APPENDIX H

ACID SULPHATE / GEOTECH REPORT

KAS DEVELOPMENTS PTY LTD

PROPOSED UNIT DEVELOPMENT

85 Ocean Parade, Coffs Harbour

GEOTECHNICAL ASSESSMENT

CH1378/1-AC

15 March 2005

CH1378/1-AC
15 March 2005

Kas Developments Pty Ltd
1/14 Pembury Close
MINTO NSW 2560

Attention: Mr John Kasbarian

Dear Sir,

RE: PROPOSED UNIT DEVELOPMENT AT 85 OCEAN PARADE, COFFS HARBOUR GEOTECHNICAL ASSESSMENT

Coffey Geosciences Pty Ltd (Coffey) is pleased to present our report on the geotechnical investigation for the above site.

We draw your attention to the attached sheet entitled "Important Information About Your Coffey Report" which should be read in conjunction with this report.

We trust that this report meets with your requirements. If you require further information please contact the undersigned in our Coffs Harbour office.

For and on behalf of

COFFEY GEOSCIENCES PTY LTD

DAVID BARKER
Senior Geotechnical Engineer

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1. INTRODUCTION

Coffey Geosciences Pty Ltd has conducted a geotechnical assessment for a proposed unit development to be located at 85 Ocean Parade, Coffs Harbour. The aim of the study, which was commissioned by Mandy Kasbarian of Kas Developments Pty Ltd, was to provide preliminary recommendations on the following:

- Site preparation.
- Excavation conditions and groundwater levels.
- Alternative footing types and founding levels, including recommendations as to allowable bearing pressure and data to allow assessment of settlements.
- Recommendations on retaining wall options and design parameters for the basement carpark retaining walls.
- Acid sulfate soils.
- Assessment of groundwater quality, levels and hydraulic conductivity of soil strata, including an assessment of the likely extent and effects of dewatering;
- Further drilling and assessment of geotechnical conditions at the site.

Coffey conducted the work in general accordance with proposal CH1378/1-AB. The proposed scope of work for the groundwater assessment was included in proposal CH1378/1-AA. This report presents the results of the site investigation.

2. SITE DESCRIPTION & PROPOSED DEVELOPMENT

The site of about $1800m^2$ is situated at Ocean Parade, Coffs Harbour. It is bounded by Park Beach Road to the south, Ocean Parade to the east, a laneway to the west, and by a residential unit development to the north. Developments in the area comprise residential unit and holiday accommodation buildings of varying height.

Regionally the site is situated within a relatively flat alluvial area. Locally, the ground surface is generally flat. An existing motel development comprising single storey buildings located along the southern, western and northern sides of the site is evident. A bitumen car park area is located in the middle of the site between the buildings. There are also small grassed areas and a swimming pool near the eastern side of the site.

Drawings provided by the client indicate that the proposed development will comprise structures of up to eight storeys, which includes two below car parking levels and six above ground residential unit levels. The drawings indicate that the basement will require excavation to about 6m depth below existing ground surface levels.

3. SCOPE OF WORK

3.1 Fieldwork

Fieldwork was carried out over two days on 7 and 8 February 2005 and comprised the drilling of two boreholes (BH1 and BH2) to depths of 23.95m. The boreholes were initially drilled using a hand auger to check for the presence of underground services at each borehole location. The boreholes were then drilled by a truck mounted drilling rig using auger and wash boring drilling methods. Standard Penetration Tests (SPT's) were conducted at about 1.5m intervals in each of the boreholes. Several thin walled tube samples were taken in place of SPT's where considered appropriate.

Standpipe piezometers were installed in the boreholes to depths of 5m and 7m below the ground surface level. Prior to installing the piezometers, the boreholes were backfilled with the drilling spoil to a depth of 0.5m below the base of the piezometer, and a 0.5m thick layer of bentonite was then placed in the boreholes. The piezometers comprised slotted PVC pipes, which were wrapped with a filter sock and placed into the borehole. The anulus between the pipe and the borehole filled with free draining sand for a height of 3m above the base of the piezometer. Above the free draining sand, the boreholes were backfilled with a 0.5m thick layer of bentonite and the drilling spoil material. The piezometers were installed such that permeability testing could be carried out over the 3m range which was backfilled with the free draining sand. Rising head permeability tests were carried out in the standpipe piezometers on 10 February 2005. A groundwater sample was taken from BH1 on 21 February 2005 for testing, after the well had been purged on several different occasions to remove any remaining drilling fluids.

The boreholes were drilled in the full time presence of a Scientist from Coffey who logged the materials observed, took samples and recorded results of in-situ testing, and installed the standpipe piezometers. Figure 1 shows the investigation locations. Engineering Logs are presented in Appendix A, with explanation sheets defining the terms and symbols used in their preparation.

4. SUB-SURFACE CONDITIONS

4.1 Stratigraphy

The Dorrigo / Coffs Harbour 1:250,000 Geological Series sheet shows that the site is underlain by Quaternary Alluvium comprising sands and clays.

The stratigraphy interpreted from the boreholes is summarised in Table 1.

TABLE 1: SUMMARISED SUBSURFACE PROFILE.

Geotechnical Unit	Depth to Base of Unit (m)	Description
Unit 1- Topsoil / Fill	0.2 to 0.35	Silty Sand in BH1 and Bitumen overlying Sandy Gravel in BH2.
Unit 2 – Marine/Alluvial Sand	11.2 to 12.2	Sand, fine to medium grained, brown, dark brown/black grading to grey in colour, generally medium dense to very dense some indurated layers to about 6m depth grading to medium dense to the base of the unit, with about an 0.5m thick layer of Silty Sand/Sandy Clay at about 3m depth.
Unit 3 – Alluvial Clay Soft to firm consistency	~14	Sandy Silty Clay, high plasticity, generally soft to firm in consistency.
Unit 4 – Alluvial Clay Firm to stiff or better consistency	21 to 21.7	Sandy Clay, high plasticity, generally firm to stiff in consistency with some stiff and very stiff layers, with layers of Gravelly Sandy Clay and Gravelly Clayey Sand below about 17m depth.
Unit 5 – Residual Soil / Extremely Weathered Material	Beyond the limit of investigation	Clay, high plasticity, pale brown to brown, relict rock structure observed

Further details of the subsurface conditions encountered in the boreholes are provided on the Engineering Logs, with explanation sheets defining the terms and symbols used in their preparation.

4.2 Groundwater

During the field investigation, groundwater levels were measured at depths of 3.1m in BH1 and 1.17m in BH2. The water levels measured are considered significantly different considering that the ground surface is relatively flat. The difference may be due to the piezometer construction, as they were primarily intended for use to assess soil unit permeability and not standing water levels. It should be noted that groundwater levels may fluctuate in response to periods of increased rainfall and tidal influence.

5. CONSIDERATIONS FOR DESIGN & CONSTRUCTION

5.1 Founding Conditions & Parameters

Due to the relatively high column loads expected for the multi-storey building and the subsurface conditions encountered at the site, it is considered that shallow footings are unlikely to satisfy serviceability criteria for the development. Therefore, whilst we have provided design parameters for shallow footings, it is likely that the building would need to be supported on piles founded within the Unit 5 materials. Geotechnical strength and serviceability parameters are provided below for assessment of both shallow footings and piled foundations.

It is recommended that further geotechnical investigations be carried out for both options, though the investigations required for the shallow footing option may need to be more detailed to assess serviceability

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and permeability parameters for soil units.

For the shallow footing option, the Allowable Bearing Pressure (ABP) used in design will be dependant upon the footing width. ABP for square footings may be calculated using the following equation:

ABP = 200B, up to a maximum of 150kPa

where B = minimum footing dimension

The design should include assessment of both strength and serviceability limit states. The values provided in Table 4 for non-displacement piles may be adopted for the preliminary assessment of serviceability for shallow foundations.

A number of pile types could be utilised for the proposed structure depending on constraints such as allowable vibration levels and Council approvals. Alternate piling types and their assessed advantages and disadvantages are shown in Table 2.

TABLE 2: ADVANTAGES AND DISADVANTAGES OF ALTERNATE PILE TYPES

Pile Type	Advantages	Disadvantages
Atlas Screw / Omega type piles. *Displacement type*	Low vibration and noise on installation. High level of performance confidence because of torque measurements on installation. Increased design strength parameters due to displacement of materials.	May be more expensive than other options. Unlikely that a local supplier can conduct the installation.
Driven Pre-Cast Concrete Piles. *Displacement type*	High level of performance confidence. Increased design strength parameters due to displacement type. No spoil removal issues	Relatively high noise and vibration during installation may affect nearby developments Would require dilapidation studies for adjacent structures and vibration monitoring during construction. Splice joints will be required due to depth if end-bearing, increasing cost.
Grout Injected Piles. *Non-displacement type*	Low vibration and noise on installation.	Additional cost of spoil removal. Typically lower values of end bearing and shaft adhesion compared to displacement piles, due to mode of installation and lower confidence in pile performance. Required depth of construction for end-bearing may be difficult to achieve. Some uncertainty about integrity due to installation process.
Bored Piles. Non-displacement type	Likely least expensive option. Relatively widely available and understood construction technology. Suitable for piled raft option due to shorter required pile length.	Additional cost of spoil removal. Typically lower values of end bearing and shaft adhesion compared to displacement piles, due to mode of installation and lower confidence in pile performance. Will require pile hole support within granular soil units to reduce risk of water inflow and pile wall collapse.

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Excavation to a depth of about 6m will mean that the site has effectively been pre-loaded, and the soils will therefore be over-consolidated. Based on the proposed excavation depth and the subsurface conditions observed in the boreholes, it is considered that settlement of soft to firm clays will likely be minor and therefore negative skin friction on piles will likely be negligible. If the basement excavation depth is altered, further advice should be sought with respect to pile design.

Preliminary design parameters for the above pile types founded at least 4 pile diameters below the excavation level are shown in Table 3. The design should include assessment of both strength and serviceability limit states. A geotechnical reduction factor of $\Phi_g = 0.65$ should be applied to the ultimate values indicated in Table 3 when considering the strength limit state.

TABLE 3: PRELIMINARY GEOTECHNICAL STRENGTH PARAMETERS FOR PILE DESIGN

Founding Material & Expected Depth Range*	Pile Type	Ultimate End Bearing Capacity (kPa)	Ultimate Shaft Adhesion (kPa)
Unit 2 Marine/Alluvial Sand Basement to 12m	Displacement	-	50
	Non-displacement	-	25
Unit 3 – Alluvial Clay 12m to 14m	Displacement	-	20
	Non-displacement	-	10
Unit 4 – Alluvial Clay 14m to 22m	Displacement	-	35
	Non-displacement	-	25
Unit 5 Extremely Weathered Siltstone >22m	Displacement	4,000	150
	Non-displacement	2,500	100

Note: * Depth below the existing ground surface.

The values of Young's modulus provided in Table 4 may be adopted for the assessment of the serviceability limit state for pile foundations. Note that parameters for the different types of piles (i.e. displacement and non-displacement piles) have been provided.

TABLE 4: PRELIMINARY PARAMETERS FOR PILE SERVICEABILITY ASSESSMENT

Founding Material & Expected Depth Range*	Pile Type	Young' Modulus, E (MPa)
Unit 2 Marine/Alluvial Sand Basement to 12m	Displacement	-
	Non-displacement & shallow footings	25
Unit 3 – Alluvial Clay 12m to 14m	Displacement	-
	Non-displacement & shallow footings	1
Unit 4 – Alluvial Clay 14m to 22m	Displacement	-
	Non-displacement & shallow footings	10
Unit 5 Extremely Weathered Siltstone >22m	Displacement	150
	Non-displacement	

Note: * Depth below the existing ground surface.

5.2 Aggressivity Testing

Exposure classifications for a groundwater sample from BH1 were assessed in accordance with AS2159-1995: Australian Standard for Piling-Design and Installation, and other associated published literature. The results are shown in Table 5 and are also attached.

TABLE 5: TEST RESULTS AND EXPOSURE CLASSIFICATIONS

Borehole	BH1
Soil Condition	A
pH	6.3
Resistivity (Ohm.cm)	700
Chlorides (ppm)	440
Sulfates (Ppm)	10
EXPOSURE CLASSIFICATION CONCRETE PILES	Mildly Aggressive
EXPOSURE CLASSIFICATION STEEL PILES	Severely Aggressive

Notes: *1 - Soil Conditions A – high permeability soils (e.g. sands and gravels) which are below ground water. 2 - Soil Conditions B – low permeability soils (e.g. silts and clays) or all soils above groundwater.*

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The results of chemical testing for chlorides and sulfates suggest a non-aggressive exposure classification, though physical properties such as resistivity and pH suggest a mildly aggressive exposure classification for concrete piles and a severely aggressive exposure classification for steel piles.

It is considered that for preliminary design purposes, a Mildly Aggressive exposure classification should be adopted for concrete piles, and a Severely Aggressive exposure classification should be adopted for steel piles. It is recommended that additional work be carried out to further assess exposure classifications for piles. This may include monitoring of water levels to assess if the groundwater table is influenced by tidal fluctuations, and testing of groundwater samples.

5.3 Excavation Conditions

As noted above, excavations to depths up to about 6m are proposed for the development. It is expected that soil profiles encountered at the site could be readily excavated by conventional earthmoving equipment such as backhoes and excavators. Our experience in the Coffs Harbour area suggests that the strength of indurated sand units can be similar to that of low strength rock. The indurated sands in Coffs Harbour are generally variably cemented and there should be locations where excavation plant could gain adequate purchase to excavate through more strongly cemented zones.

As noted above, groundwater was encountered at between 1m and 3m depth below the ground surface. Previous investigations in the Coffs Harbour area indicate a water table depth of about 1.5m to 2m depth. It is recommended that the water table depth be further assessed prior to construction. As the site soils within about 5m to 7m depth comprised mainly sand, groundwater inflows into excavations could be significant if adequate measures are not taken to address the issue. Further comments and recommendations on groundwater flows during excavation are provided below.

The materials encountered at the base of the excavation are expected to comprise medium dense sand. Such materials may be difficult to traffic, particularly as they are expected to be saturated. It is recommended that consideration be given to this issue, with potential options to reduce the risk of poor trafficability and site access comprising placement of a granular working platform over the excavated surface.

5.4 Site and Excavation Retention

The site soils will require support as vertical cuts are proposed. Excavation of temporary batter slopes for the construction of retaining structures such as conventional concrete panel or similar walls is considered impractical due to the likely mild batter slopes required to maintain an adequate factor of safety against instability, and the likely groundwater inflows and issues.

