MEMORANDUM

Date: 24/07/13

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TITLE: Geochemical Review – implications for management and environmental impact assessment for mining waste.

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1. INTRODUCTION

ABM Resources have made an application for a mineral lease to cover the Old Pirate deposit and smaller surrounding and associated deposits including Golden Hind and Old Glory. These deposits are collectively referred to as Old Pirate and Surrounds. The tenement application is referred to as Twin Bonanza and also contains the Buccaneer deposit. Buccaneer has been included for the purposes of accessing clay material for the processing and waste management at the Old Pirate Plant.

This memo focuses on the characterisation of waste as a direct result of mining the Old Pirate and surrounds; primarily excavated hard rock waste, not processing tailings. The characterisation of the tailings produced during operations is the focus of another memo.

1.2 BACKGROUND

Old Pirate and surrounds is located around 37 km to the south of the Tanami Road and around 17 km east of the Western Australian border (Figure 1).

The proposed stage 3 plan, with block models of ore, siltstone, sandstone, intercalated sandstones and siltstones, and intrusives, is outlined in Figures 2 and 3.

The object of this report is to evaluate whether the waste material, after excavation, will pose a threat to the environment as a result of acid mine and metalliferous drainage, to establish the most appropriate form of containment for the waste materials and design parameters for the waste dump construction.

Historical sampling has been undertaken by Normandy NFM, Newmont and ABM Resources; this report primarily focuses on ABM data and testing which is more current, however extensive petrological programmes undertaken by Normandy NFM / Newmont are also included.

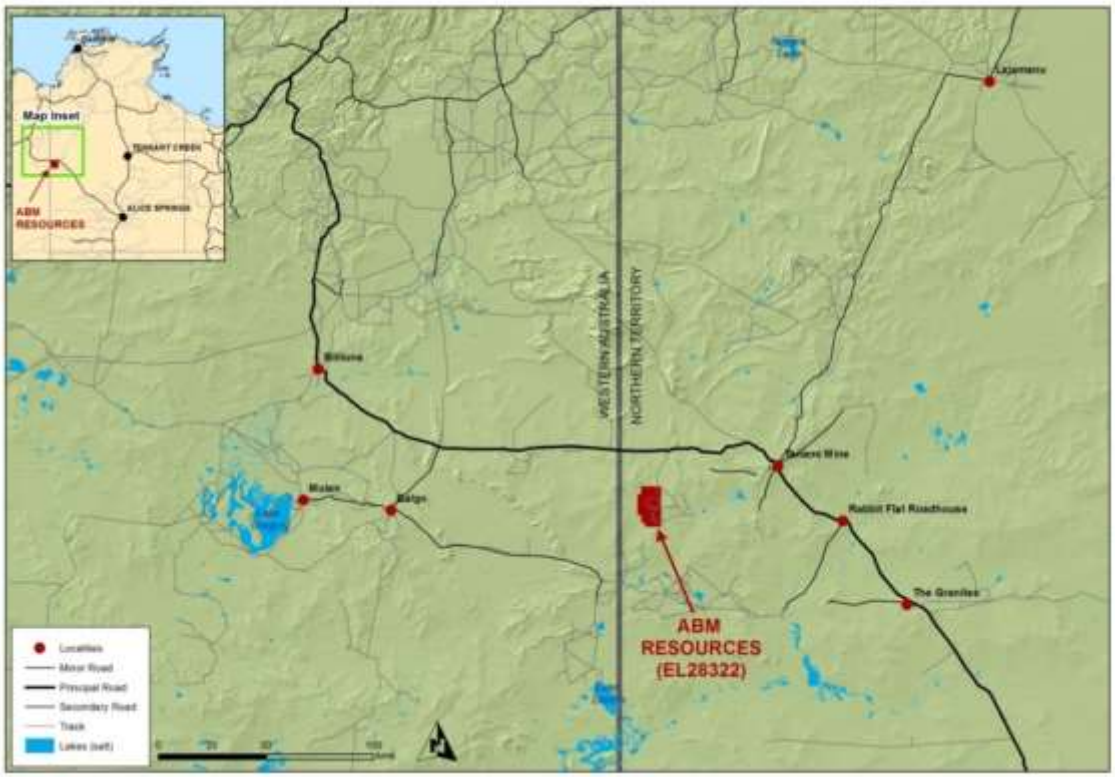

Figure 1. Twin Bonanza Locality Map

At the Old Pirate deposit there are 5 key geological units that will be disturbed by mining - quartz veins (representing the ore), sandstones, siltstones, intercalated sediments and diorite (the last 4 units characterised as waste). In addition to geological logging, analytical data aiding the characterisation of these units includes:

1. Multielement data
2. Petrography
3. X-ray diffraction (XRD)
4. X-Ray Fluorescence (XRF)
5. Acid Base Accounting (ABA)
6. Leachate quality – Water quality

ABA was used to determine the potential for Acid and metalliferous drainage (AMD) that can be expressed by:

1. The potential of materials to generate acidity following sulfide oxidation
2. Mobilisation of trace metals in response to acidic and neutral solutions that may leach from the materials contained in the tailings dam dump and waste rock dump (WRD) storage facilities.

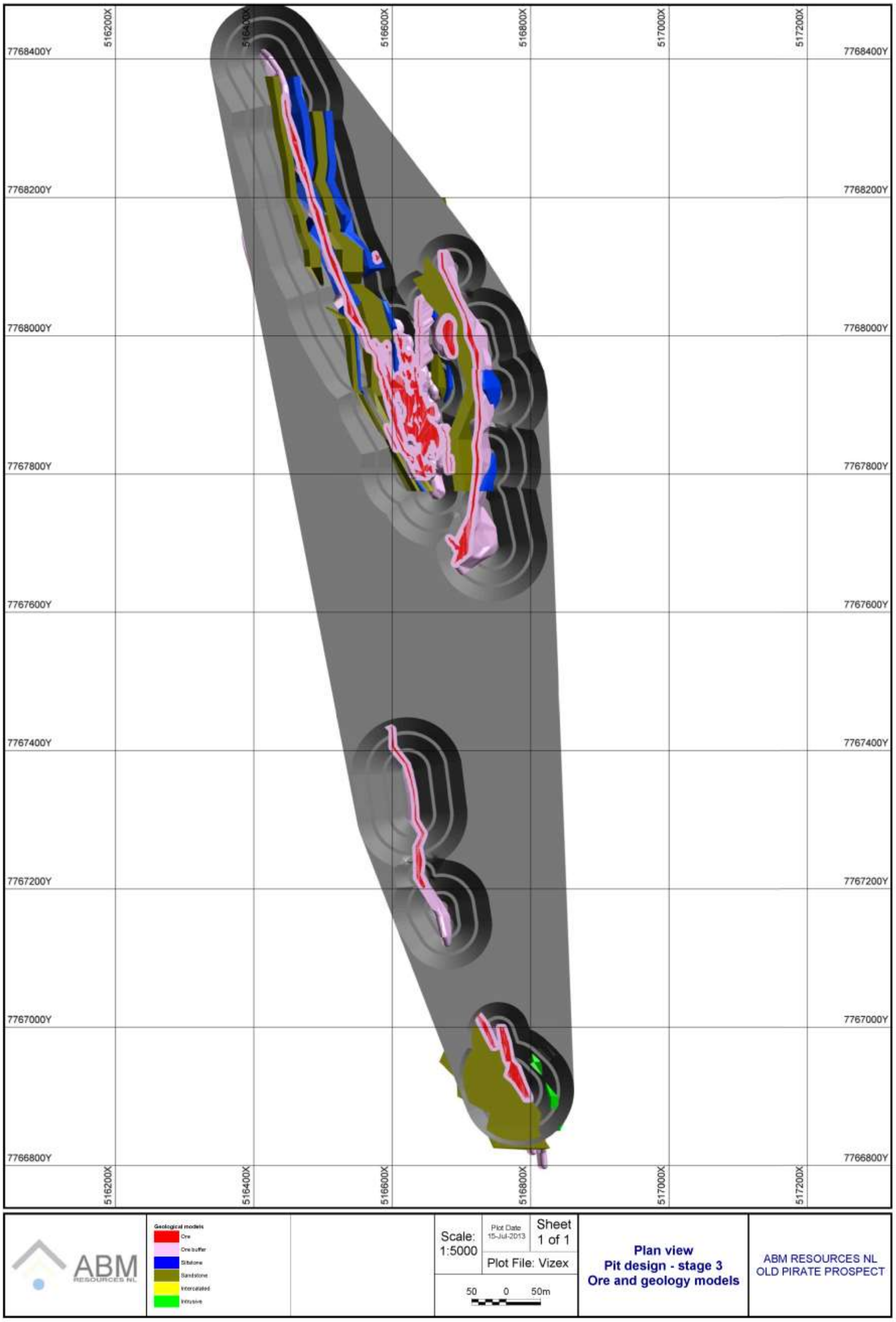

Figure 2. Plan view of proposed stage 3 with block models of ore (red), siltstone (pale yellow), sandstone (dark yellow), Intrusives (green); all areas within the pit that do not have a block model applied are assumed to be intercalated, based on geological interpretations (sandstones and siltstones with minor intrusives).

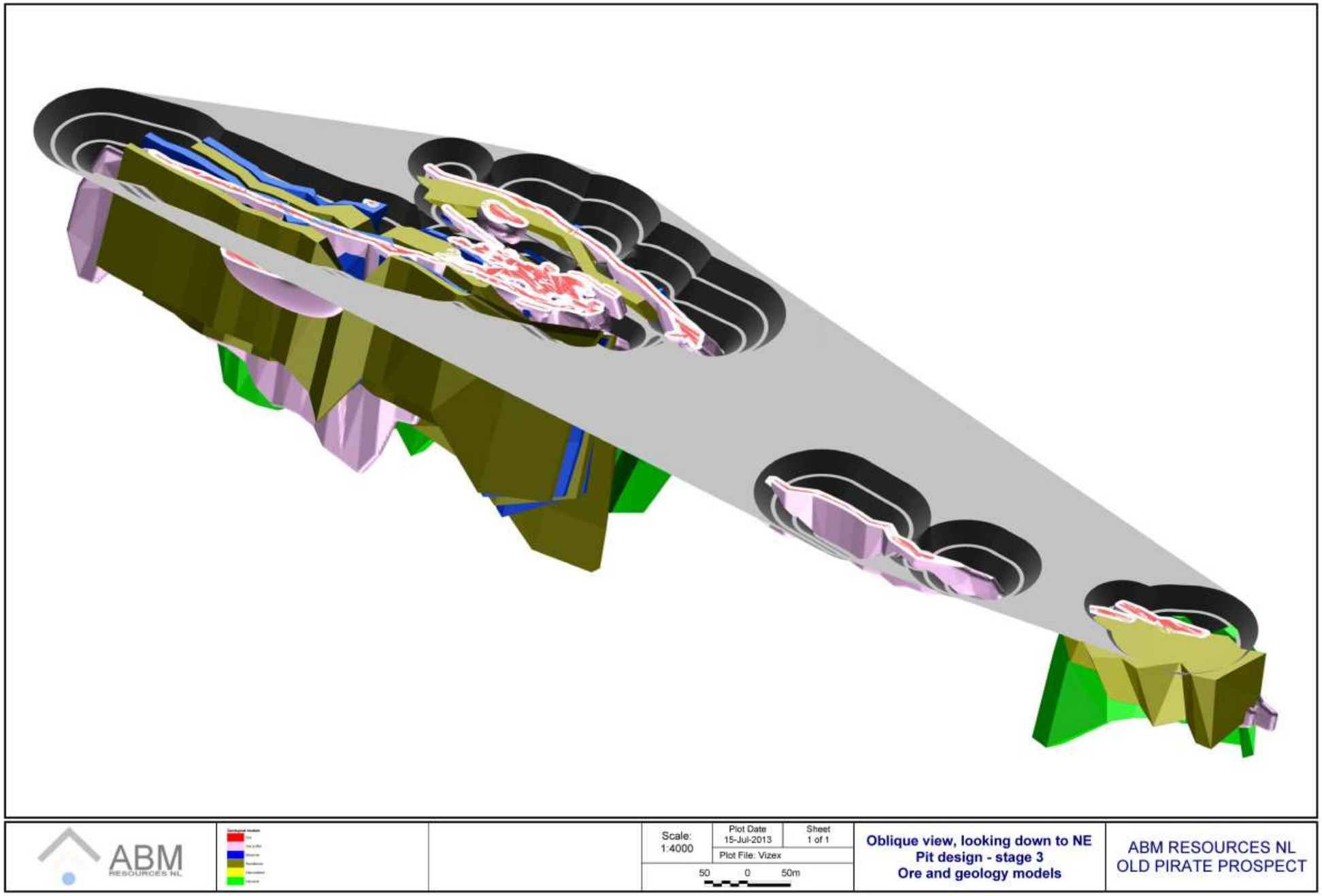

Figure 3. Oblique view of Proposed stage 3 with block models of ore (red), siltstone (pale yellow), sandstone (dark yellow), Intrusives (green); all areas within the pit that do not have a block model applied are assumed to be intercalated, based on geological interpretations (sandstones and siltstones with minor intrusives).

1.3 WASTE ROCK TYPES & CHARACTERISATION

Metamorphosed sedimentary rocks are host to the mineralisation in the Old pirate area. The grade of metamorphism varies within the greater prospect area such that primary and sedimentary textures are better preserved in some areas relative to others. The sedimentary rocks are interpreted to comprise lithic quartz and quartz lithic feldspathic arenite and related siltstone, silty mudstones and mudstones. Detrital muscovite, tourmaline, rutile and zircon are present. The more voluminous lithic quartz represents the ore material for the proposed pits.

Table 1 outlines the 5 key rock units within the proposed pit shell, including ore. The table highlights the indicative volumes for each respective waste rock and ore component. Each of the 5 units have been further divided based on weathering characteristics and are grouped into 3 main categories; oxidised, transition and fresh (Table 2). Ore and fresh rock are included in this study to provide context. In-depth characterisation of the tailings and management recommendations as a result of extraction and processing of ore are the focus of another memo.

Table 1. Rock units within the proposed pit shell; indicative volumes, tonnage and specific gravity.

UNIT TYPE	UNIT_NAME	VOLUME (m^3)	TONNAGE	SG	WASTE TYPE
Ore	Quartz Veins - Ore	195,700	518,500	2.65	Tailings
Waste rock	Sandstone	773,200	1,951,500	2.50	Waste dump
	Siltstone	169,300	428,300	2.50	Waste dump
	Diorite	1,900	4,800	2.61	Waste dump
	Intercalated sandstones & siltstones	2,111,500	5,317,800	2.50	Waste dump
	Intercalated Anomalous Arsenic	1,277,900	3,228,100	2.50	Waste dump
Pit (total)	**Stage 3**	**4,529,500**	**11,449,000**	**2.54**	

Table 2. Rock units within the proposed pit shells, broken into units for characterisation.

UNIT TYPE	UNIT_NAME	PHASE	Volume (m^3)
Ore	Quartz veins - ore	OXIDISED	144,400
		TRANSITION	51,300
		FRESH - outside pit	225,500
Waste rock	Sandstone	OXIDISED	588,300
		TRANSITION	185,000
		FRESH - outside pit	2,921,600
	Siltstone	OXIDISED	116600
		TRANSITION	52700
	Intercalated sandstones & siltstones	OXIDISED	1,721,100
		TRANSITION	390,500
		FRESH - outside pit	6,351,300
	Intercalated Anomalous Arsenic	OXIDISED	943,200
		TRANSITION	334,700
	Diorite	OXIDISED	1,900
		FRESH - outside pit	2,707,000

The fresh phases for sandstone and intercalated units have been included despite being outside the presently proposed pit boundaries. Extensive work has been completed on petrography, leachate analysis, XRD, XRF and mineralogical characterisation for the deeper fresh rock components of the system with the aim of expanding the pits in the future upon further approvals. The fresh rock characterisations will provide additional information on the nature of other components in the deposit.

This memo incorporates previous analysis by Pendragon, as detailed in the appendices, and additional samples analysed by ALS Group, Environmental Division, using the same techniques as the Pendragon report. ALS Environmental laboratories are ISO 17025 (NATA) accredited.

1.3.1 ORE

The ore material hosts the bulk of mineralisation and is described in a separate memo.

1.3.2 SANDSTONE

The sandstone can be classified as a predominately metamorphosed quartz felspathic arenite, with limited veining, with predominately trace (<5% as logged) amounts of pyrite and arsenopyrite sulphide minerals. These sulphides occur along vein selvedges and fracture surfaces with decreasing sulphides away from the ore body. The average gold grade for the sandstone is 0.035 ppm, characterising the unit as waste.

1.3.2.1 Oxidised

The oxidised sandstone unit has not been studied petrographically, however geological logging of diamond core and RC drilling chips characterises it as a metamorphosed quartz felspathic arenite, comprised of; quartz, muscovite, feldspar, biotite rutile, sericite/illite, kaolin clays and hematite. The matrix is non-carbonate and therefore

relatively resistant to weathering, however it is already significantly oxidised and in comparison to the transitional and fresh sandstone units is less stable for use in the construction of the waste rock dump.

Geological logging indicates that the unit's alteration is characterised by moderate goethite and hematite alteration; no ore minerals were observed in logging.

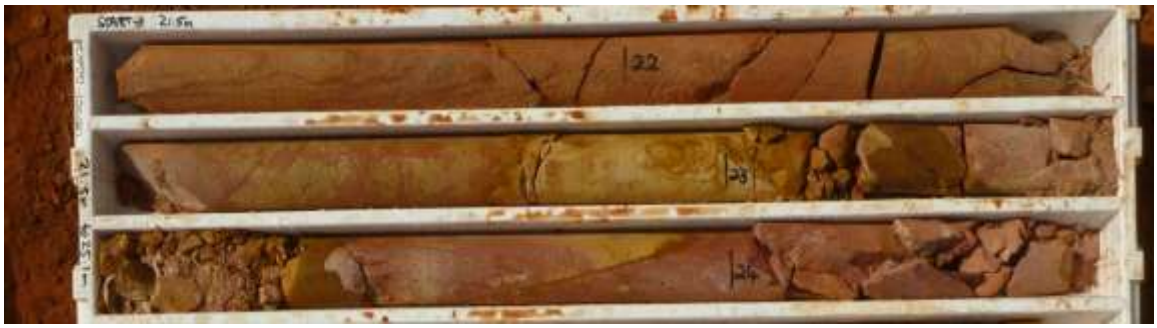

Figure 4. Typical Oxidised Sandstone samples from OPRC100001 (22-24m depth).

Geological logging is supported by XRD analysis undertaken by Pendragon Environmental Solutions. The oxide sandstone unit is characterised by Kaolinite (44.5% mass), quartz 41.5% mass and minor mica (9.5%) and trace goethite (3.5%; XRD by Pendragon Environmental Solutions). Particle sizes of samples observed during logging indicate that the majority of the oxidised sandstone unit ranges from coarse grained sand (phi 0 – 28.4%), fine grained sand (phi 2 -19.7%), medium grained sand (phi 1 – 17.6%) and very coarse sand (phi -1 – 18.6%). See Appendix B for a definition of the phi scale. Logging also recognises the presence of clay. The dominance of coarser sand grainsizes indicates that the sand unit is quite stable and more resistant to weathering.

1.3.2.2 Transition

The transition unit has a similar mineral assemblage to the oxidised sandstone. The matrix is non-carbonate and therefore relatively resistant to weathering, making this unit potentially ideal for the construction of the outer waste rock dump batters. Vein material, where present, is dominated by quartz, opaque minerals, feldspar, sericite/illite, and chlorite, and; in cavities, hematite. Minor silty mudstone can also be present.

Goethite and hematite alteration was more prevalent compared to the other rock units as well as a clay component. No ore minerals are observed in logging. The transition sands are dominated by fine-grained sand (phi 2- 36.2%), very fine clay (phi 9- 34.4%) and to a lesser extent medium grained sand (phi 1 – 18.9%). The observation of very fine clay confirms the volumetric change in the XRD results and indicates that there may be a significant portion of the clays already weathered out of the "oxidised" sands. The sandstone unit appears to have the highest percentage of sand grainsizes available and low clay concentrations in the matrix indicating that the unit will be far more resistant to weathering than the siltstones or intercalated units.

The transitional sandstone samples that were tested for Acid Base Accounting (refer to sections 2 and 3) were outside the pit boundaries, but local to classified samples within

the pit. The ABA results for the samples had similar characteristics to the oxidised sandstone to be mined.

Figure 5. Typical Transitional Sandstone samples from OPRC100011 (27-29m depth).

1.3.2.3 Fresh

The fresh sandstone unit contains carbonate inclusions in the minor quartz veins and it has been interpreted by Applied Petrological Services that the carbonate may have been part of the vein assemblage. The presence of such carbonate may provide an offset for acid formation and also appears to be in small enough quantities to not affect the structural integrity of the unit when weathered. The unit would be suitably stable for the construction of the outer waste dump batters, however is not present in sufficient volumes in the proposed pits.

Ore minerals identified in thin section include gold/electrum, sphalerite, galena, chalcopyrite, bismuth minerals, arsenopyrite, pyrite and pyrrhotite. However, on a pit scale, the most commonly identified ore minerals within the fresh sandstone unit are disseminated pyrite and arsenopyrite, and occasionally chalcopyrite, at concentrations much less than 20% and more commonly subjectively observed at less than 5%. These minerals occur within vein selvedges and on fracture surfaces and as such make up a small volume of the rock.

Weak goethite and moderate chlorite alteration was logged. Grain size distribution within the fresh sand units comprise the same proportions of medium grained sand and very fine clays, albeit slightly less percent mass than in the transition sand unit; however the fine-grained sand component (phi 2) is markedly increased to almost 50%. The sandstone unit appears to have the highest percentage of sand grainsizes indicating that the unit will be far more resistant to weathering than the siltstones or intercalated units.

No samples were tested for acid base accounting in the fresh sandstone unit (refer to sections 2 and 3).

Figure 6. Typical Fresh Sandstone samples from OPDD100003 (183.3-187.5m depth).

1.3.3 SILTSTONE

The siltstones can be classified as metamorphosed quartz felspathic siltstones related to the sandstone lithologies, with minor silty mudstone. There is limited veining, with little or no traces of ore minerals. The average gold grade for the siltstone is 0.035 ppm, characterising the unit as waste.

There were no petrographic, XRD and leachate analyses undertaken on the siltstone units within the pit boundaries (refer to sections 2 and 3); however analysis of samples within the units outside the pit boundaries have been described in the classification of the siltstone waste units. These samples outside of the pit boundaries are down strike of the unit in the pit, and are therefore still representative of the waste units in the pit.

1.3.3.1 Oxidised

Goethite and hematite alteration was weaker in the silts compared to the other rock units. No ore minerals were observed in logging. Clay content is markedly high within the oxidised siltstone unit, which was logged with 51.3% very fine clay and silt (phi 9 and 8 respectively); in addition fine-grained sand (phi 2) comprised an equal proportion at 49.3%. Sands coarser than phi 1 made up less than 8%. The siltstone is particularly susceptible to weathering with a very high clay content and very small particle size. It is unlikely that the siltstone units (oxidised and transitional) will be appropriate for the external batters of the waste rock dump. Visual observations of the weathered siltstone verify these findings stating that the unit is fissile and prone to erosion.

No samples were tested for acid base accounting (refer to sections 2 and 3) in the oxidised siltstone unit; refer to transition siltstone unit for ABA classification and characteristics of the unit.

Figure 7. Typical Oxidised Siltstone samples from OPDD100004 (10-12 depth).

1.3.3.2 Transition

The goethite and hematite alteration and lack of ore minerals was similar to the oxidised siltstone. Particle grainsize distributions show a dominance of fine-medium sands and silts, similar to the oxidised siltstone unit. Very fine clays and silts (phi 9 and 8) comprise 56.8% of the total samples. The siltstone is particularly susceptible to weathering with a very high clay content and very small particle size, which is similar to the oxidised siltstone making it unstable for waste rock outer batters.

The transitional sandstone samples that were tested for acid base accounting (refer to sections 2 and 3) were outside the pit boundaries but local to classified samples within the pit. Logging indicated that the samples were characteristic of the transition siltstone unit to be mined.

Figure 8. Typical Transitional Siltstone samples from OPDD100010 (11.2-14.1m depth).

2.1.3.3 Fresh

There are no fresh siltstone units in the current pit design.

1.3.4 INTERCALATED

The intercalated group can be defined as a unit of intercalated sandstones and siltstones (as described above) with minor dolerite intrusives and mineralised stringers; at depth the unit also contains diorite and porphyritic intrusives (fresh rock). The intercalated sediments exhibit predominately narrow stringer veins, and were logged with weak (<20%) amounts of pyrite, arsenopyrite, and oxidised sulphide ore minerals. The stringer veins are characteristically narrow and fine scale representing a small percentage volume of the entire rock unit. The average gold grade for the intercalated unit is higher than the others at 0.05 ppm; characterising the unit as waste. A maximum gold assay of 124 ppm was observed in the unit highlighting the fact that some of the smaller and isolated stringer veins are mineralised.

1.3.4.1 Oxidised

The intercalated oxidised unit is characterised as comprising intercalated metamorphosed quartz feldspathic sandstones and siltstones (i.e. a combination of the previously described sandstone and siltstone), with minor felsic intrusives. Petrography has only been completed on dolerite sills and diorites within the intercalated sediments. The silt/sand matrix is non-carbonate and therefore relatively resistant to weathering. The dolerites, where present, are classified as fine-grained dolerite intrusives with finely

dispersed pyrite and fine residual leucoxene and / or foliated, altered biotite, (chlorite) with medium grained plagioclase laths. The intrusive samples submitted for petrography are more carbonate rich and react moderately with the addition of hydrochloric acid. Minor silty mudstone can also be present.

Strong hematite alteration, along with moderate to weaker clay, goethite, kaolinite and limonite alteration, was observed in logging. Small zones characterised as iron alteration were only recorded in the oxidised phase of the intercalated unit. Mainly milky quartz veins (<50%) with lesser amounts of Bucky and Smoky veins were observed. The logging data is subjective and commonly arsenopyrite and pyrite logging corresponded to only 1m zones representing isolated and mineralised stringer zones within a more subdued bulk unit; these anomalous "stringer" zones have been separated into a seperate unit known as the Intercalated Anomalous Arsenic unit (described in 1.3.4.4 below).

Figure 9. Typical Oxidised Intercalated samples from OPDD100010 (49.77-50.05m depth).

XRD analyses indicate that the oxidised intercalated samples have a much smaller clay component and are dominated by 63 % quartz, 14.5 % kaolinite, 12.5 % goethite and 8% mica, by mass. Particle sizes observed during logging support this, with a combination of sands (dominated by fine-grained sands at 44.6 %; phi 2), silts and clays. The nature of the intercalated unit and proportion of highly erodible siltstone in the unit indicates that the transitional phase will be more susceptible to erosion over time and will not be suitable for the external batters of the waste dump.

1.3.4.2 Transition

The transition intercalated unit reported goethite and hematite alteration (XRD analysis). No ore minerals were logged, however, where observed in RC chips, the rest of the intercalated units are recorded as hosting less than 5% disseminated oxidised sulphides in very small localised zones. Milky quartz veins are present but occur predominantly at much less than 50% intensity across the unit.

The transition intercalated unit is similar to the sandstone units, characterised by kaolinite (54 %), quartz (21 %), minor mica (14 %) and weak goethite (9 %) by mass (XRD by Pendragon Environmental Solutions). Visually, clay dominates the particle distribution within the transition intercalated unit (47.5 %), with the remainder of the unit comprising of a combination of different sized sands. The high clay content and

proportion of highly erodible siltstone in the unit indicates that it will be more susceptible to erosion.

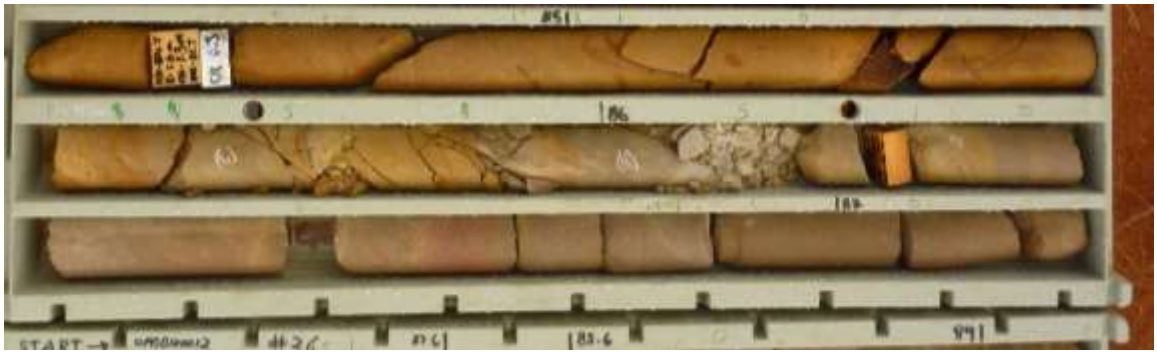

Figure 10. Typical Transitional Intercalated samples from OPDD100012 (86.7-87.6m depth).

1.3.4.3 Fresh

The most commonly identified ore minerals within the fresh intercalated unit are disseminated pyrite and arsenopyrite at contents of less than 20% in isolated veins and vein selvedges, representing only a small component of the entire unit; visible gold was observed once and no alteration was defined. The particle size distribution of the fresh intercalated unit is similar to the oxidised intercalated signature.

No samples were tested for acid base accounting in the fresh intercalated unit within the pit boundaries; however samples that were tested for acid base accounting were outside the pit boundaries, within the same unit and local to classified samples within the pit. These results are reported below. Geological logging confirmed the continuity of the unit containing the samples and the material to be mined.

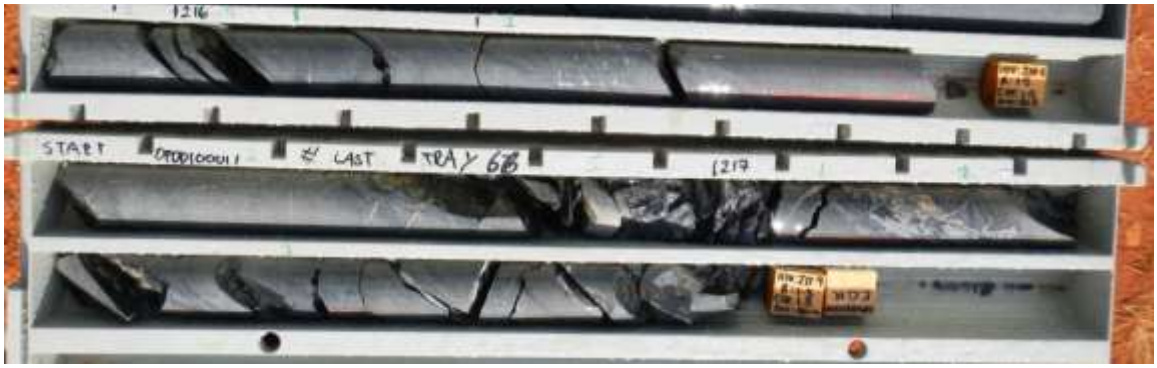

Figure 11. Typical Fresh Intercalated samples from OPDD100011 (216-217m depth).

1.3.4.4 Intercalated – Anomalous Arsenic

All samples within the intercalated anomalous arsenic unit, regardless of weathering phase, are in close proximity (within 5 metres) to the ore and anomalously identified zones and exhibit potential for AMD and significant As enrichment. For the purposes of this report these “anomalous” samples have been separated into a new unit, the intercalated anomalous arsenic unit, which includes the oxidised, transitional and fresh units of the sandstones, siltstones and intercalated units. This unit encompasses the stringer, shear zones and fracture planes that are mineralised but not captured within the ore model. They may represent low grade ore for the Old Pirate Deposit at some

stage in the future and report an average gold grade of 0.6 ppm with a maximum outlier of 411 ppm from drilling.

The intercalated anomalous arsenic unit is characterised as intercalated metamorphosed quartzo feldspathic sandstones and siltstones (of the other two waste rock units), with minor felsic intrusives, with mineralised quartz vein stringers that are anomalous in arsenic. The silt/sand matrix is non-carbonate and the clay-rich siltstone component increases the unit's susceptibility to weathering. Iron alteration is present and disseminated pyrite is visually logged at less than 20% along veins. One petrographic sample within the unit was described as "Metamorphosed quartz and carbonate veined sediment with interstitial pyrrhotite, carbonate, quartz, biotite and base metals sulphides were precipitated from a late CO2 rich and sulphurous aqueous fluid. The quartz and vein assemblage represent metamorphism of a precursor quartz + carbonate + sulphide assemblage. Sulphide veinlets link with CO2 fluid inclusion trails".

Mainly milky quartz veins (<50%) with lesser amounts of Bucky and Smoky veins were observed. The logging data is subjective and commonly arsenopyrite and pyrite (and to lesser extent chalcopyrite and oxidised sulphides) corresponded to 1m zones representing isolated and mineralised stringer zones within a more subdued bulk unit. The pyrite mineralisation has been associated closely with strong quartz veining when present. Shear zones, fracture planes and stringers also host elevated quantities of pyrite (moderate intensity >20% - ABM Geological logging) in isolated millimetre to centimetre scales. Even at depth the pyrite appears strongly oxidised especially along fracture planes and shears.

Alteration was predominately logged as strong to moderate hematite (oxide zone) with lesser concentrations of goethite, kaolinite and limonite.

The elevated arsenic of the intercalated unit and proportion of highly erodible siltstone in the unit indicates that the Intercalated Anomalous Arsenic unit will be more susceptible to erosion over time and will not be suitable for the external batters of the waste dump.

Figure 12. Typical Intercalated Anomalous Arsenic samples from OPDD100011 (208-208.7 and 209.24-210.47-217m depth).

1.3.5 DIORITE

The Diorite group is dominated by a biotite/amphibole quartz diorite with muscovite, biotite, pyrite, pyrrhotite, alkali feldspar, carbonate, and quartz. Diorite predominantly occurs outside the pit external batters and makes up a very small proportion of the pit volumes and therefore is outside the bounds of this memo; however the unit has been

included to encompass the environmental geochemical characterisation of the proposed mine.

