Appendix 8

Browns Oxide Project Tailings Storage Facility Batchelor NT Preliminary Design Report

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COMPASS RESOURCES NL

BROWNS OXIDE PROJECT TAILINGS STORAGE FACILITY BATCHELOR NT

PRELIMINARY DESIGN REPORT

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CONDITIONS OF INVESTIGATION AND REPORT

CONDITIONS OF REPORT

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7. Geotechnical site investigation necessarily involves the investigation of the subsurface conditions at a site at a few isolated locations, and the interpretation and extrapolation of those conditions to elsewhere on the site not so investigated. This procedure has been adopted at the site that is the subject of this report and due care and skill has been applied in carrying out and reporting on the work. Thus the findings, conclusions and comments contained in this report represent professional estimates and opinions and are not to be read as facts unless the context makes it clear to the contrary. In general, statements of fact are confined to statements as to what was done and/or what was observed. Other statements have been based on professional judgement.

8. The scope of the work has been planned in the absence of any fore-knowledge of the site other than that stated in the report. Unless otherwise stated we consider that the number of locations investigated and the depths to which they have been investigated are reasonable bearing in mind the scale and nature of the project, and the defined purpose for which the investigation was undertaken.

9. We do not accept any responsibility for any variance between the interpreted and extrapolated conditions and those that are revealed by any means subsequently. Specific warning is also given that many factors, either natural or artificial, may render ground conditions different from those which pertained at the time of the investigation. Should there be revealed during the construction or at any other time any apparent difference from subsurface conditions described or assessed in this report, it is strongly recommended that such differences be brought to our attention so that its significance may be assessed and appropriate advice given.

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1 INTRODUCTION

This study was commissioned by Compass Resources NL (Compass), in accordance with a proposal submitted by Australian Tailings Consultants (ATC), dated 21 June 2005.

The aim of the study was to prepare a preliminary design of the Tailings Storage Facility (TSF) for the Browns Oxide Project, and prepare a summary report for the principal purpose of inclusion in the PER for this project.

2 PROJECT OUTLINE

The Browns Oxide Project is located near Batchelor, NT. It is immediately west of the old Rum Jungle mine site. The proposal is to mine approximately 3.5Mt of a poly-metallic ore containing copper, nickel, cobalt and lead by open cut methods. It is understood that virtually no pre-stripping of the ore-body is required, but that as the development of the pit progresses, approximately 4 Mt of waste material will be generated. It is expected that this material will be comprised of weathered (oxidised) rock. The intent is to maximise the utilisation of this waste material in construction of the retaining embankment for the TSF.

Mining operations will be undertaken on a contract mining basis, and the aim is for the contractor to carry out progressive construction of the TSF as an integral part of the mine waste handling operation.

3 STUDY PARAMETERS

There are two distinct types of ore associated with this mine. The first is an oxidised Black Shale, comprising around 2.6 Mt of ore. The second is a Supergene ore comprising around 0.9 Mt. Mining is planned to be at a rate of 1 Mtpa. The sequence of processing is planned as follows:

Year 1	Black Shale ore	1 Mt
Year 2	Black Shale ore	1 Mt
Year 3	Black Shale ore	0.6 Mt followed by 0.4 Mt Supergene
Year 4	Supergene ore	0.5 Mt.

The preliminary design is therefore based on the requirement to retain 3.5 Mt of tailings at this stage. However, it is understood that the mine plane is still subject to change, and that the tonnage of tailings may increase in Year 4.

If this is the case, the tailings dam site and embankment design has sufficient flexibility that additional tailings could be retained.

It is understood that the tailings will be discharged at a slurry density around 45% Solids (w/w).

4 TAILINGS CHARACTERISTICS

4.1 Physical

Two prototype samples of tailings (remaining from metallurgical testing) have been submitted to ATC for testing and evaluation.

Visually the Black Shale tailings are a grey silty material. The Supergene tailings are a brown colour, typical of oxide tailings, and the fines are clayey. Testing of both of these samples was carried out for the following index properties:

- Particle size distribution (sieve plus hydrometer sizing)
- Plasticity (Atterberg Limits test)
- Soil particle density (SG)
- Initial settled density

The test results are summarized in Table 1. Result sheets are presented in **Appendix A**.

TABLE 1: SUMMARY OF LAB TEST RESULTS

TEST	SAMPLE	
	BLACK SHALE TAILINGS	SUPERGENE TAILINGS
Particle Size Distribution Max Size:	0.425 mm	2.36 mm
Passing 0.075mm	79%	42.8 %
Passing 0.010mm	45%	26%
Atterberg Limits:		
LL:	24	37
PI:	10	21
USC Classification:	Sandy SILT (MC)	Clayey SAND (SC)
Soil Particle Density (G)	2.80 t/m^3	2.98 t/m^3
Initial Settled Dry Density * (from 45% Solids)	0.90 t/m^3	0.99 t/m^3

* Tested in tap water

4.2 Geo-Chemical

Following the completion of the physical testing, the tailings samples were submitted for geochemical tests (NAPP, NAG) to assess the potential for acid generation.

The initial report from EGi is presented in **Appendix B**.

The testing has confirmed that the supergene tailings have a low sulphur content, and they have been classified as Non-Acid Forming (NAF).

The tests on the oxide black shale tailings show a total sulphur content of close to 1%, but suggest that possibly only one-third of this is present as pyrite. The sample returns test values of:-

Net Acid Producing Potential (NAPP) 31 kg H_2SO_4/t
Net Acid Generation (NAG) 11 kg H_2SO_4/t

and has been classified as Potentially Acid Forming (PAF).

However, the results of the Kinetic NAG tests carried out on this sample suggest a lag time of at least several months before the initiation of acid conditions.

It should be noted that these results are based on single tests of “proto-type” tailings. Compass have indicated that on the basis of the metallurgy of the oxidized black shale, a PAF result was not expected. Further testing is planned to clarify this matter.

It is noted that the current mine plan is to process all of the black shale tailings first, followed by the supergene tailings. Given the planned rate of rise of the tailings on the storage, there will be no single surface exposed for any significant time during filling. Hence, the commencement of oxidation/onset of acid conditions is not expected during filling.

5 STORAGE SITE CHARACTERISTICS

5.1 General

The possible sites for a tailings storage on the mine lease area are constrained by the location of the pit, existing water courses, provision by Compass for possible future expansion of the pit, and by the overall shape of the lease boundaries.

The adopted site for the TSF is at the west end of the lease, adjacent to the proposed plant site (refer **Figure 1**).

Air photos of the site indicate that in general it is previously undisturbed ground, with a vegetation cover of trees and grass. An old railway formation runs across the western end of the site. The TSF location has been adjusted so that the railway and the existing access road beside it are left in place.

Previous clay borrow pits which are understood to have been the source of material used to cap the Rum Jungle waste dumps exist on the mine lease area. These are mostly to the east of the TSF site, with just short sections of the east embankment being located over the edge of the old borrow area.

5.2 Topography

The TSF site is located on the top of a gentle, broad rise. The general terrain is flat to very gently sloping, with average ground slopes less than 1%, with isolated areas slightly steeper.

Because of the location and the configuration of the storage, the catchment of the TSF will be limited to the surface area of the storage only. At final capacity (ie the largest extent of the storage) this will be an area of around 26 ha.

5.3 Geology

A site visit was undertaken by Keith Seddon of Australian Tailings Consultants on 28 July, 2005, accompanied by Mr. M. Boots of Compass Resources.

A walk-over inspection of the tailings storage area was undertaken, together with an inspection of the bulk sample pit, and the waste rock from the bulk sample pit.

The rocks underlying the TSF area are understood to comprise a sequence of shales and dolomites, similar to the ore body host rocks. The general arrangement is as follows:-

- Carbonate derived rocks (from dolomite/magnesite) occur on the northern side (Coomalie Formation).
- The black shales subcrop in a band running approximately through the middle of the site, (Whites Formation) and
- Amphibolites (and interbedded shales) occur towards the south (part of Whites Formation).

Approximate boundaries over the TSF area are shown on **Figure 2** based on observations from the site inspection. These observations include limited surface outcrop, the types of soil and soil cover developed over each rock type, and inspections of a number of exploration costeans which remain open across the site.

It is understood that in the pit area some solution cavities / voids occur in conjunction with the occurrence of a fault zone in these rocks, close to the boundary between the carbonates and the black shales.

This fault is not considered by Compass geologists to continue through the TSF locality, and there appears to be no surface expression of cavities or karst type terrain. Further consideration will be given to this aspect during the site investigation and detailed design. One small incipient depressional area near the northern east corner of the site was noted during the walk over inspection and will be investigated further. At this stage it is considered that the geology will be suitable for the proposed storage.

5.4 Soils / Stratigraphy

There is limited rock outcrop over the TSF area, and indications are that the surface profile consists of a layer of clayey soils overlying extremely and highly weathered rock. As a broad generalisation on the basis of the site visit, the following soil profiles exist.

- Clayey sand/sandy clay (and some lateritic zones) over the carbonate rocks, typically to depth in excess of 1-2m.

- Thin generally clays/clayey gravels (gravels comprise angular rock flakes) over the shales, and

- Sandy clay of intermediate plasticity over the amphibolites, to depths in excess of 1-2m.

Records of previous resource drilling held by Compass indicate that auger drilling was undertaken to target depths (probably not auger refusal) of 10m across the area.

The proximity to the old Rum Jungle clay borrow pits is also an indicator of the likely presence of surface clays. These pits appear to have generally been located in the clayey soils developed over the amphibolites.

A site investigation is planned for the area to confirm these conditions. As a minimum, this will include:

- re-evaluation of existing drilling records,
- re-logging of all existing costeans,
- additional test pits (using a tracked excavator).

Soil samples will be recovered for laboratory testing and evaluation.

It is also proposed to install groundwater monitoring bores adjacent to the storage (**Section 5.6**), and the results of these bores will also be assessed as part of the investigation.

5.5 Climatic Conditions

5.5.1 Rainfall

Rainfall data have been obtained from a number of surrounding stations, as follows: Rum Jungle, Batchelor Post Office, Batchelor Aerodrome, and Batchelor Aero (note: this not the same station as Batchelor Aerodrome). Data from Darwin River Dam were also obtained, but have been excluded from the present analysis because the rainfall at that location is higher.

A composite record has been compiled from this data for the period 1958 to 2004. The record has been analysed on a July to June basis so that the full wet-season rainfall is included in each annual record. There are 6 years of incomplete record, giving 41 years of full annual data.

The results show annual rainfall varying from just above 900mm per year to in excess of 2300mm per year. The mean annual rainfall is around 1475 mm.

Table 2 shows the results for monthly rainfall for the driest year, the wettest year, and a year close to the mean annual rainfall.

These years have been used in the water balance calculations.

TABLE 2 : MONTHLY RAINFALL (mm)

Month	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
Dry Year (1985/86)	0.0	0.0	4.2	52.	117.	56.2	331.	138.	44.2	178.	0.0	0.0	922.6
"Mean" Year (1972/3)	0.0	0.0	1.5	4 45.	2 152.	109.	6 398.	2 316.	274.	6 103.	6.1	76.	1483.
Wet Year (1996/97)	0.0	26.	0.0	2 90.	2 86.2	4 482.	8 801.	1 452.	4 312.	6 1.2	51.	5 0.5	8 2304.

5.5.2 Evaporation

Preliminary information on evaporation has been derived from the Australian Climate Atlas (**Ref. 1**). The monthly evaporation data (in mm) are shown in **Table 3**, for a July-June period to match the rainfall period.

TABLE 3 : MEAN MONTHLY EVAPORATION (mm)

July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June	TOTAL
225	230	250	260	250	240	200	175	185	230	230	200	2675

5.6 Groundwater

Groundwater monitoring at the pit area (**Ref.2**) has indicated that groundwater levels vary by up to 8m between the wet and dry season, with wet season levels being typically 2-4m below ground level. ATC have observed similar behaviour in monitoring bores at other mine sites in the region.

At present there are no specific data available for the TSF area, but it is expected that this same general pattern will apply, although the depth to groundwater may be slightly greater due to the more elevated location of the TSF site.

Water monitoring bores at the bulk sample pit (**Ref.3**) indicate that the water quality in the carbonate rocks is good, with neutral pH and low conductivity. It appears that lower pH and higher conductivity values apply in the weathered black shales.