The recommended option is to install support prior to excavation. Options for support of excavations include:

- **Fully tanked structure with temporary retaining/cut-off walls:** This option comprises a temporary sheet pile or secant/contiguous pile walls combined with a permanent fully tanked basement constructed within the temporary walls. The purpose of the temporary walls would be to provide support for the excavation and to act as a low permeability cut-off wall to reduce groundwater inflows during construction.

  Founding depths for the temporary walls would likely be at about 15m to 17m depth below the existing ground surface. This likely toe depth would be required to achieve adequate embedment into the clay to reduce groundwater flows beneath the walls to a tolerable rate.

  With respect to the use of sheet piles at the site, we recommend that an experienced piling

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contractor review the available information with respect to the likelihood of sheet piles penetrating the Unit 2 Marine Sands. Based on the proposed development details, ground anchors would likely extend beyond the site boundary, and thus permission form adjacent property owners would be required. Anchors could be designed to provide temporary support for walls, with permanent support provided by internal basement walls.

The tanked basement would need to be designed to withstand full hydrostatic pressure. Uplift forces on the basement should be considered during design. Tension piles or anchors may be required to resist uplift forces on the floor of the basement. Construction practices are particularly important for fully tanked basement structures, particularly with respect to compaction and curing of concrete.

- <u>Permanent tanked retaining/cut-off walls with drained basement:</u> An alternative option comprises permanent cut-off/retaining walls comprising diaphragm or secant pile walls and a 'slab on grade' floor. For this option, the basement walls provide excavation support and act as a low permeability cut-off wall for the life of the structure. Internal piles may be constructed prior to excavation to act as supports for floor beams during top-down construction. The basement floor could be constructed as a slab on grade after the installation of a permanent pumping system in a reservoir and a drainage blanket. The drainage blanket would act as a collection point for any upward water seepage, and would channel water through a series of pipes to a reservoir. Water would then be pumped to the surface for disposal. The pumping system would need to be in operation for the life of the structure.

  Founding depths for the permanent wall option would likely be in excess of 22m depth below the ground surface within the Unit 4 Extremely Weathered Material, though this may vary depending on if the piles would be expected to support loads and the permeability of the Unit 3 and Unit 4 materials. The advantage of founding the pile walls in the Unit 4 materials is that they can be used to carry loads from the structure, though their use for this purpose would depend on the structure design. The provided drawings indicate that the basement walls are not directly beneath the wall for the upper storeys, which may limit the effectiveness of the walls to support loads from the upper storeys.

For an excavation depth of the order indicated for the development, it is considered that the wall options indicated above could be designed as cantilevered walls, though the design may need to incorporate ground anchors or props for restraint where space permits. Wall design will depend on the geotechnical and structural capacity of the wall and serviceability requirements. The need for anchors or props will depend mainly on the founding depth, the structural capacity of the walls and the design philosophy. It is considered that as the wall founding depth would likely be less for the temporary retaining/cut-off wall case, and therefore there is a higher likelihood of requiring anchors or props for this case. Design toe levels for the walls will be affected by the embedment required to satisfy structural design based on earth pressures and allowable movements, and for the wall to act as a low permeability cut off wall.

Pile design for retaining structures will require an assessment of the induced bending moments and shear forces within the retaining wall to enable design of reinforcement for the piles. All walls should be designed as a low permeability cut off wall, with the wall designed to withstand full hydrostatic pressure. The design water level will need to take into account potential changes in the groundwater table level, such as during rainfall and flood events.

With respect to excavation induced movements, the magnitude and extent of settlement will be dependant on the lateral deflection of the retaining structures and achieving little or no groundwater drawdown. For the

retaining walls, where 'at rest' earth pressure parameters are adopted in design, little or no horizontal deflection in theory would occur. Where active earth pressures are adopted, the walls would tend to deflect more, until stresses are relieved and equilibrium occurs. This could typically be of the order of 0.3% to 0.7% of the retained wall height depending on the stiffness of the wall, embedment details etc. The effect of this movement would generally extend to a distance represented by a line projected at about 45º to 60º up from the toe of the excavation. As the proposed development extends to near the site boundary, some settlement could be expected outside the site boundaries for the proposed 6m excavation depth. Further assessment of settlements could be carried out after retaining wall design is completed.

The above comments assume that the basement will be designed as a tanked structure, and therefore groundwater drawdown outside the basement excavation will not occur. The type and design of retaining structures should consider the risks resulting from groundwater drawdown at the site. Retaining structures should be designed and constructed in accordance with good engineering principles. If groundwater drawdown did occur outside the excavation (e.g. through failure, construction methods etc.), the resulting settlement could affect existing developments within a relatively large area. For example, if the groundwater level fell to 6m depth, preliminary estimates indicate that a settlement of the order of 25mm could occur for a significant distance from the site.

Cantilevered walls or walls with one row of anchors may be designed on the basis of a triangular stress distribution using the design parameters shown in Table 6. 'At rest', active and passive earth pressure coefficients for each of the geotechnical units are also provided.

TABLE 6: PRELIMINARY RETENTION DESIGN PARAMETERS.

Geotechnical Unit	Unit 2 – Marine Sand	Unit 3 – Alluvial Clay	Unit 4 – Residual Soil/Extremely Weathered Material
Assessed Depth Range (m)	0 to 12	12 to 22	>22
Unit Weight, γ (kN/m³)	20	16	19
Effective Friction Angle, Ø'	30º	15º	26º
Effective Cohesion, c' (kPa)	0	2	10
'At rest' earth pressure coefficient (K_0)	0.5	0.75	0.55
Active earth pressure coefficient (K_a)	0.33	0.6	0.4
Passive earth pressure coefficient (K_p)	3.0	1.7	2.6

If walls with more than one row of anchors are to be adopted a different stress distribution would apply. Coffey can provide this information and details for anchor design if necessary.

The values of earth pressure coefficient above assume that the area above the retaining wall is flat. Design of the walls must take into account any surcharge from sloping ground or other loadings behind the wall. It is suggested that where proposed basements are below the groundwater level, the basements should be designed as tanked structures to prevent ongoing seepage into the basements. The design of basements as tanked structures would need to account for both uplift (buoyancy) and lateral hydrostatic pressure on the structures.

5.5 Soil Permeability

The magnitude of groundwater seepage into the basement excavation during construction will be dependant on the founding level and the type of low permeability cut-off wall used in the basement design. For example, achieving a relatively watertight basement for a sheet pile or diaphragm wall depends on achieving good toe embedment, whilst for secant pile walls this is generally achieved adequately due to the construction method.

Subsurface conditions for the basement excavation generally comprised Sand soils to a depth of about 12m, overlying Clay soils of medium to high plasticity to beyond the depth of investigation. The clay was assessed to be very soft to firm in consistency with some stiff and very stiff layers to 22m depth, overlying residual soils and extremely weathered material. For the design of the low permeability cut off walls for the basement, it is likely that toe levels for the wall would be at about 15m to 17m depth. As discussed above, design toe levels will also be governed by structural design requirements.

Rising head tests were carried out in both of the piezometers installed at the site. The rising head test in BH1 indicated a permeability of about $2x10^{-6}$ m/sec. No rising head measurements were taken in BH2 due to the water rising at a faster rate than which it could be bailed from the piezometer. The results of the tests indicated the Unit 2 Marine Sands have a relatively high permeability. Based on published data, the permeability of clean sand soils is likely to be between about $1x10^{-6}$m/sec and $1x10^{-2}$m/sec. Our experience in Coffs Harbour suggests that the indurated sands could have a permeability of the order of $5x10^{-7}$m/sec to $1x10^{-6}$m/sec, and the permeability of the Unit 3 Alluvial Clay soils is of the order of $1x10^{-8}$m/sec. For design purposes, it is suggested that a preliminary permeability value of $1x10^{-5}$m/sec be adopted for the Unit 2 Marine Sands. This value is based on an approximate average of the results of testing at the site and published data. Based on our experience in Coffs Harbour, it is recommended that a preliminary permeability value of $1x10^{-8}$m/sec be adopted for the Unit 3 Alluvial Clays. It is recommended that a range of values be checked for design to assess the effect of changes in permeability.

The above permeability values are based on the assessment of the geotechnical unit as a whole. Zones of higher and lower permeability are anticipated in the Unit 2 Marine Sand geotechnical unit. Permeability values for discrete layers may be of the order of one to two orders of magnitude higher than that given above.

5.6 Dewatering and Groundwater Table Drawdown

Provided adequate embedment is achieved at the pile wall toe, and that adequate watertightness for the wall is obtained, groundwater seepages are likely to be relatively minor. It is recommended that an assessment of potential groundwater seepages be undertaken to allow the pumping system to be sized. Provided only minor seepages occur, groundwater drawdown outside the excavation is expected to be minor, and would likely be localised in the vicinity of the seepage. If the effective permeability of the sheet pile wall is lower than that of the retained soils, groundwater drawdown would likely be minimal, and therefore environmental impacts associated with groundwater drawdown are also expected to be minimal. Piezometers could be installed around the perimeter of the excavation to monitor groundwater level drawdown, to assist in managing the risk associated with potential groundwater drawdown.

6. GROUNDWATER QUALITY

One groundwater sample was taken after installation of the piezometers. The pH was measured in the field, and the samples were placed in laboratory supplied containers and sent to a NATA registered laboratory for testing. The results of the testing are summarised in Table 7.

TABLE 7: RESULTS OF GROUNDWATER TESTING

CONTAMINANT	BH1	NEPM GUIDELINE LEVELS *
pH (field test)	6.3	-
Arsenic (mg/L)	nd	0.05
Cadmium (mg/L)	nd	0.002
Chromium (mg/L)	nd	0.05
Cobalt (mg/L)	nd	-
Copper (mg/L)	0.002	0.005
Lead (mg/L)	nd	0.005
Nickel (mg/L)	0.004	0.015
Selenium (mg/L)	nd	0.07
Silver (mg/L)	nd	0.001
Vanadium (mg/L)	nd	-
Zinc (mg/L)	0.028	0.05
Mercury (mg/L)	nd	0.0001
Total Cyanide (mg/L)	nd	-
Electrical Conductivity (uS/cm)	1400	-
Total Suspended Solids (mg/L)	370	-
Total Kjeldahl Nitrogen (mg/L)	1.2	-
Total Organic Carbon (mg/L)	21	-
Ammonia as N (mg/L)	0.01	-
Turbidity (NTU)	95	-
Dissolved Oxygen (mg/L)	4.0	-
OC Pesticides (ug/L)	nd	-

Note: * Guideline Levels for Aquatic Ecosystems - Marine Waters, from the National Environment Protection Measure 1999. Numbers in bold and italic are above guideline levels.

It was noted during sampling that the groundwater at the site was relatively clear and had no obvious odour.

Concentrations of common contaminants were below the adopted guideline levels. The electrical conductivity result suggests that the water is likely to be relatively saline. Turbidity was within generally accepted standards for marine waters. Based on the results of the laboratory and field testing, disposal of groundwater into the stormwater drainage system may be permitted. Disposal into the stormwater system would need to be approved by the relevant authorities.

Other potential options for disposal of the groundwater include the pumping the water into the sewerage system (which would require local council approval), or irrigation of the water either on or off site. We understand that DIPNR require some testing of the water to be disposed of from the site. It is recommended that water quality monitoring be carried out immediately upon beginning of pumping, after 24 hours, and then, depending on results on a maximum weekly basis thereafter. A shorter timeframe may apply depending on the results of the ongoing testing.

The effectiveness of the irrigation option would be dependant on the rate at which water is pumped from the excavation, as infiltration relies on the permeability of the soils within the irrigation area. Irrigation might comprise spraying the water over the ground surface, or construction of an infiltration pit. If this option is adopted, regular testing of groundwater quality as described above should be carried out.

7. ACID SULFATE SOILS

7.1 Formation and Potential Impacts

Acid Sulfate Soils (ASS) are soils which contain significant concentrations of pyrite which, when exposed to oxygen, in the presence of sufficient moisture, oxidises, resulting in the generation of sulfuric acid. Unoxidised pyritic soils are referred to as potential ASS (PASS). When the soils are exposed, the oxidation of pyrite occurs and sulfuric acids are generated, the soils are said to be actual ASS (AASS).

Pyritic soils typically form in waterlogged, saline sediments rich in iron and sulfate. Typical environments for the formation of these soils include tidal flats, salt marshes and mangrove swamps below about RL 5m AHD. They can also form as bottom sediments in coastal rives and creeks.

Pyritic soils of concern on low lying NSW and coastal lands have mostly formed in the Holocene period, (i.e. 10,000 years ago to present day) predominantly in the 7,000 years since the last rise in sea level. It is generally considered that pyritic soils which formed prior to the Holocene period would already have oxidised and leached during periods of low sea level which occurred during ice ages, exposing pyritic coastal sediments to oxygen.

Disturbance or poorly managed development and use of acid sulfate soils can generate significant amounts of sulfuric acid, which can lower soil and water pH to extreme levels (generally <4) and produce acid and salts, resulting in high salinity.

The low pH, high salinity soils can reduce or altogether preclude vegetation growth and can produce aggressive soil conditions which may be detrimental to concrete and steel components of structures, foundations, pipelines and other engineering works.

Generation of the acid conditions often releases aluminium, iron and other naturally occurring elements from the otherwise stable soil matrices. High concentrations of such elements, coupled with low pH and alterations to salinity can be detrimental to aquatic life. In severe cases, affected waters flowing off-site can have detrimental effect on aquatic ecosystems.

7.2 Laboratory Testing

A total of 12 samples were taken at about 1m intervals to a maximum depth of 7.5m below existing ground surface levels. All samples were placed in tightly sealed plastic bags and stored in chilled insulated containers during transit to cold storage at Coffey's Coffs Harbour laboratory.

Samples obtained for the acid sulfate assessment were screened for the presence of potential ASS using laboratory methods 21Af and 21Bf of Ahern CR, Blunden B and Stone Y (eds) (1998), Acid Sulfate Soil Laboratory Methods Guidelines, ASSMAC.

The results of the acid sulfate soil screening tests are summarised in Table 8.

TABLE 8: SUMMARY OF ACID SULFATE SCREENING TESTS

Location	Sample Depth (m)	pH in water	pH in 30% H_2O_2
BH1	0.5 to 0.8	7.5	5.5
BH1	1.0 to 1.45	6.9	5.4
BH1	2.5 to 2.95	7.3	5.3
BH1	4.15 to 4.5	6.3	5.4
BH1	5.5 to 5.95	6.2	5.8
BH1	7.0 to 7.45	6.3	6.1
BH2	0.5 to 0.7	6.5	5.5
BH2	1.0 to 1.45	4.8	4.9
BH2	2.5 to 2.95	6.4	5.4
BH2	4.0 to 4.45	5.8	3.5
BH2	5.5 to 5.65	6.0	4.8
BH2	7.0 to 7.45	5.9	2.4

The following comments are noted from the results presented in Table 7.

