

Gales-Kingscliff Pty Ltd

ABN: 75 093 540 080

Cudgen Lakes Sand Extraction Project

Acid Sulfate Soils, Soil Contamination & Agricultural Suitability Assessment

Prepared by

HMC Environmental Consulting Pty Ltd

April, 2008

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Part 3

Gales-Kingscliff Pty Ltd

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GLOSSARY

AASS	–	Actual Acid Sulfate Soil and/or Sediments
AHO	–	Australian Height Datum
ANC	–	Acid Neutralising Capacity
ASS	–	Acid Sulfate Soil and Sediments
ASSMP	–	Acid Sulfate Soil and Sediment Management Plan
CEC	–	Cation Exchange Capacity
DEC	–	Department of Environment and Conservation
DECC	–	Department of Environment and Climate Change
DNR	–	Department of Natural Resources
DWE	–	Department of Water and Energy
EC	–	Electrical Conductivity
EIS	–	Environmental Impact Statement
H ₂ O ₂	–	Hydrogen peroxide
HCl	–	Hydrochloric acid
NAGP	–	Net Acid Generating Potential
NAPP	–	Net Acid Producing Potential
PASS	–	Potentially Acid Sulfate Soil and Sediments
pH _F	–	Field pH
pH _{FOX}	–	Peroxide Oxidised field pH
POCAS	–	Peroxide Oxidation Combined Acidity and Sulfate
S _{CR}	–	Chromium Reducible Sulfur
TAA	–	Total Actual Acidity
VENM	–	Virgin Excavated Natural Materials
VENM(a)	–	Non-acid generating VENM
VENM(b)	–	Acid generating VENM

EXECUTIVE SUMMARY

HMC Environmental Consulting Pty Ltd has undertaken an assessment of acid sulfate soil and sediments, potential soil contamination, and agricultural suitability for the Cudgen Lakes Sand Extraction Project (the “Project”).

Acid Sulfate Soils and Sediments

Extensive soil investigations across the Project Site and other landholdings on the Chinderah floodplain indicate that the soil profile and underlying sandy sediments are extremely homogenous, containing low concentrations of acid generating sediments within the soil and throughout the full depth of the sandy sediments. Within the sandy sediments, there are also significant sources of acid neutralising capacity, especially below 6m depth.

Very low levels of existing or actual acidity were recorded in all boreholes. Although low levels of potential acidity were recorded in samples collected throughout the soil and sediment profile below approximately 6m depth, significant acid neutralising capacity was measured which, in most cases, greatly exceeded the acid generating capacity. Potential acidity was noted in soil and sediment samples collected above the measured fluctuating groundwater table. Although the laboratory testing indicated the oxidisable sulphur in these porous soils exceeded adopted action criteria levels there is no evidence of acid induced groundwater problems.

During April to July 2006, approximately 22 000 cubic metres of material was dredged and stockpiled within the bunded initial dredge pond area on the Project Site. Monitoring of soil and water during this operation confirmed that there is significant acid neutralising capacity within the soil and sandy sediments. No soil amendment was necessary during dredging to achieve management outcomes. Additionally, water quality within the dredge pond and surrounding groundwater bores remained within applicable criteria and standards. This initial dredging operation confirmed that the proposed management strategies for the Project can ensure successful, environmentally sustainable outcomes.

Furthermore, the adjacent sand extraction operation (now Hanson Tweed Sand) has been operating successfully for more than ten years with regular monitoring confirming the management of acid sulfate soils and sediments is practical, environmentally sustainable, and cost-effective within sand extraction operations in this locality.

Soil Contamination

A detailed investigation of the site history, a walk over field inspection and soil survey was undertaken to identify the potential for soil contamination within the Project Site. Based on the sampling results, site history, geographical location and review of topographic mapping, there is a very low level of risk that the Project Site is contaminated with remnants of chemicals from current or former sugar cane cultivation.

Based on these findings it is deemed that further sampling and laboratory analysis is not required and that the Project Site can reasonably be considered, for the purpose of the proposed development, to be uncontaminated. It is considered that there is little environmental or health hazard associated with the proposed use of the subject property for sand extraction.

Agricultural Suitability

The proposed use of the land is recognised in the Northern Rivers Farmland Protection Project (DIPNR et al, 2005) as a rural industry. There is recognition that extractive industries have a place in some agricultural areas. The proposed operation appears to be compatible with existing land uses in the area and management strategies to be implemented would help ensure that alienation of other agriculture and the impacts from the Project would be minimal.

Soil and land use history investigations and site specific studies have confirmed that acid sulfate soils and sediments, potential land contamination and agricultural suitability issues are able to be appropriately managed during the construction, operation and rehabilitation of the Cudgen Lakes Sand Extraction Project.

1 INTRODUCTION

1.1 Introduction

HMC Environmental Consulting Pty Ltd has been commissioned by R.W. Corkery & Co. Pty. Limited on behalf of Gales Kingscliff Pty Ltd (the “Proponent”) to undertake an assessment of acid sulfate soils and sediments (ASS), potential soil contamination, and agricultural suitability for the Cudgen Lakes Sand Extraction Project (the “Project”).

Appendix 1 of this report lists each of the *Environmental Assessment* requirements issued by the Director-General of the Department of Planning and issues provided by other government agencies relating to ASS, soil contamination and agricultural suitability with references to the relevant sections of this report where each requirement is addressed.

The Project would include the excavation of sand together with hydraulic extraction (dredging) and pumping of the extracted material to a processing area and to nominated fill sites. The Project also includes the receipt and, where possible, recycling of Virgin Excavated Natural Materials (VENM).

A land use history and soil investigation has been undertaken to assess the potential impacts associated with the disturbance of ASS, exposure of persons and the surrounding environment to potentially contaminated land, and the agricultural suitability of the Project Site.

1.2 Description of the Project Site and Study Area

The Project would involve the removal of approximately 5 000 000m³ of sand over a period of 15 to 20 years. The Project Site covers a total area of 67ha which includes:

- a 37ha extraction site south of Altona Drive (‘southern extraction site’);
- a 9ha extraction site north of Altona Drive (‘northern extraction site’); and
- a processing area north of Altona Drive covering an area of 3.7ha.

Two pipeline corridors are proposed extending north and east from the southern extraction site. These are referred to as the “northern pipeline corridor” (0.8km in length) and the “eastern pipeline corridor” (1.5km in length). The proposed northern pipeline corridor would be located in the road reserve on the western side of Tweed Coast Road. The proposed eastern pipeline corridor would be located within the road reserve for a proposed subdivision road within land owned by the Proponent. It is acknowledged that the proposed road has not yet been approved. Therefore, an alternative eastern pipeline corridor has been proposed in the event that the proposed road is not approved within a suitable timeframe. An alternative northern pipeline has also been proposed in the event that suitable agreements are reached with an adjoining landholder.

The Study Area consists of the entire Project Site though focus has been place on the areas that would be modified by the sand extraction and processing Project. The Study Area also incorporates a nominal 30m wide area centred on the pipeline corridors.

The Project Site is located within the Tweed River floodplain and bounded to the south by the Cudgen Plateau which rises to approximately 38m AHD. The land within the Project has previously been cleared and drained and is generally level. The Project Site is currently intermittently grazed by cattle though preparatory works including a 0.5ha initial dredge pond for an approved sand extraction operation was created during 2006.

Figure 1 shows the location of the Project Site and Study Area while **Figure 2** shows the layout of the Project Site.

2 DESCRIPTION OF THE PROJECT

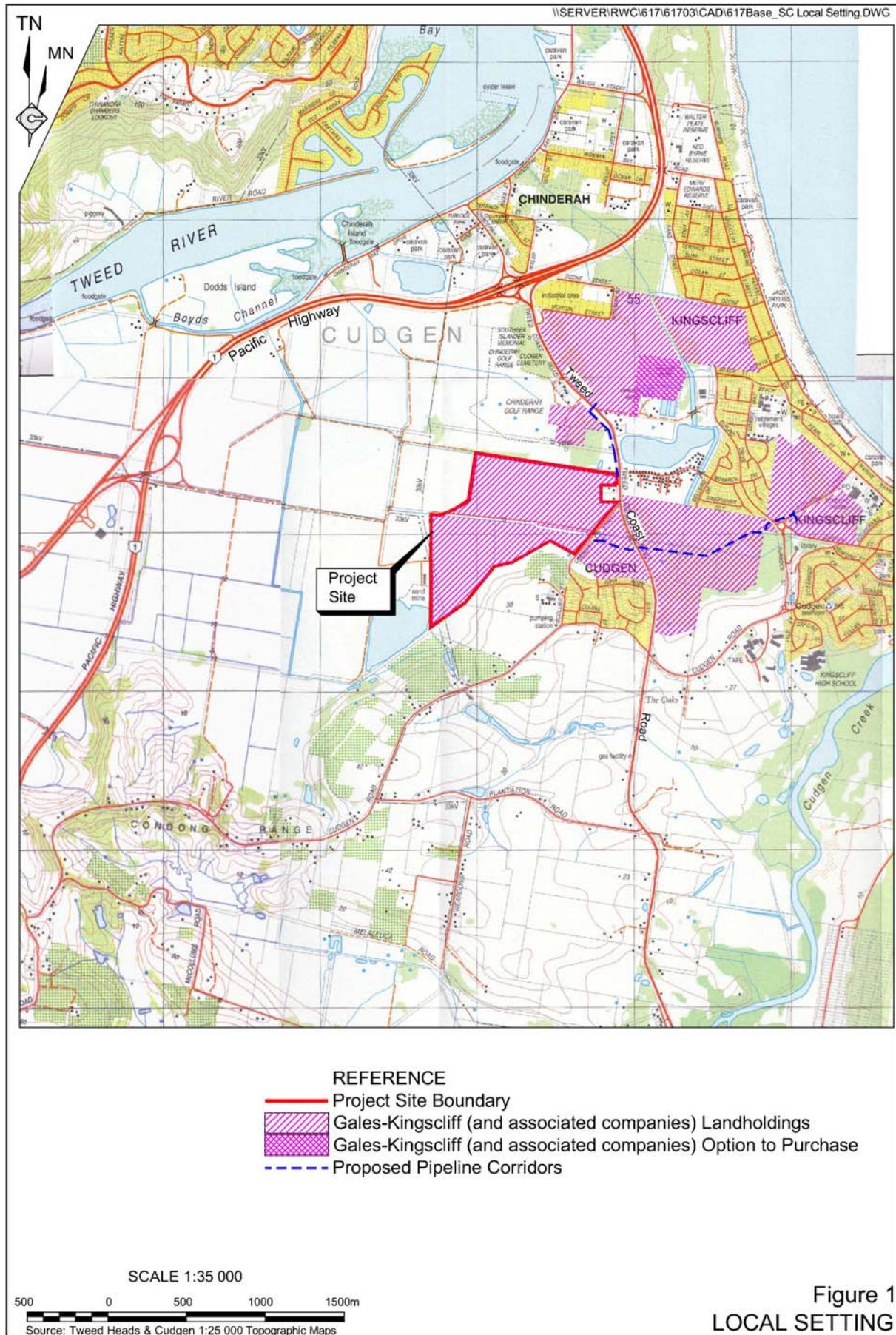
The Proponent proposes to develop and operate a sand extraction operation to supply fill sand to a number of nominated fill sites via two pipeline corridors and to produce a range of sand products for sale to the local construction industry. The Project would also be appropriately licensed to accept virgin excavated natural material (VENM) which would be used in production of saleable sand products, used to backfill the northern extraction pond or interned at the base of the southern extraction pond.

The operation has been designed to optimise the recovery of sand whilst at the same time addressing and managing the environmental constraints within and surrounding the Project Site. As the Project proceeds, the northern extraction pond would be progressively backfilled to ultimately form sporting fields and recreational facilities and finalised sections of the southern extraction pond would be progressively rehabilitated in order to form a recreational lake and surrounding parklands.

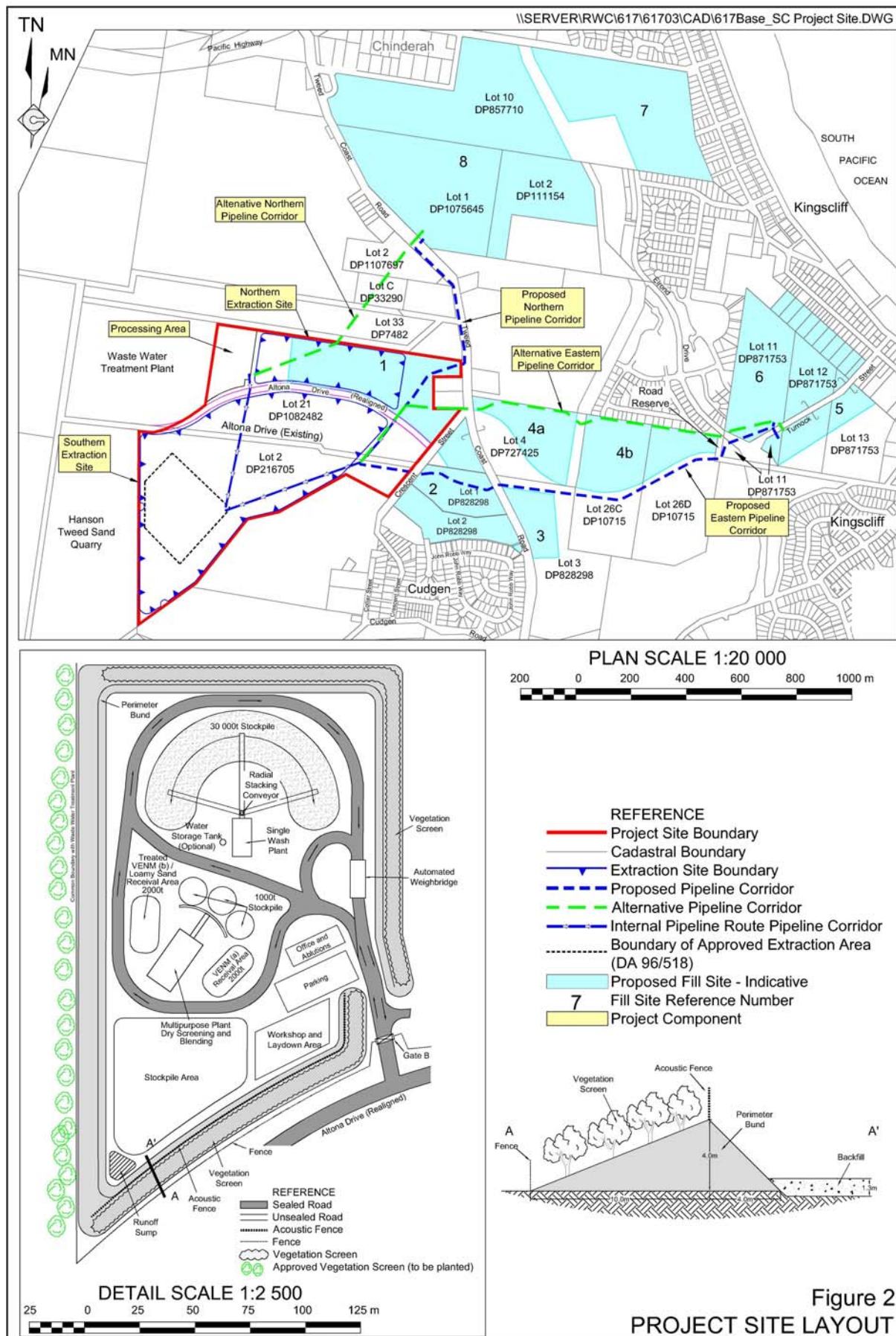
Construction and site establishment would occur over an approximately 3 month period in which three site entrances and internal roads would be constructed together with the processing plants, offices, workshop and perimeter bunding. The dredge, pipelines to the processing area, pumps and other equipment would also be installed during the construction period. Construction activities would occur between 7:00am and 6:00pm Monday to Friday and 7:00am to 1:00pm Saturday.

The extraction sequence would involve: stripping of topsoil; formation of bunds; and extraction of the sand resource (loamy sand and fine grained sand). Extraction of all material within the northern extraction site would be undertaken over four stages progressing east to west to a depth of approximately 5m using excavator and trucks. Within the southern extraction site extraction would occur over 10 stages, generally progressing west to east. Extraction would occur to the depth of the resource, typically 20m below current ground level with the upper loamy sand material extracted using an excavator and the remaining fine grained sand material extracted using a cutter-suction dredge.

The upper loamy sand material would be treated using alkaline amendments, such as agricultural lime, prior to being transferred to the processing area for production of various construction materials, such as mortar sand. The fine grained sand material would either be trucked or pumped to the processing area and washed to remove oversize and undersize materials, producing construction grade sand, or be pumped to a nominated fill site for use as fill material. All fines separated during processing or returned from the fill sites would be returned to the base of either the northern or southern extraction pond.



Note: A colour version of this figure is available on the Project CD.



Note: A colour version of this figure is available on the Project CD.

All soil removal and excavation of sand (ie. mechanical removal) would occur between 7:00am and 6:00pm Monday to Friday and 7:00am to 1:00pm Saturday. Dredging and pumping of sand to the processing area, and processing activities, would occur between 6:30am and 10:00pm Monday to Friday and 7:00am to 4:00pm Saturday whilst dredging of sand for pumping to fill sites would occur between 6:30am and 6:30pm Monday to Friday and 7:00am to 1:00pm Saturday.

Sand to be used as a filling material to raise the level of various parcels of land in the Kingscliff, Chinderah and Cudgen areas would be pumped hydraulically to the fill sites from the southern extraction site as a sand / water slurry. Water draining from the sand at the fill sites would be pumped back to the southern extraction pond. The Proponent intends to use up to two enclosed staging pumps beyond the dredge to convey the sand to the fill sites, one located within the Project Site and one within each pipeline corridor. Pumping would only occur along one corridor at a time. Up to 450 000m³ of sand could be pumped annually to the fill sites.

Based on maximum annual sales of 300 000tpa the average number of product truck movements on any weekday or Saturday would be approximately 100 and 60 respectively (50 and 30 loads). As sales would vary from day to day, the 85th percentile number of product truck movements on the local roads on a busy weekday or Saturday would be 130 and 80 respectively (65 and 40 loads). Based on the importation and receipt of up to 45 000tpa of VENM, it is estimated that the incoming VENM would generate approximately 24 truck movements (12 loads) per week. The 85th percentile volume has been estimated at 32 truck movements (16 loads) per day.

In total, it is assumed, once the Project is fully operational, the despatch of products and importation of VENM would generate up to 124 truck movements (62 loads) per day on an average day. All product distribution and VENM receipt would occur between 7:00am to 6:00pm Monday to Friday and 7:00am to 1:00pm Saturday.

Both non acid generating VENM - VENM(a) and potentially acid generating VENM – VENM(b) would be received at the Project Site via road trucks, appropriate details recorded and the material classification verified. VENM(a) would either: be processed to produce saleable products or used to backfill the northern extraction pond or finalised edges of the southern extraction pond. VENM(b) which is suitable for processing would be placed adjacent to the southern extraction pond for treatment, as for the loamy sand material, prior to processing. VENM(b) not suitable for processing would be either placed below the water table as backfill within the northern extraction pond and capped with a minimum one metre depth of clean fill or interned at the base of finalised sections of the southern extraction pond.

All VENM delivered to the Project Site and processed materials despatched from the processing area would be transported via Altona Drive, Crescent Street and Tweed Coast Road. Access to the Project Site would be provided via three entrances off Altona Drive, one to the processing area and northern extraction site and two to the southern extraction site.

The Proponent would adopt a progressive approach to site landscaping and rehabilitation to ensure that, wherever possible, disturbed areas are either temporarily or permanently stabilised to limit erosion and adverse visual impacts. An important component of the rehabilitation of the Project Site would be the progressive backfilling of selected finalised sections of the shore of the southern extraction pond and introduction of native vegetation to create wetland areas and parklands. The construction of recreational facilities such as walking and equestrian / cycling tracks would occur following completion of sand extraction activities. The final lake would have a depth of up to 20m and cover an area of approximately 37ha.

3 SITE DESCRIPTION AND PHYSICAL CHARACTERISTICS

3.1 Land Use

The Project Site is largely cleared and currently used for cattle grazing. An initial dredge pond and preparatory works have also been completed for the removal and pumping of 400 000m³ of sand from Lot 2 DP216705 under an existing approval (DA 96/518) granted in 1998. Historically used as a wet grazing block, the low-lying Project Site has previously been drained and for a number of years supported sugar cane. The Project Site is bounded to the east by Crescent Street and several residential properties and an existing sand extraction operation (Hanson Tweed Sand) to the west. The Chinderah Golf Club and marginal grazing land is located to the north while the Cudgen Plateau is located immediately south supporting agricultural uses such as cropping and orchards.. Tweed Shire Council is currently constructing the Kingscliff Waste Water Treatment Plant immediately northwest of the Project Site.

3.2 Site History

An examination of historic parish maps dating back to 1913 and topographic maps to 1947 confirm that the land has consistently been used for agricultural purposes. The early parish maps show the land as swamp while the 1947 topographic map indicates some drainage, presumably to improve the grazing potential of the land (see **Figures 3 and 4**).

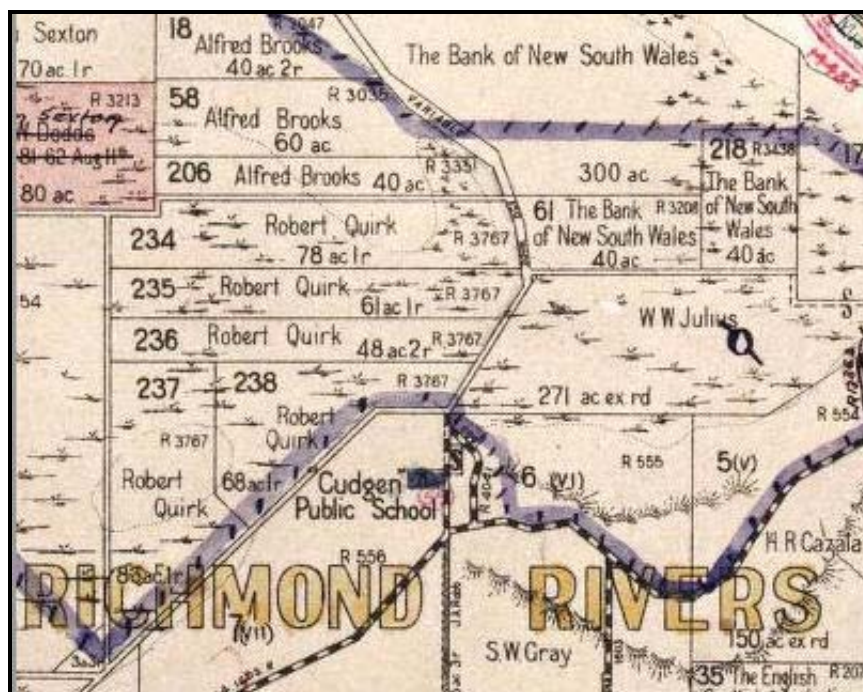


Figure 3
1913 Parish map confirming “swampy” nature of Project Site
(Source: NSW Department of Lands)

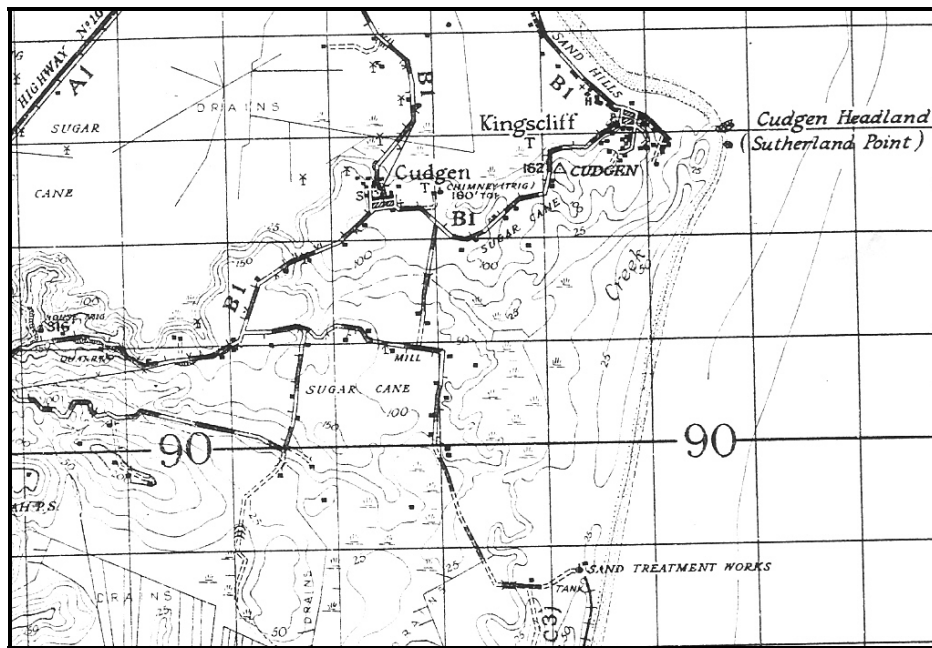


Figure 4
1947 topographic map showing drainage network
(Source: Tweed Shire Council Library)

It has been stated (Crofts, 1986) that the land within the Project Site was previously used as a wet grazing block until 1964 when the land was purchased by John Kiolrup and partially drained and developed as a tropical grass and legume seed nursery and farm by Anderson Seed Ltd and Terranora Pastures Pty Ltd. An inspection of the property about 1966 revealed that, due to a high water table and water logging, great difficulty was being experienced in growing and harvesting legume and grass seeds. Subsequently, Anderson Seed Ltd went into liquidation. The property was apparently purchased by Altona Pastoral Co. Pty Ltd on 13 December 1971 and developed as a cane property during a period of rapid expansion of the cane industry from 1973.

The 1970 aerial photo (see **Appendix 2**) appears to show intensive drainage typical of sugar cane cultivation, therefore, the cane may have been on the site a few years earlier than 1973. No cane drainage is noted in the 1962 aerial photo (see **Appendix 2**). Interestingly, the 1974 topographic map (see **Appendix 2**) does not indicate sugar cane cultivation on the site although the map would have been based on investigation and interpretation work undertaken several years earlier.

By 1984, the sugar cane enterprise was determined as non-viable due to history of production costs exceeding income. Due to the soil and drainage problems associated with the land, apart from grazing of cattle during dry periods, the land has not been used for agricultural activities since around this time. A letter dated 2 September 1987 from the NSW Cane Growers Association and included in Crofts (1986) notes the frequent inundation, poor nature of the land, and recalls that the farm was for many years known as "Frog Hollow". It was regarded by all canegrowers in the district as a non-viable cane farm.

Discussions with the NSW Sugar Milling Cooperative Ltd. (J Tait per. comm.) indicate that the last year sugar cane was grown on the site was 1988. It therefore appears sugar cane cultivation occurred on the site for a period of 10 to 15 years only.

In January 1997, Torrac Investments Pty Ltd submitted a development application to Tweed Shire Council revising the 1994 proposal submitted by Keown & Drummond Pty Ltd. At that time, Torrac Investments Pty Ltd held a contract to purchase this land parcel from Bradshaw Investments Pty Ltd.

The amended development application proposed to remove 800 000m³ of sand from an area of 14.3ha to a depth of 8.5m in the southwest corner of Lot 2 DP 216705. Of this material, 400,000m³ was to be used to raise the land surface on Lots 1 and 2 DP 828298 which is approved for an 89 lot subdivision. This initial extraction was approved to take place within a 23 week period. The remaining 400 000m³ was to be available for hydraulic extraction or transportation by truck to other approved fill sites, once the Tweed Sand and Turf operation ceased production.

The development application was determined by Tweed Shire Council and refused. However, the decision was appealed in the Land and Environment Court of NSW. In October 1998, the court ordered that the extraction be approved to remove 400 000m³ of sand by hydraulic methods to Lot 1 and Lot 2 DP829298 subject to conditions.

In 2003, a small start-up pond was excavated on the site and surface and groundwater monitoring has been undertaken to determine the baseline conditions across the Project Site. During April to July 2006, approximately 22,000m³ of material was extracted from the start-up pond to create a 0.5ha initial dredge pond to enable the placement of a suitable sized dredge. All material extracted was stockpiled within the bunded area in accordance with the 1998 approval. The material was covered with topsoil and grassed to limit sand lift-off until dredging commences.

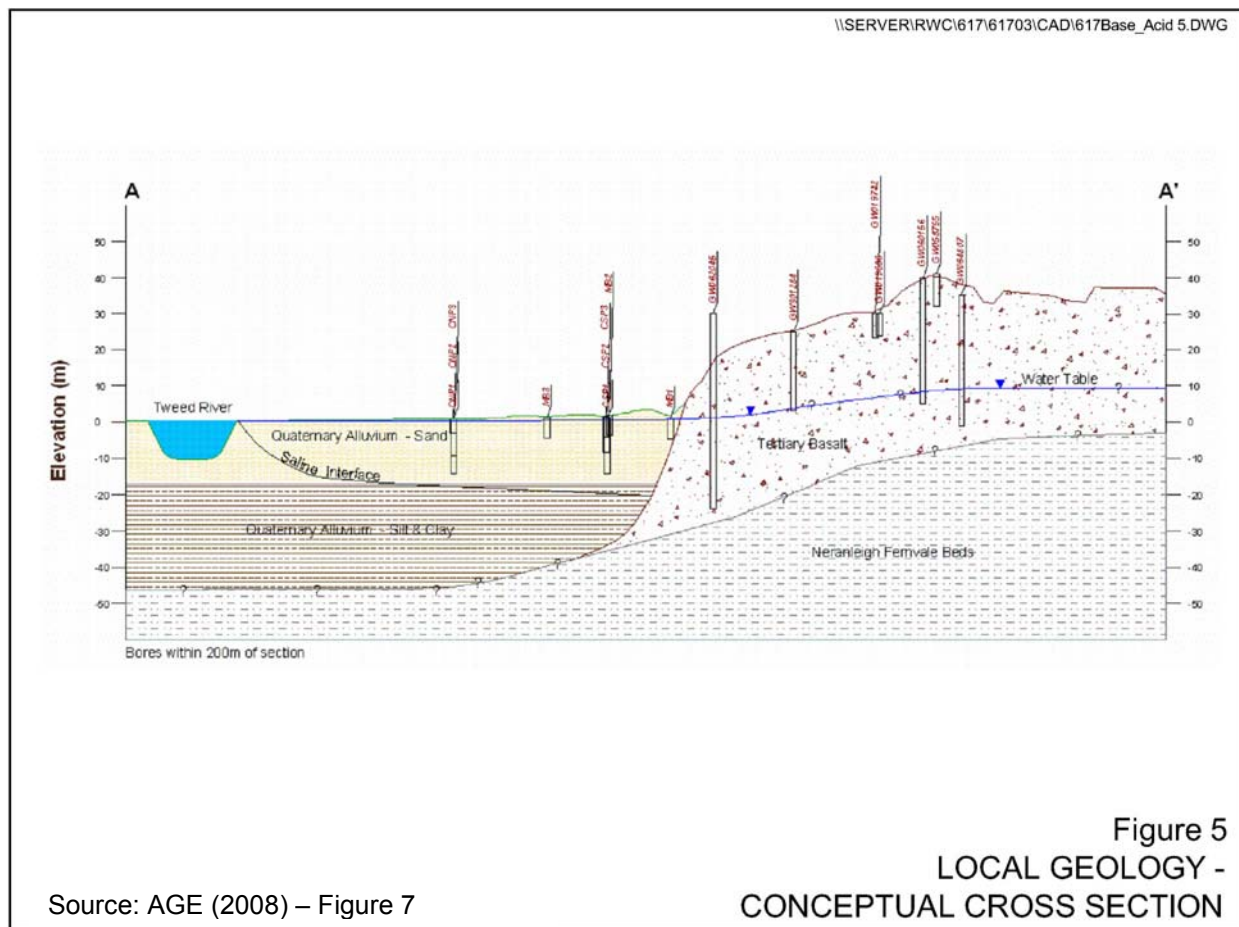
Grazing continued across the Project Site during this time.

3.3 Topography

The Project Site forms part of the Cudgen floodplain with an elevation ranging from 0.8m to 1.2m AHD. The Cudgen Plateau rises steeply immediately to the south to an elevation of 30m to 40m AHD. Drainage generally flows via formed agricultural drains from the Cudgen Plateau north towards the Tweed River (see Webb, 2008).

3.4 Geology

Coffey Geosciences (1999) described the regional bedrock beneath the Project Site as inter-bedded argillite and meta-greywacke of the Neranleigh-Fernvale Beds of lower Palaeozoic age. The basement is noted as being overlain with Quaternary organic clays which in turn are overlain by Quaternary sands. The sands were assessed as “medium to fine grained with some coarse grained, quartzose and poorly graded, with a uniform thickness across the site of around 21m”. The depositional environment is described as “deltaic, with the presence of shell and organic fragments throughout the sequence indicative of alternating marine and terrestrial influence throughout deposition”. Tertiary basalt of the Lamington Volcanics overly the Neranleigh-Fernvale beds immediately to the south of the Project Site forming the Cudgen Plateau.



3.5 Soils

These investigations have identified that the soils and sediments within the Project Site consist of black silty sand topsoil ranging from approximately 0.2m to 0.5m overlying a medium to fine grained grey sand interbedded with shelly and humic material to a depth of approximately 20m.

3.6 NSW Department of Water and Energy ASS Risk and Planning Maps

The NSW Department of Water and Energy (DWE) 1:25 000 Acid Sulfate Soil Planning Map – Cudgen indicates that the Project Site is located within a Class 3 area and may be affected by Acid Sulfate Soils (an extract from this map is duplicated as **Figure 6**). The DWE 1:25 000 ASS Risk Map – Cudgen indicates that there is a high probability of ASS being at a depth of 1m to 3m with a landform of aeolian, sandplain and an elevation of 2m to 4m AHD.

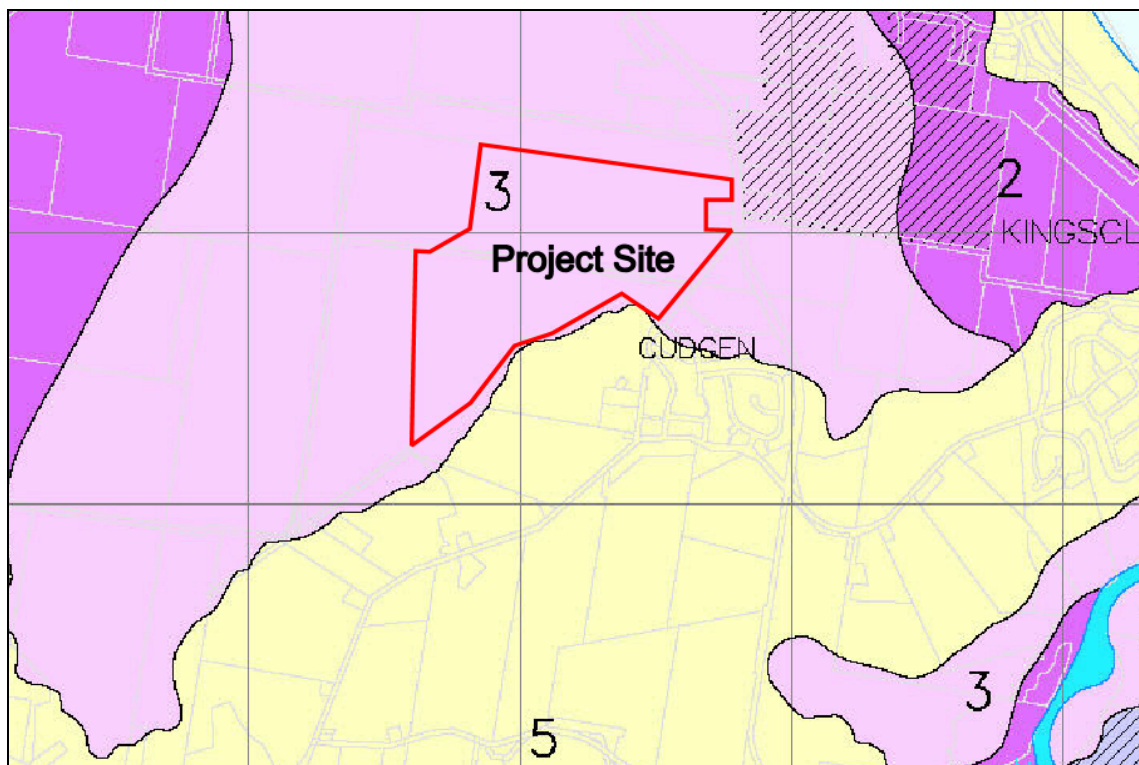


Figure 6

ASS Planning Map Classification (Source: NSW DWE ASS Planning Map-Cudgen) indicating depth below which works require preliminary ASS investigation

(1 = any works, 2 = ground surface, 3 = 1m

4 = 2m, 5 = works within 500m of 1, 2, 3 or class 4 land that potentially lower watertable below 1 m AHD)

3.7 Tweed Shire Council Local Environment Plan 2000

The Project Site is zoned Agricultural Protection 1b (2) (see **Figure 7**) and while the primary objective is to protect agricultural land, a secondary objective of this zoning is to allow development which is compatible with agricultural activities.

Clause 35 of the Tweed LEP 2000 states that where works are proposed 1m below the natural ground surface in Class 3 mapped areas, a preliminary acid sulfate soil assessment needs to be undertaken to determine the presence or otherwise of ASS. An applicant may also accept that ASS is present.

A management plan is required in accordance with the Tweed LEP 2000 should it be either confirmed or accepted that ASS is present. If a management plan is required, it must be prepared in accordance with the Acid Sulfate Soil Manual produced by the Acid Sulfate Soil Management Advisory Committee (1998).

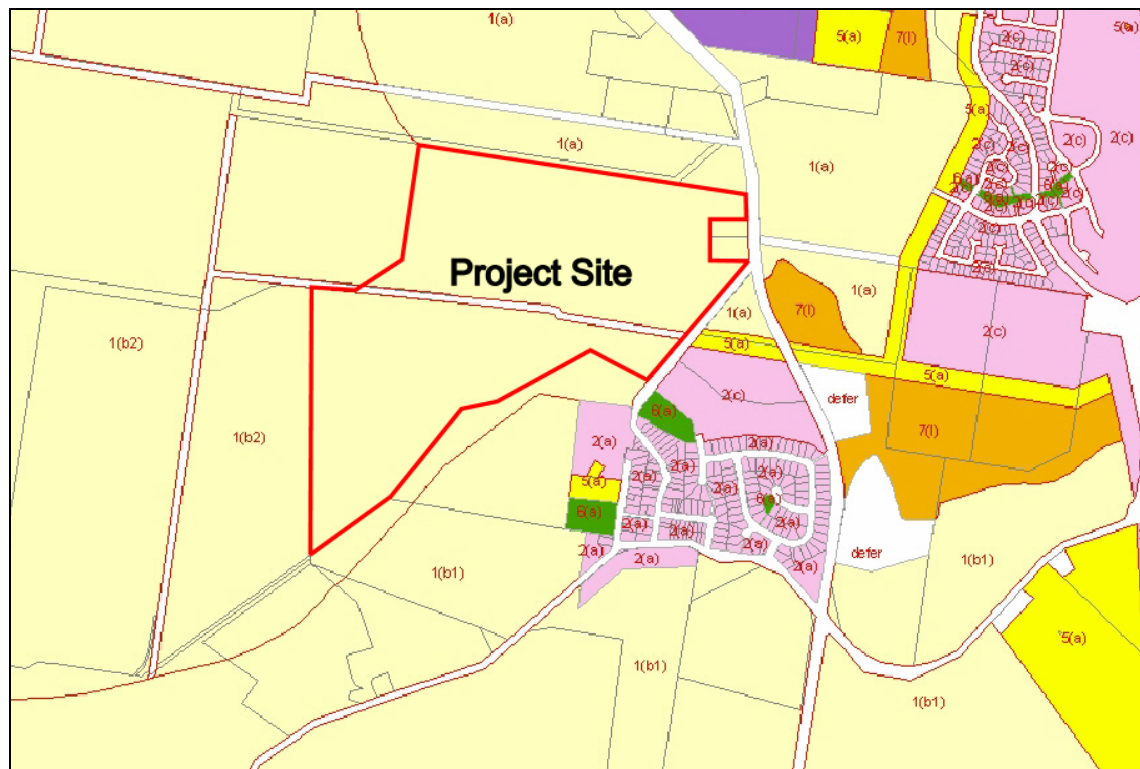


Figure 7
Tweed Shire Council LEP Zonings (Source:TSC GIS)

3.8 NSW Department of Water and Energy Soil Landscape Maps

The NSW DWE Soil Landscape Map “Murwillumbah-Tweed Heads” (Morand, 1996) shows the Project Site lies within a “Tweed landscape variant”(twb) soil landscape which is characterised by moderately well-drained Prairie Soils overlying barrier sands. The Tweed soil landscape consists of deep Quaternary alluvium and estuarine sediments of the marine plain of the lower Tweed catchment. Local relief is >1m and elevation is 1m to 3m. In this soil landscape, up to 50cm of black, strongly structured clay overlies >200cm of grey sand. Total depth is nominated as >300cm. Table 4.1 in Morand (1996) noted that while the soils in the “twb” landscape are acidic, acid sulfate potential is not listed as a limitation.

This sequence described regionally is not generally consistent with the sequence observed beneath the Project Site. The soil profile appears to reflect a Kingscliff (ki) soil landscape with a dark loamy sand topsoil. It is noted that the ki soil landscape is mapped immediately east of the Project Site. The grey sand is recorded as extending to a maximum depth of 21m. The “ki” topsoil is characterised by very strong acidity, low CEC, very low nutrient status and low water storage capacity. Table 4.1 in Morand (1996) indicates localised acid sulfate potential in this soil landscape.

4 ACID SULFATE SOILS AND SEDIMENT ASSESSMENT

4.1 Literature Review

4.1.1 Previous Soils and Sediment Investigations

Data from extensive ASS and geotechnical soil investigations on adjoining sites including the new waste water treatment plant site and Hanson Tweed Sand Quarry (formerly Tweed Turf and Sand) operation were reviewed and compared with the results from the Project Site.

A total of five extensive soil investigations have been undertaken both within the Project Site and across the surrounding floodplain over the past 20 years.

1. Coffey and Partners (1986). *Geotechnical Investigation for Proposed Extractive Industry Lot 2 DP 611021 and Lot 2 DP 216705.*

This investigation included the drilling of six bores to a maximum depth of 23m. Borelogs indicated fine to medium sands with interbedded shelly and humic material. No ASS analyses were undertaken.

2. Woodward-Clyde (1997). *Environmental Impact Statement for Proposed Sand Extraction Operation – Lot 2 DP 216705, Cudgen.*

This Environmental Impact Statement (EIS) included an ASS soil investigation for a proposed sand winning operation on the southern part of the Project Site. The investigation by Woodward-Clyde in 1991-1992 included fifteen shallow bores (<1.3m depth) with soil samples tested for in-situ pH and electrical conductivity (EC). In situ pH values ranged from 3.2 to 7.0.

A number of soil samples collected during the installation of groundwater monitoring bores were incubated for two months and analysed for total iron, total sulfur and Net Acid Producing Potential (NAPP). No significant decrease in pH was recorded in samples collected below 4m depth during incubation tests, however, pH levels did decrease in samples collected less than 3m from the ground surface. Total sulfur levels ranged from <0.01% to 0.05% although a negative NAPP was recorded with shell present in all samples. A negative NAPP indicates acid neutralising capacity within the soil.

Four test pits were also excavated to 4m depth and samples collected from the adjoining sand extraction operation. Weathering tests were undertaken on the samples over a three month period. A general decrease in pH was noted during the incubation of the bulk sand samples. However, the samples from the sand extraction operation recorded minimal pH change.

3. Gilbert & Sutherland (2003b) *Acid Sulfate Soil Assessment & Management Plan Lot 2 DP216705, Crescent Street, West Kingscliff*

This ASS investigation included hand augering of two boreholes to a depth of 1.5m within the area of the proposed initial dredge operation. The soil profiles were described as silty sand topsoil overlying sand. A total of 12 samples were subjected to preliminary screening, Chromium Reducible Sulfur (S_{CR}) and Total Actual Acidity (TAA). The S_{CR} ranged from 0.01 to 0.39%. Seven samples exceeded the action criteria of 0.03%.

Acid producing potential was noted as being greatest below the observed groundwater level (0.85m below natural ground level). TAA values ranged from -33 to 35 mol H⁺/t with two of the twelve samples recovered exceeding the action criteria of ≥18 mol H⁺. Seven of the samples recorded some neutralising capacity.

4. Coffey Geosciences (1999). Cudgen Sand Extraction – Hydrogeological Assessment and Installation of Monitoring Bores

Five monitoring bores were installed to an approximate depth of 6m on the Project Site during a hydrogeological assessment for a proposed sand extraction operation. Borelogs recorded dark grey fine to medium sand from approximately 1.5m depth. ASS investigations were not undertaken.

5. Gilbert & Sutherland (2005). Soil Survey, Acid Sulfate Soil Assessment, Agricultural Land Capability Assessment, Hydrological Assessment and Soil Management Plan & Addendum Report

Gilbert & Sutherland undertook soil investigations and auditing of soil and water management operations on the sand extraction operation (now Hanson Tweed Sand) adjoining the Project Site since before 1996. Petrographic analysis of dredged samples collected from the dredge pond in 1996 and 1997 recorded no pyrite by reaction in any of the samples tested. Monthly monitoring over a fifteen month period in 1997 and 1998 recorded oxidisable sulfur levels ranging from <0.01 to 0.03% with Acid Neutralising Capacity (ANC) ranging from <0.1 to 2.8% CaCO₃. In all cases, there was a negative Net Acid Generating Potential (NAGP) for the samples tested.

In 2000, Gilbert & Sutherland undertook an ASS investigation for an application to expand the adjoining sand extraction operation adjoining the Project Site. Fourteen boreholes were drilled to approximately 6m depth. Preliminary screening was undertaken on 172 samples with 69 of these subjected to Peroxide Oxidation Combined Acidity and Sulfate (POCAS) and some S_{CR} laboratory tests. The results recorded 44 of the 69 samples exceeding the 0.03%S actionable criteria. The majority of the samples recording exceedances were associated with the shallow grey-dark grey, fine to medium grained layer. Petrographic analyses were undertaken on only a few samples, with only one sample recording a moderate-strong reaction with hydrogen peroxide (H₂O₂). A strong reaction to hydrochloric acid (HCl) was noted in 17 of the 172 samples suggesting that some shell is available for acid neutralisation.

As part of the investigation for the application to extend the adjoining sand extraction operation, Gilbert and Sutherland undertook a detailed soil survey in 2004. Eleven deep (16m) boreholes and 20 shallow (0.6m) were excavated. Although the shallow boreholes were used as part of the agricultural suitability investigation and not subjected to ASS testing, the borelogs confirmed the uniformity of the shallow strata.

Preliminary screening was undertaken on 353 samples, 54 of which were subjected to S_{CR} and TAA analysis. The preliminary screening indicated that there was no widespread occurrence of Actual Acid Sulfate Soil (AASS) within the expansion area for the existing area. Twenty-six of the fifty four samples forwarded for analysis recorded %S levels above the action criteria (0.03%).

None of the 54 samples recorded TAA levels which exceeded the action criteria (18 mol H^+ /t). The greatest acid generating potential was noted in the dark-very dark grey fine-medium grained sand between 1.0 and 2.0m to 5.0m depth. The %S concentrations in the light-medium grained sand between 4m and 16m depth was variable with exceedances (>0.03%S) associated with thin, relatively discontinuous sand layers containing trace silt, clay or charcoal.

6. NSW Department of Planning (2006). *Tweed Turf and Sand Extraction Operation Expansion – Director-General's Environmental Assessment Report*

Section 6.1.5 of this report addressed ASS issues for the proposed expansion of the Tweed Turf and Sand operation. Gilbert and Sutherland's assessment concluded that, while some soils on the site exhibited a risk of acid generation, the potential for significant acid production on the site is low because the soils generally contain excess natural buffering capacity in the form of calcium carbonate derived from shell grit and other marine organisms. It was also concluded that the potential for acid generation would be minimised by using wet excavation methods (ie. suction dredging), hydraulic separation of fines during processing, and strategic reburial of fines below the water table. These techniques would minimise the potential for oxidation of sulfidic sediments, and hence minimise the risk of acid generation.

The Director-General notes that the assessment's conclusions and management measures are supported by the evidence from the existing quarry, which has not recorded any significant issues related to acid generation.

The Director-General concludes that:

"The Department, the DECC and the DWE are satisfied that the proposal is unlikely to result in any significant acid generation impacts."

A summary of soil investigations in the immediate vicinity of the Project Site is provided in **Table 1** and shown on **Figure 8**.