1.3.5.1 Fresh

Petrography characterises the diorite as a *"metasomatically hydrothermally altered (biotite – Mg chlorite – carbonate -tr sericite/muscovite – dusted clays) and tectonised diorite intrusive containing trace sulphides (pyrite)".*

No samples were tested for acid base accounting in the fresh diorite unit (refer to sections 2 and 3); however the fresh rock unit is currently outside of pit boundaries.

2. METHODOLOGY

2.1 GEOCHEMICAL CHARACTERISATION

Geochemical characterisation of the materials (33 samples in total) was calculated by a combination of two techniques;

1. Acid Base Accounting (ABA)
2. Net acid generation (NAG)

Acid Base Accounting (ABA), is a measure of the Net Acid Producing Potential (NAPP) and is calculated from the independent determination of acid generating potential of a material and its buffering potential and is assessed by determining the pH of paste solutions; oxidation pH, Total-S and acid-neutralizing capacity (ANC). The Net Acid Generation (NAG) procedure generates a single value that can be used to indicate the likelihood of net acid generation occurring (INAP, 2009, AMIRA (2002)). The NAG test is used in association with ABA to the geochemical classification of a sample and results into one of the following categories:

- **Non-acid forming (NAF)** - Samples classified as NAF may have a significant acid generating potential but have adequate ANC within the samples to neutralise any acidity formed. A sample is classified as NAF when it has a negative NAPP and a final NAGpH $\leqslant$4.5. PAF samples in contrast, have significant sulfur content which exceeds the sample's inherent acid neutralising capacity.
- **Potentially acid forming (PAF**) - Samples with a PAF classification pose the risk that they will oxidise and generate acidic drainage when exposed to atmospheric conditions. A sample is generally defined as PAF when it has a positive NAPP and a final NAGpH <4.5.
- **Uncertain (UC)** - An uncertain classification is used when there is a conflict between the NAPP and NAG results (i.e. when the NAPP if positive and the NAGpH <4.5). Uncertain samples require more detailed investigation to determine the acid potential.

The results of ABA and NAG tests for each unit are discussed in Section 3- Rock Types.

Whilst ABA and NAG tests have limitations, both tests in combination increase the reliability of predicting acid generation in waste and ore materials (INAP, 2009). These tests have been widely used and are based on accepted methodologies for the geochemical characterisation of mine waste materials (after Pendragon, 2013: e.g., INAP, 2009; DITR, 2007; Alarcón León *et al.,* 2004; Scharer *et al.,* 2000; Rose and Cravotta, 1998; Morin and Hutt, 1997; Miller *et al*., 1997 and Sobek *et al.,* 1978).

2.2 APR CLASSIFICATION

The Acid Potential Ratio (APR) is used to classify the leachate samples potential to produce acidic drainage. Samples with APR's less than 1 should produce acid drainage, while ratios greater than 2 should produce net alkaline drainage. Those sites with ratios between 1 and 2 could generate acid, alkaline or neutral drainage.
The APR is calculated by the following equation:

APR = ANC / MPA

where ANC is the acid-neutralizing capacity of the sample and MPA is the Maximum Potential Acidity.

The MPA is calculated by multiplying the Sulfide-S values (in %) by 30.6. The multiplication factor of 30.6 accounts for the reaction stoichiometry for the complete oxidation of pyrrhotite and pyrite by O_2 to $Fe(OH)_3$ and H_2SO_4 (Lei and Watkins, 2005).

2.2 WATER QUALITY PREDICTION

Leach testing of the materials was undertaken as a component of the AMD analysis to determine the risk of metalliferous drainage occurring under neutral conditions. A total of 22 samples were leached with deionised water (DI) in accordance with Australian Standard Leaching Procedures (after Pendragon, 2013: ASLP INAP, 2009) and the leachates analysed for pH, EC, major ions (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, HCO_3^{-}, Cl^{-} and SO_4^{2-}) and trace metals (Al, As, Be, Cd, Cr, Co, Cu, F, Fe, Hg, Mn, Ni, Pb, Se, Sb and Zn). The same characterisation units defined in Section 1.3 – Waste Rock types, have been used.

2.3 ELEMENTAL ENRICHMENT (GAI)

X-Ray Diffraction (XRD) and X-Ray fluorescence (XRF) assays were also undertaken as a component of the characterisation process (after Pendragon, 2013). XRF data was used to analyse the geochemical abundance index (GAI, Förstner *et al*., 1993) which assesses the enrichment of the samples by major elements:

GAI = log[(Cn/(1.5*Bn)),2]

where Cn is the measured content of the nth element in the sample and Bn is the average-crustal abundance of the element.

Analysing enrichment employs:

GAI	Symbol	Relevance
0	AC	The content of the element is less than, or similar to, the average-crustal-abundance.
1	3F	A 3 - fold enrichment above the average-crustal-abundance.
2	6F	A 6 - fold enrichment above the average-crustal-abundance.
3	12F	A 12 - fold enrichment above the average-crustal-abundance.
4	24F	A 24 - fold enrichment above the average-crustal-abundance.
5	48F	A 48 - fold enrichment above the average-crustal-abundance.
>6	96F	A 96 - fold, or greater, enrichment above the average-crustal-abundance.

GAI analysis compares assayed values relative to their known crustal abundance and alert level is determined at 3, which is a 12 fold enrichment above the average-crustal abundance.

3. RESULTS

3.1 Sulfur and Neutralising Capacity (ANC)

The ore units (oxidised and transition) have intermediate concentrations of Carbonate (% $CaCO_3$) in relation to the other units; whereas the sand and intercalated oxidised units are higher in carbonate at an average of 0.4 % $CaCO_3$ (Table 3).

It appears that the majority of the ore material contains the mineralised quartz-carbonate veining, whereas the intercalated, siltstone and sandstone units contain the majority of the wall rock replacement assemblages which have higher $CaCO_3$ content.

Petrographic analysis suggests that a possible source of buffering could be the metamorphosed vein assemblages which comprise quartz, carbonate, biotite, chlorite, feldspar, muscovite and ore minerals. The carbonate veining is considered to be secondary to the early quartz veining. In addition some of the wall rock replacement assemblages (within most of the waste rock units) are dominated by quartz, muscovite, biotite, chlorite, carbonate, pyrrhotite and rutile.

No analysis was conducted for the following units; Sandstone fresh, Siltstone oxidised and Diorite.

Table 3. ABA/NAG Assessment, including ANC and APR (Acid Potential Ratio) results.

UNIT TYPE	PHASE	SampleID	Hole_ID	mFrom	mTo	ANC as kg H_2SO_4 /t	ANC as % CaCO3	Sulfide-S (%)	Final pH	ANC (kg H_2SO_4/t)	NAPP (kg H_2SO_4/t)	APR	APR_Classification	ABA Classification
SANDSTONE	Oxidised	X193356	GHRC100020	31	32	<0.5	<0.1	0.01	7.3	<0.5	-0.19	1.63	Acid/Alk/Neutral	NAF
		X196241	OPRC100158	6	7	7.1	0.7	<0.01	8.9	7.1	-6.79	22.9	Alkaline drainage	NAF
	Transition - outside pit boundaries	X181581	OPRC100089	47	48	2	0.2	0	8.1	2.3	-1.994	1.633987	Acid/Alk/Neutral	NAF
		X184764	OPRC100114	80	81	4	0.5	0	8.2	4.8	-4.494	1.633987	Acid/Alk/Neutral	NAF
		X184780	OPRC100114	96	97	2	0.2	0	8	2.5	-2.194	1.633987	Acid/Alk/Neutral	NAF
		X173929	OPRC100063	51	52	2	0.3	0	6.9	2.8	-2.494	1.633987	Acid/Alk/Neutral	NAF
		X183227	OPRC100099	49	50	3	0.3	**0.02**	7.6	3.3	-2.688	0.816993	Acid drainage	NAF
SILTSTONE	Transition - outside pit boundaries	X183253	OPRC100099	75	76	1	0.2	0	6.8	1.6	-1.294	1.633987	Acid/Alk/Neutral	NAF
INTERCALATED SANDSTONE AND SILSTONES	Oxidised	**X201983**	OPRC100197	0	1	0	0	**0.57**	7.5	0	16.94	0.03	**Acid drainage**	**UC**
		X201984	OPRC100197	1	2	1	0.1	0.06	8.1	1	0.84	0.54	Acid drainage	NAF
		X201985	OPRC100197	2	3	0	0	0.03	7.8	0	0.42	0.54	Acid drainage	NAF
		X201986	OPRC100197	3	4	7	0.7	0	8.1	7	-6.69	22.88	Alkaline drainage	NAF
		X201987	OPRC100197	4	5	3.6	0.4	0.04	8.5	3.6	-2.38	2.94	Alkaline drainage	NAF & high NAG(pH7.0)
		X187428	OPRC100127	34	35	0	0	**0.02**	7.4	0.25	0.112	0.816993	**Acid drainage**	**UC**
	Transition	X202017	OPRC100197	34	35	1.5	0.2	0	7.6	1.5	-1.19	4.9	Alkaline drainage	NAF
		X202019	OPRC100197	36	37	1	0.1	0	7.6	1	-0.69	3.27	Alkaline drainage	NAF & high NAG(pH7.0)
		X202020	OPRC100197	37	38	0	0	0	7.4	0	-0.19	1.63	Acid/Alk/Neutral	NAF & high NAG(pH7.0)
		X202021	OPRC100197	38	39	0	0	0	7.9	0	-0.19	1.63	Acid/Alk/Neutral	NAF & high NAG(pH7.0)
		X202022	OPRC100197	39	40	0	0	0	8	0	-0.19	1.63	Acid/Alk/Neutral	NAF & high NAG(pH7.0)
		X187429	OPRC100127	35	36	4	0.4	0.02	7.3	4	-3.388	0.816993	Acid drainage	NAF
	Fresh - outside pit boundaries	X174577	OPRC100066	123	124	15	1.6	0	8.1	15.7	-15.394	1.633987	Acid/Alk/Neutral	NAF
		X174586	OPRC100066	132	133	3	0.4	0.02	8.4	3.9	-3.288	0.816993	Acid drainage	NAF
		X174714	OPRC100066	260	261	26	2.7	0.1	9.1	26.2	-23.14	0.163399	Acid drainage	NAF
		X174715	OPRC100066	261	262	21	2.2	0.08	9.1	21.5	-19.052	0.204248	Acid drainage	NAF
		X191591	GHRC100007	67	68	1	0.2	0	8.4	1.7	-1.394	1.633987	Acid/Alk/Neutral	NAF
		X191592	GHRC100007	68	69	3	0.3	0	8.2	3	-2.694	1.633987	Acid/Alk/Neutral	NAF
		X191617	GHRC100007	93	94	23	2.3	0	8.2	23	-22.694	1.633987	Acid/Alk/Neutral	NAF
		X191618	GHRC100007	94	95	11	1.2	0	8.1	11.8	-11.494	1.633987	Acid/Alk/Neutral	NAF
		X185866	OPRC100120	192	193	1.7	0.2	**0.96**	8.2	1.7	**27.68**	0.06	**Acid drainage**	**UC**

UNIT TYPE	PHASE	SampleID	Hole_ID	mFrom	mTo	ANC as kg H_2SO_4 /t	ANC as % CaCO3	Sulfide-S (%)	Final pH	ANC (kg H_2SO_4/t)	NAPP (kg H_2SO_4/t)	APR	APR_Classification	ABA Classification
INTERCALATED ANOMALOUS ARSENIC	ALL	X193248	GHRC100019	13	14	0	0	0.01	8.6	0	-0.19	1.63	Acid/Alk/Neutral	NAF
		X196347	OPRC100160	10	11	0	0	**0.02**	8.1	0	0.11	0.82	**Acid drainage**	**UC**
		X200943	OPRC100189	40	41	2.4	0.2	0	7.4	2.4	-2.09	7.74	Alkaline drainage	NAF & high NAG(pH7.0)
		X195974	OPRC100155	51	52	3	0.4	0	8.3	3.6	-3.294	1.633987	Acid/Alk/Neutral	NAF

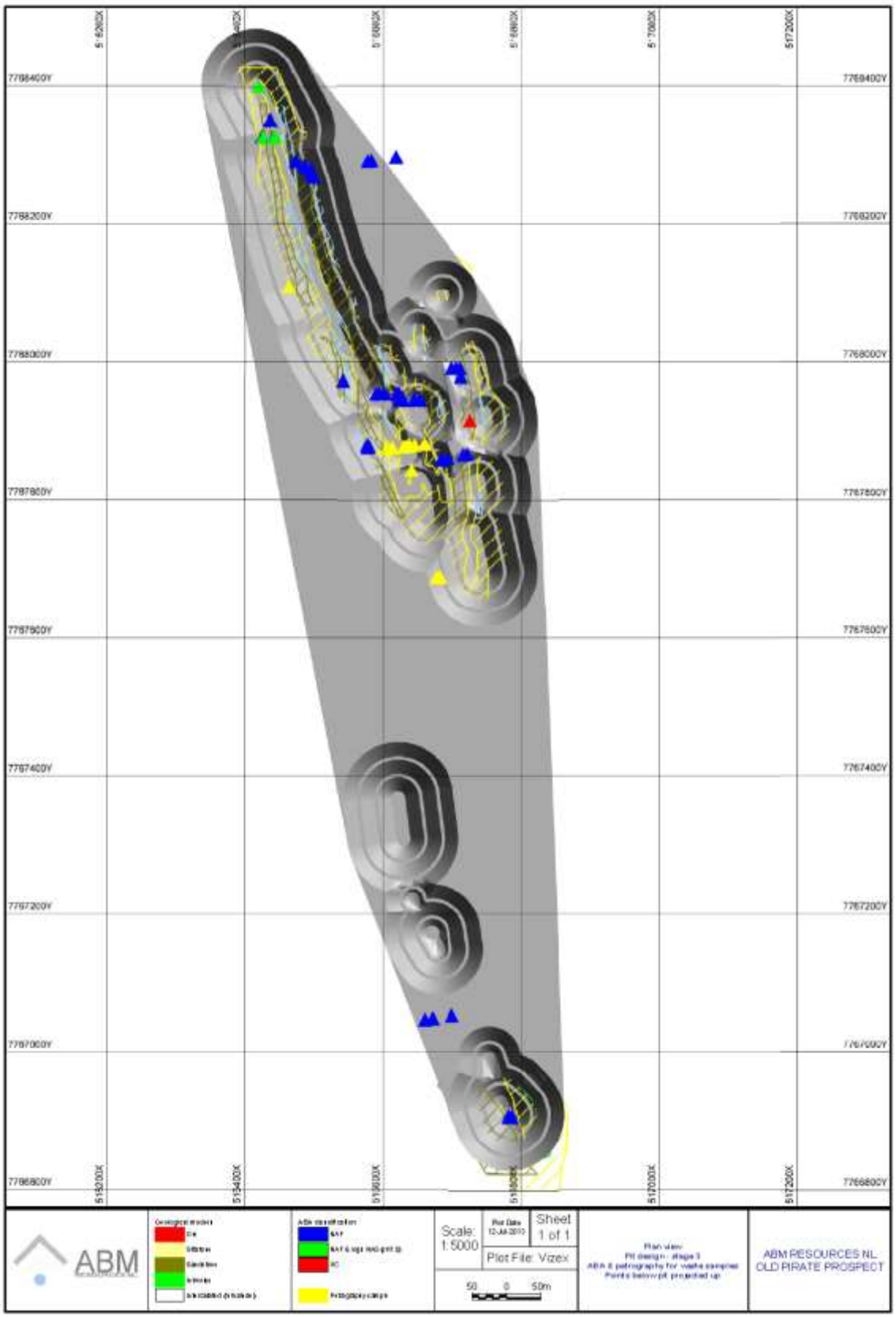

Figure 13. Location of AMD data (ABA classification: red UC, blue – NAF, green- NAF, high NAG). Yellow – petrography samples.

Figure 13 shows the location of the AMD data (ABA classification: red UC, blue – NAF, green- NAF, high NAG). Yellow triangles in Figure 13 show the locations of petrography samples described in section 1.2. It is important to note that some of the petrography samples fall outside of the pit boundaries but still correlate down strike of the geological units to be mined.

The effect of the buffering capacity is illustrated in the ABA classification, where the majority of samples are NAF.

3.1.1 Oxidised Sandstone

The leachate results (Table 3) indicate that the majority of the oxidised sandstone samples have a large reactive buffering capacity, with moderately alkaline paste pH (average 8.1).

The effect of the buffering capacity is illustrated in figure 13, where the majority of sandstone samples are NAF.

3.1.2 Transitional Sandstone

The transitional sandstone samples are all NAF (ABA classification) suggesting that the unit is comprised of very low sulphide content and a moderate buffering capacity (Figure 13).

The Sandstone units have higher NAC's and contain larger proportions of the wall rock replacement assemblages which have higher volumes of $CaCO_3$, in comparison to the ore units. The leachate results suggest that the majority of the samples have a moderate reactive buffering capacity, resulting in circum-neutral paste pH values (average 7.76).

3.1.3 Transitional Siltstone

The transitional siltstone unit has low % $CaCO_3$ content compared with the sandstone and intercalated samples. The transitional siltstone sample is classified as NAF (ABA classification) suggesting that the unit has a low sulphide content coupled with a moderate buffering capacity. As such buffering capacity would likely be predominantly attributed to silicates (Table 3).

3.1.4 Oxidised Intercalated

The oxidised intercalated samples have mixed classification and are predominately NAF due to their very low sulphide content and moderate buffering capacity (Figure 9). From the results of sulphide oxidation for the UC samples it is uncertain whether the unit would produce acid, alkaline or neutral mine drainage.

It is possible that any carbonates in the material have been removed through weathering, particularly considering the samples are in the oxidised zone near the surface of the deposit. Oxidised sulphides are observed, but it is much more common to observe partially oxidised pyrite and arsenopyrite at the surface. This may explain why samples in the oxidised units have a lower buffering capacity and therefore are

highlighted as UC (ABA classification) or potentially acid forming (APR classification – Acid Potential Ratio). The low Total S suggests that these materials are unlikely to be a high risk for AMD.

In addition, the intercalated units contain the majority of the wall rock replacement assemblages which have higher volumes of $CaCO_3$. The leachate results indicate that the majority of the samples have a large reactive buffering capacity, indicated by circum-neutral paste pH (average 7.9).

3.1.5 Transition Intercalated

The transitional intercalated samples are all NAF (ABA classification) due to the very low sulphide content and moderate buffering capacity (Figure 9, Table 3).

The intercalated units contain the majority of the wall rock replacement assemblages which have higher volumes of $CaCO_3$. The leachate results indicate that the majority of the samples have a large reactive buffering capacity, with circum-neutral paste pH (average 7.6).

3.1.6 Fresh Intercalated

The fresh intercalated samples are all NAF or non-acid forming (ABA classification) indicating that the unit is comprised of very low sulphide content and a moderate buffering capacity (Figure 9). The leachate results indicate that the majority of the samples have a large reactive buffering capacity, and returned circum-neutral paste pH (average 8.4).

3.1.7 Intercalated – Anomalous Arsenic

The intercalated anomalous arsenic samples are classified as predominately NAF, with one UC exception; therefore the results of sulphide oxidation would be predominately non-acid forming with a minor percentage uncertain in terms of whether the unit would produce acid, alkaline or neutral mine drainage.

All of the intercalated anomalous arsenic samples returned low ANC and higher sulphide concentrations when compared with the other waste units. The samples were also found to be rich in quartz, reducing the potential carbonate wall rock alteration that could increase the buffering capacity. Instead the bulk petrography indicates that the samples are similar to ore and have limited buffering capacity from the silicates.

3.2 ABA Results

The ABA plot (Figure 14) displays the samples in relation to Total Sulfur versus ANC (as described in the AMIRA guidelines 2002), and is a measure of the net acid producing potential of a sample. All of the samples are extremely low in relation to the standard guidelines. The graph displays the division between NAPP positive samples and the NAPP negative samples, and the control lines show ANC/MPA ratios of 2 and 3.

Across all units the findings show a low total sulphur level, and the potential to generate acid is very minimal, as the ANC counteracts the presence of sulphides.

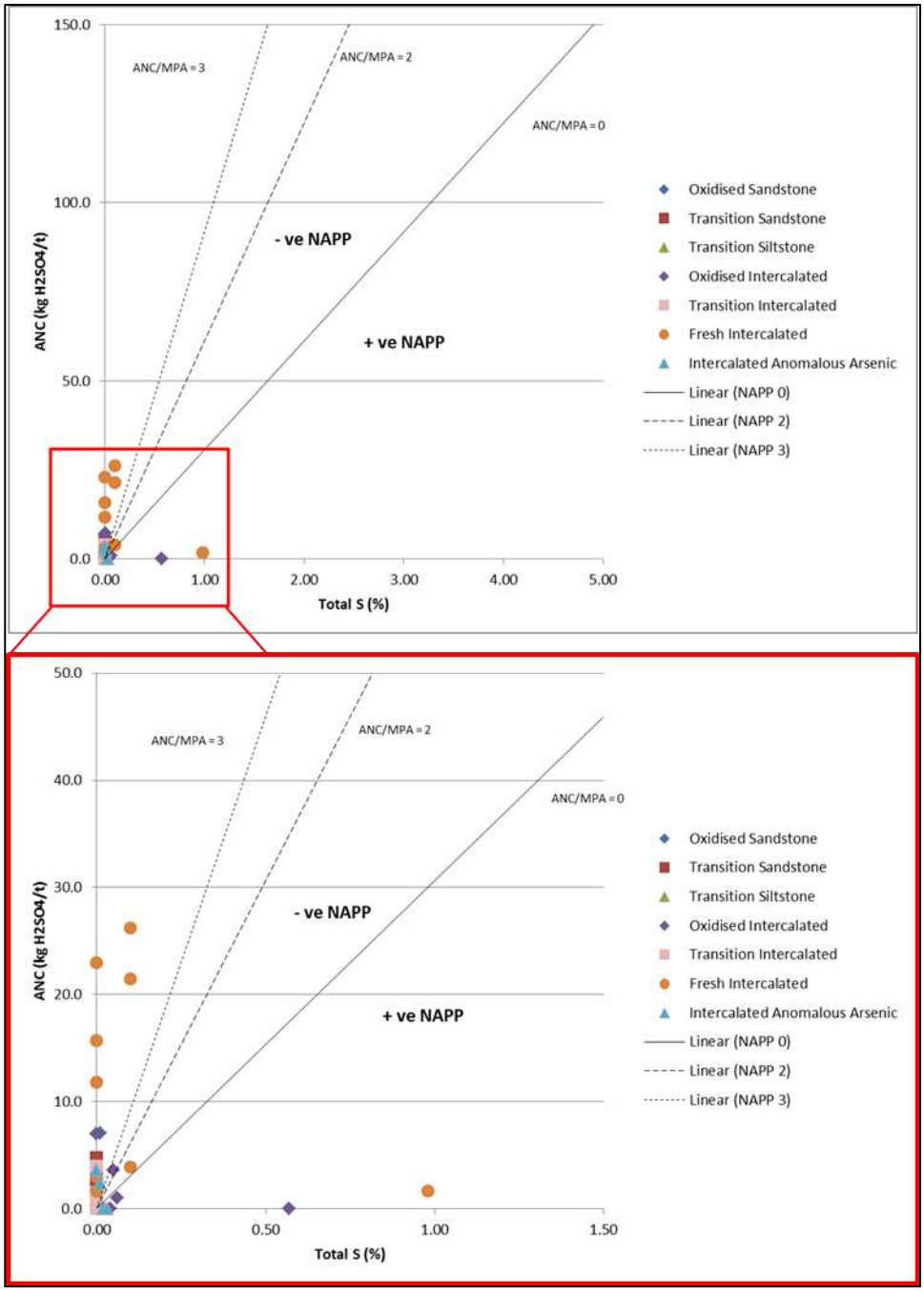

Figure 14. Acid-base account (ABA) plot for all waste samples (as described in the AMIRA guidelines 2002(Wark 2002)).

The geochemical characterisation of the samples is displayed in Figure 15, which is a geochemical characterisation plot, displaying NAPP versus NAGpH, as reported by Pendragon Environmental Solutions Consultants, with the additional leach data conducted after the Pendragon report. Table 3 illustrates the ABA results for the samples analysed.

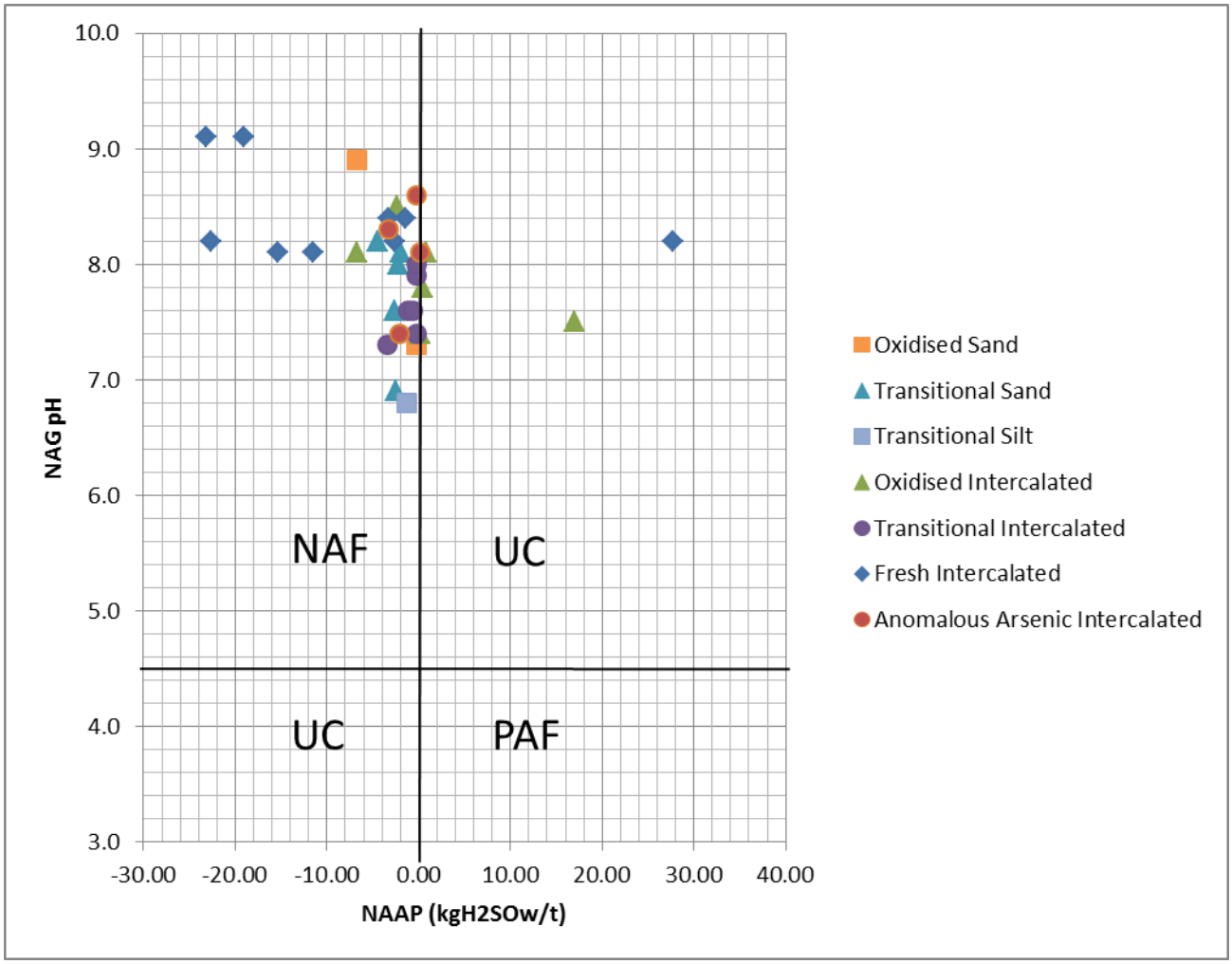

Figure 15. Geochemical Characterisation plot of waste samples: NAF – Non-acid forming, UC – uncertain, PAF – potentially acid forming.

Sections 7,768,325N and 7,767,950N (Figures 16-18) show the location of the samples with ABA classifications throughout the units of the proposed pit outline.

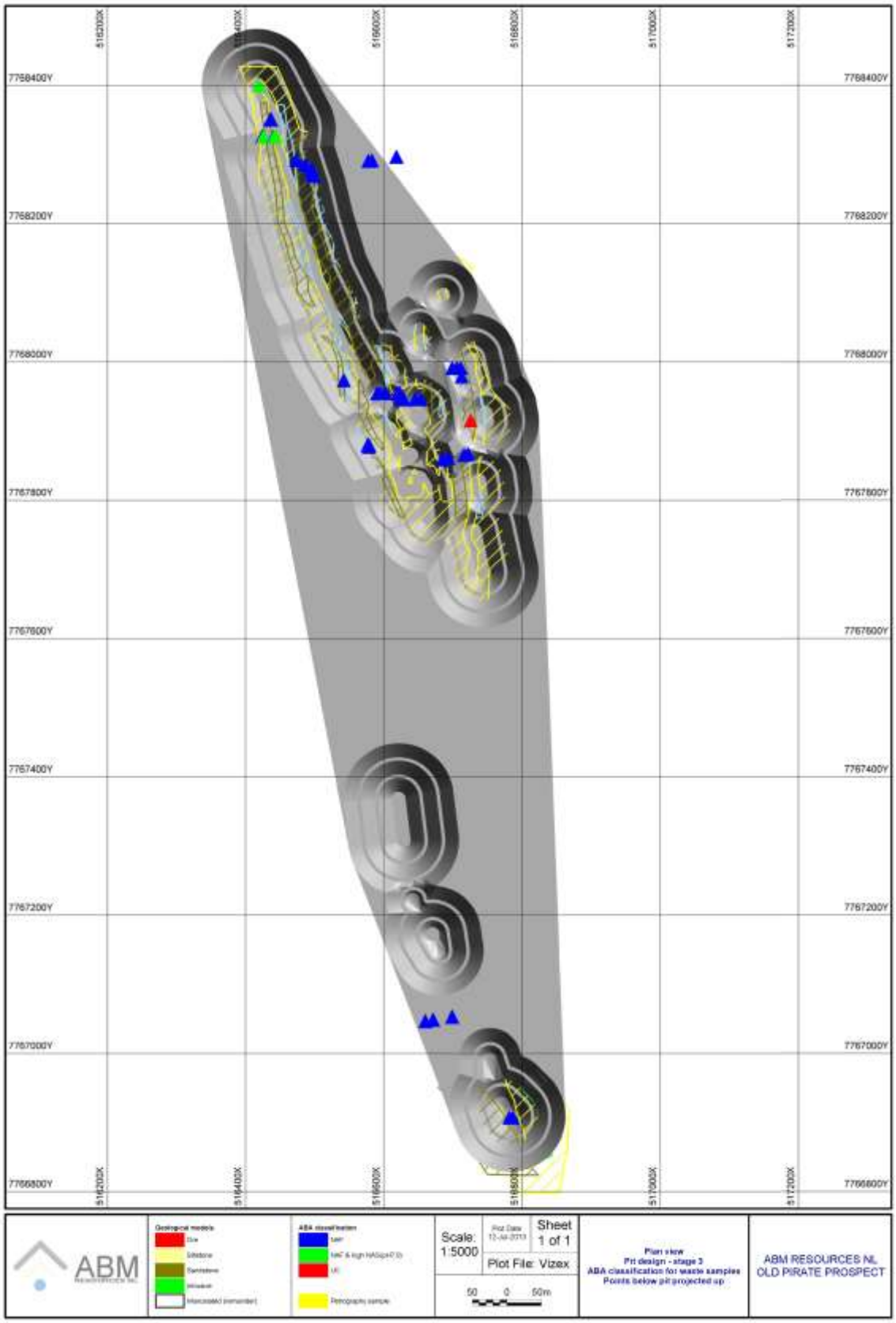

Figure 16. Plan view of stage 3 pit design with ABA classification: red UC, blue – NAF, green- NAF, high NAG).

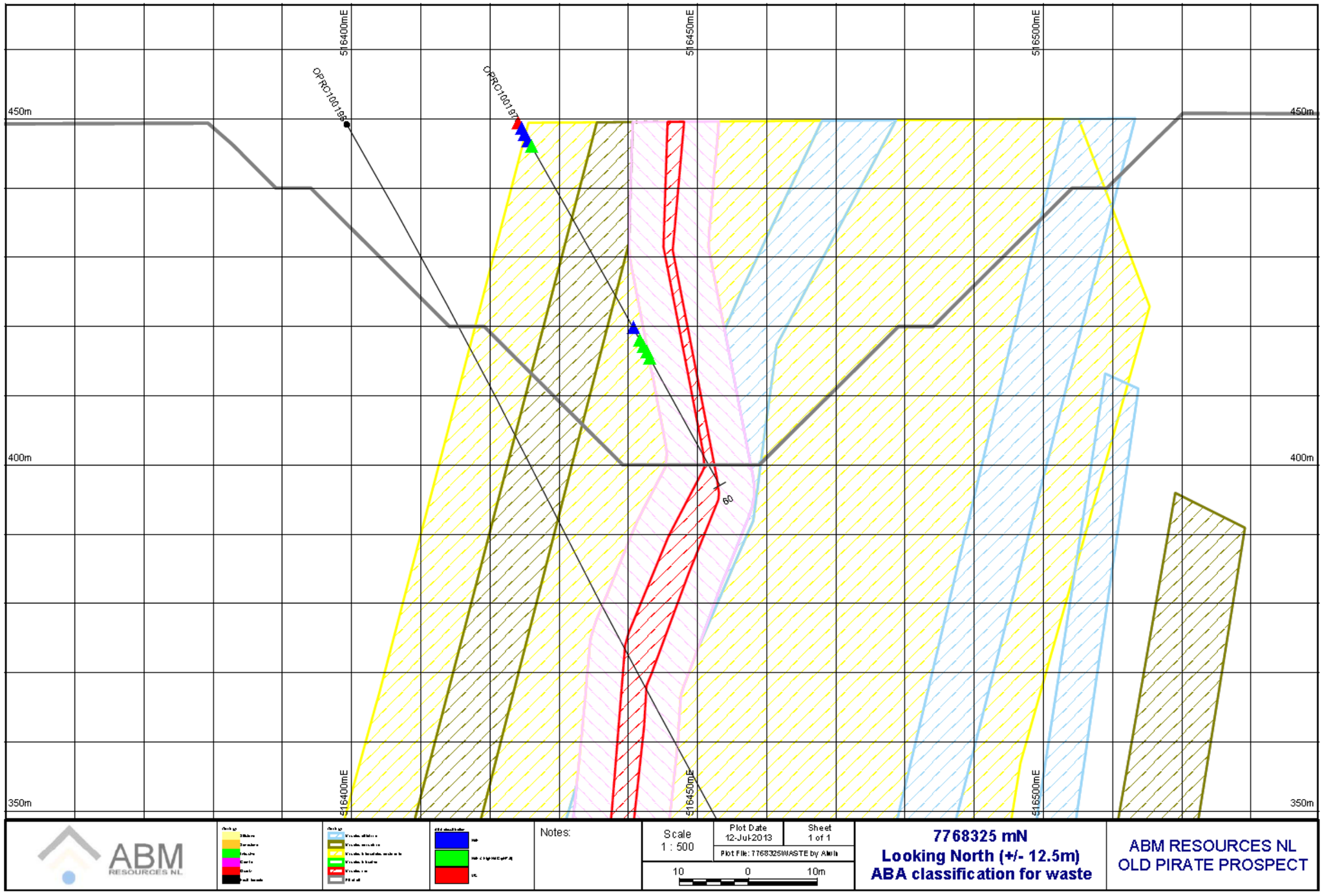

Figure 17. Cross-section through pit model (7768325N) with ABA classification: red UC, blue – NAF, green- NAF, high NAG) and geology.