- pH of 1:5 soil water solution did not produce a pH<4 in any samples tested. Soil water pH<4 in this test is an indication of actual acid sulfate soil;
- H_2O_2 oxidation produced pH<3 in one sample taken from between 7m and 7.45m depth in BH2. Soil pH<3 in this test is an indication of potential acid sulfate soil.

On the basis of the screening results, a number of samples from BH2 were selected for additional testing and sent to an external analytical laboratory for testing using the Chromium Reducible Sulfur (CRS) method to assess the potential for acid generation. The results of the CRS testing are presented in Appendix B and are summarised in Table 9.

TABLE 9: RESULTS OF CRS TESTING.

Location	Depth (m)	Texture	Reduced Inorganic Sulfur (% Scr)	Action Criteria*
BH2	0.5 to 0.7	Coarse	0.002	0.03
BH2	1.0 to 1.45	Coarse	0.027	0.03
BH2	2.5 to 2.95	Coarse	**0.059**	0.03
BH2	4.0 to 4.45	Coarse	**0.169**	0.03
BH2	5.5 to 5.65	Coarse	**0.103**	0.03
BH2	7.0 to 7.45	Coarse	**0.124**	0.03

Note: Values in bold and underlined exceed action criteria.
Action criteria adopted are based on disturbance of more than 1000 tonnes of acid sulfate soils.

7.3 Discussion and Recommendations

Based on the results of the CRS testing, it is recommended that all soils below 2m depth be considered as potential acid sulfate soils, thereby requiring an acid sulfate soils management plan to be prepared for the proposed development. An acid sulfate soil management plan is provided in Appendix C.

It should be noted that the results are based on a preliminary investigation only, and further sampling and testing will be required for the proposed development prior to excavation. Additional investigation work might comprise sampling and testing of soil taken at 1m intervals in two boreholes drilled to about 1m below the proposed excavation level.

Excavated soils will require treatment with lime to neutralise acidity produced by oxidation of the soils when excavated. Recommendations on required liming ratio for PASS excavated are provided below.

Good quality fine agricultural lime should be used to treat excavated PASS. In calculating the liming ratios, a factor of safety of 1.5 has been allowed (as recommended in the ASSMAC guidelines) above the theoretical requirement to take into account the rate of lime reactivity and the possibility of inhomogeneous mixing.

Table 10 presents the liming rates assessed for the nine samples which exceeded the action criteria of 0.03% for greater than 1000 tonnes of soil disturbed in accordance with ASSMAC (1998) Acid Sulfate Soil Guidelines.

TABLE 10: ASSESSED LIMING RATES BASED ON TEST RESULTS

Location	Depth (m)	Liming Rate (kg/m³)
BH2	2.5 to 2.95	4
BH2	4.0 to 4.45	12
BH2	5.5 to 5.65	7
BH2	7.0 to 7.45	9

Using the highest liming rate assessed for the soil samples tested, it is recommended that a liming application rate of 12kg of lime per cubic metre of soil disturbed below 2m depth should be undertaken.

7.4 Neutralisation by Lime

To reduce the risks associated with acidification of run off, we recommend that the area set aside for all spoil is blanketed with agricultural lime prior to placing the spoil, and the surface of the spoil is dosed with lime to reduce the risk of acidic runoff.

Excavated PASS should be contained within the limed area in layers of workable depth (typically not more than 0.3m loose thickness) and be thoroughly mixed with lime through use of a rotary hoe or some similar mechanical process to achieve a thorough mix. The liming should be confined to areas of manageable size. Liming areas should be bunded to allow containment of all leachate and stormwater runoff until test results indicate acceptable levels of neutralisation have been achieved.

The time required for applied lime to neutralise PASS is widely variable and depends on the specific properties of the neutralised soil, although the lime will begin to neutralise the acid soils from the time of application. Measurement of the neutralisation of the PASS being treated should be undertaken at a later

date to provide an indication that the neutralisation process is working or has worked effectively.

Soil acidity in excavated materials should be monitored through visual observation and field and laboratory testing of excavated soils. Should field pH and laboratory tests show that the soil acidity has not fallen below action criteria, or that a greater amount of lime is required, then the material should be reworked and additional lime treatment carried out until it is verified that the soil meets the required specification.

We draw your attention to the attached sheet entitled "Important Information About Your Coffey Report" which should be read in conjunction with this report.

For and on behalf of

COFFEY GEOSCIENCES PTY LTD

DAVID BARKER
Senior Geotechnical Engineer

Information

Important information about your **Coffey** Report

As a client of Coffey you should know that site subsurface conditions cause more construction problems than any other factor. These notes have been prepared by Coffey to help you interpret and understand the limitations of your report.

Your report is based on project specific criteria

Your report has been developed on the basis of your unique project specific requirements as understood by Coffey and applies only to the site investigated. Project criteria typically include the general nature of the project; its size and configuration; the location of any structures on the site; other site improvements; the presence of underground utilities; and the additional risk imposed by scope-of-service limitations imposed by the client. Your report should not be used if there are any changes to the project without first asking Coffey to assess how factors that changed subsequent to the date of the report affect the report's recommendations. Coffey cannot accept responsibility for problems that may occur due to changed factors if they are not consulted.

Subsurface conditions can change

Subsurface conditions are created by natural processes and the activity of man. For example, water levels can vary with time, fill may be placed on a site and pollutants may migrate with time. Because a report is based on conditions which existed at the time of the subsurface exploration, decisions should not be based on a report whose adequacy may have been affected by time. Consult Coffey to be advised how time may have impacted on the project.

Interpretation of factual data

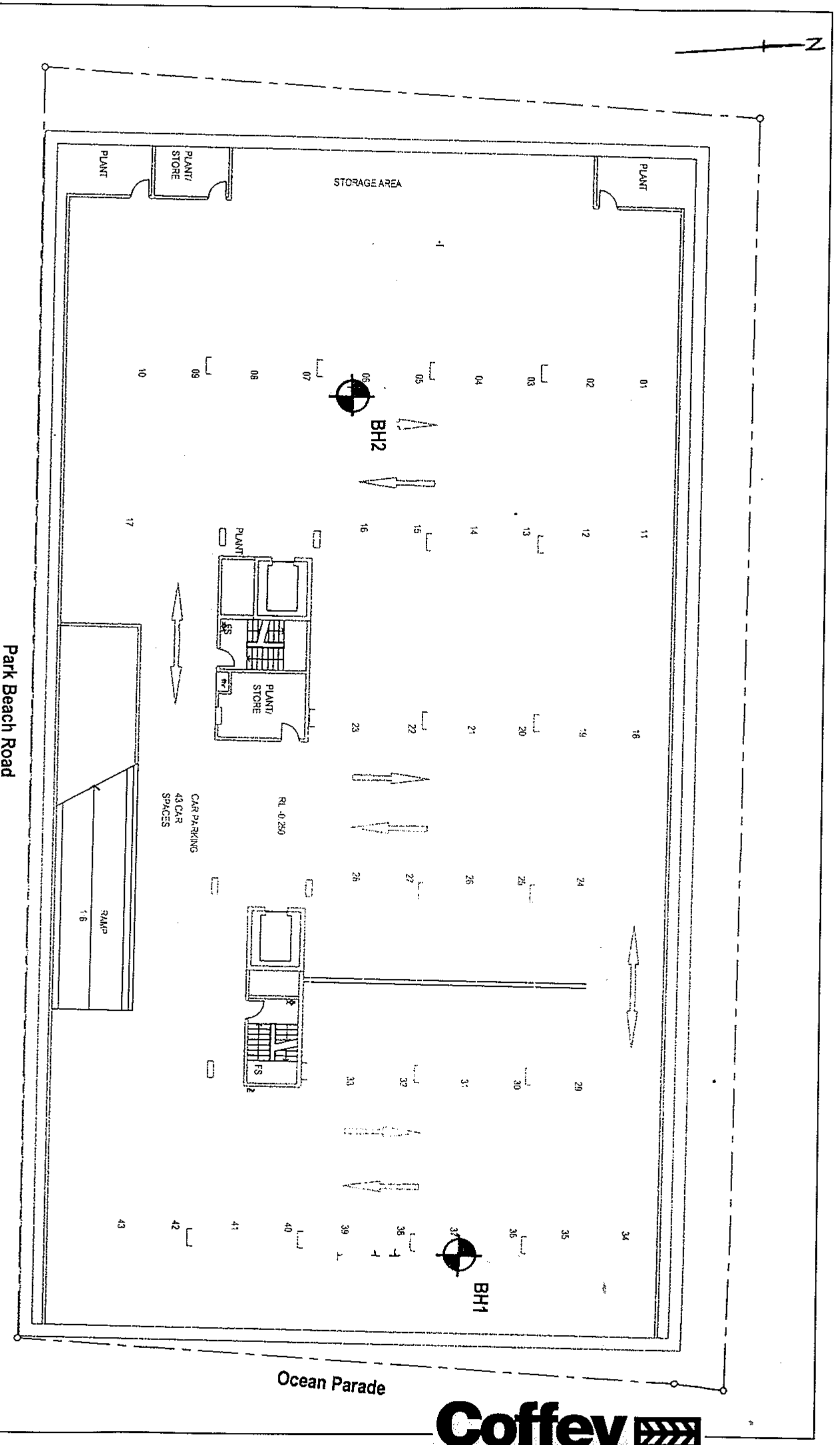
Site assessment identifies actual subsurface conditions only at those points where samples are taken and when they are taken. Data derived from literature and external data source review, sampling and subsequent laboratory testing are interpreted by geologists, engineers or scientists to provide an opinion about overall site conditions, their likely impact on the proposed development and recommended actions. Actual conditions may differ from those inferred to exist, because no professional, no matter how qualified, can reveal what is hidden by earth, rock and time. The actual interface between materials may be far more gradual or abrupt than assumed based on the facts obtained. Nothing can be done to change the actual site conditions which exist, but steps can be taken to reduce the impact of unexpected conditions. For this reason, owners should retain the services of Coffey through the development stage, to identify variances, conduct additional tests if required, and recommend solutions to problems encountered on site.

Your report will only give preliminary recommendations

Your report is based on the assumption that the site conditions as revealed through selective point sampling are indicative of actual conditions throughout an area. This assumption cannot be substantiated until project implementation has commenced and therefore your report recommendations can only be regarded as preliminary. Only Coffey, who prepared the report, is fully familiar with the background information needed to assess whether or not the report's recommendations are valid and whether or not changes should be considered as the project develops. If another party undertakes the implementation of the recommendations of this report there is a risk that the report will be misinterpreted and Coffey cannot be held responsible for such misinterpretation.

Your report is prepared for specific purposes and persons

To avoid misuse of the information contained in your report it is recommended that you confer with Coffey before passing your report on to another party who may not be familiar with the background and the purpose of the report. Your report should not be applied to any project other than that originally specified at the time the report was issued.



LEGEND

Approximate borehole location

Coffey Geosciences Pty Ltd ACN 056 335 516		Geotechnical I Resources I Environmental I Technical I Project Management	
Drawn	DJB	KAS DEVELOPMENTS PTY LTD PROPOSED UNIT DEVELOPMENT 85 OCEAN PARADE, COFFS HARBOUR BOREHOLE LOCATION PLAN	Drawing no: FIGURE 1
Approved	[signature]		
Date	11/3/05		
Scale	1:250		Job no: CH1378/1-AC

Coffey

APPENDIX A

ENGINEERING LOGS

Rock Description

Explanation Sheet (1 of 2)

Coffey

The descriptive terms used by Coffey are given below. They are broadly consistent with Australian Standard AS1726-1993.

DEFINITIONS: Rock substance, defect and mass are defined as follows:

Rock Substance In engineering terms rock substance is any naturally occurring aggregate of minerals and organic material which cannot be disintegrated or remoulded by hand in air or water. Other material is described using soil descriptive terms. Effectively homogonous material, may be isotropic or anisotropic.

Defect Discontinuity or break in the continuity of a substance or substances.

Mass Any body of material which is not effectively homogeneous. It can consist of two or more substances without defects, or one or more substances with one or more defects.

SUBSTANCE DESCRIPTIVE TERMS:

ROCK NAME Simple rock names are used rather than precise geological classification.

PARTICLE SIZE Grain size terms for sandstone are:

Coarse grained	Mainly 0.6mm to 2mm
Medium grained	Mainly 0.2mm to 0.6mm
Fine grained	Mainly 0.06mm (just visible) to 0.2mm

FABRIC Terms for layering or penetrative fabric (eg. bedding, cleavage etc.) are:

Massive	No layering or penetrative fabric.
Indistinct	Layering or fabric just visible. Little effect on properties.
Distinct	Layering or fabric is easily visible. Rock breaks more easily parallel to layering or fabric.

CLASSIFICATION OF WEATHERING PRODUCTS

Term	Abbreviation	Definition
Residual Soil	RS	Soil derived from the weathering of rock; the mass structure and substance fabric are no longer evident; there is a large change in volume but the soil has not been significantly transported.
Extremely Weathered Material	XW	Material is weathered to such an extent that it has soil properties, ie. it either disintegrates or can be remoulded in water. Original rock fabric still visible.
Highly Weathered Rock	HW	Rock strength is changed by weathering. The whole of the rock substance is discoloured, usually by iron staining or bleaching to the extent that the colour of the original rock is not recognisable. Some minerals are decomposed to clay minerals. Porosity may be increased by leaching or may be decreased due to the deposition of minerals in pores.
Moderately Weathered Rock	MW	The whole of the rock substance is discoloured, usually by iron staining or bleaching, to the extent that the colour of the fresh rock is no longer recognisable.
Slightly Weathered Rock	SW	Rock substance affected by weathering to the extent that partial staining or partial discolouration of the rock substance (usually by limonite) has taken place. The colour and texture of the fresh rock is recognisable; strength properties are essentially those of the fresh rock substance.
Fresh Rock	FR	Rock substance unaffected by weathering.

