243	148	318	2	341	2	16	47	83	4	8	<3	4	15	34	21	6	6	9	6	<3	<3	<3	6	<
CHEM056	35	313	243	154	29	109	87	2	<12	<1	157	17	45	<2	8	<3	5	<5	22	14	7	6	6	4	<3	<3	<3	<2	<
CHEM059	36	214	324	111	<15	88	93	3	39	11	108	22	61	3	8	<3	<3	<5	26	14	<5	4	8	4	<3	<3	<3	2	
CHEM062	38	208	305	95	<15	104	93	0.9	37	1	127	25	62	3	9	<3	<3	<5	14	15	16	6	10	4	<3	<3	<3	5	
CHEM064	48	233	338	118	<15	179	115	6	34	<1	146	27	70	4	9	<3	<3	<5	24	18	21	5	13	8	<3	<3	<3	<2	
CHEM065	40	203	331	95	<15	89	86	3	12	<1	198	21	55	3	8	<3	3	<5	28	13	<5	6	10	5	<3	<3	<3	<2	
CHEM066	40	218	323	100	<15	99	99	<1	37	2	127	25	64	4	8	<3	7	<5	21	16	<5	6	13	2	<3	<3	<3	3	
CHEM067	35	195	324	89	<15	72	76	5	39	5	133	21	55	3	5	<3	6	<5	30	12	12	6	12	<2	<3	<3	3	2	
CHEM068	36	209	348	90	<15	101	84	<1	91	18	107	21	59	3	12	<3	<3	<5	32	15	10	4	13	<2	<3	<3	<3	<2	
CHEM072	37	203	314	91	<15	83	83	2	12	2	150	22	57	3	11	<3	5	<5	29	14	<5	5	12	12	<3	<3	3	<2	
CHEM073	37	234	273	120	<15	100	80	4	14	3	134	18	45	2	5	<3	4	<5	32	14	5	5	16	3	<3	<3	<3	3	
CHEM074	37	250	275	162	<15	106	87	2	16	3	170	18	47	2	10	<3	3	<5	31	14	11	5	17	8	<3	<3	<3	2	
CHEM075	36	312	296	135	<15	83	78	1	48	42	121	16	46	<2	9	<3	7	<5	25	11	<5	5	6	10	<3	<3	<3	<2	
CHEM076	37	255	299	130	<15	95	82	2	14	14	119	17	46	2	12	<3	4	<5	17	12	14	4	13	10	<3	<3	<3	<2	
CHEM086	36	232	276	129	<15	109	87	5	44	10	126	19	50	3	5	<3	3	<5	27	14	5	6	13	8	<3	<3	<3	6	
CHEM096	35	241	282	133	<15	60	80	3	34	10	155	19	48	2	5	<3	6	<5	28	14	13	7	11	5	<3	<3	<3	68	<
CHEM097	36	252	290	137	<15	109	87	2	21	6	120	21	52	2	8	<3	<3	<5	26	14	<5	5	14	3	<3	<3	<3	7	
CHEM098	62	448	421	204	375	195	99	<1	300	4	4	28	81	4	8	<3	3	<5	36	28	10	6	9	9	<3	<3	3	<2	
CHEM099	90	365	498	212	259	334	94	5	182	30	18	40	68	4	4	<3	7	11	35	17	29	7	15	6	32	<3	<3	25	
CHEM100	49	288	267	78	395	157	92	<1	61	3	8	25	78	4	11	<3	7	5	29	24	7	5	10	9	<3	<3	<3	2	<

XRD

***XRD methodology*:** A representative portion of the sample was manually ground to a fine powder using a ceramic mortar and pestle. The powder was packed into a recessed plastic holder and preferred orientation was minimised. The samples were analysed using a Philips X-ray diffractometer (PW3710) scanning from 4° to 75° 2θ. The generator was set at 40kV and 40mA. Peak identification was enabled using the PDF/ICCD database and quantification achieved using Rietveld analysis using the commercial programme Siroquant (Sietronics, Australia).

XRD Results: The XRD patterns are shown in Figures 1 to 8. Figure 1 shows all of the traces together and reveals that there is a broad similarity between the samples. Figures 2 to 8 shows the plots for the individual samples together with markers for the main minerals found to be present.

It is immediately clear from the number of peaks that the mineralogy of the samples is complex. However, the mineralogy is mostly dominated by plagioclase feldspar, chlorite, amphibole, calcite and K-mica (with lesser pyroxene, hematite and quartz in some samples).

For the quantification, additional minerals were identified and included in the calculations. The weight % of minerals present, derived from Rietveld quantification, is given in Table 4. Note that values below about 4% are less accurate and the presence of those phases given as below 1% is uncertain.

Plagioclase feldspar has been modelled as albite and andesine; K-feldspar as orthoclase; amphibole as actinolite; and K-mica as muscovite and biotite.

Although the main phases have been clearly identified, the matches between observed and modelled traces are not always ideal. This is probably due to problems with modelling the exact varieties of silicates present – especially feldspar, amphibole and chlorite.

Table 4: Quantitative results of mineral phases present (weight %)

Phase	**003**	**046**	**051**	**059**	**062**	**066**	**086**
Quartz	19.3	2.4	20.3	16.8	7.3	5.8	2.2
Graphite	7.0	0.6	6.7	8.8	4.6	2.8	0.9
Albite	39.1	30.0	3.2	15.2	20.4	22.6	29.6
Andesine	0.2	2.5	0.0	0.0	2.5	0.0	0.0
Muscovite	7.0	0.0	0.0	2.5	2.1	2.3	3.1
Biotite	0.7	0.3	1.5	3.9	0.9	0.9	0.9
Calcite	8.8	0.9	0.1	19.5	9.3	1.5	1.2
Kaolinite	0.9	0.4	28.5	0.1	0.0	0.0	0.0
Orthoclase	0.0	2.1	0.0	3.1	3.0	3.5	4.7
Garnet (Ca-Fe)	0.7	2.1	0.7	3.5	2.0	2.6	2.8
Pyroxene, ortho	10.1	4.0	0.0	0.5	1.2	1.7	4.6
Hematite	0.0	0.0	2.9	0.0	0.0	0.0	0.0
Pyrite	0.0	4.4	0.0	0.6	3.1	4.0	4.1
Jarosite	0.6	0.6	1.1	1.1	0.7	0.8	0.5
Actinolite	0.0	35.2	0.0	1.6	27.2	32.4	31.4
Chlorite	5.4	14.6	34.8*	22.7	15.7	19.0	14.0

* Abundant smectite (montmorillonite) present and included in this figure; possibly as a mixed layer phase.

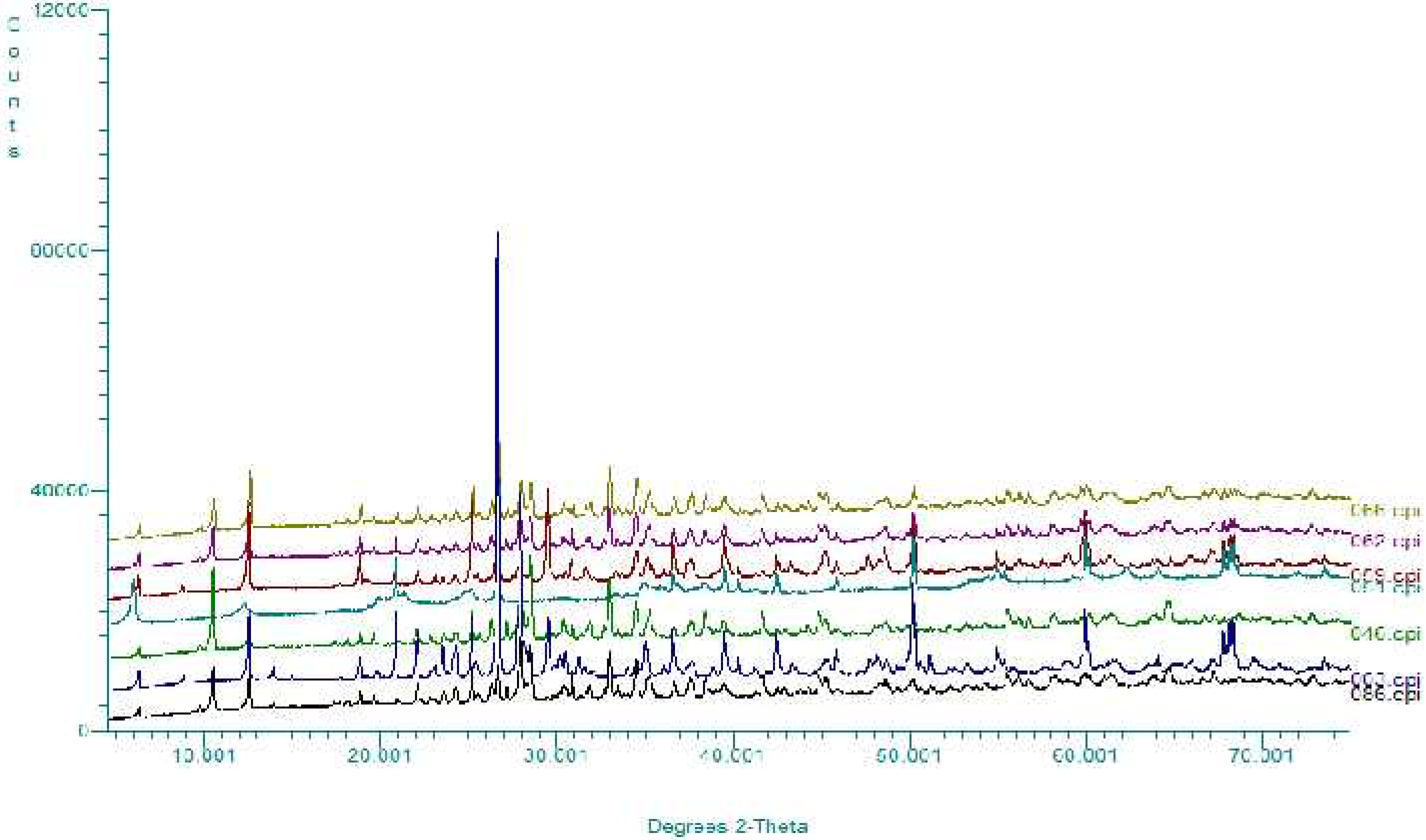

Figure 1: XRD traces for all 7 samples (prefix CHEM)

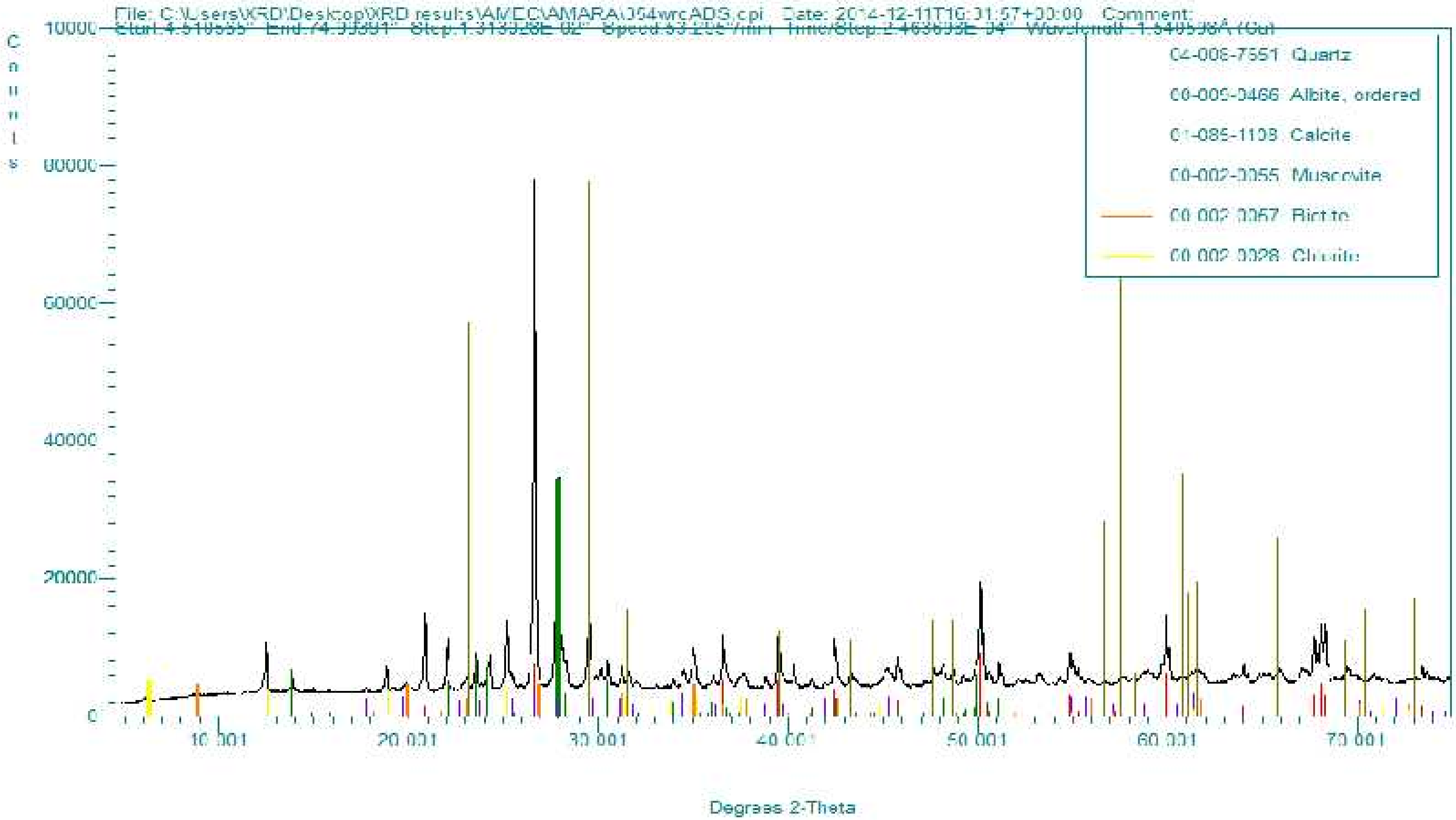

Figure 2: XRD trace for sample CHEM003 with peak markers for the main minerals present