As part of the detailed investigation for the site it is proposed to install sets of 2 groundwater investigation bores at five locations, as shown on **Figure 4**. Two bores will be installed at each location. One bore will be shallow (nominally 5- 6m) to investigate permeability to this depth. The other bore in each set will be installed to around 20m depth (or greater if required to intersect the watertable). The four deeper bores will be completed and retained as long term monitoring bores for the facility.

Groundwater investigations carried out for the project (Coffey, Ref.2) indicate that the draw-down cone created by pit excavation and dewatering will extend between 1000 m and 1500m from the pit.

Reference to **Figure 1** indicates that the western end of the TSF is a maximum of 1200m from the pit. The location of the decant structure (and the decant pond) is only 700m from the edge of the pit. The consequences of this are that groundwater movements in the area beneath the TSF will be predominantly towards the pit throughout the active life of the storage.

6 SITE CONSEQUENCE CATEGORY

The consequences of possible failure of a storage can be categorized in accordance with the provisions of the ANCOLD Guidelines on the Assessment of the Consequences of Dam Failure (**Ref.3**). This requires an assessment of the risk to life and the magnitude of damage (both physical and environmental) in the event of a failure.

In this case, because of the location of the storage adjacent to the plant area, and of the importance of the storage to the viability of the overall project, we have adopted an initial Consequence Category of HIGH C.

The consequences of this with respect to design are specified minimum requirements for flood capacity and stability under seismic conditions. There are also implications with respect to requirements for monitoring and surveillance of performance.

7 EMBANKMENT DETAILS AND STAGING

7.1 General

A “paddock” style storage (ie one comprising an embankment around all sides) is proposed for this storage. The embankment will be constructed progressively in stages throughout the period of mining.

Tailings discharge will be sub-aerial. A ring main will run around the embankment crest, and tailings will be discharged through a series of spigots (typical spacing 20m) onto a sloping beach. Decant water and rainfall run-off will collect at a low point on the beach, and will be recovered through a decant system (see below).

The combination of the rate of filling, the water management requirements, and the expected physical characteristics of the tailings means that “up-stream” raising methods are not considered to be suitable for this site. Raising of the embankment will consequently be undertaken using “down-stream” methods.

The general layout of the storage is shown on **Figure 1**, attached. Typical Sections are shown on **Figure 3**.

The storage will be formed by a zoned embankment, comprising a low permeability internal liner of clayey soils, with the majority of the embankment formed by rockfill.

Maximum utilization will be made of the waste material from the open-pit to provide the necessary rockfill. The mine bulk sample pit provides an indication of the likely material which will be available. Compass advise that almost all of the material was less than 600mm in size, with a large proportion being less than 200mm, with a well graded mix of intermediate and fine fractions. The rockfill is expected to be predominantly extremely, highly and moderately weathered. This is supported by observations made during the site visit.

7.2 Capacity and Staging

On the basis the initial laboratory testing, and previous experience, we have adopted an “end of filling” dry density of 1.3t/m3 for the tailings. This gives an overall storage capacity requirement of 2.7 Mm^3, in accordance with the mine production schedule of 3.5 Mt of tailings.

The volume v elevation characteristic for the storage is shown in **Figure 5**, assuming a horizontal tailings surface. Our initial calculations suggest that an allowance of 1m for the effects of final freeboard, beach slope and storm-water storage is reasonable.

On the basis of Figure 5, the following preliminary staging for construction of the embankment is proposed:

Stage	Stage Crest mRL	Capacity
1	82	10 months
2	86.5	1 year 2 months
3 & 4	91.5	1 year 6 months

7.3 Embankment Details

7.3.1 Foundation Preparation

All vegetation will be cleared from within the storage area. Topsoil will be stripped and stockpiled.

All of the old, open exploration costeans will be backfilled with compacted material, and will be capped with a minimum of 1 m of compacted clayey material.

Beneath the embankment footprint all tree roots and stumps will be grubbed and removed.

The exposed foundations beneath the embankment will be tyned, moisture conditioned and compacted. The same treatment will also be applied to the storage area foundations, but this will be timed to take place immediately prior to the commencement of deposition, so that the prepared surface cannot subsequently dry out.

7.3.2 Embankment Zone Details

The embankment will be constructed with upstream and downstream slopes of 2:1 (H:V).

The embankment will be comprised of the following zones:-

(Note that the embankment zones have been numbered in accordance with an informal but commonly used numbering convention. There is no provision for a Zone 2 filter layer in this design, and consequently this zone has been omitted from the following.)

Zone 1

This zone will provide an internal lining to the embankment, and will be formed from compacted clayey soil.

The likely compaction standard will be to not less than 95% Standard (Hilf) density, and a moisture range of (OMC-2)% to (OMC+2)%, where OMC is optimum moisture for compaction. Layer thickness will be a minimum of 150mm after compaction.

Stage 1 material for this zone will be sourced from a borrow pit located within the storage area. It is generally intended to limit material taken from this borrow to a depth of around 1.0m to 1.5m, with the intent of leaving some of the existing clay layer in place over the entire base of the storage area.

Stage 2 and 3 material will be derived from stripping the foundation areas of the rockfill zones for the embankment, or if necessary from an external borrow area.

Zone 3A

This will form a transition zone below the Zone 1 material and is also continued to form the outer shell of the final embankment. It will be constructed using select rockfill comprised of extremely to highly weathered particles, placed and compacted in 300mm thick layers.

At this stage it appears that material for Stage 1 will need to be obtained from a borrow source as pit waste will not be available at the time of construction of Stage 1. (The preferred location of this borrow will be in the planned area of a notional extended open-cut pit). Material for Stages 2, 3 and 4 will be from pit waste.

It is possible that revisions to the mining schedule may enable some of the Stage 1 material to be obtained from the mine waste.

Zone 3B

Zone 3B forms the core zone for the bulk of the embankment. It will be constructed using weathered rockfill, placed and compacted in 300mm thick layers.

The sourcing of this material will be as for Zone 3A.

Protection Layer (Zone 4)

A 0.5 m thick layer of rockfill will be placed (loose) over the face of the Zone 1 layer to provide protection from erosion and evaporative drying.

7.4 Management of PAF Pit waste

Compass has undertaken a preliminary classification of the acid forming potential of the mine waste. We understand that this classification is likely to be conservative, and that more detailed geochemical classification of the acid forming potential of the waste is to be undertaken.

The preliminary classification divides the waste into “Non Acid Forming” (NAF), and ‘Potentially Acid Forming” (PAF) materials. The embankment design includes an “overlay” of sections of the embankment considered to be suitable for the inclusion of PAF material. The embankment design overlay **(Figure 3)** provides for a zone to be constructed using NAF material only, and for another zone for mixed PAF materials, and NAF material.

Details of the utilization of the pit waste material within the embankment are summarised **Table 4**. This assumes that pit waste rock will have an average in-situ dry density of 2.0t/m3 when placed in the embankment. The table indicates that in general, the pit waste production will be able to match the sequential requirements for embankment construction.

As with the overall embankment construction schedule, it is possible that revisions to the mine plan may enable some earlier placement of mine waste in Stage 1 of the embankment. The volume requirements for the final part of embankment construction (embankment Zone 3C) would therefore be correspondingly reduced.

TABLE 4 : SUMMARY OF PIT WASTE UTILIZATION

MINE YEAR	PIT WASTE PRODUCTION (Preliminary)			UTILIZATION OF ROCK IN EMBANKMENT (Zones 3A, 3B, 4)				
	(For material placed in embankment at assumed density 2.0 t/m3)				Pit Waste		External Borrow Required	
	NAF	PAF	TOTAL AVAILABLE	Construction Stage	NAF Only Zone	PAF & NAF Zone	(All NAF)	TOTAL
	(m3)	(m3)	(m3)		(m3)	(m3)	(m3)	(m3)
				1	0	0	194,000	194,000
1	486,000	81,000	567,000	2	75,000	312,000	0	387,000
2	361,000	181,000	542,000	3	301,000	387,000	0	688,000
3	277,000	165,000	527,000					
4	116,000	277,000	393,000	4	220,000	650,000	0	870,000
Total:	1,240,000	704,000	1,944,000	**Total:**	596,000	1,349,000	0	2,139,400

8 WATER MANAGEMENT AND SEEPAGE

8.1 Water Balance

A preliminary water balance has been prepared for the TSF site, using monthly rainfall and evaporation data.

The aims of the model have been to evaluate:

-the quantity of excess water which may be generated in a wet year, and the required additional storage capacity to retain this water within the system

-the need for additional make-up water in a dry year and during the dry season

The model has been prepared on the basis of the conventional mass balance approach:

Stored Water = Inputs – Water Retained in Tailings - Outputs

Features of the model are set out below.

Inputs:

Tailings Water:

A slurry solids content of 45% Solids (w/w) has been adopted. For a throughput of 1.0 Mtpa of tailings on a dry basis (83,000 t/month), this is equivalent to a make-up water volume of 102,000 m3/month (about 40L/sec).

Precipitation & Runoff:

Precipitation values as discussed in Section 5.5 have been adopted.

A contributing surface area for the TSF of 26 ha has been adopted. Of this area it has been assumed that 50% represents wet beach and the surface of the decant pond. A runoff co-efficient of 1.0 has been adopted for this area. A reduced runoff coefficient of 0.5 has been adopted for the dry beach area.

Make Up Water:

Compass has advised that any required make-up water will be obtained from pit-dewatering, or from groundwater derived from a dedicated bore-field if this is required.

Retained Water:

Retained water has been calculated on the basis of the assumed initial settled density of the tailings. As a simplification, further reductions in tailings water content due to beach evaporation and consolidation have been assumed to be losses. A settled density of 0.9t/m^3, relevant to the black shale tailings (**Table 1**) has been used.

Outputs:

Evaporation:

Evaporation values as set out in Section 5.5 have been adopted.

Evaporation contributing to the pond water balance has only been allowed off the wet beach and decant pond area. (For this preliminary study, this has been assumed to be a constant area. A rigorous water balance would allow for variations in pond area as a function of the volume of stored water).

Recycle:

Recycle as plant make-up water has been allowed as the lesser of:
-the volume available for recycle, and
-the maximum plant capacity for recycle (ie 102,000 m3/month).

In cases where the volume of water exceeds the re-cycle capacity, the stored water in the decant pond increases.

8.2 Results

The results of the water balance model are summarised in **Figures 6 – 8** for the dry, mean and wet year cases respectively.

The results indicate that in the dry season, recycle from the storage may only be around 10,000 m3/month. The balance of the make-up water requirement will need to be obtained from other sources (ie around 90,000 m^3/month, or 35 L/sec). In the wet season, the volume of recycle rises. For the run using the wettest year on record, 100% make-up water is available from recycle from the TSF for 4 consecutive months, and up to 125,000m3 of excess water needs to be stored in the decant pond in this period (ie to an average depth of about 0.5m).

In an average wet season, 100% make-up from the TSF is achieved only for isolated months, and the need to store significant excess water on the tailings does not arise.

8.3 Management of Extreme Rainfall Events

Because of the ANCOLD consequence category (Section 6) the storage will be designed to either:

-have the capacity to retain the rainfall resulting from a Probable Maximum Precipitation (PMP) storm event,

or

- to have an emergency high level spillway capable of passing the excess rainfall (over and above the specified retention amount), without compromising the safety and integrity of the storage.

Preliminary calculations indicate that the 72 hr PMP could be in the range 1500 – 2000mm. Design of the storage to retain all of the water resulting from this extreme event would therefore require significant additional height to the embankment, and an emergency spillway may prove to be a better option.

Details of this aspect will be settled as part of final design.

8.4 Groundwater Interactions

Because of the fast rate of rise, and the relatively high proportion of external make-up water which will be required to operate the storage (Section 8.2), it is expected that leachate/seepage will be of relatively low salinity.

Pending confirmation of the ground conditions at the site, definitive seepage quantities from the storage have not yet been calculated. However, the proposed design provisions, including the foundation preparation and embankment design, plus the preliminary results of the water balance which indicate a minimum area decant pond for most of the storage life, indicate that seepage from the storage will be low. If it is assumed that:-

- significant seepage only originates from beneath the decant pond area (assume an area of 5 ha typical)
- the in-situ tailings has a typical permeability of around $1x10^{-8}$ m/sec
- foundation clay layer has a typical permeability of around $1x10^{-9}$ m/sec,

  then preliminary calculations indicate that for the "mature storage" seepage through the base is likely to be of the order of 20-30 m^3/day. Higher rates may apply during the start-up period until the shape of the tailings beach is fully established to minimize the decant pond area.

It is expected that seepage from the active storage will be captured by the groundwater drawdown cone resulting from the pit.