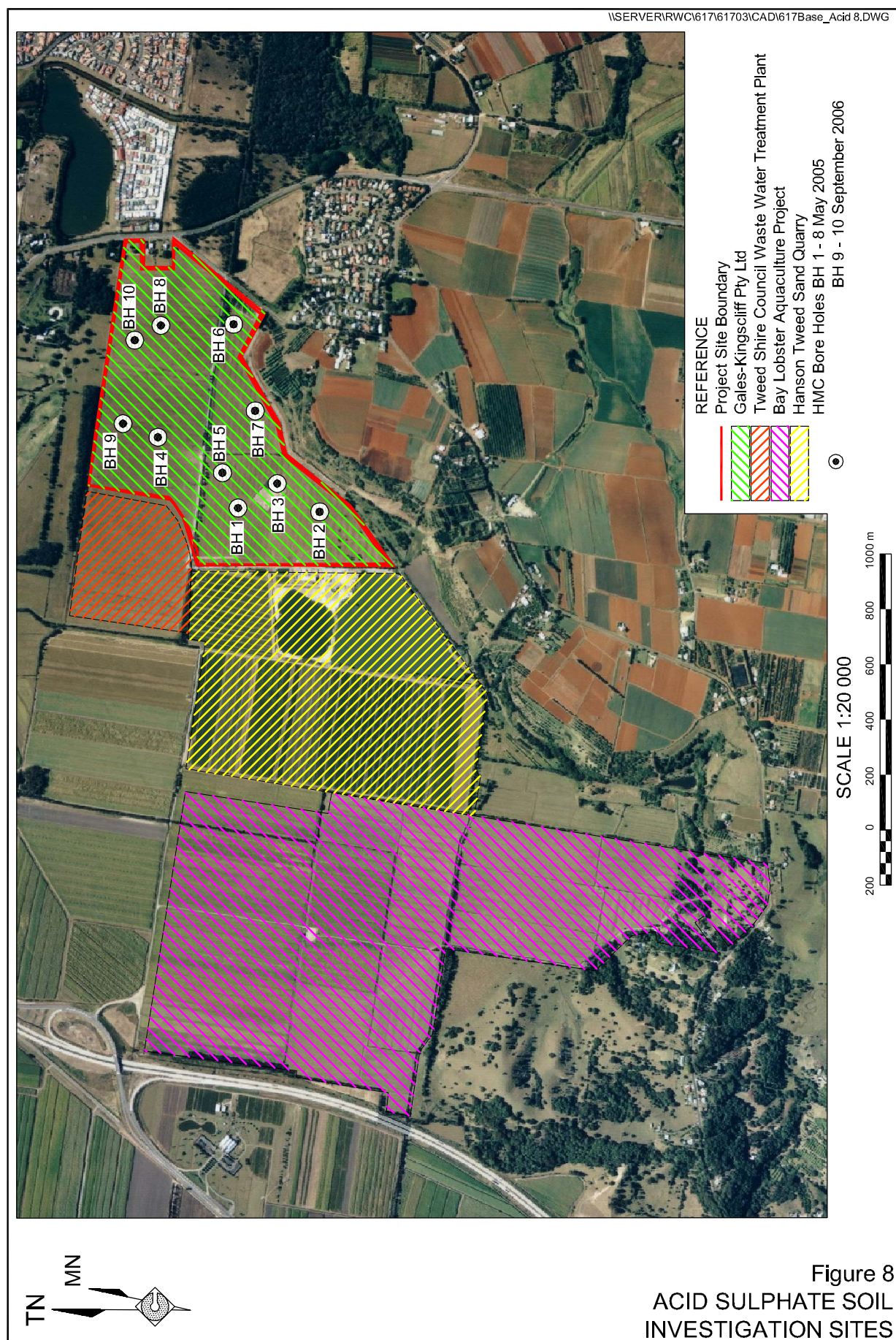
Table 1
Summary of Soil Investigations

Site	Investigator	No. of Boreholes	Depth (m)	ASS Testing					
				Y	N	No. of Samples		Max %S _{CR} /POS	Max TAA
						pHf/pHfox	S _{CR} /Pos/TAA		
Project Site	Coffey & Partners P/L 1985	6	11.0-26.0		✓				
	AGC Woodward Clyde 1992	13 3 pits 3	1.30 4.0 4.0-23.5	✓ ✓ ✓		40 33	3	0.05	
	Coffey & Partners P/L 1999	6	5.3-5.8		✓				
	Gilbert & Sutherland 2003	2	1.8	✓			12	0.39	35
	HMC Environmental 2005/06	10	9.5-20	✓		148	79	0.41	12
New Waste Water Treatment Plant	AGC Woodward Clyde 1992	2 1 pit 3	1.30 4.0 4-23.5	✓ ✓ ✓		7 8	3	0.04	
	GHD 2004	9 6	14.95-40.45 5-6	✓ ✓		108	15	0.40	2
	Coffey & Partners 2004	30	4-6.5	✓		21	21	0.36	12
Tweed Turf and Sand (now Hanson Tweed Sand)	Gilbert & Sutherland 2000	14	6	✓		172	69	0.22	
	Gilbert & Sutherland 2004	11	16	✓		353	54	0.58	12
Bay Lobster Aquaculture Project	Douglas Partners 2004	10	4	✓		80	10	0.25	30

4.2 Present Survey and Methodology

4.2.1 Soil and Sediment Sampling

During May 2005, eight (8) boreholes were drilled across the southern extraction site to a maximum depth of 20m. A further two (2) boreholes were drilled north of the realigned Altona Drive on 8 September 2006 to a maximum depth of 6m (see **Figure 8**). Soil samples were taken throughout the soil and sediment profile and subjected to preliminary screening and, where appropriate, further analyses including S_{CR} and TAA were undertaken. POCAS tests were performed on a number of samples to confirm results.



Samples were collected at 0.5m depth intervals to a depth of 3.0m to assist in identifying the oxidation front. Below 3.0m, the sampling frequency varied as summarised in **Table 2**.

Table 2
Soil Sampling Interval

Borehole	Sample Depth (m)	Sample interval (m)
BH1	0.0-3.0	0.5
	3.0-20.0	1.0
BH2	0.0-3.0	0.5
	3.0-18.0	1.0
BH3	0.0-3.0	0.5
	3.0-10.0	1.0
	10.0-18.0	2.0
BH4	0.0-3.0	0.5
	3.0-18.0	1.0
BH5	0.0-3.0	0.5
	3.0-6.0	1.0
BH6	0.5-3.0	0.5
	3.0-6.0	1.0
	6.0-9.0	3.0
BH7	0.0-3.0	0.5
	3.0-15.0	3.0
BH8	0.0-3.0	0.5
	3.0-20.0	3.0
BH9	0.0-6.0	0.5
BH10	0.0-6.0	0.5

A total of 148 samples were subjected to preliminary screening which included field pH (pH_F), peroxide oxidised field pH (pH_{FOX}), and reactions with H_2O_2 and HCl.

Of the 148 samples, 79 were selected for either S_{CR} /TAA or POCAS. The S_{CR} test was generally applied as it is more sensitive than the POCAS method in determining the acid sulfate risk in low pyritic sands and is essentially unaffected by sulfur in mineral and organic forms. However, a number of POCAS analyses were undertaken to confirm recorded oxidisable sulfur results. A good correlation was noted between the methods.

Samples selected to confirm oxidisable sulfur and existing acidity levels were selected based on the screening results, including the reduction in the soil sample pH level following peroxide oxidation and the reaction activity of the sample to H_2O_2 .

A summary of the initial ASS survey methodology and soil analysis results was forwarded to NSW DWE for comment. The DWE responded that, due to the homogenous nature of the soil profile within the floodplain in this area, the methodology was deemed acceptable although there was a requirement for the preparation of a detailed ASS management plan. A copy of the then DIPNR response is included as **Appendix 8**.

A comparison of the sampling intensity undertaken for this Project and that for the proposed sand extraction on the adjoining landholding is provided in **Table 3**.

Table 3
ASS Sampling Intensity

Project	No. of Boreholes	Area (Ha)	Boreholes / Ha	No. of Preliminary screening tests	No. of S _{CR} /TAA & POCAS tests
Tweed Turf and Sand (now Hanson Tweed Sand)	11	53.3	4.8	353	54
Cudgen Lakes Sand Extraction Project	10	45.35	4.5	148	79

The borehole intensity across both sites is almost identical. The soil testing regime varies between investigations with the emphasis on preliminary screening during the Tweed Turf and Sand investigation while the soil laboratory analysis undertaken for the Project included relatively more confirmation tests (S_{CR}/TAA & POCAS) per borehole. These different approaches were worthwhile and help to confirm the uniformity of the sand resource across the floodplain.

4.2.2 Mineralogy

In order to assist in confirming the presence of pyrite and any minerals which might be contributing to the observed acid neutralising capacity of the soil, several soil samples (BH1-2.5m, BH1-10m, BH2-3.0m, BH3-5.0m) were forwarded to the Environmental Analysis Laboratory at Southern Cross University and subjected to analysis via a scanning electron microscope. This information has also been of assistance in tailoring processing operations.

4.3 Results

4.3.1 Soil and Sediment Investigations

ASS investigations undertaken by HMC Environmental Consulting in May 2005 and September 2006 on the Project Site have confirmed previous investigations on this and adjoining sites.

Table 4
Preliminary Screening Results – Boreholes BH1 to BH4

Page 1 of 2

Depth (m)	BH1		BH2		BH3		BH4	
	pH _F	pH _{FOX}	pH _F	pH _{FOX}	pH _F	pH _{FOX}	pH _F	pH _{FOX}
0.5	4.7	3.9	5.2	3.7	6.1	4.4	5.2	4.0
1.0	4.8	4.1	6.0	4.3	5.7	2.4	5.5	2.2
1.5	4.6	3.5	5.4	2.0	6.0	2.0	5.8	2.1
2.0	5.6	2.2	6.0	2.1	6.1	2.1	5.7	2.1
2.5	5.0	2.2	5.6	2.1	6.3	2.2	6.0	2.3
3.0	5.4	2.3	6.1	2.2	6.4	2.1	7.9	2.6
4.0	8.1	3.0	7.8	3.0	7.4	2.9	7.6	2.7
5.0	7.3	2.5	8.0	5.7	7.6	3.2	7.3	2.6
6.0	9.0	6.3	8.9	5.7	7.8	3.1	8.8	6.0
7.0	9.1	6.7	8.9	6.5	8.9	6.6	8.0	3.5
8.0	9.2	7.0	9.1	6.2	9.0	6.8	8.9	6.7

Table 4 (Cont'd)
Preliminary Screening Results – Boreholes BH1 to BH4

Page 2 of 2

Depth (m)	BH1		BH2		BH3		BH4	
	pH _F	pH _{FOX}	pH _F	pH _{FOX}	pH _F	pH _{FOX}	pH _F	pH _{FOX}
9.0	9.2	6.8	9.0	6.9	9.0	6.6	8.8	6.4
10.0	9.0	7.0	9.1	6.9	9.0	6.7	9.2	7.0
11.0	8.9	6.9	9.0	6.9			9.0	7.0
12.0	8.9	7.0	8.6	6.7			9.0	7.0
13.0	9.0	7.1	9.0	6.8	8.4	6.4	9.2	6.7
14.0	9.0	6.9	8.8	6.3			8.2	6.5
15.0	8.9	6.6	8.9	6.8			9.1	6.9
16.0	9.0	6.8	8.8	6.5	8.8	7.0	8.9	6.8
17.0	9.2	6.7	8.6	6.8			9.2	7.0
18.0	9.0	7.0	8.7	6.9	8.7	6.9	9.1	7.1
19.0	9.0	7.0					9.3	7.2
20.0	8.8	7.2					8.7	6.6
Indicative of PASS								

Table 5
Preliminary Screening Results – Boreholes BH5 to BH8

Depth (m)	BH5		BH6		BH7		BH8	
	pH _F	pH _{FOX}	pH _F	pH _{FOX}	pH _F	pH _{FOX}	pH _F	pH _{FOX}
0.5	5.2	4.3	4.7	3.6	4.4	3.3	5.2	2.2
1.0	5.9	2.3	6.3	2.1	6.0	3.1	5.4	2.2
1.5	6.2	2.1	5.8	2.1	6.4	2.1	5.7	2.3
2.0	6.2	2.3	7.0	2.1	6.4	2.2	5.4	2.3
2.5	6.2	2.3	6.7	2.1	6.5	2.3	5.3	2.3
3.0	6.3	2.3	7.7	2.3	8.3	3.0	5.3	2.3
4.0	7.8	3.2	8.1	3.1				
5.0	8.5	6.1	8.3	3.6				
6.0	8.2	5.8	7.9	3.1	8.8	6.8	8.3	6.5
9.0			8.9	6.8	9.0	6.6	7.1	5.9
12.0					9.0	7.1	6.5	5.7
15.0					9.0	7.1	6.2	5.4
18.0					8.6	7.1		
20.0					7.0	5.9		
Indicative of PASS								

Table 6
Preliminary Screening Results – Boreholes BH9 and BH10

Depth (m)	BH9		BH10	
	pH _F	pH _{FOX}	pH _F	pH _{FOX}
0.5	5.1	4.2	5.5	4.3
1.0	5.6	2.0	5.6	4.4
1.5	6.0	2.2	4.9	2.3
2.0	5.7	2.5	4.7	2.4
2.5	4.5	2.5	4.5	2.5
3.0	7.0	2.5	4.5	2.5
3.5	7.1	2.6	4.7	2.5
4.0	8.6	6.7	4.8	2.7
4.5	8.9	4.7	6.1	2.7
5.0	8.3	6.5	9.1	6.0
5.5	8.4	6.0	8.7	5.9
6.0	8.7	6.4	8.7	6.1
Indicative of PASS				

Table 7
Laboratory Results - Action Criteria Exceedances in Soil and Sediment Profiles – BH1 to BH4

Depth (m)	BH1		BH2		BH3		BH4	
	S _{CR}	TAA	S _{CR}	TAA	S _{CR}	TAA	S _{CR}	TAA
0.5	0.00	7.0	0.00	9.0	0.0	0.0		
1.0	0.00	3.0	0.00	0.0	0.0	4.0		
1.5	0.08	5.0	0.33	7.0	0.26	0.0		
2.0	0.17	0.0	0.19	5.0	0.21	0.0		
2.5	0.58	5.0	0.18	0.0	0.22	0.0		
3.0	0.13	3.0	0.20	0.0	0.22	0.0		
4.0	0.09	0.0	0.15	0.0	0.15	0.0		
5.0	0.13	0.0	0.16	0.0	0.17	0.0	0.19	0.0
6.0	0.08	0.0	0.06	0.0	0.11	0.0	0.05	0.0
7.0	0.04	0.0	0.02	0.0	0.02	0.0		
10.0	0.20	0.0	0.02	0.0	0.02	0.0		
13.0	0.03	0.0	0.04	0.0				
16.0	0.01	0.0	0.16	0.0				
17.0							0.06	0.0
18.0			0.29	0.0	0.13	0.0		
20.0	0.04	7.0					1.07	0.0
Indicative of PASS								

Table 8
Laboratory Results – Action Criteria Exceedances in Soil and Sediment Profiles – BH5 to BH8

Depth (m)	BH5		BH6		BH7		BH8	
	S _{CR}	TAA	S _{CR}	TAA	S _{CR}	TAA	S _{CR}	TAA
0.5	0.0	0.0	0.0	3.0			0.31	0.0
1.0			0.41	0.0	0.01	0.0	0.25	0.0
1.5	0.28	0.0						
2.5	0.16	0.0						
3.0					0.12	0.0		
4.0	0.14	0.0						
5.0	0.06	0.0						
6.0			0.19	0.0	0.06	0.0	0.04	0.0
12.0					0.03	0.0		
15.0							0.00	0.0
20.0					0.01	0.0		
Indicative of PASS								

Table 9
Laboratory Results – Action Criteria Exceedances in Soil and Sediment Profiles – BH9 and BH10

Depth (m)	BH9		BH10	
	S _{CR}	TAA	S _{CR}	TAA
0.5				
1.0	0.11	12		
1.5			0.17	7
2.5				
3.0	0.15	7	0.06	10
3.5				
4.0				
4.5			0.06	5
5.0	0.03	0		
5.5			0.04	0
6.0				
Indicative of PASS				

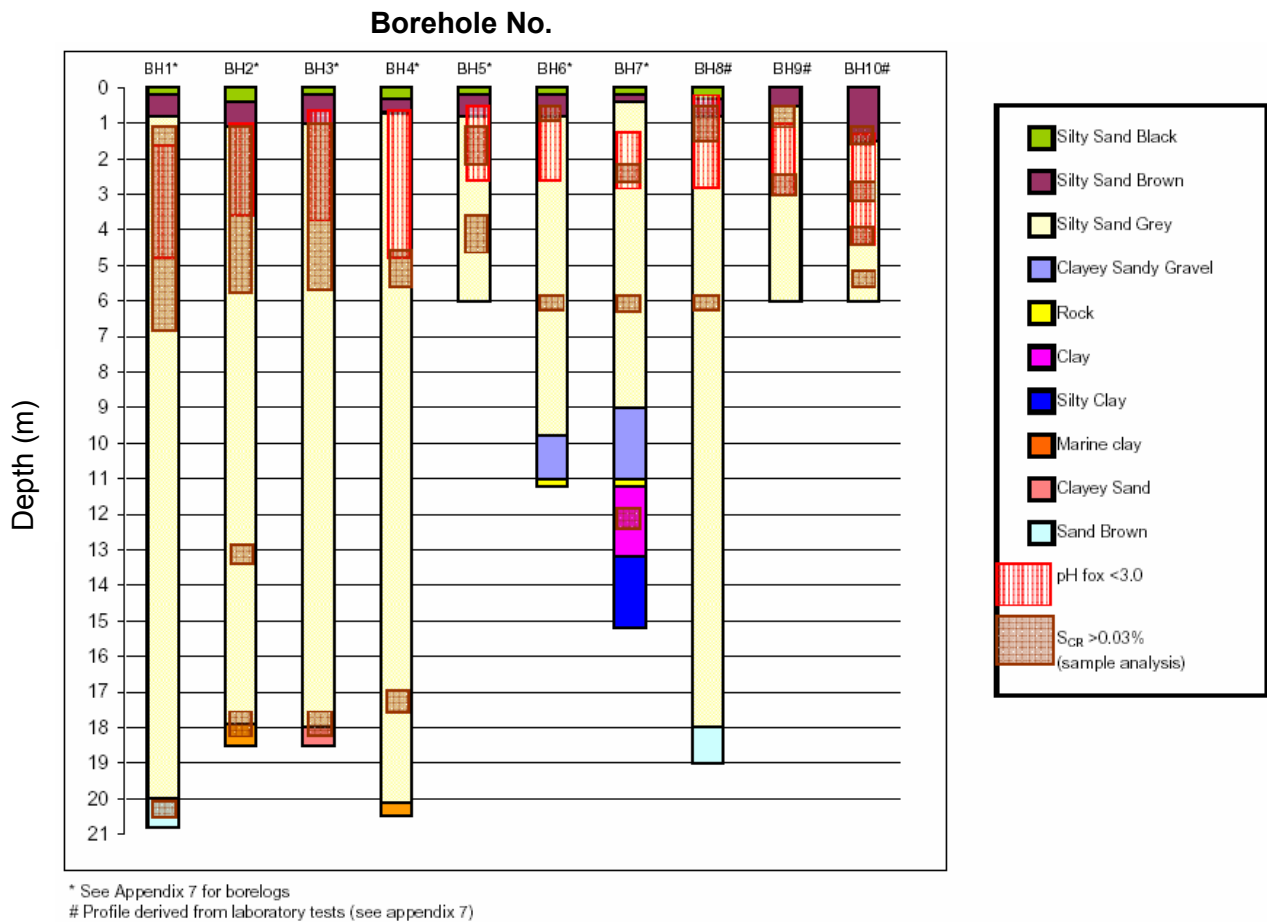


Figure 9
Soil Profiles within Boreholes

Table 10
Summary of Soil Analysis Results – Boreholes BH1 to BH4

Test	Range				Action Criteria
	BH1	BH2	BH3	BH4	
pH _F	4.6 - 9.2	5.2 - 9.1	5.7 - 9.0	5.2 - 9.3	≤4.0
pH _{FOX}	2.2 - 7.2	2.0 - 6.9	2.0 - 7.0	2.1 - 7.2	≤3.0 & min 1 unit < pH _F
Reaction to HCl	Nil-strong	Nil - moderate	Nil - strong	Nil - strong	Strong (indicative of shell etc)
Chromium Reducible Sulfur %S	0.00 - 0.58	0.00 - 0.33	0.00 - 0.26	0.05 - 1.07	0.03 (sandy sediments)
Total Actual Acidity mol H ⁺ /Tonne	0.0 - 7.0	0.0 - 9.0	0.0 - 4.0	0.0 - 0.0	18 mol H ⁺ /Tonne (sandy sediments)
Acid Neutralising Capacity mol H ⁺ /Tonne (%S)	0-263 (0.42)	0-376 (0.60)	0-195 (0.31)	116 (0.19) - 1449 (2.32)	

Table 11
Summary of Soil Analysis Results – Boreholes BH5 to BH8

Test	Range				Action Criteria
	BH5	BH6	BH7	BH8	
pHf	5.2 – 8.5	5.8 – 8.9	4.4 – 9.0	5.2 – 8.3	≤4.0
pHfox	2.1 – 6.1	2.1 – 6.8	2.1 – 7.1	2.2 – 6.5	≤3.0 & min 1 unit < pHf
Reaction to HCl	Nil – slight	Nil - moderate	Nil - slight	Nil – slight	Strong (indicative of shell etc)
Chromium Reducible Sulfur %S	0.00 – 0.28	0.00 – 0.41	0.01 – 0.12	0.00 – 0.25	0.03 (sandy sediments)
Total Actual Acidity mol H ⁺ /Tonne	0.0 – 0.0	0.0 – 3.0	0.0 – 0.0	0.0 – 0.0	18 mol H ⁺ /Tonne (sandy sediments)
Acid Neutralising Capacity mol H ⁺ /Tonne (%S)	0-129 (0.20)	0-125 (0.20)	0-101 (0.16)	7-177 (0.28)	

Table 12
Summary of Soil Analysis Results – Boreholes BH9 and BH10

Test	Range		Action Criteria
	BH9	BH10	
pHf	4.5-8.7	4.5-9.1	≤4.0
pHfox	2.0-6.7	2.3-6.1	≤3.0 & min 1 unit < pHf
Reaction to HCl	Slight-strong	Slight – strong	Strong (indicative of shell etc)
Chromium Reducible Sulfur %S	0.03 – 0.15	0.04 – 0.17	0.03 (sandy sediments)
Total Actual Acidity mol H ⁺ /Tonne	0 – 12	0 – 10	18 mol H ⁺ /Tonne (sandy sediments)
Acid Neutralising Capacity mol H ⁺ /Tonne (%S)	0-40 (0.06)	0-148 (0.24)	

No soil samples in the upper 1.0m of the soil profile recorded existing or actual acidity above the recommended action criteria ie. 18 mol H⁺/Tonne. Six of the ten boreholes recorded nil or very low levels of oxidisable sulfur in soil samples from this level. BH6, BH8 and BH9 did record elevated oxidisable sulfur concentrations less than 1m below the soil surface. No S_{CR} tests were undertaken from samples collected in the upper 1.0m of the soil profile in BH10.

In all boreholes below 5m depth, there appears to be sufficient buffering capacity within the sediments to neutralise any acid generation which might occur due to the oxidation of sulfidic sediments. There were no recordings of strong reaction to H₂O₂ in any sand sediments below 6m depth. A strong reaction was noted in some of the clayey basement samples but this material is not part of the sand resource and would not be extracted.

A moderate to strong reaction to HCl was noted in all the sediment samples collected from below 8m depth in BH1 to BH4. A strong reaction was also recorded in samples collected at or below 5.0m in BH9 and BH10. This helps confirm the presence of ANC as measured in sediment samples from this depth. The other deep borehole (BH8) recorded only a slight reaction to HCl and the buffering capacity measured may have been more related to the saline groundwater at depth in this part of the Project Site.

Soil and sediment analysis results indicate consistent soil and sediment strata with minor variation between boreholes across the Project Site and adjoining sites. Soils and sediments consist of black silty sand topsoil ranging from approximately 0.2m to 0.5m overlying a medium to fine grained grey sand interbedded with shelly and humic material to a depth of approximately 20m.. This depth reduces to approximately 9m to 10m along the southeastern part of the Project Site where it borders the Cudgen plateau. Boreholes drilled for Tweed Shire Council northwest of the Project Site indicate that the sand/silty sand depth may extend to 35m in this area.

Preliminary screening of soil and sediment samples indicate Potential Acid Sulfate Soils and Sediments (PASS) exists in all boreholes in the upper soil and sediment profile (<6m depth). There is only minor existing acidity in the soil and sediments with TAA levels in all samples below the action criteria (18mol H⁺/tonne).

Oxidisable sulfur has been recorded throughout the soil and sediment profile with action criteria (S_{CR} 0.03%) exceeded at varying depths. The maximum oxidisable sulfur level in the sand/silty sand was 0.58% (BH1, 2.5m). This result was approximately double the level of the next highest recorded level (0.33%). The average recorded S_{CR} level in the sand/silty sand for each borehole varied from 0.11% to 0.20%.

The maximum recorded oxidisable sulfur level (S_{CR} 1.07%) was in residual clay at a depth of 20m. The ANC for this sample greatly exceeded the acid generating potential. This material is not part of the sand resource and would not be extracted.

Generally, with few exceptions, the buffering capacity in the sediments below 6m depth exceeds the acid generating potential of the sediment. Evidence of shell and reaction to HCl helps confirm this observation.

4.3.2 Pilot Study – Initial Dredge Pond (DA96/518)

Between April and July 2006, a preliminary dredging operation was undertaken to establish the initial dredge pond capable of supporting the operational dredging approved in 1998 under DA96/518). Approximately 22 000m³ of sand was dredged and stockpiled within a bunded area on Lot 2 DP 216705. Water quality and acid sulfate soil management procedures were implemented as required by the Environmental Management Plan prepared by Gilbert and Sutherland (1997) and licences and approvals issued by the, then, Department of Environment and Conservation (now, Department of Environment and Climate Change (DECC)) and the, then, Department of Natural Resources (now, DWE). Daily water quality monitoring was undertaken in the dredge pond together with weekly monitoring of surrounding groundwater monitoring bores. Samples of the extracted soil material were collected at the rate of approximately 1/1000m³ and subjected to laboratory testing including preliminary screening (pH_F, pH_{FOX}) and confirmatory testing including S_{CR} and TAA. A number of samples were also subjected to the POCAS test to confirm results.

This preliminary dredging operation enlarged the excavated start-up pond from 200m² to 5,000m². The stockpile area and dredge pond were enclosed in a 2m high earthen bund. No discharge beyond the earthen bund occurred during the dredging operation.

Results from soil and sediment sampling indicated there was some oxidisable sulphur present in the extracted material at levels slightly above the action criteria for sandy sediments (S_{CR} 0.00 – 0.04%) . However, in all cases, the inherent ANC within the soil significantly exceeded any potential acid generation. The physical separation of the fines from the sand resource was evidenced by the result from a soil sample collected in the return dredge water during the dredging operation. The sample collected in the return water immediately upgradient of the initial dredge pond recorded a S_{CR} of 3.13%. Fines were returned via sluicing to the base of the initial dredge pond to ensure oxidation of any sulfidic material was minimised.

Water quality monitoring within the initial dredge pond did not record any acute acidification with the pH ranging from 6.3-8.2 with a mean value of 7.2. Weekly groundwater monitoring was undertaken at 10 sites during the preliminary dredging operation. Monitoring included in-situ testing via a multi-parameter meter and also monthly laboratory testing for chemical parameters including chloride, sulphate and dissolved metals.

4.3.3 Surface Water Quality

Regular water quality monitoring has been undertaken at a number of sites within and surrounding the Project Site including drains and the initial dredge pond. Drains in the area have been monitored intermittently since September 2003 though, monthly monitoring of the drain which bounds the southern boundary of the Project Site was undertaken during the initial dredging operation carried out during the period April to June 2006. There is very little evidence of extreme acidity with only one pH measurement recording less than pH 5.5 (SW5, 11/5/05, pH 2.73).

The initial dredge pond has consistently recorded pH levels at or above neutrality (ie. pH 7 or above) as summarised in **Table 13**.

The samples indicate that the water quality in the drains is variable with some tidal influence noted, especially during dry conditions, when electrical conductivity has been recorded up to 32,100 $\mu\text{S}/\text{cm}$ (SW6, 28/2/05). This monitoring site is located in a tidal drain northwest of the southern extraction site adjacent to the northwestern boundary of the new waste water treatment plant (see **Figure 10**).

Samples collected from the drain along the southern boundary of the Project Site (MB1A) have generally been fresh ($\text{EC} < 510 \mu\text{S}/\text{cm}$) although brackish to saline conditions have also been recorded (EC 2300 & 19510 $\mu\text{S}/\text{cm}$) during low flow conditions.

The start-up dredge pond (ie. prior to creation of the initial dredge pond) water was fresh and subject to elevated nutrient concentrations (max. nitrate 4.05mg/L, 14/10/04) presumably attributable to the permitted access of cattle into this area. This pond was bunded with no discharge off site even during major flood events (eg June 2005).

Table 13
Surface Water Monitoring

Site	Parameter					
	Range (mean)					
	pH	Electrical Conductivity (µS/cm)	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Suspended Solids (mg/L)	Dissolved Oxygen (mg/L)
SW5	2.73-8.55 (7.02)	257-24 200 (3 847)	0.25-4 (1.60)	0.06-0.32 (0.17)	1.7-16 (5.2)	1.81-13.3 (4.89)
SW6	5.98-8.57 (7.52)	102-32 100 (12 419)	0.2-2.8 (1.04)	0.05-0.38 (0.19)	1-13 (3.9)	1.45-4.48 (4.84)
MB1A	6.52-8.42 (7.26)	313-19 510 (2 992))	0.23-2.24 (1.06)	0.08-0.64 (0.34)	1.4-12 (5.07)	0.36-8.17 (2.84)
MB3A	6.71-8.93 (8.63)	488-24 200 (6 972)	0.11-1.68 (0.78)	0.04-0.42 (0.22)	2.8-10 (6.1)	0.36-8.24 (4.83)
MB4A	6.67-9.07 (7.49)	683-12 200 (5 270)	-	-	-	1.58-7.09 (5.35)
MB5A	6.76-9.3 (7.86)	62-602 (308)	-	-	-	2.33-7.95 (5.90)
Initial Dredge Pond	6.67-9.01(8.22)	120-1 390 (639)	1.7-7.0 (4.02)	0.17-0.28 (0.22)	6-68 (31)	5.84-8.37 (7.34)

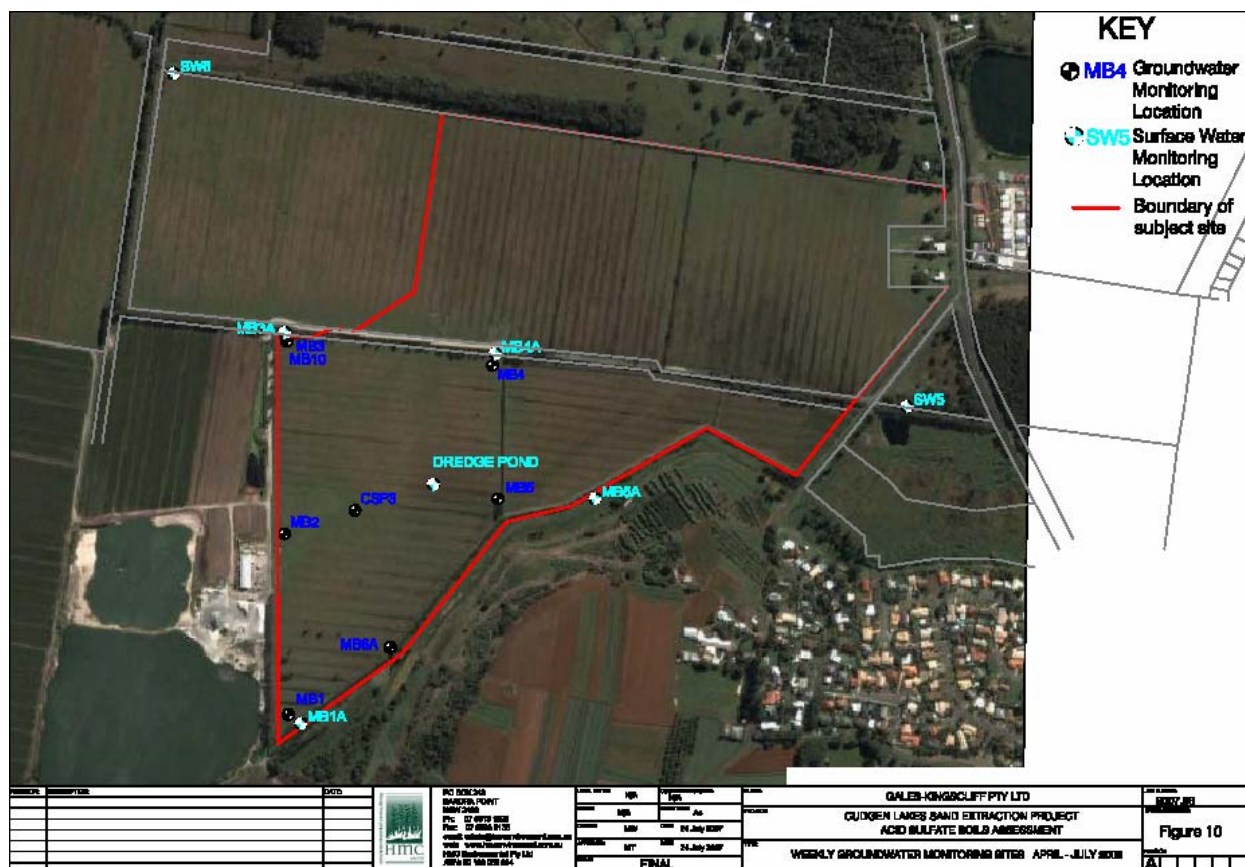
* See **Figure 10** for site locations.

The large dredge pond associated with the Hanson Tweed Sand operation has been regularly monitored for over ten years. During this period, recorded pH levels have been consistently in the range 6.5 to 9.0 and EC indicating a fresh to brackish range.

4.3.4 Groundwater Quality

A detailed investigation of the impacts of the Project on groundwater has been undertaken by Australian Groundwater and Environmental Consultants Pty Ltd (AGE, 2008). A number of groundwater investigations, including the installation of approximately 25 groundwater monitoring bores, have been conducted across the Project Site from 1991. The hydrographs for MB1 to MB5 indicate that the water table within the Project Site has a seasonal fluctuation of about ±0.50m with an average level of about 0.25m AHD. The natural ground surface level is approximately 1.0m AHD.

Analyses of groundwater samples by various investigators indicates that the salinity in the Quaternary sands aquifer is dependent on depth and distance from the Cudgen Plateau. The salinity generally increases with depth and movement north away from the Cudgen Plateau. There is also an apparent increase in salinity where monitoring bores are sited adjacent to tidally-influenced drains.



The mean pH level in all monitoring bores is around neutral (see **Tables 14** and **15**) with only one bore (MB2, mean 6.47) recording a mean pH level <6.5. This bore also recorded the only sample with a pH <5.5 (4.62, 19/7/2005). Elevated iron and aluminium levels have been measured in groundwater samples (Fe max. 26mg/L, Al max. 12 mg/L) which are indicative of ASS but are also features of the basalt soils of the Cudgen Plateau. It was noted that the scanning electron microscope recorded clay particles in the soil samples which may have been a source of the dissolved aluminium and iron.

Table 14
Groundwater Quality Summary

Monitoring bores July 1991-November 2005 ^(a)		
Parameter	Range	Mean
pH	4.62-8.75	7.28
Electrical conductivity $\mu\text{S}/\text{cm}^2$	115-38,200	6935
Chloride mg/L	8-15,198	1480
Sulphate mg/L	1-4000	435
Cl:SO ₄	0.1-0.5	
Iron mg/L	0.01-26	6.00
Aluminium mg/L	0.01-12	1.00

(a) see **Figure 10** for monitoring locations

The chloride to sulfate ratio in groundwater is acknowledged as a potential guide to the presence of ASS. A Cl:SO₄ ratio of <4 and certainly a ratio of <2 is a strong indication of an extra source of sulfate from previous sulfide oxidation (ASSMAC, 1998). The five monitoring bores MB1 to MB5 which have been sampled since 2002 have recorded Cl:SO₄ ratios ranging from 0.1 to 0.5 (see **Table 14**) which indicates a source of sulfate available that is not explained

by salinity alone. Oxidation of sulfidic sediments will lead to excess sulfate, however, if soil buffering capacity is available acid generation would not occur.

4.3.5 Mineralogy

Several soil samples were forwarded to the Environmental Analysis Laboratory (EAL) at Southern Cross University, Lismore and subjected to a Scanning Electron Microscope (SEM). The results from the SEM are summarised in **Table 16**.

Pyrite framboids were noted in the samples from 3.0m, 5.0m, and 10.0m depth (see **Figures 11** and **12**). No framboids were noted in the sample from 2.5m depth. These results support the laboratory analysis undertaken on these samples which recorded elevated levels of oxidisable sulfur in the samples from 3.0m, 5.0m and 10.0m depth. Very low levels of oxidisable sulfur (0.01%) were measured in the sample from 2.5m depth.

Table 15

Groundwater Quality Monitoring Summary - Background July 1991-March 2006 and During Initial Dredge Pond Sand Extraction April – June 2006

Site (1)	pH		EC uS/cm		Dissolved Oxygen mg/L		Calcium mg/L		Magnesium mg/L		Sodium mg/L	
	Background	Sand Extraction	Background	Sand Extraction	Background	Sand Extraction	Background	Sand Extraction	Background	Sand Extraction	Background	Sand Extraction
MB1	6.54-7.48	6.43-7.76	872-12720	948-1214	0.05-7.66	0.18-0.66	121-193	135-176	20-36	21-25	23-61	37-38
MB2	4.62-7.72	4.95-6.40	115-2394	88-199	0.16-5.09	0.16-0.43	0.4-1.8	0.2-0.5	0.33-2.5	0.1-0.2	12-19	12-16
MB3	6.56-7.73	6.68-7.35	874-3140	819-970	0.05-6.5	0.25-0.41	14.9-219	126-138	33-60	32-36	19-43	25-26
MB4	6.38-7.65	6.76-7.26	1056-6930	2240-2680	0.01-6.03	0.14-0.45	83-163	88-118	36-82	40-50	186-449	303-379
MB5	5.77-7.86	6.83-7.48	171-4850	1660-1900	0.14-7.44	0.18-2.51	82-153	90-111	36-78	45-49	155-285	225-257
MB6A	7.26-8.03	7.26-7.97	2910-4040	1953-3030	0.11-3.32	0.11-3.32	39-63	41-43	23-43	30-31	369-508	491
MB10	7.09-8.75	7.07-7.65	28600-43800	30800-36900	0.71-3.86	1.40-3.86	139-233	168	169-1150	960	6860-7460	7170
CSP3	6.50-7.80	6.34-7.21	300-901	517-591	0.09-0.34	0.15-2.61	50-157	82	5-17	6.3	9-27	18

Site (1)	Potassium mg/L		Sulphate mg/L		Iron mg/L		Aluminium mg/L		Manganese mg/L		Chloride mg/L	
	Background	Sand Extraction	Background	Sand Extraction	Background	Sand Extraction	Background	Sand Extraction	Background	Sand Extraction	Background	Sand Extraction
MB1	5-6	5	161-528	163-191	0.01-26	5.51-14	0.01-0.1	0.01-0.14	0.22-0.34	0.19-0.23	35-154	42-124
MB2	8-19	17-20	11-27	14-16	2.26-17	2.41-4.85	0.42-12	0.71-1.21	0.01-0.05	0.01	10-40	14-37
MB3	6-10	9-11	175-259	164-170	0.24-3.35	0.52-1.27	0.01-0.11	0.01-0.13	0.14-0.29	0.15-0.19	35-53	39-181
MB4	11-21	20-21	46-117	46-69	5.04-9.44	2.38-5.65	0.01-0.34	0.01-0.14	0.15-0.33	0.17-0.18	290-650	57-1141
MB5	11-40	19-24	165-291	198-256	0.06-6.43	0.67-1.36	0.01-0.09	0.01-0.13	0.16-0.34	0.17-0.18	217-328	220-606
MB6A	10-19	20	175-178	157-164	0.49-2.74	0.03-0.04	0.06-0.51	0.01	0.24-0.61	0.06	625-941	737
MB10	213-292	339	1600-2490	1680	0.81-1.96	0.03	0.05-0.2	0.03	0.52-0.64	0.08	350-13250	14000
CSP3	5-28	5	7-44	4.5	6.58-9.47	0.93	0.04-0.26	0.01	0.21-0.43	0.2	8-67	47

Site (1)	Bicarbonate mg/L		Turbidity NTU		Arsenic ug/L	
	Background	Sand Extraction	Background	Sand Extraction	Background	Sand Extraction
MB1	142-283	110-218	-	123-293	-	1-5
MB2	6-146	7.8-14	-	110-207	-	5-32
MB3	165-311	183-192	-	6.7-11	-	1-44
MB4	193-351	237-246	-	15-21.4	-	2-5
MB5	190-315	233-257	-	15-17	-	1-5
MB6A	172-206	139	-	1.9-3.2	-	11
MB10	190-250	247	-	1.2	-	111
CSP3	161-201	215	-		-	

(1) selected monitoring bores surrounding initial dredge pond

The soil sample from 10.0m depth which had the extremely high ANC showed evidence of crystalline calcium minerals which supports the evidence of buffering capacity measured within the sediments.

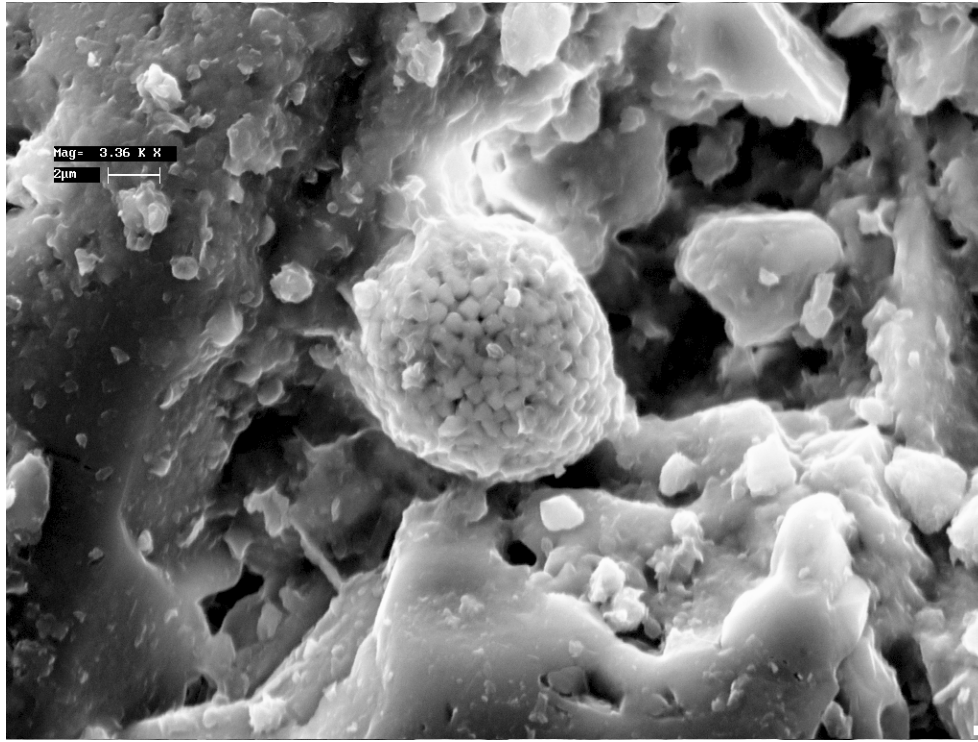


Figure 11
Scanning Electron Microscope Image - Pyrite Framboid
(Source: EAL 2006)

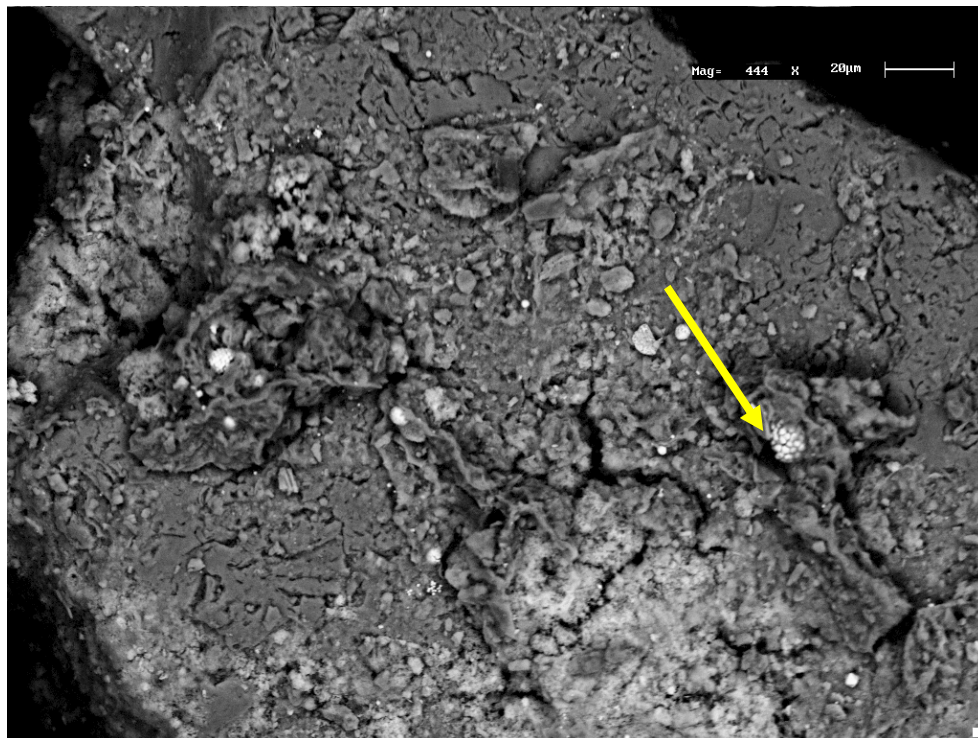


Figure 12
Scanning Electron Microscope Image - Pyrite Framboids on Sand Grain
(Source: EAL 2006)

However, as noted above, the sample collected from 2.5m in BH1 recorded an %S_{CR} of 0.01 and existing acidity of 75 mol H⁺/t. No ANC was recorded. At 3.0m depth in BH2, more oxidisable sulfur is noted (%S_{CR}, 0.11) and some existing acidity is also measured (TAA, 50mol H⁺/t). At 5.0m in BH3, there is no existing acidity but 0.16% S_{CR}. Some ANC is also recorded at this depth which is almost sufficient to offset any acid production. The soil sample from 10m depth in BH1 recorded a similar %S_{CR} level (0.15) as the sample from BH3, however, the ANC measured was 1209 mol H⁺/t which far exceeds the potential acid generation (95 mol H⁺/t) if all the sulfidic material was oxidised.

All these results confirm other laboratory analyses which provide a snapshot of the distribution of oxidisable sulfur and buffering capacity within the soil profile.


Table 16
EAL Soil Analysis including SEM Identification

RESULTS OF ACID SULFATE SOIL ANALYSIS (Page 1 of 1)											
4 samples supplied by HMC Environmental Consulting Pty Ltd on 9th February 2006 - Lab. Job No. E5234 Analysis requested by Mark Tunks.											
Sample Site	Depth (m)	EAL lab code	TAA pH _u	Titrate Actual Acidity (TAA) mole H ⁺ /tonne (to pH 6.5)	Reduced Inorganic Sulfur (% chromium reducible S) (%Scr) (note 2)	Reduced Inorganic Sulfur (Scr) mole H ⁺ /tonne	% ANCE _{FF} %CaCO ₃	a-ANCE _{FF} mole H ⁺ /tonne	NET ACIDITY Chromium Sulfate mole H ⁺ /tonne (based on %Scr)	LIME CALCULATION Chromium Sulfate kg CaCO ₃ /tonne DW (includes 1.5 safety factor)	SEM Identification Fe/ S Ratio Analysis using EDAX Photos Provided - Note 11
Method No.			23A	23F	22B	a-22B	19A2	a-19A2	note 5	note 5	
BH1	2.5m	E5234/1	4.53	75	0.011	7	0.00	0	82	6	No Pyrite Fromboids identified
BH2	3.0m	E5234/2	5.26	50	0.110	69	0.00	0	119	9	High Numbers of Pyrite Fromboids- no clay coatings
BH1	10.0m	E5234/3	9.62	0	0.152	95	6.05	1209	-711	-53	Pyrite Fromboids- clay coatings- Crystalline Calcium minerals
BH3	5.0m	E5234/4	9.22	0	0.156	97	0.55	110	24	2	Pyrite Fromboids- clay coatings

NOTE:
1 - All analysis is Dry Weight (DW) - samples dried and ground immediately upon arrival (unless supplied dried and ground)
2 - Samples analysed by SPOCAS method 23 (ie Suspension Peroxide Oxidation Combined Acidity & sulfate) and 'Chromium Reducible Sulfur' technique (Scr - Method 22B)
3 - Methods from Ahern, CR, McElnear AE, Sullivan LA (2004). *Acid Sulfate Soils Laboratory Methods Guidelines*. QLD DNRME.
4 - Bulk density was determined immediately on arrival to laboratory (insitu bulk density is preferred)
5 - ABA Equation: Net Acidity = Potential Sulfidic Acidity (ie. Scr or Sox) + Actual Acidity + Retained Acidity - measured ANC/FF
6 - For Texture: coarse = sands to loamy sands; medium = sandy loams to light clays; fine = medium to heavy clays and silty clays
7 - ... Denotes not requested or required
8 - CRS, TAA and ANC are NATA certified but other SPOCAS segments are currently not NATA certification
9 - Results at or below detection limits are replaced with '0' for calculation purposes.
10 - Projects that disturb >1000 tonnes of soil, the ±0.03% S classification guideline would apply.
11 - SEM Identification is not NATA registered but confirmation provided by EDAX X-ray analysis and photos

(Classification of potential acid sulfate material if: coarse Scr≥0.03%S or 19mole H⁺/t; medium Scr≥0.06%S or 37mole H⁺/t; fine Scr≥0.1%S or 62mole H⁺/t)

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checked: 

4.4 Discussion

Results from extensive soil investigations both within the Project Site and from surrounding areas of the Tweed River floodplain are very consistent. The soil strata is generally homogenous with a thin band of silty sand and silty loam overlying sandy sediments which are generally 20m in depth although reducing to 9m to 12m along the southeastern part of the Project Site adjacent the Cudgen Plateau. Boreholes drilled for the new wastewater treatment plant northwest of the Project Site indicate that the sand/silty sand depth may extend to 35m in this area.

Oxidisable sulfur concentrations in the sand resource are also consistent. The action criteria (S_{CR} 0.03%) was exceeded at varying depths with the average recorded S_{CR} level for each borehole varying from 0.11% to 0.20%. The maximum oxidisable sulfur level in the sand/silty sand was 0.58%. (BH1, 2.5m depth). During the investigations, the maximum recorded oxidisable sulfur level (S_{CR} 1.07%) was in residual clay below the sandy/silty sand at a depth of 20m. However, the acid neutralising capacity within the residual clay sample greatly exceeded the acid generating potential. Regardless, the basement / residual clays would not be extracted as part of the Project.

Overall, TAA levels from all investigations are very low with a maximum of 35 mol H⁺/tonne recorded on an adjoining Hanson Tweed Sand extraction operation. Significant ANC is also recorded for those sediments below 5m to 6m depth with shell fragments common. Preliminary screening of soil and sediment samples indicates that PASS is located in all boreholes in the upper soil profile (<6m depth). There is very little existing acidity in the soil with TAA levels in all samples collected within the Project Site below the action criteria (18mol H⁺/tonne).

Generally, with few exceptions, the buffering capacity in the sediment below 6m depth exceeds the acid generating potential of the soil and sediments. Evidence of shell and reaction to HCl helps confirm this observation.

4.5 Design and Operational Safeguards

4.5.1 Introduction

The dredging of the initial dredge pond in accordance with the current approval (DA96/518) to extract 400,000m³ of sand from the Project Site has provided detailed information on the management of ASS for the sand resource found in this area. The information collected together with the information obtained from the long term adjacent sand extraction operation, would help ensure that practical, cost-effective practices are adopted to minimise any acid generation from the disturbance of ASS. The information, together with previous management plans, would also be used to compile a site specific Acid Sulfate Soil and Sediment Management Plan (ASSMP) for the Project. In accordance with relevant legislation, consultation with government agencies, in particular DWE and DECC, would be undertaken during the compilation of the ASSMP for the Project.

There are two important factors which provide some intrinsic protection against acid generation during the life of the Project.

1. The physical separation and interment of the fines within the base of the extraction ponds is a management strategy which is an integral part of sand extraction and processing. The physical washing of the sand to improve the final product provides a means to separate potentially acid generating material from the resource and convey this material to a zone (below water) where acid generation is unlikely to occur.
2. The natural buffering capacity of the sediments below about 6m depth provides an acid neutralising process which requires minimal active management.

Both of these processes would occur throughout the life of the Project and provide an ongoing measure to assist in minimising any acid generation from the operation. These features of the Project have been demonstrated at the adjoining Hanson Tweed Sand operation where the sand extraction process involving hydraulic dredging has been undertaken successfully for over 10 years (as Tweed Turf and Sand).

The remainder of this section focuses on describing the activities on site that would require the management of PASS or ASS and describing the components of this management. An important component in managing and/or demonstrating effectiveness of management of PASS or ASS is the monitoring of the groundwater and surface water quality in an appropriate monitoring regime as described in throughout this subsection.

4.5.2 Activities Requiring Management

There are three main operations that would be undertaken during the life of this Project which involve the management of ASS or PASS. Details of these operations and the component activities requiring management are set out as follows.

i. Extraction (through excavation and dredging) and processing of construction materials.