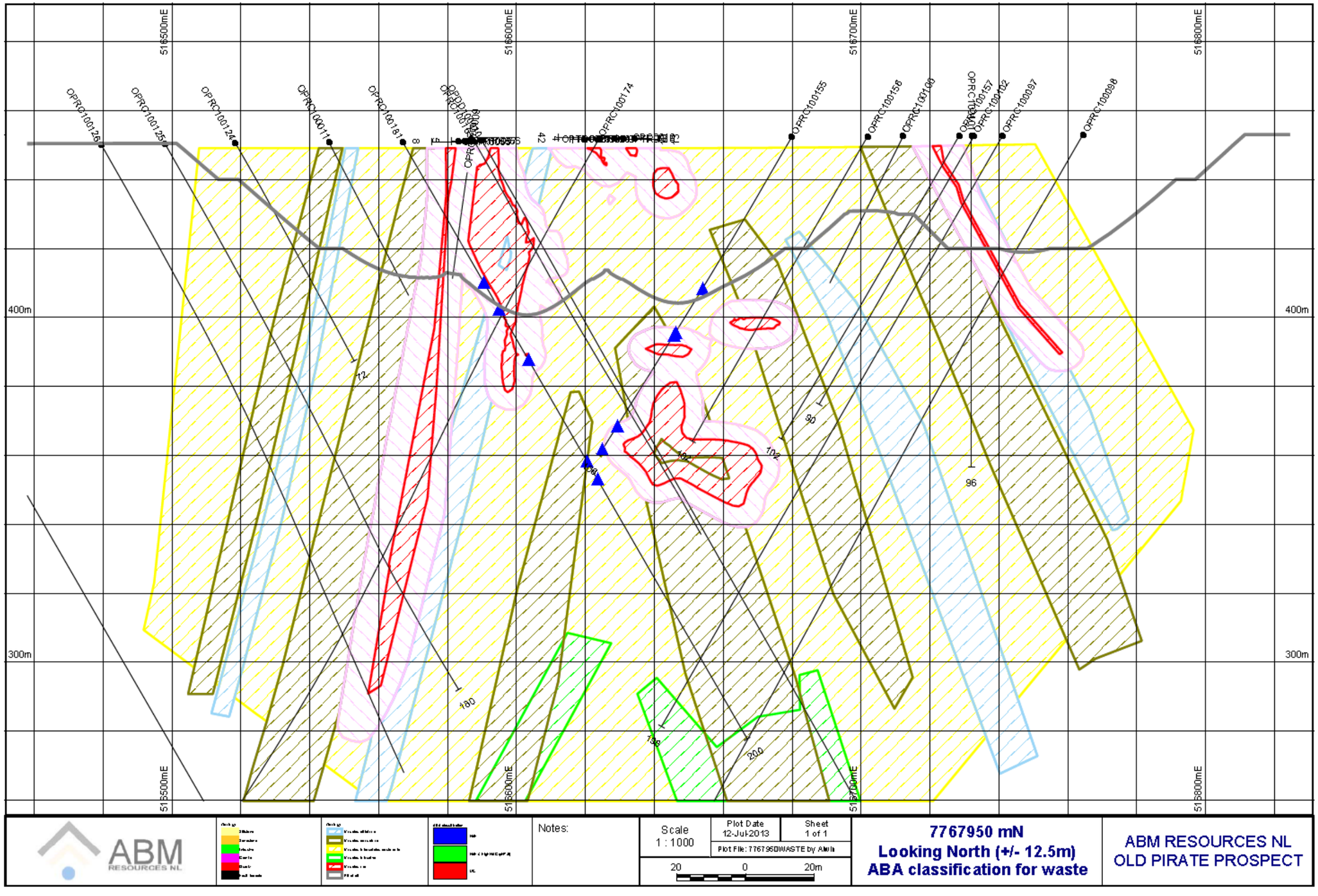

Figure 18. Cross-section through pit model (7767950N) with ABA classification: red UC, blue – NAF, green- NAF, high NAG) and geology.

3.2.1 Oxidised Sandstone

The oxidised sandstone unit contains sufficient buffering capacity (Table 3), related to silicates, to prevent acid mine drainage. The samples are classified as non-acid forming (ABA and NAG/APR classifications) and have no ability to generate acid (Figure 15).

Figure 16 shows the location of the ABA classified samples in relation to the ore.

There are no sulphides observed within the sandstone unit, therefore any potential acid formation can be attributed to the presence of pyrite and arsenopyrite within veins.

3.2.2 Transitional Sandstone

The transitional sandstone samples were mostly NAF in terms of both the ABA and NAG/APR classifications (Figure 15) and there are no sulphides observed within the sandstone unit. Sample X183227 exhibited potential acid formation characteristics under the APR classification but was classified as non-acid forming using ABA. The discrepancy between the APR and ABA classifications can be attributed to the assumption that the acid producing sulphide is primarily pyrite which may not be true for this sample. Table 3 illustrates the ABA results for the samples analysed.

3.2.3 Transitional Siltstone

The transitional siltstone sample was non-acid forming for both the ABA and NAG/APR classifications. There are no sulphides observed within the siltstone unit, therefore any potential acid formation can be attributed to the presence of pyrite and arsenopyrite within veins. Table 3 illustrates the ABA results for the samples analysed and Figures 16-18 show the location of the ABA classified samples in relation to the ore.

3.2.4 Oxidised Intercalated

The oxidised intercalated samples reported two alkaline drainage and four acid drainage classifications for the APR classification scheme. ABA classification reported four of the same samples to be NAF and two of uncertain classification; it is unclear whether they would produce acid, alkaline or neutral drainage. Table 3 illustrates the Acid Base Accounting results for the samples analysed.

ABA (Acid Base Accounting) classification confirmed the samples, X201983 and X187428 as unable to be defined as acid or alkaline producing materials.

Sample X201983 (hole OPRC100197) reported total sulphur content in the waste rock of 0.57 %, the sulphide proportion of the Total S in the samples are a combination of visually logged pyrite and arsenopyrite (in some cases weathered to scorodite) and potentially some barium sulphate. AMD guidelines indicate that samples with a Total S content of greater than 0.3 % have the potential to generate significant amounts of acid. The larger unit volume in which this unit lies has low sulphides and is classified as NAF, suggesting that AMD potential is low. The discrepancy between the ABA and APR classifications can be attributed to the assumption that the acid producing sulphide is primarily pyrite which may not hold.

The two UC materials (samples X196347 & X201983) have low to moderate enrichment and are elevated in Fe (2.3 GIA) and Pb (4.3 GIA). Other samples classified as NAF also showed high iron and occasionally lead enrichment.

For the remainder of the NAF samples there are minor amounts of sulphides (<5%) observed within the oxidised intercalated unit, which are isolated veins and vein selvedges. It is established that the two outliers (UC Samples: X201983 and X187428) are not representative of the whole unit and are associated with isolated stringer zones. The bulk of the unit has little sulphide content. This risk of AMD is therefore likely to be associated with the presence of pyrite and arsenopyrite which is limited to within the stringer system.

3.2.5 Transition Intercalated

The transition intercalated samples are classified as primarily either neutral or alkaline drainage (APR), with one outlier reported as acid drainage (Table 3). ABA classification suggests that the unit is generally neutral in nature, as all samples reported as NAF, the discrepancy between the ABA and APR classifications can be attributed to the assumption that total S values are being allocated to pyrite. Total S was below the detection limit for all samples (<0.01 ppm), with the exception of the APR acid drainage sample. The sulphides represented by the Total S are likely a combination of visually logged pyrite and arsenopyrite in isolated veins and vein selvedges. The bulk of the unit has little sulphide content. Acid formation is therefore likely to be attributed to the presence of pyrite and arsenopyrite within the vein.

3.2.6 Fresh Intercalated

The fresh intercalated samples are classified as primarily neutral drainage (APR) with four outliers reported as acid drainage (Table 3). ABA classification suggests that the unit is predominately neutral in nature, as all samples reported as NAF. Total S content is less than 0.02 ppm (below detection limit) for all samples except the APR acid drainage sample with the sulphides proportion of the Total S likely to be a combination of visually logged pyrite and arsenopyrite in isolated veins and vein selvedges. None the less, the majority has little sulphide content.

Figure 24 confirms that all of the fresh intercalated samples are NAF. Figure 16 shows the location of the ABA classified samples in relation to the ore.

Sections 7,768,325N and 7,767,950N (Figures 17-18) show the location of the samples with ABA classifications throughout the units of the proposed pit outline.

3.2.7 Intercalated – Anomalous Arsenic

Acid potential ratios indicate a mixed APR classification with ABA classification found that one sample within the unit which is ambiguous in terms of its AMD characteristics as a result of it having no buffering capacity for neutralising the potential acid that may be generated from the oxidation of the low quantities of pyrite present.

Visual observations from the logging of core indicate that where intercalated units were proximal to ore and dominated by quartz, the samples (which were classified as UC)

were dominated by relic sulphides that were already highly oxidised; and in the presence of oxygen have weathered to scorodite. Scorodite is a by-product of arsenopyrite oxidation and as such any arsenic in the system would have been released naturally as part of the oxidation process. The potential to react again and release arsenic is unlikely. This is highlighted by the mineralised soils, elevated in arsenic, across the project area. The bulk of the leachate testing identified pH's greater than 6 and less than 8, making it unlikely that the presence of scorodite will contribute to the release of arsenic and metalliferous drainage.

The presence of sulphides, coupled with a low ANC, suggests that the rock has little capacity to neutralise any acid generated from the oxidation of pyrite, however the pyrite content is sufficiently small that acid generation is likely to be minimal. ABA classification confirmed sample X196347 as ambiguous in term of it being an acid or alkaline producing material. The remaining samples fall within the acid drainage characterisation of APR but have a low ability to generate acid and a low ANC to characterise them as NAF in terms of the ABA classification (Figure 15).

The UC sample was found to be enriched in As (9.1 times the average crustal abundance) and is high in both iron (2.3) and lead (4.3). Other intercalated anomalous arsenic samples classified as NAF also reported iron and occasionally lead enrichment (Figures 16-18).

Section 7,768,325N (Figure 17) shows the location of the UC samples at the top of the deposit, where it is possible that the carbonate buffering capacity has been removed through weathering. Oxidised sulphides are observed but it is much more common to observe partially oxidised pyrite and arsenopyrite at the surface. This may explain why samples in the oxidised units have a lower buffering capacity and therefore are highlighted as UC (ABA classification) or potentially acid forming (APR classification).

Acid mine drainage can therefore be attributed to the presence of pyrite and arsenopyrite within altered parts of the unit.

3.3 APR versus total Alkalinity

The NAPP-NAG pH classification of the samples is displayed in Figure 19, which is a Water Quality Prediction tool that assesses pH characteristics of the drainage; as reported by Pendragon Environmental Solutions Consultants. Results are reported in Table 5.

Samples that were found to have a low buffering capacity (total alkalinity) were also found to be at low risk of acid mine drainage (APR).

3.3.1 Oxidised Sandstone

The oxidised sandstone sample's pH was circum-neutral to moderately alkaline, ranging from 6.9 to 8.2. The neutral to basic pH samples also correlated with higher electrical conductivity (EC) and dissolved solids (TDS) and were associated with the oxidised sand

samples. Total alkalinity was also highest in the oxidised sands, indicating that the buffering potential is higher in the sands than the other waste units.

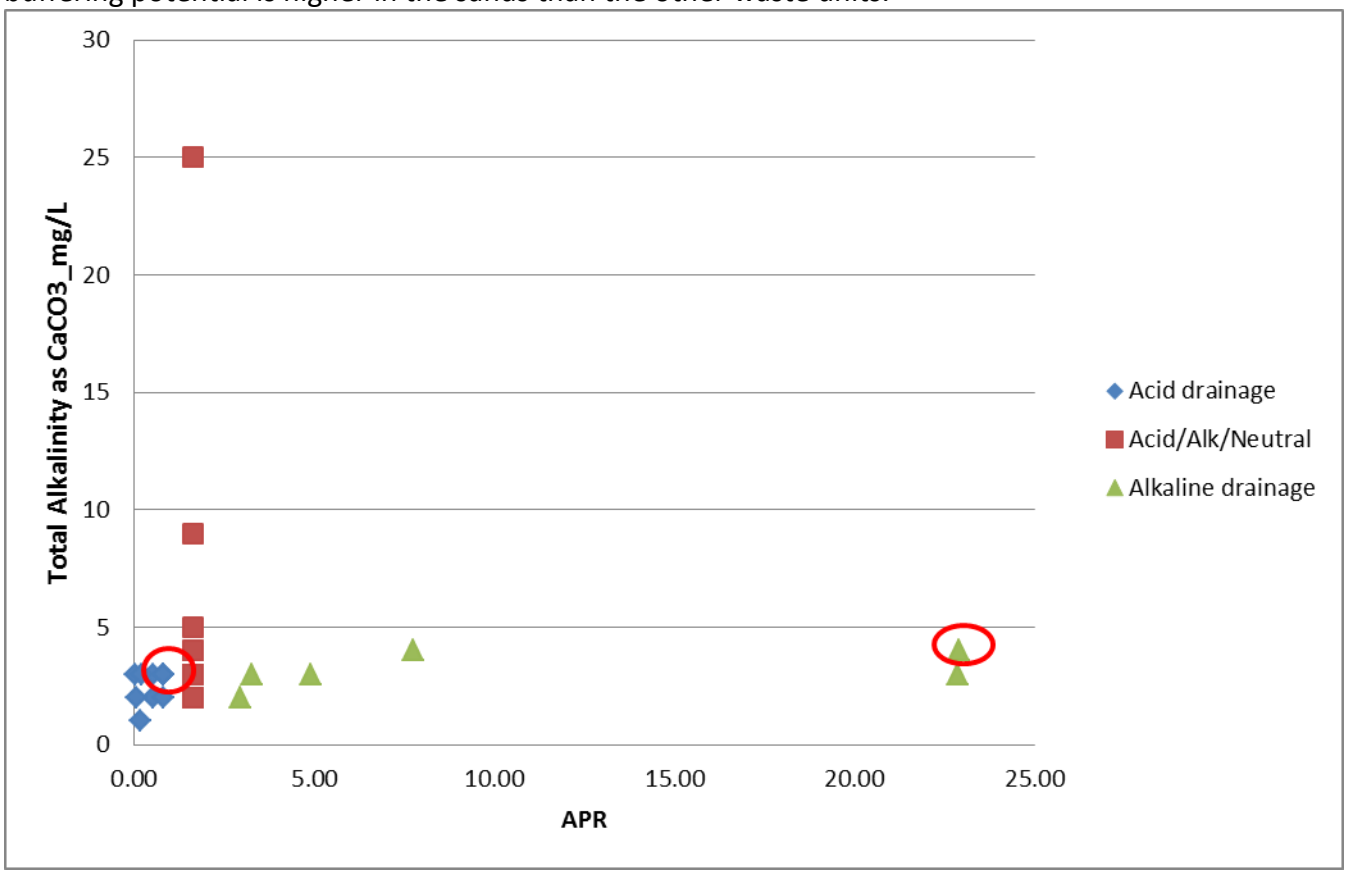

Figure 19. APR versus Total Alkalinity (as CaCO3) in Leached solutions. Red Circle: Oxidised Sandstone Unit.

1 sample was classified as potentially acid drainage (X196241) and 1 sample as potentially alkaline drainage (X1933560)(Figure 19).

3.3.2 Transitional Sandstone

The pH of the transitional sandstone leachates was circum-neutral and ranged from 6.5 to 7.06 (Table 5); the higher the pH of the samples, the higher the EC and TDS.

Total alkalinity was very low in the transitional sands compared to the oxidised sand unit. Figure 20 shows that the majority of the samples were classified as producing neutral drainage with 1 sample producing acid drainage (X183227).

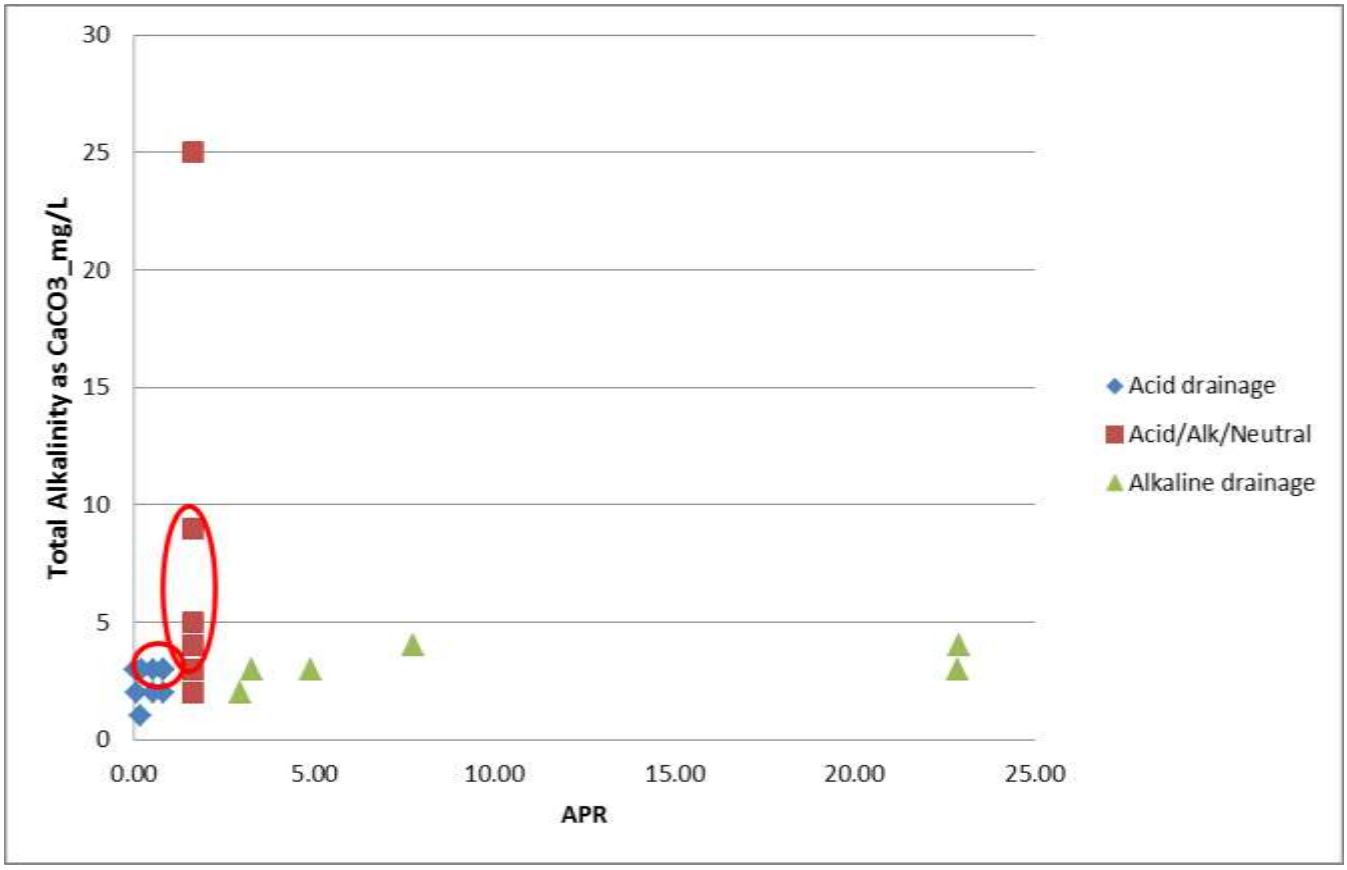

Figure 20. APR versus Total Alkalinity (as CaCO3) in Leached solutions. Red Circle: Transitional Sandstone Unit.

3.3.3 Transitional Siltstone

The leachate pH was slightly acidic at 6.64 (Table 5). Total alkalinity was relatively low in the siltstones compared to the sandstone and intercalated units. The single sample (X183253) was classified as producing neutral drainage (Figure 21).

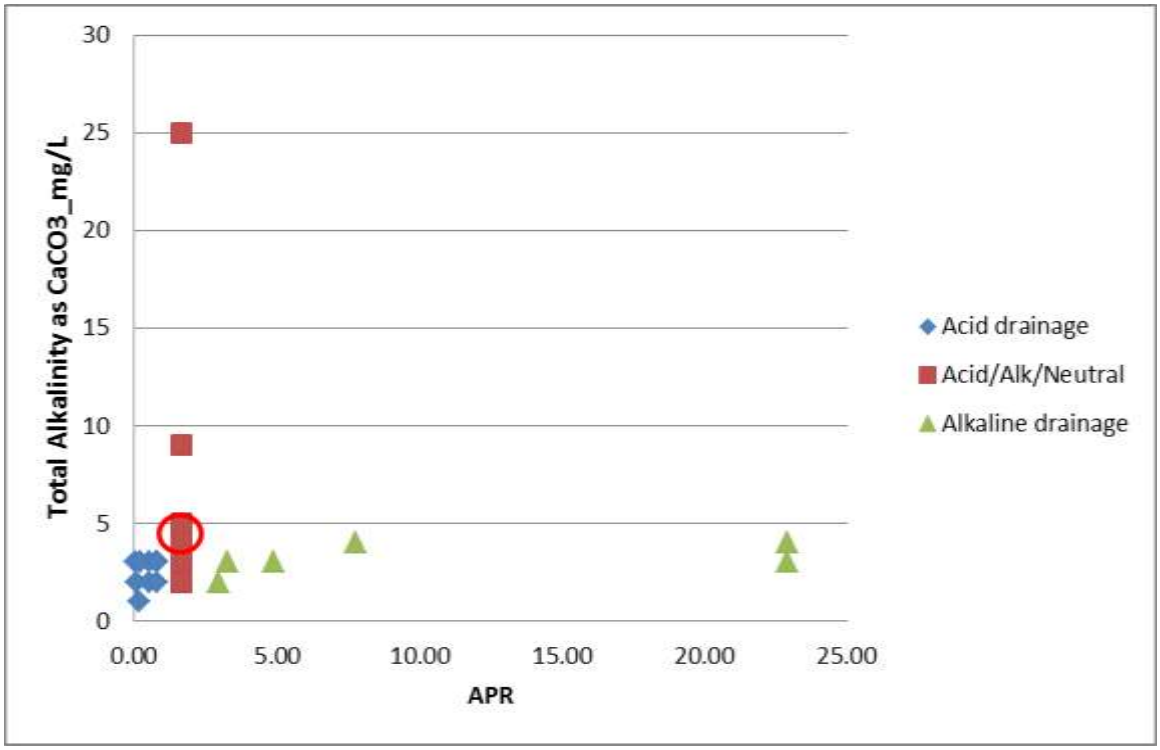

Figure 21. APR versus Total Alkalinity (as CaCO3) in Leached solutions. Red Circle: Transitional Siltstone Unit.

3.3.4 Oxidised Intercalated

The oxidised intercalated pH was mildly acidic, averaging 6.52 (Table 5). Samples ranged from having acid mine drainage to alkaline drainage; 4 samples and 2 samples respectively (Figure 22).

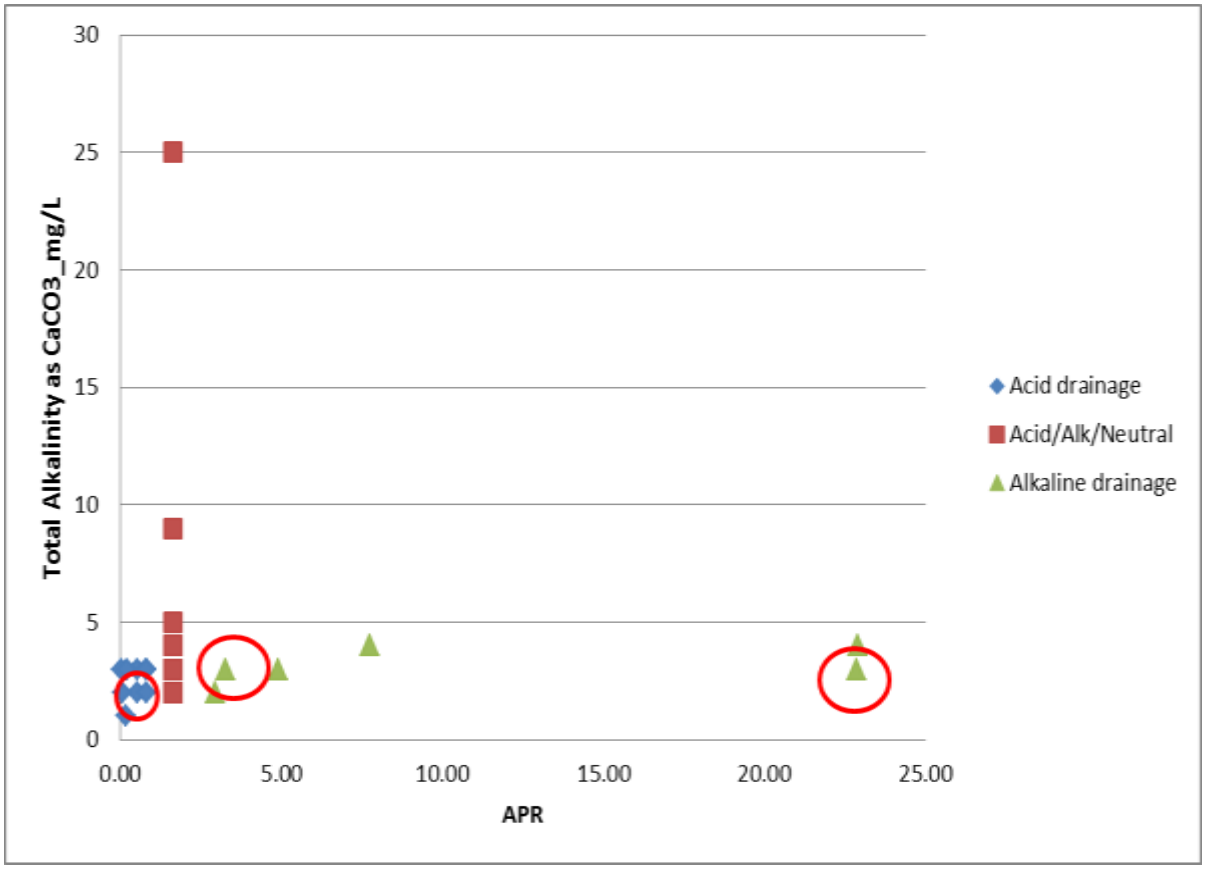

Figure 22. APR versus Total Alkalinity (as CaCO3) in Leached solutions. Red Circle: Oxidised Intercalated Unit.

3.3.5 Transition Intercalated

The transitional intercalated pH was mildly acidic, with an averaging of 6.24 (Table 5); the higher the pH of the samples, the higher the EC and TDS. Results indicate that the samples have a low buffering capacity (total alkalinity) but also have a low ability to produce acid mine drainage (APR)(Figure 23).

Figure 23 shows that the majority of the samples were classified as producing neutral or alkaline drainage (3 and 2 samples respectively) and 1 sample acid drainage (X187429).

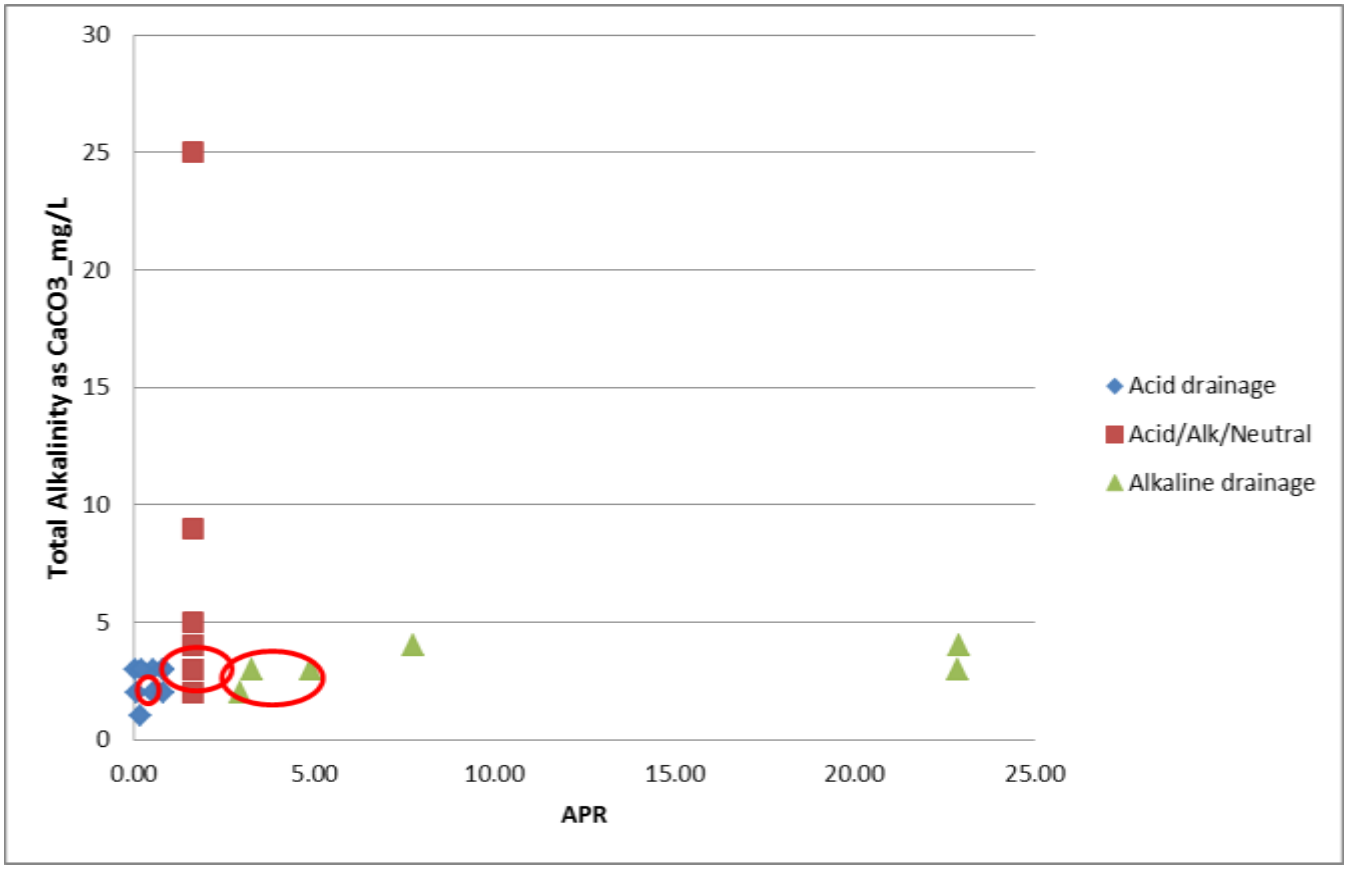

Figure 23. APR versus Total Alkalinity (as CaCO3) in Leached solutions. Red Circle: Transitional Intercalated Unit.

3.3.6 Fresh Intercalated

The fresh intercalated pH was neutral, averaging 7.32 (Table 5). The majority of the samples reported neutral to basic pH, these samples also were characterised with higher EC and TDS. These results suggest that these materials are unlikely to be a risk for acid mine drainage (APR).

Five samples were classified as producing neutral drainage and four samples were classified as producing acidic (Figure 24).