Provisions will be included in detailed design to collect any shallow seepage through the embankment if this emerges at any point, and recycle this. A check on the operation of these systems will be part of the weekly inspection and monitoring requirement for the storage (see below).

9 MONITORING, SURVEILLANCE AND REPORTING

An Operations and Maintenance Manual will be prepared for the TSF prior to the commencement of tailings deposition.

This will include details of the following:

- provisions for raising
- monitoring of the tailings and stored water levels/volumes and stored water quality
- routine inspections and monitoring of installed instrumentation
- non routine inspection requirements in abnormal circumstances
- provisions for annual surveillance audits of the storage
- requirements for reporting on performance
- protocols for action and reporting of emergency situations

10. DECOMMISSIONING AND TSF CLOSURE

The proposed sequence of mining (**Section 3**) will result in approximately 1.5m of supergene tailings (clayey sand) being deposited as the last layer of tailings. This material is non-acid forming, and is expected to be of low permeability. This layer will effectively become part of the final surface capping sequence for closure.

The most suitable form of capping would be a "store and release" type cover. The aim would be to utilize the supergene tailings as the base, low permeability layer. This would need to be capped by 1-2m of rockfill (NAF pit waste) to provide the water retention cover.

Additional work would include:-

- excavation of a long term spillway to prevent ponding of large amounts of excess water and overtopping due to wet season rainfall,
- (possible) additional flattening of the external slopes of the embankments.
- Decommissioning of the decant spillway.

A Schematic Section is shown on **Figure 9**.

Seepage through cap and into the tailings in this case will be dependent on the permeability of the supergene tailings, and the extent (area and depth) of the ponded water which occurs in the wet season. An indicative seepage value would be 20m^3/day (0.25 L/sec) in the wet season, reducing to zero in the dry.

11 CLOSURE

Your attention is drawn to the Terms and Conditions which appear on the title page of this report.

AUSTRALIAN TAILINGS CONSULTANTS

KEITH SEDDON

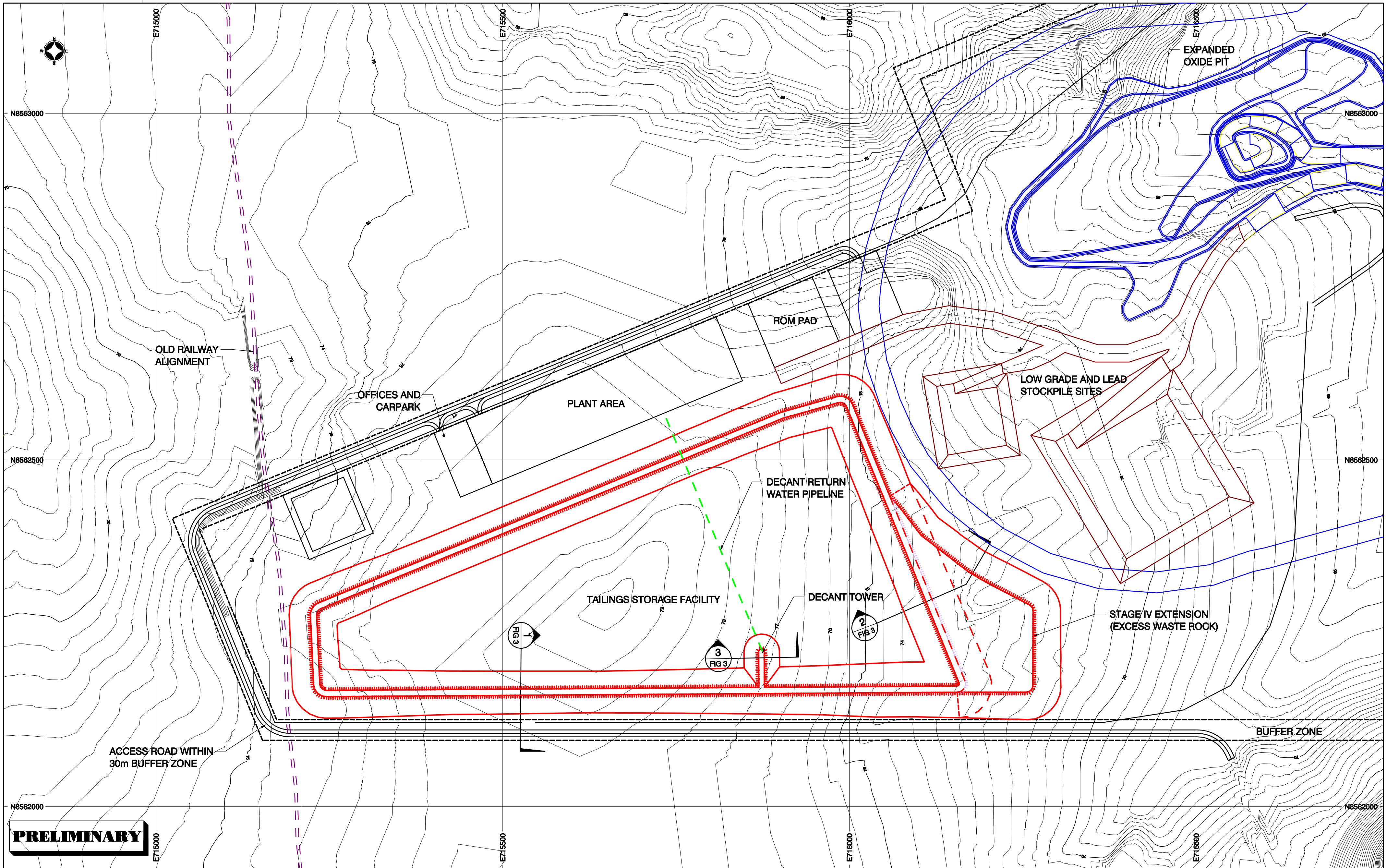
REFERENCES

Ref.1 Bureau of Meteorology. Climatic Atlas of Australia, 1988.

Ref.2 Coffey Geosciences Pty Ltd, “Browns Oxide Project, Groundwater Assessment, Batchelor, NT”. (DRAFT), MAY 2005.

Ref.3 ANCOLD “Guidelines on the Assessment for the Consequences of Dam Failure”, 2000.

FIGURES



No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D

SCALE 1:5000 @ A3	
JOB No.	105026.01
DATE	28.06.05
DESIGN	KDS
DRAWN	HAR
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APPROVED	

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E-mail : mel@mpaw.com.au

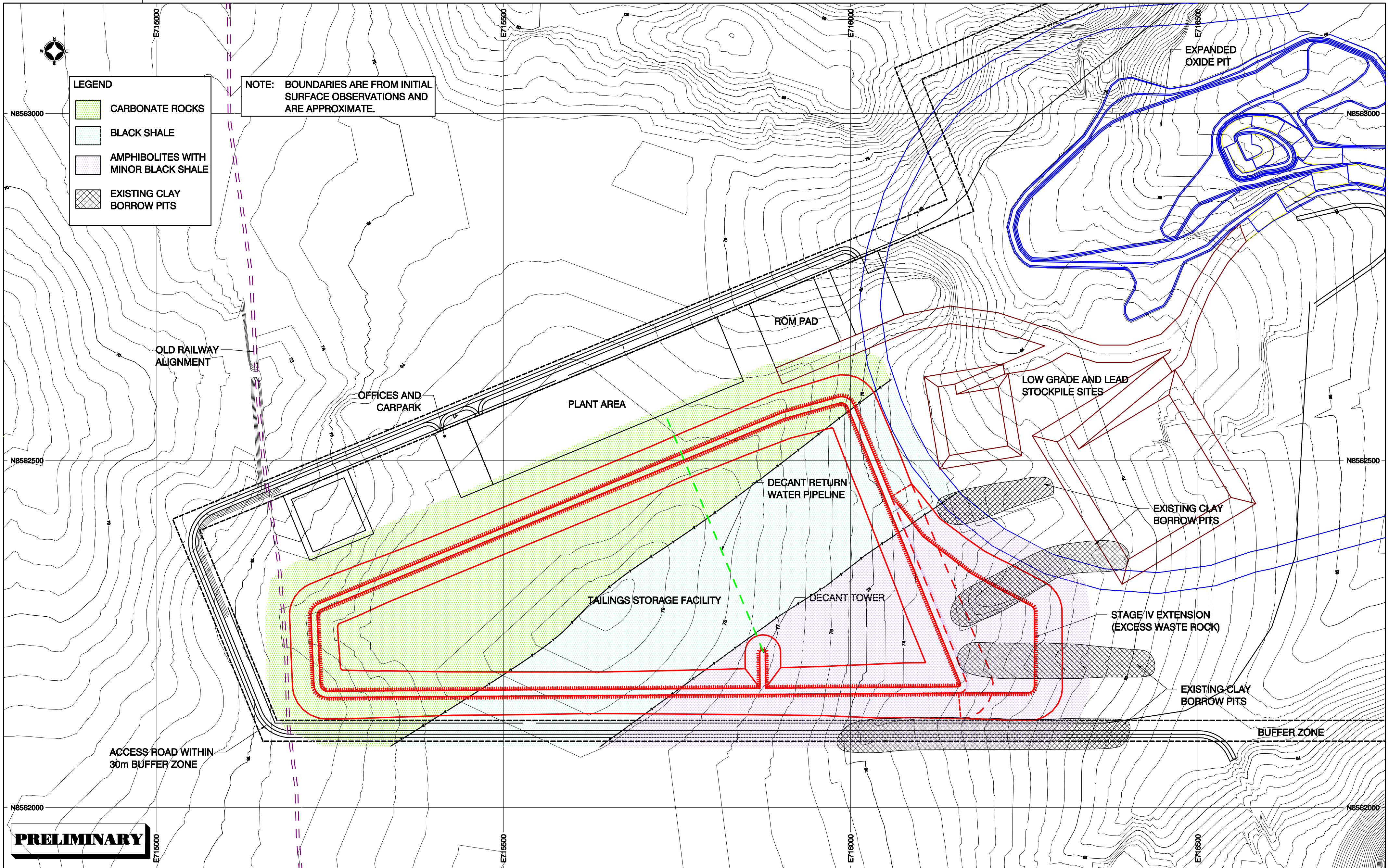
COMPASS RESOURCES NL
BROWNS OXIDE PROJECT

TAILINGS STORAGE FACILITY
GENERAL LAYOUT

FIGURE 1

CLIENT No.
CAD REF. 105026
REV. No. A
SHT SIZE A3
SHEET 1 OF 1

File J:\2005\105026 Browns Oxide Project\01 PER Submission\Data & Calcs\HAR\TSF preliminary design rev B.pro (Terramodel) Tue 30 Aug 2005 15:42:39



No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D

SCALE 1:5000 @ A3	
JOB No.	105026.01
DATE	28.06.05
DESIGN	KDS
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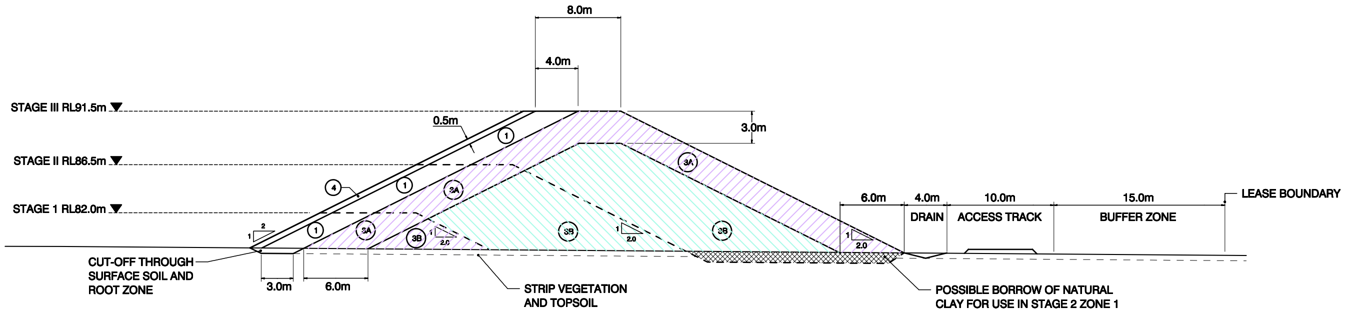
COMPASS RESOURCES NL
BROWNS OXIDE PROJECT

TAILINGS STORAGE FACILITY
SITE GEOLOGY

FIGURE 2

CLIENT No.
CAD REF. 105026
REV. No. A
SHT SIZE A3
SHEET 1 OF 1

File J:\2005\105026 Browns Oxide Project\01 PER Submission\Data & Calcs\HAR\TSF preliminary design rev B.pro (Terramodel) Tue 30 Aug 2005 15:44:21