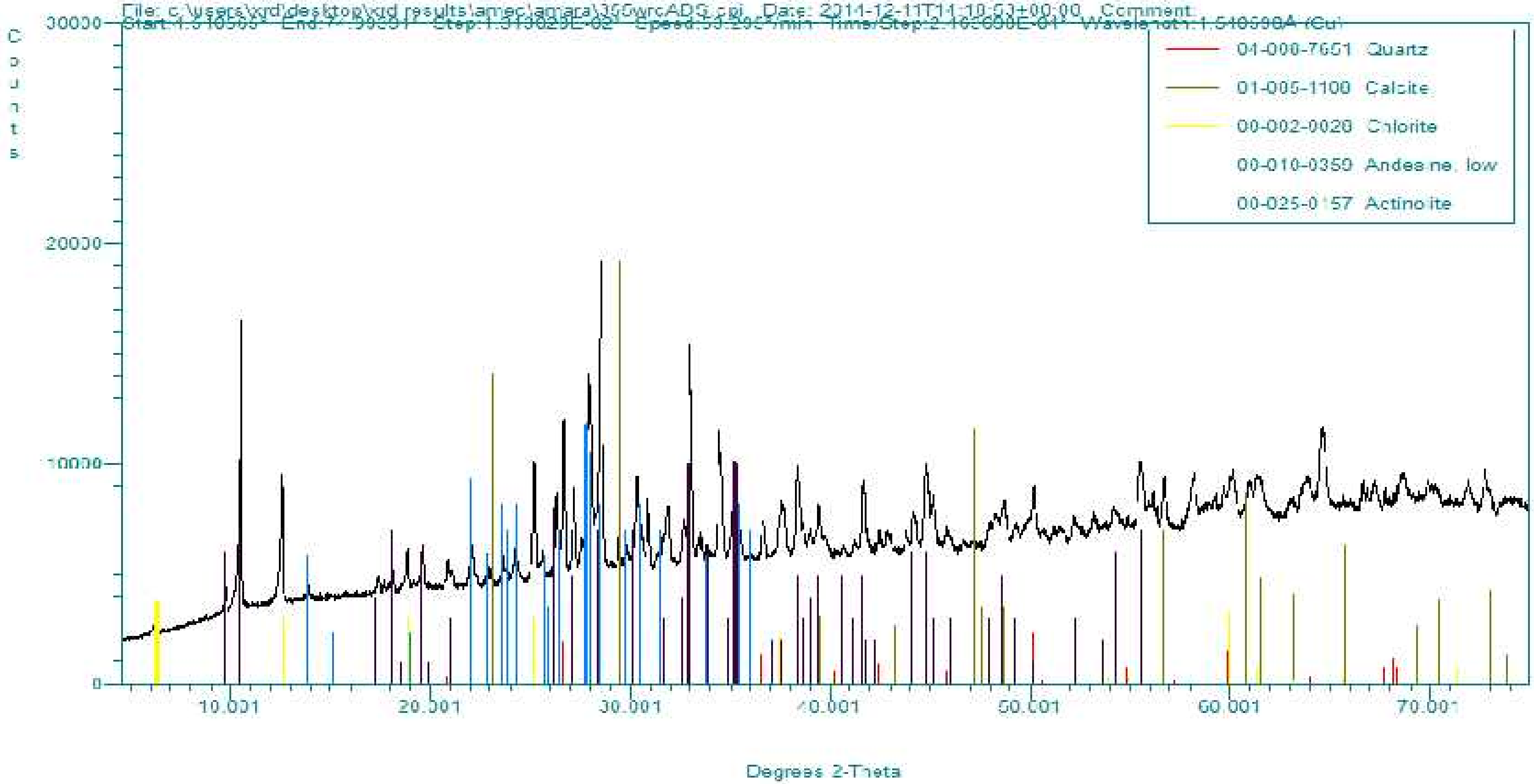

Figure 3: XRD trace for sample CHEM046 with peak markers for the main minerals present

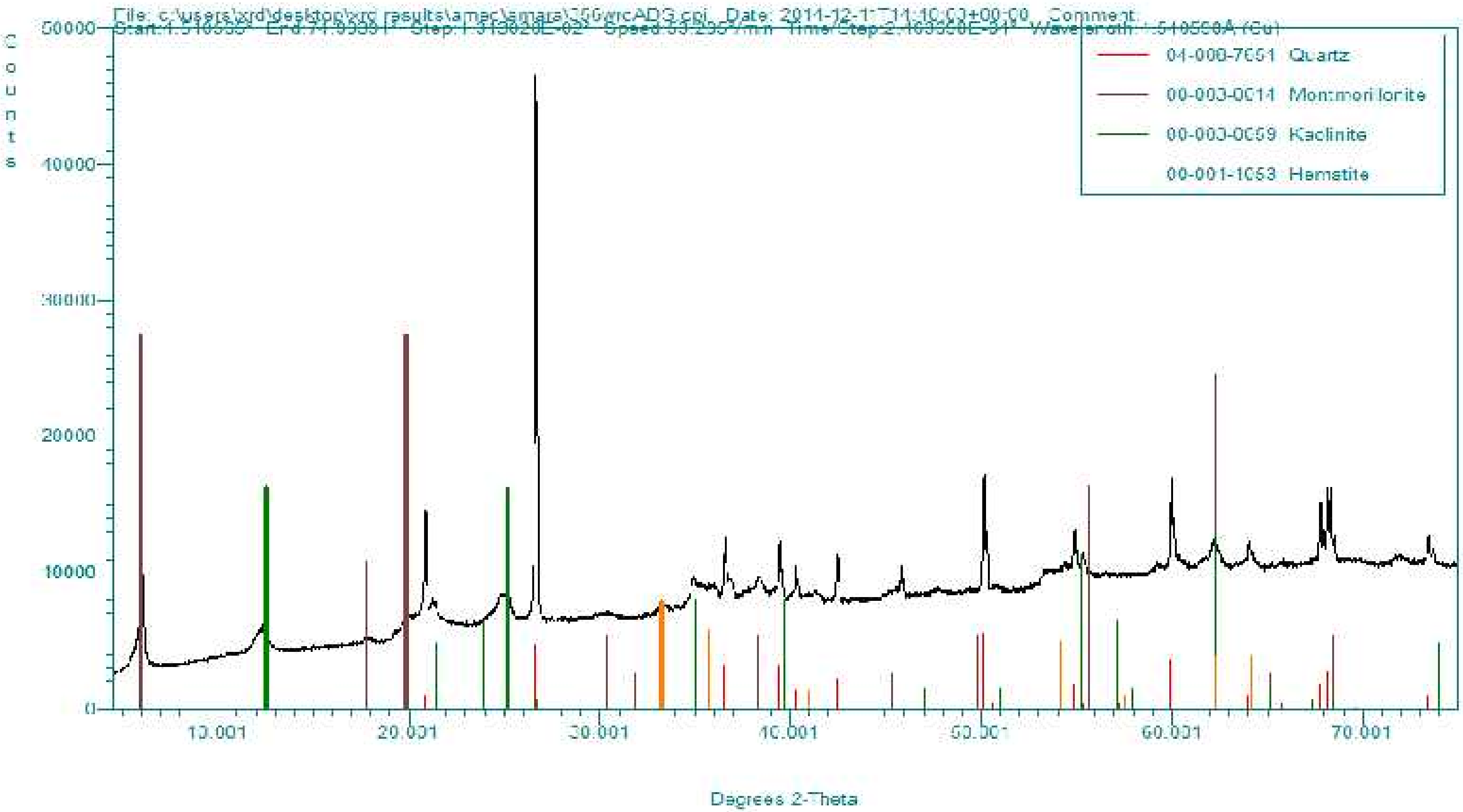

Figure 4: XRD trace for sample CHEM051 with peak markers for the main minerals present

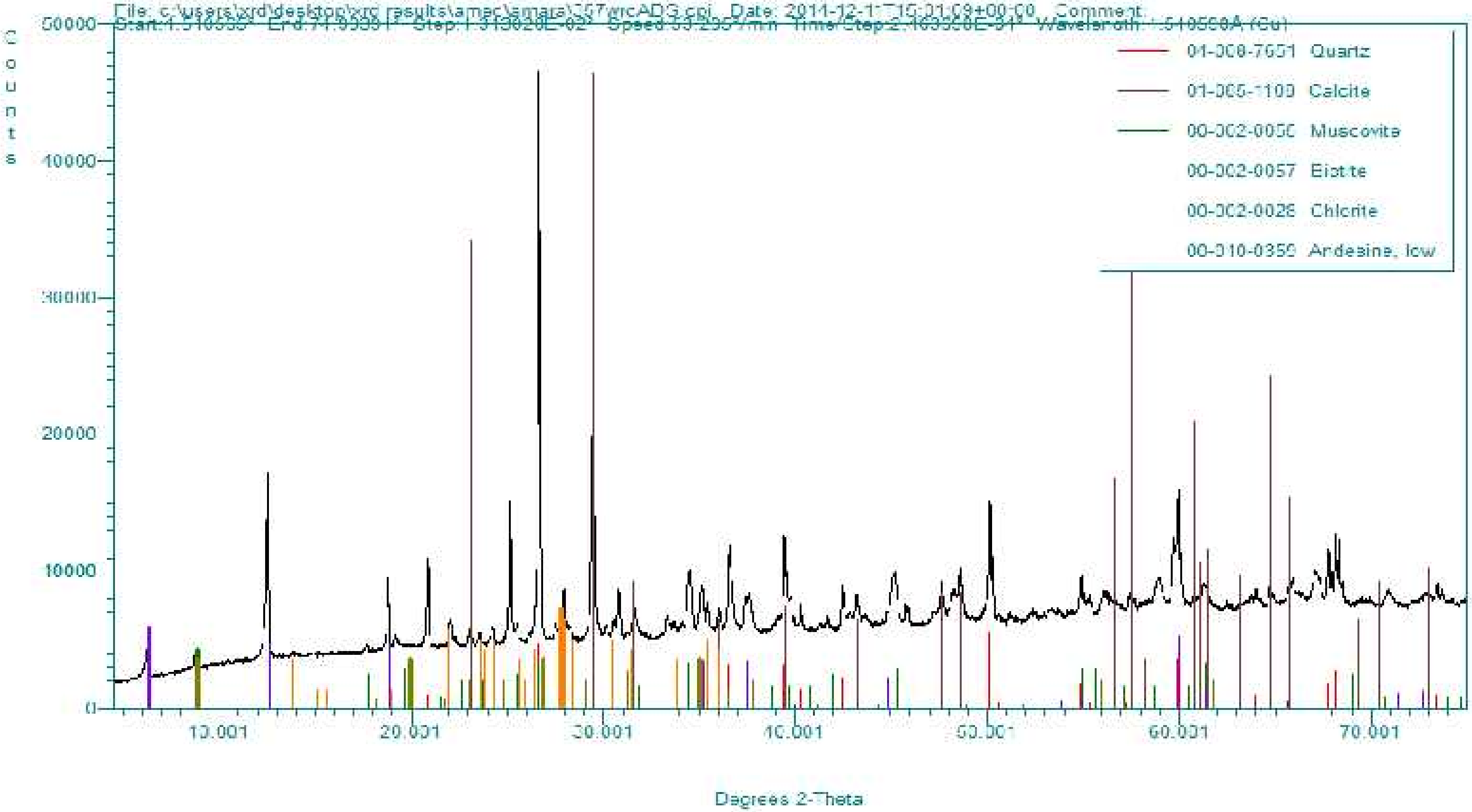

Figure 5: XRD trace for sample CHEM059 with peak markers for the main minerals present

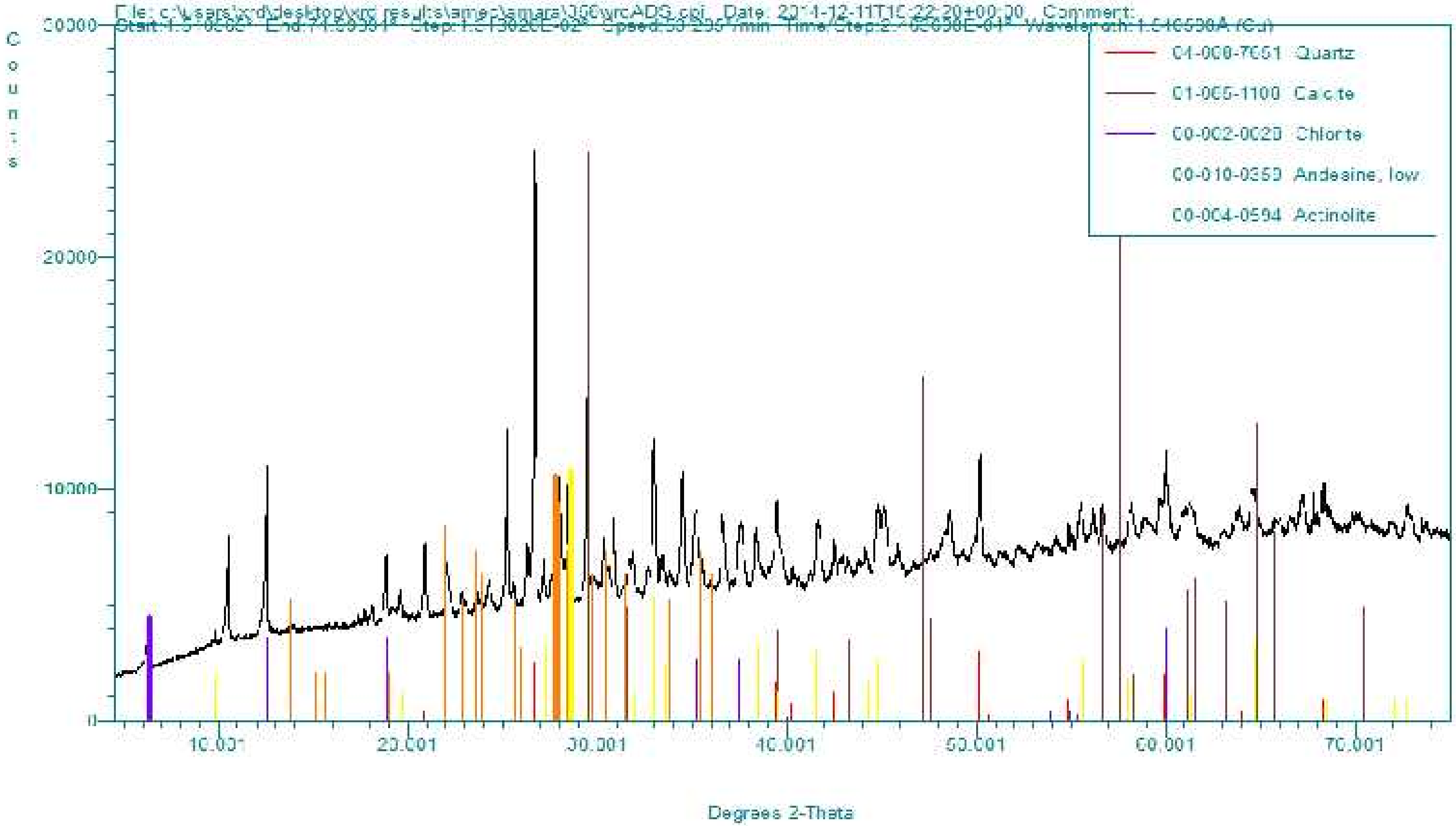

Figure 6: XRD trace for sample CHEM062 with peak markers for the main minerals present