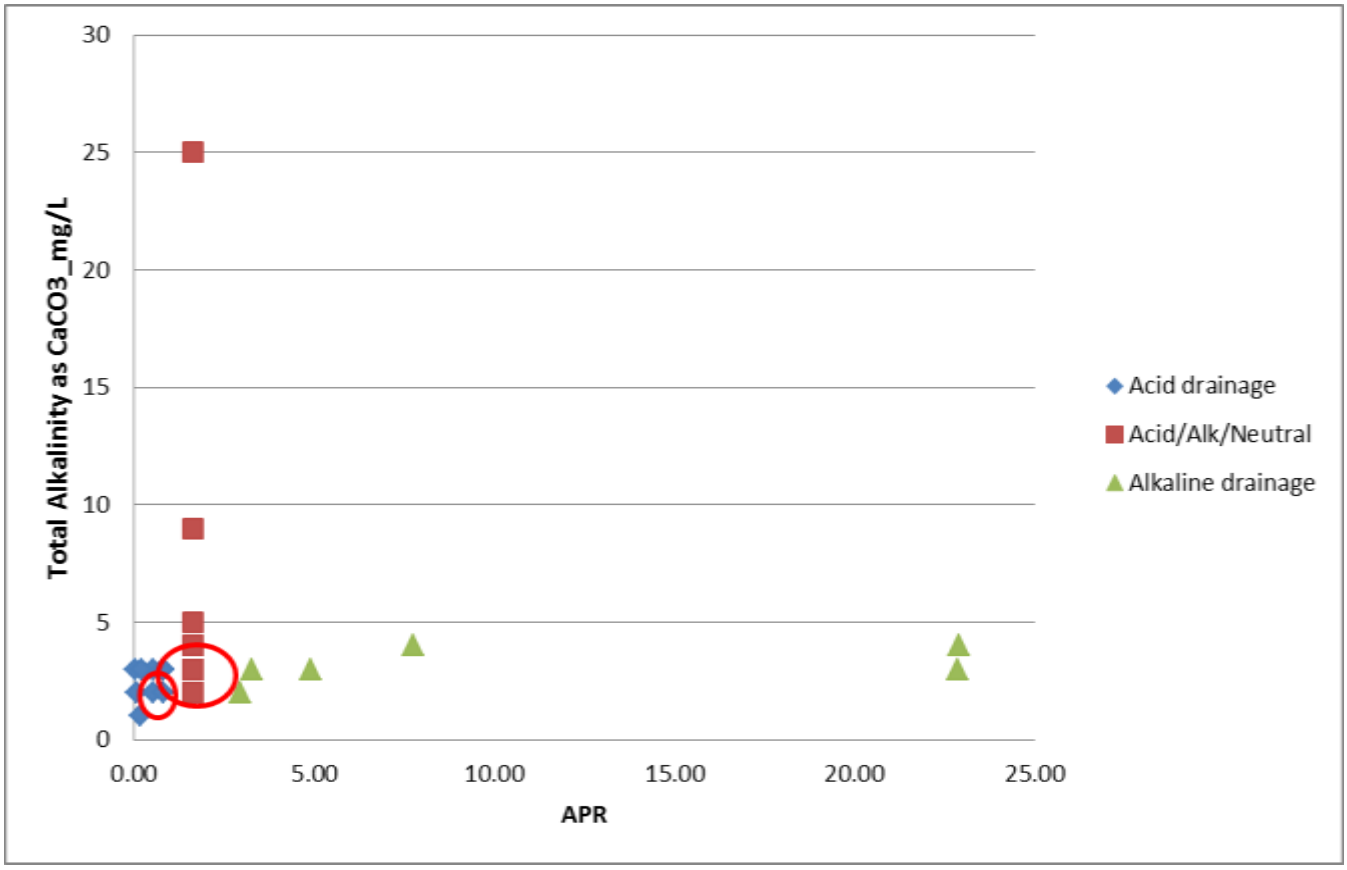

Figure 24. APR versus Total Alkalinity (as CaCO3) in Leached solutions. Red Circle: Fresh Intercalated Unit.

3.3.7 Intercalated – Anomalous Arsenic

The pH of the intercalated anomalous arsenic unit was slightly acidic, with an average of 6.87 (Table 4). Figure 24 shows that the majority of the samples were classified as producing neutral drainage (2 samples) or acid drainage (1), with only one alkaline sample (Figure 25).

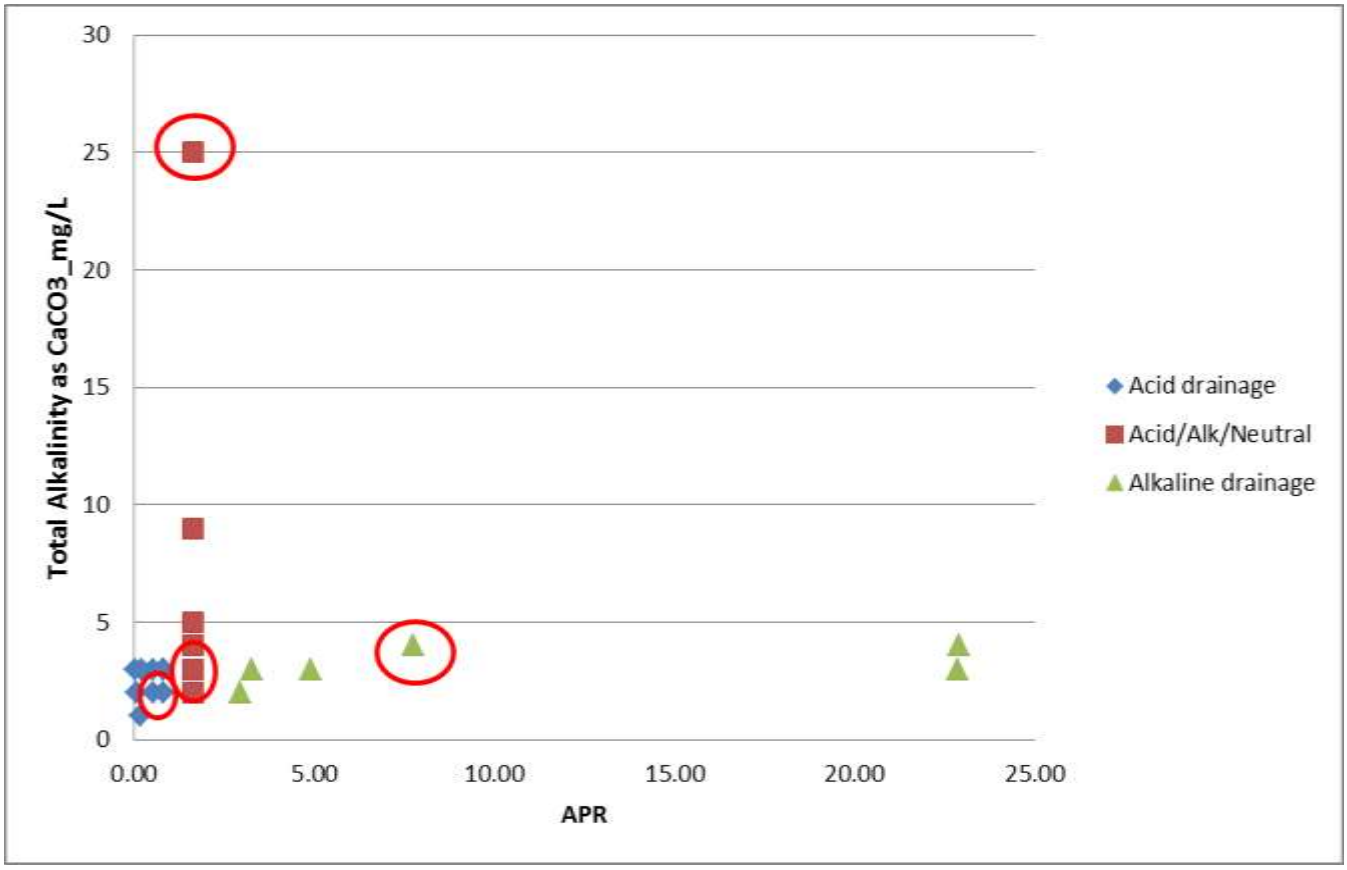

Figure 25. APR versus Total Alkalinity (as CaCO3) in Leached solutions. Red Circle: Intercalated Anomalous Arsenic Unit.

3.4 GAI Enrichment

GAI analysis identified As as the primary potential contaminant, with elemental enrichment well above the average-crustal-abundance. Table 4 reports the GAI for all units that were assessed. Barium and tin were mentioned as potentially enriched in the Pendragon Reports, but waste rock samples show no GAI above three, indicating that the elements are limited in their enrichment within the waste rock (Table 4).

Table 4. GAI Analysis to assess element enrichment – average per characterisation unit.

UNIT_NAME	PHASE	Sample ID	Al	As	Ba	Ca	Cl	Co	Cr	Cu	Fe	K	Mg	Mn	Na	Ni	P	Pb	S	Si	Sn	Sr	Ti	V	Zn	Zr
SANDSTONE	OXIDISED	*X193356*	*0*	*5.8*	*0.3*	*0*	*0*	*0*	*0*	*0*	*1.7*	*0*	*0*	*0*	*0*	*0*	*0*	*0.1*	*0*	*0*	*1.7*	*0*	*0*	*0*	*0*	*0*
		X196241	*0*	*6.6*	*0*	*0*	*0*	*0*	*0*	*0*	*1.6*	*0*	*0*	*0*	*0*	*0*	*0*	*1.1*	*0*	*0*			*0*	*0*	*0*	*0*
		AVERAGE	0	5	0.2	0	0	0	0	0	2.15	0	0	0	0	0	0	0.75	0	0	1.7	0	0	0	0	0
	TRANSITION - outside of pit	*X181581*	*NO DATA*																							
		X184764																								
		X184780																								
		X183227																								
		X173929																								
SILTSTONE	TRANSITION - outside of pit	*X183253*	*NO DATA*																							
INTERCALATED SANDSTONES AND SILTSTONES	OXIDISED	*X201983*	*0*	*4.5*	*0*	*0*	*0*		*0*		*0*	*0*	*0*	*0*	*0*		*0*		*0*	*0*	*2.5*	*0*	*0*	*0*		*0.5*
		X201984	*0*	*6.1*	*0*	*0*	*0*		*0*	*0*	*0.8*	*0*	*0*	*0*	*0*	*0*	*0*	*1.3*	*0*	*0*	*1.5*	*0*	*0*	*0.6*		*0.3*
		X201985	*0*	*6.1*	*0.5*	*0*	*0*		*0*		*0.1*	*0*	*0*	*0*	*0*		*0*		*0*	*0*	*1.5*	*0*	*0*	*0*		*0*
		X201986	*0*	*5.1*	*0*	*0*	*0*		*0*		*0*	*0*	*0*	*0*	*0*		*0*		*0*	*0*	*1.5*		*0*	*0*		*0*
		X201987	*0*	*5.5*	*0*	*0*	*0*		*0*		*0*	*0*	*0*		*0*		*0*		*0*	*0*	*1.5*	*0*	*0*	*0*		*0*
		X187428	*NO DATA*																							
		AVERAGE	0	5.46	0.1	0	0		0	0	0.18	0	0	0	0	0	0	1.3	0	0	1.7	0	0	0.12		0.16
	TRANSITION	*X202017*	*0*	*8.8*	*0.1*	*0*	*0*		*0*	*0*	*0*	*0.2*	*0*	*0*	*0*	*0*	*0*	*4*	*0*	*0*	*2.5*	*0*	*0*	*0*	*0.5*	*0*
		X202019	*0*	*7.4*	*0*	*0*	*0*		*0*	*0*	*0*	*0*	*0*	*0*	*0*		*0*	*2.1*	*0*	*0*	*1.5*	*0*	*0*	*0*		*0*
		X202020	*0*	*6.6*	*0*	*0*	*0*		*0*		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*1.7*	*0*	*0*	*2.5*	*0*	*0*	*0*		*0*
		X202021	*0*	*5.5*	*0*	*0*	*0*		*0*	*0*	*0*	*0*	*0*	*0*	*0*		*0*	*1.7*	*0*	*0*	*3.1*	*0*	*0*	*0*		*0*
		X202022	*0*	*5.5*	*0*	*0*	*0*		*0*	*0*	*0*	*0*	*0*	*0*	*0*		*0*	*1.9*	*0*	*0*	*2.5*	*0*	*0*	*0*		*0*
		X187429	*NO DATA*																							
		AVERAGE	0	6.76	0.02	0	0		0	0	0	0.04	0	0	0	0	0	2.28	0	0	2.42	0	0	0		0
	FRESH - outside of pit	*X185866*	*0*	*6*	*0*	*0*	*0*	*0*	*0*	*0*	*2.3*	*0*	*0*	*0*	*0*	*0*	*0*	*2.1*	*3.6*	*0*	*1.7*	*0*	*0*	*0*	*0.1*	*0*
		X191591	*NO DATA*																							
		X191592																								
		X191617																								
		X191618																								
		X174577																								
		X174586																								
		X174714																								
		X174715																								
		AVERAGE	0	6	0	0	0	0	0	0	2.3	0	0	0	0	0	0	2.1	3.6	0	1.7	0	0	0	0.1	0
INTERCALATED ANOMALOUS ARSENIC	ALL	*X193248*	*0*	*8*	*0*	*0*	*0*	*0*	*0*	*0*	*3.3*	*0*	*0*	*0*	*0*	*0*	*0*	*2.3*	*0*	*0*		*0*	*0*	*0*	*0*	*0*
		X196347	*0*	*9.1*	*0*	*0*	*0*	*0*	*0*	*0*	*2.3*	*0*	*0*	*0*	*0*	*0*	*0*	*4.3*	*0*	*0*	*2.7*	*0*	*0*	*0*	*0*	*0*
		X200943	*0*	*4.2*	*0.1*	*0*	*0*	*0*	*0*	*0*	*2.6*	*0*	*0*	*0*	*0*	*0*	*0*	*1.4*	*0*	*0*	*1.7*	*0*	*0*	*0*	*0*	*0*
		X195974	*NO DATA*																							
		AVERAGE	0	7.10	0.03	0.00	0.00	0.00	0.00	0.00	2.73	0.00	0.00	0.00	0.00	0.00	0.00	2.67	0.00	0.00	2.20	0.00	0.00	0.00	0.00	0.00

3.4.1 Oxidised Sandstone

The oxidised sandstone unit is elevated in As (GAI 5.8-6.6) with As values half to a third of those observed in the ore samples. Results suggest that elevated As occurs close to the ore body (mineralised quartz veins) but away from the ore. The Old Pirate area has been reported to have high background As levels well above naturally occurring soil levels. The As elevation is associated with the multiple narrow high grade veins that host mineralisation (ore). The sandstone samples, although enriched in As, are several orders of magnitude less than ore samples.

The two UC materials (samples X196347 & X201983) have low to moderate enrichment and are elevated in Fe (2.3 GIA) and Pb (4.3 GIA). Other samples classified as NAF also showed high Iron and occasionally lead enrichment.

3.4.2 Oxidised Intercalated

The oxidised intercalated unit is elevated in As (GAI average 5.46), but still much lower than the ore samples (Table 4).

Water leachates at neutral pH's would indicate that there would be limited leaching of elements (As).

3.4.3 Transition Intercalated

The transition intercalated samples are enriched in As averaging 6.76 (GAI); a 96 - fold, or greater, enrichment above the average-crustal-abundance (Table 4). Sample X202017 was elevated in Pb with a GAI of four; a 24 - fold enrichment above the average-crustal-abundance.

3.4.4 Fresh Intercalated

The transition intercalated samples were found to be enriched in arsenic with a GAI averaging 6 (Table 5). Sample X185866 was elevated in Pb with a GAI of four.

3.4.5 Intercalated – Anomalous Arsenic

The intercalated anomalous arsenic samples are enriched in As up to 9.1 (GAI), a greater than 96 fold enrichment above the average-crustal-abundance.

Water leachates at neutral pH's would indicate that there would be limited leaching of elements (As). A UC classification (ABA) for the samples suggests that they are low risk for metalliferous drainage. To be conservative ABM recommend that the intercalated anomalous arsenic unit if not processed as low grade ore is to be isolated in the centre of the waste dump to prevent the occurrence of leachates and metalliferous drainage (See Section 3 – Recommendations for Waste).

3.5 Water Quality Prediction

The leachate analysis was carried out as a component of the AMD analysis; Table 5 shows the average values for all the analytes tested. Most analytes were found to have very low concentrations that were at or below the limits of detection.

The pH was cirum-neutral to moderately alkaline. The neutral to basic pH samples also correlated with higher electrical conductivity (EC) and dissolved solids (TDS).

Pendragon identified the following:

4. Major Cation concentrations were in the order of Na>K>Ca>Mg
5. Anions are also low in the order of Cl>SO4

Table 5. Predicted water quality for each Pit classification unit and NWQMS water guidelines. The NWQMS water guidelines are adapted from the National Water Quality Management Strategy and are set at 95% protection, meaning that the guidelines allow protection of 95% of aquatic species concerned (Australian and New Zealand Environment and Conservation Council et al. 2000). Two values are reported for Arsenic 0.024 mg/L As (III) and 0.013 mg/L As (V), the assumption has been made that the two arsenic species occur in relatively a 1:1 ratio in groundwater (Mahaimairaja et al. 2005; Samanta et al. 1999) and the guideline of 0.013 is most appropriate. Samples over NWQMS Guidelines are highlighted red. NHMRC Guideline values are also included for physical and chemical characteristics of drinking water.

UNIT_NAME	PHASE	SAMPLE ID	pH Value	Electrical Conductivity @ 25°C_µS/cm	Total Dissolved Solids @180°C_mg/L	Moisture Content (dried @ 103°C)_%	Hydroxide Alkalinity as CaCO3_mg/L	Carbonate Alkalinity as CaCO3_mg/L	Bicarbonate Alkalinity as CaCO3_mg/L	Total Alkalinity as CaCO3_mg/L	Sulfate as SO4 - Turbidimetric_mg/L	Chloride_mg/L	Calcium_mg/L	Magnesium_mg/L	Sodium_mg/L	Potassium_mg/L	Aluminium_mg/L	Antimony_mg/L	Arsenic_mg/L	Beryllium_mg/L	Barium_mg/L	Cadmium_mg/L	Chromium_mg/L	Cobalt_mg/L	Copper_mg/L	Lead_mg/L	Manganese_mg/L	Nickel_mg/L	Selenium_mg/L	Vanadium_mg/L	Zinc_mg/L	Iron_mg/L	Mercury_mg/L	Fluoride_mg/L
NWQMS Water Guidelines	*Freshwater aquatic systems*																*0.055*		*0.024 OR **0.013***								*0.0015*				*0.008*	*0.04*		
NHMRC Health Guidelines	*Drinking water*														*180*			*0.003*	*0.01*		*0.7*						*0.5*				*3*			*1.5*
SANDSTONE	OXIDISED	*X193356*	*6.79*	*50*	*72*		*0*	*0*	*1*	*1*	*6*	*8*	*0*	*0*	*8*	*3*	*0.04*	*0*	*0.004*	*0*	*0.116*	*0*	*0*	*0*	*0*	*0*	*0.002*	*0*	*0*	*0*	*0.039*	*0.06*	*0*	*0.2*
		X196241	*8.67*	*101*	*90*		*0*	*2*	*25*	*27*	*5*	*8*	*6*	*2*	*9*	*10*	*0.03*	*0*	*0.048*	*0*	*0.196*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.5*
		AVERAGE	7.73	75.5	81		0	1	13	14	5.5	8	3	1	8.5	6.5	0.035	0	0.026	0	0.156	0	0	0	0	0	0.001	0	0	0	0.0195	0.03	0	0.35
	TRANSITION - outside of pit	*X181581*	*7.06*	*40*	*22*	*0*	*0*	*0*	*4*	*4*	*2*	*7*	*0*	*0*	*8*	*3*	*0.1*	*0*	*0.002*	*0*	*0.472*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.02*	*0.21*	*0*	*0.3*
		X184764	*6.57*	*22*	*10*	*0*	*0*	*0*	*3*	*3*	*0*	*3*	*0*	*0*	*4*	*3*	*0.12*	*0*	*0.002*	*0*	*0.302*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.006*	*0*	*0*	*0.3*
		X184780	*6.6*	*30*	*5*	*0*	*0*	*0*	*3*	*3*	*2*	*6*	*0*	*0*	*6*	*2*	*0.02*	*0*	*0.004*	*0*	*0.428*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.2*
		X173929	*6.64*	*45*	*10*	*0*	*0*	*0*	*3*	*3*	*2*	*8*	*0*	*0*	*8*	*4*	*0.01*	*0*	*0*	*0*	*0.568*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.013*	*0*	*0*	*0.7*
		X183227	*6.64*	*43*	*18*	*0*	*0*	*0*	*3*	*3*	*3*	*7*	*0*	*0*	*7*	*4*	*0.04*	*0*	*0.002*	*0*	*0.615*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.24*	*0*	*0.2*
		AVERAGE	6.7175	34.25	11.75	0	0	0	3.25	3.25	1.5	6	0	0	6.5	3	0.0625	0	0.002	0	0.4425	0	0	0	0	0	0	0	0	0	0.00975	0.05255	0	0.375
SILTSTONE	TRANSITION - outside of pit	*X183253*	*6.54*	*17*	*5*	*0*	*0*	*0*	*2*	*2*	*0*	*3*	*0*	*0*	*3*	*2*	*0.02*	*0*	*0*	*0*	*0.407*	*0*	*0*	*0*	*0*	*0.001*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
		AVERAGE	6.64	43	18	0	0	0	3	3	3	7	0	0	7	4	0.04	0	0.002	0	0.615	0	0	0	0	0	0	0	0	0	0	0.24	0	0.2
INTERCALATED SANDSTONES AND SILTSTONES	OXIDISED	*X201983*	*6.16*	*20*		*0*	*0*	*0*	*3*	*3*	*2*	*1*	*0*	*0*	*3*	*3*	*0.41*	*0*	*0.005*	*0*	*0.18*	*0*	*0*	*0*	*0*	*0*	*0.043*	*0*	*0*	*0*	*0.149*	*0.4*	*0*	*0*
		X201984	*6.21*	*15*		*0*	*0*	*0*	*3*	*3*	*2*	*2*	*0*	*0*	*4*	*0*	*0.16*	*0*	*0.003*	*0*	*0.131*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.039*	*0.11*	*0*	*0.2*
		X201985	*6.11*	*42*		*0*	*0*	*0*	*3*	*3*	*12*	*2*	*0*	*0*	*8*	*3*	*0.2*	*0*	*0.002*	*0*	*0.316*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.088*	*0.1*	*0*	*0.7*
		X201986	*6.27*	*41*		*0*	*0*	*0*	*4*	*4*	*6*	*5*	*0*	*0*	*10*	*0*	*0.22*	*0*	*0.003*	*0*	*0.251*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.07*	*0.09*	*0*	*0.5*
		X201987	*7.24*	*107*		*0*	*0*	*0*	*39*	*39*	*6*	*6*	*6*	*3*	*14*	*4*	*0.08*	*0*	*0.02*	*0*	*0.281*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.041*	*0*	*0*	*0.7*
		X187428	*7.13*	*77*	*44*	*0*	*0*	*0*	*9*	*9*	*11*	*8*	*2*	*0*	*10*	*6*	*0.07*	*0*	*0*	*0*	*0.409*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.03*	*0*	*0*	*0.4*
		AVERAGE	6.52	50.33	44.00	0.00	0.00	0.00	10.17	10.17	6.50	4.00	1.33	0.50	8.17	2.67	0.19	0.00	0.01	0.00	0.26	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.07	0.12	0.00	0.42

UNIT_NAME	PHASE	SAMPLE ID	pH Value	Electrical Conductivity @ 25°C_µS/cm	Total Dissolved Solids @180°C_mg/L	Moisture Content (dried @ 103°C)_%	Hydroxide Alkalinity as CaCO3_mg/L	Carbonate Alkalinity as CaCO3_mg/L	Bicarbonate Alkalinity as CaCO3_mg/L	Total Alkalinity as CaCO3_mg/L	Sulfate as SO4 - Turbidimetric_mg/L	Chloride_mg/L	Calcium_mg/L	Magnesium_mg/L	Sodium_mg/L	Potassium_mg/L	Aluminium_mg/L	Antimony_mg/L	Arsenic_mg/L	Beryllium_mg/L	Barium_mg/L	Cadmium_mg/L	Chromium_mg/L	Cobalt_mg/L	Copper_mg/L	Lead_mg/L	Manganese_mg/L	Nickel_mg/L	Selenium_mg/L	Vanadium_mg/L	Zinc_mg/L	Iron_mg/L	Mercury_mg/L	Fluoride_mg/L
INTERCALATED SANDSTONES AND SILTSTONES	TRANSITION	X187429	*6.75*	*64*	*36*	*0*	*0*	*0*	*4*	*4*	*10*	*8*	*0*	*0*	*10*	*5*	*0.03*	*0*	*0*	*0*	*0.35*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.034*	*0*	*0*	*0.3*
		X202017	*6.2*	*74*		*0*	*0*	*0*	*2*	*2*	*11*	*11*	*0*	*0*	*9*	*9*	*0.02*	*0*	*0.01*	*0*	*0.173*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.071*	*0*	*0*	*0.8*
		X202019	*6.13*	*52*		*0*	*0*	*0*	*3*	*3*	*7*	*8*	*0*	*0*	*8*	*5*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.6*
		X202020	*6.13*	*37*		*0*	*0*	*0*	*2*	*2*	*2*	*7*	*0*	*0*	*5*	*6*	*0.05*	*0*	*0.008*	*0*	*0.129*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.078*	*0*	*0*	*0.4*
		X202021	*6.1*	*49*		*0*	*0*	*0*	*3*	*3*	*4*	*8*	*0*	*0*	*9*	*4*	*0.12*	*0*	*0.008*	*0*	*0.441*	*0*	*0*	*0*	*0*	*0*	*0*	*0.001*	*0*	*0*	*0.087*	*0.06*	*0*	*0.5*
		X202022	*6.14*	*39*		*0*	*0*	*0*	*2*	*2*	*2*	*8*	*0*	*0*	*8*	*3*	*0.06*	*0*	*0.005*	*0*	*0.353*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.059*	*0*	*0*	*0.5*
		AVERAGE	6.24	52.5	36	0	0	0	2.67	2.67	6	8.33	0	0	8.17	5.33	0.05	0	0.007	0	0.24	0	0	0	0	0	0	0	0	0	0.05	0.01	0	0.52
	FRESH - outside of pit	X191591	*7.18*	*45*	*22*	*0*	*0*	*0*	*4*	*4*	*2*	*7*	*0*	*0*	*9*	*2*	*0.5*	*0*	*0.014*	*0*	*0.322*	*0*	*0*	*0*	*0.001*	*0*	*0.004*	*0*	*0*	*0*	*0.017*	*0.63*	*0*	*0.2*
		X191592	*6.82*	*41*	*31*	*0*	*0*	*0*	*4*	*4*	*2*	*7*	*0*	*0*	*9*	*1*	*0.72*	*0*	*0.017*	*0*	*0.335*	*0*	*0*	*0*	*0.001*	*0*	*0.007*	*0.001*	*0*	*0*	*0.022*	*1.34*	*0*	*0.1*
		X191617	*6.92*	*70*	*41*	*0*	*0*	*0*	*5*	*5*	*6*	*10*	*0*	*0*	*16*	*1*	*0.47*	*0*	*0.01*	*0*	*0.31*	*0*	*0.002*	*0*	*0.002*	*0*	*0.003*	*0*	*0*	*0*	*0.023*	*0.67*	*0*	*0.5*
		X191618	*6.94*	*50*	*37*	*0*	*0*	*0*	*4*	*4*	*5*	*6*	*0*	*0*	*12*	*0*	*0.92*	*0*	*0.011*	*0*	*0.342*	*0*	*0.001*	*0*	*0.002*	*0*	*0.004*	*0*	*0*	*0*	*0.023*	*0.92*	*0*	*0.4*
		X174577	*6.9*	*41*	*22*	*0*	*0*	*0*	*5*	*5*	*3*	*5*	*0*	*0*	*7*	*3*	*0.24*	*0*	*0.002*	*0*	*0.526*	*0*	*0*	*0*	*0*	*0*	*0.008*	*0*	*0*	*0*	*0.016*	*0.48*	*0*	*0.5*
		X174586	*6.97*	*25*	*14*	*0*	*0*	*0*	*4*	*4*	*2*	*3*	*0*	*0*	*5*	*2*	*0.41*	*0*	*0.004*	*0*	*0.39*	*0*	*0*	*0*	*0*	*0*	*0.006*	*0*	*0*	*0*	*0.012*	*0.38*	*0*	*0.2*
		X174714	*8.63*	*96*	*44*	*0*	*0*	*2*	*24*	*26*	*5*	*7*	*6*	*0*	*9*	*10*	*1.22*	*0.007*	*0.038*	*0*	*0.608*	*0*	*0.001*	*0*	*0.001*	*0.003*	*0.013*	*0*	*0*	*0*	*0.028*	*0.71*	*0*	*0.3*
		X174715	*8.82*	*92*	*40*	*0*	*0*	*3*	*22*	*25*	*4*	*7*	*4*	*0*	*6*	*14*	*0.5*	*0*	*0.019*	*0*	*0.477*	*0*	*0*	*0*	*0*	*0*	*0.001*	*0*	*0*	*0*	*0*	*0.1*	*0*	*0.2*
		X185866	*6.7*	*91*	*105*		*0*	*0*	*2*	*2*	*27*	*6*	*2*	*2*	*9*	*7*	*0.11*	*0*	*0.003*	*0*	*0.273*	*0*	*0*	*0*	*0*	*0*	*0.028*	*0*	*0*	*0*	*0.042*	*0.08*	*0*	*0.2*
		AVERAGE	7.32	61.22	39.56	0	0	0.56	8.22	8.78	6.22	6.44	1.33	0.22	9.11	4.44	0.57	0	0.01	0	0.4	0	0	0	0	0	0.01	0	0	0	0.02	0.59	0	0.29
INTERCALATED ANOMALOUS ARSENIC	ALL	*X193248*	*6.85*	*49*	*92*		*0*	*0*	*2*	*2*	*4*	*8*	*0*	*0*	*8*	*5*	*0.15*	*0*	*0.016*	*0*	*0.127*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.042*	*0.28*	*0*	*0.6*
		X196347	*6.9*	*47*	*45*		*0*	*0*	*2*	*2*	*9*	*4*	*0*	*0*	*7*	*6*	*0.04*	*0*	*0.01*	*0*	*0.241*	*0*	*0*	*0*	*0*	*0*	*0.005*	*0*	*0*	*0*	*0.043*	*0.06*	*0*	*0.4*
		X200943	*7.19*	*63*	*58*		*0*	*0*	*4*	*4*	*4*	*9*	*0*	*0*	*7*	*10*	*0.03*	*0*	*0.002*	*0*	*0.282*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.045*	*0*	*0*	*0.6*
		X195974	*6.54*	*36*	*12*	*0*	*0*	*0*	*2*	*2*	*2*	*7*	*0*	*0*	*6*	*4*	*0.05*	*0*	*0*	*0*	*0.222*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0.008*	*0*	*0*	*0.2*
		AVERAGE	6.87	48.75	51.75	0	0	0	2.5	2.5	4.75	7	0	0	7	6.25	0.07	0	0.01	0	0.22	0	0	0	0	0	0	0	0	0	0.03	0.09	0	0.45

3.5.1 Oxidised Sandstone

Table 4 presents the results of the leachate testing conducted by ABM, with the concentrations compared against the NWQMS water guidelines for context. Individual elements at higher levels include arsenic, whereas the rest for the trace elements are at or below limits of detection for the method. Arsenic is high in the leach solutions with an average of 0.026mg/L, reaching a maximum of 0.048 mg/L.

The oxidised sandstone samples returned average concentrations of As of 0.026 mg/L, which is in excess of the guidelines for both As (III) and As (V).

Mineralogical assessments indicate that for all samples there are high concentrations of goethite. Arsenic sorbs strongly to the surface of iron oxides such as goethite and is released under reduced/alkaline conditions (Yannick *et al* 2009). However if the pH conditions do not change then the As can remain sorbed indefinitely. Changes in pH may explain why the arsenic is so readily available in the oxidised units, particularly the sandstone.

Results of the leachate analysis indicate that metalliferous leaching is likely to be limited due to the circum-neutral pH of the oxidised sandstone samples (average 8.1). It can be concluded that, based on the sample leachate results, metalliferous mine drainage is unlikely to occur in these materials.

3.5.2 Transitional Sandstone

The transition sandstone samples reported an average 0.002 mg/L As (Table 4) which falls below the critical guideline values for both As (III) and As (V).

3.5.3 Transitional Siltstone

Arsenic and barium were found to be potentially elevated, with concentrations of the remaining trace elements at or below limits of detection (Table 4). The transition siltstone reported As values below the guidelines values for both As (III) and As (V).

3.5.4 Oxidised Intercalated

The oxidised intercalated samples had an average As content of 0.02 mg/L, which exceeds the guidelines for both As (III) and As (V)(Table 4).

Mineralogical assessments indicate that all samples high in As are also rich in goethite, which sorbs As. However pH remains neutral, reducing risk of release in the short term.

3.5.5 Transition Intercalated

Arsenic, lead and chromium were found to be potentially elevated, with the remaining trace elements found to be at concentrations at or below limits of detection. The transitional Intercalated samples average 0.007 mg/L arsenic which is within the accepted guidelines for As (III) and As (V) (Table 4).

3.5.6 Fresh Intercalated

Arsenic, lead and chromium were found to be potentially elevated, with the remaining trace elements at concentrations at or below the limits of detection. The fresh intercalated

samples report an average As concentration of 0.001 mg/L (Table 4), which is below the accepted guidelines for both As (III) and As (V).

3.5.7 Intercalated – Anomalous Arsenic

The intercalated anomalous arsenic samples were found to be elevated in arsenic with concentrations of up to 0.016 mg/L (Table 4) and exceed the accepted guideline for As (III) but fall below that for As (V).

4. SUMMARY OF MAIN FINDINGS

Arsenic was found to be naturally enriched in the Old Pirate area with GAI that were well above 3 times average-crustal abundances (ACA). However the majority of the As is found to be concentrated in narrow veins within or peripheral to the ore body, with relatively small amounts present in the waste rocks. The majority of the As is associated with arsenopyrite and is closely linked to areas of mineralisation.

The waste rock units have circum-neutral pH (average 6.3) which is likely to be a limited factor for mobilisation of metals. Based on the findings in this report AMD is unlikely to occur.

A summary of each waste rock unit is presented in Table 6.

Table 6. Geochemical Charecterisation and Leahate results sumary for all waste rock units.