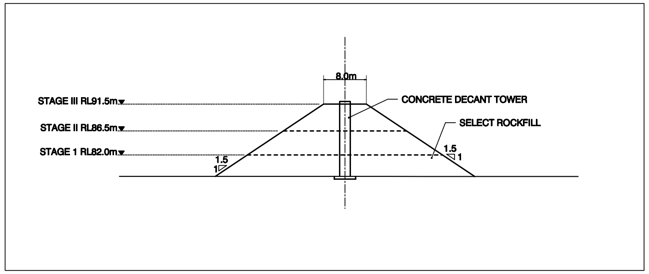


SECTION 1 / FIG 1

SCALE 1:500 @ A3

LEGEND

- NON ACID FORMING (NAF) ONLY
- NON ACID FORMING AND POTENTIALLY ACID FORMING (PAF)



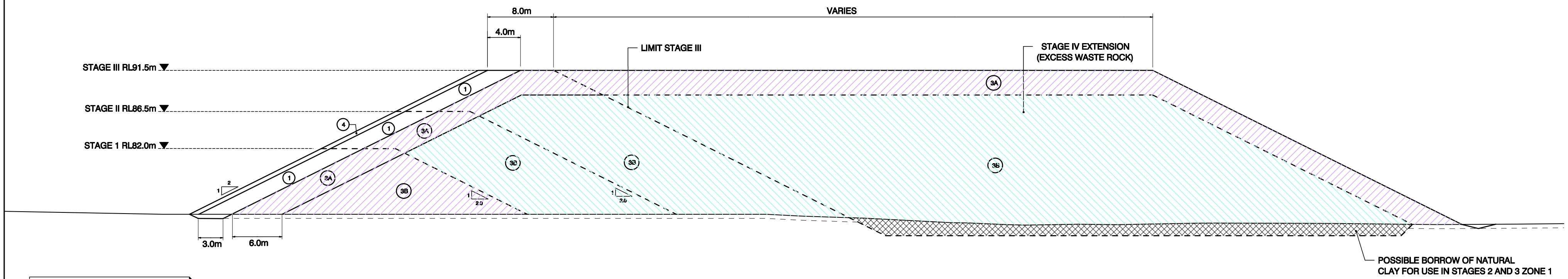
SECTION 1 / FIG 1

SCALE 1:1000 @ A3

SUMMARY OF MATERIAL ZONES

ZONE	MATERIAL	SOURCE	PLACEMENT AND COMPACTION
1	CLAY, Sandy Clay, Clayey Sand (low permeability material)	Stage 1: Internal borrow Stage 2: Borrow from footprint Stage 3: External borrow	Place in layers 0.15m max. compacted thickness, compact at not less than 95% Standard DD at moisture content in range (omc -2%) to (omc +2%)
3A	ROCKFILL: EW, HW, MW NON-ACID FORMING	Stage 1: External borrow Stage 2,3,4: Pit waste rock	Spread and compact in 0.3m thick layers (compacted thickness). Compaction to comprise of 8 passes of a 10t vibrating pad foot roller.
3B	ROCKFILL: All weathering categories NON-ACID FORMING AND POTENTIAL ACID FORMING		
4	ROCKFILL - NON-ACID FORMING		Spread on face. Compaction not required.

NOTE: THERE IS NO ZONE 2 IN THIS EMBANKMENT



PRELIMINARY

SECTION 2 / FIG 1

SCALE 1:500 @ A3

No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D

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DATE	28.06.05
DESIGN	KDS
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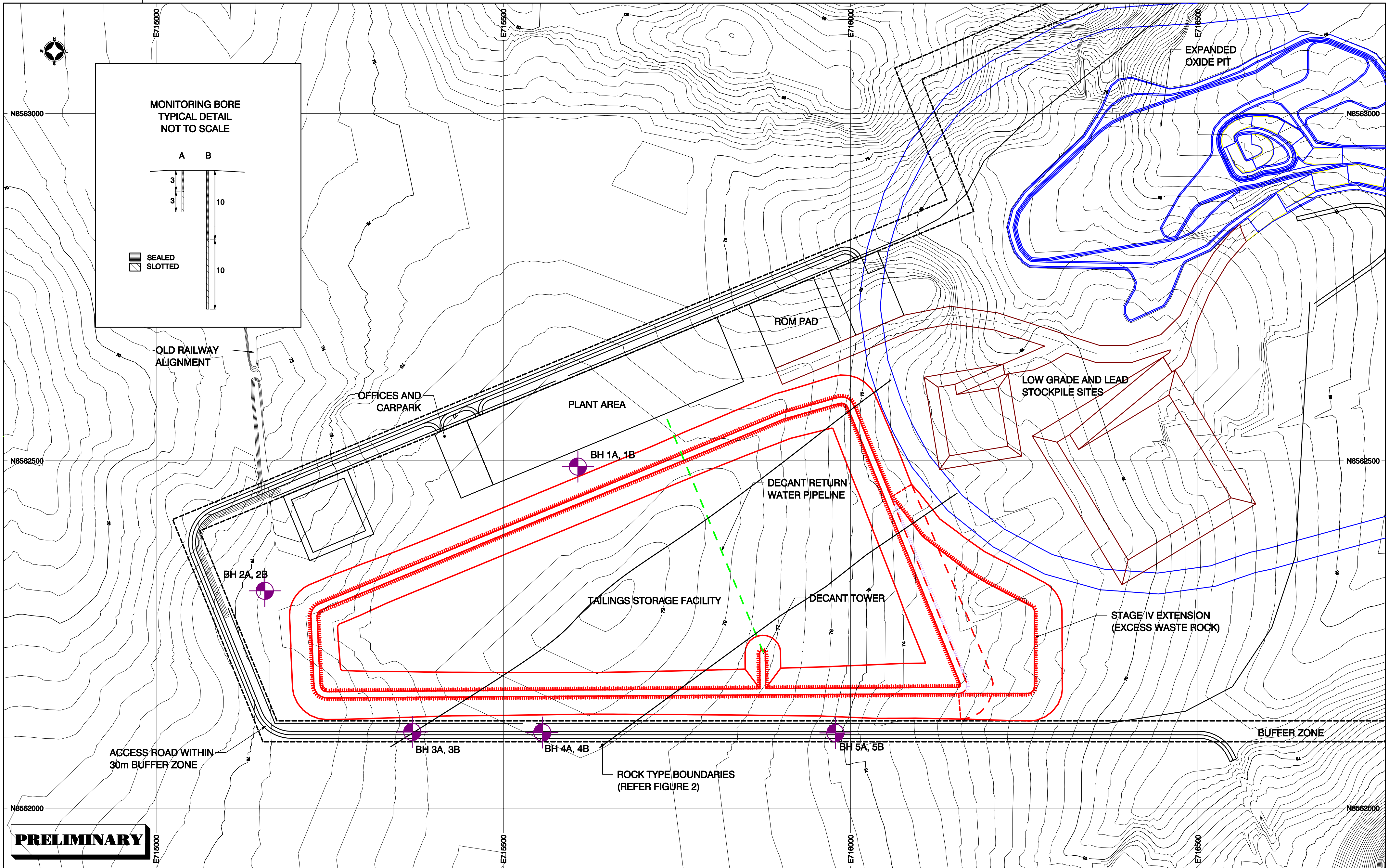
COMPASS RESOURCES NL
BROWNS OXIDE PROJECT

SECTIONS AND MATERIALS

FIGURE 3

CLIENT No.
CAD REF. 105026
REV. No. A
SHT SIZE A3
SHEET 1 OF 1

File J:\2005\105026 Browns Oxide Project\01 PER Submission\Data & Calcs\HAR\TSF preliminary design rev B.pro (Terramodel) Mon 1 Aug 2005 16:45:23



No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D

SCALE 1:5000 @ A3	
JOB No.	105026.01
DATE	28.06.05
DESIGN	KDS
DRAWN	HAR
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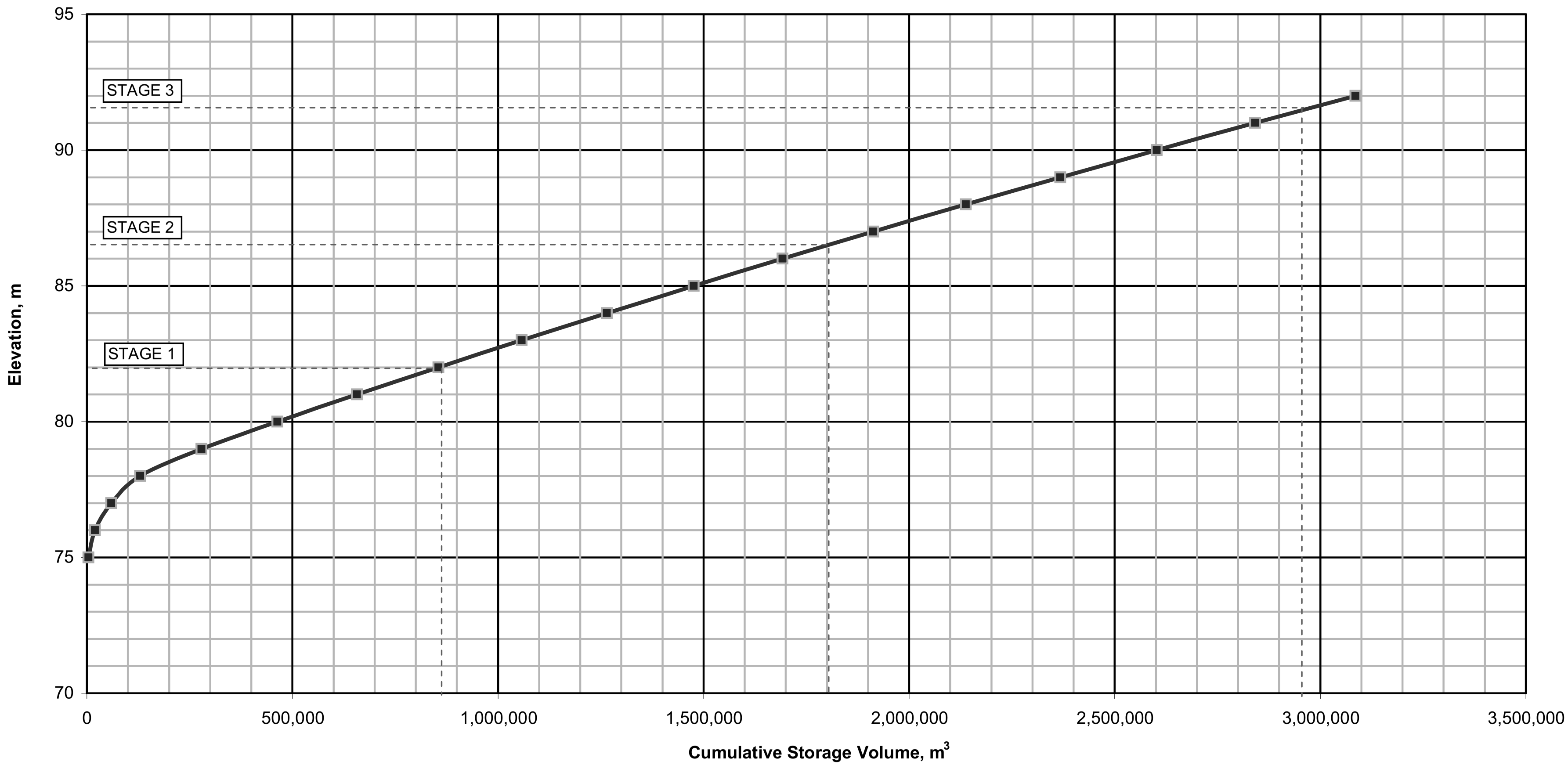
COMPASS RESOURCES NL
BROWNS OXIDE PROJECT

TAILINGS STORAGE FACILITY
MONITORING BORE LOCATIONS

FIGURE 4

CLIENT No.
CAD REF. 105026
REV. No. A
SHT SIZE A3
SHEET 1 OF 1

File J:\2005\105026 Browns Oxide Project\01 PER Submission\Data & Calcs\HAR\TSF preliminary design rev B.pro (Terramodel) Tue 30 Aug 2005 15:45:52