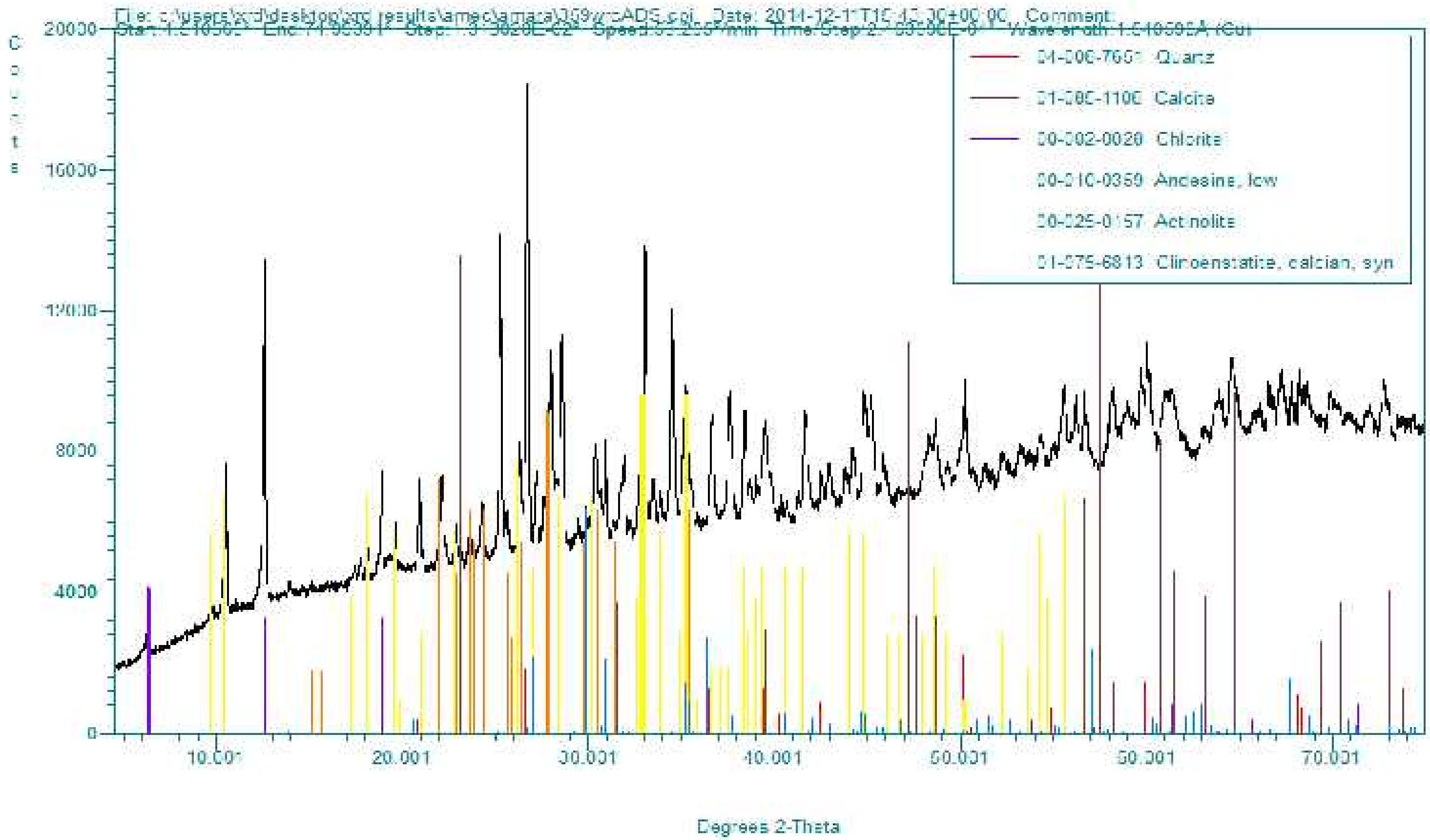

Figure 7: XRD trace for sample CHEM066 with peak markers for the main minerals present

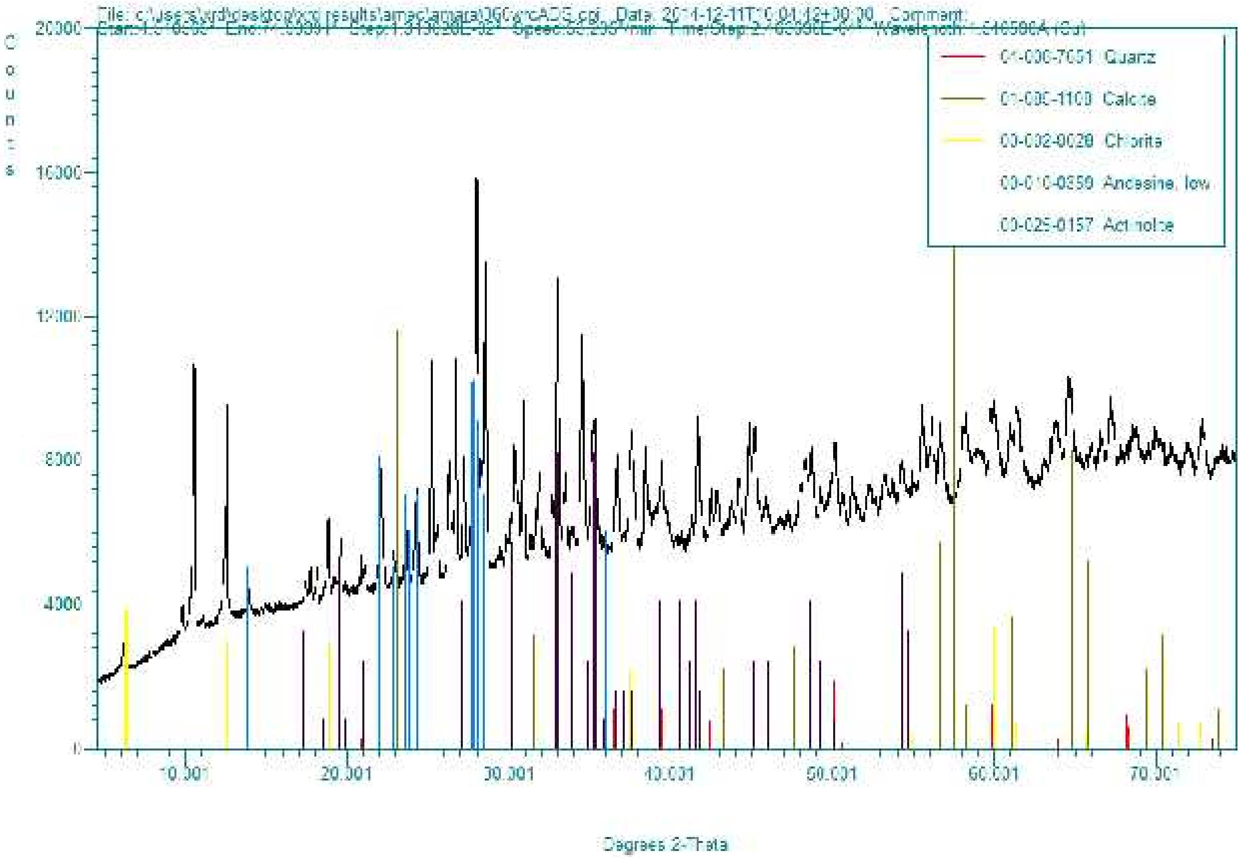

Figure 8: XRD trace for sample CHEM086 with peak markers for the main minerals present

CONCLUSIONS

The mineralogy of the samples analysed by XRD is dominated by ferromagnesian silicates (amphibole, chlorite, mica) and plagioclase feldspar. Some samples also contain elevated amounts of calcite, kaolinite and other silicates.
This observation is supported by the chemical analyses, which show high Fe, Mg, Ca, Al and Si.
High 'loss on ignition' values relate to high volatile contents (e.g. water and carbon dioxide) and a high ferrous iron content.
The 'trace' element content of the samples does not appear to be particularly distinctive as no abnormally high values appear to be present.
Calcite is quite abundant in several samples. This could explain the alkaline pH of leachates from the SPLP extraction.
The initial XRD analysis was not able to confirm the presence of pyrite. However, when this mineral is added to the Rietveld quantification the results suggest it is present up to a few %. However the accuracy of the quantification decreases below about 4% and the XRF-derived sulphur analysis is likely to be more reliable (maximum 0.2% S; suggesting that pyrite is unlikely to be present at more than about 0.5% maximum).

The analyses suggest that some samples are mineralogically and chemically distinct from the main group of samples:

1) 051: Relatively low in Mg, Ca, Na and K, and high in smectite/chlorite clay (the only sample of the 7 with this phase), kaolinite, quartz and hematite. Samples 098, 099 and 100 show similar chemical characteristics. All 4 also have very low Sr and Ca, and high Ti and Al, indicating that there is little feldspar and that leaching has left increases in residual immobile elements.

2) 003: Relatively high in feldspar and quartz. The highest in Si, K and Na, and low in Ca, Fe and Mg.

MINERALOGICAL AND CHEMICAL CHARACTERIZATION OF 6 TAILINGS SAMPLES (AMARA)

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Earth Sciences

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Egham

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UK

For: Amara Mining PLC

Aims

Six samples of rock powder were provided for analysis.

The aims were to:

1. Conduct a SPLP (synthetic precipitation leach procedure) on the samples,
2. Determine the major and trace element compositions of the samples by X-ray fluorescence (XRF), and
3. Determine the mineralogy of the samples using X-ray diffraction (XRD), including quantitative, Rietveld analysis.

The main conclusions of the work are noted at the end of this report.

Sample numbers and preparation: As received from SGS Mineral Services, the samples consisted each of approximately 300g of ground and dry, rock powder. The sample details are shown in Table 1, together with the SGS sample numbers.

Addition of dilute HCl resulted in a visible ‘fizz’ in some samples and thus carbonates are definitely present in elevated amounts.

Table 1: Sample numbers

SGS sample number (prefix SGS 567)	Description (prefix Yaoure LT8)	Colour	Fizzes with dilute HCl?
1006	Oxide	YELLOW-BROWN	NO
1007	Transition	GREEN-BROWN	YES
1008	CMA upper	GREY-GREEN	YES
1009	CMA lower	GREY-GREEN	YES
1010	‘Yaoure’ upper	GREY-GREEN	YES
1011	‘Yaoure’ lower	GREY-GREEN	YES

SPLP

The USGS methodology was followed. The powder of the 6 samples was added to an acid solution at a ratio of 1:20 (100g of solid to 2000mls of solution). The leach solution was a 60/40 H_2SO_4/HNO_3 mixture adjusted to pH 4.2. The samples were then mixed in an 'end-over-end' rotary agitator for 18 hours.

The solutions were then filtered and measured for pH and conductivity (Table 2). A representative portion of the leachate was sent for further chemical analysis.

Table 2: SPLP leachate analyses

Sample	pH	Conductivity
1006	9.1	230
1007	8.2	180
1008	8.2	180
1009	8.2	160
1010	7.7	175
1011	7.7	175

Conductivity units are µS cm-1

XRF

Sample preparation: Approximately 20 grammes of sample were dried at 100°C overnight in an oven. The sample was then further ground in a tungsten carbide 'tema' mill for 3 minutes.

Method: For trace element analysis, a pressed powder pellet was produced at a pressure of 25 tonnes with a binder in a Herzog HT40 hydraulic press. A glass disc was made by fusing this heated sample with a flux of lithium tetraborate at 1100°C and a sample:flux ratio of 10:1. The samples were chemically analysed for a wide range of elements using a Philips Magix-Pro wavelength dispersive XRF spectrometer using a 4kW Rh end-window tube. International standards were also analysed for several elements as a check on the analytical accuracy and precision (about 0.5-1%) and precision (0.5% total).

XRF Results: The XRF results are presented in Table 3 as oxide weight % for the major constituents and parts per million for the 'trace' elements.

Points to note:

1) Volatile content (e.g. water, CO_2) is given by the 'loss on ignition' value (LOI). This value has been determined as the difference between 100% and the sum of the other major constituents.

2) Total Fe is presented as ferric iron. However, the form of the iron in the rock is likely to be dominated by ferrous iron.

Table 3: Chemical composition of the samples

Sample ID		1006	1007	1008	1009	1010	1011
SiO_2	(%)	56.93	50.99	45.07	45.34	54.57	51.12
TiO_2	(%)	0.99	0.77	0.76	0.72	0.71	0.65
Al_2O_3	(%)	15.17	12.92	11.11	10.98	12.51	12.33
Fe_2O_3	(%)	13.35	9.87	10.02	9.64	9.11	8.73
MnO	(%)	0.16	0.14	0.15	0.15	0.13	0.14
MgO	(%)	2.37	5.00	5.35	5.35	4.64	4.78
CaO	(%)	0.69	4.71	8.13	8.27	7.48	8.06
K_2O	(%)	1.34	1.46	1.36	1.24	1.06	1.43
Na_2O	(%)	0.96	2.38	2.41	2.54	2.35	2.14
P_2O_5	(%)	0.10	0.12	0.23	0.23	0.10	0.13
S	(%)	<0.005	0.06	0.21	0.28	0.21	0.12
Cl	(%)	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Sum	(%)	92.1	88.4	84.8	84.7	92.9	89.6
LOI_{xrf}	(%)	7.9	11.6	15.2	15.3	7.1	10.4
As	(ppm)	33	11	5	5	9	13
Ba	(ppm)	256	305	315	399	273	330
Bi	(ppm)	13	5	7	5	6	6
Ce	(ppm)	33	47	63	53	41	27
Co	(ppm)	39	30	30	29	25	25
Cr	(ppm)	282	340	411	422	519	436
Cu	(ppm)	136	95	63	61	115	96
Ga	(ppm)	19	16	13	14	15	14
Ge	(ppm)	3	3	< 3	< 3	3	< 3
Hf	(ppm)	4	4	4	7	9	< 3
I	(ppm)	4	6	6	11	4	<2
La	(ppm)	9	6	27	29	<5	6
Mo	(ppm)	14	23	29	37	52	46
Nb	(ppm)	2	4	4	4	3	4
Ni	(ppm)	156	169	179	181	260	195
Pb	(ppm)	12	5	5	8	13	7
Rb	(ppm)	40	40	39	36	31	42
Sb	(ppm)	7	6	11	14	2	6
Sc	(ppm)	186	55	<15	<15	<15	<15
Se	(ppm)	< 3	< 3	< 3	< 3	< 3	< 3
Sn	(ppm)	11	9	9	8	7	7
Sr	(ppm)	53	176	261	330	220	239
Th	(ppm)	< 3	7	5	9	5	6
U	(ppm)	< 3	< 3	< 3	< 3	< 3	< 3
V	(ppm)	389	280	287	265	215	220
W	(ppm)	24	6	17	15	< 3	< 3
Y	(ppm)	23	15	15	14	13	12
Zn	(ppm)	131	75	77	77	74	63
Zr	(ppm)	77	76	71	70	69	70

XRD

XRD methodology: A representative portion of the sample was manually ground to a fine powder using a ceramic mortar and pestle. The powder was packed into a recessed plastic holder and preferred orientation was minimised. The samples were analysed using a Philips X-ray diffractometer (PW3710) scanning from 4° to 75° 2θ. The generator was set at 40kV and 40mA. Peak identification was enabled using the PDF/ICCD database and quantification achieved using Rietveld analysis using the commercial programme Siroquant (Sietronics, Australia).