Site Stripping/Bunding

- Survey to identify extraction and treatment areas
- Sampling of topsoil/loam (<1.0m depth) within the extraction sites to determine alkaline amendment application rate
- Application of alkaline amendments at calculated rate prior to site stripping or following placement in banded treatment areas
- Stripping of vegetation and topsoil within identified extraction area
- Validation of stripped material prior to placement in perimeter bunds or stockpiled and vegetated for rehabilitation work

Extraction and Processing of Construction Materials

- Material hydraulically removed from the southern extraction pond and pumped to the processing area
- Extracted material for processing washed via a hydrocyclone or similar hydraulic separation device
- Fines/silts returned to the extraction ponds
- Washed sand tested for PASS and existing acidity if required
- Washed sand treated with alkaline amendments if potential or actual acidity (after adjustment for measured ANC) exceeds action threshold values
- Treated material subjected to validation testing to confirm adequate alkaline amendments incorporated

ii. Extraction of fill sand and hydraulic pumping to remote fill sites via a pipeline corridor

The process would include hydraulically pumping sand to the fill sites via pipelines and pumping the silt-laden tailwater back to the extraction ponds via a separate pipeline. The operations on each fill site would be assessed further during the approval process for the filling of each site.

iii. Receipt of Virgin Excavated Natural Material (acid generating and non-acid generating)

Two types of VENM would be accepted on site.

- (i) VENM(a) – material excavated from the earth that does not contain any AASS or PASS.
- (ii) VENM(b) – sands and clays that contain AASS or PASS.

The receipt of VENM(a) would require appropriate validation and verification protocols to ensure that this material does not contain acid generating or contaminated material. Any material verified as VENM(b) which is suitable for processing would be stockpiled within an appropriate area adjacent to the active southern extraction pond for treatment or placed within the southern extraction pond at the active dredge face. Material not suitable for processing would be placed either below the water table within the northern extraction pond or placed at the base of finalised sections of the southern extraction pond.

4.5.3 Recommended Management Procedures

4.5.3.1 Management of Acid Generation During Operations

Objectives

It would be the Proponent's objective to minimise the oxidation of PASS material during site stripping, extraction and processing operations. In order to achieve this objective, the Proponent would aim to:

- place all pyritic fines within the extraction ponds in a manner which ensures adopted surface and groundwater quality criteria are met;
- treat stripped topsoil/loam at determined rates prior to use in earth bunds or rehabilitation; and
- treat and validate washed sand where required.

Management and Safeguards

These objectives would be achieved using the following operational safeguards and management measures.

Site Stripping

- Collection of soil samples at a rate of 4 per hectare prior to the removal of topsoil/loam.
- Incorporation of alkaline amendment into the soil at the calculated rate prior to stripping or following placement on treatment pads.
- Completion of validation soil sampling of treated material at a rate 1 sample per 1 000m³ prior to final placement.

Sand Extraction & Processing

- Bunding of extraction and processing areas to control drainage.
- No extraction of residual clay material from the base of the sand resource.
- Ensuring that all surface water and runoff from the extraction and processing areas drain into the extraction ponds.
- Conveyance of return water in a manner which ensures fines/silts remain in suspension and do not settle in drainage lines.
- Processing of extracted material via a hydrocyclone or similar to hydraulically separate the fines (potentially containing pyrite) from the sand resource.
- Treatment of all material not processed using a hydrocyclone or similar with alkaline amendments.
- Return of all separated fines to the extraction ponds for final placement preferably using a pipeline with its discharge point at least 1m below the water surface.
- If a pipeline is not used, any sluicing would be undertaken in a manner that ensures turbulent flow and sufficient velocity to prevent the deposition of fines material within the drainage line.
- Settlement of silts/fines a minimum depth below the projected minimum level of the southern extraction pond water surface. It is recognised practice within existing dredging operations in similar sand bodies in NSW, eg. Kurnell and Dunmore, for silts to be placed where they will settle at least 2m below the water surface (R.W. Corkery – pers. comm.). It is understood this practice has been adopted at these locations for almost the past 20 years with no deleterious impacts arising from the settled silts/fines.

It is noted that the action of the dredge would result in the recovery of the sand across the depth of the resource resulting in the mixture of the deeper materials with excess buffering capacities with the upper PASS.

Monitoring

Validation testing of extracted sand and stripped topsoil/loam, would be undertaken as described in **Table 17**.

Table 17
Acid Sulfate Soil and Sediment Testing

Site	Period	Frequency	Tests	Action criteria
Extracted sand (following hydraulic separation at fill sites and washed sand products)	Initial 2 weeks following commissioning of sand extraction operation	1 sample/day	S _{CR} /TAA	>0.03%/18 mol H ⁺ /t
	Ongoing	1 sample/week	S _{CR} /TAA	>0.03%/18 mol H ⁺ /t
Stripped topsoil/loamy sand / unwashed sand	During stripping operations	4 samples/ha	S _{CR} /TAA	>0.03%/18 mol H ⁺ /t
	Post treatment validation	1 sample/1000m ³	S _{CR} /TAA	>0.03%/18 mol H ⁺ /t

In accordance with ASSMAC guidelines, the action criteria for individual samples is >18mol H⁺/t (0.03%S) with no sample to exceed 25mol H⁺/t (0.04%). If any single sample exceeds 18mol H⁺/t (0.03%), then the average of any 6 consecutive samples (including the exceeding sample) must have an average not exceeding 25mol H⁺/t (0.04%S). If more than 1 sample in any 6 consecutive samples exceeds 25mol H⁺/t (0.04%S) then the average of any 6 consecutive samples (including the exceeding samples) must have an average content not exceeding 18mol H⁺/t (0.03%S).

In order to ensure compliance with relevant sampling guidelines, the following measures would be implemented.

- The Contractor, in consultation with a qualified consultant, would ensure that the required number of samples have been collected and tested as specified.
- The sample size, intensity, methodology, handling and laboratory analysis would be conducted in accordance with the NSW ASS Manual (ASSMAC, 1998) and amended laboratory methods.
- Soils would be described according to the Australian Soil Classification (Isbell 2002).
- Groundwater and surface water monitoring would be undertaken in accordance with ASSMP Elements GW1 & SW1.

All monitoring procedures should be reviewed annually to ensure only meaningful data is being collected.

Corrective Actions

In the event that validation or monitoring criteria are exceeded, the following corrective actions would be implemented.

- For stripped topsoil or hydraulically separated sands, the ANC of the material would be tested. If the measured ANC is insufficient to neutralise the existing and potential acidity, alkaline amendments would be incorporated at the appropriate rate.

- For stockpiled loamy sand and unprocessed sand, the TAA would be tested and, alkaline amendments would be incorporated into the material at the appropriate rate.
- Following treatment of loamy sand and unprocessed sand, validation testing would be undertaken and additional alkaline amendments applied as required. This process would be repeated until compliance criteria is met.
- If the pH level within the extraction ponds falls below pH 6.5, hydrated lime would be introduced at the appropriate rate. Care would be taken to ensure target pH level is not “overshot” leading to severely alkaline conditions (pH>9.0).

Reporting and Auditing

Records of monitoring would be kept by site management together with the application rates of the alkaline amendment used as neutralising agents. These records would be made available to the statutory authorities upon request.

The effectiveness of the operational safeguards and monitoring would also be audited internally on a quarterly basis with environmental audits of extraction and processing operations conducted by an external environmental consultant and site management on an annual basis.

4.5.3.2 Management of Imported Acid Generating VENM (VENM(b))

Objectives

It is the Proponent's objective to provide a regional facility to treat, use or store VENM(b) in accordance with relevant environmental guidelines. Therefore, it would be the Proponent's aim to ensure:

- imported VENM(b) is properly managed, including treatment and validation as required, to permit production of material suitable for construction uses or placement either at the base of the southern extraction pond or below the water table within the northern extraction pond;
- any acidic runoff is treated with alkaline amendments to meet adopted water quality targets; and
- a verification process is in place and implemented to provide protection from the receipt of unsuitable material.

Management and Safeguards

These objectives would be achieved using the following operational safeguards and management measures.

- Assessment of the soil material by a suitably trained person in the practices recorded in the NSW ASS Manual and classification as VENM(b) prior to acceptance at the Project Site.
- Provision of documentation for each truck load of VENM(b) received at the Project Site that demonstrates the excavation of VENM(b) and its transportation and handling was conducted in accordance with the NSW ASS Manual to prevent the generation of acid.

- Placement of VENM(b), received at the premises which is intended to be:
 - i. dredged or interned at the base of the southern extraction pond; or
 - ii. placed within the northern extraction site a minimum 1.0m below the lowest recorded water table elevation;both within 24 hours of the time of its excavation at the originating site.
- Testing of the pH of the VENM(b) immediately prior to under-water disposal backfilling to ensure the pH is not less than 5.5.
- Testing of the pH of the water into which the VENM(b) is placed to ensure it is not less than 6.5 at any time.
- Termination of VENM(b) receipt at the premises, if the pH of the water falls below 6.5, until approval to continue is received in writing from the DECC (EPA).

The Proponent would also follow a VENM verification procedure designed to ensure that the only waste received at the premises is VENM. The Proponent would follow procedures that include (but are not necessarily limited to) the following.

1. Conduct of pre-acceptance validation prior to agreeing to accept VENM from any source. This would incorporate a procedure for collection and recording of information about the waste including:
 - the location of the site from which the waste originates (the Waste Origin Site), including the street address;
 - a short general description of the Waste Origin Site and any improvements on the site;
 - a brief history of activities at the site with particular reference to the commercial or industrial activities which may have resulted in the site becoming chemically contaminated;
 - whether the Waste Origin Site has been the subject of contaminated site investigations and, if so, a summary of the findings of the investigations would need to be provided;
 - a brief description of the physical nature of the material(s) proposed to be transported from the Waste Origin Site to the premises;
 - sufficient other background information or analysis data to validate that the material has been properly classified as VENM; and
 - an estimate of the total amount of VENM proposed to be received from the Waste Origin Site where such amounts are greater than 100 tonnes.

Note: the procedure would also include a mechanism whereby, having obtained the above information, further inquiries as may be reasonably required, are diligently made to ensure that waste to be transported to the premises from the Waste Origin Site is VENM.

2. Verification at the time of acceptance must provide reasonable assurance that the material is from a Waste Origin Site properly identified in accordance with the pre-acceptance verification procedure and is VENM from that site. The information obtained and recorded must include:

- the date and time of entry of the transporting vehicle;
- a description of the type(s) of VENM in the load;
- the weight of each load;
- the identification details of the source of the VENM (the VENM supplier) and site of origin;
- the details of the transporting vehicle including its registration number and driver; and
- identification details of the company/individual which has employed or contracted the driver to transport VENM to the premises.

Material identified not to be VENM would not be accepted at the site.

3. Implementation of a program of inspection and audit of deliveries designed to evaluate the overall effectiveness of the above procedures and which:
 - is statistically designed to provide confidence that waste being transported to the premises from a Waste Origin Site has been properly classified as VENM;
 - segregates, in a defined area, any load of waste which is the subject of inspection and/or sampling until such time as the results of the inspection and/or sampling are known; and
 - segregates material which is found to be improperly classified as VENM in a discrete, defined area for off site disposal.

Monitoring

Monitoring as outlined in **Table 18** would be undertaken in relation to VENM(b) receipt and processing / internment.

Table 18
VENM(b) Testing and Related Monitoring

Monitoring Site	Period	Frequency	Field Tests	Action criteria
VENM	Ongoing	1 sample/day from each load	pH	<5.5
Extraction Pond Water	During placement of VENM(b)	1 sample/day	pH	<6.5
	Minimum six months after final placement	1sample/week	pH	<6.5
Up & Down Gradient Groundwater	During placement and minimum 1 year after final placement	Monthly	pH, elevation (mAHD)	<6.5 ⁽¹⁾ Minimum 0.5m above top of untreated VENM(b) in northern extraction site

⁽¹⁾This criteria may be varied, subject to approval from statutory bodies, to more closely reflect baseline conditions

Monitoring would be undertaken so that:

- the pH of each load of VENM(b) would be tested at the disposal site immediately prior to its placement under water using the test method referred to in NSW Acid Sulfate Soil Manual (Method 21A and/or Method 21Af) or other approved method;
- the pH of the water into which the VENM(b) is placed would be monitored daily during VENM(b) placement into water and thereafter weekly for a period of six months from the date the last load of VENM(b) was placed underwater; and
- the pH and elevation of up and down gradient groundwaters at the premises would be monitored a minimum 1 month and for a minimum of 1 year after the last load of VENM(b) has been disposed of.

All monitoring procedures should be reviewed annually to ensure only meaningful data is being collected.

Corrective Action

The following corrective actions would be undertaken in the event that monitoring criteria are exceeded or incorrect handling or receipt practices are identified.

- Any VENM(b) which has dried out, undergone any oxidation of sulfidic minerals or which has a pH of less than 5.5 must be sampled at the maximum rate of 1 sample/1 000m³ to determine the %S_{CR} & TAA. If analysis records S_{CR} >0.03% or TAA > 18mol H⁺/t, the material is to be treated with the calculated amount of alkaline amendment. Prior to final placement or further processing, verification testing at the rate of 1 sample/1 000m³ to confirm S_{CR} <0.03% and TAA <18mol H⁺/t would be undertaken.
- As soon as possible after becoming aware that any waste/material accepted at the premises is not VENM, the Proponent would:
 - a) notify the DECC (EPA) in writing;
 - b) remove the material/waste from the premises and dispose of it at a facility licensed to take such waste; and
 - c) implement a procedure to audit all further incoming loads from that Waste Origin Site prior to accepting any further waste, until such time as the results of such audits demonstrate that the Waste Origin Site's screening and assessment procedures have been corrected to prevent further misclassification of waste.
- Retesting of materials in the designated treatment pads using S_{CR} + TAA with additional alkaline amendment applied as necessary.

Reporting and Auditing

In accordance with the Environment Protection Licence issued for the operation, the Proponent would submit to the DECC (EPA) an annual return which would include the following.

- The results of all required monitoring.

- A graph showing pH of the water at the monitoring frequency specified for each year. The format would show pH trend for each extraction pond over the life of the licence.
- A graph showing quarterly pH in the up and down gradient groundwater at the monitoring frequency specified in **Table 18** and provided in a format that shows the groundwater pH trend over the life of the licence.

In addition to the annual return, if the pH of the water falls below 6.5, or if waste other than VENM is received at site, the Proponent would notify the EPA in writing as soon as practicable.

The Proponent would also retain certain documentation for each truck load of VENM(b) received at the site which indicates:

- a) the details of the originating site (name, address, owner & developer, contact details);
- b) the details of the transporter (name, address, contact details, vehicle registration);
- c) date and time of the extraction of the VENM(b);
- d) pH of the VENM(b) at the time of its extraction, and at the time immediately prior to its placement underwater; and
- e) the name of the person (certified practicing soil scientist) who assessed the material and classified it as VENM(b).

Both the annual return and documentation on VENM(b) received would be retained by the Proponent for four years from the date of the annual return receipt of the VENM(b).

During the initial stages of the operation, a monthly internal environmental audit of VENM(b) receipt and treatment would be undertaken to ensure appropriate treatment is being conducted and records are up to date. Additionally, verification of neutralising agent application volumes and verification results would be sought prior to burial of VENM(b).

4.5.4 Groundwater and Surface Water Monitoring

4.5.4.1 Introduction

In the event that acid is generated by either the soils or sulfidic sediments on site or the imported VENM(b), its presence would be identified in either the groundwater or surface water. Consequently, it is recommended that a comprehensive groundwater and surface water monitoring program is undertaken to establish the impacts (or lack of impacts) the site activities are having on water quality.

It is fundamental that site management has systems in place to regularly review the monitoring data to ensure that any corrective actions, such as those described in Sections 4.5.3.1 and 4.5.3.2 are implemented as soon as possible.

4.5.4.2 Groundwater Monitoring

Objectives

It is the Proponent objective to:

- minimise the impact of the extraction and processing operation on groundwater hydrology and quality; and
- where possible, maintain the groundwater elevation outside the boundary of the Project Site within the seasonal range.

Management and Safeguards

These objectives would be achieved using the following safeguards and management practices.

- Identifying all existing groundwater monitoring bores (see AGE 2008).
- Confirming baseline groundwater quality.
- Regularly measuring groundwater levels.
- Investigating complaints especially allegations of poor water quality in neighbouring dams/bores.
- Assessing groundwater monitoring results for ASS indicators and salinity.
- Preparing a response protocol for identified negative impacts from works.
- Installing a height gauge within the southern extraction pond scaled to m AHD.

Monitoring

Groundwater within the existing bores would be monitored as described in **Table 19**.

Table 19
Groundwater Quality Monitoring

Site	Frequency	Tests
All groundwater monitoring bores	Monthly during first year, extending to quarterly.	Field measurements of pH, EC, temperature, REDOX potential and groundwater level (m AHD).
	Quarterly	pH, EC, temperature, REDOX potential, groundwater level (m AHD), dissolved oxygen, calcium, magnesium, sodium, potassium, bicarbonate, sulfate, chloride, filterable iron, aluminium and arsenic.
Continuous groundwater elevation loggers (currently located in MB3, MB5 MB6A & CSP3).	Continuous during operations	Groundwater level (m AHD).

Water levels in the southern extraction pond would be monitored daily via the height gauge scaled to m AHD. Regular inspections of the site, the types, locations and effectiveness of control actions in place would also be undertaken.

Water quality in neighbouring dams would be monitored as required.

All monitoring procedures should be reviewed annually to ensure only meaningful data is being collected.

Corrective Actions

Where groundwater quality or levels are identified outside specified criteria or where detrimental effects to groundwater quality are likely to occur, the following corrective actions would be implemented.

- Treatment of oxidising PASS as required and monitoring of runoff from stockpiled VENM(b) and loamy sand.
- Isolation of ASS material exposed due to lowering of groundwater table associated with inappropriate drainage or other construction methods from stormwater and off site drainage.
- Reduction of extraction rate in event that off site groundwater drawdown exceeds predicted levels identified to be causing environmental impacts

Reporting and Auditing

Records of the monitoring activities, complaints received, and control actions subsequently taken would be maintained for a period of at least 4 years. These records would be made available to Tweed Shire Council, EPA, DWE or other statutory authorities upon request.

Internal quarterly environmental audits of extraction and processing operations would be undertaken by site management and external audits by an environmental consultant on an annual basis.

4.5.4.3 Surface Water Quality Monitoring

Objectives

It is the Proponent's objective to maintain existing surface water quality and ensure that the extraction and processing operation does not negatively impact on the background surface water quality.

Management and Safeguards

The following management procedures and safeguards would be implemented to ensure that the existing surface water quality is maintained.

- Ensuring drainage of all stormwater from the areas associated with stripping is directed to the extraction ponds.

- Placing of fines separated during washing or returned from the nominated fill sites at the base of the extraction ponds via a snorkel or similar, discharging a minimum 3m below the water surface to minimise any resuspension of the fines.
- Making flocculants available to permit dosing of the southern extraction pond should suspended solid levels exceed adopted criteria.

Monitoring

Surface water quality would be monitored as described in **Table 20**.

Table 20
Surface Water Quality Monitoring

Site	Period	Frequency	Tests	Action criteria
Extraction Ponds (0.5m depth)	Initial 2 weeks following sand extraction operation commencement	Daily	pH, EC, dissolved oxygen, redox and water level (m AHD)	pH <5.0 water quality trend outside adopted background levels
	Ongoing during operation	Weekly	pH, EC, dissolved oxygen, redox and water level (m AHD)	pH <5.0 water quality trend outside adopted background levels
		Monthly	Above + calcium, magnesium, sodium, potassium, sulfate, chloride, bicarbonate, filterable iron, aluminium, arsenic, and water level (m AHD)	pH <5.0 water quality trend outside adopted background levels
		Quarterly	pH, EC, dissolved oxygen, redox	pH <5.0 water quality trend outside adopted background levels
Extraction Ponds (1.0m depth intervals to base of excavation)				
Southern Extraction Pond (0.5m depth)	Post Operation	Quarterly	Above + calcium, magnesium, sodium, potassium, sulfate, chloride, bicarbonate, filterable iron, aluminium, arsenic, and water level (m AHD)	pH <5.0 water quality trend outside adopted background levels
Drains (SW5, SW6, MB1A, MB3A, MB5A)	Ongoing during operation	Monthly	pH, EC, dissolved oxygen, redox	pH <5.0 water quality trend outside adopted background levels

Note: All daily and weekly tests to be undertaken with hand-held meters.

Corrective Actions

If a significant deterioration in extraction pond water quality occurs, sand extraction is to be reduced and VENM placement temporarily ceased until the source is identified and appropriate amelioration measures implemented.

Reporting and Auditing

Records of the surface water quality monitoring would be kept including actions undertaken and amelioration measures implemented. These records would be made available to statutory authorities upon request.

Quarterly environmental audits of extraction and processing operations would be undertaken by site management and external audits by an environmental consultant on an annual basis.

4.6 Impact Assessment

The Project would be able to be managed to ensure any impacts from the disturbance or receipt of VENM onto the Project Site is within acceptable limits. Regular monitoring of soil, surface water and groundwater would provide an accurate assessment of the adequacy of practices implemented as part of the operation or the need to adjust practices.

4.7 Conclusion

The analysis of representative soil and sediment samples across the Project Site reveals that low levels of oxidisable sulfur are present in the sand and sediments throughout the depth of the sand resource and both above and below the natural fluctuating water table. Although rapid oxidation and subsequent acidification would be expected, the oxidisable sulfur in the porous material within the unsaturated zone does not appear to be creating any acid induced problems in the groundwater. Below a depth of approximately 6m, there appears to be adequate buffering capacity to neutralise any acid generation associated with the potential oxidation of the sulfidic sediments.

As demonstrated by the long-term successful operation of the adjoining sand extraction operation and the short-term initial dredging operation on the Project Site, the proposed management strategies for the Project provide sufficient protection to ensure any exposure of sulfidic sediments is minimised and any acid generation is either avoided due to natural buffering or is neutralised via the targeted application of alkaline amendments.

The adoption of the management procedures detailed in Section 4.5 would be an important component of this Project.

5 CONTAMINATED LAND ASSESSMENT

5.1 Land Contamination Planning Guidelines

The NSW Department of Planning through its publication *Managing Land Contamination Planning Guidelines SEPP 55 – Remediation of Land* recognises the important role in integrating land contamination management into the planning and development control process. It is considered that this planning approach will help ensure that changes of land use will not increase the risk to health or the environment.

The guidelines recommend that rezonings, development control plans and development applications are backed up by information demonstrating that the land is suitable for the proposed use, or can be made suitable, either by remediation or by the way the land is used.

The guidelines note that a planning authority may need to seek further information when the Project Site or land in the vicinity is, or may be, associated with activities listed in a schedule but it is not known whether contamination exists. Table 1 of the guidelines lists agriculture as an activity potentially causing contamination.

It is important to note that the guidelines recognise that changes of use on contaminated land may proceed provided the land is suitable for its intended use. This is a risk-based approach and complements the various guidelines for investigation and remediation of contaminated sites.

Tweed Shire Council's DCP 16 also requires that, where land is identified as being contaminated, it must be demonstrated that it is suitable for development pursuant to SEPP 55.

5.2 Preliminary Site Contamination Investigation

An investigation of the Project Site was undertaken to assess the potential for existing site contamination. The investigation included the following elements.

- Detailed site history including review of available mapping and aerial photography (see Section 3.2).
- Walk over field inspection.
- Identification of contaminants of concern.
- Soil survey including soil sampling and laboratory analysis for contaminants of concern.
- Interpretation of findings and discussion.
- Recommendations and conclusions.

5.3 Site Inspection

From early 2005 to March 2007, most of the Project Site has been traversed either by foot or via a 4WD vehicle by a consultant with HMC Environmental Consulting Pty Ltd. No areas of discoloured soil, polluted water, affected plant growth and animal population or significant odours were noted. As noted in Section 3.2, the Project Site and surrounds have been drained extensively for the development of sugar cane farming, however, this drainage is now redundant and in poor repair.

5.4 Potential Exposure to Contaminants of Concern

As the land has been previously used for sugar cane cultivation several residual agrichemicals were identified as being contaminants of concern. These included various organochlorine and organophosphorus pesticides, arsenic, lead and mercury which have been recorded constituents of agrichemicals used within cane growing operations.

The exposure of any person to potentially contaminated soil is likely to be very low. As part of the development of the proposed sand extraction operations, the site would be stripped (in stages), with the topsoil treated as required, used in bunding, and stockpiled for future stabilisation and rehabilitation works. Some topsoil may be used in blended products, however, stripping operations to remove existing vegetation is likely to remove any soil contamination within the upper 300mm of the soil profile. It is noted that soil sampling guidelines only require sampling of the surface soil (0-100mm) immediately below the vegetative layer.

Using the risk-based approach the potential exposure of any person associated with the proposed development is extremely low. The occupation of the site is limited to staff operating equipment which is either on water (dredge) or enclosed (loader, fuel tanker, water truck and tippers). Only the dredge operator and the loader driver are continuously on site and then only during working hours.

5.5 Investigation for Adjoining Development (Hanson Tweed Sand)

It is noted that the recent EIS for the proposed extension to the adjacent sand extraction operation used a detailed site history to establish the potential for soil contamination. No soil sampling and analysis for residual chemicals was undertaken. It was concluded by Gilbert & Sutherland (2005) that *"the preliminary site history investigation did not identify any previous land use activities at the site and surrounds that may have potentially resulted in contamination. The current and previous use of agrichemicals appears to be extremely limited.."*

5.6 Investigation for Local Cane Grower

Crofts (1986) notes the land was purchased in 1964 as a wet grazing block and was partially drained and developed for the production of tropical grass and legume seed until 1871. The Central Mapping Authority record it as not under cane when aerial photographs were taken in 1971.

Crofts (1986) summarises that *"all evidence available to me points to the fact that this property was developed from swampy grazing land for cane production during the 1970s when cane prices were high, has higher than average cane production costs because of its soil and drainage problems and is unlikely to become a viable cane farm unless cane prices soar. This land would appear to be more suited for other purposes."*

In consideration of the above information, the Project Site would therefore appear to have a cane-growing history of up to 13 years.

In a separate investigation during 2005, a potential soil contamination assessment was undertaken by HMC Environmental Consulting on a 20ha long-term sugar cane farm in the Tweed Valley. In this investigation, 64 samples were collected across the farm and composited into 16 soil samples for analysis (organo-chlorines, organo-phosphates, lead, arsenic, mercury, copper). None of the samples recorded residual chemical levels above accepted health investigation levels.

This farm was further up the Tweed Valley on heavier soils (clay loam) and it is expected that, due to the length of time under cultivation (>40 years) would have been subjected to many more applications of residual agrichemicals than the Project Site.

5.7 Soil Survey

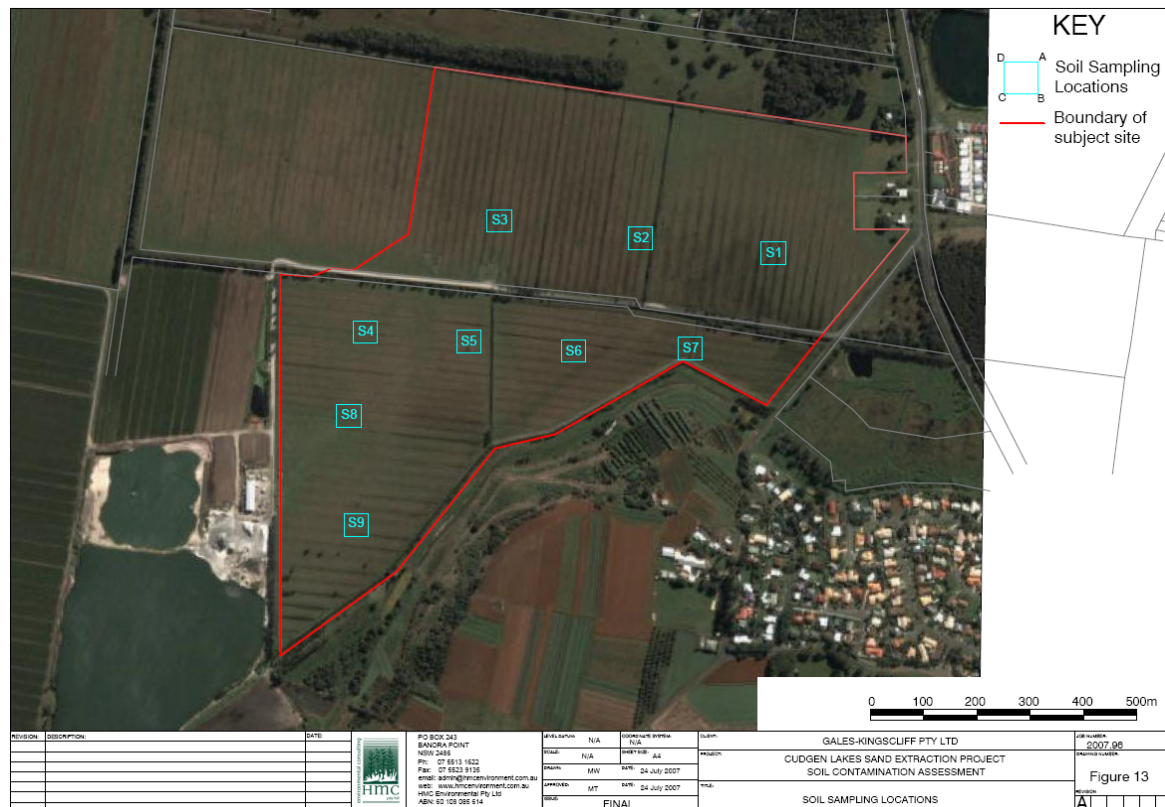
In order to help confirm the contaminant status of the Project Site, a soil survey including sampling and laboratory analysis was undertaken in March 2006.

As the distribution of potential contamination was likely to be fairly homogenous, a systematic sampling pattern was implemented. No potential “hotspots” were identified.

Six locations were established south of the existing Altona Drive alignment and three locations north of the alignment. A 20m x 20m grid was measured around each sampling location and samples collected at the corners of each grid – a total of 36 samples (see **Figure 13**). Soil samples were collected from a depth of 0-150mm. The 4 soil samples within each grid were composited to form a single sample as shown in **Table 21**.

Table 21
Sample Identification

Composite	Sub-samples	Laboratory Analyses
S1	S1A-S1D	OCP/OPP; As;Pb;Hg
S2	S2A-S2D	OCP/OPP; As;Pb;Hg
S3	S3A-S3D	OCP/OPP; As;Pb;Hg
S4	S4A-S4D	OCP/OPP; As;Pb;Hg
S5	SS5A-5D	OCP/OPP; As;Pb;Hg
S6	S6A-S6D	OCP/OPP; As;Pb;Hg
S7	S7A-S7D	OCP/OPP; As;Pb;Hg
S8	S8A-S8D	OCP/OPP; As;Pb;Hg
S9	S9A-S9D	OCP/OPP; As;Pb;Hg



Note: A colour version of this figure is available on the Project CD.

Figure 13 Soil Sampling locations

The samples were forwarded to a NATA-accredited laboratory for compositing and analysis for Lead (Pb), Arsenic (As), Mercury (Hg), Organochlorine Pesticides (OCP) and Organophosphorus Pesticides (OPP). The borehole locations were chosen to represent the surface of the cultivated soil, in order to target previous practices potentially resulting in residual pesticides and metal-based chemicals.

The soil sampling locations are shown in **Figure 13** and are identified as S1A – S9D. All borehole locations were recorded via GPS.

The adjusted laboratory results for all contaminants of concern were below the Health Investigation Levels for Residential “A” exposure setting as produced in Table 11-A of Schedule 7(b) of the National Environment Protection Council – *National Environment Protection (Assessment of Site Contamination) Measure 1999*, Table 11-A (NEPC,1999). Laboratory results are attached in **Appendix 7**.

5.8 Sampling Methodology

- All sampling was undertaken by an independent, suitably qualified scientist from HMC Environmental Consulting (Mark Tunks).
- Soil samples were collected using clean stainless steel sampling equipment (hand auger and trowel), scrubbed in distilled water, washed with “Decon 90” and rinsed with clean distilled water between samples.
- Following collection, representative samples were transferred to glass jars that were laboratory cleaned and supplied directly from Tweed Laboratory Centre.
- The jars were labelled and placed in an esky on ice for transport to the Tweed Laboratory Centre by private car.
- Samples were prepared and extracted at the laboratory prior to the expiry of holding times for each analyte.
- Chain of Custody documentation was sent with all soil samples, confirming that all samples were received chilled and in good order.

5.9 Results

The results are summarised in **Table 22** and confirm that all contaminants are below recognised guidelines for residential or commercial/industrial land uses.

No organochlorine or organophosphorus residuals were detected in any composite sample. The maximum adjusted lead and arsenic concentrations were approximately 4% of the investigation threshold for sensitive residential use. The maximum adjusted mercury level was approximately 3.5% of the investigation threshold for sensitive residential land use.

Table 22
Soil Analysis Summary

Analyte	Range mg/kg	Health investigation Level mg/kg (Residential, NEPC 1999) ¹
Organo-chlorine	<1.0	2.5 (Aldrin + dieldrin)
Organo-phosphorus	<0.5	⁽²⁾
Lead	<2 – 3	75
Arsenic	<1 – 1	25
Mercury	0.07 – 0.17	10 (organic), 15 (inorganic)
¹ Adjusted to allow for 4 composite samples		
² No guidelines value		

5.10 Impact Assessment

The preliminary site contamination investigation, including soil sampling program, did not record any potential soil contamination across the Project Site. No contamination “hotspots” have been identified. The use of stripped topsoil from extraction areas in bunding and rehabilitation work would ensure that any potential soil contamination is managed on the Project Site where any potential exposure risk is very low.

6 CONCLUSION AND RECOMMENDATIONS

The Project Site is recorded to have been used for sugar cane cultivation for approximately 13 years. Cane cultivation ceased approximately 15 to 20 years ago. Prior to cane cultivation, the land was used for “wet” cattle grazing.

Based on the sampling results, site history, geographical location and review of topographic mapping, there is a very low level of risk that the Project Site is contaminated with remnants of chemicals from current or former sugar cane cultivation.

After consideration of these findings, further sampling and laboratory analysis is not required. The Project Site can reasonably be considered, for the purpose of the proposed development, to be uncontaminated. It is considered that there is little environmental or health hazard associated with the proposed use of the subject property for sand extraction.

7 AGRICULTURAL SUITABILITY

7.1 Department of Infrastructure, Planning and Development & Department of Primary Industries Northern Rivers Farmland Protection Project

The Project Site is located within an area mapped as Regionally Significant Farmland (see **Figure 14**).

The Northern Rivers Farmland Protection Project seeks to protect important farmland from urban and rural residential development pressures; thereby keeping farming options open for the future.

The Project seeks to establish a system which would protect a broad range of lands to cater for a range of agricultural industries that may be important currently or in the future. Urban and rural residential development is proposed to be limited on mapped state and regionally significant farmland so that farming areas with the most potential for production are not lost to urban uses. The Northern Rivers Farmland Protection Project included mapping based on soil landscapes.

The proposed development is not considered an urban use and would not undermine the integrity of a Regionally Significant Farmland area. Further, the restrictions on development do not apply to rural industries which are defined as handling, treating, processing or packing of primary products. Rural industry is recommended as being allowed in farmland protection areas, without restriction.



Figure 14
Farmland Protection Mapping (Tweed Shire Council GIS)

Additionally, Section 5.4.3 lists the objectives of the farmland protection project which include:

- making provision for the co-management of important agricultural land including farming, conservation and extractive industry; and
- recognising extractive industry as a legitimate rural use which has a priority over non-rural use.

Although the Project is considered as a rural industry under the guideline document, further investigations have been made into the more stringent industrial use criteria. In particular, Section 5.4.4 of the guideline notes that Councils are able to consider regionally significant farmland for stand-alone future industrial use if all of the following apply.

- **It would not significantly undermine the integrity of a regionally significant farmland area.**

A portion of the Project Site has previously been approved for sand extraction (400,000m³) and there is an existing sand extraction operation on the adjoining property to the immediate west (approved over approximately 70ha). The new Kingscliff WWTP is being constructed on an adjoining lot to the northwest and marginal grazing land is located on the adjoining property to the north. The Project Site has been recognised as being non-viable cane growing land and is currently used for cattle grazing. The Project Site is geographically distinct from the elevated Regionally Significant Cudgen plateau farmland to the south.

- **It would not compromise local or regional agricultural potential by alienating agricultural infrastructure or agricultural transport routes, or decreasing ‘critical mass’ for any existing agricultural industry.**

The Project Site is currently being used for low-scale cattle grazing. Sugar cane was previously grown on the site but was found to be non-viable. It has been recognised that this land is not suitable for sugar cane production (Crofts, 1986) and the loss of this farmland area is not considered to have any impact on the viability of the Condong Mill. No loss of “critical mass” in cane production would occur. There are also no identifiable impacts on any agricultural infrastructure or agricultural transport routes.

- **It would not create impacts which would compromise the agricultural use of nearby regionally important land.**

The Project Site adjoins an existing sand extraction site to the west and small-cropping/orchards to the south. The elevated land to the south is on a different soil landscape and is physically separated via a large tidal farm drain. Groundwater modelling has been undertaken and monitoring would be implemented to ensure operations do not impact on existing water and groundwater resources. The physical buffer between the extraction ponds and the farming operations to the south is significant and would increase over time as the southern extraction pond extends to the north and east. It is noted that the farming community on the Cudgen Plateau have previously raised concerns relating to the viability of the family farm in this area with very few crops now competitive due to fragmentation leading to small properties. A number of growers have moved to the Bundaberg area where farms are larger allowing economies of scale.

- **It would not be located in an area where there was an identified risk of land use conflict near an existing agricultural enterprise.**

The Project Site would not likely be a source of complaint to government authorities relating to incompatible land uses. The sand extraction operation would operate during daylight hours and be operated by several plant operators. There is no residential component to this operation. Unlike residential encroachments into farmland, the proposed development is not likely to be affected by any normal farming operations which might create noise or other sources of complaint. The physical buffer between the proposed extraction ponds and the farming operations to the south is significant and would increase over time as the southern extraction pond extends to the north and east.

- **It would not involve filling part of a floodplain unless consistent with a floodplain management plan prepared in accordance with the Floodplain Management Manual.**

Flooding issues have been addressed and only minor filling of the site is proposed to protect the processing area. Heights of bunds are to be controlled and flood flow paths retained. A flooding and drainage assessment has been undertaken by SNW (2008) (Part 2 of the *Specialist Consultant Studies Compendium*).

- **No viable alternative land is available which is suitable for the proposed industrial use.**

The Project Site has a sand resource which is approximately 20m in depth. This sand is suitable for the construction industry as has been demonstrated by the adjoining operation. Due to the location of this resource and the large demand for both fill material (by the Proponent) and construction material (which cannot be fully met by the adjoining operation) it is considered that no commercially viable alternative sites are available to meet the full demand for this material or undertake the Project as proposed.

7.2 Agricultural Classification

Agricultural land in NSW has traditionally been mapped for planning purposes by the Department of Primary Industries (DPI) using the five class "Rural Land Evaluation Manual" system. This attempts to estimate potential agricultural productivity and versatility.

The Project Site has previously been assessed to determine an appropriate agricultural suitability class. This classification system was developed by the Department of Agriculture (now DPI) and the Soil Conservation Service. It provides a ranking of lands according to their productivity for a wide range of agricultural activities. It also aims to determine the potential for crop growth within certain limits.

The classification is based upon the effects of climate, topography and soil characteristics, the cultural and physical requirements for various crops and pastures, and existing socioeconomic factors including local infrastructure and geographic location, which combine to determine the productive potential of the land and determine its capacity to produce crops, pastures and livestock.

Classes 1, 2, and 3 are considered under this system to be highly productive. The Project Site is located within a Class 4 area which is defined as "Land suitable for grazing but not cultivation. Native or improved pastures established with minimum tillage" (see **Figure 15**).

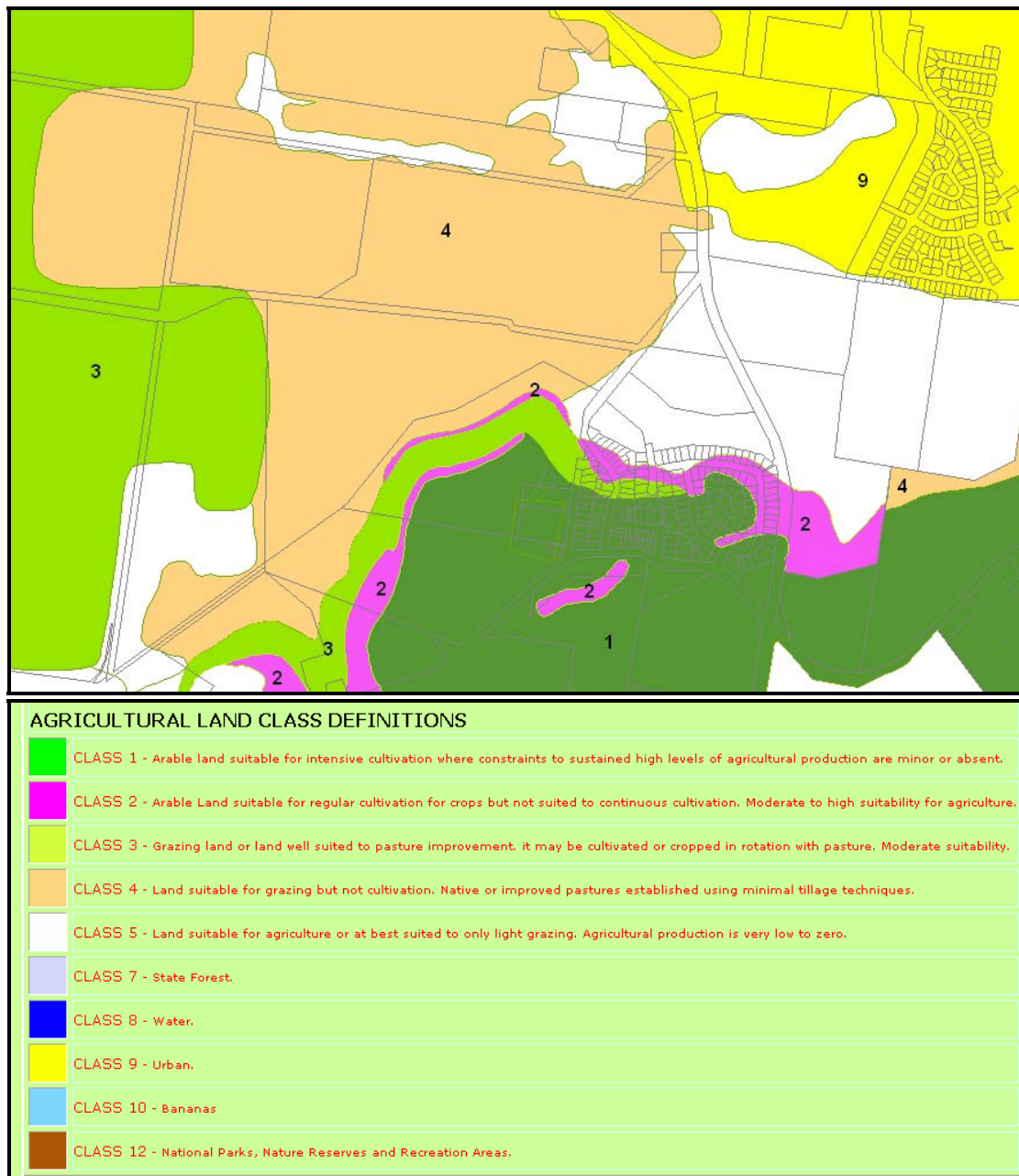


Figure 15
Agricultural Land Classifications Source: Tweed Shire Council GIS

7.3 Crofts Agricultural Suitability Assessment

During 1986 Professor Frank Crofts an agricultural farm consultant prepared an agricultural report on the Project Site (see **Appendix 3**). The report advises that standard full soil analyses were undertaken on all 10 paddocks comprising the property in January 1986. The analysis concluded the following.

1. The paddocks are highly variable in their mineral availability. This implies that the cost of properly correcting all mineral deficiencies through the addition of appropriate fertilisers would be both difficult and expensive to manage because either fertiliser regimes would have to be changed over small areas or fertiliser wasted through over-application to some areas.

2. The low to medium nitrate levels in all paddocks indicate that large quantities of nitrogen fertilisers would be needed to optimise cane yields and moreover, the low cation exchange capacities of most soil samples indicate that frequent applications of nitrogen fertilisers would be necessary.
3. While total phosphorus figures are variable, but generally not too low, the very high levels of iron in all samples and the very high levels of exchangeable aluminium in some samples indicate that a high proportion of phosphates added to these soils would be fixed, thus suggesting the need for regular and heavy application of phosphoric fertilisers.
4. Potassium soil levels are also low to medium and the very low potassium exchange capacities indicate that potassium fertiliser would also need to be applied regularly and at fairly heavy rates.

Crofts then summarises that *“the figures from the soil analysis, combined with the knowledge that a part of the property is easily waterlogged, suggest that the fertiliser cost of maintaining cane yields on this property would be higher than for most of the surrounding cane areas”*.

He goes on to conclude that *“all evidence available to me points to the fact that this property was developed from swampy grazing land for cane production during the 1970s when cane prices were high, has higher than average cane production costs because of its soil and drainage problems and is unlikely to become a viable cane farm unless cane prices soar. This land would appear to be more suited for other purposes”*.

Two appendices to this report (appendices 6.3 and 6.4) also point out the low-lying nature of the land and the record of marginal productivity.

A letter from the NSW Cane Growers' Association concluded that *“This farm has no chance of being an economic cane-farm in the foreseeable future and no other canegrower in this district is interested in this farm for the growing of cane. It is most unreasonable that the owner be locked into such a position. This land must be allowed for some other use and the proposed use (sand extraction) is compatible in the agricultural zone”*.

The letter from the neighbouring landholders also concludes that *“the property is not an economically viable sugar cane producer in average season and market conditions.”*

7.4 Tweed Turf and Sand (now Hanson Tweed Sand) Agricultural Suitability investigation

A detailed investigation of agricultural suitability including soil fertility analysis was undertaken as part of an assessment of an extension to the Tweed Turf and Sand (now Hanson Tweed Sand) extraction operation. This investigation included 20 boreholes to 700mm depth. Constraints recorded included shallow topsoil depth (0-0.5m), poor drainage, acidic soil (av.pH 5.36), and soil salinity (0.11dS/m).

It was concluded that:

“....the importance of the land for relatively low intensity agricultural production versus the value of the sand resource is of most importance. It is considered that the benefits of sand extraction to the community far outweigh the benefit of the marginally viable agricultural use of the land”.

The Director-General's *Environmental Assessment Report* of the then proposed expansion of this operation states in Section 6.2.

“The Department is satisfied, subject to the removal of Phase 5, that the site is suitable for the development. The site is adjacent to, and forms part of, an existing quarry that has been operating since the 1980's. As an existing quarry, the site is adequately serviced with the extraction and processing infrastructure required for the proposal.

The sand resource is significant and has been identified as one of only four regionally significant sand deposits in the Tweed Shire. Of these deposits, the resource at the site is the only off-stream (ie. not located in a waterbody) one which produces fine washed sand, making it the largest source of fine washed sand within Tweed Shire.

The Department acknowledges that the development would result in the destruction of existing Class 3 agricultural land and an aquifer that contains generally good quality fresh water. However the Department and DPI are satisfied that this loss is justified given the significance of the sand resource and the localised nature of the development.”

Section 8 of the report concludes:

“The Department recognises that the proposal would permanently alter the landscape of the site from low lying agricultural land to a largely aquatic landscape. This alteration would obviously sterilise the historical agricultural landuse of the site, however the Department and the DPI are satisfied this loss is not significant and is justified given the significance of the sand resource.”

The Cudgen Lakes Sand Extraction Project proposes to develop this same regionally significant resource.

7.5 Cumulative Impacts

The cumulative impact of this development on the agricultural viability of the surrounding state and regionally significant farmland has been assessed.

The floodplain on the adjoining properties is currently being used for either cattle grazing, sand extraction or residential purposes. Further to the west there are cane growing properties, however, as expressed in Croft (1986), there is no recognition by the cane industry that the proposed use of the Project Site is affecting the viability of cane production/processing in the Tweed area.

The elevated horticultural/small cropping land to the south of the property has been farmed successfully for a number of years with the ongoing sand extraction operation to the west of the Project Site. The Cudgen plateau is on a very different soil landscape and is recognised as being very productive land with some constraints. Some concerns have been expressed by the landholders in this area relating to the protection of groundwater and dam water resources. The proposed development has addressed these concerns in a detailed groundwater modelling exercise and water quality investigation (see AGE, 2008 – Part 1 of the *Specialist Consultant Studies Compendium*). The proposed sand extraction would implement management strategies to ensure that existing groundwater and dam water quality and quantity are not significantly affected by the Project's sand extraction operations.

7.6 Conclusion

The Project Site has been assessed using the Northern Rivers Farmland Protection Project guidelines (DIPNR et al, 2005) and the NSW Agriculture Land Classification Guidelines (2002). During 1986 an assessment was also undertaken in conjunction with the NSW cane industry to determine the long-term agricultural viability of the Project Site. All of the assessments have indicated that the Project Site is not suitable for intensive agriculture and is subject to a number of constraints including waterlogging and poor uneven fertility.

The Director-General's *Environmental Assessment* Report for the now approved expansion of the Tweed Turf and Sand (now Hanson Tweed Sand) extraction operation on the adjoining landholding concludes that the loss of agricultural land in that case is not significant and is justified given the significance of the sand resource.

The sand resource on the Project Site is similar to that found on the Hanson Tweed Sand landholding and it is assessed that the Project Site is less viable for agricultural production.

The proposed development would appear to provide significant benefits to the community while the potential agricultural uses are limited and do not include any intensive cultivation.

On balance, it is assessed, in relation to agricultural viability, the benefits of the proposal outweigh its potential costs.

8 REFERENCES

- Australian and New Zealand Environment and Conservation Council and National Health and Medical Research Council (January 1992) ‘ *Australian and New Zealand Guidelines for the Assessment and Management of Contaminated Sites*’.
- Australian Groundwater & Environmental Consultants Pty Ltd (2006) *Cudgen Lakes Sand Extraction Proposal Groundwater Impact Assessment Risks and Constraints*. Project No. G1267
- Australian Fresh Research & Development Corporation Pty Ltd (2004) *Statement of Environmental Effects Proposed Aquaculture Development & Water Supply Works*.
- Coffey Geosciences Pty Ltd, (Feb 1999), “*Cudgen Sand Extraction – Hydrogeological Assessment and Installation of Monitoring Bores*”, Project No. G17213/1-H.
- Crofts, F.C. (1986) *Agricultural Report for Lot 2 DP 611021 and Lot 2 DP 216705 Cudgen*
- Environmental Analysis Laboratory (2006) *Scanning Electron Microscope Report Job No. E5234*
- Gilbert & Sutherland (1999) *Revised Final Environmental Management Plan – Cudgen Sand Extraction Operation*.
- Gilbert & Sutherland (2003a) *Gales Holdings, West Kingscliff (Proposed Sand Extraction) Background Water Quality Monitoring Report*.
- Gilbert & Sutherland (2003b) *Acid Sulfate Soil Assessment & Management Plan Lot 2 DP216705, Crescent Street, West Kingscliff*
- Gilbert & Sutherland (June 2005) *Addendum Report – Proposed Expansion of Extractive Industry, Lot 2 DP 777905, Cudgen*”, Appendix K.
- Keown & Drummond Pty Ltd (1987a) *Environmental Impact Statement Sand Winning Project Cudgen*. (Hard Copy)
- National Environment Protection Council (NEPC) Guidelines forming part of the National Environment Protection (Assessment of Site contamination) Measure 1999:
- Schedule B(1) Guideline on the Investigation Levels for Soil and Groundwater, and
 - Schedule B(2) Guideline on Data Collection , Sample Design and Reporting.
- NSW Agriculture (2002). *NSW Agricultural Land Classification Guidelines*
- NSW Department of Natural Resources (2003) *Bore Licence 30BL179511*
- NSW Department of Infrastructure, Planning and Natural Resources and NSW Department of Primary Industries (2005). *Northern Rivers Farmland Protection Project Final Recommendations*

NSW Department of Planning. *State Environment Planning Policy No. 55*

NSW Environmental Protection Authority (EPA) publications:

- Guidelines for Consultants Reporting on Contaminated Sites (1997), and
- Guidelines for Assessing Banana Plantation Sites (1997), and
- Sampling Design Guidelines 1995.
- NSW Environmental Guidelines for the Assessment, Classification & Management of Liquid & Non-liquid Wastes 1999.