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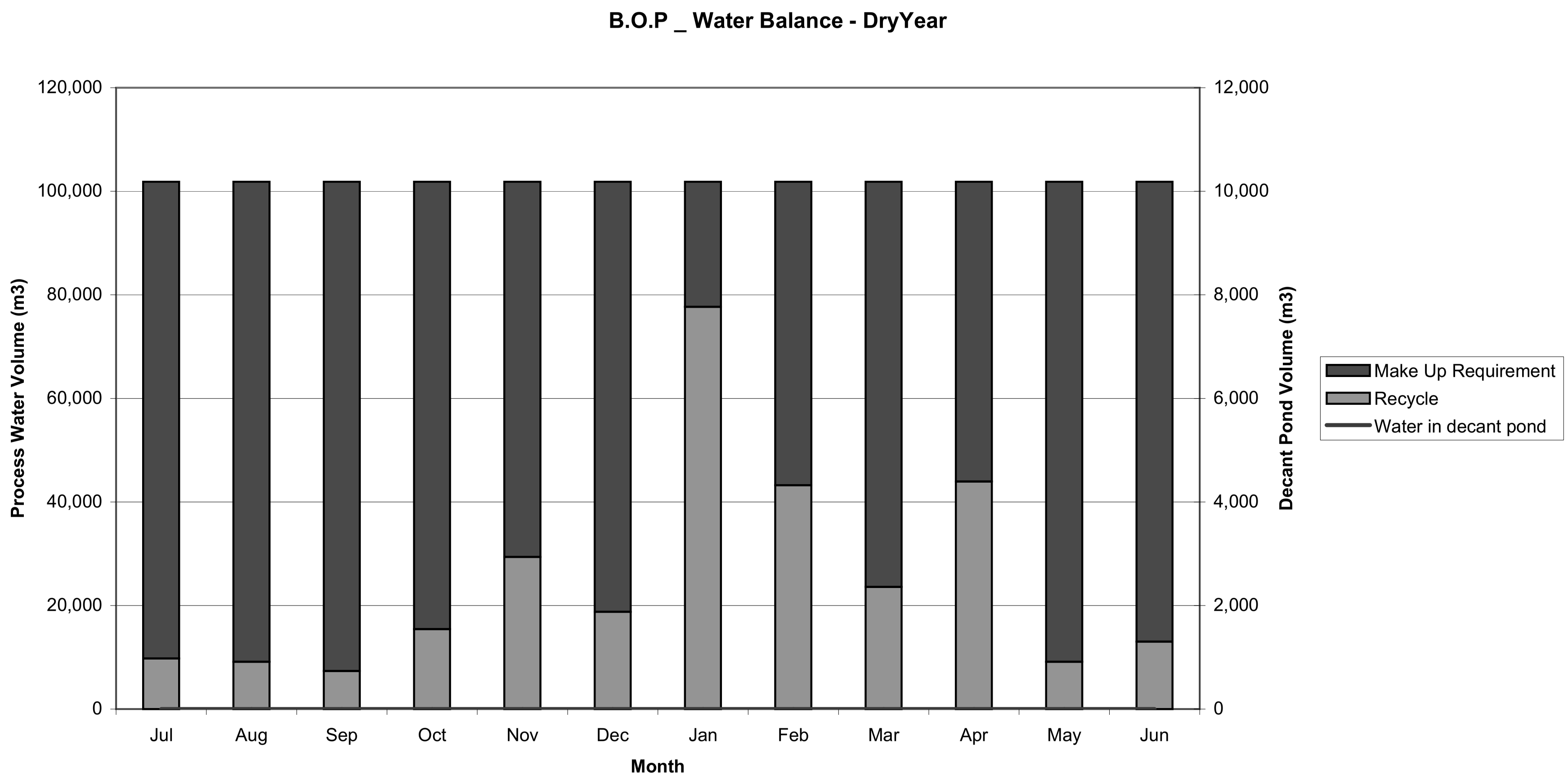
COMPASS RESOURCES
BROWNS OXIDE PROJECT

TSF - STORAGE RELATIONSHIP

Our Ref:

Date: 01-Aug-05 **Job No:** 105026.01

Figure 5



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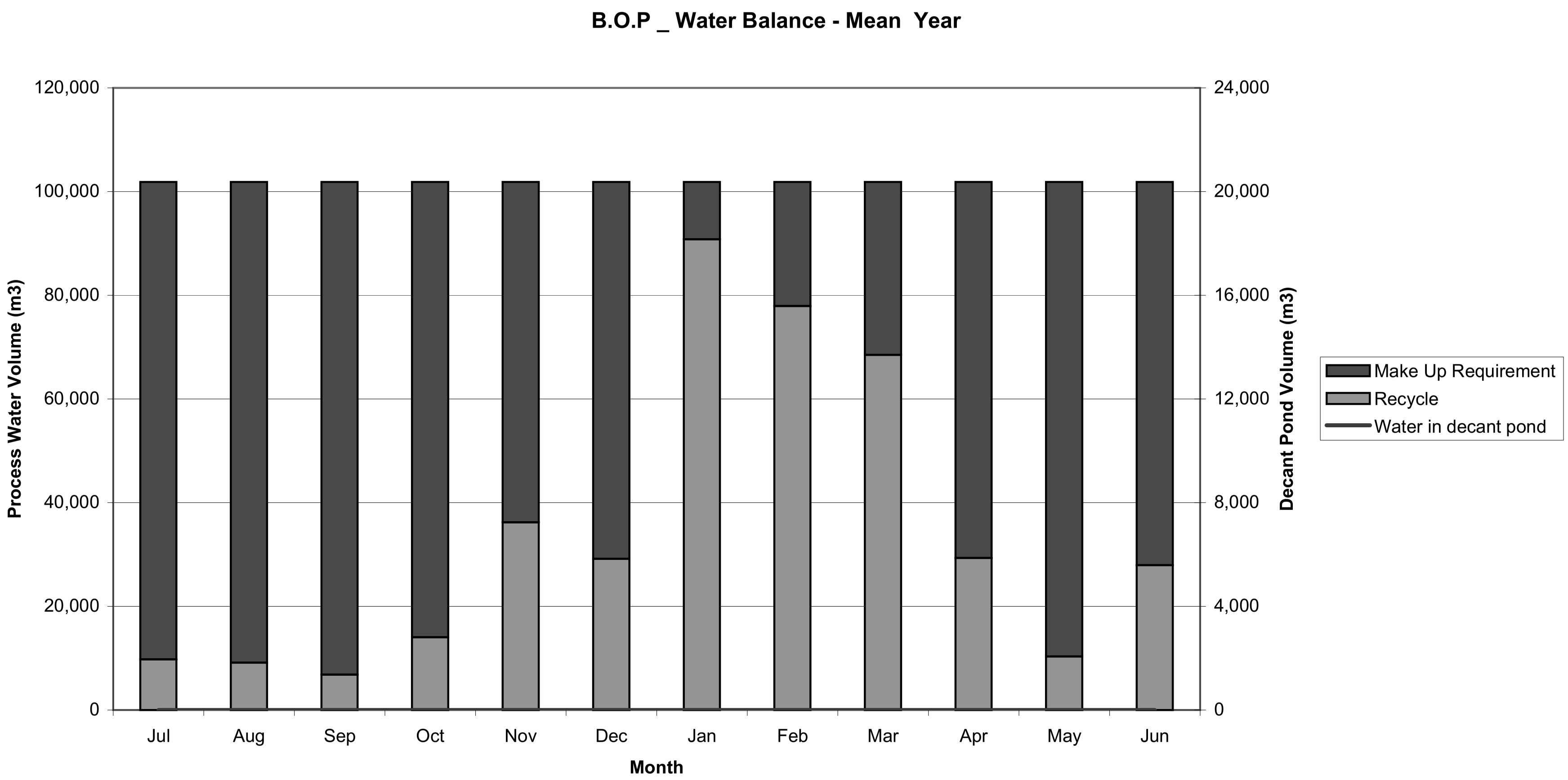
COMPASS RESOURCES
BROWNS OXIDE PROJECT

WATER BALANCE - DRY YEAR

Our Ref:
Date: 01-Aug-05 **Job No:** 105026.01

Figure 6



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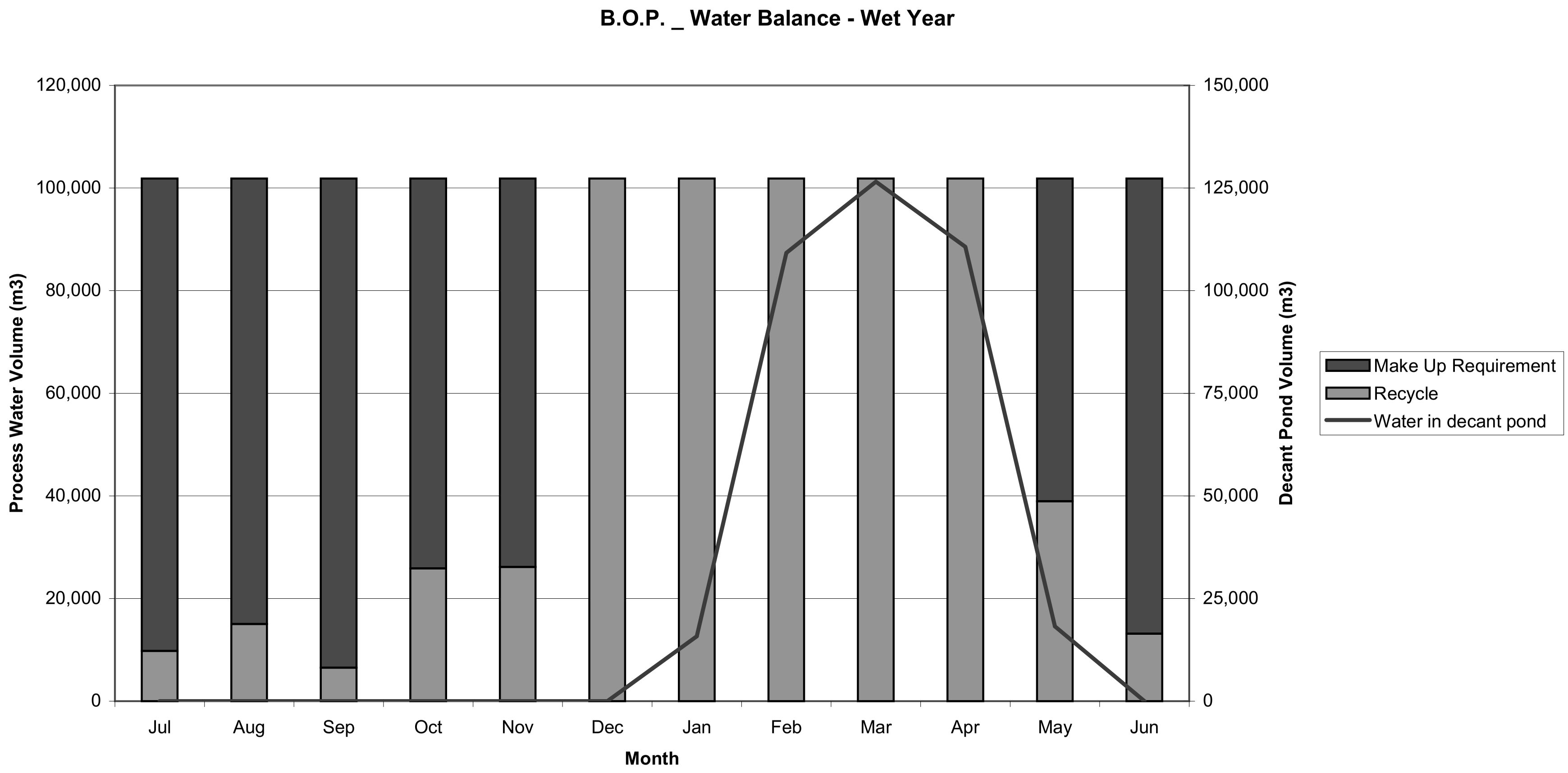
COMPASS RESOURCES
BROWNS OXIDE PROJECT