XRD Results: The XRD patterns are shown in Figures 1 to 7. Figure 1 shows the traces of 5 of the samples together to demonstrate their broad similarity (and marked difference to sample 1006). Figures 2 to 7 show the plots for the individual samples together with markers for the main minerals found to be present. (Note that, for clarity, not all of the peaks for all identified phases have been included in these plots).

It is immediately clear from the number of peaks that the mineralogy of the samples is complex. However, the mineralogy is mostly dominated by quartz, plagioclase feldspar, chlorite, pyroxene, carbonates and K-mica.

For the quantification, additional minerals were identified and included in the calculations. The weight % of minerals present, derived from Rietveld quantification, is given in Table 4. Note that values below about 4% are less accurate and the presence of those phases given as below 1% is uncertain.

For the quantification, plagioclase feldspar has been modelled as andesine; K-feldspar as orthoclase; amphibole as hornblende (pargasite); K-mica as both muscovite and biotite; chlorite as an Fe-rich variety (chamosite); and pyroxene as a mixture of both ortho- and clino-varieties. Although calcite has been identified in some samples, there is also an abundance of another carbonate (the large peak at 31°); this has been modelled as ankerite (a Ca-Fe-Mg carbonate). Although the main phases have been clearly identified, the matches between observed and modelled traces are not always ideal. This is probably due to problems with modelling the exact varieties of silicates present – especially feldspar, pyroxene, amphibole and chlorite.

Table 4: Quantitative results of mineral phases present (weight %)

Phase	1006	1007	1008	1009	1010	1011
Quartz	40.1	22.6	19.3	18.8	24.7	23.8
Chlorite	28.0	17.9	12.1	12.2	19.9	17.0
Muscovite	9.3	9.5	9.7	6.9	5.6	6.9
Biotite	1.6	0.9	0.5	1.5	1.2	2.3
Calcite	0.0	1.8	0.9	1.2	6.9	7.4
Ankerite	1.0	15.9	29.0	19.7	11.3	12.1
Goethite	3.7	0.6	0.4	0.7	0.2	0.3
Hematite	0.6	0.0	0.0	0.0	0.0	0.0
Pyrite	0.0	0.7	1.3	2.1	2.4	2.1
Orthoclase	0.0	0.5	0.5	0.9	0.0	0.3
Andesine	7.4	13.7	14.1	17.4	19.0	17.5
Hornblende	2.1	1.8	1.3	0.9	2.9	4.4
Pyroxene	3.8	11.6	9.1	16.3	4.4	4.5
Diaspore	2.4	2.3	1.7	1.4	1.5	1.3

CONCLUSIONS

From the colour, chemical analysis and XRD study it is clear that 5 of the samples are similar, whilst one is distinctly different.

Sample 1006 is distinctive because it is dominated by quartz, Fe oxides/hydroxides, K-mica and chlorite. Carbonate content is low.

The mineralogy of the other 5 samples is dominated by quartz, ferromagnesian silicates (amphibole, chlorite, mica) and plagioclase feldspar. Some samples also contain elevated amounts of carbonate (including calcite).

This observation is supported by the chemical analyses, which show high Fe, Mg, Ca, Al and Si, and some K and Na.

High 'loss on ignition' values relate to high volatile contents (e.g. water and carbon dioxide in carbonates, mica and chlorite). Sulphur contents are relatively low.

The 'trace' elements which are consistently at levels above 100ppm are Cr, Ni, Ba, V and Sr.

Calcite and an additional carbonate are quite abundant in several samples. (This could help to explain the alkaline pH of leachates from the SPLP extraction but also note that other carbonates do not react as profusely as calcite in dilute acid).

The XRD analysis indicates that pyrite is present at levels up to about 2%. However, as previously noted, the accuracy of the XRD quantification decreases below about 4% and the XRF-derived sulphur analysis is likely to be more reliable (maximum 0.2% S; suggesting that pyrite is unlikely to be present at more than about 0.5% maximum).

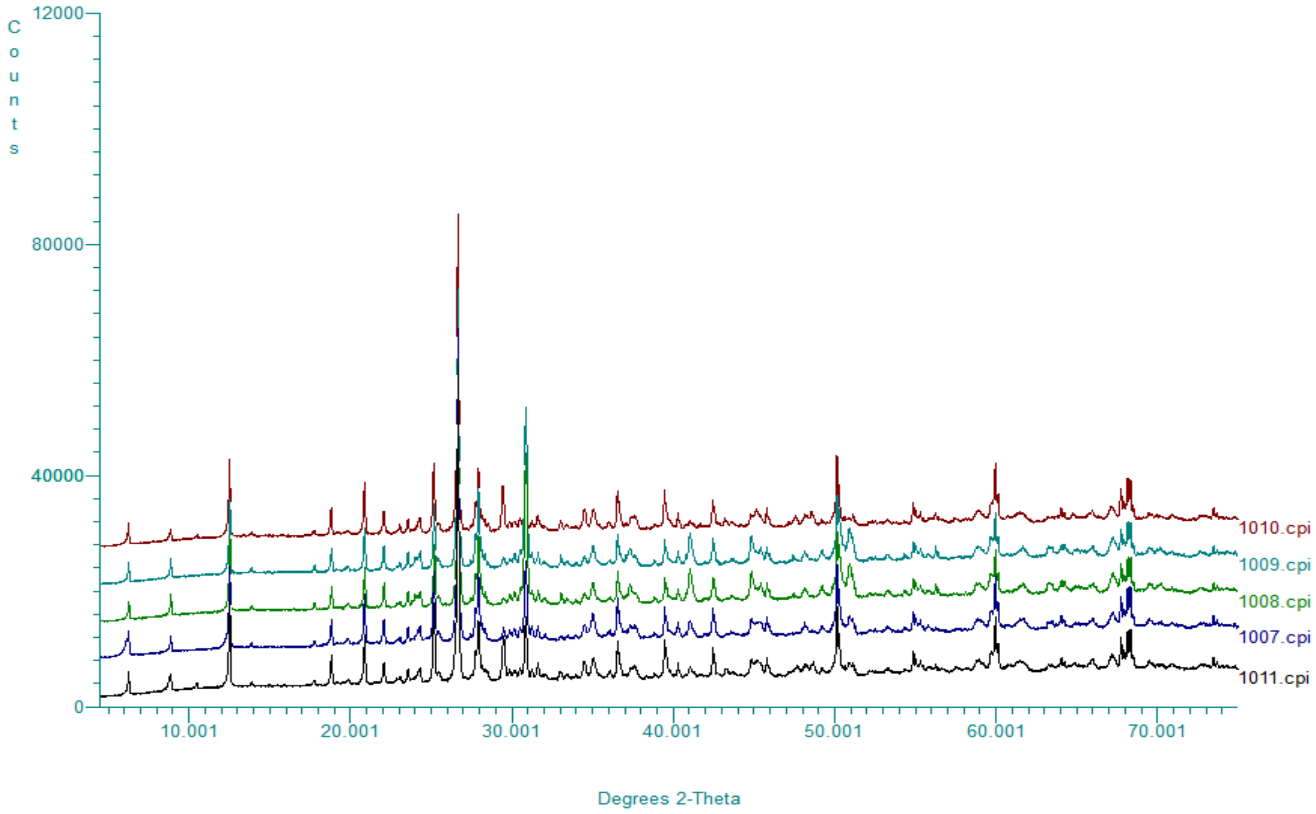

Figure 1: XRD traces for the 5 similar samples (prefix SGS 567)

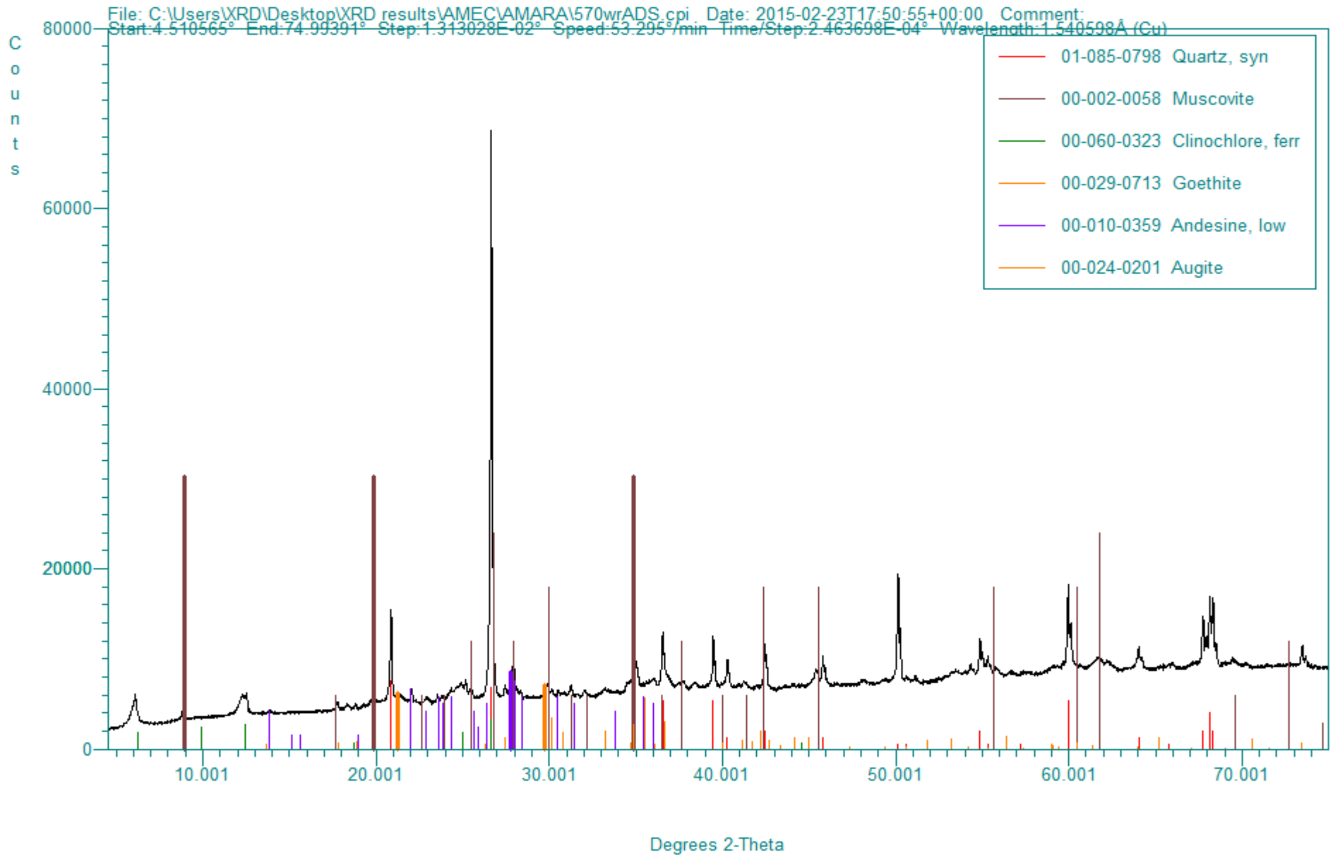

Figure 2: XRD trace for sample 1006 with peak markers for the main minerals present

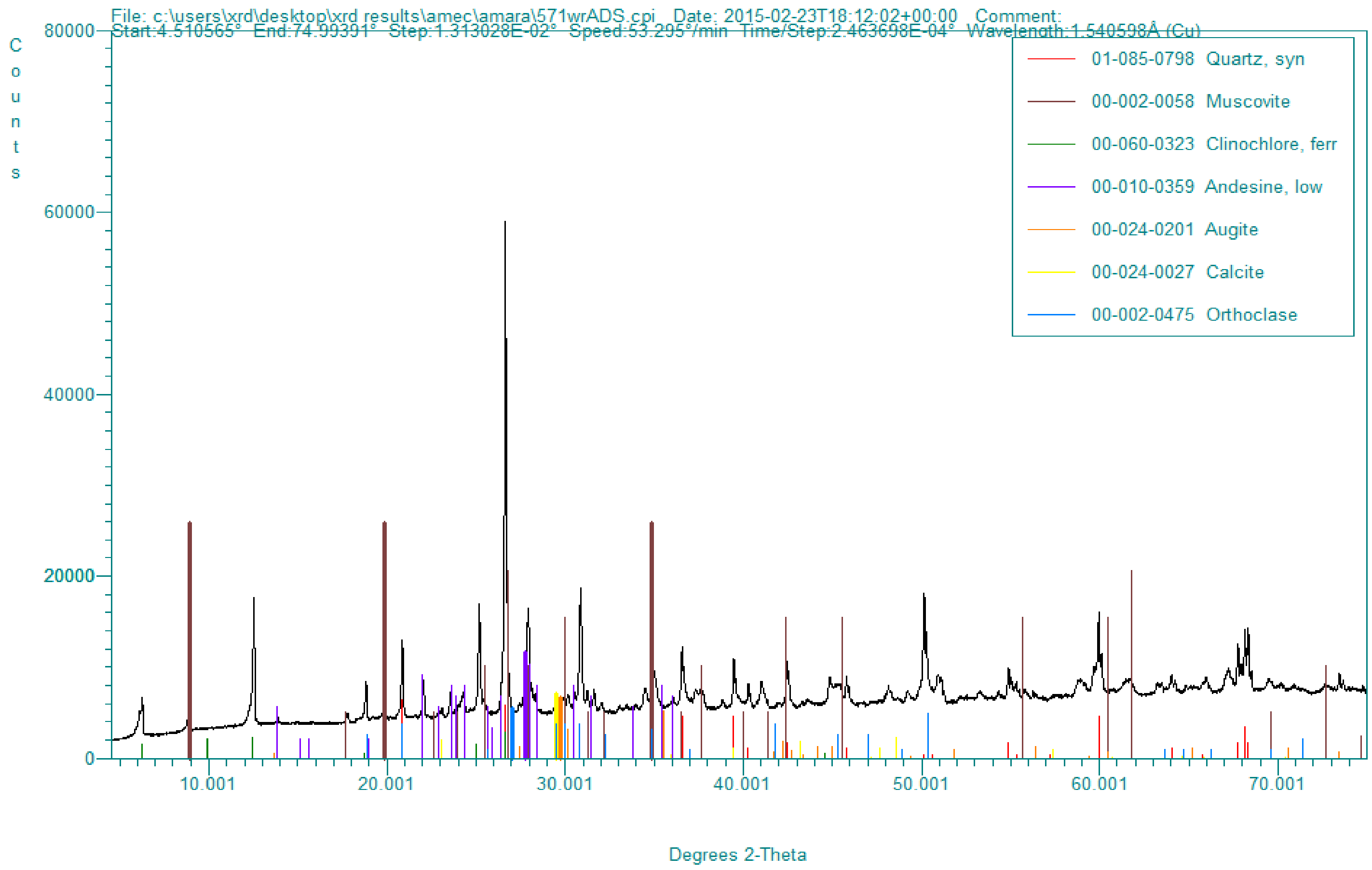

Figure 3: XRD trace for sample 1007 with peak markers for the main minerals present