Regional Geology – Coffey 16.01.86 1:25 000

Smith, R., (1997) Discussion Paper Future Land Requirements for Agricultural Industries

State Environmental Planning Policy No. 55 – Remediation of Land

Stone Y., Ahern C.R., and Blunden B. (1998). Acid Sulfate Soil Manual 1998. Acid Sulfate Soil Management Advisory Committee, Wollongbar, NSW, Australia

Tweed Shire Council (2002b) Environmental Impact Statement for the Kingscliff Wastewater Treatment Plan.

Tweed Shire Council (2000) Tweed Local Environmental Plan 2000.

Woodward-Clyde (1997a) Environmental Impact Statement for Proposed Sand extraction Operation Lot 2 DP 216705, Cudgen. (Hard Copy)

APPENDICES

(No. of pages excluding this page = 131)

Appendix 1:	Coverage of Requirements
Appendix 2:	Historic Aerial Photos 1962 - 2004
Appendix 3:	Crofts Agricultural Assessment*
Appendix 4:	Laboratory Results - Soil Analyses (Contamination) – Current Project*
Appendix 5:	Laboratory Results - Soil Analyses – Guinane Pty Ltd*
Appendix 6:	Laboratory Results - Soil Analyses – Lobster Farm*
Appendix 7:	Laboratory Results - Soil Analyses (Acid Sulphate Soils and Sediments – Current Project*
Appendix 8:	DIPNR response – Proposed ASS Sampling Survey Design.

* Note: Not included within hard copy. A copy has been provided on the Project CD.

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Appendix 1

Coverage of Requirements

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Table A1-1
Coverage of *Environmental Assessment* Requirements and Environmental Issues in the
Acid Sulfate Soils, Soil Contamination and Agricultural Suitability Assessment

Page 1 of 3

ENVIRONMENTAL REQUIREMENTS RAISED BY THE DIRECTOR-GENERAL RELATING TO ACID SULFATE SOILS, SOIL CONTAMINATION AND AGRICULTURAL SUITABILITY		
		Relevant Section(s)
Key Assessment Requirements, namely: <ul style="list-style-type: none"> The Assessment must: <ul style="list-style-type: none"> be scientifically rigorous, and prepared in accordance with best practice; be certified by the author; include an executive summary; assess the potential impacts of the Project (including any potential cumulative impacts that may arise from the combined operation of the Project with the existing or approved operations at the Bolster Quarry), and describe what measures would be implemented to avoid, minimise, mitigate, offset, manage and/or monitor these impacts; and References Refer to the: <ul style="list-style-type: none"> Guidelines for Fresh and Marine Water Quality (ANZECC), Managing Urban Stormwater: Soils & Construction (Landcom); the various State Groundwater Policy documents and Floodplain Development Manual (Department of Natural Resources); and the Acid Sulfate Soil Manual (NSW Acid Sulfate Soil Advisory Committee). 		Sections 4, 5 and 7
ENVIRONMENTAL REQUIREMENTS RAISED BY THE DIRECTOR-GENERAL RELATING TO ACID SULFATE SOILS, SOIL CONTAMINATION AND AGRICULTURAL SUITABILITY		
Government Agency	Paraphrased Requirement	Relevant Section(s)
Department of Environment and Conservation	Provide maps showing the locality of the proposed development in a regional and local context. Base local context maps on 1:25 000 topographic plans.	Figure 1
	Provide a description of: <ul style="list-style-type: none"> the existing environment on the subject and surrounding land; the proposed development and ancillary works; and the manner in which the environment will be modified by the proposal. 	Section 3 Section 2 Sections 4.6, 5.10 and 7.5.
	Clearly identify on an appropriately scaled plan the area subject to development.	Figures 1 and 2
	Document surveys and assessments that have been undertaken by suitably qualified persons and provide the qualifications and experience of the person(s) undertaking the work.	EA Section 1.6
	Describe dates, site locations, design, methodology, analysis techniques, and weather conditions at the time of the assessments and surveys. The limitations of surveys should be identified and the results interpreted accordingly.	Section 4.2

Table A1-1 (Cont'd)
**Coverage of *Environmental Assessment* Requirements and Environmental Issues in the
Acid Sulfate Soils, Soil Contamination and Agricultural Suitability Assessment**

Page 2 of 3

ENVIRONMENTAL REQUIREMENTS RAISED BY THE DIRECTOR-GENERAL RELATING TO ACID SULFATE SOILS, SOIL CONTAMINATION AND AGRICULTURAL SUITABILITY		
Government Agency	Paraphrased Requirement	Relevant Section(s)
Department of Environment and Conservation (Cont'd)	Substantiate conclusions drawn in surveys and assessments with evidence resulting from those surveys and assessments. The EIS should reflect these conclusions and clearly state where recommendations of the survey and assessments have been incorporated in the proposal.	Section 4.5
	Assess if the soils to be dredged contain Potential Acid Sulfate Soil (PASS) and develop a proposed monitoring program for all materials leaving the site.	Section 4
	Provide a detailed explanation of how the PASS fines that are proposed to be returned to the dredge pond at depth will not be disturbed during subsequent dredging activities.	Sections 2 and 4.5.3
	Provide details of site history. Consider any earthworks with regard to possible soil contamination.	Sections 3.2 and 5
	Identify impacts associated with the disturbance of acid sulfate soils and potential acid sulfate soils.	Section 4.6
	Provide any details to describe the existing soil types and properties and soil contamination.	Sections 3.5 and 5.9
	Identify any likely impacts resulting from the construction or operation of the proposal, including the likelihood of: <ul style="list-style-type: none"> – disturbing any existing contaminated soil; – contamination of soil by operation of the activity; – soil erosion; and – disturbing acid sulfate or potential acid sulfate soils. 	Section 5.10 Section 5.10 EA Section 4.3.5.5 Section 4.6
	References to relevant guidelines – <i>Contaminated Sites – Guidelines for Consultants Reporting on Contaminated Sites</i> (EPA, 1997); <i>Contaminated Sites – guidelines of Significant Risk of Harm and Duty to Report</i> (EPA, 1999).	Section 8
	Describe and assess the effectiveness or adequacy of any soil management and mitigation measures including: <ul style="list-style-type: none"> – erosion and sediment control measures; – proposals for site remediation; and – proposals for the management of these soils. 	EA Section 4.3.5.5 Section 4.5.3
Tweed Shire Council	Consider DIPNR's and DPI's Farmland Protection Project.	Section 7.1
	Conduct an assessment of contamination and potentially acid sulfate soils for the materials to be extracted/pumped.	Sections 4 and 5
Department of Primary Industries (Fisheries)	Describe the nature of sediment to be dredged, including Acid Sulfate Soil and Potential Acid Sulfate Soils.	Section 4

Table A1-1 (Cont'd)
**Coverage of *Environmental Assessment* Requirements and Environmental Issues in the
 Acid Sulfate Soils, Soil Contamination and Agricultural Suitability Assessment**

Page 3 of 3

ENVIRONMENTAL REQUIREMENTS RAISED BY THE DIRECTOR-GENERAL RELATING TO ACID SULFATE SOILS, SOIL CONTAMINATION AND AGRICULTURAL SUITABILITY		
Government Agency	Paraphrased Requirement	Relevant Section(s)
Department of Primary Industries (Fisheries)	Assess the chemical residue of the soil to be excavated and relocated.	Section 5.9
	Describe the location and implications of any cattle tick dip sites in the immediate locality.	N/A
	Describe the agricultural quality of the subject lands and immediately adjoining lands.	Section 7
	Outline the previous, current and potential agricultural use of the subject and adjoining lands.	Section 7
	Provide a description of the impacts of alienating and using the land for the purpose of an extractive industry.	Sections 7.5 and 7.6
	Describe the compatibility and impact of the operation on adjoining lands including any agricultural enterprises.	Section 7.5
Department of Natural Resources (North Coast Region)	Conduct a detailed survey relating to potential Acid Sulfate Soils of the area which complies with the ASSMAC guidelines.	Section 4
	Include a detailed ASS management plan in the EIS if ASS material is found on-site. The EIS must include any technical reports, which must include details of sampling, a map detailing locations of samples taken, profiles details, results of sampling and treatment of any ASS fines as required by the ASSMAC Guideline.	Section 4
	Provide a management plan for the disposal/storage of acid sulfate fines.	Section 4.5.3
	Assess the impact of the development on this land (Regionally Significant Agricultural Land) and cumulative impacts taking into account all other existing and proposed sand extractive developments within the area.	Section 7.5

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Appendix 2

Historic Aerial Photos 1962 - 2004

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(Source: Tweed Shire Council)



Figure 1
Aerial Photo 1962



Figure 2
Aerial Photo 1970



Figure 3
Aerial Photo 1976



Figure 4
Aerial Photo 1986



Figure 5
Aerial Photo 1993



Figure 6
Aerial Photo 1996



Figure 7
Aerial Photo 2004

Appendix 3

Crofts Agricultural Assessment

(No. of pages excluding this page = 10)

* Note: Not included within hardcopy. A copy has been provided on the project CD.

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F. C. & L. M. CROFTS
Farmers and Farm Consultants
TELEPHONES (S.T.D. 063) 31 8071 and 37 7704

Principals:
FRANK C. CROFTS, B.Sc. Agr., M.S., F.A.I.A.S.
LUCINDA M. CROFTS, B.Sc. Agr.

10 TAREENA AV.,
KELSO,
BATHURST, N.S.W. 2795

AGRICULTURAL REPORT

PROPERTY: Lot 2 D.P. 611021
and
Lot 2 D.P. 216705

CUDGEN. NEW SOUTH WALES.

February, 1986.

Frank C. Crofts.

APPENDIX 6.2

14.MAR.2001 11:23

BURCHILL PARTNERS

NO.029 P.7/15

1. BRIEF.

Report on the Agricultural Potential of the 84. hectare property near Cudgen, N.S.W. owned by Wytim Pty. Ltd. of Parks Lane, Terranora and described as Lot 2 D.P. 611021 and Lot 2 D.P. 216705.

2. AGRICULTURAL BACKGROUND OF THE LAND.

The Certificate of Title for this land (Torrens Title Register Book Volume 9466 Folio 144) and the map of Cudgen (Cudgen 9641-111-N compiled by the Central Mapping Authority of N.S.W in 1974 from aerial photography in 1971) shows that this piece of land is not long-term traditional cane land.

It was purchased by John Kidrup of Banora on 3rd March, 1964 as a wet grazing block and was partially drained and developed for the purpose of producing tropical grass and legume seed by Anderson's Seed Ltd and Terranora Pastures Pty. Ltd. until 1971. It was then transferred to Altona Pastoral Co. Pty. Ltd. on 13.12.1971. The Central Mapping Authority record it as not in cane when aerial photographs were taken in 1971. It would therefore appear to have a cane-growing history of up to thirteen years.

An inspection of the property about 1966 revealed that, due to a high water table and water logging, great difficulty was being experienced in growing and harvesting legume and grass seeds. Subsequently, Anderson Seeds went into liquidation. The property was apparently purchased by Altona Pastoral Co. Pty. Ltd. on 13.12.1971 and developed as a cane property during a period of rapid expansion of that industry from 1973.

14.MAR.2001 11:24

BURCHIL PARTNERS

NO.029 P.8/15

3. SOIL AND AGRONOMIC CHARACTERISTICS OF THE PROPERTY IN 1986.

.1 SOIL DATA

Standard full soil analysis were carried out on all 10 paddocks comprising the property in early January, 1986 by Australian Fertilisers Ltd. of 213 Miller Street, North Sydney, and details of their analysis are attached.

There analysis show that:-

- .1. The paddocks are highly variable in their mineral availability. This implies that the cost of properly correcting all mineral deficiencies through the addition of appropriate fertilisers would be both difficult and expensive to manage because either fertiliser regimes would have to be changed over small area or a good deal of fertiliser wasted through over - application to some areas.
- .2. The low to medium nitrate levels in all paddocks indicate that large quantities of nitrogen fertilisers would be needed to optimise cane yields and more over, the low cation exchange capacities (CEC in MEQ%) of most soil samples indicate that frequent applications of nitrogen fertilisers would be necessary.
- .3. While total phosphorus figures are variable, but generally not too low, the very high levels of iron in all samples and the very high levels of exchangeable aluminium in some samples indicate that a high proportion of phosphates added to these soils would be fixed, thus suggesting the need for regular and heavy application of phosphatic fertilisers.

14.MAR.2001 11:24

BURCHIL PARTNERS

NO.029 P.9/15

- .4 Potassium soil levels are also low to medium and the very low potassium exchange capacities indicate that potassium fertiliser would also need to be applied regularly and at fairly heavy rates.

The figures from the soil analysis, combined with the knowledge that a part of the property is easily waterlogged, suggest that the fertiliser cost of maintaining cane yields on this property would be higher than for most of the surrounding cane areas.

4. CANE YIELD DATA AND FARM PROFITABILITY.

A 98 page report entitled "New South Wales Sugar Industry Group Report to the Minister of Agriculture and Fisheries" was presented by R. Scarsbrick on 29th August, 1985 in an attempt to address the problems of the industry. On pages 49 and 50 of the above report, G. Buggie, Senior Economist, reports the results of 11 cane farm cane studies. These show costs of production per tonne of cane for a wide range of cane-farm types. The costs of production of cane including labour at grower's rate, range from \$14.61 to \$21.90 per tonne. Due to the soil difficulties associated with this farm, it would be expected that it would fall within the high cost end of the 11 cane study farms. With average cane prices to grower of \$16.14 in 1982/83; \$17.29 in 1983/84 and \$17.12 in 1984/85 (page 41) it would be expected that substantial increases in the price of cane would be required to make this farm viable.

5. COMMENT.

All evidence available to me points to the fact that this property was developed from swampy grazing land for cane production during the 1970's when cane prices were high, has higher than average cane production costs because of its soil and drainage problems and is unlikely to become a viable cane farm unless cane prices soar. This land would appear to be more suited for other purposes.

19.000.0001 11.04

BURCHILL PARTNERS

NO.003 F.11/10



**Soil & Plant
Analysis
service**

Australian Fertilizers Limited
(Incorporated in N.S.W.)

213 Miller Street, North Sydney, N.S.W.
Box 528 PO North Sydney NSW 2060
Telephone: (02) 923 7123
Telex AA21815 Telegraphic address "Afsyd"

J W KEON
3RD FLOOR 371 PITT ST
SYDNEY 2000

AGENT: A.F.L. PORT KEMBLA

Date of sampling:

Date received:

6/1/86

Order number:

30154

Bag number:

53211

53212

53213

53214

53215

Analyses.

NITRATE PPM	12	13	12	11	17
PHOSPHORUS PPM	32	29	14	30	29
POTASSIUM PPM	40	70	50	50	50
PH IN WATER	5.7	5.9	6.0	5.3	5.2
PH IN CALCL	4.7	5	4.1	4.2	4.1
SODIUM MEQX	0.1	0.1	0.05	0.1	0.1
POTASSIUM MEQX	0.1	0.1	0.1	0.1	0.1
CALCIUM MEQX	4.4	3.2	4.0	0.2	0.2
MAGNESIUM MEQX	0.0	1.2	0.2	0.4	0.2
ALUMINIUM MEQX	0.6	0.19	TRACE	1.3	3.4
CEC MEQX	4.2	6.70	7.05	2.6	4.0
CA/MG RATIO	5.75	4.33	5.71	1.75	3.50
EXCH SODIUM %	1.41	1.47	0.65	3.84	2.22
EXCH AL %	9.47	2.45		50.00	75.55
ORGANIC MATTER %	5	5.1	3.5	3.4	3.7
COPPER PPM	1.1	1.2	0.7	1	0.6
ZINC PPM	2.4	0.8	0.2	0.1	0.4
IRON PPM	313	245	100	234	304
MANAGANESE PPM	4.3	2.6	1.8	1.4	1
BORON PPM	0.6	0.9	1.2	0.3	0.3

For further information contact your

AFL agent or your AFL Field Officer,..... phone..... (044) 42 1522

Laboratory Supervisor

Date of report

* * * Where analyses are so marked, please see explanatory notes on back of this report.

19.MAR.2001 11:20

BURCHILL PARTNERS

NO.027 P.12/13

New South Wales Cane Growers' Association

DISTRICT Secretary: J.F. MAKEPEACE
12 Queen Street
Phone 72 2486 Murwillumbah

P.O. Box 875,
MURWILLUMBAH, 2484

TWEED BRANCH

2nd September, 1987

Mr. John Keown,
371 A Pitt Street,
SYDNEY, 2000

Dear Sir,

RE: PROPOSED SAND MINING PROJECT
CALVERT PROPERTY.. CUDGEN

Thank you for copies of information re: above matter.

The Tweed Branch Council of the New South Wales Canegrowers Association formed a special four (4) man committee to investigate the above matter and comment on information forwarded to this Association.

The members of this committee comprise:

Mr. Brian McDonald - President. A life long resident dairy farmer and cane-farmer of the Tweed.

Mr. Robert Quirk - Vice President. A fifth generation canefarmer on the Tweed.

Mr. Ron Hawken - A cane farmer who together with his son won the coveted award "Farmer of the Year 1986-1987" for the Australian Sugar Industry.

Mr. John Walker - One of the Tweed's most successful canegrowers.

The comments are attached.

Yours faithfully,



Secretary:

APPENDIX 6.3

New South Wales Cane Growers' Association

12 Queen Street
Phone 72 2488 Murwillumbah

P.O. Box 676,
MURWILLUMBAH, 2484

All four members of this committee have a first hand knowledge of the farm in question. All members clearly remember this land prior to 1960 when it was developed as a tropical pasture seed farm and subsequently assigned to cane growing. All members vividly remember the frequent inundation which occurred in this area of land and the poor nature of the land in question.

This farm has for many years been referred to as "Frog Hollow" and has been regarded by all canegrowers in the district as a non-viable cane farm. Whilst no one member of the committee has any degree in Agricultural Science, the soil analysis as supplied and the comments pertaining to those analyses, verify the strong opinion by all members that this farm is a non-viable cane-farm.

We note your reference production costs as quoted in the "New South Wales Sugar Industry Report" to the minister for Agriculture and Fisheries. In that report the Department Economist, Mr. G. Buggie, quotes a cost of production range for 1985 between \$14.61 and \$21.90 per Tonne cane. We believe this range at that time to be a reasonable assessment of cost. Allowing for C.P.I. increases over the past 2 years, it would be unreasonable to assume the top end of the range of cost of production to be in the area of \$23.50 for 1987. It is without doubt that the cost of production for this particular farm is in the upper range or even supasses the now \$23.50 tonnes cost.

It is worth considering the production and returns for this farm over the past 5 years.

<u>YEAR</u>	<u>TONNES PRODUCTION</u>	<u>\$ PER TONNE CANE</u>
1983	2822	16.14
1984	1892	17.29
1985	1800	17.12
1986	363 (Drought Affected)	19.93
1987	1500 (App)	19.00 (Approx.)

Clearly the returns versus the cost of production is uneconomic and this no doubt has contributed to the general fall in production. There is no indication that returns for sugar-cane will exceed cost of production in the near future.

Over the past 12 months a large amount of cane-farm rationalization has occurred in the Tweed district with a significant number of cane-farms have been sold. There has been absolutely no interest in the purchase of Calvert Property which has been widely known as "For Sale". It is recognised by all canegrowers as a non-economic cane farm.

....2....

2

This farm has no chance of being an economic cane-farm in the foreseeable future and no other cane-grower in this district is interested in this farm for the growing of cane. It is most unreasonable to consider that the owner of the land be locked into such a position. This land must be allowed for some other use and the proposed use is compatible in the agricultural zone.

Yours faithfully,

Levens

President.

6.4

Mr. J. W. Kaown,
J. W. Kaown Pty. Ltd.,
Consulting Surveyors & Town Planners,
37/1A Pitt St.,
Sydney, N.S.W. 2000.

25th June, 1987

Dear Sir,

Property at Cudgen - Chinderah Road being Lot 2 in D.P. 611021 and Lot 2 in D.P. 216705 owned by Wytim Pty. Limited.

We the undersigned are experienced cane growers in close proximity to the property described above. Having a detailed knowledge of the area we have been asked by you to express our opinion of the economic viability of cane growing on the subject property.

We understand that you have prepared an Environmental Impact Study of the property in which Professor Crofts of F.C. and L.M. Crofts, Farm Consultants has stated in an agricultural report that "All evidence available to me points to the fact that this property was developed from swampy grazing land for cane production during the 1970's when cane prices were high, has higher than average cane production costs because of its soil and drainage problems and is unlikely to become a viable cane farm unless prices soar. This land would appear to be more suited for other purposes."

We also understand that the Department of Agriculture on advice from the N.S.W. Sugar Milling Co-operative has taken the view that the loss of sugar cane production on the property "would pose a significant impact on the Tweed Sugar Industry and place in jeopardy one of the Shire's major income earners." The Department of Agriculture has also stated that "The Tweed section of the sugar industry is particularly vulnerable to loss of land because of the limited areas of land for expansion into cane production."

It is our opinion that the view of Professor Crofts is correct and that the property is not an economically viable sugar cane producer in average season and market conditions. Further to this opinion it is considered that there are other properties more suited to sugar cane production in the Tweed region to which the cane management of this property could be transferred.

Yours faithfully,

WYTIM PTY LTD
W.J. Calvert } Chairman
John B. Brunsford } Neighbours
Robert J. Brunsford } Cane Growers
(Brunsford Bros.) } Company
We at Brunsford }
BYRNEVALE } John J. Byrne } Neat Neighbour
Cane Growers.
(C.F. 46 on creek - Neat Neighbour)
M.M. Eglinton }
Cane Growers in district

APPENDIX 6.4

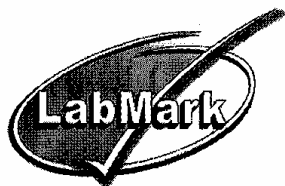
Appendix 4

Laboratory Results – Soil Analyses (Contamination) – Current Project

(No. of pages excluding this page = 15)

* Note: Not included within hardcopy. A copy has been provided on the project CD.

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CUSTOMER CENTRIC - ANALYTICAL CHEMISTS

Accredited for compliance with ISO/IEC 17025. The results of tests, calibrations and/or measurements included in this document are traceable to Australian/National standards. NATA is a signatory to the APAC manual recognition arrangement for the mutual recognition of the equivalence of testing, calibration and inspection reports.

Quarantine Approved premises criteria 5.1 for quarantine containment level 1 (QCI) facilities. Class five criteria cover premises utilised for research, analysis and/or testing of biological material, soil, animal, plant and human products.

FINAL CERTIFICATE OF ANALYSIS - ENVIRONMENTAL DIVISION

Laboratory Report No: E026004	Cover Page 1 of 3
Client Name: Tweed Laboratory Centre	plus Sample Results
Client Reference: Gales Cane Land - Kingscliff	
Contact Name: Daniel Haynes	
Chain of Custody No: na	Date Received: 22/03/2006
Sample Matrix: SOIL	Date Reported: 31/03/2006

This Final Certificate of Analysis consists of sample results, DQI's, method descriptions, laboratory definitions, and internationally recognised NATA accreditation and endorsement. The DQO compliance relates specifically to QA/QC results as performed as part of the sample analysis, and may provide an indication of sample result quality. Transfer of report ownership from Labmark to the client shall only occur once full & final payment has been settled and verified. All report copies may be retracted where full payment has not occurred within the agreed settlement period.

QUALITY ASSURANCE CRITERIA

Accuracy: matrix spike: 1 in first 5-20, then 1 every 20 samples
lcs, crm, method: 1 per analytical batch
surrogate spike: addition per target organic method

Precision: laboratory duplicate: 1 in first 5-10, then 1 every 10 samples
laboratory triplicate: re-extracted & reported when duplicate RPD values exceed acceptance criteria

Holding Times: soils, waters: Refer to LabMark Preservation & THT table
VOC's 14 days water / soil
VAC's 7 days water or 14 days acidified
VAC's 14 days soil
SVOC's 7 days water, 14 days soil
Pesticides 7 days water, 14 days soil
Metals 6 months general elements
Mercury 28 days

Confirmation: target organic analysis: GC/MS, or confirmatory column

Sensitivity: EQL: Typically 2-5 x Method Detection Limit (MDL)

QUALITY CONTROL

GLOBAL ACCEPTANCE CRITERIA (GAC)

Accuracy: spike, lcs, crm surrogate: general analytes 70% - 130% recovery
phenol analytes 50% - 130% recovery
organophosphorous pesticide analytes 60% - 130% recovery
phenoxo acid herbicides 50% - 130% recovery

anion/cation bal: +/- 10% (0-3 meq/l), +/- 5% (>3 meq/l)

Precision: method blank: not detected >95% of the reported EQL
duplicate lab 0-30% (>10xEQL), 0-75% (5-10xEQL)
RPD (metals): 0-100% (<5xEQL)
duplicate lab 0-50% (>10xEQL), 0-75% (5-10xEQL)
RPD: 0-100% (<5xEQL)

QUALITY CONTROL

ANALYTE SPECIFIC ACCEPTANCE CRITERIA (ASAC)

Accuracy: spike, lcs, crm surrogate: analyte specific recovery data <3xstd of historical mean

Uncertainty: spike, lcs: measurement calculated from historical analyte specific control charts

RESULT ANNOTATION

DQO: Data Quality Objective	s: matrix spike recovery	p: pending
DQI: Data Quality Indicator	d: laboratory duplicate	lcs: laboratory control sample
EQL: Estimated Quantitation Limit	t: laboratory triplicate	crm: certified reference material
not applicable	r: RPD relative % difference	mb: method blank

David Burns
Quality Control (Report signatory)
david.burns@labmark.com.au

Geoff Weir
Authorising Chemist (NATA signatory)
geoff.weir@labmark.com.au

Simon Mills
Authorising Chemist (NATA signatory)
simon.mills@labmark.com.au

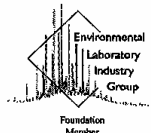
This document is issued in accordance with NATA's accreditation requirements.

LabMark PTY LTD ABN 27 079 798 397
* SYDNEY: Unit 1, 8 Leighton Place Asquith NSW 2077 * MELBOURNE: 116 Moray Street, South Melbourne VIC 3205
* Telephone: (02) 9476 6533 * Fax: (02) 9476 8219 * Telephone: (03) 9686 8344 * Fax: (03) 9586 7344

Form QS0144, Rev 01 Date Issued 10/03/05



CUSTOMER CENTRIC - ANALYTICAL CHEMISTS



Laboratory Report: E026004

Cover Page 2 of 3

NEPC GUIDELINE COMPLIANCE - DQO

1. GENERAL

- A. Results relate specifically to samples as received. Sample results are not corrected for matrix spike, lcs, or surrogate recovery data.
- B. EQL's are matrix dependant and may be increased due to sample dilution or matrix interference.
- C. Laboratory QA/QC samples are specific to this project.
- D. Inter-laboratory proficiency results are available upon request. NATA accreditation details available at www.nata.asn.au.
- E. VOC spikes & surrogates added to samples during extraction, SVOC spikes & surrogates added prior to extraction.
- F. Recovery data outside GAC limits shall be investigated and compared to ASAC (historical mean +/- 3sd). If recovery data <20%, then the relevant results for that compound are considered not reliable.
- G. Recovery data (ms, surrogate, crm, lcs) outside ASAC limits shall initiate an investigative action. Anomalous QC data is examined in conjunction with other QC samples and a final decision whether to accept or reject results is provided by the professional judgement of the senior analyst. The USEPA-CLP National Functional Guidelines are referred to for specific recommendations.
- H. Extraction (preparation) date refers to the date that sample preparation was initiated. Note that certain methods not requiring sample preparation (eg. VOCs in water, etc) may report a common extraction and analysis date.
- I. LabMark shall maintain an official copy of this Certificate of Analysis for all traceable reference purposes.

2. CHAIN OF CUSTODY (COC) & SAMPLE RECEIPT NOTICE (SRN) REQUIREMENTS

- A. SRN issued to client upon sample receipt & login verification.
- B. Preservation & sampling date details specified on COC and SRN, unless noted.
- C. Sample Integrity & Validated Time of Sample Receipt (VTSR) Holding Times verified (preservation may extend holding time, refer to preservation chart).

3. NATA ACCREDITED METHODS

- A. NATA accreditation held for each method and sample matrix type reported, unless noted below.
- B. NATA accredited in-house laboratory methods are referenced from NEPC, ASTM, modified USEPA / APHA documents. Corporate Accreditation No. 13542.
- C. Subcontracted analyses: Refer to Sample Receipt Notice and additional DQO comments.

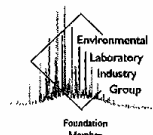
This document is issued in accordance with NATA's accreditation requirements.

LabMark PTY LTD ABN 27 079 798 397
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† Telephone: (02) 9476 6533 * Fax: (02) 9476 8219 * Telephone: (03) 9686 8344 * Fax: (03) 9686 7344

Form Q50144, Rev. 0: Date Issued 10/03/05



CUSTOMER CENTRIC - ANALYTICAL CHEMISTS



Laboratory Report: E026004

Cover Page 3 of 3

4. QA/QC FREQUENCY COMPLIANCE TABLE SPECIFIC TO THIS REPORT

Matrix: **SOIL**

Page:	Method:	Totals:	#d	%d-ratio	#t	#s	%s-ratio
1	Acid extractable mercury	9	1	11%	0	1	11%
2	Acid extractable metals	9	1	11%	0	1	11%
4	Moisture	9	--	--	--	--	--

GLOSSARY:

- #d number of discrete duplicate extractions/analyses performed.
%d-ratio NEPC guideline for laboratory duplicates is 1 in 10 samples (min 10%).
#t number of triplicate extractions/analyses performed.
#s number of spiked samples analysed.
%s-ratio USEPA guideline for laboratory matrix spikes is 1 in 20 samples (min 5%).

5. THERE ARE NO ADDITIONAL COMMENTS SPECIFIC TO THIS REPORT

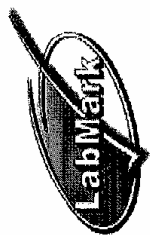
A. All tests were conducted by LabMark Environmental Sydney, NATA accreditation No. 13542, Corporate Site No. 13535., unless indicated below.

Laboratory QA/QC data shall relate specifically to this report, and may provide an indication of site specific sample result quality. LabMark DOES NOT report NON-RELEVANT BATCH QA/QC data. Acceptance of this self assessment certificate does not preclude any requirement for a QA/QC review by a accredited contaminated site EPA auditor, when and wherever necessary. Laboratory QA/QC self assessment references available upon request.

This document is issued in accordance with NATA's accreditation requirements.

LabMark PTY LTD ABN 27 079 798 397
* SYDNEY: Unit 1, 8 Leighton Place Asquith NSW 2077 * MELBOURNE: 116 Moray Street, South Melbourne VIC 3205
* Telephone: (02) 9476 6533 * Fax: (02) 9476 8219 * Telephone: (03) 9686 8344 * Fax: (03) 9686 7344

Form Q90144, Rev. 0 : Date Issued 10/03/05



Laboratory Report No: E026004
Client Name: Tweed Laboratory Centre
Contact Name: Daniel Haynes
Client Reference: Gales Cane Land - Kingscliff

Page: 1 of 3
Date: 31/03/06
This report supersedes reports issued on: N/A

Final Certificate of Analysis

Laboratory Identification		13749	13750	13751	13752	13753	13754	13755	13756	13757	13749d
Sample Identification		S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	QC
Depth (m)		--	--	--	--	--	--	--	--	--	--
Sampling Date recorded on COC		17/3/06	17/3/06	17/3/06	17/3/06	17/3/06	17/3/06	17/3/06	17/3/06	17/3/06	--
Laboratory Extraction (Preparation) Date		27/3/06	27/3/06	27/3/06	27/3/06	27/3/06	27/3/06	27/3/06	27/3/06	27/3/06	27/3/06
Laboratory Analysis Date		28/3/06	28/3/06	28/3/06	28/3/06	28/3/06	28/3/06	28/3/06	28/3/06	28/3/06	28/3/06
Method											
E026.2											
Acid extractable mercury											
Mercury		0.13	0.12	0.17	0.07	0.12	0.1	0.13	0.12	0.09	0.12
EQL		0.05									

Results expressed in mg/kg dry weight unless otherwise specified

Comments:

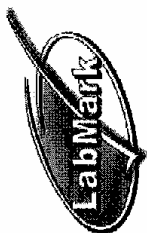
E026.2: 0.5g digested with nitric/hydrochloric acid. Analysis by CV-ICP-MS or FIMS.

Laboratory Identification		13749r	13750s	crm	lcs	mb				
Sample Identification		QC	QC	QC	QC	QC				
Depth (m)		--	--	--	--	--				
Sampling Date recorded on COC		--	--	--	--	--				
Laboratory Extraction (Preparation) Date		--	27/3/06	27/3/06	27/3/06	27/3/06				
Laboratory Analysis Date		--	28/3/06	27/3/06	27/3/06	27/3/06				
Method										
E026.2		8%	94%	93%	92%	<0.05				
Acid extractable mercury										
Mercury										
EQL		0.05								

Results expressed in mg/kg dry weight unless otherwise specified

Comments:

E026.2: 0.5g digested with nitric/hydrochloric acid. Analysis by CV-ICP-MS or FIMS.



Laboratory Report No: E026004

Client Name: Tweed Laboratory Centre

Contact Name: Daniel Haynes

Client Reference: Gales Cane Land - Kingscliff

Page: 2 of 3

plus cover page

Date: 31/03/06

This report supersedes reports issued on: N/A

Final
Certificate
of Analysis

Laboratory Identification		13749	13750	13751	13752	13753	13754	13755	13756	13757	13749d
Sample Identification		S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	QC
Depth (m)		--	--	--	--	--	--	--	--	--	--
Sampling Date recorded on COC		17/3/06	17/3/06	17/3/06	17/3/06	17/3/06	17/3/06	17/3/06	17/3/06	17/3/06	--
Laboratory Extraction (Preparation) Date		27/3/06	27/3/06	27/3/06	27/3/06	27/3/06	27/3/06	27/3/06	27/3/06	27/3/06	27/3/06
Laboratory Analysis Date		28/3/06	28/3/06	28/3/06	28/3/06	28/3/06	28/3/06	28/3/06	28/3/06	28/3/06	28/3/06
Method E022.2	Acid extractable metals										
	EQL										
	Arsenic		<1	<1	<1	<1	<1	<1	1	1	<1
Lead		<2	<2	2	2	2	<2	2	3	2	<2

Results expressed in mg/kg dry weight unless otherwise specified

Comments:

E022.2: 0.5g digested in nitric/hydrochloric acid. Analysis by ICP-MS.

Laboratory Identification		13749r	13750s	crn	les	mb					
Sample Identification		QC	QC	QC	QC	QC					
Depth (m)		--	--	--	--	--					
Sampling Date recorded on COC		--	--	--	--	--					
Laboratory Extraction (Preparation) Date		--	27/3/06	27/3/06	27/3/06	27/3/06					
Laboratory Analysis Date		--	28/3/06	27/3/06	27/3/06	27/3/06					
Method E022.2	Acid extractable metals										
	EQL										
	Arsenic		--	104%	101%	<1					
Lead		--	97%	97%	108%	<2					

Results expressed in mg/kg dry weight unless otherwise specified

Comments:

E022.2: 0.5g digested in nitric/hydrochloric acid. Analysis by ICP-MS.



Laboratory Report No: E026004
Client Name: Tweed Laboratory Centre
Contact Name: Daniel Haynes
Client Reference: Gales Cane Land - Kingscliff

Page: 3 of 3
Date: 31/03/06

Final Certificate of Analysis

This report supercedes reports issued on: N/A

Laboratory Identification		13749	13750	13751	13752	13753	13754	13755	13756	13757	13749d
Sample Identification		S-1	S-2	S-3	S-4	S-5	S-6	S-7	S-8	S-9	QC
Depth (m)		--	--	--	--	--	--	--	--	--	--
Sampling Date recorded on COC		17/3/06	17/3/06	17/3/06	17/3/06	17/3/06	17/3/06	17/3/06	17/3/06	17/3/06	--
Laboratory Extraction (Preparation) Date		24/3/06	24/3/06	24/3/06	24/3/06	24/3/06	24/3/06	24/3/06	24/3/06	24/3/06	24/3/06
Laboratory Analysis Date		27/3/06	27/3/06	27/3/06	27/3/06	27/3/06	27/3/06	27/3/06	27/3/06	27/3/06	27/3/06
Method E005.2	Moisture										
	Moisture	27	22	27	20	22	19	22	16	22	24

Results expressed in % w/w unless otherwise specified

Comments:

E005.2: Moisture by gravimetric analysis. Results are in % w/w.

Laboratory Identification		13749r																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	</
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Results expressed in % w/w unless otherwise specified

Comments:

E005.2: Moisture by gravimetric analysis. Results are in % w/w.



Quality, Service, Support

Report Date : 23/03/2006
 Report Time : 1:53:00PM

Sample
 Receipt
 Notice (SRN) for **E026004**



Client Details		Laboratory Reference Information	
Client Name: Tweed Laboratory Centre Client Phone: 07 5569 3100 Client Fax: 07 5524 2676 Contact Name: Daniel Haynes Contact Email: dhaynes@tweed.nsw.gov.au Client Address: P O Box 816 Murwillumbah NSW 2484 Project Name: Gales Cane Land - Kingscliff Project Number: - Not provided - CoC Number: - Not provided - Purchase Order: - Not provided - Surcharge: No surcharge applied (results by 6:30pm on due date) Sample Matrix: SOIL		Please have this information ready when contacting Labmark. Laboratory Report: E026004 Quotation Number: - Not provided, standard prices apply Laboratory Address: Unit 1, 8 Leighton Pl. Asquith NSW 2077 Phone: 61 2 9476 6533 Fax: 61 2 9476 8219 Sample Receipt Contact: Ros Schacht Email: ros.schacht@labmark.com.au Reporting Contact: Jyothi Lal Email: jyothi.lal@labmark.com.au	
Date Sampled (earliest date): 17/03/2006 Date Samples Received: 22/03/2006 Date Sample Receipt Notice issued: 23/03/2006 Date Preliminary Report Due: 31/03/2006		NATA Accreditation: 13542 TGA GMP License: 185-336 (Sydney) APVMA License: 6105 (Sydney) AQIS Approval: NO356 (Sydney) AQIS Entry Permit: 200409998 (Sydney)	

Sample Condition:
 COC received with samples. Report number and lab ID's defined on COC.
 Samples received in good order.
 Samples received with cooling media: Ice bricks.
 Samples received ambient.
 Security seals intact.
 Sample container & sample integrity suitable.

Comments:

Holding Times:

Date received allows for sufficient time to meet Technical Holding Times.

Preservation:

Chemical preservation of samples satisfactory for requested analytes.

Important Notes:

Sample disposal of environmental samples shall be 31 days (water) and 3 months (soil, HN03 preserved samples) after laboratory receipt, unless otherwise requested in writing by the client. Samples requested to be held in non-refrigerated storage shall incur \$5.00/ sample/ 3 months. Additional refrigerated storage shall incur \$20/ sample/ 3 months. Combination prices apply only if requested. Transfer of report ownership from LabMark to the client shall occur once full and final payment has been settled and verified. All report copies may be retracted where full payment does not occur within the agreed settlement period.

Analysis comments:

Subcontracted Analyses:

Thank you for choosing Labmark to analyse your project samples.
 Additional information on www.labmark.com.au

Form QS0012, Rev 8: Date Issued 23/07/04.



Quality, Service, Support

Report Date : 23/03/2006
Report Time : 1:53:00PM

Sample
Receipt

Notice (SRN) for **E026004**



		Requested Analysis															
		METALS (E026.2) - Acid extractable mercury	METALS (E022.2) - Acid extractable metals	SMPL_PREP (E005.2) - Moisture	SMPL_PREP (E005.2) - Not reported												
LabMark Sample ID	Client Sample ID																
13749	S -1	●	●	●	●												
13750	S -2	●	●	●	●												
13751	S -3	●	●	●	●												
13752	S -4	●	●	●	●												
13753	S -5	●	●	●	●												
13754	S -6	●	●	●	●												
13755	S -7	●	●	●	●												
13756	S -8	●	●	●	●												
13757	S -9	●	●	●	●												
Totals:		9	9	9	9												

Thank you for choosing Labmark to analyse your project samples.
Additional information on www.labmark.com.au

Form QS0012, Rev 8: Date Issued 23/07/04.

LABMARK		NATA 13542, AQIS N0356		Client Details		Safety Precaution: laboratory sample bottles may contain preservation acid / chemicals, refer to SAFETEX label on bottle.		6600001											
Dispatch samples to: Unit 1/8 Leighton Place Asquith NSW 2077 Australia		Telephone: 612-9476 6533 Facsimile: 612-9476 8219 After hours (DB): 0405 449684 After hours (IP): 0419 689300 E-mail: ros.schacht@labmark.com.au Web : www.labmark.com.au		Company & Address: TWEED LABORATORY CENTRE Project Manager: [blank] Project Name: GALE'S CANE LAND (KINGSLIFF) Project Number: [blank]		Tel: 612 556 93100 Fax: [blank] Date Required: [blank] Lab. Quote No: [blank]													
Global Specifications I require (default is Not required if Not ticked):																			
YES (tick) Vials Tests Semi- & Non-Volatile Tests Leach Nutrient Tests Other (eg. TCLP tests here) 1. Urgent TAT required? (please circle: 1 day 2 days 3 days days) 2. Fast TAT Guarantee required? (Surchage may apply - Receipt cutoff time 3.00pm) 3. Do you wish sediment present in waters to be included in organic/ inorganic extractions? 4. Additional QA/QC reported where sample batches submitted are < 10 samples? 5. Do you require DIFFERENT standard EQL's from those stated @ www.labmark.com.au? 6. Do you wish chromatograms to be supplied? (Additional fee applies). 7. Electronic data transfer (circle: fax xls csv pdf ?) Note1: Additional water sample must be submitted for lab. duplicate & spike analysis. Note2: Contact lab if consolidating multiple analyses into a single sample container.																			
Lab. Number	Sample ID	Sample Depth	Sampling Date	Matrix		Container Type (Nat. = unpreserved, Glass, Polyastic)										Comments (highly contaminated samples)	Lab Report No.	Security Seal Applied	YES/NO
				Water	Air	Solid	Slur	0.1% NaCl	0.1% HCL	0.1% HNO3	0.1% H2SO4	0.1% HF	0.1% NH4OH	0.1% CH3COOH	Other				
13749	S-1		17/5/06	X															
13750	S-2																		
13751	S-3																		
13752	S-4																		
13753	S-5																		
13754	S-6																		
13755	S-7																		
13756	S-8																		
13757	S-9																		
Totals																			
Metals (trace) As Cd, Cr, Cu, Ni, Pb, Zn, Mg, Cr, Cr*, Fe* Fe*, Be, B, Al, V, Mn, Fe, Co, Se, Sr, Sn, Mo, Ag, Ba, Ti, Bi, Sb																	Security Seal Applied	YES/NO	
Relinquished by (name): DANIEL HAYNES																	Security Seal Serial #		
Signed: [Signature]																	Lab Report No.	2075004	
Reinquired by (name): [blank]																	Date: 20-3-06	Received By: [Signature]	
Reinquired by (name): [blank]																	Date: 21/3/06	Received By: [Signature]	
Time: 10:30																	Date: 22/3	Time: 10:30	

HMC Environmental Consulting Pty Ltd



FINAL CERTIFICATE OF ANALYSIS

Laboratory Report No: 3105, 3106, 3107, 3108, 3109, 3110, 3111, 3112 & 3113
Client Name: HMC Environmental Consulting Pty Ltd
Client Reference: Gales Cane Land - Kingscliff
Contact Name: Helen & Mark Tunks **No of Samples:** 9
Chain of Custody No: Attached **Date Received:** 17/03/2006
Sample Matrix: Soil **Date Reported:** 27/03/2006

This Final Certificate of Analysis consists of sample results, QA/QC, method descriptions, laboratory definitions and internationally recognised NATA accreditation and endorsement. 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.

QUALITY ASSURANCE CRITERIA:

Accuracy: matrix spike: 1 in first 20, then 1 every 20 samples
 lcs, crm method: 1 per analytical batch
 surrogate spike: addition per target organic method
Precision: laboratory duplicate: 1 in first 20, then 1 every 10 samples
Holding Times: soils, waters: VOC's 14 days water / soil
 SVOC's 7 days water, 14 days soil
 Pesticides 7 days water, 14 days soil
Confirmation: target organic analysis: GC/MS, or confirmatory column
Sensitivity: PQL: Typically 2-5 x Method Detection Limit (MDL)

QUALITY CONTROL - GLOBAL ACCEPTANCE CRITERIA:

Accuracy: spike, lcs, crm, surrogate: general analytes 70% - 130% recovery
 phenol analytes 50% - 130% recovery
 organophosphorous pesticide analytes 60% - 130%
Precision: method blank: not detected >95% of the reported PQL
 duplicate lab RPD: 0 - 50% (>10xPQL), 0 - 75% (4-10xPQL)
 ± 2xPQL (<4xPQL)

RESULT ANNOTATION:

PQL: Practical Quantitation Limit
 LCS: Laboratory Control Standard
 IS: Internal Standard
 SS: System Surrogate
 ms: matrix spike recovery
 dup: laboratory duplicate
 r: RPD relative % difference
 mb: method blank

The test(s) covered by this document have been performed in accordance with NATA requirements of ISO/IEC 17025 and are traceable to national standards of measurement. This document shall not be reproduced except in full.



No: 12754

Daniel Haynes
Authorising Chemist (NATA signatory)
 dhaynes@tweed.nsw.gov.au

Tweed Laboratory Centre 46 Enterprise Avenue Tweed Heads South NSW 2486 Australia
 Phone: (07) 5569 3100 Fax: (07) 5524 2676



Client: HMC Environmental Consulting Pty Ltd

Address: PO Box 243

BANORA POINT NSW 2486

Page: 2 of 4

Final
Certificate
of Analysis

Attention: Helen & Mark Tunks

Date of Report: 27 March 2006

Sample Description: Gales Cane Land - Kingscliff - Soil Samples

Laboratory Identification		S1	S2	S3	S4	S5	S6	S7	S8	S9	QC	QC
Sample Identification												
Sampling Date on COC		17-Mar-2006	17-Mar-2006	17-Mar-2006	17-Mar-2006	17-Mar-2006	17-Mar-2006	17-Mar-2006	17-Mar-2006	17-Mar-2006	20-Mar-2006	20-Mar-2006
Laboratory Extraction Date		20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006
Laboratory Analysis Date		20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006
Method	PQL	S1	S2	S3	S4	S5	S6	S7	S8	S9	QC	QC
ORG01	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Organochlorine	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Pesticides (OC)	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
le-BHC	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
γ-BHC	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
δ-BHC	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Aldrin	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor epoxide	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
trans-chlordane	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
cis-chlordane	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Endosulfan I	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
DDE	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Dieldrin	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Endrin	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Endosulfan II	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
DDD	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Endrin aldehyde	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Endosulfan Sulphate	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
DDT	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Endrin Ketone	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Methoxychlor	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
2,4,5,6 Tetrachloro-Xylene (Surr @ 5mg/kg) (%)	--	108.19	102.33	98.76	102.47	102.08	99.12	102.71	102.08	98.97	101.69	100.12

Results expressed in mg/kg (ppm) unless otherwise specified.

ORG01: Extraction DCM. Analysis by GC/MS.



Client: HMC Environmental Consulting Pty Ltd
Address: PO Box 243
BANORA POINT NSW 2486
Attention: Helen & Mark Tunks

Page: 3 of 4
Date of Report: 27 March 2006
Final Certificate of Analysis

Sample Description: Gales Cane Land - Kingscliff - Soil Samples

Laboratory Identification		S1	S2	S3	S4	S5	S6	S7	S8	S9	QC MB	QC LCS
Sample Identification		17-Mar-2006	17-Mar-2006	17-Mar-2006	17-Mar-2006	17-Mar-2006	17-Mar-2006	17-Mar-2006	17-Mar-2006	17-Mar-2006	20-Mar-2006	20-Mar-2006
Sampling Date on COC		20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006
Laboratory Extraction Date		20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006
Laboratory Analysis Date		20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006
Method	PQL											%
ORG01: Organophosphorous Pesticides (OP)	Dichlorvos	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	93.11
	Mevinphos	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	90.85
	Diazinon	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	96.62
	Chlorpyrifos methyl	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	92.20
	Parathion Methyl	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	77.93
	Ronnel	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	93.15
	Fenitrothion	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	78.59
	Malathion	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	92.68
	Chlorpyrifos	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	95.67
	Fenthion	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	96.11
	Parathion	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	85.76
	Ethion	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	71.28
Triphenyl phosphate (Surr @ 5mg/kg) %		117.51	113.59	105.96	106.90	106.40	104.42	100.56	102.70	109.02	76.38	86.26
Results expressed in mg/kg (ppm) unless otherwise specified.												
ORG01: Extraction DCM. Analysis by GC/MS.												



Client: HMC Environmental Consulting Pty Ltd

Address:

PO Box 243

BANORA POINT NSW 2486

Page:

4 of 4

Final

Certificate
of Analysis

Attention:

Helen & Mark Tunks

Date of Report: 27 March 2006

Sample Description:

Gales Cane Land - Kingscliff - Soil Samples

Laboratory Identification		S1	S2	S3	S4	S5	S6	S7	S8	S9
Sample Identification										
Sampling Date on COC		17-Mar-2006	17-Mar-2006	17-Mar-2006	17-Mar-2006	17-Mar-2006	17-Mar-2006	17-Mar-2006	17-Mar-2006	17-Mar-2006
Laboratory Extraction Date		20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006
Laboratory Analysis Date		20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006	20-Mar-2006
Method	PQL									
Moisture	—	24	24	23	21	21	19	23	17	21
ORG03	Moisture									
Results expressed in % w/w unless otherwise specified.										
ORG03: Moisture by Gravimetric Analysis.										