WATER BALANCE - MEAN YEAR

Our Ref:
Date: 01-Aug-05 **Job No:** 105026.01

Figure 7



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COMPASS RESOURCES

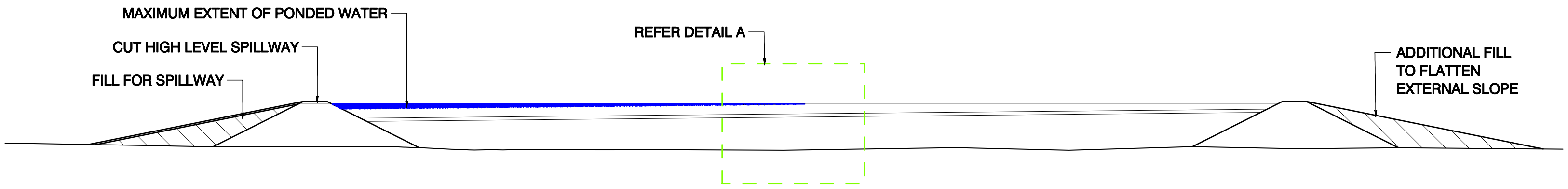
BROWNS OXIDE PROJECT

WATER BALANCE - WET YEAR

Our Ref:

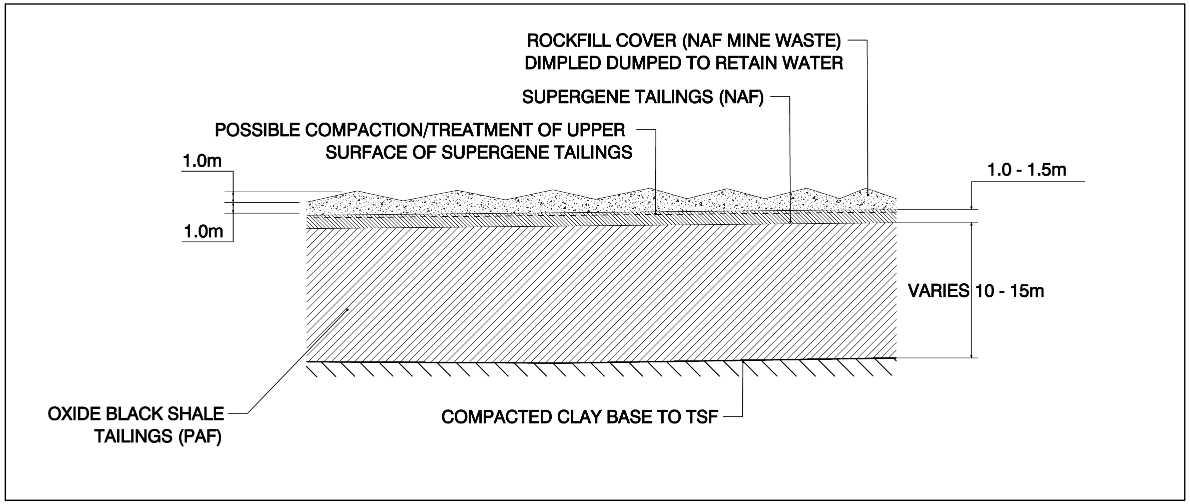
Date: 01-Aug-05 **Job No:** 105026.01

Figure 7



SCHEMATIC CLOSURE PROVISIONS

SCALE 1:2000 @ A3



DETAIL A

SCALE 1:500 @ A3

No.	DESCRIPTION	DATE	DRAWN	CHECK'D	APPR'D

SCALE AS SHOWN	
JOB No.	105026.01
DATE	30.08.05
DESIGN	KDS
DRAWN	HAR
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COMPASS RESOURCES NL
BROWNS OXIDE PROJECT

SCHEMATIC CLOSURE ARRANGEMENT

FIGURE 9

CLIENT No.
CAD REF. 105026
REV. No. A | SHT SIZE A3
SHEET 1 OF 1

File J:\2005\105026 Browns Oxide Project\01 PER Submission\Data & Calcs\HAR\TSF preliminary design rev B.pro (Terramodel) Tue 30 Aug 2005 15:51:09

APPENDIX A

PARTICLE SIZE DISTRIBUTION

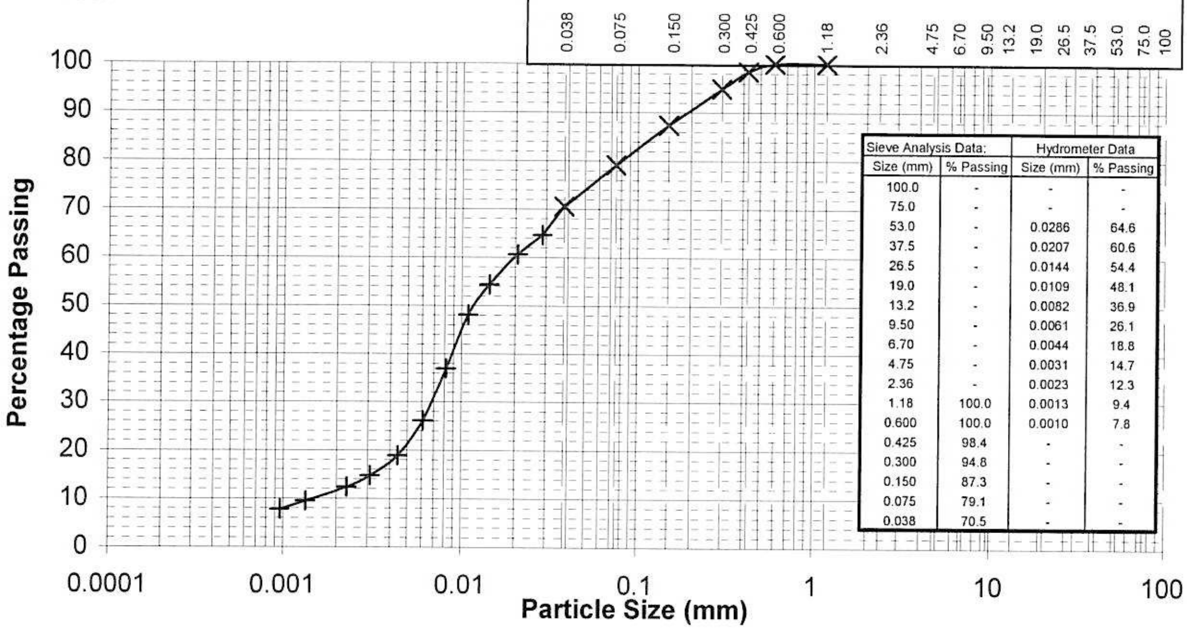
☐ AS 1289.3.6.1 ☑ AS 1289.2.1.1 ☑ AS 1289.3.6.2 ☑ AS 1289.3.6.3	NATA REPORT No. : R08205 JOB No. : 105026.01
CLIENT: Compass Resources NL.	**REGISTER No. : 10605**
CLIENT ADDRESS: Suite 4B, 384 Eastern Valley Way, Roseville, NSW, 2069	
PROJECT: Browns Oxide Project	**LOCATION:** Northern Territory
SAMPLE DESCRIPTION : Black Shale Tailings	BOREHOLE ☐ TEST PIT ☐ No. : DEPTH :

Dispersion Method Used: Mechanical Stirrer. Hydrometer Type Used: ASTM 152H

☐ Sampled by MPA Williams & Associates Pty. Ltd. in accordance with AS 1289.1.2.1.

☑ Sampled provided by the client.

Notes: Hydrometer sample was washed on a 38mm rather than a 75mm sieve. The sample was mixed with a propeller type stirrer rather than inverting the cylinder as described in AS 1289.3.6.3.



Sieve Analysis Data:		Hydrometer Data	
Size (mm)	% Passing	Size (mm)	% Passing
100.0	-	-	-
75.0	-	-	-
53.0	-	0.0286	64.6
37.5	-	0.0207	60.6
26.5	-	0.0144	54.4
19.0	-	0.0109	48.1
13.2	-	0.0082	36.9
9.50	-	0.0061	26.1
6.70	-	0.0044	18.8
4.75	-	0.0031	14.7
2.36	-	0.0023	12.3
1.18	100.0	0.0013	9.4
0.600	100.0	0.0010	7.8
0.425	98.4	-	-
0.300	94.8	-	-
0.150	87.3	-	-
0.075	79.1	-	-
0.038	70.5	-	-

CLAY	SILT			SAND			GRAVEL			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	

0.002 0.006 0.02 0.06 0.2 0.6 2 6 20 60

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Approved Signatory Steven Murphy Date 30/8/05

Name Of Signatory STEVEN MURPHY

PARTICLE SIZE DISTRIBUTION

☐ AS 1289.3.6.1 ☑ AS 1289.2.1.1
☑ AS 1289.3.6.2
☑ AS 1289.3.6.3

NATA
REPORT No. : R08105
JOB No. : 105026.01
REGISTER No. : 10505

CLIENT: Compass Resources NL.

CLIENT ADDRESS: Suite 4B, 384 Eastern Valley Way, Roseville, NSW, 2069

PROJECT: Browns Oxide Project **LOCATION:** Northern Territory

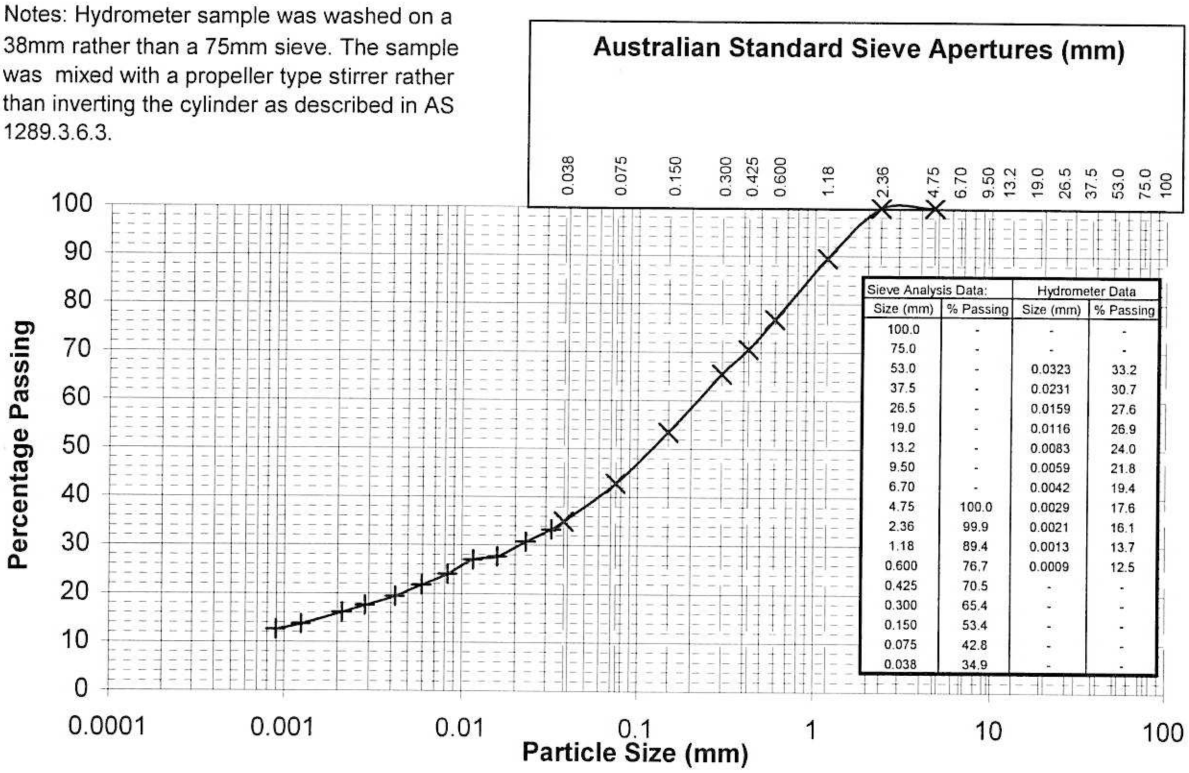
SAMPLE DESCRIPTION : Supergene Tailings

BOREHOLE ☐ TEST PIT ☐
No. : DEPTH :

Dispersion Method Used: Mechanical Stirrer. Hydrometer Type Used: ASTM 152H

☐ Sampled by MPA Williams & Associates Pty. Ltd. in accordance with AS 1289.1.2.1.
☑ Sampled provided by the client.

Notes: Hydrometer sample was washed on a 38mm rather than a 75mm sieve. The sample was mixed with a propeller type stirrer rather than inverting the cylinder as described in AS 1289.3.6.3.