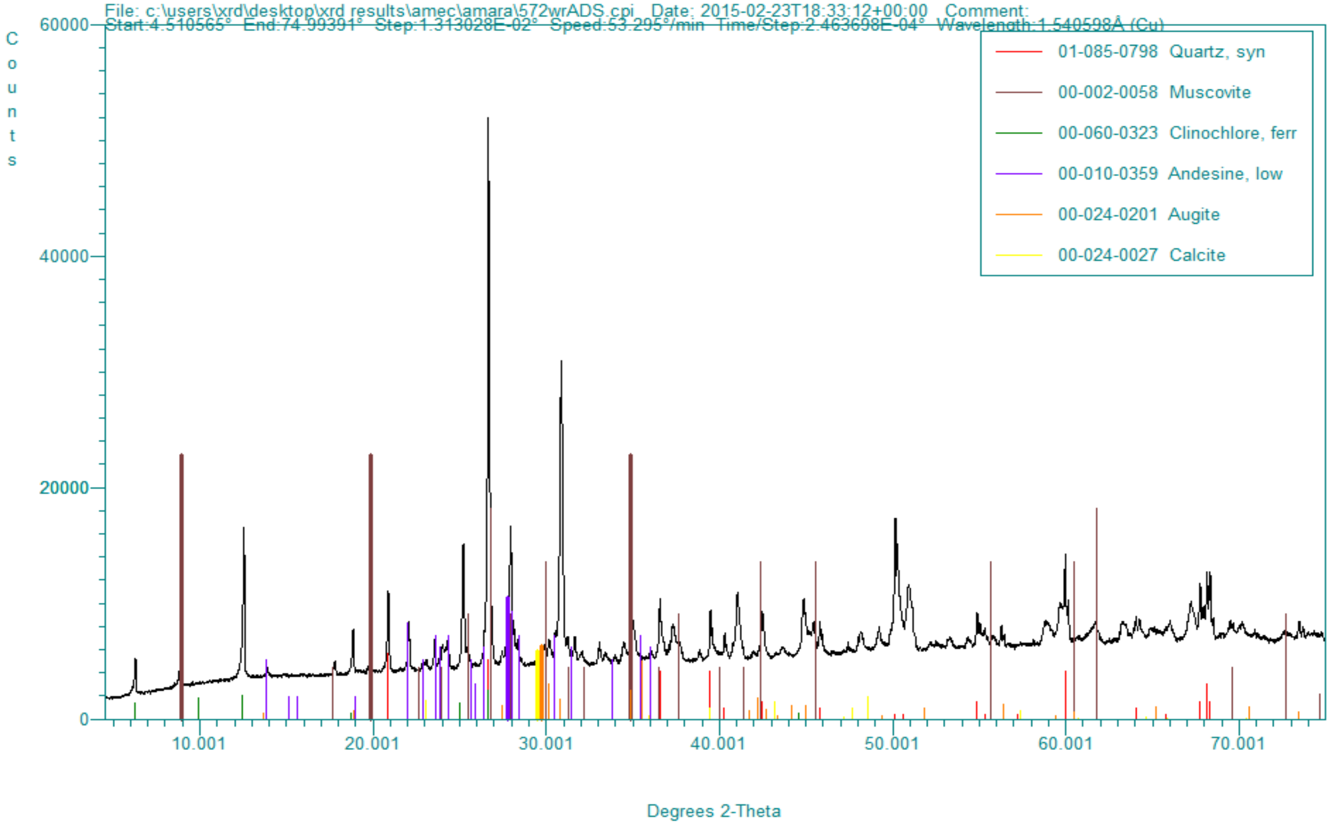

Figure 4: XRD trace for sample 1008 with peak markers for the main minerals present

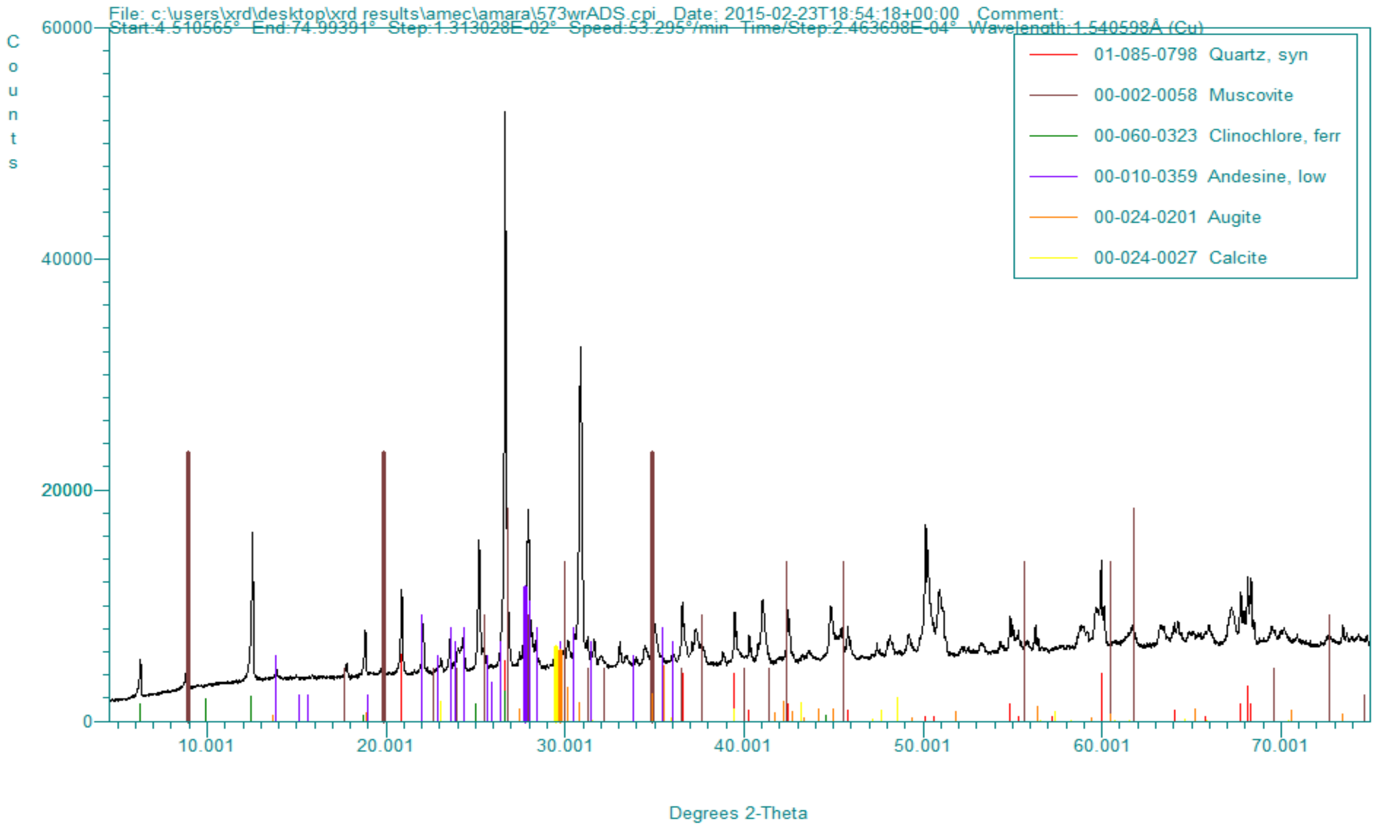

Figure 5: XRD trace for sample 1009 with peak markers for the main minerals present

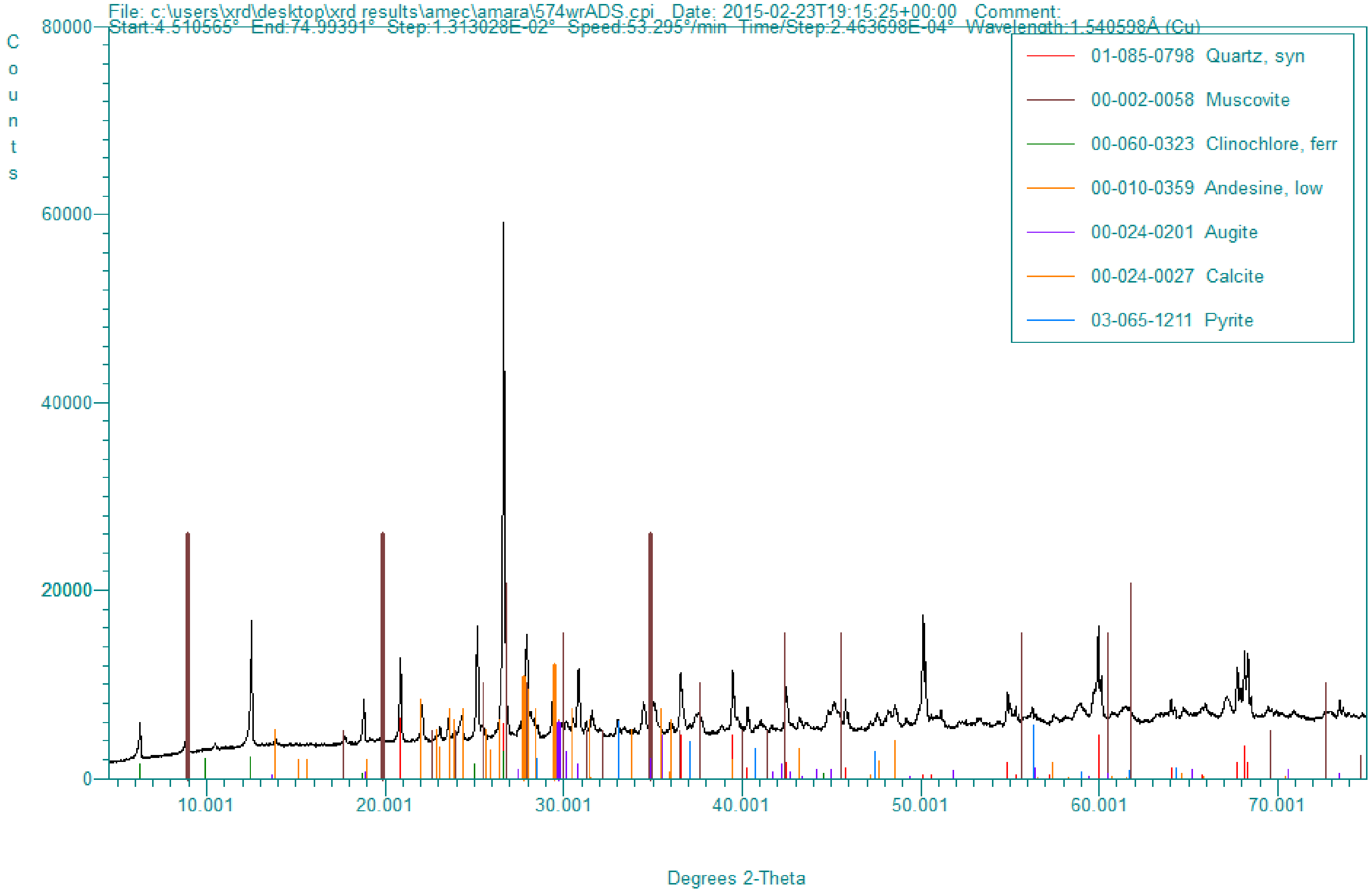

Figure 6: XRD trace for sample 1010 with peak markers for the main minerals present

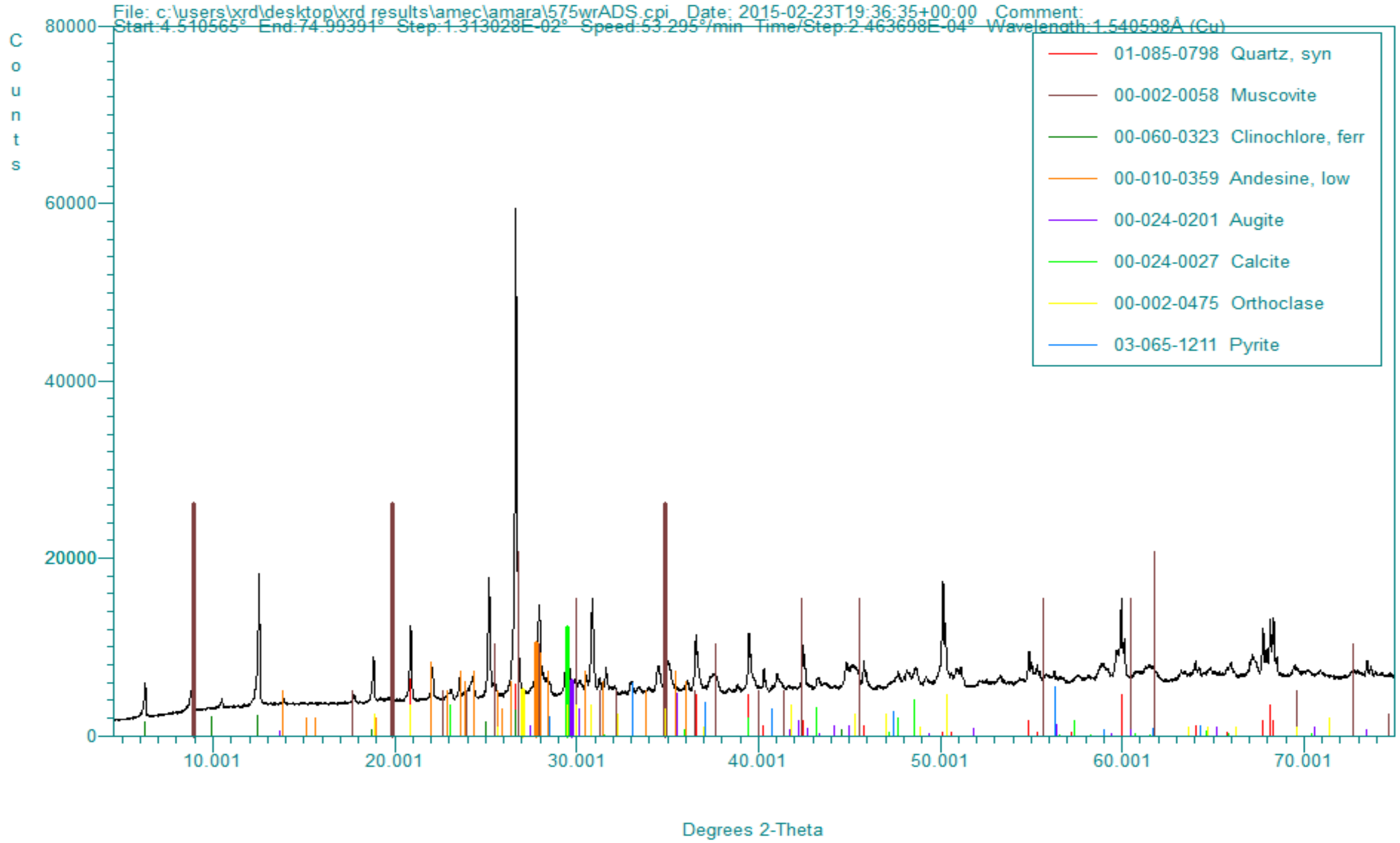

Figure 7: XRD trace for sample 1011 with peak markers for the main minerals present

APPENDIX G

ALcontrol Results Certificates

ALcontrol Laboratories

Unit 7-8 Hawarden Business Park
Manor Road (off Manor Lane)
Hawarden
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Fax: (01244) 528701
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Amara Mining Ltd
4th Floor
29-30 Cornhill
London
EC3V 3NF

Attention: Katy Hebditch

CERTIFICATE OF ANALYSIS

Date:	18 December 2014
Customer:	H_AMARA_COR
Sample Delivery Group (SDG):	141210-25
Your Reference:	
Location:	Amara Elemental Analysis
Report No:	296410

We received 7 samples on Tuesday December 09, 2014 and 7 of these samples were scheduled for analysis which was completed on Thursday December 18, 2014. Accredited laboratory tests are defined within the report, but opinions, interpretations and on-site data expressed herein are outside the scope of ISO 17025 accreditation.