HMC Environmental Consulting
Unit 2, 47 Greenway Drive
South Tweed Heads
NSW 2486
PO Box 243, Banora Point, NSW 2486
Ph (07) 5513 1622 Fax (07) 5523 9135
Email:

ENVIRONMENTAL ANALYSIS REQUEST – CHAIN OF CUSTODY RECORD																										
Company:		HMC Environmental		Project Name:		Gales Cane Land (Kingscliff)																				
Address:		47 Greenway Drive South Tweed Heads		Project Number:																						
Contact:		Mark Greg		Purchase Order No:																						
Telephone:		07 5513 1622		Results Required by:		24 hours <input type="checkbox"/> 48 hours <input type="checkbox"/> 3 – 5 Day <input type="checkbox"/> Other <input type="checkbox"/>																				
Email:		admin@hmcenvironment.com.au		Send Results to:		admin@hmcenvironment.com.au																				
				Results to be provided by:		Mail <input type="checkbox"/> Fax <input type="checkbox"/> Email: <input checked="" type="checkbox"/>																				
SAMPLE DESCRIPTION			ANALYSIS REQUIRED																							
Sample ID	HMC	Date Sampled	Time	Lab No	Soil / Water / Other	Comments ^a	COMPOSITE	VOC scan (8280)	TPH – C6-C8	TPH – C10-C36	MAHs	BTEX	SVOC scan (8270)	PAHs	PCBs	OCs	OPs	Specified Phenols	Metals – Std 17	Metals – Specify	Hg	EPA Screen (M only)	Total Phenolics	LEAD	ARSENIC	MERCURY
S1		17/03/06			Soil	Composite S1 ABCD	X									X	X	X	X	X	X	X	X	X	X	X
S2		17/03/06			Soil	Composite S2 ABCD	X									X	X	X	X	X	X	X	X	X	X	X
S3		17/03/06			Soil	Composite S3 ABCD	X									X	X	X	X	X	X	X	X	X	X	X
S4		17/03/06			Soil	Composite S4 ABCD	X									X	X	X	X	X	X	X	X	X	X	X
S5		17/03/06			Soil	Composite S5 ABCD	X									X	X	X	X	X	X	X	X	X	X	X
S6		17/03/06			Soil	Composite S6 ABCD	X									X	X	X	X	X	X	X	X	X	X	X
S7		17/03/06			Soil	Composite S7 ABCD	X									X	X	X	X	X	X	X	X	X	X	X
S8		17/03/06			Soil	Composite S8 ABCD	X									X	X	X	X	X	X	X	X	X	X	X
S9		17/03/06			Soil	Composite S9 ABCD	X									X	X	X	X	X	X	X	X	X	X	X
							Totals																			
# Please Provide Field PID Readings where possible																										
Relinquished by: <i>GASG JONES</i>							Date/Time: 17/3/06		Special Requirements (eg. OHS issues etc.)																	
Received by: <i>J. Martin</i>							Date/Time: 17/3/06		Sample Receipt Advice (Lab Use Only)																	
									All Samples Received in Good Condition <input type="checkbox"/>																	
									All Documentation in Proper Order <input type="checkbox"/>																	
									Samples Received Properly Chilled <input type="checkbox"/>																	
									Samples Received Within Recommended Holding Times <input type="checkbox"/>																	
									For Enquiries please quote Batch No. 3105																	

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Appendix 5

Laboratory Results – Soil Analyses – P. Guinane Pty Ltd

(No. of pages excluding this page = 21)

* Note: Not included within hardcopy. A copy has been provided on the project CD.

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CERTIFICATE OF ANALYSIS

ALS Environmental



CONTACT: MR A HOVEY
CLIENT: GILBERT & SUTHERLAND PTY LTD
ADDRESS: P O BOX 4115
ROBINA QLD 4230
ORDER No.: GJ0003
PROJECT:

Batch: EB61984
Sub Batch: 0
LABORATORY: BRISBANE
DATE RECEIVED: 28/01/2004
DATE COMPLETED: 02/02/2004
SAMPLE TYPE: SOIL
No. of SAMPLES: 39

COMMENTS

Results apply to sample(s) as submitted. Chromium Reducible Sulphur as per Method 22B ASSMAC Laboratory Methods Guidelines, August 1998. TAA as per the POCAS method of Ahern et al (1998). Results expressed as mole H⁺/tonne.

NOTES

This is the Final Report and supersedes any preliminary reports with this batch number. All pages of this report have been checked and approved for release.

ISSUING LABORATORY: BRISBANE

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Fax: 61-7-3243 7254
Email: michael.heery@alsenviro.com

Signatory

Michael Heery
Senior Analyst
Chromium Reducible Sulphur

LABORATORIES

AUSTRALASIA

Brisbane
Melbourne
Sydney
Newcastle
Mumbai

Hong Kong
Singapore
Kuala Lumpur
Auckland
Bogor

AMERICAS

Vancouver
San Diego
Antofagasta
Lima

Australian Laboratory Services Pty Ltd (ABN 84 009 936 029)



NATA Accredited Laboratory Number 825
Site: BRISBANE

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Page 1 of 6



CERTIFICATE OF ANALYSIS

Batch: EB61984
Sub Ba 0
Date of Issue: 14/10/2004
Client: GILBERT & SUTHERLAND PTY LTD
Client Reference:

		SAMPLE IDENTIFICATION											
		Laboratory I.D.		1	2	3	4	5	6	7	8	9	10
METHOD	ANALYSIS DESCRIPTION	Date Sampled	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004
		UNIT	LOR	BH1	BH1	BH1	BH1	BH1	BH1	BH2	BH2	BH2	BH3
		moles/tonne	2	4	8	<2	<2	<2	6	<2	<2	<2	12
		pH (KCl)	0.1	4.6	4.1	8.0	8.9	7.6	4.4	8.7	8.9	8.2	4.0
		Chromium Reducible Sulphur	%	0.02	0.17	0.24	0.02	0.05	0.28	0.02	<0.02	0.35	0.23

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Page 2 of 6

SPECIALIST CONSULTANT STUDIES
*Part 3 – Acid Sulfate Soils, Soil Contamination
 & Agricultural Suitability Assessment*

3 - 115

GALES-KINGSCLIFF PTY LTD
Cudgen Lakes Sand Extraction Project
Report No. 617/04



CERTIFICATE OF ANALYSIS

EB61984

0

14/10/2004

GILBERT & SUTHERLAND PTY LTD

Client Reference:

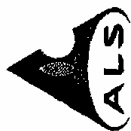
		SAMPLE IDENTIFICATION											
Laboratory I.D.		11	12	13	14	15	16	17	18	19	20		
Date Sampled		28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004		
METHOD	ANALYSIS DESCRIPTION	UNIT	LOR	BH3	BH3	BH4	BH4	BH4	BH4	BH4	BH5		
		mole/tonne	2	<2	<2	<2	8	<2	<2	<2	10	<2	
		pH (KCl)	0.1	5.7	8.5	8.6	4.2	8.3	8.6	7.2	4.1	5.1	
		Chromium Reducible Sulphur %	0.02	<0.02	<0.02	0.11	0.02	<0.02	<0.02	<0.02	0.27	0.10	

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Page 3 of 6



CERTIFICATE OF ANALYSIS

Batch: EB61984
Sub Bz: 0
Date of Issue: 14/10/2004
Client: GILBERT & SUTHERLAND PTY LTD
Client Reference:

Laboratory I.D.		SAMPLE IDENTIFICATION									
		21	22	23	24	25	26	27	28	29	30
METHOD	ANALYSIS DESCRIPTION	Date Sampled	Date Sampled	Date Sampled	Date Sampled	Date Sampled	Date Sampled	Date Sampled	Date Sampled	Date Sampled	Date Sampled
EA-022	TAA	BH6	BH5	BH5	BH6	BH6	BH6	BH6	BH6	BH6	BH7
EA-022	pH (KCl)	7.0	9.5	11.5	3.0	6.5	8.0	9.5	12.0	15.0	1.5
EA-026	Chromium Reducible Sulphur	2	<2	<2	<2	<2	<2	<2	<2	<2	4
		0.1	8.5	7.4	6.3	6.3	6.4	4.9	6.7	8.9	4.6
		0.02	0.08	<0.02	0.09	<0.02	<0.02	0.04	<0.02	<0.02	<0.02

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Page 4 of 6



CERTIFICATE OF ANALYSIS

Batch: EB61984
 Sub Ba 0
 Date of Issue: 14/10/2004
 Client: GILBERT & SUTHERLAND PTY LTD
 Client Reference:

METHOD		SAMPLE IDENTIFICATION									
		Laboratory I.D.	31	32	33	34	35	36	37	38	39
EA-022	TAA	Date Sampled	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004
EA-022	pH (KCl)	UNIT	BH7	BH7	BH7	BH7	BH7	BH7	BH8	BH8	BH8
EA-028	Chromium Reducible Sulphur	LOR	4.5	7.5	8.5	12.0	15.4	1.5	5.0	9.0	10.0
		UNIT	<2	<2	<2	<2	12	<2	<2	<2	<2
		mol/tonne	8.5	6.7	6.7	6.6	3.7	4.7	8.0	7.0	6.9
		%	<0.02	0.22	0.02	<0.02	0.44	0.21	0.04	<0.02	<0.02

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QUALITY CONTROL REPORT

Batch: EB61984
Sub Bat: 0
Date of Issue: 14/10/2004
Client: GILBERT & SUTHERLAND PTY LTD
Client Reference:

		SAMPLE IDENTIFICATION					
	Laboratory I.D.	200	201	300	301		
	Date Sampled	28/01/2004	28/01/2004	28/01/2004	28/01/2004		
METHOD	ANALYSIS DESCRIPTION	UNIT	LOR	Method Blank 1 LCS % Rec	Inorg 1 Blank 2 LCS % Rec		
EA-022	TAA	mole/litre	2	<2	---		
EA-022	pH (XG1)		0.1	---	---		
EA-026	Chromium Reducible Sulphur	%	0.02	<0.02	100	<0.02	108

CERTIFICATE OF ANALYSIS

ALS Environmental



CONTACT: MR A HOVEY
CLIENT: GILBERT & SUTHERLAND PTY LTD
ADDRESS:
P O BOX 4115
ROBINA QLD 4230
ORDER No.: GJ0063
PROJECT:

Batch: EB62539
Sub Batch: 0
LABORATORY: BRISBANE
DATE RECEIVED: 16/02/2004
DATE COMPLETED: 20/02/2004
SAMPLE TYPE: SOIL
No. of SAMPLES: 15

COMMENTS

Results apply to sample(s) as submitted. TAA as per the POCAS method or Ahern et al (1998). Results expressed as mole H⁺/tonne. Chromium Reducible Sulphur as per Method 22B ASSMAC Laboratory Methods Guidelines, August 1998.

NOTES

This is the Final Report and supersedes any preliminary reports with this batch number. All pages of this report have been checked and approved for release.

ISSUING LABORATORY: BRISBANE

Address
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Email: michael.heery@alsenviro.com

Signatory

[Signature]
Gary Heery
Senior Laboratory Supervisor

[Signature]
Michael Heery
Senior Laboratory Supervisor

[Signature]
Michael Heery
Senior Laboratory Supervisor

LABORATORIES

AUSTRALASIA
Brisbane
Bourke
Sydney
Newcastle
Mumbai

Hong Kong
Singapore
Kuala Lumpur
Auckland
Bogor

AMERICAS
Vancouver
Santiago
Antofagasta
Lima

Australian Laboratory Services Pty Ltd (ABN 84 009 936 029)



NATA Accredited Laboratory Number 825

Site: BRISBANE

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Page 1 of 4



CERTIFICATE OF ANALYSIS

Sub Batch: 0
Date of Iss 23/02/2004
Client: GILBERT & SUTHERLAND PTY LTD
Client Reference:

Laboratory I.D.		SAMPLE IDENTIFICATION									
Date Sampled		1	2	3	4	5	6	7	8	9	10
METHOD	ANALYSIS DESCRIPTION	UNIT	LOR								
	TAA	mole/tonne	2	4	<2	<2	4	<2	<2	<2	<2
	pH (KCl)		0.1	4.3	8.2	7.7	7.5	4.2	6.2	6.6	6.7
	Chromium Reducible Sulphur	%	0.02	0.16	<0.02	<0.02	<0.02	0.58	0.08	<0.02	<0.02

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Page 2 of 4



CERTIFICATE OF ANALYSIS

Sub Batch: 0
 Date of Iss: 23/02/2004
 Client: GILBERT & SUTHERLAND PTY LTD
 Client Reference:

METHOD	ANALYSIS DESCRIPTION	Laboratory I.D.					SAMPLE IDENTIFICATION				
		Date Sampled	11	12	13	14	15				
A-022	TAA	28/01/2004	BH10	BH11	BH11	BH11	BH11				
A-022	pH (KCl)	2	13.5	2.0	4.0	15.0	16.0				
A-026	Chromium Reducible Sulphur	0.1	<2	10	<2	<2	<2				
		0.02	6.8	4.2	9.0	9.1	8.7				
			<0.02	0.24	0.06	0.12	0.38				

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Australian Laboratory Services Pty Ltd (ABN 84 009 936 029)

Page 3 of 4



QUALITY CONTROL REPORT

Sub Batch: 0
Date of Iss: 23/02/2004
Client: GILBERT & SUTHERLAND PTY LTD
Client Reference:

METHOD		ANALYSIS DESCRIPTION	SAMPLE IDENTIFICATION				CHECKS AND SPIKES			
			Laboratory I.D.	200	201	16/02/2004				
			Date Sampled	16/02/2004	16/02/2004	Inorg 1				
			UNIT	LOR	Method	Blank 1				
						LCS % Rec				
022	TAA									
022	pH (KCl)		2	<2						
026	Chromium Reducible Sulphur		0.1							
			0.02	<0.02	100					

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CERTIFICATE OF ANALYSIS

CONTACT: MR A HOVEY
CLIENT: GILBERT & SUTHERLAND PTY LTD
ADDRESS:
P O BOX 4115
ROBINA QLD 4230
ORDER No.: GJ0063-2
PROJECT:

BATCH: EB62237
SUB BATCH: 0
LABORATORY: BRISBANE
DATE RECEIVED: 31/01/2004
DATE COMPLETED: 13/02/2004
SAMPLE TYPE: SOIL
No. of SAMPLES: 91

COMMENTS

Results apply to sample(s) as submitted.

NOTES

This is the Final Report and supersedes any preliminary reports with this batch number.
All pages of this report have been checked and approved for release.

ISSUING LABORATORY: BRISBANE

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Signatory 

LABORATORIES

AUSTRALASIA
Brisbane
Boume
Iney
Newcastle
Auckland
Hong Kong
Singapore
Kuala Lumpur
Bogor
Mumbai

AMERICAS
Vancouver
Santiago
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Lima



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Site: BRISBANE

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CERTIFICATE OF ANALYSIS

Batch: EB62237
Sub Batch: 0
Date of Issue: 13/02/2004
Client: GILBERT & SUTHERLAND PTY LTD
Client Reference:

		SAMPLE IDENTIFICATION											
Laboratory I.D.		1	2	3	4	5	6	7	8	9	10		
Date Sampled		28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004		
UNIT		BH9 0.5	BH9 1.0	BH9 1.5	BH9 2.0	BH9 2.5	BH9 3.0	BH9 3.5	BH9 4.0	BH9 4.5	BH9 5.0		
ANALYSIS DESCRIPTION		UNIT	LOR										
METHOD	pH (Field)	0.1		3.9	3.8	5.8	8.1	8.0	8.1	8.2	8.2		
	pH (Field Oxidation)	0.1		3.6	2.9	3.0	6.4	6.9	7.8	6.2	7.0		
	Reaction Rate	1		3	4	4	4	4	4	4	4		

ALS Environmental

Australian Laboratory Services Pty Ltd (ABN 64 009 936 029)

Page 2 of 11



CERTIFICATE OF ANALYSIS

Batch: EB62237
 Sub Batch: 0
 Date of Issue: 13/02/2004
 Client: GILBERT & SUTHERLAND PTY LTD
 Client Reference:

		SAMPLE IDENTIFICATION									
		11	12	13	14	15	16	17	18	19	20
Laboratory I.D.		28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004
Date Sampled		BH9 5.5	BH9 6.0	BH9 6.5	BH9 7.0	BH9 7.5	BH9 8.0	BH9 8.5	BH9 9.0	BH9 9.5	BH9 10.0
UNIT		LOR									
ANALYSIS DESCRIPTION											
EA-003	pH (Field)	8.5	8.5	9.2	9.0	8.8	8.9	7.8	7.6	8.1	8.6
EA-004	pH (Field Oxidation)	7.2	7.4	7.3	7.2	7.9	8.1	3.2	2.9	5.0	5.3
EA-085	Reaction Rate	1	4	4	4	4	4	4	4	4	4

ALS Environmental

Australian Laboratory Services Pty Ltd (ABN 84 009 936 029)



CERTIFICATE OF ANALYSIS

Batch: EB62237
Sub Batching: 0
Date of Issue: 13/02/2004
Client: GILBERT & SUTHERLAND PTY LTD
Client Reference:

		SAMPLE IDENTIFICATION											
Laboratory I.D.		21	22	23	24	25	26	27	28	29	30		
Date Sampled		28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004		
UNIT		BH9 10.5	BH9 11.0	BH9 11.5	BH9 12.0	BH9 12.5	BH9 13.0	BH9 13.5	BH9 14.0	BH9 14.5	BH9 15.0		
ANALYSIS DESCRIPTION		LOR											
METHOD													
EA-003	pH (Field)	0.1	8.1	8.2	8.3	7.6	7.6	6.6	7.6	6.8	7.4		
EA-004	pH (Field Oxidation)	0.1	5.7	5.7	5.6	5.3	5.2	5.1	5.1	4.4	4.3		
EA-005	Reaction Rate	1	4	4	3	3	3	3	3	3	3		

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Australian Laboratory Services Pty Ltd (ABN 64 009 936 029)

Page 4 of 11



CERTIFICATE OF ANALYSIS

Client Reference:

METHOD		ANALYSIS DESCRIPTION	SAMPLE IDENTIFICATION											
			Laboratory I.D.		31	32	33	34	35	36	37	38	39	40
			Date Sampled		BH9 15.4	BH10 0.5	BH10 1.0	BH10 1.5	BH10 2.0	BH10 2.5	BH10 3.0	BH10 3.5	BH10 4.0	BH10 4.5
			UNIT	LOR										
EA-003	pH (Field)	0.1	7.0	5.4	5.1	3.9	4.2	3.6	3.8	7.0	6.0	6.4		
EA-004	pH (Field Oxidation)	0.1	4.9	3.6	3.2	2.3	2.8	2.4	2.8	2.5	2.9	2.2		
EA-005	Reaction Rate	1	4	4	3	3	4	4	3	4	4	3		



CERTIFICATE OF ANALYSIS

Batch: EB62237
Sub Batc: 0
Date of Issue: 13/02/2004
Client: GILBERT & SUTHERLAND PTY LTD
Client Reference:

		SAMPLE IDENTIFICATION												
Laboratory I.D.		41	42	43	44	45	46	47	48	49				
Date Sampled		28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004				
UNIT		BH10 5.0	BH10 5.5	BH10 7.0	BH10 7.5	BH10 8.0	BH10 8.5	BH10 9.0	BH10 9.5	BH10 10.0				
ANALYSIS DESCRIPTION		LOR												
EA-003	pH (Field)	0.1	6.1	6.2	6.6	6.8	6.8	6.8	6.8	7.3	7.2	7.1		
EA-004	pH (Field Oxidation)	0.1	2.4	2.5	3.6	3.6	4.4	3.9	3.6	4.4	4.7	5.2		
EA-085	Reaction Rate	1	3	4	3	3	3	3	3	3	3	3		

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CERTIFICATE OF ANALYSIS

Batch: EB62237

Sub Bact. 0

Date of Issue: 13/02/2004

Client: GILBERT & SUTHERLAND PTY LTD

Client Reference:

		SAMPLE IDENTIFICATION									
		51	52	53	54	55	56	57	58	59	60
Laboratory I.D.		28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004
Date Sampled		BH10 11.0	BH10 11.5	BH10 12.0	BH10 12.5	BH10 13.0	BH10 13.5	BH10 14.0	BH10 14.5	BH11 0.5	BH11 1.0
UNIT		LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR	LOR
ANALYSIS DESCRIPTION		pH (Field)	pH (Field)	pH (Field)	pH (Field)	pH (Field)	pH (Field)	pH (Field)	pH (Field)	pH (Field)	pH (Field)
EA-003		0.1	7.4	7.1	7.1	7.2	7.4	7.5	7.4	6.1	4.3
EA-004		0.1	5.2	5.4	5.2	5.4	5.3	5.4	5.1	4.1	3.0
EA-085		1	3	3	3	3	3	3	3	3	4



CERTIFICATE OF ANALYSIS

Batch: EB62237
Sub Batt. 0
Date of Issue: 13/02/2004
Client: GILBERT & SUTHERLAND PTY LTD
Client Reference:

METHOD		ANALYSIS DESCRIPTION	UNIT	SAMPLE IDENTIFICATION										
				Laboratory I.D.	61	62	63	64	65	66	67	68	69	70
				Date Sampled	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004
			BH11 1.5	BH11 2.0	BH11 2.5	BH11 3.0	BH11 3.5	BH11 4.0	BH11 4.5	BH11 5.0	BH11 5.5	BH11 6.0		
EA-003	pH (Field)	0.1	4.7	4.0	7.5	7.7	6.4	7.9	6.7	7.6	7.2	7.6		
EA-004	pH (Field Oxidation)	0.1	3.7	2.3	2.5	3.7	5.1	6.2	5.4	6.0	6.1	6.1		
EA-085	Reaction Rate	1	4	4	4	4	4	4	4	4	4	4		

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Batch: EB62237
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 Date of Issue: 13/02/2004
 Client: GILBERT & SUTHERLAND PTY LTD
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		SAMPLE IDENTIFICATION											
Laboratory I.D.		71	72	73	74	75	76	77	78	79	80		
Date Sampled		28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004		
UNIT		BH11 6.5	BH11 7.0	BH11 7.5	BH11 8.0	BH11 8.5	BH11 9.0	BH11 9.5	BH11 10.0	BH11 10.5	BH11 11.0		
LOR													
METHOD	ANALYSIS DESCRIPTION												
EA-003	pH (Field)	0.1	7.4	7.2	7.0	7.7	7.0	7.8	8.1	8.4	8.0	8.1	
EA-004	pH (Field Oxidation)	0.1	6.2	6.2	6.8	6.7	6.7	7.0	7.0	6.7	7.2	6.9	
EA-085	Reaction Rate	1	4	4	3	3	3	3	3	3	3	3	



CERTIFICATE OF ANALYSIS

Batch: EB62237
Sub Batch: 0
Date of Issue: 13/02/2004
Client: GILBERT & SUTHERLAND PTY LTD
Client Reference:

				SAMPLE IDENTIFICATION											
Laboratory I.D.															
Date Sampled															
UNIT															
LOR															
pH (Field)															
pH (Field Oxidation)															
Reaction Rate															
METHOD	ANALYSIS DESCRIPTION	81	82	83	84	85	86	87	88	89	90				
EA-003		28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004	28/01/2004				
EA-004		BH11 11.5	BH11 12.0	BH11 12.5	BH11 13.0	BH11 13.5	BH11 14.0	BH11 14.5	BH11 15.0	BH11 15.5	BH11 16.0				
EA-085		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1				
		0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1				
		1	1	1	1	1	1	1	1	1	1				
		8.2	8.5	8.6	8.3	8.3	8.3	8.2	8.2	8.4	8.3				
		6.9	7.1	7.3	6.7	6.9	7.1	7.5	7.2	7.2	6.9				
		3	3	3	3	3	3	3	3	3	4				

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CERTIFICATE OF ANALYSIS

Batch: EB62237

Sub Batch: 0

Date of Issue: 13/02/2004

Client: GILBERT & SUTHERLAND PTY LTD

Client Reference:

			SAMPLE IDENTIFICATION									
METHOD	ANALYSIS DESCRIPTION	Laboratory I.D.										
		UNIT	LOR	Date Sampled								
EA-003	pH (Field)		0.1	28/01/2004	91							
EA-004	pH (Field Oxidation)		0.1	BH11 16.0								
EA-005	Reaction Rate		1									

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Appendix 6

Laboratory Results – Soil Analyses – Lobster Farm

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* Note: Not included within hardcopy. A copy has been provided on the project CD.

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Douglas Partners

Geotechnics • Environment • Groundwater

**REPORT on
PRELIMINARY GEOTECHNICAL AND
ACID SULFATE SOILS INVESTIGATION**

**PROPOSED BAY LOBSTER AQUACULTURE PROJECT
355 CUDGEN ROAD, CUDGEN, NSW**

prepared for
AUSTRALIAN FRESH CORPORATION PTY LTD

**Project 33579
3 September 2004**

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Attachments

- Drawing 1 – Test Location Plan
- Appendix A – Test Bore Report Sheets (Nos. 1 to 10)
 - Cone Penetration Test Report Sheets (CPTs 11 to 14)
 - Notes Relating to This Report
- Appendix B – Laboratory Report Sheets
 - Chain of Custody Documentation



CRB/KAB/apg
Project 33579
3 September 2004

**REPORT ON
PRELIMINARY GEOTECHNICAL AND ACID SULFATE SOILS INVESTIGATION
PROPOSED BAY LOBSTER AQUACULTURE PROJECT
355 CUDGEN ROAD, CUDGEN, NSW**

1.0 INTRODUCTION

This report details the results of a preliminary geotechnical and acid sulfate soils (ASS) investigation carried out for the proposed 'Bay Lobster Aquaculture Project' to be located at 355 Cudgen Road, Cudgen. The work was performed for Australian Fresh Corporation Pty Ltd, at the request of David McPhee and Associates, consulting engineers for the project.

The scope of work comprised four static cone penetration tests (CPTs), the drilling of ten test bores, logging and sampling, followed by analytical and geotechnical laboratory testing, engineering evaluation, analysis and reporting.

The objective of the work was to provide the following information as set out in the revised Douglas Partners Pty Ltd (DP) proposal P206.04 dated 28 July 2004 to Australian Fresh Corporation:

- subsurface conditions encountered, including groundwater observations;
- indicative presence or otherwise of ASS;
- suitability of excavated material for re-use as fill;
- indicative settlements;
- suitable ground improvement options (if required); and
- suitable foundation type(s).

2.0 SITE DESCRIPTION

The site is located at 355 Cudgen Road, Cudgen and comprises Lots 706, 708 to 710 on DP1000580, Lot 1 on DP267742 and Lot 1 on DP578963 in the Parish of Cudgen. The site is bounded to the north, east, south and south-west by other rural farm land, and to the north-west by a melaleuca station (refer Drawing 1). The Pacific Highway/Murwillumbah overpass exit is located immediately north-west of the site boundary. The site has a plan area of approximately 120 hectares, and at the time of the field work, was covered with mature sugarcane crops and cleared cane fields.

Ground surface levels, as indicated on the survey plan supplied by the client, vary between approximately 0.4m and 1.4m AHD. At the time of the field work, the variation in ground surface levels was not obvious due to the presence of the sugarcane.



3.0 GEOLOGY

Reference to the Geological Survey of Queensland's 1:250,000 Tweed Heads Sheet indicates the site may be underlain by Quaternary Alluvium typically comprising "river gravels, alluvium, sand and clay".

Reference to the Soil Conservation Service of New South Wales' Acid Sulphate Risk Maps, Cudgen and Tweed Heads, indicates the site to be located within an area of high probability of occurrence of ASS material within the soil profile and in an environment where deposition has been suitable for the formation of ASS materials.

4.0 FIELD WORK METHODS

The field work was undertaken between 11 and 25 August 2004 and comprised the drilling of ten test bores (designated Bores 1 to 10) and four CPTs (designated CPTs 11 to 14). The test locations are indicated on Drawing 1 attached and were measured using a hand-held Garmin GPS72.

The test bores were undertaken using a trailer-mounted drilling rig with 100mm diameter solid flight augers. The bores were drilled to maximum depths of 4m with disturbed samples generally recovered at 0.5m depth intervals for visual and tactile assessment, ASS screening tests and for geotechnical testing. Samples intended for ASS testing were double-wrapped in zip-lock bags and plastic, and kept on ice for transfer to the laboratory.

In the CPT test, a 35mm diameter cone with a following 135mm long friction sleeve is attached to rods of the same diameter and pushed continuously into the soil by hydraulic thrust provided by DP's specialist in-house ballasted cone truck. Strain gauges in the cone and sleeve measure resistance to penetration, and the results are displayed on a digital monitor and stored on computer disk for later plotting.

All field work was undertaken in the presence of an experienced geotechnical engineer who set out the test locations, supervised the drilling and testing, recovered disturbed samples, prepared descriptive logs of the materials encountered, operated the CPT computer, processed the test results (including inferred strata descriptions), dipped the test holes on completion, and conducted the field screening tests.

5.0 FIELD WORK RESULTS

The subsurface conditions encountered in the bores and inferred in the CPTs are described in the test report sheets in Appendix A together with general notes which define the descriptive terms and classification methods used.

In summary, the subsurface conditions comprised '**sand, silty sand, and gravelly sand**' underlain by '**clayey silt/silty clay**' at depth, as further described below:

- **Sand and Silty Sand** – Encountered from ground level in all bores and inferred in all CPTs, the sand and silty sand was observed to be fine to medium grained and brown and grey. This was inferred from the CPTs to be loose to medium dense near the surface, grading to loose and very loose below 0.3m to 0.75m depth. The very loose to loose sand was inferred to increase in relative density to medium dense below 3.5m to 5.3m depth, and gradually increasing to dense or interbedded medium dense and dense.
- **Gravelly Sand** – Underlying the sand and silty sand, gravelly sand was generally inferred in the CPTs below depths of approximately 8.5m to 9.5m. The gravelly sand was inferred to be dense and very dense, locally medium dense, and was inferred to depths of between approximately 16.6m and 18.5m depth in CPTs 12 to 14. CPT 11 refused in the gravelly sand at a depth of 11.02m.
- **Clayey Silt/Silty Clay** – Inferred beneath the gravelly sand in CPTs 12 to 14, clayey silt/silty clay was encountered to the termination depths of CPTs 12 to 14 at between 20m and 25m depth. The clayey silt/silty clay was inferred to be of firm to stiff strength consistency.

Free groundwater was encountered in all the test bores on completion of drilling and in CPT 14 on withdrawal of the rods at depths of between 0.8m and 1.05m corresponding to RL 0.0m to RL -0.3m. It should be noted, however, that groundwater levels are affected by climatic conditions and soil permeability and will therefore vary with time.

6.0 LABORATORY TESTING

Laboratory testing comprised particle size distribution tests, ASS field screening tests and analytical Chromium Suite tests. Detailed report sheets are attached in Appendix B and the results are summarised and discussed in the following subsections.

6.1 Geotechnical Laboratory Tests

Geotechnical laboratory testing comprised particle size distribution tests, by wet sieve analysis, on eight samples of sand recovered from the test bores. The results are summarised in Table 1 below:

Table 1 – Summary of Particle Size Distribution

Bore Location	Depth (m)	Description	Gravel Fraction (2mm to 60mm)	Sand Fraction (60µm to 2mm)	Fines (<60µm)
1	0.4-0.5	Silty sand	0	58	42
1	1.4-1.5	Slightly silty sand	0	84	16
4	0.9-1.0	Slightly silty sand	0	84	16
4	2.9-3.0	Sand with some silt	0	94	6
6	0.4-0.5	Sand with some silt	0	90	10
6	2.4-2.5	Sand with a trace of silt	0	96	4
9	0.9-1.0	Sand with some silt	0	90	10
9	1.9-2.0	Sand with some silt	0	93	7

The results indicate the samples tested to be predominantly sand with varying silt content.



6.2 ASS Testing

Soil testing for ASS was carried out with reference to the QASSIT Guidelines¹. Initially eighty samples from the bores were screened by measurement of pH after the addition of distilled water (pH_F) and peroxide (pH_{FOX}). Based on the results of the screening tests, selected samples were subjected to more rigorous Chromium Suite analytical testing.

The results of the screening tests (pH_F and pH_{FOX}) are presented in Table 2 below, along with a summary of the results of Chromium Suite testing. The complete analytical results are attached in Appendix B, together with 'Chain of Custody Documentation'.

Table 2 – Results of Field Screening and Chemical Laboratory Testing

Depth (m)	Sample Description	Field Screening Test Results				Chromium Suite Test Results (%S)				
		pH _F	pH _{FOX}	ΔpH	Reaction (1,2,3,4) * F **	Chromium Reducible Sulfur (S _{CR})	Total Actual Acidity (TAA)	Retained Acidity (NASS)	Calculated Acid Neutralising Capacity (ANC)	Net Acidity
Bore 1										
0.4-0.5	Sand	6.8	3.3	3.5	1	-	-	-	-	-
0.9-1.0	Sand	6.2	4.0	2.2	1	-	-	-	-	-
1.4-1.5	Sand	6.1	2.2	3.9	3F	-	-	-	-	-
1.9-2.0	Sand	6.7	1.9	4.8	3F	-	-	-	-	-
2.4-2.5	Sand	7.5	2.0	5.5	3F	-	-	-	-	-
2.9-3.0	Sand	6.7	2.0	4.7	3F	-	-	-	-	-
3.4-3.5	Sand	7.0	2.1	4.9	3F	-	-	-	-	-
3.9-4.0	Sand	5.9	2.1	3.8	3F	-	-	-	-	-
Bore 2										
0.4-0.5	Silty Sand	6.7	4.2	2.5	1	-	-	-	-	-
0.9-1.0	Silty Sand	7.3	2.3	5.0	2F	-	-	-	-	-
1.4-1.5	Silty Sand	7.0	2.1	4.9	3F	-	-	-	-	-
1.9-2.0	Silty Sand	8.3	2.0	6.3	3F	-	-	-	-	-
2.4-2.5	Silty Sand	8.8	2.0	6.3	3F	-	-	-	-	-
2.9-3.0	Silty Sand	7.1	2.0	5.1	3F	-	-	-	-	-
3.4-3.5	Silty Sand	9.0	2.0	7.0	3F	-	-	-	-	-
3.9-4.0	Silty Sand	9.0	2.1	6.9	3F	-	-	-	-	-
Bore 3										
0.4-0.5	Silty Sand	4.6	2.5	2.1	2F	0.10	0.05	ND	ND	0.15
0.9-1.0	Silty Sand	4.1	2.1	2.0	2F	-	-	-	-	-
1.4-1.5	Silty Sand	5.6	2.2	3.4	3F	-	-	-	-	-
1.9-2.0	Silty Sand	4.9	2.4	2.5	4F	-	-	-	-	-
2.4-2.5	Silty Sand	6.7	2.1	4.6	4F	-	-	-	-	-
2.9-3.0	Silty Sand	6.6	2.0	4.6	3F	-	-	-	-	-
3.4-3.5	Silty Sand	7.4	2.1	5.3	4F	-	-	-	-	-
3.9-4.0	Silty Sand	7.8	2.1	5.7	4F	-	-	-	-	-

¹ Ahern, C R, Ahern, M R, and Powell, B, "Guidelines for Sampling and Analysis of Lowland Acid Sulfate Soils (ASS) in Queensland 1998", QASSIT, Department of Natural Resources, Resources Sciences Centre, Indooroopilly, October 1998.

Table 2 – Results of Field Screening and Chemical Laboratory Testing (cont)

Table 2 – Results of Field Screening and Chemical Laboratory Testing (Cont)										
Depth (m)	Sample Description	Field Screening Test Results				Chromium Suite Test Results (%S)				
		pH _F	pH _{FOX}	ΔpH	Reaction (1,2,3,4) * F **	Chromium Reducible Sulfur (S _{CR})	Total Actual Acidity (TAA)	Retained Acidity (NASS)	Calculated Acid Neutralising Capacity (ANC)	Net Acidity
Bore 4										
0.4-0.5	Sand	4.7	3.2	2.5	2F	-	-	-	-	-
0.9-1.0	Sand	5.4	2.4	3.0	2F	-	-	-	-	-
1.4-1.5	Sand	6.5	1.9	4.6	4F	-	-	-	-	-
1.9-2.0	Sand	6.2	1.9	4.3	3F	0.25	<0.02	ND	ND	0.25
2.4-2.5	Sand	7.0	1.9	5.1	4F	0.25	<0.02	ND	ND	0.25
2.9-3.0	Sand	6.8	1.9	4.9	4F	-	-	-	-	-
3.4-3.5	Sand	7.2	2.0	5.2	3F	-	-	-	-	-
3.9-4.0	Sand	7.1	2.0	5.1	3F	0.14	<0.02	ND	ND	0.14
Bore 5										
0.4-0.5	Silty Sand	5.3	2.8	2.5	1F	-	-	-	-	-
0.9-1.0	Silty Sand	6.4	1.8	3.6	2F	0.03	<0.02	ND	ND	0.27
1.4-1.5	Silty Sand	6.2	2.1	4.1	3F	-	-	-	-	-
1.9-2.0	Silty Sand	6.2	2.1	4.1	3F	-	-	-	-	-
2.4-2.5	Silty Sand	6.8	2.0	4.8	4F	-	-	-	-	-
2.9-3.0	Silty Sand	6.7	2.0	4.7	3F	-	-	-	-	-
3.4-3.5	Silty Sand	6.7	2.0	4.7	4F	-	-	-	-	-
3.9-4.0	Silty Sand	7.2	2.3	4.9	4F	-	-	-	-	-
Bore 6										
0.4-0.5	Sand	6.8	3.9	2.9	1F	-	-	-	-	-
0.9-1.0	Sand	6.6	2.5	4.1	1F	-	-	-	-	-
1.4-1.5	Sand	6.8	2.0	4.8	1F	-	-	-	-	-
1.9-2.0	Sand	7.8	2.1	5.7	2F	-	-	-	-	-
2.4-2.5	Sand	7.5	2.4	5.1	3F	-	-	-	-	-
2.9-3.0	Sand	7.6	2.3	5.3	4F	-	-	-	-	-
3.4-3.5	Sand	7.4	2.8	4.6	4F	-	-	-	-	-
3.9-4.0	Sand	7.9	2.7	5.2	4F	-	-	-	-	-
Bore 7										
0.4-0.5	Silty Sand	5.7	2.5	3.2	1	-	-	-	-	-
0.9-1.0	Silty Sand	6.4	2.6	3.8	4F	-	-	-	-	-
1.4-1.5	Silty Sand	6.6	1.8	4.8	3F	0.25	0.02	ND	ND	0.27
1.9-2.0	Silty Sand	6.6	2.0	4.6	4F	-	-	-	-	-
2.4-2.5	Silty Sand	6.8	2.0	4.8	2F	-	-	-	-	-
2.9-3.0	Silty Sand	7.2	1.9	5.3	3F	0.20	<0.02	ND	ND	0.20
3.4-3.5	Silty Sand	7.0	2.0	5.0	4F	-	-	-	-	-
3.9-4.0	Silty Sand	6.8	2.0	4.8	4F	-	-	-	-	-
Bore 8										
0.4-0.5	Silty Sand	5.6	3.3	2.9	1	-	-	-	-	-
0.9-1.0	Silty Sand	5.6	3.1	2.5	1	-	-	-	-	-
1.4-1.5	Silty Sand	5.8	1.9	3.9	2F	-	-	-	-	-
1.9-2.0	Silty Sand	6.2	2.0	4.2	2F	-	-	-	-	-
2.4-2.5	Silty Sand	6.2	2.1	4.1	3F	-	-	-	-	-
2.9-3.0	Silty Sand	6.5	2.1	4.4	4F	-	-	-	-	-
3.4-3.5	Silty Sand	6.3	2.1	4.2	4F	-	-	-	-	-
3.9-4.0	Silty Sand	6.2	2.1	4.1	4F	-	-	-	-	-

Table 2 – Results of Field Screening and Chemical Laboratory Testing (cont)

Depth (m)	Sample Description	Field Screening Test Results				Chromium Suite Test Results (%S)				
		pH _F	pH _{FOX}	ΔpH	Reaction (1,2,3,4) * F **	Chromium Reducible Sulfur (S _{CR})	Total Actual Acidity (TAA)	Retained Acidity (NASS)	Calculated Acid Neutralising Capacity (ANC)	Net Acidity
Bore 9										
0.4-0.5	Sand	5.4	2.9	2.5	1F	-	-	-	-	-
0.9-1.0	Sand	5.9	2.2	3.7	2F	-	-	-	-	-
1.4-1.5	Sand	4.4	1.9	2.5	3F	-	-	-	-	-
1.9-2.0	Sand	6.1	2.1	3.5	4F	-	-	-	-	-
2.4-2.5	Sand	6.3	2.0	4.3	4F	-	-	-	-	-
2.9-3.0	Sand	4.0	2.2	1.8	4F	-	-	-	-	-
3.4-3.5	Sand	6.2	2.0	4.2	4F	0.15	<0.02	ND	ND	0.15
3.9-4.0	Sand	6.5	2.0	4.5	4F	-	-	-	-	-
Bore 10										
0.4-0.5	Silty Sand	6.3	2.6	3.7	1F	<0.02	<0.02	ND	ND	<0.02
0.9-1.0	Silty Sand	6.5	1.8	4.7	3F	0.18	<0.02	ND	ND	0.18
1.4-1.5	Silty Sand	6.6	1.8	4.8	4F	-	-	-	-	-
1.9-2.0	Silty Sand	6.5	2.0	4.5	3F	-	-	-	-	-
2.4-2.5	Silty Sand	6.9	2.0	4.9	4F	-	-	-	-	-
2.9-3.0	Silty Sand	6.7	2.0	4.7	4F	-	-	-	-	-
3.4-3.5	Silty Sand	8.0	2.6	5.4	2F	-	-	-	-	-
3.9-4.0	Silty Sand	7.2	2.7	4.5	4F	-	-	-	-	-

Notes:

* 1 – denotes slight effervescence; 2 – denotes moderate reaction; 3 – denotes vigorous reaction; 4 – denotes very strong effervescence accompanied by escape of gas/heat
 ** F – indicates a bubbly/frothy reaction (organics)
 ND – not determined

7.0 PROPOSED DEVELOPMENT

At the time of reporting, it was understood that the proposed layout of the development had not been finalised and that an additional two stages may be undertaken. It was also understood from the client's brief that Stage 1 of the aquaculture facility site may comprise:

- 75,000 square metres of greenhouse style buildings;
- a 2,000 square metre processing building of possible concrete tilt panel construction;
- a small office building and amenities block; and
- internal roads and carparking pavements.

It is understood that approximately 2m to 2.5m of filling is required to raise the site to RL 2.6m for flood reasons, with the construction of an additional perimeter flood bund to RL 3.7m. It is further understood that the filling is proposed to be won from site by excavating subsurface materials in the vicinity of the test bores (refer Drawing 1).

No structural loadings were provided at the time of reporting.

8.0 COMMENTS

8.1 Appreciation of Ground Conditions

The results of the preliminary geotechnical and ASS investigation indicate the subsurface conditions to generally comprise sandy soils which are very loose to loose in approximately the upper 3.5m to 5.5m and contain ASS. The groundwater was encountered at approximately 0.8m to 1.05m depth below present ground surface levels (ie. RL 0.0 m to RL -0.2m).

These conditions pose the following potential problems for development at this site:

- Potential for upper level footings to undergo excessively high settlement in the very loose to loose sands.
- The predominantly sand material may unravel during trafficking and may require the use of track-mounted equipment or an imported coarse granular bridging layer.
- The presence of very loose sands at shallow depth close to and below the water table would make trafficability and support of heavy equipment difficult within excavations unless drag-line equipment or equivalent was utilised.
- The predominantly sandy material proposed to be used in bund construction is relatively permeable.
- The presence of ASS, which when exposed by excavation, will require treatment prior to disposal off-site or re-use as engineered filling on site.

The above points are discussed in the sections below.

8.2 Pond Excavation

It is understood that excavation up to approximately 1m depth is proposed at the south-eastern corner of the site to win material for engineered filling beneath the proposed aquaculture facility. Excavation of the generally sandy materials should be readily achieved using hydraulic equipment; however, the presence of a shallow groundwater table may cause trafficability problems, requiring the use of tracked vehicles or a dragline.

8.3 Acid Sulfate Soils

8.3.1 Criteria for Evaluation of Test Data

The criteria on which the results of screening tests (pH_F and pH_{FOX}) were assessed as indicative of possible actual acid sulphate soils (AASS) or potential acid sulphate soils (PASS) were based on the QASSIT Guidelines as follows:



- $pH_F < 4$ indicates oxidation has occurred in the past and that AASS is present. The screening test results were at or above pH 4.0.
- $pH_{FOX} < 3$, plus a pH_{FOX} reading at least one pH unit below pH_F , plus a strong reaction with peroxide, strongly indicates the presence of PASS. This condition was encountered in seventy-three of the eighty samples, generally at or below approximately 0.5m depth.

The above criteria were used to select samples for quantitative laboratory analysis of ASS by the Chromium Suite of tests. In addition, samples with the lowest pH_{FOX} were generally selected for analytical testing.

The action criterion from the Chromium Suite of tests which triggers a requirement for ASS disturbance to be managed, was derived from the Soil Management Guidelines² and the Laboratory Methods Guidelines 2003³ as follows:

- net acidity = (SCR + TAA + NASS – ANC) of greater than or equal to 0.03% Sulfur for sand and clay soils.

The above threshold is for greater than 1,000 tonnes of soil to be disturbed.

The action criterion was exceeded in nine out of the ten samples submitted for Chromium Suite testing. It is thus concluded that a management plan is required to reduce the risk of environmental impact from oxidation of PASS during excavation and placement of filling for raising the site and flood mitigation works.

8.3.2 Presence of ASS

The results of limited Chromium Suite testing and comparison with the action plan criteria indicate that AASS are present at the site. The results of the tests indicate a variation in net acidity from <0.02% to 0.27% Sulfur. Based on limited tests conducted at random depths within the top 4m of sand, it is suggested that spoil excavated from the site and sand batters exposed on cuts above the water table, will require to be neutralised at a rate of 12kg of lime per tonne. Assuming an overall placed density of approximately 1.5 to 1.7 tonnes/m³, this equates to a lime application rate of up to approximately 18 to 21 kg/m³.

It should be noted that the ASS investigation is preliminary and that further sampling, screening and testing is required (with reference to QASSIT Guidelines) to confirm liming rates and management procedures.

² Dear, S E, Moore, N G, Dobos, S K, Watling, K M, and Ahern, C R, "Soil Management Guidelines" in "Queensland Acid Sulfate Soil Technical Manual", Department of Natural Resources and Mines, Indooroopilly, November 2002.

³ Ahern, C R, Sullivan, L A, and McElnea, A E "Laboratory Methods Guidelines 2003 – Acid Sulfate Soils" in "Queensland Acid Sulfate Soil Technical Manual", Department of Natural Resources and Mines, Indooroopilly, August 2003.



8.4 Filling Procedures

It is understood that the ground surface level beneath the proposed aquaculture facility is to be raised from the existing variable level (RL 0.6m to RL 1.0m) to approximately RL2.6m AHD. Thus the existing surface is to be raised by up to 2m using sand won from site.

Approved sand filling from the borrow area should be placed in layers not exceeding 300mm 'loose' thickness, with each layer compacted to a minimum density index of at least 75% to 80%. This is in order to minimise settlement of the filling during subsequent loading from structures and footings.

It is recommended that full-time 'Level 1' testing supervision be provided for all filling, in accordance with AS 3798-1996⁴, where the filling is to be subjected to shallow footing loads.

Due to the presence of loose sands beneath the site, it should be recognised that some settlement will be induced in the foundation soil due to placement of filling and again once structural loads are placed on the filling. If the amount of such settlement is not tolerable, then either the subgrade ground should be densified (refer Section 8.7 below) or else the structures supported on piles bearing below the loose sands on medium dense or dense sands.

It is recommended that the base of any pad or strip footing excavation be finished by hand tools and compacted by either rammer, plate vibrator or other appropriate hand-guided equipment to negate the loosening and unravelling effects of the earthmoving machinery, such as excavator/backhoe bucket teeth.

Any additional filling brought on site to raise levels and supplement the existing reworked filling should be inspected by a geotechnical engineer for consistency with the assumptions made in this report. Any imported filling must also be sampled and tested to verify the presence of any ASS and requirements for additional liming (if required).

8.5 Flood Retention

It is understood that flood retention bunds are proposed to be constructed around the aquaculture facility to prevent inundation under flood conditions. Information relating to potential flood levels and flood regression rates was not provided for the preparation of this preliminary report.

It is therefore difficult to be quantitative about bund seepage. It should be recognised, however, that the on-site sand soils (both borrow and foundation soils) are likely to exhibit relatively high permeability of approximately 10^{-3} m/s to 10^{-5} m/s. This is based on a very approximate empirical approach based on particle size distributions. For the optimistic (lowest) permeability of this estimated range, a 1m high bund with a 1m wide crest would be anticipated to have a full head of flood water seep through in only a day or so. Similarly, for a 3m head and 3m wide crest, the seepage time would increase to about 10 days. These times would decrease one hundred fold, however, for permeabilities at the highest end of the estimated range.

⁴ Australian Standard AS 3798-1996 "Guidelines on Earthworks for Commercial and Residential Developments", Standards Association of Australia.



It follows that, for a protective bund built of such sand, the crest width would have to be very large to withstand seepage from even a short duration and low flood head against it.

If a suitable bund wall is to be constructed to retain flooding, it would probably be more cost effective to import clay from elsewhere, for either complete bund construction or to use as a central clay cut-off zone. A relatively deep clay cut-off trench, however, would also require to be included, in order to prevent water from seeping beneath the bund.

As an alternative to constructing a surrounding perimeter bund, it is suggested that consideration be given to raising the complete work area to RL 3.7m.

8.6 Upper Level Footings and Settlement Estimates

It is understood that proposed footings being considered for the facility are lightly loaded pad and/or strip footings and on grade slabs founded in the engineered fill. The choice of footing option will depend upon what is considered to be acceptable in terms of settlements due to the applied working loads and the depth and varying density of the foundation soils.

On the basis of the above comments, it is suggested that maximum allowable bearing pressures for upper level footings founded in engineered filling placed under 'Level 1' testing and supervision be designed for the following:

- 150kPa for strips, pads and thickened edge beams or slab thickenings; and
- 20kPa for slab panels.

The above is subject to site preparation being undertaken in accordance with Section 8.4 above and the settlement estimates discussed below being acceptable.

Elastic settlement estimates were calculated using an in-house program, *T-REX*, which models flexible loadings on a fully flexible multi-layered foundation. Subsequent adjustment for fully rigid load applications were performed (where appropriate) by hand calculations using standard theory, generally based on 80% of the flexible load at the centre of the footing.

It should be noted that settlement estimates for footings founded in filling are highly dependent on the quality of the filling materials and any variation in compaction within the filling with respect to depth and areal extent. It is strongly recommended that full-time 'Level 1' testing and supervision be undertaken during fill placement (in accordance with AS 3798-1996), in order to minimise the risk of differential settlement occurring over and above that generally estimated.

Due to the variability in thickness of the very loose to loose sand beneath the proposed fill platform (from approximately 3.5m thick to 5.3m thick), there is a potential for differential and tilting settlements.

The results of total settlement estimates are summarised in Table 3 below for rigid pads and flexible strip and flexible slab panels, for founding in 'controlled' engineered filling under various loadings, and assuming the very loose to loose sands are left in their present state of density. Some



settlement will, of course, be incurred due to loading imposed by placement of filling, but this occurs relatively quickly and is complete prior to footing construction.