Sieve Analysis Data:		Hydrometer Data	
Size (mm)	% Passing	Size (mm)	% Passing
100.0	-	-	-
75.0	-	-	-
53.0	-	0.0323	33.2
37.5	-	0.0231	30.7
26.5	-	0.0159	27.6
19.0	-	0.0116	26.9
13.2	-	0.0083	24.0
9.50	-	0.0059	21.8
6.70	-	0.0042	19.4
4.75	100.0	0.0029	17.6
2.36	99.9	0.0021	16.1
1.18	89.4	0.0013	13.7
0.600	76.7	0.0009	12.5
0.425	70.5	-	-
0.300	65.4	-	-
0.150	53.4	-	-
0.075	42.8	-	-
0.038	34.9	-	-

CLAY	SILT			SAND			GRAVEL			COBBLES
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	

0.002 0.006 0.02 0.06 0.2 0.6 2 6 20 60

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Name Of Signatory ......STEVEN MURPHY......

Form No. : RSN 004.8
Date of Issue : May, 2005

DETERMINATION OF THE SOIL PARTICLE DENSITY OF A SOIL - TEST RESULTS AS 1289 3.5.1	NATA REPORT No. R08005 JOB No. : 105026.01

CLIENT : Compass Resources NL.

CLIENT ADDRESS : Suite 4B, 384 Eastern Valley Way, Roseville, NSW, 2069

PROJECT : Browns Oxide Project | LOCATION : Northern Territory

REGISTER NUMBER	SAMPLE DESCRIPTION	TEST PIT NUMBER	DEPTH (m)	TEST TEMPERATURE (°C)	% OF SAMPLE >2.36mm	PARTICLE DENSITY (g/cm^3)
10505	Supergene Tailings	-	-	21.4	0	2.98 #
10605	Black Shale Tailings	-	-	21.3	0	2.80 #

NOTES :

☐ Sampled by MPA Williams & Associates Pty. Ltd. in accordance with AS 1289.1.2.1.
☒ Sample provided by the client.

* = [Apparent average soil particle density - particle size less than 2.36 mm]

X = [Apparent average soil particle density - particle size greater than 2.36 mm]

= [Soil particle density of the total sample]

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Approved Signatory Steven Murphy Date 30/6/05

Name Of Signatory STEVEN MURPHY

Form No. RSN 003.2
Date of Issue : May, 2005

CLASSIFICATION TEST RESULTS

NATA REPORT No.	R07905
JOB No.	105026.01

CLIENT : Compass Resources NL.

CLIENT ADDRESS : Suite 4B, 384 Eastern Valley Way, Roseville, NSW, 2069

PROJECT : Browns Oxide Project | LOCATION : Northern Territory

REGISTER NUMBER	SAMPLE DESCRIPTION	LIQUID LIMIT (%)	PLASTIC LIMIT (%)	PLASTICITY INDEX (%)	LINEAR SHRINKAGE (%)	SAMPLE CURLED (CU) / CRUMBLED (CR)
10505	Supergene Tailings	37	21	16	-	-
10605	Black Shale Tailings	34	24	10	-	-

☐ Sampled by MPA Williams & Associates Pty. Ltd. in accordance with AS 1289.1.2.1.
☒ Sample provided by the client.

TEST METHODS :

LIQUID LIMIT	☐	AS 1289. 3.1.1	(Standard method)
	☒	AS 1289. 3.1.2	(Subsidiary method)
PLASTIC LIMIT	☒	AS 1289. 3.2.1	
PLASTICITY INDEX	☒	AS 1289. 3.3.1	
LINEAR SHRINKAGE	☐	AS 1289. 3.4.1	
MOISTURE CONTENT	☒	AS 1289. 2.1.1	

SAMPLE PREPARATION :

☐ Natural Moisture ☒ Air Dried ☐ Oven Dried ☐ Unknown
☐ Wet Sieved ☒ Dry Sieved ☐ Unsieved

MPA Williams & Associates
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Approved Signatory Steven Murphy Date 30/8/05

Name Of Signatory STEVEN MURPHY

Form No. RSN 002.2
Date of Issue : May, 2005

MOISTURE CONTENT TEST RESULTS
AS 1289.2.1.1

NATA
REPORT No. R07805

JOB No. 105026.01

CLIENT : Compass Resources NL.

CLIENT ADDRESS : Suite 4B, 384 Eastern Valley Way, Roseville, NSW, 2069

PROJECT : Browns Oxide Project | LOCATION : Northern Territory

REGISTER NUMBER	TEST PIT NUMBER	SAMPLE DESCRIPTION	DEPTH (m)	MOISTURE CONTENT (%)
10505	-	Supergene Tailings	-	0.7
10605	-	Black Shale Tailings	-	0.7

☐ Sampled by MPA Williams & Associates Pty. Ltd. in accordance with AS 1289.1.2.1.
☒ Sample provided by the Client.

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Consulting Geotechnical Engineers
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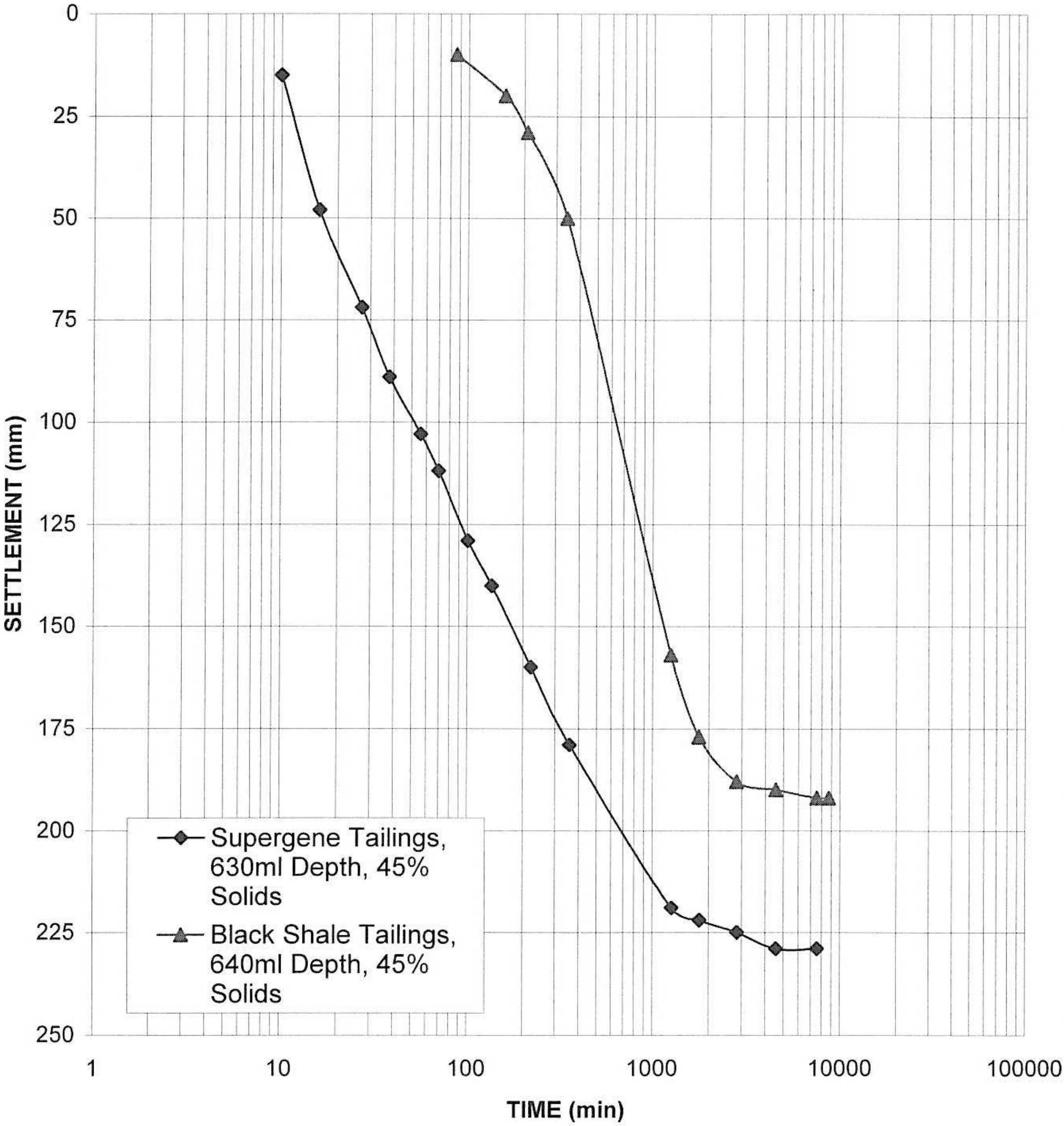
Approved Signatory Steven Murphy Date 30/5/05

Name Of Signatory STEVEN MURPHY

Form No. RSN 001.3
Date of Issue : May, 2005

Cylinder Settlement
105026.01
Browns Oxide Project
#10505, Supergene Tailings
#10605, Black Shale Tailings



Compass Resources NL **Browns Oxide Project**	SETTLING TEST RESULTS Sample Nos. 10505, 10605
MPA Williams and Associates Consulting Geotechnical Engineers 533 Nepean Hwy, Bonbeach, VIC 3196 Phone (03) 9772 9966 Fax (03) 9772 4775 Email mtech@mpaw.com.au	Job No. 105026.01 Date 30/08/2005 Our Ref **FIGURE ??**

APPENDIX B

ENVIRONMENTAL GEOCHEMISTRY INTERNATIONAL

TO:	AUSTRALIAN TAILINGS CONSULTANTS PTY LTD
ATTENTION:	Keith Seddon
FROM:	John Jeffery
DATE:	22 August 2005
SUBJECT:	Browns Oxide Project - Acid forming characteristics of tailings

As requested, EGi have carried out geochemical testing of two tailings samples from the Browns Oxide Project in the Northern Territory. One sample was representative of Black Shale tailings and the other sample was representative of Supergene tailings. The samples were provided as water slurries containing approximately 200 g of solids. The test program conducted by EGi included the following assays and calculations:

Solids

- Total sulphur content
- Acid neutralising capacity (ANC)
- Maximum potential acidity (MPA)
- Net acid producing potential (NAPP)
- Net acid generation (NAG) capacity
- Kinetic NAG testing
- Acid buffer characteristic curve
- Multi-element composition

Liquor

- pH
- Electrical conductivity (EC)

An explanation of these measurements is provided in Appendix A, and the results are summarised in Table 1 (acid forming characteristics), Table 2 (multi-element composition), Figure 1 (acid buffer characteristic curve) and Figure 2 (kinetic NAG).

Acid Forming Potential of Supergene Tailings

The results indicate that the sample representing supergene tailings was non-acid forming. The total sulphur content was low (0.16 %S) and, given the weathered nature of the material, it is likely that the sulphur present was mainly non-pyritic. The acid neutralising capacity of the supergene tailings was also low, equivalent to only 2 kg H_2SO_4/t. Although the NAPP for this sample was slightly positive (3 kg H_2SO_4/t) there was no indication of any acid generation when the sample was oxidised with hydrogen peroxide in the NAG test.

Table 1. Acid forming characteristics of tailings samples

Assay	Unit	Supergene Tailings	Black Shale Tailings
Liquor pH		7.2	8.2
Liquor EC	μS/cm	2430	2210
Total Sulphur	%S	0.16	1.06
Maximum Potential Acidity (MPA)	kg H_2SO_4/t	5	32
Acid Neutralising Capacity (ANC)	kg H_2SO_4/t	2	1
ANC/MPA Ratio	-	0.4	0.03
Net Acid Producing Potential (NAPP)	kg H_2SO_4/t	3	31
Net Acid Generation (NAG)	kg H_2SO_4/t	0	11
NAGpH	-	5.3	2.8
Classification	-	NAF	PAF

Classification Key

PAF = Potentially Acid Forming

NAF = Non-Acid Forming

Acid Forming Potential of Black Shale Tailings

The characteristics of the sample representing black shale tailings indicate significant acid forming potential. The black shale tailings had a sulphur content of 1.06 %S and virtually no ANC. The net acid producing potential (NAPP) based on the sulphur and ANC results was 31 kg H_2SO_4/t, and the tailings acidified to pH 2.8 when the sulphides within the tailings were oxidised in the NAG test. The amount of acidity generated in the NAG test was 11 kg H_2SO_4/t. Based on the positive NAPP and NAG test results the black shale tailings were classified as potentially acid forming (PAF).

It is worth noting, however, that the amount of acidity generated in the NAG test was only approximately one-third of the NAPP. The lower NAG value may indicate incomplete oxidation of sulphides during the NAG test and/or some of the sulphur occurs in forms that are not acid generating.