Unit Name	Phase	Lithology	Veins	Ore minerals	Alteration	APR	ABA	GAI Enrichment	Leachability
Sandstone	**Oxidised**	Metamorphosed quartz felspathic arenite	Limited amount of quartz veins	None	Moderate Goethite and hematite alteration (XRD analysis- 44.5% mass kaolinite and 3.5% goethite)	Acid/Neutral/Alkaline (could generate acid, alkaline or neutral drainage)	NAF	Arsenic - 5.8-6.6 times average crustal abundance	High GAI for As. Water leachates at neutral pH's would indicate that there would be limited leaching of elements (As).
	Transition	Metamorphosed quartz felspathic arenite	Limited amount of quartz veins	None	Moderate Goethite and hematite alteration	Acid/Neutral/Alkaline predominately, one potential acid drainage sample	NAF	NO DATA	Water leachates at neutral pH's would indicate that there would be limited leaching of elements (As).
	Fresh	Metamorphosed quartz felspathic arenite	Limited amount of quartz veins	Disseminated pyrite <5% in isolated veins and vein selvedges, isolated pyrite and arsenopyrite	None				
Siltstone	**Oxidised**	Metamorphosed quartz felspathic siltstones	Limited amount of quartz veins	None	None				
	Transition	Metamorphosed quartz felspathic siltstones	Limited amount of quartz veins	None	None	Acid/Neutral/Alkaline	NAF	NO DATA	Water leachates at neutral pH's would indicate that there would be limited leaching of elements (As).
	Fresh	None in Pit boundaries							
Intercalated	**Oxidised**	Intercalated metamorphosed quartz feldspathic sandstones and siltstones with minor felsic intrusives	Mainly milky quartz veins (<50%) with lesser amounts of Bucky and Smokey veins	Disseminated pyrite <5% in isolated veins and vein selvedges	12.5% goethite and 14.5% kaolinite	2 alkaline drainage and 4 acid drainage	4 NAF and 2 UC	Arsenic – 5.46 times average crustal abundance	High GAI for As. Water leachates at neutral pH's would indicate that there would be limited leaching of elements (As).
	Transition	Intercalated metamorphosed quartz feldspathic sandstones and siltstones with minor felsic intrusives	Mainly milky quartz veins (<50%)	Disseminated oxidised sulphides <5% in isolated veins and vein selvedges	Goethite and hematite alteration, high proportion of clays	Acid/Neutral/Alkaline	NAF	Arsenic -4.2-8.8 times average crustal abundance	High GAI for As. Water leachates at neutral pH's would indicate that there would be limited leaching of elements (As).

Unit Name	Phase	Lithology	Veins	Ore minerals	Alteration	APR	ABA	GAI Enrichment	Leachability
	Fresh	Intercalated metamorphosed quartz feldspathic sandstones and siltstones with minor felsic intrusives	Mainly milky quartz veins (<50%) with lesser amounts of Bucky and Smokey veins	Disseminated pyrite and arsenopyrite <20% in isolated veins and vein selvedges	None	Acid/Neutral/Alkaline or Acid drainage	NAF	Arsenic -4.2-8.8 times average crustal abundance	High GAI for As. Water leachates at neutral pH's would indicate that there would be limited leaching of elements (As).
Intercalated Anomalous Arsenic samples	**ALL**	Intercalated metamorphosed quartz feldspathic sandstones and siltstones (of the other two waste rock units), with minor felsic intrusives, with mineralised quartz vein stringers	Mainly milky quartz veins (<50%) with lesser amounts of Bucky and Smokey veins	Shear zones, fracture planes and stringers also host high quantities of pyrite (moderate intensity >20%) in isolated millimetre to centimetre scales	23.3mass% kaolinite, 9.6% goethite	Bulk of the samples had Acid/Neutral/Alkaline or alkaline APR's. Several samples were identified to potentially result in acid drainage	Bulk of samples NAF, 2 samples UC	Arsenic – 6.7-9.1 times average crustal abundance	High GAI for As. Water leachates at neutral pH's would indicate that there would be limited leaching of elements (As). A conservative approach would be to isolate this unit in centre of waste dump and manage oxidation of sulphides.
Diorite	**Oxidised**	N/A							
	Fresh	None in Pit boundaries							

5. RECOMMENDATIONS FOR WASTE ROCK UNITS AND CONSTRUCTION OF WASTE ROCK DUMP

Figures 26 and 27 provide a schematic of the proposed rock dump construction and final composition based on the main findings of this report. The figures include the proposed waste unit distribution within the dump.

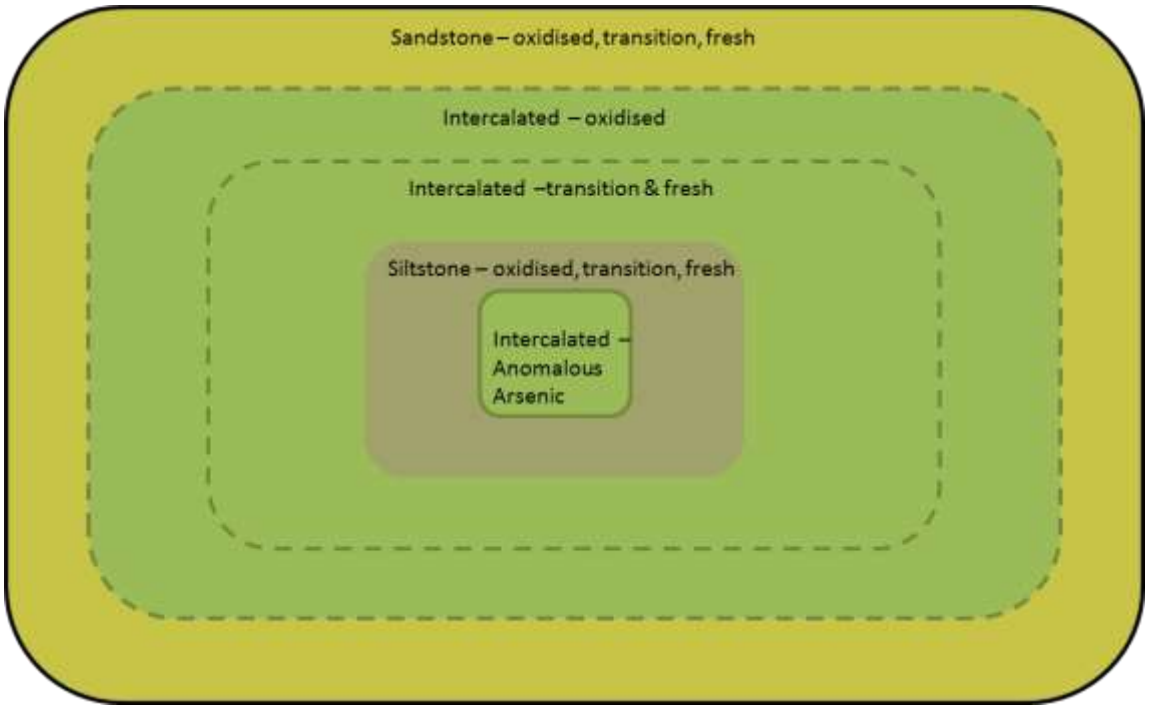

Figure 26. Schematic for waste rock dump construction and proposed waste unit distribution within the dump.

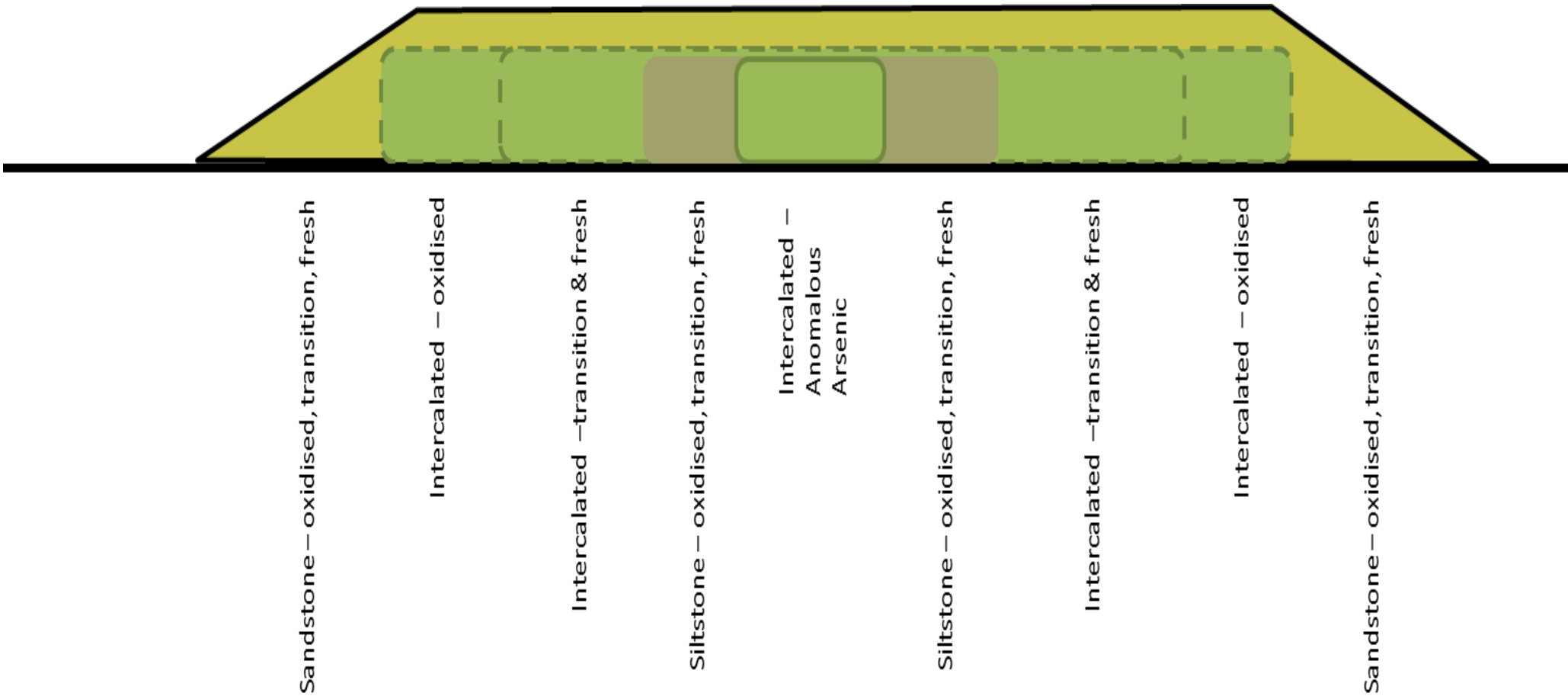

Figure 27. Cross-section schematic for waste rock dump construction and proposed waste unit distribution within the dump.

At a detailed level the proposed treatment for each waste rock unit is outlined below.

5.1 SANDSTONE

The sandstone unit is predominantly benign with trace amounts of pyrite and arsenopyrite associated with small isolated stringer veins that are weakly mineralised. The sandstone units are the most inert units and the most stable for the construction of the outer external batters of the waste rock dump.

5.1.1 Oxidised

The results of the oxidised sandstone unit suggest that the samples contain sufficient buffering capacity to inhibit AMD. In addition, the non-carbonate matrix makes the unit relatively resistant to weathering. These properties make this unit ideal to blend with the transition and fresh sandstone for the construction of the outer external batters of the waste rock dump, encapsulating any adverse chemical or physical units with the potential for AMD (Figure 26).

No sulfides were observed, and the As enrichment results (GAI) are representative of the background values for the Old Pirate deposit.

5.1.2 Transition

The transition sandstone unit is less weathered and will be structurally more competent for the construction of the outer external batters of the waste rock dump, encapsulating any units with the potential for AMD (Figure 31).

No sulphides are observed and the non-acid forming ABA classification suggests it is unlikely that the unit will form metalliferous drainage. Water leachate results report Arsenic in leachates well within the accepted NWQMS water guidelines.

5.1.3 Fresh

The volume of the fresh sandstone unit in the proposed pits is currently nil, however model constraints may result in a very small volume being extracted (<100 tonnes). This material will likely be incorporated into the transitional sandstone material upon extraction and deposition in the waste rock dump (Figure 26).

5.2 SILTSTONE

The siltstone unit is lithologically similar to the sandstones but with a finer grainsize and higher clay / silt component; making it more susceptible to erosion. It is unlikely that the siltstone units (oxidised and transitional) will be appropriate for the external batters of the Waste dump. It is therefore recommended that this material is disposed of in the middle of the dump potentially encapsulating the intercalated anomalous arsenic unit.

5.2.1 Oxidised

The oxidised siltstone is particularly susceptible to weathering with a very high clay content and very small particle size. It is therefore not recommended that the oxidised siltstone unit should be used for the external batters of the waste rock dump. Visual observations of the weathered siltstone verify these findings and suggest that this unit is frittery and prone to erosion.

No ABA analysis has been undertaken on the siltstone.

To be conservative, the siltstone unit will be encapsulated in the centre of the waste dump just outside of the Intercalated Anomalous Arsenic unit (Figure 26).

5.2.2 Transition

The transitional siltstone is physically similar to the oxidised siltstone and is considered particularly susceptible to weathering. Therefore it is not recommended that the transitional siltstone unit be used in the external batters of the waste rock dump.

The NAF classification of this material means that it is unlikely to form AMD. However, no GAI assessment was undertaken on the samples, therefore the transitional unit will be encapsulated along with the oxidised siltstones in the centre of the waste dump and just outside of the Intercalated Anomalous Arsenic unit (Figure 26).

5.2.3 Fresh

There are no fresh siltstone units in the current pit design.

5.3 INTERCALATED

The intercalated unit comprises a mixture of the sandstone and siltstones with minor dolerite intrusives and quartz stringers. The nature of the intercalated unit and proportion of highly erodible siltstone in the unit indicates that the transitional phase will be more susceptible to erosion over time and is not recommended for the external batters of the waste dump.

5.3.1 Oxidised

The oxidised Intercalated unit is characterised by visually logged disseminated pyrite (less than 5%) in isolated veins and vein selvedges. The presence of sulfides generally increases the enrichment of arsenic in isolated pockets of the unit. The APR and ABA classifications are both NAF are enriched with As. A NAF classification suggests it is unlikely to form AMD.

To be conservative, isolated arsenic anomalous samples (outlined in section 1.3.4.4) will be co-blended with the remainder of the unit, which is predominately inert material.

The competency of the intercalated unit is compromised by the siltstone component, and the unit will not be suitable for the external batters of the waste dump. ABM proposes to place the oxidised intercalated unit within the external batters of the waste dump, which are proposed to comprise the sandstone units (Figure 26) as the unit is relatively benign (with circum-neutral pH's and low AMD potential), and more resistant to weathering than siltstone.

5.3.2 Transition

The Transitional Intercalated unit is similar to the Oxidised intercalated unit, and as such will be handled in the same way as the oxidised intercalated. The APR and ABA classifications

are non-acid forming (NAF) with a high Arsenic GAI, Non-acid forming ABA classification suggests it unlikely to form metalliferous drainage.

5.3.3 Fresh

The Fresh intercalated unit comprises a small percentage of the total intercalated units' volume and therefore will be will be co-blended with the transitional intercalated unit, prior to placement in the waste dump (Figure 26). The unit is relatively benign, and more resistant to weathering than siltstone.

5.4 Intercalated Anomalous Arsenic

The localised content of pyrite, arsenopyrite and other sulfides, as observed in the geological logging, is a visual estimation. These observations were made in core (and RC chips), along sections approximately 1m length, and are only found in stringer zones, adjacent to the ore. It is important to remember that the geological logging is subjective data and the As enrichment of the unit is marginally higher than the benign sandstone unit.

Acid potential ratios indicate a mixed APR classification, and ABA classification confirms that some samples within the unit are uncertain in regards to whether they will produce AMD, due to the low buffering capacity of the rocks. In these cases the analysis suggests that the rock does not have the capacity to neutralise the acid generated from the oxidation of the low quantities of pyrite.

It is suggested that ABM take a conservative approach with the intercalated anomalous arsenic units; and if not economically viable for potential processing, those proximal to ore are placed as waste in the centre of the waste rock dump and surrounded by more inert material (i.e. sandstone), to prevent the chance of leachates and the adverse effects of As enrichment in the natural environment (Figure 26). If defined as low grade ore the material should be stockpiled and managed to prevent runoff. In the event it is not processed the material requires encapsulation by benign waste at closure.

5.4 DIORITE

The Diorite unit predominantly occurs outside the pit external batters and makes up a very small proportion of the pit volumes. The unit is not considered a major component of the mined material, and is unlikely to pose a significant environmental risk. This unit will be co-blended with the transitional and fresh intercalated units, and placed in the waste dump accordingly.

6. CONCLUSIONS

The bulk waste material is classified as benign with limited potential for Acid Mine Drainage. However there are minerals in the system that could lead to the potential leaching of elements to the environment, these include arsenopyrite, pyrite and galena; producing As and Pb. To limit the potential for leaching it is recommended that the intercalated arsenic unit (if not managed and processed as a low grade stockpile) is encapsulated by inert waste in the waste rock dump to limit the ingress of water and oxygen. Limiting access of water and oxygen will assist in reducing changes in pH and water leaching of the material.

ABM have proposed a waste rock dump that uses the most benign and stable waste materials as the outer embankment of the waste dump and isolating, by covering with inert waste, those with the highest sulphide concentrations and potential for leaching and erosion. The circum-neutral pH, with the majority of the samples having ANC/MPA ratios greater than 2, suggests that the pH of the waste rock units should be well buffered, however ongoing surface and ground water monitoring will be essential around the waste rock dump.

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APPENDICES

APPENDIX A – PENDRAGON REPORT

APPENDIX B – DEFINITION OF PHI

The Phi scale (table 6) provides a basis for a terminology that describes grain size.

Grainsize is expressed in units called Phi units (ϕ).

Table 7. Phi Scale for grain size.

φ scale	Size range (metric)	Aggregate name (Wentworth Class)	Other names
−8 <	256 mm <	Boulder	
−6 to −8	64–256 mm	Cobble	
−5 to −6	32–64 mm	Very coarse gravel	Pebble
−4 to −5	16–32 mm	Coarse gravel	Pebble
−3 to −4	8–16 mm	Medium gravel	Pebble
−2 to −3	4–8 mm	Fine gravel	Pebble
−1 to −2	2–4 mm	Very fine gravel	Granule
0 to −1	1–2 mm	Very coarse sand	
1 to 0	½–1 mm	Coarse sand	
2 to 1	¼–½ mm	Medium sand	
3 to 2	125–250 µm	Fine sand	
4 to 3	62.5–125 µm	Very fine sand	
8 to 4	3.90625–62.5 µm	Silt	Mud
> 8	< 3.90625 µm	Clay	Mud
> 10	< 1 µm	Colloid	Mud

In some schemes, gravel is anything larger than sand (comprising granule, pebble, cobble, and boulder in the table above).

Tailings Acid Mine Drainage and Leachate Assessment

Old Pirate Operations, ABM Resources

Revision No 1
February 2013

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Report

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File:	PES11009
Author(s):	Dr Edgardo Alarcón Léon
Client:	EcOz Environmental Services for ABM Resources NL
Contact:	Ray Hall
Synopsis:	This document details the acid mine drainage and leachate investigations of ore-tailing materials from the Old Pirate Operations in the Northern Territory.

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Abbreviations

ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ASLP	Australian Standard Leaching Procedures
DEHWA	Commonwealth Department of the Environment, Water, Heritage and the Arts
DME	Northern Territory Department of Mines and Energy
LoR	Limit of Reporting
MMP	Mining Management Plan
NLC	Northern Land Council
WMP	Water Management Plan
ha	hectare
hr	hour
km	kilometre
m	metre
yr	year
s	second

Acid Mine Drainage:

Acronym	Parameter Definition/(Determination)	Unit
ACM	Acid Consuming Materials	kgH_2SO_4/ton
AFP	Acid Formation Potential	kgH_2SO_4/ton
AMD	Acid Metalliferous Drainage	
ANC	Acid Neutralisation Capacity (Laboratory Analysis)	kgH_2SO_4/ton
APR	Acid Potential Ratios (Calculation)	
ARD	Acid Rock Drainage	
MPA	Maximum-Potential Acidity (Calculation)	kgH_2SO_4/ton
NAF	Non Acid Forming (Calculation): - Sulfide-S < 0.3% - Sulfide-S ≥ 0.3%, and negative NAPP value with ANC/MPA ≥ 2.0	kgH_2SO_4/ton
NAG	Net Acid Generation (Laboratory Analysis)	kgH_2SO_4/ton
NAPP	Net Acid Producing Potential (Calculation)	kgH_2SO_4/ton
PAF	Potential Acid Forming (Calculation): - Sulfide-S ≥ 0.3% and any positive NAPP value - Sulfide-S ≥ 0.3% and a negative NAPP value with ANC/MPA < 2.0	kgH_2SO_4/ton
SOR	Sulfide Oxidation Rate ['kinetic' testing]	$mgSO_4/kg/week$
Sulfide-S	Sulfide Sulfur [Sulfide-S = Total-S - Sulfate-S]	%(w/w)
Total-S	Total Sulfur (Laboratory Analysis)	%(w/w)

Executive Summary

Background

Pendragon Environmental Solutions Pty Ltd was engaged by EcOz Environmental Services, on behalf of ABM Resources NL (ABM), to undertake assessments of bulk sample materials to assess the geochemical risk associated with tailings produced from the materials. The assessment included Acid Mine Drainage (AMD) and leachate quality investigations of laboratory testing of the bulk sample materials.

ABM intends to trial mine and process 10,000t of ore extracted from the shallow mineralised zone at the Old Pirate area. This trial will result in some 10,000t of tailings which will be disposed of in a tailings storage facility (TSF).

Objectives and Scope of Work

The objective of this study is to evaluate whether the tailings will pose a threat to the environment as a result of acid mine drainage (AMD) as expressed by:

- The potential of materials to generate acid.
- Solubility of trace metals that may leach from the materials once contained in the TSF.

Salient Findings

Twenty two samples comprising both bulk and pulp materials were assessed. The bulk samples represented ore-tailings and were collected from trenches whilst the pulp samples comprised materials which may contain low grade ore from the gravity recoverable gold tests (GRGG).

All samples were characterised for their qualitative and quantitative properties by means of X-Ray Diffraction (XRD) and X-Ray Fluorescence (XRF). The Potential for Acid Formation (PAF) of the ore-tailings materials was assessed by determining the pH of paste solutions, oxidation pH, Total-S, acid-neutralization capacity (ANC) and net-acid generation (NAG).

To assess the short term quality of seepages that may originate during processing and from the TSF, samples were leached using de-ionised water and analysed for a set of analytes including pH, electrical conductivity, major ions and key trace element fingerprints.

Relevant observations resulting from these studies are:

- Minerallogically both sets of samples contain significant amounts of phyllosilicates and amorphous materials and are chemically enriched by arsenic, tin and lead.
- The great majority of the samples (95%) can be classified as non-acid forming (NAF) materials. Owing to its high sulfide as S concentration, only one pulp sample can be characterised as ‘uncertain’ and therefore, if warranted, may require further assessment for its potential to produce acidity.
- Owing to apparent conflicting results between NAPP and NAG results in about 50% of the pulp samples, these may be classified with a potential to produce acidity. However, because the other ABA parameters, including Sulfide (as S) concentrations, are very low and/or insignificant, these materials can be classified as having very low or no acid forming capacity.
- pH values of all samples are circum-neutral and major ions are very low in concentrations, with sodium being the highest in most of the pulp samples.

- The concentrations of trace elements in all the samples are relatively low and most are below their limits of reporting. However, the exception is arsenic which occurs in elevated concentrations in all samples and appears to be readily available for release or mobilisation in the short term.
- Elemental concentrations and behaviour indicate that short term leachate qualities in all samples will likely have low concentrations of most traces and would not represent an immediate risk to the wider environment.

Conclusions and Recommendations

Most of the samples are characterised with having low likelihood of producing acidity. One sample returned results that are inconclusive. However, for this relatively small-scale bulk sampling activity, the uncertainty in the assessment is considered to present a relatively low risk overall. The development of specific AMD management procedures is therefore not warranted.

It is recommended that:

- Should the project move towards full-scale mining, more targeted studies be conducted to assist in further assessment of the current uncertainty presented by sample X201983 and those samples defined as 'uncertain' in the APR assessment.
- Weekly to monthly monitoring of tail solutions be conducted to detect potential loading of arsenic. Results should assist in ascertaining long term monitoring and rehabilitation processes and systems.

1. Introduction

Pendragon Environmental Solutions Pty Ltd was engaged by EcOz Environmental Services, on behalf of ABM Resources NL (ABM), to undertake Acid Mine Drainage (AMD), including leachate quality, assessments on bulk and pulp samples from the Old Pirate Operations. It is the intention to trial mine and process 10,000t of ore extracted from the Old Pirate area. The resultant tailings from this activity will be disposed of in a tailings storage facility (TSF), designed to store the tailings below ground level. Rehabilitation of the TSF will raise the natural ground level by 1.0m.

1.1 Objectives

The Department of Mines and Energy (DME) indicated that some bulk and pulp samples should be characterised. The objective of this study is to evaluate whether the tailings will pose an environmental hazard as a result of acid mine drainage (AMD) as expressed by:

- The potential of materials to generate acid.
- Solubility of trace metals that may leach from the TSF.

Analytical data used in this study include:

- X-Ray Diffraction (XRD).
- X-Ray Fluorescence (XRF).
- Acid Base Accounting (ABA).
- Leachate quality.

2. Site Characteristics

2.1 Location

The Old Pirate Gold Deposit is located in the Northern Territory of Australia in the Buccaneer Porphyry Gold Deposit (Figure 2.1).

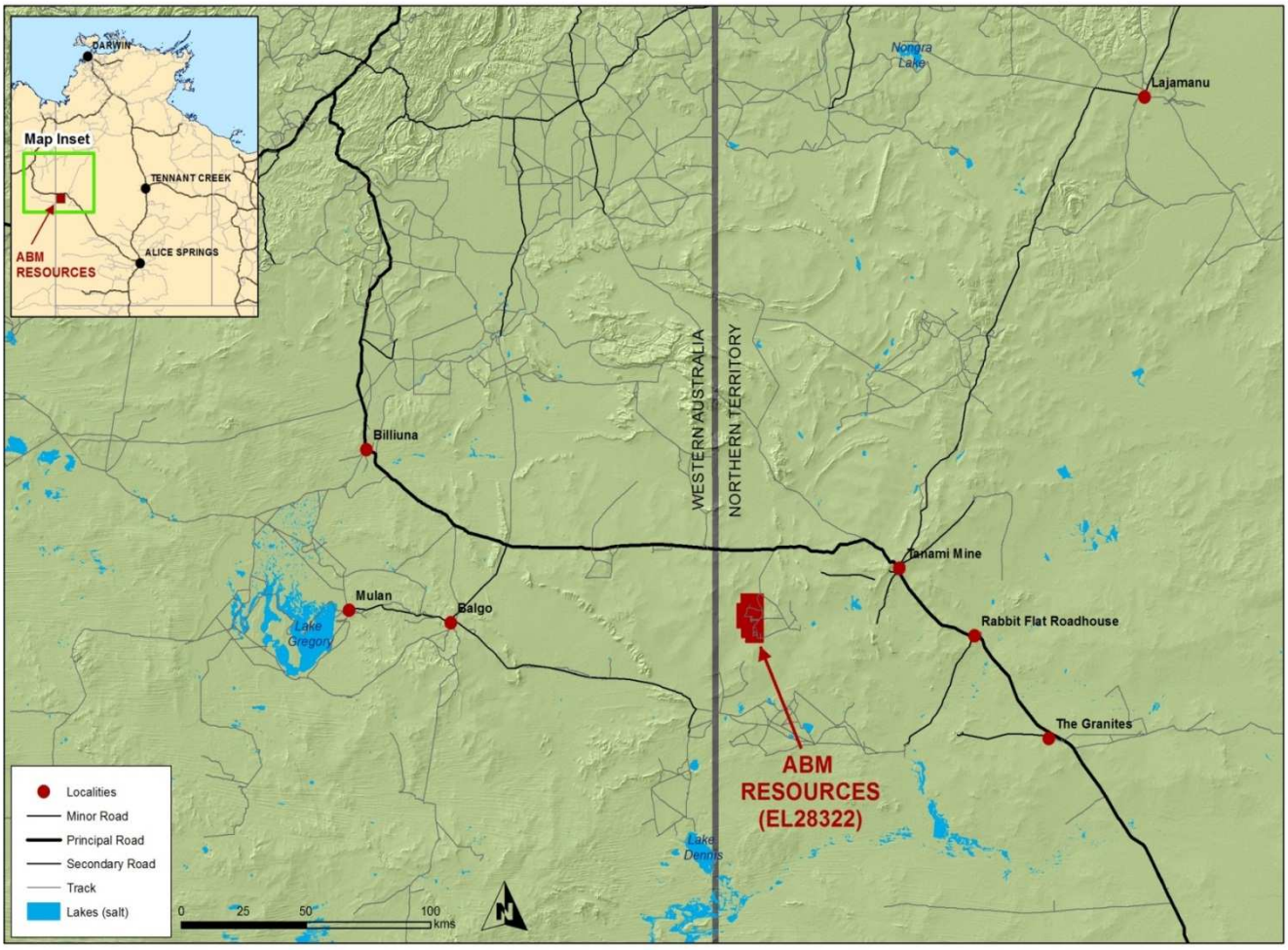

Figure 2.1: Location of the Old Pirate Deposit.

2.2 Climate

The project area is located in an arid subtropical climate with a distinctive dry (May to October) and a hot humid wet (November to April) season. Most rainfall occurs in the summer months between November and March (Figure 2.2). Rabbit Flat, the nearest weather station, has a mean annual precipitation of 427mm and an annual mean temperature of 33.6℃. Monthly temperatures vary from a December mean Maximum of 39℃ to 13 to 15℃ coole r during the winter months.

2.3 Geology and Geomorphology

The regional geology of the area has been described by many investigators (e.g. Wilford, 2003) to comprise of two major Precambrian tectonic units, with the oldest rocks related to the Granites-Tanami Block, including the lower Proterozoic metamorphosed sedimentary and volcanic rock, and the lower

to mid Proterozoic granites and acid volcanic rocks. The Birrindudu Basin sediment unit consist of arenite, siltstone, limestone, sandstone and others such as conglomerates (Wilford, 2003). These Proterozoic rocks are overlain by the Cambrian Antrim Plateau Volcanic and Upper Cambrian shallow marine and terrestrial sediments. The Cambrian and Proterozoic rocks are separated from the Cretaceous sediments by a major unconformity.

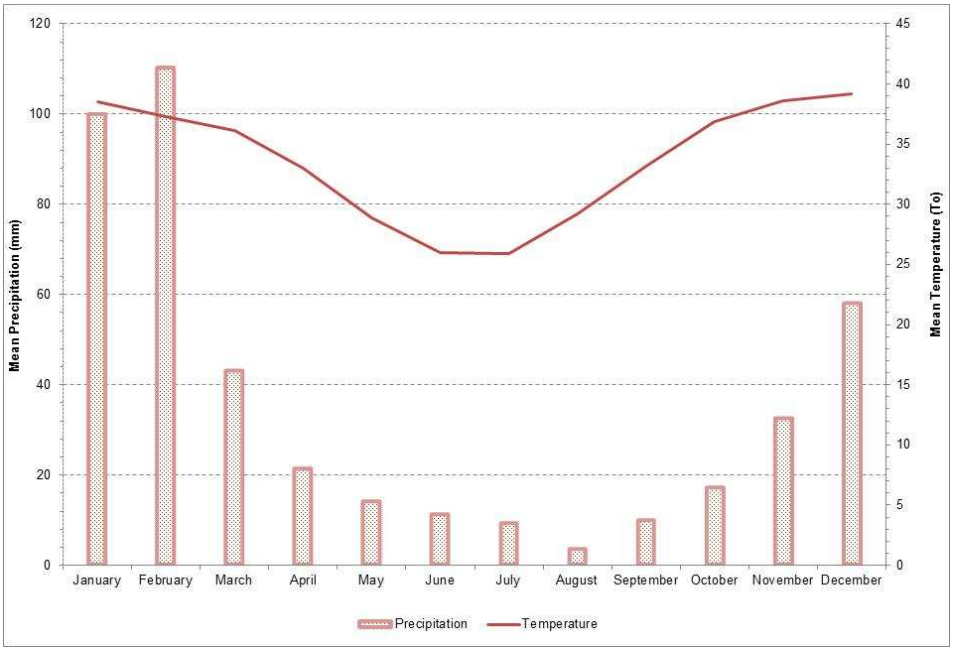

Figure 2.2: Average Monthly Temperature and Precipitation at the Rabbit Flat Station.

Locally, the Old Pirate deposit represents a high-grade (coarse) gold vein system hosted by a sequence of interlayered sandstone and shale horizons. Quartz veins ranging from 30cm to 6m in thickness host the gold mineralisation. The mineralised quartz veins preferentially follow the shale horizons with the 'mega' shales up to 25m thick (ABM Resources, 2012).

Low relief, almost flat and undulated landforms blanket the region. Outcrops are rare and bedrock is weathered extensively. Indurated regolith materials are formed by cementation with iron, silica and carbonates particularly along and above the scarp edges.

3. Geochemical Evaluation

3.1 Sample Collection

A total of 20 pulp and 8 composite samples, to compose 2 bulk samples, were obtained for this preliminary assessment (Appendix A). Locations of the composite bulk samples are indicated in Table 3.1 and Figure 3.1. Locations of the pulp samples appear in Table 3.2 and Figures 3.2 and 3.3. Bulk samples were collected from trenches and pulp samples from the gravity recoverable gold tests (GRGG). The ore-tailing samples; i.e. bulk/composite samples, comprise 3 samples from the eastern side, 2 from the central part of an area within the folding system and 3 from the western side of the proposed bulk sampling area (Figure 3.1). The pulp samples, i.e. materials which may contain low grade ore, are from the north-western side (Figure 3.2).

Table 3.1: Location of the Ore-Tailing (Bulk/Composite) Samples.

Sample ID	Eastern	Northern	Elevation (mRL)
T01575	516722	7767917	450
T01572	516722	7767920	450
T00301	516601	7767884	450
T00269	516635	7767917	452
T01215	516508	7768121	450
T00073	516642	7767893	452
T01941	516486	7768191	450
T01497	516720	7767981	450

Table 3.2: Location of the Pulp Samples.