Table 3 – Summary of Elastic Settlement Estimates

Load Application	Total Settlement (mm)
Slab Panel (20m by 5m), loaded to 20kPa	5 to 10
Long strip footing, 0.5m wide, loaded to 150kPa (ie. 75kN/m)	10 to 15
Long strip footing, 0.5m wide, loaded to 10kPa (ie. 5kN/m)	< 5
Long strip footing, 0.5m wide, loaded to 20kPa (ie. 10kN/m)	5 to 10
Rigid pad, 1m by 1m, loaded to 150kPa (ie. 150kN column load)	10 to 15
Rigid pad, 2m by 2m, loaded to 150kPa (ie. 600kN column load)	25 to 30

8.7 Ground Improvement

Should the settlement estimates in Section 8.6 above prove unfavourable, then options for reducing settlement of the underlying very loose to loose sands may include the following:

- pre-loading the foundation soils by placement of additional temporary fill at least equivalent in load to the applied load from the structures;
- compaction of the foundation soils by dynamic impact roller;
- dynamic consolidation of the foundation soils by application of a heavy weight dropped from a crane in a series of grids across the site.

Of these, the most cost effective may prove to be the use of an impact or "square" roller, provided by specialist contractors such as Broons or Landpac. As this is specialist equipment, the suppliers should be approached directly for applicability and performance at this site. It is claimed, however, by such suppliers, that significant improvement can be obtained in loose sands to depths of "at least 2m".

8.8 Pavements

It is understood that filling at the site will be undertaken under 'Level 1' testing and supervision, and at this stage, the proposed filling material is to be sand won from site. Based on experience and published data, soaked subgrade California bearing ratio (CBR) values for sand are likely to be in excess of 10%. For preliminary design purposes, it is therefore suggested that a subgrade CBR value of 10% be adopted. This suggested design value is dependent upon the provision and maintenance of adequate surface and subsurface drainage, particularly where pavements abut irrigated landscaped or garden areas.

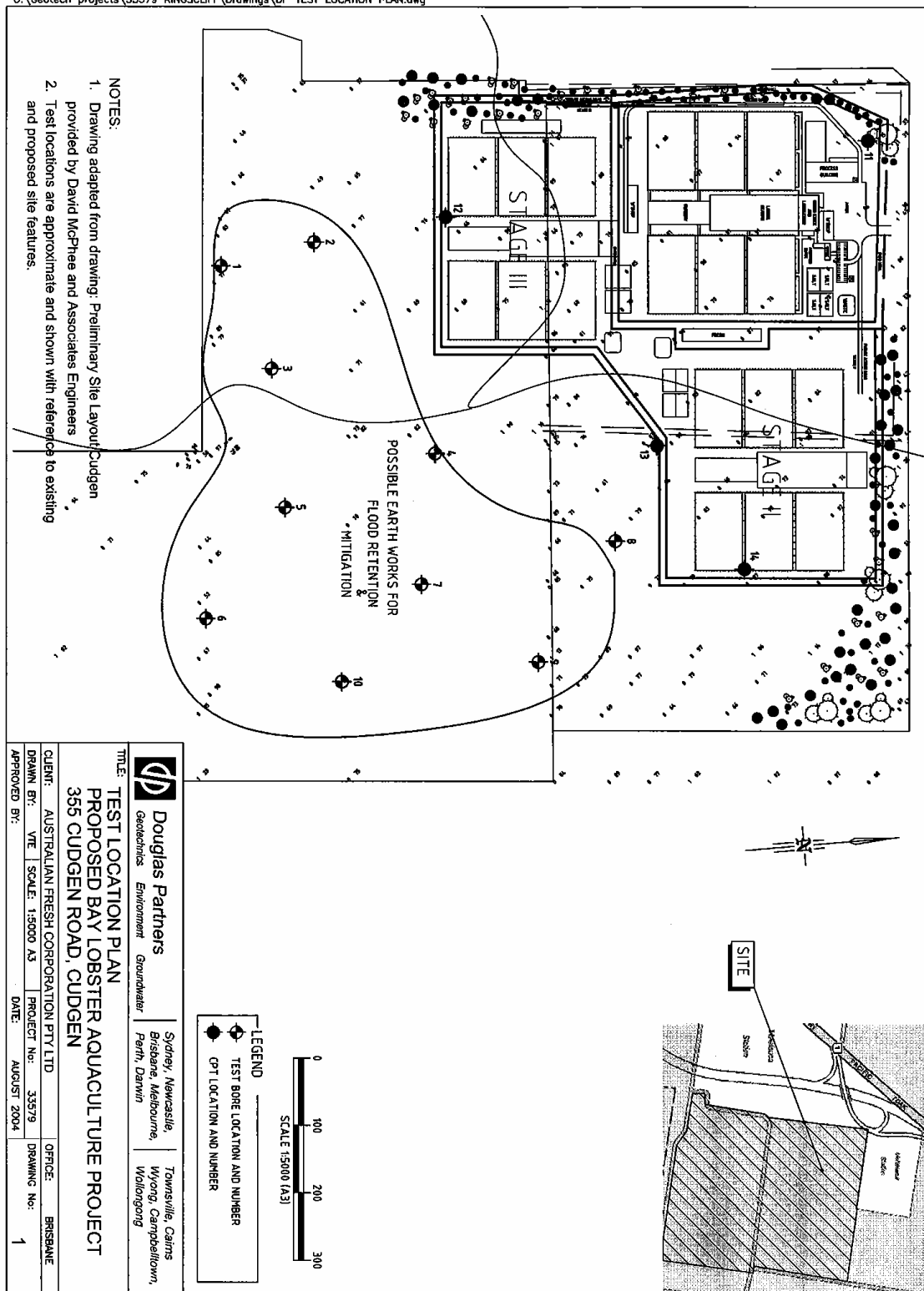
DOUGLAS PARTNERS PTY LTD

Chris Bell
Associate

Reviewed by:

Ken Boddie
Principal

O:\Geotech_projects\33579_KINGSCLIFF\Drawings\DP TEST LOCATION PLAN.dwg



APPENDIX A

*Test Bore Report Sheets (Nos. 1 to 10)
Cone Penetration Test Report Sheets (CPTs 11 to 14)
Notes Relating to This Report*

TEST BORE REPORT

CLIENT: AUSTRALIAN FRESH CORPORATION PTY LTD **PROJECT No:** 33579
PROJECT: BAY LOBSTER AQUACULTURE PROJECT **SURFACE LEVEL:** 0.8m*
LOCATION: 355 CUDGEN ROAD, CUDGEN **DIP OF HOLE:** 90°

BORE No: 1
DATE: 11 August 04
SHEET 1 OF 1
AZIMUTH: --

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results & Comments	Core Rec. %
0.15	TOPSOIL - relatively loose, brown, silty, fine grained sand	A	0.4		
	SAND - relatively loose, light brown, slightly silty, fine grained sand		0.5		
1	- becoming grey	A	0.9		
			1.0		
		A	1.4		
			1.5		
2		A	2.0		
			2.4		
			2.5		
3		A	2.9		
			3.0		
		A	3.4		
			3.5		
4		A	3.9		
4.0	TEST BORE DISCONTINUED AT 4.0m				
			4.0		

RIG: Gemco HS7

DRILLER: Mapstone

LOGGED: SAR

CASING: not used

TYPE OF BORING: 100mm dia. solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 0.9m depth

REMARKS: 551938E, 6873072N

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	PL	Point load strength ls(50) MPa
B	Bulk sample	S	Standard penetration test
C	Core drilling	U _t	Tube sample (x mm dia.)
pp	Pocket penetrometer (kPa)	V	Shear vane (kPa)

CHECKED
Initials:
Date:



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TEST BORE REPORT

CLIENT: AUSTRALIAN FRESH CORPORATION PTY LTD **PROJECT No:** 33579
PROJECT: BAY LOBSTER AQUACULTURE PROJECT **SURFACE LEVEL:** 0.7m*
LOCATION: 355 CUDGEN ROAD, CUDGEN **DIP OF HOLE:** 90°

BORE No: 2
DATE: 11 August 04
SHEET 1 OF 1
AZIMUTH: --

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results & Comments	Core Rec. %
1	SILTY SAND - relatively loose, light yellow-brown and grey-brown silty, fine grained sand with a trace of clay				
		A	0.4 0.5		
		A	0.9 1.0		
2	SILTY SAND - relatively loose, grey, silty, fine grained sand				
		A	1.4 1.5		
		A	1.9 2.0		
3					
		A	2.4 2.5		
		A	2.9 3.0		
4					
		A	3.4 3.5		
		A	3.9 4.0		
	TEST BORE DISCONTINUED AT 4.0m				

RIG: Gemco HS7

DRILLER: Mapstone

LOGGED: SAR

CASING: not used

TYPE OF BORING: 100mm dia. solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 1.0m depth

REMARKS: 551926E, 6873216N

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	PL	Point load strength Is(50) MPa
B	Bulk sample	S	Standard penetration test
C	Core drilling	U _t	Tube sample (x mm dia.)
pp	Pocket penetrometer (kPa)	V	Shear vane (kPa)

CHECKED
Initials:
Date:



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TEST BORE REPORT

CLIENT: AUSTRALIAN FRESH CORPORATION PTY LTD **PROJECT No:** 33579
PROJECT: BAY LOBSTER AQUACULTURE PROJECT **SURFACE LEVEL:** 0.8m*
LOCATION: 355 CUDGEN ROAD, CUDGEN **DIP OF HOLE:** 90°

BORE No: 3
DATE: 11 August 04
SHEET 1 OF 1
AZIMUTH: --

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results & Comments	Core Rec. %
1	SILTY SAND - relatively loose, yellow-brown and grey-brown, silty, fine grained sand with a trace of clay	A	0.4		
			0.5		
		A	0.9		
			1.0		
1.1	SILTY SAND - relatively loose, grey-brown, silty, fine grained sand with some clay				
2		A	1.4		
			1.5		
		A	1.9		
			2.0		
3		A	2.4		
			2.5		
		A	2.9		
			3.0		
4		A	3.4		
			3.5		
		A	3.9		
			4.0		
4.0	TEST BORE DISCONTINUED AT 4.0m				

RIG: Gemco HS7

DRILLER: Mapstone

LOGGED: SAR

CASING: not used

TYPE OF BORING: 100mm dia. solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 0.9m depth.

REMARKS: 552101E, 6873123N

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	PL	Point load strength $I_s(50)$ MPa
B	Bulk sample	S	Standard penetration test
C	Core drilling	U _t	Tube sample (x mm dia.)
pp	Pocket penetrometer (kPa)	V	Shear vane (kPa)

CHECKED
Initials:
Date:



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TEST BORE REPORT

CLIENT: AUSTRALIAN FRESH CORPORATION PTY LTD **PROJECT No:** 33579
PROJECT: BAY LOBSTER AQUACULTURE PROJECT **SURFACE LEVEL:** 0.9m*
LOCATION: 355 CUDGEN ROAD, CUDGEN **DIP OF HOLE:** 90°

BORE No: 4
DATE: 11 August 04
SHEET 1 OF 1
AZIMUTH: --

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results & Comments	Core Rec. %
0.2	TOPSOIL - relatively loose, brown, silty, fine grained sand				
	SAND - relatively loose, yellow-brown with orange-brown mottling, slightly silty, fine grained sand	A	0.4 0.5		
1.0	SAND - grey-brown, fine grained sand with some silt	A	0.9 1.0		
		A	1.4 1.5		
2.0		A	1.9 2.0		
		A	2.4 2.5		
3.0		A	2.9 3.0		
		A	3.4 3.5		
4.0	TEST BORE DISCONTINUED AT 4.0m	A	3.9 4.0		

RIG: Gemco HS7

DRILLER: Mapstone

LOGGED: SAR

CASING: not used

TYPE OF BORING: 100mm dia. solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 0.9m depth.

REMARKS: 552438E, 6873590N

SAMPLING & IN SITU TESTING LEGEND

A Auger sample	PL Point load strength Is(50) MPa
B Bulk sample	S Standard penetration test
C Core drilling	U _s Tube sample (x mm dia.)
pp Pocket penetrometer (kPa)	V Shear vane (kPa)

CHECKED

Initials:

Date:



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TEST BORE REPORT

CLIENT: AUSTRALIAN FRESH CORPORATION PTY LTD **PROJECT No:** 33579
PROJECT: BAY LOBSTER AQUACULTURE PROJECT **SURFACE LEVEL:** 0.8m*
LOCATION: 355 CUDGEN ROAD, CUDGEN **DIP OF HOLE:** 90°

BORE No: 5
DATE: 11 August 04
SHEET 1 OF 1
AZIMUTH: --

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results & Comments	Core Rec. %
1	SILTY SAND - relatively loose, yellow-brown and grey-brown, silty, fine grained sand with some clay				
		A	0.4 0.5		
		A	0.9 1.0		
2	- becoming grey-brown with a trace to some clay				
		A	1.4 1.5		
		A	1.9 2.0		
3					
		A	2.4 2.5		
		A	2.9 3.0		
4					
		A	3.4 3.5		
		A	3.9 4.0		
4.0	TEST BORE DISCONTINUED AT 4.0m				

RIG: Gemco HS7

DRILLER: Mapstone

LOGGED: SAR

CASING: not used

TYPE OF BORING: 100mm dia. solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 1.0m depth

REMARKS: 552308E, 6873109N

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	PL	Point load strength Is(50) MPa
B	Bulk sample	S	Standard penetration test
C	Core drilling	U	Tube sample (x mm dia.)
pp	Pocket penetrometer (kPa)	V	Shear vane (kPa)

CHECKED
Initials:
Date:



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TEST BORE REPORT

CLIENT: AUSTRALIAN FRESH CORPORATION PTY LTD **PROJECT No:** 33579
PROJECT: BAY LOBSTER AQUACULTURE PROJECT **SURFACE LEVEL:** 0.6m*
LOCATION: 355 CUDGEN ROAD, CUDGEN **DIP OF HOLE:** 90°

BORE No: 6
DATE: 11 August 04
SHEET 1 OF 1
AZIMUTH: --

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results & Comments	Core Rec. %
0.1	SAND - relatively loose, yellow-brown with orange-brown mottling, fine grained sand with some silt		0.4		
		A	0.5		
0.9	SAND - relatively loose, grey-brown, fine grained sand with a trace of silt	A	0.9		
			1.0		
1.4		A	1.4		
			1.5		
1.9		A	1.9		
			2.0		
2.4		A	2.4		
			2.5		
2.9		A	2.9		
			3.0		
3.4		A	3.4		
			3.5		
3.9		A	3.9		
			4.0		
4.0	TEST BORE DISCONTINUED AT 4.0m				

RIG: Gemco HS7

DRILLER: Mapstone

LOGGED: SAR

CASING: not used

TYPE OF BORING: 100mm dia. solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 0.8m depth

REMARKS: 552452E, 6872964N

SAMPLING & IN SITU TESTING LEGEND

A Auger sample	PL Point load strength Is(50) MPa
B Bulk sample	S Standard penetration test
C Core drilling	U _t Tube sample (x mm dia.)
pp Pocket penetrometer (kPa)	V Shear vane (kPa)

CHECKED

Initials:

Date:



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TEST BORE REPORT

CLIENT: AUSTRALIAN FRESH CORPORATION PTY LTD **PROJECT No:** 33579
PROJECT: BAY LOBSTER AQUACULTURE PROJECT **SURFACE LEVEL:** 0.8m*
LOCATION: 355 CUDGEN ROAD, CUDGEN **DIP OF HOLE:** 90°

BORE No: 7
DATE: 11 August 04
SHEET 1 OF 1
AZIMUTH: --

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results & Comments	Core Rec. %
0.15	TOPSOIL - relatively loose, brown, silty, fine grained sand				
	SILTY SAND - relatively loose, yellow-brown with slight orange-brown mottling, silty, fine grained sand				
	- becoming grey-brown				
0.4		A	0.4		
0.5			0.5		
0.9		A	0.9		
1.0			1.0		
1.4		A	1.4		
1.5			1.5		
1.9		A	1.9		
2.0			2.0		
2.4		A	2.4		
2.5			2.5		
2.9		A	2.9		
3.0			3.0		
3.4		A	3.4		
3.5			3.5		
3.9		A	3.9		
4.0	TEST BORE DISCONTINUED AT 4.0m		4.0		

RIG: Gemco HS7

DRILLER: Mapstone

LOGGED: SAR

CASING: not used

TYPE OF BORING: 100mm dia. solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 0.8m depth

REMARKS: 552454E, 6873291N

SAMPLING & IN SITU TESTING LEGEND			
A	Auger sample	PL	Point load strength ls(50) MPa
B	Bulk sample	S	Standard penetration test
C	Core drilling	U _s	Tube sample (x mm dia.)
pp	Pocket penetrometer (kPa)	V	Shear vane (kPa)

CHECKED
Initials:
Date:



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TEST BORE REPORT

CLIENT: AUSTRALIAN FRESH CORPORATION PTY LTD **PROJECT No:** 33579
PROJECT: BAY LOBSTER AQUACULTURE PROJECT **SURFACE LEVEL:** 0.8m*
LOCATION: 355 CUDGEN ROAD, CUDGEN **DIP OF HOLE:** 90°

BORE No: 8
DATE: 11 August 04
SHEET 1 OF 1
AZIMUTH: --

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results & Comments	Core Rec %
0.2	TOPSOIL - relatively loose, brown, silty, fine grained sand				
	SILTY SAND - relatively loose, yellow-brown with slight orange-brown mottling, silty, fine grained sand				
		A	0.4 0.5		
	- becoming grey-brown				
		A	0.9 1.0		
		A	1.4 1.5		
		A	1.9 2.0		
		A	2.4 2.5		
		A	2.9 3.0		
		A	3.4 3.5		
		A	3.9 4.0		
4.0	TEST BORE DISCONTINUED AT 4.0m				

RIG: Gemco HS7

DRILLER: Mapstone

LOGGED: SAR

CASING: not used

TYPE OF BORING: 100mm dia. solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 0.8m depth

REMARKS: 552438E, 6873590N

SAMPLING & IN SITU TESTING LEGEND

A Auger sample	PL Point load strength Is(50) MPa
B Bulk sample	S Standard penetration test
C Core drilling	U Tube sample (x mm dia.)
pp Pocket penetrometer (kPa)	V Shear vane (kPa)

CHECKED

Initials:

Date:



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TEST BORE REPORT

CLIENT: AUSTRALIAN FRESH CORPORATION PTY LTD **PROJECT No:** 33579
PROJECT: BAY LOBSTER AQUACULTURE PROJECT **SURFACE LEVEL:** 1.0m*
LOCATION: 355 CUDGEN ROAD, CUDGEN **DIP OF HOLE:** 90°

BORE No: 9
DATE: 11 August 04
SHEET 1 OF 1
AZIMUTH: --

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results & Comments	Core Rec. %
0.15	TOPSOIL - relatively loose, brown, silty, fine grained sand				
	SAND - relatively loose, yellow-brown with orange-brown mottling, fine grained sand with some silt				
	- becoming grey-brown				
0.4		A	0.4		
0.5			0.5		
0.9		A	0.9		
1.0			1.0		
1.4		A	1.4		
1.5			1.5		
1.9		A	1.9		
2.0			2.0		
2.4		A	2.4		
2.5			2.5		
2.9		A	2.9		
3.0			3.0		
3.4		A	3.4		
3.5			3.5		
3.9		A	3.9		
4.0	TEST BORE DISCONTINUED AT 4.0m		4.0		

RIG: Gemco HS7

DRILLER: Mapstone

LOGGED: SAR

CASING: not used

TYPE OF BORING: 100mm dia. solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 0.8m depth

REMARKS: 552597E, 6873446N

SAMPLING & IN SITU TESTING LEGEND			
A Auger sample	PL Point load strength Is(50) MPa	CHECKED	
B Bulk sample	S Standard penetration test	Initials:	
C Core drilling	U _t Tube sample (x mm dia.)	Date:	
pp Pocket penetrometer (kPa)	V Shear vane (kPa)		



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TEST BORE REPORT

CLIENT: AUSTRALIAN FRESH CORPORATION PTY LTD **PROJECT No:** 33579
PROJECT: BAY LOBSTER AQUACULTURE PROJECT **SURFACE LEVEL:** 0.8m*
LOCATION: 355 CUDGEN ROAD, CUDGEN **DIP OF HOLE:** 90°

BORE No: 10
DATE: 11 August 04
SHEET 1 OF 1
AZIMUTH: --

Depth (m)	Description of Strata	Sampling & In Situ Testing			
		Type	Depth (m)	Test Results & Comments	Core Rec. %
0.3	TOPSOIL - relatively loose, brown and orange-brown, silty, fine grained sand				
	SILTY SAND - relatively loose, grey, silty, fine grained sand	A	0.4 0.5		
1		A	0.9 1.0		
		A	1.4 1.5		
2		A	1.9 2.0		
		A	2.4 2.5		
3		A	2.9 3.0		
		A	3.4 3.5		
4		A	3.9 4.0		
	TEST BORE DISCONTINUED AT 4.0m				

RIG: Gemco HS7

DRILLER: Mapstone

LOGGED: SARq

CASING: not used

TYPE OF BORING: 100mm dia. solid flight auger

WATER OBSERVATIONS: Free groundwater observed at 0.9m depth

REMARKS: 552578E, 6873150N

SAMPLING & IN SITU TESTING LEGEND

A	Auger sample	PL	Point load strength Is(50) MPa
B	Bulk sample	S	Standard penetration test
C	Core drilling	U _t	Tube sample (x mm dia.)
pp	Pocket penetrometer (MPa)	V	Shear vane (kPa)

CHECKED

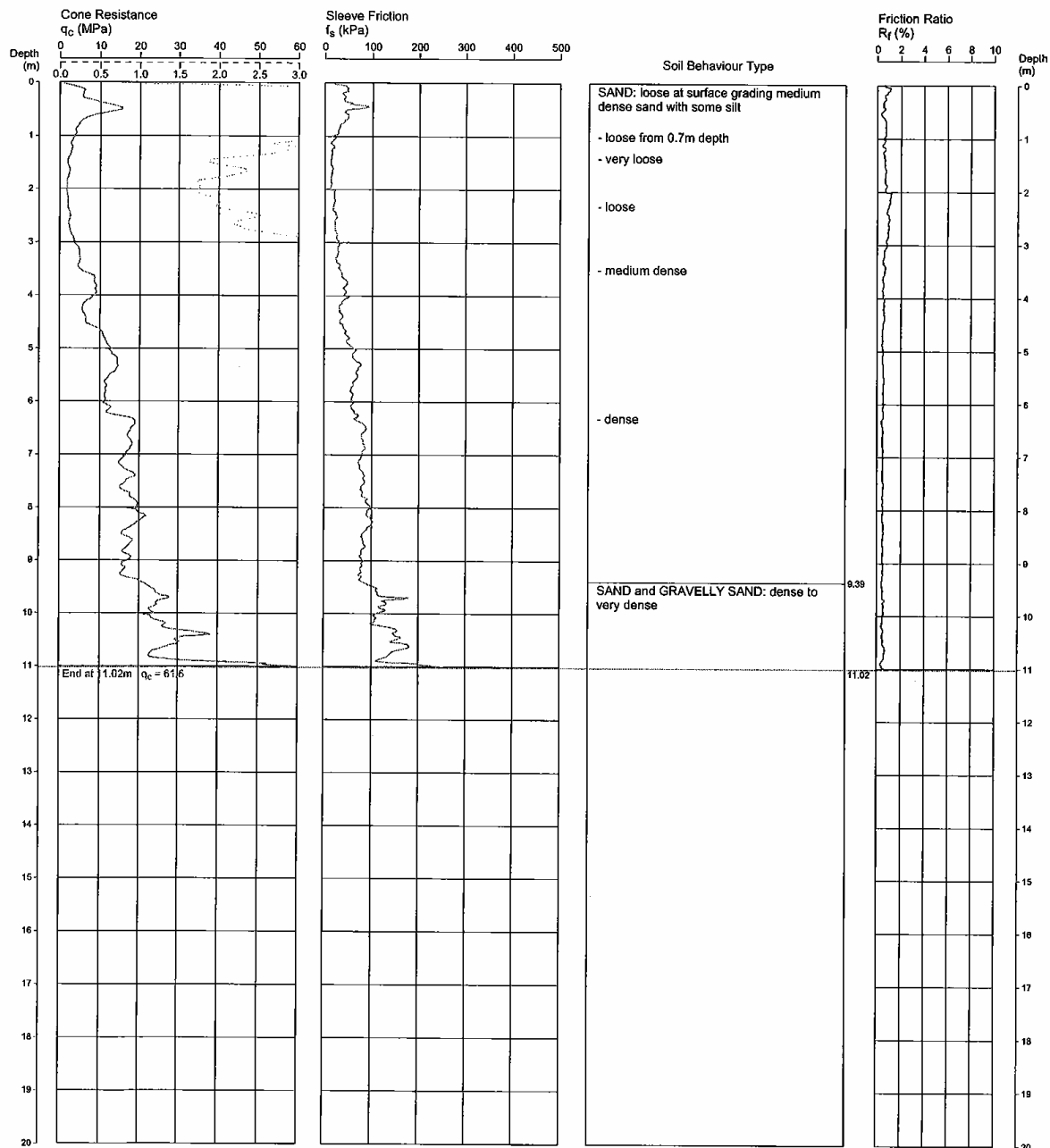
Initials:

Date:



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CONE PENETRATION TEST CLIENT: Australian Fresh Corporation Pty Ltd	PROJECT: Proposed Bay Lobster Aquaculture Project LOCATION: 355 Cudgen Road, Cudgen PROJECT No: 33579	CPT 11 Page 1 of 1 DATE 25/08/04 SURFACE RL: 1.1m*
--	---	--



REMARKS: E551913m, N6874062m.
Hole collapse at 0.85m depth, unable to record water level.* Level interpolated from client supplied drawing

Date
Plotted
Checked

File: O:\Geotech projects\33579 KINGSCLIFF\field\33579-11.CPS
Cone ID: 402 Type: 2 Standard
ConePlot Version 5.8.0
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CONE PENETRATION TEST

CLIENT: Australian Fresh Corporation Pty Ltd

PROJECT: Proposed Bay Lobster Aquaculture Project

LOCATION: 355 Cudgen Road, Cudgen

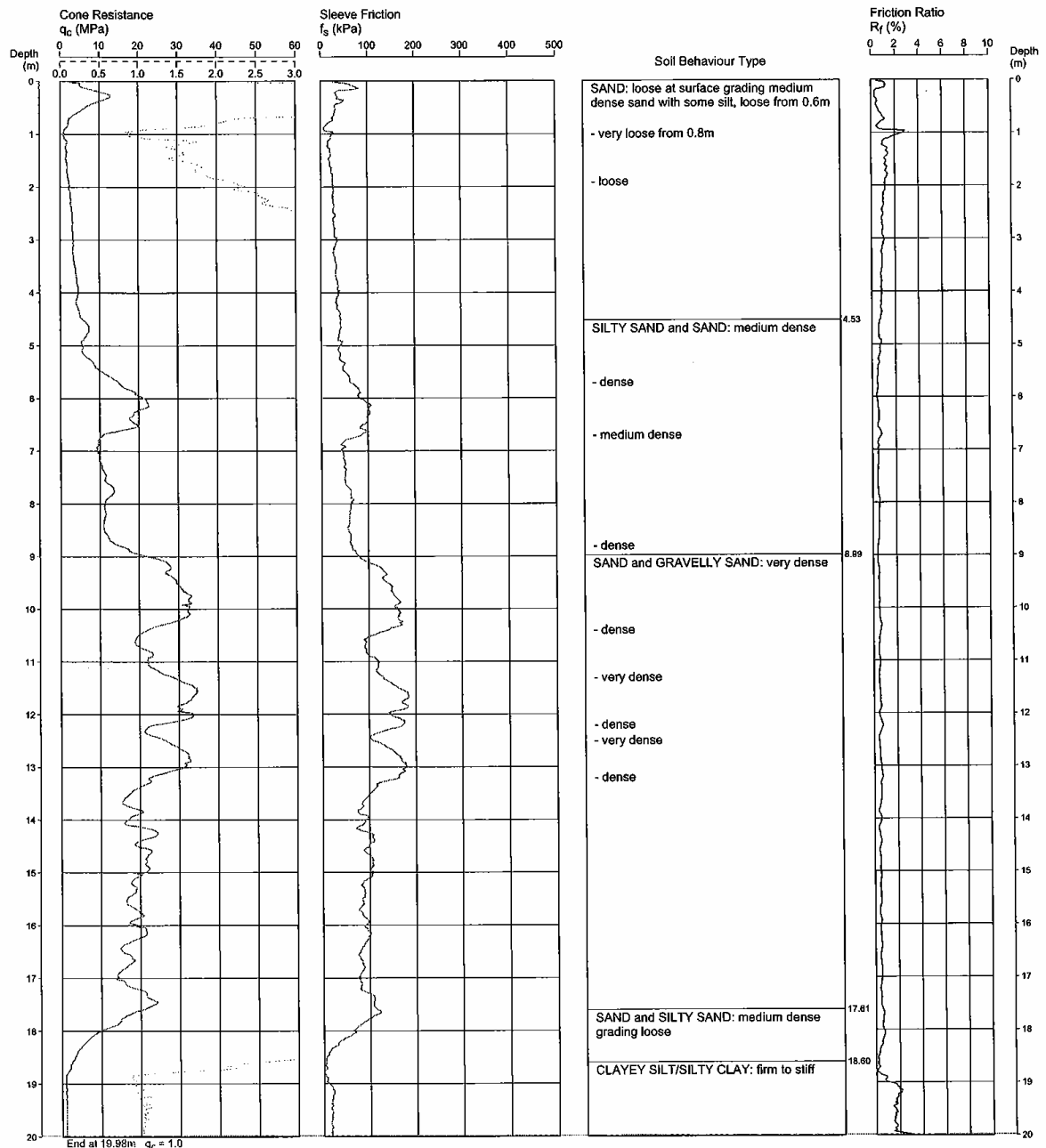
PROJECT No: 33579

CPT 12

Page 1 of 1

DATE 25/08/04

SURFACE RL: 0.7m*



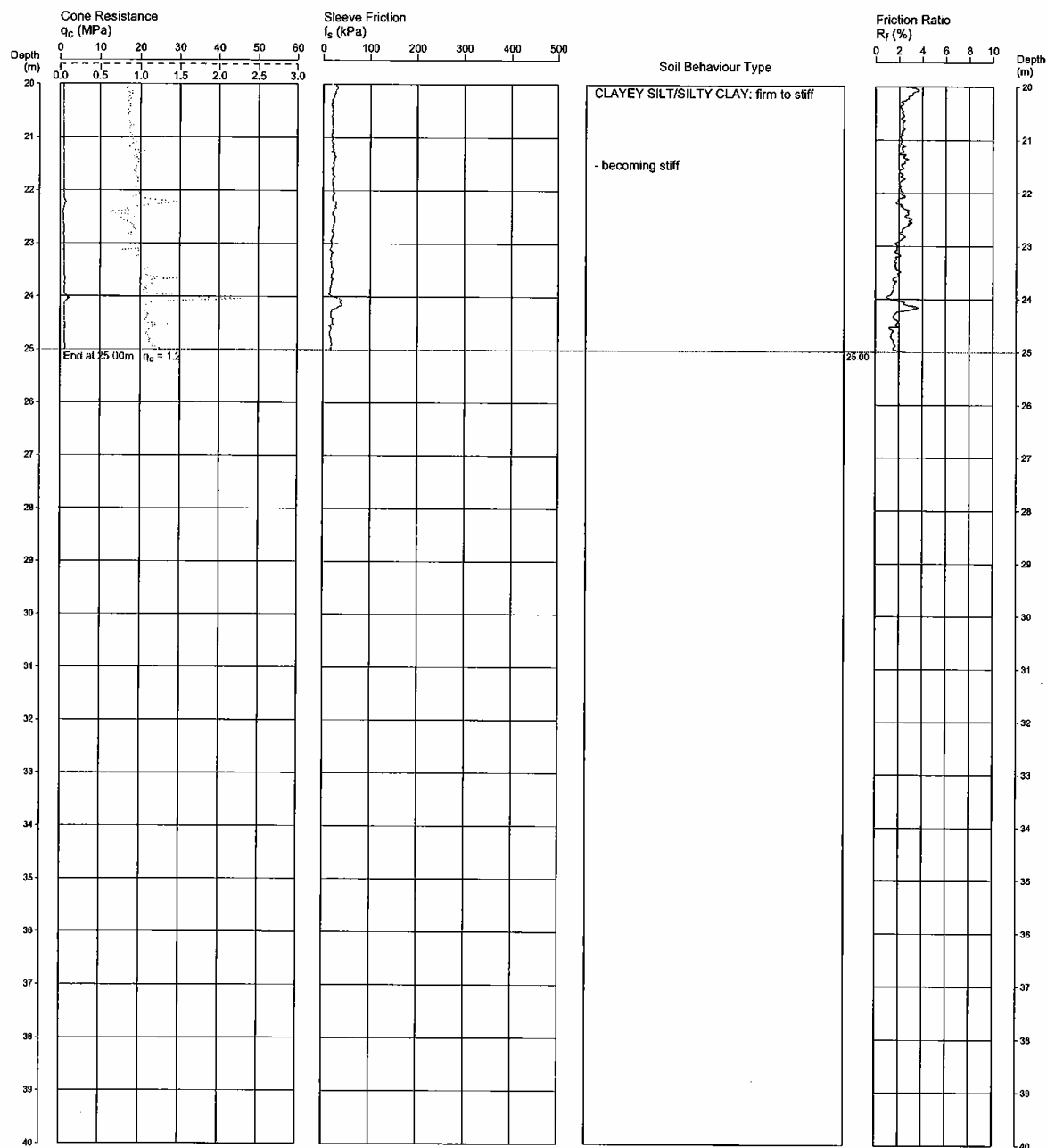
REMARKS: E551921m, N6873416m.
 Hole collapse at 1.15m depth, unable to record water level.* Level interpolated from client supplied drawing

Date
 Plotted
 Checked

File: O:\Geotech projects\33579 KINGSCLIFF\field\33579-12 CP5
 Cone ID: 402 Type: 2 Standard
 ConePlot Version 5.8.0
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CONE PENETRATION TEST	PROJECT:	Proposed Bay Lobster Aquaculture Project	CPT 13 Page 2 of 2
	CLIENT:	Australian Fresh Corporation Pty Ltd	
	LOCATION:	355 Cudgen Road, Cudgen	
	PROJECT No:	33579	
	DATE	25/06/04	
	SURFACE RL: 1.0m*		



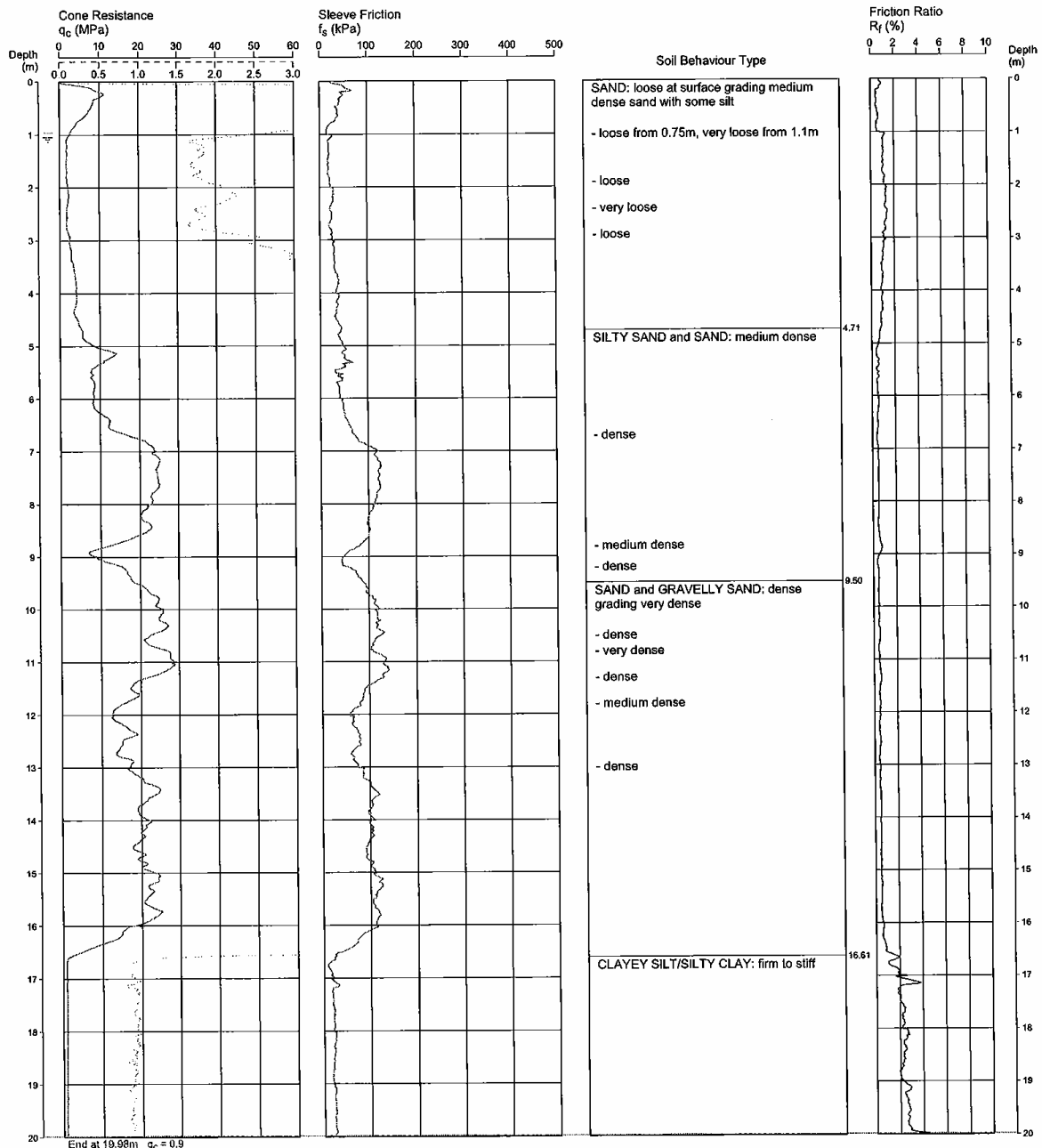
REMARKS: E552308m, N6873675m.
Hole collapse at 1.1m depth, unable to record water level.* Level interpolated from client supplied drawing

Date
Plotted
Checked

File: O:\Geotech projects\33579 KINGSCLIFF\field\33579-13.CPS
Cone ID: 402 Type: 2 Standard
ConePlot Version 5.8.0
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CONE PENETRATION TEST CLIENT: David McPhee & Associates	PROJECT: Proposed Bay Lobster Aquaculture Project LOCATION: 355 Cudgen Road, Cudgen PROJECT No: 33579	CPT 14 Page 1 of 1 DATE 25/08/04 SURFACE RL: 0.8m*
---	---	--



REMARKS: E552511m, N6873776m.
 Water level measured at 1.05m depth on withdrawal of rods.* Level interpolated from client supplied drawing

Date
 Plotted
 Checked

File: O:\Geotech projects\33579 KINGSCLIFF\33579-14.CP5
 Cone ID: 402 Type: 2 Standard
 ConePlot Version 5.8.0
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NOTES RELATING TO THIS REPORT

Introduction

These notes have been provided to amplify the geotechnical report in regard to classification methods, specialist field procedures and certain matters relating to the Discussion and Comments section. Not all, of course, are necessarily relevant to all reports.

Geotechnical reports are based on information gained from limited subsurface test boring and sampling, supplemented by knowledge of local geology and experience. For this reason, they must be regarded as interpretive rather than factual documents, limited to some extent by the scope of information on which they rely.

Description and Classification Methods

The methods of description and classification of soils and rocks used in this report are based on Australian Standard 1726, Geotechnical Site Investigations Code. In general, descriptions cover the following properties – strength or density, colour, structure, soil or rock type and inclusions.

Soil types are described according to the predominating particle size, qualified by the grading of other particles present (eg. sandy clay) on the following bases:

Soil Classification	Particle Size
Clay	less than 0.002 mm
Silt	0.002 to 0.06 mm
Sand	0.06 to 2.00 mm
Gravel	2.00 to 60.00 mm

Cohesive soils are classified on the basis of strength either by laboratory testing or engineering examination. The strength terms are defined as follows.

Classification	Undrained Shear Strength kPa
Very soft	less than 12
Soft	12–25
Firm	25–50
Stiff	50–100
Very stiff	100–200
Hard	Greater than 200

Non-cohesive soils are classified on the basis of relative density, generally from the results of standard penetration tests (SPT) or Dutch cone penetrometer tests (CPT) as below:

Relative Density	SPT "N" Value (blows/300 mm)	CPT Cone Value (q_c — MPa)
Very loose	less than 5	less than 2
Loose	5–10	2–5
Medium dense	10–30	5–15
Dense	30–50	15–25
Very dense	greater than 50	greater than 25

Rock types are classified by their geological names. Where relevant, further information regarding rock classification is given on the following sheet.

Sampling

Sampling is carried out during drilling to allow engineering examination (and laboratory testing where required) of the soil or rock.

Disturbed samples taken during drilling provide information on colour, type, inclusions and, depending upon the degree of disturbance, some information on strength and structure.

Undisturbed samples are taken by pushing a thin-walled sample tube into the soil and withdrawing with a sample of the soil in a relatively undisturbed state. Such samples yield information on structure and strength, and are necessary for laboratory determination of shear strength and compressibility. Undisturbed sampling is generally effective only in cohesive soils.

Details of the type and method of sampling are given in the report.

Drilling Methods.

The following is a brief summary of drilling methods currently adopted by the Company and some comments on their use and application.

Test Pits — these are excavated with a backhoe or a tracked excavator, allowing close examination of the in-situ soils if it is safe to descent into the pit. The depth of penetration is limited to about 3 m for a backhoe and up to 6 m for an excavator. A potential disadvantage is the disturbance caused by the excavation.

Large Diameter Auger (eg. Pengo) — the hole is advanced by a rotating plate or short spiral auger, generally 300 mm or larger in diameter. The cuttings are returned to the surface at intervals (generally of not more than 0.5 m) and are disturbed but usually unchanged in moisture content. Identification of soil strata is generally much more reliable than with continuous spiral flight augers, and is usually supplemented by occasional undisturbed tube sampling.

Continuous Sample Drilling — the hole is advanced by pushing a 100 mm diameter socket into the ground and withdrawing it at intervals to extrude the sample. This is the most reliable method of drilling in soils, since moisture content is unchanged and soil structure, strength, etc. is only marginally affected.

Continuous Spiral Flight Augers — the hole is advanced using 90–115 mm diameter continuous spiral flight augers which are withdrawn at intervals to allow sampling or in-situ testing. This is a relatively economical



means of drilling in clays and in sands above the water table. Samples are returned to the surface, or may be collected after withdrawal of the auger flights, but they are very disturbed and may be contaminated. Information from the drilling (as distinct from specific sampling by SPTs or undisturbed samples) is of relatively lower reliability, due to remoulding, contamination or softening of samples by ground water.

Non-core Rotary Drilling — the hole is advanced by a rotary bit, with water being pumped down the drill rods and returned up the annulus, carrying the drill cuttings. Only major changes in stratification can be determined from the cuttings, together with some information from 'feel' and rate of penetration.

Rotary Mud Drilling — similar to rotary drilling, but using drilling mud as a circulating fluid. The mud tends to mask the cuttings and reliable identification is again only possible from separate intact sampling (eg. from SPT).

Continuous Core Drilling — a continuous core sample is obtained using a diamond-tipped core barrel, usually 50 mm internal diameter. Provided full core recovery is achieved (which is not always possible in very weak rocks and granular soils), this technique provides a very reliable (but relatively expensive) method of investigation.

Standard Penetration Tests

Standard penetration tests (abbreviated as SPT) are used mainly in non-cohesive soils, but occasionally also in cohesive soils as a means of determining density or strength and also of obtaining a relatively undisturbed sample. The test procedure is described in Australian Standard 1289, "Methods of Testing Soils for Engineering Purposes" — Test 6.3.1.

The test is carried out in a borehole by driving a 50 mm diameter split sample tube under the impact of a 63 kg hammer with a free fall of 760 mm. It is normal for the tube to be driven in three successive 150 mm increments and the 'N' value is taken as the number of blows for the last 300 mm. In dense sands, very hard clays or weak rock, the full 450 mm penetration may not be practicable and the test is discontinued.

The test results are reported in the following form.

- In the case where full penetration is obtained with successive blow counts for each 150 mm of say 4, 6 and 7
 as 4, 6, 7
 N = 13
- In the case where the test is discontinued short of full penetration, say after 15 blows for the first 150 mm and 30 blows for the next 40 mm
 as 15, 30/40 mm.

The results of the tests can be related empirically to the engineering properties of the soil.

Occasionally, the test method is used to obtain samples in 50 mm diameter thin walled sample tubes in clays. In

such circumstances, the test results are shown on the borelogs in brackets.

Cone Penetrometer Testing and Interpretation

Cone penetrometer testing (sometimes referred to as Dutch cone — abbreviated as CPT) described in this report has been carried out using an electrical friction cone penetrometer. The test is described in Australian Standard 1289, Test 6.4.1.

In the tests, a 35 mm diameter rod with a cone-tipped end is pushed continuously into the soil, the reaction being provided by a specially designed truck or rig which is fitted with an hydraulic ram system. Measurements are made of the end bearing resistance on the cone and the friction resistance on a separate 130 mm long sleeve, immediately behind the cone. Transducers in the tip of the assembly are connected by electrical wires passing through the centre of the push rods to an amplifier and recorder unit mounted on the control truck.

As penetration occurs (at a rate of approximately 20 mm per second) the information is plotted on a computer screen and at the end of the test is stored on the computer for later plotting of the results.

The information provided on the plotted results comprises: —

- Cone resistance — the actual end bearing force divided by the cross sectional area of the cone — expressed in MPa.
- Sleeve friction — the frictional force on the sleeve divided by the surface area — expressed in kPa.
- Friction ratio — the ratio of sleeve friction to cone resistance, expressed in percent.

There are two scales available for measurement of cone resistance. The lower scale (0–5 MPa) is used in very soft soils where increased sensitivity is required and is shown in the graphs as a dotted line. The main scale (0–50 MPa) is less sensitive and is shown as a full line.

The ratios of the sleeve friction to cone resistance will vary with the type of soil encountered, with higher relative friction in clays than in sands. Friction ratios of 1%–2% are commonly encountered in sands and very soft clays rising to 4%–10% in stiff clays.

In sands, the relationship between cone resistance and SPT value is commonly in the range:—

$$q_c \text{ (MPa)} = (0.4 \text{ to } 0.6) N \text{ (blows per 300 mm)}$$

In clays, the relationship between undrained shear strength and cone resistance is commonly in the range:—

$$q_c = (12 \text{ to } 18) c_u$$

Interpretation of CPT values can also be made to allow estimation of modulus or compressibility values to allow calculation of foundation settlements.

Inferred stratification as shown on the attached reports is assessed from the cone and friction traces and from experience and information from nearby boreholes, etc. This information is presented for general guidance, but must be regarded as being to some extent interpretive. The test method provides a continuous profile of engineering properties, and where precise information on



soil classification is required, direct drilling and sampling may be preferable.

Hand Penetrometers

Hand penetrometer tests are carried out by driving a rod into the ground with a falling weight hammer and measuring the blows for successive 150 mm increments of penetration. Normally, there is a depth limitation of 1.2 m but this may be extended in certain conditions by the use of extension rods.

Two relatively similar tests are used.

- Perth sand penetrometer — a 16 mm diameter flat-ended rod is driven with a 9 kg hammer, dropping 600 mm (AS 1289, Test 6.3.3). This test was developed for testing the density of sands (originating in Perth) and is mainly used in granular soils and filling.
- Cone penetrometer (sometimes known as the Scala Penetrometer) — a 16 mm rod with a 20 mm diameter cone end is driven with a 9 kg hammer dropping 510 mm (AS 1289, Test 6.3.2). The test was developed initially for pavement subgrade investigations, and published correlations of the test results with California bearing ratio have been published by various Road Authorities.

Laboratory Testing

Laboratory testing is carried out in accordance with Australian Standard 1289 "Methods of Testing Soil for Engineering Purposes". Details of the test procedure used are given on the individual report forms.

Bore Logs

The bore logs presented herein are an engineering and/or geological interpretation of the subsurface conditions, and their reliability will depend to some extent on frequency of sampling and the method of drilling. Ideally, continuous undisturbed sampling or core drilling will provide the most reliable assessment, but this is not always practicable, or possible to justify on economic grounds. In any case, the boreholes represent only a very small sample of the total subsurface profile.

Interpretation of the information and its application to design and construction should therefore take into account the spacing of boreholes, the frequency of sampling and the possibility of other than 'straight line' variations between the boreholes.

Ground Water

Where ground water levels are measured in boreholes, there are several potential problems;

- In low permeability soils, ground water although present, may enter the hole slowly or perhaps not at all during the time it is left open.
- A localised perched water table may lead to an erroneous indication of the true water table.

- Water table levels will vary from time to time with seasons or recent weather changes. They may not be the same at the time of construction as are indicated in the report.
- The use of water or mud as a drilling fluid will mask any ground water inflow. Water has to be blown out of the hole and drilling mud must first be washed out of the hole if water observations are to be made.

More reliable measurements can be made by installing standpipes which are read at intervals over several days, or perhaps weeks for low permeability soils. Piezometers, sealed in a particular stratum, may be advisable in low permeability soils or where there may be interference from a perched water table.

Engineering Reports

Engineering reports are prepared by qualified personnel and are based on the information obtained and on current engineering standards of interpretation and analysis. Where the report has been prepared for a specific design proposal (eg. a three storey building), the information and interpretation may not be relevant if the design proposal is changed (eg. to a twenty storey building). If this happens, the Company will be pleased to review the report and the sufficiency of the investigation work.

Every care is taken with the report as it relates to interpretation of subsurface condition, discussion of geotechnical aspects and recommendations or suggestions for design and construction. However, the Company cannot always anticipate or assume responsibility for:

- unexpected variations in ground conditions — the potential for this will depend partly on bore spacing and sampling frequency
- changes in policy or interpretation of policy by statutory authorities
- the actions of contractors responding to commercial pressures.

If these occur, the Company will be pleased to assist with investigation or advice to resolve the matter.

Site Anomalies

In the event that conditions encountered on site during construction appear to vary from those which were expected from the information contained in the report, the Company requests that it immediately be notified. Most problems are much more readily resolved when conditions are exposed than at some later stage, well after the event.

Reproduction of Information for Contractual Purposes

Attention is drawn to the document "Guidelines for the Provision of Geotechnical Information in Tender Documents", published by the Institution of Engineers, Australia. Where information obtained from this investigation is provided for tendering purposes, it is



recommended that all information, including the written report and discussion, be made available. In circumstances where the discussion or comments section is not relevant to the contractual situation, it may be appropriate to prepare a specially edited document. The Company would be pleased to assist in this regard and/or to make additional report copies available for contract purposes at a nominal charge.

Site Inspection

The Company will always be pleased to provide engineering inspection services for geotechnical aspects of work to which this report is related. This could range from a site visit to confirm that conditions exposed are as expected, to full time engineering presence on site.