Should this report require incorporation into client reports, it must be used in its entirety and not simply with the data sections alone.

All chemical testing (unless subcontracted) is performed at ALcontrol Hawarden Laboratories.

Approved By:

Sonia McWhan
Operations Manager

UKAS TESTING 1291

SDG:	141210-25	**Location:**	Amara Elemental Analysis	**Order Number:**	CD1-009 Amara Mining
Job:	H_AMARA_COR-1	**Customer:**	Amara Mining Ltd	**Report Number:**	296410
Client Reference:		**Attention:**	Katy Hebditch	**Superseded Report:**	

Received Sample Overview

Lab Sample No(s)	Customer Sample Ref.	AGS Ref.	Depth (m)	Sampled Date
10535445	003			04/12/2014
10535447	046			04/12/2014
10535449	051			04/12/2014
10535450	059			04/12/2014
10535451	062			04/12/2014
10535452	066			04/12/2014
10535453	086			04/12/2014

Only received samples which have had analysis scheduled will be shown on the following pages.

CERTIFICATE OF ANALYSIS

SDG:	141210-25	**Location:**	Amara Elemental Analysis	**Order Number:**	CD1-009 Amara Mining
Job:	H_AMARA_COR-1	**Customer:**	Amara Mining Ltd	**Report Number:**	296410
Client Reference:		**Attention:**	Katy Hebditch	**Superseded Report:**	

LIQUID

Results Legend

- X — **Test**
- N — **No Determination Possible**

Lab Sample No(s)			10535445		10535447		10535449		10535450		10535451		10535452		10535453	
Customer Sample Reference			003		046		051		059		062		066		086	
AGS Reference																
Depth (m)																
Container			0.5l glass bottle (AL	Dissolved Metals Pr	0.5l glass bottle (AL	Dissolved Metals Pr	0.5l glass bottle (AL	Dissolved Metals Pr	0.5l glass bottle (AL	Dissolved Metals Pr	0.5l glass bottle (AL	Dissolved Metals Pr	0.5l glass bottle (AL	Dissolved Metals Pr	0.5l glass bottle (AL	Dissolved Metals Pr
Anions by Kone (w)	All	NDPs: 0 Tests: 7	X		X		X		X		X		X		X	
Dissolved Metals by ICP-MS	All	NDPs: 0 Tests: 7	X		X		X		X		X		X		X	
Dissolved W, Nb and Zr by ICP-MS	All	NDPs: 0 Tests: 7	X		X		X		X		X		X		X	
Fluoride	All	NDPs: 0 Tests: 7	X		X		X		X		X		X		X	
Mercury Dissolved	All	NDPs: 0 Tests: 7		X		X		X		X		X		X		X
Metals by iCap-OES Dissolved (W)	All	NDPs: 0 Tests: 7	X		X		X		X		X		X		X	

SDG:	141210-25	**Location:**	Amara Elemental Analysis	**Order Number:**	CD1-009 Amara Mining
Job:	H_AMARA_COR-1	**Customer:**	Amara Mining Ltd	**Report Number:**	296410
Client Reference:		**Attention:**	Katy Hebditch	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

Component	LOD/Units	Method	003	046	051	059	062	066
Customer Sample R			003	046	051	059	062	066
Depth (m)			.	.	.	.	.	.
Sample Type			Water(GW/SW)	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)
Date Sampled			04/12/2014	04/12/2014	04/12/2014	04/12/2014	04/12/2014	04/12/2014
Sample Time			.	.	.	.	.	.
Date Received			09/12/2014	09/12/2014	09/12/2014	09/12/2014	09/12/2014	09/12/2014
SDG Ref			141210-25	141210-25	141210-25	141210-25	141210-25	141210-25
Lab Sample No.(s)			10535445	10535447	10535449	10535450	10535451	10535452
AGS Reference								
Fluoride	<0.5 mg/l	TM104	<0.5 #	<0.5 #	<0.5 #	<0.5 #	<0.5 #	<0.5 #
Aluminium (diss.filt)	<2.9 µg/l	TM152	657 #	820 #	421 #	556 #	572 #	653 #
Antimony (diss.filt)	<0.16 µg/l	TM152	1.18	<0.16	<0.16	1.38	1.05	0.811
Arsenic (diss.filt)	<0.12 µg/l	TM152	10.8 #	1.87 #	0.281 #	0.325 #	1.01 #	0.38 #
Barium (diss.filt)	<0.03 µg/l	TM152	41.1 #	1.86 #	0.988 #	4.43 #	1.75 #	0.835 #
Beryllium (diss.filt)	<0.07 µg/l	TM152	<0.07 #	<0.07 #	<0.07 #	<0.07 #	<0.07 #	<0.07 #
Boron (diss.filt)	<9.4 µg/l	TM152	<9.4 #	<9.4 #	<9.4 #	<9.4 #	<9.4 #	<9.4 #
Cadmium (diss.filt)	<0.1 µg/l	TM152	<0.1 #	<0.1 #	<0.1 #	<0.1 #	<0.1 #	<0.1 #
Chromium (diss.filt)	<0.22 µg/l	TM152	12 #	9.71 #	9.05 #	8.34 #	1.51 #	1.88 #
Cobalt (diss.filt)	<0.06 µg/l	TM152	<0.06 #	0.278 #	0.117 #	<0.06 #	<0.06 #	0.097 #
Copper (diss.filt)	<0.85 µg/l	TM152	<0.85 #	1.63 #	1.73 #	1.12 #	<0.85 #	<0.85 #
Lead (diss.filt)	<0.02 µg/l	TM152	<0.02 #	0.036 #	<0.02 #	<0.02 #	<0.02 #	<0.02 #
Manganese (diss.filt)	<0.04 µg/l	TM152	0.82 #	8.34 #	4.69 #	5.47 #	1.24 #	3.08 #
Molybdenum (diss.filt)	<0.24 µg/l	TM152	<0.24 #	<0.24 #	0.732 #	<0.24 #	0.41 #	0.274 #
Nickel (diss.filt)	<0.15 µg/l	TM152	<0.15 #	0.854 #	0.8 #	0.19 #	0.23 #	0.316 #
Phosphorus (diss.filt)	<6.3 µg/l	TM152	<6.3 #	34.1 #	<6.3 #	31.8 #	7.23 #	18.2 #
Selenium (diss.filt)	<0.39 µg/l	TM152	0.531 #	0.404 #	0.573 #	<0.39 #	0.614 #	0.639 #
Strontium (diss.filt)	<0.05 µg/l	TM152	59.1 #	10.3 #	9.86 #	22 #	10.2 #	27 #
Tellurium (diss.filt)	<2 µg/l	TM152	<2	<2	<2	<2	<2	<2
Thallium (diss.filt)	<0.96 µg/l	TM152	<0.96	<0.96	<0.96	<0.96	<0.96	<0.96
Tin (diss.filt)	<0.36 µg/l	TM152	<0.36 #	<0.36 #	<0.36 #	<0.36 #	<0.36 #	<0.36 #
Uranium (diss.filt)	<1.5 µg/l	TM152	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Titanium (diss.filt)	<1.5 µg/l	TM152	<1.5 #	21.2 #	9.34 #	<1.5 #	<1.5 #	7.63 #
Vanadium (diss.filt)	<0.24 µg/l	TM152	1.42 #	6.21 #	2.6 #	0.507 #	1.58 #	2.46 #
Zinc (diss.filt)	<0.41 µg/l	TM152	<0.41 #	0.739 #	4.36 #	<0.41 #	<0.41 #	<0.41 #
Mercury (diss.filt)	<0.01 µg/l	TM183	<0.01 #	<0.01 #	0.0135 #	<0.01 #	<0.01 #	<0.01 #
Sulphate	<2 mg/l	TM184	<2 #	<2 #	<2 #	<2 #	<2 #	<2 #
Chloride	<2 mg/l	TM184	<2 #	<2 #	<2 #	<2 #	<2 #	<2 #
Nitrate as NO3	<0.3 mg/l	TM184	0.335 @ #	<0.3 @ #	3.58 @ #	<0.3 @ #	<0.3 @ #	<0.3 @ #
Calcium (diss.filt)	<0.012 mg/l	TM228	6.56 #	7.66 #	3.58 #	10.2 #	8.49 #	8.84 #
Sodium (diss.filt)	<0.076 mg/l	TM228	2.14 #	1.51 #	2.1 #	1.14 #	1.2 #	1.21 #
Magnesium (diss.filt)	<0.036 mg/l	TM228	0.617 #	1.29 #	1.53 #	1.18 #	1.12 #	1.25 #

ALcontrol Laboratories

Validated

CERTIFICATE OF ANALYSIS

SDG:	141210-25	**Location:**	Amara Elemental Analysis	**Order Number:**	CD1-009 Amara Mining
Job:	H_AMARA_COR-1	**Customer:**	Amara Mining Ltd	**Report Number:**	296410
Client Reference:		**Attention:**	Katy Hebditch	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&•§@	Sample deviation (see appendix)

		Customer Sample R	003	046	051	059	062	066
		Depth (m)	.	.	.	.	.	.
		Sample Type	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)
		Date Sampled	04/12/2014	04/12/2014	04/12/2014	04/12/2014	04/12/2014	04/12/2014
		Sample Time	.	.	.	.	.	.
		Date Received	09/12/2014	09/12/2014	09/12/2014	09/12/2014	09/12/2014	09/12/2014
		SDG Ref	141210-25	141210-25	141210-25	141210-25	141210-25	141210-25
		Lab Sample No.(s)	10535445	10535447	10535449	10535450	10535451	10535452
		AGS Reference						
Component	**LOD/Units**	**Method**						
Potassium (diss.filt)	<1 mg/l	TM228	1.67 #	<1 #	<1 #	3.45 #	<1 #	<1 #
Iron (diss.filt)	<0.019 mg/l	TM228	<0.019 #	0.62 #	0.148 #	<0.019 #	<0.019 #	0.167 #
Silver (diss.filt)	<1.5 µg/l	TM283	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5

14:46:27 18/12/2014

CERTIFICATE OF ANALYSIS

SDG:	141210-25	**Location:**	Amara Elemental Analysis	**Order Number:**	CD1-009 Amara Mining
Job:	H_AMARA_COR-1	**Customer:**	Amara Mining Ltd	**Report Number:**	296410
Client Reference:		**Attention:**	Katy Hebditch	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

Customer Sample R	086
Depth (m)	.
Sample Type	Water(GW/SW)
Date Sampled	04/12/2014
Sample Time	.
Date Received	09/12/2014
SDG Ref	141210-25
Lab Sample No.(s)	10535453
AGS Reference	

Component	LOD/Units	Method	086	
Fluoride	<0.5 mg/l	TM104	<0.5	#
Aluminium (diss.filt)	<2.9 µg/l	TM152	330	#
Antimony (diss.filt)	<0.16 µg/l	TM152	0.488	
Arsenic (diss.filt)	<0.12 µg/l	TM152	0.877	#
Barium (diss.filt)	<0.03 µg/l	TM152	7.45	#
Beryllium (diss.filt)	<0.07 µg/l	TM152	<0.07	#
Boron (diss.filt)	<9.4 µg/l	TM152	<9.4	#
Cadmium (diss.filt)	<0.1 µg/l	TM152	<0.1	#
Chromium (diss.filt)	<0.22 µg/l	TM152	1.85	#
Cobalt (diss.filt)	<0.06 µg/l	TM152	0.076	#
Copper (diss.filt)	<0.85 µg/l	TM152	<0.85	#
Lead (diss.filt)	<0.02 µg/l	TM152	0.1	#
Manganese (diss.filt)	<0.04 µg/l	TM152	2.35	#
Molybdenum (diss.filt)	<0.24 µg/l	TM152	10.5	#
Nickel (diss.filt)	<0.15 µg/l	TM152	0.579	#
Phosphorus (diss.filt)	<6.3 µg/l	TM152	14.3	#
Selenium (diss.filt)	<0.39 µg/l	TM152	0.708	#
Strontium (diss.filt)	<0.05 µg/l	TM152	10.3	#
Tellurium (diss.filt)	<2 µg/l	TM152	<2	
Thallium (diss.filt)	<0.96 µg/l	TM152	<0.96	
Tin (diss.filt)	<0.36 µg/l	TM152	<0.36	#
Uranium (diss.filt)	<1.5 µg/l	TM152	<1.5	
Titanium (diss.filt)	<1.5 µg/l	TM152	5.33	#
Vanadium (diss.filt)	<0.24 µg/l	TM152	3.85	#
Zinc (diss.filt)	<0.41 µg/l	TM152	<0.41	#
Mercury (diss.filt)	<0.01 µg/l	TM183	<0.01	#
Sulphate	<2 mg/l	TM184	<2	#
Chloride	<2 mg/l	TM184	<2	#
Nitrate as NO3	<0.3 mg/l	TM184	<0.3	@ #
Calcium (diss.filt)	<0.012 mg/l	TM228	8.6	#
Sodium (diss.filt)	<0.076 mg/l	TM228	1.74	#
Magnesium (diss.filt)	<0.036 mg/l	TM228	1.75	#

CERTIFICATE OF ANALYSIS

SDG:	141210-25	**Location:**	Amara Elemental Analysis	**Order Number:**	CD1-009 Amara Mining
Job:	H_AMARA_COR-1	**Customer:**	Amara Mining Ltd	**Report Number:**	296410
Client Reference:		**Attention:**	Katy Hebditch	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	*m*CERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

Customer Sample R			086
Depth (m)			.
Sample Type			Water(GW/SW)
Date Sampled			04/12/2014
Sample Time			.
Date Received			09/12/2014
SDG Ref			141210-25
Lab Sample No.(s)			10535453
AGS Reference			
Component	**LOD/Units**	**Method**	
Potassium (diss.filt)	<1 mg/l	TM228	<1 #
Iron (diss.filt)	<0.019 mg/l	TM228	0.104 #
Silver (diss.filt)	<1.5 µg/l	TM283	<1.5

SDG:	141210-25	**Location:**	Amara Elemental Analysis	**Order Number:**	CD1-009 Amara Mining
Job:	H_AMARA_COR-1	**Customer:**	Amara Mining Ltd	**Report Number:**	296410
Client Reference:		**Attention:**	Katy Hebditch	**Superseded Report:**	

Table of Results - Appendix

Method No	Reference	Description	Wet/Dry Sample [1]	Surrogate Corrected
TM104	Method 4500F, AWWA/APHA, 20th Ed., 1999	Determination of Fluoride using the Kone Analyser		
TM152	Method 3125B, AWWA/APHA, 20th Ed., 1999	Analysis of Aqueous Samples by ICP-MS		
TM183	BS EN 23506:2002, (BS 6068-2.74:2002) ISBN 0 580 38924 3	Determination of Trace Level Mercury in Waters and Leachates by PSA Cold Vapour Atomic Fluorescence Spectrometry		
TM184	EPA Methods 325.1 & 325.2,	The Determination of Anions in Aqueous Matrices using the Kone Spectrophotometric Analysers		
TM228	US EPA Method 6010B	Determination of Major Cations in Water by iCap 6500 Duo ICP-OES		
TM283		Determination of Dissolved Niobium, Tungsten, and Zirconium in Water Matrices by ICP-MS		

[1] Applies to Solid samples only. DRY indicates samples have been dried at 35°C. NA = not applicable.