Sample ID	Hole ID (prefix OPRC100)	From	To	Coordinates East	Coordinates North	Depth (mRL)	Weathering	Lith 1	Lith 1 %	Lith 2	Lith 2 %	Lith 3	Lith 3 %
X202044	200	1	2	516365	7768248	448	HW	NR	100				
X202045	200	2	3	516365	7768248	447	MW	SS	100				
X202046	200	3	4	516366	7768248	446	MW	SS	100				
X202047	200	4	5	516366	7768248	445	MW	SS	90	ST	10		
X201983	197	0	1	516424	7768326	449	HW	NR	100				
X201984	197	1	2	516425	7768326	448	HW	NR	100				
X201985	197	2	3	516425	7768326	447	MW	SS	100				
X201986	197	3	4	516426	7768326	446	MW	SS	100				
X201987	197	4	5	516426	7768326	446	MW	SS	100				
X202017	197	34	35	516441	7768326	419	MW	QT	90	ST	10		
X202019	197	36	37	516442	7768326	418	MW	NR	90	SS	5	Qz	5
X202020	197	37	38	516442	7768326	417	MW	NR	90	SS	5	Qz	5
X202021	197	38	39	516443	7768326	416	MW	NR	90	SS	5	Qz	5
X202022	197	39	40	516443	7768326	415	MW	NR	90	SS	5	Qz	5
X201777	195	88	89	516435	7768351	371	MW	NR	90	ST	10		
X201778	195	89	90	516436	7768351	370	MW	NR	89	ST	10	SS	1
X201779	195	90	91	516436	7768351	369	MW	NR	75	SS	20	ST	5
X201780	195	91	92	516437	7768351	368	MW	ST	95	SS	5		
X201781	195	92	93	516437	7768351	367	MW	SS	95	ST	5		
X201782	195	93	94	516438	7768351	367	MW	SS	95	ST	5		

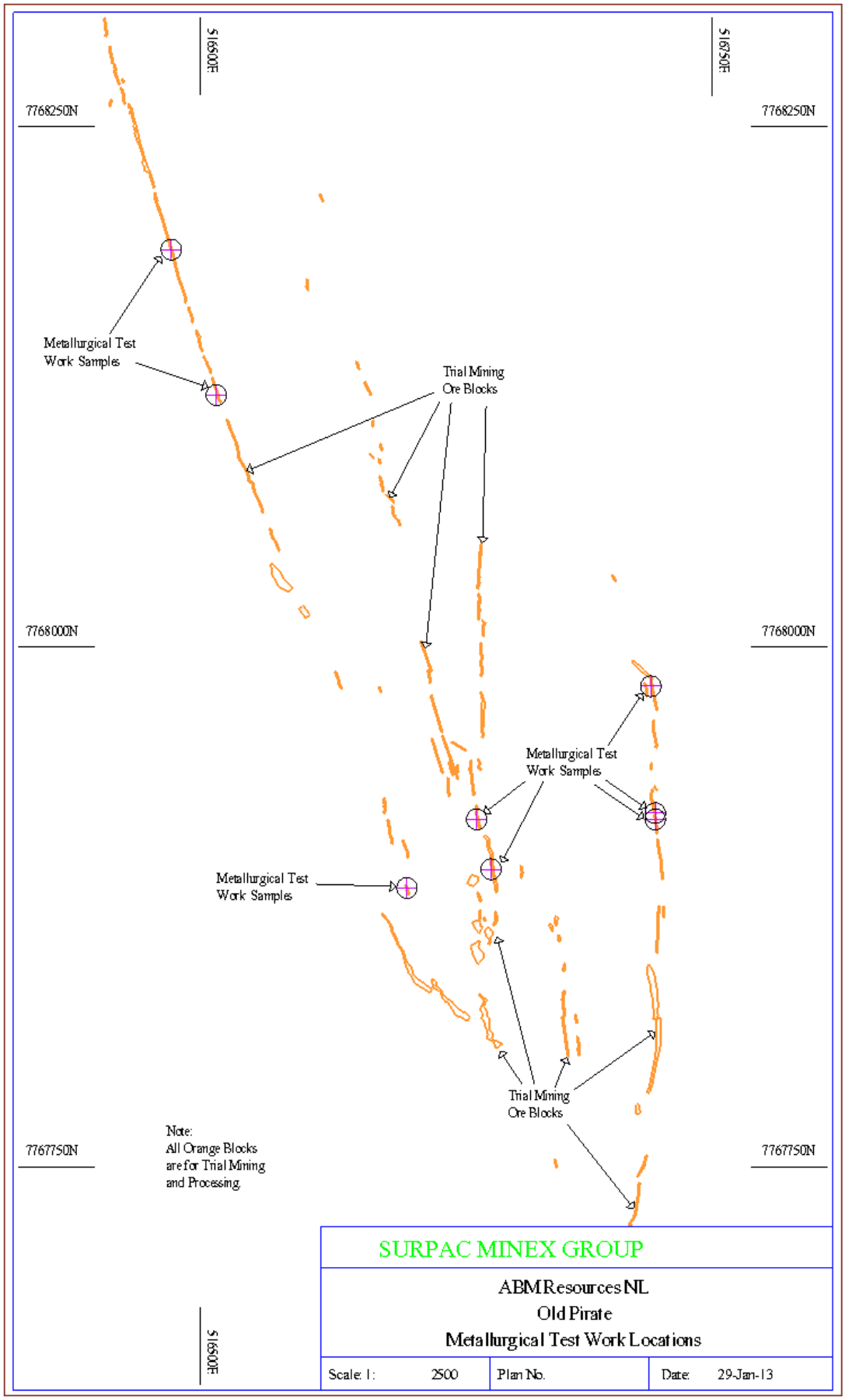

Figure 3.1: Locations of the Ore-Tailing Bulk/Composite Samples.

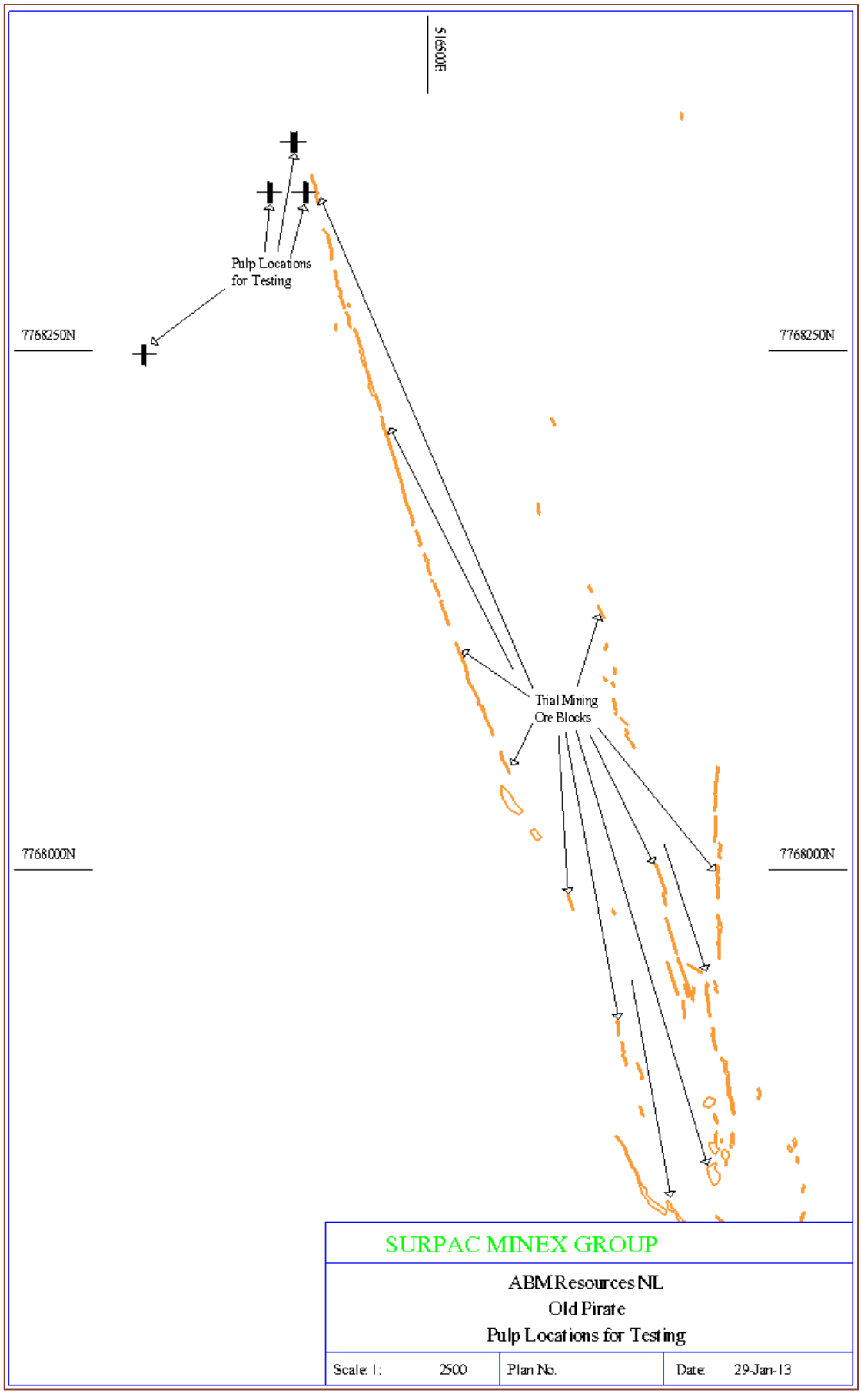

Figure 3.2: Location of the Pulp Samples for Analytical Testing.

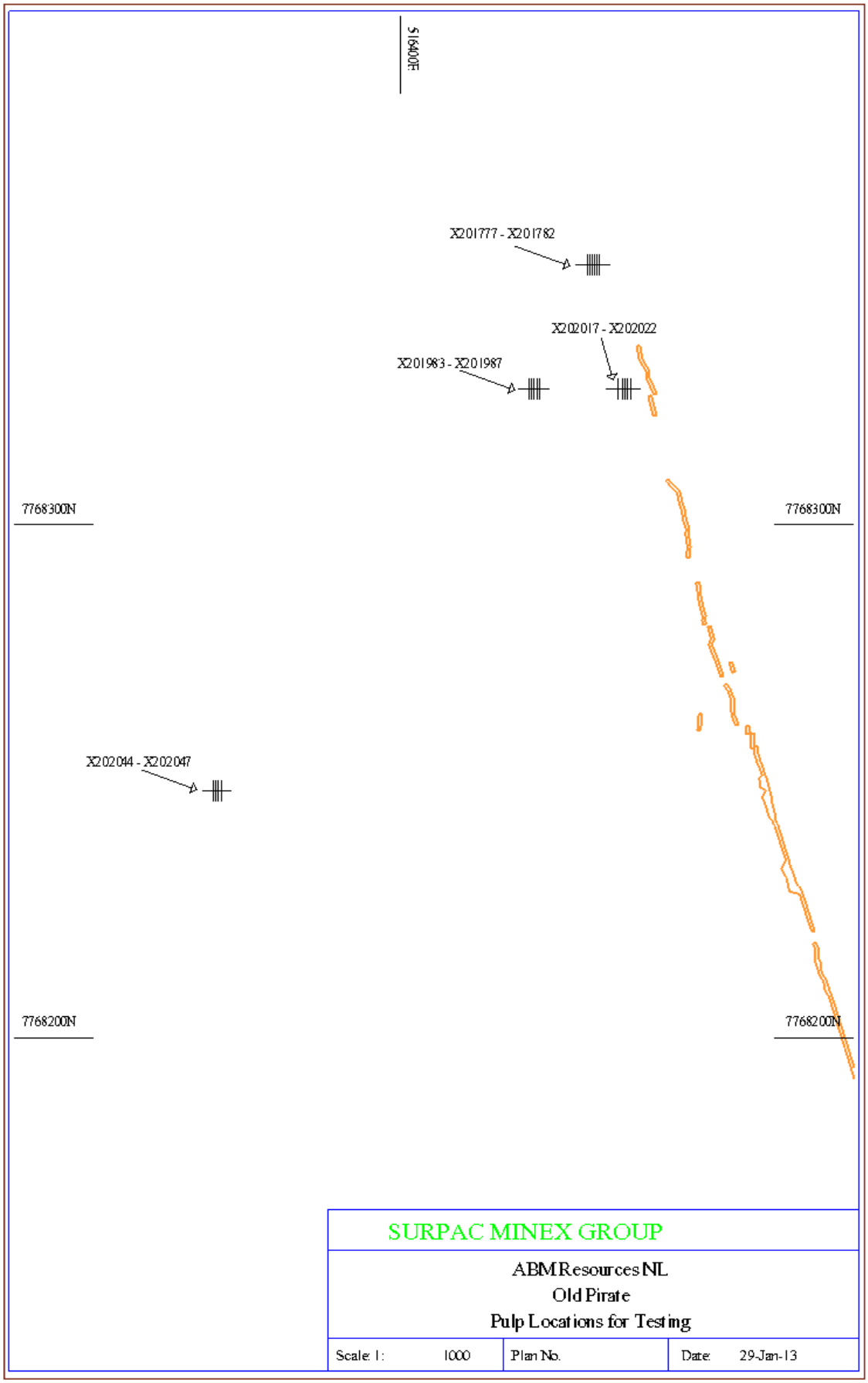

Figure 3.3 : Location of the Pulp Samples Showing Sample IDs.

3.2 Mineralogical Assessment

X-Ray Diffraction (XRD) and X-Ray fluorescence (XRF) assays were undertaken on twenty tailing samples. XRF data is used to analyse the geochemical abundance index (GAI, Förstner *et al.*, 1993) which assesses the enrichment of the samples by major elements:

GAI = log[(Cn/(1.5*Bn)),2]

where Cn is the measured content of the n^{th} element in the sample and Bn is the average-crustal-abundance of the element.

Analysing enrichment employs:

GAI	Symbol	Relevance
0	AC	The content of the element is less than, or similar to, the average-crustal-abundance.
1	3F	A 3 - fold enrichment above the average-crustal-abundance.
2	6F	A 6 - fold enrichment above the average-crustal-abundance.
3	12F	A 12 - fold enrichment above the average-crustal-abundance.
4	24F	A 24 - fold enrichment above the average-crustal-abundance.
5	48F	A 48 - fold enrichment above the average-crustal-abundance.
>6	96F	A 96 - fold, or greater, enrichment above the average-crustal-abundance.

3.3 Acid Base Accounting (ABA and NAG Tests)

The Potential for Acid Formation (PAF) of the ore-tailings materials was assessed by determining the pH of paste solutions, oxidation pH, Total-S, acid-neutralization capacity (ANC) and net-acid generation (NAG). Whilst ABA and NAG tests have limitations, both tests in combination increase the reliability of predicting acid generation in waste and ore materials (INAP, 2009). These tests have been widely used and are based on accepted methodologies for the geochemical characterisation of mine waste materials (e.g., INAP, 2009; DITR, 2007; Alarcón León et al 2004; Scharer et al., 2000; Rose and Cravotta, 1998; Morin and Hutt, 1997; Miller et al., 1997 and Sobek et al., 1978).

3.4 Hydrogeochemical Assessment

Leachate tests employed in this study are based on accepted procedures for the characterisation of mines wastes, including leaching using de-ionised water in accordance with Australian Standard Leaching Procedures (ASLP INAP, 2009). Leach solutions attained from a total of 22 samples were analysed for pH, EC, major ions (Ca, Mg, Na, K, HCO_3, Cl and SO_4) and trace metals (Al, As, Be, Cd, Cr, Co, Cu, F, Fe, Hg, Mn, Ni, Pb, Se, Sb and Zn).

3.5 Calculated Parameters

The Maximum Potential Acidity (MPA) values (in kgH_2SO_4/t) of the ore tailings were calculated by multiplying the Sulfide-S values (in %) by 30.6. The multiplication factor of 30.6 accounts for the reaction stoichiometry for the complete oxidation of pyrrotite and pyrite by O_2 to $Fe(OH)_3$ and H_2SO_4 (Lei and Watkins, 2005).

The Net Acid Producing Potential (NAPP) values (in kgH_2SO_4/t) were calculated from the corresponding MPA and Acid Neutralisation Capacity (ANC) values: NAPP = MPA - ANC. The acid potential ratios (APR) were calculated from the relationship of ANC/MPA (Paktunc, 1999).

The acid potential ratio (APR) criteria for the non-acid forming (NAF) Category reflects the need to compensate for the availability of alkalinity forms for neutralisation of acid produced through pyrite-oxidation. *A sample with an APR < 1 is classified as PAF, while a sample with an APR ≥ 2 is NAF. Samples with APR between 1 and 2 could generate either acid, alkaline, or neutral drainage* (Alarcón León, 2012 and INAP, 2009).

3.6 Classification Criteria

Table 3.3 lists the most accepted criteria for classifying PAF of mine waste materials.

Table 3.3: AFP Classification Criterion.

Category	DITR, 2007 and others	Lei and Watkins, 2005	OSS-ACMRR*-DITR
Non-Acid Forming (NAF):	Sulfide-S < 0.3% For Sulfide-S ≥ 0.3%, a negative NAPP value and APR ≥ 2.0	NAPP < -20 APR >3	NAG-pH > 4.5 NAG <5-10
Potentially Acid Forming (PAF):	For Sulfide-S ≥ 0.3%, any positive NAPP value, negative NAPP value with an APR < 2.0	NAPP > 20 APR < 1	NAG-pH <4.5 NAG > 10
Zone of Uncertainty	NAPP: between -20 and +20; APR: between 1 and 3		
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Lithotypes with Sulfide-S concentrations less than 0.3% are unlikely to oxidise at rates fast enough to result in acidification (pH less than 4.0 to 5.0). Table 3.3, which reflects field experiences in Australia and includes an APR < 1, in addition to a cut-off NAG-pH value of 4.5 (Table 3.4), was employed in the current assessment to classify the AFP of the samples. The NAG international and national approach is based upon:

Table 3.4: NAG Classification Criterion.

NAG pH	NAG (kgH_2SO_4/t)	Geochemical Classification
≥ 4.5	0	Non-Acid Forming (NAF).
<4.5	≤ 5	Potentially Acid Forming - Lower Capacity (PAF-LC).
<4.5	> 5 - 10	Potentially Acid Forming (PAF).

4. Results and Discussion

4.1 Mineralogical Analysis

4.1.1 XRD Assessment

A semi-quantitative XRD assessment is summarized in Table 4.1 below (refer also Appendix B). Negative values generally indicate a larger than usual uncertainty with regard to the quantity of the phase reported and, for some of the minor and trace phases, it might also indicate an uncertainty with regard to the phase itself, or both.

Kaolinite with an average concentration of ~40% is the most prominent mineral in the samples. A significant amount of amorphous material (e.g. goethite) appears also to be present in all samples, particularly in the near surface (up to 5m deep) pulp samples.

Hazardous elements e.g. arsenic, chromium, etc. could be present in both the zeolite minerals and goethite as well as in the amorphous component.

Table 3.5: XRD Semi-Quantitative Mineralogy Results.

Sample ID	From	To	Alpha quartz	Kaolinite	Mica	Goethite	Clay mineral	Zeolite	Chlorite	Serpentine	Amphibole	Microcline - Rutile - Titanite	Hematite
			(%)										
Coarse Bulk Sample			**91**	**2**	**1**	**-3**	**< 1**	**3**	**0**	**0**	**1**	**0**	**0**
Fine Bulk Sample			**92**	**1**	**1**	**-2**	**-1**	**2**	**0**	**0**	**< 1**	**0**	**0**
X202044	1	2	17	46	4	29	-1	-1	0	-1	-2	0	0
X202045	2	3	22	44	4	28	< 1	< 1	0	0	< 1	< 1	< 1
X202046	3	4	20	52	6	20	-1	< 1	0	-1	0	0	0
X202047	4	5	26	44	6	21	< 1	0	< 1	0	0	-2	0
X201983	0	1	69	18	1	3	-1	2	< 1	0	0	3	3
X201984	1	2	26	44	1	26	-1	0	0	0	0	< 1	2
X201985	2	3	27	46	2	23	< 1	0	0	0	0	< 1	0
X201986	3	4	46	45	3	5	< 1	-1	0	0	0	0	0
X201987	4	5	35	50	3	11	< 1	< 1	0	0	0	0	0
X202017	34	35	37	39	16	6	< 1	-1	0	0	0	0	0
X202019	36	37	25	64	6	3	< 1	-1	0	0	0	0	0
X202020	37	38	44	46	6	-2	< 1	-1	0	0	0	0	0
X202021	38	39	26	62	9	-2	< 1	-1	0	0	0	0	0
X202022	39	40	34	56	6	-2	< 1	-1	0	0	< 1	0	0
X201777	88	89	31	41	21	-5	< 1	1	0	0	0	0	0
X201778	89	90	37	34	16	10	< 1	1	0	0	-1	0	0
X201779	90	91	33	36	18	13	< 1	1	0	0	0	0	0
X201780	91	92	24	38	24	13	< 1	< 1	0	0	0	< 1	0
X201781	92	93	35	43	10	11	< 1	-1	0	0	0	0	0
X201782	93	94	57	19	6	16	-1	1	< 1	0	0	0	0

4.1.2 XRF and GAI Assessment

The elemental chemistries of both sets of samples (i.e. bulk and pulp samples) are provided in Table 4.2 and Appendix C.

The mineralogical assessment indicated that parent materials are dominantly demarcated by aluminium quartz, phyllosilicates (e.g. kaolinites and micas) and hematite minerals. Hence, the chemical fingerprint in both sets of samples are logically in the order of silicon>aluminium>iron>potassium. Among the other significant fingerprint ions, average titanium oxides are slightly higher that magnesium, sodium and calcium oxide concentrations (Table 4.2).

Minor elements are dominated by barium with an average concentration of 0.041%. Subsequent higher concentrations are those of arsenic>zirconium>chromium>lead (Table 4.2). Nutrients in the form of phosphorous are also significantly high with an average concentration of 0.031%.

Although with a scatter correlation between affine minerals such as arsenic, iron and copper (Figure 4.1), arsenic alike barium shows a distinctive concentration pattern with depth (Figure 4.2). Both elements occur in an almost steady concentration within the near surface pulp samples, increase at intermediate depths (~35m below ground level) and then steadily decrease to the lowest concentrations at about 90m depth. This behaviour indicates that these elements are somewhat associated with kaolinites and micas, which display a steadiness in abundance with depth.

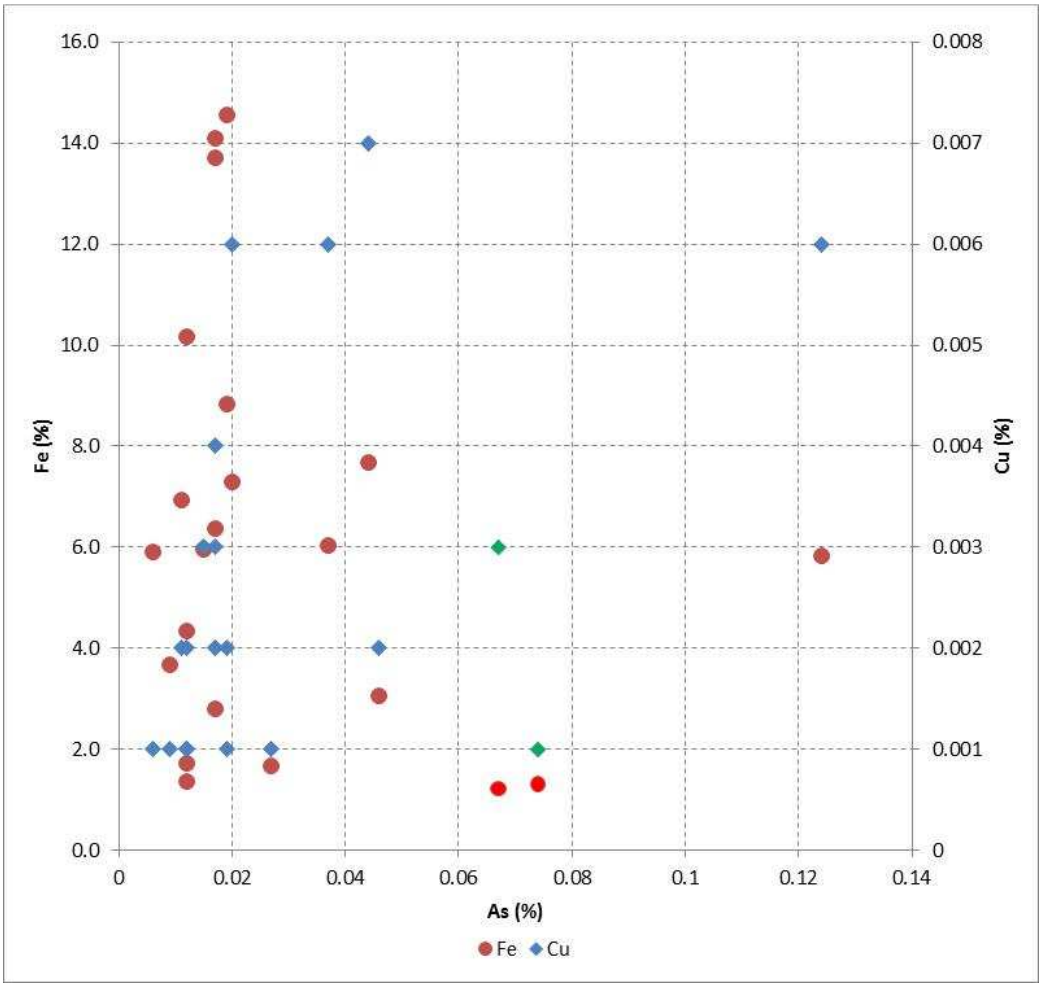

Figure 3.4: Arsenic versus Iron and Copper Concentrations.
(bulk samples are shown in Red and Green).

Table 3.6: XRF Elemental Chemistry of Bulk and Pulp Samples.

	Al	As	Ba	Ca	Cl	Co	Cr	Cu	Fe	K	Mg	Mn	Na	Ni	P	Pb	S	Si	Sn	Sr	Ti	V	Zn	Zr
Sample ID / Limits of Detection	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
	0.01	0.001	0.001	0.01	0.001	0.001	0.0006	0.001	0.01	0.001	0.01	0.001	0.005	0.001	0.001	0.001	0.001	0.01	0.001	0.001	0.01	0.001	0.001	0.001
X202044	10.84	0.017	0.023	0.122	0.004	0.001	0.020	0.002	14.10	1.017	0.229	0.030	0.064	0.002	0.025	0.009	0.007	22.37	<0.001	0.005	0.437	0.028	0.004	0.028
X202045	9.60	0.017	0.028	0.093	0.002	<0.001	0.020	0.002	13.70	1.004	0.241	0.015	0.042	0.001	0.022	0.007	0.007	23.96	<0.001	0.003	0.467	0.027	0.002	0.028
X202046	9.99	0.012	0.057	0.093	0.001	<0.001	0.014	<0.001	10.16	1.444	0.247	0.007	0.071	0.001	0.011	0.004	0.010	26.29	<0.001	0.004	0.383	0.017	0.002	0.025
X202047	8.49	0.011	0.061	0.064	0.001	<0.001	0.011	0.002	6.94	1.859	0.241	0.002	0.074	0.002	0.012	0.009	0.009	30.21	0.001	0.003	0.270	0.010	0.002	0.013
X201983	3.70	0.006	0.012	0.057	0.003	<0.001	0.012	<0.001	5.92	0.457	0.090	0.012	0.023	<0.001	0.013	<0.001	0.006	37.22	0.002	0.001	0.240	0.012	0.001	0.035
X201984	9.55	0.019	0.012	0.057	0.002	<0.001	0.011	0.002	14.55	0.632	0.163	0.013	0.042	0.002	0.012	0.005	0.015	24.00	0.001	0.003	0.407	0.028	0.002	0.030
X201985	8.44	0.019	0.092	0.057	0.002	<0.001	0.007	<0.001	8.82	1.133	0.217	0.002	0.076	<0.001	0.005	<0.001	0.027	28.95	0.001	0.003	0.347	0.014	0.001	0.019
X201986	6.45	0.009	0.029	0.064	0.008	<0.001	0.002	<0.001	3.67	0.888	0.199	0.002	0.118	<0.001	0.004	<0.001	0.020	35.26	0.001	<0.001	0.246	0.003	0.001	0.012
X201987	6.88	0.012	0.022	0.186	0.010	<0.001	0.004	<0.001	4.35	1.013	0.241	<0.001	0.108	<0.001	0.005	<0.001	0.014	34.09	0.001	0.001	0.222	0.003	0.001	0.015
X202017	8.57	0.124	0.066	0.021	0.021	<0.001	0.006	0.006	5.84	3.536	0.338	0.004	0.082	0.002	0.069	0.034	0.012	30.63	0.002	0.008	0.252	0.009	0.015	0.007
X202019	6.90	0.046	0.036	0.014	0.016	<0.001	0.005	0.002	3.06	1.751	0.187	0.002	0.051	<0.001	0.039	0.009	0.008	35.30	0.001	0.004	0.264	0.004	0.010	0.019
X202020	7.14	0.027	0.038	0.014	0.012	<0.001	0.003	<0.001	1.68	1.818	0.187	0.001	0.047	0.002	0.024	0.007	0.006	36.05	0.002	0.002	0.264	0.003	0.005	0.016
X202021	8.81	0.012	0.063	0.007	0.014	<0.001	0.006	0.001	1.36	2.822	0.271	0.002	0.070	<0.001	0.019	0.007	0.005	33.99	0.003	0.002	0.347	0.006	0.004	0.017
X202022	7.51	0.012	0.045	0.007	0.012	<0.001	0.004	0.002	1.72	1.917	0.205	0.002	0.068	<0.001	0.022	0.008	0.006	35.49	0.002	0.002	0.300	0.005	0.005	0.019
X201777	10.58	0.017	0.063	0.014	0.011	<0.001	0.008	0.003	2.80	4.258	0.404	0.004	0.089	0.002	0.040	0.006	0.003	30.40	0.001	0.004	0.311	0.006	0.009	0.007
X201778	7.64	0.044	0.044	0.021	0.007	<0.001	0.005	0.007	7.67	3.104	0.314	0.011	0.056	0.005	0.102	0.014	0.004	30.63	<0.001	0.004	0.222	0.009	0.018	0.007
X201779	9.73	0.037	0.062	0.014	0.010	<0.001	0.008	0.006	6.03	4.075	0.434	0.007	0.081	0.003	0.075	0.007	0.003	29.00	0.001	0.005	0.270	0.007	0.016	0.008
X201780	10.63	0.020	0.067	0.014	0.006	0.001	0.016	0.006	7.30	4.499	0.410	0.007	0.084	0.012	0.057	0.007	0.002	26.99	<0.001	0.005	0.300	0.008	0.017	0.009
X201781	7.91	0.015	0.040	0.014	0.005	<0.001	0.006	0.003	5.96	2.913	0.271	0.009	0.059	0.002	0.050	0.002	0.002	31.76	0.002	0.003	0.270	0.004	0.012	0.013
X201782	5.84	0.017	0.030	0.014	0.004	<0.001	0.002	0.004	6.36	1.917	0.187	0.009	0.042	0.002	0.067	0.004	0.002	34.14	<0.001	0.002	0.210	0.003	0.017	0.018
Coarse bulk sample	0.397	0.074	0.004	0.007	0.002	<0.001	0.003	<0.001	1.32	0.120	0.024	0.006	0.004	<0.001	0.001	0.027	0.007	45.16	0.002	<0.001	0.018	<0.001	<0.001	<0.001
Fine bulk sample	0.354	0.067	0.008	0.043	0.002	<0.001	0.102	0.003	1.22	0.110	0.030	0.010	0.007	0.047	0.001	0.026	0.007	45.21	0.003	<0.001	0.012	<0.001	0.001	<0.001
Average	7.54	0.03	0.04	0.05	0.007	0.001	0.013	0.003	6.12	1.92	0.23	0.007	0.06	0.006	0.03	0.011	0.008	32.14	0.002	0.003	0.28	0.010	0.007	0.017
Median	8.17	0.02	0.04	0.02	0.006	0.001	0.007	0.003	5.94	1.78	0.24	0.007	0.07	0.002	0.02	0.007	0.007	31.20	0.002	0.003	0.27	0.008	0.004	0.017
Maximum	10.84	0.12	0.09	0.19	0.021	0.001	0.102	0.007	14.55	4.50	0.43	0.030	0.12	0.047	0.10	0.027	0.027	45.21	0.003	0.008	0.47	0.028	0.018	0.035
Minimum	0.35	0.01	0.004	0.01	0.001	0.001	0.001	0.001	1.22	0.11	0.02	0.001	0.004	0.001	0.001	0.002	0.001	22.37	0.001	0.001	0.01	0.003	0.001	0.007
No Samples	22	22	22	22	22	2	22	15	22	22	22	21	22	14	22	18	22	22	16	19	22	20	21	20

Table 3.7: GAI Analysis to Assess Element Enrichment.

Sample ID	Al	As	Ba	Ca	Cl	Co	Cr	Cu	Fe	K	Mg	Mn	Na	Ni	P	Pb	S	Si	Sn	Sr	Ti	V	Zn	Zr
Coarse bulk sample	0.0	8.1	0.0	0.0	0.0		0.0		0.0	0.0	0.0	0.0	0.0		0.0	3.7	0.0	0.1	2.5		0.0			
Fine bulk sample	0.0	8.0	0.0	0.0	0.0		2.7	0.0	0.0	0.0	0.0	0.0	0.0	1.9	0.0	3.6	0.0	0.1	3.1		0.0		0.0	
X202044	0.0	6.0	0.0	0.0	0.0	0.0	0.4	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0		0.0	0.0	0.6	0.0	0.2
X202045	0.0	6.0	0.0	0.0	0.0		0.4	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0		0.0	0.0	0.6	0.0	0.2
X202046	0.0	5.5	0.0	0.0	0.0		0.0		0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0		0.0	0.0	0.0	0.0	0.0
X202047	0.0	5.3	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0
X201983	0.0	4.5	0.0	0.0	0.0		0.0		0.0	0.0	0.0	0.0	0.0		0.0		0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.5
X201984	0.0	6.1	0.0	0.0	0.0		0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	1.5	0.0	0.0	0.6	0.0	0.3
X201985	0.0	6.1	0.5	0.0	0.0		0.0		0.1	0.0	0.0	0.0	0.0		0.0		0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0
X201986	0.0	5.1	0.0	0.0	0.0		0.0		0.0	0.0	0.0	0.0	0.0		0.0		0.0	0.0	1.5		0.0	0.0	0.0	0.0
X201987	0.0	5.5	0.0	0.0	0.0		0.0		0.0	0.0	0.0		0.0		0.0		0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0
X202017	0.0	8.8	0.1	0.0	0.0		0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	2.5	0.0	0.0	0.0	0.5	0.0
X202019	0.0	7.4	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	2.1	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0
X202020	0.0	6.6	0.0	0.0	0.0		0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0
X202021	0.0	5.5	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	1.7	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.0
X202022	0.0	5.5	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	1.9	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0
X201777	0.0	6.0	0.0	0.0	0.0		0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0
X201778	0.0	7.3	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	0.0	0.0		0.0	0.0	0.0	0.8	0.0
X201779	0.0	7.1	0.0	0.0	0.0		0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	1.5	0.0	0.0	0.0	0.6	0.0
X201780	0.0	6.2	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0		0.0	0.0	0.0	0.7	0.0
X201781	0.0	5.8	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.2	0.0
X201782	0.0	6.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0		0.0	0.0	0.0	0.7	0.0
Average	0.0	6.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	2.0	0.0	0.0	0.1	0.2	0.1
Maximum	0.0	8.8	0.5	0.0	0.0	0.0	0.4	0.0	0.8	0.5	0.0	0.0	0.0	0.0	0.0	4.0	0.0	0.0	3.1	0.0	0.0	0.6	0.8	0.5
Minimum	0.0	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0

Table 3.8: ABA/NAG Assessment.