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APPENDIX B

Laboratory Report Sheets
Chain of Custody Documentation



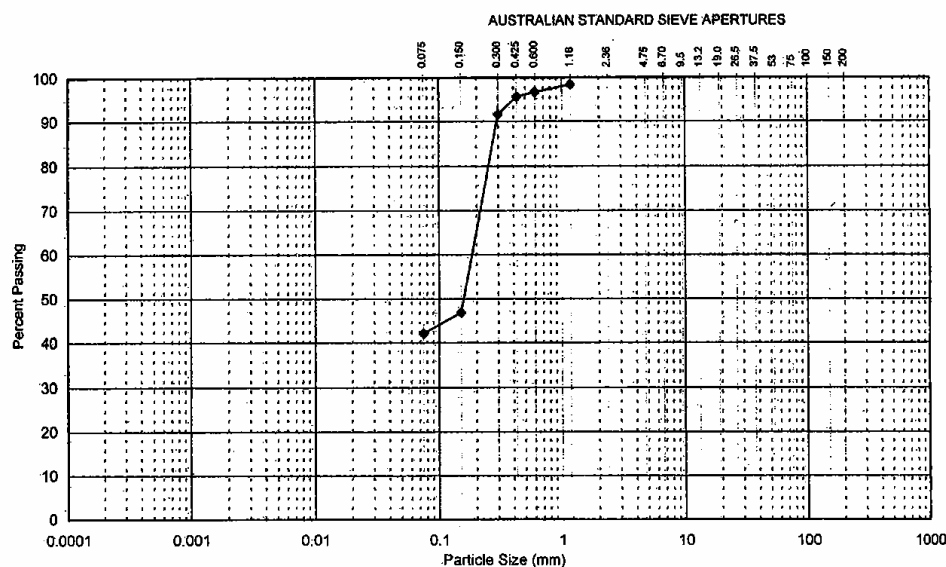
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Phone (07) 3237 8900
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dpbis@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	AUSTRALIAN FRESH CORPORATION Pty Ltd	Project No. :	33579
Project :	PROPOSED BAYLOBSTER AQUACULTURE PROJECT	Report No. :	B04 - 246
Location :	355 CUDGEN ROAD, CUDGEN	Report Date :	3/9/2004
Test Location :	BORE 1	Date Sampled:	11/08/2004
Depth / Layer :	0.4 - 0.5	Date of Test:	31/08/2004
		Page:	1 of 1



CLAY FRACTION			SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.02	0.06	0.2	0.2	0.6	2.0	6.0	20	60	

Description: Silty SAND - Light brown, fine to medium grained.
Test Method(s): AS 1289.3.6.1-1995.
Sampling Method(s): By Client
Method of Dispersion:
Remarks:

Form B04 (Rev 1) Feb 2004



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Testing Authorities, Australia. The test(s) reported herein have
been performed in accordance with its terms of accreditation.
This document shall not be reproduced except in full

Approved Signatory:

Tested: LS
Checked: AJM

Anthony J. McKenna
Laboratory Manager



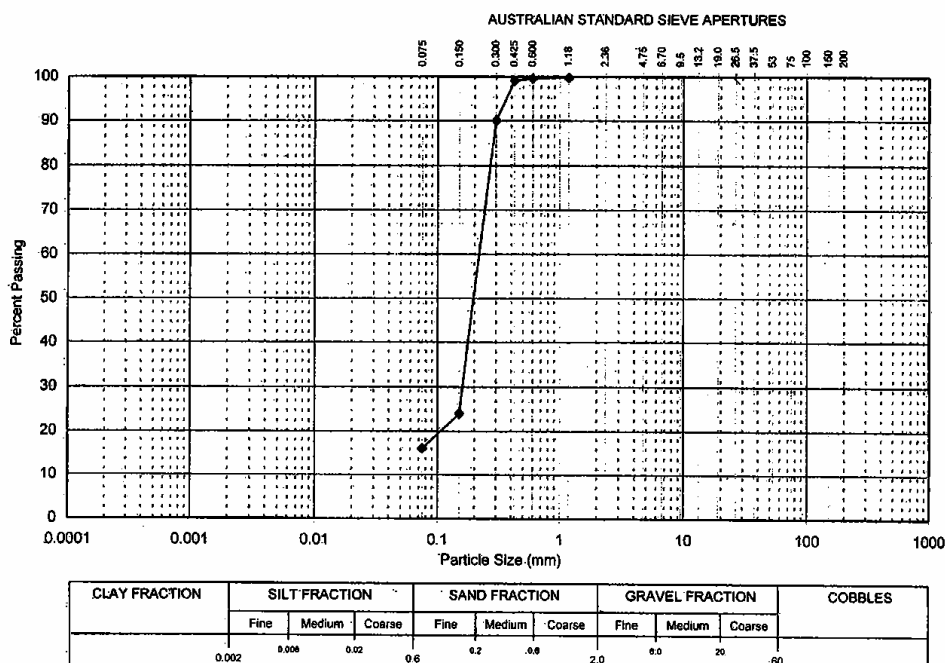
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Phone (07) 3237 8900
Fax: (07) 3237 8999
dpbris@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	AUSTRALIAN FRESH CORPORATION Pty Ltd	Project No. :	33579
Project :	PROPOSED BAYLOBSTER AQUACULTURE PROJECT	Report No. :	B04 - 247
Location :	355 CUDGEN ROAD, CUDGEN	Report Date :	3/9/2004
Test Location :	BORE 1	Date Sampled:	11/08/2004
Depth / Layer :	1.4 - 1.5	Date of Test:	31/08/2004
		Page:	1 of 1



Description: SAND - slightly silty, grey, fine to medium grained.
Test Method(s): AS 1289.3.6.1-1995.
Sampling Method(s): By Client
Method of Dispersion:
Remarks:

Form 1004 Rev 2 Feb 2004



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Approved Signatory:

Tested: LS
Checked: AJM

Anthony J. McKenna
Laboratory Manager



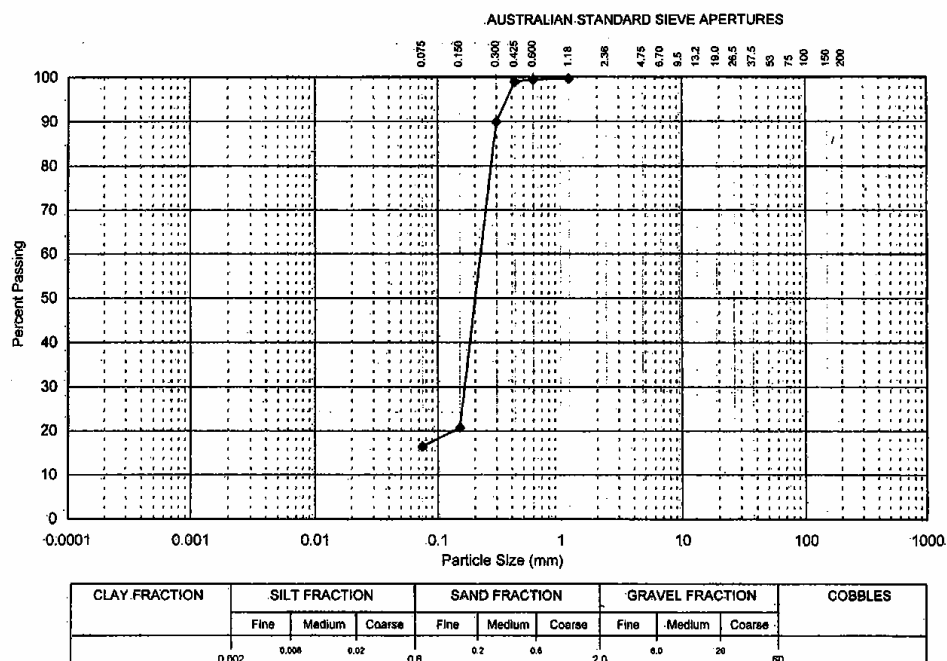
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RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	AUSTRALIAN FRESH CORPORATION Pty Ltd	Project No. :	33579
Project :	PROPOSED BAYLOBSTER AQUACULTURE PROJECT	Report No. :	B04 - 248
Location :	355 CUDGEN ROAD, CUDGEN	Report Date :	3/9/2004
Test Location :	BORE 4	Date Sampled:	11/08/2004
Depth / Layer :	0.9 - 1.0	Date of Test:	31/08/2004
		Page:	1 of 1



Description: SAND - Slightly silty, light brown, fine to medium grained
Test Method(s): AS 1289.3.6.1-1995.
Sampling Method(s): By Client
Method of Dispersion:
Remarks:

Form 1000 (Rev 5) Feb 2004



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 been performed in accordance with its terms of accreditation.
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Approved Signatory:

Tested: LS
 Checked: AJM

Anthony J. McKenna
 Laboratory Manager



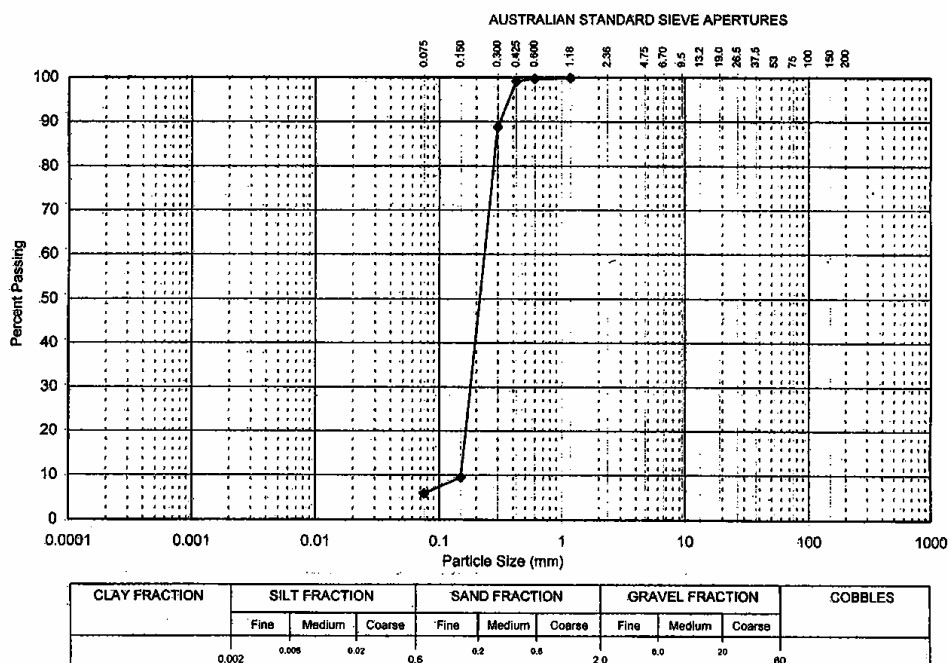
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RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	AUSTRALIAN FRESH CORPORATION Pty Ltd	Project No. :	33579
Project :	PROPOSED BAYLOBSTER AQUACULTURE PROJECT	Report No. :	B04 - 249
Location :	355 CUDGEN ROAD, CUDGEN	Report Date :	3/9/2004
Test Location :	BORE 4	Date Sampled:	11/08/2004
Depth / Layer :	2.9 - 3.0	Date of Test:	31/08/2004
		Page:	1 of 1





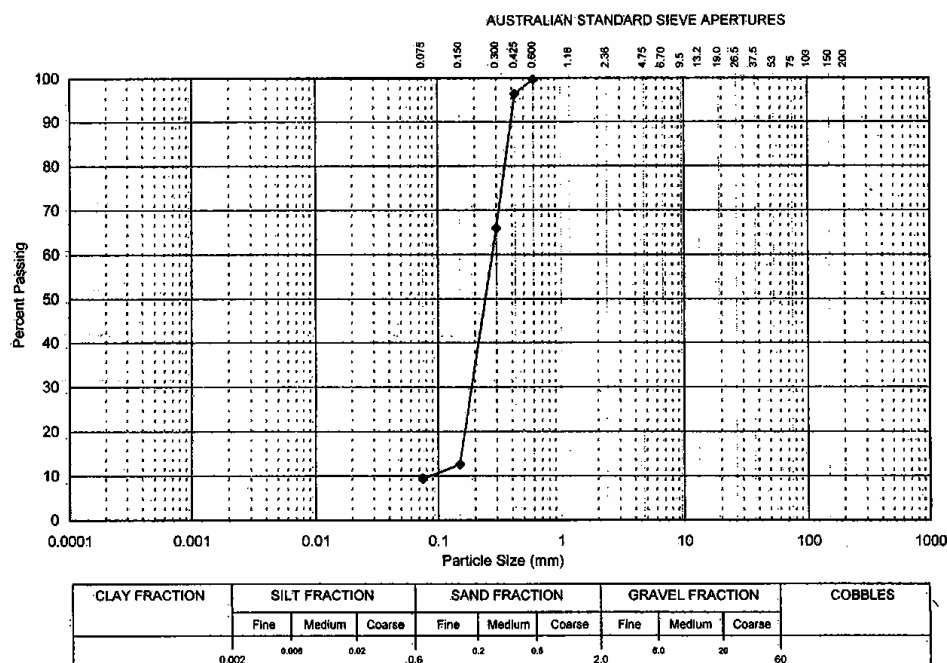
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 dperis@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	AUSTRALIAN FRESH CORPORATION Pty Ltd	Project No. :	33579
Project :	PROPOSED BAYLOBSTER AQUACULTURE PROJECT	Report No. :	B04 - 250
Location :	355 CUDGEN ROAD, CUDGEN	Report Date :	3/9/2004
Test Location :	BORE 6	Date Sampled:	11/08/2004
Depth / Layer :	0.4 - 0.5	Date of Test:	31/08/2004
		Page:	1 of 1



Description: SAND - Light Brown, medium grained with some silt.
Test Method(s): AS 1289.3.6.1-1995.
Sampling Method(s): By Client
Method of Dispersion:
Remarks:

Form R001 Rev'd 5 Feb 2004



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Approved Signatory:

Tested: LS
 Checked: AJM

Anthony J. McKenna
 Laboratory Manager



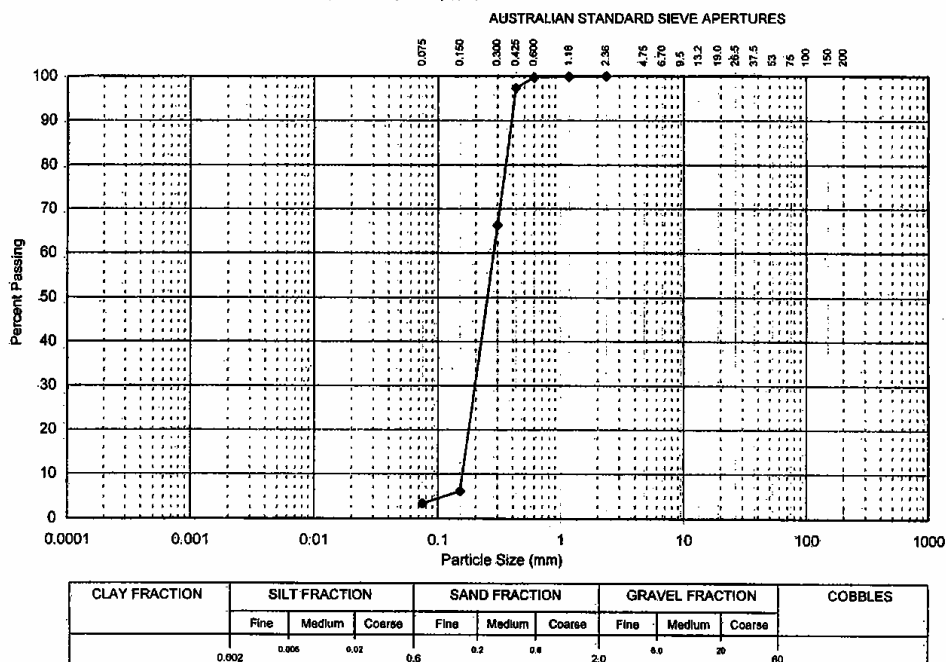
Douglas Partners
Geotechnics • Environment • Groundwater

Douglas Partners Pty Ltd
ABN 75 053 980 117
439 Montague Road
West End QLD 4101
Australia

439 Montague Road
West End QLD 4101
Phone (07) 3237 8900
Fax: (07) 3237 8999
dps@douglaspartners.com.au

RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	AUSTRALIAN FRESH CORPORATION Pty Ltd	Project No. :	33579
Project :	PROPOSED BAYLOBSTER AQUA CULTURE PROJECT	Report No. :	B04 - 251
Location :	355 CUDGEN ROAD, CUDGEN	Report Date :	3/9/2004
Test Location :	BORE 6	Date Sampled:	11/08/2004
Depth / Layer :	2.4 - 2.5	Date of Test:	31/08/2004
		Page:	1 of 1



Description: SAND - Grey, medium grained with a trace of silt.

Test Method(s): AS 1289.3.6.1-1995.

Sampling Method(s): By Client

Method of Dispersion:

Remarks:

Form 2004 Rev 1/01/2004



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Tested:	LS
Checked:	AJM

Anthony J. McKenna
Laboratory Manager



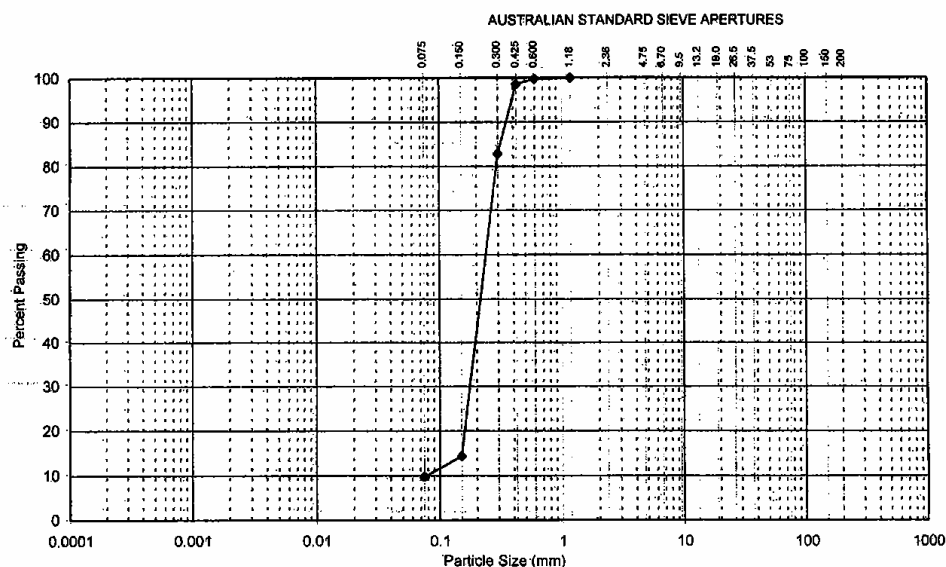
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RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	AUSTRALIAN FRESH CORPORATION Pty Ltd	Project No. :	33579
Project :	PROPOSED BAYLOBSTER AQUACULTURE PROJECT	Report No. :	B04 - 252
Location :	355 CUDGEN ROAD, CUDGEN	Report Date :	3/9/2004
Test Location :	BORE 9	Date Sampled:	11/08/2004
Depth / Layer :	0.9 - 1.0	Date of Test:	31/08/2004
		Page:	1 of 1



CLAY FRACTION			SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES
Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse	
0.002	0.006	0.02	0.02	0.06	0.2	0.2	0.6	2.0	6.0	20	60	

Description: SAND - Light brown, medium grained with some silt.
Test Method(s): AS 1289.3.6.1-1995.
Sampling Method(s): By Client
Method of Dispersion:
Remarks:

Form PDS-1, Rev 01/01/2004



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Laboratory Manager



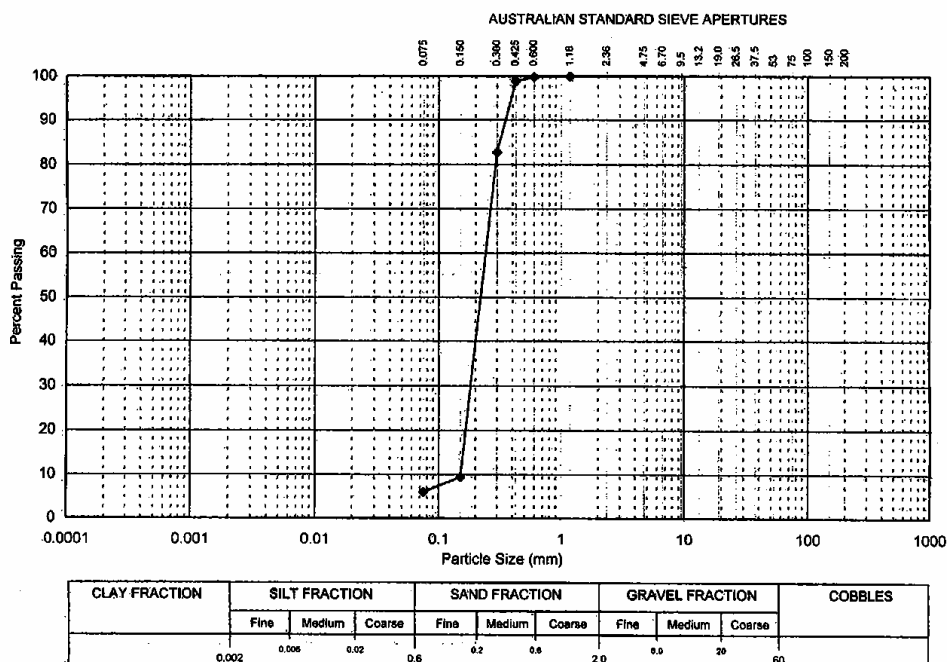
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RESULTS OF PARTICLE SIZE DISTRIBUTION TEST

Client :	AUSTRALIAN FRESH CORPORATION Pty Ltd	Project No. :	33579
Project :	PROPOSED BAYLOBSTER AQUACULTURE PROJECT	Report No. :	B04 - 253
Location :	355 CUDGEN ROAD, CUDGEN	Report Date :	3/9/2004
Test Location :	BORE 9	Date Sampled:	11/08/2004
Depth / Layer :	1.9 - 2.0	Date of Test:	31/08/2004
		Page:	1 of 1



Description: SAND - Grey, medium grained with some silt.

Test Method(s): AS 1289.3.6.1-1995.

Sampling Method(s): By Client

Method of Dispersion:

Remarks:

Form 1000 Rev 1 Feb 2004



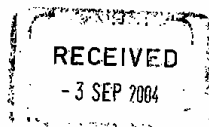
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Approved Signatory:

Tested: LS
Checked: AJM

[Signature]
Anthony J. McKenna
Laboratory Manager

ALS Environmental



CERTIFICATE OF ANALYSIS

CONTACT: MR CHRIS BELL
CLIENT: DOUGLAS PARTNERS PTY LTD
ADDRESS:
439 MONTAGUE ROAD
WEST END QLD 4101
ORDER No.: 48547
PROJECT: 33579

BATCH: AEB63472
SUB BATCH: 0
LABORATORY: BRISBANE
DATE RECEIVED: 18/08/2004
DATE COMPLETED: 01/09/2004
SAMPLE TYPE: SOIL
No. of SAMPLES: 10

COMMENTS

Results apply to sample(s) as submitted. CHROMIUM SUITE as per Method of Qld Dept of Natural Resources & Mines. Acid Base Accounting incorporates a minimum safety factor of 1.5. This report supersedes EB63472.

NOTES

This is the Final Report and supersedes any preliminary reports with this batch number. All pages of this report have been checked and approved for release.

ISSUING LABORATORY: BRISBANE

Address
32 Shand Street
Stafford QLD 4053
Australia
Signatory

Phone: 61-7-3243 7222
Fax: 61-7-3243 7218
Email: michael.heery@alsenviro.com

K. Heery

Reports signed by signatories as required

LABORATORIES

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Melbourne
Sydney
Newcastle
Auckland
Hong Kong
Singapore
Kuala Lumpur
Bogor
Mumbai

AMERICAS
Vancouver
San Diego
Antofagasta
Lima

Australian Laboratory Services Pty Ltd (ABN 64 009 936 029)



NATA Accredited Laboratory Number 825

Site: BRISBANE

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Page 1 of 3

A Campbell Brothers Limited Company



CERTIFICATE OF ANALYSIS

Batch: AEB63472
Sub Batch: 0
Date of Issue: 01/09/2004
Client: DOUGLAS PARTNERS PTY LTD
Client Reference: 33579

METHOD	ANALYSIS DESCRIPTION	UNIT	SAMPLE IDENTIFICATION									
			1	2	3	4	5	6	7	8	9	10
	Laboratory ID:		Bore 3	Bore 4	Bore 4	Bore 4	Bore 5	Bore 7	Bore 7	Bore 9	Bore 10	Bore 10
	Date Sampled											
EA-033-A	ACTUAL ACIDITY											
EA-033-A	pH KCl (23A)	0.1	4.6	5.4	5.6	5.9	5.4	5.1	5.5	5.4	5.4	5.4
EA-033-A	Titration Actual Acidity (23F)	2	31	5	<2	2	4	10	<2	4	5	9
EA-033-A	sulfidic-Titratable Act. Acidity (s-23F)	% S	0.05	<0.02	<0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02
EA-033-B	POTENTIAL ACIDITY											
EA-033-B	Chromium Reducible Sulfur (22B)	% S	0.10	0.25	0.25	0.14	0.03	0.25	0.20	0.15	<0.02	0.18
EA-033-B	sulfidic-Chromium Reducible Sulfur (s-22B)	mg/kg	62	156	156	87	19	166	125	94	<10	112
EA-033-C	ACID NEUTRALISING CAPACITY											
EA-033-C	Acid Neutralising Capacity (19A1)	% CaCO ₃	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd
EA-033-C	sulfidic-Acid Neutralising Cap. (s-19A1)	mg/kg	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd
EA-033-C	sulfidic-Acid Neutralising Cap. (s-19A1)	% S	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd	Not Det'd
EA-033-D	RETAINED ACIDITY											
EA-033-D	Net Acid Soluble Sulfur (20A)	% S	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
EA-033-D	sulfidic-Net Acid Soluble Sulfur (s-20A)	mg/kg	10	10	10	10	10	10	10	10	10	10
EA-033-D	sulfidic-Net Acid Soluble Sulfur (s-20A)	% pyrite S	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
EA-033-E	ACID BASE ACCOUNTING											
EA-033-E	ANC Fineness Factor		1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
EA-033-E	Net Acidity (acidity units)	% S	0.15	0.25	0.25	0.14	0.03	0.27	0.20	0.15	<0.02	0.18
EA-033-E	Net Acidity (acidity units)	mg/kg	93	161	166	89	23	166	125	94	<10	121
EA-033-E	Limiting Rate	kg CaCO ₃ /t	7	12	12	7	2	12	9	7	<1	9

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Page 2 of 3



QUALITY CONTROL REPORT

Batch: AEB63472
Sub Batch: 0
Date of Issue: 01/09/2004
Client: DOUGLAS PARTNERS PTY LTD
Client Reference: 33579

METHOD			ANALYSIS DESCRIPTION		UNIT		LOR		Date Sampled		Laboratory I.D.		200		SAMPLE IDENTIFICATION		CHECKS AND SPIKES	
EA-033-A	ACTUAL ACIDITY		pH KCl (23A)		mole/tonne		0.1											
EA-033-A	Titratable Actual Acidity (23F)				% S		2											
EA-033-A	sulphate-Titratable Act. Acidity (s-23F)				% S		0.02											
EA-033-B	POTENTIAL ACIDITY				% S		0.02											
EA-033-B	Chromium Reducible Sulfur (22B)				mole/tonne		10											
EA-033-B	acidity-Chromium Reducible Sulfur (s-22B)				% S		0.02											
EA-033-C	ACID NEUTRALISING CAPACITY				mole/tonne		0.01											
EA-033-C	Acid Neutralising Capacity (19A1)				% CaCO ₃		10											
EA-033-C	acidity-Acid Neutralising Cap. (s-19A1)				mole/tonne		0.01											
EA-033-C	sulphate-Acid Neutralising Cap. (s-19A1)				% S		0.01											
EA-033-D	RETAINED ACIDITY				% S		0.02											
EA-033-D	Net Acid Soluble Sulfur (20J6)				mole/tonne		10											
EA-033-D	acidity-Net Acid Soluble Sulfur (s-20J)				% pyrite S		0.02											
EA-033-E	ACID BASE ACCOUNTING				% S		0.5											
EA-033-E	ANC Fineness Factor				% S		0.02											
EA-033-E	Net Acidity (acidity units)				mole/tonne		10											
EA-033-E	Net Acidity (acidity units)				kg CaCO ₃ /t		1											
EA-033-E	Lining Rate																	

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CHAIN OF CUSTODY DOCUMENTATION										COC No. 21		Australian Laboratory Services Pty Ltd	
CLIENT: Douglas Partners				POSTAL ADDRESS: 439 Montague Road, West End QLD 4101				SAMPLERS:					
SEND REPORT TO: Chris Bell				SEND INVOICE TO: Chris Bell				PHONE: 3237 8900 FAX: 3237 8998 E-MAIL: bell@douglaspartners.com.au					
DATA NEEDED BY: 5 working days				REPORT NEEDED BY: 25/08/04				REPORT FORMAT: HARD: <input type="checkbox"/> DISK: <input type="checkbox"/> BULLETIN BOARD: <input type="checkbox"/> E-MAIL: <input checked="" type="checkbox"/>					
PROJECT ID: 33579				QUOTE NO.: EN54203				QC LEVEL: <input type="checkbox"/> QCS1 <input type="checkbox"/> QCS2 <input type="checkbox"/> QCS3 <input type="checkbox"/> QCS4 <input type="checkbox"/>					
P.O. NO.: 48847				COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:				ANALYSIS REQUIRED					
Keep Chilled										<div style="text-align: center;"> Chris Bell 18/8/04 </div>			
SAMPLE DATA				CONTAINER DATA									
SAMPLE ID	MATRIX	DATE	TIME	TYPE & PRESERVATIVE	NO.	Ph							
Bore 3 - 0.4-0.5m (1)	Soil			NIL		X							
Bore 4 - 1.9-2.0m (2)	Soil			NIL		X							
Bore 4 - 2.4-2.5m (3)	Soil			NIL		X							
Bore 4 - 3.9-4.0m (4)	Soil			NIL		X							
Bore 5 - 0.9-1.0m (5)	Soil			NIL		X							
Bore 7 - 1.4-1.5m (6)	Soil			NIL		X							
Bore 7 - 2.9-3.0m (7)	Soil			NIL		X							
Bore 9 - 3.4-3.5m (8)	Soil			NIL		X							
Bore 10 - 0.4-0.5m (9)	Soil			NIL		X							
Bore 10 - 0.9-1.0m (10)	Soil			NIL		X							
RELINQUISHED BY:							RECEIVED BY:						
NAME: Chris Bell							NAME:						
OF: Douglas Partners							OF:						
DATE: 18/08/04							DATE:						
TIME: 12:30hrs							TIME:						
NAME:							NAME:						
OF:							OF:						
DATE:							DATE:						
TIME:							TIME:						
*Container Type and Preservative Codes: P = Neutral Plastic; N = Nitric Acid Preserved; C = Sodium Hydroxide Preserved; J = Solvent Washed Acid Rinsed Jar; S = Solvent Washed Acid Rinsed Glass Bottle; VC = Hydrochloric Acid Preserved Vial; VS = Sulfuric Acid Preserved Glass Bottle; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; O = Other.													

AUSTRALIAN LABORATORY SERVICES P/L

Appendix 7

Laboratory Results – Soil Analyses (Acid Sulphate Soils and Sediments – Current Project

(No. of pages excluding this page = 31)


* Note: Not included within hardcopy. A copy has been provided on the project CD.

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 1/35 Old Pacific Highway, Yatala Ph (07) 3804 6844

BOREHOLE PROFILE


CLIENT: HMC ENVIROMENTAL CONSULTING PTY LTD				BOREHOLE No: MB8A		
PROJECT: CHINDERAH SAND QUARRY				JOB No: BT 14650		
EQUIPMENT TYPE: GCH 200			HOLE DIAMETER: 110mm			
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
ALLUVIUM / TOPSOIL			0.3		Silty SAND: Fine grained sand, With some clay, Very moist, Dark grey (SM)	
		▼	1.3		Silty SAND: Fine grained sand, Very moist, Pale brown and pale orange mottled (SM)	
			1.7		Silty SAND: Fine grained sand, Wet, Dark grey (SM)	
ALLUVIUM					SAND: Fine to medium grained sand, With shell fragments, Wet, Grey (SP)	
			9.5		Sandy GRAVEL: Fine to coarse grained sand, Fine to coarse gravel, Wet, Orange/brown (GP)	
			11.4		Clayey SAND: Fine angular grained sand, With some fine gravel, Band of Silty Clay throughout, Moist, Dark grey and dark orange/brown (SC)	
			13.5			
MB8A TERMINATED AT 13.5m LIMIT OF INVESTIGATION						
Logged By GDM		Date 8/11/05		Checked By  Date 2/11/05		

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BOREHOLE PROFILE

CLIENT: HMC ENVIROMENTAL CONSULTING PTY LTD				BOREHOLE No: BH 1 Page 1		
PROJECT: CHINDERAH SAND QUARRY				JOB No: BT 14650		
EQUIPMENT TYPE: GCH 200			HOLE DIAMETER: 100mm			
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
TOPSOIL/ ALLUVIUM			0.2		Silty SAND: Fine grained sand, With organic material (fine roots), Very moist, Black (SM)	
		▼	0.8		SAND: Fine grained sand, Very moist, Pale yellow/brown (SP)	
					Silty SAND: Fine grained sand, Wet, Grey (SM)	
ALLUVIUM			3.8		Silty SAND: Fine grained sand, With shell fragments. Wet, Grey (SM)	
	7.0m SPT 9,12,14 N = 26 7.45m		7.35		Continued on Page 2	
Logged By GDM		Date 16/5/05		Checked By 		Date 21/6/05

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BOREHOLE PROFILE

CLIENT: HMC ENVIROMENTAL CONSULTING PTY LTD				BOREHOLE No: BH 1 Page 2			
PROJECT: CHINDERAH SAND QUARRY				JOB No: BT 14650			
EQUIPMENT TYPE: GCH 200			HOLE DIAMETER: 100mm				
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density	
ALLUVIUM	8.0m SPT 11,14,14 N = 28		7.35		Continued from Page 1		
	8.45m						
	9.0m SPT 8,11,10 N = 21						
	9.45m						
	10.0m SPT 8,5,4 N = 9		10.1			Silty SAND: Fine grained sand, With shell fragments, Wet, Grey (SM)	
	10.45m						
	11.0m SPT 9,12,15 N = 27		10.7			Silty SAND: Fine grained sand. Wet, Dark grey (SM)	
	11.45m						
	12.0m SPT 13,15,18 N = 33						
	12.45m						
	13.0m SPT 13,14,14 N = 28						
	13.45m						
	14.0m SPT 9,14,17 N = 31						
	14.45m						
			15.0		Continued on Page 3		
Logged By GDM		Date 16/5/05		Checked By		Date 21/6/05	

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1/35 Old Pacific Highway, Yatala Ph (07) 3804 6844

BOREHOLE PROFILE

CLIENT: HMC ENVIROMENTAL CONSULTING PTY LTD				BOREHOLE No: BH 1 Page 3		
PROJECT: CHINDERAH SAND QUARRY				JOB No: BT 14650		
EQUIPMENT TYPE: GCH 200				HOLE DIAMETER: 100mm		
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
ALLUVIUM	15.0m		15.0		Continued from Page 2	
	SPT 9,20,38 N = 58					
	15.45m					
	16.0m					
	SPT 15,25,30/100 N = >50					
	16.4m					
	17.0m					
	SPT 18,31,20/60 N = >50					
	17.36m					
	18.0m					
	SPT 15,26,40 N = 66					
	18.45m					
	19.0m					
	SPT 20,29 N = >50					
19.3m	20.0		BH 1 TERMINATED AT 20.0m LIMIT OF INVESTIGATION			
20.0m						
	SPT 24,31 N = >50					
	20.3m					

Logged By

GDM

Date

16/5/05

Checked By

Date

21/6/05

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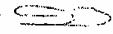
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
CLIENT: HMC ENVIROMENTAL CONSULTING PTY LTD				BOREHOLE No: BH 2 Page 1		
PROJECT: CHINDERAH SAND QUARRY				JOB No: BT 14650		
EQUIPMENT TYPE: GCH 200			HOLE DIAMETER: 100mm			
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
ALLUVIUM / TOPSOIL			0.4		Silty SAND: Fine grained sand, Very moist, Black (SM)	
		▼	1.1		Silty SAND: Fine grained sand, Very moist, Brown (SM)	
			3.3		Silty SAND: Fine grained sand, Wet, Grey (SM)	
ALLUVIUM					Silty SAND: Fine grained sand, With shell fragments, Wet, Grey (SM)	
	7.0m SPT 9,9,11 N = 20 7.45m		7.35		Continued on Page 2	
Logged By GDM		Date 17/5/05		Checked By 		Date 21/6/05

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BOREHOLE PROFILE

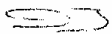
CLIENT: HMC ENVIROMENTAL CONSULTING PTY LTD				BOREHOLE No: BH 2 Page 2		
PROJECT: CHINDERAH SAND QUARRY				JOB No: BT 14650		
EQUIPMENT TYPE: GCH 200			HOLE DIAMETER: 100mm			
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
ALLUVIUM			7.35		Continued from Page 1	
			7.6		Silty SAND: Fine grained sand, With shell fragments, Wet, Grey (SM)	
	8.0m					
	SPT 10,12,12 N = 24					
	8.45m					
	9.0m					
	SPT 11,14,14 N = 28					
	9.45m					
	10.0m					
	SPT 13,14,20 N = 34					
	10.45m					
	11.0m					
	SPT 17,23,20 N = 43					
	11.45m					
	12.0m					
SPT 7,12,20 N = 32						
12.45m						
13.0m						
SPT 12,18,19 N = 37						
13.45m						
14.0m						
SPT 11,16,22 N = 38						
14.45m						
			15.0		Continued on Page 3	
Logged By GDM		Date 17/5/05		Checked By  Date 21/6/05		

Form R32 Issue 3

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GEOTECHNICAL ENGINEERING SERVICES
 6/12 Greenway Drive, Tweed Heads South Ph (07) 5524 6199
 1/35 Old Pacific Highway, Yatala Ph (07) 3804 6844

BOREHOLE PROFILE

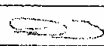
CLIENT: HMC ENVIROMENTAL CONSULTING PTY LTD					BOREHOLE No: BH 2 Page 3	
PROJECT: CHINDERAH SAND QUARRY					JOB No: BT 14650	
EQUIPMENT TYPE: GCH 200			HOLE DIAMETER: 100mm			
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
ALLUVIUM	15.0m SPT 11,18,23 N = 41		15.0		Continued from Page 2	
	15.45m		15.4		Silty SAND: Fine grained sand, With a trace of shell fragments, Wet, Grey (SM)	
	16.0m SPT 6,10,12 N = 22		16.8		Silty SAND: Fine grained sand, With a trace of shell fragments, Fine chips of burnt wood, Wet, Grey (SM)	
	16.45m					
	17.0m SPT 5,8,10 N = 18		17.9		Silty SAND: Fine grained sand, Trace of clay, With chips of burnt wood Wet, Dark grey (SM)	
	17.45m					
	18.0m SPT 1/450 N = 0		18.5		Marine CLAY	
	18.45m					
					BH 2 TERMINATED AT 18.5m LIMIT OF INVESTIGATION	
Logged By GDM		Date 17/5/05		Checked By 		Date 21/6/05

Form R32 Issue 3

BORDER - TECH

GEOTECHNICAL ENGINEERING SERVICES
6/12 Greenway Drive, Tweed Heads South Ph (07) 5524 6199
1/35 Old Pacific Highway, Yatala Ph (07) 3804 6844

BOREHOLE PROFILE

CLIENT: HMC ENVIROMENTAL CONSULTING PTY LTD					BOREHOLE No: BH 3 Page 1	
PROJECT: CHINDERAH SAND QUARRY					JOB No: BT 14650	
EQUIPMENT TYPE: GCH 200			HOLE DIAMETER: 100mm			
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
ALLUVIUM / TOPSOIL			0.2		Silty SAND: Fine grained sand, With a trace of clay and organic material (fine roots), Very moist, Black (SM)	
		▼	1.0		Silty SAND: Fine grained sand, Very moist, Pale brown with some pale orange mottling (SM)	
			3.7		Silty SAND: Fine grained sand, Wet, Dark grey (SM)	
ALLUVIUM					Silty SAND: Fine grained sand, With some shell fragments, Wet, Dark grey (SM)	
	7.0m SPT 13,16,17 N = 33		7.35		Continued on Page 2	
7.45m						
Logged By: GDM		Date: 18/5/05		Checked By: 		Date: 21/6/05

Form R32 Issue 3

BORDER - TECH

GEOTECHNICAL ENGINEERING SERVICES

6/12 Greenway Drive, Tweed Heads South Ph (07) 5524 6199
 1/35 Old Pacific Highway, Yatala Ph (07) 3804 6844

BOREHOLE PROFILE



CLIENT: HMC ENVIROMENTAL CONSULTING PTY LTD					BOREHOLE No: BH 3 Page 2	
PROJECT: CHINDERAH SAND QUARRY					JOB No: BT 14650	
EQUIPMENT TYPE: GCH 200			HOLE DIAMETER: 100mm			
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
ALLUVIUM	8.0m SPT 11,11,14 N = 25 8.45m		7.35		Continued from Page 1	
	9.0m SPT 13,16,15 N = 31 9.45m					
	10.0m SPT 11,13,14 N = 27 10.45m					
	13.0m SPT 13,11,17 N = 28 13.45m					
			15.0		Continued on Page 3	
Logged By: GDM		Date: 18/5/05		Checked By:		Date: 21/6/05

Form R32 Issue 3

BORDER - TECH

GEOTECHNICAL ENGINEERING SERVICES
6/12 Greenway Drive, Tweed Heads South Ph (07) 5524 6199
1/35 Old Pacific Highway, Yatala Ph (07) 3804 6844

BOREHOLE PROFILE


CLIENT: HMC ENVIROMENTAL CONSULTING PTY LTD				BOREHOLE No: BH 3 Page 3		
PROJECT: CHINDERAH SAND QUARRY				JOB No: BT 14650		
EQUIPMENT TYPE: GCH 200				HOLE DIAMETER: 100mm		
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
ALLUVIUM			15.0		Continued from Page 2	
			17.6		Silty SAND: Fine grained sand, With some shell fragments. Wet, Dark grey (SM)	
	18.0m		18.0		Silty SAND: Fine to medium grained sand, With some shell fragments, Trace of organic material (burnt wood). Wet, Dark grey (SM)	
	SPT N = 0		18.5		Clayey SAND: Fine to medium grained sand, With some shell fragments, Very moist. Dark grey (SC)	
	18.45m				BH 3 TERMINATED AT 18.5m LIMIT OF INVESTIGATION	
Logged By GDM		Date 18/5/05		Checked By 		Date 21/6/05

Form R32 Issue 3

BORDER - TECH

GEOTECHNICAL ENGINEERING SERVICES
 6/12 Greenway Drive, Tweed Heads South Ph (07) 5524 6199
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BOREHOLE PROFILE

CLIENT: HMC ENVIROMENTAL CONSULTING PTY LTD					BOREHOLE No: BH 4 Page 1	
PROJECT: CHINDERAH SAND QUARRY					JOB No: BT 14650	
EQUIPMENT TYPE: GCH 200			HOLE DIAMETER: 100mm			
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
ALLUVIUM / TOPSOIL			0.3		Silty SAND: Fine grained sand, With organic material (fine roots), Very moist, Black (SM)	
		▼	0.7		Silty SAND: Fine grained sand, Very moist, Brown with some orange mottling (SM)	
					Silty SAND: Fine grained sand, Wet, Dark grey (SM)	
ALLUVIUM			4.3		Silty SAND: Fine grained sand, With shell fragments, Wet, Grey (SM)	
	7.0m SPT 8,9,12 N = 21 7.45m		7.35		Continued on Page 2	
Logged By: GDM		Date: 19/5/05		Checked By: 		Date: 21/6/05

Form R32 Issue 3

BORDER - TECH

GEOTECHNICAL ENGINEERING SERVICES

6/12 Greenway Drive, Tweed Heads South Ph (07) 5524 6199

1/35 Old Pacific Highway, Yatala Ph (07) 3804 6844

BOREHOLE PROFILE

CLIENT: HMC ENVIROMENTAL CONSULTING PTY LTD				BOREHOLE No: BH 4 Page 2		
PROJECT: CHINDERAH SAND QUARRY				JOB No: BT 14650		
EQUIPMENT TYPE: GCH 200			HOLE DIAMETER: 100mm			
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
ALLUVIUM	8.0m SPT 13,14,16 N = 30		7.35		Continued from Page 1	
	8.45m					
	9.0m SPT 12,16,18 N = 34					
	9.45m					
	10.0m SPT 12,20,24 N = 44					
	10.45m					
	11.0m SPT 10,21,24 N = 45					
	11.45m					
	12.0m SPT 15,25,34 N = 59					
	12.45m					
	13.0m SPT 14,29 N = >50					
	13.3m					
	14.0m SPT 18,34 N = >50					
	14.3m		14.8 15.0			
	Continued on Page 3					
Logged By GDM		Date 19/5/05	Checked By	Date 21/6/05		


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BORDER - TECH

GEOTECHNICAL ENGINEERING SERVICES

6/12 Greenway Drive, Tweed Heads South Ph (07) 5524 6199
 1/35 Old Pacific Highway, Yatala Ph (07) 3804 6844

BOREHOLE PROFILE

CLIENT: HMC ENVIROMENTAL CONSULTING PTY LTD				BOREHOLE No: BH 4 Page 3		
PROJECT: CHINDERAH SAND QUARRY				JOB No: BT 14650		
EQUIPMENT TYPE: GCH 200				HOLE DIAMETER: 100mm		
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
ALLUVIUM	15.0m		15.0		Continued from Page 2	
	SPT 13,23,21 N = 44					
	15.45m					
	16.0m					
	SPT 14,34 N = >50					
	16.3m					
	17.0m					
	SPT 17,34,30/100 N = >50					
	17.4m					
	18.0m					
	SPT 22,34 N = >50					
	18.3m					
	19.0m					
	SPT 24,26 N = 50					
19.3m						
			19.8			
			20.1		Silty SAND: Fine to medium grained sand, Trace of clay, With shell fragments, Wet, Dark grey (SM)	
			20.5		Marine CLAY:	
					BH 4 TERMINATED AT 20.5m LIMIT OF INVESTIGATION	

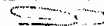
Logged By

GDM

Date

19/5/05

Checked By



Date


21/6/05

Form R32 Issue 3

BORDER - TECH

GEOTECHNICAL ENGINEERING SERVICES
6/12 Greenway Drive, Tweed Heads South Ph (07) 5524 6199
1/35 Old Pacific Highway, Yatala Ph (07) 3804 6844

BOREHOLE PROFILE

CLIENT: HMC ENVIROMENTAL CONSULTING PTY LTD				BOREHOLE No: BH 5		
PROJECT: CHINDERAH SAND QUARRY				JOB No: BT 14650		
EQUIPMENT TYPE: GCH 200				HOLE DIAMETER: 100mm		
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
ALLUVIUM / TOPSOIL			0.2		Silty SAND: Fine grained sand, With organic material (fine roots), Very moist, Black (SM)	
			0.8		Silty SAND: Fine grained sand, Moist, Pale brown and orange mottled (SM)	
					Silty SAND: Fine grained sand, Very moist, Dark grey (SM)	
ALLUVIUM		▼	3.8		Silty SAND: Fine grained sand, With some fine shell fragments, Wet, Grey (SM)	
			4.8		Silty SAND: Fine grained sand, With shell fragments, Wet, Grey (SM)	
			6.0		BH 5 TERMINATED AT 6.0m LIMIT OF INVESTIGATION	
Logged By: GDM		Date: 2/6/05		Checked By: 		Date: 21/6/05

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GEOTECHNICAL ENGINEERING SERVICES
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BOREHOLE PROFILE



CLIENT: HMC ENVIROMENTAL CONSULTING PTY LTD					BOREHOLE No: BH 6 Page 1	
PROJECT: CHINDERAH SAND QUARRY					JOB No: BT 14650	
EQUIPMENT TYPE: GCH 200			HOLE DIAMETER: 100mm			
Geological Profile	Samples	WATER	Depth in m	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
ALLUVIUM / TOPSOIL			0.2		Silty SAND: Fine grained sand, With organic material (fine roots), Very moist, Black (SM)	
			0.8		SAND: Fine grained sand, Very moist, Pale brown and orange mottled (SP)	
			1.3		Silty SAND: Fine grained sand, Wet, Dark grey (SM)	
			2.1		Silty SAND: Fine grained sand, With a trace of clay. Wet, Dark grey (SM)	
			2.7		Silty SAND: Fine grained sand, With shell fragments. Trace of clay, Wet, Grey (SM)	
			4.7		Silty SAND: Fine grained sand, With shell fragments, Wet, Grey (SM)	
ALLUVIUM			7.35		Silty SAND: Fine grained sand, With shell fragments. Wet, Pale grey (SM)	
	7.0m SPT 9,12,14 N = 26 7.45m					
Continued on Page 2						
Logged By	GDM	Date	6-6-05	Checked By		Date 21/6/05

Form R32 Issue 3

BORDER - TECH

GEOTECHNICAL ENGINEERING SERVICES
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1/35 Old Pacific Highway, Yatala Ph (07) 3804 6844

BOREHOLE PROFILE

CLIENT: HMC ENVIROMENTAL CONSULTING PTY LTD				BOREHOLE No: BH 6 Page 2		
PROJECT: CHINDERAH SAND QUARRY				JOB No: BT 14650		
EQUIPMENT TYPE: GCH 200			HOLE DIAMETER: 100mm			
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
ALLUVIUM	9.0m		7.35		Continued from Page 1	
	SPT 17,25,36 N = 61		9.8		Silty SAND: Fine grained sand, With shell fragments. Wet, Pale grey (SM)	
	9.45m		11.0		Clayey Sandy GRAVEL: Fine to coarse grained sand and gravel, Moist, Orange with some grey mottling (GP)	
RESIDUAL			11.0		ROCK	
NERANLEIGH FERNVALE BEDS			11.2		BH 6 TERMINATED AT 11.2m TUNGSTEN CARBIDE REFUSAL	
Logged By: GDM Date: 6/6/05 Checked By:  Date: 21/6/05						


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BORDER - TECH

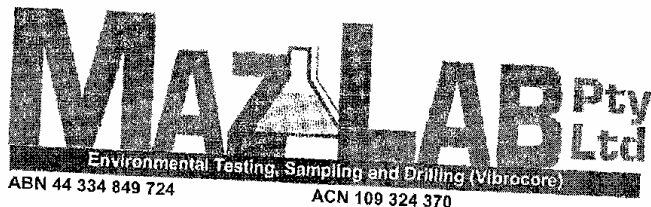
GEOTECHNICAL ENGINEERING SERVICES

6/12 Greenway Drive, Tweed Heads South Ph (07) 5524 6199
 1/35 Old Pacific Highway, Yatala Ph (07) 3804 6844