Notes on Weathering:

1. *AS1726 suggests the term "Distinctly Weathered" (DW) to cover the range of substance weathering conditions between XW and SW. For projects where it is not practical to delineate between HW and MW or it is judged that there is no advantage in making such a distinction, DW may be used with the definition given in AS1726.*
2. *Where physical and chemical changes were caused by hot gasses and liquids associated with igneous rocks, the term "altered" may be substituted for "weathering" to give the abbreviations XA, HA, MA, SA and DA.*

ROCK SUBSTANCE STRENGTH TERMS

Term	Abbreviation	Point Load Index, I_s50 (MPa)	Field Guide
Very Low	VL	Less than 0.1	Material crumbles under firm blows with sharp end of pick; can be peeled with a knife; pieces up to 30mm thick can be broken by finger pressure.
Low	L	0.1 to 0.3	Easily scored with a knife; indentations 1mm to 3mm show with firm blows of a pick point; has a dull sound under hammer. Pieces of core 150mm long by 50mm diameter may be broken by hand. Sharp edges of core may be friable and break during handling.
Medium	M	0.3 to 1.0	Readily scored with a knife; a piece of core 150mm long by 50mm diameter can be broken by hand with difficulty.
High	H	1 to 3	A piece of core 150mm long by 50mm can not be broken by hand but can be broken by a pick with a single firm blow; rock rings under hammer.
Very High	VH	3 to 10	Hand specimen breaks after more than one blow of a pick; rock rings under hammer.
Extremely High	EH	More than 10	Specimen requires many blows with geological pick to break; rock rings under hammer.

Notes on Rock Substance Strength:

1. *In anisotropic rocks the field guide to strength applies to the strength perpendicular to the anisotropy. High strength anisotropic rocks may break readily parallel to the planar anisotropy.*
2. *The term "extremely low" is not used as a rock substance strength term. While the term is used in AS1726-1993, the field guide therein makes it clear that materials in that strength range are soils in engineering terms.*
3. *The unconfined compressive strength for isotropic rocks (and anisotropic rocks which fail across the planar anisotropy) is typically 10 to 25 times the point load index (Is50). The ratio may vary for different rock types. Lower strength rocks often have lower ratios than higher strength rocks.*

Explanation Sheet (2 of 2) – Rock Description

Coffey

COMMON DEFECTS IN ROCK MASSES

Term	Definition	Diagram	Map Symbol	Graphic Log (Note 1)
Parting	A surface or crack across which the rock has little or no tensile strength. Parallel or sub parallel to layering (eg bedding) or a planar anisotropy in the rock substance (eg,cleavage). May be open or closed.		20 Bedding 20 Cleavage	(Note 2)
Joint	A surface or crack across which the rock has little or no tensile strength but which is not parallel or sub parallel to layering or planar anisotropy in the rock substance. May be open or closed.		60	(Note 2)
Sheared Zone (Note 3)	Zone of rock substance with roughly parallel near planar, curved or undulating boundaries cut by closely spaced joints, sheared surfaces or other defects. Some of the defects are usually curved and intersect to divide the mass into lenticular or wedge shaped blocks.		35	
Sheared Surface (Note 3)	A near planar, curved or undulating surface which is usually smooth, polished or slickensided.		40	
Crushed Seam (Note 3)	Seam with roughly parallel almost planar boundaries, composed of disoriented, usually angular fragments of the host rock substance which may be more weathered than the host rock. The seam has soil properties.		50	
Infilled Seam	Seam of soil substance usually with distinct roughly parallel boundaries formed by the migration of soil into an open cavity or joint. Infilled seams less than 1mm thick may be described as veneer or coating on joint surface.		65	
Extremely Weathered Seam	Seam of soil substance, often with gradational boundaries. Formed by weathering of the rock substance in place.	Seam	32	

DEFECT SHAPE TERMS

Planar	The defect does not vary in orientation
Curved	The defect has a gradual change in orientation
Undulating	The defect has a wavy surface
Stepped	The defect has one or more well defined steps
Irregular	The defect has many sharp changes of orientation

Note: The assessment of defect shape is partly influenced by the scale of the observation.

ROUGHNESS TERMS

Slickensided	Grooved or striated surface, usually polished
Polished	Shiny smooth surface
Smooth	Smooth to touch. Few or no surface irregularities
Rough	Many small surface irregularities (amplitude generally less than 1mm). Feels like fine to coarse sand paper.
Very Rough	Many large surface irregularities (amplitude generally more than 1mm). Feels like, or coarser than very coarse sand paper.

COATING TERMS

Clean	No visible coating
Stained	No visible coating but surfaces are discoloured
Veneer	A visible coating of soil or mineral, too thin to measure; may be patchy
Coating	A visible coating up to 1mm thick. Thicker soil material is usually described using appropriate defect terms (eg, infilled seam). Thicker rock strength material is usually described as a vein.

BLOCK SHAPE TERMS

Blocky	Approximately equidimensional
Tabular	Thickness much less than length or width
Columnar	Height much greater than cross section

Notes on Defects:

1. Usually borehole logs show the true dip of defects and face sketches and sections the apparent dip.
2. Partings and joints are not usually shown on the graphic log unless considered significent.
3. Sheared zones, sheared surfaces and crushed seams are faults in geological terms.

Soil Description

Explanation Sheet (1 of 2)

Coffey

DEFINITION:

In engineering terms soil includes every type of uncemented or partially cemented inorganic or organic material found in the ground. In practice, if the material can be remoulded or disintegrated by hand in its field condition or in water it is described as a soil.
Other materials are described using rock description terms.

CLASSIFICATION SYMBOL & SOIL NAME

Soils are described in accordance with the Unified Soil Classification (UCS) as shown in the table on Sheet 2.

PARTICLE SIZE DESCRIPTIVE TERMS

NAME	SUBDIVISION	SIZE
Boulders		>200 mm
Cobbles		63 mm to 200 mm
Gravel	coarse	20 mm to 63 mm
	medium	6 mm to 20 mm
	fine	2.36 mm to 6 mm
Sand	coarse	600 μm to 2.36 mm
	medium	200 μm to 600μm
	fine	75 μm to 200 μm

MOISTURE CONDITION

Dry	Looks and feels dry. Cohesive and cemented soils are hard, friable or powdery. Uncemented granular soils run freely through hands.
Moist	Soil feels cool and darkened in colour. Cohesive soils can be moulded. Granular soils tend to cohere.
Wet	As for moist but with free water forming on hands when handled.

CONSISTENCY OF COHESIVE SOILS

TERM	UNDRAINED STRENGTH s_u (kPa)	FIELD GUIDE
Very Soft	<12	A finger can be pushed well into the soil with little effort.
Soft	12 – 25	A finger can be pushed into the soil to about 25mm depth.
Firm	25 – 50	The soil can be indented about 5mm with the thumb, but not penetrated.
Stiff	50 – 100	The surface of the soil can be indented with the thumb, but not penetrated.
Very Stiff	100 – 200	The surface of the soil can be marked, but not indented with thumb pressure.
Hard	>200	The surface of the soil can be marked only with the thumbnail.
Friable	-	Crumbles or powders when scraped by thumbnail.

DENSITY OF GRANULAR SOILS

TERM	DENSITY INDEX (%)
Very loose	Less than 15
Loose	15 – 35
Medium Dense	35 – 65
Dense	65 — 85
Very Dense	Greater than 85

MINOR COMPONENTS

TERM	ASSESSMENT GUIDE	PROPORTION OF MINOR COMPONENT IN:
Trace of	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component.	Coarse grained soils: < 5% Fine grained soils: <15%
With some	Presence easily detected by feel or eye, soil properties little different to general properties of primary component.	Coarse grained soils: 5 - 12% Fine grained soils: 15 - 30%

SOIL STRUCTURE

ZONING		CEMENTING	
Layers	Continuous across exposure or sample.	Weakly cemented	Easily broken up by hand in air or water.
Lenses	Discontinuous layers of lenticular shape.	Moderately cemented	Effort is required to break up the soil by hand in air or water.
Pockets	Irregular inclusions of different material.		

GEOLOGICAL ORIGIN

WEATHERED IN PLACE SOILS

Extremely weathered material	Structure and fabric of parent rock visible.
Residual soil	Structure and fabric of parent rock not visible.

TRANSPORTED SOILS

Aeolian soil	Deposited by wind.
Alluvial soil	Deposited by streams and rivers.
Colluvial soil	Deposited on slopes (transported downslope by gravity).
Fill	Man made deposit. Fill may be significantly more variable between tested locations than naturally occurring soils.
Lacustrine soil	Deposited by lakes.
Marine soil	Deposited in ocean basins, bays, beaches and estuaries.

Explanation Sheet (2 of 2) – Soil Description

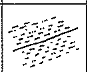
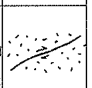
Coffey

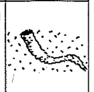
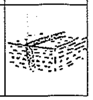
SOIL CLASSIFICATION INCLUDING IDENTIFICATION AND DESCRIPTION

FIELD IDENTIFICATION PROCEDURES (Excluding particles larger than 60 mm and basing fractions on estimated mass)						USC	PRIMARY NAME
COARSE GRAINED SOILS More than 50% of material less than 63 mm is larger than 0.075 mm	(A 0.075 mm particle is about the smallest particle visible to the naked eye)	GRAVELS More than half of coarse fraction is larger than 2.0 mm	CLEAN GRAVELS (Little or no fines)	Wide range in grain size and substantial amounts of all intermediate particle sizes.		GW	GRAVEL
				Predominantly one size or a range of sizes with more intermediate sizes missing.		GP	GRAVEL
			GRAVELS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below)		GM	SILTY GRAVEL
				Plastic fines (for identification procedures see CL below)		GC	CLAYEY GRAVEL
		SANDS More than half of coarse fraction is smaller than 2.0 mm	CLEAN SANDS (Little or no fines)	Wide range in grain sizes and substantial amounts of all intermediate sizes missing		SW	SAND
				Predominantly one size or a range of sizes with some intermediate sizes missing.		SP	SAND
			SANDS WITH FINES (Appreciable amount of fines)	Non-plastic fines (for identification procedures see ML below).		SM	SILTY SAND
				Plastic fines (for identification procedures see CL below).		SC	CLAYEY SAND
FINE GRAINED SOILS More than 50% of material less than 63 mm is smaller than 0.075 mm		IDENTIFICATION PROCEDURES ON FRACTIONS <0.2 mm.					
			DRY STRENGTH	DILATANCY	TOUGHNESS		
		SILTS & CLAYS Liquid limit less than 50	None to Low	Quick to slow	None	ML	SILT
			Medium to High	None	Medium	CL	CLAY
			Low to medium	Slow to very slow	Low	OL	ORGANIC SILT
		SILTS & CLAYS Liquid limit greater than 50	Low to medium	Slow to very slow	Low to medium	MH	SILT
			High	None	High	CH	CLAY
			Medium to high	None	Low to medium	OH	ORGANIC CLAY
HIGHLY ORGANIC SOILS		Readily identified by colour, odour, spongy feel and frequently by fibrous texture.				Pt	PEAT

• Low plasticity – Liquid Limit W_L less than 35%. • Medium plasticity – W_L between 35% and 50%.

COMMON DEFECTS IN SOIL

TERM	DEFINITION	DIAGRAM
PARTING	A surface or crack across which the soil has little or no tensile strength. Parallel or sub parallel to layering (eg bedding). May be open or closed.	
JOINT	A surface or crack across which the soil has little or no tensile strength but which is not parallel or sub parallel to layering. May be open or closed. The term 'fissure' may be used for irregular joints <0.2m in length.	
SHEARED ZONE	Zone in clayey soil with roughly parallel near planar, curved or undulating boundaries containing closely spaced, smooth or slickensided, curved intersecting joints which divide the mass into lenticular or wedge shaped blocks.	
SHEARED SURFACE	A near planar curved or undulating, smooth, polished or slickensided surface in clayey soil. The polished or slickensided surface indicates that movement (in many cases very little) has occurred along the defect	

TERM	DEFINITION	DIAGRAM
SOFTENED ZONE	A zone in clayey soil, usually adjacent to a defect in which the soil has a higher moisture content than elsewhere.	
TUBE	Tubular cavity. May occur singly or as one of a large number of separate or inter-connected tubes. Walls often coated with clay or strengthened by denser packing of grains. May contain organic matter	
TUBE CAST	Roughly cylindrical elongated body of soil different from the soil mass in which it occurs. In some cases the soil which makes up the tube cast is cemented.	
INFILLED SEAM	Sheet or wall like body of soil substance or mass with roughly planar to irregular near parallel boundaries which cuts through a soil mass. Formed by infilling of open joints.	

Form No. GEO5.7. Issue 3. Rev. 2. 20258 / 04-02

Engineering Log - Borehole

Coffey

Borehole No.	BH1
Sheet	1 of 3
Office Job No.:	CH1378/1
Date started:	7.2.2005
Date completed:	7.2.2005
Logged by:	ELC
Checked by:	

Client: *KAS DEVELOPMENTS*
Principal:
Project: *PROPOSED UNIT DEVELOPMENT*
Borehole Location: *REFER TO FIGURE 1*

drill model and mounting: P120 TRUCK | Easting: | slope: -90° | R.L. Surface:
hole diameter: 100 mm | Northing | bearing: | datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	classification symbol	material (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	moisture condition	consistency/density index	pocket penetrometer kPa 100 200 300 400	structure and additional observations
ADV		N					SP	TOPSOIL: Silty Sand, fine to medium grained, dark brown, trace coarse gravel.	D			TOPSOIL / FILL
							SP	SAND: fine to medium grained, yellow.		MD		MARINE SOIL
							SP	SAND: fine to medium grained, black.	M/D	VD		
				U_{50}				Colour change to dark brown.				
				SPT 7,11,9 N*=20		1			M			
			10:10 7/2/05						W			
						2				D		
				SPT 10,6,7 N*=13								
WB		M				3	CH	Sandy CLAY: high plasticity, dark grey				
							SP	SAND: fine to medium grained, dark brown, trace high plasticity fines.	M	VD		
				U_{50}		4						
				SPT 2,17,R N*=R								
						5						
				SPT 17,24,22 N*=46		6						
										MD		
				SPT 3,4,5 N*=9		7						
						8						

method
AS auger screwing*
AD auger drilling*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
B blank bit
V V bit
T TC bit
*bit shown by suffix
e.g. ADT

support
M mud N nil
C casing

penetration 1 2 3 4 — no resistance ranging to refusal

water
10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
V vane shear (kPa)
P pressuremeter
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

BOREHOLE CH1378-1.GPJ COFFEY.GDT 15.03.05

Form GEO 5.3 Issue 3 Rev.2

Engineering Log - Borehole

Coffey

Borehole No.	BH1
Sheet	2 of 3
Office Job No.:	CH1378/1
Date started:	7.2.2005
Date completed:	7.2.2005
Logged by:	ELC
Checked by:	