Methods / Acronyms	Fizz Rating	pH (OX)	Final pH	NAG (pH 4.5)	NAG (pH 7.0)	Total Carbon	Sulfur - Total as S	Sulfate as SO_4^{2-}	Sulfur as S	Sulfide as S	Maximum Potential Acidity	Acid Neutralisation Capacity	Net Acid Production Potential	Acid Potential Ratio	ABA Classification
							LECO	14808-79-8	63705-05-5		MPA	ANC	NAPP	APR	
Units	Fizz	pH	pH	kg H_2SO_4/t	kg H_2SO_4/t	%	%	mg/kg	mg/kg	%	kg H_2SO_4/t		kg H_2SO_4/t		
LOR	0	0.1	0.1	0.1	0.1	0.02	0.01	10	10	0.01		0.5			
Sample ID															
X202044	1	6.1	8	<0.1	4.4	<0.02	0.06	<10	<10	0.06	1.84	<0.5	1.34	0.27	NAF
X202045	1	6.5	8.1	<0.1	3	<0.02	0.04	10	<10	0.04	1.22	<0.5	0.72	0.41	NAF
X202046	1	6.3	8.2	<0.1	4	<0.02	0.02	20	<10	0.02	0.61	<0.5	0.11	0.82	NAF
X202047	1	6	8.2	<0.1	8.1	<0.02	0.02	50	20	0.01	0.31	1	-0.69	3.27	NAF
X201983	1	5.2	7.5	<0.1	**12.1**	<0.02	0.57	30	<10	**0.57**	17.44	<0.5	16.94	0.03	**UC**
X201984	1	5.6	8.1	<0.1	9.4	<0.02	0.06	10	<10	0.06	1.84	1	0.84	0.54	NAF
X201985	1	5.9	7.8	<0.1	8.8	<0.02	0.04	80	30	0.03	0.92	<0.5	0.42	0.54	NAF
X201986	1	6.1	8.1	<0.1	7.6	<0.02	<0.01	60	20	<0.01	0.31	7	-6.69	22.88	NAF
X201987	1	6	8.5	<0.1	**18.1**	<0.02	0.05	80	30	0.04	1.22	3.6	-2.38	2.94	NAF
X202017	1	5.9	7.6	<0.1	10	<0.02	<0.01	170	60	<0.01	0.31	1.5	-1.19	4.90	NAF
X202019	1	5.4	7.6	<0.1	**16.7**	<0.02	<0.01	110	40	<0.01	0.31	1	-0.69	3.27	NAF
X202020	1	5.7	7.4	<0.1	**14.6**	<0.02	<0.01	20	<10	<0.01	0.31	<0.5	-0.19	1.63	NAF
X202021	1	5.7	7.9	<0.1	**11.6**	<0.02	<0.01	80	20	<0.01	0.31	<0.5	-0.19	1.63	NAF
X202022	1	5.7	8	<0.1	**13.6**	<0.02	<0.01	30	<10	<0.01	0.31	<0.5	-0.19	1.63	NAF
X201777	1	5.9	8.4	<0.1	**10.5**	<0.02	<0.01	20	<10	<0.01	0.31	0.9	-0.59	2.94	NAF
X201778	1	6	7.9	<0.1	7.7	<0.02	0.02	30	<10	0.02	0.61	<0.5	0.11	0.82	NAF
X201779	1	6.1	8.2	<0.1	8.2	<0.02	0.02	30	10	0.02	0.61	<0.5	0.11	0.82	NAF
X201780	1	6	8.5	<0.1	9.1	<0.02	0.03	20	<10	0.03	0.92	0.8	0.12	0.87	NAF
X201781	1	6.1	8.5	<0.1	6.8	<0.02	0.03	10	<10	0.03	0.92	<0.5	0.42	0.54	NAF
X201782	1	6.2	8.2	<0.1	6	<0.02	0.04	<10	<10	0.04	1.22	<0.5	0.72	0.41	NAF
Coarse Bulk Sample	1	6.2	8.2	<0.1	7.5	<0.02	<0.01	20	<10	<0.01	0.31	<0.5	-0.19	1.63	NAF
Fine Bulk Sample	1	6.4	9.2	<0.1	6.6	<0.02	<0.01	40	10	<0.01	0.31	1.5	-1.19	4.90	NAF
Average	1.00	5.95	8.10	<0.1	9.29	<0.02	0.08	46.00	26.67	0.07	1.47	2.03	0.35	2.62	
Maximum	1.00	6.50	9.20	<0.1	18.10	<0.02	0.57	170.00	60.00	0.57	17.44	7.00	16.94	22.88	
Minimum	1.00	5.20	7.40	<0.1	3.00	<0.02	0.02	10.00	10.00	0.01	0.31	0.80	-6.69	0.03	

Note: In Bold and blue is the highest Sulfide as S Concentration. Samples with Sulphide-S>0.3% are commonly characterised as **PAF**. In bold and black are those which contains high (>10) NAG pH as H_2SO_4/t values.

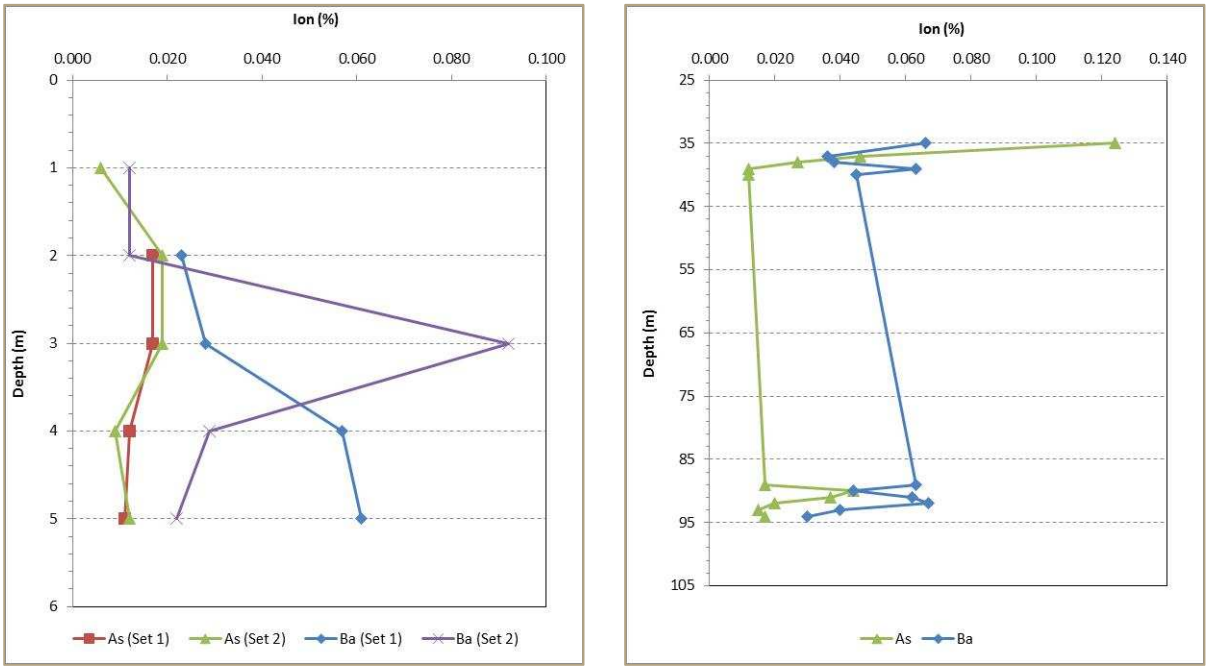

Figure 3.5: Arsenic and Barium Concentrations with Depth.

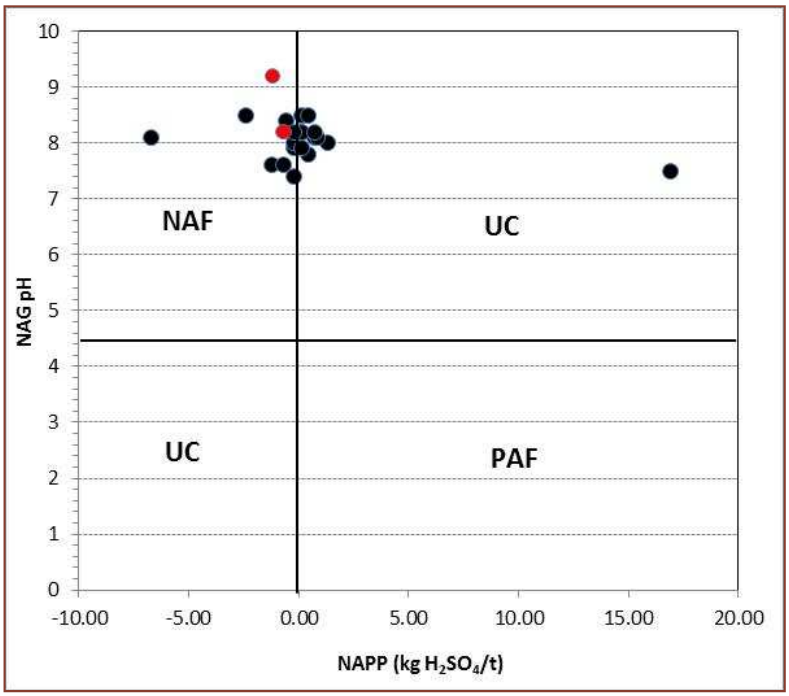

Figure 3.6: NAPP-NAG pH Classification Scheme.
(the bulk samples are shown in red dots)

An assessment of the elemental enrichment in the samples is provided in Table 4.3 and it is evident that all samples are significantly enriched with arsenic; up to about a 96-fold (or greater) enrichment above the average-crustal-abundance. Tin and lead are also enriched up to a 6-fold enrichment above the average-crustal-abundance.

The Old Pirate area has been reported to be naturally anomalous in arsenic and lead. ABM advises that these elements were the key fingerprint elements used in the discovery of the Old Pirate gold mineralised deposits (ABM historical database). The local arsenic and lead anomalies are contained within the multiple narrow high grade veins, which are within the highly weathered and poorly exposed

rock outcrops. Locally, arsenic values may vary from <10ppm up to 4,000ppm in soil and rock chip samples. Rocks and soils around the Old Pirate Deposit may also contain significant concentrations of bismuth and uranium.

4.2 ABA Acid Base Chemistry Assessment

The ABA-NAG assessment data (Appendix D) are provided in Table 4.4. A NAPP-NAG pH classification scheme is presented in Figure 4.3 (above); where NAF is non-acid forming, PAF is potentially acid forming and UC is uncertain to be defined as acid or alkaline producing materials. Red dots are the bulk samples; i.e., the fine bulk sample (high pH) and coarse bulk sample (lower pH).

An overall assessment of the ABA properties of the samples indicates:

4.2.1 Ore-Tailing Materials

- Paste pHs are circum-neutral, with an average of 6.3, while NAG pH is alkaline with an average pH of 8.7. Results indicate that both the coarse and fine bulk samples contain noteworthy and large reactive buffering capacities.
- ABA classification with regard to sulfur concentration indicates that both samples are non-acid forming (NAF) materials.
- Because of the low concentration of total sulfur in the samples, it is assumed that an ANC/MPA ratio of <1 is indicative of a rock likely to produce acid. Accordingly, both samples can be classified with no likely potential to produce acidity.
- A negative NAPP (particularly <20kg H_2SO_4 equiv/t) indicates samples have a net neutralising capacity and a positive NAPP (>20kg H_2SO_4 equiv/t) indicates samples have a net acid generating capacity. Both samples have negative NAPP values and therefore are unlikely to produce acidity.
- NAG pH <4.5 indicate rocks are likely to produce acidity. None of the samples produced low NAG pHs. If NAG is assessed against NAPP, both samples are within the NAF zone (Figure 4.3).

4.2.2 Pulp Materials

- Paste pHs are mostly circum-neutral with an average of 5.92 ranging from 5.20 (slightly acidic) to 6.50 (circum-neutral), while NAG pH are slightly alkaline with an average 8.04, ranging from 7.40 to 8.50. Results indicate that there is little or no freely available acidity in the samples.
- ABA classification with regard to sulfur concentration indicates that with the exception of a single surface sample (X201983), all samples are non-acid forming (NAF) materials. Sample X201983 was detected to contain the highest 0.57% of sulphide as S.
- ABA classification in relation to NAPP indicates that no pulp samples have the potential to produce acidity and that all can be classified as NAF samples.
- A classification on the ANC/MPA (acid potential ratio APR) ratio of <1 specify about 50% of the samples appears to have the potential to produce acidity. Significant variability in relation to the other ABA assessment criteria indicates that samples may have an overall lower buffering capacity.
- If NAG is assessed against NAPP (Figure 4.3), none of the samples are classified as PAF. However, all samples that are classified by the APR as having the potential to produce acid fall within the UC area. This would suggest that these samples need further characterisation.

5. Water Quality Prediction

Sites with APRs less than 1 should produce acid drainage, while ratios greater than 2 should produce net alkaline drainage. Those sites with ratios between 1 and 2 could generate either acid, alkaline or neutral drainage.

As detailed in Sections 4.2.1 and 4.2.2 above, neither of the ore-tailings samples (bulk materials) has the potential to produce acidity, while about 50% of the pulp samples have APRs less than 1 and are described as having the potential to produce acidity. However, as presented in Table 4.4, these samples have low NAPP and all of their other corresponding ABA values suggest that they would not impact water quality as any acid produced will be offset by the buffering capacity of the samples.

A hydro-chemical assessment of the samples (Table 5.1 and Appendix D) indicates that most of the analytes in the leachates occur in very low concentrations and/or are below their limits of reporting (LoRs). Leachates are characterised by having an overall circum-neutral pH, ranging from 6.10 to 7.49. The elevated pH corresponds to the fine bulk sample, with the lowest being pulp sample X202021. Corresponding electrical conductivities range from 15µS/cm to 107µS/cm.

Major cation concentrations in all samples are in the order of Na>K>Ca>Mg. Although sodium is very low in both bulk samples, these are relevant in the pulp samples with an average 6.23mg/L and a maximum of 14.0mg/L. Anions are also low in the order of $Cl>SO_4$, with average values of 4.74mg/L and 3.95mg/L respectively.

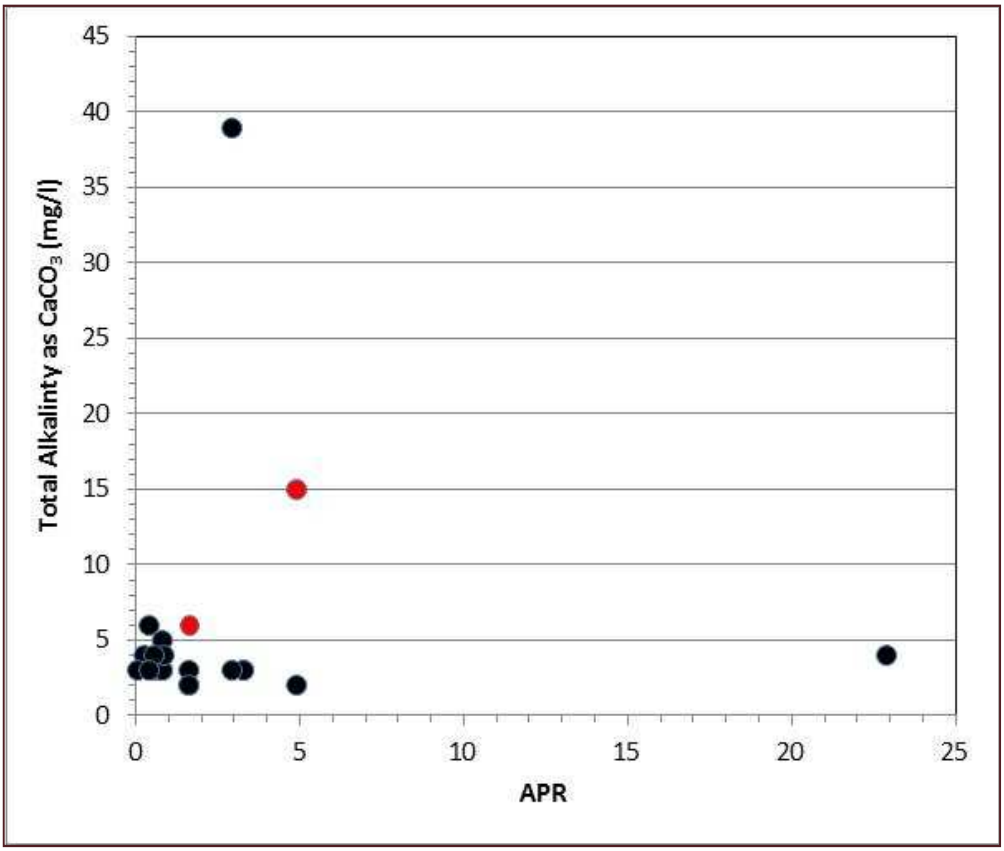

Figure 3.7: APR versus Total Alkalinity (as $CaCO_3$) in Leached Solutions.
(the bulk samples are indicated in red).

Table 3.9: Predicted Water Quality.

Analyte	pH Value	Electrical Conductivity (EC)	Hydroxide Alkalinity as $CaCO_3$	Carbonate Alkalinity as $CaCO_3$	Bicarbonate Alkalinity as $CaCO_3$	Total Alkalinity as $CaCO_3$	Sulfate as SO_4	Chloride	Calcium	Magnesium	Sodium	Potassium	Aluminium	Antimony	Arsenic	Barium	Chromium	Lead	Manganese	Nickel	Zinc	Iron	Fluoride
Units	pH Unit	µS/cm	mg/L																				
LOR	0.01	1	1	1	1	1	1	1	1	1	1	1	0.01	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.005	0.05	0.1
Sample ID																							
X202044	6.14	20	<1	<1	4	4	<1	2	<1	<1	5	1	0.28	0.003	0.002	0.213	<0.001	<0.001	0.001	<0.001	0.095	0.16	0.3
X202045	7.38	22	<1	<1	6	6	3	2	<1	<1	5	2	0.33	<0.001	0.003	0.229	<0.001	<0.001	0.001	<0.001	0.088	0.2	0.4
X202046	6.35	32	<1	<1	5	5	4	<1	<1	<1	8	<1	0.67	<0.001	0.006	0.341	0.001	<0.001	0.004	<0.001	0.104	0.71	0.5
X202047	6.18	22	<1	<1	3	3	6	<1	<1	<1	6	1	0.17	<0.001	0.009	0.11	<0.001	<0.001	<0.001	<0.001	0.065	0.1	0.5
X201983	6.16	20	<1	<1	3	3	2	1	<1	<1	3	3	0.41	<0.001	0.005	0.18	<0.001	<0.001	0.043	<0.001	0.149	0.4	<0.1
X201984	6.21	15	<1	<1	3	3	2	2	<1	<1	4	<1	0.16	<0.001	0.003	0.131	<0.001	<0.001	<0.001	<0.001	0.039	0.11	0.2
X201985	6.11	42	<1	<1	3	3	12	2	<1	<1	8	3	0.2	<0.001	0.002	0.316	<0.001	<0.001	<0.001	<0.001	0.088	0.1	0.7
X201986	6.27	41	<1	<1	4	4	6	5	<1	<1	10	<1	0.22	<0.001	0.003	0.251	<0.001	<0.001	<0.001	<0.001	0.07	0.09	0.5
X201987	7.24	107	<1	<1	39	39	6	6	6	3	14	4	0.08	<0.001	0.02	0.281	<0.001	<0.001	<0.001	<0.001	0.041	<0.05	0.7
X202017	6.2	74	<1	<1	2	2	11	11	<1	<1	9	9	0.02	<0.001	0.01	0.173	<0.001	<0.001	<0.001	<0.001	0.071	<0.05	0.8
X202019	6.13	52	<1	<1	3	3	7	8	<1	<1	8	5	<0.01	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.005	<0.05	0.6
X202020	6.13	37	<1	<1	2	2	2	7	<1	<1	5	6	0.05	<0.001	0.008	0.129	<0.001	<0.001	<0.001	<0.001	0.078	<0.05	0.4
X202021	6.1	49	<1	<1	3	3	4	8	<1	<1	9	4	0.12	<0.001	0.008	0.441	<0.001	<0.001	<0.001	0.001	0.087	0.06	0.5
X202022	6.14	39	<1	<1	2	2	2	8	<1	<1	8	3	0.06	<0.001	0.005	0.353	<0.001	<0.001	<0.001	<0.001	0.059	<0.05	0.5
X201777	6.28	35	<1	<1	3	3	1	5	<1	<1	7	4	0.38	<0.001	0.055	0.396	0.001	<0.001	<0.001	<0.001	0.098	0.26	0.7
X201778	6.28	28	<1	<1	3	3	2	4	<1	<1	5	5	0.05	<0.001	0.05	0.142	<0.001	<0.001	<0.001	<0.001	0.024	0.09	0.8
X201779	6.3	37	<1	<1	3	3	2	6	<1	<1	5	7	0.08	<0.001	0.067	0.146	<0.001	<0.001	<0.001	<0.001	0.023	0.09	0.8
X201780	6.29	28	<1	<1	4	4	2	4	<1	<1	5	4	0.11	<0.001	0.049	0.147	0.001	<0.001	0.002	<0.001	0.035	0.34	0.8
X201781	6.25	24	<1	<1	4	4	1	4	<1	<1	6	2	0.09	<0.001	0.046	0.2	<0.001	<0.001	<0.001	<0.001	0.03	0.17	0.6
X201782	6.26	21	<1	<1	3	3	<1	3	<1	<1	3	4	<0.01	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.005	<0.05	0.7
Coarse Bulk Sample	6.23	22	<1	<1	6	6	2	2	2	<1	3	<1	0.06	0.004	0.054	0.29	<0.001	0.004	0.033	<0.001	0.054	0.1	0.1
Fine Bulk Sample	7.49	32	<1	<1	15	15	2	<1	6	<1	1	<1	0.04	0.002	0.09	0.148	<0.001	0.002	<0.001	<0.001	0.014	0.06	0.1
Average	6.37	36	<1	<1	6	6	4	4.74	4.67	3.00	6.23	3.94	0.18	0.003	0.02	0.22	0.00	0.003	0.014	0.001	0.07	0.19	0.53
Maximum	7.49	107	<1	<1	39	39	12	11.00	6.00	3.00	14.00	9.00	0.67	0.004	0.09	0.44	0.00	0.004	0.043	0.001	0.15	0.71	0.80
Minimum	6.10	15	<1	<1	2	2	1	1.00	2.00	3.00	1.00	1.00	0.02	0.002	0.00	0.00	0.00	0.002	0.001	0.001	0.01	0.06	0.10

Total alkalinities of the samples have a low average value of 5.6mg/L with a range from 2.0mg/L to 39.0mg/L (Table 5.1 and Figure 5.1). Figure 5.1 shows that the majority of samples have a good correlation between low APR and low total alkalinity, which could indicate that samples have an average low buffering capacity and may tend to produce acidity. Most trace elements in all samples are relatively low in concentrations and most of them are below their LoRs (Table 5.2). Although these elements are in the order of fluoride>barium>iron>aluminium, their overall behaviour are indicative of these solutes being available for dilution and exchanges in low concentrations.

Individual toxic elements such as arsenic, chromium and lead are in the order of arsenic>lead>chromium. Arsenic is particularly high with an average of 0.02mg/L ranging from 0.002mg/L to 0.09mg/L in the fine bulk sample. Subsequent highest concentrations with an average of 0.053mg/L are confined to the pulp samples from depths between 35m to 94m below ground (deeper than any of the proposed bulk sample trenches). A mineralogical assessment indicates that all samples contain high amorphous mineral concentrations such as goethite, to which arsenic may attach and is readily available for release in the short term. Overall element concentrations and behaviours indicate short term leachate qualities in all samples will likely have low concentrations of these traces and would not present an immediate risk to the wider environment. However, arsenic, as explained, may be significant in the short term.

Table 3.10: Trace Elements with Concentrations (mg/L) below their LoRs.

Element	LoR
Beryllium	0.001
Cadmium	0.0001
Cobalt	0.001
Copper	0.001
Mercury	0.0001
Selenium	0.01
Vanadium	0.01

6. Conclusions

6.1 Mineralogical and ABA Assessments

- Mineralogically both sets of samples contain significant amounts of phyllosilicates and amorphous materials and are chemically enriched by arsenic, tin and lead.
- The great majority of the samples (95%) can be classified as non-acid forming (NAF) materials. Owing to its high sulfide as S concentration, only one pulp sample (i.e. near surface sample X201983) can be characterised as 'uncertain' and therefore, if warranted, may require further assessment for its potential to produce acidity.
- Owing to apparent conflicting results between NAPP and NAG results, about 50% of the pulp samples may be classified with a potential to produce acidity. However, because the other ABA parameters (including sulfide concentrations) are very low and/or insignificant, these materials can be classified as having very low or no acid forming capacity.

6.2 Hydrochemical Assessment

- pHs of all samples are circum-neutral and major ions are very low in concentrations with sodium being the highest in most of the pulp samples.
- Trace element concentrations in all samples are relatively low and most of them are below their limits of reporting. Generally, these are in the order of fluoride>barium>iron>aluminium.
- Individual toxic elements such as arsenic, chromium and lead are in the order of arsenic>lead>chromium. Arsenic is particularly high in all samples and appears to be readily available for release or mobilisation in the short term.
- Overall elemental concentrations and behaviour indicate short term leachate qualities in all samples will likely have low concentrations of these traces and would not represent an immediate risk to the wider environment.

7. Acid Mine Drainage (AMD) Management

Geochemical assessments indicate that most if not all of the samples are characterised with having low potentials for producing acidity. One sample returned results that are inconclusive. However, for this relatively small-scale bulk sampling activity, the uncertainty in the assessment is considered an overall low risk to the surrounding environment. The development of an AMD management procedure is therefore not warranted.

However, it is recommended that:

- Should the project move towards full-scale mining, more targeted studies be conducted to assist in further assessment of the current uncertainty presented by sample X201983 and those samples defined as 'uncertain' in the APR assessment.
- Weekly to monthly monitoring of tail solutions be conducted to detect potential loading of arsenic. Results should assist in ascertaining long term monitoring and rehabilitation processes and systems.

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Appendices

Appendix A: Coordinates and General Description of Bulk Samples

Appendix B: XRD Data Base and General Assessment

Appendix C: XRF Base Data

Appendix D: Results and Laboratory Certificates of ABA and Leachate Data

Appendix A:
Coordinates and General Description of Bulk Samples

SampleID	Au ppm	HoleID	Collar X	Collar Y	Collar Z	From	To	Sample X	Sample Y	Sample Z	Weathering	Lith 1	Lith 1 %	Lith 2	Lith 2 %	Lith 3	Lith 3 %
X202044	0.03	OPRC100200	516364.09	7768248.15	449.15	1	2	516364.85	7768248.15	447.85	HW	NR	100				
X202045	0.17	OPRC100200	516364.09	7768248.15	449.15	2	3	516365.35	7768248.15	446.99	MW	SS	100				
X202046	0.02	OPRC100200	516364.09	7768248.15	449.15	3	4	516365.86	7768248.15	446.13	MW	SS	100				
X202047	0.03	OPRC100200	516364.09	7768248.15	449.15	4	5	516366.36	7768248.15	445.26	MW	SS	90	ST	10		
X201983	0.03	OPRC100197	516424.02	7768326.42	449.46	0	1	516424.26	7768326.43	449.03	HW	NR	100				
X201984	0.01	OPRC100197	516424.02	7768326.42	449.46	1	2	516424.76	7768326.43	448.16	HW	NR	100				
X201985	0.01	OPRC100197	516424.02	7768326.42	449.46	2	3	516425.25	7768326.43	447.29	MW	SS	100				
X201986	0.02	OPRC100197	516424.02	7768326.42	449.46	3	4	516425.75	7768326.43	446.42	MW	SS	100				
X201987	0.01	OPRC100197	516424.02	7768326.42	449.46	4	5	516426.25	7768326.43	445.55	MW	SS	100				
X202017	0.51	OPRC100197	516424.02	7768326.42	449.46	34	35	516440.91	7768326.43	419.39	MW	QT	90	ST	10		
X202019	0.17	OPRC100197	516424.02	7768326.42	449.46	36	37	516441.88	7768326.43	417.63	MW	NR	90	SS	5	QT	5
X202020	0.23	OPRC100197	516424.02	7768326.42	449.46	37	38	516442.36	7768326.43	416.76	MW	NR	90	SS	5	QT	5
X202021	0.05	OPRC100197	516424.02	7768326.42	449.46	38	39	516442.84	7768326.43	415.88	MW	NR	90	SS	5	QT	5
X202022	0.08	OPRC100197	516424.02	7768326.42	449.46	39	40	516443.33	7768326.43	415.01	MW	NR	90	SS	5	QT	5
X201777	0.31	OPRC100195	516393.42	7768350.60	448.99	88	89	516435.21	7768350.60	370.99	MW	NR	90	ST	10		
X201778	0.29	OPRC100195	516393.42	7768350.60	448.99	89	90	516435.69	7768350.60	370.11	MW	NR	89	ST	10	SS	1
X201779	0.19	OPRC100195	516393.42	7768350.60	448.99	90	91	516436.16	7768350.60	369.23	MW	NR	75	SS	20	ST	5
X201780	0.24	OPRC100195	516393.42	7768350.60	448.99	91	92	516436.64	7768350.60	368.35	MW	ST	95	SS	5		
X201781	0.28	OPRC100195	516393.42	7768350.60	448.99	92	93	516437.12	7768350.60	367.47	MW	SS	95	ST	5		
X201782	0.26	OPRC100195	516393.42	7768350.60	448.99	93	94	516437.60	7768350.60	366.60	MW	SS	95	ST	5		

Notes:

NR - No recognisable lithology, SS - Sandstone, ST - Siltstone, QT - Quartz

HW - Highly weathered, MW - Moderately weathered

Appendix B:
XRD Data Base and General Assessment

MIN1418 (E)
PO A6898
ABM Resources

Samples received

The following samples were received for investigation from Patrick Smillie.

Sample 1	Coarse Bulk Sample
Sample 2	Fine Bulk Sample
Sample 3	X201777
Sample 4	X201778
Sample 5	X201779
Sample 6	X201780
Sample 7	X201781
Sample 8	X201782
Sample 9	X201983
Sample 10	X201984
Sample 11	X201985
Sample 12	X201986
Sample 13	X201987
Sample 14	X202017
Sample 15	X202019
Sample 16	X202020
Sample 17	X202021
Sample 18	X202022
Sample 19	X202044
Sample 20	X202045
Sample 21	X202046
Sample 22	X202047

Sample preparation

The samples were lightly ground and subsequently packed into a back-packed sample holder.

Method of analysis

The XRD traces were collected under the following instrument conditions:

XRD	Panalytical Empyrean
Radiation	Cu Kα 1.5406
Generator	45 kV 40 mA
Angular Range	5° to 65° 2θ
Time/Step	1s
Step Size	0.02º 2θ
Divergence Slit	0.5 mm
Anti-Scatter Slit	0.5°
Slit Type	Fixed
Rotation Speed	120 rpm

Results

This report includes the following data

- semi - quantitative mineralogy of the samples.

The quantitative results shown in the table have been normalised to 100%, and it should be noted that the values shown represent the relative proportion of the crystalline material in the sample. Totals greater or smaller than 100% are due to rounding errors.

Negative results in the table indicate normally a larger than usual uncertainty in regard to the quantity of the phase reported; for some of the minor and trace phases it might also indicate an uncertainty in regard of the phase itself, or both.

A significant amount of amorphous material appears to be present in all samples. Hazardous elements could be present in both the zeolite minerals and goethite as well as in the amorphous component. All samples should be assayed for all hazardous elements that might potentially be present.

Reported by:
Karsten Winter and Ian Davies

Date:
25-January-2013

	Coarse Bulk Sample	Fine Bulk Sample	X201777	X201778	X201779	X201780	X201781	X201782	X201983	X201984	X201985	X201986	X201987	X202017	X202019	X202020	X202021	X202022	X202044	X202045	X202046	X202047
Clay mineral	< 1	-1	< 1	< 1	< 1	< 1	< 1	-1	-1	-1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	< 1	-1	< 1	-1	< 1
Zeolite	3	2	1	1	1	< 1	-1	1	2	0	0	-1	< 1	-1	-1	-1	-1	-1	-1	< 1	< 1	0
Kaolinite	2	1	41	34	36	38	43	19	18	44	46	45	50	39	64	46	62	56	46	44	52	44
Chlorite	0	0	0	0	0	0	0	< 1	< 1	0	0	0	0	0	0	0	0	0	0	0	0	< 1
Mica	1	1	21	16	18	24	10	6	1	1	2	3	3	16	6	6	9	6	4	4	6	6
Serpentine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-1	0	-1	0
Amphibole	1	< 1	0	-1	0	0	0	0	0	0	0	0	0	0	0	0	0	< 1	-2	< 1	0	0
Microcline - Rutile - Titanite	0	0	0	0	0	< 1	0	0	3	< 1	< 1	0	0	0	0	0	0	0	0	< 1	0	-2
Alpha quartz	91	92	31	37	33	24	35	57	69	26	27	46	35	37	25	44	26	34	17	22	20	26
Goethite	-3	-2	-5	10	13	13	11	16	3	26	23	5	11	6	3	-2	-2	-2	29	28	20	21
Hematite	0	0	0	0	0	0	0	0	3	2	0	0	0	0	0	0	0	0	0	< 1	0	0

Appendix C:
XRF Base Data

Australian Laboratory Services Pty. Ltd.
32 Shand Street
Stafford
Brisbane QLD 4053
Phone: +61 (7) 3243 7222 Fax: +61 (7) 3243 7218
www.alsglobal.com

Finalized Date: 6-DEC-2012
This copy reported on 30-JAN-2013
Account: ABMRES

CERTIFICATE PH12280384

Project:

P.O. No.:

This report is for 22 Pulp samples submitted to our lab in Perth, WA, Australia on 29-NOV-2012.