BOREHOLE PROFILE

CLIENT: HMC ENVIROMENTAL CONSULTING PTY LTD				BOREHOLE No: MB6A		
PROJECT: CHINDERAH SAND QUARRY				JOB No: BT 14650		
EQUIPMENT TYPE: GCH 200			HOLE DIAMETER: 110mm			
Geological Profile	Samples	W A T E R	Depth in m	Graphic Log	Soil or Rock Type, Structure	Consistency/ Rel. Density
ALLUVIUM / TOPSOIL			0.3		Silty SAND: Fine grained sand, With some clay, Very moist, Black (SM)	
		▼	0.9		Silty SAND: Fine grained sand, Very moist, Pale orange and pale brown mottled (SM)	
			1.8		Silty SAND: Fine grained sand, Wet, Dark grey (SM)	
ALLUVIUM					SAND: Fine grained sand, With some shell fragments, Wet, Dark grey (SP)	
			11.4			
			11.7		Sandy GRAVEL: Fine to coarse grained sand, Fine to medium gravel, Wet, Grey (GP)	
					Clayey SAND: Fine grained sand, Fine to coarse sub-rounded and angular gravel, Moist, Pale orange /brown (SC)	
			14.0			
MB6A TERMINATED AT 14.0m LIMIT OF INVESTIGATION						
Logged By GDM		Date 8/11/05		Checked By  Date 2/11/05		

Form R32 Issue 3



Unit B / 33 Machinery Drive
Tweed Heads South NSW 2486

All correspondence to:
PO Box 3218
Tweed Heads South DC 2486
Telephone: 07 5523 9922
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Certificate of Test Results

Ref. No. HMC1386

Issued: 23/7/07, 12:08 PM

Project: Crescent st & Tweed coast Rd, Cudgen for HMC Environmental Consulting

Ref. No.	I.D.	Soil Type (truncated description)	Date Sampled	Reaction to Peroxide	Reaction to HCl	pH _F 1:5 suspension in 1 molar NaCl	pH _{OX} 1:5 suspension in 1 molar NaCl
6377	BH09 0.50	SAND (SP), light grey-brown	8/09/2006	Slight	Nil	5.1	4.2
6378	BH09 1.00	SAND (SP), grey, v/moist.	8/09/2006	Strong	Nil	5.6	2.0
6379	BH09 1.50	SAND (SP), grey	8/09/2006	Strong	Nil	6.0	2.2
6380	BH09 2.00	SAND (SP), grey	8/09/2006	Strong	Nil	5.7	2.5
6381	BH09 2.50	SAND (SP), grey	8/09/2006	Strong	Nil	4.5	2.5
6382	BH09 3.00	SAND (SP), grey, v/moist.	8/09/2006	Strong	Nil	7.0	2.5
6383	BH09 3.50	SAND (SP), grey	8/09/2006	Strong	Nil	7.1	2.6
6384	BH09 4.00	SAND (SP), grey	8/09/2006	Slight	Slight	8.6	6.7
6385	BH09 4.50	SAND (SP), grey	8/09/2006	Slight	Moderate	8.9	4.7
6386	BH09 5.00	SAND (SP), light grey, v/moist.	8/09/2006	Slight	Strong	8.3	6.5
6387	BH09 5.50	SAND (SP), light grey	8/09/2006	Slight	Strong	8.4	6.0
6388	BH09 6.00	SAND (SP), light grey	8/09/2006	Slight	Strong	8.7	6.4
6389	BH10 0.50	SAND (SP), light grey-brown	8/09/2006	Slight	Nil	5.5	4.3
6390	BH10 1.00	SAND (SP), light brown	8/09/2006	Slight	Nil	5.6	4.4
6391	BH10 1.50	SAND (SP), light brown, v/moist.	8/09/2006	Strong	Nil	4.9	2.3
6392	BH10 2.00	SAND (SP), grey	8/09/2006	Strong	Nil	4.7	2.4
6393	BH10 2.50	SAND (SP), grey	8/09/2006	Strong	Nil	4.5	2.5
6394	BH10 3.00	SAND (SP), grey, v/moist.	8/09/2006	Strong	Nil	4.5	2.5
6395	BH10 3.50	SAND (SP), grey	8/09/2006	Strong	Nil	4.7	2.5
6396	BH10 4.00	SAND (SP), grey	8/09/2006	Strong	Nil	4.8	2.7
6397	BH10 4.50	SAND (SP), grey, v/moist.	8/09/2006	Strong	Nil	6.1	2.7
6398	BH10 5.00	SAND (SP), light grey	8/09/2006	Slight	Strong	9.1	6.0
6399	BH10 5.50	SAND (SP), light grey, v/moist.	8/09/2006	Slight	Strong	8.7	5.9
6400	BH10 6.00	SAND (SP), light grey	8/09/2006	Slight	Strong	8.7	6.1



Unit B / 33 Machinery Drive
 Tweed Heads South NSW 2486

All correspondence to:
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Certificate of Test Results

Ref. No.: HMC1228

Issued: 10/11/05, 2:23 PM

Project: Border Tech Job No BT14650, for HMC Environmental Consulting

Ref. No.	I.D.	Soil Type (truncated description)	Date Sampled	Reaction to Peroxide	Reaction to HCl	pH _F 1:5 suspension in 1 molar NaCl	pH _{FOX} 1:5 suspension in 1 molar NaCl
1191	BH01 0.50 61875	SAND (SP), fine grained, dark brown, moist.	16/05/2005	Slight	Nil	4.7	3.9
1192	BH01 1.00 61709	SSAND (SP), fine to medium grained, grey-brown, moist.	16/05/2005	Slight	Nil	4.8	4.1
1193	BH01 1.50 61876	SSAND (SP), fine to medium grained, grey-brown, moist.	16/05/2005	Slight	Nil	4.6	3.5
1194	BH01 2.00 61710	SAND (SP), fine to medium grained, grey, wet.	16/05/2005	Strong	Nil	5.6	2.2
1195	BH01 2.50 61877	SAND (SP), fine to medium grained, grey, moist.	16/05/2005	Strong	Nil	5.0	2.2
1196	BH01 3.00 61711	SAND (SP), fine to medium grained, grey, moist.	16/05/2005	Strong	Nil	5.4	2.3
1197	BH01 4.00 61712	SAND (SP), fine to medium grained, grey, moist.	16/05/2005	Strong	Slight	8.1	3.0
1198	BH01 5.00 61713	SAND (SP), fine to medium grained, grey, moist.	16/05/2005	Strong	Slight	7.3	2.5
1199	BH01 6.00 61714	SAND (SP), fine to medium grained, light grey-brown, moist.	16/05/2005	Moderate	Slight	9.0	6.3
1200	BH01 7.00 61715	SAND (SP), fine to medium grained, light grey-brown, moist.	16/05/2005	Moderate	Moderate	9.1	6.7
1201	BH01 8.00 61716	SAND (SP), light grey-brown	16/05/2005	Moderate	Strong	9.2	7.0
1202	BH01 9.00 61717	SAND (SP), light grey-brown	16/05/2005	Moderate	Strong	9.2	6.8
1203	BH01 10.00 61718	SAND (SP), fine to medium grained, light grey-brown, very moist.	16/05/2005	Moderate	Moderate	9.0	7.0
1204	BH01 11.00 61719	SAND (SP), grey	16/05/2005	Moderate	Strong	8.9	6.9
1205	BH01 12.00 61720	SAND (SP), light grey-brown	16/05/2005	Moderate	Moderate	8.9	7.0
1206	BH01 13.00 61721	SAND (SP), fine to medium grained, light grey-brown, moist.	16/05/2005	Slight	Moderate	9.0	7.1
1207	BH01 14.00 61722	SAND (SP), light grey-brown	16/05/2005	Slight	Moderate	9.0	6.9
1208	BH01 15.00 61723	SAND (SP), light grey-brown	16/05/2005	Slight	Moderate	8.9	6.6
1209	BH01 16.00 61724	SAND (SP), fine to medium grained, light grey-brown, moist.	16/05/2005	Slight	Moderate	9.0	6.8
1210	BH01 17.00 61725	SAND (SP), light grey-brown	16/05/2005	Slight	Strong	9.2	6.7
1211	BH01 18.00 61726	SAND (SP), light grey-brown	16/05/2005	Slight	Moderate	9.0	7.0
1212	BH01 19.00 61727	SAND (SP), grey	16/05/2005	Slight	Strong	9.0	7.0
1213	BH01 20.00 61728	SAND (SP), fine to medium grained, light grey-brown, moist.	16/05/2005	Slight	Strong	8.8	7.2
1214	BH02 0.50 61878	SAND (SP), fine grained, grey & light brown, moist.	17/05/2005	Moderate	Nil	5.2	3.7
1215	BH02 1.00 61729	SAND (SP), fine grained, light grey-brown, very moist.	17/05/2005	Slight	Nil	6.0	4.3
1216	BH02 1.50 61879	SAND (SP), fine to medium grained, grey, very moist.	17/05/2005	Strong	Nil	5.4	2.0
1217	BH02 2.00 61730	SAND (SP), fine to medium grained, grey, very moist.	17/05/2005	Strong	Nil	6.0	2.1
1218	BH02 2.50 61880	SAND (SP), fine to medium grained, grey, very moist.	17/05/2005	Strong	Nil	5.6	2.1
1219	BH02 3.00 61731	SAND (SP), fine to medium grained, grey, very moist.	17/05/2005	Strong	Nil	6.1	2.2
1220	BH02 4.00 61732	SAND (SP), fine to medium grained, grey, very moist.	17/05/2005	Strong	Nil	7.8	3.0
1221	BH02 5.00 61733	SAND (SP), fine to medium grained, grey, very moist.	17/05/2005	Moderate	Slight	8.0	5.7
1222	BH02 6.00 61734	SAND (SP), fine to medium grained, light grey-brown, moist.	17/05/2005	Moderate	Slight	8.9	5.7



Unit B / 33 Machinery Drive
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Certificate of Test Results

Ref. No. HMC1228

Issued: 10/11/05, 2:23 PM

Project: Border Tech Job No BT14650, for HMC Environmental Consulting

Ref. No.	I.D.	Soil Type (truncated description)	Date Sampled	Reaction to Peroxide	Reaction to HCl	pH _F 1:5 suspension in 1 molar NaCl	pH _{FOX} 1:5 suspension in 1 molar NaCl
1223	BH02 7.00 61735	SAND (SP), fine to medium grained, light grey-brown, moist.	17/05/2005	Slight	Slight	8.9	6.5
1224	BH02 8.00 61736	SAND (SP), light grey-brown	17/05/2005	Slight	Slight	9.1	6.2
1225	BH02 9.00 61737	SAND (SP), light grey-brown	17/05/2005	Slight	Moderate	9.0	6.9
1226	BH02 10.00 61738	SAND (SP), fine to medium grained, light grey-brown, moist.	17/05/2005	Slight	Moderate	9.1	6.9
1227	BH02 11.00 61739	SAND (SP), light grey-brown	17/05/2005	Moderate	Moderate	9.0	6.9
1228	BH02 12.00 61740	SAND (SP), light grey-brown	17/05/2005	Slight	Slight	8.6	6.7
1229	BH02 13.00 61741	SAND (SP), fine grained, pale grey, occas. shell, moist.	17/05/2005	Slight	Moderate	9.0	6.8
1230	BH02 14.00 61742	SAND (SP), light grey-brown	17/05/2005	Slight	Moderate	8.8	6.3
1231	BH02 15.00 61743	SAND (SP), light grey-brown	17/05/2005	Slight	Moderate	8.9	6.8
1232	BH02 16.00 61744	SAND (SP), fine to coarse grained, grey & light grey-brown, moist.	17/05/2005	Moderate	Moderate	8.8	6.5
1233	BH02 17.00 61745	Silty SAND (SM), grey	17/05/2005	Moderate	Moderate	8.6	6.8
1234	BH02 18.00 61746	Clayey SAND (SC), fine grained, grey to dark grey, with silt, very moist.	17/05/2005	Strong	Moderate	8.7	6.9
1239	BH03 0.50 61881	SAND (SP), fine grained, brown, moist.	18/05/2005	Slight	Nil	6.1	4.4
1240	BH03 1.00 61749	Silty SAND (SM), fine grained, grey-brown, wet.	18/05/2005	Moderate	Nil	5.7	2.4
1241	BH03 1.50 61882	Silty SAND (SM), fine grained, dark grey-brown, wet.	18/05/2005	Strong	Nil	6.0	2.0
1242	BH03 2.00 61750	Silty SAND (SM), fine grained, dark grey-brown, wet.	18/05/2005	Strong	Nil	6.1	2.1
1243	BH03 2.50 61883	Silty SAND (SM), fine grained, dark grey-brown, wet.	18/05/2005	Strong	Nil	6.3	2.2
1244	BH03 3.00 61751	Silty SAND (SM), fine grained, dark grey-brown, wet.	18/05/2005	Strong	Nil	6.4	2.1
1245	BH03 4.00 61752	Silty SAND (SM), fine grained, dark grey-brown, wet.	18/05/2005	Strong	Nil	7.4	2.9
1246	BH03 5.00 61753	Silty SAND (SM), fine grained, dark grey-brown, wet.	18/05/2005	Strong	Nil	7.6	3.2
1247	BH03 6.00 61754	Silty SAND (SM), fine grained, dark grey-brown, wet.	18/05/2005	Strong	Nil	7.8	3.1
1248	BH03 7.00 61755	SAND (SP), fine to medium grained, pale grey, moist.	18/05/2005	Slight	Slight	8.9	6.6
1249	BH03 8.00 61756	SAND (SP), pale grey	18/05/2005	Slight	Moderate	9.0	6.8
1250	BH03 9.00 61757	SAND (SP), pale grey	18/05/2005	Slight	Moderate	9.0	6.6
1251	BH03 10.00 61758	SAND (SP), fine to medium grained, pale grey, moist.	18/05/2005	Slight	Moderate	9.0	6.7
1282	BH03 13.00 61761	SAND (SP), grey	19/05/2005	Moderate	Strong	8.4	6.4
1283	BH03 16.00 61764	SAND (SP), grey mottled dark grey	19/05/2005	Moderate	Strong	8.8	7.0
1284	BH03 18.00 61766	Silty SAND (SM), fine to medium grained, dark brown, occas. shell, very moist.	19/05/2005	Moderate	Moderate	8.7	6.9
1285	BH04 0.50 61884	Clayey SAND (SC), brown	19/05/2005	Moderate	Moderate	5.2	4.0
1286	BH04 1.00 61769	Silty SAND (SM), dark grey	19/05/2005	Strong	Nil	5.5	2.2
1287	BH04 1.50 61885	Silty SAND (SM), fine to medium grained, dark grey, very moist.	19/05/2005	Strong	Nil	5.8	2.1
1288	BH04 2.00 61770	Silty SAND (SM), dark grey	19/05/2005	Strong	Nil	5.7	2.1
1289	BH04 2.50 61886	Silty SAND (SM), dark grey	19/05/2005	Strong	Nil	6.0	2.3



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Certificate of Test Results

Ref. No.: HMC1228

Issued: 10/11/05, 2:23 PM

Project: Border Tech Job No BT14650, for HMC Environmental Consulting

Ref. No.	I.D.	Soil Type (truncated description)	Date Sampled	Reaction to Peroxide	Reaction to HCl	pH _F 1:5 suspension in 1 molar NaCl	pH _{FOX} 1:5 suspension in 1 molar NaCl
1290	BH04 3.00 61771	Silty SAND (SM), dark grey	19/05/2005	Strong	Nil	7.9	2.6
1291	BH04 4.00 61772	Silty SAND (SM), dark grey	19/05/2005	Strong	Nil	7.6	2.7
1292	BH04 5.00 61773	Silty SAND (SM), fine to medium grained, dark grey, occas. shell, very moist.	19/05/2005	Strong	Nil	7.3	2.6
1293	BH04 6.00 61774	SAND (SP), fine to medium grained, light grey, moist.	19/05/2005	Moderate	Moderate	8.8	6.0
1294	BH04 7.00 61775	Silty SAND (SM), dark grey	19/05/2005	Moderate	Nil	8.0	3.5
1295	BH04 8.00 61776	SAND (SP), light grey	19/05/2005	Moderate	Strong	8.9	6.7
1296	BH04 9.00 61777	SAND (SP), light grey	19/05/2005	Moderate	Moderate	8.8	6.4
1297	BH04 10.00 61778	SAND (SP), light grey	19/05/2005	Moderate	Strong	8.9	6.7
1298	BH04 11.00 61779	SAND (SP), light grey	19/05/2005	Moderate	Strong	9.2	7.0
1299	BH04 12.00 61780	SAND (SP), light grey	19/05/2005	Moderate	Strong	9.0	7.0
1300	BH04 13.00 61781	SAND (SP), fine to medium grained, light grey, moist.	19/05/2005	Moderate	Strong	9.2	6.7
1301	BH04 14.00 61782	SAND (SP), light grey	19/05/2005	Moderate	Strong	8.2	6.5
1302	BH04 15.00 61783	SAND (SP), light grey	19/05/2005	Moderate	Strong	9.1	6.9
1303	BH04 16.00 61784	SAND (SP), light grey	19/05/2005	Nil	Strong	8.9	6.8
1304	BH04 17.00 61785	SAND (SP), fine to medium grained, light grey, moist.	19/05/2005	Nil	Strong	9.2	7.0
1305	BH04 18.00 61786	SAND (SP), light grey	19/05/2005	Nil	Strong	9.1	7.1
1306	BH04 19.00 61787	SAND (SP), light grey mottled brown	19/05/2005	Nil	Strong	9.3	7.2
1307	BH04 20.00 61788	Silty CLAY (Cl), medium plasticity, dark grey-brown, some organics, moist.	19/05/2005	Strong	Moderate	8.7	6.6
1517	BH05 0.50	SAND (SP), fine grained, grey- brown, moist.	-	Slight	Nil	5.2	4.3
1518	BH05 1.00	SAND (SP), grey	-	Strong	Nil	5.9	2.3
1519	BH05 1.50	SAND (SP), fine grained, grey, v/moist.	-	Strong	Nil	6.2	2.1
1520	BH05 2.00	SAND (SP), grey	-	Strong	Nil	6.2	2.3
1521	BH05 2.50	SAND (SP), fine grained, grey, v/moist.	-	Strong	Nil	6.3	2.3
1522	BH05 3.00	SAND (SP), grey	-	Strong	Nil	6.3	2.3
1523	BH05 4.00	SAND (SP), fine grained, grey, trace of shell, v/moist.	-	Strong	Nil	7.8	3.2
1524	BH05 5.00	SAND (SP), fine grained, grey, trace of shell, v/moist.	-	Moderate	Slight	8.5	6.1
1525	BH05 6.00	SAND (SP), grey	-	Moderate	Slight	8.2	5.8



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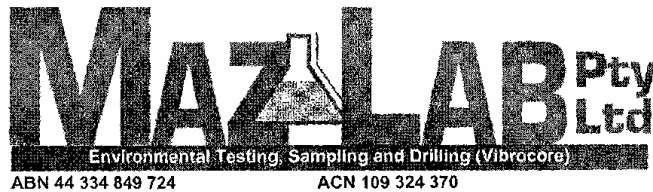
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Ref. No.: HMC1228

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Project: Border Tech Job No BT14650, for HMC Environmental Consulting

Ref. No.	I.D.	Soil Type (truncated description)	Date Sampled	Reaction to Peroxide	Reaction to HCl	pH 1:5 suspension in 1 molar NaCl	pH _{FOX} 1:5 suspension in 1 molar NaCl
1607	BH08 6.00	SAND (SP), fine grained, light grey, moist	-	Moderate	Slight	8.8	6.8
1608	BH08 9.00	SAND (SP), light grey	-	Slight	Slight	9.0	6.6
1609	BH08 12.00	SAND (SP), fine grained, light grey, moist	-	Slight	Slight	9.0	7.1
1610	BH08 15.00	SAND (SP), light grey	-	Slight	Slight	9.0	7.1
1611	BH08 18.00	SAND (SP), light grey	-	Slight	Slight	8.6	7.1
1612	BH08 20.00	SAND (SP), fine grained, brown, orange-brown, moist	-	Slight	Nil	7.0	5.9



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Project: Border Tech Job No BT14650, for HMC Environmental Consulting

Ref. No.	I.D.	Soil Type (truncated description)	Date Sampled	Reaction to Peroxide	Reaction to HCl	pHF 1:5 suspension in 1 molar NaCl	pHFox 1:5 suspension in 1 molar NaCl
1528	BH06 0.50 61890	SAND (SP), fine grained, grey-brown, moist.	-	Moderate	Slight	4.7	3.6
1528	BH06 0.50 61890	SAND (SP), fine grained, grey-brown, moist.	-	Moderate	Slight	4.7	3.6
1529	BH06 1.00 61809	SAND (SP), fine grained, grey, moist.	-	Strong	Nil	6.3	2.1
1529	BH06 1.00 61809	SAND (SP), fine grained, grey, moist.	-	Strong	Nil	6.3	2.1
1528	BH06 0.50 61890	SAND (SP), fine grained, grey-brown, moist.	-	Moderate	Slight	4.7	3.6
1528	BH06 0.50 61890	SAND (SP), fine grained, grey-brown, moist.	-	Moderate	Slight	4.7	3.6
1529	BH06 1.00 61809	SAND (SP), fine grained, grey, moist.	-	Strong	Nil	6.3	2.1
1529	BH06 1.00 61809	SAND (SP), fine grained, grey, moist.	-	Strong	Nil	6.3	2.1
1530	BH06 1.50 61891	SAND (SP), grey	-	Strong	Nil	5.8	2.1
1531	BH06 2.00 61810	SAND (SP), grey	-	Strong	Nil	7.0	2.1
1532	BH06 2.50 61892	SAND (SP), grey	-	Strong	Nil	6.7	2.1
1533	BH06 3.00 61811	SAND (SP), fine grained, grey, moist.	-	Strong	Nil	7.7	2.3
1534	BH06 4.00 61812	SAND (SP), grey	-	Strong	Slight	8.1	3.1
1535	BH06 5.00 61813	SAND (SP), grey	-	Strong	Slight	8.3	3.6
1536	BH06 6.00 61814	SAND (SP), fine grained, grey, trace of fine shell, moist.	-	Strong	Slight	7.9	3.1
1537	BH06 9.00 61817	SAND (SP), fine grained, light grey, trace of fine shell, moist.	-	Moderate	Moderate	8.9	6.8
1561	BH07 0.50	SAND (SP), fine to medium grained, grey, moist.	-	Strong	Nil	5.2	2.2
1562	BH07 1.00	SAND (SP), fine to medium grained, grey, moist.	-	Strong	Nil	5.4	2.2
1563	BH07 1.50	SAND (SP), grey-dark grey	-	Strong	Nil	5.7	2.3
1564	BH07 2.00	SAND (SP), grey	-	Strong	Nil	5.4	2.3
1565	BH07 2.50	SAND (SP), grey	-	Strong	Nil	5.3	2.3
1566	BH07 3.00	SAND (SP), fine grained, grey, moist.	-	Strong	Nil	5.3	2.3
1567	BH07 6.00	SAND (SP), fine to medium grained, light grey & trace orange brown, trace fine shell, moist.	-	Moderate	Slight	8.3	6.5
1568	BH07 9.00	Sandy GRAVEL (GP), light orange-brown	-	Strong	Nil	7.1	5.9
1569	BH07 12.00	CLAY (CH), light orange-brown & grey-brown	-	Moderate	Nil	6.5	5.7
1570	BH07 15.00	Silty CLAY (CI), medium plasticity, light grey & orange-brown mottled, with fine to medium sand, moist.	-	Slight	Nil	6.2	5.4
1601	BH08 0.50	SAND (SP), dark grey & light brown	-	Moderate	Nil	4.4	3.3
1602	BH08 1.00	SAND (SP), fine grained, grey-brown, moist.	-	Moderate	Nil	6.0	3.1
1603	BH08 1.50	SAND (SP), grey	-	Strong	Nil	6.4	2.1
1604	BH08 2.00	SAND (SP), grey	-	Strong	Nil	6.4	2.2
1605	BH08 2.50	SAND (SP), grey	-	Strong	Nil	6.5	2.3
1606	BH08 3.00	SAND (SP), fine grained, grey-brown, moist.	-	Strong	Nil	8.3	3.0

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Certificate of Test Results - Chromium Reducible Sulphur

Issued: 10/11/05, 3:04 PM

Job. No. : HMC1228 Project : Border Tech Job No BT14650, for HMC Environmental Consulting

Sam No.	Client I.D.	Date Sampled / Tested	Description	Reactions Peroxide Acid Shell Size	Density (t/m ³) M/C (%)	pH _{NaCl}	SCr (mol H+/t) (%S)	TAA (mol H+/t) %S	ANC (mol H+/t) %S	Liming Rate (Kg/dry t)
1191	BH01 0.50 61875	16/05/2005 20/05/2005	SAND (SP), fine grained, dark brown, moist.	Slight Nil	- 19.4	4.5	0 0.00	7 0.01		nil
1192	BH01 1.00 61709	16/05/2005 20/05/2005	SSAND (SP), fine to medium grained, grey-brown, moist.	Slight Nil	- 19.7	5.2	0 0.00	3 0.00		nil
1193	BH01 1.50 61876	16/05/2005 20/05/2005	SSAND (SP), fine to medium grained, grey-brown, moist.	Slight Nil	- 18.9	4.2	51 0.08	5 0.01		4.4
1194	BH01 2.00 61710	16/05/2005 20/05/2005	SAND (SP), fine to medium grained, grey, wet.	Strong Nil	- 28.0	5.5	107 0.17	0 0.00		8.3
1195	BH01 2.50 61877	16/05/2005 20/05/2005	SAND (SP), fine to medium grained, grey, moist.	Strong Nil	- 19.8	4.6	362 0.58	5 0.01		28.4
1196	BH01 3.00 61711	16/05/2005 20/05/2005	SAND (SP), fine to medium grained, grey, moist.	Strong Nil	- 24.0	5.4	84 0.13	3 0.01		6.7
1197	BH01 4.00 61712	16/05/2005 20/05/2005	SAND (SP), fine to medium grained, grey, moist.	Strong Slight	- 21.6	8.4	53 0.09	0 0.00	98 0.16	nil
1198	BH01 5.00 61713	16/05/2005 20/05/2005	SAND (SP), fine to medium grained, grey, moist.	Strong Slight	- 22.8	8.1	78 0.13	0 0.00	66 0.11	2.8
1199	BH01 6.00 61714	16/05/2005 20/05/2005	SAND (SP), fine to medium grained, light grey-brown, moist.	Moderate Slight	- 20.5	8.9	47 0.08	0 0.00	147 0.24	nil
1200	BH01 7.00 61715	16/05/2005 20/05/2005	SAND (SP), fine to medium grained, light grey-brown, moist.	Moderate Moderate	- 22.8	9.1	25 0.04	0 0.00	152 0.24	nil
1203	BH01 10.00 61718	16/05/2005 20/05/2005	SAND (SP), fine to medium grained, light grey-brown, very moist.	Moderate Moderate	- 32.1	8.6	125 0.20	0 0.00	263 0.42	nil
1206	BH01 13.00 61721	16/05/2005 20/05/2005	SAND (SP), fine to medium grained, light grey-brown, moist.	Slight Moderate	- 29.5	9.0	19 0.03	0 0.00	149 0.24	nil
1209	BH01 16.00 61724	16/05/2005 20/05/2005	SAND (SP), fine to medium grained, light grey-brown, moist.	Slight Moderate	- 25.2	8.1	8 0.01	0 0.00	149 0.24	nil
1213	BH01 20.00 61728	16/05/2005 20/05/2005	SAND (SP), fine to medium grained, light grey-brown, moist.	Slight Strong	- 30.4	8.6	25 0.04	0 0.00	260 0.42	nil
1214	BH02 0.50 61878	17/05/2005 20/05/2005	SAND (SP), fine grained, grey & light brown, moist.	Moderate Nil	- 20.3	5.1	2 0.00	9 0.01		nil
1215	BH02 1.00 61729	17/05/2005 22/05/2005	SAND (SP), fine grained, light grey-brown, very moist.	Slight Nil	- 22.1	5.6	0 0.00	0 0.00	6 0.01	nil
1216	BH02 1.50 61879	17/05/2005 22/05/2005	SAND (SP), fine to medium grained, grey, very moist.	Strong Nil	- 24.3	5.3	207 0.33	7 0.01		16.7

Test methods follow procedures described in ASS Laboratory Methods 1998 Vers 1.11
& Mazlab In-House Method 22 [After ASS Method 22]

Liming rate is calculated from SCr + TAA using a supplied combined safety and neutralising factor of 155.0% and composite action level of 18molH+/t TAA & 0.03% Scr. (Factor not applied to ANC values)

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Certificate of Test Results - Chromium Reducible Sulphur

Issued: 10/11/05, 3:04 PM

Job. No. : HMC1228 Project : Border Tech Job No BT14650, for HMC Environmental Consulting

Sam No.	Client I.D.	Date Sampled / Tested	Description	Reactions Peroxide Acid Shell Size	Density (t/m ³) M/C (%)	pH _{NaCl}	SCr (molH+/t) (%S)	TAA (mol H+/t) %S	ANC (mol H+/t) %S	Liming Rate (Kg/dry t)
1217	BH02 2.00 61730	17/05/2005 22/05/2005	SAND (SP), fine to medium grained, grey, very moist.	Strong Nil	- 25.5	5.4	119 0.19	5 0.01		9.7
1218	BH02 2.50 61880	17/05/2005 22/05/2005	SAND (SP), fine to medium grained, grey, very moist.	Strong Nil	- 24.6	5.7	112 0.18	0 0.00	11 0.02	8.1
1219	BH02 3.00 61731	17/05/2005 22/05/2005	SAND (SP), fine to medium grained, grey, very moist.	Strong Nil	- 24.6	6.0	123 0.20	0 0.00	47 0.07	7.2
1220	BH02 4.00 61732	17/05/2005 22/05/2005	SAND (SP), fine to medium grained, grey, very moist.	Strong Nil	- 23.0	8.3	92 0.15	0 0.00	87 0.14	2.8
1221	BH02 5.00 61733	17/05/2005 22/05/2005	SAND (SP), fine to medium grained, grey, very moist.	Moderate Slight	- 24.8	8.1	101 0.16	0 0.00	100 0.16	2.9
1222	BH02 6.00 61734	17/05/2005 22/05/2005	SAND (SP), fine to medium grained, light grey-brown, moist.	Moderate Slight	- 18.3	8.8	35 0.06	0 0.00	82 0.13	nil
1223	BH02 7.00 61735	17/05/2005 23/05/2005	SAND (SP), fine to medium grained, light grey-brown, moist.	Slight Slight	- 20.7	9.0	14 0.02	0 0.00	92 0.15	nil
1226	BH02 10.00 61738	17/05/2005 23/05/2005	SAND (SP), fine to medium grained, light grey-brown, moist.	Slight Moderate	- 23.9	9.1	15 0.02	0 0.00	150 0.24	nil
1229	BH02 13.00 61741	17/05/2005 23/05/2005	SAND (SP), fine grained, pale grey, occas. shell, moist.	Slight Moderate	- 24.0	8.0	24 0.04	0 0.00	150 0.24	nil
1232	BH02 16.00 61744	17/05/2005 23/05/2005	SAND (SP), fine to coarse grained, grey & light grey-brown, moist.	Moderate Moderate	- 28.1	8.4	97 0.16	0 0.00	152 0.24	nil
1234	BH02 18.00 61746	17/05/2005 23/05/2005	Clayey SAND (SC), fine grained, grey to dark grey, with silt, very moist.	Strong Moderate	- 32.5	8.6	178 0.29	0 0.00	376 0.60	nil
1239	BH03 0.50 61881	18/05/2005 23/05/2005	SAND (SP), fine grained, brown, moist.	Slight Nil	- 16.2	6.2	2 0.00	0 0.00	10 0.02	nil
1240	BH03 1.00 61749	18/05/2005 23/05/2005	Silty SAND (SM), fine grained, grey-brown, wet.	Moderate Nil	- 25.5	5.2	1 0.00	4 0.01		nil
1241	BH03 1.50 61882	18/05/2005 23/05/2005	Silty SAND (SM), fine grained, dark grey-brown, wet.	Strong Nil	- 27.6	5.9	160 0.26	0 0.00	14 0.02	11.7
1242	BH03 2.00 61750	18/05/2005 24/05/2005	Silty SAND (SM), fine grained, dark grey-brown, wet.	Strong Nil	- 27.0	6.1	128 0.21	0 0.00	25 0.04	8.7
1243	BH03 2.50 61883	18/05/2005 24/05/2005	Silty SAND (SM), fine grained, dark grey-brown, wet.	Strong Nil	- 30.3	6.1	136 0.22	0 0.00	23 0.04	9.4
1244	BH03 3.00 61751	18/05/2005 24/05/2005	Silty SAND (SM), fine grained, dark grey-brown, wet.	Strong Nil	- 30.5	6.2	140 0.22	0 0.00	25 0.04	9.6

Test methods follow procedures described in ASS Laboratory Methods 1998 Vers 1.11
& Mazlab In-House Method 22 [After ASS Method 22]

Liming rate is calculated from SCr + TAA using a supplied combined safety and neutralising factor of 155.0% and composite action level of 18molH+/t TAA & 0.03% Scr. (Factor not applied to ANC values)

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Job. No. : HMC1228 Project : Border Tech Job No BT14650, for HMC Environmental Consulting

Sam No.	Client I.D.	Date Sampled / Tested	Description	Reactions Peroxide Acid Shell Size	Density (t/m3) M/C (%)	pH _{NaCl}	SCr (mol H+/t) (%S)	TAA (mol H+/t) %S	ANC (mol H+/t) %S	Liming Rate (Kg/dry t)
1245	BH03 4.00 61752	18/05/2005 24/05/2005	Silty SAND (SM), fine grained, dark grey-brown, wet.	Strong Nil	- 29.7	7.7	95 0.15	0 0.00	73 0.12	3.8
1246	BH03 5.00 61753	18/05/2005 24/05/2005	Silty SAND (SM), fine grained, dark grey-brown, wet.	Strong Nil	- 27.5	8.0	104 0.17	0 0.00	100 0.16	3.1
1247	BH03 6.00 61754	18/05/2005 24/05/2005	Silty SAND (SM), fine grained, dark grey-brown, wet.	Strong Nil	- 23.3	8.2	71 0.11	0 0.00	98 0.16	nil
1248	BH03 7.00 61755	18/05/2005 24/05/2005	SAND (SP), fine to medium grained, pale grey, moist.	Slight Slight	- 23.1	8.8	10 0.02	0 0.00	132 0.21	nil
1251	BH03 10.00 61758	18/05/2005 24/05/2005	SAND (SP), fine to medium grained, pale grey, moist.	Slight Moderate	- 23.8	8.6	15 0.02	0 0.00	99 0.16	nil
1284	BH03 18.00 61766	19/05/2005 26/05/2005	Silty SAND (SM), fine to medium grained, dark brown, occas. shell, very moist.	Moderate Moderate	- 23.5	8.6	82 0.13	0 0.00	195 0.31	nil
1292	BH04 5.00 61773	19/05/2005 26/05/2005	Silty SAND (SM), fine to medium grained, dark grey, occas. shell, very moist.	Strong Nil	- 27.4	8.0	117 0.19	0 0.00	127 0.20	2.8
1293	BH04 6.00 61774	19/05/2005 26/05/2005	SAND (SP), fine to medium grained, light grey, moist.	Moderate Moderate	- 20.1	8.4	28 0.05	0 0.00	116 0.19	nil
1304	BH04 17.00 61785	19/05/2005 26/05/2005	SAND (SP), fine to medium grained, light grey, moist.	Nil Strong	- 24.2	9.1	36 0.06	0 0.00	224 0.36	nil
1307	BH04 20.00 61788	19/05/2005 26/05/2005	Silty CLAY (Cl), medium plasticity, dark grey-brown, some organics, moist.	Strong Moderate	- 54.8	8.8	666 1.07	0 0.00	1449 2.32	nil
1517	BH05 0.50	- 7/06/2005	SAND (SP), fine grained, grey-brown, moist.	Slight Nil	- 13.7	4.8	0 0.00	2 0.00		nil
1519	BH05 1.50	- 7/06/2005	SAND (SP), fine grained, grey, v/moist.	Strong Nil	- 24.8	5.8	176 0.28	0 0.00	16 0.03	12.8
1521	BH05 2.50	- 7/06/2005	SAND (SP), fine grained, grey, v/moist.	Strong Nil	- 24.1	6.0	101 0.16	0 0.00	26 0.04	6.5
1523	BH05 4.00	- 7/06/2005	SAND (SP), fine grained, grey, trace of shell, v/moist.	Strong Nil	- 25.6	7.7	88 0.14	0 0.00	73 0.12	3.2
1524	BH05 5.00	- 7/06/2005	SAND (SP), fine grained, grey, trace of shell, v/moist.	Moderate Slight	- 24.5	8.3	40 0.06	0 0.00	129 0.21	nil

Test methods follow procedures described in ASS Laboratory Methods 1998 Vers 1.11
& Mazlab In-House Method 22 [After ASS Method 22]

Liming rate is calculated from SCr + TAA using a supplied combined safety and neutralising factor of 155.0% and composite action level of 18molH+/t TAA & 0.03% Scr. (Factor not applied to ANC values)

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Certificate of Test Results - Chromium Reducible Sulphur

Issued: 10/11/05, 3:06 PM

Job. No. : HMC1228 Project : Border Tech Job No BT14650, for HMC Environmental Consulting

Sam No.	Client I.D.	Date Sampled / Tested	Description	Reactions Peroxide Acid Shell Size	Density (t/m ³) M/C (%)	pH _{NaCl}	SCr (mol H+/t) (%S)	TAA (mol H+/t) %S	ANC (mol H+/t) %S	Liming Rate (Kg/dry t)
1528	BH06 0.50 61890	- 10/06/2005	SAND (SP), fine grained, grey-brown, moist.	Moderate Slight	- 20.8	4.9	0 0.00	3 0.00		nil
1528	BH06 0.50 61890	- 10/06/2005	SAND (SP), fine grained, grey-brown, moist.	Moderate Slight	- 20.8	4.9	0 0.00	3 0.00		nil
1529	BH06 1.00 61809	- 10/06/2005	SAND (SP), fine grained, grey, moist.	Strong Nil	- 27.5	5.6	255 0.41	0 0.00	11 0.02	19.3
1529	BH06 1.00 61809	- 10/06/2005	SAND (SP), fine grained, grey, moist.	Strong Nil	- 27.5	5.6	255 0.41	0 0.00	11 0.02	19.3
1528	BH06 0.50 61890	- 10/06/2005	SAND (SP), fine grained, grey-brown, moist.	Moderate Slight	- 20.8	4.9	0 0.00	3 0.00		nil
1528	BH06 0.50 61890	- 10/06/2005	SAND (SP), fine grained, grey-brown, moist.	Moderate Slight	- 20.8	4.9	0 0.00	3 0.00		nil
1529	BH06 1.00 61809	- 10/06/2005	SAND (SP), fine grained, grey, moist.	Strong Nil	- 27.5	5.6	255 0.41	0 0.00	11 0.02	19.3
1529	BH06 1.00 61809	- 10/06/2005	SAND (SP), fine grained, grey, moist.	Strong Nil	- 27.5	5.6	255 0.41	0 0.00	11 0.02	19.3
1536	BH06 6.00 61814	- 10/06/2005	SAND (SP), fine grained, grey, trace of fine shell, moist.	Strong Slight	- 28.9	8.3	120 0.19	0 0.00	101 0.16	4.2
1537	BH06 9.00 61817	- 10/06/2005	SAND (SP), fine grained, light grey, trace of fine shell, moist.	Moderate Moderate	- 22.5	8.7	29 0.05	0 0.00	125 0.20	nil
1561	BH07 0.50	- 10/06/2005	SAND (SP), fine to medium grained, grey, moist.	Strong Nil	- 23.6	5.4	195 0.31	0 0.00		15.2
1562	BH07 1.00	- 10/06/2005	SAND (SP), fine to medium grained, grey, moist.	Strong Nil	- 23.4	5.5	158 0.25	0 0.00		12.2
1567	BH07 6.00	- 10/06/2005	SAND (SP), fine to medium grained, light grey & trace orange brown, trace fine shell, moist.	Moderate Slight	- 24.6	8.6	23 0.04	0 0.00	101 0.16	nil
1570	BH07 15.00	- 10/06/2005	Silty CLAY (Cl), medium plasticity, light grey & orange-brown mottled, with fine to medium sand, moist.	Slight Nil	- 20.5	6.5	0 0.00	0 0.00	10 0.02	nil
1602	BH08 1.00	- 22/06/2005	SAND (SP), fine grained, grey-brown, moist.	Moderate Nil	- 21.1	5.8	6 0.01	0 0.00	7 0.01	nil
1606	BH08 3.00	- 22/06/2005	SAND (SP), fine grained, grey-brown, moist.	Strong Nil	- 22.6	8.3	76 0.12	0 0.00	55 0.09	3.2
1607	BH08 6.00	- 22/06/2005	SAND (SP), fine grained, light grey, moist.	Moderate Slight	- 26.0	8.8	38 0.06	0 0.00	177 0.28	nil

Test methods follow procedures described in ASS Laboratory Methods 1998 Vers 1.11
& Mazlab In-House Method 22 [After ASS Method 22]

Liming rate is calculated from SCr + TAA using a supplied combined safety and neutralising factor of 155.0% and composite action level of 18molH+/t TAA & 0.03% Scr. (Factor not applied to ANC values)

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Job. No. : HMC1228 Project : Border Tech Job No BT14650, for HMC Environmental Consulting

Sam No.	Client I.D.	Date Sampled /Tested	Description	Reactions Peroxide Acid Shell Size	Density (t/m3) M/C (%)	pH _{NaCl}	SCr (molH+/t) (%S)	TAA (mol H+/t) %S	ANC (mol H+/t) %S	Liming Rate (Kg/dry t)
1609	BH08 12.00	- 22/06/2005	SAND (SP), fine grained, light grey, moist.	Slight Slight	- 20.1	9.0	17 0.03	0 0.00	157 0.25	nil
1612	BH08 20.00	- 22/06/2005	SAND (SP), fine grained, brown, orange-brown, moist.	Slight Nil	- 21.8	6.8	5 0.01	0 0.00	60 0.10	nil

Test methods follow procedures described in ASS Laboratory Methods 1998 Vers 1.11
& Mazlab In-House Method 22 [After ASS Method 22]
Liming rate is calculated from SCr + TAA using a supplied combined safety and neutralising factor of 155.0% and composite action level of 18molH+/t TAA & 0.03% Scr. (Factor not applied to ANC values)



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Certificate of Test Results - Chromium Reducible Sulphur

Ref. No. : HMC1386 Project : Crescent st & Tweed coast Rd, Cudgen for HMC Environmental Consulting

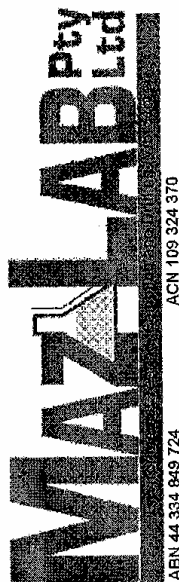
Ref. No.	I.D.	Date Sampled / Tested	Description	Reactions Peroxide Acid Shelf Size	Density (Vn3) M/C (%)	pH _{HCl}	SCr (mol H+/t) (%S)	TAA (mol H+/t) %S	ANC SNAS (mol H+/t)	Liming Rate (Kg/dry t)
6378	BH09 1.00	8/09/2006 13/09/2006	SAND (SP), grey, v/moist.	Strong Nil	- 26.5	4.7	70 0.11	12 0.02	-	6.4
6382	BH09 3.00	8/09/2006 13/09/2006	SAND (SP), grey, v/moist.	Strong Nil	- 22.4	5.0	94 0.15	7 0.01	-	7.9
6386	BH09 5.00	8/09/2006 13/09/2006	SAND (SP), light grey, v/moist.	Slight Strong	- 23.5	9.2	18 0.03	0 0.00	40	nil
6391	BH10 1.50	8/09/2006 13/09/2006	SAND (SP), light brown, v/moist.	Strong Nil	- 23.9	4.9	105 0.17	7 0.01	-	8.7
6394	BH10 3.00	8/09/2006 13/09/2006	SAND (SP), grey, v/moist.	Strong Nil	- 23.7	4.7	40 0.06	10 0.02	-	3.8
6397	BH10 4.50	8/09/2006 13/09/2006	SAND (SP), grey, v/moist.	Strong Nil	- 23.7	5.1	37 0.06	5 0.01	-	3.2
6399	BH10 5.50	8/09/2006 13/09/2006	SAND (SP), light grey, v/moist.	Slight Strong	- 23.2	9.9	27 0.04	0 0.00	148	nil

Test method follows procedures described in Acid Sulfate Soils Laboratory Methods Guidelines - Version 2.1

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Certificate of Pocas Test Results

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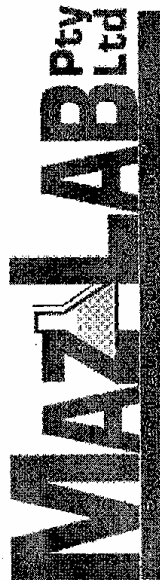
Ref. No.: HMC1228 Project: Border Tech Job No BT14650, for HMC Environmental Consulting

Ref. No.	I.D.	Date Sampled / Tested	Description	Reactions to Peroxide & Acid	Exclud. Gravel Shell	Density (t/m ³) M/C (%)	Limiting Rate Using TPA	Limiting Rate Using TAA + Spos	pH _{Ca} pH _{ox}	TAA TPA (mol H+/t)	SKCL SP (mol SO ₄ /t)	Spos (%)
1533	BH08 3.00 01811	14/08/2005	SAND (SP), fine grained, grey, moist.	Strong Nil	-	29.4	9.0	17.5	7.1 2.8	0 117	0 113	0.36
1566	BH07 3.00	14/08/2005	SAND (SP), fine grained, grey, moist.	Strong Nil	-	23.9	9.5	11.3	4.6 2.3	17 122	0 64	0.21

e Density value from moisture content, estimated saturation and assumed s.g. of 2.65
v Density value from measured volume.
r Density value from remoulded sample.
Test method follows procedures described in POCAS - Method 21, (Vers. 2.1, 6 Nov 97)
Peroxide Oxidation - Combined Acidity & Sulfate (POCAS) Method. [ASS Method 21]
Limiting rate is calculated using a supplied combined safety and neutralising factor of 165.0%
and combined action levels of 18molH+/t & 0.03% S. (safety factor not applied to negative TAA values)

POCAS Analysis Codes
pH_{Ca} 21A
pH_{ox} 21B
TAA 21F
TPA 21G
SKCL 21Ca
SP 21Da
Spos 21Ea

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Ref. No.: HMC1228 Project: Border Tech Job No BT14650, for HMC Environmental Consulting

Ref. No.	I.D.	Date Sampled / Tested	Description	Reactions to Peroxide & Acid	Exclud. Gravel Shell	Density (t/m3) M/C (%)	Limiting Rate (Kp/t) Using TPA	Limiting Rate (Kp/t) Using TAA + Spox	pH _{KCl} pH _{H₂O}	TAA TPA (mol H ⁺ /t)	SKCL SP (mol SO ₄ ²⁻ /t)	Spox (%)
1194	BH01 2.00 61710	18/05/2005 25/05/2005	SAND (SP), fine to medium grained, grey, wet.	Strong Nil	-	- 28.0	6.8 8.1	8.1	4.6 2.7	3 88	1 52	0.16
1203	BH01 10.00 61718	18/05/2005 25/05/2005	SAND (SP), fine to medium grained, light grey-brown, very moist.	Moderate	-	- 32.1	0.0 6.7	6.7	9.2 8.3	0 0	1 44	0.14
1217	BH02 2.00 61730	17/05/2005 25/05/2005	SAND (SP), fine to medium grained, grey, very moist.	Strong Nil	-	- 25.5	7.5 8.4	8.4	4.4 2.6	3 97	0 53	0.17
1229	BH02 13.00 61741	17/05/2005 25/05/2005	SAND (SP), fine grained, pale grey, occas. shell, moist.	Slight Moderate	-	- 24.0	0.0 0.0	0.0	9.4 8.0	0 0	0 2	0.01
1244	BH03 3.00 61751	18/05/2005 25/05/2005	Silty SAND (SM), fine grained, dark grey-brown, wet.	Strong Nil	-	- 30.5	7.2 9.3	9.3	4.9 2.7	1 93	1 50	0.19
1251	BH03 10.00 61753	18/05/2005 25/05/2005	SAND (SP), fine to medium grained, pale grey, moist.	Slight Moderate	-	- 23.3	0.0 0.0	0.0	9.4 7.7	0 0	0 8	0.02
1287	BH04 1.50 61855	19/05/2005 26/05/2005	Silty SAND (SM), fine to medium grained, dark grey, very moist.	Strong Nil	-	- 28.9	11.9 12.3	12.3	4.9 2.5	1 153	0 78	0.25
1300	BH04 13.00 61781	19/05/2005 26/05/2005	SAND (SP), fine to medium grained, light grey, moist.	Moderate Strong	-	- 24.6	0.0 2.3	2.3	9.7 9.3	0 0	2 17	0.05

^a Density value from moisture content, estimated
^b saturation and assumed s.g. of 2.65
^c v Peroxide Oxidation - Combined Acidity & Sulfate (POCAS) Method, [ASS Method 21]
^d Limiting rate is calculated using a supplied combined safety and neutralising factor of 155.0%
^e r Density value from remoulded sample, and combined action levels of 18molH⁺/t & 0.03% S (safety factor not applied to negative TAA values)

Test method follows procedures described in POCAS - Method 21, (Vers. 2.1, 6 Nov 97)
POCAS Analysis Codes
pH_{KCl} 21A TAA 21F SKCL 21Ca
pH_{H₂O} 21B TPA 21G SP 21Da
Spox 21Ea

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Appendix 8

DIPNR Response – Proposed ASS Sampling Survey Design

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Department of
Infrastructure, Planning and Natural Resources

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Mark Tunks
HMC Environmental
PO Box 243
Banora Point NSW 2486

Our ref:
Your ref:
File:

Tuesday, 8 November 2005

Dear Mark,

Subject: ASS Sampling Protocol Gales Projects Pty Ltd Properties, Cudgen

I have been asked to consider your letter of 7th October 2005, in which you make a submission to DNR that the ASS sampling protocol should be varied in the context of processing the EIS for proposed sand extraction operations at Cudgen.

The question is essentially whether there is adequate information already available to prepare a detailed ASS management plan for the proposed operation.

The grounds on which the case is based is that there has been a certain amount of sampling on the site to date, there has been considerable sampling of adjacent sites, and based on this available data, it can be concluded that the sand deposit is of relatively uniform character, and that it has a relatively low pyrite concentration.

It is acknowledged in the submission that the proposed sampling rate does not meet the guidelines as set out in the ASS Manual. It is then argued that additional data that would be required to meet the conditions in the ASS Manual would be onerous and would not in fact make any difference to the proposed management plan.

I agree that from an ASS management perspective, it is a reasonable argument that sufficient data exists to prepare a detailed ASS management plan. You will however need to justify the case in the EIS.

You will also be required to prepare a thorough ASS management plan documenting how pyritic materials will be processed to ensure that no environmental harm will occur. This will include methods of separating pyritic fines from the sands, internment of the fines, quality testing of the separated sands, thresholds and processes for re-treatment of the sands, routine surface and groundwater quality monitoring, water treatment procedures, triggers that indicate failure of the treatment process and closure of operations and contingency arrangements.

You have indicated that the money saved by not having to meet the ASS manual guidelines can be better spent on ASS management. I look forward to seeing that additional level of commitment in the management plan.

This submission has been considered on the merits of the case and should not be considered a precedent for limited sampling in the future.

Yours sincerely

Dept Natural Resources PO Box 149 West Kempsey NSW 2440

Glenn Atkinson
Senior Natural Resource Analyst -
Acid Sulfate Soils
Kempsey

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