Client: KAS DEVELOPMENTS
Principal:
Project: PROPOSED UNIT DEVELOPMENT
Borehole Location: REFER TO FIGURE 1

drill model and mounting: P120 TRUCK | Easting: | slope: -90° | R.L. Surface:
hole diameter: 100 mm | Northing | bearing: | datum:

drilling information / **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	moisture condition	consistency/ density index	pocket penetro-meter kPa (100 200 300 400)	structure and additional observations
WB		M						SP	SAND: fine to medium grained, dark brown, trace high plasticity fines. *(continued)*	M	MD		
				SPT 4,5,8 N*=13		9							
									Colour change to grey.				
				SPT 6,9,11 N*=20		10							
						11		CH	Sandy CLAY: high plasticity, grey, sand is fine to medium grained.		S/F		ALLUVIAL SOIL
				U_{50}		12							
				SPT 0,0,0 N*=0		13						x x x	
						14			Colour change to pale grey.		VSt		
				U_{50}		15						x	
						16							

method
AS auger screwing*
AD auger drilling*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
B blank bit
V V bit
T TC bit
*bit shown by suffix
e.g. ADT

support
M mud N nil
C casing
penetration 1 2 3 4 no resistance ranging to refusal
water
10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
V vane shear (kPa)
P pressuremeter
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Form GEO 5.3 Issue 3 Rev.2

BOREHOLE CH1378-1.GPJ COFFEY.GDT 15.03.05

Engineering Log - Borehole

Coffey

Borehole No.	BH1
Sheet	3 of 3
Office Job No.:	CH1378/1
Date started:	7.2.2005
Date completed:	7.2.2005
Logged by:	ELC
Checked by:	

Client: KAS DEVELOPMENTS
Principal:
Project: PROPOSED UNIT DEVELOPMENT
Borehole Location: REFER TO FIGURE 1

drill model and mounting: P120 TRUCK | Easting: | slope: -90° | R.L. Surface:
hole diameter: 100 mm | Northing | bearing: | datum:

drilling information / **material substance**

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	moisture condition	consistency/ density index	pocket penetro-meter kPa (100 200 300 400)	structure and additional observations
WB		M		SPT 4,8,10 N*=18				CH	Sandy CLAY: high plasticity, grey, sand is fine to medium grained. *(continued)*	M	VSt	x x x	
						17		CH	Sandy CLAY / Clayey SAND: clay is high plasticity, sand is fine to medium grained, grey, some fine to medium grained gravel.		St		
				SPT 5,4,5 N*=9		18		CH	Sandy CLAY: high plasticity, grey, trace fine grained gravel.		F/St	x x	
				SPT 0,0,2 N*=2		19			Layers of Gravelly Sandy Clay and Gravelly Clayey Sand				
						20			Colour change to pale grey with pale brown mottle.				RESIDUAL/ALLUVIAL SOIL?
				SPT 0,0,1 N*=1		21			Bands of gravel at 21m and 21.8m depth		VSt	x x x	EXTREMELY WEATHERED SILTSTONE
				SPT 14,5,8 N*=13		22			Band of highly weathered siltstone.				
						23							
				SPT 7,13,18 N*=31		24							

Borehole BH1 terminated at 23.95m

method
AS auger screwing*
AD auger drilling*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
B blank bit
V V bit
T TC bit
*bit shown by suffix
e.g. ADT

support
M mud N nil
C casing
penetration 1 2 3 4 no resistance ranging to refusal
water
10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
V vane shear (kPa)
P pressuremeter
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Form GEO 5.3 Issue 3 Rev.2

BOREHOLE CH1378-1.GPJ COFFEY.GDT 15.03.05

Engineering Log - Borehole

Client:	KAS DEVELOPMENTS	Borehole No.	BH2
Principal:		Sheet	1 of 3
Project:	PROPOSED UNIT DEVELOPMENT	Office Job No.:	CH1378/1
Borehole Location:	REFER TO FIGURE 1	Date started:	7.2.2005
		Date completed:	7.2.2005
		Logged by:	ELC
		Checked by:	[signature]

Coffey

drill model and mounting: P120 TRUCK Easting: slope: -90° R.L. Surface:
hole diameter: 100 mm Northing bearing: datum:

drilling information / **material substance**

method	support	water	notes samples, tests, etc	depth metres	classification symbol	material (soil type: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency/density index	structure and additional observations
ADV	N			0.0		BITUMEN	M/D		BITUMEN SEAL
					GP	FILL: Sandy Gravel, fine to medium grained, grey, sand is fine to medium grained.			FILL
			D		SP	SAND: fine to medium grained, yellow	M	MD	MARINE SOIL
			SPT 1,1,2 N*=3	1		Colour change to dark brown.	W		
		10:00 8/2/05		2				D	
WB	M		SPT 4,7,7 N*=14	3		Thin bands of indurated sand			
					SP	Silty SAND: fine to medium grained, grey.			
					SP	SAND: fine to medium grained, dark brown, slightly indurated		L	
			SPT 1,3,1 N*=4	4					
						Sand indurated from 4.6m to 6.5m	M/W		
				5				VD	
			SPT 30,R,R N*=R	6					
								MD	
			SPT 5,8,7 N*=15	7					
				8					

BOREHOLE CH1378-1.GPJ COFFEY.GDT 15.03.05

Form GEO 5.3 Issue 3 Rev.2

method		support		notes, samples, tests		classification symbols and soil description	consistency/density index	
AS	auger screwing*	M mud	N nil	U_{50}	undisturbed sample 50mm diameter	based on unified classification system	VS	very soft
AD	auger drilling*	C casing		U_{63}	undisturbed sample 63mm diameter		S	soft
RR	roller/tricone	penetration 1 2 3 4	no resistance ranging to refusal	D	disturbed sample		F	firm
W	washbore			N	standard penetration test (SPT)		St	stiff
CT	cable tool	water		N*	SPT - sample recovered	moisture	VSt	very stiff
HA	hand auger	10/1/98 water level on date shown		Nc	SPT with solid cone	D dry	H	hard
DT	diatube	water inflow		V	vane shear (kPa)	M moist	Fb	friable
B	blank bit	water outflow		P	pressuremeter	W wet	VL	very loose
V	V bit			Bs	bulk sample	Wp plastic limit	L	loose
T	TC bit			E	environmental sample	W_L liquid limit	MD	medium dense
*bit shown by suffix				R	refusal		D	dense
e.g.	ADT						VD	very dense

Engineering Log - Borehole

Client:	KAS DEVELOPMENTS	Borehole No.	BH2
Principal:		Sheet	2 of 3
Project:	PROPOSED UNIT DEVELOPMENT	Office Job No.:	CH1378/1
Borehole Location:	REFER TO FIGURE 1	Date started:	7.2.2005
		Date completed:	7.2.2005
		Logged by:	ELC
		Checked by:	[signature]

Coffey

drill model and mounting: P120 TRUCK Easting: slope: -90° R.L. Surface:
hole diameter: 100 mm Northing bearing: datum:

drilling information / **material substance**

method	support	notes samples, tests, etc	depth metres	classification symbol	material (soil type: plasticity or particle characteristics, colour, secondary and minor components)	moisture condition	consistency/density index	structure and additional observations
WB	M		8	SP	SAND: fine to medium grained, dark brown, slightly indurated *(continued)*	M/W	MD	
		SPT 4,8,9 N*=17	9					
		SPT 5,7,12 N*=19	10					
			11		Colour change to grey.			
		SPT 11,10,5 N*=15	12					
				CH	Sandy Silty CLAY: high plasticity, grey, sand is fine to medium grained.		F	ALLUVIAL SOIL
		SPT 0,0,0 N*=0	13					
			14				F/St	
		U_{50}	15					
							F	
			16					

BOREHOLE CH1378-1.GPJ COFFEY.GDT 15.03.05

Form GEO 5.3 Issue 3 Rev.2

method		support		notes, samples, tests		classification symbols and soil description	consistency/density index	
AS	auger screwing*	M mud	N nil	U_{50}	undisturbed sample 50mm diameter	based on unified classification system	VS	very soft
AD	auger drilling*	C casing		U_{63}	undisturbed sample 63mm diameter		S	soft
RR	roller/tricone	penetration 1 2 3 4	no resistance ranging to refusal	D	disturbed sample		F	firm
W	washbore			N	standard penetration test (SPT)		St	stiff
CT	cable tool	water		N*	SPT - sample recovered	moisture	VSt	very stiff
HA	hand auger	10/1/98 water level on date shown		Nc	SPT with solid cone	D dry	H	hard
DT	diatube	water inflow		V	vane shear (kPa)	M moist	Fb	friable
B	blank bit	water outflow		P	pressuremeter	W wet	VL	very loose
V	V bit			Bs	bulk sample	Wp plastic limit	L	loose
T	TC bit			E	environmental sample	W_L liquid limit	MD	medium dense
*bit shown by suffix				R	refusal		D	dense
e.g.	ADT						VD	very dense

Coffey

Engineering Log - Borehole

Borehole No. **BH2**
Sheet 3 of 3
Office Job No.: *CH1378/1*

Client: *KAS DEVELOPMENTS*
Principal:
Project: *PROPOSED UNIT DEVELOPMENT*
Borehole Location: *REFER TO FIGURE 1*

Date started: *7.2.2005*
Date completed: *7.2.2005*
Logged by: *ELC*
Checked by:

drill model and mounting: P120 TRUCK | Easting: | slope: -90° | R.L. Surface:
hole diameter: 100 mm | Northing | bearing: | datum:

method	penetration 1 2 3	support	water	notes samples, tests, etc	RL	depth metres	graphic log	classification symbol	material (soil type: plasticity or particle characteristics, colour, secondary and minor components.)	moisture condition	consistency/ density index	pocket penetro-meter kPa	structure and additional observations
WB		M		SPT 1,0,0 N*=0				CH	**Sandy Silty CLAY:** high plasticity, grey, sand is fine to medium grained. *(continued)*	M/W	F	X X X	
						17		CH	**Sandy CLAY / Clayey SAND:** high plasticity clay, fine to medium grained sand.		F/St		
				SPT 5,8,9 N*=17					Interbedded layers of clay and gravelly sandy clay about 0.5m thick.				
						18							
				SPT 0,0,0 N*=0		19							
						20			Band of gravel about 0.2m thick.				
				SPT 4,10,11 N*=21		21							
								CH	**CLAY:** high plasticity, pale brown / white / brown.	M	VSt	X	EXTREMELY WEATHERED SILTSTONE
				SPT 7,10,12 N*=22		22							
						23							
				SPT 6,10,19 N*=29		24			Borehole BH2 terminated at 23.95m				

method
AS auger screwing*
AD auger drilling*
RR roller/tricone
W washbore
CT cable tool
HA hand auger
DT diatube
B blank bit
V V bit
T TC bit
*bit shown by suffix
e.g. ADT

support
M mud N nil
C casing

penetration
1 2 3 4
no resistance ranging to refusal

water
10/1/98 water level on date shown
water inflow
water outflow

notes, samples, tests
U_{50} undisturbed sample 50mm diameter
U_{63} undisturbed sample 63mm diameter
D disturbed sample
N standard penetration test (SPT)
N* SPT - sample recovered
Nc SPT with solid cone
V vane shear (kPa)
P pressuremeter
Bs bulk sample
E environmental sample
R refusal

classification symbols and soil description
based on unified classification system

moisture
D dry
M moist
W wet
Wp plastic limit
W_L liquid limit

consistency/density index
VS very soft
S soft
F firm
St stiff
VSt very stiff
H hard
Fb friable
VL very loose
L loose
MD medium dense
D dense
VD very dense

Coffey

APPENDIX B

LABORATORY TEST RESULTS

RESULTS OF ACID SULPHATE SOIL ANALYSIS (Page 1 of 1)

6 samples supplied by Coffey on 15th February, 2005 - Lab. Job No. E3304
Analysis requested by David Barker. - Your Project: CH1378/1

Sample Site	Depth (m)	Texture (note 9)	Reduced Inorganic Sulphur (% chromium reducible S) (%Scr) (note 2)	% ANC %CaCO3 (note 11)	NAGP Kg H2SO4/ Tonne soil (note 12)	TAA pH	Total Actual Acidity (TAA) mole / Kg	Lab. Bulk Density tonne DW/m³	Potential Acidity Neutralising Calculation Kg Lime/m³ (based on %Scr)	Actual Acidity Neutralising Calculation Kg Lime/m³ (based on TAA)	Neutralising of Actual and Potential ASS Kg Lime/m³ (see note 10)	COMMENTS RE: Classification as actual or potential acid sulphate soil (ASS) (based on %Scr results)
BH2	0.5-0.7m	Coarse	0.002	2.30	-22.9	9.74	0.000	1.55	0.1	0.0	0.1	NOT Actual or Potential ASS
BH2	1.0-1.45m	Coarse	0.027	0.00	0.8	5.40	0.005	1.59	1.3	0.4	1.7	NOT Actual / YES Potential ASS
BH2	2.5-2.95m	Coarse	0.059	0.00	1.8	5.14	0.006	1.62	3.0	0.4	3.4	NOT Actual / YES Potential ASS
BH2	4.0-4.45m	Coarse	0.169	0.00	5.3	4.74	0.014	1.66	8.8	1.1	9.9	NOT Actual / YES Potential ASS
BH2	5.5-5.65m	Coarse	0.103	0.00	3.2	5.00	0.013	1.47	4.7	0.9	5.7	NOT Actual / YES Potential ASS
BH2	7.0-7.45m	Coarse	0.124	0.00	3.9	5.06	0.004	1.55	6.0	0.3	6.3	NOT Actual / YES Potential ASS
									Refer Note 6 & 7	Refer Note 6 & 7	Refer Note 6, 7 & 10	

NOTE:
1 - All analysis is Dry Weight (DW) - samples dried and ground immediately upon arrival (unless supplied dried and ground)
2 - Samples analysed by POCAS method (ie Peroxide Oxidation - Combined Acidity and Sulphate - Version 3 updated published method) and 'Chromium Reducible Sulphur' technique (Scr - Method 22B)
3 - Methods from Stone, Y, Ahern CR, and Blunden B (1998), Acid Sulphate Soil Manual 1998. ASSMAC, Wollongbar, NSW.
4 - Total carbon and total sulphur determined using a LECO CNS 2000 analyser
5 - Bulk density was determined immediately on arrival to laboratory (insitu bulk density is preferred)
6 - Neutralising Requirement (based on NAGP, chromium reducible sulphur or total sulphur) = Kg H_2SO_4/tonne x bulk density
7 - The neutralising requirement does not include a safety margin for complete neutralisation (a factor of 1.5 is often recommended)
8 - Conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm
9 - For Texture: coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays
10 - Neutralisation Calculation for neutralisation of actual and potential acidity (ie. sum of calculation based on Cis and TAA)
11 - ANC= Acid Neutralising Capacity of the Soil (Detection limit of 0.05% $CaCO_3$ Equivalent)- (this procedure is currently NOT NATA registered)
12 - NAGP= Net Acid Generating Potential= ($31.3*\%S_{cr}$)-(10*%ANC) (From Mulvey, 1993)

(Classification of potential acid sulphate material if: coarse Scr≥0.03%S; medium Scr≥0.06%S; fine Scr≥0.1%S)
(equivalent conversions - 0.03%S = 0.019 mole/ Kg; 0.06%S = 0.037 mole/ Kg; 0.1%S = 0.062 mole/ Kg)
* Projects that disturb >1000 tonnes of ASS soils with ≥0.03% S, a detailed management plan may be required.