To ensure complete oxidation of all sulphides, a sequential NAG test was carried out on the black shale tailings. This involved reaction of the solids three times with hydrogen peroxide. The pHs of the NAG liquor after each stage were 2.8, 3.7 and 4.8, respectively. The acidities after each stage were 9, 2 and 0 kg H_2SO_4/t, respectively. These results indicate that most sulphide was oxidised in the first stage, and the remainder oxidised in stage 2. There was no evidence of sulphide oxidation or acid generation in stage 3.

Therefore, the difference in the NAPP and NAG results suggests that a significant amount of the sulphur within the black shale tailings occurs in forms that are either not acid generating (e.g. sulphate) or generate less acidity than pyrite when oxidised (*e.g.* sphalerite and galena).

[NOTE: the multi-element data, when available, should shed more light on this]

Acid Buffer Characteristic Curves

Acid buffer characteristic curves were produced for the two tailings samples to verify the low ANCs (Figure 1). The buffer characteristic curve is determined by slow addition of weak acid to a sample, and it represents a far less aggressive treatment of a sample than that applied in the ANC method. The acid buffer curve provides an indication of the presence of more soluble carbonates within a sample such as calcite and dolomite.

The shapes of the curves in Figure 1 suggest there is little, if any, reactive carbonate within either of the two tailings samples. When carbonate mineralisation is present, and is the main contributor of ANC, it typically produces a plateau region in the buffer curve between pH 7 to 8. Clearly, no plateaus were produced by the tailings, and the curves indicate that an addition of only 2 kg H_2SO_4/t was sufficient to acidify the tailings to around pH 4.

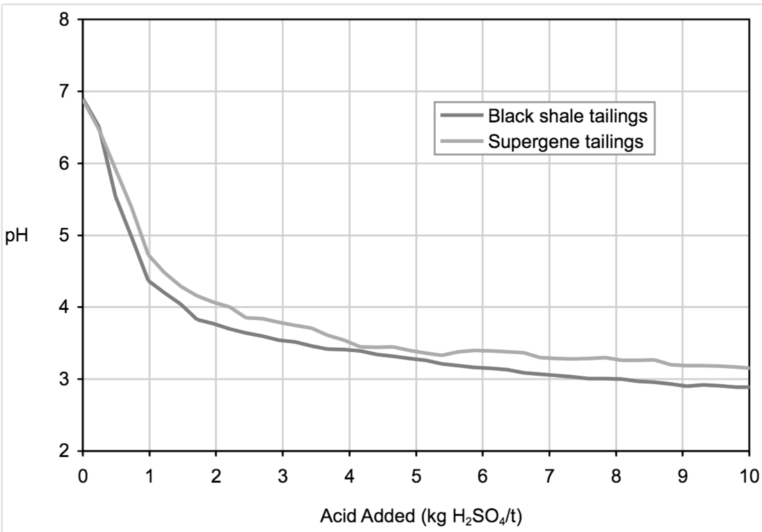


Figure 1. Acid buffer characteristic curves for tailings samples

Kinetic NAG Test

Given the low acid buffer capacity within the black shale tailings it might be expected that such tailings would acidify rapidly (*i.e.* have a short lag) if exposed to atmospheric conditions within a tailings storage. However, the results of the kinetic NAG test (Figure 2) suggest that the sulphides within the tailings are not highly reactive and that it may take some time for a low pH condition to be reached. The pH profile indicates a small amount of buffering at around pH 5.7 during the first two hours, after which the tailings steady acidified to pH 2.8.

The overall time for acidification was relatively slow for a PAF material under NAG test conditions. Based on EGi's experience with similar behaving materials from other mine sites, the kinetic NAG results suggest a lag of several months or more. Further clarification of the likely lag period will require longer-term column testing.

Another feature of the kinetic NAG test was that there was only limited heating of the NAG liquor during the test. Typically, samples that contain more than 1 %S as pyrite produce a significant temperature increase, often to the point of the NAG liquor reaching boiling point. The temperature increase can be attributed primarily to catalytic decomposition of the peroxide (which is an exothermic, or heat generating, process) which usually only occurs in the presence of significant pyrite content (*i.e.* at least 0.5 %S as pyrite). The absence of this type of response with the black shale tailings is consistent with the expectation that only some of the sulphur within the tailings occurs as pyrite. Sphalerite, which probably accounts for the majority of the sulphur, does not generate acidity when oxidised, nor does it result in catalytic breakdown of the hydrogen peroxide.

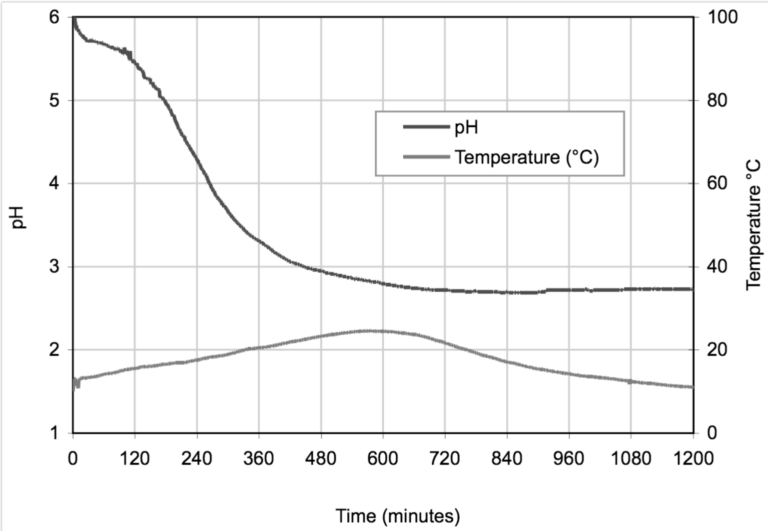


Figure 2. Kinetic NAG profiles for the Black shale tailings

Multi-Element Composition of Tailings

Multi-element analyses of the tailings solids were carried out by Genalysis Laboratory Services Pty Ltd using NATA registered procedures. Samples were digested by multi-acid addition and the digests were analysed for a suite of 29 elements.

The multi-element data for the tailings solids are given in Table 2, together with the respective geochemical abundance indices (GAI). The GAI for a particular element provides an indication of the relative enrichment of that element within the tailings solids compared to the median soil abundance. The GAI is expressed on a log 2 scale which includes 7 integer increments (0 through to 6, respectively). A GAI of 0 indicates the element is present at a concentration similar to, or less than, median soil abundance and a GAI of 6 indicates approximately a 100-fold, or greater, enrichment above median soil abundance. The main purpose of the GAI is to identify elements that occur at concentrations that may be environmentally significant.

[NOTE; Multi-element data will be included when available]

Table 2. Multi-element composition of tailings samples

Element	Unit	Composition Supergene Tailings	Composition Black Shale Tailings	Median Soil	GAI Supergene Tailings	GAI Black Shale Tailings
Al	%			7.1		
Ca	%			1.5		
Fe	%			4.0		
K	%			1.4		
Mg	%			0.5		
Na	%			0.5		
S	%			0.03		
Si	%			33.0		
As	ppm			6		
Ba	ppm			500		
Be	ppm			0.3		
Cd	ppm			0.35		
Co	ppm			8		
Cr	ppm			70		
Cu	ppm			30		
F	ppm			200		
Hg	ppm			0.06		
Mn	ppm			1000		
Mo	ppm			1.2		
Ni	ppm			50		
P	ppm			800		
Pb	ppm			35		
Sb	ppm			1		
Se	ppm			0.4		
Sn	ppm			4		
Sr	ppm			250		
Th	ppm			9		
U	ppm			2		
Zn	ppm			90		

\# *Median soil abundance data were taken from Bowen, H.J.M. (1979). Environmental Chemistry of the Elements, Academic Press, New York, p36-37.*

Appendix A

Determination of Acid Forming Characteristics

Total Sulphur Content

The total sulphur content of each sample was determined by the Leco furnace method. Sulphur assays were carried out by Sydney Environmental Laboratory Pty Ltd under a quality assurance system certified as complying with ISO 9002.

Maximum potential acidity (MPA) of the contained sulphur

The MPA is the maximum amount of acid that could be generated by the sulphur contained within a sample assuming that all the sulphur occurs as reactive pyrite. The MPA of each sample was calculated from the total sulphur content as follows: MPA (kg H_2SO_4/t) = (Total %S) x 30.6.

Acid neutralising capacity (ANC)

The acid produced by pyrite oxidation will to some extent react with other minerals contained within a sample. This inherent acid buffering is quantified in terms of the ANC, which has the same units as MPA. The ANC was determined using the Sobek Method. This involved reacting a sample with a known amount of acid at a pH of less than 1 for 1 to 2 hours, then back-titrating the residual acidity to determine the amount of acid consumed by the sample.

Net acid producing potential and ANC/MPA Ratio

The NAPP is the amount of acid that potentially can be produced by a sample after allowing for ANC. It is calculated by subtracting the ANC value from the MPA value. If the NAPP is negative then it is likely that the material has sufficient inherent buffer capacity to prevent acid generation. Conversely, if the NAPP is positive then the material may be acid generating.

The ANC/MPA ratio is essentially another way of looking at the balance between ANC and MPA, and provides an indication of the relative margin of safety with respect to the acid forming potential of a sample. A ratio less than 1 corresponds to a positive NAPP and indicates a material may be acid generating. Conversely, an ANC/MPA ratio of 2 or more generally signifies that there is a high probability that the material will remain circum-neutral in pH (*i.e.* the material should not be problematic with respect to ARD).

Net acid generation (NAG)

NAG is an alternate method of estimating the acid forming potential of a sample. The NAG test involves reaction of a sample with hydrogen peroxide to rapidly oxidise any sulphide minerals present. Both acid generation and acid neutralisation occur simultaneously during the NAG test, hence the end result represents a direct measurement of the net amount of acid that a sample can generate. If the sample after reaction has a pH of 4.5 or less (*i.e.* NAGpH≤4.5) then it is considered to be acid forming. The actual amount of acidity generated can be determined by titration of the mixture.

Sequential NAG Test

The sequential NAG test is a multi-stage procedure involving a series of single addition NAG tests on the one sample (*i.e.* 2.5 g of sample was reacted three times with 250 mL aliquots of 15% hydrogen peroxide). At the end of each stage, the sample is filtered to separate the solids and NAG liquor. The NAG liquor is assayed for pH and acidity, as per a standard NAG test. The solids are recovered for repeat oxidation using another aliquot of hydrogen peroxide the solid residue. The overall NAG capacity of the sample is determined by summing the individual acid capacities from each stage.

Kinetic NAG Testing

The kinetic NAG test provides an indication of the reactivity of sulphides within a sample and provides a quick, qualitative assessment of the likely lag time for acidification to occur under field conditions. The method is similar to the standard NAG test, except that pH and temperature are constantly recorded during the test. The reaction kinetics exhibited in the NAG test are extrapolated to the field situation on the basis of correlations previously derived by EGi from numerous leach column tests and field observations at other mine sites.

Measurement of acid buffering characteristic curves (ABCC)

The ABCC is determined by slowly acidifying a sample with dilute acid to around pH 3 over a 16 to 24-hour period. It therefore represents a far less aggressive treatment of a sample than that applied in the ANC method, and it typically only accounts for more readily-available carbonates such as calcite and dolomite. When present in sufficient quantity, these minerals will typically buffer a waste rock at near-neutral pH, which is essential for maintaining low metal solubilities.

ARD Classification Scheme

The acid forming potential of a sample is classified on the basis of the NAPP and NAG test results into one of the following categories:

<u>Non-acid forming (NAF)</u> A sample classified as NAF may, or may not, have a significant sulphur content but the content and reactivity of carbonate minerals and ANC within the material is more than adequate to neutralise all the acid that theoretically could be produced by any contained sulphide minerals. Material classified as NAF is considered unlikely to be a source of acidic drainage. The criteria used to define a NAF material are a negative NAPP and a NAGpH greater than 4.5.

<u>Potentially acid forming (PAF)</u> PAF material always has a significant sulphur content, the acid generating potential of which exceeds the inherent acid neutralising capacity of the material. This means there is a risk that such a material, even if pH circum-neutral when freshly mined and processed, could oxidise and generate acidic drainage if exposed to atmospheric conditions. The criteria used to define PAF material are a positive NAPP and a NAGpH less than, or equal to 4.5.

<u>Uncertain (UC)</u> An uncertain classification is used when there is an apparent conflict between the NAPP and NAG results (*i.e.* when the NAPP is positive and NAGpH > 4.5, or when the NAPP is negative and NAGpH ≤ 4.5). Uncertain samples are generally given a tentative classification that is shown in brackets *e.g.* UC(PAF), but further testing would be required to confirm the tentative classification.