The following have access to data associated with this certificate:

BERDINE M PATRICK SMILLIE	ROBIN M BRAD VALIUKAS	LAB RESULTS

SAMPLE PREPARATION

ALS CODE	DESCRIPTION
LEV-01	Waste Disposal Levy
LOG-24	Pulp Login - Rcd w/o Barcode

ANALYTICAL PROCEDURES

ALS CODE	DESCRIPTION	INSTRUMENT
ME-XRF21n	Iron Ore by XRF Fusion	XRF
ME-GRA05	H2O/LOI by TGA furnace	TGA

To: **ABM RESOURCES NL**
ATTN: BRAD VALIUKAS
LEVEL 1
141 BROADWAY ROAD
NEDLANDS WA 6009

This is the Final Report and supersedes any preliminary report with this certificate number. Results apply to samples as submitted. All pages of this report have been checked and approved for release.

Signature:

Wayne Abbott, Operations Manager, Western Australia

Australian Laboratory Services Pty. Ltd.
32 Shand Street
Stafford
Brisbane QLD 4053
Phone: +61 (7) 3243 7222 Fax: +61 (7) 3243 7218
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CERTIFICATE OF ANALYSIS PH12280384

Sample Description	Method	ME-XRF21n	ME-XRF21n	ME-XRF21n	ME-XRF21n	ME-XRF21n	ME-XRF21n	ME-XRF21n	ME-XRF21n	ME-XRF21n	ME-XRF21n	ME-XRF21n	ME-XRF21n	ME-XRF21n	ME-XRF21n	ME-XRF21n
	Analyte	Al2O3	As	Ba	CaO	Cl	Co	Cr2O3	Cu	Fe	K2O	MgO	Mn	Na2O	Ni	P
	Units	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
	LOR	0.01	0.001	0.001	0.01	0.001	0.001	0.0006	0.001	0.01	0.001	0.01	0.001	0.005	0.001	0.001
X202044		20.5	0.017	0.023	0.17	0.004	0.001	0.0296	0.002	14.10	1.225	0.38	0.030	0.086	0.002	0.025
X202045		18.15	0.017	0.028	0.13	0.002	<0.001	0.0290	0.002	13.70	1.210	0.40	0.015	0.056	0.001	0.022
X202046		18.90	0.012	0.057	0.13	0.001	<0.001	0.0201	<0.001	10.16	1.740	0.41	0.007	0.096	0.001	0.011
X202047		16.05	0.011	0.061	0.09	0.001	<0.001	0.0159	0.002	6.94	2.24	0.40	0.002	0.100	0.002	0.012
X201983		7.00	0.006	0.012	0.08	0.003	<0.001	0.0182	<0.001	5.92	0.551	0.15	0.012	0.031	<0.001	0.013
X201984		18.05	0.019	0.012	0.08	0.002	<0.001	0.0164	0.002	14.55	0.762	0.27	0.013	0.057	0.002	0.012
X201985		15.95	0.019	0.092	0.08	0.002	<0.001	0.0104	<0.001	8.82	1.365	0.36	0.002	0.102	<0.001	0.005
X201986		12.20	0.009	0.029	0.09	0.008	<0.001	0.0029	<0.001	3.67	1.070	0.33	0.002	0.159	<0.001	0.004
X201987		13.00	0.012	0.022	0.26	0.010	<0.001	0.0058	<0.001	4.35	1.220	0.40	<0.001	0.146	<0.001	0.005
X202017		16.20	0.124	0.066	0.03	0.021	<0.001	0.0091	0.006	5.84	4.26	0.56	0.004	0.110	0.002	0.069
X202019		13.05	0.046	0.036	0.02	0.016	<0.001	0.0067	0.002	3.06	2.11	0.31	0.002	0.069	<0.001	0.039
X202020		13.50	0.027	0.038	0.02	0.012	<0.001	0.0047	<0.001	1.68	2.19	0.31	0.001	0.064	0.002	0.024
X202021		16.65	0.012	0.063	0.01	0.014	<0.001	0.0085	0.001	1.36	3.40	0.45	0.002	0.094	<0.001	0.019
X202022		14.20	0.012	0.045	0.01	0.012	<0.001	0.0054	0.002	1.72	2.31	0.34	0.002	0.092	<0.001	0.022
X201777		20.00	0.017	0.063	0.02	0.011	<0.001	0.0118	0.003	2.80	5.13	0.67	0.004	0.120	0.002	0.040
X201778		14.45	0.044	0.044	0.03	0.007	<0.001	0.0068	0.007	7.67	3.74	0.52	0.011	0.075	0.005	0.102
X201779		18.40	0.037	0.062	0.02	0.010	<0.001	0.0118	0.006	6.03	4.91	0.72	0.007	0.109	0.003	0.075
X201780		20.1	0.020	0.067	0.02	0.006	0.001	0.0234	0.006	7.30	5.42	0.68	0.007	0.113	0.012	0.057
X201781		14.95	0.015	0.040	0.02	0.005	<0.001	0.0095	0.003	5.96	3.51	0.45	0.009	0.079	0.002	0.050
X201782		11.05	0.017	0.030	0.02	0.004	<0.001	0.0031	0.004	6.36	2.31	0.31	0.009	0.056	0.002	0.067
Coarse bulk sample		0.75	0.074	0.004	0.01	0.002	<0.001	0.0039	<0.001	1.32	0.144	0.04	0.006	0.006	<0.001	0.001
Fine bulk sample		0.67	0.067	0.008	0.06	0.002	<0.001	0.1495	0.003	1.22	0.132	0.05	0.010	0.010	0.047	0.001

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CERTIFICATE OF ANALYSIS PH12280384

Sample Description	Method	ME-XRF21n	ME-XRF21n	ME-XRF21n	ME-XRF21n	ME-XRF21n	ME-XRF21n	ME-XRF21n	ME-XRF21n	ME-XRF21n	ME-XRF21n	ME-GRA05
	Analyte	Pb	S	SiO2	Sn	Sr	TiO2	V	Zn	Zr	Total	LOI
	Units	%	%	%	%	%	%	%	%	%	%	%
	LOR	0.001	0.001	0.01	0.001	0.001	0.01	0.001	0.001	0.001	0.01	0.01
X202044		0.009	0.007	47.9	<0.001	0.005	0.73	0.028	0.004	0.028	99.96	8.49
X202045		0.007	0.007	51.3	<0.001	0.003	0.78	0.027	0.002	0.028	99.94	8.04
X202046		0.004	0.010	56.3	<0.001	0.004	0.64	0.017	0.002	0.025	100.00	7.02
X202047		0.009	0.009	64.7	0.001	0.003	0.45	0.010	0.002	0.013	99.97	5.81
X201983		<0.001	0.006	79.7	0.002	0.001	0.40	0.012	0.001	0.035	99.99	3.44
X201984		0.005	0.015	51.4	0.001	0.003	0.68	0.028	0.002	0.030	100.00	7.66
X201985		<0.001	0.027	62.0	0.001	0.003	0.58	0.014	0.001	0.019	99.95	6.63
X201986		<0.001	0.020	75.5	0.001	<0.001	0.41	0.003	0.001	0.012	99.97	4.82
X201987		<0.001	0.014	73.0	0.001	0.001	0.37	0.003	0.001	0.015	100.05	5.31
X202017		0.034	0.012	65.6	0.002	0.008	0.42	0.009	0.015	0.007	99.97	3.88
X202019		0.009	0.008	75.6	0.001	0.004	0.44	0.004	0.010	0.019	100.05	3.77
X202020		0.007	0.006	77.2	0.002	0.002	0.44	0.003	0.005	0.016	100.05	3.68
X202021		0.007	0.005	72.8	0.003	0.002	0.58	0.006	0.004	0.017	99.98	3.84
X202022		0.008	0.006	76.0	0.002	0.002	0.50	0.005	0.005	0.019	99.95	3.84
X201777		0.006	0.003	65.1	0.001	0.004	0.52	0.006	0.009	0.007	100.00	4.16
X201778		0.014	0.004	65.6	<0.001	0.004	0.37	0.009	0.018	0.007	100.05	3.82
X201779		0.007	0.003	62.1	0.001	0.005	0.45	0.007	0.016	0.008	99.95	4.21
X201780		0.007	0.002	57.8	<0.001	0.005	0.50	0.008	0.017	0.009	99.96	4.53
X201781		0.002	0.002	68.0	0.002	0.003	0.45	0.004	0.012	0.013	99.93	3.68
X201782		0.004	0.002	73.1	<0.001	0.002	0.35	0.003	0.017	0.018	99.98	3.38
Coarse bulk sample		0.027	0.007	96.7	0.002	<0.001	0.03	<0.001	<0.001	<0.001	99.96	0.21
Fine bulk sample		0.026	0.007	96.8	0.003	<0.001	0.02	<0.001	0.001	<0.001	100.00	0.14

Appendix D:
Results and Laboratory Certificates of ABA Leachate Data

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ **Sydney**: 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
☐ **Newcastle**: 5 Rosegum Rd, Warabrook NSW 2304 Ph:02 4968 9433 E:samples.newcastle@alsenviro.com
☐ **Brisbane**: 32 Shand St, Stafford QLD 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
☐ **Townsville**: 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville.environmental@alsenviro.com
☐ **Melbourne**: 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
☐ **Adelaide**: 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E:adelaide@alsenviro.com
☐ **Perth**: 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ **Launceston**: 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: ABM RESOURCES	**TURNAROUND REQUIREMENTS :** ☐ Standard TAT **(List due date):**	**FOR LABORATORY USE ONLY (Circle)**	
OFFICE:	(Standard TAT may be longer for some tests e.g., Ultra Trace Organics) ☐ Non Standard or urgent TAT **(List due date):**	Custody Seal Intact?	Yes No N/A
PROJECT: **PROJECT NO.:**	**ALS QUOTE NO.: EP/825/12 V2**	Free ice / frozen ice bricks present upon receipt?	Yes No N/A
ORDER NUMBER: **PURCHASE ORDER NO.:**	**COUNTRY OF ORIGIN:**	Random Sample Temperature on Receipt:	°C
PROJECT MANAGER: Patrick Smillie **CONTACT PH: 9423 9713**	**COC SEQUENCE NUMBER (Circle)** COC: 1 2 3 4 5 6 7 OF: 1 2 3 4 5 6 7	Other comment:	

SAMPLER: **SAMPLER MOBILE:**	**RELINQUISHED BY:**	**RECEIVED BY:** *Luke Jones*	**RELINQUISHED BY:**
COC Emailed to ALS? (YES / NO) **EDD FORMAT (or default):**			
Email Reports to : labresults@abmresources.com.au	DATE/TIME:	DATE/TIME: *06/12/2012 10:25*	DATE/TIME:
Email Invoice to : patricks@abmresources.com.au			

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).							Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	ANALYSIS AS PER QUOTE EP/825/12 V2							Comments on likely contaminant levels, dilutions, or samples requiring specific QC analysis etc.
#1-#22	See attached Spreadsheet		S		1-18 (1 Bag), 19-22 (2 Bags)	×							
				TOTAL									

Environmental Division
Perth
Work Order
EP1210177

Telephone : +61-8-9209 7655

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved Glass;
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

ALS ID	Sample ID	Analysis as per quote EP/825/12 V2 (Both DI Suite and AMD Suite)
1	X202044	×
2	X202045	×
3	X202046	×
4	X202047	×
5	X201983	×
6	X201984	×
7	X201985	×
8	X201986	×
9	X201987	×
10	X202017	×
11	X202019	×
12	X202020	×
13	X202021	×
14	X202022	×
15	X201777	×
16	X201778	×
17	X201779	×
18	X201780	×
19	X201781	×
20	X201782	×
21	Coarse Bulk Sample	×
22	Fine Bluk Sample	×

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **EP1210177**	Page	: 1 of 17
Client	: **ABM RESOURCES NL**	Laboratory	: Environmental Division Perth
Contact	: Kate Eiloart	Contact	: Scott James
Address	: level 1, 141 Broadway Nedlands - Perth Perth Western Australia 6009	Address	: 10 Hod Way Malaga WA Australia 6090
E-mail	: katee@abmresources.com.au	E-mail	: perth.enviro.services@alsglobal.com
Telephone	: +61 08 9423 9777	Telephone	: +61-8-9209 7655
Facsimile	: ----	Facsimile	: +61-8-9209 7600
Project	: ----	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 06-DEC-2012
Sampler	: ----	Issue Date	: 18-DEC-2012
Site	: ----		
		No. of samples received	: 22
Quote number	: EP/825/12 V2	No. of samples analysed	: 22

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Canhuang Ke	Metals Instrument Chemist	Perth Inorganics
Chas Tucker	Inorganic Chemist	Perth Inorganics
Jonathon Angell	Inorganic Coordinator	Stafford Minerals - AY
Leanne Carey	Acid Sulfate Soils Supervisor	Perth ASS
Scott James	Laboratory Manager	Perth Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **ASS: EA013 (ANC) Fizz Rating: 0- None; 1- Slight; 2- Moderate; 3- Strong; 4- Very Strong; 5- Lime.**

Analytical Results

Sub-Matrix: **DI WATER LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	X202044	X202045	X202046	X202047	X201983
				Client sampling date / time	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00
					EP1210177-001	EP1210177-002	EP1210177-003	EP1210177-004	EP1210177-005
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**6.14**	**7.38**	**6.35**	**6.18**	**6.16**
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**20**	**22**	**32**	**22**	**20**
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		<1.0	<1.0	<1.0	<1.0	<1.0
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**4**	**6**	**5**	**3**	**3**
Total Alkalinity as CaCO3	----	1	mg/L		**4**	**6**	**5**	**3**	**3**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		<1	**3**	**4**	**6**	**2**
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		**2**	**2**	<1	<1	**1**
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	<1	<1	<1	<1
Magnesium	7439-95-4	1	mg/L		<1	<1	<1	<1	<1
Sodium	7440-23-5	1	mg/L		**5**	**5**	**8**	**6**	**3**
Potassium	7440-09-7	1	mg/L		**1**	**2**	<1	**1**	**3**
EG020W: Water Leachable Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.28**	**0.33**	**0.67**	**0.17**	**0.41**
Antimony	7440-36-0	0.001	mg/L		**0.003**	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		**0.002**	**0.003**	**0.006**	**0.009**	**0.005**
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.213**	**0.229**	**0.341**	**0.110**	**0.180**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	**0.001**	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.001**	**0.001**	**0.004**	<0.001	**0.043**
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)				Client sample ID	X202044	X202045	X202046	X202047	X201983
				Client sampling date / time	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00
Compound	CAS Number	LOR	Unit		EP1210177-001	EP1210177-002	EP1210177-003	EP1210177-004	EP1210177-005
EG020W: Water Leachable Metals by ICP-MS - Continued									
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.095**	**0.088**	**0.104**	**0.065**	**0.149**
Iron	7439-89-6	0.05	mg/L		**0.16**	**0.20**	**0.71**	**0.10**	**0.40**
EG035W: Water Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.3**	**0.4**	**0.5**	**0.5**	<0.1

Analytical Results

Sub-Matrix: **DI WATER LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	X201984	X201985	X201986	X201987	X202017
				Client sampling date / time	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00
					EP1210177-006	EP1210177-007	EP1210177-008	EP1210177-009	EP1210177-010
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		6.21	6.11	6.27	7.24	6.20
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		15	42	41	107	74
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		<1.0	<1.0	<1.0	<1.0	<1.0
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		3	3	4	39	2
Total Alkalinity as CaCO3	----	1	mg/L		3	3	4	39	2
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		2	12	6	6	11
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		2	2	5	6	11
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	<1	<1	6	<1
Magnesium	7439-95-4	1	mg/L		<1	<1	<1	3	<1
Sodium	7440-23-5	1	mg/L		4	8	10	14	9
Potassium	7440-09-7	1	mg/L		<1	3	<1	4	9
EG020W: Water Leachable Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.16	0.20	0.22	0.08	0.02
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		0.003	0.002	0.003	0.020	0.010
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		0.131	0.316	0.251	0.281	0.173
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)				Client sample ID	X201984	X201985	X201986	X201987	X202017
				Client sampling date / time	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00
Compound	CAS Number	LOR	Unit		EP1210177-006	EP1210177-007	EP1210177-008	EP1210177-009	EP1210177-010
EG020W: Water Leachable Metals by ICP-MS - Continued									
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.039**	**0.088**	**0.070**	**0.041**	**0.071**
Iron	7439-89-6	0.05	mg/L		**0.11**	**0.10**	**0.09**	<0.05	<0.05
EG035W: Water Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	**0.7**	**0.5**	**0.7**	**0.8**

Analytical Results

Sub-Matrix: **DI WATER LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	X202019	X202020	X202021	X202022	X201777
				Client sampling date / time	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00
					EP1210177-011	EP1210177-012	EP1210177-013	EP1210177-014	EP1210177-015
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		6.13	6.13	6.10	6.14	6.28
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		52	37	49	39	35
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		<1.0	<1.0	<1.0	<1.0	<1.0
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		3	2	3	2	3
Total Alkalinity as CaCO3	----	1	mg/L		3	2	3	2	3
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		7	2	4	2	1
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		8	7	8	8	5
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	<1	<1	<1	<1
Magnesium	7439-95-4	1	mg/L		<1	<1	<1	<1	<1
Sodium	7440-23-5	1	mg/L		8	5	9	8	7
Potassium	7440-09-7	1	mg/L		5	6	4	3	4
EG020W: Water Leachable Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	0.05	0.12	0.06	0.38
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		<0.001	0.008	0.008	0.005	0.055
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		<0.001	0.129	0.441	0.353	0.396
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)				Client sample ID	X202019	X202020	X202021	X202022	X201777
				Client sampling date / time	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00
Compound	CAS Number	LOR	Unit		EP1210177-011	EP1210177-012	EP1210177-013	EP1210177-014	EP1210177-015
EG020W: Water Leachable Metals by ICP-MS - Continued									
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.078**	**0.087**	**0.059**	**0.098**
Iron	7439-89-6	0.05	mg/L		<0.05	<0.05	**0.06**	<0.05	**0.26**
EG035W: Water Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.6**	**0.4**	**0.5**	**0.5**	**0.7**

Analytical Results

Sub-Matrix: **DI WATER LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	X201778	X201779	X201780	X201781	X201782
				Client sampling date / time	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00
					EP1210177-016	EP1210177-017	EP1210177-018	EP1210177-019	EP1210177-020
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**6.28**	**6.30**	**6.29**	**6.25**	**6.26**
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**28**	**37**	**28**	**24**	**21**
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		<1.0	<1.0	<1.0	<1.0	<1.0
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**3**	**3**	**4**	**4**	**3**
Total Alkalinity as CaCO3	----	1	mg/L		**3**	**3**	**4**	**4**	**3**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**2**	**2**	**2**	**1**	<1
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		**4**	**6**	**4**	**4**	**3**
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		<1	<1	<1	<1	<1
Magnesium	7439-95-4	1	mg/L		<1	<1	<1	<1	<1
Sodium	7440-23-5	1	mg/L		**5**	**5**	**5**	**6**	**3**
Potassium	7440-09-7	1	mg/L		**5**	**7**	**4**	**2**	**4**
EG020W: Water Leachable Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.05**	**0.08**	**0.11**	**0.09**	<0.01
Antimony	7440-36-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Arsenic	7440-38-2	0.001	mg/L		**0.050**	**0.067**	**0.049**	**0.046**	<0.001
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.142**	**0.146**	**0.147**	**0.200**	**0.002**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	**0.001**	<0.001	<0.001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		<0.001	<0.001	**0.002**	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: **DI WATER LEACHATE** (Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	Client sample ID	X201778	X201779	X201780	X201781	X201782
				Client sampling date / time	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00	11-DEC-2012 12:00
					EP1210177-016	EP1210177-017	EP1210177-018	EP1210177-019	EP1210177-020
EG020W: Water Leachable Metals by ICP-MS - Continued									
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.024**	**0.023**	**0.035**	**0.030**	<0.005
Iron	7439-89-6	0.05	mg/L		**0.09**	**0.09**	**0.34**	**0.17**	<0.05
EG035W: Water Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.8**	**0.8**	**0.8**	**0.6**	**0.7**

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)				Client sample ID	Coarse Bulk Sample	Fine Bluk Sample	----	----	----
				Client sampling date / time	11-DEC-2012 12:00	11-DEC-2012 12:00	----	----	----
Compound	CAS Number	LOR	Unit		EP1210177-021	EP1210177-022	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**6.23**	**7.49**	----	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**22**	**32**	----	----	----
EA055: Moisture Content									
Moisture Content (dried @ 103°C)	----	1.0	%		<1.0	<1.0	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**6**	**15**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**6**	**15**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**2**	**2**	----	----	----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		**2**	<1	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**2**	**6**	----	----	----
Magnesium	7439-95-4	1	mg/L		<1	<1	----	----	----
Sodium	7440-23-5	1	mg/L		**3**	**1**	----	----	----
Potassium	7440-09-7	1	mg/L		<1	<1	----	----	----
EG020W: Water Leachable Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.06**	**0.04**	----	----	----
Antimony	7440-36-0	0.001	mg/L		**0.004**	**0.002**	----	----	----
Arsenic	7440-38-2	0.001	mg/L		**0.054**	**0.090**	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	----	----	----
Barium	7440-39-3	0.001	mg/L		**0.290**	**0.148**	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	----	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	----	----	----
Lead	7439-92-1	0.001	mg/L		**0.004**	**0.002**	----	----	----
Manganese	7439-96-5	0.001	mg/L		**0.033**	<0.001	----	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	----	----	----

Analytical Results

Sub-Matrix: DI WATER LEACHATE (Matrix: WATER)				Client sample ID	Coarse Bulk Sample	Fine Bluk Sample	----	----	----
				Client sampling date / time	11-DEC-2012 12:00	11-DEC-2012 12:00	----	----	----
Compound	CAS Number	LOR	Unit		EP1210177-021	EP1210177-022	----	----	----
EG020W: Water Leachable Metals by ICP-MS - Continued									
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.054**	**0.014**	----	----	----
Iron	7439-89-6	0.05	mg/L		**0.10**	**0.06**	----	----	----
EG035W: Water Leachable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.1**	**0.1**	----	----	----

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	X202044	X202045	X202046	X202047	X201983
				Client sampling date / time	06-DEC-2012 10:25	06-DEC-2012 10:25	06-DEC-2012 10:25	06-DEC-2012 10:25	06-DEC-2012 10:25
					EP1210177-001	EP1210177-002	EP1210177-003	EP1210177-004	EP1210177-005
EA009: Nett Acid Production Potential									
Acid Production Potential (APP)	----	0.5	kg H2SO4/t		**1.8**	**1.2**	**0.6**	**0.6**	**17.4**
Net Acid Production Potential	----	0.5	kg H2SO4/t		**1.8**	**1.2**	**0.6**	<0.5	**17.4**
EA011: Net Acid Generation									
pH (OX)	----	0.1	pH Unit		**6.1**	**6.5**	**6.3**	**6.0**	**5.2**
NAG (pH 4.5)	----	0.1	kg H2SO4/t		<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t		**4.4**	**3.0**	**4.0**	**8.1**	**12.1**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		<0.5	<0.5	<0.5	**1.0**	<0.5
ANC as CaCO3	----	0.1	% CaCO3		<0.1	<0.1	<0.1	**0.1**	<0.1
Fizz Rating	----	0	Fizz Unit		**1**	**1**	**1**	**1**	**1**
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		<100	<100	**110**	**160**	<100
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		<10	**10**	**20**	**50**	**30**
Sulfur as S	63705-05-5	10	mg/kg		<10	<10	<10	**20**	<10
Silica	7631-86-9	1	mg/kg		**64**	**104**	**101**	**77**	**64**
Silicon	7440-21-3	1	mg/kg		**30**	**48**	**47**	**36**	**30**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.06**	**0.04**	**0.02**	**0.02**	**0.57**
EK085M: Sulfide as S2-									
Sulfide as S	----	0.01	%		**0.06**	**0.04**	**0.02**	**0.01**	**0.57**
EN60: Bottle Leaching Procedure									
Final pH	----	0.1	pH Unit		**8.0**	**8.1**	**8.2**	**8.2**	**7.5**
EP003TC: Total Carbon (TC) in Soil									
Total Carbon	----	0.02	%		<0.02	<0.02	<0.02	<0.02	<0.02

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	X201984	X201985	X201986	X201987	X202017
				Client sampling date / time	06-DEC-2012 10:25	06-DEC-2012 10:25	06-DEC-2012 10:25	06-DEC-2012 10:25	06-DEC-2012 10:25
					EP1210177-006	EP1210177-007	EP1210177-008	EP1210177-009	EP1210177-010
EA009: Nett Acid Production Potential									
Acid Production Potential (APP)	----	0.5	kg H2SO4/t		**1.8**	**1.2**	<0.5	**1.5**	<0.5
Net Acid Production Potential	----	0.5	kg H2SO4/t		**0.8**	**1.2**	**-7.0**	**-2.1**	**-1.5**
EA011: Net Acid Generation									
pH (OX)	----	0.1	pH Unit		**5.6**	**5.9**	**6.1**	**6.0**	**5.9**
NAG (pH 4.5)	----	0.1	kg H2SO4/t		<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t		**9.4**	**8.8**	**7.6**	**18.1**	**10.0**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		**1.0**	<0.5	**7.0**	**3.6**	**1.5**
ANC as CaCO3	----	0.1	% CaCO3		**0.1**	<0.1	**0.7**	**0.4**	**0.2**
Fizz Rating	----	0	Fizz Unit		**1**	**1**	**1**	**1**	**1**
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		**120**	**410**	**210**	**160**	**280**
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		**10**	**80**	**60**	**80**	**170**
Sulfur as S	63705-05-5	10	mg/kg		<10	**30**	**20**	**30**	**60**
Silica	7631-86-9	1	mg/kg		**78**	**77**	**58**	**124**	**11**
Silicon	7440-21-3	1	mg/kg		**36**	**36**	**27**	**58**	**5**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.06**	**0.04**	<0.01	**0.05**	<0.01
EK085M: Sulfide as S2-									
Sulfide as S	----	0.01	%		**0.06**	**0.03**	<0.01	**0.04**	<0.01
EN60: Bottle Leaching Procedure									
Final pH	----	0.1	pH Unit		**8.1**	**7.8**	**8.1**	**8.5**	**7.6**
EP003TC: Total Carbon (TC) in Soil									
Total Carbon	----	0.02	%		<0.02	<0.02	<0.02	<0.02	<0.02

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)				Client sample ID	X202019	X202020	X202021	X202022	X201777
				Client sampling date / time	06-DEC-2012 10:25	06-DEC-2012 10:25	06-DEC-2012 10:25	06-DEC-2012 10:25	06-DEC-2012 10:25
Compound	CAS Number	LOR	Unit		EP1210177-011	EP1210177-012	EP1210177-013	EP1210177-014	EP1210177-015
EA009: Nett Acid Production Potential									
Acid Production Potential (APP)	----	0.5	kg H2SO4/t		<0.5	<0.5	<0.5	<0.5	<0.5
Net Acid Production Potential	----	0.5	kg H2SO4/t		-1.0	<0.5	<0.5	<0.5	-0.9
EA011: Net Acid Generation									
pH (OX)	----	0.1	pH Unit		5.4	5.7	5.7	5.7	5.9
NAG (pH 4.5)	----	0.1	kg H2SO4/t		<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t		16.7	14.6	11.6	13.6	10.5
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		1.0	<0.5	<0.5	<0.5	0.9
ANC as CaCO3	----	0.1	% CaCO3		0.1	<0.1	<0.1	<0.1	<0.1
Fizz Rating	----	0	Fizz Unit		1	1	1	1	1
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		180	140	120	110	<100
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		110	20	80	30	20
Sulfur as S	63705-05-5	10	mg/kg		40	<10	20	<10	<10
Silica	7631-86-9	1	mg/kg		12	19	10	16	17
Silicon	7440-21-3	1	mg/kg		5	9	5	8	8
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		<0.01	<0.01	<0.01	<0.01	<0.01
EK085M: Sulfide as S2-									
Sulfide as S	----	0.01	%		<0.01	<0.01	<0.01	<0.01	<0.01
EN60: Bottle Leaching Procedure									
Final pH	----	0.1	pH Unit		7.6	7.4	7.9	8.0	8.4
EP003TC: Total Carbon (TC) in Soil									
Total Carbon	----	0.02	%		<0.02	<0.02	<0.02	<0.02	<0.02

Analytical Results

Sub-Matrix: **SOIL** (Matrix: **SOIL**)

Compound	CAS Number	LOR	Unit	Client sample ID	X201778	X201779	X201780	X201781	X201782
				Client sampling date / time	06-DEC-2012 10:25	06-DEC-2012 10:25	06-DEC-2012 10:25	06-DEC-2012 10:25	06-DEC-2012 10:25
					EP1210177-016	EP1210177-017	EP1210177-018	EP1210177-019	EP1210177-020
EA009: Nett Acid Production Potential									
Acid Production Potential (APP)	----	0.5	kg H2SO4/t		**0.6**	**0.6**	**0.9**	**0.9**	**1.2**
Net Acid Production Potential	----	0.5	kg H2SO4/t		**0.6**	**0.6**	<0.5	**0.9**	**1.2**
EA011: Net Acid Generation									
pH (OX)	----	0.1	pH Unit		**6.0**	**6.1**	**6.0**	**6.1**	**6.2**
NAG (pH 4.5)	----	0.1	kg H2SO4/t		<0.1	<0.1	<0.1	<0.1	<0.1
NAG (pH 7.0)	----	0.1	kg H2SO4/t		**7.7**	**8.2**	**9.1**	**6.8**	**6.0**
EA013: Acid Neutralising Capacity									
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t		<0.5	<0.5	**0.8**	<0.5	<0.5
ANC as CaCO3	----	0.1	% CaCO3		<0.1	<0.1	<0.1	<0.1	<0.1
Fizz Rating	----	0	Fizz Unit		**1**	**1**	**1**	**1**	**1**
ED040: Sulfur as SO4 2-									
Sulfate as SO4 2-	14808-79-8	100	mg/kg		<100	<100	<100	<100	<100
ED040S : Soluble Sulfate by ICPAES									
Sulfate as SO4 2-	14808-79-8	10	mg/kg		**30**	**30**	**20**	**10**	<10
Sulfur as S	63705-05-5	10	mg/kg		<10	**10**	<10	<10	<10
Silica	7631-86-9	1	mg/kg		**18**	**18**	**16**	**15**	**20**
Silicon	7440-21-3	1	mg/kg		**8**	**8**	**8**	**7**	**10**
ED042T: Total Sulfur by LECO									
Sulfur - Total as S (LECO)	----	0.01	%		**0.02**	**0.02**	**0.03**	**0.03**	**0.04**
EK085M: Sulfide as S2-									
Sulfide as S	----	0.01	%		**0.02**	**0.02**	**0.03**	**0.03**	**0.04**
EN60: Bottle Leaching Procedure									
Final pH	----	0.1	pH Unit		**7.9**	**8.2**	**8.5**	**8.5**	**8.2**
EP003TC: Total Carbon (TC) in Soil									
Total Carbon	----	0.02	%		<0.02	<0.02	<0.02	<0.02	<0.02

Analytical Results

Sub-Matrix: SOIL (Matrix: SOIL)			Client sample ID	Coarse Bulk Sample	Fine Bluk Sample	----	----	----
			Client sampling date / time	06-DEC-2012 10:25	06-DEC-2012 10:25	----	----	----
Compound	CAS Number	LOR	Unit	EP1210177-021	EP1210177-022	----	----	----
EA009: Nett Acid Production Potential								
Acid Production Potential (APP)	----	0.5	kg H2SO4/t	<0.5	<0.5	----	----	----
Net Acid Production Potential	----	0.5	kg H2SO4/t	<0.5	**-1.5**	----	----	----
EA011: Net Acid Generation								
pH (OX)	----	0.1	pH Unit	**6.2**	**6.4**	----	----	----
NAG (pH 4.5)	----	0.1	kg H2SO4/t	<0.1	<0.1	----	----	----
NAG (pH 7.0)	----	0.1	kg H2SO4/t	**7.5**	**6.6**	----	----	----
EA013: Acid Neutralising Capacity								
ANC as H2SO4	----	0.5	kg H2SO4 equiv./t	<0.5	**1.5**	----	----	----
ANC as CaCO3	----	0.1	% CaCO3	<0.1	**0.2**	----	----	----
Fizz Rating	----	0	Fizz Unit	**1**	**1**	----	----	----
ED040: Sulfur as SO4 2-								
Sulfate as SO4 2-	14808-79-8	100	mg/kg	<100	<100	----	----	----
ED040S : Soluble Sulfate by ICPAES								
Sulfate as SO4 2-	14808-79-8	10	mg/kg	**20**	**40**	----	----	----
Sulfur as S	63705-05-5	10	mg/kg	<10	**10**	----	----	----
Silica	7631-86-9	1	mg/kg	**38**	**35**	----	----	----
Silicon	7440-21-3	1	mg/kg	**18**	**16**	----	----	----
ED042T: Total Sulfur by LECO								
Sulfur - Total as S (LECO)	----	0.01	%	<0.01	<0.01	----	----	----
EK085M: Sulfide as S2-								
Sulfide as S	----	0.01	%	<0.01	<0.01	----	----	----
EN60: Bottle Leaching Procedure								
Final pH	----	0.1	pH Unit	**8.2**	**9.2**	----	----	----
EP003TC: Total Carbon (TC) in Soil								
Total Carbon	----	0.02	%	<0.02	<0.02	----	----	----