Laboratory Accreditation No.: 14960

checked:

Environmental Analysis Laboratory

amdel
www.amdel.com
A subsidiary of The Gribbles Group

NATA Accredited Laboratory Number: 1464

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CERTIFICATE OF ANALYSIS

Contents :
1. Cover Pages (2)
2. Analysis Report Pages
3. QA/QC Appendix
4. Additional Reports - External (if applicable)
5. Chain of Custody (if applicable)

Report No.	:	5E0688
Attention	:	Mr David Barker
Client	:	Coffey Geosciences Pty Ltd 601 Coramba Rd Coffs Harbour NSW 2450
Samples	:	1
Reference/Order	:	CH1378/1/COC#32320
Project	:	CH1378/1
Received Samples	:	22/02/05
Instructions	:	22/02/05
Date Reported	:	01/03/05

PLEASE SEE FOLLOWING PAGES FOR METHOD LISTING AND RESULTS

RESULTS

All samples were analysed as received. This report relates specifically to the samples as received. Results relate to the source material only to the extent that the samples as supplied are truly representative of the sample source. This report replaces any preliminary results issued. Note that for methods indicated with "#", NATA accreditation does not cover the performance of this service. Three significant figures (or 2 for <10PQL) are reported for statistical purposes only. Where "Total" concentrations are reported for organic suites of compounds this is the summation of the individual compounds and the PQL is noted for reporting purposes only. This report has been authorized by the NATA signatories listed in the method descriptions section on the following page.

James McMahon

James McMahon B.Sc.,Ph.D. (Chem.)
Manager - Environmental

amdel

Report No. : 5E0688

Please note: Where samples are collected/submitted over several days, the date on which the last samples were analysed or extracted is reported.
Unless Ferrous Iron is determined on site, the possibility of a ferrous-ferric ratio change may occur.

Method	Description	Extracted	Analysed	Authorised	
E4870	Dissolved Metals by ICP-MS	25/02/05	25/02/05	DLU	093
E4850	Mercury	23/02/05	24/02/05	DLU	093
E2430	Conductivity	22/02/05	22/02/05	PKE	101
E2670	Suspended Solids	24/02/05	24/02/05	PKE	101
E2580	Total Organic Carbon	25/02/05	25/02/05	PKE	101
E2770	TKN	23/02/05	25/02/05	PKE	101
E2330	Ammonia as N	23/02/05	23/02/05	PKE	101
E2450	Total Cyanide	22/02/05	22/02/05	PKE	101
E0080	Organochlorine Pesticides	23/02/05	24/02/05	LHA	095
E0090	Organophosphorus Pesticides	23/02/05	28/02/05	LHA	095
E2790	Turbidity	22/02/05	22/02/05	PKE	101
E2480	Dissolved Oxygen	22/02/05	22/02/05	PKE	101

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NATA Signatory

Initials	Name	Sections/Methods
MCM	James McMahon	093, 094, 095, 101
MNG	Minh Nguyen	094, 095
MFA	Mark Fahmy	094, 095
LHA	Ly Kim Ha	094, 095, 096
DJA	Dilanthi Jayamanne	094
GTO	Greg Towers	094
GPE	Geoff Peterson	095
DLU	Darrel Luck	093
MAV	Merrin Avery	101
DBL	Dianne Blane	101
NCO	Nathan Cooper	101
AGR	Alison Graham	101
PKE	Peter Keyte	101

amdel

Job Number : 5E0688
Client : Coffey Geosciences Pty Ltd
Reference : CH1378/1/COC#32320
Project : CH1378/1

Analyte	Lab No	E179840				
		BH1				
	Sample Id	21.02.05				
	PQL					
E4870 Dissolved Metals in Waters						
Cadmium	0.0001	nd				
Chromium	0.001	nd				
Cobalt	0.001	nd				
Copper	0.001	0.002				
Lead	0.001	nd				
Nickel	0.001	0.004				
Zinc	0.002	0.028				
Arsenic	0.001	nd				
Silver	0.001	nd				
Selenium	0.002	nd				
Thalium	0.001	nd				
Vanadium	0.001	nd				
E4850 Dissolved Mercury in Waters						
Mercury	0.001	nd				

PQL = Practical Quantitation Limit
LNR = Samples Listed not Received
nd = <PQL
-- = Not Applicable

Soils : mg/kg (ppm) dry weight unless otherwise specified
Waters : mg/L (ppm) unless otherwise specified in Method Header
Leachates : mg/L (ppm) in leachate unless otherwise specified in Method Header

Refer to Amdel standard laboratory qualifier codes for comments.

amdel

Job Number : 5E0688
Client : Coffey Geosciences Pty Ltd
Reference : CH1378/1/COC#32320
Project : CH1378/1

Analyte	Lab No	E179840				
		BH1				
	Sample Id	21.02.05				
	PQL					
E2430 Conductivity (uS/cm at 25.0 C)						
Electrical Conductivity	5	1400				
E2670 Suspended Solids in Water						
Suspended Solids	1	370				
E2580 TOC in Water						
TOC	2	F 21				
E2770 Kjeldahl Nitrogen in Water						
Kjeldahl Nitrogen	0.1	1.2				
E2330 Ammonia as N in Water						
Ammonia as N	0.01	0.01				
E2450 Total Cyanide in Water						
Total Cyanide	0.005	nd				
E2790 Turbidity in Water (NTU)						
Turbidity	0.1	95				
E2480 Dissolved Oyxgen						
Dissolved Oxygen	0.1	4.0				

PQL = Practical Quantitation Limit
LNR = Samples Listed not Received
nd = <PQL
-- = Not Applicable

Soils : mg/kg (ppm) dry weight unless otherwise specified
Waters : mg/L (ppm) unless otherwise specified in Method Header
Leachates : mg/L (ppm) in leachate unless otherwise specified in Method Header

Refer to Amdel standard laboratory qualifier codes for comments.

amdel

Job Number : 5E0688
Client : Coffey Geosciences Pty Ltd
Reference : CH1378/1/COC#32320
Project : CH1378/1

Analyte	Lab No	E179840				
		BH1				
	Sample Id	21.02.05				
	PQL					
E0080 OC Pesticides in Water (ug/L)						
HCB	1	nd				
a-BHC	1	nd				
g-BHC	1	nd				
Heptachlor	1	nd				
Aldrin	1	nd				
b-BHC	1	nd				
d-BHC	1	nd				
Oxychlordane	1	nd				
Heptachlor epoxide	1	nd				
Endosulfan 1	1	nd				
Chlordane-Trans	1	nd				
Chlordane-Cis	1	nd				
trans-Nonachlor	1	nd				
DDE	1	nd				
Dieldrin	1	nd				
Endrin	1	nd				
DDD	1	nd				
Endosulfan 2	1	nd				
DDT	1	nd				
Endosulfan sulfate	1	nd				
Methoxychlor	1	nd				
2.4.5.6-TCMX-SURROGATE	1	92%				

PQL = Practical Quantitation Limit
LNR = Samples Listed not Received
nd = < PQL
-- = Not Applicable

Soils : mg/kg (ppm) dry weight unless otherwise specified
Waters : mg/L (ppm) unless otherwise specified in Method Header
Leachates : mg/L (ppm) in leachate unless otherwise specified in Method Header

Refer to Amdel standard laboratory qualifier codes for comments.

amdel

Job Number : 5E0688
Client : Coffey Geosciences Pty Ltd
Reference : CH1378/1/COC#32320
Project : CH1378/1

Analyte	Lab No	E179840				
		BH1				
	Sample Id	21.02.05				
	PQL					
E0090 OP Pesticides in Water (ug/L)						
Dichlorvos	10	nd				
Mevinphos	10	nd				
Ethoprop	10	nd				
Phorate	10	nd				
Demeton-s-methyl	10	nd				
Diazinon	10	nd				
Disulfoton	10	nd				
Ronnel	10	nd				
Chlorpyrifos methyl	10	nd				
Chlorpyrifos	10	nd				
Merphos	10	nd				
Parathion methyl	10	nd				
Fenthion	10	nd				
Malathion	10	nd				
Fenitrothion	10	nd				
Prothiofos	10	nd				
Stirophos	10	nd				
Ethion	10	nd				
Bolstar	10	nd				
Fensulfothion	10	nd				
Azinphos methyl	10	nd				
Coumaphos	10	nd				
2-nitro-m-xylene-SURROGATE	1	102%				

PQL = Practical Quantitation Limit
LNR = Samples Listed not Received
nd = < PQL
-- = Not Applicable

Soils : mg/kg (ppm) dry weight unless otherwise specified
Waters : mg/L (ppm) unless otherwise specified in Method Header
Leachates : mg/L (ppm) in leachate unless otherwise specified in Method Header

Refer to Amdel standard laboratory qualifier codes for comments.

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AMDEL INTERNAL QUALITY ASSURANCE REVIEW.

Job No. 5E0688

General

1. Laboratory QA/QC including Method Blanks, Duplicates, Matrix Spikes, Laboratory Control Samples or CRM's are included in this QA/QC appendix. (Where applicable)
2. Inter-Laboratory proficiency trial results are available upon request.
3. PQLs are matrix dependent and are increased accordingly where sample extracts are diluted due to interferences.
4. Results are uncorrected for matrix spike or surrogate recoveries.
5. Where 3 and 2 significant figures are reported for > 10x PQL and < 10x PQL respectively, the last figure is uncertain and is provided for statistical purposes only.
6. Samples duplicated or spiked are from this job only and are identified in the following QA/QC report.
7. SVOC analyses on waters are performed on homogenized, unfiltered samples, unless noted otherwise.

Maximum Holding Times for Soils, Sediments and Waters

Parameter	Holding Times
Soils	
Volatile and Semi-Volatile Organic Analysis.	Extracted in 14 days, analysed within 40 days.
Metals	Extracted and analysed within 28 days-6 months.
Inorganics*	Extracted and analysed within 7-28 days.
TCLPs*	Extracted and analysed within 14 days, (Zero Headspace-TCLP 7 days).
Waters	
Volatile Organic Analysis	Analysed within 7 days (USEPA requires 14 days).
Semi-Volatile Organic Analysis	Extracted in 7 days, analysed within 40 days.
Inorganics*	Analysed within 24 hrs-28 days.
Metals (dissolved metals should be supplied field filtered)	Prepared and analysed within 28 days.

* Please refer to 'Preservation Information Chart for Soils, Sediments & Waters' for further information. (ISFORM.098). Holding times may be extended with the use of preservation bottles and/or freezing samples. Holding times can be calculated from dates reported in the body of the report. Tests clearly exceeding holding times will be noted when sufficient information is provided.
Reference: USEPA SW846 and AMDEL SPM-01 (incorporating NEPM Guidelines).

Chain of Custody and Sample Integrity	Yes/NO/NA
Chain of Custody / instructions received with samples	Yes
Custody seals were received intact, if used	NA
Samples were received chilled and in good condition	Yes
Samples received appropriately preserved for all tests	Yes
VOC/SVOC samples were received in teflon lined containers	Yes
Samples received with Zero Headspace	Yes
Chain of Custody completed and attached (if applicable)	Yes

Chromatography Calibration/Acceptence Criteria (if applicable)

Retention time window meets acceptance criteria (+/-2%)	Yes
Reference standard meets acceptance criteria (+/-10%)	Yes
Recalibration standard meets acceptance criteria (+/-15%)	Yes
Internal standard recovery acceptable.	Yes

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AMDEL INTERNAL QUALITY ASSURANCE REVIEW Cont..

Amdel QA/QC Compliance Assessment

	Compliance
Surrogates performed on all appropriate GC analyses and meet acceptance limits (70% - 130% recovery*).	Please see body of report
Matrix Spikes performed once per process batch and at least 1 in 20 samples (Results meet acceptance limits - 70% - 130% recovery* or 80% - 120% recovery* for inorganics in water.)	Please see body of report
Laboratory Control samples performed once per process batch and at least 1 in 20 samples (Results meet acceptance limits - 70% - 130% recovery* in soil or 70%-130%/90-110% recovery* for waters.)	Yes
Laboratory Duplicate samples performed once per process batch and at least 1 in 10 samples	Yes
Laboratory duplicates meet acceptance criteria < 4 PQL - +/- 2 PQL 4-10 PQL - 25-50 or 50% RPD > 10 PQL - 10-30 or 30% RPD	Please see body of report
Method Blanks performed once per process batch and at least 1 in 20 samples (Results not detected at the PQL).	Yes

N/A = Not Applicable.

* Phenols 50% - 130% recovery
* SVOCs 60% - 130% recovery
* Phenoxy Acid Herbicides 60% - 140% recovery

QA/QC Appendix

Please refer to the following pages for the QA/QC data.
For further information on samples or non-conformance in QC protocols please see notations in the body of the report plus comments on the following page.

Additional Comments

James McMahon

James McMahon B.Sc.,Ph.D. (Chem.)
Manager - Environmental

AMDEL STANDARD LABORATORY QUALIFIER CODES.

Job NO. 5E0688

Qualifier Codes	Description
*	PQLs are raised due to matrix interference.
@	PQLs are raised due to insufficient sample provided for analysis.
\$	The mass imbalance indicates the presence of other ions not measured as part of this procedure.
nd	< PQL
--	Not applicable
LNR	The sample was listed on the COC, but not received.
IS	Insufficient sample was supplied to conduct this analysis.
AN	The analysis indicates the presences of an analyte that has been 'tentatively' identified, and the associated numerical value represents it's approximate concentration.
A	Sample results are reported on an 'as received' basis (not moisture corrected).
B	The sample was not received in a suitable timeframe to allow completion within the recommended holding time.
C	This sample was received with headspace.
D	This sample was received with the incorrect preservation for this analysis.
E	The raw data indicates the absence of 0.055g of Copper Sulphate in the sample.
F	This sample contained significant amounts of solids and was therefore analysed by settling and decanting the aqueous phase to avoid including the solid in the analysis portion.
G	This test was performed outside the recommended holding time.
H	This sample contained significant material > 5mm which was removed prior to analysis.
ISD	Insufficient sample was supplied to conduct duplicate analyses.
ISM	Insufficient sample was supplied to conduct matrix spike analyses.
W	The spike recovery is outside of the recommended acceptance criteria. An acceptable recovery was obtained for the laboratory control sample indicating a sample matrix interference.
J	The duplicate %RPD is outside the recommended acceptance criteria. Further analysis indicates sample heterogeneity as the cause.
K	The matrix spike concentration is less than five times the background concentration in the sample, and therfore the spike recovery can not be determined.
L	The surrogate recovery is outside of the recommended acceptance criteria, due to matrix interference.
M	The surrogate recovery is outside of the recommended acceptance criteria. Insufficent sample remains to perform re-analysis.
N	Results are expressed in mg/L (ppm) due to the high concentration of the analyte.
O	The results reported are 'recoverable organics' for this fraction, as the chromatogram and peak shape indicates the presence of a significant concentration of polar compounds.
P	The concentration reported is mainly due to a single peak.
Q	This samples contains volatile halogenated oxygenated or other compounds that are included and quantitated as part of TPH C6-9.
R	Theoretically the total result should be greater or equal to the dissolved concentration. However the difference reported is within the uncertainty of the individual tests.
S	The mass imbalance was equal to or less than 0.2 milli-equivalents.
T	During Kjeldahl digestion, nitrate (> 10mg/L) can oxidise ammonia resulting in a negative TKN interference, which may have occurred for this sample.
U	Theoretically the TKN result should be greater or equal to ammonia concentration. However the difference reported is within the uncertainty of the individual tests.
V	This sample contained significant amounts of sediment which was included in the analysis portion as requested.
SUR	Surrogate recoveries could not be determined due to the dilution required to quantify the analyte.