SDG: 141210-25
Job: H_AMARA_COR-1
Client Reference:
Location: Amara Elemental Analysis
Customer: Amara Mining Ltd
Attention: Katy Hebditch
Order Number: CD1-009 Amara Mining
Report Number: 296410
Superseded Report:

Test Completion Dates

Lab Sample No(s)	10535445	10535447	10535449	10535450	10535451	10535452	10535453
Customer Sample Ref.	003	046	051	059	062	066	086
AGS Ref.							
Depth							
Type	LIQUID	LIQUID	LIQUID	LIQUID	LIQUID	LIQUID	LIQUID
Anions by Kone (w)	18-Dec-2014	18-Dec-2014	18-Dec-2014	18-Dec-2014	18-Dec-2014	18-Dec-2014	18-Dec-2014
Dissolved Metals by ICP-MS	18-Dec-2014	18-Dec-2014	18-Dec-2014	18-Dec-2014	18-Dec-2014	18-Dec-2014	18-Dec-2014
Dissolved W, Nb and Zr by ICP-MS	17-Dec-2014	17-Dec-2014	17-Dec-2014	17-Dec-2014	17-Dec-2014	17-Dec-2014	17-Dec-2014
Fluoride	16-Dec-2014	16-Dec-2014	16-Dec-2014	16-Dec-2014	16-Dec-2014	16-Dec-2014	16-Dec-2014
Mercury Dissolved	16-Dec-2014	16-Dec-2014	16-Dec-2014	16-Dec-2014	16-Dec-2014	16-Dec-2014	16-Dec-2014
Metals by iCap-OES Dissolved (W)	18-Dec-2014	16-Dec-2014	18-Dec-2014	18-Dec-2014	18-Dec-2014	16-Dec-2014	16-Dec-2014
Nitrite by Kone (w)	16-Dec-2014	16-Dec-2014	16-Dec-2014	16-Dec-2014	16-Dec-2014	17-Dec-2014	16-Dec-2014

Appendix

General

1. Results are expressed on a dry weight basis (dried at 35ºC) for all soil analyses except for the following: NRA and CEN Leach tests, flash point LOI, pH, ammonium as NH4 by the BRE method, VOC TICS and SVOC TICS.

2. Samples will be run in duplicate upon request, but an additional charge may be incurred.

3. If sufficient sample is received a sub sample will be retained free of charge for 30 days after analysis is completed (e-mailed) for all sample types unless the sample is destroyed on testing. The prepared soil sub sample that is analysed for asbestos will be retained for a period of 6 months after the analysis date. All bulk samples will be retained for a period of 6 months after the analysis date. All samples received and not scheduled will be disposed of one month after the date of receipt unless we are instructed to the contrary. Once the initial period has expired, a storage charge will be applied for each month or part thereof until the client cancels the request for sample storage. ALcontrol Laboratories reserve the right to charge for samples received and stored but not analysed.

4. With respect to turnaround, we will always endeavour to meet client requirements wherever possible, but turnaround times cannot be absolutely guaranteed due to so many variables beyond our control.

5. We take responsibility for any test performed by sub-contractors (marked with an asterisk). We endeavour to use UKAS/MCERTS Accredited Laboratories, who either complete a quality questionnaire or are audited by ourselves. For some determinands there are no UKAS/MCERTS Accredited Laboratories, in this instance a laboratory with a known track record will be utilised.

6. When requested, the individual sub sample scheduled will be analysed in house for the presence of asbestos fibres and asbestos containing material by our documented in house method TM048 based on HSG 248 (2005), which is accredited to ISO17025. If a specific asbestos fibre type is not found this will be reported as "Not detected". If no asbestos fibre types are found all will be reported as "Not detected" and the sub sample analysed deemed to be clear of asbestos. If an asbestos fibre type is found it will be reported as detected (for each fibre type found). Testing can be carried out on asbestos positive samples, but, due to Health and Safety considerations, may be replaced by alternative tests or reported as No Determination Possible. The quantity of asbestos present is not determined unless specifically requested.

7. If no separate volatile sample is supplied by the client, or if a headspace or sediment is present in the volatile sample, the integrity of the data may be compromised. This will be flagged up as an invalid VOC on the test schedule and the result marked as deviating on the test certificate.

8. If appropriate preserved bottles are not received preservation will take place on receipt. However, the integrity of the data may be compromised.

9. NDP -No determination possible due to insufficient/unsuitable sample.

10. Metals in water are performed on a filtered sample, and therefore represent dissolved metals -total metals must be requested separately.

11. Results relate only to the items tested.

12. LODs for wet tests reported on a dry weight basis are not corrected for moisture content.

13. **Surrogate recoveries** -Most of our organic methods include surrogates, the recovery of which is monitored and reported. For EPH, MO, PAH, GRO and VOCs on soils the result is not surrogate corrected, but a percentage recovery is quoted. Acceptable limits for most organic methods are 70 -130 %.

14. **Product analyses** -Organic analyses on products can only be semi-quantitative due to the matrix effects and high dilution factors
employed.

15. Phenols monohydric by HPLC include phenol, cresols (2-Methylphenol, 3-Methylphenol and 4-Methylphenol) and Xylenols (2,3 Dimethylphenol, 2,4 Dimethylphenol, 2,5 Dimethylphenol, 2,6 Dimethylphenol, 3,4 Dimethyphenol, 3,5 Dimethylphenol).

16. Total of 5 speciated phenols by HPLC includes Phenol, 2,3,5-Trimethyl Phenol, 2-Isopropylphenol, Cresols and Xylenols (as detailed in 15).

17. Stones/debris are not routinely removed. We always endeavour to take a representative sub sample from the received sample.

18. In certain circumstances the method detection limit may be elevated due to the sample being outside the calibration range. Other factors that may contribute to this include possible interferences. In both cases the sample would be diluted which would cause the method detection limit to be raised.

19. Mercury results quoted on soils will not include volatile mercury as the analysis is performed on a dried and crushed sample.

20. For the BSEN 12457-3 two batch process to allow the cumulative release to be calculated, the volume of the leachate produced is measured and filtered for all tests. We therefore cannot carry out any unfiltered analysis. The tests affected include volatiles GCFID/GCMS and all subcontracted analysis.

21. For all leachate preparations (NRA, DIN, TCLP, BSEN 12457-1, 2, 3) volatile loss may occur, as we do not employ zero headspace extraction.

22. We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials - whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample. Other coarse granular material such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

23. Analysis and identification of specific compounds using GCFID is by retention time only, and we routinely calibrate and quantify for benzene, toluene, ethylbenzenes and xylenes (BTEX). For total volatiles in the C5-C12 range, the total area of the chromatogram is integrated and expressed as ug/kg or ug/l. Although this analysis is commonly used for the quantification of gasoline range organics (GRO), the system will also detect other compounds such as chlorinated solvents, and this may lead to a falsely high result with respect to hydrocarbons only. It is not possible to specifically identify these non-hydrocarbons, as standards are not routinely run for any other compounds, and for more definitive identification, volatiles by GCMS should be utilised.

Sample Deviations

1	Container with Headspace provided for volatiles analysis
2	Incorrect container received
3	Deviation from method
4	Holding time exceeded before sample received
5	Samples exceeded holding time before presevation was performed
§	Sampled on date not provided
•	Sample holding time exceeded in laboratory
@	Sample holding time exceeded due to sampled on date
&	Sample Holding Time exceeded - Late arrival of instructions.

Asbestos

Identification of Asbestos in Bulk Materials & Soils

The results for identification of asbestos in bulk materials are obtained from supplied bulk materials which have been examined to determine the presence of asbestos fibres using Alcontrol Laboratories (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

The results for identification of asbestos in soils are obtained from a homogenised sub sample which has been examined to determine the presence of asbestos fibres using Alcontrol Laboratories (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

Asbestos Type	Common Name
Chrysotile	White Asbestos
Amosite	Brown Asbestos
Crocidolite	Blue Asbestos
Fibrous Actinolite	-
Fibrous Anthophyllite	-
Fibrous Tremolite	-

Visual Estimation Of Fibre Content

Estimation of fibre content is not permitted as part of our UKAS accredited test other than:
- Trace - Where only one or two asbestos fibres were identified.

Further guidance on typical asbestos fibre content of manufactured products can be found in HSG 264.

The identification of asbestos containing materials and soils falls within our schedule of tests for which we hold UKAS accreditation, however opinions, interpretations and all other information contained in the report are outside the scope of UKAS accreditation.

Unit 7-8 Hawarden Business Park
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Deeside
CH5 3US
Tel: (01244) 528700
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Website: www.alcontrol.com

Amara Mining Cote d'Ivore Ltd
4th Floor
29-30 Cornhill
London
EC3V 3NF

Attention: Katy Hebditch

CERTIFICATE OF ANALYSIS

Date:	27 February 2015
Customer:	H_AMARA_COR
Sample Delivery Group (SDG):	150218-12
Your Reference:	
Location:	Amara Elemental Analysis
Report No:	303624

We received 6 samples on Tuesday February 17, 2015 and 6 of these samples were scheduled for analysis which was completed on Friday February 27, 2015. Accredited laboratory tests are defined within the report, but opinions, interpretations and on-site data expressed herein are outside the scope of ISO 17025 accreditation.

Should this report require incorporation into client reports, it must be used in its entirety and not simply with the data sections alone.

All chemical testing (unless subcontracted) is performed at ALcontrol Hawarden Laboratories.

Approved By:

Sonia McWhan
Operations Manager

UKAS TESTING 1291

SDG:	150218-12	**Location:**	Amara Elemental Analysis	**Order Number:**	CD1-017
Job:	H_AMARA_COR-1	**Customer:**	Amara Mining Cote d'Ivore Ltd	**Report Number:**	303624
Client Reference:		**Attention:**	Katy Hebditch	**Superseded Report:**	

Received Sample Overview

Lab Sample No(s)	Customer Sample Ref.	AGS Ref.	Depth (m)	Sampled Date
10853519	1006			12/02/2015
10853520	1007			12/02/2015
10853521	1008			12/02/2015
10853522	1009			12/02/2015
10853523	1010			12/02/2015
10853524	1011			12/02/2015

Only received samples which have had analysis scheduled will be shown on the following pages.

CERTIFICATE OF ANALYSIS

SDG:	150218-12	**Location:**	Amara Elemental Analysis	**Order Number:**	CD1-017
Job:	H_AMARA_COR-1	**Customer:**	Amara Mining Cote d'Ivore Ltd	**Report Number:**	303624
Client Reference:		**Attention:**	Katy Hebditch	**Superseded Report:**	

LIQUID

Results Legend

- X — **Test**
- N — **No Determination Possible**

Lab Sample No(s)			10853519		10853520		10853521		10853522		10853523		10853524	
Customer Sample Reference			1006		1007		1008		1009		1010		1011	
AGS Reference														
Depth (m)														
Container			0.5l glass bottle (AL	Dissolved Metals Pr	0.5l glass bottle (AL	Dissolved Metals Pr	0.5l glass bottle (AL	Dissolved Metals Pr	0.5l glass bottle (AL	Dissolved Metals Pr	0.5l glass bottle (AL	Dissolved Metals Pr	0.5l glass bottle (AL	Dissolved Metals Pr
Anions by Kone (w)	All	NDPs: 0 Tests: 6	X		X		X		X		X		X	
Dissolved Metals by ICP-MS	All	NDPs: 0 Tests: 6	X		X		X		X		X		X	
Dissolved W, Nb and Zr by ICP-MS	All	NDPs: 0 Tests: 6	X		X		X		X		X		X	
Fluoride	All	NDPs: 0 Tests: 6	X		X		X		X		X		X	
Mercury Dissolved	All	NDPs: 0 Tests: 6		X		X		X		X		X		X
Metals by iCap-OES Dissolved (W)	All	NDPs: 0 Tests: 6	X		X		X		X		X		X	

ALcontrol Laboratories

Validated

CERTIFICATE OF ANALYSIS

SDG:	150218-12	**Location:**	Amara Elemental Analysis	**Order Number:**	CD1-017
Job:	H_AMARA_COR-1	**Customer:**	Amara Mining Cote d'lvore Ltd	**Report Number:**	303624
Client Reference:		**Attention:**	Katy Hebditch	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted test.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-5&♦§@	Sample deviation (see appendix)

Component	LOD/Units	Method	1006	1007	1008	1009	1010	1011
Customer Sample R			1006	1007	1008	1009	1010	1011
Depth (m)			.	.	.	.	.	.
Sample Type			Water(GW/SW)	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)
Date Sampled			12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015
Sample Time			.	.	.	.	.	.
Date Received			17/02/2015	17/02/2015	17/02/2015	17/02/2015	17/02/2015	17/02/2015
SDG Ref			150218-12	150218-12	150218-12	150218-12	150218-12	150218-12
Lab Sample No.(s)			10853519	10853520	10853521	10853522	10853523	10853524
AGS Reference								
Fluoride	<0.5 mg/l	TM104	<0.5 #	<0.5 #	<0.5 #	<0.5 #	<0.5 #	<0.5 #
Aluminium (diss.filt)	<2.9 µg/l	TM152	171 #	29.7 #	286 #	358 #	288 #	188 #
Antimony (diss.filt)	<0.16 µg/l	TM152	0.72	0.659	0.555	0.524	1.35	1.78
Arsenic (diss.filt)	<0.12 µg/l	TM152	14.7 #	1.87 #	0.725 #	0.828 #	0.792 #	1.74 #
Barium (diss.filt)	<0.03 µg/l	TM152	0.449 #	1.38 #	93.5 #	86.7 #	5.48 #	4.56 #
Beryllium (diss.filt)	<0.07 µg/l	TM152	<0.07 #	<0.07 #	<0.07 #	<0.07 #	<0.07 #	<0.07 #
Boron (diss.filt)	<9.4 µg/l	TM152	<9.4 #	<9.4 #	<9.4 #	<9.4 #	<9.4 #	<9.4 #
Cadmium (diss.filt)	<0.1 µg/l	TM152	<0.1 #	<0.1 #	<0.1 #	<0.1 #	<0.1 #	<0.1 #
Chromium (diss.filt)	<0.22 µg/l	TM152	9.09 #	7.99 #	8.5 #	8.64 #	8.23 #	8.77 #
Cobalt (diss.filt)	<0.06 µg/l	TM152	1.31 #	0.101 #	0.356 #	0.251 #	0.143 #	0.098 #
Copper (diss.filt)	<0.85 µg/l	TM152	1.04 #	<0.85 #	<0.85 #	<0.85 #	<0.85 #	<0.85 #
Lead (diss.filt)	<0.02 µg/l	TM152	0.115 #	<0.02 #	<0.02 #	<0.02 #	0.051 #	<0.02 #
Manganese (diss.filt)	<0.04 µg/l	TM152	3.23 #	2.16 #	3.93 #	3.99 #	5.23 #	5.13 #
Molybdenum (diss.filt)	<0.24 µg/l	TM152	6.27 #	1.51 #	2.03 #	3.22 #	1.41 #	1.1 #
Nickel (diss.filt)	<0.15 µg/l	TM152	4.02 #	0.161 #	0.399 #	0.351 #	0.319 #	0.307 #
Phosphorus (diss.filt)	<6.3 µg/l	TM152	138 #	<6.3 #	<6.3 #	<6.3 #	8.61 #	<6.3 #
Selenium (diss.filt)	<0.39 µg/l	TM152	0.667 #	1.66 #	0.934 #	1.1 #	1.39 #	1.64 #
Strontium (diss.filt)	<0.05 µg/l	TM152	3.76 #	25.5 #	110 #	428 #	48.8 #	58.9 #
Tellurium (diss.filt)	<2 µg/l	TM152	<2	<2	<2	<2	<2	<2
Thallium (diss.filt)	<0.96 µg/l	TM152	<0.96	<0.96	<0.96	<0.96	<0.96	<0.96
Tin (diss.filt)	<0.36 µg/l	TM152	<0.36 #	<0.36 #	<0.36 #	<0.36 #	<0.36 #	<0.36 #
Uranium (diss.filt)	<1.5 µg/l	TM152	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5
Titanium (diss.filt)	<1.5 µg/l	TM152	8.02 #	<1.5 #	<1.5 #	<1.5 #	2.88 #	<1.5 #
Vanadium (diss.filt)	<0.24 µg/l	TM152	26.2 #	3.37 #	0.939 #	1.11 #	0.757 #	0.488 #
Zinc (diss.filt)	<0.41 µg/l	TM152	0.602 #	0.5 #	<0.41 #	0.423 #	6.73 #	0.523 #
Mercury (diss.filt)	<0.01 µg/l	TM183	<0.01 #	<0.01 #	<0.01 #	<0.01 #	<0.01 #	<0.01 #
Sulphate	<2 mg/l	TM184	<2 #	<2 #	<2 #	<2 #	<2 #	<2 #
Chloride	<2 mg/l	TM184	<2 #	<2 #	<2 #	<2 #	<2 #	<2 #
Nitrate as NO3	<0.3 mg/l	TM184	0.411 @ #	<0.3 @ #	<0.3 @ #	<0.3 @ #	0.58 @ #	0.467 @ #
Calcium (diss.filt)	<0.012 mg/l	TM228	1.4 #	11.4 #	12.8 #	13.1 #	14.2 #	15.7 #
Sodium (diss.filt)	<0.076 mg/l	TM228	26.8 #	7.76 #	3.48 #	2.66 #	2.15 #	1.46 #
Magnesium (diss.filt)	<0.036 mg/l	TM228	0.268 #	2.76 #	4.8 #	4.77 #	2.97 #	2.23 #

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ALcontrol Laboratories

CERTIFICATE OF ANALYSIS

Validated

SDG:	150218-12	**Location:**	Amara Elemental Analysis	**Order Number:**	CD1-017
Job:	H_AMARA_COR-1	**Customer:**	Amara Mining Cote d'Ivore Ltd	**Report Number:**	303624
Client Reference:		**Attention:**	Katy Hebditch	**Superseded Report:**	

Results Legend
- # ISO17025 accredited.
- M *m*CERTS accredited.
- aq Aqueous / settled sample.
- diss.filt Dissolved / filtered sample.
- tot.unfilt Total / unfiltered sample.
- * Subcontracted test.
- ** % recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
- (F) Trigger breach confirmed
- 1-5&+§@ Sample deviation (see appendix)

		Customer Sample R	1006	1007	1008	1009	1010	1011
		Depth (m)	.	.	.	.	.	.
		Sample Type	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)	Water(GW/SW)
		Date Sampled	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015	12/02/2015
		Sample Time	.	.	.	.	.	.
		Date Received	17/02/2015	17/02/2015	17/02/2015	17/02/2015	17/02/2015	17/02/2015
		SDG Ref	150218-12	150218-12	150218-12	150218-12	150218-12	150218-12
		Lab Sample No.(s)	10853519	10853520	10853521	10853522	10853523	10853524
		AGS Reference						
Component	**LOD/Units**	**Method**						
Potassium (diss.filt)	<1 mg/l	TM228	<1 #	1.47 #	2.95 #	2.89 #	2.7 #	4.16 #
Iron (diss.filt)	<0.019 mg/l	TM228	0.427 #	<0.019 #	<0.019 #	<0.19 #	<0.019 #	<0.019 #
Silver (diss.filt)	<1.5 µg/l	TM283	<1.5	<1.5	<1.5	<1.5	<1.5	<1.5

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SDG:	150218-12	**Location:**	Amara Elemental Analysis	**Order Number:**	CD1-017
Job:	H_AMARA_COR-1	**Customer:**	Amara Mining Cote d'Ivore Ltd	**Report Number:**	303624
Client Reference:		**Attention:**	Katy Hebditch	**Superseded Report:**	

Table of Results - Appendix

Method No	Reference	Description	Wet/Dry Sample [1]	Surrogate Corrected
TM104	Method 4500F, AWWA/APHA, 20th Ed., 1999	Determination of Fluoride using the Kone Analyser		
TM152	Method 3125B, AWWA/APHA, 20th Ed., 1999	Analysis of Aqueous Samples by ICP-MS		
TM183	BS EN 23506:2002, (BS 6068-2.74:2002) ISBN 0 580 38924 3	Determination of Trace Level Mercury in Waters and Leachates by PSA Cold Vapour Atomic Fluorescence Spectrometry		
TM184	EPA Methods 325.1 & 325.2,	The Determination of Anions in Aqueous Matrices using the Kone Spectrophotometric Analysers		
TM228	US EPA Method 6010B	Determination of Major Cations in Water by iCap 6500 Duo ICP-OES		
TM283		Determination of Dissolved Niobium, Tungsten, and Zirconium in Water Matrices by ICP-MS		

[1] Applies to Solid samples only. DRY indicates samples have been dried at 35°C. NA = not applicable.

SDG:	150218-12	**Location:**	Amara Elemental Analysis	**Order Number:**	CD1-017
Job:	H_AMARA_COR-1	**Customer:**	Amara Mining Cote d'Ivore Ltd	**Report Number:**	303624
Client Reference:		**Attention:**	Katy Hebditch	**Superseded Report:**	

Test Completion Dates

Lab Sample No(s)	10853519	10853520	10853521	10853522	10853523	10853524
Customer Sample Ref.	1006	1007	1008	1009	1010	1011
AGS Ref.						
Depth						
Type	LIQUID	LIQUID	LIQUID	LIQUID	LIQUID	LIQUID
Anions by Kone (w)	25-Feb-2015	25-Feb-2015	25-Feb-2015	25-Feb-2015	26-Feb-2015	25-Feb-2015
Dissolved Metals by ICP-MS	26-Feb-2015	26-Feb-2015	26-Feb-2015	26-Feb-2015	26-Feb-2015	26-Feb-2015
Dissolved W, Nb and Zr by ICP-MS	27-Feb-2015	27-Feb-2015	27-Feb-2015	27-Feb-2015	27-Feb-2015	27-Feb-2015
Fluoride	25-Feb-2015	25-Feb-2015	25-Feb-2015	25-Feb-2015	25-Feb-2015	25-Feb-2015
Mercury Dissolved	26-Feb-2015	26-Feb-2015	26-Feb-2015	26-Feb-2015	26-Feb-2015	26-Feb-2015
Metals by iCap-OES Dissolved (W)	25-Feb-2015	25-Feb-2015	25-Feb-2015	25-Feb-2015	25-Feb-2015	25-Feb-2015
Nitrite by Kone (w)	23-Feb-2015	23-Feb-2015	23-Feb-2015	23-Feb-2015	25-Feb-2015	23-Feb-2015

Appendix

General

1. Results are expressed on a dry weight basis (dried at 35ºC) for all soil analyses except for the following: NRA and CEN Leach tests, flash point LOI, pH, ammonium as NH4 by the BRE method, VOC TICS and SVOC TICS.

2. Samples will be run in duplicate upon request, but an additional charge may be incurred.

3. If sufficient sample is received a sub sample will be retained free of charge for 30 days after analysis is completed (e-mailed) for all sample types unless the sample is destroyed on testing. The prepared soil sub sample that is analysed for asbestos will be retained for a period of 6 months after the analysis date. All bulk samples will be retained for a period of 6 months after the analysis date. All samples received and not scheduled will be disposed of one month after the date of receipt unless we are instructed to the contrary. Once the initial period has expired, a storage charge will be applied for each month or part thereof until the client cancels the request for sample storage. ALcontrol Laboratories reserve the right to charge for samples received and stored but not analysed.

4. With respect to turnaround, we will always endeavour to meet client requirements wherever possible, but turnaround times cannot be absolutely guaranteed due to so many variables beyond our control.

5. We take responsibility for any test performed by sub-contractors (marked with an asterisk). We endeavour to use UKAS/MCERTS Accredited Laboratories, who either complete a quality questionnaire or are audited by ourselves. For some determinands there are no UKAS/MCERTS Accredited Laboratories, in this instance a laboratory with a known track record will be utilised.

6. When requested, the individual sub sample scheduled will be analysed in house for the presence of asbestos fibres and asbestos containing material by our documented in house method TM048 based on HSG 248 (2005), which is accredited to ISO17025. If a specific asbestos fibre type is not found this will be reported as "Not detected". If no asbestos fibre types are found all will be reported as "Not detected" and the sub sample analysed deemed to be clear of asbestos. If an asbestos fibre type is found it will be reported as detected (for each fibre type found). Testing can be carried out on asbestos positive samples, but, due to Health and Safety considerations, may be replaced by alternative tests or reported as No Determination Possible. The quantity of asbestos present is not determined unless specifically requested.

7. If no separate volatile sample is supplied by the client, or if a headspace or sediment is present in the volatile sample, the integrity of the data may be compromised. This will be flagged up as an invalid VOC on the test schedule and the result marked as deviating on the test certificate.

8. If appropriate preserved bottles are not received preservation will take place on receipt. However, the integrity of the data may be compromised.

9. NDP -No determination possible due to insufficient/unsuitable sample.

10. Metals in water are performed on a filtered sample, and therefore represent dissolved metals -total metals must be requested separately.

11. Results relate only to the items tested.

12. LODs for wet tests reported on a dry weight basis are not corrected for moisture content.

13. **Surrogate recoveries** -Most of our organic methods include surrogates, the recovery of which is monitored and reported. For EPH, MO, PAH, GRO and VOCs on soils the result is not surrogate corrected, but a percentage recovery is quoted. Acceptable limits for most organic methods are 70 -130 %.

14. **Product analyses** -Organic analyses on products can only be semi-quantitative due to the matrix effects and high dilution factors
employed.

15. Phenols monohydric by HPLC include phenol, cresols (2-Methylphenol, 3-Methylphenol and 4-Methylphenol) and Xylenols (2,3 Dimethylphenol, 2,4 Dimethylphenol, 2,5 Dimethylphenol, 2,6 Dimethylphenol, 3,4 Dimethyphenol, 3,5 Dimethylphenol).

16. Total of 5 speciated phenols by HPLC includes Phenol, 2,3,5-Trimethyl Phenol, 2-Isopropylphenol, Cresols and Xylenols (as detailed in 15).

17. Stones/debris are not routinely removed. We always endeavour to take a representative sub sample from the received sample.

18. In certain circumstances the method detection limit may be elevated due to the sample being outside the calibration range. Other factors that may contribute to this include possible interferences. In both cases the sample would be diluted which would cause the method detection limit to be raised.

19. Mercury results quoted on soils will not include volatile mercury as the analysis is performed on a dried and crushed sample.

20. For the BSEN 12457-3 two batch process to allow the cumulative release to be calculated, the volume of the leachate produced is measured and filtered for all tests. We therefore cannot carry out any unfiltered analysis. The tests affected include volatiles GCFID/GCMS and all subcontracted analysis.

21. For all leachate preparations (NRA, DIN, TCLP, BSEN 12457-1, 2, 3) volatile loss may occur, as we do not employ zero headspace extraction.

22. We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials - whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample. Other coarse granular material such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

23. Analysis and identification of specific compounds using GCFID is by retention time only, and we routinely calibrate and quantify for benzene, toluene, ethylbenzenes and xylenes (BTEX). For total volatiles in the C5-C12 range, the total area of the chromatogram is integrated and expressed as ug/kg or ug/l. Although this analysis is commonly used for the quantification of gasoline range organics (GRO), the system will also detect other compounds such as chlorinated solvents, and this may lead to a falsely high result with respect to hydrocarbons only. It is not possible to specifically identify these non-hydrocarbons, as standards are not routinely run for any other compounds, and for more definitive identification, volatiles by GCMS should be utilised.

Sample Deviations

1	Container with Headspace provided for volatiles analysis
2	Incorrect container received
3	Deviation from method
4	Holding time exceeded before sample received
5	Samples exceeded holding time before presevation was performed
§	Sampled on date not provided
•	Sample holding time exceeded in laboratory
@	Sample holding time exceeded due to sampled on date
&	Sample Holding Time exceeded - Late arrival of instructions.

Asbestos

Identification of Asbestos in Bulk Materials & Soils

The results for identification of asbestos in bulk materials are obtained from supplied bulk materials which have been examined to determine the presence of asbestos fibres using Alcontrol Laboratories (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

The results for identification of asbestos in soils are obtained from a homogenised sub sample which has been examined to determine the presence of asbestos fibres using Alcontrol Laboratories (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

Asbestos Type	Common Name
Chrysotile	White Asbestos
Amosite	Brown Asbestos
Crocidolite	Blue Asbestos
Fibrous Actinolite	-
Fibrous Anthophyllite	-
Fibrous Tremolite	-

Visual Estimation Of Fibre Content

Estimation of fibre content is not permitted as part of our UKAS accredited test other than:
- Trace - Where only one or two asbestos fibres were identified.

Further guidance on typical asbestos fibre content of manufactured products can be found in HSG 264.

The identification of asbestos containing materials and soils falls within our schedule of tests for which we hold UKAS accreditation, however opinions, interpretations and all other information contained in the report are outside the scope of UKAS accreditation.