Job Number : 5E0688

QAQC : Laboratory Control Sample(s)

Analyte	Level	Level Detected			Recovery Details		
		Result1	Result2	Result3	Rec 1 (%)	Rec 2 (%)	Rec 3 (%)
E4870 Dissolved Metals in Waters							
Cadmium	0.1000	0.10			103%		
Chromium	0.100	0.109			109%		
Cobalt	0.100	0.104			104%		
Copper	0.100	0.108			108%		
Lead	0.100	0.107			107%		
Nickel	0.100	0.108			108%		
Zinc	0.100	0.109			109%		
Arsenic	0.100	0.108			108%		
Silver	0.050	0.050			100%		
Selenium	0.100	0.107			107%		
Thalium	0.100	0.091			91%		
Vanadium	0.100	0.103			103%		
E4850 Dissolved Mercury in Waters							
Mercury	0.010	0.010			100%		

PQL = Practical Quantitation Limit
-- = Not Applicable
nd = < PQL

(S) Soils : mg/kg (ppm) dry weight
(W) Waters : mg/L (ppm) unless otherwise specified

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Job Number : 5E0688

QAQC : Method Blank(s)

ANALYTE	Sample ID PQL	Blank1	Blank2	Blank3	Blank4	Blank5
E4870 Dissolved Metals in Waters						
Cadmium	0.0001	nd				
Chromium	0.001	nd				
Cobalt	0.001	nd				
Copper	0.001	nd				
Lead	0.001	nd				
Nickel	0.001	nd				
Zinc	0.002	nd				
Arsenic	0.001	nd				
Silver	0.001	nd				
Selenium	0.002	nd				
Thalium	0.001	nd				
Vanadium	0.001	nd				
E4850 Dissolved Mercury in Waters						
Mercury	0.001	nd				

PQL = Practical Quantitation Limit
nd = <PQL
-- = Not Applicable

(S) Soils : mg/kg (ppm) dry weight
(W) Waters : mg/L (ppm) unless otherwise specified

amdel

Job Number : 5E0688

QAQC : Laboratory Control Sample(s)

Analyte	Level	Level Detected			Recovery Details		
		Result1	Result2	Result3	Rec 1 (%)	Rec 2 (%)	Rec 3 (%)
E2430 Conductivity (uS/cm at 25.0 C)							
Electrical Conductivity	303	310	310		103%	102%	
E2670 Suspended Solids in Water							
Suspended Solids	75	70			93%		
E2580 TOC in Water							
TOC	100	110			109%		
E2770 Kjeldahl Nitrogen in Water							
Kjeldahl Nitrogen	1	1.0			94%		
E2330 Ammonia as N in Water							
Ammonia as N	1.0	1.01	1.01		101%	101%	
E2450 Total Cyanide in Water							
Total Cyanide	0.10	0.107	0.107		107%	107%	
E2790 Turbidity in Water (NTU)							
Turbidity	20	20			100%		

PQL = Practical Quantitation Limit
-- = Not Applicable
nd = <PQL

(S) Soils : mg/kg (ppm) dry weight
(W) Waters : mg/L (ppm) unless otherwise specified

amdel

Job Number : 5E0688

QAQC : Method Blank(s)

ANALYTE	Sample ID PQL	Blank1	Blank2	Blank3	Blank4	Blank5
E2430 Conductivity (uS/cm at 25.0 C)						
Electrical Conductivity	5	nd				
E2670 Suspended Solids in Water						
Suspended Solids	1	nd				
E2580 TOC in Water						
TOC	2	nd				
E2770 Kjeldahl Nitrogen in Water						
Kjeldahl Nitrogen	0.1	nd				
E2330 Ammonia as N in Water						
Ammonia as N	0.01	nd				
E2450 Total Cyanide in Water						
Total Cyanide	0.005	nd				
E2790 Turbidity in Water (NTU)						
Turbidity	0.1	nd				

PQL = Practical Quantitation Limit
nd = <PQL
-- = Not Applicable

(S) Soils : mg/kg (ppm) dry weight
(W) Waters : mg/L (ppm) unless otherwise specified

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Job Number : 5E0688

QAQC : Laboratory Control Sample(s)

Analyte	Level	Level Detected			Recovery Details		
		Result1	Result2	Result3	Rec 1 (%)	Rec 2 (%)	Rec 3 (%)
E0080 OC Pesticides in Water (ug/L)							
HCB	10	10			97%		
a-BHC	10	10			104%		
g-BHC	10	10			103%		
Heptachlor	10	10			98%		
Aldrin	10	10			98%		
b-BHC	10	9			93%		
d-BHC	10	10			105%		
Oxychlordane	10	10			96%		
Heptachlor epoxide	10	10			97%		
Endosulfan 1	10	10			97%		
Chlordane-Trans	10	10			99%		
Chlordane-Cis	10	10			97%		
trans-Nonachlor	10	10			99%		
DDE	20	20			98%		
Dieldrin	10	10			100%		
Endrin	10	10			100%		
DDD	20	20			98%		
Endosulfan 2	10	10			97%		
DDT	20	21			103%		
Endosulfan sulfate	10	10			96%		
Methoxychlor	10	13			125%		

PQL = Practical Quantitation Limit
-- = Not Applicable
nd = <PQL

(S) Soils : mg/kg (ppm) dry weight
(W) Waters : mg/L (ppm) unless otherwise specified

amdel

Job Number : 5E0688

QAQC : Method Blank(s)

ANALYTE	Sample ID PQL	Blank1	Blank2	Blank3	Blank4	Blank5
E0080 OC Pesticides in Water (ug/L)						
HCB	1	nd				
a-BHC	1	nd				
g-BHC	1	nd				
Heptachlor	1	nd				
Aldrin	1	nd				
b-BHC	1	nd				
d-BHC	1	nd				
Oxychlordane	1	nd				
Heptachlor epoxide	1	nd				
Endosulfan 1	1	nd				
Chlordane-Trans	1	nd				
Chlordane-Cis	1	nd				
trans-Nonachlor	1	nd				
DDE	1	nd				
Dieldrin	1	nd				
Endrin	1	nd				
DDD	1	nd				
Endosulfan 2	1	nd				
DDT	1	nd				
Endosulfan sulfate	1	nd				
Methoxychlor	1	nd				

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-- = Not Applicable

(S) Soils : mg/kg (ppm) dry weight
(W) Waters : mg/L (ppm) unless otherwise specified

amdel

Job Number : 5E0688

QAQC : Laboratory Control Sample(s)

Analyte	Level	Level Detected Result1	Result2	Result3	Recovery Details Rec 1 (%)	Rec 2 (%)	Rec 3 (%)
E0090 OP Pesticides in Water (ug/L)							
Dichlorvos	100	100			106%		
Mevinphos	100	100			99%		
Ethoprop	100	100			96%		
Phorate	100	100			95%		
Demeton-s-methyl	100	100			96%		
Diazinon	100	100			95%		
Disulfoton	100	100			97%		
Ronnel	100	100			95%		
Chlorpyrifos methyl	100	100			98%		
Chlorpyrifos	100	100			96%		
Merphos							
Parathion methyl	100	100			95%		
Fenthion	100	100			95%		
Malathion	100	100			95%		
Fenitrothion	100	100			96%		
Prothiofos	100	90			92%		
Stirophos	100	90			85%		
Ethion	100	100			96%		
Bolstar	100	100			96%		
Fensulfothion	100	100			96%		
Azinphos methyl	100	80			84%		
Coumaphos	100	100			95%		

PQL = Practical Quantitation Limit
-- = Not Applicable
nd = <PQL

(S) Soils : mg/kg (ppm) dry weight
(W) Waters : mg/L (ppm) unless otherwise specified

amdel

Job Number : 5E0688

QAQC : Method Blank(s)

ANALYTE	Sample ID PQL	Blank1	Blank2	Blank3	Blank4	Blank5
E0090 OP Pesticides in Water (ug/L)						
Dichlorvos	10	nd				
Mevinphos	10	nd				
Ethoprop	10	nd				
Phorate	10	nd				
Demeton-s-methyl	10	nd				
Diazinon	10	nd				
Disulfoton	10	nd				
Ronnel	10	nd				
Chlorpyrifos methyl	10	nd				
Chlorpyrifos	10	nd				
Merphos	10	nd				
Parathion methyl	10	nd				
Fenthion	10	nd				
Malathion	10	nd				
Fenitrothion	10	nd				
Prothiofos	10	nd				
Stirophos	10	nd				
Ethion	10	nd				
Bolstar	10	nd				
Fensulfothion	10	nd				
Azinphos methyl	10	nd				
Coumaphos	10	nd				

PQL = Practical Quantitation Limit
nd = <PQL
-- = Not Applicable

(S) Soils : mg/kg (ppm) dry weight
(W) Waters : mg/L (ppm) unless otherwise specified

Coffey

Chain of Custody

No: 32320

Despatch to: AMDEL, 99 MITCHELL RD, CARDIFF NSW 2285

Job No: Sheet 1 of 1

Sampled by: ELC

Consigning Officer: ELC

Project Manager: DAVID BARKER

Date Dispatched: 21/2/05

Courier Service: AAE

Consignment Note No:

Received by: Liz Pitstock – Amdel Ltd

Date: 22/2/05 Time: 9:30 AM

23.2°C

Date Sampled: 21/2/05

Analyses Required: Metals 13, MAHs + BTEX, TPHs, PAHs, TOC, TKN, Ammonia, OCP/OPP

Container Type and Preservative: AMBER GLASS, GLASS VIAL, PLASTIC RED/ filtered, PLASTIC GREEN/ 500ml

Comments: 13 Metals = Cd, Co, Cr, Cu, Pb, Hg, Ni, Zn, As, Silver, Selenium, Thallium, Vanadium

RECEIVED 22 FEB 2005 5E0618

RECEIVED 07 MAR 2005 5E0688A

Special Laboratory Instructions:

Detection Limits: NORMAL

Turnaround Required: ASAP

JOB NUMBER MUST BE REFERENCED ON ALL SUBSEQUENT PAGES

04/03/2005 11:50 0265515194

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NATA Accredited Laboratory Number: 1464

The tests, calibrations or measurements covered by this document have been performed in accordance with NATA requirements which include the requirements of ISO/IEC 17025 and are traceable to Australian national standards of measurement. This document shall not be reproduced, except in full.

ANALYTICAL SERVICES DIVISION
ABN 30 008 127 802
Correspondence to:
PO Box 331
HUNTER REGIONAL MAIL
CENTRE NSW 2310

99 Mitchell Rd
CARDIFF NSW 2285
Telephone: (02) 4902 4800
Facsimile: (02) 4902 4899

CERTIFICATE OF ANALYSIS

Contents :
1. Cover Pages (2)
2. Analysis Report Pages
3. QA/QC Appendix
4. Additional Reports - External (if applicable)
5. Chain of Custody (if applicable)

Report No.	:	5E0688A
Attention	:	Mr David Barker
Client	:	Coffey Geosciences Pty Ltd 601 Coramba Rd Coffs Harbour NSW 2450
Samples	:	1
Reference/Order	:	CH1378/1/COC#32320
Project	:	CH1378/1
Received Samples	:	22/02/05 Instructions : 07/03/05
Date Reported	:	14/03/05

PLEASE SEE FOLLOWING PAGES FOR METHOD LISTING AND RESULTS

RESULTS

All samples were analysed as received. This report relates specifically to the samples as received. Results relate to the source material only to the extent that the samples as supplied are truly representative of the sample source. This report replaces any preliminary results issued. Note that for methods indicated with "#", NATA accreditation does not cover the performance of this service. Three significant figures (or 2 for < 10PQL) are reported for statistical purposes only. Where "Total" concentrations are reported for organic suites of compounds this is the summation of the individual compounds and the PQL is noted for reporting purposes only. This report has been authorized by the NATA signatories listed in the method descriptions section on the following page.

James McMahon

James McMahon B.Sc.,Ph.D. (Chem.)
Manager - Environmental

amdel

Report No. : 5E0688A

Please note: Where samples are collected/submitted over several days, the date on which the last samples were analysed or extracted is reported.
Unless Ferrous Iron is determined on site, the possibility of a ferrous-ferric ratio change may occur.

Method	Description	Extracted	Analysed	Authorised
E2380	Chloride	09/03/05	09/03/05	PKE 101
E2720	Sulphate	09/03/05	09/03/05	PKE 101
E2435	Resistivity (Ohm.cm)	10/03/05	10/03/05	PKE 101

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NATA Signatory

Initials	Name	Sections/Methods
MCM	James McMahon	093, 094, 095, 101
MNG	Minh Nguyen	094, 095
MFA	Mark Fahmy	094, 095
LHA	Ly Kim Ha	094, 095, 096
DJA	Dilanthi Jayamanne	094
GTO	Greg Towers	094
GPE	Geoff Peterson	095
DLU	Darrel Luck	093
MAV	Merrin Avery	101
DBL	Dianne Blane	101
NCO	Nathan Cooper	101
AGR	Alison Graham	101
PKE	Peter Keyte	101

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Job Number : 5E0688A
Client : Coffey Geosciences Pty Ltd
Reference : CH1378/1/COC#32320
Project : CH1378/1

	Lab No	E179840				
		BH1				
Analyte.	Sample Id	21.02.05				
	PQL					
E2380 Chloride in Water						
Chloride	1	440				
E2720 Sulphate in Water						
Sulphate	1	10				
E2435 Resistivity						
Resistivity	1	700				

PQL = Practical Quantitation Limit
LNR = Samples Listed not Received
nd = < PQL
-- = Not Applicable

Soils : mg/kg (ppm) dry weight unless otherwise specified
Waters : mg/L (ppm) unless otherwise specified in Method Header
Leachates : mg/L (ppm) in leachate unless otherwise specified in Method Header

Refer to Amdel standard laboratory qualifier codes for comments.

amdel

AMDEL INTERNAL QUALITY ASSURANCE REVIEW.

Job No. 5E0688A

General

1. Laboratory QA/QC including Method Blanks, Duplicates, Matrix Spikes, Laboratory Control Samples or CRM's are included in this QA/QC appendix. (Where applicable)
2. Inter-Laboratory proficiency trial results are available upon request.
3. PQLs are matrix dependent and are increased accordingly where sample extracts are diluted due to interferences.
4. Results are uncorrected for matrix spike or surrogate recoveries.
5. Where 3 and 2 significant figures are reported for > 10x PQL and < 10x PQL respectively, the last figure is uncertain and is provided for statistical purposes only.
6. Samples duplicated or spiked are from this job only and are identified in the following QA/QC report.
7. SVOC analyses on waters are performed on homogenized, unfiltered samples, unless noted otherwise.

Maximum Holding Times for Soils, Sediments and Waters

Parameter	Holding Times
Soils	
Volatile and Semi-Volatile Organic Analysis.	Extracted in 14 days, analysed within 40 days.
Metals	Extracted and analysed within 28 days-6 months.
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Metals (dissolved metals should be supplied field filtered)	Prepared and analysed within 28 days.

* Please refer to 'Preservation Information Chart for Soils, Sediments & Waters' for further information. (ISFORM.098). Holding times may be extended with the use of preservation bottles and/or freezing samples. Holding times can be calculated from dates reported in the body of the report. Tests clearly exceeding holding times will be noted when sufficient information is provided.
Reference: USEPA SW846 and AMDEL SPM-01 (incorporating NEPM Guidelines).

Chain of Custody and Sample Integrity	Yes/NO/NA
Chain of Custody / instructions received with samples	Yes
Custody seals were received intact, if used	NA
Samples were received chilled and in good condition	Yes
Samples received appropriately preserved for all tests	Yes
VOC/SVOC samples were received in teflon lined containers	NA
Samples received with Zero Headspace	NA
Chain of Custody completed and attached (if applicable)	Yes

Chromatography Calibration/Acceptence Criteria (if applicable)

Retention time window meets acceptance criteria (+/-2%)	No
Reference standard meets acceptance criteria (+/-10%)	NA
Recalibration standard meets acceptance criteria (+/-15%)	NA
Internal standard recovery acceptable.	NA

amdel

AMDEL INTERNAL QUALITY ASSURANCE REVIEW Cont..

Amdel QA/QC Compliance Assessment

	Compliance
Surrogates performed on all appropriate GC analyses and meet acceptance limits (70% - 130% recovery*).	Please see body of report
Matrix Spikes performed once per process batch and at least 1 in 20 samples (Results meet acceptance limits - 70% - 130% recovery* or 80% - 120% recovery* for inorganics in water.)	Please see body of report
Laboratory Control samples performed once per process batch and at least 1 in 20 samples (Results meet acceptance limits - 70% - 130% recovery* in soil or 70%-130%/90-110% recovery* for waters.)	Yes
Laboratory Duplicate samples performed once per process batch and at least 1 in 10 samples	Yes
Laboratory duplicates meet acceptance criteria < 4 PQL - +/- 2 PQL 4-10 PQL - 25-50 or 50% RPD > 10 PQL - 10-30 or 30% RPD	Please see body of report
Method Blanks performed once per process batch and at least 1 in 20 samples (Results not detected at the PQL).	Yes

N/A = Not Applicable.

* Phenols 50% - 130% recovery
* SVOCs 60% - 130% recovery
* Phenoxy Acid Herbicides 60% - 140% recovery

QA/QC Appendix

Please refer to the following pages for the QA/QC data.
For further information on samples or non-conformance in QC protocols please see notations in the body of the report plus comments on the following page.

Additional Comments

James McMahon

James McMahon B.Sc.,Ph.D. (Chem.)
Manager - Environmental

amdel

AMDEL STANDARD LABORATORY QUALIFIER CODES.

Job NO. 5E0688A

Qualifier Codes	Description
*	PQLs are raised due to matrix interference.
@	PQLs are raised due to insufficient sample provided for analysis.
$	The mass imbalance indicates the presence of other ions not measured as part of this procedure.
nd	<PQL
--	Not applicable
LNR	The sample was listed on the COC, but not received.
IS	Insufficient sample was supplied to conduct this analysis.
AN	The analysis indicates the presences of an analyte that has been 'tentatively' identified, and the associated numerical value represents it's approximate concentration.
A	Sample results are reported on an 'as received' basis (not moisture corrected).
B	The sample was not received in a suitable timeframe to allow completion within the recommended holding time.
C	This sample was received with headspace.
D	This sample was received with the incorrect preservation for this analysis.
E	The raw data indicates the absence of 0.055g of Copper Sulphate in the sample.
F	This sample contained significant amounts of solids and was therefore analysed by settling and decanting the aqueous phase to avoid including the solid in the analysis portion.
G	This test was performed outside the recommended holding time.
H	This sample contained significant material >5mm which was removed prior to analysis.
ISD	Insufficient sample was supplied to conduct duplicate analyses.
ISM	Insufficient sample was supplied to conduct matrix spike analyses.
W	The spike recovery is outside of the recommended acceptance criteria. An acceptable recovery was obtained for the laboratory control sample indicating a sample matrix interference.
J	The duplicate %RPD is outside the recommended acceptance criteria. Further analysis indicates sample heterogeneity as the cause.
K	The matrix spike concentration is less than five times the background concentration in the sample, and therfore the spike recovery can not be determined.
L	The surrogate recovery is outside of the recommended acceptance criteria, due to matrix interference.
M	The surrogate recovery is outside of the recommended acceptance criteria. Insuffcient sample remains to perform re-analysis.
N	Results are expressed in mg/L (ppm) due to the high concentration of the analyte.
O	The results reported are 'recoverable organics' for this fraction, as the chromatogram and peak shape indicates the presence of a significant concentration of polar compounds.
P	The concentration reported is mainly due to a single peak.
Q	This samples contains volatile halogenated oxygenated or other compounds that are included and quantitated as part of TPH C6-9.
R	Theoretically the total result should be greater or equal to the dissolved concentration. However the difference reported is within the uncertainty of the individual tests.
S	The mass imbalance was equal to or less than 0.2 milli-equivalents.
T	During Kjeldahl digestion, nitrate (>10mg/L) can oxidise ammonia resulting in a negative TKN interference, which may have occurred for this sample.
U	Theoretically the TKN result should be greater or equal to ammonia concentration. However the difference reported is within the uncertainty of the individual tests.
V	This sample contained significant amounts of sediment which was included in the analysis portion as requested.
SUR	Surrogate recoveries could not be determined due to the dilution required to quantify the analyte.

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Job Number : 5E0688A

QAQC : Laboratory Control Sample(s)

Analyte	Level	Level Detected			Recovery Details		
		Result1	Result2	Result3	Rec 1 (%)	Rec 2 (%)	Rec 3 (%)
E2380 Chloride in Water							
Chloride	50	46			93%		
E2720 Sulphate in Water							
Sulphate	20	20			99%		
E2435 Resistivity							
Resistivity		320					

PQL = Practical Quantitation Limit
-- = Not Applicable
nd = <PQL

(S) Soils : mg/kg (ppm) dry weight
(W) Waters : mg/L (ppm) unless otherwise specified

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Job Number : 5E0688A

QAQC : Laboratory Duplicate(s)

Analyte	Dupl A	Dupl B	Average	RPD (%)	Dupl A	Dupl B	Average	RPD (%)
E2380 Chloride in Water (E179840)								
Chloride	440	440	440	0%				

PQL = Practical Quantitation Limit
nd = < PQL
-- = Not Applicable

(S) Soils : mg/kg (ppm) dry weight
(W) Waters : mg/L (ppm) unless otherwise specified

The number in brackets after the method header identifies the sample tested.

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Job Number : 5E0688A

QAQC : Method Blank(s)

ANALYTE	Sample ID PQL	Blank1	Blank2	Blank3	Blank4	Blank5
E2380 Chloride in Water						
Chloride	1	nd				
E2720 Sulphate in Water						
Sulphate	1	nd				

PQL = Practical Quantitation Limit
nd = < PQL
-- = Not Applicable

(S) Soils : mg/kg (ppm) dry weight
(W) Waters : mg/L (ppm) unless otherwise specified

APPENDIX C

ACID SULFATE SOIL MANAGEMENT PLAN

Neutralisation by Lime

General

ASS stockpile / treatment areas must be completely surrounded by bunds designed to be of sufficient capacity to accommodate a critical storm event. Bunds should be constructed of imported material and be of sufficiently low permeability to ensure that uncontrolled loss of water to the surrounding area does not occur. This could generally be achieved by use of clay fill. The bund should be compacted by rolling with a pad foot roller to bind the material into a cohesive earth fill rather than a loose or granular material. A minimum of 95% Standard Compaction should be achieved in all earth bunds constructed for environmental protection. Bunded areas should be graded to allow water within the bunded area to flow to a sump area, where the water may be assessed and treated as necessary.

Excavated Potential Acid Sulfate Soils (PASS) should be spread within the bunded area in layers of workable depth (typically not more than 0.3m loose thickness) and be thoroughly mixed with lime through use of a rotary hoe, pulvi-mixer or some similar mechanical process nominated by the contractor to achieve a thorough mix. The liming should be confined to areas of manageable size. Liming areas should remain bunded to allow collection of all leachate and stormwater runoff until test results indicate acceptable levels of neutralisation have been achieved.

Alternatively, the soils may be mixed with lime prior to excavation. This could be achieved by spreading the required amount of lime over the surface of the excavation, assuming a depth of about 300mm will be treated after each application. The lime should be thoroughly mixed with the soil through use of a rotary hoe, pulvi-mixer or some similar mechanical process nominated by the contractor to achieve a thorough mix. After mixing, the material could then be excavated from the basement area and disposed of as required. This option would not require bunding of a separate area for soil treatment, and due to the head of water outside the basement, groundwater would flow into the excavation rather than out of it, where it could be pumped out and treated as discussed below.

Liming Ratios

Good quality fine agricultural lime should be used. In calculating the liming ratios presented herein a factor of safety of 1.5 has been allowed above the theoretical requirement to take into account the rate of lime reactivity and the possibility of inhomogeneous mixing.

The available test results indicated the liming ratio requirements are 12kg of lime per cubic metre of soil for all soils excavated from below 2m depth.

Liming ratios should be confirmed by testing at the time of construction.

The time required for applied lime to neutralise ASS is widely variable and depends on the specific properties of the neutralised soil, although the lime will begin to neutralise the acid soils from the time of application. Monitoring of the neutralisation rates of the ASS to be removed should be undertaken to provide an indication of the rate of neutralisation and to confirm that the process is working effectively.

Management of Leachate and Excavation Water

A groundwater sample should be obtained to assess the background pH of the groundwater prior to excavation of PASS at the site. Results of this testing should be forwarded to the ASS Consultant for the project, as a review of recommended pH values for groundwater monitoring during construction may be required.

All water runoff from bunded or other treatment areas is to be collected, monitored and then neutralised prior to release. Water pumped out during dewatering should be monitored on a regular basis during the dewatering period. It is suggested that water pH be checked several times throughout the day. If pH levels are found to become consistently lower over several tests, and the pH value approaches the minimum allowable pH of 6.5, all water should be contained and treated prior to release. Once an acceptable water quality is achieved, the treated water may be released. It is recommended that monitoring of turbidity and dissolved oxygen be carried out immediately upon beginning of pumping, after 24 hours, and then, depending on results on a maximum weekly basis thereafter. A shorter timeframe may apply depending on the results of the ongoing testing. The testing interval could be revised at a later date should no significant changes in groundwater quality be evident.

The method of neutralisation is either to add lime as a slurry to the collected leachate / excavation water (depending on the salinity of the water to be treated) or to use a mechanical lime spreader to spread lime over an area close to the inlet point of the collection area. The addition of lime will be undertaken in conjunction with field testing to avoid achieving excessively high pH levels. The quality of the water to be finally discharged must meet appropriate guidelines for release.

Monitoring Program

Materials Treated in Bunded Areas

Field testing of the pH of lime treated materials will be required to assess whether pH values are being held at greater than 4. The pH testing should be supplemented with a minimum of two standard ASS laboratory tests from the excavated soil. Testing will be required to produce Total Potential Acidity (TPA) results of zero or indicating a small amount of excess lime. Laboratory results indicating soil containing up to 0.5kg H_2SO_4/tonne would be acceptable. The laboratory samples should each be made up of a minimum of 10 subsamples from different parts of the stored materials to provide an average value of TPA.

Delivery dockets for the agricultural lime should be kept with other site records to demonstrate that adequate neutralising agent was used on site.

Excavation Monitoring

Natural soils exposed in the walls and floor of all excavations during dewatering should be checked a number of times for the generation of acid conditions, using an approved field pH screening test. Lime should be added to the exposed surface of the soils if values of pH<4 occur. The liming ratio recommended above should be used, assuming the outer 100mm of soil within the exposed face will be affected. Any water collected in the excavation should also be checked for indications of acid production. Water pumped out during dewatering should be monitored at regular intervals for indications of acid production. Contingency measures should be put in place in accordance with this plan if water pH values of less than pH 6.5 occur.

Soils exposed within the excavation, including those above the water table, shall be maintained in a wet condition by frequent irrigation to restrict oxygen entry into the soil within the excavation.

Contingency Measures

Soil acidity in disturbed materials should be monitored. Should the field pH tests and the laboratory tests show that the soil acidity has not achieved the minimum required standard, then the material must be reworked and additional lime treatment carried out until it is verified that the soil meets the required standard.

If monitoring of the collected water at the point of discharge indicates the pH is below acceptable discharge limits then discharge must immediately cease and further treatment be carried out. Hydrated lime may only be applied in the presence of the ASS Consultant who shall ensure that it is added in small increments so as not to cause unduly high water pH levels, (i.e. above 8.5). The hydrated lime shall be stored in a covered and bunded area to prevent accidental release to waters.

In the event that pH measurement of exposed soils in excavations does not meet required levels, lime shall be spread over the affected area and the pH levels further monitored.

Sufficient lime is to be stored in a dry location on-site to permit the immediate implementation of the above contingency measures.